OSI SAF High Latitudes L2 Sea and Sea Ice Surface Temperature Product User Manual

OSI-205
Version 1.0

Gorm Dybkjaer, Steinar Eastwood, Roolf-Helge Pfeiffer and Eva Howe*

*Danish Meteorological Institute and Norwegian Meteorological Institute**

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1 Introduction

1.1 EUMETSAT Ocean and Sea Ice SAF

For complementing its Central Facility capability in Darmstadt and taking more benefit from specialized expertise in Member States, EUMETSAT created Satellite Application Facilities (SAFs), based on co-operation between several institutes and hosted by a National Meteorological Service. More on SAFs can be read from [www.eumetsat.int].
The Ocean & Sea Ice Satellite Application Facility (OSI SAF) is producing a range of air-sea interface products on operational basis, namely: wind, sea ice characteristics, Sea and Ice Surface Temperatures and radiative fluxes.
Since the Continuous Development and Operation Phase (CDOP) 2007 to 2012 - the OSI SAF consortium is hosted by Météo-France. The sea ice processing is performed at the High Latitude processing facility (HL centre), operated jointly by the Norwegian and Danish Meteorological Institutes, MET Norway and DMI.

1.2 Scope

This product user manual presents the High Latitude Surface Temperature product, OSI-205, from the EUMETSAT Ocean and Sea Ice Satellite Application Facility (OSI SAF). The focus of the manual is to present an overview of how this product is produced and describe technical details about the product format to enable users to understand and use the product.

1.3 Overview

The EUMETSAT OSI SAF is producing a range of operational air-sea interface products, namely: wind, sea ice characteristics, Surface Temperatures and radiative fluxes. More details on the products and OSI SAF project are available at http://www.osi-saf.org.
Surface Temperature (ST), Surface Solar Irradiation (SSI) and Downward Long-wave irradiance (DLI) products from the OSI SAF are produced using geostationary and polar orbiting satellites and are available in level 2 and level 3 formats, with different timeliness depending on the production setup.

This product consist of a stand-alone High Latitude Level-2 Surface Temperature product. It is providing input data for the specific L3 Northern High Latitude SST and IST product (OSI-203-a) that is produced by OSI SAF covering the High Latitudes North of 50N. The integrated ST product consists of Sea and Ice Surface temperatures (SST and IST) and an unvalidated test temperature field, Land Ice

Surface Temperature (LIST) for the Greenland and Antarctic ice caps.
The OSI-205 covers the sea and ice areas polewards of latitudes 50N and 50S with 3 minute data segments in level2, with data processed and archived continuously throughout the day, as data comes available. Approximately 110 3-minute segments per day. The production use AVHRR data from Metop-B from EUMETCast and cloud mask data using the PPS software from NoW-Casting Satellite Application Facility (NWC-SAF).

Chapter 2 presents a brief description of the algorithms and chapter 3 gives an overview of the input data processes; chapter 4 explains the processing scheme and chapter 5 provides detailed information on the product variables; finally, chapter 6 is explaining file format, conventions and overall product specifications.

1.4 Glossary

Acronym	Description
AVHRR	Advanced Very High Resolution Radiometer
CDOP2	Continuous Development and Operations Phase 2
DLI	Downward Longwave Irradiance
DMI	Danish Meteorological Institute
GTS	Global Telecommunication System by World Meteorological Organization
HL	High Latitudes
IST	Ice Surface Temperature
LIST	Land Ice Surface Temperature
MDB	Match-up Data Base
MET	Norwegian Meteorological Institute
NOAA	National Oceanic and Atmospheric Administration
NESDIS	The National Environmental Satellite, Data, and Information Service
NWC	Nowcasting
RTM	Radiative Transfer Model
RTTOV	Radiative Transfer for TOVS
SAF	Satellite Application Facility
SSES	Sensor Specific Error Statistics
SSI	Surface Solar Irradiance
SST	Sea Surface Temperature
Tb	Brightness Temperature
TOVS	TIROS Operational Vertical Sounder

1.5 Applicable document

[RD.1] OSI SAF CDOP-2 Product Requirement Document, v3.3.

[RD.2] OSI SAF Algorithm theoretical basis document for the OSI SAF High Latitude L2 Sea and Sea Ice Surface Temperature L2 processing chain. SAF/OSI/CDOP/DMI/SCI/MA/223, product OSI-205, Version 1.1 - Apr. 2015.
[RD.3] OSI SAF High Latitude L2 Sea and Sea Ice Surface Temperature Validation Report, SAF/OSI/CDOP2/DMI/TEC/RP/247, v1.0 – Dec 2015.
[RD.4] The EUMETSAT OSI SAF Sea Ice Concentration Algorithm Theoretical Basis Document v1.2
[RD.5] OSI SAF project team (2014). Low earth orbiter sea surface temperature product user manual. Version 2.6 Prepared by Météo France.
[RD.6] OSI SAFproducts. http://osisaf.met.no/p/ice/index.htm

Several of these documents are available at (http://osisaf.met.no/docs).

2 Algorithms Description

The OSI-205 algorithm is a suite of algorithms that are applied for different domains of surface temperature and sun-zenith angles. These algorithms are:

- An Ice Surface Temperature (IST) algorithm, which consists of three specific algorithms for different temperature domains together with specific algorithm coefficients. These are: IST_{cold}, IST_{medium}, and IST_{warm}.
- A Sea Surface Temperature (SST) algorithm, which consists of two specific algorithms and a combined algorithm correspond to different sun-zenith angles. These are: SST_{day}, SST_{night}, and $SST_{twilight}$.
- A Marginal Ice Zone Surface Temperature (MIZT) algorithm, which is a linearly scaled average of the IST and the SST algorithms, i.e. it computes average temperatures for mixed ice and water surface areas.

The primary choice of algorithm lies in the distinction between sea and ice surfaces. This distinction is based on a brightness temperature threshold, which is an approach adapted from the integrated IST/SST algorithm, CASSTA, introduced by Vincent et al. (2008).

2.1 Surface temperature algorithm decision logic

The algorithm selection and surface temperatures calculations are based the following inputs:

- *T37*, near infrared brightness temperature from AVHRR channel 3b with center wavelength at ~3.7 microns.
- *T11*, thermal infrared brightness temperature from AVHRR channel 4 with center wavelength at ~11 microns.
- *T12*, thermal infrared brightness temperature from AVHRR channel 5 with center wavelength at ~12 microns.
- *Tclim*, first guess of SST, use the most resent SST values from the DMI Optimal Interpolation SST product (Hoyer and She 2007, Hoyer et al. 2014).
- *satza*, sat-zenith angle (view angle).
- *sunza*, sun-zenith angle (solar elevation angle).

2.1.1 The IST Algorithm

The *IST* algorithm, see Equation (1) is a split window algorithm, working within three domains as suggested by Key et al. (1997). The algorithm coefficients *a*, *b*, *c*, and *d* for three *T11* temperature intervals, IST_{cold}, IST_{medium} and IST_{warm}. are shown in Table 2 with respect to Metop-A and -B AVHRR.

$$IST = a + b\,T11 + c\,(T11 - T12) + d\,((T11 - T12)(1.0/\cos(satza)) - 1.0) \quad (1)$$

The *IST* algorithm domains are:

- IST_{cold}, cold ice calibration for $T11 < 240K$
- IST_{medium}, medium ice calibration *for* $240K \leq T11 < 260K$
- IST_{warm}, warm ice calibration for $T11 \geq 260K$

2.1.2 The SST Algorithm

The sea surface temperature algorithms SST_{day}, *SSTnight* and *SSTtwilight* (equations 2, 3 and 4, respectively) are, calibrated for for the *day* and *night* domains:

- *SSTday*, day time calibration for $sunza \leq 90$ *degrees*. The day time algorithm formalism is a slightly modified version of the operational day time algorithm used in the OSISAF SST product [RD.2] to deal with a bias for the North Atlantic area (Le Borgne et al., 2014).
- *SSTnight*, night time calibration for $sunza \geq 110$ *degrees*. The night time algorithm formalism is identical to the operational night time algorithm used in the OSISAF Global SST product [RD.2].
- *SSTtwilight*, twilight calibration for 110 *degree* $> sunza > 90$ *degree*. SSTtwilight is a linear scaling of *SSTday* and *SSTnight*, in accordance with the *sunza* [RD.2].

The *SSTday* and SST*night* algorithm coefficients (*a* to *g*) are shown in Table 1 for Metop-A and -B AVHRR.

$$SSTday = (a + b\,steta)T11 + (c + d\,steta + e\,Tclim)(T11 - T12) + f + g\,steta\,,\,(Eq.\,2)$$

$$SSTnight = (a + b\,steta)T37 + (c + d\,steta)(T11 - T12) + e + f\,steta\,,\,(Eg.\,3)$$

$$SSTtwilight = 0.05(sunza - 90)SSTnight - 0.05(sunza - 110)SSTday\,,\,(Eq.4)$$

where $steta = (1/(\cos(satza))) - 1$

2.1.3 The MIZT Algorithm

Finally, the surface temperature is also defined for the marginal ice zone, *MIZT* (see equation 5 and 6+7). The *MIZT* is linearly scaling of *SST* and *IST* in the T11 temperature interval $268.95\ K \leq T11 < 270.95\ K$. This is adapted from Vincent et al. (2008)

- $MIZT_{day}$ for *sunza* <= 90°
- $MIZT_{night}$ for *sunza* >= 110°

$$MIZT = \begin{matrix} MIZT_{day} \ldots sunza \leq 90^{o} \\ MIZT_{night} \ldots sunza \geq 110^{o} \end{matrix} \quad (5)$$

$$MIZT_{day} = 0.5 * (T_{11} - 268.95) * SST_{day} - 0.5 * (T_{11} - 270.95) * IST \quad (6)$$

$$MIZT_{night} = 0.5 * (T_{11} - 268.95) * SST_{night} - 0.5 * (T_{11} - 270.95) * IST \quad (7)$$

2.2 Algorithm tuning method

There are basically two ways to calibrate the surface temperature algorithms used in this data set: 1) To compare satellite measurements to in situ observations, and 2) to relate modeled surface temperatures with modeled top-of-atmosphere brightness temperatures, determined by a radiative transfer model (RTM). However, each AVHRR sensor has slightly different response functions to incoming radiation, which demands a large number of in situ observations to obtain statistically robust calibration data for each of the two Metop AVHRR instruments used here. It is not feasible to collect sufficiently and well distributed in situ observations from all areas of interest, to obtain sufficient calibration statistics for the applied and new sensors. Calibration of both the IST and SST algorithms is therefore carried out using the RTM approach (see [RD.2]).

2.2.1 SST calibration

Satellite	Algorithm	a	b	c	d	e	f	g
Metop-A (02)	SST day	1.030	0.017	-0.300	0.255	0.006	-8.132	-3.737
	SST night	1.019	0.036	1.200	0.058	-4.453	-8.877	0.000
Metop-B (01)	SST day	1.033	0.019	0.326	0.261	0.004	-8.871	-3.951
	SST night	1.019	0.037	1.180	0.062	-4.384	-8.857	0.000

Table 1: SST algorithm coefficients.

Coefficients for the SST algorithms were generated using a simulated brightness temperature (Tb) dataset in turn generated from a dataset containing 31,673 Arctic profiles (Francois et al., 2002). The simulated Tb’s were generated from RTTOV (RTTOV) using 10 different satellite zenith angles (0.0, 36.87, 48.19, 55.15, 60, 63.61, 66.42, 68.68, 70.53, 72.08). Coefficients for each sensor and algorithm were determined using least squares regression. The coefficients derived and applied for the SST *day* and *night* algorithms are listed in table 1. More details on the SST calibration procedure is given in the product ATBD [RD.2].

2.2.2 IST calibration

Like the calibration of the SST algorithms, the IST algorithm calibrations are carried out using modeled surface and TOA brightness temperatures. The basis for the coefficients tuning is an Arctic profile database covering one year (2011) of ERA Interim atmospheric data (ERAint, 2014-09).

Satellite	Algorithm	a	b	c	d
Metop-A (02)	IST cold	-3.216	1.014	0.866	0.036
	IST mid	-3.200	1.013	1.443	0.024
	IST warm	-3.877	1.015	1.461	0.311
Metop-B (01)	IST cold	-3.295	1.014	0.749	0.015
	IST mid	-4.017	1.016	1.417	-0.030
	IST warm	-4.612	1.018	1.378	0.307

Table 2: IST algorithm coefficients.

The initial profile database has 8,695 profiles. Profiles were picked from a sample of 960 locations each day of the year, at times 0, 6, 12 and 18 UTC. Each profile complies with a land-ratio of zero, surface temperatures less than 272K, and a cloud cover of less than 10%. Simulated TOA brightness temperatures associated with the ERA-interim surface temperatures for over 10 different satellite zenith angles (0.0, 36.87, 48.19, 55.15, 60, 63.61, 66.42, 68.68, 70.53, 72.08), where generated using RTTOV11 (RTTOV). Ultimately, the simulated IST calibration data set consisted of 86,950 data points. The coefficients derived and applied for the IST *cold*, *mid* and *warm* algorithms are listed in table 2. More details on the IST calibration procedure is given in the product ATBD [RD.2].

3 Input Data

The primary input data used in the OSI-205 production are brightness temperature (Tb) data from Metop-B AVHRR instrument. The surface temperature product is calculated from the Tb’s and the associated view and sun elevation information and a climatological SST temperature. In addition, data from the visible AVHRR channels are used for the calculation of sea, ice and water probability fields. Metop completes 14 full orbits per day and provides therefore approximately bi-hourly passages over polar regions. The input data, i.e., Tb data, cloud mask and satellite-sun-earth geometry data are generated by the Polar Platform System (PPS) cloud processing

software, from NWCSAF (NWCSAF, Dybbroe et al., 2005a+b).
In addition, the most reason daily SST data from an independent HL SST processing chain (Høyer and She 2007) provided by DMI are used by the daytime SST algorithm as a first SST guess (see equation 2). All other data are ancillary fields of information that can be used as filters or to customize data selection. The data flow is illustrated in figure 1. The individual input data fields are described further below.

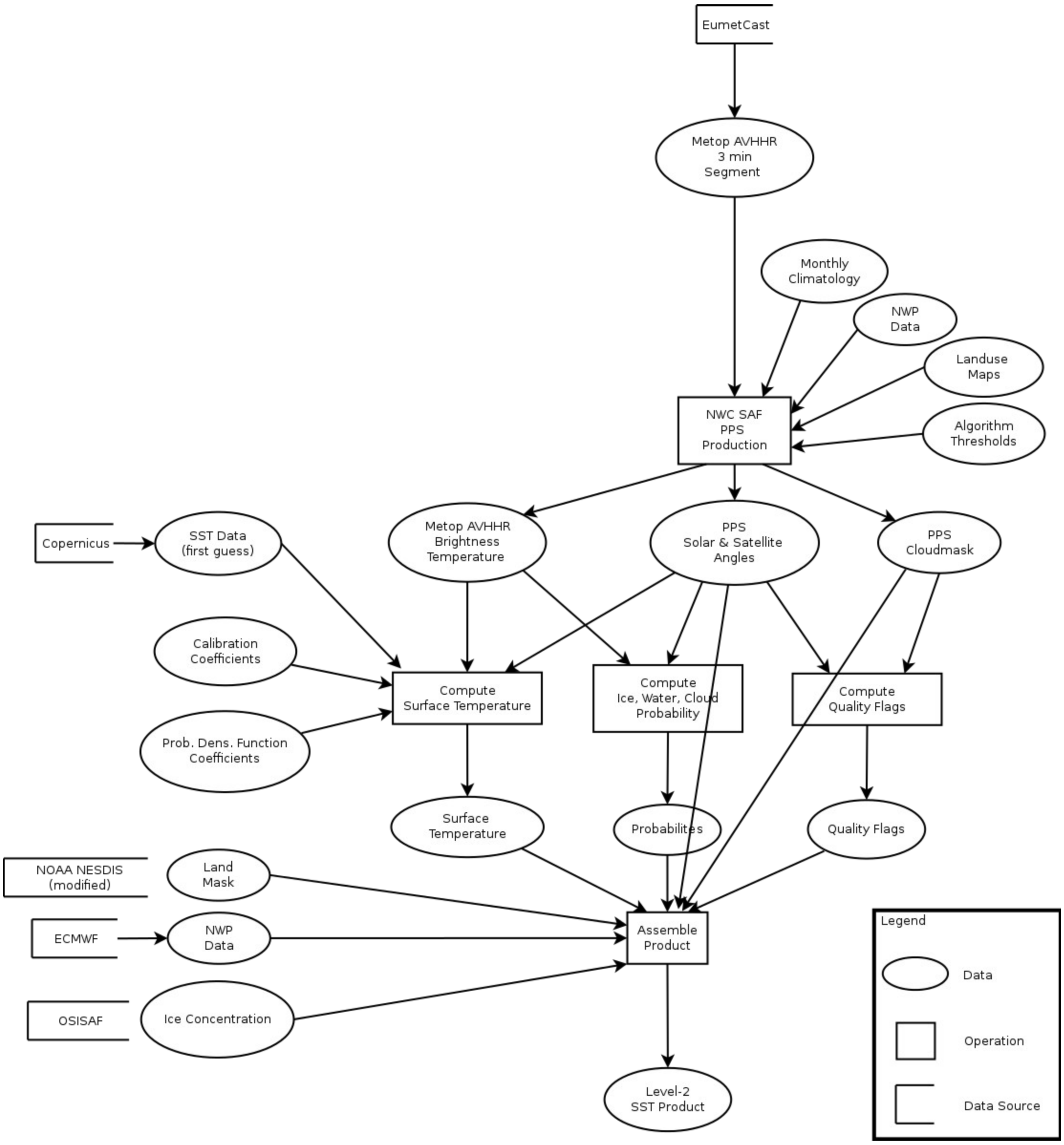

Figure 1: Overview of the Ice and Sea Surface Temperature (IST/SST) L2 processing chains (OSI-205).

3.1 Metop-A/B AVHRR

Brightness temperatures and associated data from METOP-A/-B AVHRR level 1 and 2 data.

- Brightness Temperatures (Tb) from 3 bands with centre wave length at ~3.7 microns (mid infrared), ~11 and ~12 microns (thermal infrared). Continuously on-board calibrated measurements.
- Cloud mask from the Polar Platform System (PPS, version 2014) cloud processing software (Dybbroe et al., 2005a+b),
- Solar and Satellite geometry. Some geometrical data are used in the surface temperature algorithms and others are added to the output data set for post processing purposes, see section *output data* and *algorithms*.

3.2 Ice concentration

The OSISAF Sea Ice Concentration [RD.5] product is used to provide a sea ice concentration mask with the L2 SST/IST product. This is mainly for the users convenience when filtering data. The most recent sea ice concentration product is used.

3.3 NWP data

Data from Numerical Weather Prediction models are not used to calculate surface temperatures, however, it is used in the PPS software to produce cloud mask data n the OSI-205 processing chain, NWP data are passed-on to the output file for data filtering and customization purposes, NWP data are not used in any of the ST calculations.
The applied NWP model is the current operational deterministic model at ECMWF. Data are spatially re-sampled to a 0.5 degree grid. The nearest NWP data in time and space is passed on the OSI-205 grid. The NWP fields used are 12h–24h prognosis in 3h steps from 2 daily analysis, at 00z and 12z.
The applied parameters are 2m temperatures (variable 167; ECMWF-table128) and 10m wind speed (calculated from variable 165 and variable 166; ECMWF-table128).

3.4 Static Land, Sea and Land-Ice mask

LAND, SEA and LAND-ICE mask is produced from combining the ‘ice_surface’ and ‘bedrock’ ETOPO1 data sets from NOAA NESDIS NGDC global relief maps (NOAA_ngdc, 2014-09). Elevation thresholds of 10m and -5m are used on “ice-surface”/”bedrock” differences data to distinguish between Ice-Cap and Water/Sea-Ice, to minimize noise in the relief maps. Following procedure is used to classify the 3 surfaces:

- LAND ICE: ‘ice_surface’ - ‘bedrock’ > 10 m
- SEA/SEA ICE: ‘ice_surface’ - ‘bedrock’ <= -5 m

- LAND: Where NO ICE CAP and NO WATER/SEAICE.

This is an add-on data set for stratification of land, water and ice caps (See ‘output data’). It is not used for surface temperatures calculations.

4 Processing scheme

4.1 Overview

A schematic overview of the full algorithm decision tree is given in figure 2. The input data is the spectral Metop AVHRR data and the satellite-sun-earth geometry information. from the NWC SAF PPS system. Firstly, the processing chain checks if the Metop AVHRR data lies within the area of interest, i.e. if the three minute segments are north of 50^{o}N or south of 50^{o}S. Only for data within this area the OSI-205 surface temperature is computed. The algorithms for computation of ice surface temperature and the algorithms for computation of sea surface temperature are executed on the input data based on testing the sun zenith angles (*satza*) and the brightness temperature (*T11*), see figure 2. If *T11* is lesser than 240K the IST_{cold} algorithm is applied, if it is in between 240K and 260K the IST_{medium} algorithm is applied, and for *T11* larger or equal to 260K the IST_{warm} algorithm is applied. If the sun zenith angle *satza* is lesser or equal to 90^{o} the SST_{day} algorithm is applied, if it is in between 90^{o} and 110^{o} the $SST_{twilight}$ algorithm is applied, and for *satza* larger or equal to 110^{o} the SST_{night} algorithm is applied. In case of invalid values for *satza* no SST is computed. Subsequently, based on another test of the brightness temperature *T11*, the final surface temperature is set to the previously computed IST if *T11* is lesser than 268.95K, to the previously computed SST if *T11* is larger or equal to 270.95K, or it is set to the result of the MIZT algorithm if *T11* is in between 268.95K and 270.95K. Finally, a 'reality check' is applied to the resulting surface temperature value (*Ts*). The surface temperature *Ts* is rejected an unrealistically, if the difference between the brightness temperatures *T11* and *T12* is larger than 2K and *T11* is larger than 268.95K. Similarly, if the surface temperature *Ts* is lesser than *T11*, lesser than 150K or larger than 350K, *Ts* is rejected as unrealistic.

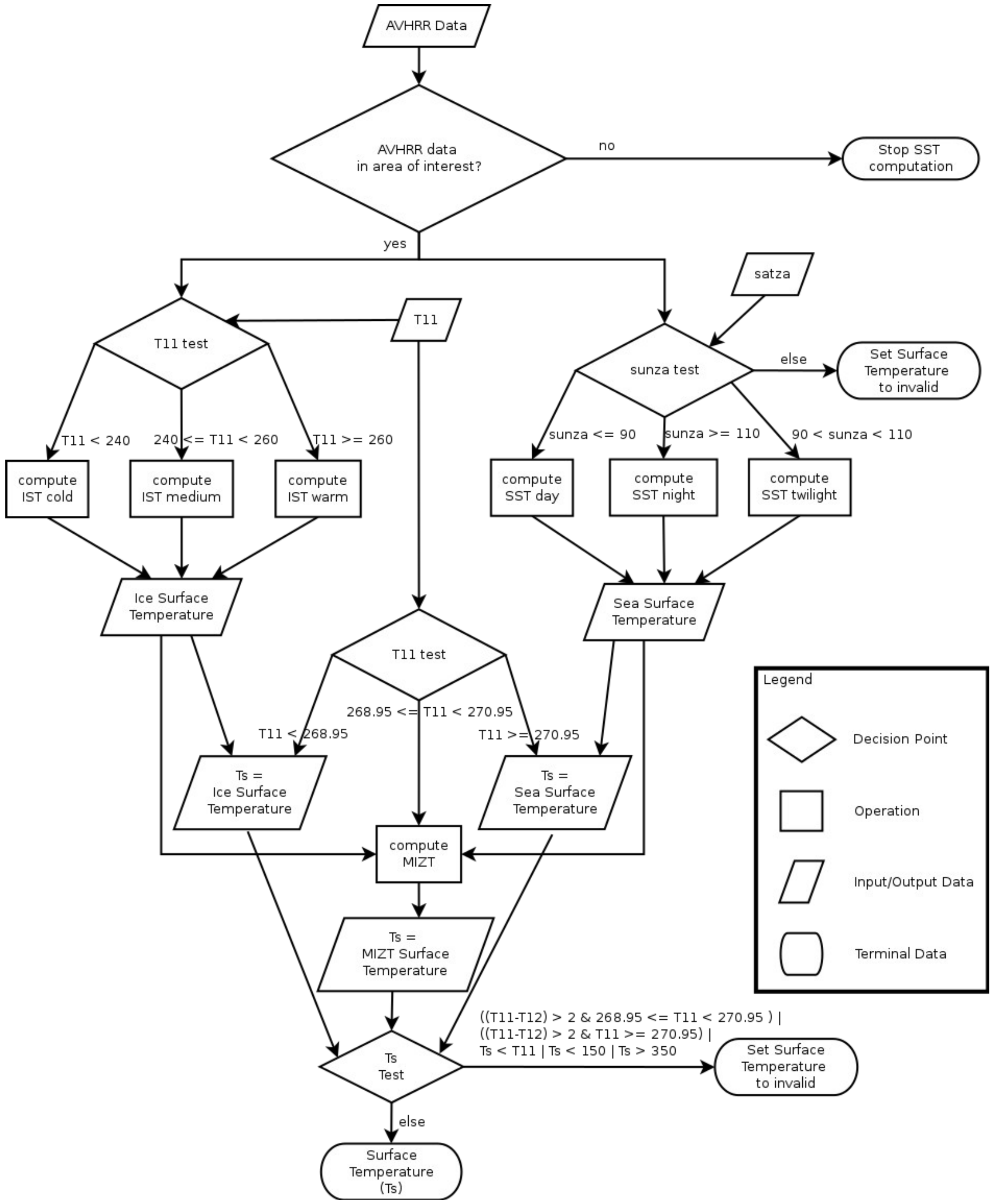

Figure 2: OSI-205 surface temperature algorithm decision tree

4.1.1 Preprocessing

The Metop AVHRR data are received through EUMETCAST in 3 minute segments. The METOP AVHRR data are subsequently passed to the NWC-SAF PPS software (PPScloud) for generation of cloud mask data. This preprocessing step is not part of the OSI SAF processing chain, but a part of the basic Metop AVHRR processing at

DMI. The output data stream from the PPS processing chain is a data package of 3 files, containing the AVHRR VIS and IR data, cloud mask information and sun/satellite/earth-grid geometry information. These 3 files are passed to the OSI-205 processing chain as indicated in figure 1.

4.1.2 Cloud masking

The applied cloud mask is computed from the PPS software (version v2014) package with patch 20150327 from NWC-SAF.
Cloud mask values are:

- Cloud mask quality high or low.
- Cloud mask not processed
- Cloud free - no contamination by snow/ice covered surface or clouds
- Cloud contaminated - partly cloudy or semitransparent.
- Cloud filled - opaque clouds completely filling the FOV
- Snow ice contaminated
- Undefined - containing no data or corrupted data.

Of these categories “Cloud Free” and “Snow ice contaminated” are considered cloud free – the latter for IST data only.

4.2 Validation

At DMI a match-up database (MDB) is built monthly from collocated in situ measurements (buoys and ships) and satellite estimates of IST and SST. The in situ data are collected through the DMI-GTS network at ECMWF from drifting buoys, moored buoys and ships. These observations are partly quality controlled and will subsequently be checked against NWP data. The observations are collocated with satellite surface temperature data within a time constrain of +/- 30 minutes and within vicinity of 5 km.
From the match-up database various statistics are made to validate the accuracy and precision of the products, mainly by investigating the bias and standard deviation of the estimated surface temperatures compare to the in situ measurement. Initial validation results are presented in OSI-205 validation report [RD.3] and in the half-yearly reports from the OSI SAF, available at http://www.osi-saf.org.
For future quarterly validation and inter-comparison exercises, it is planned to install the Felyx data match-up software (Felyx) that presently is being implemented through the EUMETSAT (OSISAF/CAF) Federate Activity, the Sentinel-3 Cal/Val project (S3vt-fa).

4.3 Quality control

The quality of the delivered products is controlled through examination of the half-yearly validation statistics. The quality control is done by the OSI SAF R&D team. The automatic control is based on monthly statistics. On a monthly basis the standard deviation and bias estimates satellite ST are compared with observed in situ surface temperatures. For the daily quality control warnings are issued to the production team if production alarms are called. All these statistics are reported in the half-yearly report.

5 Product Variable description

The content of this OSI-205 product largely follows the recommendations from the Group for High Resolution Sea Surface Temperature (GHRSST) Science Team, as described in the GHRSST Data Specification document (GDS, version 2.00 - revision 5). GHRSST is the driving organization for satellite sea surface temperature algorithm and product development and production, and for that reason the OSISAF team decided to comply to the GDS product format for this product. The obvious benefits are that this format is acknowledged and implemented by most satellite-SST user communities. However there are minor differences between this data format and GDS, since the OSI-205 product also covers ice surface temperatures. We have included additional information and data fields to the standard GDS description and, some of the features of the standard GDS format are not relevant for the IST part of this product. For users of the ordinary SST field, this product comply fully to the GDS format, where IST users may want to use some of the ancillery information of the IST field for filtering before use. In section 5.1 and 5.2 is a description of each field contained in the OSI-205 product and appendix A is a header dump of an actual NetCDF data file.

5.1 Geophysical and calculated variables

5.1.1 Sea ice fraction

The Sea ice fraction field that is added to the products is the nearest neighboring sea ice concentration (SIC) value from the OSI SAF OSI-401 product [RD.5]. OSI-401 is a daily SIC field at 10km spatial resolution, based on passive microwave data.

5.1.2 Surface temperature

The integrated surface temperature field, including SST, IST and MIZT, calculated from equations 1 to 7.

5.1.3 Sea Surface Temperature

A conventional SST field using equations 2, 3 or 4. This field is a subset of the surface temperature field above, included for traditional SST data use only that it comply completely to GHRSST GDS conventions.

5.1.4 Quality_level

The quality level (QL) is the overall quality indicator used for all IST, SST and MIZT values.
The QL uses an incremental scale from 0 to 5 to provide the user with an indication of the quality of the L2P SST data. QL = 0 indicate missing data and QL = 1 is assigned SST data that are NOT cloud free and IST/MIZT data that are NOT cloud free OR

Snow/Ice contaminated. QL values between 2 and 5 are assigned to the data based on the number of strikes they have received in a penalty system. Each data pixel undergoes a series of tests and each time the data fails to comply the test, the data gets an additional strike (penalty). If a given pixel comply to all tests, i.e. number of strikes=0, this data is of highest quality, QL = 5.
The accumulative penalty system is as follows:
+1 strike if the cloud mask quality level is low (see pps quality flag, PPScloud).
+1 strike if at least one of the surrounding 8 pixels is NOT *cloud free* or *Snow/Ice contaminated* (for IST only).
+1 strike if satellite zenith angle > 60º
+1 strike if sun zenith angle > 80º (IST only, there are consequently no QL5 IST data during the polar night.)
+1 strike if the absolute difference between SST and the first guess SST value is larger that 10K (SST only)
+1 strike if 95º > sun zenith angle > 80º (SST only)

The Quality Levels are thus given according to following rules:
QL = 0; No data: No data or surface temperature failed sanity check (see section xx in algorithm description)
QL = 1; Bad data: NOT *cloud free* or NOT *Snow/Ice contaminated* (for IST).
QL = 2; Worst quality: *3 strikes* or more.
QL = 3; Low quality : 2 *strike.*
QL = 4; Acceptable quality : 1 *strike.*
QL = 5; Best quality: if zero *strikes*.

5.1.5 Sses_standard_deviation

This uncertainty element is fixed to 0 (zero) in OSI-205 version 1.0. Next version will include distributed uncertainties.

5.1.6 Sses_bias

This uncertainty element is fixed to 0 (zero).

5.1.7 Probability_of_water, probability_of_ice

The probability of cloud free water and cloud free ice/snow and cloud are produced in a three-way classifier and the probabilities of water and ice are added to the output data set to provide additional filtering means for the user, to minimize further the risk of using cloud contaminated surface temperature values. The probability of cloud is not included, but can be retrieved as the three probabilities of water, ice and cloud summarize to 1.0 for each pixel. This information is not included in the quality level assessment, due to lack of statistics at this stage of the product. At present the probabilities are not provided for night time data.
The procedure calculating these probabilities is fully explained in Killie et al. (2011) and a comparison with the PPS cloud mask is shown in Dybbroe et al. (2014).

5.1.8 NWP data

Wind speed and air temperatures data are interpolated on to OSI-205. These fields are 2m temperatures (variable 167; ECMWF-table128) and 10m wind speed (calculated from variable 165 and variable 166; ECMWF-table128) from the current operational deterministic model at ECMWF.

5.2 Other Variables

5.2.1 Latitude

Latitude units are in degrees North and valid polewards of 50N and 50S.

5.2.2 Longitude

Longitude units are in degrees East and valid between -180 and 180.

5.2.3 L2p_flags

A 2-BYTE bit-field including miscellaneous information in accordance with GDS format descriptions (GDS):

- Bit 0: microwave [not in use; not relevant]
- Bit 1: land [from cloud mask conditions]
- Bit 2: ice [if ice-concentration is > 15%]
- Bit 3: lake [not in use]
- Bit 4: river [not in use]
- Bit 5: reserved_for_future_use [not in use]
- Bit 6: ice-cap [from land/sea/land-ice mask, see section 3.4]
- Bit 7: water [from land/sea/land-ice mask, see section 3.4]
- Bit 8: land [from land/sea/land-ice mask, see section 3.4]
- Bit 9: cloudmask_quality_high [from PPS cloud mask stream]
- Bit 10: cloudmask_not_processed [from PPS cloudmask, see section 4.1.2]
- Bit 11: cloud_free [from PPS cloudmask, see section 4.1.2]
- Bit 12: cloud_contaminated [from PPS cloudmask, see section 4.1.2]
- Bit 13: cloud_filled [from PPS cloudmask, see section 4.1.2]
- Bit 14: snow_ice_contaminated [from PPS cloudmask, see section 4.1.2]
- Bit 15: undefined [not in use]

5.2.4 Processing_flags(time, nj, ni)

The processing flag is not a standard GDS data field. This flags carries information specifically related to the ice surface temperatures:

- Bit 0: noalgorithm [No temperature data are associated with this label]
- Bit 1: sstday [see eq. 2]
- Bit 2: sstnight. (see eq. 3)
- Bit 3: ssttwilight (see eq. 4)

- Bit 4: istwarm (see eq. 1)
- Bit 5: istmid (see eq. 1)
- Bit 6: istcold (see eq. 1)
- Bit 7: miztsstdayist (Linearly scaled IST and SST)
- Bit 8: miztsstnightist (Linearly scaled IST and SST)
- Bit 9: miztssttwilightist (Linearly scaled IST and SST)
- Bit 10: Ts is less than T11 then Ts value equals 140
- Bit 11: for2 68.95 <= T11 < 270.95 and T11-T12 > 2 then Ts value equals 141 (assumed atmospheric ice crystals)
- Bit 12: for T11 >= 270.95 and T11-T12>2 then Ts values equals 142 (assumed atmospheric ice crystals)
- Bit 13: undefined [not in use]
- Bit 14: undefined [not in use]
- Bit 15: undefined [not in use]

5.2.5 Satellite_zenith_angle

Field of satellite zenith angles.

5.2.6 Solar_zenith_angle

Field of solar zenith angles.

6 Data description

6.1 Overview

The OSI-205 product is computed with a timeliness of 3 hours from time of recording. The product is made available continuously as they are processed. The area covered by the product is polewards of latitudes 50° N and 50° S. Each full Metop swath takes approximately 100 minutes thus consisting of 33 3-minute segments of which ~15 segments per full swath cover the polar areas of interest (see figure 3 and 4). Each 3-minute segment that contains data inside the area of interest is processed.

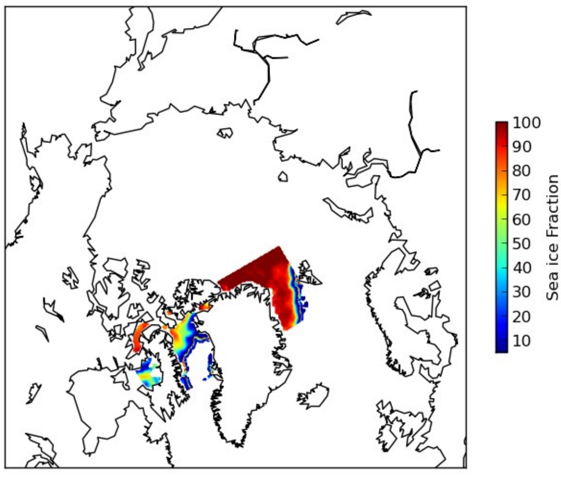

Figure 3: An ice concentration field from a 3 minute segment of a OSI-205 product.

6.2 Coverage

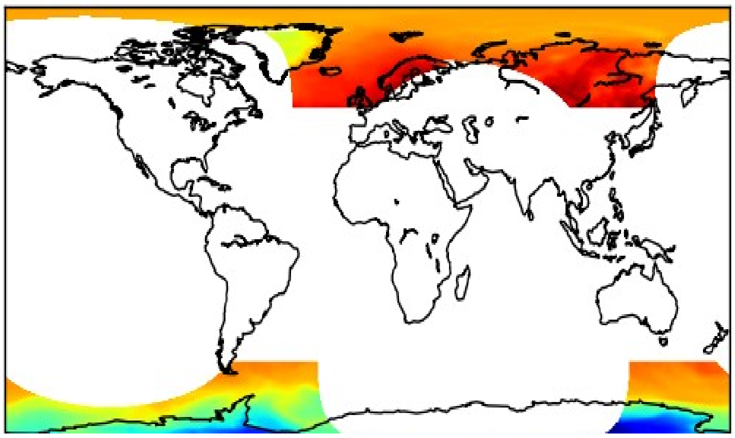

Figure 4: Product coverage is polewards of latitudes 50N and 50S. The data field is 2m Temperatures from ECMWF, corresponding to a full AVHRR swath.

The area of interest for OSI-205 is illustrated in figure 4 by a full Metop AVHRR swath cut off at the Northern and Southern latitude limits, 50N and 50S, respectively. Here the swath is represented by a NWP based 2m temperature field(ECMWF).

6.3 File formats

The file format of the OSI-205 product is NetCDF4. The product file follows the GHRSST Data Specification (GDS, version 2.00 -revision 5). The meta data are compatible with CF conventions (CF).

6.4 File Name convention

The OSI-205 file name convention follows the GDS file format description (GDS, 2014-09):
<Indicative Date><Indicative Time>-<RDAC>-<Processing Level>_GHRSST-<SST Type>- <Product String>-<Additional Segregator>-v<GDS Version>-fv<File Version>.<File Type>

where:

- Indicative Date: The data set, acquisition start date
- Indicative Time: The data set, acquisition start date
- RDAC: Place of creation
- Processing Level: Processing level code
- ST Type: Type of surface temperature
- Product String: The data set identification

- Additional segregator: optional text – here describing the area of interest.
- GDS Version: Version 2
- File Version: The version of the output data set
- File Type: Type of output file.

OSI-205 file name example:

20150813094600-DMI-L2P_GHRSST-STskin-AVHRR_nh_SST_IST-metopa_00000-v02.0-fv01.0.nc

6.5 Updates

This product is within CDOP2 planned to be updated with VIIRS data and uncertainties in Q3 2016.

6.6 Data distribution

There are two main sources for collecting the OSI SAF OSI-205 IST/SST product; by FTP or through EUMETCast. At the OSI SAF High Latitude FTP server ftp://osisaf.met.no/prod/sst/sst_ist-hl-l2, the products are available on NetCDF4 format. Here products from the last month can be collected. In addition there is a separate directory with archive of all previous products: ftp://osisaf.met.no/archive/sst/sst_ist-hl-l2. The file name convention for these products is given in section 6.4.
Through the EUMETSAT EUMETCast service the OSI SAF OSI-205 SST/IST product is available on the NetCDF4 format. Different file name conventions have been chosen for the OSI-205 products at EUMETCast since many different products are disseminated through EUMETCast. More information about the EUMETCast service can be found at: http://www.eumetsat.int.

6.7 Validation results

The accuracy of the OSI-205 production is monitored for L2 since August 2015. This version has been running in parallel with the similar Metop AVHRR level 2 production used by the Copernicus Marine Service. The OSI-205 is a higher developed product with features like quality levels and probability fields that can be used to customize the data.

See validation report [RD.3].

7 References

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Appendix A:

Sea and Sea Ice Surface Temperature products in NetCDF format
A header dump of a OSI-205 data set:

```
netcdf \20151003051300-DMI-L2P_GHRSST-STskin-AVHRR_nh_SST_IST-metopa_00000-v02.0-fv01.0 {
dimensions:
	time = 1 ;
	ni = 2048 ;
	nj = 1080 ;
variables:
	double time(time) ;
		time:units = "seconds since 1978-01-01 00:00:00" ;
		time:long_name = "reference time of ST fields" ;
		time:standard_name = "time" ;
		time:calendar = "Gregorian" ;
	float lat(time, nj, ni) ;
		lat:units = "degrees_north" ;
		lat:long_name = "latitude coordinate" ;
		lat:standard_name = "latitude" ;
		lat:valid_min = -90.f ;
		lat:valid_max = 90.f ;
	float lon(time, nj, ni) ;
		lon:units = "degrees_east" ;
		lon:long_name = "longitude coordinate" ;
		lon:standard_name = "longitude" ;
		lon:valid_min = -180.f ;
		lon:valid_max = 180.f ;
	byte sea_ice_fraction(time, nj, ni) ;
		sea_ice_fraction:units = "1" ;
		sea_ice_fraction:long_name = "sea_ice_concentration" ;
		sea_ice_fraction:standard_name = "sea_ice_area_fraction" ;
		sea_ice_fraction:scale_factor = 0.01f ;
		sea_ice_fraction:add_offset = 0.f ;
		sea_ice_fraction:valid_min = -100b ;
		sea_ice_fraction:valid_max = 100b ;
		sea_ice_fraction:_FillValue = -100b ;
		sea_ice_fraction:source = "OSI SAF reprocessed sea ice concentration product (OSI-409) v1.1" ;
	short surface_temperature(time, nj, ni) ;
		surface_temperature:units = "K" ;
```

surface_temperature:long_name = "sea and sea ice temperature" ;

surface_temperature:standard_name = "surface_temperature" ;

surface_temperature:coordinates = "lon lat" ;

surface_temperature:comment = "Temperature of the skin of the ocean and ice" ;

surface_temperature:scale_factor = 0.01f ;

surface_temperature:add_offset = 0.f ;

surface_temperature:valid_min = 15000s ;

surface_temperature:valid_max = 32315s ;

surface_temperature:_FillValue = -32768s ;

short sea_surface_temperature(time, nj, ni) ;

sea_surface_temperature:units = "K" ;

sea_surface_temperature:long_name = "sea surface subskin temperature, 1 to 1.5 millimetres" ;

sea_surface_temperature:standard_name = "sea_surface_subskin_temperature" ;

sea_surface_temperature:coordinates = "lon lat" ;

sea_surface_temperature:scale_factor = 0.01f ;

sea_surface_temperature:add_offset = 0.f ;

sea_surface_temperature:valid_min = 27115s ;

sea_surface_temperature:valid_max = 32315s ;

sea_surface_temperature:_FillValue = -32768s ;

short st_dtime(time, nj, ni) ;

st_dtime:units = "seconds" ;

st_dtime:long_name = "time difference from reference time" ;

st_dtime:standard_name = "time" ;

st_dtime:scale_factor = 0.1666667f ;

st_dtime:add_offset = 0.f ;

st_dtime:comment = "reference time plus st_dtime gives seconds after 1978-01-01 00:00:00 UTC" ;

short l2p_flags(time, nj, ni) ;

l2p_flags:long_name = "L2P flags" ;

l2p_flags:comment = "These flags are important to properly use the data. The land-water-ice mask is produced from the NOAA NESDIS NGDC GLOBAL RELIEF MAPS, ETOPO1 Ice Surface and ETOPO1 Bedrock (http://www.ngdc.noaa.gov/mgg/global/global.html). Cloud mask data is from the PPS cloud mask. " ;

l2p_flags:flag_meanings = "microwave land ice lake river reserved_for_future_use ice-cap water land cloudmask_quality_high cloudmask_not_processed cloud_free cloud_contaminated cloud_filled snow_ice_contaminated undefined" ;

l2p_flags:valid_min = 0s ;

l2p_flags:valid_max = 32767s ;

l2p_flags:flag_masks = "1s, 2s, 4s, 8s, 16s, 32s, 64s, 128s, 256s, 512s, 1024s, 2048s, 4096s, 8192s, 16384s, 32768s" ;

l2p_flags:_FillValue = -32768s ;

short processing_flags(time, nj, ni) ;

processing_flags:_FillValue = -32768s ;

processing_flags:long_name = "processing and algorithm flags" ;

processing_flags:valid_min = 0s ;

processing_flags:valid_max = 1023s ;

processing_flags:flag_meanings = "no_algorithm sst_day sst_night sst_twilight ist miszt_day miszt_night Ts<T11 for268.95<=T11<270.95_T11-T12>2 forT11>=270.95_T11-T12>2 " ;

processing_flags:comment = "These flags are important to properly use the data." ;

processing_flags:flag_masks = "1s, 2s, 4s, 8s, 16s, 32s, 64s, 128s, 256s, 512s" ;

byte quality_level(time, nj, ni) ;

quality_level:long_name = "quality level of st pixel" ;

quality_level:comment = "These are the overall quality indicators and are used for all SIST and SST values" ;

quality_level:flag_meanings = "no_data bad_data worst_quality low_quality acceptable_quality best_quality" ;

quality_level:valid_min = 0s ;

quality_level:valid_max = 5s ;

quality_level:_FillValue = -100b ;

byte sses_standard_deviation(time, nj, ni) ;

sses_standard_deviation:long_name = "SSES standard deviation" ;

sses_standard_deviation:units = "K" ;

sses_standard_deviation:valid_min = -127s ;

sses_standard_deviation:valid_max = 127s ;

sses_standard_deviation:_FillValue = -100b ;

byte sses_bias(time, nj, ni) ;

sses_bias:long_name = "SSES bias estimate" ;

sses_bias:units = "K" ;

sses_bias:valid_min = -127s ;

sses_bias:valid_max = 127s ;

sses_bias:_FillValue = -100b ;

byte probability_of_water(time, nj, ni) ;

probability_of_water:long_name = "probability of water" ;

probability_of_water:units = "percent" ;

probability_of_water:comment = "Sum of pwater, pice, and pcloud (not included) is 100" ;

probability_of_water:valid_min = -100b ;

probability_of_water:valid_max = 100b ;

probability_of_water:_FillValue = -127b ;

byte probability_of_ice(time, nj, ni) ;

probability_of_ice:long_name = "probability of ice" ;

probability_of_ice:units = "percent" ;

probability_of_ice:comment = "Sum of pwater, pice, and pcloud (not included) is 100" ;

probability_of_ice:valid_min = -100b ;

probability_of_ice:valid_max = 100b ;

probability_of_ice:_FillValue = -127b ;

float wind(time, nj, ni) ;

wind:units = "m/s" ;

wind:long_name = "wind speed, 10m" ;

wind:standard_name = "wind_speed" ;

wind:comment = "10m wind speed from ERA-INTERIM reanalysis, ECMWF" ;

wind:valid_min = 0.f ;

wind:valid_max = 100.f ;

wind:_FillValue = -1.f ;

float t2m(time, nj, ni) ;

t2m:units = "K" ;

t2m:long_name = "air temperature, 2m" ;

t2m:standard_name = "air_temperature" ;

t2m:comment = "2m Temperature from ERA-INTERIM reanalysis, ECMWF" ;

t2m:valid_min = 150.f ;

t2m:valid_max = 350.f ;

t2m:_FillValue = -1.f ;

ubyte satellite_zenith_angle(time, nj, ni) ;

satellite_zenith_angle:long_name = "satellite zenith angle" ;

satellite_zenith_angle:units = "degree" ;

satellite_zenith_angle:comment = "Calculated satellite zenith angle based on the satellite geometry at the time of data acquisition" ;

satellite_zenith_angle:valid_min = 0s ;

satellite_zenith_angle:valid_max = 80s ;

satellite_zenith_angle:_FillValue = 255UB ;

ubyte solar_zenith_angle(time, nj, ni) ;

solar_zenith_angle:units = "degrees" ;

solar_zenith_angle:long_name = "solar zenith angle" ;

solar_zenith_angle:valid_min = 0s ;

solar_zenith_angle:valid_max = 180s ;

solar_zenith_angle:_FillValue = 255UB ;

// global attributes:

:topiccategory = "Oceans Climatology Meteorology Atmosphere" ;

:keywords = "Sea Ice Skin Temperature, Sea Surface Temperature, Sea Ice, Oceanography, Meteorology, Climate, Remote Sensing" ;

:gcmd_keywords = "Cryosphere > Sea Ice > Sea Ice Surface Temperature\nOcean > Sea Surface > Sea Surface Temperature\nGeographic Region > Northern Hemipshere, above 60N\nVertical Location > Sea Surface\nEUMETSAT OSISAF\nGreenland Climate and Research Center\nNORMAP" ;

:activity_type = "Space borne instrument" ;

:Conventions = "CF-1.6" ;

:history = "2015-10-03 06:35:00 UTC creation" ;

:version = "v1.00" ;

:area = "North of 50N and South of 50S" ;

:PI_name = "Gorm Dybkjaer" ;

:contact = "gd@dmi.dk" ;

:distribution_statement = "Free" ;

:project_name = "EUMETSAT - OSISAF" ;

:references = "Contact producer for documentation." ;

:title = "EUMETSAT OSISAF; OSI-205 Level 2 - High Latitude Sea and Sea Ice Surface Temperature" ;

:abstract = "Sea and Sea Ice Surface Temperature fields obtained from infrared satelite imagery. The product resolution is approximately 1 km, for Metop AVHRR data.\nThis dataset is intended mainly for data assimilation/validation, due to large data gaps caused by opaque atmosphere.\nMultiple daily 3 minute products are freely available from the EUMETSAT data distributing system, EUMETCAST.\nThis product is based on IR swath data, in 3 minute segments with at least 1 data value position higher than 60 degree N,\nfrom the EUMETSAT Metop satellite." ;

:product_name = "osisaf_ssist" ;

:id = "OSI-205" ;

:product_status = "Beta version - with some empty fields containing no error statistics and probability fields." ;

:institution = "Danish Meteorological Institute (dmi.dk) and Norwegian Meteorological Institute (MET)" ;

:satelliteID = "metopa" ;

:date = "2015-10-03 05:13:00 UTC" ;

:start_time = "20151003T051303Z" ;

:stop_time = "20151003T051603Z" ;

:platform = "AVHRR" ;

:northernmost_latitude = 82.318f ;

:easternmost_longitude = 179.999f ;

:southernmost_latitude = 61.602f ;

:westernmost_longitude = -179.999f ;

:comment = "This product is based on IR swath data that are sensitive to atmospheric water. Hence, the swath data will contain areas with non valid surface temperature data." ;