SUBJECT: **GGSPS Products User Guide**

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This document will also be available from the GGSPS web site to registered users of the GERB data.

CHANGE RECORD

Issue	Date	Pages/Sect	Reason for change
3	08-Dec-2006		Initial version available to authorised users. To coincide with release of Edition 1 Level 1.5 NANRG products.

Table of Contents

1. INTRODUCTION

1.1 Purpose

The purpose of this document is to provide a detailed description of the data products available from the archive of the GERB Ground Segment Processing System (GGSPS), including how to access these products and how to read them.

Issue 2 of this document is being generated to coincide with the Edition 1 release of the MSG-1 GERB-2 data.

1.2 Scope

This document is intended for authorised users wishing to read GGSPS science products. The document is intended to provide enough information for an authorised user to access, read, understand and use the GGSPS science products stored in the GGSPS archive, without having to resort to more technical documentation in the GERB document archive. It is assumed, however, that this guide will be used in conjunction with information available on the GGSPS web site (including the relevant quality summaries), the RMIB web site, and information on HDF and IDL available on the HDF Group and ITT Visual Information Solutions web sites respectively.

1.3 References

1.3.1 Applicable documents

This User Guide is intended to be, as far as possible, a standalone document. However, users of the L15_GEO and level 2 unfiltered radiance and flux products will need to consult the RMIB User Guide [AD 1]. Users of any given product type must consult the relevant quality summaries [AD 2], [AD 3].

Document Number.	Document Title	Date	Issue	AD number
MSG-RMIB-GE-UG	L2 RMIB GERB Products User Guide	08-Jun-2006	2.1	1
-	QUALITY SUMMARY: GERB L2 ARG: 3 scan average Edition 1 product	23-May-2006	-	2
-	QUALITY SUMMARY: GERB L1.5 NANRG: filtered radiance Edition 1 product	TBD	-	3

1.4 Acronyms and abbreviations

AD	Applicable Document
AO	Announcement of Opportunity
API	Application Program Interface
ARG	Averaged, Rectified and Geolocated
BADC	British Atmospheric Data Centre
BARG	Binned Averaged Rectified Geolocated
BB	Black body

BDRF	Bi directional reflectance function
CCSDS	Consultative Committee for Space Data Systems
CDS	CCSDS Day Segmented Time Code
CUC	CCSDS Unsegmented time code
EFRF	Earth fixed (reference) frame
EGSE	Electronic Ground Support Equipment
EP	Engineering Product
ER	Engineering Report
ERB	Earth Radiation Budget
ESA	European Space Agency
ET	Long term engineering trend data file
EUMETSAT	EUropean organisation for the exploitation of METeorological SATellites
EV	Earth View
GERB	Geostationary Earth Radiation Budget
GGSPS	GERB Ground Segment Processing System
GIST	GERB International Science Team
GL0	GERB Level 0 product
GOT	GERB Operations Team (based at Imperial)
HDF	Hierarchical Data Format
HRIT	High Rate Information Transmission
h/k	House keeping
ICD	Interface Control Document
IFR	Instantaneous Filtered Radiance
IS	Integrating sphere (calibration monitor)
LOS	Line of sight
LRIT	Low Rate Information Transmission
LW	Long Wave
MCC	Mission Control Centre
MSG	Meteosat Second Generation
NANRG	Not Averaged, Not Rectified, Geolocated
NCSA	National Center for Supercomputer Applications
NERC	Natural Environment Research Council
nrt	near real time
PSF	Point Spread Function
RAL	Rutherford Appleton Laboratory
RD	Reference Document
RGP	RMIB GERB Processing System
ROLSS	RMIB On Line Short term Services
RMIB	Royal Meteorological Institute of Belgium
SEVIRI	Spinning Enhanced Visible and Infra Red Imager
SHI	Snapshot High resolution Image (type of Level 2 Flux Product)
SOL	Start Of Line
SW	Short Wave
TBC	To Be Confirmed
TBD	To Be Determined
TOA	Top Of Atmosphere
URD	User Requirements Document
wrt	with respect to
WWW	World Wide Web

1.5 Definition of terms.

Not all these terms may appear in this document.

Authorised Users (See also "Users")
Authorised users of the GGSPS. In order to become an Authorised user, users will be required to register with the GERB project scientist (on behalf of NERC and/or EUMESTAT). Once the registration has been approved the user will be able to perform catalogue searches, and request and obtain products from the GGSPS, and will be given username and password details, from which they will be able to gain access to Edition products.

calibration
The processing of GERB in-flight and ground data to derive the gain and offset values which may then be applied to the digitised pixel counts to convert the pixel counts to filtered radiances.

CGI
The Common Gateway Interface allows a WWW Server to pass information supplied by a WWW viewer to a system routine, and allows that routine to pass information back to the viewer

complete Earth scan
A collection of GERB data which together contains all pixel data (Earth view, deep space, calibration black body target, and diffuse calibration source), housekeeping and auxiliary data for complete views of the Earth, for both the TOTAL and SW channels.

Earth fixed frame
A Cartesian frame of reference having 3 axes (X, Y and Z), and whose origin is at the centre of the Earth. The Z axis is parallel to the axis of Earth rotation, the X axis is in the plane containing 0° longitude (the Greenwich meridian). The Y axis completes the right hand set.

Earth scan
(Or single Earth scan) - as for **complete Earth scan** but for a single channel only; either TOTAL or SW, but not both.

"Edition" data
Validated products released to the public from the GERB archive, and with an assessment of quality and documentation to support their pedigree. A data product is only considered part of the "Edition" data set if it is both included in the climate archive and bears the name Edition (denoted by "EDnn" in the product filename, e.g. "ED01" for Edition 1).

geolocation, **geolocate,** or **geolocated**
The allocation of a pair of geographical co-ordinates to each Earth view pixel.

ground segment
The data processing centres and the activities involved in all aspects of processing (GERB) data from receipt of the data on the ground, through to the preparation of products prior to scientific analysis. The ground segment also includes instrument performance monitoring and related commanding of the instrument.

Level 0 Raw GERB data packets grouped into products containing single Earth scans.

Level 1.5 (or **L1.5**) GERB data products containing geometrically corrected filtered radiances.

Level 2 (or **L2**) GERB unfiltered radiance and flux products.

Local solar vector
Unit vector starting at the reference ellipsoid, pointing towards Sun (centre). (Also defined during night time, pointing goes through the Earth in this case) for flux determination.

Local vertical vector
The unit vector starting at the reference ellipsoid, and perpendicular to the ellipsoid at that point.

Local viewing vector
Unit vector starting at the reference ellipsoid, pointing towards GERB instrument.

Near Real Time (NRT) products.
Products available from RMIB that are processed with the same version of the software as released products are considered Near Real Time (NRT) products until they have passed quality assurance and been included in the Edition archive as part of the Edition dataset.

Pre-release GERB data
All products processed with versions of the software for which there are no corresponding Edition products are considered **pre-release GERB data**.

raw GERB data.
Unprocessed data from GERB as supplied to the GGSPS by Eumetsat, consisting of Earth view and deep space pixel data, black body and diffuse calibration monitor pixel data, house keeping data, auxiliary data, plus all additional header data, clock information and check sum.

Relative azimuth angle
The azimuth angle between the local viewing vector and the solar beam (which is opposite in direction to the local solar vector). It is the angle between the "viewing zenith plane" (the plane containing the local vertical and the local viewing vectors) and the "solar zenith plane" (the plane containing the local vertical and the local solar vectors), defined to lie in the range 0°-180° depending on the relative directions of the local viewing vector and solar beam.

rectification or **rectified**
The process of interpolating data from the actual known pixel positions to an alternative specified grid.

Reference ellipsoid
The ellipsoid with main axes along X, Y, Z, half axis length along X, Y equal to the equatorial Earth radius R_E = 6378.136 km, and half axis length along Z equal to the polar Earth radius R_p = 6356.751 km.

RMIB, RGP, ROLSS registration
RMIB is the Royal Meteorological Institute of Belgium. RGP refers to the RMIB GERB Processing system. ROLSS refers to the RMIB On-Line Short-term Services. See http://gerb.oma.be/ for more details.

Solar zenith angle

The angle between the local vertical vector and the local solar vector. (Also defined during the night, greater than 90° in this case).

TOTAL
The total radiation measurement, taken with the quartz filter out of the view of the sensor.

Users (See also "Authorised Users")
A GGSPS user is any one with WWW access who accesses the GGSPS web site. However, only "Authorised users" will have access to products from the GGSPS.

Viewing zenith angle
The angle between the local vertical vector and the local viewing vector.

X, Y, Z
See "Earth fixed frame."

2. OVERVIEW OF GERB AND GROUND SEGMENT PROCESSING

2.1 Introduction

GERB (Geostationary Earth Radiation Budget) is an Announcement of Opportunity instrument on board the Meteosat Second Generation (MSG) series of satellites. It is designed to measure the outgoing components of the Earth's radiation budget at high temporal resolution (i.e. every 15 minutes), and to high accuracy (1.0 % in both thermal and solar channels), at a spatial resolution of approximately 50 km at the sub-satellite point. MSG will be in geostationary orbit above 0°N 0°E, and GERB will have an 18° field of view covering the entire Earth disk visible from that point, forming an image consisting of 256 x 256 pixels.

GERB has two broadband channels, achieved through use of a quartz filter:

Channel	Filter	Wavelength / µm
TOTAL (i.e. thermal + solar)	Filter Out	0.32 - 500
Short Wave (i.e. solar)	Filter In	0.32 - 4.0

The thermal contribution can then be obtained by computing a synthetic Long Wave (LW) channel by interpolation and subtraction.

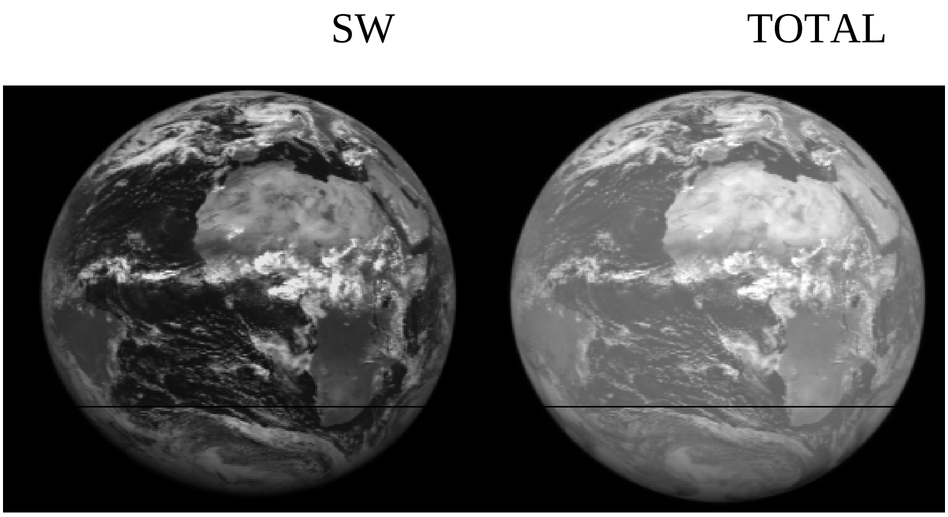


Figure 1: The Earth as seen by GERB-2 (24th June 2004, 12:01) from geostationary orbit above 3.4° W. GERB has an 18° x 18° field of view covering the full Earth disk at a resolution of about 50 km at the sub-satellite point. GERB has two broadband channels, the SW or visible channel (on the left) and the TOTAL (visible and infra-red) channel (right). The LW (infra-red) component can be obtained by interpolation and subtraction.

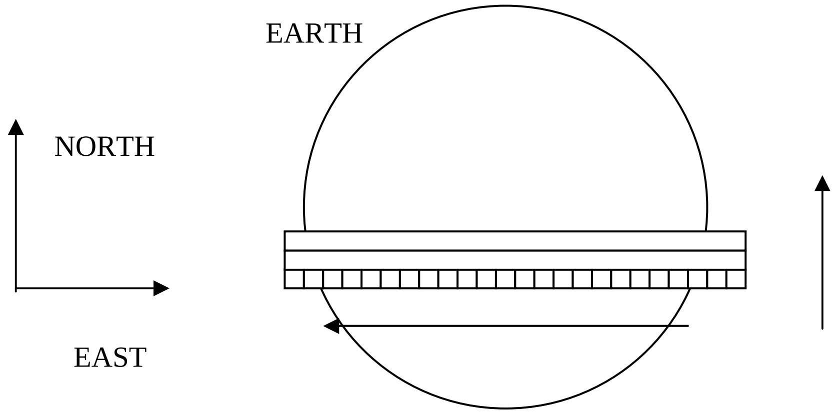
2.2 MSG Satellite

MSG's primary role is its use in operational weather-forecasting. It is designed to continue and improve on the role played by the Meteosat series of satellites since 1977. Its primary payload is SEVIRI (Spinning Enhanced Visible and Infra-Red Imager). SEVIRI has improved on the existing Meteosat imagers through:

- a greater number of channels (12 narrow-band channels in either visible or infra-red, as opposed to 4 for Meteosat);
- improved spatial resolution (~ 3 km in most channels; 1 km in one of the visible channels);

- improved repetition rate (images every 15 minutes, compared to Meteosat's 30 minute repetition rate) .

The MSG satellites are spin-stabilised satellites (to give the required pointing accuracy), rotating at (100 ± 1) revolutions per minute with spin axis aligned to the Earth north-south axis. SEVIRI images are built up row by row using a single pixel detector for each channel, one row acquired for each rotation of the satellite. The satellite rotation itself is used to sweep the SEVIRI line of sight from east to west across the Earth disk. An adjustable scan mirror is used to modify the north-south position of the line of sight from one row to the next. It takes about 12.5 minutes to build up a complete Earth image. SEVIRI starts a new image every 15 minutes, the remaining 2.5 minutes of each repeat cycle being dead time during which the scan mirror position is reset.



SEVIRI images are built up row by row, one row acquired for each rotation of the satellite. A complete image is built up in ~12 minutes.

As already mentioned, MSG will be positioned in geostationary orbit above 0° longitude, meaning that MSG should always have the same view of the Earth. However, a number of factors affect this.

The MSG orbit is allowed to be inclined to the equatorial plane by up to 1°. This means that over a 24 hour period, the satellite can move from 1°N to 1°S and back again. Conversely the Earth will appear to shift in a north-south direction in the SEVIRI and GERB Fields of View over a 24 hour period, and at the extremes of this motion the view of the poles will be clipped. The spin axis of the satellite is normally tilted over partway such that it lies between the perpendicular to the orbital plane and the Earth's own North-South spin axis; this limits the apparent North-South motion of the Earth in the GERB field of view.

During commissioning, these parameters can take on more extreme values. Both MSG-1 and MSG-2 started life with an orbital inclination close to 2° - this is designed such that the satellite will naturally drift back to an inclination of 1° and this be within its specified tolerances by the time commissioning is completed and the satellite enters operational service. During commissioning the spin axis of the satellite is tilted over by up to 1° to limit the apparent Earth north-south movement and Earth clipping.

There is a tendency for the satellite to drift from its station and change its longitude: at 0° longitude, the satellite will tend to drift from west to east. This means that from time to time manoeuvres will be required to hold it at the desired longitude. MSG is kept to within ± 1° (or better) of its target longitude. Note also that new MSG satellites are planned to be commissioned at approximately 10° W or E, and are only moved to the 0° station when they become the operational satellite. In fact, for operational reasons there can be deviations from this plan, and this has happened for both MSG-1 and MSG-2, as indicated in the table below.

Satellite	Commissioning longitude	Date Range	Operational longitude	Date range
MSG-1	10.5° W	Dec 2002 - 15 Jan 2004	3.4° W	29 Jan 2004 onwards
MSG-2	6.5° W	Feb 2006 - 06 Jul 2006	0°	18 Jul 2006 onwards

The majority of higher level GERB (and SEVIRI) products are **rectified**: measurements are interpolated from their original location onto predefined grid points. Rectification attempts to compensate for satellite motion by reconstructing the image as though it had been observed from some idealised satellite location, and renders successive images directly comparable. Movement of the satellite from its ideal station results in data near one of the Earth limbs being missing, or less accurate, and particular sections of the image will be under or oversampled. Note that the GERB Level 1.5 NANRG filtered radiance product (described later) is not rectified, however, and the effects of satellite motion will be fully visible in that product.

The SEVIRI and GERB acquisitions are triggered on each rotation by a Start of Line pulse. This is a signal which is derived from a Sun sensor and an Earth sensor on board MSG, and is defined to arrive a fixed time before SEVIRI will be viewing the centre of the Earth disk. This pulse acts as the reference point against which GERB sets how far east or west it is looking relative to the Earth (see next section).

A diagram of the MSG satellite, showing the location of GERB, is given below. GERB is positioned on the edge of the satellite, and because of the high spin rate experiences high g-forces (~ 16g).

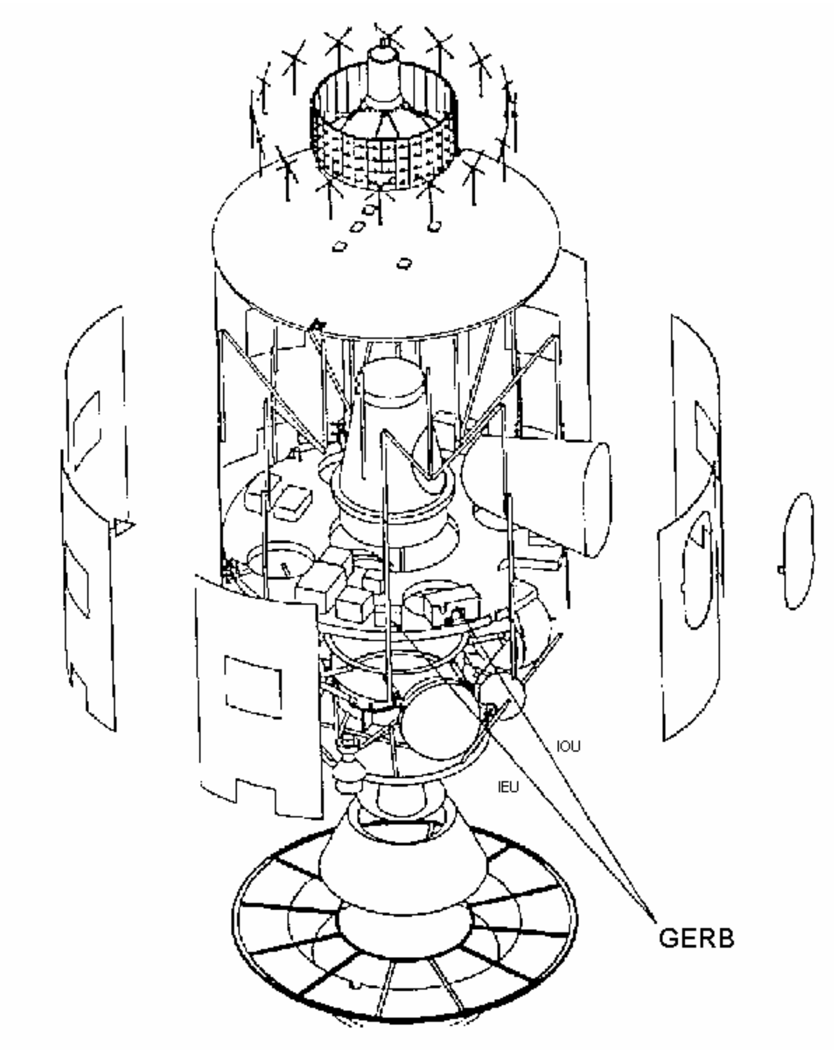
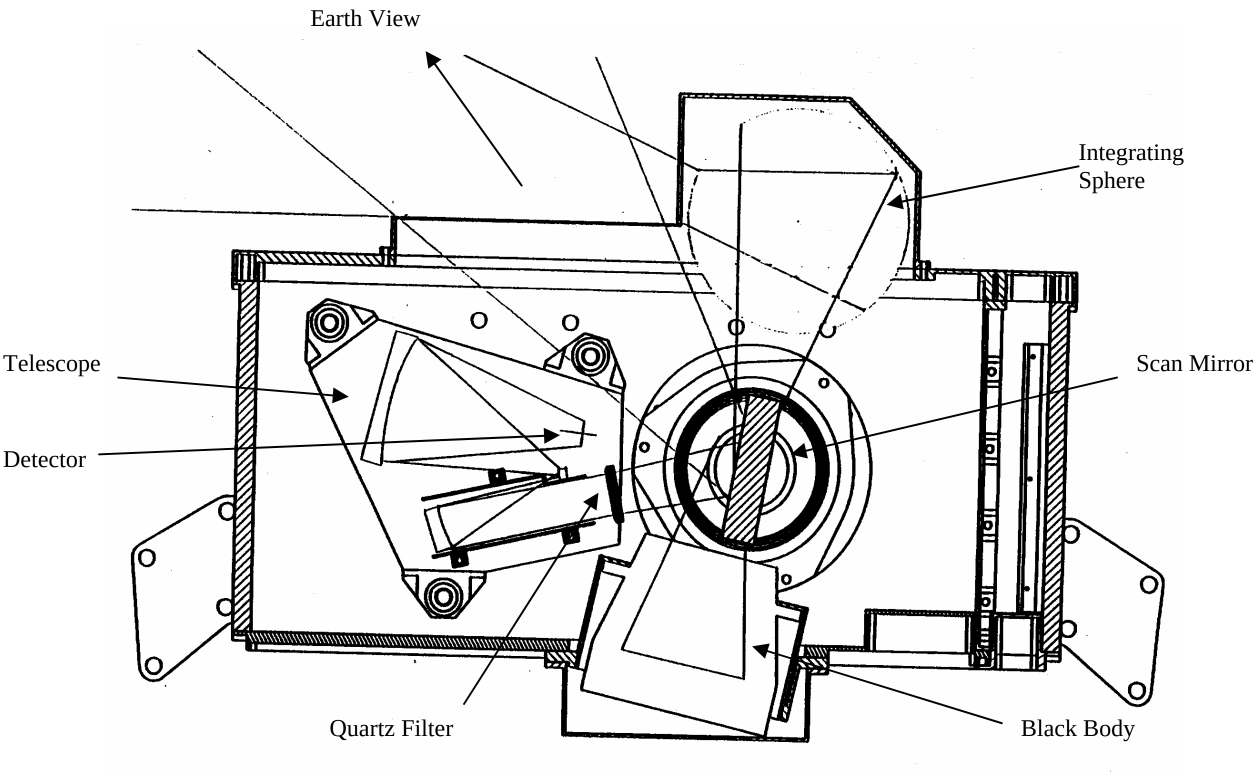


Figure 3: Location of GERB on the MSG satellite

2.3 GERB Instrument and Scanning Mechanism



The diagram above shows a cross-section of the GERB instrument. GERB uses a three-mirror anastigmatic **telescope** to view the Earth, with an additional fold mirror to minimise sensitivity to polarisation. Channel separation is achieved through use of a **quartz filter**[1] which can be moved into and out of the optical path; it can also be moved into a third position to block the optical path completely. In the focal plane of the telescope is a columnar (N-S) **detector** consisting of 256 pixels. The detectors consist of thermo-electric devices 55 μm in size, blackened to give close-to-uniform spectral response over the required wavelength range. The detectors have a relatively long time constant, of order ~5 ms. In order to view a constant scene, a de-spin **scan mirror** is required to counter-act the effects of the spacecraft rotation. This de-spin mirror must rotate at exactly half the rate of the satellite rotation, and in the opposite sense. The de-spin scan mirror allows a constant scene to be viewed for 40 ms. This is still not quite sufficient for the detector reading to reach a final stable value, and numerical filters are applied by the front end electronics to the detector output as a function of time in order to enable this final value to be computed.

One north-south column of an Earth image is viewed on each MSG rotation (i.e. every 0.6 s). One scan of the Earth is built up from 282 columns[2] in a little over 2.5 minutes. The east-west position of each column is stepped by about 0.07° on each rotation (by adjusting the phase of the GERB scan mirror relative to the SOL pulse). Alternate scans are either west-to-east or east-to-west, and either SW (filter in) or TOTAL (filter out). Note that this is very different to the way SEVIRI builds an image (see previous section).

[1] Quartz transmits uniformally over the wavelength range covered by the solar spectrum, but becomes absorbing for wavelengths above 4 μm.

[2] 282 rather than 256 to allow for extra space readings at each end of the scan, to be used for calibration. Some initial commissioning prior to March 2003 was carried out using scans comprised of 262 columns.

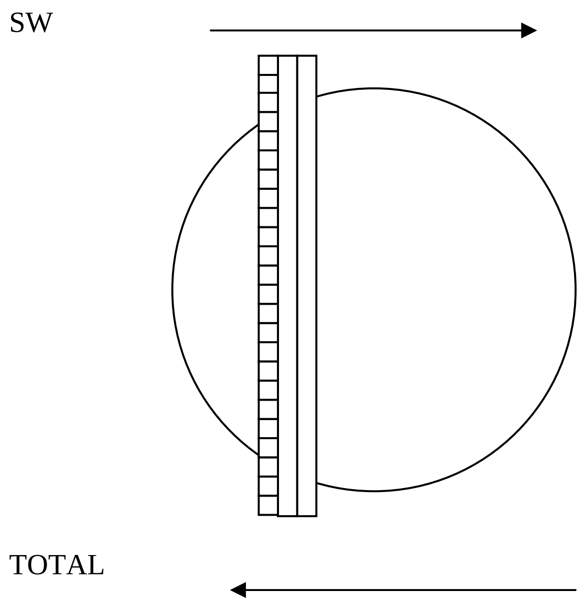


Figure 4: GERB scanning mechanism: images are built up by scanning using a columnar detector array. Successive columns are stepped by 0.07° to build up a complete 18° image from 282 columns.

Over a period of slightly longer than 15 minutes, GERB will build up data for 3 SW scans and 3 TOTAL scans. In order to achieve the required signal to noise ratio, the three scans in each channel will be averaged: the main GERB data products will be produced on a (close to) 15 minute time scale. Note that there is no attempt to synchronise the timings of the acquisition of GERB images with those of SEVIRI.

GERB has two onboard calibration sources: a warm **black body** and an **integrating sphere** which under certain conditions is illuminated by sunlight. The black body is used to adjust continually the calibration of each of the 256 detector pixels. The integrating sphere is used to monitor long-term variations in GERB calibration, particularly degradations in the quartz filter transmission. GERB also makes use of space views for calibration.

2.4 GERB Operations and Data Processing

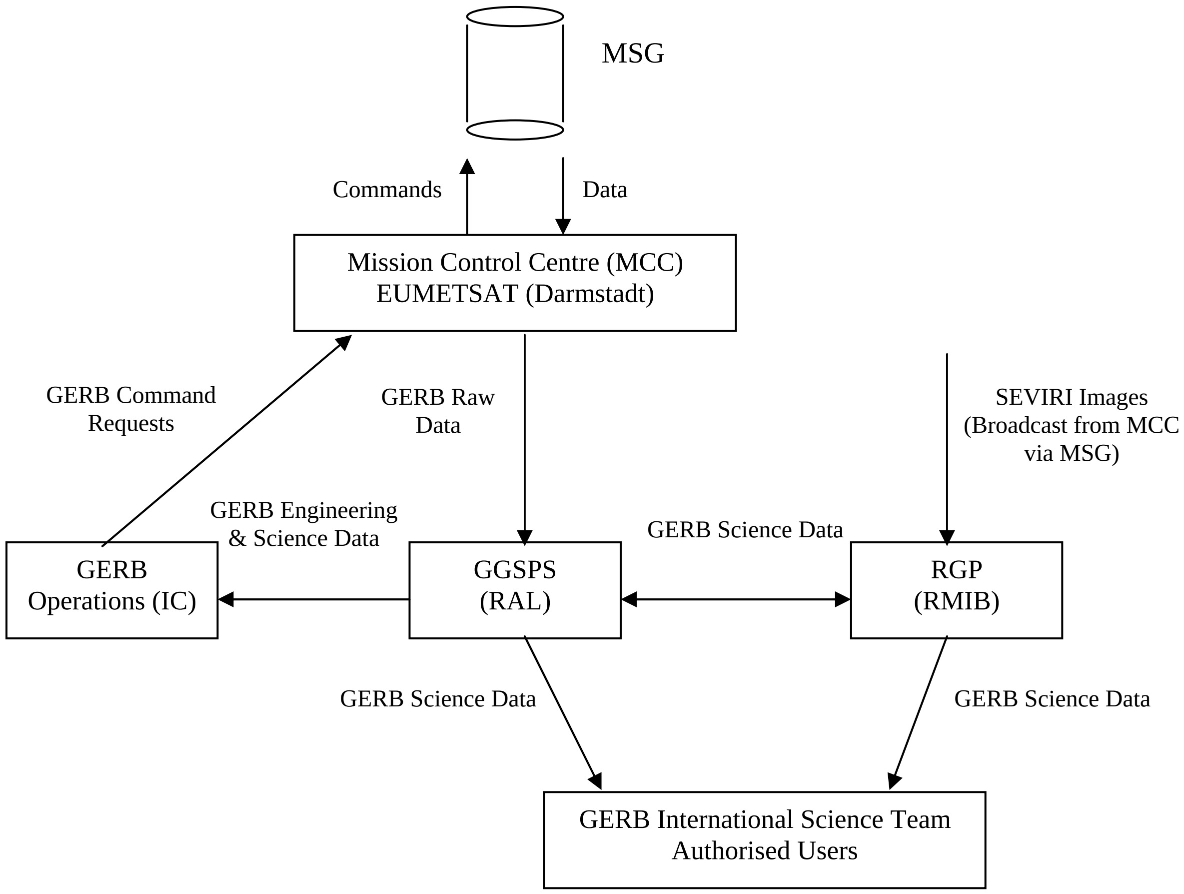


Figure 5: Layout of the GERB Ground Segment

All communication with the GERB instrument is handled via the EUMETSAT Mission Control Centre in Darmstadt, Germany. EUMETSAT operates the MSG satellites, processes the data from the primary instrument, SEVIRI, and transmits the processed SEVIRI images (via MSG itself) to the MSG user community. The UK and Belgium are responsible for GERB operations and data processing.

GERB raw data are transmitted from the MCC to the GERB Ground Segment Processing System (GGSPS) at RAL. The GGSPS archives the raw data and performs a first stage of processing, to generate filtered radiance products.

The filtered radiance products are transmitted to the RMIB GERB Processing System (RGP) at the Royal Meteorological Institute of Belgium. Here the GERB images are combined with the SEVIRI images in a second stage of processing, to generate unfiltered radiances and flux products.

Scientists can obtain the GERB data products from archives maintained at the respective institutes. The processing is carried out in near real time, such that access to certain data products will be available within 4 hours of generation by the GERB instrument. In particular, a range of flux products are available on this timescale from RMIB, at the ROLSS (RMIB On-Line Short-term Services) web site http://gerb.oma.be/, described in [AD 1]. The data archive at RMIB will be a rolling forty day archive. Users should contact RMIB for access to these near real time products. Note though that these near real time products do not constitute the official GERB climate dataset until they are included in the climate archive as Edition products.

The main climate dataset is subject to a 40 day delay, to allow quality checks to be made on the data. No changes are made to the data products during this period, but products can be withdrawn from the climate dataset. If a product passes its quality checks, it is named as an "Edition" product and archived long-term by the GGSPS.

An operations team at Imperial College monitors raw and processed engineering data supplied by the GGSPS to check the performance of the GERB instrument. They can issue commands to the GERB instrument via the MCC at EUMETSAT.

2.5 GGSPS Processing

The GGSPS has three main functions:

- to receive and archive raw GERB data packets from the GERB instrument;
- to process this raw GERB data to science and engineering products;
- to maintain an archive of products which can be accessed by authorised users.

2.5.1 Raw Data Archival

The GGSPS receives raw GERB data packets and processes the data into science products 24 hours per day, in close to real time. The MSG satellite transmits GERB data to the MSG ground station at EUMETSAT. From EUMETSAT the GERB packets are transmitted over a network link to the GGSPS. The GGSPS receives a GERB packet every 0.6 seconds, and combines these packets into GERB Level 0 files spanning one instrument scan (in "normal" mode). These Level 0 files form the input to the GGSPS science processing.

2.5.2 Data Processing

The main science processing carried out by the GGSPS is to convert the level 0 files resulting from data archival into filtered radiance products. This involves:

- recalibrating each detector pixel continuously, using data from the onboard warm black body and views of space away from the Earth, and so converting the Earth view pixel counts into filtered radiances;
- geolocating each view of the Earth and assigning a longitude and latitude, using, in addition to data within the GERB packet, orbit and attitude information on the MSG satellite contained within the header of the SEVIRI Level 1.5 image product (this header is relayed to the GGSPS via RMIB);
- rectifying each image onto a uniform equiangular grid defined relative to an idealised satellite location;
- time averaging three successive scans.

Two science products are generated:

- the NANRG (Non-Averaged Non-Rectified Geolocated) filtered radiance product is the output from calibration and geolocation, and forms the starting point for the conversion to fluxes; NANRG products are copied to RMIB and processed by the RGP within 4 hours of generation of the raw data on the instrument;

- the ARG (Averaged Rectified Geolocated) filtered radiance product additionally has the rectification and time averaging steps carried out.

The NANRG and ARG both cover a timeframe of three Earth scans in each channel, i.e. close to seventeen minutes. More details on these products can be found in Section 3.

The GGSPS receives level 2 flux products[3] generated by the RGP for long term archive, with a delay of 40 days. Only those products which have passed quality assurance checks at RMIB and are to be included in an Edition dataset will be received and archived at the GGSPS.

The GGSPS also processes housekeeping data in the GERB telemetry packets to generate a series of engineering products, and from these a series of daily and long term trace plots are generated. Access to the engineering products will be limited to the GERB Operations Team and those engaged in validation studies; limited access to the engineering plots will be allowed for authorised users.

2.5.3 User Access

The GGSPS will maintain an archive of GERB level 0 products (bundled raw data), the GGSPS filtered radiance products, the RGP ARG and BARG level 2 flux products, and the engineering products. The size of this archive is expected to be approximately 0.5 TB for each year of data. Authorised users of GERB data have access to the filtered radiance and flux products via the GGSPS web site at http://ggsps.rl.ac.uk/ . Access to level 0 products and engineering products is restricted to the GERB Operations Team. Full details of how to register as an authorised user and access these products is given in Section 5.

2.6 The Edition 1 Release

"Edition 1" is the first GERB data which has been approved for scientific study. It is a release for the GERB-2 instrument on MSG-1 (Meteosat-8). Data were first released in May 2006. It is an incremental release: a small amount of data has been made available for the initial release, but this dataset will be expanded both forwards in time (as new data arrive) and backwards (data will be reprocessed back to February 2004).

Currently only two products are included in the Edition 1 release:

- the **Level 2 ARG** flux product, together with a companion geolocation product;
- the **Level 1.5 NANRG** filtered radiance product, together with a companion geolocation product.

Quality summaries [AD 2], [AD 3] for the Edition 1 release are available from the GGSPS web site. Each quality summary (one per product type) details the expected accuracy of the Edition 1 dataset as determined from validation studies on a sample of the data, and notes known problems with the data. All users of the Edition 1 dataset should read these documents to determine whether their intended use of the data is appropriate and consistent with the information provided. These documents will be updated as more is learned: users should recheck these documents for the latest status before publication of any scientific paper using Edition 1 data.

Edition 1 products will be identifiable through the "ED01" field in the filename and an "Edition" attribute (with value = 1) in the data products. Products should not be used for scientific study if they do not contain this identification. Searches by authorised users using the GGSPS catalogue will only select Edition products.

[3] The ARG and BARG products only, the RGP high resolution products are not archived by the GGSPS.

3. GGSPS PRODUCT FILES

This section outlines the various science products which will be available in the GGSPS archive for authorised users.

3.1 Level 1.5 Non-Averaged Non-Rectified Geolocated (NANRG) Filtered Radiance Product

In this product, the raw pixel values have been converted into filtered radiances[4] (in units of $Wm^{-2}sr^{-1}$); and geolocation coordinates (a latitude and longitude, in units of degrees) assigned to each pixel are available in the companion L15_GEO product. There is, however, no time averaging of data, nor any regridding or change of perspective (rectification). The product will therefore contain:

- data for up to six scans[5], three in the Short Wave Channel and three in the TOTAL channel;
- the view of the Earth will be as seen from the actual position of the satellite.

Note that the optics of the GERB instrument are such that the column viewed by the GERB detector pixels is actually curved, with pixels at the top and bottom of the array displaced by up to three-pixels width from the central pixel. This means that if individual scan data in a NANRG file is treated as a simple image, then optical distortions will be present. These optical distortions are accounted for, however, in the geolocation coordinates supplied in the L15_GEO product (see Section 3.2).

The main fields contained in this product are:

- filtered radiances for up to six scans;
- spectral parameters used in combining the TOTAL and SW channels together to form LW data;
- scan mirror information (the so-called east-west line of sight position histogram) which is specifically used by RMIB for making corrections to the GERB PSF for the movement of the GERB scan mirror);
- detector gain and offset information which is mainly used as a quality check on processing;
- satellite position information;
- timing information (the time as registered by the onboard clock on the GERB spacecraft, and the UTC time this corresponds to) for each column of data.

Note that the product also contains:

- latitude coordinates for up to six scans (for pixels which view space rather than the Earth, the elevation angle relative to an Earth fixed frame is supplied instead);
- longitude coordinates for up to six scans (for pixels which view space rather than the Earth, the azimuth angle relative to an Earth fixed frame is supplied instead).

However, the geolocation (either as latitude/longitude or space angles) contained within the Edition 1 level 1.5 NANRG product itself is not sufficiently accurate. It **must not** be used in scientific studies. The companion RGP level 1.5 geolocation products (see Section 3.2) must be used instead.

A number of fields are in the product simply for reference, or for use with the processing at RMIB: the crucial field for science users is the filtered radiances, together with the geolocation (longitude and latitude) coordinates from the L15_GEO product. More details on how to interpret these fields are contained in Sections 4.1 and 4.2.

[4] The term 'filtered' implies no correction is made for the non-uniform spectral response of the GERB instrument.

[5] NANRG products can contain less than six scans if there is missing data due to a break in transmission, if instrument operations result in a change of mode before an integral number of six scans have been performed, or if GERB is in a calibration scanning mode.

The NANRG product is one of two level 1.5 scientific products generated by the GGSPS, and is the only one available for Edition 1. It also forms the input to the RMIB processing system. It is the highest level of product generated for calibration data taken using unusual scan patterns, and as such should also be of use for calibration activities. This product is available in HDF5 format.

3.2 RGP Level 1.5 Geolocation Product

A number of problems currently exist with the geolocation in the Level 1.5 NANRG product. The geolocation of the Level 1.5 NANRG product is recalculated by the RGP, as an initial step in its level 2 processing, by comparing GERB and SEVIRI radiance images. This RGP geolocation is currently more accurate than the GGSPS one, and is used in subsequent level 2 processing.

This RGP geolocation is available to authorised users in a dedicated product, the RGP level 1.5 geolocation (L15_GEO) product. Each product contains latitude and longitude coordinates for a single scan, together with optimised fit parameters used in modelling the geolocation. For Edition 1, the latitude and longitude coordinates must be used in place of the equivalent latitude and longitude fields in the NANRG.

Note that only the longitude and latitude values in the L15_GEO product form part of the Edition 1 release. Other parameters (and in particular the fit parameters) in the product cannot be assumed to be physically reasonable, and are not necessarily expected to be so. The product does, however, contain flags and timestamps which will be of use - these fields are described in Section 4.2.

Note that, since each L15_GEO product defines the geolocation for a single Earth scan, up to six L15_GEO products are required to match each NANRG. NANRG and L15_GEO files can be matched using the timestamps in the filename of each product, or by using data contained within each file as explained in Section 4.2.1.1.

The L15_GEO product is available in HDF5 format, and is available for Edition 1.

3.3 Level 1.5 Averaged Rectified Geolocated (ARG) Filtered Radiance Product

The Level 1.5 ARG product will not be available as part of the Edition 1 release.

This is the other level 1.5 scientific product generated by the GGSPS. It is intended to be scientifically useful, yet contain as little manipulation of the data as possible; so although the data are both rectified and time-averaged, they are given in the original TOTAL and SW channels.

The product contains filtered radiances supplied at a series of pre-defined grid points, the rectification grid. The rectification grid is defined to be equiangular as viewed from an idealised satellite position.

The product contains the following main fields:

- filtered radiances on a 256×256 grid for the SW channel and the TOTAL channel;
- longitude and latitude coordinates for each grid point;
- a series of values defining the main parameters of the rectification grid;
- viewing angles (viewing zenith, solar zenith and relative azimuth) at each of the rectification grid points.

There is one SW and one TOTAL image per file. Each image is a result of time averaging of the data from three individual scans in that channel. The total timescale covered by the file is about 17 minutes.

Some points to be aware of when using the level 1.5 ARG product.

- The radiances supplied have the GERB PSF footprint; no deconvolution is applied to convert these values to radiances with a square footprint matching the pixel spacing.
- The radiances supplied are filtered radiances, i.e. no correction is made to remove the effect of the spectral response of the GERB instrument.
- The non-zero inclination of the MSG orbit and allowed tolerances in the MSG-1 spin axis (see Section 2.2) mean that the Earth moves up and down in the GERB field of view with a period of 24 hours. **This means that a particular row in the rectification grid will not always correspond to the same detector pixel or pixels.** This needs to be borne in mind given that different detector pixels have different PSFs and different spectral responses.

This product is written in HDF5 format.

3.4 Level 2 ARG Flux and Geolocation Files

The GGSPS maintains an archive of level 2 ARG flux files generated by the RMIB processing system. These files are available from the GGSPS with a delay of 40 days from their original generation from RMIB; during these initial 40 days they are only available from the RMIB Online Short-term Services (ROLSS) server as near real time products, and will not have undergone any quality assurance checks.

The main contents of the level 2 ARG flux files are as follows:

- a 256×256 array of fluxes (solar channel or thermal channel) in Wm^{-2};
- a 256×256 array of unfiltered radiances in $Wm^{-2}sr^{-1}$;
- several sets of 256×256 arrays containing scene identification and angular information.
- parameters defining the rectification grid.

There are separate products for solar and thermal data.

Note that the geolocation coordinates (i.e. latitude and longitude) of each rectification grid point are not included in the file. Instead, a separate geolocation file exists with this information; the name of this file is contained within the L2 flux product. As the data is rectified to a fixed grid, the longitude and latitude of each point in the 256×256 array remains constant, and so the same geolocation file is generally used for many L2 flux files.

ARG files have:

- data averaged over the timespan of the three SW and three TOTAL Earth scans contributing to the corresponding level 1.5 ARG filtered radiance product (i.e. over a period slightly greater than 15 minutes);
- pixels with footprints corresponding to the GERB Point Spread Function (as for the level 1.5 ARG filtered radiance product - see above).

For more details on the differences between ARG files and other RMIB products see [AD 1].

These products are written in HDF5 format.

3.5 Level 2 BARG Flux and Geolocation Files

The Level 2 BARG flux product is not currently available as part of the Edition 1 release. Sections in this User Guide relating to the level 2 BARG product are only for GERB International Science Team members engaged in validation studies using this product.

After release, the GGSPS will maintain an archive of level 2 BARG flux files generated by the RMIB processing system. These files will be available from the GGSPS with a delay of 40 days from their original generation from RMIB; during these initial 40 days they are only available from the RMIB Online Short-term Services (ROLSS) server as near real time products, and will not have undergone any quality assurance checks.

The main contents of the level 2 BARG flux files are as follows:

- a 247×247 array of fluxes (solar channel or thermal channel) in Wm^{-2};
- a 247×247 array of unfiltered radiances in $Wm^{-2}sr^{-1}$;
- several sets of 247×247 arrays containing scene identification and angular information.
- parameters defining the rectification grid.

There are separate products for solar and thermal data.

Note that the geolocation coordinates (i.e. latitude and longitude) of each rectification grid point are not included in the file. Instead, a separate geolocation file exists with this information; the name of this file is contained within the L2 flux product. As the data is rectified to a fixed grid, the longitude and latitude of each point in the 247×247 array remains constant, and so the same geolocation file is generally used for many L2 flux files.

BARG files have:

- data integrated over exact 15 minute time steps (00:00 - 00:15 etc.), corresponding to the time steps in which matching SEVIRI products are generated;
- pixels with idealised rectangular footprints - each BARG pixel corresponds to 15×15 SEVIRI pixels.

For more details on the differences between BARG files and other RMIB products see [AD 1].

These products are written in HDF5 format.

3.6 Filename Conventions

The GGSPS file name components are:

<GERB Id>[_<Imager Id>]_<type>[<subtype>]_<date>[_<co-ordinate>]_<version>.<file_type>

Level 2 ARG and BARG products, and the RGP level 1.5 GEO product, follow a slightly different naming convention:

<GERB Id>_<Imager Id>_<type>_<subtype>_<rad_type>_[<time_res>_<spatial_res>_]<date>_<version>.<file_type>

Each field is described below (‘[‘ and ‘]’ indicate a field may not appear in all product names):

<GERB Id> This identifies the GERB instrument from which the data was taken. It can have the value G1, G2, G3 etc…

<Imager Id> Used only for level 2 files, this identifies the SEVIRI instrument used in deriving the flux files. It can take the values ‘SEV1’, ‘SEV2’, ‘SEV3’ etc.

<type> This is the basic field type, the table below shows the possible values:

Product	< type>
L1.5 product	L15
L2.0 product	L20

<subtype> This field is used when there is more than one product with the same <type> value, the table below shows the possible values:

Product	<subtype>
NANRG product	N
L15 ARG product	A
L20 ARG product	ARG
L20 BARG product	BARG
Geolocation data file	GEO

<rad_type> This field is used in the Level 2 ARG/BARG scheme and is RMIB's radiation type/geolocation identifier:

Product	<rad_type>
Thermal	TH
Solar	SOL
Total	TW
Short Wave	SW
Geolocation product	GEO

Note that "Thermal" and "Solar" refer to unfiltered (level 2) channels, while "Total" and "Short Wave" refer to the level 1.5 filtered radiance channels.

<time_res> This field is used in the Level 2 ARG/BARG scheme and is particular to the BARG product. M15 is the only value expected for products available from the GGSPS.

Product	<time_res>
<nn>-minute time bin	M<nn>

<spatial_res> This field is used in the Level 2 ARG/BARG scheme and is particular to the BARG product. R50 is the only value expected for products available from the GGSPS.

Product	<spatial_res>
<mm>-km product	R<mm>

<date> The date field contains the date and time of the start of the period for which the product applies: for example, for NANRG and ARG products this will be the time of acquisition of the first GERB data from which the product is derived. The date field has two components as shown below:

<datepart>[_<timepart>], where:

<datepart> = yyyymmdd The datepart must be present in all file names.

<timepart> = hhmmss The timepart is only required in products that cover a period of less than 24 hours.

In both <datepart> and <timepart> leading zeros are required.

<version> For formally released data, this field contains the Edition number. The Edition number appears in the form "ED"<value>, where value starts at the number 1 and increments. The value always appears as 2 digits, i.e. 01 – 99.

For unreleased data, this field contains the Product Version number. This appears in the form "V"<value>, where value starts at the number one and increments. The value always appears as 3 digits, ie: 001 – 999. All GGSPS products, whether released or unreleased, have a product version number, which is visible in the product; but it appears in the filename only for unreleased data.

All scientific studies should be carried out using released data, i.e. data labelled with an Edition number. See Section 3.7 for more details.

<file_type> This field indicates the type of the data file and always contains 3 characters. All the products discussed will be HDF5 files and will have <file_type> = "hdf"

3.6.1 Examples

The following give an example of each product type:

Product Type	Examples
L1.5 NANRG product	G2_L15N_20060115_165550_ED01.hdf
L1.5 GEO product (SW)	G2_SEV1_L15_GEO_SW_20060115_165550_ED01.hdf
L1.5 GEO product (TOTAL)	G2_SEV1_L15_GEO_TW_20060115_165840_ED01.hdf
L1.5 ARG product	G2_L15A_20060115_165550_V001.hdf
L2 ARG solar (SW) flux product	G2_SEV1_L20_ARG_SOL_20060115_165550_ED01.hdf
L2 ARG thermal (LW) flux product	G2_SEV1_L20_ARG_TH_20060115_165550_ED01.hdf
L2 ARG Geolocation data file	G2_SEV1_L20_ARG_GEO_20060115_165550_ED01.hdf[6]
L2 BARG solar (SW) flux product	G2_SEV1_L20_BARG_SOL_M15_R50_20060115_170000_V003.hdf
L2 BARG thermal (LW) flux product	G2_SEV1_L20_BARG_TH_M15_R50_20060115_170000_V003.hdf
L2 BARG Geolocation data file	G2_SEV1_L20_BARG_GEO_M15_R50_20060115_170000_V003.hdf

Only the Level 1.5 NANRG, the Level 1.5 GEO product and the Level 2 ARG are included in the initial Edition 1 release.

3.7 Edition Number and GGSPS Version Numbers

The GGSPS uses a series of version numbers to track the version of software used to generate a particular product:

1. GGSPS Software Release Ids – tracking all changes to source code.

[6] Level 2 ARG (and BARG) flux files contain the filename of the corresponding geolocation file. The filename cited may be the "pre-release" version (i.e. the nrt version before quality control) e.g. G2_SEV1_L20_ARG_GEO_20060115_165550_V003.hdf which would be named G2_SEV1_L20_ARG_GEO_20060115_165550_ED01.hdf in the GGSPS archive.

2. Parameter File version numbers – tracking all changes to all parameter files used by the GGSPS software.
3. Product version numbers – tracking all changes to GGSPS software and/or GGSPS parameter files which have caused a change to the content of a GGSPS product.

The RGP similarly uses software and product version numbers.

However, not all product versions will be successfully validated for release to general users (i.e. those not involved in operations and validation). The product versions for the different product types generated by the GGSPS and RMIB can also change independently of one another.

Hence, to aid traceability of released products, all science products included in a given release will be given the same **Edition number**. This Edition number will be available:

- as part of the filename ("EDnn", where nn = 01 - 99);
- as an integer attribute ("Edition") in the product.

It is this Edition number which will be of primary interest for scientific use. No product without an Edition number should be used for scientific study.

More information on the use of the other version numbers is given in Appendix D (Section 10).

4. CONTENTS OF PRODUCT FILES

This section defines the hierarchical structure of the level 1.5 products archived by the GGSPS, and provides a data dictionary for each of the fields stored within that file. Note equivalent definitions of the Level 2 ARG and Level 2 BARG products are available in the RMIB User Guide [AD 1].

4.1 Level 1.5 NANRG Filtered Radiance Product

4.1.1 Overview

The principal dataset in the NANRG file is the filtered radiances. For Edition 1, they should be used in conjunction with geolocation values from the L1.5 GEO product. The geolocation coordinates within the NANRG product itself are not as accurate and do not form part of the Edition release.

4.1.1.1 Filtered Radiances

Filtered radiances are stored in datasets labelled “Short Wave Radiance Image 1”, “Short Wave Radiance Image 2” etc. They are coded as 16 bit signed integers. Each dataset has an attribute “Quantisation Factor”, which specifies how the filtered radiance value is encoded; it can be decoded using the equation

$$\text{Filtered radiance value} = \text{quantisation factor} \times \text{encoded value.}$$

A quantisation factor of 0.05 will normally be used. Units (i.e. for the filtered radiance value, not the encoded value) will be in $Wm^{-2}sr^{-1}$ (and is indicated in a “Unit” attribute).

Images are written out row by row from north to south, with each row written from west to east. Geolocation coordinates will follow the same ordering: in fact there will be a one to one correspondence between geolocation values and filtered radiance values. This ordering is also followed in the rectified HDF products.

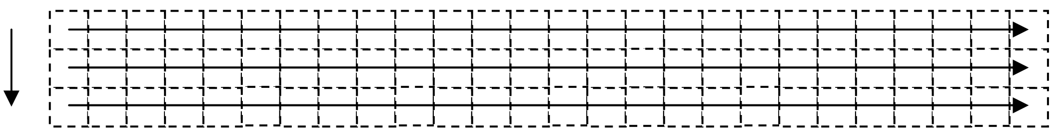


Figure 6: Ordering of filtered radiance data (and geolocation data in the L15_GEO product). Data is written out row by row, starting with the northernmost row (pixel 0), and ending with the southernmost row (pixel 255). Within each row, data is written from west to east. There will always be 256 rows given. For the NANRG file, the number of columns in each image is specified by a “Number of Columns” attribute within the Radiometry group. There is one to one correspondence between the filtered radiance and geolocation values.

Short Wave and Total scans are labelled 1, 2, 3 in time order. For a NANRG with six scans, this would correspond to a scanning order {SW1, TOTAL1, SW2, TOTAL2, SW3, TOTAL3}. For NANRGs with fewer than six scans, the overall scanning order should be determined from data in the “Times” group (see below).

4.1.1.2 Other Fields of Interest

The filtered radiances and associated quantisation factors (together with geolocation coordinates from the companion L15_GEO product) are by far the most important fields in the NANRG product. There are many other fields, however; some of them are intended for use in the level 2 processing by the RGP at RMIB, or in calibration studies, and will probably not be of interest for general science use. The following section points out other fields of note which may be of interest for science users.

- **Number of Columns …** Specifies how wide each of the (up to) six images is.
- **Edition** attribute specifies the edition number and confirms that this product is part of an Edition release.
- **Instrument Identifier**. Be aware of which GERB instrument produced the data.
- **Instrument Mode**. Indicates whether the instrument is performing normal Earth scanning or a more complicated scanning pattern to collect calibration data. "Normal" mode has a value of "33"; data taken in other modes will not be included in the Edition release.
- **Instrument Test Identifier**. A secondary value indicating that the instrument is in a non-nominal configuration. A value of "0" indicates standard operations; data taken with other values will not be included in the Edition release.
- **Nominal Satellite Longitude** (or **Actual Satellite Longitude**). The location of the satellite may be of interest. The time variation is also available in the product if required.
- **Data Fraction** and **Data Quality.** Data fraction indicates how much of the expected data (assuming 6 scans in normal mode) is actually present. Data quality indicates whether any anomaly flags have been sent (and counts the number of scans where anomaly flags are set).
- **Product Confidence Flags**. Overall flags (one for each of up to 6 scans) indicating quality of each scan. A value of "0" means that all is well (as far as is known), but non-zero values do not necessarily mean the product is not useable. These flags provide more detailed information on problems flagged in the "Data Quality" field.
- **A Values (per GERB detector cell)**. These values will be needed to calculate LW filtered radiances from the TOTAL and SW values. Note, however, that the SW and TOTAL measurements are taken neither at the same place nor the same time: to do a proper subtraction would require careful interpolation in both space and time. (The C Values are currently small and should not be needed for this subtraction).
- **First Packet Time/Last Packet Time**: contain the time range of the data.
- **UTC Time (per column)**. More detailed timing information (a time for each image column). Useful if comparing data with other ground-based or satellite measurements. These data (column 0 for SW scans and column 281 for TOTAL scans) are used to define the timestamp in the corresponding L15_GEO file. Note that the Onboard Time (per column) should not be needed.

Information on all these fields, and the others in the NANRG product, are contained below.

Note that the gains, offsets and α values are intended for quality checking and traceability, and are not needed in interpreting the filtered radiance values. The histograms of line of sight east-west positions are not needed in interpreting the geolocation values.

4.1.2 Hierarchical Data Structure

Hierarchical Structure	Type	Section	Page
/	Group		
/File Name	Attribute	4.1.3.1	32
/File Creation Time	Attribute	4.1.3.2	32
/Edition	Attribute	4.1.3.3	32
/Duplication Information/	Group	4.1.3.4	32
/Duplication Information/Number of ARG Files to be Generated	Attribute	4.1.3.5	33
/Duplication Information/Nominal Start Time for First ARG File	Attribute	4.1.3.6	33

Azimuth)/Quantisation Factor			
/Geolocation/Short Wave Image 1/Longitude (or Azimuth)/Unit	Attribute	4.1.3.26	38
/Geolocation/Short Wave Image 1/SOL_SOE_Delay	Dataset	4.1.3.37	45
/Geolocation/Short Wave Image 1/SOL_SOE_Delay/Quantisation Factor	Attribute	4.1.3.35	43
/Geolocation/Short Wave Image 1/SOL_SOE_Delay/Unit	Attribute	4.1.3.26	38
/Geolocation/Short Wave Image 1/Satellite Spin Period	Dataset	4.1.3.38	45
/Geolocation/Short Wave Image 1/Satellite Spin Period/Quantisation Factor	Attribute	4.1.3.35	43
/Geolocation/Short Wave Image 1/Satellite Spin Period/Unit	Attribute	4.1.3.26	38
/Geolocation/Short Wave Image 2/	Group	4.1.3.30	40
... Datasets and Attributes as for /Geolocation/Short Wave Image 1/			
/Geolocation/Short Wave Image 3/	Group	4.1.3.30	40
... Datasets and Attributes as for /Geolocation/Short Wave Image 1/			
/Geolocation/TOTAL Image 1/	Group	4.1.3.39	46
... Datasets and Attributes as for /Geolocation/Short Wave Image 1/			
/Geolocation/TOTAL Image 2/	Group	4.1.3.39	46
... Datasets and Attributes as for /Geolocation/Short Wave Image 1/			
/Geolocation/TOTAL Image 3/	Group	4.1.3.39	46
... Datasets and Attributes as for /Geolocation/Short Wave Image 1/			
/Input Information/	Group	4.1.3.40	46
/Input Information/Number of Input Level 0 Files	Attribute	4.1.3.41	47
/Input Information/Age of SEVIRI File Used (minutes)	Attribute	4.1.3.42	47
/Input Information/UTC Jump First Packet (in seconds)	Attribute	4.1.3.43	47
/Input Information/Input GERB L0 Files	Dataset	4.1.3.44	47
/Input Information/Input SEVIRI Header Files	Dataset	4.1.3.45	48
/Input Information/TSOL Jitter Input Files	Dataset	4.1.3.46	48
/Product Confidence Flags	Dataset	4.1.3.47	48
/Product Confidence Summary	Group	4.1.3.48	50
/Product Confidence Summary/Data Fraction	Attribute	4.1.3.49	50
/Product Confidence Summary/Data Quality	Attribute	4.1.3.50	50
/Product Confidence Summary/Number of Scans	Attribute	4.1.3.51	51
/Radiometry/	Group	4.1.3.52	51
/Radiometry/Number of Columns in Short Wave Image 1	Attribute	4.1.3.53	51
/Radiometry/Number of Columns in Total Image 1	Attribute	4.1.3.54	52
/Radiometry/Number of Columns in Short Wave Image 2	Attribute	4.1.3.53	51
/Radiometry/Number of Columns in Total Image 2	Attribute	4.1.3.54	52
/Radiometry/Number of Columns in Short Wave Image 3	Attribute	4.1.3.53	51
/Radiometry/Number of Columns in Total Image 3	Attribute	4.1.3.54	52
/Radiometry/A Values (per GERB detector cell)	Dataset	4.1.3.55	52
/Radiometry/Alpha Values (per GERB detector cell)	Dataset	4.1.3.56	53
/Radiometry/C Values (per GERB detector cell)	Dataset	4.1.3.57	53
/Radiometry/Short Wave Gain Image 1	Dataset	4.1.3.58	53
/Radiometry/Short Wave Gain Image 2	Dataset	4.1.3.58	53
/Radiometry/Short Wave Gain Image 3	Dataset	4.1.3.58	53

/Times/Total Image 2/Onboard Time (per column)	Dataset	4.1.3.71	57
/Times/Total Image 2/UTC Time (per column)	Dataset	4.1.3.72	58
/Times/Total Image 3/	Group	4.1.3.73	58
/Times/Total Image 3/Onboard Time (per column)	Dataset	4.1.3.71	57
/Times/Total Image 3/UTC Time (per column)	Dataset	4.1.3.72	58

4.1.3 Detailed Items

A key to the data types listed here is available in Appendix F (Section 12).

4.1.3.1 File Name [Attribute]

Description: The name of the file, including filetype extension.

HDF Path: "/File Name"

Data Type: H5T_C_S1

The size of the character string in the HDF file will be dimensioned to the size required for the filename (including the C-style trailing '\0'). This string size will not exceed 40, however.

The filename will conform to the standards for NANRG file names defined in Section 3.6.

4.1.3.2 File Creation Time [Attribute]

Description: The UTC time when the file was created.

HDF Path: "/File Creation Time"

Data Type: H5T_C_S1

The UTC time is supplied to second accuracy according to the definition in Appendix C (Section 9).

4.1.3.3 Edition [Attribute]

Description: This is an identifier specifying which release the product belongs to.

HDF Path: "/GGSPS/Edition"

Data Type: H5T_C_S1

Only products included in an Edition release will contain this attribute.

All science products included in a given release will be given the same Edition number. No product without an Edition number should be used for scientific study. See Section 3.7 for more details.

4.1.3.4 Duplication Information [Group]

Description: This group contains information on what GGSPS Level 1.5 ARG and RGP Level 2 ARG products will be derived from this NANRG file.

HDF Path: "/Duplication Information"

The Duplication Information group contains information for use by the RGP processing system, to coordinate the ARG timestamping at level 2 with that used by the GGSPS at level 1.5. The information was designed to allow ARG products to be timestamped (and occasionally duplicated) to match one to one with SEVIRI products. However, a simpler scheme has been adopted: ARG products carry the same timestamp in the filename as the parent NANRG, and are never duplicated. The information contained within the group will reflect this.

4.1.3.5 Number of ARG Files to be Generated [Attribute]

Description: The number of time bins that will be covered using data from this NANRG file.

HDF Path: "/Duplication Information/Number of ARG Files to be Generated"

Data Type: H5T_STD_I32BE

This number will take the value 1 when GERB is scanning in normal mode, and 0 when GERB is in any other mode.

4.1.3.6 Nominal Start Time for First ARG File [Attribute]

Description: The start time of the first time bin that will be covered using data from this NANRG file.

HDF Path: "/Duplication Information/Nominal Start Time for First ARG File"

Data Type: H5T_C_S1

The UTC time is supplied to second accuracy according to the definition in Appendix C (Section 9).

This field is always present. If the number of ARG files to be generated is 0, then this field will contain the string " ".

4.1.3.7 Nominal Start Time for Second ARG File [Attribute]

Description: The start time of the second time bin that will be covered using data from this NANRG file.

HDF Path: "/Duplication Information/Nominal Start Time for Second ARG File"

Data Type: H5T_C_S1

This field is always present, but will always contain the string " " - ARG files will not be duplicated.

4.1.3.8 GERB [Group]

Description: This group contains information on the GERB instrument (specifically which GERB instrument the product is derived from, the instrument mode and the instrument test identifier).

HDF Path: "/GERB/"

4.1.3.9 Instrument Identifier [Attribute]

Description: An identifier specifying the instrument generating the data from which this product is derived.

HDF Path: "/GERB/Instrument Identifier"

Data Type: H5T_C_S1

The string will be of the form "GERB1", "GERB2" etc.

4.1.3.10 Instrument Mode [Attribute]

Description: An identifier specifying the mode in which the instrument is operating. The instrument mode specifies the region of the sky (relative to the Earth) that the instrument scans, the spacing between columns, the number of columns taken scanning in each direction, and the position of the quartz filter (i.e. the channel selected) during the scan.

HDF Path: "/GERB/Instrument Mode"

Data Type: H5T_STD_I32BE

Edition data will always be in “normal” mode (the standard Earth scanning mode), and have a GERB mode value of 33. Data taken in other modes, usually calibration data, will not be included in the Edition. A list of GERB mode values is given in Appendix H (Section 14.1), and is also available under the Information page on the GGSPS web site, but only GERB Operations Team members should need this information.

4.1.3.11 Instrument Test Identifier [Attribute]

Description: A word written by the onboard flight software for GERB to flag to the ground system when non-standard operations which do not constitute a change of mode are in progress.

HDF Path: “/GERB/Instrument Test Identifier”

Data Type: H5T_STD_I32BE

Edition data will always have a test identifier value of 0. A list of test identifier values is given in Appendix H (Section 14.2), and is also available under the Information page on the GGSPS web site, but only GERB Operations Team members should need this information.

4.1.3.12 GGSPS [Group]

Description: This group contains information on the GGSPS software used to generate the NANRG product

HDF Path: "/GGSPS/"

This is essentially a collection of software version numbers.

4.1.3.13 Software Version [Attribute]

Description: This is the GGSPS software release identifier. It is a string having the form "VXX_yy", i.e. it will be a string of length 7.

HDF Path: "/GGSPS/Software Version"

Data Type: H5T_C_S1

The software release identifier will be updated whenever there is a change to any subsystem of the GGSPS code. Changes to associated parameter files will not trigger an update in software version number. Major software changes will cause an increment to "XX", and "yy" will be reset to 0. Minor software changes will cause an increment in "yy" only. See Section 10.1 for more details.

4.1.3.14 L1.5 NANRG Product Version [Attribute]

Description: This is the version number of the NANRG product. It is an integer in the range 0-999.

HDF Path: "/GGSPS/L1.5 NANRG Product Version"

Data Type: H5T_STD_I32BE

The product version number will be incremented whenever a change occurs either to the GGSPS software, or to one or more of the parameter files on which generation of the NANRG product depends, when that change causes a change to the body of the NANRG product. See Section 10.3 for more details.

4.1.3.15 Table Names [Dataset]

Description: An array of the names of 40 data tables used in the generation of the NANRG product.

HDF Path: "/GGSPS/Table Names"

Data Type: H5T_C_S1

Each string in the array will only be as long as it needs to be, but table names will not exceed a size of 40. Unused tables will have the string " ".

4.1.3.16 Table Version Numbers [Dataset]

Description: An array of the version numbers of 40 data tables used in the generation of the NANRG product. Version numbers are written out as a string (decimal).

HDF Path: "/GGSPS/Table Version Numbers"

Data Type: H5T_C_S1

There is a one to one correspondence between table names and table versions. Unused tables will have the string " ". See section 10.2 for more details.

4.1.3.17 Geolocation [Group]

Description: This group contains assorted geolocation information about the NANRG product, including primarily the longitude and latitude values for each of the (up to) six scans in the NANRG file.

HDF Path: "/Geolocation/"

4.1.3.18 Actual Satellite Longitude (degrees) [Attribute]

Description: The actual value of the satellite longitude corresponding to the time of the first packet of data from which the NANRG file is derived.

HDF Path: "/Geolocation/Actual Satellite Longitude (degrees)"

Data Type: H5T_IEEE_F64BE
Units are degrees (as the field name suggests). If for any reason this value is undefined, the field will contain a value -256.0

4.1.3.19 Nominal Satellite Longitude (degrees) [Attribute]

Description: The nominal value of the satellite longitude i.e. the station to which the satellite is maintained.

HDF Path: "/Geolocation/Nominal Satellite Longitude (degrees)"

Data Type: H5T_IEEE_F64BE

Units are degrees (as the field name suggests). If for any reason this value is undefined, the field will contain a value -256.0

4.1.3.20 Line of Sight North-South Speed [Attribute]

Description: The angular speed in a north-south direction of the GERB line of sight during the Earth view.

HDF Path: "/Geolocation/Line of Sight North-South Speed"

Data Type: H5T_IEEE_F64BE

Units are degrees/second. If for any reason this value is undefined, the field will contain a value 0.0 This information is calculated based on a knowledge of the size and orientation of any misalignment between the GERB axis and the MSG spin axis (it is this misalignment which causes the line of sight to move). It is used in the RMIB processing to make a correction to the Point Spread Function to account for the dynamic effects caused by this movement in the Line of Sight.

4.1.3.21 Satellite Orbit and Attitude History [Group]

Description: This subgroup of Geolocation contains actual orbit and attitude values corresponding to the beginning of each scan covered by the NANRG file, and also a value corresponding to the end of the last scan. There will be an array of seven values for each item for which a history is supplied.

HDF Path: "/Geolocation/Satellite Orbit and Attitude History/"

4.1.3.22 Attitude Component l History [Dataset]

Description: x component, in the Earth Fixed Reference Frame, of the attitude (spin) axis of MSG.

HDF Path: "/Geolocation/Satellite Orbit and Attitude History/Attitude Component l History"

Data Type: H5T_IEEE_F64BE

Normalisation is as given in the header of the SEVIRI Level 1.5 Image Product: no particular normalisation is guaranteed, although in practice the numbers are normalised to 1, and the attitude parameters are therefore direction cosines of the spin axis.

The dataset consists of an array of up to seven such values. Missing or invalid values will take the value "-256.0". The values correspond one to one with those of the other datasets in the orbit and attitude history group.

4.1.3.23 Attitude Component m History [Dataset]

Description: y component, in the Earth Fixed Reference Frame, of the attitude (spin) axis of MSG.

HDF Path: "/Geolocation/Satellite Orbit and Attitude History/Attitude Component m History"

Data Type: H5T_IEEE_F64BE

Normalisation is as given in the header of the SEVIRI Level 1.5 Image Product: no particular normalisation is guaranteed, although in practice the numbers are normalised to 1, and the attitude parameters are therefore direction cosines of the spin axis.

The dataset consists of an array of up to seven such values. Missing or invalid values will take the value "-256.0". The values correspond one to one with those of the other datasets in the orbit and attitude history group.

4.1.3.24 Attitude Component n History [Dataset]

Description: z component, in the Earth Fixed Reference Frame, of the attitude (spin) axis of MSG.

HDF Path: "/Geolocation/Satellite Orbit and Attitude History/Attitude Component n History"

Data Type: H5T_IEEE_F64BE

Normalisation is as given in the header of the SEVIRI Level 1.5 Image Product: no particular normalisation is guaranteed, although in practice the numbers are normalised to 1, and the attitude parameters are therefore direction cosines of the spin axis.

The dataset consists of an array of up to seven such values. Missing or invalid values will take the value "-256.0". The values correspond one to one with those of the other datasets in the orbit and attitude history group.

4.1.3.25 Orbit Latitude History [Dataset]

Description: Actual (geocentric) latitude of MSG.

HDF Path: "/Geolocation/Satellite Orbit and Attitude History/Orbit Latitude History"

Data Type: H5T_IEEE_F64BE

Units are "Degree", but are in any case defined in a "Unit" attribute.

The dataset consists of an array of up to seven such values. Missing or invalid values will take the value "-256.0". The values correspond one to one with those of the other datasets in the orbit and attitude history group.

4.1.3.26 Unit [Attribute]

Description: Character string defining units of data in dataset to which this is an attribute.

HDF Path: Occurs in several places:
"/Geolocation/Satellite Orbit and Attitude History/Orbit Latitude History/Unit"
"/Geolocation/Satellite Orbit and Attitude History/Orbit Longitude History/Unit"
"/Geolocation/Satellite Orbit and Attitude History/Orbit Radius History/Unit"
"/Geolocation/Short Wave Image 1/Histogram of Line of Sight East-West Positions/Unit"
"/Geolocation/Short Wave Image 2/Histogram of Line of Sight East-West Positions/Unit"
"/Geolocation/Short Wave Image 3/Histogram of Line of Sight East-West Positions/Unit"

"/Geolocation/Total Image 1/Histogram of Line of Sight East-West Positions/Unit"
"/Geolocation/Total Image 2/Histogram of Line of Sight East-West Positions/Unit"
"/Geolocation/Total Image 3/Histogram of Line of Sight East-West Positions/Unit"
"/Geolocation/Short Wave Image 1/Latitude (or Elevation)/Unit"
"/Geolocation/Short Wave Image 2/Latitude (or Elevation)/Unit"
"/Geolocation/Short Wave Image 3/Latitude (or Elevation)/Unit"
"/Geolocation/Total Image 1/Latitude (or Elevation)/Unit"
"/Geolocation/Total Image 2/Latitude (or Elevation)/Unit"
"/Geolocation/Total Image 3/Latitude (or Elevation)/Unit"
"/Geolocation/Short Wave Image 1/Longitude (or Azimuth)/Unit"
"/Geolocation/Short Wave Image 2/Longitude (or Azimuth)/Unit"
"/Geolocation/Short Wave Image 3/Longitude (or Azimuth)/Unit"
"/Geolocation/Total Image 1/Longitude (or Azimuth)/Unit"
"/Geolocation/Total Image 2/Longitude (or Azimuth)/Unit"
"/Geolocation/Total Image 3/Longitude (or Azimuth)/Unit"
"/Geolocation/Short Wave Image 1/SOL_SOE_Delay/Unit"
"/Geolocation/Short Wave Image 2/SOL_SOE_Delay/Unit"
"/Geolocation/Short Wave Image 3/SOL_SOE_Delay/Unit"
"/Geolocation/Total Image 1/SOL_SOE_Delay/Unit"
"/Geolocation/Total Image 2/SOL_SOE_Delay/Unit"
"/Geolocation/Total Image 3/SOL_SOE_Delay/Unit"
"/Geolocation/Short Wave Image 1/Satellite Spin Period/Unit"
"/Geolocation/Short Wave Image 2/Satellite Spin Period/Unit"
"/Geolocation/Short Wave Image 3/Satellite Spin Period/Unit"
"/Geolocation/Total Image 1/Satellite Spin Period/Unit"
"/Geolocation/Total Image 2/Satellite Spin Period/Unit"
"/Geolocation/Total Image 3/Satellite Spin Period/Unit"
"/Radiometry/Short Wave Radiance Image 1/Unit"
"/Radiometry/Short Wave Radiance Image 2/Unit"
"/Radiometry/Short Wave Radiance Image 3/Unit"
"/Radiometry/Total Radiance Image 1/Unit"
"/Radiometry/Total Radiance Image 2/Unit"
"/Radiometry/Total Radiance Image 3/Unit"

Data Type: H5T_C_S1

Character string is as long as it needs to be, but in no event will it exceed 80 characters.

4.1.3.27 Orbit Longitude History [Dataset]

Description: Actual longitude of MSG.

HDF Path: "/Geolocation/Satellite Orbit and Attitude History/Orbit Longitude History"

Data Type: H5T_IEEE_F64BE

Units are "Degree", but are in any case defined in a "Unit" attribute.

The dataset consists of an array of up to seven such values. Missing or invalid values will take the value "-256.0". The values correspond one to one with those of the other datasets in the orbit and attitude history group.

4.1.3.28 Orbit Radius History [Dataset]

Description: Radius of current orbit position of MSG (relative to centre of Earth).

HDF Path: "/Geolocation/Satellite Orbit and Attitude History/Orbit Radius History"

Data Type: H5T_IEEE_F64BE

Units are "Km from Earth centre", but are in any case defined in a "Unit" attribute.

The dataset consists of an array of up to seven such values. Missing or invalid values will take the value "-256.0". The values correspond one to one with those of the other datasets in the orbit and attitude history group.

4.1.3.29 Orbit and Attitude History UTC Times [Dataset]

Description: UTC Times corresponding to each element of the datasets in the Satellite Orbit and Attitude History Group.

HDF Path: "/Geolocation/Satellite Orbit and Attitude History/Orbit and Attitude History UTC Times"

Data Type: H5T_C_S1

The seven values contained in the orbit and attitude history arrays correspond to the start time for each Earth scan within the NANRG, and the end time for the last scan. The values are given in time order.

UTC times follow the format defined earlier, and are defined to millisecond precision. Elements for which no history data is supplied (e.g. when there are less than six constituent scans in the NANRG file) are denoted by the string "INVALID_UTC_TIME".

4.1.3.30 Short Wave Image n (n=1,2,3) [Group]

Description: This subgroup of Geolocation contains a series of datasets - in particular the latitude and longitude datasets - relating in particular to the first/second/third SW scan covered in the NANRG file.

HDF Path: "/Geolocation/Short Wave Image 1/"
"/Geolocation/Short Wave Image 2/"
"/Geolocation/Short Wave Image 3/"

If there is no first/second/third SW scan to be covered, the group will still be present, but will be empty i.e. the constituent datasets will not be defined.

Note that a group of the same name also exists as a subgroup of the "Times" group.

4.1.3.31 Histogram of Line of Sight East-West Positions [Dataset]

Description: Histogram showing the variation in east-west line of sight position over the 40 ms during which the Earth view data is acquired. It is derived by comparing the satellite rotation rate, as measured by the time delay between successive Start of Line pulses measured using an internal clock, with the 117 readings of scan mirror position acquired during the 40 ms of Earth view data acquisition.

HDF Path: "/Geolocation/Short Wave Image 1/Histogram of Line of Sight East-West Positions"
"/Geolocation/Short Wave Image 2/Histogram of Line of Sight East-West Positions"
"/Geolocation/Short Wave Image 3/Histogram of Line of Sight East-West Positions"
"/Geolocation/Total Image 1/Histogram of Line of Sight East-West Positions"
"/Geolocation/Total Image 2/Histogram of Line of Sight East-West Positions"
"/Geolocation/Total Image 3/Histogram of Line of Sight East-West Positions"

Data Type: H5T_STD_U8BE

This dataset is intended for use by the RMIB processing system in correcting the GERB PSF for dynamic effects introduced by any non-standard behaviour of the GERB scan mirror. No other scientific use for this data is foreseen. In particular, it is not needed when interpreting the geolocation coordinates supplied in either the NANRG product or the L15_GEO product. The accuracy and reliability of this data item remains unvalidated.

As explained in section 2.3, GERB uses a despin mirror to counter the effects of satellite rotation, and to keep the GERB Line of Sight pointing in a constant direction over the 40 ms Earth viewing period. In order to do this, the scan mirror must rotate at exactly half the rotation rate of the satellite.

The east-west line of sight position is defined by:

2 * Mirror rotation – Satellite rotation

and each rotation is measured relative to its position at the start of acquisition of Earth view data. If this quantity at a given point during the 40 ms acquistion has a value 0, then the scan mirror is keeping pace exactly with the satellite rotation. A positive value indicates that the mirror is moving too fast, driving the line of sight off to the east; likewise a negative value indicates that the mirror is moving too slowly, causing the line of sight to move to the west. The data is sampled 117 times over the 40 ms in question, and a histogram built up of the 117 measured values of east-west line of sight position. A separate histogram is made for each column of Earth view data.

Dataset is a two dimensional array, with 81 histogram bins supplied for each column of each image. The datatype is unsigned char: this is used as an unsigned 1 byte integer to record the number of entries in each of the histogram bins.

Data is supplied for each image column in turn. Image columns are ordered from west to east.

The number of columns is not fixed (it should be 282 for normal mode data, but this is not guaranteed) but can be deduced from the dataset properties. It will, however, also match the Number of Columns parameter for the corresponding scan, which is defined within the Radiometry group.

The histogram covers, in 81 bins, a range of two column widths either side of a central value which is defined by the first mirror position used. The "Lowest Value", "Interval Size" and "Unit" of the binning are defined in three attributes to the dataset.

The first bin within each column is the westernmost one. Underflows and overflows are included in the first and last bins respectively.

This dataset will only be present for scans which exist.

4.1.3.32 Lowest Value [Attribute]

Description: Lower bound of the Histogram of Line of Sight East-West Positions.

HDF Path:
"/Geolocation/Short Wave Image 1/Histogram of Line of Sight East-West Positions/Lowest Value"
"/Geolocation/Short Wave Image 2/Histogram of Line of Sight East-West Positions/Lowest Value "
"/Geolocation/Short Wave Image 3/Histogram of Line of Sight East-West Positions/Lowest Value "
"/Geolocation/Total Image 1/Histogram of Line of Sight East-West Positions/Lowest Value "
"/Geolocation/Total Image 2/Histogram of Line of Sight East-West Positions/Lowest Value "
"/Geolocation/Total Image 3/Histogram of Line of Sight East-West Positions/Lowest Value "

Data Type: H5T_IEEE_F64BE

Value is given in Pixel[7] units (but is in any case defined by the "Unit" attribute of the Histogram of Line of Sight East-West Positions dataset). The normal value for this attribute will be -2.025.

This attribute is (obviously) only present when the parent dataset is present.

4.1.3.33 Interval Size [Attribute]

Description: Interval (bin) size of the Histogram of Line of Sight East-West Positions.

HDF Path:
"/Geolocation/Short Wave Image 1/Histogram of Line of Sight East-West Positions/Interval Size"
"/Geolocation/Short Wave Image 2/Histogram of Line of Sight East-West Positions/Interval Size"
"/Geolocation/Short Wave Image 3/Histogram of Line of Sight East-West Positions/Interval Size"
"/Geolocation/Total Image 1/Histogram of Line of Sight East-West Positions/Interval Size"
"/Geolocation/Total Image 2/Histogram of Line of Sight East-West Positions/Interval Size"
"/Geolocation/Total Image 3/Histogram of Line of Sight East-West Positions/Interval Size"

Data Type: H5T_IEEE_F64BE

Value is given in Pixel units (but is in any case defined by the "Unit" attribute of the Histogram of Line of Sight East-West Positions dataset. The normal value for this attribute will be 0.05.

This attribute is (obviously) only present when the parent dataset is present.

4.1.3.34 Latitude (or Elevation) [Dataset]

Description: Geodetic latitude or elevation for each GERB data point. Geodetic latitude is supplied if the GERB line of sight intersects the reference ellipsoid which represents the Earth's surface; elevation is supplied otherwise. Both latitude and elevation are supplied as 16 bit signed integers.

To distinguish whether it is latitude or elevation which is supplied for a particular pixel, an offset of 128 degrees (equivalent to adding or subtracting a value of 0x4000 to the encoded value) is added to the numerical elevation value.

Geodetic latitude and elevation are both defined in the overview.

[7] The units should more correctly be named “column width” units, i.e. 1 unit is the standard spacing between image columns of 4.219 arcmins.

HDF Path: "/Geolocation/Short Wave Image 1/Latitude (or Elevation)"
"/Geolocation/Short Wave Image 2/Latitude (or Elevation)"
"/Geolocation/Short Wave Image 3/Latitude (or Elevation)"
"/Geolocation/Total Image 1/Latitude (or Elevation)"
"/Geolocation/Total Image 2/Latitude (or Elevation)"
"/Geolocation/Total Image 3/Latitude (or Elevation)"

Data Type: H5T_STD_I16BE

Dataset is a two dimensional array, following the standard user format ordering explained in the overview. The number of columns in each row can be determined from the properties of the dataset or from the "Number of Columns" attribute for this image in the "Radiometry" group.

Values are 2 byte encoded integers; the "Quantisation Factor" attribute defines how to derive the true floating point values. A "Unit" attribute defines the units (following application of the Quantisation Factor"), which for this dataset will be "Degree". The quantisation factor used will be 0.0078125.

Invalid values are denoted by the (encoded) value -32767.

This dataset will only be present for scans which exist.

The latitude coordinates within the Edition 1 NANRG product are not sufficiently accurate and do not form part of the Edition release. They should not be used for scientific purposes; use instead the latitude coordinates in the corresponding L15_GEO product.

4.1.3.35 Quantisation Factor [Attribute]

Description: Quantisation factor used to encode filtered radiances, latitudes or longitudes. The encoded value is related to the true value by:

$$\text{True value} = \text{Quantisation factor} \times \text{Encoded value}$$

HDF Path: "/Geolocation/Short Wave Image 1/Latitude (or Elevation)/Quantisation Factor"
"/Geolocation/Short Wave Image 2/Latitude (or Elevation)/Quantisation Factor"
"/Geolocation/Short Wave Image 3/Latitude (or Elevation)/Quantisation Factor"
"/Geolocation/Total Image 1/Latitude (or Elevation)/Quantisation Factor"
"/Geolocation/Total Image 2/Latitude (or Elevation)/Quantisation Factor"
"/Geolocation/Total Image 3/Latitude (or Elevation)/Quantisation Factor"
"/Geolocation/Short Wave Image 1/Longitude (or Azimuth)/Quantisation Factor"
"/Geolocation/Short Wave Image 2/Longitude (or Azimuth)/Quantisation Factor"
"/Geolocation/Short Wave Image 3/Longitude (or Azimuth)/Quantisation Factor"
"/Geolocation/Total Image 1/Longitude (or Azimuth)/Quantisation Factor"
"/Geolocation/Total Image 2/Longitude (or Azimuth)/Quantisation Factor"
"/Geolocation/Total Image 3/Longitude (or Azimuth)/Quantisation Factor"
"/Geolocation/Short Wave Image 1/SOL_SOE_Delay/Quantisation Factor"
"/Geolocation/Short Wave Image 2/SOL_SOE_Delay/Quantisation Factor"
"/Geolocation/Short Wave Image 3/SOL_SOE_Delay/Quantisation Factor"
"/Geolocation/Total Image 1/SOL_SOE_Delay/Quantisation Factor"

"/Geolocation/Total Image 2/SOL_SOE_Delay/Quantisation Factor"
"/Geolocation/Total Image 3/SOL_SOE_Delay/Quantisation Factor"
"/Geolocation/Short Wave Image 1/Satellite Spin Period/Quantisation Factor"
"/Geolocation/Short Wave Image 2/Satellite Spin Period/Quantisation Factor"
"/Geolocation/Short Wave Image 3/Satellite Spin Period/Quantisation Factor"
"/Geolocation/Total Image 1/Satellite Spin Period/Quantisation Factor"
"/Geolocation/Total Image 2/Satellite Spin Period/Quantisation Factor"
"/Geolocation/Total Image 3/Satellite Spin Period/Quantisation Factor"
"/Radiometry/Short Wave Radiance Image 1/Quantisation Factor"
"/Radiometry/Short Wave Radiance Image 2/Quantisation Factor"
"/Radiometry/Short Wave Radiance Image 3/Quantisation Factor"
"/Radiometry/Total Radiance Image 1/Quantisation Factor"
"/Radiometry/Total Radiance Image 2/Quantisation Factor"
"/Radiometry/Total Radiance Image 3/Quantisation Factor"

Data Type: H5T_IEEE_F64BE

Values will normally be 0.0078125 for latitude, longitude, elevation and azimuth; 0.05 for filtered radiances; 1.073×10^{-6} for SOL_SOE_Delay and Satellite Spin Period.

4.1.3.36 Longitude (or Azimuth) [Dataset]

Description: Longitude or azimuth for each GERB data point. Longitude is supplied if the GERB line of sight intersects the reference ellipsoid which represents the Earth's surface; azimuth is supplied otherwise. Both longitude and azimuth are supplied as 16 bit signed integers.

It is not possible to distinguish directly from the value supplied whether longitude or azimuth has been used. This can be done, however, by checking the corresponding latitude or elevation value (there is a one to one correspondance): elevation values have an offset of 128 degrees (equivalent to adding or subtracting a value of 0x4000 to the encoded value).

Invalid values are denoted by the (encoded) value -32767.

Longitude and azimuth are both defined in the overview.

HDF Path: "/Geolocation/Short Wave Image 1/Longitude (or Azimuth)"
"/Geolocation/Short Wave Image 2/Longitude (or Azimuth)"
"/Geolocation/Short Wave Image 3/Longitude (or Azimuth)"
"/Geolocation/Total Image 1/Longitude (or Azimuth)"
"/Geolocation/Total Image 2/Longitude (or Azimuth)"
"/Geolocation/Total Image 3/Longitude (or Azimuth)"

Data Type: H5T_STD_I16BE

Dataset is a two dimensional array, following the standard user format ordering explained in the overview. The number of columns in each row can be determined from the properties of the dataset or from the "Number of Columns" attribute for this image in the "Radiometry" group.

Values are 2 byte encoded integers; the "Quantisation Factor" attribute defines how to derive the true floating point values. A "Unit" attribute defines the units (following application of the Quantisation Factor"), which for this dataset will be "Degree". The quantisation factor used will be 0.0078125.

This dataset will only be present for scans which exist.

The longitude coordinates within the Edition 1 NANRG product are not sufficiently accurate and do not form part of the Edition release. They should not be used for scientific purposes; use instead the longitude coordinates in the corresponding L15_GEO product.

4.1.3.37 SOL_SOE_Delay [Dataset]

Description: The value of the SOL_SOE delay for each GERB packet, or column of data. This is the time between the Start of Line pulse and the Start of Earth Acquisition, and is an input used in the level 1.5 geolocation algorithms, measuring how far east/west a particular column is positioned. Its raw encoded value is measured in clock pulses of 1.073 μs. The associated units and quantisation factor can be used to convert the value into seconds.

HDF Path: "/Geolocation/Short Wave Image 1/SOL_SOE_Delay"
"/Geolocation/Short Wave Image 2/SOL_SOE_Delay"
"/Geolocation/Short Wave Image 3/SOL_SOE_Delay"
"/Geolocation/Total Image 1/SOL_SOE_Delay"
"/Geolocation/Total Image 2/SOL_SOE_Delay"
"/Geolocation/Total Image 3/SOL_SOE_Delay"

Data Type: H5T_STD_I32BE

This dataset is intended for use by RAL, RMIB and instrument scientists in monitoring the performance of the geolocation and geolocation algorithms. No scientific use for this quantity is intended. In particular, it is not needed when interpreting the geolocation coordinates supplied in either the NANRG product or the L15_GEO product. This quantity is also known to be subject to measurement noise.

The dataset is a one dimensional array, with one value for each column in a particular image: the ordering of columns follows the standard user format ordering explained in the overview. The number of columns can be determined from the properties of the dataset or from the "Number of Columns" attribute for this image in the "Radiometry" group.

Values are 4 byte encoded integers; the "Quantisation Factor" attribute defines how to derive the true floating point values. A "Unit" attribute defines the units (following application of the Quantisation Factor"), which for this dataset will be "seconds". The quantisation factor used will be 1.073×10^{-6}.

This dataset will only be present for scans which exist.

4.1.3.38 Satellite Spin Period [Dataset]

Description: The value of Satellite Spin Period for each GERB packet, or column of data. This is the time between two consecutive Start of Line pulses, and is an input used in the level 1.5 geolocation algorithms, as a normalising factor for the SOL_SOE_Delay described in the preceding section. Its raw encoded value is measured in clock pulses of 1.073 μs. The associated units and quantisation factor can be used to convert the value into seconds.

HDF Path: "/Geolocation/Short Wave Image 1/Satellite Spin Period"
"/Geolocation/Short Wave Image 2/Satellite Spin Period"
"/Geolocation/Short Wave Image 3/Satellite Spin Period"
"/Geolocation/Total Image 1/Satellite Spin Period"
"/Geolocation/Total Image 2/Satellite Spin Period"
"/Geolocation/Total Image 3/Satellite Spin Period"

Data Type: H5T_STD_I32BE

This dataset is intended for use by RAL, RMIB and instrument scientists in monitoring the performance of the geolocation and geolocation algorithms. No scientific use for this quantity is intended. In particular, it is not needed when interpreting the geolocation coordinates supplied in either the NANRG product or L15_GEO product.

The dataset is a one dimensional array, with one value for each column in a particular image: the ordering of columns follows the standard user format ordering explained in the overview. The number of columns can be determined from the properties of the dataset or from the "Number of Columns" attribute for this image in the "Radiometry" group.

Values are 4 byte encoded integers; the "Quantisation Factor" attribute defines how to derive the true floating point values. A "Unit" attribute defines the units (following application of the Quantisation Factor"), which for this dataset will be "seconds". The quantisation factor used will be 1.073×10^{-6}.

This dataset will only be present for scans which exist.

4.1.3.39 Total Image n (n = 1,2,3) [Group]

Description: This subgroup of Geolocation contains a series of datasets - in particular the latitude and longitude datasets - relating in particular to the first/second/third Total scan covered in the NANRG file.

HDF Path: "/Geolocation/Total Image 1/"
"/Geolocation/Total Image 2/"
"/Geolocation/Total Image 3/"

If there is no first/second/third Total scan to be covered, the group will still be present, but will be empty i.e. the constituent datasets will not be defined.

Subordinate fields are as for the "Short Wave Image 1" group.

4.1.3.40 Input Information [Group]

Description: Group containing information on the input data used to derive the NANRG file.

HDF Path: "/Input Information/"

4.1.3.41 Number of Input L0 Files [Attribute]

Description: Number of input GERB Level 0 Files (i.e. Earth scans) used to derive this product.

HDF Path: "/Input Information/Number of Input L0 Files"

Data Type: H5T_STD_I32BE

Value will be in the range 1-6. 6 will be the usual value in normal operations.

4.1.3.42 Age of Seviri File Used (minutes) [Attribute]

Description: Time difference between the first GERB packet from which this product is derived, and the start of the 15 minute repeat cycle time for the SEVIRI product used in processing the first GERB scan covered by this product.

HDF Path: "/Input Information/Age of Seviri File Used (minutes)"

Data Type: H5T_STD_I32BE

4.1.3.43 UTC Jump First Packet (in seconds) [Attribute]

Description: Time difference in seconds between first packet time of NANRG, and first packet time that would have been assigned using the UTC coefficients used to process the preceding group.

HDF Path: "/Input Information/UTC Jump First Packet (in seconds)"

Data Type: H5T_STD_I32BE

This parameter is used for internal monitoring of data processing at RAL and RMIB. It is used to identify problems with the UTC conversion coefficients used in converting onboard time to UTC time.

4.1.3.44 Input GERB L0 Files [Dataset]

Description: Array of up to 6 filenames containing names of input GERB Level 0 files.

HDF Path: "/Input Information/Input GERB L0 Files"

Data Type: H5T_C_S1

The number of filenames contained in the dataset is contained in the properties of the dataset, and is also given by the value of the "Number of Input L0 Files" attribute of the "Input Information" group. It will not exceed 6. Length of each string holding a filename is as long as it needs to be, but this length will not exceed 40.

Files are listed in time order: for six scans, the order will be {SW1, TOT1, SW2, TOT2, SW3, TOT3}.

4.1.3.45 Input SEVIRI Header Files [Dataset]

Description: Array of up to 5 filenames containing names of input SEVIRI header files

HDF Path: "/Input Information/Input SEVIRI Header Files"

Data Type: H5T_C_S1

The number of filenames contained in the dataset is contained in the properties of the dataset. It will not exceed 5. Length of each string holding a filename is as long as it needs to be, but this length will not exceed 40.

4.1.3.46 TSOL Jitter Input Files [Dataset]

Description: Array of up to 5 filenames containing names of input TSOL Jitter files

HDF Path: "/Input Information/TSOL Jitter Input Files"

Data Type: H5T_C_S1

The number of filenames contained in the dataset is contained in the properties of the dataset; the number will typically be of the order of 5 or 6. Length of each string holding a filename is as long as it needs to be; TSOL Jitter file names are currently up to length 54 (including trailing '\0').

4.1.3.47 Product Confidence Flags [Dataset]

Description: Array of six integers indicating the overall usefulness of each of the six Earth scans in the NANRG file.

HDF Path: "/Product Confidence Flags"

Data Type: H5T_STD_I32BE

Scans are given in the order: Short Wave scan 1; TOTAL scan 1; SW scan 2; TOTAL scan 2; SW scan 3; TOTAL scan 3. If there are less than six scans present in the NANRG file, non-existent scans are denoted by the value -1.

Each word is a bit pattern, each bit flagging a different problem affecting the data. For example, a value of 515 (0x203) would indicate a scan affected by a quartz filter anomaly, direct stray light and a black body temperature anomaly.

Values taken by the confidence flags are as follows:

Bit	Value	Value (hex)	Meaning	Severity
	-1	0xffffffff	no scan	-
		0	good scan	-
0	1	0x1	Quartz filter anomaly	Major

1	2	0x2	Direct stray light	Major
2	4	0x4	Direct stray light affecting gain calculation	Minor
3	8	0x8	Diffuse stray light	Minor
4	16	0x10	Stray light in black body	Minor
5-8			Unused	
9	512	0x200	Black body temperature anomaly	Minor
10	1024	0x400	Detector temperature anomaly (“warning” level)	Minor
11	2048	0x800	Detector temperature anomaly (“alarm” level)	Minor
12-13			Not currently used	
14	16384	0x4000	There has been a satellite manoeuvre within the last 6 hours (i.e. geolocation less accurate)	Minor
15-17			Not currently used	
18	262144	0x40000	Old TSOL Jitter information used.	Minor
19-31		0x10000	Not currently used	

Anomalies are classed as “major” (data probably unuseable for scientific study) or “minor” (data may be used with care). In most cases, data flagged with major anomalies will have been removed from the Edition dataset. These anomalies are explained in more detail below.

- **Quartz filter anomaly**. Indicates that the quartz filter (channel separator) was in an incorrect or undetermined position for a particular scan. This is considered a major anomaly and the filtered radiances will not be useable. These data should not be used for scientific study.

- **Direct stray light**. Another major anomaly. Indicates the presence of a “stray light bar” in the GERB image - this is stray light arising from scattering of sunlight off the upper/lower edges of the telescope aperture, and occurs at around midnight local time. Reaches its largest value when closest to the Sun avoidance season (Sun is closest to the field of view). There will be large stray light contamination of the measured filtered radiances, and these data will be very difficult to use for scientific study.

- **Direct gain stray light**. Minor anomaly. Indicates the presence of a vertical stray light bar at the edge of, or just outside, the GERB field of view, which could in principle affect the gain calculation. However, the gain calculation is protected from these data, and these data should in fact be unaffected.

- **Diffuse stray light**. Minor anomaly. Indicates the presence of stray light arising from scattering from the telescope mirror surfaces. The stray light level is much lower than for direct stray light, but is spread over a wider area and lasts for a longer time around midnight.

- **Stray light in black body**. Minor anomaly. Indicates the presence of a low level of stray light in the Black Body (usually between 10:00 and 12:30 local time), which in turn affects the calibration and measured filtered radiances. It is at a maximum at the equinoxes.

- **Black body temperature anomaly**. Minor anomaly. Indicates that the black body temperature is anomalously low or high, or that the temperature is changing over the course of the scan.

- **Detector temperature anomaly**. Minor anomaly. Indicates that the temperature of the GERB pixels is anomalously low or high. "Alarm" limits are wider than "warning" limits.

- **Satellite manoeuvre within last 6 hours**. Minor anomaly. Indicates that the geolocation quality may be reduced. Note that the SEVIRI geolocation is normally also affected in these circumstances, and hence the RGP geolocation may also be affected.

- **Old TSOL Jitter information**. Minor anomaly. This information is used by the GGSPS Level 1.5 geolocation within the NANRG product; the RGP geolocation should not be affected. Edition 1 data can be used as normal.

Note: for GERB-2 Edition 1, an error has been found in the stray light flagging: the daily time range for which data is flagged is shifted from the ideal by up to 30 minutes. All data affected by "direct" stray light have been removed from the Edition 1 data set, but "diffuse" stray light (stray light contamination of the filtered radiances of between 0.25 Wm-2sr-1 and 3.5 Wm-2sr-1) and "black body" stray light are only classed as minor anomalies and these data form part of the Edition 1 dataset. The periods currently flagged in the products, and those that should be treated with caution, are indicated below. Users should be aware that all data in the caution periods may be of reduced accuracy because of stray light effects.

	Spring Date Range	Autumn Date Range	(Approximate) Flagged Time Range	Caution Time Range
Diffuse Stray Light	15 Jan - 23 May	21 Jul - 26 Nov	23:00 - 01:00	22:26 - 01:34
Black Body Stray Light			10:05 - 12:30	09:31 - 13:04

4.1.3.48 Product Confidence Summary [Group]

Description: Group containing summary information on data quality.

HDF Path: "/Product Confidence Summary/"

4.1.3.49 Data Fraction [Attribute]

Description: Fraction of data present (as an integer from 0-100); 100 = all data present.

HDF Path: "/Product Confidence Summary/Data Fraction"

Data Type: H5T_STD_I32BE

There is one number per NANRG. The fraction includes both the amount of data missing from each scan, and the number of scans missing from a standard NANRG (i.e. 6 scans for normal mode data). For example, a data fraction of "67" might indicate 6 scans each with 1/3 of their data missing, or alternatively 4 complete and 2 missing scans. The "Number of Scans" attribute provides extra information to help distinguish the two cases.

4.1.3.50 Data Quality [Attribute]

Description: Count of scans affected by major and minor anomalies

HDF Path: "/Product Confidence Summary/Data Quality"

Data Type: H5T_STD_I32BE

This number summarises how many scans are affected by anomalies affecting the quality of the data. The number given is:

$$10 \times \text{nmajor} + \text{nminor}$$

where nmajor is the number of scans affected by one or more major anomaly, and nminor is the number of scans affected by one or more minor anomaly. Therefore '0' indicates good quality data, 1-6 indicates data affected by minor anomalies, ≥ 10 indicates data affected by one or more major anomalies.

Information on which anomalies affect which scans can be found in the "Product Confidence Flags" dataset.

4.1.3.51 Number of Scans [Attribute]

Description: Count of scans

HDF Path: "/Product Confidence Summary/Number of Scans"

Data Type: H5T_STD_I32BE

Number of scans present in the NANRG. Included in the Product Confidence Summary group to help interpretation of "Data Fraction" attribute (i.e. whether any data missing is missing as whole scans or parts of scans).

Is equivalent to "/Input Information/Number of Input Level 0 Files".

4.1.3.52 Radiometry [Group]

Description: Group containing filtered radiances and spectral information.

HDF Path: "/Radiometry/"

4.1.3.53 Number of Columns in Short Wave Image n (n=1, 2, 3) [Attribute]

Description: Number of columns (packets) in Short Wave scan 1/2/3.

HDF Path: "/Radiometry/Number of Columns in Short Wave Image 1"
"/Radiometry/Number of Columns in Short Wave Image 2"
"/Radiometry/Number of Columns in Short Wave Image 3"

Data Type: H5T_C_S1

The attribute only exists if the corresponding scan exists.

4.1.3.54 Number of Columns in Total Image n (n = 1, 2, 3) [Attribute]

As for "Number of Columns in Short Wave Image n", but for TOTAL scan 1/2/3.

HDF Path: "/Radiometry/Number of Columns in Total Image 1"
"/Radiometry/Number of Columns in Total Image 2"
"/Radiometry/Number of Columns in Total Image 3"

4.1.3.55 A Values (per GERB detector cell) [Dataset]

Description: The relative SW sensitivity of the TOTAL channel (A) is used to define the GERB synthetic Long Wave filtered radiance. 'A' is defined as the ratio between the GERB filtered TOTAL radiance and the GERB filtered SW radiance for a 5800 K black body.

TOTAL (L_{TOT}), LW (L_{LW}) and SW (L_{SW}) filtered radiances are then related by the equation

$$L_{TOT} = L_{LW} + A\ .\ \ L_{SW}$$

The 'A' values provided in the NANRG file are directly copied from those derived during ground calibration of the instrument at ICSTM.

A possible upgrade to the ground segment is foreseen, whereby updated 'A' values would be calculated using data from the integrating sphere (GERB's SW calibration monitor).

HDF Path: "/Radiometry/A Values (per GERB detector cell)"

Data Type: H5T_IEEE_F64BE

Dataset is a one dimensional dataset with 256 elements (i.e. one per detector cell). Values are generally in the range 1.15 - 1.25.

The A values are used in calculating long wave filtered radiances from the TOTAL and short wave, i.e. rearranging the equation above[8]:

$$L_{LW} = L_{TOT} - A\ .\ \ L_{SW}$$

However, take great care if subtracting the Short Wave channel from the TOTAL using the NANRG product, since the measurements in the two channels are made neither at the same time, nor in the same place (due to scan mirror non-repeatability and satellite orbit motion). A proper interpolation in both space and time is required in order to make this subtraction.

[8] In fact, the ratio between the SW filtered radiance and the SW part of the TOTAL filtered radiance has a small dependence on the scene viewed; ‘A’ as defined using a 5800 K black body (and supplied in the NANRG product) is an approximation to this ratio. LW filtered radiances are nevertheless calculated as outlined here; scene-dependent corrections are made when unfiltering the radiances (e.g as part of the RMIB processing).

4.1.3.56 Alpha Values (per GERB detector cell) [Dataset]

Description: Constant for each detector cell related to the time constant for that cell. The onboard processing of the detector response computes the integrals (I_1 and I_2) over time of the detector response combined with two separate weighting functions. The final pixel reading (V) is determined from

$$V = I_1 + \alpha . I_2$$

where α is the constant (1 value per detector cell) given in this field.

HDF Path: "/Radiometry/Alpha Values (per GERB detector cell)"

Data Type: H5T_IEEE_F64BE

Dataset is a one dimensional dataset with 256 elements (i.e. one per detector cell). Values are typically in the range 0.03 to 0.06.

This method is used because the detector time constants are not long enough for the detector output to stabilise completely during the 40 ms acquisition time, and the weighting functions are chosen to enable an estimate of the final asymptotic value of the detector output which will be independent of the detector's initial conditions.

Note that the α values are included in the NANRG product only to ensure easy traceability (for RMIB) of the values used in deriving the filtered radiances contained within the NANRG product. Since the original pixel I_1 and I_2 values are not contained in the product, the α values are not needed by science users when interpreting the data contained in the NANRG.

4.1.3.57 C Values (per GERB detector cell) [Dataset]

Description: The relative LW sensitivity of the SW channel (C) measures the long wave leakage through the quartz filter. 'C' is defined as the ratio between the GERB filtered SW radiance and the GERB filtered TOTAL radiance for a 300 K black body.

'C' values are measured from the current data set during data processing by using data from the GERB internal black body.

HDF Path: "/Radiometry/C Values (per GERB detector cell)"

Data Type: H5T_IEEE_F64BE

Dataset is a one dimensional dataset with 256 elements (i.e. one per detector cell). Typical values should be around 0.0. No correction to the data using these C values should currently be necessary.

4.1.3.58 Short Wave Gain Image n (n = 1, 2, 3) [Dataset]

Description: SW gain from the first SW scan for each detector cell. This is the gain actually used in converting pixel counts to filtered radiances using the equation

$L^F = (V - Offset)/Gain$

where V represents the detector reading in counts and L^F the corresponding filtered radiance.

HDF Path: "/Radiometry/Short Wave Gain Image 1"
"/Radiometry/Short Wave Gain Image 2"
"/Radiometry/Short Wave Gain Image 3"

Data Type: H5T_IEEE_F64BE

Dataset is a one dimensional dataset with 256 elements (i.e. one per detector cell). This dataset will only be present for scans which exist.

4.1.3.59 Short Wave Offset (Mean) Image n (n = 1, 2, 3) [Dataset]

Description: Mean offset from the first/second/third SW scan for each detector cell. Offset is defined using the equation

$$L^F = (V - Offset)/Gain$$

where V represent the detector reading in counts and L^F the corresponding filtered radiance. A separate value for the offset is calculated for each column of an Earth image; the value given here is the mean value over these columns. Outliers lying outside three standard deviations are removed from the mean calculation: i.e. mean and standard deviation are calculated, outliers are identified and removed, and mean and standard deviation are recalculated using the remaining data.

HDF Path: "/Radiometry/Short Wave Offset (Mean) Image 1"
"/Radiometry/Short Wave Offset (Mean) Image 2"
"/Radiometry/Short Wave Offset (Mean) Image 3"

Data Type: H5T_IEEE_F64BE

Dataset is a one dimensional dataset with 256 elements (i.e. one per detector cell). This dataset will only be present for scans which exist.

4.1.3.60 Short Wave Offset (Standard Deviation) Image n (n = 1, 2, 3) [Dataset]

Description: Standard deviation of the offsets from the first/second/third SW scan for each detector cell. Offset is defined using the equation

$$L^F = (V - Offset)/Gain$$

where V represents the detector reading in counts and L^F the corresponding filtered radiance. A separate value for the offset is calculated for each column of an Earth image; the value given here is the standard deviation of the values over these columns. Outliers are removed as explained in the calculation of the means (see "Short Wave Offset (Mean) Image n").

HDF Path: "/Radiometry/Short Wave Offset (Standard Deviation) Image 1"
"/Radiometry/Short Wave Offset (Standard Deviation) Image 2"
"/Radiometry/Short Wave Offset (Standard Deviation) Image 3"

Data Type: H5T_IEEE_F64BE

Dataset is a one dimensional dataset with 256 elements (i.e. one per detector cell). This dataset will only be present for scans which exist.

4.1.3.61 Short Wave Radiance Image n (n = 1, 2, 3) [Dataset]

Description: SW filtered radiance from the first/second/third SW scan for each measured point, supplied as an encoded 16 bit signed integer.

HDF Path: "/Radiometry/Short Wave Radiance Image 1"
"/Radiometry/Short Wave Radiance Image 2"
"/Radiometry/Short Wave Radiance Image 3"

Data Type: H5T_STD_I16BE

Dataset is a two dimensional array, following the standard user format ordering explained in the overview. The number of columns in each row can be determined from the properties of the dataset or from the "Number of Columns" attribute for this image in the "Radiometry" group.

Values are 2 byte encoded integers; the "Quantisation Factor" attribute defines how to derive the true floating point values. A "Unit" attribute defines the units (following application of the Quantisation Factor"), which for this dataset will be "Watt per square meter per steradian". The quantisation factor used will be 0.05. Invalid values will be denoted by the (encoded) value -32767.

This dataset will only be present for scans which exist.

4.1.3.62 Space Flags [Dataset]

Description: Flag indicating which pixels are identified as space pixels when calculating gains. There is one value or flag for each (row,column) combination in the NANRG images. Each flag is a single byte containing a bit field: the different bits within each bitfield refer to the different constituent Earth scans covered by the NANRG.

HDF Path: "/Radiometry/Space Flags"

Data Type: H5T_STD_U8BE

Note this field is not required for normal scientific use of the NANRG product; it is intended for monitoring by RAL and RMIB of the calibration algorithms used in the science processing.
Dataset is a two dimensional array, following the standard user format ordering explained in the overview. The number of columns in each row can be determined from the properties of the dataset and corresponds to the maximum value taken by the "Number of Columns" attribute amongst the different image groups within the "Radiometry" group.

Values are 1 byte unsigned integers; each value is a flag containing a bit field specifying for which scans this particular (column,row) combination was used as a space pixel. Individual bits within this flag correspond to particular scans as follows:

Bit	Scan
0 (i.e. least significant bit)	SW scan 1
1	TOTAL scan 1
2	SW scan 2
3	TOTAL scan 2
4	SW scan 3
5	TOTAL scan 3

A particular bit is set to 1 if that particular (row,column) combination corresponded to an identified space pixel for that scan.

For example, if the space flag for (row,column) combination (87,258) has a value 51 (= 33 hex), it means that (row (pixel) 87, column 258) was identified as a space pixel for scans SW 1, TOTAL 1, SW 3 and TOTAL 3, but was not identified as such for scans SW 2 and TOTAL 2.

4.1.3.63 Total Gain Image n (n = 1, 2, 3) [Dataset]

As for Short Wave Gain Image 1, but for Total Image 1/2/3.

HDF Path: "/Radiometry/Total Gain Image 1"
"/Radiometry/Total Gain Image 2"
"/Radiometry/Total Gain Image 3"

4.1.3.64 Total Offset (Mean) Image n (n =1, 2, 3) [Dataset]

As for Short Wave Offset (Mean) Image 1, but for Total Image 1/2/3.

HDF Path: "/Radiometry/Total Offset (Mean) Image 1"
"/Radiometry/Total Offset (Mean) Image 2"
"/Radiometry/Total Offset (Mean) Image 3"

4.1.3.65 Total Offset (Standard Deviation) Image n (n = 1, 2, 3) [Dataset]

As for Short Wave Offset (Standard Deviation) Image 1, but for Total Image 1/2/3.

HDF Path: "/Radiometry/Total Offset (Standard Deviation) Image 1"
"/Radiometry/Total Offset (Standard Deviation) Image 2"
"/Radiometry/Total Offset (Standard Deviation) Image 3"

4.1.3.66 Total Radiance Image n (n = 1, 2, 3) [Dataset]

As for Short Wave Radiance Image 1, but for Total Image 1/2/3.

HDF Path: "/Radiometry/Total Radiance Image 1"

"/Radiometry/Total Radiance Image 2"
"/Radiometry/Total Radiance Image 3"

4.1.3.67 Times [Group]

Description: Group containing packet timing information.

HDF Path: "/Times/"

4.1.3.68 First GERB Packet [Attribute]

Description: UTC acquisition time of the first GERB packet used in deriving this product.

HDF Path: "/Times/First GERB Packet"

Data Type: H5T_C_S1

Data is in UTC format defined in overview, to second accuracy.

4.1.3.69 Last GERB Packet [Attribute]

Description: UTC acquisition time of the last GERB packet used in deriving this product.

HDF Path: "/Times/Last GERB Packet"

Data Type: H5T_C_S1

Data is in UTC format defined in overview, to second accuracy.

4.1.3.70 Short Wave Image n (n = 1, 2, 3) [Group]

Description: This subgroup of Times contains onboard and UTC times for the first SW scan covered in the NANRG file

HDF Path: "/Times/Short Wave Image 1/"
"/Times/Short Wave Image 2/"
"/Times/Short Wave Image 3/"

If there is no first/second/third SW scan to be covered, the group will still be present, but will be empty i.e. the constituent datasets will not be defined.

Note that groups of the same name also exist as subgroups of the "Geolocation" group.

4.1.3.71 Onboard Time (per column) [Dataset]

Description: One dimensional dataset containing onboard time for each column (packet) of the scan in question.

HDF Path: "/Times/Short Wave Image 1/Onboard Time (per column)"
"/Times/Short Wave Image 2/Onboard Time (per column)"
"/Times/Short Wave Image 3/Onboard Time (per column)"
"/Times/Total Image 1/Onboard Time (per column)"
"/Times/Total Image 2/Onboard Time (per column)"
"/Times/Total Image 3/Onboard Time (per column)"

Data Type: H5T_C_S1

Data is written out as a character string containing a decimal integer representing the onboard time (see overview). The precise time written out is the onboard time of the Start of Line pulse following the packet in question.

Invalid values are written out as "99999999999999999" (17 digits).

The dataset only exists for scans which exist.

4.1.3.72 UTC Time (per column) [Dataset]

Description: One dimensional dataset containing UTC time for each column (packet) of the scan in question.

HDF Path: "/Times/Short Wave Image 1/UTC Time (per column)"
"/Times/Short Wave Image 2/UTC Time (per column)"
"/Times/Short Wave Image 3/UTC Time (per column)"
"/Times/Total Image 1/UTC Time (per column)"
"/Times/Total Image 2/UTC Time (per column)"
"/Times/Total Image 3/UTC Time (per column)"

Data Type: H5T_C_S1

Data is written out as a character string containing a decimal integer representing the onboard time (see overview). The precise time written out is the onboard time of the SOL pulse following the packet in question.

Invalid values are written out as "INVALID_UTC_TIME"

The dataset only exists for scans which exist.

4.1.3.73 Total Image n (n = 1, 2, 3) [Group]

Description: This subgroup of Times contains onboard and UTC times for the first/second/third Total scan covered in the NANRG file.

HDF Path: "/Times/Total Image 1/"
"/Times/Total Image 2/"
"/Times/Total Image 3/"

If there is no first/second/third Total scan to be covered, the group will still be present, but will be empty i.e. the constituent datasets will not be defined.

Note that groups of the same name also exist as subgroups of the "Geolocation" group.

4.2 Level 1.5 Geolocation (L15_GEO) Product

4.2.1 Overview

This product contains the geolocation coordinates to be used in conjunction with the filtered radiances in the Level 1.5 NANRG file. Each file contains geolocation coordinates for one Earth scan: there are normally six geolocation files matching each (6 scan) NANRG file. Matching of the Level 1.5 NANRG file with the correspnding L15_GEO files can be done from the timestamps in the filenames: in addition each L15_GEO file carries the filename of the corresponding NANRG.

The L15_GEO product is described fully in the RMIB User Guide [AD 1], but for convenience a short overview is given here.

4.2.1.1 Matching L1.5 NANRG and L15_GEO files

The matching between a Level 1.5 NANRG file and its corresponding L15_GEO files is evident from the timestamps in the filenames. Given a Level 1.5 NANRG file, it is possible to predict what the matching L15_GEO files will be, using data within the (NANRG) file; the reverse is also possible.

L15_GEO → NANRG. Each L15_GEO file carries the filename of the corresponding NANRG (attribute "/GGSPS/L1.5 NANRG File Name").

NANRG → L15_GEO. The filenames of L15_GEO files matching a particular NANRG can be predicted exactly from timestamps contained within the NANRG. These timestamps are found in the "UTC Times per Column" datasets within the "Times" group. There is one such dataset for each scan: for SW scans the timestamp given corresponds to column 0, while for TOTAL scans it corresponds to column 281 (i.e. the last column).

L1.5 NANRG Filename	Scan	UTC Time per Column	L15_GEO Filename
G2_L15N_20060901_200029_ED01	SW1	20:00:29.7	G2_SEV1_L15_GEO_SW_20060901_200030_ED01
	TOT1	20:03:19.3	G2_SEV1_L15_GEO_TW_20060901_200319_ED01
	SW2	20:06:08.9	G2_SEV1_L15_GEO_SW_20060901_200609_ED01
	TOT2	20:08:58.4	G2_SEV1_L15_GEO_TW_20060901_200858_ED01
	SW3	20:11:47.9	G2_SEV1_L15_GEO_SW_20060901_201148_ED01
	TOT3	20:14:37.47	G2_SEV1_L15_GEO_TW_20060901_201437_ED01

The table above shows an example of filenames of a Level 1.5 NANRG and its matching L15_GEO files. Note that the timestamp in the L15_GEO filename is rounded to the nearest whole second; whereas the timestamp in the Level 1.5 NANRG filename is truncated, which (as in this case) can sometimes give inconsistencies between the timestamps in the L1.5 NANRG filename and the SW1 L15_GEO filename (these should in principle be the same).[9]

[9] Inconsistencies between the L1.5 NANRG and SW1 L15_GEO timestamps can also arise because the Level 1.5 NANRG timestamp is not necessarily derived from the same clock calibration data as that available for "UTC Time per Column": the latter should be more accurate.

4.2.1.2 Geolocation Values (Latitude and Longitude)

The principle fields of interest are the geolocation values themselves. These are stored in datasets labelled "Latitude (degrees)" and "Longitude (degrees)", and are contained within an overall "Geolocation" group. Unlike the filtered radiance values in the NANRG (which are encoded into 2-byte integers using a quantisation factor), the geolocation values in the L15_GEO product are given directly as 4-byte floating point values. Pixels which do not view the Earth are given a default value of '0'.

The latitude and longitude are given for the point where the GERB Line of Sight intersects the Reference Ellipsoid. The Reference Ellipsoid is a representation of the surface of the Earth; it is an ellipsoid defined by a polar radius (R_P) and an equatorial radius (R_E). It is the geodetic (or geographic) latitude which is supplied: this is defined with respect to the perpendicular to the reference ellipsoid at a particular point (as opposed to the geocentric latitude, which is defined with reference to the radial direction at that point).

This is illustrated in the figure below. The geodetic latitude is the angle between the perpendicular vector AP and the equatorial plane; the geocentric latitude is the angle between the radial vector OP and the equatorial plane. Geodetic and geocentric latitudes are related by:

$$\tan(\theta_d) = (R_E / R_P)^2 \tan(\theta_c)$$

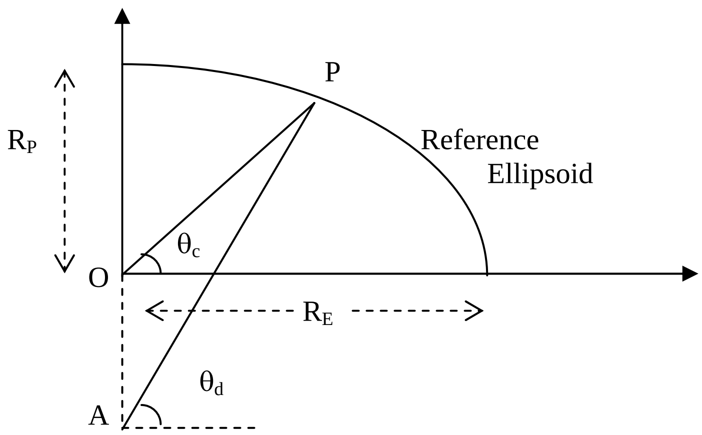


Figure 7. Geocentric (θ_c) and geodetic (θ_d) latitude of a point P on the surface of the reference ellipsoid, which is defined by a polar radius (R_P) and an equatorial radius (R_E). The geocentric latitude is the angle between the radial vector OP and the equatorial plane. The geodetic latitude is the angle between the vector perpendicular to the reference ellipsoid at the point P (AP) and the equatorial plane. Geodetic latitude is the one used for latitude coordinates in the NANRG (and ARG) products.

The geolocation coordinates supplied are for the “centre” of the pixel. This is defined as the centroid of the PSF of each pixel as determined experimentally during calibration at Imperial. A correction is made to the PSF using optical models to allow for deformations caused by the 16g rotation effects and 0g gravity experienced in space.

The two dimensional arrays of latitude and longitude values are given in the same order as the filtered radiances are given in the NANRG (i.e. row by row from north to south, with each row running west to east). There is a one-to-one correspondence between geolocation coordinates given in the L15_GEO product, and filtered radiance values from the matching scan in the corresponding Level 1.5 NANRG product.

4.2.1.3 Other Fields of Interest

There are other fields which may be useful when using the L15_GEO product.

- **Number of columns** and **Number of detectors** attributes define the overall size of the two-dimensional datasets holding the latitude and longitude coordinates.
- **Earth Flag** is a two dimensional array whose value indicates whether each pixel is viewing the Earth (255), space (0) or does not contain valid data (1). There is a one to one correspondence to values in the latitude and longitude datasets.
- **L1.5 NANRG File Name** specifies which NANRG matches this geolocation file.
- **Radiation Type Identifier** specifies whether this is a “SW” or “TW” (Total) scan (this information is also present in the file name).

- **Edition** attribute specifies the edition number and confirms that this product is part of an Edition release.

4.2.2 Hierarchical Data Structure

The position within the HDF hierarchy of the most important data items is given below. A full listing of the HDF hierarchy of the L15_GEO product is included in the RMIB User Guide [AD 1].

Hierarchical Structure	Type
/	Group
/File Name	Attribute
/Radiation Type Identifier	Attribute
/Edition	Attribute
/GGSPS/	Group
/GGSPS/L1.5 NANRG File Name	Attribute
/Geolocation/	Group
/Geolocation/Number of columns	Attribute
/Geolocation/Number of detectors	Attribute
/Geolocation/Earth Flag	Dataset
/Geolocation/Latitude (degrees)	Dataset
/Geolocation/Longitude (degrees)	Dataset

4.2.3 Detailed Items

For a detailed explanation of each item in the L15_GEO product, please see the RMIB User Guide [AD 1].

4.3 Level 1.5 ARG Filtered Radiance Product

This product has not been finalised for edition release. Its description will be included in this guide at such time as it becomes part of the edition climate data archive.

4.4 Level 2 ARG Products

For a description of the Level 2 ARG Products, please see the RMIB User Guide [AD 1].

4.5 Level 2 BARG Products

For a description of the Level 2 BARG Products, please see the RMIB User Guide [AD 1].

5. DATA ACCESS

Access to released GERB data is available through the GGSPS web site at

http://ggsps.rl.ac.uk/

and also via the British Atmospheric Data Centre (BADC) at

http://badc.nerc.ac.uk/

This document describes access using the GGSPS; see the BADC web pages for more information on access via that route.

Using the GGSPS web pages, authorised users can query an on-line catalogue of available products, specifying the product type and required date ranges, and can access these products for download.

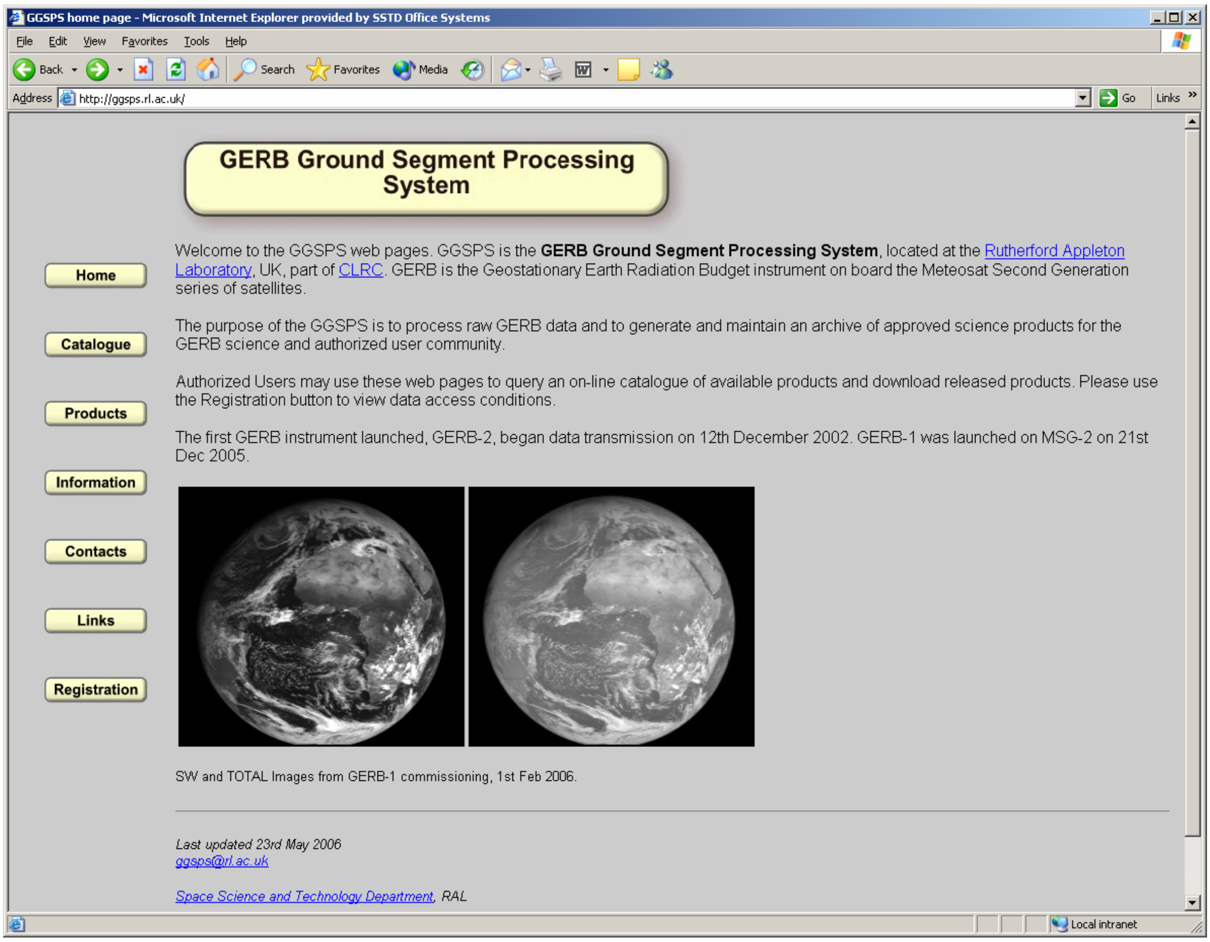


Figure 11: GGSPS Web Site Home Page

5.1 Registration

In order to become an authorised user of GERB data, please contact the GERB Project Team at Imperial College (gerb@imperial.ac.uk), including a brief description of the research for which you intend to use the data. You will need to comply with the terms of the GERB Data Policy, which is included in Appendix A (Section 7) and also available on the GGSPS website.

For up to date information on registration procedures and the terms of the GERB Data Policy, click on the "Registration" button on the GGSPS web site home page.

5.2 Catalogue Searches

To perform a search of the GGSPS catalogue, click on the "Catalogue" button on the GGSPS home page. Note that a catalogue search only gives a list of available files, not access to the files themselves. You will be presented with the page illustrated below.

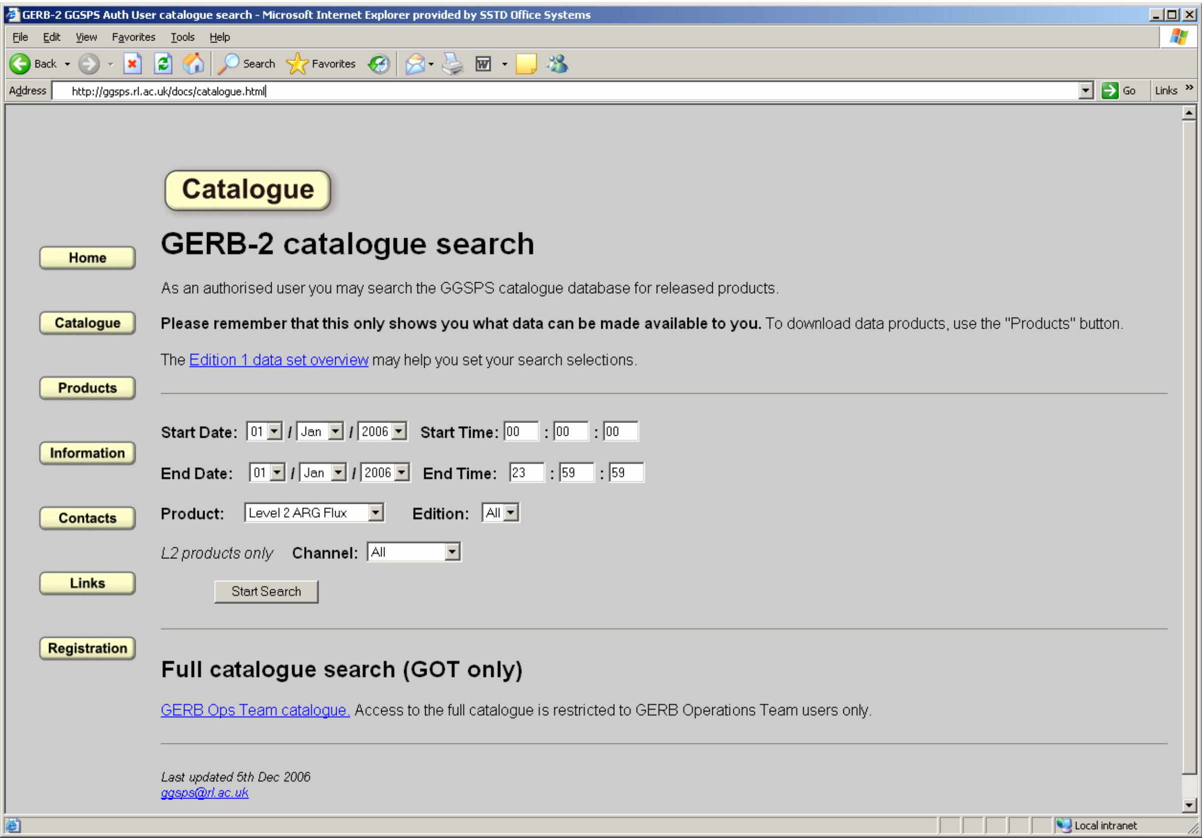


Figure 12: Catalogue Search Web Page

You can then use the following fields in specifying the catalogue search:

- **Start Date/Start Time**. Together specify the earliest data to be included in the search
- **End Date/End Time**. Together specify the latest data to be included in the search
- **Product**. Type of product to be selected (see below). One product type must be selected
- **Edition**. Select a particular edition, or all editions.
- **Channel**. For level 2 products, select a specific channel (Thermal, Solar or both) .

When selecting start and end times, please be careful not to make the search criteria too wide: restrict searches to periods of not more than a few days. This will prevent the database server from becoming overloaded.

The product types are:

- **Level 1.5 NANRG** (see sections 3.1 and 4.1).
- **Level 2 ARG Flux**. The Level 2 ARG unfiltered radiance and flux product generated by the RGP at RMIB.
- **L2 ARG Geolocation**.A companion product to the level 2 ARG flux product, this defines the coordinates in longitude and (geodetic) latitude at the Earth's surface of each point on the rectification grid used in the ARG flux product.

Once selections have been made, click on the "Start Search" button. A results page similar to the following will be returned to you.

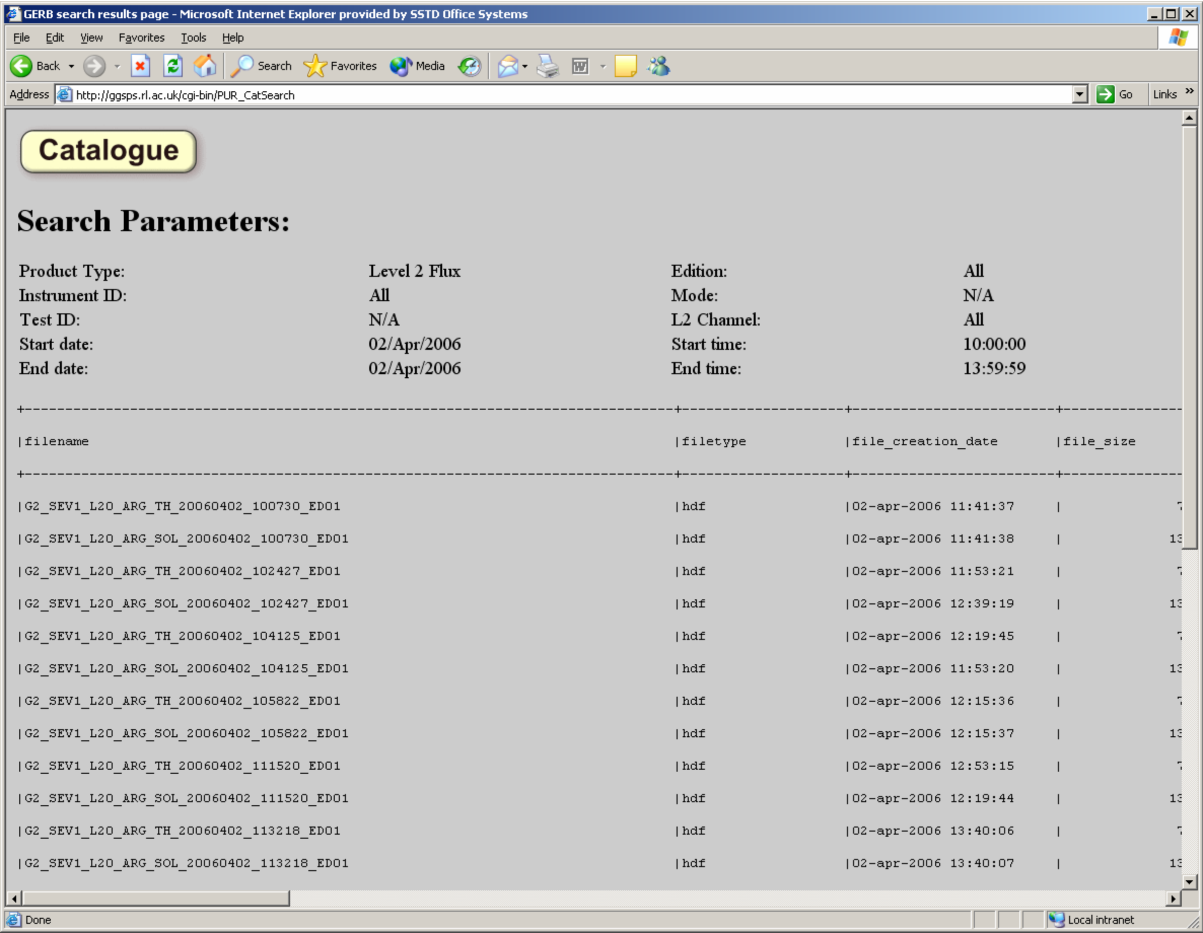


Figure 13: Results page from catalogue search

After confirming the parameters used in the search, a list of products meeting these criteria will be given, each new product on a new line. Selected catalogue fields for each product will be listed. A full list of these fields, and their meaning, is given in Appendix B (Section 8). To modify the search criteria, or to access other parts of the GGSPS web site, please use the "Back" button on your web browser to return to the Catalogue Search Web Page.

5.3 Access to Data Products

To access GERB data, click on the "Products" button on the GGSPS home page. Access to GERB data is password protected, and you will be required to supply the appropriate user name and password given to you on registration. You will be presented with a page similar to the one illustrated below.

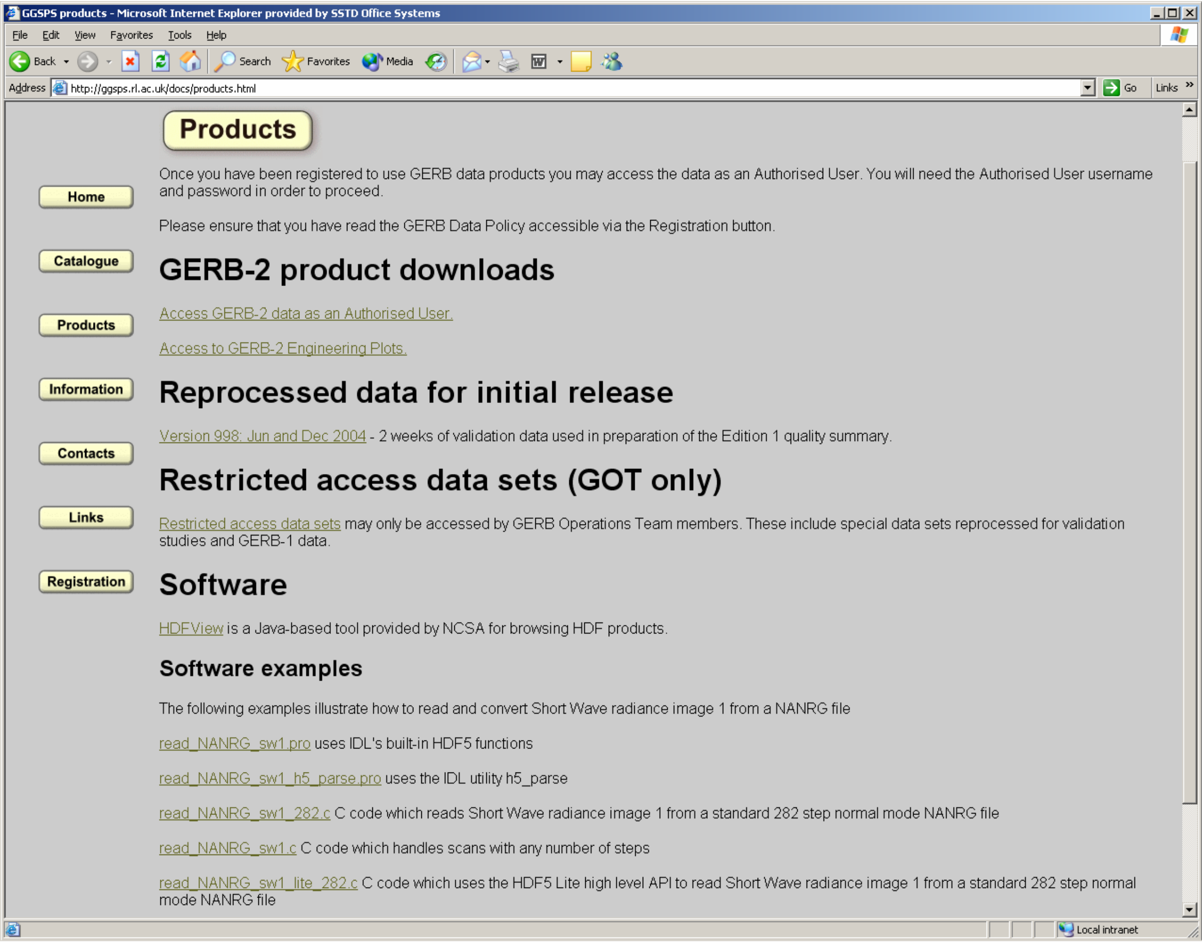


Figure 14: Products page

To access data products, select the first option ("Access GERB-2 data as an Authorised User"). This then links you to the authorised user product page as displayed below. This page contains a link to the Edition 1 quality summaries ([AD 2], [AD 3]) which you are required to read as part of the registration conditions.

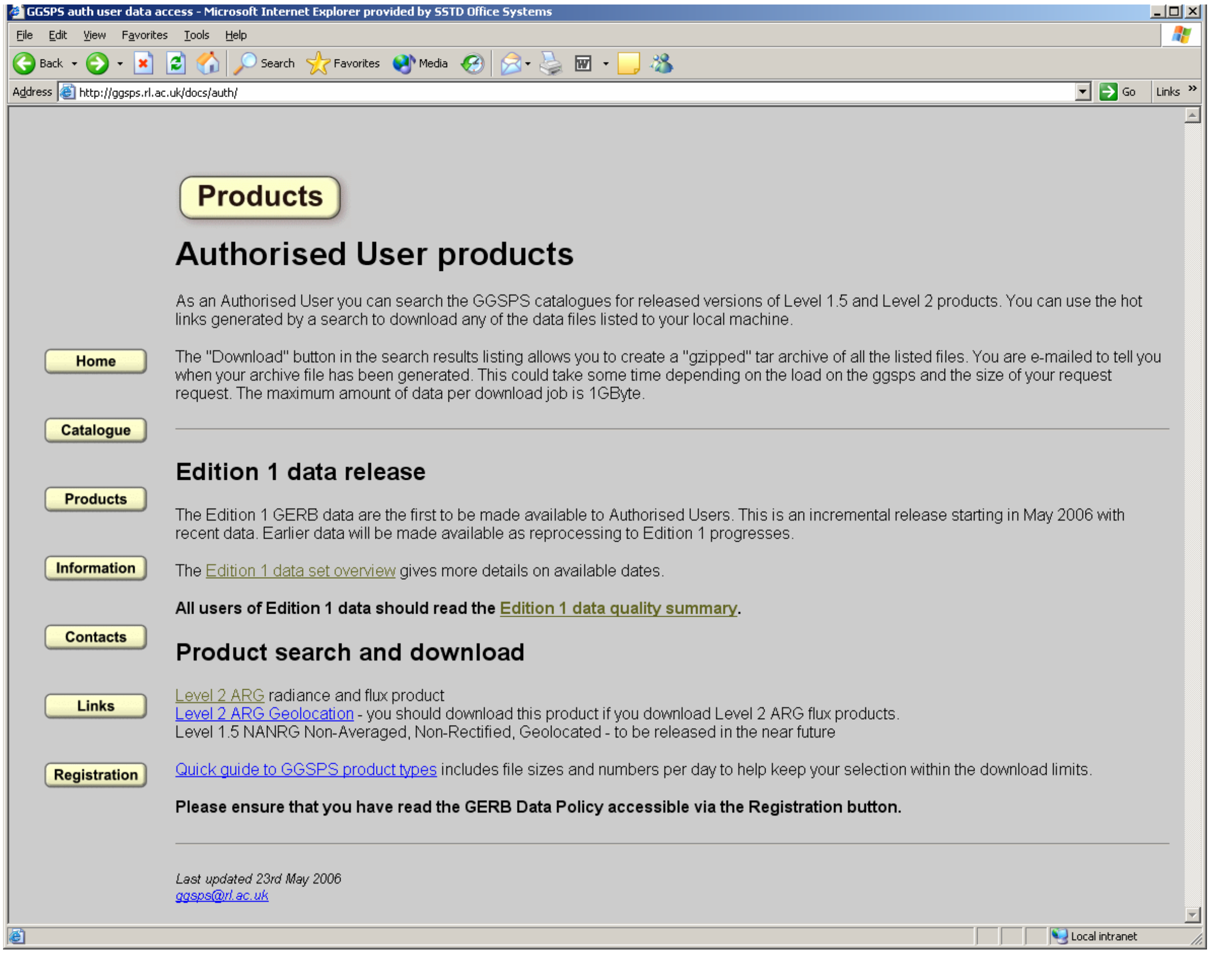


Figure 15: Authorised User Products page

To access data, choose the link for the specific product required (for example, “Level 2 ARG”). You will then be presented with a catalogue selection page similar to that shown in section 5.2, but with search options tailored for the specific product selected. Proceed exactly as for a catalogue search; however, when the search results are returned, each filename will be a link which can be clicked in order to download the file concerned.

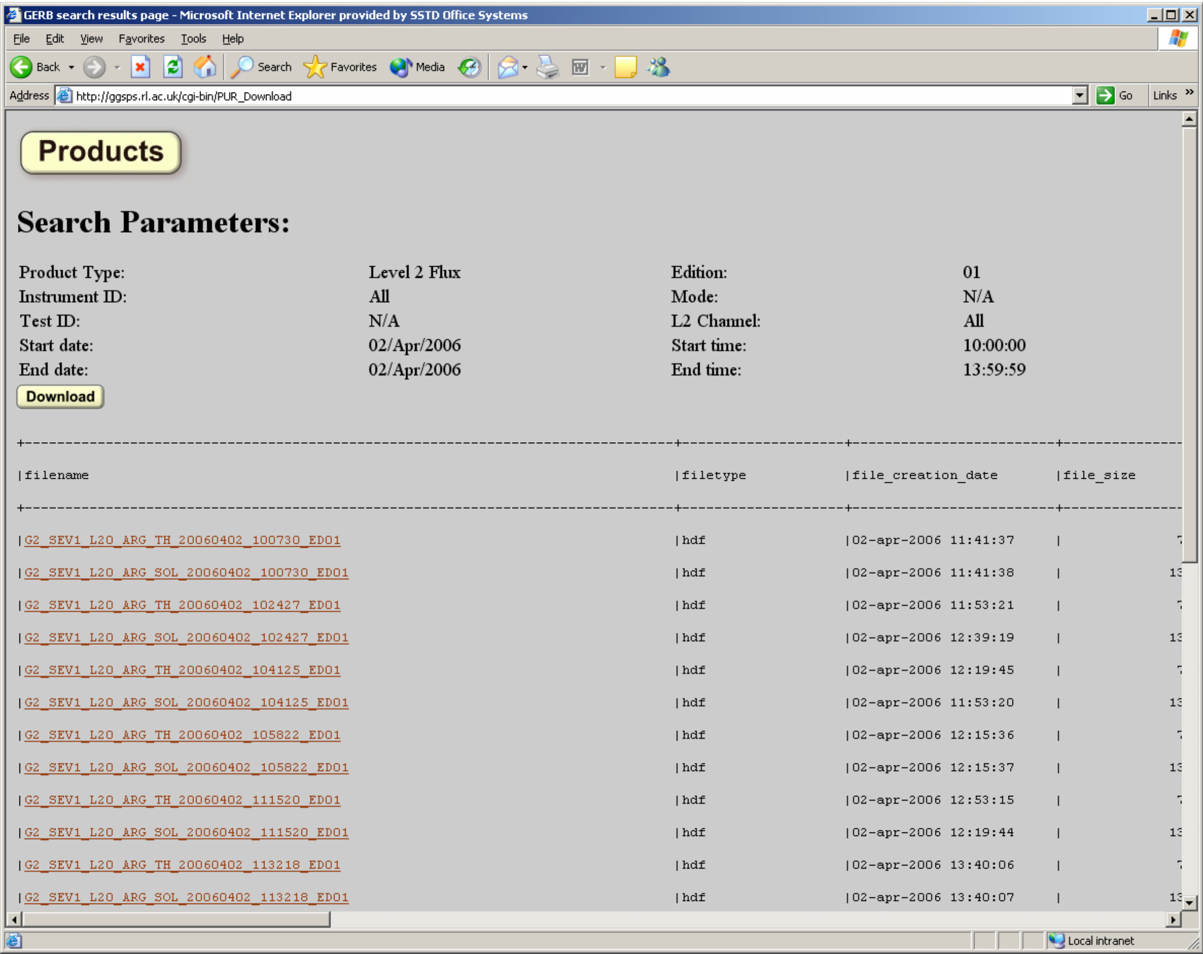


Figure 16: Results page from products search

As for ordinary catalogue searches, please be careful not to make the search criteria too wide: restrict searches to periods of not more than a few days. The "Products" page additionally imposes a hard limit of 1GB on the total volume of products which can be selected and downloaded (this corresponds to about 4 days of NANRG products or 6 days of level 2 ARG products).

In order to download all the files passing a specific set of selection criteria, a "Download" button is supplied at the top and bottom of the page. If you click on this button, you will be asked to supply an e-mail address. You will then be e-mailed when a zipped file containing all of the selected products has been prepared (this should normally take a few minutes); the e-mail will contain a link to this zipped file which can be clicked on to download the file. Note you will only have a limited period to react to this e-mail and collect the file. As already noted, a maximum of 1 GB can be downloaded in one operation using this method.

5.3.1 Access to the L15_GEO Product

Access to the L15_GEO product is different, because this product does not have its own catalogue table. Catalogue queries and product searches are not possible for this product type.

Instead, a link to the directory tree housing these products is supplied along with the results of searches for the Level 1.5 NANRG product. The directory tree will be subdivided into year, month amd day, such that each individual directory will contain all the files for one day. A tar file containing all the day's L15_GEO products bundled into one file will be made available in the same directory.

5.4 Example Software

Example read software in C and IDL is available to read the Level 1.5 NANRG files. This is available through the Products page (click on "Products" from the GGSPS home page). Note however that in order to read the GERB Edition 1 products:

- using a C program, it will be necessary to link to version 1.6.1 or greater of the HDF5 library.
- using IDL, version 6.1 or greater will be needed.

Examples of how to read HDF files are also given in section 6.

5.5 Further Help

A range of support information can be accessed by clicking on the "Information" button on the GGSPS home page (the button is also available on other pages such as the catalogue and products pages). This includes help on using the web site, access to key documentation such as the quality summaries and user guides, and further support information on the GERB-2 instrument and calibration, and the Edition1 dataset. Note that the example read software is available from the products page.

If you have a question about access to or use of the GERB data, then the GERB project should be contacted as follows:

- to register as an authorised user, contact the GERB project team at Imperial College (gerb@imperial.ac.uk) - see Section 5.1;
- for problems accessing data or relating to the use of the GGSPS web site, contact the GGSPS team (ggsps@rl.ac.uk);
- questions regarding the data and its use may be addressed to the GERB project team at Imperial (gerb@imperial.ac.uk) or RMIB (gerb@oma.be).

The contacts page on the web site also contains details of how to contact the GERB project.

6. READING HDF FILES

The GERB scientific products are written in HDF 5 format. HDF (Hierarchical Data Format) is a file format supported by The HDF Group, a corporation spun off from the US National Center for Supercomputer Applications (NCSA), and the associated software is freely available from their web site at

http://www.hdfgroup.org/

There are two types of HDF format, HDF4 (and earlier versions), and HDF5. The two formats are not compatible: the GERB products are written in HDF5 format.

Moreover, the GERB Edition 1 products are written using HDF5 version 1.6.5. The format of these products is compatible only with HDF5 version 1.6.1 and following: any programs or utilities used to read GERB products must use HDF5 version 1.6.1 or a later version.

There are three main ways of reading HDF files.

- HDF Standard Tools
- IDL
- The HDF APIs

These will be discussed in turn below.

6.1 HDF Standard Tools

HDF provide a number of standard tools for visualising and printing HDF files. They are a useful starting point for learning about the contents of an HDF file.

- **h5dump** provides a text listing of either the entire contents of an HDF file, or of the hierarchical structure of the file ("-header" option). The output from this tool will be quite lengthy.
- **h5ls** provides a text listing of the hierarchical structure of the file.
- **H5View** is a Java based viewer which can be used for both browsing and editing HDF files.

All are available from the HDF web site.

6.2 IDL

IDL provides built-in functionality for reading HDF5 files. In order to read the GERB Edition 1 files, version 6.1 or greater will be required. To obtain IDL, see the ITT Visual Information Solutions (formerly RSI) website at

http://www.ittvis.com/

IDL permits easier access to the data than is attained using the HDF APIs, and of course allows for rapid visualisation of the data.

In the HDF 5 format, the full group hierarchy of the data is still present. Therefore to get at a particular dataset, one needs to:

- open the file;
- open the root group;
- open any lower level groups;

- open the dataset;
- read the dataset;
- close the dataset, groups and file.

So the following IDL code illustrates how to open an HDF5 NANRG file, read the filtered radiances for SW scan 1 and convert their units. The filtered radiances for SW scan 1 can be found in the radiometry group, which can in turn be found in the top level group, the root group. Note that for any of the open commands, be it for a group or dataset, one gives the id of the parent group (or, for the root group, the overall file id) and the name of the target dataset/group.

```
PRO read_NANRG_sw1, FileName

; define number of columns in image

ncol   = 282
npixel = 256

; define file, dataset (radiance SW scan 1),
; quantisation factor attribute to be read

ROOT_GROUP = '/'
RADIOMETRY_GROUP = 'Radiometry'
SW_1 = 'Short Wave Radiance Image 1'
QUANTISATION_FACTOR = 'Quantisation Factor'

; open HDF file ... H5F_OPEN returns an identifier which
;   can be used to access the file in subsequent calls

FILE_ID = H5F_OPEN(FileName)

; open root and radiometry groups

root_group_id = H5G_OPEN(FILE_ID,ROOT_GROUP)
radiometry_group_id = H5G_OPEN(root_group_id,RADIOMETRY_GROUP)

; open and read the dataset

SW1_ID = H5D_OPEN(radiometry_group_id,SW_1)
SW1Data = H5D_READ(SW1_ID)

; SW1Data contains the radiance values encoded as
; 2 byte integers. To convert them to radiance values, need to
; open and read the quantisation factor attribute

ATT_ID = H5A_OPEN_NAME(SW1_ID,QUANTISATION_FACTOR)
SW1_QF_Data = H5A_READ(ATT_ID)

; close attribute and dataset

H5A_CLOSE, ATT_ID
H5D_CLOSE, SW1_ID

; close groups

H5G_CLOSE, radiometry_group_id
H5G_CLOSE, root_group_id

; close file

H5F_CLOSE, FILE_ID

; and then convert to radiance values for this dataset

; SW1Data contains the encoded (2 byte integer) values
; SW1Rad will contain the actual (floating point) values

; note IDL has loose typing (IDL can change the type of
; a variable from line to line): the following sequence
; ensures that SW1Rad remains a 2D floating point array
; throughout

SW1_QF = SW1_QF_Data[0]
SW1Rad = fltarr(ncol,npixel)
SW1Rad(0:(ncol-1),0:(npixel-1)) = float(SW1Data)
```

```
SW1Rad(0:(ncol-1),0:(npixel-1)) = SW1Rad * SW1_QF

; do anything with the data
; this prints column 140 row (pixel) 128

print, 'SW1Rad[140,128] = ',SW1Rad[140,128]

END
```

Alternatively, one can include the full hierarchical structure of the target dataset using what is called the absolute path name, to bypass opening the intermediate groups. The HDF file structure can be navigated rather like a UNIX directory structure, and one can use relative path names, as in the previous example, or absolute path names. So, if we define

```
SW_1 = '/Radiometry/Short Wave Radiance Image 1'
```

(an absolute path name), then we can gain access to this dataset simply by opening the file and then opening the dataset directly:

```
FILE_ID = H5F_OPEN(FileName)
SW1_ID = H5D_OPEN(FILE_ID,SW_1) ;give the FILE_ID here, not the radiometry group id
```

and then proceed as before.

IDL provides two standard utilities, **h5_browser** and **h5_parse**, for looking at HDF5 files, and loading the data into structures.

- **h5_parse** can be used to read the entire contents of an HDF5 file into an IDL structure whose hierarchy is equivalent to that in the HDF5 file, and whose structure members have similar names to those of the original HDF5 groups, datasets and attributes (spaces in HDF names will be replaced by underscores in the IDL names).
- **h5_browser** will present the user with a GUI which can be used to browse interactively the contents of the HDF5 file and to load selected datasets and attributes into IDL structures.

The previous example can be modified to use h5_parse as follows:

```
PRO read_NANRG_sw1_h5_parse, FileName

; define number of columns in image

ncol   = 282
npixel = 256

; read the HDF file

NANRG = h5_parse(FileName, /READ_DATA)

; values from FileName will be loaded into a structure "NANRG" ; structure member names will
be related to corresponding group,
;   dataset and attribute names in NANRG
; to see structure member names, do
; help, NANRG, /struct
; help, NANRG.RADIOMETRY, /struct
;  etc.

SW1Data     = NANRG.RADIOMETRY.SHORT_WAVE_RADIANCE_IMAGE_1._DATA
SW1_QF_Data = NANRG.RADIOMETRY.SHORT_WAVE_RADIANCE_IMAGE_1.QUANTISATION_FACTOR._DATA

; and then convert to radiance values for this dataset

; SW1Data contains the encoded (2 byte integer) values
; SW1Rad will contain the actual (floating point) values

; note IDL has loose typing (IDL can change the type of
; a variable from line to line): the following sequence
; ensures that SW1Rad remains a 2D floating point array
; throughout
```

```
SW1_QF = SW1_QF_Data[0]
SW1Rad = fltarr(ncol,npixel)
SW1Rad(0:(ncol-1),0:(npixel-1)) = float(SW1Data)
SW1Rad(0:(ncol-1),0:(npixel-1)) = SW1Rad * SW1_QF

; do anything with the data
; this prints column 140 row (pixel) 128

print, 'SW1Rad[140,128] = ',SW1Rad[140,128]

END
```

6.3 HDF APIs

HDF provides APIs (Application Programming Interfaces) for a number of programming languages including:

- Fortran90;
- C;
- C++;
- Java.

These allow one to write one's own program to read and process HDF5 files, simply by linking to the appropriate library (and inclusion of the relevant header files where appropriate). The libraries and header file are available from the HDF web site at the top of this section.

Here is given an example of a C program which carries out the same task of reading the filtered radiances for SW scan 1 from a NANRG file and converting them into the appropriate units. It appears longer than the IDL examples, because error handling is included, but it essentially goes through the same process of opening the file, groups, and dataset, reading the dataset, opening, reading the quantisation factor attribute, and then closing the dataset, groups and file, and finally converting the dataset read back into proper units using the quantisation factor. Note that specific NANRG datasets may not always be of a fixed size from product to product, but may have differing numbers of columns. IDL automatically dimensions the returned arrays appropriately, but in C code the user has to take care of that. There are three ways of doing this:

- declare the array into which you read the dataset to be large enough to accommodate the dataset you are reading (the simplest way, the only way of avoiding dynamically declaring arrays using malloc/calloc) - this is the way used in the example below;
- read the number of columns attributes in the radiometry group - this is the only variable in the size of the datasets, so the arrays can then be declared accordingly (an additional example illustrating this method is available on the GGSPS web site);
- associated with each dataset is a dataspace which stores the information on type, dimensions and size of the dataset, the HDF API provides functions to extract this information from the dataspace (H5Dget_space, H5Sget_simple_extent_npoints) - use these functions to determine the extent of the dataset and declare the arrays accordingly (this way is by far the most complicated).

Using fixed, pre-defined array sizes as in the example below should be adequate if only Edition normal mode data are to be read - these products all contain scans of 282 columns. Different scan lengths are only encountered in data taken in other instrument modes (scanning patterns), or during the early commissioning of GERB-2. Note that the rectified products (level 1.5 and level 2 ARG, level 2 BARG) have fixed grid and hence dataset sizes, so pre-defined array sizes should be perfectly adequate for these.

Also be aware that some NANRGs contain fewer than 6 scans, so it is possible that one or more of the expected datasets will be missing.

```
#include <stdio.h>
```

```
#include <string.h>
#include "hdf5.h"

#define GRP_ROOT                  "/"
#define GRP_RADIOMETRY            "Radiometry"
#define DST_SW_RADIANCE_IMAGE_1  "Short Wave Radiance Image 1"
                                         /* dataset title          */
#define ATT_QUANTISATION_FACTOR "Quantisation Factor"
#define PRODUCT_NAME_LENGTH      80      /* max. length of filename */
#define STATUS_OK                 0      /* status values          */
#define ERROR                     1
#define NCOL                    282      /* number of columns in each image  */
#define NPIXEL                  256      /* number of GERB pixels   */

#define MODULE   "read_NANRG_sw1_282"

int main(int argc, char *argv[]) {

   int status = STATUS_OK;         /* status to be returned to main function */
   hid_t file_id = -1;             /* HDF5 identifier for file */
   hid_t root_group_id = -1;       /* HDF5 identifier for root group */
   hid_t radiometry_group_id = -1; /* HDF5 identifier for radiometry group */
   hid_t SW1_dataset_id = -1;      /* HDF5 identifier for SW1 radiance dataset */
   hid_t attr_qf_id = -1;          /* HDF5 identifier for quantisation factor  */
                                   /*    attribute SW scan 1 */
   short data_array[NPIXEL][NCOL]; /* pointer to data to be read from dataset  */
   double converted_array[NPIXEL][NCOL];  /* pointer to array holding          */
                                   /*          converted data                  */
   double quantisation_factor = 0.0;  /* quantisation factor for SW scan 1     */
   int icol;                       /* counter/index over columns of image      */
   int irow;                       /* counter/index over rows of image         */
   char filename[PRODUCT_NAME_LENGTH];

   /* set filename from command line argument */

   if (argc > 1) {
      strcpy(filename,argv[1]);
   }
   else {
      printf("%s: No filename supplied\n",MODULE);
      status = ERROR;
   }

   /* open HDF file */

   if ((file_id = H5Fopen(filename, H5F_ACC_RDONLY, H5P_DEFAULT)) < 0) {
      printf("Can not open HDF file %s\n", filename);
      status = ERROR;
   }

   if (status == STATUS_OK) {          /* open root group */
      if ((root_group_id = H5Gopen(file_id,GRP_ROOT)) < 0) {
         printf("Can not open root group for HDF file %s\n", filename);
         status = ERROR;
      }
   }
   if (status == STATUS_OK) {          /* open radiometry group */
      radiometry_group_id = H5Gopen(root_group_id,GRP_RADIOMETRY);
      if (radiometry_group_id < 0) {
         printf("Can not open radiometry group for HDF file %s\n", filename);
         status = ERROR;
      }
   }

   /* open SW1 radiance dataset */

   if (status == STATUS_OK) {
      if ((SW1_dataset_id = H5Dopen(radiometry_group_id, DST_SW_RADIANCE_IMAGE_1)) < 0) {
         printf("Can not open SW 1 radiance dataset for HDF file %s\n", filename);
         status = ERROR;
      }
   }

   if (status == STATUS_OK)   {
       /* Read the dataset - H5T_NATIVE_SHORT specifies we are reading a dataset
           of short signed integers (32 bits)
           H5S_ALL indicates the entire dataset is read.
```

```
           H5P_DEFAULT specifies data transfer properties  */

       /* note data_array is a 2-dimensional array   */
       /* data_array[0] is a pointer to short int and points to first element */
       /*  in this 2D array                                                   */

       if ((status = H5Dread(SW1_dataset_id, H5T_NATIVE_SHORT, H5S_ALL, H5S_ALL,
                    H5P_DEFAULT, data_array[0])) < 0) {
          printf("Error reading SW 1 radiance dataset for HDF file %s\n", filename);
          status = ERROR;
       }
   }

   /* and read quantisation factor attribute attached to dataset */

   if (status == STATUS_OK) {
      if ((attr_qf_id = H5Aopen_name(SW1_dataset_id, ATT_QUANTISATION_FACTOR)) < 0) {
         printf("Can not open SW rad scan 1 quantisation factor attribute for HDF file %s\n",
                filename);
         status = ERROR;
      }
   }
   if (status == STATUS_OK) {
      /* Note H5Aread requires a pointer for value of attribute */
      if (H5Aread(attr_qf_id, H5T_NATIVE_DOUBLE, &quantisation_factor) < 0) {
        printf("Error reading SW rad scan 1 quantisation factor attribute for HDF file %s\n",
                 filename);
         status = ERROR;
      }
   }
   if (attr_qf_id > -1) H5Aclose(attr_qf_id);

/*    close dataset */

   if (SW1_dataset_id > -1) H5Dclose(SW1_dataset_id);

/*    close groups */

   if (radiometry_group_id > -1) H5Gclose(radiometry_group_id);
   if (root_group_id       > -1) H5Gclose(root_group_id);

/*    close file   */

   if (file_id             > -1) H5Fclose(file_id);

/*  and convert the dataset */

   for (irow = 0; irow < NPIXEL; irow++) {
      for (icol = 0; icol < NCOL; icol++) {
         converted_array[irow][icol] = ((double) data_array[irow][icol]) *
                                  quantisation_factor;
      }
   }

   /* do whatever you want with the data - here we just print it out */

   printf("converted_array[128][140] = %f\n",
          converted_array[128][140]);

   return status;
}
```

6.3.1 HDF High Level APIs

HDF have provided a number of high level APIs to simplify the way objects are handled in HDF. In particular, the HDF5 Lite (H5LT) API simplifies the way datasets and attributes are created and read: in many cases the required option can be reduced to a single call. The high level APIs act as wrapper functions which in turn call functions from the standard HDF5 API.

The preceding example, modified to use the equivalent H5LT functions, is given here.

```
#include <stdio.h>
#include <string.h>
#include "hdf5.h"
#include "H5LT.h"

#define GRP_ROOT                  "/"
#define GRP_RADIOMETRY            "Radiometry"
#define DST_SW_RADIANCE_IMAGE_1  "Short Wave Radiance Image 1"
                                     /* dataset title           */
#define ATT_QUANTISATION_FACTOR "Quantisation Factor"
#define PRODUCT_NAME_LENGTH      80      /* max. length of filename */
#define STATUS_OK                 0      /* status values           */
#define ERROR                     1
#define NCOL                    282      /* number of columns in each image  */
#define NPIXEL                  256      /* number of GERB pixels   */
#define HDF_PATH_LEN            192      /* Size of full path name for HDF item */

#define MODULE   "read_NANRG_sw1_lite_282"

int main(int argc, char *argv[]) {

   int status = STATUS_OK;         /* status to be returned to main function */
   herr_t status_HDF = STATUS_OK;  /* status returned from HDF function calls */
   hid_t file_id = -1;             /* HDF5 identifier for file */
   char dataset_full_path[HDF_PATH_LEN];
   short data_array[NPIXEL][NCOL]; /* pointer to data to be read from dataset  */
   double converted_array[NPIXEL][NCOL];  /* pointer to array holding */
                                          /*  converted data  */
   double quantisation_factor = 0.0;  /* quantisation factor for SW scan 1 */
   int icol;                       /* counter/index over columns of image  */
   int irow;                       /* counter/index over rows of image     */
   char filename[PRODUCT_NAME_LENGTH];

   /* set filename from command line argument */

   if (argc > 1) {
      strcpy(filename,argv[1]);
   }
   else {
      printf("%s: No filename supplied\n",MODULE);
      status = ERROR;
   }

   /* open HDF file */

   if ((file_id = H5Fopen(filename, H5F_ACC_RDONLY, H5P_DEFAULT)) < 0) {
      printf("Can not open HDF file %s\n", filename);
      status = ERROR;
   }

   /* read SW1 radiance dataset */

   /* note data_array is a 2-dimensional array   */
   /* data_array[0] is a pointer to short int and points to first element */
   /*  in this 2D array                                                   */

   if (status == STATUS_OK) {
       sprintf(dataset_full_path,"/%s/%s",GRP_RADIOMETRY,DST_SW_RADIANCE_IMAGE_1);
       status_HDF = H5LTread_dataset_short(file_id,
                                          dataset_full_path,
                                          data_array[0]);
       if (status_HDF < 0) {
         printf("Can not read SW 1 radiance dataset for HDF file %s\n", filename);
         status = ERROR;
      }
   }

   /* and read quantisation factor attribute attached to dataset */

   if (status == STATUS_OK) {
     status_HDF = H5LTget_attribute_double(file_id,
                                          dataset_full_path,
                                          ATT_QUANTISATION_FACTOR,
                                          &quantisation_factor);
     if (status_HDF < 0) {
         printf("Error reading SW1 radiance quantisation factor for HDF file %s\n",
                filename);
```

```
         status = ERROR;
      }
    }

  /*    close file   */

    if (file_id             > -1) H5Fclose(file_id);

 /*  and convert the dataset */

    for (irow = 0; irow < NPIXEL; irow++) {
       for (icol = 0; icol < NCOL; icol++) {
        converted_array[irow][icol] = ((double) data_array[irow][icol]) *
                                          quantisation_factor;
       }
    }

    /* do whatever you want with the data - here we just print it out */

    printf("converted_array[128][140] = %f\n",
            converted_array[128][140] );

    return status;
 }
```

6.4 Further Information

The examples given in this section (together with companion C examples illustrating the dynamical allocation of arrays) are available for download from the GGSPS website (see section 5.4). Detailed information on reading HDF5 files is available from the HDF website (http://www.hdfgroup.org/), including a tutorial, user guide and reference manual. Since the GGSPS level 1.5 products and the RGP level 2 products have very similar structures, the RMIB user guide (MSG-RMIB-GE-UG), available from the RMIB web site (http://gerb.oma.be/), which contains examples of how to read the level 2 products, will also be of help. The ITT Visual Information Solutions website (http://www.ittvis.com/) may also be of help for information on IDL.

7. APPENDIX A: GERB DATA POLICY

7.1 Aims

The aims of the data policy are as follows:

- To ensure the timely scientific exploitation of GERB data, once these data are judged by the Principal Investigator as fit for that purpose;
- To ensure that users of the GERB data are kept informed about the appropriate use of the GERB products;
- To ensure that all released Edition GERB data are adequately validated, and the characteristics well documented;
- To ensure appropriate exploitation of the GERB near-real time products;
- To ensure that only scientists closely concerned with, and therefore knowledgeable about, the validation of GERB data should use pre-release GERB data in publications.

7.2 Definitions

Three categories of GERB data are discussed in this document, these are "Edition" GERB products, "Near-real time" ("NRT") GERB products and "pre-release" GERB products. Definitions are given below.

- Data released to the public from the GERB archive will be labelled as **"Edition" data**: these will be validated products, with an assessment of quality and documentation to support their pedigree. Data is only considered part of the "Edition" data set if it is both included in the climate archive and bears the name Edition (denoted by "EDnn" in the product filename, e.g. "ED01" for Edition 1).
- Products available from RMIB that are processed with the same version of the software as released products are considered **Near Real Time (NRT) products** until they have passed quality assurance and been included in the Edition archive as part of the Edition dataset.
- All products processed with versions of the software for which there are no corresponding Edition products are considered **pre-release GERB data.**
- Edition data may be used for scientific study, but users are required to first read the data quality summary and ensure the data is suitable for their purpose.
- Near real time (NRT) and pre-release versions of GERB products should be treated as un-validated products provided without assurance of quality or consistency
- NRT GERB products may be used with caution for scientific studies if no suitable Edition product is available, but the user should bear in mind that their validation is ongoing and they may be of reduced accuracy compared to the Edition GERB products.
- Pre-release GERB products are not suitable for scientific exploitation and should only be used by GERB science team members and associated scientists in the context of validation studies.

- Users should refer to the data distribution websites to determine which GERB product versions have corresponding Edition products and can therefore be considered NRT products.

7.3 Data Policy

Anyone wishing to use GERB data for any reason should first register for data access. This registration should be made even if data has been obtained from some other source, this will ensure that the use of the data are appropriate and enable the GERB project to keep all users informed of any relevant findings or changes to the data.

To register for access to the released Edition GERB data, users should contact gerb@imperial.ac.uk. For access to the near real time GERB products users should go to https://gerb.oma.be/mailman/listinfo/rolss/.

All GERB data may be used solely for the purpose for which they were supplied. They may not be used by any other projects or researchers unless these have obtained permission to do so by registering for data access. Please note that this applies even for other bona fide academic work.

Data sets must not be passed on to third parties under any circumstances. Any scientist requiring data that happens to have been supplied already to someone else, even within the same institute or program of research, must first register for data access. It is the responsibility of registered users to ensure that any subsequent use of the data downloaded for a specified project is registered.

All publications resulting from the use of any GERB data should clearly state the data product used and reference Harries et al. (2005). It is requested that authors acknowledge the GERB project in their publication and forward electronic copies of papers accepted for publication to the GERB project teams at Imperial and RMIB.

"Edition" GERB data products are released data that have undergone validation. Every attempt will have been made to ensure consistency of processing within a given edition. **These data may be used quantitatively for approved scientific studies by scientists who have registered for access to the GERB data.** It is the responsibility of users of released Edition GERB data to read the associated quality summary and determine if the products are suitable for the intended studies.

All GERB products not bearing Edition in their name or appearing in the Edition archive are near-real time or pre-release versions of the GERB data. These should be considered un-validated products provided without assurance of quality or consistency. However, once a near-real time product has passed quality assurance and been included as part of the Edition dataset it may be considered as Edition data.

Near-real time products may be used with caution for scientific studies if they are produced with a software version for which there are corresponding "Edition" GERB products. However, the user is advised that the validation of these products is ongoing, and that the quality indicators applied to the Edition products are not necessarily relevant to the near-real time products. **Any work using these data should clearly state that 'near real time GERB products which may be of reduced accuracy compared to Edition GERB data' are being used** and should note the version number and product type. These data may be presented in conference papers by any registered user of the GERB data if it is made clear that NRT GERB data are used. NRT data should only be included in peer-reviewed publication if the existing Edition data are not adequate for the study, and it must be clearly stated in the publication that near real time GERB data which may be of reduced accuracy compared to Edition GERB products are used. Users are advised to clarify with the GERB project team that their use of the near real time products is appropriate before submitting studies making use of these data for peer review.

All GERB products produced with versions of the software for which there are no Edition products are considered pre-release data. Such data are **not approved for quantitative scientific study** and are intended only, for example, for instrument monitoring and data validation. These data may be presented by GIST members and collaborating scientists in conference papers but it should be made clear in any presentation referring to these products that pre-release data were used. **Studies involving pre-release data products should only be included in peer reviewed papers dealing with their validation, and approval for their inclusion should first be obtained from the GERB Principal Investigator.** Such publications should make it clear that the data used were pre-release un-validated versions. Such studies should be carried out in collaboration with the GERB science team and proper acknowledgement should be given to the GERB project.

No warranty is given or implied regarding the suitability of these data for purposes intended by the recipient, and no liability is accepted for any loss, damage, claim, demand, cost or expense directly or indirectly arising from any use, receipt or supply of data under this agreement.

7.4 Referencing GERB data

The following paper should be referenced when referring to or using GERB data in publications:

The Geostationary Earth Radiation Budget Project.

Bulletin of the American Meteorological Society, 2005, Volume 86, No. 7, pp 945-960.

Harries, J. E., J. E. Russell, J. A. Hanafin, H. Brindley, J. Futyan, J. Rufus, S. Kellock, G. Matthews, R. Wrigley, A. Last, J. Mueller, R. Mossavati, J. Ashmall, E. Sawyer, D. Parker, M. Caldwell, P. M. Allan, A. Smith, M. J. Bates, B. Coan, B. C. Stewart, D. R. Lepine, L. A. Cornwall, D. R. Corney, M. J. Ricketts, D. Drummond, D. Smart, R. Cutler, S. Dewitte, N. Clerbaux, L. Gonzalez, A. Ipe, C. Bertrand, A. Joukoff, D. Crommelynck, N. Nelms, D. T. Llewellyn-Johnes, G. Butcher, G. L. Smith, Z. P. Szewczyk, P. E. Mlynczak, A. Slingo, R. P. Allan and M. A. Ringer.

7.5 GERB project team contacts:

GERB project at Imperial College: gerb@imperial.ac.uk

GERB project at RMIB: gerb@oma.be

8. APPENDIX B: FIELDS RETURNED BY CATALOGUE SEARCHES

Nearly all fields returned by catalogue searches will be data items contained within the products themselves, or derived from data items in these products. This section specifies the mapping between items in the catalogues and items in the data files, and defines any exceptional items which are not held internally within the product.

8.1 Level 1.5 NANRG Table

Catalogue name	HDF path of corresponding product field. Comments
filename	/File Name Entry in catalogue does not include '.hdf' filetype extension, which is present in File Name field within product.
filetype	/File Name Entry in catalogue is filetype extension part of File Name. It is always 'hdf'
file_creation_date	/File Creation Time Date string has a different format to that in the product. See Appendix C (Section 9.3).
file_size	Not in product. File size in bytes
date_of_first_packet	/Times/First GERB Packet Date string has a different format to that in the product. See Appendix C (Section 9.3).
date_of_last_packet	/Times/Last GERB Packet Date string has a different format to that in the product. See Appendix C (Section 9.3).
ggsps_version	/GGSPS/Software Version
product_version	/GGSPS/L1.5 NANRG Product Version
gerb_instrument_id	/GERB/Instrument Identifier Will be in form "G1", "G2" etc. in catalogue search, whereas in product it is stored in form "GERB1", "GERB2".
test_id	/GERB/Instrument Test Identifier
instrument_mode	/GERB/Instrument Mode Important for separating normal science data from calibration data
sat_position_lam	/Geolocation/Actual Satellite Longitude (degrees)
data_fraction	/Product Confidence Summary/Data Fraction
data_quality	/Product Confidence Summary/Data Quality
no_l0_prods_used	/Input Information/Number of Input Level 0 Files
age_seviri_header	/Input Information/Age of SEVIRI File Used (minutes)
lta_directory	Location within GGSPS archive (for GGSPS internal use only)

8.2 L15_GEO Product

There is no catalogue for the L15_GEO products. Links to the directory containing these products is supplied with the results of searches for Level 1.5 NANRG products.

8.3 Level 1.5 ARG Tables

Note that the level 1.5 ARG product is not included in the Edition 1 release.

Catalogue name	HDF path of corresponding product field. Comments
filename	/File Name Entry in catalogue does not include '.hdf' filetype extension, which is present in File Name field within product.
filetype	/File Name Entry in catalogue is filetype extension part of File Name. It is always 'hdf'
file_creation_date	/File Creation Time Date string has a different format to that in the product. See Appendix C (Section 9.3).
file_size	Not in product. File size in bytes
date_of_first_packet	/Times/First GERB Packet Date string has a different format to that in the product. See Appendix C (Section 9.3).
date_of_last_packet	/Times/Last GERB Packet Date string has a different format to that in the product. See Appendix C (Section 9.3).
ggsps_version	/GGSPS/Software Version
product_version	/GGSPS/Product Version
gerb_instrument_id	/GERB/Instrument Identifier Will be in form "G1", "G2" etc. in catalogue search, whereas in product it is stored in form "GERB1", "GERB2".
seviri_instrument_id	Not currently populated in catalogue.
test_id	/GERB/Instrument Test Identifier
instrument_mode	/GERB/Instrument Mode ARG products will only be generated in normal science mode.
sat_position_r	Distance of satellite from Earth centre (km) Not currently populated in catalogue
sat_position_phi	Actual Satellite Latitude (degrees) Not currently populated in catalogue
sat_position_lam	/Geolocation/Actual Satellite Longitude (degrees)
prod_conf_flag	/Product Confidence Flags First product confidence flag (the one for SW averaged image) is currently catalogued.
no_l0_prods_used	/Input Information/Number of Input Level 0 Files
age_seviri_header	/Input Information/Age of SEVIRI File Used (minutes)
lta_directory	Location within GGSPS archive (for GGSPS internal use only)

8.4 Level 2 ARG Table

Catalogue name	HDF path of corresponding product field. Comments
filename	/File Name Entry in catalogue does not include '.hdf' filetype extension, which is present in File Name field within product.
filetype	/File Name Entry in catalogue is filetype extension part of File Name. It is always 'hdf'

file_creation_date	/File Creation Time Date string has a different format to that in the product. See Appendix C (Section 9.3).
file_size	Not in product. File size in bytes
date_of_first_packet	/Times/First GERB Packet Date string has a different format to that in the product. See Appendix C (Section 9.3).
date_of_last_packet	/Times/Last GERB Packet Date string has a different format to that in the product. See Appendix C (Section 9.3).
gerb_instrument_id	/GERB/Instrument Identifier
rmib_sw_id	/RMIB/Software Identifier
rmib_product_version	/RMIB/Product Version
seviri_imager_id	/Imager/Instrument Identifier
seviri_imager_type	/Imager/Type
wavelength	/Radiation Type Identifier If “SOL”, a value “SW” is catalogued. If “TH”, a value “LW” is catalogued.
longitude	/Geolocation/Rectified Grid/Lop (i.e. longitude to which product is rectified)
data_fraction	/Extra Solar Product Confidence Information (/Extra Thermal Product Confidence Information) /Data Fraction
data_quality	/Extra Solar Product Confidence Information (/Extra Thermal Product Confidence Information) /Data Quality Note “Data Quality” is not currently populated in the level 2 ARG product.
confidence_flag	/Summary Solar Products Confidence (/Summary Thermal Products Confidence)
nanrg_file	/GGSPS/L1.5 NANRG File Name For thermal products (which have two L1.5 products listed, it is the first (and principle) NANRG file name which is catalogued.
geolocation_file	/Geolocation/Geolocation File Name

8.5 Level 2 ARG Geolocation Table

Catalogue name	HDF path of corresponding product field. Comments
filename	/File Name Entry in catalogue does not include '.hdf' filetype extension, which is present in File Name field within product.
filetype	/File Name Entry in catalogue is filetype extension part of File Name. It is always 'hdf'
gerb_instrument_id	/GERB/Instrument Identifier
rmib_sw_id	/RMIB/Software Identifier
file_creation_date	/File Creation Time
file_size	Not in product. File size in bytes
first_utc_time_of_data	/Times/First GERB Packet

longitude	/Geolocation/Rectified Grid/Lop

9. APPENDIX C: TIME FORMATS

The main time format used in science products will be a UTC time written as an ASCII string, described in section 9.2. Catalogue searches return a slightly different ASCII string format, explained in section 9.3. The only other time format used is a 7 byte onboard time defined by the satellite software. It is explained in section 9.1 for completeness, but is unlikely to be of interest for ordinary science use.

9.1 Onboard Times

The onboard time is the timestamp added to the packet by the onboard software. The time corresponds to the time of the Start of Line pulse following the data acquired.

The timestamp is written in CUC 4,3 format. These means that it is written out in 7 bytes, the four most significant of which give a count in seconds, the three least significant indicating fractions of a second (or, equivalently, counts of $1/(256^3)$ of a second). In writing this number out to the NANRG file, it is converted to a long integer (as though the seven bytes formed the least significant seven bytes of an 8 byte integer), and this long integer is written out in decimal form to a character string (which is as long as it needs to be, but will have a maximum size of 18 (including trailing '\0').

The onboard time is measured relative to a spacecraft epoch - in other words the time at which the onboard clock was reset. UTC correlation parameters within the SEVIRI header allow conversion of this time to UTC format. Note that the onboard clock is not guaranteed to run completely true; the conversion parameters handle the cases when it runs fast or slow, and even when it speeds up or slows done (there is a quadratic term). These conversion parameters are not supplied within the NANRG file, as the job of conversion is already done: an equivalent UTC time is supplied for each onboard time.

9.2 UTC Times

UTC time strings are either given to an accuracy of seconds or milliseconds and therefore will have one of two forms:

YYYYMMDD HH:MM:SS

or

YYYYMMDD HH:MM:SS.mmm

where "YYYY" is the four digit year, the first "MM" is the two digit month (01-12), "DD" is the two digit day (01-31), "HH" is the two digit hour (00-23), the second "MM" is the two digit minute (00-59), "SS" is the two digit second (00-59), and "mmm" is the three digit millisecond count (000-999).

The size of the character string in the HDF file will be dimensioned to the size required for the times string (including the C-style trailing '\0'). As the format of the time string is fixed, this string size will normally be 18 for second accuracy, and 22 for millisecond accuracy. The only exception is for invalid/missing times, which are flagged as "INVALID_UTC_TIME".

9.3 Catalogue UTC Times

UTC times returned by GGSPS catalogue searches have a slightly different format, and are only given to second accuracy. The format is:

dd-mmm-yyyy HH:MM:SS

where "dd" is the day of the month ("01"-"31"), "mmm" is the first three letters of the month (lower case, "jan" - "dec"), "yyyy" is the four digit year, "HH" is the two digit hour (00-23), "MM" is the two digit minute (00-59), and "SS" is the two digit second (00-59)

10. APPENDIX D: VERSION NUMBER CONVENTIONS

As indicated in Section 3.6, the GGSPS uses a series of version numbers to track the version of software used to generate a particular product:

1. GGSPS Software Release Ids – tracking all changes to source code.
2. Parameter File version numbers – tracking all changes to all parameter files used by the GGSPS software.
3. Product version numbers – tracking all changes to GGSPS software and/or GGSPS parameter files which have caused a change to the content of a GGSPS product.

10.1 GGSPS Software Release Identifier

The GGSPS software release identifier will be a string, having the form "VXX_yy". The identifier will be updated whenever the system is released, following changes to any part of the GGSPS code, and regardless of which subsystem(s) the change(s) occurs in. Major software changes will cause an increment in XX, and yy to be reset to 0. Minor software changes will cause an increment in yy only.

The GGSPS software release identifier will not change if a change occurs to any of the associated parameter files used by the software.

The GGSPS software release identifier will be included as a field in all GGSPS products.

10.2 GGSPS Parameter File Version Numbers

A parameter file is any file which is used by the GGSPS software in order to operate correctly. It refers to look-up tables and data tables supplied as part of the GGSPS system, and does not refer to data files that are being processed by the GGSPS. Parameter files do not contain any source code and are never compiled.

A two-tier system of parameter files is used by the GGSPS. For each type of parameter file, there is a configuration file which defines:

- a version number for this configuration;
- the parameter files which correspond to this configuration;
- the times for which each parameter file is valid.

This allows for time dependent parameter files (needed for example for calibration parameters).

Note that the version number refers to the configuration file, and not to an individual parameter file. (although individual parameter file names may also have version numbers and/or dates to identify them). Therefore, to identify which parameter file was used to process a particular product, one needs:

- the version number and hence configuration file used;
- the date/time of first packet being processed, to identify which of the parameter files in the configuration was valid.

All the parameter configuration file names on which a product depends, together with the version numbers of those configurations, will be included as fields in the header of all products generated by the GGSPS.

Parameter files are discussed further in Appendix E (Section 11).

10.3 GGSPS Product version numbers

Each product generated by the GGSPS will have a product version number which will be included in the header of that product. The product version number will be an integer in the range 0-999.

A product's version number will only be updated whenever a change is made to:

- the GGSPS software, where the results of this change impact scientifically (or on data format) on a particular product;

- any of the parameter files on which the body of this product depends.

Note that the GGSPS software version can increment without a corresponding increment in product version (software changes which do not affect the product), likewise the product version can increment without the software version incrementing (changes to data tables).

The product version will appear as a field in all GGSPS products, and also in the product filename.

10.4 Level 2 Product software and version numbers

RMIB use an independent but similar version number system for the level 2 ARG flux and geolocation products which are generated by the RGP and archived by the GGSPS. There are two version numbers given in the level 2 flux files.

- The RMIB software identifier is a string having the form "YYYYMMDDHHMM" where: YYYY stands for year; MM for month; DD for day; HH for hour; MM for minutes. This string is automatically changed for any compilation of the source files of the RGP and the source files are tagged with this identifier and saved for archiving.
- The RMIB version number is defined using the RMIB software identifier and the NANRG product version number of the input NANRG file. The RMIB version number is updated whenever a change is made to the RAL version number. It will also be updated when an important change is made to the RGP.

The level 2 ARG flux products contain the level 1.5 NANRG product version as a field in the product, thus enabling correlation between level 1.5 NANRG product versions and level 2 product versions.

11. APPENDIX E: PARAMETER FILES AFFECTING PRODUCTS

Parameter files are files containing calibration or other data needed by the GGSPS's processing algorithms.

Parameter files usually (there are some exceptions) follow the following naming convention:

G*n*_*TYPE*_(PIX*ppp*_)*yyyymmdd*_V*vvv*.txt

where:
G*n* refers to the GERB instrument (i.e. "G1", "G2");
TYPE specifies the data contained in the file, e.g. "ALPHA", "BAT", "BBRAW";
PIX*ppp* (only used with BBRAD files) specifies the detector pixel for which the file is used (*ppp* = 000-255);
yyyymmdd specifies a date associated with the file (usually date of generation of the file) – *yyyy* = 4 digit year, *mm* = 01-12, *dd* = 01-31;
V*vvv* specifies the version number of the file (*vvv* = 000-999).

They are all text files, although many originated as Excel spreadsheets and can easily be read back into Excel.

As explained in section 3.6, there is a two tier system of parameter files, with a first layer of configuration files specifying which parameter files are valid for a particular date/time range.

Configuration files are required because different versions of the same data table may exist (e.g. after reanalysis of calibration data), and multiple versions may be needed for processing if e.g. the calibration of the GERB instrument drifts with time. There is a configuration file for each type of data file, and this specifies a time range over which each data file is to be used. A typical configuration file (GALIGNS, with 2 version of the parameter file defined) is illustrated below.

```
PPL15_G2_GALIGNS.txt            ! File name for this file
4                               ! Version number for this file
2                               ! Number of different file versions
0                               ! Period number 1
G2_GALIGNS_20030312_V004.txt    ! File name of galigns file
19990101 00:00:00               ! Start date for validity period
20030123 17:00:00               ! End date for validity period
1                               ! Period number 2
G2_GALIGNS_20030312_V005.txt    ! File name of galigns file
20030123 17:00:00               ! Start date for validity period
21000101 00:00:00               ! End date for validity period

! History Section
!
! Version 1.  09-03-2001  M. Bates  Original Version
!             08-04-2001  M. Bates  Remove dummy period
!             13-06-2001  M. Bates  Add extra period, adjust validity dates
!                                   to pick up a GALIGNS file set up for the
!                                   RMIB simulator.
!             01-04-2002  M. Bates  Add 3rd period, to extend file set up
!                                     for RMIB simulator and test
!                                     PPL15_CheckTables
!             06-12-2002  M. Bates  Revert to G2 file for start of GERB 2 running
! Version 2.  15-12-2002  M. Bates  Switch from G2_GALIGNS_20010309_V001.txt
!                                            to G2_GALIGNS_20021213_V002.txt
!                                  (parameter SSEAW_to_Gearth decreased by 9 degs)
! Version 3.  24-01-2003  M. Bates  Switch from G2_GALIGNS_20021213_V002.txt
!                                            to G2_GALIGNS_20030124_V003.txt
```

```
!                                (parameter SSEAW_to_Gearth increased by 2 pixels)
! Version 4.  12-03-2003  M. Bates  Define two GALIGNS periods:
!                                    Switch from G2_GALIGNS_20030124_V003.txt
!                                             to G2_GALIGNS_20030312_V004.txt
!                               (parameter SSEAW_to_Gearth increased by 0.6 pixels)
!                                         and to G2_GALIGNS_20030312_V005.txt
!                               (parameter SSEAW_to_Gearth decreased by 2.5 pixels)
!                                - accomodates tuning and change of earth centering
!                                    seen around 23 Jan 2003 17:00 (actual shift in
!                           centering took place between 15:30 and 17:20, centering
!                                       unstable during this period).
```

There is a history section to record any changes that are made in the file.

Configuration files usually follow the following naming convention:

*(subsystem_)*G*n_TYPE*.txt

where G*n* and *TYPE* are as for the corresponding parameter file, and *subsystem*, if it exists, refers to the GGSPS subsystem (usually "PPL15") which uses the file.

The main types of parameter file and their contents are described below. Files not described below do not affect the science processing of the data.

Table	Use	Source / Contents
ALPHA	Contains pixel weights (α values). This is a file containing one number per pixel which is related to the time constant of that pixel. They are used in determining the final asymptotic voltage V for each detector reading from the two raw numbers (I1 and I2) output by the front end processing algorithm: $V = I1 + \alpha\ I2$.	Source: Leicester/Imperial. Contents: pixel_no., α value per pixel (2 x 256 numbers).
BAT	Contains pixel gains (B), relative SW sensitivity of TOTAL channel (A), filter transmission (T) for each pixel, and their corresponding errors. The 'B' values are used in deriving the Short Wave gains. The "A" values are forwarded to RMIB for use in calculating LW filtered radiances by subtraction (and are also used in the GGSPS to calculate the LW filtered radiance of the black body).	Source: Imperial pixel_no., B, δB, A, δA, T, δT for each pixel. (256x7 numbers).
BBRAD	Contains data (per pixel) required to convert black body temperature to black body TOTAL and SW filtered radiances. Note that the data files are unusual in that there is one data file per detector pixel (256 in total).	Source: Imperial temperature, LTOT, δLTOT, LSW, δLSW for a range of temperatures (currently 7.0°C to 30.0°C in steps of 0.1°C) - 5 x 231 numbers per file, (up to) 256 files.
BBRAW	Contains coefficients required to convert raw black body PRT values to temperatures.	Source: AEA (Harwell), Leicester, Imperial. probe_no., Rref, A, B, C for each of 5 temperature probes.
BBRAW_LOCAL	Contains limits to be used to validate black body temperatures, and flags which indicate which probes should contribute to the average black body temperature. The limits indicate the temperature range for which BBRAD data is supplied.	Source: Imperial. probe_no., WarningLow, WarningHigh, AlarmLow, AlarmHigh, Mask for each of 5 temperature probes.
CALPROC	Contains parameters used by the algorithms used to convert pixel counts to filtered radiances.	Source: RAL Set of 11 parameters used in calibration processing (mainly in selection of space pixels).

CORRUPT	Contains flag indicating whether packets identified as corrupt (by internal checksums or checks at EUMETSAT) are excluded from further processing.	Source: RAL Contains: Single corruption flag.
CVSHD	Map file which defines the layout of SEVIRI Header (header of MSG Level 1.5 Data Product) containing MSG state vector information.	Source: RAL Contains: byte offsets for orbit, attitude data etc.
EARTH	Contains parameters used to define the reference ellipsoid (i.e. earth's surface)	Source: RAL. 3 parameters defining the geolocation reference ellipsoid and Top of Atmosphere ellipsoid (polar radius, equatorial radius, height of atmosphere)
GALIGNS	Contains alignments and offsets used by geolocation algorithms	Source: RAL.
GEOTUNE	Contains additional, tuneable offsets used by geolocation algorithms	Source: RAL.
L20G	L2 (ARG) geolocation file from RMIB, used to define rectification grid for a particular GERB instrument.	Source: RMIB Contains a 256 x 256 set of latitude and longitude grid point coordinates, plus an equivalent set of 12 parameters defining the rectification grid. File is in HDF(5) format.
LeapSecond	Table of leap seconds.	Source: IERS Rapid Service/Prediction Center for Earth Orientation Parameters.
PIXEL_LIMIT S	Defines limits to be used in validating raw pixel data	Source: RAL. Contains pixel_no, I1_low, I1_high, I2_low, I2_high, validity flag for each pixel (6 x 256 numbers)
PIXPOS	Contains lines of sight for each pixel in an instrument coordinate frame.	Source: IMPERIAL/RAL Contains pixel_no, azimuth, elevation, validity flag for each pixel (6 x 256 numbers). Derived from PSF data measured at Imperial.
STRAYLIGHT	Contains date and time ranges of data affected by stray light.	Source: RAL. For each of four classes of stray lights, defines spring and autumn season date ranges, and time range affected during these seasons.
TeleMap	Map file which defines the layout of raw GERB data packets.	Contains: byte offsets, masks and parameter types for the data in the raw packet, and conversion constants and limits for selected items in the packet.

12. APPENDIX F: HDF DATA TYPES USED IN PRODUCTS

The following data types are used in the GGSPS data products.

HDF identifier	Data type.
H5T_C_S1	C style character string with null ('\0') terminator.
H5T_STD_U8BE	8 bit unsigned integer.
H5T_STD_I16BE	16 bit signed (2s complement) integer in Big Endian byte order (i.e. most significant byte first)
H5T_STD_I32BE	32 bit signed (2s complement) integer in Big Endian byte order
H5T_IEEE_F64BE	64 bit (i.e. double precision) floating point (standard IEEE definition) in Big Endian order

These are predefined HDF5 data types. The standard HDF or IDL interface used to read the HDF product should convert these data types into data types used on the local machine (e.g. convert from Big Endian to Little Endian, if appropriate).

More information on HDF5 data types can be found in the section on datatypes in the HDF5 Users' Guide, available on the HDF website http://www.hdfgroup.org/

13. APPENDIX G: GGSPS LEVEL 1.5 GEOLOCATION

The GGSPS geolocation included in the body of the L1.5 NANRG product should not be used for science studies. Instead, the RGP geolocation contained in the matching L15_GEO products should be used. The GGSPS geolocation will still be used, however, by GERB Operations Team members for validation studies, and a short explanation of the information contained in the L1.5 NANRG product is included in this appendix.

Geolocation values are stored in datasets labelled “Latitude (or Elevation)” and “Longitude (or Azimuth)”. It is the group in which they are stored which defines which image they belong to: the relevant groups are named “Short Wave Image 1” etc., and are contained within an overall “Geolocation” group. Latitude and longitude are only written out for pixels which view the Earth; for pixels which do not, a pair of deep space angles is given instead: these angles define the line of sight of the pixel relative to an Earth fixed frame.

The latitude and longitude of the point where the GERB Line of Sight intersects the Reference Ellipsoid is given. The Reference Ellipsoid is a representation of the surface of the Earth; it is an ellipsoid defined by a polar radius (R_P) and an equatorial radius (R_E). It is the geodetic (or geographic) latitude which is supplied: this is defined with respect to the perpendicular to the reference ellipsoid at a particular point (as opposed to the geocentric latitude, which is defined with reference to the radial direction at that point).

This is illustrated in the figure below. The geodetic latitude is the angle between the perpendicular vector AP and the equatorial plane; the geocentric latitude is the angle between the radial vector OP and the equatorial plane. Geodetic and geocentric latitudes are related by:

$$\tan(\theta_d) = (R_E / R_P)^2 \tan(\theta_c)$$

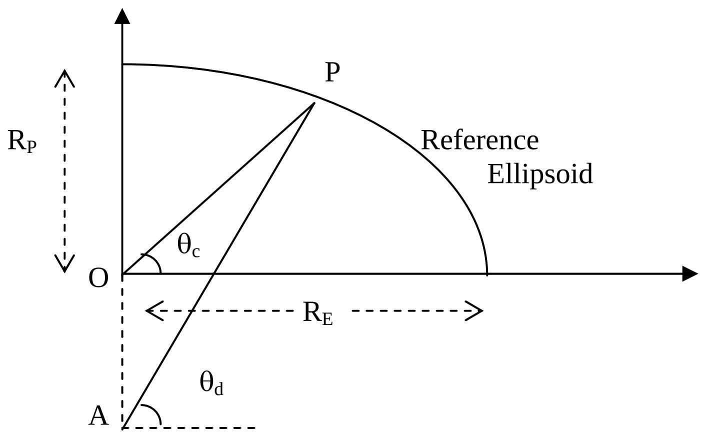


Figure 7. Geocentric (θ_c) and geodetic (θ_d) latitude of a point P on the surface of the reference ellipsoid, which is defined by a polar radius (R_P) and an equatorial radius (R_E). The geocentric latitude is the angle between the radial vector OP and the equatorial plane. The geodetic latitude is the angle between the vector perpendicular to the reference ellipsoid at the point P (AP) and the equatorial plane. Geodetic latitude is the one used for latitude coordinates in the NANRG (and ARG) products.

Space pixels will have a pair of angles supplied, specifying the azimuth and elevation relative to the axes of the Earth fixed frame. Azimuth will be written in the space provided for longitude, and elevation in the space provided for latitude. To distinguish between space view and Earth view pixels, the modulus of the elevation angle will have 128° added to it (i.e. the second most significant bit of the bit pattern will be set), so that the angle itself lies either between –218° and –128° or +128° and +218°. As latitude will be between –90° and +90°, this will provide the distinction between longitude/latitude coordinates and azimuth/elevation coordinates i.e. between Earth view and space view pixels. Azimuth will be signed positive towards the east; elevation positive towards the north. Note azimuth is defined relative to the X axis of the Earth Fixed Reference Frame, regardless of the actual, nominal or rectification longitudes for GERB.

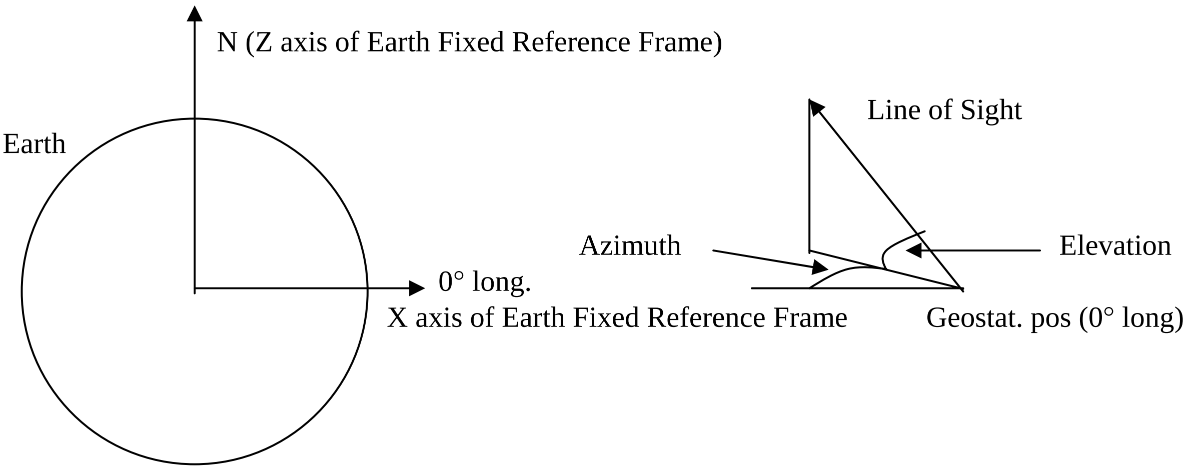


Figure 8: Azimuth and elevation coordinates used for deep space angles.

Geolocation values, whether latitude-longitude coordinates or space angles, are encoded in the same way as filtered radiance values, i.e. using a Quantisation Factor which is supplied as an attribute to the dataset. For geolocation coordinates, the Quantisation Factor is 0.0078125 and the Unit “degree”. An invalid (encoded) value of -32767 is used.

The geolocation coordinates supplied are for the “centre” of the pixel. This is defined as the centroid of the PSF of each pixel as determined experimentally during calibration at Imperial. A correction is made to the PSF using optical models to allow for the deformation effects caused by the 16g rotation effects and 0g gravity experienced in space.

14. APPENDIX H: GERB MODE AND TEST ID VALUES

This section is included for the benefit of GERB Operations Team members engaged in validation studies. Users engaged in science studies will be using the Edition dataset which only contains normal mode (mode = 33) data with test identifier = 0.

14.1 GERB Instrument Mode

The GERB Instrument Mode is an identifier specifying the mode in which the instrument is operating. It specifies the region of the sky (relative to the Earth) that the instrument scans, the spacing between columns, the number of columns taken scanning in each direction, and the position of the quartz filter (i.e. the channel selected) during the scan.

Mode	Value	Comment
Normal	33	This is the normal scanning mode, i.e. GERB scans east and west across the surface of the Earth, switching from SW to TOTAL and back on alternate scans. The NANRG product will contain up to six such scans, each of which will have (up to) 282 columns. This file will be processed by RMIB, and the GGSPS will generate a level 1.5 ARG file from it.
Deep space	34	GERB scans from west to east and back to west again, but scans an area of space off the west limb of the Earth in addition to the Earth itself. The NANRG product will only contain up to two such scans (one SW, one TOTAL), each will have (up to) 512 columns. Column spacing is as for normal scanning. These data are not processed to level 2 or level 1.5 ARG files.
SW calibration light	35	GERB scans from west to east, tracking the movement of the Sun in the sky. The GERB field of view is aligned such that the Sun optimally illuminates the integrating sphere (a device for monitoring the Short Wave calibration of GERB) - note that the Sun is not directly in the GERB Field of View. The NANRG product will contain data from one such GERB scan; however, the data is stored within two scans within the NANRG product to separate SW and TOTAL data (GERB switches from SW to TOTAL half-way through the scan) - there should be 750 columns in each channel. Note that the main purpose of this mode is to study integrating sphere data which is not present in the NANRG product; the NANRG product will only be used to verify that the Earth view is viewing deep space as intended. These data are not processed to level 2 or level 1.5 ARG files.
SW calibration dark	36	As for SW calibration light, except that the GERB field of view is aligned such that the Sun does not illuminate the integrating sphere at all. This mode is used to subtract the effect of thermal emission from the integrating sphere when studying data from the SW calibration light mode. This mode additionally clips the west limb of the Earth at the very end of the scan (i.e. with the TOTAL data). These data are not processed to level 2 or level 1.5 ARG files.
PSF	37	GERB scans from west to east and back to west again, alternating channels, but scans with a fraction of the step size used for normal

		scanning. The aim is to use north-south coastlines or other features which can be used to study the GERB East-West Point Spread Function in flight. The NANRG product will only contain up to two such scans (one SW, one TOTAL), each will have a non-standard number of columns and step size. Both the number of columns per scan and the step size will vary from operation to operation in this mode: for example, in initial GERB-2 operations the whole Earth has been scanned in steps of 1/5 normal GERB pixel, with 1402 columns in each scan. These data are not processed to level 2 or level 1.5 ARG files.
Lunar Channel 1	38	GERB scans backwards and forwards west to east, in a region of space well away from the west limb of the Earth. It is timed and phased to scan slowly across the surface of the Moon from west to east, at 1/10 of the column step size used for normal scanning. The Moon will move across the field of view from west to east, at roughly 1/30 normal GERB pixel per rotation; this will allow GERB to scan backwards and forwards a couple of times across the Moon while it remains within the angular range covered by the sky. The NANRG product will contain up to two scans (one SW, one TOTAL). Each scan will have (up to) 316 columns. These data are not processed to level 2 or level 1.5 ARG files. An alternative scanning pattern for the Moon has also been used for GERB-2, again with 316 steps, but using a step size of 1/5 of a pixel, and scanning an enlarged region of the sky. This pattern has been referred to as “Lunar Far West”, and can be identified from the test identifier value of 4 (see below).
Lunar Channel 2	39	As for Lunar Channel 1 mode, but a region of space closer to the west limb is scanned. It is normally run immediately following Lunar Channel 1 mode, as the Moon moves from one scan region into another. The position of the quartz filter is reversed relative to that for Lunar Channel 1, such that TOTAL data is acquired west to east and SW east to west. This is so that data with the same step size relative to the Moon can be compared for the two channels. As for Lunar Channel 1, an alternative scanning pattern for the Moon has also been used for GERB-2. This is referred to as “Lunar West” and scans a region of sky adjacent to the “Lunar Far West” region. It can be identified from the test identifier value (4). Unlike the Lunar Channel 2 pattern, there is no reversal of the directions of the channels.
Lunar East	(40)	As for Lunar Far West mode, but a region of space close to (and partially obscured by). It is normally run ~1 hour after Lunar West mode finishes, as the Moon moves into the correct region of sky. Some data was taken in this mode with GERB-2 early in 2003, but it has not been used since, has the use of just two scanning patterns (Lunar Channels 1 and 2) has become become the default method of lunar scanning. A (temporary) mode value of 40 was used for this scan, together with a test identifier value of 0x4, but note this mode value is also used for alpha verification mode (for which NANRG products are not generated, and hence is not described here).

SEVIRI Lunar SW	41	This mode is for use in conjunction with SEVIRI scanning the lunar surface; the required phasing of the GERB scan mirror is TBD. No data has been acquired in this mode to date.
SEVIRI Lunar TOTAL	42	This mode is for use in conjunction with SEVIRI scanning the lunar surface; the required phasing of the GERB scan mirror is TBD. No data has been acquired in this mode to date.

The scanning pattern and use associated with each mode value are subject to change. An up to date list of mode values is maintained on the "Information" page of the GGSPS web site (see Section 5).

14.2 GERB Test Identifier

The GERB Test Identifier is a word written by the onboard flight software for GERB to flag to the ground system when non-standard operations which do not constitute a change of mode are in progress.

The following values are currently defined for this parameter. More may be added.

Value	Meaning
0	Normal conditions
1	Black body linearity test. Used in conjunction with data in deep space mode. The black body is heated up and then allowed to cool. This is flagged because the calibration of the instrument is less reliable at these temperatures, but to first order the data can be treated normally
2	Normal mode with an unusual number of steps. Used in conjunction with normal mode data. Was originally used to flag a set of 282 step data when the default was 262; post April 2003, the default is 282 steps, so this test identifier value will be used to flag a number of steps different from 282.
3	"Scanning" with a step size of zero. Used in conjunction with normal mode data. The same column of the Earth will be viewed all the time.
4	Used to denote a particular type of lunar scan (see mode value descriptions above). Used in conjunction with lunar mode. Has been accidentally left set for some normal mode data; normal mode data is unaffected for this test identifier value.
5	Mirror side offset scan. EW offset (= half step size) is applied to one side of scan mirror, such that both mirror faces view the same scene. Used in PSF mode.
16	May be used to denote alpha verification mode data (should not appear in a NANRG product).
17	Denotes data acquired exclusively in the TOTAL channel i.e. GERB scans backwards and forwards in just the one channel. Used in conjunction with normal mode.

The use associated with each test identifier value is subject to change. An up to date list of test identifier values is maintained on the "Information" page of the GGSPS web site (see Section 5).