Monte Carlo Uncertainty Analysis Program v1.0

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"Uncertainty estimates are an essential element of a complete inventory greenhouse gas emission and removals."

- 2006 IPCC Guidelines for National Greenhouse Gas Inventories

- An analysis software is needed to:
  - Assist in the uncertainty calculation,
  - Automate the calculation process,
  - Standardize/harmonize the estimation process,
  - Making the calculation process transparent.

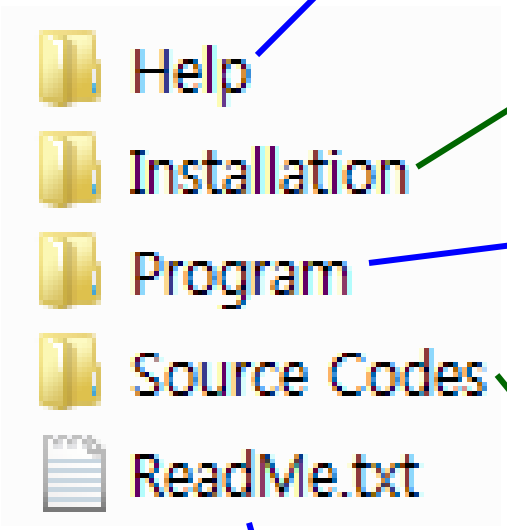
- **Available popular analysis softwares are:**
  - **@RISK: Palisade Cooperation (US$2,000),**
  - **Crystal Ball: Oracle (US$1,000).**

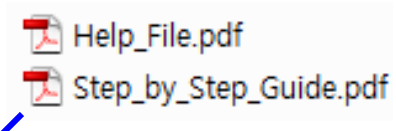
- **The hefty price tag discourages:**
  - **Uncertainty analysis in developing countries with a lack of resources,**
  - **Technology and knowledge transfer to developing countries.**

- **The motivation is:**
  - **Developing an open source analysis software that is freely available to developing countries to assist uncertainty analysis in their greenhouse gas report to IPCC and to assist knowledge transfer.**

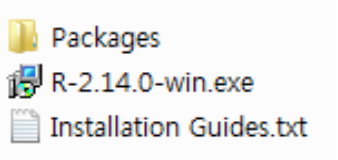
As a result of this effort

Monte Carlo Uncertainty Analysis Program v1.0

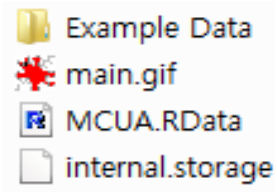




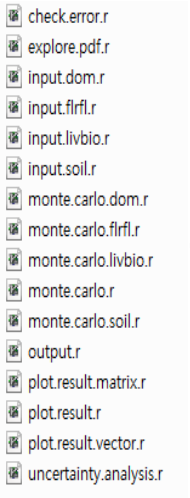
Help Documents



Necessary Installation Softwares and Guides



Main program and example datasets



Source codes of the subroutines of the program

Information on the package

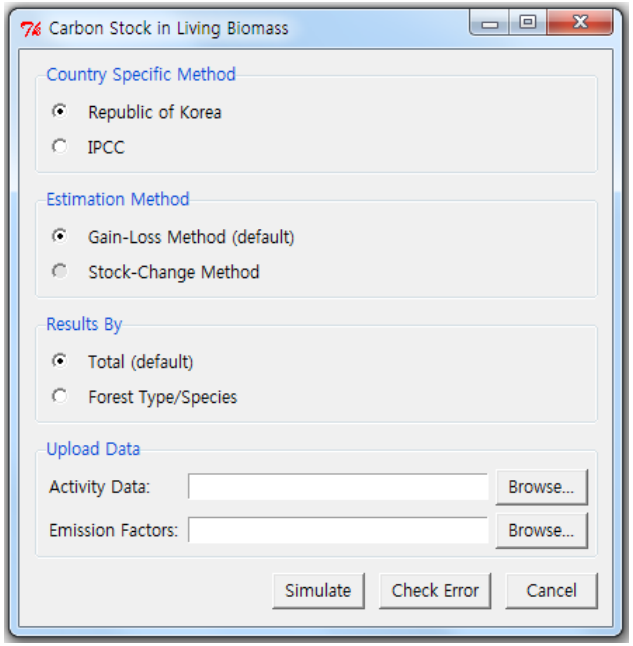
- The program is built in the  statistical software:
  - The software is distributed under General Public License (GPL),
  - It is freely available to any individual and any place,
  - It is a powerful statistical analysis software that could do all kinds of analysis.

- The structure of the program is separated into two parts:
  - Front-end (Graphic User Interface – GUI)
  - Back-end (analysis framework)

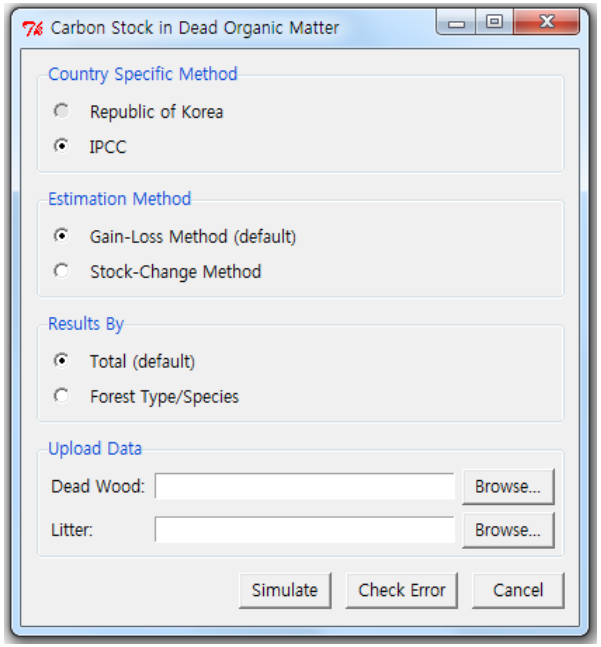
- The program relies heavily on available R packages, which are functions that perform analysis or routines.

- **The GUI of the program:**
  - **Is built from `tcltk`, `rpanel` and `tkrplot` packages,**
  - **They provide a convenient way to operate the program,**
  - **80% of the codes in the program.**

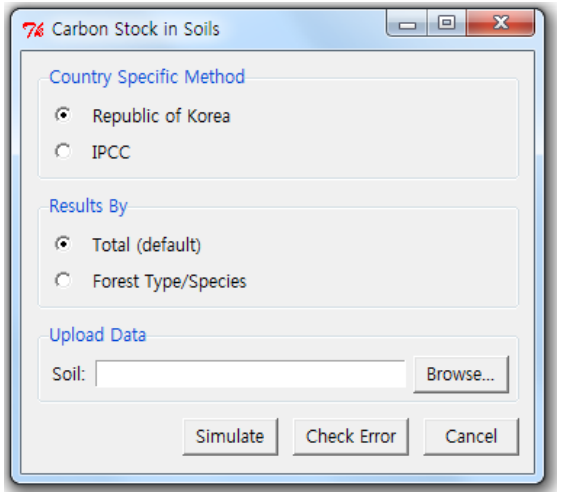
Above- and belowground biomass

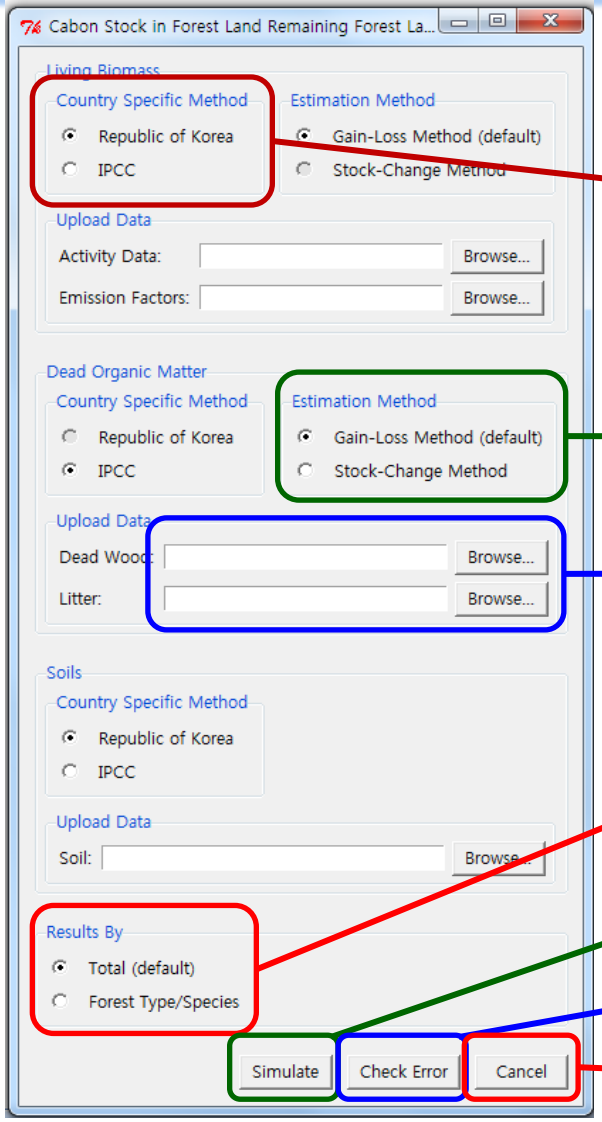


Dead Organic Matter



Soils





Forest Land Remaining Forest Land (FLRFL)

Methods/equations specific to a country (Korea or IPCC)

Estimation methods (Gain-Loss, Stock-Change)

Upload data files

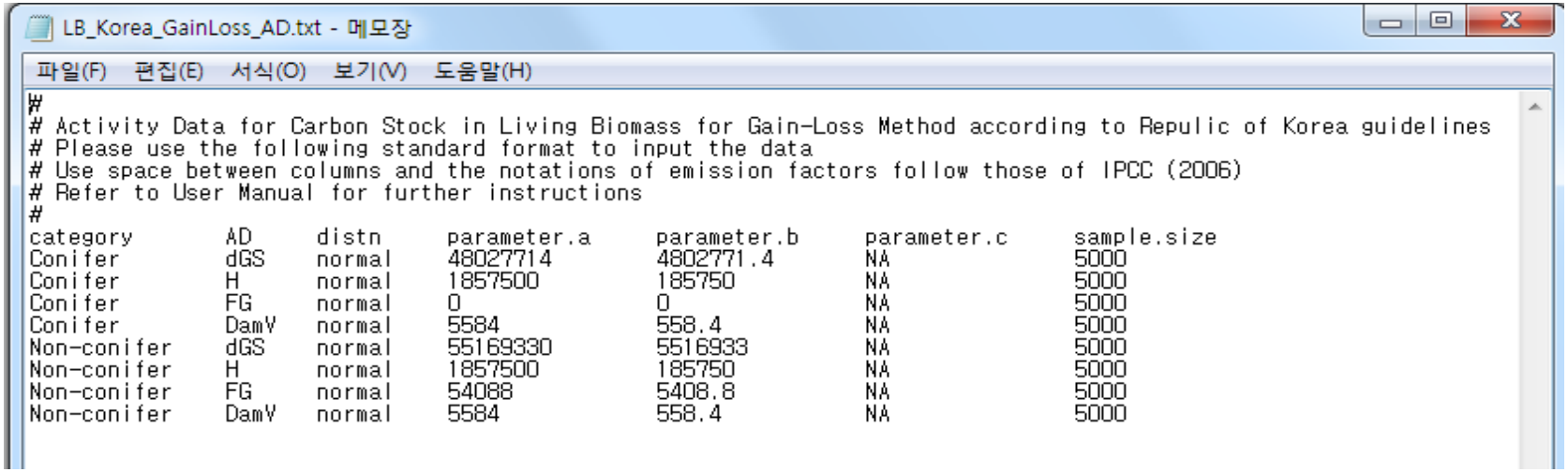
Output results by total or by categories

Start the simulation

Check for common error in data files

Exit the GUI

- **Preparing input data files:**
  - **The preparation maybe tricky and complex because the data files have to follow specific formats depending on biomass component, country specific method and estimation method,**
  - **The specific preparation is explained in the Help File,**
  - **At present, only text file (.txt) is accepted and spaces are used to separate columns (spacebar).**



- **The analysis framework (back-end) of the program:**
  - **Is built from `MASS` and `triangle` packages,**
  - **They provide functions to randomly draw values from a specified probability distribution function (pdf),**
  - **The pdfs available for this program to generate random numbers are:**
    - **Normal pdf (`rnorm`),**
    - **Log-normal pdf (`rlnorm`),**
    - **Exponential pdf (`rexp`),**
    - **Gamma pdf (`rgamma`),**
    - **Weibull pdf (`rweibull`),**
    - **Triangle pdf (`rtriangle`)**

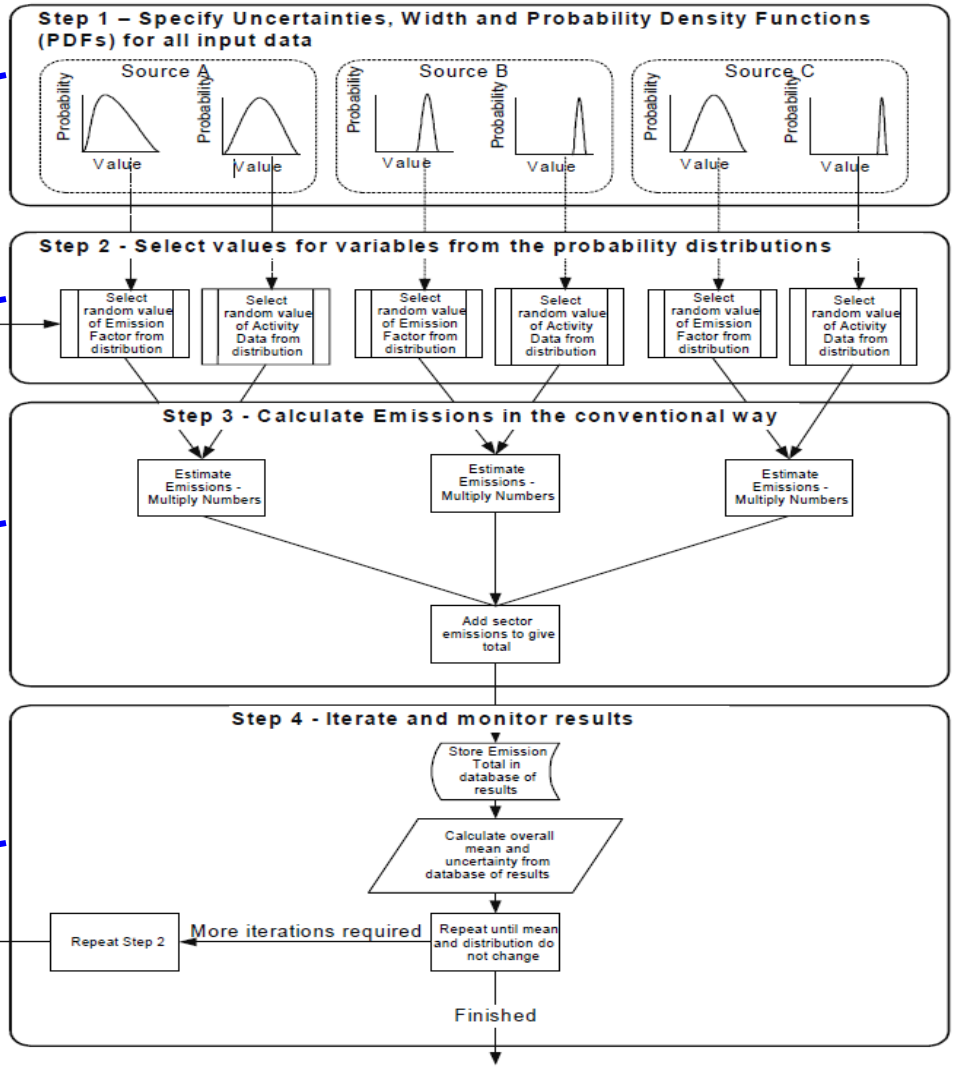
The concept of Monte Carlo Uncertainty Analysis is

Step 1: specify pdfs for all variables in the equations representing their uncertainties.

Step 2: select one random value from the specified pdf for each variable.

Step 3: Pretend the randomly selected values are collected from a sample, estimate emission using the selected values.

Step 4: Go back to Step 2 until the number of iteration is over



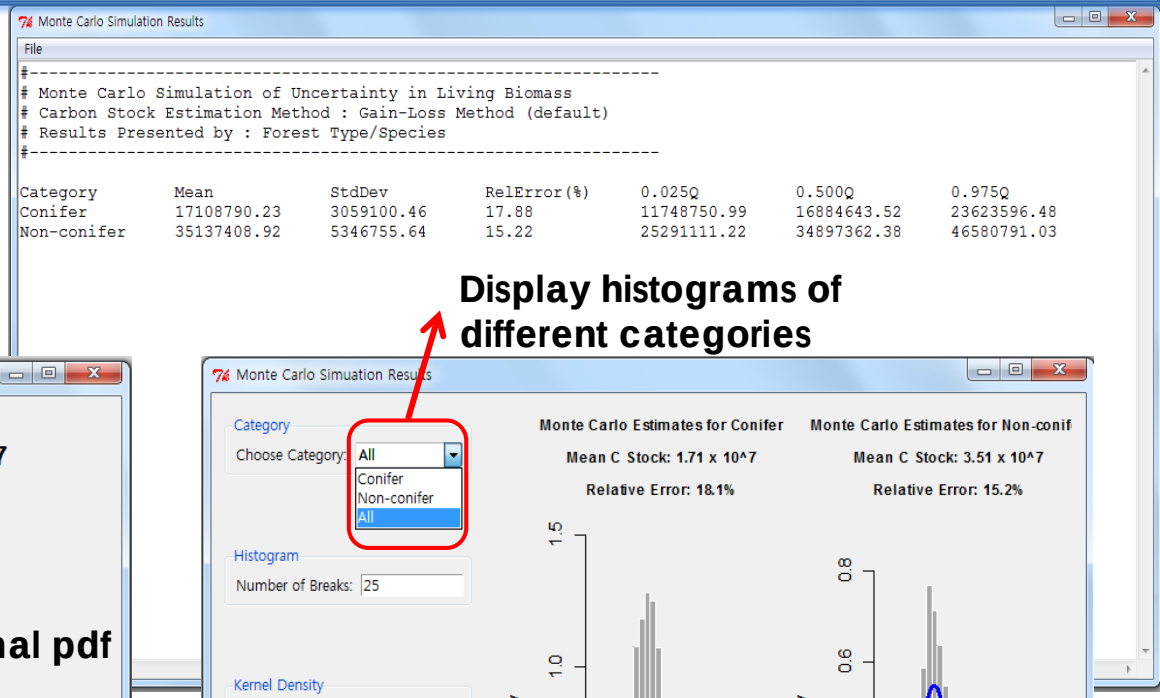
Monte Carlo Uncertainty Analysis Program v1.0

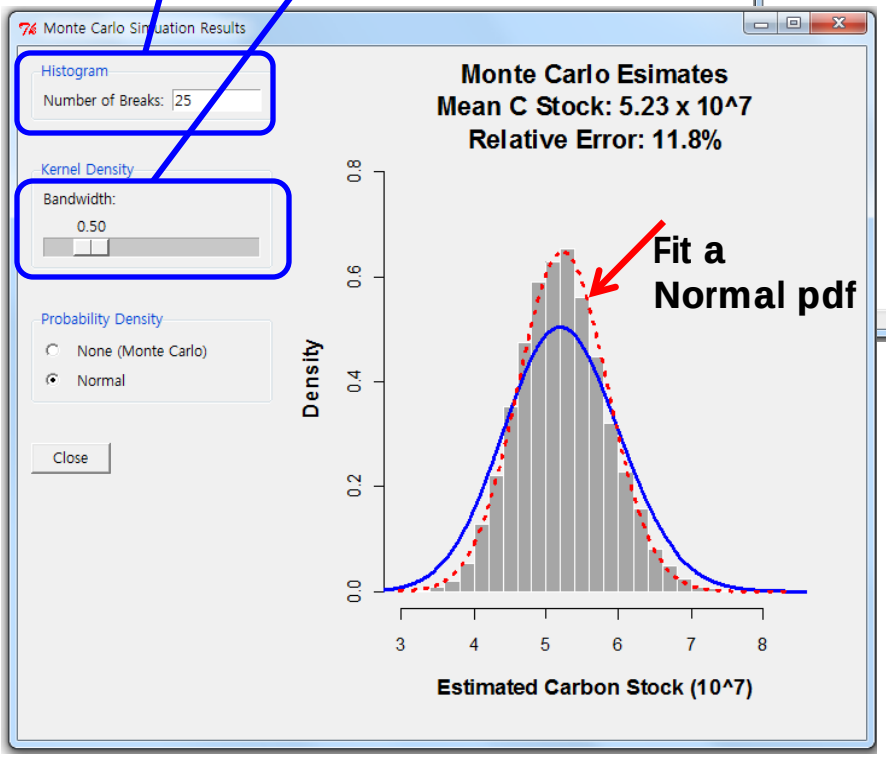
Outputs

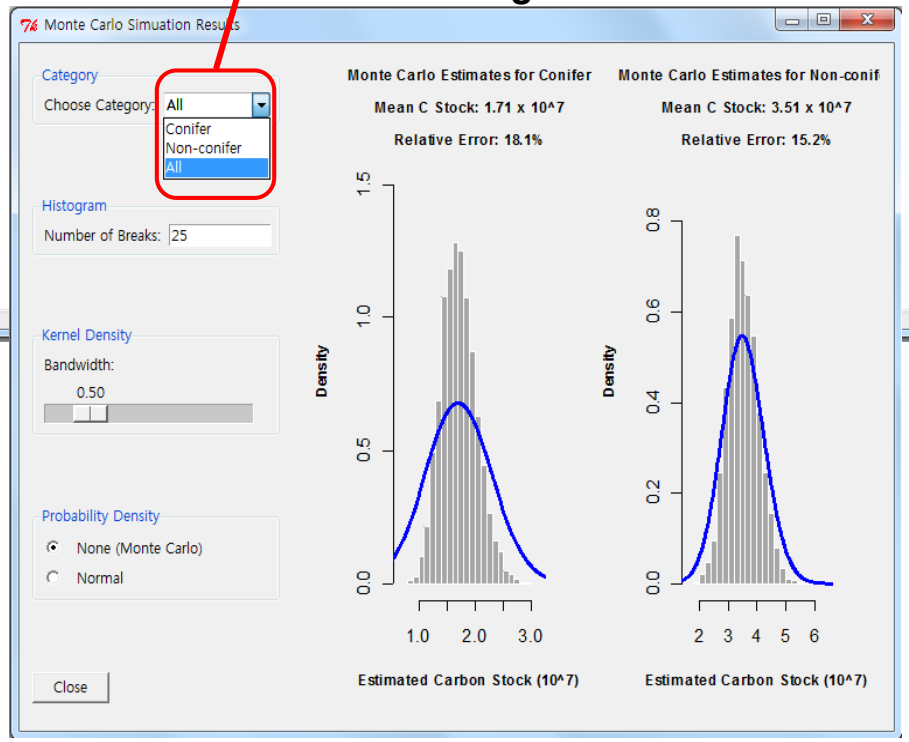
Change number of breaks in histogram

Change smoothness of blue curve

Display histograms of different categories







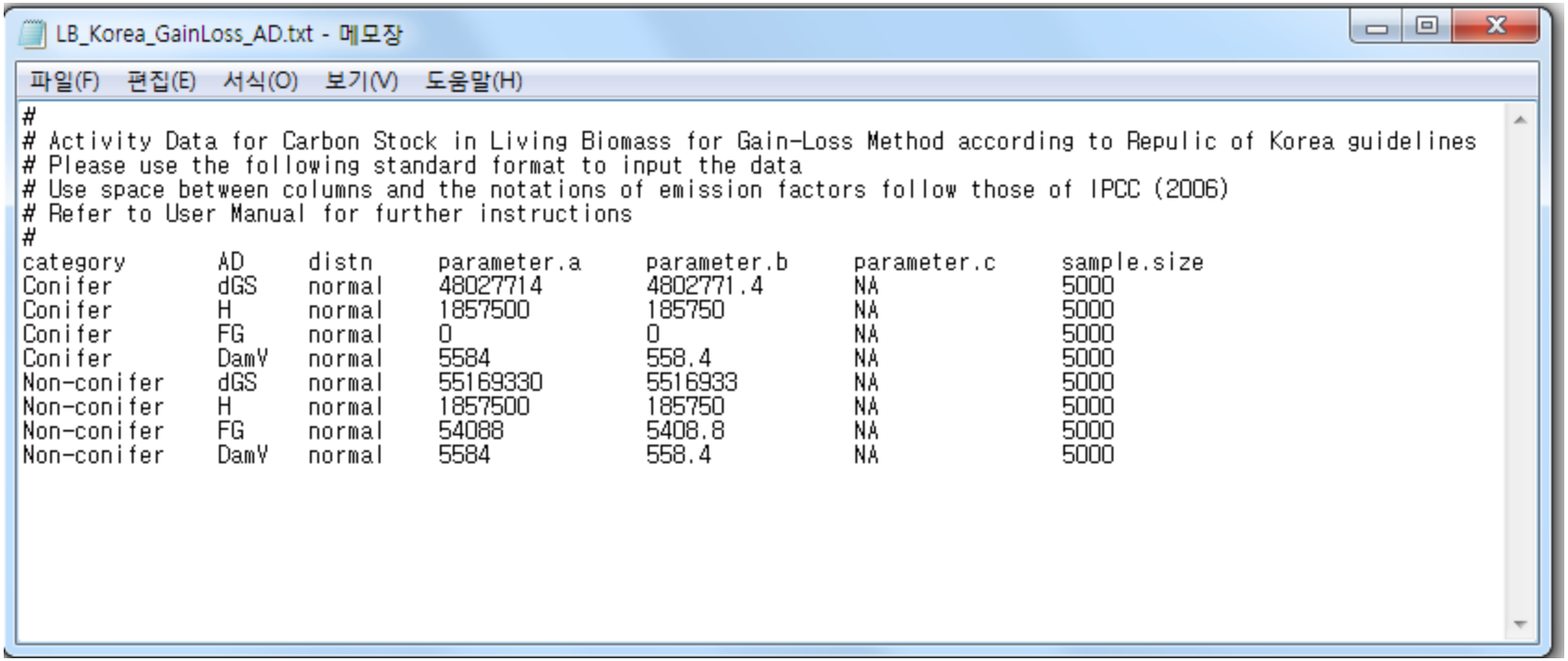
- **The advantages:**
  - **Freely available and portable,**
  - **Expandable to include other countries specific methods or other biomass component,**
  - **Expandable to include other more complex estimation method (correlation between variables),**
  - **A bit of learning curve to operate the software but the GUI helps.**

- **The disadvantages:**
  - **Limited functionalities in version 1.0: current assumption is that all variables are independent,**
  - **Non-fancy GUI and basic output options,**
  - **"A/S" After-sales support (website, feedback forum) needs to be set up,**
  - **Need manpower to continuously improve on the program.**

Estimating uncertainty for 2010 emission level of Above- and belowground biomass in Republic of Korea using Gain-Loss Method for Conifer and Non-conifer forests

Step 1: Prepare Data Files

Activity Data


LB_Korea_GainLoss_AD.txt - 메모장

파일(F) 편집(E) 서식(O) 보기(V) 도움말(H)

```
#
# Activity Data for Carbon Stock in Living Biomass for Gain-Loss Method according to Repulic of Korea guidelines
# Please use the following standard format to input the data
# Use space between columns and the notations of emission factors follow those of IPCC (2006)
# Refer to User Manual for further instructions
#
category        AD      distn     parameter.a     parameter.b     parameter.c     sample.size
Conifer         dGS     normal    48027714        4802771.4       NA              5000
Conifer         H       normal    1857500         185750          NA              5000
Conifer         FG      normal    0               0               NA              5000
Conifer         DamV    normal    5584            558.4           NA              5000
Non-conifer     dGS     normal    55169330        5516933         NA              5000
Non-conifer     H       normal    1857500         185750          NA              5000
Non-conifer     FG      normal    54088           5408.8          NA              5000
Non-conifer     DamV    normal    5584            558.4           NA              5000
```

Step 1: Prepare Data Files

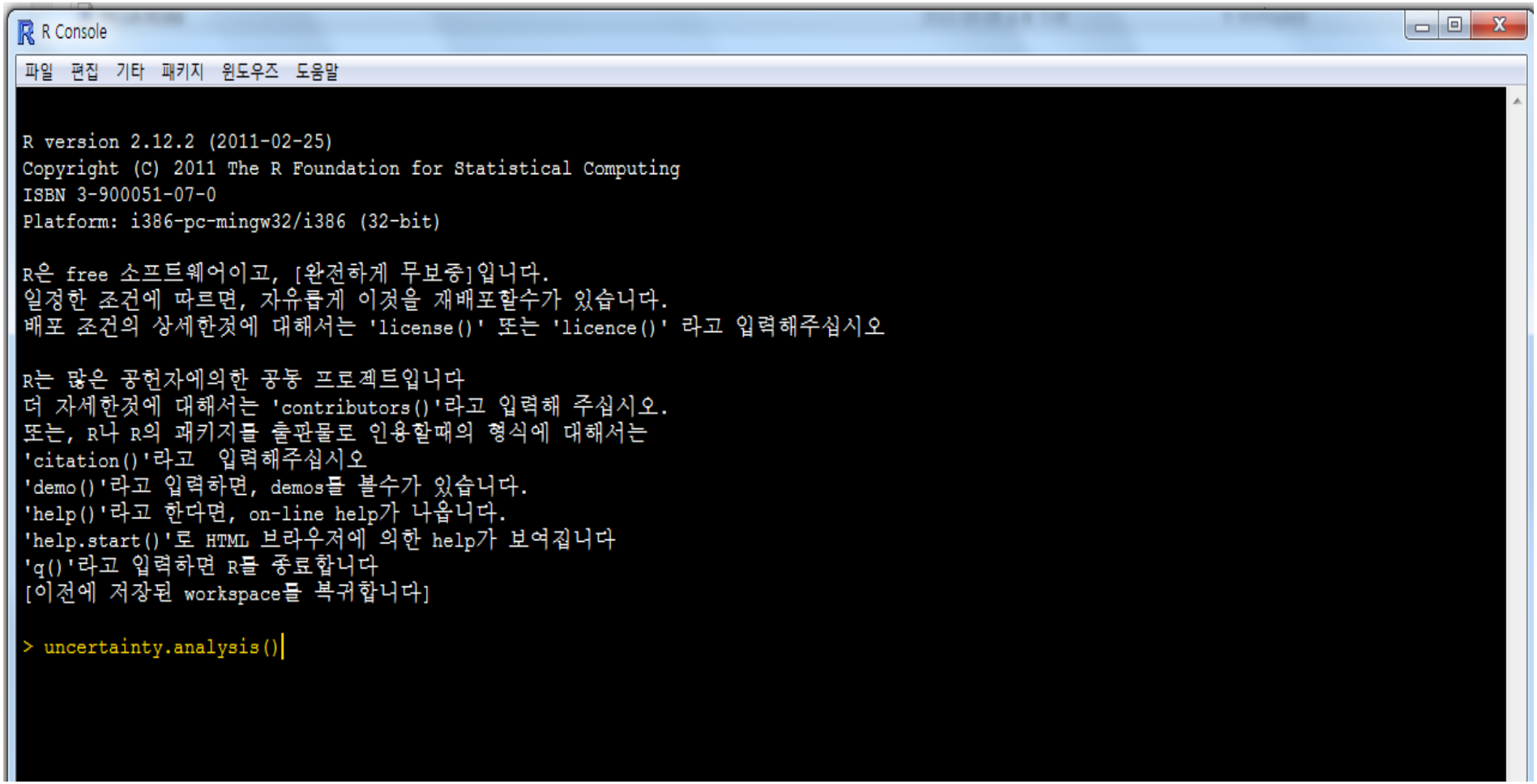
Emission Factors

LB_Korea_GainLoss_EF.txt - 메모장

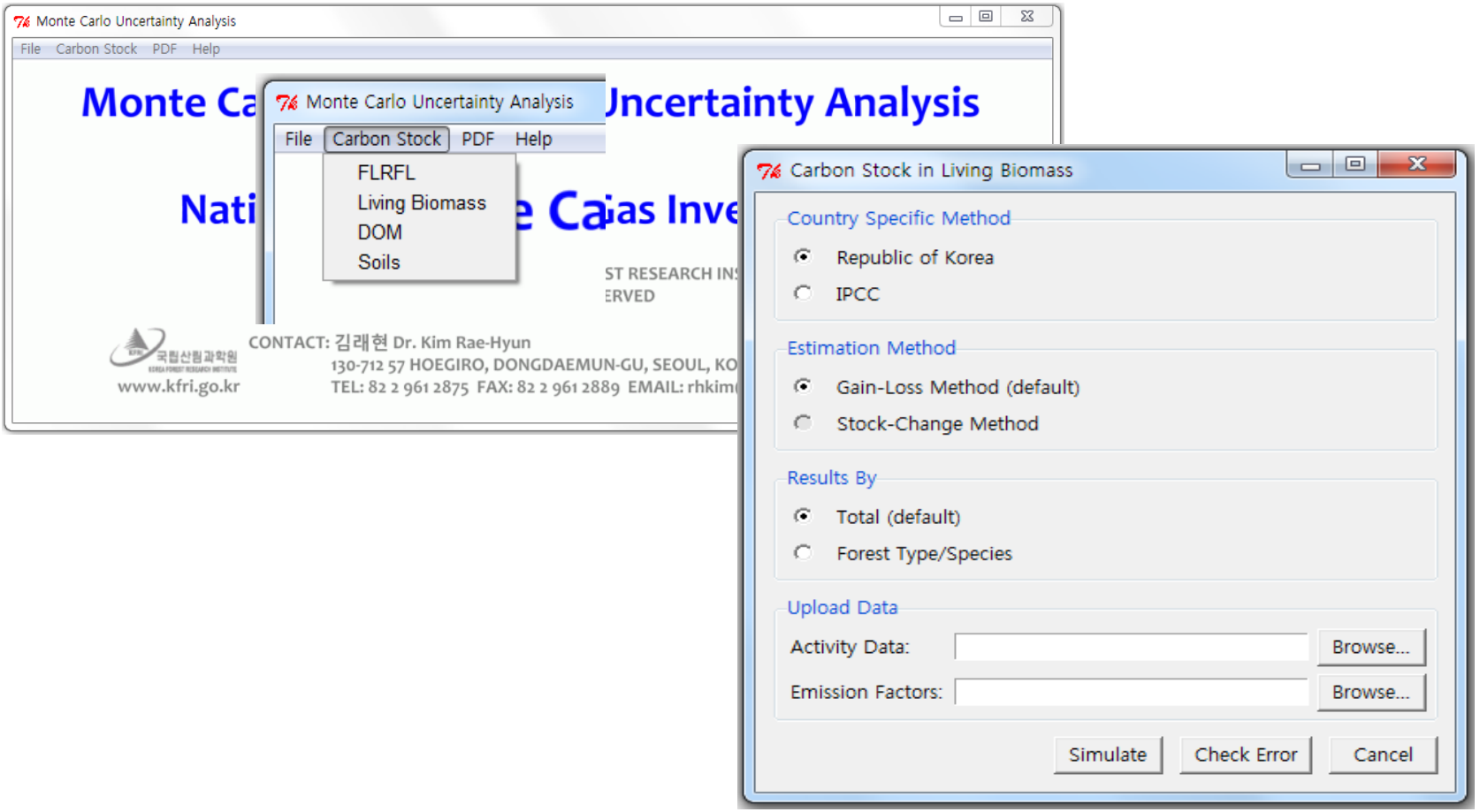
파일(F) 편집(E) 서식(O) 보기(V) 도움말(H)

```
#
# Emission Factors for Carbon Stock in Living Biomass for Gain-Loss Method according to Repulic of Korea
guidelines
# Please use the following standard format to input the data
# Use space between columns and the notations of emission factors follow those of IPCC (2006)
# Refer to User Manual for further instructions
#
category        EF      distn         parameter.a     parameter.b     parameter.c     sample.size
Conifer         BEF2    normal        1.251           0.1             NA              5000
Conifer         R       normal        0.284           0.05            NA              5000
Conifer         D       normal        0.461           0.05            NA              5000
Conifer         fBL     normal        0               0               NA              5000
Non-conifer     BEF2    normal        1.438           0.1             NA              5000
Non-conifer     R       normal        0.337           0.05            NA              5000
Non-conifer     D       normal        0.685           0.05            NA              5000
Non-conifer     fBL     normal        0               0               NA              5000
```

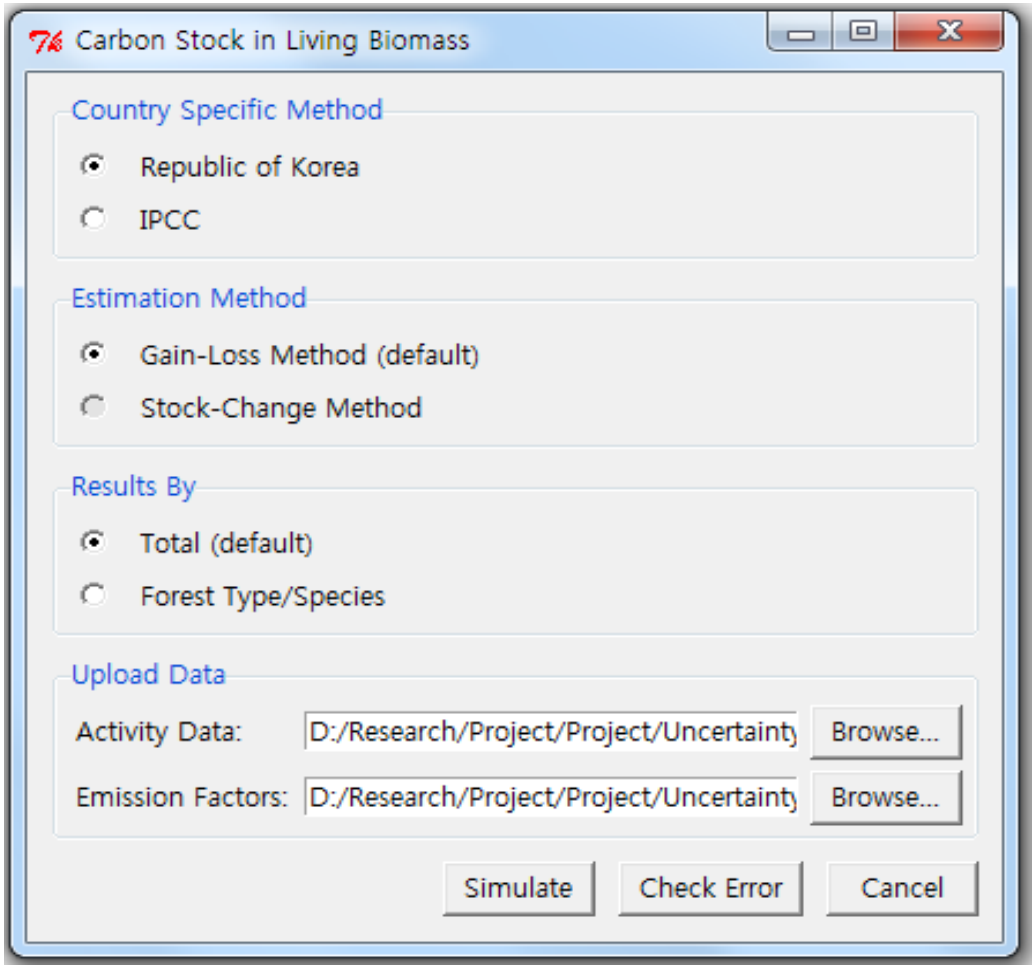
Step 2: Start the Program



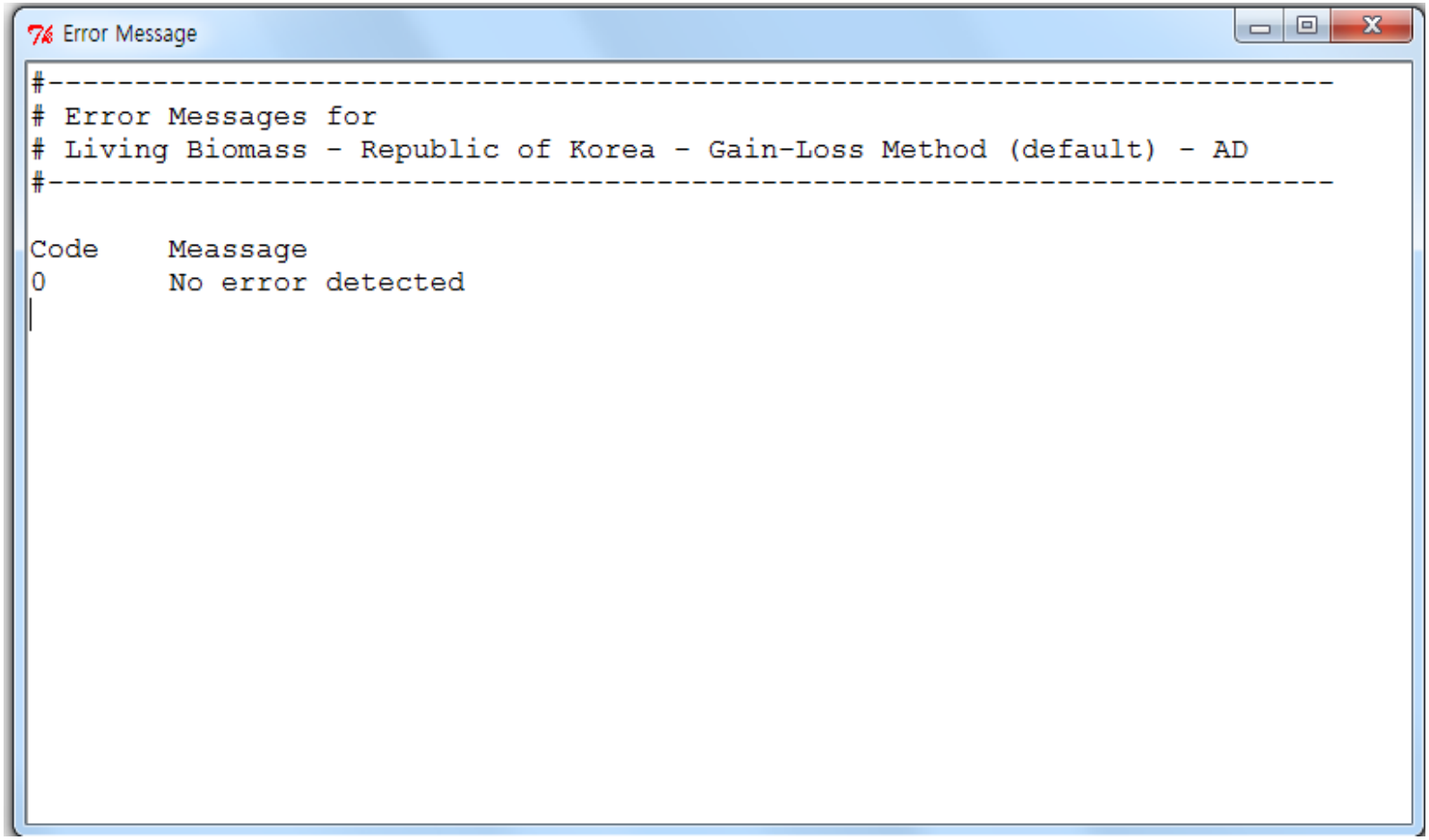
Step 3: Open the Living Biomass Window



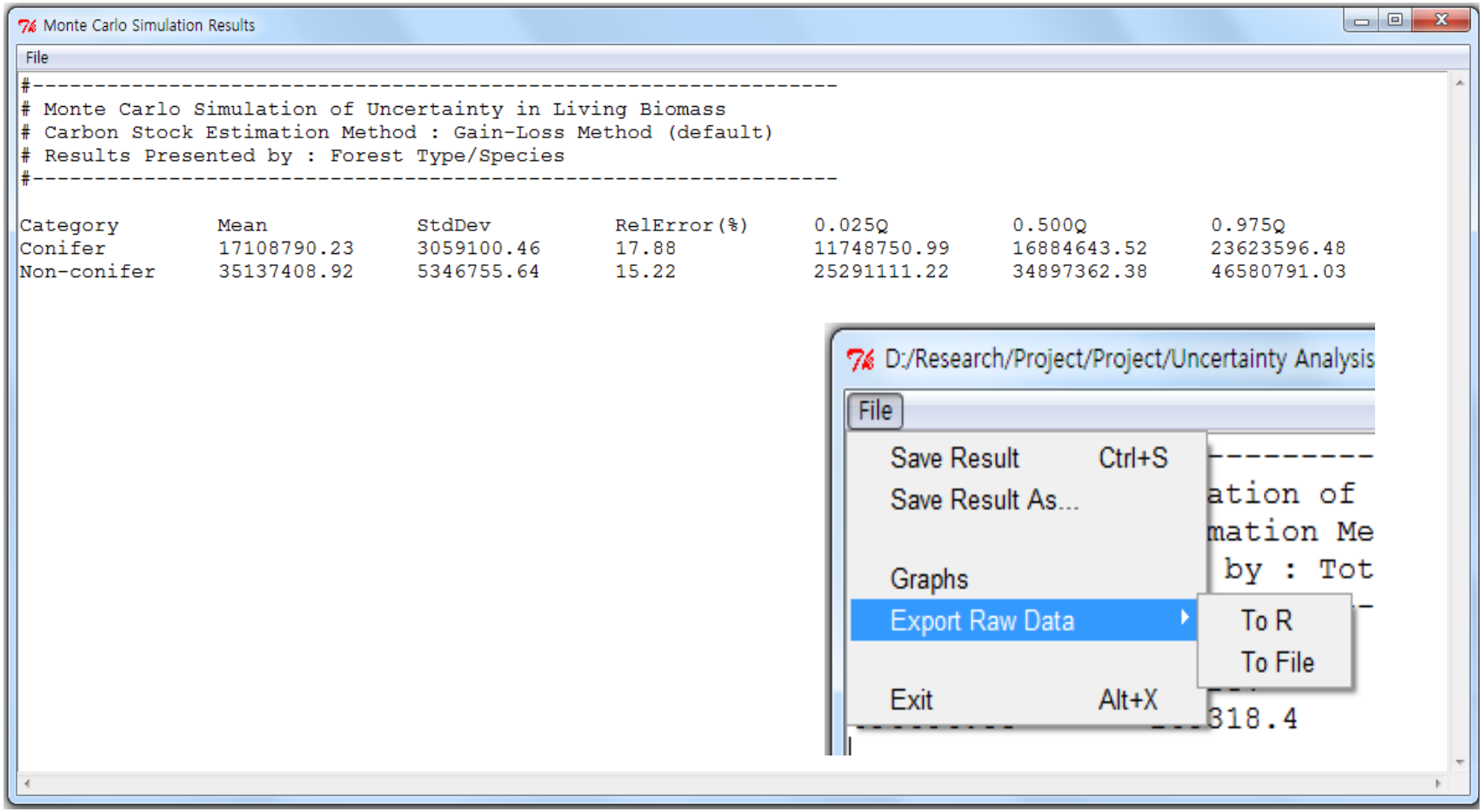
Step 4: Enter the Necessary Information



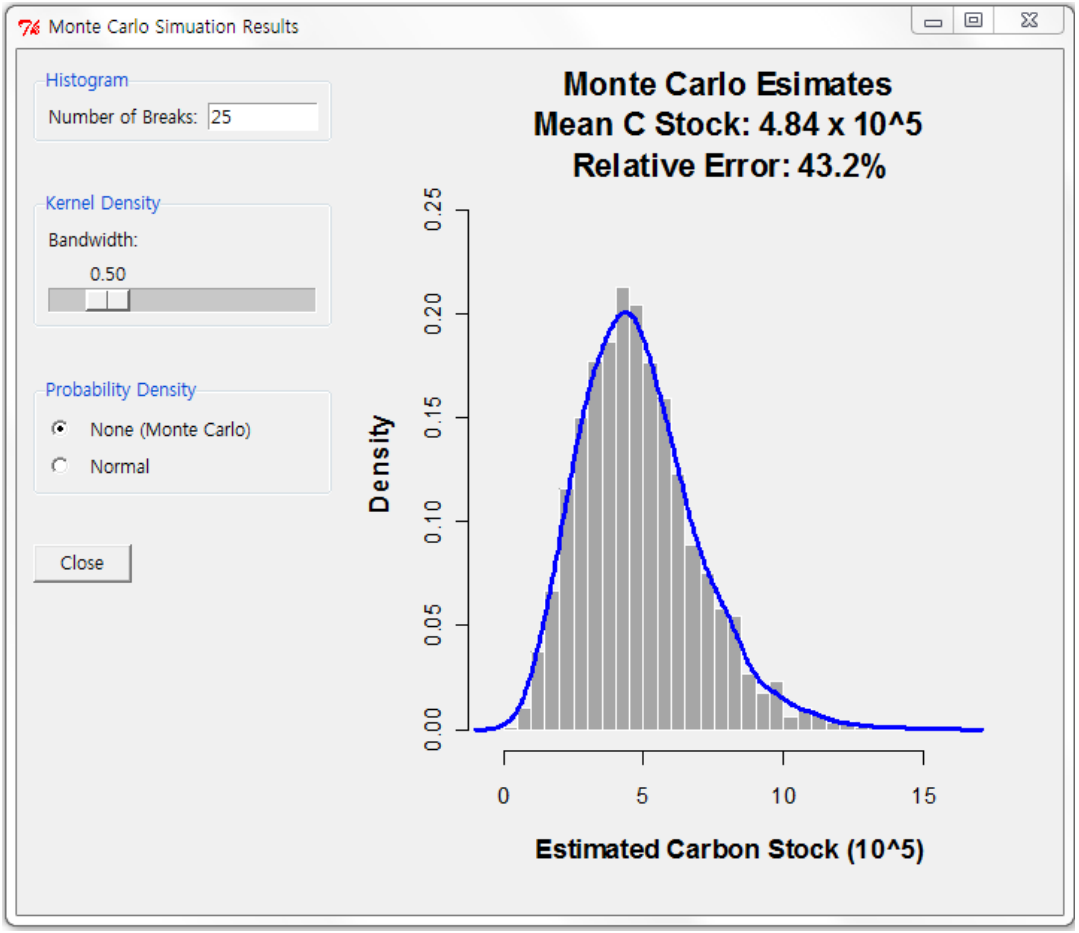
Step 5: Check for Data Error



Step 6: Run the Simulation and get Outputs



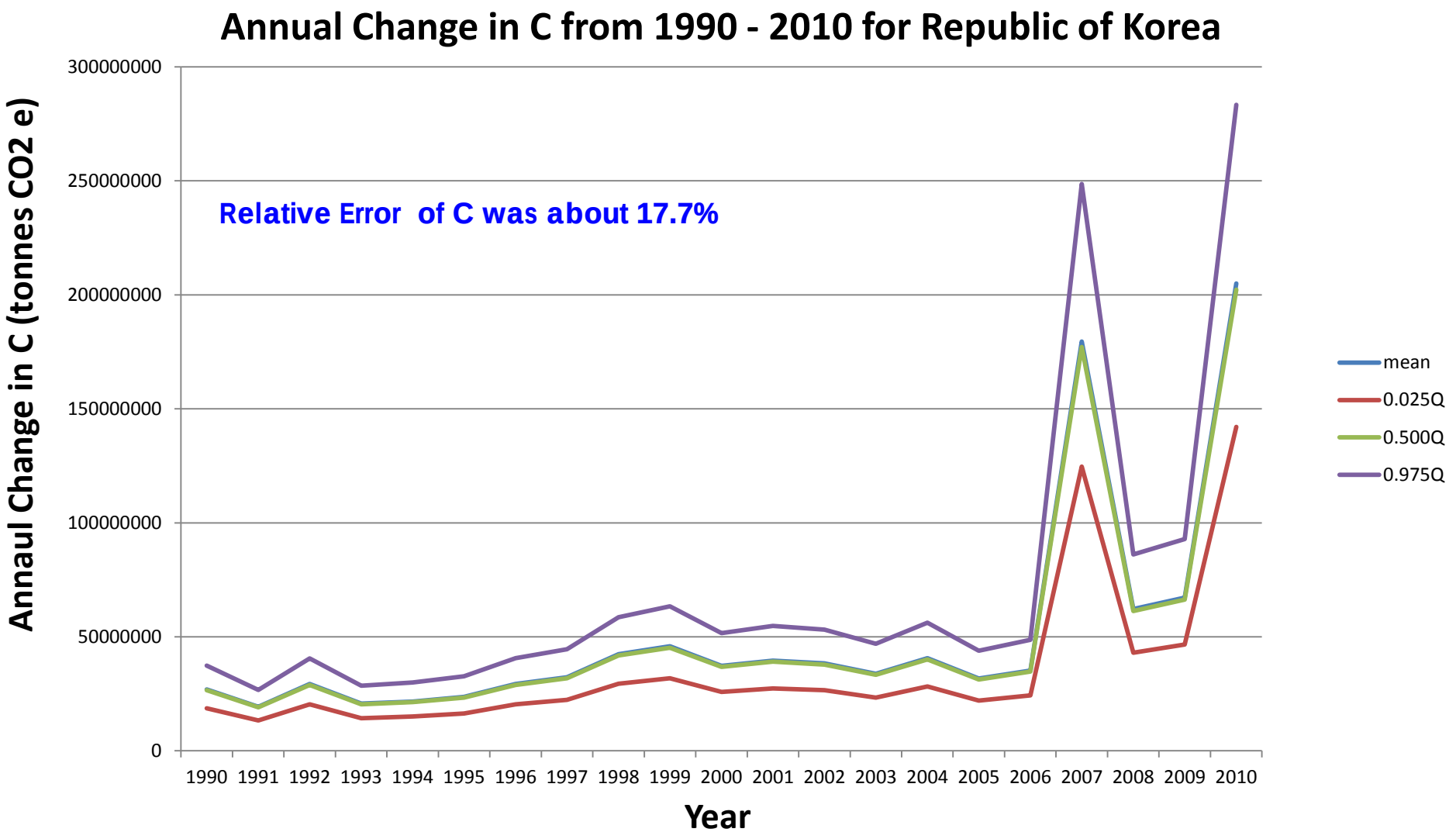
Step 7: Display the Outputs



Estimating uncertainty for 1990 - 2010 emission level of Above- and belowground biomass in Republic of Korea using Gain-Loss Method

- **Data:**
  - **Statistical Yearbook of Forestry published by Korea Forest Service**

- **Assumptions:**
  1. **10% variation for all activity data and emission factors,**
  2. **Activity data are all assumed normally distributed,**
  3. **Emission factors are all assumed lognormally distributed,**
  4. **Half of harvest volume comes from conifer forests and half of harvest volume comes from non-conifer forests,**
  5. **Half of fire damage volume comes from conifer forests and another half from non-conifer forests,**
  6. **All fuelwood gathering come from non-conifer forests,**
  7. **50,000 iterations.**


Annual Change in C from 1990 - 2010 for Republic of Korea
Relative Error of C was about 17.7%
Annaul Change in C (tonnes CO2 e)
300000000
250000000
200000000
150000000
100000000
50000000
0
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010
Year
mean
0.025Q
0.500Q
0.975Q

Thank You for Your Attention!
Questions?