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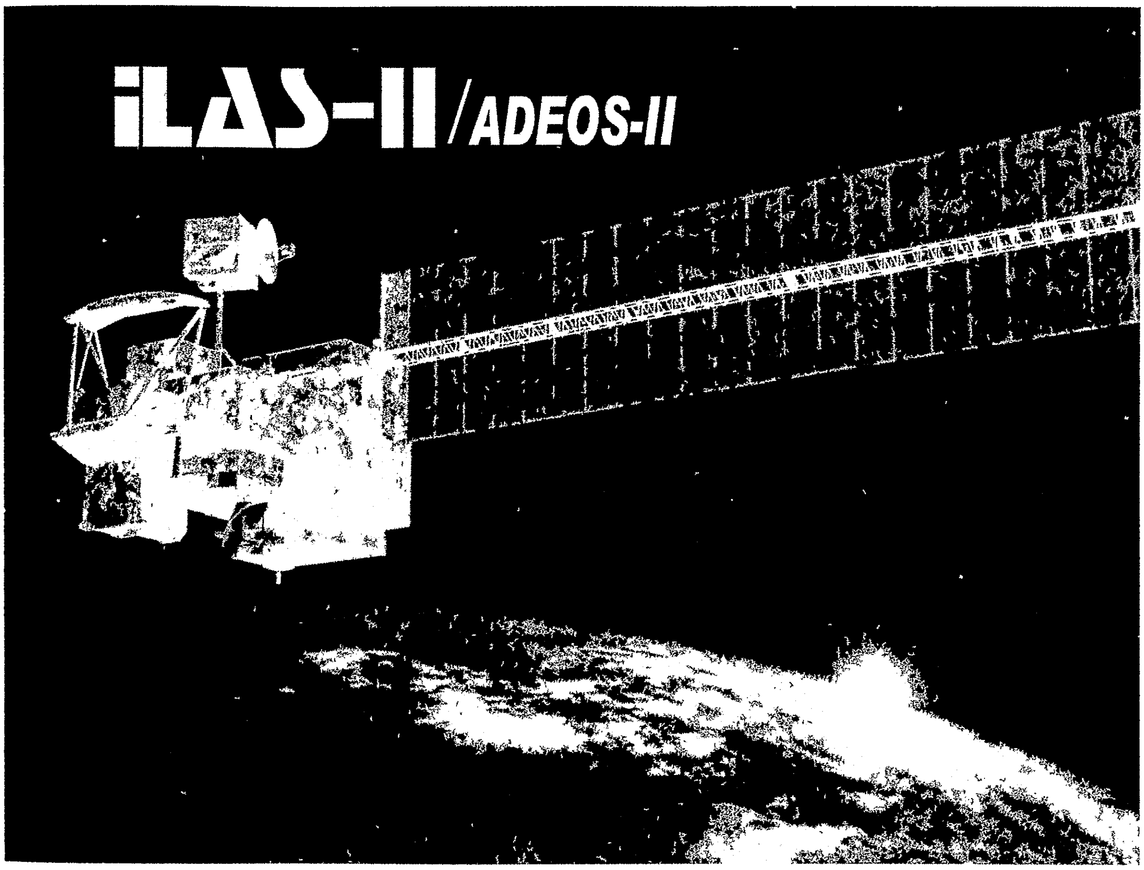
ILAS-II User's Handbook

(Version 1.0)



Edited by
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ILAS-II Project

February, 2001

National Institute for Environmental Studies

Center for Global Environmental Research

Preface

In the 1970s, the problem of ozone layer depletion was raised and discussed at international forums on protecting the global environment and the general public became aware of its seriousness. Various countermeasures were taken under the provisions of the Vienna Treaty and Montreal Protocol adopted in the 1980s. However, since the latter half of the 1990s, some people have believed that the problem of ozone layer depletion had been largely resolved. They seem to think optimistically that ozone layer depletion would get no longer worse and the ozone layer would begin to recover on schedule in the mid 2000s. This is despite the fact that newspaper reports have cited the phenomena, which seems to be ozone holes, being observed over the North Pole in addition to over the South Pole, and that the minimum measured value for ozone in the South Pole has further decreased. Some scientists have expressed their concern that global warming, that is, warming in the troposphere, is closely related to cooling phenomena in the stratosphere, which will hinder restoration of the ozone layer.

To understand the behavior of the stratospheric ozone layer and to predict changes in it, it is necessary to understand all the aspects of ozone, as well as of various atmospheric trace constituents related to ozone layer science, aerosols, polar stratospheric clouds, and temperature distribution and associated changes. To meet this challenge, ILAS (Improved Limb Atmospheric Spectrometer) was developed and the ADEOS spacecraft (Midori) carrying the ILAS instrument was successfully launched in 1996 to monitor the polar ozone layer for the first time. While in orbit, ILAS observed the ozone layer over an eight-month period from November 1996 to June 1997 and acquired data useful for investigating its depletion mechanism. However, ILAS is no longer operational even though it has become increasingly necessary to monitor the ozone layer to predict whether it will recover or deteriorate, and to acquire data for more precise studies. To meet these needs for observation and monitoring, ILAS-II, an improved version of ILAS that features enhanced specifications, a wider observation spectral range, and increased vertical resolution, was developed and is undergoing preparations for launch in 2002. ILAS-II is expected to acquire data useful for understanding the chemical reaction and dynamic processes in the upper atmosphere (from the upper troposphere to the stratosphere) over high-latitude areas in both the northern and southern hemispheres.

This handbook provides information on the standard ILAS-II processed data and related data processed and edited by ILAS-II DHF. It also provides comparisons with ILAS to facilitate use of the data by ILAS users, and includes information on the following topics.

Chapter 1, "Satellite System," gives an overview on observation and monitoring of the ozone layer by ILAS-II, including a description of ADEOS-II (ADvanced Earth Observing Satellite II) with ILAS-II mounted and the ILAS-II observation principle.

Chapter 2, "ILAS-II Data Processing," explains the functions and the configuration of the systems at the ILAS-II Data Handling Facility, and describes the ILAS-II data processing procedure and methods for data evaluation and analysis. Note that the descriptions of the processing procedure also include information which is useful for applying the data.

Chapter 3, "Distribution of ILAS-II Standard Processed Data" gives information on the procedures for searching and ordering standard processed data from ILAS-II. Note that this handbook version (1.0) also describes how general users can access the data distribution service.

Chapter 4, "Contact Points," lists the contact points where users can ask questions about the ILAS-II project and data distribution service.

Chapter 5, "References," provides a list of related materials, terms, and abbreviations for easy reference.

The end of the handbook contains general information such as "Product Format Descriptions," "Guide for Using ILAS-II Data Distribution System," and "List of ILAS/ILAS-II Related Reports". "Product Format Descriptions" explains the formats in which data products are distributed and the method for handling data, and "Guide for Using ILAS-II Data Distribution System" describes the methods for searching and ordering data products using the data distribution system. Finally, "List of ILAS/ILAS-II Related Reports" introduces the reports and articles, which were written in English, published by both internal and external researchers from 1991 to September 2000 for reference. I hope that researchers will find this handbook useful in their studies using ILAS-II data.

February 2001

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1. Satellite System

1.1 Outline of ADEOS-II

(1) ADEOS-II spacecraft

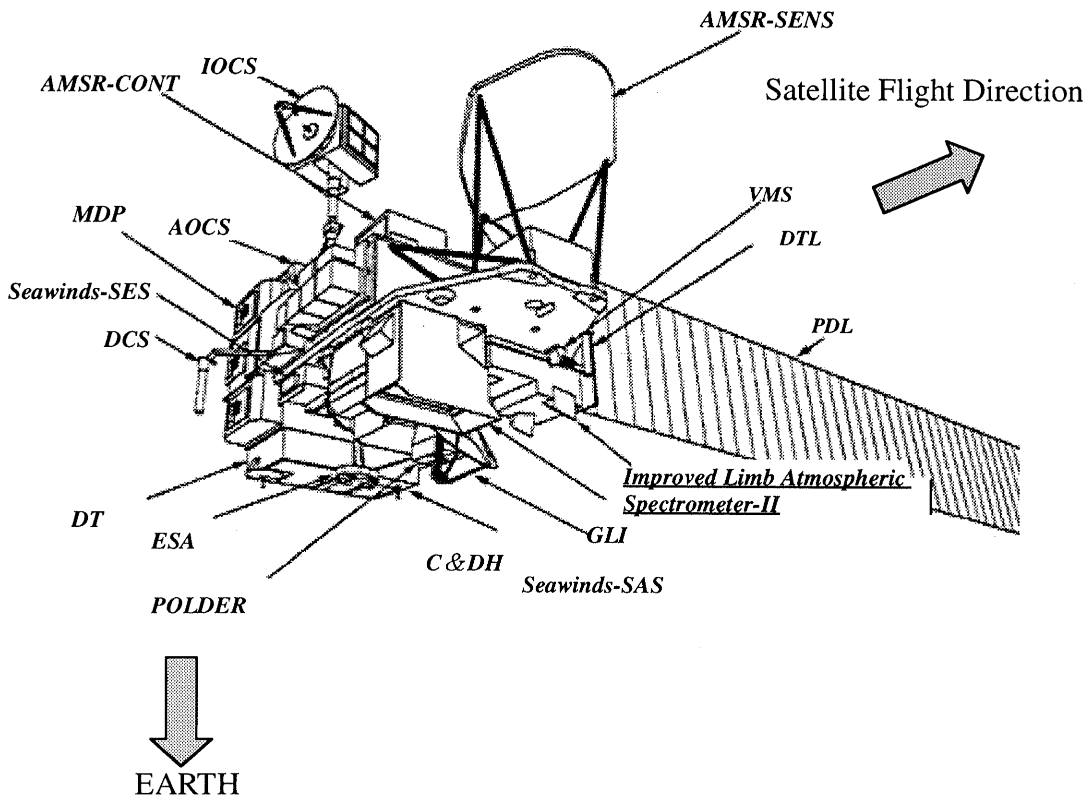


Fig. 1.1-1 External view of ADEOS-II spacecraft (source: the ADEOS-II home page of the National Space Development Agency of Japan (NASDA))

ADEOS-II, mounted with Improved Limb Atmospheric Spectrometer-II (hereafter, simply referred to as ILAS-II), is the successor to ADEOS. Its mission of global environmental monitoring is designed to collect data essential to the studies on various changes in global environmental patterns. The valuable data derived from ADEOS -II allows us to investigate the mechanisms of global environmental changes, such as global warming, depletion of the ozone layer, and abnormal weather events, in various regions throughout the world. ADEOS-II, a large spacecraft with an approximate size of 6×4×4 (m), consists of two modules; a mission module equipped with observation instruments in the front part, and a bus module with primary spacecraft facilities in the rear. As can be seen in Fig. 1.1-1, the mission module is equipped with ILAS-II, as well as with an Advanced Microwave Scanning Radiometer (AMSR), Global Imager (GLI), Sea Winds, Polarization and Directionality of the Earth's Reflectance (POLDER), Data Collecting System (DCS), and Technical Data Acquisition Equipment (TEDA) on the earth-facing side, and the IOCS antenna for relaying inter-orbit communication data and PDL on the opposite, zenith-facing side. The bus module contains Communication and Data Handling (C&DH), Inter-orbit Communications System (IOCS), Mission Data Processing (MDP), Direct Transmission

(DT), EPS, Altitude Orbit Control System (AOCS), and RCS.

(2) ADEOS-II Orbit

ADEOS-II travels in a sun-synchronous sub-recurrent polar orbit at an inclination angle of 98.62° and altitude of about 800 km. It takes approximately 101 minutes to turn around the globe to provide the proper observation granularities required of the sensors for global observation.

Table 1.1-1 Main ADEOS-II specifications

Dimensions	Main body: approx. 6×4×4 m Solar array paddle: approx. 3×24 m	
Mass	Total mass: approx. 3700kg (at launch) Mission instrument mass: approx. 1300kg	
Altitude stabilization	Zero-momentum/3-axis	
Designed life span Propellant	3 years For 5 years	
Launch vehicle	H-II A rocket	
Launch site	Tanegashima Space Center	
Launch period	Winter 2001	
Orbit parameters	Category	Sun-synchronous Sub-recurrent orbit
	Altitude	802.9 km
	Inclination angle	98.62 deg.
	Period	101 min.
	Recurrent cycle	4 days
	Post-through-grid time (local)	10:30 (am) +/-15 min.
Instruments	Improved Limb Atmospheric Spectrometer-II (ILAS-II)	
	Advanced Microwave Scanning Radiometer (AMSR)	
	GLobal Imager (GLI)	
	SeaWinds	
	Polarization and Directionality of the Earth's Reflectances (POLDER)	
	Technical Data Acquisition equipment (TEDA)	

1.2 ILAS Operation Principle and Observation Targets

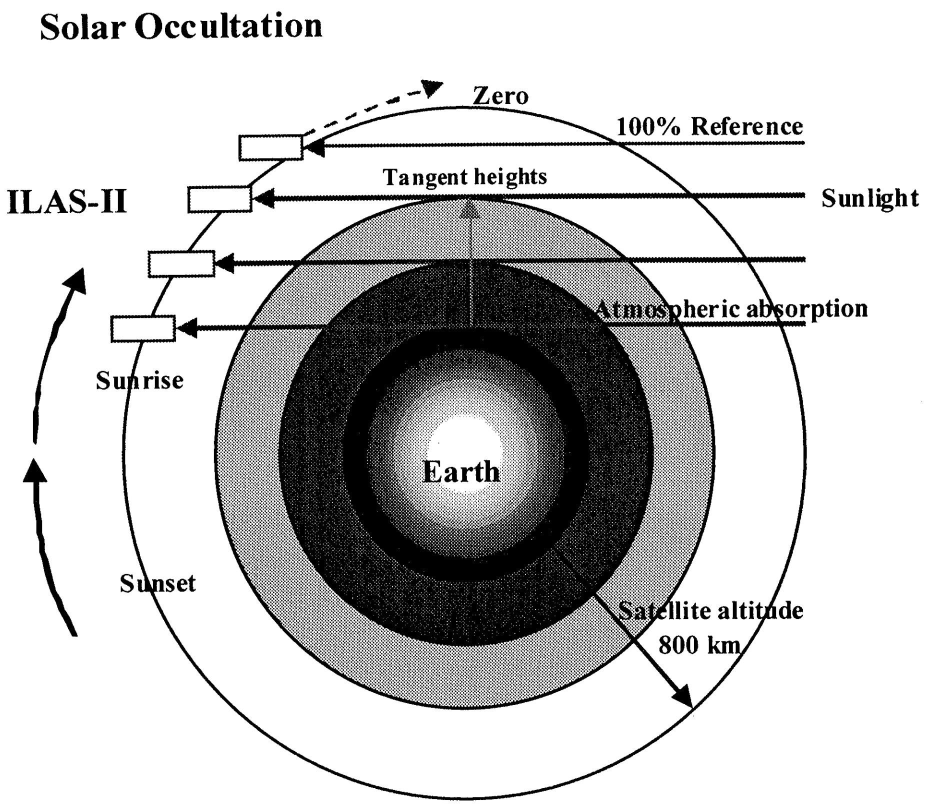


Fig. 1.2-1 ILAS-II Observation Principle

Like ILAS, ILAS-II makes observations based on the Solar Occultation method (Fig. 1.2-1). The usefulness of this principle has been well established by other satellite sensors including SAGE II and HALOE. The Solar Occultation method measures the components of solar light absorbed while passing through the atmospheric layer surrounding the earth and resolves it into spectra. The substances in the atmosphere layer may be identified and quantified through spectral resolution of absorbed light because of their specific spectral absorption characteristics. Continuous observations following the sun's path give us a wide variety of information when sunlight passes through the atmospheric layers at different altitudes. Since sunlight passing through the atmosphere is measured at different altitudes, this provides information on the altitude distribution of the light absorbing substances in the various atmospheric layers. ILAS-II is designed to provide the altitude distributions of the concentrations of ozone (O_3), nitric acid (HNO_3), nitrogen dioxide (NO_2), nitrous oxide (N_2O), water vapor (H_2O), and methane (CH_4). The absorption measurements are done by infrared (IR) channels (ch.1: 6.2 μm - 11.8 μm) and mid-IR channels (ch.2: 3.0 μm - 5.7 μm), from which the aerosol extinction coefficients are also meassured. Compared with ILAS, the accuracy of the aerosol/PSCs measurement by ILAS-II has been vastly improved by incorporating an additional feature for measuring mid-IR spectra. CFC-11 and CFC-12 can be also measured with an altitude resolution and measurement accuracy somewhat lower than those for other gases. Observations of the $ClONO_2$ channel (ch3: 12.78 μm - 12.85 μm) may provide information on the altitudinal distribution of chlorine nitrate ($ClONO_2$). $ClONO_2$ serves as a reservoir of chlorine and is an essential molecule for determining the mechanism and conditions for ozone layer depletion. The data derived from the observations of absorption by oxygen molecules in the visible channel define the altitude distributions of temperature, atmospheric pressure, and aerosol extinction coefficients. The aerosol extinction coefficient data from the measurements in the visible and IR channels identify the types of aerosols (distinction of sulfuric aerosol from the polar stratospheric clouds). ILAS-II has an altitude measurement range of 10 - 60 km and an altitude resolution of 1 km.

The Solar Occultation method provides the highest precision of measurements by using the sun as a higher-intensity light source, and improves reliability by taking measurements of the light source outside the atmosphere and using the resultant data as reference-light data to obtain the attenuation of light through absorption by atmospheric trace constituents. This prevents deterioration of the on-board instruments.

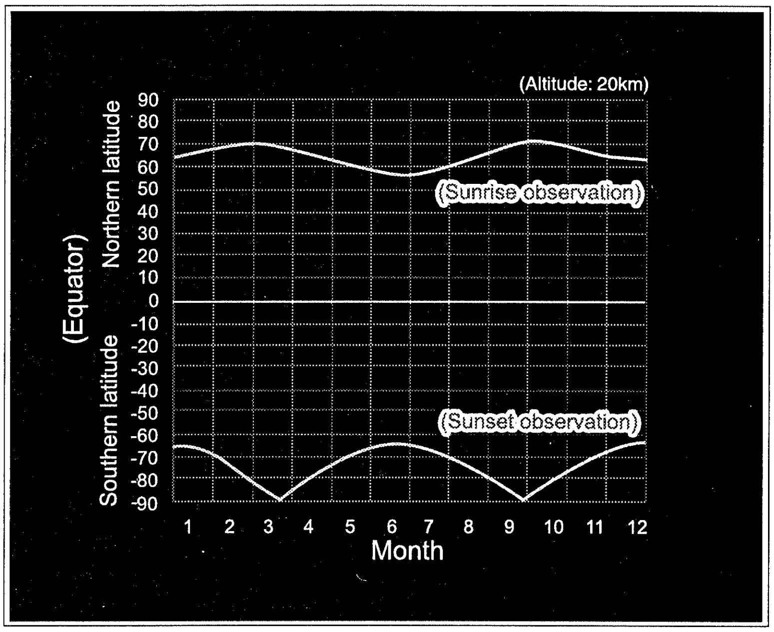


Fig. 1.2-2 ILAS-II Latitudinal range of observation

Since ADEOS-II travels on a sun-synchronous polar orbit and ILAS-II uses the sun as a light source, ILAS-II, like ILAS, can observe only the atmospheric regions above the high latitude areas in both the northern and southern hemispheres (Fig. 1.2-2). SAGE II and HALOE, which are mounted on a spacecraft traveling in a sun-asynchronous polar orbit at low inclination angles, can observe a wider area ranging from high latitudes in one hemisphere to those in the other hemisphere through the equator. However, ILAS-II slowly moves over relatively narrow areas covering a 57 - 72° latitude range in the northern hemisphere and a 65 - 90° latitude range in the southern hemisphere for observation. ADEOS-II revolves around the globe some fourteen times a day, which means that it takes measurements in each hemisphere fourteen times. The fourteen daily measurement points lie along a circle of almost the same latitude, but at 25° longitude apart from one another.

Figure 1.2-3 shows the distributions of the points of ILAS-II measurements during one month, September, in the northern hemisphere and Fig. 1.2-4 shows those in the southern hemisphere. Although ILAS-II is not suitable for global observation, it can detect changes in atmospheric environments in some latitude ranges and follow them in detail at a given time interval. This suggests that we can benefit from ILAS-II repetitive measurements over the narrow areas by obtaining detailed data on the temporal changes in the latitude - altitude cross section. This advantage allows us to collect very uniform measurement data useful for investigating temporal changes in the chemical environment, which is the underlying requirement for understanding stratospheric phenomena, including ozone holes. By observing at the primary points in the stratosphere over high altitude areas, ILAS-II is expected to provide valuable data which enables us to learn about the state of the stratospheric ozone depletion (ozone holes), changes in the chemical environment, and the relationship between these phenomena and state of the atmospheric temperature field.

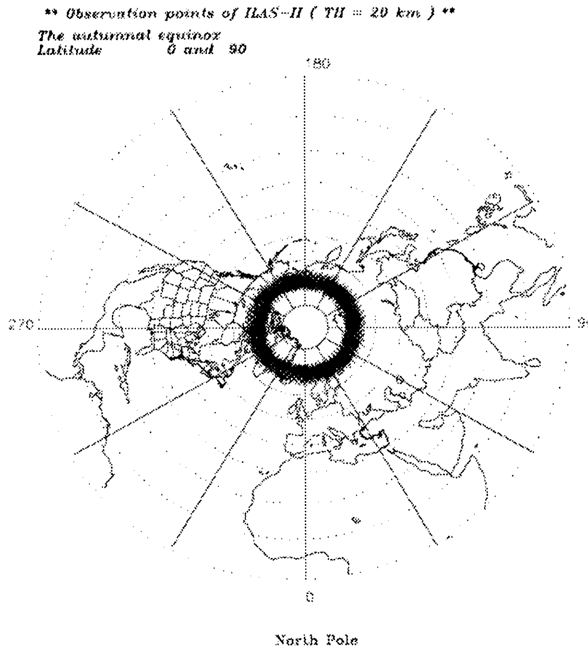


Fig. 1.2-3 ILAS-II Observation points (approximate values of the points in the northern hemisphere during a one-month period, September - polar stereo projection)

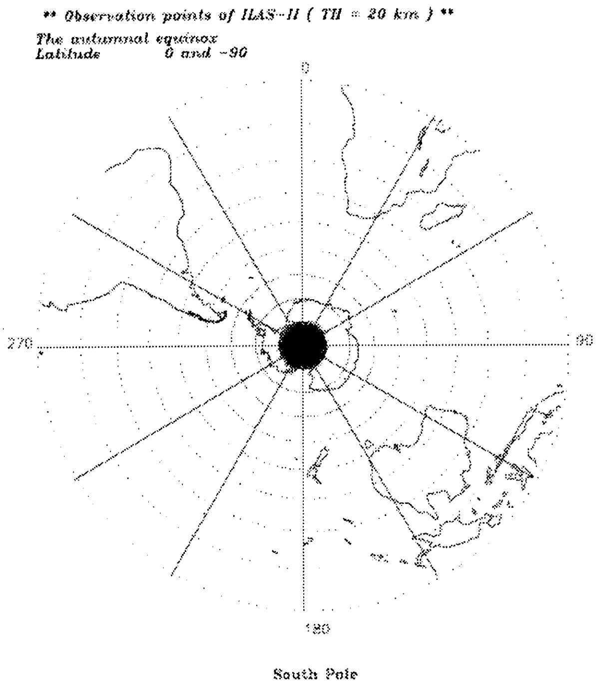


Fig. 1.2-4 ILAS-II Observation points (approximate values of the points in the southern hemisphere during a one-month period, September - parallel projection)

1.3 Outline of ILAS-II

(1) ILAS configuration

ILAS-II has the same basic hardware configuration as that of ILAS (the predecessor of ILAS-II), which is equipped with such fundamental components as a tracking system (gimbal mirror) to track the brightness center of the sun while traveling in its orbit, a spectro-optical system to collect and resolve the incident sunlight into spectra, a signal detection system, electronic circuitry, and a power system. The enhancements of ILAS-II include additional infrared (IR) spectrometers (mid-IR and $ClONO_2$ channels), improved vertical resolution in the instantaneous field of view (1 km), a new feature for scanning the surface of the sun, and a hood that prevents intrusion from debris floating in space. Figure 1.3-1 illustrates an external view of the earth model (EM) with its protective cover (chassis) removed. Table 1.3-1 compares the ILAS and ILAS-II hardware characteristics and Fig. 1.3-2 shows an ILAS-II block diagram[1].

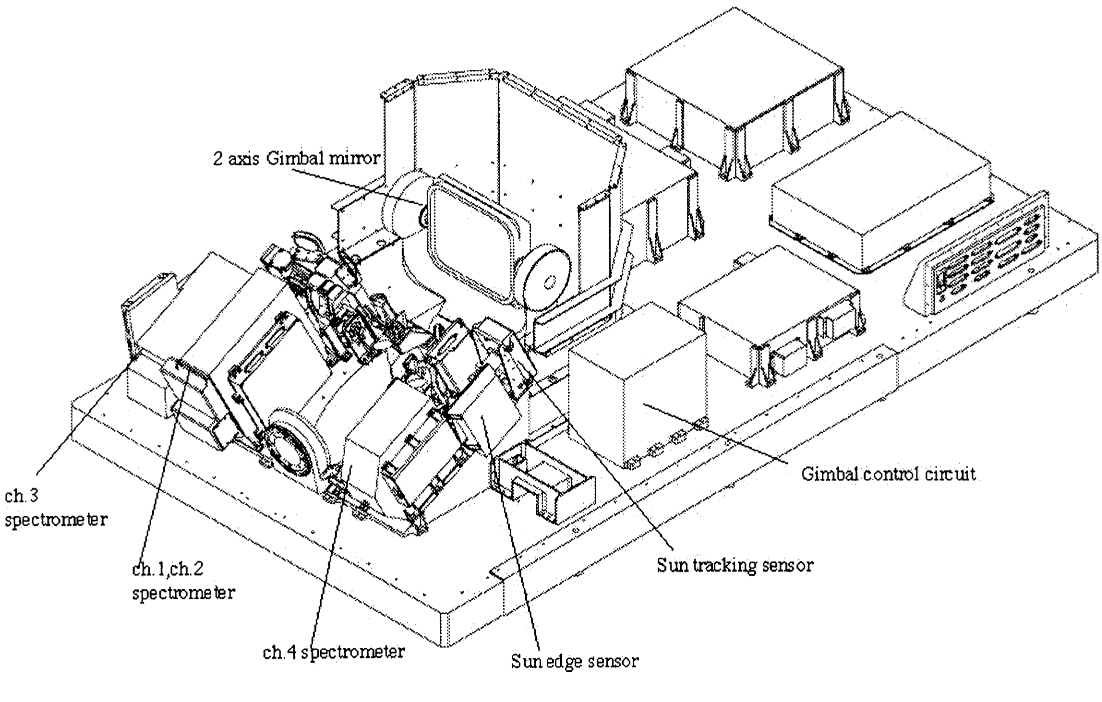


Fig. 1.3-1 Plain view of the ILAS-II instrument

[1] http://www-ilas.nies.go.jp/,
http://adeos2.hq.nasda.go.jp/

Table 1.3-1 Comparison of ILAS and ILAS-II hardware characteristics

			ILAS-II	ILAS	Remarks
Component		Size	950×1670×600 mm	800×1630×550 mm	
		Weight	132.6 kg	130 kg	Measured value
		Power	96 W (118 W) observation (contamination heater ON, nominal)	83 W observation	Power consumption
		Operating time	Sunrise/sunset: 12 min. each	Sunrise/sunset: 10 min. each	
Function	Spectral coverage, IFOV	Ch.1	6.211-11.765 μm (1610-850 cm^{-1}) IFOV: 1 km×13 km output: DC/AD switch	6.211-11.765 μm (1610-850 cm^{-1}) IFOV: 2 km×13 km output: DC	O_3, HNO_3, H_2O, N_2O, NO_2 CH_4, CFC-11, CFC-12, aerosol,
		Ch.2	3.0-5.7 μm (3333-1754 cm^{-1}) IFOV: 1 km×13 km output: DC/AD switch	—	O_3, N_2O, H_2O, CH_4, CO_2 (for pressure measurement), aerosol
		Ch.3	12.78-12.85 μm (782.4-778.2 cm^{-1}) IFOV: 1 km×21.7 km (separate IFOV) output: DC	—	$ClONO_2$
		Ch.4	0.753-0.784 μm (13280-12755 cm^{-1}) IFOV : 1 km×2 km power: DC	0.753-0.784 μm (13280-12755 cm^{-1}) IFOV: 2 km×2 km DC	Temperature, atmospheric density, aerosol
	Detector	Ch.1	0.18 mm×1 mm, pitch 0.2 mm, 44 pixels	0.38 mm×1 mm, pitch 0.4 mm, 44 pixels	Pyro-electric linear array sensor Ch.1, 2: LPF window Ch.3: BPF window
		Ch.2,3	0.18 mm×1 mm, pitch 0.2 mm, 22 pixels		
		Ch.4	0.02mm×2.5 mm, pitch 0.025 mm, 1024 pixels		MOS linear array sensor
	Chopper freq.		30 Hz (4 sampling)	15 Hz	
	Quantization		13 bits + 1 bit	11 bits + 1 bit	
	Sun-edge sensor		Resolution: 8.160 arcsecond - slit image projection	Resolution: 8.196 arcsecond - sun image projection	
	Solar disk scan		yes	no	

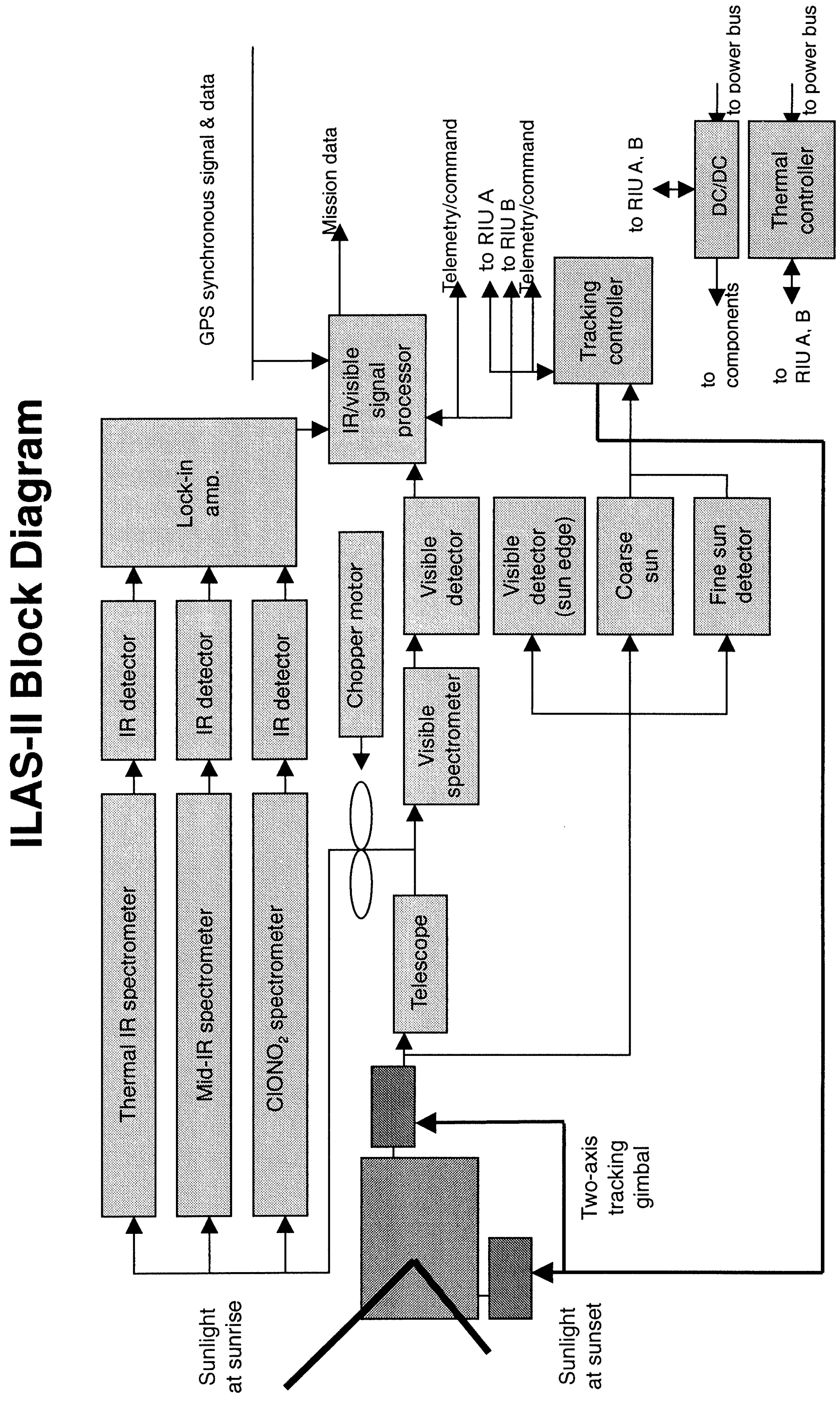


Fig. 1.3-2 ILAS-II Block Diagram

(2) Operation mode

The ILAS-II operation modes are described below.

1) All-off mode

In the All-off mode, all the power sources are off. ILAS-II will initially be in this mode when ADEOS-II is launched. ILAS-II never enters this mode during normal operation.

2) Stand-by mode

In the Stand-by mode, only the power source of the heater is on and other power sources, which are turned on during measurement, are off. This mode may be used to deal with an emergency in ILAS-II. In case of an emergency in ADEOS-II or ILAS-II, we might use the LLM and autonomous commands to sequentially turn the sources off and switch to this mode.

3) Observation at a predetermined position inside ILAS-II

This observation type measures the predetermined positions inside ILAS-II for calibration.

4) Calibration 1

Calibration 1 observes outer space for 0%-level signal calibration.

5) SR observation

SR observation takes measurements of the atmosphere at sunrise and at100%-level signal calibration. It detects and tracks incident sunlight in the atmosphere for observation.

6) Scanning the surface of the sun

This mode observes the surface of the sun through mirror scanning at a constant speed.

7) Calibration 2

Calibration 2 directly observes sunlight for 100%-level signal calibration.

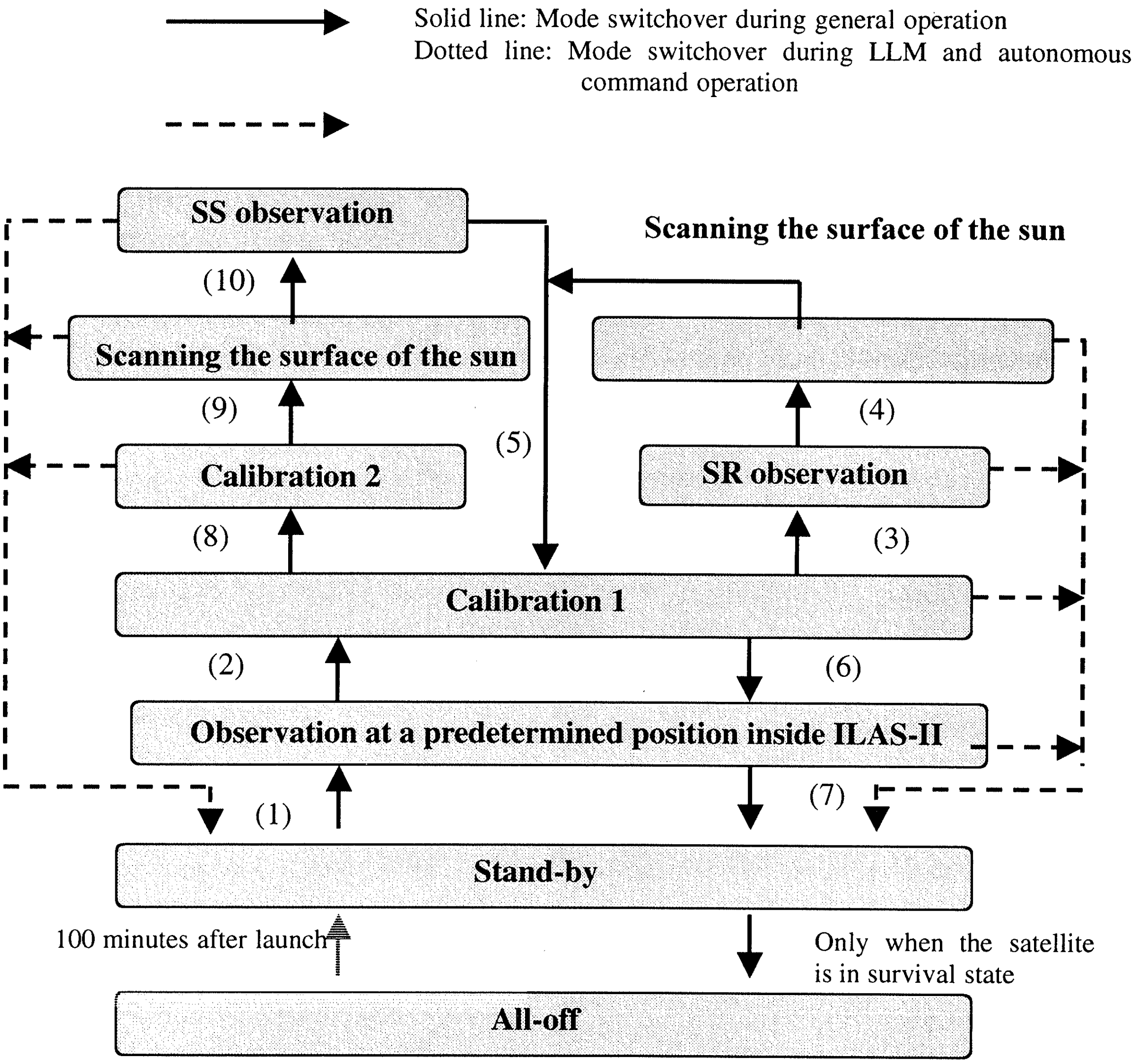
8) SS observation

SS observation takes measurements of the atmosphere at sunset. This mode detects and tracks sunlight incident into the atmosphere for observation.

During one traveling cycle (about 101 minutes), ADEOS-II enters modes 3) to 8) listed above for 12 minutes at sunrise and sunset from its viewpoint, for a total of 24 minutes. Switchover between the modes depends on whether observations are made at sunrise or at sunset.

Figure 1.3-3 shows the switchover between the ILAS-II operation modes.

Mode switchover at sunrise observation: (1) (2) (3) (4) (5) (6) (7)
Mode switchover at sunset observation: (1) (2) (8) (9) (10) (5) (6) (7)



All-off	: The mode when the satellite is launched
Stand-by	: Only the power source of the heater is on
Calibration 1	: 0% calibration
Calibration 2	: 100% calibration
SR observation	: Atmosphere observation at sunrise and 100% calibration
SS observation	: Atmosphere observation at sunset

Fig. 1.3-3 Switchover between ILAS-II operation mode

2. ILAS-II Data Processing

The data derived from ILAS-II observation is received and collected at the Earth Observation Center of NASDA (NASDA/EOC) and the foreign ground station (NASA/Alaska, NASA/Wallops, and Sweden/Kiruna). With information such as satellite orbit data added, the observation data is transferred to the ILAS-II Data Handling Facility (DHF) at the National Institute for Environmental Studies for processing and analysis, and then provided to the ILAS-II project members and its collaborating institutes, as well as finally general users.

2.1 LAS-II Data Handling Facility (ILAS-II DHF)

2.1.1 ILAS-II DHF features

The ILAS-II Data Handling Facility in the Central Research Building III of the National Institute for Environmental Studies is designed not only to operate the ILAS-II data processing system covering a series of processes ranging from receiving ILAS-II data to providing it, but also to evaluate the algorithms and analyze the collected data. DHF has three rooms: a parallel processing room equipped with parallel computers, a database server machine, and a mass-storage system; a control room where operators perform their daily jobs; and an analysis room for algorithm evaluation and data analysis. The facility is linked to NASD/EOC through a high-speed dedicateded digital line (ATM 1 Mbps) and to external researchers and institutes through the Internet.

On the Internet, DHF collects the monthly report of assimilated data on global temperature and atmospheric pressure from the U.K. Meteorological Office, and solar image data from the Communications Research Laboratory in Japan and astronomical observatories in the U.S. at a given granularity. It also provides an information and data distribution service to the members of science and validation experimentation teams, authorized users and general users. Figure 2.1-1 shows the functional schematic of the ILAS-II DHF.

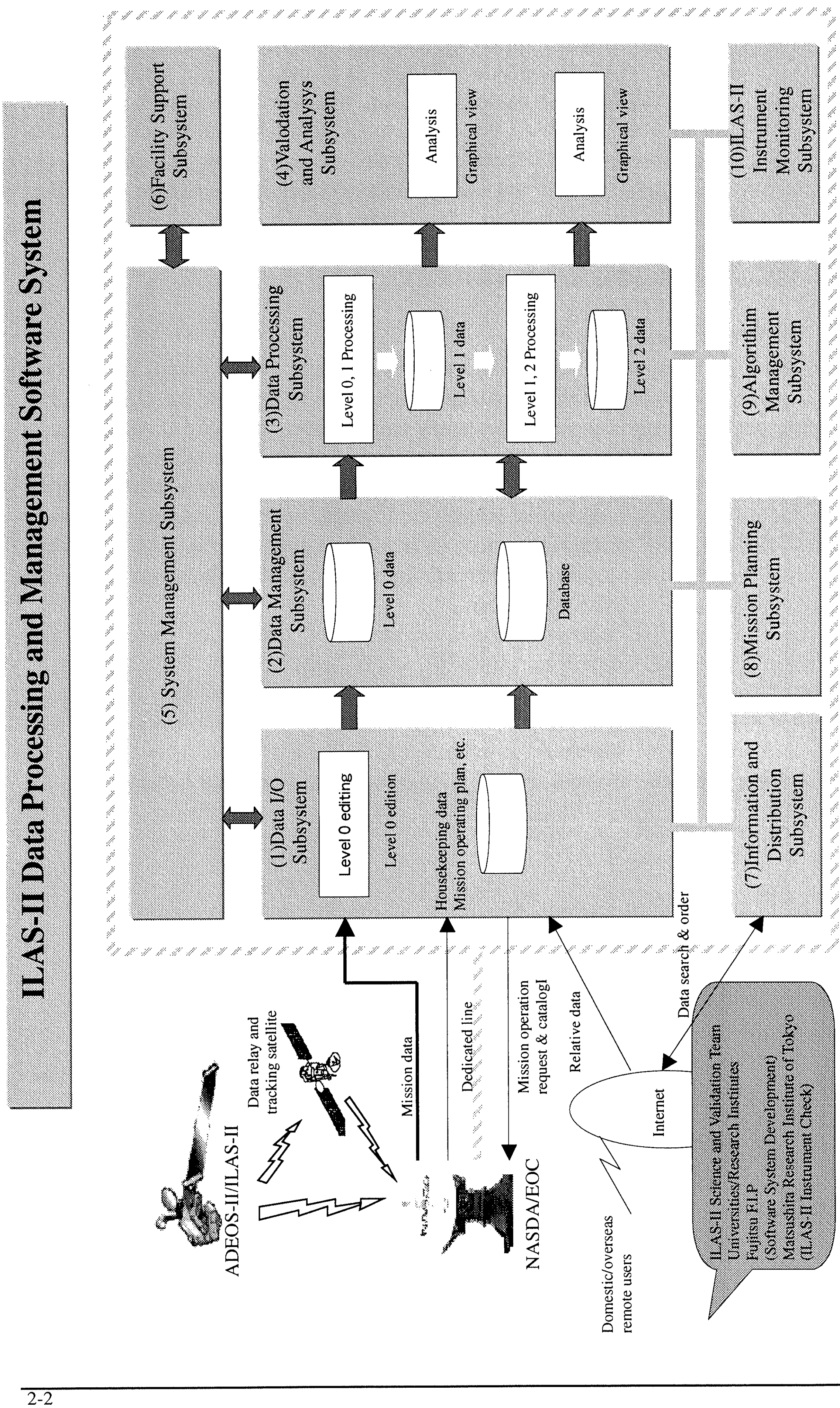


Fig. 2.1-1 Functional schematic of ILAS-II data-processing

2.1.2 DHF software system

The DHF software facility deployed in the ILAS-II DHF covers the entire process: ILAS-II observation planning, acquisition of ILAS-II data from NASDA/EOC on a quasi-real-time basis, data processing/evaluation/analysis, and data distribution to the authorized researchers and general users. The software configuration includes ten subsystems including the data processing subsystem, which is highly independent of each other to facilitate system maintenance and safeguard against failure in any other subsystem. Most software functions are accessible through the user's browser, thus improving operability and allowing remote operation.

(1) System management

System-operation management subsystem

- Manages all the subsystem functions.
- Schedules data processing (regular operation, special operation for research, etc.).
- Displays the activities of data input/output and data processing, and status information.

Data management subsystem

- Stores data and centrally manages it.
- Executes various data manipulations such as registration, update, deletion, and search.

Facility management support subsystem

- Supports operators' jobs (daily/weekly/monthly/ reporting, etc.).
- Executes the support processes such as data backup, data restoration, disk cleaning, etc.
- Monitors facility operation status (through a network, etc.).
- Monitors user activities.

Algorithm management subsystem

- Manages program versions.
- Manages data processing algorithms.

(2) Data processing

Data processing subsystem

- Level 0→1 data processing:

  Useful data extraction, observation point calculation, spike noise and missing value handling, infrared (IR) de-convolution handling, and relative intensity voltage correction, etc.

- Level 1→2 data processing:

  Processing of data from sun-edge sensors, as well as computation of temperatures, atmospheric pressures, aerosol extinction coefficients, gas constituent concentrations, chlorine nitrate concentration, etc.

- Data quality evaluation, etc.

(3) Instrumentation diagnosis

ILAS-II-instrumentation monitoring subsystem

- Monitors ILAS-II sensors.
- Displays housekeeping data.
- Displays mission data.

(4) NASDA interface

Data input/output subsystem

- Transmits/receives data to/from NASDA/EOC.
- Edits level 0 data.
- Obtains data from external institutes.

Mission management subsystem

- Makes a plan of ILAS-II observation requirements.
- Monitors ILAS-II operation status.
- Displays the activities of ILAS-II mission data acquisition.

(5) Data utilization

Evaluation/analysis subsystem

- Evaluates and analyzes ILAS-II data.
- Evaluates and analyzes abnormal data.
- Evaluates and analyzes data provided to researchers.
  (Correlation charts, residual graphs, tracing lines, IFOV positions, solar images, verification experiment support, etc.)

Information distribution subsystem

- Searches and distributes data service products.
- Publishes various types of information on the Web site.
- Supports the jobs that use the available data.

2.1.3 DHF hardware system

To facilitate the processing of the vast amount of ILAS-II data, the ILAS-II DHF computing system comes with an IBM RS/6000 SP that has been configured as a distributed memory-type terminal, to which a total of 48 workstations are connected on the inter-connection network through high-performance switches to function as parallel computers. To store and search a vast volume (more than 5T bytes) of data, mass-storage array disks are now being used in the digital mass-storage system and database. These disks can be accessed using any of the parallel computers or any other computer. Tables 2.1-1 and 2.1-2 show the main hardware specifications of the ILAS-II DHF computing system and Fig. 2.1-2 shows the system configuration.

Table 2.1-1 Main hardware specifications of ILAS-II DHF computing system (part 1)

Name of device		Parts list and specifications
Parllel processing system	CPU	Parallel processing Part: Power2 Super 160 MHz × 1 (44nodes) Serial processing part: PowerPC 604e 332 MHz×4 (4 nodes)
(IBM RS/6000 SP)	Computing performance / nodes (Parallel Processing Part)	SPECint95 8.61 SPECfp95 25.8 Linpack (100x100) 311.9
	SP switch data transfer speed	150 MB/sec (one way)
	Capacity of main memory system	1 GB/ nodes
	Capacity of integrated disk	18.2 GB/ nodes
	Control workstation	RS/6000 43P-140
Data server (IBM RS/6000 F50)	CPU	PowerPC 604e 332 MHz× 4
	Capacity of main memory system	3 GB
	Capacity of integrated disk	77.3 GB
Sub-data server (IBM RS/6000 F50)	CPU	PowerPC 604e 332 MHz× 4
	Capacity of main memory system	2 GB
	Capacity of integrated disk	18.2 GB
Disk array system (IBM 7133 SSA)	Capacity	Total 864.5 GB
	RAID	RAID5
Mass storage system (IBM 3590-B1A x3, 3494-L12,3494-D12)	Capacity	10 GB (uncompressed)×545
	Data transfer speed	9 MB/sec

Table 2.1-2 Main hardware specifications of ILAS-II DHF computing system (part 2)

Name of device		Parts list and specifications
Intranet Sever (Sun Ultra Enterprise 450)	CPU	UltraSPARC-II 300 MHz× 4
	Capacity of main memory system	512 MB
	Capacity of integrated disk	25.2 GB
	External disk	163.8 GB
Workstation for WWW (Sun Ultra Enterprise 450)	CPU	UltraSPARC-II 300 MHz×2
	Capacity of main memory system	512 MB
	Capacity of integrated disk	21 GB
Network	Dedicated line (for NASDA/EOC)	1.0 Mbps (TBD)
	Internet	135 Mbps
In addition to the above devices, Sun SPARC station, IBM RS/6000, IBM PC, Macintosh, and printer are installed for validation, analysis, and data processing.		

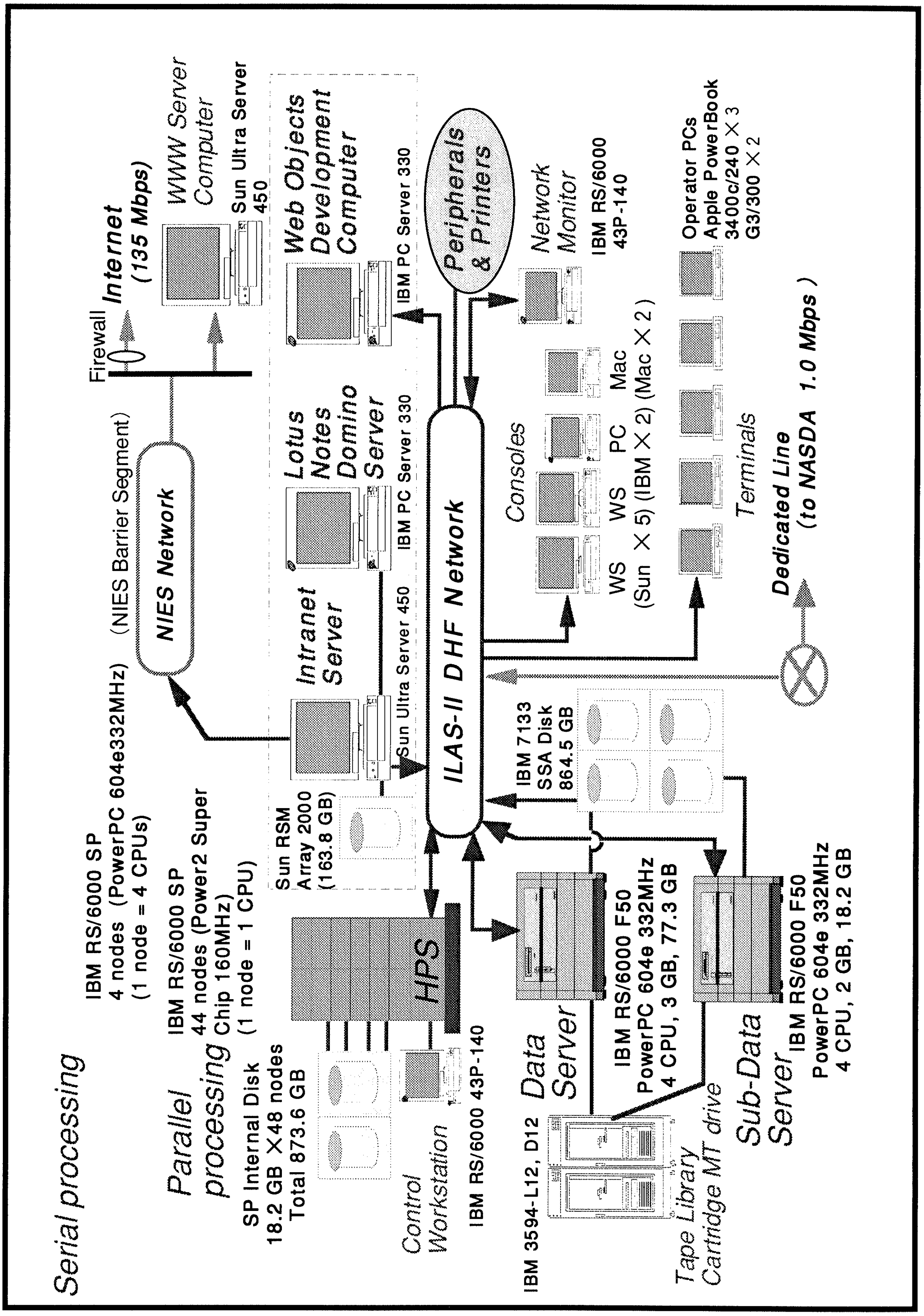


Fig. 2.1-2 Structure of the ILAS-II DHF hardware system

2.2 Receiving and Recording ILAS-II Data

Data from ILAS-II is received at the ground station with measurements from other sensors (AMSR, GLI, SeaWinds, POLDER, TEDA, and DOS) mounted ADEOS-II, HK telemetry and other data through the ADEOS-II mission data processing and telecommunications/data processing systems. ADEOS-II provides two types of transmission systems. In one system, data is transmitted by the inter-orbit communications system (IOCS) through the data relay transmission system to the Earth Observation Center of NASDA and in the other system, data is directly transmitted to the ground station (as with ADEOS). Accordingly, two ILAS-II mission data transmission paths are provided between ADEOS-II and ILAS-II DHF. These paths are described below in detail. Note that ILAS-II mission data includes ILAS-II level 0 data (measured values) and ILAS-II HK telemetry data (temperature and status information of sensors and other instruments).

(1) Transmission path through the data relay spacecraft (Mode 1)

- Data Relay Test Satellite (DRTS) is used for a data relay spacecraft.
- Observation data is recorded in the mounted recorder (MDR) whenever ADEOS-II travels around the earth one time, and received at the ground NASDA/EOC station through the Ka band during the next measurement via DRTS
- The NASDA/EOC station, after receiving the raw data, refines it into ILAS-II mission data (level 0 data and HK telemetry data), then transmits it to ILAS-II DHF.
- LAS-II DHF may obtain ILAS-II level 0 data within four hours after ILAS-II observation provided there is no equipment failure.

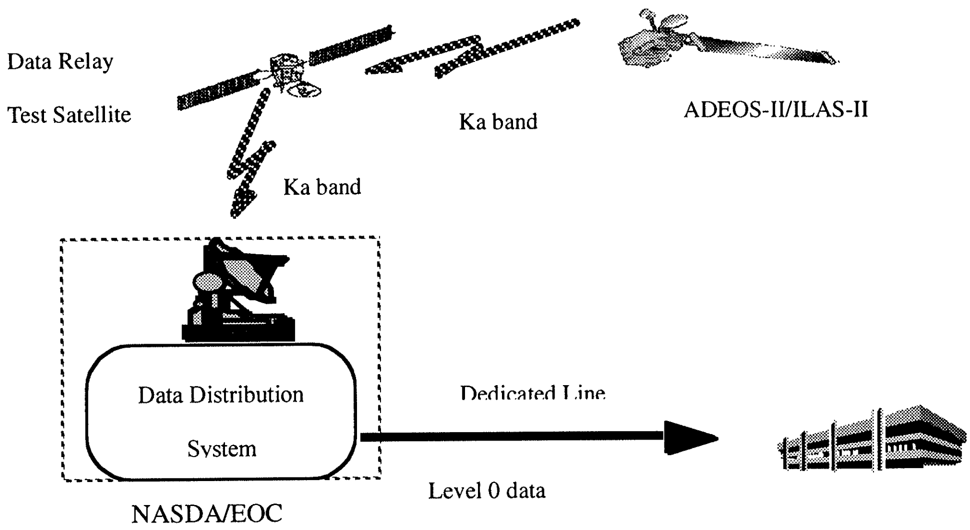


Fig. 2.2-1 Mission data transmission path between ADEOS-II and ILAS-II DHF (part 1)

(2) Path direct to the ground station (Mode 2)

- Observation data is recorded in MDR installed on the spacecraft whenever it travels around the earth one time and transmitted directly to the ground station (NASDA/EOC, foreign stations:NASA/ALS, NASA/WFF, and Kiruna stations, etc.) through the X band.
- Any of the stations receiving the data can separate it into ILAS-II level 0 and ILAS-II HK telemetry components to transmit it to ILAS-II DHF on an on-line basis. Any data received at the foreign stations is forwarded to ILAS-II DHF through NASDA/EOC on the dedicated transmission line.
- Provided there is no equipment failure, ILAS-II DHF may obtain ILAS-II mission data within five hours after ILAS-II observation.

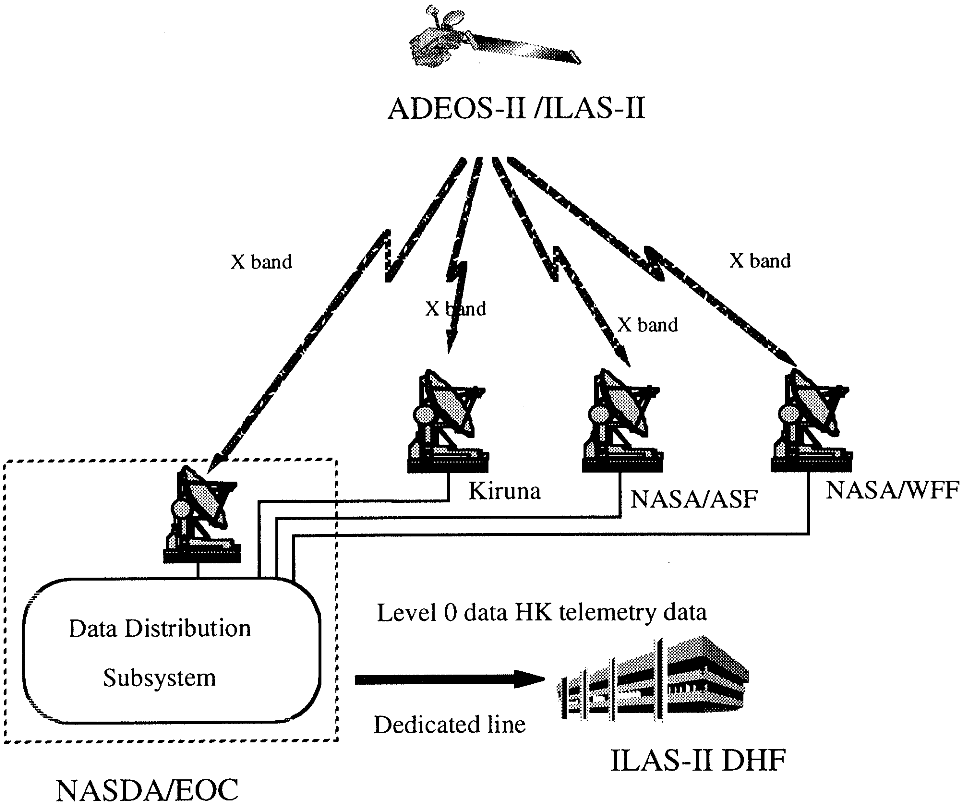


Fig. 2.2-2 Mission data transmission path between ADEOS-II and ILAS-II DHF (part 2)

2.2.1 Receiving ILAS-II measurement data

(1) Editing level 0 data

ILAS-II mission data is available from NASDA/EOC on the dedicated line. ILAS-II mission data includes ILAS-II 0 level data and ILAS-II HK telemetry data, both are received at NASDA/EOC and the foreign stations. ILAS-II level 0 data is the time-series data from ILAS-II sensor observation that is extracted from raw data including data from other sensors. This data is transmitted to ILAS-II DHF as a sequential volume of the data received and recorded at the ground station. For this purpose, ILAS-II DHF must edit this data into individual ILAS-II sensor occultation events. The edited ILAS-II occultation event data is defined as "edited level 0 data". ILAS-II occultation event data are defined as shown in the following figure.

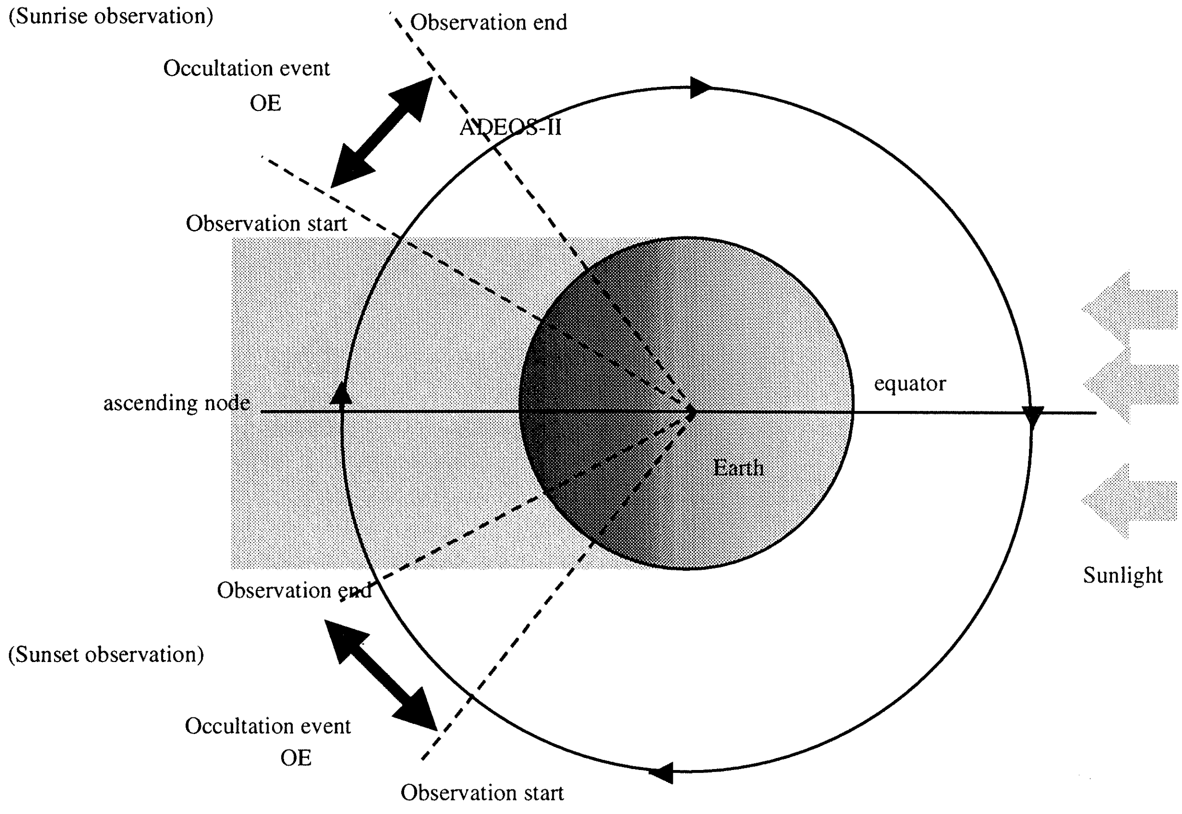


Fig. 2.2-3 Definition of ILAS-II occultation event data

(2) Interface connecting NASDA and ILAS-II

Figure 2.2-4 shows the connection schematic for transmitting and receiving ILAS-II mission data and other status information files between NASDA/EOC and ILAS-II DHF. The stations are connected by the dedicated line. The file interface system used for data exchange at NASDA/EOC is the edited-data transmission subsystem, through which ILAS-II mission data passes. ILAS-II DHF uses the necessary functions of the data I/O subsystem to provide a NASDA file interface.

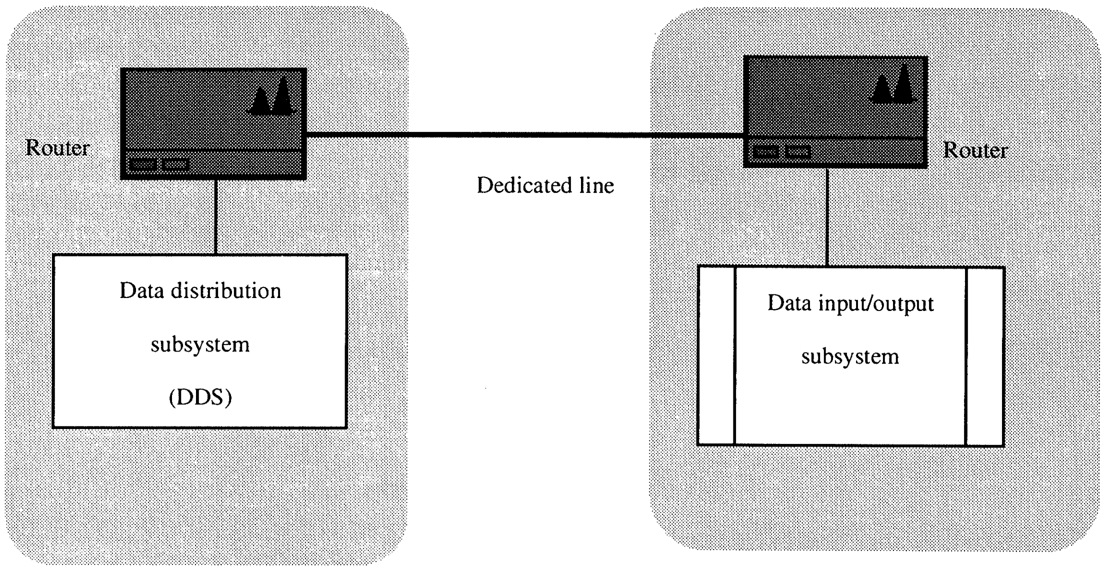


Fig. 2.2-4 Connection schematic between ILAS-II DHF and NASDA/EOC

(3) Data transmission procedure

Between NASDA/EOC and ILAS-II DHF, data is transmitted and received by issuing Ready for Data Transmission and Data Reception Completed notifications through a mail handling process. Actual data are obtained as FTP data. Figure 2.2-5 shows how data is handled.

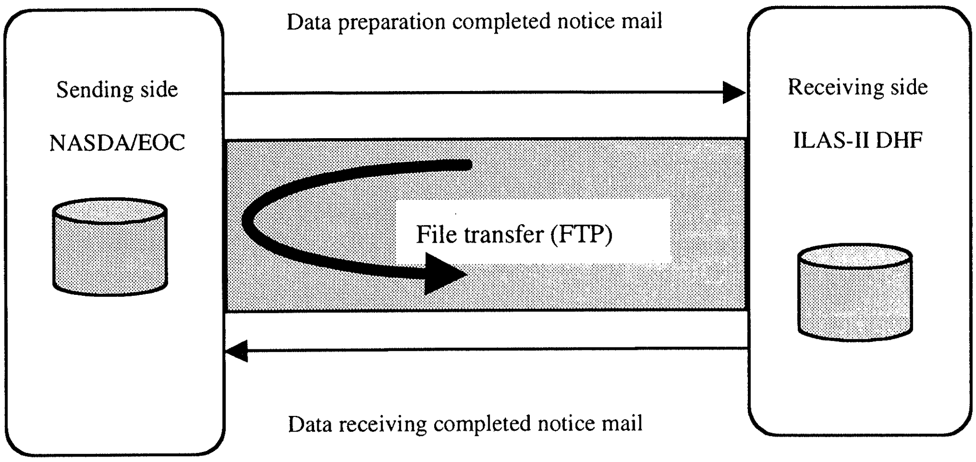


Fig. 2.2-5 Handling of data

ILAS-II mission data

- The sending station (NASDA/EOC) notifies the receiving station by SMTP mail that it is ready for data transmission (ILAS-II DHF).
- The receiving station accesses the system specified by the sending station and obtains ILAS-II mission data as TCP/IP FTP data.

The receiving station notifies the sending station by SMTP mail that it has received the transmitted data.

2.2.2 Recording ILAS-II observation data

NASDA/EOC and ILAS-II DHF constantly exchange various types of data including ILAS-II mission data necessary for ILAS-II operation. ILAS-II DHF records and manages not only observation data but also all the related information. Figure 2.2-6 shows the data exchange between NASDA/EOC and ILAS-II DHF and Table 2.2-1 describes the contents of the exchanged data.

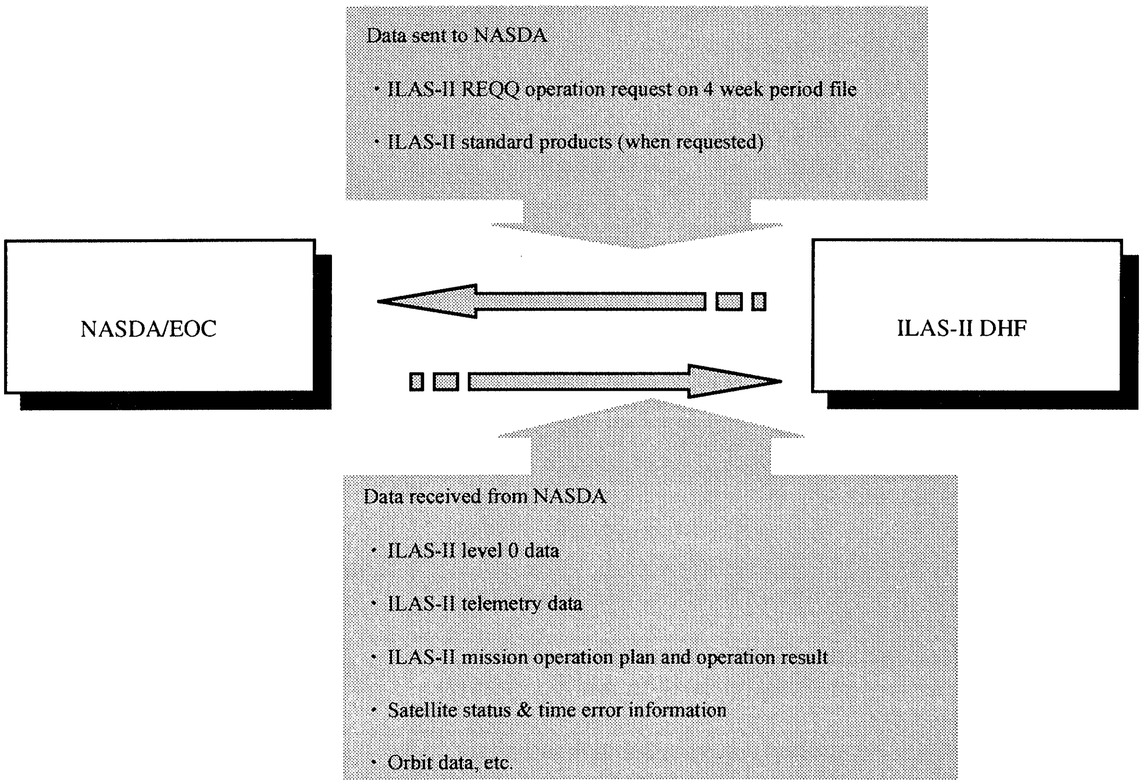


Fig. 2.2-6 Data exchanged between NASDA and ILAS-DHF

Table 2.2-1 Description of data content

Recording items	Contents
ILAS-II observation request	Parameter and command information required for operating sensor of ILAS-II
ILAS-II data of standard products	ILAS-II products for distribution
ILAS-II level 0 data	ILAS-II observation data consisting of PCD data basket, and including PCD data and information on packet defects
ILAS-II HK telemetry data	House-keeping data showing the conditions of the ILAS-II sensor
Plan of ILAS-II observation	Plan of sensor operation which was planned by NASDA
Conditions of the satellite and time error	Data on status of the satellite and ground station, and information on time error
Orbit data, etc.	Forecasted data and actual data on flying orbit at one-minute intervals
ILAS-II observation results	Data received and recorded at NASDA/EOC and foreign stations

2.3 ILAS-II data processing

2.3.1 Definition of processed ILAS-II data

Level 0 data, which is ILAS-II observation data, is transmitted from NASDA/EOC to ILAS-II DHF, where it is edited into occultation event level 0 data for further processing. The processed data are classified into levels 0a, 0b, 0c, 1, 1s, 1a, and 2 according to the degree of processing. The ILAS-II data subject to ILAS-II data processing are defined in Table 2.3-1.

Table 2.3-1 Definitions of ILAS-II data

Data type	Definition	Availability	Storage period
Level 0 data	ILAS-II mission data distributed from NASDA/EOC, which consists of CCSDS source packets. This data contains PCD data and missing packet information.	No	Long
Level 0a data (L0a data)	Data parts extracted from edited level 0 data: inner instrument observation part, outer-space observation part, atmospheric transmittance part, 100% signal, sun surface scanning part, which are necessary for later processing	No	Long
Level 0b data (L0b data)	Data after processing for spike noise and missing value handling	No	Temporary
Level 0c data (L0c data)	Data after infrared (IR) deconvolution, which exists only in IR region data (IR, mid-IR, $ClONO_2$ channels)	No	Temporary
Level 1 data (L1 data)	Data in the atmospheric transmittance part after pseudo-transmittance computation	No	Temporary
Level 1s data (L1s data)	Data in the sun surface scanning part after pseudo-transmittance computation	Yes (PS,ST,VT)	Long
Level 1a data (L1a data)	Data after sunspot correction	No	T.B.D
Level 2 data (L2 data)	Retrieval processing result data. To calculate vertical profiles of the following products and error of the vertical profiles: ・ Standard product - Concentration of minor atmospheric constituents (O_3, HNO_3, NO_2, N_2O, H_2O, CH_4) - Visible aerosol extinction coefficients - Visible temperature and atmospheric pressure ・ Research product Concentration of minor atmospheric constituents (CFC-11, CFC-12, COF_2, CO_2, CO, OCS, C_2H_6, N_2O_6, $ClONO_2$), IR and mid-IR aerosol extinction coefficients, mid-IR temperature and pressure	Yes	Long

2.3.2 Data processing procedure

Level 0 data, which is ILAS-II observation data received from NASDA/EOC, is edited into occultation event units and then processed at ILAS-II DHF. The data processing procedure involves the four stages of pre-processing, level 0 to 1 processing, level 1 to 2 processing, and post-processing.

(1) Pre-processing

Pre-calculates table data necessary for level 0 to 1 and level 1 to 2 processing and sets the computation conditions.

(2) Level 0 to 1 processing

Extracts useful observation data, handles spike noise and missing values as well as infrared (IR) data deconvolution, and executes data drift and relative brightness corrections to obtain relative pseudo-transmittance values (level 1 data).

(3) Level 1 to 2 processing

Obtains solar angles of the field of view using sun-edge determination and retrieves various types of physical volumes from L1a data, from which the effects of solar limb darkening extinction and sunspots have been removed.

(4) Post-processing

Evaluates data quality.

Figure 2.3-1 and Table 2.3-2 show the functional schema of ILAS-II data processing.

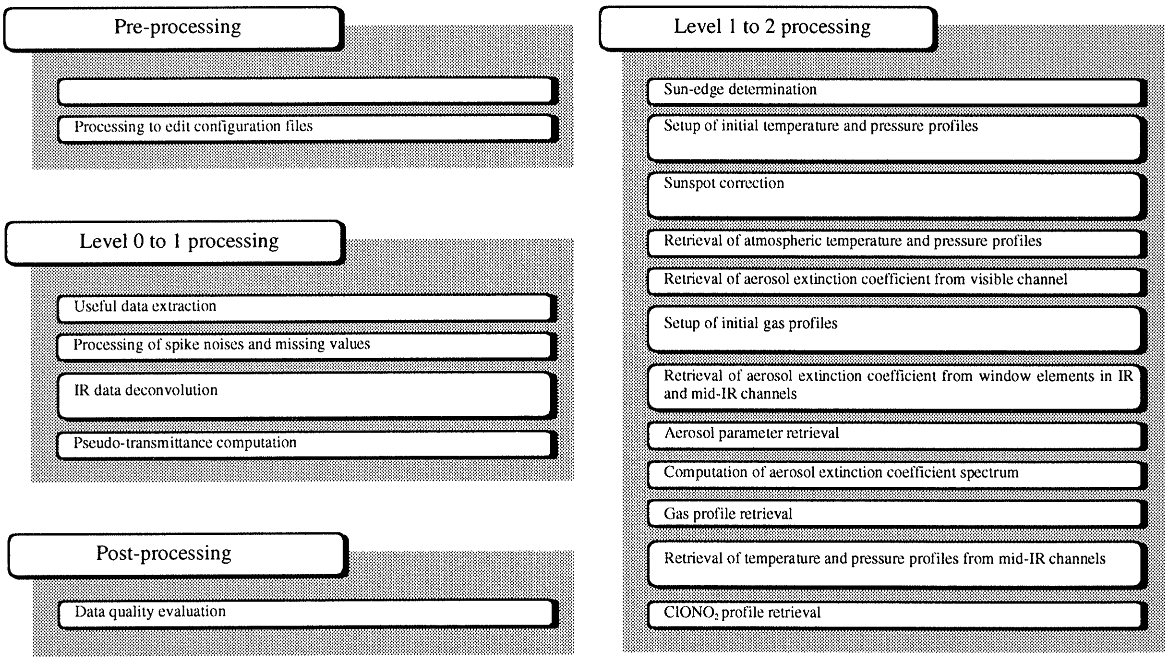


Fig. 2.3-1 Functional schema of ILAS-II data processing

Table 2.3-2 Functional structure of the ILAS-II data processing

Function		Description
Pre-processing function		
	Function to edit various tables	To produce and edit tables, which are used for ILAS-II data processing including P-T table, sun irradiance table, instrument function, lock-in amplifier response function.
	Function to produce processing condition file	To fix the calculation condition when processing data.
Function of level 0 to 1 processing		
	Useful data extraction	To extract the necessary part from edited L0 data, check data, and fix flag on observation.
	Spike noise and missing value handling	To extract spike noise and adjust the time of each channel data, edit IR 4 sampling data, and convert IR data from AC to DC format.
	IR data deconvolution	To remove the effects of time constant of lock-in-amp from observation data.
	Pseudo-transmittance computation	To convert the observation value to pseudo-transmittance by using 0% signal and 100% signal which consider the drift effect of element signal.
Function of level 1 to 2 processing		
	Sun-edge determination	To compute solar angles between the edge of the sun and center part of IFOV, which are needed for determination of the ray path, using data from the sun-edge sensor.
	Setup of initial temperature and pressure	To produce the initial profiles of temperature and pressure, which are used for temperature and pressure computation processing.
	Sunspot correction	To correct the transmission calculation error caused by sunspots, limb darkening, or sun tracking error, using sun surface scanning data.
	Retrieval of temperature and pressure profiles	To retrieve temperature and pressure profiles from level 1a data of visible channel after correction of signal drift and effect of sunspots.
	Retrieval of aerosol extinction coefficients from visible channel	To calculate profiles of aerosol extinction coefficients after subtracking the components of ozone Wulf band absorption and Rayleigh scattering from visible channel data around 780 nm.
	Setup of initial gas profiles	To calculate and produce the initial gas profiles which are used in the following procedures such as IR and mid-IR aerosol extinction calculation, gas retrieval, and $ClONO_2$ retrieval.
	Retrieval of aerosol extinction coefficients from window elements in IR and mid-IR channels	To derive vertical profiles of the IR and mid-IR aerosol extinction coefficients at the window elements in the IR and mid-IR channels.
	Aerosol parameter retrieval	To retrieve aerosol extinction coefficients from window elements in visible, IR and mid-IR channels. The aerosol parameters are retrieved by fitting the theoretical pattern of the extinction coefficients to the data with a non-linear least squares method.
	Computation of aerosol extinction coefficient spectrum	To estimate the aerosol extinction coefficient spectrum by Mie scattering calculation at fixed wave number intervals in the IR and mid-IR region from the previously calculated aerosol parameters and reflective indices of the aerosol type discriminated from the previous procedure.

	Gas profile retrieval	To derive profiles of minor gas constituents by fitting the theoretical spectrum to the measurement data of the IR and mid-IR channels which are corrected for signal drift and the effects of sunspots. This fitting method is a forward procedure, and is a non-linear least squares method.
	Retrieval of temperature and pressure profiles from IR and mid-IR channels	To retrieve atmospheric temperature and pressure profiles by fitting the theoretical spectrum to the measurement data of the IR and mid-IR channels which are corrected for signal drift and the effects of sunspots. This fitting method is a forward procedure, and is a non-linear least squares method.
	$ClONO_2$ profile retrieval	To detect $ClONO_2$ profiles by fitting the theoretical spectrum to the measurement data of the IR and mid-IR channels which are corrected for signal drift and the effects of sunspots. This fitting method is a forward procedure, and is a non-linear least squares method.
Post-processing		
	Data quality evaluation	Data quality is judged by a threshold which is dependent on the error information about the instrument operation error, level 0 to level 1 processing error, level 1 to level 2 processing error, or error and residual information stored in the data quality log file. This data quality information is edited and registered in the database.

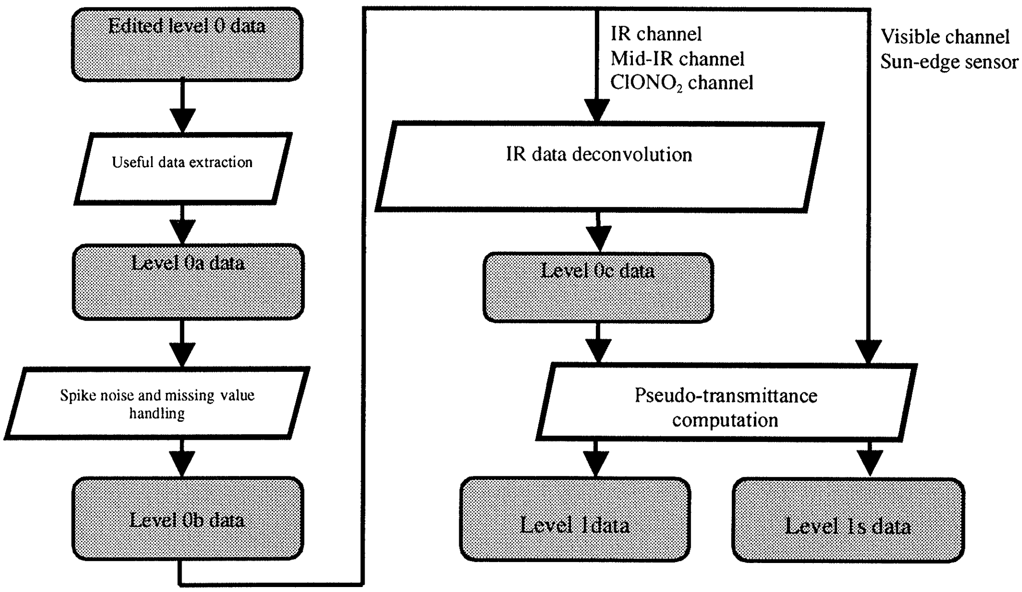


Fig. 2.3-2 Flow of level 0 to 1 processing

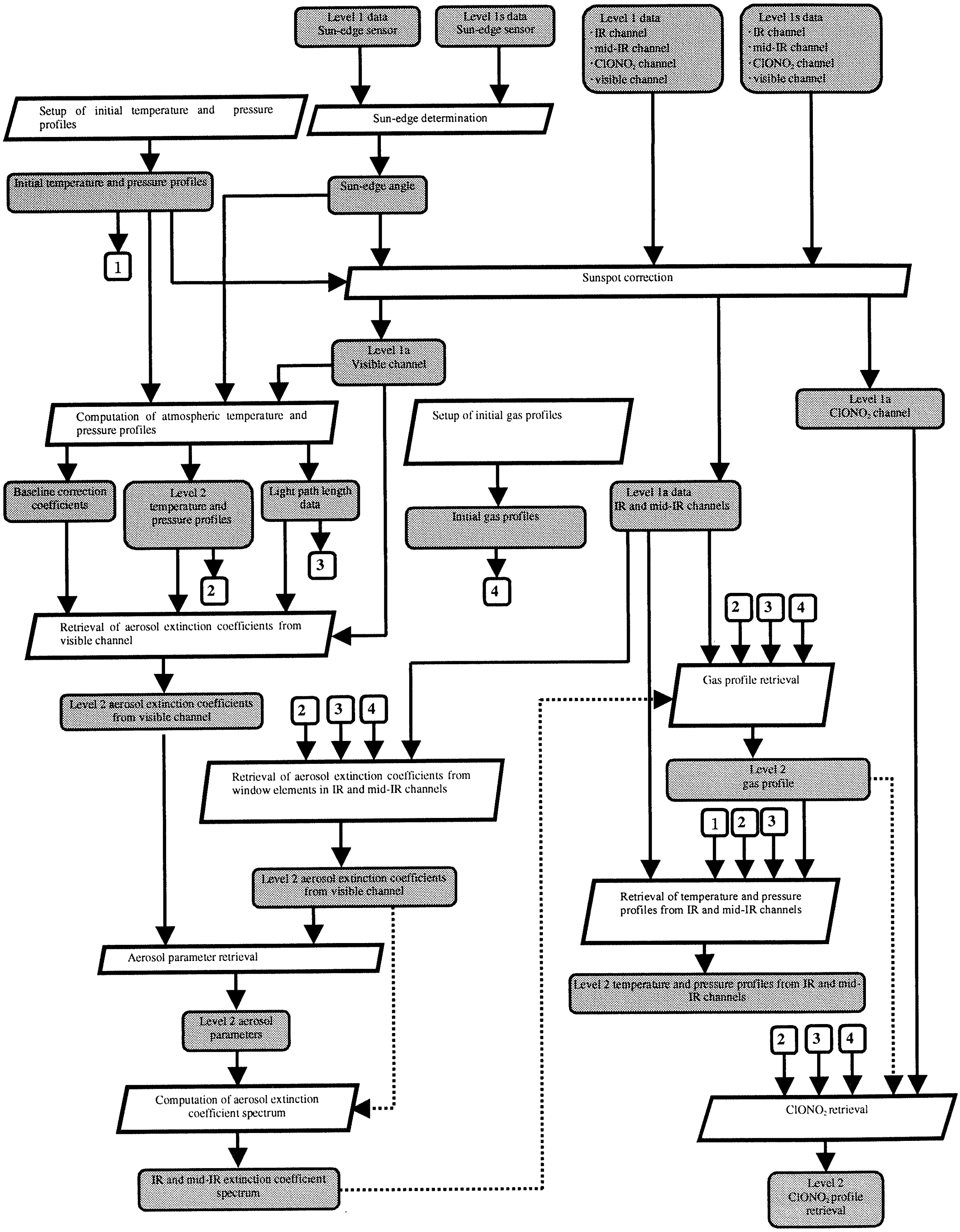


Fig. 2.3-3 Flow of level 1 to 2 processing

(1) Pre-processing

Pre-processing creates the tables required for ILAS-Ⅱ data processing and the processing condition files for setting processing conditions. The following tables are created.

a) Tables of basic physical and scientific data

Sunlight source data table	By multiplying the values in the table by their own theoretical transmittance values, the output values for components in the atmosphere are calculated to retrieve temperature, atmospheric pressure, and gas-concentration profiles. The table should be created based on the sunlight source data (TBD) in LBLRTM, which was acquired from ground measurements and supplied by Kurucz.
Visual O_2 line parameter table	Used for computing the O_2 absorption value with respect to a visible light channel to retrieve temperature and air pressure profiles. The table should be created based on the HITRAN96 (TBD) database.
P-T table	For some types of gases to be measured by ILAS-Ⅱ, tens of thousands of absorption lines must be included in computing their cross-sectional data, which is time consuming. To avoid this problem, instead of cross-sectional data, interpolation based on the data table of computed coefficients is used in the routine process. The coefficient table is referred to as "P-T table" because it is created by computing the coefficients for atmospheric pressure (P) and temperature (T) values on the typical grids (functions of P, T).
Cross-sectional data table	In the spectral band of the infrared channel through which ILAS-Ⅱ will make measurements, some gases whose line parameters are not available. The absorption values of a few gases among them were e approximately computed using their cross-sectional data such as that in HITRAN96 (TBD). Some cross-sectional data of the gases, which may affect the computation of gas concentrations, were tabulated prior to absorption computation.
Complex reflective Index table	A table of data acquired from laboratory measurements as a function of wavelength for each type of aerosol. At present, the following 25 types of data are available: Sulfuric acid (concentration: 25, 38, 50, 75, 84.5, 95.6%) Sulfuric acid (concentration: 75, 90%) PSC's (Water Ice, α-NAT, β-NAT, NAD, NAM, a-NAT, a-NAD, a-NAM) Nitric acid: 10%, Ternary solution (sulfuric acid: 75%, nitric acid: 10%, water: 15%) H_2O, Nitric acid (3.1, 6.1, 11.8, 22.3, 40.3, 70.0%)
Extinction coefficient dataset	A table of extinction coefficients in the spectral band associated with the window channel for each type of aerosol. The coefficients are computed using the predefined combinations of particle-size distribution parameters and the acquired complex reflective indexes. Used for determining the types of aerosols.

b) Tables of various types of climatological data

Data of reference atmospheric model	Monthly and latitudinal tables of the data acquired from measurements by other spacecrafts (sensors); UARS (HALOE, ISAMS, CLAES, MLS), AEM-B (SAGE I), ERBS (SAGE Ⅱ), SPOT-3 (POAM Ⅱ), SPOT-4 (POAM Ⅲ), Nimbus-7 (SAM Ⅱ) and ADEOS (ILAS). The data will be used as initial values in retrieving gas-concentration profiles.

Data table of standard atmosphere model	A table of standard atmosphere model data used when the data processing system has no required profile data incorporated.

c) Tables of data from instrumentation

Instrumental function data table (slit functions)	Conversion from level 1 to level 2 requires instrument functions for individual components including optical aberration and slit diffraction effects, which are required for theoretically simulating the values of signals output from each detector element.
Lock-in amplifier response function data table	Data output from the ILAS-II infrared spectrometer is amplified by a lock-in amplifier. The signals input to the amp are integrated over time and then output. This means that part of previous data may be overlapped with part of succeeding data. To avoid this problem and acquire correct data at prescribed time points, response functions should be created so that they can be used in the infrared deconvolution process.
Cross-talk data table	To precisely compare the theoretical transmittance values with the measured values, the transmittance values should be corrected taking into account any cross talk occurring among adjacent detector elements.

d) Table of errors

Error-weighted coefficient matrix	The least squares method requires an error-weighted coefficient matrix in retrieving temperature/pressure and gas-concentration profiles.

e) Table of ILAS operational data

Data-Processing condition file	A file containing the parameters for the data-processing conditions, which are used in data processing by the ILAS-II DHF. Created when the data processing system is started operation and when any parameter item is modified due to a revision to the existing algorithm.

(2) Level 0 to 1 processing

Corrects the level 0 data received from NASDA/EOC and edits it into occultation event units including spike noise and missing values and drift correction to create level 1 and level 1s data, and transmittance data for each element of the atmospheric transmission and sun surface scanning parts.

(i) Useful data extraction

Identifies and extracts useful data from edited L0 data derived from the inner instrument observation part, outer-space observation part, atmospheric transmission part, direct sun observation part, and sun surface scanning part (Fig. 2.3-4). It also checks data for any error, converts data into the given format, and computes measurement time points.

□ Useful data extraction

・Inner instrument observation part

Gives the observed values when the gimbal mirror is at the given home position.

・Outer-space observation part

Gives the observed values when observing outer-space. The values are used for estimating the drift lines in the pseudo-transmission computation and for converting the values into the transmittances for individual elements.

・Atmospheric transmission part

Gives the observed values of light being transmitted through the atmosphere.

・Direct sun observation part

Gives the observed values when observing sunlight outside the atmosphere. The values are used for estimating the drift lines in pseudo- transmittance computation and for converting the values into the transmittances for individual elements.

・Sun surface scanning part

Gives the observed values when scanning the sun surface from outside the atmosphere. The values are used for sunspot correction to correct the effects of solar limb darkening and sunspots.

□ Data checking

・Format error

Checks the data format and address by Top & End sync.

・Data error

Checks the data using codes, checksum, and limit values.

・Packet missing check

Checks through packet sequence counting

The results of these checks are recorded in the result flags for L0a data. (For more information on the result flags, see Table 2.3-3.)

□ Data conversion

Removes the codes for checking from binary data to restore the original data.

□ Data items to be computed and evaluated

・The satellite positions in the observation frames, observation times, observation points, and observation altitudes are computed and evaluated.

・The effects of a sun eclipse.

・The probable graph of PSC and sunspot effects (the values are computed or forecast data are input at the data processing part).

The results from computation and evaluation are output to L0a data files.

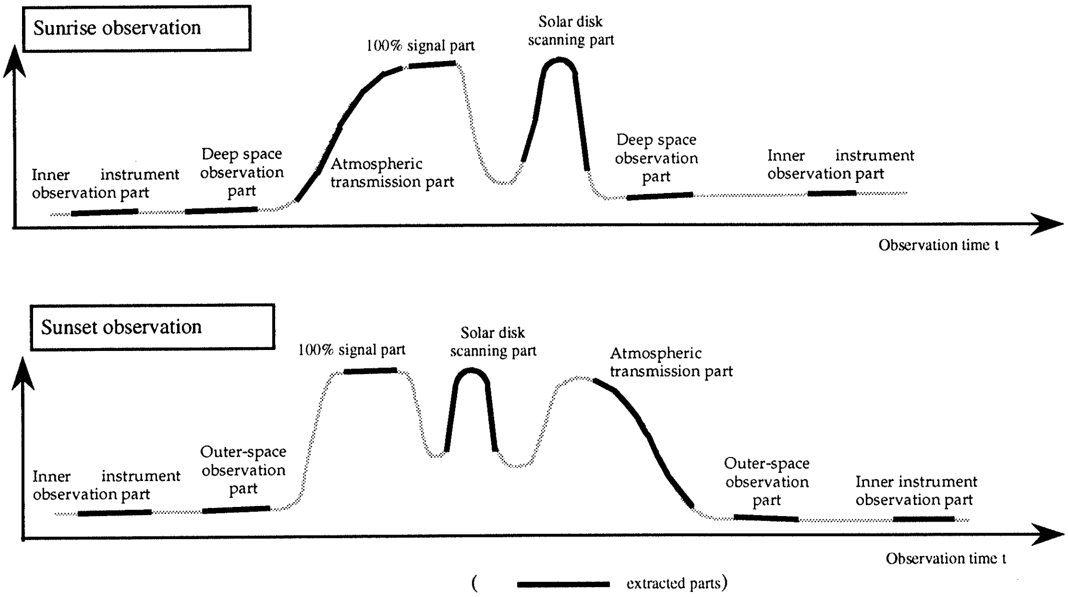


Fig. 2.3-4 Data parts extracted in the useful data extraction

Table 2.3-3 Contents of Result Flags

Result flag (8 bit)	Meaning of bit	Content assigned
0th bit	Missing value	If a missing value is present, this bit is set to 1.
1st bit	Top & End sync error	If a Top & End sync error is present, this bit is set to 1.
2nd bit	Address error	If an address error is present, this bit is set to 1.
3rd bit	Parity error	If a parity error is present, this bit is set to 1.
4th bit	Error in checking with critical value	If an error checking with critical value is present, this bit is set to 1.
5th bit	Check sum error	If a check sum error is present, this bit is set to 1.
6th bit	Spike noise	If spike noise is present, this bit is set to 1.
7th bit	Already revised flag	If any revisions are made to correct any spike noises or missing values, this bit is set to 1.

(ii) Spike noise and missing value handling

Detects spike noises, corrects data acquisition times, edits the data from the IR channels (which are sampled four times a frame), converts AC data into DC data if IR channel AC data contain phase data, and processes L0a data into L0b data. This process counts the number of detected spike noises and missing values and the number of continuous occurrences of the frames (more than a given number of times) in which spike noises and missing values are detected for data quality evaluation, and averages data in the 100% part for each element for trend monitoring of 100% output values.

□ Spike noise detection

- Detection using 2D and 3D curves (Fig. 2.3-5)
- Detection by averaging previous and next data

Either of the two methods listed above may be selected and specified in the processing condition with the thresholds for spike noise detection. The results from detection for each element are output in the form of a result flag. For more information on the result flags, see Table 2.3-3.

□ Time correction

Since the observation time of L0a data depends on the channel and element used for data acquisition, L0a data is corrected into the data observed at the same time for each frame.

□ IR 4-sampling data edition

Since IR channel data is sampled four times a frame, these data are edited into one datum for each frame.

□ IR AC-DC data conversion

To use AC signal data as IR channel data, waveform data including phase data is converted into the amplitude value representing the signal intensity. When an AC signal is used, the DC/non-DC flag for L0b data is set to 1 (one).

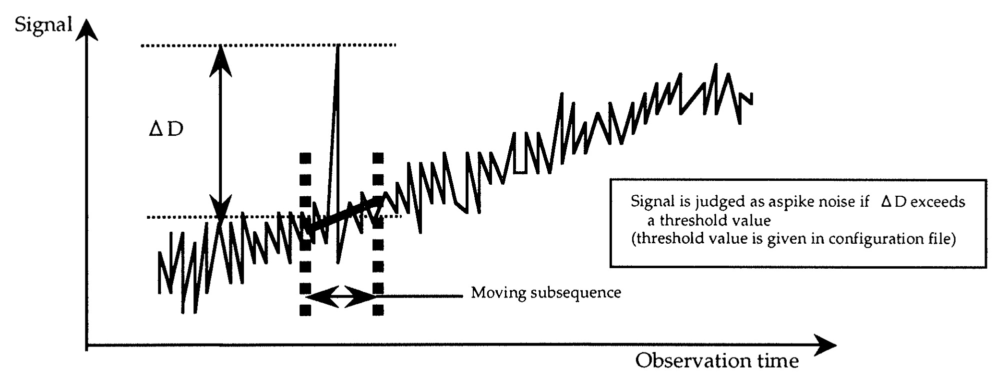


Fig. 2.3-5 Example of spike noise judgment and restoration processing in the spike noise and missing value handling

(iii) IR data de-convolution processing

The data from the IR channel is affected by the time constant of the lock-in amplifier. To compare it to the transmittance at a given time, which is computed in the level 1 → 2 processing stage, the effect of the time constant must be removed from the data. In this process, the data are deconvoluted from the atmospheric transmission and sun scanning parts to remove the effect of the lock-in amplifier, resulting in L0c data. The time constant of the lock-in amplifier (lock-in amplifier response function) is generated in the pre-processing stage.

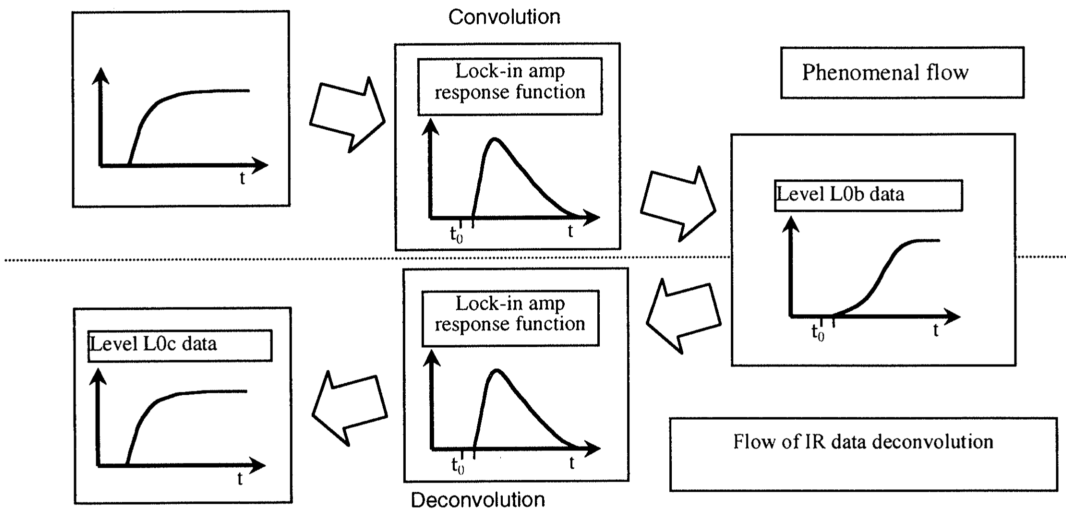


Fig. 2.3-6 Concept of infrared data deconvolution

(iv) Pseudo-transmission computation

Using 0% values from ILAS-II outer-space observation and 100% values from extra-atmospheric observation, the transmittance is obtained for each element. A change in the signal values due to a temperature drift is linearly approximated (resulting in a drift line) and corrected.

□ Drift line

Focusing on a certain element, the 0% values obtained from the observations at starting and ending times are different from one another due to a temperature drift effect even though they are in the same OE (Occultation Event). To remove such effects, this process corrects data by assuming that the graph of the change in time due to drift is linear. For example, a signal value at time t_i is d_i. In this case, the coefficient of the line $y=ax+b$ may be obtained using n points from the equations:

$$a = \frac{n\sum_i (t_i \cdot d_i) - \left(\sum_i t_i\right)\left(\sum_i d_i\right)}{n\sum_i t_i^2 - \left(\sum t\right)} \qquad b = \frac{\left(\sum_i t_i^2\right)\left(\sum_i d_i\right) - \left(\sum_i t_i\right)\left(\sum_i (t_i \cdot d_i)\right)}{n\sum_i t_i^2 - \left(\sum t\right)}$$

□ Element transmittance

The transmittance for each element is obtained using an estimated drift line. Assuming that an observed signal at the time t is L, a value on the 0% line is L_0, and a value on the 100% line is L_{100}, the element transmission rate is obtained from the equations (Fig. 2.3-7):

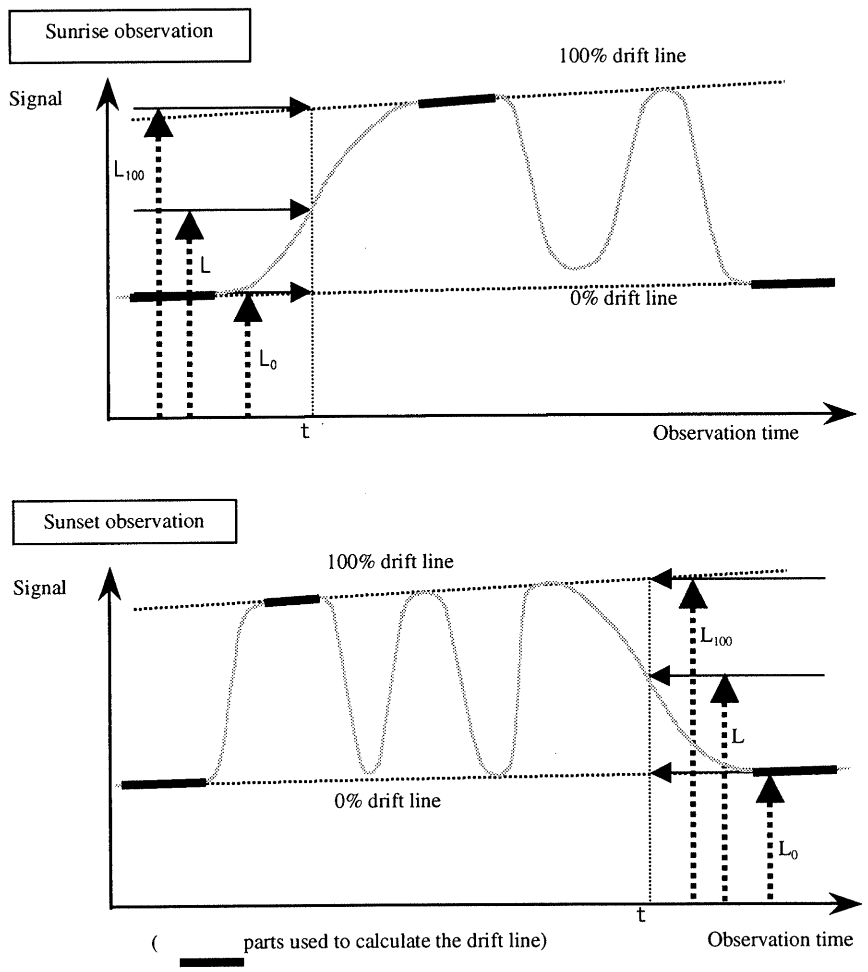


Fig. 2.3-7 Pseudo-transmittance computation

(3) Level 1 to 2 processing

Uses the level 1 and level 1s data derived from the level 0 to 1 processing to compute various physical parameters. Visible channel data for the visible light band is used to obtain atmospheric temperatures and pressures, and aerosol extinction coefficients. IR and mid-IR channel data are used to compute aerosol extinction coefficients, concentrations of gas constituents including ozone, and atmospheric temperatures and pressures (currently applicable only to studies) for IR and mid-IR channels. $ClONO_2$ channel data are used to calculate $ClONO_2$ concentrations.

(i) Sun-edge determination

Uses data from the sun-edge sensors to compute the field angles between the top of the sun and the IFOV center and the bottom of the sun and the IFOV center. These data are required for determining optical paths. As shown in the following figure, the following four types of field angles are obtained: the top and bottom field angles for the first, second, and fourth channels, and those for the third channel.

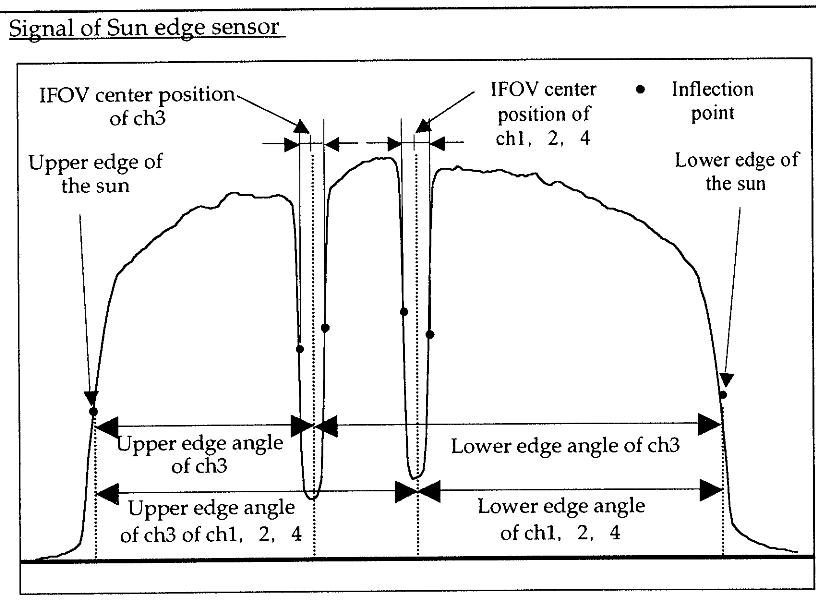


Fig. 2.3-8 Conceptual schematic illustration of processing to judge the solar edge

(ii) Setup of initial atmospheric temperature and pressure

Uses only data selected from reference data to create the profiles of initial atmospheric temperature and pressure values, which are used for setup of atmospheric temperatures and pressures.

(iii) Sunspot correction

If the observed surface of the sun has sunspots, the brightness distribution of the sun surface is not uniform in the instantaneous field angle and an error may occur in the transmittance due to variance in instantaneous field angles during atmospheric and 100%

observations. In addition, solar limb darkening and tracking error may induce errors in transmittances. To correct these errors, ILAS-II has been equipped with atmospheric trailing mode and extra-atmosphere sun surface scanning mode. From the brightness distribution data of the sun surface derived from these additional mechanisms, 100% signal values are estimated for the entire instantaneous field angle during atmospheric observation to correct the effect of the errors. Alternately, the same formula for solar limb darkening as for ILAS can be used to correct the errors, instead of using scanned data. Input level 1 data may be output as level 1a data without applying sunspot correction.

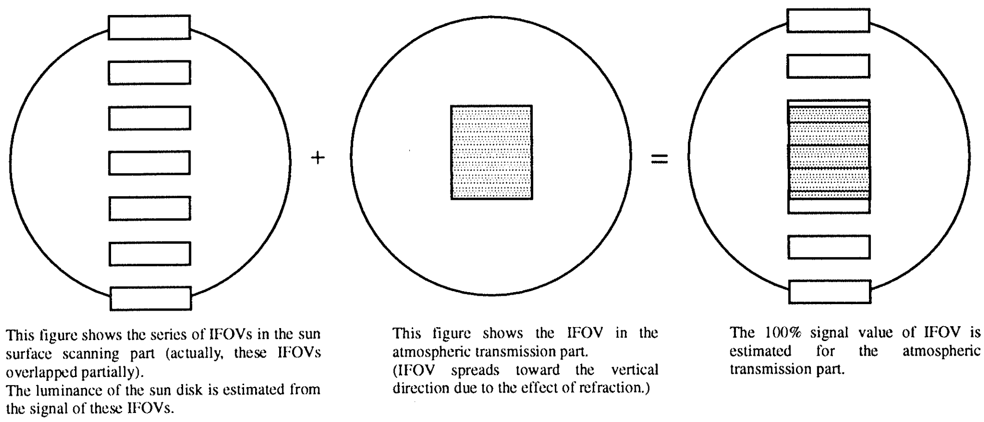


Fig. 2.3-9 Concept of processing to correct the effect of sunspots and solar limb darkening

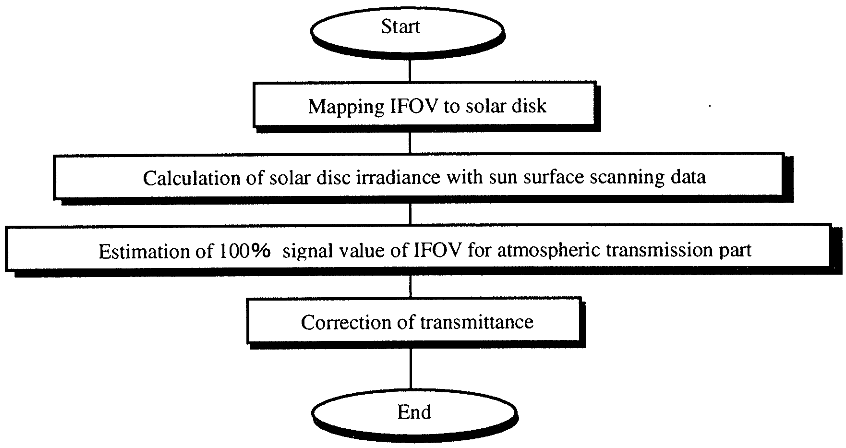


Fig. 2.3-10 Flow of sunspot correction

(iv) Retrieval of temperature and pressure profiles

This process uses the level 1a data from the visible channel after correcting drift and sunspot effects to the vertical distributions of atmospheric temperatures and pressures.

Appropriate initial values are given to the temperatures and pressures in individual atmospheric layers, optical absorption spectra by oxygen molecules are computed based on the line-by-line method, and the transmittances are theoretically estimated considering the effects of widening fields of view and instrument functions. The lengths of optical paths and observation altitudes can be basically obtained from satellite position data and computed sun field angles taking the index of optical refraction. They may also be obtained using the atmospheric altitudes as in ILAS. The baseline can be estimated either by fitting the effects to the observed values in advance or by estimating the coefficient along with temperatures and pressures.

Spectral fitting is executed on the computed theoretical transmittances and sunspot-corrected element transmittances, the non-linear least squares method is used to adjust the theoretical temperature and pressure values toward their actual values, and then fitting is applied again. To compute the altitude distribution, this process is repeated. For each layer, convergence is repeatedly reached using the onion peeling method, in which temperatures and pressures are sequentially determined downward from the top layer.

The optical paths are obtained from the computed temperatures and pressures while considering the index of atmospheric refraction to find the deterministic values for the observation locations.

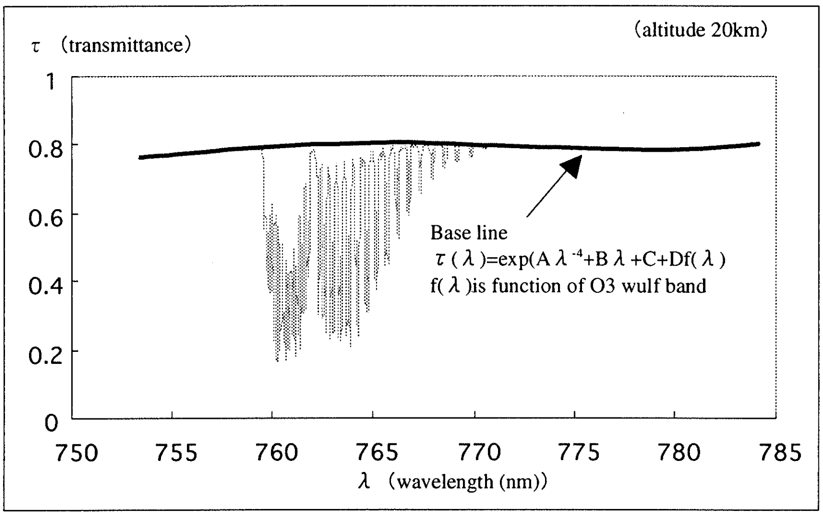


Fig. 2.3-11 Example of level 1a visible band

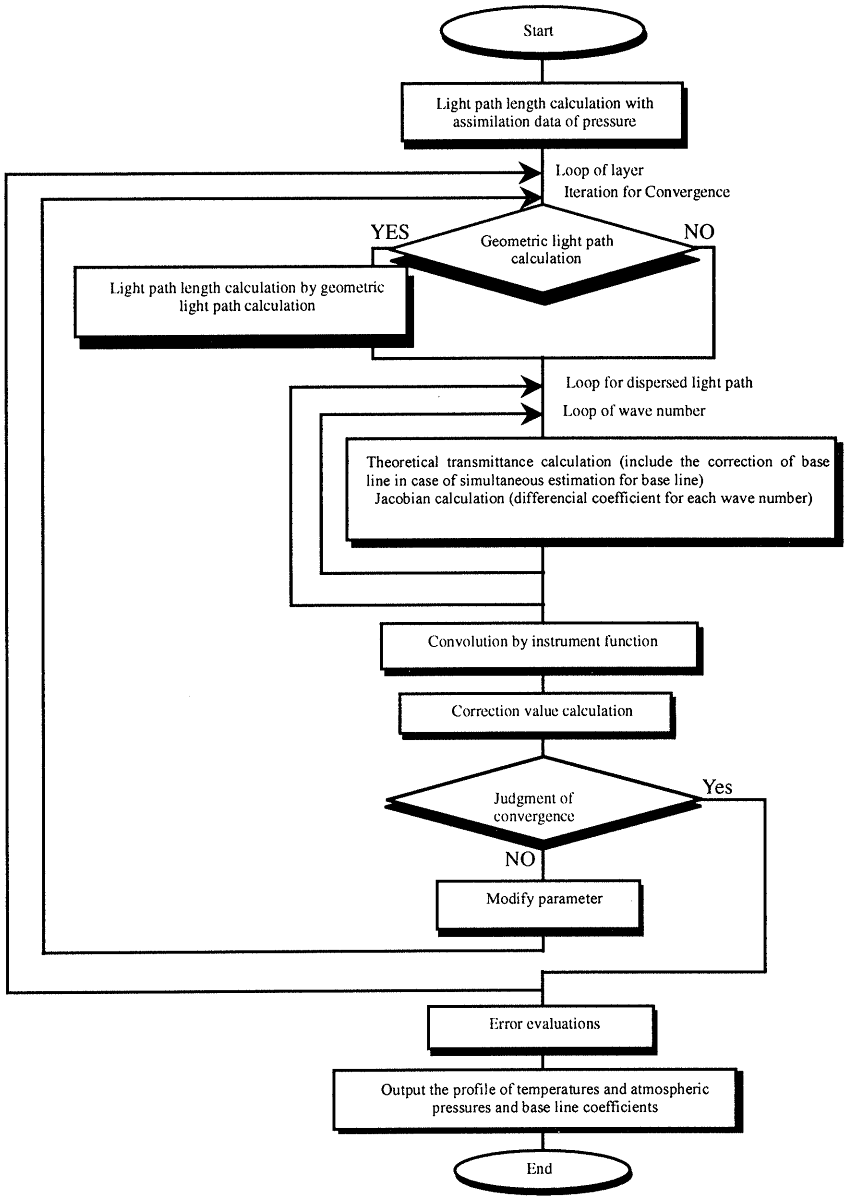


Fig. 2.3-12 Flow of processing to derive temperatures and atmospheric pressures

(v) Retrieval of aerosol extinction coefficients from visible channel

This computation, which is out of the visible channel, uses ca. 780 nm wavelength elements with no O_2 absorption to obtain their extinction coefficients and retrieve the aerosol extinction coefficient from the visible channel by subtracting the contributions of O_3 Wulf band absorption and Rayleigh scattering. With respect to the elements used for the extinction coefficient computation, an average value(s) of measured transmission rate(s) for one or more elements may be used or the aerosol extinction coefficients may be obtained for one or more elements and their average value calculated. Two options are provided for computing extinction coefficients. One method divides atmospheric layers into individual altitude groups and obtains the extinction coefficients of all the atmospheric layers in one group at the same time. The other method computes the extinction coefficients of atmospheric layers downward from the top layer by progressive substitution.

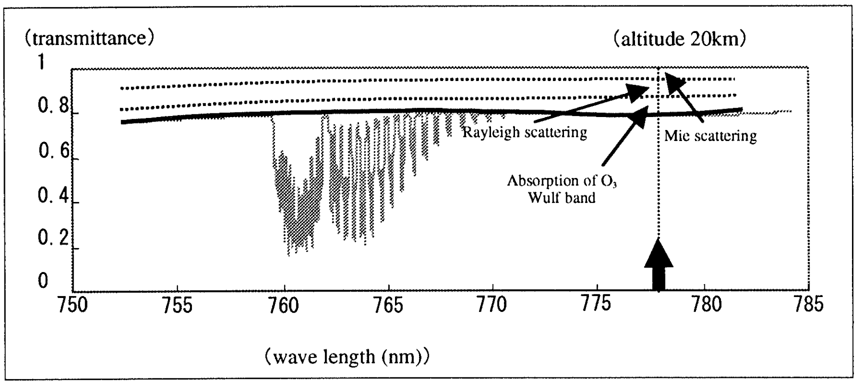


Fig. 2.3-13 Contribution of aerosol extinction in visible band data

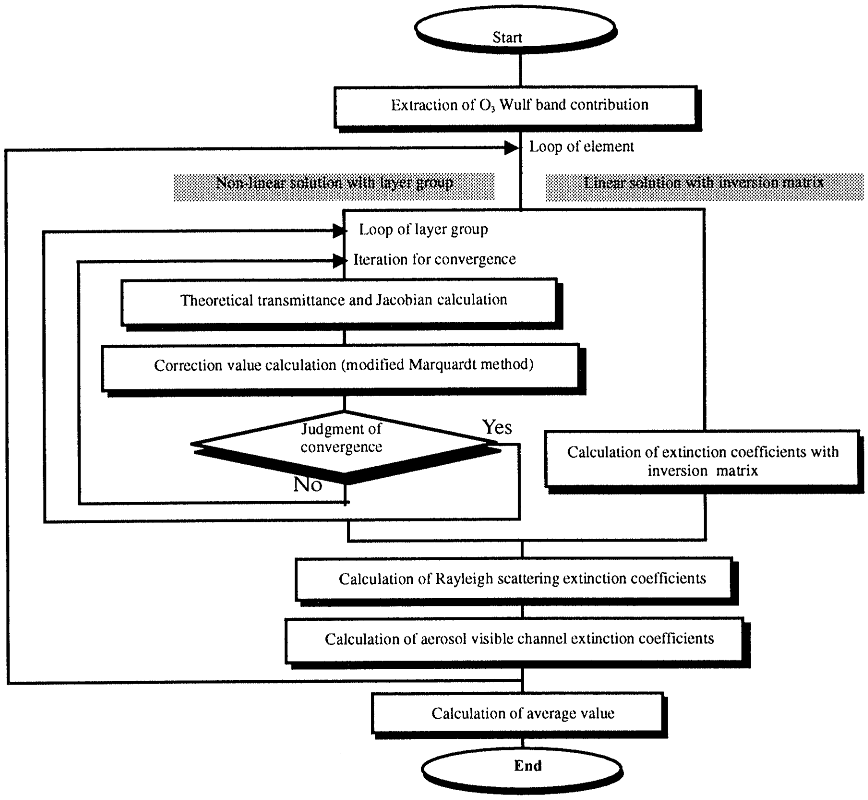


Fig. 2.3-14 Flow of retrieval of aerosol extinction coefficient from visible channel

(vi) Setup of initial gas profiles

This process uses measurement time and position information retrieved from atmospheric temperature and pressure profiles to extract the profiles of gas concentrations corresponding to given times and position from reference atmospheric model data created in pre-processing. It also creates the initial gas-concentration value file, which is used in the retrieval of aerosol extinction coefficients, gas profiles, and $ClONO_2$ profiles from IR and mid-IR channels.

(vii) Retrieval of aerosol extinction coefficient from window elements in IR and mid-IR channels

Within the aerosol window elements for the IR and mid-IR channels (with less absorption by any other gas or less estimated absorption error), the altitude distribution of aerosol IR/mid-IR extinction coefficients are computed at seven wavelength points: the 7^{th} (7.12 μm), 16^{th} (8.28 μm), 34^{th} (10.60 μm), and 43^{rd} (11.76 μm) elements in the IR channel; and the 0^{th} (3.00 μm), 6^{th} (3.77 μm), and 16^{th} (5.06 μm) pixel in the mid-IR channel.

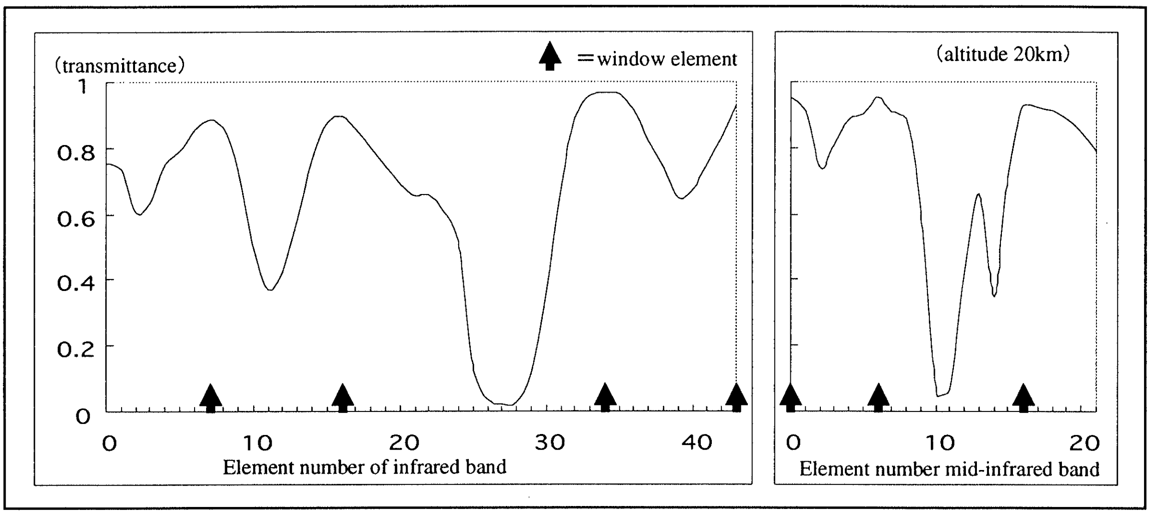


Fig. 2.3-15 Window elements for aerosol estimation

(viii) Aerosol parameter etrieval

This process determines the types of extinction coefficients for individual wavelengths derived from the aerosol extinction coefficient (visible, IR, and mid-IR) computation by comparing them with a set of extinction coefficient data. It also uses the forward method, in which non-linear least squares fitting is applied to the extinction coefficients derived from theoretical computation, to obtain aerosol parameters (e.g., particle granularity, particle-size parameters (including concentrations for sulfate aerosol)).

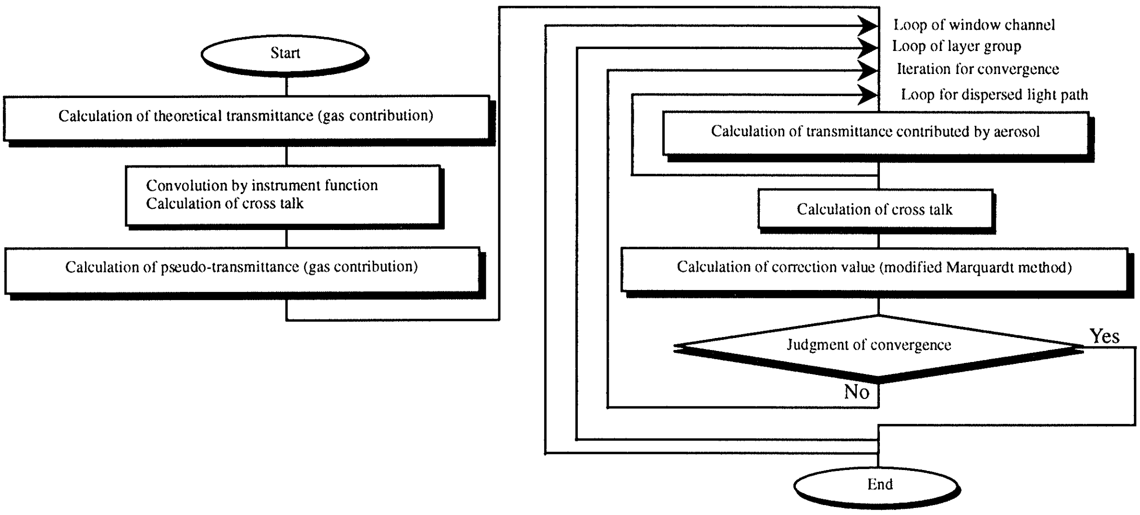


Fig. 2.3-16 Flow of retrieval of aerosol extinction coefficient from IR and mid-IR channel

(ix) Computation of aerosol extinction coefficient spectrum

Computes the extinction coefficients for individual wave number points with a constant spacing in the IR and mid-IR channels based on Mie scattering coefficients from the complex refractive indexes of the types determined in aerosol parameter estimation and the computed aerosol parameters (Method A). However, if no aerosol parameter can be computed for some reason, the extinction coefficients can be computed by linearly interpolating the aerosol extinction coefficients within the window elements in IR and mid-IR channels in the wave number direction at every altitude (Method B).

The extinction coefficients derived from this process are used to remove the aerosol contribution from gas profile retrieval.

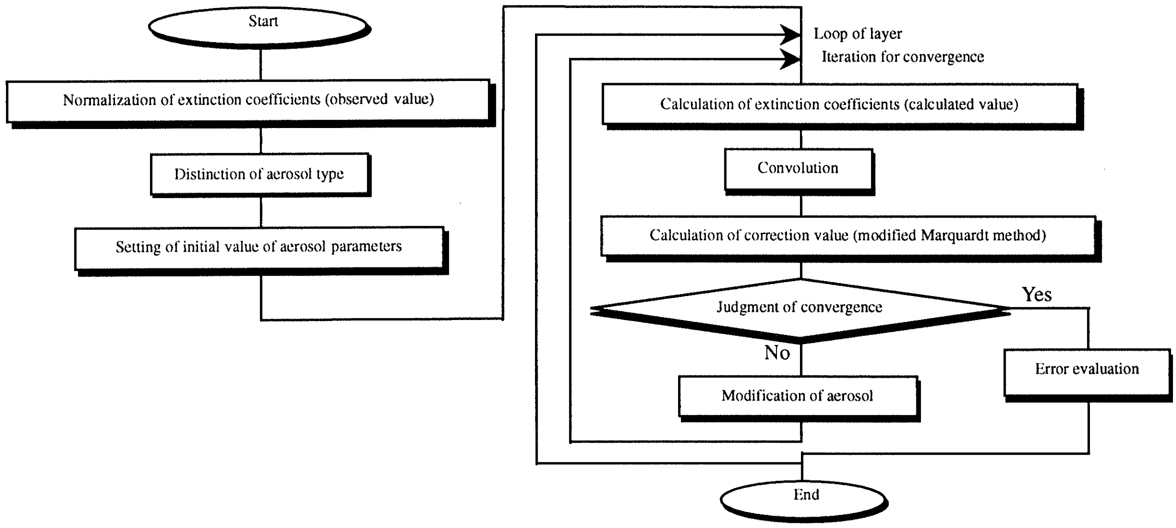


Fig. 2.3-17 Flow of aerosol parameters retrieval

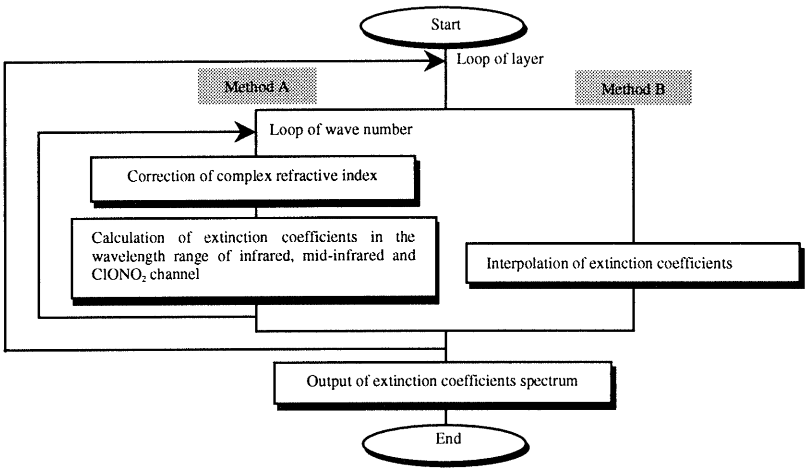


Fig. 2.3-18 Flow of processing to derive aerosol extinction coefficients spectrum

(x) Gas profile retrieval

This process iterates computation by the non-linear least squares method so that pseudo-transmittances derived from theoretical computation fit the pseudo-transmittances for individual elements (IR and mid-IR level 1a data) that are observed in the IR and mid-IR channels. The drift and sunspot effects are then removed to compute trace gas concentrations. The flow of the process is described below.

The concentrations of such gases as O_3, HNO_3, NO_2, N_2O, H_2O, CH_4, CFC-11, CFC-12, and COF_2 are computed. In theoretical computation, the atmospheric temperatures, pressures and the lengths of optical paths retrieved from atmospheric temperature and pressure profiles are used. In cross section computation, the P-T table created in pre-processing is used for higher efficiency. In theoretical computation, the wave-number point steps are 0.001 cm^{-1} for the IR channel and 0.002 cm^{-1} for the mid-IR channel. To deal with the vast amount of wave number points, data distributed parallel processing is conducted. There are two methods for removing aerosol effects. One method estimates the effects of gases along with the gases themselves. The other method removes the effects in advance using the aerosol extinction coefficient spectrum obtained from the computation of aerosol extinction coefficient spectrum. To compute the profiles, one of two methods may be selected: the onion peeling method, or computation of all the unknown gas concentrations in several layers.

(xi) Retrieval of temperature and pressure profiles from IR and mid-IR channels

This process repeats computation by the non-linear least squares method so that pseudo-transmittances rates derived from theoretical computation fit the pseudo-transmittances for individual elements (IR and mid-IR level 1a data), which are observed in the IR and mid-IR channels. Drift and sunspot effects are then removed to compute atmospheric temperatures and pressures. The flow of the process is described below.

Assuming that the CO_2 concentration is known, higher CO_2 absorption in the mid-IR channel is used. However, since computed values are used for other reference gas concentrations, they are affected by the atmospheric temperatures and pressures in the visible channel. Thus, level 2 atmospheric temperature and pressure data in the IR and mid-IR channels are only temporarily applicable for research.

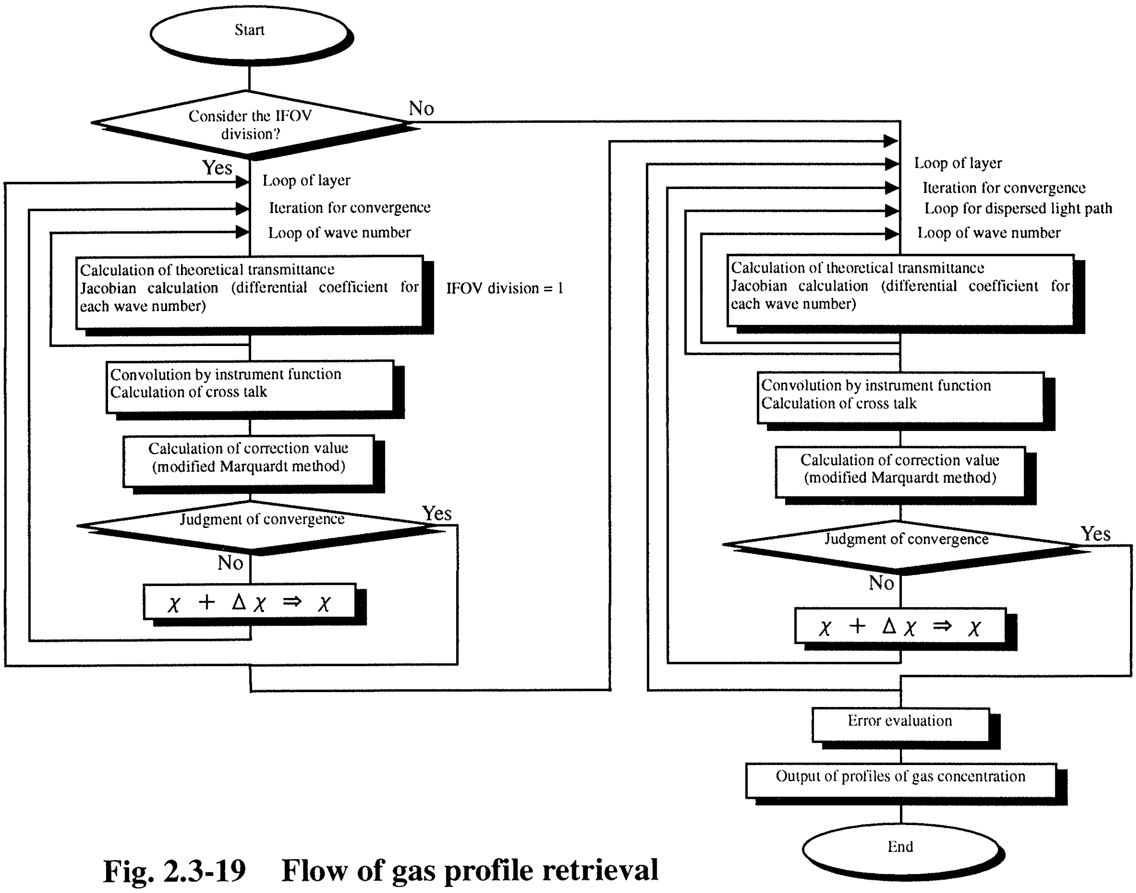


Fig. 2.3-19 Flow of gas profile retrieval

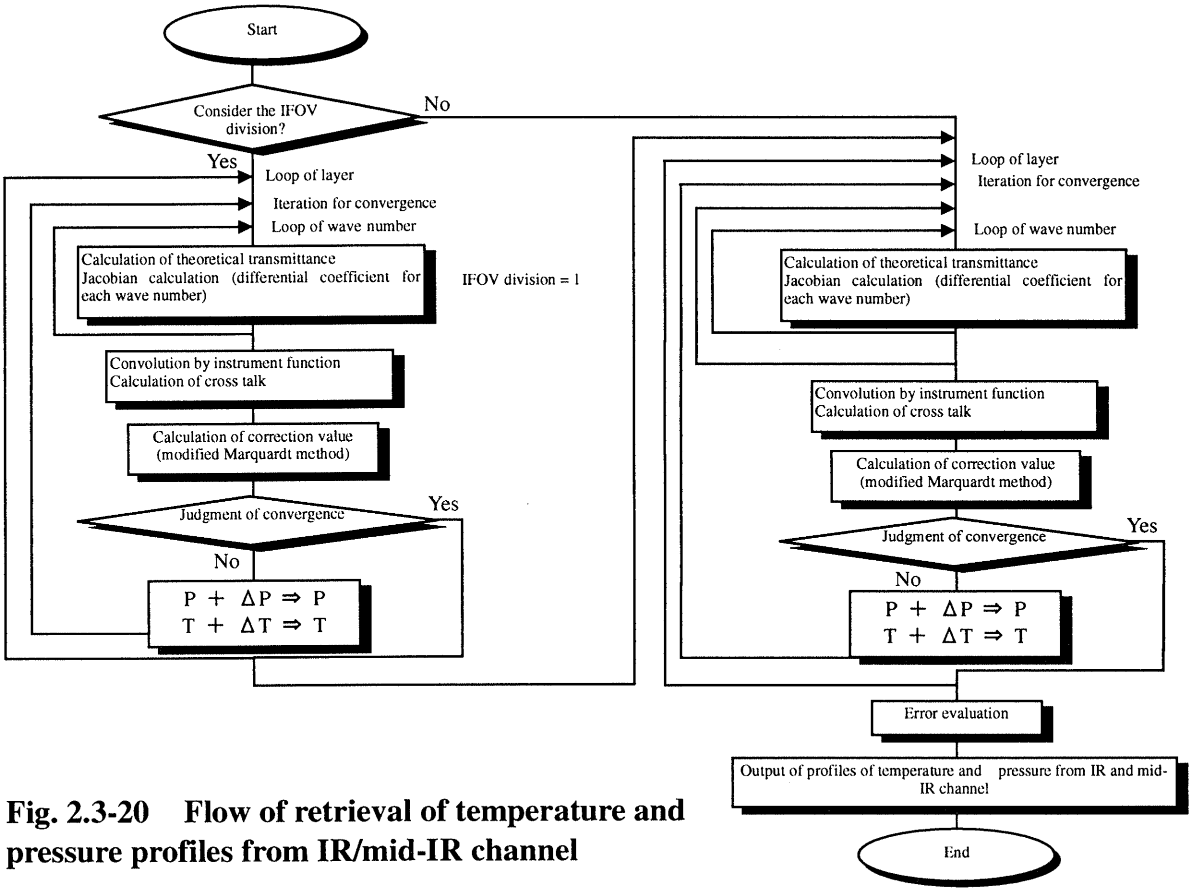


Fig. 2.3-20 Flow of retrieval of temperature and pressure profiles from IR/mid-IR channel

(xii) $ClONO_2$ profile retrieval

This process repeats computation by the non-linear least squares method so that pseudo-transmittances derived from theoretical computation fit the pseudo-transmittances for individual elements ($ClONO_2$ channel level 1a data), which are observed in the IR and mid-IR channels. Drift and sunspot effects are then corrected to compute $ClONO_2$ profiles. The flow of the process is described below. The reference gases other than $ClONO_2$ include HNO_3,O_3, H_2O, and CO_2. The results from gas profile retrieval may be used for the concentrations of these gases or they may be calculated with that of chlorine nitrate. The extinction coefficient, aerosol/PSC is also computed at the same time assuming that it is a constant in the vicinity of chlorine nitrate absorption. Since this channel has a low S/N ratio, $ClONO_2$ is detected and if possible, its concentration is computed for a while.

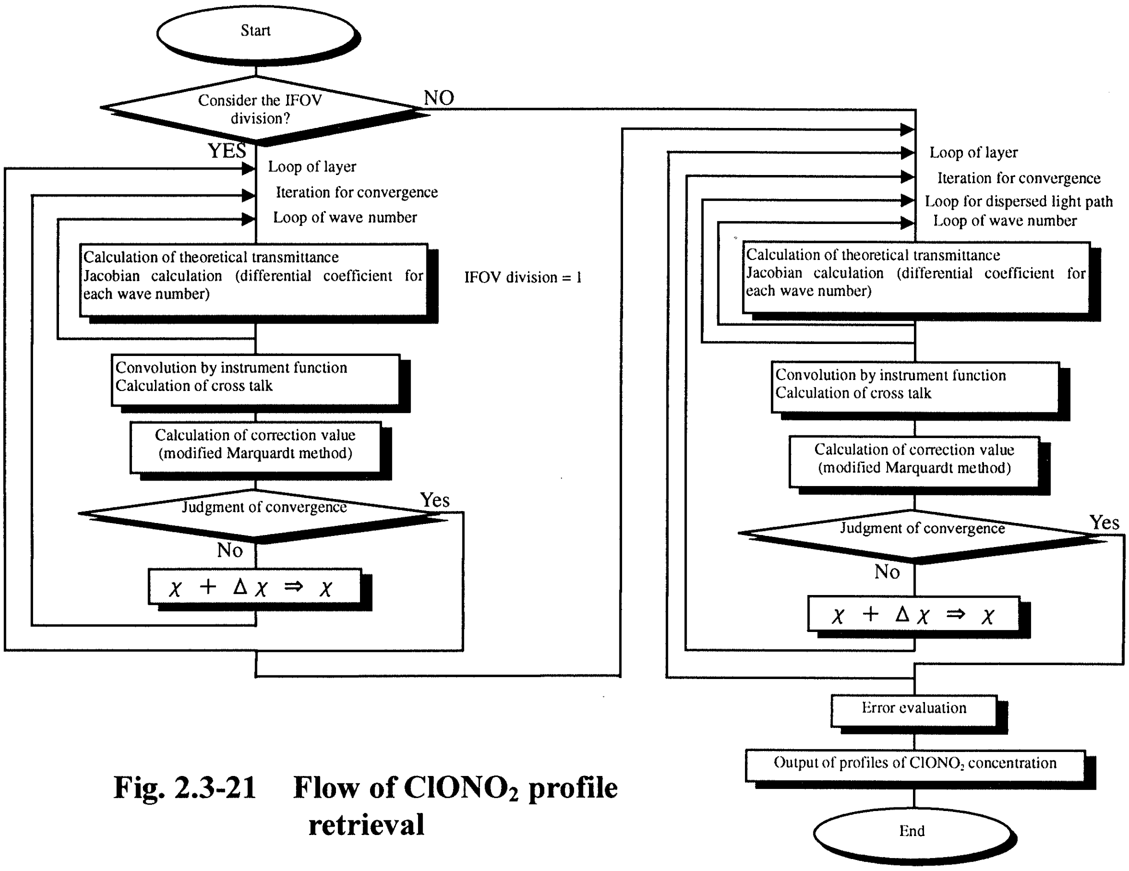


Fig. 2.3-21 Flow of $ClONO_2$ profile retrieval

(4) Post-processing

(i) Data quality evaluation

This process automatically evaluates data quality using thresholds with reference to fault and error information output in the historical quality file in level 0 →1 and level 1 → 2 processing and abnormal ILAS-II instrumentation information recorded in the database. The results are edited and registered in the database. For more information on data quality and how to evaluate it, see Section 2.4, "Evaluation and Analysis".

2.3.3 Data precision

Tables 2.3-4 and 2.3-5 list the estimated precisions of level 2 data created from ILAS-II data processing. These estimated values were obtained from simulation.
This means that it is not assured that they have the same precision level as that for level 2 data obtained from the measured data.

Table 2.3-4 Estimated errors of ILAS-II level 2 data (standard data products)

Parameter \ Altitude	10 km	20 km	30 km	40 km	50 km
O_3	±10%	±2%	±2%	±2%	±7%
HNO_3	±10%	±3%	±15%	N.D.	N.D.
NO_2	N.D.	±20%	±20%	±30%	N.D.
N_2O	±3%	±1%	±4%	±25%	N.D.
H_2O	±3%	±1%	±4%	±10%	±30%
CH_4	±3%	±3%	±10%	±20%	30%
Aerosol extinction coefficient (780 nm)	±5%	±6%	±40%	N.D.	N.D.
Temperature	<±1K	<±1K	<±1K	±1K	±5K
Pressure	±2%	±1%	±2%	±2%	±5%

Table 2.3-5 Estimated errors of ILAS-II level 2 data (data products for researches)

Parameter \ Altitude	10 km	20 km	30 km	40 km	50 km
CFC-11	±4%	±25%	N.D.	N.D.	N.D.
CFC-12	±8%	±25%	N.D.	N.D.	N.D.
COF_2	(TBD)	(TBD)	(TBD)	(TBD)	(TBD)
CO_2	±7%	±5%	±1%	±2%	±6%
CO	±3%	±30%	N.D.	N.D.	N.D.
OCS	±42%	±46%	N.D.	N.D.	N.D.
C_2H_6	N.D.	N.D.	N.D.	N.D.	N.D.
N_2O_5	N.D.	N.D.	N.D.	N.D.	N.D.
$ClONO_2$	(TBD)	(TBD)	(TBD)	(TBD)	(TBD)
Aerosol extinction coefficient (IR pixel 7)	±60%	±30%	N.D.	N.D.	N.D.
Aerosol extinction coefficient (IR pixel 16)	±70%	±10%	±80%	N.D.	N.D.
Aerosol extinction coefficient (IR pixel 34)	N.D.	N.D.	N.D.	N.D.	N.D.

Aerosol extinction coefficient (IR pixel 43)	N.D.	N.D.	N.D.	N.D.	N.D.
Aerosol extinction coefficient (Mid-IR pixel 0)	±97%	±10%	±80%	N.D.	N.D.
Aerosol extinction coefficient (Mid-IR pixel 6)	N.D.	±8%	±60%	N.D.	N.D.
Aerosol extinction coefficient (Mid-IR pixel 16)	N.D.	±15%	±85%	N.D.	N.D.
IR and mid-IR temperature	(TBD)	(TBD)	(TBD)	(TBD)	(TBD)
IR and mid-IR pressure	(TBD)	(TBD)	(TBD)	(TBD)	(TBD)

Note: N.D. indicates that the error exceeds 100% or no estimated convergent value was obtained because the absorption signal for the gas was too weak or the gas was affected by the higher absorption of some other gas.

* Simulation was made by adding expected random noise values (S/N=700 – 7000: IR, 8000: visible) and quantification errors for individual elements in each channel.

2.3.4 Differences between ILAS and ILAS-II data processing methods

Compared with ILAS, ILAS-II has been enhanced such as increased data precision through improvement of the observation facility, process modification using new additional spectrometers and data acquisition modes, and improved processing methods.

Table 2.3-6 shows a comparison between ILAS and ILAS-II data processing methods.

Table 2.3-6 Differences between ILAS and ILAS-II data processing methods

Item of data processing	Differences
Useful data extraction	·Computing time and location by GPS data is added. ·To extraction of useful data parts by gimbal mirror information is possible.
Spike noise and missing value handling	·Process to adjust timing among sensor components is added. ·The process is added due to sampling of IR channel data increased to 4 times per / 1 frame. ·Transform processing (from AC data to DC data) is added since the AC mode is additionally acquired, which includes the phase.
Sun-edge determination	·Change of processing due to the recording of the position of IFOV in the edge sensor.
Sunspot correction	·Process newly added due to the addition of sun surface scanning mode.
Retrieval of temperature and pressure profiles	·Simultaneous computation of baseline coefficient added.
Retrieval of temperature and pressure from visible channel	·Linear approximation method added.
Retrieval of aerosol extinction coefficient from window elements in IR and mid-IR channels	·Number of window channels increased by adding mid-IR channel.
Gas profile retrieval	·Mid-IR channel added. · Interval of wave number in theoretical computation changed: 0.002 cm^{-1} → 0.001 cm^{-1} ·Non-linear least squares method improved: Marquardt method → Modified Marquardt method ·Gas concentration and aerosol computed simultaneously.
Retrieval of temperature and pressure profiles from IR channel	·Process newly applied due to addition of mid-IR channel.
$ClONO_2$ profile retrieval	·Process is newly applied due to addition of $ClONO_2$ channel.
Data quality evaluation	· Process newly applied to evaluate data quality automatically.

2.4 Evaluation and Analysis

2.4.1 Outline of evaluation and analysis

Some ILAS-II data may be automatically evaluated and analyzed; other data must be processed by geophysical specialists.

The ILAS-II data is automatically evaluated and analyzed using the thresholds with reference to historical fault and error information output from the various processes and abnormal ILAS-II instrumentation and sensor information registered in the database. The primary targets of level 1 and level 2 product evaluation and analysis are described below.

(1) Quality of level 1 product

Since most of the level 0 → 1 processing, in which level 1 data is edited, detects and corrects abnormal data, it does not affect the quality of observation values; rather, the quality of level 1 products largely depends on the level 1 data itself, which may be affected by faults in instrumentation and transmission. In data quality evaluation, the following items are checked:

(i) Error (HK data) in ILAS-II instrument information (temperatures, azimuth angles, and others)
(ii) Number of continuous data errors
(iii) Dispersion in 100% signal values around the drift line
(iv) Trend of output values for the elements from each channel

These items are automatically checked using their thresholds except for (ii) Number of continuous data errors. Since these four items have different properties, they are recorded in the level 1 product quality evaluation file individually. For each item, quality is recorded for individual elements or channels.

(2) Quality of level 2 product

In level 1 → 2 processing, various types of physical quantities are computed. During this process, not only measurement and quantization errors in observation data but also the precisions of input tables and rounding errors in numerical computation affect product data quality. These factors affecting product quality are largely divided into two groups, accidental errors and systematic errors. The contributions of some of the accidental errors may be considered to be automatically included in the convergent errors. The accidental and systematic errors that are not included in the convergent errors are investigated and discussed separately.

Since each product has its error record given, as described in section 2.4.3, users can determine data product quality based on the error values. The data quality evaluation process provides the evaluation and analysis subsystem function, through which the default value is set as level 2 product quality data depending on whether the product is created successfully with no evaluation. Using this function, researchers can set quality data at their discretion.

2.4.2 Quality and error information

Since various factors may induce errors, it is difficult to represent information on all the errors on an error bar. To overcome this problem, on the error bar, the convergent errors given from data processing, and other random and systematic errors evaluated by prior simulation are represented. Since new factors must be included depending on the progress of the research and time series analysis on observation results, error information may be updated following the directions given by the project leader.

Quality and error information is supplied in any of the following forms.

(1) Level 1 product quality information

Normal or Abnormal is set for ILAS-II instrument information and the number of errors for continuous data errors in the quality comment field. For other items, Good, Poor, or No Data is set.

(2) Level 2 product quality information

The convergent errors due to retrieval are identified from those due to other factors (other accidental and systematic errors) and a standard deviation value σ for each type of error is displayed on the error bar on either the + side or – side.

2.4.3 Analyzing level 2 product errors

- The scales of errors may be estimated by the following methods.
- Errors are automatically estimated from the experimental results and by numerical simulation.
- The specialist, for example, a project staff, estimates the errors and the estimation standard is obtained by numerical simulation.
- The specialist, for example, a data quality evaluator or project staff, must estimate the error from the geophysical standpoint.

The errors in atmospheric temperature/pressure, and gas concentration (including $ClONO_2$) products are obtained using the convergent errors derived from the least squares method and the random and systematic errors estimated by simulation from the formula:

$$(\text{Total error})^2 = (\text{convergent error})^2 + (\text{other random error})^2 + (\text{systematic error})^2$$

In this case, convergent and total errors are recorded.

The error in the aerosol extinction coefficient for the level-2 product is obtained using the random errors computed in data processing, and the random and systematic errors estimated by simulation from the formula:

$$(\text{Total error})^2 = (\text{random error})^2 + (\text{other random error})^2 + (\text{systematic error})^2$$

In this case, the total error is recorded.

The error factors include the following sources. Although the levels of these error sources are different from each other, they are neglected here.

(1) Errors caused by hardware faults

1) Solar tracing error, 2) absorption by residual gases in instruments, 3) non-linearity of element output, 4) non-linearity of an amplifier, 5) abnormal A/D conversion, 6)

instrument functions, 7) cross talk, error in stray light data, 8) misalignment, 9) errors in time, satellite position, and satellite traveling speed data given from the GPS, 10) quantization error, and 11) heat noise, electronic circuit, transmission noise.

(2) Errors caused by software faults

1) Rounding and truncating errors, 2) error in Hermite interpolation for time, satellite position, and satellite traveling speed data, 3) error in interpolation for spike noise and missing values, 4) error in selecting a smoothing parameter value λ in the infrared (IR) deconvolution process, 5) error in sun-edge determination algorithm, 6) error due to declined satellite altitude, 7) error in solar position computation, 8) error due to neglecting dependency of a refraction index on wave number data in refraction optical path computation, 9) error due to neglecting Doppler Effect (IR and mid-IR channels), 10) error in assuming that the global geometry is a sphere with a local radius between observation points, 11) error in sunspot correction, 12) mapping error when atmospheric model data is used in sunspot correction, 13) error due to the finite field, 14) error due to the assumption of an inner-layer distribution, 15) error in line-by-line computation, 16) error in numerical differential, 17) error in interpolation for the reference temperatures and pressures in the latitude, longitude, and altitude directions when atmospheric pressure and altitude data are used, 18) error in interpolation for reference atmospheric model data in the altitude direction when they are used for gas absorption evaluation in computing an aerosol extinction coefficient for a window channel, 19) error derived from the aerosol/PSC scattering estimation algorithm, 20) error in P-T interpolation when P-T table is used, 21) absorption by unknown gases, 22) error in error-weighted coefficient matrix, 23) radiation and multiple scattering effects, and 24) error due to unfixed line coupling.

(3) Errors in theoretical computation

1) Error in physical constants, 2) error in drift effect correction, 3) error in correcting the drift effect due to the sunspot effect in the vicinity of the IFOV boundary during 100% observation, 4) error in the refractive index expression, 5) mapping error due to mock mirage, 6) error in sunlight source data, 7) error in line parameters, 8) error due to neglecting dependency of Wulf band on temperature, 9) error in pseudo-line data, 10) error in continuum cross-section data, 11) absorption by other gases, and 12) error in reference atmospheric temperature and pressure data when atmospheric pressure and altitude data are used (UKMO, CIRA).

2.4.4 Setting quality data

(1) Level 1 product data quality

1) Abnormal ILAS-II instrument information (HK data including abnormal temperatures, gimbal azimuth angle, etc.) is stored in the HK data file and registered in the database after being checked by the instrument management system. In quality evaluation, quality is set to:

Normal, when no error is detected, and

Abnormal, when one or more data are detected

in gimbal angle (azimuth, elevation) source status, and temperature data.

2) Number of continuous errors

To determine the quality of data transmission, record, and packet edition, the number of continuous data errors determined to be spike noise or missing data among atmospheric observation data in spike noise and missing value handling must be obtained as follows.

$$\underset{(i=1,2,3)}{\text{Number of continuous errors } i} = \sum_{\text{element}} \left[\begin{array}{l}\text{Number of case that spike noise or missing frame} \\ \text{continues more than } N_i \text{ frame}\end{array} \right]$$

An Ni value is specified in the processing condition file for spike noise and missing value handling. The number of continuous errors in the data from five channels, infrared (IR), mid-IR, $ClONO_2$, visible, and sun edge sensor and the total sum of the numbers for five channels, is recorded as quality data.

3) Dispersion in 100% signal values around the drift line

In pseudo-transmittance computation, dispersion around the 100% drift line is obtained as RMS values for each channel element. In quality evaluation, an average of RMS values is obtained for all the elements from each channel and data quality is ranked Good, Poor, or No Data based on the thresholds given by processing conditions.

The entire quality is evaluated to:

Good	if the data from all the channels,
Poor	if the data from any of the channels, and
No Data	if No Data is derived from any channel.

After a sufficient amount (~1000 OE) of observation data has been accumulated, the thresholds must be determined by investigating the frequency distribution.

4) Trend of the output values from the elements for each channel

To monitor the elements for decrease in element output due to deterioration and detect defective elements, if any, trend monitoring is executed on output values from the elements in the direct sun observation part. In spike noise and missing value handling, an average of the frames in the 100% value observation part, in which no data is determined to be spike noise or a missing value, is obtained for each of the IR, mid-IR, ClONO2 channel, visible, and sun-edge sensor elements. In quality evaluation, the thresholds in the condition file are used as follows.

$$\left|\text{mean value of signals} - \mu_{trend}^{old}\right| \le \text{threshold} \times \sigma_{trend}^{old} \longrightarrow \text{Good}$$

$$\left|\text{mean value of signals} - \mu_{trend}^{old}\right| > \text{threshold} \times \sigma_{trend}^{old} \longrightarrow \text{Poor}$$

where

$$\mu_{trend}^{new} = \frac{\mu_{trend}^{old} \times N_{trend} + \text{mean value of signals}}{N_{trend} + 1}$$

$$\sigma^{2\,new}_{trend} = \frac{\sigma^{2\,old}_{trend} \times N_{trend} + (\text{mean value of signals} - \mu_{trend}^{old})^2}{N_{trend} + 1}$$

Not revised, in case of abnormal (Poor, No Data)

The entire quality of all the channels determined from the quality of the elements is recorded into the database with quality for each element as follows.

Good if all the elements are good,
Poor if any of them is poor, and
No Data if any of the elements is No Data.

Since averages of output values from the elements may have an almost normal distribution, a value of 2 or 3 is set for the threshold.

(2) Level 2 product quality

In quality evaluation, the default settings are Good if the product is created successfully and No Data otherwise, for level 2 product quality data. In this case, the quality evaluation is not executed. On the other hand, researchers may rank the level 2 product quality as Good, Poor, or No Data using the evaluation/analysis subsystem function. Note that if abnormal data is processed in an unconventional way, it may default to Poor instead of Good.

3. Distribution of ILAS-II Standard Processed Data

To make full use of ILAS-II data, level 1 and level 2 data, into which ILAS-II data (level 0 data) has been processed, are stored in the storage devices appropriate for their volume and usage at ILAS-II DHF. ILAS-II DHF distributes the stored data on the specified media to users.

3.1 Storing ILAS-II Data

All the ILAS-II level 0 data received from NASDA/EOC are classified into individual observations stored in the hard disk and mass-storage device for management. ILAS-II level 1 data, into which ILAS-II level 0 edited data have been processed, are also stored and managed this way. Mass-storage devices consist of mass-storage tape libraries and tape drives, and serves as an intermediate hierarchical storage between these devices and the hard disk. This automatically enables the frequently accessed files to remain in the hard disk and the others to be moved to the tape libraries.

The final resulting ILAS-II level 2 data from throughout the observation period are stored together in the hard disk for management. Out of all the data stored and managed at ILAS-II DHF, only ILAS-II level 1 and level 2 data are provided to users on desired media. The types of ILAS-II data are listed in Table 3.1-1.

Table 3.1-1 Types of stored data

Type	Storage medium	Storage period	Availability
ILAS-II Edited level 0 data	Hard disk Mass-storage system	Storage of ILAS-II data of entire mission period Move to mass-storage system in order of observation date	No
ILAS-II level 1 data	Hard disk Mass-storage system	Storage of ILAS-II data of entire mission period. Move to mass-storage system in order of low access	Yes
ILAS-II level 2 data	Hard disk	Storage of ILAS-II data of entire mission period	Yes

3.2 Data Distribution Policy

Before ILAS-II standard data processed at ILAS-II DHF can be distributed to users, data quality evaluation, validation analysis, and instrument trend evaluation must have been executed. This means that the types available and the times when they may be distributed to users depend on the purpose of data acquisition, the current validation stage, and user's registration class.

3.2.1 User class

ILAS-II data users are generally divided into two groups, authorized users and general users, depending on their registration class. The authorized users include ILAS-II project staff, science team members, and validation experiment team members. General users include general researchers other than those in the authorized group. Table 3.2-1 shows user types according to the user's registration class.

Table 3.2-1 User types according to user's registration class

Category of user		Remarks
Authorized users	PS (ILAS-II Projec tStaff)	ILAS-II Project Staff approved by the project leader
	ST (Science Team Member)	Co-I, Assistant, Associate of ILAS-II Science Team approved by the project leader
	VT (Validation Experiment Team Member)	Co-I, Assistant, Associate of ILAS-II Validation Experiment Team approved by the team leader
General user	GU (General User)	Other researchers

3.2.2 Validation stage

Before ILAS-II products can be distributed to users, the following three validation processes must have been executed.

1) Data quality evaluation

General data evaluation is executed. The quality of level 1 and level 2 data products are evaluated. Level 1 data are evaluated for each element and channel, and level 2 data for each observation parameter. The results from evaluation are ranked as either Good, Poor, and No Data for each parameter. For more information, see Section 2.4, "Evaluation and Analysis". If a warning appears continuously during quality determination, the person responsible for data quality evaluation must investigate the cause to determine whether it is an avoidable problem or a fault in instrumentation.

2) Validation analysis

In validation analysis, the data derived from experiments is used. In the validation process, ILAS-II observation data is compared with that measured at the almost same time and same observation points on the ground.

3) Instrument trend evaluation

To investigate the various effects such as deterioration of ILAS-II sensors on data quality, the time-series trend data is evaluated over about one year. This enables validation of data validity and stability.

The distributed data are classified into three types: unverified, verified, and established data. Table 3.2-2 shows the relationship between user classes and validation stages.

The data that have been subjected to general data evaluation, are referred to as unverified data. Unverified data are further verified and analyzed to ensure the instrument stabilization trend and seasonal repeatability of ILAS-II one year after initial validation. These data are called verified data. The data distributed to users, which have been subjected to validation and stabilization evaluation for more than one year after validation, are referred to as established data.

Unverified and verified data may be distributed to authorized users.

Table 3.2-2 User classes and verification stages

User category	Validation stage	Definition
Specific users **PS, ST, PI, VT**	**Unverified data** **(U)**	Unverified data (After regular operation started)
	Verified data **(V)**	All the data obtained using the observation instrument and processing algorithms whose validity has been verified through validation analysis with verified data (TDBs after launch)
General user **GU**	**Confirmed data** **(C)**	Verified data that has been trend-evaluated between TDBs and their validity has been verified. (TDBs after launch)

3.2.3 Purpose of data use

The data of the products at the validation stages described above depend on the user class and usage purpose. The purposes of data use are roughly divided into algorithm studies, validation analyses, and applied studies. Table 3.2-3 shows the available data classified according to the user's purpose.

Table 3.2-3 Available data classified according to user's purpose

	Algorithm research	Validation analysis	Application research
Authorized users			
PS	**U, V, C**	**U, V, C**	**U, V, C**
ST	**U, V, C**	**U, V, C**	**U, V, C**
VT	**-**	**U, V, C**	**-**
General user GU	**C**	**C**	**C**

U: Unverified data, V: Verified data, and C: Confirmed data

3.3 Searching and Ordering Data

ILAS-II processed data may be obtained by one of the following two methods using the searching and ordering service by either access to the Web server, or by written letter or fax. The products available to users are sequentially updated throughout the ILAS-II mission period. Using the data search system, users can search the desired up-to-date data.

1) Access to Web server (on-line data distribution/on media)

Users can access the ILAS-II WWW server for data publication via the Internet to use the data search and ordering service. After searching data, users may directly download the desired data via the Internet or select "Ordering data on media" to order the product from the ILAS-II DHF office. For more information on searching and ordering data, see Appendix B, "Guide for using the ILAS-II Data Distribution System".

2) Written letter or fax (on media)

Users can order the product by sending a written letter or fax to the ILAS-II DHF office. After receiving the order, the ILAS-II office searches the ordered data for users and distributes it on the specified media to them (see Section 3.4, "Data Distribution").
Table 3.3-1 describes how to search and order the available data by user class.

Table 3.3-1 Searching and ordering available data by user class

Category of user	Data level	Retrieval and order of product
Specific users PS, ST, PI, VT	Level 1 data	1) Access to Web server (on media) 2) Written letter or fax (on media)
	Level 2 data	1) Access to Web server (data via the Internet or on media) 2) Written letter or fax (on media)
General user GU	Level 2 data	1) Access to Web server (data via the Internet)

3.3.1 Data search and ordering service for authorized users

ILAS-II DHF offers a data search and ordering service for authorized users, either by access to the Web server or by written letter or fax. Available products are sequentially updated throughout the mission period.

(1) Data search requirements

The searching items required for authorized users to use the ILAS-II data search and ordering service provided by ILAS-II DHF are described below in Table 3.3-2.

Table 3.3-2 Items required for data search and ordering

Item	Required/ Omissible	Description of contents
Product level	Required	Level 1 or level 2
Data version	Required	Specify the data version. For level 2 data products, the data version is assigned to the data on all gases.
Observation objects Parameter	Required	For level 2 data, specify parameters of observation objects from the source list. Selectable parameters depend on the users' category.
Observation date and time	Omissible	Observation data period (Specify the starting and ending dates.) Set the entire observation period as the default.
Observation position	Omissible	Specify the ranges of observation latitude and longitude areas from the following: 1) Entire sphere 2) Northern hemisphere 3) Southern hemisphere 4) Center and radius 5) Rectangular (upper left and lower right corners) Set "Entire sphere" as the default.
Processing date and time	Omissible	May specify data processing date for the search conditions.
Quality	Omissible	May specify data quality for the search conditions. (Only level 2 data) Select either "Good", "Poor or higher," or "No Data" (all).

(2) Version information

ILAS-II data processing algorithms are revised by distributing products to researchers for examining data quality, and refinement of the algorithms by ILAS-II DHF based on feedback data. Since, as mentioned above, algorithms may be changed depending on the results of analysis and validation after sensors are regularly operated, more than one version of the same data product(s) are distributed to users.

This enables users to reference enhancement information between the current and previous versions at data search, as well as the current status for each version.

(3) Data ordering and download

When selecting the data search and ordering service through access to the Web server, users may download the desired data on-line or may receive it on the specified media. If downloading, users must specify the data archiving method. If ordering data on media, users must select one of the available media described in the next section.

When ordering by written letter or fax, users must provide information including their name, delivery place, desired media, and search items in the given form and send it with an attached letter or by fax. The ILAS-II office will relay the results of the search by written letter or fax. If target data are found, then they will be distributed to the user on the specified media. The order form can be downloaded from the ILAS-II Web server.

3.4 Data Distribution

ILAS-II data are basically distributed online through the Web server. The ILAS-II office will distribute the ordered data on the specified media to authorized users who have registered in advance.

(1) Data distribution method

The products may be distributed on media or online, and can be accessed by authorized users in either way. Table 3.4-1 shows the data distribution methods.

Table 3.4-1 Data distribution method

User category	Product level	Delivery
Authorized users	Level 1	Medium
	Level 2	Medium Online
General users	Level 2	Online

(2) Data distribution media

The media on which data is stored for distribution to users are listed in Table 3.4-2.

Table 3.4-2 Media on which products are stored for distribution

Medium	Storage capacity	Format
3.5-inch floppy disk	2HD: 1.44 MB, (1.2 MB)	PC-DOS, Macintosh and UNIX format
MO	230 MB approx. 640 MB approx.	PC-DOS, Macintosh format
Zip	100 MB approx.	PC-DOS, Macintosh format
8-mm tape	5 GB approx.	ISO
4-mm DAT	2 GB approx.	ANSI DDS2 format
CD-ROM	650 MB approx.	ISO9660 (Level 1/2, Joliet, Apple HFS Plus), HFS, Hybrid

(3) Product format

The ILAS-II product formats are listed below. They are the same as for ILAS.

1) Level 1 product format
HDF format (Hierarchical Data Format)

2) Level 2 product format
Text format (AMES format)

The HDF format was developed by NCSA (National Center for Supercomputing Applications) of Illinois University so that users might handle data easily in a diverse-computer environment. The text format, AMES, enables users to obtain data without any special tool. For more information on formats, see Appendix A, "Product Formats Descriptions".

(4) Data capacity requirement for each product

The data capacity requirements are listed in Table 3.4-3 for level 1 and level 2.

Table 3.4-3 Data capacity requirements for level 1 and level 2

Product level	Volume in one product	Volume in product/day	Volume in product/year
Level 1	12 MB	336 MB (12 MB * 28 OE)	120 GB (336 MB * 365 days)
Level 2	4 KB	2.6 MB (4 KB * 24 parameters* 28 OE)	950 MB (2.6 MB * 365 days)

Note: One level 1 product includes data for each occultation event. One level 2 product includes data for each calculated physical data with respect to every occultation event.

The methods for data search and ordering by written letter and fax are described on the next two pages.

ILAS-II Data Search and Order Form (1/2)

Addressee:

DHF Data Manager
ILAS-II DHF
National Institute for Environmental Studies
16-2, Onogawa Tsukuba, Ibaraki, 305-0053, Japan
TEL +81-298-50-2568
FAX +81-298-56-6995
E-mail: admdhf@ilas2.nies.go.jp

Date:

Please check one of the following boxes.

- ☐ Request for data search
- ☐ Request for data search and ordering the data, if found

Orderer: If you have received your own user ID, please write it.

User class: Authorized

User ID:

Address ______

Company ______

Department ______

Title ______

Name ______

TEL: ______ FAX: ______

E-mail ______

(1) Data type

Satellite/sensor name: ADEOS-II/ILAS-II

Product: (required)

☐ Level 1 data

☐ Level 2 data

Target parameter type: (Example) ozone

1. ______
2. ______
3. ______
4. ______
5. ______

Product quality: (omissible for all the defaults)

☐ Good or higher

☐ Poor or higher

☐ No Data or higher

ILAS-II Data Search and Order Form (2/2)

(2) Observation date/region specification (if omitted, the "entire period" and "all regions" are used by default.)

From/to observation dates (required)

(DDMMYY) From   To

☐Southern/Northern Hemisphere: (omissible)

Over the entire Northern Hemisphere☐

Over the entire Southern Hemisphere☐

☐Observation region: (omissible))

Latitude ☐N, ☐S_____° _____,~☐N ,☐S_____° _____,

Longitude☐N ,☐S_____° _____,~☐N ,☐S_____° _____,

☐Center and radius: (omissible)

Longitude of the central area

Latitude ☐N ,☐S_____° _____,

Longitude☐N ,☐S_____° _____,

Radius________km

(3) Purpose of data usage

Purpose: (required)

☐Algorithm study ☐Validation analysis ☐Applied study

(4) Distribution method (if ordering data)

Media: (required)

☐ 3.5-inch floppy disk (2HD):

☐MS-DOS format ☐Macintosh format ☐UNIX format

☐ MO (230 MB or 640 MB):

☐ MS-DOS format ☐Macintosh format

☐ Zip:

☐ MS-DOS format ☐Macintosh format

☐ 4-mm magnetic tape (DAT):

☐ 8-mm magnetic tape:

☐ CD-ROM :

☐ISO9660 format ☐HFS format ☐Hybrid

4. Contact Points

Information about ILAS-II project:

Yasuhiro Sasano
ILAS-II Project Leader
Global Environmental Division, Manager
National Institute for Environmental Studies,

16-2, Onogawa, Tsukuba, Ibaraki, 305-8506, Japan
TEL: +81-298-50-2444
FAX: +81-298-50-2575
E-mail: sasano@nies.go.jp

Information about the available ILAS-II data processing:

Tatsuya Yokota
ILAS-II DHF Manager
Center for Global Environmental Research
National Institute for Environmental Studies,

16-2, Onogawa, Tsukuba, Ibaraki, 305-8506, Japan
TEL: +81-298-50-2550
FAX: +81-298-58-2645
E-mail: yoko@nies.go.jp

Information about the available ILAS-II data:

DHF data Manager
ILAS-II DHF
Center for Global Environmental Research
National Institute for Environmental Studies,

16-2, Onogawa, Tsukuba, Ibaraki, 305-8506, Japan
TEL: +81-298-50-2568
FAX: +81-298-56-6995
E-mail: admdhf@ilas2.nies.go.jp

5. References

5.1 Glossary

Term	Description
Atmospheric window	The spectral area with a relatively high transmittance where light passing through the atmosphere is less subject to air molecules and aerosol particles. The typical areas include 2-2.5 μ m, 3-4 μ m, and 8-13 μ m in the infrared region.
Brightness	The brightness/unit area of a luminophor. Assuming that the surface area of the luminophor is A, the luminous intensity in the observation direction is I, and the angle defined between the normal to the luminophor surface and the observation direction is θ, the brightness B is given by the formula B=(1/cos θ). It is expressed in candela/cm^2 by the International System of Units or in any other unit.
Cross talk	Originally, a phenomenon occurring during voice communication on the telephone line in which current flows through another line, resulting in cross talk in that line. Here, the term refers to signals that leak into adjacent modules. Some cross talk phenomena occur due to electrical, thermal, or optical effects.
Extinction coefficient	Light is transmitted through the atmosphere while being absorbed or scattered by the molecules or aerosol particles floating in the atmosphere. The attenuation of light intensity is called "extinction" and the ratio of extinction to a given optical path length is called "extinction coefficient".
Fraunhofer line	An absorption line appearing in the solar spectrum discovered by Fraunhofer. Continuous light emitted by the spherical source appears as a dark line (absorption line) because it is absorbed by various atoms and ions in the lower part of the chromosphere layer. For the ILAS-II visible light channel, the wavelength of the spectroscope may be calibrated by utilizing the features of the Fraunhofer line spectrum.
Instantaneous Field of View (IFOV)	The field within which the optical system and detection element of the optical mechanism can detect instantaneously.

Lock-in amplifier	This a phase detector that detects only signals synchronized with the external reference signal to eliminate the noise effect. It outputs DC current and the relationship shown below is established. $E = A\cos\phi$ E: output voltage A: amplitude of input signal ϕ: phase difference from the reference signal For ILAS-II, it is used as an infrared detector.
Mie scattering	Electromagnetic scattering by uniform spherical particles. It includes Rayleigh scattering under extreme conditions in the case of minute particles. Mie scattering is used in lidar-based aerosol and cloud observation.
Module configuration	Interchangeable components. ADEOS-II consists largely of a bus module and mission module. The mission devices for observation such as sensors and the bus devices such as data processing, telecommunications, and altitude control systems are mounted in the box or on the panel and incorporated in the modules as units.
PSC (Polar Stratospheric Cloud)	Thought to be a hydrate containing crystal or nitric acid constituents or to be a collection of overcooled 3-constituent liquid drops. It may be observed at an altitude of 15-25 km above the polar region in winter. Cl_2 and HClO generated through the phase-phase reaction occurring on the cloud surface are accumulated at night. It is thought that accumulated Cl_2 and HClO play an important role in the series of ozone depletion processes.
Rayleigh scattering	Scattering by fine particles that are smaller than wavelength order. Light scattering with no variance in wavelength. This mechanism is used for lidar-based atmospheric density observation. The vertical distribution of atmospheric temperatures can be derived from the altitude distribution of air density observed by lidars using the rules governing gases and approximation of static equilibrium.
Resolution	The minimum interval or field of view defined between two points, which can be identified in the imaging system such as optical devices (including electro-optical devices).

Retrieval	Extraction of target information (parameters) from the measurement signals generally described in parameter integrals in remote sensing and elsewhere.
Scattering	A wave advancing in one direction spreads in more than one direction around it when it encounters an obstacle. This phenomenon is called scattering. When sensors are used for atmospheric observation, electromagnetic waves emitted from the target are scattered upon collision with molecules and aerosol particles in the atmosphere during propagation. In observation using sensors, scattering causes attenuation in electromagnetic energy during propagation from the target to the sensor, and also causes an electromagnetic wave incident from a off-direction between the target and the sensor. Light scattering includes Mie scattering, Rayleigh scattering, and others and is classified according to the wavelength and particle size.
Telemetry	Information on voltage, current, temperature, and pressure representing the activities of instrumentation of satellite subsystems (mission devices such as sensors(e.g. ILAS), and bus devices such as the power line and control system)
Three-axis altitude control	Altitudes of satellites are maintained by controlling three-way (rolling, pitching, yawing) axes against the earth. This control method is applied to satellites orbiting the earth for observation. Although the method is somewhat complicated, it enables the satellites to face the earth.
Zenith	The intersection at which a line extended on the normal line passing through the observation point upward meets the circumference of the celestial sphere.

5.2 List of Abbreviations

A

ADEOS	Advanced Earth Observing Satellite
ADEOS II	Advanced Earth Observing Satellite II
AMSR	Advanced Microwave Scanning Radiometer
AOCS	Attitude and Orbit Control System

B

BBM	Bread Board Model

C

C&DH	Communication & Data Handling
CLAES	Cryogenic Limb Array Etalon Spectrometer
CRL	Communications Research Laboratory

D

DAT	Digital Audio Tape
DCS	Data Collection System
DHF	ILAS-II Data Handling Facility
DRTS	Data Relay Test Satellite
DT	Direct Transmission
DTL	Direct Transmission for Local Users

E

EM	Engineering Model
EOC	Earth Observation Center
EPS	Electrical Power Subsystem
ESA	Earth Sensor Assembly
ERBS	Earth Radiation Budget Satellite

F

FM	Flight Model
FTP	File Transfer Protocol

G	
GLI	GLobal Imager
GPS	Global Positioning Satellite System
H	
HALOE	Halogen Occultation Experiment
HK	House Keeping
I	
IFOV	Instantaneous Field of View
ILAS	Improved Limb Atmospheric Spectrometer
ILAS-II	Improved Limb Atmospheric Spectrometer-II
IOCS	Inter Orbit Communication Subsystem
IR	Infrared
ISAMS	Improved Stratospheric and Mesospheric Sounder
M	
MDP	Mission Data Processor
MDR	Mission Data Recorder
MLS	Microwave Limb Sounder
MO	Magneto-Optical Disk
N	
NASA	National Aeronautics and Space Administration
NASDA	National Space Development Agency of Japan
NASDA/EOC	NASDA/Earth Observation Center
NIES	National Institute for Environmental Studies
O	
OBC	On Board Computer
OE	Occultation Event
P	
PCD	Payload Correction Data
PDL	Paddle
PFM	Proto Flight Model
POAM	Polar Ozone and Aerozol Measurement
POLDER	Polarization and Directionality of the Earth's Reflectances

PSC	Polar Stratospheric Cloud

Q

QQC	Quality, Quantity and Continuity

T

TEDA	Technical Data Acquisition Equipment

S

SAGE	Stratospheric Aerosol and Gas Experiment
SAM	Stratospheric Aerosol Measurement

T

TBD	To Be Determined
TEDA	Technical Data Acquisition Equipment

U

UARS	Upper Atmosphere Research Satellite
UKMO	United Kingdom Meteorological Office

V

VMS	Visual Monitoring System

Appendix A

Product Format Descriptions

Version 1.0

1. Introduction

This Handbook describes the standard processed products for those researchers who are users of the data from ILAS-II sensors mounted on the ADEOS-II satellite. ILAS-II standard processed products are created at the ILAS-II Data Handling Facility (ILAS-II DHF) at the National Institute for Environmental Studies for data processing and distribution. These products are distributed to general users if necessary.

The same formats are used in ILAS-II standard processed products as for ILAS as shown below.

1) Level 1 data
・HDF format (Hierarchical Data Forma)

2) Level 2 data
・Text format (AMES format)

2. Outline of products

2.1 Processing level definition

ILAS-II observation data are sent to ILAS-II DHF from NASDA/EOC. These ILAS-II observation data are defined as "Level 0". Using the data processing system deployed in ILAS-II DHF, "Level 1" data are derived from "level 0" data by applying effective data extraction, abnormal/missing value processing, and signal trend correction. "Level 2" data may be derived from "Level 1" data. "Level 2" data give the vertical distributions of atmospheric trace gas concentrations and their physical amounts. "Level 1" and "Level 2" data are included in the ILAS-II standard processed product.

Processing level definition and data units

Level	Description	Unit
Level 1	Extracts 0%, 100%, and effective part observation data from Level 0 data and applies abnormal/missing value handling and relative brightness voltage correction to it.	For each occultation event (OE) [Data capacity requirement: TBD bytes]
Level 2	Gives the vertical distributions of geophysical amounts computed through the retrieval processing from Level 1 data.	At least one type of geophysical amount (Level 2) is computed for each OE. [Data capacity requirement: about 5 K bytes]

Note 1) The observation unit by ILAS-II is defined as an Occultation Event (OE). 28 –unit observations are performed a day.

2.2 Product type

There are two product types depending on the user and the verification stage. The data provided as a product are verified to ensure their quality and reliability. Depending on their current verification stage, data are classified into three types. Unverified and verified data products are provided to authorized users. Only the established data products whose validity and stability have been evaluated after data verification by experiment observation, are provided to general users.

The product types are described in detail below.

Product type

Type	User	Stage	Definition
General user product	General users: Example: General researchers (including authorized users)	Established	Verified data that have been trend-evaluated between TDBs and their validity has been verified. (TDBs after launch)
Authorized user product	Authorized users (TBD): project staffs, members of science teams and experiment teams.	Verified	All the data obtained using the observation instrument and processing algorithms whose validity has been verified through verification analysis with verified data. (TDBs after launch)
		Unverified	Unverified data (After regular operation started: TBD)

3. Level 1 product

3.1 Outline

Level 1 product includes transmittance data calibrated using 0% and 100% values for signals after being extracted from the effective part level 0 data, ILAS-II observation data and processed for correcting abnormal and missing values. (Note that the data from sun edge sensors are brightness data.) This product consists of data from individual visible, infrared, mid-IR, and $ClONO_2$ channels and sun edge sensors.

The Level 1 product configuration is shown below.

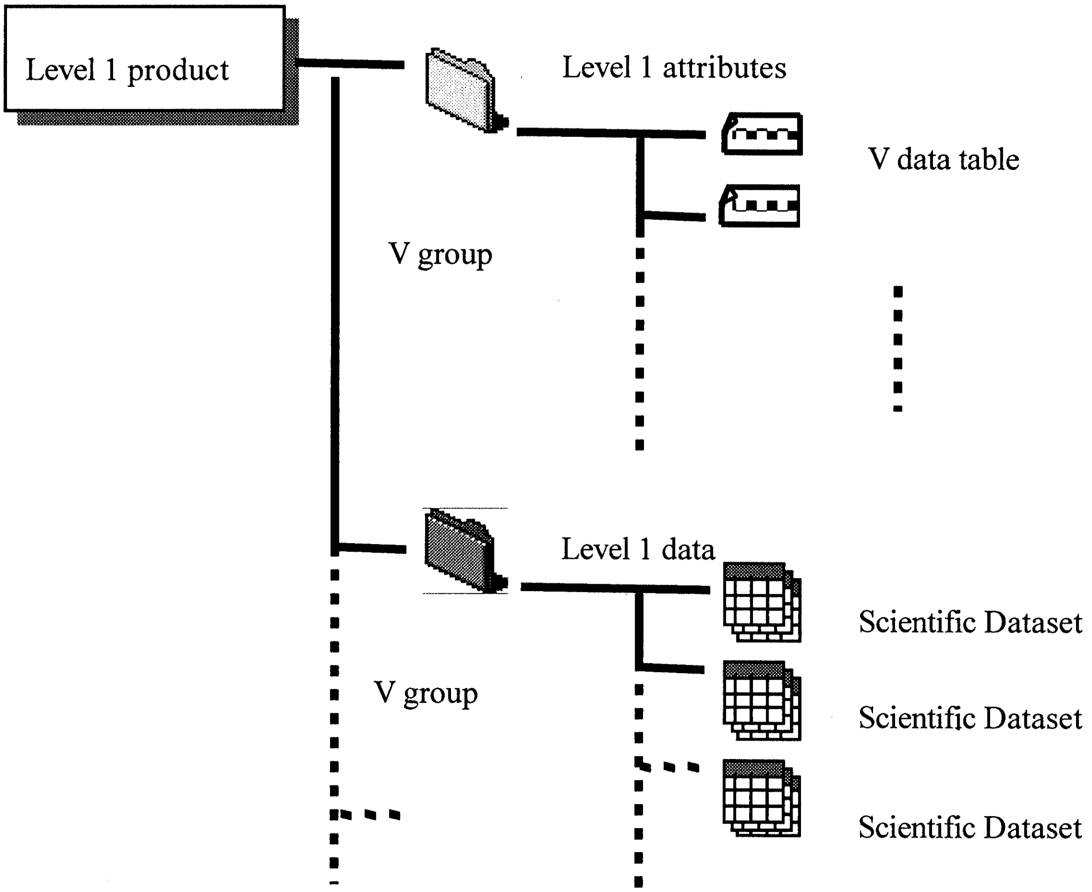


Fig. 3-1. Level 1 product configuration

There are two types of "V group", one contains L1 product attributes, and the other one contains actual data as Scientific Data Set (SDS) format.

3.2 Level 1 product format

The Level 1 product data set includes the V groups listed below. They are classified together into the attribute group and the channel-type group. Channel-type data is actual data and consists of multi-dimensional arrays in the form of scientific data SDS.

Level 1 Data Attribute	(V group name: L1_Data_Attribute)
Infrared Channel Data	(V group name: Infrared_Channel_Data)
Mid-infrared Channel Data	(V group name: Mid-infrared_Channel_Data)
$ClONO_2$ Channel Data	(V group name: ClONO2_Channel_Data)
Visible Channel Data	(V group name: Visible_Channel_Data)
Sun Edge Sensor Data	(V group name: Sun_Edge_Sensor_Data)
Infrared Channel Scan Data	(V group name: Infrared_Channel_Scan_Data)
Mid-infrared Channel Scan	(V group name: Mid-infrared_Channel_Scan_Data)
$ClONO_2$ Channel Scan Data	(V group name: ClONO2_Channel_Scan_Data)
Visible Channel Scan Data	(V group name: Visible_Channel_Scan_Data)
Sun Edge Sensor Scan Data	(V group name: Sun_Edge_Sensor_Scan_Data)
Drift Correction Coefficient Data	(V group name: Drift_Correction_Coefficient_Data)

Note that the data types listed below are used.

Cha :	Character string
Short :	2 bytes integer
Real :	4 bytes real number

3.2.1 Level 1 data attributes

L1 Data Attribute contains attribute information such as product descriptions. (V group name: L1 Data Attribute)

- **L1 product information**

This defines the creating organization, dataset name, and label of the Level 1 product.

L1 Data Product Table

Data name	Data type	Size (Byte)	Number of data	Contents of description
Data center	Cha	19	1	Facility that produced the product: "EA/NIES/ILAS-II DHF"
Data product name	Cha	27	1	File name "YYYYMMDDNN{0|1}vxxxx{r|s}l1.hdf " YYYYMMDD : The year of observation (UTC) NN{0|1} : The unique number in a cycles of satellite orbit vxxxx : Data version (4 digits) {r|s} : Observation mode (r: Sun Rise s: Sun Set) Note: A revision number is added to internal product file name. "YYYYMMDDNN{0|1}vxxxxxxxx{r|s}l1.hdf"
Satellite name	Cha	8	1	Name of Satellite used: "ADEOS-II"
Sensor name	Cha	7	1	Name of sensor used: "ILAS-II"
Investigator	Cha	15	1	Name of researcher "Yasuhiro Sasano"
Data level	Cha	7	1	Processing level "Level 1"
Processing time	Cha	17	1	Time of level 1 processing (UTC) "YYYYMMDD hh:mm:ss"
Data version	Cha	6	1	Data version "Vxx.xx"
Data revision	Cha	5	1	Data revision "xx.xx"
Project name	Cha	24	1	Project name "ADEOS-II/ILAS-II PROJECT"

■ L1 observation management and time information

This contains data observation time and point information.

L1 Observation Information Table

Data name	Data type	Size (Byte)	Number of data	Contents of description
Observation start Time	Cha	21	1	Time of commencing observation for atmospheric transmittance parts (UTC) (First frame of channel data) "YYYYMMDD hh:mm:ss.ttt"
Observation end Time	Cha	21	1	Time of completing observation for atmospheric transmittance parts (UTC) (Last frame of channel data) "YYYYMMDD hh:mm:ss.ttt"
Start time of solar scan observation	Cha	21	1	Time of commencing observation for solar surface scanning parts (UTC) (First frame of sun scan data) "YYYYMMDD hh:mm:ss.ttt"
End time of solar scan observation	Cha	21	1	Time of completing observation for solar surface scanning parts (UTC) (Last frame of sun scan data) "YYYYMMDD hh:mm:ss.ttt"
Number of extracted effective channel data	Short	2	1	The number of effective data extracted from data of atmospheric transmittance parts : n
Number of extracted effective channel scan data	Short	2	1	The number of effective data extracted from data of solar surface scanning parts: m
Path number	Short	2	1	RSP path number for commencing observation "1" ~ "57"
Orbit number	Short	2	1	Orbit number for commencing observation "1" ~ "57"
Occultation event number	Cha	11	1	Occultation event number A unique number of the used in the software at ground system "YYYYMMDDNN{0|1}" YYYYMMDD: Observation Date (UTC) NN{0|1}: The unique number in a cycles of satellite orbit
Time of a tangent point	Cha	21	1	The time of the typical position for observation at a tangent height of 20 km (UTC) "YYYYMMDD hh:mm:ss.ttt"
Latitude of a tangent point	Real	4	1	The latitude of the typical position for observation at a tangent height of 20 km (deg, positive=North)
Longitude of a tangent point	Real	4	1	The longitude of the typical position for observation at a tangent height of 20 km (deg, positive=East)
Sunrise/Sunset flag	Cha	3	1	Observation mode "SRE": Observation at sunrise "SSE": Observation at sunset

L1 product quality information

This defines processing information such as product quality as shown below.

L1 product Quality Table

Data name	Data type	Size (Byte)	Number of data	Contents of description
Quality of infrared channel	Cha	1*44	44	The quality of every elements of infrared channel (TBD) (Infrared channel : 44 elements) "G" : GOOD "P" : POOR "N" : NO DATA
Quality of mid-infrared channel	Cha	1*22	22	The quality of every elements of mid-infrared channel (TBD) (Mid-infrared channel:22 elements) "G" : GOOD "P" : POOR "N" : NO DATA
Quality of $ClONO_2$ channel	Cha	1*22	22	The quality of every elements of $ClONO_2$ channel (TBD) ($ClONO_2$ channel :22 elements) "G" : GOOD "P" : POOR "N" : NO DATA
Quality of visible channel	Cha	1*1024	1024	The quality of every elements of visible channel (TBD) (Visible channel : 1024 elements) "G" : GOOD "P" : POOR "N" : NO DATA
Quality of sun edge sensor	Cha	1*1024	1024	The quality of every elements of sun edge sensor (TBD) (sun edge sensor : 1024 elements) "G" : GOOD "P" : POOR "N" : NO DATA

3.2.2 Infrared data

This is Level 1 data derived from the ILAS-II infrared channel during atmospheric observation.

■ Infrared Channel Data

(V group name: Infrared_Channel_Data)

Data name	Data type	Number of data (Dimension)	Size (Byte)	Contents of description
Observation time of infrared channel	Cha	n (1 dimension)	18*n	Observation time of infrared channel (UTC) 'YYYYMMDDhhmmss.ttt'
Spacecraft position of infrared channel	Real	3*n (2 dimensions)	4*(3*n)	x, y, z components of satellite position (km)
Spacecraft velocity of infrared channel	Real	3*n (2 dimensions)	4*(3*n)	x, y, z components of satellite velocity (km/second)
Observation data of infrared channel	Real	44*n (2 dimensions)	4*(44*n)	Infrared channel data (Infrared channel: 44 elements)
Processing result flag of infrared channel	Cha	44*n (2 dimensions)	1*(44*n)	Flags of the results of infrared channel '00000000' = Normal value '00000001' = Missing value '00000010' = Top & End sync error '00000100' = Address error '00001000' = Parity error '00010000' = Limit check error '00100000' = Checksum error '01000000' = Spike Noise '10000000' = Modified value

n : Number of extracted effective channel data

3.2.3 Middle infrared data

This is Level 1 observation data derived from the ILAS-II middle infrared channel during atmospheric observation.

■ Mid-infrared Channel Data

(V group name: Mid-infrared_Channel_Data)

Data name	Data type	Number of data (Dimension)	Size (Byte)	Contents of description
Observation time of mid-IR channel	Cha	n (1 dimension)	18*n	Observation time of mid-infrared channel (UTC) 'YYYYMMDDhhmmss.ttt'
Spacecraft position of mid-IR channel	Real	3*n (2 dimensions)	4*(3*n)	x, y, z components of satellite position (km)
Spacecraft velocity of mid-IR channel	Real	3*n (2 dimensions)	4*(3*n)	x, y, z components of satellite velocity (km/second)
Observation data of mid-IR channel	Real	22*n (2 dimensions)	4*(22*n)	Mid-infrared channel data (Mid-infrared channel: 22 elements)
Processing result flag of mid-IR channel	Cha	22*n (2 dimensions)	1*(22*n)	Flags of the results of mid-infrared channel '00000000' = Normal value '00000001' = Missing value '00000010' = Top & End sync error '00000100' = Address error '00001000' = Parity error '00010000' = Limit check error '00100000' = Checksum error '01000000' = Spike Noise '10000000' = Modified value

n : Number of extracted effective channel data

3.2.4 Infrared narrow band data

This is Level 1 data derived from the ILAS-II infrared narrow band channel during atmospheric observation.

■ **$ClONO_2$ Channel Data**

(V group name: ClONO2_Channel_Data)

Data name	Data type	Number of data (Dimension)	Size (Byte)	Contents of description
Observation time of $ClONO_2$ channel	Cha	n (1 dimension)	18*n	Observation time of $ClONO_2$ channel (UTC) 'YYYYMMDDhhmmss.ttt'
Spacecraft position of $ClONO_2$ channel	Real	3*n (2 dimensions)	4*(3*n)	x, y, z components of satellite position (km)
Spacecraft velocity of $ClONO_2$ channel	Real	3*n (2 dimensions)	4*(3*n)	x, y, z components of satellite velocity (km/second)
Observation data of $ClONO_2$ channel	Real	22*n (2 dimensions)	4*(22*n)	$ClONO_2$ channel data ($ClONO_2$ channels: 22)
Processing result flag of $ClONO_2$ channel	Cha	22*n (2 dimensions)	1*(22*n)	Flags of the results of mid-infrared channel '00000000' = Normal value '00000001' = Missing value '00000010' = Top & End syncerror '00000100' = Address error '00001000' = Parity error '00010000' = Limit check error '00100000' = Checksum error '01000000' = Spike Noise '10000000' = Modified value

n : Number of extracted effective channel data

3.2.5 Visible data

This is Level 1 data derived from the ILAS-II visible channel during atmospheric observation.

■ Visible Channel Data

(V group name: Visible_Channel_Data)

Data name	Data type	Number of data (Dimension)	Size (Byte)	Contents of description
Observation time of visible channel	Cha	n (1 dimension)	18*n	Observation time of visible channel (UTC) 'YYYYMMDDhhmmss.ttt'
Spacecraft position of visible channel	Real	3*n (2 dimensions)	4*(3*n)	x, y, z components of satellite position (km)
Spacecraft velocity of visible channel	Real	3*n (2 dimensions)	4*(3*n)	x, y, z components of satellite velocity (km/second)
Observation data of visible channel	Real	1024*n (2 dimensions)	4*(1024*n)	Visible channel data (Visible channels:1024)
Processing result flag of visible channel	Cha	1024*n (2 dimensions)	1*(1024*n)	Flags of the results of visible channel '00000000' = Normal value '00000001' = Missing value '00000010' = Top & End sync error '00000100' = Address error '00001000' = Parity error '00010000' = Limit check error '00100000' = Checksum error '01000000' = Spike Noise '10000000' = Modified value

n : Number of extracted effective channel data

3.2.6 Sun edge sensor data

This is Level 1 data derived from the ILAS-II sun edge sensors during atmospheric observation.

■ **Sun Edge Sensor Data**

(V group name: Sun_Edge_Sensor_Data)

Data name	Data type	Number of data (Dimension)	Size (Byte)	Contents of description
Observation time of sun edge sensor	Cha	n (1 dimension)	18*n	Observation time of sun edge sensor (UTC) 'YYYYMMDDhhmmss.ttt'
Spacecraft position of sun edge sensor	Real	3*n (2 dimensions)	4*(3*n)	x, y, z components of satellite position (km)
Spacecraft velocity of sun edge sensor	Real	3*n (2 dimensions)	4*(3*n)	x, y, z components of satellite velocity (km/second)
Observation data of sun edge sensor	Real	1024*n (2 dimensions)	4*(1024*n)	Sun edge sensor data (Sun edge sensor channels:1024)
Processing result flag of sun edge sensor	Cha	1024*n (2 dimensions)	1*(1024*n)	Flags of the results of sun edge sensor '00000000' = Normal value '00000001' = Missing value '00000010' = Top & End sync error '00000100' = Address error '00001000' = Parity error '00010000' = Limit check error '00100000' = Checksum error '01000000' = Spike Noise '10000000' = Modified value

n : Number of extracted effective channel data

3.2.7 Infrared scanned data

This is Level 1 data derived from the ILAS-II infrared channel during solar surface scanning observation for about 30 seconds.

■ Infrared Channel Scan Data

(V group name: Infrared_Channel_Scan_Data)

Data name	Data type	Number of data (Dimension)	Size (Byte)	Contents of description
Observation time of infrared channel scan data	Cha	m (1 dimension)	18*m	Observation time of infrared channel scan data (UTC) 'YYYYMMDDhhmmss.ttt'
Spacecraft position of infrared channel scan data	Real	3*m (2 dimensions)	4*(3*m)	x, y, z components of satellite position (km)
Spacecraft velocity of infrared channel scan data	Real	3*m (2 dimensions)	4*(3*m)	x, y, z components of satellite velocity (km/second)
Observation data of infrared channel scan data	Real	44*m (2 dimensions)	4*(44*m)	Solar surface scanning data of infrared channel (Infrared channels: 44)
Processing result flag of infrared channel scan data	Cha	44*m (2 dimensions)	1*(44*m)	Flags of the results of infrared channel scan data '00000000' = Normal value '00000001' = Missing value '00000010' = Top & End sync error '00000100' = Address error '00001000' = Parity error '00010000' = Limit check error '00100000' = Checksum error '01000000' = Spike Noise '10000000' = Modified value

m : Number of extracted effective channel scan data

3.2.8 Middle infrared scanned data

This is Level 1 data derived from the ILAS-II mid-IR channel during solar surface scanning observation for about 30 seconds.

■ **Mid-infrared Channel Scan Data**

(V group name:: Mid-infrared_Channel_Scan_Data)

Data name	Data type	Number of data (Dimension)	Size (Byte)	Contents of description
Observation time of mid-infrared channel scan data	Cha	m (1 dimension)	18*m	Observation time of mid-infrared channel scan data (UTC) 'YYYYMMDDhhmmss.ttt'
Spacecraft position of mid-infrared channel scan data	Real	3*m (2 dimensions)	4*(3*m)	x, y, z components of satellite position (km)
Spacecraft velocity of mid-infrared channel scan data	Real	3*m (2 dimensions)	4*(3*m)	x, y, z components of satellite velocity (km/second)
Observation data of mid-infrared channel scan data	Real	22*m (2 dimensions)	4*(22*m)	Solar surface scanning data of mid-infrared channel (Mid-infrared channel: 22)
Processing result flag of mid-infrared channel scan data	Cha	22*m (2 dimensions)	1*(22*m)	Flags of the results of mid-infrared channel scan data '00000000' = Normal value '00000001' = Missing value '00000010' = Top & End sync error '00000100' = Address error '00001000' = Parity error '00010000' = Limit check error '00100000' = Checksum error '01000000' = Spike Noise '10000000' = Modified value

m : Number of extracted effective channel scan data

3.2.9 Infrared narrow band scanned data

This is Level 1 data derived from the ILAS-II infrared narrow band channel during solar surface scanning observation for about 30 seconds.

■ **$ClONO_2$ Channel Scan Data**

(V group name: ClONO2_Channel_Scan_Data)

Data name	Data type	Number of data (Dimension)	Size (Byte)	Contents of description
Observation time of $ClONO_2$ channel scan data	Cha	m (1 dimension)	18*m	Observation time of $ClONO_2$ channel scan data (UTC) 'YYYYMMDDhhmmss.ttt'
Spacecraft position of $ClONO_2$ channel scan data	Real	3*m (2 dimensions)	4*(3*m)	x, y, z components of satellite position (km)
Spacecraft velocity of $ClONO_2$ channel scan data	Real	3*m (2 dimensions)	4*(3*m)	x, y, z components of satellite velocity (km/second)
Observation data of $ClONO_2$ channel scan data	Real	22*m (2 dimensions)	4*(22*m)	Solar surface scanning data of $ClONO_2$ channel ($ClONO_2$ channels: 22)
Processing result flag of $ClONO_2$ channel scan data	Cha	22*m (2 dimensions)	1*(22*m)	Flags of the results of $ClONO_2$ channel scan data '00000000' = Normal value '00000001' = Missing value '00000010' = Top & End sync error '00000100' = Address error '00001000' = Parity error '00010000' = Limit check error '00100000' = Checksum error '01000000' = Spike Noise '10000000' = Modified value

m : Number of extracted effective channel scan data

3.2.10 Visible scanned data

This is Level 1 data derived from the ILAS-II visible channel during solar surface scanning observation for about 30 seconds.

■ Visible Channel Scan Data

(V group name: Visible_Channel_Scan_Data)

Data name	Data type	Number of data (Dimension)	Size (Byte)	Contents of description
Observation time of visible channel scan data	Cha	m (1 dimension)	18*m	Observation time of visible channel scan data (UTC) 'YYYYMMDDhhmmss.ttt'
Spacecraft position of visible channel scan data	Real	3*m (2 dimensions)	4*(3*m)	x, y, z components of satellite position (km)
Spacecraft velocity of visible channel scan data	Real	3*m (2 dimensions)	4*(3*m)	x, y, z components of satellite velocity (km/second)
Observation data of visible channel scan data	Real	1024*m (2 dimensions)	4*(1024*m)	Solar surface scanning data of visible channel (Visible channel:1024)
Processing result flag of visible channel scan data	Cha	1024*m (2 dimensions)	1*(024*m)	Flags of the results of visible channel scan data '00000000' = Normal value '00000001' = Missing value '00000010' = Top & End sync error '00000100' = Address error '00001000' = Parity error '00010000' = Limit check error '00100000' = Checksum error '01000000' = Spike Noise '10000000' = Modified value

m : Number of extracted effective channel scan data

3.2.11 Sun edge sensor scanned data

This is Level 1 data derived from the ILAS-II sun edge sensor during solar surface scanning observation for about 30 seconds.

■ **Sun edge sensor scan data**

(V group name: Sun_Edge_Sensor_Scan_Data)

Data name	Data type	Number of data (Dimension)	Size (Byte)	Contents of description
Observation time of sun edge sensor scan data	Cha	m (1 dimension)	18*m	Observation time of Sun edge sensor scan data (UTC) 'YYYYMMDDhhmmss.ttt'
Spacecraft position of sun edge sensor scan data	Real	3*m (2 dimensions)	4*(3*m)	x, y, z components of satellite position (km)
Spacecraft velocity of sun edge sensor scan data	Real	3*m (2 dimensions)	4*(3*m)	x, y, z components of satellite velocity (km/second)
Observation data of sun edge sensor scan data	Real	1024*m (2 dimensions)	4*(1024*m)	Solar surface scanning data of sun edge sensor (Sun edge sensor channels: 1024)
Processing result flag of sun edge sensor scan data	Cha	1024*m (2 dimensions)	1*(1024*m)	Flags of the results of sun edge sensor scan data '00000000' = Normal value '00000001' = Missing value '00000010' = Top & End sync error '00000100' = Address error '00001000' = Parity error '00010000' = Limit check error '00100000' = Checksum error '01000000' = Spike Noise '10000000' = Modified value

m : Number of extracted effective channel scan data

3.2.12 Drift correction coefficient data

■ Drift Correction Coefficient Data

(V group name: Drift Correction Coefficient Data)

Data name	Data type	Number of data (Dimension)	Size (Byte)	Contents of description
Drift correction coefficient of infrared channel	Real	44*2 (2 dimensions)	4*44*2	Coefficient data used to eliminate the 100% drift effect. The values for regression correction coefficients a_{100} and b_{100} sampled at infrared 44-channel sampling points.
Zero-drift correction coefficient of infrared channel	Real	44*2 (2 dimensions)	4*44*2	Coefficient data used to eliminate the 0% drift effect. The values for regression correction coefficients a_0 and b_0 sampled at infrared 44-channel sampling points.
Drift correction coefficient of mid-infrared channel	Real	22*2 (2 dimensions)	4*22*2	Coefficient data used to eliminate the 100% drift effect. The values for regression correction coefficients a_{100} and b_{100} sampled at mid-infrared 22-channel sampling points.
Zero-drift correction coefficient of mid-infrared channel	Real	22*2 (2 dimensions)	4*22*2	Coefficient data used to eliminate the 0% drift effect. The values for regression correction coefficients a_0 and b_0 sampled at mid-infrared 22-channel sampling points.
Drift correction coefficient of $ClONO_2$ channel	Real	22*2 (2 dimensions)	4*22*2	Coefficient data used to eliminate the 100% drift effect. The values for regression correction coefficients a_{100} and b_{100} sampled at infrared-narrow-band 22-channel sampling points.
Zero-drift correction coefficient of $ClONO_2$ channel	Real	22*2 (2 dimensions)	4*22*2	Coefficient data used to eliminate the 0% drift effect. The values for regression correction coefficients a_0 and b_0 sampled at infrared-narrow-band 22-channel sampling points.
Drift correction coefficient of visible channel	Real	1024*2 (2 dimensions)	4*1024*2	Coefficient data used to eliminate the 100% drift effect. The values for regression correction coefficients a_{100} and b_{100} sampled at visual 1024-channel

				sampling points.
Zero-drift correction coefficient of visible channel	Real	1024*2 (2 dimensions)	4*1024*2	Coefficient data used to eliminate the 0% drift effect. The values for regression correction coefficients a_0 and b_0 sampled at visual 1024-channel sampling points.
Drift correction coefficient of sun edge sensor	Real	1024*2 (2 dimensions)	4*1024*2	Coefficient data used to eliminate the 100% drift effect. The values for regression correction coefficients a_{100} and b_{100} sampled at 1024-sun edge sensor-sampling points.
Zero-drift correction coefficient of sun edge sensor	Real	1024*2 (2 dimensions)	4*1024*2	Coefficient data used to eliminate the 0% drift effect. The values for regression correction coefficients a_0 and b_0 sampled at 1024-sun edge sensor-sampling points.

4. Level 2 product

4.1 Outline

Level 2 product contains the results from the retrieval process, which have been computed in Level 1 to 2 processing (atmospheric temperature/pressure, aerosol extinction coefficient computation, and gas concentration computation). The product gives the vertical distributions of atmospheric trace gas concentrations, physical parameters, and measurement errors. Although the Level 2 product has more than one computed atmospheric trace gas concentration (observation type) during each ILAS-II observation, data are edited into one product for each observation type.

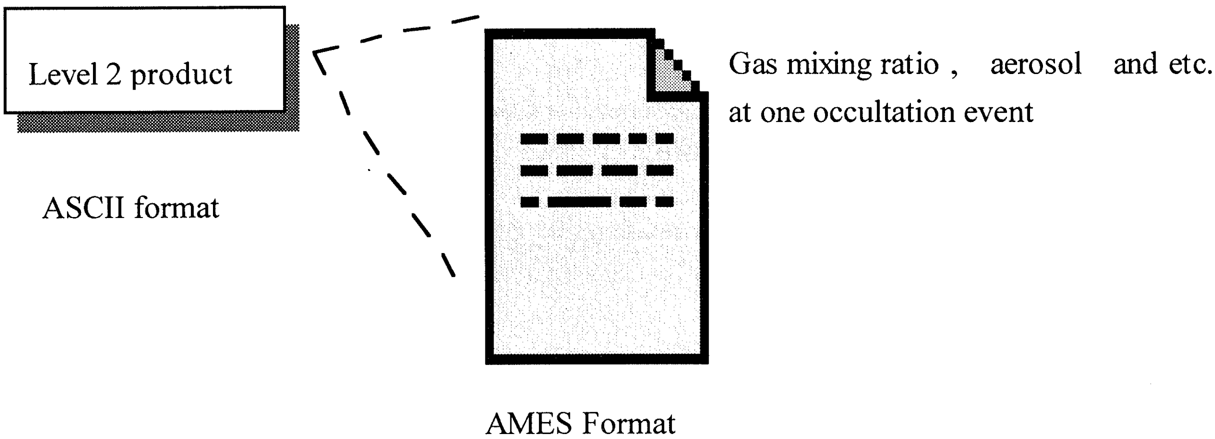


Fig. 4-1. Level 2 product configuration

4.2 Level 2 product format

The Level 2 data product format is described below. The format to be used conforms to the AMES format recommended by NASA. Format ID 2160, which is widely used for ozone sonde data, is introduced.

4.2.1 Level 2 product name

YYYYMMDDNN{0|1}vxxxx{r|s}.[Observation type].ames   Note 1)

YYYYMMDD : Observation date (UTC) (UTC)
NN{0|1} : Unique number in one revolution
vxxxx : Data version
{r|s} : Observation mode (r: Sun Rise s: Sun Set)
[Observation type] : variable number of characters (up to 9)

Note 1) The product has a name consisting of its product version and revision inside the system.

＜List of standard products type＞

	Discrimination	Name of observation type
Standard products	o3	Ozone
	hno3	Nitric acid
	no2	Nitrogen dioxide
	n2o	Nitrous oxide
	h2o	Water vapor
	ch4	Methane
	aecvis	Aerosol extinction coefficient at $0.78*10^{-6}$ m
	temsvis	Temperature (calculated from visible channel)
	previs	Pressure (calculated from visible channel)

<List of research product type>

	Discrimination	Name of observation type
Research products (TBD)	cfc11	CFC-11 (Trichlorofluoromethane)
	cfc12	CFC-12 (Dichlorodifluoromethane)
	cof2	Carbonyl fluoride
	co2	Carbon dioxide
	co	Carbon mono-oxide
	ocs	Carbonyl sulfide
	c2h6	Ethane
	n2o5	Dinitrogen pentoxide
	clono2	Chlorine nitrate
	aecmir0	Aerosol extinction coefficient at $3.0*10^{-6}$ m
	aecmir6	Aerosol extinction coefficient at $3.8*10^{-6}$ m
	aecmir16	Aerosol extinction coefficient at $5.1*10^{-6}$ m
	aecir7	Aerosol extinction coefficient at $7.1*10^{-6}$ m
	aecir16	Aerosol extinction coefficient at $8.3*10^{-6}$ m
	aecir34	Aerosol extinction coefficient at $10.6*10^{-6}$ m
	aecir43	Aerosol extinction coefficient at $11.8*10^{-6}$ m
	clono2irn	Chlorine nitrate (calculated infrared narrow channel)
	tempmir	Temperature (calculated from mid-IR channel)
	presmir	Pressure (calculated from mid-IR channel)
	tempukmo	Temperature of UKMO assimilation data (TBD)
	presukmo	Pressure of UKMO assimilation data (TBD)
	ptukmo	Potential Temperature of UKMO assimilation data (TBD)
	pvukmo	Potential vorticity of UKMO assimilation data (TBD)

4.2.2 Data format

Record Number	Format Definition	Contents
1	NLHEAD FFI	Number of file header lines / File format index "39 2160"
2	ONAME	The name of the originator "Yasuhiro Sasano" (fixed value)
3	ORG	The organization of the originator "National Institute for Environmental Studies" (fixed value)
4	SNAME	The source of the measurements "Improved Limb Atmospheric Spectrometer - Ⅱ" (fixed value)
5	MNAME	The name of mission "ADEOS-Ⅱ/ILAS-Ⅱ PROJECT" (fixed value)
6	IVOL NVOL	Volume number / Total number of volumes "1 1" (fixed value)
7	DATE RDATE	Date of commencing observation / Date of data revision "YYYY MM DD YYYY MM DD"
8	DX(1)	Interval between values of the 1st independent variable The 1st independent variable is tangent height, and recorded in the interval 1 km. "1" (fixed value)
9	LENX(2)	Number of characters of the 2nd independent variable which values is recorded as character strings. "16" (fixed value)
10	XNAME(1)	Description of the 1st independent variable "Tangent height (km)" (fixed value)
11	XNAME(2)	Description of the 2nd independent variable which values are recorded as character strings. "Satellite name / Sensor name" (fixed value)
12	NV	Number of primary variables "4" (fixed value)
13	VSCAL(n) n=1,…,4	Scale factor by which one multiplies recoded values of the n-th primary variable to convert them to the units specified in VNAME(n) Temperature, Pressure: "0.001 0.001 0.001 0.001" O_3, H_2O, CH_4: "0.001 0.00001 0.00001 0.00001" HNO_3, N_2O : "0.001 0.000001 0.000001 0.000001"

		CFC-11、CFC-12、N_2O_5、NO_2、Aerosol extinction coefficient : "0.001 0.0000001 0.0000001 0.0000001" Other products are TBD
14	VMISS(n) n=1,...,4	A quantity indicating missing or erroneous data values for n-th primary variable. "99999999 999999 999999 999999" (fixed value)
15	VNAME(1)	Description of the 1st primary variable. "Observation time (second)": (fixed value) The total second from 0:00
16	VNAME(2)	Description of the 2nd primary variable. "Temperature (K)" "Pressure (hPa)" "XXXXXX mixing ratio (ppmv)" XXXX : The symbol of element [O_3, NO_2, HNO_3, N_2O, H_2O, CH_4 etc.] "XXXXXX nm aerosol extinction coefficient (km^{-1})" XXXXXX : Each wavelength
17	VNAME(3)	Description of the 3rd primary variable. "Temperature internal error (K)" "Pressure internal error (hPa)" "XXXXXX mixing ratio error (ppmv)" XXXX : The symbol of element [O_3, NO_2, HNO_3, N_2O, H_2O, CH_4 etc.] "XXXXXX nm aerosol extinction coefficient internal error (km^{-1}) " XXXXXX : Each wavelength
18	VNAME(4)	Description of the 4th primary variable. "Temperature total error (K)" "Pressure total error (hPa)" "XXXXXX mixing ratio total error (ppmv)" XXXX : The symbol of element [O_3, NO_2, HNO_3, N_2O, H_2O, CH_4 etc.] "XXXXXX nm aerosol extinction coefficient total error (km^{-1})" XXXXXX : Each wavelength
19	NAUXV	Number of auxiliary variables "2" (fixed value)
20	NAUXC	Number of auxiliary variables which values are recorded as character strings. "1" (fixed value)
21	ASCAL(1)	Scale factor by which one multiplies recoded values of the auxiliary variable to convert them to the units specified in ANAME(1) "1" (fixed value)
22	AMISS(1)	A quantity indicating missing or erroneous data values for ANAME(1) "999" (fixed value)
23	LENA(2)	Number of characters used to record auxiliary variable ANAME(2)

		"7" (fixed value)
24	AMISS(2)	A quantity indicating missing or erroneous data values for ANAME(2) "ZZZZZZZ" (fixed value)
25	ANAME(1)	Description of the 1st auxiliary variable Number of tangent height levels (Number of records of real data parts) "Number of tangent height levels"
26	ANAME(2)	Description of the 2nd auxiliary variable whose values is recorded as character strings. Observation mode (Sunrise or Sunset) "Observation mode (Sunrise or Sunset)" (fixed value)
27	NSCOML	Number of special comment lines "10"
28	SCOM(1)	The 1st special comment Data level of product "Data level: Level2" (fixed value)
29	SCOM(2)	The 2nd special comment Information of data quality "Data quality: XXXXXXX" XXXXXXX: "GOOD" : " POOR" :" NO DATA"
30	SCOM(3)	The 3rd special comment Information of data processing version "Data version: Vxx.xx "
31	SCOM(4)	The 4th special comment Information of revision number of data processing version "Revision: nn.nn"
32	SCOM(5)	The 5th special comment Observation time at a typical tangent height TH = 20 km "Observation time (UTC,TH=20km point): YYYY MM DD hh:mm:ss.ttt"
33	SCOM(6)	The 6th special comment Unique number to use at data receiving ground stations "Occultation event number: YYYYMMDDNN{0|1}" YYYYMMDD : Observation Date (UTC) NN{0|1} : Unique number in one revolution
34	SCOM(7)	The 7th special comment Latitude at a typical tangent height TH = 20 km "Latitude (deg. positive=north): ±99.99"
35	SCOM(8)	The 8th special comment Longitude at a typical tangent height TH = 20 km "Longitude (deg. positive=east): ±999.99"
36	SCOM(9)	The 9th special comment

		Time of commencing observation of product "Start time of data: YYYY MM DD hh:mm:ss.ttt"
37	SCOM(10)	The 10th special comment "Data -99999 represents diverged value in retrieval calculation" (fixed value)
38	NNCOML	Number of normal comment lines "1" (fixed value)
39	NCOM(1)	Normal comment "TH(km) Time(s) Values Int.er Tot.er" (fixed value)
40	X(1,2)	Value of the 2nd independent variable "ADEOS-II/ILAS-II" (fixed value)
41	NX(1) (A(1))	Value of the 1st auxiliary variable (Number of values for the first independent variables) "NNN"
42	A(2)	Value of the 2nd auxiliary variable "Sunrise" or "Sunset "
43	X(1,1) (V(1,n),n=1,...,4)	Real data parts Independent variable (1,1), Primary variable (1,1), Primary variable (1,2), Primary variable (1,3), Primary variable (1,4) (The 1st record of real data parts)
44	X(2,1) (V(2,n),n=1,...,4)	Independent variable (2,1), Primary variable (2,1), Primary variable (2,2), Primary variable (2,3), Primary variable (2,4) (The 2nd record of real data parts)
: : : :	: : : :	: : : :
42+m	X(NX(1),1) (V(NX(1),n),n=1 ,...,4)	Independent variable (NX(1),1), Primary variable (NX(1),1), Primary variable (NX(1),2), Primary variable (NX(1),3), Primary variable (NX(1),4) (The NX(1)-th record of real data parts)

4.2.3 Example of an ILAS-II Level 2 product

product name : 20021119501v0310s.o3.ames

39 2160	Number of file header lines / File format index
Yasuhiro Sasano	The name of the originator
National Institute for Environmental Studies	The organization of the originator
Improved Limb Atmospheric Spectrometer-Ⅱ	The source of the measurements
ADEOS-Ⅱ/ILAS-Ⅱ PROJECT	The name of mission
1 1	Volume number / Total number of volumes
2002 03 02 2002 12 16	Date of commencing observation / Date of data revision
1	Interval value of the 1st independent variable
16	Number of characters of the 2nd independent variable
Tangent height (km)	Description of the 1st independent variable
Satellite name / Sensor name	Description of the 2nd independent
4	Number of primary variables
0.001 0.00001 0.00001 0.00001	Scale factor of primary variables
99999999 999999 999999 999999	Missing or erroneous data values for primary variable
Observation time (second)	Description of the 1st primary variable
O3 mixing ratio (ppmv)	Description of the 2nd primary variable
O3 internal error (ppmv)	Description of the 3rd primary variable
O3 total error (ppmv)	Description of the 4th primary variable
2	Number of auxiliary variables
1	Number of auxiliary variables of character strings (2nd)
1	Scale factor of the 1st auxiliary variables
999	Missing data value for the 2nd auxiliary variables
7	Number of characters of the 2nd auxiliary variable
zzzzzzz	Missing or erroneous data value for the 2nd auxiliary variable
Number of tangent height levels	Description of the 1st auxiliary variable
Observation mode (Sunrise or Sunset)	Description of the 2nd auxiliary variable
8	Number of special comments
Data level: Level2	The 1st special comment
Data quality: GOOD	The 2nd special comment
Data version: V03.10	The 3rd special comment
Revision:00.02	The 4th special comment
Observation time (UTC,TH=20km point): 2002 11 19 13:22:11.442	The 5th special comment
Occultation event number: 20021119501	The 6th special comment
Latitude (deg. positive=north): -78.02	The 7th special comment
Longitude (deg. positive=east): 141.80	The 8th special comment
Start time of data: 2002 11 19 13:19:00.137	The 9th special comment
Data -99999 represents diverged value in retrieval calculation	The 10th special comment
1	Number of normal comments
TH(km) Time(s) Values Int.er Tot.er	Normal comments
ADEOS-Ⅱ/ILAS-Ⅱ	Value of the 2nd independent variable
59	Value of the 2nd auxiliary variable (Number of values for the 1st independent variables)

```
Sunset                                        Value of the 2nd auxiliary variable
 10.00 43451137     0     0     0             Real data parts
 11.00 43451305     0     0     0
                 :
                 :
                 :
                 :
                 :
```

Appendix B

Guide for Using ILAS-II Data Distribution System

Version 1.0

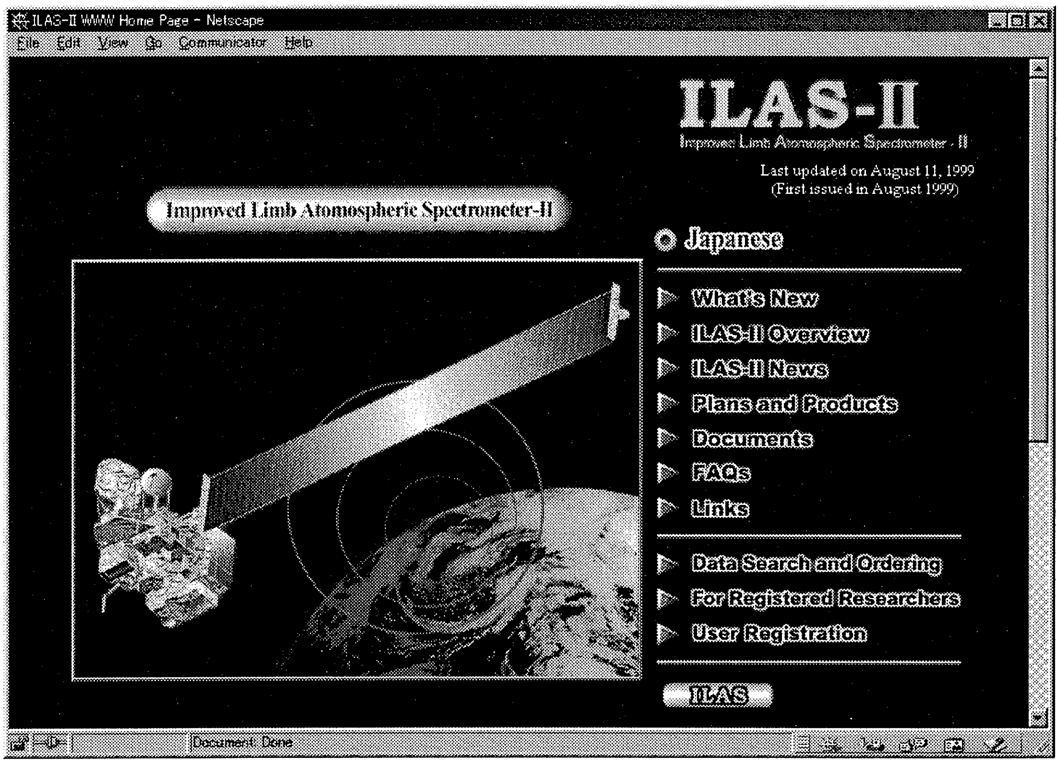
1. Home page

1.1 URL

http://www-ilas2.nies.go.jp

1.2 Procedure for accessing product information from ILAS-II Home page

Start your browser and the Home Page appears as shown below.



User Registration:

Register or update the user.

Before you can order the data product, you must have completed user registration.

⇒ See Chapter 2.

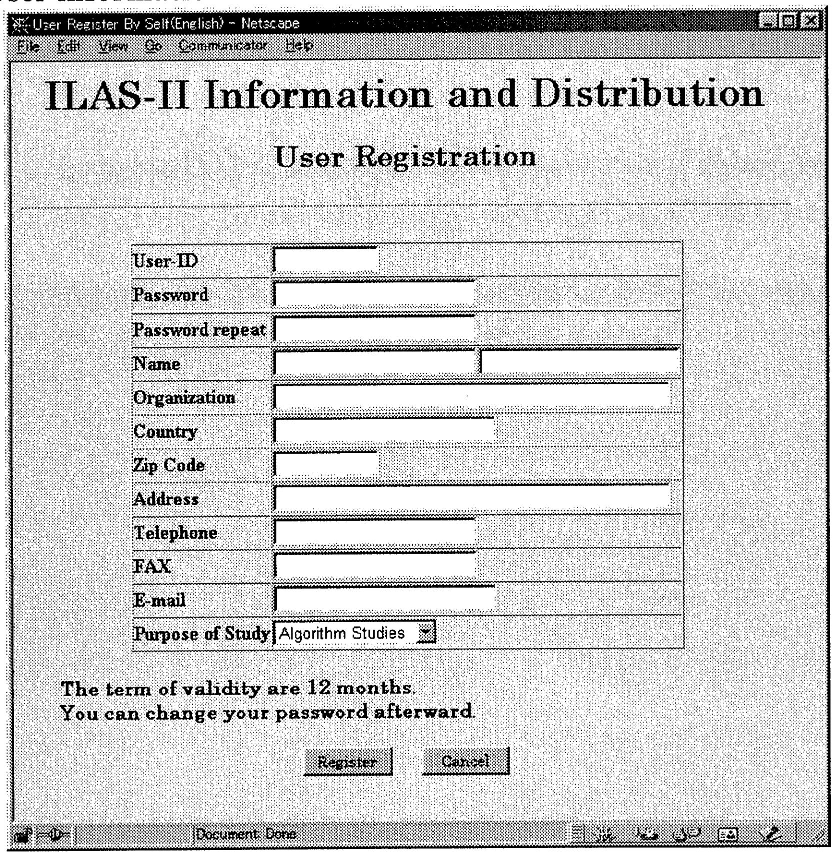
Data Search and Ordering:

Search data under any condition(s) and order or download it, if found.

⇒ See Chapter 3.

User registration

2.1 User information



User ID: Enter any ID with alphanumeric characters starting with a letter of the alphabet. Sensitive to the case. (Required)

Password: Enter a string of 5 –8 alphabetic letters starting with a lower-case character. Specify a combination of alphanumeric characters only. (Required)

Password repetition: Re-enter the same password described above. (Required)

Name: Enter your family name and then given name. (Required)

Company or organization: Enter your company or organization name. (Optional)

Country: Enter your country. (Ex. Japan, U.S.A.) (Required)

Postal code: Enter your postal/zip code using numbers and a hyphen (I-bit). (Required)

Address: Enter your address. (Required)

Telephone No.: Enter your telephone number including your country code. Ex. (+81) 3-1111-2222 (Required)

FAX: Enter your FAX number including your country code. (Required)

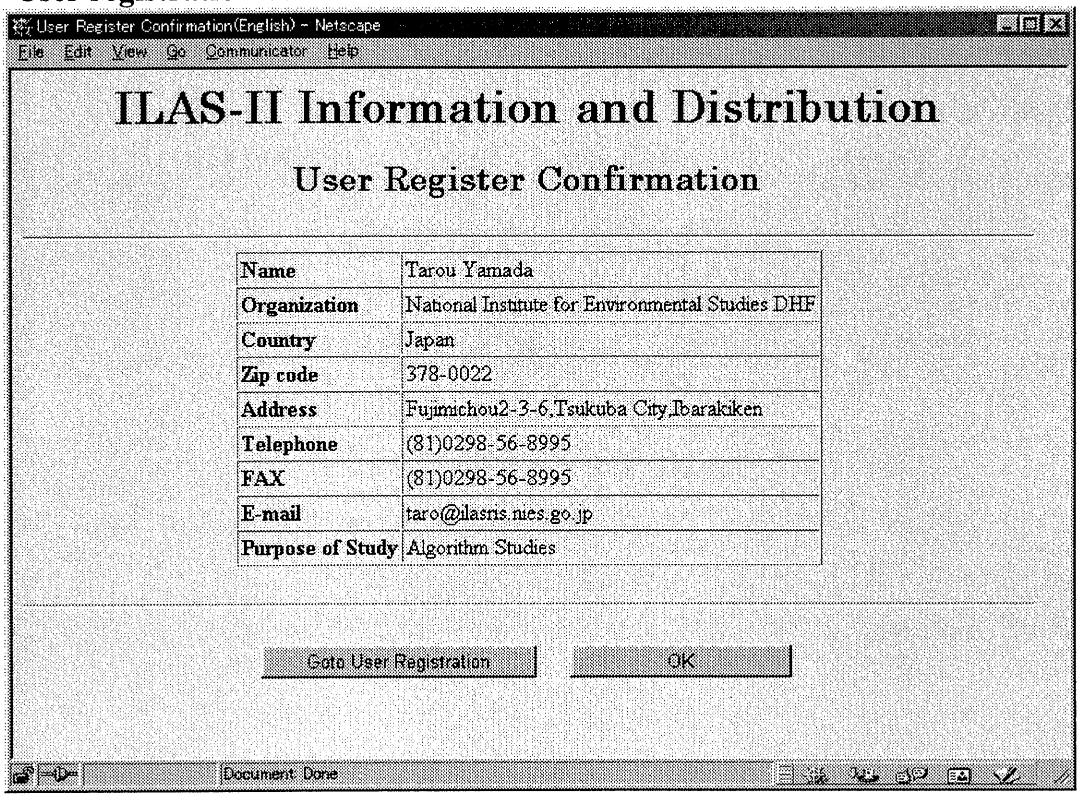
E-mail: Enter your e-mail address. (Optional)

Purpose for data use: Select one of "Algorithm Studies", "Validation Analysis/Instrument Characterization", or "Scientific Application". (Required)

[Registration] goes to 2.2 Registration.

[Cancel] returns to 1. Initial Menu.

2.2 User registration confirmation

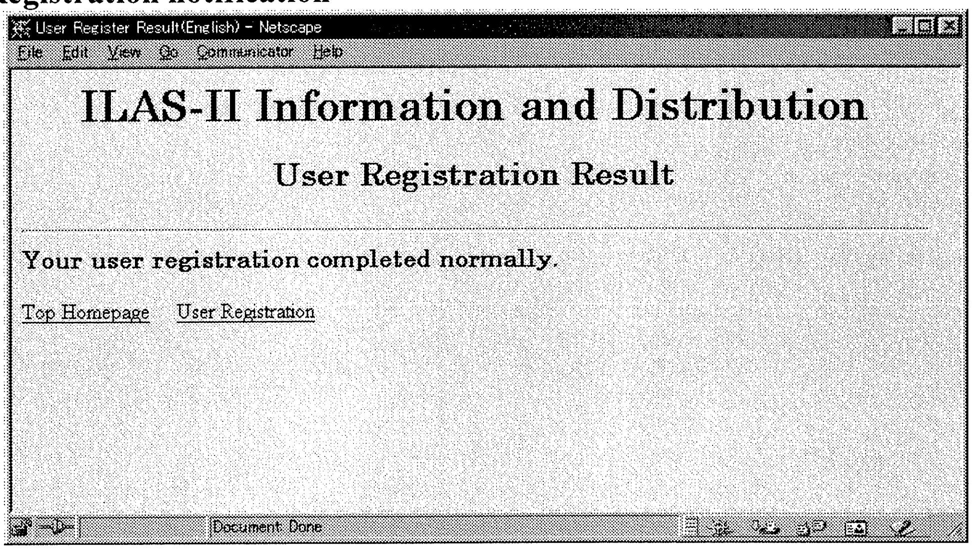


The confirmation screen for the entry in 2.1 appears.

Registration — Returns to the previous screen.

OK — Saves the entry in the database. After that, the data distribution service becomes available.

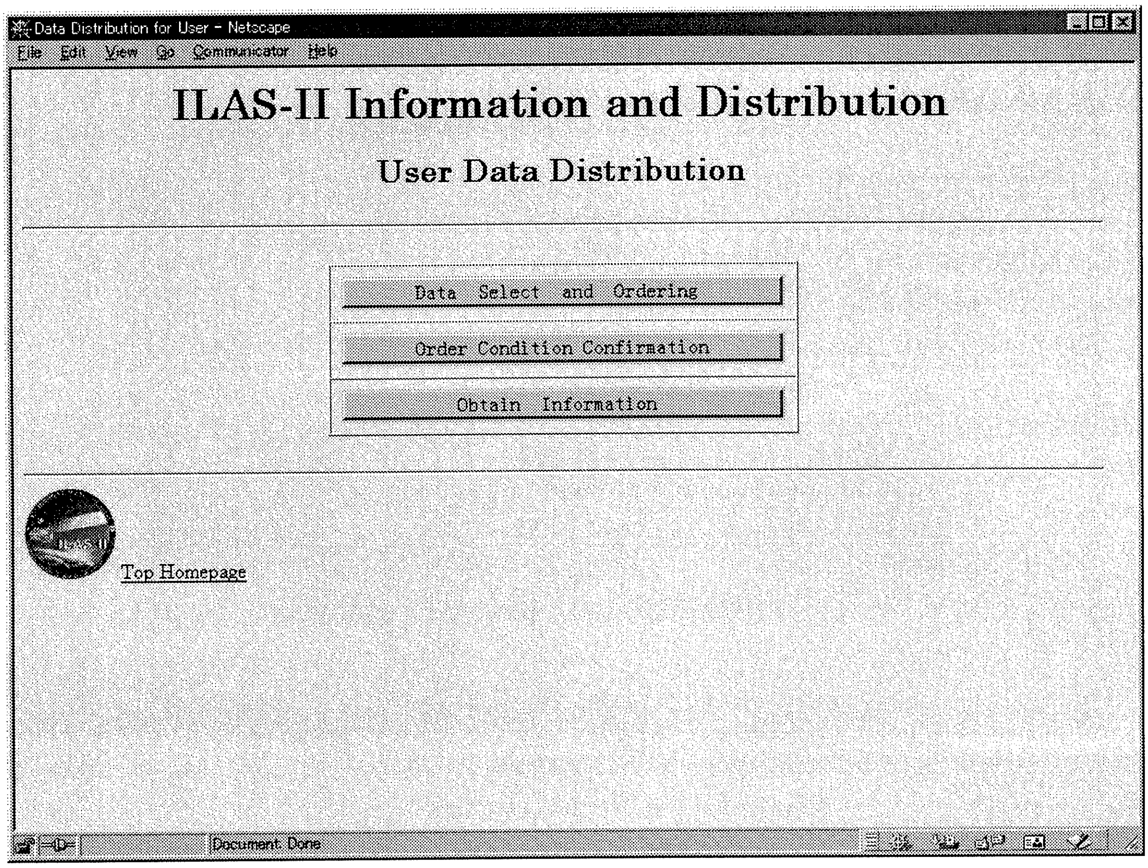
2.3 Registration notification



When this screen appears, it indicates that registration has been successful.

3 Data search and ordering

3.1 Initial Menu



Data Select and Ordering	Moves to data search.

Appendix C

List of ILAS/ILAS-II Related Reports

Version 1.0

Publications (Author, Title, Journal etc., Volume, Page, Year)
95 titles

1991

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ILAS-Ⅱ User's Handbook (Version 1.0)
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