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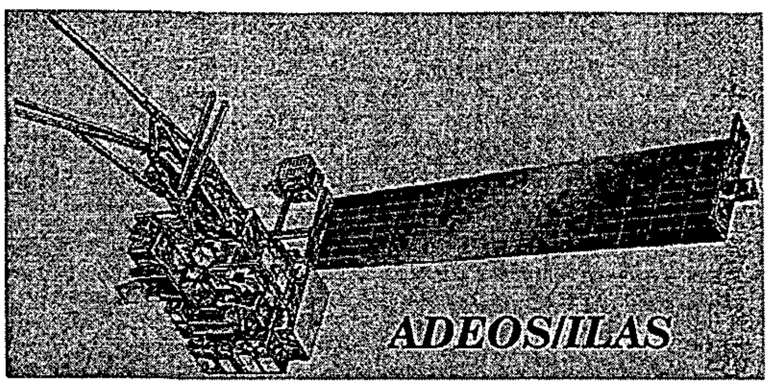
ILAS Correlative Measurements Plan



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NATIONAL INSTITUTE FOR ENVIRONMENTAL STUDIES

Foreword

This document defines the ILAS Correlative Measurements Plan. The term "Correlative Measurements" is adopted following the terminology of UARS (Upper Atmosphere Research Satellite) project. The purposes of the document are as follows:

(1) To assemble all the plans of measurement experiments to be conducted for ILAS validation in one volume to allow the ILAS project members to easily understand the outline of each measurement experiment, such as the team in charge, the time, place, equipment to be used, and brief descriptions

(2) To facilitate the implementation of measurement experiments as the ILAS Project

(3) To use it as the basic archive when conducting validation analyses for ILAS measurements

(4) To put ILAS Correlative Measurements on record to be referred to when the results of measurement experiments will be published and when the ILAS-II validation experiment plan will be drawn up in the future

I wish the document will be helpful for the above-mentioned purposes. Please note that this describes a plan at present: The plan is now evolving, and the result of implementation will not necessarily be the same as the plan.

The plan has been developed through the discussion in meetings of the ILAS Science Team led by Dr. Yasuhiro Sasano of National Institute for Environmental Studies and in meetings of the Committee on ILAS Validation Experiment Planning chaired by Prof. Yutaka Kondo of Nagoya University. Both activities have been supported by the Environment Agency. The effort of Mr. Tatsuro Nishimura of the Japan Weather Association in compiling the document was essential to completing it. Each plan of validation experiment in Appendix A was drafted by the Principal Investigator of each experiment.

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January 1997

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ABSTRACT

This document presents a plan for correlative measurements with the satellite sensor of ILAS (Improved Limb Atmospheric Spectrometer). It describes especially the concepts of correlative measurements and validation experiments for ILAS, and the present plan of the validation experiments. ILAS, a solar occultation sensor, is on board the ADEOS (Advanced Earth Observing Satellite) spacecraft, and is measuring vertical profiles of ozone and ozone-related species in the high-latitude stratosphere.

1. Introduction

ILAS (Improved Limb Atmospheric Spectrometer) is on board the ADEOS (Advanced Earth Observing Satellite) spacecraft of NASDA (National Space Development Agency of Japan) which was launched in 17 August 1996 with an expected mission lifetime of 3 years. Routine measurements by ILAS started in November 1996. Details of ILAS measurements are given in Section 2.

ILAS, which measures vertical profiles of ozone and ozone-related species in the high-latitude stratosphere, is an Announcement of Opportunity (AO) sensor provided by the Environment Agency of Japan (EA). [Note that an ozone sensor, TOMS (Total Ozone Mapping Spectrometer), is on board ADEOS also as an AO sensor provided by NASA.] The National Institute for Environmental Studies (NIES) of EA supports EA scientifically and is developing the ILAS Data Handling Facility (DHF). The ILAS project is thus promoted cooperatively by EA and NIES. In 1990, the ILAS project established the ILAS Science Team to promote ILAS science. Its members include scientists from Japan and several other countries.

The two main objectives of the ILAS mission are: (a) to monitor stratospheric ozone layer changes, and (b) to provide the scientific community with data for upper atmospheric chemistry and dynamics.

To attain these objectives, the quality of the satellite remote sensing data from ILAS should be evaluated. For the evaluation, validation experiments are planned for comparing their data with ILAS-derived data on ozone and other measured species and physical parameters. The objectives of validation experiments is to acquire an independent data set of sufficient size and quality to validate the accuracy of the ILAS measurements: The measurements by the validation experiments should overlap with the measurement by the ILAS in space and time as much as possible.

This document describes the plan of the ILAS correlative measurements including the ILAS validation experiments on the basis of each plan of the validation experiment drafted by the Principal Investigator of each experiment shown in Appendix A. The framework of the ILAS correlative measurements plan were described in Kanzawa et al. (1995).

2. ILAS Measurements for Validation Strategy

2.1 ILAS Measurements

Specifications of ILAS measurements for validation and data use are summarized in Table 2-1, and the estimated precision is given in Table 2-2. Specifications of the ILAS instrument itself are given, e.g., in Suzuki et al. (1995).

Table 2-1 *Specifications of ILAS measurements for validation*

Species and physical parameters:	O3, HNO3, NO2, N2O, H2O, CH4, CFC-11 (CFCl3), (possibly CFC-12 (CF2Cl2), N2O5), Aerosol, Temperature, Pressure
Satellite observation period:	1996 - (mission life: ~3 years)
Principle:	Solar occultation technique (infrared and visible spectroscopy)
Latitude coverage:	~58 - 73 degrees North; ~65 - 90 degrees South
Altitude range:	~10 - 60 km (depending on species and physical parameters)
Spatial resolution (one occultation):	~2 km in vertical; ~13 km* × ~300 km in horizontal (*~2 km for aerosol, temperature, pressure)
Longitudinal resolution:	~25 degrees (14 occultations per day both for an Arctic and Antarctic latitude circle)

Table 2-2 ILAS measurement precision: Preliminary estimates

Height (km)		10	20	30	40	50
O3	(%)	± 5	± 3	± 4	± 5	± 10
HNO3	(%)	± 10	± 3	± 15	ND	ND
NO2	(%)	ND	± 25	± 60	ND	ND
N2O	(%)	± 2	± 4	± 40	ND	ND
H2O	(%)	± 2	± 3	± 5	± 10	± 50
CH4	(%)	± 3	± 5	± 10	± 50	± 100
CFC-11	(%)	± 5	± 20	ND	ND	ND
CFC-12	(%)			under study		
N2O5	(%)			under study		
Aerosol	(%)			under study		
Temperature	(K)	± 1	± 1	± 1	± 1	± 3
Pressure	(%)	± 0.5	± 0.5	± 0.5	± 0.5	± 2

Note: "ND" means "Not Detectable".

2.2 Validation Experiment Strategy

The ILAS validation measurement is considered to be one of the ILAS correlative measurements.

2.2.1 Correlative Measurements for ILAS

Correlative Measurements for ILAS are divided into three categories as follows:
(1) Validation Measurements: To acquire an independent data set of sufficient size and quality to evaluate the accuracy of the ILAS measurements. The validation measurements should overlap with ILAS in space and time as much as possible.

(2) Complementary Measurements: To provide data on atmospheric species and physical parameters that are not measured by ILAS but will be complementary to scientific studies using the ILAS data. The complementary measurements will include those of halogen species that provide important information on chlorine chemistry and have an important link with the ILAS nitrogen chemistry measurements.

(3) Coordinated Measurements: To measure the ILAS-related species at the sites such as Spitzbergen that are not covered by ILAS. The coordinated measurements, together with the ILAS data, provide useful information on stratospheric processes in the polar regions such as heterogeneous processes, transport processes, etc.

UK Meteorological Office stratospheric analysis assimilation data (UKMO data) provided to the ILAS project are considered to be one of the correlative measurements.

2.2.2 Category of the Validation Measurements

The validation measurements are most important for the ILAS project. They are divided into three categories as follows:

(1) Core Experiments: Research observation experiments fully or partially funded by the ILAS project, i.e., by EA/NIES

(2) Cooperative Experiments: Research observation experiments not funded by the ILAS project but contributed by scientists/institutions on a data exchange basis

(3) Routine Measurements: Operational measurements routinely carried out by meteorological agencies associated with WMO (World Meteorological Organization) and others

2.2.3 Validation Experiment

The term "validation experiment" is applied to the first two categories, i.e., core experiments and cooperative experiments. The ILAS project established the ILAS Validation Experiment Team to promote and implement the validation experiments. Its members consist of Principal Investigators of the validation experiments. Data exchange policy for each category is codified in a "Memorandum of Understanding (MOU) for Participating in the ILAS Project". The MOU is signed by both the ILAS Project Leader and most of members of the Validation Experiment Team: The MOU is applied not only to the Validation Experiment Team members but also to other participants in the ILAS project as described in Section 3.1. Parts of the MOU are reproduced in some parts of this document, particularly in Chapter 7.

2.2.4 Validation analysis and data quality monitoring

Validation measurements can be performed with various instruments for various species and/or physical parameters at various sites. They do not generally cover comprehensively all the species and physical parameters measured by ILAS. The ILAS project established a scientist group responsible for validation analysis of ILAS data for each species or physical parameter measured by ILAS and for monitoring the data quality during the life of the ILAS mission. The chief of each group is a member of the ILAS Science Team.

3. Functional Organization and Investigator

A functional organization chart depicting the working relationships in the ILAS Validation Experiments Program is presented in this section. In addition, the principal investigator involved in making experiments for ILAS validation are identified.

3.1 Functional Organization

The Functional Organization for the ILAS Validation Experiments is illustrated in Fig. 3-1. Functional responsibilities of the blocks with regard to the ILAS Validation Experiments are as follows.

(1) ILAS PROJECT

Overall validation experiments planning. Funding management of all core validation experiments.

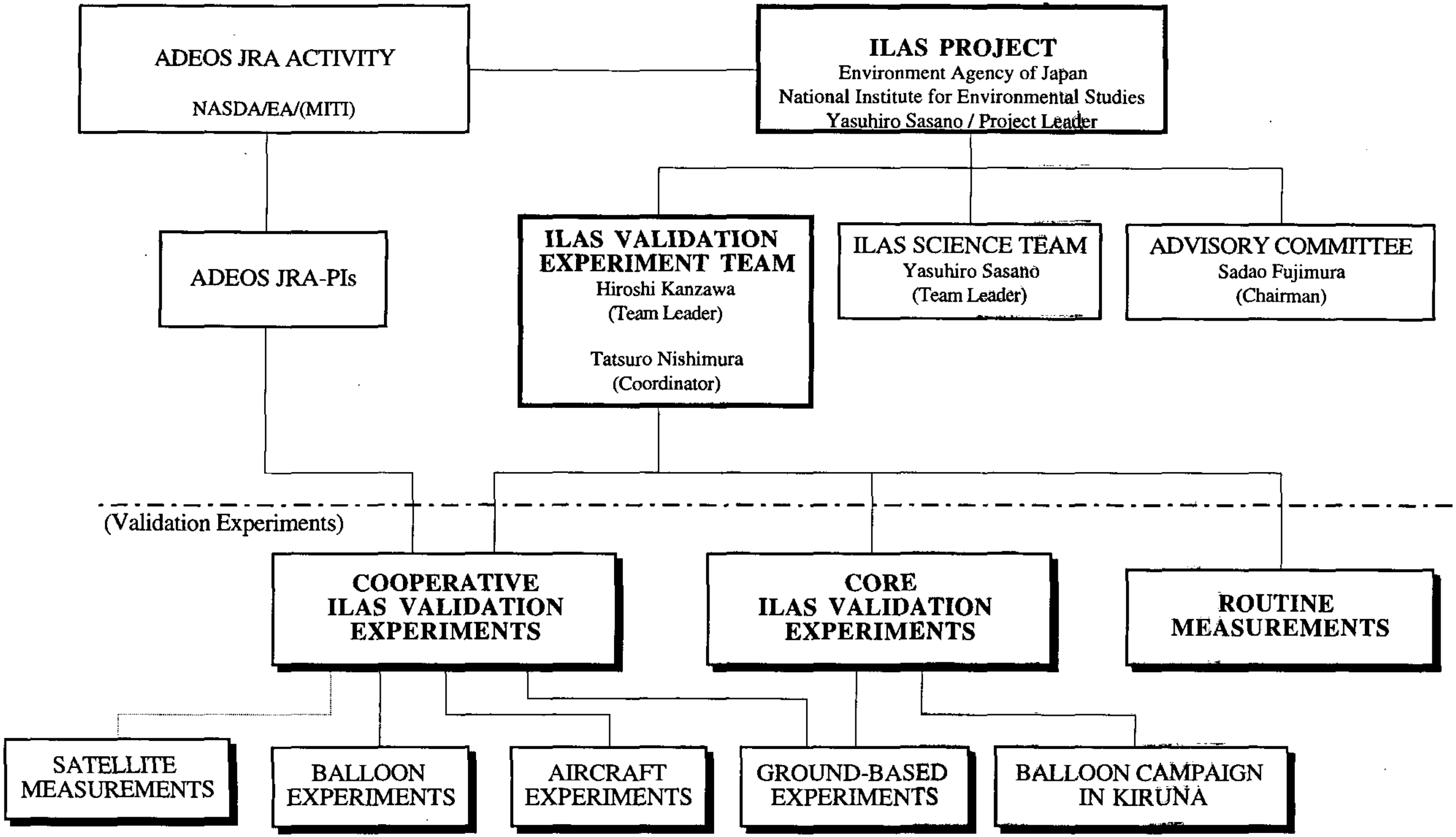

Fig. 3-1 Functional organnization for ILAS Validation Experiments

The Project Leader has all the responsibilities to promote the project in order to produce scientifically-valid ILAS data.

(2) ILAS VALIDATION EXPERIMENT TEAM

Overall management of the ILAS Validation Experiments implementation.

The Validation Experiment Team Leader, designated by the Project Leader, is responsible for coordinating activities to obtain data for validation. All Validation Experiment Team members are requested to submit experiment plans to the Validation Experiment Team Leader in advance: The experiment plans are shown in Appendix A.

The data obtained in the core experiments fully or partially funded by the project must be provided to the ILAS-CMDB (Correlative Measurement Data Base) according to the data protocol for ground/balloon/aircraft measurement data exchange (see Section 7 below). Participants in cooperative experiments are requested to submit their data to the ILAS Data Manager according to the data protocol for ground/balloon/aircraft measurement data exchange. It is highly recommended that they provide their data to the ILAS-CMDB.

(3) ILAS SCIENCE TEAM

Overall direction and management of ILAS science. Coordination of the integration of core validation experiments with ILAS science through the Science Team.

The ILAS Science Team Leader, designated by the Project Leader, has all the responsibilities to run the Science Team and to coordinate research activities by its members. All Science Team members who wish to use the information on ILAS, the ILAS data, and the ILAS-CMDB must submit research plans which meet the project goals to the Science Team Leader. By doing so, they can access all the information they need. They are also allowed to utilize the software and computer resources developed in the project.

(4) ADVISORY COMMITTEE

The ILAS Project Advisory Committee members, commissioned by the Project Leader, are requested to review and study important issues related to the project and report to the Project Leader. The ILAS Project Advisory Committee members who wish to use the information on ILAS, the ILAS data, and the ILAS-CMDB must submit research plans which meet the project goals to the Science Team Leader. By doing so, they can access all the information they need. They are also allowed to utilize the software and computer resources developed in the project.

(5) ADEOS JRA-PIs

The Joint Research Announcement (JRA) Activities concerning the ADEOS are conducted for peaceful purposes by NASDA, the Environment Agency (EA), and the Ministry of International Trade and Industry (MITI). JRA-PIs will carry out their research according to the Agreement between them and the corresponding data provision organizations.

ILAS data will be provided to the JRA-PIs according to a research plan submitted and agreed in advance. JRA-PIs participating in ILAS validation experiments are requested also to be members of the ILAS Validation Experiment Team. Those who have their own data relevant to sciences using ILAS data are highly requested to provide the data to ILAS-CMDB.

The researchers are requested to publish their scientific achievements in appropriate scientific journals.

In addition, the ILAS Project defines "ILAS Sensor Team" for convenience of communication. The ILAS Sensor Team includes all researchers in the categories from the above items (1) to (5). The purpose of the ILAS Sensor Team is to promote better communication among ILAS-related researchers and with other ADEOS researchers.

3.2 Principal Investigators of Core ILAS validation experiments

The principal investigators of Core ILAS validation experiments selected are listed below in the left-hand column of Table 3-1. The right-hand column is a list of the functional organization for ILAS which each of the PIs belongs to. The number of the PIs are 19; 5 from France, 5 from Germany, 5 from Japan, 2 from U.S.A., 1 from New Zealand, and 1 from Sweden. Note that the PIs of the ILAS validation experiments are automatically members of the ILAS Validation Experiment Team.

Table 3-1 Principal investigators of Core ILAS validation experiments: The number of the PIs are 19.

Principal Investigators and Affiliation	Functional Organization for ILAS
Colette Brogniez Universite des Sciences et Technologies de Lille; France	Validation Experiment Team
Claude Camy-Peyret Laboratoire de Physique Moleculaire	Validation Experiment Team/Science Team

et Applications, CNRS; France	
Terry Deshler University of Wyoming; U.S.A.	Validation Experiment Team
Andreas Engel Johann Wolfgang Gothe Universitaet Frankfurt; Germany	Validation Experiment Team/JRA-Co. PI with C. Schiller
Hiroshi Fukunishi Tohoku University; Japan	Validation Experiment Team
Yasunobu Iwasaka Nagoya University; Japan	Validation Experiment Team/ Advisory Committee
Hiroshi Kanzawa National Institute for Environmental Studies; Japan	Validation Experiment Team (Leader)/ Science Team
Yutaka Kondo Nagoya University, Japan	Validation Experiment Team/Science Team
W. Andrew Matthews NIWA-Climate Lauder; New Zealand	Validation Experiment Team/Science Team
Frank J. Murcray University of Denver; U.S.A.	Validation Experiment Team/JRA-PI
Takakiyo Nakazawa Tohoku University; Japan	Validation Experiment Team/ Advisory Committee
Hermann Oelhaf Forschungszentrum Karlsruhe; Germany	Validation Experiment Team
Joelle Ovarlez Laboratoire de Meteorologie Dynamique, CNRS; France	Validation Experiment Team
Michel Pirre Laboratoire de Physique et Chimie de l'Environnement, CNRS; France	Validation Experiment Team
Jean-Pierre Pommereau Service d'Aeronomie, CNRS; France	Validation Experiment Team
Cornelius Schiller Forschungszentrum Jüelich; Germany	Validation Experiment Team/JRA-PI
Ulrich Schmidt Johann Wolfgang Gothe Universitaet Frankfurt; Germany	Validation Experiment Team/JRA-Co. PI with C. Schiller
Ake Steen Swedish Institute of Space Physics; Sweden	Validation Experiment Team (Co. PI with Y. Kondo)
Peter Thomas Forschungszentrum Karlsruhe; Germany	Validation Experiment Team (Co. PI with Y. Kondo)

3.3 Principal Investigators of Cooperative ILAS validation experiments

The principal investigators of Cooperative ILAS validation experiments are listed below in the left-hand column of Table 3-2. The right-hand column is a list of the functional organization for ILAS which each of the PIs belongs to. The number of PIs are 26; 10 from U.S.A., 7 from Germany, 3 from Japan, 3 from France, 1 from U.K., 1 from Russia, and 1 from China. Note that the PIs of the ILAS validation experiments are automatically members of the ILAS Validation Experiment Team.

Table 3-2 Principal investigators of Cooperative ILAS validation experiments:
The number of PIs are 26.

Principal Investigators and Affiliation	Functional Organization for ILAS
Frank Arnold Max-Planck-Institut for Nuclear Physics; Germany	Validation Experiment Team (Co. PI with H. Schlager)
Terry Deshler University of Wyoming; U.S.A.	Validation Experiment Team
David Fahey National Oceanic and Atmospheric Administration; U.S.A.	Validation Experiment Team
Horst Fischer Max-Planck-Institut for Chemistry; Germany	Validation Experiment Team (Co. PI with H. Schlager)
K. H. Fricke University of Bonn; Germany	Validation Experiment Team
Hiroshi Fukunishi Tohoku University; Japan	Validation Experiment Team
Hartwig Gernandt Alfred Wegener Institute for Polar and Marine Research; Germany	Validation Experiment Team/JRA-PI
Sophie Godin Service d'Aeronomie, CNRS; France	Validation Experiment Team
Florence Goutail Service d'Aeronomie, CNRS; France	Validation Experiment Team
Michael R. Gunson Jet Propulsion Laboratory; U.S.A.	Validation Experiment Team/JRA-PI
Neil R.P. Harris University of Cambridge; U.K.	Validation Experiment Team
Alain Hauchecorne Service d'Aeronomie, CNRS; France	Validation Experiment Team
Eric Hintsa Harvard University; U.S.A.	Validation Experiment Team

Yasunobu Iwasaka Nagoya University; Japan	Validation Experiment Team/ Advisory committee
Da-ren Lu Institute of Atmospheric Physics; China	Validation Experiment Team/JRA-PI
M. Patrick McCormick Hampton University; U.S.A.	Validation Experiment Team/Science Team
Frank J. Murcray University of Denver; U.S.A.	Validation Experiment Team/JRA-PI
Jae H. Park NASA HQ; U.S.A.	Validation Experiment Team/Science Team
Michael H. Proffitt National Oceanic and Atmospheric Administration; U.S.A.	Validation Experiment Team
Hans Schlager DLR; Germany	Validation Experiment Team
Marcus Serwazi GKSS, Forschungszentrum Geesthacht; Germany	Validation Experiment Team
Cornelius Schiller Forschungszentrum Jüelich; Germany	Validation Experiment Team (Co. PI with H. Schlager)
Kazuo Shibasaki Kokugakuin University; Japan	Validation Experiment Team
Geoffrey C. Toon Jet Propulsion Laboratory; U.S.A.	Validation Experiment Team/JRA-PI
Wesley A. Traub Harvard Smithsonian Center for Astrophysics; U.S.A.	Validation Experiment Team/JRA-PI
Vladimir V. Yushkov Central Aerological Observatory; Russia	Validation Experiment Team/JRA-PI

The same names as those of core experiments are seen because they will carry out several experiments some of which are core experiments while others are cooperative experiments. Total number of PIs of both Core and Cooperative experiments are 40 if the overlap is not counted; 11 from Germany, 10 from U.S.A., 8 from France, 6 from Japan, 1 from New Zealand, 1 from Sweden, 1 from U.K., 1 from Russia, and 1 from China.

4. Experiments

Most of the experiments can be categorized into two in view of the obtained data as follows.

(1) Vertical profile measurements: The balloon campaigns at Kiruna-Esrange (68N, 21E) will provide vertical profiles of all of the species and physical parameters measured by ILAS. Details are given in Section 4.1 and 4.4. Some balloon experiments with cryogenic samplers will be made at Syowa (69S, 40E), and some ozonesonde and aerosol sonde measurements will be made at several sites. Lidar measurements at several sites will provide vertical profiles of ozone, aerosols, temperature, and water vapor.

(2) Column amount measurements: Ground-based measurements using instruments such as FTS's (Fourier Transform Infrared Spectrometers), UV-visible spectrometers, laser heterodyne spectrometers, Dobson spectrometers, etc., will be made. Most of the instruments measure only column amounts or vertical profiles with coarse resolution. However, they will cover many sites in space and a long time span.

Other experiments include some aircraft measurement campaigns and some satellite measurements. More international cooperation is now being pursued.

In addition to the validation experiment data, routine measurement data will be collected for temperature, pressure, and ozone from WMO and/or WMO-associated meteorological agencies.

4.1 Core Validation Experiments

The various core experiments for ILAS validation are given in Table 4-1 and 4-2. Table 4-1 shows all experiments of the ILAS Validation Balloon Campaign in Kiruna-Esrange (68N), Sweden in February - March 1997 with a list of Principal Investigators (PIs) of gondola, name of instruments, PIs of the instruments, and target species and physical parameters for ILAS validation. Nine investigators were selected as PIs of gondola of large balloons, and two investigators were selected as PIs of small balloon experiments: The total number of the instruments is seventeen. There is a possibility that some experiments by some investigators will participate additionally. The balloon campaign is considered to be the most extensive one among various validation experimental activities for ILAS, and will provide vertical profiles of all of the species and physical parameters measured by ILAS. Details are given in Section 4.4. Core experiments of ground-based measurements and small balloon measurements are shown

Table 4-1 **Core Experiments for ILAS Validation**

(ILAS Validation Balloon Campaign at Esrange, Kiruna (68N, 21E) in February-March 1997)

Gondola's P. I.	Name of Instrument	Instrument's P. I.	Target species and physical parameters for ILAS
Kondo, Y.	CLD	Kondo, Y.	profiles of NO (NO2), NOy (HNO3)
	ECC ozonesonde	Kondo, Y.	profiles of O3
	Aerosol counter	Deshler, T.	profiles of Aerosol
	CAESR (IR radiometer)	Murcray, F. J.	profiles of HNO3, O3, N2O, CH4, CFC-11, CFC-12, N2O5
	ASTRID (Grab sampler)	Schmidt and Engel	profiles of N2O, CFC-11, CFC-12
Camy-Peyret, C.	LPMA (FTS)	Camy-Peyret, C.	profiles of O3, CH4, N2O, NO2, HNO3, H2O, CFC-12, (N2O5)
	CAESR (IR radiometer)	Murcray, F.J.	profiles of HNO3, O3, N2O, CH4, CFC-11, CFC-12, N2O5
	DOAS (Dif. Opti. Absorp. Spectroscopy)	Pfeilsticker, K.	profiles of O3, NO2
Nakazawa, T.	SAKURA (Cryogenic sampler)	Nakazawa, T.	profiles of N2O, CH4, CFC-11
Pommereau, J.-P.	SAOZ (UV-visible solar occultation)	Pommereau, J.-P.	profiles of O3, NO2, Aerosol, PSC
	DESCARTES*	Harris, N.R.P.	profiles of CFC-11
Ovarlez, J.	ELHYSA (Hygrometer, Aerosol counter)	Ovarlez, J.	profiles of H2O, Aerosol
Brogniez, C	RADIBAL/BALLAD/BOCCAD	Brogniez, C.	profiles of Aerosol properties and size distribution, Ozone number density
Pirre, M	AMON (Star occultation)	Pirre, M.	profiles of O3, Aerosol, NO2
Schiller, C.	FISH (Hygrometer)	Schiller, C.	profiles of H2O
	BONBON (Cryogenic sampler)	Schmidt and Engel	profiles of N2O, CH4, CFC-11, CFC-12
	BROCOLI** (ClO/BrO monitor)	Stroh, F.	(profiles of ClO, BrO)
Oelhaf, H.	MIPAS-B (FTS)	Oelhaf, H.	profiles of O3, H2O, CH4, N2O, NO2, HNO3, CFC-11, CFC-12, N2O5
Deshler, T.	Frost point hygrometer (small balloon)	Deshler, T.	profiles of H2O
Kanzawa, H.	ECC ozonesonde (small balloon)	Kanzawa, H.	profiles of O3 (almost daily during the campaign)

(note) * : The measurements using the DESCARTES is carrying out as a cooperative experiment
** : Target species of BROCOLI is not made a measurements by ILAS

Table 4-2 **Core Experiments for ILAS Validation**

(Ground-based Measurements)

Experiment's P. I.	Location	Name of Instrument	Target species and physical parameters for ILAS
Kondo, Y.	Kiruna (68N, 21E)	FTS	profiles of CH4, N2O, O3 and total column of HNO3, NO2, CH4, N2O, O3, CFC-11
		UV-visible spectrometer	total column of NO2, O3
Fukunishi, H.	Fairbanks (65N, 148W)	TDLHS (Tunable Diode Laser Heterodyne Spectrometer)	profiles and total column of O3, CH4, N2O
Iwasaka, Y.	Fairbanks (65N, 148W)	Rayleigh/Mie lidar	profiles of aerosols and temperature
Matthews, W.A.	Macquarie Island (55S, 159E)	UV-visible spectrometer	total column of O3, NO2
Kondo, Y.	Syowa (69S, 40E)	UV-visible spectrometer	total column of O3, NO2
Matthews, W.A.	Arrival Heights (78S, 167E)	UV-visible spectrometer Dobson spectrophotometer FTS	total column of O3, NO2 total column of O3 total column of HNO3, CH4, N2O, CFC-12

(Small balloon Measurements)

Experiment's P. I.	Location	Name of Instrument	Target species and physical parameters for ILAS
Kanzawa, H	Syowa (69S, 40E)	Small balloon/Ozonesonde	profiles of O3

in Table 4-2. In the table, PIs' name, locations, name of instruments, and species and physical parameters measured for ILAS are listed. Four investigators are selected as PIs of ground-based measurements, and one is selected as PI of small balloon measurements. Locations of their measurements are Kiruna-Esrange (68N), Fairbanks (65N), Macquarie Island (55S), Syowa (69S), and Arrival Heights (78S). Instruments of ground-based measurements are FTS (Fourier Transform Infrared Spectrometer), UV-visible spectrometer, TDLHS (laser heterodyne spectrometer), Rayleigh/Mie lidar, and Dobson spectrophotometer. Column amounts are measured by FTS, UV-visible, and Dobson spectrophotometer. Vertical profiles will be measured by lidar, FTS, and laser heterodyne spectrometer. Ozonesonde measurements by small balloons will be made at Syowa (69S).

4.2 Cooperative Experiments

The various cooperative experiments for ILAS validation are presented in Tables 4-3, 4-4, and 4-5, respectively. All ground-based measurements of the cooperative experiments are listed in Table 4-3. Eleven investigators were organized as PIs of 17 experiments of the ground-based measurement. Twelve locations of their measurements are Scoresbysund (71N), ALOMAR (69N), Kiruna-Esrange (68N), Sodankyla (67N), Zhigansk (67N), Fairbanks (65N), Yakutsk (62N), Mirny (66S), Dumont d'Urville (67S), Zhongshan (69S), Syowa (69S), and Neumayer (71S). The instruments used are SAOZ (UV-visible spectrometer), Rayleigh/Mie/Raman lidar, TDLHS (laser heterodyne spectrometer), FTS, Brewer spectrophotometer, Photometer, Ozone lidar, Brewer and UV-spectrometer. SAOZ, Brewer spectrophotometer, and Brewer and UV-spectrometer will measure only column amounts of the corresponding species, and the various photometers will measure spectral aerosol column. Other instruments will provide vertical profiles of species and/or physical parameters. Table 4-4 shows the various balloon-borne measurements of the cooperative experiments. A balloon campaign by cooperation of NASDA with NASA will be made at Fairbanks (65N) in Alaska in April 1997. On the other hand, some balloon experiments with cryogenic samplers will be made at Syowa (69S), and some small balloon measurements, such as ozonesonde, aerosol sonde, radio sonde, etc., will be carried out at several sites. The aircraft measurements of the cooperative experiments are presented in Table 4-5. The measurements will be made at each Arctic region centered on Fairbanks (65N) in Alaska and Kiruna (68N) in Sweden. Around Fairbanks, the NASA ER-2 measurements will be carried out on summer 1997 as part of the Polar Ozone Loss in the Arctic Region in Summer (POLARIS) mission. Around Kiruna, the FALCON aircraft measurements of POLSTAR (Polar Stratospheric Aerosol Experiment) and

Table 4-3 **Cooperative Experiments for ILAS Validation**
(Ground-based Measurements)

Experiment's P. I.	Location	Name of Instrument	Target species and physical parameters for ILAS
Goutail, F.	Scoresbysund (71N, 27W)	SAOZ (UV-visible)	total column of O3, NO2
Hauchecorne, A.	ALOMAR (69N, 16E)	Rayleigh/Mie/Raman lidar	profiles of H2O, Aerosol, Temperature
Serwazi, M.	Kiruna-Esrange (68N, 21E)	Rayleigh/Mie/Raman lidar	profiles of O3, Aerosol, Temperature, H2O
Fricke, K.H.	Kiruna-Esrange (68N, 21E)	University of Bonn lidar	profiles of Aerosol
Goutail, F.	Sodankyla (67N, 26E)	SAOZ (UV-visible)	total column of O3, NO2
Goutail, F.	Zhigansk (67N, 127E)	SAOZ (UV-visible)	total column of O3, NO2
Fukunishi, H.	Fairbanks (65N, 148W)	TDLHS	profiles and total column of O3, CH4, N2O
Iwasaka, Y.	Fairbanks (65N, 148W)	Rayleigh/Mie lidar	profiles of Aerosols and Temperature
Murcray, F.J.	Fairbanks (65N, 148W)	FTS	profiles and column amounts of N2O, O3, CH4 column amounts of NO2, HNO3
Fukunishi, H.	Yakutsk (62N, 130E)	TDLHS	profiles and total column of O3, CH4, N2O
Yushkov, V.	Yakutsk (62N, 130E)	Brewer spectrophotometer	total column of O3
Gernandt, H.	Mirny (66S, 93E)	Photometer ABAS No. 06	total Aerosol column, (sun light measurements)
Goutail, F.	Dumont d'Urville (67S, 140E)	SAOZ (UV-visible)	total column of O3, NO2
Godin, S.	Dumont d'Urville (67S, 140E)	Ozone lidar Rayleigh/Mie lidar	profiles of O3 profiles of Aerosol
Lu, D.	Zhongshan (69S, 76E)	Brewer and UV-spectrometer	total column of O3
Gernandt, H.	Syowa (69S, 40E)	Photometer EKO 120 Photometer SP-1A No. 02	total Aerosol column (sun light measurements) total Aerosol column (sun and moon light measurements)
Gernandt, H.	Neumayer (71S, 08W)	Photometer SP-2H No. 02	total Aerosol column (sun and moon light measurements)

Table 4-4 **Cooperative Experiments for ILAS Validation**
(Balloon-borne Mesurements)

P. I.	Location	Name of Instrument	Instrument's P.I.	Target species and physical parameters for ILAS
Harris, N.R.P.	Andoya (69N, 16E)	DESCARTES	Harris, N.	profiles of CFC-11
Harris, N.R.P.	Kiruna-Esrange(68N, 21E)	DESCARTES	Harris, N.	profiles of CFC-11
Traub, W.A.	Fairbanks (65N, 148W)	SAO FIRS-2 Interferometer	Traub, W.A.	profiles of O3, N2O, HNO3, NO2, H2O, N2O5, Temperature, Pressure
		JPL Mk IV Interferometer	Toon, G.C.	profiles of O3, N2O, HNO3, NO2, CH4, H2O, N2O5, CFC-11, Temperature, Pressure
		JPL ozone photometer	Margitan, J.J.	profiles of O3
		JPL SLS spectrometer	Stachnik, R.A.	profiles of O3, N2O, HNO3
		DU CAESR spectrometer	Murcray, F.J.	profiles of O3, HNO3, CH4, Aerosol, CFC-11, N2O5, CFC-12, Temperature
		Aerosol sampler	Hayashi, M.	profiles of Aerosol
Shibasaki, K.	Fairbanks (65N, 148W)	ECC Ozonesonde	Shibasaki, K.	profiles of Ozone and Temperature
Yushkov, V.	Yakutsk (62N, 130E)	Ozonesonde Optical hygrometer Backscattersonde Radiosonde	Yushkov, V. Yushkov, V. Yushkov, V. Yushkov, V.	profiles of O3 profiles of H2O profiles of Aerosol profiles of Temperature, Pressure, Relative Humidity
Godin, S.	Dumont d'Urville (67S, 140E)	Ozonesonde	Godin, S.	profiles of O3
Nakazawa, T.	Syowa (69S, 40E)	FUBUKI (Cryogenic sampler)	Nakazawa, T.	profiles of N2O, CH4, CFC-11
Lu, D.	Zhongshan (69S, 76E)	Ozonesonde	Lu, D	profiles of O3
Gernandt, H	Neumayer (71S, 8W)	ECC ozonesonde Radiosonde	Gernandt, H. Gernandt, H.	profiles of O3 profiles of Temperature, Pressure, and Humidity
Deshler, T.	McMurdo (78S, 166E)	Aersol counter Ozonesonde	Deshler, T Deshler, T	profiles of Aerosol profiles of O3

Table 4-5 Cooperative Experiments for ILAS Validation

(Aircraft Measurements)

P. I.	Location	Name of Instrument	Instrument's P. I.	Target species and physical parameters for ILAS
Fahey, D.W.	Arctic region*	Chemiluminescence/ER-2**	Fahey, D.W.	profiles of NO2
Proffitt, M.H.	Arctic region*	UV ozone photometer/ER-2**	Proffitt, M.H.	profiles of O3
Hintsa, E.	Arctic region*	Lyman-alpha hygrometer/ER-2**	Hintsa, E.	profiles of H2O
Kuellmann, H.	Arctic region***	Sub-millimeter wave sensors/ FALCON****	Kuelmann, H.	profiles and column of O3, N2O, (HNO3, H2O)
Schlager, H.	Arctic region***	NOx-NOy-O3-Measuring System/ FALCON*****	Schlager, H.	O3, NO, NO2, NOy at altitudes of 10, 12, and 12.5 km
Schlager, H.	Arctic region***	HAAMAS (Mass Spectrometer)/ FALCON*****	Arnold, F.	HNO3 at altitudes of 10, 12, and 12.5 km
Schlager, H.	Arctic region***	TRISTAR (Infrared Absorption Spectroscopy)/FALCON*****	Fischer, H.	N2O at altitudes of 10, 12, and 12.5 km
Schlager, H.	Arctic region***	FISH (Lyman-alpha photofragment fluorescence)/FALCON*****	Schiller, C.	H2O at altitudes of 10, 12, and 12.5 km

(note) *: The Arctic region here is the circles centered on Fairbanks, Alaska (65N, 148W).
**: The NASA ER-2 aircraft measurements will be made in 1997 as part of the Polar Ozone Loss in the Arctic Region in Summer (POLARIS) mission.
***: The Arctic region here is the circles centered on Kiruna (68N, 21E) with a range of 2000 km and a flight altitude of 10-13 km.
****: The measurements using sub-millimeter wave sensor onboard the FALCON aircraft will be made in February 1997.
*****: The measurements using these instruments onboard the FALCON aircraft will be made as part of the POLSTAR campaign in February 1997.

(Satellite Measurements)

Experiment's P.I.	Name of Instrument	Target species and physical parameters for ILAS
McCormick, M. P.	SAGE-II (, possibly SAGE-III)	profiles of O3, NO2, H2O, Aerosol
Park, J. H.	HALOE	profiles of O3, NO2, CH4, H2O, Aerosol, Temperature

the other experiment will be made during the period of ILAS Validation Balloon Campaign in 1997.

Table 4-5 also lists the satellite measurements of the cooperative experiments. The instruments used are SAGE-II (and possibly SAGE-III) and HALOE. SAGE-II is on board ERBS. HALOE is carried by UARS. SAGE-II will give "validation" data of O3, NO2, H2O, and aerosol while HALOE will give the data of O3, NO2, CH4, H2O, and aerosol.

4.3 Routine Measurements

Meteorological data by routine measurement will be collected for temperature, pressure, and ozone from WMO and/or WMO-associated meteorological agencies. The number of stations for temperature and pressure is about 239 (224 for the Arctic and 15 for the Antarctic) while that for ozone is 23 (15 for the Arctic and 8 for the Antarctic).

4.4 ILAS Validation Balloon Campaign at Kiruna-Esrange

The balloon campaign for the ILAS validation will be carried out as one of the Core Experiments under cooperation between CNES (Centre National d'Etudes Spatiales) and EA (Environment Agency of Japan)/NIES (National Institute for Environmental Studies). The Agreement between CNES and EA on the ILAS Validation Balloon Campaigns was concluded and signed in October 1995.

The large balloon operation will be made by CNES while the small balloon operation will be made by Esrange. Stratospheric meteorological information briefing will be made by Free University of Berlin. The detailed implementation plan such as the number of balloon flights, flight order strategy, and the preparation status were discussed in the meeting at Paris, France in October 1996. The present plan involves 19 large balloon flights, 2 small balloon flights, and about 40-50 ozonesonde flights at Kiruna-Esrange (68N, 21E) in February - March 1997 as shown in Table 4-6. Performance of most of the instruments has been proven to be suitable for ILAS validation by the EASOE (European Arctic Stratospheric Ozone Experiment; 1991/1992) campaign (see, e.g., Geophys. Res. Lett., 1994), the SESAME (Second European Stratospheric Arctic and Mid-Latitude Experiment; 1994-1995) campaign, and other experiments. Temperature and pressure are measured in all of the flights as fundamental parameters. The balloon campaigns thus cover all of the species and physical parameters measured by ILAS. Note that ECC ozonesonde observation in accordance with the ILAS observation will be carried out almost every day during the campaign period of about 40 days as an experiment of the balloon campaign.

Table 4-6 **The Plan of Time Table for Balloon Flights in the ILAS Validation Balloon Campaign at Esrange, Kiruna in February-March 1997**

Name of Gondola (Name of P. I.)	1997, month 2 (days 1–28)	1997, month 3 (days 1–31)
Remarks		2–7 (Campaign Break)
Opening flight	1	
CLD/CAESR/Aerosol ASTRID/BONBON (Y. Kondo)	3 (400 MHz); 18 (400 MHz)	
LPMA/CAESR/ DOAS (C. Camy-Peyret)	3 (1.5 GHz); 18 (1.5 GHz)	10 (1.5 GHz)
SAKURA (T. Nakazawa)	21 (400 MHz)	10 (400 MHz)
SAOZ (J-P. Pommereau)	3 (400 MHz); 13 (400 MHz); 21 (400 MHz)	10 (400 MHz)
ELHYSA (J. Ovarlez)	3 (400 MHz); 24 (400 MHz)	
RADIBAL/BALLAD/ BOCCAD (C. Brogniez)	10 (400 MHz); 18 (400 MHz)	
AMON (M. Pirre)	26 (1.5 GHz)	
FISH/BONBON/ BROCOLI (C. Schiller)	3 (400 MHz)	
MIPAS-B (H. Oelhaf)	3 (1.5 GHz); 18 (1.5 GHz)	
Small balloon/ Hygrometer (T. Deshler)	11 (400 MHz); 21 (400 MHz)	
Small balloon/ ECC Ozonesonde (H. Kanzawa)	1–28	1–12
Weeks	(1) 3–10; (2) 10–17; (3) 17–24; (4) 24–3/3	(4) to 3; (5) 3–10; (6) 10–17; (7) 17–24
Total days	5, 10, 15, 20, 25	30, 35, 40, 45, 50, 55

The marks with "400 MHz" or "1.5 GHz" show the dates when the gondolas should be ready for flight.

The second campaign is envisaged at the same site, Kiruna-Esrange, in August - September 1998.

4.5 Experiments by Locations

The ILAS validation experiments are arranged in the latitudes of the experiment locations for the Arctic in Table 4-7 and for the Antarctic in Table 4-8. These tables show the names of the station, the method of the measurements, and the instruments used. The number of locations in the Arctic area is 7: Scoresbysund (71N), ALOMAR (69N), Kiruna (68N), Sodankyla (67N), Zhigansk (67N), Fairbanks (65N), Yakutsk (62N). The number in the Antarctic area is 8: Macquarie Island (55S), Mirny (66S), Dumont d'Urville (67S), Syowa (69S), Zhongshan (69S), Neumayer (71S), Arrival Heights (78S), McMurdo (78S). Total number of locations is thus 15.

4.6 Experiments for Each Species and Physical Parameters

The validation experiments are arranged for each species or physical parameter measured by ILAS in Table 4-9 (a) - (l). This table may be useful to carry out validation analyses. The order of Table 4-9 is O3 (a), HNO3 (b), NO2 (c), N2O (d), H2O (e), CH4 (f), CFC-11 (g), CFC-12 (h), N2O5 (i), Aerosol (j), Temperature (k), and Pressure (l).

4.7 Schedule of ILAS Validation Experiments

The schedules of all ILAS Validation Experiments are listed in Table 4-10 (a) - (b), which are based on each experiment plan of Principal Investigators as shown in Appendix A. The schedules of core validation experiments are shown in Table 4-10 (a), and those of cooperative validation experiments are shown in Table 4-10 (b). Each table shows the schedule for the period of 37 months from August 1996 to August 1999, because the mission life of ADEOS satellite is said to be 3 years.

Table 4-7. **Locations and Instruments of ILAS Validation Experiments in Arctic Region**

Name of Station	Location	Method	Name of Instrument
Scoresbysund, Greenland	(71N, 27W)	Ground based	SAOZ (UV-visible)
ALOMAR, Norway	(69N, 16E)	Ground based	Rayliegh/Mie/Raman lidar
Kiruna, Sweden	(68N, 21E)	**Balloon**	**CLD** (Chemiluminescence Detector)
		Balloon	**ECC ozonesonde**
		Balloon	**Aerosol counter**
		Balloon	**CAESR** (IR radiometer)
		Balloon	**ASTRID** (Grab sampler)
		Balloon	**BONBON** (Cryogenic sampler)
		Balloon	**SAKURA** (Cryogenic sampler)
		Balloon	**LPMA** (FTS)
		Balloon	**DOAS** (Optical absorption Spectroscopy)
		Balloon	**SAOZ** (UV-visible solar occultation)
		Balloon	**ELHYSA** (Hygrometer, Aerosol counter)
		Balloon	**RADIBAL/BALLAD/BOCCAD**
		Balloon	**AMON** (Star occultation)
		Balloon	**MIPAS-B** (FTS)
		Balloon	**FISH** (Hygrometer)
		Balloon	BROCOLI (ClO/BrO monitor)
		Balloon	DESCARTES (Grab sampler)
		Small balloon	**Frost point hygrometer**
		Small balloon	**ECC ozonesonde**
		Ground based	**FTS**
		Ground based	**UV-visible**
		Ground based	Rayleigh/Mie/Raman lidar
		Ground based	University of Bonn lidar
		Aircraft	Sub-millimeter wave sensors
		Aircraft	NOx/NOy/O3-Measuring System
		Aircraft	HAAMAS (Mass Spectrometer)
		Aircraft	TRISTAR (Infrared Absorption Spectroscopy)
		Aircraft	FISH (Lyman-alpha photofragment fluorescence)
Sodankyla, Finland	(67N, 26E)	Ground based	SAOZ (UV-visible)
Zhigansk, Russia	(67N, 127E)	Ground based	SAOZ (UV-visible)
Fairbanks, USA	(65N, 148W)	**Ground based**	**TDLHS** (Laser heterodyne spectrometer)
		Ground based	**Rayleigh/Mie lidar**
		Ground based	FTS
		Balloon	SAO FIRS-2 Interferometer
		Balloon	JPL Mk IV Interferometer
		Balloon	JPL ozone photometer
		Balloon	JPL SLS spectrometer
		Balloon	DU CAESR spectrometer
		Balloon	Aerosol sampler
		Small balloon	ECC ozonesonde
		Aircraft	Chemiluminescence/ER-2
		Aircraft	UV ozone photometer/ER-2
		Aircraft	Lyman-alpha hygrometer/ER-2
Yakutsk, Russia	(62N, 130E)	Ground based	TDLHS (Laser heterodyne spectrometer)
		Ground based	Brewer spectrophotometer
		Small balloon	Ozonesonde, Optical hygrometer, Backscattersonde (with Ozone, Radiosonde)

Note: The **bold** letters indicate the core experiments while the plain letters indicate the cooperative experiments.

Table 4-8. **Locations and Instruments of ILAS Validation Experiments in Antarctic Region**

Name of Station	Location	Method	Name of Instrument
Macquarie Island	(55S, 159E)	**Ground based**	**UV-visible**
Mirny	(66S, 93E)	Ground based	Photometer ABAS
Dumont d'Urville	(67S, 140E)	Ground based	SAOZ (UV-visible)
		Ground based	Ozone lidar
		Ground based	Rayleigh/Mie lidar
		Small balloon	Ozonesonde
Syowa	(69S, 40E)	**Ground based**	**UV-visible**
		Ground based	Photometer EKO 120
		Ground based	Photometer SP-1A
		Small balloon	**Ozonesonde**
		Balloon	FUBUKI (Cryogenic sampler)
Zhongshan	(69S, 77E)	Ground based	Brewer and UV-spectrometer
		Ground based	Mie ruby lidar
		Small balloon	Ozonesonde
Neumayer	(71S, 08W)	Ground based	Photometer SP-2H
		Small balloon	ECC ozonesonde
		Small balloon	Radiosonde
Arrival Heights	(78S, 167E)	**Ground based**	**UV-visible**
		Ground based	**Dobson spectrophotometer**
		Ground based	**FTS**
McMurdo	(78S, 166E)	Balloon	Aersol counter
		Small balloon	Ozonesonde

Note: The **bold** letters indicate the core experiments while the plain letters indicate the cooperative experiments.

Table 4-9 (a) **Core/Cooperative Validation Experiments for O3**

Profile/ Column	Measurement method/Instrument	Location	P. I. of Experiment
(Core Experiments)			
Profile	Small balloon/Ozonesonde	Kiruna (68° N)	Kanzawa
	Balloon/Ozonesonde	Kiruna	Kondo
	Balloon/LPMA (FTS)	Kiruna	Camy-Peyret
	Balloon/SAOZ (UV-visible)	Kiruna	Pommereau
	Balloon/AMON (Star occultation)	Kiruna	Pirre
	Balloon/CAESR (IR radiometer)	Kiruna	Murcray
	Balloon/DOAS (optical absorption spectroscopy)	Kiruna	Pfeilsticker
	Balloon/MIPAS-B (FTS)	Kiruna	Oelhaf
	Ground/FTS	Kiruna	Kondo
	Ground/TDLHS (Laser heterodyne spectrometer)	Fairbanks (65° N)	Fukunishi
	Small balloon/Ozonesonde	Syowa (69° S)	Kanzawa
Column	Ground/FTS	Kiruna (68° N)	Kondo
	Ground/UV-visible	Kiruna	Kondo
	Ground/TDLHS (Laser heterodyne spectrometer)	Fairbanks (65° N)	Fukunishi
	Ground/UV-visible	Macquarie Island (55° S)	Matthews
	Ground/UV-visible	Syowa (69° S)	Kondo
	Ground/FTS	Arrival Heights (78° S)	Matthews
	Ground/UV-visible	Arrival Heights	Matthews
	Ground/Dobson Spectrophotometer	Arrival Heights	Matthews
(Cooperative Experiments)			
Profile	Ground/Rayleigh-Mie-Raman lidar	Kiruna (68° N)	Serwazi
	Aircraft/NOx-NOy-O3-Measurements System	Arctic region (Kiruna)	Schlager
	Aircraft/Sub-millimeter wave sensors	Arctic region (Kiruna)	Kuellmann
	Ground/FTS	Fairbanks (65° N)	Murcray
	Balloon/SAO FIRS-2 Interferometer	Fairbanks	Traub
	Balloon/JPL MkIV Interferometer	Fairbanks	Toon
	Balloon/JPL SLS Spectrometer	Fairbanks	Stachnik
	Balloon/JPL Ozone Photometer	Fairbanks	Margitan
	Balloon/DU CAESR	Fairbanks	Murcray
	Small balloon/Ozonesonde	Fairbanks	Shibasaki
	Aircraft/ER-2/UV ozone photometer	Arctic region (Fairbanks)	Profitt
	Balloon/Ozonesonde	Yakutsk (62° N)	Yushkov
	Ground/TDLHS (Laser heterodyne spectrometer)	Yakutsk	Fukunishi
	Small balloon/Ozonesonde	Dumont d'Urville (67° S)	Godin
	Ground/Ozone lidar	Dumont d'Urville	Godin
	Small balloon/Ozonesonde	Zhongshan (69° S)	Lu
	Small balloon/Ozonesonde	Neumayer (71° S)	Gernandt
	Small balloon/Ozonesonde	McMurdo (78° S)	Deshler
	Satellite/SAGEs	-	McCormick
	Satellite/HALOE	-	Park
Column	Aircraft/Sub-millimeter wave sensors	Arctic region (Kiruna)	Kuellmann
	Ground/UV-visible	Scoresbysund (71° N)	Goutail
	Ground/UV-visible	Sodankyla (67° N)	Goutail
	Ground/UV-visible	Zhigansk (67° N)	Goutail
	Ground/FTS	Fairbanks (65° N)	Murcray
	Ground/TDLHS (Laser heterodyne spectrometer)	Yakutsk (62° N)	Fukunishi
	Ground/UV-visible	Dumont d'Urville (67° S)	Goutail
	Ground/Brewer and UV-spectrometer	Zhongshan (69° S)	Lu
(Routine)			
Profile	Small balloon/Ozonesonde	Arctic area (15 stations)	WMO
		Antarctic area (8 stations)	WMO

Table 4-9 (b) **Core/Cooperative Validation Experiments for HNO3**

Profile/ Column	Measurement method/Instrument	Location	P. I. of Experiment
(Core Experiments)			
Profile	Balloon/LPMA (FTS)	Kiruna (68° N)	Camy-Peyret
	Balloon/CAESR (IR radiometer)	Kiruna	Murcray
	Balloon/MIPAS-B (FTS)	Kiruna	Oelhaf
Column	Ground/FTS	Kiruna (68° N)	Kondo
	Ground/FTS	Arrival Heights (78° S)	Matthews
(Cooperative Experiments)			
Profile	Aircraft/HAAMAS (Mass Spectrometer)	Arctic region (Kiruna, 68° N)	Arnold
	?Aircraft/Sub-millimeter wave sensors	Arctic region (Kiruna, 68° N)	Kuellmann
	Balloon/SAO FIRS-2 Interferometer	Fairbanks (65° N)	Traub
	Balloon/JPL MkIV Interferometer	Fairbanks	Toon
	Balloon/JPL SLS Spectrometer	Fairbanks	Stachnik
	Balloon/DU CAESR	Fairbanks	Murcray
Column	?Aircraft/Sub-millimeter wave sensors	Arctic region (Kiruna, 68° N)	Kuellmann
	Ground/FTS	Fairbanks (65° N)	Murcray

Note: The question mark (?) denotes the measurement which can measure the species if conditions are good.

Table 4-9 (c) **Core/Cooperative Validation Experiments for NO2**

Profile/ Column	Measurement method/Instrument	Location	P. I. of Experiment
(Core Experiments)			
Profile	Balloon/CLD	Kiruna (68° N)	Kondo
	Balloon/LPMA (FTS)	Kiruna	Camy-Peyret
	Balloon/DOAS	Kiruna	Pfeilsticker
	Balloon/SAOZ (UV-visible)	Kiruna	Pommereau
	Balloon/AMON (Star occultation)	Kiruna	Pirre
	Balloon/MIPAS-B (FTS)	Kiruna	Oelhaf
Column	Ground/UV-visible	Kiruna (68° N)	Kondo
	Ground/FTS	Kiruna	Kondo
	Ground/UV-visible	Macquarie Island (55° S)	Matthews
	Ground/UV-visible	Syowa (69° S)	Kondo
	Ground/FTS	Arrival Heights (78° S)	Matthews
	Ground/UV-visible	Arrival Heights	Matthews
(Cooperative Experiments)			
Profile	Aircraft/NOx-NOy-O3-Measurements System	Arctic region (Kiruna, 68° N)	Schlager
	Balloon/SAO FIRS-2 Interferometer	Fairbanks (65° N)	Traub
	Balloon/JPL MkIV Interferometer	Fairbanks	Toon
	Aircraft/ER-2/Chemiluminescence	Arctic region	Fahey
	Satellite/SAGEs	-	McCormick
	Satellite/HALOE	-	Park
Column	Ground/UV-visible	Scoresbysund (71° N)	Goutail
	Ground/UV-visible	Sodankyla (67° N)	Goutail
	Ground/UV-visibl	Zhigansk (67° N)	Goutail
	Ground/FTS	Fairbanks (65° N)	Murcray
	Ground/UV-visible	Dumont d'Urville (67° S)	Goutail

Table 4-9 (d) **Core/Cooperative Validation Experiments for N2O**

Profile/ Column	Measurement method/Instrument	Location	P. I. of Experiment
(Core Experiments)			
Profile	Balloon/SAKURA (Cryogenic sampler)	Kiruna (68° N)	Nakazawa
	Balloon/LPMA (FTS)	Kiruna	Camy-Peyret
	Balloon/BONBON (Cryogenic sampler)	Kiruna	Schmidt and Engel
	Balloon/ASTRID (Grab sampler)	Kiruna	Schmidt and Engel
	Balloon/CAESR (IR radiometer)	Kiruna	Murcray
	Balloon/MIPAS-B (FTS)	Kiruna	Oelhaf
	Ground/FTS	Kiruna	Kondo
	Ground/TDLHS (Laser heterodyne spectrometer)	Fairbanks (65° N)	Fukunishi
Column	Ground/FTS	Kiruna (68° N)	Kondo
	Ground/TDLHS (Laser heterodyne spectrometer)	Fairbanks (65° N)	Fukunishi
	Ground/FTS	Arrival Heights (78° S)	Matthews
(Cooperative Experiments)			
Profile	Aircraft/TRISTAR	Arctic region (Kiruna, 68° N)	Fischer
	Aircraft/Sub-millimeter wave sensors	Arctic region (Kiruna, 68° N)	Kuellmann
	Ground/FTS	Fairbanks (65° N)	Murcray
	Balloon/SAO FIRS-2 Interfero	Fairbanks	Traub
	Balloon/JPL MkIV Interferometer	Fairbanks	Toon
	Balloon/JPL SLS Spectrometer	Fairbanks	Stachnik
	Ground/TDLHS (Laser heterodyne spectro.)	Yakutsk (62° N)	Fukunishi
	Balloon/FUBUKI (Cryogenic sampler)	Syowa (69° S)	Nakazawa
Column	Aircraft/Sub-millimeter wave sensors	Arctic region (Kiruna, 68° N)	Kuellmann
	Ground/FTS	Fairbanks (65° N)	Murcray
	Ground/TDLHS (Laser heterodyne spectrometer)	Yakutsk (62° N)	Fukunishi

Table 4-9 (e) **Core/Cooperative Validation Experiments for H2O**

Profile/ Column	Measurement method/Instrument	Location	P. I. of Experiment
(Core Experiments)			
Profile	Balloon/LPMA (FTS)	Kiruna (68° N)	Camy-Peyret
	Balloon/UV-visible	Kiruna	Pommereau
	Balloon/ELHYSA (Hygrometer)	Kiruna	Ovarlez
	Balloon/FISH (Hygrometer)	Kiruna	Schiller
	Balloon/Hygrometer	Kiruna	Deshler
	Balloon/MIPAS-B (FTS)	Kiruna	Oelhaf
(Cooperative Experiments)			
Profile	Ground/ Rayleigh-Mie-Raman lidar	Kiruna (68° N)	Serwazi
	Aircraft/FISH	Arctic region (Kiruna, 68° N)	Schiller
	?Aircraft/Sub-millimeter wave sensors	Arctic region (Kiruna, 68° N)	Kuellmann
	Ground/Rayleigh/Mie/Raman lidar	ALOMAR (69°N)	Hauchecorne
	Balloon/SAO FIRS-2 Interferometer	Fairbanks (65° N)	Traub
	Balloon/JPL MkIV Interferometer	Fairbanks	Toon
	Balloon/Optical hygrometer	Yakutsk (62° N)	Yushkov
	Aircraft/ER-2/Hygrometer	Arctic region	Hintsa
	Satellite/SAGE-II	-	McCormick
	Satellite/HALOE	-	Park
Column	?Aircraft/Sub-millimeter wave sensors	Arctic region (Kiruna, 68° N)	Kuellmann

Note: The question mark (?) denotes the measurement which can measure the species if conditions are good.

Table 4-9 (f) **Core/Cooperative Validation Experiments for CH4**

Profile/ Column	Measurement method/Instrument	Location	P. I. of Experiment
(Core Experiments)			
Profile	Balloon/SAKURA (Cryogenic sampler)	Kiruna (68° N)	Nakazawa
	Balloon/LPMA (FTS)	Kiruna	Camy-Peyret
	Balloon/BONBON (Cryogenic sampler)	Kiruna	Schmidt and Engel
	Balloon/CAESR (IR radiometer)	Kiruna	Murcray
	Balloon/MIPAS-B (FTS)	Kiruna	Oelhaf
	Ground/FTS	Kiruna	Kondo
	Ground/TDLHS (Laser heterodyne spectrometer)	Fairbanks (65° N)	Fukunishi
Column	Ground/FTS	Kiruna (68° N)	Kondo
	Ground/TDLHS (Laser heterodyne spectrometer)	Fairbanks (65° N)	Fukunishi
	Ground/FTS	Arrival Heights (78° S)	Matthews
(Cooperative Experiments)			
Profile	Ground/FTS	Fairbanks (65° N)	Murcray
	Balloon/JPL MkIV Interferometer	Fairbanks	Toon
	Balloon/DU CAESR	Fairbanks	Murcray
	Ground/TDLHS (Laser heterodyne spectrometer)	Yakutsk (62° N)	Fukunishi
	Balloon/FUBUKI (Cryogenic sampler)	Syowa (69° S)	Nakazawa
	Satellite/HALOE	-	Park
Column	Ground/FTS	Fairbanks (65° N)	Murcray
	Ground/TDLHS (Laser heterodyne spectrometer)	Yakutsk (62° N)	Fukunishi

Table 4-9 (g) **Core/Cooperative Validation Experiments for CFC-11**

Profile/ Column	Measurement method/Instrument	Location	P. I. of Experiment
(Core Experiments)			
Profile	Balloon/SAKURA (Cryogenic sampler)	Kiruna (68° N)	Nakazawa
	Balloon/BONBON (Cryogenic sampler)	Kiruna	Schmidt and Engel
	Balloon/ASTRID (Grab sampler)	Kiruna	Schmidt and Engel
	Balloon/CAESR (IR radiometer)	Kiruna	Murcray
	Balloon/MIPAS-B (FTS)	Kiruna	Oelhaf
Column	Ground/FTS	Kiruna (68° N)	Kondo
(Cooperative Experiments)			
Profile	Balloon/DESCARTES	Kiruna (68° N)	Harris
	Balloon/JPL MkIV Interferometer	Fairbanks (65° N)	Toon
	Balloon/DU CAESR	Fairbanks	Murcray
	Balloon/FUBUKI (Cryogenic sampler)	Syowa (69° S)	Nakazawa
Column	-	-	-

Table 4-9 (h) **Core/Cooperative Validation Experiments for CFC-12**

Profile/ Column	Measurement method/Instrument	Location	P. I. of Experiment
(Core Experiments)			
Profile	Balloon/CAESR (IR radiometer)	Kiruna (68° N)	Murcray
	Balloon/BONBON (Cryogenic sampler)	Kiruna	Schmidt and Engel
	Balloon/ASTRID (Grab sampler)	Kiruna	Schmidt and Engel
	Balloon/MIPAS-B (FTS)	Kiruna	Oelhaf
Column	Ground/FTS	Arrival Heights (78° S)	Matthews
(Cooperative Experiments)			
Profile	Balloon/DU CAESR (IR radiometer)	Fairbanks (65° N)	Murcray
Column	-	-	-

Table 4-9 (i) **Core/Cooperative Validation Experiments for N2O5**

Profile/ Column	Measurement method/Instrument	Location	P. I. of Experiment
(Core Experiments)			
Profile	Balloon/CAESR (IR radiometer)	Kiruna (68° N)	Murcray
	Balloon/MIPAS-B (FTS)	Kiruna	Oelhaf
	? Balloon/LPMA (FTS)	Kiruna	Camy-Peyret
Column	-	-	-
(Cooperative Experiments)			
Profile	Balloon/SAO FIRS-2 Interferometer	Fairbanks (65° N)	Traub
	Balloon/JPL Mk IV Interferometer	Fairbanks	Toon
	Balloon/DU CAESR (IR radiometer)	Fairbanks	Murcray
Column	-	-	-

Note: The question mark (?) denotes the measurement which can measure the species if conditions are good.

Table 4-9 (j) **Core/Cooperative Validation Experiments for Aerosol**

Profile/ Column	Measurement method/Instrument	Location	P. I. of Experiment
(Core Experiments)			
Profile	Balloon/SAOZ (UV-visible)	Kiruna (68° N)	Pommereau
	Balloon/Aerosol counter	Kiruna	Deshler
	Balloon/RADIBAL (Photopolarimeter)	Kiruna	Brogniez
	Balloon/ELHYSA (Aerosol counter)	Kiruna	Overlez
	Balloon/AMON (Star occultation)	Kiruna	Pirre
	Ground/Rayleigh-Mie lidar	Fairbanks (65° N)	Iwasaka
Column	-	-	-
(Cooperative Experiments)			
Profile	Ground/Rayleigh-Mie-Raman lidar	ALOMAR (69° N)	Hauchecorne
	Ground/ Rayleigh-Mie-Raman lidar	Kiruna (68° N)	Serwazi
	Ground/University of Bonn lidar	Kiruna	Fricke
	Balloon/Aerosol sampler	Fairbanks (65° N)	Hayashi
	Balloon/DU CAESR	Fairbanks	Murcray
	Balloon/Backscattersonde	Yakutsk (62° N)	Yushkov
	Ground/Reyliegh-Mie lidar	Dumont d'Urville (67° S)	Godin
	Ground/Aerosol lidar	Zhongshan (69° S)	Lu
	Balloon/Aerosol counter	McMurdo (78° S)	Deshler
	Satellite/SAGE-II	-	McCormick
	Satellite/HALOE	-	Park
Column	Ground/Photometer ABAS	Mirny (66° S)	Gernandt
	Ground/Photometer EKO 120/SP-1A	Syowa (69° S)	Gernandt
	Ground/Photometer SP-2H	Neumayer (71° S)	Gernandt

Table 4-9 (k) **Core/Cooperative Validation Experiments for Temperature**

profile	Measurement method/Instrument	Location	P. I. of Experiment
(Core Experiments)			
Profile	Ground/Rayleigh/Mie lidar	Fairbanks (65° N)	Iwasaka
(Cooperative Experiments)			
Profile	Ground/Rayleigh Mie Raman lidar	ALOMAR (69°N)	Hauchecorne
	Ground/Rayleigh Mie Raman lidar	Kiruna (68° N)	Serwazi
	Balloon/SAO FIRS-2 Interferometer	Fairbanks (65° N)	Traub
	Balloon/JPL MkIV Interferometer	Fairbanks	Toon
	Balloon/DU CAESR	Fairbanks	Murcray
	Balloon/Radiosonde	Yakutsk (62° N)	Yushkov
	Ground/Rayliegh-Mie lidar	Dumont d'Urville (67° S)	Godin
	Small balloon/Radiosonde	Neumayer (71° S)	Gernandt
	Satellite/HALOE	-	Park
(Routine)			
Profile	Small balloon/Radiosonde	Arctic area (224 stations)	WMO
	Small balloon/Radiosonde	Antarctic area (15 stations)	WMO

Table 4-9 (l) **Core/Cooperative Validation Experiments for Pressure**

Profile	Measurement method/Instrument	Location	P. I. of Experiment
(Core Experiments)			
	-	-	-
(Cooperative Experiments)			
Profile	Balloon/SAO FIRS-2 Interferometer	Fairbanks (65° N)	Traub
	Balloon/JPL MkIV Interferometer	Fairbanks	Toon
	Balloon/Radiosonde	Yakutsk (62° N)	Yushkov
	Small balloon/Radiosonde	Neumayer (71° S)	Gernandt
(Routine)			
Profile	Small balloon/Radiosonde	Arctic area (224 stations)	WMO
	Small balloon/Radiosonde	Antarctic area (15 stations)	WMO

Table 4-10 (a) The Time Table Plan for the Schedule of ILAS Validation Experiments: Core Experiments

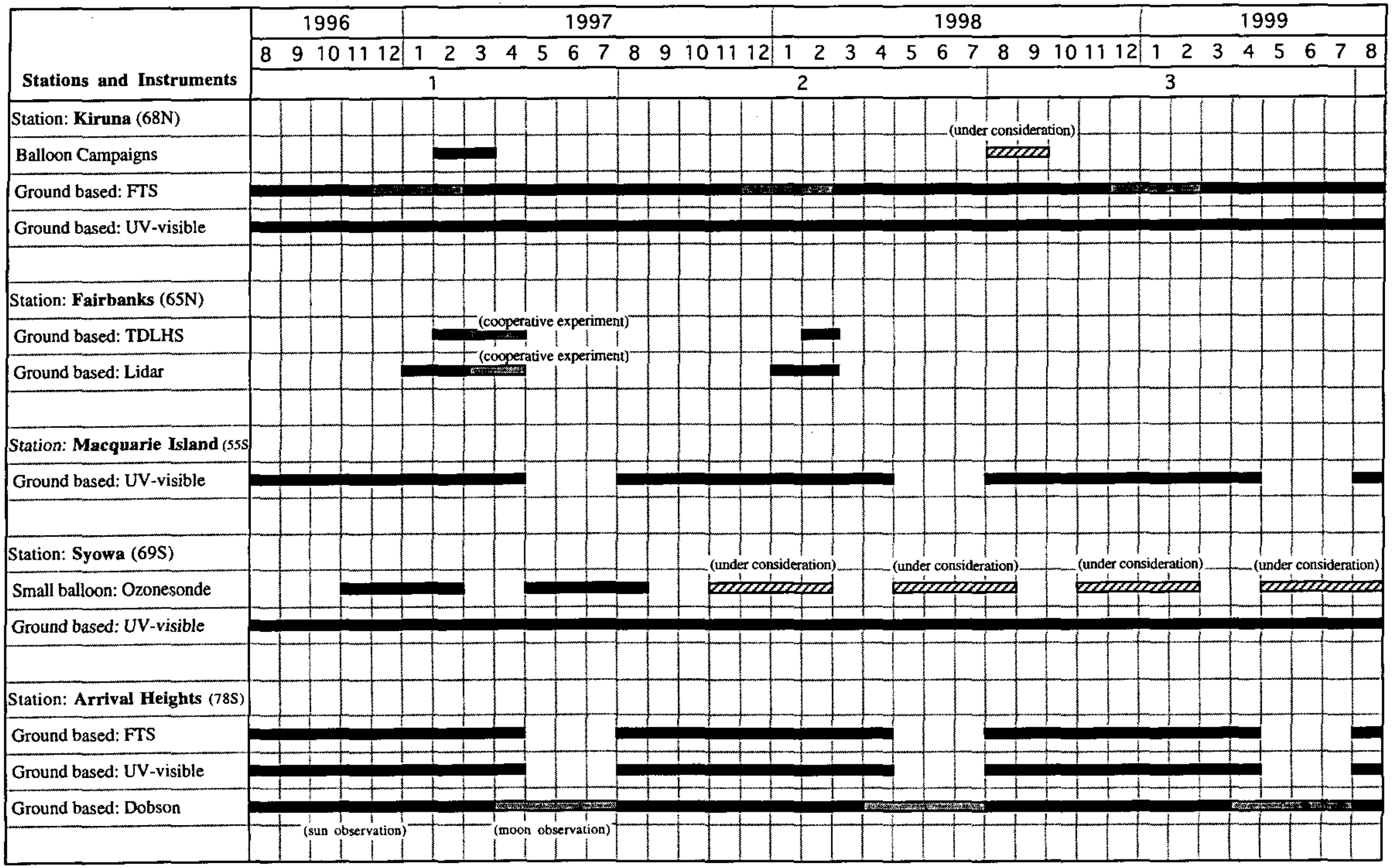

Table 4-10 (b) -1 The Time Table Plan for the Schedule of ILAS Validation Experiments: Cooperative Experiments

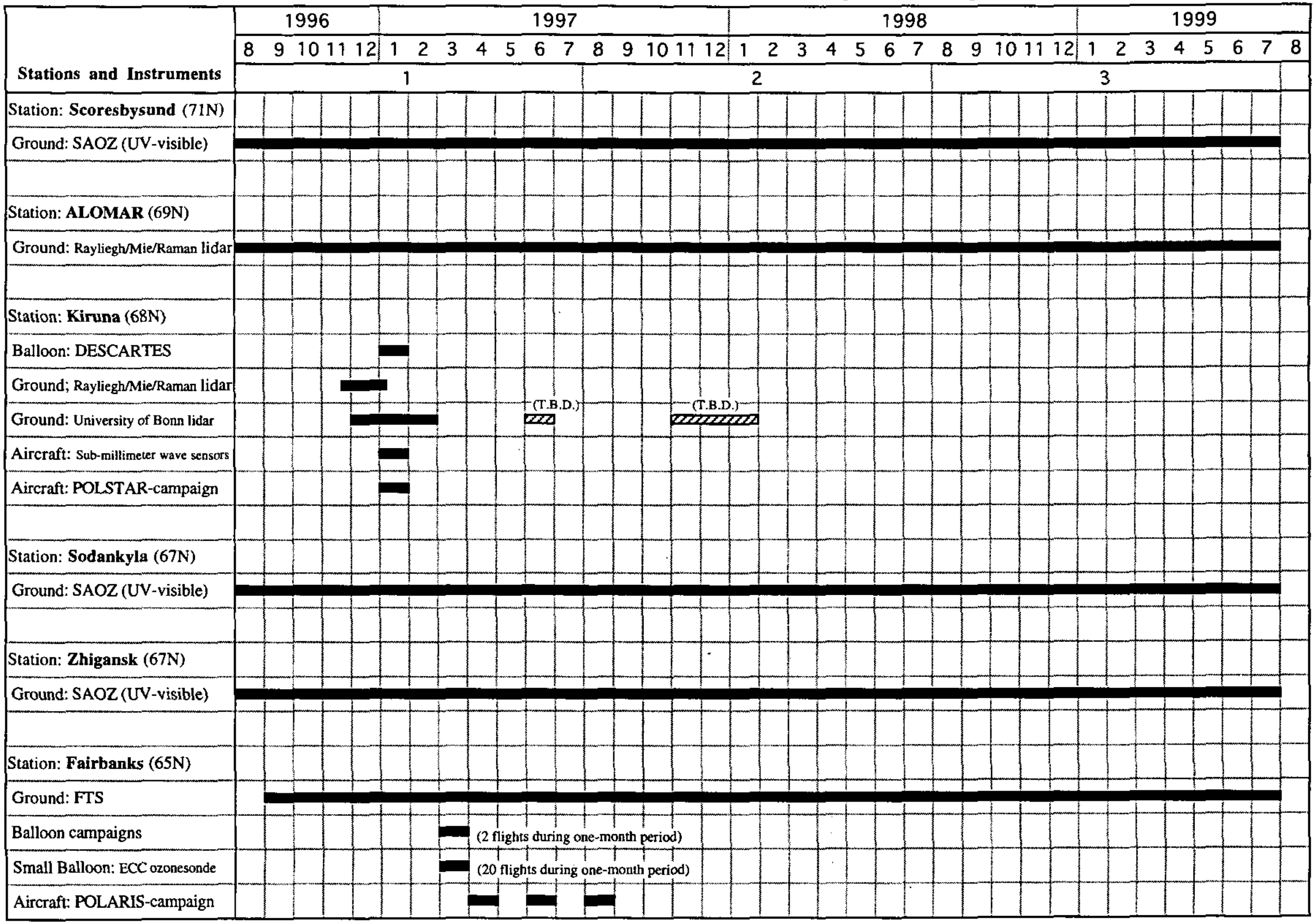

Table 4-10 (b) -2 The Time Table Plan for the Schedule of ILAS Validation Experiments: Cooperative Experiments (continued)

Stations and Instruments	Period
Station: **Yakutsk** (62N)	
Small balloons: Ozone, Radio, Optical hygrometer, Backscatter	1996/9 – 1997/4; 1997/5 – 1999/8 (T.B.D.)
Ground: Brewer spectrometer	1996/9 – 1997/4; 1997/5 – 1999/8 (T.B.D.)
Station: **Mirny** (66S)	
Ground: Photometer ABAS	1996/11 – 1997/11
Station: **Dumont d'Urville**(67S	
Ground: SAOZ (Uv-visible)	1996/8 – 1999/7
Ground: Ozone lidar, Ozonesonde, Rayliegh/Mie lidar	1996/8 – 1996/10; 1997/2 – 1997/10; 1998/2 – 1998/10; 1999/2 – 1999/7
Station: **Syowa** (69S)	
Ground: Photometer EKO 120, SP-1A	1996/11 – 1997/11
Balloon: FUBUKI (Cryogenic sampler)	1997/11 – 1997/12 (1 flight)
Station: **Zhongshan** (69S)	
Ground: Brewer and UV-visible, Mie ruby lidar	1996/8 – 1997/11
Small balloon: Ozonesonde	1996/8 – 1997/11
Station: **Neumayer** (71S)	
Ground: Photometer SP-2H	1996/11 – 1997/11
Small balloon: ECC Ozonesonde, Radisonde	1996/11 – 1997/11
Station: **McMurdo** (78S)	
Balloon: Aerosol counter	1996/9; 1997/7 – 1997/9; 1998/7 – 1998/9
Small balloon: Ozonesonde	1996/9; 1997/7 – 1997/9; 1998/7 – 1998/9

5. Guidelines for ILAS Validation Experiments

The validation measurements should be made with comparable or better accuracy and resolution as the ILAS measurements.

The validation measurements should be made as close as possible in space and time to the ILAS occultation event. It is considered that the validation measurements at each site should be carried out, in principle, when the distance between the site and the ILAS measurement region is less than 500 km, and when the time difference between the two measurements is less than a few hours. However, this criterion depends on species, season, location, time of day, etc. More detailed consideration should be required in this respect. For example, critical values both in space and time, "preferred" and "acceptable", may be set. Additional correlative measurements using a Lagrangian viewpoint are useful especially for chemically inactive species.

We are planning to provide information that will be needed when the validation experiments are implemented, such as "Validation Calendar Dates and Times" geared to each measurement point, to everyone in charge of an experiment. We will use the means such as WWW, ftp, e-mail, fax, etc., to send the information.

6. Data Format

The measured data to be submitted to the ILAS Data Manager should be in the NASA Ames format (the format adopted in the aircraft campaigns of NASA, European campaigns such as EASOE and SESAME, UARS Correlative Measurements, etc.). The format is described in the Appendix B "Correlative Measurements Data Format" of "Upper Atmosphere Research Satellite (UARS) Correlative Measurements" compiled by Hypes (1993). See it for details.

7. Protocol for Ground/balloon/aircraft/meteorological Data Exchange

The aims of this protocol are to encourage rapid dissemination of the validation experiment data and other data for scientific purposes among the ILAS researchers, to uphold the rights of the individual researchers and have all the involved researchers treated equitably. The contents of this chapter are taken from part of "Memorandum of Understanding (MOU) for Participating in the ILAS Project" as referred to in Section 2.2.3.

7.1 ILAS-CMDB

An ILAS Correlative Measurement Data Base (ILAS-CMDB) will be constructed to provide ILAS researchers with validation experiment data and other correlative measurement data for scientific use. The ILAS-CMDB is managed by the ILAS Data Manager who is designated by the Project Leader.

Data providers must submit their data to the Data Manager with sufficient information on data quality. The Data Manager determines whether submitted data are suitable for registration to ILAS-CMDB by consulting with the Data Evaluation Committee, the members of which are designated by the Project Leader.

7.2 Core Validation Experiments

Preliminary data obtained through the core validation experiments must be submitted to the ILAS Data Manager as soon as possible as described in the individual experiment plan. Any corrections/amendments to the preliminary data should be submitted to the Data Manager as soon as possible. All the data obtained within one year after the launch must be submitted in the final form within fifteen months after the launch. It is the data providers' responsibility to provide the best data available at that time with sufficient error information.

The Validation Experiment Team members who are funded, partially or fully, by the project for their experiments shall not distribute the data obtained through the Core Validation Experiments to third persons without the written consent by the ILAS Project Leader.

7.3 Cooperative Validation Experiments

Preliminary data obtained through the cooperative validation experiments must be submitted to the ILAS Data Manager as soon as possible as described in the individual experiment plan. Any corrections/amendments to the preliminary data should be submitted to the Data Manager as soon as possible. All the data obtained within one year after the launch must be submitted in the final form within fifteen months after the launch. It is the data providers' responsibility to provide the best data available at that time with sufficient error information.

Science Team members who are designated to be in charge of validation analysis by the Science Team Leader, will be permitted to use the data when made available.

Data providers are encouraged to register their data to ILAS-CMDB. When the data are registered, the providers are permitted to access other data.

7.4 Meteorological Data

UK Meteorological Office stratospheric analyses and software are supplied to the ILAS Sensor Team for use in research in connection with the ILAS project. The UK Met Office grants to each member of the ILAS Sensor Team a non-exclusive license to use, adapt and modify those data and software. Commercial exploitation, business use, resale, or transfer to any third party are not permitted without the written consent of the UK Met Office. The UK Met Office retains the intellectual property rights on the data and software.

No liability is accepted by the UK Met Office for any errors or omissions in the data, software or associated information and/or documentation. No warranty is given as to their suitability for use on the licensee's equipment.

This license to use UK Met Office data and software shall run from the date of signature of this agreement until the conclusion of the ILAS project (as designated by the Project Leader). The UK Met Office reserves the right to terminate this license without notice if the licensee is in breach of the conditions stated here.

8. Concluding Remarks

We have organized the validation experiments program so that the accuracy of the ILAS measurements can be evaluated reliably. It is expected that the ILAS project will contribute to monitoring of stratospheric ozone layer changes and better understanding of processes occurring in the high-latitude ozone layer by producing the best integrated data set of ILAS measurements and correlative measurements including the validation experiments.

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- J. Geophys. Res. (1996): Special Section: Evaluation of the UARS Data. Vol. 101, No. D 6, 9539-10476.
- Kanzawa, H., Kondo, Y., Camy-Peyret, C., and Sasano, Y. (1995): Balloon campaigns at Kiruna-Esrange planned in ILAS Correlative Measurements Program. Proc. 12th ESA Symp. European Rocket and Balloon Programmes and Related Research (Lillehammer, Norway, 29 May - 1 June 1995), ESA SP-370 (September 1995), 345-349.
- Suzuki, M., Matsuzaki, A., Ishigaki, T., Kimura, N., Araki, N., Yokota, T., and Sasano, Y. (1995): ILAS, the Improved Limb Atmospheric Spectrometer, on the Advanced Earth Observing Satellite. IEICE Trans. Commun., Vol. E78-B, No. 12 December 1995, 1560-1570

APPENDIX A

Description of the ILAS Validation Experiment Plan

Note 1: The Appendix A is a compilation of the papers drafted by the Principal Investigators of the experiments, i.e., members of ILAS Validation Experiment Team. Most of the papers were submitted in summer of 1996.

Note 2: The Appendix A does not include the papers of satellite measurements.

Contents

*: The experiment is categorized as a cooperative experiment, but is presented here within core experiments for convenience.

1. Title of ILAS validation experiment

Validation of ILAS data by balloon-borne measurement of NO, NOy, HNO3, NO2, O3, and aerosol from Kiruna

2. Investigators

1) Principal Investigator

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2) Co-Investigators

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3. Target Species, profiles or column

1) **Target Species for ILAS:** **profiles of HNO3, NO2, O3, N2O, CH4, CFC-11, and Aerosol**

2) Other target Species: profiles of NO, NOy

4. **Category** of ILAS validation experiments

Core experiment

5. **Significance** of the validation experiment for ILAS

We plan to make simultaneous measurements of NO, HNO3, NOy, O3, and aerosol from Kiruna, Sweden to compare with ILAS measurements. Profiles of these species up to the altitude of 32 km can be obtained by using 100,000 m3 or larger balloons.

6. **Details of implementation plan** for the experiment

1) **Location: Esrange (Kiruna, Sweden**; 68N, 21E)

2) **Instruments**:

(1) Name:

	a) **CLD***:	NO, NOy
	b) **CAESR****:	HNO3, O3, CFC-11
	c) **ECC Ozonesonde**:	O3
	d) **Aerosol counter*****:	Aerosol
	e) **Grab sampler**:	N2O, CFC-11, CFC-12
	f) **Cryogenic sampler**:	N2O, CH4, CFC-11, CFC-12 (possibly)

*) CLD: Chemiluminescence Detector or Chemiluminescence Detector combined with a gold converter

**) CAESR: Cold Atmospheric Emission Spectral Radiometer

***) Aerosol counter: Mie scattering particle counter with radii from 0.15 to 2 micron meters

(2) Principle:

Profiles of NO2 mixing ratio can be derived with an uncertainty of 10% from NO data using photochemical models. Simultaneous spectroscopic NO2 measurements will be of interest. We have made simultaneous balloon-borne measurements of NO with UARS and SAGE NO2 measurements in 1992. The comparison of NO2 data for 1992 showed good correlation. HNO3 can also be derived with an uncertainty of 10% from NOy using photochemical models. We found that NOy and ozone are highly correlated below 22 km by previous measurements at mid-latitudes. If this can be found also at high latitudes, ozone data can be used for validation of HNO3 at other locations and times. This is very important since the number of large balloon flights are limited. We have made similar measurements from France in 1993 and from Kiruna in 1995. These data combined with the 1997 data will also be very useful in interpreting and validating ILAS HNO3 data. The uncertainty of the aerosol measurements is estimated to be 15%. We have made simultaneous balloon-borne measurements of aerosol with SAGE measurements in 1992. The comparison of aerosol data for 1992 showed good correlation.

3) Altitude range (AR), Accuracy/Precision (A/P), Vertical resolution (VR), Averaging time (AT):

Species	AR (top level)	A / P	VR	AT
NO	32 km	10 % / 10 %	25 m	5 sec.
NOy	32 km	10 % / 10 %	25 m	5 sec.
HNO3 (CAESR)	32 km	10 % / 15 %	1 km	60 sec.
O3 (ECC Sonde)	32 km	5-10 % / 5 %	25 m	5 sec.
Aerosol	32 km	15 % / 15 % (0.18 - 2 μm)	25 m	5 sec.
N2O	32 km	5 % / 5-20 %	2 km	10 sec.- 5 min.
CH4	32 km	5 % / 5-20 %	2 km	10 sec.- 5 min.
CFC-11	32 km	10 % / 5-20 %	2 km	10 sec.- 5 min.

4) Situation on facilities and equipment for the experiment:
Esrange can be used for balloon experiments. It is very important to cooperate with CNES and French scientists.

5) Schedule for the experiment:
(1) Preparation:
Preparation of the instruments started in 1996.
Current instruments can be used for Februaly-March 1997 flights.

(2) Execution period of the measurements:
February-March 1997 (2 flights during two-month period), and around late August - September 1998 (1 flight during one- or two-month period)

(3) Data submission:
4 months after the measurements

7. Details of implementation plan for ILAS validation analysis using the experiment data

1) Requested ILAS data for the analysis:
(1) Species or physical properties: O3, HNO3, NO2, N2O, CH4, H2O

(2) Dates and Location:
a. Dates: First date when ILAS data are obtained - March 1997

b. Location: Kiruna (68N, 21E), Sweden

2) Method of the analysis:
Direct comparison between ILAS and in-situ data
O3-HNO3, HNO3-N2O, HNO3-CH4, O3-NO2 correlations analysis

3) Submission dates of the results:
6 months after the balloon launch

8. Related Publications

1) Instrument explanation:

- Kondo, Y., A. Iwata, M. Takagi, and W. A. Matthews, Balloon-borne chemiluminescent sonde for the measurement of tropospheric and stratospheric nitric oxide, Rev. Sci. Instrum., 55, 1328-1332, 1984.

- Kondo, Y., A. Iwata, W. A. Matthews, Y. Morita, and M. Takagi, Measurement of oxides of nitrogen in the free troposphere over Japan, Atmospheric ozone, Reidel Pub. Co., pp 180-183, 1985.

2) Scientific results:

- Kondo, Y., W. A. Matthews, A. Iwata, and M. Takagi, Measurement of nitric oxide from 7 to 32 km and its diurnal variation in the stratosphere, J. Geophys. Res., 90, 3813-3819, 1985.
- Kondo, Y., W. A. Matthews, P. Aimedieu, and D. E. Robbins, Diurnal variation of nitric oxide at 32 km: measurements and interpretation, J. Geophys. Res., 93, 2451-2460, 1988.
- Kondo, Y., A. Iwata, P. Aimedieu, W. A. Matthews, W. R. Sheldon, and J. R. Benbrook, Profiles of nitric oxide in the upper stratosphere, Geophys. Res. Lett., 16, 1379-1382, 1989.
- Kondo, Y., P. Aimedieu, W. A. Matthews, W. R. Sheldon, and J. R. Benbrook, A mid-latitude balloon-borne observation of total odd nitrogen, Geophys. Res. Lett., 17, 73-76, 1990.
- Kondo, Y., P. Aimedieu, W. A. Matthews, D. W. Fahey, D. G. Murcray, D. J. Hofmann, P. V. Johnston, Y. Iwasaka, A. Iwata, and W. R. Sheldon, Balloon-borne measurements of total reactive nitrogen, nitric acid, and aerosol in the cold Arctic stratosphere, Geophys. Res. Lett., 17, 437-440, 1990.
- Kondo, Y., P. Aimedieu, M. Pirre, W. A. Matthews, R. Ramaroson, W. R. Sheldon, J. R. Benbrook, and A. Iwata, Diurnal variation of nitric oxide in the upperstratosphere, J. Geophys. Res., 95, 22513-22522, 1990.
- Kondo, Y., P. Aimedieu, M. Koike, Y. Iwasaka, P. A. Newman, U. Schmidt, and W. A. Matthews, Reactive nitrogen, ozone, and nitrate aerosols observed in the Arctic stratosphere in January 1990, J. Geophys. Res., 97, 13025-13038, 1992.
- Kondo, Y., U. Schmidt, T. Sugita, P. Aimedieu, M. Koike, H. Ziereis, and Y. Iwasaka, Total reactive nitrogen, N2O, and ozone in the winter Arctic stratosphere, Geophys. Res. Lett., 21, 1247-1250, 1994.
- Kondo, Y., W. A. Matthews, S. Solomon, M. Koike, M. Hayashi, K. Yamazaki, H. Nakajima, and K. Tsukui, Ground based measurements of column amounts of NO2 over Syowa Station, Antarctica, J. Geophys. Res., 99, 14535-14548, 1994.

1. **Title of ILAS validation experiment**

Vertical aerosol profiles at high northern latitudes in conjunction with ILAS overpasses.

2. Investigators

1) **Principal Investigator**

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2) Co-Investigator

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3. Target species, profiles

1) **Target species for ILAS:** **Vertical profiles of Condensation Nuclei and Optical Aerosol** ($r > 0.15$ μm)

2) Other target species: none

4. **Category** of ILAS validation experiments

Core experiment

5. **Significance** of the validation experiment for ILAS

Stratospheric aerosol, through the development of polar stratospheric clouds, play critical roles in polar ozone loss. After major volcanic eruptions they also appear to impact mid latitude ozone levels. They are also important in considerations of the global heat balance, and can impact satellite radiation measurements both emission and absorption. For these reasons it is important for both ILAS data analysis and interpretation to have an accurate characterization of stratospheric aerosol levels.

Aerosol measurements using optical particle counters provide size distributions which can be used to infer aerosol extinctions at any wavelength. These measurements can thus be compared directly with ILAS data products.

6. **Details of implementation plan** for the experiment

1) **Location: Esrange (Kiruna, Sweden**; 68N, 21E)

2) **Instrument**:

(1) Name: **Aerosol counter**

(2) Principle:

The Wyoming aerosol counter are optical particle counters which measure the light scattered by single particles as they pass through the chamber. The condensation nuclei concentrations are measured by causing the particles to grow to optically detectable sizes through condensation of ethylene glycol vapor in a growth chamber preceding the optical counter. From the concentrations measured at several sizes, size distributions can be inferred.

3) Altitude range (AR), Accuracy/Precision (A/P), Vertical resolution (VR), Averaging time (AT):

Phy. prop.	AR	A / P	VR	AT	(remark)
Aerosol	10-35 km	10 % / 2-5 %	0.05 km	10 s	(for optical aerosol concentrations 0.001-1.0 cm^{-3})
		10 % / 5 %	0.05 km	10 s	(for condensation nuclei concentrations)

(note) The height of balloon burst is 35 km

4) Situation on facilities and equipment especially for the experiment:

Three sets of aerosol counters will be shipped to Sweden in late January 1997.
Similar instruments have been flown a number of times in the past from Kiruna.

5) Schedule for the experiment:

(1) Preparation:

The optical aerosol and condensation nuclei counters will be integrated onto the Nagoya (Y. Kondo) gondola and tested for proper operation. Typically 1 - 2 days are required for this procedure. Access to the condensation nuclei counter will be required 1 hour prior to flight.

(2) Execution period of the measurements:

Flights will be conducted in February/March 1997 in conjunction with the Nagoya gondola, coinciding with ILAS overflights of Kiruna.

(3) Data submission:

As early as possible, 3 months after the measurements at the latest

7. Details of implementation plan for ILAS validation analysis using the experiment data

1) Requested ILAS data for the analysis:

(1) Species or physical properties:

Vertical profiles of aerosol extinction at both visible and infrared wavelengths.

(2) Dates and Location:

a. Dates: Coinciding with aerosol flights from Kiruna.

b. Location: Kiruna (68N, 21E) within a range of 500 km.

2) Method of the analysis:

Comparison between vertical profiles of extinction, calculated from size distributions fit to the in situ aerosol concentrations measured, and the corresponding ILAS data. The in situ data will be averaged to match the vertical resolution of the ILAS data.

3) Submission dates of the results:
18 months after the measurements.

8. Related Publications

1) Instrument explanation:

- Hofmann, D. J. and T. Deshler, Stratospheric cloud observations during formation of the Antarctic ozone hole in 1989, J. Geophys. Res., 96, 2897-2912, 1991.
- Deshler, T., In situ measurements of the size distribution of the Pinatubo aerosol over Kiruna on four days between 18 January and 13 February 1992, Geophys. Res. Lett., 21, 1323-1326, 1994.

2) Scientific results:

- Grainger, R. G., A. Lambert, C. D. Rodgers, F. W. Taylor, and T. Deshler, Stratospheric aerosol effective radius, surface area, and volume estimated from infrared measurements, J. Geophys. Res., 100, 16507-16518, 1995.
- Adriani, A., T. Deshler, G. Di Donfrancesco, and G. P. Gobbi, Polar stratospheric clouds and volcanic aerosol during 1992 spring over McMurdo Station, Antarctica: Lidar and particle counter comparisons, J. Geophys. Res., 100, 25877-25898, 1995.
- Hervig, M.E., J.M. Russell III, L. L. Gordley, J. H. Park, S. R. Drayson, and T. Deshler, Validation of aerosol measurements made by the Halogen Occultation Experiment, J. Geophys. Res., 101, 10267-10275, 1995.

1. **Title of ILAS validation experiment**

Balloon borne CAESR for stratospheric species

2. Investigators

1) **Principal Investigator**:

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2) Co-Investigator:

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3. Target species, profiles or column

1) **Target species for ILAS**: **vertical profiles of O3, HNO3, N2O, CH4, and CFC-11**

2) Other target species: CFC-12, N2O5

4. **Category** of ILAS validation experiments

Core experiment

5. **Significance** of the validation experiment for ILAS

Part of ADEOS cal/val plan calls for balloon flights to be made from Kiruna, Sweden with instruments which will provide profiles of the constituents measured by ILAS. Four flights will be made with gondolas furnished by Dr. Camy-Peyret and Dr. Kondo. The CAESR is a small cryogenically cooled grating spectrometer which measures the atmospheric spectral emission as the balloon ascends. These data are used to measure altitude profiles for HNO3, O3, N2O, CFC-11, CFC-12 and CH4. These profiles will be compared with data obtained by ILAS to cal/val the ILAS data.

6. **Details of implementation plan** for the experiment

1) **Location**: **Esrange (Kiruna, Sweden**; 68N, 21E)

2) **Instrument**:

(1) Name: **CAESR**; Cryogenically cooled grating infrared spectrometer (IR radiometer)

(2) Principle:

The CAESR is a small cryogenically cooled grating spectrometer which measures the atmospheric spectral emission as the balloon ascends. The grating spectrometer is mounted inside a dual cryogen dewar. The unit is equipped with Ge:Cu detector which is cooled by liquid helium. The spectrometer is mounted in thermal contact with the liquid helium dewar and surrounded by the walls of a liquid nitrogen dewar. The only warm element in the spectrometer field of view is the window which allows the atmospheric radiation to reach the spectrometer.

The spectrometer is capable of a spectral resolution of 3 cm^{-1} and is exceedingly sensitive. The instrument is equipped with optical filters which limit the spectral region scanned to the region from 8.0 to 13.5 microns. With this spectral resolution it is possible to isolate features due to CH4, N2O, O3, HNO3, CFC-11 and CFC-12.

3) Altitude range (AR), Accuracy/Precision (A/P), Vertical resolution (VR), Averaging time (AT):

Species	AR	A / P	VR	AT
O3	12 - 36 km	15 % / 5 %	1 km	2 min.
HNO3	12 - 36 km	20 % / 10 %	1 km	2 min.
N2O	12 - 25 km	10 % / 10 %	1 km	2 min.
CFC-11	12 - 20 km	20 % / 15 %	1 km	2 min
CH4	12 - 36 km	15 % / 10 %	1 km	2 min.

(note); Assuming 36 km float altitude, and 12 km tropopause height

4) Situation on facilities and equipment especially for the experiment:

Esrange, at Kiruna, Sweden as part of ILAS balloon campaign

5) Schedule for the experiment:

(1) Preparation:

Instruments have flown on Camy-Peyret's gondola. Final arrangements for telemetry still needed.

(2) Execution period of the measurements:

February - March 1997 (4 flights during two-month period)

(3) Data submission:

4-6 months after the measurements

7. Details of implementation plan for ILAS validation analysis using the experiment data

1) Requested ILAS data for the analysis:

(1) Species: O3, HNO3, N2O, CH4, CFC-11

(2) Dates and Location:

a. Dates: Flight dates +/- 3 days

b. Location: Kiruna (68N, 21E),Sweden

2) Method of the analysis:

Compariso between CAESR and ILAS height proriles, and profiles measured with other balloon instruments.

3) Submission dates of the result:
6-8 months after the measurements

8. Related Publications

1) Instrument explanation:

- Murcray, F.J., J.R. Starkey, W.J. Williams, W. A Matthews, U. Schmidt, P. Aimedieu and C. Camy-Peyret, HNO3 profiles obtained during the EASOE campaign, Geophys. Res. Lett., 21, 1223-1226, 1994.

2) Scientific results:

- Kumer, J.B., et al., Comparison of correlative data iwth HNO3 version 7 from the CLAES instrument deployed on the Nasa Upper Atmosphere Research Satellite, J. Geophys. Res., 101, 9621-9656, 1996.
- Williams, W.J., F.J. Murcray, R. D. Blatherwick, P.F. Fogal, P Sullivan, and C. Camy-Peyret, Nitric Acid Observations during the Arctic Winter, Polar Stratospheric Ozone, ed. Pyle, Harris, Amanatidis, European Commision, 1996.

1. **Title of ILAS validation experiment**

Correlative measurements of water vapour and long-lived tracers for comparison of in-situ data with measurements from the ADEOS satellite

2. Investigators

1) **Principal Investigator**

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3. Target species, profiles or column

1) **Target species for ILAS**: **profiles of H2O, N2O, CH4, CFC-11, CFC-12**

2) Other target species: profiles of H2, CO2, ClO, BrO, other CFCs

4. **Category** of ILAS validation experiments

Core experiment

5. ***Significance*** *of the validation experiment for ILAS*

The balloon flight will provide data on the vertical distribution of H2O. The water vapor is also measured by the ILAS sensor aboard the ADEOS satellite. The comparison of the satellite data with these well established techniques will be a valuable test for the new sensor on board ADEOS. In order to assess the validity of the satellite data such a direct intercomparison is therefore necessary at high latitudes.

Another measurement will be performed with the whole-air sampler on the same flight, and will provide data on the vertical distribution of CFCs, N2O, CO2, H2, and CH4. The simultaneous measurement of the total hydrogen (H2O + 2 × CH4) from balloon in-situ experiments and space borne remote sensing instrument will be a valuable validation experiment for the sensor. There is still a higher variability between the different measurements of total hydrogen than suggested by instrument errors. This may either be due to an underestimation of instrumental errors or to a higher natural variability of this parameter than generally assumed. Therefore, the additional in-situ measurement of H2 is of considerable interest.

6. **Details of implementation plan** for the experiment

1) **Location:** **Esrange (Kiruna, Sweden**; 68N, 21E)

2) **Instruments**:

(1) Name: a. **Fast In-situ Stratospheric Hygrometer (FISH)**
b. **whole air samplers** (cryosampler: **BONBON**, grabsampler: **ASTRID)**
c. **BRO-ClO Lightweight In-situ instrument (BROCOLI)**

(2) Principle:

The Lyman-alpha fluorescence hygrometer FISH is a fast response water vapor instrument capable of detecting changes of 0.2 ppmv of water vapor with an integration time of approximately 3 seconds. It is based on the photofragmentation of water vapor by Lyman-alpha radiation and the detection of the subsequent fluorescence of the exited OH radical. FISH is calibrated before and after each flight in the laboratory. For this purpose, synthetic air is moistened to mixing ratios between 5 and 1000 ppmv and the mixing ratio is determined using a frost point hygrometer. This calibration is carried out at several pressure levels between 1000 and 50 hPa.

The whole air samplers collect 15 - 16 air samples per flight which are analyzed using gas chromatography. The cryosamplers collect samples of about 20 l STP which can be analyzed for a large number of trace gases. The air samples collected by the grabsamplers can be analyzed only for a limited number of gases, e.g. N2O, CFC-11, and CFC-12, due to the reduced sample volume. However, using correlations between different tracers obtained by cryosampler data the budget of Cly, NOy and hydrogen families can be deduced from the grabsampler profiles. Calibration is tracable to the OGIST-ALE standard (Rasmussen et al.) and compared with NOAA-CMDL standard (Elkins et al.).

The technique of BROCOLI uses resonance fluorescence after reduction of ClO and BrO by adding NO. Calibration is accomplished before and after each flight in the laboratory.

3) Altitude range (AR), Accuracy/Precision (A/P), Vertical resolution (VR), Averaging time (AT):

Species	AR	A / P	VR	AT
H2O	30 km	5 % / <0.2 ppmv	<0.01 km	1 - 3s
CH4	30 km	5 % / 5 %	approx. 1 km	5 - 600 s
H2	30 km	5 % / 5 %	approx. 1 km	5 - 600 s
N2O	30 km	5 % / 5 %	approx. 1 km	5 - 600 s
CO2	30 km	5 % / 5 %	approx. 1 km	5 - 600 s
CFC-11	30 km	5 % / 5 %	approx. 1 km	5 - 600 s
CFC-12	30 km	5 % / 5 %	approx. 1 km	5 - 600 s
Others	30 km	5 % / 5 %	approx. 1 km	5 - 600 s
ClO	13-30 km	20 % / 5 %	≤100 m	20 s
BrO	13-30 km	35 % / 5 %	≤100 m	20 s

4) Situation on facilities and equipment especially for the experiment:

The measurements will be carried out in cooperation with the University of Frankfurt, Institute for Meteorology and Geophysics (head: Prof. U. Schmidt). The GC laboratory equipment and whole air samplers which has been used in the past at KFA will be installed at the University. Therefore the analyses used in the samples will be carried out in the laboratory at the University of Frankfurt.

5) Schedule for the experiment:

(1) Preparation:

Minor improvements of FISH; another flight of this payload will be in autumn 1996 at mid-latitudes

(2) Execution period of the measurements:

February - March 1997 (1 flight during two-month period: FISH+BONBON +BROCOLI, 1 piggy pack flight of BONBON with NOy instrument Nagoya, 1 piggy pack flight of ASTRID with NOy instrument Nagoya)

(3) Data submission:

3 months after the measurements

7. Details of implementation plan for ILAS validation analysis using the experiment data

1) Requested ILAS data for the analysis:

(1) Species or physical properties:

O3, HNO3, NO2, N2O, CH4, H2O, CFC-11, aerosol, temperature, pressure, if available CFC-12, N2O5

(2) Dates and Location:

a. Dates: January - March 1997, if possible Oct./Nov. 1996

b. Location: Kiruna (68N, 21E), Sweden; Northern Hemisphere

2) Method of the analysis:

Comparison between retrieved height profile and ILAS data (for N2O, H2O, CH4, CFC-11, CFC-12)

Budget determination of trace gas families Cly, NOy, hydrogen

Trajectory studies (optional)

3) Submission dates of the results:

6 months after campaign

8. Related Publications

1) Instrument explanation:

- Bauer, R., A. Engel, H. Franken, E. Klein, G. Kulessa, C. Schiller, U. Schmidt, R. Borchers, and J. Lee, Monitoring the vertical structure of the arctic polar vortex over northern Scandinavia during EASOE: Regular N2O profile observations, Geophys. Res. Lett., 21, 1211-1214, 1994.
- Schmidt, U., R. Bauer, A. Khedim, E. Klein, G. Kulessa, and C. Schiller, Profile observations of long-lived trace gases in the Arctic vortex, Geophys. Res. Lett., 4, 767-770, 1991.

- Mörschel, U., E. Klein, D. Kley and U. Schmidt, A new balloon borne stratospheric hygrometer, in Proc. 10th ESA Symposium on European rocket and balloon programmes and related research, pp. 201-205, edited by B. Kaldeich ESA Publications Division, ESTEC, 1991.

2) Scientific results (selection of recent results)

- Engel, A., C. Schiller, U. Schmidt, R. Borchers, H. Ovarlez, and J. Ovarlez, The total hydrogen budget in the arctic winter stratosphere during EASOE, J. Geophys. Res., in press, 1996.
- Engel, A., U. Schmidt, and R. A. Stachnik, Partitioning between chlorine reservoir species deduced from observations in the winter stratosphere, J. Atm. Chem., in press, 1996.
- Kondo, Y., U. Schmidt, A. Engel, M. Koike, P. Aimedieu, M. R. Gunson, and J. Rodriguez, NOy correlation with N2O and CH4 in the midlatitude stratosphere, subm. Geophys. Res. Lett., 1996.

1. Title of ILAS validation experiment

Balloon-borne measurements of stratospheric species with the LPMA instrument

2. Investigators

1) **Principal investigator**

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3. Target species, profiles or column

1) **Target species for ILAS**:

vertical profiles of O3, CH4, N2O, NO2, HNO3, H2O, and CFC-12 (+ some information on the aerosols ?)

2) Other target species: vertical profiles of HCl and ClNO2 + (HF, N2O5 ?)

4. **Category** of ILAS validation experiments

Core experiment

5. **Significance** of the validation experiment for ILAS

Validate the ILAS vertical mixing ratio profiles for the target species O3, CH4, N2O, NO2, HNO3, H2O and CFC-12 using remote sensing balloon-borne Fourier transform spectroscopy in absorption. Vertical profiles of several atmospheric species of interest for the ILAS validation will be obtained through inversion of high resolution solar absorption spectra recorded simultaneously with a HgCdTe (MCT) and a InSb. The MCT detector allows to cover at high resolution the same spectral region as the ILAS IR spectrometer.

6. **Details of implementation plan** for the experiment

1) **Location: ESRANGE (Kiruna, Sweden**; 68N, 21E)

2) **Instrument:**

(1) Name: **LPMA** (Limb Profile Monitor of the Atmosphere); Fourier Transform InfraRed (**FTIR**) absorption spectrometry

(2) Principle:

We use a new high resolution (0.020 cm^{-1} apodized) balloon-borne instrument developed by LPMA to perform remote sensing measurements of atmospheric trace species using the sun as a source. The Fourier transform instrument LPMA is based on a BOMEM DA2.01 instrument with a specially designed 2 detectors output optics allowing simultaneous acquisition of 2 interferograms covering 2 different spectral regions.

Typically the region 800-1400 cm^{-1} is covered with an HgCdTe detector. This spectral region is covered by ILAS. The region 1900-4500 cm^{-1} can be covered with the InSb detector. The actual spectral intervals covered for the validation campaign are:

MCT	650 - 950 cm^{-1}	O3, HNO3, ClONO2, CF2Cl2
MCT	1100 - 1300 cm^{-1}	O3, CH4, N2O, H2O (N2O5? depends on time/date)
InSb	2800 - 3050 cm^{-1}	CH4, NO2, HCl
InSb	4000 - 4100 cm^{-1}	HF, H2O

This is because numerical filtering on-board allows to process 2 intervals per optical channel. The spectral intervals are fixed by the reduction factor used to perform numerical filtering on board. This allows a decrease of the data rate to levels acceptable by the telemetry (TM) or the on board recorder.

The 500 kbit/s TM rate (provided by CNES) can allow to cover the 4 intervals at 0.020 cm^{-1} apodized resolution (FWHM of the sinc function = 0.013 cm^{-1}) without loss of performance. If the concentration of N2O5 is high enough (no conversion to HNO3 in aerosols) this species can also be measured using the band around 1250 cm^{-1}.

HCl, ClONO2 and HF are species that are not measured by ILAS but which will be of importance to get a more complete picture of the overall ozone chemistry and transport during the validation campaigns: HCl and ClONO2 can be used to quantify the chlorine burden and to check for heterogeneous chemistry, ClONO2 is the link between the ClOx and NOx families and HF is a good passive tracer.

The results are obtained using the sun as a source on a gondola pointed towards the sun during ascent. The pointing system is operated as a cooperation between LPMA, Observatoire de Geneve and CNES. The flights will be performed from ESRANGE near Kiruna (Sweden). In addition to measurements performed during ascent it will also be possible to optimize the launch time to record sunset data (from about 30 km) if float duration permits (constraints with the Russian border). The instrument has been flown from Aire-sur-l'Adour in October 1994 and from Kiruna in March 1995 for measurements during the SESAME campaign. It has been flown in the full 4 channels configuration from Leon (Spain) in November 1995.

The LPMA gondola will also accomodate (as was done during SESAME) the University of Denver (DU) spectroradiometer CAESR (Cold Atmospheric Emission Spectral Radiometer) operating in the emission mode during ascent and looking in the direction opposite to the sun. This instrument is also measuring HNO3 (see DU proposal by F. J. Murcray and J. Williams).

3) Altitude range (AR), Accuracy/Precision (A/P), Vertical resolution (VR), Averaging time (AT):

Species	AR	A / P	VR	AT	(remark)
O3	13 - 30 km	8 % / 5 %	2 km	50 s	
CH4	13 - 30 km	10 % / 5 %	2 km	50 s	
N2O	13 - 25 km	10 % / 5 %	2 km	50 s	
NO2	15 - 30 km	15 % / 10 %	2 km	50 s	
HNO3	15 - 28 km	15 % / 15 %	2 km	50 s	
H2O	13 - 30 km	10 % / 10 %	2 km	50 s	
CF2Cl2	13 - 23 km	15 % / 15 %	2 km	50 s	
HCl	13 - 30 km	10 % / 8 %	2 km	50 s	
ClONO2	15 - 30 km	20 % / 15 %	2 km	50 s	
HF	10 - 30 km	10 % / 10 %	2 km	50 s	
N2O5	20 - 30 km	25 % / 20 %	2 km	50 s	(if proper conditions)

4) Situation on facilities and equipment especially for the experiment:
Hanging system (available at Esrange) to be used for pointing tests.

5) Schedule for the experiment:
(1) Preparation:
The instrument is to be shipped to ESRANGE at the end of January 1997. Optical tests will be performed as usual, initially in the Skylark integration hall, then using the real sun outside when the sun reappears at ESRANGE. Integration will proceed in Skylark with tests of the pointing system in Maxus, and final tests with the sun on the launching pad after TM/TC tests in the launching pad building.

(2) Execution period of the measurements:
February - March 1997 (2 nominal flights during a two-month period)
One additional optional flight to be performed within the same timeframe will be devoted to the visible O2 channel ILAS validation using Si detectors covering at high resolution the spectral region covered by the ILAS visible spectrometer which is devoted to T(z)/N(z) and aerosols measurements. Because this flight is optional (pending on funds for the balloon and readiness of the payload for a third flight) no precise commitment is provided at this stage.
If this flight is possible the DOAS experiment of the University of Heidelberg (visible-UV spectrometer sharing the same heliostat as the LPMA instrument through fibre optics) will be accomodated in place of the DU instrument. The DOAS (P.I.: K. Pfeilsticker) will measure profiles of O3, NO2, BrO and aerosols.

(3) Data submission:
6 months after the measurements for N2O, NO2, CH4, H2O and HCl.
2 more months for HNO3, ClONO2 and CF2Cl2 which are more difficult to retrieve from an algorithmic point of view because these species do not present single well isolated lines but more complex spectral signatures.

7. Details of implementation plan for ILAS validation analysis using the experiment data

1) Requested ILAS data for the analysis:
(1) Species or physical properties:
a. Profiles of N2O, NO2, CH4, H2O, HNO3 and CF2Cl2
b. T(z) and N(z) profiles
c. Profiles of aerosols

(2) Dates and Location:
a. Dates: February-March 1997
b. Location: Arctic occultations of ILAS

(3) Ancillary data needed:
Meteorological field such as ECMWF fields specially for PV but also for T(z) and P(z) to check the homogeneity of the meteorological fields

2) Method of the analysis:
Simultaneous retrievals of several species in selected micro-windows using a global fit algorithm. Ascent and occulation spectra will be first processed separately and combined in a second step if the geophysical fields are uniform enough.

3) Submission dates of the results:
October 1997

4) Comments:
Detailed comparisons of LPMA and ILAS profiles will be performed taking into account errors for each instrument and possible geographical differences.
A direct comparison of the observed high resolution LPMA spectra with the ILAS calculated spectra (before convolution over the 44 IR channels of ILAS) will be possible as a consistency check. Comparison of the measurements with the REPROBUS model results is also expected.

8. Related Publications

1) Instrument explanation:

- C. Camy-Peyret, Balloon-borne infrared Fourier transform spectroscopy for measurements of atmospheric trace species, Spectrochimica Acta 51A, 1143-1152 (1995)
- C. Camy-Peyret, P. Jeseck, T. Hawat, G. Durry, S. Payan, G. Berube, L. Rochette and D. Huguenin, The LPMA balloon-borne FTIR spectrometer for remote sensing of atmospheric constituents, ESA Publications SP-370, 323-328 (1995)
- T. Hawat, C. Camy-Peyret, P. Jeseck and R. Torguet, Description and performances of a balloon-borne heliostat for solar absorption measurements, ESA Publications SP-370, 445-451 (1995)

2) Scientific results:

- C. Camy-Peyret, P. Jeseck, S. Payan, T. Hawat, G. Durry and J.M. Flaud, Comparison of CH4 and N2O profiles at high and mid-latitudes using the LPMA balloon-borne Fourier transform instrument, Air Pollution Research Report 56, Polar stratospheric ozone, Eds. J.A. Pyle, N.R.P. Harris and G.T. Amanatidis, pp. 95-100 (1996)
- S. Payan, C. Camy-Peyret, P. Jeseck, G. Durry, T. Hawat and F. Lefevre, HCl and ClONO2 profiles in the late vortex during SESAME, Air Pollution Research Report 56, Polar stratospheric ozone, Eds. J.A. Pyle, N.R.P. Harris and G.T. Amanatidis, pp. 280-285 (1996)
- W. J. Williams, F.J. Murcray, R. Blatherwick, P. Fogal, P. Sullivan and C. Camy-Peyret, Nitric acid observations during arctic winter, Air Pollution Research Report 56, Polar stratospheric ozone, Eds. J.A. Pyle, N.R.P. Harris and G.T. Amanatidis, pp. 179-182 (1996)

- F. Murcray, J.R. Starkey, W.J. Williams, W.A. Matthews, U. Schmidt, P. Aimedieu and C. Camy-Peyret, HNO3 profiles obtained during the EASOE campaign, Geophys Res. Lett. 21,1223-1226 (1994)
- C. Camy-Peyret, J.M. Flaud, A. Perrin, C.P. Rinsland, A. Goldman and F.J. Murcray, Stratospheric N2O5, CH4 and N2O profiles from IR solar occultation spectra, J. Atmos. Chem. 16, 31-40 (1993)

1. **Title of ILAS validation experiment**

Balloon-borne measurements of stratospheric species with the DOAS instrument

2. Investigators

1) **Principal investigator**

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3. Target species, profiles or column

1) **Target species for ILAS**: **vertical profiles of O3, NO2**

2) Other target species: OClO, BrO, CH2O, IO, O4, H2O, HNO2,

4. **Category** of ILAS validation experiments

Core Experiment

5. **Significance** of the validation experiment for ILAS

Validate the ILAS vertical mixing ratio profiles for the target species O3, and NO2 using remote sensing balloon-borne optical absorption spectroscopy in the UV/visible spectral range (320 nm - 680 nm). Vertical profiles of several atmospheric species of interest for the ILAS validation will be obtained through inversion of differential optical absorption spectroscopy of the solar light.

6. **Details of implementation plan** for the experiment

1) **Location**: **ESRANGE (Kiruna, Sweden**; 68N, 21E)

2) **Instrument**

(1) Name: **DOAS** (Differential Optical Absorption Spectroscopy)

(2) Principle:

The instrument consists of two spectrographs, working in the visible (390 - 690 nm) and UV (290 - 390 nm) wavelength range. The detection of the light is performed using two photodiode array (1024) detectors, thermostat at <- 40° C. It is a light weight (44 kg), low power consuming (< 30 Watt) instrument well suited for balloon measurements.

Compared to the technique used on the Transall previously, the new DOAS-instruments allows direct- and zenith scattered sunlight measurements, from which the stratospheric column amounts as well as the profile of the gases can be derived. The direct sun observation is performed using the sun tracker of the LPMA- instrument, anyway on-board the payload.

Beside the measurements of the vertical profiles of O3, NO2, and OClO, already measured with the DOAS-technique in the past, the new instrument is designed to measure the vertical profiles of HNO2 for the first time (see the SPADE measurements of Salawitch et al. 1995), BrO NO3, SO2 (after a major volcanic eruption), and IO for the first time (see Solomon et al. 1994) and BrO (see Toohey et al. 1995) (see Table 1).

Species and their estimated detection limits detectable by the new DOAS balloon borne instrument (for SZA = 90°, 20 km height and a detection limits of 10E-4 for the differential optical absorption of the gases).

Species	Wavelength (nm)	Diff. cross section (cm^2)	Detection limit ($molec/cm^2$)	Comments
NO2	448	3*10E-19	1.1*10E12	
NO3	663	2.2*10E-17	9.0*10E10	during night
BrO	348	1.5*10E-17	1.3*10E11	0.027 ppt
OClO	360	9*10E-18	2.1*10E11	
HNO2	354	5*10E-19	4.0*10E12	0.8 ppt
SO2	304	6*10E-19	6.9*10E12	1.5 ppt
IO	428	3*10E-17	8.7*10E10	0.018 ppt
O3	505	4.5*10E-22	0.6 DU	
O4	577	1.1*10E-46 $cm^3/molec^2$	1.6*10E40 cm^{-3}	
H2O	650	1.6*10E-25	1.6*10E20	

The detection limits for the gases are estimated by assuming for:

BrO a Gaussian profile at 20 km height and 4 km HWHM
OClO a Gaussian profile at 20 km height and 4 km HWHM
NO2 a Gaussian profile at 28 km height and 5 km HWHM
SO2 a Box profile 15 - 25 km
IO, HNO2 and H2O constant stratospheric mixing ratios
O3 a standard ozone profile

3) Altitude range (AR), Accuracy/Precision (A/P), Vertical resolution (VR), Averaging time (AT):

Species	AR	A / P	VR	AT
O3	13 - 30 km	3 % / 5 %	2 km	4 s
NO2	13 - 30 km	3 % / 5 %	2 km	4 s
BrO	13 - 25 km	5 % / 10 %	2 km	4 s
OClO	15 - 30 km	10 % / 15 %	2 km	4 s
HNO2	15 - 28 km	15 % / 15 %	2 km	4 s
IO	13 - 30 km	10 % / 20 %	2 km	4 s
CH2O	13 - 23 km	15 % / 20 %	2 km	4 s
SO2	13 - 30 km	10 % / 20 %	2 km	4 s

4) Situation on facilities and equipment especially for the experiment:
Hanging system (available at Esrange) to be used for pointing tests.

5) Schedule for the experiment:

(1) Preparation:

The instrument is to be shipped to ESRANGE at the end of January 1997.

Optical tests will be performed as usual, initially in the Skylark integration hall, then using the real sun outside when the sun reappears at ESRANGE.

Integration will proceed in Skylark with tests of the pointing system in Maxus, and final tests with the sun on the launching pad after TM/TC tests in the launching pad building.

(2) Execution period of the measurements:

According to the planning of the Paris Oct. 7/8 meeting, the instrument will fly on the LPMA-gondola within the first balloon cluster beginning Feb. 3, 1997.

(3) Data submission:

6 months after the measurements for all the gases to become detected.

7. Details of implementation plan for ILAS validation analysis using the experiment data

1) Requested ILAS data for the analysis:

(1) species or physical properties:

Profiles of N2O, NO2, CH4, H2O, HNO3 and CF2Cl2
T(z) and N(z) profiles
Profiles of aerosols

(2) Dates and Location:

a. Dates: Feb.-March 1997

b. Location: Arctic occultation of ILAS

(3) Ancillary data needed

ECMWF fields specially for PV but also for T(z) and P(z) to check the homogeneity of the meteorological fields.

2) Method of the analysis:

Simultaneous non-least square fitting of all the relevant absorbers within the absorption bands studied. Simultaneous inversion of the optical densities measured to obtain the vertical profiles of the trace gas.

3) Submission dates of the results:

October 1997

4) Comments:

Detailed comparisons of DOAS and ILAS profiles will be performed taking into account errors for each instrument and possible geographical differences.
Comparison of the measurements with the TOMCAT/SLIMCAT model (University of Cambridge) is also expected.

8. Related Publications

1) Instrument explanation:

- Pfeilsticker, K., F. Ferlemann, N. Bauer, H. Harder, D. Perner, U. Platt, and, P. Vradelis, A new DOAS-instrument for aircraft- and balloon borne trace gas studies, paper in prep. for J. Applied Spectroscopy.

- Platt, U., Differential optical absorption spectroscopy (DOAS), Air Monitoring by Spectroscopic Techniques, Edited by M. Siegrist, Chemical Analysis Series, Vol. 127, 1994.

2) Scientific results:

- Erle F., Pfeilsticker K., and Platt U., On the influence of troposphere clouds on zenith-scattered-light measurements of stratospheric species, Geophys. Res. Lett., 22, 20, 2725-2728, 1996.
- Fiedler, M., H. Frank, T. Gomer, M. Hausmann, K. Pfeilsticker, U. Platt, Groundbased spectroscopic measurements of stratospheric NO2 and OClO in the Arctic winter 1989/90, Geophys. Res. Lett., 20, 10, 963-966, 1993.
- Fiedler, M., H. Frank, T. Gomer, M. Hausmann, K. Pfeilsticker, U. Platt, The 'Minihole' event on Feb. 6, 1990, Influence of Mie-scattering on the evaluation of spectroscopic measurements, Geophys. Res. Lett., 20, 10, 959-962, 1993.
- Notholt, J., and K. Pfeilsticker, Stratospheric Trace Gas Measurements in the near-UV and Visible Spectral Range with the sun as a light source using a Fourier Transform Spectrometer, Applied Spectroscopy, Vol. 50, 5, 1996.
- Platt, U. und K. Pfeilsticker, Ozonforschung in der arktischen Stratosphere, Phys. Blaetter 48, 6, 1992.
- Pfeilsticker, K., and Arnold, F., Perturbation of middle atmospheric ion composition measurements by telemetry-induced radio wave ionization, J. Atmos. and Terrestrial Physics, 49, 11/12, 1163-1168, 1987.
- Pfeilsticker, K., and F. Arnold, Perturbations of Middle Atmospheric Ion Composition Measurements by Telemetry-Induced Radio Wave Ionization, Proceeding of the European Telemetry Conference, Garmisch Partenkirchen, June 6 to 9, 1988.
- Pfeilsticker, K., and Arnold, F., Telemetry radio wave interaction with the atmospheric plasma, Planet. Space Sci., 37, 2, 229-238, 1989.
- Pfeilsticker, K., and Arnold, F., First ion composition measurements on the stratopause region, using a rocket-borne parachute drop sonde, Planet. Space Sci., 37, 3, 315-328, 1989.
- Pfeilsticker K., and U. Platt, Airborne Measurements during the Arctic Stratospheric Experiment: Observation of O3 and NO2, Geophys. Res. Lett. 21, 13, 1375, 1994.
- Pfeilsticker, K., C.E. Blom, R. Brandtjen, H. Fischer, N. Glatthor, A. Grendel, T. Gulde, M. Hoepfner, D. Perner, Ch. Piesch, U. Platt, W. Renger, F. Runge, J. Sessler, and M. Wirth, Aircraft-borne Detection of the Stratospheric Column Amounts of O3, NO2, OClO, ClNO3, HNO3 and Aerosols around the Arctic Vortex (79N to 39N) during Spring 1993, 1. Observational data Journ. of Geophys. Res. (final version submitted June 1996).
- Pfeilsticker, K. und M. Helmling, Ozonverlust in der Stratosphere, Die Rolle der Halogenoxide im Spaetwinter, Phys. in uns. Zeit, 25, 264-270, 1996.
- Pfeilsticker, K., Erle, F., and Platt, U., Absorption of solar radiation by atmospheric O4, J. Atmos. Science, accepted Oct. 1996.
- Pfeilsticker, K., F. Erle and U. Platt, Observation of the stratospheric NO2 latitudinal distribution in the northern winter hemisphere, submitted to JAC (March 1996).
- Otten, C., F. Ferlemann, U. Platt, T. Wagner, and K. Pfeilsticker, Groundbased DOAS UV/visible measurements at Kiruna (Sweden) during the SESAME winters 1993/94 and 1994/95, submitted to JAC (March 1996).

- Sessler, J., K. Pfeilsticker, and U. Platt, Aircraft-borne DOAS-vis measurements during the Arctic 1992/93, Annales Geophysicae, Supplement III to Volume 11, 1993.
- Sessler, J., K. Pfeilsticker, U. Platt, M. P. Chipperfield, and J. Pyle: Comparison of aircraft-borne DOAS-vis measurements and 3D model results, Annales Geophysicae, Supplement III to Volume 12, 1994.
- Vaughan, G., H.K. Roscoe, L.M. Bartlett, F.M. O'Connor, A. Sarkissian, M. van der Roozendael, J.C. Lambert, P.C. Simon, K. Karlson, A. Kastad Hiokar, R.L. Jones, R. Freshwater, J.P. Pommereau, F. Goutail, S.B. Anderson, D.G. Drew, P.A. Hughes, D. Moore, J. Mellquist, E. Hegels, T. Kluepfel, F. Erle, K. Pfeilsticker and U. Platt, Intercomparison of ground-based UV-visible sensor of ozone and NO2, J. Geophys. Res., 1996 (in press).
- Zahn, A., V. Barth, K. Pfeilsticker and U. Platt, Identification of PSC sedimentation by HDO, H2{18}O, and HTO measurements near the Arctic tropopause, submitted to JAC (March 1996).

1. **Title of ILAS validation experiment**

Validation of ILAS data by balloon-borne measurement of N2O, CH4, and CFC-11 from Kiruna

2. Investigators

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3. Target species, profiles or column

1) **Target species for ILAS:** **profiles of N2O, CH4 and CFC-11**

2) Other target species: CFC-12, CO2, ^{13}C, ^{14}C

4. **Category** of ILAS validation experiments

Core experiment

5. **Significance** of the validation experiment for ILAS

The concentrations of stratospheric trace gases such as N2O, CH4 and CFC-11 are relatively measured using ILAS, while those are determined directly by analyzing air samples collected with a balloon-borne cyogenic sampler. Therefore the balloon sampling with subsequent laboratory analysis is indispensable for validating ILAS data.

6. **Details of implementation plan** for the experiment

1) **Location: Esrange (Kiruna, Sweden**; 68N, 21E)

2) **Instrument**:
(1) Name: **Balloon-borne cryogenic sampler** (SAKURA)

(2) Principle:
Stratospheric air samples are collected cryogenically at assigned heights, and then analyzed for their N2O, CH4 and CFC-11 concentrations using gas chromatographs.

3) Altitude range (AR), Accuracy/Precision (A/P), Vertical resolution (VR), Averaging time (AT):

Species	AR	A / P	VR	AT
N2O	10 - 35 km	0.4 % / 0.4 %	2 km	1-20 min.
CH4	10 - 35 km	0.2 % / 0.2 %	2 km	1-20 min.
CFC-11	10 - 35 km	2 % / 2-5 %	2 km	1-20 min.

4) Situation on facilities and equipment especially for the experiments:
The cryogenic sampler will be launched in cooperation with the Centre National d'Etudes Spatiales of France using facilities of the Swedish Space Corporation/Esrange in Kiruna. The sampler has been installed.

5) Schedule for the experiment:
(1) Preparation:
Preparation of the instruments of cryogenic sampling must be started in October 1995.

(2) Execution period of the measurements:
February-March 1997 (2 flights during two-month period), and around late August-September 1998 (1 flight during one- or two-month period)
(3) Data submission:
6 months after the measurements

7. Details of implementation plan for ILAS validation analysis using the experiment data

1) Requested ILAS data for the analysis:
(1) Species or physical properties:
Concentrations of N2O, CH4 and CFC-11

(2) Dates and Location:
a. Dates: When ILAS data are obtained in February and March, 1997.

b. Location: Over Kiruna (68N, 21E) and its adjacent area

2) Method of the analysis:
Comparison of measured verical N2O, CH4 and CFC-11 profiles with those from ILAS.

3) Submission dates of the results:
6 months after the measurements

8. Related Publications

1) Instrument explanation:

- H. Honda, S. Aoki, T. Nakazawa, S. Morimoto and N. Yajima, Cryogenic air sampling system for measurements of the concentrations of stratospheric trace gases and their isotopic ratios over Antarctica, J. Geomagnetism and Geoelectricity, in press, 1996.

2) Scientific results:

- T. Nakamura, T. Nakazawa, H. Honda, H. Kitagawa, T. Machida, A. Ikeda and E. Matsumoto, Seasonal variations in ^{14}C concentration of stratospheric CO2 measured with accelerator mass spectrometer, Nuclear Instruments and Method in Physics Research, B92, 413-416, 1994.
- T. Gamo, M. Tsutsumi, H. Sakai, T. Nakazawa, T. Machida, H. Honda and T. Itoh, Long-term monitoring of carbon and oxygen isotopic ratios of stratospheric CO2 over Japan, Geophys. Res. Lett., 22, 397-400, 1995.
- T. Nakazawa, H. Honda, T. Machida, S. Sugawara, S. Murayama, G. Hashida, S. Morimoto and T. Itoh, Measurements of the stratospheric carbon dioxide concentration over Japan using a balloon-borne cryogenic sampler, Geophys. Res. Lett., 22, 1229-1232, 1995.

1. **Title of ILAS validation experiment**

Balloon borne UV-visible solar occultation (SAOZ) for stratospheric species

2. Investigators

1) **Principal Investigator**

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2) Co-Investigators

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3. Target species, profiles or column

1) **Target species for ILAS**: **vertical profiles of O3, NO2, Aerosol, PSC** (optical extinction)

2) Other target species: OClO, BrO, O4, tropospheric H2O

4. **Category** of ILAS validation experiments

Core experiment

5. **Significance** of the validation experiment for ILAS

Measurements will be performed in a variety of atmospheric conditions (e.g. outside and inside the vortex) that is in a large range of concentration, providing an excellent test of the retrieval procedure. In addition, if possible, consecutive sunrise and sunset measurements will be conducted for defining the amplitude of the diurnal variation, particularly useful for NO2 comparisons for which the local time of the measurement must be taken into account.

6. **Details of implementation plan** for the experiment

1) **Location**: a. **Esrange** (**Kiruna, Sweden**; 68N, 21E)
b. **Andoya Rocket Range** (**Norway**; 69N, 16E)

2) **Instrument**:

(1) Name: **UV-visible spectrometer using solar occultation** (**SAOZ**)

(2) Principle:

The SAOZ sonde, the balloon borne version of the ground-based instrument developped by J.P. Pommereau and F. Goutail at Service d'Aeronomie du CNRS is a diode array spectrometer (1024 diodes) working in the ultraviolet and visible wavelength ranges (290-630 nm) with a spectral resolution of 0.8 nm.

The performances of the instrument have been validated by gound-based comparisons conducted in the frame of the NDSC as well as with ozone sondes as well as SAGE II and Haloe for profiles.

3) Altitude range (AR), Accuracy/Precision (A/P), Vertical resolution (VR), Horizontal resolution (HR):

Species	AR	A / P	VR	HR	(remark)
O3	5-30 km	2 % / 0.5 %	1 km	220 km	(90° SZA, cloud top to max altitude of the balloon)
NO2	5-30 km	10 % / 2 %	1 km	220 km	(90° SZA)
H2O	5-12 km	10 % / 5 %	1 km		(90° SZA)
Aerosol/PSC	5-30 km	0.0005 km^{-1}	1 km	220 km	(90° SZA , Optical extinction at 550nm)

4) Situation on facilities and equipment especially for the experiment:

The SAOZ measurements have already been used for the validation of UARS, POAM, TOMS and the GOME instruments.

A cooperation between France and Japan in the field of ADEOS validation has already been initiated. Through the participation of C. Camy-Peyret to the ILAS science team and under the general direction and expected financial support of the national agencies (CNES for France, EA for Japan), a balloon campaign is being prepared for February-March 1997 in Kiruna, Sweden. Two scientific coordinators (Y. Kondo for Japan, C. Camy-Peyret for France) have been given the responsibility to prepare the corresponding campaigns.

5) Schedule for the experiment:

(1) Preparation:

Operational

(2) Execution period of the measurements:

January - April 1997 (2 flights + 2 optional from Kiruna, 2 to 3 flights from Andoya within the frame of a European project of Stratospheric Regular Sounding, SRS)

(3) Data submission:

4 weeks after the measurements

7. Details of implementation plan for ILAS validation analysis using the experiment data

1) Requested ILAS data for the analysis:

(1) Species or physical properties:

O3, NO2, optical extinction by aerosol and PSC

(2) Dates and Locations:

a. Dates: Depending on flight conditions, between January and April 1997

b. Locations: Northern Scandinavia (300 km area centered at 67N, 20 E)

2) Method of the analysis:

Comparison between retrieved profiles + Lagrangian model for local time correction.

3) Submission dates of the result:

Preliminary, without modelling: 4 weeks. Final: 6 months

8. Related Publications

1) Instrument explanation:

- Pommereau, J.P., F. Goutail, J. Piquard, L. Denis et C. Phillips, The SAOZ balloon optical sonde for atmospheric chemistry study, Proc. 11th ESA Symp., Eur. Rocket & Balloon Prog., ESA SP 355, 87, 1994.
- Pommereau, J. P. and J. Piquard, Ozone, Nitrogen dioxide and Aerosol vertical distributions by UV-visible solar occultation from balloons, Geophys. Res. Lett., 13, 1227-1230, 1994.

2) Scientific results:

- Pommereau, J. P. and J. Piquard, Ozone, Nitrogen dioxide and Aerosol vertical distributions by UV-visible solar occultation from balloons, Geophys. Res. Lett., 13, 1227-1230, 1994.
- Pommereau, J.P., and J. Piquard, Observations of the vertical distribution of stratospheric OClO, Geophys. Res. Lett., 13, 1231-1234, 1994.
- Lateltin E., J. P. Pommereau, H. LeTexier, M. Pirre, R. Ramaroson, Perturbation of stratospheric nitrogen dioxide by volcanic aerosol in the arctic, Geophys. Res. Lett.,, 13, 1411-1414, 1994.
- Pundt, I., C. Phillips and J. P. Pommereau, Upper limit of the IO concentration at twilight in the arctic and mid-latitude lower stratosphere, Proc. 3rd Europ. Symp. on Polar Ozone, 1996.
- Phillips, C., I. Pundt and J. P. Pommereau, Effect of Pinatubo aerosol on the NO2 vertical profile at mid-latitudes in summer, Proc. 3rd Europ. Symp. on Polar Ozone, 1996.
- Brogniez, C., R. Ramananahrisoa, J. Lenoble, J-P. Pommerau , C. Phillips and L. Denis, Balloon measurements of aerosol extinction, ozone and NO2 profiles for the validation of the GOME algorithms and products, Workshop on GOME validation, ESA, 1996.
- Oelhaf, H., G. Wetzel, T. von Clarmann, M. Schmidt, J. B. Renard, M. Pirre, E. lateltin, P. Aimedieu, C. Phillips, F. Goutail, J. P. Pommereau, Y. Kondo, T. Sugita, N. Nakajima, M. Koike, W.J. Williams, F.J. Murcray, P. Sullivan, E. Engel, U. Schmidt and A.M. Lee, Correlative balloon measurements of the vertical distribution of N2O, NO, NO2, NO3, HNO3, N2O5, ClONO2 and total reactive NOy inside the polar vortex during SESAME, Proc. 3rd Europ. Symp. on Polar Ozone, 1996.
- Pundt, I. , C. Phillips, and J-P. Pommereau, Measurements of the upper limit of the iodine oxide concetration at twilight in the arctic and mid-latitude lower stratosphere with SAOZ balloon sonde, J. Atm. Chem., submitted, 1996.
- Goutail, F., J-P. Pommereau, C. Phillips, F. Lefevre, E. Kyro, M. Rummukainen, P. Ericksen, S.B. Andersen, B-A Kaastadt Hoiskar, G. Braathen, V. Dorokhov and V.U. Khattatov, Ozone depletion in the Arctic during the winter 1994-95, J. Atm. Chem., submitted, 1996.

1. Title of ILAS validation experiment

DESCARTES

2. Investigators

1) Principal Investigator

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3. **Target species**, profiles or column

vertical profiles of CFC-11

4. **Category** of ILAS validation experiments

Cooperative experiment

5. **Significance** of the validation experiment for ILAS

Measurements will be performed in a variety of atmospheric conditions (e.g. outside and inside the vortex) that is in a large range of concentration, providing an excellent test of the retrieval procedure.

6. **Details of implementation plan** for the experiment

1) **Location**: a. **Esrange (Kiruna, Sweden**; 68N, 21E)

b. **Andoya Rocket Range (Norway**; 69N, 16E)

2) **Instrument**:

(1) Name: DESCARTES

(2) Principle:

A measured volume of ambient air is pumped through sample tubes containing an adsorbent which removes CFCs and other chlorocarbons. The sample tubes are subsequently returned to the laboratory where they are heated to desorb the CFC-11 which is then measured using gas chromatography. 12-15 samples can be taken on each flight at pressures between 250 and 10 hPa according to a pre-determined strategy. No TM or TC is required and DESCARTES is lightweight allowing it to be flown on small balloons (with SAOZ) or, when opportunities present themselves, with payloads on large balloons.

3) Specifications:

Altitude range	250-10 hPa
Vertical resolution	typically 1 km (can be better over shorter ranges)
Precision	5%
Accuracy	5%

4) Situation on facilities and equipment especially for the experiment:

Personnel and equipment are supported by the European Commission.

5) Schedule for the experiment:

(1) Preparation:

Operational

(2) Execution period of the measurements:

January - April 1997 (2 flights + 2 optional from Kiruna, 2 to 3 flights from Andoya within the frame of a European project of Stratospheric Regular Sounding, SRS)

Other flights from Kiruna if opportunities arise. Possibilities: Elhysa, MIPAS, Triple.

7. Related Publication

- Danis, F., N.R.P. Harris, W.H. Taylor, D. Trigg, P.G. Simmonds and J.A. Pyle, Descartes: Tracer measurements with a lightweight balloon-borne instrument, In Polar Stratospheric Ozone (J.A. Pyle, N.R.P. Harris, G.T. Amanatidis, Eds.), Air Pollution Research Report 56, 84 - 89, European Commission, Brussels, 1996.

1. ***Title of ILAS validation experiment***

Balloon borne hygrometer and aerosol counter (ELHYSA) for stratospheric species

2. Investigators

1) **Principal Investigator**

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2) Co-Investigator

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3. Target species, profiles or column

1) **Target species for ILAS**: **vertical profiles of H2O and Aerosol**

2) Other target species: Pressure and Temperature

4. **Category** of ILAS validation experiments

Core experiment

5. **Significance** of the validation experiment for ILAS

We plan to make simultaneous measurements of H2O and Aerosol distribution from Kiruna, Sweden to compare with ILAS measurements.

6. **Details of implementation plan** for the experiment

1) **Location**: **Esrange (Kiruna, Sweden**; 68N, 21E)

2) ***Instruments***:

(1) Name: a. **Frost-point Hygrometer**: H2O

b. **Laser diode particle counter**: Aerosol

(2) Principle:

The hygrometer is a cryogenic frost-point hygrometer based on the optical detection of frost on a cooled mirror.

The aerosol counter is a laser diode particle counter based on the measurement of the intensity of the forward scattered light by particles as they pass through a laser illuminated sensing volume. The size range is arranged in 7 bands from 0.3 to 3 microns diameter.

Accuracy/precision are given on size determination, with respect to spherical particles, refractive indices 1.59.

The accuracy on counting, calculated in a statistical way, depends on the counting range - It is about 80% at 10^{-3} /cm^3 and 20% at 1/cm^3.

3) Altitude range (AR), Accuracy/Precision (A/P), Vertical resolution (VR), Averaging time (AT):

Species	AR	A / P	VR	AT
H2O	10 - 25 km	10 % / 0.2 ppmv	0.1 km	15 sec
Aerosol	10 - 25 km	10 % / 10 %	0.2 km	30 sec

4) Situation on facilities and equipment especially for the experiment:
Facilities of ESRANGE

5) Schedule for the experiment:
(1) Preparation:
Preparation of the payload 1 week before launching. When ready the payload can be launched 2 hours after the decision for launch.

(2) Execution period of the measurements:
February - March 1997 (2 flights during two-month period)

(3) Data submission:
4 months after the measurements

7. Details of implementation plan for ILAS validation analysis using the experiment data

1) Requested ILAS data for the analysis:
(1) Species or Physical properties: H2O, Aerosols

(2) Dates and Locations:
a. Dates: February and March 1997 for the days and 2 days around the date of ELHYSA payload launch

b. Locations: Kiruna (68N, 21E) and adjacent regions in the range of 500 km

2) Method of the analysis:
Comparison between retrieved pressure (or height) profiles and ILAS data

3) Submission dates of the results:
6 months after the measurements

8. Related Publications

1) Instrument explanation:

- Ovarlez J, B. Brioit, J. Capus and H. Ovarlez, Development et essays en vol balloon d'un hygrometre a point de rosee pour sondage de l'atmosphere, Bull. B.N.M., 69, 9-14, 1987.
- Ovarlez J., J.Capus, M. Forichon and H. Ovarlez, Mesures in situ d'humidite dans l'atmosphere moyenne, Proc. Ninth European Symp. on European Rocket and Balloon programmes, ESA SP-291, June 1989.

2) Scientific results:

- Ovarlez Joelle And Henri Ovarlez, Stratospheric water vapor content evolution during EASOE, Geophys. Res. Lett., 21, 13, 1235-1238, 1994.
- Ovarlez J. and H. Ovarlez, Water vapor and aerosol measurements during SESAME, and the observation of low water vapor layers, Air pollution report 56, Polar Stratospheric Ozone, European commission, 1996
- Teitelbaum H., J. Ovarlez, H. Ovarlez and P. van Velthoven, Aerosol measurement during SESAME and its relationship with the polar vortex, Air Pollution Report 56, Polar Stratospheric Ozone, European Commission, 1996.

1. **Title of ILAS validation experiment**

Balloon-borne RADIBAL/BALLAD/BOCCAD experiments for aerosol and ozone validation

2. Investigators

1) **Principal Investigator**

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2) Co-Investigators

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3. Target species, profiles or column

1) **Target species for ILAS**: **Aerosol properties and size distribution profile, Ozone number density profile**

2) Other target species: none

4. **Category** of ILAS validation experiments

Core experiment

5. **Significance** of the validation experiment for ILAS

We will provide aerosol characteristics required to deduce aerosol data useful for ILAS in the infrared to deduce the aerosol contibution. We will also provide an aerosol extinction coefficient profile at 780 nm and an ozone number density profile which could be compared directly to ILAS measurements.

6. **Details of implementation plan** for the experiment

1) **Location**: **Esrange (Kiruna, Sweden**; 68N, 21E)

2) **Instrument**:

(1) Name: **RADIBAL/BALLAD/BOCCAD** (Limb radiance and polarization)

(2) Principle:

a. **RADIBAL** is a photopolarimeter which measures the radiance and the polarization ratio of the light scattered by the atmosphere under various scattering angles during the ascent or/and the descent of the balloon. The analysis of the measured diagrams at 1650 and 850 nm leads to the determination of the aerosol refractive index and of the aerosol size distribution.

b. **BALLAD** is a linear CCD radiopolarimeter which allows the measurement of the radiance and of the polarized radiance of the Earth's limb from the balloon ceiling level at 850, 600 and 450 nm under various azimuth angles. The analysis allows the retrieval of the aerosol size and of the aerosol extinction profile.

c. **BOCCAD** is a matrix CCD detector which observes the solar occultation from the balloon ceiling level at 850, 780, 600 and 450 nm. The inversion of the measurements leads to the aerosol extinction and to the ozone profiles.

3) Altitude range (AR), Accuracy/Precision (A/P), Vertical resolution (VR), Averaging time (AT):

Species	AR	A / P	VR	AT
Aerosol	10-22 km	8-10 % / 2- 3 % (radius) 2- 3 % / 1 % (refractive index) 10-20 % / 5-10 % (extinction)	500 m	-
Ozone	13-27 km	5-20 % / 3- 5 %	500 m	-

4) Situation on facilities and equipment especially for the experiment:
Facilities of ESRANGE

5) Schedule for the experiment:

(1) Preparation:
End of 1996

(2) Execution period of the measurements:
February - March 1997 (2 flights during two-month period)

(3) Data submission:
4 months after the measurements.

7. Details of implementation plan for ILAS validation analysis using the experiment data

1) Requested ILAS data for the analysis:

(1) Species or physical properties:
Aerosol extinction profile in the visible channel, Ozone number density profile, temperature and pressure profiles, nitrogen dioxide number density profile

(2) Dates and Location:

a. Dates: February-March 1997.

b. Location: Kiruna (68N, 21E)

2) Method of the analysis:
Comparison of aerosol and ozone profiles measured by ILAS with our profiles.

3) Submission dates of the results:
7 months after the measurements.

8. Related Publications

1) Instrument explanation:

- RADIBAL: Herman, M., J.Y. Balois, L. Gonzalez, P. Lecomte, J. Lenoble, R. Santer and C. Verwaerde, Stratospheric aerosol observations from balloon-borne polarimetric experiment. Appl. Opt. 25, 3573-3584, 1986.
- BALLAD: Ramon, D., Detection des aerosols stratospheriques par mesure ballon du rayonnement diffus au limbe: mise au point d'un nouvel instrument et premiers resultats, Ph.D. thesis, Univ. of Lille, Villeneuve d'Ascq, France, 1995.

2) Scientific results:

- Brogniez, C., J. Lenoble, D. Ramon, R. Ramananaherisoa, Inversion algorithm and validation of POAM II aerosol products. In atmospheric sensing and modeling, R.P. Santer, Editor, Proc. SPIE 2311, 10-18, 1994.
- Ramon, D., C. Brogniez, P. Lecomte, J. Lenoble, C. Verwaerde, P.C. Simon, C. Muller, In atmospheric sensing and modeling, R.P. Santer, Editor, Proc. SPIE 2311, 10-18, 1995.
- Brogniez, C., J. Lenoble, M. Herman, P. Lecomte and C. Verwaerde, Analysis of two balloon experiments in coincidence with SAGE II in case of large stratospheric aerosol amount: post-Pinatubo period. J. Geophys. Res., 101, D1, 1541-1552, 1996.
- Brogniez, C., R. Ramananaherisoa, J. Lenoble, J.P. Pommereau, C. Phillips, L. Denis, Balloon measurements of aerosol extinction, ozone and NO2 profiles for the validation of the GOME algorithms and products. Proc. of the GOME validation workshop, 179-183, 1996.
- Brogniez,C., J. Lenoble, R. Ramananaherisoa, K.H. Fricke,E.P. Shettle, K.W. Hoppel, R.M. Bevilacqua, and J.S. Hornstein, J. Lumpe, M.D. Fromm, and S.S. Krigman, SESAME Campaign : Correlative Measurements of Aerosol in the Northern Polar Atmosphere, J. Geophys. Res., in press.

1. **Title of ILAS validation experiment**

Balloon borne star occultation (AMON) for stratospheric species

2. Investigators

1) **Principal Investigator**

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3. Target species, profile or column

1) **Target species for ILAS**: **profiles of O3, Aerosol, and NO2**

2) Other target species: profiles of OClO, NO3

4. **Category** of ILAS validation experiments

Core experiment

5. **Significance** of the validation experiment for ILAS

We plan to make measurements of NO2, O3 and aerosols close to ILAS measurements but at a different local time (by night). Modeling calculations will check consistency between ILAS and AMON measurements. Since measurements of NO3 and OClO are also possible, AMON instrument will provide important scientific information for the ILAS nitrogen chemistry: NO3 has a role in the heterogeneous reactions involving nitrogen species which is not yet understood, OClO could be an indicator of a denoxification of air parcels processed by PSCs.

6. **Details of experiment plan** for the experiment

1) **Location** : **ESRANGE (Kiruna, Sweden**; 68N, 21E)

2) **Instrument**:

(1) Name: **AMON**; Stellar occultation method (UV-visible spectrometer)

(2) Principle:

The vertical profiles of species are retrieved by using inversion techniques.

3) Altitude range (AR), Accuracy/Precision (A/P), Vertical resolution (VR), Averaging time (AT):

Species	AR	A / P	VR	AT
O3 (profile)	10-35 km	5 % / 5 %	1 - 2 km	90 min.
NO2 (profile)	15-35 km	10 % / 10 %	1 - 2 km	90 min.
Aerosols (profile)	10-35 km	5 % / 5 %	1 - 2 km	90 min.
OClO (profile)	15-35 km	20 % / 20 %	1 - 2 km	90 min.
NO3 (profile)	15-35 km	20 % / 20 %	1 - 2 km	90 min.

4) Situation on facilities and equipment especially for the experiment :

Hanging system (available at Esrange) to be used for pointing tests.

5) Schedule for the experiment :

(1) Preparation :

End of January 1997

(2) Execution period of the measurements :

February 1997 (1 flight during one-month period).

(3) Data submission :

4 months after the measurements

7. Details of implementation plan for ILAS validation analysis using the experiment data

1) Requested ILAS data for the analysis:

(1) Species or physical properties: O3, NO2, aerosols, HNO3, CH4, H2O, N2O

(2) Date and locations:

a. Date: First date when ILAS data are obtained - March 1997

b. Locations: total coverage of ILAS (for the 3-D and lagrangian modeling initializations)

2) Method of analysis :

Comparison between ILAS and AMON measurements by using modeling calculations.

3) Submission dates of the results :

8 months

8. Related Publications

1) Instrument explanation:

- Huguenin, D., Design and performance of stratospheric balloon-borne platforms for infrared astrophysical observations, Infrared Phys. Technol., 35, 2/3, 195-202, 1994.
- Naudet, J.P., C. Robert, and D. Huguenin, Balloon measurements of stratospheric trace species using a multichanel UV-visible spectrometer, Proceedings of the 14th ESA symposium on European rocket and balloon programs and related research, Montreux, ESA SP-355, pp. 165-168, 1994.
- Robert, C., Realisation d'un spectrometre stellaire multicanal embarquable sous ballon statospherique, Doctoral thesis, University of Orléans, Orleans, 1992.

2) Scientific results:

- Chipperfield, M.H., Good, P., Lee, A.M., Pyle, J.A., Sessler, J., Arlander, D.W., Bartlett, L.M., Blom, C.E., Burrows, J., Eisinger, M., Engel, A., Galle, B., Glatthor, N., Goutail, F., Hopfner, M., Mees, J., Mellqvist, J., McKinney, K.A., Oelhaf, H., Pierson, J.M., Pirre, M., Raffalski, U., Renard, J.B., Richter, A., Robert, C., Schmidt, U., Sinnhuber, B.M., Toohey, D.W., Urban, J., Vaughan, G., Waters, J.W., Wetzel, G., Wittrock J., and Wohlgemuth, J., (1996), Comparison of SESAME data with 3D Chemical Transport Model, J. Atmosph. Chem., submitted.
- Lary, D.J., Toumil, R., Lee, A.M., Newchurch, M., Pirre M., and Renard, J.B. (1996), Carbon aerosols and atmospheric photochemistry, J. Geophys. Res., in accepted.
- Oelhaf, H., Wetzel, G., Von Clarmann, T., Schmidt, M., Renard, J.B., Pirre, M., Lateltin, E., Aimedieu, P., Phillips, C., Goutail, F., Pommereau, J.P., Kondo, Y., Sugita, T., Nakajima, H., Koike, M., Williams, W.J., Murcray, F.J.,Sullivan, P., Engel, A., Schmidt, U., and Lee, A.M. (1996), Correlative balloon measurements of the vertical distribution of N2O, NO, NO2, NO3, H NO3, N2O5, ClONO2 and total reactive NOy inside the polar vortex during SESAME, in Polar stratospheric ozone, Proceedings of the third European workshop,. Pyle, J.A., Harris, N.R.P, and Amanatidis, G.T. eds., European commission., pp. 187-192.
- Renard, J.B., Lefevre, F., Pirre, M., Robert, C., and Huguenin, D. (1996) Vertical profile of the nighttime stratopsheric OClO, J. Atmosph. Chem., accepted.
- Renard, J.B., Pirre, M., Lefevre, F., Robert, C., Lateltin, E., Noziere, B., and Huguenin, D. (1996), Vertical distribution of nighttime stratopsheric NO2 from balloon measurements. Comparison with models, Geophys. Res. Lett., in revision.
- Renard, J.B., Pirre, M., Lefevre, F., Robert, C., Lateltin, E., Noziere, B. and Huguenin, D. (1996), Balloon measurements of statospheric NO2, NO3, and OClO using the AMON instrument. Comparison with models, in Polar stratospheric ozone, Proceedings of the third European workshop,. Pyle, J.A., Harris, N.R.P, and Amanatidis, G.T. eds., European commission., pp. 193-196.
- Renard, J.B., Pirre, M., Robert, C., Huguenin, D., Moreau, G., and Russell III, J.M., (1996), Nocturnal vertical distribution of stratospheric O3, NO2 and NO3 from balloon measurements, J. Geophys. Res., accepted.

1. **Title of ILAS validation experiment**

Validation of ILAS profile data by balloon borne limb emission sounding of ILAS target molecules and of complementary species with MIPAS-B

2. Investigators

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3. Target species, profiles or column

1) **Target species for ILAS**: **profiles of O3, H2O, CH4, N2O, NO2, HNO3, and CFC-11**

2) Other primary target species: profiles of N2O5, ClONO2, CFC-12, CFC-22

4. **Category** of ILAS validation experiments

Core experiment

5. **Significance** of the validation experiment for ILAS

MIPAS is capable of simultaneously measuring profiles of all the molecules ILAS is covering. In addition, key reservoir species like ClONO2 and N2O5 will be detected that provide important scientific information about chlorine chemistry and allow the complete nitrogen partitioning and budget to be determined. The extremely high performance of the MIPAS-B2 pointing system virtually avoids any mapping of pointing errors into retrieval errors.

6. **Details of implementation plan** for the experiment

1) **Location**: **Esrange (Kiruna, Sweden** 68N, 21E)

2) **Instrument**:

(1) Name: **MIPAS-B** (Michelson Interferometer for Passive Atmospheric Sounding-Balloon experiment)

(2) Principle:

The MIPAS-B2 sensor is a cryogenic Furrier Transform Infrared Spectrometer (FTIR) specially tailored to the operation on a stratospheric balloon gondola and equipped with suitable subsystems to efficiently and precisely allow limb emission sounding of atmospheric constituents. Depending on flight duration, one or several complete limb sequences (i.e. vertical profiles), e.g. from different azimuth directions, can be recorded. Absolute radiometric calibration is performed on the basis of blackbody and 'deep-space' spectra that are recorded several times during flight. The calibrated spectra are analyzed using multi-parameter non-linear least-squares curve fitting methods in combination with the onion-peeling technique.

3) Altitude range (AR), Accuracy/Precision (A/P), Vertical resolution (VR), Averaging time (AT):

Species	AR	A / P(*)	VR	AT
O3	10 km to CL (Ceiling Level)	15 % / 10 %	2-3 km	1-10 min.
H2O	8 km to CL	10 % / 5 %	2-3 km	1-10 min.
CH4	8 km to CL	10 % / 5 %	2-3 km	1-10 min.
N2O	8 km to CL	15 % / 5 %	2-3 km	1-10 min.
NO2	15 km to CL	25 % / 15 %	2-3 km	1-10 min.
HNO3	10 km to CL	10 % / 5 %	2-3 km	1-10 min.
CFC-11	5 km to 18 km	15 % / 7 %	2-3 km	1-10 min.
N2O5	18 km to CL	25 % / 15 %	2-3 km	1-10 min.
ClONO2	13 km to CL	15 % / 5 %	2-3 km	1-10 min.
CFC-12	8 km to 20 km	15 % / 10 %	2-3 km	1-10 min.
CFC-22	5 km to 20 km	15 % / 12 %	2-3 km	1-10 min.

4) Situation on facilities and equipment especially for the experiment:

The MIPAS-B team is well acquainted with the campaign conditions at SSC Esrange. Requested lab space approx. 40 m^2 (Balloon Preparatory Building located close to launch pad). Necessary cryogenics: lHe, lN2, dry ice. Crane or Maxus launcher building requested for 1 day for checks of pointing system.

5) Schedule for the experiment:

(1) Preparation:

Preparation time 2 weeks for first flight, 5 to 10 days for 2nd flight.

(2) Execution period of the measurements:

February - March 1997 (2 flights, preferably first half of February)

(3) Data submission:

6 to 12 months after the measurements

6) Comments:

Data given under 3) depend on state of the atmosphere (inside/outside vortex), altitude and averaging time, and ought to be regarded as approximate.

7. Details of implementation plan for ILAS validation analysis using the experiment data

1) Requested ILAS data for the analysis:

(1) Parameter(s) (species or physical properties):

ILAS target molecules, aerosol extinction, pressure, and temperature.

(2) Dates and Location(s):

a. Dates: 10 days prior to and after MIPAS-B flight dates

b. Location(s): complete data set during that period

2) Method of the analysis:

Comparison of MIPAS-B profiles with ILAS profiles. Correlation, partitioning and budget analyses. Details to be determined yet.

3) Submission dates of the results:

12 months after the MIPAS-B measurements.

4) Comments:

Cooperation with models.

8. Related Publications

1) Instrument explanation:

- Friedl-Vallon, F., G. Maucher, H. Oelhaf, and M. Seefeldner, The new balloon borne MIPAS-B2 limb emission sounder, Proc. 1995 Int. Geoscience and Remote Sensing Symp., IEEE Cat. No. 95CH35770, 242-244, 1995.
- Oelhaf, H., T. von Clarmann, H. Fischer, F. Friedl-Vallon, C. Keim, G. Maucher, C. Sartorius, M. Seefeldner, O. Trieschmann, G. Wetzel, M. Woelfel, Remote sensing of the Arctic stratosphere with the new balloon borne MIPAS-B2 instrument, Proc. Third European Workshop on Polar Stratospheric Ozone, Air Pollution Research Report No. 56, European Commission, Brussels, pp. 270-275, 1996.

- Fischer H. and H. Oelhaf, Remote sensing of vertical profiles of atmospheric trace constituents with MIPAS limb-emission spectrometers, Appl. Optics 53, 16 2787-2796, 1996.

2) Scientific results:

- Oelhaf, H.,T. v. Clarmann, H. Fischer, F. Friedl-Vallon, Ch. Fritzsche, A. Linden, Ch. Piesch, and M. Seefeldner, Stratospheric ClONO2 and HNO3 profiles inside the Arctic vortex from MIPAS-B limb emission spectra obtained during EASOE, Geophys. Res. Lett., 21, 1263-1266, 1994.
- von Clarmann, T., A. Linden, H. Oelhaf, H. Fischer, F. Friedl-Vallon, C. Piesch, M. Seefeldner, W. Völker, R. Bauer, A. Engel, and U. Schmidt, Determination of of the stratospheric organic chlorine budget in the spring arctic vortex from MIPAS-B limb emission spectra and air sampling experiments, J. Geophys. Res., 100, 13979-13997, 1995.
- Wetzel, G., T. von Clarmann, H. Oelhaf, and H. Fischer, Vertical profiles of N2O5 along with CH4, N2O and H2O in the late arctic winter retrieved from MIPAS-B limb emission measurements, J. Geophys. Res., 100, 23173-23181, 1995.
- Oelhaf, H. and H. Fischer, Observations of the stratospheric composition with the balloon borne and space based MIPAS limb emission sounders, Proc. 1995 Int. Geoscience and Remote Sensing Symp., IEEE Cat. No. 95CH35770, 435-439, 1995.
- Kouker, W., A. Beck, H. Fischer, and K. Petzoldt, Downward transport in the upper stratosphere during the minor warming in February 1979, J. Geophys. Res., 100, 11069-11084, 1995.
- Oelhaf, H., G. Wetzel, T. von Clarmann, M. Schmidt, J. B. Renard, M. Pirre, E. Lateltin, P. Aimedieu, C. Phillips, F. Goutail, J. P. Pommereau, Y. Kondo, T. Sugita, N. Nakajima, M. Koike, W. J. Williams, F. J. Murcray, P. Sullivan, E. Engel, U. Schmidt, and A. M. Lee, Correlative balloon measurements of the vertical distribution of N2O, NO, NO2, NO3, HNO3, N2O5, ClONO2 and total reactive NOy inside the polar vortex during SESAME, Proc. 3rd Europ. Symp. on Polar Ozone, Schliersee 1995, Air Pollution Research Report, 56, European Commission, 270-275, 1996.

1. Title of ILAS validation experiment

Vertical water vapor profiles at high northern latitudes in conjunction with ILAS overpasses

2. Investigators

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3. Target species, profiles or column

1) **Target species for ILAS**: **vertical profiles of H2O**

2) Other target species: none

4. **Category** of ILAS validation experiments

Core experiment

5. **Significance** of the validation experiment for ILAS

Stratospheric water vapor plays a critical role in a number of global processes, from the development of polar stratospheric clouds and resultant ozone loss, to characterizing intrusion and transport of tropospheric air from the equatorial regions. Thus the use of ILAS water vapor data will have many applications. As such the absolute accuracy of the ILAS measurements must be characterized through comparisons with other instruments which measure profiles of water vapor.

6. **Details of implementation plan** for the experiment

1) **Location: Esrange (Kiruna, Sweden**; 68N, 21E)

2) **Instrument**:
(1) Name: **Frost point hygrometer**

(2) Principle:
A frost point hygrometer measures the temperature of a cooled mirror which is held just at the frost point with a thermostat controlled by an optical detector sensing the light reflected from the mirror. The instrument was initially developed by Mastenbrook in the late 1960's.

3) Altitude range (AR), Accuracy/Precision (A/P), Vertical resolution (VR), Averaging time (AT):

Species	AR	A / P	VR	AT
H2O	10 - 25 km	10 % / 10 %	0.5 km	100 sec.

4) Situation on facilities and equipment especially for the experiment:
Two instruments will be bought from the National Oceanic and Atmospheric Administration by the University of Wyoming. These instruments along with necessary supplies will be shipped to Kiruna. Similar instruments have in the past been flown from Kiruna.

5) Schedule for the experiment:
(1) Preparation:
The water vapor instruments will be assembled for flight in the field, and tested for proper operation. Typically 0.5 days are required for this procedure.

(2) Execution period of the measurements:
Two flights will be conducted in February/March 1997 coinciding with ILAS overflights of Kiruna.

(3) Data submission:
As early as possible, 3 months after the measurements at the latest

7. Details of implementation plan for ILAS validation analysis using the experiment data

1) Requested ILAS data for the analysis:
(1) Species:
Vertical profiles of water vapor mixing ratio.

(2) Dates and Location:
a. Dates: Coinciding with water vapor balloon flights from Kiruna

b. Location: Kiruna (68N, 21E) within a range of 500 km.

2) Method of the analysis:
Comparison between vertical profiles from the in situ data and the corresponding ILAS data. The in situ data will be averaged to match the vertical resolution of the ILAS data.

3) Submission dates of the results:
One year after the measurements.

8. Related Publications

1) Instrument explanation:

- See: Masterbrook, H. J., Water vapor distribution in the stratosphere and the high troposphere, J. Atmos. Sci., 5, 299-311, 1968.
- Voemel, H., S. J. Oltmans, D. J. Hofmann, T. Deshler, J. M. Rosen, The evolution of the dehydration in the Antarctic stratospheric vortex, J. Geophys. Res., 100, 13919-13926, 1995.

2) Scientific results:

- Hofmann, D. J., S. J. Oltmans, and T. Deshler, Simultaneous balloon borne measurements of stratospheric water vapor and ozone in the polar regions, Geophys. Res. Lett., 18, 1011-1014, 1991.
- Voemel, H., S. J. Oltmans, D. J. Hofmann, T. Deshler, J. M. Rosen, The evolution of the dehydration in the Antarctic stratospheric vortex, J. Geophys. Res., 100, 13919-13926, 1995.

1. Title of ILAS validation experiment

Ozonesonde observation in the ILAS Validation Balloon Campaigns at Kiruna-Esrange, Sweden

2. Principal Investigator

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3. Target species, profiles or column

1) **Target species for ILAS:** **Vertical profile of O3, Temperature**

2) Other target species: none

4. **Category** of ILAS validation experiments

Core experiment

5. **Significance** of the validation experiment for ILAS

The ozone profile is a key parameter of the ILAS measurement. The ozonesonde measurements provide the most reliable vertical profile of ozone. Moreover, the measurements will be made as a basic experiment during the ILAS Validation Balloon Campaigns at Kiruna-Esrange, Sweden where the various experiments will be made with large balloons, covering all of the species and physical properties of the ILAS measurement.

6. **Details of implementation plan** for the experiment

1) **Location: Esrange (Kiruna, Sweden**; 68N, 21E)

2) **Instrument**:

(1) Name: **ECC ozonesonde**

(2) Principle:

Ozone: Ozonesonde measurements are made with Electrochemical Concentration Cell (ECC) and the RS 80 radiosonde. The partial pressure of ozone is measured with measurement range of 0 to 20 mPa. ECC has agreement better than 5 % with optical concentration measurement. Variability between sensors is claimed to be 1.2 - 4.5 %.

Pressure: Capacitive aneroid sensor with measuring range of 1060 to 3 hPa (resolution: 0.1 hPa), and with accuracy (standard deviation) of ±0.5 hPa.

Temperature: Capacitive bead sensor with measuring range of +60° to -90°C (resolution: 0.1°C), and with accuracy (standard deviation) of ±0.2°C.

3) Altitude range (AR), Accuracy/Precision (A/P), Vertical resolution (VR), Averaging time (AT):

Species/ Physical properties	AR	A / P	VR	AT
O3	0 - 30 km	5 % / 5 %	a few hundreds meters	a few ten seconds
Temperature	0 - 30 km	1 K / 1 K	a few hundreds meters	a few ten seconds

4) Situation on facilities and equipment especially for the experiment:

The facilities required for the ozonesonde measurements are equipped in Esrange and the measurement operation is provided by Esrange.

5) Schedule for the experiment:

(1) Preparation:

The arrangements with Esrange will require a few months before the campaign.

(2) Execution period of the measurements:

About forty flights will be conducted on every day basis in February/March 1997 and possibly in August/September 1998 coinciding with ILAS over flights of Kiruna.

(3) Data submission:

Final: A few weeks after the measurements (Preliminary: A few days after the measurements)

7. Details of implementation plan for ILAS validation analysis using the experiment data

1) Requested ILAS data for the analysis:

(1) Species or physical properties:

Vertical profiles of O3 mixing ratio and temperature.

(2) Dates and Location:

a. Dates: Coinciding with ozonesonde flights from Kiruna

b. Location: Kiruna (68N, 21E) within a range of 500 km

2) Method of the analysis:

Comparison between vertical profiles from the in situ ozonesonde data and the corresponding ILAS data. The in situ data will be averaged to match the vertical resolution of the ILAS data.

3) Submission dates of the results:

Final: Three months after the measurements. (Preliminary: A few days after the measurements)

8. Related Publications

1) Instrument explanation:

- Grant, W.B. ed. (1989): Ozone Measuring Instruments for the Stratosphere, Vol. 1 of Collected Works in Optics. Washington, D.C., Optical Society of America, 93-95.
- About the overall campaign: Kanzawa, H., Kondo, Y., Camy-Peyret, C., and Sasano, Y. (1995): Balloon campaigns at Kiruna-Esrange planned in ILAS Correlative Measurements Program. Proc. 12th ESA Symp. European Rocket and Balloon Programmes and Related Research (Lillehammer, Norway, 29 May - 1 June 1995), ESA SP-370 (September 1995), 345-349.

2) Scientific results:

- Kanzawa, H. and Kawaguchi, S. (1990): Large stratospheric sudden warming in Antarctic late winter and shallow ozone hole in 1988. Geophys. Res. Lett., 17, No. 1, 77-80.
- Hayashi, M., Murata, I., Fujii, R., Iwasaka, Y., Kondo, Y. and Kanzawa, H. (1994): Observation of ozone and aerosols in the Antarctic ozone hole of 1991 under the Polar Patrol Balloon (PPB) project -Preliminary result-. Ozone in the Troposphere and Stratosphere (Proc. Quadrennial Ozone Symp. 1992, Charlottesville, Virginia, U.S.A., June 4-13, 1992), Hudson, R.D., Ed., NASA Conf. Pub. 3266, 565-568.
- Gernandt, H., Dethloff, K. and Kanzawa, H. (1994): A qualitative assessment of height dependent interannual variability of polar stratospheric ozone Part 1: Long-term variability and stratospheric ozone depletion. Proc. NIPR Symp. Polar Meteorol. Glaciol., 8, 1-13.

1. Title of ILAS validation experiment

Validation of ILAS data by ground based measurement of HNO3, NO2, CH4, N2O, O3, and CFC-11 from Kiruna

2. Investigators

1) Principal Investigator

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3. Target Species, profiles or column

1) **Target Species for ILAS:** **profiles of CH4, N2O, O3 and total column of HNO3, NO2, CH4, N2O, O3, and CFC-11**

2) Other target Species: HCl, HF, CO, NO, ClONO2, ClO

4. **Category** of ILAS validation experiments

Core experiment

5. **Significance** of the validation experiment for ILAS

We plan to make simultaneous measurements of HNO3, NO2, CH4, N2O, O3, and CFC-11 from Kiruna, Sweden to compare with ILAS measurements. Since the measurements of HCl and HF are possible, the correlative FTS measurements will provide important scientific information in their own right about chlorine chemistry and this will be an important link to the ILAS nitrogen chemistry.

6. **Details of implementation plan** for the experiment

1) **Location: Swedish Institute of Space Physics (Kiruna, Sweden;** 68N, 21E)

2) **Instrument**:

(1) Name: **Fourier Transform infrared Spectrometer** (Bruker IFS-120HR) with high resolution (0.0025 cm^{-1})

(2) Principle:

The instrument to measure these Species is a ground-based high resolution FTS. The FTS measures solar and/or lunar IR spectra which were absorbed by terrestrial atmospheric Species. Vertical column amounts of several minor constituents are derived by a least square fitting technique, taking into account the laboratory determined absorption cross section of molecules in the wave number region of interest. Altitudinal profile of several Species (O3, N2O, and CH4) are going to be retrieved from the high resolution spectra by using the inversion technique.

3) Altitude range (AR), Accuracy/Precision (A/P), Vertical resolution (VR), Averaging time (AT):

Species	AR	A / P	VR	AT
HNO3 (column)	-	15 % / 15 %	-	5-20 min.
NO2 (column)	-	15 % / 15 %	-	5-20 min.
CH4 (column)	-	10 % / 10 %	-	5-20 min.
CH4 (profile)	10-25 km	30 % / 30 %	4 km	5-20 min.
N2O (column)	-	10 % / 10 %	-	5-20 min.
N2O (profile)	10-25 km	30 % / 30 %	4 km	5-20 min.
O3 (column)	-	10 % / 10 %	-	5-20 min.
O3 (profile)	10-30 km	20 % / 20 %	4 km	5-20 min.
CFC-11 (column)	-	20 % / 20 %	-	5-20 min.

4) Situation on facilities and equipment for the experiment:

Facilities of Swedish Institute of Space Physics is available for ground based experiments. FTS with a resolution of 0.0025 cm-1 has been installed.

5) Schedule for the experiment:
(1) Preparation:
A new FTS (Bruker IFS-120HR) was installed in March 1996 at Kiruna.

(2) Execution period of the measurements:
Ground based measurements started in March 1996

(3) Data submission:
4 months after the measurements

7. Details of implementation plan for ILAS validation analysis using the experiment data

1) Requested ILAS data for the analysis:
(1) Species or physical properties: O3, HNO3, NO2, N2O, CH4, H2O

(2) Dates and Location:
a. Dates: First date when ILAS data are obtained-March 1997

b. Location: r<1000 km from Kiruna (68N, 21E), Sweden

2) Method of the analysis:
Comparison between retrieved height profile and ILAS data (for O3, N2O, and CH4).
Comparison between column values by FTS spectra and those calculated from ILAS data Correlation analysis of O3-HNO3, HNO3-N2O, HNO3-CH4, N2O-CH4 etc.

3) Submission dates of the results:
6 months after the measurements

8. Related Publications

1) Instrument explanation:

- See references in Grant, W. B., Ozone measuring instruments for the stratosphere, Optical Society of America, pp21-23, 1989.
- Jones, N. B., M. Koike, W. A. Matthews, and B. M. McNamara, Southern hemisphere mid-latitude seasonal cycle in total column nitric acid, Geophys. Res. Lett., 21, 593-596, 1994.

2) Scientific results:

- Koike, M., N. B. Jones, W. A. Matthews, P. V. Johnston, R. L. McKenzie, D. Kinnison, and J. Rodriguez, Impact of Pinatubo aerosols on the partitioning between NO2 and HNO3, Geophys. Res. Lett., 21, 597-600, 1994.
- Liu, X., F. J. Murcray, D. G. Murcray, and J. M. Russell III, Comparison of HF and HCl vertical profiles from ground-based high resolution infrared solar spectra with HALOE observations, J. Geophys. Res. in press, 1996.

1. **Title of ILAS validation experiment**

Validation of ILAS data by ground based measurement of NO2, and O3 from Kiruna

2. Investigators

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3. Target species, profiles or column

1) **Target species for ILAS**: **total column of NO2 and O3**

2) Other target species: none

4. **Category** of ILAS validation experiments

Core experiment

5. **Significance** of the validation experiment for ILAS

We plan to make simultaneous measurement of total column amount of O3 and NO2 from Kiruna, Sweden to compare with ILAS measurements.

6. **Details of implementation plan** for the experiment

1) **Location**: **Swedish Institute of Space physics (Kiruna, Sweden**; 68N, 21E)

2) **Instrument**

(1) Name: **UV-visible spectrometer**

(2) Principle:

The instrument to measure NO2 and O3 is a UV/Visible spectrometer. Slant NO2 and O3 column amounts are derived twice (sunrise and sunset) a day by taking the ratio of the twilight and mid-day control spectra. These numbers are obtained by least square fitting taking into account the absorptions of NO2, O3, O4, H2O, and Ring effect. A correlation coefficient which indicates the precision in fitting the synthetic spectra to the measured spectra is calculated for all NO2 and O3 data.

3) Accuracy/Precision (A/P), Averaging time (AT):

Species		A / P	AT
NO2	(column)	5 % / 5 %	2 min
O3	(column)	5 % / 5 %	2 min

4) Situation on facilities and equipment especially for the experiment

Facilities at Swedish Institute of Space physics in Kiruna are available for ground-based experiments. Visible spectrometer has been installed.

5) Schedule for the experiment:

(1) Preparation:

Preparation of instrument for the experiment started on 1995.

(2) Execution period of the measurements:

Ground based measurements from late August 1996.

(3) Data submission:

4 months after the measurements.

7. Details of implementation plan for ILAS validation analysis using the experiment data

1) Requested ILAS data for the analysis:

(1) Species or Physical properties: O3, NO2, HNO3, N2O

(2) Dates and Locations:

a. Dates: First data when ILAS data are obtained --- March 1997

b. Locations: Site over Kiruna (68N, 21E) and adjacent regions in the range of 500 km.

2) Method of the analysis:

Comparison between column amounts by visible spectrometer and those calculated from ILAS data.

3) Submission dates of the results:

6 months after the arrival of data

8. Related Publications

1) Instrument explanation:

- Solomon, S., A. L. Schmeltekopf, and R. W. Sanders, On the interpretation of zenith sky absorption measurements, J. Geophys. Res., 92, 8311-8319, 1987.

2) Scientific results:

- Koike, M., Y. Kondo, W.A. Matthews, P.V. Johnston, Decrease of stratospheric NO2 observed at 44N due to Pinatubo volcanic aerosols, Geophys. Res. Lett., 20, 1975-1978, 1993.
- Kondo, Y., W. A. Matthews, S. Solomon, M. Koike, M. Hayashi, K. Yamazaki, H. Nakajima, and K. Tsukui, Ground-based measurements of column amounts of NO2 over Syowa Station, Antarctica, J. Geophys. Res., 99, 14,535-14,548, 1994.

1. **Title of ILAS validation experiment**

Measurements of O3, CH4, and N2O with a laser heterodyne spectrometer in February - March 1997

2. Investigators

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3. Target species, profiles or column

1) **Target species for ILAS:** ***profiles and column of O3, CH4, and N2O***

2) Other target species: none

4. **Category** of ILAS validation experiments

Core experiment

5. **Significance** of the validation experiment for ILAS

In this validation experiment vertical profiles of ozone, methane and nitrous oxide obtained from ILAS measurements will be compared with those obtained from ground-based laser heterodyne spectrometer measurements. Since the laser heterodyne spectrometer can derive absolute values of vertical profiles and column densities of those species, theoretical performance of the ILAS instrument will be confirmed by this experiment. The significance of this experiment is not only for the validation of the ILAS instrument but also for scientific interest in measurements of those minor species with a high-time resolution at a fixed place in the winter polar region.

6. **Details of implementation plan** for the experiment

1) **Location: Poker Flat Research Range (Fairbanks, Alaska;** 65N, 148W)

2) **Instrument**:

(1) Name: **TDLHS; Tunable Diode Laser Heterodyne Spectrometer**

(2) Principle:

Vertical profiles of ozone, methane, and nitrous oxide are derived from high resolution absorption spectra using an inversion technique. The instrument employed to obtain the spectra is a Tunable Diode Laser Heterodyne Spectrometer (TDLHS). TDLHS measures solar infrared absorption line profiles of atmospheric trace constituents with a wavenumber resolution of as high as 0.0013 cm-1.

3) Altitude range (AR), Accuracy/Precision (A/P), Vertical resolution (VR), Averaging time (AT):

Species		AR	A / P	VR	AT
O3	(profile)	10 - 30 km	10 % / 10 %	5 km	10 min.
O3	(column)	-	5 % / 5 %	-	10 min.
CH4	(profile)	2 - 30 km	20 % / 20 %	15 km	1 hour
CH4	(column)	-	5 % / 5 %	-	1 hour
N2O	(profile)	2 - 30 km	10 % / 10 %	5 km	1 hour
N2O	(column)	-	5 % / 5 %		1 hour

4) Situation on Facilities and Equipment especially for the experiment:

A proposal has been submitted to Geophysical Institute, University of Alaska concerning preparation of facilities for IR measurements at the new optical building of Poker Flat Research Range. Our portable TDLHS has already been in use. Another TDLHS will be available by the time of validation experiments.

5) Schedule of the experiment:

(1) Preparation:

August - September 1996 Installation and calibration of new local oscillator lasers
October - December 1996 Test observation in Sendai
January 1997 Shipping to Alaska

(2) Execution period of the measurements:

The beginning of February - The beginning of March 1997, 40 days, during clear sky daytime

(3) Data submission:

4 months after the measurements

7. Details of implementation plan for ILAS validation analysis using the experiment data

1) Requested ILAS data for the analysis:

(1) Species: O3, N2O, CH4

(2) Dates and Location:

a. Dates: February - March 1997

b. Location: Fairbanks, Poker Flat Research Range (65N, 148 W)

2) Method of the analysis:
Comparison between vertical profiles obtained by TDLHS and ILAS measurements
Comparison between column densities obtained by TDLHS and ILAS measurements

3) Submission dates of the results:
6 months after the measurements

8. Related Publications

1) Instrument explanation:

- Fukunishi, H., S. Okano, M. Taguchi, and T. Ohnuma, Laser heterodyne spectrometer using a liquid nitrogen cooled tunable diode laser for remote measurements of atmospheric O3 and N2O, Appl. Opt., 18, 2722-2728, 1990.

2) Scientific results:

- Koide, M., M. Taguchi, H. Fukunishi, and S. Okano, Ground-based remote sensing of atmospheric O3, N2O, HNO3 and CH4 with a tunable diode laser heterodyne spectrometer at Syowa station, Antarctica, Proceedings for International Symposium on Optical Science, Engineering and Instrumentation, Denver, CO U.S.A., 4-9 August, 1996.

1. **Title of ILAS validation experiment**

Lidar observations of aerosols in Alaska

2. Investigators

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3. Target species, profiles or column

1) **Target species for ILAS**: **profiles of Stratospheric aerosols and temperature**

2) Other target species: none

4. **Category** of ILAS validation experiments

Core experiment

5. **Significance** of validation experiments for ILAS

Monitoring of troposphere and stratospheric aerosol density and particle nonspherisity with a lidar should provide basic data set to understand scattering processes of particulate and gases measured by ILAS. Combination of measurements at two different wavelengths also can provide useful information about size of particulate.

6. **Details of implementation plan** for the experiment

1) **Location: Fairbanks (Alaska, USA**; 65N, 148W)

2) **Instrument**:

(1) Name: **Rayleigh/Mie Lidar**

(2) Principle: Nd-YAG Laser Pulse Repetition 10 Hz Power 0.5 J/pulse
Wavelength 1.06 and 0.53 mm
Polarization Measurement
30 cm f Telescope for scattering light detection
Scattering Ratio at l=1.06 and 0.53 mm
Depolarization Rastio l= 0.53 mm
Size Parameter aÅ (b µ l - a)
Atmospheric Temperature

3) Altitude Range (AR), Accuracy/Precision (A/P), Vertical resolution (VR), Integration time (IT):

Species	AR	A / P	VR	IT
Aerosol	15 - 35 km	max 1 %(<10 km)/ 3 min. 5 %(<30 km)/ 10 min.	150 m	10 min. (average)
Temperature	10 - 60 km	max 5 %(<30 km)/ 30 min. 5 %(<60 km)/100 min.	900 m	120 min. (average)

4) Situation on facilities and equipment especially for the experiment:

STEL/Nagoya University has been making a cooperation on polar stratospheric aerosols with Geophysical Institute/University of Alaska, Fairbanks and Department of Physics/Fukuoka University at the lidar station of Fairbanks since December 1991. Those facility will be used for this ILAS validation experiment and measurements on aerosol backscattering coefficients, depolarization ratio, alpha, and atmospheric temperature will be provided.

5) Schedule for the experiment:

(1) Preparation

Practically, we are ready. Small parts of optics and mechanics will be transported in November 1996 if it will be necessary.

(2) Execution period of the measurements

The beginning of January-the beginning of March, 1997, 80 days

(3) Data submission

1st version data will be provided 2 weeks after the measurements

6) Comments:

We have a plan to make measurements in same location on April, 1997 as a cooperative experiment for ILAS Validation.

7. Details of implementation plan for ILAS validation analysis using the experiment data

1)Requested ILAS data for the analysis

(1) Species or physical properties:

aerosol density or extinction coefficient (vertical and horizontal in the northern polar region) observed at multiwavelengths

(2) Date and Location

Fall-winter-spring, at least the date corresponding to lidar measurements period
At least near the lidar station (65N, 148W)

2) Method of analysis

Comparison of Lidar Data and ILAS Data

3) Submission Dates of results

May 1997

4) Comments

Meteorological information should be essential to enhance data quality. We hope we can smoothly obtain meteorological data from the ILAS Project.

8. Related Publications

1) Scientific Results

- Transport of Pinatubo aerosols to the Arctic region: Lidar measurements in Alaska, winter 1991/1992, Y. Iwasaka, M. Hayashi, T. Shibata et al., Proc. NIPR Symp. Polar Meteorol. Galciol., 8, 27-33, 1994.
- Lidar measurements at Alaska, 1991-1994, Y. Iwasaka, T. Shibata, M. Hayashi, et al., Laser Rev., 23, 166-170, 1995. Significance of the validation experiment for ILAS.

1. **Title of ILAS validation experiment**

Co-ordinated Ground-based Observations at High Latitudes

2. Investigators

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Name (role):	Dr. Hideaki Nakajima (UV/visible analysis)
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3. Target species, profiles or column

1) **Target species for ILAS:** **column of NO2, O3, HNO3, CFC-12, CH4, and N2O**

2) Other target species: column of CFC-22, ClONO2

4. **Category** of ILAS validation experiments

Core experiment

5. **Significance** of the validation experiment for ILAS

Measure the column abundance of key ILAS species from the ground at sites in Antarctica including Arrival Heights at 78 S and Macquarie Island at 55 S. This data series will provide a longer term data series against which the ILAS measurements can be validated and the longer term series at these sites gives an indication of the expected shorter term variation as well as season trends. Time series from sunrise and sunset observation every day will be obtained from the zenith viewing UV-visible spectrometer systems. In addition, the altitude distribution can be obtained from special studies using the Umkehr methodology for some periods of the year. The FTS system will deliver column abundance measurements under clear sun conditions and when the solar elevation is less than 85 degree so that there is sufficient signal to noise. A satellite link exists between the New Zealand Antarctic Base, Arrival Heights and Lauder in New Zealand and hence it is possible to work interactively with the scientists in Antarctica and use File Transfer Protocol (FTP) to send the data sets to Lauder for quality control and near real time data analysis. Consequently it is anticipated that specific subsets (e.g. clear sky conditions and satellite co-location), will be transmitted electronically to Lauder for processing and then relayed to ILAS instrument PIs for validation purposes. This is seen as particularly valuable in the early stages of the mission.

6. **Details of implementation plan** for the experiment

1) **Locations**:

a. **Arrival Heights (Antarctica**; 78 S, 167 E)

b. **Macquarie Island** (55 S, 159 E)

2) **Instruments**:

(1) Name:

a. **UV/visible spectrometer**: NO2, O3 at Arrival Heights, Macquarie Island

b. **Dobson spectrophotometer**: O3 at Arrival Heights

c. **FTS**: HNO3, CH4, N2O, CFC-12, CFC-22, OClNO2 at Arrival Heights

(2) principle:

High resolution absorption spectroscopy will be used as the method to obtain the absorption signature of the species of interest.

a. **UV/visible spectrometer**: NO2 and O3 will be measured using UV-visible spectrometers at Arrival Heights and Macquarie Island. The technique uses a multiparameter least squares fitting technique that uses not only the laboratory absorption cross sections of NO2, O3 and water vapor, but also instrumental effects resulting from temperature changes, polarization and the Ring effect. At a number of these sites an extensive data series already exists and this would be extended during the ILAS mission to provide the background against which the ILAS can not only be validated, but also it will allow a degree of algorithm testing. Both NO2 and O3 are measured in the 405 - 465 nm region.

b. **Dobson spectrophotometer**: NIWA also operates a Dobson spectrophotometer at Arrival Heights and this data will also be made available to the ILAS team.

c. **FTS**: At Arrival Heights, a high resolution FTS will be operated during the mission to obtain both column abundance, and with some species an idea of the vertical distribution of such important species as:

HNO3 865 - 875 cm^{-1}

CFC-12	920 - 924 cm^{-1}	Q -nu6 band with structure
CFC-22	828 - 829 cm^{-1}	Q2 -nu2 line at 829.05 cm^{-1}
OClNO2	779 - 781 cm^{-1}	Q -nu4 lines at 780.2 cm^{-1}

and CH4 and N2O at a number of wave numbers. (CFC- 11 at 830 - 870 cm^{-1} is very broad feature and is very difficult to quantify with any useful precision.) The FTS system will be operated in a direct sun mode and at appropriate solar elevations.

3) Accuracy/Precision (A/P), Averaging time (AT):

Species	A	/	P	AT
<UV-visible>				
NO2	(+/-)$2x10^{15}$ mol/cm^2	/	$2x10^{15}$ mol/cm^2	5 min.
O3	(+/-)$2x10^{18}$ mol/cm^2	/	$2x10^{18}$ mol/cm^2	5 min.
<Dobson>				
O3	3 %	/	2 %	5 min.
<FTS>				
HNO3	15 %	/	15 %	5-20 min.
N2O	10 %	/	10 %	5-20 min.
CH4	10 %	/	10 %	5-20 min.
CFC-12	20 %	/	20 %	5-20 min.
CFC-22	20 %	/	20 %	5-20 min.
OClNO2	25 %	/	25 %	10-30 min.

4) Situation on facilities and equipment especially for the experiment:

The fully equipped Laboratory at Arrival Heights is maintained by the New Zealand Antarctic Institute (NZAI). The Laboratory is serviced by scientists and engineers from Scott Base some 6 km away. These are permanent facilities and are fully manned all year. The NIWA experiments are operated by joint NIWA / NZAI scientists and engineers and staff from Lauder visit the site during the open season.

The site at Macquarie Island is operated and maintained by the Australian Bureau of Meteorology and an NO2/O3 spectrometer is operated there on our behalf in a joint experiment.

5) Schedule for the experiment:

(1) Preparation:

The instrumentation detailed above has already been field tested and these experiments will remain in the field at the locations listed for the ILAS mission. It is possible that the only changes to be made to existing systems will be those for routine maintenance or system upgrades.

(2) Execution period of the measurements:

a. UV-visible: 2 observations per day August-April each year, twilight measurements not effected by cloud

b. Dobson: August through March on direct sun observations under clear sky, and some moon observations through winter

c. FTS: each Spring through Fall on available sunny days.

(3) Data submission:

6 months after the measurements dependent on time of year

7. Details of implementation plan for ILAS validation analysis using the experiment data

1) Requested ILAS data for the analysis:

(1) Species or physical properties:

O3, NO2, HNO3, N2O, CH4, H20, CFC-11

(2) Dates and Locations:

a. Dates: as soon as possible after switch on and then continuing.

b. Locations: Arrival Heights (Antarctica 78 S, 167 E),
Macquarie Island (55 S, 159 E)

2) Method of the analysis:

Comparison between retrieved height profile and ILAS data (for O3, N2O, and CH4).

Comparison between column values by FTS spectra and those calculated from ILAS data.

Correlation analysis of O3-HNO3, HNO3-N2O, HNO3-CH4, N2O-CH4, etc.

3) Submission dates of the results:

6 months after the measurements

8. Related Publications

1) Instrument explanation:

- Jones, N.B., M. Koike, W.A. Matthews, and B.M. McNamara, Southern hemisphere mid-latitude seasonal cycle in total column nitric acid, Geophys. Res. Lett., 21, 593-596, 1994.

2) Scientific results:

- Keys, J. G., P. V. Johnston, R. D. Blatherwick, and F. J. Murcray, Evidence of heterogeneous reactions involving nitrogen compounds in the Antarctic stratosphere, Nature, 361, 49-51, 1993.
- Koike, M., N.B. Jones, W.A. Matthews, P.V. Johnston, R.L. McKenzie, D. Kinnison, and J. Rodriguez, Impact of Pinatubo aerosols on the partitioning between NO2 and HNO3, Geophys. Res. Lett., 21, 597-600, 1994.
- Liu, X., F.J. Murcray, D.G. Murcray, and J.M. Russell III, Comparison of HF and HCl vertical profiles from ground-based high resolution infrared solar spectra with HALOE observations, J. Geophys. Res., in press, 1996.

1. Title of ILAS validation experiment

Ground-based Observation with UV-visible spectrometer at Syowa Station Antarctica

2. Investigators

1) **Principal Investigator**

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3. Target species, profiles or column

1) **Target species for ILAS**: **total column of NO2 and O3**

2) Other target species: none

4. **Category** of ILAS validation experiments

Core experiment

5. **Significance** of the validation experiment for ILAS

We plan to make simultaneous measurement of total column amount of O3 and NO2 from Syowa Station, Antarctica to compare with ILAS measurements.

6. **Details of implementation plan** for the experiment

1) **Location: Syowa Station (Antarctica**; 69S, 40E)

2) **Instrument**:

(1) Name: **UV-visible Spectrometer**

(2) Principle:

The instrument to measure NO2 and O3 is a UV/Visible spectrometer. Slant NO2 and O3 column amounts are derived twice (sunrise and sunset) a day by taking the ratio of the twilight and mid-day control spectra. These numbers are obtained by least square fitting taking into account the absorptions of NO2, O3, O4, H2O, and Ring effect. A correlation coefficient which indicates the precision in fitting the synthetic spectra to the measured spectra is calculated for all NO2 and O3 data.

3) Accuracy/Precision (A/P), Averaging time (AT)

Species		A / P	AT
NO2	(column)	5 % / 5 %	2 min.
O3	(column)	5 % / 5 %	2 min.

4) Situation on Facilities and Equipment especially for the experiment:

Facilities of Syowa Station is available for ground-based experiments.
Visible spectrometer has been installed.

5) Schedule for the experiment:

(1) Preparation:

Preparation of instrument for the experiment started on 1989.

(2) Execution period of the measurements:

The measurements was executed from 1990.

(3) Data submission:

4 months after the arrival of data.

6) Comments:

Cooperated observation with National Institute of Polar Research (NIPR)

7. Details of implementation plan for ILAS validation analysis using the experiment data

1) Requested ILAS data for the analysis:

(1) Species or physical properties: O3, NO2, HNO3, N2O

(2) Dates and Locations:

a. Dates: First data when ILAS data are obtained --- March 1997

b. Loctations: Site over the Syowa Station (69S, 40E) and adjacent regions in the range of 500 km.

2) Method of the analysis:

Comparison between column amounts by visible spectrometer and those calculated from ILAS data.

3) Submission dates of the results:
6 months after the arrival of data

8. Related Publications

1) Instrument explanation:

- Solomon, S., A. L. Schmeltekopf, and R. W. Sanders, On the interpretation of zenith sky absorption measurements, J. Geophys. Res., 92, 8311-8319, 1987.

2) Scientific results:

- Koike, M., Y. Kondo, W. A. Matthews, P. V. Johnston, Decrease of stratospheric NO2 observed at 44N due to Pinatubo volcanic aerosols, Geophys. Res. Lett., 20, 1975-1978, 1993.
- Kondo, Y., W. A. Matthews, S. Solomon, M. Koike, M. Hayashi, K. Yamazaki, H. Nakajima, and K. Tsukui, Ground-based measurements of column amounts of NO2 over Syowa Station, Antarctica, J. Geophys. Res., 99, 14, 535-14, 548, 1994.

1. **Title of ILAS validation experiment**

Ozonesonde observation at Syowa Station, Antarctica

2. Investigators

1) **Principal Investigator**

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3. **Target species**, profiles or column

1) Target species for ILAS: **Vertical profile of O3, Temperature**

2) Other target species: none

4. **Category** of ILAS validation experiments

Core experiment

5. **Significance** of the validation experiment for ILAS

The ozone profile is a key parameter of the ILAS measurement. The ozonesonde measurements will provide one of the earliest validation data for vertical profile of ozone. They will thus be very much useful to firstly check the quality of ILAS data.

6. **Details of implementation plan** for the experiment

1) Location: **Syowa Station** (**Antarctica**: 69S, 40E)

2) Instrument

(1) Name: Ozonesonde (type RS II-KC79D)

(2) Principle: Electrochemical reaction

The RS II-KC79D ozonesonde operates electrochemically on the reaction of ozone with potassium iodide solution. The air is drawn into the solution by a small pump which is made of methacrylic resin. The detector cell is made of methacrylic resin. Ozone (O3) in the air drawn in reacts with the potassium iodide solution in the detector cell and liberates free iodine (I2). The free iodine contacts a platinum gauze electrode and is reconverted into iodide ($2I^-$). Accordingly, one ozone molecule produces a current of two electrons. The resulting current is amplified by a D.C. amplifier.

The atmospheric pressure is measured with an aneroid barometer.

The air temperature and the cell temperature are measured with thermistors.

3) Altitude range (AR), Accuracy/Precision (A/P), Vertical resolution (VR), Averaging time (AT):

Species	AR	A / P	VR	AT
O3	0 - 30 km	5 % / 5 %	a few hundreds meters	a few ten seconds

4) Situation on facilities and equipment especially for the experiment:

The ozonesonde observations have been continuously carried out since 1967 by the Japan Meteorological Agency (JMA) at Syowa Station as one of the activities of the Japanese Antarctic Research Expedition (JARE) managed by the National Institute of Polar Research (NIPR). Additional ozonesonde soundings for ILAS validation will be made cooperatively by ILAS project of NIES and NIPR with help of JMA from 1996. The ground system for data receiving and processing which have been installed and maintained by JMA and JARE will be used for the present observation. The data will be sent from Syowa Station to Japan via e-mail.

5) Schedule for the experiment:

(1) Preparation:

Materials for ozonesonde observations were prepared, and were shipped from Japan toward Syowa Station in November 1995 by JARE-37 and in November 1996 by JARE-38.

(2) Execution period of the measurements:

About 24 soundings around November 1996 - February 1997

About 24 soundings around May - July 1997

Possibly other soundings in other periods

(3) Data submission:

Final: Three months after the measurements. (Preliminary: A few days after the measurements)

(4) Comments:

Cooperative observation with National Institute of Polar Research

7. **Details of implementation plan** for ILAS validation analysis using the experiment data

1) Requested ILAS data for the analysis:

(1) Parameters (species or physical properties):

Vertical profiles of O3 mixing ratio and temperature.

(2) Dates and Location(s):

a. Dates: Coinciding with ozonesonde flights from Syowa Station

b. Location(s): Syowa Station (69S, 40 E) within a range of 500 km.

2) Method of the analysis:

Comparison between vertical profiles from the in situ ozonesonde data and the corresponding ILAS data. The in situ data will be averaged to match the vertical resolution of the ILAS data.

3) Submission dates of the results:
Final: Three months after the measurements. (Preliminary: A few days after the measurements)

4) Comments:
None

8. Related Publications

1) Instrument explanation:

- Grant, W.B. ed. (1989): Ozone Measuring Instruments for the Stratosphere, Vol. 1 of Collected Works in Optics. Washington, D.C., Optical Society of America, 93-95.

2) Scientific results:

- Kanzawa, H. and Kawaguchi, S. (1990): Large stratospheric sudden warming in Antarctic late winter and shallow ozone hole in 1988. Geophys. Res. Lett., 17, No. 1, 77-80.
- Hayashi, M., Murata, I., Fujii, R., Iwasaka, Y., Kondo, Y. and Kanzawa, H. (1994): Observation of ozone and aerosols in the Antarctic ozone hole of 1991 under the Polar Patrol Balloon (PPB) project -Preliminary result-. Ozone in the Troposphere and Stratosphere (Proc. Quadrennial Ozone Symp. 1992, Charlottesville, Virginia, U.S.A., June 4-13, 1992), Hudson, R.D., Ed., NASA Conf. Pub. 3266, 565-568.
- Gernandt, H., Dethloff, K. and Kanzawa, H. (1994): A qualitative assessment of height dependent interannual variability of polar stratospheric ozone Part 1: Long-term variability and stratospheric ozone depletion. Proc. NIPR Symp. Polar Meteorol. Glaciol., 8, 1-13.

1. **Title of ILAS validation experiment**

Ground-based SAOZ UV-visible spectrometer stations in Greenland, Finland, Siberia, and Antarctica

2. Investigators

1) **Principal Investigator**

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2) Co-Investigator

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3. Target species, profiles or column

1) **Target species for ILAS**: **total column of O3 and NO2**

2) Other target species: PSCs (colour index)

4. **Category** of ILAS validation experiments

Cooperative experiment

5. **Significance** of the validation experiment for ILAS

Daily all weather sunrise and sunset total column measurements throughout the year. NO2 diurnal variation. Large number of continuous data for checking the possible seasonal dependences of the retrieved column species.

6. Details of implementation plan for the experiment

1) **Location**: a. **Scoresbysund (Greenland**; 71N, 27W)
b. **Sodankyla (Finland**; 67N, 26E)
c. **Zhigansk (Siberia**; 67N, 127E)
d. **Dumont d'Urville (Antarctica**; 67S, 140E)

2) **Instrument**:

(1) Name: **UV-visible Spectrometer (SAOZ)**

(2) Principle:

The instrument developed by J.P. Pommereau and F. Goutail at Service d'Aeronomie du CNRS is a diode array spectrometer (512 or 1024 diodes) working in the ultraviolet and visible wavelength ranges (290-630 nm) with a spectral resolution of 0.8 nm. Total ozone is measured in the visible Chappuis bands, which allows the measurements to be performed at large solar zenith angles, especially during the high latitude winter period.

Such measurements are also independent of the stratospheric temperature. The performance of the instrument have been validated in the recent NDSC instrument validation campaign in New Zealand (1992), UK (1994), Arosa (1995) and Haute Provence (1996).

3) Accuracy/Precision (A/P) and Averaging time (AT):

Species		A / P	AT
O3	(column)	3 % / 1 %	20 min
NO2	(column)	10 % / 2 %	20 min

4) Situation on facilities and equipment especially for the experiment:

The instruments are measuring twice a day the total columns of ozone, nitrogen dioxide and can detect the presence of polar stratospheric clouds in the polar winter. The data are processed in real time and the results are immediately available through the Argos satellite data collection system. The SAOZ measurements have already been used for the validation of UARS, POAM, of the TOMS instrument on both the Nimbus-7 and Meteor-3 satellite, and of the GOME-ERS2.

5) Schedule for the experiment:

(1) Preparation:
Operational

(2) Execution period of the measurements:
Station running permanently

(3) Data submission:
Preliminary data available in real time. Final form a few months later (2 months for Finland and Greenland; 1 year for Siberia and Antarctica). Very little difference between preliminary and final data.

6) Comments:

Access to data of other polar SAOZ stations run by foreign institutes (Ny-Alesund and Thule in the Arctic, Rothera in the Antarctic)

7. Details of implementation plan for ILAS validation analysis using the experiment data

1) Requested ILAS data for the analysis:

(1) Species or physical properties:
O3 and NO2 columns (or profiles) above the stations

(2) Dates and Locations

a. Dates: from the beginning of the measurements and onward

b. Locations:
a. Scoresbysund (Greenland 71N, 27W)
b. Sodankyla (Finland 67N, 26E)
c. Zhigansk (Siberia 67N, 127E)
d. Dumont d'Urville (Antarctica 67S, 140E)

2) Method of the analysis:

Comparisons of time series, sun zenith angle, temperature and profile dependences.

3) Submission dates of the results:

3 months

8. Related Publications

1) Instrument explanation:

- Pommereau, J.P. and F. Goutail, O3 and NO2 Ground-Based Measurements by Visible Spectrometry during Arctic Winter and Spring 1988, Geophys. Res. Lett., 891, 1988.
- Pommereau, J.P. and F. Goutail, Stratospheric O3 and NO2 Observations at the Southern Polar Circle in Summer and Fall 1988, Geophys. Res. Lett., 895, 1988.
- Sarkissian, A., J. P. Pommereau and F. Goutail, Identification of polar stratospheric clouds from the ground by visible spectrometry, Geophys. Res. Lett., 18, 779, 1991.

2) Scientific results:

- Sarkissian A., J. P. Pommereau, F. Goutail and E. Kyro, PSC and volcanic aerosol observations during EASOE by UV-visble ground-based spectrometry, Geophys. Res. Lett., 13, 1319-1322, 1994.
- Goutail F., J.P. Pommereau, A. Sarkissian, E. Kyro and V. Dorohkov, Total nitrogen dioxide at the Arctic polar circle since 1990, Geophys. Res. Lett., 13, 1371-1374, 1994.
- Sarkissian, A., H.K. Roscoe, D. Fish, M. Van Roozendael, M. Gil, H. B. Chen, P. Wang, J.P. Pommereau and J. Lenoble, Ozone and NO2 AMF for zenith sky spectrometer: Intercomparison of calculations with different radiative transfert model, J. Geophys. Res., 1113-1116, 1995.
- Hofmann, D.,J., P. Bonasoni, M. De Mazière, F. Evangelisti, A. Sarkissian, G. Giovanelli, A. Goldman, F. Goutail, J. Harder, R. Jakoubek, P. Johnston, J. Kerr, T. McElroy, R. McKenzie, G. Mount, J. P. Pommereau, P. Simon, S. Solomon, J. Stutz, A. Thomas, M. Van Roozendael, E. Wu, Intercomparison of UV/Visible Spectrometers for measurements of Stratospheric NO2 for the Network for the Detection of Stratospheric Change, J. Geophys. Res., 16,765-16,791, 1995.
- Vaughan G., H. K Roscoe, L.M. Bartlett, F.M. O'Connor, A. Sarkissian, M. Van Roozendael, J-C. Lambert, P. C. Simon, K. Karlsen, B. A. Kastad Hoskar, D. J. Fish, R. L. Jones, R. Freshwater, J-P. Pommereau, F. Goutail, S. B. Andersen, D. G. Drew, P. A. Hughes, D. Moore, J. Mellqvist, E. Hegels, T. Klupfel, F. Erle, K. Pfeilsticker, and U. Platt, An intercomparison of ground-based UV- visible sensors of Ozone and NO2; J. Geophys. Res., in press, 1996.
- Hoiskar, B.A.K., A. Dahlbak, G. Vaughan, G.O. Braathen, F. Goutail, J.P. Pommereau and R.Kivi, Seasonal variations in airmass factors for ozone computations based on climatology data, J. Quant. Res. Spect. Trans, in press, 1996.
- Van Roozendael, M., M. de Mazière, C. Hermans, P.C. Simon, J.P. Pommereau, F. Goutail, X.X. Tie, G. Brasseur and C. Granier, Ground-Based Observations of Stratospheric NO2 at high and mid-latitudes in Europe after the Mt Pinatubo Eruption, J. Geophys. Res., in press, 1996.
- Goutail, F., J-P. Pommereau, C. Phillips, F. Lefevre, E. Kyro, M. Rummukainen, P. Ericksen, S.B. Andersen, B-A Kaastadt Hoiskar, G. Braathen, V. Dorokhov and V.U. Khattatov, Ozone depletion in the Arctic during the winter 1994-95, J. Atm. Chem., submitted, 1996.
- Van Roozendael, M., P. Peeters, P.C. Simon, H. Roscoe, A. Jones, L. Bartlett, G. Vaughan, F. Goutail, J. P. Pommereau, E. Kyro, C. Walhstrom and G. Braathen, Absolute calibration of SAOZ measurements of ozone by comparison with Dobson and Brewer instruments, Proc. 3rd Europ. Symp. on Polar Ozone, EC ed., 1996.

- Pommereau, J. P., F. Goutail and A. Sarkissian, SAOZ total ozone measurements in Antarctica. Comparisons with TOMS versions 6 and 7, Proc. 3rd Europ. Symp. on Polar Ozone, EC ed., 1996.
- Lambert, J-C, M. Van Roozendael, P.C. Simon, M. de Maziere, J-P. Pommereau, F. Goutail, A. Sarkissian, L. Denis, V. Dorokhov, P. Ericksen, E. Kyro, J. Leveau, H.K. Roscoe, G. Vaughan and C. Walhstrom, GOME products validation with the SAOZ network, Workshop on GOME validation, ESA, 1996.

1. Title of ILAS validation experiment

Ground-based Observation with Rayleigh/Mie/Raman Lidar at ALOMAR in Norway

2. Investigators

1) **Principal Investigator**

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2) Co-Investigators

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Name (role):	Federico Fierli (Rotational Raman lidar temperature)
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(The Rayleigh/Mie/Raman Lidar at ALOMAR is operated in cooperation with other scientists that are not directly involved in the ILAS Validation Experiment)

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Name (role):	Dr. K. H. Fricke (Rayleigh, aerosols, H2O)
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3. Target species, profiles or column

1) **Target species for ILAS**: **vertical profiles of aerosols, temperature, H_2O**

2) Other target species: none

4. **Category** of ILAS validation experiments

Cooperative experiment

5. **Significance** of the validation experiment for ILAS

We plan to make simultaneous measurements of temperature and aerosols when good coincidences are possible to compare with ILAS measurements. Since the depolarisation ratio of aerosols backscattering is measured, it will help to interpret measurements of aerosols extinction made by ILAS.

6. **Details of implementation plan** for the experiment

1) **Location: ALOMAR station** at Andoya Rocket Range (**Norway**; 69N, 16E)

2) **Instrument**:

(1) Name: **The ALOMAR Rayleigh/Mie/Raman lidar**

(2) Principle:

a. Temperature profile above 25-30 km: obtained from Rayleigh scattering at 532 nm (density profile) and assumption of the hydrostatic equilibrium

b. Temperature profile below 25-30 km: measured by the rotational Raman technique

c. Aerosols: Mie scattering at 3 wavelengths (1064 nm, 532 nm and 355 nm) + depolarisation ratio at 532 nm

d. H2O: vibrational Raman scattering

3) Altitude range (AR), Accuracy/Precision (A/P), Vertical resolution (VR), Averaging time (AT):

Species	AR	A / P	VR	AT
H2O (profile)	8-12 km	20 %/ 20 %	150 m	1 hour
Aerosol (profile)	8-30 km	2 %/ 1 %	150 m	3 min.
Temperature (profile)	8-90 km	2 K/ 1K (below 50 km) 5 K/ 5K (at 70 km) 10 K/ 10K (at 80 km)	150 m	30 min.

4) Situation on facilities and equipment especially for the experiment:

The Arctic Observatory for Middle Atmosphere Research (ALOMAR) is an international research facility built on the Andoya Island (69N, 16E) in Northern Norway administrated by Andoya Rocket Range. It is operational since the summer of 1994. The core instrument is the Rayleigh/Mie/Raman lidar. It includes 2 oriental telescopes (1.8 m diameter), 2 Nd-Yag laser, 12 optical channels. Several other instruments are operational including a stratospheric ozone lidar and a MST radar.

5) Schedule for the experiment:

(1) Preparation:

The measurements are presently performed routinely at ALOMAR. They are limited to clear sky conditions.

(2) Execution period of the measurements:

All around the year including the summer period with 24 hours day-time

(3) Data submission:

3 months after the measurements

7. Details of implementation plan for ILAS validation analysis using the experiment data

1) Requested ILAS data for the analysis:

(1) Parameter(s) (species or physical properties):
Temperature pressure and aerosols ILAS profiles

(2) Dates and Location:
a. Dates: All around the year

b. Location: 1000 km around the ALOMAR station (Norway 69N, 16E)

2) Method of the analysis:
case by case and statistical comparisons of ILAS and lidar profiles.

3) Submission dates of the results:
6 months after the measurements

8. Related Publications

1) Instrument explanation:

- HAUCHECORNE A., M.L. CHANIN, Density and temperature profiles obtained by lidar between 35 and 70 km, Geophys. Res. Lett., 7, 565-568, 1980.
- KECKHUT P., A. HAUCHECORNE, M.L. CHANIN, A critical review of the data base acquired for the long term surveillance of the middle atmosphere by Rayleigh lidar, J. Atm. Ocean. Tech., 10, 850-867, 1993.
- NEDELJKOVIC N., A. HAUCHECORNE, M.L. CHANIN, Rotational Raman lidar to measure the atmospheric temperature from the ground to 30 km, IEEE Transactions on Geoscience and Remote Sensing, 31, 91-101, 1993.

2) Scientific results:

- HAUCHECORNE A., M.L. CHANIN, P. KECKHUT, Climatology and trends of the middle atmospheric temperature (33-87 km) as seen by Rayleigh lidar above south of France, J. Geophys. Res., 96, 15297-15309, 1991.
- KECKHUT P., A. HAUCHECORNE, AND M.L. CHANIN, Mid-latitude long-term variability of the middle atmosphere: trends, cyclic and episodic changes, Accepted in J. Geophys. Res., 1995.
- LEBLANC T., A. HAUCHECORNE, M.L. CHANIN, C. RODGERS, F. TAYLOR, AND N. LIVESEY, Mesospheric temperature inversions as seen by isams in December 1991, Geophys. Res. Let., 22, 1485-1488, 1995.
- A. HAUCHECORNE, D. NEDELJKOVIC, M.L. CHANIN, B. NARDI, G. VON COSSART, J. FIEDLER, U. VON ZAHN, K.-H. FRICKE AND V. NUSSBAUMER, Evolution of the stratospheric temperature and relation with the presence of PSCs as seen by ALOMAR Rayleigh and Raman lidar during SESAME, Proceedings of the third European workshop on polar stratospheric ozone, pp 117-121, published by European Commission, Brussels, 1996.

1. **Title of the ILAS Validation experiment**

Validation of ILAS data by ground based measurement with the GKSS Raman lidar from Kiruna.

2. **Principle Investigator**

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3. **Target Species**, Profiles or column

Profiles of stratospheric **Ozone**, stratospheric and tropospheric **aerosol properties** (PSCs), stratospheric **temperature**, and tropospheric **water vapor** during darkness.

4. **Category** of ILAS validation experiments

Cooperative Experiment

5. **Significance** of the validation experiment for ILAS

1) Basic comparison of Ozone, water vapor, temperature and aerosol properties at the most correlated data points during the period between 20 December 1996 until 3 Febrauray 1997.

2) Quantitative informations (optical depth, if necessary) on the stratospheric aerosol content (PSCs) between 7 January and 24 January 1997.

3) Together with other ground based instruments of the ILAS campaign operated at IRF (e.g. FTIR; Nagoya Univ.) comparison and interpretation with respect to the stratospheric meteorological situation.

6. **Details of the experiments plan**

1) **Location**: **Esrange (Kiruna, Sweden;** 67.88 N, 21.06 E, 485 m a.s.l.)

2) **Instrument**: **a ground based lidar system**

It is operated at Esrange Radar Hill and uses the conventional differential absorption technique (DIAL) as well as the new developed Raman DIAL technique to obtain the atmospheric ozone concentration. Profiles of aerosol parameters (extinction coefficients, backscatter coefficients, and depolarization profiles), and water vapor are measured using the conventional Raman lidar technique. The temperature measurements are performed by the integration of the backscattered signals of the Rayleigh and the Raman signals. The temperature measurements actually are inferred by aerosols. They could only be used in altitudes above the aerosol (PSC) layers. The instrument reaches its full performance only if it is operated during darkness.

3) Altitude range (AR), Accuracy/Precision (A/P), Vertical resolution (VR), Averaging time (AT):
The resolutions are given with respect to perfect tropospheric measurement conditions (darkness, no (optical dense) clouds, no precipitation) and the restrictions mentioned above.

Species	AR	A/P	VR	AT
Ozone	8 - 35 km	better 10 %	between 960 and 2400 m	60 min.
Backscattering	> 2 km	better 10 %	between 120 and 360 m	2 min.
Extinction coeff.	> 2 km	better 10 %	between 120 and 2400 m	10 min. to 60 min.
Water vapor mixing ratio	2 km - tropopause	better 10 %	120 - 600 m	20 min.
Temperature	< 60 km	better 3 K	600 m	120 min.

4) Situations
Fully operational between 20 December 1996 and 7 February 1997.

5) Schedule
Operation of the instrument from 20 December 1996 to early February 1997.
The instrument is operated on every possibility when darkness and weather conditions allow measurements.
Preliminary data could be performed easily. The fully processed data from all days could be submitted 8 months after the measurements.

7. Details of experiment plan for ILAS validation analysis using the experiment data

1) ILAS request
(1) Profiles from ozone, water vapor temperature and aerosols on every day between 20 December 1996 and 6 February 1997 from the data taken next to Esrange station (68N, 21E).

(2) Request on correlated core instruments
a. Ozone sonde data from early February 1997.
b. FTIR Spectrometer data from IRF (Prof. Kondo's group).

2) Method of analysis:
Comparison of the data. Looking to the influence of aerosols on both instruments.
Interpretations with respect to Ozone chemistry

3) Submission date of the results
As soon as possible

4) Comments:
Submission dates depends also on the comparison and work of the other groups.
Therefore - at the moment - no information avalilable.

8. Related Publications

- M. Serwazi, J. Reichardt and C. Weitkamp; Combined lidar measurements of cloud properties, stratospheric aerosols, and ozone profiles over Geesthacht (53.4 N, 10.4 E), SPIE, 1995, 2505/75-2505/80
- J. Reichardt, U. Wandinger, M. Serwazi, and C. Weitkamp; Combined Raman lidar for aerosol, ozone, and moisture measurements, Opt. Eng., 35, 1457-1465, 1996
- J. Reichardt, A. Ansmann, M. Serwazi, C. Weitkamp, and W. Michaelis; Unexpectedly low ozone concentration in midlatitude tropospheric ice clouds: a case study, Geophys. Res. letters, 23, 1929-1932, 1996

- M. Serwazi, J. Reichardt, and C. Weitkamp; Ozone Measurements above Geesthacht during Spring 1995 with a Raman-DIAL, Air pollution research report 56, 1996, 467-472
- A. Ansmann, U. Wandinger, M. Riebesell, C. Weitkamp, and W. Michaelis; Independent measurements of extinction and backscatter profiles in cirrus clouds using a combined Raman elastic-backscatter lidar, Appl. Opt., 31, 7113-7131, 1992

1. **Title of ILAS validation experiment**

Polar Stratospheric Clouds and Noctilucent Clouds by Backscatter Lidar from Esrange (Sweden)

2. **Principal Investigator**

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3. Measurements objective, **Target species**

Time-sequences of **vertical profiles of** clouds/**aerosols** in the middle atmosphere

4. **Category** of ILAS validation experiments

Cooperative Experiment

5. **Significance** of the validation experiment for ILAS

- identification of PSCs over a wide range of optical thickness
- precise geometric altitude from lidar
- vertical local sounding lidar vs. deconvolution of horizontal LOS averaged ILAS values
- vertical profile shape
- backscatter from lidar vs. extinction from ILAS

6. **Details of experiment plan** for the experiment

1) **Location**: **Esrange (Kiruna, Sweden**; 67.88 N, 21.06 E)

2) **Instrument**:

(1) Name: **University of Bonn Lidar**

(2) Principle:

Backscatter lidar based on Nd:YAG laser transmitting on 532 nm and a 50-cm Newtonian recording on 532 nm with 3 intensity cascaded photomultipliers in parallel and 1 photomultiplier in perpendicular polarization as well as on 608 nm the N_2 vibrational Raman signal.

Backscatter ratios in the stratosphere are determined from Rayleigh/Mie scattering at the emitted wavelength and the N_2 vibrational Raman signal.

3) Altitude range, Vertical resolution, Accuracy, Precision, and Integration Time:

(1) Altitude range: 5 to 90 km

(2) Vertical resolution: 150 m

(3) Accuracy, Precision and Integration time: depend on signal strength and need be traded against each other

4) Situation of facilities and equipment especially for the experiment

The lidar was moved to Esrange in December 1996 and has taken first data on January 9, 1997. We expect upgrades (telescope receiver area, multi-colour capability) in 1997. Data processing procedures will be adapted to the new lidar in 1997.

5) Schedule for the experiment:

(1) Execution period of the measurements:

The Lidar is operated on a campaign basis. It was operated in Jan/Feb/Mar 1997 and is planned to be operated in mid-summer 1997 and winter 1997/98 (details t.b.d.)

(2) Data:

Quicklook data are available at Esrange immediately after measurements.

7. Validation Analysis

We are prepared to support the ILAS validation effort through cooperation with the ILAS team member conducting the aerosol validation. This would involve selecting lidar data, special processing of such data and advising on the interpretation.

We are interested to obtain limited, next-in-time and near-in-geographic-space profiles of middle atmosphere clouds to support our local lidar measurements with data on the horizontal extent of the phenomena

8. Related publications

- M. Langer, K.P. Müller, and K.H. Fricke: Rayleigh lidar detection of aerosol echoes from noctilucent cloud altitudes at the Arctic Circle, Geophys. Res. Letts 22, 381-384, 1995
- K.H. Fricke, K.P. Müller, M. Langer, K. Römke, and F.J. Lübken: Visual and Lidar Observations of Rocket Induced Effects in the Upper Atmosphere above Andoya on January 25, 1995, ESA SP-370, 107-112, 1995
- K.P. Müller, M. Langer, K. Römke, and K.H. Fricke: PSCs and Aerosol above Andoya during SESAME Winters 1993/94 and 1994/95, Proceedings of the Third European Symposium on Polar Stratospheric Ozone, EC Air pollution Research Report 56, 122-125, 1995
- F.J. Lübken, K.H. Fricke, and M. Langer: Noctilucent clouds and the thermal structure near the Arctic mesopause in summer, J. Geophys. Res., 101, 9489-9508, 1996
- C. Brogniez, J. Lenoble, R. Ramananaherisoa, K.H. Fricke, J. Lumpe, K. Hoppel, S. Krigman, R. Bevilaqua, and E. Shettle: SESAME Campaign: Correlative measurements of aerosol in the polar atmosphere, J. Geophys. Res., 102, accepted, 1997

1. **Title of ILAS validation experiment**

Measurements of O3, CH4, and N2O with a laser heterodyne spectrometer in April 1997

2. Investigators

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3. Target species, profiles or column

1) **Target species for ILAS**: **profiles and column of O3, CH4 and N2O**

2) Other target species: none

4. **Category** of ILAS validation experiments

Cooperative experiment

5. **Significance** of the validation experiment for ILAS

This experiment will be carried out as an ADEOS validation campaign supported by NASDA. In this validation experiment vertical profiles of ozone, methane and nitrous oxide obtained from ILAS measurements will be compared with those obtained from ground-based laser heterodyne spectrometer measurements. Since the laser heterodyne spectrometer can derive absolute values of vertical profiles and column densities of those species, theoretical performance of the ILAS instrument will be confirmed by this experiment. The significance of this experiment is not only for the validation of the ILAS instrument but also for scientific interest in measurements of those minor species with a high-time resolution at a fixed place in the winter polar region.

6. **Details of implementation plan** for the experiment

1) **Location:** **Poker Flat Research Range (Fairbanks, Alaska;** 65N, 148W)

2) **Instrument**:

(1) Name: **Tunable Diode Laser Heterodyne Spectrometer (TDLHS)**

(2) Principle:

Vertical profiles of ozone, methane, and nitrous oxide are derived from high resolution absorption spectra using an inversion technique. The instrument employed to obtain the spectra is a Tunable Diode Laser Heterodyne Spectrometer (TDLHS). TDLHS measures solar infrared absorption line profiles of atmospheric trace constituents with a wavenumber resolution of as high as 0.0013 cm^{-1}.

3) Altitude range (AR), Accuracy/Precision (A/P), Vertical resolution (VR), Averaging time (AT):

Species		AR	A / P	VR	AT
O3	(profile)	10 - 30 km	10 % / 10 %	5 km	10 min.
O3	(column)	-	5 % / 5 %	-	10 min.
CH4	(profile)	2 - 30 km	20 % / 20 %	15 km	1 hour
CH4	(column)	-	5 % / 5 %	-	1 hour
N2O	(profile)	2 - 30 km	10 % / 10 %	5 km	1 hour
N2O	(column)	-	5 % / 5 %	-	1 hour

4) Situation on Facilities and Equipment especially for the experiment:

A proposal has been submitted to Geophysical Institute, University of Alaska concerning preparation of facilities for IR measurements at the new optical building of Poker Flat Research Range. Our portable TDLHS has already been in use. Another TDLHS will be available by the time of validation experiments.

5) Schedule of the experiment:

(1) Preparation:

August - September 1996	Installation and calibration of new loacl oscillator lasers
October - December 1996	Test observation in Sendai
January 1997	Shipping to Alaska

(2) Execution period of the measurements:

Around April 1997, during clear sky daytime

(3) Data submission:

4 months after the measurements

7. Details of implementation plan for ILAS validation analysis using the experiment data

1) Requested ILAS data for the analysis:

(1) Species: O3, N2O, CH4

(2) Dates and Location(s):

a. Dates: Around April 1997

b. Location: Fairbanks, Poker Flat Research Range (65N, 148 W)

2) Method of the analysis:
Comparison between vertical profiles obtained by TDLHS and ILAS measurements
Comparison between column densities obtained by TDLHS and ILAS measurements

3) Submission dates of the results:
6 months after the measurements

8. Related Publications

1) Instrument explanation:

- Fukunishi, H., S. Okano, M. Taguchi, and T. Ohnuma, Laser heterodyne spectrometer using a liquid nitrogen cooled tunable diode laser for remote measurements of atmospheric O3 and N2O, Appl. Opt., 18, 2722-2728, 1990.

2) Scientific results:

- Koide, M., M. Taguchi, H. Fukunishi, and S. Okano, Ground-based remote sensing of atmospheric O3, N2O, HNO3 and CH4 with a tunable diode laser heterodyne spectrometer at Syowa station, Antarctica, Proceedings for International Symposium on Optical Science, Engineering and Instrumentation, Denver, CO U.S.A., 4-9 August, 1996.

1. **Title of ILAS validation experiment**

Validation of ILAS data using ground based infrared measurements from Fairbanks

2. **Principal Investigator**

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3. Target species, profiles or column

1) **Target species for ILAS:**
column amounts and altitude profiles of N2O, O3, CH4; column amounts of NO2 and HNO3

2) Other target species: HCl, HF, CO, ClONO2, ClO

4. **Category** of ILAS validation experiments

Cooperative experiment

5. **Significance** of the validation experiment for ILAS

This experiment is very similar to Dr. Kondo's ground based measurements in Kiruna. We plan to make simultaneous measurements of HNO3, NO2, CH4, N2O, and O3 from Fairbanks, Alaska to compare with ILAS measurements. We also measure HCl and HF and ClONO2, which allow the correlative measurements to provide important scientific information for the ILAS chemistry.

6. **Details of implementation plan** for the experiment

1) **Location:** **Fairbanks (Alaska, USA**; 65N, 148W)

2) **Instruments**:

(1) Name: **The high resolution FT spectrometer system**

(2) Principle:

The instrument is high resolution FTS, which uses the sun as an exo-atmospheric, high instensity source. The FTS measures the absorption by terrestrial atmospheric gases. Vertical column amounts of several minor constituents are derived by a spectral least square fitting technique, taking into account the laboratory determined absorption cross section of molecules in the wave number region of interest. Altitudinal profile of several species (O3, N2O, and CH4) are going to be retrieved from the high resolution spectra by using the pressure broadening infromation in the spectra.

3) Altitude range (AR), Accuracy/Precision (A/P), Vertical resolution (VR), Averaging time (AT):

Species		AR	A / P	VR	AT
O3	(column)	-	5 % / 3 %	-	5-20 min.
O3	(profile)	8-30 km	20 % / 15 %	4 km	5-20 min.
HNO3	(column)	-	15 % / 10 %	-	5-20 min.
CH4	(column)	-	10 % / 5 %	-	5-20 min.
CH4	(profile)	10-25 km	30 % / 20 %	4 km	5-20 min.
N2O	(column)	-	10 % / 5 %	-	5-20 min.
N2O	(profile)	10-25 km	30 % / 20 %	4 km	5-20 min.
NO2	(column)	-	25 % / 20 %	-	5-20 min.

4) Situation on facilities and equipment especially for the experiment:
The Geophysical Institute at the University of Alaska Fairbanks (65N, 148W) will operate the system on a routine basis.

5) Schedule for the experiment:
(1) Preparation:
The high resolution solar spectrometer system is being modified to be more automatic. It will be ready for installation at the Geophysical Institute in September 1996.

(2) Execution period of the measurements:
Beginning at installation, about 3 years.

(3) Data submission:
4 months after the measurements

7. Details of implementation plan for ILAS validation analysis using the experiment data

1) Requested ILAS data for the analysis:
(1) Species: O3, HNO3, NO2, N2O, CH4, H2O profiles

(2) Dates and Location:
a. Dates: September, 1996 forward

b. Location: Fairbanks (65N, 148W)

2) Method of the analysis:
Comparison between retrieved height profile and ILAS data (for O3, N2O, and CH4)
Comparison between column values by FTS spectra and those calculated from ILAS data.
Correlation analysis of O3-HNO3, HNO3-N2O, HNO3-CH4, N2O-CH4, etc.

3) Submission dates of the results:
6 months after measurements

8. Related Publications

1) Instrument explanation:

- David, S.J., F.J. Murcray, A. Goldman, C.P. Rinsland, D.G. Murcray, The effect of the Mt. Pinatubo aerosol on the HNO3 column over Mauna Loa, Hawaii, Geophys. Res. Lett., 21, 1003-1006, 1994.

2) Scientific results:

- Rinsland, C.P., B.J. Connor, N.B. Jones, I. Boyd, W.A. Matthews, A. Goldman, F.J. Murcray, D.G. Murcray, S.J. David, N.S Pougatchev, Comparison of infrared and Dobson total ozone columns measured from Lauder, New Zealand, Geophys. Res. Lett., 23, 1025-1028, 1996.
- Liu, X., F.J. Murcray, D.G. Murcray, and J.M. Russell III, Comparison of HF and HCl vertical profiles from ground-based high resolution infrared solar spectra with HALOE observations, J. Geophys. Res., 101, 10175-10181, 1996.

1. **Title of ILAS validation experiment**

Balloon-borne Regular and Correlative Measurements of Ozone, Water vapor, and Aerosol at Yakutsk Station

2. Investigators

1) **Principal Investigator**

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3. Target species, profiles or column

1) **Target species for ILAS**:
vertical profile of O3, H2O, Temperature, Pressure, and Aerosol (backscatter ratio at two wavelengths)

2) Other target species: total ozone

4. **Category** of ILAS validation experiments

Cooperative experiment

5. **Significance** of the validation experiment for ILAS

It is proposed to measure with balloon-borne instruments the vertical profiles of several basic stratospheric species (O3, H2O, aerosol) and other parameters (local temperature, pressure) that play a major role in understanding of the response of the upper atmosphere to natural and human-caused environmental changes.

This measurements have strong connections with TOMS, IMG, ILAS instruments onboard ADEOS:
* they provide concentration of members of the same family species as measured by ADEOS;
* they give directly the vertical distribution of the measured species;
* they will allow to validate the satellite instruments dedicated to measure the atmospheric composition as well as to extend the time coverage of measurements;
* they will improve the empirical model of vertical ozone, aerosol, water vapor distribution at high latitude of the Northern Hemisphere.

6. **Details of implementation plan** for the experiment

1) **Location: Yakutsk (Eastern Siberia, Russia**; 62N, 130E)

2) **Instruments**:

(1) Name:

	a. **Ozonesonde**;	O3
	b. **Optical Hygrometer**;	H2O
	c. **Backscattersonde**;	Aerosol
	d. **Radiosonde**;	Temperature, Pressure, Relative Humidity
	e. **Brewer spectrophotometer**;	Total Ozone

(2) Principle:

a. **Ozonesonde:**
It is expected that observations will be made once a week, using ECC-5 ozonesondes interfaced to Vaisala radiosonde RS-80 with T-MAX interface card. Ground-based telemetry station will consist of UHF receiver, radio modem, and personal computer for data acquisition and processing.

b. **Optical Hygrometer:**
The optical hygrometer is a balloon-borne instrument for night-time in situ measurements of water vapor in the stratosphere and upper troposphere, using a technique of photo fragment fluorescence. The optical hygrometer was developed for balloon-borne or rocket-borne water vapor measurements. These devices were used in Rylsk (Russia) campaign in 1991, EASOE (Kiruna, Sweden) campaign in 1991-92, and balloon campaigns in France in 1991, 1993, 1994.
The instrument's function is well known. Its accuracy is considered to be 10%. The vertical resolution is about 30 meters. This instrument is very useful for analyzing the vertical gradients and, in general, the fine structure of the stratosphere.

c. **Backscattersonde:**
For stratospheric aerosol measurements, the use of balloon-borne backscattersondes is suggested. The time of launches will be tied to the passing of ADEOS over Yakutsk. The backscattersonde is equipped with ECC ozonesonde and Vaisala radiosonde. Backscattersonde measures the amount of light backscattered from a high-intensity xenon flash lamp triggered approximately every 5 seconds. Two photodiode detectors operating at different wavelengths (480 nm and 940 nm) are employed, making it possible to infer some crude (but often adequate) information about particle size. Backscattersondes were used in two phases of the Soviet-American experiments in polar regions in 1988-89 and 1990-91, as well as during 1991-92 EASOE campaign and 1993 field campaigns under SESAME project in France.

3) Altitude range (AR), Accuracy/Precision (A/P), Vertical resolution (VR), Averaging time (AT):

Species	AR	A / P	VR	AT
O3	0 - 30 km	6 % / 6 %	50 m	15 sec
H2O	7 - 30 km	10 % / 10 %	30 m	5 sec
Aerosol	0 - 30 km	10 % / 10 %	30 m	5 sec
Temperature	0 - 30 km	0.4 K / 0.4 K	50 m	15 sec
Pressure	0 - 30 km	0.5 hPa / 0.5 hPa	50 m	15 sec
H2O (Relative Humidity)	0 - 10 km	10% / 10 %	50 m	15 se
Total ozone	-	3 % / 2 %	-	-

4) Situation on facilities and equipment especially for the experiment:
Observations will be conducted in Yakutsk, at an upper-air station equipped with balloon-sounding facilities. The importance of the new ozonesonde station is approved,

and Yakutsk is the 1st regular ozone observation site on a vast territory of Siberia. The data obtained at the new station will serve as a ground truth for satellite observations of total ozone and its vertical distribution.

5) Schedule for the experiment:
(1) Preparation:
August 1996 - September 1996
Purchasing ozonesondes, backscattersondes and UV-hygrometers, ground-based equipment, and consumable (gas, batteries, etc.)
Testing and calibration the flight devices at the laboratory, Brewer calibration.

(2) Execution period of the measurements;
September 1996 - April 1997
Regular, weekly ozonesonde soundings (Wednesday) at Yakutsk station. Launching several backscattersondes and UV-hygrometers in winter and spring seasons as a correlative measurements with ADEOS. When the track of satellite is predicted to have the desired orientation with respect to the launching station at Yakutsk, the balloon would be launched and a vertical profile to 25 - 30 km altitude would be measured. Frequency, date and time of the launches will be specified jointly by P.I. of TOMS, IMG, ILAS instruments. It seems practical to plan such regular measurements for a 2 - or 3 - year period.

(3) Data submission:
One months after the measurements

7. Details of implementation plan for ILAS validation analysis using the experiment data

1) Requested ILAS data for the analysis:
(1) Species or phhysical properties:
Vertical distribution of ozone, water vapor, aerosol (backscatter ratio), temperature, pressure, humidity as well as total ozone values.

(2) Dates and Location:
a. Dates: First date when ILAS data are obtained

b. Location: Yakutsk (62N, 130E) and adjacent in the range of 300 km

2) Method of the analysis:
Comparision between obtained vertical profiles and ILAS data (for O3, H2O, aerosol, temperature, pressure) as well as total ozone values.

3) Submission dates of the results:
6 months after measurements.

8. Related Publications

1) Instrument explanation:

- V. Yushkov et al., Optical fluorescent hygrometer for water vapor low concentration measurements, Proceedings EUROPTO Series "Air Pollution and Visibility Measurements" Peter Fabian, Volker Klein, Marus Tacke, Konradin Weber, Christian Werner, Editors, v2506, 1995, p.783-794
- J. Rosen, N. Kjome, Backscattersonde: a new instrument for atmospheric aerosol reseach. Applied Optics, 30, 1552-1561, 1991

2) Scientific results:

- V. Dorokhov, T. Potapova, F. Goutail, J-P. Pommereau, Observation of total ozone in Eastern Siberia in the winter of 1994-1995 during SESAME. Proceeding 3rd European Symposium of Stratospheric Ozone Reseach, report 56, 1996, p.463-466.
- H. Nakane, Akiyoshi, I. Matsui, N. Sugimoto, Y. Iwasaka, T. Shibata, M. Hayashi, T. Itabe, K. Mizutani, T. Uekubo, K. Matsubara, T. Kotake, H. Fukunishi, V. Yushkov, V. Dorokhov, V. Khattatov, Variation of ozone and aerosol in Eastern Asia during SESAME. Proceeding 3rd European Symposium of Stratospheric Ozone Reseach, report 56, 1996, p.492-497
- V. Khattatov, V. Yushkov, M. Khaplanov, I. Zaitzev, J. Rosen, N. Kjome, Some results of water vapor, ozone and aerosol measurements during EASOE. Geophys. Res. Lett. 21, 1994, p.1299-1302.

1. Title of ILAS validation experiment

Calibration and Validation Studies of ILAS Data by Ground based Observations at Southern Polar Latitudes (Neumayer, Syowa, Mirny)

2. Investigators

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3. Target species, profiles or column

1) **Target species for ILAS**: **vertical profile of O3 and temperature, vertical profile and total column of aerosol**

2) Other target species: none

4. **Category** of ILAS validation experiments

Cooperative experiment

5. **Significance** of the validation experiment for ILAS

1) Ozone and temperature profiles:

Using the ECC sensor regular balloon-borne ozone soundings are performed at the Antarctic Neumayer station once per week. We plan to perform additional balloon launchings during overpass flights of ADEOS. So in-situ ozone and temperature profiles can be directly compared with ILAS measurements. That completes the corresponding intercomparison of ILAS data with the balloon-borne sensor KC-79 at Syowa station.

Since the regular observations of ozone profiles at Neumayer station have delivered the mean annual pattern of the vertical ozone distribution in the Antarctic troposphere and stratosphere, actually both data sets by balloon sondes and ILAS will provide important scientific information on the variability of tropospheric and stratospheric ozone above the Antarctic.

2) Spectral total aerosol column:

The validation of the total aerosol column retrieved from ILAS spectral channels can be compared with the spectral total aerosol column data between 350 and 1060 nm regularly obtained by photometers at Neumayer station and Mirny station during the total operational period of ILAS. The direct intercomparison of total aerosol column for ILAS and ground based photometers is addressed for the 778 nm channel.

A special joint network for ILAS validation will be established by running two radiance calibrated photometers at the Antarctic stations Neumayer and Syowa during the first year after ADEOS launch. The sun photometer ABAS will be operated at Mirny station during the total operational period of ILAS.

Data obtained by these photometers are comparable each other. Additionally at Syowa station simultaneous observations will be obtained with the sun photometers EKO 120 regularly operated at Syowa station and photometer SP-1A also operated at Syowa station as a part of the network.

As we could show by a joint analysis of SAM/SAGE satellite data and ground-based sun photometer data the tropospheric aerosol level is very low in the Antarctic region (Herber et al., 1996). It shows a very small seasonal variation. These results confirm that the Antarctic region is most convenient for validation experiments. So the correlative network will provide important information on the accuracy of retrieved stratospheric aerosol column densities from ILAS.

The photometers SP-2H and SP-1A were also successfully used for observations using moon light. This high sensitivity of the instruments implies measurements during night conditions and probably during twilight conditions. Twilight measurements might be of great importance for the validation, because the ILAS instrument uses the limb technique. So the tangential point exactly coincides with ground-based observations which are performed during twilight conditions. So twilight observations by photometers might be of great importance for ILAS validation.

6. **Details of implementation plan** for the experiment

1) **Locations**:

a. **Russian station Mirny (Antarctica; 66S, 93E)**
Arctic and Antarctic Research Institute, St. Petersburg

b. **Japanese station Syowa (Antarctica; 69S, 40E)**
Japan Meteorological Agency, National Institute of Polar Research, both at Tokyo

c. **German station Neumayer (Antarctica; 71S, 08W)**
Alfred Wegener Institute for Polar and Marine Research Research Unit Potsdam

2) **Instruments**:

(1) Name:

a. Russian station Mirny:

- **Photometer ABAS No. 06**: spectral optical thickness, total aerosol column, sun light measurements, 8 spectral channels, ILAS validation channel 780 nm

b. Japanese station Syowa:

- **Photometer EKO 120**: spectral optical thickness, total aerosol column, sun light measurements, ILAS validation channel 778 nm
- **Photometer SP-1A No. 02**: spectral optical thickness, total aerosol column, sun and moon light measurements, 14 spectral channels, ILAS validation channel 778 nm

c. German station Neumayer:

- **Ozonesonde ECC 5A**: profiles ozone mixing ratio
- **Radiosonde RS 80**: Temperature, Pressure, Humidity, and wind
- **Photometer SP-2H No. 02**: spectral optical thickness, total aerosol column, sun and moon light measurements, 17 spectral channels (350 - 1060 nm), ILAS validation channel 778 nm

(2) Principle:

a. **Electrochemical concentration cell (ECC 5A) and Standard radiosonde RS 80:**

The ozone sensors (ECC 5A) employ an electrochemical technique which gives the ozone partial pressure of the surrounding air. In addition to the ozone sensor a regular meteorological package (RS 80) is flown on the same payload, which gives temperature, tropospheric humidity, pressure, wind speed and direction. The geopotential altitude is usually determined by integrating the temperature and pressure profiles assuming the ideal gas law and the hydrostatic equilibrium. Sonde data is typically sampled every 10 sec and the balloon has a nominal ascend rate of 5 m/s which results in a typical altitude resolution of 50 m. Rubber balloons are employed, which yield maximum altitudes above 30 km or 10 hPa in the polar regions during winter. The ozone concentration profile can be easily integrated to give ozone column densities. The column density above the balloon burst point is estimated by assuming a constant ozone mixing ratio. Its contribution above 30 km to the total ozone column density is around 5 %.

b. **Radiance calibrated photometers:**

The radiance calibrated photometers SP-1A, SP-2H, and sun photometer ABAS measure direct solar transmittance, and thus the atmospheric optical depth by using interference filters, at different narrow wavelength intervals between 0.35 and 1.10 μm. The SP-1A and SP-2H instruments can be operated by using sun and moon light. The SP-1A instrument is program controlled.

All instruments used in the network are radiance calibrated and provide comparable data. The spectral aerosol optical depth is obtained from the atmospheric optical depth by accounting for the effects of Rayleigh scattering and absorption by trace gases including NO2, O3, and H2O. The Rayleigh-scattering correction is derived from the technique described by Fröhlich and Shaw (1980). The measurements of the column ozone concentration with a M-124 filter spectrometer are used to correct for the ozone absorption at measurement wavelengths within the Chappius band (0.45 to 0.75 μm). The instrument is calibrated using the Langley procedure during stable meteorological and optical conditions in the mountains, like Zugspitze (Alps), or in Antarctica at different solar elevation angles. The accuracy of the aerosol optical depth is estimated to be +/-0.005. On cloudy days measurements cannot be performed. The time resolution of the measurements depends on actual tasks, normally daily mean values are calculated.

3) Altitude range (AR), Accuracy/Precision (A/P), Vertical resolution (VR), Averaging time (AT):

Species	AR	A / P	VR	AT
O3	30 km	< 5 % / ? (16-26 km) <10 % / ? to tropopause <12 % / ? (26-31 km)	50 m	about two hours for one profile
Temperature	30 km	+/- 0.2 °C / ?	50 m	about two hours for one profile
Pressure	30 km	+/- 0.5 hPa/ ?	50 m	about two hours for one profile
Aerosol (column)		+/- 0.005 / ?	-	15 minutes, 60 minutes, or daily means

4) Situation on facilities and equipment especially for the experiment:

At Neumayer station the ozone launching facility is regularly operated. Beyond the regular weekly soundings 20 ozonesondes are available for ILAS validation experiments. Three photometers are available for the observations within the network at the stations Neumayer, Syowa, Mirny.

5) Schedule for the experiment:

(1) Preparations:

Photometers for Neumayer and Mirny will have been calibrated until the end of June 1996. These instruments will be installed until the beginning of summer season 1996/97 at both stations. The briefing for running the SP-1A photometer for JARE-38 staff will have been finished until the end of September 1996. The instrument will be installed in the beginning of summer season 1996/97 at Syowa station.

The ground-based and balloon-borne observations at Neumayer station are regularly performed. Additional ozone sondes will be delivered until summer season 1996/97.

(2) Execution period of measurements:

a. Validation experiments December 1996 to December 1997:

- Regular ozone soundings and additional soundings according to satellite overpasses.
- Photometer network observations by using the Langley plot procedure at Neumayer, Syowa, Mirny on clear sky days during the sunlit period.
- Regular photometer observations with sun and moon light at Neumayer and Syowa on clear sky days until December 1997.

b. Planned contributions for the total period of ILAS operation:

- Regular observations at Neumayer station:
  Ozone soundings with one launch per week, radiosondes with one launch per day. Photometer observations by using sun and moon light on clear sky days.
- Regular observations at Mirny station:
  Photometer observations by using sun light on clear sky days.

(3) Data submission:

a. Ozone profiles:

- Preliminary data (NASA Ames format) could be available one day after observation from Neumayer station.
- Final data including quality check for a three months period will be provided three months later.

b. Photometer data (spectral aerosol column):

- Weekly preliminary data (special data format) could be available one week later from Neumayer and Syowa, and one month later from Mirny station.

- Final data (NASA Ames format) for the period of one month will be compiled for Neumayer, Syowa, Mirny three months later.
- Confirmed data can be produced after recalibration of the instruments about six months after the end of the corresponding expedition (wintering).

6) Comments:

At Neumayer station the launching dates within the regular ozone sounding program can be shifted to satellite overpasses on special request by the ILAS Validation experiment team leader. Photometer measurements depend on clear sky conditions. So the fit of photometer measurements to satellite overpasses depends on clear sky conditions.

Ozone sonde and radiosonde data as well as final photometer data will be submitted in the NASA Ames format.

7. Details of implementation plan for ILAS validation analysis using the experiment data

1) Requested ILAS data for the analysis:

(1) Species and physical properties:

a. Profiles of O3, temperature, and aerosol
b. Spectral aerosol column

(2) Dates: satellite overpasses during the operational period of ILAS

(3) Locations: a. near to Neumayer (Antarctica 71S, 08W)
b. near to Mirny (Antarctica 66S, 93E)
c. near to Syowa (Antarctica 69S, 40E)

2) Method of the analysis:

Comparison between in-situ altitude profiles and ILAS data for O3 and temperature.

Comparison between column values obtained by ground-based photometers and ILAS data spectral aerosol column.

3) Submission dates of the results:

15 month after ADEOS launch

8. Related Publications

1) Instrument explanation:

- Fröhlich, C., and G.E. Shaw, New determination of Rayleigh scattering in the terrestrial atmosphere, Appl. Opt., 19, 1773-1775, 1980.
- Gernandt, H.; Contribution to ozonesonde observations at both polar regions - application of electrochemical ozonesondes in the Antarctic and Arctic, Contribution to "Scientific Assessment of Ozone Depletion 1994" by Harris, N. et al., WMQ - Report No. 37, 1995.
- Hilsenrath, E., J. Ainsworth, W. Attmannspacher, R. Barnes, A. Bass, W. Evans, A. Holland, W. Komhyr, K. Mauersberger, J. Mentall, A.J. Miller, M. Proffitt, D. Robbins, S. Taylor, A. Torres, and E. Weinstock, Results from the balloon ozone intercomparison campaign, 454, Atmospheric Ozone, Proceedings of the Quadrennial Ozone Symposium, D. Reidel, edited by Zerefos and Ghazi, 1984.
- Komhyr, W.D., Electrochemical concentration cells for gas analysis, Ann. Geophys., 25, 203-210, 1969.

- Komhyr, W.D., and T.B. Harris, Development of an ECC ozonsonde, NOAA Technical Report ERL 200-APCL 18, 54 pp, Atmospheric Physics and Chemistry Laboratory, Boulder, Colo., 1971.
- Komhyr, W.D., S.J. Oltmans, A.N. Chopra, and P.R. Franchois, Performance characteristics of high-altitude ECC ozonsondes, in Atmospheric Ozone, Proc. Quadrennial Ozone Symposium, Halkidiki, Greece, September 3-7, 1984, edited by C.S. Zerefos and A. Ghazi, pp. 499-503, D. Reidel, Dordrecht, Holland, 1985.
- Leiterer, U., and M. Weller, Sunphotometer BAS and ABAS for atmospheric research, WMO Tech. Doc., 222, 21-26, 1988.
- Schulz, K.H., Spectroradiometer SP-2H and SP-1A, Technical description - Fa. Schulz & Partner GmbH, 1996.

2) Scientific results:

- Beyerle, G., A. Herber, R. Neuber, and H. Gernandt, Temporal development of Mt. Pinatubo aerosol as observed by lidar and sun photometer at Ny-Ålesund, Spitsbergen, Geophys. Res. Lett., Vol. 22, NO. 18, 2497-2500, 1995.
- Gernandt, H., K. Dethloff, and H. Kanzawa, A qualitative assessment of the height dependent interannual variability of polar stratospheric ozone. Part I: Long-term variability and stratospheric ozone depletion, Proceedings of the NIPR Symposium on Polar Meterology and Glaciology, No. 8, pp. 1-13, 1994.
- Gernandt, H.; U. Goersdorf, H. Claude, and C.A. Varotsos, Possible impact of polar stratospheric processes on mid-latitude vertical ozone distributions, Int. J. Remote Sensing, Special Issue, Vol. 16, No. 10, 1839-1850,1995.
- Gerrnandt, H., A. Herber, P. von der Gathen, M. Rex, A. Rinke, S. Wessel, and S. Kaneto, Variability of ozone and aerosols in the polar atmosphere, Proceedings of the International Symposium on Environment Research in the Arctic, in press, 1996.
- Gernandt, H., P. von der Gathen, and A. Herber, Ozone change in the polar atmosphere, NATO ASI Series, in press, 1996.
- Herber, A., L.W. Thomason, V.F. Radionov and U. Leiterer, Comparison of Trends in the Tropospheric and Stratospheric Aerosol Optical Depths in the Antarctic, J. Geophys. Res., Vol. 98, NO D10, 18441-18447, 1993.
- Herber, A., L.W. Thomason, K. Dethloff, P. Viterbo. V.L. Radionov, and U. Leiterer, Volcanic perturbation of the atmosphere in both polar regions: 1991-1994, J. Geophys. Res., Vol. 101, NO. D2, 3921-3928, 1996.
- Kurgansky, M.V., K. Dethloff, I.A. Pisnichenko, H. Gernandt, F.-M.Chmielewski, and W. Jansen, Long-term climate variability in a simple, nonlinear atmospheric model, J. Geophys. Res., Vol. 101, NO. D2, 4299-4314, 1996.

1. **Title of ILAS validation experiment**

Ground-based Observation with Ozonesonde, Ozone Lidar, and Aerosol Lidar at Dumont d'Urville in Antarctica

2. Investigators

1) **Principal Investigator**

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3. Target species, profiles or column

1) **Target species for ILAS**: **vertical profile of O3, Aerosol and Temperature**

2) Other target species: none

4. **Category** of ILAS validation experiments

Cooperative experiment

5. **Significance** of the validation experiment for ILAS

We plan to make simultaneous measurements of ozone, aerosols and temperature when good coincidences are possible to compare with ILAS measurements. Since the depolarisation ratio of aerosols backscattering is measured, it will help to interpret measurements of aerosols extinction made by ILAS.

6. **Details of implementation** plan for the experiment

1) **Locations**: **Dumont d'Urville** (**Antarctica**; 67S, 140E)

2) **Instruments**:

(1) Name:
a. **Ozonesonde, Ozone lidar**: O3
b. **Rayleigh/Mie lidar**: Aerosol

(2) Principle: a. lidar DIAL (ozone) with raman channels for the low stratosphere

b. backscatter lidar (aerosol)

3) Altitude range (AR), Accuracy/Precision (A/P), Vertical resolution (VR), Averaging time (AT):

Species	AR	A / P	VR	AT
O3 (lidar)	10-40 km	(*) / 2 % at 10 km (*) / 20 % at 40 km	0.6 km at 10 km 5 km at 40 km	2 hours
O3 (ozonesonde)	0 - 30 km	5 % / ?	100 m	2 hours
Aerosol (lidar)	0 - 30 km	10 % / ?	500 m	2 hours

(*): add 3 % to these number in periods of background aerosols

4) Situation on facilities and equipment especially for the experiment:

The Dumont d'Urville station is operated on a routine basis with measurements of the various variables being performed either continuously (SAOZ) or at least two to three times per week. Time of the measurements can be adapted to take into account the requirement of the validation program of the ADEOS satellite. In addition, the proposing team is presently involved in the development of the primary NDSC site Concordia to be implemented at Dome Concorde (74S, 124E), on the Antarctic Plateau starting operation in 2000 with assumably lidar measurements of aerosol and PSC.

5) Schedule for the experiment:

(1) Preparation:

The measurements are presently performed routinely in Dumont d'Urville.

(2) Execution period of the measurements:

form March to November

(3) Data submission:

3 months after the measurements

7. Details of implementation plan for ILAS validation analysis using the experiment data

1) Requested ILAS data for the analysis:

(1) Physical properties: local Pressure - temperature profile of the ILAS profile

(2) Dates and Location:

a. Dates: the lidar operates on clear skies

b. Location: 500 km around the site

(3) submission date of results :

6 months after the measurements

8. Related Publications

1) Instrument explanation:

- STEFANUTTI L., F. CASTAGNOLLI, M. DEL GUASTA, M. MORANDI, V.M. SACCO, L. ZUCCAGNOLLI, S. GODIN, G. MEGIE, J. PORTENEUVE : The Antarctic Ozone Lidar System, Appl. Phys. B 55, 3-12, 1992

2) Scientific results:

- STEFANUTTI L, M. MORANDI, M. DEL GUASTA, S. GODIN, C DAVID, Unusual PSCs observed by lidar in Dumont d'Urville, Geophys. Res. Lett., 22, 17, 2377-2380, 1995

- GODIN S., A. SARKISSIAN, C. DAVID, G. MEGIE, J.P. POMMEREAU, F. GOUTAIL, P. AIMEDIEU, J. PIQUARD, E. LE BOUAR, L. STEFANUTTI, M. MORANDI, M. DELGUASTA : Systematic stratospheric observations on the Antarctic continent at Dumont d'Urville, Proc. Quad. Ozone Symp., 561, NASA conf. Pub. 3266, 1994
- GODIN S., C. DAVID AND M. GUIRLET, Evolution of the Mt. Pinatubo Volcanic Cloud and Analysis of its Effect on the Ozone Amount as Observed from Ground-Based Measurements Performed in Northern and Southern Latitudes, NATO workshop on "the effect of the Mount Pinatubo eruption on the atmosphere and climate", Rome, September 1994
- DAVID C. Etude des Nuages Stratosphériques Polaires et des Aérosols Volcaniques en Régions Polaires par Sondage Laser, PhD thesis, Université Paris VI 1995

1. **Title of ILAS validation experiment**

Validation of the ILAS measurements by the balloon-borne and ground based observations at Zhongshan station, Antarctica

2. Investigators

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3. Target species, profiles or column

1) **Target species for ILAS**: **vertical profiles of O3 and Aerosol, total Column of O3**

2) Other target species: none

4. **Category** of ILAS validation experiments

Cooperative experiment

5. **Significance** of the validation experiment for ILAS

ILAS level 2 data of ozone and aerosols will be compared with the balloon-borne and ground based measurements to validate the measurements.

6. **Details of implementation plan** for the experiment

1) **Location**: **Zhongshan station** (**Antarctica**; 69° 22′ S, 76° 22′ E)

2) **Instruments**:
(1) Name:
a. **Ozonesonde, Brewer and UV-spectrometer**: O3

b. **Mie Ruby lidar**: Aerosol

(2) Principle:
a. The ozonesondes of electrochemical type are used to measure vertical profiles of ozone. Ozone concentration is determined according to electric current occurred as a result of chemical reaction of KI with O3 in the reaction cell.

b. The Brewer measures column amount of ozone absorption in UV spectral region.

c. The UV spectrometer measures diffuse lights in 330-340 nm region from Zenith.

d. The Mie Ruby lidar

3) Altitude range (AR), Accuracy/Precision (A/P), Vertical resolution (VR), Averaging time (AT):

Species	AR	A	/ P	VR	AT
O3 (profile)	30 km	+/- 2nb ozone partial pressure	/ ?	100m	?
O3 (column)	-	3%	/ ?	-	?
Aerosol (profile)	30 km	TBD	/ TBD	300m	10 shots

4) Situation on facilities and equipment especially for the experiment:
The sounding system of the balloon-borne ozonesonde has been used at the Zhongshan Station since 1993. During the validation period of ILAS, balloon-borne sounding will be conducted during the satellite overpassing.
The measurements by the combination of the Brewer and UV-spectrometer will be conducted during daytime continuously to obtain the temporal variation of the total ozone content at this location. This information can provide supplement to the validation as well as scientific analysis.
The aerosol lidar started observation at the Zhongshan Station in 1993. Intensive observations will be conducted during the satellite overpassing as well as routine observations.

5) Schedule for the experiment:
(1) Preparation:
1994 -1996 (Pre-launch)

a. Analysis of the lidar and ozonesonde data obtained in 1993 - 1995, calibration of the ozonesonde, improvement of the lidar system to meet the validation requirement

b. Retrieval algorithm development and field experiment with the UV-spectrometer

(2) Execution period of the measurements:
1996 - 1997

a. Installation of the image and data processing system for satellite remote sensing

b. Conducting UV-spectrometer observation at the Zhongshan Station

c. Observation of ozone and aerosol over Antarctica by Ozonesonde, Brewer and UV spectrometer, and aerosol lidar coordinated with the ILAS observation

(3) Data submission:
6 months after receiving the data

7. Details of implementation plan for ILAS validation analysis using the experiment data

1) Requested ILAS data for the analysis:
(1) Species: O_3, NO_x, aerosol

(2) Dates and Location:
a. Dates: first date when ILAS data are obtained

b. Location: Zhongshan station (Antarctica 69S, 76E)

2) Method of the analysis:
Comparison of the measured profiles of O_3, column O_3 with ILAS data

3) Submission dates of the results:
6 months after the data received and analyzed.

8. Related Publications

1) Instrument explanation:

- Kong Qinxin et al: A balloon-borne electrochemical O_3 sounding system, Meteor. Hydrol. and Marine Instruments, No. 1 1996.

2) Scientific results:

- Sun Jinhui, Xia Qilin, Qiu Jinhuan and Lu Daren: The Observations on polar stratospheric clouds at Zhongshan station Antarctica, Antarctic Research, Vol. 6 No. 2.

1. Title of ILAS validation experiment

Stratospheric Measurements from a Multi-Instrument Balloon Platform for Calibration/Validation of ADEOS

2. Investigators

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3. Target species, profiles or column

1) **Target species for ILAS**:
O3, N2O, HNO3, NO2, CH4, H2O, Pressure, Temperature, CFC-11, N2O5: all profiles; Aerosols

2) Other target: CO, OH, HO2, H2O2, ClO, HOCl, ClONO2, HCl, HF, CFC-12, NO, HNO4, OCS, HCN, CCl4, CF4, COF2, CHF2Cl, CH3Cl, C2H2, C2H6, 3 isotopomers of H2O, 3 isotopomers of O3: all profiles.

4. **Category** of ILAS validation experiments

Cooperative experiment ("NASA Cooperative Flights")

5. **Significance** of the validation experiment for ILAS

We propose to carry out two balloon flights from Fairbanks, Alaska in April 1997, as one of the calibration/validation campaigns for the Advanced Earth Observing Satellite (ADEOS), during the years 1996-1998. The primary purpose of the balloon flights is to calibrate and validate data from the following three sensors on ADEOS: Improved Limb Atmospheric Spectrometer (ILAS), Interferometric Monitor for Greenhouse Gases (IMG), and Total Ozone Mapping Spectrometer (TOMS). From the spectra acquired during the flights the abundance profiles over the 10 km to 35 km altitude range of over 30 different gases will be retrieved. The gases include O3, N2O, HNO3, NO2, CH4, H2O, CFC-11, and N2O5, all of which will also be measured by ILAS. Aerosols will also be measured for comparison with IMG and ILAS. This flight will be timed to coincide closely with an overpass of the ILAS footprint so that the abundance retrieved by the MkIV interferometer may be used to validate those obtained by ILAS. The validation will not just compare the volume mixing ratio profiles retrieved from the balloon spectrometers and ILAS data. It will first check that the spectra themselves are consistent (after adjustments for the differing spectral resolutions of the instruments). The balloon spectrometers will also be able to provide volume mixing ratio profiles on gases not measured by ILAS, which may be useful in correctly interpreting the ILAS results.

6. **Details of implementation plan** for the experiment

1) **Location: Fairbanks (Alaska, U.S.A.**; 65N, 148W)

2) **Instruments**:

(1) Name:
a. **SAO FIRS-2 Interferometer**: far-infrared remote thermal-emission FTS; PI: W.A. Traub; payload 1.

b. **JPL MkIV Interferometer**: mid-infrared remote solar-absorption FTS; PI: G.C. Toon; payload 2.

c. **JPL SLS Spectrometer**: sub-millimeter heterodyne remote thermal-emission; PI: R.A. Stachnik; payload 1.

d. **JPL Ozone Photometer**: ultraviolet in-situ absorption; PI: J.J. Margitan; payload 1 and 2.

e. **Nagoya Aerosol Sampler**: in-situ sampler; PI: M. Hayashi; payload 1 and 2.

f. **DU CAESR Spectrometer**: mid-infrared remote thermal-emission grating; PI: F.J. Murcray; payload 2.

(2) Principle:

a. **SAO FIRS-2 Interferometer**:

The FIRS-2 is a remote-sensing Fourier-transform spectrometer that measures the mid- and far-infrared (14 to 140 micron) thermal emission spectrum of the stratosphere from balloon and aircraft platforms. The spectrometer has had 9 successful balloon flights from 1987 to 1994, flying at float altitudes of about 38 km, and collecting 128 hours of mid-latitude stratospheric limb spectra. The spectrometer also flew on a NASA DC-8 aircraft, as part of the second Airborne Arctic Stratospheric Expedition (AASE-II), collecting 140 hours of overhead spectra at latitudes ranging from the equator to the North Pole. Its advantage is that it can observe during both day and night. FIRS-2 measures the range 70-700 cm-1 using 2 detectors simultaneously, with a signal-to-noise ratio of about 100 per scan, and at high spectral resolution (0.004 cm-1 per data point).

b. **JPL MkIV Interferometer**:

The JPL MkIV is a high resolution FTIR spectrometer designed to make remote observations of atmospheric composition by the solar absorption technique. Since being built at JPL in 1985, the MkIV has performed 7 balloon flights (all successful) from New Mexico and California. On all of these flights sunset occultation were observed and on three flights sunrise was also observed. The MkIV has also flown in three DC-8 campaigns; to the Antarctic in 1987 and to the Arctic in 1989 and 1992. Additionally, the MkIV has made hundreds of ground-based observations from various locations including McMurdo Station, Antarctica. Optically, the MkIV instrument is very similar to the ATMOS instrument which has flown four times on the Shuttle. The chief advantage of the MkIV is that, by employing two detectors in parallel (a HgCdTe photoconductor and an InSb photodiode), it is able to measure the entire mid-infrared spectral region (600-5500 cm-1) simultaneously while still preserving a high signal-to-noise ratio (600:1) and high spectral resolution (0.008 cm-1).

c. **JPL SLS Spectrometer**:

The Submillimeterwave Limb Sounder (SLS) is a heterodyne detection spectrometer which measures atmospheric thermal emission at submillimeter wavelengths. As a high resolution (2 MHz min channel width) emission remote sensing instrument, the SLS can provide continuous vertical profile (15km to 45 km altitude) measurements during day or night. Developed at JPL in 1990 as an advanced balloon/aircraft version of the UARS Microwave Limb Sounder, the SLS has been flown on 10 high altitude balloon flights, all fully successful. During 1991-1994 the instrument was flown as part of the UARS Correlative Measurements program from sites in New Mexico and California. The SLS instrument also participated in Phases I, II, and III of SESAME, the Second European Stratospheric Arctic and Midlatitude Experiment, with a series of joint flights with the KFA sampling instruments (U. Schmidt, A. Engel). During SESAME, the SLS had a total of four Arctic winter flights from the ESRANGE facility at Kiruna, Sweden. Two of these were within the polar vortex, one during 'cold' conditions when high levels of activated chlorine were observed.

d. **JPL Ozone Photometer**:

The JPL Ozone Photometer has made 20 flights in the past 8 years aboard gondolas flying in NASA's Upper Atmosphere Research Program. It has made 9 flights for the

UARS Correlative Measurements Program, providing cal/val data for the UARS instruments MLS, HALOE, ISAMS, and CLAES. It flew from Kiruna in 1994 and 1995 along with SLS and UC Irvine's ClO instrument. Presently it is flying with the in situ suite of instruments for NASA's Observations of the Middle Stratosphere project. The photometer will provide continuous ozone data from launch until landing with 1 second time resolution, including ascent and descent profiles and at float. The ascent profile will have a corresponding vertical resolution of about 5 meters. The balloon photometer is a twin of the ozone measuring instrument that flies on board the NASA ER-2 in the Polar Ozone Campaigns.

e. **Nagoya Aerosol Sampler**:
The sampler samples the aerosols in the air, which is pumped by a small air pump onto the surface of filter whose size is a few mm in diameter. The sampler is often called an impacter sampler since the aerosols stick on the filter surface by the collision on it with the air flow by the pump. After return to the laboratory, the morphology of the aerosols is observed with an electron microscope, and the chemical composition is analyzed with a laser microprobe mass spectrometer.

f. **DU CAESR Spectrometer**:
The University of Denver mid-infrared remote thermal-emission grating spectrometer measures atmospheric radiation with essentially zero instrumental background. It is a small, He-cooled grating radiometer, for the region 7.5 to 12.6 micron. Profile measurements are made on ascent.

3) Altitude range (AR), Accuracy/Precision (A/P), Vertical resolution (VR), Averaging time (AT):

(Note: The stated altitude range is that range over which each species is measured; the accuracy/precision values are applicable for the stated vertical resolution and averaging time, but only in the altitude range for which the corresponding mixing ratio is roughly one-half or more of the peak mixing ratio, which varies for each species, and depends upon the time of day in some cases. We assume a float altitude of about 36 km.)

Species	AR	A / P	VR	AT
(SAO FIRS-2 Interferometer)				
O3	15-40 km	5 % / 3 %	4 km	150 min for 3-4 vertical profiles
N2O	15-40 km	9 % / 4 %	4 km	150 min
HNO3	15-40 km	11 % / 4 %	4 km	150 min
NO2	15-40 km	20 % / 20 %	4 km	150 min
H2O	15-40 km	6 % / 3 %	4 km	150 min
T (temperature)	15-40 km	1 K / 0.2 K	4 km	150 min
P (pressure)	15-40 km	3 % / 2 %	4 km	150 min
N2O5	15-40 km	20 % / 20 %	4 km	150 min
OH	15-40 km	10 % / 8 %	4 km	150 min
HO2	15-40 km	11 % / 10 %	4 km	150 min
H2O2	15-40 km	40 % / 40 %	4 km	150 min
HOCl	15-40 km	15 % / 15 %	4 km	150 min
ClONO2	15-40 km	20 % / 20 %	4 km	150 min
HCl	15-40 km	8 % / 4 %	4 km	150 min
HF	15-40 km	9 % / 5 %	4 km	150 min
(JPL MkIV Interferometer)				
O3	15-40 km	5 % / 3 %	2 km	25 min per vertical profile, 93 sec per spectrum
N2O	15-40 km	4 % / 4 %	2 km	25 min

Species	AR	A / P	VR	AT
HNO3	15-40 km	10 % / 5 %	2 km	25 min
NO2	15-40 km	6 % / 5 %	2 km	25 min
CH4	15-40 km	4 % / 3 %	2 km	25 min
H2O	15-40 km	5 % / 5 %	2 km	25 min
T (temperature)	15-40 km	2 K / 2 K	2 km	25 min
P (pressure)	15-40 km	4 % / 2 %	2 km	25 min
CO	15-40 km	10 % / 6 %	2 km	25 min
CFC-11	15-40 km	10 % / 5 %	2 km	25 min
N2O5	15-40 km	15 % / 10 %	2 km	25 min
H2O2	15-40 km	50 % / 50 %	2 km	25 min
HOCl	15-40 km	30 % / 30 %	2 km	25 min
ClONO2	15-40 km	15 % / 10 %	2 km	25 min
HCl	15-40 km	7 % / 5 %	2 km	25 min
HF	15-40 km	8 % / 6 %	2 km	25 min
CFC-12	15-40 km	8 % / 4 %	2 km	25 min
NO	15-40 km	10 % / 8 %	2 km	25 min
HNO4	15-40 km	20 % / 20 %	2 km	25 min
OCS	15-40 km	15 % / 15 %	2 km	25 min
HCN	15-40 km	10 % / 10 %	2 km	25 min
CCl4	15-40 km	20 % / 20 %	2 km	25 min
CF4	15-40 km	20 % / 20 %	2 km	25 min
COF2	15-40 km	15 % / 15 %	2 km	25 min
CHF2Cl	15-40 km	20 % / 15 %	2 km	25 min
CH3Cl	15-40 km	20 % / 20 %	2 km	25 min
C2H2	15-40 km	20 % / 20 %	2 km	25 min
C2H6	15-40 km	15 % / 10 %	2 km	25 min
CFC-22	15-40 km	15 % / 10 %	2 km	25 min
(JPL SLS Spectrometer)				
O3	15-45 km	8 % / 6 %	3 km	15 min
N2O	15-45 km	6 % / tbd	3 km	15 min
HNO3	15-45 km	20 % / 10 %	3 km	15 min
HO2	15-45 km	25 % / 15 %	3 km	15 min
ClO	15-45 km	15 % / 10 %	3 km	15 min
HCl	15-45 km	10 % / 5 %	3 km	15 min
(JPL Ozone Photometer)				
O3	0-36 km	3 % / 1 %	5 m	1 sec per sample
(Nagoya Aerosol Sampler)				
Aerosols	5-36 km	(not applicable)	1-2 km	3-6 min per sample
(DU CAESR Spectrometer)				
O3	15-36 km	15 % / 10 %	1 km	3 min per sample
HNO3	15-36 km	15 % / 10 %	1 km	3 min
CH4	15-36 km	20 % / 15 %	1 km	3 min
T (temperature)	15-36 km	3 K / 2 K	1 km	3 min
Aerosol	15-36 km	15 % / tbd	1 km	3 min
CFC-11	15-36 km	20 % / tbd	1 km	3 min
N2O5	15-36 km	20 % / tbd	1 km	3 min
CFC-12	15-36 km	15 % / tbd	1 km	3 min

4) Situation on facilities and equipment especially for the experiment:
Four instruments each will fly on separate gondolas:

- Payload 1: (a) SAO FIRS-2 Interferometer; (c) JPL SLS Spectrometer; (d) JPL Ozone Photometer; (e) Nagoya Aerosol Sampler.
- Payload 2: (b) JPL MkIV Interferometer; (d) JPL Ozone Photometer; (e) Nagoya Aerosol Sampler; (f) DU CAESR Spectrometer.

All instruments have all flown on many previous flights, and some (a-d) on the same gondola, so we expect that the combination should be successful.

The gondolas will be provided by JPL, and are the same as have been used on many successful flights. The ground-support-equipment for the gondolas and experiments will be provided by JPL and the scientists, respectively. All balloon launch services will be provided by the National Scientific Balloon Facility, based in Palestine, Texas; the NSBF is run by NASA, and has great expertise in this area. The NSBF will arrange for all needed local facilities in Fairbanks, including hanger space, cryogens, weather forecasting, launch, tracking, and recovery. Each research group has sufficient computer equipment to analyze the data.

5) Schedule for the experiment:

(1) Preparation:

Our research schedule is keyed to two balloon flights from Fairbanks, Alaska in April 1997. These dates were chosen in preliminary discussions between several Japanese and American investigators as part of the ILAS Correlative Experiments Plan. The NSBF and scientific groups will ship their equipment to Fairbanks in sufficient time for the expected April launch window, on a schedule which will be determined later.

(2) Execution period of the measurements:

April 1997 (2 flights during one-month period).

(3) Data submission:

The data will be available to ADEOS about 2-4 months after the measurements. Some preliminary data analysis will be possible in the field, either during the flight or just after. This will allow us to make an immediate assessment of the data quality, even before the payload is returned. All flight data will be recorded in digital format and hand-carried home after the campaign. Data analysis will begin immediately thereafter. At JPL and SAO, complete data reduction systems (hardware and software) are currently in place. The expected data products are vertical mixing ratio profiles of the species listed in section "6-3)" above, plus pressure, temperature, and aerosol profiles. For those species where ADEOS requires a column amount for comparison, we will provide that amount as well.

Data will be provided in standard NASA Ames format.

6) Comments

This experiment will be carried out as an ADEOS validation campaign, with logistical support from NASDA, and scientific support from NASA.

For NASA purposes, each flight will be called a "NASA Cooperative Flight". A preliminary experiment plan, including an NSBF report on the Fairbanks launch site, can be found in the Discussion Document "Arctic Chemistry Experiment by Balloon in 1997 for ADEOS", dated April 30, 1996, which was circulated to both NASA and NASDA officials.

7. Details of implementation plan for ILAS validation analysis using the experiment data

1) Requested ILAS data for the analysis:

(1) Parameter(s) (species or physical properties):

We will request ILAS Standard Data Products at times and places around the balloon flights from Fairbanks. The volume of data will be modest, since we only need to examine the relevant ADEOS measurements in the immediate vicinity of our own, for the purpose of calibration and validation.

For ILAS we will need unvalidated level 2 (vertical profile) data for all species measured, including pressure and temperature, near the balloon flight track and time.

(2) Dates and Location:

a. Dates: April 1997

b. Location: Fairbanks (Alaska, U.S.A.; 65N, 148W)

2) Method of the analysis:

The ADEOS data will be used for comparison with the results from the Multi-Instrument gondola, and an assessment will be made in terms of bias, offset, and other characteristics, using appropriate statistical tests.

At this point we anticipate that extensive collaboration will occur with the ADEOS Principal Investigators and co-workers. As stated in the MOU and ADEOS Joint Research Announcement, the data will be used for peaceful and research purposes only, and we agree not to transfer the data to a third party unless specifically requested or consented to by the appropriate ILAS project and ADEOS officials.

3) Submission dates of the results:

Approximately July to September 1997.

8. Related Publications

1) Instrument explanation:

- Johnson, D.G., K.W. Jucks, W.A. Traub, and K.V. Chance, Smithsonian stratospheric far-infrared spectrometer and data reduction system, J. Geophys. Res., 100, pp.3091-3106, 1995.
- M.H. Proffitt, Ozone measurement from a balloon payload using a new fast-response uv-absorption photometer, in Atmospheric Ozone, C.S. Zerefos and A. Ghazi, eds., Reidel, Dordrecht, p. 470, 1985.
- Stachnik, R.A., J.C. Hardy, J.A. Tarsala, J.W. Waters, and N.R. Erikson, Submillimeter heterodyne measurements of stratospheric ClO, HCl, O3, and HO2: First results, Geophys. Res. Lett., 19, pp. 1931-1934, 1992.
- Toon, G.C., The JPL MkIV interferometer, Opt. Photonics News, 2, pp. 19-21, 1991.
- Traub, W.A., K.V. Chance, D.G. Johnson, and K.W. Jucks, Stratospheric spectroscopy with the far-infrared spectrometer (FIRS-2): Overview and recent results, SPIE, 1491, pp. 298-307, 1991.

2) Scientific results:

- For the results of balloon validation of satellite results, see many of the 46 papers on UARS validation in the JGR special issue: JGR 101, pp. 9539-10473, 1996.

- L. Jaegle, Y.L. Yung, G.C. Toon, B. Sen, and J.-F. Blavier, Balloon observations of organic and inorganic chlorine in the stratosphere: the role of HClO4 production on sulfate aerosols, Gephys. Res. Lett., 23, pp. 1749-1752, 1996.
- D.G. Johnson, J. Orphal, G.C. Toon, K.V. Chance, W.A. Traub, K.W. Jucks, G. Guelachvili, and M. Morillon-Chapey, Measurement of chlorine nitrate in the stratosphere using the nu4 and nu5 bands. Gephys. Res. Lett., 23, pp. 1745-1748, 1996.
- F.J. Murcray, J.R. Starkey, W.J. Williams, W.A. Matthews, U. Schmidt, P. Aimedieu, and C. Camy-Peyret, HNO3 profiles obtained during the EASOE campaign, Jour. Geophys. Res., 21, pp. 1223-1226, 1994.
- W.J. Williams, F.J Murcray, R.D. Blatherwick, P. Fogal, P. Sullivan and C. Camy-Peyret, Nitric Acid observations during Arctic winter, in Polar Stratrospheric Ozone: proceedings of the third European Workshop, ed Pyle, Harris and Amanatidis, pp 179-182, 1996.
- M.H. Proffitt, J.J. Margitan, K.K. Kelly, M. Loewenstein, J.R. Podolske, and K.R. Chan, Ozone loss in the Arctic polar vortex inferred from high-latitude aircraft measurements, Nature, 97, pp. 31-36, 1990.
- W.A. Traub, K.W. Jucks, D.G. Johnson, M.T. Coffey, W.G. Mankin, and G.C. Toon, Comparison of column abundances from three infrared spectrometers during AASE II, Geophys. Res. Lett., 21, pp. 2591-2594, 1994.
- Y. Iwasaka, M. Hayashi, Y. Kondo, M. Koike, S. Koga, M. Yamato, P. Aimedieu, and W. A. Matthews, Chemical state of Polar Stratospheric Aerosols, Proceedings of the NIPR Symposium on Polar Meteorology and Glaciology, 5, pp 1-8, 1992
- Y. Iwasaka, M. Hayashi, Y. Kondo, M. Koike, S. Koga, M. Yamato, P. Aimedieu, and M. Mattews, Two different type nitrate aerosols in the winter polar stratosphere: Morphology of individual particles observed with an electron microscope, J. Geomag. Geoelectr., 45, pp. 1181-1192, 1993.
- Y. Kondo, P. Aimedieu, M. Koike, Y. Iwasaka, P.A. Newman, U. Schmidt, W.A. Matthews, M. Hayashi, and W.R. Sheldon, Reactive nitrogen, ozone, and nitrate aerosols observed in the Arctic stratosphere in January 1990, J.G.R., 97,13025-13038, 1992.
- K. Hara, T. Kikuchi, K. Furuya, M. Hayashi, and Y. Fujii, Characterization of Antarctic aerosol particles using Laser Microprobe Mass spectrometry, Environmental Sci. Tech., 30, 385-391, 1996.
- A. Engel, U. Schmidt, R.A. Stachnik, Partitioning between chlorine species deduced from observations in the Arctic winter Stratosphere, J. Atm. Chem, in press, 1996.

1. **Title of ILAS validation experiment**

Observation of Stratospheric Ozone Profile by Ozonesonde Sounding

2. Investigators

1) **Principal Investigator**

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3. Target species, profiles

1) **Target species for ILAS**: **Ozone vertical profile, Temperature profile**

2) Other target species: none

4. **Category** of ILAS validation experiment

Cooperative Experiment

5. **Significance** of the validation experiment for ILAS

We propose to carry out extensive ozonesonde measurements from Geophysical Institute, University of Alaska Fairbanks in April 1997, as one of the calibration/validation campaigns for the ADEOS Satellite. The primary purpose of the ozonesonde experiment is to calibrate and validate data from the three atmospheric sensors on board ADEOS: ILAS, IMG, and TOMS. Ozone and temperature profiles over the ground to about 30 km will be measured during ozonesonde flights. We plan to carry out 20 ozonesonde flights during one month, April, period. Ozone is a key species in the stratosphere and also in the troposphere. Our measurements will provide a dynamical behavior of ozone field during the breakup of polar vortex. These data will also be used for comparison with ozone measurements by ILAS, TOMS, and IMG. Our data will be useful not only for direct comparison with coincident ILAS observation but also for revealing ozone field in polar region during April in combination with ozone measurements made at various polar sites other than Fairbanks.

6. **Details of implementation plan** for the experiment

1) **Location**: **Fairbanks (Alaska,** U. S. A.; 65N, 148W)

2) **Instrument**:

(1) Name: **Model 2Z ECC Ozonesonde** by EN-SCI Corporation

(2) Principle:

Electrochemical concentration cell (ECC) contains KI (potassium iodide) solutions. When ozone in air enters the sensor, ozone is detected by measuring the cell current (electron flow) produced through chemical reactions as the following.

$2KI + O_3 + H_2O \rightarrow 2KOH + I_2 + O_2$
$I_2 + 2e \rightarrow 2I^-$

3) Altitude range (AR), Accuracy/Precision (A/P), Vertical resolution (VR), Averaging time (AT):

Species/ Physical properties	AR	A / P	VR	AT
O3	0 - 35 km	5 % / 3 %	0.3 km	-

4) Schedule for the experiment

(a) Execution period of the measurement: April 1997 (20 flights; about 5 flights / week)

7. Implementation plan for ILAS validation analysis using the experiment data

1) Requested ILAS data for the analysis:

(a) Parameters:

We will request ILAS Standard Data Products at times and places around the balloon flights. We will need vertical profile (level 2) data for ozone, temperature, and pressure.

(b) Dates and Location:

Dates: April 1997
Location: Fairbanks, Alaska, U.S.A. (65N, 148W)

2) Method of the analysis:

We will compare the ozone profiles measured with ozonesonde and ILAS.

3) Submission dates of the results:

Approximately August to September 1997.

8. Related publications

1) Instrument explanation and performance

- Komhyr, W. D., J. A. Lathrop, D. P. Opperman, R. A. Barmes, and G. B. Brothers, ECC ozonesonde performance evaluation during STOIC 1989, J. Geophys. Res., 100, 9231, 1995.

2)Related scientific results:

- For the results of balloon validation of sattellite, please refer the 46 papers on UARS validation in JGR special issue: JGR, 101, pp9539-10473, 1996.

- Shibasaki, K., K. V. Chance, D. G. Johnson, K. W. Jucks, and W. A. Traub, Long term trend of stratospheric HF and HCl derived from balloon-borne far infrared emission spectroscopy, Proc. Ozone Symp., L'Aquila (Italy), 1996.
- Watanabe, T., Suzuki, K., Shibasaki, K., and Ogawa, T., Observation of stratospheric ozone with the rocket ozonesondes during the decreasing phase of 11-year solar cycle, Proc. Ozone Symp, L'Aquila (Italy), 1996.

1. Title of ILAS validation experiment

Validation of ILAS data by balloon-borne measurement of N2O, CH4, and CFC-11 from Syowa station, Antarctica

2. Investigators

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3. Target species, profiles or column

1) **Target species for ILAS:** **vertical profiles of N2O, CH4 and CFC-11**

2) Other target species: CFC-12, CO2, ^{13}C, ^{14}C

4. **Category** of ILAS validation experiments

Cooperative experiment

5. **Significance** of the validation experiment for ILAS

The concentrations of stratospheric trace gases such as N2O, CH4 and CFC-11 are relatively measured using ILAS, while those are determined directly by analyzing air samples collected with a balloon-borne cyogenic sampler. Therefore the balloon sampling with subsequent laboratory analysis is indispensable for validating ILAS data.

6. **Details of implementation plan** for the experiment

1) **Location**: **Syowa Station (Antarctica**; 69S, 40E)

2) **Instrument**:
(1) Name: **Balloon-borne cryogenic sampler**

(2) Principle:
Stratospheric air samples are collected cryogenically at assigned heights, and then analyzed for their N2O, CH4 and CFC-11 concentrations using gas chromatographs.

3) Altitude range (AR), Accuracy/Precision (A/P), Vertical resolution (VR), Averaging time (AT):

Species	AR	A / P	VR	AT
N2O	10 - 35 km	0.4 % / 0.4 %	2 km	1-20 min
CH4	10 - 35 km	0.2 % / 0.2 %	2 km	1-20 min
CFC-11	10 - 35 km	2 % / 2 - 5 %	1 - 2 km	1-20 min

4) Situation on facilities and equipment especially for the experiments:
The cryogenic sampler will be launched in cooperation with the 38th and 39th Japanese Antarctic Research Expedition teams using facilities of Japanese Antarctic station, Syowa. The sampler is in process of assembling.

5) Schedule for the experiment:
(1) Preparation:
Preparation of the instruments of cryogenic sampling has started in 1995.

(2) Execution period of the measurements:
December 1997 - January 1998, 1 flight

(3) Data submission:
7 months after the measurements

7. Details of implementation plan for ILAS validation analysis using the experiment data

1) Requested ILAS data for the analysis:
(1) Species or physical properties: Concentrations of N2O, CH4 and CFC-11

(2) Dates and Location:
a. Dates: When ILAS data are obtained in December, 1997-January, 1998.

b. Location: Syowa station (Antarctica 69S, 40E)

2) Method of the analysis:
Comparison of measured verical N2O, CH4 and CFC-11 profiles with those from ILAS.

3) Submission dates of the results:
   7 months after the measurements

8. Related Publications

1) Instrument explanation:

- H. Honda, S. Aoki, T. Nakazawa, S. Morimoto and N. Yajima, Cryogenic air sampling system for measurements of the concentrations of stratospheric trace gases and their isotopic ratios over Antarctica, J. Geomagnetism and Geoelectricity, in press, 1996.

2) Scientific results:

- T. Nakamura, T. Nakazawa, H. Honda, H. Kitagawa, T. Machida, A. Ikeda and E. Matsumoto, Seasonal variations in 14C concentrations of stratospheric CO2 measured with accelerator mass spectrometer, Nuclear Instruments and Method in Physics Research, B92, 413-416, 1994.
- T. Gamo, M. Tsutsumi, H. Sakai, T. Nakazawa, T. Machida, H. Honda and T. Itoh, Long-term monitoring of carbon and oxygen isotope ratios of stratospheric CO2 over Japan, Geophys. Res. Lett., 22, 397-400, 1995.
- T. Nakazawa, H. Honda, T. Machida, S. Sugawara, S. Murayama, G. Hashida, S. Morimoto and T. Itoh, Mesurements of the stratospheric carbon dioxide concentration over Japan using a balloon-borne cyogenic sampler, Geophys., Res. Lett., 22, 1229-1232, 1995.

1. **Title of ILAS validation experiment**

Vertical aerosol and ozone profiles at high southern latitudes in conjunction with ILAS overpasses

2. Investigators

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3. Target species, profiles or column

1) **Target species for ILAS**: **Profiles of Aerosol and O3**

2) Other target species: none

4. **Category** of ILAS validation experiments

Cooperative experiment

5. **Significance** of the validation experiment for ILAS

Stratospheric aerosol, through the development of polar stratospheric clouds, play critical roles in polar ozone loss. After major volcanic eruptions they also appear to impact mid latitude ozone levels. They are also important in considerations of the global heat balance, and can impact satellite radiation measurements, both emission and absorption. For these reasons it is important for both ILAS data analysis and interpretation to have an accurate characterization of stratospheric aerosol levels.

Polar ozone loss is a global problem and it is important to calibrate new satellite sensors against ground based and in situ standard measurements.

6. **Details of implementation plan** for the experiment

1) **Location**: **McMurdo (Antarctica**; 78S, 166E)

2) **Instrument**:

(1) Name: a. **Aerosol counter**: Aerosol

b. **Ozonesonde**: O3

(2) Principle:

a. Aerosol counter: The Wyoming aerosol counter are optical particle counters which measure the light scattered by single particles as they pass through the chamber. The condensation nuclei concentrations are measured by causing the particles to grow to optically detectable sizes through condensation of ethylene glycol vapor in a growth chamber preceding the optical counter. From the concentrations measured at several sizes, size distributions can be inferred.

b. Oznesonde: Electrochemical cell ozonesonde. The sensor measures the current flow which occurs as electrons are released during a chemical reaction between ozone in an air stream which passes through a potassium iodide solution.

3) Altitude range (AR), Accuracy/Precision (A/P), Vertical resolution (VR), Averaging time (AT):

Species	AR	A / P	VR	AT	(remark)
Aerosol	0 - 35 km	10 % / 5 - 2 %	0.05 km	10 s	for optical aerosol concentrations 0.001-1.0 cm^{-3}
		10 % / 5 %			for condensation nuclei concentrations
Ozone	0 - 35 km	5 % / 5 %	0.05 km	10 s	

4) Situation on facilities and equipment especially for the experiment:

Pending funding from the U.S. National Science Foundation, instruments will be shipped to McMurdo in time for the August - October sampling period. Similar measurements have been made from there since 1986.

5) Schedule for the experiment:

(1) Preparation:

The instruments will be prepared in the field once the season begins.

(2) Execution period of the measurements:

Ozonesonde flights will be conducted roughly every 3 days from 20 August through 31 October. During the same period up to 15 aerosol counter flights will be made. These will primarily occur in late August and early September.

(3) Data submission:

12 months after the measurements

7. Details of implementation plan for ILAS validation analysis using the experiment data

1) Requested ILAS data for the analysis:

(1) Species or physical properties:

Vertical profiles of aerosol extinction at both visible and infrared wavelengths
Vertical ozone profiles

(2) Dates and Location:

a. Dates: Coinciding with balloon flights from McMurdo
b. Location: McMurdo (78S, 166E) within a range of 500 km

2) Method of the analysis:

Comparison between vertical profiles of extinction, calculated from size distributions fit to the in situ aerosol concentrations measured, and the corresponding ILAS data. The in situ data will be averaged to match the vertical resolution of the ILAS data. Similar averaging will be used to compare vertical ozone profiles from the ozonesondes with ILAS profiles.

3) Submission dates of the results:
18 months after the measurements.

8. Related Publications

1) Instrument explanation:

- Hofmann, D. J. and T. Deshler, Stratospheric cloud observations during formation of the Antarctic ozone hole in 1989, J. Geophys. Res., 96, 2897-2912, 1991.
- Deshler, T., D. J. Hofmann, J. V. Hereford, and C. B. Sutter, Ozone and temperature profiles over McMurdo Station, Antarctica, in the spring of 1989, Geophys. Res. Lett., 17, 151-154, 1990.
- Deshler, T., In situ measurements of the size distribution of the Pinatubo aerosol over Kiruna on four days between 18 January and 13 February 1992, Geophys. Res. Lett., 21, 1323-1326, 1994.

2) Scientific results:

- Grainger, R. G., A. Lambert, C. D. Rodgers, F. W. Taylor, and T. Deshler, Stratospheric aerosol effective radius, surface area, and volume estimated from infrared measurements, J. Geophys. Res., 100, 16507-16518, 1995.
- Adriani, A., T. Deshler, G. Di Donfrancesco, and G. P. Gobbi, Polar stratospheric clouds and volcanic aerosol during 1992 spring over McMurdo Station, Antarctica: Lidar and particle counter comparisons, J. Geophys. Res., 100, 25877-25898, 1995.
- Hervig, M.E., J.M. Russell III, L. L. Gordley, J. H. Park, S. R. Drayson, and T. Deshler, Validation of aerosol measurements made by the Halogen Occultation Experiment, J. Geophys. Res., 101, 10267-10275, 1995.
- Deshler, T., A. Adriani, D. J. Hofmann, and G. P. Gobbi, Evidence for denitrification in the 1990 Antarctic spring stratosphere: II Lidar and aerosol measurements, Geophys. Res. Lett., 18, 1999-2002, 1991.

1. **Title of ILAS validation experiment**

Validation of ILAS data using in situ reactive nitrogen observations from the NASA ER-2 aircraft during POLARIS

2. **Principal Investigator**

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3. Target species, profiles or column

1) **Target species for ILAS**: **NO2**

2) Other target species: none

4. **Category** of ILAS validation experiments

Cooperative experiment

5. **Significance** of the validation experiment for ILAS

In situ measurements of NO2 in summer polar regions can be directly compared to ILAS profiles if measurement periods and locations coincide.

6. **Details of implementation plan** for the experiment

1) **Location**: **Arctic region of the circles centered on Fairbanks** (64.5N, 147.4W) **with a radius of 24-degree latitude**

2) **Instrument**:

(1) Name: **Chemiluminescence/ER-2/POLARIS**

(2) Principle:

Photolysis of NO2 to form NO and subsequent detection of NO by NO-O3 chemiluminescent reaction

3) Altitude range, Accuracy, Precision, Vertical resolution, and Averaging time:

a. Altitude range: 15-20.5 km
b. Accuracy : 30-60% depending on conditions
c. Precision : 0.050 ppbv typical
d. Vertical resolution: Much less than 1 km
e. Averaging time: 1 sec integration time on platform moving at 200 meters/sec

4) Situation on facilities and equipment especially for the experiment:
Instrument is integrated on the NASA ER-2 aircraft and will be participating in the NASA POLARIS mission in 1997 based in Fairbanks, Alaska.

5) Schedule for the experiment:
(1) Preparation:
complete

(2) Execution period of the measurements:
May, July, and September 1997

(3) Data submission:
Approximately 6 months after the measurements

6) Comments:
Note from the editor:
The following phrase is a part of the letter dated 27 August 1995 from David W. Fahey (NOAA/AL), Michael J. Kurylo (NASA/HQ), and Randall R. Friedl (NASA/HQ) to H. Kanzawa (ILAS Validation Experiment Team Leader), being slightly modified for this plan:

"The data set obtained from NASA ER-2 aircraft missions in 1997 as part of the Polar Ozone Loss in the Arctic Region in Summer (POLARIS) mission will be of value to the ILAS validation. On the other hand, ILAS data set will be useful for the POLARIS mission in extending its interpretation of POLARIS data to a broader range of altitudes, latitudes, and seasons. Such cooperation is in keeping with NASA's desire to maximize the scientific output from the various field exercises and to promote international collaboration on scientific issues of mutual interest. The ER-2 instrument Principal Investigators (PI's) and NASA program officials think that the most successful interactions will be those that involve direct contact of the ILAS project with the PI's. In this way, the POLARIS mission insure proper interpretation and understanding of each aircraft data set by outside investigators."

7. Details of implementation plan for ILAS validation analysis using the experiment data

No ILAS data products are being requested at this time.

8. Related Publications

1) Instrument explanation:

- In-situ measurements of total reactive nitrogen, total water, and aerosol in polar *stratospheric clouds in the Antarctic stratosphere*, D.W. Fahey, K.K. Kelly, G.V. Ferry, L.R. Poole, J.C. Wilson, D.M. Murphy, M. Loewenstein, K.R. Chan, Journal of Geophysical Research 94, 11299-11315, 1989.
- New photolysis system for NO2 measurements in the lower stratosphere, R.S. Gao, E. R.Keim, E.L. Woodbridge, S.J. Ciciora, M.H. Proffitt, T.L. Thompson, R.J. McLaughlin, D.W. Fahey, Journal of Geophysical Research 99, 20673-20681, 1994.

2) Scientific results:

- The distribution of hydrogen, nitrogen, and chlorine radicals in the lower stratosphere: Implications for changes in O3 due to emission of NOy from supersonic aircraft, R.J. Salawitch, S.C. Wofsy, P.O. Wennberg, R.C. Cohen, J.G. Anderson, D.W. Fahey, R.S. Gao, E.R. Keim, E.L. Woodbridge, R.M. Stimpfle, J.P. Koplow, D.W. Kohn, C.R. Webster, R.D. May, L. Pfister, E.W. Gottlieb, H.A. Michelsen, G.K. Yue, J.C. Wilson, C.A. Brock, H.H. Jonsson, J.E. Dye, D. Baumgardner, M.H. Proffitt, M.

Loewenstein, J.R. Podolske, J.W. Elkins, G.S. Dutton, E.J. Hintsa, A.E. Dessler, E.M. Weinstock, K.K. Kelly, K.A. Boering, B.C. Daube, K.R. Chan, S.W. Bowen, Geophysical Research Letters 21, 2547-2550, 1994.

- In situ measurements constraining the role of sulphate aerosols in mid-latitude ozone depletion, D.W. Fahey, S.R. Kawa, E.L. Woodbridge, P. Tin, J.C. Wilson, H.H. Jonsson, J.E. Dye, D. Baumgardner, S. Borrmann, D.W. Toohey, L.M. Avallone, M.H. Proffitt, J. Margitan, M. Loewenstein, J.R. Podolske, R.J. Salawitch, S.C. Wofsy, M.K. W. Ko, D.E. Anderson, M.R. Schoeberl, K.R. Chan, Nature 363, 509-514, 1993.
- In situ observations in aircraft exhaust plumes in the lower stratosphere at mid-latitudes, D.W. Fahey, E.R. Keim, E.L. Woodbridge, R.S. Gao, K.A. Boering, B.C. Daube, S.C. Wofsy, R.P. Lohmann, E.J. Hintsa, A.E. Dessler, C.R. Webster, R.D. May, C A. Brock, J.C. Wilson, P.O. Wennberg, R.C. Cohen, R.C. Miake-Lye, R.C. Brown, J.M. Rodriguez, M. Loewenstein, M.H. Proffitt, R.M. Stimpfle, S. Bowen, K.R. Chan, Journal of Geophysical Research 100, 3065-3074, 1995.

1. **Title of ILAS validation experiment**

Ozone measurement from ER-2 during POLARIS

2. **Principal Investigator**

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3. Target species, profiles or column

1) **Target species for ILAS**: **O3**, in-situ

2) Other target species: none

4. **Category** of ILAS validation experiments

Cooperative experiment

5. **Significance** of the validation experiment for ILAS

Highly accurate ozone measurements will be available up to 20 km for comparison with ILAS ozone measurements

6. **Details of implementation plan** for the experiment

1) **Location: Arctic region of the circles centered on Fairbanks** (64.5N, 147.4W) **with a radius of 24-degree latitude**

2) **Instrument**:
(1) Name: **dual-beam UV ozone photometer/ER-2/POLARIS**
(2) Principle: ultraviolet absorption within dual-beam photometer

3) Altitude range, Accuracy/Precision, Vertical resolution, and Averaging time:
a. Altitude range: ground to about 20 km
b. Accuracy/Precision: better than 5% accurate in stratosphere
c. Vertical resolution: depends upon aircraft ascent and descent rate
d. Averaging time: 1 second

4) Situation on facilities and equipment especially for the experiment:
ER-2 aircraft

5) Schedule for the experiment:
(1) Preparation:
fully integrated on aircraft with more than 200 successful flights completed

(2) Execution period of the measurements:
May, July, and September 1997

(3) Data submission:
data usually available within 1 hour after a flight

6) Comments:
Note from the editor:
The following phrase is a part of the letter dated 27 August 1995 from David W. Fahey (NOAA/AL), Michael J. Kurylo (NASA/HQ), and Randall R. Friedl (NASA/HQ) to H. Kanzawa (ILAS Validation Experiment Team Leader), being slightly modified for this plan:

"The data set obtained from NASA ER-2 aircraft missions in 1997 as part of the Polar Ozone Loss in the Arctic Region in Summer (POLARIS) mission will be of value to the ILAS validation. On the other hand, ILAS data set will be useful for the POLARIS mission in extending its interpretation of POLARIS data to a broader range of altitudes, latitudes, and seasons. Such cooperation is in keeping with NASA's desire to maximize the scientific output from the various field exercises and to promote international collaboration on scientific issues of mutual interest. The ER-2 instrument Principal Investigators (PI's) and NASA program officials think that the most successful interactions will be those that involve direct contact of the ILAS project with the PI's. In this way, the POLARIS mission insure proper interpretation and understanding of each aircraft data set by outside investigators."

7. Details of implementation plan for ILAS validation analysis using the experiment data

No ILAS data products are being requested at this time.

8. Related Publications

1) Instrument explanation:

- Proffitt, M.H., and McLaughlin, R.J., Fast-response dual-beam UV-absorption ozone photometer suitable for use on stratospheric balloons, Rev. Sci. Instrum., 54, 1719-1728, 1983.
- Proffitt, M.H., Steinkamp, M.J., Powell, J.A., McLaughlin, R.J., Mills, O.A., Schmeltekopf, A.L., Thompson,T.L., Tuck, A.F., Tyler, T., Winkler, R.H., and Chan, K.R., In situ ozone measurements within the 1987 Antarctic ozone hole from a high-altitude ER-2 aircraft, J.Geophys. Res., 94, 16547-16555, 1989.

2) Scientific results:

- Proffitt, M.H., Powell, J.A., Tuck, A.F., Fahey, D.W., Kelly, K.K, Krueger, A.J., Schoeberl, M.R., Gary, B.L., Margitan, J.J., Chan, K.R., Loewenstein, M., and Podolske, J.R., A chemical definition of the boundary of the Antarctic Ozone Hole, J. Geophys. Res., 94, 11437-11438, 1989.
- Proffitt, M.H., Fahey, D.W., Kelly, K.K., and Tuck, A.F., High-latitude ozone loss outside the Antarctic ozone hole, Nature, 342, 233-237, 1989.
- Proffitt, M.H., Margitan, J.J., Kelly, K.K., Loewenstein, M., Podolske, J.R., and Chan, K.R., Ozone loss in the Arctic polar vortex inferred from high-altitude aircraft measurements, Nature, 347, 31-36, 1990.
- Proffitt, M.H., Aikin, K., Margitan, J.J., Loewenstein, M., Podolske, J.R., Weaver, A., Chan, K.R., Fast, H., and Elkins, J.W., Ozone loss inside the northern polar vortex during the 1991-92 Winter, Science, 261, 1150-1154, 1993.

1. **Title of ILAS validation experiment**

ILAS data validation using water vapor data from the NASA ER-2 aircraft

2. Investigators

1) **Principal Investigator**

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2) Co-Investigators

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3. Target species, profiles or column

1) **Target species for ILAS**: **H2O**

2) Other target species: none

4. **Category** of ILAS validation experiments

Cooperative experiment

5. **Significance** of the validation experiment for ILAS

We will measure water vapor in the stratosphere up to 21 km in the northern hemisphere on the NASA ER-2 aircraft. Measurements will be made in May, July and September 1997. The ER-2 also provides data on many other chemical species which will be of use for ILAS validation, including N2O and CH4.

6. **Details of implementation plan** for the experiment

1) **Location**: **Arctic region of the circles centered on Fairbanks** (64.5N, 147.4W) **with a radius of 24-degree latitude**

2) **Instrument**:

(1) Name: **Fast response Lyman-alpha hygrometer/ER-2/POLARIS**

(2) Principle:

The Lyman-alpha hygrometer measures water vapor in the stratosphere and upper troposphere by photofragment fluorescence. A Lyman-alpha lamp (121.6 nm) photodissociates water, producing about 10% of the OH fragments in the first excited electronic state. Fluorescence from the OH is detected at right angles to the lamp and flow direction. Stratospheric air is sampled through a 3" square duct at 50 m/sec. to give very fast time response.

The instrument is calibrated in the laboratory by adding known amounts of water vapor as a function of pressure and temperature.

3) Altitude range (AR), Accuracy/Precision (A/P), Vertical resolution (VR), Averaging time (AT):

Species	AR	A/P	VR	AT
H2O	10-20.5 km	10 % / 0.1 ppmv	N/A	4 seconds

(N/A: Resolution is about 800 m along ER-2 flight track, though higher resolution data can be obtained)

4) Situation on facilities and equipment especially for the experiment:

Airfields and laboratories at Ames Research Center and in Fairbanks, Alaska, are available for ER-2 operations.

5) Schedule for the experiment:

(1) Preparation:

The water vapor instrument has been successfully flown on the ER-2 in 1993, 1995 and 1996. It is ready to fly again in 1997 for the POLARIS mission.

(2) Execution period of the measurements:

May, July, and September 1997

(3) Data submission:

Within 3 months after the measurements

6) Comments:

Note from the editor:

The following phrase is a part of the letter dated 27 August 1995 from David W. Fahey (NOAA/AL), Michael J. Kurylo (NASA/HQ), and Randall R. Friedl (NASA/HQ) to H. Kanzawa (ILAS Validation Experiment Team Leader), being slightly modified for this plan:

"The data set obtained from NASA ER-2 aircraft missions in 1997 as part of the Polar Ozone Loss in the Arctic Region in Summer (POLARIS) mission will be of value to the ILAS validation. On the other hand, ILAS data set will be useful for the POLARIS mission in extending its interpretation of POLARIS data to a broader range of altitudes, latitudes, and seasons. Such cooperation is in keeping with NASA's desire to maximize the scientific output from the various field exercises and to promote international collaboration on scientific issues of mutual interest. The ER-2 instrument Principal Investigators (PI's) and NASA program officials think that the most successful interactions will be those that involve direct contact of the ILAS project with the PI's. In this way, the POLARIS mission insure proper interpretation and understanding of each aircraft data set by outside investigators."

7. Details of implementation plan for ILAS validation analysis using the experiment data

No ILAS data products are being requested at this time

8. Related Publications

1) Instrument explanation:

- Weinstock, E.M., E.J. Hintsa, A.E. Dessler, J.F. Oliver, N.L. Hazen, J.N. Demusz, N.T. Allen, L.B. Lapson and J.G. Anderson, A new fast response photofragment fluorescence hygrometer for use on the NASA ER-2 and Perseus remotely piloted aircraft, Rev. Sci. Instrum., 65, 3544-3554, 1994.

2) Scientific results:

- Hintsa, E.J., E.M. Weinstock, A.E. Dessler, J.G. Anderson, M. Loewenstein and J.R. Podolske, SPADE H2O measurements and the seasonal cycle of stratospheric water vapor, Geophys. Res. Lett., 21, 2559-2562, 1994.
- Dessler, A.E., E.M. Weinstock, E.J. Hintsa, J.G. Anderson, C.R. Webster, R.D. May, J.W. Elkins, and G.S. Dutton, An examination of the total hydrogen budget of the lower stratosphere, Geophys. Res. Lett., 21, 2563-2566, 1994.

1. **Title of ILAS validation experiment**

ILAS validation and correlative measurements of ClO, HCl, N2O, O3 and other minor stratospheric constituents by aircraft microwave radiometry

2. Investigators

1) **Principal Investigator**

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2) Co-Investigators

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Name (role):	Gerhard Schwaab (600 GHz observation and data analysis)
Affiliation:	Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt (DLR-WS / Berlin, FRG)
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Name (role):	Brian John Kerridge (500 GHz observation and data analysis)
Affiliation:	Rutherford Appleton Laboratory (RAL / Chilton, UK)
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3. Target species, profiles or column

1) **Target species for ILAS**: **O3, N2O, (HNO3, H2O) profiles, column**

2) Other target species: ClO, HCl, (HO2, BrO, HOCl) profiles, column

4. **Category** of ILAS validation experiments

Cooperative experiment

5. **Significance** of the validation experiment for ILAS

Our contribution to the ADEOS validation: The sub-millimeter sensors onboard the aircraft are flexible in time and location of measurements to underfly the ADEOS sattelite as well as to coordinate with other instruments. The aims of validation will be:

- direct comparison with ILAS measurements of O3, N2O, (HNO3), (H2O)
- measurements of complementary molecules like ClO, HCl, (HO2), (BrO), (HOCl)

- In coordination with balloon measurements (e.g. MIPAS-B and BrO/ClO in-situ sensor) the chlorine, nitrogen and hydrogen families are widely covered. Partitioning and budget will be investigated.

6. **Details of implementation** *plan for the experiment*

1) **Location:** **Arctic region of the circles centered on Kiruna** (68N, 21E) with a range of 2000 km and a flight altitude of 10-13 km

2) **Instrument**:

(1) Name: **The sub-millimetre wave sensors** onboard the FALCON aircraft

(2) Principle:

In February 1997 a measurement campaign using the german FALCON research aircraft is planned. Two sub-millimetre passive radiometers with superconducting SIS detectors will be used to measure thermal emission lines of trace gas molecules in the stratosphere. Four european groups will be involved:

- Institute of Environmental Physics (IUP), University of Bremen, FRG
- Space Research Organisation Netherlands (SRON), Groningen/Utrecht, NL
- Rutherford Appleton Laboratory (RAL), Chilton, UK
- Institute of Space Sensor Technology (DLR-WS), Berlin, FRG

The ASUR sensor (SRON / IUP) receives in the 625/650 GHz spectral range and has been used for validation of UARS/MLS (1993) and GOME (1996) satellites. A newly developed 500 GHz sensor (RAL) has been designed to measure ClO and BrO. Both sensors participated in the SESAME campaign (1994/95).

The spectral ranges of the receivers cover the following molecules (the brackets indicate weak lines possibly detectable using long integration time):

625/650 Ghz: ClO, HCl, N2O, O3, (HO2), (BrO), (HOCl)
500 Ghz: ClO, N2O, O3, (BrO), (HNO3), (H2O)

Switching between the molecules can be done within a few minutes. A minimum of two days is needed to replace one receiver by the other.

3) Altitude range (AR), Accuracy/Precision (A/P), Vertical resolution (VR), Horizontal resolution (HR), and Averaging time (AT):

Species	AR	A/P	VR	HR	AT
O3	10-50 km	1 ppmv	8-10 km	< 5 km	7 s
N2O	10-50 km	40 ppbv	8-10 km	15 km	70 s
HCl	10-50 km	0.5 ppbv	8-10 km	15 km	70 s
ClO	10-50 km	0.2 ppbv	8-10 km	35 km	175 s

(Note: Data analysis provides vertical profiles (approx. 10-50 km, depending on flight altitude) with a height resolution of 8-10 km due to the up-looking geometry (78 degrees zenith angle). The horizontal resolution for the stronger lines is better than 50 km.)

4) Situation on facilities and equipment especially for the experiment:

The radiometers have been approved and tested during former campaigns using the FALCON aircraft operated by the DLR Oberpfaffenhofen. The aircraft will be based at Kiruna (Arena Arctica). The facilities of Kiruna airport and ESRANGE will be available for maintenance and supplying the sensors with cooling gases and for pre-analysis of the raw data.

5) Schedule for the experiment:

(1) Preparation:

Preparation and calibration of the sensors will be in Dec.96/Jan.97. Each receiver will be installed into the aircraft (located near Munich) within 2 days before its mission, respectively.

(2) Execution period of the measurements:
Three weeks in 1997 from February 10th to March 2nd. 1st week the 500 GHz sensor and 2nd/3rd weeks the 625/650 GHz sensor will be used.

(3) Data submission:
6 to 8 months after the measurements.

6) Comments:
The scientific aims of the aircraft campaign 1997 will be:
- investigation of detectability of small amplitude molecular lines
- measurements of diurnal (day/night) variations of stratospheric trace gases
- vortex edge and filament observations
- coordinated measurements (e.g. with balloons and satellites)

7. Details of implementation plan for ILAS validation analysis using the experiment data

1) Requested ILAS data for the analysis:
(1) Parameter(s) (species or physical properties):
O_3, N_2O, HNO_3, H_2O, NO_2, CFC-11, aerosols, pressure and air temperature

(2) Dates and Location(s):
a. Dates: Feb. 10th to March 2nd 1997

b. Location: Region over Kiruna (68N, 21E) within aircraft flight radius (approx. 2000 km)

2) Method of the analysis:
Comparison between retrieved height profiles and ILAS data (for O_3, N_2O).
Comparison between column values and ILAS data (for HNO_3, H_2O if measured).
Partitioning of the chlorine family using aircraft, balloon and ILAS data.
Correlation analysis of ClO-N_2O, HCl-N_2O, etc.

3) Submission dates of the results:
10-12 months after the measurements

8. Related Publications

1) Instrument explanation:

- J. Mees, S. Crewell, H. Nett, G. de Lange, H. van de Stadt, J.J. Kuipers, R.A. Panhuyzen "ASUR - An airborne SIS receiver for atmospheric measurements of trace gases at 625 to 760 Ghz" IEEE Transaction on Microwave Theory and Techniques, Vol. 43, No. 11, pp. 2543 - 2548, November 1995.

2) Scientific results:

- S. Crewell, R. Fabian, K. Kuenzi, H. Nett, T. Wehr, W. Read, J. Waters "Comparison of ClO measurements by airborne and spaceborne microwave radiometers in the Arctic winter stratosphere 1993" Geophysical Research Letters, Vol. 22, No. 12, pp. 1489 - 1492 June 15, 1995.

- T. Wehr, S. Crewell, K. Kuenzi, J. Langen, H. Nett, J. Urban, P. Hartogh "Remote sensing of ClO and HCl over northern Scandinavia in winter 1992 with an airborne submillimeter radiometer" Journal of Geophysical Research, Vol. 100, No. D10, pp. 20,957 - 20,968 October 20, 1995.
- J. de Valk, A. Goede, A. de Jonge, J. Mees, B. Franke, S. Crewell, H. Kuellmann, J. Urban, J. Wohlgemuth, M. Chipperfield, A. Lee "Airborne heterodyne measurements of stratospheric ClO, HCl, O3, and N2O during SESAME 1 over northern Europe" Journal of Geophysical Research, 1996 (accepted).
- J. de Valk, A. Goede, A. de Jonge, J. Mees, B. Franke, H. Kuellmann, J. Urban, J. Wohlgemuth "Observation in the atmosphere of the J=4,N=4 to J=2,N=3 transition frequency of 18O16O obtained with an airborne heterodyne SIS-receiver" J. of Quant. Spectr. and Rad. Transf. 1996 (submitted).

1. **Title of ILAS validation experiment**

POLSTAR (Polar Stratospheric Aerosol Experiment)

2. Investigators

1) **Principal Investigator**

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3. **Target species** for ILAS

O3, N2O, H2O, HNO3, NOy, NO2 (in-situ measured from the Falcon aircraft at 10, 12, and 12.5 km altitude)

4. **Category** of ILAS validation experiments

Cooperative Experiment

5. **Significance** of the validation experiment for ILAS

Simultaneous measurements of the trace gases given above will be performed on 4 Feb. 1997 west of the Scandinavian coast at altitudes of 12 and 12.5 km close to an occultation event point of ADEOS/ILAS at 68 N, 11 E

6. **Details of experiment plan** for the experiment

1) **Location**: Aircraft measuring leg close to 68 N 11 E and 14.18 UTC on 4 Feb. 1997 in the frame of a POLSTAR flight. The Falcon will start from Kiruna, Arena Arctica.

2) **Name of Instruments** (PI)
(1) NOx/NOy/O3-Measuring System (H. Schlager)
(2) High Altitude Automatic Aircaft-borne Mass Spectrometer - HAAMAS (F. Arnold)
(3) TRISTAR (H. Fischer)
(4) Fast In situ Stratospheric Hygrometer-FISH (C. Schiller)

3) Principle of Instruments (PI):
(1) NOx/NOy/O3-Measuring System:
a. O3: UV-absorption at 254 nm
b. NO: Chemiluminescence (CL)
c. NO2: CL+ photolytic converter
d. NOy: CL+ reduction converter

(2) HAAMAS: HNO3: CIMS (Chemical Ionisation Mass Spectrometry)

(3) TRISTAR: N2O: Infrared Absorption Spectroscopy using Tunable Diode Laser (TDLAS) at 4.54 μm

(4) FISH: H2O: Lyman-alpha photofragment fluorescence

4) Accuracy, Precision, Averaging Time (minimum):

Species	Accuracy	Precision	Averaging Time
O3	5%	2%	2s
NO	10%	5%	1s
NO2	15%	10%	5s
NOy	20%	10%	1s
HNO3	40%	20%	12s
N2O	2%	2% (3 sigma)	1s
H2O	5%	4%	1s

5) Situation of facilities and equipment especially for the experiment

In addition to the trace gases given above particle size distribution and total CN concentration are measured by the University of Mainz (St. Borrmann and V. Dreiling).

The airborne instruments used have been flown successfully in the framework of several national and international projects (e.g. CEC-projects STREAM, POLINAT, APE)

6) Schedule for the experiment:
(1) Preparation:

The aircraft-borne instruments are prepared, calibrated and deployed within the POLSTAR-campaign scheduled for 20 Jan. - 6 Feb. 1997. Campaign site is Kiruna, Arena Arctica.

(2) Execution period of the measurements:

The POLSTAR flight for the ILAS Validation Project is planned for 4 Feb. 1997.

(3) Data submission:

Five months after the measurements

7. Details of experiment plan for ILAS validation analysis using the experiment data

1) ILAS data requested for the analysis:
ILAS data for the occultation event point west of Kiruna on 4 Feb. 1997 (68 N, 11 E)

2) Parameters:
available trace gases, in particular the ones also measured from the Falcon

3) Method of the analysis:
Comparison between averaged in-situ measured trace gas volume mixing ratios and ILAS data (for O3, N2O, H2O, HNO3, NOy, and NO2)

4) Submission dates of the results
5 months after the measurements

8. Related publications

- Arnold, F., et al., Observations of nitric acid perturbations in the winter Arctic stratosphere: Evidence for PSC-sedimentation, accepted by J. Atm. Chemi., SESAME special issue, 1997.
- Fischer, H., et al., Development and application of multilaser TDLAS instruments for ground-based, shipboard, and airborne measurements of atmospheric trace gases, in Application of Tunable Diode and other Infrared Sources for Atmospheric Studies and Industrial Process Monitoring, Alan Fried (ed.), Proc. SPIE 2834, pp 130-141, 1996.
- Schiller, C., et al., A novel family of balloon-borne and airborne lyman-alpha photofragment fluorescence hygrometers, submitted Rev. Sci. Instr., 1997.
- Schlager, H., et al., In situ observations of air traffic emission signatures in the North Atlantic flight corridor, J. Geophys. Res., in press, 1997.

APPENDIX B

List of Acronyms

ADEOS:	Advanced Earth Observing Satellite
CGER:	Center for Global Environmental Research (NIES)
CLD:	Chemiluminescence Detector
CNES:	Centre National d'Etudes Spatiales
CNRM:	Centre National de la Recherches Météorologiques
CNRS:	Centre National de la Recherche Scientifique
Co-I:	Cooperative Investigator
Co-PI:	Cooperative Principal Investigator
DHF:	Data Handling Facilities
EA:	Environment Agency
EASOE:	European Artic Stratospheric Experiment
ECC:	Electrochemical Concentration Cell
ESA:	European Space Agency
FTIR:	Fourier Transform Infrared Spectrometer
FTS:	Fourier Transform Infrared Spectrometer
HALOE:	Halogen Occultation Experiment
ILAS:	Improved Limb Atmospheric Spectrometer
IR:	Infrared
IRA:	Internal Research Announcement
ISAS:	Institute of Space and Astronautical Science
JMA:	Japan Meteorological Agency
JPL:	Jet Propulsion Laboratory
JRA:	Joint Research Announcement
JWA:	Japan Weather Association
LaRC:	Langley Research Center (NASA)
LASER:	Light Amplification by Stimulated Emission of Radiation
LHS:	Laser Heterodyne Spectrometer
LIDAR:	Light Detection and Ranging
LPMA:	Laboratoire de Physique Moleculaire et Applications (CNRS)
LPMA:	Limb Profile Monitor of the Atmosphere (FTS Instrument)
MITI:	Ministry of International Trade and Industry
MRI:	Meteorological Research Institute
MRIT:	Matsushita Research Institute Tokyo
NASA:	National Aeronautics and Space Administration
NASDA:	National Space Development Agency
NDSC:	Network for the Detection of Stratospheric Change

NIES:	National Institute for Environmental Studies
NIPR:	National Institute of Polar Research
NIWA:	National Institute of Water & Atmospheric Research Ltd.
NOAA:	National Oceanic and Atmospheric Administration
PI:	Principal Investigator
PSC:	Polar Stratospheric Cloud
RIS:	Retroreflector In Space
SAGE:	Stratospheric Aerosol and Gas Experiment
SAM-II:	Stratospheric Aerosol Measurement-II
SSC:	Swedich Space Cooperation
STEL:	Solar-Terrestrial Environment Laboratory (Nagoya University)
TDLHS:	Tunable Diode Laser Heterodyne Spectrometer
TOMS:	Total Ozone Mapping Spectrometer
UARS:	Upper Atmosphere Research Satellite
UNEP:	United Nations Environment Programme
WMO:	World Meteorological Organization