National Aeronautics and Space Administration Goddard Earth Science Data Information and Services Center (GES DISC)

README Document for Sounder PEATE Calibration Subset (CalSub) Products

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1 Introduction

This document provides basic information for using Version 10 Calibration Subset (CalSub) products produced by the Sounder Product Evaluation and Test Element (PEATE)[1]. Calibration Subsets provide sampled data from various sounder platforms to support calibration, validation and other data quality studies. Calibration Subsets conveniently reduce and characterize a day of data in a much smaller package.

Infrared temperature sounders generate a large amount of calibrated radiance data (SDRs for SNPP, L1B for AIRS, and L1C for IASI), and in many cases much too much data are available for performing productive trending and other Cal/Val studies. For example, the AIRS instrument with 2378 infrared channels, along its companion instruments, AMSU and AIRS Visible/Near-Infrared (15 channels and 4 channels, respectively) create 3x240 files each day, for a total of over 500 MB of data. That's nearly 2TB annually. Adding multiple years to a study will only multiply the problem. There's too much data to deal with. In order to see the forest from the trees, daily subsets are needed. Thus, the Calibration Subset was created.

The purpose of the PEATE Calibration Data Subsets is extract key information from these data into a manageable dataset to:

1. Facilitate a quick evaluation of the absolute calibration
2. Facilitate an assessment of the instrument performance under clear, cloudy and extreme hot and cold conditions
3. Facilitate the evaluation of trends and their significance relative to climate trends
4. Facilitate the comparison of CrIS with AIRS and IASI data through comparison of their equivalent data subsets

Calibration Subsets were first produced by the AIRS Project in support Cal/Val and data trending studies. The basic algorithm has now been updated and adapted to support development of Calibration Subsets from Suomi NPP and MetOp platforms.

[1] The Sounder PEATE, or SNPP Sounder PEATE, is one six PEATEs formed by NASA to support NASA Science Teams studying instrument data from the Soumi NPP (previously known as NPP) satellite. The Suomi NPP satellite is managed by the National Polar-orbiting Partnership (NPP) which includes elements from NASA, NOAA and DoD. Specific details about SNPP can be found at: http://npp.gsfc.nasa.gov/index.html.

Currently, CalSub supports three instrument platforms: Suomi NPP, Aqua and MetOp (both A and B). Four unique subsets can be produced for any day's data: (1) clear fields of view, (2) clouds, (3) random and (4) fixed-site validation sites.

1.1 Mission Instrument Description

All instruments selected for Calibration Subset observations are infrared and microwave sounders and are paired on orbital platforms such as Aqua (AIRS/ASMSU), MetOP (IASI/AMSU/MHS) and SNPP (CrIS/ATMS). All data products used for generating Calibration Subsets are obtained from publically accessible data archives. Most products are obtained from the NOAA Comprehensive Large Array-data Stewardship System (CLASS). These data products include SNPP data products as well as MetOp A and B products. The other remaining data products (AIRS and AMSU) are obtained from the Goddard Earth Sciences (GES) Data and Information Services Center (DISC) are from the Aqua platform. By prior arrangement, some of these products pass through intermediary destinations before they reach the Sounder PEATE. These include the AIRS Project for AIRS and AMSU data and the SD3E component of NASA's SNPP Science Data System (SDS) for CrIS and ATMS products. These intermediary stops are identified only for completeness, as these sites do not alter the original data products in any form.

Table 1.1-1 and Table 1.1-2contain summaries of selected instrument and platform parameters. Calibration subset products are produced for SNPP, Aqua-AIRS, and MetOp-A, -B.

Table 1.1-1 Instrument parameters. *CrIS additionally reports 12 unusable "guard" channels (2 on each band edge). First dimension of the above scan patterns reflects the field-of-regard (for) along the scan direction.

Platform	Instrument	Instrument Type	PEATE Id	Scan Rate (s)	Scan Range (°)	Scan Pattern	FOR Dia (km, nadir)	Spectral Channels
SNPP	CrIS	IR (FTS)	901	8	±50	30 x 3 x 3	14	1305*
	ATMS	MW	301	8/3	±53	96	16-75	22
Aqua	AIRS	IR (Grating)	801	8/3	±50	90	14	2378
	AMSU-A	Primary MW	101	8	±50	30	41	15
	HSB	Secondary MW	201	8/3	±50	90	14	4
MetOp-A/B	IASI	IR (FTS)	1001 1002	8	±48	30 x 2 x 2	12	8461
	AMSU-A	Primary MW	121 122	8	±50	30	47	15
	MHS	Secondary MW	221 222	8/3	±50	90	16	5

Table 1.1-2 Approximate orbital parameters. *Orbital drift of NOAA satellites not tightly constrained.

Platform	NORAD Id	Alt	Orbit Incl. (°)	Equator X Time	Period	Repeat Orbits	Repeat Days	Launch
SNPP	37849	824	98.7	13:30*	101	228	16	28 Oct 2011
Aqua	27424	705	98.2	13:30	98.8	233	16	04 May 2002
MetOp-A	29499	817	98.7	09:30	101.3	412	29	19 Oct 2006
MetOp-B	38771	817	98.7	09:30	101.3	412	29	17 Sep 2012

1.2 Sounder PEATE

With the launch of the Suomi NPP (SNPP, previously known as NPP) on October 28, 2011, NASA became a data customer for the next suite of Earth-observing platforms. This role is quite different when compared to previous Earth missions where NASA served additional roles as the primary data provider and curator of data products. Just how well SNPP data products would fit into the science and observation paradigm established over more than a decade of Earth missions was not known. Would these products support long-term climate studies that began utilizing data products that preceded SNPP? NASA commissioned SNPP science teams to analyze SNPP data products and determine whether those products would be “climate quality” and support ongoing climate studies. Six science teams were selected through a competitive proposal process to analyze data from SNPP’s five instruments. Six data processing systems and support teams were formed to support each of the six science teams. They are referred to as PEATEs for “Product Evaluation and Test Element.”

Table 1.2-1 PEATEs.

Science Team	PEATE	Instrument(s) Analyzed
Sounder	Sounder	CrIS and ATMS
Ozone	Ozone	OMPS
Ceres	CERES CARS	CERES
Land	Land	VIIRS
Atmospheres	Atmospheres	VIIRS
Ocean	Ocean	VIIRS

Collectively, each SNPP science team and associated PEATE has been charged with two fundamental tasks: First, they are to ascertain whether SNPP data products can be used to continue ongoing climate studies. Second, they are expected to improve the SNPP data production algorithms when possible in order to (1) produce climate quality products or (2) produce better climate quality products.

The PEATE’s roles in supporting their science teams are extensive. PEATEs develop products that help the science teams evaluate the quality of SNPP products. If the science teams identify potential improvements to those products through enhancements to existing or new algorithms, the PEATEs provide a computational environment and software development staff to enable coding and testing these potential improvements. The PEATEs may also develop additional products that may help their science teams analyze how well SNPP products will be useful for continuing ongoing climate studies. Consequently, most PEATEs produce a variety of data products for their science teams. Since it is possible that many of these data products may have general utility to the science community beyond the SNPP science teams, NASA requests that PEATE products be made available to the public. This is consistent with NASA's Earth Science Data Policy (http://science.nasa.gov/earth-science/earth-science-data/data-information-policy/).

The Sounder PEATE produces several such products including Simultaneous Nadir Observations, Calibration Subsets and Level 3 products. Calibration Subsets are described in this document. Other Sounder PEATE products are described in other Readme documents.

Data are received from a variety of sources for the production of Calibration Subsets. Our major source of data products is from the NOAA Comprehensive Large Array Data Stewardship Data System (CLASS). In actuality, all input data with the exception of AIRS data products are obtained from CLASS. SNPP products, however, are obtained via an interface with the SNPP Science Data Segment's Data Depository Element (SD3E) at the GSFC. All AIRS data products are obtained from the AIRS Project at JPL. But, these products are actually produced at the Goddard Earth Sciences Data and Information Services Center (GES DISC) at GSFC.

The physical interface from NOAA through the SD3E is for the convenience of NOAA. But, should SD3E cease to exist, then the Sounder PEATE will obtain SNPP products directly from NOAA Class.

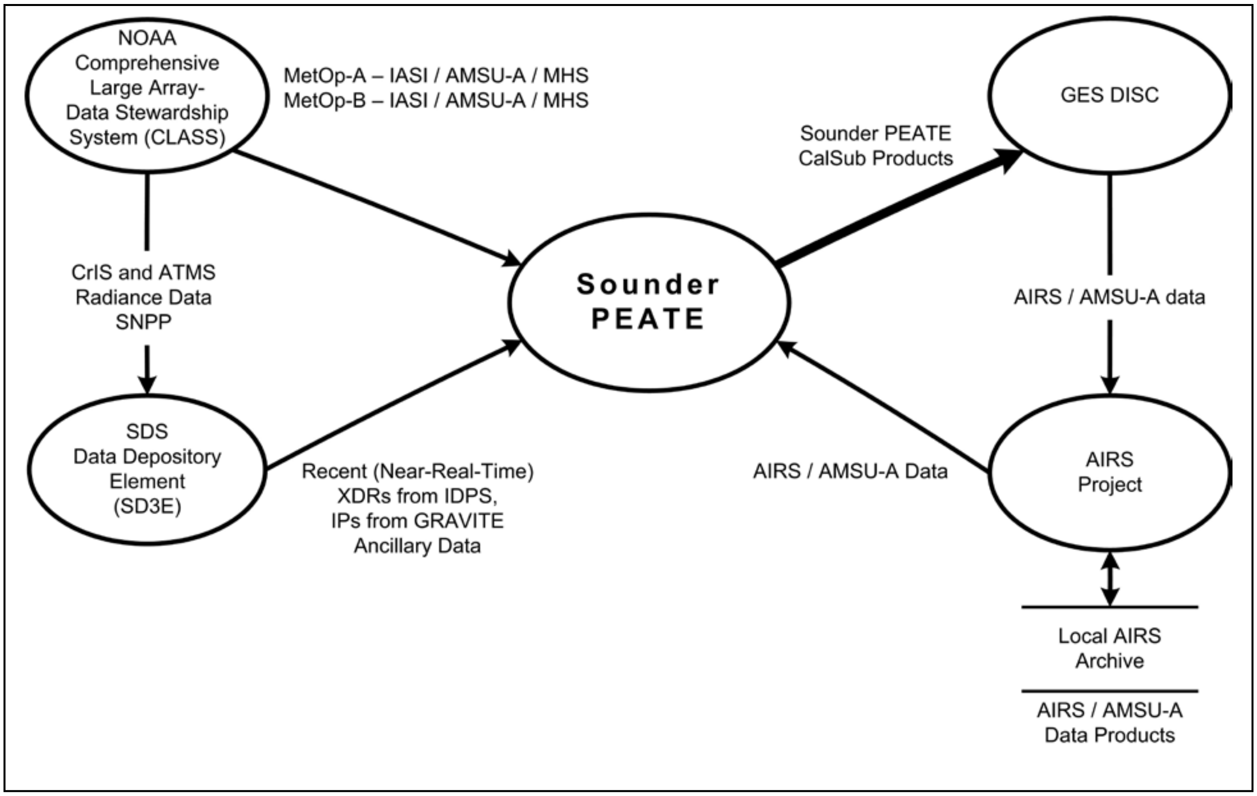


Figure 1.2-1 Sounder PEATE Data Flow. Data are received from a variety of sources for SNO processing.

1.3 Algorithm Background

1.3.1 Overview

CalSub product files are constructed from calibrated radiance files (infrared and microwave) from either the SNPP, Aqua or MetOP-A/B. Nominally one logical file is constructed for a 24-hour period, from midnight to midnight of the following day. This file is split into a set of four physical files to support specific concept studies and to further minimize the need to handle extraneous data. The four files are:

1. Clear fields of view
2. Fixed calibration sites (ARMS sites)
3. Clouds and extreme conditions
4. Randomly selected spectra within 3-degrees of nadir

These output files conform to the Sounder PEATE RTP3 format. They are Hierarchical Data Format Version 5 (H5), NetCDF-4 compliant.

About 1% of the spectra generated each day are saved. The parameter “reason” identifies categories of spectra by setting bit flags (Table 1.3-1). Each category is pulled out into a separate netcdf file. Additional information is saved in the parameter “siteid.”

Table 1.3-1 Bitfield *reason*.

Bit No.	Reason	siteid	Notes
0	Clear	-2, -1, 0, 99	See Section 1.3.3
1	Special calibration sites	1-25	See Section 1.3.4
2	Cloud tops colder than 225K between 50N and 50S	99	See Section 1.3.5
3	Random spectra within 3 degree of nadir	88	See Section 1.3.2
4	The hottest spectrum in each granule	97	See Section 1.3.6
5	Unused	n/a	
6	Non Frozen ocean low stratus	96	See Section 1.3.7

For some spectra multiple bits may be set, i.e. a random spectrum (reason bit 3 set) could also be clear (reason bit 0 set).

As previously noted, four distinct physical files of CalSub data are produced daily:

Table 1.3-2 Mapping of Reason bitfield to CalSub product.

CalSub File	Contains Data with Bit Flags
Clear File	0, 4
Fixed Sites File	1
Cloud File	2, 6
Random File	3

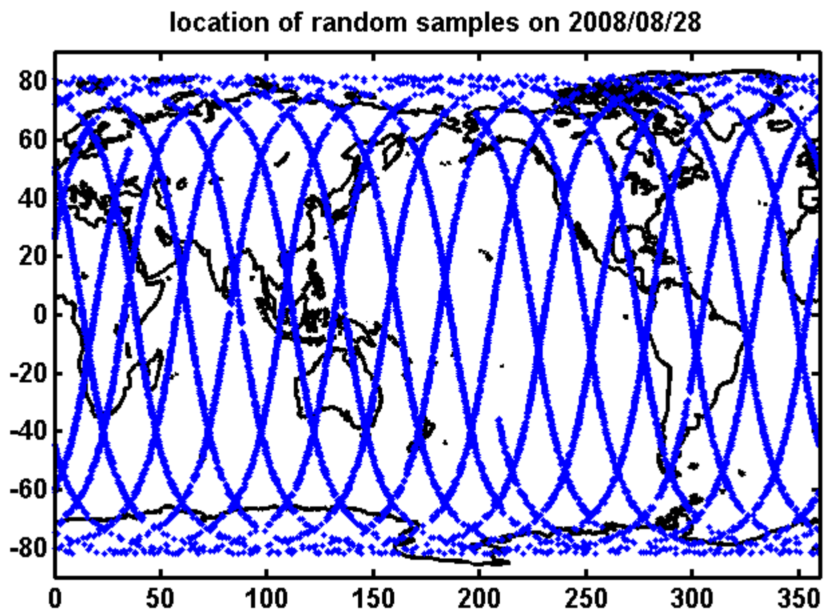
In addition to each spectrum, a number of parameters are copied from source the radiance (SDR, L1C or L1B) files. Additional parameters are calculated from the spectra and are augmented with additional parameters obtained from outside sources.

Various features of the CalSub Data Subsets are described in the following sections using prototype AIRS data for 2008/08/28 and 2012/02/25.

1.3.2 Random Selection

The random spectra selection was designed to support climate applications with IR data. Each day, AIRS produces three million spectra that are saved in 720 files (three sets of 240 files – IR L1b, AIRS Vis, AMSU). Due to the nature of the polar orbit, the high latitudes are oversampled. The EOS Aqua orbit at 705 km altitude has a 16-day orbit repeat cycle. The intent of the CalSub Random data set is to create a much smaller daily sample, which represent a uniform sample of the globe, regardless of latitude. Each spot on the equator has an equal likelihood to be sample every 32 days. Samples are thinned from the northern latitudes in such a way that their likelihood of selection is also every 32 days. When depicted graphically (Figure 1.3-1), thinning of the samples at high latitudes is evident.

It is important to note that for critical climate application the data are unbiased and area representative. Of the 18425 random AIRS spectra collected from 2012/02/25, 74% were from within 50S and 50N. Based on area integration over the sphere between 50S and 50N we expect 76%. The small difference between the observed and expected fractions is consistent with our sampling method. It is also important to point out that qualifying nadir observations are restricted to those having instrument scan angles of ±3° degrees. In any given day, only the



first 10,000 matched pairs are recorded.

Figure 1.3-1 Location of random samples in a typical AIRS CalSub product.

1.3.3 Clear Selection

It is widely accepted that on the 15 km scale of the AIRS FOV, none of AIRS footprints are truly free of clouds. However, for many objectives it is important to identify spectra that are largely free of clouds. The Clear CalSub file contains footprints that meet the algorithmic specifications of being *clear*. While every attempt to provide only clear footprints is made, it is important to note that the clear filter rejects some clear data as cloudy (false alarm) and accepts some spectra as clear which are cloudy. These outliers can be readily removed in a statistical analysis. The clear spectra are identified with reason=1. The site id's provides additional details of how and under what conditions this *clear* state was determined. One more caveat should be mentioned: A monthly climatology-surface skin temperature for the descending (1:30AM) and ascending (1:30PM) overpasses on a 1 degree grid is used to separate frozen surface (<274K) and non-frozen surfaces. In the following we use the elevation to separate ocean and land and use the term "ocean" as non-frozen ocean, "land" as non-frozen land.

There are basically three methods for detecting clear conditions under day and night conditions: 1) forecast clear 2) spectral clear and 3) spatial coherence clear. They are explained in the next three sections:

1.3.3.1 Forecast Clear

If the surface temperature and emissivity and are known from the forecast, we can calculate the brightness temperature expected in a good window channel (*calc1231*) and compare it to the observed brightness temperature (*bt1231*) where we use the 1231 cm^{-1} window channel and d1231=bt1231-calc1231. This is numerically identical to d1231=sst1231-rtgsst. Here sst1231 is the surface temperature calculated using bt1231, the known emissivity and a water vapor correction derived from the spectrum, q3=bt1231-bt1227. The rtgsst is the Real Time Global SST (RTGSST) from NCEP associated with each spectrum. We then identify all spectra which satisfy the abs(d1231)<2 condition as "forecast clear".

For AIRS, from the 11004 random ocean spectra from 2008/08/28 this identifies 3571 (32%) spectra, with mean(d1231)=-0.68K and stdev(d1231)=0.72K. This evaluation works reliably only over "non-frozen" ocean, since the forecast surface skin temperature over land and for frozen surfaces under clear conditions can be in error by as much as 20K, particularly for dry soil conditions. We use d1231 to evaluate the effectiveness of other clear test over ocean. Under clear ocean conditions d1231 should have normal distribution with zero mean.

1.3.3.2 Spectral Clear

The presence of clouds in the data can be detected in the spectra. We use two tests: The Pseudo Lapse Rate (PLR) test and the Q3 test.

1.3.3.2.1 PLR Test

The PLR test makes use of the fact that the presence of clouds in the FOV is seen in lower tropospheric sounding channels. We use the difference between two temperature sounding channels, one of which sounds lower, the other sounds in the mid troposphere. We illustrate this with two channels at 723.0 cm^{-1} and 712.5 cm^{-1} and refer to the measured brightness temperatures as bt723.0 and bt712.75, respectively. Under cloud free conditions bt723 and bt712.75 sound the temperatures in broad layers of the atmosphere with the 50% transmission centered on 580 and 300 hPa, respectively. The temperature difference measured by d723=bt723.0-bt712.75 under clear conditions is related to the real temperature lapse rate. Under cloudy conditions the both channels measure a combination of the cloud top temperature for the cloudy part of the FOV, and the clear column for the clear fraction of the

FOV. This difference is always less than d723 expected under clear conditions. Figure 1.3-2 shows d723 calculated under clear conditions for a wide range of temperature and water vapor profiles as function of the surface temperature. The solid line defines d723clim, the boundary between clear and cloudy as function of the surface temperature. Points below the d723clim boundary are likely cloud contaminated. The larger scatter in d723 is due to water vapor absorption. At TSurf<285, d723 has a surface temperature sensitivity of 0.18K/K. At surface temperature above about 285K the increasing water vapor in the lowest 1 km of the atmosphere makes the surface invisible, and d723 becomes temperature independent. Figure 1.3-3 shows d723 as function of TSurf under "forecast clear" ocean conditions for 2008/08/28 ocean data. The d723clim line, which is the same as in Figure 1.3-2, indicates that the model calculations agree with the observed clear data.

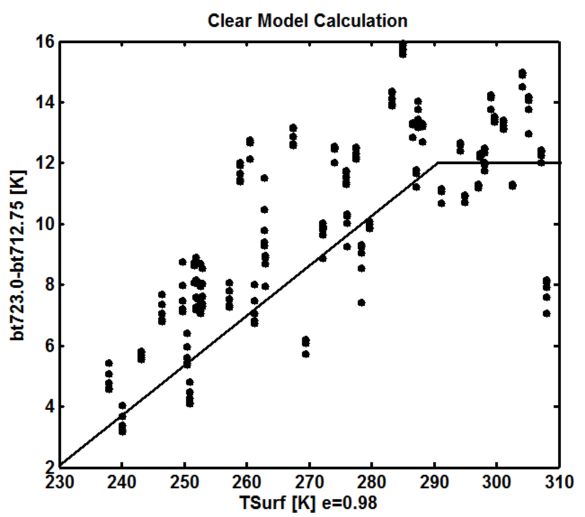


Figure 1.3-2 d 723=bt723.0-bt712.75 from clear model spectra. The vertical dots in correspond to scan angles between 0 and 50°. The big outlier at 308K was calculated for 120% relative humidity, assuming it to be clear. The line delineates the boundary between clear and cloudy.

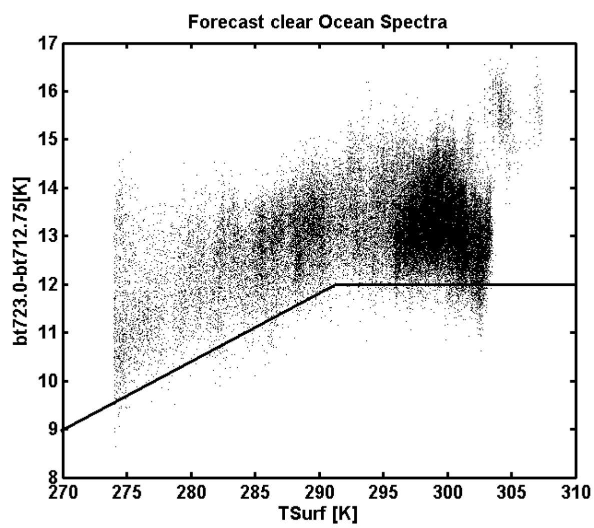


Figure 1.3-3 d723 as function of TSurf under "forecast clear" ocean conditions. The black line delineates the boundary derived from the model data.

While the forecast clear filter requires a very accurate knowledge of the surface temperature, the calculation of d723clim requires only an approximate knowledge surface temperature. Since the surface skin temperature from the forecast for land and frozen surfaces under clear conditions is unreliable, we use a monthly climatology on a one-degree grid derived from 4 years of AIRS L2 data (separate for the day and night overpasses). The d723clim sensitivity to surface temperature for temperatures colder than 285K is 0.18K/K, none at TSurf>285K (due to the strong water vapor absorption at warmer temperatures).

In Matlab:

```
d723clims=2*ones(size(rtgs));
v=find(tsurf_clims>230);
d723clims(v)=2+0.18*(tsurf_clims(v)-230);
v=find(tsurf_clims>290);d723clims(v)=12;
```

If, in a particular situation the climatology is 10 K warmer than the actual skin temperature, then a steeper lapse rate is expected, and a possibly clear spectrum would be rejected as likely cloudy. Missing some clear spectra is not a serious problem. On the other hand, if the climatology predicts TSurf<285K, but the actual TSurf is 10 K warmer, a 1.5 K less steep lapse rate would be expected for d723clim and a cloudy spectrum from land or frozen surface would be erroneously identified as clear.

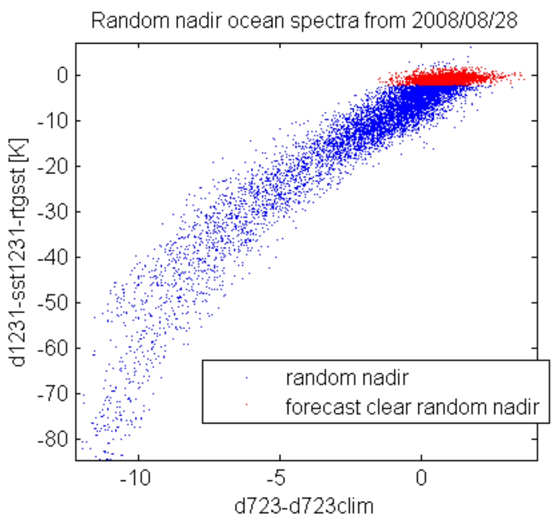


Figure 1.3-4 Random nadir spectra (blue) and spectra identified as forecast clear (red). The d723-d723clim>0 threshold separate very cloudy and mostly clear spectra for ocean.

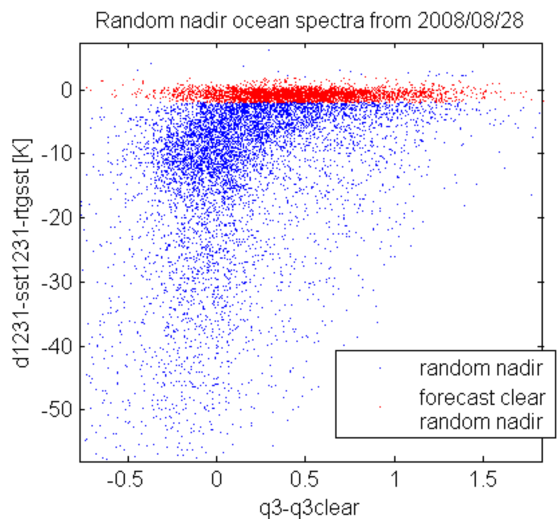


Figure 1.3-5 Random nadir spectra (blue) and spectra identified as forecast clear (red). The q3-q3clear>0 threshold separate very cloudy and mostly clear spectra for ocean.

1.3.3.2.2 Q3 Test

The Q3 test makes use of the fact that most water vapor is in the lowest 2 km of the atmosphere. Define q3=bt1231-bt1227, where bt1231 and bt1227 are the brightness temperature at 1231.3 cm-1 and 1227.7 cm-1 .

In Matlab:

```
q3clear=0.1*ones(size(rtgs));v=find(tsurf_clims>295);
q3clear(v)=(tsurf_clims(v)-295)/7.5+0.1;
```

Figure 1.3-4 and Figure 1.2-1 illustrates the action of the Q3 filter for random nadir ocean data.

Non-frozen ocean spectra which pass the PLR and Q3 tests and cx1231<5 are saved as reason=1 (bit 0 set), site id=98. Non-frozen land spectra which pass the PLR and Q3 test are saved with reason=1, site id=-1. Frozen land and ocean spectra which pass the PLR and Q3 test are saved with reason=1, site id=-2. The tsurf_clim<273 is used to separate frozen and non-frozen surface conditions. Land and frozen ocean spectra are not filtered with the SCT.

1.3.3.3 Spatial Coherence Test (SCT)

The Spatial Coherence Test (SCT) assumes that differences between adjacent FOV are entirely due to clouds. This difference is measured as cx1231=max(bt1231)-min(bt1231) in a 3x3 array centered on the spectrum under evaluation. The spatial coherence test parameter, cx1231, is associated with each spectrum. Figure 1.3-6 shows the 4641 spectra from the 11004 random nadir spectra that satisfy cx1231<5. It can be seen that a significant number of cloud contaminated spectra pass this test, almost no matter how small cx1231. Figure 1.3-7 shows the result of adding the PLR and Q3 spectra test. The red points pass the cx1231<5 test and the PLR and Q3 test.

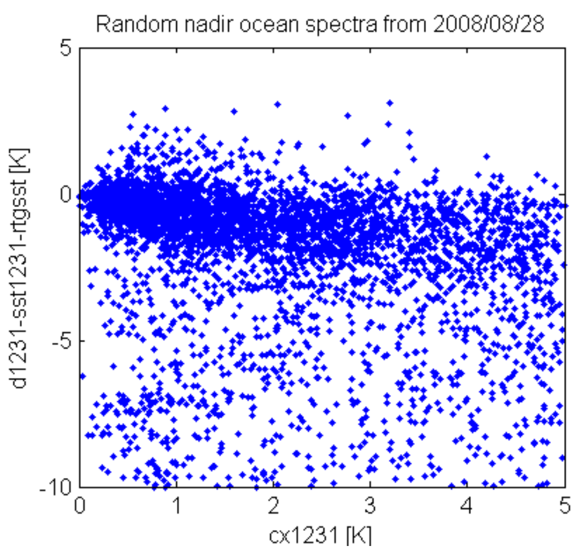


Figure 1.3-6 The 4641 of 11004 random nadir ocean spectra which satisfy cx1231<5.

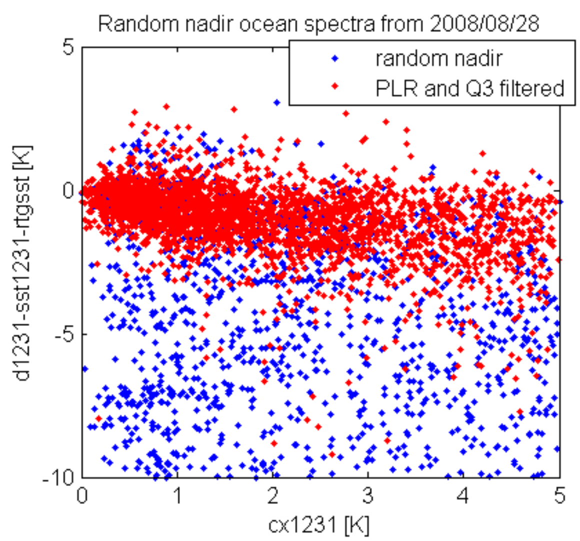


Figure 1.3-7 The 4641 of 11004 random nadir ocean spectra which satisfy cx1231<5.

The SCT test can only be used only over ocean. Ocean spectra which pass the SCT test with the condition cx1231<0.5 are identified by reason=1 and site id=0. The identification of clear land and frozen surfaces use only the spectral tests.

Since a very large number of spectra is identified as likely clear on any one day, not all spectra identified as “clear” need to be saved. In Version 5.0 of the AIRS data we limited the size of the clear data by using very tight thresholds. This has the curious consequence that the data that were saved were spatially correlated. For example on 2008/08/28 there were 35521 SCT clear ocean spectra, roughly equally split for day and night, 99.8% of these had at least on immediate spatially adjacent spectrum also identified as clear. For Version 6 of the AIRS data we are changing this strategy. We use physically reasonable thresholds and limit the data volume by random sampling. Of the spectra with site id=0 we randomly select and save 2500 during the day, 2500 at night. Of the spectra with site id=98 we randomly select and save up to 2500 during the day, up to 2500 at night. Of the PLR clear land spectra with site id=-1 we randomly select and save up to 10,000 during the day, and up to 10,000 at night. Of the PLR clear frozen surfaces identified with site id=-2 we randomly select and save up to 1000 during the day, and up to 1000 at night. This random selection strategy limits the Clear subset to 32,000 spectra per day, roughly the same number as saved in the AIRS version 5, with less clear ocean and much more clear land.

1.3.4 Special Calibration Sites

All footprints within 50 km of 21 special calibration sites are saved with reason=2 (bit 1 set).

The site id's identify the special calibration sites by name and coordinates. The definitions are in Table 3.3-9. For 2008/08/28 (2012/02/25) there were 4718 (5794) spectra from special calibration sites. Due the orbit configuration and the width of the AIRS cross-track scan, only sites above 30N or below 30S are seen twice each day (at 1:30AM and 1:30PM). Some high latitude sites, like Dome Concordia in Antarctica is seen on 8 overpasses each day.

1.3.5 Cold Clouds

The Cloud subset (site id=99) consists of all spectra where bt1231<215K or (bt1231-bt1419)<2. This makes storms in the mid latitude visible. For 2008.08.28 this saves 15365 cold clouds between latitude 50S and 50N spectra, identified with reason bit 2 set (reason = 4). For severe storms the data should be refiltered with dw<-4. This prescription for clouds has been modified since the V5 version of CalSub which saved all spectra where the brightness temperature at 1231 cm^{-1} is colder than 210K between latitudes 50S and 50N with bit 2 set (reason= 4). This threshold biases the data towards the equator, where the tropopause is close to 210K. For 2008/08/28 12/02/25 7360 spectra would pass this 210K threshold. If the threshold were relaxed to 215K (220K, 225K) 13410 (22374, 34344) spectra would pass. Most of these clouds are well below the tropopause in the tropics, but could be close to the mid-latitude tropopause.

1.3.6 Hot scenes

There is considerable interest in the statistics of extreme cases such as *extreme hot* FOVs. For each granule we find the hottest bt1231s. This spectrum is saved with reason bit 3 set (reason=16), site id=97. The QFlag is not tested. As an example of this we use the data from

2008/08/28. The hottest bt1231s was 335.46 K. The spectrum came from E58.85, N27.06 (southern part of Iran) at 604 meter mean elevation, with d723-d723clims=10.3 (easy pass the PLR test), but cx1231=16.8K. Since for land the SCT test is not used, this spectrum is identified as clear, but would as such not be saved due to the 1 in 4 saving strategy. Now it would be saved as clear, since reason=17 (bits 0 and bit 3 set).

It should be noted that the hottest land conditions will be associated with clear noon time conditions. Figure 1.3-8 shows the location of the 16092 land spectra identified as PLR land clear with bt1231>310K. Of these 1754 had bt1231>324K.

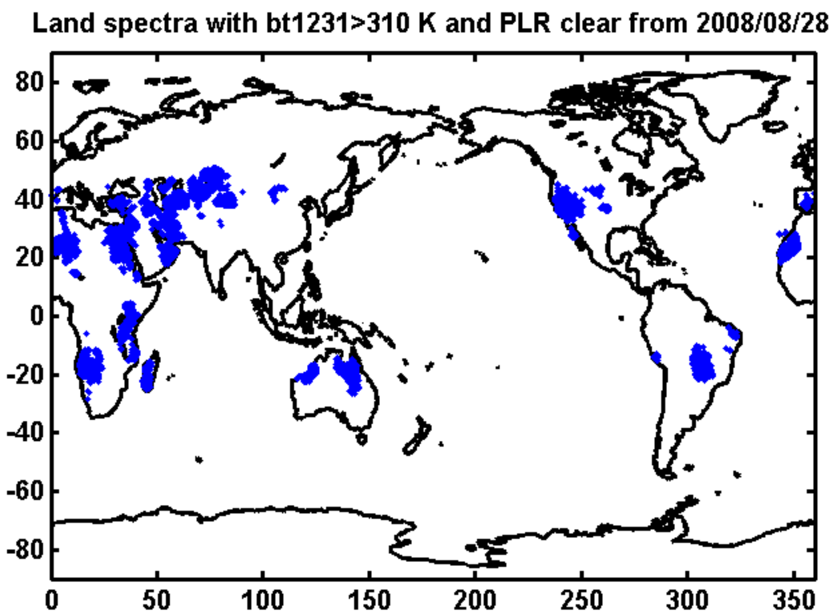


Figure 1.3-8 Location of the 16092 spectra with bt1231>324K.

1.3.7 Low Stratus

Low Stratus (reason bit = 6, site id = 96) are clear data that pass the spatial coherence test but fail other tests. Usually, they are further than 10 K off from the SST.

1.3.8 Input Data

A list of input file types is given in Table 1.3-3. Note AIRS HSB ceased operations in February 2003 and is not included in the analyses.

Table 1.3-3 Input data types for Sounder PEATE CalSub Version 10

CalSub Input	Input Files	Input Granularity	Format	Data Source	Version ID
SNPP IR	CrIS SDR (Sensor Data Record) (SCRIS) CrIS SDR Geolocation (GCRSO)	8 min, 15-granule aggregation	H5	SDS SD3E	Ops (See Table 1.3-4)
SNPP MW	MW TDR (Temperature Data Record) (SATMS) ATMS SDR Geolocation (GATMO)	8 min, 15-granule aggregation	H5	SDS SD3E	
Aqua IR	AIRS L1B	6 min	HDF-EOS	GES DISC	Collection 5
Aqua MW	AIRS AMSU-A L1B	6 min	HDF-EOS	GES DISC	Collection 5
MetOpA/B IR	IASI L1C	3 min	H5	NOAA CLASS	Ops (See Table 1.3-5)
MetOpA/B MW	NOAA AMSU-A L1B NOAA AMSU-B L1B	twice per orbit	NOAA KLM binary	NOAA CLASS	Ops
NCEP RTG_SST	Real-time, global, sea surface temperature analysis	daily	grib	ftp://polar.ncep.noaa.gov/pub/sst	n/a

Table 1.3-4 SNPP SD3E operational algorithm versions.

Version	Start Date	Orbit Number	Comments
Mx5.0	3-Nov-2011	88	Launch Version; Bad ATMS sidelobe correction
Mx5.1	9-Dec-2011	601	Zero ATMS sidelobe correction
Mx5.2	1-Feb-2012	1365	
Mx5.3	2-Apr-2012	2232	Emergency delivery to fix CrIS geolocation issue
Mx6.2	9-Aug-2012	4056	Mx5.3 merged with main CM tree
Mx6.3	15-Oct-2012	5010	
Mx6.4	16-Oct-2012	5025	Emergency delivery to fix OMPS related issue
Mx6.5	27-Nov-2012	5621	
Mx6.6	28-Feb-2013	6944	
Mx6.7	13-Mar-2013	7131	
Mx7.1	10-Jul-2013	8812	
	Nov 20, 2013		ATMS sidelobe correction started
Mx8.1	Jan 2014(?)	?	

Table 1.3-5 IASI operational L1C algorithm versions.

Version	Start Date
3.6	28-Feb-2007
4.0	4-Dec-2007
5.0	18-May-2010
5.1	1-Dec-2010
0.0	29-Sep-2011
6.2	22-Feb-2012
6.5	22-May-2013
7.0	8-Aug-2013

1.4 Data Disclaimer

Most data contained in Sounder PEATE CalSub products are derived from source files noted in Table 1.3-3. CalSub primarily filters those data products according to an algorithm and writes out selected data fields. To foster better consistency between matched pairs between all instruments, a small subset of fields are calculated when the source does not contain them: *salt* (surface altitude), *landfrac* (land fraction), *scanang* (scan angle) and *ascflag* (ascending flag).

For documentation of specific instrument data included in Sounder PEATE SNO products, see references in Section 8.

1.4.1 Acknowledgement

All data contained in Sounder PEATE CalSub products are derived from the original sources of those data products. We freely acknowledge and attribute the source data to the following organizations:

- Acknowledgement for AIRS and AMSU-A data:

  Distribution of GES DISC data sets is funded by NASA's Science Mission Directorate (SMD). The data are not copyrighted and are open to all for both commercial and non-commercial uses. If you used GES DISC data for a publication (research or otherwise), or for any other purpose, we request that you include the following acknowledgment:

  > "The data used in this effort were acquired as part of the activities of NASA's Science Mission Directorate, and are archived and distributed by the Goddard Earth Sciences (GES) Data and Information Services Center (DISC)."

We would appreciate receiving a copy of your publication, which can be forwarded to the following address:

Goddard Earth Sciences DISC Help Desk
Code 610.2
NASA/Goddard Space Flight Center
Greenbelt, MD 20771

Or, you may email the publication reference gsfc-help-disc@lists.nasa.gov.

- Acknowledgement for NOAA instruments – ATMS and CrIS:

NOAA distributes all data for ATMS and CrIS via the Comprehensive Large Array-data Stewardship System (CLASS), http://www.class.ngdc.noaa.gov. The NOAA CLASS data disclaimer, listed below, can be found at http://www.ncdc.noaa.gov/oa/pod-guide/ncdc/docs/podug/disclaim.htm:

> *While every effort has been made to ensure that this documentation is accurate and reliable, NOAA cannot assume liability for any damages caused by inaccuracies in the NOAA polar orbiter data or documentation, or as a result of the failure of the data or software to function in a particular manner. The software (included in the appendices) was developed by the U.S. Government and is not intended for resale. The user should be aware that phone numbers, fax numbers, addresses and Internet Uniform Resource Locators (URLs) are subject to change and cannot be expected to remain constant. NOAA makes no warranty, expressed or implied, nor does the fact of distribution constitute a warranty.*

All NOAA data used in SNPP Sounder PEATE SNO products is free for use and reuse in accordance with the “NOAA/National Climatic Data Center Open Access to Physical Climate Data Policy.” More information can be found at: http://www.ncdc.noaa.gov/oa/about/open-access-climate-data-policy.pdf.

- Acknowledgement for IASI (MetOP-A/B):

IASI data are obtained via CLASS from EUMETSAT via use agreement. The Level 1C data are considered free for use based on an international use agreement. References for acknowledgement should include the following statement:

> *IASI data were obtained from CLASS via a special use agreement with EUMETSAT. The data are free for use based on their posting on NOAA CLASS in accordance with the* “NOAA/National Climatic Data Center Open Access to Physical Climate Data Policy” described above.

Specific reference information can be found at: http://www.eumetsat.int/website/home/AboutUs/LegalInformation/index.html.

Within the above link, EUMETSAT's data use policy can be found at http://www.eumetsat.int/website/wcm/idc/idcplg?IdcService=GET_FILE&dDocName=PDF_LEG_DATA_POLICY&RevisionSelectionMethod=LatestReleased&Rendition=Web. It specifically states that a METOP data license "is granted to all users without charge, and against the signature of a license agreement. They may not be redistributed without transformation." NOAA maintains such a license agreement with EUMETSAT. As representation of METOP-A data as represented in SNO products is a subset of source product, they are considered to be *transformed*.

1.4.2 Contact Information

For more information about Sounder PEATE data products including CalSub products, please contact the Sounder PEATE System Engineer, Ruth Monarrez. Ms. Monarrez' contact information is provided below:

Ruth Monarrez, (Ruth.Monarrez@jpl.nasa.gov)
Jet Propulsion Laboratory
MS 168-414
4800 Oak Grove Dr.
Pasadena CA, 91109

2 Data Organization

For each platform there are four CalSub file types per day, contains data selected for different values of the "reason" bitfield. Each file consists of a sequence of profiles, with each profile describing a single observation.

2.1 File Naming Convention

The PEATE CalSub product naming convention is as follows:

SNDR.*platform.instr.yyyymmdd.***D1.RTP3**.*mask.source.sampling*.**standard**.***v****n_m_l*.**S**.*prodStamp***.nc**

- SNDR = Sounder PEATE product
- platform = satellite platform [NPP, AQUA, METOPA, METOPB]
- instr = primary instrument of data in file:
  - NPP: CRIS
  - AQUA: AIRS
  - METOPA/B: IASI

- yyyymmdd = nominal start date of data
  - yyyy: 4 digit year number [2002 -].

- mm: 2 digit month number [01-12]
- dd: 2 digit day of month [01-31]
- D1 = daily product
- RTP3 = Sounder PEATE RTP3 File Type

- (p) mask = 7 char string, for these products one of 'xxixmxx, 'xxixmxb']
  from left to right, starting with position 0; possible non 'x' values:
  - position 2 = i indicates observed IR radiances are present in file
  - position 4 = m indicates observed primary MW-instrument radiances are present in file
  - position 6 = b indicates observed secondary MW-instrument radiances are present in file

- (content) source = sequence of 3 char mnemonics describing each non-x member of content
  mask, delimited by "_" , mnemonics are:
  - IR: [CRN, AIN, IAN]; CRIS, AIRS or IASI, combined with SNPP RTG SST
  - Primary MW: [ATT, AMA]; ATMS TDR, AMSU-A respectively
  - Secondary MW: [MHS]

- sampling = indicator of what the profiles in the file were matched to:
  - [CalSub_Clear, CalSub_Cloud, CalSub_Fixed, CalSub_Random]

- standard = PEATE Collection Label identifying standard processing configuration
- v*nn_m_l* = algorithm version identifier of major version, minor version, release version.
- S = file produced in Sounder PEATE Operational data stream

- prodStamp = datetime stamp of product generation, yymmddhhmmss:
  - yy: year number without century
  - mm: month number [01-12]
  - dd: day of month [01-31]
  - hhmmss: hours, minutes and seconds UTC time.

- nc = NetCDF 4 formatted file

2.2 CalSub Product Granules

The orderable CalSub subtypes, along with example filenames and sizes are given below. Note there will be some variability in daily CalSub file sizes; file sizes shown are only approximate.

2.2.1 SNPP CalSubs

2.2.1.1 SNPP CrIS Clear Calibration Subset

Short Name	**SPCSNP1D**
Long Name	Sounder PEATE SNPP CrIS Clear Calibration Subset
File Size	1.8 GB
Sample Filename	*SNDR.NPP.CRIS.20120920.D1.RTP3.xxixmxx.CRN_ATT.CalSub_Clear.standard.v10_0_0.S.131107202726.nc*

2.2.1.2 SNPP CrIS Cloud Calibration Subset

Short Name	**SPCSNP2D**
Long Name	Sounder PEATE SNPP CrIS Cloud Calibration Subset
File Size	300 MB
Sample Filename	*SNDR.NPP.CRIS.20120920.D1.RTP3.xxixmxx.CRN_ATT.CalSub_Cloud.standard.v10_0_0.S.131107202726.nc*

2.2.1.3 SNPP CrIS Fixed Site Calibration Subset

Short Name	**SPCSNP3D**
Long Name	Sounder PEATE SNPP CrIS Fixed Site Calibration Subset
File Size	40 MB
Sample Filename	*SNDR.NPP.CRIS.20120920.D1.RTP3.xxixmxx.CRN_ATT.CalSub_Fixed.standard.v10_0_0.S.131107202726.nc*

2.2.1.4 SNPP CrIS Random Calibration Subset

Short Name	**SPCSNP4D**
Long Name	Sounder PEATE SNPP CrIS Random Calibration Subset
File Size	250 MB
Sample Filename	*SNDR.NPP.CRIS.20120920.D1.RTP3.xxixmxx.CRN_ATT.CalSub_Random.standard.v10_0_0.S.131107202726.nc*

2.2.2 Aqua CalSubs

2.2.2.1 Aqua AIRS Clear Calibration Subset

Short Name	**SPCSAQ1D**
Long Name	Sounder PEATE Aqua AIRS Clear Calibration Subset
File Size	1.2 GB
Sample Filename	*SNDR.AQUA.AIRS.20120920.D1.RTP3.xxixmxx.AIN_AMA.CalSub_Clear.standard.v10_0_0.S.131107202726.nc*

2.2.2.2 Aqua AIRS Cloud Calibration Subset

Short Name	**SPCSAQ2D**
Long Name	Sounder PEATE Aqua AIRS Cloud Calibration Subset
File Size	250 MB
Sample Filename	*SNDR.AQUA.AIRS.20120920.D1.RTP3.xxixmxx.AIN_AMA.CalSub_Cloud.standard.v10_0_0.S.131107202726.nc*

2.2.2.3 Aqua AIRS Fixed Site Calibration Subset

Short Name	**SPCSAQ3D**
Long Name	Sounder PEATE Aqua AIRS Fixed Site Calibration Subset
File Size	25 MB
Sample Filename	*SNDR.AQUA.AIRS.20120920.D1.RTP3.xxixmxx.AIN_AMA.CalSub_Fixed.standard.v10_0_0.S.131107202726.nc*

2.2.2.4 Aqua AIRS Random Calibration Subset

Short Name	**SPCSAQ4D**
Long Name	Sounder PEATE Aqua AIRS Random Calibration Subset
File Size	150 MB
Sample Filename	*SNDR.AQUA.AIRS.20120920.D1.RTP3.xxixmxx.AIN_AMA.CalSub_Random.standard.v10_0_0.S.131107202726.nc*

2.2.3 MetOp-A CalSubs

2.2.3.1 MetOp-A IASI Clear Calibration Subset

Short Name	**SPCSMA1D**
Long Name	Sounder PEATE MetOp-A IASI Clear Calibration Subset
File Size	1.6 GB
Sample Filename	*SNDR.METOPA.IASI.20120920.D1.RTP3.xxixmxb.IAN_AMA_MHS.CalSub_Clear.standard.v10_0_0.d.131107202726.nc*

2.2.3.2 MetOp-A IASI Cloud Calibration Subset

Short Name	**SPCSMA2D**
Long Name	Sounder PEATE MetOp-A IASI Cloud Calibration Subset
File Size	700 MB
Sample Filename	*SNDR.METOPA.IASI.20120920.D1.RTP3.xxixmxb.IAN_AMA_MHS.CalSub_Cloud.standard.v10_0_0.S.131107202726.nc*

2.2.3.3 MetOp-A IASI Fixed Site Calibration Subset

Short Name	**SPCSMA3D**
Long Name	Sounder PEATE MetOp-A IASI Fixed Site Calibration Subset
File Size	40 MB
Sample Filename	*SNDR.METOPA.IASI.20120920.D1.RTP3.xxixmxb.IAN_AMA_MHS.CalSub_Fixed.standard.v10_0_0.S.131107202726.nc*

2.2.3.4 MetOp-A IASI Random Calibration Subset

Short Name	**SPCSMA4D**
Long Name	Sounder PEATE MetOp-A IASI Random Calibration Subset
File Size	500 MB
Sample Filename	*SNDR.METOPA.IASI.20120920.D1.RTP3.xxixmxb.IAN_AMA_MHS.CalSub_Random.standard.v10_0_0.S.131107202726.nc*

2.2.4 MetOp-B CalSubs

2.2.4.1 MetOp-B IASI Clear Calibration Subset

Short Name	**SPCSMB1D**
Long Name	Sounder PEATE MetOp-B IASI Clear Calibration Subset
File Size	1.6 GB
Sample Filename	*SNDR.METOPB.IASI.20120920.D1.RTP3.xxixmxb.IAN_AMA_MHS.CalSub_Clear.standard.v10_0_0.S.131107202726.nc*

2.2.4.2 MetOp-B IASI Cloud Calibration Subset

Short Name	**SPCSMB2D**
Long Name	Sounder PEATE MetOp-B IASI Cloud Calibration Subset
File Size	700 MB
Sample Filename	*SNDR.METOPB.IASI.20120920.D1.RTP3.xxixmxb.IAN_AMA_MHS.CalSub_Cloud.standard.v10_0_0.S.131107202726.nc*

2.2.4.3 MetOp-B IASI Fixed Site Calibration Subset

Short Name	**SPCSMB3D**
Long Name	Sounder PEATE MetOp-B IASI Fixed Site Calibration Subset
File Size	40 MB
Sample Filename	*SNDR.METOPB.IASI.20120920.D1.RTP3.xxixmxb.IAN_AMA_MHS.CalSub_Fixed.standard.v10_0_0.S.131107202726.nc*

2.2.4.4 MetOp-B IASI Random Calibration Subset

Short Name	**SPCSMB4D**
Long Name	Sounder PEATE MetOp-B IASI Random Calibration Subset
File Size	500 MB
Sample Filename	*SNDR.METOPB.IASI.20120920.D1.RTP3.xxixmxb.IAN_AMA_MHS.CalSub_Random.standard.v10_0_0.S.131107202726.nc*

2.3 File Format and Structure

Data files are in NetCDF-4 (Network Common Data Form) format; see http://www.unidata.ucar.edu/software/netcdf/. NetCDF-4 is an extension of the Hierarchical Data Format Version 5 (H5), developed at the National Center for Supercomputing Applications http://www.hdfgroup.org. Tools written to read H5 versions 1.8 or later will also operate on NetCDF-4 files. These data files in particular were created with NetCDF-4.1.2.

Most data fields are contained within the top-level H5 groups IRInst, MWInst, and MWBInst. Which groups are present depend on whether there is a secondary MW instrument on the platform.

2.4 Key Science Data Fields

2.4.1 Time and Geolocation

Observation times, latitudes and longitudes for each profile are provided for each instrument group in the fields, *time*, *lat* an *lon*. Time is expressed in seconds since an epoch, which is provided in ASCII UTC format in the global attribute, *epoch*. Additional geolocation-related quantities are present depending on the instrument and platform (see tables in Section 3.3).

2.4.2 Radiance and Antenna Temperatures

IR radiances vs. channel are provided for each profile in the *IRInst* field, *robs*. Center channel wavenumbers are in the profile-independent *IRInst* field, *fchan*. For CrIS, the imaginary spectrum is provided in field *robsimag*.

Uncorrected raw MW antenna temperatures vs. channel are provided for each profile in the *MWInst* and *MWBInst* fields, *btobs*. Center channel frequencies are in profile-independent *MWInst* and *MWBInst* fields, *fchan*.

3 Data Contents

3.1 Dimensions

A description of Science Data Set (SDS) dimensions is given in Table 3.1-1.

Table 3.1-1 Dimensions used in product.

Dimensions	Description
irnchan	Number of infrared channels; IRInst group only
mwba	Number of secondary MW (MWB) scanner footprints along track per primary mw scanner footprint, in MWBInstr group only
mwbnchan	Number of secondary MW (MWB) channel; MWBInstr group only
mwbx	Number of secondary mw scanner footprints cross-track per primary mw scanner footprint; MWBInstr group only
mwnchan	Number of primary MW channels; MWInstr group only
mwnif	Max number of intermediate frequency stages per MW channel
nprof	Number of profiles
nqc	Maximum number of possible quality indicators across all groups
utcMAX	Fixed size of UTC time strings (= 25 including null terminator)

3.2 Global Attributes

In addition to Data Set arrays containing variables and dimension scales, global metadata is also stored in the files. Some metadata are required by standard conventions, some are present to meet data provenance requirements and others as a convenience to users of **CalSub** products. Global attributes in a **CalSub** file can be viewed with *ncdump* software:
ncdump –h -c <Product file>.

A summary of global attributes present in all files is shown in Table 3.2-1.

Table 3.2-1 Global metadata attributes associated with each product file.

Global Attribute	Type	Description
calsubversion	string	Version string for CalSub algorithm
comments	string	Miscellaneous information about the data or methods used to produce it. Can be empty.
Conventions	string	CF standard used in file (= “CF-1.4”)
enddatetime	string	Nominal end time of the file in UTC; for daily CalSub products this corresponds to midnight of the day following the nominal day of observation.
epoch	string	UTC reference time for all time fields that are reported in seconds.
featureType	string	= “point”
geometry	string	A delimited list of dimensions (innermost to outermost) for interpreting nprof as a swath. CalSub files are collections of single profiles and the geometry is “1, nprof”.
history	string	Provides an audit trail for modifications to the original data – time ordered list

		of (executable name, version, variant)
internalcrc	string	Currently not implemented (value is placeholder).
institution	string	Processing facility that produced this file (e.g., "JPL/Caltech Sounder PEATE Operations")
platform	string	= ["npp", "aqua", "metop_a", "metop_b"]
references	string	ATDB and design documents describing processing algorithms. Can be empty.
source	string	The method of production of the original data, e.g. ECMWF, radiosondes, surface observations; can be empty.
rtpversion	string	RTP (Radiative Transfer Protocol) File Format Version
startdatetime	string	Nominal start time of the file in UTC; for daily CalSub products this corresponds to midnight of the nominal day of observation.
title	string	A succinct description of what is in the dataset.

Table 3.2-2 NetCDF attributes associated with each data set.

Name	Type	Description
_FillValue	Same as data set	Value used to identify missing data.
long_name	string	Ad hoc description of the variable.
units	string	The units of the variable.

3.3 Products/Parameters

3.3.1 Data Fields in Root Group

Fields in Table 3.1-1 appear in all products.

Table 3.3-1 Data fields in root group.

Name	Type	Dimensions	Description	Units
filetype	bitfield	scalar	A bit-mapped summary of groups and subgroups in file. See Table 3.3-2. (Bits 0-6 correspond to fields in pmask in filename in LSB to HSB order).	1
maxmatch updist	float	scalar	Maximum difference in time between matchup footprints.	km
maxmatch uptime	float	scalar	Maximum difference in time between matchup footprints.	s

Table 3.3-2 Bitfield *filetype*.

Bit Offset	Description
0	Contains state data
1	Contains calculated IR radiances
2	Contains observed IR radiances
3	Contains calculated primary MW brightness temperatures
4	Contains observed primary MW brightness temperatures
5	Contains calculated secondary MW brightness temperatures
6	Contains observed secondary MW brightness temperatures
7	Unused
8	Unused
9	Member of matchup pair (not used for calsub)

3.3.2 Data Fields in IRInst Group

Fields in Table 3.3-3 appear in all products.

Table 3.3-3 Data fields in IRInst group. Dimension order is outermost to innermost.

Name	Type	Dims	N	A	M	Description	Units
ascflag	int	nprof	y	y	y	Ascending orbit flag: 1 if ascending, 0 descending	1
atrack	int	nprof	y	y	y	1-based along-track index of field of regard from original input file	1
calflag	int	nprof, irnchan	y	y	y	Instrument-dependent per-channel calibration flag (See Sections 3.3.6.3, 3.3.7.2, 3.3.8.3)	1
fchan	float	irnchan	y	y	y	Channel center frequency	cm-1
fcmax	float	scalar	y	y	y	Channel set max frequency	cm-1
fcmin	float	scalar	y	y	y	Channel set min frequency	cm-1
findex	int	nprof	y	y	y	input file reference: AIRS daily granule number (1-240) or HHMMSS start time of file for IASI/CrIS andSNPP	1
ichan	int	irnchan	y	y	y	Channel numbers	1
ifov	int	nprof	y	y	y	1-based field of view index within field of regard	1
instid	int	scalar	y	y	y	Instrument ID of IR Instrument	1
iqcinfo	int	nprof, nqc	y	y	y	Instrument-dependent integer quality (see Sections 3.3.6.1, 3.3.7.1, 3.3.8.1)	various
landfrac	float	nprof	y	y	y	land fraction; for IASI, approximated by averaging nearest 9 grid boxes of 30 arc sec DEM	1
lat	float	nprof	y	y	y	Observation latitude	degree north
lon	float	nprof	y	y	y	Observation longitude	degree east
qcinfo	int	nprof, nqc	y	y	n	Instrument-dependent floating point quality info (see Sections 3.3.6.2, 3.3.8.2)	various
qual	int	nprof	y	y	y	Instrument-dependent overall quality flag (See Sections 3.3.6.4, 3.3.7.3, 3.3.8.4)	1
reason	int	nprof	y	y	y	Reason bitfield; See Table 1.3-x	1
robs	float	nprof, irnchan	y	y	y	Observed IR radiance	mW m-2 cm sr-1
robsimag	float	nprof, irnchan	y	n	n	Imaginary component of observed IR radiance	mW m-2 cm sr-1
salt	float	nprof	y	y	y	Surface height; for IASI, approximated by averaging nearest 9 grid boxes of 30 arc sec DEM	m
satalt	float	nprof	y	y	y	Satellite altitude	km
satzen	float	nprof	y	y	y	IR zenith angle	degree
scanang	float	nprof	y	y	y	IR scan angle (for non-Aqua, approximated from sat zen angle)	degree
siteid	int	nprof	y	y	y	Validation Site IDs; See Table 3.3-9	nprof
solazi	float	nprof	y	y	y	Sun azimuth angle	degree
solzen	float	nprof	y	y	y	Sun zenith angle	degree
sst_8um	float	nprof	y	y	y	Sea Surface Temperature predicted assuming clear conditions using radiances of several channels, primarily 1232.50 cm-1	K
stemprtg	float	nprof	y	y	y	RTG Skin Surface Temperature (nearest grid point)	K

time	double	nprof	y	y	y	Observation time	s
upwell	int	nprof	y	y	y	Radiation direction (= 1)	1
xtrack	int	nprof	y	y	y	1-based cross-track index of field of regard	1
Column legend: N: Whether field present in SNPP CalSub files A: Whether field present in Aqua CalSub files M: Whether field present in MetOp CalSub files							

Table 3.3-4 Attributes in IRInst group.

Name	Type	Dims	Description	Units
qcinfo_descr	string	scalar	Description of qcinfo fields	1
rqcinfo_descr	float	scalar	Description of iqcinfo fields	1

3.3.3 Data Fields in MWInst Group

Table 3.3-5 describes the data fields in the MWInst group. This group contains the spatially nearest MW observation for each profile in IRInst. This group is present in all CalSubs.

Table 3.3-5 Data fields in MWInst group. Dimension order is outermost to innermost.

Name	Type	Dims	N	A	M	Description	Units
ascflag	int	nprof	y	y	y	Ascending orbit flag, 1 if ascending, 0 descending	1
atrack	int	nprof	y	y	y	1-based along-track index of observation from original input file	1
btobs	float	nprof, mwnchan	y	y	y	Observed MW scene antenna temperatures	K
calflag	int	nprof, mwnchan	y	y	y	Instrument-dependent per-channel calibration flag (see Sections 3.3.9.3, 3.3.10.2, 3.3.11.2)	1
fchan	float	mwnchan	y	y	y	MW channel frequencies	GHz
findex	int	nprof	y	y	y	Input file reference: 1-based granule index or HHMMSS start time of file for IASI/CrIS	1
ifchan	float	mwnchan, mwnif	y	y	y	Frequency offset of ith intermediate frequency stage	GHz
instid	int	scalar	y	y	y	Instrument ID of MW Instrument	1
iqcinfo	int	nprof, nqc	y	y	y	Instrument-dependent integer quality info and other parameters (see tables 3.3.9.1, 3.3.10.1, 3.3.11.1)	various
landfrac	float	nprof	y	y	y	land fraction; for IASI, approximated by averaging nearest 9 grid boxes of 30 arc sec DEM	1
lat	float	nprof	y	y	y	Observation latitude	degree north
lon	float	nprof	y	y	y	Observation longitude	degree east
qcinfo	int	nprof, nqc	n	y	n	Instrument-dependent floating point quality info (see Section 3.3.9.2)	various
qual	int	nprof	y	y	y	Instrument-dependent overall quality flag (see Sections 3.3.9.4, 3.3.10.3, 3.3.11.3)	1

salt	float	nprof	y	y	y	Surface height; for MetOp/NOAA, approximated by averaging nearest 9 grid boxes of 30 arc sec DEM	m
satalt	float	nprof	n	y	n	Satellite altitude	km
satazi	float	nprof	y	y	y	MW azimuth angle	degree
satzen	float	nprof	y	y	y	MW zenith angle	degree
scanang	float	nprof	y	y	y	MW scan angle (for non- Aqua, approximated from sat zen angle)	degree
solazi	float	nprof	y	y	n	Sun azimuth angle	degree
solzen	float	nprof	y	y	n	Sun zenith angle	degree
time	double	nprof	y	y	y	Observation time	s
upwell	int	nprof	y	y	y	Radiation direction (= 1)	1
xtrack	int	nprof	y	y	y	1-based cross-track index of field of regard	1
Column legend: N: Whether field present in SNPP CalSub files A: Whether field present in Aqua CalSub files M: Whether field present in MetOp CalSub files							

Table 3.3-6 Attributes in MWInst group.

Name	Type	Dims	N	A	M	Description	Units
iqcinfo_info _descr	string	scalar	y	y	y	Comma delimited string describing non-fill fields of iqcinfo	1
qcinfo_info_ descr	string	scalar	y	y	y	Comma delimited string describing non-fill fields of qcinfo	1
Column legend: N: Whether field present in SNPP CalSub files A: Whether field present in Aqua CalSub files M: Whether field present in MetOp CalSub files							

3.3.4 Data Fields in MWBInst Group

Table 3.3-7 describes the data fields in the MWBInst group. The center observation of each 3x3 spatial array is the MWBInst observation spatially nearest to the center of the corresponding MWInst profile. The other eight observations are the surrounding MWBInst observations (based on atrack, xtrack). This group is present MetOp CalSubs only.

Table 3.3-7 Data fields in MWBInst group. Dimension order is outermost to innermost.

Name	Type	Dims	N	A	M	Description	Units
ascflag	int	nprof, mwba, mwbx	n	n	y	Ascending orbit flag, 1 if ascending, 0 descending	1
atrack	int	nprof, mwba, mwbx	n	n	y	1-based along-track index of observation from original input file	1
btobs	float	nprof, mwba, mwbx, mwbnchan	n	n	y	Observed MWB scene antenna temperatures	K

calflag	int	nprof, mwba, mwbx, mwbnchan	n	n	y	Instrument-dependent per-channel calibration flag (see Section 3.3.11.2)	1
fchan	float	mwbnchan	n	n	y	MWB channel frequencies	GHz
findex	int	nprof, mwba, mwbx	n	n	y	Input file reference: 1-based granule index or HHMMSS start time of file for IASI/CrIS	1
ifchan	float	mwbnchan , mwnif	n	n	y	Frequency offset of ith intermediate frequency stage	GHz
instid	int	scalar	n	n	y	Instrument ID of MWB Instrument	1
iqcinfo	int	nprof, nqc	n	n	y	Instrument-dependent integer quality info (see Section 3.3.10.1)	various
landfrac	float	nprof, mwba, mwbx	n	n	y	Land fraction; for MetOp/NOAA, approximated by averaging nearest 9 grid boxes of 30 arc sec DEM	1
lat	float	nprof, mwba, mwbx	n	n	y	Observation latitude	degree north
lon	float	nprof, mwba, mwbx	n	n	y	Observation longitude	degree east
qual	int	nprof mwba, mwbx	n	n	y	Instrument-dependent overall quality flag (see Section 3.3.10.3)	1
salt	float	nprof, mwba, mwbx	n	n	y	Surface height; for MetOp/NOAA, approximated by averaging nearest 9 grid boxes of 30 arc sec DEM	m
satazi	float	nprof, mwba, mwbx	n	n	y	MWB azimuth angle	degree
satzen	float	nprof, mwba, mwbx	n	n	y	MWB zenith angle	degree
scanang	float	nprof, mwba, mwbx	n	n	y	MW scan angle (approximated from sat zen angle)	degree
time	double	nprof, mwba, mwbx	n	n	y	Observation time	s
upwell	int	nprof, mwba, mwbx	n	n	y	Radiation direction (= 1)	1
xtrack	int	nprof, mwba, mwbx	n	n	y	1-based cross-track index of field of regard	1

Column legend:
N: Whether field present in SNPP CalSub files
A: Whether field present in Aqua CalSub files
M: Whether field present in MetOp CalSub files

Table 3.3-8 Attributes in MWBInst group.

Name	Type	Dims	N	A	M	Description	Units
iqcinfo_info_descr	string	scalar	n	n	y	Comma delimited string describing non-fill fields of iqcinfo	1
qcinfo_info_descr	string	scalar	n	n	y	Comma delimited string describing non-fill fields of qcinfo	1
Column legend: N: Whether field present in SNPP CalSub files A: Whether field present in Aqua CalSub files M: Whether field present in MetOp CalSub files							

3.3.5 Validation Site Ids

Table 3.3-9 lists matching criteria for validation site matches, as well as special site id encodings.

Table 3.3-9 Validation site ids.

Site id	Name	Lat	Lon	dLat	dLon	Add'l Params
1	Egypt-1 test site	27.12	26.1	0.5	0.56	
2	Simpson Desert	-24.5	137	0.5	0.55	
3	Dome Concordia 3200 meter elevation	-75.12	123.37	0.5	1.95	
4	Mitu Colombia/Brazil Tropical Forest	1.5	290.5	1	1.00	
5	Boumba S.E. Cameroon Tropical Forest	3.5	14.5	1	1.00	
6	Sonora Desert	32.25	245.35	0.5	0.59	
7	ARM SGP	36.62	262.5	1	1.25	
8	TWP Manus	-2.006	147.425	0.5	0.50	
9	TWP Naru	-0.521	166.916	0.5	0.50	
10	N.Pole	89	173	0.5	28.65	
11	S.Pole	-89	183	0.5	28.65	
12	Siberian tundra (Surgut)	61.15	73.37	1	2.07	
13	Hunnan Rainforest	23.9	100.5	0.5	0.55	
14	ARM Barrow Alaska	71.32	203.34	0.5	1.56	
15	ARM Atqusuk	70.32	203.33	0.5	1.48	
16	TWP Darwin	-12.425	130.891	0.5	0.51	
17	Lake Qinhai 3196 meter elevation (water)	36.75	100.33	2	2.50	elev < 3300
18	Dunhuang Gobi Desert 3176 meter elevation	40.17	94.33	0.5	0.65	
19	Lake Titicata 3800 meter elevation (water)	-15.88	290.67	2	2.08	elev < 3900
20	Lake Tahoe California	39.1	240	0.5	0.64	
21	Toolik Alaska	68.6	210.4	0.5	1.37	
22	Park Falls, WI Tower	45.94	269.73	0.5	0.72	
23	Brenham, TX	30.1592	263.6079	0.5	0.58	
24	Crosbyton, TX	33.6571	258.75495	0.5	0.60	
25	Beltsville, MD	39.05	283.13	0.5	0.64	
26	Pacific Missile Range W. Kawai	22.02	200.21	0.5	0.54	
-2	frozen surfaces clear spectra	n/a	n/a	n/a	n/a	

-1	clear non-frozen land spectra	n/a	n/a	n/a	n/a	
0	clear non-frozen ocean spectra	n/a	n/a	n/a	n/a	
88	random selected near nadir spectra	n/a	n/a	n/a	n/a	
96	ocean low stratus	n/a	n/a	n/a	n/a	
97	hottest spectrum in each granule	n/a	n/a	n/a	n/a	
98	PLR clear non-frozen ocean spectra	n/a	n/a	n/a	n/a	
99	cold cloud spectra	n/a	n/a	n/a	n/a	

3.3.6 Aqua AIRS IR Data Quality Assurance (QA) Indicators

All users of AIRS data are strongly encouraged to read the "AIRS/AMSU/HSB Version 5 Level L1B QA Quick Start" documentation.

3.3.6.1 AIRS iqcinfo Array

Inner Index	Description	Units
1	State [0:Process, 1:Special, 2:Erroneous, and 3: Missing]	1
2	SceneInhomogeneous	1
3	dust_flag	1
4	dust_score	1
5	spectral_clear_indicator	1
6-20	_FillValue	1

3.3.6.2 AIRS qcinfo Array

Inner Index	Description	Units
1	sun_glint_distance	km
2	Rdiff_swindow	mW m-2 cm sr-1
3	Rdiff_lwindow	mW m-2 cm sr-1
4	BT_diff_SO2	K
5-20	_FillValue	1

3.3.6.3 AIRS calflag Bitfield

Bit Offset	Description
0	cold scene noise
1	telemetry out of limit condition
2	n/a (zeroed out from AIRS calflag)
3	n/a (zeroed out from AIRS calflag)
4	pop detected
5	gain bad
6	offset bad
7	scene over/underflow
8	ExcludedChans > 2
9	ExcludedChans > 5

3.3.6.4 AIRS qual Bitfield

Bit Offset	Description
0	latitude is out of [-90, 90] or longitude is out of [-180, 360]
1	state is not ==0

3.3.7 MetOp IASI Data Quality Assurance (QA) Indicators

3.3.7.1 IASI iqcinfo Array

Inner Index	Description	Units
1	GQisFlagQual	1
2	GQisFlagQualDetailed (IASI Version 5 or later)	1
3	GEUMAvhrr1BCldFrac (IASI Version 5 or later)	%
4	GEUMAvhrr1BLandFrac (IASI Version 5 or later)	%
5-20	_FillValue	1

3.3.7.2 IASI calflag

Prior to IASI Version 5: always 0.

IASI Version 5 and later: calflag set from IASI GQisQualFlag[1:3] spread out over the band, i.e.,
calflag[1:2260] = GQisQualFlag[1]
calflag[2261:5740] = GQisQualFlag[2]
calflag[5741:8461] = GQisQualFlag[3]

3.3.7.3 IASI qual field

Bit Offset	Description
0	latitude is out of [-90, 90] or longitude is out of [-180, 360]
1	GQisFlagQual is not ==0

3.3.8 SNPP CrIS Data Quality Assurance (QA) Indicators

IR Quality fields are qcinfo and iqcinfo, calflag and qual.

3.3.8.1 CriS iqcinfo Array

Each RTP3 profile maps to 1 input [FOV, FOR, scanline].

Inner Index	Description	Units
1	QF1_SCAN_CRISSDR	1
2	QF2_CRISSDR[1]	1
3	QF2_CRISSDR[2]	1
4	QF2_CRISSDR[3]	1
5	QF3_CRISSDR[1]	1
6	QF3_CRISSDR[2]	1
7	QF3_CRISSDR[3]	1
8	QF4_CRISSDR[1]	1
9	QF4_CRISSDR[2]	1
10	QF4_CRISSDR[3]	1
11	QF1_CRISSDRGEO	1
12-20	_FillValue	1

3.3.8.2 CriS qcinfo Array

Inner Index	Description	Units
1	max(abs(ES_ImaginaryLW)) using only those elements of ES_Imaginary_LW with frequency in [800.0, 980.0] cm-1	mW m-2 cm sr-1
2	max(abs(ES_ImaginaryMW)) using only those elements of ES_Imaginary_MW with frequency in [1500.0, 1700.0] cm-1	mW m-2 cm sr-1
3	max(abs(ES_ImaginarySW)) using only those elements of ES_Imaginary_SW with frequency in [2250.0, 2350.0] cm-1	mW m-2 cm sr-1
4	stddev(ES_ImaginaryLW)	mW m-2 cm sr-1
5	stddev(ES_ImaginaryMW)	mW m-2 cm sr-1
6	stddev(ES_ImaginarySW)	mW m-2 cm sr-1
7	the element of ES_RealLW with frequency = 900.0 cm-1	mW m-2 cm sr-1
8	the element of ES_ImaginaryLW with frequency = 900.0 cm-1	mW m-2 cm sr-1
9	the element of ES_RealMW with frequency = 1232.5 cm-1	mW m-2 cm sr-1
10	the element of ES_ImaginaryMW with frequency = 1232.5 cm-1	mW m-2 cm sr-1
11	the element of ES_RealSW with frequency = 2507.5 cm-1	mW m-2 cm sr-1
12	the element of ES_ImaginarySW with frequency = 2507.5 cm-1	mW m-2 cm sr-1
13-20	_FillValue	1

3.3.8.3 CriS calflag

1 for all LW channels if qcinfo[1] > 1.5 mW m-2 cm sr-1

1 for all MW channels if qcinfo[2] > 0.5 mW m-2 cm sr-1

1 for all SW channels if qcinfo[3] > 0.05 mW m-2 cm sr-1

3.3.8.4 CriS qual Bitfield

Bit Offset	Description
0	latitude is out of [-90, 90] or longitude is out of [-180, 360]
1	if any of the following conditions are true. 1) ES_RealLW(900.0cm-1) is equal to exactly 0.0 2) ES_RealMW(1232.5cm-1) is equal to exactly 0.0 3) ES_RealSW(2507.5cm-1) is equal to exactly 0.0 4) ES_ImaginaryLW(900.0cm-1) is less than -100.0 5) ES_ImaginaryMW(1232.5cm-1) is less than -100.0 6) ES_ImaginarySW(2507.5cm-1) is less than -100.0

3.3.9 AIRS MW Data Quality Assurance (QA) Indicators

3.3.9.1 AIRS MW iqcinfo Array

Inner Index	Description	Units
1	qa_receiver_a11	1
2	qa_receiver_a12	1
3	qa_receiver_a2	1
4	qa_scanline	1
5-20	_FillValue	1

3.3.9.2 AIRS MW qcinfo Array

Inner Index	Description	Units
1	sun_glint_distance	km
2-20	_FillValue	1

3.3.9.3 AIRS MW calflag Bitfield

Bit Offset	Description
0	All space view counts were bad for this channel and scanline
1	Space view counts were marginal for this channel and scanline
2	Space view counts could not be smoothed
3	All blackbody counts were bad for this channel and scanline
4	Blackbody counts were marginal for this channel and scanline
5	Blackbody counts could not be smoothed
6	Most recent calibration coefficients used
7	n/a (zeroed out from AIRS MW calflag)

3.3.9.4 AIRS MW qual Bitfield

Bit Offset	Description
0	latitude is out of [-90, 90] or longitude is out of [-180, 360]
1	neither of {state1, state2} are zero

3.3.10 MetOp/NOAA MW Data Quality Assurance (QA) Indicators

3.3.10.1 MetOp/NOAA iqcinfo Array

Inner Index	Description	Units
1	Scan Line Quality Flags	1
2	Quality Indicator Bit Field	1
3	Instrument Status A1	1
4	Instrument Status A2	1
5-20	_FillValue	1

3.3.10.2 MetOp/NOAA calflag

Set to Calibration Quality Flag.

3.3.10.3 MetOp/NOAA qual Bitfield

Bit Offset	Description
0	latitude is out of [-90, 90] or longitude is out of [-180, 360]
1	Quality Indicator Bit Field is not == 0

3.3.11 SNPP ATMS Data Quality Assurance (QA) Indicators

3.3.11.1 ATMS TDR iqcinfo Array

Inner Index	Description	Units
1	InstrumentMode	1
2	QF19_SCAN_ATMSSDR	1
3-20	_FillValue	1

3.3.11.2 ATMS calflag

The ATMS calflag is zero unless BrightnessTemperature raw integer value >= 65528; then 1.

3.3.11.3 ATMS qual Bitfield

Bit Offset	Description
0	latitude is out of [-90, 90] or longitude is out of [-180, 360]
1	QF19_SCAN_ATMSSDR is not zero

4 Options for Reading the Data

4.1 Command Line Utilities/Tools/Programming

Files can be read using tools and libraries for either NetCDF -4 or H5.

4.1.1 h5dump

The h5dump tool can be used as a simple browser for H5 data files, and comes with the H5 distribution. Type h5dump –h for usage information.

4.1.2 ncdump

The ncdump tool can be used as a simple browser for netCDF data files, to display the dimension names and sizes; variable names, types, and shapes; attribute names and values; and optionally, the values of data for all variables or selected variables in a netCDF file. The most common use of ncdump is with the –h option, in which only the header information is displayed.

ncdump [-c|-h] [-v ...] [[-b|-f] [c|f]] [-l len] [-n name] [-d n[,n]] filename
Options/Arguments:
[-c] Coordinate variable data and header information
[-h] Header information only, no data
[-v var1[,...]] Data for variable(s) <var1>,... only data
[-f [c|f]] Full annotations for C or Fortran indices in data
[-l len] Line length maximum in data section (default 80)
[-n name] Name for netCDF (default derived from file name)
[-d n[,n]] Approximate floating-point values with less precision filename File name of input netCDF file

Note: the ncdump tool will only display variables whose ranks are great than 1. In other words, you will not see one dimensional vectors such as *satheight* using this tool.

The ncdump program can be found in bin directory of the HDF installation area. Consult your local computer system administrator for the specifics.

4.1.3 HDFView

HDFView is a Java based graphical user interface created by the HDF Group which can be used to browse TRMM VIRS HDF files. The utility allows users to view all objects in an HDF file hierarchy which is represented as a tree structure. HDFView can be downloaded at ftp://ftp.hdfgroup.org/HDF5/hdf-java/. Documentation for HDFView can be viewed at

http://www.hdfgroup.org/products/java/hdf-java-html/hdfview/UsersGuide/index.html.

5 Data Services

If you need assistance or wish to report a problem:

Email: gsfc-help-disc@lists.nasa.gov
Voice: 301-614-5224
Fax: 301-614-5268
Address:
Goddard Earth Sciences Data and Information Services Center NASA Goddard Space Flight Center Code 610.2 Greenbelt, MD 20771 USA

6 More Information

Documentation on input products used:

SNPP: http://npp.gsfc.nasa.gov/documents.html

AIRS: http://disc.sci.gsfc.nasa.gov/AIRS/documentation/

IASI: http://oiswww.eumetsat.org/WEBOPS/eps-pg/IASI-L1/IASIL1-PG-0TOC.htm

NOAA KLM: http://www.ncdc.noaa.gov/oa/pod-guide/ncdc/docs/intro.htm

7 Acknowledgements

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8 References

- AIRS (Aqua):
  ftp://airsl1.gesdisc.eosdis.nasa.gov/ftp/data/s4pa/Aqua_AIRS_Level1/AIRIBRAD.005/doc/README.AIRIBRAD.pdf

- AMSU-A (including Aqua and MetOP-A/B):
  http://airsl1.gesdisc.eosdis.nasa.gov/Aqua_AIRS_Level1/AIRABRAD.005/doc/README.AIRABRAD.pdf. Note: the referenced document pertains to AMSU-A on Aqua, but generally describes all AMSU-A data.)

- ATMS (SNPP):
  http://npp.gsfc.nasa.gov/sciencedocuments/2013-12/474-00076_OAD-ATMS-SDR_C.pdf

- IASI (MetOP-A/B):
  IASI data are obtained via CLASS from EUMETSAT. The product guide can be found at:
  http://oiswww.eumetsat.org/WEBOPS/eps-pg/IASI-L1/IASIL1-PG-6ProdFormDis.htm

- CrIS (SNPP):
  http://npp.gsfc.nasa.gov/sciencedocuments/2014-02/474-00071_OAD-CrIS-SDR_D.pdf