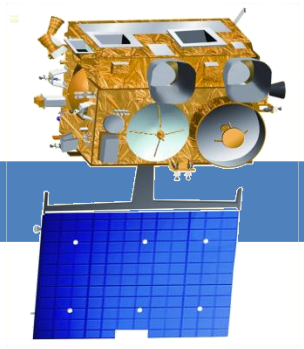
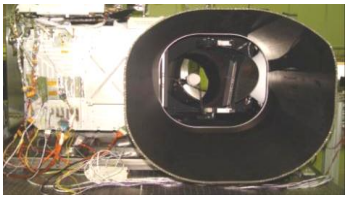
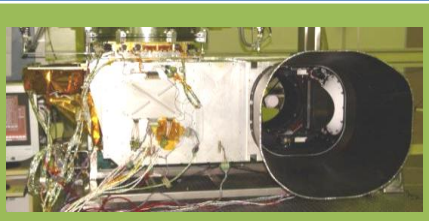
SAC/IMDPS/SIPA/DPSG/MSDPD/TN-01/FEB 2014

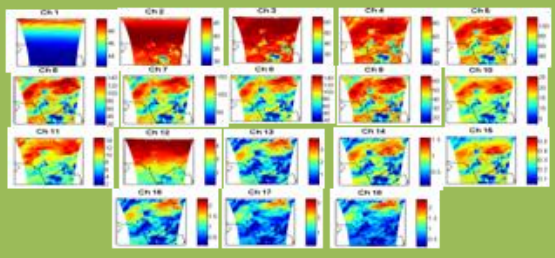


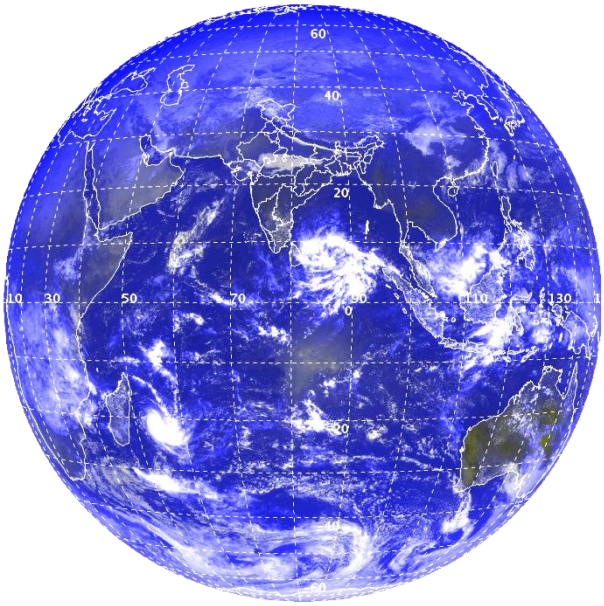
**Version 1.1, February 2014**

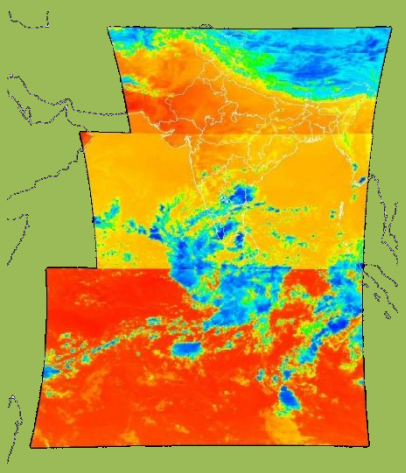
# INSAT-3D Data Products Format Document

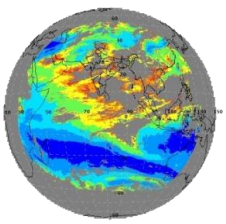


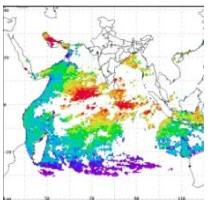


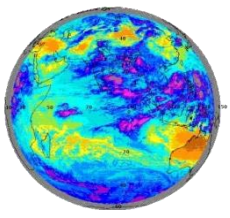












**Data Products Software Group**

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# Document Control and Data sheet

| | |
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| **8. Distribution** | **: Open Circulation** |

# Contents

# Document Change History

*A: Addition; M: Modification; D: Deletion

| Version No | Date. | Section No | A/M/D * | Description of change |
|---|---|---|---|---|
| V1.0 | Sept 1, 2012 | | A | NetCDF-4 enhanced Data Model based |
| V1.0 | May 3,2012 | | M | Switching to Netcdf4- classic model |
| V1.0 | July 22, 2013 | | M | New Levels of Geophysical Parameters, KML Format |
| V1.1 | Feb. 19, 2014 | | A,M | For Imager VISIBLE and SWIR bands Radiance is included in place of Albedo.<br>For SOUNDER Visible Band Radiance is included in place of Albedo |

# Chapter 1: Introduction

## 1.1 Scope

The document describes the format layout of Sounder and Imager INSAT-3D Digital Data Products provided in HDF5 (Hierarchical Data Format) and Keyhole Markup Language (KML). These include Standard and Geophysical Parameters provided in HDF5 Format and KML. This format document is valid for Level-1, Level-2 and Level-3 products.

## 1.2 Purpose and Objectives

This document serves as a format document for the INSAT-3D data products in HDF5 Format. The reader should note that this document does not discuss the structures underlying HDF or the specific conventions employed. For more information on HDF, its design philosophy, and its logical and physical formats, the reader is referred to NCSA website [1]. The HDF5 library and utilities (provided by NCSA) can be used to read the contents of the HDF products.

## 1.3 INSAT-3D Payloads

The INSAT-3D spacecraft (parked at 82° East) carries two meteorological payloads: (i) Imager working from the visible to the infrared spectral bands (0.55 to 12.5 μm) and (ii) Sounder working in 18 IR (7 in LWIR,5 in MWIR,6 in SWIR) channels and one in Visible spectral range. Brief specification of Imager and Sounder are as follows.

### IMAGER

The IMAGER provides imaging capability of the earth disk from geostationary altitude in one Visible (VIS) in 0.55 to 0.75 μm range and five infrared channels. The specifications of the payload are summarized in Table 1.2.1.

There are two flexible modes of operations possible with the IMAGER payloads:

- Full frame mode scans 18° E-W x 18°N-S covering the entire earth disk and some space around. The acquisition time for full globe is around 26 minutes. So daily 48 acquisitions are possible in every half hourly interval.
- Program mode covering 18° in E-W direction; N-S coverage can be defined in terms of the number of lines to be scanned

**Table 1.1 Payload Specification for IMAGER**

| Spectral Channels | Spectral Range (µm) | Resolution (km) | Quantization bits |
|---|---|---|---|
| VIS | 0.55 – 0.75 | 1 | 10 |
| SWIR | 1.55-1.70 | 1 | 10 |
| MIR | 3.80-4.00 | 4 | 10 |
| WV | 6.50-7.10 | 8 | 10 |
| TIR 1 | 10.3-11.3 | 4 | 10 |
| TIR 2 | 11.5 – 12.5 | 4 | 10 |

**SOUNDER**

The Sounder onboard INSAT 3D has 18 Infra Red channels, out of which 7 are in long wave IR (LWIR), 6 in short wave IR (SWIR) and 5 in medium wave IR (MWIR) bands and 1 Visible Channel.

**Table 1.2 Payload Specification for Sounder**

| Spectral Channels | Spectral Range (µm) | Resolution (km) | Quantization Bits |
|---|---|---|---|
| VISIBLE | 0.67 – 0.72 | 10 | 12 |
| SWIR (6 Channels) | 3.67 – 4.59 | 10 | 14 |
| MWIR (5 Channels) | 6.38 – 11.33 | 10 | 14 |
| LWIR (7 Channels) | 11.66 – 14.85 | 10 | 14 |

## 1.4 INSAT-3D Data Products Types

Supported data products as given as:

**Table: 1.3 INSAT-3D Data Product Levels and Types**

| Product Description | Processing level | Corrections Applied | Format/Remarks |
|---|---|---|---|
| Standard Corrections | LEVEL 1B | Radiometrically corrected (Line loss correction, Failed detector correction and RAD LUT applied) | **HDF5** |
| Standard Corrections with Geo-referencing | LEVEL 1C | Radiometric + Geometric correction applied (Geo-referenced) | **HDF5** |
| Geo-physical Parameter | LEVEL 2B | Geophysical parameters derived from L1B | **HDF5** |
| Geo-physical Parameter | LEVEL2G | Geophysical Parameters Gridded at a pre-defined Resolution | **HDF5** |

| | | | |
|---|---|---|---|
| Geo-physical Parameter | LEVEL2P | Geophysical Parameters provided as Point Datasets | **HDF5/ KML** |
| Geo-physical Parameter | LEVEL 3B | Binned Geophysical Parameters derived from L2B | **HDF5** |
| Geo-physical Parameter | LEVEL3G | Binned Geophysical Parameters derived from L2G | **HDF5** |

**1.5 Product File Naming Convention**

The hdf5 product file name is coined as:
SSNNN_DDMMMYYYY_HHmm_LOP_XXX.h5

Where
SS=Satellite ID (e.g. 3D for INSAT-3D)

NNN=Sensor ID (IMG for Imager, SND for Sounder)

DDMMMYYYY=Date of Acquisition (DD=Day of Month, MMM=Month of the year, YYYY= year of Pass e.g. 23MAY2012)

HHmm=Time of Acquistion (HH=Hour of day mm=minute of the hour)

LOP=Level of Processing (L1B, L1C, L2B)

XXX=Parameter Name (See Table 1.5) or STD or Sector Name (See Table 1.4) e.g. 3DIMG_26SEP2012_0730_L1B_STD.h5

**Table 1.4 Sector Name and Mnemonics**

| Sr. No | Sector Name | Mnemonics | Description/ Remark | SENSOR |
|---|---|---|---|---|
| 1 | ASIA_MER | ASI_MER | Area Of Interest (AOI) based Products | IMAGER |
| 2 | SGP | SGP | | |
| 3 | SA1 | SA1 | | SOUNDER |
| 4 | SB1 | SB1 | | |

**Table 1.5 Geo-physical Parameter Name and Mnemonics**

| Sr. No | Geo-physical Parameter Name | SENSOR | Level | Mnemonics |
|---|---|---|---|---|
| **Per Pixel Products (IMAGER)** | | | | |
| 1. | Outgoing Longwave Radiation | IMAGER | L2B | OLR |
| 2. | Hydro Estimator derived Precipitation | IMAGER | L2B | HEM |
| 3. | Cloud Mask | IMAGER | L2B | CMK |
| 4. | Sea Surface Temperature | IMAGER | L2B | SST |
| 5. | Upper Troposphere Humidity | IMAGER | L2B | UTH |

| | | | | |
|---|---|---|---|---|
| **Gridded Geophysical Parameters (IMAGER)** | | | | |
| 6. | Quantitative Precipitation Estimate (IMR Method) | IMAGER | L2G | IMR |
| 7. | Quantitative Precipitation Estimate (GPI Method) | IMAGER | L2G | GPI |
| 8. | Aerosol Optical Depth | IMAGER | L2G | AOD |
| **Point Geophysical Parameters (IMAGER)** | | | | |
| 9. | Wind Vectors | IMAGER | L2P | VIS/IR/WV/MIR |
| 10. | Smoke | IMAGER | L2P | SMK |
| 11. | Fire | IMAGER | L2P | FIR |
| **Map Projected Geophysical Parameters (IMAGER)** | | | | |
| 12. | Fog | IMAGER | L2C | FOG |
| 13. | Snow Cover | IMAGER | L2C | SNW |
| **Per Pixel Products (SOUNDER)** | | | | |
| 14. | Atmospheric Profiles and Derived Parameters | SOUNDER | L2B | SA1/SB1 (Sector Acquired) |

# Chapter 2: INSAT-3D Data Products HDF5 File Structure

This chapter gives details of underlying product structure of INSAT-3D HDF Data Product corresponding to various Processing levels as described in previous chapter.

## 2.1 Products Overview

Standard Products (L1B and L1C) will have following datasets:

**Table 2.1 Overview of Standard Products Structure**

| S. No. | Dataset Categories | Description |
|---|---|---|
| 1. | Channel Datasets | The various channels in which satellite image is acquired |
| 2. | Geo-location Information Datasets | The Geo-location Information in the form of 2-D Latitude Longitude Disks (containing per pixel Lat/Lon values) for L1B and Map Projection information in case of L1C Products |
| 3. | Calibration Datasets | Calibration Lookup Tables (Radiance and Brightness Temperature for IR and WV channels and Radiance for Visible and SWIR Channels). Quadratic, Gain and Offset coefficients also provided for calculating radiances directly from count (See APPENDIX II) |
| 4. | Ancillary Datasets | Ancillary Information (Satellite Azimuth, Satellite Elevation, Sensor Azimuth and Sensor Elevation) |

Geophysical Parameters will have following datasets:

**Table 2.2 Overview of Geophysical Parameters Structure**

| S. No. | Datasets | Description | |
|---|---|---|---|
| 1. | Geophysical Parameters | For Imager, all geophysical parameters are provided in separate HDF file along with geo-location information and ancillary information (if any e.g. quality flags). For Sounder Profiles, atmospheric profiles, surface parameters along with derived parameters are provided in a single product. | |
| 2. | Geo-location Information | L2B/ L3B | 2-D Latitude/ Longitude HDF5 Datasets |
| | | L2G/ L3G | 1-D Latitude/ Longitude HDF5 dimension Scales |
| | | L2P | 1-D Latitude/ Longitude HDF5 Datasets for every Point observation |

## 2.2 INSAT-3D Digital Data Products File Formats

This section gives detailed structure of digital data Products in HDF5. The data product follows CF-conventions (Climate and forecasting conventions [2]). Root group will have following attributes:

**Table 2.3 Root Group Attributes**

| S. No. | Attribute Name | Attribute Value/ Format | Description |
|---|---|---|---|
| 1. | conventions | CF-1.6 | Conventions used in the data product |
| 2. | title | e.g. 3DIMG_01SEP2012_0130_L1B | A description of what is in the dataset. |
| 3. | institute | =BES,SAC/ISRO, Ahmedabad for BES, Bopal<br>=IMD,New Delhi, INDIA for IMD, Delhi | Specifies where the original data was processed. |
| 4. | source | INSAT-3D Imager (IMG) /INSAT-3D Sounder (SND) | The satellite Payload which acquired the data. |
| 5. | Unique_Id | 3DIMG_01SEP2012_0130 | Unique Job ID |
| 6. | Product_Creation_Time | YYYY-MM-DDTHH:mm:ss | Date and Time when product was created |
| 7. | Output_Format | hdf5-1.8.8 | HDF-5 library used for generating the product |
| 8. | HDF_Product_File_Name | See Section 1.5 | IMDPS-generated HDF5 file |
| 9. | Station_Id | = BES (For BES, Bopal)<br>=IMD (For IMD, Delhi) | Station ID for the ground station that processed data |
| 10. | Ground_Station | = IMD New Delhi, INDIA (For IMD, Delhi)<br>=BES, SAC/ISRO, Ahmedabad, INDIA (For BES, Bopal) | Description of Ground station where data was received |
| 11. | Product_Type | = Standard (Full Disk)<br>= SECTOR | Identifier to inform user of product Type |
| 12. | Sensor_Id | = IMG (For Imager)<br>= SND (For Sounder) | ID for Sensor |
| 13. | Sensor_Name | IMAGER (For Imager)<br>SOUNDER (For Sounder) | Descriptive Name of Sensor |
| 14. | Acquisition_Date | DDMMMYYYY | Date image was acquired |
| 15. | Acquisition_Time_in_GMT | hhmm | Representative time of acquisition in GMT |
| 16. | Acquisition_Start_Time | DD-MM-YYYYTHH:MM:SS | Start Time for Data Acquisition |
| 17. | Acquisition_End_Time | DD-MM-YYYYTHH:MM:SS | End Time for Data Acquisition |
| 18. | Processing_Level | L1B/L1C/L2B/L2G/L2P/ | Level of Processing |

| | | | |
|---|---|---|---|
| | | L3B/L3G | |
| 19. | Satellite_Name | INSAT-3D | Name of the Satellite |
| 20. | Location_of_Satellite(degrees) | 82° E | Location of Satellite |
| 21. | Imaging_Mode | =FULL FRAME<br>=NORMAL FRAME<br>=SECTOR FRAME | Type of acquisition |
| 21. | Nominal_Altitude(km) | 36000.0 | Nominal Altitude of Satellite |
| 22. | Observed Altitude(km) | 64-bit floating point | Observed Altitude of Satellite |
| 23. | Field_of_View(degrees) | 64-bit floating point | Field of View of Satellite |
| 24. | Nominal_Central_Point_Coordinates(degrees)_Latitude_Longitude | 0.0, 82.0 | Nominal co-ordinate of the central point |
| 25. | Software Version | 1.0 | Version of the DP Software used for Processing |
| 26. | left_longitude | +180° to -180° (32bit floating point) | South Bounds of data |
| 27. | right_longitude | | North Bounds of data |
| 28. | upper_latitude | +90° to -90° (32bit floating point) | Upper Bounds of data |
| 29. | lower_latitude | | Lower Bounds of data |
| 30. | Datum | WGS84 | Datum used |
| 31 | Ellipsoid | WGS84 | Ellipsoid used |
| 32. | Imaging_Mode | FULL_FRAME or SECTOR | Mode of Imaging |
| 33. | FastScan_Linearity_Enabled | Yes/No | Whether Fast Scan (W-E or E-W) Linearity was enabled onboard during acquisition |
| 34. | SlowScan_Linearity_Enabled | Yes/No | Whether Slow Scan (N-S) Linearity was enabled onboard during acquisition |
| 35. | Attitude_Source | STAR /EARTH/ZERO | Source of Attitude used for product generation<br>STAR: Star Sensor<br>EARTH: Earth Sensor<br>ZERO: No Attitude Available (Zero Attitude Used) |
| 36. | Radiometric_Calibration_Type | LAB CALIBRATED/ONLINE CALIBRATED | Whether Radiometric Calibration was carried out (Lab Coefficients or Online Black Body measurements) |

**Table 2.4 Root Group Attributes (Specific to Imager L1B Products)**

| S. No. | Attribute Name | Attribute Value/ Format | Description |
|---|---|---|---|
| 1. | TIR1_Gain_Mode | =1<br>=2<br>=3<br>=4 | Gain Mode for TIR1 |
| 2. | TIR2_Gain_Mode | | Gain Mode for TIR2 |
| 3. | MIR_Gain_Mode | | Gain Mode for MIR |
| 4. | WV_Gain_Mode | | Gain Mode for WV |
| 5. | VIS_Gain_Mode | | Gain Mode for SWIR |
| 6. | SWIR_Gain_Mode | | Gain Mode for VIS |
| 7. | TIR1_Acquisition_Mode | =MAIN (For Main)<br>=RED (for Redundant) | Acquisition Mode for TIR1 (Main or Redundant) |
| 8. | TIR2_Acquisition_Mode | | Acquisition Mode for TIR2 (Main or Redundant) |
| 9. | MIR_Acquisition_Mode | | Acquisition Mode for MIR (Main or Redundant) |
| 10. | WV_Acquisition_Mode | | Acquisition Mode for WV (Main or Redundant) |
| 11. | VIS_Acquisition_Mode | | Acquisition Mode for VIS (Main or Redundant) |
| 12. | SWIR_Acquisition_Mode | | Acquisition Mode for SWIR (Main or Redundant) |

**Table 2.5 Root Group Attributes (Specific to Binned Products)**

| S. No. | Attribute Name | Attribute Value/ Format | Description |
|---|---|---|---|
| 1. | Input_Date_Times | DDMMMYYYY_HHMM | Input Date Times used for binning |
| 2. | Binning_Function | = MIN (Minimum)<br>= MAX (Maximum)<br>= AVG (Average)<br>= SUM (Accumulated) | Binning Function Used |
| 3. | Binning_Period | =Daily<br>=Weekly<br>=Monthly<br>=Yearly | |
| 4. | Num_Input_Date_Times | | Number of Input Date Times used |

## 2.3 Channel Datasets

For Imager, following are the channel Datasets

**Table 2.6 Channel Datasets for IMAGER**

| S. No. | Dataset Name | Data Type | Description |
|---|---|---|---|
| 1. | IMG_VIS | 16-bit unsigned integer | Gray Counts for Visible channel |
| 2. | IMG_SWIR | 16-bit unsigned integer | Gray Count for Shortwave Infrared Channel |
| 3. | IMG_TIR1 | 16-bit unsigned integer | Gray Counts for Thermal Infrared Channel 1 |
| 4. | IMG_TIR2 | 16-bit unsigned integer | Gray Counts for Thermal Infrared Channel 2 |
| 5. | IMG_MIR | 16-bit unsigned integer | Gray Counts for Middlewave Infrared Channel |
| 6. | IMG_WV | 16-bit unsigned integer | Gray Counts for Shortwave Infrared Channel |

The resolution value for L1B Products is at NADIR and for L1C, it is uniform over full image.

**Table 2.7 Channel Datasets for SOUNDER (Data Type: 16-bit unsigned integer)**

| S. No. | Dataset Name | Description |
|---|---|---|
| 1. | SND_LWIR1 | Gray Counts for Longwave Infrared Channel 1 |
| 2. | SND_LWIR2 | Gray Counts for Longwave Infrared Channel 2 |
| 3. | SND_LWIR3 | Gray Counts for Longwave Infrared Channel 3 |
| 4. | SND_LWIR4 | Gray Counts for Longwave Infrared Channel 4 |
| 5. | SND_LWIR5 | Gray Counts for Longwave Infrared Channel 5 |
| 6. | SND_LWIR6 | Gray Counts for Longwave Infrared Channel 6 |
| 7. | SND_LWIR7 | Gray Counts for Longwave Infrared Channel 7 |
| 8. | SND_MWIR1 | Gray Counts for Middlewave Infrared Channel 1 |
| 9. | SND_MWIR2 | Gray Counts for Middlewave Infrared Channel 2 |
| 10. | SND_MWIR3 | Gray Counts for Middlewave Infrared Channel 3 |
| 11. | SND_MWIR4 | Gray Counts for Middlewave Infrared Channel 4 |
| 12. | SND_MWIR5 | Gray Counts for Middlewave Infrared Channel 5 |
| 13. | SND_SWIR1 | Gray Counts for Shortwave Infrared channel 1 |
| 14. | SND_SWIR2 | Gray Counts for Shortwave Infrared Channel 2 |
| 15. | SND_SWIR3 | Gray Counts for Shortwave Infrared Channel 3 |
| 16. | SND_SWIR4 | Gray Counts for Shortwave Infrared Channel 4 |
| 17. | SND_SWIR5 | Gray Counts for Shortwave Infrared Channel 5 |
| 18. | SND_SWIR6 | Gray Counts for Shortwave Infrared Channel 6 |
| 19. | SND_VIS | Gray Counts of Visible Channel |

Each of these datasets has following attributes giving meta-information about each channel:

**Table 2.8 Attributes of Datasets within Channel Datasets**

| S. No. | Attribute Name | Data type | Description | Applicable Levels |
|---|---|---|---|---|
| 1. | long_name | string, length=variable | Descriptive name of the channel | L1B, L1C |
| 2. | invert | string, length=4 or 5 | Whether the channel is inverted or not. Possible values=true or false. All IR/WV channels are inverted. | L1B, L1C |
| 3. | bandwidth | 32-bit floating point | Bandwidth of channel (same units as that of central wavelength) | L1B, L1C |
| 4. | central_wavelength | 32-bit floating point | Central wavelength | L1B, L1C |
| 5. | wavelength_unit | string, length=2 | Units of central wavelength | L1B, L1C |
| 6. | bits_per_pixel | 32-bit integer | Bits per pixel of the data | L1B, L1C |
| 7. | resolution | 32-bit floating point | Spatial Resolution at NADIR in case of L1B and for full image in case of L1C | L1B, L1C |
| 8. | resolution_unit | string, length=2 | Units of Spatial resolution | L1B, L1C |
| 9. | coordinates | string, length=variable | CF-compliant attribute for associating coordinate variables with the data variable. For example “time latitude longitude” | L1B |
| 10. | grid_mapping | string, length=variable | CF-compliant attribute for associating coordinate variables with the data variable. For example “mercator” for Mercator Projection. | L1C |
| 11.# | lab_radiance_scale_quad | 64-bit floating point | Quadratic term for lab calibrated radiance calculation from count | L1B, L1C |
| 12.# | lab_radiance_scale_factor | 32-bit floating point | Slope term for lab calibrated radiance calculation from count | L1B, L1C |
| 13.# | lab_radiance_add_offset | | Offset term for lab calibrated radiance calculation from count | L1B, L1C |
| 14. | online_radiance_quad | 64-bit floating point | Offset term for online calibrated radiance calculation from count | L1B, L1C |
| 15.# | online_radiance_scale_factor | 32-bit floating point | Quadratic term for online calibrated radiance calculation from count | L1B, L1C |
| 16.# | online_radiance_add_offset | | Slope term for online calibrated radiance calculation from count | L1B, L1C |

**# For detailed description of these fields Refer Appendix-I: Radiometric Calibration**

## 2.4 Geophysical Parameter Datasets

Geophysical Parameters are classified into three types:

1. **L2B:** The parameters derived from L1B
2. **L2G:** The Parameters derived from L1B gridded at predefined grid interval.
3. **L2P:** The Parameters derived from L1B with output as point datasets.

**Table 2.9 L2B Geophysical Parameters (IMAGER)**

| S. No | Geophysical Parameter Name | Dataset(s) Name | Description | Data Type |
|---|---|---|---|---|
| 1. | Outgoing Longwave Radiation | OLR | Outgoing Longwave Radiation Dataset | 32-bit floating point |
| 2. | Fog | FOG | FOG Dataset | 8-bit signed character |
| 4. | Hydro Estimator derived Precipitation | HEM | Hydro estimator derived HEM Dataset | 32-bit floating point |
| 5. | Cloud Mask | CMK | Cloud Mask Dataset 0:Clear;1:Cloudy;2: Probably_Clear;3:Probably_Cloudy | 8-bit signed character |
| 6. | Upper Troposphere Humidity | UTH | Upper Troposphere Humidity Dataset | 32-bit floating point |
| 7. | Sea Surface Temperature | SST | Sea Surface Temperature Dataset | 32-bit floating point |
| | | SST_QFLAGS | SST Quality Flags 1:Cloud Masked; 2:Climatology Check Failed; 3:High Confidence; 4:Land | 8-bit unsigned character |

**Table 2.10 L2B SOUNDER Geophysical Parameters (Data Type: 32-bit floating point)**

| S. No. | Dataset(s) Name | Description |
|---|---|---|
| 1. | H2OMMRPhy | Water Vapor Profile (Physical Retrieval) |
| 2. | H2OMMRReg | Water Vapor Profile (Regression Retrieval) |
| 3. | O3VMRReg | Ozone Profiles (Regression Retrieval) |
| 4. | TAirPhy | Temperature Profile (Physical Retrieval) |
| 5. | TAirReg | Temperature Profile (Regression Retrieval) |
| 6. | TSurfPhy | Surface Skin Temperature (Physical Retrieval) |
| 7. | TSurfReg | Surface Skin Temperature (Regression Retrieval) |
| 8. | totO3Reg | Total Column Ozone (Regression Retrieval) |
| 9. | DMI | Dry Microburst Index |
| 10. | FORC_SKIN_TEMP | Forecast Skin Temperature |
| 11. | FOR_SURF_HUMIDITY | Forecast Surface Humidity |

| | | |
|---|---|---|
| 12. | GEO_POT_HEIGHT | Geo-potential Height |
| 13. | L1_PREC_WATER | Layer-1 Precipitable Water (1000 to 900 mb) |
| 14. | L2_PREC_WATER | Layer-2 Precipitable Water (900 to 700 mb) |
| 15. | L3_PREC_WATER | Layer-1 Precipitable Water (700 to 300 mb) |
| 16. | LI | Lifted Index |
| 17. | MEAN_SURF_PRES | Mean Surface Pressure |
| 18. | WI | Wind Index |
| 19. | Theta-e | Maximum vertical theta-e |
| 20. | totH2O | Total Water Vapor |

**Table 2.11 L2G Geophysical Parameters (Data Type: 32-bit floating point)**

| S. No | Geophysical Parameter Name | Dataset(s) Name | Description |
|---|---|---|---|
| 1. | Quantitative Precipitation Estimate (IMR Method) | IMR | IMSRA (INSAT Multispectral Rainfall Algorithm ) derived Precipitation Dataset |
| 2. | Quantitative Precipitation Estimate (GPI Method) | GPI | Precipitation Derived from GPI Method |
| 3. | Aerosol Optical Depth | AOD | Aerosol Optical Depth |

**Table 2.12 L2C Geophysical Parameters (Data Type: 8-bt signed character)**

| S. No | Geophysical Parameter Name | Dataset(s) Name | Description |
|---|---|---|---|
| 1. | Snow Cover | SNW | Snow Cover Dataset |
| 2. | FOG | FOG | FOG Dataset |

**Table 2.13 L2P Wind Vector Geophysical Parameter Datasets**

| S.No. | Dataset(s) Name | Description | Data Type |
|---|---|---|---|
| 1. | MEAN_BT | Average Brightness Temperature (Only for TIR/WV/MIR channels) | 32-bit floating point |
| 2. | MIN_BT | Minimum Brightness Temperature (Only for TIR/WV/MIR channels) | |
| 3. | OBSERVATION_TIME | Time of Observation | 64-bit floating point |
| 4. | SCANS | Scan Number | 32-bit signed integer |
| 5. | PIXELS | Pixel Number | |
| 6. | PRESSURE | Pressure | 32-bit floating point |
| 7. | QUALITY_INDICATOR | Wind Quality | |
| 8. | HEIGHT ASSIGNMENT | Height Assignment Method. HWIN: Infrared Window | 8-bit signed character |

| | | | |
|---|---|---|---|
| | METHOD | Technique<br>HH2O: H2O intercept method<br>BASE: Cloud Base method<br>CLRR : Clear Sky WV wind<br>HOLD : Old Empirical method<br>(When forecast is not available)<br>For MIR Channel<br>0:HWIN;1:BASE;2:HOLD<br>For TIR Channel<br>0:HWIN;1:HH2O;2:BASE;3:HOLD<br>For WV Channel<br>0:HWIN;1:BASE;2:CLRR;3:HOLD<br>For VIS Channel<br>0:HWIN;1:BASE;2:HOLD | |
| 9. | UCOMP | U Component of Wind | 32-bit floating point |
| 10. | VCOMP | V Component of Wind | |
| 11. | WIND_DIRECTION | Wind Direction | |
| 12. | WIND_SPEED | Wind Speed | |
| 13. | SAT_ZEN | Satellite Zenith | |

Note: The L2P HDF Geophysical Parameters have a extra attribute in the root group with following details:

**Table 2.14 Attribute in Root Group of L2P Geophysical Parameter Datasets**

| S. No. | Attribute Name | Data Type | Description |
|---|---|---|---|
| 1. | :featureType | string, value=”point” | CF-compliant attribute used to indicate that dataset is point dataset |

The dataset containing geophysical parameter has following of attributes:

**Table 2.15 Attributes of Geophysical Parameter Datasets**

| S. No. | Attribute Name | Data type | Description |
|---|---|---|---|
| 1. | long_name | string, length=variable | Descriptive name of the geophysical parameter |
| 2. | standard_name | string, length=variable | Standard name of the geophysical parameter |
| 3. | _FillValue | Same as dataset data-type | CF-compliant attribute used where the parameter is missing (wherever applicable) |
| 4. | units | String, length=units | Unit string defining the units of geophysical parameter |
| 5. | coordinates | string, length=variable | CF-compliant attribute for associating coordinate variables with the data variable. (Applicable for L2B and L2P) |

## 2.5 Geo-location Information Datasets (For details Refer Appendix-II: Geometric Calibration)

These datasets contain geo-location information corresponding to the channel or geophysical parameter data stored in the product. For L1B and L2B products, the geo-location information is provided in terms of latitude/longitude datasets. For L1B products, the latitude/ longitude datasets are stored corresponding to each distinct resolution (1km/ 4km/ 8km for IMAGER and 10 km for SOUNDER).

**Table 2.16 Geo-location Datasets for L1B, L2B and L2P (HDF) Products**

| S. No. | Dataset Name | Data Type | Description | Applicable Levels |
|---|---|---|---|---|
| 1. | Latitude | 16-bit signed integer | Latitude values. (For L1B Products, it corresponds to IR channels.) | L1B, L2B, L2P |
| 2. | Longitude | | Longitude values (For L1B Products, it corresponds to IR channels.) | L1B, L2B, L2P |
| 3. | Latitude_VIS | 32-bit signed integer | Latitude values for VIS and SWIR channels | L1B |
| 4. | Latitude_VIS | | Longitude values for VIS and SWIR channels | L1B |
| 5. | Latitude_WV | 16-bit signed integer | Latitude values for WV channels | L1B |
| 6. | Longitude_WV | | Longitude values for WV channels | L1B |

Each of these datasets has following attributes:

**Table 2.17 Attributes Geo-location Information Datasets**

| S. No. | Attribute Name | Data type | Description |
|---|---|---|---|
| 1. | add_offset | 32-bit floating point | CF-compliant attribute for defining add offset (used in scaling the values). |
| 2. | scale_factor | | CF-compliant attribute for defining scale factor (used in scaling the values). |
| 3. | units | string (degrees_north for latitude, degrees_east for longitude) | CF-compliant attribute for defining units of latitude and longitude variables |
| 4. | _FillValue | Same as dataset data-type | CF-compliant attribute used where the parameter is missing |
| 5. | long_name | string, length=variable | long name for latitude and longitude variables |

For L1C products, the geo-location information is provided in terms of map projection (grid mapping in CF terminology) parameters. Grid Mapping is specified by creating "Projection_Information Dataset" and grid mapping is defined as a set of attributes of this dataset. For INSAT-3D, the supported projections are:

1. Mercator
2. Lambert Conformal Conic

For Mercator, the grid mapping is defined as following set of attributes:

**Table 2.18 Grid Mapping Description for Mercator projection (for L1C and L2C)**

| S. No. | Attribute Name | Data type | Description |
|---|---|---|---|
| 1. | grid_mapping_name | string, length=variable | CF compliant attribute, its value is 'mercator' |
| 2. | false_easting | 64-bit floating point | False Easting for Mercator Projection |
| 3. | false_northing | | False Northing for Mercator Projection |
| 4. | longitude_of_projection_origin | | Longitude of Projection Origin for Mercator Projection |
| 5. | semi_minor_axis | | Semi major axis of earth (in meters) |
| 6. | semi_major_axis | | Semi minor axis of earth (in meters) |
| 7. | standard_parallel | | Standard Parallel for Mercator Projection, Latitude at which true_scale=1 (EPSG 9805) |

For Lambert Conformal Conic, the grid mapping is defined as following set of attributes:

**Table 2.19 Grid Mapping Description for Lambert Conformal Conic Projection (for L1C and L2C)**

| S. No. | Attribute Name | Data type | Description |
|---|---|---|---|
| **1.** | grid_mapping_name | string, length=variable | CF compliant attribute, its value is 'lambert_conformal_conic' |
| 2. | false_easting | 64-bit floating point | False Easting for LCC Projection |
| 3. | false_northing | 64-bit floating point | False Northing for LCC Projection |
| 4. | longitude_of_central_meridian | 64-bit floating point | Longitude of Central Meridian for LCC Projection |
| 5. | latitude_of_projection_origin | 64-bit floating point | Latitude of Projection Origin for LCC Projection |
| 6. | semi_minor_axis | 64-bit floating | Semi-major axis of earth |

| | | | |
|---|---|---|---|
| | | point | |
| 7. | semi_major_axis | 64-bit floating point | Semi-minor axis of earth |
| 8. | standard_parallel | 64-bit floating point | Standard Parallels for LCC Projection |

For L2G products, geo-location information is provided as Latitude/ Longitude Dimension scales.

**Table 2.20 Dimension Scales for L2G Geophysical Parameters (Data Type: 64-bit floating point)**

| S. No. | Dataset Name | Description |
|---|---|---|
| 1. | Latitude | Latitude values for each grid point in latitude direction. |
| 2. | Longitude | Longitude values for each grid point in longitude direction. |

Each dimension scale has following attributes:

**Table 2.21 Attributes of Dimension Scales for L2G Geophysical Parameters**

| S. No. | Attribute Name | Data Type | Description |
|---|---|---|---|
| 1. | long_name | string, length=variable | long name for dimension scale |
| 2. | standard_name | string, length=variable | standard name for dimension scale |
| 3. | units | String (degrees_north for latitude, degrees_east for longitude) | Units for latitude and longitude |

## 2.6 Calibration Datasets

This calibration datasets contain calibration information for Imager and sounder channel data. For Imager, following are the Calibration Information datasets:

**Table 2.22 Calibration Information Datasets for IMAGER (Data Type: 32-bit floating point)**

| S. No. | Dataset Name | Description |
|---|---|---|
| 1. | IMG_VIS_RADIANCE | Visible Radiance |
| 2. | IMG_SWIR_RADIANCE | Short Wave Infrared Radiance |
| 3. | IMG_MIR_RADIANCE | Middlewave Infrared Radiance |
| 4. | IMG_MIR_TEMP | Middlewave Infrared Temperature |
| 5. | IMG_TIR1_RADIANCE | Thermal Infrared 1 Radiance |
| 6. | IMG_TIR1_TEMP | Thermal Infrared 1 Temperature |
| 7. | IMG_TIR2_RADIANCE | Thermal Infrared 1 Radiance |
| 8. | IMG_TIR2_TEMP | Thermal Infrared 2 Temperature |
| 9. | IMG_WV_RADIANCE | Water Vapor Infrared Radiance |
| 10 | IMG_WV_TEMP | Water Vapor Infrared Temperature |

For Sounder, the Calibration Information datasets are listed below:

**Table 2.23 Calibration Information Datasets for SOUNDER (Data Type: 32-bit floating point)**

| S. No. | Dataset Name | Description |
|---|---|---|
| 1. | SND_LWIR1_RADIANCE | Radiance Lookup Table for Longwave Infrared Channel 1 |
| 2. | SND_LWIR1_TEMP | Brightness Temperature Lookup Table for Longwave Infrared Channel 1 |
| 3. | SND_LWIR2_RADIANCE | Radiance Lookup Table for Longwave Infrared Channel 2 |
| 4. | SND_LWIR2_TEMP | Brightness Temperature Lookup Table for Longwave Infrared Channel 2 |
| 5. | SND_LWIR3_RADIANCE | Radiance Lookup Table for Longwave Infrared Channel 3 |
| 6. | SND_LWIR3_TEMP | Brightness Temperature Lookup Table for Longwave Infrared Channel 3 |
| 7. | SND_LWIR4_RADIANCE | Radiance Lookup Table for Longwave Infrared Channel 4 |
| 8. | SND_LWIR4_TEMP | Brightness Temperature Lookup Table for Longwave Infrared Channel 4 |
| 9. | SND_LWIR5_RADIANCE | Radiance Lookup Table for Longwave Infrared Channel 5 |
| 10. | SND_LWIR5_TEMP | Temperature for Longwave Infrared Channel 5 |
| 11. | SND_LWIR6_RADIANCE | Radiance Lookup Table for Longwave Infrared Channel 6 |
| 12. | SND_LWIR6_TEMP | Brightness Temperature Lookup Table for Longwave Infrared Channel 6 |
| 13. | SND_LWIR7_RADIANCE | Radiance Lookup Table for Longwave Infrared Channel 7 |
| 14. | SND_LWIR7_TEMP | Brightness Temperature Lookup Table for Longwave Infrared Channel 7 |
| 15. | SND_MWIR1_RADIANCE | Radiance Lookup Table for Middlewave Infrared Channel 1 |
| 16. | SND_MWIR1_TEMP | Brightness Temperature Lookup Table for Midwave Infrared Channel 1 |
| 17. | SND_MWIR2_RADIANCE | Radiance Lookup Table for Middlewave Infrared Channel 2 |
| 18. | SND_MWIR2_TEMP | Brightness Temperature Lookup Table for Middlewave Infrared Channel 2 |
| 19. | SND_MWIR3_RADIANCE | Radiance Lookup Table for Middlewave Infrared Channel 3 |
| 20. | SND_MWIR3_TEMP | Brightness Temperature Lookup Table for Middlewave Infrared Channel 3 |
| 21. | SND_MWIR4_RADIANCE | Radiance Lookup Table for Middlewave Infrared Channel 4 |

| | | |
|---|---|---|
| 22. | SND_MWIR4_TEMP | Brightness Temperature Lookup Table for Middlewave Infrared Channel 4 |
| 23. | SND_MWIR5_RADIANCE | Radiance Lookup Table for Middlewave Infrared Channel 5 |
| 24. | SND_MWIR5_TEMP | Brightness Temperature Lookup Table for Middlewave Infrared Channel 5 |
| 25. | SND_SWIR1_RADIANCE | Radiance Lookup Table for Shortwave Infrared Channel 1 |
| 26. | SND_SWIR1_TEMP | Brightness Temperature Lookup Table for Shortwave Infrared Channel 1 |
| 27. | SND_SWIR2_RADIANCE | Radiance Lookup Table for Shortwave Infrared Channel 2 |
| 28. | SND_SWIR2_TEMP | Brightness Temperature Lookup Table for Shortwave Infrared Channel 2 |
| 29. | SND_SWIR3_RADIANCE | Radiance Lookup Table for Shortwave Infrared Channel 3 |
| 30. | SND_SWIR3_TEMP | Brightness Temperature Lookup Table for Shortwave Infrared Channel 3 |
| 31. | SND_SWIR4_RADIANCE | Radiance for Lookup Table Shortwave Infrared Channel 4 |
| 32. | SND_SWIR4_TEMP | Brightness Temperature Lookup Table for Shortwave Infrared Channel 4 |
| 33. | SND_SWIR5_RADIANCE | Radiance Lookup Table for Shortwave Infrared Channel 5 |
| 34. | SND_SWIR5_TEMP | Brightness Temperature Lookup Table for Shortwave Infrared Channel 5 |
| 35. | SND_SWIR6_RADIANCE | Radiance Lookup Table for Shortwave Infrared Channel 6 |
| 36. | SND_SWIR6_TEMP | Brightness Temperature Lookup Table for Shortwave Infrared Channel 6 |
| 37. | SND_VIS_RADIANCE | Radiance Lookup Table for Visible Channel |

All the datasets have following set of attributes:

**Table 2.24 Attributes of Calibration Information Datasets for SOUNDER**

| S. No. | Attribute Name | Data type | Description |
|---|---|---|---|
| 1. | _FillValue | Same as dataset data-type | CF-compliant attribute used where the calibration dataset is missing |
| 2. | long_name | string, length=variable | Descriptive name of the calibration dataset |
| 3. | units | String, length=variable | Unit string defining the units of calibration dataset |
| 4. | invert | string (true or false) | Whether the dataset is inverted (wherever applicable) |

## 2.7 Ancillary Datasets

Ancillary Datasets provide ancillary Information (Satellite Azimuth/Elevation and Sensor Azimuth/Elevation). The details of corresponding datasets are listed below:

**Table 2.25 Ancillary Datasets**

| S. No. | Dataset Name | Data Type | Description |
|---|---|---|---|
| 1. | Sat_Azimuth | 16-bit unsigned integer | Satellite Azimuth |
| 2. | Sat_Elevation | 16-bit signed integer | Satellite Elevation |
| 3. | Sun_Azimuth | 16-bit unsigned integer | Sun Azimuth |
| 4. | Sun_Elevation | 16-bit signed integer | Sun Elevation |

Meta information related to these datasets is provided as attributes along with each dataset:

**Table 2.26 Attributes of Ancillary Datasets**

| S. No. | Attribute Name | Data type | Description | Applicable Levels |
|---|---|---|---|---|
| 1. | long_name | string, length=variable | Descriptive name of the dataset | L1B, L1C |
| 2. | add_offset | string, length=variable | CF-compliant attribute for defining add offset (used in scaling the values). | L1B, L1C |
| 3. | scale_factor | string, length=variable | CF-compliant attribute for defining scale factor (used in scaling the values). | L1B, L1C |
| 4. | _FillValue | Same as dataset data-type | CF-compliant attribute used where the dataset is missing | L1B, L1C |
| 5. | units | string, length=variable | Unit string defining the units of Ancillary dataset | L1B, L1C |
| 6. | coordinates | string, length=variable | CF-compliant attribute for associating coordinate variables with the ancillary variable. For example “time latitude longitude” | L1B |
| 7. | grid_mapping | string, length=variable | CF-compliant attribute for associating coordinate variables with the ancillary variable. For example “Mercator” for Mercator Projection. | L1C |

For generating latitude and longitude, formulae for forward and inverse transformation can be referred at:

1. For Lambert Conformal Conic, refer [3]
2. For Mercator, refer [4]

## 2.8 Dimension Scales

By default for every dataset created dimension scales are created for every dimension of unique length. For L1B and L2B Products following dimensions are created:

**Table 2.27 Dimension for L1B and L2B Products**

| S. No. | Dimension Name | Description |
|---|---|---|
| 1. | time | Time dimension for All Channels |
| 2. | GeoX | Dimension for pixel direction of TIR1, TIR2, and MIR channels |
| 3. | GeoY | Dimension for scan direction of TIR1, TIR2, and MIR channels |
| 4. | GeoX1 | Dimension for pixel direction of WV channels |
| 5. | GeoY1 | Dimension for scan direction of WV channels |
| 6. | GeoX2 | Dimension for VIS and SWIR channels |
| 7. | GeoY2 | Dimension for VIS and SWIR channels |

GeoY* and GeoX* contains the scan and pixel values of the image along scan and pixel direction. For L1C Products, following dimensions are created:

**Table 2.28 Dimension for L1C Products**

| S. No. | Dimension Name | Description |
|---|---|---|
| 1. | time | Time dimension for All Channels |
| 1. | X | Dimension for pixel direction of all channels |
| 2. | Y | Dimension for scan direction of all channels |
| 3. | proj_dim | Dimension for Grid Mapping Dataset |

The X dimension contains the projection coordinates along pixel direction starting from left. And Y dimension contains projection coordinates along scan direction starting from top. X and Y dimensions have following attributes required as part of CF conventions:

**Table 2.29 Attributes of X,Y dimensions for L1C Products**

| S.No. | Dimension Name | Attribute Name | Value |
|---|---|---|---|
| 1. | X | long_name | x coordinate of projection |
| 2. | X | standard_name | projection_x_coordinate |
| 3. | X | units | m |
| 4. | Y | long_name | y coordinate of projection |
| 5. | Y | standard_name | projection_y_coordinate |
| 6. | Y | units | m |

For L1B and L1C Products, following dimension is also created:

**Table 2.30 Additional Dimension for L1B and L1C Products**

| S. No. | Dimension Name | Description |
|---|---|---|
| 1. | GreyCount | Dimension for storing calibration information as lookup table for all the channels. |

Time dimension has following Attributes:

**Table 2.31 Attributes of Time Dimension**

| S. No. | Attribute Name | Units | Description |
|---|---|---|---|
| 1. | units | "minutes since 2000-01-01 00:00:00" | Units of Time dimension |

**NOTES:**

1. All the dimension scales have an attribute named REFERENCE_LIST which is maintained by HDF5 dimension scale API for referring to in which all datasets it is being used as dimension.
2. All the Datasets in Products have and attribute named DIMENSION_LIST whose value is an array of references to the dimension scales (e.g. time, GeoY, GeoX). This attribute is maintained by the HDF5 dimension Scale API.

# Appendix- I : INSAT-3D Radiometric Calibration

## COUNT TO RADIANCE

INSAT-3D counts can be converted to radiance either using the lookup table (LUT) or the calibration coefficients.

## LOOKUP TABLE

The look up table (XXX_YYYY_RADIANCE, where XXX is the sensor, YYYY is Band) provides mapping from count to corresponding radiance. A field name "Radiometric_Calibration_Type" provided as attribute of Root Group in HDF product describes source of calibration coefficients used for generating this LUT (Ref Table 2.3).

## CALIBRATION COEFFICIENTS

Lab and Online radiometric calibration coefficients are available as part of HDF product, which can be used for computing radiance directly from count:

- Lab Calibration coefficients are generated using pre-launch ground test data, where each IR detector element along with its associated processing channel is characterized in Thermo-vacuum chamber using two Blackbody targets-a Space Reference Target (SRT) simulating space and a Variable Temperature Blackbody Source (VTBS) simulating the earth scene from 180K to 340K temperature range. Using these data quadratic coefficients (slope, offset and quadratic term) for EOM 10°C, 25°C and 40°C were generated. Based on EOM temperature of an acquisition lab slope, offset and quadratic term are derived and provided in product.

  In HDF products a field named "invert" (provided as attribute of each channel dataset) indicates whether image counts are inverted or not. While computing the radiance values the counts should be inverted (only for bands having invert = True) .The lab coefficients provided for Count to radiance conversion are used in following way:

  **Count = $DN_{Max}$- Count (only if invert = True)**

  Where $DN_{Max}$ 1023 for Imager and $DN_{Max}$ = 16383 for Sounder

  **R (in mw $cm^{-2}$ $sr^{-1}$ $um^{-1}$) = lab_radiance_quad*$(Count)^2$ + lab_radiance_scale_factor*(Count) + lab_radiance_add_offset**

- Online calibration is performed using onboard internal blackbody serving as a "hot target" and space view count as "cold target". From these two online slope and offset are computed. Quadratic term is derived using inter sensor calibration.

In HDF products a field named *invert* indicates inversion of image counts. While computing the radiance values the counts should be inverted (only for bands having invert = True) . The online coefficients provided for Count to radiance conversion are used in following way:

**Count = $DN_{Max}$- Count (only if invert == true)**

Where $DN_{Max}$ 1023 for Imager and $DN_{Max}$ = 16383 for Sounder

**R (in mw $cm^{-2}$ $sr^{-1}$ $um^{-1}$)=online_radiance_quad *$(Count)^2$ + online_radiance_scale_factor*(Count)+online_radiance_add_offset**

## COUNT TO BRIGHTNESS TEMPERATURE

Count can be converted to Brightness Temperature (BT) using 2 methods:

- Using LUT provided in the product (XXXX_YYY_TEMP, where XXXX is Sensor YYY is Band).
- First convert count to radiance as discussed above and then generate BT from radiance using inverse planck's law as given below.

**brightness_temperature = C2 / (cwl * log(C1 / (1.0E6 * rad_w_m2 * pow (cwn, 5.0)) + 1))**

**Where**

cwl(metres)= central_wavelength(um)/1000000.0 (Field *central_wavelength* in product)
rad_w_m2 = radiance*10.0 (For converting from mw $cm^{-2}$ $sr^{-1}$ $um^{-1}$ to w $m^{-2}$ $sr^{-1}$ $um^{-1}$)
h = 6.6260755e-34 kg $m^2$ $s^{-1}$;
c = 2.9979246e+8 $ms^{-1}$;
k = 1.380658e-23 kg $m^2$ $s^{-2}$ $k^{-1}$;
C1 = 2.0 * h *c * c;
C2 = (h * c) / k;

**RECOMMENDATION**: It is recommended to use coefficients of type of calibration (Radiometric_Calibration_Type) to generate radiance from counts. The other calibration source at some times may have issues.

# Appendix- II : INSAT-3D Geometric Calibration

## 1. INSAT-3D IMAGER

a) IMAGER L1B and L2B products are Fixed Grid product generated using GEOS [5] projection. Per pixel geo-location can either be computed using the GEOS projection parameters or per pixel navigation provided in HDF product. For Water-vapor band this navigation information (Table 2.8) is provided at 8 Km, for IR(TIR1,TIR2,MIR) channels (Table 2.8) at 4Km. and for Visible (Table 2.8),SWIR (Table 2.8) at 1Km. The geo-location datasets and ancillary datasets (sun azimuth/elevation and sensor azimuth/elevation are scaled to reduce data size. (Ref Table 2.17 for geo-location datasets scaling information and Ref Table 2.26 for ancillary datasets scaling information).

b) L1C products are Map Projection based products and the Map-Projection parameters (Table 2.18 and Table 2.19) are provided in the product for navigation of each pixel.

## 2. INSAT-3D SOUNDER

Sounder L1B and L2B products are generated using Lat-Lon [5] navigation. The per pixel navigation information is provided at 10 Km for all 19 channels.

# Abbreviations and Acronyms

| | |
|---|---|
| HDF | Hierarchical Data Format |
| IMD | India Meteorological Department |
| INSAT | Indian National Satellite |
| IR | Infrared |
| ISRO | Indian Space Research Organisation |
| LCC | Lamberts Conformal Conic Projection |
| NCSA | National Center for Supercomputing Applications |
| SAC | Space Applications Centre |
| SWIR | Shortwave Infrared |
| TIR | Thermal Infrared |
| MIR | Middlewave Infrared |
| LWIR | Longwave Infrared |
| USGS | United States Geological Survey |
| WV | Water Vapour |
| VIS | Visible band |
| CF Conventions | Climate and Forecasting Conventions |
| GEOS Projection | Geo-stationary Satellite Projection |
| DN | Digital Number |

# References

[1] http://hdf.ncsa.uiuc.edu/
[2] http://cf-pcmdi.llnl.gov/documents/cf-conventions/1.6/cf-conventions.html
[3] http://www.remotesensing.org/geotiff/proj_list/lambert_conic_conformal_2sp.html
[4] http://www.remotesensing.org/geotiff/proj_list/mercator_2sp.html
[5] CGMS 03 (Coordinate Group for Meteorological Satellites – LRIT/HRIT Global Specifications.