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# ILAS-II Correlative Measurement Plan

Edited by T. Sugita and H. Kanzawa
ILAS-II Validation Experiment Team
ILAS-II Project

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# Foreword

This document defines the ILAS-II Correlative Measurements Plan. The purposes of the document are as follows:

(1) To assemble all the plans for measurement experiments to be conducted for ILAS-II validation in one volume to allow the ILAS-II project members to grasp the outline of each 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-II Project,

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

(4) To put ILAS-II Correlative Measurements on record for future reference when the results of measurement experiments are published.

I hope the document will be helpful for these purposes. Please note that it describes plans before the ADEOS-II satellite stopped operating on 25 October, 2003. Therefore, although some of the plans included here were not implemented, they contain useful information on how we were planning to validate the ILAS-II data products.

The plans were developed through discussions in meetings of the ILAS-II Science Team/Validation Experiment Team led by Dr. Yasuhiro Sasano (the leader of the ILAS-II project) and Dr. Hideaki Nakajima (the leader of the ILAS-II Science Team) of the National Institute for Environmental Studies and Dr. Hiroshi Kanzawa (the leader of the ILAS-II Validation Experiment Team) of Nagoya University. Both activities have been supported by the Ministry of the Environment. The efforts of Mr. Seiichi Shinoki of the Japan Weather Association and Mr. Taro Washida of Mitsubishi Research Institute Inc. in compiling this document were essential to its completion. Each plan for the validation experiments in Appendix A was drafted by the Principal Investigator of each experiment.

Takafumi Sugita
ILAS-II Validation Experiment Team Sub-Leader
National Institute for Environmental Studies

December 2003

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## ABSTRACT

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


## 1. Introduction

ILAS-II (Improved Limb Atmospheric Spectrometer-II) is on board the ADEOS-II (Advanced Earth Observing Satellite-II) spacecraft of NASDA (National Space Development Agency of Japan, now JAXA, the Japan Aerospace Exploration Agency) which was launched on 14 December 2002 with an expected mission lifetime of 3 years. Routine measurements by ILAS-II started in April 2003. Very regrettably, however, the ADEOS-II spacecraft stopped communicating with the ground from 25 October 2003. On 31 October, JAXA officially announced that there is very little possibility of restoring operations based on their seven-day investigations and attempts to restore the satellite functions following the loss of contact with ADEOS-II on October 25.

Details of ILAS-II measurements are given in Chapter 2. ILAS-II, which measures vertical profiles of ozone and ozone-related species in the high-latitude stratosphere, is a solar occultation sensor provided by the Ministry of the Environment (MOE). ILAS-II is the successor of ILAS, which operated from November 1996 to June 1997 on board the ADEOS satellite. The correlative measurement plan for ILAS is given by Kanzawa (1997).

The National Institute for Environmental Studies (NIES) supports MOE scientifically and is developing the ILAS-II Data Handling Facility (DHF). The ILAS-II project is thus a collaborative effort between MOE and NIES. At the end of 1999, the ILAS-II project established the ILAS-II Science Team and Validation Experiment Team to promote ILAS-II science. Its members include scientists from Japan and several other countries.

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

To attain these objectives, the quality of the satellite remote sensing data from ILAS-II should be evaluated. It is therefore planned to conduct validation experiments, the results of which will be compared with ILAS-II-derived data on ozone and other measured species and physical parameters. The objectives of validation experiments are to acquire an independent data set of sufficient size and quality to validate the accuracy of the ILAS-II measurements, and so the validation experiment measurements should overlap with the ILAS-II measurements in space and time as much as possible.

This document describes the plan for the ILAS-II correlative measurements including the ILAS-II validation experiments on the basis of each plan for the validation experiment drafted by the Principal Investigator of each experiment shown in Appendix A. The framework of the ILAS-II correlative measurements plan was described in Kanzawa et al. (2003).

# 2. ILAS-II Measurements and Validation Strategy

2.1 ILAS-II Measurements

The specifications of ILAS-II 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-II instrument itself are given, e.g., in: Sasano et al. (2001) and Nakajima et al. (in press).

2.2 Validation Experiment Strategy

2.2.1 Correlative Measurements for ILAS-II

Correlative Measurements for ILAS-II may be classified 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-II measurements. The validation measurements should overlap with ILAS-II measurements in space and time as much as possible. Details are given in the guidelines in Chapter 5.

(2) Complementary Measurements: To provide data on atmospheric species and physical parameters that are not measured by ILAS-II but will be complementary to scientific studies using the ILAS-II 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-II nitrogen chemistry measurements.

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

2.2.2 Categories of Validation Measurements

The validation measurements are indispensable for the ILAS-II project. They may be classified into three categories as follows:

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

(2) Cooperative Validation Experiments: Research observation experiments not funded by the ILAS-II 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 Routine Meteorological Data from UKMO (the Met Office, UK)

The Met Office grants to the ILAS-II Project Staff, Science Team members and Validation Experiment Team members a non-exclusive license to use, adapt, and modify those data and software. Commercial exploitation, business use, or transfer to any third party is not permitted without the written consent of the Met Office. The Met Office retains the intellectual property rights on the data and software.

UK Meteorological Office Stratospheric Analysis Data provided to the ILAS-II project are considered to be one of the correlative measurements. The ILAS-II Project members express our sincere gratitude to the Met office, especially to Dr. Richard Swinbank for supplying the above data to our project.

Table 2-1

Specifications of ILAS-II measurements for validation

| Species and physical parameters | |
|---|---|
| - Standard Products: | $O_3$, $HNO_3$, $NO_2$, $N_2O$, $CH_4$, $H_2O$, Aerosol(vis) |
| - Research Products: | $ClONO_2$, $N_2O_5$, CFC-12, CFC-11, CO, $C_2H_6$, OCS, $CO_2$, NO, $O_3$(Isotopomers), Aerosol(IR), Temperature, Pressure |
| Satellite observation period | 2003 – (mission life: - 3 years) |
| Principle: | Solar occultation technique (infrared and visible spectroscopy) |
| Latitude coverage: | 57 – 73 degrees North; - 64 – 90 degrees South |
| Altitude coverage: | 10 – 60km |
| Height resolution (one occultation): | 1km |

## Table 2-2
## ILAS-II measurement precision: Preliminary estimates

| Height | (km) | 10 | 20 | 30 | 40 | 50 |
|---|---|---|---|---|---|---|
| **Standard Products** | | | | | | |
| $O_3$ | (%) | 10 | 2 | 1 | 2 | 5 |
| $HNO_3$ | (%) | 25 | 2 | 10 | - | - |
| $NO_2$ | (%) | - | 10 | 10 | 40 | - |
| $N_2O$ | (%) | 5 | 2 | 5 | 50 | - |
| CH4 | (%) | 2 | 2 | 5 | 30 | - |
| $H_2O$ | (%) | 1 | 1 | 3 | 15 | 15 |
| Aerosols (vis.) | (%) | 10 | 5 | 30 | 90 | - |
| **Research Products** | | | | | | |
| $ClONO_2$ | (%) | - | 35 | 25 | - | - |
| CFC-12 | (%) | 3 | 15 | - | - | - |
| CFC-11 | (%) | 2 | 25 | - | - | - |
| CO | (%) | 5 | 35 | - | - | - |
| OCS | (%) | 20 | 40 | - | - | - |
| $CO_2$ | (%) | 2 | 5 | 2 | 2 | 2 |
| Aerosol (IR7) | (%) | 5 | 60 | - | - | - |
| (IR16) | (%) | 3 | 15 | 70 | - | - |
| (IR34) | (%) | 20 | - | - | - | - |
| (IR43) | (%) | 55 | - | - | - | - |
| (mid-IR0) | (%) | 5 | 50 | - | - | - |
| (mid-IR6) | (%) | 5 | 30 | - | - | - |
| (mid-IR16) | (%) | 5 | 50 | - | - | - |
| Temperature ($O_2$) | (K) | 1 | 1 | 1 | 1 | 3 |
| Pressure ($O_2$) | (%) | 1 | 1 | 2 | 2 | 5 |

NOTE: The Symbol "-" means precision over 100%
$N_2O5$ and $C_2H_6$ precisions are over 100% at all altitudes
(*In former ILAS, $N_2O_5$ could be retrieved when there was a certain amount of concentration).
NO, Pressure /Temeperature ($CO_2$), and Isotopomers of $O_3$, $H_2O$ etc. are to be investigated.

# 3. Functional Organization and Investigators

3.1 Project Leader and Sub-Leader

The Project Leader has overall responsibility for promoting the project in order to produce scientifically valid ILAS-II data. Project Staffs work for the Project Leader under his direction. The Project Leader also appoints the Science Team Leader and the Validation Experiment Team Leader.

Project Leader

**Sasano, Yasuhiro**
Director, Atmospheric Environment Division, Ozone Layer Research Project Leader, NIES

Project Sub-Leader

**Kobayashi, Hirokazu**
Visiting Research Fellow, Ozone Layer Research Project, NIES

3.2 ILAS-II Project Advisory Committee

The ILAS-II Project Advisory Committee has been established for the purpose of receiving advice and reviewing the overall progress of the project by external specialists. There are 5 members under 1 chairman, from 6 different institutes at present (October 2003).

Chairman

**Fujimura, Sadao**
Teikyo Heisei University

Members

**Aoki, Tadao**
Director, Physical Meteorology Research Dept., Meteorological Research Institute
**Ogawa, Toshihiro**
Director, Earth Observation Research Center, Japan Aerospace Exploration Agency
**Shimoda, Haruhisa**
Professor, Tokai University Research & Information Center
**Tsubaki, Hiroe**
Professor, Institute of Policy and Planning Sciences, University of Tsukuba
**Yajima, Nobuyuki**
ex-Professor, Scientific Ballooning, Institute of Space and Astronautical Science

3.3 ILAS-II Project Staff

Project Staff are the staff of NIES (National Institute for Environmental Studies), who work for the Project Leader under his direction. They are allowed to access all data generated in the Project. There are 10 members, including a Project leader and a Sub-leader at present (April 2003).

Staff Scientists (excluding Project Leader and Sub-leader)

**Yokota, Tatsuya**
**Nakajima, Hideaki**
**Sugita, Takafumi**
**Ejiri, Mitsumu**
**Irie, Hitoshi**
**Saitoh, Naoko**
**Tanaka, Tomoaki**
**Terao, Yukio**

3.4 Science Team

The ILAS-II Science Team members are the researchers selected through the Joint Research Announcement (JRA), which was performed by NASDA (National Space Development Agency of Japan), NASA (National Aeronautics and Space Administration), CNES (Centre National d'Etudes Spatiales) and MOE (Ministry of Environment/Japan) in 1999. The representative of each proposed research plan is called a Principal Investigator (PI), and their co-researchers specified in the plans are called Cooperative Investigators (Co-I). All PIs and Co-I as a whole comprise the ILAS-II Project Science Team.

All Project member candidates are requested to read the MOU (Memorandum of Understanding for Participating in the ILAS-II Project) and to sign it before joining the Project. The signed form should be sent to the ILAS-II Project Leader. The MOU copy is attached at the end of this document for reference.

The ILAS-II Science Team Leader, designated by the Project Leader, has overall responsibility for running the Science Team and coordinating research activities by its members. All Science Team members will carry out their research according to a research plan submitted and agreed in advance.

PI Members of the Science Team are listed below. There are 33 PIs including a Team Leader, 12 from USA, 9 from Japan, 5 from Germany, 2 from France and New Zealand, and 1 from Canada, Korea and Russia respectively (as of February 2003). The list of Members may be changed at any time by the addition of new participants selected by the Project, or by dismissal when requested. When such a change is made, it will be announced to all members as soon as possible.

Members are encouraged to attend ILAS-II Science Team meetings and are requested to publish their scientific achievements in appropriate scientific journals.

Science Team Leader
**Nakajima, Hideaki**
Team Head, Ozone Layer Research Project, Satellite Remote Sensing Research Team, NIES

Science Team Regular PI Members (July 2003)
(Regular Members)
**Blumenstock, Thomas**
Institute of Meteorology and Climate Research (IMK), Germany
**Bodeker, Greg E.**
National Institute of Water and Atmospheric Research (NIWA), New Zealand
**Camy-Peyret, Claude**
Laboratorie de Physique Moleculaire et Applications (LPMA/CNRS), France
**Cunnold, Derek M.**
Georgia Institute of Technology, USA
**Danilin, Michael**
The Boeing Company, USA
**Elderring, Annmarie**
University of California at Los Angeles (UCLA), USA
**Engel, Andreas**
University of Frankfurt, Germany
**Fukabori, Masashi**
Meteorological Research Institute, Japan
**Gernandt, Hartwig**
Alfred Wegener Institute for Polar and Marine Research (AWI), Germany
**Hayashida, Sachiko**
Nara Women's University, Japan
**Johnson, David G.**
NASA Langley Research Center, USA
**Kondo, Yutaka**
Research Center for Advanced Science and Technology, University of Tokyo, Japan
**Kurosu, Thomas P.**
Harvard-Smithsonian Center for Astrophysics (SAO), USA
**Lee, Kwang-Mog**
Kyungpook National University, Korea
**Lefevre, Franck**
Service d'Aeronomie du CNRS (CNRS/SA), France
**Massie, Steven T.**
National Center for Atmospheric Research (NCAR), USA
**Matsumi, Yutaka**
Solar-Terrestrial Environment Laboratory, Nagoya University, Japan
**Matthews, W. Andrew**
National Institute of Water and Atmospheric Research (NIWA), New Zealand
**Murayama, Yasuhiro**
Communications Research Laboratory (CRL), Japan

**Murcray, Frank J.**
University of Denver, USA
**Nakane, Hideaki**
National Institute for Environmental Science (NIES), Japan
**Pan, Liwen Laura**
National Center for Atmospheric Research (NCAR), USA
**Park, Jae H.**
Seoul National University, USA
**Randall, Cora E.**
University of Colorado, USA
**Sato, Kaoru**
National Institute of Polar Research, Japan
**Schiller, Cornelius**
Forschungszentrum Juelich GmbH, Institut for Stratospheric Research (ICG-I), Germany
**Shiotani, Masato**
Graduate School of Kyoto University, Japan
**Sloan, J.J.**
University of Waterloo, Canada
**Thomason, Larry W.**
NASA Lanley Research Center (LaRC), USA
**Toon, Geoffrey**
Jet Propulsion Laboratory (JPL), California Institute of Technology, USA
**Wetzel, Gerald**
Institute for Meteorology and Climate Research (IMK), Germany
**Yushkov, Vladimir V.**
Central Aerological Observatory, Russia

3.5 Validation Experiment Team

The Validation Experiment Team is composed of research representatives of the Validation Experiment groups for the ILAS-II validation. Members conduct the experiments according to the master plans developed by the Project Staff or the research themes adopted through the JRA (details for JRA are described in Section 3.4). All researchers participating in the validation experiments are encouraged to become a member of the Validation Experiment Team as well. Those who have their own data relevant to scientific studies using ILAS-II data are strongly requested to provide the data to the ILAS-II Correlative Measurement Data Base (ILAS-II CMDB). The protocol for data exchange is described in Chapter 7.

All members are provided with ILAS-II data for the period of their experiments described in their plans. Those who have registered their validation data in the ILAS-II CMDB are permitted to access other data in the database. Members are requested to carry out validation analysis in cooperation with the Science Team members who are in charge of validation data analysis.

PI Members of the Validation Experiment Team are listed below (as of November 2003). There are 18 PIs including a Team Leader, 5 from Japan, 5 from Germany, 4 from USA, and 1 from each of France, Korea, New Zealand and Russia.

Note that some of the names are the same as on the Science Team, for many of them serve in both teams.

Members or their representatives are requested to attend Validation Experiment Team meetings, and are also requested to publish their scientific achievements in appropriate scientific journals.

Validation Experiment Team Leader
**Kanzawa, Hiroshi**
Nagoya University, Japan

Core Validation Experiment Members (July 2003)
**Camy-Peyret, Claude**
Laboratorie de Physique Moleculaire et Applications (LPMA/CNRS), France
**Deshler, Terry**
University of Wyoming, USA
**Engel, Andreas**
University of Frankfurt, Germany
**Hayashi, Masahiko**
Fukuoka University, Japan
**Murcray, Frank J.**
University of Denver, USA
**Nakazawa, Takakiyo**
Tohoku University, Japan
**Suzuki, Makoto**
National Space Development Agency of Japan (NASDA), Japan
**Toon, Geoffrey**
Jet Propulsion Laboratory (JPL), California Institute of Technology, USA
**Wetzel, Gerald**
Institute for Meteorology and Climate Research (IMK), Germany

Cooperative Validation Experiment Members (November 2003)
**Blumenstock, Thomas**
Institute of Meteorology and Climate Research (IMK), Germany
**Gernandt, Hartwig**
Alfred Wegener Institute for Polar and Marine Research, Germany
**Johnson, David G.**
NASA Langley Research Center, USA
**Kim, Jhoon**
Yonsei University, Korea
**Matthews, W. Andrew**
National Institute of Water and Atmospheric Research (NIWA), New Zealand
**Murayama, Yasuhiro**
Communications Research Laboratory (CRL), Japan

**Schiller, Cornelius**
Forschungszentrum Juelich GmbH, Institut for Stratospheric Research (ICG-I), Germany
**Yushkov, Vladimir V.**
Central Aerological Observatory, Russia

3.6 Validation Analysis Team

The Validation Analysis Team is a newly established group in the Project. The team consists of Validation Analysis Chiefs and Advisory Group Members (= Advisors). Validation Analysis Chiefs were designated from NIES Project Staff and Postdoctoral Fellows, while the Advisors were authorized in a Science Team Meeting. Some Advisors were selected from NIES staff, while others were selected from other institutions related with the project (see the table below).

The Validation Analysis Chief is a person who is in charge of analysis for a certain Standard or Research Product measured by ILAS-II. They will retrieve and prepare validation data from ILAS-CMDB or other project related experiments, to carry out their data evaluation tasks through validation. This process will be done by means of comparison with other data with the ILAS-II Standard/Research Products data. Two Advisors are designated for each Validation Analysis Chief, in order to give appropriate advice for their validation tasks. Each Validation Analysis Chief is in charge of validation of one or two measurement species.

Members are encouraged to carry on their tasks of Validation Analysis through close communication with the data providers, and to hold meetings when required. In addition, they are responsible for reporting their progress at Science Team Meetings, and are obliged to publish papers related with their data evaluation.

Validation Analysis Team

| **Gas Species** | **Analysis Chief** | **Advisors** |
|---|---|---|
| $O_3$ and $H_2O$ | Sugita, Takafumi | Nakajima, Hideaki<br>Yokota, Tatsuya |
| $HNO_3$ and $NO_2$ (and $ClONO_2$, $N_2O_5$) | Irie, Hitoshi | Kondo, Yutaka<br>Hayashida, Sachiko |
| $N_2O$ and $CH_4$ (and CO, $C_2H_6$) | Terao, Yukio | Shiotani, Masato<br>Kanzawa, Hiroshi |
| *[1]AEC@780nm (and AEC@IR) | Saitoh, Naoko | Hayashida, Sachiko<br>Hayashi, Masahiko |
| CFC-11 and CFC-12 | Ejiri, Mitsumu | Nakazawa, Takakiyo<br>Nakajima, Hideaki |
| Temperature and Pressure | Yokota, Tatsuya and Kobayashi, Hirokazu | Shiotani, Masato<br>Sugita, Takafumi |

(*1: AEC = Aerosol Extinction Coefficient)

3.7 Project Office (ILAS-II Project Secretariats)

The ILAS-II Project Office is established in NIES, and its secretariats handle the project's business affairs in and outside Japan. In addition, a Data Manager for interfacing with outside researchers is appointed to distribute ILAS-II data and collect validation data.

**Ishigaki, Takeo**
**Shinoki, Seiichi**
**Washida, Taro**

# 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 (68°N, 21°E) will provide vertical profiles of all of the species and physical parameters measured by ILAS. Details are given in Sections 4.1 and 4.4. Some balloon experiments with cryogenic samplers will be made at Syowa (69°S, 40°E), 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 FTSs (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 over a long time span.

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

## 4.1 Core Validation Experiments

The various core experiments for ILAS-II validation are presented in Table 4-1.

## 4.2 Cooperative Validation Experiments

The various cooperative experiments for ILAS-II validation are presented in Table 4-2.

## 4.3 Experiments by Location

The ILAS-II validation experiments are arranged in the latitudes of the experiment locations for the Arctic in Table 4-3 and Map 1. The same is done for the Antarctic in Table 4-4 and Map 2.

## 4.4 Routine Measurements

Meteorological data by routine radiosonde measurement will be collected for temperature and pressure from WMO-associated meteorological agencies. The number of stations used here is more than 200 (High latitude stations only).

## 4.5 Experiments for Each Standard Product

The validation experiments are arranged for each standard product measured by ILAS-II in Table 4-5. Details of the standard products are given in Chapter 2.

## 4.6 Experiments for Each Research Product

The validation experiments are arranged for each research product measured by ILAS-II in Table 4-6. Details of the research products are given in Chapter 2.

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

| No. | PI | Location | Instrument | Target species and physical parameters for ILAS-II | Other Species | Remarks (Observation period / frequency) |
|---|---|---|---|---|---|---|
| 1 | Hayashi, Masahiko | Syowa (68°N, 21°E Antarctica) | LPC+OPC aerosolsonde | Aerosol | Humidity, wind | 2 flights during ETO (early turn on) stage of ILAS-II, etc. (TBD) |
| 2 | Kanzawa, Hiroshi | Kiruna (68°N, 21°E) | ECC ozonesonde | $O_3$, temperature | Humidity, wind | Dairy during the balloon campaign periods at Kiruna |
| 3 | Kanzawa, Hiroshi | Syowa (68°N, 21°E Antarctica) | RS II-KC79D ozonesonde | $O_3$, temperature | Humidity, wind | 24 obs./year in May to Jul and Nov to Feb |
| 4 | Nakazawa, Takakiyo | Kiruna (68°N, 21°E Sweden) | SAKURA (Cryogenic sampler) | $N_2O$, $CH_4$, CFC-11 | | |
| 5 | Suzuki, Makoto and Claude Camy-Peyret (Gondola's PI) | Kiruna (68°N, 21°E) | B-GS (Balloon-borne Grating Spectrograph) + LPMA (FTIR spectrometer) (PI: Camy-Peyret, Claude) | $O_2$-A band, (pressure, temperature)<br><br>$O_3$, $HNO_3$, $NO_2$, $N_2O$, $CH_4$, $H_2O$, $ClONO_2$, CFC12, NO | <br><br>HCl, HF | - Utilization of the ILAS Engineering Model (Planned in August 2002)<br><br>- LPMA measurement will be conducted as well, in a similar way as another flight in coopeartive experiment |
| 6 | Toon, Geoffrey | Kiruna (68°N, 21°E) (or Lynn Lake (57°N, 101°W Canada)) | JPL MkIV interferometer (FTIR spectrometer) | $O_3$, $HNO_3$, $NO_2$, $N_2O$, $CH_4$, $H_2O$, $ClONO_2$, $N_2O_5$, CFC-12, CFC-11, CO, NO | $HNO_4$, $COF_2$, CFC-13, $CHF_2Cl$, $SF_6$ | |
| 7 | Wetzel, Gerald | Kiruna (68°N, 21°E) | MIPAS-B (FTIR spectrometer) | $O_3$, $HNO_3$, $NO_2$, $N_2O$, $CH_4$, $H_2O$, $ClONO_2$, $N_2O_5$, CFC-12, CFC-11, NO, temperature | $HO_2NO_2$, HCFC-22, $SF_6$ | Cooperative validation experiments will be conducted as well. |

ILAS-II observation species

Standard Product: $O_3$, $HNO_3$, $NO_2$, $N_2O$, $CH_4$, $H_2O$, aerosol(vis.)

Research Product: $ClONO_2$, $N_2O_5$, CFC-12, CFC-11, CO, $C_2H_6$, OCS, $CO_2$, NO, $O_3$(isotopomer), aerosol(IR), temperature, pressure

**Table 4-2 Cooperative Validation Experiments for ILAS-II Validation**

| No. | PI | Location | Instrument | Target species and physical parameters for ILAS-II | Other Species | Remarks (Observation period / frequency) |
|---|---|---|---|---|---|---|
| 1 | Blumenstock, Thomas | Kiruna (68°N, 21°E Sweden) | FTIR spectrometer Bruker 120 HR | $O_3$, $HNO_3$, $NO_2$, $N_2O$, $CH_4$, $H_2O$, $ClONO_2$, CO, NO | HCl, HF, ClO | Solar measurement between mid-January and mid-November |
| 2 | Camy-Peyret, Claude and Pfeilsticker, Klaus | Kiruna (68°N, 21°E) | LPMA (FTIR spectrometer) (Instrument's PI: C. Camy-Peyret) | $O_3$, $HNO_3$, $NO_2$, $N_2O$, $CH_4$, $H_2O$ | HCl, HF, $CO_2$, NO | Core validation experiments will be conducted as well. |
| | | | DOAS (Instrument's PI: K. Pfeilsticker, Klaus) | $O_3$, $NO_2$, $H_2O$ | BrO, OClO, $O_4$ | |
| 3 | Gernandt, Hartwig | Koldewey (79°N, 12°E Arctic) | Electrochemical ozone sonde (ECC)+Ground-based microwave radiometer&ozone lidar | $O_3$, temperature | Humidity, wind | As requested by validation experiment plan. |
| | | Neumayer (71°S, 8°W Antarctica) | Electrochemical ozone sonde (ECC) | $O_3$, temperature | Humidity, wind | As requested by validation experiment plan. |
| 4 | Johnson, David G. | Lynn Lake (57°N, 101°W Canada) | SAO FIRS-2 | $O_3$, $HNO_3$, $NO_2$, $N_2O$, $CH_4$, $H_2O$, $ClONO_2$, CFC-12, CFC-11, temperature, pressure | $C_2H_6$, OCS, OH, $HO_2$, H2O2, HCl, HOCl, $HNO_4$, HF, CCl4, $CH_3Cl$, HCFC-22, $C_3H_6O$, HCN, $SF_6$ | From mid-June through mid-July or 15 July to 8 August |
| 5 | Kim, Jhoon | King Sejong (62°S, 58°W Antarctica) | Brewer Spectrophotometer, MkIV | $O_3$ | | |
| 6 | Matthews, W. Andrew | Kiruna (68°N, 21°E) | UV/Vis. spectrometer | $O_3$, $NO_2$ | BrO, OClO | |
| | | Arrival Heights (78°S, 166°E Antarctica) | UV/Vis. spectrometer | $O_3$, $NO_2$ | BrO, OClO | |
| | | | FTIR interferometer | $O_3$, $HNO_3$, $NO_2$, $N_2O$, $CH_4$, $H_2O$, $CO_2$ | | |
| | | | Dobson spectrophotometer | $O_3$ | | |
| | | | Microwave radiometer | $O_3$, $H_2O$ | ClO | |
| | | Lauder (45°S, 170°E NZ) | UV/Vis. spectrometer | $O_3$, $NO_2$ | BrO, OClO | |
| | | | FTIR interferometer | $O_3$, $HNO_3$, $NO_2$, $N_2O$, $CH_4$, $H_2O$, $CO_2$ | | |
| | | | ECC ozonesonde | O3, temperature, pressure | Humidity, wind | Weekly throughout validation experiment |
| | | | Dobson spectrophotometer | $O_3$ | | |
| | | | UV lidar (RIVM, Netherlands) | $O_3$ , temperature, aerosol | | Year-round |
| | | | Microwave radiometer | $O_3$, H2O | ClO | Year-round |
| | | Macquarie Island (55°S, 159°E Aus) | UV/Vis. spectrometer | $O_3$, $NO_2$ | BrO, OClO | |

| No. | PI | Location | Instrument | Target species and physical parameters for ILAS-II | Other Species | Remarks (Observation period / frequency) |
|---|---|---|---|---|---|---|
| 7 | Murayama, Yasuhiro | Poker Flat (Fairbanks) (65°N, 147°W Alaska) | Multiwavelength / Millimeter-wave radiometer, | $O_3$ | | |
| | | | FTIR | $O_3$, $HNO_3$, $N_2O$, $H_2O$, CO | | |
| | | | Aerosol lidar | Aerosol | | |
| | | | Rayleigh (Doppler) lidar | Temperature | | |
| | | | Ozonesonde | $O_3$, temperature | | |
| 8 | Murcray, Frank J. | Poker Flat (65°N, 147°W) | FTIR spectrometer | $O_3$, $HNO_3$, $CH_4$, $N_2O$, $H_2O$, (possibly CFC-11, CFC-12) | | Every day when the sun is visible |
| | | Arrival Heights (78°S, 166°E Antarctica) | FTIR spectrometer | $O_3$, $HNO_3$, $N_2O$, $CH_4$, $H_2O$, (possibly CFC-11, CFC-12) | | Every day when the sun is visible |
| 9 | Schiller, Cornelius | Kiruna (68°N, 21°E) | FISH hygrometer | $H_2O$ | | |
| | | | Bonbon (whole air sampler) | $N_2O$, $CH_4$, CFC-12, CFC-11, $CO_2$ | $H_2$, ClO, BrO | |
| 10 | Wetzel, Gerald | Kiruna (68°N, 21°E) | MIPAS-B (FTIR spectrometer) | $O_3$, $HNO_3$, $NO_2$, $N_2O$, $CH_4$, $H_2O$, $ClONO_2$, $N_2O_5$, CFC-12, CFC-11, NO, temperature | $HO_2NO_2$, HCFC-22, $SF_6$ | Core validation experiments will be conducted as well. |
| 11 | Yushkov, Vradimir | Salekhard (67°N, 67°E Siberia) | ECC ozonesonde | $O_3$, temperature, pressure | | |
| | | | Backscatter sonde (BKS) | Aerosol backscatter ratio | | |
| | | | FLASH hygrometer (FLASH-B) | $H_2O$ | | |
| | | Yakutsk (61°N, 126°E Siberia) | ECC ozonesonde | $O_3$, temperature, pressure | | |
| | | | Backscatter sonde (BKS) | Aerosol backscatter ratio | | |
| | | | FLASH hygrometer (FLASH-B) | $H_2O$ | | |
| | | | Brewer spectrophotometer #045 | $O_3$ | | |

LAS-II observation species

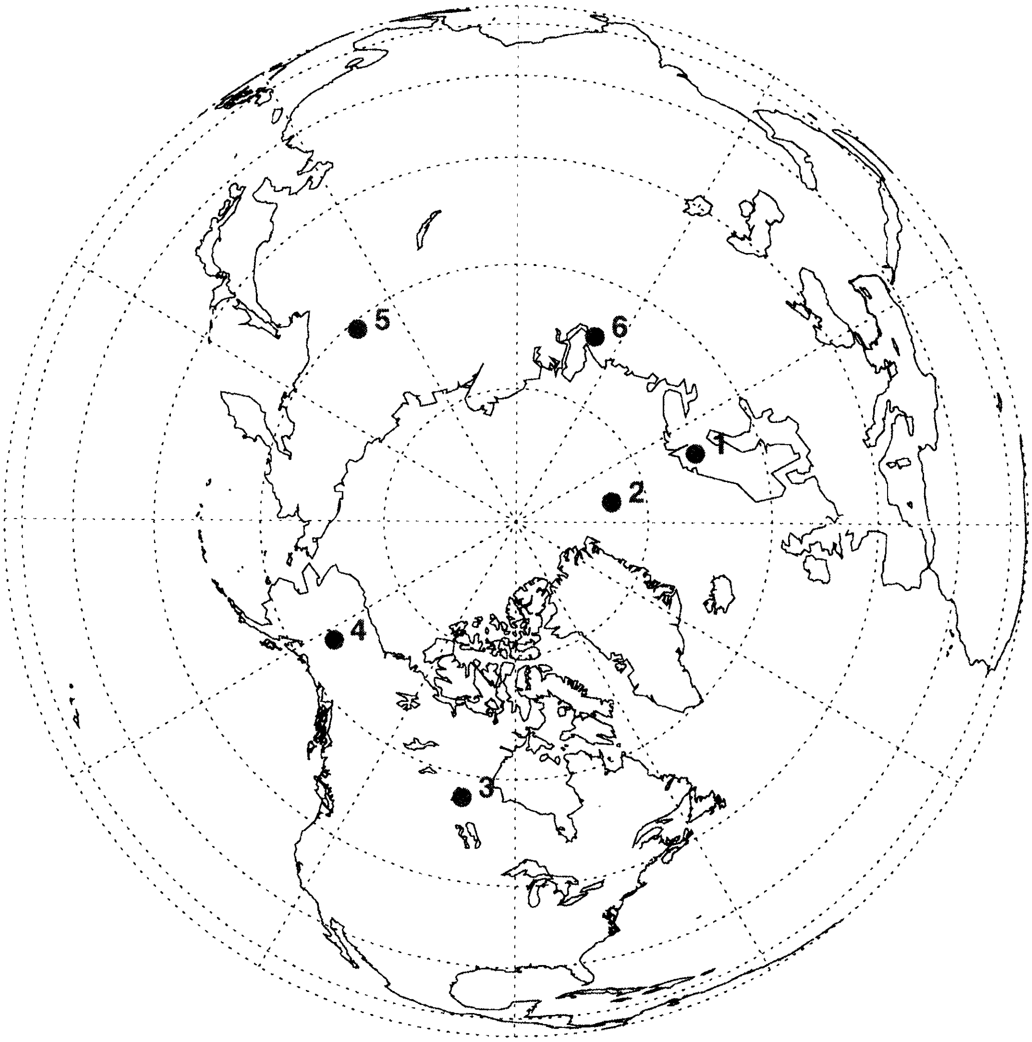
Standard Product: $O_3$, $HNO_3$, $NO_2$, $N_2O$, $CH_4$, $H_2O$, aerosol(vis.)

Research Product: $ClONO_2$, $N_2O_5$, CFC-12, CFC-11, CO, $C_2H_6$, OCS, $CO_2$, NO, $O_3$(isotopomer), aerosol(IR), temperature, pressure

## Table 4-3 ILAS-II Validation Experiments in Arctic Region

| Station | Method | Instrument | Core/ Cooperative | Target Species | P.I. | Appendix No. |
|---|---|---|---|---|---|---|
| * Kiruna, Sweden (67.89°N, 21.13°E) | Large Balloon | SAKURA(Cryogenic sampler) | Core | $N_2O$, $CH_4$, CFC-11 | T. Nakazawa | - A4 |
| | | Aerosol Counter-2 (LPC+OPC) | Core | Aerosol | M. Hayashi | - A1 |
| | | CAESR (IR radiometer), possibly | Core | $HNO_3$, $O_3$, CFC-11 | F.J. Murcray | - A15 |
| | | LPMA (FTIR spectrometer) | Core | $ClONO_2$, $HNO_3$, OC, $NO_2$, $N_2O$, $CH_4$, $H_2O$, CFC-12, NO | C. Camy-Peyret | - A9 |
| | | DOAS (Optical Absorption Spectroscopy) | Core | $O_3$, $NO_2$ | K. Pfeilsticker | - A9 |
| | | MIPAS-B (FTIR spectrometer) | Core | $O_3$, $HNO_3$, $NO_2$, $N_2O$, $CH_4$, $H_2O$, $ClONO_2$, CFC-12, CFC-11, temperature | G. Wetzel | - A7 |
| | | JPL MkIV interferometer (FTIR spectrometer) | Core | CFC-11, CFC-12, $HNO_3$, $CH_4$, $N_2O$, $NO_2$, $O_3$, $H_2O$, $ClONO_2$, $N_2O_5$ | G. Toon | - A6 |
| | Balloon&Aircraft | FISH hygrometer | Cooperative | $H_2O$ | C. Schiller | - A16 |
| | Small Balloon | ECC ozonsonde | Core | $O_2$, pressure, temperature | H. Kanzawa | - A2 |
| | | Bonbon (whole air sampler) | Cooperative | $N_2O$, $CH_4$, CFC-12, CFC-11, $CO_2$<br>$O_3$, $HNO_3$, NO, $N_2O$, $CH_4$, $H_2O$, CO | C. Schiller | |
| | Ground-based | FTIR spectrophotometer Bruker 120HR | Cooperative | Total column of $O_3$, $HNO_3$, NO, $N_2O$, $CH_4$, $H_2O$, CO, $NO_2$ and $ClONO_2$ | T. Blumenstock | - A8 |
| (67.89°N, 21.06°E) | | UV/Vis. Spectrometer | Cooperative | Total column of $O_3$, $NO_2$ | W.A. Matthews | - A13 |
| * Koldewey, Arctic (78.9°N, 11.9°E) | Small Balloon | ECC (Electrochemical ozonsonde) | Cooperative | $O_3$, pressure, temperature | H. Gernandt | - A10 |
| | Ground-based | Microwave radiometer, ozone lidar | Cooperative | $O_3$, aerosol | H. Gernandt | - A10 |
| * Lynn Lake, Canada (56.9°N, 101.1°W) | Large Balloon | SAO FIRS-2 (Interferometer) | Cooperative | $O_3$, $HNO_3$, $NO_2$, $N_2O$, $CH_4$, $H_2O$, CFC-11, CFC-12, $ClONO_2$, $N_2O_5$, OCS, $C_2H_6$, temperature, pressure | D. Johnson | - A11 |
| * Poker Flat, Alaska (65.12°N, 147.47°W) | Small Balloon | Ozonsonde | Cooperative | $O_3$, pressure, temperature | Y. Murayama | - A14 |
| | Ground-based | Multiwavelength / Rayleigh (Doppler) lidars, Millimeterwave radiometer, FTIR | Cooperative | $O_3$, $HNO_3$, $N_2O$, aerosol, temperature, Total column of $NO_2$, $CH_4$, CFC, $H_2O$, $ClONO_2$ | Y. Murayama | - A14 |
| | | FTIR spectrophotometer | Cooperative | $CH_4$, $N_2O$, $O_3$, $H_2O$, $HNO_3$, (possibly CFC-11, CFC-12) | F.J. Murcray | - A15 |
| * Yakutsk, Siberia (62.03°N, 129.63°E) | Small Balloon | OPC(Optical Particle Counter), BKS(backscattersonde) | Cooperative | $O_3$, $H_2O$, aerosol, temperature, pressure | V. Yushkov | - A17 |
| | | FLASH(Small sized and low weight ballon optical fluorescent hygrometer), ECC ozonsonde, radiosonde | | | V. Yushkov | - A17 |
| | Ground-based | Brewer #045 spectrophotometer | Cooperative | Total columne of $O_3$ | V. Yushkov | - A17 |
| * Salekhard, Siberia (67.5°N, 67.5°E) | Small Balloon | OPC(Optical Particle Counter), BKS(backscattersonde) | Cooperative | $O_3$, $H_2O$, aerosol, temperature, pressure | V. Yushkov | - A17<br>- A17 |
| | | FLASH(Small sized and low weight ballon optical fluorescent hygrometer), ECC ozonsonde, radiosonde | Cooperative | | V. Yushkov | - A17 |
| | Ground-based | SAOZ spectrometer | Cooperative | Total columne of $O_3$ | V. Yushkov | - A17 |

# ILAS-II Validation Experiment points (Arctic Region)



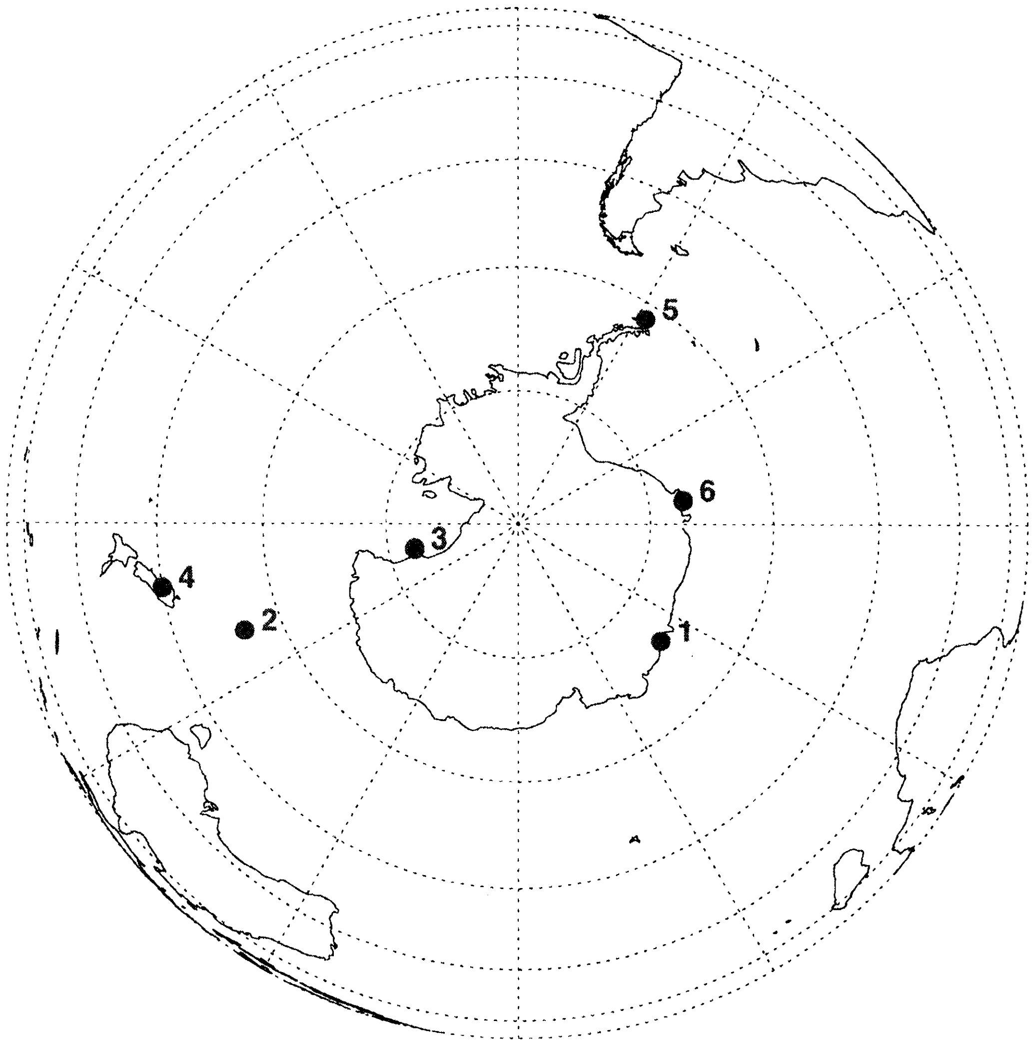

1 : Kiruna, Sweden(68N, 21E) – LB, SB, G
2 : Koldeway, Arctic(79N, 12E) – SB, G
3 : Lynn Lake,Canada(57N, 101W) – LB
4 : Poker Flat, Alaska(65N, 147W) – SB, G
5 : Yakutsuk, Siberia(61N, 130E) – SB,G
6 : Salekhard, Siberia(67N,67E) – SB, G

LB : Large Balloon
SB : Small Balloon
G : Ground–based

## Table 4-4 ILAS-II Validation Experiments in Antarctic Region

| Station | Method | Instrument | Core/ Cooperative | Target Species | P.I. | Appendix No. |
|---|---|---|---|---|---|---|
| * Syowa, Antarctica (69.00°N, 39.58°E) | Small Balloon | KC ozonsonde | Core | $O_3$, pressure, temperature | H. Kanzawa | A3 |
| | Small Balloon | LPC+OPC aerosolsonde | Core | Aerosol, pressure, temperature | M. Hayashi | A1 |
| * Macquarie Island, Australia (54.5°S, 159.0°E) | Ground-based | UV/Vis. spectrometer | Cooperative | Total column of $O_3$, $NO_2$ | W.A. Matthews | A13 |
| * Arrival Heights, Antarctica (77.83°S, 166.65°E) | Ground-based | UV/Vis. Spectrometer | Cooperative | Total column of $O_3$, $NO_2$ | W.A. Matthews | A13 |
| | Ground-based | FTIR interferometer | Cooperative | $O_3$, $CH_4$, $N_2O$, $HNO_3$, Total column of $H_2O$, $NO_2$, | W.A. Matthews | A13 |
| | Ground-based | Dobson spectrophotometer | Cooperative | Total column of $O_3$ | W.A. Matthews | A13 |
| | Ground-based | FTIR spectrometer | Cooperative | $CH_4$, $N_2O$, $O_3$, $H_2O$, $HNO_3$, (possibly CFC-11, CFC-12) | F.J. Murcray | A15 |
| * Lauder, New Zealand (45.04°S, 169.68°E) | Small Balloon | ECC ozonsonde | Cooperative | $O_3$, pressure, temperature | W.A. Matthews | A13 |
| | Ground-based | UV/Vis. Spectrometer | Cooperative | Total column of $O_3$, $NO_2$ | W.A. Matthews | A13 |
| | Ground-based | FTIR interferometer | Cooperative | $O_3$, $CH_4$, $N_2O$, $HNO_3$, Total column of $H_2O$, $NO_2$, $CO_2$ | W.A. Matthews | A13 |
| | Ground-based | Dobson spectrophotometer | Cooperative | $O_3$, Total column of $O_3$ | W.A. Matthews | A13 |
| | Ground-based | UV lidar (RIVM, Netherland) | Cooperative | $O_3$(8 to 45km), temperature(8 to 70km), aerosol(8 to 30km) | W.A. Matthews | A13 |
| | Ground-based | Microwave radiometer | Cooperative | $O_3$(20 to 70km), $H_2O$(35 to 80km) | W.A. Matthews | A13 |
| | Ground-based | Two aerosol lidars | Cooperative | Aerosol, temperature | W.A. Matthews | A13 |
| * King Sejong, Antarctica (62.2°S, 58.8°W) | Ground-based | Brewer Spectrophotometer, MkIV | Cooperative | $O_3$, mainly column but profile possible | J. Kim | A12 |
| * Neumayer, Antarctica (70.62°S, 08.37°W) | Small Balloon | ECC (Electrochemical ozonsonde) | Cooperative | $O_3$, pressure, temperature | H. Gernandt | A10 |

## ILAS-II Validation Experiment points (Antarctic Region)




1 : Syowa(69S, 39E) - SB
2 : Macquarie Island,Australia(55S, 159E) - G
3 : Arrival Heights,Antarctica(78S, 167E) - G
4 : Lauder, NewZealand(45S, 170E) - SB, G
5 : King Sejong, Antarctica (62S, 58W) - G
6 : Neumayer, Antarctica(71S, 8W) - SB

LB : Large Balloon
SB : Small Balloon
G : Ground-based

## Tale 4-5 Validation Experiments for Standard Products

### Validation Experiments for $O_3$

**Arctic Region**

| | Station | Method | Instrument | P.I. | Appendix No. |
|---|---|---|---|---|---|
| | <Profile Measurement> | | | | |
| Core | 1 Kiruna, Sweden (67.89°N, 21.12°E) | LB | LPMA (FTIR spectrometer) | C. Camy-Peyret | A9 |
| | | | DOAS (Optical Absorption Spectroscopy) | C. Camy-Peyret | A9 |
| | | | MIPAS-B (FTIR spectrometer) | G. Wetzel | A7 |
| | | | JPL MkIV interferometer (FTIR spectrometer) | G. Toon | A6 |
| | | SB | ECC ozonsonde | H. Kanzawa | A2 |
| Coop. | 1 Koldewey, Arctic (78.9°N, 11.9°E) | SB | ECC (Electrochemical ozonsonde) | H. Gernandt | A10 |
| | | G | Microwave radiometer | H. Gernandt | A10 |
| | | | Ozone lidar (DIAL) | H. Gernandt | A10 |
| | | | FTIR (Bruker 120 HR Michelson-interferometer) | H. Gernandt | A10 |
| | 2 Kiruna, Sweden (67.89°N, 21.10°E) | G | FTIR spectrophotometer Bruker IFS 120HR | T. Blumenstock | A8 |
| | (67.88°N, 21.06°E) | | UV/Vis. Spectrometer | W.A. Matthews | A13 |
| | 3 Salekhard, Siberia (67.5°N, 67.5°E) | SB | ECC ozonsonde, radiosonde | V. Yushkov | A17 |
| | 4 Poker Flat, Alaska (65.12°N, 147.47°W) | SB | Ozonsonde | Y. Murayama | A14 |
| | | G | Millimeterwave radiometer | Y. Murayama | A14 |
| | | | FTIR spectrophotometer | Y. Murayama | A14 |
| | | | FTIR (Bruker120HR interferometer) | F.J. Murcray | A15 |
| | 5 Yakutsk, Siberia (62.03°N, 129.63°E) | SB | ECC ozonsonde, radiosonde | V. Yushkov | A17 |
| | 6 Lynn Lake, Canada (56.9°N, 101.1°W) | LB | SAO FIRS-2 (Interferometer) | D. Johnson | A11 |
| | <Column Measurements> | | | | |
| Coop. | 1 Kiruna, Sweden (67.89°N, 21.10°E) | G | FTIR spectrophotometer Bruker IFS 120HR | T. Blumenstock | A8 |
| | (67.88°N, 21.06°E) | | UV/Vis. Spectrometer | W.A. Matthews | A13 |
| | 2 Poker Flat, Alaska (65.12°N, 147.47°W) | G | FTIR (Bruker120HR interferometer) | F.J. Murcray | A15 |
| | 3 Yakutsk, Siberia (62.03°N, 129.63°E) | G | Brewer #045 spectrophotometer | V. Yushkov | A17 |

**Antarctic Region**

| | Station | Method | Instrument | P.I. | Appendix No. |
|---|---|---|---|---|---|
| | <Profile Measurements> | | | | |
| Core | 1 Syowa, Antarctica (69.00°N, 39.58°E) | SB | RS II-KC79D ozonsonde | H.Kanzawa | A3 |
| Coop. | 1 Lauder, New Zealand (45.04°S, 169.68°E) | SB | ECC ozonsonde | W.A. Matthews | A13 |
| | | G | Dobson spectrophotometer | W.A. Matthews | A13 |
| | | | UV/Vis. Spectrometer | W.A. Matthews | A13 |
| | | | FTIR interferometer | W.A. Matthews | A13 |
| | | | UV lidar (RIVM, Netherland) | W.A. Matthews | A13 |
| | | | Microwave radiometer | W.A. Matthews | A13 |
| | 2 Macquarie Island, Australia (54.5°S, 159.0°E) | G | UV/Vis. spectrometer | W.A. Matthews | A13 |
| | 3 Neumayer, Antarctica (70.62°S, 08.37°W) | SB | ECC (Electrochemical ozonsonde) | H. Gernandt | A10 |
| | 4 Arrival Heights, Antarctica (77.83°S, 166.65°E) | G | UV/Vis. Spectrometer | W.A. Matthews | A13 |
| | | G | FTIR interferometer | W.A. Matthews | A13 |
| | | G | FTIR (Bruker120M interferometer) | F.J. Murcray | A15 |
| | <Column Measurements> | | | | |
| Coop. | 1 Lauder, New Zealand (45.04°S, 169.68°E) | G | Dobson spectrophotometer | W.A. Matthews | A13 |
| | | G | UV/Vis. Spectrometer | W.A. Matthews | A13 |
| | 2 Macquarie Island, Australia (54.5°S, 159.0°E) | G | UV/Vis. spectrometer | W.A. Matthews | A13 |
| | 3 Arrival Heights, Antarctica (77.83°S, 166.65°E) | G | Dobson spectrophotometer | W.A. Matthews | A13 |
| | | G | UV/Vis. Spectrometer | W.A. Matthews | A13 |
| | | G | FTIR (Bruker120M interferometer) | F.J. Murcray | A15 |
| | 4 King Sejong, Antarctica (62°S, 58°W) | G | Brewer spectrophotometer, MkIV | J. Kim | A12 |

Note: LB: Large Balloon, SB: Small Balloon, G: Ground-based measurement

## Validation Experiments for $HNO_3$

### Arctic Region

| | Station | Method | Instrument | P.I. | Appendix No. |
|---|---|---|---|---|---|
| | <Profile Measurement> | | | | |
| Core | 1 Kiruna, Sweden (67.89°N, 21.10°E) | LB | MIPAS-B (FTIR spectrometer) | G.Wetzel | A7 |
| | | LB | LPMA (FTIR spectrometer) | C.Camy-Peyret | A9 |
| | | LB | JPL MkIV interferometer (FTIR spectrometer) | G.Toon | A6 |
| Coop. | 1 Kiruna, Sweden (67.89°N, 21.10°E) | G | FTIR spectrophotometer Bruker IFS 120HR | T.Blumenstock | A8 |
| | 2 Poker Flat, Alaska (65.12°N, 147.47°W) | G | FTIR spectrophotometer | Y.Murayama | A14 |
| | | G | FTIR (Bruker120HR interferometer) | F.J.Murcray | A15 |
| | 3 Lynn Lake, Canada (56.9°N, 101.1°W) | LB | SAO FIRS-2 (Interferometer) | D.Johnson | A11 |
| | <Column Measurement> | | | | |
| Coop. | 1 Kiruna, Sweden (67.89°N, 21.12°E) | G | FTIR spectrophotometer Bruker IFS 120HR | T.Blumenstock | A8 |
| | 2 Poker Flat, Alaska (65.12°N, 147.47°W) | G | FTIR (Bruker120HR interferometer) | F.J.Murcray | A15 |

### Antarctic Region

| | Station | Method | Instrument | P.I. | Appendix No. |
|---|---|---|---|---|---|
| | <Profile Measurement> | | | | |
| Coop. | 1 Lauder, New Zealand (45.04°S, 169.68°E) | G | FTIR interferometer | W.A.Matthews | A13 |
| | 2 Arrival Heights, Antarctica (77.83°S, 166.65°E | G | FTIR interferometer | W.A.Matthews | A13 |
| | | | FTIR (Bruker120M interferometer) | F.J.Murcray | A15 |
| | <Column Measurements> | | | | |
| | 1 Arrival Heights, Antarctica (77.83°S, 166.65°E | G | FTIR (Bruker120M interferometer) | F.J.Murcray | A15 |

Note: LB: Large Balloon, SB: Small Balloon, G: Ground-based measurement

## Validation Experiments for $NO_2$

### Arctic Region

| | Station | Method | Instrument | P.I. | Appendix No. |
|---|---|---|---|---|---|
| | <Profile Measurements> | | | | |
| Core | 1 Kiruna, Sweden (67.89°N, 21.10°E) | LB | LPMA (FTIR spectrometer) | C.Camy-Peyret | A9 |
| | | LB | DOAS (Optical Absorption Spectroscopy) | C.Camy-Peyret | A9 |
| | | LB | MIPAS-B (FTIR spectrometer) | G.Wetzel | A7 |
| | | LB | JPL MkIV interferometer (FTIR spectrometer) | G.Toon | A6 |
| Coop. | 1 Kiruna, Sweden (67.89°N, 21.14°E) | G | UV/Vis. Spectrometer | W.A.Matthews | A13 |
| | 2 Lynn Lake, Canada (56.9°N, 101.1°W) | LB | SAO FIRS-2 (Interferometer) | D.Johnson | A11 |
| | <Column Measurements> | | | | |
| Coop. | 1 Kiruna, Sweden (67.89°N, 21.13°E) | G | FTIR spectrophotometer Bruker IFS 120HR | T.Blumenstock | A8 |
| | | G | UV/Vis. Spectrometer | W.A.Matthews | A13 |
| | 2 Poker Flat, Alaska (65.12°N, 147.47°W) | G | Millimeterwave radiometer, FTIR | Y.Murayama | A14 |

### Antarctic Region

| | Station | Method | Instrument | P.I. | Appendix No. |
|---|---|---|---|---|---|
| | <Profile Measurements> | | | | |
| Coop. | 1 Lauder, New Zealand (45.04°S, 169.68°E) | G | UV/Vis. Spectrometer | W.A.Matthews | A13 |
| | 2 Macquarie Island, Australia (54.5°S, 159.0°E) | G | UV/Vis. spectrometer | W.A.Matthews | A13 |
| | 3 Arrival Heights, Antarctica (77.83°S, 166.65°E | G | UV/Vis. Spectrometer | W.A.Matthews | A13 |
| | <Column Measurements> | | | | |
| Coop. | 1 Lauder, New Zealand (45.04°S, 169.68°E) | G | FTIR interferometer | W.A.Matthews | A13 |
| | | G | UV/Vis. Spectrometer | W.A.Matthews | A13 |
| | 2 Macquarie Island, Australia (54.5°S, 159.0°E) | G | UV/Vis. spectrometer | W.A.Matthews | A13 |
| | 3 Arrival Heights, Antarctica (77.83°S, 166.65°E | G | FTIR interferometer | W.A.Matthews | A13 |
| | | G | UV/Vis. Spectrometer | W.A.Matthews | A13 |

**Note: LB: Large Balloon, SB: Small Balloon, G: Ground-based measurement**

## Validation Experiments for $N_2O$

### Arctic Region

| | Station | Method | Instrument | P.I. | Appendix No. |
|---|---|---|---|---|---|
| | <Profile Measurements> | | | | |
| Core | 1 Kiruna, Sweden (67.89°N, 21.13°E) | LB | SAKURA(Cryogenic sampler) | T.Nakazawa | A4 |
| | | LB | LPMA (FTIR spectrometer) | C.Camy-Peyret | A9 |
| | | LB | JPL MkIV interferometer (FTIR spectrometer) | G.Toon | A6 |
| | | LB | MIPAS-B (FTIR spectrometer) | G.Wetzel | A7 |
| Coop. | 1 Kiruna, Sweden (67.89°N, 21.13°E) | LB | Bonbon (Whole air sampler) | C.Schiller | A16 |
| | | G | FTIR spectrophotometer Bruker IFS 120HR | T.Blumenstock | A8 |
| | 2 Poker Flat, Alaska (65.12°N, 147.47°W) | G | FTIR spectrophotometer | Y.Murayama | A14 |
| | | G | FTIR (Bruker120HR interferometer) | F.J.Murcray | A15 |
| | 3 Lynn Lake, Canada (56.9°N, 101.1°W) | LB | SAO FIRS-2 (Interferometer) | D.Johnson | A11 |
| | <Column Measurements> | | | | |
| Coop. | 1 Kiruna, Sweden (67.89°N, 21.13°E) | G | FTIR spectrophotometer Bruker IFS 120HR | T.Blumenstock | A8 |
| | 2 Poker Flat, Alaska (65.12°N, 147.48°W) | G | FTIR (Bruker120HR interferometer) | F.J.Murcray | A15 |

### Antarctic Region

| | Station | Method | Instrument | P.I. | Appendix No. |
|---|---|---|---|---|---|
| | <Profile Measurements> | | | | |
| Coop. | 1 Lauder, New Zealand (45.04°S, 169.68°E) | G | FTIR interferometer | W.A.Matthews | A13 |
| | 2 Arrival Heights, Antarctica (77.83°S, 166.65°E | G | FTIR interferometer | W.A.Matthews | A13 |
| | | G | FTIR (Bruker120M interferometer) | F.J.Murcray | A15 |
| | <Column Measurements> | | | | |
| | 1 Arrival Heights, Antarctica (77.83°S, 166.65°E | G | FTIR (Bruker120M interferometer) | F.J.Murcray | A15 |
| | | G | FTIR interferometer | W.A.Matthews | A13 |

Note: LB: Large Balloon, SB: Small Balloon, G: Ground-based measurement

## Validation Experiments for $CH_4$

### Arctic Region

| | Station | Method | Instrument | P.I. | Appendix No. |
|---|---|---|---|---|---|
| | <Profile Measurements> | | | | |
| Core | 1 Kiruna, Sweden (67.89°N, 21.13°E) | LB | SAKURA(Cryogenic sampler) | T.Nakazawa | A4 |
| | | LB | LPMA (FTIR spectrometer) | C.Camy-Peyret | A9 |
| | | LB | MIPAS-B (FTIR spectrometer) | G.Wetzel | A7 |
| | | LB | JPL MkIV interferometer (FTIR spectrometer) | G.Toon | A6 |
| Coop. | 1 Kiruna, Sweden (67.89°N, 21.13°E) | LB | Bonbon (Whole air sampler) | C.Schiller | A16 |
| | | G | FTIR spectrophotometer Bruker IFS 120HR | T.Blumenstock | A8 |
| | 2 Poker Flat, Alaska (65.12°N, 147.47°W) | G | FTIR (Bruker120HR interferometer) | F.J.Murcray | A15 |
| | 3 Lynn Lake, Canada (56.9°N, 101.1°W) | LB | SAO FIRS-2 (Interferometer) | D.Johnson | A11 |
| | <Column Measurements> | | | | |
| Coop. | 1 Kiruna, Sweden (67.89°N, 21.13°E) | G | FTIR spectrophotometer Bruker IFS 120HR | T.Blumenstock | A8 |
| | 2 Poker Flat, Alaska (65.12°N, 147.47°W) | G | FTIR | Y.Murayama | A14 |
| | | G | FTIR (Bruker120HR interferometer) | F.J.Murcray | A15 |

### Antarctic Region

| | Station | Method | Instrument | P.I. | Appendix No. |
|---|---|---|---|---|---|
| | <Profile Measurements> | | | | |
| Coop. | 1 Lauder, New Zealand (45.04°S, 169.68°E) | G | FTIR interferometer | W.A.Matthews | A13 |
| | 2 Arrival Heights, Antarctica (77.83°S, 166.65°E | G | FTIR interferometer | W.A.Matthews | A13 |
| | | G | FTIR (Bruker120M interferometer) | F.J.Murcray | A15 |
| | <Column Measurements> | | | | |
| Coop. | 1 Lauder, New Zealand (45.04°S, 169.67°E) | G | FTIR interferometer | W.A.Matthews | A13 |
| | 2 Arrival Heights, Antarctica (77.83°S, 166.64°E | G | FTIR interferometer | W.A.Matthews | A13 |
| | | G | FTIR (Bruker120M interferometer) | F.J.Murcray | A15 |

**Note: LB: Large Balloon, SB: Small Balloon, G: Ground-based measurement**

## Validation Experiments for $H_2O$

### Arctic Region

| | Station | Method | Instrument | P.I. | Appendix No. |
|---|---|---|---|---|---|
| | <Profile Measurements> | | | | |
| Core | 1 Kiruna, Sweden (67.89°N, 21.12°E) | LB | LPMA (FTIR spectrometer) | C. Camy-Peyret | A9 |
| | | LB | DOAS (Optical Absorption Spectroscopy) | C. Camy-Peyret | A9 |
| | | LB | MIPAS-B (FTIR spectrometer) | G.Wetzel | A7 |
| | | LB | JPL MkIV interferometer (FTIR spectrometer) | G.Toon | A6 |
| Coop. | 1 Kiruna, Sweden (67.89°N, 21.13°E) | LB, Aircraft | FISH (Fast In-situ Stratospheric Hygrometer) | C.Schiller | A16 |
| | | G | FTIR spectrophotometer Bruker IFS 120HR | T.Blumenstock | A8 |
| | 2 Salekhard, Siberia (67.5°N, 67.5°E) | SB | FLASH(Small sized and low weight ballon optical fluorescent hygrometer), ECC ozonsonde, | V.Yushkov | A17 |
| | 3 Poker Flat, Alaska (65.12°N, 147.47°W) | G | FTIR (Bruker120HR interferometer) | F.J.Murcray | A15 |
| | 4 Yakutsk, Siberia (62.03°N, 129.63°E) | SB | FLASH(Small sized and low weight ballon optical fluorescent hygrometer), ECC ozonsonde, | V.Yushkov | A17 |
| | 5 Lynn Lake, Canada (56.9°N, 101.1°W) | LB | SAO FIRS-2 (Interferometer) | D.Johnson | A11 |
| | <Column Measurements> | | | | |
| Coop. | 1 Kiruna, Sweden (67.89°N, 21.13°E) | G | FTIR spectrophotometer Bruker IFS 120HR | T.Blumenstock | A8 |
| | 2 Poker Flat, Alaska (65.12°N, 147.47°W) | G | FTIR spectrophotometer | Y.Murayama | A14 |
| | | G | FTIR (Bruker120HR interferometer) | F.J.Murcray | A15 |

### Antarctic Region

| | Station | Method | Instrument | P.I. | Appendix No. |
|---|---|---|---|---|---|
| | <Profile Measurements> | | | | |
| Coop. | 1 Lauder, New Zealand (45.04°S, 169.68°E) | G | Microwave radiometer | W.A.Matthews | A13 |
| | 2 Arrival Heights, Antarctica (77.83°S, 166.65°E | G | FTIR (Bruker120M interferometer) | F.J.Murcray | A15 |
| | <Column Measurements> | | | | |
| Coop. | 1 Lauder, New Zealand (45.04°S, 169.68°E) | G | FTIR interferometer | W.A.Matthews | A13 |
| | 2 Arrival Heights, Antarctica (77.83°S, 166.65°E | G | FTIR interferometer | W.A.Matthews | A13 |
| | | G | FTIR (Bruker120M interferometer) | F.J.Murcray | A15 |

**Note: LB: Large Balloon, SB: Small Balloon, G: Ground-based measurement**

## Validation Experiments for Aerosol

### Arctic Region

| | Station | Method | Instrument | P.I. | Appendix No. |
|---|---|---|---|---|---|
| | <Profile Measurements> | | | | |
| Coop. | 1 Salekhard, Siberia (67.5°N, 67.5°E) | SB | BKS(backscattersonde) | V. Yushkov | A17 |
| | 2 Poker Flat, Alaska (65.12°N, 147.47°W) | G | Multiwavelength Lidar (Aerosol Lidar) | Y. Murayama | A14 |
| | 3 Yakutsk, Siberia (62.03°N, 129.63°E) | SB | BKS(backscattersonde) | V. Yushkov | A17 |

### Antarctic Region

| | Station | Method | Instrument | P.I. | Appendix No. |
|---|---|---|---|---|---|
| | <Profile Measurements> | | | | |
| Core | 1 Syowa, Antarctica (69.00°N, 39.58°E) | SB | OPC sonde (Optical Particle Counter sonde) | M. Hayashi | A1 |
| | | SB | LPC sonde (Laser Particle Couner sonde) | M. Hayashi | A1 |
| Coop. | 1 Lauder, New Zealand (45.04°S, 169.68°E) | G | UV lidar (RIVM, Netherland) | W.A. Matthews | A13 |

Note: LB: Large Balloon, SB: Small Balloon, G: Ground-based measurement

## Table 4-6 Validation Experiments for Research Products

### Validation Experiments for $ClONO_2$

| | Station | Method | Instrument | P.I. | Appendix No. |
|---|---|---|---|---|---|
| Core | 1 Kiruna, Sweden | LB | LPMA (FTIR spectrometer) | C.Camy-Peyret | A9 |
| | | LB | MIPAS-B (FTIR spectrometer) | G.Wetzel | A7 |
| | | LB | JPL MkIV interferometer (FTIR spectrometer) | G.Toon | A6 |
| Coop. | 1 Kiruna, Sweden | G | FTIR spectrophotometer Bruker 120HR | T.Blumenstock | A8 |
| | 2 Lynn Lake, Canada | LB | SAO FIRS-2 (Interferometer) | D.Johnson | A11 |

### Validation Experiments for $N_2O_5$

| | Station | Method | Instrument | P.I. | Appendix No. |
|---|---|---|---|---|---|
| Core | 1 Kiruna, Sweden | LB | MIPAS-B (FTIR spectrometer) | G.Wetzel | A7 |
| | | LB | JPL MkIV interferometer (FTIR spectrometer) | G.Toon | A6 |

### Validation Experiments for CFC-11

| | Station | Method | Instrument | P.I. | Appendix No. |
|---|---|---|---|---|---|
| Arctic Region | | | | | |
| Core | 1 Kiruna, Sweden | LB | SAKURA(Cryogenic sampler) | T.Nakazawa | A4 |
| | | LB | MIPAS-B (FTIR spectrometer) | G.Wetzel | A7 |
| | | LB | JPL MkIV interferometer (FTIR spectrometer) | G.Toon | A6 |
| Coop. | 1 Kiruna, Sweden | LB | Bonbon (Whole air sampler) | C.Schiller | A16 |
| | 2 Lynn Lake, Canada | LB | SAO FIRS-2 (Interferometer) | D.Johnson | A11 |
| | 3 Poker Flat, Alaska | G | FTIR spectrophotometer | F.J.Murcray | A15 |
| Antarctic Region | | | | | |
| Coop. | 1 McMurdo, Antarctic | G | FTIR spectrometer | F.J.Murcray | A15 |

### Validation Experiments for CFC-12

| | Station | Method | Instrument | P.I. | Appendix No. |
|---|---|---|---|---|---|
| Arctic Region | | | | | |
| Core | 1 Kiruna, Sweden | LB | LPMA (FTIR spectrometer) | C.Camy-Peyret | A9 |
| | | LB | MIPAS-B (FTIR spectrometer) | G.Wetzel | A7 |
| | | LB | JPL MkIV interferometer (FTIR spectrometer) | G.Toon | A6 |
| Coop. | 1 Kiruna, Sweden | LB | Bonbon (Whole air sampler) | C.Schiller | A16 |
| | 2 Lynn Lake, Canada | LB | SAO FIRS-2 (Interferometer) | D.Johnson | A11 |
| | 3 Poker Flat, Alaska | G | FTIR spectrophotometer | F.J.Murcray | A15 |
| Antarctic Region | | | | | |
| Coop. | 1 Arrival Heights | G | FTIR spectrometer | F.J.Murcray | A15 |

## Validation Experiments for CO

| | Station | Method | Instrument | P.I. | Appendix No. |
|---|---|---|---|---|---|
| Core | 1 Kiruna, Sweden | G | FTIR spectrophotometer Bruker 120HR | T.Blumenstock | A8 |
| | | LB | JPL MkIV interferometer (FTIR spectrometer) | G.Toon | A6 |
| Coop. | 1 Poker Flat, Alaska | G | Millimeterwave radiometer, FTIR | Y.Murayama | A14 |

## Validation Experiments for OCS

| | Station | Method | Instrument | P.I. | Appendix No. |
|---|---|---|---|---|---|
| Coop. | 1 Lynn Lake, Canada | LB | SAO FIRS-2 (Interferometer) | D.Johnson | A11 |

## Validation Experiments for $CO_2$

| | Station | Method | Instrument | P.I. | Appendix No. |
|---|---|---|---|---|---|
| Coop. | 1 Kiruna, Sweden | LB | Bonbon (Whole air sampler) | C.Schiller | A16 |
| | 2 Arrival Heights, Ant | G | FTIR interferometer | W.A.Matthews | A13 |
| | 3 Lauder, New Zealan | G | FTIR interferometer | W.A.Matthews | A13 |

## Validation Experiments for NO

| | Station | Method | Instrument | P.I. | Appendix No. |
|---|---|---|---|---|---|
| Core | 1 Kiruna, Sweden | LB | LPMA (FTIR spectrometer) | C.Camy-Peyret | A9 |
| | | LB | MIPAS-B (FTIR spectrometer) | G.Wetzel | A7 |
| Coop. | 1 Kiruna, Sweden | G | FTIR spectrophotometer Bruker 120HR | T.Blumenstock | A8 |

## Validation Experiments for $O_3$(isotopomer)

| | Station | Method | Instrument | P.I. | Appendix No. |
|---|---|---|---|---|---|
| Coop. | 1 Koldewey, Arctic | G | FTIR (Bruker 120 HR Michelson-interferometer) | H.Gernandt | A10 |
| | 2 Lynn Lake, Canada | LB | SAO FIRS-2 (Interferometer) | D.Johnson | A11 |

## Validation Experiments for Temperature

| | Station | Method | Instrument | P.I. | Appendix No. |
|---|---|---|---|---|---|
| Arctic Region | | | | | |
| Core | 1 Kiruna, Sweden | LB | MIPAS-B | G. Wetzel | A7 |
| | | SB | ECC ozonesonde | H. Kanzawa | A2 |
| Coop. | 1 Koldeway, Arctic | SB | ECC ozonesonde + Ground-based microwave | H. Gernandt | A10 |
| | 2 Poker flat, Alaska | G | Rayleigh lidar | Y. Murayama | A14 |
| | 3 Lynn lake, Canada | LB | SAO FIRS-2 (Interferometer) | D. Johnson | A11 |
| Antactic Region | | | | | |
| Core | 1 Syowa, Antarctica | SB | RS II-KC79D ozonsonde | H. Kanzawa | A3 |
| Coop. | 1 Lauder, New Zealan | G | UV lidar (RIVM, Netherland) | W.A.Matthews | A13 |
| | | G | Two aerosol lidars | W.A.Matthews | A13 |

## Validation Experiments for Pressure

| | Station | Method | Instrument | P.I. | Appendix No. |
|---|---|---|---|---|---|
| Arctic Region | | | | | |
| Coop. | 1 Lynn Lake, Canada | LB | SAO FIRS-2 (Interferometer) | D.Johnson | A11 |
| | 2 Poker Flat, Alaska | SB | Ozonsonde | Y.Murayama | A14 |
| | 3 Salekhard, Siberia | SB | ECC ozonsonde, radiosonde | V.Yushkov | A17 |
| | 4 Yakutsk, Siberia | SB | ECC ozonsonde, radiosonde | V.Yushkov | A17 |
| Antactic Region | | | | | |
| Core | 1 Syowa, Antarctica | SB | KC ozonsonde | H.Kanzawa | A3 |
| Coop. | 1 Lauder, New Zealan | SB | ECC ozonsonde | W.A.Matthews | A13 |

## 5. Guidelines for ILAS-II Validation Experiments

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

The validation measurements should be made as close as possible in space and time to the ILAS-II occultation event. In principle, the validation measurements at each site should be carried out when the distance between the site and the ILAS-II 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. and more detailed consideration is required. 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. The information will be distributed by WWW, ftp, e-mail, fax, etc.

## 6. Data Format

The measured data to be submitted to the ILAS-II Data Manager should be in the format described in "Format Specification for Data Exchange" written by Steven E. Gaines and R. Stephen Hipskind, NASA Ames Research Center. The format is often used for exchanging ASCII data, and is described at:
http://espoarchive.nasa.gov/archive/forspec.html
The present version is 1.3 (as of April 2003).

## 7. Protocol for 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-II researchers, to uphold the rights of the individual researchers and have all the involved researchers treated equitably.

Parts of this chapter are extracted from the "Memorandum of Understanding for Participating in the ILAS-II Project (MOU on ILAS-II)", which is attached at the end of this document as an appendix (Appendix B). For details, see Chapter 4 of the MOU.

### 7.1 Data Submission

#### 7.1.1. ILAS-II CMDB

An ILAS-II Correlative Measurement Data Base (ILAS-II-CMDB) will be constructed, the same as the ILAS-CMDB for the former ILAS project, to provide ILAS-II researchers with core and cooperative validation experiment data and other correlative measurement data.

The ILAS-II-CMDB is managed by the ILAS-II Data Manager who is designated by the Project Leader. Data providers should 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-II-CMDB. A similar procedure had been carried out for the former ILAS project. Details for CMD registration procedure are explained in the "ILAS-II Correlative Measurement Data Registration Manual" (Appendix C).

7.1.2. Core Validation Experiment Data

Preliminary data obtained through the core validation experiments should be submitted to the ILAS-II Data Manager at the latest 6 months after the experiment. Any corrections or amendments to the preliminary data should be submitted to the Data Manager at the latest 12 months after the experiment. When a data provider is considering making a complete 1-year dataset, data submission is requested within 15 months after the experiment.

7.1.3. Cooperative Validation Experiment Data

Preliminary data obtained through the cooperative validation experiments are requested to be submitted to the ILAS-II Data Manager as soon as possible, as described in the individual experiment plan. Any corrections or amendments to the preliminary data are requested to be reported as well. When a data provider is considering making a complete 1-year dataset, data submission is requested within 15 months after the experiment.

7.1.4. Data Format

Data should be in AMES Format and sent to the Data Manager by means of E-mail attachments.

7.2. Data Access

Data providers are encouraged to register their data to ILAS-II-CMDB, as mentioned above. Data providers will be permitted to access other data in the ILAS-II CMDB, when their data are submitted via the Data Manager.

Science Team members who are designated by the Science Team Leader to take charge of validation analysis, will be permitted to use the data for the purpose when it becomes available. All Science Team members will be allowed to access the ILAS-II-CMDB for their scientific studies 12 months after the first registration of the data.

Validation Experiment Team members whose data are registered to the ILAS-II-CMDB may access all other data during the validation experiment period.

Project Staff are able to access all the data in the ILAS-II-CMDB and use them for their research.

7.3 Meteorological Data of Met Office, UK

The Met Office Stratospheric Analysis data and access software are supplied to the ILAS-II Project for research, in accordance with the Met Office Standard Terms & Conditions, ref. SFC00. Please check the details in the MOU on ILAS-II (Appendix B).

## 8. Protocol for Publications

All research results obtained by using ILAS-II data are expected to be published in appropriate scientific journals. The protocol for publications is stated in Chapter 5 of the MOU on ILAS-II (Appendix).

## 9. Concluding Remarks

We have organized the validation experiments program so that the accuracy of the ILAS-II measurements can be evaluated reliably. The ILAS-II project is expected to contribute to the 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-II measurements and correlative measurements including the validation experiments.

Unfortunately, ILAS-II measurements ceased in the end of October 2003, because the ADEOS-II spacecraft stopped communicating with the ground system. We therefore canceled the ILAS-II validation balloon campaign scheduled to be held in Kiruna in March/April 2004. Nevertheless, we should complete the evaluation of data quality of ILAS-II in cooperation with the ILAS-II-related scientists, by collecting as much validation data as possible.

## References


- Kanzawa, H., T. Sugita and H. Nakajima (2003), A plan for ILAS-II correlative measurements, *Proc. 16th ESA symposium on European Rocket and Balloon Programmes and Related Research,* St. Gallen, Switzerland, ESA SP-530, 493-498, ESA Publications Division, ESTEC, Noordwije, The Netherlands.

- Kanzawa, H. ed. (1997), *ILAS Correlative Measurements Plan*, NIES Technical Report, F-105- '97/NIES, 178pp, National Institute for Environmental studies.

- Nakajima, H., T. Sugita, T. Yokota, and Y. Sasano (2004), Current status and early result of the ILAS-II onboard the ADEOS-II satellite, *Proc. SPIE*, **5234**, in press.

- Sasano, Y., T. Yokota, H. Nakajima, T. Sugita and H. Kanzawa (2001), ILAS-II instrument and data processing system for stratospheric ozone layer monitoring, *Proc. SPIE*, **4150**, 106-114.

# APPENDIX A

# Description of the ILAS-II 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-II Validation Experiment Team. Most of the papers were submitted in spring of 2003.

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

# Contents

## 1. Title of ILAS-II validation experiment

# Balloon-borne Observations of Aerosol Size Distribution from 0.056 to 1.8 μm in radius at Syowa Station, Antarctica: Validation of Aerosol Extinction by ILAS-II

## 2. Investigators

1) Principal Investigator

| | |
|---|---|
| Name: | **Masahiko Hayashi** |
| Affiliation: | Fukuoka university |
| Contact address: | 8-19-1, Nanakuma, Johnan-ku, Fukuoka, 814-0181, Japan |
| Telephone number: | +81-92-871-6631 ex.6181 |
| Fax number: | +81-92-865-6030 |
| E-mail address: | mhayashi@fukuoka-u.ac.jp |

2) Co-Investigator

| | |
|---|---|
| Name (role): | Kouichi Shiraishi (data analysis) |
| Affiliation: | Fukuoka University |
| E-mail address: | siraisi@fukuoka-u.ac.jp |


## 3. Target Species, profiles or column

1) Target Species for ILAS-II:

Vertical profile of Aerosol extinction (vis.)

2) Other target Species:

Aerosol size distribution

## 4. Category of ILAS-II validation experiments

Core experiment

## 5. Significance of the validation experiment for ILAS-II

The profile of extinction by aerosol is a key parameter of the ILAS-II measurement. The measurements with LPC and OPC sondes provide the most reliable vertical profile of aerosol size distribution. Especially, LPC is only system to provide aerosol size distribution from 0.056 to 0.15 μm in radius up to 30 km in altitude.

## 6. Details of implementation plan for the experiment

1) Location: Syowa Station (Antarctica; 68S, 39E)

2) Instruments:

(1) Name:

a) Optical Particle Counter sonde (OPC sonde)

b) Laser Particle Counter sonde (LPC sonde)

(2) Principle:

Aerosol size and concentration: OPC and LPC measure electrical pulse hight distribution converted from scattered light by each particles introduced to optical chamber. Intensity of scattered light is corresponding to size of particles and number of light pulse corresponding to number of particles. Particle concentration is measured with measurement range of 0.001 to 60 particles/cm$^3$. Size of particle is calibrated with mono-dispersed standard particles. Variability between sensors is within 10 % to each together.

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

| Species | AR | A / P | VR | AT |
|---|---|---|---|---|
| aerosol (size and concentration) | 0 - 30 km | 10%/10% | about 100 m | 20 seconds |

4) Situation on facilities and equipment for the experiment:

The facilities and equipment required for OPC/LPC sonde measurement are equipped in Syowa Station, and the measurements operation is provided by wintering teams of 43th and 44th Japanese Antarctic Research Expedition (JARE 43, JARE 44).

5) Schedule for the experiment:

(1) Preparation:

All of instruments are prepared by end of October, 2002 and have to be shipped with Ice Breaker "Shirase". The arrangements with JARE44 will required by end of October, 2002.

(2) Execution period of the measurements:

January - February 2003

Two sets of OPC/LPC launching will be carried out at Syowa Station. First observation will be performed in January, for test. Simultaneous observation with ILAS-II will be performed at Early Turn On observation in February 2003.

(3) Data submission:
a) Preliminary: One month after the measurements
b) Final: Two month after the measurements

6) Comments:
None

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

1) ILAS-II data required for the analysis:
(1) Species or physical properties:

Vertical profiles of visible aerosol extinction

(2) Date and Location:
a) Date: Early Turn On measurements during February 2003
b) Location: Syowa Station (68S, 39E) within a range of 500 km

2) Method of the analysis:

Comparison between vertical profiles of extinction at 780nm calculated from size distributions obtained with LPC/OPC measurements and corresponding ILAS-II data. The in situ data will be averaged to mach the vertical resolution of ILAS-II data. Spacial and temporal variation of extinction profiles are also considered comparing with all of ILAS-II data.

3) Submission date of the results:
(1) Preliminary: Three months after the measurements

(2) Final: Six months after the measurements

4) Comments:
None

## 8. Related Publications

1) Instrument explanation


- M. Tsuchiya, T. Kasai, M. Hayashi, Y. Iwasaka and K. Takami (1996): Development of aerosol sonde for observation balloon. Keisoku Jidou Seigyo Gakkai Ronbunsyu, 32, 290-296 (in Japanese).
- T. Kasai, M. Tsuchiya, K. Takami, M. Hayashi, and Y. Iwasaka(2003): Balloon borne optical particle counter for stratospheric observation. Rev. Sci. Instrum., 74, 1082-1092.

2) Scientific results


- T. Matsumura, M. Hayahsi, M. Fujiwara, K. Matsunaga, M. Yasui, S. Slamet, M. Timbul, and S. Agus (2001): Observation of stratospheric aerosols by balloon-borne optical particle counter at Bandung, Indonesia. J. Meteorol. Soc. Jpn, 79, 709-718.
- K. Shiraishi, M. Fujiwara, M. Hayashi, Y. Matsumoto, Y. Iwasaka, T. Shibata, H. Adachi, T. Sakai, S. Ishii, K. Tamura, T. Oohashi, T. Katou (2001): Polar stratospheric clouds observed above Ny-Aalesund,Norway, and Dome station, Antarctic. Proc. Spie's Secound International Asia-Pacific Symp., 4150, 410-419.
- T. Matsumura, M. Hayahsi, M. Fujiwara, K. Matsunaga, M. Yasui, K. Mizutani, T. Nagai, T. Fujimoto, S. Kaloka, M. Timbul, and H .Saipul (2000): Comparison of lidar measurement with balloon-borne OPC measurement over Bandung, Indonesia. Proc. SPIE, 4153, 496-504.
- Shibata, T., K. Shiraishi, H. Adachi, Y. Iwasaka, M. Fujiwara (1999): On the lidar-observed sandwich structure of polar stratospheric clouds (PSCs) 1. Implication for the mixing state of the PSC particles. J. Geophys. Res., 104, 21603-21611.
- Shiraishi, K., M. Fujiwara, S. Ayukawa, Y. Iwasaka, T. Shibata, H. Adachi, T. Sakai, and K. Tamura (1998): Lidar observation above Svalbard, Norway during winter1996/97, -Characteristics of backscattering ratio and depolarization ratioof PSC particles-, Proc. NIPR Symp., Polar Glaciol. Meteorol., 12, 29-39.
- M. Hayashi, Y. Iwasaka, M. Watanabe, T. Shibata, M. Fujiwara, H. Adachi, T. Sakai, M. Nagatani, H. Gernandt, R. Neuber, and M. Tsuchiya (1997): Size and number concentration of liquid PSCs: Balloon-borne measurements at Ny-Alesund, Norway in winter of 1994/95. J. Meteorol. Soc. Jpn, 76, 549-560.
- Shibata, T., Y. Iwasaka, M. Fujiwara, M. Hayashi, M. Nagatani, K. Shiraishi, H. Adachi, T. Sakai, K. Susumu, and Y. Nakura (1997): Polar stratospheric clouds observed lidar over Spitsbergen in the winter 1994/1995: liquid particles and vertical "sandwich" structure. J. Geophys. Res., 102, 10829-10840.


## 9. Comments

None

## 1. Title of ILAS-II validation experiment

# Ozonesonde observation at Kiruna-Esrange, Sweden

## 2. Investigators

1) Principal Investigator

| | |
|---|---|
| Name: | **Hiroshi Kanzawa** |
| Affiliation: | Graduate School of Environmental Studies, Nagoya University |
| Contact address: | Furo-cho, Chikusa-ku, Nagoya 464-8601, Japan |
| Telephone number: | +81-52-789-3482 |
| Fax number: | +81-52-789-3436 |
| E-mail address: | kanzawa@ihas.nagoya-u.ac.jp |

2) Co-Investigators

| | |
|---|---|
| Name (role): | Takafumi Sugita (data analysis) |
| Affiliation: | National Institute for Environmental Studies |
| E-mail address: | tsugita@nies.go.jp |


## 3. Target species, profiles or column

1) Target species for ILAS-II: Vertical profile of $O_3$, Temperature

2) Other target species: None

## 4. Category of ILAS-II validation experiments

Core experiment

## 5. Significance of the validation experiment for ILAS-II

The ozone profile is a key parameter of the ILAS-II measurement. The ozonesonde measurements provide the most reliable vertical profile of ozone. Moreover, the main part of the measurements will be made as a basic experiment during the ILAS-II 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-II 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 a 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 |
|---|---|---|---|---|
| $O_3$ | 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 (or a few weeks) before the campaign.

(2) Execution period of the measurements:

a) February – March 2003
b) March - April 2004 (during the balloon campaign)
c) August - September 2005 (TBD)
d) November – December 2007 (TBD)

Ozonesonde flights will be carried out on nearly every day basis during the balloon campaign, coinciding with ILAS-II measurements over Kiruna as done in the ILAS Validation Balloon Campaign (Kanzawa et al., 1995; 1997).

(3) Data submission:

a) Preliminary: A few days after the measurements

b) Final: A few weeks after the measurements

6) Comments:

None

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

1) ILAS-II data required for the analysis:

(1) Species or physical properties:

Vertical profiles of O3 mixing ratio and temperature.

(2) Date and Location:

a. Date: 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-II data. The in situ data will be averaged to match the vertical resolution of the ILAS-II data as done in the ILAS ozone validation analyses (Sasano et al., 1999; Sugita et al., 2002).

3) Submission dates of the results:

a) Preliminary: Three months after the measurements

b) Final: Nine months 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.


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.
- 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.

- Knudsen, B.M., Larsen, N., Mikkelsen, I.S., Morcrette, J.-J., Braathen, G.O., Kyro, E., Fast, H., Gernandt, H., Kanzawa, H., Nakane, H., Dorokhov, V.,Yushkov, V., Hansen, G., Gil, M., and Shearman, R.J. (1998): Ozone depletion in and below the Arctic vortex for 1997, Geophys. Res. Lett., 25, No. 5, 627-630.
- Kreher, K., Bodeker, G.E., Kanzawa, H., Nakane, H., and Sasano, Y. (1999): Ozone and temperature profiles measured above Kiruna inside, at the edge of, and outside the Arctic polar vortex in February and March 1997, Geophys. Res. Lett., 26, No. 6, 715-718.
- Sasano, Y., Nakajima, H., Kanzawa, H., Suzuki, M., Yokota, T., Nakane, H., Gernandt, H., Schmidt, A., Herber, A., Yushkov, V., Dorokhov, V., and Deshler, T. (1999): Validation of ILAS Version 3.10 ozone with ozonesonde measurements, Geophys. Res. Lett., 26, No. 7, 831-834.
- Schulz, A., Rex, M., Steger, J., Harris, N.R.P., Braathen, G.O., Reimer, E., Alfier, R., Beck, A., Alpers, M., Cisneros, J., Claude, H., De Backer, H., Dier, H., Dorokhov, V., Fast, H., Godin, S., Hansen, G., Kanzawa, H., Kois, B., Kondo, Y., Kosmidis, E., Kyro, E., Litynska, Z., Molyneux, M.J., Murphy, G., Nakane, H., Parrondo, C., Ravegnani, F., Varotsos, C., Vialle, C., Viatte, P., Yushkov, V., Zerefos, C., and von der Gathen, P. (2000): Match observations in the Arctic winter 1996/97: High stratospheric ozone loss rates correlate with low temperatures deep inside the polar vortex, Geophys. Res. Lett., 27, No. 2, 205-208.
- Sugita, T., T. Yokota, H. Nakajima, H. Kanzawa, H. Nakane, H. Gernandt, V. Yushkov, K. Shibasaki, T. Deshler, Y. Kondo, S. Godin, F. Goutail, J.-P. Pommereau, C. Camy-Peyret, S. Payan, P. Jeseck, J.-B. Renard, H. Bösch, R. Fitzenberger, K. Pfeilsticker, M. von König, H. Bremer, H. Küllmann, H. Schlager, J.J. Margitan, B. Stachnik, G.C. Toon, K. Jucks, W.A. Traub, D.G. Johnson, I. Murata, H. Fukunishi, and Y. Sasano, (2002): Validation of ozone measurements from the Improved Limb Atmospheric Spectrometer (ILAS), J. Geophys. Res., 107(D24), 8212, doi:10.1029/2001JD000602.


3) Others

About the overall balloon 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), ESA Publications Division, ESTEC, Noordwijk, The Netherlands, 345-349.
- Kanzawa, H., Ed. (1997): ILAS Correlative Measurements Plan, National Institute for Environmental Studies, F-105-'97-NIES, 178p. (37p.+139p.+2p.). [January 1997]
- Kanzawa, H., Camy-Peyret, C., Kondo, Y., and Papineau, N. (1997): Implementation and first scientific results of the ILAS Validation Balloon Campaign at Kiruna-Esrange in February - March 1997, Proc. 13th ESA Symp. European Rocket and Balloon Programmes and Related Research (Oland, Sweden, 26-29 May 1997), ESA SP-397

(September 1997), ESA Publications Division, ESTEC, Noordwijk, The Netherlands, 211-215.

- Kanzawa, H., Camy-Peyret, C., Nakajima, H., and Sasano, Y. (2001): A plan for ILAS-II correlative measurements with emphasis on a validation balloon campaign at Kiruna-ESRANGE, Proc. 15th ESA Symp. European Rocket and Balloon Programmes and Related Research (Biarritz, France, 28-31 May 2001), ESA SP-471 (August 2001), ESA Publications Division, ESTEC, Noordwijk, The Netherlands, 305-308.
- Kanzawa, H., Sugita, T., and Nakajima, H. (2003): A plan for ILAS-II correlative measurements. Proc. 16th ESA Symp. European Rocket and Balloon Programmes and Related Research, St. Gallen, Switzerland, 2-5 June 2003, ESA SP-530, ESA Publications Division, ESTEC, Noordwijk, The Netherlands, in press.

## 9. Comments

None

## 1. Title of ILAS-II validation experiment

# Ozonesonde observation at Syowa Station, Antarctica

## 2. Investigators

1) Principal Investigator

| | |
|---|---|
| Name: | **Hiroshi Kanzawa** |
| Affiliation: | Graduate School of Environmental Studies, Nagoya University |
| Contact address: | Furo-cho, Chikusa-ku, Nagoya 464-8601, Japan |
| Telephone number: | +81-52-789-3482 |
| Fax number: | +81-52-789-3436 |
| E-mail address: | kanzawa@ihas.nagoya-u.ac.jp |

2) Co-Investigators

| | |
|---|---|
| Name (role): | Takashi Yamanouchi (observation and data management) |
| Affiliation: | National Institute of Polar Research |
| E-mail address: | yamanou@pmg.nipr.ac.jp |
| Name (role): | Head, Office of Antarctic Observations (presently Yasuo Nomura) (observation and data management) |
| Affiliation: | Japan Meteorological Agency |
| E-mail address: | wgam-sec@hq.kishou.go.jp |
| Name (role): | Takafumi Sugita (data analysis) |
| Affiliation: | National Institute for Environmental Studies |
| E-mail address: | tsugita@nies.go.jp |


## 3. Target species, profiles or column

1) Target species for ILAS-II: Vertical profile of $O_3$, Temperature
2) Other target species: None

## 4. Category of ILAS-II validation experiments

Core experiment

## 5. Significance of the validation experiment for ILAS-II

The ozone profile is a key parameter of the ILAS-II measurement. The ozonesonde measurements provide the most reliable vertical profile of ozone. They will thus be very much useful to firstly check the quality of ILAS-II data.

## 6. Details of implementation plan for the experiment

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

2) Instrument:

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

(2) Principle:

Ozone: 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 ($O_3$) in the air drawn in reacts with the potassium iodide solution in the detector cell and liberates free iodine ($I_2$). 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.

Pressure: The atmospheric pressure is measured with an aneroid barometer.

Temperature: 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/ Physical properties | AR | A / P | VR | AT |
|---|---|---|---|---|
| $O_3$ | 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 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-II validation will be made cooperatively by ILAS project of NIES and NIPR with help of JMA. 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 of 24 flights were prepared by the ILAS project with help of NIPR, JMA, and JARE-43, and were shipped from Japan toward Syowa Station in November 2002 by JARE-43. The preparation and shipping will be made every year in a similar way.

(2) Execution period of the measurements:
a) February - March 2003
b) May 2003
c) July - August 2003
d) May - August 2004 (TBD)
e) November 2004 - February 2005 (TBD)
f) May - August 2005 (TBD)
g) November 2005 - February 2006 (TBD)
h) May - August 2006 (TBD)
i) November 2006 - February 2007 (TBD)

(3) Data submission:
a) Preliminary: A few days after the measurements

b) Final: A few weeks after the measurements

6) Comments:
Cooperative observation of the ILAS project with NIPR with help of JMA.

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

1) ILAS-II data required for the analysis:
(1) Species or physical properties:
Vertical profiles of $O_3$ mixing ratio and temperature.

(2) Date and Location:
a. Date: Coinciding with ozonesonde flights from Syowa Station

b. Location: 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-II data. The in situ data will be averaged to match the vertical resolution of the ILAS-II data as done in the ILAS ozone validation analyses (Sasano et al., 1999; Sugita et al., 2002).

3) Submission dates of the results:
a) Preliminary: Three months after the measurements

b) Final: Nine months 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.

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.
- Sasano, Y., Nakajima, H., Kanzawa, H., Suzuki, M., Yokota, T., Nakane, H., Gernandt, H., Schmidt, A., Herber, A., Yushkov, V., Dorokhov, V., and Deshler, T. (1999): Validation of ILAS Version 3.10 ozone with ozonesonde measurements, Geophys. Res. Lett., 26, No. 7, 831-834.
- Sugita, T., T. Yokota, H. Nakajima, H. Kanzawa, H. Nakane, H. Gernandt, V. Yushkov, K. Shibasaki, T. Deshler, Y. Kondo, S. Godin, F. Goutail, J.-P. Pommereau, C. Camy-Peyret, S. Payan, P. Jeseck, J.-B. Renard, H. Bösch, R. Fitzenberger, K. Pfeilsticker, M. von König, H. Bremer, H. Küllmann, H. Schlager, J.J. Margitan, B. Stachnik, G.C. Toon, K. Jucks, W.A. Traub, D.G. Johnson, I. Murata, H. Fukunishi, and Y. Sasano, (2002): Validation of ozone measurements from the Improved Limb Atmospheric Spectrometer (ILAS), J. Geophys. Res., 107(D24), 8212, doi:10.1029/2001JD000602.


3) Others


- Kanzawa, H., Sugita, T., and Nakajima, H. (2003): A plan for ILAS-II correlative measurements, Proc. 16th ESA Symp. European Rocket and Balloon Programmes and Related Research, St. Gallen, Switzerland, 2-5 June 2003, ESA SP-530, ESA Publications Division, ESTEC, Noordwijk, The Netherlands, in press.


## 9. Comments

None

## 1. Title of ILAS-II validation experiment

# Validation of ILAS-II data by balloon-borne measurement of $N_2O$, $CH_4$, and CFC-11 from Kiruna

## 2. Investigator

1) Principal Investigator

| | |
|---|---|
| Name: | **Takakiyo Nakazawa** |
| Affiliation: | Center for Atmospheric and Oceanic Studies, Graduate School of Science, Tohoku University |
| Contact address: | Aramaki-Aza-Aoba, Aoba-ku, Sendai 980, Japan |
| Telephone number: | +81-22-217-5791 |
| Fax number: | +81-22-217-5797 |
| E-mail address: | nakazawa@mail.cc.tohoku.ac.jp |

2) Co-Investigators

| | |
|---|---|
| Name (role): | Shuji Aoki (Observation and data analysis) |
| Affiliation: | Center for Atmospheric and Oceanic Studies, Graduate School of Science, Tohoku University |
| E-mail address: | aoki@mail.cc.tohoku.ac.jp |
| Name (role): | Toshinobu Machida (Observation and data analysis) |
| Affiliation: | National Institute for Environmental Studies |
| E-mail address: | tmachida@nies.go.jp |
| Name (role): | Hideyuki Honda (Observation) |
| Affiliation: | The Institute of Space and Astronomical Science |
| E-mail address: | honda@newslan.isas.ac.jp |
| Name (role): | Yoshihiro Makide (Data analysis) |
| Affiliation: | Isotope Center, University of Tokyo |
| E-mail address: | makide@chem.s.u-tokyo.ac.jp |
| Name (role): | Sakae Toyoda (Observation and data analysis) |
| Affiliation: | Interdisciplinary Graduate School of Science and Engineering, Tokyo Institute of Technology |
| E-mail address: | stoyoda@chemenv.titech.ac.jp |


## 3. Target Species, profiles or column

1) Target Species for ILAS-II: profiles of $N_2O$, $CH_4$ and CFC-11

2) Other target Species: profiles of CFC-12, $CO_2$, $SF_6$, $\delta^{13}C(CO_2)$ and $\Delta^{14}C(CO_2)$

## 4. Category of ILAS-II validation experiments

Core experiment

## 5. Significance of the validation experiment for ILAS-II

The concentrations of stratospheric trace gases such as $N_2O$, $CH_4$ and CFC-11 are relatively measured using ILAS-II, while those are determined directly by analyzing air samples collected with a balloon-borne cryogenic sampler. Therefore the direct air sampling with subsequent laboratory analysis is indispensable for validating the ILAS-II data.

## 6. Details of implementation plan for the experiment

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

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

(2) Principle:

Stratospheric air samples are collected cryogenically at assigned heights, and then analyzed for their $N_2O$, $CH_4$ and CFC-11 concentrations using gas chromatographs.

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

| Species | AR | A / P | VR | AT |
|---|---|---|---|---|
| $N_2O$ | 10 - 35 km | 0.4 % / 0.4 % | 2 km | 1-20 min. |
| $CH_4$ | 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 for the experiment:
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 has already been started in August 2000.

(2) Execution period of the measurements:
November-December 2003 (1 flight during two-month period)

(3) Data submission:
6 months after the measurements

6) Comments:
None

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

1) ILAS-II data required for the analysis:
(1) Species or physical properties:

Concentrations of $N_2O$, $CH_4$ and CFC-11

(2) Date and Location:
a) Date: When the ILAS-II data are obtained in November and December 2003.
b) Location: Over Kiruna (68°N, 21°E) and its adjacent area

2) Method of the analysis:
Comparison of measured vertical $N_2O$, $CH_4$ and CFC-11 profiles with those from ILAS-II.

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

4) Comments:
None

## 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, 48, 1145-1155, 1996.
- Honda, H., N., Yajima, T., Yamagami, S., Aoki,G., Hashida, T., Machida and S., Morimoto, Balloon operation for stratospheric air sampling at Antarctica, Adv. in Space Res., 26, 1369-1372, 2000.


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 $CO_2$ 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 $CO_2$ 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.
- S. Sugawara, T. Nakazawa, Y. Shirakawa, K. Kawamura, S. Aoki, T. Machida and H. Honda, Vertical profile of the carbon isotopic ratio of stratospheric methane over Japan, Geophys. Res. Lett., 24, 2989-2992, 1997.
- T. Shirai, M. Hirabayashi, Y. Makide, S. Aoki, T. Nakazawa, H. Honda and N. Yajima, Vertical distributions of ozone-depleting halocarbons over Sanriku (Japan) and Kiruna (Sweden) obtained by balloon-borne cryogenic sampling followed by GC/ECD and GC/Ms measurements in laboratory, Proc. of 21st Intern. Symp. Space Tech. and Sci., Vol. II, 1562-1567, 1998.
- S. Aoki, T. Nakazawa, H. Honda, N. Yajima, T. Machida, S. Sugawara, K. Kawamura and S. Yoshimura, $CO_2$, $CH_4$ and $N_2O$ concentrations and $^{13}C$ in $CO_2$ and $CH_4$ in the stratosphere over Scandinavia and Japan, Proc. of 21st Intern. Symp. Space Tech. and Sci., Vol. II, 1568-1571, 1998.
- N. Yajima, T. Yamagami, H. Honda, S. Aoki, T. Nakazawa and H. Kanzawa, Balloon observations synchronized with Earth monitoring satellite, Proc. of 21st Intern. Symp. Space Tech. and Sci., Vol. II, 1598-1603, 1998.
- Y. Kondo, M. Koike, A. Engel, U. Schmidt, M. Muller, T. Sugita, H. Kanzawa, T. Deshler, T. Nakazawa, S. Aoki, H. Irie, N. Toriyama and T. Suzuki, NOy-$N_2O$ correlation observed inside the Arctic vortex in February 1997: dynamical and chemical effect, J. Geophys. Res., 104, 8215-8224, 1999.

- S. Toyoda, N. Yoshida, T. Urabe, S. Aoki, T. Nakazawa, S. Sugawara and H. Honda, Fractionation of $N_2O$ isotopomers in the stratosphere, J. Geophys. Res., 106, 7515-7522, 2001.
- T. Nakazawa, S. Aoki, K. Kawamura, T. Saeki, S. Sugawara, H. Honda, G. Hashida, S. Morimoto, N. Yoshida, S. Toyoda, Y. Makide and T. Shirai, Variations of stratospheric trace gases measured using a balloon-borne cryogenic sampler, Advances in Space Research, 30, 1349-1357, 2002.
- S., Aoki, T., Nakazawa, T., Machida, S., Sugawara, S., Morimoto, G., Hashida, T., Yamanouchi, K., Kawamura and H., Honda, Carbon Dioxide Variations in the Stratosphere Over Japan, Scandinavia and Antarctic, Tellus, in press, 2003.

3) Others

None

## 9. Comments

None

## 1. Title of ILAS-II validation experiment

# Verification of $O_2$ A band measurement and P-T retrieval by balloon borne spectrograph

## 2. Investigators

1) Principal Investigator

| | |
|---|---|
| Name: | **Makoto Suzuki** |
| Affiliation: | JAXA/EORC |
| Contact address: | 1-8-10 Harumi, Triton Square X Tower 23F, Chu-ou, Tokyo |
| Telephone number: | 81-3-6221-9032 |
| Fax number: | 81-3-6221-9191 |
| E-mail address: | suzuki@eorc.nasda.go.jp |

2) Co-Investigators

| | |
|---|---|
| Name (role): | Yukari Yui (Spectrograph Instrumentation) |
| Affiliation: | JAXA/EORC |
| E-mail address: | yyyui@eorc.nasda.go.jp |
| Name (role): | Sin-ichiro Okumura (Theoretical Spectrograph Characterization) |
| Affiliation: | JAXA/EORC |
| E-mail address: | okumura@eorc.nasda.go.jp |

## 3. Target Species, profiles or column

1) Target Species for ILAS-II:

$O_2$, P, T

2) Other target Species:

$O_3$ using visible band

## 4. Category of ILAS-II validation experiments

Core experiment

## 5. Significance of the validation experiment for ILAS-II

Pressure - Temperature measurement, and Tangent Height determination are crucial part of accurate species retrieval in limb observations. The P-T measurement using $O_2$ A band in ILAS program could not achieve the expected accuracy, thus further conclusive verification experiment should be necessary within ILAS-II validation program at early stage.

## 6. Details of implementation plan for the experiment

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

2) Instruments:
   (1) Name: Balloon-borne Grating Spectrograph (B-GS)

   (2) Principle:

   - Balloon-borne solar occultation technique

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

| Species | AR | A / P | VR | AT |
|---|---|---|---|---|

$O_2$ 5-38 km (to be determined by CNRS FTS experiment)
0.1 % SNR
VR is determined by CNRS FTS experiment as balloon position
AT is 4 second

4) Situation on facilities and equipment for the experiment:

Spectrograph System is already under labo test, and is under final design stage for interface with CNRS FTS system (Dr. Yui has been CNRS in Sep. 13-14, 2001 to discuss details).

5) Schedule for the experiment:
   (1) Preparation:
   To be defined by CNRS FTS experiment.

   (2) Execution period of the measurements:
   No preference on measurement period.
   a) August – September, 2002
   (or November – December, 2002)
   b) February – April, 2004 (tentative)
   c) November – December, 2005 (tentative)

   (3) Data submission:
   a) Preliminary:
   Spectrograph Data, 3 months after experiment

b) Final:
P-T verification report, 15 months after experiment or faster

6) Comments:
None

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

1) ILAS-II data required for the analysis:
(1) Species or physical properties:

ILAS and ILAS-II visible spectrograph, as many as possible (preferably all of them).

with Sun-Edge Sensor data, and other supporting data necessary for P-T retrieval.

(2) Date and Location:
a) Date:
TBD
b) Location: Kiruna

2) Method of the analysis:
Balloon spectra are examined together with ILAS-II measurements.
ILAS data is also useful to distinguish the difference between -I and -II.
Instrument characteristics, P-T retrieval theoretical study will be performed to conclude whether P-T retrieval using $O_2$ A band is indeed feasible as expected by original ILAS proposal

3) Submission date of the results:
(1) Preliminary:

9 months after measurements

(2) Final:

15 months after measurements

4) Comments:
None

## 1. Title of ILAS-II validation experiment

# High latitude balloon flight of the JPL MkIV interferometer and Dual-beam UV-Absorption Ozone Photometer for ILAS-II validation

## 2. Investigators

1) Principal Investigator

| | |
|---|---|
| Name: | **Geoffrey Toon** |
| Affiliation: | Jet Propulsion Laboratory, California Institute of Technology |
| Contact address: | 4800 Oak Grove Dr., Mail Stop 183-601 |
| Telephone number: | +1-818-354-8259 |
| Fax number: | +1-818-354-5148 |
| E-mail address: | Geoffrey.C.toon@jpl.nasa.gov |

2) Co-Investigators

| | |
|---|---|
| Name (role): | James.J. Margitan (O3 Photometer) |
| Affiliation: | Jet Propulsion Laboratory |
| E-mail address: | James.J.Margitan@jpl.nasa.gov |
| | |
| Name (role): | Bhaswar Sen (MkIV) |
| Affiliation: | Jet Propulsion Laboratory |
| E-mail address: | sen@mimir.jpl.nasa.gov |
| | |
| Name (role): | Jean-Francois Blavier (Cognizant Engineer) |
| Affiliation: | Jet Propulsion Laboratory |
| E-mail address: | |

## 3. Target species, profiles or column

1) Target species for ILAS-II:

Vertical profile of $O_3$, $HNO_3$, $NO_2$, $N_2O$, $CH_4$ and $H_2O$

2) Other target species:

Vertical profile of CFC-11, CFC-12, $ClONO_2$, $N_2O_5$, CO, NO and more (profiles of over 30 gas species are expected to be retrieved)

## 4. Category of ILAS-II validation experiments

Core and Cooperative experiments

## 5. Significance of the validation experiment for ILAS-II

Make measurements of the composition of the atmosphere for the purpose of:

- Validate the ILAS-II satellite measurements of atmospheric trace species and reactive species by making near-simultaneous balloon-borne measurements in the same air mass.
- Improving our understanding of the processes that cause ozone loss during the high latitude winter and spring.

## 6. Details of implementation plan for the experiment

1) Location: Esrange (Kiruna, Sweden; 67.9N, 21.1E)

2) Instrument:

(1) Name:

a) MkIV interferometer

b) Dual-beam UV-Absorption Ozone Photometer

(2) Principle:

The MkIV interferometer (http://mark4sun.jpl.nasa.gov) is a high-resolution Fourier Transform Infra-Red (FTIR) spectrometer designed to remotely sense the composition of the Earth's atmosphere. It operates in solar occultation mode, meaning that direct sunlight is spectrally analyzed as the Sun rises or sets through the atmosphere. The variation of the depths of the absorption lines of the different molecules provides information on the atmospheric composition at different altitudes.

The photometer's primary components are a mercury lamp, two identical sample chambers, two detectors, and a scrubber. The lamp provides 254nm radiation that is transmitted through the length of the chambers to the detectors, one chamber containing the air sample with ozones and other containing air with the ozone removed. Ozones strongly absorbs this wave length, allowing virtually continuous measurements of ozones by comparing the detected signals in the two chambers, and periodically alternating the loss roles of the two chambers [Proffitt and McLaughlin, 1983; Profitt et al., 1989a]. The ozone number density in the chamber is calculated using the well known ozone absorption cross-section. Measurement of the chamber temperature and pressure allows for the calculation of the ozone mixing ratio which is invariant between the chamber and the atmosphere.

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

| Species | AR | P@20km | VR | AT |
|---|---|---|---|---|
| $O_3$ | 10 to 40 km | 6% (MkIV) | 1km | |
| | | 3% (O3 photometer) | " | 1sec |
| $HNO_3$ | " | 15% | " | |
| $NO_2$ | " | 10% | " | |
| $N_2O$ | " | 5% | " | |
| $CH_4$ | " | 5% | " | |
| $H_2O$ | " | 6% | " | |
| $CO_2$ | " | 5% | " | |
| CO | " | 5% | " | |
| HCl | " | 5% | " | |
| CFC-12 | " | 10% | " | |
| CFC-11 | " | 10% | " | |
| HCFC-22 | " | 10% | " | |
| $N_2$ | " | 7% | " | |
| NO | " | 5% | " | |
| $N_2O_5$ | " | 15% | " | |
| $ClONO_2$ | " | 15% | " | |
| $H_2O_2$ | " | 25% | " | |
| HDO | " | 7% | " | |
| $C_2H_6$ | " | 5% | " | |
| $C_2H_2$ | " | 10% | " | |

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

The facilities for performing a balloon flight are available in the Swedish Space Corporation/Esrange, and the measurement operation will be implemented by the cooperation with the CNES (Centre National d'Etudes Spatiales France).

5) Schedule for the experiment:

(1) Preparation:

The arrangements with Esrange will require a few months (or a few weeks) before the campaign.

(2) Execution period of the measurements:

a) March 2004

(3) Data submission:

a) Preliminary: 6 months after the measurements

b) Final: 12 months after the measurements

6) Comments:

None

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

1) ILAS-II data required for the analysis:

(1) Species or physical properties:

Vertical profiles of all ILAS-II target species.

(2) Date and Location:

a. Date: Coinciding with balloon flights from Kiruna

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

2) Method of the analysis:

According to the method described in Toon, G.C. et al. (2002).

3) Submission dates of the results:

a) Preliminary: 12 months after the measurements

b) Final: 18 months after the measurements

4) Comments:

None

## 8. Related Publications

1) Instrument explanation:


- Toon, G.C., The JPL MkIV Interferometer, *Opt. Photonics News, 2,* 19-21, 1991.
- Profitt, M.H. and R.J. McLaughlin, Fast response dual bean UV absorption ozone photometer suitable for use on stratospheric balloons, *Rev. Sci. Instrum.*, 54, 1719-1728, 1983.


2) Scientific results:


- Steele, H.M., A.M. Eldering, B. Sen, and G. C. Toon, Retrieval of Stratospheric Aerosol Size and Composition Information from Solar Infrared Transmission Spectra, *Appl. Opt., 42(12),* 2140-2154, 2003.
- Salawitch, R.J., J.J. Margitan, B. Sen, G.C. Toon, G.B. Osterman, M. Rex, J.W. Elkins, E.A. Ray, F.L. Moore, D.F. Hurst, P.A. Romashkin, R.M. Bevilacqua, K. Hoppel, E.C. Richard, and T.P. Bui, Chemical loss of ozone during the Arctic winter of 1999-2000: An analysis based on balloon borne observations, *J. Geophys. Res., 107(D20),*, 8269, doi:10.1029/2001JD000620, 2002.
- Toon, G.C., B. Sen, J.F. Blavier, Y. Sasano, T. Yokota, H. Kanzawa, T. Ogawa, M. Suzuki, and K. Shibasaki, Comparison of ILAS and MkIV profiles of atmospheric trace gases measured above Alaska in May 1997, *J. Geophys. Res., 107(D24),* 8211, doi:10.1029/2001JD000640, 2002.
- Salawitch, R.J., P.O. Wennberg, G.C. Toon, B. Sen, and J.F. Blavier, Near IR photolysis of $HO_2NO_2$: Implications for $HO_x$, *Geophys. Res. Lett., 29(16),* doi:10.1029/2002GL015006, 2002.
- Irion, F.W., M.R. Gunson, G.C. Toon, A.Y. Chang, A. Eldering, E. Mahieu, G.L. Manney, H.A. Michelsen, E.J. Moyer, M.J. Newchurch, G.B. Osterman, C.P. Rinsland, R.J. Salawitch, B. Sen, Y.L. Yung, and R. Zander, Atmospheric Trace Molecule Spectroscopy (ATMOS) Experiment Version 3 data retrievals, *Appl. Opt., 41(33),* 6968-6979, 2002.
- Koike, M., Y. Kondo, H. Irie, F.J. Murcray, J. Williams, P. Fogal, R. Blatherwick, C. Camy-Peyret, S. Payan, H. Oelhaf, G. Wetzel, W. Traub, D. Johnson, K. Jucks, G.C. Toon, B. Sen, J.-F. Blavier, H. Schlager, H. Zeireis, N. Toriyama, M.Y. Danilin, J.M. Rodriguez, H. Kanzawa, and Y. Sasano, A comparison of Arctic HNO3 profiles measured by the ILAS spectrometer and balloon-borne sensors, *J. Geophys. Res., 105,* 6761-6771, 2000.
- Toon, G.C., J.-F. Blavier, B. Sen, J.J. Margitan, C.R. Webster, R.D. May, D.W. Fahey, R. Gao, L. Del Negro, M. Proffitt, J. Elkins, P.A. Romashkin, D.F. Hurst, S. Oltmans, E. Atlas, S. Schauffler, F. Flocke, T.P. Bui, R.M. Stimpfle, G.P. Bonne, P.B. Voss, and R.C. Cohen, Comparison of MkIV balloon and ER-2 aircraft profiles of atmospheric trace gases, *J. Geophys. Res., 104,* 26,779-26,790, 1999.

- Toon, G.C., J.-F. Blavier, B. Sen, R.J. Salawitch, G.B. Osterman, J. Notholt, M. Rex, C.T. McElroy, and J.M. Russell III, Ground-based observations of Arctic ozone loss during spring and summer 1997, *J. Geophys. Res., 104,* 26,497-26,510, 1999.


3) Others
   None

## 1. Title of ILAS-II validation experiment

# Intercomparison and validation of ILAS-II target species with MIPAS-B measurements

## 2. Investigators

1) Principal Investigator

| | |
|---|---|
| Name: | **Gerald Wetzel** |
| Affiliation: | IMK-ASF |
| Contact address: | Forschungszentrum Karlsruhe, P.O.B. 3640, D-76021 Karlsruhe |
| Telephone number: | +49-7247-82 5947 |
| Fax number: | +49-7247-82 6141 |
| E-mail address: | gerald.wetzel@imk.fzk.de |

2) Co-Investigators

| | |
|---|---|
| Name (role): | Hermann Oelhaf (MIPAS-B group leader) |
| Affiliation: | IMK-ASF |
| E-mail address: | hermann.oelhaf@imk.fzk.de |
| Name (role): | Felix Friedl-Vallon (Responsible for experiment) |
| Affiliation: | IMK-ASF |
| E-mail address: | felix.friedl-vallon@imk.fzk.de |

## 3. Target species, profiles or column

1) Target species for ILAS-II:

$O_3$, $HNO_3$, $NO_2$, $N_2O$, $CH_4$, $H_2O$, $ClONO_2$, CFC-11, CFC-12, temperature

2) Other target species:

e.g. $N_2O_5$, $HO_2NO_2$, NO, HCFC-22, $SF_6$

## 4. Category of ILAS-II validation experiments

Core experiment

## 5. Significance of the validation experiment for ILAS-II

MIPAS-B is capable of simultaneously measuring vertical profiles of all target species ILAS is covering with an accuracy of about 10%. The complete nitrogen partitioning and budget will be determined from the measured spectra. The extremely high performance of the MIPAS-B pointing system virtually avoids any mapping of pointing errors into retrieval errors.

## 6. Details of implementation plan for the experiment

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

2) Instruments:
   (1) Name: MIPAS-B (Michelson Interferometer for Passive Atmospheric Sounding, Balloon version)

   (2) Principle: The balloon-borne MIPAS is an advanced high-resolution Fourier Transform Infra Red (FTIR) spectrometer specially tailored to the operation on a stratospheric balloon gondola. Equipped with suitable subsystems, MIPAS-B allows precise limb emission sounding of chemical constituents related to the stratospheric ozone problem and to the greenhouse effect under day- and night-time conditions. Calibrated spectra are analyzed using multi-parameter non-linear least-squares fitting procedures (see, e.g., *Wetzel et al.,* 2002).

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

| Species | AR | A / P | VR | AT |
|---|---|---|---|---|
| $HNO_3$ | 10 - CL km | 10 % / 5 % | 1.5 - 3 km | 10 - 30 min |
| $ClONO_2$ | 12 - CL km | 10 % / 5 % | 1.5 - 3 km | 10 - 30 min |
| $NO_2$ | 17 - CL km | 20 % / 15 % | 1.5 - 3 km | 10 - 30 min |
| $N_2O$ | 8 - CL km | 10 % / 5 % | 1.5 - 3 km | 10 - 30 min |
| $CH_4$ | 8 - CL km | 10 % / 5 % | 1.5 - 3 km | 10 - 30 min |
| $H_2O$ | 8 - CL km | 10 % / 7 % | 1.5 - 3 km | 10 - 30 min |
| $O_3$ | 10 - CL km | 10 % / 7 % | 1.5 - 3 km | 10 - 30 min |
| Temperature | 8 - CL km | 0.8 K / 0.5 K | 1.5 - 3 km | 10 - 30 min |

(CL=Ceiling Level)

4) Situation on facilities and equipment for the experiment:
   The facilities for performing a balloon flight are available in Esrange, and the measurement operation is provided by CNES.

5) Schedule for the experiment:
(1) Preparation:
The arrangements with CNES and Esrange as well as the preparation together with the transfer of the instrument will require a few months before the campaign.

(2) Execution period of the measurements:
a) Nov./Dec. 2003
b) TBD

(3) Data submission:
a) Preliminary: 3 months after measurement, 6 months at latest
b) Final: 6 months after measurement, 12 months at latest

6) Comments:
Final data submission is dependent on the overall performance and the conditions during the flight.

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

1) ILAS-II data required for the analysis:
(1) Species or physical properties:
Vertical profiles of all ILAS target species and temperature (see section 3.1)

(2) Date and Location:
a) Date: Coinciding with balloon flight from Kiruna
b) Location: Kiruna (68°N, 21°E) within a range of 5000 km.

2) Method of the analysis:
The MIPAS-B pointing will be adjusted to allow the best possible coincidence with ILAS overpasses. A detailed comparison of vertical profiles measured by MIPAS-B to the corresponding ILAS-II data will be performed. Mismatches in time and location can be balanced, e.g., with the help of model calculations (e.g. 3-D CTM, *Ruhnke et al.,* 1999) by 'transferring' the MIPAS results to the time and location of the ILAS observation (see, *Oelhaf et al.,* 1998).

3) Submission date of the results:
(1) Preliminary: 6 months after measurement
(2) Final: 12 months after measurement

4) Comments:
None

**8. Related Publications**

1) Instrument explanation


- Fischer, H., and H. Oelhaf, Remote sensing of vertical profiles of atmospheric trace constituents with MIPAS limb-emission spectrometers, *Appl. Opt., 35*, 2787-2796, 1996.
- Friedl-Vallon, F., A. Kleinert, O. Trieschmann, H. Oelhaf, and G. Wetzel, Radiometric calibration of MIPAS-B2 spectra, *Proc. 8th Intern. Workshop on Atmospheric Science from Space using Fourier Transform Spectroscopy,* Toulouse, 16-18 Nov. 1998.
- Friedl-Vallon, F., G. Maucher, H. Oelhaf, M. Seefeldner, O. Trieschmann, G. Wetzel, and H. Fischer, The balloon-borne Michelson Interferometer for Passive Atmospheric Sounding (MIPAS-B2) - Instrument and Results, in *Proceedings of SPIE, 3756*, 9-16, 1999.
- Maucher, G., Das Sternreferenzsystem von MIPAS-B2: Sichtlinien-Bestimmung für ein ballongetragenes Spektrometer zur Fernerkundung atmosphärischer Spurengase, *Rep. FZKA 6227*, Forschungszentrum Karlsruhe GmbH, Karlsruhe, Germany, 1999.


2) Scientific results


- Becker, G., R. Müller, D. S. McKenna, M. Rex, K. S. Carslaw, and H. Oelhaf, Composition and Chemistry - Ozone loss rates in the Arctic stratosphere in the winter 1994/1995: Model simulations underestimate results of the Match analysis, *J. Geophys. Res., 105*, 15175-15184, 2000.
- Evans, J.T., M.P. Chipperfield, H. Oelhaf, M. Stowasser, and G. Wetzel, Effect of near-IR photolysis of $HO_2NO_2$ on stratospheric chemistry, *Geophys. Res. Lett.,* in press, 2003.
- Höpfner, M., H. Oelhaf, G. Wetzel, F. Friedl-Vallon, A. Kleinert, A. Lengel, G. Maucher, H. Nordmeyer, N. Glatthor, G. Stiller, T. von Clarmann, H. Fischer, C. Kröger, T. Deshler, Evidence of scattering of tropospheric radiation by PSCs in mid-IR limb emission spectra: MIPAS-B observations and KOPRA simulations, *Geophys. Res. Lett., 29*(8), 1278, doi: 10.1029/2001GL014443, 2002.

- Müller, R., Th. Peter, P.J. Crutzen, H. Oelhaf, G.P. Adrian, T. von Clarmann, A. Wegner, U. Schmidt, and D. Lary, Chlorine chemistry and the potential for ozone depletion in the arctic stratosphere in the winter of 1991/1992, *Geophys. Res. Lett., 21*, 1427-1430, 1994.
- Oelhaf, H., T. von Clarmann, H. Fischer, F. Friedl-Vallon, C. Fritzsche, A. Linden, C. Piesch, M. Seefeldner, and W. Völker, Stratospheric $ClONO_2$ and $HNO_3$ profiles inside the Arctic vortex from MIPAS-B limb emission spectra obtained during EASOE, *Geophys. Res. Lett., 21*, 1263-1266, 1994.
- Oelhaf, H., G. Wetzel, D. Raff, M. Stowasser, R. Ruhnke, F. Friedl-Vallon, G. Maucher, M. Seefeldner, O. Trieschmann, T. v. Clarmann, H. Fischer, and T. Peter, Denitrification and Mixing in the 1994/1995 Arctic Vortex Derived from MIPAS-B Measurements and Modelling, in Stratospheric ozone 1999, *Proc. 5th European Symposium 27th September to 1st October 1999, St. Jean de Luz, France,* 292-295, 2000.
- Ruhnke, R., W. Kouker, and T. Reddmann, The influence of the $OH+NO_2+M$ reaction on the NOy partitioning in the late Arc-tic winter 1992/1993 as studied with KASIMA, *J. Geophys. Res.,104*, 3755-3772, 1999.
- Stowasser, M., H. Oelhaf, G. Wetzel, F. Friedl-Vallon, G. Maucher, M. Seefeldner, O. Trieschmann, T. v. Clarmann, and H. Fischer, Simultaneous measurements of HDO, $H_2O$ and $CH_4$ with MIPAS-B: Hydrogen budget and indication of dehydration inside the polar vortex, *J. Geophys. Res., 104*, 19213-19226, 1999.
- Stowasser, M., H. Oelhaf, R. Ruhnke, G. Wetzel, F. Friedl-Vallon, A. Kleinert, W. Kouker, A. Lengel, G. Maucher, H. Nordmeyer, Th. Reddmann, O. Trieschmann, T. v. Clarmann, H. Fischer, and M. P. Chipperfield, A characterization of the warm 1999 Arctic winter by observations and modeling: NOy partitioning and dynamics, *J. Geophys. Res., 107*(D19), 4376, doi: 10.1029/2001JD001217, 2002.
- Stowasser, M., H. Oelhaf, R. Ruhnke, A. Kleinert, G. Wetzel, F. Friedl-Vallon, W. Kouker, A. Lengel, G. Maucher, H. Nordmeyer, Th. Reddmann, and H. Fischer, The variation of short-lived NOy species around sunrise at mid-latitudes as measured by MIPAS-B and calculated by KASIMA, *Geophys. Res. Lett.,* doi: 10.1029/2002GL016727, in press, 2003.
- Sugita, T., Y. Kondo, H. Nakajima, U. Schmidt, A. Engel, H. Oelhaf, and G. Wetzel, Denitrification observed inside the Arctic vortex in February 1995, *J. Geophys. Res., 103*, 16221-16233, 1998.
- von Clarmann, T., H. Fischer, F. Friedl-Vallon, A. Linden, H. Oelhaf, C. Piesch, M. Seefeldner, and W. Völker, Retrieval of stratospheric $O_3$, $HNO_3$, and $ClONO_2$ profiles from 1992 MIPAS limb emission spectra: Method, results, and error analysis, *J. Geophys. Res., 98*, 20495-20506, 1993.

- 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 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.

- von Clarmann, T., G. Wetzel, H. Oelhaf, F. Friedl-Vallon, A. Linden, G. Maucher, M. Seefeldner, O. Trieschmann, and F. Lefèvre, $ClONO_2$ vertical profile and estimated mixing ratios of ClO and HOCl in the winter Arctic stratosphere from MIPAS limb emission spectra, *J. Geophys. Res., 102*, 16157-16168, 1997.

- Waibel, A. E., Th. Peter, K. S. Carslaw, H. Oelhaf, G. Wetzel, P. J. Crutzen, U. Pöschl, A. Tsias, E. Reimer, H. Fischer, Arctic ozone loss due to denitrification, *Science, 283*, 2064-2068, 1999.

- Wetzel, G., H. Fischer, and H. Oelhaf, Remote sensing of trace gases in the midinfrared spectral region from a nadir view, *Appl. Opt., 34*, 467-479, 1995.

- Wetzel, G., T. von Clarmann, H. Oelhaf, and H. Fischer, Vertical profiles of N2O5 along with $CH_4$, $N_2O$, and $H_2O$ in the late Arctic winter retrieved from MIPAS-B infrared limb emission measurements, *J. Geophys. Res., 100*, 23173-23181, 1995.

- Wetzel, G., H. Oelhaf, T. von Clarmann, H. Fischer, F. Friedl-Vallon, G. Maucher, M. Seefeldner, O. Trieschmann, and F. Lefèvre, Vertical profiles of $N_2O_5$, $HO_2NO_2$, and $NO_2$ inside the Arctic vortex, retrieved from nocturnal MIPAS-B2 infrared limb emission measurements in February 1995, *J. Geophys. Res., 102*, 19177-19186, 1997.

- Wetzel, G., H. Oelhaf, R. Ruhnke, F. Friedl-Vallon, A. Kleinert, W. Kouker, G. Maucher, Th. Reddmann, M. Seefeldner, M. Stowasser, O. Trieschmann, T. von Clarmann, and H. Fischer, NOy partitioning and budget and its correlation with $N_2O$ in the Arctic vortex and in summer mid-latitudes in 1997, *J. Geophys. Res., 107*(D16), 4280, doi: 10.1029/2001JD000916, 2002.


3) Others
ILAS cal./val. connected publications:


- Irie, H., Y. Kondo, M. Koike, M.Y. Danilin, C. Camy-Peyret, S. Payan, J.P. Pommereau, F. Goutail, J.-B. Renard, H. Oelhaf, G. Wetzel, G.C. Toon, B. Sen, J.-F. Blavier, R. Salawitch, R.M. Bevilacqua, J.M. Russell III, H. Kanzawa, H. Nakajima, Y. Yokota, T. Sugita, and Y. Sasano, Validation of $NO_2$ and $HNO_3$ measurements from the Improved Limb Atmospheric Spectrometer (ILAS) with the version 5.20 retrieval algorithm, *J. Geophys. Res., 107*(D24), 8206, doi: 10.1029/2001JD001304, 2002.

- Kanzawa, H., C. Schiller, J. Ovarlez, C. Camy-Peyret, S. Payan, P. Jeseck, H. Oelhaf, M. Stowasser, W.A. Traub, K. Jucks, D.G. Johnson, G.C. Toon, B. Sen, J.-F. Blavier, J.H. Park, G. Bodeker, L. Pan, T. Sugita, H. Nakajima, T. Yokota, M. Suzuki, M. Shiotani, and Y. Sasano, Validation and data characteristics of water vapor profiles observed by the Improved Limb Atmospheric Spectrometer (ILAS) and processed with the version 5.20 algorithm, *J. Geophys. Res., 107*(D24), 8217, doi: 10.1029/2001JD000881, 2002 (Errata, *J. Geophys. Res., 108*(D4), 8218, doi: 10.1029/2003JD001601, 2003).

- Kanzawa, H., T. Sugita, H. Nakajima, G.E. Bodeker, H. Oelhaf, M. Stowasser, G. Wetzel, A. Engel, U. Schmidt, I. Levin, G.C. Toon, B. Sen, J.-F. Blavier, S. Aoki, T. Nakazawa, K.W. Jucks, D.G. Johnson, W.A. Traub, C. Camy-Peyret, S. Payan, P. Jeseck, I. Murata, H. Fukunishi, M. von König, H. Bremer, H. Küllmann, J.H. Park, L.L. Pan, T. Yokota, M. Suzuki, M. Shiotani, and Y. Sasano, Validation and data characteristics of nitrous oxide and methane profiles observed by the Improved Limb Atmospheric Spectrometer (ILAS) and processed with the Version 5.20 algorithm, *J. Geophys. Res.,* doi: 10.1029/2002JD002458, in press, 2003.
- Koike, M., Y. Kondo, H. Irie, F.J. Murcray, J. Williams, P. Fogal, R. Blatherwick, C. Camy-Peyret, S. Payan, H. Oelhaf, G. Wetzel, W. Traub, D. Johnson, K. Jucks, G.C. Toon, B. Sen, J.-F. Blavier, H. Schlager, H. Ziereis, N. Toriyama, M.Y. Danilin, J.M. Rodriguez, H. Kanzawa, and Y. Sasano, A comparison of Arctic HNO3 profiles measured by ILAS and balloon-borne sensors, *J. Geophys. Res., 105*, 6761-6771, 2000.
- Oelhaf, H., H. Fischer, G. Wetzel, M. Stowasser, F. Friedl-Vallon, G. Maucher, O. Trieschmann, R. Ruhnke, and Y. Sa-sano, Intercomparison of ILAS/ADEOS with MIPAS-B measurements in late March 1997, *SPIE Vol. 3501*, 92-100, 1998.

## 9. Comments

None

## 1. Title of ILAS-II validation experiment

# Validation of ILAS-II data by ground-based measurement of $O_3$, $HNO_3$, $NO_2$ and $ClONO_2$ at Kiruna

## 2. Investigators

1) Principal Investigators

| | |
|---|---|
| Name: | **Thomas Blumenstock** |
| Affiliation: | Institute of Meteorology and Climate Research (IMK) |
| Contact address: | P.O. Box 3640, D-76021 Karlsruhe, Germany |
| Telephone number: | +49-7247-82-2434 |
| Fax number: | +49-7247-82-4742 |
| E-mail address: | thomas.blumenstock@imk.fzk.de |
| | |
| Name: | Yutaka Kondo |
| Affiliation: | Research Center for Advanced Science and Technology, The University of Tokyo |
| Contact address: | 4-6-1 Komaba, Meguro, Tokyo 153-8904, Japan |
| Telephone number: | +81-3-5452-5145 |
| Fax number: | +81-3-5452-5148 |
| E-mail address: | kondo@atmos.rcast.u-tokyo.ac.jp |
| | |
| Name: | Uwe Raffalski |
| Affiliation: | Swedish Institute of Space Physics (IRF) |
| Contact address: | P.O. Box 812, S-98128 Kiruna, Sweden |
| Telephone number: | +46-980-79021 |
| Fax number: | +46-980-79050 |
| E-mail address: | uwe.raffalski@irf.se |

2) Co-Investigator

| | |
|---|---|
| Name (role): | Frank Hase (observation and data analysis) |
| Affiliation: | Institute of Meteorology and Climate Research (IMK) |
| E-mail address: | frank.hase@imk.fzk.de |

## 3. Target Species, profiles or column

1) Target Species for ILAS-II:
Columns and profiles of $O_3$, $HNO_3$, $N_2O$, $CH_4$, $H_2O$, CO, and NO.
Column amounts of $NO_2$ and $ClONO_2$.

2) Other target Species:
HCl, HF, and ClO (if chlorine is activated).

## 4. Category of ILAS-II validation experiments

Cooperative experiment

## 5. Significance of the validation experiment for ILAS-II

We plan to make ground-based FTIR measurements coincident with ILAS-II. Since the spectral region used is quite similar to ILAS-II, most of the species covered by ILAS-II can be measured and compared with ground-based FTIR. Ground-based validation experiments provides a good statistics for validation and allows us to check the long-term stability. In addition to column amounts some profile information can be retrieved. Furthermore, additional species like HCl and HF will be measured.

## 6. Details of implementation plan for the experiment

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

2) Instruments:
   (1) Name: Fourier Transform infrared Spectrometer (Bruker IFS 120HR)
   (2) Principle:

In the framework of the NDSC (Network for the Detection of Stratospheric Change) a ground-based high resolution Fourier Transform Spectrometer (FTS) is operated at the IRF Kiruna. It is a BRUKER IFS 120HR with a spectral resolutions of 0.0025 cm-1. Absorption spectra are measured in the spectral region from 2 to 14 μm using the sun as sources of radiation. The high spectral resolution is needed to separate lines of different species and to allow profile retrieval for some species. Vertical profiles and column amounts of several minor constituents are derived by a least squares fitting technique, taking into account spectroscopic data from laboratory measurements. Profile information is retrieved from the pressure broadening of the absorption lines using the inversion technique. To make sure that the line shape is reproduced correctly by the instrument cell measurements are made routinely and analyzed with LINEFIT.

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

| Species | AR | A / P | VR | AT |
|---|---|---|---|---|
| $O_3$ (column) | | 4 % / 7 % | | 15 min. |
| $O_3$ (profile) | 5 – 35 km | | 8 km | 15 min. |
| $HNO_3$ (column) | | 4 % / 11 % | | 15 min. |
| $HNO_3$ (profile) | 5 – 35 km | | 10 km | 15 min. |
| $N_2O$ (column) | | 3 % / 6 % | | 15 min. |
| $N_2O$ (profile) | 0 – 25 km | | 8 km | 15 min. |
| $CH_4$ (column) | | 4 % / 7 % | | 15 min. |
| $CH_4$ (profile) | 0 – 25 km | | 8 km | 15 min. |
| $H_2O$ (column) | | | | 15 min. |
| $H_2O$ (profile) | 0 – 15 km | | 8 km | 15 min. |
| CO (column) | | 3 % / 6 % | | 15 min. |
| CO (profile) | 0 – 25 km | | 8 km | 15 min. |
| NO (column) | | 12 % / 15 % | | 15 min. |
| NO (profile) | 5 – 35 km | | 8 km | 15 min. |
| $NO_2$ (column) | | 10 % / 11 % | | 15 min. |
| $ClONO_2$ (column) | | 8 % / 14 % | | 15 min. |

4) Situation on facilities and equipment for the experiment:

Instrument is in operation since March 1996. Instrument is ready for ILAS-II validation.

5) Schedule for the experiment:

(1) Preparation:

The instrument was installed in March 1996. Since then a new solar tracker was installed. The spectrometer itself was permanently maintained and checked for alignment and stability.

(2) Execution period of the measurements:

Ground based measurements started in March 1996. The instrument is operated continuously in the framework of the NDSC (Network for the Detection of Stratospheric Change). Measurements are made about 2 times per week and more frequent during winter time and international campaigns if weather conditions allows it. This will be continued during the next years.

(3) Data submission:

a) Preliminary: 3 months after the measurements
b) Final: 6 months after the measurements

6) Comments:

None

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

1) ILAS-II data required for the analysis:

(1) Species or physical properties:
$O_3$, $HNO_3$, $N_2O$, $CH_4$, $H_2O$, CO, NO, $NO_2$, $ClONO_2$, CFC-12, CFC-11.

(2) Date and Location: Date and location of co-located ILAS observations; coincidence criteria:

a) Date: within +/- 12 hours
b) Location: within 500 km radius around Kiruna, Sweden (68N, 21E).

2) Method of the analysis:

Comparison of column amounts derived from FTS spectra with those calculated from ILAS. Comparison of vertical profiles of $O_3$, $HNO_3$, $N_2O$, $CH_4$, $H_2O$, CO, and NO retrieved from FTS observations with convolved ILAS profiles. ILAS profiles will be convolved to adopt the vertical resolution to that of ground-based FTS.

3) Submission date of the results:

(1) Preliminary: 6 months after the measurements
(2) Final: 12 months after the measurements

4) Comments:

None

## 8. Related Publications

1) Instrument explanation


- F. Hase, T. Blumenstock, and C. Paton-Walsh: Analysis of the Instrumental Line Shape of high-resolution Fourier Transform IR spectrometers with gas cell measurements and new retrieval software, Appl. Opt. 38, 3417 - 3422, 1999.
- M. Höpfner, G. Stiller, M. Kuntz, T. von Clarmann, G. Echle, B. Funke, N. Glatthor, F. Hase, H. Kemnitzer, S. Zorn: The Karlsruhe optimized and precise radiative transfer algorithm, Part II: Interface to retrieval applications, *SPIE Proceedings Vol. 3501, 186-195, 1998.*
- M. Kuntz, M. Höpfner, G. Stiller, T. von Clarmann, G. Echle, B. Funke, N. Glatthor, F. Hase, H. Kemnitzer, S. Zorn: The Karlsruhe optimized and precise radiative transfer algorithm, Part III: ADDLIN and TRANSF algorithms for modeling spectral transmittance and radiance, *SPIE Proceedings Vol. 3501, 247-256, 1998.*
- G. Stiller, M. Höpfner, M. Kuntz, T. von Clarmann, G. Echler, H. Fischer, B. Funke, N. Glatthor, F. Hase, H. Kemnitzer, S. Zorn: The Karlsruhe optimized and precise radiative transfer algorithm, Part I: Requirements, justification, and model error estimation, *SPIE Proceedings 3501, in press, 1998*

2) Scientific results

- T. Blumenstock, H. Fischer, A. Friedle, F. Hase, P. Thomas: Column amounts of $ClONO_2$, HCl, $HNO_3$, and HF from groundbased FTIR measurements made near Kiruna, Sweden, in late winter 1994, *Journal of Atmospheric Chemistry 26, 311-321, 1997.*
- Wegner, G. Stiller, T. von Clarmann, G. Maucher, T. Blumenstock, and P. Thomas: Sequestration of $HNO_3$ in polar stratospheric clouds and chlorine activation as monitored by groundbased Fourier transform infrared solar absorption measurements, *J. Geophys. Res. 103, 22181-22000, 1998*
- M. Höpfner, T. Blumenstock, F. Hase, A., Zimmermann, H. Flentje, S. Fueglistaler: Mountain polar stratospheric cloud measurements by ground based FTIR solar absorption spectroscopy, Geophys. Res. Lett. 28, 2189 – 2192, 2001.
- G. Kopp, H. Berg, T. Blumenstock, H. Fischer, F. Hase, G. Hochschild, M. Höpfner, W. Kouker, T. Reddmann, R. Ruhnke, U. Raffalski, Y. Kondo: Evolution of ozone and ozone related species over Kiruna during the THESEO 2000-SOLVE campaign retrieved from ground-based millimeter wave and infrared observations, JGR, in press, 2003.

3) Others

None

## 9. Comments

None

## 1. Title of ILAS-II validation experiment

# ILAS-II campaign in spring 2004 by LPMA (LWIR), CAESR and DOAS

## 2. Investigator

1) Principal Investigator

| | |
|---|---|
| Name: | **Claude Camy-Peyret** |
| Affiliation: | Laboratoire de Physique Moleculaire et Applications (LPMA) |
| Contact address: | Universite Pierre et Marie Curie / CNRS, UMR 7092 Tour 13 / 3eme etage / Case 76, 4 Place Jussieu, F-75252 Paris Cedex 05, France |
| Telephone number: | +33-1-4427-4477 |
| Fax number: | +33-1-4427-7033 |
| E-mail address: | camy@ccr.jussieu.fr |

2) Co-Investigators

| | |
|---|---|
| Name (role): | Sebastien Payan (analysis and science) |
| Affiliation: | Laboratoire de Physique Moleculaire et Applications (LPMA) |
| E-mail address: | payan@ccr.jussieu.fr |
| Name (role): | Pascal Jeseck (optics, analysis) |
| Affiliation: | Laboratoire de Physique Moleculaire et Applications (LPMA) |
| E-mail address: | jeseck@ccr.jussieu.fr |
| Name (role): | Jean Evrard (gondola and of its azimuth control) |
| Affiliation: | CNES (Centre National D'etudes spatiales |
| E-mail address: | jean.evrard@cnes.fr |

**Partner PIs by two different configurations:**

#1 Payload LPMA(LWIR)/DOAS/mini-DOAS

Principal Investigator for DOAS and mini-DOAS

| | |
|---|---|
| Name (role): | Klaus Pfeilsticker |
| Affiliation: | University of Heidelberg |
| E-mail address: | klaus.pfeilsticker@iup.uni-heidelberg.de |

#2 Payload LPMA(NIR)/B-GS/DOAS/mini-DOAS

Principal Investigator for B-GS (Balloon-borne Grating Spectrograph)

| | |
|---|---|
| Name (role): | Makoto Suzuki |
| Affiliation: | Japan Aerospace Exploration Agency/ Earth Observation Research and Application Center (JAXA/EORC) |
| E-mail address: | suzuki@eorc.nasda.go.jp |

## 3. Target Species, profiles or column

### LPMA

1) Target Species for ILAS-II:

   Profiles of $O_3$, $HNO_3$, $NO_2$, $N_2O$, $CH_4$, $H_2O$ and $CO_2$ (#1 payload)

   Profiles of $H_2O$ and $O_2$ (#2 payload)

2) Other target Species:

   Profiles of HCl, HF and NO (#1 payload)

### DOAS and mini-DOAS

1) Target Species for ILAS-II:

   Profiles of $O_3$, $NO_2$ and $H_2O$

2) Other target Species:

   Profiles of BrO, OClO and $O_4$

### B-GS

1) Target Species for ILAS-II:
2) Other target Species:

   ***Details of this instrument will be described separately in another CMP (PI: M.Suzuki).**

## 4. Category of ILAS-II validation experiments

Core & Cooperative experiments

## 5. Details of implementation plan for the experiment

1) Location: Kiruna, Esrange (67.89N, 21.10E)

2) Instruments:

   (1) Name:

   a) LPMA (NIR): Fourier transform spectrometer operation solar absorption in the oxygen A band and $H_2O$ band.

   b) LPMA ($O_2$ spectrometer): Grating spectrometer operating in direct solar absorption in the oxygen A band around 765nm.

c) B-GS: Grating spectrometer of the ILAS-II type operating in direct solar absorption in the oxygen A band around 765nm.

d) DOAS: Grating spectrometer operating in direct solar absorption in the UV-visible range.

e) Mini-DOAS: Reduced and simplified version of DOAS for nadir (first mini-spectrometer) and limb (second mini-spectrometer).

(2) Principle:

***LPMA Fourier transform instrument***

The LPMA (Limb Profile Monitor of the Atmosphere Instrument) is a Fourier transform infrared (FTIR) spectrometer with a standard Bomem DA2.01 interferometer and a custom made output optics with two channels (i.e. interferograms are recorded simultaneously with two detectors). The instruments and associated gondola have been described in [Camy-Peyret, 1995, Camy-Peyret *et al.*, 1995]. The solar radiation is fed into the FTIR through the sun tracker as a parallel beam. Two configurations will be used and are listed in Table 4.
The LPMA (LWIR) configuration is covering the long wave infrared region especially for the validation of ILAS-II, but also for the validation of MIPAS, SCIAMACHY and GOMOS.
The LPMA (NIR) configuration is covering the near infrared region specially for the validation of the ILAS-2 visible channel (radiative transfer in the $O_2$ A band), but also for the validation of SCIAMACHY and GOMOS (940 and 765 nm regions). The LPMA(SWIR) configuration will not be used during the present campaign but may be considered as a backup configuration.

**Table 4 – Optical configurations of the LPMA instrument**

| Configuration | Detectors for channel 1/channel 2 | Region covered | Scientific objectives |
|---|---|---|---|
| LPMA(LWIR) | HgCdTe/InSb | S1A=750-1300 $cm^{-1}$<br>S1B=1800-2000 $cm^{-1}$<br>S2A=2800-3050 $cm^{-1}$<br>S2A=4000-4100 $cm^{-1}$ | $HNO_3$, $O_3$, $H_2O$, $CO_2$, $CH_4$, $N_2O$<br>NO, $CO_2$, $H_2O$<br>$CH_4$, $NO_2$, HCl, $O_3$<br>HF, $H_2O$ |
| LPMA(SWIR) | InSb/InSb | S1A=2050-2200 $cm^{-1}$<br>S1B=2800-3050 $cm^{-1}$<br>S2A=4200-4300 $cm^{-1}$<br>S2A=4801-5000 $cm^{-1}$ | CO, $O_3$, OCS, $H_2O$<br>$CH_4$, $NO_2$, HCl, $O_3$<br>CO, $CH_4$<br>$CO_2$, $H_2O$ |
| LPMA(NIR) | Si/Si | S1A=10500-11500 $cm^{-1}$<br>S1B=12800-13200 $cm^{-1}$ | $H_2O$<br>$O_2$ |

In all cases an apodised spectral resolution of 0.020 $cm^{-1}$ is obtained as the maximum optical path difference is $OPD_{max}$ = 50 cm.

***LPMA $O_2$ spectrometer***

This instrument is covering the region 750-790 nm at 0.08 nm resolution. It is used to validate radiative transfer calculations in the $O_2$ A band around 765 nm in direct sun light and to define precisely the actual line-of-sight (LOS) during sunset for negative solar elevation angles (precise tangent height determination). This spectrometer is fed through an optical fibre collecting a small part at the edge of the parallel beam coming out from the sun tracker.

***B-GS***

This instrument will be a “piggy-back” of the LPMA gondola for the ILAS-2 validation flight. It is derived from the “breadboard” of the ILAS-II spectrometer onboard ADEOS.
The scientific goal is to evaluate the current understanding of the $O_2$ A band spectroscopy and its application to atmospheric remote sensing. As for the other high resolution instruments of the gondola the measurement methods uses solar occultation, feeding the ILAS-B spectrometer through an optical fibre also collecting a small part at the edge of the parallel beam coming out from the sun tracker. The region covered and the spectral resolutions are very similar to the LPMA $O_2$ spectrometer.
* Details of measurements plan using this instrument is described separately in another CMP (PI: M.Suzuki).

***DOAS***

This instrument is including 2 grating spectrometers in on thermostated (273 K) and evacuated housing. It is using an array of 1024 photodiodes cooled at 260 K. The characteristics and the objectives of the instrument are given in Table 5.
The 2 spectrometers are receiving the solar radiation through 2 optical fibres with optical heads taking a small part of the solar beam at the output of the sun tracker. The DOAS instrument is contributing to the validation of SCIAMACHY (and MIPAS) within the German balloon validation project funded by the German Space Agency (DLR).

**Table 5 – Characteristics of DOAS**

| Spectrometer | Spectral range | Resolution | Scientific objectives |
|---|---|---|---|
| UV | 316-418 nm | 0.5 nm | $O_3$, BrO, OClO |
| Visible | 418-653 nm | 1.3 nm | $NO_2$, $O_3$, $O_4$, $H_2O$ |

**Mini-DOAS**

This instrument consists of 2 grating spectrometers in one thermostated (273 K) housing. The region covered in both cases is the UV-vis from 320 to 520 nm at 0.8 nm resolution. One spectrometer is coupled by a fibre bundle to a small optical head looking in the nadir direction. The second one is scanning the bright limb (not the direct sun) with elevations from + 1° to – 5°. The targets are $O_3$, $O_4$, $NO_2$ and possibly OClO and BrO (depending on chlorine/bromine activation).

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

**LPMA (LWIR)**

| Species | AR | P | VR | AT |
|---|---|---|---|---|
| O3 | 10-30km | | 1-2km | |
| HNO3 | " | | " | |
| $NO_2$ | " | | " | |
| $N_2O$ | " | | " | |
| $CH_4$ | " | | " | |
| $H_2O$ | " | | " | |
| $CO_2$ | " | | " | |
| HCl | " | | " | |
| HF | " | | " | |
| NO | " | | " | |

**LPMA (NIR)**

| Species | AR | A / P | VR | AT |
|---|---|---|---|---|
| $H_2O$ | 10-30km | | 1-2km | |
| $O_2$ | " | | " | |

**DOAS and mini-DOAS**

| Species | AR | A / P | VR | AT |
|---|---|---|---|---|
| $O_3$(UV) | 10-30km | | 1km | |
| $O_3$ (vis.) | " | | " | |
| $NO_2$ (vis.) | " | | " | |
| $H_2O$ (vis.) | " | | " | |
| BrO (UV) | " | | " | |
| OClO (UV) | " | | " | |
| $O_4$ (vis.) | " | | " | |

* Details of B-GS will be described separately in another CMP (PI: M.Susuki)

4) Schedule for the experiment:

(1) Preparation:

Two flights with possible Russian recovery are scheduled.

(2) Execution period of the measurements:

The exact order is not yet known and will depend on the exact planning and priorities or the campaign during the period March- April 2004.

Flight #1: Payload LPMA (LWIR)/DOAS/mini-DOAS for the validation of ILAS-II onboard ADEOS-II, SCIAMACHY, MIPAS and GOMOS onboard ENVISAT.

Flight #2: Payload LPMA (NIR)/B-GS/DOAS/mini-DOAS for the validation of ILAS-II onboard ADEOS-II.

(3) Data submission:
a) Preliminary:
b) Final:

6 months after the measurements for $O_3$, $N_2O$, $NO_2$, $CH_4$, H2O and HCl. 2 months more for species 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.

5) Comments:
None

**6. Details of implementation plan for ILAS-II validation analysis using the experiment data**

1) ILAS-II data required for the analysis:
(1) Species or physical properties:

Vertical profiles of all ILAS-II target species.

(2) Date and Location:
a) Date: Coinciding with balloon flights from Kiruna
b) Location: Kiruna (67.89N, 21.10E) within range of 500km

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

3) Submission date of the results:
(1) Preliminary: 6 months after the measurements

(2) Final: 12 months after the measurements

4) Comments:
None

## 7. Related Publications

1) Instrument explanation


- Camy-Peyret C., Jeseck P., Hawat T., Durry G., Payan S., Berubé G., Rochette L., Huguenin D.
  The LPMA balloonborne FTIR spectrometer for remote sensing of atmospheric constituents
  ESA Publ. SP-370 (European Space Research and Technology Centre, Noordwijk, The Netherlands, 1995), pp. 323-~28.
- Hawat T., Camy-Peyret C., Torguet R.
  Sun tracker for atmospheric remote sensing
  Opt. Eng. 1998, *37*, 1633-1642
- Camy-Peyret C.
  Balloon-borne infrared Fourier transform spectroscopy for measurements of atmospheric trace species
  Spectrochim. Acta Part 1995, *A 51*, 1143-1152


2) Scientific results


- Irie H., Kondo Y., Koike M., Danilin M.Y., Camy-Peyret C., Payan S., Pommereau J.P., Goutail F., Renard J.-B., Oelhaf H., Wetzel G., Toon G.C., Sen B., Blavier J.-F., Salawithch R., Bevilacqua R.M., Russell III J.M., Kanzawa H., Nakajima H., Yokota T., Sugita T., Sasano Y.,
  Validation of $NO_2$ and $HNO_3$ from the Improved Limb Atmospheric Spectrometer (ILAS) with the version 5.20 retrieval algorithm.
  J. Geophys. Res. 2002, *107*, 8206
- Sugita T., Yokota T., Nakajima H., Kanzawa H., Nakane H., Gernandt H., Yushkov V., Shibasaki K., Desler T., Kondo Y., Godin S., Goutail F., Pommereau J.-P., Camy-Peyret C., Payan S., Jeseck P., Renard J.-B., Bösch H., Fitzenberger R., Pfeilsticker K., von König M., Bremer H., Küllmann H., Schlager H., Margitan J.J., Stachnik B., Toon G.C., Jucks K., Traub W.A., Johnson D.G., Muraa I. Fuknishi H., Sasano Y.,
  Validation of ozone measurements from the Improved Limb Atmospheric Spectrometer (ILAS)
  J. Geophys. Res. 2002, *107*, 8212
- Kanzawa H., Schiller C., Ovarlez J., Camy-Peyret C., Payan S., Jeseck P., Oelhaf H., Stowasser M., Traub W.A., Jucks K., Johnson D.G., Toon G.C., Sen B., Blavier J.-F., Park J.H., Bodeker G., Pan L., Sugita T., Nakajima H., Yokota T., Suzui M., Shiotani M., Sasano Y.
  Validation and data characteristics of water vapor profiles observed by the Improved Limb Atmospheric Spectrometer (ILAS) and processed with version 5.20 algorithm.
  J. Geophys. Res. 2002, *107*, 8217
- Kanzawa H., Schiller C., Ovarlez J., Camy-Peyret C., Payan S., Jeseck P., Oelhaf H., Stowasser M., Traub W.A., Jucks K., Johnson D.G., Toon G.C., Sen B., Blavier J.-F., Park J.H., Bodeker G., Pan L., Sugita T., Nakajima H., Yokota T., Suzui M.,

Shiotani M., Sasano Y.
Validation and data characteristics of water vapor profiles observed by the Improved Limb Atmospheric Spectrometer (ILAS) and processed with version 5.20 algorithm. *(erratum)*
J. Geophys. Res. 2003, *108*, 8218

- Camy-Peyret C., Payan S., Jeseck P., Té Y.
Mesures spectroscopiques de constituants et de polluants atmosphériques par techniques *in situ* et à distance, au sol ou embarquées
C. R. Acad. Sci. Paris Sér. IV 2001 *2*, 1-18

- Camy-Peyret C., Hawat T., Jeseck P., Payan S.,
Recent results obtained by the LPMA balloon-borne experiment during SESAME and the ILAS validation campaign
ESA Publ. SP-397, (European Space Research and Technology Centre, Noordwijk, The Netherlands, 1997), 223-229.

- Wildi F.P.
New concepts and performances in azimuth control of large balloon gondolas
ESA Publ. SP-317 (European Space Research and Technology Centre, Noordwijk, The Netherlands, 1991), pp. 357-361.

- Hartmann J.-M., Kochel J.-M., Camy-Peyret C., Payan S., Engel A.
$CF_2Cl_2$ mixing ratio profiles in the 1995 late winter Arctic vortex from balloon-borne spectra
Geophys. Res. Lett. 1997, *24*, 2367-2370

- Harder H., Camy-Peyret C., Ferlemann F., Fitzengerber R., Hawat T., Osterkamp H., Schneider M., Perner D., Platt U., Vradelis P., Pfeilsticker K.
Stratospheric BrO profiles measured at different latitudes and seasons: atmospheric observations.
Geophys. Res. Lett. 1998, *25*, 3843-3846

- Ferlemann F., Camy-Peyret C., Fitzenberger R., Harder H., Hawat T., Osterkamp H., Schneider M., Perner D., Platt U., Vradelis P., Pfeilsticker K.
Stratospheric BrO profiles measured at different latitudes and seasons: instrument description, spectral analysis and profile retrieval.
Geophys. Res. Lett. 1998, *25*, 3847-3850

- Fitzenberger R., Bösch H., Camy-Peyret C., Chipperfield M.P., Harder H., Platt U., Sinnhuber B.-M., Wagner T., Pfeilsticker K.,
First profile measurements of tropospheric BrO.
Geophys. Res. Lett. 2000, *27*, 2921-2924

- Pfeilsticker K., Sturges W.T., Bösch H., Camy-Peyret C., Chipperfield M.P., Engel A., Fitzenberger R., Müller M., Payan S., Sinnhube B.-M.,
Lower stratospheric organic and inorganic bromine budget for the arctic winter 1998/99.
Geophys. Res. Lett. 2000, *27*, 3305-3308

- Harder H., Bösch H., Camy-Peyret C., Chipperfield M.P., Fitzenberger R., Payan S., Perner D., Platt U., Sinnhuber B.-M., Pfeilsticker K.,
  Comparison of measured and modeled stratospheric BrO: implications for the total amount of stratospheric bromine.
  Geophys. Res. Lett. 2000, *27*, 3695-3698

3) Others

## 9. Comments

None

## 1. Title of ILAS-II validation experiment

# Validation of ILAS-II ozone profiles and chemical loss rates by balloon-borne observations in Antarctica and complementary studies including ozone isotopes in the Arctic.

## 2. Investigators

1) Principal Investigator

| | |
|---|---|
| Name: | **Hartwig Gernandt** |
| Affiliation: | Alfred Wegener Institute for Polar and Marine Research |
| Contact address: | Postfach 12 01 61, D-27515 Bremerhaven, Germany |
| Telephone number: | +49-471-4831-160 |
| Fax number: | +49-471-4831-355 |
| E-mail address: | hgernandt@awi-bremerhaven.de |

2) Co-Investigators

| | |
|---|---|
| Name: | Hideaki Nakajima (Data analysis / ILAS II ozone profiles and ozone isotopes) |
| Affiliation: | National Institute for Environmental Studies |
| e-mail address: | hide@nies.go.jp |
| Name: | Andreas Herber (Measurements / operational ozonesonde soundings, Data submission control, and Data analysis / ozone profiles) |
| Affiliation: | Alfred Wegener Institute for Polar and Marine Research |
| e-mail address: | aherber@awi-bremerhaven.de |
| Name: | Peter von der Gathen (Data analysis / match method, and Measurements / ozonesonde data quality check) |
| Affiliation: | Alfred Wegener Institute for Polar and Marine Research |
| e-mail address: | gathen@awi-potsdam.de |
| Name: | Roland Neuber (Measurements / ozone lidar, Data submission / ozone lidar, and Data analysis / ozone profiles) |
| Affiliation: | Alfred Wegener Institute for Polar and Marine Research |
| e-mail address: | neuber@awi-potsdam.de |
| Name: | Justus Notholt (Measurements / FTIR, Microwave radiometer, Data submission / FTIR, Microwave radimeter, and Data analysis / ozone isotopes, ozone profiles) |
| Affiliation: | University of Bremen, Institute of Environmental Physics |

e-mail: jnotholt@iup.physik.uni-bremen.de

Name: Gert König-Langlo (Measurements / ozonesonde soundings, ozonesonde data quality check, Data submission / ozonesondes)
Affiliation: Alfred Wegener Institute for Polar and Marine Research
e-mail: gkoenig@awi-bremerhaven.de

## 3. Target Species, profiles or column

1) Target Species for ILAS-II: vertical profiles of $O_3$, temperature

2) Other target Species: $O_3$ (isotopes) column densities

## 4. Category of ILAS-II validation experiments

Co-operative experiment

## 5. Significance of the validation experiment for ILAS-II

(a) The ozone profile is a key parameter of ILAS-II measurements. The electrochemical ozonesondes will provide one of the most reliable vertical profile of ozone with high vertical resolution up to about 30 km. Ozonesondes will provide the earliest validation data for vertical profiles of ozone. At Neumayer station Antarctic) we plan to carry out regular ozonesonde flights once per week as well as additional measurements for direct comparison with coincident ILAS II observations. This activity is the key contribution to our co-operative experiment.

(b) At Koldewey station (Arctic) we intend to complete validation objectives for ILAS II ozone data by regular ground- based observations such as:
* Microwave radiometer and ozone lidar to get ozone profiles up to greater altitudes (about 70 km). Although the vertical resolution is small (about 5-10 km) these measurements provide profiles with high time resolution.
* Fourier Transform Infrared Spectrometer (FTIR) to retrieve the column densities of ozone isotopes for comparison with ILAS II retrievals. Within the validation of ILAS-II the seasonal variabilty of ozone and its fractionation will be studied in the Arctic and compared with the ILAS-II data.

(c) A special effort is planned for the period from June until December 2003. In connection with the Project "Quantitative Understanding of the Ozone losses by Bipolar Investigations (QUOBI)" ILAS-II ozone data will be used to perform Match type analyses and compare them with the balloon-borne Match results.

## 6. Details of implementation plan for the co-operative experiment

1) Location: Neumayer station (71°S, 08°W)
Koldewey station (79°N, 12°E)

2) Instruments:

(1) Name:
a) Ozonesonde at Neumayer station
b) Microwave radiometer at Koldewey station
c) Ozone lidar (DIAL) at Koldewey station
d) FTIR at Koldewey station

(2) Principle:

**Ozonesonde** at Neumayer station

Electrochemical Concentration Cell (ECC) with standard radiosonde RS 90 for pressure and temperature.

**Microwave radiometer** at Koldewey station

Microwave spectroscopy is used to measure ozone profiles. The heterodyne receiver consists of two front-ends for the observation of ozone at 142 GHz, which is operated in a time sharing mode. The back end consists of a 2048 channel acousto-optical spectrometer with a center frequency of 2.1 GHz. Both front-ends consist of a rotable mirror for calibration, a quasi optics and mixer-HEMT pre-amplifier stage with potter horn antenna. The mixer and pre-amplifier can be cooled to 12 K by a closed cycle refrigerator. The normal operation mode of the radiometer is 10 minutes for ozone spectra. So the ozone data can be recorded with a very high time resolution.

**Ozone lidar** (DIAL) at Koldewey station

The stratospheric ozone LIDAR instrument consist of two lasers, a XeCl-Excimer laser for UV-wavelengths and a Nd:YAG-laser for near IR- and visible wavelengths, two telescopes (of 60 cm and 150 cm diameter) and a detection system with eight channels. Ozone profiles are obtained by the DIAL method using the wavelengths at 308 and 353 nm. During polar day conditions, when daylight deteriorates LIDAR measurements, a dedicated two channel detector is employed for ozone DIAL measurements only. It comprises small bandwidth interference filters and pressure tuned Fabry-Perot-Etalons for the wavelengths of 308, and 353 nm in order to sufficiently suppress the background light.

**FTIR** at Koldewey station

Atmospheric trace gases are measured in the infrared spectral region using the sun or moon as light source. The observations are performed at a resolution of typically 0.005 wavenumbers using the commercial Bruker 120 HR Michelson-interferometer. The analysis is performed using either SFIT-2 (NASA-Langley and NIWA-Lauder) or GFIT (NASA/JPL-Pasadena).

The high resolution measurements in the infrared allow to study the isotopic fractionation of several trace gases, including ozone. An advantage of the spectroscopic observations is the possibility to separate the symmetric and asymmetric isotopomers.

The ozone fractionation ($^{16}O^{16}O^{16}O$, $^{16}O^{18}O^{16}O$ and $^{18}O^{16}O^{16}O$) has already been studied by us in the past in Spitsbergen. The highest sensitivity of these FTIR-observations lies in the altitude region 5-30 km.

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

| Species | AR | A/P | VR | AT |
|---|---|---|---|---|
| Ozonesonde ($O_3$) | 0 – 30 km | 5% / 5% | 50 m | 10 sec |
| Microwave ($O_3$) | 10 - 70 km | | 5 km | 10 min. |
| Lidar ($O_3$) | 10 – 45 km | | 2 km | |
| FTIR ($O_3$ isotopes) | 5 – 30 km | | column density | |

4) Situation on facilities and equipment for the experiment:

Neumayer and Koldewey station are operated on a routine basis. The instrumentation as well as data processing is used in the frame of long-term observations. Materials for balloon-borne ozone soundings are available on site.

5) Schedule for the experiment:

(1) Preparation:
The preparations are completed at Neumayer and Koldewey station. The co-operative experiments will be performed in the frame of regular observations until the end of ILAS II validation experiments.

(2) Execution period of the measurements:
a) At Neumayer regular ozonesonde flights will be carried out ones per week. Additional ozone soundings will be performed according to the prediction calendar for ILAS-II overpasses (Match radii up to 500 km).

b) c) d) At Koldewey station measurements will be carried out in the frame of regular observations. Data records will be provided for coincident ILAS II observations for distances up to 1000 km.

(3) Data submission:
a) Preliminary: Few days after the measurements for ozonesondes.
b) Final: Three month after the measurements for ozonesondes.

6) Comments:
Data of Microwave, Lidar, FTIR measurements will be regularly processed and provided for comparison with ILAS II data three months after measurements.

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

1) ILAS-II data required for the analysis:

(1) Species or physical properties: vertical profiles of ozone mixing ratio
vertical profiles of temperature
column densities of ozone isotopes

(2) Date and Location:
a) Date:
According to the prediction calendar for overpasses up to match radii of 500 km for Neumayer station.
According to the prediction calendar for closest distance to Koldewey station

b) Location: Neumayer (71°S, 08°W) within a range of 500 km
Koldewey (79°N, 12°E)

2) Method of the analysis:
Comparison between vertical profiles of ozonesonde and corresponding ILAS-II data. The ozonesonde data will be averaged to match the vertical resolution of the ILAS-II data as done in the ILAS ozone validation analysis (Sasano et al., 1999; Sugit et al., 2001).
Ozone profiles and ozone isotope column densities will be compared with ILAS II data.

3) Submission date of the results:

(1) Preliminary: 6 months after measurements
(2) Final: 9 months after the measurements

4) Comments: **Match analyses**
Within the QUOBI campaign several hundred ozone sondes will be launched at various Antarctic stations in a co-ordinated manner such that single air parcels will be probed twice. Differences in the ozone values will be attributed to chemical ozone loss in a statistical sense (Match method). Date from several satellite-borne instruments, among them ILAS-II, will be used in the same way as the ozone sonde measurements

Applying this approach it will be possible to validate scientific products retrieved from ILAS-II to balloon-borne studies. In the Arctic stratosphere ozone depletion rates have been successfully retrieved by ozone soundings using the "Match" technique meanwhile for 10 years. A first promising approach was made to retrieve those depletion rates by means of ILAS ozone data in 1997.

This might contribute to further develop the satellite "Match" technology. Satellite match technique might be a more powerful tool for long-term observations as the rather complicated co-ordination of balloon-borne campaigns.

## 8. Related Publications

1) Instruments and method explanation

- Gathen, P. von der et al.: Observational evidence for chemical ozone depletion over the Arctic in winter 1991-92, Nature, 375, 131-134, 1995.
- Meier, A., and J. Notholt, Determination of the isotopic abundances of heavy $O_3$ as observed in arctic ground-based FTIR-spectra, *Geophys. Res. Lett., 23,* 551-554, 1996.
- McGee, T. J.,Gross, M.,Newman, P.,Beyerle, G.,Beninga, I.,Dahl, A.,Neuber, R.,Wahl, P.,Schrems, O.(1998). Lidar temperature measurements at Ny-Ålesund (79N) during winter, 1998, Proceedings 19th International Laser Radar Conference, NASA/CP-1998-207671/PT1,343-345.
- Terao, Y., et al., Stratospheric ozone loss in the 1996/1997 Arctic winter: Evaluation based on multiple trajectory analysis for double sounded air parcels by ILAS, J. Geophys. Res., doi: 10.1029/2001JD000615, 2002.

2) Scientific results

- Gernandt, H.; Gloede, P.; Feister, U.; Peters, G., Thees, B.: Vertical distributions of ozone in the lower stratosphere over Antarctica and their relations to the spring depletion. Planet. Space Sci. Vol. 37, No. 8, p. 915-933, 1989.
- Bruehl, C., S.R. Drayson, J.M. Rusell III, P.J. Crutzen, J.M. McInery, P.N. Purcell, H. Claude, H. Gernandt, Th. J. McGee, I.S. McDermid, and M.R. Gunson, Hologen Occultation Experiment ozone channel validation, J. Geophys. Res., Vol. 101, 10,217-10,240, 1996.
- Müller, R., P.J. Crutzen, J.-U. Grooß, Ch. Brühl, J.M. Russell, H. Gernandt, D.S. McKenna, and A.F. Tuck, Severe chemical ozone loss in the Arctic during the winter of 1995-96, Nature, 389, 709-712, 1997.
- Neuber, R.,Beyerle, G.,Gathen, P. von der,Wahl, P.,Dahl, A.,Gross, M.,McGee, Th.,Klein, U.,Steinbrecht, W.(2001). An intercomparison campaign of ozone and temperature measurements in the Arctic (NAOMI-98, Ny-Ålesund/Spitsbergen), Mem. Natl Inst. Polar Res., Spec. Issue, Vol. 54, 65-70, 2001.

- Notholt, J., G.C. Toon, F. Stordal, S. Solberg, N. Schmidbauer, A. Meier, E. Becker, B. Sen, Seasonal variations of Atmospheric trace gases in the high Arctic at 79°N, J. Geophys. Res., 102, 12855-12861, 1997.
- Rex, M., et al., Prolonged stratospheric ozone loss in the 1995/96 Arctic winter, Nature, 389, 835-838, 1997.
- Sasano, Y., Nakajima, H., Kanzawa, H., Suzuki, M., Yokota, T., Nakane, H., Gernandt, H., Schmidt, A., Herber, A., Yushkov, V., Dorokhov, V., and Deshler, T., Validation of ILAS Version 3.10 ozone with ozonesonde measurements, Geophys. Res. Lett., 26, 831-834, 1999.
- Sugita, T., Yokota, T., Nakajima, H., Kanzawa, H., Nakane, H., Gernandt, H., Yushkov, V., Shibasaki, K., Deshler, T., Kondo, Y., Godin, S., Goutail, F., Pommereau, J.-P., Camy-Peyret, C., Payan, S., Jeseck, P., Renard, J.-B., Bosch, H.,Fitzenberger, R.,Pfeilsticker, K., Koenig, M. von,Bremer, H., Kullmann, H., Schlager, H., Margitan, J.J., Stachnik, B., Toon, G.C., Jucks, K., Traub, W.A., Johnson, D.G., Murata, I., Fukunishi, H., Sasano, Y., Valdiation of ozone measurements from the Improved Limb Atmospheric Spectrometer (ILAS), J. Geophys. Res., Vol. 107, D24, 8212, doi:10.1029/2001JD000602, 2002.

3) Others
None

**9.Comments**
None

## 1. Title of ILAS-II validation experiment

# High-Latitude Balloon Flights of the FIRS-2 Spectrometer for ILAS-II Validation

## 2. Investigators

1) Principal Investigator
Name: **David G. Johnson**
Affiliation: National Aeronautics and Space Administration, Langley Research Center
Contact address: Hampton, Virginia, 23681, USA
Telephone number: +1+757-864-8580
Fax number: +1+757-864-8828
E-mail address: d.g.johnson@larc.nasa.gov

2) Co-Investigators
Name (role): Wesley A. Traub (Spectrometer and data reduction)
Affiliation: Smithsonian Astrophysical Observatory (SAO)
E-mail address: wtraub@cfa.harvard.edu

Name (role): Kelly V. Chance (Spectrometer and data reduction)
Affiliation: SAO
E-mail address: kchance@cfa.harvard.edu

Name (role): Kenneth Jucks(Spectrometer and data reduction)
Affiliation: SAO
E-mail address: kjucks@cfa.harvard.edu

Name (role): Kazuo Shibasaki (Planning and interfaces)
Affiliation: Kokugakuin University and NASDA/EORC
E-mail address: skazuo@kokugakuin.ac.jp

## 3. Target Species, profiles or column

1) Target Species for ILAS-II:
Standard items: $O_3$, $HNO_3$, $NO_2$, $N_2O$, $CH_4$, $H_2O$
Research Items: $ClONO_2$, $N_2O_5$, CFC-12, CFC-11, $C_2H_6$, OCS, temperature, pressure, $O_3$ (isotopes).

2) Other target Species:
OH, $HO_2$, $H_2O_2$, HCl, HOCl, $HNO_4$, HF, $CCl_4$, $CH_3Cl$, HCFC-22, $C_3H_6O$ (acetone), HCN, $SF_6$, $H_2O$ (isotopes).

## 4. Category of ILAS-II validation experiments

Cooperative experiment

## 5. Significance of the validation experiment for ILAS-II:

We plan to provide vertical profiles for all species listed in item 3 above with precision equal to or greater than that provided for ILAS in 1997. We are able to measure all standard items (except for visible aerosol extinction) and most of the research items provided by ILAS-II as well as many complementary species. By providing the ILAS-II team with measurements of the same species we provided for ILAS our measurements can serve as a transfer standard between ILAS and ILAS-II. In addition, because FIRS-2 measurements have been used to validate CLAES, HALOE, and MLS on UARS and have been compared with data from SAGE-II as well as other balloon-borne and aircraft-borne instruments, comparisons with FIRS-2 measurements provide a rich context for interpreting ILAS-II measurements.

## 6. Details of implementation plan for the experiment

1) Location: Lynn Lake, Canada (56.9N, 101.1W)

2) Instruments:
   (1) Name: Smithsonian Astrophysical Observatory Far-Infrared Spectrometer (FIRS-2)
   (2) Principle:
   FIRS-2 is a far-infrared Fourier-transform spectrometer that observes thermal emission from the Earth's limb in two wavelength bands: 80-330 $cm^{-1}$ and 330-1250 $cm^{-1}$. Vertical mixing ratio profiles are obtained by scanning the limb and inverting the observed slant columns. Temperature profiles and pointing corrections are derived from the 15 μm band of $CO_2$.

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

| Species | AR (km) | P / A | VR (km) | AT (hours) |
|---|---|---|---|---|
| Temperature | 12-35 | 1 K/1 K | 3-4 | ~2 for entire profile |
| OH | 12-35 | 1.5 ppt/4% | " | " |
| $HO_2$ | 12-35 | 5 ppt/2% | " | " |
| $H_2O_2$ | 12-35 | 10 ppt/4% | " | " |
| HCl | 12-35 | 70 ppt/3% | " | " |
| $ClONO_2$ | 12-35 | 10%(20 ppt)/10% | 3-4 | ~2 for entire profile |
| HOCl | 12-35 | 7 ppt/2% | " | " |
| $HNO_3$ | 12-35 | 150 ppt/10% | " | " |
| $HNO_4$ | 12-35 | 50 ppt/10% | " | " |
| $N_2O_5$ | 12-35 | 30%(50 ppt)/10% | " | " |
| $NO_2$ | 12-35 | 900 ppt/2% | " | " |
| $N_2O$ | 12-35 | 2%/3% | " | " |
| HF | 12-35 | 30 ppt/4% | " | " |
| $CCl_4$ | 12-35 | 7%(7 ppt)/10% | " | " |
| CFC-11 | 12-35 | 6%( 15 ppt)/10% | " | " |
| CFC-12 | 12-35 | 6%(30 ppt)/10% | " | " |
| $CH_3Cl$ | 12-35 | 50%(300 ppt)/10% | " | " |
| HCFC22 | 12-35 | 20%(20 ppt)/10% | " | " |
| OCS | 12-35 | 15%(70 ppt)/5% | " | " |
| $C_2H_6$ | 12-35 | 250 ppt/5% | " | " |
| $C_3H_6O$ | 12-35 | 150 ppt/50% | " | " |
| HCN | 12-35 | 80ppt/2% | " | " |
| $SF_6$ | 12-35 | 16%( 1ppt)/5% | " | " |
| $CH_4$ | 12-35 | 500 ppb/2% | " | " |
| $H_2O$ | 12-35 | 160 ppb/3% | " | " |
| $\delta D$ | 12-35 | 2%/4% | " | " |
| $\delta^{18}O$ | 12-35 | 4%/9% | " | " |
| $O_3$ | 12-35 | 3%(50 ppb)/3% | " | " |

NOTE: Accuracy here indicates systematic errors only, not the combination of random and systematic errors; in some cases the precision is listed both as a sensitivity limit and fractional error in the column.

4) Situation on facilities and equipment for the experiment:

The National Scientific Balloon Facility (NSBF) has held summer campaigns at Lynn Lake for the past 10 years, and if a summer campaign is approved for 2003 the launch facilities will be available.

5) Schedule for the experiment:

(1) Preparation: The arrangements with NSBF for launch services and with the Jet Propulsion Laboratory (for gondola support) will take place several months before the field campaign.

(2) Execution period of the measurements: July-August 2003 (TBD).

(3)Data submission:
Preliminary: within 6 months of the balloon flight.
Final: within 12 months of the flight.

6)Comments:
We are waiting to hear about the availability of NASA funding for this campaign. Should NASA be unable to fund our flight we will not be able to provide cooperative measurements this year.

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

1) ILAS-II data required for the analysis:
(1) Species or physical properties: Vertical profiles for the standard and research items listed in section 3.1 above.

(2) Date and Location:
a) Date: Coinciding with the date of the balloon flight from Lynn Lake.
b) Location: Within 500 km of Lynn Lake (56.9N, 101.1W).

2) Method of the analysis:
We will compare vertical profiles retrieved from FIRS-2 measurements with the nearest ILAS-II profiles. Profiles for diurnally-varying species (such as $NO_2$ and $ClONO_2$) will be adjusted as required using a photochemical model as we did for ILAS.

3) Submission date of the results:
(1) Preliminary: within 6 months of the balloon flight.
(2) Final: within 12 months of the balloon flight.

4) Comments:
None.

**8. Related Publications**

1) Instrument explanation


- Smithsonian Stratospheric Far-Infrared Spectrometer and Data Reduction System, D. G. Johnson, K. W. Jucks, W. A. Traub, and K. V. Chance, *Journal of Geophysical Research*, 100, 3091-3106, 1995.

2) Scientific results

- Stratospheric Hydroperoxyl Measurements, W. A. Traub, D. G. Johnson, and K. V. Chance, *Science*, 247, 446-449, 1990.
- Measurement of the Stratospheric Hydrogen Peroxide Concentration Profile Using Far Infrared Thermal Emission Spectroscopy, K. V. Chance, D. G. Johnson, W. A. Traub, and K. W. Jucks, *Geophysical Research Letters*, 18, 1003-1006, 1991.
- Detection of HBr and Upper Limit for HOBr: Bromine Partitioning in the Stratosphere, D. G. Johnson, W. A. Traub, K. V. Chance, and K. W. Jucks, *Geophysical Research Letters*, 22, 1373-1376, 1995.
- Simultaneous Measurements of Stratospheric $HO_X$, $NO_X$, and $Cl_X$: Comparison with a Photochemical Model, K. Chance, W. A. Traub, D. G. Johnson, K. W. Jucks, P. Ciarpallini, R. A. Stachnik, R. J. Salawitch, and H. A. Michelsen, *Journal of Geophysical Research*, 101, 9031-9043, 1996.
- Comparison of Correlative Data with $HNO_3$ Version 7 from the CLAES Instrument Deployed on the NASA Upper Atmosphere Research Satellite, J. B. Kumer, J. L. Mergenthaler, A. E. Roche, R. W. Nightingale, G. A. Ely, W. G. Uplinger, J. C. Gille, S. T. Massie, P. L. Bailey, M. R. Gunson, M. C. Abrams, G. C. Toon, B. Sen, J.-F. Blavier, R. A. Stachnik, C. R. Webster, R. D. May, D. G. Murcray, F. J. Murcray, A. Goldman, W. A. Traub, K. W. Jucks, and D. G. Johnson, *Journal of Geophysical Research*, 101, 9621-9656, 1996.
- Validation of $CH_4$ and $N_2O$ Measurements by the Cryogenic Limb Array Etalon Spectrometer Instrument on the Upper Atmosphere Research Satellite, A. E. Roche, J. B. Kumer, R. W. Nightingale, J. L. Mergenthaler, G. A. Ely, P. L. Bailey, S. T. Massie, J. C. Gille, D. P. Edwards, M. R. Gunson, M. C. Abrams, G. C. Toon, C. R. Webster, W. A. Traub, K. W. Jucks, D. G. Johnson, D. G. Murcray, F. J. Murcray, A. Goldman, and E. C. Zipf, *Journal of Geophysical Research*, 101, 9679-9710, 1996.
- Validation of Hydrogen Chloride Measurements made by the Halogen Occultation Experiment from the UARS Platform, James M. Russell III, Lance E. Deaver, Mingzhao Luo, Jae H. Park, Larry L. Gordley, Adrian F. Tuck, Geoffrey C. Toon, Michael R. Gunson, Wesley A. Traub, David G. Johnson, Kenneth W. Jucks, David G. Murcray, Rudolphe Zander, Ira G. Nolt, and Christopher R. Webster, *Journal of Geophysical Research*, 101, 10151-10162, 1996.
- Validation of Hydrogen Fluoride Measurements made by the Halogen Occultation Experiment from the UARS Platform, James M. Russell III, Lance E. Deaver, Mingzhao Luo, Ralph J. Cicerone, Jae H. Park, Larry L. Gordley, Geoffrey C. Toon, Michael R. Gunson, Wesley A. Traub, David G. Johnson, Kenneth W. Jucks, Rudolphe Zander, and Ira G. Nolt, *Journal of Geophysical Research*, 101, 10163-10174, 1996.
- Measurement of chlorine nitrate in the stratosphere using the [nu] 4 and [nu] 5 bands, D. G. Johnson, J. Orphal, G. C. Toon, K. V. Chance, W. A. Traub, K. W. Jucks, G. Guelachvili, and M. Morillon-Chapey, *Geophysical Research Letters*, 23, 1745-1748, 1996.

- Ozone production and loss rate measurements in the middle stratosphere, K. W. Jucks, D. G. Johnson, K. V. Chance, W. A. Traub, R. J. Salawitch, and R. A. Stachnik, *Journal of Geophysical Research*, 101, 28,785-28,792, 1996.
- Observations of of OH, $HO_2$, $H_2O$, and $O_3$ in the upper stratosphere: Implications for $HO_x$ photochemistry, K. W. Jucks, D. G. Johnson, K. V. Chance, W. A. Traub, J. J. Margitan, G. B. Osterman, R. J. Salawitch, and Y. Sasano, *Geophysical Research Letters*, 25, 3935-3938, 1998.
- Stratospheric age spectra derived from observations of water vapor and methane, D. G. Johnson, K. W. Jucks, W. A. Traub, K. V. Chance, G. C. Toon, J. M. Russell III, and M. P. McCormick, *Journal of Geophysical Research*, 104, 21,595-21,602, 1999.
- Nitric acid in the middle stratosphere as a function of altitude and aerosol loading, K. W. Jucks, D. G. Johnson, K. V. Chance, W. A. Traub, R. J. Salawitch, *Journal of Geophysical Research*, 104, 26,715-26,723, 1999.
- A comparison of Arctic $HNO_3$ profiles measured by the Improved Limb Atmospheric Sounder and balloon-borne sensors, M. Koike, Y. Kondo, H. Irie, F. J. Murcray, J. Williams, P. Fogal, R. Blatherwick, C. Camy-Peyret, S. Payan, H. Oelhaf, G. Wetzel, W. Traub, D. Johnson, K. Jucks, G. C. Toon, B. Sen, J.-F. Blavier, H. Schlager, H. Ziereis, N. Toriyama, M. Y. Danilin, J. M. Rodriguez, H. Kanzawa, and Y. Sasano, *Journal of Geophysical Research*, 105, 6761-6771, 2000.
- Isotopic composition of stratospheric ozone, D. G. Johnson, K. W. Jucks, W. A. Traub, K. V. Chance, *Journal of Geophysical Research*, 105, 9025-9031, 2000.
- Isotopic composition of stratospheric water vapor: Measurements and photochemistry, D. G. Johnson, K. W. Jucks, W. A. Traub, K. V. Chance, *Journal of Geophysical Research*, 106, 12,211-12,218, 2001.
- Isotopic composition of stratospheric water vapor: Implications for transport, D. G. Johnson, K. W. Jucks, W. A. Traub, K. V. Chance, *Journal of Geophysical Research*, 106, 12,219-12,226, 2001.

3) Others

None

**9. Comments**

None

## 1. Title of ILAS-II validation experiment

# Brewer Spectrophotometer observation of ozone in the ILAS-II Validation at King Sejong Station, Antarctica

## 2. Investigators

1) Principal Investigator

| | |
|---|---|
| Name: | **Jhoon Kim** |
| Affiliation: | Yonsei University |
| Contact address: | Rm. 545, Atmospheric Science Program, College of Science, 134 Sinchon-dong, Seodaemoon-gu, Seoul 120-749, Rep. of Korea |
| Telephone number: | +82-2-2123-5682 |
| Fax number: | +82-2-365-5163 |
| E-mail address: | jkim2@yonsei.ac.kr |

2) Co-Investigators

| | |
|---|---|
| Name (role): | Hiroshi Kanzawa |
| Affiliation: | Nagoya University |
| E-mail address: | kanzawa@ihas.nagoya-u.ac.jp |
| Name (role): | Bang Yong Lee (Instrument Operation Management) |
| Affiliation: | Korea Ocean R&D Institute |
| E-mail address: | bylee@kari.re.kr |

## 3. Target Species, profiles or column

1) Target Species for ILAS-II:

   O3, column mainly (profile observations are scheduled, but rare due to sky conditions)

2) Other target Species:

   n/a

## 4. Category of ILAS-II validation experiments

Cooperative experiment

## 5. Significance of the validation experiment for ILAS-II

The ozone profile is a key parameter of the ILAS-II measurement. The Brewer Spectrophotometer measurements provide the reliable total ozone amount which can serve as a part of the ILAS-II Validation Campaigns. At King Sejong Station, Antarctica, located near the boundary of polar vortex, the ozone observations are carried out on a daily basis, together with UV radiation measurements. As the Station is located near the northern boundary of ILAS-II's orbit coverage in the Southern Hemisphere, it will serve as one of the key stations for the ILAS-II validation.

## 6. Details of implementation plan for the experiment

1) Location:
   King Sejong Station, Antarctica (62 deg 13 min S., 58 deg 47 min W.)
2) Instruments:
   (1) Name:
   a) Brewer Spectrophotometer, Mk IV

   (2) Principle:
   O3 : The Brewer grating spectrophotometer is similar in its principle to the Dobson, where the ratios of the direct sunlight intensities are measured at two standard wavelengths or couple of pairs of wavelengths referred to as the AD pair (305.5-325.4, 317.6-339.8 nm). Its main principle is based on the differential absorption method in the ultraviolet Huggins band where ozone exhibits strong absorption features.

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

| Species | AR | A / P | VR | AT |
|---|---|---|---|---|
| O3 | (total) | 2%/2% | 10 km(Umkehr) | |

4) Situation on facilities and equipment for the experiment:
The facilities required for the Brewer Spectrophotometer measurements are equipped in King Sejong Station, and the daily measurement operation is provided by KORDI(Korea Ocean R&D Institute)..

5) Schedule for the experiment:
(1) Preparation:
As the daily observation schedules are performed except for the winter season due to lack of sunlight for the measurements, validation/comparison can be carried out any

time without prior notice. However, with prior notice by two-week advance would help the operation people to prepare for special care of the experiment.

(2) Execution period of the measurements:

a) Jan. – Feb. every year

As the ILAS-II orbit covers near 64 deg S. in January and February of the year, the comparison/validation can be carried out during the two months. Depending on the situation, December may be a reasonable time to perform the experiment.

(3) Data submission:

a) Preliminary: One week after the measurements
b) Final: A few weeks after the measurements

6) Comments:

With the UV radiation data at King Sejong Station, the effect of ozone amount change on the surface UV radiation can be evaluated simultaneously, which would add extra value to the ILAS-II measurements.

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

1) ILAS-II data required for the analysis:

(1) Species or physical properties:

Vertical profiles of O3 mixing ratio, temperature, and pressure

(2) Date and Location:

a) Date: December, January and February when the ILAS-II covers north of 70 S.

b) Location: King Sejong Station (62 D 13 M S., 58 D 47 M W.)

2) Method of the analysis:

Comparison between total ozone amounts from the Brewer Spectrophotometer data and the corresponding quantity from ILAS-II data. The ILAS-II data with climatological ozone values are combined for the comparison of total amounts. Umkehr measurements for the vertical profiles of ozone will be tried upon the clear sky conditions are met for several hours. Also, sounding rocket experiment for vertical profile measurement of ozone may be carried out at Antarctica depending on the financial approval from the Government. Then direct profile comparison can be carried out.

3) Submission date of the results:

(1) Preliminary: three months after measurements

Final: nine months after measurements

4) Comments:
None

## 8. Related Publications

1) Instrument explanation


- Kerr, J.B. and C.T. McElroy, Total ozone measurements made with Brewer Spectrophotometer during STOIC 1989, *J. Geophys. Res.*, 100, 9225-9230, 1995.
- Kerr, J.B., C.T. McElroy, and W.F. J. Evans, The automated Brewer spectrophotometer for measurement of $SO_2$, $O_3$, and aerosols, *paper presented at Symposium in Meteorological Observations and Instrumentation*, pp. 470-472, World Meteorol. Organ./Am. Meteorol. Soc./CMOS, Toronto, Ontario, Canada, 1983.


3) Scientific results


- Contributed to 'Chapter 4 Ozone Trend' in *Scientific Assessment of Ozone Depletion*(1998, UNEP/WMO).
- Kim, J., S.J. Lee, J.D. Lee, G.R. Cho, Y.I. Won, H.K. Cho, Measurement of middle atmospheric ozone density profile by rocket-borne radiometer onboard KSR-II, *Advances in Space Research*, 27, 2025, 2001.


4) Others


- Cho, H.K., S.K. Baek, J. Kim, Dependence of total ozone trends on natural oscillations, *manuscripts in preparation*, 2003.
- Seung-Hyun Hwang, Jhoon Kim, Seung-Hoon Lee, Soo-Jin, Lee, Jun-Kyu Kim, Hi Ku Cho, Young-Soon Jang, Young-Doo Chun, Jeong-Joo Park, Gwang-Rae Cho, and Young In Won, Application of Rocket-borne UV Radiometer onboard KSR-III to $O_3$ measurement, revised, *J. Kor. Phys Soc.*, 2003.
- Su Jeong Son, Yong Ha Kim, Jhoon Kim and Gwang Rae Cho, Rocket measurement of middle atmospheric ozone concentration profile by KSR-II, A.20, 1620-03, paper presented at IUGG, Birmingham, 1999.
- Kim, J., H.K. Cho, Y.I. Won, and Y.H. Kim, Mesospheric ozone density peak measured by the rocket-borne photometer, 34th COSPAR Scientific Assembly, Houston, Texas, U.S.A., October, 2002.
- Kim, J., C.J. Park, K.Y. Lee, D.H. Lee, Y.O. Kim, H.K. Cho, G.R. Cho, and J. H. Park, Rocket soundings of ozone profiles in the stratosphere over the Korean Peninsula, *J. Geophys. Res.*, 102, 16121, 1997.

## 9. Comments

None

## 1. Title of ILAS-II validation experiment

# Validation of ILAS-II data products from ground-based measurements at Kiruna, Lauder, Macquarie Island and Arrival Heights and through comparisons with satellite-based HIRDLS retrievals

## 2. Investigators

1) Principal Investigator

| | |
|---|---|
| Name: | **Andrew W. Matthews** |
| Affiliation: | National Institute of Water and Atmospheric Research (NIWA) |
| Contact address: | P.O.Box 14-901, Kilbirnie, Wellington, New Zealand |
| Telephone number: | + 64 – 4 – 386 - 0528 |
| E-mail address: | a.matthews@niwa.co.nz |

2) Co-Investigators

| | |
|---|---|
| Name (role): | G.E.Bodeker |
| Affiliation: | NIWA |
| E-mail address: | g.bodeker@niwa.co.nz |
| Name (role): | B.J.Conner |
| Affiliation: | NIWA |
| E-mail address: | b.connor@niwa.co.nz |
| Name (role): | R.G. Grainger |
| Affiliation: | University of Oxford |
| E-mail address: | r.grainger@physics.ox.ac.uk |
| Name (role): | P.V.Johnston |
| Affiliation: | NIWA |
| E-mail address: | b.johnston@niwa.co.nz |
| Name (role): | K. Kreher |
| Affiliation: | NIWA |
| E-mail address: | k.kreher@niwa.co.nz |
| Name (role): | J.B. Liley |
| Affiliation: | NIWA |
| E-mail address: | b.liley@niwa.co.nz |
| Name (role): | R.L. McKenzie |
| Affiliation: | NIWA |
| E-mail address: | r.mckenzie@niwa.co.nz |
| Name (role): | S.W. Wood |
| Affiliation: | NIWA |
| E-mail address: | s.wood@niwa.co.nz |

## 3. Target Species, profiles or column

1) Target Species for ILAS-II: Vertical profiles of O3 and Aerosol
   Total columns of $CH_4$, $N_2O$, $HNO_3$, $H_2O$, $NO_2$, $CO_2$ and $O_3$
2) Other target Species: ClO, BrO and OClO

## 4. Category of ILAS-II validation experiments

Cooperative experiment

## 5. Significance of the validation experiment for ILAS-II

## 6. Details of implementation plan for the experiment

1) Locations:
   a) Kiruna (67.88N, 21.06E)
   b) Arrival Heights (77.83S, 169.68E)
   c) Lauder (45.04S, 169.68E)
   d) Macquarie Island (54.5S, 159.0E)

2) Instruments:
   (1) Name:
   a) Kiruna (67.88N, 21.06E):
      - UV/visible spectrometer
   b) Arrival Heights (77.83S, 169.68E):
      - UV/visible spectrometer
      - FTIR interferometer
      - Dobson spectrophotometer
      - Microwave radiometer
   c) Lauder (45.04S, 169.68E):
      - UV/visible spectrometer
      - FTIR interferometer
      - ECC ozonsonde
      - Dobson spectrophotometer
      - UV lidar
      - Microwave radiometer
   d) Macquarie Island (54.5S, 159.0E):
      - UV/visible spectrometer

(2) Principle:

1. UV/Visible spectrometer

Grating spectrometers operating in the UV/visible wavelength regions will be used to make slant column measurements of $O_3$ and $NO_2$ at Kiruna, Lauder, Macquarie Island and Arrival Heights. A Monte Carlo radiative transfer model [Bodeker et al., 1996] will be used to convert these slant column measurements to vertical columns for direct comparison with those from ILAS-II. A vertical profile retrieval algorithm, based on the variation of slant column density with solar zenith angle (SZA), will be used to retrieve $NO_2$ profiles at Lauder, Arrival Heights and Kiruna [Preston et al., 1997]. In addition to the original UV/vis spectrometer operating at Arrival Heights, a second instrument, capable of making simultaneous off-axis field of view (FOV) spectral measurements, was installed at Arrival Heights during the early spring of 1998. A new retrieval algorithm based on the sequential estimation method of Rodgers [1976] will be developed to retrieve vertical profiles from the two resultant slant column time series. It is planned to use this system to retrieve vertical profiles of $O_3$, $NO_2$, BrO and OClO.

2. FTIR interferometer

High resolution Fourier transform infrared (FTIR) interferometers will be operated at Lauder and Arrival Heights to retrieve vertical profiles, partial columns and/or total columns of $O_3$, $CH_4$, $N_2O$, $HNO_3$ $H_2O$, $NO_2$, and $CO_2$. These instruments meet NDSC specifications for high resolution measurements in the infrared, allowing retrieval of height information of the absorbing gas from the observed shape of the pressure-broadened absorption lines. Profile retrievals from the FTIR will be typically at 8 km vertical resolution between the surface and 30 km. The techniques for doing this have been developed at NIWA and NASA Langley and are based on accurate spectroscopic line data, a complete description of the instrument lineshape, and an optimal estimation retrieval algorithm. These theoretical elements have been combined in a model to obtain profiles of $O_3$ [Pougatchev et al., 1996], HCl and $HNO_3$ [Connor et al., 1997], and CO and $C_2H_6$ [Rinsland et al., 1998].

3. Dobson spectrophotometer

Dobson spectrophotometers operated at Lauder (no. 72) and Arrival Heights (no. 17) will be used to measure total column $O_3$ using direct sun measurements and, for Lauder only, vertical $O_3$ profiles using the Umkehr technique.

4. Microwave radiometer

Microwave radiometers for $O_3$ (110 GHz), $H_2O$ (22 GHz) and ClO (278 GHz) form part of the NDSC framework. These instruments measure emission spectra of the respective gases, integrating over several hours to obtain both day and night-time data. The very high spectral resolution allows the emission lines of $O_3$ and water vapour to be studied in detail, and the vertical distribution of these species is obtained from the observed pressure broadening. An ozone microwave radiometer has been operated continuously at Lauder since its installation in November 1992. Profiles are measured between 20 and 70 km with a vertical resolution ranging from 3 to 8 km. Water vapour profiles are obtained between 35 and 80 km. A similar instrument operating year-round at Arrival Heights will be used to measure the vertical distribution of ClO from about 15 to 50 km from the emission line shape with a resolution of about 10 km. The technique is well established, with an extended history of measurements of ClO [Solomon et al., 1987; Emmons et al., 1995], $O_3$ [Connor et al., 1995] and other gases.

5. ECC ozonsonde

Ozonesonde flights have been made at Lauder from August 1986 to the present. Flights are made weekly from the beginning of the year to mid-August and then twice weekly for the remainder of the year. Primary measured parameters are $O_3$ partial pressure (mPa), sonde pump temperature (°C), air pressure (hPa), air temperature (°C), humidity (%), wind speed and wind direction. Measurements are made from the surface (370 m) to an average altitude of 31 km, typically at 10 m vertical resolution. Electrochemical Cell (ECC) ozonesondes have been used throughout this period although the cathode solution concentration was changed from 1% to 0.5% at the beginning of August 1996 [Boyd et al., 1998]. 1Z series ECC ozonesondes manufactured by the EN-SCI corporation will be flown weekly throughout the ILAS-II validation campaign to measure vertical $O_3$, temperature and pressure profiles.

6. UV lidar

The UV lidar from the RIVM, Bilthoven, The Netherlands, will provide night-time vertical profiles of $O_3$ (8 to 45 km), temperature (8 to 70 km) and aerosols (8 to 30 km). The instrument detects with Raman channels, allowing high quality ozone retrievals even under heavy aerosol loading of the stratosphere after major volcanic eruptions. The system has undergone thorough validation in a refereed, blind intercomparison campaign in 1995 [McDermid et al., 1998a; McDermid et al., 1998b]. Recent years show an average of over 100 nights of measurements per year. This lidar is presently the only instrument of its kind in the Southern Hemisphere with a year-round, quality assured monitoring program.

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

| Species/ Physical properties | AR | A/P | VR | AT |
|---|---|---|---|---|
| (UV/Vis interferometer) | | | | |
| $O_3$(columns) | | 3%(0.2molecules/cm2) | | |
| $NO_2$(columns) | | 3%(0.2molecules/cm2) | | |
| (FTIR) | | | | |
| $O_3$(columns) | 0-30km | | -8km | |
| $CH_4$(columns) | 0-30km | 1-10% | -8km | |
| $N_2O$(columns) | 0-30km | 1-10% | -8km | |
| $HNO_3$(columns) | 0-30km | 5-15% | -8km | |
| $H_2O$(columns) | | 2% | | |
| $NO_2$(columns) | | 5% | | |
| $CO_2$(columns) | | 1% | | |
| (Dobson spectrophotometer) | | | | |
| $O_3$(columns) | | 2% | | |
| (Microwave radiometer) | | | | |
| $O_3$(profiles) | 20-70km | 4-6% | 3-8km | |
| $H_2O$(profiles) | 35-80km | | | |
| (ECC Ozonesonde) | | | | |
| $O_3$(profiles) | 0-31km | 5-10% | 40m | |

| Physical properties | AR | A/P | VR | AT |
|---|---|---|---|---|
| (UV lidar) | | | | |
| $O_3$(profiles) | 8-35km | 2% | 300m | |
| | -40km | 5% | 300m | |
| | -50km | 40% | 300m | |
| Temperature(profiles) | 8-70km | | | |
| Aerosol(profiles) | 6-35km | 20% | | |

4) Situation on facilities and equipment for the experiment:

The ground-based validation measurements proposed here will be conducted primarily at Kiruna (67.88°N, 21.06°E) and Arrival Heights (77.83°S, 166.65°E) with ancillary measurements at Lauder (45.04°S, 169.68°E) and Macquarie Island (54.5°S,159.0°E) which will be mapped to ILAS-II measurement locations using techniques described in the 'Analysis Methodology' section below. These measurements will target all species measured by ILAS-II. The NIWA site at Lauder is the Southern Hemisphere midlatitude charter site for the Network for Detection of Stratospheric Change (NDSC), making available a wide range of instrumentation for measuring atmospheric trace gases. Arrival Heights, also an NDSC site, together with Lauder and Macquarie Island comprise a middle and high latitude Southern Hemisphere chain which will provide valuable data for ILAS-II validation in this data sparse region of the globe.

5) Schedule for the experiment:
   (1) Data submission:
      a) Preliminary: 6 months after the measurements
      b) Final: 12 months after the measurements

6) Comments:
   None

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

1) ILAS-II data required for the analysis:
Species or physical properties: Vertical profiles of $O_3$ and Aerosol,
Total columns of $CH_4$, $N_2O$, $HNO_3$, $H_2O$, $NO_2$, $CO_2$ and $O_3$

2) Method of the analysis:

Analysis methodology and algorithms used for the two primary measurement sites (Arrival Heights and Kiruna), whose locations are sampled directly by ILAS-II, measurement schedules will be adapted to coincide with ILAS-II tangent point overpasses. Spatial and temporal simultaneity criteria will be established to extract measurements suitable for ILAS-II validation from each time series. For measurements made at the secondary sites (Lauder and Macquarie Island) more advanced intercomparison techniques will be used to generate data suitable for ILAS-II validation. Isentropic, global potential vorticity (PV) fields, made available by the UKMO through the ILAS-II project, will be used to calculate the transformation from true latitude to equivalent latitude using the algorithm of Nash et al. [1996]. Together with zonal and meridional wind fields, these results can also be used to determine the existence, strength and location of the circumpolar vortex. For species with a long atmospheric lifetime at the isentropic level of interest, and whose distribution is sensitive to the existence and location of the vortex, such a mapping reduces the simultaneity criterion from three dimensions (latitude, longitude and time) to two (equivalent latitude and time). Therefore, during periods when the vortex exists in the hemisphere under study, satellite and ground-based measurements of appropriate species, occurring sufficiently close in time and equivalent latitude, can be intercompared.

Backtrajectory analyses can also be used to find data at Lauder and Macquarie Island suitable for ILAS-II validation. For chemically active species, these backtrajectories will be used together with a Lagrangian chemical box model, that has been developed at NIWA Lauder, to advect ILAS-II measurements to Lauder and Macquarie Island locations. Similar techniques will be used when comparing ILAS-II and HIRDLS aerosol profile measurements. Local variation in aerosol type and loading will be accounted for using temporal and spatial decorrelation techniques. Alternatively air parcels will be examined along Lagrangian trajectories which are multiply sampled by both instruments to determine instrument measurement variation.

Since measurements of ILAS-II target trace gases have been made at Arrival Heights and Kiruna for many years prior to the planned launch of ADEOS-II, not only will this validation programme contribute directly to ensuring the highest standard of ILAS-II data, it will also provide long-term climatologies of the species which can be used to understand the temporal context of the ILAS-II data. For example, if climatologies developed using ILAS-II data differ from those developed elsewhere (e.g. the UARS reference atmosphere project), data differ from those developed elsewhere (e.g. the UARS reference atmosphere project), investigation of long time series measured at Lauder, Kiruna and Arrival Heights can be used to investigate whether the ILAS-II measurement time period was anomalous in any sense.

Product utilization plan

For validation of ILAS-II level 2 data products using the ground-based measurements, the following iterative cycle will be implemented as each version of the data becomes available:

i) Retrieving the complete level 2 data base.
ii) Processing of the data base into a form suitable for intercomparison with the ground-based measurements (e.g. profile integration, equivalent latitude remapping, data selection according to simultaneity criteria),
iii) Reporting the results to the ILAS-II data processing team at NIES in the form of written reports data validation meeting attendance, and in the international refereed literature.
iv) New version of level 2 data is made available following improvements to the retrieval algorithm based on these and other validation studies.

Therefore, the complete ILAS-II level 2 data base will be required as each new version of the data becomes available. In addition, where necessary, certain level 1 data may be requested for purposes of intercomparison of ILAS-II and HIRDLS data.

3) Submission date of the results:

a) Preliminary: 12 months after the measurements
b) Final: 18 months after the measurements

4) Comments:

None

## 8. Related Publications

1) Instrument explanation


- Boyd, I.S.; Bodeker, G.E.; Connor, B.J.; Swart, D.P.J.; Brinksma, E.J. (1998). An assessment of ECC ozonesondes operated using 1% and 0.5% KI cathode solutions at Lauder, New Zealand. Geophysical Research Letters 25(13): 2409-2412.


2) Scientific results


- Bodeker, G.E.; Kreher, K.; Johnston, P.V. (1997). The calculation of airmass factors using a Monte Carlo model applied to OClO and BrO observations. In: Proceedings of the XVIII Quadrennial Ozone Symposium, pp. 473-476. Visconti, R.D.B.a.G. (ed.) Parco Scientifico e Technologico d'Abruzzio, L'Aquila, Italy.
- Connor, B.J.; Jones, N.B.; Wood, S.W.; Keys, J.G.; Rinsland, C.P.; Murcray, F.J. (1997). Retrieval of HCl and $HNO_3$ profiles from ground-based FTIR data using SFIT2. In: Proceedings of the XVIII Quadrennial Ozone Symposium, pp. 485-488. Visconti, R.D.B.a.G. (ed.) Parco Scientifico e Technologico d'Abruzzio, L'Aquila, Italy.
- Emmons, L.K.; Shindell, D.T.; Reeves, J.M.; de, R.L. (1995). Stratospheric ClO profiles from McMurdo Station, Antarctica, spring 1992. Journal of Geophysical Research 100(D2): 3049-3055.
- McDermid, I.S.; Bergwerff, J.B.; Bodeker, G.E.; Boyd, I.S.; Brinksma, E.J.; Connor, B.J.; Farmer, R.; Gross, M.R.; Kimvilakani, P.; Matthews, W.A.; McGee, T.J.; Ormel, F.T.; Parrish, A.; Singh, U.; Swart, D.P.J.; Tsou, J.J.; Wang, P.H.; Zawodny, J. (1998a). OPAL: Network for the detection of stratospheric change ozone profiler assessment at Lauder, New Zealand 1. blind intercomparison. Journal of Geophysical Research 103(D22): 28683-28692.
- McDermid, I.S.; Bergwerff, J.B.; Bodeker, G.E.; Boyd, I.S.; Brinksma, E.J.; Connor, B.J.; Farmer, R.; Gross, M.R.; Kimvilakani, P.; Matthews, W.A.; McGee, T.J.; Ormel, F.T.; Parrish, A.; Singh, U.; Swart, D.P.J.; Tsou, J.J. (1998b). OPAL: Network for the detection of stratospheric change ozone profiler assessment at Lauder, New Zealand 2. intercomparison of revised results. Journal of Geophysical Research 103(D22): 28693-28699.
- Nash, E.R.; Newman, P.A.; Rosenfield, J.E.; Schoeberl, M.R. (1996). An objective determination of the polar vortex using Ertel's potential vorticity. Journal of Geophysical Research 101(D5): 9471-9478.
- Pougatchev, N.S.; Connor, B.J.; Jones, N.B.; Rinsland, C.P. (1996). Validation of ozone profile retrievals from infrared ground-based solar spectra. Geophysical Research Letters 23(13): 1637-1640.
- Preston, K.E.; Jones, R.L.; Roscoe, H.K. (1997). Retrieval of $NO_2$ vertical profiles from ground-based UV-visible measurements: Method and validation. Journal of Geophysical Research 102D15: 19089-19097.
- Rinsland, C.P.; Jones, N.B.; Connor, B.J.; Logan, J.A.; Goldman, A.; Murcray, F.J.;

Stephen, T.M.; Pougatchev, N.S.; Zander, R.; Demoulin, P.; Mahieu, E. (1998). Northern and southern hemisphere ground-based infrared spectroscopic measurements of tropospheric carbon monoxide and ethane. Journal of Geophysical Research 103(D21): 28,197-28,218.

- Rodgers, C.D. (1976). Retrieval of atmospheric temperature and composition from remote measurements of thermal radiation. Reviews of Geophysics and Space Physics 14(4): 609-624.
- Solomon, P.M.; Connor, B.J.; de Zafra, R.L.; Parrish, A.; Barrett, J.; Jaramillo, M. (1987). High concentrations of chlorine monoxide at low altitude in the Antarctic spring stratosphere, II: secular variation. Nature 328: 411.

3) Others
   None

## 9. Comments

None

## 1. Title of ILAS-II validation experiment

# Correlative observations at Fairbanks, Alaska, with the ILAS-II satellite, sondes, and intensive ground-based experiments including FTIR, lidars and microwave radiometer

## 2. Investigators

1) Principal Investigator

| | |
|---|---|
| Name: | **Yasuhiro Murayama** |
| Affiliation: | Communications Research Laboratory |
| Contact address: | 4-2-1 Nukui-kita, Koganei, Tokyo 184-8795, JAPAN. |
| Telephone number: | +81-423-27-6685 |
| Fax number: | +81-423-27-6678 |
| E-mail address: | murayama@crl.go.jp |

2) Co-Investigators

| | |
|---|---|
| Name (role): | Kazuo Shibasaki (ozonesonde experiment) |
| Affiliation: | Kokugakuin Univ./NASDA-EORC |
| E-mail address: | skazuo@kokugakuin.ac.jp |
| Name (role): | Isao Murata (ozonesonde experiment/FTIR collaboration) |
| Affiliation: | Tohoku Univ. |
| E-mail address: | murata@pat.geophys.tohoku.ac.jp |
| Name (role): | Miho Yamamori (balloon sonde/coordination) |
| Affiliation: | CCSR/Univ. of Tokyo |
| E-mail address: | yamamori@ccsr.u-tokyo.ac.jp |
| Name (role): | Kohei Mizutani (lidar experiment) |
| Affiliation: | Communications Research Laboratory |
| E-mail address: | mizutani@crl.go.jp |
| Name (role): | Satoshi Ochiai (millimeter-wave radiometer experiment) |
| Affiliation: | Communications Research Laboratory |
| E-mail address: | ochiai@crl.go.jp |
| Name (role): | Yasuko Kasai (FTIR analysis) |
| Affiliation: | Communications Research Laboratory |
| E-mail address: | ykasai@crl.go.jp |

## 3. Target Species, profiles or column

1) Target Species for ILAS-II:
   Ozone, $N_2O$, $CH_4$, $ClONO_2$, etc.(profiles and column)
2) Other target Species:
   Aerosol profile, temperature profile

## 4. Category of ILAS-II validation experiments

Cooperative experiment

## 5. Significance of the validation experiment for ILAS-II

Fairbanks, Alaska (65N) is one of important sites for ILAS-II cooperative measurements. CRL's Alaska Project has been implementing various atmospheric observations at Poker Flat, developing close collaboration with Geophysical Institute of University of Alaska. FTIR, lidars, and millimeter-wave radiometer will provide vertical profiles of various minor constituents, aerosol, and temperature. Also ozonesonde and rawinsonde campaigns are under consideration for Fairbanks or Poker Flat, coordinated with the ground-based and ILAS-II observations.

## 6. Details of implementation plan for the experiment

1) Location:
Fairbanks and Poker Flat (40 km apart), Alaska (65N, 147W)

2) Instruments:
(1) Name:
a) FTIR
b) Rayleigh lidar
c) Multi-wave length lidar (aerosol lidar)
d) Millimeter-wave radiometer
e) Sonde (ozone and rawin)

(2) Principle:
a) FTIR is an high-resolution infrared spectrometer which receives solar infrared spectrum which is absorbed by various atmospheric trace gases.
b) Rayleigh lidar is to measure stratosphere/mesosphere temperature by receiving laser light emitted from the ground and scattered by atmosphere.
c) Aerosol lidar: Visible and infrared lights will be used to obtain information of aerosol. This instrument is also equipped with Raman channel for water vapor.
d) Millimeter-wave radiometer: Super high-frequency microwave radiometer with 2 Rx channels of 200GHz bands observes ozone emission lines mainly (also capable of ClO, $H_2O_2$, etc.) to deduce 20-70 km ozone mixing ratio every 10 minutes during day and night for all seasons.
e) Ozonesonde will be ECC sonde (maybe En-Sci, combined with GPS wind finding).

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

| Species | AR | A / P | VR | AT |
|---|---|---|---|---|
| (Millimeter-wave radiometer: day+night, all season) | | | | |
| $O_3$ | 20-70km | | 5-10 km | 10 min. |
| (FTIR; day time, Feb-Sep) | | | | |
| $O_3$ | 0-30 km | | ~5 km | ~10 min. |
| CO | 0-10 km | | ~5 km | ~10 min. |
| H2O | 0-10 km | | ~5 km | ~10 min. |
| $HNO_3$ | 0-35 km | | ~5 km | ~10 min. |
| N2O | 0-20 km | | ~5 km | ~10 min. |
| (Aerosol lidar) | | | | |
| aerosol | 0-30 km | | < 1km | ~minutes |
| (Rayleigh lidar) | | | | |
| temp. | 35-80 km | | <1km | ~0.5-1 hr |
| (Ozonesonde) | | | | |
| $O_3$ | 0-30 km | | <1km | |
| Temp. | 0-30 km | | <1km | |

4) Situation on facilities and equipment for the experiment:

Fairbanks (UAF campus) and Poker Flat will be used. Power, communication, and road access are no problem for those sites.

5) Schedule for the experiment:

(1) Preparation:

TBD

(2) Execution period of the measurements:

a) FTIR: FEB-SEP.
b) Sonde: May (TBD) and August or December (TBD)
c) Lidars and Radiometer: TBD.

(3) Data submission:

a) Preliminary: TBD. Available after initial check, in principle.
b) Final: TBD Available after initial check, in principle.

6) Comments:

None

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

1) ILAS-II data required for the analysis:
   (1) Species or physical properties:
   The same species as our ground-based observations. Temperature.
   (2) Date and Location:
      a) Date: Coincide with the Alaska experiments.

      b) Location: 65N, 147W.

2) Method of the analysis:
   TBD.

3) Submission date of the results:
   (1) Preliminary: TBD
   (2) Final: TBD

4) Comments:
   None

## 8. Related Publications

1) Instrument explanation

- Mizutani, K., T. Itabe, M. Yasui, Y. Murayama, and R. Collins, Rayleigh and Rayleigh Doppler lidars for the observations of the arctic middle atmosphere, IEICE Trans., E83-B, 2004--2009, 2000
- K. Mizutani, T. Itabe, M. Yasui, T. Aoki, S.Ishii, M. Sasano, Y. Murayama, and R. L. Collins, Lidar instruments for the observations of the arctic atmosphere in Alaska-project, Journal of the Communications Research Laboratory, no.2, vol.49, 2003.
- S. Ochiai, Development of millimeter-wave radiometers and stratospheric observation, Journal of the Communications Research Laboratory, no.2, vol.49, 2003.

2) Scientific results

- Y. Murayama, H. Mori, M. Ishii, M. Kubota, S-I. Oyama, M. Yamamoto, K. Seki, K. Mizutani, S. Ochiai, T. Kikuchi, K. Nozaki, K. Igarashi, H. Masuko, R. W. Smith, M. Conde, B. J. Watmins, R. L. Collins, H. C. Stenbaek-Nielsen, W. R. Simpson, V. Bedford, J. Harrison, F. Williams, and S-I. Akasofu, CRL Alaska Project - International collaborations for observing arctic atmosphere environment in Alaska -, Journal of the Communications Research Laboratory, no.2, vol.49, 2003.
- Kouji SEKI, Yasuko KASAI, Yasuhiro MURAYAMA, Kohei MIZUTANI, Toshikazu ITABE, Frank J. MURCRAY, William R. SIMPSON, and Steven A. LLOYD Trace

Gas Observation with Poker Flat FTIR, Journal of the Communications Research Laboratory, no.2, vol.49, 2003.

3) Others
None

## 9. Comments

None

## 1. Title of ILAS-II validation experiment

# Validation of ILAS-II data using constituent profiles determined from very high resolution ground based infrared solar spectra.

## 2. Investigators

1) Principal Investigator

Name: **Frank J. Murcray**
Affiliation: University of Denver
Contact address: 2112 E. Wesley Ave., Denver, CO 80208, USA
Telephone number: +01-303-871-3557
Fax number: +01-303-778-0406
E-mail address: fmurcray@du.edu

2) Co-Investigators

Name (role): Ronald D. Blatherwick (Data Analysis)
Affiliation: University of Denver
E-mail address: rblather@du.edu

Name (role): Pierre Fogal (Data Analysis)
Affiliation: University of Denver
E-mail address: pfogal@du.edu

## 3. Target Species, profiles or column

Target Species for ILAS-II:

Vertical mixing ratio profiles (and total column) of $CH_4$, $N_2O$, $HNO_3$, $O_3$, and $H_2O$.

## 4. Category of ILAS-II validation experiments

Cooperative experiment

## 5. Significance of the validation experiment for ILAS-II

Profiles of the stratospheric gases $O_3$ and $HNO_3$ can be used for direct validation of co-located ILAS-II measurements from the lower to mid stratosphere, while profiles of the predominately tropospheric gases $CH_4$ and $N_2O$ can be used for ILAS validation in the upper troposphere to lower stratosphere region. $H_2O$ profiles determined from ground based measurements will probably extend only from the surface to the mid troposphere, but should still be useful in checking the lower ILAS values, or as constraints to the ILAS inversions. In addition, our measurements should prove useful in extending the ILAS measurements down to the surface for these coincident events, providing useful science in these cases.

## 6. Details of implementation plan for the experiment

1) Location: Arrival Heights, Antarctica 77.85°S , 166.78°E (jointly operated with the New Zealand National Institute for Water and Air research (NIWA)), and Poker Flat, Alaska 65.12°N, 147.48°W, in cooperation with the Communication Research Laboratory

2) Instruments:
   (1) Name: Bruker 120M interferometer (Arrival Heights)
   Bruker 120 HR Interferometer (at Poker Flat)
   (2) Principle: Both instruments measure solar radiation transmitted through the earth's atmosphere at ~0.002 $cm^{-1}$ spectral resolution. Vertical mixing ratio profiles are deduced from the spectra using standard inversion codes (SFIT2, SEASCRAPE). These codes utilize the fact that the pressure broadened line width is a function of altitude.

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

| Species | AR | A / P | VR | AT |
|---|---|---|---|---|
| $O_3$ | 20-35 km | 15% / 10% | ~4 km | a few minutes |
| $HNO_3$ | 20-35 km | 15% / 10% | ~4 km | a few minutes |
| $CH_4$ | 0- 20 km | 10% / 10% | ~4 km | a few minutes |
| $N_2O$ | 0-20 km | 10% / 10% | ~4 km | a few minutes |
| $H_2O$ | 0-10 km | 15% / 10% | ~2 km | a few minutes |

4) Situation on facilities and equipment for the experiment:
   Both sites are in routine operation during the sun light months.

5) Schedule for the experiment:
   (1) Preparation:
   As indicated above, both of these sites are in routine operation, and DU personal have access to all of the data acquired at these sites. It will therefore be necessary only to select data from the sites which is in good temporal and spatial coincidence with ILAS-II overpasses to processes for the desired molecules.

   (2) Execution period of the measurements:
   High resolution spectra are obtained continuously, and these measurements are planned to continue. Therefore, these measurements can be used not only for initial validation, but for on going verification of the ILAS-II data.

   (3) Data submission:
   (a) Preliminary: A few weeks after the measurement.
   (b) Final: A few months after the measurement.

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

1) ILAS-II data required for the analysis:
   (1) Species or physical properties:
   $HNO_3$, $O_3$, $N_2O$, $CH_4$, and $H_2O$ vertical profiles for a number of coincidences.
   (2) Date and Location:
      a) Date: Several days in temporal coincidence with the ground FTIR data.
      b) Locations: Poker Flat, Alaska & Arrival Heights, Antarctica

2) Method of the analysis:
   Comparison of the ILAS-II profiles with those deduced from the inversion of the FTIR data for common altitudes; possibly also partial column amounts obtained by integrating VMR's over a common altitude interval.

3) Submission date of the results:
   1) Preliminary: Four months after measurement
   2) Final: Eight months after measurement.

## 8. Related Publications

1) Instrument explanation


- 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 Halogen Occultation Experiment Observations", *J. Geophys. Res.,* 101, 10,175-10,181, 1996.


2) Scientific results


- Roche, A.E., J.B. Kumer, R.W. Nightingale, J.L. Mergenthaler, G.A. Ely, P.L. Bailey, S.T. Massie, J.C. Gille, D.P. Edwards, M.R. Gunson, M.C. Abrams, G.C. Toon, C.R. Webster, W.A. Traub, K.W. Jucks, D.G. Johnson, D.G. Murcray, F.H. Murcray, A. Goldman and E.C. Zipf, "Validation of $CH_4$ and $N_2O$ Measurements by the Cryogenic Limb Array Etalon Spectrometer Instrument on the Upper Atmosphere Research Satellite", *J. Geophys. Res.,* 101, 9679-9710, 1996.
- Nakajima, H., X. Liu, I. Murata, Y. Kondo, Y. Zhao, F.J. Murcray and H. Nakane, "Retrievals of Vertical Profiles of Ozone by High-resolution FTIR Spectra over Rikubetsu, Japan", *J. Geophys. Res.*, 102, 29,981-29,990, 1997.
- Koike, M., Y. Kondo, H. Irie, F.J. Murcray, J. Williams, P. Fogal, R. Blatherwick, et al., "A Comparison of Arctic $HNO_3$ Profiles Measured by ILAS and Balloon-borne Sensors", *J. Geophys. Res.*, 105, 6761-6771, 2000.


3) Others
   None

## 1. Title of ILAS-II validation experiment

# Balloon-borne and airborne validation of ILAS II water vapour distribution in the lower stratosphere

## 2. Investigators

1) Principal Investigator

| | |
|---|---|
| Name: | **Cornelius Schiller** |
| Affiliation: | Forschungszentrum Jülich, ICG-I |
| Contact address: | 52425 Jülich, Germany |
| Telephone number: | +49-2461-615272 |
| Fax number: | +49-2461-615346 |
| E-mail address: | c.schiller@fz-juelich.de |

2) Co-Investigators

| | |
|---|---|
| Name (role): | Fred Stroh (PI of ClO/BrO instrument) |
| Affiliation: | Forschungszentrum Jülich, ICG-I |
| E-mail address: | f.stroh@fz-juelich.de |
| Name (role): | Andreas Engel (PI of cryosampler) |
| Affiliation: | University Frankfurt, Germany |
| E-mail address: | an.engel@meteor.uni-frankfurt.de |


## 3. Target Species, profiles or column

1) Target Species for ILAS-II:

$H_2O$ (and long-lived tracers such as $CH_4$, $N_2O$ etc)

2) Other target Species:

Halogen radicals

## 4. Category of ILAS-II validation experiments

Cooperative experiment

## 5. Significance of the validation experiment for ILAS-II

The balloon flights will provide data on the vertical distribution of $H_2O$. 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 ILAS II. In order to assess the validity of the satellite data such a direct intercomparison is therefore necessary at high latitudes. Since the balloon-borne hygrometer has been used in previous validation experiments (e.g. ILAS, HALOE, ENVISAT) it can be used as a transfer standard to these sensors.

Another measurement will be performed with the whole-air sampler on the same flight, and will provide data on the vertical distribution of CFCs, $N_2O$, $CO_2$, H2, and $CH_4$. The simultaneous measurement of the total hydrogen ($H_2O + 2 \times CH4$) 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:
   Balloon: Kiruna (06.03.03 and one during summer 2003)
   Aircraft (Geophysica): Kiruna (14 flights January-March 2003)

2) Instruments:
   (1) Name:
   a) FISH (Fast in-situ stratospheric hygrometer)
   b) Bonbon (balloon only)
   c) ClO/BrO monitor

   (2) Principle:
   a) Lyman-alpha fluorescence hygrometer
   b) whole air sampler
   c) chemical conversion resonance fluorescence

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

| Species | AR | A / P | VR | AT |
|---|---|---|---|---|
| $H_2O$ | 30 km | 5 % / <0.2 ppmv | <0.01 km | 1 - 3s |
| $CH_4$ | 30 km | 5 % / 5 % | approx. 1 km | 5 - 600 s |
| $H_2$ | 30 km | 5 % / 5 % | approx. 1 km | 5 - 600 s |
| $N_2O$ | 30 km | 5 % / 5 % | approx. 1 km | 5 - 600 s |

| Species | AR | A / P | VR | AT |
|---|---|---|---|---|
| $CO_2$ | 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 |

Aircraft measurements limited to maximum 20 km altitude

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

5) Schedule for the experiment:
(1) Preparation:
ready

(2) Execution period of the measurements:
a) Jan-March 03
b) June or August 03

(3) Data submission:
a) Preliminary:
b) Final: 3 months after campaign

6) Comments:

None

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

1) ILAS-II data required for the analysis:
  (1) Species or physical properties:

  $O_3$, $N_2O$, $CH_4$, $H_2O$, CFC-11, CFC-12, aerosol, temperature, pressure,

  (2) Date and Location:
    a) Date: March 03 (may even help if not coincident in time with our measurements) June or August 2003
    b) Location: Kiruna (68°N, 21°E)

2) Method of the analysis:

  Comparison between retrieved height profile and ILAS data (for $N_2O$, $H_2O$, $CH_4$, CFC-11, CFC-12)
  Budget determination of trace gas families Cly, NOy, hydrogen
  Trajectory studies (optional)

3) Submission date of the results:
  (1) Preliminary:
  (2) Final: 3 months after campaign

4) Comments:
  None

## 8. Related Publications

1) Instrument explanation

- M. Zöger, A. Afchine, N. Eicke, M.-T. Gerhards, E. Klein, D. S. McKenna, U. Mörschel, U. Schmidt, V. Tan, F. Tuitjer, T. Woyke, and C. Schiller Fast in situ stratospheric hygrometers: A new family of balloonborne and airborne Lyman-α photofragment fluorescence hygrometers J. Geophys. Res., 104, 1807-1816 (1999).

2) Scientific results

- H. Kanzawa, C. Schiller, J. Ovarlez, C. Camy-Peyret, P. Jesek, H. Oelhaf, M. Stowasser, W. A. Traub, K.W. Jucks, D.G. Johnson, G. C. Toon, B. Sen, J.-F. Blavier, J. Park, G.E. Bodeker, L.L. Pan, T. Sugita, H. Nakajima, T. Yokota, M. Suzuki, M. Shiotani, Y. Sasano Validation and data characteristics of water vapor profiles

observed by the Improved Limb Atmospheric Spectrometer (ILAS) and processed with Version 5.20 algorithm J. Geophys. Res., 107, D24, 8217, 2001JD000881 (2002).

- C. Schiller, R. Bauer, F. Cairo, T. Deshler, A. Dörnbrack, J. Elkins, A. Engel, H. Flentje, N. Larsen, I. Levin, M. Müller, S. Oltmans, H. Ovarlez, J. Ovarlez, J. Schreiner, F. Stroh, C. Voigt, H. Vömel Dehydration in the Arctic stratosphere during the THESEO2000 / SOLVE campaigns J. Geophys. Res., 107, SOL 36.1-9, (2002).
- D. Kley, J. Russell III, C. Phillips (eds.), A. Gettelman, J. Harries, P. Mote, S. Oltmans, E. Remsberg, K. Rosenlof, C. Schiller SPARC Assessment of Water Vapour in the Stratosphere and Upper Troposphere WCRP-113, WMO/TD No. 1043, SPARC Report No. 2, (2000).

3) Others
None

## 9. Comments

None

## 1. Title of ILAS-II validation experiment

# Correlative ozone and related profile measurements in Siberia for ILAS-II validation

## 2. Investigators

1) Principal Investigator

Name: **Vladimir Yushkov**
Affiliation: Central Aerological Observatory
Contact address: Pervomayskaya str.3, Moscow Region, Dolgoprudny, 141700 RUSSIA
Telephone number: +7(095) 408-6140
Fax number: +7(095)576-3327
E-mail address: vladimir@caomsk.mipt.ru

2) Co-Investigators

Name (role): Valery Dorokhov (measurements)
Affiliation: Central Aerological Observatory
E-mail address: vdor@caomsk.mipt.ru
Name (role): Alexander Lukyanov (data analyses)
Affiliation: Central Aerological Observatory
E-mail address: lukynov@caomsk.mipt.ru

## 3. Target Species, profiles or column

1) Target Species for ILAS-II:
   Vertical profile of $O_3$, Temperature, $H_2O$, Aerosol,
   Column ozone
2) Other target Species: none

## 4. Category of ILAS-II validation experiments

Cooperative experiment

## 5. Significance of the validation experiment for ILAS-II

The ozone profile is a key parameter of the ILAS-II measurements. Two stations (Salekhard and Yakutsk) will be involved in validation experiment.

Yakutsk station (62N,130E) is located in area of eastern Siberia climatic ozone maximum region where column ozone values in winter-spring periods reach 500-550 D.U. It provides the calibration procedure of the ILAS-II instrument at large ozone optical depth.

Salekhard station (67N,67E) is located in polar region in western Siberia. And in contrast with Yakutsk small column ozone values inside the polar vortex can be validated with ILAS-II measurements.

## 6. Details of implementation plan for the experiment

1) Location: Yakutsk, eastern Siberia, Russia (62N,130E)
   Salekhard, western Siberia, Russia (67N, 67E)

2) Instruments:
   (1) Name:
   a) ECC ozonesonde (ECC)
   b) backscatter sonde (BKS)
   c) fluorescent hygrometer (FLASH-B)
   d) column ozone (Brewer #045)
   (2) Principle:

**Ozone**: Ozonesonde measurements are made with Electrochemical Concentration Cell (ECC) ozonesonde and a 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 measurements. Variability between sensors is claimed to be 1.2-4.5%

**Pressure:** Capacitive aneroid sensor with measurements range of 1060 to 3 hPa (Resolution: 0.1 Hpa) and with accuracy (standard deviation) of ± 0.5 hPa

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

**Aerosol backscatter profile:** Aerosol backscatter profiles are obtained from ground level to 27-30 km. In the backscatter sonde two photometers operating at 940 nm and 490 nm are used to detect locally backscattered light from a collimated xenon flash lamp beam. The flash is triggered at 7 s intervals. The light intensity measured with the photometers is normalized by the pure molecular scattering signal (Ralay scattering), which is determined by calibration against a standard instrument similar to the backscatter sonde but which is different in that it can be calibrated in chamber flushed with aerosol-free air. The data product achieved in this way is the backscatter ratio (BSR). The BSR is closed to unity in clean atmosphere condition and may be more than 2 magnitudes greater in strong PSCs.

**Water vapor**: FLASH-B operates by photo dissociation of H2O molecules at Lyman alpha followed by the measurement of the fluorescence of excited OH. The Lyman-alpha source of VUV radiation is a hydrogen discharge lamp. The detector of OH fluorescence at 308 nm is a photo-multiplier run in photon counting mode. The intensity of the fluorescent light as well as the instrument readings is directly proportional to the water vapor mixing ratio under stratospheric conditions ( Pressure > 10 hPa) with negligible oxygen absorption. The pump generally used in such applications for reducing the perturbation of out gassing from the gondola has been removed by using an open layout where the optics is looking directly into the outside. This co-axial optical layout allows reducing the size of the instrument to a single cylinder of 120 mm diameter x 230 mm, for a total weight of 0.5 kg. However, this arrangement is suitable for nighttime measurements only at SZA > 98

**Column ozone**: Brewer spectrophotometer #045 (at Yakutsk station)

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

| Species | AR | A / P | VR | AT |
|---|---|---|---|---|
| $O_3$ | 0-30km | 5%/5% | a few hundred meters | few ten seconds |
| Temperature | 0-30 km | 1K/1K | a few hundred meters | few ten seconds |
| Aerosol | | | | |
| -Backscatter | 0-30 km | 5%/10% | 30 m | few second |
| -Ratio | | | | |
| Water vapor | 8-30 | 0.2 ppmv/7% | 20m | few second |

4) Situation on facilities and equipment for the experiment:

The facilities required for the ozonesonde measurements and total ozone observation are equipped in Yakutsk and Salekhard, and Central Aerological Observatory provides the measurement operation

5) Schedule for the experiment:

(1) Preparation:

The arrangements with Yakutsk and Salekhard will be required a few months before the campaign

(2) Execution period of the measurements:

a) March-May 2003
b) August 2003 (TBD)
c) January-February 2004, 2005 (TBD)

Ozonesonde flights and balloon campaign will be carried out on nearly two times per week during the nearest ADEOS-2 overpass as done in the ILAS validation in Yakutsk and Salekhard in 1997

(3) Data submission:

a) Preliminary: A few days after the measurements
b) Final: A few weeks after the measurements

6) Comments:

None

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

1) ILAS-II data required for the analysis:

(1) Species or physical properties:

Vertical profiles of $O_3$, $H_2O$ mixing ratio, aerosol extinction coefficient and temperature

(2) Date and Location:

a) Date: Coinciding with ozonesonde flights from Yakutsk and Salekhard

b) Location: Yakutsk (62N,130E) within a range of 500 km
Salekhard (67N,67E) within a range of 500 km

2) Method of the analysis:

Comparison between vertical profiles from the in situ ozonesonde, backscatter sonde and hygrometer data and the corresponding ILAS-II data. The in situ data will be averaged to match the vertical resolution of the IIAS-II data. Trajectory model will be used for comparison satellite and ozonesonde data.

3) Submission date of the results:

(1) Preliminary: Three months after the measurement
(2) Final: Nine months 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.
- Rosen, J.M., and N.T.Kjome (1991) The Backscattersonde: a new instrument for atmospheric aerosol research, *Appl. Opts., 30,* 1552-1561.
- Komhyr W.D., Barnes R.A., Brothers G.B., Lathrop J.A., Opperman D.P., Electrochemical concentration cell ozonesonde performance evaluation during STOIC 1989, (1995) *J. Geophys. Res., 100,* 9231-9244.
- Yushkov V., et al., (200) A Lyman alpha hygrometer for long duration IR Montgolfier during the THESEO Lagrangian Experiment, *Proc. 5$^{th}$ European Ozone Workshop,* EC Air Pollution Report 73, 400-403 .


2) Scientific results


- Knudsen B.M., Larsen N., Mikkelsen I.S., Morcrette J.-J., Braathen G.O., Kyro E., Fast H., Gernandt H., Kanzawa H., Nakane H., Dorokhov V., Yushkov V., Hansen G., Gil M., and Shearman R.J. (1998): Ozone depletion inside at the edge of, and outside the Arctic polar vortex in February and March 1997. Geophys.Res.Lett., 25,No.5, 627-630.

- Schulz, A., Rex, M., Harris, N. R. P., Braathen, G. O., Reimer, E., Alfier, R., Kilbane-Dawe, I., Eckermann, S., Allaart, M., Alpers, M., Bojkov, B., Cisneros, J., Claude, H., Cuevas, E., Davies, J., De Backer, H., Dier, H., Dorokhov, V., Fast, H., Godin, S., Johnson, B., Kois, B., Kondo, Y., Kosmidis, E., Kyrö, E., Litynska, Z., Mikkelsen, I. S., Molyneux, M. J., Murphy, G., Nagai, T., Nakane, H., O'Connor, F., Parrondo, C., Schmidlin, F. J., Skrivankova, P., Varotsos, C., Vialle, C., Viatte, P., Yushkov, V., Zerefos, C., von der Gathen, P.(2001): Arctic ozone loss in threshold conditions: Match observations in 1997/1998 and 1998/1999, *J. Geophys. Res., 106*, 7,495-7,503.
- Suortti, T., Karhu, J., Kivi, R., Kyrö, E., Rosen, J., Kjome, N., Larsen, N., Neuber, R., Khattatov, V., Rudakov, V., Yushkov, V. and Nakane, H. (2001): Evolution of the Artic stratospheric aerosol mixing ratio measured with balloon-borne aerosol backscatter sondes for years 1988-2000., *J. Geophys. Res, 106,* 20759-20766.
- Schulz, A., Rex, M., Steger, J., Harris, N., Braathen, G.O., Reimer, E., Alfier, R., Beck, A., Alpers, M., Cisneros, J., Claude, H., De Backer, H., Dier, H., Dorokhov, V., Fast, H., Godin, S., Hansen, G., Kondo, Y., Kosmidis, E., Kyro, E., Molyneux, M.J., Murphy, G., Nakane, H., Parrondo, C., Ravagnani, F., Varostos,C., Vialle, C., Yushkov, V., Zerefos, C., Von Der Gathen, P.(2000) : Match observation in the Artic winter 1996/97 : High stratospheric ozone loss rates correlate with low temperatures deep inside the polar vortex, *Geophys. Res. Let., 27*, 205-208 .
- Rex, M., P. von der Gathen, G. O. Braathen, N. R. P. Harris, E. Reimer, A. Beck, R. Alfier, R. KrM-|ger-Carstensen, M. Chipperfield, H. De Backer, D. Balis, F. O'Connor, H. Dier, V. Dorokhov, H. Fast, A. Gamma, M. Gil, E. KyrM-v, Z. Litynska, I. S. Mikkelsen, M. Molyneux, G. Murphy, S. J. Reid, M. Rummukainen, and C. Zerefos. (1999): Chemical ozone loss in the Arctic winter 1994/95 as determined by the Match technique, *J. Atmos. Chem., 32,* 35-59 .
- Rex, M., P. von der Gathen, N. R. P. Harris, D. Lucic, B. M. Knudsen, G. O. Braathen, S. J. Reid, H. De Backer, H. Claude, R. Fabian, H. Fast, M. Gil, E. KyrM-v, I. S. Mikkelsen, M. Rummukainen, H. G. Smit, J. StM-dhelin, C. Varotsos, I. Zaitcev.(1998): In-situ measurements of stratospheric ozone depletion rates in the Arctic winter 1991/92: a Lagrangian approach, *J. Geophys. Res., 103,* 5843-5853 .
- Rex, M., N. R. P. Harris, P. von der Gathen, R. Lehmann, G. O. Braathen, E. Reimer, A. Beck, M. P. Chipperfield, R. Alfier, M. Allaart, F. O'Connor, H. Dier, V. Dorokhov, H. Fast, M. Gil, E. Kyro, Z. Litynska, I. S. Mikkelsen, M. G. Molyneux, H. Nakane, J. Notholt, M. Rummukainen, P. Viatte, J. Wenger.(1997): Prolonged stratospheric ozone loss in the 1995/96 Arctic winter, *Nature, 389,* 835-838.
- Sugita T., T.Yokota, H.Nakajima, H.Kanzawa, H.Nakane, H.Gernandt, V.Yushkov, K.Shibasaki, T.Deshler, Y.Kondo, S.Godin, F.Goutail, J-P.Pommereau, C.Camy-Peret, S.Payan, P.Jeseck, J.-B.Renard, H.Bosch, R. Fitzenberger, K. Pfeildticker, M.von Konig, H.Bremer, H.Kullmann, H.Schlager, J.J.Margitan, B.Stachnik, G.C.Toon, K.Jucks, W.A.Traub, D.G. Johnson, I.Murata, H.Fukunishi, and Y, Sasano. (2002): Validation of ozone measurements from the Improved Limb Atmospheric Spectrometer (ILAS) (2002), J.Geophys.Res.107, D24, 10.1029/2001 JD000602

3) Others
   None

## 9. Comments

The proposed correlative measurements will be conducted in March-May 2003 under the ISTC Project #1619 "Survey of ozone in Eastern Siberia. Instrument development and observations" funded by Japan and US. This project will be completed in May 2003.

The proposed correlative measurement plan for 2003-2005 can be realized in case of extension of the ISTC Project #1619 for the next 2 years (June 2003- May 2005) or in case of Japanese financial support for satellite validation activity.

# APPENDIX B

# Memorandum of Understanding for Participating in the ILAS-II Project (MOU on ILAS-II)

# Memorandum of Understanding
# for Participating in the ILAS-II Project

Contents

## 1. Introduction

This Memorandum of Understanding (MOU) describes the conditions for researchers to participate in the ILAS-II (Improved Limb Atmospheric Spectrometer-II) Project and the data exchange and distribution policy which applies to the participating researchers. The aims of defining the data policy are:

1) to carry out rapid and appropriate verification of ILAS-II products,

2) to encourage research that uses ILAS-II products, and

3) to give all researchers participating in the ILAS-II Project and registered in the same categories equal opportunity to access the data.

This Memorandum prescribes the principal terms and conditions. For items not provided for in this Memorandum, the Project Leader will have overall responsibility for the fair treatment of matters in accordance with the aims described above.

## 2. Rights and Responsibilities

2.1 Category of Participating Researcher

The participating researchers are categorized as:

a) Project Leader and Project Staff,

b) ILAS-II Science Team members, i.e. Principal Investigators (PIs) selected through Joint Research Announcement (JRA), and

c) ILAS-II Validation Experiment Team members.

The membership for each category is shown in Attachment 2, the list in which is subject to change by addition of new participating scientists, selected by the ILAS-II Project, or by deletion thereof when so requested. The new list will be distributed to all members.

All researchers whose names are included in the membership list (Attachment 2) must sign the form (Attachment 1) stating that they understand and will abide by the following conditions for participation, as well as on behalf of their co-workers if any. The signed form should be sent to the ILAS-II Project Leader.

Researchers who wish to become newly involved in the ILAS-II project must submit their research proposal to the Project Leader for approval.

2.2 Project Leader and Project Staff

The Project Leader has overall responsibility for promoting the project in order to produce scientifically valid ILAS-II data. Project Staff work for the Project Leader under his or her direction. Project Staff are allowed to access all data generated in the Project.

2.3 ILAS-II Science Team members

The ILAS-II Science Team Leader, designated by the Project Leader, has overall responsibility for running the Science Team and coordinating research activities by its members.

All Science Team members will carry out their research according to a research plan submitted and agreed in advance.

The information on ILAS-II, the ILAS-II data and the data of the ILAS-II Correlative Measurement Data Base (ILAS-II-CMDB: defined below) will be provided to the members according to their research plans. They are also allowed to utilize the software and computer resources developed by the project.

All members are expected to attend ILAS-II Science Team meetings and are requested to publish their scientific achievements in appropriate scientific journals. The members participating in validation experiments are requested to be members of the Validation Experiment Team, too. Those who have their own data relevant to sciences using ILAS-II data are strongly requested to provide the data to ILAS-II-CMDB.

2. 4 ILAS-II Validation Experiment Team members

The ILAS-II 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 data obtained in those core validation experiments that are funded fully or partially by the project must be provided to the ILAS-II-CMDB according to the protocol for exchanging correlative measurement data (see section 4). Participants in cooperative experiments are strongly requested to submit their data to the ILAS-II Data Manager according to the protocol.

All members are provided with ILAS-II data for the period of their experiments described in their plans. Those whose data are registered in the ILAS-II-CMDB are permitted to access other data in the ILAS-II-CMDB.

All members are requested to carry out validation analysis in cooperation with the Science Team members who are in charge of validation data analysis. All members or their representatives are requested to attend Validation Experiment Team meetings. All members are also requested to publish their scientific achievements in appropriate scientific journals.

## 3. Data Provision

3.1 Data Category

Processed data of ILAS-II will be verified through validation analysis and trend analysis. According to the stage of verification, the processed data will be defined as unverified (U) or verified (V). When the validation analysis is completed and evaluated by using the core and cooperative validation experiment data as well as routine meteorological data, all the data which the ILAS-II instrument generates will be registered as "Verified". After that, the verified data will be checked twice for the specified season to confirm the consistency of the data and algorithm. Processed data of ILAS-II will be managed by the ILAS-II Data Manager who is designated by the Project Leader.

The provision of data depends on the categories to which researchers belong and the purposes of their respective research (algorithm studies, validation analysis, and scientific application; see Table 1).

Table 1. Data Provision by Researcher Category and Research Purposes

| (Purpose) (Category) | Algorithm Studies | Validation Analysis | Scientific Application |
|---|---|---|---|
| Project Staff | U, V | U, V | U, V |
| Science Team members | U, V | U, V | U, V |
| Validation Experiment Team members | N/A | U, V (only for the experiment period) | N/A |

(Note: U: Unverified; V: Verified; N/A: not applicable)

3.2 Schedule of Data Provision

Provision of unverified and verified data to researchers will start in July 2003 or December 2003, respectively. Unverified data will be distributed 3 months after data acquisition, and verified data will be distributed 8 months after data acquisition. It takes at least one year after data acquisition for the data to be opened to the public due to the process of performance characterization.

The times described here are not fixed but may be changed due to actual operating conditions. The changes will be notified to all members concerned. The schedule of data provision is summarized in Table 2.

Table 2. Start Time and Schedule of Data Provision

| | | |
|---|---|---|
| Unverified data provision | July 2003 | 3 months after data acquisition |
| Verified data provision | December 2003 | 8 months after data acquisition |
| Open to the public (Standard products only) | April 2004 | 1 year after data acquisition |

3.3 Amendment of Research and Experiment Plan

Should the supplied ILAS-II data need to be transferred to a third party who is not included as a research associate in the original research or experiment plan, either the Science Team member or the Validation Experiment Team member must submit an amendment of the plan to the Project Leader or the Validation Experiment Team Leader, respectively, for approval.

## 4. Protocol for Correlative Measurement and 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-II researchers, to uphold the rights of the individual researchers, and to ensure that all researchers involved are treated equitably.

### 4.1 ILAS-II-CMDB

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

Data providers should 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-II-CMDB.

Project Staff are able to access all the data in the ILAS-II-CMDB and use them for their research.

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

All Science Team members will be allowed to access the ILAS-II-CMDB for their sciences 12 months after the first registration of the data.

Validation Experiment Team members whose data are registered to ILAS-II-CMDB can access all other data during the validation experiment period in the ILAS-II-CMDB.

### 4.2 Core Validation Experiment Data

Preliminary data obtained through the core validation experiments should be submitted to the ILAS-II Data Manager at the latest 6 months after the experiment. Any corrections or amendments to the preliminary data should be submitted to the Data Manager at the latest 12 months after the experiment. When a data provider is considering making a complete 1-year dataset, data submission is requested within 15 months after the experiment. It is the data providers' responsibility to provide the best data available at the said time with sufficient error information. The data obtained through the Core Validation Experiments can be distributed to a third party with the written consent between the data provider and the ILAS-II Project Leader.

### 4.3 Cooperative Validation Experiment Data

Preliminary data obtained through the cooperative validation experiments should be submitted to the ILAS-II Data Manager as soon as possible as described in the individual experiment plan. Any corrections or amendments to the preliminary data should be submitted to the Data Manager as soon as possible. When a data provider is considering making a complete 1-year dataset, data submission is requested within 15 months after the experiment. It is the data providers' responsibility to provide the best data available at the said time with sufficient error information.

Data providers are encouraged to submit their data to the Data Manager for registration to ILAS-II-CMDB. When the data are registered, the data providers are permitted to access other data.

4.4 Meteorological Data of Met Office, UK

The Met Office Stratospheric Analysis data and access software are supplied to the ILAS-II Project for research, in accordance with the Met Office Standard Terms & Conditions, ref. SFC00. The Met Office grants to the ILAS-II Project Staff, Science Team members and Validation Experiment Team members a non-exclusive license to use, adapt, and modify those data and software. Commercial exploitation, business use, resale, or transfer to any third party is not permitted without the written consent of the Met Office. The Met Office retains the intellectual property rights on the data and software.

No liability is accepted by the 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 Met Office data and software shall run from the date of signature of this agreement until the conclusion of the ILAS-II project (as designated by the Project Leader). The Met Office reserves the right to terminate this license without notice if the licensee is in breach of the conditions stated here.

## 5. Publication Protocol

5.1 Publications

All research results obtained by using ILAS-II data are expected to be published in appropriate scientific journals.

At least one of the Project Staff should be a co-author of publications of research results obtained by using the ILAS-II Unverified and/or Verified (not yet opened to the public) data. The paper will be sent to all co-authors for review and comments in advance of submission.

Research results obtained by using core and/or cooperative validation experiment data may not be published without the written consent of the data provider.

All publications using the ILAS-II data must acknowledge that the data used were obtained with the Improved Limb Atmospheric Spectrometer (ILAS-II) developed by the Ministry of the Environment of Japan (MOE) and on board the ADEOS-II launched by the National Space Development Agency of Japan (NASDA), and that the data were processed at the ILAS-II Data Handling Facility, National Institute for Environmental Studies (NIES).

A reprint of the paper must be sent to the Project Leader (ILAS-II Project Leader, NIES, Tsukuba, Ibaraki, 305-8506 Japan).

5.2 Public Relations

Although public relations such as press releases, public lectures, etc. by the participants is encouraged, information to be conveyed must be as accurate as possible.

5.3 Validity Period

This publication protocol shall remain in force until the Project Leader announces the end of the ILAS-II Project.

Prepared by:

Yasuhiro Sasano
ILAS-II Project Leader

Attachment 1: **Form for signature**

The undersigned understands the spirit of this memorandum (Memorandum of Understanding for Participating in the ILAS-II Project) and agrees to the conditions described herein.

Name (print):

Official title:

Affiliation:

Status:

(Check the appropriate item(s) below)

- ☐ Project Staff
- ☐ ILAS-II Science Team member
- ☐ ILAS-II Validation Experiment Team member

Date:

Signature:

Attachment 2: **Membership of the ILAS-II project**

**[ILAS-II Project Staff]**

(Project Leader)
Yasuhiro Sasano

(Project Sub-leader)
Hirokazu Kobayashi

(Staff Scientists)
Hideaki Nakajima
Hiroshi Kanzawa
Tatsuya Yokota
Takafumi Sugita
Hitoshi Irie
Mitsumu Ejiri
Yukio Terao
Naoko Saitoh

**[ILAS-II Science Team]**

(Science Team Leader)
Hideaki Nakajima

(Regular Members with Validation Task)
Thomas Blumenstock
Claude Camy-Peyret
Andreas Engel
Hartwig Gernandt
David G. Johnson
Yutaka Kondo
Kwang-Mog Lee
Franck Lefevre
W. A. Matthews
Yasuhiro Murayama
Frank J. Murcray
Hideaki Nakane
Jae H. Park
C. E. Randall
Cornelius Schiller
Geoffrey Toon
Gerald Wetzel

(Regular Members)
G. E. Bodeker

Derek M. Cunnold
Michael Y. Danilin
Annmarie Eldering
Masashi Fukabori
Sachiko Hayashida
Thomas P. Kurosu
Steven T. Massie
Yutaka Matsumi
Liwen Pan
Kaoru Sato
Masato Shiotani
J. J. Sloan
Larry W. Thomason

**[ILAS-II Validation Experiment Team]**

(Validation Experiment Team Leader)
Hiroshi Kanzawa

(Core Validation Experiment Members)
Claude Camy-Peyret
Terry Deshler
Andreas Engel
Masahiko Hayashi
Yutaka Kondo
Frank J. Murcray
Takakiyo Nakazawa
Makoto Suzuki
Geoffrey Toon
Gerald Wetzel

(Cooperative Validation Experiment Members)
Thomas Blumenstock
Hartwig Gernandt
David G. Johnson
W. Andrew Matthews
Yasuhiro Murayama
Cornelius Schiller
Vladimir V. Yushkov

As of February 2003.
The membership may be changed with the written consent of members or possible members and the Project Leader.

# APPENDIX C

# ILAS-II Correlative Measurement Data Registration Manual

# ILAS-II Correlative Measurement Data Registration Manual
(Version 1.1)

September, 2003

# Contents

## 1. Introduction

Researchers who have conducted validation experiments or other correlative measurements necessary for validating ILAS-II retrieved parameters are asked to provide their data (correlative measurement data: CMD) to the ILAS-II database as prescribed in the Memorandum of Understanding for Participating in the ILAS-II Project (MOU on ILAS-II). In principle, the provided CMD shall be examined by the Evaluation Committee, registered in the CMD database (CMDB), and used by the participants of the ILAS-II Project for validation analysis and other scientific studies under the conditions given in the MOU.

Note: The ILAS-II CMDB is wholly independent of the ILAS CMDB.

This manual describes in the detail the procedures for sending ILAS-II CMDs. For their registration to the ILAS-II CMDB, an enormous volume of diverse ILAS-II CMDs must be handled prudently, efficiently and consistently, so that they may be ready to be released for validation analysis and scientific research as soon as possible. Thus, although the procedures for registration may be somewhat complicated and time-consuming, we ask for your understanding and cooperation.

Note: The CMDs that have been registered into the ILAS-II CMDB may be made open to the public for general scientific usage, at the same time as the ILAS-II Level 2 Data Standard products are provided in general users. We ask for your understanding and cooperation.

## 2. How to Provide and Register Correlative Measurement Data into the ILAS-II CMD Database

This chapter describes methods for providing and registering ILAS-II correlative measurement data (ILAS-II CMD) into the ILAS-II Correlative Measurement Database (ILAS-II CMDB), which is managed by the ILAS-II Data Handling Facility (ILAS-II DHF).

### 2.1 Terminology

| | |
|---|---|
| Provider: | The person who provides and registers the CMD. |
| Readme File: | The document file that gives information on a "CMD File" (name of the Principal Investigator (PI), items of data provided, measurement instrument, data file format, etc.). It is attached to the CMD Sending Mail. The format is detailed later. |
| CMD File: | The data file of the Correlative Measurement Data. |
| CMD Sending Mail: | The e-mail that the CMD provider sends to the DHF when the data provider provides and registers his CMD into the ILAS-II CMDB. |
| CMD Receipt Mail: | The e-mail that is sent to the CMD provider by the DHF when the DHF receives the CMD Sending Mail. (Note: This does not mean that registration of the CMD into the ILAS-II CMDB is complete.) |
| Accept Mail: | The e-mail that is sent to the CMD provider by the DHF when registration of the CMD into the ILAS-II CMDB has been completed. |

### 2.2 Outline of the procedure for providing and registering data into the CMDB

The procedure for provision, registration, and disclosure to identified users is as follows:

(1) The Provider sends a CMD Sending Mail to the DHF by e-mail, attached Readme Files and CMD Files to be registered into ILAS-II CMDB.
Note: The CMD File provided in NASA-Ames format will be checked using the Dataex NASA-Ames file format checker* program after being received in the DHF.
If possible, please check your data file format by using the checker program before sending your CMD Sending Mail.
*: http://badc.nerc.ac.uk/help/formats/NASA-Ames/
Checking your data files
http://badc.nerc.ac.uk/cgi-bin/dataex_file.cgi.pl

(2) The DHF sends the CMD Receipt Mail to the provider after receiving his CMD Sending Mail.

(3) The DHF checks the Readme File and CMD File according to a check-sheet, and reports the status of the CMD to the Data Manager and CMD Evaluation Committee.

(4) If the CMD is inadequate, the Data Manager and CMD Evaluation Committee will ask the CMD provider for his data.

(5) The DHF obtains the approval of the Data Manager and CMD Evaluation Committee, and registers the CMD into the ILAS-II CMDB. The CMD will be made open to the public according to the MOU on ILAS-II after registration.

(6) The DHF sends the Accept Mail to the CMD provider after registration of the provided CMD into the ILAS-II CMDB.
(Note: CMD that was registered and that is intended to be widely used will be made open to the public immediately with the provider's consent at the same time as the Level 2 data Standard Products of ILAS-II were provided in general users.)

After registration into the ILAS-II CMDB, data access to the ILAS-II CMDB and ILAS CMDB will become possible according to the rights described in the MOU on ILAS-II. In addition, note that even if you are already registered to use the ILAS CMDB, you do not automatically have data access rights to the ILAS-II CMDB unless you newly register with the ILAS-II CMDB.

## 3. How to send a CMD Sending Mail

The CMD provider should send the DHF (at the following email address) a CMD Sending Mail, with the subject name as shown in Appendix 1.

Mail address: datamanager@ilas2.nies.go.jp
Subject: (PI name)_(measurement instrument)_(observation point)_(observation date)

* NOTE: In case of measuring more than 2 days (and the data files sent by a single CMD Sending Mail), **the first date of the observation** shall be entered to the subject.

The CMD Sending Mail should contain the following.

Contents of CMD Sending Mail:

(1) Name of the Principal Investigator (PI)
(2) Affiliation, address, phone number, facsimile number, and e-mail address of the PI
(3) Name of the attached file and details (State all file names included in any archived CMD File.)
(4) Attached files (Readme File, CMD File)

Please start a new line for each of items (1) to (3).
An example of a CMD Sending Mail is shown in Appendix 2.

### 3.1 Contents of Readme File

The provider should create a Readme File containing the following information, and send a CMD Sending Mail to the DHF by e-mail. (Note that more information for item (17) is required for Core Validation Experiments.)

Note: The registered data must be in the NASA-Ames format.

Contents of the Readme File:

(1) Name of the Readme File
(2) Name of the Principal Investigator (PI)
(3) Affiliation, address, phone number, facsimile number, and e-mail address of the PI
(4) Items of data provided
(5) Measurement instrument used
(6) Observation point (location, longitude and altitude)
(7) Detailed explanation of the data file format*
(8) Version description of Data "A"
(9) Explanation of Data "A" quality
(10) Other comments on Data "A"
(11) Version description of Data "B"
(12) Explanation of Data "B" quality
(13) Other comments on Data "B"
(14) Version description of Data "C"
(15) Explanation of Data "C" quality
(16) Other comments on Data "C"
(17) Metadata parameters registered in the NILU Database for the Envisat Cal/Val database at NADIR (Note: Only Core Validation Experiment members)**

.......................................................

*: Please leave a blank line between each of items (1) to (17).

**: The Data Manager will give providers who are Core Validation Experiment members of ILAS-II, the manual: "Generic metadata guidelines on atmospheric and oceanographic datasets for the Envisat Calibration and Validation Project". Please create your metadata (Dataset Attribute, Variable Description Attribute (on page 51 in the Guidelines)) for the NILU Database as described in the manual and send it to the DHF.

An example of a Readme File is shown in Appendix 3.

## 3.2 Data Format

The data provided by the Data Manager of ILAS-II shall be created in the NASA-Ames format (Ref. "Format Specification for Data Exchange" Steven E. Gaines and R. Stephen Hipskind (1998), NASA Ames Research Center; latest version as of April 2003 is Ver. 1.3). This is the data format usually used for exchanging ASCII data. Detailed information is available at http://espoarchive.nasa.gov/archive/forspec.html.

## 3.3 Contents of CMD File

The data provider shall send an e-mail with the CMD File attached to the ILAS-II DHF (datamanager@ilas2.nies.go.jp).

CMD Files should be created:

(1) in the NASA-Ames format,
(2) with the file name explained in Appendix 1,
(3) including the observation date, observation point, observation altitude, and
(4) all data needed for converting into a ppmv unit, in case of providing gas concentrations.

An example of a CMD File is shown in Appendix 4.

## 4. Acknowledgment

We use the dataex program which checks for compliance with the NASA-Ames format with the BADC website. We thank Dr. S. E. Gaines of the NASA Ames Research Center.

## 5. Contact

For more information about CMD provision and registration, please contact us by e-mail at:

ILAS-II Data Manager
National Institute for Environmental Studies
16-2, Onogawa, Tsukuba, Ibaraki 305-8506, Japan
Fax: +81-29-863-3874
E-mail: datamanager@ilas2.nies.go.jp

## Appendix 1. Naming Rule for Mail Subjects and CMD Files

The name of a CMD Sending Mail must consist of lowercase letters and underscores ("_"), and must not exceed the designated number of characters. If your computer cannot name a CMD File within the given number of characters, specify your own naming standard in the Readme File.

Name of CMD Sending Mail:
(PI name)_(measurement instrument)_(observation point)_(observation date)

Name of Readme File:
(PI name)_(measurement instrument)_(observation point).readme

The number of characters in the file name must not be more than 21 from (PI name) to (observation point), which should be followed by ".readme" (7 characters).

Name of CMD File:
(PI name)_(measurement instrument)_(observation point) _(observation date)_(consecutive file number)

The number of characters in the file name must not be more than 21 from (PI name) to (observation point), which should be followed by "_(observation date)_(consecutive file number)" (10 characters in total).

Examples for each item are given below.

(a) PI name
Enter the full name or nickname of the Principal Investigator who provided the CMD.
Example: kanzawa, kondo, etc.

(b) Measurement instrument
Enter the abbreviation of the measurement instrument. The provider may use his/her own abbreviation, consisting of 3 to 6 characters. Always use the same abbreviation for the same instrument.
Example:

| | |
|---|---|
| Ozonsonde: | os, |
| Fourier transform infrared spectrometer: | fts (or ftir), |
| UV-visible spectrometer: | uv, etc. |

(c) Observation point
Enter the name of the observation point.
Example: kiruna, syowa, etc.

(d) Observation date
Observation dates should be expressed as "YYMMDD".
YY: observation year, which is the lower 2 digits of the A.D. year.
MM: observation month
DD: observation date (UT)
In case of measuring more than 2 days, the first date of the observation shall be entered.

(e) Consecutive file number
Enter a consecutive file number to distinguish all of the CMD Files that are measured with the same instrument on the same date. Each consecutive number should consist of two figures. A lower number should be used for data measured at an earlier time. If there is only one CMD File for the day, the number "01" should be entered. Numbers should be expressed as NN: 01-99.

Example of CMD File:
Example 1: kanzawa_os_syowa_030801_01
Example 2: kondo_fts_kiruna_030810_01

## Appendix 2. CMD Sending Mail

Name of the principal investigator (PI): Hiroshi Kanzawa

Affiliation, Address, Phone number, Facsimile number, E-mail address of the PI:


Affiliation : Independent Administrative Institute, National Institute for Environmental Studies

Address : 16-2, Onogawa, Tsukuba, Ibaraki, 305-8506, Japan

Phone number : +81-29-850-2431

Facsimile number : +81-29-858-2645

E-mail address : kanzawa@nies.go.jp


Attached File Name:

Readme File : kanzawa_os_kiruna.readme

CMD File : kanzawa_os_syowa_0308.tar.gz

All list before archiving

kanzawa_os_syowa_030801_01
kanzawa_os_syowa_030801_02
kanzawa_os_syowa_030802_01
kanzawa_os_syowa_030803_01
kanzawa_os_syowa_030804_01
kanzawa_os_syowa_030805_01
kanzawa_os_syowa_030806_01
kanzawa_os_syowa_030807_01
kanzawa_os_syowa_030808_01

## Appendix 3. Readme File

[Name of the Readme file]: kanzawa_os_kiruna.readme

[Name of the principal investigator (PI)]: Hiroshi Kanzawa

[Affiliation, address, telephone number, facsimile number, e-mail address of the PI]:


Affiliation: National Institute for Environmental Studies
Address: 16-2 Onogawa, Tsukuba, Ibaraki 305-8506, Japan
Phone number: +81-298-50-2431
Facsimile number: +81-298-58-2645
E-mail address: kanzawa@nies.go.jp


[Items of data provided]: Ozone, Temperature, Humidity

[Measurement instrument]: ECC (6A) Ozonesonde

[Observation Point]: ESRANGE KIRUNA, 21.10E 67.89N

[Detailed explanation of data file format]: Ames Format 2160

| Record | Type | Input | Comments |
|---|---|---|---|
| 01 | Header | 60 2160 | Number of lines in header including comments lines , file format index |
| 02 | Header | HIROSHI KANZAWA | PI name ( Last name, First name) |
| 03 | Header | NIES | Organization |
| 04 | Header | Ozonesonde | Measurement instrument |
| 05 | Header | ILAS VALIDATION BALLOON CAMPAIGN | Expedition Name |
| 06 | Header | 1 1 | Volume Number, Total Volume Number |
| 07 | Header | 1997 3 25 1997 3 25 | Mission start date (UT), Data revision date (UT) (YYYY MM DD) |
| 08 | Header | 0 | Interval between values of independent. Zero for a nonuniform pressure interval. |
| 09 | Header | 20 | Length of character string defining station |
| 10 | Header | Pressure at observation (hPa) | Independent variable (1) |
| 11 | Header | Station name | Independent variable (2) |
| 12 | Header | 8 | Number of primary variables |
| 13 | Header | 1 1 1 1 1 1 1 1 | Scale factors for primary variables |
| 14 | Header | 99999 99999 999.9 999 999.9 99.9 999 999.9 | Missing values for primary variables |
| 15 | Header | Time after launch (s) | Comment line 1 of primary variables |
| 16 | Header | Geopotential height (gpm) | Comment line 2 of primary variables |
| 17 | Header | Temperature (C) | Comment line 3 of primary variables |
| 18 | Header | Relative humidity (%) | Comment line 4 of primary variables |
| 19 | Header | Temperature inside styrofoam box (C) | Comment line 5 of primary variables |
| 20 | Header | Ozone partial pressure (mPa) | Comment line 6 of primary variables |
| 21 | Header | Horizontal wind direction (degrees) | Comment line 7 of primary variables |
| 22 | Header | Horizontal wind speed (m/s) | Comment line 8 of primary variables |
| 23 | Header | 20 | Number of total auxiliary variables (Real-valued and character strings) |
| 24 | Header | 10 | Number of auxiliary variables as character strings |
| 25 | Header | 1 1 1 1 1 1 1 1 1 1 | Scale factors for auxiliary variables |
| 26 | Header | 9999 99.999 999.99 999.99 999.9 99.9 99999.9 99999.9 99999.9 99999.9 | Missing values for auxiliary variables |
| 27 | Header | 2 7 20 20 40 10 20 20 20 20 | Length of character auxiliary variables |

| | | | |
|---|---|---|---|
| 28 | Header | zz | Missing values for character auxiliary variables |
| 29 | Header | zzzzzzz | Missing values for character auxiliary variables |
| 30 | Header | zzzzzzzzzzzzzzzzzzzz | Missing values for character auxiliary variables |
| 31 | Header | zzzzzzzzzzzzzzzzzzzz | Missing values for character auxiliary variables |
| 32 | Header | zzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzz | Missing values for character auxiliary variables |
| 33 | Header | zzzzzzzzzz | Missing values for character auxiliary variables |
| 34 | Header | zzzzzzzzzzzzzzzzzzzz | Missing values for character auxiliary variables |
| 35 | Header | zzzzzzzzzzzzzzzzzzzz | Missing values for character auxiliary variables |
| 36 | Header | zzzzzzzzzzzzzzzzzzzz | Missing values for character auxiliary variables |
| 37 | Header | zzzzzzzzzzzzzzzzzzzz | Missing values for character auxiliary variables |
| 38 | Header | Number of pressure levels | Comment line 1 of auxiliary variables |
| 39 | Header | Launch time (UT hours from 0 hours on day given by DATE) | Comment line 2 of auxiliary variables |
| 40 | Header | East Longitude of station (degrees) | Comment line 3 of auxiliary variables |
| 41 | Header | Latitude of station | Comment line 4 of auxiliary variables |
| 42 | Header | Wind speed at ground at launch (m/s) | Comment line 5 of auxiliary variables |
| 43 | Header | Temperature at ground at launch (C) | Comment line 6 of auxiliary variables |
| 44 | Header | Free lift for rubber balloon (g) | Comment line 7 of auxiliary variables |
| 45 | Header | Dummy weight for plastic balloon (g) | Comment line 8 of auxiliary variables |
| 46 | Header | Balloon volume for plastic balloon (m^3) | Comment line 9 of auxiliary variables |
| 47 | Header | Balloon weight for rubber balloon (g) | Comment line 10 of auxiliary variables |
| 48 | Header | Lifting gas | Comment line 11 of auxiliary variables |
| 49 | Header | Balloon material (RUBBER or PLASTIC) | Comment line 12 of auxiliary variables |
| 50 | Header | Balloon brand (e.g. TOTEX, RAVEN) | Comment line 13 of auxiliary variables |
| 51 | Header | Balloon type (e.g. TX1200, CL0019) | Comment line 14 of auxiliary variables |
| 52 | Header | Reason for discontinuation | Comment line 15 of auxiliary variables |
| 53 | Header | Weather condition at launch | Comment line 16 of auxiliary variables |
| 54 | Header | Balloon pretreatment | Comment line 17 of auxiliary variables |
| 55 | Header | Serial number of ECC | Comment line 18 of auxiliary variables |
| 56 | Header | Serial number of interface card | Comment line 19 of auxiliary variables |
| 57 | Header | Serial number of RS-80 | Comment line 20 of auxiliary variables |
| 58 | Header | 0 | Number of special comment lines ( There are no special comment lines.) |
| 59 | Header | 1 | Number of normal comment lines |
| 60 | Header | P time Z T U TI PO3 DIR SPD | Normal comment line |
| 61 | Data | ESRANGE KIRUNA | Station name (Independent variable (2)) |
| 62 | Data | 551 15.900 21.10 67.89 4.3 -7.6 2300.0 99999.9 99999.9 1200.0 | Real-valued auxiliary variables |
| 63 | Data | He | Lifting gas |
| 64 | Data | RUBBER | Balloon material (RUBBER or PLASTIC) |
| 65 | Data | TOTEX | Balloon brand (e.g. TOTEX, RAVEN) |
| 66 | Data | - | Balloon type, (e.g. TX1200, CL0019) |
| 67 | Data | BURST | Reason for discontinuation |
| 68 | Data | FAIR/SUNNY | Weather condition at launch |
| 69 | Data | NONE | Balloon pretreatment |
| 70 | Data | 6A1361 | Serial number of ECC |
| 71 | Data | 5064100015 | Serial number of interface card |
| 72 | Data | 162940450 | Serial number of RS-80 |
| 73 | Data | 979.3 0 314 -7.6 47 27.9 3.5 999 999.9 | 1st primary data line Independent variable (1), primary variables |
| 74- | Data | 959.0 18 477 -8.9 52 27.8 3.3 999 999.9 | 2nd primary data line |
| 75 | Data | 952.5 28 529 -9.2 52 27.8 3.4 999 999.9 | 3rd primary data line |

[Data version of O3 data]: Version 1

[Comment on the data quality of O3]:
Accuracy and precision are of the order of 5 per cent for the altitude of 0 - 30 km.

[Other comments on O3 data]:
(1) The ECC ozone soundings were conducted by ESRANGE during the Early Turn On (ETO) period and the System Total 1 period as a part of the ILAS-II Validation Balloon Campaign. Some data of bad quality were not excluded in the database because the exclusion cannot be automatically made and subjective omission of bad data might miss some good data. The omission of data of bad quality is asked to be made by the data user.

(2) Observation Period: 12 February 2003 to 22 March 2003

(3) The number of soundings: 8

[Data version of Temperature data]: Version 1

[Comment on the data quality of Temperature]:
Accuracy and precision are of the order of 1 K for the altitude of 0 - 30 km.

[Other comments on Temperature data]: Same as in O3

[Data version of Humidity data]: Version 1

[Comments on the data quality of Humidity]:
The data quality of humidity in the upper troposphere and stratosphere is not sufficient to validate the ILAS-II water vapor data.

[Other comments on Humidity data]: Same as in O3

For NILU DB
DATA_DESCRIPTION=Contains Esrange balloon ozone data
DATA_DISCIPLINE=ATMOSPHERIC.CHEMISTRY;INSITU;BALLOON
DATA_GROUP=EXPERIMENTAL;PROFILE.MOVING
DATA_LOCATION=ESRANGE
DATA_SOURCE=SONDE.O3_NIES001
DATA_TYPE=s2
DATA_VARIABLES=LONGITUDE;LATITUDE;PRESSURE_INSITU;DATETIME;ALTITUDE.GPH;TEMPERATURE_INSITU;HUMIDITY.RELATIVE_INSITU;TEMPERATURE.INTERNAL.BOX_INSITU;O3.CONCENTRATION_INSITU;WIND.DIRECTION_INSITU;WIND.SPEED_INSITU
DATA_FILE_VERSION=001
DATA_MODIFICATIONS=

VAR_NAME = LONGITUDE
VAR_DESCRIPTION = Longitude in degrees.
VAR_NOTES =
VAR_DIMENSION = 1
VAR_DEPEND = CONSTANT
VAR_DATA_TYPE = REAL
VAR_UNITS = deg
VAR_SI_CONVERSION = 0.0;1.0;deg
VAR_MONOTONE = FALSE
VAR_AVG_TYPE = NONE
VAR_FILL_VALUE = -999999.0

VAR_NAME = LATITUDE
VAR_DESCRIPTION = Latitude in degrees.
VAR_NOTES =
VAR_DIMENSION = 1
VAR_DEPEND = CONSTANT

VAR_DATA_TYPE = REAL
VAR_UNITS = deg
VAR_SI_CONVERSION = 0.0;1.0;deg
VAR_MONOTONE = FALSE
VAR_AVG_TYPE = NONE
VAR_FILL_VALUE = -999999.0

VAR_NAME = PRESSURE_INSITU
VAR_DESCRIPTION = Pressure in hPa
VAR_NOTES =
VAR_DIMENSION = 1
VAR_DEPEND = INDEPENDENT
VAR_DATA_TYPE = REAL
VAR_UNITS = hPa
VAR_SI_CONVERSION = 0;1.0E+2;Pa
VAR_MONOTONE = DECREASE
VAR_AVG_TYPE = NONE
VAR_FILL_VALUE = -999999

VAR_NAME = DATETIME
VAR_DESCRIPTION = Time after launch
VAR_NOTES =
VAR_DIMENSION = 1
VAR_DEPEND = PRESSURE_INSITU
VAR_DATA_TYPE = DOUBLE
VAR_UNITS = DIMENSIONLESS
VAR_SI_CONVERSION = 0.0;1.0;DIMENSIONLESS
VAR_MONOTONE = INCREASE
VAR_AVG_TYPE = NONE
VAR_FILL_VALUE = -999999

VAR_NAME = ALTITUDE.GPH
VAR_DESCRIPTION = Geopotential height
VAR_NOTES =
VAR_DIMENSION = 1
VAR_DEPEND = PRESSURE_INSITU
VAR_DATA_TYPE = REAL
VAR_UNITS = m
VAR_SI_CONVERSION = 0.0;1.0;m
VAR_MONOTONE = INCREASE
VAR_AVG_TYPE = NONE
VAR_FILL_VALUE = -9999999

VAR_NAME = TEMPERATURE_INSITU
VAR_DESCRIPTION = Temperature
VAR_NOTES = Accuracy and precision are of the order of 1 K for the altitude of 0 - 30 km.
VAR_DIMENSION = 1
VAR_DEPEND = PRESSURE_INSITU
VAR_DATA_TYPE = REAL
VAR_UNITS = degC
VAR_SI_CONVERSION = 273.15;1;K
VAR_MONOTONE = FALSE
VAR_AVG_TYPE = NONE
VAR_FILL_VALUE = -999999

VAR_NAME = HUMIDITY.RELATIVE_INSITU
VAR_DESCRIPTION = Relative humidity
VAR_NOTES = The data quality of humidity in the upper troposphere and stratosphere is not sufficient to validate the ILAS-II water vapor data.
VAR_DIMENSION = 1

VAR_DEPEND = PRESSURE_INSITU
VAR_DATA_TYPE = REAL
VAR_UNITS = %
VAR_SI_CONVERSION = 0;0.01;DIMENSIONLESS
VAR_MONOTONE = FALSE
VAR_AVG_TYPE = NONE
VAR_FILL_VALUE = -999999

VAR_NAME = TEMPERATURE.INTERNAL.BOX_INSITU
VAR_DESCRIPTION = Temperature inside styrofoam box
VAR_NOTES =
VAR_DIMENSION = 1
VAR_DEPEND = PRESSURE_INSITU
VAR_DATA_TYPE = REAL
VAR_UNITS = degC
VAR_SI_CONVERSION = 273.15;1;K
VAR_MONOTONE = FALSE
VAR_AVG_TYPE = NONE
VAR_FILL_VALUE = -999999

VAR_NAME = O3.CONCENTRATION_INSITU
VAR_DESCRIPTION = Ozone partial pressure
VAR_NOTES = Accuracy and precision are of the order of 5 per cent for the altitude of 0 - 30 km.
VAR_DIMENSION = 1
VAR_DEPEND = PRESSURE_INSITU
VAR_DATA_TYPE = REAL
VAR_UNITS = mPa
VAR_SI_CONVERSION = 0.0;1.0E-3;Pa
VAR_MONOTONE = FALSE
VAR_AVG_TYPE = NONE
VAR_FILL_VALUE = -999999

VAR_NAME = WIND.DIRECTION_INSITU
VAR_DESCRIPTION = Horizontal wind direction
VAR_NOTES =
VAR_DIMENSION = 1
VAR_DEPEND = PRESSURE_INSITU
VAR_DATA_TYPE = REAL
VAR_UNITS = deg
VAR_SI_CONVERSION = 0;1.74533E-2;rad
VAR_MONOTONE = FALSE
VAR_AVG_TYPE = NONE
VAR_FILL_VALUE = -999999

VAR_NAME = WIND.SPEED_INSITU
VAR_DESCRIPTION = Horizontal wind speed
VAR_NOTES =
VAR_DIMENSION = 1
VAR_DEPEND = PRESSURE_INSITU
VAR_DATA_TYPE = REAL
VAR_UNITS = m s-1
VAR_SI_CONVERSION = 0;1;m s-1
VAR_MONOTONE = FALSE
VAR_AVG_TYPE = NONE
VAR_FILL_VALUE = -999999

## Appendix 4. CMD File (In case of a Readme in Appendix 3)

60 2160
HIROSHI KANZAWA
NIES
Ozonesonde
ILAS VALIDATION BALLOON CAMPAIGN
1 1
2003 8 02 2003 8 02
0
20
Pressure at observation (hPa)
Station name
8
1 1 1 1 1 1 1 1
99999 99999 999.9 999 999.9 99.9 999 999.9

Time after launch (s)
Geopotential height (gpm)
Temperature (C)
Relative humidity (%)
Temperature inside styrofoam box (C)
Ozone partial pressure (mPa)
Horizontal wind direction (degrees)
Horizontal wind speed (m/s)
20
10
1 1 1 1 1 1 1 1 1 1
9999 99.999 999.99 999.99 999.9 99.9 99999.9 99999.9 99999.9 99999.9
2 7 20 20 40 10 20 20 20 20
zz
zzzzzzz
zzzzzzzzzzzzzzzzzzzz
zzzzzzzzzzzzzzzzzzzz
zzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzz
zzzzzzzzzz
zzzzzzzzzzzzzzzzzzzz
zzzzzzzzzzzzzzzzzzzz
zzzzzzzzzzzzzzzzzzzz
zzzzzzzzzzzzzzzzzzzz
Number of pressure levels
Launch time (UT hours from 0 hours on day given by DATE)
East Longitude of station (degrees)
Latitude of station
Wind speed at ground at launch (m/s)
Temperature at ground at launch (C)
Free lift for rubber balloon (g)
Dummy weight for plastic balloon (g)
Balloon volume for plastic balloon (m^3)
Balloon weight for rubber balloon (g)
Lifting gas
Balloon material (RUBBER or PLASTIC)
Balloon brand (e.g. TOTEX, RAVEN)
Balloon type (e.g. TX1200, CL0019)
Reason for discontinuation
Weather condition at launch

Balloon pretreatment
Serial number of ECC
Serial number of interface card
Serial number of RS-80
0
1
P time Z T U TI P03 DIR SPD
ESRANGE KIRUNA
551 15.900 21.10 67.89 4.3 -7.6 2300.0 99999.9 99999.9 1200.0
He
RUBBER
TOTEX
-
BURST
FAIR/SUNNY
NONE
6A1361
5064100015
162940450

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 979.3 | 0 | 314 | -7.6 | 47 | 27.9 | 3.5 | 999 | 999.9 |
| 959.0 | 18 | 477 | -8.9 | 52 | 27.8 | 3.3 | 999 | 999.9 |
| 952.5 | 28 | 529 | -9.2 | 52 | 27.8 | 3.4 | 999 | 999.9 |

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**ILAS-II Correlative Measurement Plan**

Inquiries to: NIES Dr. Sugita, Takafumi
Tel: +81-29-850-2460

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