ADEOS-II Data Users Handbook

3rd Edition

March 2006

Japan Aerospace Exploration Agency

Global environment change has become a worldwide concern in recent years. In order to clarify these environmental changes, the Advanced Earth Observing Satellite (ADEOS-II, renamed “Midori II” after launch) has been developed for the purpose of monitoring the Earth environment using remote sensing technology from space. Midori II carries mission instruments that are particularly dedicated to clarify the water energy cycle and the carbon cycle, and is expected to be utilized for international climate change research programs.

Midori II was launched by an H-IIA rocket in December 2002 from Tanegashima Space Center of NASDA (reorganized to JAXA in October 2003), and is in a circular orbit of altitude 803 km, inclination angle 98.7 degree and period 101 min. After launch, seven mission instruments on Midori II operated until October 2003 (GLI, AMSR, SeaWinds, ILAS-II, POLDER, DCS, and TEDA). Observing data by these mission instruments has been received at JAXA/EOC, NASA ground stations at Alaska SAR Facility and Wallops Flight Facility, and Kiruna station of Sweden Space Corporation. AMSR and GLI observation data received at foreign ground stations was transmitted to JAXA/EOC and processed to the various products.

JAXA had conducted calibration and validation of these AMSR and GLI observation data for about one year. As the result, the AMSR and GLI products became available to distribute to public users.
After November 1, 2004, GLI products processed by using algorithm version 2 are published. Publication of AMSR version 3 products was started from March 2005.

The purpose of this handbook is to provide users with the necessary information for proper utilization of AMSR and GLI products. We hope many kinds of products from not only AMSR and GLI but also all the mission instruments on Midori II as described in this handbook can contribute to studies on global environment change monitoring, preservation and so on.

March 2006
Earth Observation Center
Japan Aerospace Exploration Agency

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1 Introduction

The Advanced Earth Observing Satellite-II (ADEOS-II) was launched by the H-IIA Launch Vehicle Flight No.4 from Tanegashima Space Center at 10:31am on December 14, 2002 (Japanese Standard Time). ADEOS-II was placed into the planned orbit successfully and named "Midori-II".

The objective of ADEOS-II, as a successor to the Advanced Earth Observing Satellite (ADEOS) launched in August 1996, was to acquire data to contribute to international global climate change research, as well as for applications such as meteorology and fishery.

After launch, initial check out of ADEOS-II was performed during four months, and then ADEOS-II routine operation was started in April 2003. However, ADEOS-II operation on orbit was given up on October 31 2003, because sufficient electric power was not available to maintain operation of the satellite.

In addition to the two core instruments, AMSR and GLI developed by NASDA[*1], SeaWinds, POLDER and ILAS-II were provided both from international and domestic partners.

1.1 Purpose

The purpose of this document is to provide users with necessary information to utilize ADEOS-II data, such as product processing algorithms and product formats. Moreover, this document introduces an overview of ADEO-II mission operation including both the spacecraft and ground segments as reference information for users.

1.2 Scope

This document includes the following 6 sections and some appendices.

Section 1	: Purpose and scope of this document, overview of ADEOS-II mission operation.
Section 2	: Specification of ADEOS-II spacecraft and on-board mission instruments, ADEOS-II operation pattern, orbit parameters, maneuvering, attitude control operation and so on.
Section 3	: Operation and role of ADEOS-II ground segment of JAXA and related international and domestic agencies.
Section 4	: Definition of operation phase for both spacecraft and ground segment after launch.
Section 5	: Overview of product specification of each mission instrument, especially data processing algorithms and data formats of AMSR and GLI.

[*1]: As of October 1, 2003, Japanese space-related research and development institutes (NASDA, ISAS and NAL) have been integrated into JAXA.

Section 6 : Overview of ADEOS-II data delivery services of Earth Observation and Information System (EOIS) of JAXA.

Section 7 : Present the result of ADEOS-II mission after launch, including initial on-orbit checkout, calibration and validation and major observation results.

Appendices: Glossary, Acronyms, related information including contact points and product formats of AMSR and GLI.

1.3 ADEOS-II Mission Operation Overview

Scientific Goals of ADEOS-II are summarized in three points.

- Monitor regularly the water and energy cycle as a part of the global climate system,
- Estimate quantitatively the biomass and fundamental productivity as a part of carbon cycle, which plays an important role for global warming,
- Detect the signal of long term climate change as the result of continuous observation succeeded from ADEOS.

It becomes impossible to realize the monitoring of the earth environment by long-term continuous observation having given up operation of ADEOS-II. However, the observation data acquired by ADEOS-II during its ten months, is very important to the various researches about earth environment, such as the climate system and global warming.

For example, monitoring of water and energy cycle, among the three above, is the most important one for the ADEOS-II mission. Water related parameters such as water vapor, precipitation, soil moisture, snow depth, retrieved from AMSR data; cloud related parameters, water vapor, aerosol, estimated from GLI data; sea surface stress parameters derived from SeaWinds data; aerosol estimation from POLDER data; ozone distribution estimated from ILAS-II data will be of great use to achieve this goal. SeaWinds data, continued observation on sea surface stress from NSCAT on ADEOS, will play a role for understanding the ocean tidal cycling, as well.

Estimation of fundamental productivity and chlorophyll, as a part of the carbon cycle, is another important goal for ADEOS-II. Multi-channel observation and 250 meter resolution data of GLI must play a significant role to achieve the goal. ILAS-II data, continued observation on ozone and minor species from ILAS on ADEOS, is expected to play a role for understanding the stratospheric chemistry, as well.

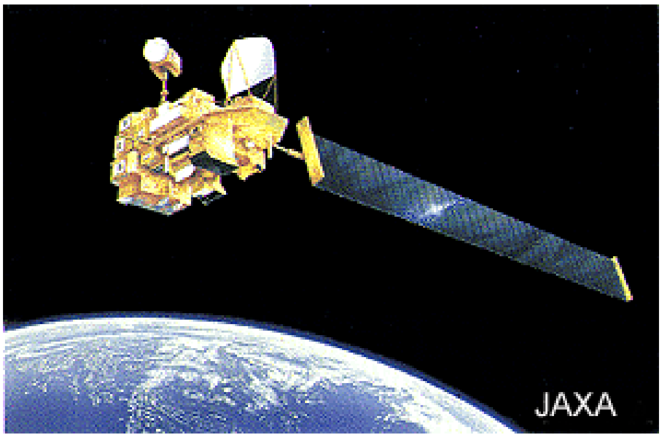


Figure 1.3-1 Depiction of ADEOS-II on Orbit

2 ADEOS-II Satellite Overview

This section gives an outline of the specifications of ADEOS-II spacecraft and on-board mission instruments, ADEOS-II operation pattern, orbit parameters, maneuvering, attitude control operation and so on.

2.1 Satellite System

ADEOS-II was launched by the H-IIA Launch Vehicle Flight No.4 from NASDA Tanegashima Space Center at 10:31 am (JST) on December 14, 2002. After launch, ADEOS-II was successfully placed in a sun-synchronous sub-recurrent orbit altitude of about 800 km, inclination 98.7 degree and period 101min. Mission designed lifetime was three years with five years expected for operations. However, ADEOS-II operation on orbit was given up on October 31 2003, because sufficient electric power was not available to maintain the satellite (final data receiving was on October 24 2003). Table 2.1-1 shows the principal characteristics of the ADEOS-II spacecraft.

Table 2.1-1 Characteristics of ADEOS-II Spacecraft

Items		Characteristics
Launch Vehicle		H-IIA Flight No. 4
Launch Date and Time		December 14, 2002 10:31 am (JST)
Altitude	Apogee	820 km
	Perigee	803 km
Inclination		98.7 degree
Dimension	Body (X x Y x Z)	Approx. 5 x 4 x 4m
	Solar Array Paddle	Approx. 3 x 24m
Mass		Approx. 3,730 kg
Power		More than 5,000 W
Attitude Control		Zero momentum / 3 axis control
Mission Life	Designed	3 years
	Propellant	5 years

The ADEOS-II spacecraft consists of a mission module that carries mission instruments and a bus module that contains the bus subsystem.

On the mission module, were seven mission instruments as shown in table 2.1-2.

Table 2.1-2 ADEOS-II Mission Instruments

Name	Provider
Advanced Microwave Scanning Radiometer (AMSR)	JAXA (NASDA)
Global Imager (GLI)	JAXA (NASDA)
Improved Limb Atmospheric Spectrometer-II (ILAS-II)	MOE
SeaWinds	NASA/JPL
Polarization and Directionality of the Earth's Reflectance (POLDER)	CNES
Data Collecting System (DCS)	JAXA (NASDA)/CNES
Technical Data Acquisition Equipment (TEDA)	JAXA (NASDA)

On the bus module, were nine bus instruments, as shown in table 2.1-3, to maintain satellite orbit and to control mission instruments.

Table 2.1-3 ADEOS-II Bus Instruments

Subsystem	Outline
Communications and Data Handing Subsystem (C&DH)	C&DH has the function to receive and decode commands from the Tracking & Control Station (TACS), and transmit to all instruments of ADEOS-II. Temperature, voltage and status are edited then transmitted to TACS by 2GHz frequency.
Inter Orbital Communication Subsystem (IOCS)	IOCS is a subsystem to perform inter-satellite communications at S band and Ka band using data-relay satellites such as the Data Relay and Tracking Satellite (DRTS).
Mission Data Processing Subsystem (MDP)	MDP determines where selected mission data is sent. Mission data plus added necessary data is edited and forwarded to the DT, IOCS, or MDR Subsystems. Three mission Data Recorders (MDRs) can record observation data at 6Mbps, which can be reproduced at 60Mbps and transmitted to ground stations such as the EOC when visible to the S/C.
Direct Transmission Subsystem (DT)	DT transmits data observed by ADEOS via X band to a ground station. The medium and high-speed mission data is transmitted by X band (6Mbps data and 60Mbps). The 60Mbps data line has redundant functions to assure system qualities.
Optical-disk Data Recorder (ODR)	ODR is the first space-borne data recorder utilizing Magnetic-Optical disk (MO) technology. It has capability of very high data storage capacity, random access and flexible I/O interfaces compared with existing flight tape recorders.
Electrical Power Subsystem (EPS)	EPS controls the bus voltage to every subsystem of the satellite, charges and discharges the batteries and controls ordnance power. The EPS supplies a floating bus voltage by discharging Batteries (BAT) during eclipses. The EPS also supplies the ordnance power via the Ordnance Controller (ODC) to the EEDs (Electric Explosive Devices) of each deployment mechanism of the Solar Array Paddle, the DCS Antennas, the IOCS unit and for uncaging of AMSR, SeaWinds.
Paddle subsystem (PDL)	The PDL transforms solar power into electric power. The lightweight high power (over 5000W; End Of Life) PDL has an extendible mast, 50 flexible blankets with 55,680 solar cells and can be stowed compactly. The 2m-long stiff extendible mast extends to 24m within 35mims, by the mast deployment mechanism on orbit.
Attitude and Orbit Control Subsystem (AOCS)	The role of the AOCS is acquiring initial three-axes altitude after orbit injection, keeping stable attitude of the satellite while controlling the sequence of orbit maneuvers and sending drive signals to the Solar Array Paddle. The AOCS has the Inertial Reference unit (IRU), The Earth Sensor Assembly (ESA) and the Fine Sun Sensor Assembly (FSSA) for attitude sensing, and four sets of Reaction Wheel Assemblies (RWA) and two Magnetic Torquers (MTQ) as attitude control actuators. The AOCS also sends drive signals to the RCS subsystem in order to control satellite attitude and orbit. The Attitude and Orbit Control Electronics (AOCE) is the most important component of the AOCS, which includes three channels of CPU and its peripheral devices to realize high reliability
Reaction Control Subsystem (RCS)	The RCS generates the thrust necessary for the initial attitude acquisition and the orbital maneuvers using 1N and 20N thrusters under AOCS control.
Direct Transmission for Local Users (DTL)	Direct Transmission for Local Users (DTL) transmits Global Imager (GLI) coarse data (spatial resolution: about 6km x 6km) for Local Users like fishing boats etc, in the UHF band (467.7MHz BPSK, data rate 23Kbps). Data is 4 bands (3 visible bands and 1 infrared band) among 36 GLI bands, its data is used for determination of ocean conditions, temperature distribution and primary products. UHF Transmitter is installed in the mission module and is doesn't have independent thermal control.

Additionally, Dynamics Monitoring System (DMS) and Visual Monitoring System (VMS) are experimentally boarded on ADEOS-II from the lessons of ADEOS malfunction. DMS consists of the star tracker sensor and has capability to determine high accuracy satellite attitude by using star positions. VMS consists of a CCD camera to monitor Solar Array Paddle, AMSR, SeaWinds and IOCS antenna. Data of these equipments are multiplexed with the other mission instrument data and transmitted to ground stations via IOCS or DT.

The depiction of ADEOS-II is shown in figure 2.1-1.

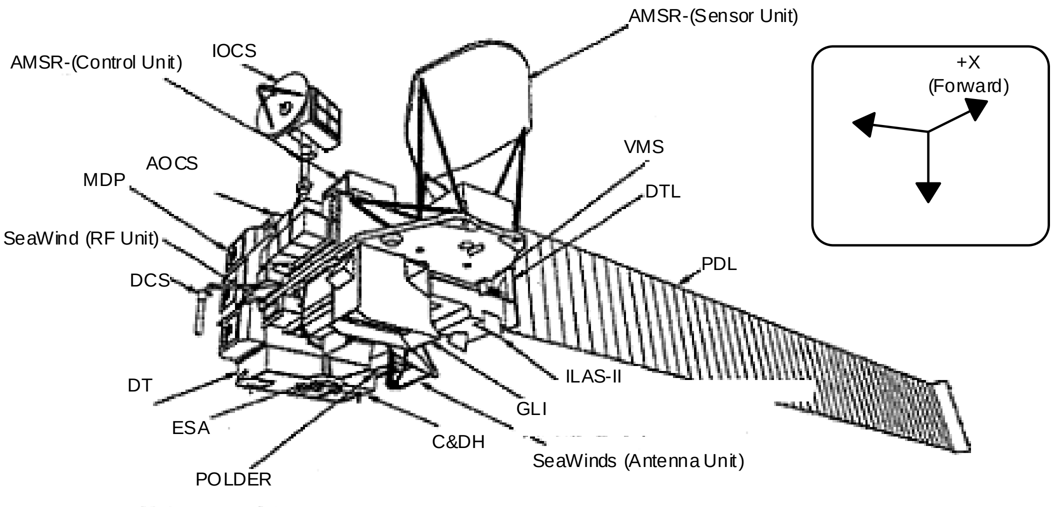


Figure 2.1-1 ADEOS-II Depiction

2.2 Mission Instruments

2.2.1 AMSR

AMSR (Advanced Microwave Scanning Radiometer) will observe various physical content concerning to water (H_2O) by receiving weak microwaves naturally radiated from the Earth's surface and atmosphere (for example, water vapor content, precipitation, sea surface temperature, sea surface wind, sea ice, etc.) and also regardless of day or night, the presence of clouds. Those sensors aim at collecting global data for mainly understanding the circulation of water and energy.

AMSR is a radiometer to observe eight frequency bands from 6.9GHz to 89GHz bands respectively by vertical and horizontal polarized waves except two frequency bands of 50GHz. It acquires radiance data by scanning the Earth's surface conically or mechanically rotating its antenna along the satellite flight path. Also AMSR has the function and high-temperature calibration source to acquire radiance temperatures in deep space (about2.7K) for calibrating observation data.

The aperture diameter of AMSR's antenna is 2m and its instant field of view is about 5km (89GHz band). It scans conically an angle of incidence on the Earth's surface (a nominal angle: 55°) to be constant and minimizes the effect of sea surface wind upon observation data and accomplishes a swath width of about 1600km.

The main characteristics of the AMSR instrument and its observation concept are shown in table 2.2-1 and figure 2.2-1.

Table 2.2-1 AMSR Instrument Specifications

Items	Specification							
Frequency (GHz)	6.9	10.65	18.7	23.8	36.5	89.0	50.3	52.8
Spatial Resolution	50km		25km		15km	5km	10km	
Band Width (MHz)	350	100	200	400	1000	3000	200	400
Polarization	Horizon and Vertical						Vertical	
Swath Width	Approx.1600km							
Data Rate	111.09 Kbps (Actually 87.38 Kbps*1)							

*1: There is no packet distribution time during 1 scan of AMSR instrument.

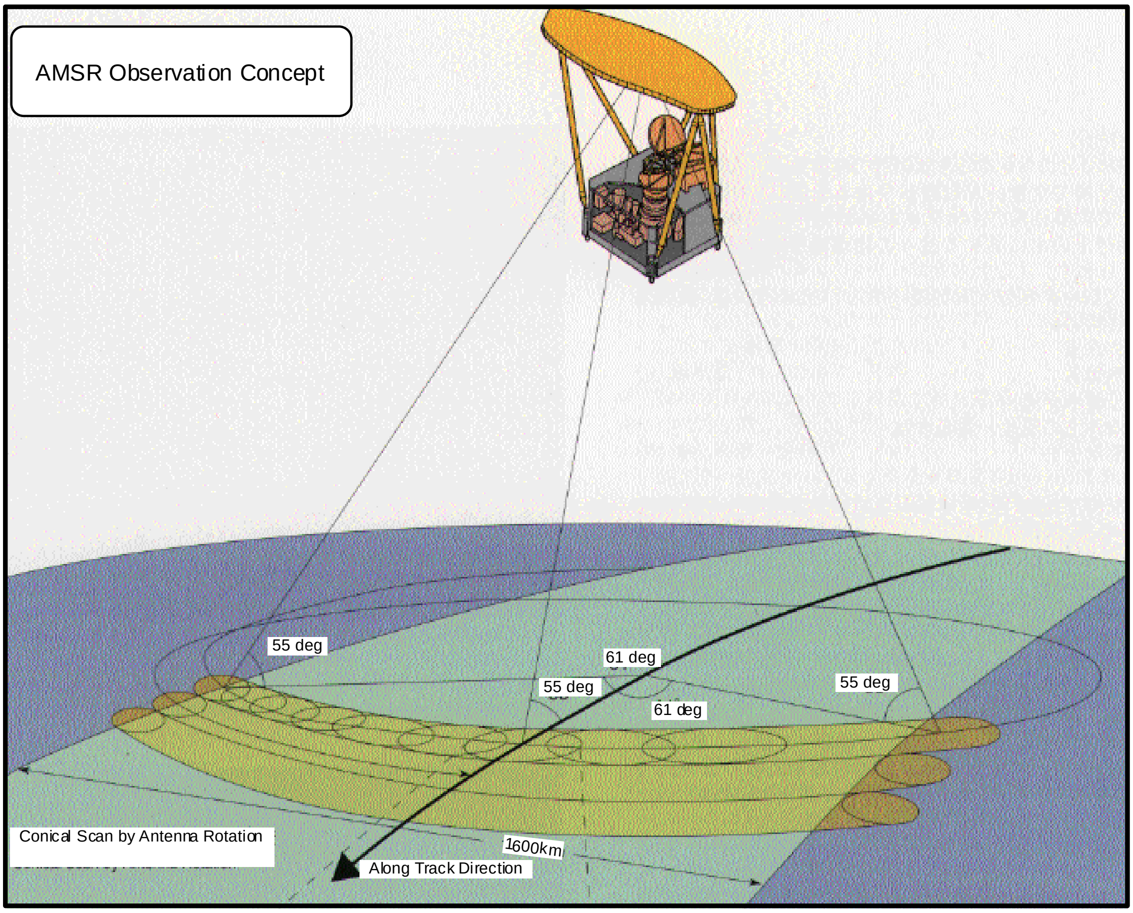


Figure 2.2-1 AMSR Observation Concept

AMSR operation modes during routine operation phase are shown in table 2.2-2.

Table 2.2-2 AMSR Operation Modes (Routine Operation Phase)

Mode	Operation	Condition
Normal	Acquiring of observation data or standby of data acquisition.	Nominal mode during routine operation phase
Sleep	Observation data is not acquired. AMSR antenna is rotated in normal speed, and heater is enabled.	LLM (Light Load Mode) command*1 is executed or unexpected maneuver, which includes yaw maneuver, is performed.

*1: ADEOS-II On Board Computer (OBC) will execute LLM command to all instruments as autonomous operation in case of satellite anomaly.

2.2.2 GLI

GLI (Global Imager) is an optical sensor aiming at observing globally and frequently the reflected solar radiation from the earth's surface including land, ocean and cloud or the infrared radiation for measuring the physical content such as chlorophyll, dissolved organic matter, surface temperature, vegetation distribution, vegetation biomass, distribution of snow/ice, and snow/ice Albedo, etc. These data may be used for understanding the global circulation of carbon, monitoring cloud, snow, ice and sea surface temperature, and grasping the primary marine production. GLI succeeds to and makes progress in the mission of the Ocean Color and Temperature Scanner (OCTS) on board ADEOS that was launched in the summer of 1996.

GLI has 23 channels in visible and near-infrared region (VNIR), six channels in short-wavelength infrared region (SWIR), and seven channels in middle and thermal infrared region for its multispectral observation. Although the ground resolution is 1 km at the nadir, a part of the channels in VNIR and SWIR has a resolution of 250m at the nadir that will be used for observing vegetation and clouds. The observation region by mechanical scanning is 12 or 48 pixels (12km) in the along-track direction and 1600km in the cross-track direction. GLI has capability to change the observation FOV from nadir to ±20 degrees along the satellite flight direction to avoid data saturation caused by direct incidence of sea surface reflection. Moreover, GLI coarse data (3 bands of VNIR: 443, 565, 666 nm and 1 band of MTIR: 10.8 μm, spatial resolution: approx. 6 km x 6km) is transmitted via DTL to local users like a fishing boats etc, in the UHF band.

The main characteristics of GLI instrument and its observation concept are shown in table 2.2-3 and figure 2.2-2.

Table 2.2-3 Main Characteristics of GLI Instrument

Items			Characteristics
Spectral Range	VNIR (nm)	1km	380, 400, 412, 443, 460, 490, 520, 545, 565, 625, 666, 678, 680, 710, 710, 749, 763, 865, 865
		250m	460, 545, 660, 825
	SWIR (nm)	1km	1050, 1135, 1240, 1380
		250m	1640, 2210[*1]
	MTIR (μm)		3.715, 6.7, 7.3, 7.5, 8.6, 10.8, 12.0
Spatial Resolution			1 km or 250m
Swath Width			1600 km
Data Rate			1km resolution : 3.9 Mbps 250m resolution : 16 Mbps[*1] 6 km resolution : 23.529 kbps

*1: Concerning about ch. 28 (1640 nm) and ch. 29 (2210 nm), resampling data to 2km resolution is included in 1 km resolution data.

*2: Data downlink rate is 60 Mbps with dummy data.

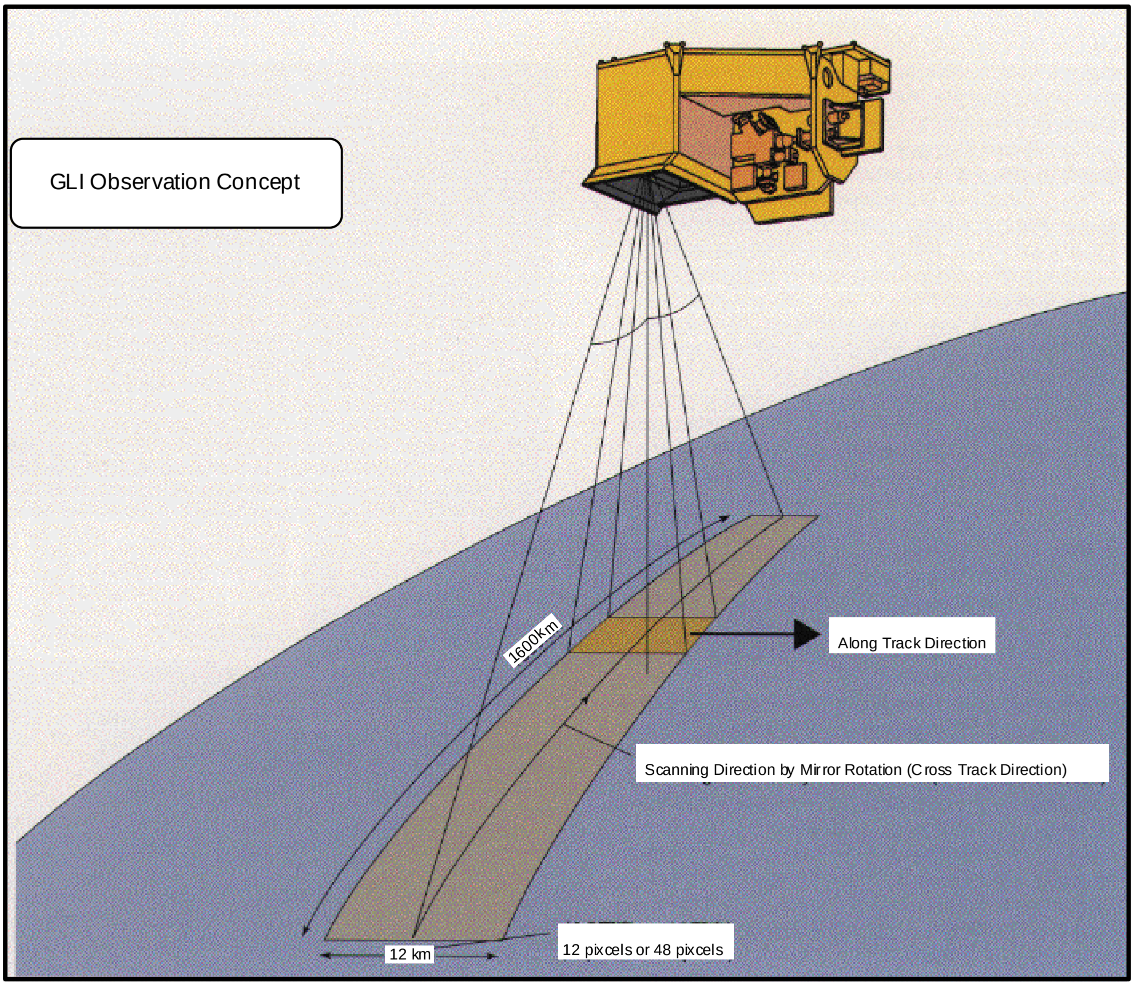


Figure 2.2-2 GLI Observation Concept

GLI operation modes during routine operation phase are shown in table 2.2-4. And, GLI typical mode shift pattern during 1 orbit is illustrated in figure 2.2-3.

Table 2.2-4 GLI Operation Modes (Routine Operation Phase)

Mode	Operation	Condition
Daytime Observation	All bands data are acquired during daytime on ground. This is done in one of three modes in accordance with the tilting angle. (0 degree mode, +20 degree mode and –20 degree mode)	Nominal mode during daytime on ground
Nighttime Observation	MTIR bands data are acquired during nighttime on ground.	Nominal mode during nighttime on ground
Sunlight Calibration	Optical calibration data is acquired for VNIR using sunlight at the beginning of daytime of satellite.	Shifted from Nighttime Obs. Mode or other Cal. Mode once an orbit.
Inner-Lamp Calibration	Optical calibration data is acquired for VNIR and SWIR using halogen lamp within GLI instrument. This is done in one of two modes in accordance with the tilting angle. (0 degree mode and 20 degrees mode)	Shifted from Nighttime Obs. Mode approximately once a week.
Electronic Calibration	Dummy signal is input to Pre-Amp of VNIR/ SWIR and Post-Amp of MTIR to acquire electronic calibration data. This is done in one of two modes in accordance with the tilting angle. (0 degree mode and 20 degrees mode)	Shifted from Inner-Lamp Cal. Mode approximately once a week.
Safety	Observation data is not acquired. Heater is enabled.	LLM (Light Load Mode) command*1 is executed or unexpected maneuver, which includes yaw maneuver, is performed.

*1: ADEOS-II On Board Computer (OBC) will execute LLM command to all instruments as autonomous operation. in case of satellite anomaly.

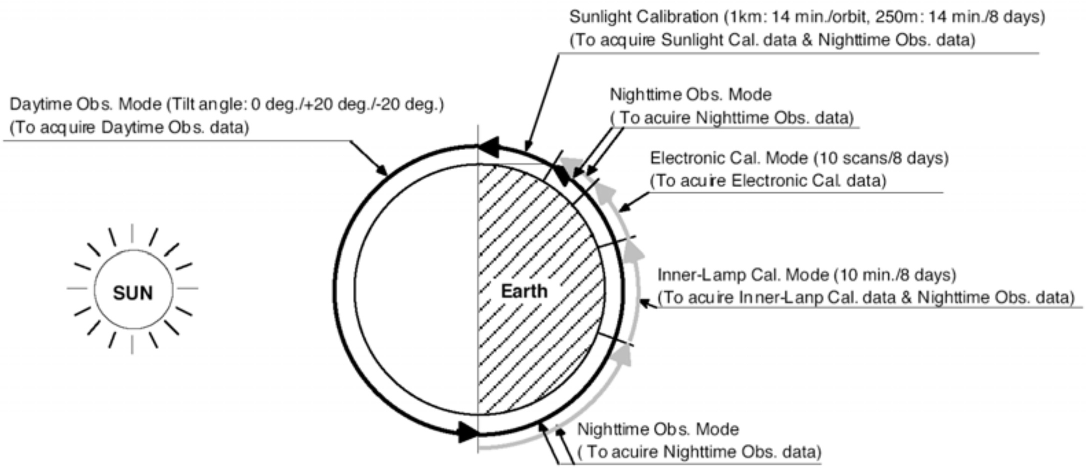


Figure 2.2-3 GLI Mode Shift Pattern

2.2.3 ILAS-II

ILAS-II (Improved Limb Atmospheric Spectrometer-II) developed by the Ministry of the Environment is a sensor to monitor the high-latitude stratospheric ozone layer. The objectives of ILAS-II are to monitor and study changes in the stratosphere which are triggered by emissions of chlorofluorocarbons (CFC), and to evaluate the effectiveness of worldwide emission controls of CFCs. ILAS-II is a spectrometer which observes the atmospheric limb absorption spectrum from the upper troposphere to the stratosphere using sunlight as a light source (solar occultation technique). The spectrometer covers the infrared region (3-13mm) and the near visible region (753 to 784nm). ILAS-II's observations are focused on the high latitude regions because of the geometrical relation of the solar occultation events with the sun-synchronous orbit. From these spectral observations, ILAS-II can measure the vertical profiles of species related to ozone depletion phenomena : ozone (O_3), nitrogen dioxide (NO_2), nitric acid (HNO_3), aerosols, water vapor (H_2O), CFC-11, CFC-12, methane (CH_4), nitrous oxide (N_2O), chlorine nitrate ($CIONO_2$), temperature, and pressure. The main characteristics of ILAS-II instrument and its observation concept are shown in table 2.2-5 and figure 2.2-4.

Table 2.2-5 Main Characteristics of ILAS-II Instrument

Items		Characteristics
Frequency	Infrared	6.2 - 11.8、3.0 - 5.7、12.78 - 12.85μm
	Visible	753 ~ 784 nm
Spatial Coverage (height)		10 ~ 60 km
Vertical Resolution		1 km
Data Rate		453.62 Kbps

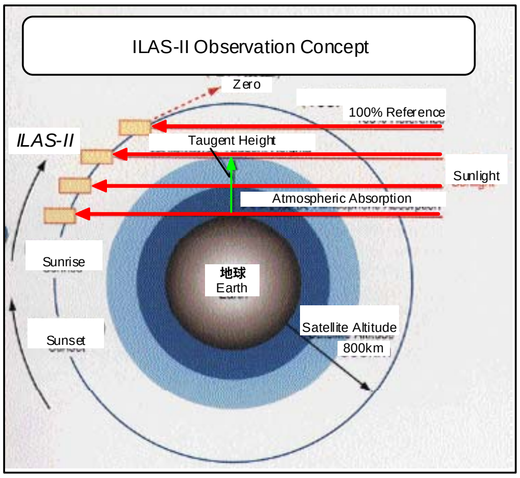


Figure 2.2-4 ILAS-II Observation Concept

2.2.4 SeaWinds

NASA's SeaWinds scatterometer provides high accuracy wind speed and direction measurements over at least 90% of the ice-free global oceans every 2 days. SeaWinds provides a continuing set of long term wind data for studies of ocean circulation, climate, air-sea interaction and weather forecasting. SeaWinds is a follow on to the NASA Scatterometer (NSCAT) which was part of ADEOS and will, like NSCAT, provides measurements of ocean surface winds in all weather and cloud conditions. The SeaWinds will use a one meter diameter dish antenna with two beams rotated the satellite nadir axis at 18 rpm. SeaWinds radiates and receivers microwave pulses at a frequency of 13.4 GHz across 1800km wide swath.

Scatterometers use a highly indirect technique to measure wind velocity over the ocean. Changes in the wind velocity cause changes in ocean surface roughness, modifying the radar cross section of the ocean and magnitude of the backscattered power. Multiple, collocated, measurements acquired from several directions can be used to solve wind speed and direction simultaneously. The main characteristics of SeaWinds instrument and its observation concept are shown in table 2.2-6 and figure 2.2-5.

Table 2.2-6 Main Characteristics of SeaWinds Instrument

Items	Characteristics
Frequency	13.402 GHz
Spatial Resolution	25 km
Swath Width	1800 km
Data Rate	35.378 Kbps (Min.:31.840 Kbps Max.:38.208 Kbps)

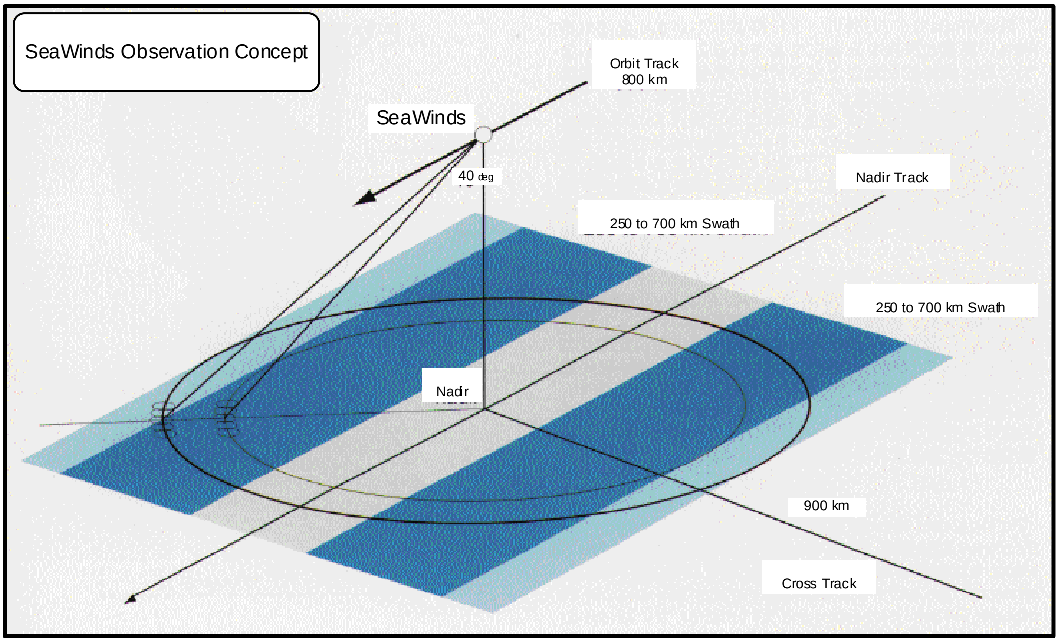


Figure 2.2-5 SeaWinds Observation Concept

2.2.5 POLDER

The POLDER (POLarization and Directionality of the Earth's Reflectances) instrument observes the polarization, directional and spectral characteristics of the solar light reflected by aerosols, clouds, oceans and land surfaces.

POLDER is a two-dimensional CCD array, wide field of view, and multi-band imaging radiometer/polarimeter developed by CNES. Multi-angle viewing is achieved by the along-track migration at the spacecraft velocity of a quasi-square footprint intercepted by the total instantaneous 43 deg. x 51 deg. wide FOV. This footprint is partitioned into 242 x 274 elements of quasi-constant 7km x 6km resolution, imaged by a CCD matrix in the focal. Simultaneously, a filter/polarizer wheel rotates and scans eight narrow spectral band in the visible and near infrared (443,490,565,670,763,765,865 and 910 nm), and three polarization angles at 443,670 and 865 nm.

The main characteristics of POLDER instrument and its observation principle are shown in table 2.2-7 and figure 2.2-6.

Table 2.2-7 Main Characteristics of POLDER Instrument

Items		Characteristics
Frequency (nm)	No Polarized	443, 490, 565, 670, 763, 765, 865, 910
	Polarized (0, 45, 90 deg.)	443, 670, 865
FOV		±43 deg. x ±51 deg.
Spatial Resolution		6 km x 7 km
Swath Width		1800 km x 2400 km
Data Rate		882.352 Kbps

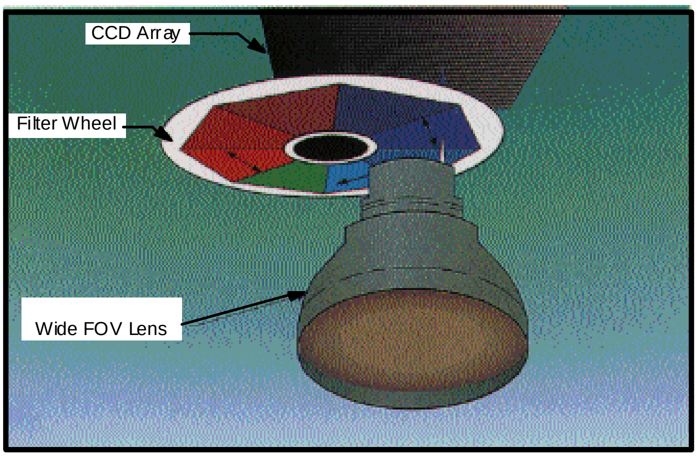


Figure 2.2-6 POLDER Observation Principle

2.2.6 DCS

DCS (Data Collection System) receives observation data (Uplink Message), which is transmitted from the DCPs (Data Collection Platform) on sea surface or land surface, and can transmit control messages(Downlink Message) to DCPs.

Especially, the DCS on ADEOS-II has a function to transmit commands to the DCP, which has not been introduced previously. By using this function, DCPs can be controlled, and several systems are proposed to be installed. One of these systems has functions to go down to deep sea by adjusting buoyancy and collects vertical sea data. When it comes up the surface it transmits observed data to the DCS and goes down to the deep sea again.

The main characteristics and operation concept of DCS instrument are shown in table 2.2-8 and figure 2.2-7.

Table 2.2-8　Main Characteristics of DCS Instrument

Items		Characteristics
Data Rate		10 Kbps
Downlink Message	Frequency	465.9875 MHz
	Data Rate	200 bps
Uplink Message	Frequency	401.65 MHz
	Data Rate	400 bps

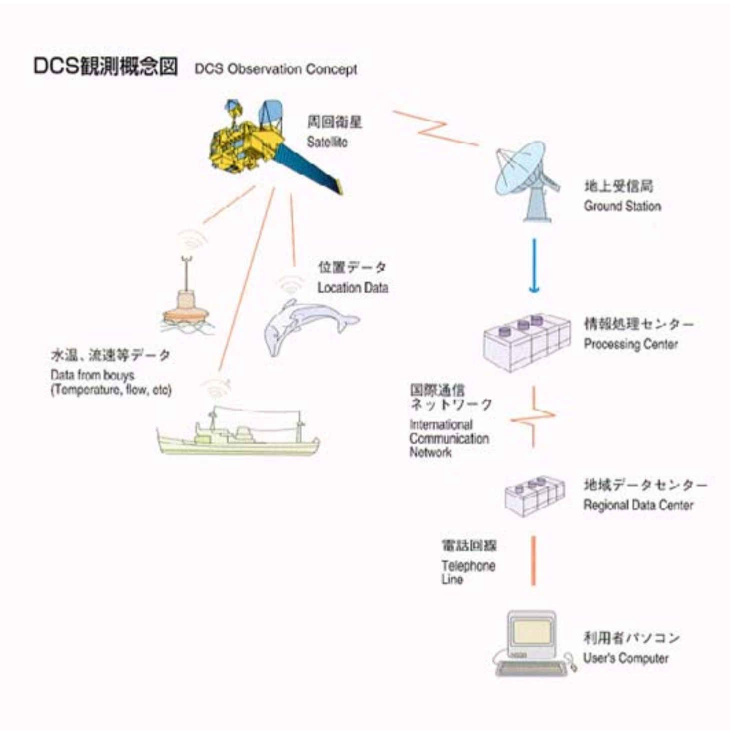


Figure 2.2-7　DCS Operation Concept

2.2.7 TEDA

TEDA (Technical Data Acquisition Equipment) monitors space environment and acquires engineering data to clarify the relations of degradation, radiation damage and anomaly of space use parts and materials. TEDA was carried on ETS-V, ETS-VI, ADEOS, ETS-VII etc., and it is planned to be carried on Japanese Experiment Module Kibo's Exposed Facility, ALOS, ETS-VIII etc. TEDA consists of Dose Monitor (DOM), Single Event Upset Monitor (SUM) and Dosimeter (DOS) which are controlled by System Interface Module (SIM). The data from those three monitors are stored in the database and will be utilized for the development of future satellite parts and materials, and also will widely be utilized for clarifying the relation between solar activities and space radiation environment.

2.3 ADEOS-II Mission Operation Overview (as Reference)

2.3.1 Mission Operation Pattern

Operation pattern of each mission instrument onboard ADEOS-II is shown in table 2.3-1 and figure 2.3-1.

Table 2.3-1 ADEOS-II Mission Instrument Operation Pattern

Sensor	Coverage	Operation Condition	Remark
AMSR	Global	Continuous	
GLI (1km)	Global	Continuous	MTIR
		Daytime	VNIR SWIR
GLI (250 m)	Land area	Daytime	VNIR SWIR
ILAS-II	high latitudes	Sunrise and sunset of ADEOS-II	
SeaWinds	Global	Continuous	
POLDER	Global	Sun Elevation ≥ 15˚	
TEDA	Global	Continuous	without ILAS-II operation and VMS images transferring from its own memory to MDR.
DCS	Global	Continuous	

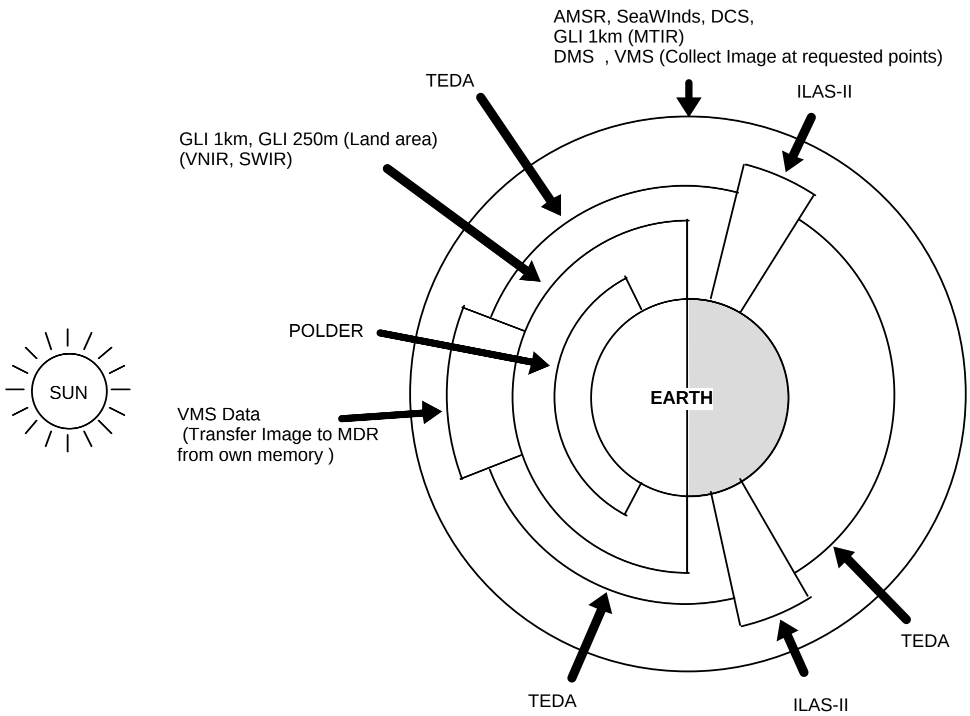


Figure 2.3-1 ADEOS-II Mission Instruments Operation Pattern

2.3.2 MDR Operation Pattern

The ADEOS-II spacecraft carries three MDRs. Observation data of AMSR、GLI 1km、ILAS-II、SeaWinds、POLDER、DCS and TEDA, except GLI 250m, are multiplexed to 6 Mbps mission data and recorded on MDR. Three MDRs will be used alternately to record observation data of mission instruments globally (except GLI 250m) with 8 minutes overlapping. MDR reproducing speed is ten times higher than recording speed, and the reproducing data is transmitted to Ground Stations via data relay satellite or X band. The MDR operation pattern is illustrated in figure 2.3-2.

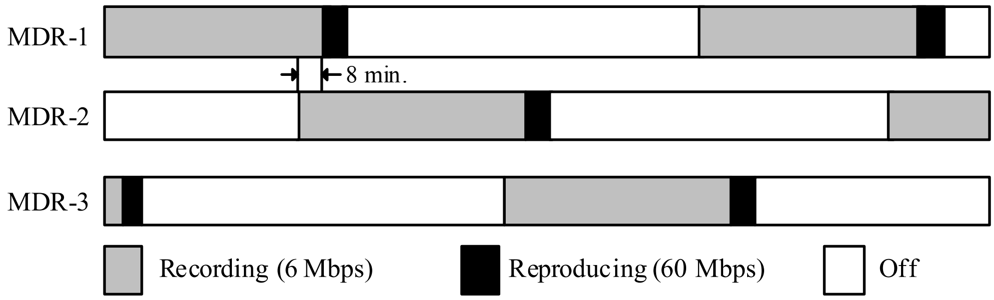


Figure 2.3-2 MDR Operation Pattern

2.3.3 ODR Operation Pattern

GLI 250m data will not be transmitted to ground station in real time in the following situation.

- Without visible area of data relay satellite or X band ground station
- During MDR data transmission

In the above cases, ODR (Optical Data Recorder) will be used to record GLI 250m data as an experimental operation. GLI 250m data, recorded on ODR, will be reproduced and transmitted to ground station in same orbit of data recording. However, ODR data recording time is limited within 4 minutes per orbit, because ODR operation time affects to X-band operation time by reason of thermal constraints. The ODR operation pattern is illustrated in figure 2.3-3.

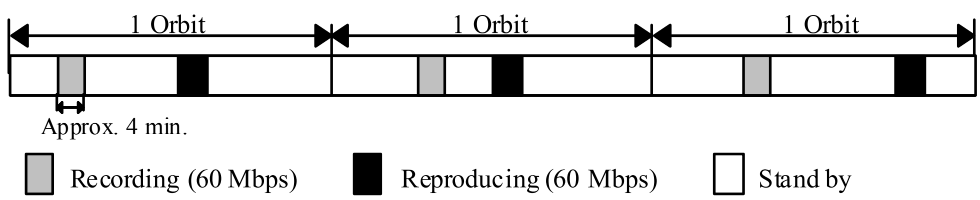


Figure 2.3-3 ODR Operation Pattern

2.3.4 Data Transmission Pattern

Multiplexed mission data of AMSR, GLI 1km, ILAS-II, SeaWinds, POLDER, DCS and TEDA (hereinafter refereed as “MRT Data”), MDR high speed reproducing data (“MDR Data”), GLI 250m data and ODR reproducing data (“ODR Data”) will be transmitted from ADEOS-II spacecraft to ground stations by using IOCS or X-band direct transmission.

Table 2.3-2 shows data rate of each mission data and transmission system.

Table 2.3-2 Data Rate of Mission Data and Transmission System

		Data Rate	Data Contents
Mission Data			
MRT Data		6 Mbps	Real time data of AMSR, GLI 1km, ILAS-II, SeaWinds, POLDER, DCS and TEDA
MDR Data		60 Mbps	Global data of AMSR, GLI 1km, ILAS-II, SeaWinds, POLDER, DCS and TEDA
GLI 250m Data		60 Mbps	Real time data of GLI 250m
ODR Data		60 Mbps	ODR recorded GLI 250m data
Transmission System			
IOCS	Q Ch	60 Mbps	MDR data, GLI 250m data or ODR data
	I Ch	6 Mbps	MRT data
Direct Transmission	X1	60 Mbps	MDR data, GLI 250m data or ODR data
	X3	6 Mbps	MRT data

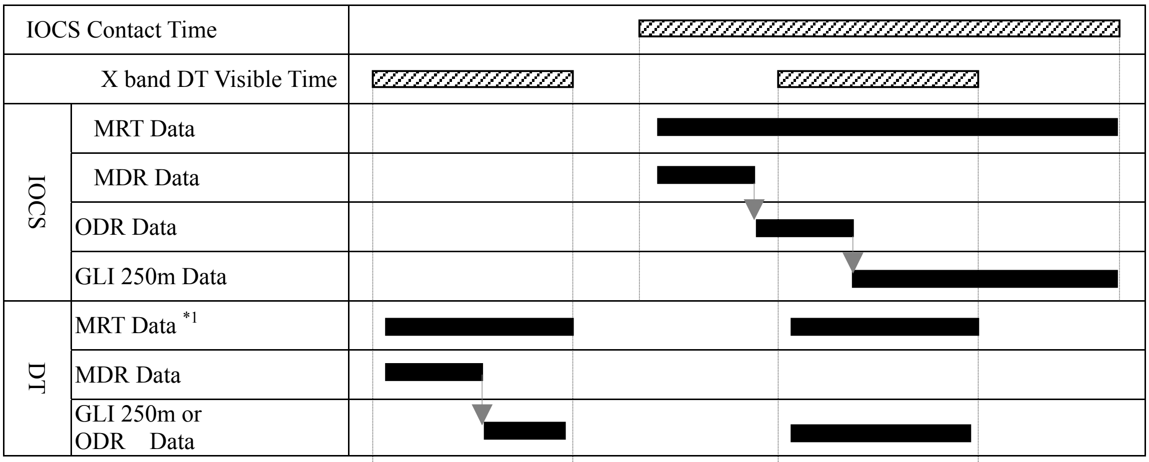
Table 2.3-3 shows the data transmission pattern corresponding to the mission instruments, MDR and ODR operation pattern.

Table 2.3-3 Data Transmission Operation Pattern

Data Resource												Data Transmission			
Total Data Rate (Mbps)	GLI		AMSR	SeaWinds	ILAS-II*3	POLDER*3	DCS	TEDA	MDR	ODR	Operation Area	IOCS (Mbps)		DT (Mbps)	
	1 km	250 m										Q	I	X1	**X3**
6 *1	O		O	O	O		O	O			Nighttime	-	6	-	**6**
	O		O	O		O	O	O			Daytime				
6+60 *2	O		O	O	O		O	O	@		Nighttime	60	6	60	**6**
	O		O	O	O		O	O		@					
	O	@	O	O		O	O	O			Daytime				
	O		O	O		O	O	O	@						
	O		O	O		O	O	O		@					
6+6+60+60	O	@	O	O		O	O	O	@		Daytime	60	6	60	**6**
	O	@	O	O		O	O	O		@					

*1：One of IOCS (Ich) and DT (X3) is operational
*2：One of IOCS (Qch, Ich) and DT (X1, X3) is operational
*3：ILAS-II observes sun light at sunrise and sunset of satellite, so operation area of ILAS-II is in nighttime area.
O: 6 Mbps @: 60 Mbps

Figure 2.3-4 shows the mission data transmission pattern corresponding to contact time of IOCS or visible time of X band ground stations. GLI 250m data and ODR data will be transmitted to ground station via IOCS (Qch) or X band (X1) as long as it will not affect to the MDR data transmission, because of the global data acquisition is top priority for ADEOS-II mission operation.



*1: When MRT data is transmitted via both Ich and X3 band, MRT data via Ich will not be acquired at EOC

Figure 2.3-4 Data Transmitted via both Ich and X3

Table 2.3-4 shows the outline of IOCS contact time and X band DT visible time.

Table 2.3-4 IOCS Contact Time and X band DT Visible Time

		Visible Time/Frequency		Note
IOCS (DRTS)		Contact Time	45 min./Orbit	It is Maximum time in accordance with the constraints of IOCS. Actual contact time is 40 minutes, because 5 min is necessary to establish communication link between ADEOS-II and data relay satellite. Moreover contact time may be reduced by reason of the conflict with the other satellite, which also use data relay satellite.
		Visible Pass	Approx. 13 pass/day	1 pass is not available per day by reason of intervention with Solar Array Paddle.
DT *1	EOC	Visible Time	Approx. 12min./pass	Maximum time
		Visible Pass	4 ~ 5 pass/day	
	ASF	Visible Time	Approx. 13min./pass	Maximum time
		Visible Pass	10 ~ 11 pass/day	
	WFF	Visible Time	Approx. 13min./pass	Maximum time
		Visible Pass	3 pass/day	
	Kiruna	Visible Time	Approx. 13min./pass	Maximum time
		Visible Pass	6 pass/day	6 passes are available per day in accordance with the operation agreement.

*1: Each X band DT station is explained in section 3.

2.4 Orbit/Attitude Control Operation (as Reference)

2.4.1 Orbit Control Operation

(1) Nominal Orbit Parameter

Nominal orbit parameters of ADEOS-II are as follows (Nominal parameters, specified before launch).

➢ Orbit Type	: sun-synchronous sub-recurrent orbit
➢ Recurrent period	:4 days
➢ Revolutions per recurrent period	:57 rev./4days
➢ Revolutions per day	:14+1/4 rev./day
➢ Local sun time at descending node	:10:15-10:45 (AM)
➢ Altitude above equator	:803 km (perigee e) ~ 820 (apogee)
➢ Orbital Period	:101 min.
➢ Inclination	:98.7 degree
➢ Longitude Repeatability	:± 5 km

Figure 2.4-1 shows the ADEOS-II orbit foot print. In Path 6, ADEOS-II will pass over Japan.

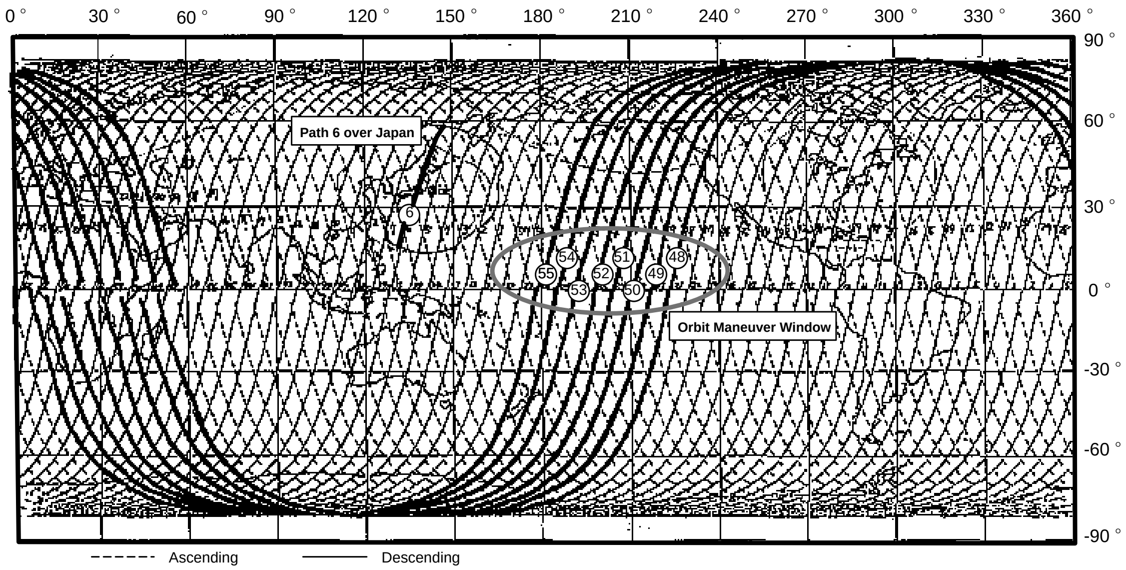


Figure 2.4-1 ADEOS-II Orbit

(2) Orbit Maneuvering Operation

During routine operation phase, orbit altitude control maneuver and orbit inclination control maneuver will be done to keep accuracy of ADEOS-II orbit.

a) Orbit Altitude Control (+ΔV Maneuver)

This orbit maneuver is performed in accordance with the requirement to keep recurrent accuracy and sub-recurrent orbit (side lap).

JAXA will assign 2 orbits as window for +ΔV maneuver, and these 2 orbits are selected from fixed 8 orbits (path 48 ~ path 55: see figure 2.4-1).

In the 2 orbits of +ΔV maneuver window, mission instrument operations are not suspended, but mission data acquisition through data relay satellite can not be performed. So, X band direct transmission will be used to acquire mission data for this +ΔV maneuver window.

b) Inclination Control

During this maneuver, orbit inclination angle is changed to keep enough electric power and accuracy of local sun time at descending node within 10:30 am ±15 min. This maneuvering for inclination control requires a large amount of fuel and electric power. Therefore, during inclination control maneuver, all mission instrument must stop observation and be set into minimum power mode (sleep mode, safety mode, stand by mode and so on).

ADEOS-II orbit maneuvering is shown in table 2.4-1.

Table 2.4-1 ADEOS-II Orbit Maneuver

Purpose	Condition	Type
keep accuracy of longitude repeatability	within ±5 km on the equator	Altitude Control (Speed up :+□V)
keep accuracy of local sun time at descending node	within 10:30 am ±15 min	Inclination Control

2.4.2 Attitude Control Operation

Satellite attitude control is performed in accordance with the pointing stability requirements from mission instrument side. Pointing stability requirements from mission instrument are listed in table

2.4-2 and pointing accuracy is shown in table 2.4-3.

Table 2.4-2 ADEOS-IIPointing Stability Requirements

Instrument	Attitude Stability Requirement			Note
	Item	Requirement (deg.)	Observing Time (sec.)	
AMSR	Roll	0.047	3.0	20% of sampling interval on scanning direction of 89Ghz
	Pitch	0.018		0.7 km sampling interval on scanning direction of 89Ghz
	Yaw	0.044		20% of sampling interval on scanning direction of 89Ghz
GLI	Roll	0.0215	1.79	0.3 pixel of 1km observation mode.
	Pitch			
	Yaw			
	Roll	1.850E-04	1.795E-03	Requirement for registration between observation bands. Observing time is defined as necessary time period to observe one point by all channels of MTIR.
	Pitch	1.432E-04		
	Yaw	2.400E-04		
SeaWinds	Roll	0.1	3.33	
	Pitch			
	Yaw			
	Roll	0.01	6.00E-03	
	Pitch			
	Yaw			
ILAS-II	Roll	5.56E-04	3.33E-02	
	Pitch			
	Yaw			

Table 2.4-3 ADEOS-II Pointing Accuracy

Item	Pointing Accuracy
Roll	±0.3 deg.
Pitch	±0.3 deg.
Yaw	±0.3 deg.

ADEOS-II AOCS unit consists of the GPSR, and GPS data is used to decide satellite attitude in nominal operation. The satellite attitude using GPS is more accurate than the existing attitude determination method, which is using orbit timer. The attitude determination method using GPS is called "Hybrid Navigation System", and the existing attitude determination method using orbit timer is called "Existing Navigation System".

Table 2.4-4 shows the pointing determination accuracy for each Hybrid Navigation System and Existing Navigation System. However, the following values are not applicable while the Earth sensor is interfered by the moon.

Table 2.4-4 Pointing Determination Accuracy (3σ)

Navigation System	Axis	Determination Accuracy
Existing Navigation System	Roll	±0.155 deg.
	Pitch	±0.155 deg.
	Yaw	±0.175 deg.
Hybrid Navigation System	Roll	±0.100 deg.
	Pitch	±0.080 deg.
	Yaw	±0.140 deg.

However, these values shown in the above tables are not applicable in the following cases.

- While starting and stopping AMSR antenna rotation, GLI scanning mirror rotation, ODR or MDR.
- While maneuver;
- While there is interference of the Earth Sensor by the moon.

2.5 Data Relay Satellite

The following data relay satellite will be used to transmit mission data from ADEOS-II to ground stations.

Table 2.5-1 Data Relay Satellite for ADEOS-II Mission Data Transmission

Satellite	Location on Orbit	Data Receiving Ground Station	Mission Data to be Relayed
DRTS	Long. 90˚/E	JAXA/EOC (Japan)	6 Mbps: MRT data 60 Mbps: MDR data, GLI 250m data and ODR data

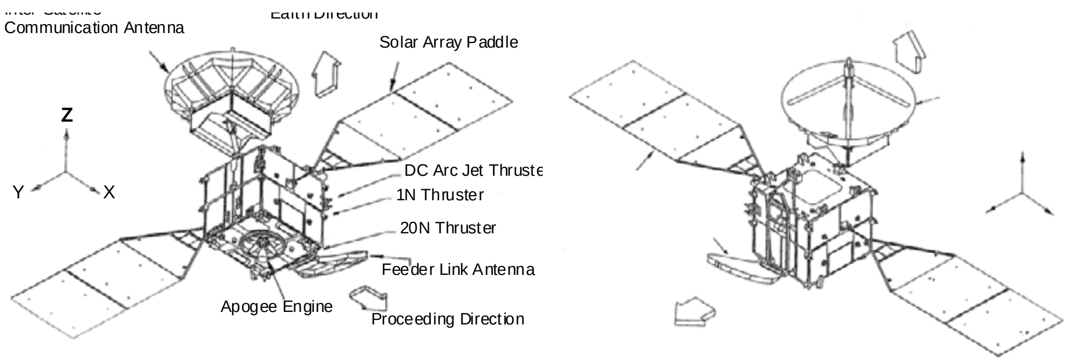


Figure 2.4-2 DRTS Depiction

3 ADEOS-II Ground Segment Overview

During the routine operation phase, ADEOS-II mission operation will be done by the ground segments of JAXA and related domestic/overseas agencies. This chapter introduces the operation overview of the ADEOS-II ground segment.

About the descriptions in this chapter, ground segment operations for data receiving, operation planning and satellite tracking and controlling have been terminated as of the end of October 2003.

3.1 ADEOS-II Ground Segment Overall

ADEOS-II ground segment consists of the following systems.

< JAXA Internal>

- ADEOS-II Mission Operation System: @ Earth Observation Center (EOC)
- Earth Observation Data & Information System/Data Distribution and Management Subsystem
- EOIS/DDMS: @EOC
- Other Related System: @EOC
  - Real-time Control System
  - Observation Requests Handling System (OREQ)
  - Mission Information Server (MIFS)
- Tracking and Control System: @Tsukuba Space Center (TKSC)
- Earth Observation Research Center (EORC)

< JAXA External >

- Overseas Stations
  - NASA Ground Stations
  - Alaska SAR Facility (ASF): @Fairbanks, Alaska
  - Wallops Flight Facility (WFF): @Wallops Island, Virginia
  - Kiruna Station : Kiruna, Sweden
- GLI 250m Direct Receiving Stations
  - Showa Base in Antarctica (National Institute of Polar Research)
- Sensor Providers
- Users
  - Principal Investigator (PI)
  - Near Real-Time (NRT) Data Users
  - General Users

Figure 3.1-1 shows the ADEOS-II ground segment configuration.

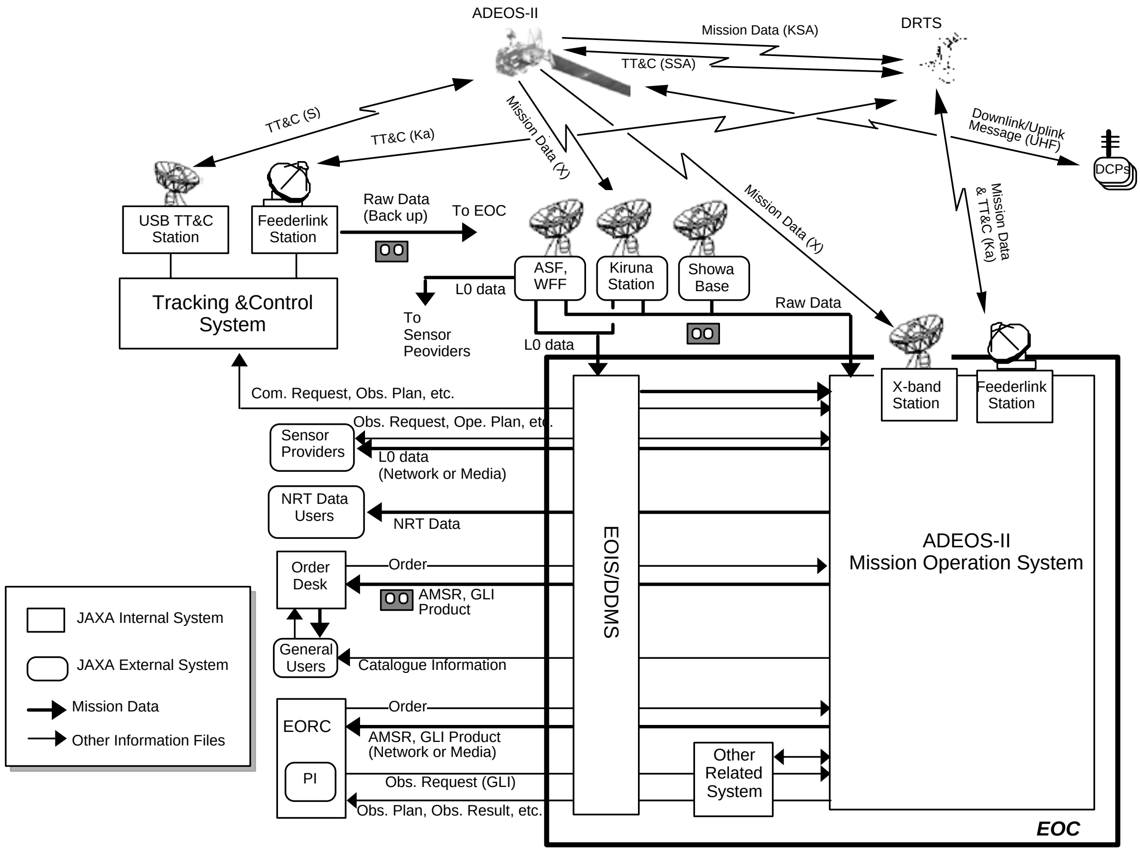


Figure 3.1-1 ADEOS-II Ground Segment Configuration

(1) ADEOS-II Mission Operation System

ADEOS-II Mission Operation System, located at the Earth Observation Center (EOC) in Hatoyama, is the main planning organization for ADEOS-II mission operations. For this role, the ADEOS-II Mission Operation System plans the operation of ADEOS-II onboard instruments based on the operation requests from sensor providers, and it also schedules data downlinks and plans MDR operations (tape management).

The ADEOS-II Mission Operation System serves as a Feeder Link Station for Data Relay Satellite (DRTS), and serves as a Direct Downlink Station for X-band direct transmission. ADEOS-II mission data, acquired by the ADEOS-II Mission Operation System, is processed to level 0 data for each of the mission instruments. AMSR and GLI level 0 data is processed to standard product (level 1, 2 and 3 products) at the ADEOS-II Mission Operation System. Moreover, DCS level 0 data is also processed at this system* 1.

The level 0 data of each mission instrument, except for AMSR and GLI level 0 data, is delivered

* 1: Only JAXA DCP's data is processedby the ADEOS-II Mission Operation System.

from the ADEOS-II Mission Operation System to sensor providers by using network communication or physical media. AMSR and GLI standard products are delivered from the ADEOS-II Mission Operation System to data users via EOIS using network or physical media.

Moreover, AMSR and GLI mission data is processed to Near Real Time (NRT) products at the ADEOS-II Mission Operation System, and these products are provided to NRT data users by network communication.

Additionally, in anomaly case of TKSC Feeder Link Station, EOC Feeder Link Station will be used for tracking and commanding operation as back up.

(2) EOIS/DDMS

The EOIS/DDMS at EOC provides network services for exchanging mission data and any information files between EOC and related domestic/overseas agencies via the network. Moreover, ADEOS-II mission data, acquired at the ADEOS-II Mission Operation System, Overseas Stations, will be archived at EOIS/DDMS as raw data[*1]. And, standard products of AMSR and GLI will also be archived at EOIS/DDMS.

Additionally, EOIS/DDMS stores catalogue information of AMSR and GLI, makes it available to users, and provides users with the AMSR and GLI standard product on demand.

(3) Other Related System

In the EOC, except for EOIS, there are the following three systems necessary for operation of the ADEOS-II Mission Operation System.

a) EOC Real-Time Control System

EOC X band station will be used to receive mission data from several earth observation satellites including ADEOS-II. EOC Real-Time Control System coordinates and optimizes conflicts between several satellites including ADEOS-II and assigns an available antenna to data reception of each satellite mission data. The ADEOS-II Mission Operation System receives the antenna information available for ADEOS-II data reception from EOC Real-Time Control System, and makes an operation plan of X-band stations to receive ADEOS-II mission data.

[*1]: ADEOS-II Mission Data will be archived as level 0 data in the future.

EOC Real-Time Control System controls EOC X-band station in accordance with the operation plan, which is prepared by the ADEOS-II Mission Operation System.

b) Observation Requests Handling System (OREQ)

OREQ generates GLI observation request files based on the requirements from EORC, and provides them to the ADEOS-II Mission Operation System. Then, OREQ receives ADEOS-II mission operation plan and result from the ADEOS-II Mission Operation System, and makes the information public to EORC on its WWW site.

c) Mission Information Server (MIFS)

MIFS stores on its own server the ADEOS-II orbit data, time difference data and etc., and provides them to plural systems of the ADEOS-II Mission Operation System on demand.

(4) Tracking and Control System

The ADEOS-II Mission Operation System makes the ADEOS-II mission operation plan and provides it to Tracking and Control System, which is located at Tsukuba Space Center (TKSC). The Tracking and Control System verifies the plan against command constraints, power constraints, and then generates operation commands, which are uploaded to ADEOS-II spacecraft. The commands are transmitted from USB TT&C Stations to ADEOS-II directly or from TKSC Feeder Link Station via the Data Relay Tracking Satellite.

Moreover, the Tracking and Control System acquires the satellite engineering telemetry data and ranging data by USB TT&C Stations or TKSC Feeder Link Station for monitoring satellite and instrument status, and for orbit determination.

Additionally, in the anomaly case of EOC Feeder Link Station, the TKSC Feeder Link Station will be used to acquire mission data as back up. In this case, the mission data is recorded on physical media and sent to the ADEOS-II Mission Operation System.

(5) Earth Observation Research Center (EORC)

Data Analysis System (DAS) is a part of EOIS and located at EORC. The EOIS/DAS is used to produce scientific products and data set of ADEOS-II (not standard products).

Moreover, EORC has responsibility to coordinate requests from PIs for GLI tilt angle changing and GLI-250m observation area, and to inform OREQ of the GLI operation requests.

(6) Overseas Stations

NASA ground stations and Kiruna station serve as overseas X band stations to support ADEOS-II mission operations, and these ground stations receive ADEOS-II mission data from passes, which are not available at EOC.

Kiruna station is located at Kiruna, Sweden, and NASA ground stations consist of the Alaska SAR Facility (ASF) located at Fairbanks, Alaska and the Wallops Flight Facility (WFF) located at Wallops Island, Virginia.

ADEOS-II Mission Operation System provides the data receiving plan to the three Overseas stations. Each station acquires ADEOS-II mission data via X band in accordance with the receiving plan, and processes the mission data to level 0 data for each mission instrument, except for POLDER and GLI 250m. NASA ground stations transmit the level 0 data to sensor providers and EOC, and Kiruna station transmits the level 0 data to EOC.

Moreover, Overseas stations record raw data of MDR data and GLI 250 data on physical media, and ship it regularly to EOC.

(7) Sensor Providers

Sensor providers have responsibility to develop mission instruments except for AMSR and GLI, and these consist of the Ministry of Environment (MOE) for ILAS-II, JAXA/Space Environment Measurement Group (SEMG) for TEDA, NASA Jet Propulsion Laboratory (JPL) for SeaWinds, Center National d’Etudes Spatials (CNES) for POLDER and DCS.

Sensor providers receive their own mission instrument level 0 data, from EOC or Overseas stations by using network or physical media, and process it to level 1, level 2 and more higher level products.

Moreover, sensor providers make operation requests for their own mission instrument and provide it to ADEOS-II Mission Operation System. However, operation requests are not necessary for TEDA and DCS during routine operation phase, except for contingency cases, because these instruments maintain continuous operation in fixed mode.

(8) GLI 250m Direct Receiving Station

At the GLI 250m Direct Receiving Station, real time GLI 250m data is received within the visible area of the station through X band. During ADEOS-II operation, a station established by National Institute of Polar Research at Showa base in Antarctica was used for receiving GLI 250m data. GLI 250m data received at Showa base is recorded onto media, shipped to JAXA/EOC once a year by observation ship “Shirase” and processed at JAXA/EOC.

(9) Data Users

a) Principal Investigator (PI)

PIs are defined as the investigators (or representative of investigator groups) who propose research themes using ADEOS-II data to JAXA and are selected officially by JAXA. PIs are entitled to order from JAXA the AMSR and GLI products by on-line, and obtain these products via network or physical media freely. Moreover PIs can request the GLI tilt angle and GLI 250 m observation area to EORC.

b) Near Real Time Data User (NRT Data User)

NRT Data users are defined as specific organizations, which have an ADEOS-II NRT products utilizable agreement with JAXA. Currently, JAXA admits National Oceanic and Atmospheric Administration (NOAA), US, Japan Meteorological Agency (JMA), and Japan Fisheries Information Center (JAFIC) as NRT data users.

c) General Users

General users are defined as all ADEOS-II data users, except for PIs and NRT data users. General users can search catalogue information of AMSR and GLI standard products by on-line. However, they can use only off-line methods to order and obtain these standard products.

4 ADEOS-II Mission Operation Phase

4.1 Satellite Operation Phase Definitions

ADEOS-II operation phases are defined as follows during ADEOS-II mission life.

(1) Launch Phase

a) Pre-Launch Phase (→ Launch)

This phase is defined as period from the beginning of launch preparation to the launch.

b) Launch Phase (→ Launch + 16 min.)

This phase is defined as period from the ADEOS-II launch to separation of spacecraft from the launch vehicle. ADEOS-II spacecraft is separated from the launch vehicle about 16 min. after lift-off.

(2) Initial Operation Phase

a) Critical Phase (→ Launch + 22 days)

This phase is defined as the period from spacecraft separation to the beginning of normal attitude control operation. After ADEOS-II separation from the launch vehicle, the Solar Array Paddle and IOCS antenna are extended. And then, orbit maneuvers are performed to adjust ADEOS-II initial orbit to nominal orbit. After that, the AMSR antenna is rotated. At this point, satellite attitude is controlled in the normal mode (3 axis control mode), and mission instruments are pointed to the earth.

b) Initial Checkout Phase (→ Launch + about 4 months)

During this phase, at first, the function of each bus instrument and mission instrument is evaluated individually. After that, satellite overall functions are checked, and compatibility between satellite and ground stations are confirmed.

(3) Routine Operation Phase (→ End of mission life)

This phase is started after finish of Initial Checkout phase, and continues to the end of mission life. During this phase, each mission instrument is operated in accordance with the operation plan, which is specified in section 2.3 of this document.

4.2 Ground Segment Operation Phase Definitions

(1) Initial Checkout

a) Test Operation Phase 1 (Launch → Launch + about 4 Months)

This phase is synchronized with the satellite check out phase. In this phase, fundamental functions of the ground segment are checked by using the operational satellite on orbit and the actual mission data. The major check items during this phase are:

- Global data acquiring function at ground stations, including overseas stations.
- Mission operation planning and scheduling functions and procedures.
- Level 0 data processing function and validation

At the end of this phase, routine operation is started for global data acquisition and level 0 data processing and distribution.

b) Test Operation Phase 2 (→ Launch + about 9 Months)

In this phase, parameter tuning of AMSR and GLI level 1 processing and DCS data processing is carried out, and AMSR, GLI level 1 product and DCS processed data are validated by using routinely delivered global data. At the end of this phase, AMSR level 1 product delivery to PIs is started.

c) Test Operation Phase 2 (→ Launch + about 12 Months)

In this phase, processing parameter tuning and processed data validation is carried out for AMSR and GLI products. The target of this phase is the start of AMSR and GLI standard product delivery to general users.

5 ADEOS-II Data Product

5.1 AMSR

5.1.1 Scene Definitions

(1) Level 1A / Level 1B / Level 2

- The scene of AMSR level 1A, level 1B and level 2 products is defined as a half orbit from center of scanning at southernmost point to northernmost point. These products contain 10 scan overlapping at the beginning and end of each scene, as shown in figure 5.1-1. Level 2 product covers from the scan including the northernmost point or the southernmost point in the scanning central point to the scan just before the one including the next northernmost point or the next southernmost point.

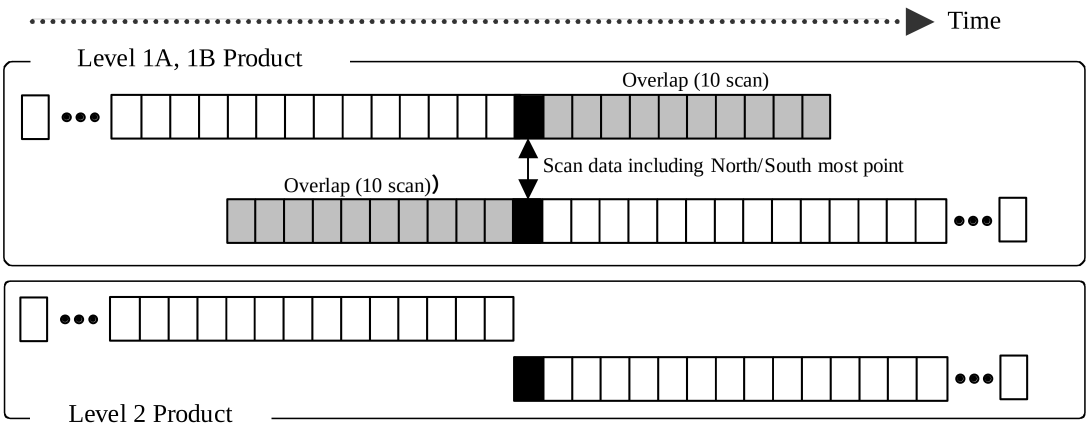


Figure 5.1-1 Scene Definition of Level1, 1B and 2 Product

(2) Level 1B Map / Level 2 Map

- Product size is 300 x 300 pixels, and each pixel is defined as approximately 10 km x 10 km. That is, scene size of a map is approximately 3000 km x 3000 km.
- The map projection method is selected from Equi-rectangular (EQR), Mercator (MER) or Polar Stereographic (PS). (see table 5.1-1 and figure 5.1-2)
- As the earth model, WGS 84 is adopted.
- Referential latitude for scene extracting is selected from the following 3 types. Here, the definition of referential latitude is the latitude of the point of contact at which the earth (sphere) is projected onto the map (plane).

- Standard Latitude :For EQR and MER, the standard latitude is set onto the 0˚ (equator).
  For PS, the standard latitude is set onto the ±90˚ (pole)
- Scene Center :Latitude of scene center by which users specify for map extracting.
- Specified Latitude :Latitude specially specified by users. User can specify latitude every 5˚.

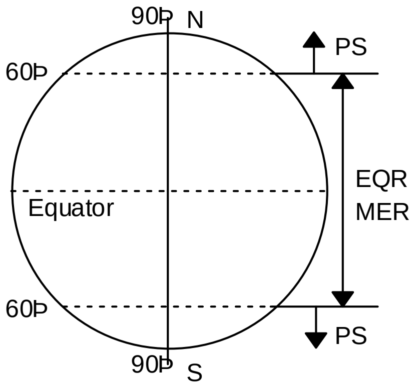


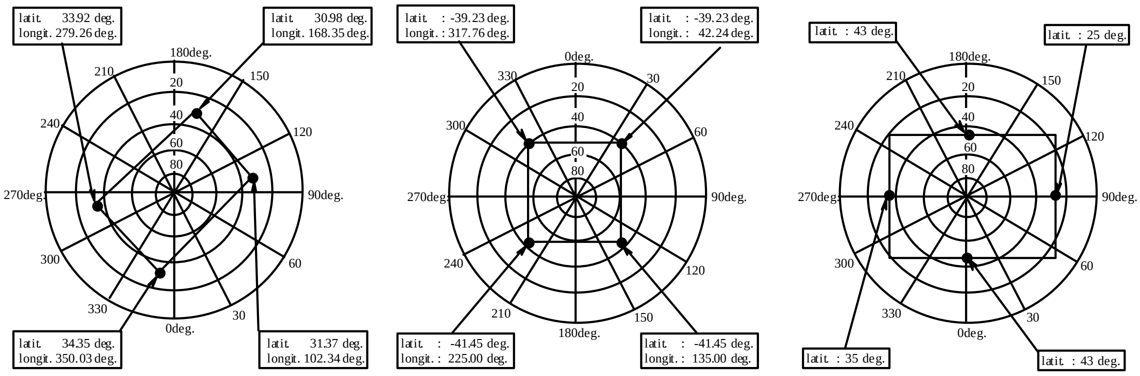
Figure 5.1-2　Map Projection Method

Table 5.1-1　Map Projection Method

Latitude	Projection Method		
	EQR	MER	PS
0˚ - 60˚	O	O	x
60˚ - 90˚	x	x	O

(3) Level 3

- Level 3 is global map product
- There are 2 kinds of map projection method, one is EQR and the other is PS.
- Grid interval of EQR is 0.25˚ and PS is 25 km.
- The definition of the target area for PS map is shown in figure 5.1-3 (a) – (c).



(a) Brightness Temp. & Sea Ice Concentration (North Hemisphere)　(b) Brightness Temp. & Sea Ice Concentration (South Hemisphere)　(c) Snow Depth (North Hemisphere)

Figure 5.1-3　Definition of Target Area of Level 3 Product for PS

5.1.2 Standard Product Definition

5.1.2.1 Level 1 Product

(1) Level 1A Product

- Dummy data is filled for the missing packets in level 0 data.
- Extracted to scene of half orbit from pole to pole.
- Bit array of the observation data (10 or 12 bits) is converted to 16 bits.
- Influence of the Earth radiation on low temperature calibration source (CSM: Cold Sky Mirror) for 6 GHz is corrected.
- Influence of the Moon radiation on CSM is corrected.
- Radio interferometry from GEO satellite at 10 GHz is corrected.
- Stray light from the Sun to CSM for 6 GHz is corrected.
- Temperature of high temperature calibration source (HTS: High Temperature noise Source) is corrected.
- Longitude and latitude, incidence angle, sun azimuth and sun elevation are calculated for corresponding observation data.
- Amount of the missing packets is checked and quality information is appended.
- Land/Ocean flag is appended.

(2) Level 1B Product

- Antenna temperature is calculated from digital count value in level 1A product.
- Scanning bias is corrected for 6 GHz.
- Calibration curve is applied for antenna temperature.
- Antenna temperature is converted to brightness temperature
- Observation data within ±61˚ of antenna angle is extracted.

(3) Level 1B Map Product

- Level 1B data projected onto map (EQR, MER or PS).

Table 5.1-2 AMSR Level 1 Products

Products	Data Unit	Frequency	Data Volume*1
Level 1A	Scene (Half orbit)	28-29/day* 2	38 MB
Level 1B	Scene (Half orbit)	28-29/ day * 2	32 MB
Level 1B Map	Scene (EQR, MER or PS)	Order	5 MB* 3

* 1: Estimated data volume per data unit
* 2: Revolutions per day = 14.25rev./day
* 3: The data volume depends on the map projection method and standard latitude.

5.1.2.2 Higher Level Product

(1) Level 2 Product

- Geophysical parameters are calculated from level 1B data.

- As same as level 1B product, geometric information, quality information and ancillary information (time tag of each scan based on TAI93, and orbit number) are appended.

Table 5.1-3 AMSR Level 2 Products

Product	Code	Data Unit	Frequency*1	Data Volume*2
Water Vapor	WV	Scene (Half orbit)	28-29/day	2.6 MB
Cloud Liquid Water	CLW	Scene (Half orbit)	28-29/day	2.6 MB
Amount of Precipitation	AP	Scene (Half orbit)	28-29/day	2.6 MB
Sea Surface Wind	SSW	Scene (Half orbit)	28-29/day	2.6 MB
Sea Surface Temperature	SST	Scene (Half orbit)	28-29/day	2.6 MB
Snow Depth	SWE	Scene (Half orbit)	28-29/day	2.6 MB
Sea Ice Concentration	IC	Scene (Half orbit)	28-29/day	2.6 MB
Soil Moisture* 3	SM	Scene (Half orbit)	28-29/day	2.6 MB

* 1: Revolutions per day = 14.25rev./day
* 2: Estimated data volume per data unit
* 3: Addition to standard productfrom processing algorithm ver. 2

(2) Level 2 Map Product

- Level 2 data projected onto map (EQR, MER or PS).
- Each pixel data is re-sampled to 10 km interval by using nearest neighbor method.

Table 5.1-4 AMSR Level 2Map Products

Product	Code	Data Unit	Frequency	Data Volume*1	Map	Referential Latitude		
						Standard	Scene Center	Specified
Water Vapor	WV	Scene	Order	5.5 MB	EQR	O	O	O
					MER	O	O	O
					PS	O		O
Cloud Liquid Water	CLW	Scene	Order	5.5 MB	EQR	O	O	O
					MER	O	O	O
					PS	O		O
Amount of Precipitation	AP	Scene	Order	5.5 MB	EQR	O	O	O
					MER	O	O	O
					PS	O		O
Sea Surface Wind	SSW	Scene	Order	5.5 MB	EQR	O	O	O
					MER	O	O	O
					PS	O		O
Sea Surface Temperature	SST	Scene	Order	5.5 MB	EQR	O	O	O
					MER	O	O	O
					PS	O		O
Snow Depth	SWE	Scene	Order	5.5 MB	EQR	O	O	O
					MER	O	O	O
					PS	O		O
Sea Ice Concentration	IC	Scene	Order	5.5 MB	EQR	O	O	O
					MER	O	O	O
					PS	O		O
Soil Moisture* 2	SM	Scene	Order	5.5 MB	EQR	O	O	O
					MER	O	O	O
					PS	O		O

* 1: Estimated data volume per data unit
* 2: Addition to standard productfrom processing algorithm ver. 2

(3) Level 3 Product

- Level 1B data (Brightness Temperature) and level 2 data (Geophysical Parameters) are averaged temporally and spatially. 2 kinds of temporally averaged data are produced, one is for daily data and the other is for a monthly data. The averaged data is projected onto global map of EQR or PS.

➢ Data unit is specified as global data for each product, however these are divided to the ascending path data and the descending path data. Here, the ascending path data and descending path data is defined as follows.

- Ascending : Observation data from the southernmost point to the northernmost point.
- Descending : Observation data from the northernmost point to the southernmost point.

Table 5.1-5 AMSR Level 3 Product

Product	Code	Data Unit	Frequency	Map	Data Volume*1
Brightness Temperature	TB	Global (A/D)	1/day, month	EQR	2.10 MB* 2
				PS (North)	1.10 MB* 2
				PS (South)	0.85 MB* 2
Water Vapor	WV	Global (A/D)	1/day, month	EQR	2.10 MB
Cloud Liquid Water	CLW	Global (A/D)	1/day, month	EQR	2.10 MB
Amount of Precipitation	AP	Global (A/D)	1/day, month	EQR	2.10 MB
Sea Surface Wind	SSW	Global (A/D)	1/day, month	EQR	2.10 MB
Sea Surface Temperature	SST	Global (A/D)	1/day, month	EQR	2.10 MB
Snow Water Equivalent	SWE	Global (A/D)	1/day, month	EQR	2.10 MB
				PS (North)* 3	0.50 MB
Sea Ice Concentration	IC	Global (A/D)	1/day, month	PS (North)	0.28 MB
				PS (South)	0.22 MB
Soil Moisture* 4	SM	Global (A/D)	1/day, month	EQR	2.10 MB

A: Ascending D: Descending

* 1: Estimated data volume per data unit

* 2: There are 14 channels data of brightness temperature, and the data volume of 1 file correspond to 1 channel data.
  - Horizontal polarization (6 ch.): 6.9, 10.65, 18.7, 23.8, 36.5, 89.0 GHz
  - Vertical polarization (6 ch.): 6.9, 10.65, 18.7, 23.8, 36.5, 50.3, 52.8, 89.0 GHz

* 3: SWE projected onto PS of south hemisphere is not produced.

* 4: Addition to standard product from processing algorithm ver. 2

5.1.3 Level 1 Processing Algorithm

5.1.3.1 Editing

For AMSR level 0 data, quality check (detecting the missing data, etc.), filling data gap by dummy data, interpolation of anomalous data is carried out. And then, the observation data is extracted to scene of half orbit from pole to pole. If a scene is composed by several level 0 data, the divided input data is edited to make the data of scene unit. Additionally, level 0 data includes redundant data. So, the redundant data is deleted before generating scene data. In redundant deletion processing, the quality information on corresponding data is compared and the data of the higher quality is chosen. Here, concept of data editing is shown in figure 5.1-4, and data processing flow is shown in figure 5.1-5. Additionally, each step of the processing flow is explained in the following.

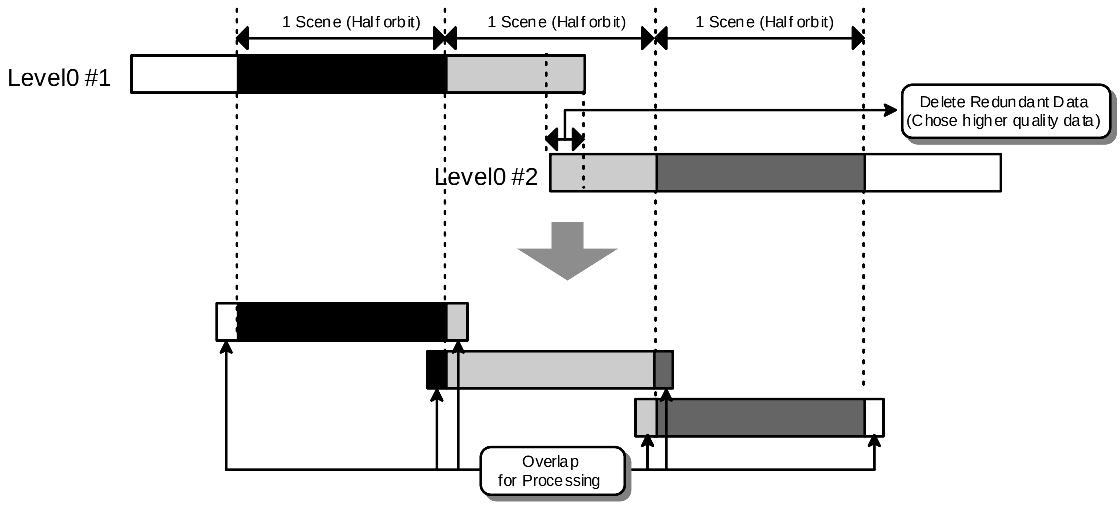


Figure 5.1-4 Concept of Data Editing

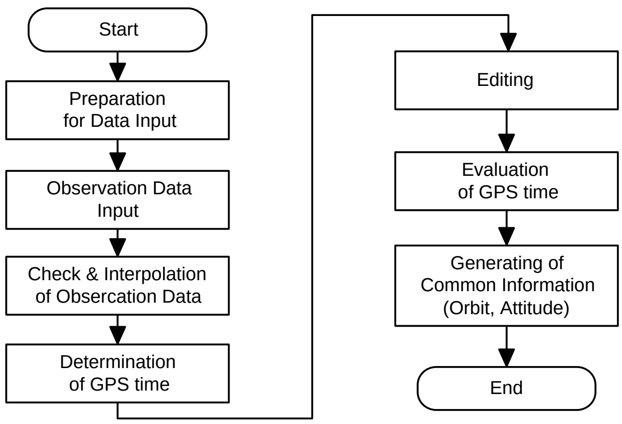


Figure 5.1-5 Processing Flow of Data Editing

(1) Preparation for Data Input

The following information is picked up from the AMSR observation data which compose a scene, and quality check is carried out (the missing packets detection, etc.).

- Packet ID and its byte address
- Packet sequence counter

Based on the check result of the above, the following necessary parameters are calculated for reading observation data.

- Address of the packet head
- Number of the missing packets

(2) Observation Data Input

In accordance with the parameters derived from the data input preparation processing, the observation data is read. At this time, dummy data is inserted into the missing packet.

(3) Check and Interpolation of Observation Data

The engineering data is converted from the following data included in observation data, and anomalous data caused by bit error is checked. Except for calibration data, the anomalous data is interpolated by using the data around it. The check result is output to the database.

- Ephemeris epoch time (GPS time)
- GPSR count
- Taco pulse count
- Calibration data
- Temperature of HTS
- Attitude data
- Orbit data

(4) Determination of GPS TIme

AMSR observation data includes the 3 kinds of time information shown in below. GPS time which corresponds to the mission data is specified using reference time as TAI (International Atomic Time).

- GPS Time (TT, NT)
- Spacecraft Time (CU)
- Ground Time (UTC)

Here, the relationship between TAI, UTC and GPS time is shown in below.

TAI = UTC + leap seconds (IERS data is applied))
TAI = GPS time + 19 (Time gap of leap second is remained, because GPS time count is started at 1/6/1980 0:00 am.)

The processing flow is shown in figure 5.1-6, about GPS time determination.

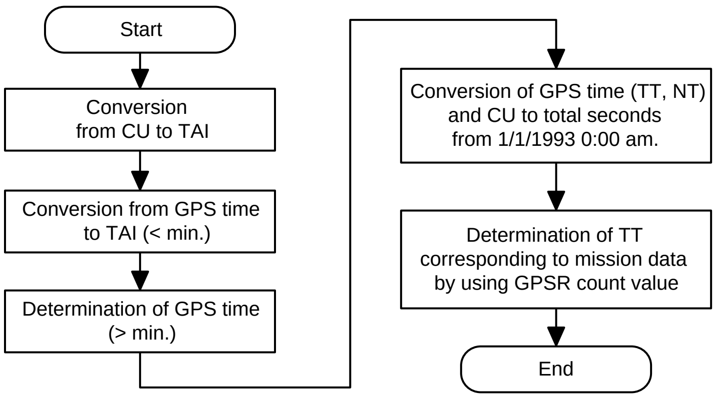


Figure 5.1-6 Processing Flow of GPS Time Determination

(5) Evaluation of GPS Time

The quality of GPS data in the edited AMSR mission data is evaluated and judged whether it can be used for level 1A processing. In case that GPS time is not available, TAI is approximately calculated from spacecraft time (CU) of 1 second unit, and AMSR scan start timing.

(6) Editing

The observation data is edited to scene after completion of pre-processing, that is inserting of dummy data, interpolation of the anomalous data.

(7) Generating of Common Information

The timing of orbit data and attitude data included in observation data is not always synchronized with the scan data. For this reason, the orbit and attitude data is independently extracted from scan data as a common information for processing.

5.1.3.2 Level 1A Processing

Level 1A processing is carried out to derive geometric and radiometric information from edited AMSR data, as shown in figure 5.1-7.

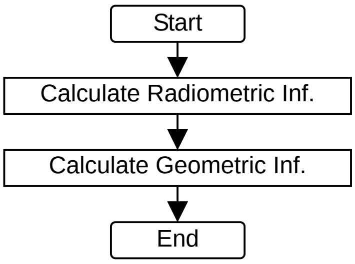


Figure 5.1-7　Level 1A Product Processing Flow

(1) Calculation of the Radiometric Information

Processing flow for calculation of radiometric information is shown in Figure 5.1-8.

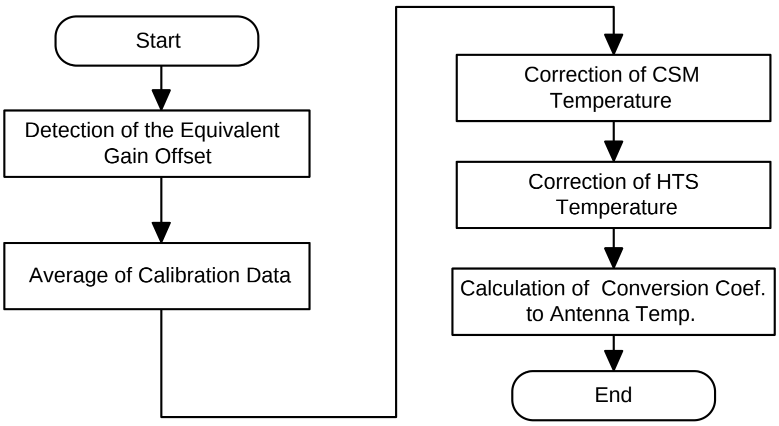


Figure 5.1-8　Processing Flow for Calculation of Conversion Coefficient to Antenna Temperature

a) Detection and Equation of the Equivalent Gain Offset

The range from which low and high temperature calibration data was acquired on the same AGC (Antenna Gain Control) level (gain and offset) is specified. And then, the calibration data of same AGC level is averaged. Data of different gain and offset is not averaged.

b) Correction of CSM and HTS Calibration Data

Observation count value of the low and high temperature calibration source (CSM and HTS) is corrected, as shown in below.

- Correction of HTS calibration data: Correction algorithm is applied.
- Correction of CSM calibration data: Radiation from the Moon and the Earth, radio interferometry from GEO satellite, and stray light from the Sun are removed.

c) Calculation of Conversion Coefficients to Antenna Temperature for all Frequencies

The coefficients of linear equation (A, B) converting observation count value (C_a) to antenna temperature (T_a) are calculated from expected temperature of HTS (T_h), average of HTS data (C_h), expected temperature of CSM and average of CSM data (C_c). (See Figure 5.1-9)

$$T_a = A \times C_a + B$$

$$A = \frac{T_h - T_c}{C_h - C_c} \qquad B = \frac{T_h - T_c}{C_h - C_c} \times (-C_c) + T_c$$

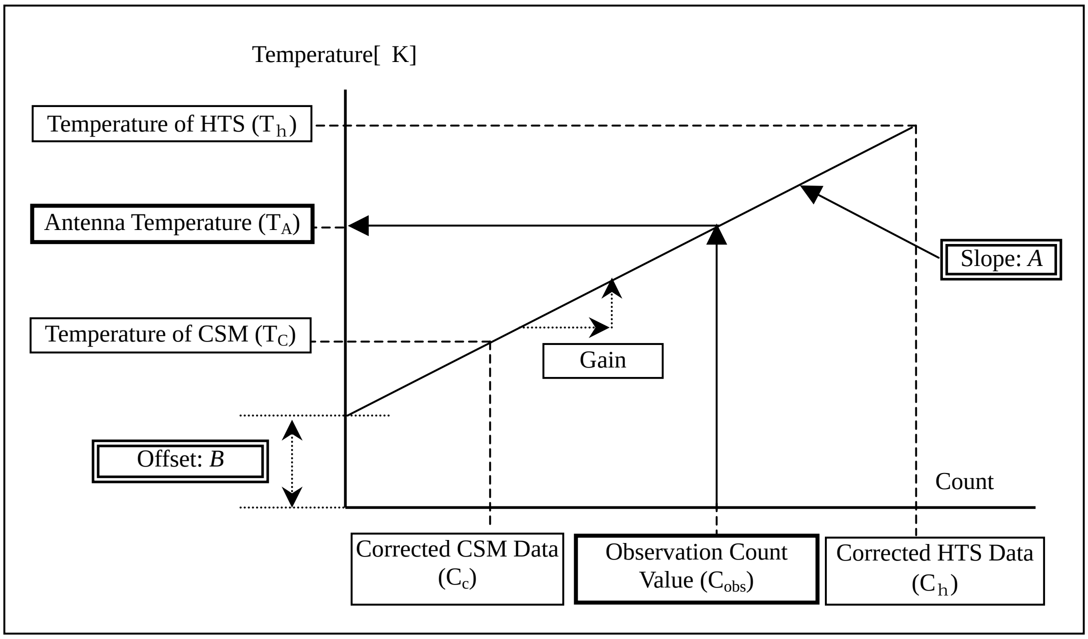


Figure 5.1-9 Conceptual Diagram of Radiometric Information Calculation

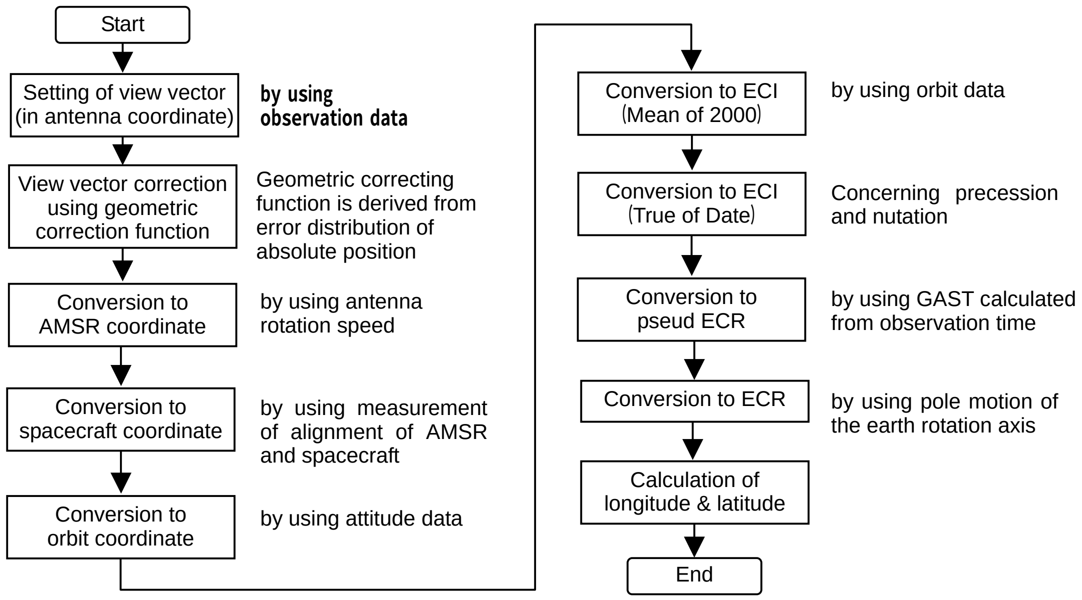
(2) Calculation of the Geometric Information

The following calculation is carried out in this process.

- Calculate the following information.
  - Latitude and longitude of the observation point.
  - Calculate elevation angle and direction angle of the Sun at the observation point.
  - Calculate land surface incident angle and direction angle of observing view vector.
  - Set Land/Ocean flag for all observation frequency

a) Longitude and Latitude of the observation point

The processing flow is shown in figure 5.1-10, about calculation of longitude and latitude of the observation point on the earth.



ECI: Earth-Centered Inertial Coordinate System ECR: Earth-Centered Rotating Coordinate System
GAST: Greenwich Apparent Sidereal Time

Figure 5.1-10 Processing Flow of Calculation of Longitude and Latitude

• View vector correction

Elevation angle and direction angle of view vector is corrected in accordance with position error in satellite progressive direction (Δ Line) and scanning direction (Δ Pixel). Δ Pixel is corrected by adjusting of direction angle. Δ Line is corrected by adjusting of both elevation and direction angle. Figure 5.1-11 shows the relationship between view vector and the corrected observation point.

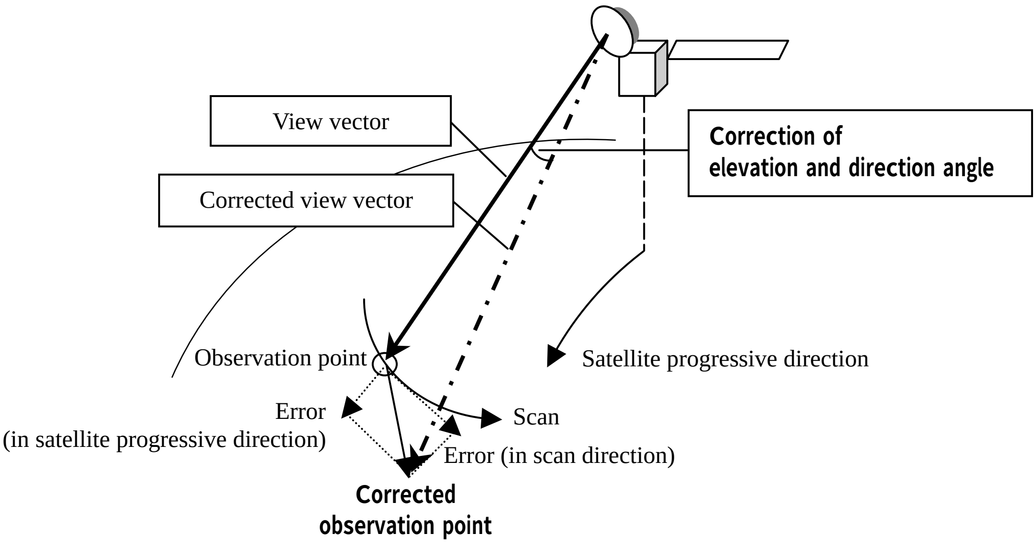


Figure 5.1-11 Relationship between View Vector and the Corrected Observation Point

• Coordinate Conversion

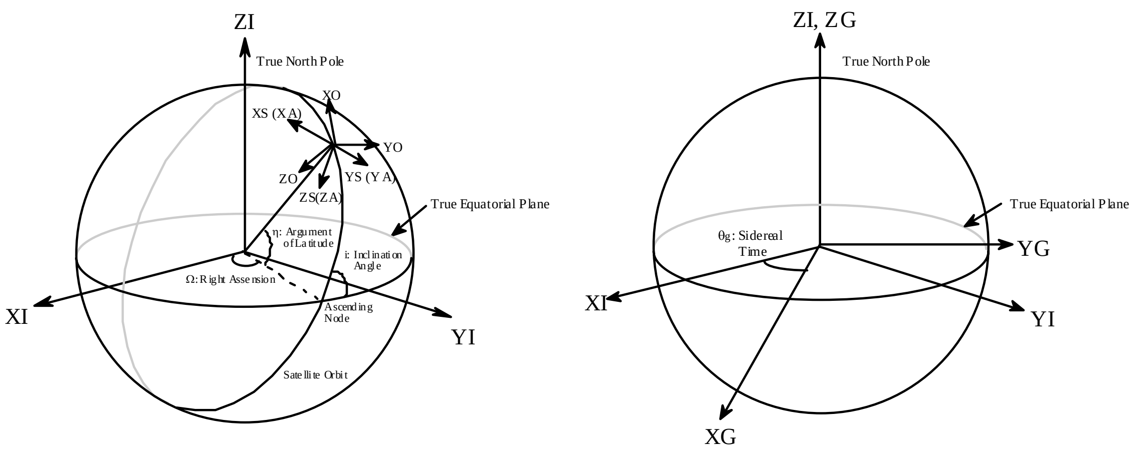
Latitude and longitude information is the position corresponding to observation data of 89 GHz, and calculated from observation time and satellite position for each observation point through coordination system conversion of vector. Earth model is the WGS 84 and the calculated latitude is geodetic latitude. Geometric information for observation frequency other than 89 GHz is not included in level 1A product. But this information can be converted from geometric information of 89 GHz using relative registration parameter, which is one of core metadata. On the other hand, when geometric information of 89 GHz is substituted for the other observation frequency, its position error on the Earth surface is expected about 5 through 10 km.

Here, the definitions of coordinate systems are shown in table 5.1-6 and figure 5.1-12, for calculation of longitude and latitude of observation point.

Table 5.1-6 Definitions of Coordinate System

Coordinate System	Symbol	Origin/Axis	Definitions
Antenna Coordinate System	R	Origin (OR)	Center of antenna rotation axis
		XR	Same as XA, in case of rotation angle 0°*1
		YR	Same as YA, in case of rotation angle 0°*1
		ZR	Same as ZA
AMSR Coordinate System	A	Origin (OA)	Center of rotation
		XA	Same direction as spacecraft roll axis
		YA	ZA x XA
		ZA	Same direction as spacecraft yaw axis
Spacecraft Coordinate System	S	Origin (OS)	Gravity point of spacecraft
		XS	Spacecraft roll axis
		YS	Spacecraft pitch axis
		ZS	Spacecraft yaw axis
Orbit Coordinate System	O	Origin (OO)	Gravity point of spacecraft
		XO	YO x ZO
		YO	Opposite direction of orbit angular momentum vector
		ZO	Earth center direction
ECI (Mean of 2000)	I_{2000}	Origin (O I_{2000})	Earth center
		X I_{2000}	Mean equinox direction
		Y I_{2000}	Z I_{2000} x X I_{2000}
		Z I_{2000}	Vertical direction to mean equatorial plane
ECI (True of Date)	I_{True}	Origin (O I_{True})	Earth center
		X I_{True}	True equinox direction
		Y I_{True}	Z I_{True} x X I_{True}
		Z I_{True}	Vertical direction to true equatorial plane
Pseud ECR		Origin (OG)	Earth center
		XG	Prime meridian direction
		YG	ZG x XG
		ZG	True earth rotation axis
ECR	G	Origin (OG)	Earth center
		XG	Prime meridian direction on equatorial plane
		YG	ZG x XG
		ZG	Based on the IERS Referential Point (IRP)

* 1: "Rotation angle 0" is defined as the moment inwhich rotation start is triggered. Position error of antenna rotation is corrected when conversion to antenna coordinate system is carried out.



(a) Relationship between Coordinate System of AMSR, Spacecraft and ECI

(b) Relationship between Coordinate System ECI and ECR

Figure 5.1-12 Definition of Coordinate System

b) Solar elevation angle and a direction angle at observing point

Solar elevation angle and the solar direction angle corresponding to the observation position of 89GHz are calculated from the latitude and longitude of the observing point, and the position information of the Sun.

c) Land surface incidence angle and direction angle of observing view vector

Land surface incidence angle and direction angle of observation view direction vector are calculated from the latitude and longitude of the observing point, and the position information of the Sun.

d) Land/Ocean Flag

Land/Ocean flag information is retrieved from the existing database using latitude and longitude information, and is set up.

5.1.3.3　Level 1B Processing

Input data of level 1B processing is level 1A product and the processing flow is shown in Figure 5.1-13.

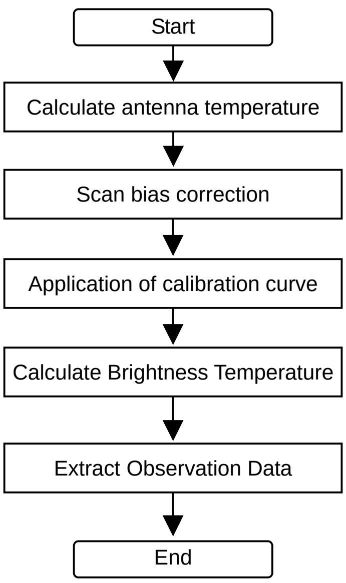


Figure 5.1-13　Level 1B Product Processing Flow

(1) Calculate Antenna Temperature

Observation count value C_{obs} is converted to antenna temperature T_A by using the antenna conversion coefficients A and B derived from level 1A product processing.

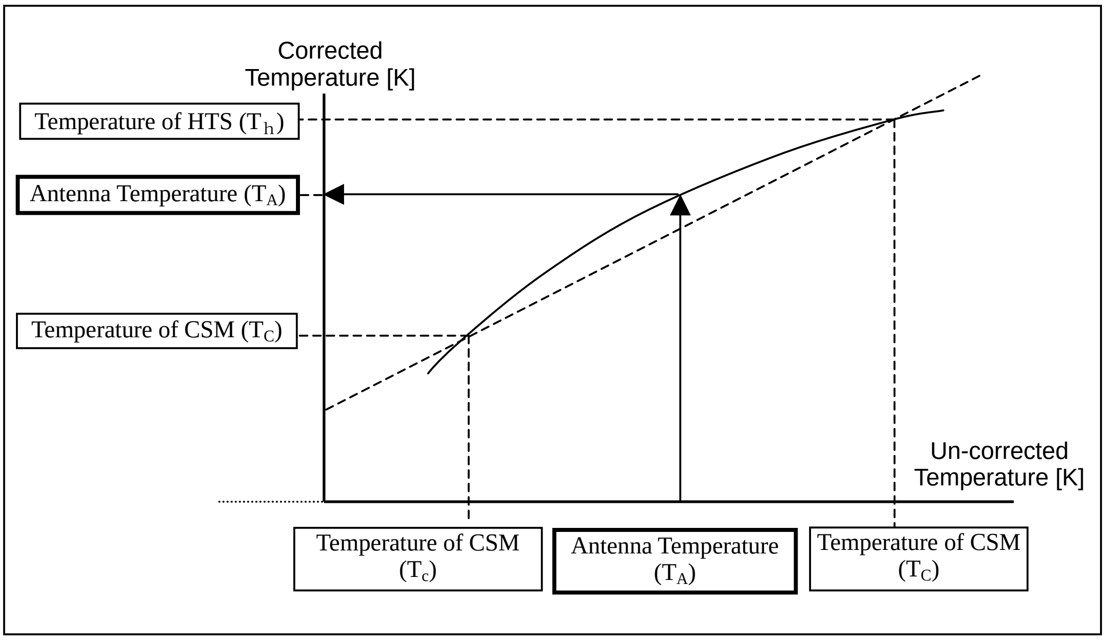
(2) Scan Bias Correction

Scan-bias of 30 points at the first part of a scan data (total 196 points) in level 1B product are corrected by using conversion coefficients.

(3) Application of Calibration Curve

Antenna temperature T_A is converted to the corrected antenna temperature T_A' by using calibration coefficients C_1, C_2, C_2, C_4 and C_5.

$$T_A{}' = C_1 + C_2 \cdot T_A + C_3 \cdot T_A{}^2 + C_4 \cdot T_A{}^3 + C_5 \cdot T_A{}^4$$



(4) Calculation of Brightness Temperature

Brightness temperature (V polarization: TBvb and V polarization: TBhb) is calculated from the antenna temperature TA of each V and H polarized wave.

$$T_{Bvb} = A_{vv}T_{Av} + A_{hv}T_{Ah} + 2.7A_{ov}$$
$$T_{Bhb} = A_{hh}T_{Ah} + A_{vh}T_{Av} + 2.7A_{oh}$$

(5) Extraction of Observation Data

The observation data within the range of ±61 degrees in which the data is not influenced by CSLM and HTS is extracted from the observation data acquired within the range of ±90 degrees in the level 1A product.

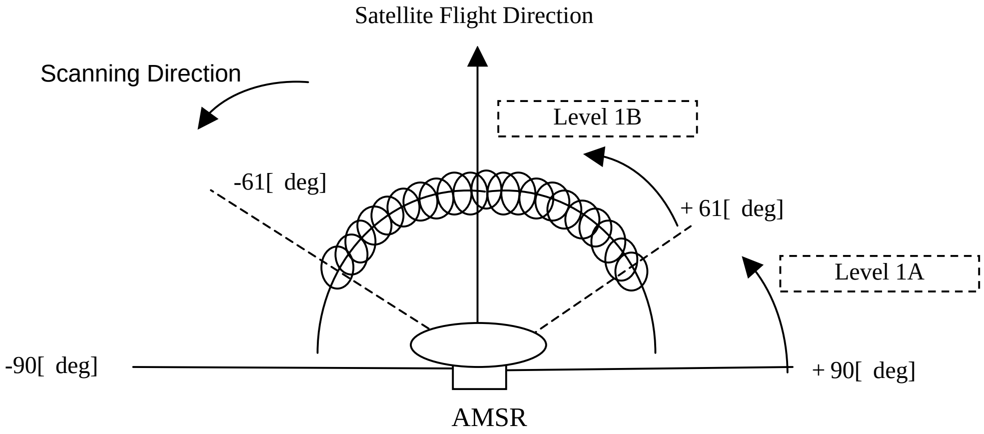


Figure 5.1-14 Observation Image and Product Storing Range

5.1.3.4 Level 1B Map Processing

Level 1B Map product processing is to extract level 1B product in accordance with specified center latitude and standard latitude, and to project it onto map using the specified projection method (Equi-Rectangular, Mercator or Polar Stereographic).

- Data of the area, which is projected onto map, is extracted from a level 1B product based on the specified center latitude.
- The extracted level 1B data is divided to blocks and correspond the center positions of output fixed area (3000 km x 3000 km) and the one of the extracted level 1B.
- 4 corner positions of each block extracted from level 1B product are converted according to the specified map projection method.
- Position of each pixel is previously known, because output area of level 1B Map product is fixed. And so, coefficients from coordinate system of output area to level-1B area are calculated from the known position and mapped position of the extracted level 1B.
- Level 1B data block corresponding to the pixel of output area is extracted by using the conversion coefficients of coordinate system. And observation brightness temperature is calculated using Nearest Neighbor technique.
- When there is no level-1B data corresponding to the output area, 0 is set as brightness temperature.

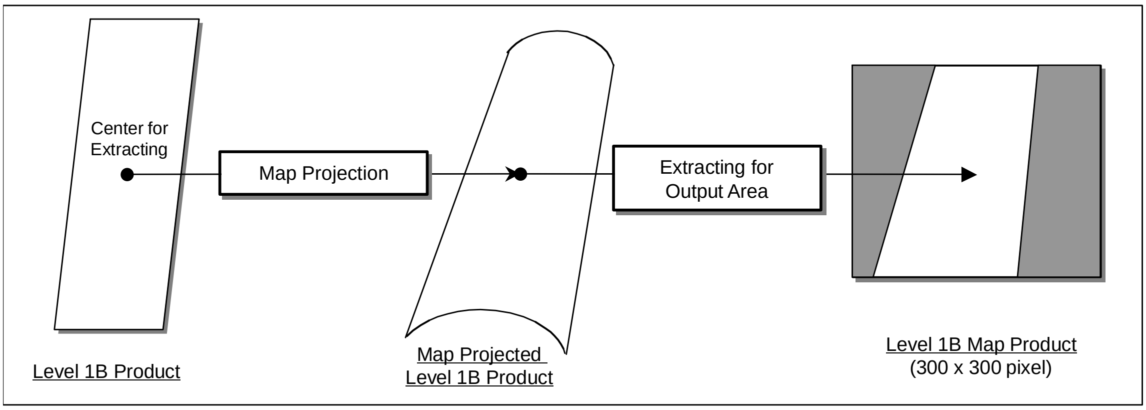


Figure 5.1-15 Concept of Map Projection

5.1.4 Higher Level Processing Algorithm

5.1.4.1 Level 2 Processing

There are eight kinds of the geophysical parameters calculated from AMSR level 1B data. They are Water Vapor, Cloud Liquid Water, Amount of Precipitation, Sea Surface Wind, Sea Surface Temperature, Sea Ice Concentration, Snow Depth and Soil Moisture.

5.1.4.1.1 Water Vapor

(1) Input Data

For water vapor processing, the following information is necessary as input data.

- AMSR Level 1 Product
  - 18.7、23.8、36.5 GHz Brightness Temperature (V/H Polarization)
  - Longitude / Latitude
  - Incidence Angle
  - Observation Time
- Land / Ocean Flag
- Sea Ice Map (AMSR sea ice product, etc.)
- Sea Surface Temperature
- Sea Surface Wind
- Temperature at 850 hPa

(2) Algorithm Overview

a) Land and Sea ice Mask

Land and sea ice is masked by using land/ocean flag and sea ice data. Sea ice data will be revised once a day by using the latest data such as AMSR sea ice level 3 products. If a FOV of AMSR is judged as land or sea ice, then the flag ‘ land/sea ice' is set and the retrieval is quit.

b) Quality Check of AMSR Brightness Temperature Data

If below conditions are false, then the flag bad ' TBB' is added and the retrieval is quit.

- Brightness temperatures for 18.7GHz (V/H), 23.8GHz (V/H) and 36.5 GHz (V/H) are within the range from 90 K to 300 K,
- The difference between brightness temperatures for 18.7GHz (V) and the one for 18.7GHz(H) is positive,
- The difference between brightness temperatures for 23.8GHz (V) and the one for 23.8GHz(H) is positive,
- The difference between brightness temperatures for 36.5GHz (V) and the one for 36.5GHz(H) is positive and
- The difference between brightness temperatures for 23.8GHz (V) and the one for 18.7 GHz(H) is less than threshold temperature (K).

c) Quality Check of Ancillary Data

- If sea surface wind speed (Vs) of ancillary data set is out of the range from 0 to 60 m/s, a default value Vs = 5 m/s is set.
- If sea surface temperature (SST) of ancillary data set is out of the range from -2 to 35 ˚C, the flag ' others ' is added and the retrieval is quit.
- If temperature at 850 hPa (T85) of ancillary data set is out of the range from 200 K to 300 K, a default value T85 = SST - 10 K is set.

d) Calculation of Index of Cloudiness & Quality Check

Sea surface emissivities at 19 GHz V/H, 24 GHz V/H, and 37 GHz V/H are calculated from frequency, Sea Surface Temperature (SST), and incidence angle, and the derived emissivities are corrected with SST and Sea Surface Wind Speed. And then, the index of cloudiness (CCI) is calculated. If the CCI is less than -0.05, the flag ' bad TBB' is added and the retrieval is quit.

e) Decision of Clear, Cloudy, or Rain Category

- If brightness temperatures for 18.7GHz (V) are larger than 240 K, it is assumed to be rainy condition.
- If brightness temperatures for 18.7GHz (V) are less than 240 K and CCI is larger than 0.2, it is assumed to be cloudy condition.
- If brightness temperatures for 18.7GHz (V) are less than 240 K and CCL is less than 0.2, it

is assumed to be clear condition.

f) Calculation of Vertical Mean Temperature of Atmosphere and Square of Atmospheric Transmittance & Quality Check

For each channel, i.e. 18.7 GHz V/H, 23.8 GHz V/H, 36.5 GHz V/H, square of atmospheric transmittance (Tr) and vertical mean temperature of atmosphere (Ta) are calculated from temperature at 850hPa (T85), sea surface emissivity, sea surface temperature (SST) and brightness temperature iteratively. In the case that Ta cannot be obtained or vertical mean temperature of atmosphere-sea surface system α is less than TBB, the flag ‘ bad TBB’, is added and the retrieval is quit.

g) Calculations of Water Vapor Content Iindex and Cloud Liquid Water Index

Cloud liquid water index (CWI) is derived from brightness temperature V/H, atmospheric transmittance (Tr) and vertical mean temperature of atmosphere (Ta) at 18.7 GHz and 36.5 GHz. And then, water vapor index (PWI) is calculated from the CWI, atmospheric transmittance (Tr) at 18.7 GHz and 23.8 GHz and the coefficients obtained from the specified look up table. The coefficients are determined so that we can get the maximum correlation between PWI and PWA from radio sonde.

h) Conversion PWI to Water Vapor Content

PWI is converted to total water vapor content (PWA, kg/m^2) using a look-up table, which is designed as the provability of PWA with AMSR retrievals is equivalent to that of PWA with radio sonde. If PWI is out of range of look-up table, the flag ' low accuracy' is added.

i) Heavy rain Correction to Water Vapor Content

In the case of rainy category, PWA is corrected by T19H/19V.

- If T19/T19V is less than 0.884
  → PWA = PWA-1.51.
- If T19H/T19V is more than 0.884
  → PWA = PWA+ (T19H/T19V-0.884)/(0.960-0.884)* 16.5- 1.51.

5.1.4.1.2 Cloud Liquid Water

(1) Input Data

For cloud liquid water processing, the following information is necessary as input data.

- AMSR Level 1 Product
  - 6.925, 10.65, 18.7, 23.8, 36.5 GHz Brightness Temperature (V/H Polarization)
  - Longitude / Latitude
  - Incidence Angle
- Land Map (1/12˚ Resolution)

(2) Algorithm Overview

a) Quality Check of AMSR Brightness Temperature Data

This process checks whether the Brightness Temperature input of 5 frequencies fall into the range of possible ocean observations. Lower and upper bound for each channel and for the difference between vertical polarization and horizontal polarization are preset. The subroutine returns a flag of 1 if the brightness temperature values fall outside these bounds.

b) Normalization of Brightness Temperature Data

This is a utility procedure that normalizes the brightness temperature observations by adjusting the brightness temperature to a constant incidence angle of 55˚. This routine also adds the experimentally decided offsets to remove the absolute calibration error. There is one offset number for each channel.

c) Land and Seaice Mask

This process takes as input the latitude and the longitude of a cell and determines whether it is close to land or coast by comparing the input with an l/12 degree resolution land bit map. The subroutine then returns 1 to indicate land or 0 otherwise.

Moreover, total ice concentration is calculated from the latitude and the brightness temperatures by using AMSR team ice algorithm.

An error flag is set if any check returns true and the corresponding cell is excluded from the calculation of cloud liquid water.

d) Calculation of Cloud Liquid Water

Integrated cloud liquid water is calculated from brightness temperature of 10 channels (5 frequencies X 2 polarization) by using a Linear Statistical Regression (LSR) algorithm. In this processing, a combination of coefficients is utilized and these are specified in accordance with a simulation in which brightness temperatures for a wide variety of ocean scenes (sea surface temperature, wind speed, water vapor and cloud liquid water) are computed by the Radiative Transfer Model (RTM). These coefficients were found such that the rms difference between estimated value and the true value for the specified environmental scene was minimized

If the value of cloud liquid water is above 0.18 mm, it flags the observation as having rain.

5.1.4.1.3 Precipitation

(1) Input Data

For precipitation (rain rate) processing, the following information is necessary as input data.

- AMSR Level 1 Product
    - 18.7, 36.5, 89.0 GHz Brightness Temperature (V/H Polarization)
    - Longitude / Latitude
    - Incidence Angle
- Sea Surface Temperature (AMSR level 3 product)
- Sea Ice Concentration (AMSR level 3 product)

(2) Algorithm Overview

Combinations of both emission and scattering signatures are used in retrieval algorithm. The algorithm retrieves rainfall over ocean and land areas except for the following surfaces: coastal (~ 25 km from coastal line), sea ice, snow-covered land, and desert areas. Separate algorithms are applied for over ocean and over land regions. Generally, retrievals over ocean have better quality than those over land. The sea ice flag is based on sea ice concentration retrievals from AMSR provided by the EOC integrated retrieval system. Snow-covered land and desert surface detection is based on AMSR brightness temperatures and embedded in the precipitation retrieval algorithm.

a) Precipitation Retrieval Algorithm (Ocean)

A combination of emission and scattering signature is used as the key parameter for rainfall determination.

$$f = (1 - \frac{D}{D_0}) + 2(1 - \frac{PCT}{PCT_0})$$

where D is the depolarization of 18.7 GHz (D = T_{B19V} - T_{B19H}), and D_0 is D at the threshold of rain onset; PCT is the polarization corrected brightness temperature defined PCT = 1.818T_{B89V} - 0.818T_{B89H}, and PCT_0 is PCT at the threshold of rain onset.

D_0 and PCT_0 are determined monthly for every 3° (latitude) x 6° (longitude) box based on 37 GHz depolarization and sea surface temperature, and are saved in a file as a look-up table. The relationship between f and rainfall rate is determined by radiative transfer calculation result with consideration of beam-filling effect, and can be expressed by the following equation.

$$R = \alpha f^{\beta}$$

where α and β are spatial scale-dependent coefficients. The dependence of α and β on spatial scale is due to the spatial dependence of beam-filling effect.

b) Precipitation Retrieval Algorithm (Land)

The land portion of precipitation retrieval algorithm uses 18.7 and 89 GHz brightness temperatures. It is expressed by the following equation.

$$R = a(DT_B - DT_{B0})$$

where a= 0.2 is a coefficient derived from radiative transfer model simulations; D_{TB} = $T_{B18.7}$ - T_{B89}. DT_{B0} is DT_B at the threshold of rain onset that is determined monthly for every 3° (latitude) x 6° (longitude) box and is saved in a file as a look-up table.

5.1.4.1.4 Sea Surface Wind Speed

(1) Input Data

For sea surface wind speed processing, the following information is necessary as input data.

- AMSR Level 1 Product
  - 10.65, 36.5 GHz Brightness Temperature (V/H Polarization)
  - 6.925 GHz Brightness Temperature (H Polarization)

(2) Algorithm Overview

Sea surface wind speed (SSW) is retrieved mainly from 36.5 GHz vertical (V) and horizontal (H) brightness temperature of AMSR by a graphical method. The retrieval is restricted to no rain condition since the brightness temperature of 36.5 GHz is saturated under rainy condition, SSW obtained only from 36.5 GHz has a large anisotropic feature depending on an angle between antenna direction and wind direction. Its anisotropic feature is corrected by using two data from 36.5 and 10.65 GHz, since 10.65 GHz data are less anisotropic. Even under rainy condition, 10.65 and 6.925 GHZ data are not saturated, so wind speed will be retrieved by using those H data. Retrieval accuracy of wind speed using 10.65 and 6.925 GHz will become worse than using 36.5 GHz, since a sensitivity of 10.65 and 6.925 GHz to wind speed is not so strong.

5.1.4.1.5 Sea Surface Temperature

(1) Input Data

For cloud liquid water processing, the following information is necessary as input data.

- AMSR Level 1 Product
  - 6.925, 10.65 GHz Brightness Temperature (V/H Polarization)
  - 23.8, 36.5 GHz Brightness Temperature (H Polarization)
  - Incidence angle

(2) Algorithm Overview

a) Incident angle correction

Corrections for the brightness temperature due to incident angle variation is given by the following equations;

$$dA = -2.9 \times (A-55.0) \quad \cdots \; 6(V)$$

$$dA = -2.7 \times (A-55.0) \quad \cdots \; 10(V)$$

Where A is the incident angle. The horizontal polarization data are also corrected by similar equations.

b) Atmospheric correction

A correction for atmospheric opaque is obtained from a pair of two temperatures of 23 GHz and 37 GHz (V polarization). Because brightness temperatures of 23 V and 37 V are changed with SST, the table is made with 5 ˚C interval of SST from 0 to 35 ˚C. It is necessary to omit data contaminated by rain, since SST accuracy becomes worse in rain areas. Its judge is made by counting the number of pixels within 6 GHz or 10 GHz spatial resolution. If the number of pixels with out of range is larger than a threshold, SST is missing.

c) Surface wind correction

Brightness temperature of V polarization is constant under condition of sea surface wind speed less than 7-8 m/s. But, the one with H polarization increases uniformly. Above 7 - 8 m/s, both brightness temperature of V and H polarization increase with wind speed. Based on this correlation, corrections for sea surface wind are calculated independently from two frequencies; 6 V and 6 H, and 10 V and 10 H, which are already corrected for atmospheric opaque.

d) Land contamination correction

Contamination by land emission increases drastically when the pixel approaches a shoreline, or the pixel includes an island. Here, land contamination is removed for cases that it is less than 2 K For pixels of contamination larger than 2 K, SST is missing.

e) Sun glitter removal

Sun glitter is checked by using a relative angle between the antenna beam and sun direction, which is given by LIB. SST is missing for pixels with the relative angle larger than 30˚.

f) Salinity correction

Salinity effect can not be neglected when SST is high as 30 ˚C, and an amount of correction is an order of 0.1 or 0.3 K. Its effect is calculated in advance by using the climate salinity, and data set of correcting salinity effect is prepared with spatial resolution of 1 degree. This data set is not modified even after the launch.

g) Sea ice removal

Sea ice is checked by using the same table as atmospheric correction. If the value exceeds 5.5 K in the latitude larger than 65˚, the pixel is contaminated. SST is missing when the number of pixels with sea ice contamination exceeds a specified value.

h) Conversion to SST

The relationship between 6V (or 10V) and SST is calculated by using the complex relative dielectric constant.

i) Spatial running mean

The temperature resolution at 6 GHz is about 0.3 K for one pixel, which is corresponding to about 0.6 ˚C of SST. It is necessary to reduce its noise. A current method is a spatial running mean with 5 pixels by 5 pixels (50 km by 50 km area). The simulation indicates the reduced noise becomes less than 0.1 K after applying 5 by 5 running mean.

5.1.4.1.6 Snow Depth

(1) Input Data

For snow water equivalence processing, the following information is necessary as input data.

- AMSR Level 1 Product
  - 18.7 and 89 GHz Brightness Temperature (V Polarization)
  - 36.5 GHz Brightness Temperature (V/H Polarization)
  - Longitude / Latitude
  - Incidence Angle
- Land/sea/ice
- Topography

- Snow class (Strum *et al*, 1995)
- Snow (im)possible

(2) Algorithm Overview

a) Detection of the Snow Region

The first step is to determine the kind of surface present (flat land, water body on land, ice, ocean, mountainous terrain, snow climatologically (im)possible, forest cover). Unless the surface is flat land without heavy forest cover, the procedure flags the surface type and does not attempt to compute the snow depth. For flat land without heavy forest cover, the algorithm proceeds to the next step, which reads, in AMSR channel brightness temperatures.

Next a rough surface temperature (either snow covered or snow free) will be calculated. These estimated temperatures would also be used to determine whether snow cover is possible for this pixel. A threshold (275K) is used as the threshold for the present time.

When there is raining or wet snow, no accurate snow parameter estimates can be produced. The rain and wet snow tests will then be applied.

Liquid precipitation can affect the microwave signatures over land. Thus, when it is raining, snow parameters may not be retrieved. A multi frequency procedure to filter the rain cases is adopted to remove the pixels affected by the rain signal.

Wet snow can confound snow depth retrievals by depressing the scattering behaviour of the snow. Ultimately, this leads to underestimation of the pack. Unfortunately, at present there is little that can be done to overcome this problem directly although at least the detection of wet snow is possible by using a combination of information about the surface temperature, polarization difference at 36.5 GHz.

b) Calculation of Snow Depth

Compared with non-snow surfaces, therefore, a snowpack has a distinctive electromagnetic signature at frequencies above 25 GHz. When viewed using passive microwave radiometers from above the snowpack, the scattering of upwelling radiation depresses the brightness temperature of the snow at increasingly high frequencies. This scattering behavior of snow can be exploited to detect the presence of snow on the ground. Having detected the snow, it is then possible to estimate the snow depth of the pack using the degree of scattering.

Wet soil snow depth is estimated by the following equation.

$$SD = 1.66 \times \Delta Tb$$

Otherwise, dry soil snow depth is estimated by the following equation.

$$SD = a \times \Delta Tb / (1 - ff)$$

The D_{TB} term is the difference in brightness temperature between 18.7 GHz and 36.5 GHz channels (vertical polarization). The a coefficient should, therefore, be varied both spatially and temporally and so we have computed a set of coefficients for each month of the year. The spatial distribution of the coefficients is achieved using the seasonal snow pack classification of Sturm et al. (1995) which divides the northern hemisphere into 6 dominant regional snow types. ff is the forest fraction in percent.

5.1.4.1.7 Sea Ice Concentration

(1) Input Data

For sea ice concentration processing, the following information is necessary as input data.

- AMSR Level 1 Product
  - 6.925, 18.7 GHz Brightness Temperature (V Polarization)
  - 36.5 GHz Brightness Temperature (V/H Polarization)
  - Longitude / Latitude
  - Incidence Angle

(2) Algorithm Overview

The technique uses data from the 6 GHz and 37 GHz channels at vertical polarization to obtain an initial estimate of sea ice concentration and ice temperature. The derived ice temperature is then utilized to estimate the emissivities for the corresponding observations at all the other channels. Ice concentrations are derived mainly from 37 GHz and 19 GHz channels, as in the Bootstrap technique, but makes use of emissivities instead of brightness temperatures to minimize errors associated with spatial changes in ice temperatures within the ice pack.

The ice temperature is in the end normalized using the derived ice concentration value, for it to represent temperature only of the sea ice part of the satellite observational area.

5.1.4.1.8 Soil Moisture

(1) Input Data

For soil moisture processing, the following information is necessary as input data.

- AMSR Level 1 Product
  - 6.925, 10.6, 18.7, 36.5, 89.0 GHz Brightness Temperature (V/H Polarization)
  - Longitude / Latitude
  - Incidence Angle

(2) Algorithm Oveview

In general, at a smooth interface between two semi-infinite media, the emissivity is equal to one minus the Fresnel power reflectivity, which is calculated by using dielectric constant of the media and incident angle. Among the water surface emissivities at AMSR observing frequencies, 6.9; l0.6, 18.7, 36.5 and 89 GHz, the emissivity is larger at the higher frequency than at the lower one for both polarizations.

The following index, the discrepancy between the brightness temperatures at two frequencies divided by one at lower frequency, can be used as an index for surface wetness.

$$ISW = \frac{(T_{bhigh} - T_{blow})}{T_{blow}}$$

ISW :Index of Surface Wetness
T_{bhigh} :Brightness Temperature (High Frequency)
T_{blow} : Brightness Temperature (Low Frequency)

The temperature dependency of ISW is negligible. Figure 5.1-16 shows the relationship between observed surface soil moisture and are ISW calculated by the combination of the brightness temperatures at 36.5 GHz and 6.9 GHZ obtained through the AMR experiments. This combination shows the best performance.

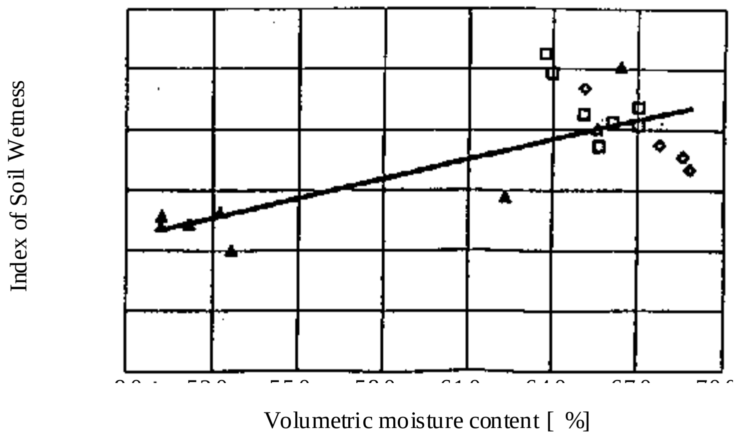


Figure 5.1-16 Soil Moisture – ISW Relationship

Vegetation canopy reduces the signal of land surface wetness, that is, the dependency of ISW on surface soil moisture. Figure 5.1-17 shows the relationship between Global Vegetation Index (GVI) and ISW using 19 GHz and 37 GHz channels of SSM/I. The maximum value of ISW decreases as GVI increases. The liner regression equation for soil moisture estimation is shifted with keeping its slope angle as the equation satisfies a maximum surface soil wetness and its corresponding ISW identified empirically under each vegetation condition.

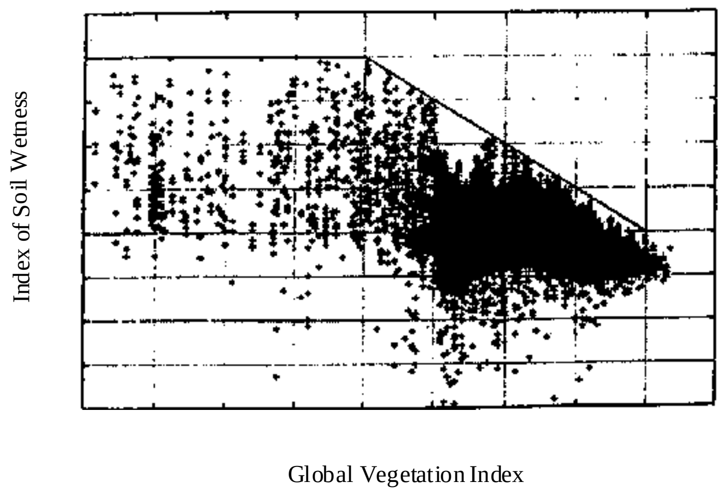


Figure 5.1-16 GVI – ISW Relationship derived from SSM/I

5.1.4.2 Level 2 Map Processing

Level 2 product is projected onto the map in accordance with specified reference latitude and map projection method (Equi-Rectangular, Mercator or Polar Stereographic), as described in the section5.1.3.4. Here, level 2 map processing method is the same as level 1B Map product.

Moreover, when packet is missed caused by any reasons, the observation data corresponding to the portion into which the missing packet is filled by dummy data. Dummy data value is always -9999.

5.1.4.3 Level 3 Processing

The level 1B and level 2 data of 1 day is projected to the map in accordance with the specified projection technique (Equi-Rectangular or Polar Stereographic) as described in the section 5.1.1, and then the arithmetic average of 1 day is computed on each grid. Moreover, level 3 data for 1 day of each geophysical parameter is inputted for 1 month, arithmetic average of 1 month is computed on each grid, as the same way as 1 day average calculation. These statistical values are computed for observation data on ascending orbit and descending orbit respectively.

When packet is missed caused by any reasons, the observation data corresponding to the portion into which the missing packet is filled by dummy data. Dummy data value is always -9999.Additionally, when there is no data in a grid, -8888 is set to the grid as dummy data.

5.1.5 Product Format

As a format which stores AMSR level 1 - 3 product, HDF is applied by the following reasons.

- Various toolkits are available
- It is easy to access from a user, HDF does not depend on computer environment, for example
- It is easy to adapt to system, because ECS of NASA also applies this as standard format.

The detailed format of AMSR level 1 ~ 3 products is specified in the documents, which are listed in below and attached to this handbook as the appendix 3.

- AMSR Level 1 Product Specifications (including level 1A, 1B and 1B Map)
- AMSR Level 2 Product Specifications
- AMSR Level 2 Map Product Specifications
- AMSR Level 3 Product Specifications

5.2 GLI

5.2.1 Processing Unit Definitions

(1) Level 1A/1B/1B Map

Level 1A, 1B and 1B Map products of GLI 1km and 250m are generated in scene unit.

a) Scene Definition

GLI scene is defined as follows.

- Ascending node of an orbit is specified as center of scene 1 for each orbit.
- GLI 1 scene is corresponding to the observation time of RSP value 13.8528 degrees.
- There are 26 scenes in an orbit, and each scene is numbered from 1 to 26.
- Each scene has no overlapped area with any other.
- A scene is divided to two scenes in case of tilt angle change or GLI mode shift.

b) Scene Size

GLI scene size is defined as follows.

- Cross track direction : 1600 km (swath width)
- Along track direction (tilt angle is 0 degree) : 1560 km (approx. 130 scans)

c) Size of Product Image

GLI product size is defined as follows.

- Level 1 product includes completely 1 scene and has overlap area with the adjacent product.
- Overlap area is 10 scans for level 1A and 8 scans for level 1B. (including error of approx. 1 scan)
- Number of samples in each scan is shown in below for GLI level 1 products.
  - ✓ GLI 1km level 1A : 1276 samples/scan
  - ✓ GLI 1km level 1B : 1236 samples/scan
  - ✓ GLI 250m level 1A : 5104 samples/scan
  - ✓ GLI 250m level 1B : 4944 samples/scan
- Product size of level 1B map is different by position of observation. However, it is basically defined as level 1B projected to a specific map coordinate system, which are Equi-Rectangular (EQR), Polar Stereographic (PS) or Mercator (MER).

(2) Level 2A (GLI 1km)

Level 2A product of GLI 1km is generated in path unit or area unit.

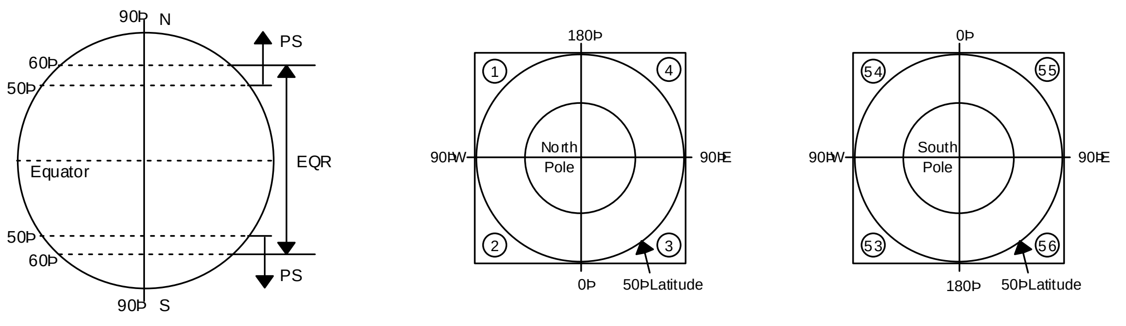
a) Path Unit

Path is defined as 1 revolution from an ascending node to the next ascending node, and 1 recurrent cycle is divided to 57 paths. The product of path unit, is the coarse image which is simply sampled every 4 pixels and 4 lines (i.e. every 4km).

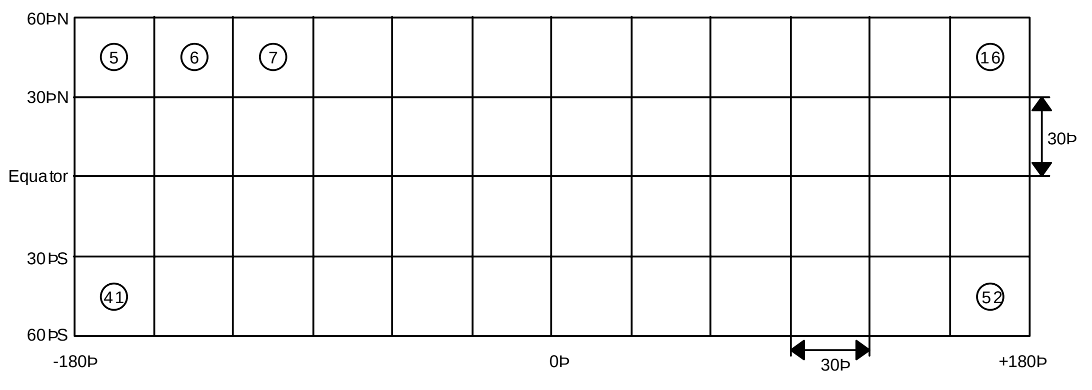
b) Area

There are 56 areas, which are divided in accordance with the following rules.

- North and South Pole area of 50 or more degrees latitude is respectively divided to 4 areas which is projected on polar Stereographic.
- Middle area of 60 or less degrees latitude is divided to 48 areas (30˚ interval) which is projected on equi-rectangular map.
- The area number, shown in figure 5.2-1 as the circled number, is fixed.



Polar Stereographic (PS)



Equi Rectangular (EQR)

Figure 5.2-1 Definitions of Area

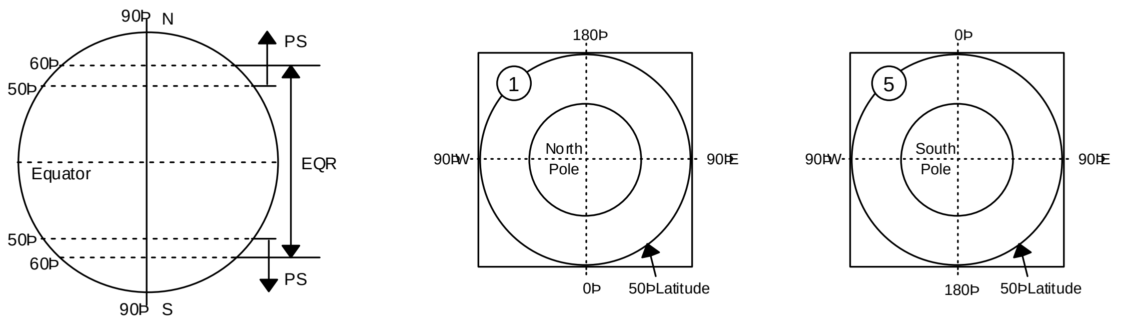
(3) Level 2 (GLI 1km)

Level 2 product of GLI 1 km is generated in unit of scene, path, zone or global. Here, the definitions of scene and path for level 2 product is same as for level 1B or 2A product.

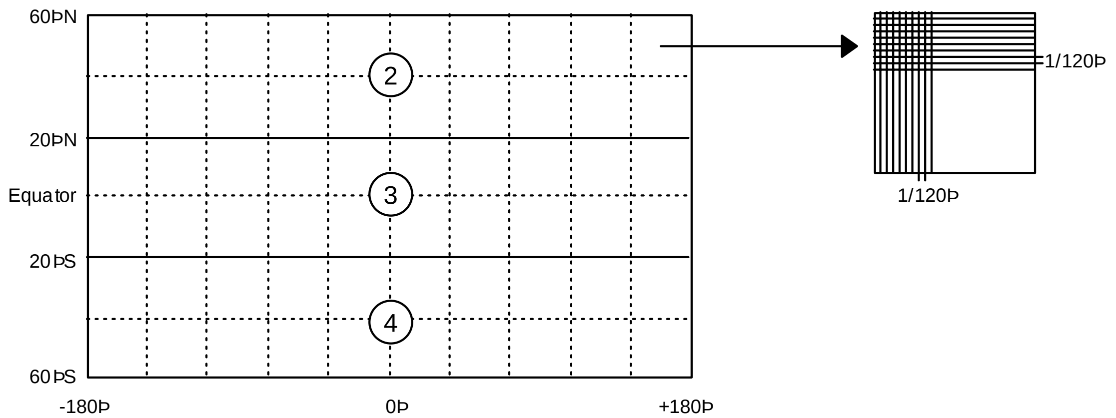
a) Zone

There are 5 zones, which are divided in accordance with the following rules.

- North and South Pole area of 50 or more degrees latitude is respectively specified as 1 zone that is projected on Polar Stereographic.
- Middle area of 60 or less degrees latitude is divided to 3 zones (40˚ latitude interval), which is projected on equi-rectangular map.
- The area number, shown in figure 5.2-2 as the circled number, is fixed.
- The snow ice product is not generated for the zone of the north-south 20 degrees latitude belt that includes the equator.



Polar Stereographic (PS)



Equi Rectangular (EQR)

Figure 5.2-2 Definitions of Zone

b) Global

The global data of GLI 1km level 2 product is generated in a latitude longitude mesh of 0.25˚.

(4) Level 2 Map (GLI 1km)

Level 2 Map product of GLI 1 km is generated in scene unit same as level 1B map. The map projection method is selected from Equi-rectangular (EQR), Mercator (MER) or Polar Stereographic (PS). As the earth model, WGS 84 is adopted.

Referential latitude for scene extracting is selected from the following 2 types. Here, the definition of referential latitude is the latitude of the point of contact at which the earth (sphere) is projected onto the map (plane).

- Scene Center : Latitude of scene center by which users specify for map extracting.
- Specified Latitude : Latitude specially specified by users. User can specify latitude every 5˚.

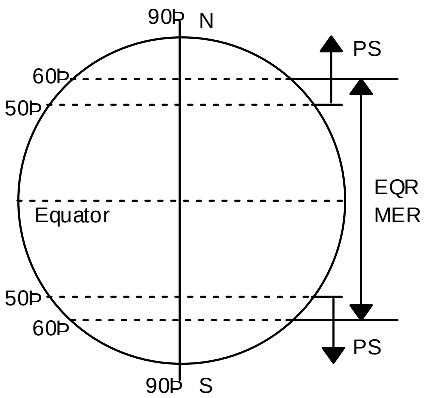


Table 5.2-1 Map Projection Method

Latitude (N and S)	Projection Method		
	EQR	MER	PS
0˚ - 50˚	O	O	X
50˚ - 60˚	O	O	O
60˚ - 90˚	X	X	O

Figure 5.2-3 Map Projection Method

(5) Level 3 binned (GLI 1km)

Level 3 binned product is generated in accordance with the following definitions. (No product is generated for land area)

- Atmosphere : Map projection method is equi-rectangular as same as level 2 global product (0.25˚ latitude /longitude mesh). The numbering rule of binned grid is shown in figure 5.2-4. Here the binned grid number is fixed.
- Ocean : Map projection method is equal area of 9km x 9km same as ADEOS OCTS level 3 binned product. The numbering rule of binned grid is

shown in figure 5.2-5. Here the binned grid number is fixed and ordered from North Pole to South Pole.

- Cryosphere : As for Equi-rectangular (EQR) map projection method, the coverage area of product is 0 - 90 of both south and north latitude. Spatial resolution of grid is 360˚/5’ = 4320 points for latitude direction and 180˚/5’ = 2160 points for longitude direction. The numbering rule of binned grid is shown in figure 5.2-6. Here the binned grid number is fixed.

  As for Polar Stereographic (PS) map projection method, there are two types of product, one is for north hemisphere and the other is for south hemisphere. The spatial resolution of grid is 10 km at the projection center. The numbering rule of binned grid is shown in figure 5.2-7. Here the binned grid number is fixed.

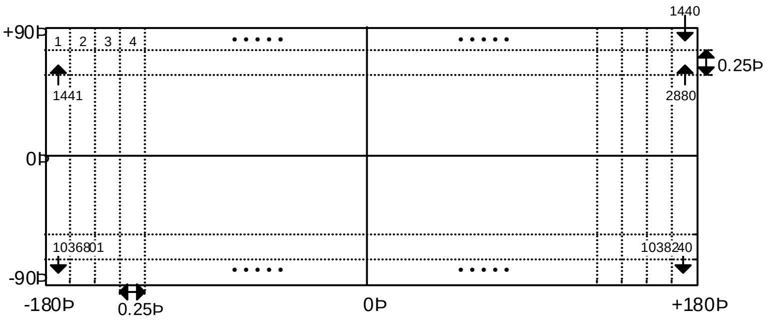
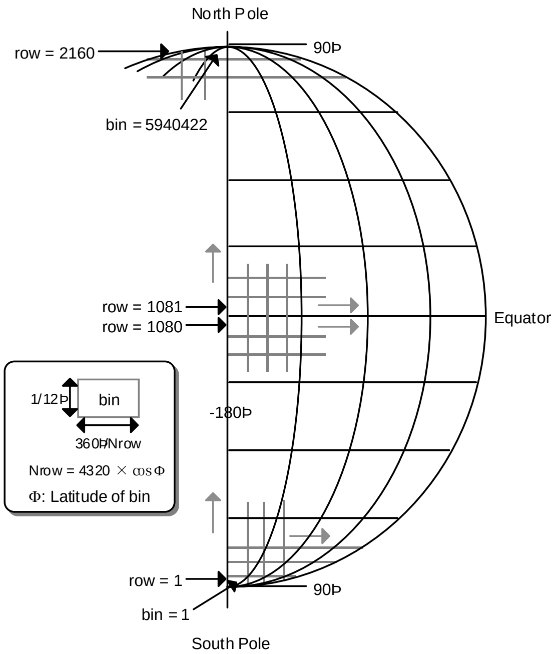


Figure 5.2-4 Binned Grid Definition of Level 3 Binned Product (Atmosphere)



In the above figure, if latitude of a row center is Φ, the number of binned grids including the row is calculated from the following equation.
Number of binned grids (Nrow) = [4320 x cosΦ] (where, [ ] means half adjust)
Ex. (Number of binned grids included in a row): raw 1→ 3 grids, row 2→ 9 grids • • row 1080→ 4320 grids • • row 2160 → 3 grids

Figure 5.2-5 Binned Grid Definition of Level 3 Binned Product (Ocean)

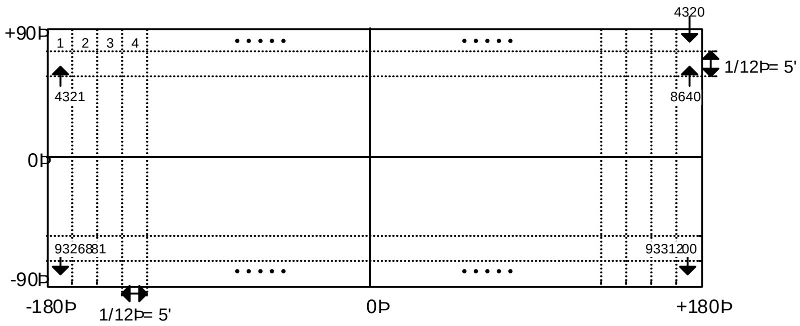


Figure 5.2-6 Binned Grid Definition of Level 3 Binned Product (Cryosphere: EQR)

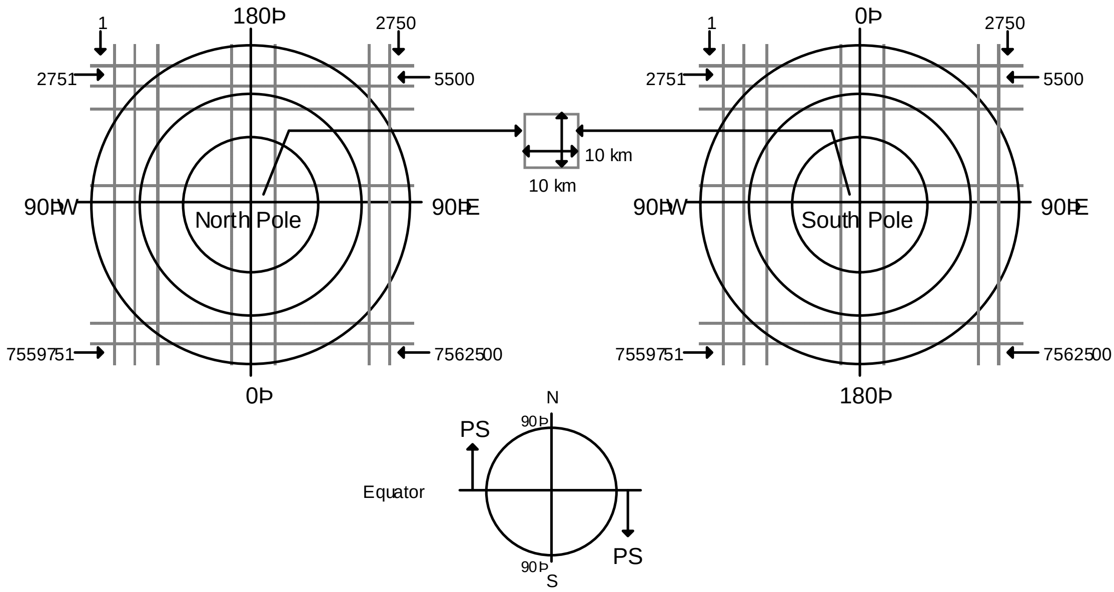


Figure 5.2-7 Binned Grid Definition of Level 3 Binned Product (Cryosphere: PS)

(6) Level 3 STA Map

Level 3 STA Map product is generated in accordance with the following definitions.

- Atmosphere: Equi-rectangular (0.25˚ mesh: 25 km x 25 km)
- Ocean: Equi-rectangular (360/4096˚ mesh: 9 km x 9 km)
- Land: Equi-rectangular (1/12˚ = 5’ mesh)
- Cryosphere: Equi-rectangular (0 - 90˚ north, south latitude) and Polar Stereographic (South hemisphere, North hemisphere)

5.2.2 Standard Product Definitions

5.2.2.1 Level 1 Products

(1) GLI 1km

a) Level 1A Product

- Level 0 missing packets are filled with dummy data
- Bit string (13 bits) of level 0 is transformed into byte unit (16 bits)
- To be cut into separate scenes (approx. 1600km x 1600km)
- Image data are grouped in bands. All pixel data of a band are arranged in lines forming a contiguous image scene.
- Radiometric and Geometric correction coefficients are attached
- 250m-sampled data (used as 2km-resolution) are included
- Missing data flag and piecewise linear flag are attached.
- 3 kinds of products are processed according to channel number: VNIR (ch.1 – 19), SWIR (ch. 24 – 29), MTIR (ch. 30 – 36). Channel 28, 29 data in SWIR band is resampled image data to 2km resolution.
- VNIR and SWIR data is normally acquired during daytime, and MTIR data is always acquired.

b) Level 1B Product

Level 1A with

- Radiometric corrections applied
- Geometric corrections applied
- Band registrations done
- Projection coefficients attached
- Ocean/Land flags attached
- Missing data/saturation /supersaturation flag, transient response flag and piecewise liner flag are attached.
- 3 kinds of products are processed according to channel number: VNIR (ch.1 – 19), SWIR (ch. 24 – 29), MTIR (ch. 30 – 36). Channel 28, 29 data in SWIR band is resampling image data to 2km resolution.

Additionally, satellite position product, which contains information used for computation of satellite positions for each band, is produced as level 1B product (applied to scenes where registrations were made).

c) Level 1B Map Product

- Level 1B (excepting satellite position data) projected to Equi-rectangular (EQR), Polar Stereographic (PS) or Mercator (MER).
- Missing data/saturation /supersaturation flag and transient response flag are attached.

(2) GLI 250m

a) Level 1A Product

- Level 0 missing frames are filled with dummy data
- Bit string (13 bits) of level 0 is transformed into byte unit (16 bits)
- To be cut into separate scenes (approx. 1600km x 1600km)
- Image data are grouped in bands. All pixel data of a band are arranged in lines forming a contiguous image scene.
- Radiometric and Geometric correction coefficients are attached
- Missing data flag and piecewise linear flag are attached.
- GLI 250m data is acquired in accordance with the observation request. GLI 250m data can be acquired within 60 scenes/day as maximum due to the limitation of satellite resources.

b) Level 1B Product

Level 1A with

- Radiometric corrections applied
- Geometric corrections applied
- Band registrations done
- Projection coefficients attached
- Ocean/Land flags attached
- Missing data/saturation /supersaturation flag, transient response flag and piecewise liner flag are attached.

c) Level 1B Map Product

- Level 1B projected to Equi-rectangular (EQR), Polar Stereographic (PS) or Mercator (MER).
- Missing data/saturation /supersaturation flag and transient response flag are attached.

Table 5.2-2 GLI Level 1 Product

Product		Data Unit	Frequency	Data Volume*1
GLI 1km	Level 1A(VNIR)	Scene	Approx. 185/Day*2	92.0MB
	Level 1A (SWIR)	Scene	Approx. 185/Day*2	24.9MB
	Level 1A (MTIR)	Scene	Approx. 370/Day*3	35.8MB
	Level 1B (VNIR)	Scene	Approx. 185/Day*2	85.8MB
	Level 1B (SWIR)	Scene	Approx. 185/Day*2	26.8MB
	Level 1B (MTIR)	Scene	Approx. 370/Day*3	36.9MB
	Level 1B (Satellite Position)	Scene	Approx. 185/Day*2	2.7MB
	Level 1B Map (VNIR)	Scene (EQR、MER、PS)	Order*4	159.2MB
	Level 1B Map (SWIR)	Scene (EQR、MER、PS)	Order*4	35.8MB
	Level 1B Map (MTIR)	Scene (EQR、MER、PS)	Order*4	60.5MB
GLI 250 m	Level 1A	Scene	According to Observation Request	413.0MB
	Level 1B	Scene	According to Observation Request	400.2MB
	Level 1B Map	Scene (EQR、MER、PS)	Order*4	346.9MB

* 1：Estimated data volume per data unit
* 2：13 scene/orbit x 14.25orbit/day = 185.25 scene/day (Daytime)
* 3：26 scene/orbit x 14.25orbit/day = 3705 scene/day (Day and Nighttime)
* 4：In the condition of map projection: EQR/reference latitude = 35 degree (N). Data volume is changed due to map projection condition.

5.2.2.2 Higher Level Products

(1) Level 2A Product

- Level 2A product is defined as common product for each science group and whole observation data of GLI 1km is processed to level 2A.
- There are two kinds of level 2A product shown below.
  - ✓ Atmosphere, Ocean: Simply sampled level 1B product by every 4 pixels and 4 lines, and interconnected several scenes to 1 pass.
  - ✓ Land, Cryosphere: Global cloud free composite data of every 16 days.

Table 5.2-3 GLI Level 2A Product

Product	Code	Data Unit	Frequency	Data Volume*1	Data Array /Map Projection
Atmosphere, Ocean	L2A_ OA	Path	Every Path	219MB	4pixel/4line Sampled
Land, Cryosphere	L2A_ LC	Area	1/16 days	1498MB	PS
Land, Cryosphere	L2A_ LC	Area	1/16 days	775MB	EQR

* 1: Estimated data volume per data unit

(2) Level 2 Product

- Level 2 product consists of geophysical parameters that are calculated from level 1B product.
- Two types of level 2 product are generated as shown below.
  - ✓ Projected to EQR or PS
  - ✓ The same data array type as level 1B or level 2A.

Table 5.2-4 GLI Level 2 Product

Product	Code	Data Unit	Frequency	Data Volume[*1]	Map Projection	Data Array
Atmosphere						
Aerosol angstrom exponent	ARAE	Global	1/4 days	2.0MB	EQR	
Aerosol optical thickness	AROP	Global	1/4 days	2.0MB	EQR	
Cloud flag	CLFLG_ p[*2]	Scene	Every path	9.8MB		Same as L1B
Cloud fraction	CLFR	Global	1/4 days	38MB	EQR	
Cloud optical thickness	CLOP_ p[*2]	Scene	order	7.9MB		Same as L1B
Precipitable water[*7]	PRCPW_ p	Scene	order	11.8 MB		Same as L1B
Cloud effective particle radius	CLER_ w_ r[*3]	Global	1/4 days	3.0MB	EQR	
	CLER_ i_ e[*3]	Global	1/4 days	2.0MB	EQR	
Cloud optical thickness	CLOP_ w_ r[*3]	Global	1/4 days	3.0MB	EQR	
	CLOP_ i_ r[*3]	Global	1/4 days	3.0MB	EQR	
	CLOP_ i_ e[*3]	Global	1/4 days	2.0MB	EQR	
Cloud top temperature	CLTT_ w_ r[*3]	Global	1/4 days	3.0MB	EQR	
	CLTT_ i_ e[*3]	Global	1/4 days	2.0MB	EQR	
Cloud top height	CLHT_ w_ r[*3]	Global	1/4 days	3.0MB	EQR	
Cloud liquid water	CLWP_ w_ r[*3]	Global	1/4 days	3.0MB	EQR	
Ocean						
Normalized water leaving radiance	NL_ FR[*4]	Scene	Order	90.2MB		Same as L1B
	NL_ LR[*5]	Path	Every path	73.3MB		Same as L2A_ OA
Ocean color	CS_ FR[*4]	Scene	Order	19.3MB		Same as L1B
	CS_ LR[*5]	Path	Every path	15.7MB		Same as L2A_ OA
Bulk sea surface temperature	ST_ FR[*4]	Scene	Order	8.6MB		Same as L1B
	ST_ LR[*5]	Path	Every path	14MB		Same as L2A_ OA
Land						
Vegetation index	VGI	Zone	1/16 days	435MB	EQR	
	VGI	Zone	1/16 days	210MB	PS	
Precise geometric correction parameter	PGCP	Path	Every path	0.1MB		
Atmospheric correction data for land and cryosphere	ACLC	Area	1/16 days	489MB	EQR	
	ACLC	Area	1/16 days	946MB	PS	
Cryosphere						
Snow impurities, grain size and surface temperature	SNGI	Zone	1/16 days	1958MB	EQR	
	SNGI	Zone	1/16 days	946MB	PS	
	SNGI_ p	Scene	Order	19.3MB		Same as L1B

* 1: Estimated data volume per data unit
* 2: Parameter of pixel unit
* 3: _ w_r→ water cloud reflectance, _ i_ r→ ice cloud reflectance, _ i_ e→ ice cloud emission
* 4: Full resolution product (resolution 1 km)
* 5: Low resolution product (resolution 4 km)
* 6: This parameter is a parameter that combines with L1B,and obtains precise geometry correction image (PGCI:Work File).
* 7: Addition to standard product from processing algorithm ver. 2

(3) Level 2 Map Product

- Level 2 map product is map projected level 2 data. However, vegetation index (VGI) level 2 product is already projected to MER, so it is not processed to level 2 map product.
- Level 2 product is produced as full resolution product (resolution 1 km).
- Sampling method is chosen from Bi-liner (BL), Nearest Neighbor (NN) or Cubic Convolution (CC).
- See 5.2.1 (4) as for map projection method.

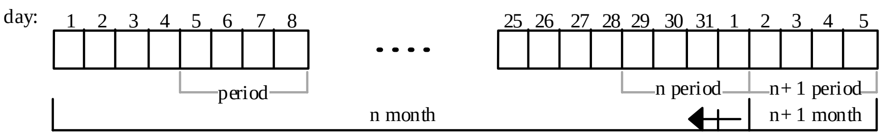
Table 5.2-5 GLI Level 2 Map Product

Product	Code	Data Unit	Frequency	Data Volume[*1]	Map Projection
Atmosphere					
Cloud flag	CLFLG_ p[*2]	Scene	Order	10.4MB	EQR, MER, PS
Cloud optical thickness	CLOP_ p	Scene	Order	5.2MB	EQR, MER, PS
Precipitable Water[*3]	PRCPW_ p	Scene	Order	694.2MB	EQR, MER, PS
Ocean					
Normalized water leaving radiance	NW	Scene	Order	121.8MB	EQR, MER, PS
Aerosol radiance	LA	Scene	Order	56.2MB	EQR, MER, PS
Chlorophyll a	CHLA	Scene	Order	9.4MB	EQR, MER, PS
Suspended solid weight	SS	Scene	Order	9.4MB	EQR, MER, PS
Absorption of colored dissolved organic matter	CDOM	Scene	Order	9.4MB	EQR, MER, PS
Attenuation coefficient at 490 nm	K490	Scene	Order	9.4MB	EQR, MER, PS
Bulk sea surface temperature	ST	Scene	Order	9.4MB	EQR, MER, PS
4-byte quality flag for ocean color	QF_ OC[*2]	Scene	Order	18.7MB	EQR, MER, PS
Quality flag for the product, ST	QF_ ST[*2]	Scene	Order	9.4MB	EQR, MER, PS
Cryosphere					
Snow impurities, grain size and surface temperature	SNGI_ p	Scene	Order	23.4MB	EQR, MER, PS

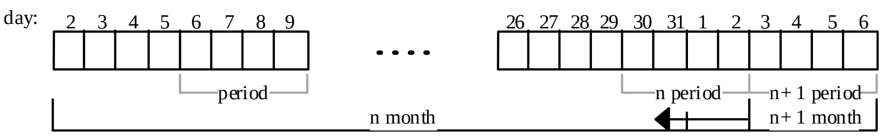
* 1: Estimated data volume per data unit
* 2: As for CLFLG_ p, QF_ OC and QF_ ST, nearest neighbor (NN) can be chosen as data sampling method. Additionally, land surface classification flag is one parameter in the SNGI_ p, processed by using NN method only.
* 3: Addition to standard product from processing algorithm ver. 2.

(4) Level 3 binned Product

- Level 3 binned product is temporarily and spatially sampled level 2 data. (level 3 binned product is not produced for land.)
- Level 3 binned product includes necessary information to each area product, such as sum, square sum, number of samples and so on.
- Definition of grid for each area data, except for land area, is shown in 5.2.1 (5).
- Definition of monthly processing is shown in below figure.
  - ✓ Atmosphere: There are two kinds of monthly binned data, which is generated from every day data and every 4 days data. 4 days period is not counted doubly at the two months, and period over two month is taken as the target of binned data processing for the month, which includes many days in the period.



ex.1: In case that the period n includes 3 days in month n and 1 day in month n+ 1, the period is taken as the target of binned processing for the month n.



ex.2: In case that the period n includes 2 days in month n and 2 day in month n+ 1, the period is taken as the target of binned processing for the month n.

Figure 5.2-8 Monthly Processing of Atmosphere Products

- ✓ Ocean : In accordance with calendar
- ✓ Cryosphere : In accordance with calendar

Table 5.2-6 GLI Level 3 Product

Product	Code	Data Unit	Frequency	Data Volume*1	Binned Grid
Atmosphere					
Aerosol angstrom exponent	ARAE	Global	16 days	23.8MB	EQR
			month	23.8MB	ditto
Aerosol optical thickness	AROP	Global	16 days	23.8MB	EQR
			month	23.8MB	ditto
Cloud fraction	CLFR	Global	16 days	417MB	EQR
			month	417MB	ditto
Cloud effective particle radius	CLER_ w_ r*2	Global	16 days	23.8MB	EQR
			month	23.8MB	ditto
	CLER_ i_ e*2	Global	16 days	23.8MB	EQR
			month	23.8MB	ditto
Cloud optical thickness	CLOP_ w_ r*2	Global	16 days	23.8MB	EQR
			month	23.8MB	ditto
	CLOP_ i_ r*2	Global	16 days	23.8MB	EQR
			month	23.8MB	ditto
	CLOP_ i_ e*2	Global	16 days	23.8MB	EQR
			month	23.8MB	ditto
Cloud top temperature	CLTT_ w_ r*2	Global	16 days	23.8MB	EQR
			month	23.8MB	ditto
	CLTT_ i_ e*2	Global	16 days	23.8MB	EQR
			month	23.8MB	ditto
Cloud liquid water	CLWP_ w_ r*2	Global	16 days	23.8MB	EQR
			month	23.8MB	ditto
Cloud top height	CLHT_ w_ r*2	Global	16 days	23.8MB	EQR
			month	23.8MB	ditto
Ocean					
Normalized water leaving radiance	NW*3	Global	day	477.3MB	Equal Area
			8 days	561.5MB	ditto
			month	561.5MB	ditto
Aerosol radiance	LA*3	Global	day	250.8MB	Equal Area
			8 days	295MB	ditto
			month	295MB	ditto
Ocean color	CS*3	Global	day	194.2MB	Equal Area
			8 days	228.4MB	ditto
			month	228.4MB	ditto
Bulk sea surface temperature	ST*3	Global	day	194.2MB	Equal Area
			8 days	228.4MB	ditto
			month	228.4MB	ditto
Cryosphere					
Snow grain size (865nm)	SNWG	Global	16 days	76.9MB	EQR
			month	76.9MB	ditto
		North Hemisphere	16 days	62.3MB	PS
			month	62.3MB	ditto
		South Hemisphere	16 days	62.3MB	PS
			month	62.3MB	ditto
Snow impurities	SNGI	Global	16 days	76.9MB	EQR
			month	76.9MB	ditto
		North Hemisphere	16 days	62.3MB	PS
			month	62.3MB	ditto
		South Hemisphere	16 days	62.3MB	PS
			month	62.3MB	ditto
Snow grain size (1.64 μm)*4	SNWGS	Global	16 days	35.6MB	EQR
			month	52.9MB	ditto
		North Hemisphere	16 days	11.6MB	PS
			month	16.3MB	ditto
		South Hemisphere	16 days	2.8MB	PS
			month	6.3MB	ditto
Snow Surface Temperature*4	SNWTS	Global	16 days	35.6MB	EQR
			month	52.9MB	ditto
		North Hemisphere	16 days	11.6MB	PS
			month	16.3MB	ditto
		South Hemisphere	16 days	2.8MB	PS
			month	6.3MB	ditto

* 1: Estimated data volume per data unit
* 2: _ w_ r: water cloud reflectance, _ i_ r: ice cloud reflectance, _ i_ e: ice cloud emission
* 3: Produced from low resolution (_ LR) Level 2 ocean product (See table 5.2-3).
* 4: Addition to standard productfrom processing algorithm ver. 2.

(5) Level 3 STA Map

- Level 3 STA Map products of atmosphere, ocean and cryosphere are the representative values, which are estimated from level 3 binned products and projected onto map. As for the estimation method, arithmetic mean, geometric mean and maximum likelihood mean are applied and the most suitable method is chosen for estimation.
- Level 3 STA Map product of land is the representative values, which are estimated from level 3 binned product and projected onto map. As for the estimation method is applied

Table 5.2-7 GLI Level 3 STA Map Product

Product	Code	Data Unit	Frequency	Data Volume[*1]	Map Projection
Atmosphere					
Aerosol angstrom exponent	ARAE	Global	16 days	2.0MB	EQR
			month	2.0MB	ditto
Aerosol optical thickness	AROP	Global	16 days	2.0MB	EQR
			month	2.0MB	ditto
Cloud fraction	CLFR	Global	16 days	37.6MB	EQR
			month	37.6MB	ditto
Cloud effective particle radius	CLER_ w_r[*2]	Global	16 days	2.0MB	EQR
			month	2.0MB	ditto
	CLER_ i_e[*2]	Global	16 days	2.0MB	EQR
			month	2.0MB	ditto
Cloud optical thickness	CLOP_ w_r[*2]	Global	16 days	2.0MB	EQR
			month	2.0MB	ditto
	CLOP_ i_r[*2]	Global	16 days	2.0MB	EQR
			month	2.0MB	ditto
	CLOP_ i_e[*2]	Global	16 days	2.0MB	EQR
			month	2.0MB	ditto
Cloud top temperature	CLTT_ w_r[*2]	Global	16 days	2.0MB	EQR
			month	2.0MB	ditto
	CLTT_ i_e[*2]	Global	16 days	2.0MB	EQR
			month	2.0MB	ditto
Cloud liquid water	CLWP_ w_r[*2]	Global	16 days	2.0MB	EQR
			month	2.0MB	ditto
Cloud top height	CLHT_ w_r[*2]	Global	16 days	2.0MB	EQR
			month	2.0MB	ditto
Ocean					
Normalized water leaving radiance	NW	Global	Day	110.5MB	EQR
			8 days	110.5MB	ditto
			month	110.5MB	ditto
Aerosol radiance	LA	Global	Day	51MB	EQR
			8 days	51MB	ditto
			month	51MB	ditto
Chlorophyll a	CHLA	Global	Day	8.5MB	EQR
			8 days	8.5MB	ditto
			month	8.5MB	ditto
Suspended solid weight	SS	Global	Day	8.5MB	EQR
			8 days	8.5MB	ditto
			month	8.5MB	ditto
Absorption of colored dissolved organic matter	CDOM	Global	Day	8.5MB	EQR
			8 days	8.5MB	ditto
			month	8.5MB	ditto
Attenuation coefficient at 490 nm	K490	Global	Day	8.5MB	EQR
			8 days	8.5MB	ditto
			month	8.5MB	ditto
Sea surface temperature (Day/Night)	ST_ DayNight[*3]	Global	Day	17MB	EQR
			8 days	17MB	ditto
			month	17MB	ditto
Sea surface temperature (all)	ST_ all[*4]	Global	Day	8.5MB	EQR
			8 days	8.5MB	ditto
			month	8.5MB	ditto
Land					
Vegetation index	VGI	Global	16 days	9.8MB	EQR

Table 5.2-7 GLI Level 3 STA Map Product (cont'd)

Product	Code	Data Unit	Frequency	Data Volume*1	Map Projection
Cryosphere					
Snow grain size (865nm)	SNWG	Global	16 days	9.8MB	EQR
		ditto	month	9.8MB	ditto
		North Hemisphere	16 days	7.9MB	PS
		ditto	month	7.9MB	ditto
		South Hemisphere	16 days	7.9MB	PS
		ditto	month	7.9MB	ditto
Snow impurities	SNWI	Global	16 days	9.8MB	EQR
		ditto	month	9.8MB	ditto
		North Hemisphere	16 days	7.9MB	PS
		ditto	month	7.9MB	ditto
		South Hemisphere	16 days	7.9MB	PS
		ditto	month	7.9MB	ditto
Snow grain size (1.64μm)	SNWGS* 5	Global	16 days	8.9MB	EQR
		ditto	month	8.9MB	ditto
		North Hemisphere	16 days	7.2MB	PS
		ditto	month	7.2MB	ditto
		South Hemisphere	16 days	7.2MB	PS
		ditto	month	7.2MB	ditto
Snow surface temperature	SNWTS* 5	Global	16 days	8.9MB	EQR
		ditto	month	8.9MB	ditto
		North Hemisphere	16 days	7.2MB	PS
		ditto	month	7.2MB	ditto
		South Hemisphere	16 days	7.2MB	PS
		ditto	month	7.2MB	ditto

* 1: Estimated data volume per data unit
* 2: _ w_ r: water cloud reflectance, _ i_ r: ice cloud reflectance, _ i_ e: ice cloud emission
* 3: Two kinds of geophysical parameters are included, ST_ Day (daytime) and ST_ Night (nighttime).
* 4: Sea surface temperature data for daytime and nighttime is averaged.
* 5: Addition to standard product from processing algorithm ver. 2.

5.2.3 GLI Level 1 Processing Algorithm

5.2.3.1 Front-end Processing Program

(1) Initial processing

- Allocate all the work space, including tables, used for Front-end processing.
- Open the processing control information file specified by the filename as an execution parameter. The program reads required processing control information and expands it into a processing control information table.
- Read and expands a local parameter file.
- Use the threshold file directory name and the filename of the processing control information table to open the threshold data file. The thresholds that are needed during Front-end processing are read and expanded into a threshold data table.
- Determine the number of scans of the scene.
  - ✓ Calculates the estimated number of scans of the scene to be processed.
  - ✓ Estimated number of scans = (Scene end time- Scene start time)/Scan interval time
- Open a level 1A product that is used for level 1A processing, or HDF, and also sets V group information for HDF.
  - ✓ Open the product file (HDF).
  - ✓ Initialize the V group of the product.
  - ✓ Initialize the image data array (SD) in the array size matched to the number of scans of the scene.
  - ✓ Number of lines for 1 km = Number of scans x 12

(2) Reading Level 0 data

Identify the position of the data associated with the scene start time and reads that data.

(3) Packet information extraction[*1]

- Extract packet information
- Calculate the number of missing packets and the missing packet start position from two sets of information - the packet sequence flag and the packet sequence counter.
- Check for ST bit errors from the two sets of information - the ST data and the missing packet flag.
- Interpolate the bit error ST.

[* 1]: In the descriptions about GLI 250m data processing, "packets" is read as "frame".

(4) Packet editing

Interpolates missing packet data and sets dummy values to generate integrated scan data (level 0 data array).

- Generates a level 0 data array.
- Unpacks the data stored in the L0 data array, scan by scan (from 13 bits to 16 bits) and sorts them in order by channel to generate level 1A data (band, line, sample). The scans intervening between the scene start time and the scene end time, plus a period of 32 seconds, are processed.
- Write data from the level 1A data array to the level1A product file.

(5) Engineering data conversion

- Convert data to engineering values using the appropriate conversion expression, except for scans with completely missing packets.
- Read an engineering data conversion coefficient from the calibration coefficient file to convert the image correction data to engineering values.

(6) Threshold checking

Check the entire scene for bit errors and interpolates error data (bit errors and missing packets).

- Defect check
  - ✓ Total the number of missing packets in the image data and in the PCD/image correction data on the basis of the scan information in the level 0 data array.
  - ✓ Total the number of missing lines based on the scan information in the level0 data array. The number of missing lines is an integer multiple of 12, since it equals the number of lines with the scan flag "completely missing,"
  - ✓ Check to see if the number of defects totaled exceeds the OK/FAIR or FAIR/NG threshold in the threshold data file.
  - ✓ Terminate processing if any number of defects totaled exceeds the NG threshold; processing would be continued, however, if the number of defects totaled is FAIR.

- Limit check
  - ✓ Check to see if all data other than defects falls between the maximum and minimum settings in the threshold data file. If any other data falls out of bounds, a data error is assumed and an error flag is set.
  - ✓ Perform linear interpolation (interpolation and extrapolation) on error and defect data on the basis of preceding and succeeding data, setting an interpolation complete flag for data that is interpolated.

- Trend (continuity and variance) check
  - ✓ Check all other data than defects for its trends. If any other data is found not to

conform to the trends, a data error is assumed and an error flag is set.

- ✓ Perform linear interpolation (interpolation and extrapolation) on error and defect data on the basis of preceding and succeeding data, setting an interpolation complete flag for data that is interpolated.

- ➢ Threshold data check
  - ✓ Total the size of data, by data item, for which an error flag or interpolation complete flag is set.
  - ✓ Check to see if the size of data totaled exceeds the OK/FAIR or FAIR/NG threshold in the threshold data file.
  - ✓ Terminate processing if any size of data totaled exceeds the NG threshold; processing would be continued, however, if the size of data totaled is FAIR.

(7) GPS data editing

- ➢ GPS timing signal time restoration
  - ✓ Extract the ST (UTC) and TT from the PCD data array (scene) that were in effect when the GPS timing signal (TT) was updated, every 8 seconds.
  - ✓ Identify minute information through comparisons with the preceding and succeeding data (minute) and preceding and succeeding TTs.

- ➢ Scan start time calculation
  - ✓ Add the value of the GPS timing signal time calculated to the scan-specific scan start timing signal monitor (0 to 16 seconds) to determine the start time of the scan.
  - ✓ If an uncalculatable scan start time exists, performs extrapolation on the basis of the preceding and succeeding data (scan period addition).
  - ✓ Perform a time-series conversion from GPS time to UTC.

- ➢ GPS navigation time restoration
  - ✓ Extract the ST (UTC), GPS position, and velocity from the PCD data array (scene) that were in effect when the GPS navigation time (NT) was updated, every 8 seconds.
  - ✓ If a scan with all-zero NT/position/velocity data exists, cancels the GPS data calculation process by assuming a GPS error. Then, continues with processing by setting a program exit code to denote a GPS error.
  - ✓ If all-zero TT data exists, it is judged as malfunction of GPS equipment on ADEOS-II. In this case, observation time is estimated from spacecraft time and processing is continued.

(8) Exit processing

- ➢ Write all data to a level 1A product, except for image data.
- ➢ Write a processing result information file.
- ➢ Write a Front-end processing log.

- Close the level 1A product that has been used in Front-end processing.
- Free the work buffers and table space used during Front-end processing .
- Exit the program by setting an exit code.
  Code type: Normal, abnormal, FAIR, GPS error, or no product

(9) Emergency termination

Terminate the program by setting a return code on receiving a termination signal.

5.2.3.2 Level 1A Processing Program

(1) Starting the Level 1A processing program

- The level 1A processing program is started from the level 1 processing control program.
- For 1 km, get the processing control information filename and band name (distinction among VNIR, SWIRM, and MTIR) from arguments.
- For 250 m or near-real-time processing, get the processing control information filename from an argument.
- Carry out band-specific processing according to the band.

(2) Initialization

- Load the contents of the processing control information file into the processing control information table.
  - ✓ Target channels
  - ✓ Process detail division
  - ✓ Output file directory name
  - ✓ Number of orbit data files
  - ✓ Orbit data file directory name
  - ✓ Orbit data file name 1, orbit data file name 2
  - ✓ Calibration coefficient file directory name
- Identify if GPS data is available or not based on the "processing control information file process detail division." If GPS data is not available, orbit data file is used instead of GPS data hereafter.
- Identify the channel to be processed on the basis of the target channel information and appropriate band type.
- Read global attribute information (number of scans) from the level 1A data file.
- Read the following parameters from the local file:
  - ✓ Block size in the L1A sample direction (default = 12)
  - ✓ Equatorial radius
  - ✓ Polar radius

- ✓ Flat rate
- ✓ Moonlight view evaluation threshold in the deep space image
- ✓ Radiometric correction reference detector number (1 km: 1 to 12, 250 m: 1 to 48)

(3) Radiometric correction coefficient calculation

- Read image correction data engineering values (tilt angle, scan mirror surface, scan angle, and blackbody temperature (for MTIR only)) from the level 1A data file.
- Read calibration image data(deep space image, blackbody image/wall-clump image(for MTIR only)) from level 1A data file.
- Read calibration coefficient data from the calibration coefficient file.
- Evaluate the moonlight view in the deep space image. If the mean value of the image data is higher than the moonlight view threshold specified as a local parameter, a moonlight view is assumed and the offset calculation coefficient calculation is bypassed.
- Calculate the radiometric correction coefficient for each target channel.
- Write the calculated radiometric correction coefficient to the level 1A data file.

(4) Orbit data interpolation coefficient calculation

- If GPS is functioning normally, reads GPS orbit data from the level 1A data file and calculates the orbit data in effect at the start of each scan.
- If GPS is malfunctioning, reads orbit data from the orbit data file (a definitive value, or for near-real-time processing, a predicted value) to calculate the orbit data.
- Calculate interpolation coefficients (by scan) from the orbit data thus calculated (for calculating the geocentric latitude and longitude).
- Write the ECR satellite position and ECR satellite velocity in effect at each scan start time to a level 1A data file.
- If GPS is malfunctioning, writes the data from the orbit data file to a level A data file.

(5) Telemetric information reading

- Read telemetric information on each scan (scan start time, attitude angle, tilt angle flag, tilt angle, scan mirror surface, and scan angle) from the level 1A data file.
- Convert the scan start time from UTC to TAI.

(6) Geocentric latitude and longitude and geometric correction coefficient calculation

Because calculating the geocentric latitude and longitude for all pixels on all channels would entail a vast amount of calculation work, the level 1A image is blocked so as to calculate the geocentric latitude and longitude of the pixels at the four corners of each block.

- Iterate the following sequences for each of the channels to be processed defined in the processing control information file:

✓ Iterate the following sequences ((a)~ (e)) for each scan

(a) Generate a matrix for converting each scan to a satellite-fixed coordinate system.

(b) Iterate through the following sequences for each block in the sample direction, and the starting and ending detectors:

(c) Calculate the geocentric latitude and longitude of each pixel. For the calculation instructions, refer to the Processing Algorithm Description.

(d) Write the geocentric latitude and longitude calculated for each scan to the level 1A data file.

(e) Write the coefficient of geometric correction (pseudo-affine transformation) between the pixel address and the geocentric latitude and longitude to the level 1 A data file.
Note: Calculate the following detector numbers for each of the geocentric latitude and longitude combinations of 1 km, 250 m/2 km and 250 m:

- 1 km: First and 12th detectors (VNIR, SWIR, MTIR)
- 250 m/2 km: Eighth and 48th detectors (SWIR)

(7) Other data output

- Calculate and generates the scene attributes (the geocentric latitude and longitude of the four corners and the center of a scene). The geocentric latitude and longitude are calculated using the virtual detector at the center of the light axis. The center of a scene refers to an intermediate scan and sample position.
- Calculate the solar position vector at each scan start time.
- Get the system time and updates the processing time data.
- Write the calculation result to the level 1A data file.

(8) Exit processing

- Write the processing results to the level 1A processing result information file.
- If the program ends abnormally, writes the filename of the file and line number in which the error occurred to a program operation log file, along with a comment.
- Exits the program by setting an exit code according to the result of level A processing.

(9) Emergency termination

- Terminates the program by writing an level A processing emergency termination to the program operation log file on receiving a termination signal (SIGCHLD) from the level 1 processing control program.

5.2.3.3 Level 1B Processing Program

(1) Starting the Level 1B processing program

- The level 1B processing program is started from the level 1 processing control program.
- For 1 km, get the processing control information filename and band name (distinction among VNIR, SWIRM, and MTIR) from arguments.
- For 250 m or near-real-time processing, get the processing control information filename from an argument.
- Carry out band-specific processing according to the band.

(2) Initialization

- Load the contents of the processing control information file (target channels and process detail division) into the processing control information table.
- Identify the channel to process on the basis of the target channel information.
- Read the global attribute information (number of scan line) from level 1A data file.
- Read the level 1B block size (line and sample directions), the radiometric correction flag (ON/OFF), earth long radius, earth short radius, flat rate, and number of transient response samples.

(3) Telemetric information reading

- Read telemetric information on each scan (scan start time, attitude angle, tilt angle flag, tilt angle, scan mirror surface, and scan angle) from the level 1A data file.
- For 1 km VNIR/SWIR band, calculates the satellite position reference time (= scan start time - a. seconds) from the start time of the first scan of the level 1A image (ae: macro definition).

(4) Orbit data extraction

- Read the scan start time of each scan and the orbit data (ECR satellite position and velocity) from the level 1A data.
- Calculate the orbit data interpolation coefficient.

(5) L1B image block grid setting

- Calculate the number of lines in the level 1B image by reducing one scan (1 km: 12 lines, 250 m: 480 lines, 250 m/2 km: 6 lines) at a time from the start and end of the scans in the level 1A image.
- Calculate the number of samples of the level 1B image by reducing 20 sample (1 km: 20 samples, 250 m: 80 samples, 250 m/2 km: 10 samples) at a time from the start and end of the samples of the level 1A image.

- Divide the number of lines and samples (1 km: 1,236, 250 m: 4,944, 250 m/2 km: 618) by the level 1B block size (line and sample directions) and set the block grids of the level 1B image. If the number of lines and samples are not divisible by the block size, defines a block with the remainder.

(6) Radiometric correction coefficient extraction

- Reads the radiometric correction coefficient for the target channels from the level 1A file.

(7) Geocentric latitude and longitude and geometric correction coefficient calculation for Level 1B block grid points

- Iterate the following sequences for each of the level 1B blocks in the line direction:
  - ✓ Calculate the scan start time of each line direction address by interpolation. Telemetry information other than the scan start time (tilt angle flag, tilt angle, attitude angle, scan mirror surface and scan angle) is used as telemetry information on the line direction address as it is.
  - ✓ Generate a matrix for converting each scan to a satellite-fixed coordinate system at each line direction address.
  - ✓ Iterate the following sequences at each address in the sample direction :
    - Calculate the geocentric latitude and longitude of each block grid point.
    - Write the geocentric latitude and longitude of each block grid point, its addresses in the line and sample directions and the coefficient of geometric correction (pseudo-affine transformation) between the address and the geocentric latitude and longitude to the level 1B data file.

(8) L1B image data generation

Generates level 1B image data on the target channels (among the channels defined in the processing control information file that are subject to 1B processing).

- Iterate the following sequences for each of the target channels:
  - ✓ Read the geocentric latitude and longitude (the starting and ending detector latitudes and longitudes per scan) and the positional address of the target channel.
  - ✓ Generate the level 1A' image block grids of the geocentric latitude and longitude and the positional address from the block grids in the level 1A image. A level 1A' image block grid is an image consisting of only the first detector (first line) of each scan to assure the scan-to-scan continuity of the level 1A image.
  - ✓ Calculate the coefficient of geometric correction (pseudo-affine transformation) between the geocentric latitude and longitude of each block grid in the level 1A' image and its positional address.
  - ✓ Calculate a coefficient of conversion from each block point positional address in the level 1A' image to an level 1A image address.
  - ✓ Iterate the following sequences for each level 1B block grid in the line direction:

- Determine the starting and ending scan numbers of the appropriate level 1B block (line interval per block) from its starting and ending line numbers and read the level 1A image data from starting scan number to the ending scan number from the level 1A data file. The level 1A image data is actually read from the starting scan number -1 to the ending scan number + 1 (extra reading).
- Perform radiometric correction on all the pixels in the level 1A image data thus read, but not when the radiometric correction flag in the local file is OFF.
- Iterate the following sequence of actions for each level 1B block grid in the sample direction:
- Iterate the following sequence of actions at the four corners of each level 1B block grid:
- Calculate the pixel position of the level 1A' image from the geocentric latitude and longitude of the target level 1B block grid point through pseudo-affine transformation. Iterate through this process until the pixel position calculated meets the requirements of the pseudo-affine coefficient used for positioning in the range of the level 1A' block grid (convergence calculation).
- Calculate the geocentric latitude and longitude of the four corners of the level 1A' pixel through pseudo-affine transformation to argument the accuracy of the pixel position in the level 1A' block calculated. (If the four corners of the level 1A' pixel are not positioned within the level 1A' block, the geocentric latitude and longitude are calculated using a pseudo-affine coefficient for another level 1A' block.) A pseudo-affine coefficient is generated from the geocentric latitude and longitude and positional addresses of the four corners to recalculate the pixel position in level 1A' on the basis of the geocentric latitude and longitude of the L1B block grid point of interest.
- Verifie that the pixel position in level 1A' as recalculated is included in the range of the positional addresses of the four corners; if not, assume the absence of a pixel.
- Calculate a pseudo-affine coefficient between the positional addresses of the four corners of the level 1B block grid and the positional address in L1A' calculated.
- Calculate the positional address, in level 1A', of all pixels in the level 1B block through pseudo-affine transformation.
- Calculate the positional addresses in level 1A of all the pixels in the L1B block on the basis of their calculated positional addresses in level 1A'.
- Extract the appropriate level 1A image data from the calculated positional addresses in level 1A of all the pixels in the level 1B block by using the nearest neighbor method to generate a level 1B image (resampling).
- For the 1 km VNIR/SWIR band, calculate the level 1A image data observation time from the scan start time to generate satellite position information data (difference from the satellite position reference time in units of 10 ms).
- After iterating the above-mentioned sequences for each level 1B block grid in the sample direction, write level 1B image data generated for each line direction of the level 1B block to a level 1B data file and also write satellite position information data to a satellite position information file.

(9) Scan geometry calculation

- Generates a scan geometry (solar and satellite zenith and azimuth angles) from the observed time and orbit data and writes it to the L1B data file.

(10) L1B data output (other than L1B image data)

- Read global attribute information from the level 1A data file and writes it to the level 1B data file. The product filename, title, processing time, number of pixels per line, and the number of scan lines in the scene are updated.
- Calculate and writes the scene attributes (the geocentric latitude and longitude of the center and the four corners of the scene). The geocentric latitude and longitude are calculated by using the virtual detector at the center of the light axis. The center of a scene refers to an intermediate scan and sample position.
- Read scan line attribute information from the level 1A data file and write it to the level 1B data file. Write level 1B block information (block size, grid point geocentric latitude and longitude, and in-block pseudo-affine coefficient) in place of the level 1A block information.
- Read ADEOS-II raw data (other than level 1A image data) from the level 1A data and writes it to the level 1B data file.
- Read the PCD/image correction, navigation, tilt, radiometric correction coefficient, time correction, and orbit data and write it to the level 1B data file.
- During the above procedure, delete a part of the level 1A data scans and samples to meet the level 1B image size.

(11) Satellite position information output (other than satellite position data)

- For the 1 km VNIR/SWIR band, read global attribute information (mission and documentation, data time, data quality and reference time) from the level 1B data file and write it to the satellite position information file.
- Write difference of detector number, scan number and sample number between level 1B and level 1A.

(12) Exit processing

- Write the processing results to the level 1B processing result information file.
- For the stationary 1 km VNIR/SWIR band, write the processing results to the satellite position information processing result information file.
- If the program ends abnormally, writes the filename of the file and line number in which the error occurred to a program operation log file, along with a comment.
- Exits the program by setting an exit code according to the result of level 1B processing.

(13) Emergency termination

- Terminate the program by writing a level 1B processing emergency termination to the program operation log file on receiving a termination signal (SIGCHLD) from the level 1 processing control program.

5.2.3.4 Land-Water Flag Generation Processing Program

(1) Initialization

- The Land-Water Flag Generation processing program is started from the processing control program. When it starts, it is assigned a processing control information filename as an argument.
- Write a program start log using a program operation log output function.
- Read WORKORDER_ CONTROL_ NUMBER, PROCESS_ DETAIL_ DIVISION, SENSOR_ NAME (sensor resolution (1 km/250 m), and OUTPUT_ FILE_ DIRECTORY from the processing information control file using a function to read “key = value” .
- Get the level 1B data filename using a filename get function.
- Get the land-water bitmapped data filename and land-water bitmapped data index filename from environmental variables.
- Verify the availability of the file specified by the level 1B data filename (for 1 km planned processing, one file is available for each band). Land-water flag data is written to the file available at this point.If a file is not available at all, calls an exit routine to terminate.
- Read the number of lines, number of samples and latitude and longitude information about each pixel from the first level 1B data file to be found.

(2) Land-water flag generation

- Read the land-water bitmapped data file and the land-water bitmapped data index file.
- Carry out the following operation on the basis of the latitude and longitude information about each pixelin the L1B data file:
- Calculate the bin number.
- Extract the index value associated with the bin number calculated
  - ✓ If the index is 0, assume a water zone and then flags the index value.
  - ✓ If the index is 1, assume a land zone and then flags the index value.
  - ✓ If the index is 2, the program accesses the bitmapped data for the bin and reads the flag from the bitmapped file, thereby establishing a flag value for the point in question.

(3) Land-water flag output

- Target files are only the level 1B files which have already been identified at initialization.
- Add the land-water flag data (number of lines x number of samples) to the level 1B data file.

(4) Exit processing

- Write a program end log using a program operation log output function.
- Exit the program by setting an exit code (normal or abnormal) according to the result of processing.

(5) Emergency termination

- Terminate the program by setting a return code (forced termination) on receiving a termination signal (SIGINT) from the processing control program.

5.2.4 Higher Level Processing Algorithm

5.2.4.1 Level 2A Processing

(1) Atmosphere and Ocean Product (Level-2A_OA)

a) Input Data

For level 2A_ OA product processing, the following information is necessary as input data.

- Level 1B Product
- Cloud flag Dataset (CLFLG_ p)

b) Algorithm Overview

This is a basic product for atmosphere and ocean level 2 products. Level 2A_ OA consists of 4 pixel/4 line sampled all 1km GLI ch. Data, auxiliary data for atmosphere and ocean, cloud flag data and deviation table for removed data. The scene separated level 1B images are connected to tilt segment and eliminated overlapped scan lines. Level 2A_ OA includes one path data.

(2) Land and Cryosphere (Level-2A_LC)

a) Input Data

For level 2A_ LC product processing, the following information is necessary as input data.

- PGCI (Precise Geometric Correction Level 1B Image) (Temporally data)

b) Algorithm Overview

Level 2A_ LC is the composite product of GLI PGCI data every 16 days. Two composite methods are used: MVC and CMVC. MVC means Maximum Vegetation Index Value Compositing and CMVC means constraint MVC.

5.2.4.2 Level 2 Processing

5.2.4.2.1 Algorithm Overview

GLI level 2 processing algorithms are listed in table 5.2-8, as for the algorithms applied for order processing.

Table 5.2-8 GLI Level 2 Processing Algorithm

Category	Algorithm Code	Overview
Atmosphere	ATSK1/2	Algorithm for identifying clear sky and cloudy region.
	pre_ ATSK3_ p	Algorithm for identifying water cloud and ice cloud
	ATSK3_ p	Retrieval algorithm of cloudparameters (pixel by pixel).
	ATSK6_ p* 3	Retrieval algorithm of precipitable water (pixel by pixel)
	ATSK3_ r	Retrieval algorithm of cloud parameters (segment) (by Reflection method).
	ATSK3_ e	Retrieval algorithm of cloud parameters (segment) (by emission method).
	ATSK5	Retrieval algorithm of aerosol parameters.
	post_ ATSK5	Algorithm for combining aerosol characteristics
	ATSK16	Algorithm for cloud type and fraction.
	ATSKD	Data segmentation algorithm for atmosphere.
	Rmin Gen.4	Minimum reflectance generation program (4 atm. Seg. → Rmin-4days)
	Rmin.Gen.	Minimum reflectance generation program (Rmin-4days → Rmin.)
Ocean	OTSK1a_ LR/FR* 1	Atmospheric correction algorithm.
	OTSK2_ LR/FR* 1	Chlorophyll-a algorithm.
	OTSK5_ LR/FR* 1	K490 algorithm.
	OTSK6_ LR/FR* 1	Suspended solid algorithm.
	OTSK7_ LR/FR* 1	Colored dissolved organic matter algorithm.
	OTSL13_ LR/FR* 1	Sea surface temperature (Bulk) algorithm.
Land	LTSKG	Precise geographical position.
	LTSK1	Algorithm for atmospheric correction and reflectance.
	LTSK9	Vegetation index algorithm.
	LTSK10d	Data mosaicking (daily mosaicking)
	LTSK10f	Data mosaicking (final mosaicking)
Cryosphere	CTSK1	Cloud detection algorithm (1a: cloud/snow discriminator, 1b: snow/ice discriminator)
	CTSK2b1_ g/s* 2	Algorithm for snow grain size and impurities
	CRSK2d_ g/s* 2 * 3	Retrieval algorithm of snow surface temperature

* 1: LR→ Algorithm for low resolution product processing (4 km)
FR→ Algorithm for full resolution product processing (1 km)
* 2: g→ Algorithm for global data s → Algorithm for scene data
* 3: Addition to standard product from processing algorithm ver. 2.

(1) Algorithm Overview (Atmosphere)

a) ATSK1/2: Cloud Detection Algorithm

The hierarchical approach used in the ATSK1 of the cloud mask is:

- Determine if the pixel is of a land or water scene.
- Determine the ecosystem type.
- Determine if pixel is in a sun glint region.
- Determine If the pixel is in a day or night regime.

- Retrieve information from snow cover and ice database.
- Apply appropriate single FOV masking tests and set initial unobstructed FOV determination for the given domain. Initial confidence flag is assigned for each test result depending on its relative position to the threshold
  - For daytime testing solar zenith angles are constrained to be less than 85˚.
  - Ocean tests are applied to open ocean and for large lakes.
  - Sun glint occurs when the reflected sun angle lies between 0˚ and 36˚.
  - The land algorithm is applied to non-desert and non-water areas.
  - The desert algorithm is applied to desert ecosystems.
  - The snow algorithm is applied to regions passing the NSDI test.
  - For the single pixel clear-sky determination, 11 single FOV tests are implemented and an obstructed/not obstructed bit set (0 for obstructed, 1 for clear) for each test.

- The single FOV cloud test results are grouped and the minimum of each group determined.
- The group minimums are then multiplied together, and the N^{th} root taken (where N represents the number of groups) producing the initial cloud mask. If any of the individual tests are high confidence cloudy (clear confidence of 0), the product is zero.
- If confidence level is still uncertain (between 0.05 and < 0.95), use spatial uniformity tests on 3x3 pixel regions (Currently not implemented over land).
  - Spatial IR variability test applied with band 3 1 using Δ_{sv} = 0.50 K over water.
  - Adjust quality flag if appropriate by increasing or decreasing confidence levels.
- Output cloud mask.

b) ATSK 3_p/3_r: Retrieval Algorithm of Cloud Parameters

The ATSK3_ p (the pixel by pixel analysis corresponding GLI Lebel-1b area) and ATSK3 _ r (the segment analysis for near-global area) uses LUT (Look up Table)-Iteration Method (LIM) to retrieve the target geophysical parameters from satellite-derived radiance data.

In the ATSK3_ r, a non-absorption channel (band 13), an absorption channel (band 30), and a thermal channel (band 35) are used to derive cloud optical thickness (CLOP), cloud effective particle radius (CLER), and cloud top temperature (CLTT). Adding to these radiance data some ancillary input data, such as the vertical profile of the temperature, pressure, water vapor, ground Albedo are also used to calculate related geophysical parameters; cloud top height (CLHT) and cloud top pressure (CLTP) are retrieved by comparing cloud top temperature and temperature profile from ancillary data; liquid water path (CLWP) is calculated by cloud optical thickness and effective particle radius (Eq.9). Additional flag which identifies cirrus cloud will be output from ATSK3_ r. The cirrus flag is set by the brightness temperature difference (BDT) between band 35 and 36 larger than 1.5 K.

On the contrary, ATSK3_ p uses only a non-absorption channel (band 13) to retrieve cloud optical thickness (CLOP), because 3-channel LIM takes more computing time.

c) ATSK3_e: Retrieval Algorithm of Cloud Parameters

This ATSK3_ e can retrieve thin cirrus cloud microphysical parameters, effective particle radius, optical thickness and cloud top temperature from several MTIR bands data (Band 30, 35 and 36) in GLI nighttime observation.

d) ATSK6_p: Retrieval Algorithm of Precipitable Water

The ATSK6_ p algorithm is newly added from version 2, and can retrieve precipitable water using radiance observed by channels 24, 25 and 26 of GLI.

In near infrared spectral region, there are some strong water vapor absorbing bands around 1135nm and 1380nm spectral region. Around these water vapor absorbing bands, there also exist window spectral regions such as 865nm, 1050nm, 1240nm, 1640nm, and 2210nm. If surface reflection is identical between water vapor absorbing and non-absorbing bands, a radiance ratio between absorbing band and non-absorbing has information of the water vapor absorption mainly in principle.

Calibration curves between radiance ratio versus water vapor amount are determined using GSS simulation based upon a theory for the strong water vapor absorbing bands under a clear sky condition. Even though there is aerosol loading, GSS simulations reveal that the calibration curves almost identical under small or moderate aerosol loading condition over a bright target.

Consequently, this enables us to retrieve the precipitable water over a bright target (e.g., vegetation, snow and ice surfaces) even under a small or moderate aerosol loading condition.

e) ATSK5: Retrieval Algorithm of Aerosol Parameters

The ATSK5 retrieves aerosol optical thickness at 0.500nm and user defined wavelength, and Angstrom exponent from two channel radiant data (band 13 and 19), that is, visible and near-IR, satellite data. Satellite-received radiance is synthesized with four look-up tables (LUTs). For retrievals, ancillary data are needed, which include wind velocity at 10 meter height, ozone and water vapor amount to correct radiance for surface reflectance, ozone and water vapor absorption.

f) ATSK16: Algorithm for Cloud Type and Fraction

The algorithm described in the ATSK16 can classify clouds into several types using data from ATSK3_ r, based on the ISCCP categories. The characteristics of this algorithm have an index of cloud shape and an additional classification of cirrus. The cloud shape can be determined by sum of spatial differences between each pixel in an area of 0.25° x 0.25° in Lat. and Lon., so a high difference means cumulus-type and a low one stratus-type. The split window technique can separate a cirrus cloud from other clouds.

The cloud information by the ATSK16 algorithm can be used for estimation of surface radiation budget as a research product. The logic flow is following:

- Separation of ice cloud by the split window (in ATSK_ 3_ r),
- Classification of cloud pixel by the cloud top pressure (CLTP w_ r) into 3 categories,
- Averaging the cloud top temperature (CLTT_ w_ r) and the cloud optical thickness (CLOP_ w_ r) in the each category,
- Classification of 3 cloud top pressure categories by the cloud optical thickness (CLOP_ w_ r) into 9 categories and counting number of pixel in each category
- Calculating the index of inhomogeneity from all the cloud top temperature

(2) Algorithm Overview (Ocean)

a) OTSK1: Atmospheric Correction Algorithm

This algorithm is originated from the Ocean Color Atmospheric Correction algorithm currently used to process the OCTS data. An extension from the OCTS algorithm is being made to improve the processing accuracies by making use of many additional and new GLI bands. The OCTS algorithm, in turn, was initially developed based on an atmospheric correction method used to handle SeaWiFS data(Gordon and Wang, 1 994), in taking the following effects into consideration:

- Polarized Rayleigh scattering (including the multiple scattering)
- Aerosol scattering
- Scattering among aerosol particles and gas molecules
- Reflection of sky light from sea surface
- Absorption effect by ozone
- Transmittance along the path sun-to-sea surface-to-satellite
- Sun glint

Corrections of the light components due to Rayleigh scattering and aerosol scattering etc. are made by using lookup tables prepared beforehand. In addition to the atmospheric pressure, ozone concentration, wind speed etc., the atmospheric correction requires also other kinds of analysis data made available by Meteorological Agency.

When applying to GLI, the following effects will be newly taken into account:

- Influence of white cap
- Absorbing effect of water vapor
- Absorbing effects of carbon dioxide gas and others

b) OTSK2/5/6/7: Retrieval Algorithm of CHLA, K490, SS and CDOM

The algorithms retrieve concentration of chlorophyll-a, K490, concentration of inorganic suspended solid and CDOM, by using empirical relationships based on in-water NWLR and measurements of the products of interest.

c) OTSK13: Sea surface Temperature (Bulk) Algorithm.

The OTSK13 algorithm contains the following two processes: the cloud detection and the atmospheric correction. The former is the process to find clear, or no cloud-contaminated, pixels in the image. The latter is needed to obtain SST of clear pixels from the brightness temperatures observed by GLI.

As for the cloud detection, the combination of the threshold tests is used to detect clouds. A pixel, which passes through all the tests, is flagged as clear. The tests need to set coefficients and thresholds; they will be adjusted using the real GLI data of ADEOS-II. As for the atmospheric correction, the Multi-Channel SST (MCSST) technique is used. The radiative transfer model and the match-up data set are used to determine the coefficients of the MCSST equation.

(3) Algorithm Overview (Land)

a) LTSKG: Precise Geographical Position

The accuracy of geometric correction is dependent much on the accuracy of the satellite position and attitude. The LTSKG algorithm developed here enables to determine the precise satellite position and attitude using ground control points (GCP).

The rectification of original image is carried out using the results of the exterior orientation. This work has the following objectives:

- To extract GCP automatically,

- To determine precise satellite position and attitude based on photogrammetry.
- To map rectified image.

The methodology is realized by the following six software.

- To convert satellite position, velocity and attitude for one segment to navigation data.
- To determine precise satellite position and attitude utilizing GCPs based on the collinearity condition and get ground coordinates on the regular grids.
- To extract GCP automatically by image matching between image data and coastal line data.
- To get parameters to specify each scene.
- To modify orientation results for one segment to those for each scene.
- To map rectified image data and scan geometry data onto Latitude/Longitude coordinates or Polar Stereo Projection.

b) LTSK1: Algorithm for Atmospheric Correction and Reflectance

The algorithm has the following objective: To atmospherically correct the composited, normalized radiances for "Rayleigh scattering and ozone absorption". Rayleigh scattering and ozone absorption are corrected with the assistance of ancillary data, such as the TOMS data set and ETOPO 5.

c) LTSK9: Vegetation index algorithm

The algorithms have the following objective: To compute two vegetation indices (VI' s) from the atmospherically corrected and composited reflectances;

- The normalized difference vegetation index (NDVI) and
- The enhanced vegetation index (EVI)

The NDVI is a scaled, non-linear transform of the simple ratio (SR = NIR/red), originally developed to enhance the vegetation signals over sparsely vegetated range land. EVI was developed to optimize the vegetation signal from deserts to rain forests while minimizing aerosols and canopy background sources of uncertainty.

d) LTSK10: Data Mosaicking

The algorithm has the following objective:

To mosaic and composite the normalized, at-sensor radiances (apparent reflectance) for the 250m and 1 km GLI bands;

- 20, 21 ,22, 23, 28, 29 (250m band)

- 4, 5, 9, 13, 15, 17, 19, 24, 26 (1km bands)

At-sensor radiances are radiometrically calibrated at the GAIT facility to produce Level-1B data. The cloud detection and screening algorithm (ATSK 1,2 and CTSKla,b) produces cloud flags on a pixel per pixel basis (CLFLG_ p). Precise geographic registration follows with the LTSKG algorithm to produce the Level 1B and CLFLG_ p meshed 1 km resolution. The mosaicking algorithm connects to the data stream at this level.

After precise registration and meshing, the mosaicking/compositing algorithm to produce the 1 day and 16 days composites will ingest Level-1B + cloud mask data. The mosaicking algorithm selects the best value over a composite period, based on cloudiness and atmospheric contamination. The maximum value composite (MVC) technique tentatively serves as the mosaicking algorithm to generate the 16-day reflectance composites.

(4) Algorithm Overview (Cryosphere)

a) CTSK1: Cloud Detection Algorithm

CTSK1 is the algorithm for the cloudy/clear discriminator (CTSK1a) and the snow/sea-ice discriminator (CTSKlb) to be applied in the polar regions and in snow/covered mid-latitude areas.

The calibrated radiance data at level 1B of GLI measurements in channels 8,13, 17, 19, 24, 27, 30, 31, 34, 35 and 36 will be used as input to this algorithm. The algorithm is based on pre-defined thresholds. The snow/sea-ice discriminator works only during daytime. Fortunately, bare sea-ice conditions are expected to occur primarily in summer, and the bright polar summer will offer the opportunity to use the snow/sea-ice discriminator.

The output of the cloudy/clear and snow/sea-ice discriminator algorithm will be an 8-bit word for each field of view. It includes information about whether a view of the surface is obstructed by cloud and the surface type for each pixel. The output of the algorithm is not a simple yes/no judgment for cloudy/clear discrimination. There are four levels of confidence to indicate whether a pixel is judged to be cloudy or clear. In addition, this algorithm also allows for on-screen display of a color image of the output file of a scene remotely-sensed by satellite. This color image will be a plot of the distribution of cloud and various types of surfaces, The output file of this algorithm is also an important and necessary input for cloud and surface property retrieval algorithms as well as other related studies.

b) CTSK2b1: Algorithm for snow grain size and impurities

The algorithm presented here for the retrieval of snow grain size, using GLI channels 5 and 19, is based on the principle that the reflectance of snow is known to be dependent on snow grain size in the near infra-red (NlR) range and pollution in the visible range. This algorithm works only under clear-sky conditions. It can be applied at high latitude (polar) as well as mid-latitude regions.

In this algorithm several lookup tables have been constructed by using atmospheric optical properties obtained from MODTRAN in conjunction with the DISORT radiative transfer code. The bi-directional reflectance of snow is taken into account. In the lookup tables the radiances that would be measured by the satellite instrument are simulated as a function of snow grain size and mass fraction of soot mixed in the snow.

The rationale behind the retrieval procedure of this algorithm is that the snow properties can be determined through a comparison of measured (by ADEOS-II/GLI) and simulated (the lookup table) radiance.

The comparison will be done for GLI channels 5 and 19 in order to retrieve the mass fraction of soot and the snow grain size, respectively. The snow grain size and mass fraction of soot are obtained by requiring the simulated radiances to be consistent with the measured ones in both GLI channel 5 and channel 19.

The retrieval of snow grain size is sensitive to the aerosol type. The tropospheric aerosol and Antarctic background aerosol models have been applied to the Arctic and Antarctic regions, respectively. The standard rural, urban, and Navy maritime aerosol models adopted from MODTRAN are employed for the mid-latitude area.

For CTSK2b1 algorithm version 2, the retrieval algorithm of snow grain size using channel 28 (1.64 μm) was newly added.

c) CTSK2d: Algorithm for snow surface temperature

The ATSK6_ p algorithm is newly added from version 2. This algorithm consists of two parts: (i) one for retrieving the sea surface temperature (SST) for an area consisting of a mixture of snow/ice and meltponds, and (ii) the another one for retrieving the snow/ice surface temperature (IST) for ocean areas covered by snow/ice. This algorithm can also be applied to snow-covered land, if the snow depth is larger than 5 cm. It works only under clear-sky conditions. Even though the method and the technique used in this algorithm are similar to those used in estimating sea and land surface temperatures, this algorithm has been developed specifically for the polar regions and for the use with GLI measurements (channel 35 and 36). Although the thermal emissivity of snow/ice is quite insensitive to surface parameters including density, grain size, thickness, liquid water content, and impurity content, it has an angular and spectral dependency. In this study the MODTRAN radiative transfer model is employed to simulate the radiances measured by the satellite sensor (e.g., GLI) using the directional snow emissivities that are computed with the DISORT radiative transfer model.

5.2.4.2.2 Processing Overview (Atmosphere)

(1) Input Data

Input data for GLI atmosphere product processing is shown in table 5.2-9.

Table 5.2-9 Input Data for GLI Level 2 Atmosphere Product Processing

Product	Code	Input Data*1
Aerosol angstrom exponent	ARAE	- Segment data*2 - Lookup table (Single scattering component, Multi scattering component, Correction of water vapor absorption) - Ancillary data (Column water vapor amount, Column ozone amount and wind velocity)
Aerosol optical thickness	AROP	ditto
Cloud flag	CLFLG_ p	- Level 1B product
Cloud fraction	CLFR	- GLI level 2 cloud products from ATSK3_ r (work file): CLTT_ w_ r, CLOP_ w_ r, CLOP_ i_ r, CLER_ w_ r, CLHT_ w_ r, CLWP_ w_ r, CLTP_ w_ r, Cirrus flag - GLI level 2 cloud products from ATSK3_ e (work file): CLTT_ i_ e, CLER_ i_ e, CLOP_ i_ e - Segment data (Channel 35 radiance data)
Cloud optical thickness (reflectance, water , ice cloud)	CLOP_ p	- Level 1B product
Precipitable Water	PRCPW_ p	- Level 1B product
Cloud effective particle radius	CLER_ w_ r*3	- Segment data*2
Cloud optical thickness	CLOP_ w_ r*3	ditto
Cloud optical thickness	CLOP_ i_ r*3	ditto
Cloud top temperature	CLTT_ w_ r*3	ditto
Cloud top height	CLHT_ w_ r*3	ditto
Cloud liquid water	CLWP_ w_ r*3	ditto
Cloud effective particle radius	CLER_ i_ e*3	- Segment data*2 - Lookup table - Ancillary data (Water vapor profile, pressure profile, temperature profile and surface temperature)
Cloud optical thickness	CLOP_ i_ e*3	ditto
Cloud top temperature	CLTT_ i_ e*3	ditto

* 1: Cloud flag (CFLG_ p) is commonly inputted into processing of all level 2 products.
* 2: Radiance data, satellite zenith angle, solar zenith angle, relative zenith angle, scan time
* 3: _ w_ r → water cloud reflectance, _ i_ r → ice cloud reflectance, _ i_ e → ice cloud emission

(2) Correspondence between Products and Algorithm

Correspondence between level 2 atmosphere products and algorithm is shown in table 5.2-10.

Table 5.2-10 Correspondence between Atmosphere Products and Algorithm

Products		Algorithm										
		ATSK 1/2	pre ATSK3_p	ATSK 3	ATSK 6_p	ATSK 5	post ATSK5	ATSK 16	ATSKD	Rmin. Gen.4	Rmin. Gen.	その他
Aerosol angstrom exponent	ARAE					O	O		O	O	O	
Aerosol optical thickness	AROP					O	O		O	O	O	
Cloud flag	CLFLG_ p	O										CTSK1
Cloud fraction	CLFR			R*2				O	O	O	O	
Cloud optical thickness (reflectance, water , ice cloud)	CLOP_ p		O	P*2								
Precipitable Water	PRCPW_ p				O							
Cloud effective particle radius	CLER_ w_ r*1			R*2				O	O	O	O	
Cloud optical thickness	CLOP_ w_ r*1			R*2				O	O	O	O	
Cloud optical thickness	CLOP_ i_ r*1			R*2				O	O	O	O	
Cloud top temperature	CLTT_ w_ r*1			R*2				O	O	O	O	
Cloud top height	CLHT_ w_ r*1			R*2				O	O	O	O	
Cloud liquid water	CLWP_ w_ r*1			R*2				O	O	O	O	
Cloud effective particle radius	CLER_ i_ e*1			E*2				O	O			
Cloud optical thickness	CLOP_ i_ e*1			E*2				O	O			
Cloud top temperature	CLTT_ i_ e*1			E*2				O	O			

* 1: _ w_ r→ water cloud reflectance, _ i_ r→ ice cloud reflectance, _ i_ e→ ice cloud emission
* 2: P→ ATSK3_ p, R→ ATSK3_ r, E→ ATSK3_ e

5.2.4.2.3 Processing Overview (Ocean)

(1) Input Data

Input data for GLI ocean product processing is shown in table 5.2-11.

Table 5.2-11 Input Data for GLI Level 2 Ocean Product Processing

Products	Code	Input Data*1
Normalized water leaving radiance	NL_ FR	- Level 1B product
	NL_ LR	- Level 2A OA product
Ocean color	CS_ FR	- 1 km resolution Normalized water leaving radiance (NL_ FR)
	CS_ LR	- 4 km resolution Normalized water leaving radiance (NL_ LR)
Bulk sea surface temperature	ST_ FR	- Level 1B product
	ST_ LR	- Level 2A OA product

* 1: Cloud flag (CLFLG_ p) is commonly inputted into processing of all level 2 products.

(2) Correspondence between Products and Algorithm

Correspondence between level 2 ocean products and algorithm is shown in table 5.2-12.

Table 5.2-12 Correspondence between Ocean Products and Algorithm

Products		Algorithm					
		OTSK1a	OTSK2	OTSK5	OTSK6	OTSK7	OTSK13
Normalized water leaving radiance	NL_ FR	F*1					
	NL_ LR	L*1					
Ocean color	CS_ FR		F*1	F*1	F*1	F*1	
	CS_ LR		L*1	L*1	L*1	L*1	
Bulk sea surface temperature	ST_ FR						F*1
	ST_ LR						L*1

* 1: F→ FR algorithm、 L → LR algorithm

5.2.4.2.4 Processing Overview (Land)

(1) Input Data

Input data for GLI land product processing is shown in table 5.2-13.

Table 5.2-13 Input Data for GLI Level 2 Land Product Processing

Products	Code	Input Data*1
Atmospheric correction data for land and cryosphere	ACLC	- L2A_ LC - TOVS ozone data - GTOPO30 DEM data
Vegetation index	VGI	- Atmospheric correction data for land and cryosphere (ACLC)
Precise geometric correction parameter	PGCP	- Level 1B

* 1: Cloud flag (CLFLG_ p) is commonly inputted into processing of all level 2 products.

(2) Correspondence between Products and Algorithm

Correspondence between level 2 land products and algorithm is shown in table 5.2-14.

Table 5.2-14 Correspondence between Land Products and Algorithm

Products		Algorithm				
		LTSKG	LTSK1	LTSK9	LTSK10d	LTSK10f
Atmospheric correction data for land & cryosphere	ACLC		O		O	O
Vegetation index	VGI			O	O	O
Precise geometric correction parameter	PGCP	O				

5.2.4.2.5 Processing Overview (Cryosphere)

(1) Input Data

Input data for GLI cryosphere product processing is shown in table 5.2-15.

Table 5.2-15 Input Data for GLI Level 2 Cryosphere Product Processing

Products	Code	Input Data*1
Cloud flag	CLFLG_ p	- Level 1B product, ancillary data
Snow impurities grain size and surface temperature	SNGI	- Level 2A_ LC
	SNGI_ p	- Level 1B product

* 1: Cloud flag (CLFLG_ p) is commonly inputted into processing of all level 2 products.

(2) Correspondence between Products and Algorithm

Correspondence between level 2 cryosphere products and algorithm is shown in table 5.2-16.

Table 5.2-16 Correspondence between Cryosphere Products and Algorithm

Products		Algorithm			
		CTSK1	CTSK2b1	CTSK2d	その他
Cloud flag	CLFLG_ p	O			ATSK1/2
Snow impurities, grain size and surface temperature	SNGI		G*1	G*1	
	SNGI_ p		S*1	S*1	

* 1: G→ CTSK2b1_ g, CTSK2d_ g S→ CTSK2b1_ s, CTSK2d_ s

5.2.4.3 Level 2 Map

(1) Algorithm Overview

Level 2 data is projected on Equi-rectangular (EQR), Polar Stereographic (PS) or Mercator (MER). For level 2 map product processing, common map projection algorithm is used.

(2) Input Data

Input data for GLI level 2 Map product processing is shown in table 5.2-17.

Table 5.2-17 Input Data for GLI Level 2 Map Product Processing

Products		Code	Input Data
Atmosphere	Cloud flag	CLFLG_ p	- Level 2 cloud flag product (CFLG_ p)
	Cloud optical thickness (reflectance, water , ice cloud)	CLOP_ p	- Level 2 cloud opticalthickness product (CLOP_ p)
	Precipitable water	PRCPW_ p	- Level 2 precipitable water product (PRCPW_ p)
Ocean	Normalized water leaving radiance	NW	- 1km resolution normalized water leaving radiance (NL_ FR)
	Aerosol radiance	LA	ditto
	4-byte quality flag for ocean color	QF_ OC	ditto
	Chlorophyll a	CHLA	- 1km resolution ocean color product (CS_ FR)
	Suspended solid weight	SS	ditto
	Absorption of colored dissolved organic matter	CDOM	ditto
	Attenuation coefficient at 490 nm	K490	ditto
	Bulk sea surface temperature	ST	- 1km resolution sea surface temperature product (ST_ FR)
	Quality flag for the product, ST	QF_ ST	ditto
Cryosphere	Snow impurities, grain size and surface temperature	SNGI_ p	• Level 2 snow impurities, grain size and surface temperature product (SNGI_ p)

5.2.4.4 Level 3 Products (Binned, STA Map)

5.2.4.4.1 Algorithm Overview

GLI level 3 binned product and STA Map product processing algorithms are listed in table 5.2-18.

Table 5.2-18 GLI Level 3 Processing Algorithm

Category	Algorithm Code	Overview
Atmosphere	L3ASBin	Atmosphere spatial binning algorithm
	L3ATBin	Atmosphere temporal binning algorithm
	L3ASMap	Atmosphere Level 3 STA map product generation algorithm
Ocean	L3OSBin	Ocean spatial binning algorithm
	L3OTBin	Ocean temporal binning algorithm
	L3OSMap	Ocean Level 3 STA map product generation algorithm
Land	L3LSMap	Land Level 3 STA map product generation algorithm
Cryosphere	L3CSBin	Cryosphere spatial binning algorithm
	L3CTBin	Cryosphere temporal binning algorithm
	L3CSMap	Cryosphere Level 3 STA map product generation algorithm

5.2.4.4.2 Processing Overview (Atmosphere)

(1) Input Data

a) Level 3 Binned Product

Input data for atmosphere level 3 binned product processing is the corresponding level 2 atmosphere products.

b) Level 3 STA Map Product

Input data for atmosphere level 3 STA map product processing is the corresponding level 3 binned products.

(2) Correspondence between Products and Algorithm

Correspondence between level 3 atmosphere products and algorithm is shown in table 5.2-19.

Table 5.2-19 Correspondence between Level 3 Atmosphere Products and Algorithm

Products		Algorithm		
		L3ASBin	L3ATBin	L3ASMap
Level 3Binned	16 days	O	O	
	Month	O	O	
Level 3STA Map	16 days			O
	Month			O

5.2.4.4.3 Processing Overview (Ocean)

(1) Input Data

Input data for GLI level 3 ocean products processing is shown in table 5.2-20.

Table 5.2-20 Input Data for GLI Level 3 Ocean Product Processing

Products				Input Data
Binned	Normalized water leaving radiance	Day	NW	4km resolution level 2 Normalized water leaving radiance product (NL)
		8 day/month	〃	NW level 3 binned product (day)
	Aerosol radiance	Day	LA	4km resolution level 2 Normalized water leaving radiance product (NL)
		8 day/month	〃	LA level 3 binned product (day)
	Ocean color	Day	CS	4km resolution level 2 ocean color product (CS)
		8 day/month	〃	CS level 3 binned product (day)
	Bulk sea surface temperature	Day	ST	4km resolution level 2 sea surface temperature product (ST)
		8 day/month	〃	ST level 3 binned product (day)
STA MAP	Normalized water leaving radiance	Day	NW	NW level 3 binned product (day)
		8 day/month		NW level 3 binned product (8 day/month)
	Aerosol radiance	Day	LA	LA level 3 binned product (day)
		8 day/month		LA level 3 binned product (8 day/month)
	Chlorophyll a	Day	CHLA	CS level 3 binned product (day)
		8 day/month	〃	CS level 3 binned product (8 day/month)
	Suspended solid weight	Day	SS	CS level 3 binned product (day)
		8 day/month	〃	CS level 3 binned product (8 day/month)
	Absorption of colored dissolved organic matter	Day	CDOM	CS level 3 binned product (day)
		8 day/month	〃	CS level 3 binned product (8 day/month)
	Attenuation coefficient at 490 nm	Day	K490	CS level 3 binned product (day)
		8 day/month		CS level 3 binned product (8 day/month)
	Sea surface temperature (Day/Night)	Day	ST_ DayNight	ST level 3 binned product (day)
		8 day/month		ST level 3 binned product (8 day/month)
	Sea surface temperature (all)	Day	ST_ all	ST level 3 binned product (day)
		8 day/month	〃	ST level 3 binned product (8 day/month)

(2) Correspondence between Products and Algorithm

Correspondence between level 3 ocean products and algorithm is shown in table 5.2-21.

Table 5.2-21 Correspondence between Level 3 Ocean Products and Algorithm

Products		Algorithm		
		L3OSBin	L3OTBin	L3OSMap
Level 3Binned	Day	O	O	
	8 day/month		O	
Level 3STA Map	Day			O
	8 day/month			O

5.2.4.4.4 Processing Overview (Land)

As for land area, level 3 binned product is not processed. Vegetation index product (VGI) is generated as level 3 STA Map product of land area, and level 2 vegetation index product is used for the processing as input data.

5.2.4.4.5 Processing Overview (Cryosphere)

(1) Input Data

Input data for GLI level 3 cryosphere products processing is shown in table 5.2-22.

Table 5.2-22 Input Data for GLI Level 3 Cryosphere Product Processing

Products				Input Data
Binned	Snow grain size (865 nm)	16 days	SNWG	Level 2 snow impurities, grain size and surface temperature product (SNGI)
		Month	ditto	Snow grain size (865 nm) level 3binned product (16 days)
	Snow impurities	16 days	SNWI	Level 2 snow impurities, grain size and surface temperature product (SNGI)
		Month	ditto	Snow impurities level 3binned product (16 days)
	Snow grain size (1.64 μm)	16 days	SNWGS	Level 2 snow impurities, grain size and surface temperature product (SNGI)
		Month	ditto	Snow grain size (1.64 μm) level 3binned product (16 days)
	Snow surface temperature	16 days	SNWTS	Level 2 snow impurities, grain size and surface temperature product (SNGI)
		Month	ditto	Snow surface temperature level 3binned product (16 days)
STA MAP	Snow grain size	16 days	SNWG	Snow grain size (865 nm) level 3binned product (16 days)
		Month	ditto	Snow grain size (865 nm) level 3binned product (Month)
	Snow impurities	16 days	SNWI	Snow impurities level 3binned product (16 days)
		Month	ditto	Snow impurities level 3binned product (Month)
	Snow grain size (1.64 μm)	16 days	SNWGS	Snow grain size (1.64 μm) level 3binned product (16 days)
		Month	ditto	Snow grain size (1.64 μm) level 3binned product (Month)
	Snow surface temperature	16 days	SNWTS	Snow surface temperature level 3binned product (16 days)
		Month	ditto	Snow surface temperature level 3binned product (Month)

(2) Correspondence between Products and Algorithm

Correspondence between level 3 cryosphere products and algorithm is shown in table 5.2-23.

Table 5.2-23 Correspondence between Level 3 Cryosphere Products and Algorithm

Products		Algorithm		
		L3CSBin	L3CTBin	L3CSMap
Level 3Binned	16 days	O	O	
	Month		O	
Level 3STA Map	16 days			O
	Month			O

5.2.5 GLI Product Format

The detailed format of GLI level 1 ~ 3 products is specified in the documents, which are listed in below and attached to this handbook as the appendix 3.

- ADEOS-II GLI Level-1 Product Format Description
- GLI Standard Higher Products File Specification

6 EOIS Data Service

The Earth Observation Data and Information System (EOIS) provides comprehensive on-line information services. In using the EOIS, users are able to implement searches against the earth observation data and view the related information and its browse as well.

6.1 Outline of EOIS Services

EOIS provides data services to users categorized into Principle Investigator (PI), General Researcher and Guest User, as shown in table 6.1-1. The outline of EOIS services are listed in the table 6.1-2.

Table 6.1-1 User Definition

User Category	Definition
Principle Investigator （PI）	Data is offered to PI from JAXA free of charge to achieve a common research purpose in cooperation with JAXA at the research.
General Researcher	General researchers need user registration. They can obtain earth observation satellite data from EOIS free of charge via internet. (Available data is limited)
Guest User	Guest users need neither a special qualification nor application to obtain data at catalogue price.

Table 6.1-2 EOIS Data Services

Services		Users			Reference*1
		PI	General Researcher	Guest User	
Scene Order					
	Scene Search	O	O	O	6.3.1(1)
	Product Order	O		O*2	6.3.1(2)
	Sample Data Download	O	O	O	6.4.3
Data Set Order					
	Data Set Search	O			6.3.2(1)
	Data Set Order	O			6.3.2(2)
Standing Order					
	Product Order	O*2			6.3.3(1)
Image Catalog					
	Display of Image Catalog	O	O	O	6.3.4(1)
	Editing of Image Catalog	O	O	O	6.3.4(1)
Map					
	Observation Area Indicate	O	O	O	6.3.4(2)
Status Search					
	Status Search	O	O		6.3.4(3)
	Product Download	O	O		6.4.2

*1: Corresponding section in this document. *2: By other services than EOIS user service

Users can use EOIS data services, shown in the table 6.1-2, by accessing to “Data search & Data Order” menu in the EOC web site (www.eoc.jaxa.jp/homepage.html).

The outline of EOIS services are explained in the following sections of this document. For more detail, “EOIS User’s Manual” is available for PIs, general researchers and guest users respectively. Users can obtain the “EOIS User’s Manual” from the web site of EOIS data services.

6.2 Data Distribution Method

There are three kinds of method for data distribution to users (scene order, data set order and standing order).

(1) Scene Order

Each scene can be specified by satellite, sensor, observation date and location (latitude/longitude or GRS/WRS). Users order on a scene-by-scene basis. For scheduled products, this service is available to all users including PIs, general researchers and guest users. Moreover, this service is available to PIs for ordered products.

(2) Dataset Order

Users can order a specified multiple-kinds or multiple-days products of a specified sensor as a single dataset. This service is available only to PIs. Because the purpose of this data set order is to deliver large number of the products of planned processing to users at a time, the ordered products cannot be selected by using this method.

(3) Standing Order

Users specify conditions (i.e., sensor, processing level, products, period or latitude/longitude) for JAXA to process data in advance. Data are stored in media and delivered to users at the requested frequency (e.g., 16 days, one month). This service is available only to PIs. When latitude/longitude is specified as one of the conditions, EOC will deliver data, the scene center of which falls in the specified latitude/longitude range.

6.3 Product Search and Order

6.3.1 Scene Order

(1) Scene Search

Scene search is a function to allow users to search catalog information of the Earth observation data that are archived in the EOC. Users can search data that meet search conditions such as satellite, sensor, observation date and location (latitude/longitude or GRS/WRS). This service is available to all users. For AMSR and GLI all scheduled products, listed in Table 6.3-1, are available for scene search.

Table 6.3-1 AMSR and GLI Products (Available to Scene Search)

Level		Physical Parameters	Map Projection*1 EQR	PS	PN	Note
AMSR						
1A、1B			-	-	-	
2		WV, CLW, AP, SSW, SST, IC, SM*4	-	-	-	
3	Day Month	TB (for 14 channels)	O	O	O	A/D*3
3	Day Month	WV, CLW, AP, SSW, SST, SM*4	O	-	-	A/D*3
3	Day Month	IC	-	O	O	A/D*3
3	Day Month	SWE	O	-	O	A/D*3
GLI 1km						
1A		VNIR、SWIR、MTIR Observation Data, Calibration Data	-	-	-	
1B		VNIR、SWIR、MTIR Observation Data, Satellite Position	-	-	-	
2A		Atmosphere, Ocean	-	-	-	
2A		Land, Cryosphere	O	O	O	
2		ARAE, AROP, CLFR, CLOP (wr/ir/ie)*2、CLER (wr/ie)*2, CLTT (wr/ie)*2, CLHT, CLWP	O	-	-	
2		CLOP	-	-	-	
2		NL, CS, ST	-	-	-	Low Resolution
2		VGI, ACLS, SNGI	O	O	O	
2		PGCP	-	-	-	
3 binned	16 days Month	ARAE, AROP, CLFR, CLOP (wr/ir/ie)*2、CLER (wr/ie)*2, CLTT (wr/ie)*2, CLHT (wr)*2, CLWP (wr)*2	O	-	-	
3 binned	16 days Month	SNWG, SNGI	O	O	O	
3 binned	Day, 8 days, Month	NW, LA, CS, ST	-	-	-	
3 STA MAP	16 days Month	ARAE, AROP, CLFR, CLOP (p/wr/ir/ie)*2、CLER (wr/ie)*2, CLTT (wr/ie)*2, CLHT (wr)*2, CLWP (wr)*2	O	-	-	
3 STA MAP	16 days Month	SNWG, SNGI, SNWGS*4, SNWTS*4	O	O	O	
3 STA MAP	Day, 8 days, Month	NW, LA, CHLA, SS, CDOM, K490, ST_DayNight, ST_all	O	-	-	
3 STA MAP	16 days	VGI	O	-	-	
GLI 250m						
L1A		Observation Data, Calibration Data	-	-	-	
L1B		Observation Data	-	-	-	

*1: EQR → Equi-rectangular PS → Polar Stereo (South hemisphere) PN → Polar Stereo (North hemisphere)
*2: p→ Pixel by pixel product
wr → Water cloud (reflection method), ir → Ice cloud (reflection method), ie → ce cloud (emission method)
*3: A → Ascending orbit data), D → Descending orbit data)
*4: Addition to standard product from processing algorithm ver. 2

Search results are displayed as a list with detailed descriptions. If processed products for ordered production are archived in the EOC, information on the processed products is displayed as part of the detailed information on scheduled products, which is the information that was used to generate requested products.

If a user wishes to specify the location by latitude/longitude, the user can do so by graphically selecting the area on the map that is displayed on the monitor. Observation area (coverage), which is included in a search result, can be graphically displayed on the map that is displayed on the monitor. As cloud cover is not evaluated for ADEOS-II images, cloud coverage cannot be used as a search parameter. For GLI data, GLI Saturation Ratio, which can be an alternative parameter of cloud coverage, can be used as a search parameter.

(2) Product Order

PIs can submit a request for a scene order for any scheduled product and ordered product via the scene search results screen (on-line). This service is available to general researchers for scheduled product request.

For AMSR and GLI, processing information of scheduled products is displayed as a search result. All users need to do is choose products from the search result and specify media. For ordered products, users need to do a catalog search of scheduled products (refer to Table 6.3-2) and choose scenes from the search result. Based on the inventory information of the selected scenes, users need to create order information by specifying order parameters such as processing level and map projection parameters.

Table 6.3-2 Source Information for Requesting Ordered Products

	Ordered Products		Source Information for Requesting	
AMSR	Level 1B Map	-	L1B	-
	Level 2 Map	WV, CLW, AP, SSW, SST, IC, SWE, SM[*2]	L2	WV, CLW, AP, SSW, SST, IC, SWE, SM[*2]
GLI-1km	Level 1B Map	VNIR、SWIR、MTIR	L1B	VNIR、SWIR、MTIR
	Level 2	CLOP_p[*1], PRCPW_p[*1,*2], NL_FR, CS_FR, SNGI_p[*1]	L1B	MTIR (Daytime Observation Data)[*3]
		ST_FR	L1B	MTIR
	Level 2 Map	CLFLG_p, ST, QF_ST	L1B	MTIR
		CLOP_p[*1], PRCPW_p[*1,*2], NW, LA, QF_OC, CHLA, SS, CDOM, K490, SNGI_p[*1]	L1B	MTIR (Daytime Observation Data)[*3]
GLI-250m	Level 1B Map	VNIR、SWIR、MTIR	L1B	VNIR、SWIR、MTIR

*1: p→ Pixel by pixel product
*2: Addition to standard product from processing algorithm ver. 2

*3: Nighttime data is not processable, but it can be ordered. So, requester should be careful not to order nighttime data.

Guest users should request products via the data distribution agent* specified by JAXA.

*: In FY2005, the Remote Sensing Technology Center (RESTEC) is the data distribution agent.

(3) Product Version

a) Scheduled Products

Scheduled products data are processed using the current and previous versions of product processing algorithm, and are archived in the EOC and available for users. If a user uses the EOIS online services, the user can search data that were generated using a specified version of processing algorithm by specifying Product Version Number for the search.

b) Ordered Products

For ordered products, only data which are processed using the current version of processing algorithm are available for users.

6.3.2 Data Set Order

(1) Data Set Search

Data set search is a function to allow users to search data set, which includes specified multiple kinds or multiple-days products of a specified sensor. Users can search data set by using observation date and data set name. This service is available only to PIs. For AMSR and GLI data set, listed in Table 6.3-3, are available for data set search.

Table 6.3-3 AMSR and GLI Products (Available to Data Set Search)

Data Set			Contents
AMSR			
	Level 1A, 1B		
	Level 2+3 (Day)		WV, CLW, AP, SSW, SST, SWE, IC, SM*2
	Level 3 (Day, Month)		TB (for 14 channels), WV, CLW, AP, SSW, SST, SWE, IC, SM*2
GLI 1km			
	Level 1A		VNIR、SWIR、MTIR Observation Data, Calibration Data
	Level 1B		VNIR、SWIR、MTIR Observation Data, Satellite Position
	Level 2A		Atmosphere, Ocean
			Land, Cryosphere
	Level 2	Scene	CLFLG_p
		Path	NL_FR, CL_FR, ST_FR, PGCP
		4 days	ARAE, AROP, CLFR, CLOP (wr/ir/ie)*1、CLER (wr/ie) *1, CLTT (wr/ie) *1, CLHT (wr) *1, CLWP (wr) *1
		16 days	VGI, ACLC, SNGI
	Level 3 binned	16 days, Month	ARAE, AROP, CLFR, CLOP (wr/ir/ie)*1、CLER (wr/ie) *1, CLTT (wr/ie) *1, CLHT (wr) *1, CLWP (wr) *2, SNWG, SNGI, SNWGS*2, SNWTS*2
		Day, 8days , Month	NW, LA, CS, ST
	Level 3 STA MAP	16 days, Month	ARAE, AROP, CLFR, CLOP (wr/ir/ie)*1、CLER (wr/ie) *1, CLTT (wr/ie) *1, CLHT (wr) *1, CLWP (wr) *2, SNWG, SNGI, SNWGS*2, SNWTS*2
		Day, 8days , Month	NW, LA, CHLA, SS, CDOM, K490, ST_DayNight, ST_all
		16 days	VGI

*1: wr → Water cloud (reflection method), ir → Ice cloud (reflection method), ie → ce cloud (emission method)
*2: Addition to standard product from processing algorithm ver. 2

(2) Data Set Order

PIs can submit a request for a data set via the data set search results screen (on-line).

6.3.3 Standing Order

(1) Product Order

Users are requested to complete the order form (paper sheet). If a total processing volume requested by PIs exceeds the EOC processing capability, the PC (Project Coordinator) of JAXA/EORC will coordinate with the registered users to maintain the proper processing load.

(2) Product Versions

For Standing Order, users can choose from options of “Current version” or “Version not specified”. When “Current version” is chosen, data which are produced using the current version of processing software at the time of media production, are delivered, e.g., Ver. 3 in Figure 6.3-1. When “Version not specified” is chosen, the most recent version of data for the requested period are delivered, e.g., if Ver. 2 and Ver.3 are archived, Ver. 3 data are delivered.

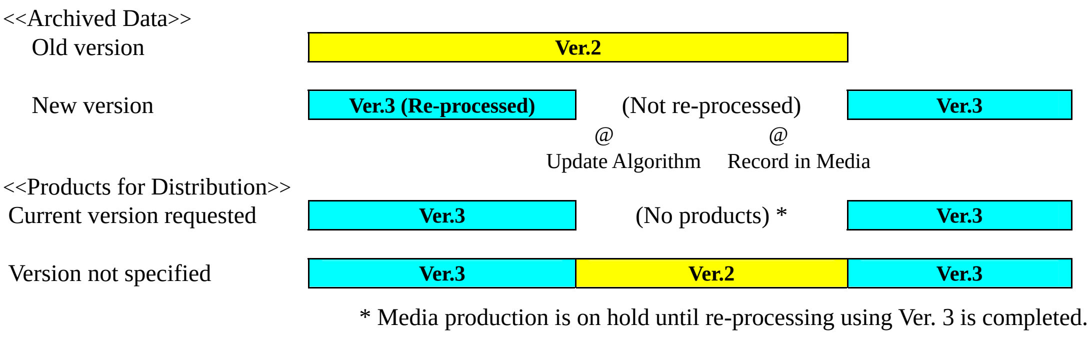


Figure 6.3-1 Product Versions for Standing Order

6.3.4 Support Information for Product Search and Order

EOIS provides users with support information for product search and order.

(1) Display of Image Catalog

For products shown in Table 6.3-4, image catalog can be displayed for the products which are extracted as the result of scene search or data set search, and it helps users to confirm observation areas and cloud coverage, among other things.

Table 6.3-4 AMSR and GLI Image Catalog Data

Level		Physical Parameters	Map Projection[*1] EQR	PS	PN	Note
AMSR						
3	Day	TB (6.9, 36.5, 89 GHz Vertical Polarization)	O	O	O	A/D[*3]
3	Day Month	WV, CLW, AP, SSW, SST, SM[*4]	O	-	-	A/D[*3]
3	Day Month	IC	-	O	O	A/D[*3]
3	Day Month	SWE	O	-	O	A/D[*3]
GLI 1km						
1B		VNIR (ch13, 8, 5: RGB), SWIR (ch26), MTIR (ch35)	-	-	-	
2		ARAE, AROP, CLFR, CLOP (p/wr/ir/ie)[*2]、 CLER (wr/ie)[*2], CLTT (wr/ie)[*2], CLHT (wr)[*2], CLWP (wr)[*2]	O	-	-	
2		NL, CS, ST	-	-	-	Low Resolution
2		VGI, ACLS, SNGI	O	O	O	
3 STA MAP	16 days, Month	ARAE, AROP, CLFR, CLOP (p/wr/ir/ie)[*2]、 CLER (wr/ie)[*2], CLTT (wr/ie)[*2], CLHT (wr)[*2], CLWP (wr)[*2]	O	-	-	
3 STA MAP	16 days, Month	SNWG, SNGI, SNWGS[*4], SNWTS[*4]	O	O	O	
3 STA MAP	Day, 8 days, Month	NW, LA, CHLA, SS, CDOM, K490, ST_DayNight, ST_all	O	-	-	
3 STA MAP	16 days	VGI	O	-	-	
GLI 250m						
L1B		Observation Data (ch22, 21, 20: RGB)	-	-	-	

*1: EQR → Equi-rectangular PS → Polar Stereo (South hemisphere) PN → Polar Stereo (North hemisphere)
*2: p→ Pixel by pixel product
wr → Water cloud (reflection method), ir → Ice cloud (reflection method), ie → ce cloud (emission method)
*3: A → Ascending orbit data), D → Descending orbit data)
*4: Addition to standard product from processing algorithm ver. 2

Products with multiple band data are displayed in RGB color. A single band data can be displayed in pseudo-color using pre-defined pallet information. Brightness and size of image catalog can be adjusted, and scene shift line can be displayed.

GLI1km Level 2 (VGI)

Pseudo-color Image

Figure 6.3-2 Screen Image (Image Catalog)

(2) Display of Map

For the products which are extracted as the result of scene search or data set search, observation area can be displayed on the coverage map screen.

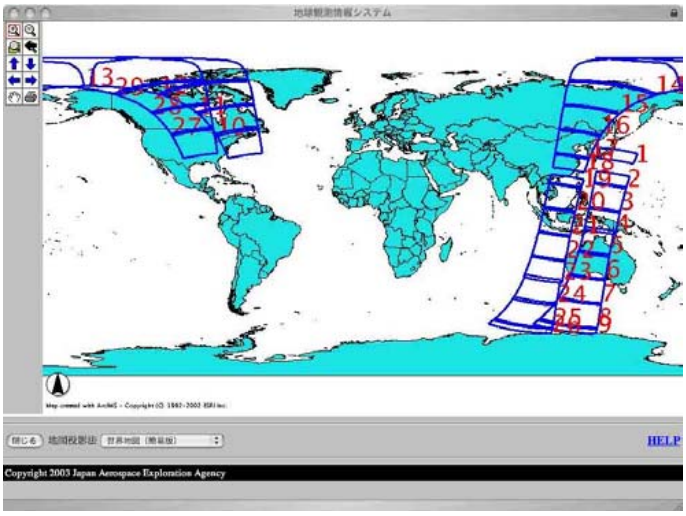


Figure 6.3-3 Screen Image (Display of Scene in Map)

(3) Status Search

PIs and general researchers can confirm the preparation status of the product that was ordered via scene order or data set order. If a PI or general researcher selects “Online data download” for ordered product, the product can be downloaded from EOIS online. (see 6.4.1 (2))

6.4 Product Distribution

6.4.1 Distribution Method

For scene order, CD-ROM, 8mm tape, DLT tape, DVD-R and on-line are available as media for data distribution to PIs. Basically, a physical medium contains a single product. However, if a multi-file option is specified, multiple-products can be stored on a physical medium. For general researchers, only on-line product distribution is available. For guest users, products are delivered from the agent specified by JAXA (As of FY2005, RESTEC) by CD-ROM.

For datasets, CD-ROM, 8mm tape, DVD-R and on-line are available as product distribution method to PIs.

For standing order, CD-ROM, 8mm tape, DVD-R and DLT are available as product distribution method to PIs. Basically a physical medium contains a series of specified products (e.g., VNIR). However, for some products, a combination of different products (e.g., VNIR and SLPT) can be recorded in one medium. EOC will determine available combinations of products, from which users choose what meets their needs.

Data distribution methods for the scene order, data set order and standing order are summarized in Table 6.4-1 intended for PI and general researchers..

Table 6.4-1 Data Distribution Method

Service	Media				
	CD-ROM	8mm	DVD-R	DLT	Online
Scene Order	O	O	O	X	@
Data Set Order	O	O	O	X	O
Standing Order	X	O	O	O	X

@: Available to PIs and general researchers O: Available to PI X: Not available

The format of product in distribution media is NCSA-HDF

6.4.2 Online Product Distribution

PI and general researchers can confirm whether or not the product is ready to download on the “Order status result screen”. If “On-line” button is displayed on the record, the product can be downloaded. Moreover, an e-mail is sent to users as notification when the product is ready to download.

Product for download are compressed (gzip). Download file includes a shipping list (text file), and is archived by tar.

6.4.3 Sample Data Distribution

Pre-selected products are staged on a server for a pre-defined period, allowing downloading via the Internet. This service is available to all users including guest users.

Sample data can be downloaded by clicking “Sample data button” in the scene search result screen. If sample data is not ready, PI can apply for acquiring sample data.

In consideration of ordinary Internet environments, the file size of products available through this service is around 10 Mbytes (max. 50 MB). To meet this constraint, Level 3 products of AMSR and Level 3 STA Map of GLI-1km are available and staged in the server for about 3 months. For specific product names, refer to Table 6.4-2.

Table 6.4-2 Sample Data Provided though the Internet

Level			Physical Parameters	Map Projection*1			Note
				EQR	PS	PN	
AMSR							
	3	Day Month	TB (for 14 channels)	O	O	O	A/D*3
			WV, CLW, AP, SSW, SST, SM*4	O	-	-	A/D*3
			IC	-	O	O	A/D*3
			SWE	O	-	O	A/D*3
GLI 1km							
	3 STA MAP	16 days, Month	ARAE, AROP, CLFR, CLOP (p/wr/ir/ie)*2、CLER (wr/ie) *2, CLTT (wr/ie) *2, CLHT (wr) *2, CLWP (wr) *2	O	-	-	
			SNWG, SNGI, SNWGS*4, SNWTS*4	O	O	O	
		8 days, Month	CHLA, SS, CDOM, ST_all	O	-	-	
		16 days	VGI	O	-	-	

*1: EQR → Equi-rectangular PS → Polar Stereo (South hemisphere) PN → Polar Stereo (North hemisphere)
*2: p→ Pixel by pixel product
wr → Water cloud (reflection method), ir → Ice cloud (reflection method), ie → ce cloud (emission method)
*3: A → Ascending orbit data), D → Descending orbit data)
*4: Addition to standard product from processing algorithm ver. 2

Files for download are compressed with an extension "gz".

6.5 User Services from EORC

Earth Observation Research Center (EORC) provides PIs with the services. EORC user services are described in the document "ADEOS-II Users Handbook" in detail. Users can get this document from EORC website. The URL is as follows.

- http://sharaku.eorc.jaxa.jp/ADEOS2/doc/document.html

7 ADEOS-II Operation Status and Results

In this chapter, it is introduced around the information related to the AMSR and GLI about the results of initial check-out on orbit, calibration and validation, observation results, etc. ADEOS-II was launched on December 14, 2002 (Japanese Standard Time), but its operation on orbit was given up on October 31 2003, because sufficient electric power was not available to maintain operation of the satellite. However, the observation data acquired by ADEOS-II during its ten months, is used for various researches, and a lot of results are reported. Moreover, data products of ADEOS-II are published routinely and improvement of product processing algorithm is continuously performed.

Main events after launch of ADEOS-II are shown as follows:

Table 7-1 Main Events after Launch of ADEOS-II

Date (JST)		Events
2002	December 14	Launched by the H-IIA Launch Vehicle Flight No.4 from Tanegashima Space Center
	December 15	Completion of initial check-out on orbit
	December 23	Maneuver for placing into the planned orbit
2003	January 8	
	January 3 ~ 7	AMSR run-up (Increase antenna rotation to normal operation speed (40 rpm))
	January 10	GLI cool down (cool down sensor part to predetermined temperature)
	January 18	AMSR first image acquisition (press release: Jan. 20)
	January 23	ILAS-II first image acquisition (press release: Feb. 5)
	January 25	GLI first image acquisition (press release: Jan. 27)
	January 28, 29	SeaWinds first image acquisition (press release: Feb. 25)
	February 1	POLDER first image acquisition (press release: Feb. 21)
	April 16	Operation phase was shift to routine, calibration and validation phase.
	October 25	Operation anomaly
	October 31	Operation on orbit was given up.
	December 24	AMSR and GLI products (algorithm version 1)were released.
2004	November 1	GLI products (algorithm version 2) were released.
2005	March 1	AMSR level 1 product (algorithm version 2) and higher level products (algorithm version 3) were released.

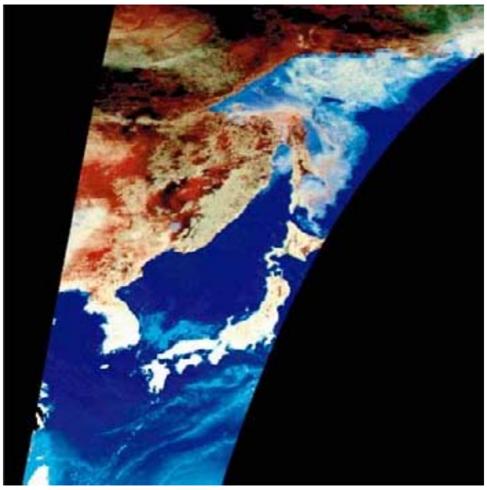
7.1 Initial Check-out on Orbit

JAXA confirmed that the Advanced Earth Observing Satellite-II launched on December 14, 2002 (JST) from the Tanegashima Space Center maintained its stable attitude. The inter-satellite communication antenna of ADEOS-II was deployed at 9:25 a.m. on December 17 (JST), then ADEOS-II started the wheel controlled attitude control at 11:08 a.m. on the same day (JST) to be in the stably controlled attitude. Then orbit maneuver was performed to place ADEOS-II into the scheduled orbit during the period from December 23 to January 8, 2003.

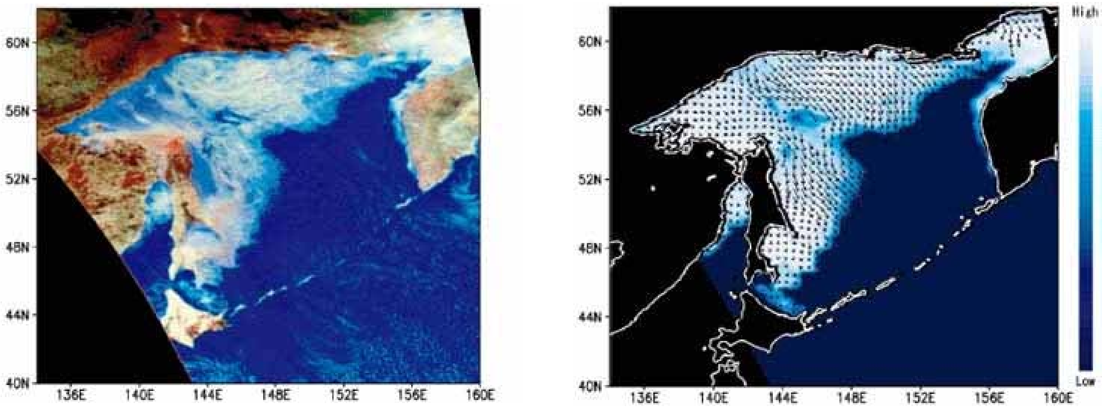
AMSR antenna run-up and GLI sensor cool-down was completed during the period from January 3 to January 10. Successful completion of these operations were confirmed by analyzing of telemetry data from satellite. After that, initial checkout was performed on orbit during three months, to check functions of bus instruments and mission instrument.

(1) AMSR First Image

AMSR acquired observation data around Japan twice at 11:00 am and 8:00 pm on January 18, 2004 (JST). These observation data were released as the first image of AMSR on January 20.



***The false-color composite image of AMSR.** Brightness temperatures of 36.5-GHz (horizontal polarization) and 89.0-GHz (both vertical and horizontal polarization) channels were used. The data is acquired around 11 a.m. on January 18, 2003 JST. Over the Pacific Ocean and Japan Sea, the areas of light blue correspond to high-concentration liquid water clouds. In the Sea of Okhotsk, colors varying from light blue to white correspond to sea ice distribution.*

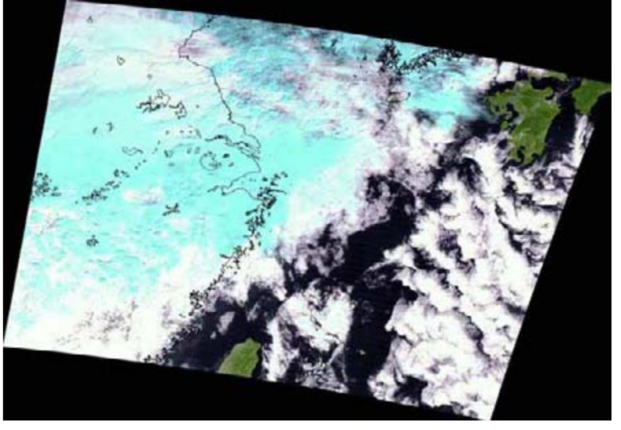


Sea ice distribution in the Sea of Okhotsk observed by AMSR. The left image is a false-color composite using the data acquired at night time (around 20:30) on January 18, 2003 JST. Brightness temperatures of 36.5-GHz (horizontal polarization) and 89.0-GHz (both vertical and horizontal polarization) channels were used. In the Sea of Okhotsk, colors varying from light blue to white correspond to sea ice. Distribution of newly-formed sea ice is approximately indicated by light blue. Areas of light blue over the Pacific Ocean correspond to high-concentration liquid water clouds. It is the advantages of microwave observation techniques to enable measurements during night and day. Thus, through non-precipitating clouds, the sea ice extension can be well distinguished using the night-time image.
The right image shows the sea ice concentration estimated from the same data. Cobalt blue indicates open sea surface with no sea ice coverage. Increase of sea-ice covered areas is indicated by colors varying from cobalt blue to white. The arrows superimposed on the map shows sea ice motion derived by comparing AMSR data acquired at 8:30 p.m. and that from the same day about 10 hours before. It can be seen that sea ice is advancing southward from northern part of the Sea of Okhotsk and reaching to the Shiretoko Peninsula. This year, the sea ice is advancing southward faster than in other years. At the Abashiri weather station in Hokkaido, Japan, approaching sea ice was observed on January 11th at the first time.

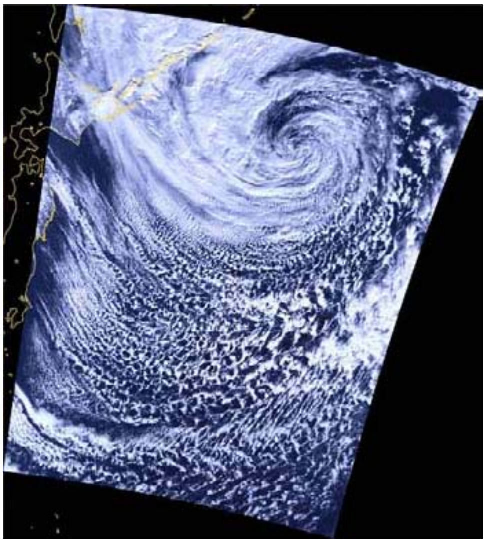
Figure 7.1-1 AMSR First Image (Observation date: January 18, 2003)

(2) GLI First Image

GLI acquired observation data over Kyushu Island, southern Japan, and the East China Sea at 11:30 am on January 25, 2004 (JST), and observed a great winter cyclone over the eastern part of Hokkaido island at 9:45 am in the same day. These observation data were released as the first image of GLI on January 27.



The color composite image was derived from the GLI spectral channels 28 (1640nm), 23 (825nm), and 22(660nm). The spatial ground resolution is 250m. Thick cloud systems stretching from the Asian continent to the East China Sea are visible in the image, with low altitude warm clouds appearing white and higher altitude ice clouds in blue. Kyushu Island and northern part of Taiwan can be identified at the chink of the clouds systems.



The cyclone developed off the Pacific coast of Tohoku area between January 23 and 24, during which it brought severe weather conditions to eastern and northern part of Japan. The GLI instrument observes and measures the types and structures of clouds using a large number of spectral channels.

Figure 7.1-2 GLI First Image (Observation date: January 25, 2003)

7.2 Calibration and Validation

This section is a introduction of the outline of calibration and validation of AMSR and GLI. Although the ADEOS-II in not in operation at present, the product which made from the data of AMSR and GLI acquired for the operation period is being offered to the user through the data service introduced in Chapter 6, and the data validation to improve the quality of those products is continued.

7.2.1　AMSR Calibration and Validation

(1) Calibration Overview

AMSR calibration is defined as the task for evaluation and adjustment of Brightness Temperature (TB) data. Outline of AMSR data calibration after launch is described as in below.

a) Brightness Temperature Calibration

TB data was evaluated, it is called as radiometric calibration that includes absolute evaluation of TB value and relative evaluation of scan bias. Radiometric noise, physical temperature of components of GLI sensor are monitored regularly.

b) Geometric Calibration

Evaluation includes rough beam patterns, inter-channel co-registration and absolute position accuracy. Antenna rotation speed, attitude notation and the like was monitored regularly.

c) Data Quality Evaluation

Includes evaluations of the quality of initial data, the soundness of all engineering values and deductive algorithms.

(2) Validation Overview

Major objectives of the AMSR validation is to define accuracy of products quantitatively, to generate the products with required accuracy and to improve the algorithms if necessary. Outline of AMSR data validation after launch is described as in below.

a) Evaluation of Accuracy of Physical Quantities

Accuracy of physical quantities is evaluated. Although the method differs with each quantity, comparing the physical quantities will generally do evaluation estimated from AMSR data with independently measured quantities (survey data, aircraft data and other similar satellite data).

b) Evaluation of Data Quality

Initial quality is evaluated, the same as for Level 1. Data insufficiencies resulting from algorithm malfunction and the like and image quality when viewed as images is evaluated.

7.2.2 GLI Calibration and Validation

(1) Calibration Overview

Calibration refers to the procedure of determining the absolute value of spectral radiance arriving at the satellite. The response characteristics of multiple detectors for each of the GLI channels, spectral-reflection characteristics of both sides of the scanning mirror, polarization characteristics, and other performance properties need to be evaluated, and the accuracy of observation data must be maintained. Ground calibration before launch, in-orbit calibration using the internal lamp and solar rays, vicarious calibration using the spectral radiance observation data near the land surface, and other methods of calibration are used to maintain the accuracy of spectral radiance values during operation.

a) On-Orbit Calibration

In the visible range, the internal lamp and diffused solar rays is used as calibration sources to calibrate each channel. The saturation radiance varies between the ocean channels and other (atmosphere, land, and cryosphere) channels, so it is necessary to calibrate them by appropriately selecting the calibration source, either the diffused solar rays or the internal lamp.

In the intermediate infrared and heat infrared wavelength ranges, the calibration sources is the internal black-body heat source and the radiant temperature of deep space.

b) Vicarious Calibration

Vicarious calibration refers to the procedure of estimating the satellite-arrival radiance on the upper surface of the atmosphere through an optical model by combining the radiance measured upward on the ground with other in-situ measured data such as the optical thickness of aerosols observed on the ground. By comparing the values of this satellite-arrival radiance with the satellite-arrival radiance obtained by the GLI, correction coefficients is calculated for each wavelength band of the GLI.

(2) Validation Overview

Validation refers to the procedure of validating the Earth's geophysical parameters estimated from the spectral radiance measured by each channel. Either standard products or research products of geophysical parameters will be established for each region, and validated each region will be using validation standards. When upward spectral radiance is used as a geophysical parameter, Level-1B data is validated. Validation is mainly carried out with match-up data sets. A match-up data set is a set of data consisting of in-situ observation data and GLI-generated data, collected at the same time or almost at the same time at the same location. The method, period, and frequency of in-situ observation vary, depending on the geophysical parameters under consideration. Eventually, however, parameters for higher-order processes is adjusted and algorithms is revised based on the calculations of errors of GLI higher-order products by comparing the geophysical parameters calculated from these two sets of data.

7.2.3 Calibration and Validation Plan and Result

Such as accuracy of the data included in AMSR and the GLI product obtained by calibration and validation are open to the public on the AMSR/AMSR-E webpage and the GLI webpage as notes to handle the product. URL of AMSR/AMSR-E and GLI are as follows.

AMSR/AMSR-E: http://suzaku.eorc.jaxa.jp/AMSR/index_ e.htm

GLI: http://suzaku.eorc.jaxa.jp/GLI/index_ e.html

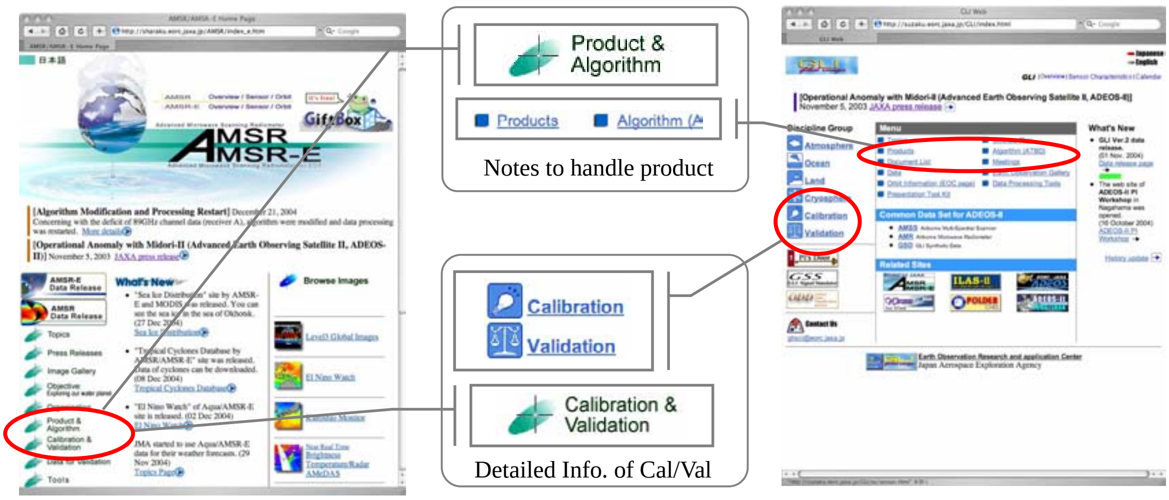


Figure 7.2-1 AMSR/AMSR-E and GLI Webpage

Details of calibration and validation of AMSR and GLI, such as a plan and validation data, can be obtained from these homepages. However, access to a certain part of information is limited, and only PIs of AMSR and GLI have accesses to the data.

7.3 Utilization of AMSR and GLI Data

Here is introduction of utilization example of observational data by AMSR and GLI. The example here is an excerpt from "ADEOS-II Earth View" image collection made to introduce the result of ADEOS-II by JAXA. It introduces many observation results including AMSR and GLI developed by JAXA and ILAS-II of Ministry of the Environment, SeaWinds of and United States NASA and POLDER of France CNES and other. "ADEOS-II Earth View" can be downloaded by accessing "CD-ROMs and DVD-ROMs issued by EORC" on the page of "Reports & Publication" on the JAXA/EORC webpage shown in following URL.

“Reports & Publication” on EORC webpage:
http://www.eorc.jaxa.jp/en/imgdata/publication/

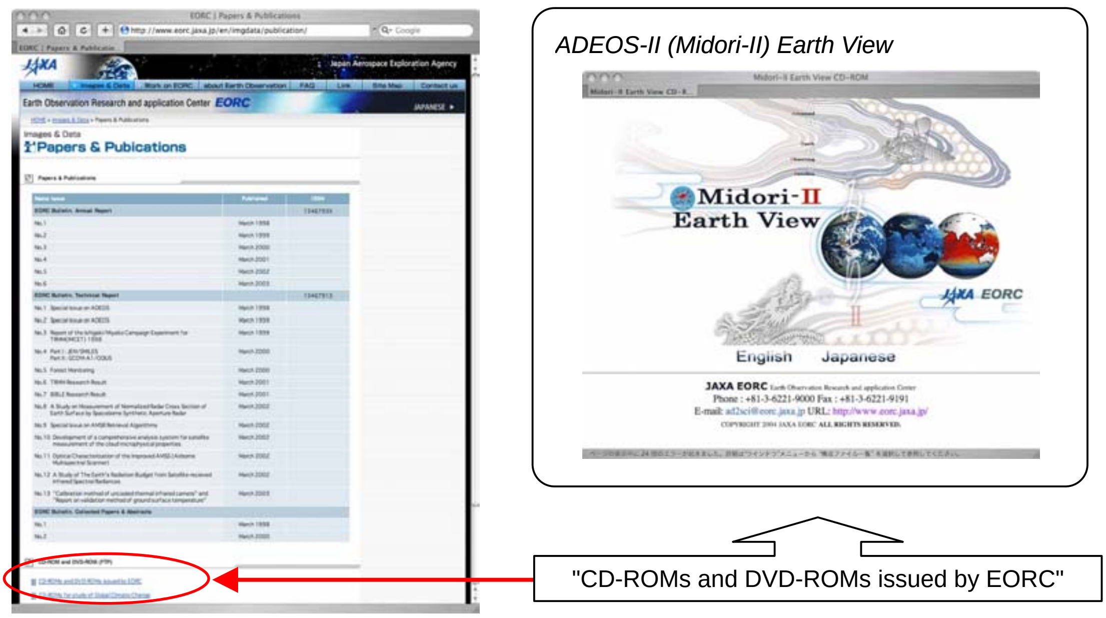


Figure 7.3-1　Download Site of ADEOS-II Earth View

Moreover, a lot of sample images of AMSR and GLI are published on the ADEOS-II web pages of JAXA/EOC and EORC.

EOC/ADEOS-II Webpage:
http://www.eoc.jaxa.jp/adeos2/index_ e.html

EORC/ADEOS-II Webpage
http://suzaku.eorc.jaxa.jp/ADEOS2/index.html

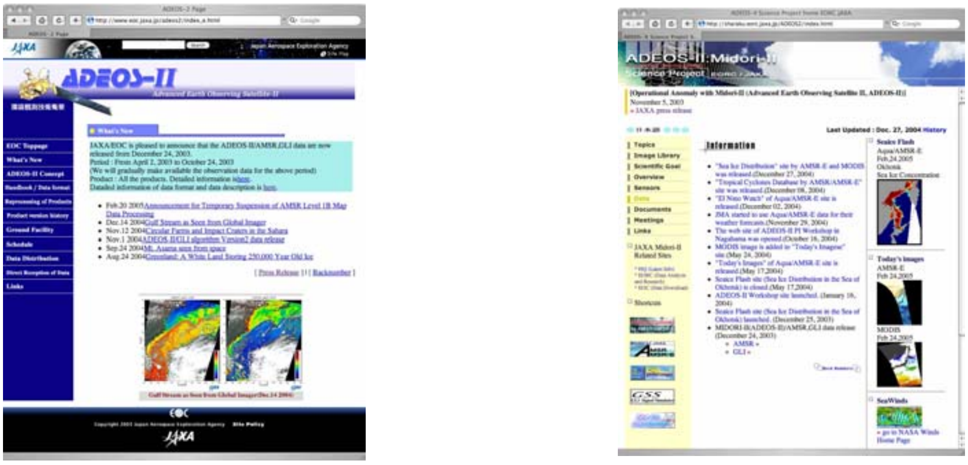
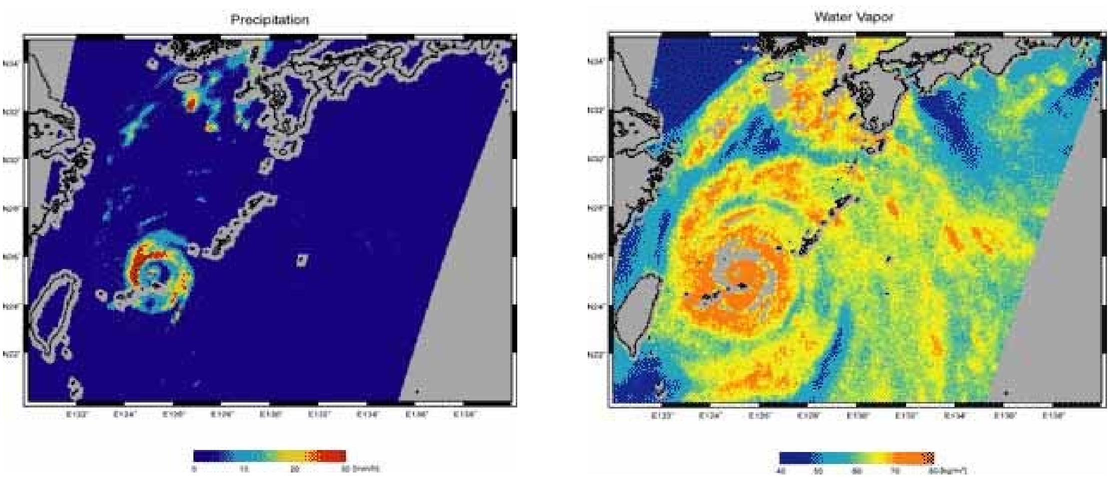


Figure 7.3-2 ADEOS-II Webpage of EOC and EORC

(1) Observation of Typhoon No.14 "Maemi"

a) Observation by AMSR

AMSR observed Typhoon No. 14' s approach to Miyako Island where it caused great damage to the area on September 10, 2003. The images illustrate the distribution of precipitation (left) and water vapor (right) estimated from AMSR data. In both images, colors varying from blue to red indicate increasing values of precipitation or water vapor. Heavy rainfall areas surround the center of the typhoon. The water vapor image reveals that the effect of the typhoon is already extending to the Kyusyu area.



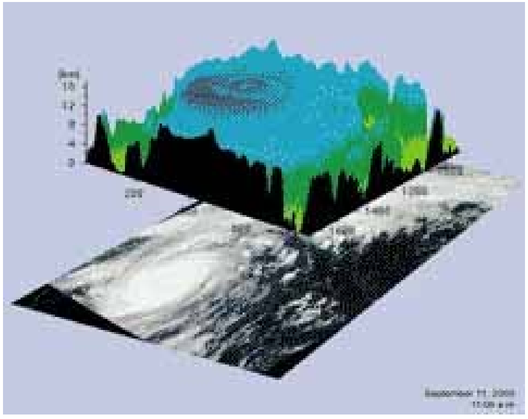
Precipitation Water Vapor

Figure 7.3-3 Observation of Typhoon No.14 "Maemi" by AMSR

b) Observation by GLI

Cloud-top heights were retrieved from a GLI image captured on September 11, 2003. The cloud top reached 16 km at very low temperature (-70°C). A high cloud top indicates a strong typhoon. The two-track eye in the typhoon center is clearly visible.

The GLI analysis algorithm retrieves cloud-top temperature, cloud particle size, and so on, in addition to cloud-top height.



This 3D graphic image was generated by using a different color for each cloud-top height, which varies according to the areas. Although the image indicates continuous clouds from the cloud top to the land surface, the three-dimensional cloud structure is not necessarily continuous.

JMA GANAL data was used for supporting this analysis.

Figure 7.3-4 Observation of Typhoon No.14 "Maemi" by GLI

(2) Application of Sea Surface Temperature for Fisheries

This is a composite map of AMSR SST and fishing grounds east of Japan, in which locations of fishing grounds are reported to the Japan Fisheries Information Service Center (JAFIC). Yellow markers indicate purse seine fishing for sardine, mackerel and common horse mackerel along the coast. Red markers indicate long-line fishing boats fishing for albacore, swordfish, yellow-fin tuna and big-eye tuna. Green markers indicate saury stick-held dip net boats. Blue markers indicate pole and line fishing boats fishing for bonito and albacore. Fishing grounds for bonito and albacore are located in warm sea surface temperature (SST) regions of the Kuroshio Current, and saury, in cold SST regions of the Oyashio Current. Additionally, fishing grounds are located in flared portions of warm SST and current rip. The fishing grounds of each species will be detected by using SST data provided by satellites, so AMSR measurements are expected to improve the fishing efficiency.

** Part of this result was obtained form the agreement concerning AMSR of JAXA and JAFIC. This image was provided by JAFIC.*

Figure 7.3-5 Application of Sea Surface Temperature for Fisheries

(3) Smoke of Siberian Forest Fires

Figure 7.3-6 presents the aerosol concentration based on GLI data acquired on May 19, 2003 . Aerosols are microscopic particles suspended in the atmosphere and have a large variety of species and sources, such as gas exhausted from cars and plants, dust from deserts, sea salt particles from the oceans, and smoke from forest fires and slash-and-burn agriculture. Figure 1 depicts the eastern half of the Eurasian Continent, the Northern Pacific Ocean and parts of North America. It indicates that the highly dense aerosol (yellow and red) originated near Lake Bajkal in Siberia and spread to Alaska after passing northwest of the Kamchatka Peninsula. Black indicates screened-out cloudy regions or areas where no observations were made.

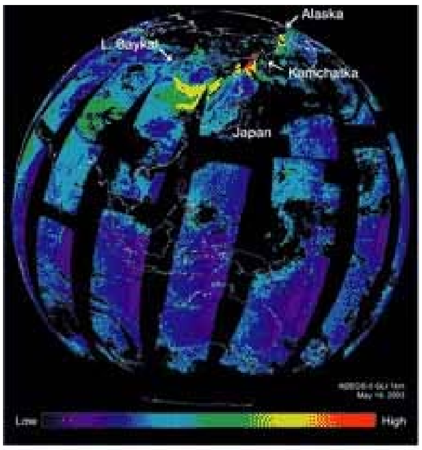


Fig.1 Aerosol Concentration

This is the cooperative research work between JAXA and The University of Tokyo.

Figure 7.3-6 Smoke of Siberian Forest Fires

Appendix-1 Acronyms & Abbreviations

A

ACE : Advanced Composition Explorer
ACFS : Attitude Control Flight Software
A/D : Analog to Digital
ADEOS : Advanced Earth Observing Satellite
ADEOS-II : Advanced Earth Observing Satellite-II
ADS : Advertisement Subsystem
AGSID : ADEOS-II to Ground Stations Interface Document
ALOS : Advanced Land Observing Satellite
AMSR : Advanced Microwave Scanning Radiometer
ANSI : American National Standard Institute
ANT : Antenna
AOCE : Attitude and Orbit Control Electronics
AOCS : Attitude and Orbit Control Subsystem
AOD : ADEOS-II Operational Document
AOS : Acquisition of signal
APE : Antenna Pointing Electronics
API : Application Programming Interface
APID : Application Process Identification
APM : Antenna Pointing Mechanism
ARCH : Archive Subsystem
ARTEMIS : Advanced Relay and Technology Mission
ASCA : Advanced Stellar Compass Assembly
ASCII : American Standard for Computer and Information Interchange
ASF : Alaska SAR Facility (University of Alaska)
AVNIR : Advanced Very Near Infrared Radiometer
AWG : American Wire Gage

B

BAT : Battery
BBM : Bread Board Model
BCCU : Battery Charge Control Unit
BCN : Beacon
BDS : Browse data Distribution Subsystem
BER : Bit Error Rate
BFA : Baffle
Biφ-L : Bi-Phase Level
BM :
BMA : Body Mounted Accelerometer
BOL : Beginning of Life
BPF : Band Pass Filter
BPSK : Bi-Phase Shift keying
bps : Bit per Second
BUF : Buffer
BUV : Backscatter Ultraviolet (Spectrometer)

C

C&DH : Command and Data Handling (Subsystem)
CADS : Catalogue data Distribution System
CATS : Catalogue Subsystem
CCD : Charge Coupled Device
CCR : Corner Cube Reflector
CCITT : International Telegraph and Telephone Consultative Committee
CCSDS : Consultative Committee for Space Data Systems
CCT : Computer Compatible Tape
CD : Compact Disc
CDR : Critical Design Review
CE : Conductive Emission
CEOS : Committee On Earth Observation Satellites
CEOS-IDN : Committee on Earth Observations Satellites-International Directory Network
CFRP : Carbon fiber Reinforced Plastic
ch : Channel
CHU : Camera Hed Unit
CIS : Catalogue Interoperability Subsystem
CLIVER : Climate Variability Research Program
CLS : Collect Localization Satellites
CMD : Command
CME : Coronal Mass Ejection
CNES : Centre National d’Etudes Spatiales
COM : Communication Subsystem
COMB : Combiner
COMETS : Communications and Broadcast Engineering Test Satellite
CONT : Controller
CRC : Cyclic Redundancy Code
CRL : Communications Research Laboratory
CTLG : Catalogue data file
CU : Central Unit

D

DCP : Data Collection Platform
DCR : Development Completion Review
DCS : Data Collection System
DDMS : Data Distribution and Management System (JAXA)
DDS : Data Distribution Subsystem
DES : Data Editing Subsystem
DGS : Data Generation System
DH : Data Handling Subsystem
DIP : Diplexer
DMMC : Downlink Messages Management Center
DMS : Dynamics Monitoring System
DMU : Dynamics Mounted Unit
DOD : Depth of Discharge
DOM : Dose Monitor
DOS : Dosimeter
DPU : Dynamics Power Unit
DRS : Data Retrieval Subsystem
DRTS : Data Relay and Tracking Satellite
DSS : Data Storage System
DT : Direct Transmission(Subsystem)
DTL : Direct Transmission subsystem for Local Users

E

EA : Environment Agency of Japan
ECI : Earth Center Inertial coordinates
ED : Definitive orbital Element
EIRP : Equivalent Isotropic Radiated Power
EM : Engineering Model
EMC : Electro-Magnetic Compatibility
EOC : Earth Observation Center (JAXA)
EOIS : Earth Observation Data and Information System (JAXA)
EOL : End of Life
EOM : End of Mission
EORC : Earth Observation Research and application Center (JAXA)
EOS : Earth Observing System (NASA)
EOSDIS : EOS Data and Information System
EP : Predictive orbital Element
EPS : Electrical Power and Paddle Subsystem
Electrical Power Subsystem
ERS-1 : Earth Resources Satellite-1
European Remote Sensing Satellite-1
ESA : Earth Sensor Assembly
ESA : European Space Agency
ESDIS : Earth Science Data and Information System
ETS : Engineering Test Satellite
ETS-V, VI : Engineering Test Satellite-V, VI
EUS : EOIS User interface Software

F

F : Filter
FAX : Facsimile Message
FD : Floppy Disk
FDDI : Fiber-optic Data Distribution Interface
FGS : Foreign Ground Station
FMEA : Failure Modes and Effects Analysis
FOV : Field of View
FRR : Flight Readiness Review
FSSA : Fine Sun Sensor Assembly
FSSE : Fine Sun Sensor Electronics
FSSH : Fine Sun Sensor Head
FTAM : File Transfer Access and Management
FTP : File Transfer Protocol

G

G/T : Gain to Noise Temperature Ratio
GCI : Geocentric Celestial Inertial
GDOP : Geometrical Dilution of Precision
GDR : Ground segment Design Report Meeting
GEO : Geostationary
GEWEX : Global Energy and Water Cycling Research Experiment
GFD : Gas Fill and Drain Valve
GLI : Global Imager
GN : Ground Network
GOES : Geostationary Operational Environment Satellite
GPS : Global Positioning Satellite System
GPSR : GPS Receiver
GRS : Global Reference System
GSFC : Goddard Space Flight Center (NASA)
GUI : Graphical User Interface

H

H/W : Hardware
HDDT : High Density Digital Tape
HDF : Hierarchical Data Format
HK : Housekeeping
HK TLM : Housekeeping Telemetry
HKMU : House Keeping Memory Unit
HYB : Hybrid Circuit

I

I/F : Interface
ICD : Interface Control Documentation
Interface Control Drawing
ICS : Interface Control Specification
ID : Identification
IEOS : International Earth Observing System
IF : Intermediate Frequency
IFOV : Instantaneous FOV
IGBP : International Geosphere and Biosphere Research Program
IIP : Instrument Implementation Plan
ILAS : Improved Limb Atmospheric Spectrometer
ILAS-II : Improved Limb Atmospheric Spectrometer-II
INT : Integration Hardware (Subsystem)
IOCS : Inter-Orbit Communication Subsystem
IP : Implementation Plan
IP : Internet Protocol
IPCN : Implementation Plan Change Notice
IPCP : Implementation Plan Change Proposal
IR : Infrared
IRD : Interface Requirements Document
IRU : Inertial Reference Unit
ISAS : Institute of Space and Astronautical Science

J

JAXA : Japan Aerospace Exploration Agency
JEM : Japanese Experiment Module
JFIF : JPEG File Interchange Format
JMA : Japan Meteorological Agency
JPL : Jet Propulsion Laboratory (California Institute of Technology)
JPEG : Joint Photographic Coding Experts Group
JPRD : Joint Program Requirement Document
JST : Japanese Standard Time

K

KSA : K-band Single Access

L

LAV : Latch Valve
LAN : Local Area Network
LEO : Low Earth Orbit
LLM : Light Load Mode
LNA : Low Noise Amplifier
LOS : Loss of Signal

M

MCS : Media Conversion Subsystem
MDP : Mission Data Processing Subsystem
Mission Data Processor
MDR : Mission Data Recorder

MMO : Mission operation Management Organization
MMOFE : Mission operation Management Organization Front-End (Directory)
MOA : Memorandum of Agreement
MOD : Modulator
MOIP : Mission Operations Implementation Plan
MOIS : Mission Operations Interface Specification
MOM : Mission Operations Meeting
MOS : Metal Oxide Semiconductor
MOS-1 : Marine Observation Satellite-1
MOU : Memorandum of Understanding
MRT : Mission Real Time
MS : Margin of Safety
MT : Mode Transducer
MTQ : Magnetic Torquer
MYQE, MTQED : Magnetic Torquer Drive Electronics
MUX : Multiplexer

N

N/A : Not Applicable
NAL : National Aerospace Laboratory of Japan
NASA : National Aeronautics and Space Administration
NASDA : National Space Development Agency of Japan
NESDIS : National Environmental Satellite Data and Information Service
NGN : NASA/NOAA Ground Network
NIES : National Institute for Environmental Studies
NOAA : National Oceanic and Atmospheric Administration
NRT : Near Real Time Data (Directory)
NRZ-L : Non Return to Zero Level
NSCAT : NASA Scatterometer
NTSK : NASDA Transportable Station-Kiruna

O

OBC : On-Board Computer
OCL : Operations Coordination Letter
ODC : Ordnance Controller
ODR : Optical Data Recorder
OMN, OMNI : Omnidirectional (Antenna)
Opr. : Operational
OPLN : Operation Plan (between EOC and an agency)
OPL1 : Operation Plan (between EOC and CNES / POLDER)
ORR : Operational Readiness Review
ORST : Operation Result Status
OS : Operating System
OSDPD : NOAA/NESDIS Office of Satellite Data Processing and Distribution

P

PA : Power Amplifier
PAF : Payload Attach Fitting
PAD : Solar Array Paddle
PAR : Pre-Acceptance Review
PC : Personal Computer
PCD : Payload Correction Data
PCM : Pulse Coded Modulation
PCM-PM : Pulse Code Modulation-Phase Modulation
PCU : Power Control Unit
PDE : Paddle drive electronics
PDL : Solar Array Paddle Subsystem
PDM : Paddle drive Mechanism
PDR : Preliminary Design Review
PDU : Power Distribution Unit
PFD : Propellant Fill Drain Valve
PFM : Proto-Flight Model
PHA : Phase
PI : Principal Investigator
PIU : Power Interface Unit
PMA : Paddle Monitoring Acceleration
PN : Pseudo Noise
PO.DAAC : Physical Oceanography Distributed Active Archive Center
POLDER : Polarization and Directionality of the Earth' s Reflectances
PPR : Pre-project Review
PQR : Post Qualification(Test) Review
PRA : Process Amplifier Assembly
PRE : Pressure Transducer
PROC : Processing Subsystem
PRN : Pseudo-Random Noise
PRV : Propellant Valve
PSK : Phase Shift Keying
PSM : Paddle Stroke Monitor
PSR : Pre Shipment Review
PTM : Paddle Tension Monitor

Q

Q/L : Quick Look
QPSK : Quadrature Phase Shift Keying
QQC : Quality, Quantity and Continuity

R

RAM : Random Access Memory
RCS : Reaction Control Subsystem
RCV : Receiving Subsystem
RCD : Recording Subsystem
RDRD : Readability report of Raw Data
RDZD : Readability report of level Zero Data
RE : Radiative Emission
REAC : Result of Acquisition
REQ : Request for Operation (between TACC and EOC)
REQA : Reply on 4 week Request (particular)
REQQ : Request for 4 week period
REQR : Request for Raw data record
RESTEC : Remote Sensing Technology Center of Japan
REV : Revolution
RF : Radio Frequency
RGS : Receiving Ground Station
RIU : Remote Interface Unit
Rms : Root Mean Square
ROM : Read Only Memory

RORR : Routine Operation Readiness Report meeting
RS : Reed Solomon
RSP : Reference System for Planning
RTIG : Real Time processing Information for GLI data
RW : Reaction Wheel
RX : Receiver

S

SA : Single Access
SAA : South Atlantic Anomaly
SAP : Solar Array Paddle
SAR : Synthetic Aperture Radar
S/C : Spacecraft
SCID : Spacecraft Identifier
SeaPAC : SeaWinds Processing and Analysis Center
SeaWinds : NASA-JPL Scatterometer On ADEOS-II
SEU : Single Event Upset
SHNT : Shunt
SIM : System Interface Module
SITE : System Integration and Test Building
SLM : Static Load Model
SM : Structure Model
SMS : Schedule Management System
SMSS : Schedule Management Subsystem
SN : Space Network
S/N : Signal to Noise
SODS : Space Operation and Data System
SOE : Sequence of Event
SOHO : Solar Heliosphere Observatory
SOOH : Spacecraft Orbital Operations Handbook
SOP : Spacecraft Operation Procedure
SPSS : Solar Paddle Sun Sensor
SQPN : Staggered Quadriphase Pseudonoise
SQPSK : Staggered Quadrature Phase Shift Keying
SRRD : Shipment Report of Raw Data
SRS : Shock Response Spectrum
SRZD : Shipment Report of level Zero Data
SSA : S-band Single Access
SSFP : Space Station Freedom Program
SSPA : Solid State Power Amplifier
SSR : Switching Series Regulator
STA : Science and Technology Agency
STAD : Status information on ADEOS
STE : Star Tracker Electronics
STGS : Status of Ground Station
STH : Star Tracker Head
STM : Structural Thermal Model
STR : Structure(Subsystem)
SUM : Single event Upset Monitor
SW : Switch Circuit

T

TACC : Tracking and Control Center
TACS : Tracking And Control Station (JAXA)
TBD : To Be Determined
TCM : Tension Control Mechanism
TCP : Transmission Control Protocol
TCP/IP : Transmission Control Protocol/Internet Protocol
TCS : Thermal Control Subsystem
TEDA : Technical Data Acquisition Equipment
TFG : Transfer Flame Generator
THR : Thruster
TKSC : Tsukuba Space Center (JAXA)
TL : Time of Launch
TLM : Telemetry
TM : Thermal Model
TNK : Propellant Tank
TRP : Transponder
TD : Time Difference file
TRR : Technical Readiness Review
TT&C : Telemetry Tracking and Command
TTL : Transistor-Transistor Logic
TTY : Teletype
TX : Transmitter

U

UHF : Ultra High Frequency
URL : Universal Resource Locator
UPC : UP Converter
UQPSK : Unbalance QPSK
URS : User Request Management Subsystem
USB : Unified S-Band
UTC : Universal Time Coordinate
UTCF : Universal Time Correlation Factor

V

VCID : Virtual Channel Identification
VMS : Visual Monitoring System
VLV : Valve
VMPDE : Valve, Magnetic Torquer and Paddle Drive Electronics

W

WDE : Wheel Drive Electronics
WFF : Wallops Flight Facility
WGS : World Geometric System
WRS : World Reference System
WS : Workstation
WWW : World Wide Web

X

X-PDR : Transponder

Appendix 2 RELATED INFORMATION

A2.1 Reference Documents

The titles, provider, and contents of the reference documents are shown below:

(1) “ADEOS-II Users Handbook”

- Prepared by JAXA
- Contents: This document was written for providing basic information about ADEOS-II' s science plan, mission instruments, products and operation system.

(2) “Earth Observation Data and Information System Users Manual”

- Prepared by JAXA
- Contents: Document which explains the operation method of the EOIS.

A2.2 Related Sites over Internet

URLs of the homepages related to ADEOS-II are listed below.

■ Japanese Site

(1) JAXA Homepage

- http://www.jaxa.jp/index_ e.html

(2) JAXA/Earth Observation Center (EOC) Homepage

- http://www.eoc.jaxa.jp/homepage.html

a) ADEOS-IIHomepage

- http://www.eoc.jaxa.jp/adeos2/index_ e.html

b) EOIS

- https://isswww.eoc.jaxa.jp/iss/en/index.html

(3) JAXA/Earth Observation Research and application Center (EORC) Homepage

- http://www.eorc.jaxa.jp/eorctop.htm

a) ADEOS-II Science Project Homepage

- http://sharaku.eorc.jaxa.jp/ADEOS2/

b) AMSR/AMSR-E Homepage

- http://sharaku.eorc.jaxa.jp/AMSR/index_ e.htm

c) GLI Homepage

- http://suzaku.eorc.jaxa.jp/GLI/index.html

(4) JAXA/Tsukuba Space Center (TKSC)

a) TEDA Homepage

- http://sees.tksc.nasda.go.jp/English/

(5) National Institute for Environmental Studies (NIES)

- http://www.nies.go.jp/index.html

a) ILAS-IIHomepage

- http://www-ilas2.nies.go.jp/en/index.html

(6) Remote Sensing Technology Center of Japan (RESTEC) Homepage

- http://www.restec.or.jp/restec_ e.html

■ Overseas Site

(1) NASA Homepage

- http://www.nasa.gov/

a) Aqua Homepage

- http://aqua.gsfc.nasa.gov/

b) AMSR-E Homepage (NASA/MSFC)

- http://wwwghcc.msfc.nasa.gov/AMSR/

(2) NASA/JPL Homepage

a) SeaWinds Homepage

- http://windss.jpl.nasa.gov/

b) PO.DAAC Homepage

- http://podaac.jpl.nasa.gov/

(3) CNES Homepage

- http://www.cnes.fr/

a) POLDER Homepage

- http://smsc.cnes.fr/POLDER/

b) DCS Homepage (Argos System)

- http://www.cls.fr/html/argos/welcome_ en.html

(4) NCSA HDF Homepage

- http://hdf.ncsa.uiuc.edu/

A2.3 Points of Contact

■ Data Distribution Service

(1) General Users

Application and Service Dept.
Remote Sensing Technology Center of Japan
Roppongi First Bldg.
1-9-9, Roppongi, Minato-ku,
Tokyo 106-0032, Japan

TEL: + 81-3-5561-9777 FAX: + 81-3-5574-8515
E-mail: data@restec.or.jp URL: http://www.restec.or.jp/restec_ e.html

(2) Specific Users (PI, RA)

Order Desk
JAXA Earth Observation Research and application Center (EORC)
Harumi Island Triton Square Office Tower X 23F
1-8-10 Harumi, Chuo-ku,
Tokyo 104-6023 Japan

TEL: + 81-3-6220-1306 FAX: + 81-3-6221-0205
E-mail: orderdesk@eorc.nasda.go.jp URL: http://www.eorc.jaxa.jp/eorctop.htm

■ Contact point related to EOIS

Order Desk
Earth Observation Division Earth Observation Department
Remote Sensing Technology Center of Japan (RESTEC)

JAXA Earth Observation Center
1401 Numanoue, Ohashi, Hatoyama-machi,
Hiki-gun, Saitama, Japan, 350-0302

TEL: 81-49-298-1307 FAX: 81-49-298-1398
E-mail: eusadmin@nsaeoc.eoc.jaxa.jp

■ Contact point related to This Document

JAXA Earth Observation Center
1401 Numanoue, Ohashi, Hatoyama-machi,
Hiki-gun, Saitama, Japan, 350-0302

TEL: 81-49-298-1200 FAX: 81-49-298-1001
URL: http://www.eoc.jaxa.jp/homepage.html

Appendix 3 AMSR/GLI Product Format

A3.1 AMSR Product Format

The following documents, which specify the detailed format of AMSR level 1 ~ 3 products, are attached to this handbook.

- AMSR Level 1 Product Specifications (including level 1A, 1B and 1B Map)
- AMSR Level 2 Product Specifications
- AMSR Level 2 Map Product Specifications
- AMSR Level 3 Product Specifications

A3.2 GLI Product Format

The following documents, which specify the detailed format of GLI level 1 ~ 3 products, are attached to this handbook.

- ADEOS-II GLI Level-1 Product Format Description
- GLI Standard Higher Products File Specification