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# SATELLITE-BASED OCEAN PRODUCTS PROVIDED BY EUMETSAT

This paper provides an overview of satellite-based ocean products provided by EUMETSAT. It tables the specifications of the currently operational and planned products for e.g., Sea Surface Temperature, Sea Surface Winds, Sea Ice and Sea Surface Height making reference to related operational needs. Details of the general and programmatic context and of several key projects are provided in working paper CGMS38-WP16.

CGMS to take note

# Satellite-based ocean products provided by EUMETSAT

## 1 Introduction

Being a user-driven organization, EUMETSAT's objective is to ensure that essential data and operational products of high quality are made available in a sustained manner to the widest possible user community. Currently EUMETSAT is providing already a broad variety of operational and pre-operational satellite-based ocean products with the related operational services. The bulk of the user products are produced by the EUMETSAT Ocean and Sea Ice Satellite Application Facility (OSI SAF). In addition, satellite altimetry products are procured for now and in the future in the Jason-2 and Jason-3 program. The purpose of this document is to provide an overview of the characteristics of products and services.

## 2 The EUMETSAT Ocean and Sea Ice Satellite Application Facility

The EUMETSAT OSI-SAF (www.osi-saf.org) is dedicated to the common requirements of meteorology and oceanography for comprehensive information on the ocean-atmosphere interface. The core objective of the OSI SAF is the operational near real-time production, distribution and archiving of a coherent set of information characterising the ocean surface and the energy fluxes through the surface. It provides sea-surface temperature fields, radiative fluxes, wind vectors and sea ice products. Every operational product is delivered with a user manual and a report on product validation. Products are routinely monitored on availability, stability and quality. The range of products areas has been set to take into account different domains and spatial scales of application: The Global Oceans (GLB), the Atlantic Ocean at low and mid latitude (ATL) (including Western most part of Indian Ocean), The Atlantic/Arctic High latitudes (AHL), and the Nearest Atlantic and European seas (NAR).

### 2.1 Sea Surface Temperate products

*"Sea Surface Temperature (SST) at the ocean atmosphere interface is a fundamental variable for understanding, monitoring and predicting fluxes of heat, momentum and gas at a variety of scales from local to global climate that determine complex interactions between atmosphere and ocean."* [Donlon et al. 2010]. The OSI SAF produces core level 2 products on the basis of the SEVIRI (Meteosat Second Generation) and AVHRR (EUMETSAT Polar System, NOAA) instruments. Table 1 summarizes the characteristics of the products.

***Table 1 The EUMETSAT OSI SAF sea surface temperature products.***

| reference | Product Name | Product acronym | Characteristics and Methods | Input data | Satellite | Dissemination Means | Format | Timeliness | spatial coverage | generation frequency | spatial resolution |
|---|---|---|---|---|---|---|---|---|---|---|---|
| OSI-201 | GLB MetOp Sea Surface Temperature | GLB SST | underskin temperature (°K). multispectral algorithm | MetOp/ AVHRR | | EUMETCast FTP UMARF | GRIB NetCDF L3P and L3P core | 6 h | Global | 12 h for each satellite | 0.05° |
| OSI-202 | NAR Sea Surface Temperature | NAR SST | underskin temperature (°K). multispectral algorithm | NOAA, MetOp, NPP/ VIIRS | | EUMETCast FTP UMARF | GRIB NetCDF L3P and L3P core | 4 h | Northern Atlantic and Regional seas | 6 h | 2 km |
| OSI-203 | AHL Sea Surface Temperature | AHL SST | underskin temperature (°K). multispectral algorithm | AVHRR, NPP/ VIIRS | | EUMETCast FTP UMARF | GRIB NetCDF HDF5 | 3 h 30 | Atlantic High Latitude | 12 h | 5 km |
| OSI-204 | Full resolution MetOp Sea Surface Temperature metagranules | MGR SST | underskin temperature (°K). multispectral algorithm | MetOp/ AVHRR | | FTP | NetCDF L2P | 4 h | Global | Continuous | 1 km |
| OSI-205 | Full resolution NOAA Sea Surface Temperature | FRN SST | underskin temperature (°K). multispectral algorithm | NOAA/ EARS AVHRR | | FTP | NetCDF HDF5 | 3 h | North of 50N | Continuous | 1 km |
| OSI-206 | METEOSAT Sea Surface Temperature | MET SST | underskin temperature (°K). multispectral algorithm | MET | | EUMETCast FTP UMARF | GRIB NetCDF L2P | 3 h | 60S-60N 60W-60E | 1 h | 0.05° |
| OSI-207 | GOES-E Sea Surface Temperature | GOES-E SST | underskin temperature (°K). multispectral algorithm | GOES-E | | EUMETCast FTP UMARF | GRIB NetCDF L2P | 3 h | 60S-60N 135W-15W | 1 h | 0.05° |

The NetCDF (L2P and L3P) products comply with the standards set by the GHRSST community. These standards have recently been updated as GDS2.0 and will also be used for Sentinel-3 products in close cooperation with EUMETSAT central facilities. A L2P product based on IASI SST retrievals is in development.

## 2.2 Surface flux products

*"Flux products quantifying exchanges between ocean and atmosphere are needed for forcing models, understanding ocean dynamics, investigating the ocean's role in climate, and assessing coupled models*." [Fairall et al., 2010]. In addition, to the SST products for the determination of the ocean-atmosphere heat flux the OSI SAF produces level 2 products for the downward longwave irradiance and the short-wave solar irradiance. Table 2 summarizes the characteristics of the products.

***Table 2 The EUMETSAT OSI SAF sea surface flux products.***

| reference | Product Name | Product acronym | Characteristics and Methods | Input Satellite data | Dissemination Means | Format | Timeliness | spatial coverage | generation frequency | spatial resolution |
|---|---|---|---|---|---|---|---|---|---|---|
| OSI-301 | AHL Downward Longwave Irradiance | AHL DLI | W/m². Bulk parameterization | NOAA/ AVHRR, MetOp/ AVHRR | EUMETCast FTP UMARF | GRIB NetCDF HDF5 | 3 h 30 | Atlantic North of 50N | 12 h | 5 km |
| OSI-302 | AHL Short-wave Solar Irradiance | AHL SSI | W/m². physical parameterization | NOAA/ AVHRR, MetOp/ AVHRR | EUMETCast FTP UMARF | GRIB NetCDF HDF5 | 3 h 30 | Atlantic North of 50N | 12 h | 5 km |
| OSI-303 | METEOSAT Downward Longwave Irradiance | MET DLI | W/m². Bulk parameterization | MET | EUMETCast FTP UMARF | GRIB NetCDF | 2 h | 60S-60N 60W-60E | 1 h + daily integrated | 0.05° |
| OSI-305 | GOES-E Downward Longwave Irradiance | GEOS-E DLI | W/m². Bulk parameterization | GOES-E | EUMETCast FTP UMARF | GRIB NetCDF | 2 h | 60S-60N 135W-15W | 1 h + daily integrated | 0.05° |
| OSI-304 | METEOSAT Short-wave Solar Irradiance | MET SSI | W/m². physical parameterization | MET | EUMETCast FTP UMARF | GRIB NetCDF | 2 h | 60S-60N 60W-60E | 1 h + daily integrated | 0.05° |
| OSI-306 | GOES-E Short-wave Solar Irradiance | GOES-E SSI | W/m². physical parameterization | GOES-E | EUMETCast FTP UMARF | GRIB NetCDF | 2 h | 60S-60N 135W-15W | 1 h + daily integrated | 0.05° |

## 2.3 Sea surface vector wind products

*"Ocean surface vector winds (OSVW) are used to estimate momentum transfer (surface stress) between the atmosphere and ocean, and are critically important for determining the large scale ocean circulation and transport."*[Bourassa et al 2010]. The OSI SAF is producing state of the art level 2 products based on the ASCAT (EUMETSAT Polar System) and Seawinds scatterometer instruments. Table 3 summarizes the characteristics of the products.

***Table 3 The EUMETSAT OSI SAF ocean surface vector wind products.***

| Reference | Product Name | Product acronym | Characteristics and Methods | Input Satellite data | Dissemination Means | Format | Timeliness | spatial coverage | generation frequency | spatial resolution |
|---|---|---|---|---|---|---|---|---|---|---|
| OSI-101 | SeaWinds 25km Wind | SeaW25 | wind speed (m/s) and direction (degrees). Sigma0's and swath winds | SeaWinds | EUMETCast FTP UMARF | BUFR, NetCDF | 3 h 30 | Global | Continuous | 25 km |
| OSI-110 | SeaWinds 100km Wind | SeaW100 | wind speed (m/s) and direction (degrees). Sigma0's and swath winds | SeaWinds | EUMETCast FTP UMARF | BUFR, NetCDF | 3 h 30 | Global | Continuous | 100 km |
| OSI-102 | ASCAT 25 km Winds | ASCAT25 | wind speed (m/s) and direction (degrees). Sigma0's and swath winds | ASCAT | EUMETCast FTP UMARF | BUFR, NetCDF | 2 h 45 | Global | Continuous | 25 km |
| OSI-103 | ASCAT 12.5 km Winds | ASCAT12 | wind speed (m/s) and direction (degrees). Sigma0's and swath winds | ASCAT | EUMETCast FTP UMARF | BUFR, NetCDF | 2 h 45 | Global | Continuous | 12.5 km |
| OSI-104 | ASCAT coastal Winds | ASCAT12+ | wind speed (m/s) and direction (degrees). Sigma0's and swath winds | ASCAT | EUMETCast FTP UMARF | BUFR, NetCDF | 2 h 45 | Global | Continuous | 12.5 km |

The operational production of the OSI SAF SeaWinds product has stopped in November 2009 with the end of lifetime of the QuikSCAT mission.

The ASCAT Coastal Wind Product (OSI-104) is still in development, see also section 3.

## 2.4 Sea Ice Products

"*Sea ice data from satellites represent one of the longest earth observation records from space. The variations in temperature, emissivity and reflectivity of sea ice and the differences compared to the surrounding open ocean make it an ideal application of remote sensing. Several techniques and instruments have been developed and successfully utilized and today it is impossible to imagine operational sea ice monitoring and analysis without satellite data.*" [Breivik et al, 2010]. The OSI SAF is producing state of the art products for both the Arctic and Antarctic. Table 3 summarizes the characteristics of the products.

***Table 4 The EUMETSAT OSI SAF sea ice products.***

| reference | Product Name | Product acronym | Characteristics and Methods | Input Satellite data | Dissemination Means | Format | Time liness | spatial coverage | generation frequency | spatial resolution |
|---|---|---|---|---|---|---|---|---|---|---|
| **OSI-401** | Global Sea Ice Concentration | GBL SIC | Fractional ice cover in percentage. Multisensor analysis. | SSM/I, SSMIS, | EUMETCast FTP UMARF | GRIB NetCDF HDF5 | 5 h | Global | 1 day | 10km |
| **OSI-402** | Global Sea Ice Edge | GBL SIE | Discrimination Open ice/Closed ice/No ice. Multisensor analysis | SSM/I, SSMIS, ASCAT, AMSR | EUMETCast FTP UMARF | GRIB NetCDF HDF5 | 5 h | Global | 1 day | 10 km |
| **OSI-403** | Global Sea Ice Type | GBL SIT | Discrimination First year, Multi year. Multisensor analysis | SSM/I, SSMIS, ASCAT, AMSR | EUMETCast FTP UMARF | GRIB NetCDF HDF5 | 5 h | Global | 1 day | 10 km |
| **OSI-404** | Global Sea Ice Emissivity | GBL SIEM | Multisensor analysis | SSM/I, SSMIS, ATOVS, AMSR | EUMETCast FTP UMARF | GRIB NetCDF HDF5 | 5 h | Global | 1 day | 10 km |
| **OSI-405** | Low Resolution Sea Ice Drift | GBL LR SID | km. Single and multi sensor analysis. Displacement after 48 hours. | ASCAT, AMSR, SSM/I, SSMIS | EUMETCast FTP UMARF | NetCDF (GRIB if requested) | 6 h | Global | 1 day | 62.5 km |
| **OSI-406** | Regional Sea Ice Edge | REG SIE | discrimination Open Ice/closed Ice/no Ice. Multisensor analysis | AVHRR VIIRS | EUMETCast FTP UMARF | GRIB NetCDF HDF5 | 3 h 30 | Regional | 12 h | 1.5 km |
| **OSI-407** | Medium Resolution Sea Ice Drift | GBL MR SID | Km Single sensor analysis. Displacement after 24 hours. | AVHRR | EUMETCast FTP UMARF | NetCDF (GRIB if requested) | 6 h | Global | 1 day | 20 km |
| **OSI-408** | Global AMSRE Sea Ice Concentration | GBL AMSR SIC | Fractional ice cover in percentage. | AMSR | EUMETCast FTP UMARF | GRIB NetCDF HDF5 | 5 h | Global | 1 day | 10km |
| **Osi-409** | Global reprocessed Sea Ice Concentration | GBL REP SIC | Fractional ice cover in percentage | SMMR, SSM/I | FTP | NetCDF | Offline | Global | 1 day | 10km |

***Table 5 Altimeter products in near real time.***

| *Mission* | *Prod Name* | *Param.* | *Spacing of observ.* | *Source* | *Access point* | *Format* |
|---|---|---|---|---|---|---|
| *Jason-2* | ***OGDR*** | *Global SWH, wind speed, Height* | *6 km along track* | *EUMETSAT+ NOAA* | *EUMETCast/ NOAA DDS* | *netCDF* |
| *Jason-2* | ***OGDR-BUFR*** | | | | *EUMETCast/ NOAA DDS/ GTS* | *BUFR* |
| *Jason-2* | ***OGDR-SSHA*** | | | | *EUMETCast/ NOAA DDS* | *netCDF* |
| *Jason-1* | ***OSDR*** | *Global SWH, wind speed* | *6 km along track* | *CNES* | *EUMETCast/ AVISO ftp / NASA JPL ftp* | *netCDF* |
| | | | | *Meteo-France (encoding)* | *EUMETCast/ GTS* | *BUFR* |
| *ENVISAT* | ***RA_WWV*** | *Global SWH, wind speed* | *7 km along track* | *ESA* | *ESRIN ftp/ GTS (expected soon)* | *ENVISAT format/ BUFR* |

## 3 Altimetry products in near real time

*"Observations of the surface topography – together with complementary in situ observations collected within the ocean by systems such as Argo – are central to understanding the dynamics of the global oceans, assessing their role in climate, and sustaining a robust operational forecast capability."* [Wilson et al. 2010]. Within the Jason-2 program EUMETSAT together with NOAA is providing the Operational Geophysical Data Records (level 2 products) in near real time, see Table 5. It has to be noted that the OGDR services are of key importance for the operational sea state monitoring as for example done with coupled wave atmosphere models.

The Operation Service Specification for the Jason-3 mission is currently in draft, but in essence the product suite as provided from the Jason-2 mission will be continued.

# 4 Product developments

## 4.1 Coastal products

In recent years, in a general sense, there has been strong emphasis in satellite oceanography to process the observational data closer to the coast. In many cases several instrumental and coastal physical constraints have to be dealt with. Examples are the wind product (OSI-104) has given in table 3, and new re-tracking algorithms that are developed for the altimetric measurements. These activities will results in updated or dedicated products.

## 4.2 Climate Products.

The enhanced need for climate monitoring drives several already started or planned re-processing activities within the EUMETSAT programs and in the OSI SAF with the goal of providing dedicated climate products. It is beyond this paper to describe this in detail.

# 5 Third Party products

EUMETSAT together with partners and the OSI SAF are heavily involved to relay now and in the near future near real time products from third party missions to its user community. For example Table 5 provides details of the altimeter products which are re-distributed via EUMETCAST.

# 6 Conclusions

EUMETSAT is providing a broad variety of operational and pre-operational satellite-based ocean products with the related operational services. For most ocean variables the product services comprise level 1 and level 2 products. Dissemination is dominantly done via EUMETCAST, GTS and FTP. The current collection of products includes those of the highest priority for NWP, marine meteorology and operational oceanography with realistic ocean models only, e.g., sea surface temperature, ocean surface vector winds, sea surface heights and sea ice products.

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