Ocean & Sea Ice SAF

Surface Solar Irradiance Product Manual

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DOCUMENT SIGNATURE TABLE

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DOCUMENTATION CHANGE RECORD

Issue / Revision	Date :	Change :	Description :
Version 1.0	18/06/01		First version.
Version 1.1	27/11/01	Normal	Updated version : - Appendix A : correction in the description of the quality index content

Version 1.2	04/10/02	Normal	Updated version, prepared for DFR close-out : - § 2.1 updated (PUM3_deSmet_101) - § 2.2 updated (PUM3_deSmet_101) - § 3.2.2 updated (cloud info re-mapping) (PUM3_deSmet_082) - § 3.6 updated (PUM3_deSmet_084 and 101) - § 3.7 updated (visual examination) (PUM3_deSmet_083) - § 4.2.1 updated (PUM3_deSmet_101) - § 4.6 updated (PUM3_deSmet_085 and 101) - Annex A updated (PUM3_deSmet_101) - Annex D updated (PUM4_deSmet_102) - Figure 2 corrected - § 4.8 added : O&SI SAF website presentation - Annex G added : help in reading HDF format

Issue / Revision	**Date :**	**Change :**	**Description :**
Version 1.3	13/07/04	Normal	Updated version - § 1.1 updated to take into account new ftp server : ftp.meteo.fr - § 1.2 updated - § 2.1 updated - § 2.2 GOES-12 replaces GOES-8 - § 2.3 new § specific to MSG - § 2.4 new references - § 3.7 updated - § 4.6 more stations, new figures 3, 4, 5 - § 4.7 new figure 6 - § 4.8 description of new Website : www.osi-saf.org - Appendix F updated
Version 1.4	01/04/2005	Normal	- in § 4.4 : *and HDF format* replaced by and Météo-France ftp server, under Net CDF and HDF formats*

Version 1.5	14/11/2005	Normal	Convention file for the dissemination of the product via EUMETCAST added in appendix H - Mention of the Quarterly Reports and long term Validation Reports in § 4.6

CONTENT

1. Introduction

1.1. Overview

This document is one of the product manuals dedicated to the O&SI SAF products users. The main content of these manuals is a description of the product content and format. They also briefly review the algorithms used and the processing methods adopted. The present manual describes the Atlantic SSI products, which cover the Low and Mid Latitudes (LML) area with 3-hourly products, and the Merged Atlantic Product (MAP) area with daily products.

The Ocean & Sea Ice Satellite Application Facility (O&SI SAF) is producing on a preoperational basis a range of air-sea interface products, namely: wind, sea ice characteristics, Sea Surface Temperatures (SST) and radiative fluxes, Surface Solar Irradiance (SSI) and Downward Longwave Irradiance (DLI).

SST, SSI and DLI products are available within 2 hours after the last satellite data acquisition over the following grids:
NAR: Near Atlantic Regional, six areas at 2 km resolution
LML: Low and Mid Latitudes, 100W - 45E and 60N - 60S, at 0.1 degree resolution
MAP: Merged Atlantic Products, 100W - 45E and 89.9N - 60S, at 0.1 degree resolution.

NAR products are derived from NOAA polar orbiter data, LML products from the geostationary satellite data (GOES on the western area, MSG on the eastern area), and MAP products from the geostationary and polar orbiter data (in the northern area). The time samplings corresponding to these grids are shown below:

	NAR	LML	MAP
SST	Every 6 h	**3 hourly**	**12 hourly**
SSI		3 hourly	24 hourly
DLI		3 hourly	24 hourly

These products are delivered in GRIB format throught Météo-France FTP server ftp.meteo.fr , in HDF and NETcdf format through the IFREMER server ftp://ftp.ifremer.fr/pub/ifremer/cersat/SAFOSI and in GRIB format through the Regional Meteorological Data Communication Network (RMDCN) to the European Meteorological services. Access to data on ftp.meteo.fr is free but subject to prior user registration on the OSI SAF Web site.
Moreover MAP SST is delivered in GRIB format via EUMETcast.
See also the OSI SAF Web site www.osi-saf.org for real time images of the products and updated information.

Section 2 presents the algorithm, section 3 the processing scheme and section 4 the data files. In the present version, the algorithm and processing scheme of NOAA polar orbiter data are not described.

1.2. Glossary

ATL Atlantic
AVHRR Advanced Very High Resolution Radiometer
CERES Clouds and Earth's Radiant Energy System
CMS Centre de Météorologie Spatiale

DLI	Downward Longwave Irradiance
DMI	Danish Meteorological Institute
DNMI	Det Norske Meteorologiske Institutt (now Met.no)
ECMWF	European Center for Medium range Weather Forecast
GOES	Geostationary Operational Environmental Satellite
GRIB	Gridded Binary format
HDF	Hierarchical Data Format
HL	High Latitudes
IFREMER	Institut Français de Recherche pour l'Exploitation de la Mer
IR	Infrared
LML	Low and Mid Latitudes
LMD	Laboratoire de Météorologie Dynamique
MAP	Merged Atlantic Products
MDB	Match up Data Base
Met.no	Norske Meteorologiske Institutt (Norvegian Meteorological Institute)
MSG	Meteosat Second Generation
NAR	Near Atlantic Regional
NOAA	National Oceanic and Atmospheric Administration
NWC SAF	Nowcasting and very short range forecasting SAF
O&SI SAF	Ocean and Sea-Ice SAF
RMDCN	Regional Meteorological Data Communication Network
SAF	Satellite Application Facility
SEVIRI	Spinning Enhanced Visible and Infrared Imager
SSI	Surface Solar Irradiance
SST	Sea Surface Temperature
TOA	Top of atmosphere
UT	Universal Time

2. Algorithm

The O&SI SAF algorithm is a physical parameterization applied separately to every pixel of a satellite image to derive an instantaneous field of the Solar Surface Irradiance. This section presents the basic equations of the method and those specific to a given satellite (only GOES-8, at present). The method uses several parameters that may vary in the operational scheme lifetime; they are designated by a name in capital letters. Their present and past values can be found in the configuration file available on the O&SI SAF website (see also 4.5 and appendix E). This section gives some values used in 2001 mainly as examples.

2.1. Equations

The main input for SSI calculation is the satellite visible image and the various steps of the method are the following.

Calibration

This step, which converts the satellite visible count into a bi-directional reflectance, depends on the considered radiometer channel. It concerns the unique visible channel of GOES and two channels, visible and near infrared, for MSG. The formulation of equation (1) depends on the instrument and will be presented in the following paragraphs.

$$L_{sc} = L_{sc}(t, C) \quad (1)$$

$$R_{nb} = L_{sc} / [\nu(j) \cos(\theta_0)] \quad (2)$$

$$\nu(j) = 1 + 0.0334 \cos[2\pi (j-2) / 365.25] \quad (3)$$

with

- C : radiometer count
- t : current time (julian day)
- θ_0 : sun zenith angle
- $\nu(j)$: corrective term accounting for the Earth-sun distance seasonal variation, j is the day of year
- L_{sc} : scaled radiance i.e. radiance divided by the “effective solar constant”, which is the solar spectral irradiance convoluted with the radiometer filter
- R_{nb} : narrowband reflectance

Narrow to broadband conversion

The reflectance relative to the narrow band of the radiometer spectral filter is converted into the reflectance relative to the broadband of the solar spectrum. This step is satellite dependent, only one channel being available for GOES and two for MSG. It also depends on the scene type, for instance vegetation, desert, ocean or cloud.

Anisotropy correction

The broadband bi-directional reflectance is converted into the planetary albedo, which is independent of satellite viewing angle. This step is based on the Manalo-Smith et al. 1998 formulas (derived from Earth Radiation Budget Instrument data), where the anisotropic factor is an analytical function of the viewing angles depending on the scene type.

$$A(\theta_0) = R / f_{aniso} \quad (4)$$

with

- A : Top Of Atmosphere (TOA) albedo or planetary albedo

R : broadband reflectance

f_{aniso} : anisotropic factor or bi-directional reflectance function (BDRF)

Clear sky parameterization

This step uses the Frouin and Chertock, 1992 parameterization, where the atmospheric transmittance is an analytical formula depending on the satellite and sun zenith angles, the integrated water vapor content of the atmosphere, ozone content, horizontal visibility and surface albedo (for the multiple scattering corrective term).

$$E = E_0 \, \nu(j) \cos(\theta_0) \, T_a \qquad \text{in clear case} \qquad (5)$$

with

E : surface solar irradiance

E_0 : solar constant

T_a : clear sky atmospheric transmittance (with multiple scattering)

Cloudy sky parameterization

This step uses a physical parameterization of the SSI as a function of the planetary albedo and the basic equations are given below (see Brisson et al., 1999 for more details).

$$E = E_0 \, \nu(j) \cos(\theta_0) \, T_1 \, T_{cl} \qquad \text{in cloudy case} \qquad (6)$$

$$T_{cl} = T_c \, / \, (1 - T_{bc} A_s \, . \, A_c) \qquad (7)$$

$$T_c = 1 - A_c - A_c \, m \cos(\theta_0) \qquad (8)$$

$$A = A_{ray} + T_{2top} A_c + A_S T_2 T_c^2 \, / \, (1 - T_{bc} A_s \, . \, A_c) \qquad (9)$$

with

T_1 : sun-surface atmospheric transmittance, without multiple scattering (consistent with T_a)

T_2 : sun-surface-satellite transmittance

T_{2top} : sun-cloud-satellite transmittance

T_{bc} : transmittance below cloud (to account for multiple scattering)

A_{ray} : Rayleigh albedo

A_s : surface albedo

A_c : cloud albedo

T_c : cloud transmittance

T_{cl} : cloud factor

m : cloud absorption factor

The sea surface albedo can be calculated theoretically, while the land surface albedo is derived from an atlas. Both of them vary with respect to the sun zenith angle. The Briegleb et al., 1986 formulas are used:

land $A_s = A_s(0) \, (1+2d) \, / \, (1+2d \, \mu_0)$ $d = 0.4$ (10)

sea with clear sky : $A_s = 0.026/(0.065 + \mu_0^{\,1.7}) + 15.0(\mu_0 - 0.1)(\mu_0 - 0.5)(\mu_0 - 1.)$ (11)

sea with cloudy sky : $A_s = 0.06$ (12)

where $\mu_0 = \cos(\theta_0)$

The method is based on already published parameterizations except for one parameter, the cloud absorption factor (m in equation (8) or PAF_PAR_MABSCLD), which has been tuned on GOES-8 data. The calibration of GOES-8 against Meteosat-7 visible channel is presented in Le Borgne et al., accepted in 2004. It should be noted that the tuned value (m = 0.11) is not fully independent from the satellite calibration.

2.2. GOES-12 specific

Calibration of GOES-12 visible channel

In the case of GOES-12, the calibration equation, (1), is written as follows:

$$L_{SC} = \alpha \, [\, 1 + \beta \, (t - t_0) \,] \, (C - C_0) \qquad (1a)$$

with

- C : radiometer count
- C_0 : radiometer space count
- α : calibration coefficient valid at t_0 ($count^{-1}$)
- β : radiometer drift ($count^{-1}$ day^{-1})
- t_0 : reference time (julian day)
- t : current time (julian day)

There is no absolute calibration of GOES-12 visible channel, available from NOAA in real time. The CMS operational scheme, which ingests and pre-processes GOES-12 data, uses the pre-launch calibration coefficients, available in Weinreb and Han, 2000 (they slightly differ for the eight detectors of the visible channel).

GOES-12 visible channel has been inter-calibrated against Meteosat-7 visible channel, using data at 37.5W around local noon, Meteosat-7 visible channel being calibrated with a reference value based on CERES shortwave radiances and a drift estimated by monitoring desert targets (Le Borgne et al., accepted in 2004). The GOES-12/Meteosat-7 comparison period, April to September 2003, was not long enough to estimate the radiometer drift, but only a mean corrective factor of 1.07, which leads to the following coefficients:

α = pre-launch values PAF_PAR_FCORCALIB PAF_PAR_FCORCALIB = 1.07
β = PAF_PAR_DRIFTCALIB = 0.
t_0 = PAF_PAR_TREFCALIB = 19523 i.e. 15 June 2003
(day 0 = January 1st, 1950 at 00:00 UT)

Narrow to broadband band conversion

As proposed in Pinker and Lazlo, 1992, this conversion is made with a linear formula :

$$R = M \, R_{nb} + B \qquad (13)$$

where the M and B coefficients depend on the scene type. Instead of one type "cloud" as in Pinker and Lazlo, 1992, several types of clouds have been introduced, since the reflectance of fractional and semi-transparent clouds vary with the underlying surface.

	ocean	vegetation	desert	cloud over ocean	cloud over vegetation	cloud over desert
M	0.916	0.851	0.854	0.817	0.763	0.763
B	0.005	0.091	0.000	0.003	0.058	0.058

Table 1: narrow to broadband band coefficients.

The clear cases coefficients have been deduced from simulation results using Modtran 3.5, however, they are not used in the present scheme (as explained in 3.2.3). Both simulation results and GOES-8/Meteosat-7 comparison results at 37.5W, over ocean and over Brazil, have been used to obtain coefficients, "cloud over ocean" and "cloud over vegetation", respectively. The "cloud over desert" coefficients are the same as those of "cloud over vegetation", simply because no data were available to obtain specific values over desert. The coefficients obtained with GOES-8 data are used for GOES-12 data.

2.3. MSG-1 specific

Calibration of SEVIRI visible channel

At present, the SSI is derived from the 0.6µm visible channel of SEVIRI. According to Rogers and Pili, 2001 and to Pili, 2002 (personal communication), the calibration equation, (1), can be written as follows:

$$L_{SC} = (cal\_offset + cal\_slope\ C) / f \qquad (1b)$$

with

C : radiometer count
cal_offset : calibration offset of SEVIRI level 1.5 header, in mW m^{-2} sr^{-1} $(cm^{-1})^{-1}$
cal_slope : calibration slope of SEVIRI level 1.5 header, in mW m^{-2} sr^{-1} $(cm^{-1})^{-1}$
f : radiance to reflectance factor, f= 21.21 mW m^{-2} sr^{-1} $(cm^{-1})^{-1}$ for the 0.6µm channel (Pili, 2002, personal communication)

The calibration coefficients of SEVIRI level 1.5 data are updated several times per year, as a result of the vicarious calibration method presented in Govaerts and Clerici, 2003. However, the correspondence between the level 1.5 values and those in Govaerts and Clerici, 2003 has not been explicitly presented and is not straightforward (different units, intermediate constants not given and, likely, different offset calculation).
The radiometer drift is taken into account in the level 1.5 calibration coefficients, so the SAF O&SI corrective parameter are simply:
PAF_PAR_FCORCALIB=1.0
PAF_PAR_DRIFTCALIB=0.0

Narrow to broadband band conversion

The coefficients obtained for GOES-8 visible channel are presently used for SEVIRI 0.6 µm channel. This step may evolve in the future, by changing the coefficient values or by deriving the broadband reflectance from the two visible channels of SEVIRI (0.6 µm and 0.8 µm).

2.4. References

Briegleb B. P., P. Minnis, V. Ramanathan and E. Harrison, 1986, Comparison on regional clear-sky albedos inferred from satellite observations and model computations, Journal of Climate and Applied Meteorology, 25, 214-226.

Brisson, A., P. LeBorgne, A. Marsouin, 1999, Development of algorithms for Surface Solar Irradiance retrieval at O&SI SAF low and Mid Latitude, February 1999. Météo-France/DP/Centre de Météorologie Spatiale, BP 147, 22302 Lannion, France.

Frouin R. and B. Chertock, 1992, A technique for global monitoring of net solar irradiance at the ocean surface. Part 1: Model, Journal of Applied Meteorology, 31,1056-1066.

Govaerts Y.M. and M. Clerici, 2003, Operation Vicarious calibration of the MSG/SEVIRI Solar Channels, EUMETSAT Meteorological Satellite Data Users' conference, Weimar, Germany, 29.09-03.10 2003, pp 147-154.

Le Borgne Pierre, Gérard Legendre and Anne Marsouin, accepted in 2004, Meteosat And GOES-East Imager Visible Channel Calibration, to appear in Journal of Atmospheric and Oceanic Technology.

Manalo-Smith N., G.L. Smith, S. N. Tiwari and W.F. Staylor, 1998, Analytic forms of bidirectional reflectance functions for application to Earth radiation budget studies, Journal of Geophysical Research, Vol. 103, D16, pp. 19,733-19,751, August 27, 1998.

Pinker, R.T., and Laszlo, I., 1992, Modeling surface solar irradiance for satellite applications on global scale, Journal of Applied Meteorology, 31, 194-211.

Rogers C. and P. Pili, 2001, Meteosat Second Generation Level 1.5 Image, Data Format Description, EUM/MSG/ICD/105 Issue2, November 2001.

Weinreb, M. and D. Han, 2000: Calibration of the Visible Channels of the GOES Imagers and Sounders, revised August 2000. [Available online at http://www.oso.noaa.gov/GOES/GOES-calibration.]

3. Processing scheme

3.1. Overview

The delivered SSI products are 3-hourly products on LML area, derived from the geostationary satellite data (GOES and MSG) and daily products on MAP area, derived from GOES, MSG and NOAA polar orbiter satellite data.

This section fully describes the geostationary satellites processing scheme and presents also the merging with the High Latitude (HL) products. GOES or MSG images are processed every hour, producing instantaneous solar irradiance fields. These instantaneous fields are called hourly SSI, because of their time sampling. The hourly SSI fields are combined to produce 3-hourly and daily SSI fields. All these tasks (sections 3.2 to 3.4) are performed separately for each satellite, GOES or MSG and the mono-satellite products are merged afterwards (section 3.5). The validation and quality control, which concern mono-satellite or multi satellite products, are presented in sections 3.6 and 3.7.

Each SSI field (hourly, 3-hourly or daily, mono or multi-satellite) is associated with a quality index, which includes a confidence level corresponding to the quality of the calculated SSI and information on the processing conditions. The quality index is mentioned in this section, when needed, but is described in section 4.3.

In the LML area, the SSI products cover both ocean and land. Calculations over land are needed for the validation, since the pyranometer stations are essentially in land. The algorithm and processing scheme have been developed for ocean and “normal” land. The calculated SSI may be erroneous over mountains, desert, ice or permanent snow.

The method uses several parameters that may vary in the operational scheme lifetime, they are designated by a name in capital letters. Their present and past values can be found in the configuration file available on the website (see also 4.5 and appendix E). This section gives some values used in 2001 mainly as examples.

3.2. Hourly calculations

The hourly processing scheme combines the algorithm presented in chapter 2 and various auxiliary parameters (atlas, monthly climatology or instantaneous field). Figure 1 gives an overview of GOES scheme, which will be valid also for MSG. The working grid of the SSI hourly scheme is the LML grid. The visible image and cloud type are re-mapped onto this grid, as a first step, and all other data files in figure 1 are on the LML grid.

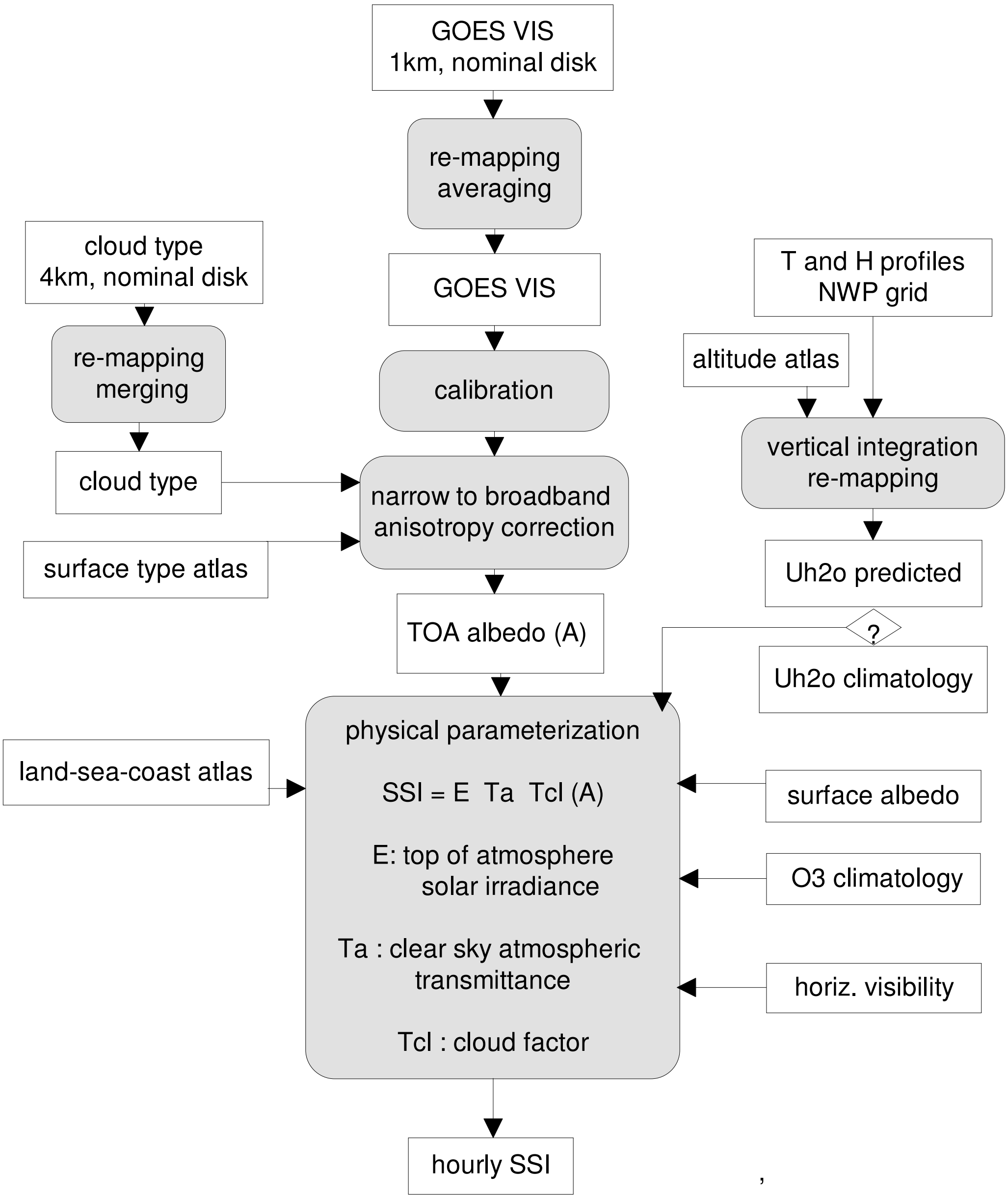

Figure 1: hourly SSI processing scheme

3.2.1. Re-mapping

GOES or MSG data, which are used as input of the hourly scheme, are in satellite projection, which is satellite dependent, but constant with time. Visible and infrared (IR) channels do not have the same resolution, at least for GOES. The IR resolution is the one adopted for the NWC SAF cloud products and is also the natural one for the Sea Surface Temperature and Downward Longwave Irradiance. Therefore, it is also used in the SSI scheme and the GOES visible images are first reduced to the IR resolution by averaging.

The LML grid is a linear scaling in latitude and longitude with a 0.1-degree resolution. The re-mapping from the IR satellite image to LML grid is made as follows: to each LML pixel is associated a set of IR pixels, weighted accordingly to their contribution to the coverage of the LML pixel. So the value of LML pixel will be the weighted average of several IR pixel values, this definition being straightforward for all quantitative parameters and more complicate for qualitative parameters like cloud type, for instance.

3.2.2. Auxiliary parameters

ATLAS

Land-sea-coast: contains land, sea and lake occurrences and the percentage of coverage by land. It has been derived from the World Vector Shoreline, which includes sea and lake coastlines, accessed through the freeware Global Mapping Tool.
The SSI scheme actually considers 3 types of pixels: “land” = only land, “sea” = sea or lake, “coast” = mixed, i.e. land and (sea or lake).

Altitude: contains a mean altitude derived from the global atlas GTOPO30 at 0.00833 degree resolution in latitude and longitude.

Surface type: contains the prevailing land cover type derived from a global atlas at 1/6 degree resolution of the CERES SARB Working Group (which contains 18 types).

MONTHLY CLIMATOLOGIC FIELDS

Surface albedo: contains monthly values over land of broadband surface albedo with sun at zenith, obtained by remapping of a monthly climatology at 0.144 degree resolution by Csizar and Gutman, 1999.

Water vapor content: contains monthly values of the atmospheric integrated water vapor content, derived from Ort monthly climatology of specific humidity profiles at 2.5 degree latitude and 5 degree longitude resolution and from the altitude atlas.
This climatology is used only if the predicted water vapor content field is missing.

Ozone: contains monthly values of ozone content, built from monthly fields of Total Ozone Mapping Spectrometer data on the period January 81 to December 92 at about 1 degree resolution.

Visibility: contains monthly value of the horizontal visibility; at present, they are simply latitude and month dependent according to the figure 5 in Stuhlman et al, 1990.

INSTANTANEOUS FIELDS

Predicted water vapor content: contains predicted values at 0, 6, 12 or 18h UT of the atmospheric integrated water vapor content, derived from predicted temperature and humidity profiles and from the altitude atlas. The predicted profiles are 12 and 18-hour range forecasts on a 1.5-degree resolution grid, obtained twice daily from Meteo-France Numerical Weather Predicting model ARPEGE. The SSI scheme used the water vapor content field closest in time to the satellite image, which is dated by its rounded central time.

Cloud type&cover: contains the prevailing cloud type, i.e. covering more than 50% of the pixel, and the cloud cover of the pixel. There may be no prevailing type. The cloud cover is a “total” coverage, by all cloud types. It is coded from 0 to 10:

0 <=> [0,10%[1 <=> [10%,20%[… 9 <=> [90%,100%[10 <=> 100%

The original cloud type field contains the NWC SAF detailed cloud types in satellite IR projection. The NWC SAF classification is presented in Derrien and Le Gléau, 1999, and fully explained in Le Gleau and Derrien, 2000. The detailed cloud types are merged into simplified cloud types in satellite projection (as explained in the DLI Product Manual), then the prevailing cloud type and cloud cover are calculated on the LML grid.

The calculation and re-mapping, which are made simultaneously, are summarized below.

The LML pixel corresponds to a weighted average of several satellite IR pixels (see 3.2.1), each IR pixel being covered by only one cloud type. Each LML pixel is processed as follows:

Cloud cover calculation
The cloud coverage of an IR pixel is defined as 0 for "clear sky", 0.5 for "fractional cloud" and 1 for all other types. This cloud coverage is a quantitative parameter and its weighted average over the IR pixels gives the LML pixel cloud cover.

Prevailing cloud type calculation
The LML pixel coverage by a given cloud type is the sum of the weights of the IR pixels having this cloud type divided by the sum of all IR pixel weights. If there is a cloud type for which this ratio is higher 0.5, this type is the prevailing cloud type; otherwise there is no prevailing cloud type.

3.2.3. Cook-book

This section explains how the algorithm presented in section 2 is applied in the actual image.

The SSI calculation is attempted only if the following conditions are true:
solar zenith angle =< PAR_ZENSOL_MAX = 80 degrees
satellite zenith angle =< PAR_ZENSAT_MAX = 75 degrees

Land / sea
The nature of a pixel as "land" or "sea" depends on its nature in the land-sea-coast atlas and also on its surface albedo (of the month):
sea = sea-in-atlas or (coast-in-atlas and As(0) < PAR_COAST_ALB_THRESHOLD)
land = land-in-atlas or (coast-in-atlas and PAR_COAST_ALB_THRESHOLD =< As(0))
with PAR_COAST_ALB_THRESHOLD = 0.05

Sea surface albedo
It is calculated by weighting the clear and cloudy sky sea albedo formulas, equations (11) and (12), according to the total cloud cover of the pixel (x, varying from 0 to 1) .

$$A_S = (1 - x) A_{sea\_clear}(\theta_0) + x A_{sea\_cloudy} \quad (14)$$

Clear / cloudy
The cloud cover is used to separate clear and cloudy cases, as follows:
- if cloud cover < 10% the pixel is considered as "clear"
  the clear sky scheme is used, even in case of sun glint
- else the pixel is considered as "cloudy"
  the cloud sky scheme is applied.

Narrow to broad band conversion
This conversion is needed only for the cloudy pixels, which enter the cloudy sky scheme, however it is made for all pixels in order to allow a future evolution of the method. The conversion is based on table 1 coefficients, the cloudy pixels are simply considered as "cloud", while the clear pixels are separated into "ocean", "vegetation" and "desert" according to their land/sea nature (defined above) and to the surface type atlas for the vegetation/desert separation.

Anisotropy correction
This correction is made only for the cloudy pixels, which enter the cloudy sky scheme. Manalo-Smith's paper gives formulas for various scene types, the scene type is chosen according to the pixel nature and cloud information, as indicated below:

scene type	choice criteria
partly cloudy over ocean	sea and (10% =< cloud cover < 70% or prevailing type is thin cirrus)
mostly cloudy over ocean	sea and (70% =< cloud cover < 100% and prevailing type is not thin cirrus)
overcast	sea and (100% = cloud cover and prevailing type is not thin cirrus) or land and 10% =< cloud cover

Table 2: choice criteria for the scene type of the anisotropy correction

3.2.4. Sun glint

The "sun glint" effect is the increase of the sea reflectance occurring with clear sky for viewing angles close to the specular reflection (same sun and satellite zenith angles and sun, satellite and viewed point in a vertical plane). A quality index is associated to the NWC SAF cloud type and contains a flag to indicate sun glint conditions. So, a flag indicating occurrence of sun glint in the LML pixel can be defined, when re-mapping the cloud type. When the sun glint flag is on, a specific scheme is applied, as explained below.

The Manalo-Smith formula for ocean (we use the formula called "clear ocean[a]") permits to calculate a theoretical bi-directional reflectance of the sea, R_{sea}. The value of this reflectance together with the cloud cover are used to separate the sun glint cases into two types:

- **If R_{sea} < 0.2 or (60% =< cloud cover < 90% and prevailing type not thin cirrus)** **"weak sun glint effect"**: the theoretical reflectance is not too high or the pixel is rather cloudy. The anisotropy correction according to "mostly cloudy over ocean" is supposed to work correctly and the usual SSI scheme is applied.

- **Else,** "**critical sun glint effect**": The anisotropy correction on a mixed pixel, cloud and sea, seems questionable in these conditions and the usual SSI scheme is not applied. The cloud cover x and R_{sea} are used to derive the reflectance of the cloudy part of the pixel by:

$$R_{cloud} = [\ R - (1 - x)\, R_{sea}\ ]\ /\ x \qquad (15)$$

  - If $R_{cloud} > 0.2$: R_{cloud} seems valid and is converted into albedo using Manalo-Smith anisotropy coefficient for the type "overcast", f_{aniso_ovc} :

$$A_{cloud}(\theta_0) = R_{cloud} / f_{aniso\_ovc} \qquad (16)$$

  - Else, a typical cloud having a TOA albedo of 0.5 at zenith is assumed; it is corrected to the actual θ_0 by:

$$A_{cloud} = 0.5\ (\ A_{ovc}(0)\ /\ A_{ovc}(\theta_0)\ ) \qquad (17)$$

  where $A_{ovc}(\theta_0)$ is Manalo-Smith albedo formulation for the type "overcast"
  In that case, the calculated SSI fully depends on the cloud type&cover.

Finally, the SSI of the cloudy part, E_{cloud}, is derived from A_{cloud} by the cloudy parameterization and the SSI of the clear part, E_{clear}, is calculated by the clear sky parameterization and are combined as follows:

$$E = (1 - x)\, E_{clear} + x\, E_{cloud} \qquad (18)$$

3.3. 3-hourly calculations

The 3-hourly SSI fields are calculated separately for GOES and MSG data. A 3-hourly value is simply the average of three valid hourly values. Some value may be null near the sunset or sunrise time. If one hourly value is missing because of a failure of the hourly scheme, then the 3-hourly SSI is missing also.

The 3-hourly SSI (and DLI) products are the average fluxes calculated on the 3h periods between two consecutive SST fields, this timing choice being consistent with the use of the products by numerical model. As the 3-hourly SST are centered at 1:00, 4:00, 7:00, 10:00 ,… the 3-hourly SSI are centered at 2:30, 5:30, 8:30,11:30, … UT.

3.4. Daily calculations

The daily SSI fields are calculated separately for GOES and MSG data. The daily SSI is derived from the available hourly SSI values and the calculated sunrise and sun set times, independently for every pixel. The number of expected hourly values is determined by the one hour sampling and the condition θ_0 =< PAR_ZENSOL_MAX . Some hourly values may be missing, because of a whole image missing or of local failure in the hourly SSI scheme.

- **If** (two successive hourly values are missing
  or more than 50% of the expected hourly values are missing)
  the daily SSI is not calculated

- **Else**, each missing value is replaced by an interpolated value, which is obtained by a spline function or by a linear interpolation (if the spline interpolation fails). Then the daily SSI is obtained by the following equation:

$$E_d = [\ (t_1 - t_r + 1)/2\ E_h(t_1) + E_h(t_1+1) + \ldots + E_h(t_{n-1}) + (t_s - t_n + 1)/2\ E_h(t_n)\ ] / 24 \qquad (19)$$

with E_d : daily solar irradiance in W/m^2 , i.e. solar energy divided by the 24 hour period
E_h : hourly solar irradiance in W/m^2
t_r, t_s : sunrise and sunset times, in hours
t_1, t_n: times of the first and last hourly SSI (where $\theta_0 < 80$ degrees), in hours
Note that equation (19) assumes a one hour time step.

Solar day configuration

When $0 < t_r < t_s < 24$, the solar day is fully included in the UT day and applying equation (19) is straightforward. When $0 < t_s < t_r < 24$, there are two uncompleted solar days in the UT day, i.e. day 1 / night / day 2. In the LML area, the 2-day configuration occurs :

- on the eastern border, at 45E and about 60N or 60S: during the local summer only, day 1 is nearly complete and day 2 lasts about 15 min. This would not correspond to any MSG images useful for SSI calculation.

- on the western border, near 100W: a short day 1 and long day 2 are always observed, but in a seasonally variable area. At the equator, day 1 is about 20mn all year round. At mid-latitudes, day 1 only appears during the local summer. Day 1 duration reaches about 4 hours at 60N (and S), corresponding to only two GOES images useful for SSI calculations (where $\theta_0 < 80$ degrees).

A rigorous method would have been to replace equation (19) by two similar equations:
day 1 equation, starting by a term using $t_1 - 1$ and finishing by the sunset term ,
day 2 equation, starting by the sunrise term and finishing by a term using $t_n + 1$,
where $t_1 - 1$ and $t_n + 1$ are situated respectively in the previous and following UT days. Such a method would have complicated the processing scheme significantly, for a problem concerning a limited part of the processed area.

An approximate solution has been adopted, applying equation (19) with day 1 translated by 24 hours. This leads to an awkward interpolation between the SSI values at t_n and t_1, which is acceptable only because these SSI values are low.

3.5. Merging

The GOES and MSG 3-hourly or daily SSI fields are merged into a LML product and finally, the daily LML and HL products are merged into the MAP product. In overlapping areas, two satellite values are available and the merging process is a choice between them. Such a method can be easily applied to the product and to its quality index. The choice between the two satellite values mainly depends on the corresponding quality indexes, according to the following principles (to be applied when MSG and HL data are available).

GOES and MSG merging
The overlapping area is centered on the 37.5W, i.e. the middle of 75W for GOES and 0 for MSG, and its shape is shown in figure 2.

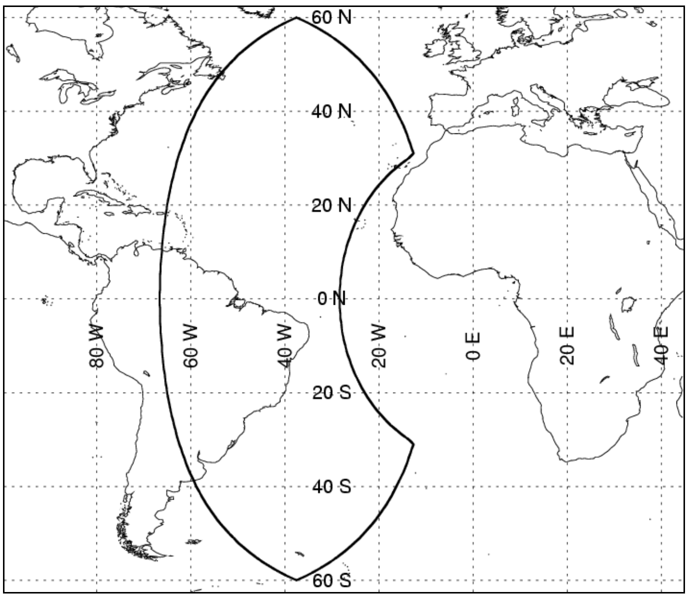

Figure 2: GOES/MSG overlapping area

The area limits correspond to GOES image edge, on the eastern border between 30S and 30N approximately, and, elsewhere to a maximum satellite zenith angle of 75 degrees.

The SSI value is chosen as follows:
- sun glint case is excluded, if possible
- best confidence level, if any
- GOES west of 37.5W and MSG east of 37.5W

LML/HL merging
The overlapping area is the 50N to 60N latitude band.
The SSI value is chosen as follows:
- best confidence level, if any
- HL value

3.6. Validation

A Match-up data base (MDB) including coincident pyranometer measurements and satellite data has been created for each satellite and is routinely updated in the processing scheme. There are actually three types of MDB (hourly, 3-hourly and daily) and each of them consists of elementary files that contain one day of data. This paragraph will not give a detailed description, but only present some essential characteristics.

The hourly MDB contains calculated and measured SSI data and, also, auxiliary or intermediate parameters of the SSI scheme, in order to assess the accuracy of the product, analyze the error and re-calculate the SSI with an improved algorithm. The measured SSI is a value centered on the time of the satellite data, obtained from several pyranometer measurements, by integration or interpolation (the original measurements being 3, 15 or 60 minute averages, depending on the network). The calculated SSI and its quality index are stored on a 0.3-degree square box centered on the pyranometer station (9 pixels) and the average on the box is compared to the hourly measurement.

The 3-hourly and daily MDB are simpler, since they only aim to assess the accuracy of the product. They essentially contain calculated SSI and quality index on the 9 pixel box and measured SSI, derived from the original pyranometer measurements, by integration or interpolation.

The MDBs are automatically updated in near real time for satellite data and monthly for pyranometer measurements, with a delay of about 50 days. Non automatic updates may occur with a longer delay, 6 months to one year, in case of numerous missing measurements. Statistics and graphics are produced automatically after each monthly update and some of them are available on the O&SI SAF website (see section 4.6 and Appendix F).

3.7. Quality control

The quality of the delivered products is controlled through a visual examination of the products and the automatic production of control parameters.

A visual examination has been made during several months after the start of the routine production. This visual examination can be considered as "experimental" since its main objective was to identify defaults in the processing scheme, program bugs and algorithm weaknesses. An expert has examined on a weekly basis, with a specific interactive tool, the SSI field, its quality index and some intermediate fields of the processing scheme**.** For instance, the following points were examined mainly on hourly fields and also on 3-hourly and daily fields:

- distribution of missing data
- bad confidence level: frequency, dependence on cloud type or location?
- do some artifacts appear in the sun glint area? between land and sea?

The results of the visual examination have been recorded in hand written documents and in word files.
The precise rules of the visual examination to be applied routinely are not yet defined.

The automatic control concerns each product of the SSI scheme (hourly, 3-hourly or daily, mono or multi-satellite) and calculates for each image, the confidence level distribution over the oceanic part of the image. This distribution associates to a given value of the confidence level the percentage of pixels having this value with respect to the number of sea pixels. These statistics are recorded in the information file for each file in GRIB format or in the HDF attributes for each file in HDF format (described in 4.4 and Appendix C and D) The individual information files are concatenated into compiled information files, separately for each type of product. Graphics showing the temporal evolution of the confidence level distribution are produced automatically (see examples in section 4.7).

3.8. References

Csiszar I. and G. Gutman, 1999 : mapping global land surface albedo from NOAA/AVHRR, JGR, vol. 104, N° D6, pp. 6215-6228.

Derrien M. and H. Le Gléau, 1999, Cloud classification extracted from AVHRR and GOES imagery, Proceedings of the 1999 EUMETSAT Meteorological Satellite Data Users' Conference, Copenhagen, 6-10 September 1999.

Le Gléau H. and Derrien M., 2000, Prototype Scientific Description for Meteo-France/CMS, February 2000, SAF/NWC/MFCMS/MTR/PSD, Issue 1, Rev.0.

Stuhlmann, R., M. Rieland and E. Raschke, 1990, An improvement of the IGMK Model to derive total and diffuse solar radiation at the surface from satellite data, Journal of Applied Meteorology 29, 586-603.

4. Data description

4.1. Overview

Data users have access to the following categories of data

For each 3-hourly LML product or daily MAP product:

- a SSI field,
- a quality index field,

These fields are coded in GRIB or HDF format. Each GRIB file is associated to a so called "global information file" presenting information relevant to the whole field. For HDF files, this information is in the HDF attributes.

For each satellite (GOES, MSG or NOAA):

- A configuration file providing the current and past processing information. The SSI and DLI processing schemes have a common configuration file.

For each type of product (i.e. 3-hourly LML or daily MAP)

- A validation statistic report, containing monthly results available since the beginning of the processing (statistic reports may be available separately for each satellite).
- A compiled global information file, i.e. concatenated individual global information files

This section describes the SSI products in 4.2, the quality indexes in 4.3 and briefly presents the data file formats in 4.4 and the other files in 4.5 to 4.7. Additional information can be found in Appendix A to F.

4.2. SSI products

4.2.1. Common characteristics

Physical definition

The SSI is the solar irradiance reaching the Earth surface in the 0.3-4 µm band, the irradiance being the radiant flux received per unit area. This defines an instantaneous SSI value, which corresponds to the definition of the hourly SSI. The 3-hourly and daily SSI values are mean values over the considered period of time, 3 or 24 hours.

NB: The 0.1 degree spatial resolution has been chosen for consistency with SST product but is not consistent with the 1, 3 or 24-hour resolution. A 0.2 or 0.3 degree resolution would be sufficient for the hourly and 3-hourly SSI and a larger one for the daily SSI.

Units

SSI values are expressed in tenths of in W/m^2 and coded in 16-bit words. Unprocessed data, for whatever reason, are equal to –32768 in HDF format or flagged as missing in GRIB section 3.

4.2.2. 3-hourly LML characteristics

Origin

The main input are hourly data of GOES or MSG visible channels at full resolution. Input data are first re-mapped onto the grid by averaging. The hourly SSI is calculated from a physical parameterization using auxiliary parameters (NWC SAF cloud type, predicted atmospheric water vapor content) and 3 hourly values are averaged into a 3-hourly SSI. The merging is made on the 3-hourly values, by choosing between the GOES and MSG values.

Range
The 3-hourly SSI expected range is 0 to 1000 W/m^2, the maximum value being approximate.

Geographical definition
Projection: linear scaling in latitude and longitude
Resolution: 0.1 degree in latitude and longitude
Size: 1451 columns, 1201 lines
Longitudes and latitude limits : 100W, 45E, 60N, 60S
Conversion of the pixel coordinates into the latitude and longitude of the pixel center:
Longitude = -100. + 0.1 (column - 1)
Latitude = 60. - 0.1 (line - 1)

4.2.3. Daily MAP characteristics

Origin
The main input are GOES, MSG or NOAA polar orbiter visible channels.
GOES or MSG: hourly visible channels at full resolution are first re-mapped onto the grid by averaging. The hourly SSI is calculated from a physical parameterization using auxiliary parameters (NWC SAF cloud type, predicted atmospheric water vapor content). The daily SSI is derived from the hourly SSI values and the calculated sunrise and sun set times.
NOAA polar obiter: the algorithm is very similar to the geostationary one but the input data have an irregular time sampling and the daily SSI is calculated in a polar strereographic grid at 1.5 km and the data are re-mapping by averaging afterwards.
The merging is made on the daily values by a two-step process, first GOES data with MSG data, then the results with NOAA data. Data from distinct satellites are not averaged together.

Range
The daily SSI expected range is 0 to 400 W/m^2, the maximum value being approximate.

Geographical definition
Projection: linear scaling in latitude and longitude
Resolution: 0.1 degree in latitude and longitude
Size: 1451 columns, 1500 lines
Longitudes and latitude limits : 100W, 45E, 89.9N, 60S
Conversion of the pixel coordinates into the latitude and longitude of the pixel center:
Longitude = -100. + 0.1 (column - 1)
Latitude = 89.9 - 0.1 (line - 1)

4.3. SSI Quality indexes

4.3.1. Common characteristics

Each SSI field (hourly, 3-hourly or daily, mono or multi-satellite) is associated with a quality index field, coded in 16-bit words. This index includes a confidence level corresponding to the quality of the calculated SSI and information on the processing conditions, which may have some interest to the user, the O&SI SAF team or both.

The confidence level scale is the same for all SST and radiative fluxes products. The pixels where the calculation has been attempted are labeled on a five level scale: 5 = “excellent”, 4= “good”, 3=”acceptable”, 2=“bad”, 1=“erroneous”, whereas the pixels where the calculation has not been attempted for normal reasons (out of the processed area, night for SSI, land for SST) have a distinct confidence level 0=“unprocessed”. The “erroneous” confidence level may be attributed to a parameter missing due to a failure of the algorithm or present but with a very low level of confidence.

This section explains the information included in the SSI quality indexes, but not the coding of the 16-bit word, which is described in Appendix A. The hourly index, which is not distributed, is presented since it directly contributes to the 3-hourly and daily indexes.

4.3.2. Hourly SSI quality index

The hourly index concerns GOES and MSG data, only, and is closely related to the processing scheme. The confidence level is mainly based upon the consistency between the SSI calculations and the cloud type&cover, which has been used as auxiliary input. The index contains additional information, such as clear or cloudy pixel or sun glint occurrence and indicates the failure cause, when no SSI has been calculated.

SSI algorithm failures

The SSI cloudy sky parameterization (equations (7) to (9)) leads to theoretical minimum and maximum values of the TOA albedo:

$$A_{min} = A_{ray} + A_S T_2 \qquad (19)$$

$$A_{max} = A_{ray} + T_{2top} / (1 + m \cos(\theta_0)) \qquad (20)$$

The SSI cloudy sky parameterization calculates the cloud factor, T_{cl}, as an intermediate parameter (equation (7)). The cloud factor varies from 0, for “maximum cloudiness”, A being equal to A_{max}, to 1, for clear case, A being equal to A_{min}. The maximum cloudiness corresponds to a total coverage by a very thick cloud that would be completely opaque. If the TOA albedo is not between A_{min} and A_{max}, the cloud factor cannot be calculated. Therefore, the SSI scheme works as follows:

range of TOA albedo	SSI scheme results
A < A_{min} - PAF_PAR_EPSAMIN	SSI algorithm fails
[A_{min} - PAF_PAR_EPSAMIN , A_{min}]	T_{cl} = 1, clear according to SSI scheme SSI calculated by equation (6)
] A_{min}, A_{max}[	0 < T_{cl} < 1 cloudy according to SSI scheme SSI calculated by equations (7) to (9)
[A_{max}, 1]	T_{cl} = 0, maximum cloudiness SSI = 0
1 < A	SSI algorithm fails

Table 3: hourly SSI scheme and TOA albedo

Confidence level

The consistency between the cloud factor and the cloud type&cover is defined as follows:

- If (0.8 =< T_{cl} and cloud cover = 100%
  and prevailing cloud type is low, medium or high opaque)
  “***high cloud factor inconsistent with prevailing cloud type***”

- else if T_{cl} =< 0.2 and cloud cover < 60%

"***low cloud factor inconsistent with cloud cover***"

- else "***cloud factor consistent with cloud type&cover***"

The confidence level takes into account this consistency and also the problems (if any) encountered in the SSI calculation (albedo reaching the minimum or maximum albedo, sun glint conditions). The consistency is tested for normal cases without sun glint and for cases with weak sun glint. It is not tested for cases with critical sun glint, which take the confidence level "acceptable". See Appendix A for the precise attribution of the confidence levels.

4.3.3. LML 3-hourly and daily SSI quality indexes

The 3-hourly and daily indexes contain the same information, except for the solar day configuration. As for the hourly index, the index contains:

1. a confidence level, which is basically an average of hourly confidence levels,
2. information, such as clear or cloudy pixel or sun glint occurrence, which are a compilation of the information available in the hourly indexes,
3. failure causes, when no SSI has been calculated.

4.4. File formats

The products are available under the WMO GRIB format for those delivered through the Regional Meteorological Data Communication Network (RMDCN) and Météo-France ftp server, under NetCDF and HDF formats for the products delivered through the IFREMER server.

A complete description of the GRIB format can be found in WMO publication No 306, Manual on Codes. A few parameters are encoded in the GRIB header. The header sections of the GRIB files, specific to the O&SI SAF products, are described in the appendix B.

A GRIB encoding and decoding software is maintained and distributed by the European Center for Medium range Weather Forecast (ECMWF). All information about the software and its ordering is available from ECMWF website http://www.ecmwf.int/ (Home > Products > Data Services > Software > GRIB). Requests for software should be addressed to:

Data Services
ECMWF
Shinfield Park
Reading
RG2 9AX
UNITED KINGDOM
Fax : +44 118 986 9450
E-mail : Data.Services@ecmwf.int

A so-called "global information file" has been created to palliate the inability of the GRIB header to store all the necessary information. This text file is fully described in Appendix D. A global information file is associated to every GRIB file. The user may note that a SSI field and its quality index both have a global information file, containing duplicated information. Two historical files gathering all available global information files (one concerning the 3-hourly products and the other the daily products) are available on the web server http://www.osi-saf.org

The HDF format is a public format, which is not described here. The HDF attributes have been used to store all the necessary information, which are the GRIB header or in the information file. Appendix D describes the HDF attributes defined for the SSI, DLI and SST data.

A C program to read HDF format is also available under the IFREMER server ftp://ftp.ifremer.fr/pub/ifremer/cersat/SAFOSI/Tools. Instructions to install this program are provided in appendix G.

The user can also find other free software that read HDF-EOS files at the following address : http://hdfeos.gsfc.nasa.gov/hdfeos/softwarelist.cfm

The file name convention for the MAP and LML SSI products disseminated via EUMETCAST are in appendix H.

4.5. Configuration file

The information relative to the processing conditions is given in the configuration file. It contains an identification of the algorithm formalism and a set of parameters, used in the processing scheme (most of them have been presented in section 2, 3 and 4.3). The configuration file is satellite dependent. The SSI and DLI processing schemes have a common configuration file.

The configuration file is an ASCII file, which is read by the programs of the processing chain. It records all the consecutive versions with the dates of the change in the header of the file. Comments are also added in the parameter section. It should be managed with a version tool. The version number is at present manually updated in the auxiliary data. Appendix E shows the SSI-DLI configuration file, relative to GOES processing scheme.

4.6. Validation results

Error statistics are calculated monthly for the three temporal resolutions, separately for each satellite, GOES or MSG, using the Match Up Data Base presented in 3.6. They are stored in ASCII files, called validation statistic reports. The mono-satellite reports over one month are rather detailed, including overall results, results per station and results per day. They can be combined to produce reports over longer period or LML or MAP reports, merging results from several satellites (GOES, MSG and possibly NOAA). The content of the validation statistic report, which is used both for SSI and DLI, is described in Appendix F.

Statistics covering 3 month period are presented in the Quarterly Reports, and Validation Reports on long term series are also produced. Both kinds of reports are available on the Web Site.

For each satellite, a limited set of stations, where in situ data are available in a reasonable delay and rather well distributed in the processed area, is considered as the reference set of stations to be used for most of the routine validation. The reports over long period, which are distributed to users, concern the limited set(s) of stations.

All validation stations processed in the MDBs are shown in figure 3, those of the limited sets are presented in figure 4 and table 4. An example of daily SSI validation for GOES and MSG over one year is given in figure 5

name	abv	latitude	longitude
Bondville_IL	bon	40.060	-88.370
Goodwin_Creek_MS	gwn	34.250	-89.870
Sterling	ste	38.980	-77.470
Oak_ridge	ort	35.960	-84.290
Tallahassee	tlh	30.380	-84.370
Madison	msn	43.130	-89.330
Central_Facility	cen	36.605	-97.485
Bermuda	ber	32.300	-64.750
Chesapeake_Light	chl	36.910	-75.710
Penn_State_PA	psu	40.720	-77.930
Le_Lamentin	lla	14.593	-60.999
Vauclin_Chateaup	vch	14.552	-60.840
Rochambeau	roc	4.833	-52.367
Kourou_CSG	kou	5.188	-52.770
Saint_Quentin	sqt	49.810	3.200
Nancy	nan	48.683	6.217
Rennes	ren	48.060	-1.710
Macon	mac	46.290	4.790
Bordeaux	bor	44.833	-0.683
Marignane	mgn	43.450	5.210
Ajaccio	aja	41.917	8.800
Carpentras_CRC	cac	44.083	5.059
Camborne	cam	50.367	-5.533
De_Aar	daa	-30.667	23.983

Table 4 : GOES and MSG limited sets of pyranometer stations

Column 2 gives the abbreviated name that is used in the SAF O&SI validation figures and listings. The stations of the first lines (until "psu") are in GOES area, four stations ("lla", "vch","roc","kou") are in GOES/MSG overlapping area and the stations of the last lines (starting at "sqt") are in MSG area.

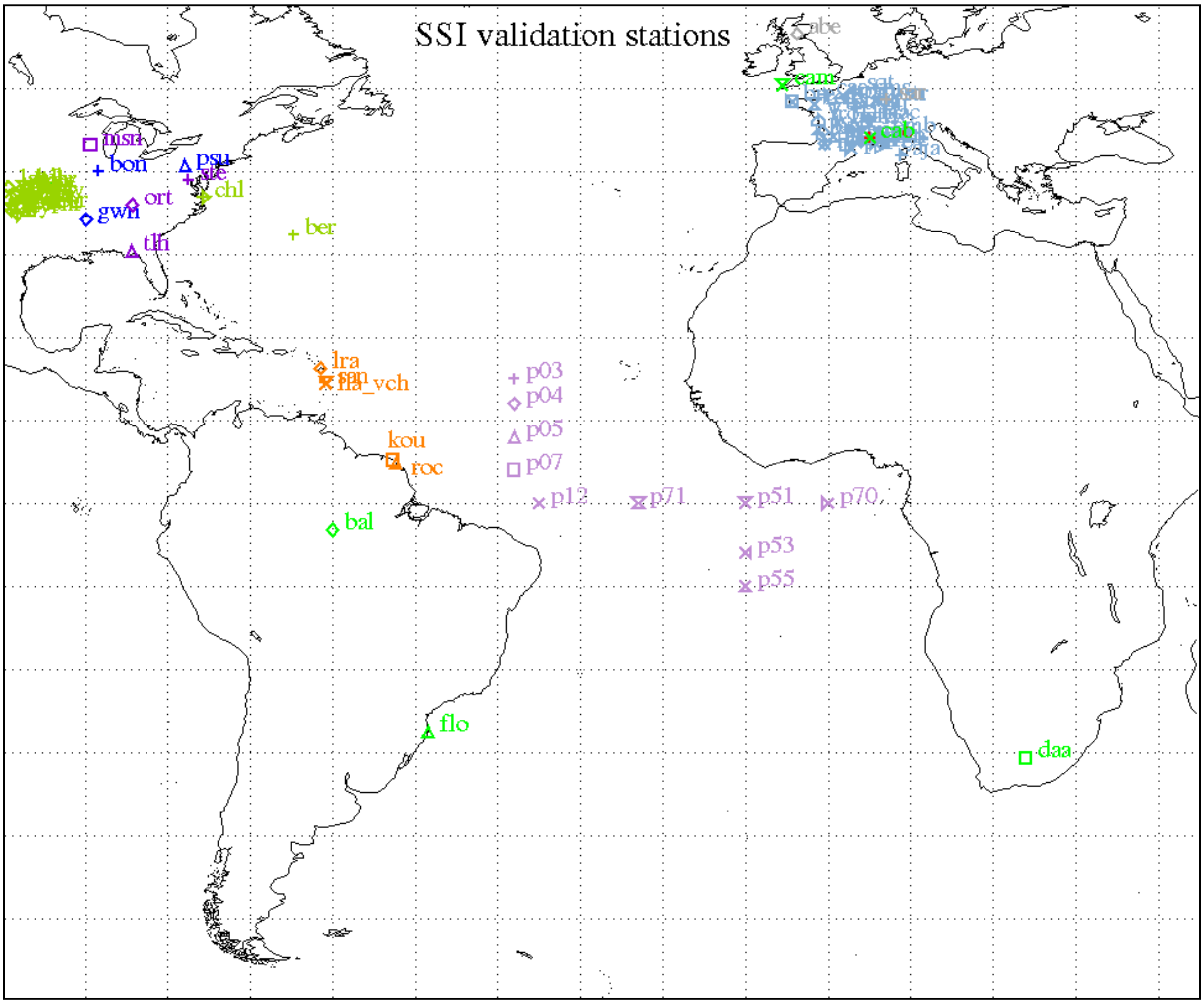

Figure 3 : All stations processed in the SSI Match Up Data Bases

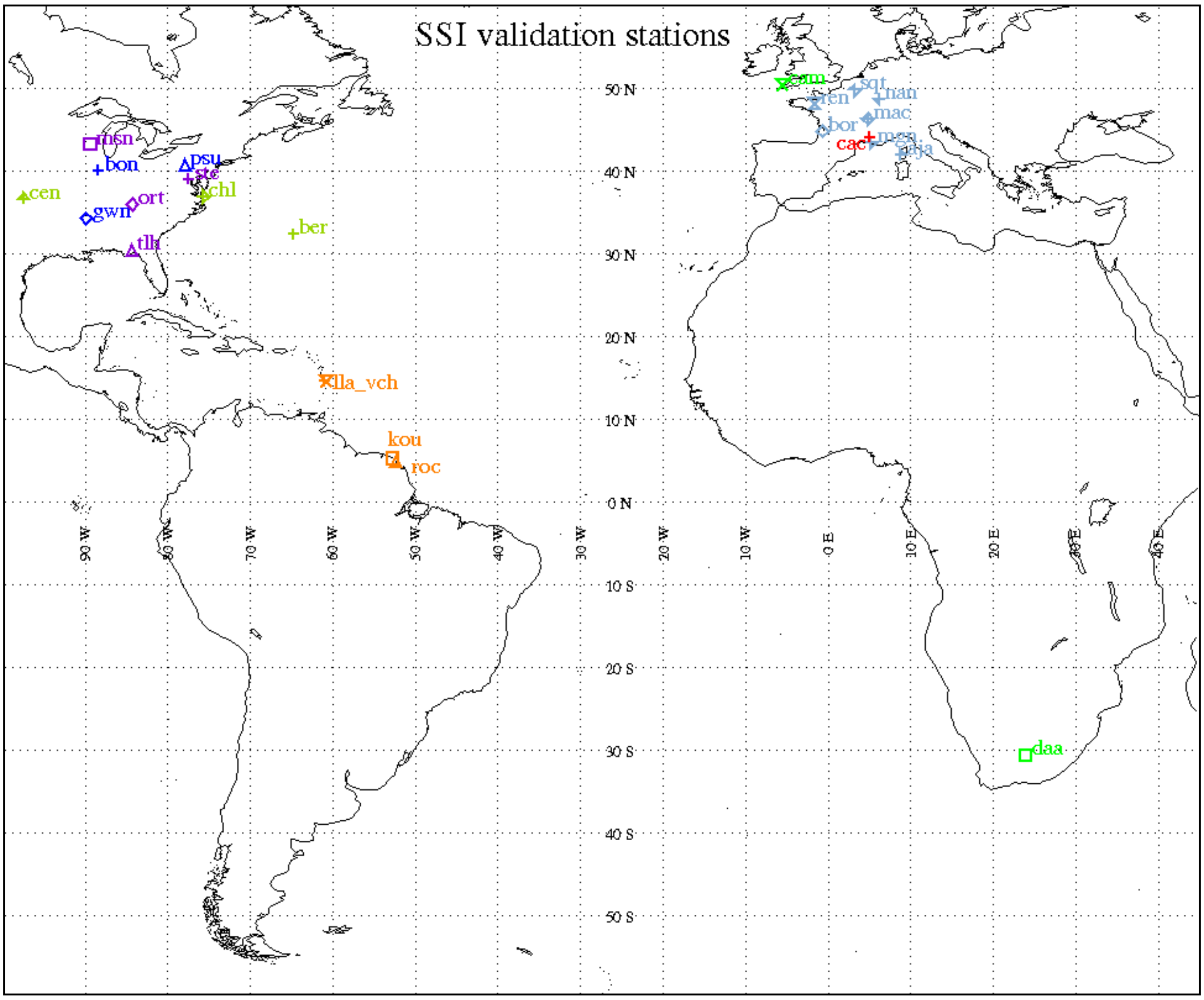

Figure 4 : GOES and MSG limited sets of pyranometer stations

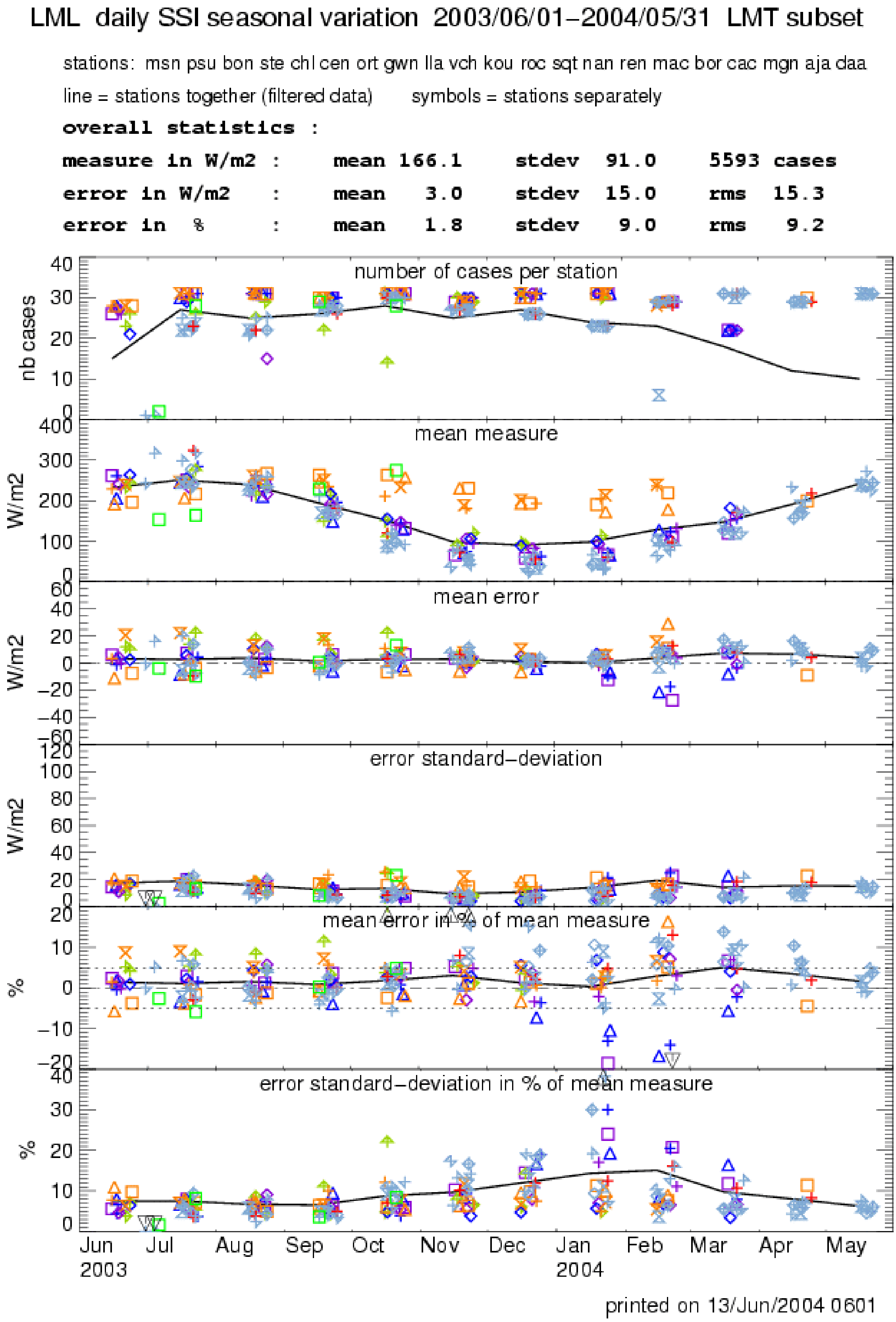

Figure 5 : Example of daily SSI validation results

The results of the stations “lla”, “vch”,”roc” and ”kou”, situated in the GOES/MSG overlapping area west of 37.5W, are those obtained with GOES data.

4.7. Quality control results

The automatic quality control, presented in 3.7, calculates the confidence level distribution over the oceanic part of the image, stores the results in the global information file of the image (described in Appendix C) and concatenates these files into a compiled global information file. This compiled file is specific to each type of product (3-hourly LML, daily MAP or any intermediate product) and starts at the beginning of the processing.

Figures are also produced automatically covering different periods of time, the last ten days (not shown), the previous month or the last 12 months (figure 6). The 15% of unprocessed data remaining in June 2004 show that the MAP area is not fully covered: the.HL product, based on NOAA data acquired in Oslo, does not cover the north-west and the LML product, based on GOES sectors, does not cover the south-west.

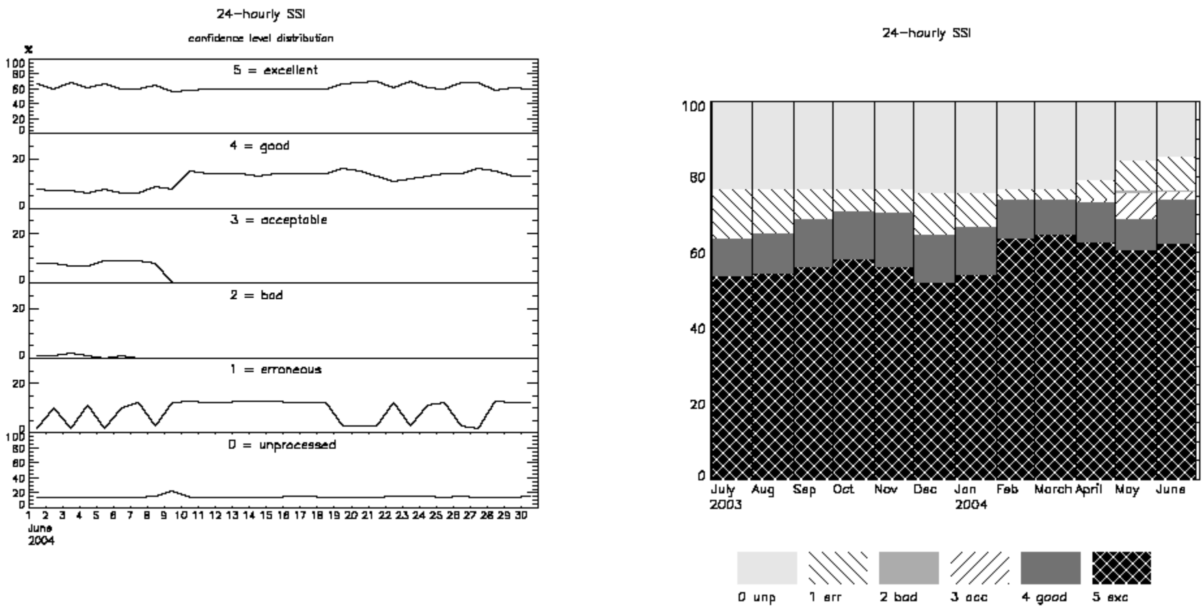

Figure 6 : Example of quality control results for the daily MAP SSI, over one month (left) and over one year (right)

4.8. O&SI SAF website

An O&SI SAF website www.osi-saf.org has been implemented in early 2004 to provide general information on the O&SI SAF, detailed information on the O&SI SAF products and their quality, as well as near real-time access to O&SI SAF products quick-looks and files.
This section provides some additional information about the general organization of the site, focusing on the way to access quick-looks and other relevant information concerning ATL SSI product.
The status of the LML and MAP Fluxes (SSI and DLI) production is indicated in the table on the right side of the home page.
From the home page the user can get access to :
- the ATL SSI products presentation by selecting in the left-hand side column "Products presentation", and then "Atlantic Surface Solar Irradiance".
- LML and MAP Fluxes (SSI and SSI) products configuration, by selecting Products Configuration.
- ATL SSI quality results, by selecting in the left-hand side column "Production centers WEB sites " , and then in the table "Centre de meteorologie Spatiale de Meteo-France" , in section "SSI", by selecting "validation"

Figure 5 shows the O&SI SAF website entry page for the Atlantic SSI products images

Surface Solar Irradiance on Atlantic exepted Higth Latitudes

Images

Select a product type, a geographical area and then push the 'Validate' button to load the selected image.
Geographic areas are shown on the image below the form.
Important note: the sub-areas have been defined only for zooming purpose; the products are available only on the LML or MAP areas.

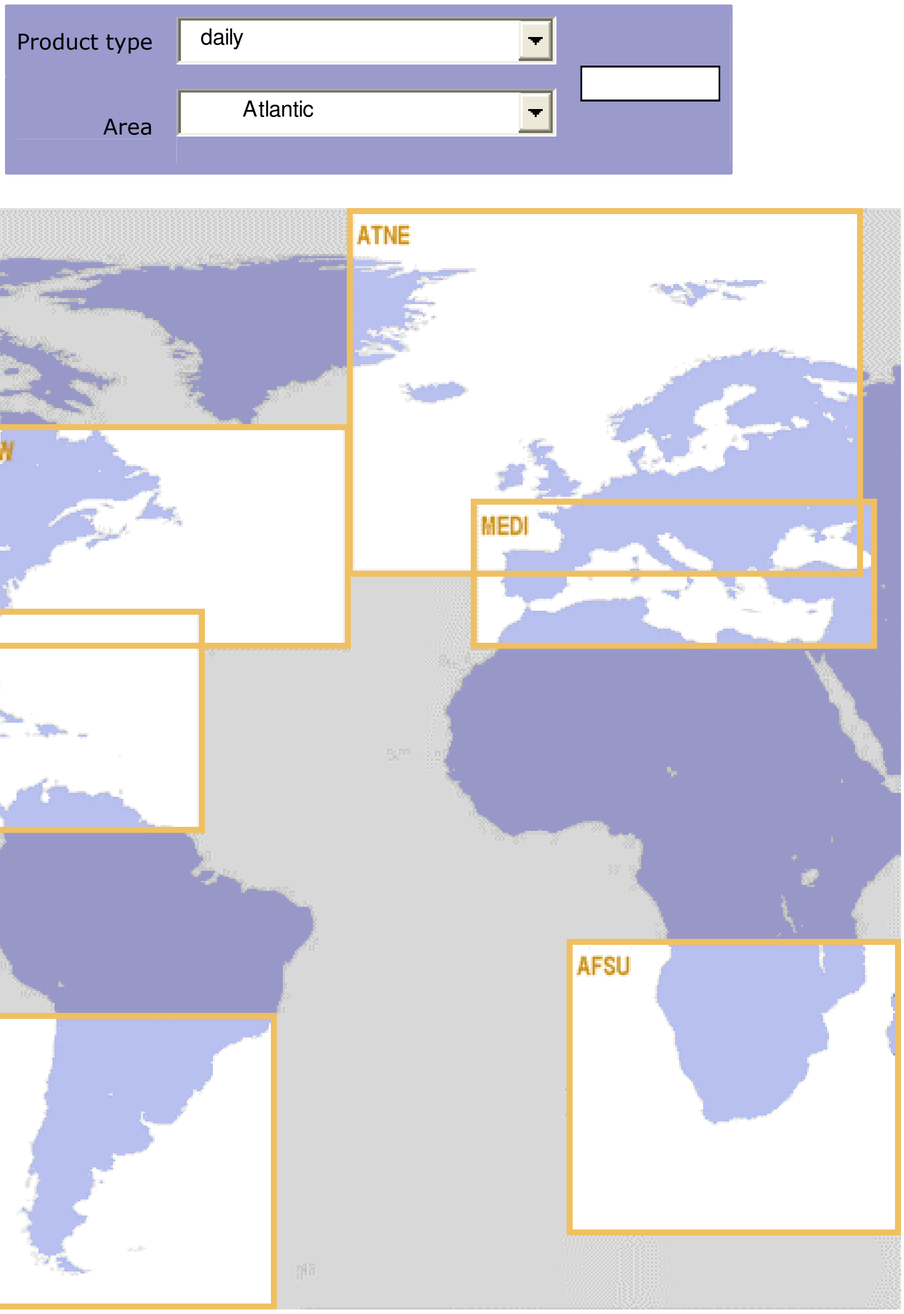

Figure 5 : entry page of the O&SI SAF website for the Atlantic SSI products images

From this entry page, the user has to select a product type (3-hourly or daily) and a geographical area, using the two selection boxes in the bottom, then to press the “Load” button to display the last corresponding quick-look. For the Atlantic SSI products, the geographical sub-areas are proposed for quick-looks display only, but the products files cover the whole Atlantic area (LML or MAP).

APPENDIX A: SSI quality indexes

Hourly SSI quality index	
bit	**signification**
0-2	Confidence level 5 = excellent, 4 = good, 3 =acceptable, 2 = bad, 1 = erroneous, 0 = unprocessed This confidence level is based upon the internal results of the SSI algorithm: excellent: clear pixel or 0 < cloud factor <1 and consistent with cloud type&cover good: high cloud factor <1 and inconsistent with prevailing cloud type acceptable: cloud factor = 1 (consistent or not with prevailing cloud type) or cloud factor = 0 and consistent with cloud cover or critical sun glint bad: low cloud factor inconsistent with cloud cover erroneous: no cloud classification or failure in SSI calculations unprocessed: out of area or night for SSI where: cloud factor varies from 1, for clear case, to 0, for maximum cloudiness cloud type&cover are auxiliary data derived NWC SAF cloud classification
3	clear pixel — cloud cover < 10%
4	overcast pixel — cloud cover = 100%
5	weak sunglint conditions — sun glint conditions in at least one IR pixel
6	ice presence — ice detected in at least one IR pixel
7	aerosol presence — aerosol detected in at least one IR pixel
8	critical sunglint conditions — close to specular reflection and rather clear pixel (if bit 8 =1 then bit 5 = 1)
9-14	bit 15 dependent
15	no SSI value
	If bit 15 = 0
bit	**signification**
9	unused
10	unused
11	unused
12	consistency between cloud factor and cloud type&cover
13	maximum cloudiness — SSI = 0 cloud factor = 1
14	clear sky SSI — cloud factor = 0
	If bit 15 = 1
bit	**signification**
9	internal error in cloudy factor calculation
10	TOA albedo too high — $1 < A$
11	TOA albedo too low — $A < A_{min}$ - PAF_PAR_EPSAMIN
12	night for SSI — PAR_ZENSOL_MAX < θ_0
13	missing cloud type&cover — at least, one IR pixel is “unclassified”
14	out of the processed area

The table concerns the LML hourly SSI products (merged and mono-satellite), which are not distributed. The LML pixel of 0.1 degree in latitude and longitude corresponds to a weighted average of several satellite IR pixels. The NWC SAF cloud classification is made in satellite projection and all information at IR pixel resolution come from this classification.

3-hourly or daily SSI quality index	
bit	**signification**
0-2	Confidence level 5 = excellent, 4 = good, 3 =acceptable, 2 = bad, 1 = erroneous, 0 = unprocessed This confidence level is deduced from the N hourly input confidence levels, with the following rules: 0, when the N hourly confidence levels are 0, or 1, in case of 3-hourly or daily calculation failure, or average of N' hourly confidence levels (calculated in real value and rounded). N is the number of hourly values expected for the 3-hourly or daily calculation N' is the number of valid hourly values effectively used or, which is equivalent, the number of hourly confidence levels equal or better than "bad".
3-4	Satellite code 0 = Goes, 1 = Meteosat (MTP or MSG), 2 = Polar (NOAA or EPS), 3 = unused
5	sun glint occurrence weak sun glint conditions for, at least, one hourly value used in the calculation
6	snow or sea ice occurrence snow or sea ice presence for, at least, one hourly value used in the calculation
7	aerosol occurrence detected for, at least, one IR pixel in one hourly value used in the calculation
8	unused
9-14	bit 15 dependent
15	no SSI value
If bit 15 = 0	
bit	**signification**
9-10	configuration of the solar day compared to the UT day 0 =solar day included in the current UT day : 0h < Tsunrise < Tsunset < 24h 1 = solar day in two parts : 0h < Tsunset < Tsunrise < 24h 2 = permanent day
11-14	for daily index, temporal coverage of the day, i.e: number of hourly SSI values used in the daily calculation divided by the the solar day duration in hours (multiplied by 10 for coding) for 3-hourly index, number of hourly values used in the 3-hourly calculation
If bit 15 = 1	
bit	**signification**
9-10	unused
11	not enough hourly values for 3-hourly or daily calculation
12	night for SSI over the whole period PAR_ZENSOL_MAX < θ_0
13	no satellite data only used for merged product
14	out of the processed area

The table concerns all SSI products, intermediate mono-satellite and distributed LML 3-hourly and MAP daily. At present, the description is detailed for GOES and MSG data, only.

APPENDIX B: Limited description of the GRIB file header

The header sections of the GRIB files, specific to the O&SI SAF products, are given in the following table. The parameter names or values with a star * refer to the GRIB manual, in WMO publication No 306 - Manual on Codes. The table below is consistent with the KSEC1 content description in this manual.

element	content	value
ksec1*		
1	version number	3
2	centre identifier	211 for Lannion
3	process identifier	229 for Lannion
4	grid definition	255 (grid defined in section 2)
5	flag section 2 and 3	128* for the quality index fields 192* for the other fields
6	parameter	11* for sst 115 for dli 116 for ssi 210 for sst quality index 211 for sst time 215 for dli quality index 216 for ssi quality index
7	type of level	102* sst and sst time 1* others
8	level	0*
10-14 and 21	reference time	
15	time unit indicator	1* for 3-hourly and 12-hourly products 2* for daily products
16	P1*	0
17	P2*	0
18	time range indicator	0
19	number of products included	number of hourly fields (or orbits) actually included in the product
20	number of products missing	number of missing hourly fields (or orbits)
23	decimal scale factor	0*
24	local use flag	0* (no local use)
ksec3*		
1	bitmap flag	1* for the quality index field 0* for the other fields

APPENDIX C: Description of the global information file

A global information file is associated to each SST, SSI and DLI GRIB file, including information that were not compatible with GRIB format. The file is an ASCII file where the separator between each field is the blank character.
Example:
sst12 map 2001-03-27 1200 2001-03-27 0600 0 1 10 41 31 3 17 1 7 0 0 0 0 230 28551 28531 50 0 -99999 -99999 -99999 0 0 0 0 0 0 0 0 0 -99999 -99999 -99999 goes08 noaa14 noaa16 / / g1.0p1.1 n1.0p2.1 h1.0p1.0 / /

field name	purpose
product_name	coded product name: product acronym: sst, ssi or dli prefixed by q for a quality index, t for a time suffixed by the time resolution in hours: 1, 3, 12 or 24
grid_id	grid identifier: hl, lml, map mocc, mori, norv, cana, gasc, mnor (NAR SST only)
ref_date	reference date and time of the product in UT the reference time is a nominal mean instant format : YYYY-MM-DD (date) and HHMN (time)
ref_time	
start_date	date and time in UT of the first satellite data, used in the product format : YYYY-MM-DD (date) and HHMN (time)
start_time	
slot	orbit or slot number when the product is derived from a unique satellite orbit or slot, 0 otherwise
global_quality_flag	overall confidence level: 0 → normal 1 → suspect 2 → extremely suspect interactively assigned in the processing scheme
nb_hourly_field	number of hourly fields (or orbits) actually included in the product; it may be lower than expected
lvl0_percent	percentage of sea pixels with confidence level 0, 0 to 100
lvl1_percent	percentage of sea pixels with confidence level 1, 0 to 100
lvl2_percent	percentage of sea pixels with confidence level 2, 0 to 100
lvl3_percent	percentage of sea pixels with confidence level 3, 0 to 100
lvl4_percent	percentage of sea pixels with confidence level 4, 0 to 100
lvl5_percent	percentage of sea pixels with confidence level 5, 0 to 100
ovl1_nb	statistic on the GOES/MSG overlapping area : ovl1_nb is the number of comparison case ovl1_mean1 is the mean GOES value ovl1_mean2 is the mean MSG value ovl1_sigma is the standard deviation of the difference 0 in these 4 fields means that no comparison has been attempted due to the lack of GOES or MSG data 0 in the first field and –999 in the others means that no data were comparable in the overlapping area
ovl1_mean1	
ovl1_mean2	
ovl1_sigma	
ovl2_nb	statistic on the GOES/NAR overlapping area
ovl2_mean1	
ovl2_mean2	
ovl2_sigma	
ovl3_nb	statistic on the GOES/HL overlapping area
ovl3_mean1	
ovl3_mean2	

ovl3_sigma	
ovl4_nb	statistic on the MSG/NAR overlapping area
ovl4_mean1	
ovl4_mean2	
ovl4_sigma	
ovl5_nb	statistic on the MSG/HL overlapping area
ovl5_mean1	
ovl5_mean2	
ovl5_sigma	
ovl6_nb	statistic on the NAR/HL overlapping area
ovl6_mean1	
ovl6_mean2	
ovl6_sigma	
satid(5)	identifiers of the satellites, whose data are used in the product the array dimension is 5, since a merged product cannot concern more than 5 satellites examples: noaa16, goes08, meteosat7, msg1 an empty field contains one / character
algorithm_version_id(5)	algorithm version identifiers (correspond to the satellite identifiers) coded as : <a><x.y>p<z.t> with: <a><x.y> algorithm version. <a> process code: g → goes n→ nar h→ hl <x.y> version number of this process p<z.t> configuration file version for instance: g1.1p2.0 an empty field contains one / character

Comments:

The reference time is a nominal value of the mean time of the product in UT:

NAR SST	: 0500 and 1500 for NOAA-14 0200 and 1200 for NOAA-16
hourly Atlantic SST	: 0100, 0200, 0300, …., 2300
hourly SSI or DLI	: 0030, 0130, 0230, …., 2330
3-hourly Atlantic SST	: 0100, 0400, 0700, 1000, 1300, 1600, 1900, 2200
3-hourly SSI or DLI	: 0230, 0530, 0830, 1130, 1430, 1730, 2030, 2330
12-hourly Atlantic SST	: 0000 and 1200
daily SSI or DLI	: 1200

The global quality flag is normally 0. It is equal to 1 or 2, when a problem is known by the producer: for instance, bad quality of a channel critical for the product, GOES-8 hourly SST filed close to the “midnight” calibration problem, …

The parameters beginning by “ovl” are mainly for O&SI SAF internal validation. A merged product contains one or more overlapping areas between two satellites, where some statistics are calculated. 6 types of overlapping have been pre-defined to cover all situations encountered on the SST, SSI and DLI products.

APPENDIX D: Definition of the HDF attributes

attribute name	type	purpose
files attributes		
HDF_version_id	char*8	HDF software version
HDF_EOS_version_id	char*8	HDF-EOS software version
grid attributes		
product_name	char*80	product name (fully written) ex: Sea Surface Temperature
product_id	char*12	product identifier: sst, ssi or dli
producer_id	char*12	producer identifier, i.e. M-F/DP/CMS
project_id	char*12	project identifier, i.e. O&SI SAF
grid_id	char*8	grid identifier: hl, lml, map mocc, mori, norv, cana, gasc, mnor (NAR SST only)
lat_min	float32	minimum and maximum latitudes and longitudes over all pixels of the grid in degrees, western longitudes being negative
lon_min	float32	
lat_max	float32	
lon_max	float32	
satellite_id	char*8 [5]	identifiers of the satellites, whose data are used the array dimension is 5, since a merged product cannot concern more than 5 satellites examples: noaa16, goes08, meteosat7, msg1 an empty field contains one / character
orbit_number	uint16	orbit or slot number when the product is derived from a unique satellite orbit or slot, 0 otherwise
central_date	char*8	reference date and time of the product in UT the reference time is a nominal mean instant format : YYYYMMDD (date) and HHMN (time)
central_time	char*8	
range_start_date	char*8	date and time in UT of the first and last satellite data, used in the product format : YYYYMMDD (date) and HHMN (time)
range_stop_date	char*8	
overal_quality_flag	char*20	overall confidence level: normal , suspect or extremely_suspect interactively assigned in the processing scheme
nb_hourly_field	uint16	number of hourly fields (or orbits) actually included in the product; it may be lower than expected
quality_level	uint16[6]	for the six confidence level values (0 to 5) percentage of sea pixels having this value
compilation_method	char*12	compilation method: mean or integration
ovl_nb	uint16[6]	statistics on 6 overlapping areas between two satellites: number of comparison cases
ovl_mean1	uint16[6]	product mean value using satellite 1
ovl_mean2	uint16[6]	product mean value using satellite 2
ovl_sigma	uint16[6]	standard deviation of the difference

attribute name	type	purpose
algorithm_version_id	char*40	algorithm version identifiers (correspond to satellite identifiers) coded as : <a><x.y>p<z.t> with: <a><x.y> algorithm version. <a> process code: g → goes n→ nar h→ hl <x.y> version number of this process p<z.t> configuration file version for instance: g1.1p2.0
field attributes		
long_name	char*12	coded product name: product acronym: sst, ssi or dli prefixed by q for a quality index, t for a time suffixed by the time resolution in hours: 1, 3, 12 or 24
units	char*12	unit of the data for instance: K, W/m^2 , minutes, none
valid_range	int16[2]	effective minimum and maximum values of the field
missing_value	int16	value used in case of missing data
scale_factor	float64	scale factor value_in_unit = value_in_the_file * scale factor

Comments:

The reference time is a nominal value of the mean time of the product in UT:

NAR SST	: 0500 and 1500 for NOAA-14 0200 and 1200 for NOAA-16
hourly Atlantic SST	: 0100, 0200, 0300, …., 2300
hourly SSI or DLI	: 0030, 0130, 0230, …., 2330
3-hourly Atlantic SST	: 0100, 0400, 0700, 1000, 1300, 1600, 1900, 2200
3-hourly SSI or DLI	: 0230, 0530, 0830, 1130, 1430, 1730, 2030, 2330
12-hourly Atlantic SST	: 0000 and 1200
daily SSI or DLI	: 1200

For LML and MAP grids, which are a regular scaling in latitude and longitude, the lat_max and lon_min parameters can be used to convert the pixel column and line numbers into the latitude and longitude of the pixel center by:

longitude = lon_min. + 0.1 (column – 1)
latitude = lat_max - 0.1 (line - 1)

The global quality flag is usually “normal”. It is “suspect” or “extremely _suspect”, when a problem is known by the producer: for instance, bad quality of a channel critical for the product, GOES-8 hourly SST field close to the “midnight” calibration problem, …

The parameters beginning by “ovl” are mainly for O&SI SAF internal validation. A merged product contains one or more overlapping areas between two satellites, where some statistics are calculated. The “ovl” array index corresponds to 6 pre-defined comparisons, covering all situations encountered on the SST, SSI and DLI products:
1=GOES/MSG 2=GOES/NAR 3=GOES/HL 4=MSG/NAR 5=MSG/HL 6=NAR/HL

APPENDIX E: The SSI/DLI configuration file

```
#-------------------------------------------------------------------------------
#
#              file parameters of the safo flux applications
#
#  geoflx : calculation of the radiative fluxes derived from one geostationary
#           satellite
#  mrgflx : merging of the radiative fluxes derived from several satellite
#  ctlflx : control of the retrieved flux fields through match up database
#
#-------------------------------------------------------------------------------
#
# two sections in this file :
#    section 1 : ArchiPEL management
#    section 2 : Algorithms parameters
#
# When section 2 is modified, ALL_PAR_VERSION should be increased
#
#-------------------------------------------------------------------------------
#
#-------------------------------------------------------------------------------
# History
#   date      version   comment
# 10/04/2001  g1.0p1.0  initial version
# 11/05/2001  g1.0p1.1  change value of PAF_PAR_DRIFTCALIB
#
#------ section 1 --------------------------------------------------------------

# max delivery time delay for flux products (in hours)
GEO_PAR_DELIVERY_TIME_DELAY=2

# on line sst fields duration in hours
GEO_PAR_KEEP_ON_LINE_SSI1=48
GEO_PAR_KEEP_ON_LINE_SSI3=48
GEO_PAR_KEEP_ON_LINE_SSI24=48
GEO_PAR_KEEP_ON_LINE_DLI1=48
GEO_PAR_KEEP_ON_LINE_DLI3=48
GEO_PAR_KEEP_ON_LINE_DLI24=48
GEO_PAR_KEEP_ON_LINE_AUX=48
GEO_PAR_KEEP_ON_LINE_WRK_SRC=2
MRG_PAR_KEEP_ON_LINE_SSI3=48
MRG_PAR_KEEP_ON_LINE_SSI24=48
MRG_PAR_KEEP_ON_LINE_DLI3=48
MRG_PAR_KEEP_ON_LINE_DLI24=48

# on line control images duration in days
ALL_PAR_NB_DAYS_CONTROL_SSI1=3
ALL_PAR_NB_DAYS_CONTROL_SSI3=10
ALL_PAR_NB_DAYS_CONTROL_SSI24=30
ALL_PAR_NB_DAYS_CONTROL_DLI1=3
ALL_PAR_NB_DAYS_CONTROL_DLI3=10
ALL_PAR_NB_DAYS_CONTROL_DLI24=30

# on line quicklook images duration in days
ALL_PAR_NB_DAYS_QUICKLOOK=100

# on line graphe images duration in days
ALL_PAR_NB_DAYS_GRAPHE=400

#------ section 2 --------------------------------------------------------------

# until 11/05/01
#   ALL_PAR_VERSION=g1.0p1.0
# from 11/05/01
ALL_PAR_VERSION=g1.0p1.1

export ALL_PAR_VERSION

# start acquisition time of the first image to be processed (hhmn)
GEO_PAR_FIRST_SAMPLE_TIME=0015
```

```
#step time between two consecutive images to be processed (hhmn)
GEO_PAR_SAMPLE_PERIOD=0030

export PAF_PAR_FIRST_SAMPLE_TIME PAF_PAR_SAMPLE_PERIOD

#Sample product definitions
PAF_PAR_FIRST_SAMPLE_IN_FLX1=1
PAF_PAR_FIRST_SAMPLE_IN_FLX3=3
PAF_PAR_FIRST_SAMPLE_IN_FLX24=1
PAF_PAR_NUMBER_OF_SAMPLES_IN_FLX1=2
PAF_PAR_NUMBER_OF_SAMPLES_IN_FLX3=6
PAF_PAR_NUMBER_OF_SAMPLES_IN_FLX24=48


#...... sub-section 2.1 (geoflx application parameters) .......................

GEO_PAR_VIEW_SAT=goesnorthsouth
export GEO_PAR_VIEW_SAT

#view angles limits definition
PAF_PAR_ZENSOL_MAX=80
PAF_PAR_ZENSAT_MAX=85

# threshold of albedo on coastal area
PAF_PAR_COAST_ALB_THRESHOLD=0.05
export PAF_PAR_COAST_ALB_THRESHOLD

#goes visible calibration coefficients
PAF_PAR_FCORCALIB=1.10
# until 11/05/01
#   PAF_PAR_DRIFTCALIB=0.000208
# from 11/05/01
PAF_PAR_DRIFTCALIB=0.000164
PAF_PAR_TREFCALIB=17758

#Albedo_min delta and max Albedo_max
PAF_PAR_EPSAMIN=0.05
PAF_PAR_MAXAMAX=1.0

#cloud absorption factor
PAF_PAR_MABSCLD=0.4

PAF_PAR_TRSNUAG=0.96

export PAF_PAR_ZENSOL_MAX PAF_PAR_ZENSAT_MAX
export PAF_PAR_FCORCALIB PAF_PAR_DRIFTCALIB PAF_PAR_TREFCALIB
export PAF_PAR_EPSAMIN PAF_PAR_MAXAMAX
export PAF_PAR_MABSCLD
export PAF_PAR_TRSNUAG


#---------------------------------------------------
# environment variables used in DLI programs
#---------------------------------------------------

PAF_PAR_CONTRIB_CLASSIF_UNCLASSIFIED=0.00
PAF_PAR_CONTRIB_CLASSIF_CLEAR=0.00
PAF_PAR_CONTRIB_CLASSIF_LOW=0.82
PAF_PAR_CONTRIB_CLASSIF_MEDIUM=0.78
PAF_PAR_CONTRIB_CLASSIF_HI_THICK=0.72
PAF_PAR_CONTRIB_CLASSIF_CIRRUS_FIN=0.11
PAF_PAR_CONTRIB_CLASSIF_CIRRUS=0.49
PAF_PAR_CONTRIB_CLASSIF_FRACTIONAL=0.15
PAF_PAR_CONTRIB_CLASSIF_ASH=0.00
PAF_PAR_CONTRIB_CLASSIF_SAND=0.52
PAF_PAR_CONTRIB_CLASSIF_CLR_RCL=0.00
PAF_PAR_CONTRIB_CLASSIF_MED_DUBIOUS=0.15
export PAF_PAR_CONTRIB_CLASSIF_UNCLASSIFIED PAF_PAR_CONTRIB_CLASSIF_CLEAR
```

```
export PAF_PAR_CONTRIB_CLASSIF_LOW PAF_PAR_CONTRIB_CLASSIF_MEDIUM
export PAF_PAR_CONTRIB_CLASSIF_HI_THICK PAF_PAR_CONTRIB_CLASSIF_CIRRUS_FIN
export PAF_PAR_CONTRIB_CLASSIF_CIRRUS PAF_PAR_CONTRIB_CLASSIF_FRACTIONAL
export PAF_PAR_CONTRIB_CLASSIF_ASH PAF_PAR_CONTRIB_CLASSIF_SAND
export PAF_PAR_CONTRIB_CLASSIF_CLR_RCL PAF_PAR_CONTRIB_CLASSIF_MED_DUBIOUS

PAF_PAR_CONTRIB_MASK_CLEAR=0.00
PAF_PAR_CONTRIB_MASK_CLOUD=0.63
export PAF_PAR_CONTRIB_MASK_CLEAR PAF_PAR_CONTRIB_MASK_CLOUD

PAF_PAR_P0_PRATA=1013.25
PAF_PAR_C_PRATA=46.5
export PAF_PAR_P0_PRATA PAF_PAR_C_PRATA


#...... sub-section 2.2 (mrgflx application parameters) .......................


#...... sub-section 2.3 (ctlflx application parameters) .......................
CTL_PAR_MDBSSI_STAT_NOTEMIN=0
CTL_PAR_MDBDLI_STAT_NOTEMIN=0
export CTL_PAR_MDBSSI_STAT_NOTEMIN CTL_PAR_MDBDLI_STAT_NOTEMIN

#------ end of file ------------------------------------------------------------
```

APPENDIX F: Description of a SSI/DLI validation statistic report

A validation statistic report contains validation results relative to hourly, 3-hourly or daily SSI or DLI products (mono-satellite, LML or MAP, over one month or a longer period). The reports used for SAF internal validation are often more detailed than those distributed to the users, the format presented here is valid for both types.

A validation statistic report is an ASCII file composed of several types of line:
title line, blank line, border line, legend line, separation line and statistic line.

The file is commonly organized as follows:

line 1 : title line
line 2 : blank line
line 3 : blank line
line 4 : border line
line 5 : legend line
line 4 : border line
following lines : statistic line(s)
comment line
statistic line(s)
comment line …and so on

Line content and format

title line:

(blank characters) xxx zzz flux M D B printed on yyyy-mm-dd hhhh

where xxx = H L for high latitudes
L M L for low and mid latitudes
G L M L for low and mid latitudes, GOES data only
M L M L for low and mid latitudes, MSG data only
M A P for Merged Atlantic Product
zzz = H O U R L Y or D A I L Y or 3 - H O U R L Y
flux = D L I or S S I

border line:

+-+---+----------+----------+-----+------+------+------+------+---------------+--------------+--------------+-----+

legend line:

|t|sta| begin | end | occ |msrmea|msrsig|calmea|calsig| errmea (%msr) | errsig (%msr) | errqua (%msr) | corr|

separation line:

FORTRAN format: ("|",a1,"|",a3,"|",a10,"|",a10,"|",5x,"|",4(6x,"|"), 1x, 3(6x," ", 6x," |"),5x,"|")

statistic line:

This line contains statistical results between satellite-derived values (calculated) and the corresponding in-situ measurements (measured), for one station or a set of stations over a variable period of time:

FORTRAN format: ("|",a1,"|",a3,"|",a10,"|",a10,"|",i5,"|",4(f6.2,"|"),1x, 3(f6.2," (",f6.2,")|"),f5.2,"|")

The statistic line contains the following parameters:

code, sta, begin, end, occ, msrmea, msrsig, calavg, calsig, erravg, erravgp, errsig, errsigp, errrms, errrmsp, cor

which are defined as indicated below:

code: code describing the type of the statistics, i.e. period and station(s)

G or g	= several days, several stations
m	= one month, several stations
S or s	= several days, one station
e	= one month, one station, values considered as dubious or erroneous
D	= one day, several stations

(capital letters are used for statistics directly calculated on a MDB file and lower case letters for statistics derived from other statistic reports)

sta: set of stations shortname, with the following values:

ALL = all stations available
LMT = limited set of stations well distributed in the area
VAL = SAF O&SI internal use

or station shortname, if only one station is used

begin	: date of the first day of the statistics, coded yyyy-mm-dd	
end	: date of the last day of the statistics, coded yyyy-mm-dd	
occ	: number of cases	
msrmea	: mean measured flux	W/m^2
msrsig	: standard deviation of the measured flux	W/m^2
calavg	: mean calculated flux	W/m^2
calsig	: standard deviation of the calculated flux	W/m^2
erravg	: mean error , i.e. calculated flux - measured flux	W/m^2
erravgp	: mean SSI error in percentage of the mean measure	%
errsig	: standard deviation of the error	W/m^2
errsigp	: standard deviation of the error in percentage of the mean measure	%
errrms	: root mean square (rms) error	W/m^2
errrmsp	: rms error in percentage of the mean measure	%
corr	: correlation coefficient	

Missing values are coded -99.99, except the correlation coefficient which is -9.99.

APPENDIX G: Help in reading HDF format

A C program to read HDF format (read_hdf.c) is available under the IFREMER server ftp://ftp.ifremer.fr/pub/ifremer/cersat/SAFOSI/Tools.

To install this program proceed as follows:

- Download the HDF 4.1r5 software from ftp://ftp.ncsa.uiuc.edu/HDF/HDF/HDF_Current (get HDF4.1r5.tar.gz)
- Download the HDF_EOS 2.7v1.00 source code and test drivers from http://hdfeos.gsfc.nasa.gov/hdfeos/softwarelist.cfm
- Since read_hdf.c produces a pgm file as an output example, you must download the PBMPLUS toolkit from http://www.acme.com/software/pbmplus
- Check that the following include files are present:

```
stdio.h         (standard include)
hdf.h           (hdf library include)
HdfEosDef.h     (hdfeos library include)
pgm.h           (pgm library include)
```

- You can use the following makefile as a template (to be adapted to your environment)

```
#=====================================================================
#
# Makefile (example) :
#
#=====================================================================

SOFT=soft

CMS=$(SOFT)/cms

INC_CMS=-I/$(CMS)/include
INC_HDF=-I/$(SOFT)/hdf/include
INC_HDFEOS=-I/$(SOFT)/hdfeos/include
INC_PBMPLUS=-I/$(SOFT)/pbmplus/include
INC_ALL=$(INC_CMS) $(INC_HDF) $(INC_HDFEOS) $(INC_PBMPLUS)

LNK_HDF=-L/$(SOFT)/hdf/lib -lmfhdf -ldf -ljpeg -lz -lnsl
LNK_HDFEOS=-L/$(SOFT)/hdfeos/lib -lhdfeos -lGctp
LNK_PBMPLUS=-L/$(SOFT)/pbmplus/lib -lpnm -lppm -lpgm -lpbm
LNK_M=-lm
LNK_ALL=$(LNK_HDF) $(LNK_HDFEOS) $(LNK_PBMPLUS) $(LNK_M)

CC=cc

read_hdf:read_hdf.c
        $(CC) -g  $(INC_ALL) -o read_hdf read_hdf.c $(LNK_ALL)
```

APPENDIX H: Convention file for the dissemination of the SSI product via EUMETCAST

The following table provides the file mane convention used for the dissemination of the SSI product through EUMETCAST

OSI SAF product name	Sub-product Name	Format	File name convention
MAP SSI	MAP SSI field	GRIB	S-OSI_-FRA_-MULT-MAPSSI_FIELD-<date>.grb.gz
	MAP SSI quality index field		S-OSI_-FRA_-MULT-MAPSSI_QUAL_-<date>.grb.gz
	MAP SSI Global Information File	ASCII	S-OSI_-FRA_- MULT-MAPSSI GINF_-<date>.txt.gz
LML SSI	LML SSI field	GRIB	S-OSI_-FRA_- MULT -LMLSSI_FIELD-<date>.grb.gz
	LML SSI quality index field		S-OSI_-FRA_- MULT -LMLSSI _QUAL_-<date>.grb.gz
	LML SSI Global Information File	ASCII	S-OSI_-FRA_- MULT -LMLSSI _ GINF_-<date>.txt.gz