EUMETSAT OSI SAF
OCEAN AND SEA ICE

Product User Manual for Atlantic High Latitudes level 3 Radiative Flux products

OSI-301-c and OSI-302-c

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Document Change record

Document version	Software version	Date	Author	Change description
1.0		14-04-2011	Øystein Godøy	Preparation for separate dissemination of High Latitude Fluxes from the OSISAF High Latitude Centre.
1.1		26-04-2011	Øystein Godøy	Correction of typos.
2.0-draft	5.3	05-12-2019	Amélie Neuville	New draft version for ORR of new product versions OSI-301-b and OSI-302-b, which includes updated algorithms and NetCDF output.
2.0	5.3	24-01-2020	Steinar Eastwood	Minor changes after ORR review.
2.1	5.4	15-02-2023	Steinar Eastwood	New version for ORR of new product versions OSI-301-c and OSI-302-c, with inclusion of Metop-C AVHRR and NPP/NOAA-20 VIIRS data.

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1. Introduction

1.1. The EUMETSAT Ocean and Sea Ice SAF

The Satellite Application Facilities (SAFs) are dedicated centres of excellence for processing satellite data – hosted by a National Meteorological Service – which utilise specialist expertise from institutes based in Member States. EUMETSAT created Satellite Application Facilities (SAFs) to complement its Central Facilities capability in Darmstadt. The Ocean and Sea Ice Satellite Application Facility (OSI SAF) is one of eight EUMETSAT SAFs, which provide users with operational data and software products. More on SAFs can be read at www.eumetsat.int.

The objective of the OSI SAF is the operational near real-time production and distribution of a coherent set of information, derived from earth observation satellites, and characterising the ocean surface and the energy fluxes through it: sea surface temperature, radiative fluxes, wind vector and sea ice characteristics. For some variables, the OSI SAF is also aiming at providing long term data records for climate applications, based on reprocessing activities.

The radiative fluxes products includes longwave and shortwave downward irradiance at the surface. The longwave product is labelled Downward Longwave Irradiance (DLI) product, with identifier OSI-301-c. The shortwave product is labelled Surface Shortwave Irradiance (DLI) product, with identifier OSI-302-c.

The OSI SAF consortium is hosted by Météo-France. The high latitude radiative processing is performed at the High Latitude processing facility (HL centre), under the responsibility of the Norwegian Meteorological Institute.

1.2. Disclaimer

Note: The comments that we get from our users is an important input when defining development activities and updates, and user feedback to the OSI SAF project team is highly valued.

Acknowledgement and citation

Use of these products should be acknowledged with the following citations:

OSI SAF (2022): Product User Manual for Atlantic High Latitude level 3 Radiative Flux, EUMETSAT SAF on Ocean and Sea Ice. https://osi-saf.eumetsat.int/products/radiative-fluxes-products

1.3. Scope of this document

This product user manual presents the Atlantic High Latitude (AHL) Level 3 Radiative Flux products from the EUMETSAT Ocean and Sea Ice Satellite Application Facility (OSI SAF). The focus of the

manual is to present a short overview of how these products are produced and describe technical details about the products format to enable users to understand and use the products.

1.4. Overview

The high latitude radiative flux products have been produced since 2002. In the start the products were merged with the low/mid latitude products for a complete Atlantic coverage. Since 2011 the high latitude products have been distributed separately, as OSI-301 for DLI and OSI-302 for SSI.

This PUM describes the updated version of the products, labelled OSI-301-c and OSI-302-c. The major changes for this update are:

- Including NPP and NOAA-20 VIIRS data
- Including Metop-C AVHRR data (no longer using Metop-A)
- Replacing the cloud type product from PPS v2014 with v2021.

1.5. Reference and applicable documents

1.5.1. Reference documents

[RD.1] EUMETSAT OSI SAF
Algorithm Theoretical Basis Document for Atlantic High Latitudes level 3 Radiative Flux products.
SAF/OSI/CDOP3/MET-Norway/SCI/MA/255, version 1.2, 05.01.2022

[RD.2] EUMETSAT OSI SAF
Scientific Validation Report for Atlantic High Latitudes level 3 Radiative Flux product.
SAF/OSI/CDOP3/MET-Norway/SCI/RP/372, version 2.1, 07.01.2022

1.5.2. Applicable documents

[AD.1] EUMETSAT OSI SAF
Product Requirements Document
SAF/OSI/CDOP3/MF/MGT/PL/2-001, version 1.9, 31.12.2021

[AD.2] EUMETSAT OSI SAF
Service Specification Document
SAF/OSI/CDOP3/MF/MGT/PL/003, version 1.12, 31.12.2021

1.6. Glossary

Acronym	Description
AHL	Atlantic High Latitudes
AVHRR	Adanced Very High Resolution Radiometer
DLI	Downward Longwave Irradiance
ECMWF	European Centre for Medium range Weather Forecasts
HL	High Latitudes

Acronym	Description
NetCDF	Network Common Data Form
NOAA	National Oceanic and Atmospheric Administration
NWC SAF	Nowcasting SAF
NWP	Numerical Weather Prediction
OSI SAF	Ocean and Sea Ice SAF
PPS	Polar Processing System
SAF	Satellite Application Facility
SSI	Solar Surface Irradiance
VIIRS	Visible Infrared Imaging Radiometer Suite

2. Processing scheme

Full details about the processing scheme is provided in the [RD.1], only an overview is provided here.

2.1. Overview

The high latitude SSI and DLI processing is based on data from AVHRR and VIIRS instruments on the NOAA and EUMETSAT polar orbiting satellites. At present the Metop-C, Metop-B, NPP, NOAA-20 and NOAA-19 satellites are used. Each orbit is processed separately for SSI and DLI, using cloud information from the NWC SAF PPS v2021 cloud type processor, ECMWF NWP data, OSI SAF sea ice information and climatologies. Each of the orbital L2 files are then gridded to the final product grid. The daily product is then produced based on all available gridded orbital files through the day. For SSI this involves a weighting of observations according to the daily cycle of insolation. For DLI this is a standard averaging.

2.2. Validation and quality control

The quality assessment of the OSI SAF AHL SSI and DLI products OSI-301-c and OSI-302-c is done first just before becoming an operational/pre-operational product distributed by the OSI SAF. This first assessment is explained in this scientific validation report [RD.2]. Then continuous monitoring of the product quality is done by the OSI SAF team and presented in the half-yearly operations reports available on the OSI SAF web site project documentation.

The quality assessment of the OSI-301-c and OSI-302-c is done against the target accuracy requirement defined in the OSI SAF Service Specification [AD.2].

The target accuracy corresponds to the desired performance level (the target accuracy). If the values are not compliant to the target accuracy requirement, we consider that the product is still useful/useable as long as the values are compliant to the threshold requirement.

	Threshold accuracy (%)		Target accuracy (%)		*Optimal accuracy* (%)	
	Mean diff	*Std*	Mean diff	Std	*Mean diff*	*Std*
DLI, OSI-301-c	*10*	*20*	5	10	*0*	*3*
SSI, OSI-302-c	*20*	*50*	10	30	*0*	*10*

Table 1: DLI and SSI quality requirements thresholds (from [AD.2]).

3. Product description

3.1. Overview

The AHL flux products are distributed in one product file containing both SSI and DLI for each 24 hour integration period. The file contains these data :

- radiative flux fields, both SSI and DLI
- confidence level fields for both SSI and DLI
- latitude and longitude coordinate fields
- grid specification (Polar Stereographic)
- global attribute meta data

Data are provided in Unidata NetCDF 4 format. A brief description of the NetCDF format used is given later.

3.2. Grid specification

The grid specification is given in Table Table II. The area covered is specified in Figure 1.

Table II Grid specification.

Map projection	Polar Stereographic true at 60°N
Horizontal resolution	5km
Horizontal dimension	1260 columns × 900 lines
Central meridian	0°E
Lower left corner	37.39928°N, 40.16765°W (geographical coordinates)
Upper left corner	-3795.00, 5.00 (in UCS coordinates, Bx and By in km)
Radius of Earth	6371.0 km
PROJ4 string	+proj=stere +a=6371000 +b=6371000 +lat_0=90 +lat_ts=60 +lon_0=0

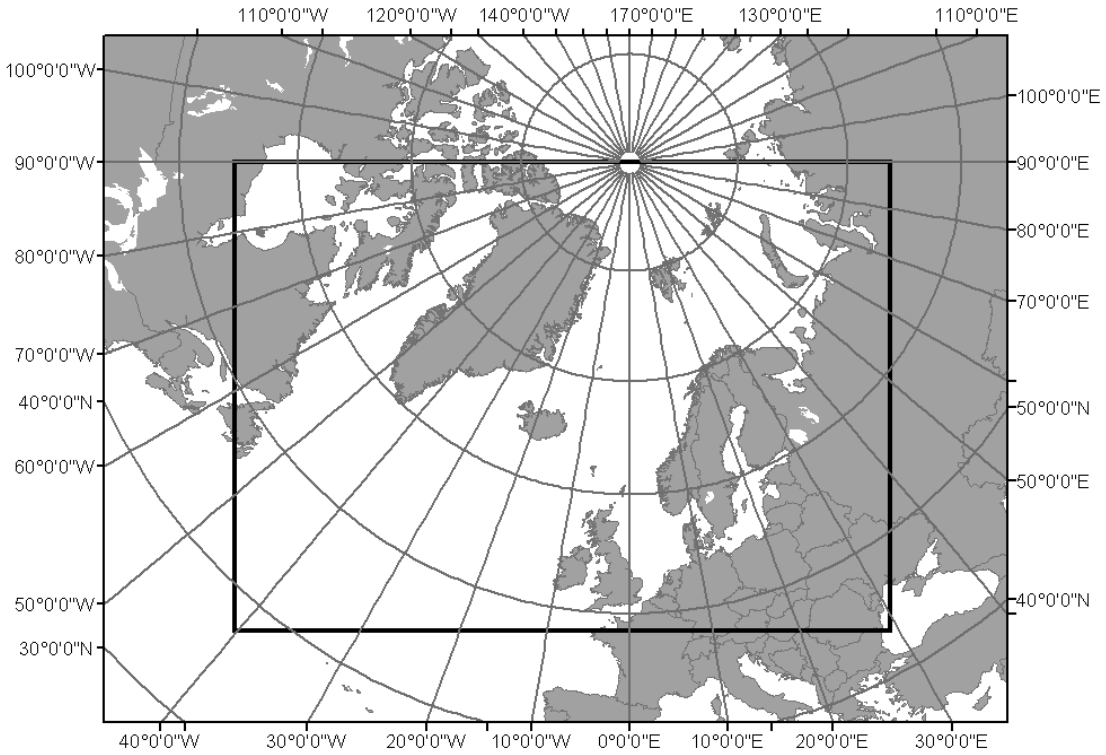

Figure 1 Area coverage of the Atlantic High Latitude OSI SAF SSI and DLI products.

3.3. Radiative fluxes

3.3.1. Surface Shortwave Irradiance

The surface downward solar irradiance (global radiation) is presented. Units are W/m^2.

The daily SSI is estimated by estimating the daily mean clear sky solar irradiance. Each hourly estimate is used to compute a clear sky index by dividing the hourly 5 km grid estimate with the clear sky irradiance. The product of the clear sky index and the daily mean clear sky irradiance is averaged to get the daily mean cloud dependent value. Only hourly estimates having a confidence level equal to or above acceptable (defined later) are used in the averaging processes.

3.3.2. Downward Longwave Irradiance

The surface downward longwave irradiance is presented. Units are W/m^2.

The daily DLI is estimated by a straightforward process averaging the mono-passage products from the highest resolution onto the SAF grid and subsequently averaging all mono-passage products into a daily product. Only estimates having a confidence level equal to or above acceptable (defined later) are used in the averaging processes.

3.4. Confidence levels

Each DLI or SSI pixel value is associated to a confidence level expressed on a scale with 6 values:

0: unprocessed, 1: erroneous, 2: bad, 3: acceptable, 4: good, 5: excellent.

The 0 value corresponds most of the time to space or missing data, and, for SSI, to a solar zenith angle (SOZ) larger than 80 degrees. The 1 value corresponds to an error in the algorithms or software logic. The other value meanings depend on the products and are described below. When attributing the confidence levels, the conditions are checked from the worse level to the best level, and a given confidence level cannot be attributed if conditions for lower confidence levels are met. The description of the conditions below are described in more detail in [RD-1].

3.4.1. SSI

The single passage SSI confidence levels are defined as follows:

- Excellent - cloud factor between 0 and 1 and consistent with cloud cover (rules for consistency given below), this is never used for partly cloud contaminated pixels.
- Good - no sunglint and cloud factor between 0.2 and 1 and not fully consistent with cloud cover, or fractional cloud conditions.
- Acceptable - clear sky, cloud factor equals 0 and is consistent with cloud cover or cloud factor equals 1 (regardless of consistency), or sunglint and fractional clouds, or sunglint and cloud factor equals 0.
- Bad - low cloud factor and inconsistent with cloud cover.
- Erroneous - error in NTOB or BRDF or clear sky insolation or cloud transmittance.
- Unprocessed - out of area, night, or SOZ>80 degrees.

Each single SSI passage is then resampled to a polar stereographic map projection with 5 km grid resolution. The pixels of the single passage SSI data are used in the resampling process only if their confidence levels are equal or better than acceptable. The confidence level associated to the resampled SSI value is set so that at least 99% of the passage pixels used to obtain this value have an equal or better confidence level than the one which is finally set. During the daily averaging, the confidence levels of the gridded products are averaged and rounded to the nearest confidence level.

3.4.2. DLI

The single passage DLI confidence levels are defined as follows:

- Excellent - using SSI of excellent confidence level and no night, sunglint or twilight in the cloud type conditions and no low level quality inversion of the cloud type. When SSI is not used (bulk parametrization), and the solar zenith angle is lower than 80 degrees.
- Good - using SSI of good confidence level together with no night, sunglint or twilight in the cloud type conditions and no low level quality inversion of the cloud type.
- Acceptable - when using bulk parametrization and low or medium level cloud types are found together with a less than 80 degrees solar zenith angle and together with one of the following conditions: bad or questionable quality of the cloud type, or low level inversion of the cloud type, or reclassified cloud type. Or when solar zenith angle is higher than 80 degrees.
- Bad - when using bulk parametrization and low or medium level cloud types are found together with an over 80 degrees solar zenith angle and together with one of the following conditions :

bad or questionable quality of the cloud type, or low level inversion of the cloud type, or reclassified cloud type. When using bulk parametrization and the cloud type is not defined.

- Erroneous – no cloud type or failure in DLI computations (ex: failure in cloud contribution).
- Unprocessed - out of area.

The confidence level for daily products is found by averaging the single passage DLI estimates averaged to the AHL grid (5 km). Only pixels with confidence level equal to or better than acceptable (3) is used in the average, confidence level bad, erroneous and unprocessed are removed.

3.5. File format

The AHL Flux product is delivered in Unidata NetCDF 4 format, and follows the CF-1.6 metadata convention. It contains both the DLI OSI-301-c and SSI OSI-302-c products. An example of the file structure and metadata provided with the product is given in appendix 4.1.

3.6. Access to the products

There are three main access interfaces to radiative flux products. This is through FTP, EUMETCast or Thredds.

FTP access to NRT product is offered through ftp://osisaf.met.no/prod/flux/ . An online archives is also available at ftp://osisaf.met.no/archive/flux/.

Products are available through EUMETCast. More information about EUMETCast is found at http://navigator.eumetsat.int/.

Thredds access is offered through http://thredds.met.no/thredds/osisaf/osisaf.html .

The file name convention used is provided below.

Filename convention for OSISAF AHL Radiative flux products	
FTP and Thredds	
DLI and SSI NetCDF4	osisaf_radiative_flux_24h_hl_polstere-050_multi_<date>.nc
EUMETCast	
DLI and SSI NetCDF4	S-OSI_-NOR_-MULT-AHLDLISSID__-<date12>Z.nc

3.7. Helpdesk

Users are welcomed and encouraged to contact the OSI SAF in case of questions to or problems with OSI SAF products and OSI SAF support the users as far as possible. Please use the helpdesk form available on the OSI SAF web site https://osi-saf.eumetsat.int (you might need to register on the web site to send the form).

We recommend users to subscribe to OSI SAF service messages (specific to the products used) to be aware of any production anomaly and of products upgrades. See https://osi-saf.eumetsat.int (you need to be registered to receive service messages).

4. Appendices

4.1. ncdump of a product

```
netcdf osisaf_radiative_flux_24h_hl_polstere-050_multi_202302131200 {
dimensions:
    yc = 900 ;
    xc = 1260 ;
    time = UNLIMITED ; // (1 currently)
    nv = 2 ;
variables:
    int64 time(time) ;
           time:standard_name = "time" ;
           time:long_name = "time" ;
           time:bounds = "time_bnds" ;
           time:units = "seconds since 1981-01-01 00:00:00" ;
    int64 time_bnds(time, nv) ;
           time_bnds:long_name = "time bounds" ;
           time_bnds:units = "seconds since 1981-01-01 00:00:00" ;
    float ssi(time, yc, xc) ;
           ssi:_FillValue = -999.99f ;
           ssi:coordinates = "lon lat" ;
           ssi:units = "W m-2" ;
           ssi:standard_name = "surface_downwelling_shortwave_flux_in_air" ;
           ssi:missing_value = -999.99f ;
           ssi:valid_min = 0.f ;
           ssi:valid_max = 1000.f ;
           ssi:long_name = "surface solar irradiance" ;
           ssi:grid_mapping = "Polar_Stereographic_Grid" ;
    float lat(yc, xc) ;
           lat:long_name = "geographical latitude" ;
           lat:units = "degrees_north" ;
           lat:standard_name = "latitude" ;
           lat:valid_min = -90.f ;
           lat:valid_max = 90.f ;
    float lon(yc, xc) ;
           lon:long_name = "geographical longitude" ;
           lon:units = "degrees_east" ;
           lon:standard_name = "longitude" ;
```

```
            lon:valid_min = -180.f ;
            lon:valid_max = 180.f ;
      float dli(time, yc, xc) ;
            dli:_FillValue = -999.99f ;
            dli:coordinates = "lon lat" ;
            dli:units = "W m-2" ;
            dli:standard_name = "surface_downwelling_longwave_flux_in_air" ;
            dli:missing_value = -999.99f ;
            dli:valid_min = 0.f ;
            dli:valid_max = 1000.f ;
            dli:long_name = "downward longwave irradiance" ;
            dli:grid_mapping = "Polar_Stereographic_Grid" ;
      byte dli_confidence_level(time, yc, xc) ;
            dli_confidence_level:_FillValue = 0b ;
            dli_confidence_level:flag_values = 0b, 1b, 2b, 3b, 4b, 5b ;
            dli_confidence_level:flag_meanings = "unprocessed erroneous bad acceptable
good excellent" ;
            dli_confidence_level:valid_min = 0b ;
            dli_confidence_level:valid_max = 5b ;
            dli_confidence_level:long_name = "dli confidence level" ;
            dli_confidence_level:standard_name = "status_flag" ;
            dli_confidence_level:grid_mapping = "Polar_Stereographic_Grid" ;
      byte ssi_confidence_level(time, yc, xc) ;
            ssi_confidence_level:_FillValue = 0b ;
            ssi_confidence_level:flag_values = 0b, 1b, 2b, 3b, 4b, 5b ;
            ssi_confidence_level:flag_meanings = "unprocessed erroneous bad acceptable
good excellent" ;
            ssi_confidence_level:valid_min = 0b ;
            ssi_confidence_level:valid_max = 5b ;
            ssi_confidence_level:long_name = "ssi confidence level" ;
            ssi_confidence_level:standard_name = "status_flag" ;
            ssi_confidence_level:grid_mapping = "Polar_Stereographic_Grid" ;
      int Polar_Stereographic_Grid ;
            Polar_Stereographic_Grid:grid_mapping_name = "polar_stereographic" ;
            Polar_Stereographic_Grid:long_name = "Polar Stereographic Grid" ;
            Polar_Stereographic_Grid:straight_vertical_longitude_from_pole = 0.f ;
            Polar_Stereographic_Grid:latitude_of_projection_origin = 90.f ;
            Polar_Stereographic_Grid:standard_parallel = 60.f ;
            Polar_Stereographic_Grid:false_easting = 0. ;
            Polar_Stereographic_Grid:false_northing = 0. ;
            Polar_Stereographic_Grid:semi_major_axis = 6371000.f ;
```

```
            Polar_Stereographic_Grid:semi_minor_axis = 6371000.f ;


   // global attributes:
            :title = "Surface Radiative Fluxes for Atlantic High Latitudes from EUMET-
SAT OSI SAF" ;
            :summary = "This product consist of daily surface shortwave irradiance
(SSI) and downward longwave irradiance ((DLI) retrieved from satellite data, and their
confidence level, in a polar stereographic projection. The product is produced by the
EUMETSAT Ocean and Sea Ice Satellite Application Facility (OSI SAF)." ;
            :reference_time = "20230213T120000Z" ;
            :time_coverage_start = "20230213T000000Z" ;
            :time_coverage_end = "20230213T235959Z" ;
            :date_created = "20230214T013328Z" ;
            :platform = "NOAA-19, NOAA-20, Metop-B, Metop-C, SNPP" ;
            :sensor_name = "AVHRR, VIIRS, AVHRR, AVHRR, VIIRS" ;
            :source = "AVHRR/VIIRS data from multiple satellites (accessed through EU-
METCast),ECMWF operational analysis and forecast." ;
            :processing_level = "L3" ;
            :project = "OSI SAF - EUMETSAT" ;
            :institution = "OSI SAF - EUMETSAT" ;
            :creator_name = "OSI SAF - EUMETSAT" ;
            :creator_type = "institution" ;
            :creator_url = "http://osi-saf.eumetsat.int" ;
            :creator_email = "osi-saf.helpdesk@meteo.fr" ;
            :publisher_name = "Norwegian Meteorological Institute" ;
            :product_id = "osi-301-c osi-302-c" ;
            :product_name = "osi_saf_atlantic_high_latitude_level3_radiative_flux" ;
            :product_status = "operational" ;
            :license = "All intellectual property rights of the Ocean and Sea Ice
Satellite Application Facility (OSI SAF) products belong to EUMETSAT. The use of these
products is granted to every user, free of charge. If users wish to use these products,
EUMETSAT\'s copyright credit must be shown by displaying the words \"Copyright EUMET-
SAT\" under each of the products shown. EUMETSAT offers no warranty and accepts no liab-
ility in respect of the OSI SAF products. EUMETSAT neither commits to nor guarantees the
continuity, availability, or quality or suitability for any purpose of, the OSI SAF
products." ;
            string :keywords = "Earth Science > Oceans > Ocean Heat Budget > Longwave
Radiation\n", "Earth Science > Oceans > Ocean Heat Budget > Shortwave Radiation\n" ;
            :keywords_vocabulary = "GCMD Science Keywords" ;
            string :contributor_name = "Øystein Godøy, Amelie Neuville, Steinar East-
wood, Atle Sørensen" ;
            :contributor_role = "PrincipalInvestigator,author,author,author" ;
            :history = "2023-02-14T01:33:28Z creation" ;
            :reference = "Product User Manual v2.1 (Feb 2023), Algorithm Theoretical
Basis Document v1.2 (Feb 2023)" ;
            :region_name = "Atlantic High Latitudes" ;
```

```
            :geospatial_lat_min = 37.3152 ;
            :geospatial_lat_max = 90. ;
            :geospatial_lon_min = -180. ;
            :geospatial_lon_max = 180. ;
            :Conventions = "CF-1.6" ;
}
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