GEOSAT500 SYSTEM MANUAL

THEORY OF OPERATION AND DESCRIPTION OF SYSTEM SOFTWARE

FOR VERSION 2.11

(REVISION 2)

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1. The GEOSAT500 system

The EEC GEOSAT500 groundstation is a high-performance system that receives/processes downlinks from the Japanese Meteorological Agency's Himarwari-8/9 spacecraft, the Korea Meteorological Administration's COMS-1 satellite, NOAA's GOES spacecraft, and the Chinese Meteorological Agency's Fengyun-2 satellite[1]. It can additionally receive and process data from the JMA's MTSAT satellite, although this spacecraft is currently in a standby state and is not transmitting. It is a complete turn-key system, providing all hardware and software necessary to receive transmissions and process the data into image files.

The system can be configured to receive MTSAT/FY-2/COMS-1 data via direct satellite broadcast, and HIMAWARI-8/9 via HimawariCast. The COMS1 data is encrypted. It is customers' responsibility to apply the decryption key from the National Meteorological Satellite Center of Korea Meteorological Administration.

The system can also be configured to receive MTSAT/HIMAWARI-8/9 and COMS-1 from JMA and KMA Internet service. In this configuration, the dish, feed, receiver, and acquisition workstation are not required and so information in this document pertaining to those components can be ignored. The site administrator is responsible for providing and maintaining a reliable internet connection so this data can be downloaded automatically. See section 2.3.6 for more details.

The GEOSAT500 groundstation comprises a fixed parabolic dish, LNA, downconverter, and three or more computers:

1. Acquisition Workstation. Houses the receiver and pre-processed raw data. The raw data is automatically transferred to the Data Processing Workstation for image generation;
2. Data Processing Workstation. Receives pre-processed raw data from the Acquisition Workstation and produces final image products according to user-defined setups. These final image products are automatically transferred to the Display Workstations; and
3. One or more Display Workstations. Each Display Workstation runs the EEC PROTEUS product for the display and analysis of satellite imagery. All image products are transferred automatically to these machines from the Data Processing Workstation.

[1] Depending on groundstation location and configuration selected.

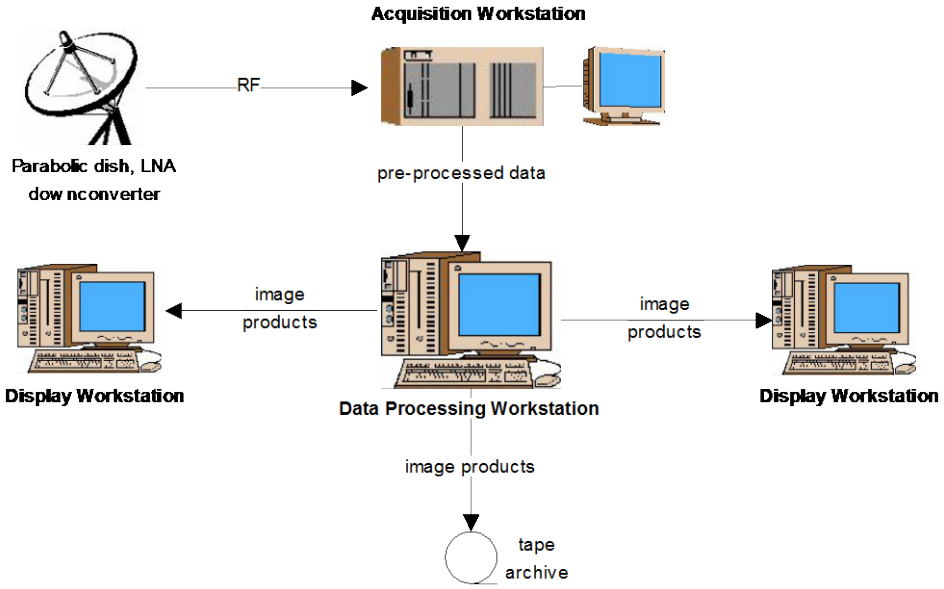
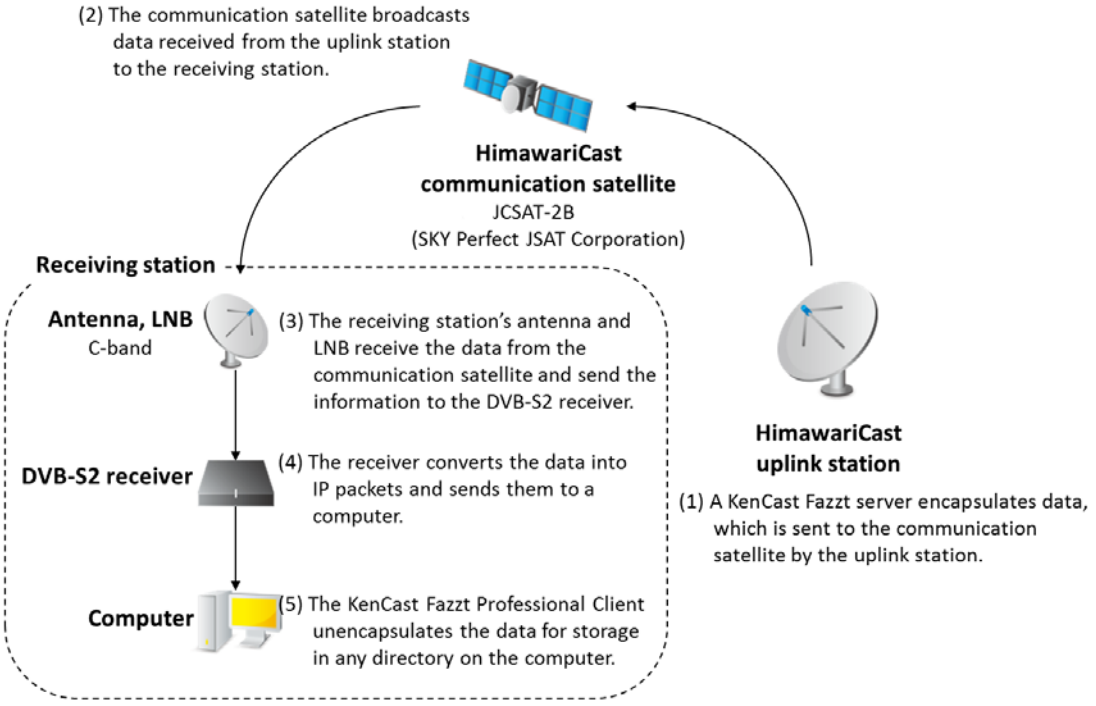


Figure 1 Typical GEOSAT500 system

2. Himawari Reception Systems

2.1. Himawaricast

Data from the Himawari-8/9 spacecraft is being re-broadcast through JCSAT-2B.



Data link parameters:

Type: DVB-S2

Modulation: QPSK

Symbol rate: 2,586.148 ksps

Frequency: 4,148.000 MHz (C-band)

Polarization: Linear

2.2. Antenna

An antenna for Himawaricast is a fixed dish, typically 2.4 or 3.6m. It can be a mesh dish or a fibre glass reinforced mesh dish.

A typical Himawaricast Antenna installation consists of these components:

2.2.1. Antenna Components

Dish, 2.4 or 3.6m prime focus dish

Feed

Filter

LNB

Satellite transmission (MHz):	4,148.000
Local Oscillator (MHz):	5,150.000
Receiving frequency (MHz):	1,002.000

2.3. Novra Receiver

The Novra-S200/S300 receiver is a digital DVB-

Figure 2: Novra-S300 receiver

S2 satellite data receiver. Data is output on its built-in network interface.

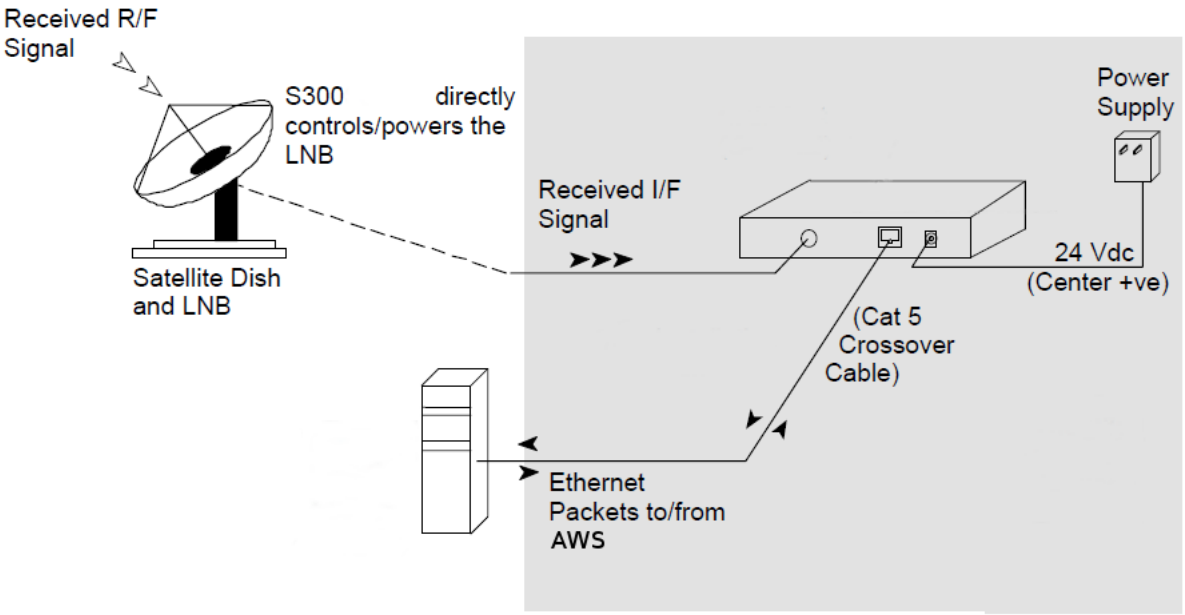


Figure 3: Novra Receiver System Setup

2.4. Network Setup

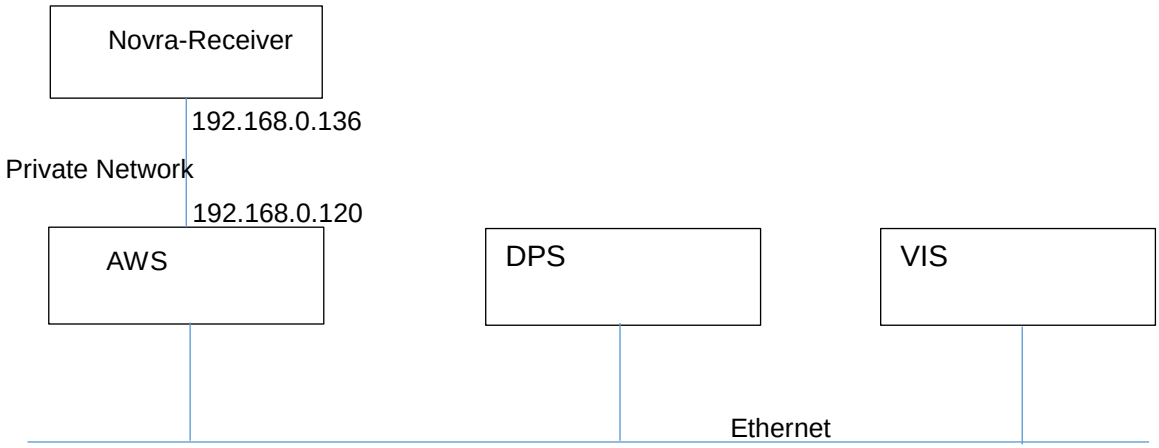


Figure 4: Novra Receiver Network Diagram

2.5. Acquisition Workstation

The Acquisition Workstation (AWS) is receiving data from the satellite receiver, formats it to level-1b data and stores it on disk and provides data services to provide that data to processing

workstations.

The AWS runs a Centos Linux operating system. Installed software consists of:

- Kencast Professional Client
- Novra Console
- GEOSAT500 installation

2.5.1. Control and Monitoring

The Nova-Console is used to configure and monitor the Novra receiver. The system is fully factory configured for the reception of the Himawaricast data.

Monitoring facilities include signal strength and bit error rate.

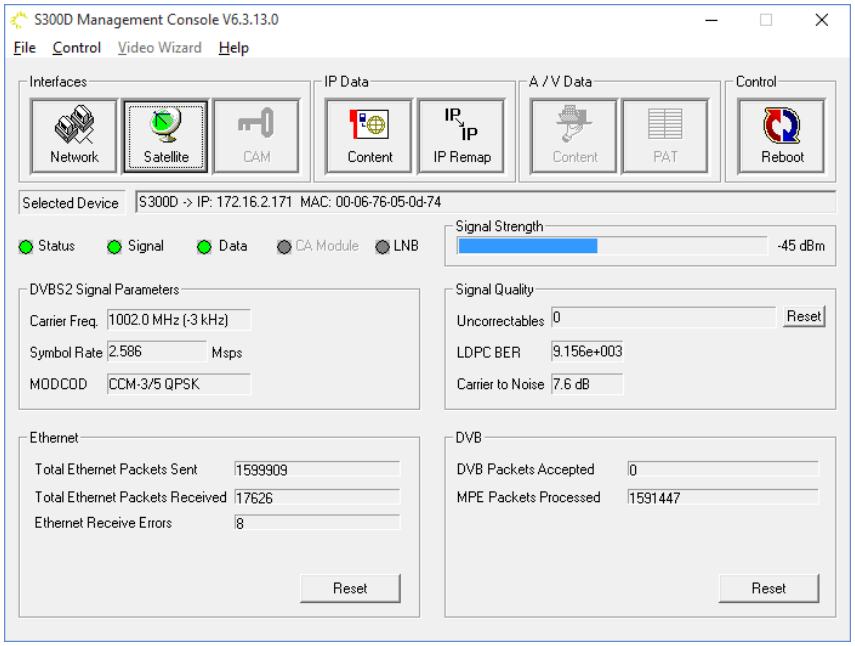


Figure 5: Novra Receiver Console Main Screen

2.5.2. Configuration

2.5.2.1. Network configuration

The network communication between the receiver and the AWS is usually been configured to be a private network. That way no other devices can congest the network, thus interruption the continuous data stream from the satellite receiver.

2.5.2.2. Typical network setup

AWS IP address: 192.168.0.120
Receiver IP address: 192.168.0.136
Netmask: 255.255.255.0

2.5.2.3. LNB configuration

RF Frequency: 4148.000 MHz

LO Frequency: 5150.000 MHz
Symbol Rate: (automatic)
LNB Power: 18V (typically)
Band (Tone): off
Search Mode: DVB-S2

2.5.2.4. IP Data configuration

The PID for the Himawaricast data stream is 1001 (hex 0x3e9).

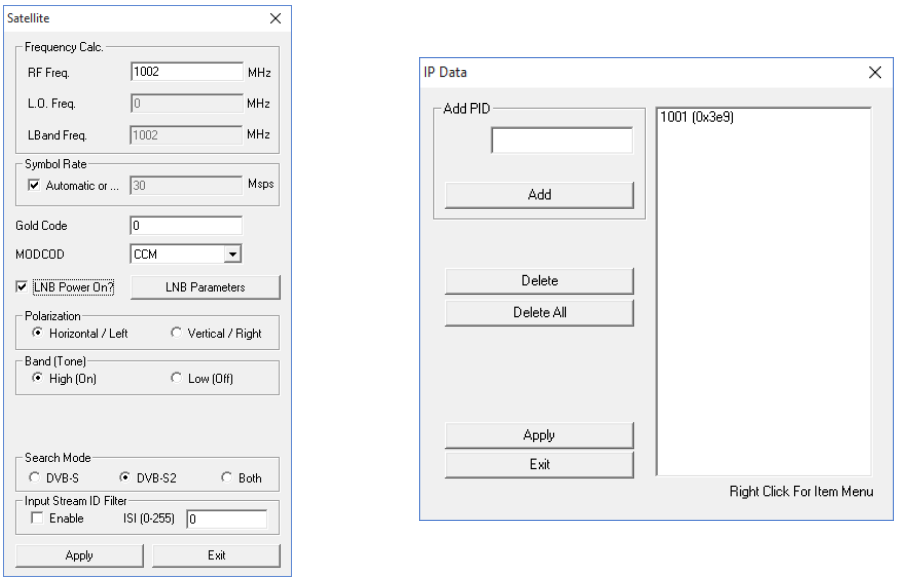


Figure 6: Novra-Receiver Configuration Screens

2.6. Data Ingest

Data ingest is done by the Kencast Fazzt Professional Client. Configuration and monitoring is accessible through a web page on the Acquisition Workstation:

Open a Web browser (Firefox):

url: https://localhost:4039/admin

New received data is being stored in /data/incoming/HRIT_in. The processing workstation will pickup data from that directory for image processing.

2.6.1. Configuration Settings

In order to receive the Himawaricast data from the NOVRA receiver, a data channel needs to be configured. Here, the data channel of interest is called “Himawaricast”.

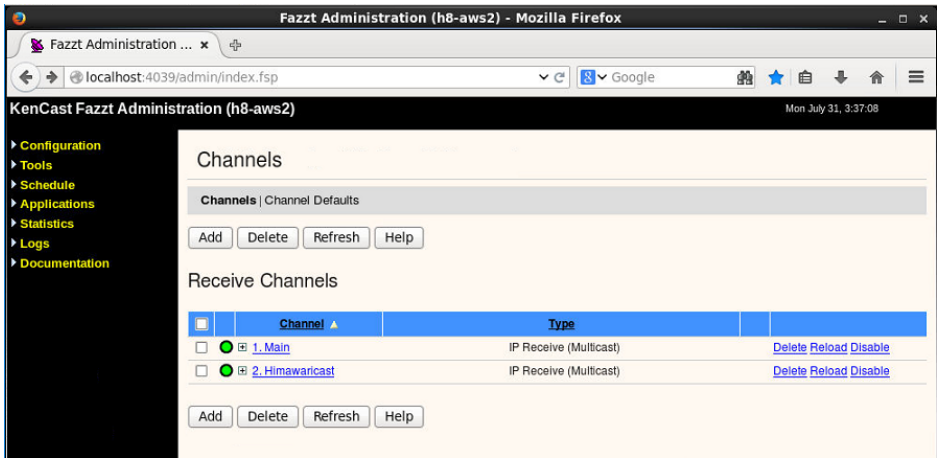


Figure 7: Kencast Fazzt Channel Configuration (1)

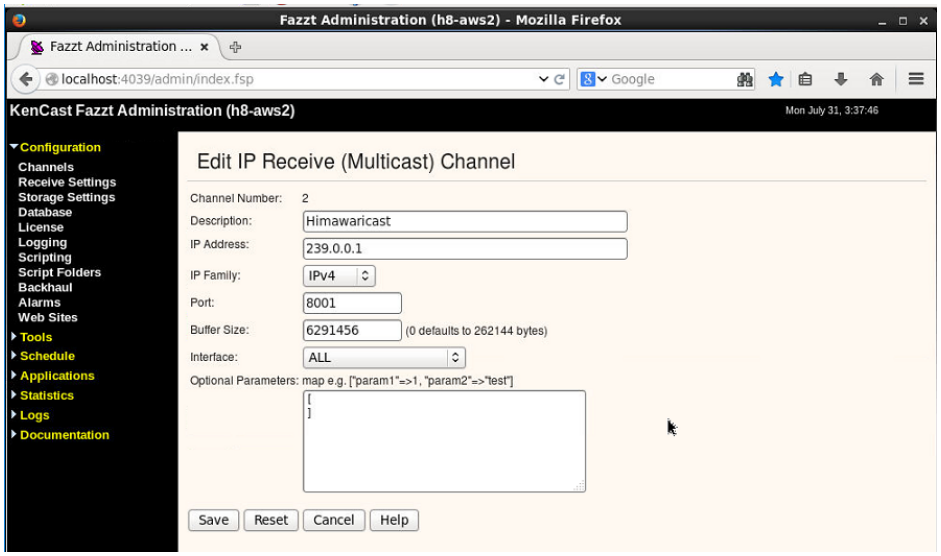


Figure 8: Kencast Fazzt Channel Configuration (2)

Once the receiver is been connected to the antenna and is able to demodulate the signal, the Kencast Fazzt Client should be able to pickup the data stream and write Himawaricast data file to disk.

The output file for the data files (level-1b files) is /ess/data/satellite/himawari89/level1b

2.6.2. Monitoring and System Test

Check receiver network connectivity

ping <receiver_ip>

View receiver signal level and bit error rate

Use Management Console

Use the web interface to

- check the reception status (System > DVB Receiver)
- check on received files (Logs > Received Files)

- check log files (Logs > Logs)

Monitor received files

ls –l /data/incoming/HRIT_in

3. Himawari Reception Systems with Kencast Edgespan Workstation

In case a Kencast Edgespan Workstation with an integrated DVB-S2 receiver card has been installed, the above section about Himawaricast applies, with the exception that the Novra receiver is being replaced by a DVB-S2 card which is housed inside the Kencast Edgespan Workstation.

The workstation is connected to the network just as a normal workstation. The IP configuration can be dynamic (DHCP) or static.

The following screens show the configuration screens for the DVB-S2 card inside the Kencast software.

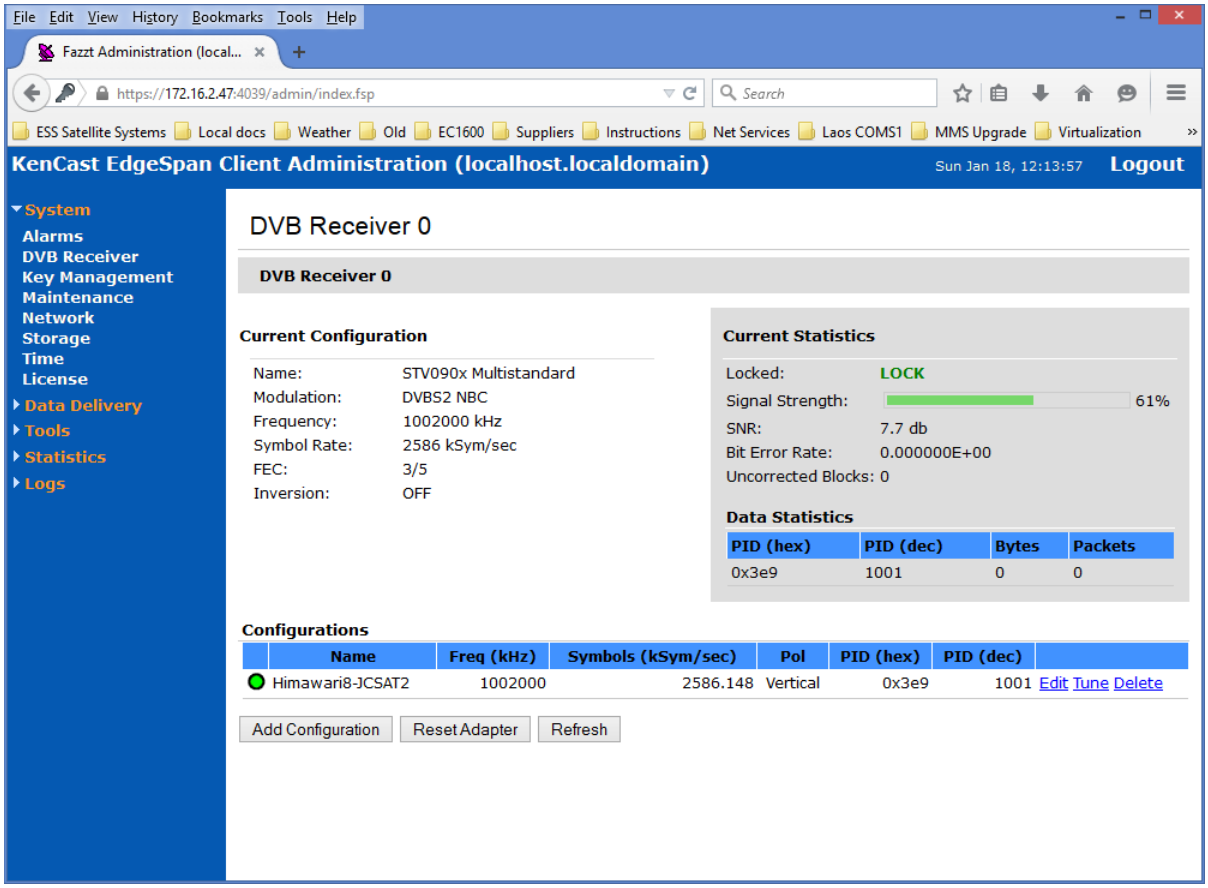


Figure 9: Kencast Fazzt – DVB Receiver Configuration

3.1. Monitoring and System Test

The web interface is accessible at this address: https://localhost:4039/admin

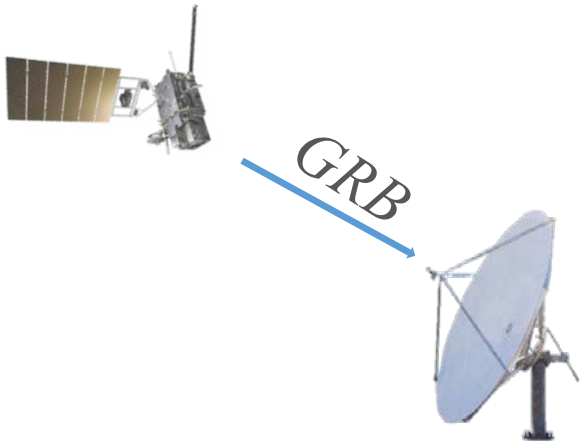
Use the web interface to

- check the reception status (System > DVB Receiver)
- check on received files (Logs > Received Files)

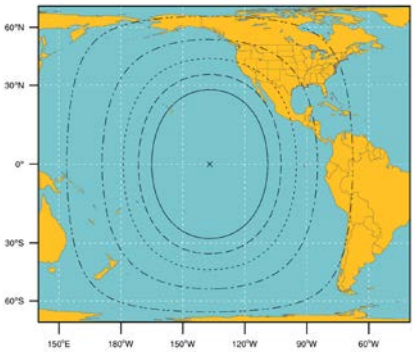
- check log files (Logs > Logs)

4. GRB Reception System

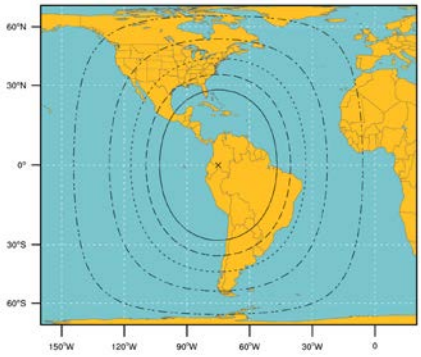
The GOES-GRB reception system received the direct broadcast from GOES-16 and later. This is an L-band transmission, using a fixed dish.

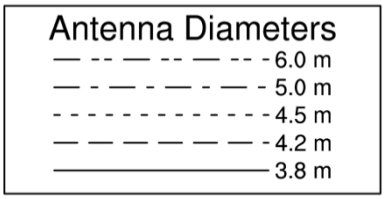


GOES-West



GOES-East





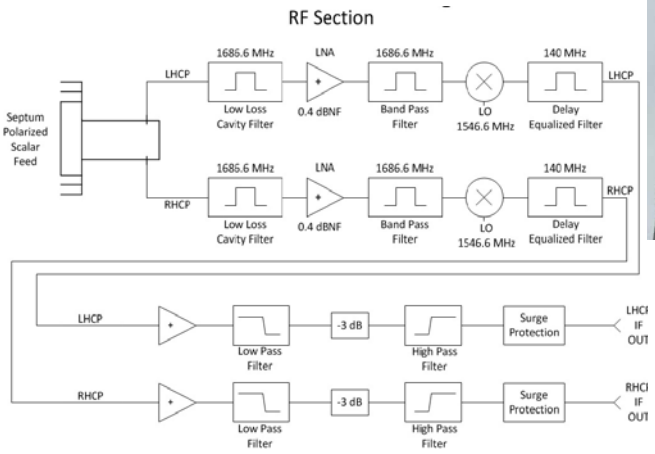
NOTES:

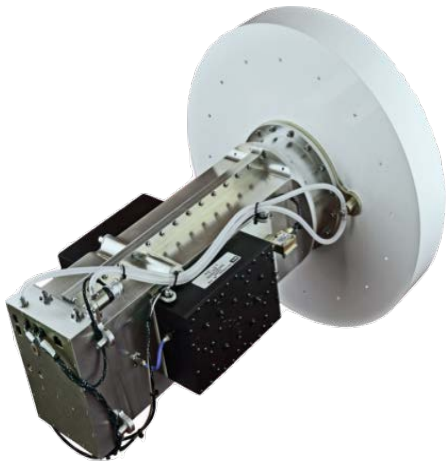
1. Calculations based on available data as of May 2011
2. Each antenna size is usable within the indicated contour
3. Rain attenuations included are: 1.3/1.6/2.0/2.2/2.5 dB (3.8 to 6 m)
4. An operating margin of 2.5 dB is included as the dual polarization isolation is likely to vary within each antenna size area

4.1. Antenna

Electrical		Series 1451 C-Band	Ku-Band
Antenna Size		4.5 M (15 ft.)	4.5 M (15 ft.)
Operating Frequency (GHz)		3.625 - 4.2	10.95 - 12.75
Midband Gain (±.2dB)		42.9 dBi	52.6 dBi
Polarization		Linear	Linear
3dB Beamwidth		1.2°	.42°
Feed Interface		CPR 229	WR 75
First Sidelobe (Typical)		-20 dB	-20 dB
Cross-Pol Isolation		>30 dB Min. (on axis)	>30 dB Min. (on axis)
VSWR		1.3:1 Max.	1.3:1 Max.
Mechanical			
Reflector Material		Glass Fiber Reinforced Polyester SMC	
Antenna Optics		8 Piece Axisymmetric, Prime Focus	
Mast Pipe Size		10" SCH 40 Pipe (10.75" OD) 27.30 cm.	
Elevation Adjustment Range		5° to 90° Continuous Fine Adjustment	
Azimuth Adjustment Range		360° Continuous	
Shipping Specifications	Weight	950 lbs. (428 kg.)	
Environmental Performance			
Wind Loading	Operational Survival	45 mph (72 km/h) 125 mph (201 km/h)	
Temperature	Operational Survival	-40° to 140° F (-40° to 60° C) -50° to 160° F (-46° to 71° C)	
Atmospheric Conditions		Salt, Pollutants and Contaminants as Encountered in Coastal and Industrial Areas	
Solar Radiation		360 BTU/h/ft²	

4.1.1. Feed





Feed Structure	High Efficiency Scalar Waveguide
Center Frequency	1686.6 MHz
Polarizer	Septum Type, Dual Left Hand and Right Hand
Polarity Isolation	> 27 dB
RF Filtering	Multi-Pole Extremely Hi Q Cavity Filter (Pre LNA)
RF Bandwidth	20 MHz Converted Bandwidth
LNA (s)	25K Noise Temp (0.4 dB Noise Figure)
Downconverter (s) LO Frequency	1546.6 MHz
Image Rejection	> 100 dB
Output Frequency (Dual Channel)	140 MHz Dual Channel LHC and RHC
Downconverter (s) Performance	Very High TOIP +36 dBm, Low Phase Noise -93dBc/Hz @ 10 kHz
Feed Power	+24 VDC @ 400 mA Supplied by Demodulator Through Control Cable
Environmental	-40 to +50 C

4.2. Receiver

100 – 230VAC FEED POWER SD Slot Ethernet LHCP/RHCP Input

Basic Demodulator Structure	Advanced ASIC Based Digital Demodulation, DVB-S2 Standard Compliant
GRB Modes / Decoding Supported	QPSK 9/10 Symbol Rate 8.665938 Msps / 8PSK 2/3 Symbol Rate 7.825768 Msps
FEC Supported	LDPC / BCH
GRB Coding and Modulation	CCM (Constant Coding and Modulation)
Implementation Loss	Near Shannon-Limit
Typical Eb/No for QEF Performance	4.1 dB (QPSK 9/10)
QEF = PER Better than 1E-6	3.9 dB (8PSK 2/3)
Transport Stream Support	Generic Transport Stream for Space Data Packets
Matched Filtering	0.25 Roll-Off Factor
Channels Supported	Simultaneous LHCP and RHCP Reception
Input Frequency (Dual Channel)	140 MHz
Input Filtering	SAW Filter Matched to GRB Signal Bandwidth

Data / Status Interface	GB Ethernet / CADU packets via UDP
Receive Signal Strength Indicator (RSSI)	DC Voltage Output for Remote Antenna Alignment
Size	1U Rack Mount
Power	Universal 100 - 240 VAC, 47 to 63 Hz
RF Input Connectors (2)	Type N Female
Feed Support	Provides Power To and Monitors Status of GRB Dual Polarity Feed

4.3. Acquisition Workstation

Here a Dell R430 workstation is being show. Note that this is likely to change as new workstations are being sold or if the customer requires a different model.

4.3.1. Typical AWS Specification

	Requirements

CPU	12 Core 2.4GHz CPU
MEMORY	32 GBytes min
HARD DISK	100 Gbytes min
LAN	2 x Gigabit Ethernet
POWER SUPPLY	Single or Dual
Operating System	64 bit CentOS 6

4.4. Processing Workstation

4.4.1. Typical DPS Specification

	Requirements
CPU	20 Core 2.4GHz CPU
MEMORY	192 GB

HARD DISK	14 TB min
LAN	Gigabit Ethernet
POWER SUPPLY	Single or Dual
Operating System	64 bit CentOS 6

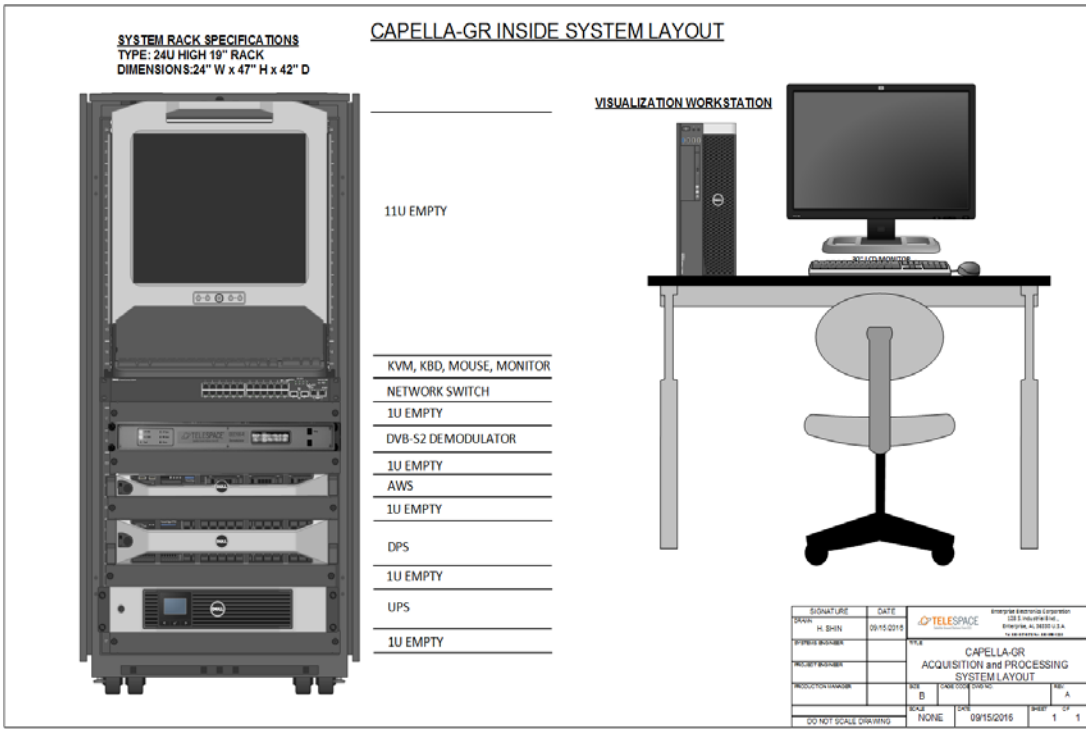
4.5. Visualization Workstation

4.5.1. Typical Visualization Workstation Specification

	Requirements
CPU	Quad Core i7 or Xeon
MEMORY	16 GB
HARD DISK	2 TB

LAN	Gigabit Ethernet
Monitor	20” (1980x1280)
Operating System	64 bit CentOS 6

4.6. Example Setup



4.6.1. Network Diagram

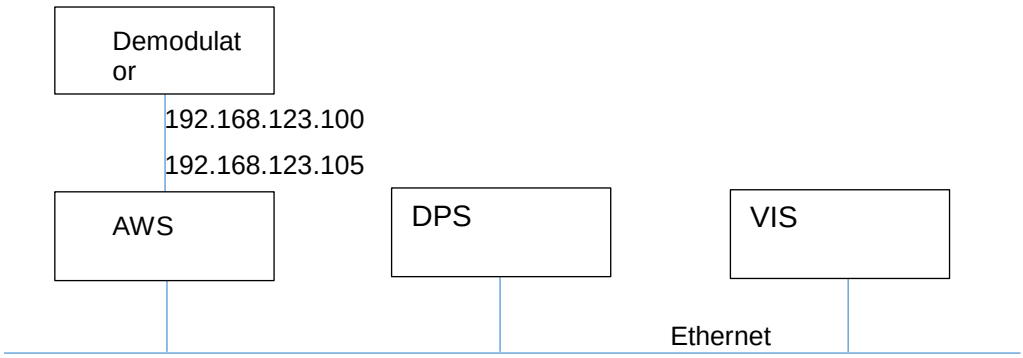
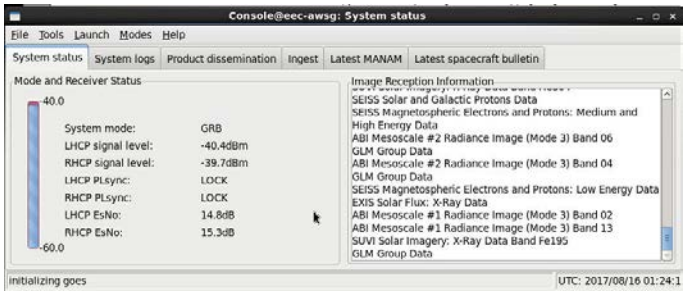


Figure 11: GRB Reception System – Network Diagram

4.7. Monitoring of Receiver and Data Reception



4.8. Data ingest

Data ingest is done by the software package CSPP_GEO_CSPP. The software is installed in the directory /ess/packages. A symbolic link i/ess/packages/CSPP/cspp-geo-grb links to the actually installed package, i.e. /ess/packages/CSPP_GEO/cspp-geo-grb-<version>. Please refer to the documentation for CSPP_GEO_CSPP about configuration options.

Data from CSPP_GEO_CSPP is been written to ${CSPP_HOME}/cspp-geo-grb/output, which in turn is a link to /ess/data/satellite/goes/grb/level1b/incoming.

Configuration files:

${CSPP_HOME}/cspp-geo-grb/grb_env.sh

${CSPP_HOME}/cspp-geo-grb/output -> /ess/data/satellite/goes/grb/level1b/incoming

${CSPP_HOME}/cspp-geo-grb/RT-CSPP/config/GRB.xml

${CSPP_HOME}/cspp-geo-grb/RT-CSPP/jsw/conf/grb-ingestor.conf

CSPP_GEO_GRB is started by skManageCSPPGeo, which calls cspp-rt-grb.sh start|stop|status.

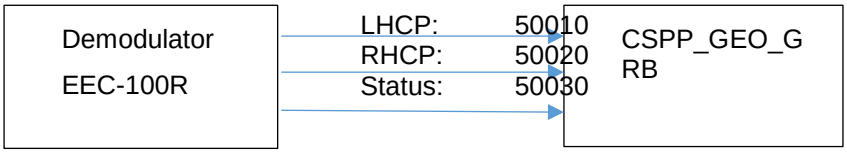


Figure 12:EEC-100R Communication Channels

4.8.1. Monitoring of CSPP_GEO_GRB

ifconfig <Ethernet interface> Check packet counters

cspp-rt-grb.sh status PID

lsof –i –p <pid> Port numbers 500x0

ingest log:

$CSPP_GEO_GRB_HOME/output/var/log/grb.log

5. COMS1 Reception System

5.1. Antenna

The Korean COMS1 spacecraft sends data via direct broadcast trough an L-band channel. Data is being formatted as HRIT.

Dish: 3.6m

Frequency: 1695.4MHz

Polarization: linear

Data rate: 3000kbps

LNB local oscillator: 1553.5MHz

IF: 137.5 MHz

Satellite longitude: 128.2 degree

Receiver: LRD-200 or LRD-200B

Feed: Scalar feed and downconverter

Figure 13: COMS1 antenna

5.2. Feed and Downconverter

A Scalar feed is being used. The downconverter is directly been attached to the feed. The output of the downconverter is at 137.5MHz and directly be connected to the receivers input.

Power to the downconverter is supplied by the receiver.

Figure 14: Feed and downconverter

5.3. Receiver

A Quourm LRD-200GEO or LRD-200B is being used to demodulate the received signal. Data is being output via USB.

The Receiver control is either through RS232 or Ethernet.

The Ethernet is setup to use the manufacturers default IP setup. It is connected to a dedicated network port on the AWS. Data transfer uses the receivers USB interface.

Figure 15: LRD-200 receiver

In case of RS232 communication, the interface is set for 9600 bps, 8 bit per data word, no parity, 1 stop bit (9600-8N1).

The receiver will supply 12 DC via its RF connector to power the downconverter.

The receiver is housed in a 1U high rack mount enclosure.

Mains RS232 Ethernet USB RF Input

Figure 16: LRD-200 Rear Panel

5.4. Network Diagram

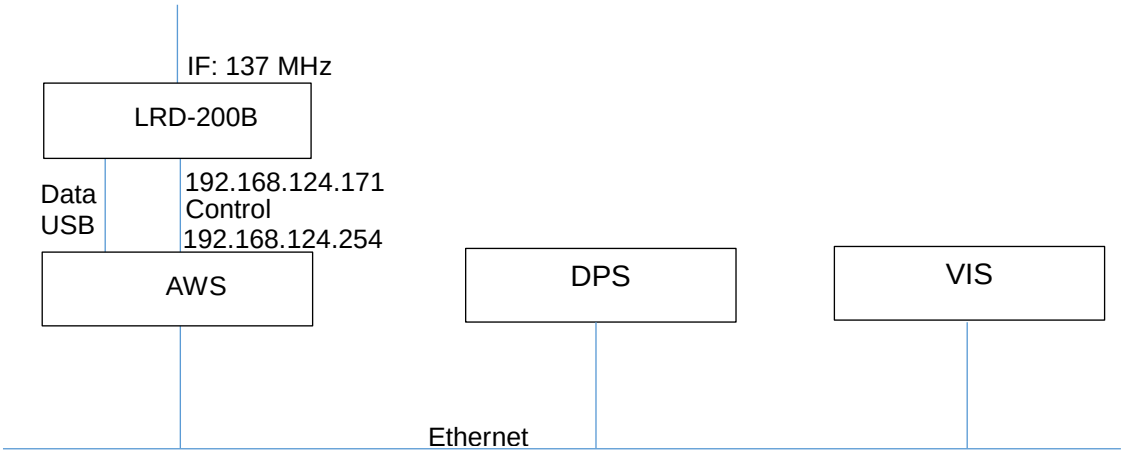


Figure 17: Network Diagram

5.5. Data ingest

The receiver provides demodulated on its USB interface. In the AWS, the process qrx takes the data from the USB and forwards it to the frame formatting program satingest via socket communication on the local host. qrx and satingest are been started from a cron job and should be running all the time. Start and end of the data reception are driven by the satellite data itself. No external control is needed.

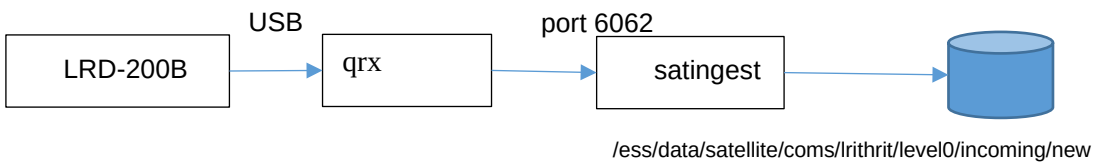


Figure 18: Data ingest for COMS1 (and GVAR)

Data processing will pickup the data from the directory

/ess/data/satellite/coms/lrithrit/level0/incoming/new and then produce image products.

5.6. Control and Monitoring

The receiver frequency and mode can be controlled over its user interface on the front panel. See the separate manual for the receiver.

The Console on the AWS queries and displays the status of the receiver. This is done either through the Ethernet or the RS232 interface.

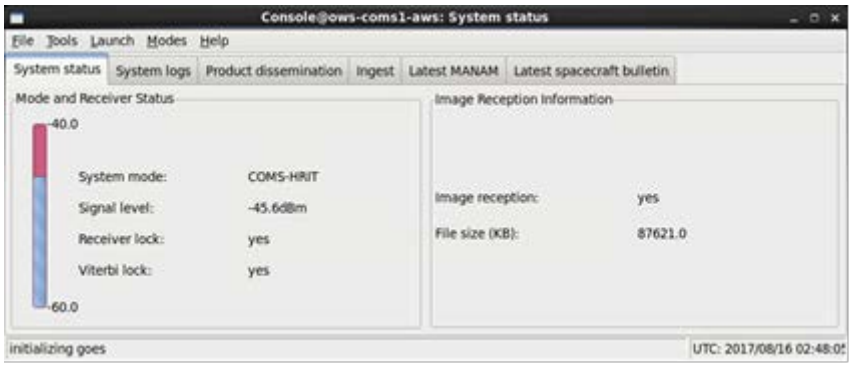


Figure 19: Console showing COMS reception status

5.6.1. Process Monitoring

Check that qrx and satingest are running:

ps –ef | grep qrx

ps –ef | grep satingest

6. GVAR Reception System

The GOES-GVAR reception system is very similar to the COMS1 reception system. The antenna, receiver and workstations share the same requirements.

Differences are:

- For the data ingest, satingest is being replaced by frame_gvar
- Satellite frequency: 1685.7 MHz

7. The MTSAT, Fengyun-2, COMS-1, Himarwai and GOES satellites

7.1. MTSAT

Figure 20 MTSAT-1R

MTSAT-1R or MTSAT-2 is a geostationary spacecraft with two mission objectives: to assist in air traffic control and navigation for the Civil Aviation Bureau of the Ministry of Land, Infrastructure and Transport., and to provide meteorological data for the Japan Meteorological Agency. MTSAT-1R/2 replaces the Geostationary Meteorological Satellite (GMS) series as the next generation of spacecraft covering East Asia and the Western Pacific. It is currently in a standby mode, with Himawari-8/9 replacing its service.

MTSAT LRIT and HRIT are new digital data streams designed to replace the WeFAX and SVISSR formats transmitted by the GMS series. The LRIT and HRIT formats are identical, the only difference being the data rate: if this is < 256kbits/s, the communication link is referred to as LRIT, and as HRIT when the rate is >= 256kbits/s. HRIT is the only transmission that contains all of the data sampled by the spacecraft at the maximum spectral and spatial resolutions.

Band name	Wavelength (μm)
VIS	0.55 – 0.9
IR1	10.3 – 11.3
IR2	11.5 – 12.5
IR3	6.5 – 7.0
IR4	3.5 – 4.0

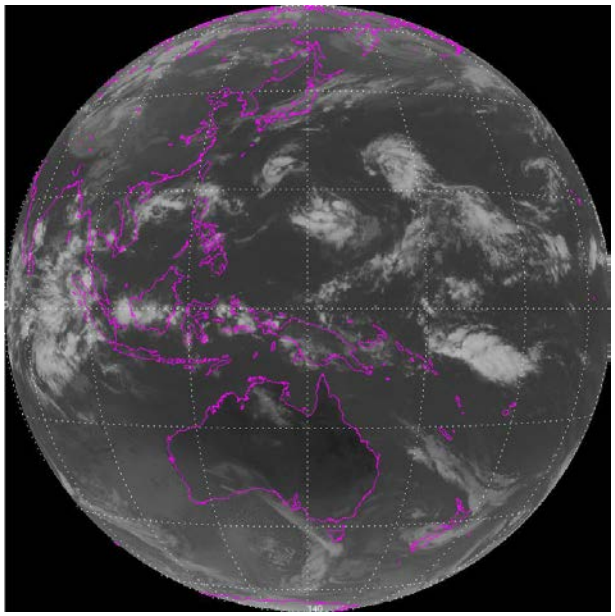
Table 2-1 MTSAT spectral bands

The data is formatted in accordance to standards defined by the Consultative Committee for Space Data Systems (CCSDS), a packetized data format that is now used for a wide variety of space-based data communications.

MTSAT-1R also transmits similar data in HiRID format, which is backwards compatible with the

GMS SVISSR format.

The GEOSAT500 can receive and process imagery in HRIT and, as options, LRIT, and HiRID formats.



7.1.1. MTSAT HRIT transmissions

MTSAT HRIT data is comprised of navigated, calibrated JPEG data covering three Earth sectors.

7.1.1.1. Earth Disk sector

Sector label	DK01
Projection	Normalised geostationary
Channels	VIS, IR1, IR2, IR3, IR4
Bits/pixel	10
Resolution	1km/pixel at sub-satellite point (VIS) 4km/pixel at sub-satellite point (IR)
JPEG type	Lossless
Image size	2200 x 2200
Segmented?	Yes: 10 segments of size 2200 x 220

All sectors are segmented, which means that the data is transmitted in separate files. The GEOSAT500 software automatically combines these segments.

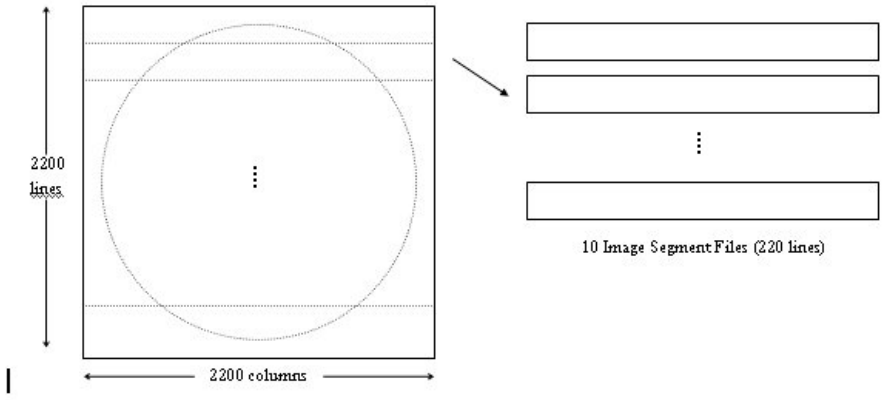
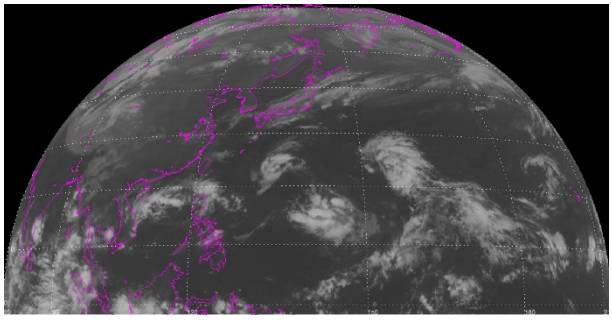


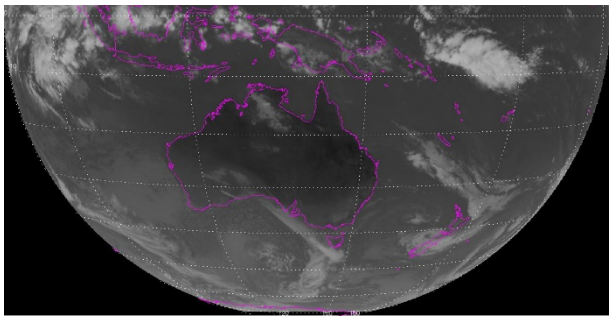
Figure 21 Earth disk segments

7.1.1.2. Northern hemisphere sector



Sector label	DK02
Projection	Normalised geostationary
Channels	VIS, IR1, IR2, IR3, IR4
Bits/pixel	10
Resolution	1km/pixel at sub-satellite point (VIS) 4km/pixel at sub-satellite point (IR)
JPEG type	Lossless
Image size	2200 x 1100
Segmented?	Yes: 5 segments of size 2200 x 220

7.1.1.3. Southern hemisphere sector



Sector label	DK03
Projection	Normalised geostationary
Channels	VIS, IR1, IR2, IR3, IR4
Bits/pixel	10
Resolution	1km/pixel at sub-satellite point (VIS) 4km/pixel at sub-satellite point (IR)
JPEG type	Lossless
Image size	2200 x 1100
Segmented?	Yes: 5 segments of size 2200 x 220

7.1.1.4. Other data transmissions

During certain downlinks, the spacecraft will transmit one-bit overlay files for each of the three sectors. These overlay files contain coastlines and latitude/longitude gridlines registered to the image data.

The MANAM is also telemetered at various points in the schedule. The MANAM is akin to that for GMS, describing the transmission schedules for a fixed period of time together with any information notices.

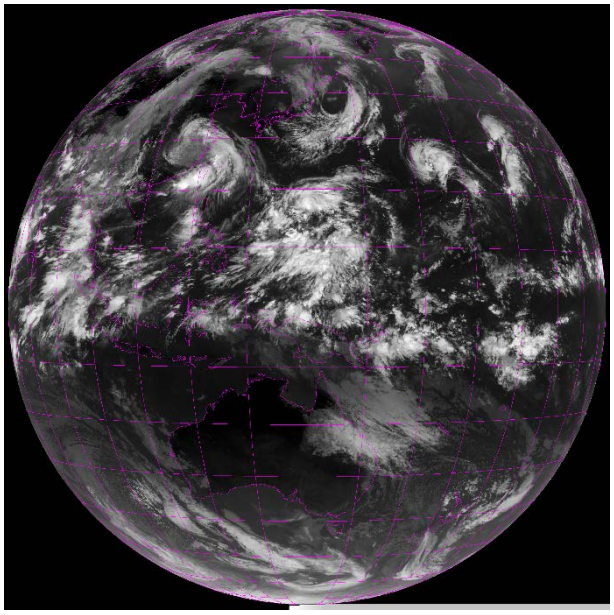
For critical information that requires immediate dissemination to users, special bulletins will be transmitted separately to the MANAM. For critical weather information, the satellite may also transmit a further sector (SF01) covering the area of interest.

The GEOSAT500 automatically overlays coastlines/gridlines on the image data, extracts the MANAM, special bulletins, and any extra SF01 sectors, making them available to the operator.

7.1.2. MTSAT LRIT transmissions

LRIT data is comprised of navigated, calibrated JPEG data covering four Earth sectors.

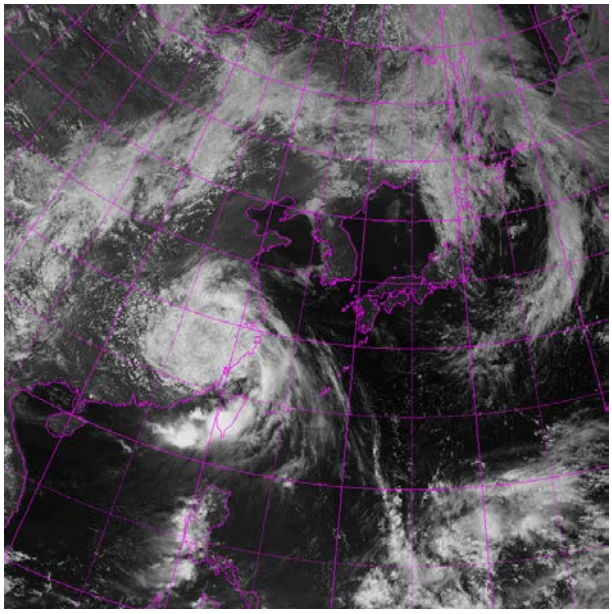
7.1.2.1. Earth Disk sector



Sector label	DK01
Projection	Normalised geostationary
Channels	IR1, IR3
Bits/pixel	8
Resolution	5km/pixel at sub-satellite point
JPEG type	Lossless
Image size	2200 x 2200
Segmented?	Yes: 10 segments of size 2200 x 220

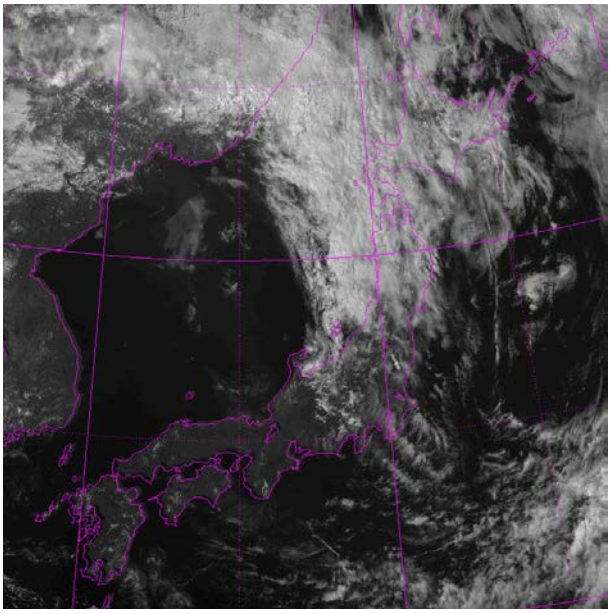
As for HRIT, Earth disk sectors are segmented, which means that the full disk is transmitted in separate files. The GEOSAT500 software automatically combines these segments.

7.1.2.2. East Asia sector



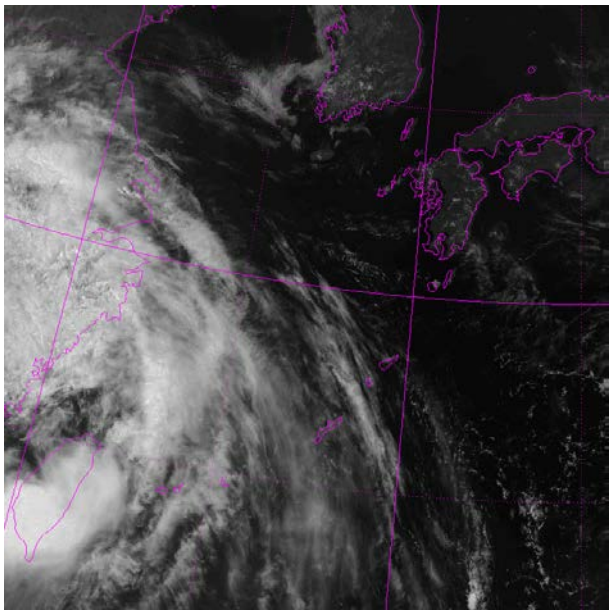
Sector label	PS01
Projection	Polar stereographic
Channels	VIS, IR1, IR3, IR4
Bits/pixel	6 (VIS), 8 (IR)
Resolution	6.4km/pixel at sub-satellite point
JPEG type	Lossy
Image size	800 x 800
Segmented?	No

7.1.2.3. North-East Japan sector



Sector label	PS02
Projection	Polar stereographic
Channels	VIS
Bits/pixel	6
Resolution	2.4km/pixel at sub-satellite point
JPEG type	Lossy
Image size	800 x 800
Segmented?	No

7.1.2.4. South-West Japan sector



Sector label	PS03
Projection	Polar stereographic
Channels	VIS
Bits/pixel	6
Resolution	2.1km/pixel at sub-satellite point
JPEG type	Lossy
Image size	800 x 800
Segmented?	No

7.1.2.5. Other data transmissions

These are similar to the additional transmissions for HRIT. The GEOSAT500 automatically overlays coastlines/gridlines on the image data, extracts the MANAM, special bulletins, and makes them available to the operator.

7.1.3. MTSAT HiRID transmissions

As an option, the GEOSAT500 can also receive HiRID transmissions from MTSAT. This format is compatible with the old GMS SVISSR format and allows ground stations to continue receiving data from MTSAT-1R using GMS equipment. HiRID offers no advantages over HRIT: in fact, HRIT is the only transmission from MTSAT-1R to contain all four channels at the maximum resolution. HRIT downlinks are also more frequent that HiRID. JMA will discontinue HiRID broadcasts in December 2007.

Some key properties of HiRID transmissions:

- Three sectors: Full disk, Northern hemisphere, and Southern hemisphere;
- Channels: VIS, IR1, IR2, and IR3. Calibration data for IR4 is not present in the downlink.
- Resolution: 1.25km/pixel max for the visible channel, 5km/pixel max for the IR channels.

7.1.4. Observation schedules and the MANAM

The MANAM describes when MTSAT data will be transmitted by the spacecraft, the schedule varying according to JMA's observation priorities. Some example MANAM entries are below:

```
SCHEDULE:
TIME(UTC)  HRIT                  7   8   9  10  11  12  13  14  15  16
0000-0006  F00   FULL-DISK       0   0   0   0   0   0   0   0   0   0
0018-0021  S00   SOUTH           0   0   0   0   0   0   0   0   0   0
```

```
0034-0037  S00W  SOUTH            0   0   0   0   0   0   0   0   0   0
```

The MTSAT MANAM is more complex than that from the GMS series. The times stated in the GMS MANAM refer to both observation and transmission times: data is transmitted as soon as it's sampled by the satellite. This is not the case with MTSAT, where data is observed then stored on-board for later transmission.

Take the 0018 downlink as an example. The MANAM states that the type is "S00". This means that although the data is transmitted at 0018, the data was sampled by the spacecraft at observation time S00. A further data source must be examined in order to determine the S00 time.

The MTSAT observation schedule can be found at http://mscweb.kishou.go.jp/operation/index.htm and contains the observation times for all MTSAT data streams. The S00 entry states that the observation begins at 2359 and ends at 0012. So in this particular example, the data transmitted at 0018 was actually observed at 2359 the previous day. Therefore, the images produced from this transmission will have the **observation time** (2359) in their filename and **not the transmission time** (0018).

Note that the MANAM is for informational purposes only. The GEOSAT500 does not use the MANAM to start/end ingest operations: it continuously monitors the data from the antenna and ingests any transmission received.

7.2. Fengyun-2

Figure 22 Fengyun 2C

Fengyun-2 (FY2) is a geostationary meteorological spacecraft series managed by the Chinese Meteorological Agency[2]. The operational satellites in 2014 are FY-2D and FY-2E, located at 86° East and 105° East separately while FY-2F is in a standby backup state. These satellites transmit five bands of image data in SVISSR format.

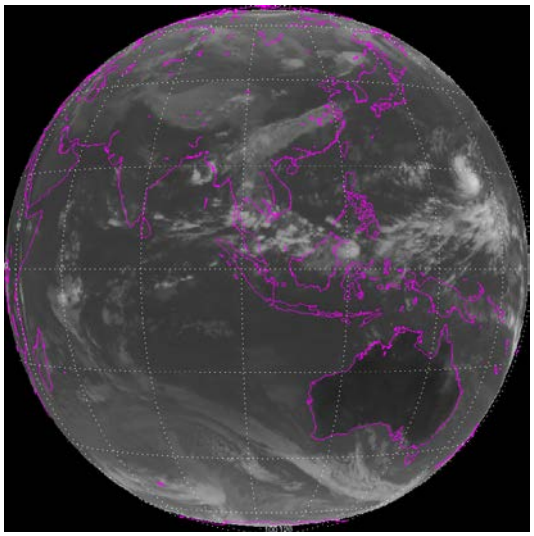
Band name	Wavelength (μm)
VIS	0.55 – 0.9
IR1	10.3 – 11.3
IR2	11.5 – 12.5
IR3	6.3 – 7.6

[2] FY-2 reception is available as a GEOSAT500 option

IR4	3.5 – 4.0

7.2.1. FY2 SVISSR transmissions

Fengyun-2 SVISSR downlinks cover the entire Earth disk.



Channels	VIS, IR1, IR2, IR3, IR4
Bits/pixel	10 (IR), 6 (VIS)
Resolution	1km/pixel at sub-satellite point (VIS) 4km/pixel at sub-satellite point (IR)

7.2.2. Observation schedules and the MANAM

The FY2 MANAM describes when data will be transmitted by the spacecraft, the schedule varying according to CMA's observation priorities. The MANAM is included with each image downlink and is automatically extracted by the GEOSAT500 and made available to the operator via the GEOSAT500 Console. Some example MANAM entries are below:

```
TIME(UTC)   VISSR   09     10     11     12     13     14     15
0000 – 0026 V-0 F   O      O      O      O      O      O      O
0100 – 0126 V-1 F   O      O      O      O      O      O      O
0200 – 0226 V-2 F   O      O      O      O      O      O      O
```

The transmission start/end times are given in the first column. The second column states an identifier for the downlink and the remaining columns give the downlink status for the subsequent seven days: an "O" means operational and other values, given in a legend at the bottom of the MANAM, mean that the downlink will not occur for some reason, such as an eclipse operation.

Note that the MANAM is for informational purposes only. The GEOSAT500 does not use the MANAM to start/end ingest operations: it continuously monitors the data from the antenna and ingests any transmission received.

7.3. COMS1

7.3.1. Introduction to COMS1

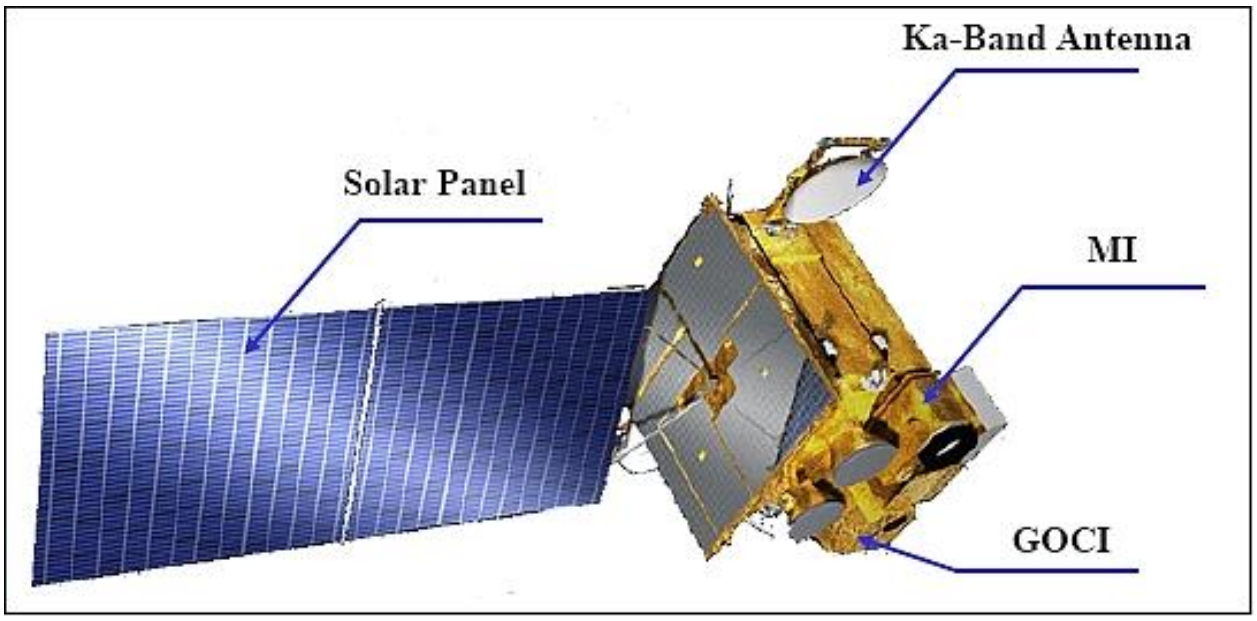


Figure 23 COMS1 satellite

COMS1 is a South Korean geostationary satellite primarily designed for meteorological and oceanographic observations.

COMS1 is operated by the Korean Aerospace Research Institute (KARI).

Launched in June 2010, expected to have a 7-8 year operating life.

Two main instruments:

Meteorological Imager (MI)

Designed for weather observation and forecasting

5 bands (1 x VIS, 4 x IR)

Same channels and resolution as MTSAT

MI data publically available via direct broadcast and internet

Several image areas, including whole earth disk and selected sub regions

Available via internet or direct broadcast

Global Ocean Color Instrument (GOCI)

Designed for coastal ocean monitoring, for biological analysis and fishing resource management

8 bands (6 x VIS, 2 x NIR)

First geostationary ocean colour instrument

Covers areas around Korean peninsula

Available only in Korea by high speed direct broadcast

The data of COMS1 Meteorological Imager is broadcasted via HRIT/LRIT in a very similar way like MTSAT. **But COMS1 HRIT/LRIT are encrypted be default. So customers need to apply the**

decryption key from KMA for the reception of COMS1 HRIT/LRIT.

7.3.2. COMS1 scan types

Observation mode	Observation target area	Minimum observation period	Observation time per cycle
Global	FD: Full disk (East-West) direction	30 minutes	≤ 27 minutes
Regional	APNH: Asia-Pacific northern hemisphere ENH: Extended northern hemisphere LSH: Limited southern hemisphere	30 minutes 30 minutes 30 minutes	Per scan speed of the global observation mode
Local	LA: Local area	10 minutes	1 minute

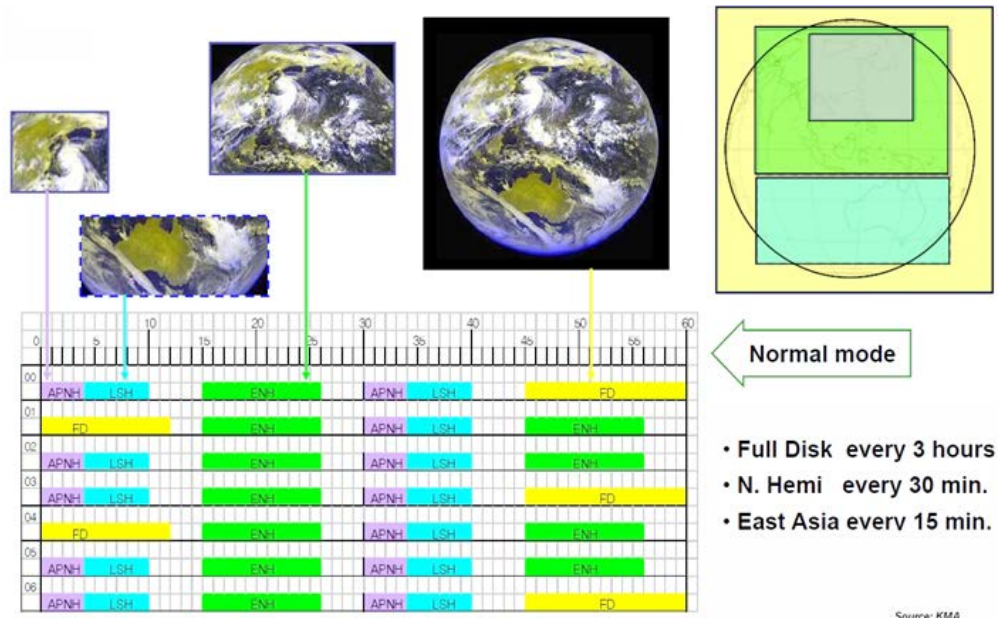


Figure 24 COMS1 scan types

In the real operation schedule of COMS-1, the Full Disk is observed once every 3 hours, ENH is observed 4 times at non full disk hour and twice at full disk hour. So the total observations each day is 88.

7.3.3. COMS1 footprint

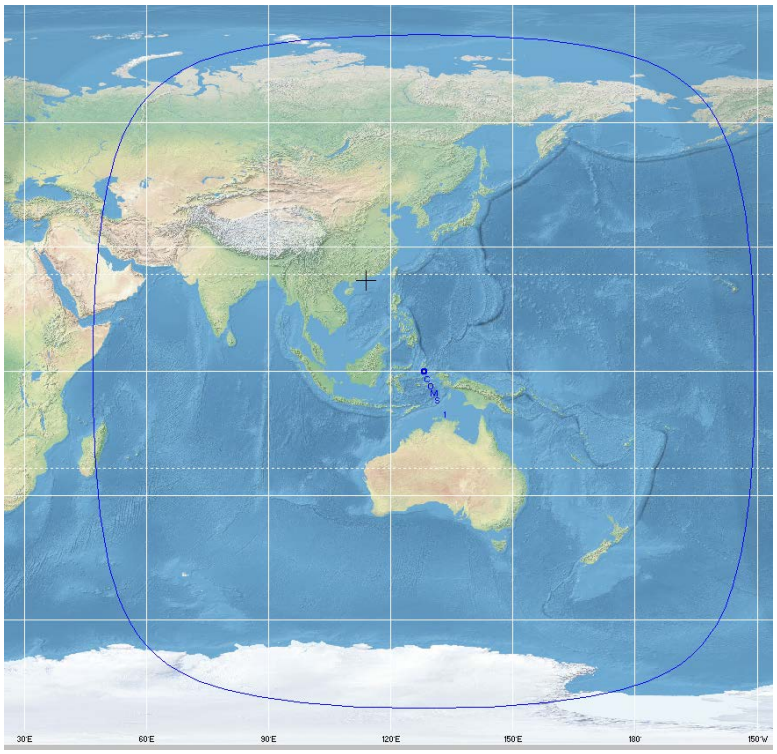


Figure 25 COMS1 footprint

7.3.4. COMS1 instruments

7.3.4.1. Meteorological imager

Number of Channels			5ch (Vis-1ch, IR-4ch)
Digitization			10 bits
Full Disc Scan Time			< 27min.
Channel	Spectral band(㎛)	IFOV (km)	Application
VIS (Visible)	0.675	1	Daytime cloud imagery Detection of special event (yellow dust, fire, haze, etc.), Atmospheric motion vector
SWIR	3.75	4	Nighttime fog/stratus, Fire detection, Surface temperature
WV (Water Vapor)	6.75	4	Upper atmospheric water vapor, Upper atmospheric motion
WIN1 (Window)	10.8	4	Standard IR split window channel (Cloud, Sea surface temperature, Yellow sand detection)
WIN2 (Window)	12.0	4	Standard IR split window channel (Cloud, Sea surface temperature, Yellow sand detection)

Source: KMA

7.3.4.2. Global Ocean Colour Imager

Item	Requirements					
Spatial Resolution	500m X 500m (± 10%)					
Coverage	2,500km X 2,500km					
No. of Band	8 Visible bands					
Band Center Band Width Nominal Radiance Max Radiance NEdL SNR	Band Center [nm]	Band Width [nm]	Nom. Rad [Wm^{-2} $um^{-1}sr^{-1}$]	Max. Rad. [$Wm^{-2}um^{1}sr^{-1}$]	NEdL	SNR
	412	20	100	150.0	0.100	1,000
	443	20	92.5	145.8	0.085	1,090
	490	20	72.2	115.5	0.067	1,170
	555	20	55.3	85.2	0.056	1,070
	660	20	32.0	58.3	0.032	1,010
	680	10	27.1	46.2	0.031	870
	745	20	17.7	33.0	0.020	860
	865	40	12.0	23.4	0.016	750
MTF	≥ 0.3 at Nyquist frequency					
Dynamic Range	≥ 11bit					
Sensor Calibration	- Calibration type : Solar Calibration - Accuracy of Radiometric Calibration : ≤ 3%					
Number of observation	· 10:00 ~ 17:00 : 8 times, · 22:00, 02:00 : 2 times					

Source: KMA

7.3.5. COMS1 HRIT RF characteristics

Parameters	Values
Information data rate	3 Mbps
Coding	Reed-Solomon (255/223, 4) and Convolutional coding (1/2, K=7)
Pulse shaping	Root-Raised Cosine with 0.5 of roll-off factor
Modulation	NRZ-L/QPSK
Bandwidth	≈ 5.2 MHz
Center frequency	1695.4 MHz
Polarization	Linear in north-south direction
Satellite EIRP	55.0 dBm
Satellite to SDUS distance (SDUS antenna elevation angle = 10 degree)	40586 km
Free space loss	189.27 dB
Atmospheric loss	0.5 dB
MDUS G/T	11.1 dB/K

For further information on setting up Internet COMS1 data distribution, see Appendix F.

7.3.6. Receiving MTSAT/COMS-1 data via the Internet Service

As an option, the GEOSAT500 can be configured to receive MTSAT/COMS-1 HRIT level-1b data from the JMA Data Dissemination Systems (JDDS) or KMA FTP Service. Such a configuration obviates the need for a dish, feed, receiver, and acquisition workstation.

To apply ftp username and password for the JMA JDDS service, please refer to JMA web link http://www.jma.go.jp/jma/jma-eng/satellite/nmhs/guide_JDDS.pdf

To apply ftp username and password for the KMA FTP service, please refer to KMA web link http://nmsc.kma.go.kr/html/homepage/en/dataservice/system_info.do

A service runs on the Data Processing System to automatically download MTSAT/COMS-1 HRIT data at fixed intervals. As this is HRIT level-1b data, the system does not need to construct the level-0 CCSDS file and parse it to create level-1b. The downloaded level-1b data is fed straight to the DPS workstation where it is processed in the same way as a level-1b file obtained through direct reception; indeed, the DPS has no knowledge of the where the level-1b data originated from.

This document contains information pertinent to both the direct reception and JMA JDDS/KMA FTP configurations. In the latter case, information pertaining to the dish, feed, receiver, acquisition workstation, CCSDS, level-0 data and its processing to level-1b can be ignored. The software sections contain more detail on how HRIT level-1b data is downloaded and injected into DPS.

Section 3.10 contains details of how to configure the system to download from the internet service rather than direct broadcast.

7.4. HIMAWARI-8 and 9

HIMAWARI-8 and 9 are the follow-on satellites to the previous MTSAT series of JMA. HIMAWARI-8 was successfully launched on 7 October 2014 and was put into operation on 7 July 2015. HIMAWARI-9 will be launched in 2016. Himawari-8 and 9 have a dedicated meteorological mission, whereas MTSAT performs both meteorological and aeronautical functions. They have a new payload called the Advanced Himawari Imager (AHI) with 16 bands as below.

Spectral Characteristics of AHI in 16 bands

as of MTSAT-1R/2

	Band	Wavelength [μm]	Quantization [bit]	Spatial Resolution (km)
VIS	1	0.46	11	1km
VIS	2	0.51	11	1km
VIS	3	0.64	11	0.5km
	4	0.86	11	1km
	5	1.6	11	2km
	6	2.3	11	2Km
IR4	7	3.9	14	2Km
IR3	8	6.2	11	2Km
IR3	9	7.0	11	2Km
IR3	10	7.3	12	2Km
	11	8.6	12	2Km
	12	9.6	12	2Km
IR1	13	10.4	12	2Km
IR1	14	11.2	12	2Km
IR2	15	12.3	12	2Km
	16	13.3	11	2Km

Similar to ABI for GOES-R

RGB band Composited

0.51 μm (Band 2) instead of ABI's 1.38 μm

Water vapor

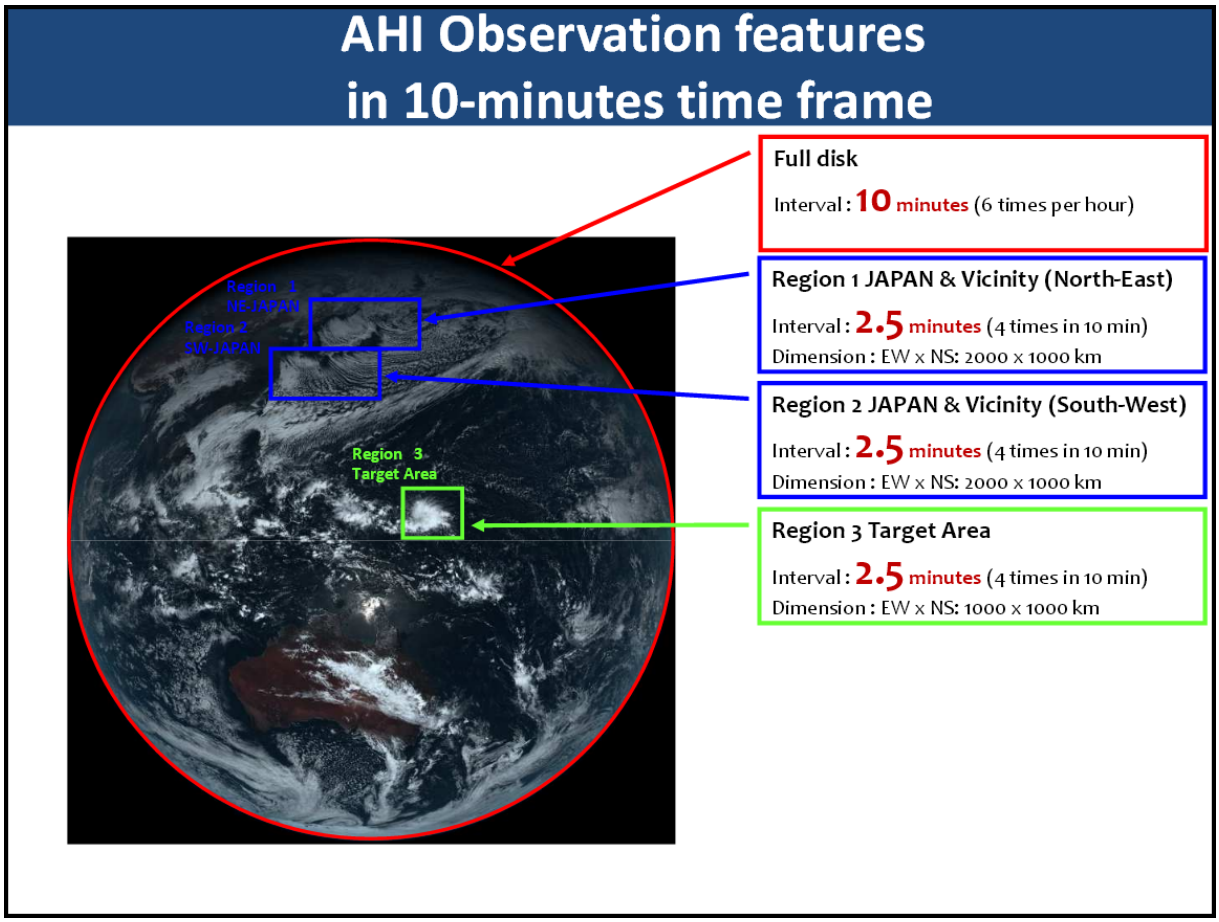
SO_2

O_3

Atmospheric Windows

CO_2

Himawari-8 and 9 carry AHI scanning with five areas: Full Disk (images of the whole Earth as seen from the satellites), the Japan Area (Regions 1 and 2), the Target Area (Region 3) and two Landmark Areas (Regions 4 and 5). While the scan ranges for Full Disk and the Japan Area will be preliminarily fixed, those of the Target Area and Landmark Areas will be flexible to enable prompt reaction to meteorological conditions. At the beginning of Himawari-8's operation, Landmark Area data will be used only for navigation, and are not intended for use as satellite products. In the future, JMA plans to use Region 5 for observation of phenomena such as rapidly developing cumulonimbus clouds and to provide the resulting data to users. In each 10-minute period, the AHI will scan the Full Disk once, the Japan Area and Target Area four times, and the two Landmark Areas twenty times, as below.



Himawari-8 and 9 don't carry equipment for direct dissemination. Instead, all imagery derived from the satellites is distributed to NMHSs via an Internet cloud service (see (a) in the figure below). Full sets of data also are provided to researchers via archive servers operated by the Japanese Science Group on a best-effort basis ((b) in the figure). The HimawariCast service additionally disseminates primary sets of imagery via a communication satellite using Digital Video Broadcasting — Satellite — Second Generation (DVB-S2) technology((c) in the figure).

Further details of the HimawariCast service are available at:
http://www.data.jma.go.jp/mscweb/en/himawari89/himawari_cast/himawari_cast.html.

More information on the cloud service are available at:

http://www.data.jma.go.jp/mscweb/en/himawari89/cloud_service/cloud_service.html.

Section 3.10 contains details of how to configure the system to receive HSD data from the internet service rather than HimarwariCast.

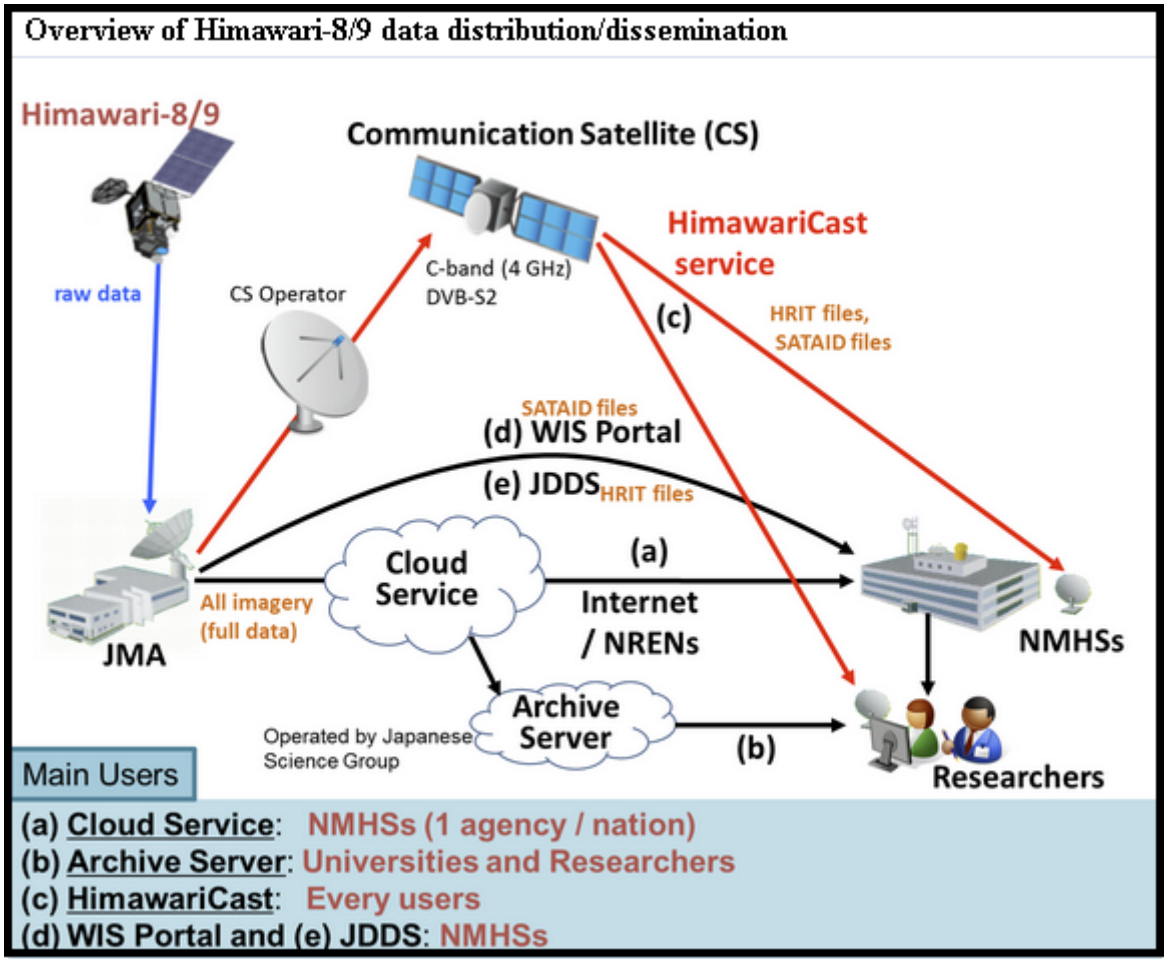
In addition, JMA continues the online imagery distribution service; WIS Portal ((d) in the figure) and the JMA Data Dissemination System (JDDS) ((e) in the figure)

More information about WIS Portal are available at:

http://www.wis-jma.go.jp/cms/sataid/

More information about JDDS are l are available at:

http://www.jma.go.jp/jma/jma-eng/satellite/nmhs/dssm_JDDS_HRIT.html


Overview of Himawari-8/9 data distribution/dissemination
Himawari-8/9
Communication Satellite (CS)
HimawariCast service
raw data
CS Operator
C-band (4 GHz)
DVB-S2
(c)
HRIT files,
SATAID files
SATAID files
(d) WIS Portal
(e) JDDS
HRIT files
Cloud Service
(a)
Internet / NRENs
All imagery (full data)
JMA
NMHSs
Archive Server
Operated by Japanese Science Group
(b)
Researchers
Main Users
(a) Cloud Service: NMHSs (1 agency / nation)
(b) Archive Server: Universities and Researchers
(c) HimawariCast: Every users
(d) WIS Portal and (e) JDDS: NMHSs

7.5. GOES

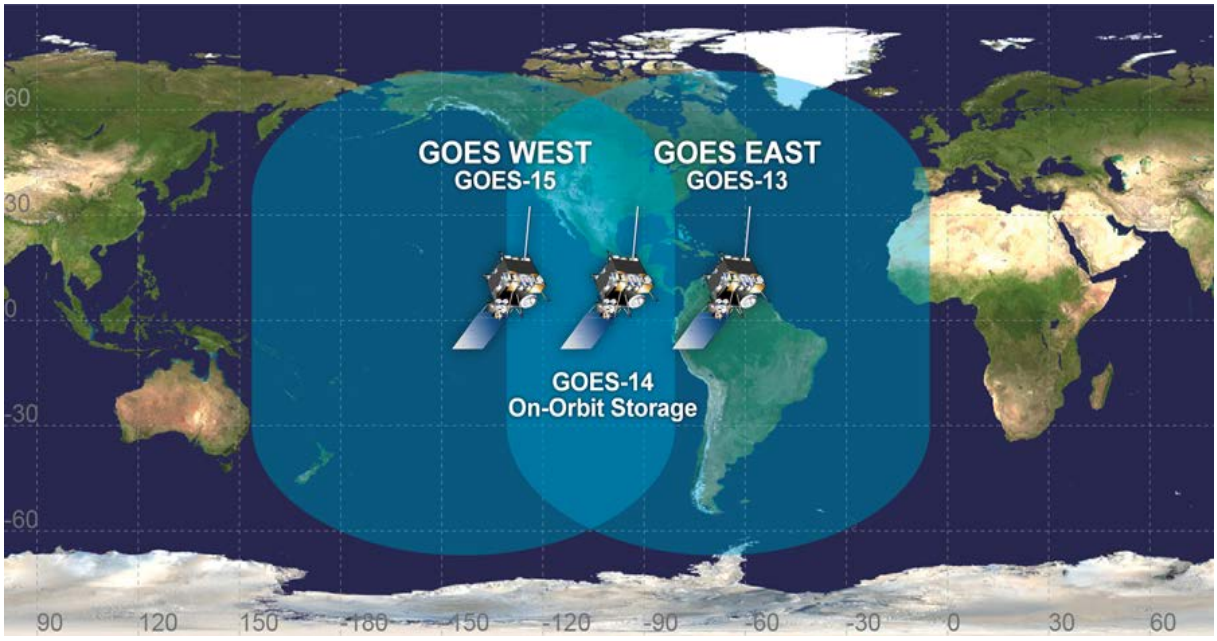
The National Oceanic and Atmospheric Administration (NOAA) of United States operates a system of environmental satellites in geostationary orbits to provide continuous weather imagery and monitoring of meteorological data for the United States, Latin America, much of Canada, and most of the Atlantic and Pacific ocean basins. The Geostationary Operational Environmental Satellite (GOES) system provides atmospheric, oceanic, climatic, and solar products supporting weather forecasting and warnings, climatologic analysis and prediction, ecosystems management, and safe and efficient public and private transportation. The GOES Series system also provides a platform for space environmental observations, and auxiliary communications services that provide for GOES data rebroadcast, data collection platform relay, low resolution imagery, emergency weather communications, and satellite-aided search and rescue.

Three GOES-N series satellites GOES-13, GOES-14, and GOES-15 are currently available for operational use. The GOES-R series of spacecraft is in the development phase. The first GOES-R series satellite, GOES-16, was launched on 19 November 2016. Now it is undergoing on-orbit testing. It will be moved to the GOES-East position at 75 degrees west longitude, once it is declared operational in November.

7.5.1. Geostationary Operational Environmental Satellite-N Series, GOES-13/14/15

GOES-13/14/15 are known as **GOES-N/O/P** before becoming operational.

The NOAA normally operates two meteorological satellites in geostationary orbit over the equator. Each satellite views almost a third of the Earth's surface: one monitors North and South America and most of the Atlantic Ocean, the other North America and the Pacific Ocean basin. GOES-13 (or GOES-East) is positioned at 75 W longitude and the equator, while GOES-15 (or GOES-West) is positioned at 135 W longitude and the equator. The two operate together to produce a full-face picture of the Earth, day and night. Coverage extends approximately from 20 W longitude to 165 E longitude. NOAA also maintains an on-orbit spare GOES satellite, currently which is GOES-14, in the event of an anomaly or failure of GOES East or GOES West. This figure shows the coverage provided by each satellite.



The main mission of GOES-13/14/15 is carried out by the primary instruments, the Imager and the Sounder.

The imager is an imaging radiometer that senses radiant energy and reflected solar energy from the Earth's surface and atmosphere. It uses data obtained from its five channels to continuously produce images of the Earth's surface, oceans, severe storm development, cloud cover, cloud temperature and height, surface temperature, and water vapor. It allows users to identify fog at night, distinguish between water and ice clouds during daytime hours, detect hot spots (such as volcanoes and forest fires), locate a hurricane eye, and acquire measurements of ground and sea surface temperatures.

Imager Data Products

Wavelength (µm)	*Products*	*Pixel size (km)*
visible - 0.52 - 0.71	Daytime cloud cover	1
3.73 - 4.07	Nighttime cloud cover	4
5.80 - 7.30	Water vapor	4
10.20 - 11.20	Earth and cloud images; sea surface temperature and water vapor	4
13.00 - 13.70	Cloud cover and cloud height	8 on GOES-N; 4 on GOES-O&P

The Sounder probes the atmosphere measuring emitted radiation in one visible band and 18 thermal bands that are sensitive to temperature, moisture, and ozone as well as to reflected solar radiation. It provides data to determine the vertical temperature and moisture profile of the atmosphere, surface and cloud top temperatures, and ozone distribution.

Sounder Channel Allocation and Purpose

Detector	*Channel Number*	*Central Wavelength (µm)*	*Purpose*
Longwave	1	14.71	Temperature sounding
	2	14.37	Temperature sounding
	3	14.06	Temperature sounding
	4	13.64	Temperature sounding
	5	13.37	Temperature sounding
	6	12.66	Temperature sounding
	7	12.02	Surface temperature
Midwave	8	11.03	Surface temperature
	9	9.71	Total ozone
	10	7.43	Water vapor
	11	7.02	Water vapor
	12	6.51	Water vapor
Shortwave	13	4.57	Temperature sounding
	14	4.52	Temperature sounding
	15	4.45	Temperature sounding
	16	4.13	Temperature sounding
	17	3.98	Surface temperature
	18	3.74	Surface temperature
Visible	19	0.70	Cloud detection

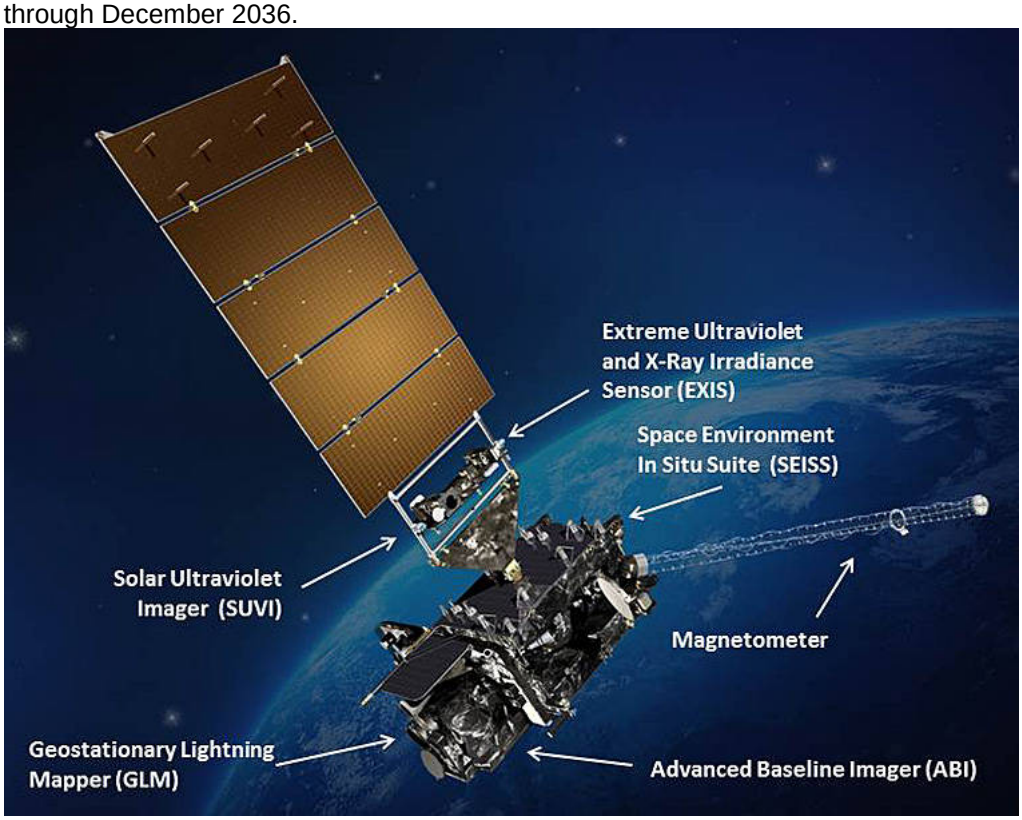
7.5.2. Geostationary Operational Environmental Satellite-R Series, GOES-16

The Geostationary Operational Environmental Satellite-R Series (GOES-R) is the next generation of geostationary weather satellites. It is a collaborative development and acquisition effort between the NOAA and NASA. The first GOES-R series satellite, GOES-16, was launched on 19 November 2016. Now it is undergoing on-orbit testing. It will be moved to the GOES-East position at 75 degrees west longitude, once it is declared operational in November. It is going to provide continuous imagery and atmospheric measurements of Earth's Western Hemisphere and space weather monitoring once it is put into operation.

The advanced spacecraft and instrument technology used on the GOES-R series will result in more timely and accurate forecasts and warnings. It will improve support for the detection and observations of meteorological phenomena that directly affect public safety, protection of property, and ultimately, economic health and development. GOES-R will help meteorologists observe and predict local weather events, including thunderstorms, tornadoes, fog, flash floods, and other severe weather. In addition, GOES-R will monitor hazards such as aerosols, dust storms, volcanic eruptions, and forest fires and will also be used for space weather, oceanography, climate monitoring, in-situ data collection, and for search and rescue.

The GOES-R spacecraft is designed for 10 years of on-orbit operation preceded by up to five years of on-orbit storage. The satellite will be able to operate through periodic station-keeping and momentum adjust maneuvers, which will allow for near-continuous instrument observations.

The GOES system currently consists of GOES-13 operating as GOES-East in the eastern part of the constellation and GOES-15, operating as GOES-West. The GOES-R series will maintain the 2-satellite system implemented by the current GOES series. The GOES-R Series operational lifetime extends through December 2036.



The GOES-R instrument suite consists of Earth sensing, solar imaging, and space environment measurement payloads. There are six primary instruments: two of them point toward Earth, another two point to the sun, and two in-situ, as indicated by the image above.

7.5.2.1. ABI and GLM, two of the GOES-R instruments point toward Earth

1, ABI

The **Advanced Baseline Imager(ABI)** is the primary instrument with 16 bands on GOES-R for imaging Earth's weather, climate and environment. The table below shows the details of each band.

TABLE 1. Summary of the wavelengths, resolution, and sample use and heritage instrument(s) of the ABI bands. The minimum and maximum wavelength range represent the full width at half maximum (FWHM or 50%) points. [The Instantaneous Geometric Field Of View (IGFOV).]

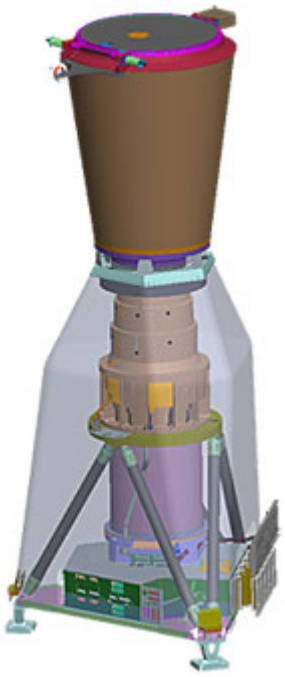
Future GOES imager (ABI) band	Wavelength range (μm)	Central wavelength (μm)	Nominal subsatellite IGFOV (km)	Sample use	Heritage instrument(s)
1	0.45–0.49	0.47	1	Daytime aerosol over land, coastal water mapping	MODIS
2	0.59–0.69	0.64	0.5	Daytime clouds fog, insolation, winds	Current GOES imager/ sounder
3	0.846–0.885	0.865	1	Daytime vegetation/burn scar and aerosol over water, winds	VIIRS, spectrally modified AVHRR
4	1.371–1.386	1.378	2	Daytime cirrus cloud	VIIRS, MODIS
5	1.58–1.64	1.61	1	Daytime cloud-top phase and particle size, snow	VIIRS, spectrally modified AVHRR
6	2.225–2.275	2.25	2	Daytime land/cloud properties, particle size, vegetation, snow	VIIRS, similar to MODIS
7	3.80–4.00	3.90	2	Surface and cloud, fog at night, fire, winds	Current GOES imager
8	5.77–6.6	6.19	2	High-level atmospheric water vapor, winds, rainfall	Current GOES imager
9	6.75–7.15	6.95	2	Midlevel atmospheric water vapor, winds, rainfall	Current GOES sounder
10	7.24–7.44	7.34	2	Lower-level water vapor, winds, and SO_2	Spectrally modified current GOES sounder
11	8.3–8.7	8.5	2	Total water for stability, cloud phase, dust, SO_2 rainfall	MAS
12	9.42–9.8	9.61	2	Total ozone, turbulence, and winds	Spectrally modified current sounder
13	10.1–10.6	10.35	2	Surface and cloud	MAS
14	10.8–11.6	11.2	2	Imagery, SST, clouds, rainfall	Current GOES sounder
15	11.8–12.8	12.3	2	Total water, ash, and SST	Current GOES sounder
16	13.0–13.6	13.3	2	Air temperature, cloud heights and amounts	Current GOES sounder/ *GOES-12+* imager

Source: Schmit, T.J., Gunshor, M.M., Menzel, W.P., Gurka, J.J., Li, J., Bachmeier, A.S., 2005, Introducing the Next-Generation Advanced Baseline Imager on GOES-R, Bulletin of the American Meteorological Society, v. 86, p. 1079-1096.

ABI is a multi-channel passive imaging radiometer designed to observe the Western Hemisphere and provide variable area imagery and radiometric information of Earth's surface, atmosphere and cloud cover. The instrument has two scan modes. The default mode will concurrently take a full disk (Western Hemisphere) image every 15 minutes, an image of the Continental U.S. every five minutes, and two smaller, more detailed images of areas where storm activity is present, every 60 seconds. The ABI can also operate in continuous full disk mode, providing uninterrupted scans of the full disk every 5 minutes.
Full Disk: Hemispheric Coverage of 83° local zenith angle, temporal resolution of 5-15 minutes, and spatial resolution of 0.5 to 2km
Mesoscale: Provides coverage over a 1000x1000km box with a temporal resolution of 30 seconds, and spatial resolution of 0.5 to 2km.
Continental US: The CONUS scan is performed every 5 minutes, providing coverage of the 5000km (E/W) and 3000km (N/S) rectangle over the United States. The spatial resolution is 0.5 to 2km.

2, GLM

The **Geostationary Lightning Mapper(GLM)** detects and maps total lightning (in-cloud and cloud-to-ground flashes). It is the first operational lightning mapper flown in geostationary orbit.



The Geostationary Lightning Mapper is a single-channel, near-infrared optical transient detector that can detect the momentary changes in an optical scene, indicating the presence of lightning. GLM will measure total lightning (in-cloud, cloud-to-cloud and cloud-to-ground) activity continuously over the Americas and adjacent ocean regions with near-uniform spatial resolution of approximately 10 km.

GLM collects information such as the frequency, location and extent of lightning discharges to identify intensifying thunderstorms and tropical cyclones. Trends in total lightning that will be available with the GLM have the promise of providing critical information to forecasters which will allow them to focus on developing severe storms much earlier than they can currently, and before these storms produce damaging winds, hail or even tornadoes. Such storms exhibit a significant increase in total lightning activity, often many minutes before the radar detects the potential for severe weather. Used in combination with radar, satellite data, and surface observations, total lightning data from GLM has great potential to increase lead time for severe thunderstorm and tornado warnings and reduce false alarm rates. Knowledge of total lightning activity and its extent will help improve public safety. Data

from the instrument will also be used to produce a long-term database to track decadal changes in lightning activity. This is important due to lightning's role in maintaining the Earth-atmosphere electrical balance.

GLM measurements can provide vital information to help the operational weather, aviation, disaster preparedness, and fire communities in a number of areas:

1. Improvement in tornado and severe thunderstorm lead times and false alarm reduction
2. Early warning of lightning ground strike hazards
3. Advancements in the initialization of numerical weather prediction models through better identification of deep convection
4. Improved routing of commercial, military, and private aircraft over oceanic regions where observations of thunderstorm intensity are scarce
5. Improved ability to monitor intensification or decay of storms during radar outages, or where radar coverage is poor or scarce, such as in mountainous areas and oceanic regions
6. Better detection and short range forecasts of heavy rainfall and flash flooding
7. Ability to monitor the intensity change of tropical cyclones, which is often accompanied by increased lightning activity
8. Continuity and refinements of lightning climatology within the GOES field of view

GLM Characteristics

- Staring CCD imager (1372x1300 pixels)
- Near uniform spatial resolution 8 km nadir, 14 km edge fov
- Coverage up to 52 deg N lat
- 0-90% flash detection day and night
- Single band 777.4 nm
- 2 ms frame rate
- 7.7 Mbps downlink data rate (for comparison- TRMM LIS 8 kbps)
- 20 sec product latency

7.5.2.2. SUVI and EXIS, two instruments point to the sun

The **Solar Ultraviolet Imager(SUVI**) will monitor solar X-ray flux with increased dynamic range, resolution and sensitivity.

The **Extreme Ultraviolet and X-ray Irradiance Sensors(EXIS)** will monitor solar irradiance in the upper atmosphere.

7.5.2.3. SEISS and Magnetometer, two in-situ instruments monitor the space environment

The **Space Environment In-Situ Suite(SEISS)** will monitor proton, electron and heavy ion fluxes at geosynchronous orbit and assess the risk of radiation posed to astronauts and high-altitude aircraft.

The **Magnetometer** will monitor Earth's geomagnetic field, including geomagnetic storms and sub-storms.

7.6. Introduction to setups

The images produced by the GEOSAT500 are defined by setups. A setup is a geographical region of interest for which satellite imagery will be extracted and processed into final image products. The setup region can cover any geographical area, from a very small region of only a few square kilometres to the entire Earth disk, and at least one setup must be defined before the system can generate output.

Setups can control many more features of the final image products, such as the color table used, whether image analysis tools are automatically applied, the resolution of the coastlines, and the presence and color of gridlines. The following two figures show the system output for two different setups.

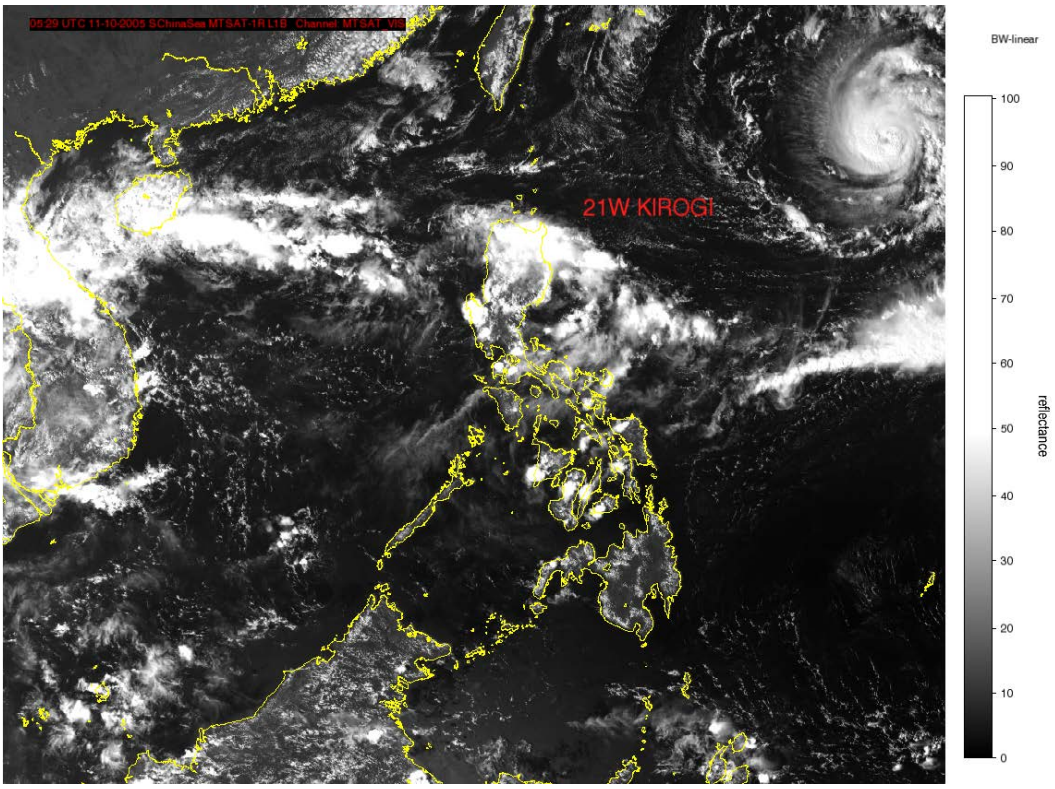


Figure 26 Area showing the South China Sea, yellow high-resolution coastlines, automatic image titles and text annotation

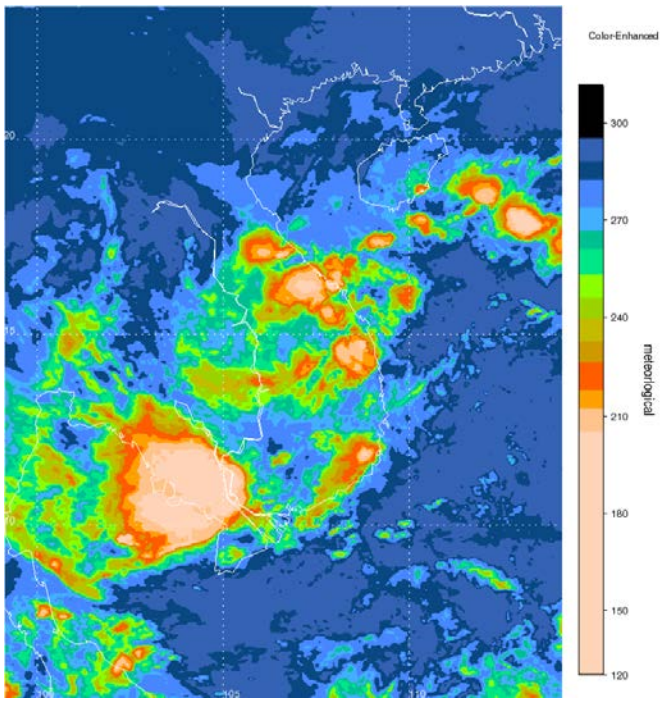


Figure 27 Area surrounding Laos, white low-resolution coastlines with a meteorological color-table emphasising cold cloud

Setups are used to define all GEOSAT500 image outputs. A full list of features that can be controlled by setups, together with information on the usage and creation of setups, can be found in section 3.3.

8. GEOSAT500 software

The system operator interacts with two main packages: the Console, which is used to monitor the system and examine operation logs; and PROTEUS, a program used to display and analyze all of the image products received from the satellite. Both can be accessed by clicking on the relevant desktop icon.

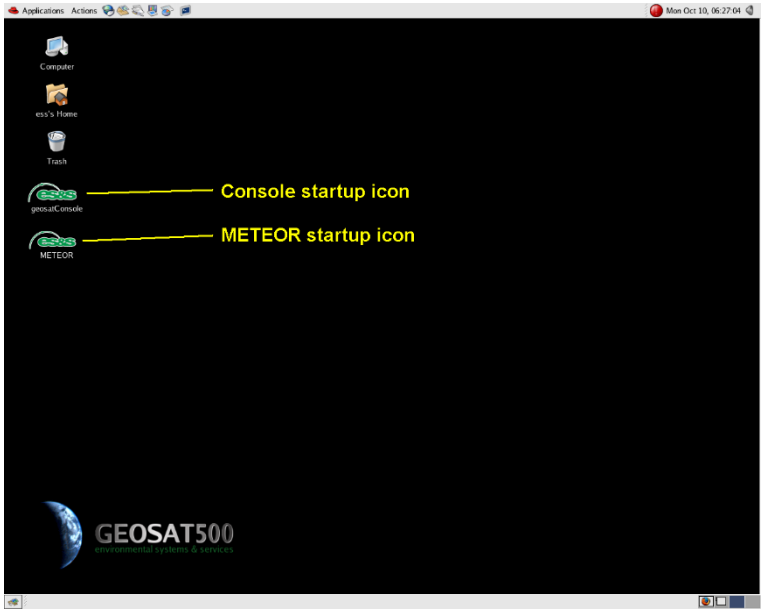


Figure 28 System desktop

The following sections contain further details on these packages, plus other aspects of the software:

- Section **Error! Reference source not found.** introduces PROTEUS, and lists some of the image display and analysis functions that can be performed. Further details can be found in the Quickstart document, and in the complete PROTEUS User Manual;
- The Console is presented in section 3.2, describing how the operator can use this tool to monitor the system status and operation;
- Section 3.3 describes the use of setups to define and customise the output products;
- All image products generated can be viewed on a web page as well as from PROTEUS. Section 3.4 describes the web page and how to interact with it;
- All image products can also be automatically transferred (or e-mailed) to other network hosts. Section 3.5 covers the Disseminator, a software tool used to perform the transfers;
- Section 3.6 describes the Archiver tools, used to backup and restore satellite data to tapes;
- Section 3.7 describes the Quicklook display;
- Section 3.8 introduces the operator and forecaster modes;
- Section 3.9 describes how to backup the entire system configuration; and
- Section 3.10 details how the role of any workstation in the system can be changed.

8.1. PROTEUS

PROTEUS is used to display and analyse the satellite image products. Figure 11 shows the main window.

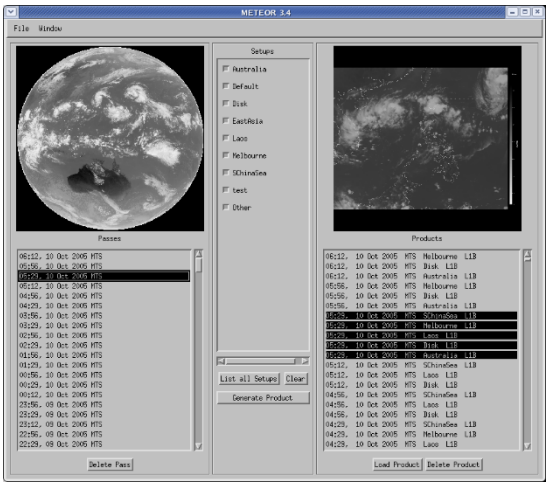


Figure 29 PROTEUS main window

By clicking on an entry in the list, the image is loaded up into an image window where the operator can access a range of display and analysis functions, including:

- zoom and pan;
- histogram equalisation;
- manual brightness and contrast controls;
- distance and bearing between two points;
- define and load new colour tables.

The PROTEUS main window and all image windows will automatically update to show new data when ingest and processing completes. Images derived from MTSAT/COMS-1 HRIT transmission are labelled “MTS/CMS” in the main window, those from MTSAT/COMS-1 LRIT are labelled “MTL/CML”, those from MTSAT HiRID have the label “MTH”, and those from FY2C are labelled with “F2C”.

Further details can be found in the Quickstart document, and in the complete PROTEUS User Manual

8.2. Console

The Console is used by the operator to:

1. View the current status of the system;
2. Configure ingest operations;
3. Change the reception mode;
4. Examine and print the latest MANAM;
5. View any special spacecraft bulletins;

6. Configure data dissemination;
7. Configure data archiving; and
8. Scroll through the logs of recent system activity.

Figure 12 shows the console and its various tabs.

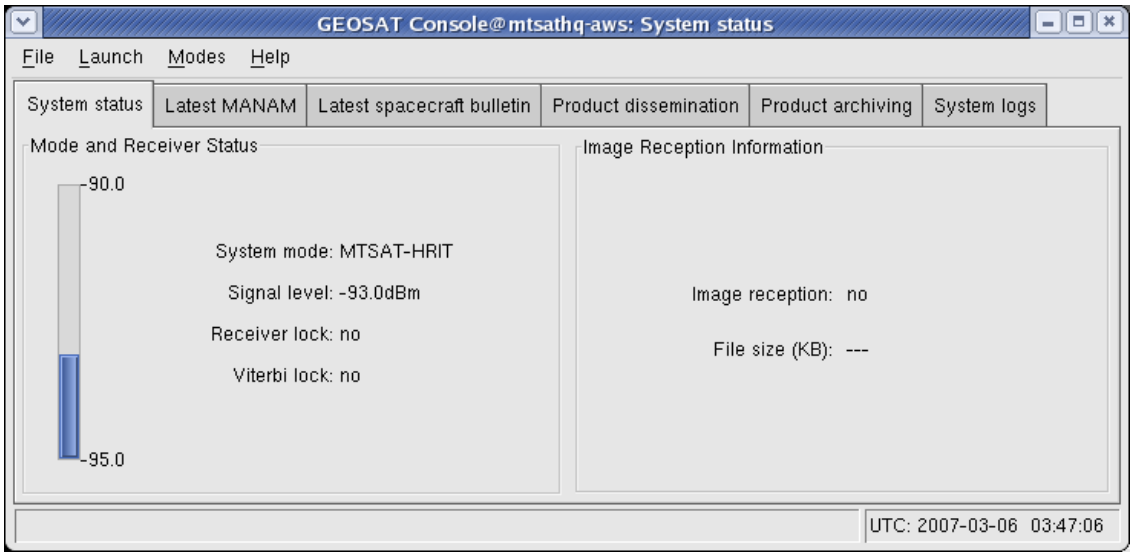


Figure 30 Console

8.2.1. Status tab

The status tab, shown in Figure 12 above, is the default. The receiver status area on the left shows:

- the reception mode: one of MTSAT-HRIT, MTSAT-LRIT, MTSAT-HIRID, or FY2C-SVISSR;
- the signal strength via a scrolling bar and text readout;
- whether the receiver is locked onto a carrier signal; and
- whether the receiver is Veterbi locked, which occurs when modulated MTSAT LRIT/HRIT data is being received.

The Image reception information area on the right shows:

- whether new satellite data is being written to disk, which will occur shortly after the transmission times in the relevant MANAM; and
- the size in KB of the level-0 file.

As described in the Hardware Manual, the signal strength indicators are used during dish alignment and in the diagnosis of any RF-related issues.

8.2.2. Ingest tab

The Ingest tab details the configuration of all ingest operations, such as which satellites can be ingested, receiver configuration, output directories and more. See section 5.5.3 for full details on all configurable aspects of system ingest.

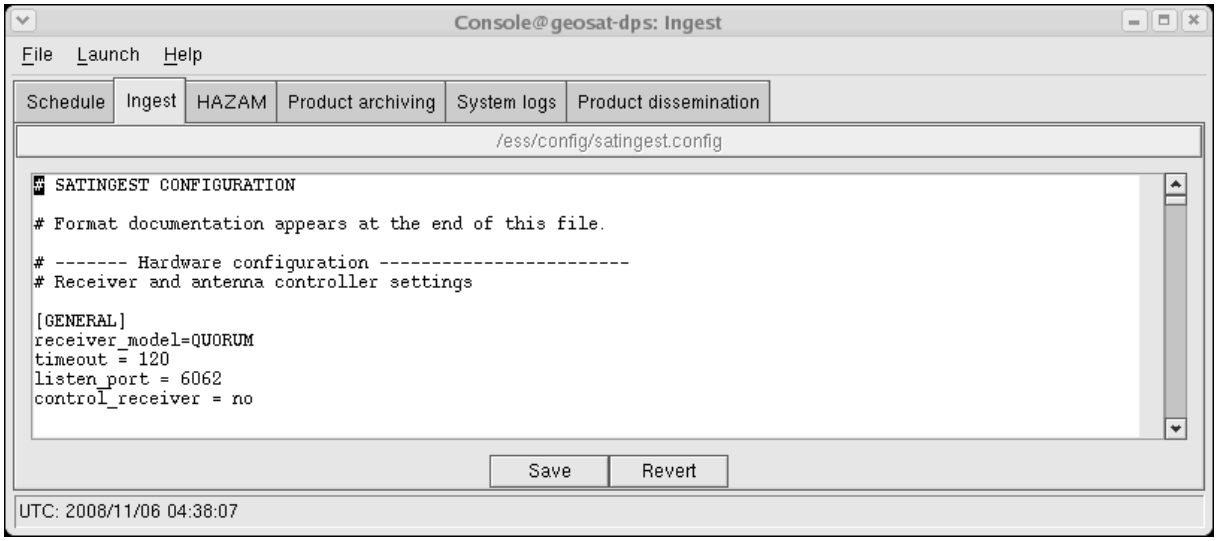


Figure 31 Ingest tab

8.2.3. MANAM tab

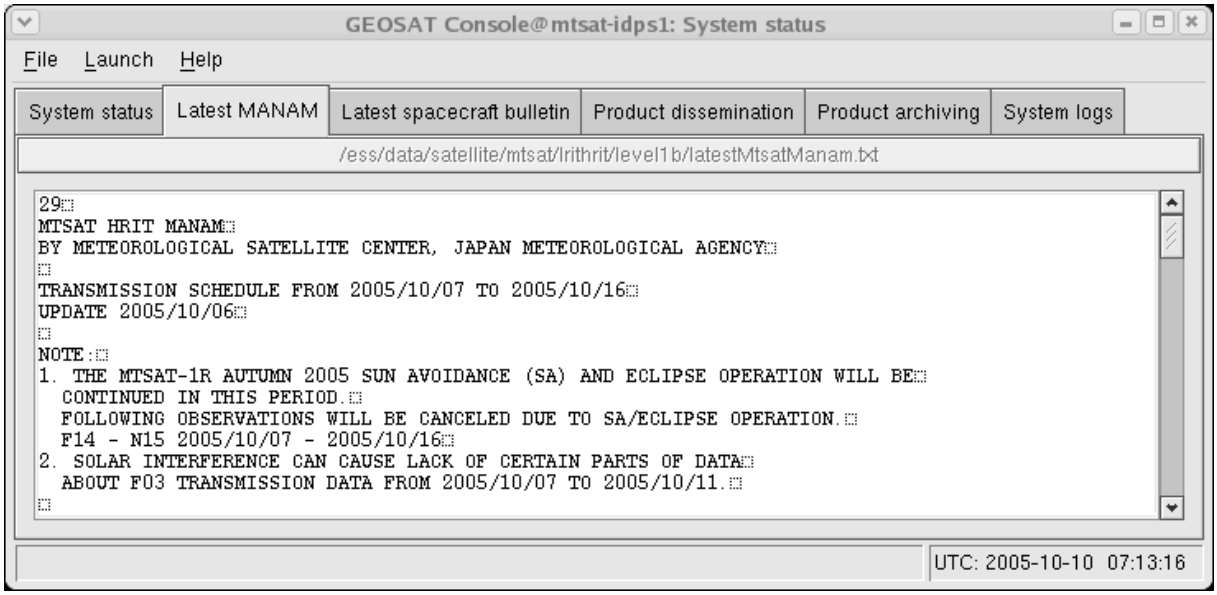


Figure 32 MANAM tab

The latest MTSAT LRIT/HRIT/HIRID or FY2C MANAM is automatically extracted by the GEOSAT500 and shown in this tab. Use the File>>Print menu option to print the MANAM to the default printer.

8.2.4. Special bulletins tab (MTSAT only)

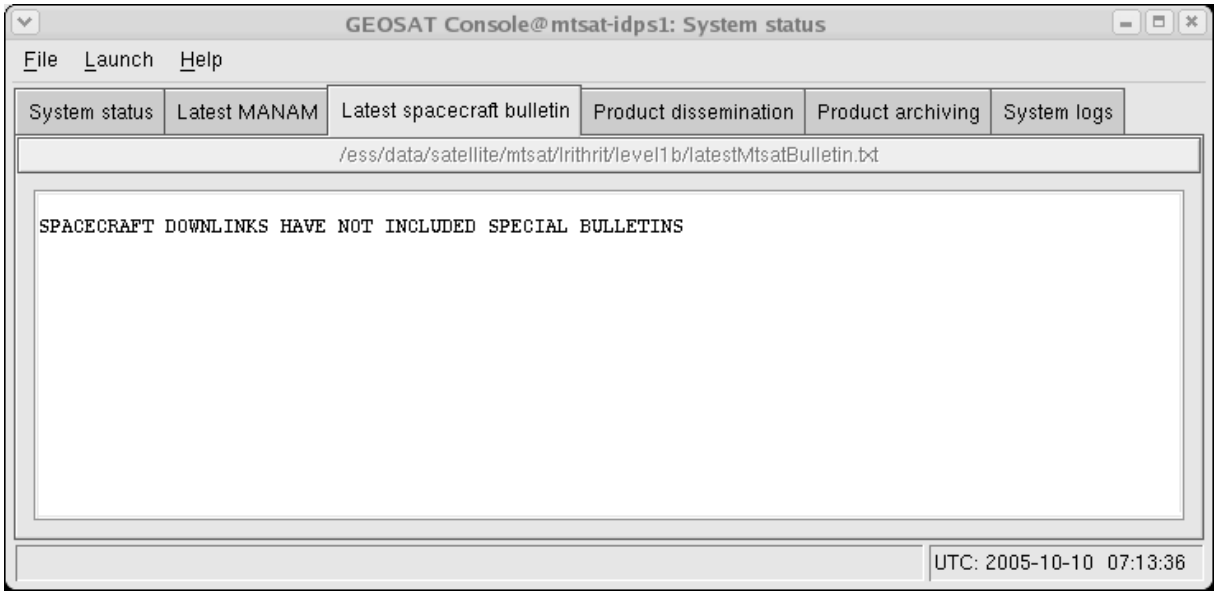


Figure 33 Bulletins tab

The MANAM is transmitted twice a day and contains schedules and other user information. Certain events may necessitate a more immediate dissemination of information to ground station operators, and so “special bulletins” may be transmitted during any spacecraft observation. The latest bulletin can be accessed via this console tab.

8.2.5. Product dissemination tab

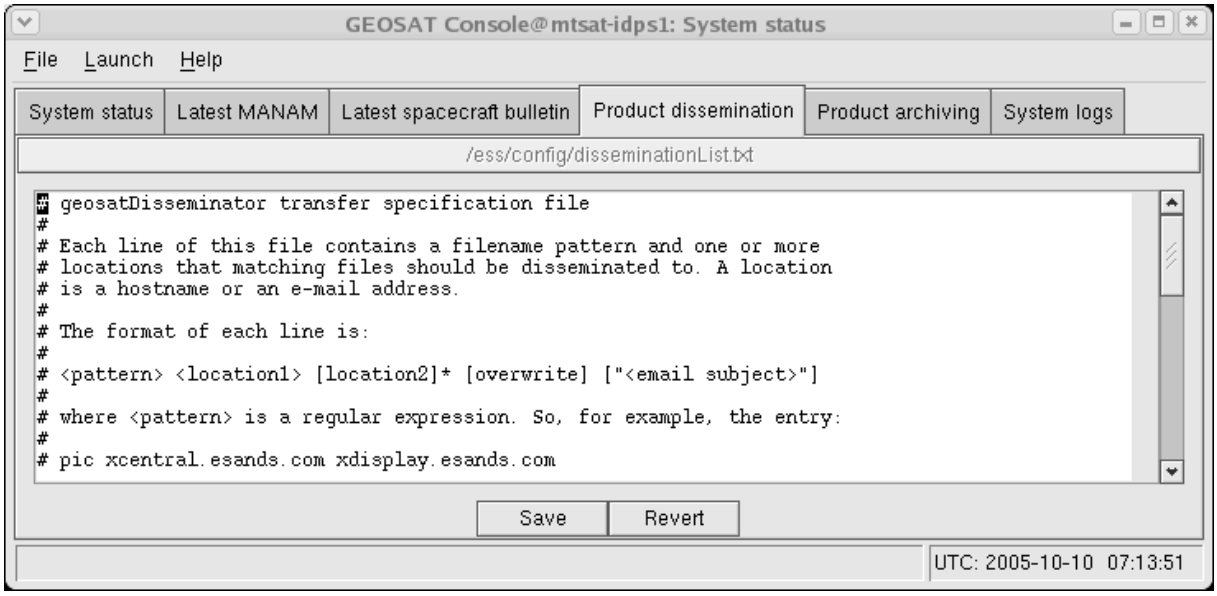


Figure 34 Product dissemination

The system can disseminate (transfer) data to any networked computer. The following data types

can be disseminated:

1. Level-0 files;
2. Level-1b files;
3. MANAMs;
4. Bulletins;
5. The generation list, setups and annotations;
6. The archive configuration
7. The dissemination configuration itself;
8. System events;
9. PICs; and
10. The standard images formats produced by the system: JPEGs, PNGs, BMPs, TIFFs, GIFs, HDF, netCDF, etc.

The operator uses the Product dissemination tab on the console to specify the data types to transfer to particular network hosts. The system is installed with a default dissemination configuration that results in final image products, bulletins and MANAMs being transferred from the Data Processing Workstation to all Display Workstations.

See section 3.5 for full details on configuring product dissemination.

8.2.6. Product archiving tab

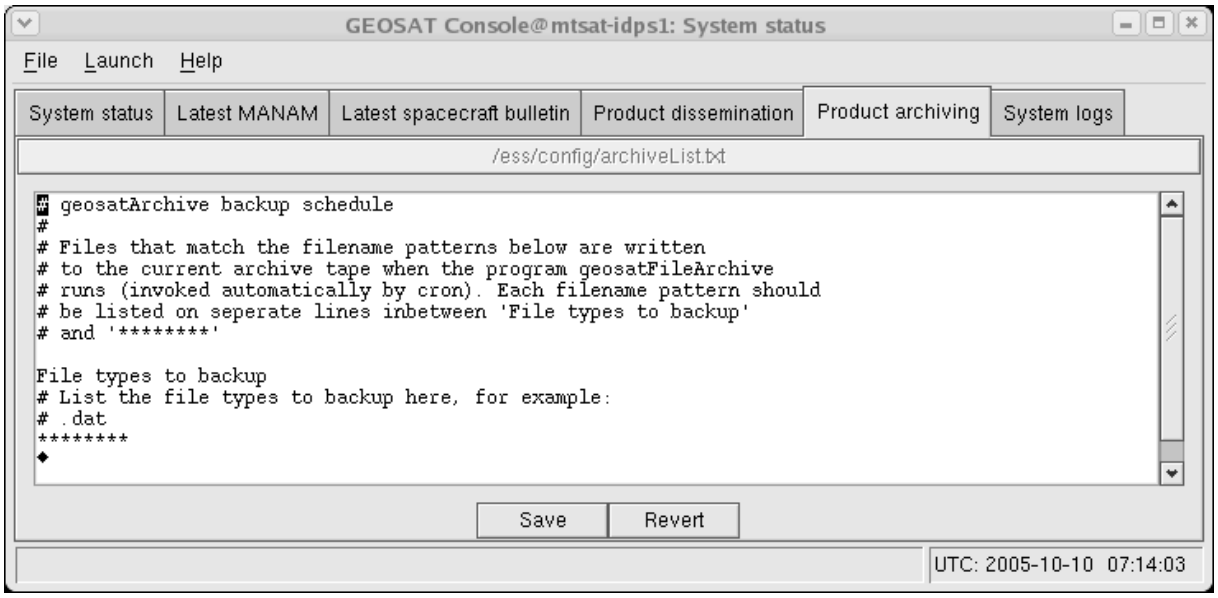


Figure 35 Product archiving

The Product archiving tab only appears if a tape drive is attached to the computer. If a tape drive is available, the system can be configured to archive particular file types to tape every 12 hours. The operator uses the Product archiving tab to specify filename patterns: new files that match the patterns are written to tape.

See section 3.6 for full details on configuring and using the archive tools.

8.2.7. Log view tab

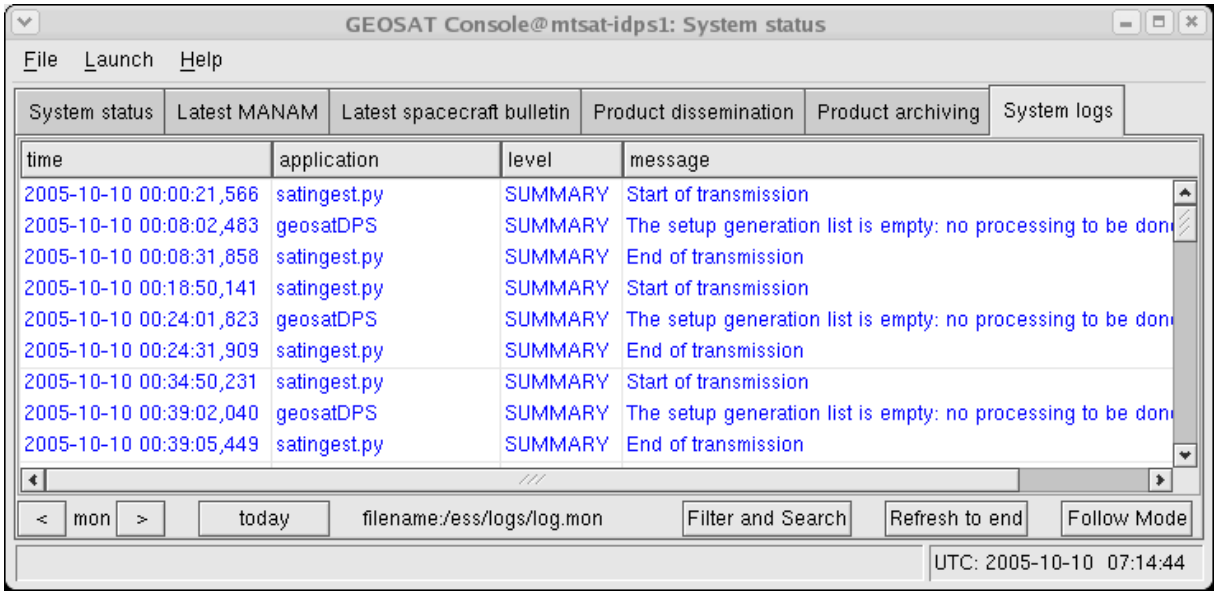


Figure 36 Log view

All components of the system log information messages to the system logs, which can be viewed using this tab. The system maintains a seven day log of operations. See section 5.1 for details of where these log files are stored and maintained.

Each entry in the log contains the:

- date and time at which the event occurred;
- name of the program that logged the event;
- severity of the event
- description of the event.

The entries are colour-coded according to their severity:

- CRITICAL: operator intervention required otherwise the system will no longer ingest and/or process imagery. Data may have been lost
- ERROR: an error has prevented the ingest or processing of one transmission. Data may have been lost, but for this downlink only
- WARNING: an anomalous event has occurred, but it has not affected image generation. No data has been lost
- SUMMARY: description of a main processing stage, such as the start of image reception and the generation of PIC files
- INFO: more detail of data processing stages
- DEBUG: very detailed description of data processing

The default log view shows the first four severity levels only, hiding all detailed system information from the operator. Normally, the log view contains only blue SUMMARY entires, meaning that the system is working normally and has received all downlinks.

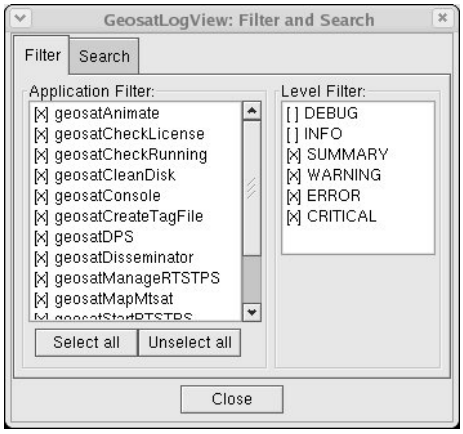
The Refresh To End button shows the most recent log messages, and the Follow Mode button, when toggled on, causes the log view to automatically update whenever new messages are added

to the system logs.

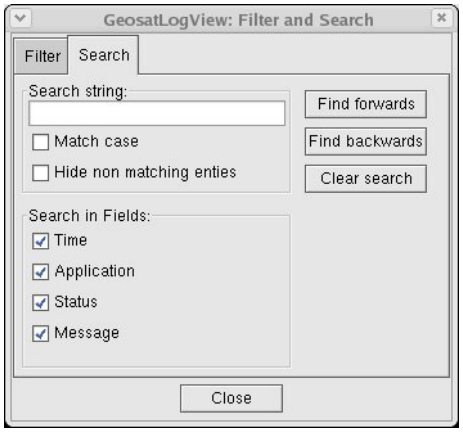
The forward and backward arrow buttons move through the week of logs stored on the system. The Today button moves to the log for the current day.

8.2.7.1. Advanced options

Clicking the Filter and Search button brings up the Filter and Search dialog which allows the user to select the applications and log levels to be displayed in the log viewer. String searches can also be performed.



This dialog consists of two panes which are



accessible through the “Filter” and “Search” tabs. The Filter tab allows users to selectively view error messages. To enable/disable the display of log messages from particular programs, toggle the checkbox next to the program name in the “Application Filter” area. To change the event levels shown, toggle the checkbox next to the severity level in the “Level Filter” area.

The Search tab provides the facility to search for a string in log messages. The search is performed based on the currently selected log messages in “Filters”, and provides an option for case sensitive search. If checked, the option “Hide non matching entries” hides all log entries that do not match the search string. Furthermore, the search can be limited to some fields in the log view. This can be done by toggling the checkbox against one or more of “Time”, “Application”, “Status” and “Message”.

A search is started by pressing the button “Search forward” or “Search backward”. All matching entries in the log view are highlighted and the cursor is positioned at the first/last occurrence. If clicked again, the cursor is placed at the next/previous occurrence and so on.

Note that if “Hide non matching entries” is enabled, no highlighting is performed since all remaining entries would be highlighted. Also, if the “Filter and Search” dialog is closed, all filtering and search options persist. To disable the search, press “Clear search” and set the application and level filter to your preferred default.

8.2.7.2. Sending system events by email

The system can be configured to send CRITICAL, ERROR, and WARNING events to one or more e-mail addresses. To do this:

1. Set the variable SATKIT_EVENT_EMAIL to CRITICAL, ERROR, or WARNING in the SATKIT configuration file (see section 5.5.1). Thereafter, if a published event is at least as severe as the configured level, the details are marked for dissemination.
2. Configure dissemination to send these system events to one or more e-mail addresses. See the comments in the dissemination configuration file for details (section 3.2.5).

8.2.8. Changing the reception mode of the system

The Modes menubar option is used to change the reception mode of the system and is available only on acquisition workstations [3].

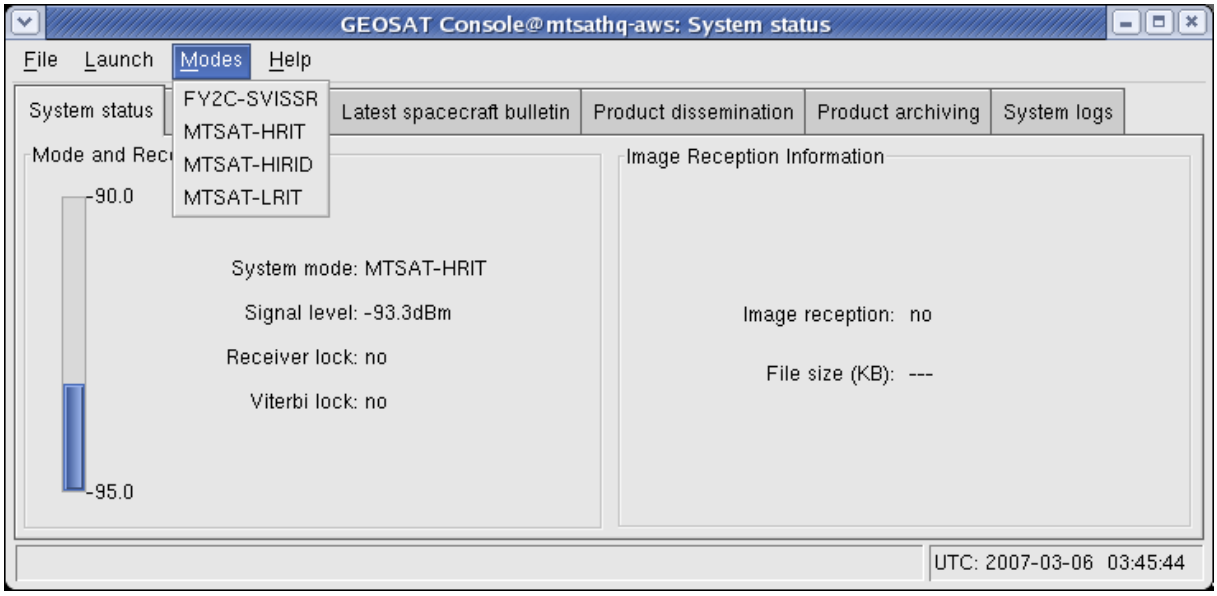


Figure 37 Console Modes option

When the ingest mode is changed, the receiver is immediately set into the new mode interrupting any transmissions being received. The system will then start receiving the new satellite downlinks. Image products will be produced when one or more of the setups in the generation list contain products for the satellite in question.

Image products derived from MTSAT HRIT downlinks are labelled as “MTS” in the PROTEUS main window, COMS-1 HRIT as “CMS”, MTSAT HiRID as “MTH”, MTSAT LRIT as “MTL”, COMS-1 LRIT as “CML”, and Fengyun-2C SVISSR as “F2C”.

The default ingest mode is restored whenever the acquisition workstation is rebooted. The default can be set in `the /ess/config/satingest.config` file (see section 5.5.3).

8.2.9. Reprocess data

The File >> Reprocess data… option is used to reprocess one or more level-0 files. The various level-0 directories are examined and a list of all files contained therein presented to the operator (see section 5.1 for directory details). The files selected are queued for processing by moving them into their respective level0/incoming directory where they’re automatically processed using the current generation list (see section 3.3.2).

[3] Modes other than MTSAT LRIT, HRIT, and HiRID depend on groundstation options selected.

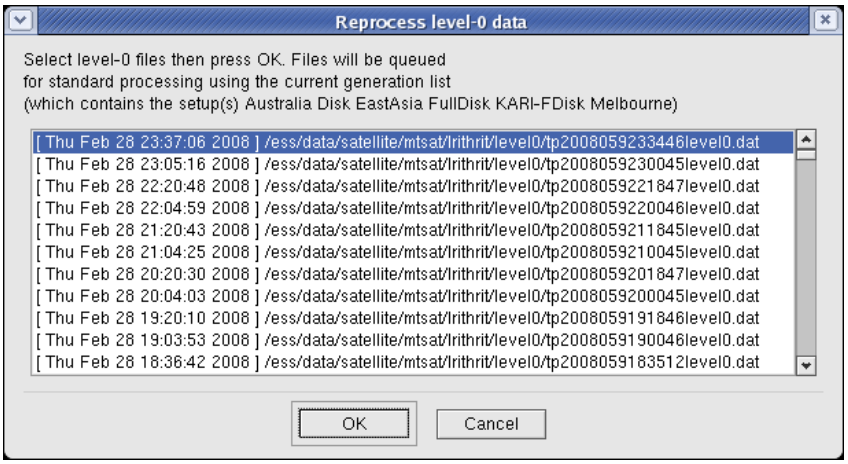


Figure 38 Reprocess data dialog

8.2.10. Launch other programs

The Launch menubar option can be used to launch various other programs and web pages, all documented in the following sections.

8.2.11. System help

The Help menubar option displays the versions of installed software and launches the product documentation, if installed.

8.3. Using setups to configure the image products

As first introduced in section 2.3, the images produced by the system for PROTEUS display are defined by setups. A setup is a geographical region of interest for which satellite imagery will be extracted and processed into final image products. The setup region can cover any geographical area, from a very small region of only a few square kilometres to the entire Earth disk, and at least one setup must be defined before the system can generate output.

8.3.1. Setup overview

Setups can control many more properties of the final image products, such as the colour table used, whether image analysis tools are automatically applied, the resolution of the coastlines, the presence and colour of gridlines, and whether level-2 products should be generated. Figure 8 and Figure 9 show system output for two different setups.

A full list of the image properties that can controlled via setups is:

1. Geographical coverage
2. Default projection
3. Minimum coverage for this area before images are created
4. The satellite(s) to which the setup applies
5. For each channel in the satellite data
    a. Default colour-table
    b. Resolution
    c. The standard image formats to automatically create (PNG, JPEG, TIFF, BMP, SVG, HDF, or netCDF).

d. When to overlay another channel, or combine channels, prior to creating the standard images.
e. The image tools to automatically apply (histogram equalisation, image smoothing, and/or image sharpening)
f. Whether coastlines should be overlayed, and their colour and resolution
g. Whether gridlines should be overlayed, and their colour and spacing
h. Whether to overlay political boundaries, and the colour to use
i. Whether a title should be overlayed on the image, containing date and time of the downlink and the source satellite
j. Whether to show a colour-bar at the side of the image
k. The image annotations to apply
l. Whether various image statistics should be automatically generated and written to disk.

The greater the geographical coverage, the longer the setup takes to process. Similarly, setups specifying high-resolution datasets take longer to produce.

All setups are stored in the directory /ess/setups.

8.3.2. The generation list

The generation list is a list of setups to apply to new downlinks from the satellite. The operator can add and remove setups from the list, controlling the products output by the system. The greater the number of setups in the generation list, the longer each satellite downlink takes to process. The generation list is defined by the file /ess/setups/generationList.txt.

Only the Data Processing Workstation has entries in the generation list: the Acquisition and Display Workstations have empty generation lists by default.

8.3.3. Setup manager

Setups, together with the generation list, are created and managed by the Setup Manager. This tool can be launched from the Console, as described in section 3.2.

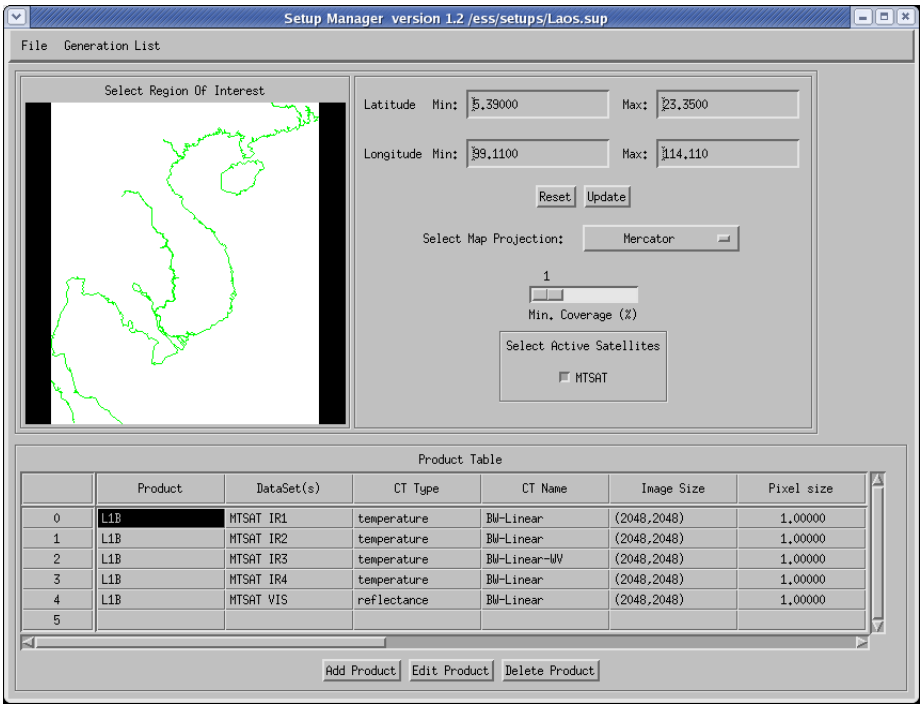


Figure 39 Setup Manager main window

Figure 21 shows the main setup manager window. The general procedure for creating a new setup is as follows:

1. First, specify the geographical area of interest using the upper part of the setup manager main window
    a. The area can be defined by zooming into the map on the left. Use the LMB to zoom into an area and the RMB to zoom out.
    b. Alternatively, the exact latitudes and longitudes can be specified using the controls on the right. After entering the co-ordinates, press the 'Update' button and the map updates to show the specified area. The 'reset' button returns to the default co-ordinates
    c. The default map projection is Mercator. If a different projection is required, set the projection from the available list. This projection will be used for all automatically created standard images, the webpage images, the PROTEUS preview, and for the default projection when an image is first loaded into PROTEUS. The projection of an image in PROTEUS can be subsequently changed using the PROTEUS 'Projection' menubar.
    d. The default minimum coverage is 1%. If a different minimum coverage is required, specify the value. This is a percentage of the geographical area that must be covered by data in order for products to be produced. So for example, if the setup is for the entire Earth disk and the coverage is set to 75%, images will be produced for full disk downlinks but not for half-disk downlinks (as the coverage would be only 50% of the setup area).
    e. Finally, set the satellites to which this setup should apply. A default list of level-1b channel products appears in the products table.
2. The setup is now ready to be used: a series of setup products has been defined and these are shown in the products table at the bottom of the main window. Skip to step 5 which describes how to save the setup and add it to the generation list. Alternatively, follow the steps below to further customise the setup products and change the appearance of the

output images.

3. Products can be removed from the setup using the ‘Delete product’ button. Alternatively, additional level-1b channel products or level-2 products can be added/edited:
    a. Press the ‘Add product’ button to add a level-1b channel or level-2 product. The dialog shown in Figure 22 appears
    b. If multiple satellites were selected in setup (e) above, then choose which one supplies the desired product
    c. Select the product type: either level-1b or level-2
    d. Next, choose the product from the list of those available.
    e. Change the default colour-table if required
    f. Alter the resolution if necessary. The system default is 4km/pixel for both MTSAT and FY2C, but this can be increased if necessary. Remember that the higher the resolution, the longer the setup takes to process.
    g. Finally, select the standard image formats to be automatically created for this channel. All or none of the following can be specified: BMP, JPG, PNG, TIFF, GIF, SVG, HDF4, HDF5, netCDF, ASCII, GEOTIFF, BUFR. These standard images are written to the /ess/data/processed directory.
4. Press the ‘Save to table” button to complete the configuration for the product, accepting all other defaults. The new product appears in the products table at the bottom of the main window. Go back to step 2 and repeat for all other products required. Alternatively, the product appearance can be further configured:
    a. Click on the Tools tab and choose one or more tools to automatically apply to the channel: histogram equalisation, image smoothing, and/or image sharpening.
    b. Click on the Overlays tab and configure
        i. Whether coastlines should be overlayed, and their colour and resolution
        ii. Whether gridlines should be overlayed, and their colour and spacing
        iii. Whether to overlay political boundaries, and the colour to use
        iv. Whether a title should be overlayed on the image, containing the date and time of the downlink and the source satellite. Can also select to show local time, rather than UTC in the titles, in which case your local zone should be entered into the file /ess/config/imageproductconfig. For example, “TIMEZONE = Hongkong”. A list of available zones can be found in /usr/share/zoneinfo.
        v. Whether to show a colour-bar at the side of the image
    c. The Annotations tab can be used to automatically overlay PROTEUS annotations on images (see PROTEUS User Manual for details on how to created annotations).
    d. The image overlays tab can be used to automatically overlay another channel’s data in all automatically generated standard images.
5. When all channels have been configured, save the setup using File>>Save as… Note this does not “activate” the new setup: it first needs to be added to the generation list.
6. The setup manager also manages the generation list. Use Generation List>>Edit on the setup manager menubar to launch the dialog shown in Figure 24. Toggle the desired setups on/off then click OK to save the generation list. All enabled setups will be applied to subsequent downlinks.

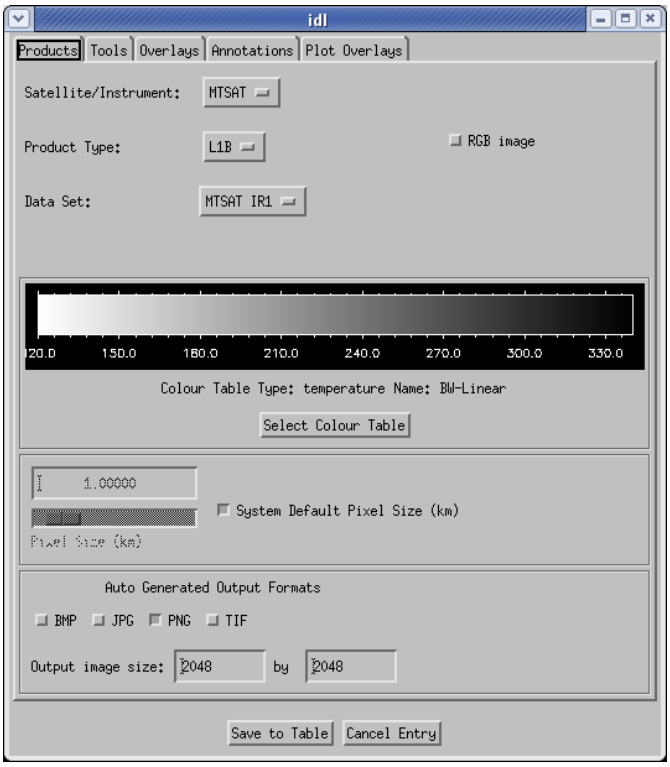


Figure 40 Configuring a satellite channel

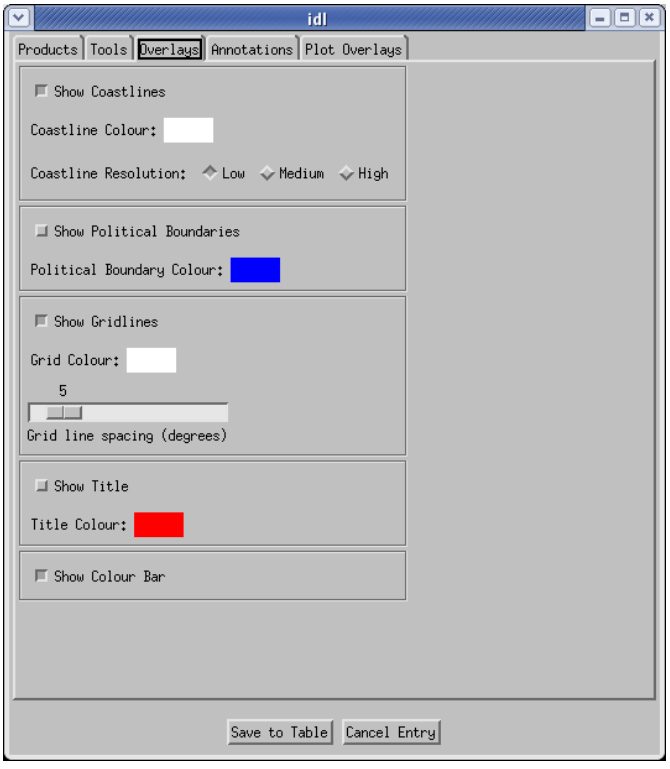


Figure 41 Overlays can be enabled and configured

Figure 42 Defining the generation list

8.3.4. Setups and image resolutions

Each setup can contain multiple level-1b products. The output of each setup is a PIC file containing all of these level-1b products.

The PIC outputs from a single setup have the same resolution, which is 4km/pixel by default. The resolution of any product can be changed as described above. If a setup contains products at different resolutions, the resolution of the PIC outputs will be that of the lowest resolution product specified in the setup. So for example, if a setup contains five products, four at 4km/pixel and one at 1km/pixel, the PIC outputs will all be at 4km/pixel.

8.3.5. Overlay resolutions

The resolution of all image overlays, such as coastlines and political boundaries, exceeds 1km.

8.4. Products web page

As described in section 3.3, each satellite transmission is processed according to user-defined setups resulting in various final image products. These images can be viewed in PROTEUS, but they are also available for viewing and downloading using the system web pages.

To view the system web pages, start the default browser using use Launch menubar in the console. This will launch a browser showing the products available on the Data Processing Workstation. However, as the web server runs on all machines, visiting the URL http:://<hostname> allows web access to local products on any networked machine.

Thumbnail images for all products are shown and are sorted, by default, with the most recent image first. Click on a thumbnail to view the full-resolution image.

Each PIC generated by the system can be converted to multiple image formats, such as PNG,

JPEG, and TIFF, as well as other data formats, such as HDF, netCDF, BUFR, and GRIB (see section 3.3.3 for a full list). The original PIC and PIC header, together with all format conversions, can be downloaded from the web pages by pressing the 'Download' button beneath the relevant thumbnail. A list of the available files is presented and those required can be selected. The files selected are zipped into a single file for download.

Depending on setup configuration, each PIC may result in multiple thumbnails on the web pages. For example, if a setup contains 10 products and each one is converted to PNG, 10 thumbnails will appear on the web pages. The web server allows the operator to download the original PIC and format conversions irrespective of the channel thumbnail selected for download.

Filters at the top of the page allow datasets to be queried by satellite, product group, product, geographical area, start and end times. The configurable URL jump-list beneath the date controls can be used to access other web pages. Lastly, the controls above the thumbnails allow the number of images/page and the sort order to be defined.

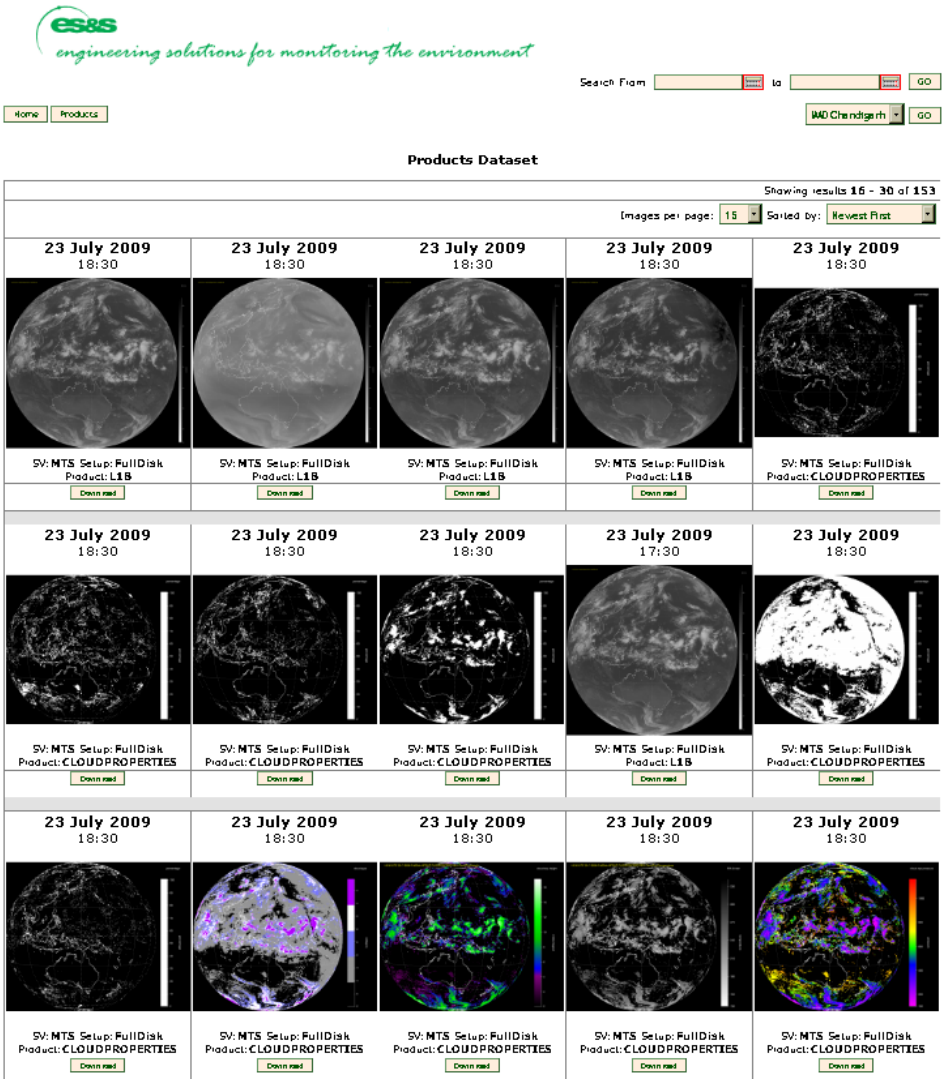


Figure 43 System web page showing MTSAT data. Imagery from all spacecraft received by the system is shown here.

8.4.1. Web server configuration

Visit the URL http://<hostname>/edit.php to configure the web server. The following properties can

be changed by editing the XML:

1. The banner shown at the top of the home page;
2. The background and foreground colours;
3. The page refresh time, defaulting to 900 seconds. This is the time between automatic updates to the client page;
4. The font and font size used;
5. Whether an edit configuration button is shown on the pages;
6. The subdirectories used to store data. A button for each is shown on the pages; and
7. URLs for each linked web page.

The default configuration should only be changed by an experienced system administrator.

8.4.2. Web server security

By default, no restrictions are placed on access to the web server. To enforce password access:

1. Find the section `<Directory "/ess/data/html">` in `/usr/local/apache2/conf/httpd.conf` and uncomment the following lines:

   AuthType Basic
   AuthName "ESS Web Software"
   AuthUserFile /ess/config/passwords
   AuthGroupFile /ess/config/groups
   Require group WebAccess

2. Create a new password file with a single user by running this command as root:

   ```
   htpasswd -c /ess/config/passwords <user>
   ```

3. Add further users using the above command without the –c switch.
4. Add all users to the WebAccess group by modifying /ess/config/groups to read

   ```
   WebAccess: <user1> … <usern>
   ```

5. Reboot the machine.

To disable password access, comment the above lines and reboot.

8.5. Product dissemination

The Disseminator can be configured to transfer data across a network, either by file transfer or e-mail. The following files types can be automatically disseminated after they're created/modified:

1. Level-0 files;
2. Level-1b files;
3. MANAMs;
4. Bulletins;
5. The generation list, setups and annotations;
6. The archive configuration
7. The dissemination configuration itself,
8. PICs; and
9. The standard images formats produced by the system: JPEGs, PNGs, BMPs, TIFFs,

GIFs, etc.

After a file is created/modified by the system, it becomes a candidate file for dissemination and is referenced by a small “tag file” in /ess/newfiles. Every minute, the disseminator reads the configuration file /ess/config/disseminatorList.txt to determine which of the candidate files should be transferred to which hosts. By default, the system transfers the files to the same directory on the target machine.

The Console is used to change the dissemination configuration when required (see section 3.2.5).

8.5.1. Default dissemination

The default dissemination configuration file on the machines is such that:

1. The Data Processing Workstation automatically disseminates the following files to all Display Workstations:
    a. PROTEUS PIC files, their headers, and PNG preview images
    b. PROTEUS browse images
    c. Setups and annotations
    d. MANAMs and spacecraft bulletins
2. The Data Processing Workstation automatically disseminates the following files to the Acquisition Workstation:
    a. MANAMs and spacecraft bulletins
3. Each Display Workstations automatically disseminates the following files to the Data Processing Workstation and any other Display Workstations:
    a. Setups and annotations.

8.5.2. Custom dissemination

The Console is used to change the dissemination configuration when required (see section 3.2.5). Each line of the file /ess/config/disseminationList.txt contains a filename pattern, one or more locations to which matching files should be transferred to, plus any options. A location is a hostname or an e-mail address. The format, then, of each line is:

<pattern> <location>+ [<option>]*

where <pattern> is a regular expression. Some example custom entries are:

```
.pic mtsat-idps1 mtsat-idps2
.hdr mtsat-idps1 mtsat-idps2
.png modis-idps1 mtsat-idps2 chris.skelsey@esands.com
```

With this configuration, PIC files (and their headers) will be automatically transferred to mtsat-ips1 and mtsat-idps2 for PROTEUS display on those machines. PNG files will be disseminated by file transfer to mtsat-idps1 and mtsat-idps2, and by e-mail to chris.skelsey@esands.com.

The options override global defaults to change the way in which the matching files are transferred. System defaults and optional overrides are discussed in the following sections.

Note that:

- Dissemination of files is sequential: concurrent dissemination is not performed.
- A failure to disseminate to one target does not affect subsequent dissemination to any other targets.
- The pattern specification is in the form of a regular expression (see section 5.6.1.2.1 for details of this standard format). For example, the pattern

png

will match all PNG files. To limit this to PNG files from one sector:

```
DK01.*png
```

8.5.3. System defaults

By default, dissemination will:

- Transfer a file to the same directory on the target machine as on the source machine;
- Use ftp as the file-transfer protocol
- Limit e-mail dissemination to 4MB
- Use the filename as the email subject.

These defaults can be changed for all transfers by editing the main GEOSAT500 configuration file (see section 5.5 for full details). This file defines environment variables for core properties of the system, including the following dissemination defaults:

Variable	Purpose	Method	Default
SATKIT_DISS_METHOD	Dissemination method, either FTP, RSYNC-OVER-SSH, move, or copy. RSYNC-OVER-SSH provides encrypted communications and the ability to skip a file transfer if another machine is transferring the same file to the same target. move and copy transfers must be between directories mounted on the local machine specified by the –targetDir override (see next section).	n/a	FTP
SATKIT_DISS_RSYNCOPTIONS	Additional options for rsync	rsync	None
SATKIT_DISS_SSHOPTIONS	Additional options for ssh	rsync	None
SATKIT_FTP_TYPE	ftp transfer method: PASSIVE or ACTIVE	ftp	PASSIVE
SATKIT_DISS_USERNAME	Username for ftp transfers	ftp	ess
SATKIT_DISS_PASSWORD	Password for ftp transfers	ftp	essess
SATKIT_DISS_REMOTE_DIR	If None, files will be transferred to the same directory as on the source machine. Otherwise, specify the name of the target directory to which all files will be transferred	all	None
SATKIT_DISS_LATESTFIRST=True	Transfer order depends on when the file was marked for dissemination. If True, the order is by increasing age (so files most recently marked will be sent first). Otherwise, the order is decreasing age (oldest-marked files first).	all	True
SATKIT_DISS_ATTEMPTS=1	Number of dissemination attempts.	all	1
SATKIT_DISS_WAIT	Dissemination will sleep for this number of seconds between attempts	all	60
SATKIT_DISS_COMPRESS	Whether to compress data before RSYNC-OVER-SSH transfers. Results in increased CPU load.	rsync	False
SATKIT_DISS_OVERWRITE	Whether to overwrite files if they already exist on the target machine.	rsync, copy, move	False

Variable	Purpose	Method	Default
SATKIT_DISS_MAXEMAILSIZE	Maximum file size for e-mail dissemination	email	4MB
SATKIT_DISS_DEFAULTSUBJECT	Default subject for e-mail dissemination	email	“EEC satellite product”
SATKIT_DISS_EMAILBODY	Default message text for e-mail dissemination	email	None
SATKIT_DISS_TIMEOUT	Transfers timeout after this number of seconds	rsync, ftp	600
SATKIT_DISS_MAXLIFE	Transfer is killed after this number of seconds	all	7200

8.5.4. Overriding the defaults for individual entries

In addition, each entry in the dissemination file can override many of the system defaults. So for instance, even if the default is to transfer a file using ftp, any dissemination entry can override this to use secure communications. So to transfer PNG files using the secure RSYNC-OVER-SSH protocol whilst leaving the default protocol as ftp, the entry would look like this:

```
.png mtsat-idps1 --method="RSYNC-OVER-SSH"
```

A common use of these overrides is to transfer specific types of file to specific directories. If a web server requires PNG imagery in /satdata/png whilst a centralised data server requires level-0 data in /satdata/level-0, for example, the entries would be similar to:

```
png webserver1 –targetDir=”/satdata/png”
level0.dat nas –targetDir=”/satdata/level-0”
```

The following table details all possible overrides.

Override option	Value	Purpose	Method
--method	• RSYNC-OVER-SSH • FTP • copy • move	Dissemination method. RSYNC-OVER-SSH provides encrypted communications. move and copy transfers must be between directories mounted on the local machine specified by the –targetDir override.	n/a
--rsyncoptions	String	Pass these additional options to rsync	rsync
--sshoptions	String	Pass these additional options to ssh	rsync
--ftptype	• PASSIVE • ACTIVE	ftp transfer type. Passive transfers are often required when targets are behind a firewall.	ftp
--username	String	Username for ftp transfers	ftp
--password	String	Password for ftp transfers	ftp
--targetDir	String	Destination directory	all
--attempts	Integer	Try to send the file this number of times before giving up.	all
--overwrite	• True • False	Whether to overwrite files during RSYNC-OVER-SSH transfers if they already exist on the target machine.	rsync, move, copy
--compress	• True • False	Whether to compress data before RSYNC-OVER-SSH transfers. Results in increased CPU load.	rsync
--timeout	Integer	Transfers timeout after this number of seconds	rsync, ftp
--emailsubject	String	Default message text for e-mail dissemination	email

8.5.5. Secure data communications

By default, data dissemination uses ftp as the underlying protocol. Secure data transfer is also possible through the use of rsync with SSH as the protocol. This is referred to as RSYNC-OVER-SSH.

This option requires SSH to be configured between the source and target machines such that no passwords are required. There are three main configuration options for SSH that allow password-less logins:

- SHOST-based trusted host communication;
- RHOSTS-RSA authentication; or
- Full RSA-based authentication, supporting public-key cryptography.

Security policies, and the appropriate configuration of SSH, are the responsibility of the local system administrator.

As an example, SSH can be configured for RHOSTS-RSA authentication as follows. For each machine <target> that will be disseminated to by this machine <local>:

1. Add <target> to /etc/ssh/shosts.equiv on this machine
2. ssh <target> and enter password
3. Add <local> to /etc/ssh/shosts.equiv on <target>
4. ssh <local> and enter password
5. Verify ssh <target> no longer requires a password.

8.6. Product archiving

Every machine has a tape drive as an option, allowing the computer to automatically archive data files to tape every day for long-term storage. If a tape drive is available, the operator can use Console to configure the file types written to tape, as described in section 3.2.6.

The operator uses the Product archiving tab in the console to specify filename patterns: new files that match the patterns are written to tape. The most important file type to archive is level-0: these files contain data for the entire downlink and can be used to regenerate all setup products.

An example configuration is:

```
level0.dat
.png
```

which will cause all files whose filenames contain ‘level0.dat’ or ‘.png’ to be written to tape. Files that match the ‘level0.dat’ pattern are level-0 files, the most important type to archive, and those matching ‘.png’ are final image products in PNG format.

The system contains two archiving tools: File Archive, which writes data files to tape twice a day; and Archiver, which allows the operator to view the contents of the tape archive, manage the archive, and restore files to disk.

The File Archive is invoked by cron twice a day, and reads the configuration file /ess/config/archiverList.txt to determine which files on disk should be written to the current tape. The operator edits this configuration file using the Console.

A file whose name matches one of the patterns in the configuration file is a candidate for tape archiving. File Archive maintains an online index of the archive contents in /ess/packages/backup/online_index.lst: if a candidate file is already in the on-line index, it’s already been written to a tape and is therefore skipped. All other files are written to the current tape.

The Archiver is used to manage and view the tape archive, and restore files to disk. It can be launched via the Console launch menu.

Figure 44 Archiver

There are three panels in the main window:

- I the left panel, a list of all tapes in the archive. Each tape is numbered sequentially, starting from 1. All tapes must be cleaned and initialised using Archiver before they can be used by the File Archiver. Double-click on a tape to see file content statistics.
- In the middle panel, a list of all files on the selected tape. Double-click on a file to view file information.
- On the right panel, a list of all files restored from tape.

When a tape is full, a warning is shown above the file lists.

8.6.1. Managing the tape archive

The tape archive is a list of all tapes that have been used by the computer to record satellite data plus their contents. Each tape has a number which is automatically assigned by the Archiver. The number assigned increments by 1 each time a new tape is used, so normally a tape archive contains tapes with numbers ranging from 1 to n, where n is the number of tapes used.

8.6.1.1. Adding a new tape

Before a new tape can be used by File Archive, the Archiver program is used to first clean the tape and then initialise it. Cleaning the tape ensures that there are no data files present, and initialising it writes the tape number onto the tape and creates a new entry in the online database.

Both the clean and initialise steps are invoked using the Archiver Tools menu.

The Archiver will issue warnings when:

- The operator tries to initialise a tape that hasn't been cleaned;
- The tape to be cleaned has already been initialised and contains satellite data

The File Archive will issue warnings when it tries to write data to the drive but:

- There is no tape in the drive
- The number of the tape is not the most recent initialised by the system

8.6.1.2. Restoring a file from a tape

Any file written to any tape can be restored back onto disk. When restored, the file will be written to the same directory from which it was originally archived. To restore a file, use the Archiver to first select the tape. A list of all files on the tape is shown in the 'Archived File' list. Select the file(s) required, and click the restore file option from the Restore menu. The system will find the file(s) on the tape and restore it to disk.

Note that this operation can take some time to complete depending on the size of the tape and the number of files already written to it.

The Archiver will issue warnings when it tries to restore a file from the tape but:

- The tape in the drive is not the one selected in the tape list;
- There is no tape in the drive.

8.6.1.3. Systems with two tape drives

As an option, two tape drives can be supplied with any computer. This allows the File Archive to write new data to disk at the same time as the Archiver is restoring old files back onto disk.

If the computer has only one drive, it is referred to as both the 'backup' and 'restore' drive. For two-drive system, the 'backup' drive is the one to which new files are written and from which tapes are initialised. The 'restore' drive is the one from which files are restored and new tapes cleaned.

8.6.1.4. When a tape is full

When a tape is full, a warning is issued to the logs and to a highlighted area in the Archiver. The operator should clean and initialise a new tape for the archive.

Figure 45 Tape full warning in the Archiver

8.6.1.5. Re-using previous tapes and resetting the archive

A tape previously used in the archive can be re-used, although all data on the tape will be lost. Simply use the Archiver to clean and initialise the tape as normal: a new number will be assigned to the tape and the previous contents removed from the online database.

To reset the entire archive, removing all entries from the online database, execute the command 'skResetArchive' from a command prompt.

8.6.1.6. Using linux commands to access data on the tape

Normally, the Archiver will be used to restore data from tape and examine tape contents. Alternatively, the operator can use the linux command 'tar' to interact with the tape.

Each tape is split into multiple sections, one section being used for header information then one section used to record files each time the File Archiver invokes. The speed of file restoration is improved by splitting the tape into sections like this.

So, 'tar tvf /dev/nst0' will list the contents of the first tape section. Repeat the command to see the contents of the subsequent section. The command 'mt' is also of use in positioning the tape to the correct section. See the linux manual pages for tar(1) and mt(1) for more details.

8.6.2. Archiver menus

8.6.2.1. Tools

- Clean tape. When a tape is full, another tape must be added to the archive. Insert the new tape into the drive, and use this option to clean the tape of previous contents. When the

operation is complete, the tape is ejected.

- Initialise tape. A new (cleaned) tape must first be initialised before File Archive can write to it. Insert the tape the drive, and select this option. Once the operation is complete, the tape should be left in the drive: File Archive will only write to the tape that has been most recently initialised.
- Exit. Exit from the Archiver

8.6.2.2. Restore

- Restore selected file. To restore a file from tape, select the required tape in the left panel then the required file from the middle panel. Restore the file using this option. Once complete, the restored file is added to the restored file list on the left of the main window.
- Clear list of restored files. The restored file list can be cleared using this option. Note that this doesn't remove the file from disk, only from the online database of restored files.

8.6.2.3. Options

- Refresh lists. After skFileArchive operations or a restore function, this option should be selected to ensure the list displayed in the main window are up-to-date.

8.6.2.4. Status

- Daily backup. States whether skFileArchive operations are underway;
- File restoration. States whether a file is currently being restored from a tape;
- Selected file statistics. Shows statistics for the selected file, which can also be obtained by double-clicking on the file entry in the middle panel;
- Selected volume statistics. Shows statistics for the selected tape, which can also be obtained by double-clicking on the tape entry in the left panel; and
- Current volume label: number of the current backup tape.

8.7. Quicklook display

The Quicklook program is launched from the Console to display the level-0 HRIT/LRIT/HiRID data as it's received from the spacecraft.

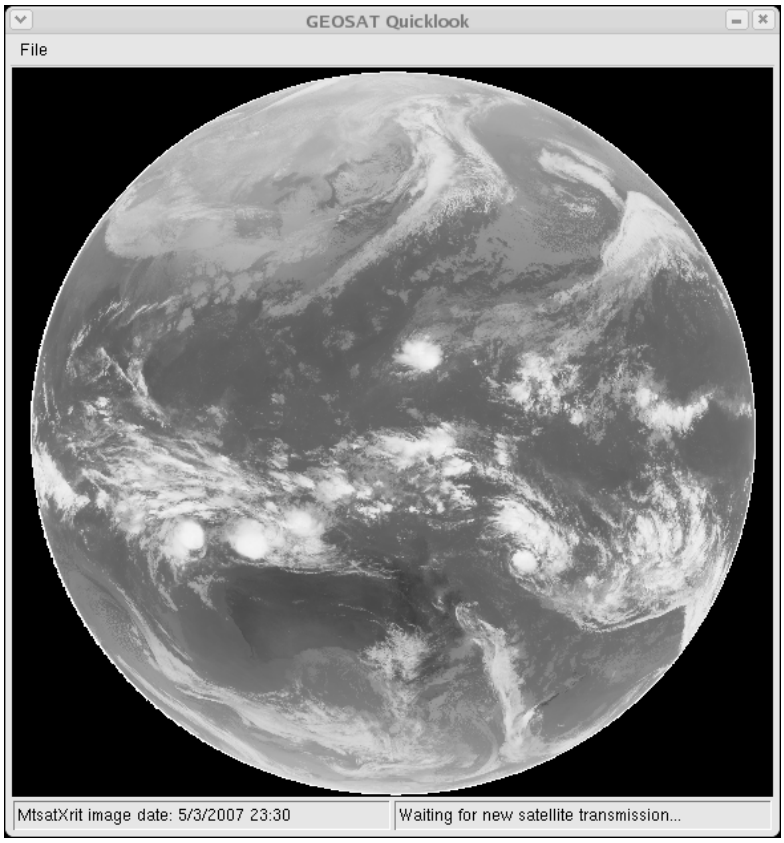


Figure 46 Quicklook

The information panel on the left gives the data format together with the date and time of the observation. The panel on the right gives the quicklook status: waiting for new satellite transmission or extracting data from a file being received.

The Quicklook can also be used as a level-0 file viewer for previously-received passes. See section 5.7 for details.

8.8. Operator and forecaster modes

The system runs in one of two modes:

1. The operator mode, allowing full access to all parts of the system software. This mode is entered by logging into a workstation as the ‘ess’ user.
2. The forecaster mode, which prevents users changing the basic configuration of the system. This mode is entered by logging into a workstation as the ‘frcaster’ user.

The forecaster cannot:

1. Change the reception mode of the system;
2. Change antenna pointing;
3. Modify the ingest configuration;
4. Modify dissemination;
5. Modify disk-space maintenance configuration;
6. Modify the archiver configuration;
7. View archive contents or retrieve files from tape;

8. View, modify, or create setups; or
9. View or modify the generation list.

Passwords for both accounts are at the end of this document.

8.9. Backup up the system configuration

To take a “snapshot” of the current system configuration from any machine, the following should be transferred to some archive medium:

1. The contents of /ess/config/ (core system configuration)
2. The file /ess/packages/backup/tape_data.cfg (tape archive database)
3. The file /ess/packages/backup/config.cfg (tape archive configuration)
4. The contents of /ess/setups (setups and the generation list).

8.10. Setting/changing the role of a workstation

The system is comprised of one or more of the following types of workstation:

1. Acquisition;
2. Data processing;
3. Operator display; and/or
4. Combined acquisition and processing (for single-workstation systems).

Each workstation has identical software. The specific workstation type, or role, is set in the system configuration files and crontabs described in section 5. The program skSetRole handles all necessary file changes and can be run at any time to set or change the workstation role. This includes configuring the system to download and process Himawari HSD data rather than HimawariCast and to download COMS-1 from the JMA JDDS service rather than direct broadcast.

An example session is:

```
skSetRole
-----------------------------------------
Choose a role for this workstation:
1: Acquisition Workstation (ingest only)
2: Acquisition Workstation (ingest plus processing)
3: Data Processing Workstation
4: Display Workstation
1
Which data processing workstations are to receive level-0 data in real-time?
(max of three hostnames or IP addresses, space delimited) [modis-dps1 modis-dps2 modis-
dps3]

-----------------------------------------
Specify latitude, longitude, and altitude of groundstation:
(space-delimited floating-point numbers) [-37.81608 145.01312 40.0]

-----------------------------------------
Does this machine have a tape drive (y or n)?
y
-----------------------------------------
What is the hostname or IP address of the product webserver?
modis-dps2
-----------------------------------------
Will this workstation:
1: Download GRIB data directly from the internet
2: Not use GRIB data or be fed GRIB data from some other machine
2
-----------------------------------------
skConfigCat INFO Catenated product config files into /ess/crontabs/crontab.ess
skConfigCat INFO Catenated product config files into /ess/crontabs/crontab.root
```

```
----------------------------------------
Specify receiver:
1: ESS3000
2: Quorum
1
----------------------------------------
----------------------------------------
Workstation has been configured. Run 'skSetRole' at any time to re-configure.

MACHINE MUST BE REBOOTED BEFORE CHANGES TAKE EFFECT
```

8.11. Monitoring system workstations remotely

Each workstation in the system runs a VNC server and has VNC client software installed, facilitating remote diagnosis and user assistance. VNC allows an operator to view and interact with the desktop of a remote workstation, just as if the operator was seated in-front of the remote machine.

The VNC server is started automatically when a system workstation boots. To view this workstation's desktop from a remote machine:

1. On the remote machine, select Applications >> Accessories >> VNC viewer
2. Specify <machine-name>:1 as the VNC server
3. Enter the VNC password when prompted. This password was specified during system installation and is, by default, the same as the ess account (see the section APPENDIX E: System passwords).

9. Level-2 products

As options, the GEOSAT500 can generate the following level-2 products from MTSAT/COMS-1 HRIT data and/or Himawari AHI data.

1. Cloud-top pressure;
2. Cloud-top height;
3. Cloud-top temperature;
4. Cloud type;
5. Cloud amount;
6. Sea-surface temperature;
7. Land-surface temperature;
8. Fire points;
9. Fog;
10. Dust;
11. Convective Area;
12. Dust and Fog;
13. Rain Rate Estimation;
14. Volcanic Ash;
15. Clear Sky Radiances (AHI only);
16. RGB Products (AHI only);
    - Burned Area
    - Natural Color
    - Day Convective Storm
    - Air Mass
    - Dust
    - Day Micro-Physics
    - Night Micro-Physics
    - Snow and Fog
    - Biomass Burning
17. Automatic Dvorak analysis (MSAT HRIT only); and
18. Cloud center of rotation (MSAT HRIT only).

Cloud detection is a critical component of most of the products. The algorithm applies up to six tests on each pixel to determine if the area is cloud contaminated, and these are detailed below. Many of the tests make use of the MTSAT IR1 and IR2 channels, referred to as the split window. Both are atmospheric windows, in that they are relatively unaffected by atmospheric water vapour and other gases, but there is a difference (split): water vapour absorbs more energy in the IR1 band than IR2 and vice-versa for water-ice.

The six tests are:

1. Thick cloud (day and night). IR1 <= 275K and split-window difference is positive and <= 2K. Thick clouds are cold and opaque: the detected values are from the cloud-top only. As there is relatively little water vapour between the top and the sensor, the IR1 value is very similar to IR2.

2. Thin cloud (day only). IR1 <= 290K and VIS >= 5%. Thin clouds have a degree of transparency so the detected value includes the underlying surface as well as the cloud. The detected value is therefore warmer but the reflectivity of the cloud is still relatively high.
3. Thin high cloud (day and night). IR1 <= 290K and split-window difference <= -2K. As above, detected values contain components of the cloud and the underlying surface and appear warmer. High, thin clouds are formed of water-ice and this attenuates IR2 from the surface more than IR1 resulting in a negative difference in the split window channels.
4. Intermediate high cloud (day and night). IR1 <= 250K and split-window difference > -2 and < 0K. Some clouds fail the above tests because their increased opacity does not result in the split window difference being < -2K, yet some radiation from the surface still gets through and is still attenuated in IR2 more than IR1 by water-ice. These are detected when the split window > -2 and < 0K together with a lower temperature, as the cloud is more opaque and less surface energy is being detected.
5. Day cloud (day only): VIS > 5%. Clouds are highly reflective in the day time.
6. Low cloud (night only): difference between IR4 and IR1 is > 2K. Low (warmer) clouds are difficult to detect in the night as there's no reflectance data and their temperatures are similar to the surrounding land/sea. The emissivity of low cloud in IR4 is less than IR1 leading to a detectable difference.

9.1. Cloud-top pressure

9.1.1. Product overview

This product determines the pressure, in hPa, at the cloud tops.

Generation	Day and night downlinks
Resolution	Can be set via setup. Optimum is 4km as algorithm is based on IR channels.
Channels used	VIS, IR1, IR2, IR4
Physical values	hPa
Example setup	/ess/setups/FullDisk.sup
Reference	The international standard atmosphere is described at http://www.aeromech.usyd.edu.au/aero/atmosphere/

9.1.2. Product description

Clouds are detected using the algorithm described in section 4. This product employs the standard atmosphere which requires accurate temperature as an input: since reliable temperature cannot be derived for thin clouds (as radiation from the surface contributes to the detected value), they are not included in this product. The standard atmosphere is used to derive pressure via:

$$P = Po\left(\frac{T}{To}\right)^{\frac{g}{LR}}$$

which gives pressure variation in the troposphere. In the above equation:

P: pressure

Po: standard sea-level pressure (101.3kPa)

T: temperature

To: standard sea-level temperature (288K)

g: gravitational acceleration (9.8m/s^2)

L: lapse rate (0.0065K/m)

G: gas constant for air (287 m^2/s^2/K)

9.1.3. Generating the cloud-top pressure product

The cloud-top pressure product can be added to any setup:

1. Launch the setup manager from the GEOSAT500 console
2. Create a new setup or edit an existing setup
3. Press ‘Add product’ and select ‘CLOUDPROPERTIES’ from the product group and ‘CloudTopPressure’ from the available level-2 products.
4. Press ‘Save to table’ to save the new product, or continue to configure the cloud product as described in section 3.3.
5. Save the setup using the File menu.

The cloud-top pressure product will be produced for subsequent downlinks.

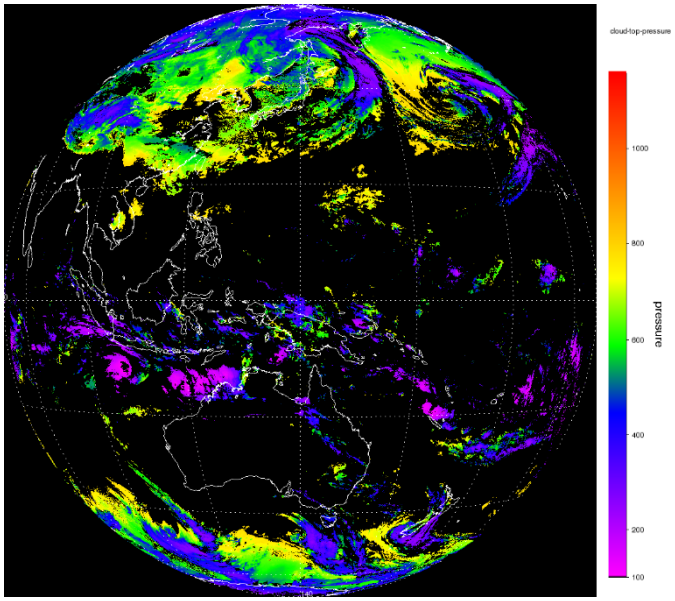


Figure 47 Cloud-top pressure

9.2. Cloud-top height

9.2.1. Product overview

This product determines the height, in km, of the cloud tops.

Generation	Day and night downlinks
Resolution	Can be set via setup. Optimum is 4km as algorithm is based on IR channels.
Channels used	VIS, IR1, IR2, IR4

Physical values	km
Example setup	/ess/setups/FullDisk.sup
Reference	The international standard atmosphere is described at http://www.aeromech.usyd.edu.au/aero/atmosphere/

9.2.2. Product description

Clouds are detected using the algorithm described in section 4. This product employs the standard atmosphere which requires accurate temperature as an input: since reliable temperature cannot be derived for thin clouds (as radiation from the surface contributes to the detected value), they are not included in this product. The standard atmosphere is then used to derive heights via:

$$h = (To - T) / L$$

where

h: height (km)

To: standard sea-level temperature (288K)

T: temperature

L: lapse rate (6.5K/km)

9.2.3. Generating the cloud-top height product

The cloud-top height product can be added to any setup:

1. Launch the setup manager from the GEOSAT500 console
2. Create a new setup or edit an existing setup
3. Press ‘Add product’ and select ‘CLOUDPROPERTIES’ from the product group and ‘CloudTopHeight’ from the available level-2 products.
4. Press ‘Save to table’ to save the new product, or continue to configure the cloud product as described in section 3.3.
5. Save the setup using the File menu.

The cloud-top height product will be produced for subsequent downlinks.

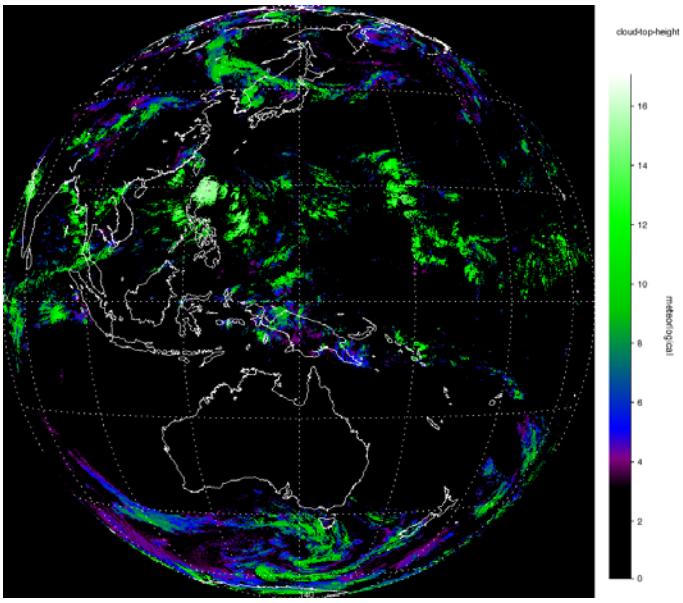


Figure 48 Cloud-top height

9.3. Cloud-top temperature

9.3.1. Product overview

This product masks clouds with IR1 leaving temperature values for the cloud-tops only.

Generation	Day and night downlinks
Resolution	Can be set via setup. Optimum is 4km as algorithm is based on IR channels.
Channels used	VIS, IR1, IR2, IR4
Physical values	K
Example setup	/ess/setups/FullDisk.sup

9.3.2. Product description

Clouds are detected using the algorithm described in section 4. Cloud pixels are then masked with the IR1 channel to leave a dataset containing temperature values for the cloud-tops only.

9.3.3. Generating the cloud-top temperature product

The cloud-top temperature product can be added to any setup:

1. Launch the setup manager from the GEOSAT500 console
2. Create a new setup or edit an existing setup
3. Press ‘Add product’ and select ‘CLOUDPROPERTIES’ from the product group and ‘CloudTopTemperature’ from the available level-2 products.
4. Press ‘Save to table’ to save the new product, or continue to configure the cloud product as described in section 3.3.
5. Save the setup using the File menu.

The cloud-top temperature product will be produced for subsequent downlinks.

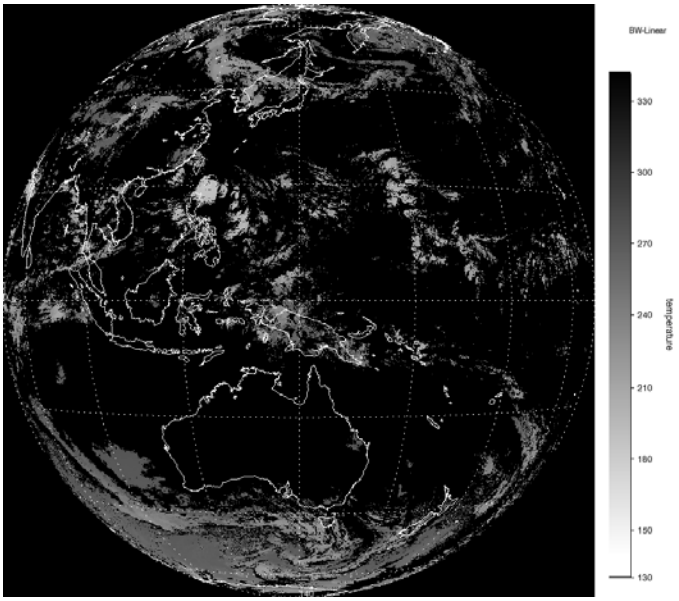


Figure 49 Cloud-top temperature

9.4. Cloud type

9.4.1. Product overview

This product categorises clouds into low-level mid-level, high-level, and convective.

Generation	Day and night downlinks
Resolution	Can be set via setup. Optimum is 4km as algorithm is based on IR channels.
Channels used	VIS, IR1, IR2, IR4
Physical values	0 (no cloud), 1 (low-level), 2 (mid-level), 3 (high-level), 4 (convective)
Example setup	/ess/setups/FullDisk.sup
Reference	• http://www.aeromech.usyd.edu.au/aero/atmosphere/ • Analysis and Use of Meteorological Satellite Images, Meteorological Satellite Centre, Japan Meteorological Agency, April 2002.

9.4.2. Product description

Clouds are detected using the algorithm described in section 4. Cloud-top pressure data is then derived as described in that section and used to categorise the cloud into:

1. Low/thin (>= 600hPa);
2. Medium (>=400 and < 600 hPa);
3. High (<400hPa); and
4. Convective.

Convective clouds are those spanning multiple layers. A characteristic is that there is relatively little

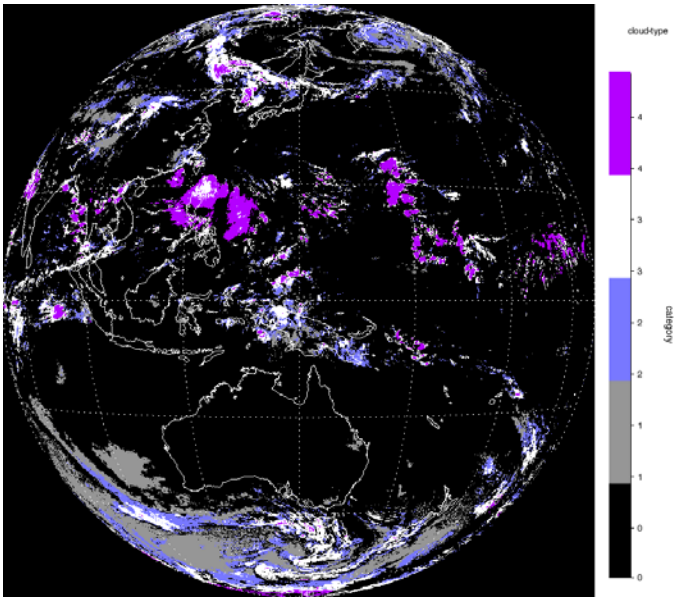
water vapour between the tops of convective clouds and the satellite sensor when compared with other cloud types: they can be identified as those where the IR3 and IR1 difference is < 2K.

9.4.3. Generating the cloud type product

The cloud type product can be added to any setup:

1. Launch the setup manager from the GEOSAT500 console
2. Create a new setup or edit an existing setup
3. Press ‘Add product’ and select ‘CLOUDPROPERTIES’ from the product group and ‘CloudType’ from the available level-2 products.
4. Press ‘Save to table’ to save the new product, or continue to configure the cloud product as described in section 3.3.
5. Save the setup using the File menu.

The cloud-top height product will be produced for subsequent downlinks.



9.5. Cloud amount

9.5.1. Product overview

These products determine the amount of cloud cover in the scene at various pressure levels:

1. surface to 700hPa
2. 700 - 600hPa
3. 600 - 500hPa
4. above 400hPa:

together with

5. Total cloud amount

Generation	Day and night downlinks
Resolution	Can be set via setup. Optimum is 4km as algorithm is based on IR channels.
Channels used	VIS, IR1, IR2, IR4
Physical values	Percentage of area covered by cloud
Reference	The international standard atmosphere is described at http://www.aeromech.usyd.edu.au/aero/atmosphere/

9.5.2. Product description

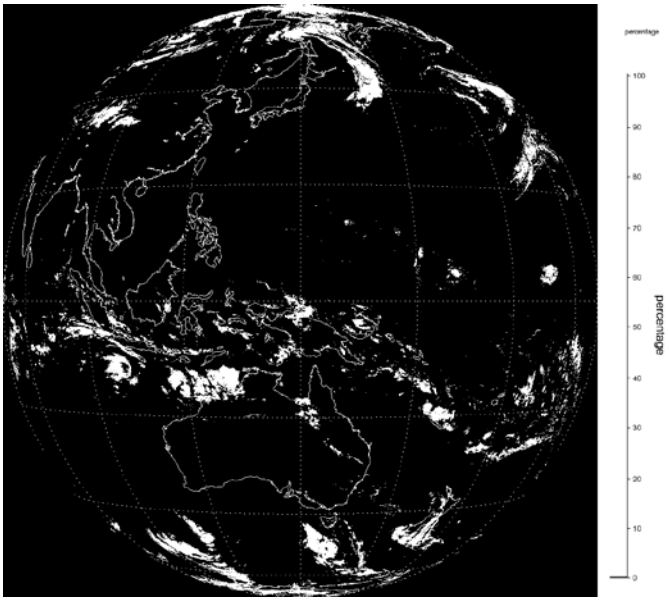
Clouds are detected using the algorithm described in section 4. The pressure-level products employ the standard atmosphere which requires accurate temperature as an input: since reliable temperature cannot be derived for thin clouds (as radiation from the surface contributes to the detected value), they are not included in these products. Cloud-top pressure data is derived and used to categorise the cloud into the relevant pressure range. The total cloud amount is the union of the four range products plus thin clouds.

9.5.3. Generating the cloud amount products

The cloud type product can be added to any setup:

1. Launch the setup manager from the GEOSAT500 console
2. Create a new setup or edit an existing setup
3. Press ‘Add product’ and select ‘CLOUDPROPERTIES’ from the product group and ‘CloudAmountSurfaceTo700’, ‘CloudAmount700To600’, ‘CloudAmount600To500’, ‘CloudAmount400Plus’, and/or ‘CloudAmountTotal’ from the available level-2 products.
4. Press ‘Save to table’ to save the new product, or continue to configure the cloud products as described in section 3.3.
5. Save the setup using the File menu.

The cloud-top amount product(s) will be produced for subsequent downlinks.



9.6. Sea-surface temperature

9.6.1. Product overview

This product derives the sea-surface temperature (SST) for cloud-free areas and mosaics the latest dataset with previous results.

Generation	Day and night downlinks
Resolution	Can be set via setup. Optimum is 4km as algorithm is based on IR channels.
Channels used	VIS, IR1, IR2, IR4
Physical values	C
Example setup	/ess/setups/FullDisk.sup
Reference	Improved Estimates of Wide-Ranging Sea Surface Temperature from GMS S-VISSR Data, Journal of Oceanography, Vol 56, pp 345-358, 2000.

9.6.2. Product description

In idealised circumstances, the value of the IR1 atmospheric window channel represents the sea-surface temperature. In reality, however, the physical values reported by this channel have been attenuated by atmospheric gases, absorbed by cloud, and contain uncertainties due to factors such as wide sensor zenith angles.

The first and most critical step of deriving accurate SST values is to remove cloud. The cloud removal algorithm utilises the visible, IR1, IR2, and IR4 channels to detect cloud in both day and night downlinks, as described in section 4.

SST values are then derived for remaining pixels using a multi-channel SST formula, which includes the sensor zenith angle (SZA) in the IR1 and split window terms:

$$a.IR1 + b.(IR1 - IR2) + c.(IR1 - IR2)(\sec\theta - 1)^2 + d.IR1(\sec\theta - 1)^2$$

where a-d are coefficients determined by regression analysis against ground-truth data and θ is the SZA. Pixels for which θ exceeds 68^o are not included in the output SST: atmospheric attenuation introduces significant uncertainty.

Once the SST values have been derived, the single-downlink SST PIC is written. The PIC is then mosaicked with previous SST data for that setup and a mosaic SST PIC also created. Values in the mosaicked SST PIC are replaced when new values are derived from subsequent downlinks.

Note that a new mosaic is started whenever the geographical area or resolution changes in the setup.

9.6.3. Generating the sea-surface temperature product

The SST product can be added to any setup:

1. Launch the setup manager from the GEOSAT500 console
2. Create a new setup or edit an existing setup
3. Press ‘Add product’ and select ‘SURFACEPROPERTIES’ from the product group and ‘SST’ from the available level-2 products.
4. Press ‘Save to table’ to save the new product, or continue to configure the SST product as described in section 3.3.
5. Save the setup using the File menu.

SST PICs and SST mosaic PICs will be produced for subsequent downlinks.

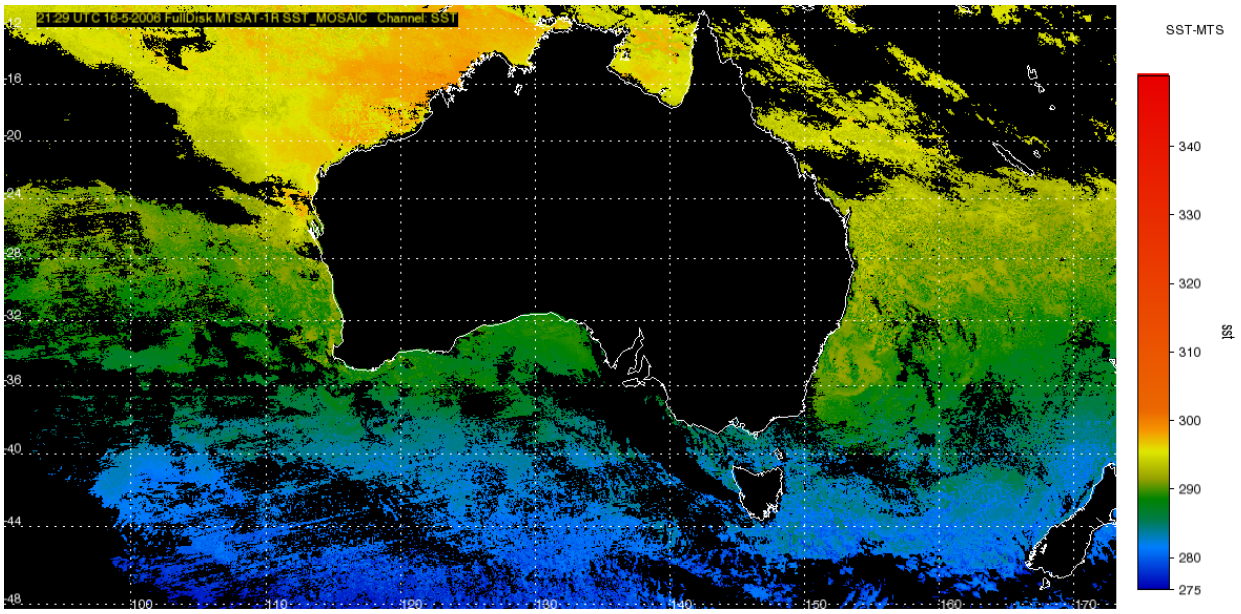


Figure 50 SST MOSAIC

9.7. Land-surface temperature

9.7.1. Product overview

This product derives the land-surface temperature (LST) for cloud-free areas and mosaics the latest dataset with previous results.

Generation	Day and night downlinks
Resolution	Can be set via setup. Optimum is 4km as algorithm is based on IR channels.
Channels used	VIS, IR1, IR2, IR4
Physical values	Degrees Celsius
Example setup	/ess/setups/FullDisk.sup

9.7.2. Product description

The LST is derived in a similar fashion to the SST except sea is masked out of the final product rather than land. Once the LST values have been derived, the single-downlink LST PIC is written. As LST is changes quickly with respect to SST, the mosaic product is not updated after every downlink: instead, the operator configures the system such that LST mosaics are only updated between certain hours of the day, allowing the product to represent day temperatures only for instance.

To do this, edit the GEOSAT_LST_MOSAIC_TIME variable in the GEOSAT500 configuration file (see section 5.5) to specify the required time period. The format is “<start time>:<end time>”. For example, to update the mosaic during 2330 and 0630Z, set the value to "2330:0630". To force mosaicking after every downlink, set the end time equal to the start time.

When the time is within range, the PIC is mosaicked with previous LST data for that setup and a mosaic LST PIC created. Values in the mosaicked LST PIC are replaced when new values are derived from subsequent downlinks.

Note that a new mosaic is started whenever the geographical area or resolution changes in the setup.

9.7.3. Generating the land-surface temperature product

The LST product can be added to any setup:

1. Launch the setup manager from the GEOSAT500 console
2. Create a new setup or edit an existing setup
3. Press ‘Add product’ and select ‘SURFACEPROPERTIES’ from the product group and ‘LST’ from the available level-2 products.
4. Press ‘Save to table’ to save the new product, or continue to configure the LST product as described in section 3.3.
5. Save the setup using the File menu.

LST PICs and LST mosaic PICs will be produced for subsequent downlinks.

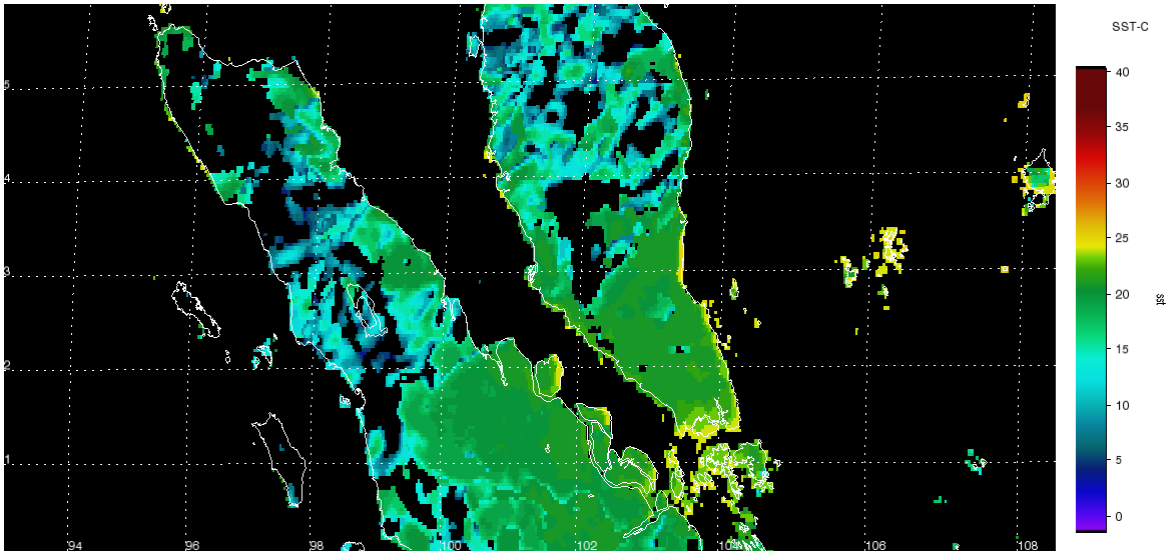


Figure 51 Land-surface temperature

9.8. Fire points

9.8.1. Product overview

This product identifies thermal anomalies in cloud-free land areas and outputs the latitude and longitude of each to a text file. The output file is time- and date-stamped and written to /ess/data/processed.

Generation	Day and night downlinks
Resolution	4km (fire burning somewhere in the 4km^2 area)
Channels used	VIS, IR2, IR4
Physical values	Latitude, longitude coordinate

Example setup	/ess/setups/FullDisk.sup

9.8.2. Product description

The product identifies fires in cloud-free, land areas: the first stage is to detect clouds using the algorithm described in section 4 and remove them from the input data along with sea pixels.

The second stage of the algorithm locates candidate fire pixels: fire points that will be confirmed or refuted by third stage context checks. Fires are treated as thermal blackbodies, which emit strongly in the 3.75um channel (IR4) and to a lesser degree in the 12um channel (IR2). A pixel is marked as a candidate fire if the following three tests are true:

1. VIS reflectance <= 12%. IR4 is contaminated by solar reflectance from bright objects which can lead to channel saturation and difficulties thresholding IR4. Removing these bright areas means that high IR4 values are more likely to be caused by higher underlying temperatures.
2. IR4 temperature exceeds 319K (day) or 300K (night); and
3. IR4-IR2 > 10K and < 50K during the day or > 3K and < 40K during the night. This test exploits the relative difference in IR4 and IR2 responses caused by fires but places an upper limit on any difference to account for solar-contamination in the 3.75um band: in other words, to distinguish bright, cooler pixels from hotter pixels.

The third stage performs a context analysis on all candidate fire pixels, refuting the pixel as a fire if any of these three tests are true:

4. There aren't enough pixels to perform a context check: fewer than two non-fire, non-saturated, non-zero pixels in a 3x3 IR4 neighbourhood; or
5. The surrounding pixels aren't significantly cooler in IR4: the average of surrounding non-fire, non-saturated, non-zero pixels in a 3x3 IR4 neighbourhood is <= 3K cooler; or
6. The surrounding pixels are significantly cooler in IR2, suggesting something other than a fire (eg. land/sea boundary): the average of surrounding non-fire, non-saturated, non-zero pixels in a 3x3 IR2 neighbourhood is > 4K. Fires are usually sub-pixel in size and don't affect IR2 values significantly.

9.8.3. Generating the fire points product

The fire points product can be added to any setup:

1. Launch the setup manager from the GEOSAT500 console
2. Create a new setup or edit an existing setup
3. Edit one of the channel datasets, select Plot Overlays, and turn on fire points for the last 12, 24, or 36 hours.
4. Press ‘Save to table’ to save the new configuration
5. Save the setup using the File menu.

Fire points will be generated for subsequent downlinks and automatically overlaid on the channel specified in step 2 above. The PROTEUS Overlays>>Fire Points option can be used to manually overlays the points on any other level-1b or level-2 product. PROTEUS colours the points thus: red (detected in the last 12 hours), yellow (last 24 hours), and cyan (last 36 hours).

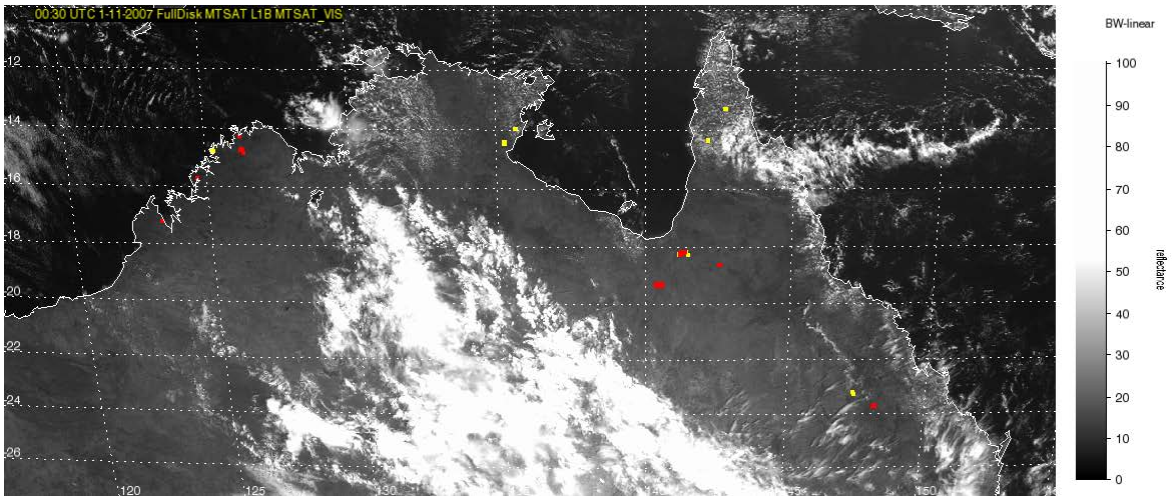


Figure 52 Fire points

9.9. Fog

9.9.1. Product overview

Resolution	Same as input level-1b
Generation	Night passes only
Channels used	1, 4
Physical values	0 (no fog), 1 (fog)
Applications	• Fog monitoring
Example setup	/ess/imagedata/setups/Fulldisk.sup

9.9.2. Product description

During the night-time, fog and low-stratus cloud emissivity results in a positive difference between channels IR1 and IR4. A pixel is classified as fog/low-stratus if this value > 2.5K.

Unlike other level-2 products, the fog product is produced using a channel combination preset in PROTEUS. It can also be derived automatically by inserting the fog product in a setup.

9.9.3. Generating the fog product

1. Launch the setup manager from the Console
2. Open the setup you wish to generate the fog product for (using the File menu).
3. Add a new product entry to the products table.
4. Choose Combination then Fog from the products list, and configure the colour-table, overlays, the standard images which should be generated, etc. Select at least one standard image.
5. Save the product to the products table and then save the setup using the File menu.
6. The selected standard images produced contain fog cover data. Note that fog data does not appear in PIC products but can be generated using PROTEUS channel combination presets (see PROTEUS manual).

9.10. Dust

9.10.1. Product overview

Resolution	Same as input level-1b
Generation	Day and passes
Channels used	1, 2, 4
Physical values	0 (no dust), 1 (dust)
Applications	• Dust detection
Example setup	/ess/imagedata/setups/Fulldisk.sup

9.10.2. Product description

This product detects the presence of dust in day- and night-time imagery.

Unlike other level-2 products, the dust product is produced using a channel combination preset in PROTEUS. It can also be derived automatically by inserting the dust product in a setup.

9.10.3. Generating the dust product

1. Launch the setup manager from the Console
2. Open the setup you wish to generate the dust product for (using the File menu).
3. Add a new product entry to the products table.
4. Choose Combination then dust from the products list, and configure the colour-table, overlays, the standard images which should be generated, etc. Select at least one standard image.
5. Save the product to the products table and then save the setup using the File menu.
6. The selected standard images produced contain dust data. Note that dust data does not appear in PIC products but can be generated using PROTEUS channel combination presets (see PROTEUS manual).

9.11. Convective Area

9.11.1. Product overview

Resolution	Same as input level-1b
Generation	Day and night passes
Channels used	Ir1, ir2, ir3
Physical values	Temperature. Center of storm highlighted in blue/green.
Applications	• Area of developing convection

9.11.2. Product description

The algorithm for detecting rapidly developing convective area is based on three infrared channels (6.7 µm ($T_{6.7}$), 10.8 µm (T_{11}) and 12.0 µm (T_{12}).

- $T_{6.7}$ is lower than T_{11} and T_{12} when clouds are in the development stage and their tops do not reach the tropopause.
- $T_{6.7}$, T_{11} and T_{12} are almost identical when convective cloud tops reach the tropopause,
- $T_{6.7}$ may be higher than T_{11} when cloud tops overshoot into the stratosphere.
- The temperature difference between T_{11} and T_{12} increases when thin cirrus clouds are observed.

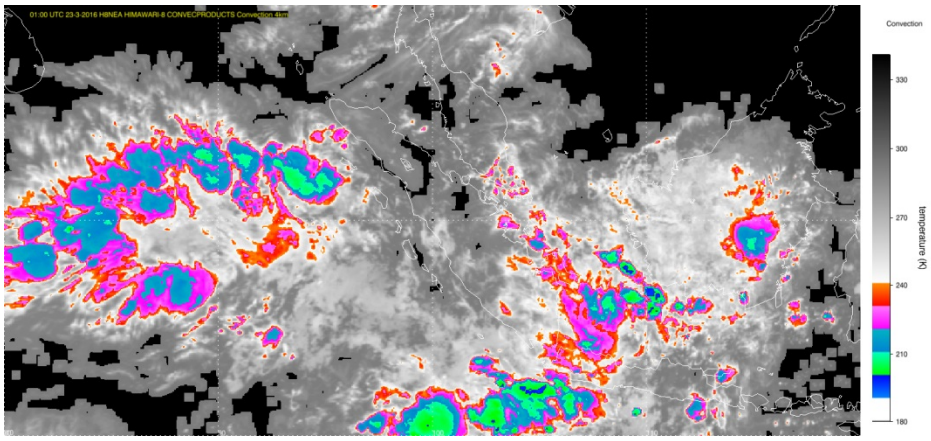


Figure 53 Convective Area

9.11.3. Generating the convective area product

1. Launch the setup manager from the Console
2. Open the setup you wish to generate the convective area product for (using the File menu).
3. Add a new product entry to the products table.
4. Choose CONVECPRODUCTS from the products list, and configure the colour-table, overlays, the standard images which should be generated, etc. Select at least one standard image.
5. Save the product to the products table and then save the setup using the File menu. The selected standard images produced contain area of strong convection data.

9.12. Dust and Fog

9.12.1. Product overview

Resolution	Same as input level-1b
Generation	Day passes
Channels used	Ir1, ir2, ir3
Physical values	0 (no dust), 1 (dust)
Applications	• Dust tracking,
Example setup	/ess/imagedata/setups/Fulldisk.sup

9.12.2. Product description

The Reverse Absorption technique of detecting dust or fog is based on the following characteristics.

- Infrared radiation is absorbed by dust more strongly at 10.8 μm channel than at 12 μm channel.
- Radiation absorption by water or ice cloud is stronger at 12 μm that at 10.8 μm.
- Dust shows negative T(10.8) – T(12) and this characteristic is most valuable in detecting heavy dust storms.

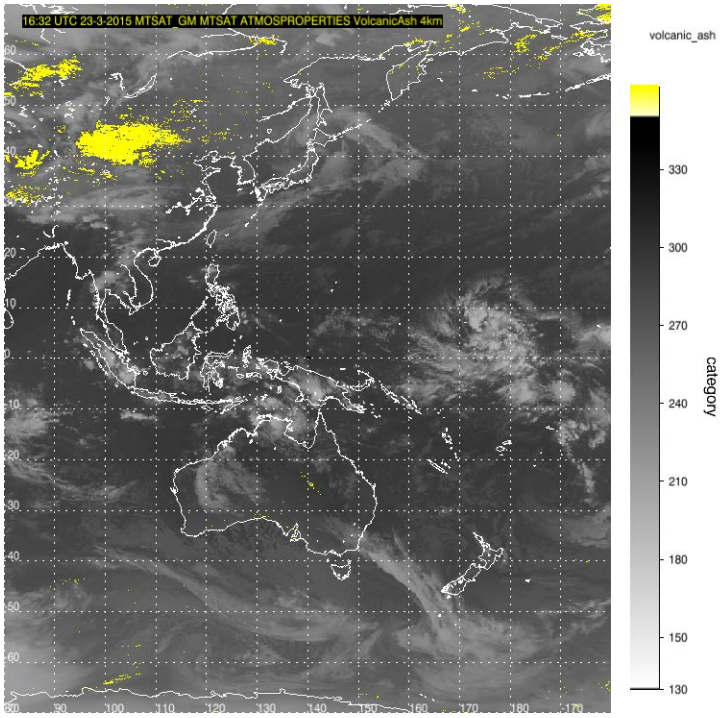


Figure 54 Yellow Dust from China

9.12.3. Generating the dust & fog product

1. Launch the setup manager from the Console
2. Open the setup you wish to generate the dust product for (using the File menu).
3. Add a new product entry to the products table.
4. Choose Combination then dust from the products list, and configure the colour-table, overlays, the standard images which should be generated, etc. Select at least one standard image.
5. Save the product to the products table and then save the setup using the File menu. The selected standard images produced contain dust data. Note that dust data does not appear in PIC products but can be generated using PROTEUS channel combination presets (see PROTEUS manual).

9.13. Rain Rate Estimation

9.13.1. Product overview

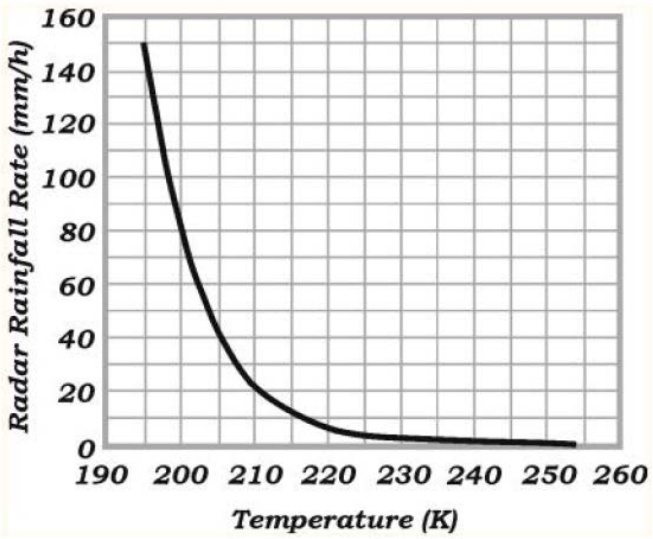
This product estimates rain fall rate in mm/hr. by examining IR radiation and statistically generated rain rate estimation using weather radar.

Resolution	Same as input level-1b
Generation	Day & Night passes
Channels used	Ir1
Applications	• Rain rate over convective clouds

9.13.2. Product description

Rain rate is estimated using the fact that clouds with cold tops in the IR imagery produce more rainfall than those with warmer tops. The auto-estimator initially computes rainfall rates based on a nonlinear, power-law regression relationship between cloud-top temperature (10.7μm brightness temperature) and radar derived rainfall estimates.

The mean rainfall rate for each temperature from 195 to 255 K computed from collocated pairs of radar-derived rainfall rate estimates and IR cloud-top temperature. The computed power-law regression curve is shown below.



The result of the regression fit is given by

$$R = 1.1183 \times 10^{11} \exp(-3.682 \times 10^{-2} T^{0.5})$$

where R is the rainfall rate in millimeters per hour and T is the cloud-top temperature in Kelvin.

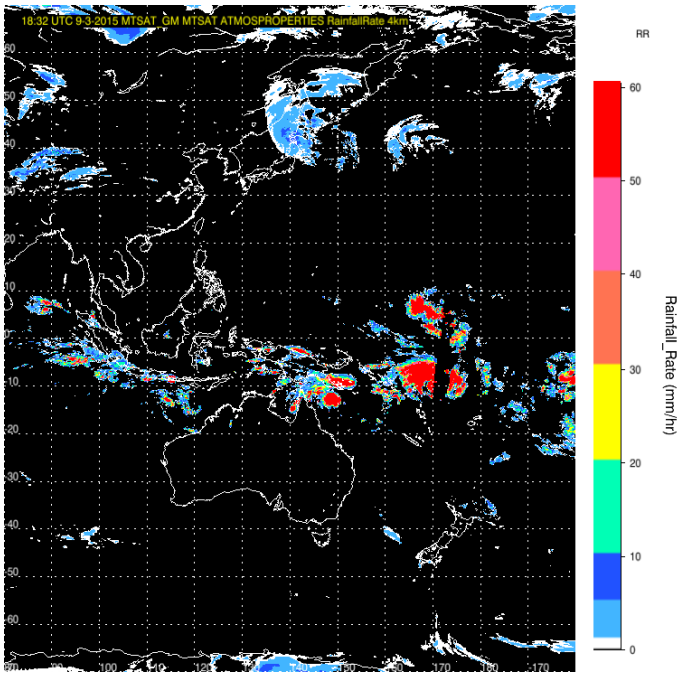


Figure 55 Rain Rate product

9.13.3. Generating the rain rate estimation product

1. Launch the setup manager from the Console
2. Open the setup you wish to generate the dust product for (using the File menu).
3. Add a new product entry to the products table.
4. Choose Combination then dust from the products list, and configure the colour-table, overlays, the standard images which should be generated, etc. Select at least one standard image.
5. Save the product to the products table and then save the setup using the File menu. The selected standard images produced contain dust data. Note that dust data does not appear in PIC products but can be generated using PROTEUS channel combination presets (see PROTEUS manual).

9.14. Volcanic Ash

9.14.1. Product overview

Resolution	Same as input level-1b
Generation	Day & Night passes (AHI)
Channels used	IR1, IR2 and IR4
Applications	Volcanic ash eruption detection, Aviation

9.14.2. Product description

Volcanic ash products are generated using brightness temperature of three IR channels, ir1,ir2 and ir4.

- If brightness temperature of 11 µm is less than 233K and difference between 11µm and 12µm is less than -2 and difference between 3.8 µm and 11 µm is greater than zero, then the pixel is classified as volcanic ash.
- If brightness temperature of 11 µm is greater than 233K and difference between 11µm and 12µm is less than 0 and difference between 3.8 µm and 11 µm is greater than zero, then the pixel is classified as volcanic ash.

9.14.3. Generating the volcanic ash product

1. Launch the setup manager from the Console
2. Open the setup you wish to generate the volcanic ash product for (using the File menu).
3. Add a new product entry to the products table.
4. Choose ATMOSPROPERTIES from the products list, and configure the colour-table, overlays, the standard images which should be generated, etc. Select at least one standard image.
5. Save the product to the products table and then save the setup using the File menu. The selected standard images produced contain volcanic asht data.

9.15. Clear Sky Radiances (CSR)

9.15.1. Product overview

This RGB depicts surface and atmospheric features such as vegetated areas, deserts, clouds and ocean. This is done using a combination of visible and near-infrared channels.

Resolution	Same as input level-1b
Generation	Day passes (AHI only)
Channels used	R:vis, G:b15, B:b14
Gamma	R:1.0 G:1.0 B:1.0
Applications	• Vegetated areas are green • Deserts are brown • Clouds are white • Water is blue

9.15.2. Product description

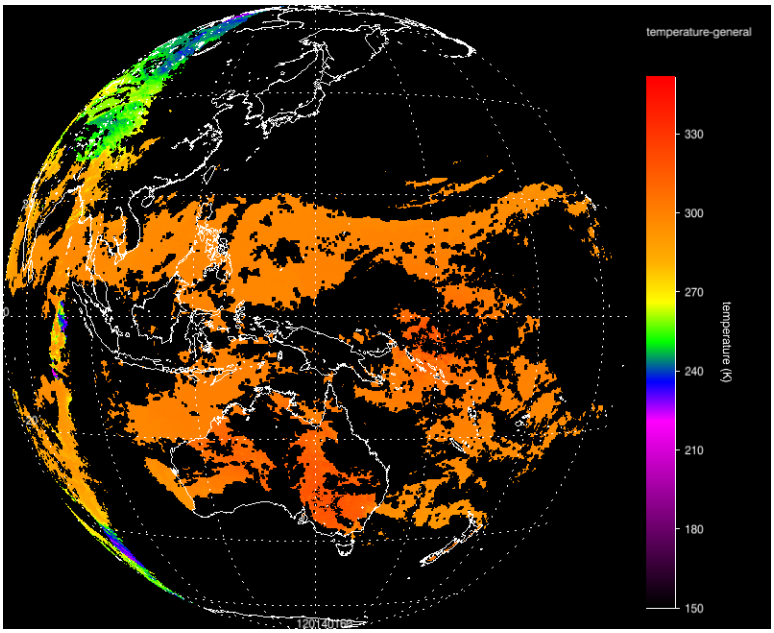


Figure 56 Clear Sky Radiance for IR4

9.15.3. Generating the clear sky radiance product

1. Launch the setup manager from the Console
2. Open the setup you wish to generate the CSR product for (using the File menu).
3. Add a new product entry to the products table.
4. Choose CSRPRODUCTS from the products list, and configure the colour-table, overlays, the standard images which should be generated, etc. Select at least one standard image.
5. Save the product to the products table and then save the setup using the File menu.

9.16. RGB Products (AHI only)

9.16.1. Product overview

This RGB model has three primary colors: red, green, and blue. By combining them in various ways, we get a broad array of colors, from the secondary colors of yellow, magenta, and cyan, to the grays, black, and white. By assigning each of the three spectral channels to a different primary color and combining them into one product, we get far more information than any single channel could provide.

9.16.2. Product description

1. Burned Area

This RGB depicts surface and atmospheric features such as vegetated areas, deserts, clouds and ocean. This is done using a combination of visible and near-infrared channels.

Resolution	Same as input level-1b
Generation	Day passes
Channels used	R:b06, G:b04, B:vis
Gamma	R:1.0 G:1.0 B:1.0
Applications	• Active fire in pink • Burned areas in dark magenta • Vegetated area in green

2. Natural Colour

This RGB product is created without all 3 requisite solar channels. RGB product is used to interpret surface and atmospheric features, such as vegetated areas, clouds, and ocean.

Resolution	Same as input level-1b
Generation	Day passes
Channels used	R:b05, G:b04, B:vis
Gamma	R:1.0 G:1.0 B:1.0
Applications	• Low clouds are white • Vegetation is green • Deserts are reddish brown • Snow cover and high ice clouds are cyan • Water is dark

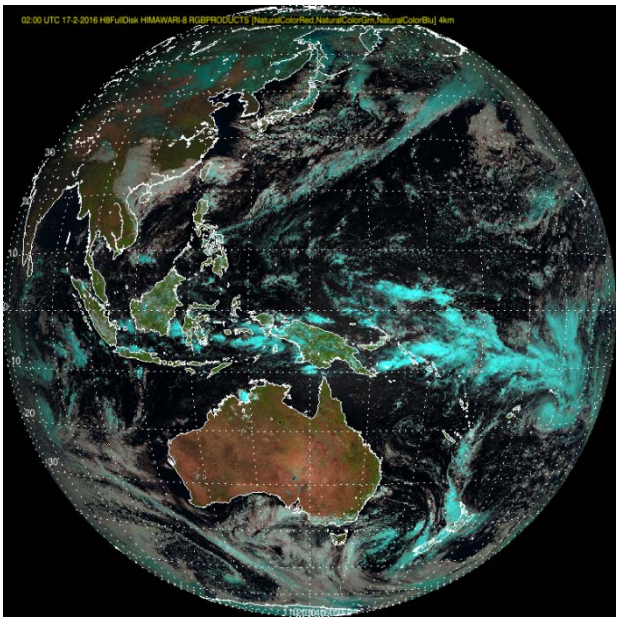


Figure 57 Natural Color RGB

3. Day Convective Storm

This RGB product is used to identify important microphysical trends in convection, such as small ice particles and mark intense updrafts and are potential indicators of imminent severe weather.

Resolution	Same as input level-1b
Generation	Day passes
Channels used	R:ir3-b10, G:ir4-ir1, B:b05-vis
Gamma	R:1.0 G:0.5 B:1.0
Applications	• The background is blue/magenta • High-level thick, ice clouds, including convective cumulonimbus clouds, are red • Particles within convective cloud tops are yellow

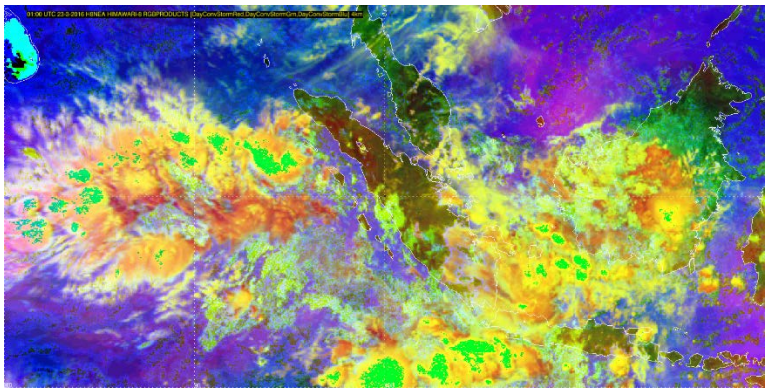


Figure 58 Day Convective Storm RGB

4. Air Mass

This RGB is for monitoring the evolution of cyclones, rapid cyclogenesis, jet streaks, and potential vorticity anomalies. This product provides information primarily about the middle and upper levels of the troposphere.

Resolution	Same as input level-1b
Generation	Day passes
Channels used	R:ir3-b10, G:b12-ir1, B:ir3
Gamma	R:1.0 G:1.0 B:1.0

Applications	• Ozone-poor tropical air masses are green • Ozone-rich polar air masses are blue • Dry air masses in the upper troposphere (such as those related to sub-tropical high pressure systems, PV anomalies, jet streaks, and deformation zones) are red to orange • High-level clouds are white • Mid-level clouds are brown • Magenta often appears at the edge of the full disk and should be disregarded

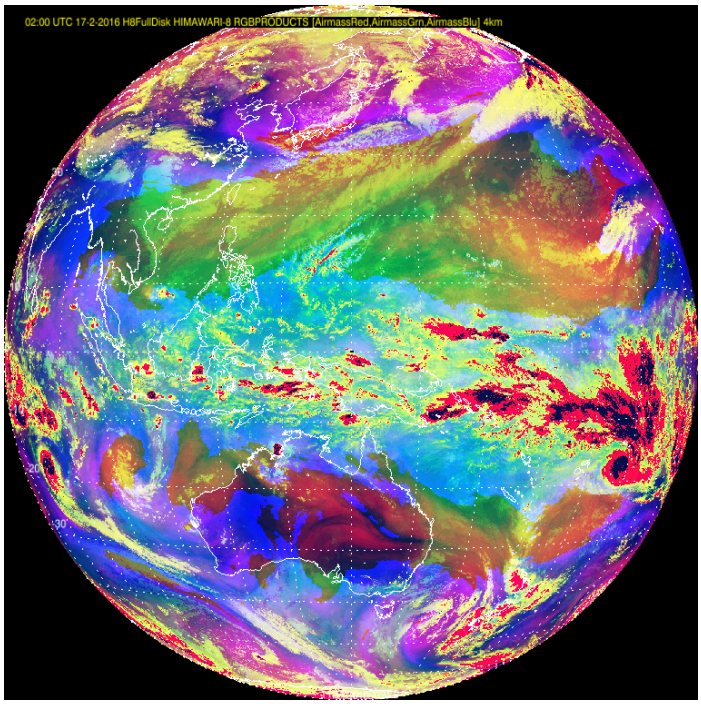


Figure 59 Air mass RGB

5. Dust

This RGB product is used to monitor the evolution of dust storms during both day and night. Note that the appearance of dust changes radically from day to night.

Resolution	Same as input level-1b
Generation	Day & Night passes
Channels used	R:ir2-ir1, G:ir1-b11, B: ir1
Gamma	R:1.0 G:1.0 B:1.0

Applications	• Ozone-poor tropical air masses are green • Ozone-rich polar air masses are blue • Dry air masses in the upper troposphere (such as those related to sub-tropical high pressure systems, PV anomalies, jet streaks, and deformation zones) are red to orange • High-level clouds are white • Mid-level clouds are brown • Magenta often appears at the edge of the full disk and should be disregarded

6. Day Micro-Physics

This RGB is useful for cloud analysis, convection, fog, and fires.

Resolution	Same as input level-1b
Generation	Day passes
Channels used	R:ir4, G:b06, B:ir1
Gamma	R:1.0 G:1.5 B:1.0
Applications	• Ozone-poor tropical air masses are green • Ozone-rich polar air masses are blue • Dry air masses in the upper troposphere (such as those related to sub-tropical high pressure systems, PV anomalies, jet streaks, and deformation zones) are red to orange • High-level clouds are white • Mid-level clouds are brown • Magenta often appears at the edge of the full disk and should be disregarded

7. Night Micro-Physics

This RGB product is effective for low-cloud distinction in night time especially fog. Also it can effectively distinguish thick Cb cloud at night time.

Resolution	Same as input level-1b
Generation	Night passes
Channels used	R:ir2-ir1, G:ir1-b06, B:ir1
Gamma	R:1.0 G:1.0 B:1.0
Applications	• Very cold, think high-level cloud in orange-red color • Cirrus clouds in blue • Low-level clouds and fog in pinkish white

8. Snow & Fog

This RGB product is useful in identifying fog, low-clouds, and snow.

Resolution	Same as input level-1b
Generation	Day passes
Channels used	R:vis, G:b15, B:b14
Gamma	R:1.0 G:1.0 B:1.0
Applications	• Low clouds are white • Snow cover and high ice clouds are cyan

9. Biomass Burning

This RGB depicts surface and atmospheric features such as vegetated areas, deserts, clouds and ocean. This is done using a combination of visible and near-infrared channels.

Resolution	Same as input level-1b
Generation	Day passes
Channels used	R:b05, G:b06, B:ir4
Gamma	R:1.0 G:1.0 B:1.0
Applications	• Relatively cool/small fires appear red • Warmer larger fires appear yellow • Large, hot fires appear white • Liquid cloud in blue • Ice clouds in dark green

9.16.3. Generating the RGB product

1. RGB products are displayed by loading RGBPRODUCTS, then select “RGB composite” on Channel menu. RGB Composite interface will appear. Assign red. green, and blue channel for the desired product and press “Draw” button. If desired RGB combination is not displayed adjusting “EQU” and/or “INV” channels to enhace features.

9.17. GEOCAT Level-2 products

CSPP Geo Geostationary Cloud Algorithm Testbed (GEOCAT) software package is used for processing GOES-13/14/15 Imager AREA files to generate NetCDF4 Level 2 products.

Two major groups of level-2 products are generated by GEOCAT. The first group is Cloud, and the second is FLS(Fog/Low Stratus).

9.17.1. GEOCAT Cloud products

The cloud group include 11 products, cloud mask, cloud type, cloud phase, cloud top height, cloud top pressure, cloud top temperature, cloud emissivity, cloud effective radius, cloud optical depth, cloud liquid water path, cloud ice cloud path.

The cloud products can be added to any GOES-13/14/15 setup for the generation:

A, Launch the setup manager from the GEOSAT500 console

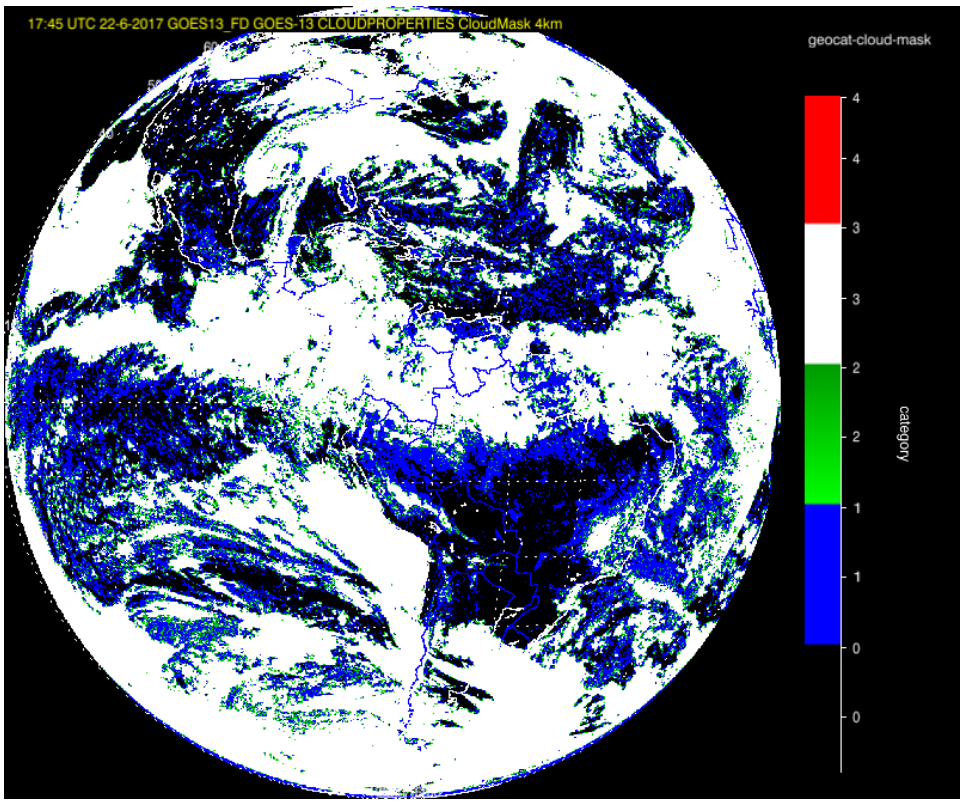
B, Create a new setup or edit an existing setup for GOES-13/14/15

C, Press ‘Add product’, select ‘CLOUDPROPERTIES’ from the ‘Product Type’, then select any product listed above from ‘Data Set’.

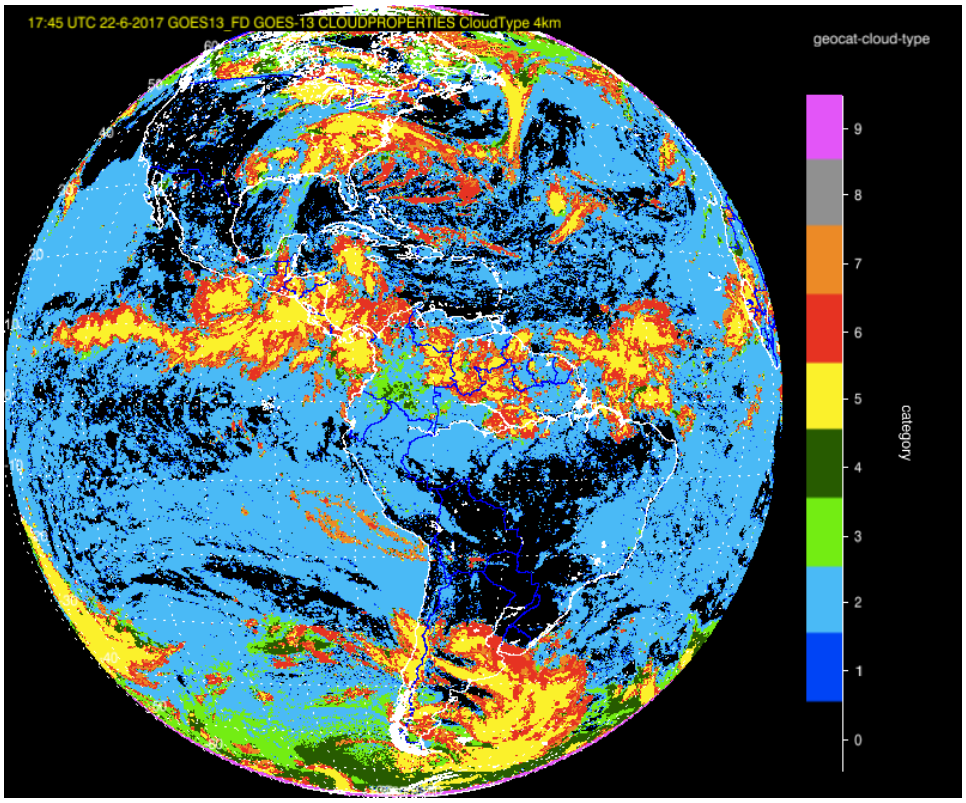
D, Press ‘Save to table’ to save the new product. Repeat step C and D to add more products.

E, Save the setup using the File menu.

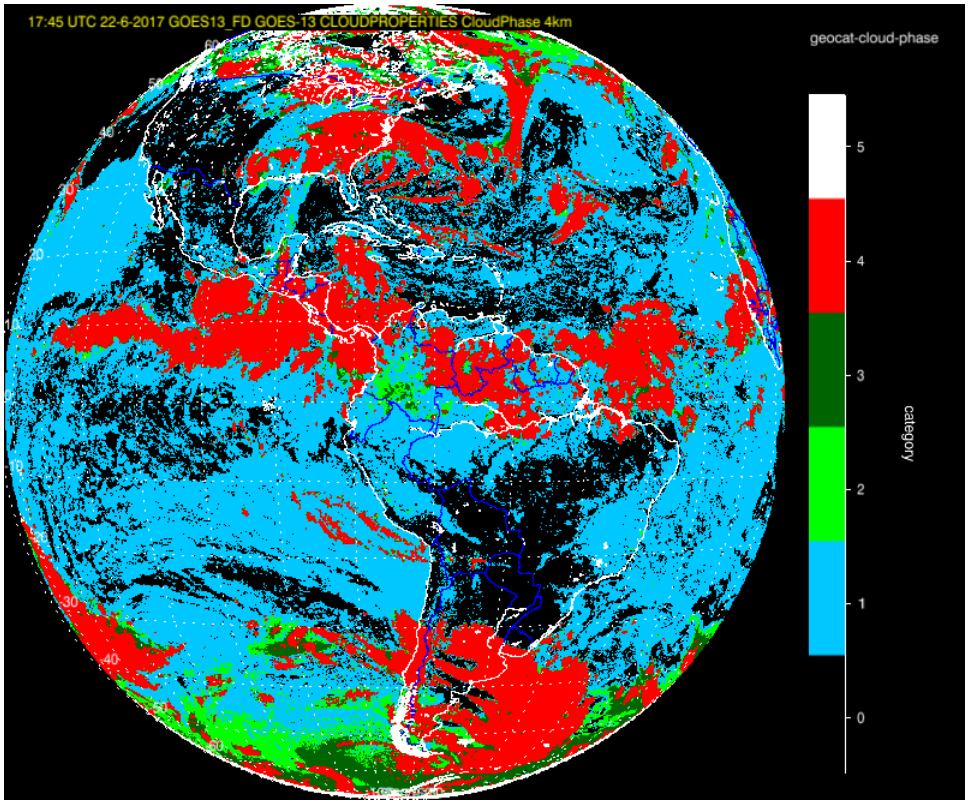
1, Cloud Mask: Its categories are 0 confident clear, 1 probably clear, 2 probably cloudy, 3 confident cloudy, 4 uncertain.



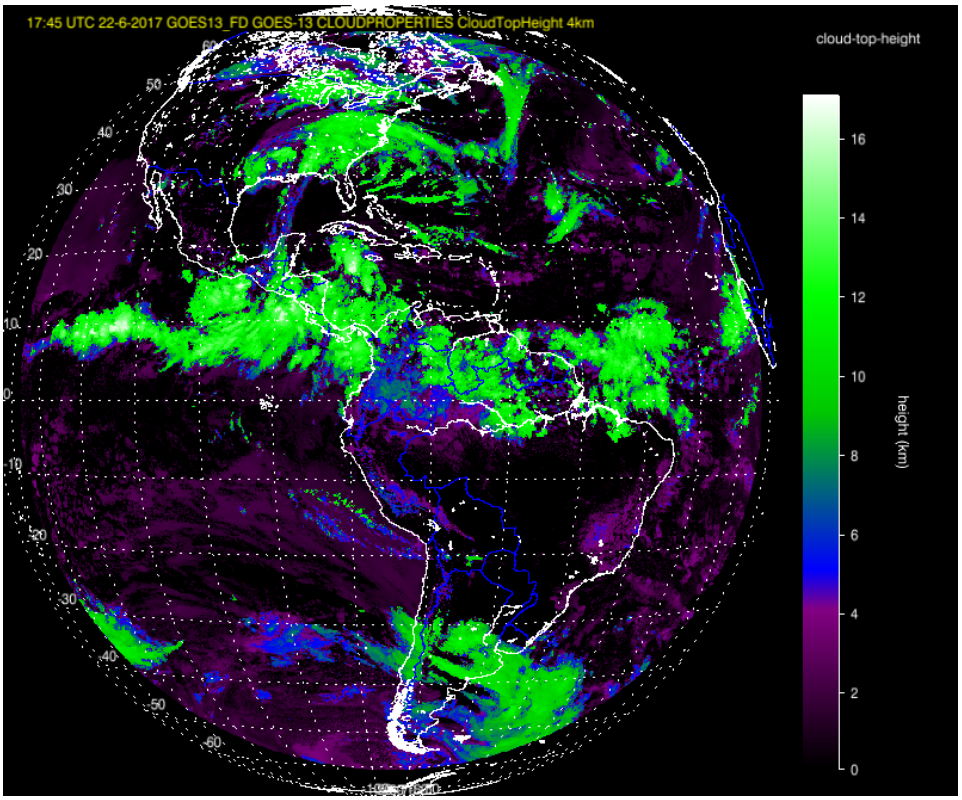
2, Cloud Type: there are 10 categories of cloud type,0 clear sky,1 spare, 2 water cloud, 3 supercooled cloud,4 mixed cloud,5 thick ice cloud,6 thin ice cloud,7 multilayer cloud,8 spare,9 uncertain.



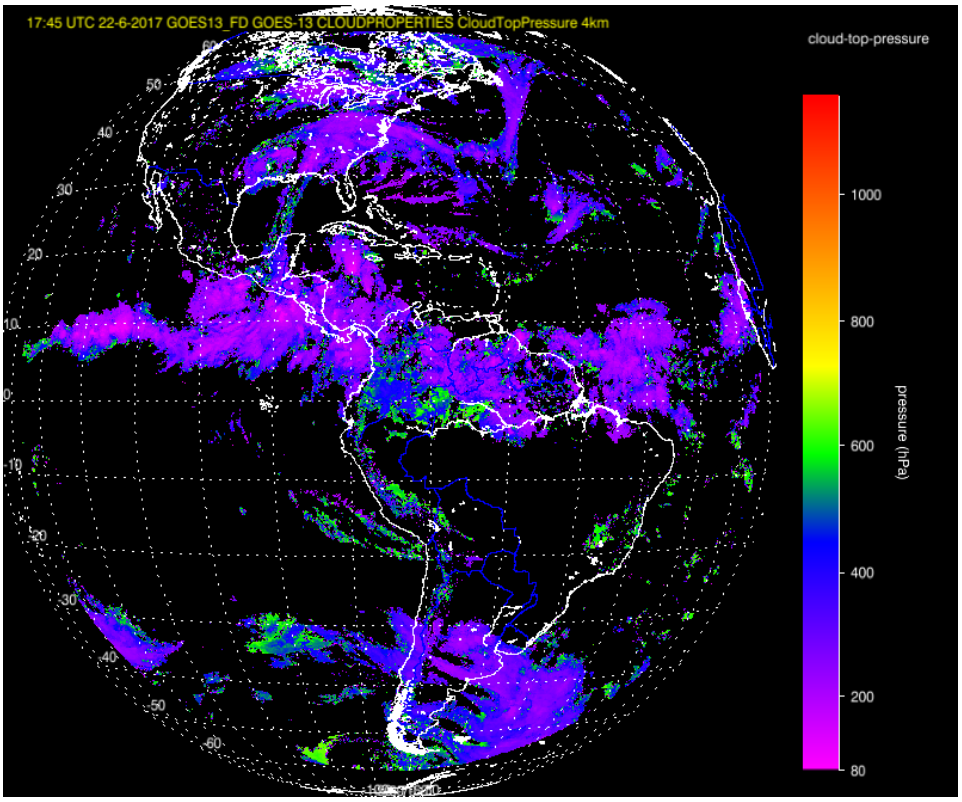
3, Cloud Phase: there are 6 categories of cloud phase, 0 clear sky, 1 water cloud, 2 supercooled cloud, 3 mixed cloud, 4 ice cloud, 5 unknown.



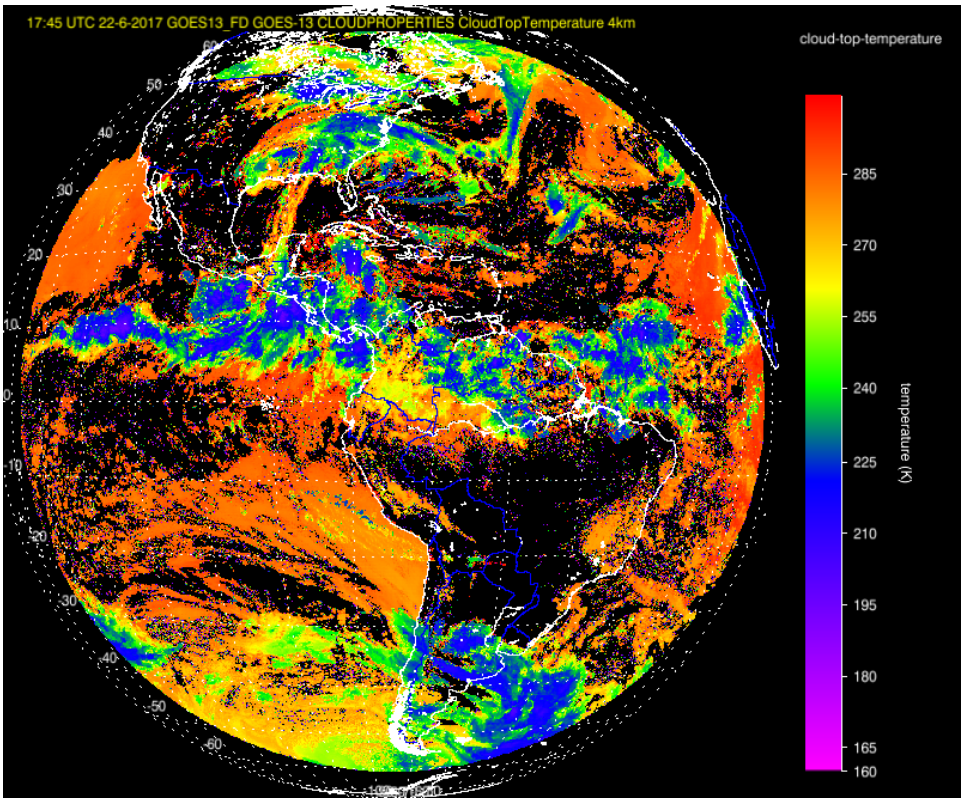
4, Cloud Top Height: the unit is km.



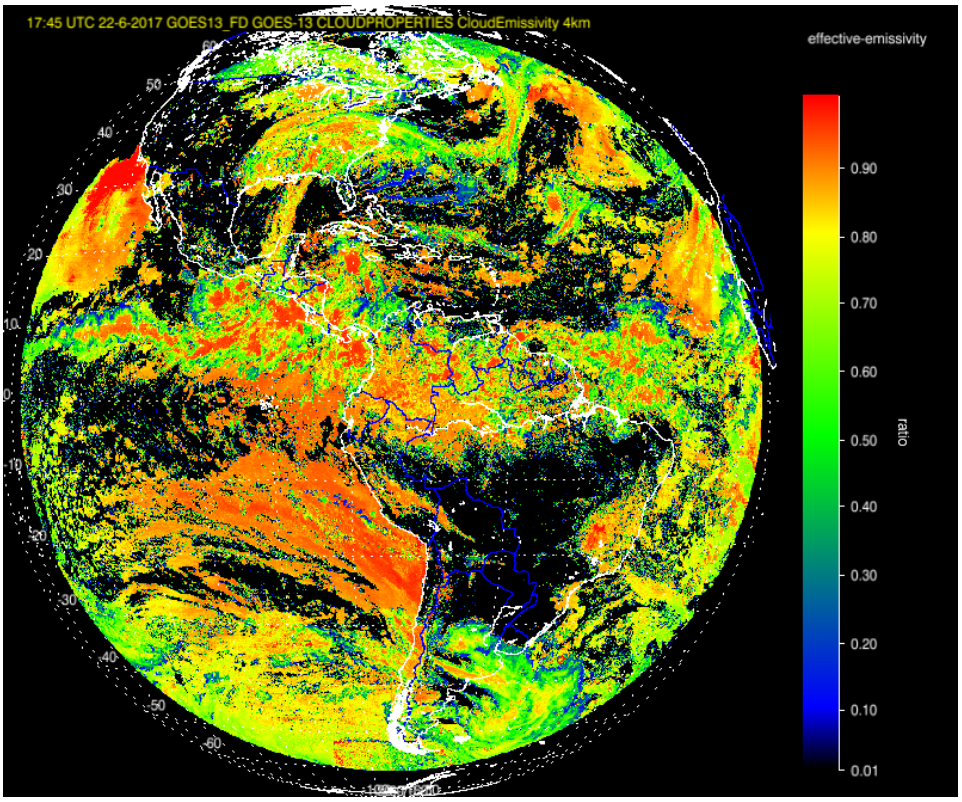
5, Cloud Top Pressure: the unit is hPa.



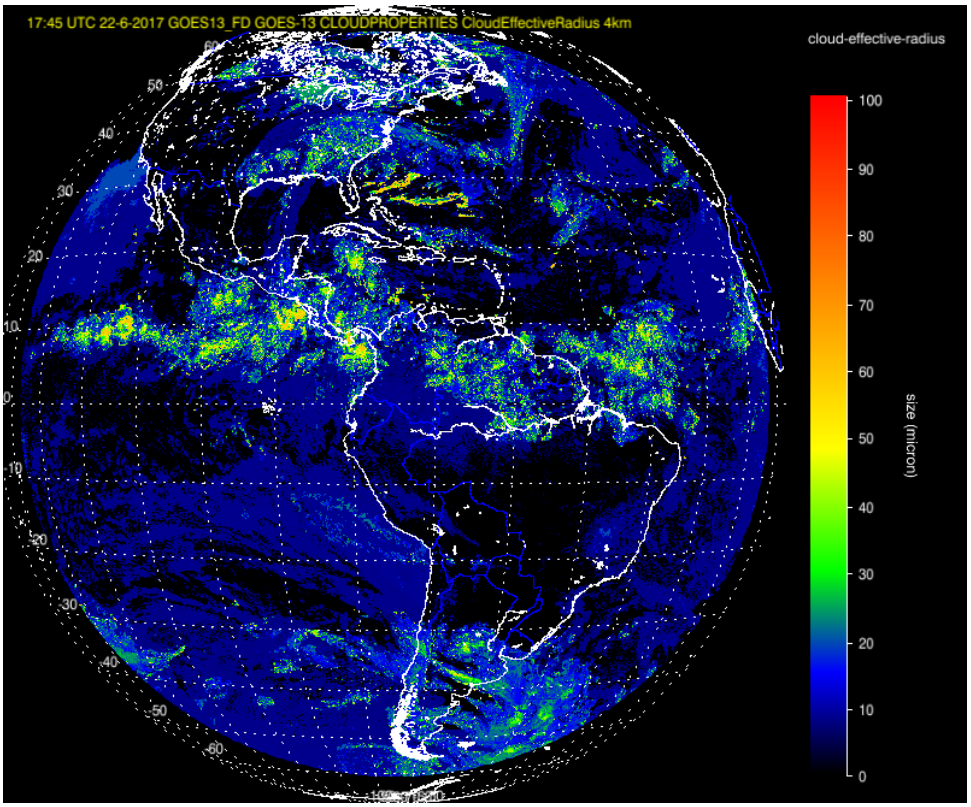
6, Cloud Top Temperature: the unit is K.



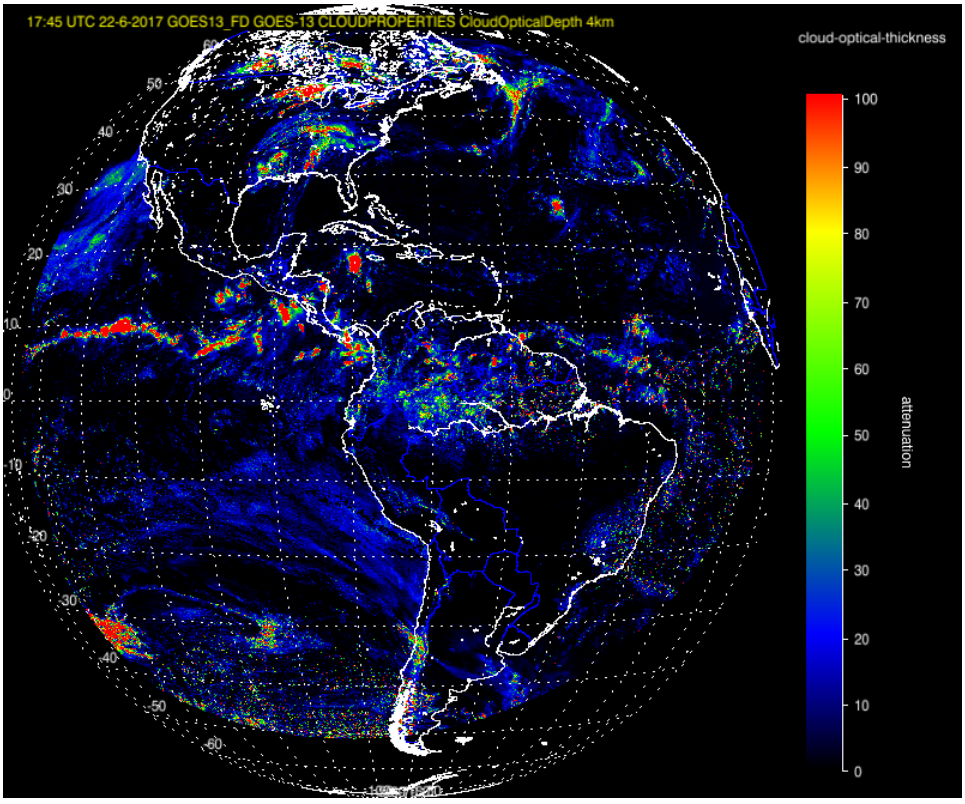
7, Cloud Emissivity: it is a ratio from 0.0 to 1.0, no unit.



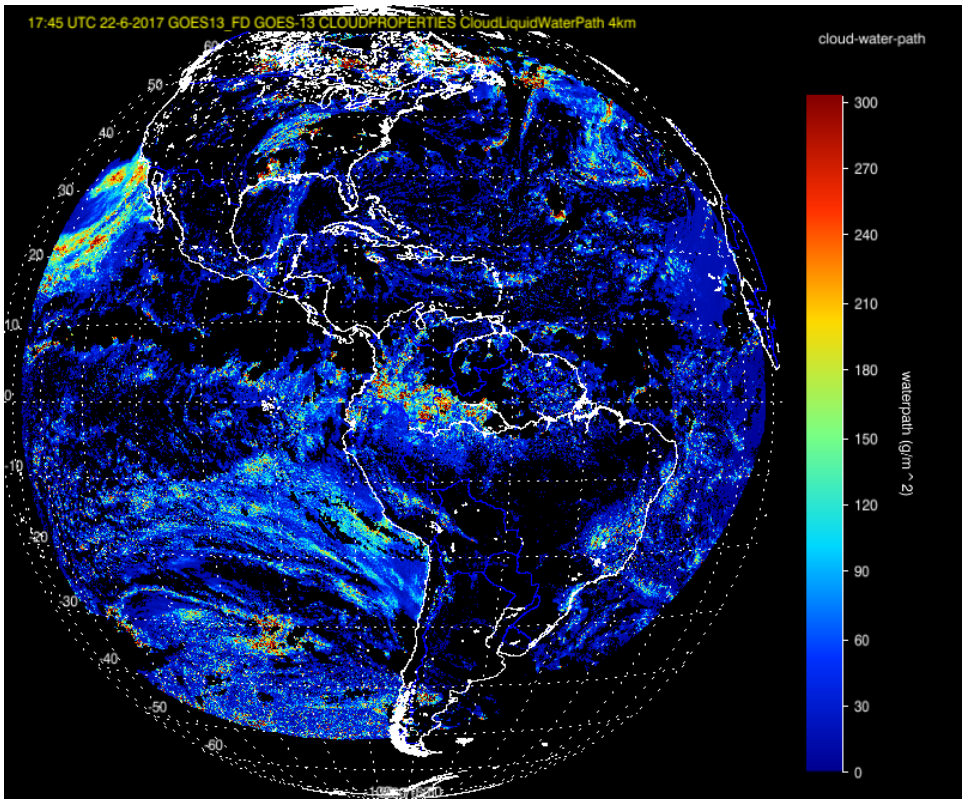
8, Cloud Effective Radius: the unit is micron.



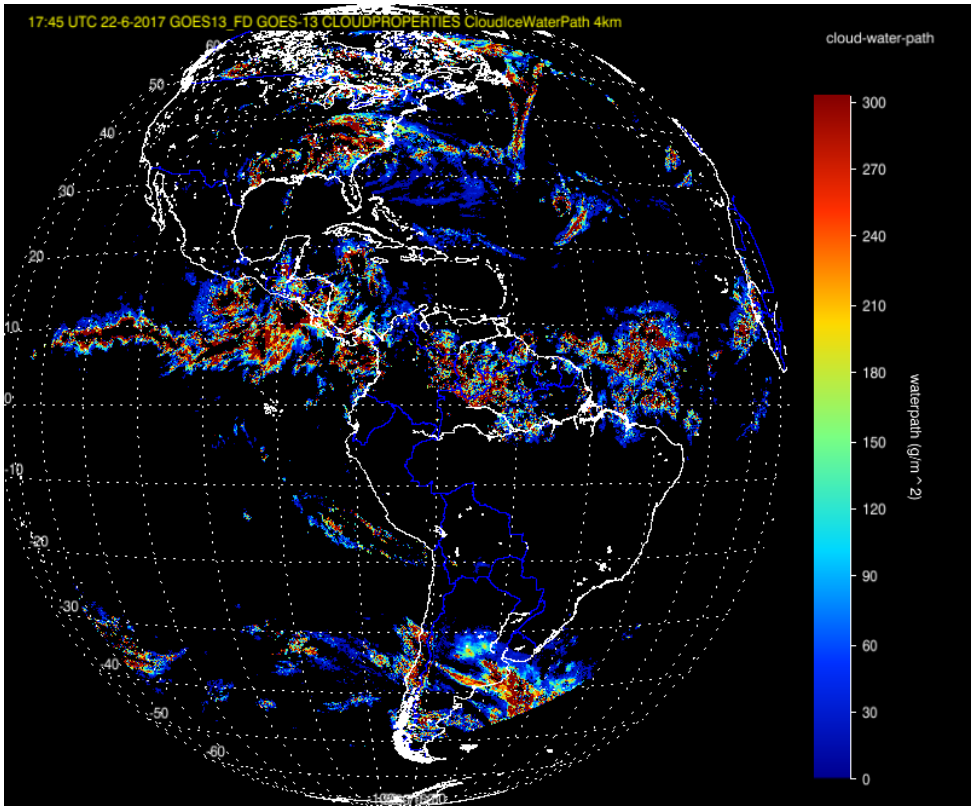
9, Cloud Optical Depth: no unit.



10, Cloud Liquid Water Path: the unit is g/m^2.



11, Cloud Ice Cloud Path: the unit is g/m^2.



9.17.2. GEOCAT FLS(Fog/Low Stratus) products

Fog/low stratus impacts aviation on a regular basis. So the goal of FLS algorithm is to identify cloudy regions that have ceilings less than 1000 feet and/or surface visibilities less than 3 miles. These criteria correspond to Instrument Flight Rules (IFR).

VFR - Visual Flight Rules, cloud ceiling > 3000 feet and visibility > 5 mile.

MVFR - Marginal Visual Flight rules, 1000 feet < cloud ceiling < 3000 feet or 3 miles < visibility < 5 miles.

IFR - Instrument Flight Rules. 500 feet < cloud ceiling < 1000 feet or 1 mile < visibility < 3 miles.

LIFR - Low Instrument Flight Rules. Cloud ceiling < 500 feet or visibility < 1 mile.

The FLS group includes 4 products, fog depth, Low Instrument Flight Rules(LIFR) fog probability, Instrument Flight Rules(IFR) fog probability, and Marginal Visual Flight Rules (MVRF) fog probability.

The FLS products can be added to any GOES-13/14/15 setup for the generation:

A, Launch the setup manager from the GEOSAT500 console

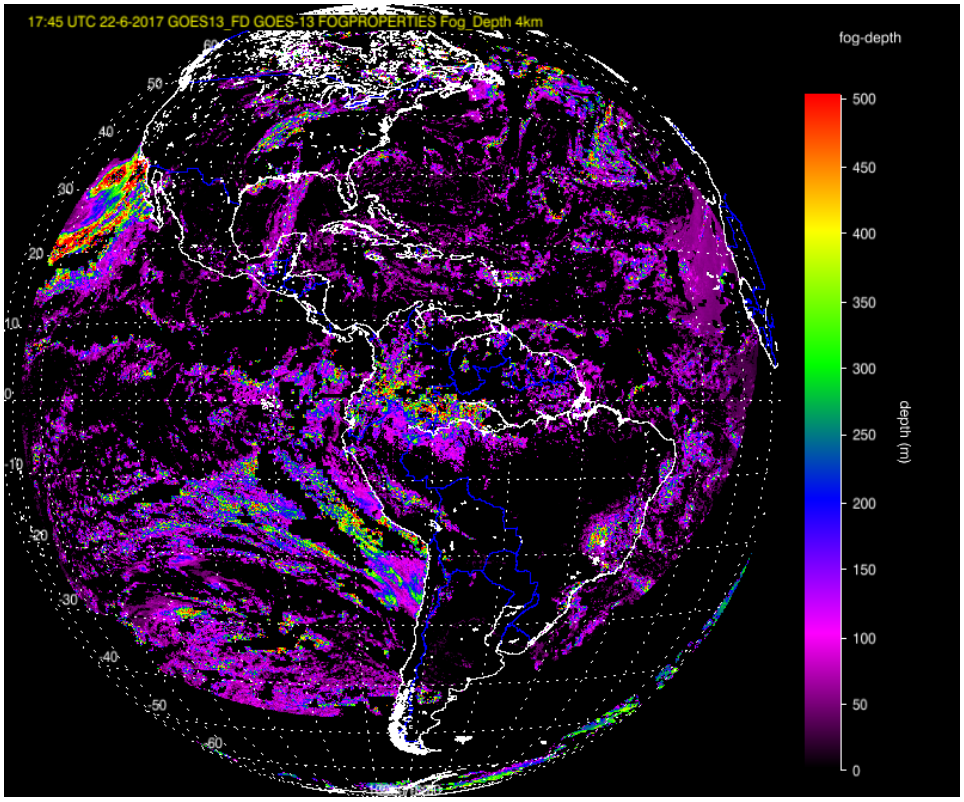
B, Create a new setup or edit an existing setup for GOES-13/14/15

C, Press ‘Add product’, select ‘FOGPROPERTIES’ from the ‘Product Type’, then select any product listed above from ‘Data Set’.

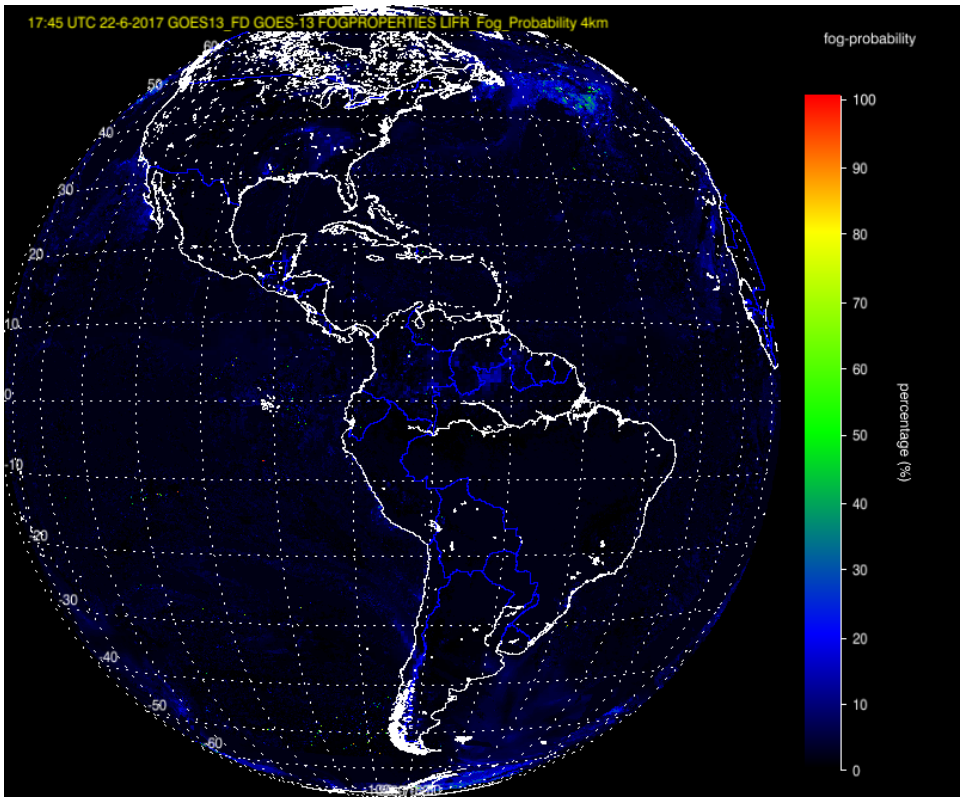
D, Press ‘Save to table’ to save the new product. Repeat step C and D to add more products.

E, Save the setup using the File menu.

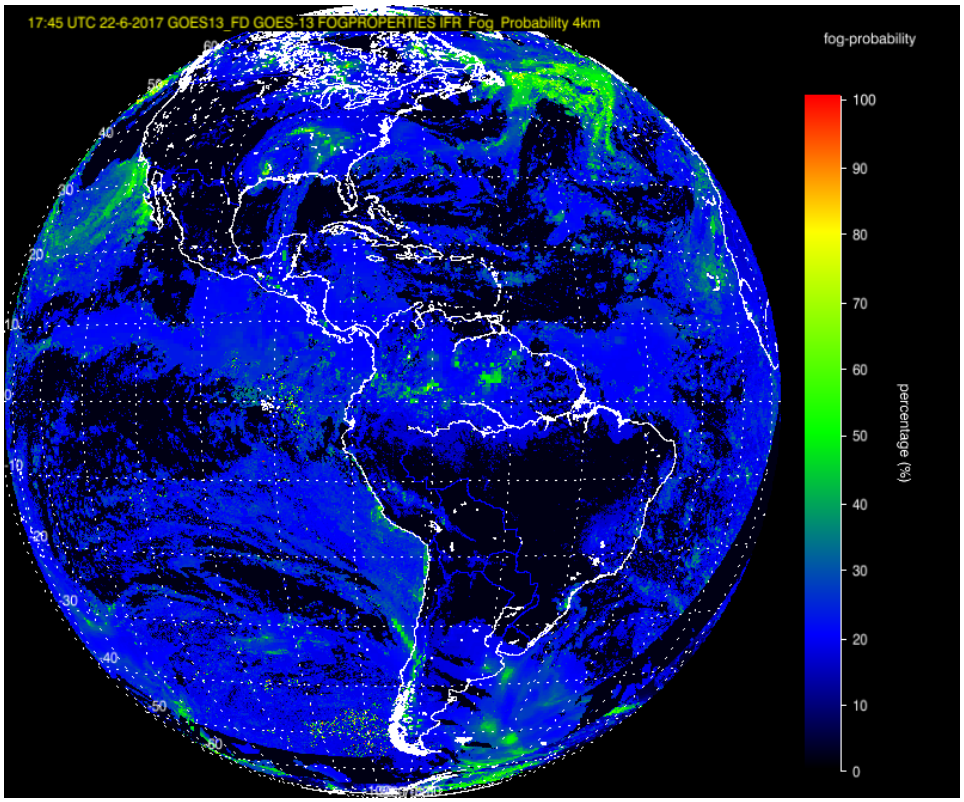
1, Fog Depth, the unit is m.



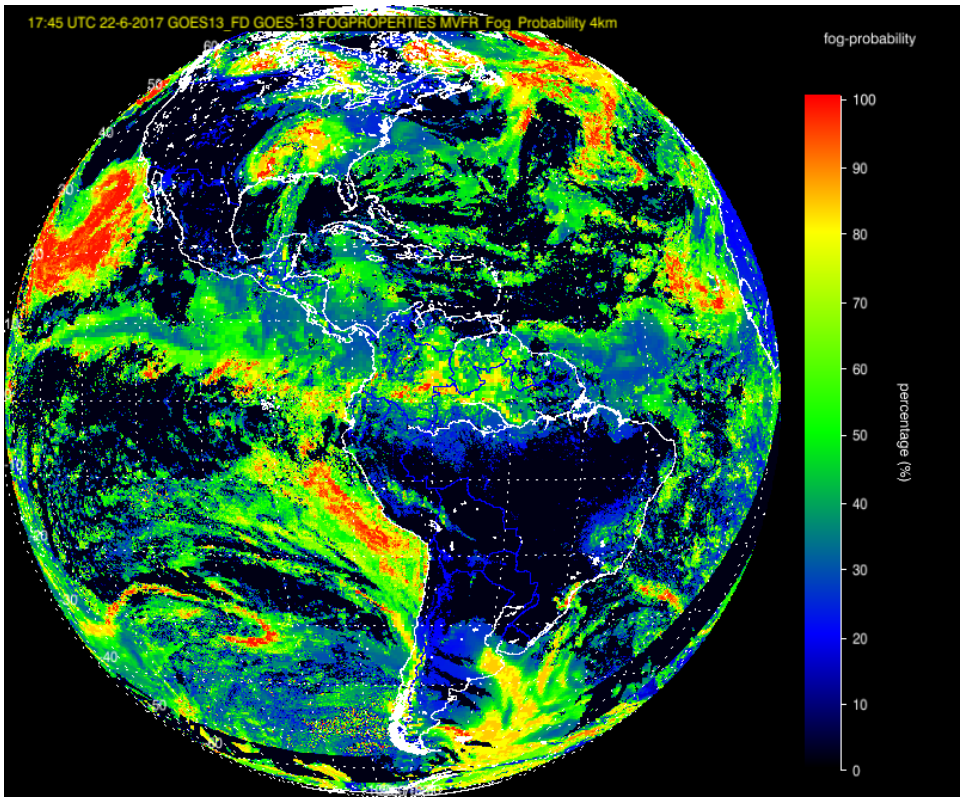
2, Low Instrument Flight Rules(LIFR) Fog Probability. The unit is %.



3, Instrument Flight Rules(IFR) Fog Probability. The unit is %.



4, Marginal Visual Flight Rules(MVFR) Fog Probability. The unit is %.



9.18. Automatic Dvorak analysis

9.18.1. Product overview

The Advanced Objective Dvorak Technique (AODT) analyses MTSAT IR1 data to determine tropical cyclone (TC) intensities and other statistics. The output is a textual analysis of the TC, unlike the SST and cloud products which generate raster images.

Generation	Day and night downlinks (MTSAT only)
Resolution	4km
Channels used	IR1
Reference	Appendix A

9.18.2. Product description

The Automatic Dvorak analysis product incorporates the McIDAS AODT algorithm developed at the University of Wisconsin-Madison/Cooperative Institute for Meteorological Satellite Studies and integrates this seamlessly with PROTEUS. The PROTEUS operator simply identifies the TC eye in a selected image and the McIDAS/AODT analysis is displayed in a separate PROTEUS window. There is no need to interact directly with McIDAS, although this can be used as the primary interface if required. The figures below detail the PROTEUS interface.

Full details of the AODT algorithm are given in appendix A and the PROTEUS manual contains details of the interface. The results produced by the algorithm include:

1. Eye latitude and longitude
2. CI#
3. Eye temperature
4. Cloud region temperature
5. Mean sea-level pressure
6. Max wind speed
7. Scene type: one of UIFORM CDO, EMBEDDED CENTER, IRREGULAR CDO, CURVED BAND, or SHEAR
8. Ocean basin designation

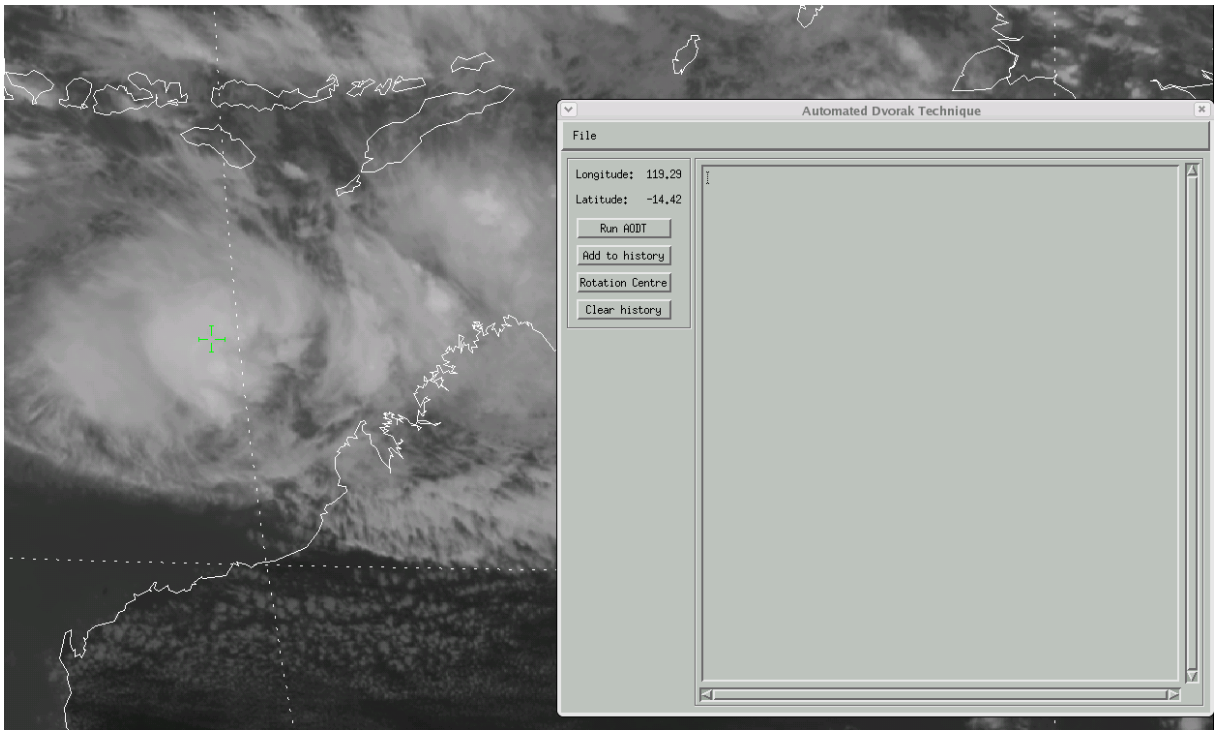


Figure 60 The PROTEUS AODT tool. The TC eye (green cross) is manually selected in a satellite image

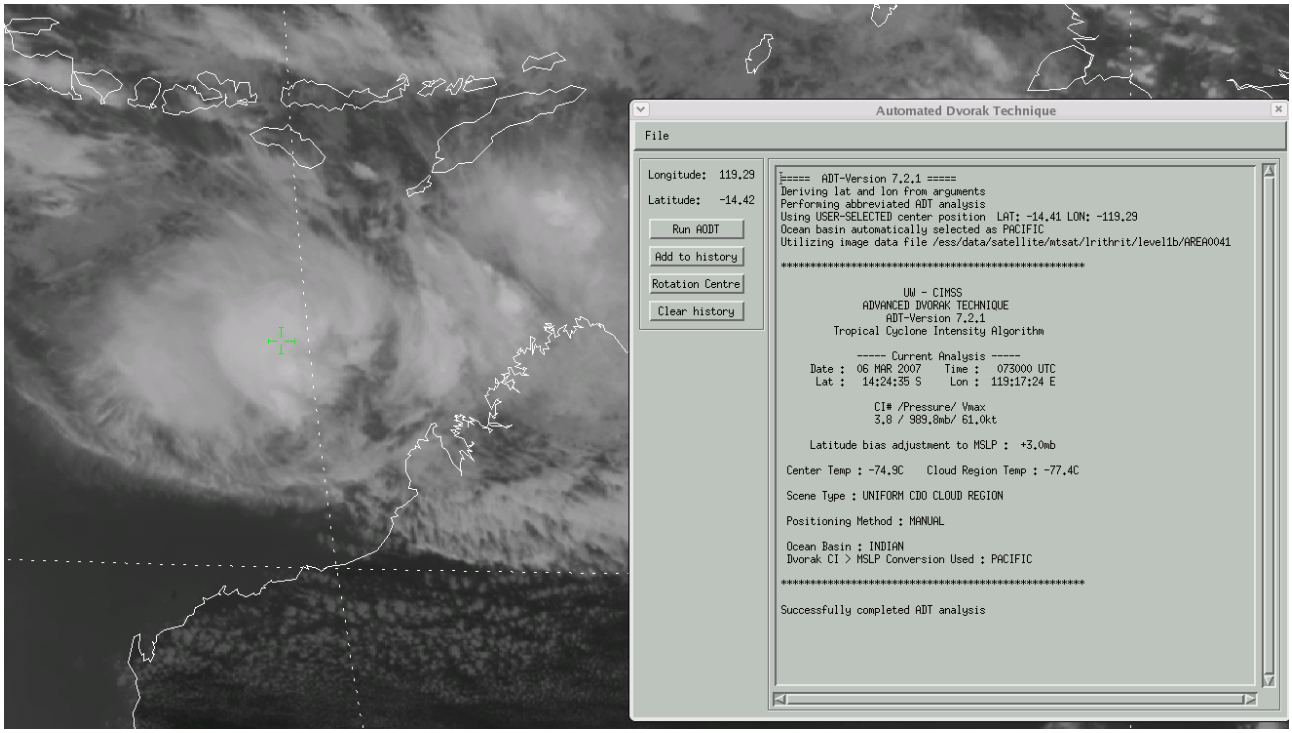


Figure 61 After the "Run AODT" button is pressed, a full AODT analysis of the TC is conducted and results displayed in the PROTEUS AODT window

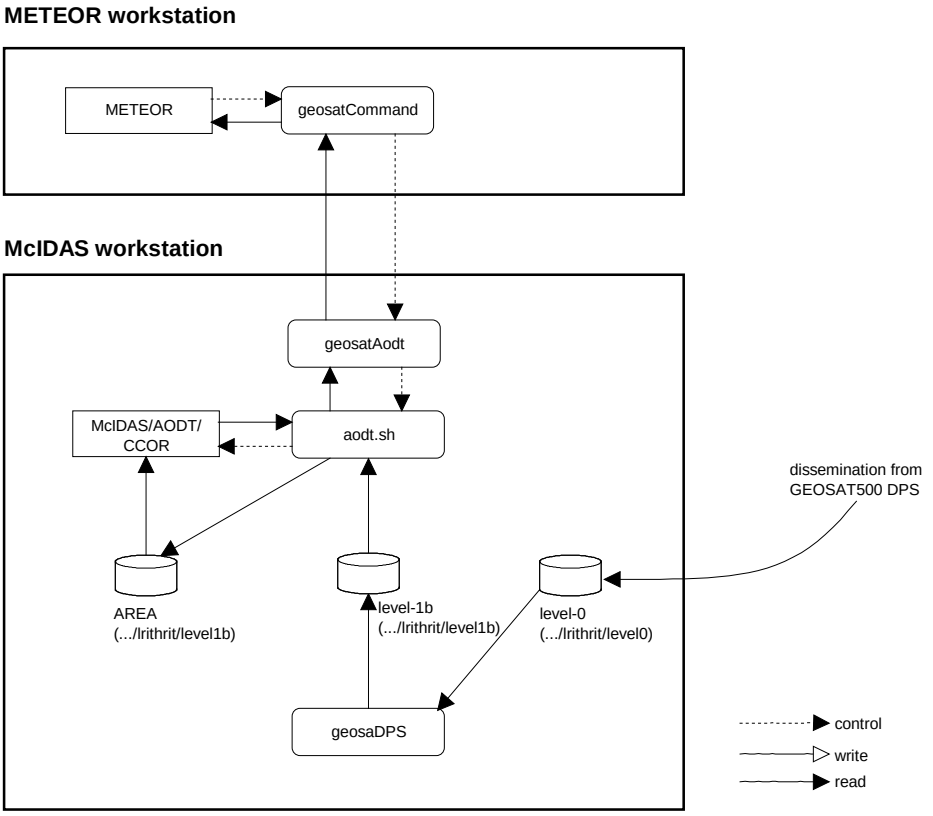


Figure 62 AODT integration with the GEOSAT500

9.19. Cloud mass centre of rotation

9.19.1. Product overview

The Cloud Mass Centre of Rotation (CCOR) product analyses MTSAT IR1 data to automatically locate tropical cyclone rotation points. The output is the centre latitude and longitude, plus a time-series analysis of the tropical cyclone.

Generation	Day and night downlinks (MTSAT only)
Resolution	4km
Channels used	IR1
Reference	Appendix A

9.19.2. Product description

The CCOR utilises the automatic centre of rotation detection algorithm within the McIDAS AODT (see above). As for the AODT, this functionality is seamlessly integrated with PROTEUS: the operator simply loads an image and the CCOR algorithm will identify any centre of rotation. There is no need to interact directly with McIDAS, although this can be used as the primary interface if required. The figures below detail the PROTEUS interface.

Before the CCOR can be used, a history of AODT analyses for a particular TC must exist. The algorithm extrapolates from this time-series to predict candidate locations for the centre in the specified image. A variety of image-analysis operations are performed to fine-tune the location.

Full details of the CCOR and AODT are given in appendix A and the PROTEUS manual contains details of the interface. The results produced by the algorithm include:

1. Eye latitude and longitude, automatically determined
2. CI#, Raw T#, Final T# (3 hour average), Final T# (6 hour average)
3. Eye temperature
4. Cloud region temperature
5. Mean sea-level pressure
6. Max wind speed
7. Scene type: one of UIFORM CDO, EMBEDDED CENTER, IRREGULAR CDO, CURVED BAND, or SHEAR
8. Ocean basin designation

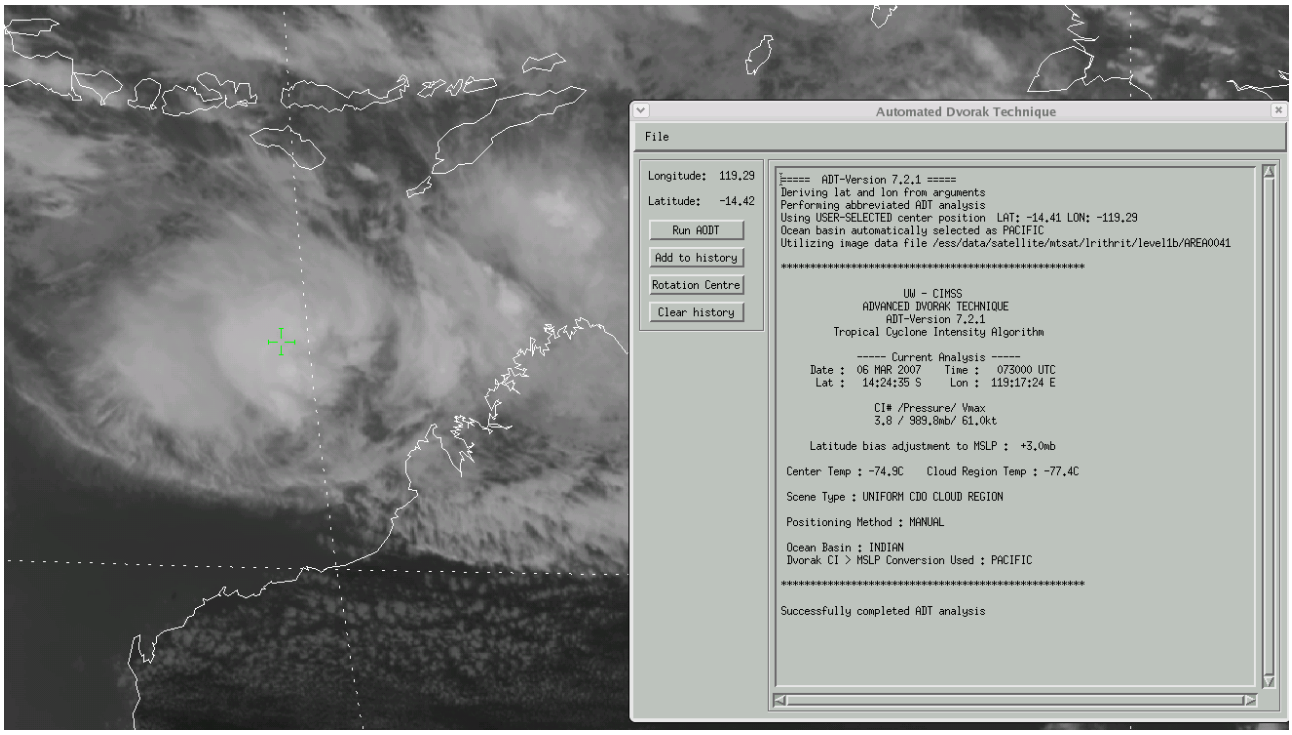


Figure 63 Using the CCOR in PROTEUS. After an AODT analysis is returned, the "Add to history" button is used to store the results.

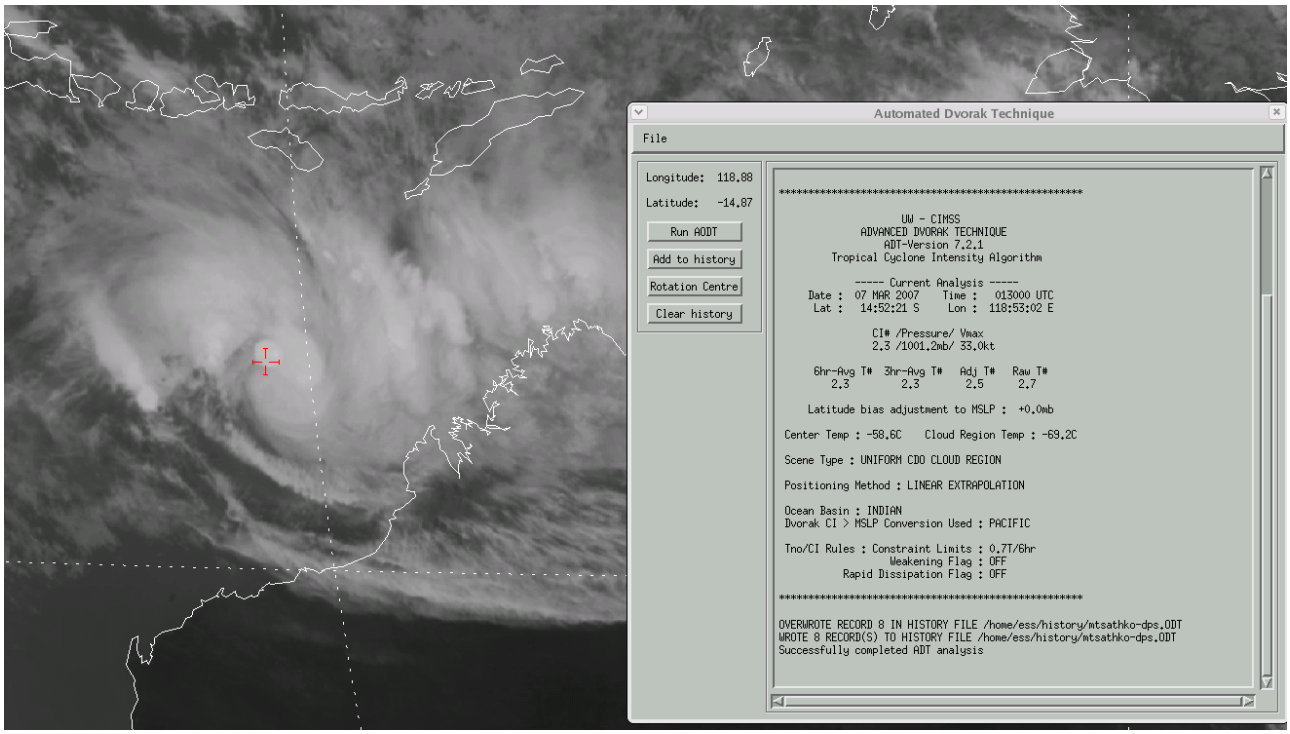


Figure 64 After the TC has been analysed over a series of images, the CCOR is able to automatically locate the centre of rotation in a new image (red cross).

10. Details of system operation

10.1. Directory structure

The directory structure used in the GEOSAT500 is as follows. Some entries below have [lrithrit | hirid] in their name and these describe two directories: the 'lrithrit' directory is used for HRIT data, and the 'hirid' directory for HiRID data files.

Directory	Purpose
/ess	Root directory
/ess/bin	Executable programs
/ess/config	Configuration files and license files
/ess/config/satkit.conf.d	Custom configuration scripts, automatically executed
/ess/crontab	Crontabs
/ess/data	Root data directory
/ess/data/html	HTTPD root
/ess/data/processed	Final GEOSAT500 products
/ess/data/processed/thumbs/jpg	HTML thumbnails and JPEG images
/ess/data/satellite/raw	MTSAT, H8, and COMS-1 raw data
/ess/data/satellite/himawari89/	H8 data root
/ess/data/satellite/himawari89/lrithrit/level1b/	H8 level-1b files from HimawariCast.
/ess/data/satellite/himawari89/lrithrit/level1b/incoming/	H8 level-1b files from HimawariCast to be processed.
/ess/data/satellite/himawari89/lrithrit/level1b/incoming/new	H8 level-1b files written during HimawariCast reception. Moved to parent when complete.
/ess/data/satellite/himawari89/hsd/level1b/	H8 level-1b HSD files.
/ess/data/satellite/himawari89/hsd/level1b/incoming/	H8 level-1b HSD files to be processed.
/ess/data/satellite/himawari89/hsd/level1b/incoming/new	H8 level-1b files written during HSD download. Moved to parent when complete.
/ess/data/satellite/mtsat/[lrithrit | hirid]	MTSAT data root
/ess/data/satellite/mtsat/[lrithrit | hirid]/level0	MTSAT processed level-0 files
/ess/data/satellite/mtsat/[lrithrit | hirid]/level0/incoming	MTSAT level-0 files to be processed
/ess/data/satellite/mtsat/[lrithrit | hirid]/level0/incoming/new	MTSAT level-0 files written during a downlink. Moved to parent when complete
/ess/data/satellite/mtsat/[lrithrit | hirid]/level1b/	MTSAT level-1b files.
/ess/data/satellite/mtsat/[lrithrit | hirid]/level1b/incoming/	MTSAT level-1b files downloaded from JDDS and to be processed into PICs.
/ess/data/satellite/mtsat/[lrithrit| hirid]/level1b/incoming/new	MTSAT level-1b files written during JDDS download. Moved to parent when complete.
/ess/data/satellite/coms/lrithrit	COMS-1 data root
/ess/data/satellite/coms/lrithrit/level0	COMS-1 processed level-0 files
/ess/data/satellite/coms/lrithrit /level0/incoming	COMS-1 level-0 files to be processed
/ess/data/satellite/coms/lrithrit/level0/incoming/new	COMS-1 level-0 files written during a downlink. Moved to parent when complete
/ess/data/satellite/coms/lrithrit/level1b/	COMS-1 level-1b files.
/ess/data/satellite/coms/lrithrit/level1b/incoming/	COMS-1 level-1b files downloaded from KMA and to be

	processed into PICs.
/ess/data/satellite/mtsat/lrithrit/level1b/incoming/new	COMS-1 level-1b files written during KMA download. Moved to parent when complete.
/ess/data/satellite/fy2c/svissr	FY2C data root
/ess/data/satellite/fy2c/svissr/raw	FY2C raw data
/ess/data/satellite/fy2c/svissr/level-0	FY2C processed level-0 files
/ess/data/satellite/fy2c/svissr/level-0/incoming	FY2C level-0 files to be processed
/ess/data/satellite/fy2c/svissr/level-0/incoming/new	FY2C level-0 files written during a downlink. Moved to parent when complete
/ess/data/satellite/fy2c/svissr/level-1b	FY2C level-1b files
/ess/doc	System documentation
/ess/icons	Various icons
/ess/imagedata/annotations	Annotation files for PROTEUS
/ess/imagedata/coastlines	Coastline files for PROTEUS
/ess/imagedata/colourtables	Colour tables for PROTEUS
/ess/lib	Library routines
/ess/lock	Process lock files
/ess/logs	System logs
/ess/meteor	The EEC PROTEUS product. See the PROTEUS manual for more details.
/ess/newfiles	Tagfiles for dissemination
/ess/packages	Third-party software used by the GEOSAT500
/ess/packages/rt-stpts	RT-STPS
/ess/setups	Setups used to manage PIC creation

10.2. Overview of processing sequence

An overview of the system inputs and outputs are shown below, which vary slightly depending on whether the system uses a Quorum, ESS3000 or ESS3000E receiver.

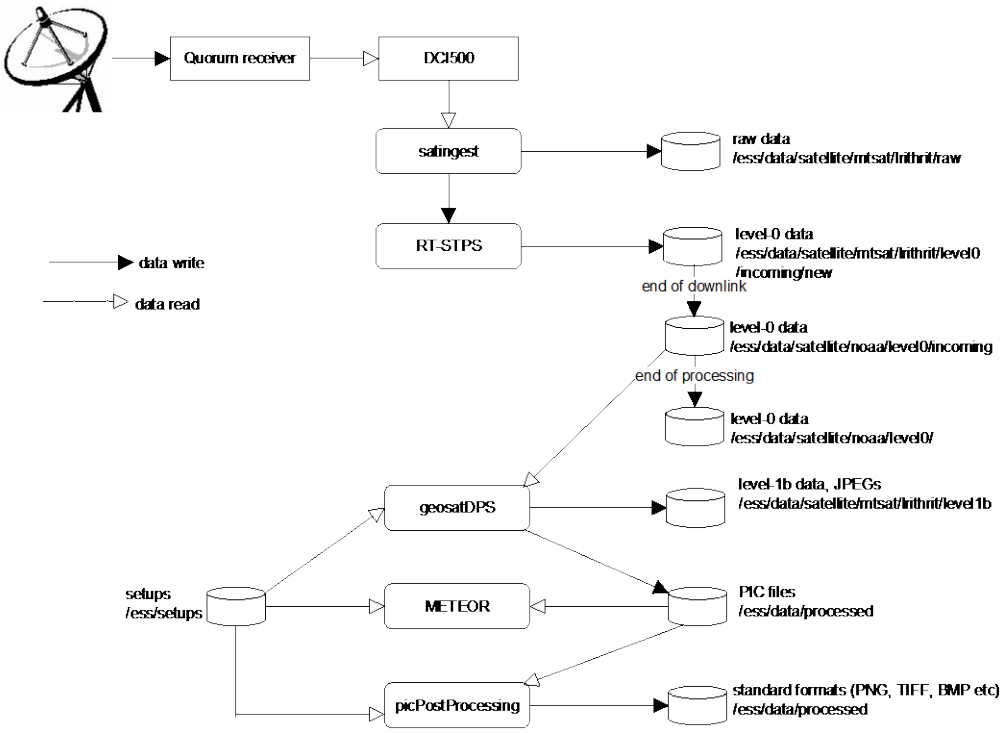


Figure 65 GEOSAT500 overview (with Quorum receiver)

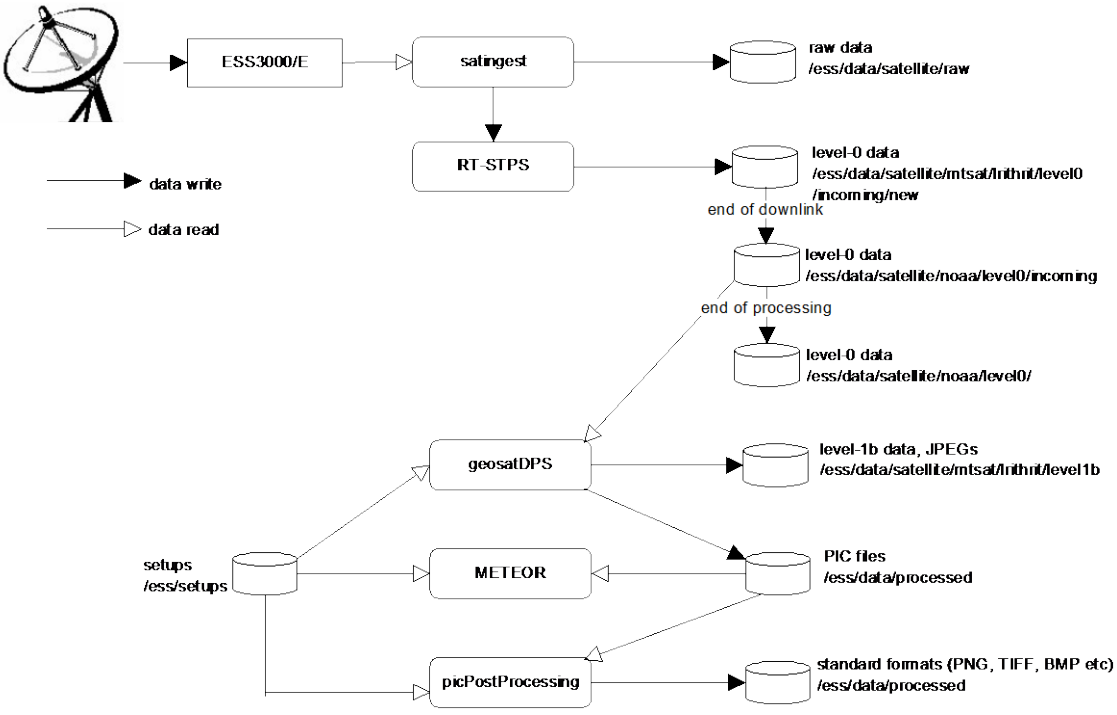


Figure 66 GEOSAT500 overview (with ESS3000/E receiver)

The main system input is RF from the antenna. This data is processed into a series of level1b JPEG files, PIC files and standard image formats, such as PNGs and TIFFs, as specified by the user-defined setups. The PIC files can be displayed and analysed in PROTEUS, whilst the JPEG files etc can be viewed with any suitable display software.

RF from the antenna enters the receiver, which demodulates the signal and outputs data and clock either to the DCI500 USB interface card for the Quorum receiver, directly to the USB interface for the ESS300E, or outputs CCSDS packets directly to the network interface for the ESS3000. Bit-aligned, raw CCSDS data is written to file as well as sent to the RT-STPS program via a socket. RT-STPS reconstructs and time-orders the CCSDS packets, applying Reed-Solomon decoding when necessary, and its output is a file in a format referred to as level-0.

The level-0 file contains one or more MTSAT data files, and it's the job of geosatDPS to extract this data. Once complete, one or more MTSAT files (also referred to as level-1b files) exist on disk, each containing a JPEG image and a series of headers. For convenience, geosatDPS pulls out the JPEG data so that it can be viewed with a suitable viewer program.

From here, the level-1b data is read by mapMtsat which generates PIC files for display and analysis in PROTEUS.

In the case of JDDS downloads, geosatDPS monitors the corresponding level-1b directories and processes the data it finds. So instead of reading new files from mtsat/lrithrit/level0 as above, it processes the data found in mtsat/lrithrit/level1b. Downstream processing is identical.

10.2.1. Internet downloads

The groundstation operator should maintain a continuous, reliable internet connection. This is required for the ancillary NWP datasets required for PROTEUS overlays. The table below details the files that must be regularly updated.

File	Purpose	Priority	Updated by	Update frequency
GRIB	PROTEUS overlays	3	skUpdateNCEP	Every day
SYNOP	PROTEUS overlays	3	skUpdateSYNOP	Every 3 hours

Across all EEC groundstation products, such ancillary data is prioritised as follows:

1. Must be up-to-date for the system to track, receive, and generate level-1b products (not used by the GEOSAT500);
2. Not required for level-1b products, but must be up-to-date for level-2 products (not used by the GEOSAT500); and
3. Not required for level-1b or level-2 product generation, but must be up-to-date to overlay NWP data in PROTEUS.

If a site has a low-bandwidth connection, priority 3 datasets can be turned off, noting that NWP overlays in PROTEUS will no longer be possible. To disable the downloading of any dataset, find the name of the downloading program in the table above and comment that job in the ess crontab (see section 5.4.1).

10.3. Details of processing sequence

The main system input is RF from the antenna. This data is processed into a series of level1b JPEG files, PIC files and standard image formats, such as PNGs and TIFFs, as specified by the user-defined setups. The PIC files can be displayed and analysed in PROTEUS, whilst the JPEG files etc can be viewed with any suitable display software. The components of the GEOSAT500 system are shown in Figure 49. See section 5.1 for details of the directory structure used.

10.3.1. Ingest subsystem

The ingest subsystem takes RF from the antenna and outputs time-ordered CCSDS packets. These files are referred to as level-0 files.

10.3.1.1. With Quorum receiver

When the machine starts, the skCheckRunning component launches the core components of the ingest subsystem: usbcapture, satingest., and skManageRTSTPS. At this point, the system is ready to receive data from the RF equipment.

Data and clock output by the Quorum receiver is passed to the DCI500 capture card. usbcapture reads data from the card and sends it through a network socket to the sync-detection and buffering program satingest. This program searches through the data for a CCSDS sync pattern. If a sync is found, the data read so far from the socket is byte-aligned, written to the file <YYYYMMDDHHMMSS>.ccsds (located in the raw directory, see section 5.1) and also sent through a network socket to the next program in the chain, RT-STPS.

RT-STPS takes CCSDS input from satingest.py, reconstructs and time-orders the packets, applies Reed-Solomon decoding where necessary, and its output is a file in a format referred to as level-0. This file is written into the "… level0/incoming/new" directory, as explained in section 5.1. RT-STPS is managed by the program skManageRTSTPS, which starts it up and resets it at the end of each downlink. skManageRTSTPS monitors the level-0 output of RT-STPS and concludes the end of a downlink when the file has not grown for a time period defined by the environment variable SATKIT_TIMEOUT which, by default, is 160s for MTSAT and 560s for COMS-1. At this point, RT-STPS is reset which ensures the next downlink is written to a new file.

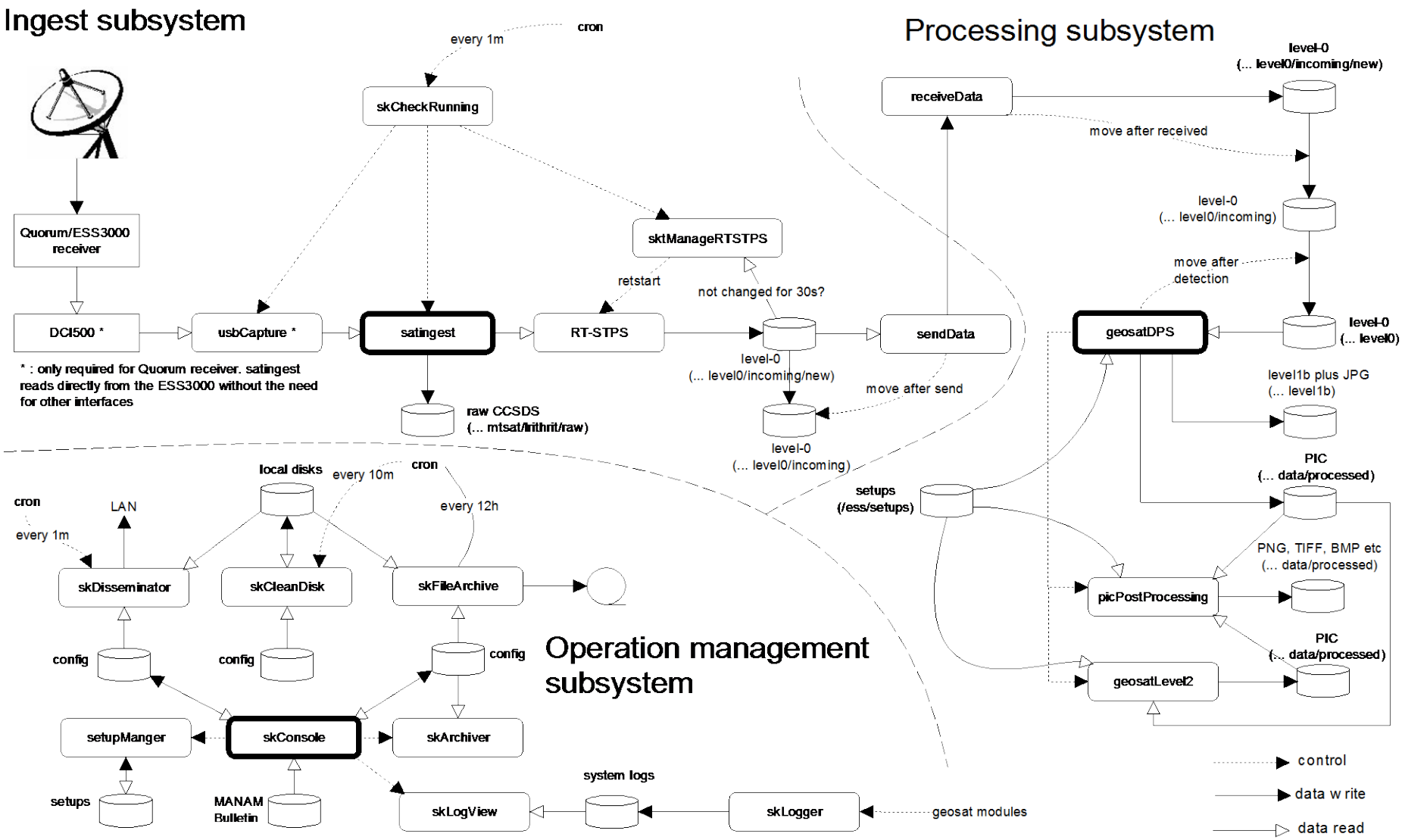


Figure 67 GEOSAT500 system structure

10.3.1.2. With ESS3000/E receiver

When the machine starts, the skCheckRunning component launches the core components of the ingest subsystem: satingest and skManageRTSTPS. At this point, the system is ready to receive data from the RF equipment.

satingest reads the CCSDS data directly from the ESS3000 via the network interface and directly from the USB interface for the ESS300E. This program searches through the data for a CCSDS sync pattern. If a sync is found, the data read so far from the socket is byte-aligned, written to the file <YYYYMMDDHHMMSS>.ccsds (located in the raw directory, see section 5.1) and also sent through a network socket to the next program in the chain, RT-STPS.

RT-STPS takes CCSDS input from satingest.py, reconstructs and time-orders the packets, applies Reed-Solomon decoding where necessary, and its output is a file in a format referred to as level-0. This file is written into the "… level0/incoming/new" directory, as explained in section 5.1. RT-STPS is managed by the program skManageRTSTPS, which starts it up and resets it at the end of each downlink. skManageRTSTPS monitors the level-0 output of RT-STPS and concludes the end of a downlink when the file has not grown for a time period defined by the environment variable SATKIT_TIMEOUT which, by default, is 160s for MTSAT and 560s for COMS-1. At this point, RT-STPS is reset which ensures the next downlink is written to a new file.

10.3.1.3. Real-time data transfer

The level-0 file output by RT-STPS is sent in real-time from the Acquisition Workstation (AWS) to the Data Processing Workstation (DPW). This means that at the end of the downlink, the file has already been transferred to the DPW ready for processing: the system does not have to wait for any further data transfer. The transfer is managed by sendData, running on the AWS, and receiveData, running on the DPS.

The crontab on both machines checks every 15 minutes that send/receiveData is running and starts it if it's not found. sendData is invoked with a port, filename pattern, and target machine specified on the command line. receiveData is invoked with the same port number, allowing the processes to communicate over a common socket.

Every 30s, sendData checks the directory "… level0/incoming/new" for non-zero byte files matching the specified filename pattern. The filename pattern by default is "level0.dat" which matches the level-0 file output by RT-STPS. If a file is not found, sendData sleeps for 20s then checks again. If a file is found, an attempt is made to establish a socket connection with the receiveData on the DPW machine. If a connection cannot be made, sendData sleeps for 20s then tries the host again.

Once a connection is established, the contents of the file are sent to receiveData. The first packets that are sent contain the name of the file, used by the remote process to establish an identical filename for the data on the DPW. When the entire file has been sent, sendData sleeps for 20s and checks the file size again. If more data is available, it's transmitted as normal. If the file size hasn't changed, sendData will sleep for a further 20s before rechecking the file size. This repeats for up to 90s by default. If the file size hasn't changed in this time period, the downlink is considered complete and the socket is closed.

Once the socket is closed, sendData checks to see if any process has the file open for writing. If one exists, the file is left in its current location: it's possible that the 90s timeout was insufficient and more data is yet to be added. If not, the file is moved to the parent directory. sendData then starts looking for new matching files to send.

The socket will also be closed under these circumstances:

- the socket cannot be written to for 60s;
- the remote receiveData process closes the socket; or

- the socket has an exception.

This ensures correct behaviour under network outages, errors and severe network loads.

When data is received on the port, receiveData builds the filename from the first packets and creates the file in the directory "… level0/incoming/new" on the DPS. As packets are received, they're written into the file. The file is considered complete and is moved to the parent directory when the socket is closed where it will start to be processed by geosatDPS. The socket is closed under the following circumstances:

- the remote sendData closes the socket;
- the socket cannot be read for 120s (sendData timeout + 30s); or
- the socket has an exception.

A received file will be deleted if a file of the same name is found in the parent directory. Note that this file will still exist on the Acquisition workstation.

10.3.2. Processing subsystem

The main function of the processing subsystem is to take the level-0 files generated by the ingest subsystem and convert them to PIC files and standard image formats as specified by the user-defined setups.

geosatDPS monitors the "… level0/incoming" directory (see section 5.1) for new level-0 CCSDS files. When one is found, it extracts the one or more level-1b files encoded within it, each one containing an MTSAT image plus a series of MTSAT headers. The JPEG image in each level-1b file is extracted before the file is further processed into PIC files.

For each of the setups, geosatDPS converts the JPEGs into PIC files. It then calls skPicPostProcessing to convert the PIC into a preview images for the webpage and any further standard data formats specified in the setup. skPicPostProcessing automatically overlays coastlines and gridlines if required by the setup.

10.3.2.1. HRIT level-1b segment replacement

As for all satellite-transmitted data, factors such as external interference and local network problems can lead to corruption in MTSAT HRIT imagery. The GEOSAT500 detects whether image corruption has occurred within level-1b segment files and can be configured to replace the files with those from some other source: from a physically separate ground station, for instance, or via a feed from the JMA. Obtaining replacement files from other sources is the responsibility of the user.

As described above, the GEOSAT500 reconstructs level-1b data from the level-0 data files. A level-1b file contains an MTSAT header plus a JPEG image and its filename is specified in the transmitted data itself. If any level-1b file contains JPEG image corruption and segment replacement is enabled, the GEOSAT500 checks for an identically-named level-1b file on a staging area. The staging area is a directory on some user-specified machine upon which the user is staging HRIT level-1b files from some other source. Centralising this repository facilitates level-1b segment replacement on multiple processing machines.

If a replacement level-1b file is available on the staging area, it's downloaded and the image re-processed. The original segment file is renamed with a ".orig" suffix.. If it isn't available, a user-supplied download script is invoked with the filename of the corrupt level-1b as an argument. This script should attempt to obtain a replacement segment from some other source and place the file on the staging area. When the download script completes, the GEOSAT500 checks the staging area again and downloads the replacement segment if it's now available.

Errors/timeouts in any of the above results in the original corrupt segment being used to form final image products.

Section 5.5 details how to enable segment replacement and configure the download process.

10.3.2.2. With JMA JDDS or KMA FTP download

The main function of the processing subsystem is to take the level-1b files downloaded from the JMA JDDS or KMA FTO service and convert them to PIC files and standard image formats as specified by the user-defined setups.

geosatDPS monitors the "… level1b/incoming" directory (see section 5.1) for new level-1b HRIT files. When one is found, it extracts the one or more level-1b files encoded within it, each one containing an MTSAT/COMS-1 image plus a series of MTSAT/COMS-1 headers. The JPEG image in each level-1b file is extracted before the file is further processed into PIC files.

For each of the setups, geosatDPS converts the JPEGs into PIC files. It then calls skPicPostProcessing to convert the PIC into a preview images for the webpage and any further standard data formats specified in the setup. skPicPostProcessing automatically overlays coastlines and gridlines if required by the setup.

10.3.3. Operation management subsystem

The operation management subsystem contains a series of tools to assist in monitoring and managing the GEOSAT500. The principal tools are the Console (see section 3.2), the Disseminator (section 3.5), the Archiver (section 3.6), the Setup Manager (section 3.3), the Logger, used by all components to log events (section 3.2.7) and the Clean-disk program (section 5.6).

10.3.4. Reprocessing old data

From the above, geosatDPS automatically processes any level-0 files found in /ess/data/satellite/mtsat/lrithritlevel0/incoming. Therefore, should you wish to re-process a previous downlink (perhaps you've defined a new setup that you'd like processed) move the level-0 file from the parent /ess/data/satellite/mtsat/lrithrit/level0 directory down into the incoming subdirectory. geosatDPS will then automatically process the old level-0 file.

Alternatively, the geosatDPS program can be called directly on the command line with –file and –setup options (see section 5.7).

A further alternative is to use the Reprocess data option from the Console, as described in section 3.2.9.

10.3.5. HiRID operation

The above sections describe the ingest and processing flow for LRIT/HRIT data. If the system is in HiRID mode, the flow is almost identical. The differences are:

1. Data is written to and processed from the /ess/data/satellite/mtsat/hirid root directory;
2. The level-0 data contains complete lines of imagery prefixed with sync codes, not packetised CCSDS;
3. The RT-STPS CCSDS packet decoder is not used (neither is its management program skManageRTSTPS), so satingest writes directly to the level-0 directory /ess/data/satellite/mtsat/hirid/level0/incoming/new;
4. The level-0 file contains a single HiRID image and so is processed into a single level-1b file;
5. The program mapSvissr processes a level-0 HiRID fille into final image products, not geosatMapMtsat; and
6. Level-1b data contains imagery in a binary format, not a standard JPEG.

10.3.6. FY2C SVISSR operation

The above sections describe the ingest and processing flow for LRIT/HRIT data. If the system is receiving FY2C [4], the flow is almost identical. The differences are:

1. Data is written to and processed from the /ess/data/satellite/fy2c/svissr root directory;
2. The level-0 data contains complete lines of imagery prefixed with sync codes, not packetised CCSDS;
3. The RT-STPS CCSDS packet decoder is not used (neither is its management program skManageRTSTPS), so satingest writes directly to the level-0 directory /ess/data/satellite/fy2c/svissr/level0/incoming/new;
4. The level-0 file contains a single SVISSR image and so is processed into a single level-1b file;
5. The program mapSvissr processes a level-0 SVISSR fille into final image products, not geosatMapMtsat; and
6. Level-1b data contains imagery in a binary format, not a standard JPEG.

10.4. crontabs

There are two crontabs in the system, one for the ess user, the other for root. Each machine contains identical software but is configured to take on a particular role: as an Acquisition Workstation (AWS), a Data Processing System (DPS), or an Operator Display Workstation (ODW). Configuring the cronjobs is a central part of this role configuration, and the role to which the jobs apply is included in the following tables.

10.4.1. ess cron jobs

Job	Role	Purpose	Frequency
geosatDPS	AWS, DPS, ODW	Process new level-0 files into PICs if setups are present in the generation list.	Every minute
checkRunning (skManageRTSTPS)	AWS	Make sure this program is running	Every minute
checkRunning (sendData)	AWS	Make sure this program is running	Every minute
checkRunning (receiveData)	DPS	Make sure this program is running	Every minute
skDisseminator	AWS, DPS, ODW	Disseminate new products	Every minute
skCleanDisk	AWS, DPS, ODW	Manage disk space	Every 10 minutes
skFileArchive	Any machine with a tape drive	Write new files to tape	Every 12 hours
skUpdateNCEP	DPS, ODW	Download GRIB datasets for image overlay	Every day
skUpdateSYNOP	DPS, ODW	Download GRIB datasets for image overlay	Every 3 hours
geosatGetMTSAT	DPS	Download new MTSAT HRIT level-1b files from the JMA's JDDS service	Twice an hour

10.4.2. root cron jobs

Job	Role	Purpose	Frequency

[4] FY-2C reception is available as a GEOSAT500 option

checkRunning (usbcapture)	AWS with Quorum receiver	Make sure this program is running	Every minute
checkRunning (satingest.py)	AWS	Make sure this program is running	Every minute

10.5. System configuration

The system is configured via four files:

1. The GEOSAT500 configuration file (/ess/config/geosatConfig). This stores high-level MTSAT-specific configurations;
2. The SATKIT configuration file (/ess/config/skConfig). SATKIT provides basic system services, such as logging, archiving, dissemination, and generic satellite scheduling;
3. The satingest configuration file (/ess/config/satingest.config). satingest is responsible for receiver commanding and all data ingest. Also used by the scheduler; and
4. The dataservices configuration file (/ess/config/dataservices.txt). This file stores the URLs of all external datasets required by the GEOSAT500, such as GRIB data.

The following sections provide full listings of all three configuration files. The comments in each file detail all possible configuration items. See section 3.10 for details on how these files are modified to change the role of the workstation (eg, from an Acquisition workstation to a Data processing workstation).

Further customisation of the environment can be achieved by adding scripts to /ess/conf/satkit.config.d. These are automatically executed each time the SATKIT environment is established.

10.5.1. SATKIT configuration file

```
!/bin/bash

# SATKIT CONFIGURATION FILE

# $Id: skConfig,v 1.26 2009/08/25 01:28:30 chris Exp $

#########################################################
# SATKIT config
#########################################################

# Groundstation class: GOES (geostationary) or POES (polar-orbiting)
export SATKIT_CLASS=GOES

# Set to True if this is an acquisition workstation.
export SATKIT_ACQUISITION_WS=False

# Use the predict program instead of wxtrack.
export SATKIT_USE_PREDICT=False

# various URLS (e.g. TLE's, NCEP GRIB)
[ -e ${SATKIT_HOME}/config/dataservices.satkit ] && .
${SATKIT_HOME}/config/dataservices.satkit

# If this is an acquisition workstation, specify the receiver model:
# one of Quroum, ESS3000, or RX6000.
export SATKIT_RECEIVER_MODEL="Quorum"

# Address of the machine that processes setups and creates
# the product webpage. Used by the console launch menu to
# display the webpage from the appropriate machine.
export SATKIT_DPS=localhost

# Set to True if a tape drive is present
```

```
export SATKIT_HASTAPE=False

# For redundant servers with NASs to be kept in sync, specify the
# remote NAS as an rsync target and the mount point of the local NAS.
export SATKIT_NASSYNC_SOURCE=mtsathq-dps2::nas
export SATKIT_NASSYNC_TARGET=/nas

# Name of account that has unrestricted privileges.
# Operations under other accounts are restricted.
export SATKIT_UNRESTRICTED_ACCOUNT="ess"

# If a system event occurs and is at least as severe as the following
# level, the details are marked for e-mail dissemination. The levels
# can be None (no dissemination), WARNING, ERROR, or CRITICAL.
export SATKIT_EVENT_EMAIL=None

# The system can issue arbitrary commands to remote servers. Specify
# the address of the default remote server here, or leave as "" to
# disable remote commanding on this workstation.
export SATKIT_SERVER=""

# PIC read buffer is this number of rows in size.
export SATKIT_PIC_BUFFER=1024

# Level-2 processing will be launched via ssh on this server.
# Processing is skipped unless secure, passwordless communications has
# been established.
export SATKIT_LEVEL2_SERVER=""

# IDL programs, such as those performing land/sea masking, are given
# this preamble. Useful when such programs are to be run on other
# servers due to a lack of IDL support natively.
export SATKIT_IDL_LAUNCHER=""

# ------- Scheduler ------------------------

if [ -z "$SATKIT_HOME" ]; then
    export SATKIT_HOME=/ess
fi

if [ -z "$SATKIT_PROCESSED" ]; then
    export SATKIT_PROCESSED=${SATKIT_HOME}/data/processed
fi

# ------- Scheduler ------------------------

# TLE file
export SATKIT_SCHEDULER_TLE_FILE=${SATKIT_HOME}/data/satellite/ancillary/tle.txt

# Config file
export SATKIT_SCHEDULER_CONFIG=${SATKIT_HOME}/config/satingest.config

# HAZAM config file
export SATKIT_SCHEDULER_HAZAM_CONFIG=${SATKIT_HOME}/config/hazamList.txt

# Scheduler working directory
export SATKIT_SCHEDULER_WORK_DIR=${SATKIT_HOME}/data/satellite/scheduler

# ------- Web and imagery ------------------------

# Products will stay on the web page for this number of days
export SATKIT_WEBPAGE_DAYS=1

# ------- Console  -------------------------------------

export SATKIT_CONSOLE_GAUGE_MIN=-70.0
export SATKIT_CONSOLE_GAUGE_MAX=-50.0

# ------- Dissemination --------------------------------

# Some of these default values can be overridden by each entry in the
```

```
# dissemination list. For example, it's possible to have files sent by
# multiple methods and for ftp transfers to use different
# usernames/password for different targets. See the dissemination list
# file or associated system documentation for full details.

# Transfer method to use when disseminating, either RSYNC-OVER-SSH or
# FTP. In both cases, the default destination directory is the same
# directory on the target machine as on the source
# machine. RSYNC-OVER-SSH provides encrypted communicatons and
# requires that SSH be installed and configured for password-less
# logins on the source and target machines. FTP offers simpler,
# clear-text communicatons.
export SATKIT_DISS_METHOD=FTP

# If disseminating by ftp, use either PASSIVE or ACTIVE transfers.
export SATKIT_FTP_TYPE=PASSIVE

# For FTP transfers, files will be placed into the following
# directory.  If set to 'None', files will be placed into the same
# directory on the target machine as on the source machine, thereby
# requiring a mirrored directory structure. If not set to None, the
# file will be placed into the specified directory only when
# transferring to the machine SATKIT_DISS_REMOTE_HOST.
export SATKIT_DISS_REMOTE_DIR=None
export SATKIT_DISS_REMOTE_HOST=

# For FTP transfers, use the following username and password
export SATKIT_DISS_USERNAME=ess
export SATKIT_DISS_PASSWORD=essess

# For RSYNC transfers, set to 'True' or 'False' to enable/disable the
# use of compression during dissemination. Will create additional
# cpu load if enabled.
export SATKIT_DISS_COMPRESS=False

# For RSYNC transfers, set to 'True' or 'False' to enable/disable
# overwriting files that already exist on the target.
export SATKIT_DISS_OVERWRITE=False

# For RSYNC transfers, set the following string to any additional
# rsync options required.
export SATKIT_DISS_RSYNCOPTIONS=""

# For RSYNC transfers, set the following string to any additional
# ssh options required.
export SATKIT_DISS_SSHOPTIONS=""

# Transfer order depends on when the file was marked for
# dissemination. If the following is True, the order is by increasing
# age (so files most recently marked will be sent first). Otherwise,
# the order is decreasing age (oldest-marked files first).
export SATKIT_DISS_LATESTFIRST=True

# Number of dissemination attempts.
export SATKIT_DISS_ATTEMPTS=1

# Dissemination will sleep for this number of seconds between attempts.
export SATKIT_DISS_WAIT=60

# Dissemination will timeout after this number of seconds
export SATKIT_DISS_TIMEOUT=600

# Dissemination will be killed after this number of seconds
export SATKIT_DISS_MAXLIFE=1800

# Dissemination will not send email larger than this number of bytes
export SATKIT_DISS_MAXEMAILSIZE=4000000

# Disseminator will use this subject line for all emails.
export SATKIT_DISS_DEFAULTSUBJECT="EEC satellite product"
```

```
# Dissemination will use this as the body for e-mail messages
export SATKIT_DISS_EMAILBODY=\
"\nThis e-mail was generated by EEC groundstation equipment.\n\n"\
"This is an automated e-mail. See system administrator for further information."

# Full pathname to the dissemination list
export SATKIT_DISS_LIST=${SATKIT_HOME}/config/disseminationList.txt

# ------- Core properties ------------------------------

# Groundstation location
export SATKIT_LONGITUDE=145.01312
export SATKIT_LATITUDE=-37.81608
export SATKIT_ALTITUDE=40

# Parameters for pointing optimization
export SATKIT_SCAN_AREA=400

# After this number of seconds without data being received, the system
# concludes the downlink has ended and processing begins. Any further
# data will be processed as part of the subsequent downlink. Increase
# this value to make the system more robust to lengthy dropouts during
# a downlink, at the expense of a longer wait until final products
# appear.
#
# Detailed notes: after frames have been detected from the
# DCI500, satingest sends the data to RT-STPS for level-0
# processing. When no more frames have been detected for this timeout
# period, satingest closes the socket with RT-STPS. Also,
# geosatMoveData uses this timeout period to determine when to move
# the file up to the incoming directory for processing.
export SATKIT_TIMEOUT=180
export SATINGEST_CONFIG=${SATKIT_HOME}/config/satingest.config

# usbcapture sends output to this port
export SATKIT_USBCAPTURE_PORT=6062

# ------- Miscellany -----------------------------------

# Size of new data files are written to this file
export SATKIT_NEW_DATA_SIZE="/tmp/newDataSize.txt"

# skSetMode writes the current system mode to this file.
export SATKIT_MODE=${SATKIT_HOME}/CURRENT-MODE

# Filename seperator for product level
export SATKIT_PRODUCT_SEP="--"

############################################################
# RT-STPS
############################################################
export RTSTPS_HOME=${SATKIT_HOME}/packages/rt-stps/stps
export RTSTPS_CONFIG=${SATKIT_HOME}/config/mtsatLritHrit.xml
export RTSTPS_PORT=4935
export CCSDS_PACKET_ID=0
export LHRIT_MAX_USER_DATA_LEN=8190

############################################################
# Serial ports
############################################################
#export SATKIT_QUORUM_PORT="/dev/usb/ttyUSB2"
#export SATKIT_GPS_PORT="/dev/usb/ttyUSB1"

############################################################
# Python
############################################################
export PYTHONPATH=${SATKIT_HOME}/lib:${SATKIT_HOME}/bin:${SATKIT_HOME}/config
export ESS_PY_INCLUDES='-I/usr/include/python2.3'

############################################################
# IDL
```

```
############################################################
export IMAGECONFIG=${SATKIT_HOME}/config/imageproductconfig
if ( ! echo "$-" | grep 'i' >/dev/null ); then
    export DISPLAY=:0.0
fi

############################################################
# Paths
############################################################
if ( ! echo $PATH | grep "${RTSTPS_HOME}" > /dev/null); then
    export
PATH=${SATKIT_HOME}/bin:${RTSTPS_HOME}/bin:${GBAD_HOME}:${HDFBIN}:/usr/local/bin:.:$PATH
fi
export CLASSPATH=$RTSTPS_HOME/classes
export LD_LIBRARY_PATH="${SATKIT_HOME}/lib:${HDFHOME}/lib:${HDF5HOME}/lib"
export TCLLIBPATH="${SATKIT_HOME}/lib /usr/local/ActiveTcl/lib/tk8.4/"

############################################################
# File permissions
############################################################
# Ensure 0002 even for non-interactive shells (eg. cron jobs)
umask 0002

############################################################
# Organisation Information
############################################################
export ORGANIZATION_STRING=""
export ORGANIZATION_LOGO="esslogo.png"

############################################################
# System Logger
############################################################
export SATKIT_LOGGER=${SATKIT_HOME}/bin/skLogger.py

############################################################
# Execute custom scripts
############################################################
for config in `ls ${SATKIT_HOME}/config/satkit.conf.d`; do
    . ${SATKIT_HOME}/config/satkit.conf.d/$config
done
```

10.5.2. GEOSAT configuration file

If it is a DPS machine to process COMS-1 data from direct broadcast, there are two options which must be set correctly before the data can be decrypted and processed successfully. These two options are:

```
#Decryption - COMS
export GEOSAT_COMS_DECRYPTION_MAC_ADDRESS="003048922942"
export GEOSAT_COMS_DECRYPTION_BIN_File=${GEOSAT_HOME}/config/DecryptionKeyMessage.bin
```

The **GEOSAT_COMS_DECRYPTION_MAC_ADDRESS** is a MAC address which the customer send to KMA for the application of a decryption binary file. The **GEOSAT_COMS_DECRYPTION_BIN_File** is the path of COMS-1 decryption binary file.

The whole contents of GEOSAT configuration file /ess/config/geosatConfig are listed below.

```
-----------------------
source /ess/config/skConfig

# GEOSAT CONFIGURATION FILE

# $Id: geosatConfig,v 1.44 2008/03/28 05:34:31 chris Exp $

############################################################
# GEOSAT config
############################################################
```

```
# GEOSAT500 is a geostationary satellite system.
export SATKIT_CLASS="GOES"

# ------- Level-2 products ----------------------------

# LST is mosaicked with previous LST products between these times (UTC).
# Set the times equal to always mosaic.
export GEOSAT_LST_MOSAIC_TIME="0330:0630"

# ------- External data service -----------------------

# If corruption is detected in an XRIT segment, an external data
# service can be invoked to make a new segment available from some
# other source. Set the following to the name of the local script
# providing this service or to None to disable segment
# replacement. The GEOSAT500 invokes this script with one argument:
# the name of the level-1b segment containing corruption.
export GEOSAT_DATA_SERVICE=None

# If True, will mark the XRIT segment as corrupt if any decompression
# errors occur. Otherwise, will try to determine whether the corruption
# results in visible problems with the image. A value of True will
# decrease false negatives but increase false positives.
export GEOSAT_STRICT_CORRUPTION_DETECTION=True

# The data service can either download replacement segments to this
# machine or centralise the data on some other host to better support
# multiple processing machines. Specify the host and dir here. The
# GEOSAT500 first checks this location before invoking the data
# service.
export GEOSAT_DATA_SERVICE_HOST=localhost
export GEOSAT_DATA_SERVICE_DIR=/ess/data/satellite/mtsat/lrithrit/staging

# Data service will be killed after this number of seconds in which
# case the system will use the original segment data.
export GEOSAT_DATA_SERVICE_KILL=600

# After the data service has made the new segment available in the
# host/dir specified above, the file will be ftp transferred to this
# machine for processing.  Specify the ftp username and password here.
export GEOSAT_SEG_DOWNLOAD_UNAME=ess
export GEOSAT_SEG_DOWNLOAD_PASSWD=essess

# Segments are downloaded using ncftpget. Specify any further required
# options here.
export GEOSAT_SEG_DOWNLOAD_OPTIONS=""

# Segment download will timeout/be killed after this number of seconds
# in which case the system will use the original segment data.
export GEOSAT_SEG_DOWNLOAD_TIMEOUT=60
export GEOSAT_SEG_DOWNLOAD_KILL=70

# ------- Core properties -----------------------------

# Paths - general
export GEOSAT_HOME=${SATKIT_HOME}
export GEOSAT_PROCESSED=${GEOSAT_HOME}/data/processed

# Paths - XRIT
export GEOSAT_RAW=${GEOSAT_HOME}/data/satellite/mtsat/lrithrit/raw
export GEOSAT_LEVEL0=${GEOSAT_HOME}/data/satellite/mtsat/lrithrit/level0
export GEOSAT_INCOMING=${GEOSAT_LEVEL0}/incoming
export GEOSAT_INCOMINGNEW=${GEOSAT_INCOMING}/new
export GEOSAT_LEVEL1B=${GEOSAT_HOME}/data/satellite/mtsat/lrithrit/level1b
export GEOSAT_WORKING=${GEOSAT_LEVEL1B}/intermediate

# Paths - HiRID
export GEOSAT_RAW_HIRID=${GEOSAT_HOME}/data/satellite/mtsat/hirid/raw
export GEOSAT_LEVEL0_HIRID=${GEOSAT_HOME}/data/satellite/mtsat/hirid/level0
export GEOSAT_INCOMING_HIRID=${GEOSAT_LEVEL0_HIRID}/incoming
```

```
export GEOSAT_INCOMINGNEW_HIRID=${GEOSAT_INCOMING_HIRID}/new
export GEOSAT_LEVEL1B_HIRID=${GEOSAT_HOME}/data/satellite/mtsat/hirid/level1b
export GEOSAT_WORKING_HIRID=${GEOSAT_LEVEL1B_HIRID}/intermediate

# Paths - SVISSR
export GEOSAT_RAW_FY2C=${GEOSAT_HOME}/data/satellite/fy2c/svissr/raw
export GEOSAT_LEVEL0_FY2C=${GEOSAT_HOME}/data/satellite/fy2c/svissr/level0
export GEOSAT_INCOMING_FY2C=${GEOSAT_LEVEL0_FY2C}/incoming
export GEOSAT_INCOMINGNEW_FY2C=${GEOSAT_INCOMING_FY2C}/new
export GEOSAT_LEVEL1B_FY2C=${GEOSAT_HOME}/data/satellite/fy2c/svissr/level1b
export GEOSAT_WORKING_FY2C=${GEOSAT_LEVEL1B_FY2C}/intermediate

# Paths - COMS
export GEOSAT_RAW_COMS=${GEOSAT_HOME}/data/satellite/coms/lrithrit/raw
export GEOSAT_LEVEL0_COMS=${GEOSAT_HOME}/data/satellite/coms/lrithrit/level0
export GEOSAT_INCOMING_COMS=${GEOSAT_LEVEL0_COMS}/incoming
export GEOSAT_INCOMINGNEW_COMS=${GEOSAT_INCOMING_COMS}/new
export GEOSAT_LEVEL1B_COMS=${GEOSAT_HOME}/data/satellite/coms/lrithrit/level1b
export GEOSAT_WORKING_COMS=${GEOSAT_LEVEL1B_COMS}/intermediate

#Decryption - COMS
export GEOSAT_COMS_DECRYPTION_MAC_ADDRESS="003048922942"
export GEOSAT_COMS_DECRYPTION_BIN_File=${GEOSAT_HOME}/config/DecryptionKeyMessage.bin

# Paths - quicklook
export GEOSAT_QUICKLOOK=${GEOSAT_HOME}/data/satellite/quicklook

# JPEG extraction and decompression is killed if it doesn't complete
# within this number of seconds
export GEOSAT_IMAGEEXTRACT_TIMEOUT=180

# Browse creation is killed if it doesn't complete within this number
# of seconds
export GEOSAT_BROWSE_TIMEOUT=60

# PIC creation is killed if it doesn't complete within this number of
# seconds
export GEOSAT_PIC_TIMEOUT=180

# ------- Miscellany -----------------------------------

# MTSAT-1R height and sub-satellite longitude
export GEOSAT_MTSAT1R_HEIGHT=35786
export GEOSAT_MTSAT1R_SSL=140.0

# Used to identify and write spacecraft bulletins and MANAMs
export GEOSAT_MANAM=${GEOSAT_LEVEL1B}/latestMtsatManam.txt
export GEOSAT_MANAM_ID="MTSAT HRIT MANAM"
export GEOSAT_BULLETIN=${GEOSAT_LEVEL1B}/latestMtsatBulletin.txt

# Id of all MTSAT L/HRIT sectors that can be segmented (transmitted in
# seperate sections). Modify the variable if JMA introduce new segmented sectors.
export GEOSAT_MTSAT_SEGMENTED_SECTOR_IDS="DK01;DK02;DK03;SF01"

# Id of all MTSAT L/HRIT full sectors (are not transmitted in
# seperate segments). Modify the variable if JMA introduce new full sectors.
export GEOSAT_MTSAT_FULL_SECTOR_IDS="PS01;PS02;PS03"

# Latitude and longitude ranges of all MTSAT sectors. Modify the
# variable if JMA introduce new sectors. The format of these entries
# are: "<sector>":(<num segments>,<min lat>,<max lat>,<min long>,<max long>)
export GEOSAT_SECTOR_RANGES={\
\"DK01\":\(10,-80,80,60,220\),\
\"DK02\":\(5,0,80,60,220\),\
\"DK03\":\(5,-80,0,60,220\),\
\"PS01\":\(1,7,59,83,167\),\
\"PS02\":\(1,30,48,124,151\),\
\"PS03\":\(1,20,38,115,136\),\
\"SF01\":\(1,-80,80,60,220\)\}

# Maps sector ids to meaningful names
```

```
export GEOSAT_SECTOR_MAPPING="{\"PS01-L\":\"East Asia\",\"PS02-L\":\"NE Japan\",\"PS03-
L\":\"SW Japan\",\"DK01-L\":\"Disk\"}"


############################################################
# McIDAS config
############################################################
export PATH=$PATH:/home/mcidas/bin

############################################################
# AODT config
############################################################
export ODTHOME=/home/mcidas/aodt
export ODTTOPO=$ODTHOME
export ODTHISTORY=/home/ess/history
export ODTAUTO=$HOME/odt/data/forecasts
export ODTOUTPUT=/home/ess/output
export ODTSST=$HOME/odt/data/sst
export ODTLSERVER=LOCAL
export ODTLAREA=7777
export MCPATH=${GEOSAT_LEVEL1B}:/home/user/mcidas/data:/home/mcidas/data:/home/mcidas/help
export JAVA_HOME=/usr/java/j2re
```

10.5.3. satingest configuration file

```
# SATINGEST CONFIGURATION

# Format documentation appears at the end of this file.

# ------- Hardware configuration ------------------------
# Receiver and antenna controller settings

[GENERAL]
receiver_model = ESS3000
timeout = 120
listen_port = 6062
control_receiver = no

[ESS3000]
hostname = ess3000
data_addr = 192.168.0.254
data_port = 6062
cmd_port = 6061
rf_input = 1
satellite_mode = mtsat-hrit
set_mode = no

[QUORUM]
local_oscillator = 1553.500
power_feed = 0
clock_data_on_which_edge = 0
data_true_on_positive = 0
serial_port = 1
satellite_mode = mtsat-hrit

[ANTENNA CONTROLLER]
pass vector type = 0
set time = no
serial port = 1

# ------- GOES configuration ----------------------
# Configuration for geostationary satellites

[MTSAT-HRIT]
frequency = 1687.100
quorum_mode = ma
ess3000_mode = mtsat-hrit
ac_post_command =

[MTSAT-LRIT]
```

```
frequency = 1691.000
quorum_mode = m9
ess3000_mode = mtsat-lrit
ac_post_command =

[MTSAT-HIRID]
frequency = 1687.100
quorum_mode = m1
ess3000_mode = gms
ac_post_command =

[FY2C-SVISSR]
frequency = 1687.500
quorum_mode = m1
ess3000_mode = gms
ac_post_command =

# ------- POES configuration ------------------------
# Configuration for polar-orbiting satellites

[SCHEDULER]
schedule = TERRA, AQUA, NOAA 15, NOAA 16, NOAA 17, NOAA 18, FENGYUN 1D
minimum elevation = 300
signal_plot_max = -45
signal_plot_min = -80

[NOAA 15]
receiver = ESS3000
control antenna = yes
frequency = 1702.5
mode = noaa
priority = 5
ingest = satingest
downconverter = 9
rf_relay = 1

[NOAA 16]
receiver = ESS3000
control antenna = yes
frequency = 1702.5
mode = noaa
priority = 5
ingest = satingest
downconverter = 9
rf_relay = 1

[NOAA 17]
receiver = ESS3000
control antenna = yes
frequency = 1707.0
mode = noaa
priority = 7
ingest = satingest
downconverter = 13
rf_relay = 1

[NOAA 18]
receiver = ESS3000
control antenna = yes
frequency = 1698.0
mode = noaa
priority = 7
ingest = satingest
downconverter = 4
rf_relay = 1

[FENGYUN 1D]
receiver = ESS3000
control antenna = yes
frequency = 1700.4
mode = fy1
```

```
priority = 4
ingest = satingest
downconverter = 5
rf_relay = 1

[METOP-A]
receiver = ESS3000
control antenna = yes
frequency = 1700.4
mode = mh
priority = 1
ingest = satingest
downconverter = 5
rf_relay = 1


[ORBVIEW 2]
receiver = ESS3000
control antenna = yes
frequency = 1702.5
mode = noaa
priority = 3
ingest = satingest
downconverter = 3
rf_relay = 1

[TERRA]
receiver = ESS3000
control antenna = yes
frequency = 1700.4
mode = terra
priority = 8
ingest = rtstps
downconverter = 12
rtstps_config = /ess/packages/rt-stps/stps/config/essTerra.xml
data_port = 6060
rf_relay = 0

[AQUA]
receiver = ESS3000
control antenna = yes
frequency = 1700.4
mode = aqua
priority = 8
ingest = rtstps
downconverter = 8
rtstps_config = /ess/packages/rt-stps/stps/config/essAqua.xml
data_port = 6060
rf_relay = 0

# ------- Ingest configuration ------------------------
# Configuration for transmission formats.

[INGEST_SVR]
active = no
fileoutput = yes
directory = /ess/data/satellite/mtsat/hirid/level0/incoming/new
directory_scid_35 = /ess/data/satellite/fy2/hirid/level0/incoming/new

[INGEST_CCSDS]
active = yes
send_to_port = yes
send_port = 4935
bitalign = true
fileoutput = no
directory = /ess/data/satellite/raw
rs_decode = true

[INGEST_HPT]
active = yes
fileoutput = yes
```

```
padding = 2
directory = /ess/data/satellite/noaa/level0/incoming/new
directory_fy1 = /ess/data/satellite/fenyung/level0/incoming/new
postprocess = /ess/bin/satingest_postprocess

[RAW_WRITE]
active = no
directory = /ess/data/satellite/raw

# --------------
# FORMAT DOCUMENTATION
#
# ------- 1. Hardware configration
# Receiver and antenna controller settings
#
# [GENERAL]
# receiver_model                = <name of a receiver specified in this file>
# timeout                       = <default timeout for receiver comms>
# listen_port                   = <port on which data is received>
# control_receiver              = <if 'yes', system can command the receiver. If 'no'
#                                 receiver control is prevented>
#
# [ESS3000]
# hostname                      = <network hostname>
# data_addr                     = <receiver IP>
# data_port                     = <port on which data is received>
# cmd_port                      = <port to which commands are sent>
# rf_input                      = <RF input>
# satellite_mode                = <name of a receiver mode specified in this file>
# set_mode                      = <if yes, set receiver mode to default each time a connection
is made.
#                                 If no, only do this during 1st connection. Set to 'no' for
mult-mode
#                                 systems>
#
# [QUORUM]
# local_oscillator              = <local oscillator frequency>
# power_feed                    = <1 to power feed, 0 otherwise>
# clock_data_on_which_edge      = <0 for rising edge, 1 for falling>
# data_true_on_positive         = <0 for data true on positive, 1 for data false>
# serial_port                   = <serial port>
# satellite_mode                = <name of a receiver mode specified in this file>
#
# [ANTENNA CONTROLLER]
# pass vector type              = <1 to flip pass vectors, 0 otherwise>
# set time                      = <not used in this version>
# serial port                   = <serial port>
#
# ------- 2. GOES configuration
# Configuration for geostationary satellites
#
# [<GOES satellite>]
# frequency                     = <frequency>
# quorum_mode                   = <command to change quorum receivers to this mode>
# ess3000_mode                  = <command to change ess3000 receivers to this mode>
# ac_post_command               = <comma-separated list of antenna controller commands issued
#                                    whenever this mode is entered. Can be used to re-point
antenna>
#
# ------- 2. POES configuration
# Configuration for polar-orbiting satellites
#
# [SCHEDULER]
# schedule                      = <comma-separated list of POES satellites to be tracked. Each
satellite
#                                    must be defined in this file>
# minimum elevation             = <minimum elevation in 100ths of a degree before a pass will
be tracked>
# signal_plot_max               = <max signal strength value for signal plots>
# signal_plot_min               = <min signal strength value for signal plots>
#
```

```
# [<POES satellite>]
# receiver                      = <override for receiver_model in GENERAL section>
# control antenna               = <override for control_receiver in GENERAL section>
# frequency                     = <frequency>
# mode                          = <command to change thhe receiver to this mode>
# priority                      = <1..10, 10 is highest priority. For conflicts between
satellites
#                                 with the same priority, that with the highest elevation is
selected>
# ingest                        = <satingest or rtstps>
# rtstps_config                 = <RT-STPS config file>
# downconverter                 = <downconverter channel>
# rf_relay                      = <0 for X-band, 1 for L-band>
#
# ------- 3. Ingest configuration
# Configuration for transmission formats: SVISSR, CCSDS, and/or HRPT.
#
# [INGEST_SVR]
# [INGEST_CCSDS]
# [INGEST_HPT]
# active                        = <yes to activate ingest from specified satellites, no
otherwise>
# fileoutput                    = <yes to write level-0 data, no otherwise>
# directory                     = <level-0 output directory>
# directory_scid_??             = <level-0 output directory for spacecraft with id ??>
# send_to_port                  = <yes to send level-0 data to a port, no otherwise>
# send_port                     = <port to send level-0 data to>
# bitalign                      = <yes to bit-align data, no otherwise>
# rs_decode                     = <yes to apply Reed-Solomon decoding, no otherwise>
# forward_rs_uncorrectables     = <yes to forward uncorrectable packets, no otherwise>
# descramble                    = <yes to PN-decode the data, no otherwise>
# log_rs_verbose                = <yes to verbosly log Reed-Solomon operations, no otherwise>
# postprocess                   = <post-process script - called at end of transmission>

# [RAW_WRITE]
# active                        = <yes to activate raw writing, no otherwise>
# directory                     = <directory to which raw data should be written>
```

10.5.4. dataservices configuration file

```
# EEC satellite systems require data from various internet locations
# in order to track satellites and generate level-2 products. The URLs
# below define the internet locations of this data.

# ------- TLEs ------------------------
# Satellite tracking and navigation

export TLE_WEATHER="http://celestrak.com/NORAD/elements/weather.txt"
export TLE_RESOURCE="http://celestrak.com/NORAD/elements/resource.txt"
export TLE_NORAD="ftp://is.sci.gsfc.nasa.gov/ancillary/ephemeris/tle/norad.tle"

# ------- NCEP GRIB -------------------
# Met product GRIB overlays

# Outgoing longwave radiation
export
NCEP_GFS1_URL="ftp://ftpprd.ncep.noaa.gov/pub/data/nccf/com/gfs/prod/gdas.%s/gdas2.t00z.sfluxg
rbf00.grib2"
export NCEP_GFS1_GRIB1_FILE="gdas2.t00z.sfluxgrbf00"

# Precipitable Water, Global Instability, Total Ozone
export
NCEP_GFS2_URL="ftp://ftpprd.ncep.noaa.gov/pub/data/nccf/com/gfs/prod/gdas.%s/gdas1.t00z.pgrbf0
0.grib2"
export NCEP_GFS2_GRIB1_FILE="gdas1.t00z.pgrbf00"

# Accumulated Rainfall (7 days). AR_FORECASTS defines the forecast files downloaded: edit this
list
# to reduce download quantity.
```

```
export
NCEP_GENS1_URL="ftp://ftpprd.ncep.noaa.gov/pub/data/nccf/com/gens/prod/gefs.%s/00/pgrb2a/gec00
.t00z.pgrb2af"
export NCEP_GENS1_GRIB1_FILE="gec00.t00z.pgrbaf"
export AR_FORECAST="06,24,48,72,96,120,144"

# ------- SYNOP -----------------------
# Weather observations

export SYNOP_URL="http://dweb.met.fsu.edu/rawdata/syn"

# The SYNOP URL contains one file for each hour. The delta controls which
# of those hours are downloaded (eg 0, 3, 6, ...)
export SYNOP_DELTA=3
```

10.6. Disk space management

The GEOSAT500 system receives, processes and generates a considerable amount of data each day. The GEOSAT500 Clean Disk program runs automatically every 10 minutes to ensure that an adequate amount of disk space is always available to the system.

Clean Disk examines each partition on each disk and repeatedly removes the oldest files until a minimum amount of free space exists. Clean Disk is only allowed to delete certain types of file and is optimally configured by default to ensure the maximum amount of data is available at all times. There should be no need to modify Clean Disk's configuration.

10.6.1. Details of operation

Although there will be no need to modify the configuration from the optimum default, this section provides further details on how the program works as it's a central part of the GEOSAT500.

Warning: Clean Disk is designed to delete data. A misconfigured Clean Disk may delete data that was not intended for deletion. Only an experienced linux system administrator should modify the configuration of this program.

The Clean Disk configuration file is /ess/config/skCleanDiskList.txt. It contains details of which directories to monitor, the minimum amount of free space to maintain in the directory partitions, and details of the operation to perform (delete, or move).

An example entry in the configuration is:

```
# Clean any files from /ess/data/satellite

[target]

dir= /ess/data/satellite

keep_free= 5G

pattern= /ess/data/satellite/
```

When Clean Disk executes it performs the following functions in order for each target directory specified:

- recursively find all files in target directory which match any of the delete patterns for the target directory
- sort the files in order of age with oldest at the start of the list. If any file matches an offset_map pattern, change its date by the amount specified
- go through the list in order of (modified) date and for each file
- if it is in a protected pattern leave it
- if it is in a move pattern, move the file to its destination and only delete it if the move is successful
- delete the file

The process stops when either (a) the free space target is met for the target directory or (b) there is nothing left that can be deleted according to the configuration file. skCleanDisk then moves on to the next target specified in the configuration file and is done when there are no more targets to process.

10.6.1.1. Configuration file format

These rules apply to the general format and are use in all sections.

- Blank lines are ignored.
- Comment lines begin with a '#' character, like most UNIX configuration files.
- A section starts with a section name in square brackets, eg. [target] specifies a target section.
- Within a section parameters are added using the keyword/value pattern keyword = value. Here keyword is a special keyword for the section and value is any value which can be used for it. Any whitespace before or after a keyword or value is ignored. So keywords and values cannot have a space as their first or last character.

10.6.1.1.1. Target Sections

Target sections specify top-level directories where Clean Disk will start searching for files. skCleanDisk will not cross mount points when searching for files.

Keyword: dir

Only one of these may occur for each target section and should be the first keyword defined. This specifies the directory from which files can be removed in order to meet minimum free space on the partition containing the directory. This is an important point: due to the nature of linux filesystems, clean disk manages the free space in disk partitions, not directories.

Keyword: keep_free

Defines the target amount of free space as a number. Only one instance of this line may occur for each target section and it should immediately follow the dir line. Space is defined as either bytes (for only a number), or the shorthand values 'G' for gigabyte and 'M' for megabyte can be used as the last character after a floating point number.

Keyword: pattern

Any number of pattern lines can occur within a target section. Each line specifies a regular expression (RE) pattern which files must match in order for them to be deleted. A file only needs to match one of the pattern directives to be considered for deletion.

Example

[target]

dir= /ess/data/satellite

keep_free= 4.0G

pattern=/ess/data/satellite/mtsat

10.6.1.1.2. Move Sections

Move sections define files which should be moved to another place rather than deleted. An example might be if a Network Attached Storage device is available for archiving.

Keyword: pattern

This keyword specifies an RE pattern to match for files to be moved to the destination location. Exactly one pattern line must occur in each move section.

Keyword: destination

The keyword specifies where files matching the pattern keyword should be moved to. It is a fully qualified path to a directory in the filesystem. Exactly one destination line must occur in each move section.

Example

[move]

pattern=.*level0\.dat

destination=/mnt/NAS/hritLevel0

10.6.1.1.3. Offset sections

Offset sections specify date offsets for particular filename patterns. This is used to make some types of files seem older or newer to artificially move them up or down the delete order. This can be useful if there are particular types of files that need to be retained longer than others, or files which can be removed earlier because they have no value.

Keyword: pattern

Exactly one pattern line must occur in each offset section. The value is the RE pattern which a filename must match to get the offset value. Offset values are not cumulative. If a filename matches multiple offset patterns, only the first one matched is used.

Keyword: amount_days

Exactly one amount_days line must occur for each offset section. The value is the amount of time in days that the effective date of the file should be moved. A positive value keeps the file for longer and a negative value deletes the file earlier.

Example

[offset]

pattern=MOD09G/.*[.]hdf

amount_days=2

10.6.1.1.4. Protect Sections

Protect sections are used to specify filename patterns which should never be deleted.

Keyword: pattern

A pattern line specifies a pattern for filenames which should not be deleted. Any number of pattern lines may occur in a protect section. There is no reason why multiple protect sections should exist, but they are allowed.

Examples

[protect]

pattern=/ess/data/processed/myFavouriteHritImage.png

10.6.1.2. Pattern matching

The Clean Disk program uses the Regular Expression pattern syntax for describing filename patterns which are matched. When describing which files have which properties in the Clean Disk configuration file, filename patterns are expressed as Regular Expressions (REs). Regular expressions were chosen over globbing patterns (which use * and ? wildcards) because they offer a much more precise way of defining a pattern.

When it comes to matching filenames with regular expressions, the RE need not match the entire pathname or filename. If the RE matches any part of the pathname then the file is considered a match. As an example, a pattern of bac will match /mnt/backup/somefile and

/some/dir/filename.abacus. To force an entire pathname match you can use the special characters ^ and $. The ^ character means from before the first character and $ means after the last character. So the RE pattern [.]hdf$ means all filenames which end in '.hdf'.

10.6.1.2.1. Working with regular expressions

In Regular Expressions (REs), the dot character (.) is a special character which matches anything, so to search for a dot in a filename you must write it as [.]. The square brackets take away the special meaning of the dot.

Obviously square brackets have special meaning as well, they mean match any ONE of the characters in the brackets. So [abc] will match a or b or c (but only one of those characters).

A regular expression component can be repeated. eg. [abc]{3} will match 3 characters in a row if all of them are either a, b or c. Parentheses can be used to make longer pattern pieces. eg. (a.c){3} would match abca_ca%c.

10.6.1.3. Testing skCleanDisk configurations

The Clean Disk program comes with a testing mode which allows the user to determine if they have configured the system properly. The '--debug' option to Clean Disk will do a test run, and will print to stdout, the files which would normally be deleted, in the order they would be deleted. All files which are candidates for deletion are printed, not just those required to reach free space. If a file does not appear in the output then it would not ever be deleted by the Clean Disk configuration.

Warning: to test the configuration, the Clean Disk configuration file must be changed. Remember to temporarily disable the skCleanDisk cron job before making changes so it does not accidentally use the experimental configuration file until it has been properly tested.

10.7. Calling GEOSAT500 programs manually

The GEOSAT500 provides full automation for satellite data processing. The system is comprised of a number of individual programs and all of these can be called manually on the command line or from user-defined programs. These GEOSAT500 interface programs are listed below: run the command with the –help option to determine full details.

Program	geosatDPS
Function	Processes level-0 satellite data into level-1b and level-2 PIC products according to a series of setups. Supported data formats are MTSAT LRIT, MTSAT HRIT, MTSAT HiRID, and FY2C SVISSR. Can also process level-1b MTSAT XRIT data directly into level-1b and level-2 PICs. The various satellite incoming directories are searched for an input file if one is not specified on the command line. Similarly, the generation list is used as a source of setups to process unless one is specified on the command line. A lock is obtained during processing to prevent concurrent operations. Level-2 processing is performed after all level-1b processing for all setups and this program does not block awaiting completion. Each invocation will process at most one input file. The input level-0 file is moved to the parent directory if it was found in one of the satellite incoming directories.
Usage	geosatDPS [options] options: --version: show program's version number and exit -h, --help: show this help message and exit --file=FILENAME: Process the level-0 file FILENAME instead of querying incoming directories

--l1bfile=L1BFILES: Process the level-1b file L1BFILES only. Can be specified multiple times.

--setup=SETUPNAME: Process using SETUPNAME instead of querying the generation list

--format=FORMAT: Level-0 file can be LRIT, HRIT, HiRID, or FY2C SVISSR. System determines the format automatically, but can be overridden with this option. Specify one of XRIT HIRID FY2C.

--ignorel1b: Ignore level-1b files already on-disk. By default, existing level-1b files that match the sector and observation time of those extracted from a level-0 file will be included in PIC processing. Existing level-1b files are always ignored if --l1bfile is specified.

--usehiridsmb: If format is HIRID, use SMB- rather than model-based navigation. SMB navigation allows IR4 to be extracted, but model-based navigation is faster.

--disseminate: Disseminate level-0, level-1b and PIC products

--dissgoodl1b: Only disseminate level-1b files that don't contain errors

--allsegments: Process all XRIT segments regardless of setup coverage

--datafeed: Convert level-0 XRIT into standard level-1b only. PICs and level-2 products are not produced.

--mcidas: Convert level-0 XRIT into McIDAS level-1b format. All channels are converted by default. PICs and level-2 products are not produced.

--mcchannel=MCCHANNELS: Only convert this XRIT channel to McIDAS level-1b format. Can be specified multiple times. Valid channels are: VIS IR1 IR2 IR3 IR4

--smallfile: Level-0 files < 100K are not processed unless this option is specified

--forcel2: Generate HRIT level-2 products even if corruption found in the level-1b

---

Program skPicPostProcessing

Function Generate standard images and other data formats from all level-1b PICs according to the setup that created the PIC.

Usage skPicPostProcessing.py <PIC filename>

Performs post-processing operations for PIC files. The operations are:

1. Create tag files for dissemination;

2. Convert PIC to HDF4, HDF5, netCDF, ASCII and BUFR as required by setup; and

3. Create standard image products as required by setup.

options:

--version show program's version number and exit

-h, --help show this help message and exit

Program skDisseminator [options]

Function Sends registered data files to target locations (hosts or email accounts) using rsync, ftp, copy, move, and/or mutt. First, a list of tagfiles is obtained from $SATKIT_HOME/newfiles (see skCreateTagfile.py for format and other details). Each tagfile references a file somewhere in the file system.

Second, a list of transfer specifications is obtained from the dissemination list

	$SATKIT_DISS_LIST. A transfer specification is a filename pattern plus one or more target locations (hosts/email accounts) that matching data files should be sent to. A transfer specification also includes options that override default properties of the transfer. Duplicate hosts/emails and entries for the local host are removed as the transfer specifications are constructed. All target hosts set to 'localdisk' will be transferred to the local machine. See the dissemination list file for details of its format. Finally, the transfer specifications are processed: if the tagfile matches the pattern in a transfer specification, it is sent to the associated target location. The tagfile is removed after a successful transfer. If no data can be sent for $SATKIT _DISS_TIMEOUT seconds, the transfer returns without doing further work. Any data already transferred is removed (rsync only). If the transfer process is still running after $SATKIT _DISS_MAXLIFE seconds, the process is sent a SIGALRM which causes it to exit. Again, any data already transferred is removed (rsync only).
Usage	skDisseminator.py [options] options: --version: print version info --help: print help --file=TARGETFILE Transfer this file only.
Program	skCreateTagFile
Function	Creates a dissemination tagfile in the GEOSAT_HOME/newfiles directory. A tagfile is a reference to a file somewhere on the system and these are used by skDisseminator to locate files for transfer. All arguments to this program must be fully qualified pathnames.
Usage	skCreateTagFile <file> [options] <file>: mark the specified file for dissemination options: --alt=ALTFILE: use this file as an alternative, should the primary file not be available when the GEOSAT500 disseminator starts. --version: print version info --help: print help
Program	skCleanDisk
Function	Remove old files from each disk partition until a minimum amount of free space is available. The configuration file is /ess/config/skCleanDiskList.conf
Usage	skCleanDisk
Program	skFileArchive
Function	Write new files to the current tape. The configuration file is /ess/config/archiveList.txt
Usage	skFileArchive
Program	skArchiver
Function	Start the GEOSAT500 Archiver console.
Usage	skArchiver

Program	skConsole.py
Function	Start the GEOSAT500 console.
Usage	geosatConsole.py
Program	setupManager
Function	Start the GEOSAT500 setup manager
Usage	setupManager
Program	skSetMode
Function	Changes the reception mode of the system to allow another source of satellite data to be ingested and processed. If the supplied mode is valid, the receiver is commanded into this new mode then any necessary commands sent to the antenna controller (to repoint the dish, for example). Settings for all valid modes and receivers, together with antenna controller commands, are taken from the satingest.config file. The name of the current system mode is written to the file $GEOSAT_MODE.
Usage	skSetMode [options] options: --version: show program's version number and exit -h, --help: show this help message and exit --mode=MODE: Set demodulator mode. Modes are: FY2C-SVISSR MTSAT-HRIT MTSAT-HIRID MTSAT-LRIT --skipreceiver: Do not change receiver mode: only move antenna if required. Useful if some other component is responsible for receiver modes (eg. satingest commands the receiver at boot time, so don't want this program to do this at boot time) --list-modes List availale demodulator modes
Program	skSetRole
Function	Sets the role of a workstation (AWS, DPS, AWS+DPS, or ODW) by entering into a dialog with the operator and making various changes to these files: ess crontab, root crontab, skConfig, and/or rc.ess. The machine should be rebooted after running this script. These configurations include configuring the system to download Himawari HSD data rather than HimawariCast and to download COMS-1 from the JMA JDDS service rather than direct broadcast.
Usage	skSetRole
Program	geosatQuicklook
Function	Starts a GUI and a file monitoring thread to search for new MTSAT level-0 files. When the file monitor finds a new level-0 file, it's parsed into constituent level-1b files, a browse file generated, and the GUI updated to show the image data so far received. The level-0 file is checked after a time interval and any further imagery displayed in the GUI (only complete L/HRIT level-1b segments will be shown). The GUI is cleared when a new level-0 file is found.

Usage	geosatQuicklook [options] options: --version: show program's version number and exit -h, --help: show this help message and exit --file=L0FILE: Show the image contents of this file only. --maxage=MAXAGE: Files are considered new if the modtime is > this number of seconds (default: 45) --delay=DELAY: Wait for this number of seconds between file checks (default: 20) --verbose: Produce detailed output if running from a tty
Program	skCommand.py
Function	Executes the specified command on the specified server using ssh. Stderr/out from the command appears on this program's stderr/out and in the GEOSAT500 logs.
Usage	skCommand <command> [options] <command>: command to execute options: --version: show program's version number and exit -h, --help: show this help message and exit --timeout=TIMEOUT: ssh call will timeout after this number of seconds [default: 120] --server=SERVER: Send command to this server using ssh [default: $SATKIT _SERVER] --noservercheck: Do not test ssh comms with server before issuing command [default: False] --noclient: Will include '--client=<hostname>' with the command unless this option is specified [default: False]
Program	syncDir
Function	Uses rsync to synchronise the content of two directories: files/dirs present in <fromDir> that are not in <toDir> (or files that are of a different size) are transferred. This is a one-way operation where <fromDir> is considered more up-to-date than <toDir>. These arguments can be any valid rsync target (see rsync(1)). The rsync operation transfers whole files, preserves ownership, permissions, and file modification times. If the transfer fails because the rsync server on the target has reached max connections, or if the target host is not available on the network, the program sleeps then retries. The operation will timeout if no data is transferred within limits.

Usage	syncDir <fromDir> <toDir> [options] options: --version show program's version number and exit -h, --help show this help message and exit --retries=RETRIES rsync will fail if the target host is not available or another rsync with the target is underway: retry this number of times [Default: 3] --retrypause=RETRYPAUSE Wait this number of seconds between retries [Default: 60] --timeout=TIMEOUT Timeout after no data transferred for this number of seconds [Default: 60] --exclude=EXCLUDE Exclude files matching this pattern [Default: .* (hidden files)] --quiet When running in a tty, send detailed rsync logs to GEOSAT log rather than terminal.
Program	hritdisp.py
Function	MTSAT HRIT level-1b image viewer. Input is a single MTSAT HRIT level-1b segment: this is parsed, the JPEG extracted, decompressed, then displayed.
Usage	hritdisp.py <HRIT level-1b file> [options] options: --version show program's version number and exit -h, --help show this help message and exit

11. File formats

11.1. PIC

Each PIC image is composed of two files, the header and the data. The header file has a filename extension of ".hdr" which the data has an extension of ".pic". The data file format is intentionally simple; it is a flat binary image file with channels organised in the order specified in the header file. The data organization is summarised in the diagram below.

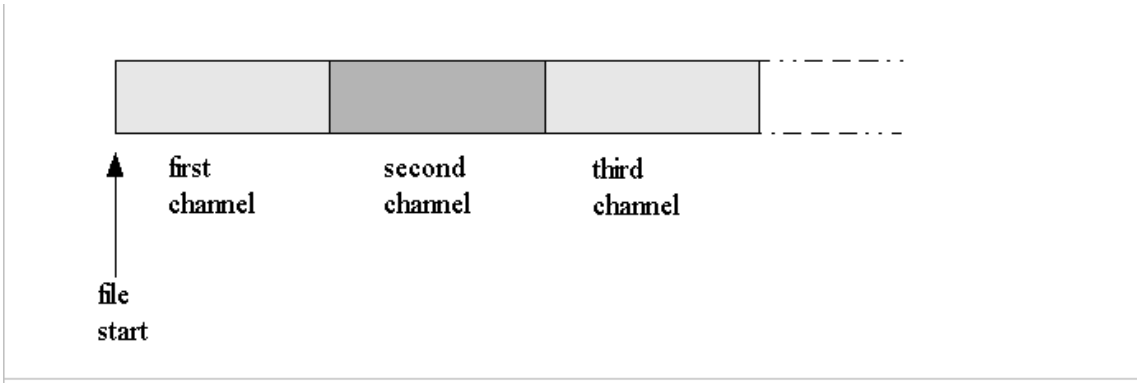


Figure 68 PIC format

Each channel is the same size in bytes, and the same size in pixels in each dimension. The dimensions of the image channels are specified in the header file.

Within each channel, all data is interpreted as big-endian unsigned integer type with a number of bytes per value as specified in the header file.

Within each channel section of the file, the data is organized as shown in the diagram below.

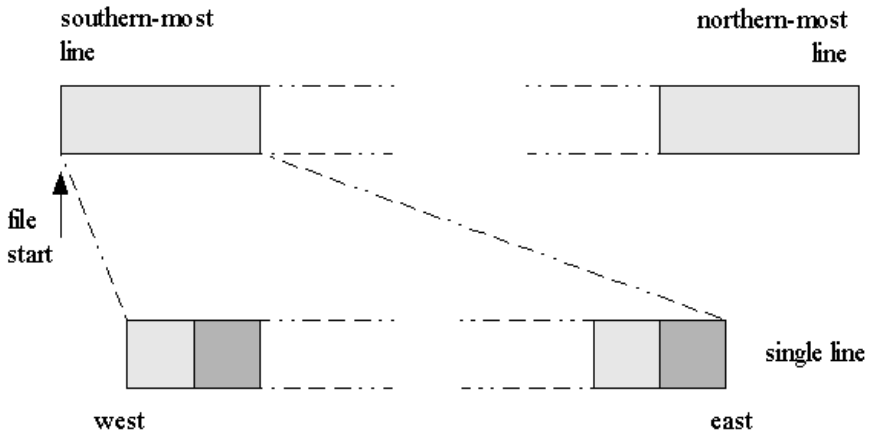


Figure 69 Channels in PIC files

To summarize:

- each entire channel is written completely before the next channel is started and the order of channels is as specified in the header file

- within each channel, lines are ordered from south to north
- within each line, points are written from west to east
- at each point, the single data value is encoded as an unsigned integer in big-endian encoding with a number of bytes as specified in the header format.

11.1.1. PIC Header File Format

The PIC header specifies how the data within the data file should be interpreted. A PIC header has the following sections

overall region and encoding description

lookup tables

All sections are encoded as plain ASCII text to allow for easy debugging and manual manipulation and reuse.

Each channel which is encoded in the PIC data file has a corresponding lookup table (LUT) section. The order of the LUT sections in the PIC header specifies the order in which data is encoded in the PIC data file.

Example

```
-37.000000
140.000000
-47.000000
155.000000
-37.000000
140.000000
-47.000000
155.000000
0.005000
3001
2001
3
100.000000
2
L1B - MTSAT_VIS,MTSAT_IR1,MTSAT_IR2,MTSAT_IR3,MTSAT_IR4
MTSAT_VIS LUT 65536
     0   0.000     1   0.016     2   0.032     3   0.048
     4   0.063     5   0.079     6   0.095     7   0.111
     8   0.127     9   0.143    10   0.159    11   0.175
    12   0.190    13   0.206    14   0.222    15   0.238
    16   0.254    17   0.270    18   0.286    19   0.302
```

The above example shows the start of a PIC header file for a L1B PIC with five channels.

11.1.1.1. File Parameters Section

The file parameters section is exactly 14 lines long. The meaning of the lines is, in order

1. region maximum latitude (north boundary)
2. region minimum longitude (west boundary)

3. region minimum latitude (south boundary)
4. region maximum longitude (east boundary)
5. valid data maximum latitude (north boundary)
6. valid data minimum longitude (west boundary)
7. valid data minimum latitude (south boundary)
8. valid data maximum longitude (east boundary)
9. degrees per sample value
10. samples west-east
11. sample north-south
12. number of channels encoded
13. percent coverage of region
14. bytes per sample

All boundary coordinates are in degrees.

All values are encoded as floating point text representations except count values (lines 10, 11, 12 and 14).

11.1.1.2. LUT Section

The LUT section begins with the 15th line.

The first line is a summary of the PIC and all its channels.

Immediately following the summary line is the set of LUTs for the channels.

11.1.1.3. LUT Summary

The LUT summary line has the following structure

<PRODUCT_NAME> - <CHANNEL_NAME>, <CHANNEL_NAME>, ...

The product name should match the naming of the PIC file. It identifies the overall product which is the combination of all the channels encoded.

The channel names which follow the dash character will appear in the drop-down list of channels within PROTEUS. The values here are only used for identification purposes. Channel names may not contain space characters; so typically space characters are converted to underscore characters.

11.1.1.4. Lookup Tables

Each LUT which follows the LUT summary line has the following sections:

summary line

LUT mappings

The summary line has the following form:

<CHANNEL_NAME> LUT <NUM_ENTRIES>

Here <CHANNEL_NAME> is the name of the channel and must match the name used in the LUT summary line; <NUM_ENTRIES> is an integer text representation of the number of entries in the LUT. This should match the number of possible values for the “bytes per sample” value in the file parameters section (line 14).

For example, 2 bytes per sample is 16 bits; so the number of LUT entries should be 2^16 = 65536.

The LUT mapping entries are arranged as follows

ordered by input value

four entries to each line

entries are separated by whitespace

each entry consists of “<input> <output>”

<input> is an unsigned integer text value which is the PIC data value encoded in the data file

<output> is a floating point text value which is the physical output value corresponding to the integer input value.

an <output> value of 0.0 indicates a fill value, ie. a point at which no valid data exists.

The summary line of the next LUT immediately follows the last LUT mapping line of the previous LUT (as shown in the example below).

11.2. Browse

The browse image format has the following sections, in order

header line

image data

11.2.1. Header Line

The browse image header line is exactly 512 bytes long. Where data is not encoded the bytes should be set to ASCII character 0x20 (space).

The header line encodes two values as follows

<height> <width>

Both <height> and <width> are text encoded unsigned integer values and refer to the number of lines and number of pixels per line stored in the image data.

A single space character separates the two values.

11.2.2. Image Data

The image data in a browse image is encoded as follows

lines are written from top to bottom

within each line, pixels are written from left to right

each pixel is an 8-bit unsigned integer value (0-255) which is mapped to a greyscale output value where 0 is black and 255 is white.

The values top, bottom, left and right indicate those directions on the PROTEUS display window. No attempt is made to associate physical meaning to the values or locations in a browse image. For example 'top' does not indicate north.

11.3. Converting PICs to other scientific data formats

The PICTOOLS package is supplied with all EEC groundstation products. It contains utilities for converting PIC to other scientific data formats and is invoked by the main processing core when the setup demands output in other formats. The conversion functions can also be invoked from the command line, as detailed in the following sections.

11.3.1. PIC to HDF4/5

The pic2hdf command generates an HDF4 (Scientific Data – SD) or 5 format file. Each PIC data

channel is written as an HDF SD unsigned 8 or 16 bit variable (DFNT_UINT8 or DFNT_UINT16) with the following name:

<CHANNEL>_DATA

Each PIC calibration curve (lookup table / LUT) is written as an HDF SD floating point variable (DFNT_FLOAT32) with the following name:

<CHANNEL__LUT

The following global attributes are written

Name	Type	Description
MINLON	DFNT_FLOAT32	Minimum longitude
MAXLON	DFNT_FLOAT32	Maximum longitude
MINLAT	DFNT_FLOAT32	Minimum latitude
MAXLAT	DFNT_FLOAT32	Maximum latitude
DATA_MINLON	DFNT_FLOAT32	Minimum data longitude
DATA_MAXLON	DFNT_FLOAT32	Maximum data longitude
DATA_MINLAT	DFNT_FLOAT32	Minimum data latitude
DATA_MAXLAT	DFNT_FLOAT32	Maximum data latitude
RESOLUTION	DFNT_FLOAT32	Resolution
COVER	DFNT_FLOAT32	Coverage
NLON	DFNT_INT32	Number of longitude points
NLAT	DFNT_INT32	Number of latitude points
BPP	DFNT_INT32	Bytes per pixel (1 or 2)
DATETIME	DFNT_CHAR8	Date/Time: YYYYMMDDhhmm
SEPERATOR	DFNT_CHAR8	Internal Use
PRODUCT	DFNT_CHAR8	Product (e.g. L1B, SST)
SETUP	DFNT_CHAR8	Setup (Disk, Australia)
SATELLITE	DFNT_CHAR8	Short Satellite (e.g MTS, AQUA, TERRA)
NCHAN	DFNT_INT32	Number of channels
CHANNELS	DFNT_CHAR8	Channel Names (comma separated list)

11.3.1.1. Usage

```
Usage: pic2hdf -i PIC_FILE [-o HDF_FILE] [-8] [-b 0|1] [-h] [-v] -5
Converts a satellite image in PIC format to HDF (v4) format
       -i Input     PIC file (.pic)
Options:
       -o Output    File name for output HDF file
       -8           Convert 16 to 8 bit
       -b <0|1>     0: no byteswap, 1: byteswap (default)
       -v           Verbose output
       -h           Usage info
```

```
    -5          Generates HDF5 file
```

11.3.2. HDF4 to PIC

hdf2pic is used to convert a pic2hdf-converted HDF4 back to PIC again.

11.3.2.1. Usage

```
usage: hdf2pic -i <HDF4 file> [options]
Converts EEC HDF4 or Huayun FY2C HDF4 into EEC PIC files.
return: 0 upon success, 1 otherwise.

options:
  --version             show program's version number and exit
  -h, --help            show this help message and exit
  -iFILE, --file=FILE   HDF file to process into PIC
  --bswap=BYTESWAP      0: no byteswap, 1: byteswap (default)
  --verbose             Verbose output
  --huayun              Convert HDF4 from Huayun FY2C system rather than
                         EEC
                        format (supply --setup if using this option)
  --setup=SETUP         Process FILE using this setup (supply with --huayun
                        option only)
```

11.3.3. PIC to netCDF

The pic2netcdf command converts data in PIC format to NetCDF format. Each PIC data channel is written as a two dimensional variable, of type NC_BYTE (8 bite data) or NC_SHORT (16 bit data) with the following name

<CHANNEL>_DATA

Each PIC calibration curve (lookup table/LUT) is written as a one dimension variable of type NC_FLOAT, with the following name:

<CHANNEL>_LUT

The following global attributes are written:

Name	Type	Description
MINLON	NC_FLOAT	Minimum longitude
MAXLON	NC_FLOAT	Maximum longitude
MINLAT	NC_FLOAT	Minimum latitude
MAXLAT	NC_FLOAT	Maximum latitude
DATA_MINLON	NC_FLOAT	Minimum data longitude
DATA_MAXLON	NC_FLOAT	Maximum data longitude
DATA_MINLAT	NC_FLOAT	Minimum data latitude
DATA_MAXLAT	NC_FLOAT	Maximum data latitude
RESOLUTION	NC_FLOAT	Resolution

COVER	NC_FLOAT	Coverage
NLON	NC_INT	Number of longitude points
NLAT	NC_INT	Number of latitude points
BPP	NC_INT	Bytes per pixel (1 or 2)
NCHAN	NC_INT	Number of channels
DATETIME	TEXT	Date/Time: YYYYMMDDhhmm
SEPERATOR	TEXT	Internal Use
PRODUCT	TEXT	Product (e.g. L1B, SST)
SETUP	TEXT	Setup (Disk, Australia)
SATELLITE	TEXT	Short Satellite (e.g MTS, AQUA, TERRA)
CHANNELS	TEXT	Channel Names (comma separated list)

11.3.3.1. Usage

```
Usage: pic2netcdf -i PIC_FILE [-o NETCDF_FILE] [-b 0|1] [-h] [-v]
Converts a satellite image in PIC format to NETCDF format
       -i Input     PIC file (.pic)
Options:
       -o Output    File name for output NETCDF file
       -b <0|1>     0: no byteswap, 1: byteswap (default)
       -v           Verbose output
       -h           Usage info
```

11.3.4. netCDF to PIC

netcdf2pic converts a pic2netcdf-converted netCDF back to PIC again.

11.3.4.1. Usage

```
Usage: netcdf2pic -i NETCDF_FILE [-b 0|1] [-q] [-h] [-v] [-d]
Converts a satellite image in NETCDF format to PIC format
       -i Input     NetCDF file (.nc)
Options:
       -q           Query mode (print header info to stdout only)
       -b <0|1>     0: no byteswap, 1: byteswap (default)
       -d           Print debug
       -v           Verbose output
       -h           Usage info
```

11.3.5. PIC to GRIB

pic2grib converts a single channel from a PIC file to GRIB format. The cnvgrib command may be used to convert from Version 1 to Version 2. The wgrib command may be used to concatenate grib files together to create multi channel files.

11.3.5.1. Usage

```
Usage: pic2grib -i PIC_FILE [-o GRIB_FILE] [-c CHANNEL] [-h] [-v]
Converts a satellite image in PIC format to WMO GRIB (v1)
       -i Input     PIC file (.pic)
Options:
```

```
       -o Output    File name for output GRIB file
       -c Channel   Channel (default: 0)
       -l b|r       Force parameter (Brightness Temp | Reflectance)
       -v           Verbose output
       -h           Usage info
```

11.3.6. PIC to BUFR

pic2bufr converts each channel of the specified PIC into a BUFR file.

11.3.6.1. Usage

```
Usage: pic2bufr -i PIC_FILE -o BUFR_FILE
Converts a satellite image in PIC format to BUFR format
       -i Input     PIC file (.pic)
Options:
       -o Output    File name for output BUFR file
       -h           Usage info
       -b <n>       <n> is the WMO Block Number
       -s <n>       <n> is the WMO Station Number
       -t <n>       <n> is the Station Type Indicator
       -m <n>       <n> is the Master Table
       -c <n>       <n> is the Center Number
       -d <n>       <n> is the Sub-Center Number
       -e <n>       <n> is the Message Type
       -f <n>       <n> is the Message Subtype
       -g <n>       <n> is the Version of Master Table
       -j <n>       <n> is the Version of Local Table
```

11.3.7. PIC to ASCII

pic2ascii converts each channel of the specified PIC into an ASCII file.

11.3.7.1. Usage

```
Usage: pic2ascii -i PIC_FILE -o ASCII_FILE
Converts a satellite image in PIC format to ASCII format
       -i Input     PIC file (.pic)
Options:
       -o Output    File name for output ASCII file
       -h           Usage info
       -d           Dump PIC Header in ASCII files
       -t           Delimit ASCII values by a tab instead of comma
```

11.4. Converting PICs to other image formats

The program imageGen is used to convert PIC files into these image formats: BMP, JPG, PNG, TIFF, GIF, SVG, and GEOTIFF. It is invoked by the main processing core when the setup demands output in other formats and can also be called from the command line.

11.4.1.1. Usage

```
Usage: imageGen [-h] [-v] [-f <scale>] -p picfile
This program creates image products from a PIC file
```

```
using settings (e.g. formats, defaults) from the associated setup

options:
          -h              Print Usage
          -v              Verbose mode
          -f <scale>      Apply scale factor to TEXT annotations
```

11.4.2. NESDIS LAC/GAC to PIC

The saa2pic command provides the ability to convert archived L1B AVHRR data from the NOAA Polar-orbiting Operational Environmental Satellites (POES) to PIC format for Meteor display and analysis. This data is available from the US National Environmental Satellite, Data and Information Service (NESDIS) CLASS archive http://www.class.noaa.gov/nsaa/products/welcome

saa2pic supports 16 bit (unpacked) version 2 and version 3 (post 28/04/2005) LAC and GAC data sets from the NESDIS archive. Further information regarding NOAA L1B archive formats can be found in Section 8. of the NOAA KLM users guide http://www.class.noaa.gov/nsaa/products/welcome

11.4.2.1. Ancilliary data

The conversion process requires TBUS data (see algorithm description below), which is available via anonymous FTP from the University of Tokyo: ftp://ftp.tkl.iis.u-tokyo.ac.jp/pub/TBUS

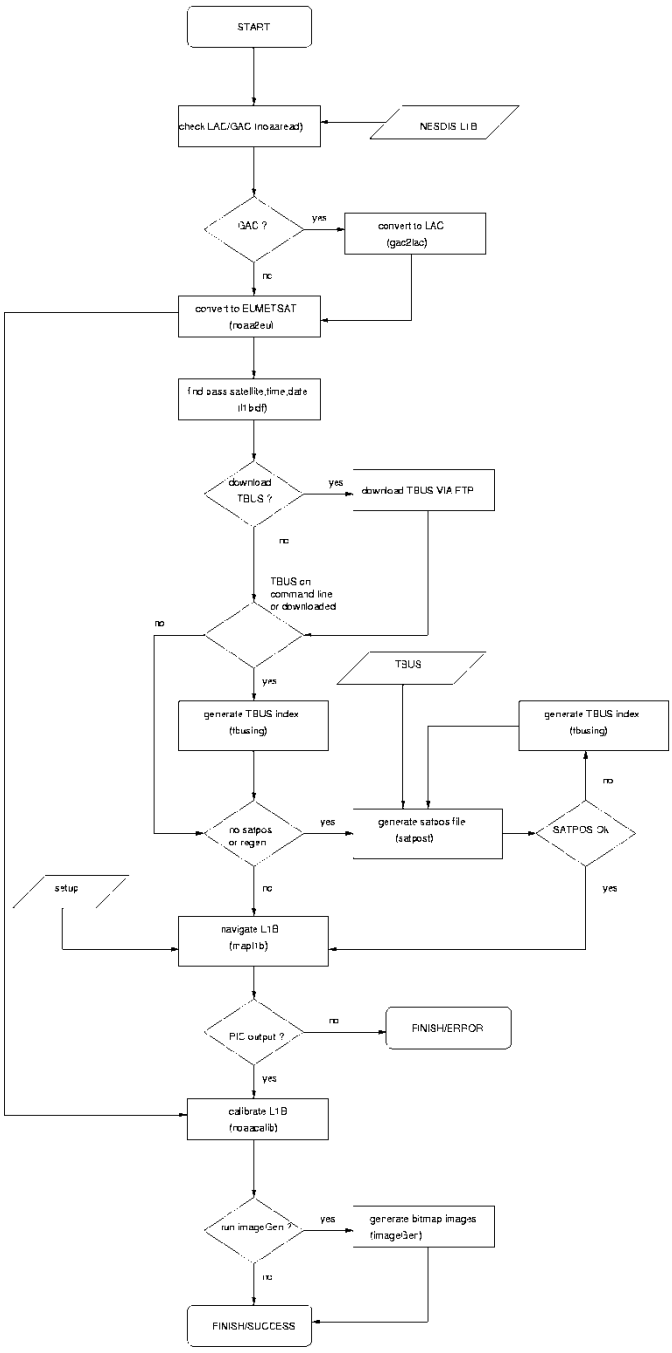
TBUS data corresponding to the satellite and pass date should be obtained from the above site, and copied to the following location /ess/data/satellite/ancillary/orbelems/tbus_db**/**YYYY**/**MMM/tbus_*.txt

where YYYY is a 4 digit year, MMM is 3 character month (Jan/Feb/…). The TBUS filename must have a prefix of tbus, and suffix .txt.

TBUS data may also be specified on the command line, in which case it will be copied to the correct location, or downloaded automatically from the FTP site above (see command line options below)

11.4.2.2. Conversion Algorithm

The saa2pic program coordinates several programs required for the conversion of NESDIS L1B GAC or LAC archive datasets to PIC format. The programs used and data flow is illustrated by the following flowchart.



11.4.2.3. Usage

To convert a NESDIS L1B LAC or GAC archive data set to PIC, first define a setup using setupManager which intersects the geographic region covered by the pass dataset.

```
Usage: /ess/bin/saa2pic -s Setup [options] file

Convert NESDIS/SAA/CLASS L1B archive image to PIC

Options:
        -d dir          : output directory [/ess/data/processed]
```

```
-t TBUS file    : TBUS (tracking) data file
-w              : download TBUS from WWW
                  [ftp://ftp.tkl.iis.u-tokyo.ac.jp/pub/TBUS]
-S              : force satpos update
-g 0|1          : disable/enable imageGen [enabled]
-h              : help
-v              : verbose
```

12. System installation

The GEOSAT500 is comprised of two software products: the GEOSAT500 (GEOS reception and processing), and SATKIT (base satellite utilities). The following sections detail the installation procedure.

In the following, the CD/DVD mount point is assumed to be `/media/cdrecorder`. Your system may mount to an alternative, such as `/mnt/cdrom`.

`Note: the timezone on all workstations is automatically set to UTC after each boot. Setting the clock to another timezone is not supported and may result in unexpected behaviour.`

12.1. Upgrading from a previous version

To upgrade the GEOSAT500 from a previous version, follow the instructions below. To install on a new machine without an OS, see section 7.2.

12.1.1. Install the GEOSAT500

As root:

1. Insert the GEOSAT500 system software CD. If the CD does not auto-mount, open a terminal and type `'mount /media/cdrecorder'`
2. `Type 'cd /media/cdrecorder'`
3. Enter the GEOSAT500 directory and type `'./install_geosat500'`. This will install/upgrade the GEOSAT500 and supporting SATKIT utilities.

12.1.1.1. Add local customisations to configuration files

The GEOSAT500 is packaged as RPMs. Usually, RPM can automatically merge local customisations into the latest version of configuration files. However, with major system upgrades where the content/format of the configuration file has changed, RPM may not be able to automatically merge in the local customisations.

If a configuration file is found which cannot be automatically updated, a warning is given during the installation/upgrade process. For example:

```
warning: /ess/config/disseminationList.txt saved as
/ess/config/disseminationList.txt.rpmsave
```

This means that the previous version of the file has been modified by the local site operators and these changes cannot be automatically merged into the latest version. For each configuration file that cannot be automatically updated by RPM:

1. determine the differences between the old version (<file>.rpmsave) and the new version of the configuration file. Linux tools such as ‘diff’ and ‘sdiff’ may be useful here
2. for any changes that local operators have made and you wish to keep, edit the new version of the file appropriately.

12.1.2. Define the role of the workstation

Identical software is installed on all GEOSAT500 machines and simple changes in configuration

files are used to turn the machine into an Acquisition Workstation, Data Processing Workstation, or Display Workstation. All configuration files have now been installed, so the role of the machine can now be defined.

As root:

1. Type `'/ess/bin/skSetRole'`
2. Select the required role: Acquisition Workstation (ingest only); Acquisition Workstation (ingest + processing); Data Processing Workstation; or Display Workstation.
3. Answer all configuration questions.
4. Reboot the machine.

12.1.2.1. Post-configuration

If this machine:

1. Has a NAS that should be kept in sync with another networked NAS, as the ess user:
    a. Edit the file `/ess/config/skConfig` and specify the name of the other NAS in SATKIT_NASSYNC_SOURCE and the mount point of the local NAS in SATKIT_NASSYNC_TARGET
    b. Uncomment the `'syncDir'` entry in `/ess/bin/rc.ess`
    c. Uncomment the `'syncDir'` entry in the crontab (use `'crontab -e'` to edit).
2. Is running McIDAS and the AODT package, then as the ess user edit the crontab (use `'crontab -e'` to edit) and:
    a. Comment the initial geosatDPS entry in the GEOSAT500: ALL MACHINES section
    b. Uncomment the McIDAS geosatDPS entry in the GEOSAT500: OTHER MACHINES section.
3. Is running PROTEUS and requires access to the AODT algorithm, as the ess user:
    a. Set SATKIT_SERVER to the name of the McIDAS workstation in `/ess/config/skConfig`
    b. Ensure this workstation can ssh to the McIDAS workstation (user ess) without being asked for a password. To setup password-less RHOSTS-RSA communication, for example, see section 3.5.5.

12.1.3. License the workstation

If upgrading from a very old version of the GEOSAT500, the EEC license may need to be re-issued.

1. Type `'skCheckLicense'`
2. If errors are reported, the license needs to be re-issued: follow the instructions in section □ i.

12.1.4. Restart machine

The upgrade is now complete. Reboot the computer, and the system will ingest and process MTSAT imagery at the next downlink. Note that the ingest processes run even when the computer is not logged into an account.

12.2. Installing on a new machine

Follow these instructions to install the OS and GEOSAT500 on a new machine.

It is assumed that all disks and RAID cards have been installed and properly configured. See the appendices otherwise.

12.2.1. Operating system installation

The system software runs under Redhat Enterprise WS 4 version 6, 32-bit x86 (RHEL4.6) or WS 6 version 1 32-bit x86 (RHEL6.1).

To simplify the installation and configuration of the OS, the system software includes a linux "kickstart" usbstick. The data on this usbstick is read during the installation of the OS and is used to automate disk partitioning, firewall configuration, package selection, and other major configuration steps. It also contains the RAID card driver, required during OS install.

To install the operating system, you will need:

1. RHEL DVD; and the
2. linux kickstart usbstick

12.2.1.1. BIOS configuration

1. Boot the PC and enter the BIOS configuration
2. Set the CDROM to be the first boot device
3. Under power management options, set the PC to switch on automatically after power is restored

12.2.1.2. OS installation

1. Insert the kickstart usbstick and remove all other peripherals apart from the keyboard, mouse, monitor, and network cable.
2. Insert the RHEL4.6 installation CD/DVD and reboot the PC. The machine will boot to the command prompt `'boot:'`
3. If the workstation has an Adaptec RAID card, at the prompt, type `'linux dd ks=hd:sdb:/ks.cfg'`. Otherwise type `'linux ks=hd:sdb:/ks.cfg'`
4. Installation and configuration of the operating system will then proceed automatically.
5. Components of the workstation (eg. networking, SCSI cards) may not have driver support built-in to the OS. All necessary drivers can be found on the EEC media in the SATKIT<version>/drivers subdirectory. If any of the following steps fail, you may need to install relevant drivers from this location.

12.2.1.3. OS configuration

Login to the root account and:

1. Ensure the network is properly configured: unless a DHCP and DNS server was found during OS installation, some configuration will be required.
    a. RHEL4.6
        i. Start the network tool with the `Applications>>System Settings>>Network` option.

ii. Click on the DNS tab and examine the hostname setting. If set to `'localhost'`, specify the desired hostname for the machine.

iii. Use the `File` menu to save the new configuration. Important: examine the file /etc/hosts and make sure the first line is similar to "`127.0.0.1 localhost.localdomain localhost <hostname>".` A bug in some versions of this network tool result in this line being deleted: add it back in if it's missing. If you had to make any changes to this file, run 'newaliases' afterwards.

b. RHEL6.1

i. Set the hostname by editing the file /etc/hosts. The hostname should be inserted at the end of the "127.0.0.1" line so it looks similar to: 127.0.0.1 localhost localhost.localdomain <hostname>"

c. Specify the appropriate network settings for the site using the network tool. The local network administrator should assist if necessary. Once configured, ensure the network is operating normally.

d. Exit from the network configuration tool.

e. Log out then back in to the 'root' account.

2. Configure the graphics display.

a. If using a dedicated NVIDIA graphics card, install the driver located on the EEC media:

i. Press CTRL-ALT-F1 to get a text prompt then login to the root account;

ii. Stop X with `'telinit 3'`

iii. `'cd /media/cdrecorder/SATKIT<version>/drivers/graphics'`

iv. Find the latest NVIDIA*.run package and install with `'sh <package>'` and follow the prompts to install the driver.

v. Start X with `'telinit 5'`

vi. Login as root and run the program `'nvidia-settings'` to set the resolution to that of the monitor. Save changes when done.

vii. Restart X with CTRL-ALT-BACKSPACE and verify the new resolution is set.

b. If using an adaptor other than NVIDIA, follow the instructions in the supplied manual.

c. If specific drivers are not available, the default VESA drivers may be suitable. Examine the screen resolution and colours using the `Applications>>System Settings>>Display` option. The resolution should be set to the native resolution of the monitor and the colours set to `'true-colour'` or `'millions of colours'.` If any modifications are necessary, press CRTL-ALT-BACKSPACE once complete to restart the X-server and verify the new resolution is set.

3. Set the system time.

a. RHEL4.6

i. Select Applications>>System Settings>>Date and Time

ii. If the machine **will not** use a time server, set the UTC date and time using

the Date and Time tab

iii. If the machine **will** use a time server, specify the server using the Network Time Protocol tab. An example internet time server is pool.ntp.org.

b. RHEL6.1

i. Select System>>Administration>>Date and Time

ii. If the machine **will not** use a time server, deselect the Synchronise date and time over the network option and set the UTC date and time

c. If the machine **will** use a time server, select the Synchronise date and time over the network option and specify the NTP server. An example internet time server is pool.ntp.org.

12.2.2. IDL installation

The EEC GEOSAT500 software uses the ITT IDL package for image management and analysis functions. To install IDL, login to the root account and:

1. Insert the IDL system software CD. If the CD does not auto-mount, open a terminal and type `'mount /media/cdrecorder'`
2. `'cd /media/cdrecorder'`
3. As root, type `'./xinstall.sh'`. This will start a graphical program to guide you through the product installation.
4. The program will first ask you to select packages. Choose:
   - IDL Program Files;
   - IDL Online Manuals;
   - High-resolution maps;
   - Linux OS
5. Press `Install` to proceed and follow all prompts:
   - Choose to create symbolic links when asked
   - When asked to create license information, select 'yes' and record the resultant information
   - Accept all other defaults

12.2.3. GEOSAT500 installation

Follow sections 7.1.1 – 7.1.3 to install and configure the GEOSAT500 software

12.2.4. Ingest configuration

The role of the workstation was defined in step 7.2.3. Skip this section if this machine is not an acquisition computer.

12.2.4.1. Satellite modes

The file `/ess/config/satingest.config` defines the satellites and transmissions to be received by the system: MTSAT-HRIT, MTSAT-LRIT, MTSAT-HiRID, and/or FY2C-SVISSR.

1. By default, MTSAT-HRIT and MTSAT-LRIT will be received. To change this, uncomment the appropriate satellites/transmissions in the section `'GOES configuration'.` The

modes selected will then be available from the Console Modes menu (see section 3.2.8).

2. If using a tracking antenna and receiving from more than one satellite, the antenna will have to be moved when reception modes are changed. Enter the appropriate antenna controller commands in the `ac_post_command` keyword for each selected mode.

12.2.4.2. Receiver configuration

When setting the role in section 7.2.3, the receiver model was selected. The file `/ess/config/satingest.config` sets various properties of this receiver and the defaults should now be checked.

If using a Quorum MetCom receiver:

1. Find the section `'QUORUM'` in the configuration file.
2. If powering the feed from the receiver, change `power_feed` to 1
3. Ensure local_oscillator is correct for your installation
4. If the default mode should be something other than mtsat-hrit, change the keyword `satellite_mode` to one of those defined in the previous section.

If using an ESS3000 receiver:

1. Find the section `'ESS3000'` in the configuration file.
2. Ensure data_addr is the IP of eth1 (see setup instructions in the GEOSAT500 Hardware manual).
3. If the default mode should be something other than mtsat-hrit, change the keyword `satellite_mode` to one of those defined in the previous section.

12.2.5. Dissemination configuration

Edit the file /ess/config/disseminationList.txt. If this is a data processing workstation:

- Find the section DEFAULT DISSEMINATION FOR DATA PROCESSING WORKSTATIONS and add the names of display workstations and acquisition workstations as prompted.

If this is a display workstation:

- Find the section DEFAULT DISSEMINATION FOR DISPLAY WORKSTATION and add the names of display workstations and data processing workstations as prompted.

12.2.6. Desktop configuration

For the 'ess' account and the 'frcaster' account:

1. Create a new application launcher for the desktop by right-clicking on the background and selecting `'Create launcher'`:
    - Set the name to `Console`
    - Set the command to `/ess/bin/skConsole.py`.
    - Set the icon to /ess/icons/essIconLogo.png
    - Once complete, stretch the icon to a suitable size
2. If this machine is not an Acquisition Workstation, create a new application launcher for the desktop by right-clicking on the background and selecting `'Create launcher'`:

- Set the name to PROTEUS
- Set the command to `/ess/meteor/bin/meteor`
- Set the icon to /ess/icons/essIconLogo.png
- Once complete, stretch the icon to a suitable size

3. Change the desktop background by right-clicking on the background and selecting `'Change desktop background'`:
   - Select `'Add wallpaper'`
   - Browse to the file `/ess/icons/GEOSAT500Background.tiff`
   - Follow the prompts to set this file as the new background

When complete, the desktop should appear as in Figure 10.

For the root account on machines with an Adaptec RAID card:

1. Create a new application launcher for the desktop by right-clicking on the background and selecting `'Create launcher'`:
   - Set the name to StorMan
   - Set the command to `/usr/StorMan/StorMan.sh`
   - Launch the application and:
     i. Use the File >> Preferences option to set audible alerts on with a 10-second pause between alerts;
     ii. Use the Configure >> local >> General settings option to enable event broadcasting and alarms, with a 5-second pause between alarms.
     iii. Use the Configure >> local >> Notifications option to configure a local administrator e-mail address for errors, warnings, and info.

12.2.7. Licensing

The machine must now be licensed. The license requires that eth0, eth1, or a bonded interface called bond0 is defined.

1. Run the command `/ess/bin/skGetHostId` and send the output text to EEC. A license file will be returned to you, together with installation instructions.
2. Send the IDL license information obtained in section 3 to EEC. A license file will be returned to you, together with installation instructions.
3. If necessary, create an account with Redhat and subscribe to the OS update service.

12.2.8. PROTEUS installation

If the EEC PROTEUS software is to be installed on the machine, follow the instructions at the back of the PROTEUS User and Installation Manual.

12.2.9. UPS driver installation

Drivers for APC UPSs are automatically installed with the GEOSAT500. To query the UPS, point a browser to http://<localhost>/cgi-bin/multimon.cgi.

If using another brand of UPS, install drivers as per your UPS manual.

12.2.10. Orbit configuration

Start the Orbit program from the Console's launch menu. Update the keplers when asked and, using the Setup tab, set the location of the groundstation and the satellites being received. Press the map tab and verify the satellite footprints are correctly shown. The radio horizon and groundstation location can be shown via the Options menu.

12.2.11. Restart machine

The installation is now complete. Reboot the computer, and the system will ingest and process MTSAT imagery at the next downlink. Note that the ingest processes run even when the computer is not logged into an account.

12.2.12. Configure printing

If required, configure a local or network printer using standard OS facilities.

12.3. Hostname changes

If the hostname of a workstation changes, the new name needs to be inserted into the IDL license file. To do this, edit the file /usr/local/itt/license/license.dat and replace the old hostname with the new name at the top of the file. Save the file and reboot.

The EEC license does not need to be changed.

APPENDIX A: AODT and CCOR documentation

APPENDIX B: Troubleshooting

The groundstation administrator should perform two simple tasks each day to verify normal operation:

- check the products web page (or use PROTEUS) to ensure new products are being generated from satellite transmissions
- check the logs on the GEOSAT500 workstations for any unusual warnings or errors

The following steps should be followed to diagnose system problems

1. Is the workstation producing an audible alert or is there a message on the screen describing a disk or RAID failure?

   Yes: → 13

   No: → 2

2. View the system logs on the workstation using the console. Are there any warnings or errors?

   Yes: Follow the instructions given in the logs to resolve the problem or → 12

   No: → 3

3. Are new satellite data files present in the level-0 directory?

   Yes: → 12

   No: → 4

4. Problem may lie in the front-end receiving equipment. If using an ESS300 receiver → 5. Otherwise, verify communication with the receiver by typing 'minicom' then type 'v'. Press return a few times. Does the output look similar to

   Current Input 0 Status

   S-85.9dBm

   V1.422volts

   F1698.000MHz

   O1565.000MHz

   I0

   P1

   C0

   D0

   HRPT

   UL

   Yes (system with tracking antenna): → 5

   Yes (system with fixed antenna): → 6

   No: Check serial cables to receiver and → 12 if problem persists

5. Verify communication with the antenna controller by typing 'minicom ttyS1' then type 'v'. Press return a few times. Does the output look similar to

   Q 03:29:27 az: 1 el: 899 ofs: 0 Inc: 9 00 PK -3068 0

OK

Yes: → 6

No: → 12

6. Note the signal strength on the front of the receiver. Is the value different to the value just after system installation? Or, when the RF cable is removed from the back of the receiver, does the value stay the same?

   Yes or no (system with tracking antenna): → 7

   Yes or no (system with fixed antenna): → 10

7. Is power being supplied to the antenna controller and power module?

   Yes: → 8

   No: → 12

8. Are any error conditions reported on the antenna controller LED panel?

   Yes: → 12

   No: → 9

9. Can the antenna be moved 0-180º in both axes? For azimuth, move the AZ mode switch to MANUAL. Then, whilst holding down the OVERRIDE button, turn the knob to both extents. Similar for the elevation axis. When done, switch both axis modes to AUTO.

   Yes: → 10

   No: → 12

10. Carefully examine all cables from the AWS to the antenna, including cable terminations. Is there any sign of damage?

    Yes: → 12

    No: → 11

11. Inspect the antenna, feed etc. Are any components loose or is any other obvious sign of damage, such as water ingress?

    Yes: → 12

    No: → 12

12. Contact satsupport@esands.com with full details of each troubleshooting step followed and the outputs of any commands issued. Also run the command /ess/bin/syscheck (as root) which creates a detailed status report of the machine in the file /home/ess/syscheck.<date>. Send this file along with your problem report.

13. One of the disks in the computer has failed. Each machine has two disks in a RAID 1 (mirrored) configuration: this allows operations to continue even when one disk fails, but the disk should be replaced as soon as possible.

    Workstation with linux OS: → 14

    Workstation with Windows OS: → 15

14. Log out of the ess account and into the root account. Start the StorMan program using the desktop icon. Press the events button to obtain the serial number of the failed disk.

    → 16

15. A notice will appear on the desktop alerting the operator. Press the notice. This starts the Intel Matrix Storage Manager software (which can also be started at any time from the Program menu). Use this software to note the serial number of the failed disk.

→ 16

16. Power-down the computer, find the disk matching the reported serial number, and remove it. Whilst a replacement disk is being obtained, the computer can be used normally.

    → 17

17. As soon as an identically-sized replacement disk is obtained, install the drive into the computer and restart. The drive will be automatically added into the RAID 1 array: this will take several hours, during which time the computer can be used normally.

APPENDIX C: EonStor NAS configuration and management

Introduction

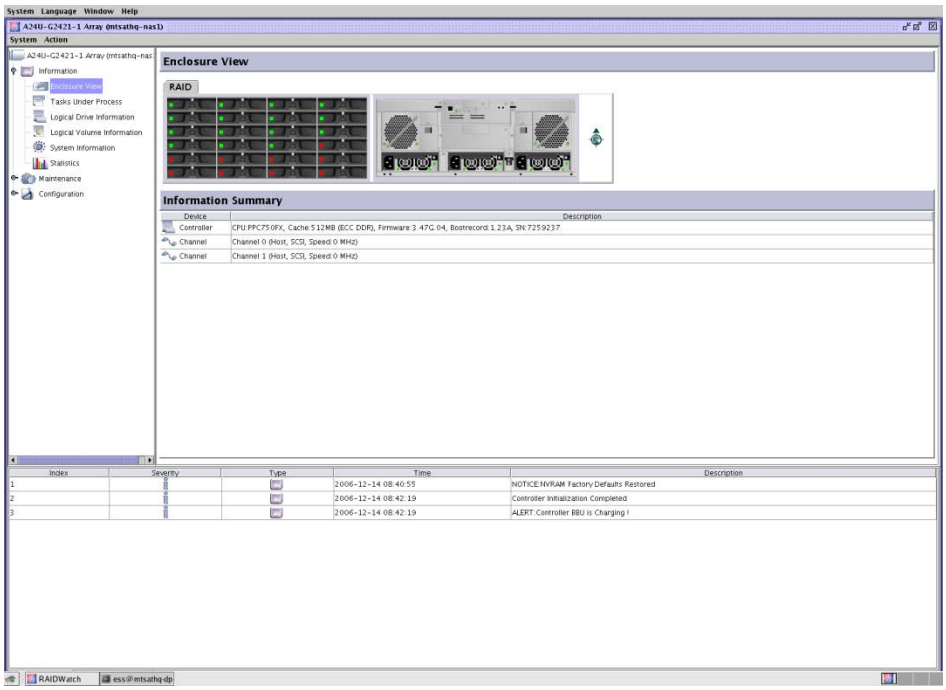
As an option, the system can be supplied with an Infortrend EonStor NAS unit. This appendix describes the management of the unit and the configuration steps required to construct a NAS array using the Infortrend EonStor 4U SATA II to SCSI RAID unit (http://www.infortrend.com/main/2_product/es_a24u-g2421.asp) together with RedHat Enterprise Linux Workstation 4 (update 6)

The A24U-G2421 is a 4U 24 bay SATAII RAID enclosure with dual SCSI 320 host interfaces. Onboard cache memory is 512 MB by default, upgradable to 2GB.

Management Software

The A24U-G2421 can be configured using the front panel LCD, by serial interface or via the RAIDwatch management software operating over the network management port. By default the unit is configured to use DHCP to obtain a network address. To obtain the network address connect the unit to a network containing a DHCP server and power on. The IP address assigned via DHCP may then be obtained from the LCD panel configuration menu.

The RAIDwatch software ((/usr/local/Infortrend Inc/RAID GUI Tools/raidwatch.sh) is pre-installed on the host server and can be started via the icon on root's desktop. By default, there is no password on the NAS administration and configuration accounts but this is changed to the standard root password given at the back of this document. See the Infortrend documentation supplied with the unit for full details of NAS management.



The NAS is pre-configured as a RAID 5 array and the OS on the host server configured to allow the array to be access via the /nas mount point. The following sections detail this configuration.

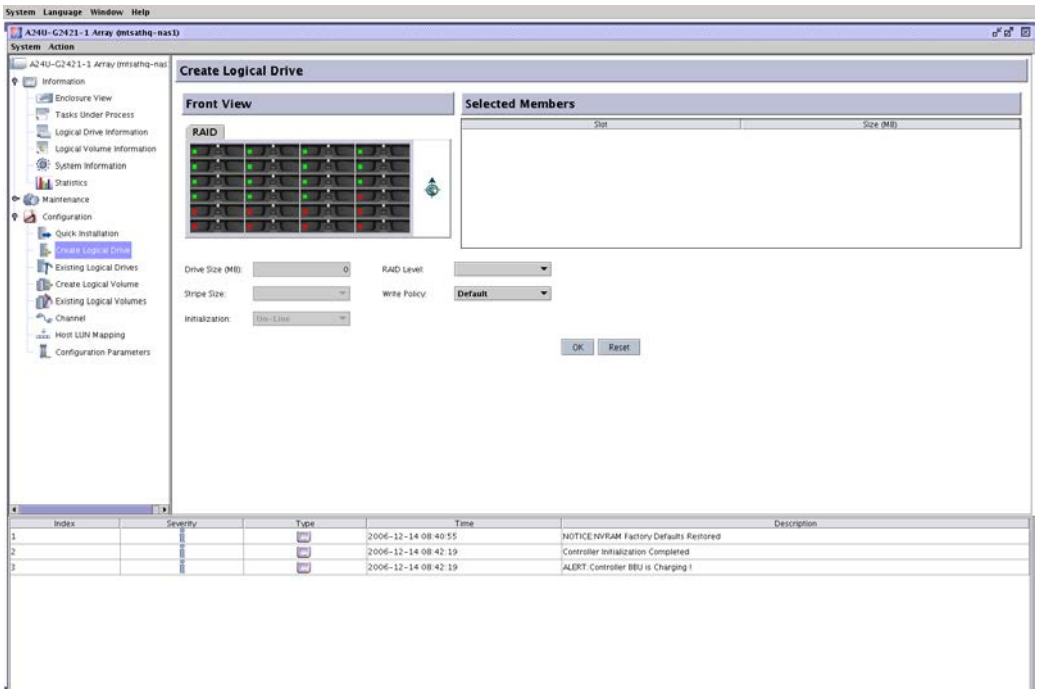
NAS configuration

In this document we assume the device has been populated with 18 x 1TB drives. The aim is to present as much of the raw storage as possible to the host operating system. Since there is a 2GB limit on partition size in the default RHEL4.5 Linux kernel, storage is broken up into 2TB LUNS, and the Logical Volume Manager (LVM) is used to stitch together LUN's to create the final raw device. The ext3 or XFS journaling filesystems are used to present the storage to applications and optionally to the network using NFS or CIFS. XFS is a 64 bit filesystem and has proved to be reliable and fast under RHEL4 with filesystems up to 16TB. The limit on ext3 filesystems is 8TB, with a 4096 block size.

Physical connections

Connect the "channel-0 in" port at the back of the NAS unit to the SCSI card on the host using the supplied cable.

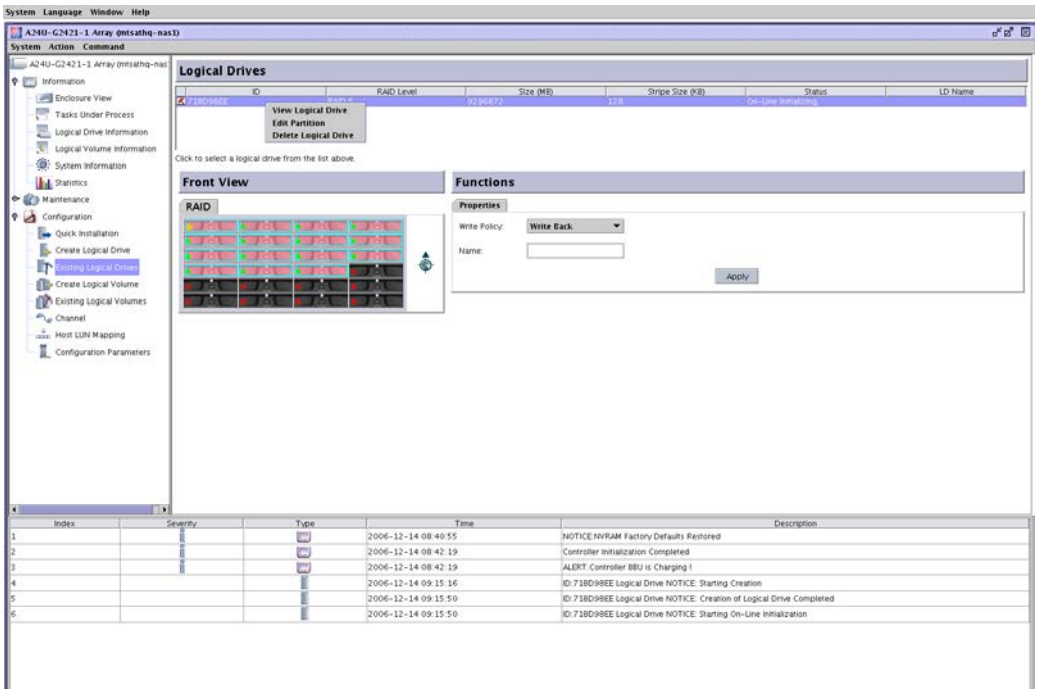
Create a Logical Drive



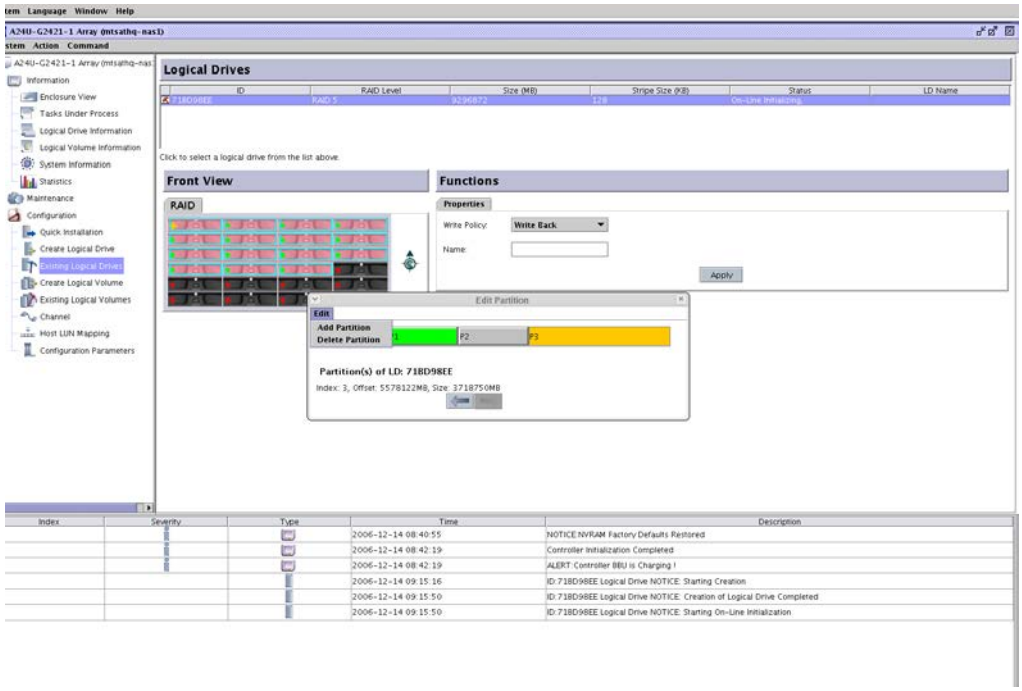
A logical drive groups together physical disks into a RAID set. To create a logical drive select Configuration->Create Logical Drive. Select the RAID level, Write Policy and number of spare drives. To maximize the available space, use RAID 5 with 1 spare. The Write Policy should be set to write through unless a Battery Backup Unit (BBU) is present. Without a BBU, data corruption may occur on power loss.

Create Partitions

A partition is a subset of a logical drive created in the previous step. To create partitions, select Configuration->Existing Logical Drives. The top panel shows a line for each logical drive. Right click on the tool icon on the left hand side, then select Edit Partitions



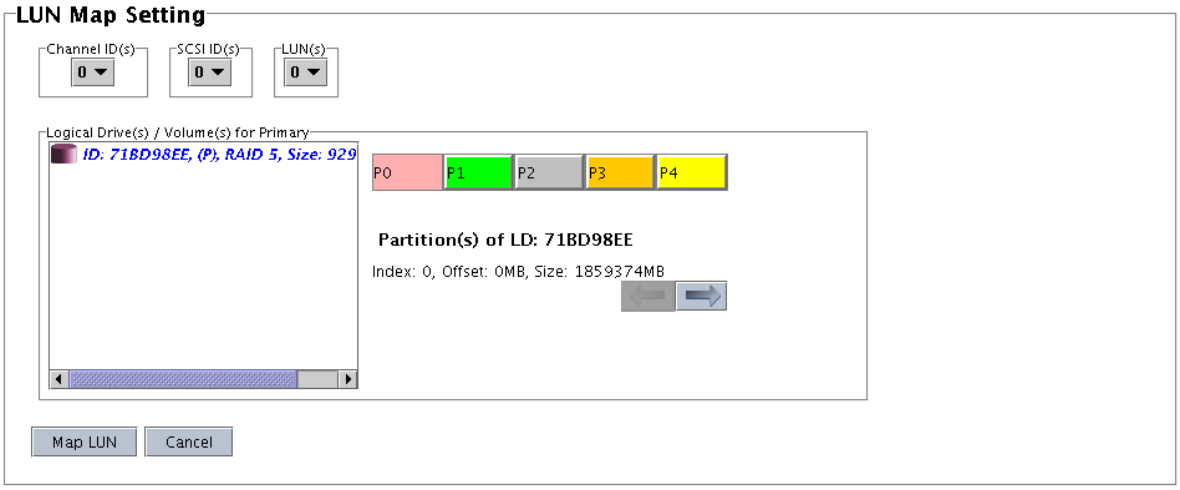
.



Now select Edit->Add Partition. A suggested size is 1907218 MB. Continue to create partitions until the entire logical drive is assigned.

Create LUNs

LUNS are the interface to the host operating system and are used to present the partitions created in the previous step. To create LUNs, select Configuration->Host LUN Mapping. Right click and select Add LUN MAP.



Each partition should be mapped to controller 0, SCSI ID 0, and a unique LUN number. If the host contains a dual port SCSI controller, it may increase performance to alternate controllers between LUN's.

Change password

In RAIDwatch, use the communication parameter settings to change the password for 'configuration' and 'management' to the root password found at the back of this document.

Host configuration

Once LUN's have been mapped, the host should be rebooted.

RAID BIOS configuration

Enter the RAID BIOS, select "Configure/view SCSI controller settings" then "SCSI device configuration" and change the speed of SCSI id 0 and 7 (the card itself) to U160. Reboot

Check partitions

The partition table will contain entries as follows:

```
[ess@poes-aws ~]$ cat /proc/partitions
major minor  #blocks  name

   8     0 1952991232 sda
   8    16 1952991232 sdb
   8    32 1952991232 sdc
   8    48 1952991232 sdd
   8    64 1952991232 sde
   8    80 1952991232 sdf
```

```
   8    96 1952991232 sdg
   8   112 1952991232 sdh
   8   128  312498944 sdi
   8   129     104391 sdi1
   8   130   20482875 sdi2
   8   131   20482875 sdi3
   8   132          1 sdi4
   8   133   10241406 sdi5
   8   134   10241406 sdi6
   8   135    5116671 sdi7
   8   136    2048256 sdi8
   8   137  243778311 sdi9
 253     0 15623913472 dm-0
```

Note that the devices start at sda. The host operating system must be installed prior to connecting/configuring the RAID – filesystem labels will then ensure that the correct devices are mounted for the system volumes.

Create Physical Volumes

Use the pvcreate command to initial LUNs for use by LVM. In the current configuration, we have 8 devices: /dev/sd[a-h], each 2TB (of the original 18TB, we have 1 TB consumed for RAID5 overhead, and 1 TB for the spare)

```
pvcreate /dev/sdc /dev/sdd /dev/sde /dev/sdf /dev/sdg /dev/sdh
```

The pvdisplay command can then be used to show the newly created physical volumes.

Create Volume Group

```
vgcreate PAK_Server1_NAS /dev/sda /dev/sdb /dev/sdc /dev/sdd /dev/sde
/dev/sdf /dev/sdg /dev/sdh
```

The vgdisplay command can be used to show the newly created volume groups.

Create Logical Volume

```
lvcreate -L 15T PAK_Server1_NAS
```

This command will create the logical volume, which may be accessed under **/dev/PAK_Server1_NAS/lvol0**

The lvdisplay command may be used to show the newly created logical volume.

```
[root@poes-aws ~]# lvdisplay
  --- Logical volume ---
  LV Name                /dev/PAK_Server1_NAS/lvol0
  VG Name                PAK_Server1_NAS
  LV UUID                Y0QnPe-Rlm0-452j-qgfS-G6rW-X9RX-2Nqzu3
```

```
LV Write Access         read/write
LV Status               available
# open                  1
LV Size                 14.55 TB
Current LE              3814432
Segments                1
Allocation              inherit
Read ahead sectors      0
Block device            253:0
```

Create a filesystem

The maximum ext3 filesystem size on 32-bit platforms is 8TB with a 4096 block size. To create an ext3 filesystem, use '`mkfs.ext3 –L NAS -b 4096 /dev/PAK_Server1_NAS/lvol0'`. The ext3 volume may then be mounted and added to /etc/fstab with an entry such as

```
LABEL=NAS /nas ext3 defaults 1 2
```

To create filesystems up to 16TB, use the XFS filesystem. In order to create an XFS filesystem using RHEL4.6, the kernel must be modified to include XFS support. Once configured, the xfsprogs RPM (2.6.13-3.2 has been tested) should be installed. This package includes mkfs.xfs. To create a filesystem, run mkfs in the usual way

```
mkfs.xfs /dev/PAK_Server1_NAS/lvol0
```

The XFS volume may then be mounted and added to /etc/fstab.

APPENDIX C: Disk and RAID card configuration

EEC workstations may be supplied with an Adaptec RAID card and a minimum of two disks in a RAID 1 array. The disks and array will be preconfigured. The procedure involved in this initial configuration is:

1. Physically install the disks and RAID card and connect;
2. Boot the machine and enter the RAID BIOS. Follow the prompts and:
    a. Create a single RAID 1 array containing all disks;
    b. Mark the array as bootable;
    c. Disable the write cache (ie. set the array to write through);
    d. Assign the label ‘ess’ to the array;
    e. Select ‘build’
    f. Exit from the RAID BIOS. Warnings that that array build will be cancelled can be ignored, as the OS install can proceed as the build is progressing
3. Boot and enter the main system BIOS:
    a. Some BIOSs will halt the boot if an enabled SATA port isn’t connected to anything. So disbale all SATA ports that aren’t connected to disks/DVDs. So if all disks are connected to the RAID card, disabled all of them bar the one used for the DVD;
    b. Change the boot order to (1) DVD then (2) RAID array.
    c. Save and exit
4. Boot, and confirm one logical array is found and the boot continues as expected.

APPENDIX D: Creation of driver disk/kickstart usbstick

EEC workstations may be supplied with a usbstick containing the operating system kickstart (which configures the OS automatically during installation) and any drivers required during installation. The EEC media distribution contains all data necessary to recreate this usbstick should the original become lost. The procedure is:

1. Format the usbstick as FAT32 using Windows or suitable linux commands;
2. The RAID card driver is required during the OS install. An image of the “driver disk” needs to be placed onto the usbstick:
    a. Enter the SATKIT/drivers/raid directory on the EEC media and navigate into the directory corresponding to your RAID card;
    b. This directory contains RAID driver disk images for RHEL4.6, both 32- and 64-bit. Identify the appropriate 32-bit driver image (.img extension)
    c. Insert the usbstick and determine its device name
    d. Run the command ‘dd if=<driver image>.img <usbstick device>’
3. Mount the usbstick and copy the OS kickstart onto it using standard linux commands. The kickstart file is called ‘ks.cfg’ and is found in the product directory on the EEC media. For example, if this is a GEOSAT500 system, the kickstart is in the directory GEOSAT500<version> on the media.
4. Unmount the usbstick.

APPENDIX E: System passwords

All GEOSAT500 machines are configured with three user accounts with the following passwords:

1. User ‘ess’, password ‘essess’
2. User ‘frcaster’, password ‘frcaster’
3. User ‘root’, password ‘*mtsat!’

Appendix F: INTERNET ACCESS TO COMS1 DATA

GEOSAT500v2.0 and METEORv3.32 incorporates COMS1 internet access capability. This service is provided by KMA in the form of an FTP server which hosts the COMS1 data.

The configuration is shown in the figure 45 below.

The AWS downloads COMS-1 compressed HRIT level-1b data from an ftp server and sends the data to the DPS. The DPS decompresses the data and sends the processed data to display machines.

In order to incorporate COMS1 reception in the same way as other satellites are received (ie thru a local antenna), the configuration for COMS1 reception is via an AWS, in keeping with the standard EEC architecture.

This keeps standard commonality across reception hardware, regardless of whether the data is received through a local antenna or through the Internet.

Setting up COMS1

There are three main configuration files on the receiving computer associated with the reception of COMS1 data into the system via the Internet:

`/ess/config/dataservices.geosat500`

`/ess/config/geosatconfig`

`/ess/config/satelliteSubpoints`

/ess/config/dataservices.geosat500

This file is used to define the location from which the data is collected by setting the variable COMS_FTP_URL.

The variable contains the location and password of the user's account with KMA.

The variable is of the form

ftp://pppppp:wwwwww@ftp.sine.weather.gov.hk/COMS

Where

`pppppp is the sites user name and wwwwww is the sites password`

For example,

`ftp://comsat:8ew23kjn@ftp.sine.weather.gov.hk/COMS`

is a typical COMS_FTP_URL variable for user name:comsat, password: 8ew23kjn

The location of the parameter defining the ftp source of the COMS1 data is in the above file

Default is

COMS_FTP_URL="ftp://comsat:8ew23kjn@ftp.sine.weather.gov.hk/COMS"

The URL can be changed to point to a different ftp source.

/ess/config/geosatConfig

This file contains a number of file locations and other parameters required for COMS1 reception.

Paths

Paths - COMS

```
export GEOSAT_RAW_COMS=${GEOSAT_HOME}/data/satellite/coms/lrithrit/raw
export GEOSAT_LEVEL0_COMS=${GEOSAT_HOME}/data/satellite/coms/lrithrit/level0
export GEOSAT_INCOMING_COMS=${GEOSAT_LEVEL0_COMS}/incoming
export GEOSAT_INCOMINGNEW_COMS=${GEOSAT_INCOMING_COMS}/new
export GEOSAT_LEVEL1B_COMS=${GEOSAT_HOME}/data/satellite/coms/lrithrit/level1b
export GEOSAT_WORKING_COMS=${GEOSAT_LEVEL1B_COMS}/intermediate
```

Download

Download URL as defined in the file /ess/config/dataservices.geosat500

```
export COMS_FTP_URL=${COMS_FTP_URL}
```

The download service will download historical data up to this number of hours prior to the current hour.

```
export COMS_BACK_DOWNLOAD_HOUR=1
```

Set this variable to only download full disks from COMS FTP server

```
export COMS_DOWNLOAD_ONLY_FULLDISK=False
```

MANAM

Used to identify and write spacecraft bulletins and MANAMs

```
export GEOSAT_MANAM_ID_COMS="COMS HRIT MANAM"
export GEOSAT_BULLETIN_COMS=${GEOSAT_LEVEL1B_COMS}/latestMtsatBulletin.txt
```

HRIT sector IDs

Ids of all COMS L/HRIT sectors that can be segmented (transmitted in separate sections).

Modify the variable if KMA introduces new segmented sectors.

COMS has 8 full disk ID from FD_01 to FD_08, and 80 ENH ID from ENH_01 to ENH_80. It is too long to list them here. So it is defined as a range and the whole list will be reset at geosatSatellites.ComsXrit.classifyLevel1b()

export GEOSAT_COMS_SEGMENTED_SECTOR_IDS={\"FD\":\(1,8\),\"ENH\":\(1,80\)\}

Latitude and longitude ranges of the COMS sectors

These variables are modified if KMA introduces new sectors. The format of these entries are: "<sector>":(<num segments>,<min lat>,<max lat>,<min long>,<max long>)

Note: FD_01 and ENH_01 are COMS sectors; others are MTSAT sectors

```
export GEOSAT_SECTOR_RANGES={\
\"DK01\":\(10,-80,80,60,220\),\
\"FD_01\":\(10,-80,80,48,208\),\
```

```
\"ENH_01\":\(4,-10,65,58,198\),\
\"DK02\":\(5,0,80,60,220\),\
\"DK03\":\(5,-80,0,60,220\),\
\"PS01\":\(1,7,59,83,167\),\
\"PS02\":\(1,30,48,124,151\),\
\"PS03\":\(1,20,38,115,136\),\
\"SF01\":\(1,-80,80,60,220\)\}
```

/ess/config/satelliteSubpoints

This file lists the sub satellite point for each geostationary satellite received by the system.

It is the longitude of the point on the earth directly below the satellite.

```
MTL = 140
MTH = 140
MTS = 140
GMS = 140
G09 = 155
F2C = 105
COM = 128
```

Sending data from AWS to DPS

COMS1 data is stored on the AWS as level1 files, in a similar way to other data files which are received by a local antenna.

The script file *GeosatGetCOMS.py* checks for new files every 5 minutes, and transfers the data across to the /ess…./incoming directory on the DPS. From there it is processed in the same way as other raw files into higher level products, and stored in the ../processed directory.

Refer to Figures 52 or 53.

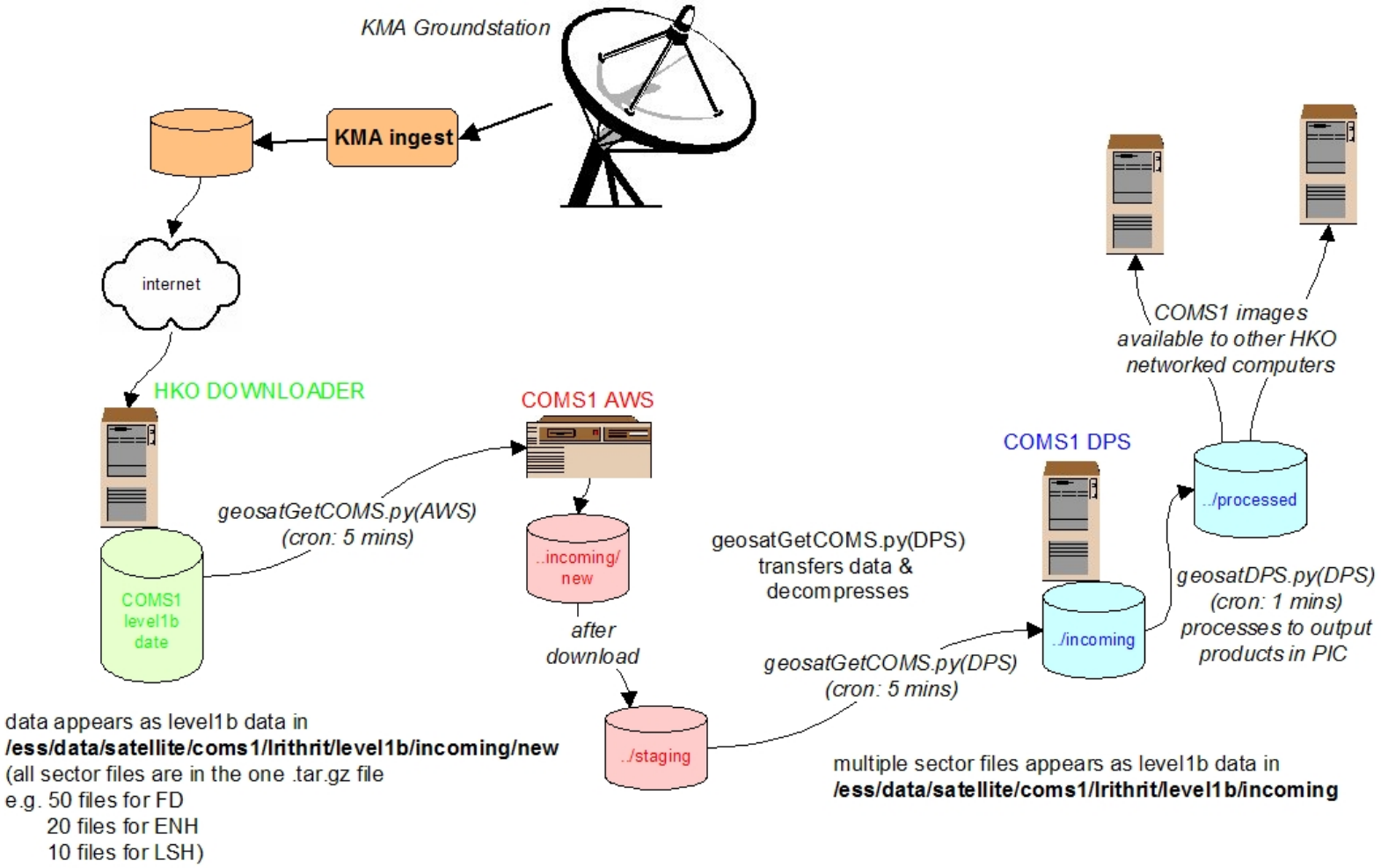


Figure 70 COMS1 Internet feed via local server

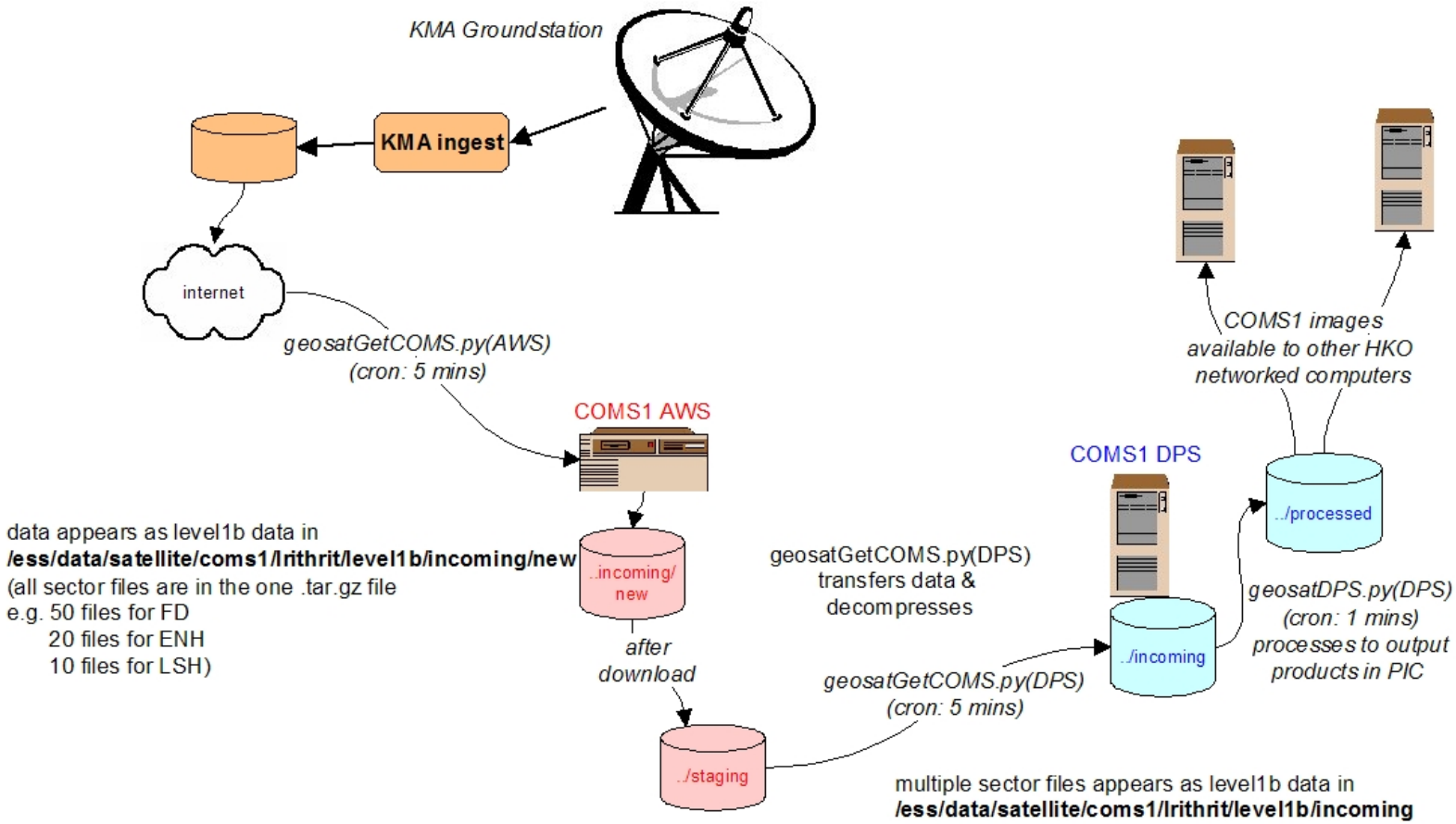


Figure 71 COMS1 Internet feed direct from KMA

Appendix G: REVISION HISTORY

Rev	Date	Pages	Description	Author
1.3-4	17/7/06	64	1. Added this table 2. Added instructions to enable wu-ftp 3. Documented configuration of GEOSAT_DPS for Display Workstations	CS
1.3.1.1-1	10/10/06	65	Documentation for v1.3.1.1	CS
1.3.1.1-2	22/11/06	65	1. Improvements to installation instructions 2. Added ESS3000E details in main body.	CS
1.3.1.2-1	22/11/06	66	Details of new mode-changing functionality to main body and installation instructions.	CS
1.4-1	8/3/07	89	Review and modification in accordance with GEOSAT500 v1.4 developments.	CS
1.4-2	18/4/07	89	Modifications to installation instructions	CS
1.4-3	30/4/07	89	Modifications to installation instructions	CS
1.4.3-1	9/7/07	93	Review and modification in accordance with GEOSAT500 v1.4.3 developments.	CS
1.5-1	8/8/07	97	Review and modification in accordance with GEOSAT500 v1.5 developments.	CS
1.5-2	20/8/07	97	Improvements to installation instructions	CS
1.5-3	3/10/07	44,54	Spelling. Replaced D'vorak with Dvorak	TK
1.6-1	1/11/07	97	1. Added SATKIT details 2. Upper tropospheric humidity product 3. Fire product	CS
1.6-2	16/1/08	98	Updated installation instructions	CS
1.6-3	18/1/08	102	New system diagrams and minor updates	CS
1.6-4	31/1/08	102	Minor update to fire algorithm description	CS
1.7-1	9/4/08	103	Updates for v1.7	CS
1.7-2	10/4/08	103	Added description of –wait dissemination option	CS
1.7-3	14/4/08	105	Added troubleshooting guide	CS
1.7.1-1	5/11/08	102	Restructuring and details of new version	CS
1.7.1-3	17/11/08	105	Details of new version	CS
1.7.1-4	1/12/08	105	Minor formatting and NAS details	CS
1.7.2-2	28/1/09	110	Details of new version	CS
1.7.3-1	15/9/09	112	Updates for new version	CS

1.7.3-2	16/2/10	112	Added new appendices describing RAID array and usbstick creation, and modified install instructions to describe usbsticks instead of floppies.	CS
1.7.3-3	8/6/10	116	Updates for new SATKIT version	CS
1.7.3-5	14/12/10	117	More details on RAID card configuration	CS
1.7.3-6	17/12/10	118	Updated section on Infortrend NAS configuration	CS
1.9.2-1	26/7/13	120	Updates for new version	CS
1.9.2-2	29/8/13	19-22, 119	Add COMS1 information, and the ability of processing COMS-1 data downloaded from KMA ftp server	GQ
2.0-1	10/10/14	119	Change above 1.9.2 to 2.0-1 because the version number 19.2 isn't correct. No other changes.	WY
2.2-1	10/10/14	121	Add the ability of processing COMS-1 data from direct broadcast	WY
2.5-1	26/08/15	123	Updates for Himawari-8 and 9	WY
2.5-2	1/4/16	128	Documentation of new level-2 algorithms	HS
2.5-3	6/5/16	128	Formatting and minor corrections	CS
2.5-4	16/5/16	128	skSetRole updates	CS
2.11-1	30/07/17	128	Change the document version number as 2.11-1 in accordance with GEOSAT500 software Updates for GOES-13/14/15 and GOES-16 Updates for GEOCAT Level-2 products	WY