Operational derivation of surface albedo and down-welling short-wave radiation based on MSG observations

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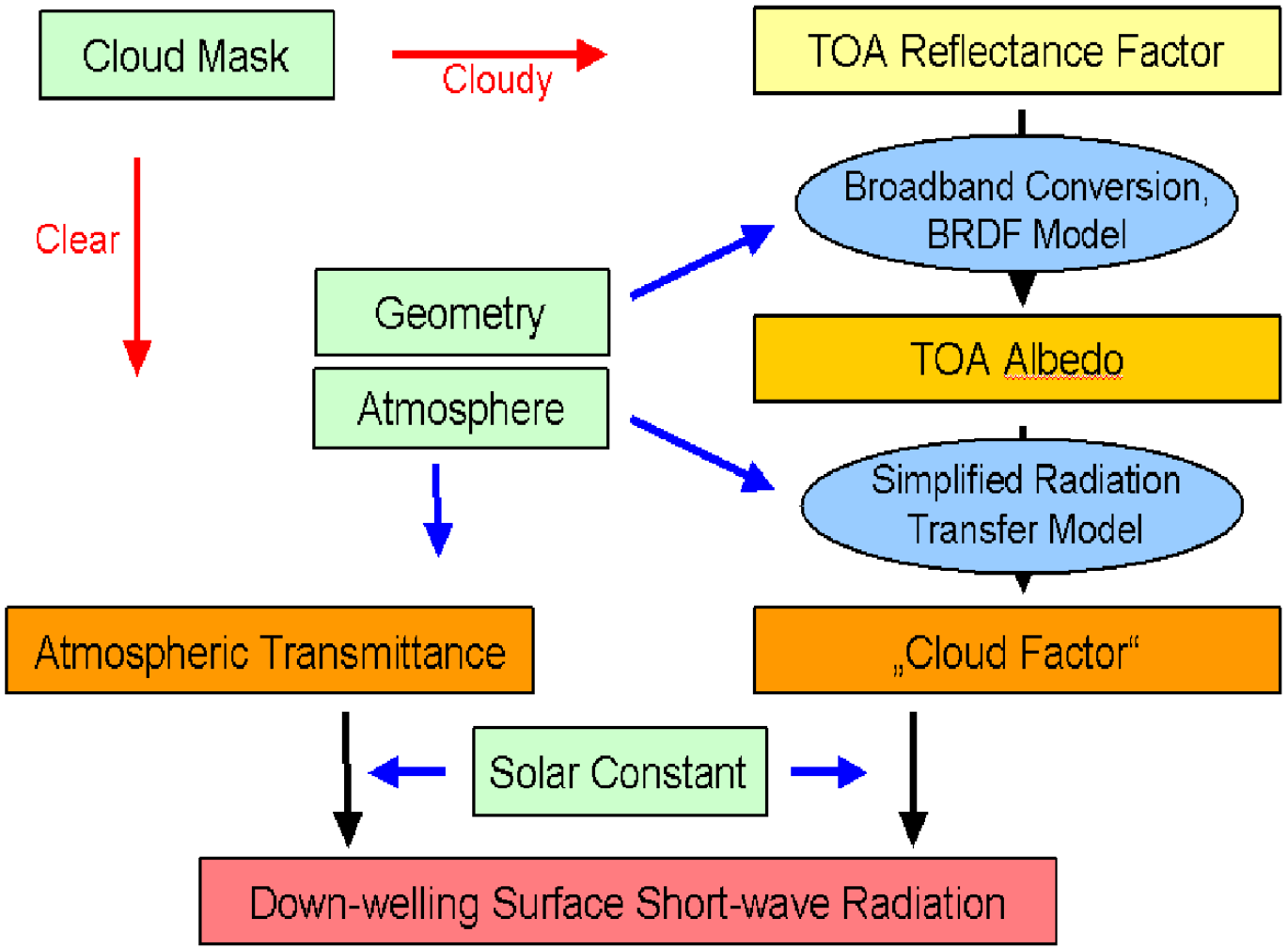
CNRM / Météo France

Characteristics of DSSF products

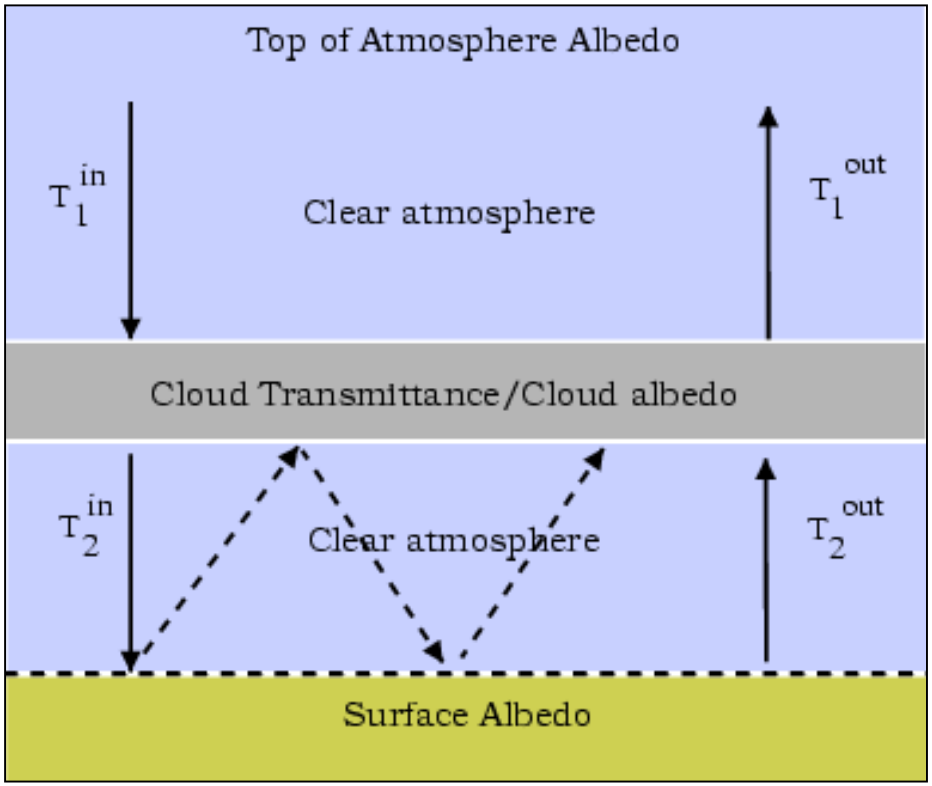
Product	Horizontal Resolution & Coverage	Temporal Resolution	Generation Frequency	Target Accuracy
DSSF – Down-welling Surface Short-wave Flux	MSG disk	Instantaneous & Daily	30 min & Daily	5-10 %

=> completed with METOP/AVHRR to improve high latitudes coverage

DSSF : method of estimation

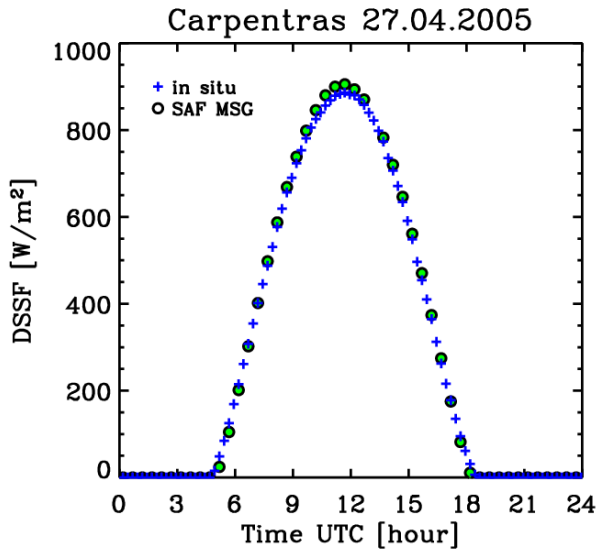


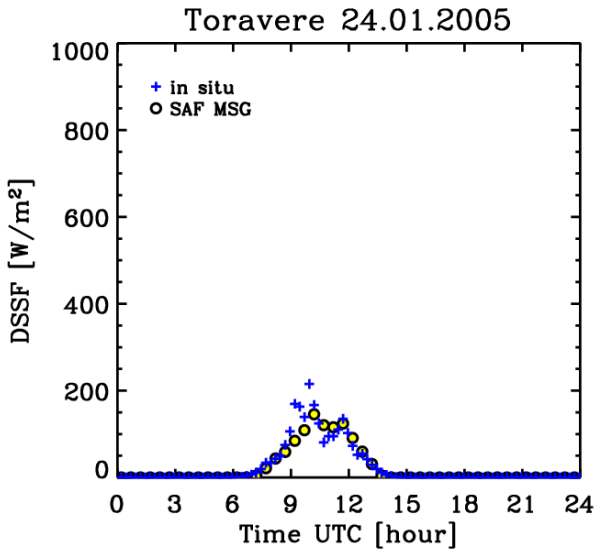
Cloudy Sky Parameterisation

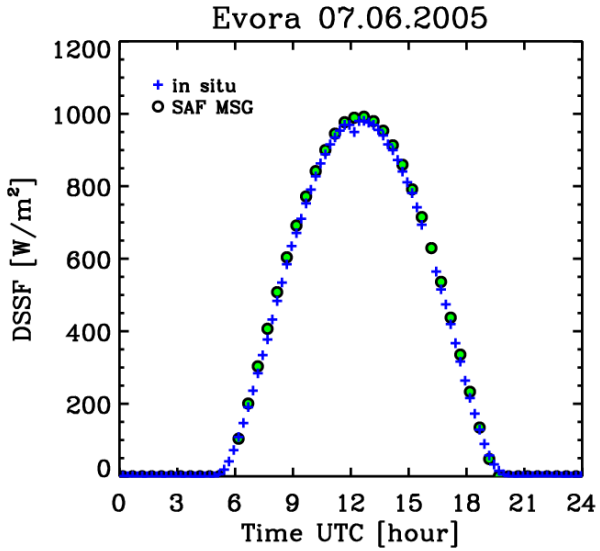


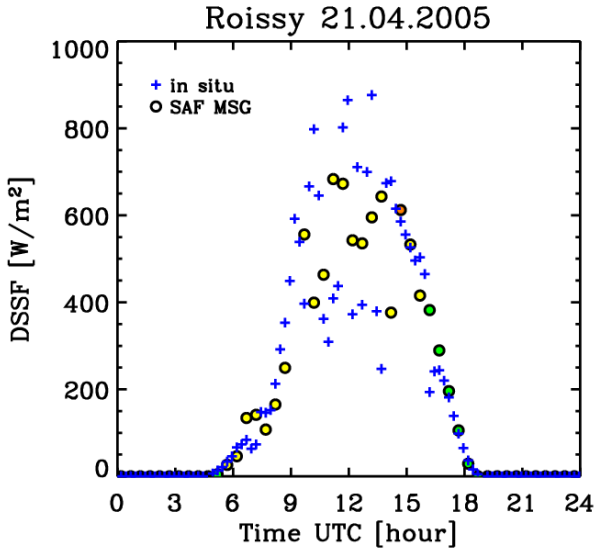
$$F \approx F_0 \, v(j) \cos\theta_{sun} T_{atm} \frac{T_{cloud}}{1 - T_{atm\_below\_cloud} A_{surf} A_{cloud}}$$

Validation with in situ measurements

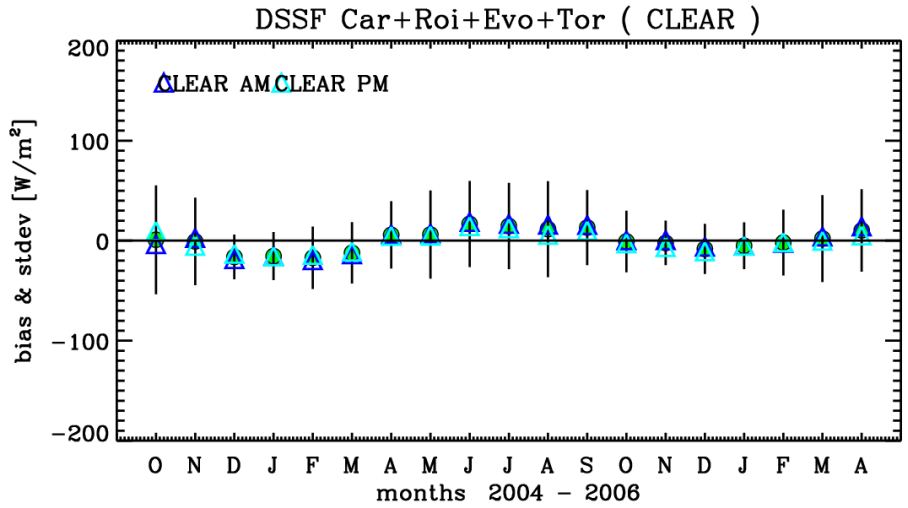


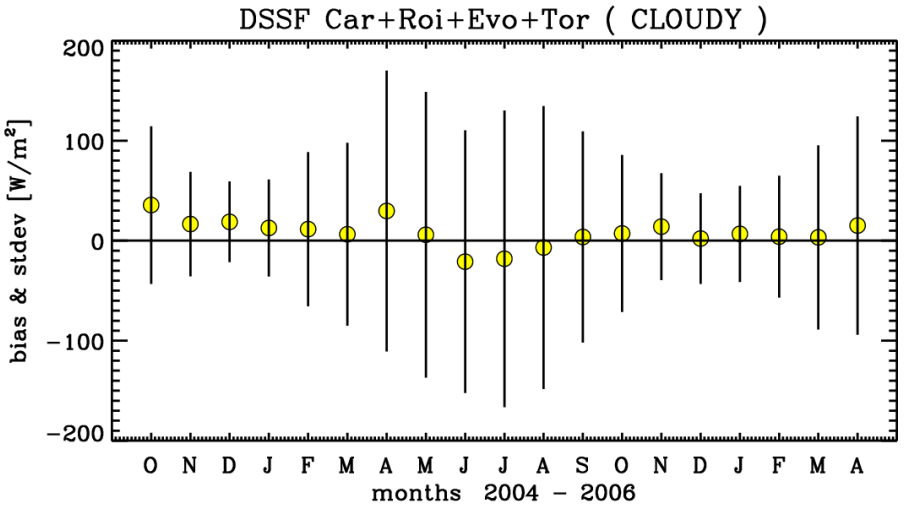






Comparisons with in-situ measurements (period 2004-2006)





Stat. 2004 à 2006

***Clear sky* :**

bias : 5 W/m2

stdev : 40 W/m2

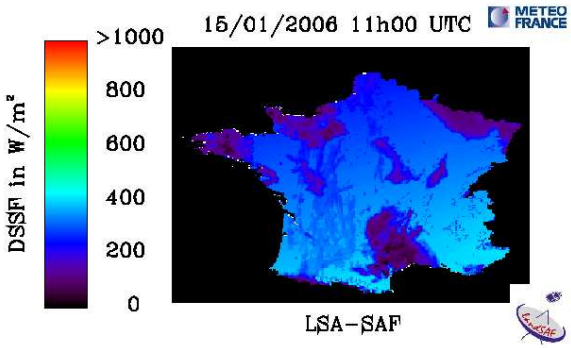
***Cloudy sky* :**

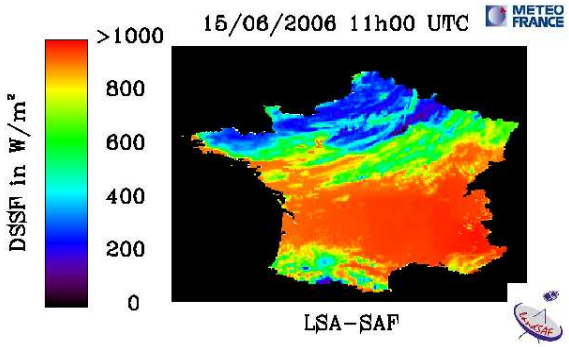
bias : 5 W/m2

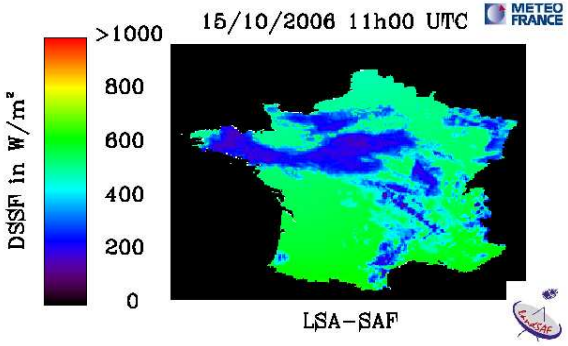
stdev : 115 W/m2

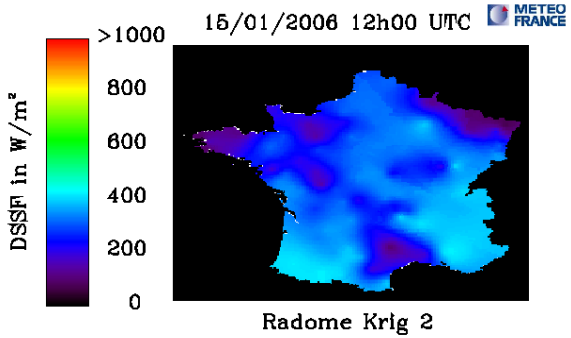
Validation of DSSF with RADOME network (8 km)

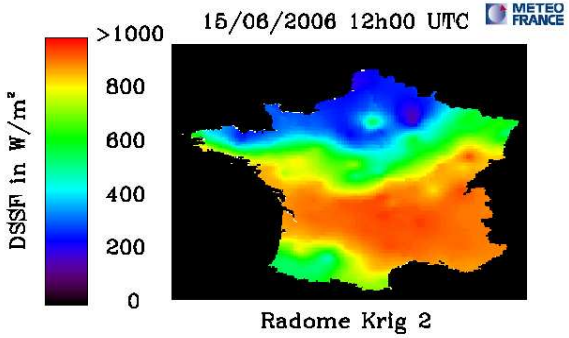
15/01/2006 12 h	15/06/2006 12 h	15/10/2006 12 h

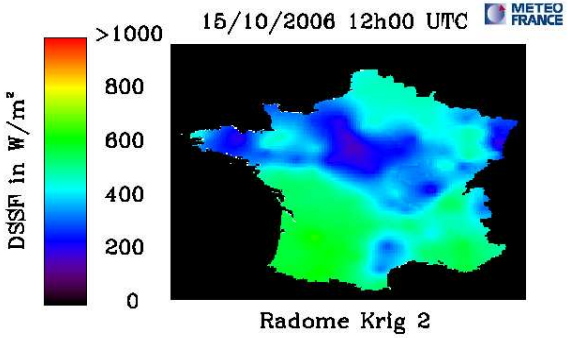


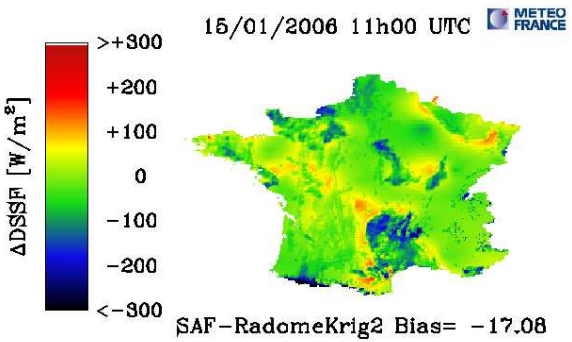


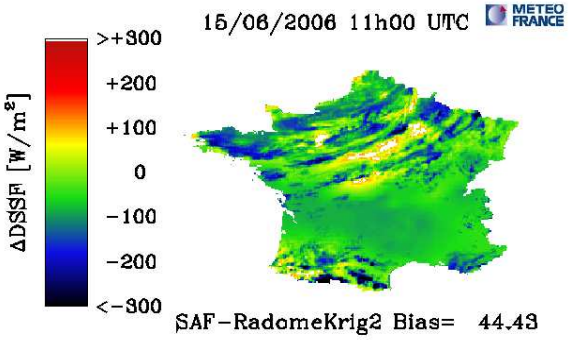


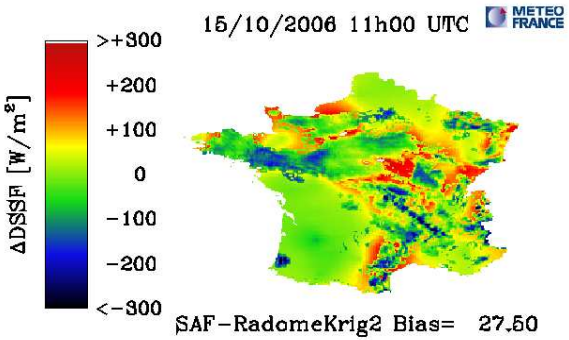




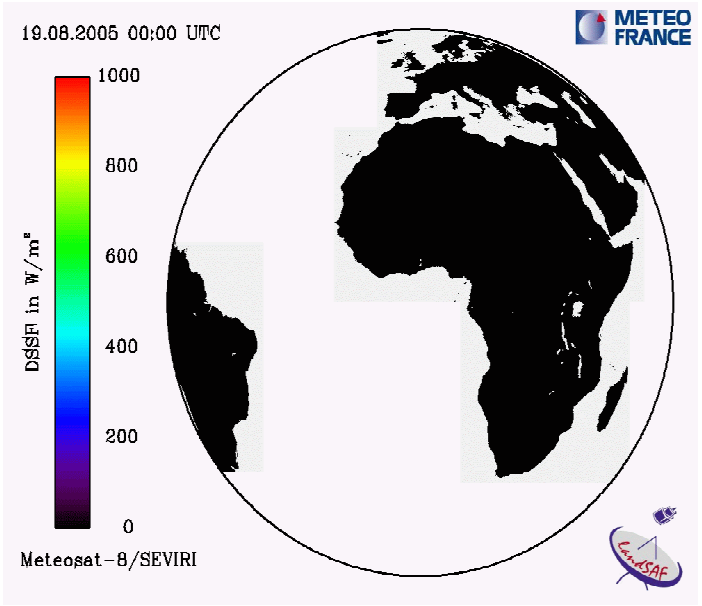


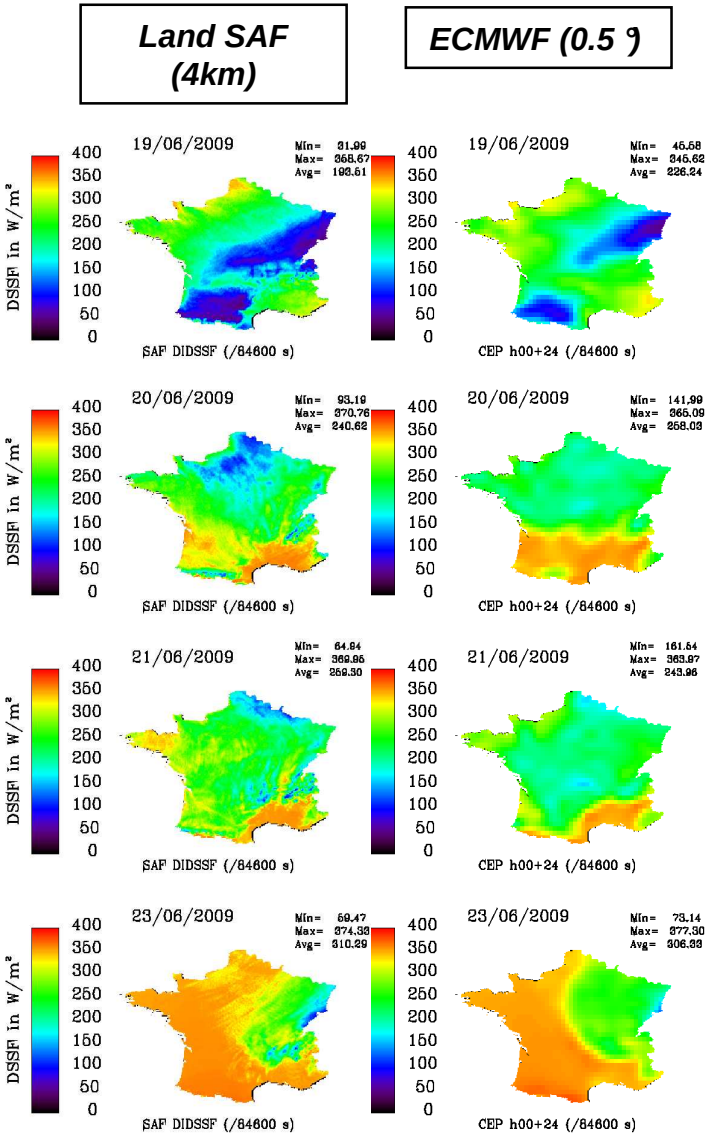






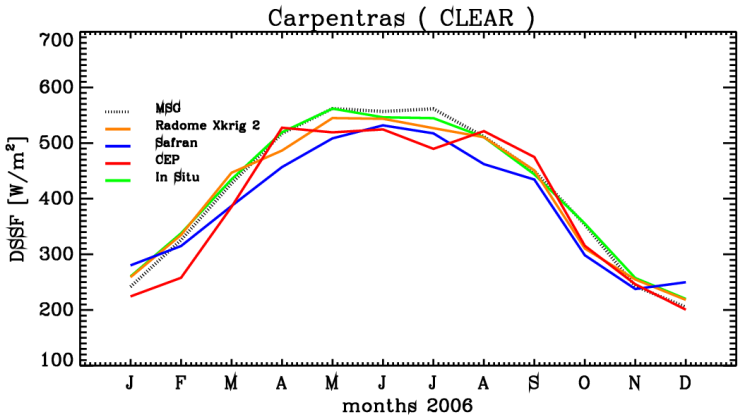
DSSF product

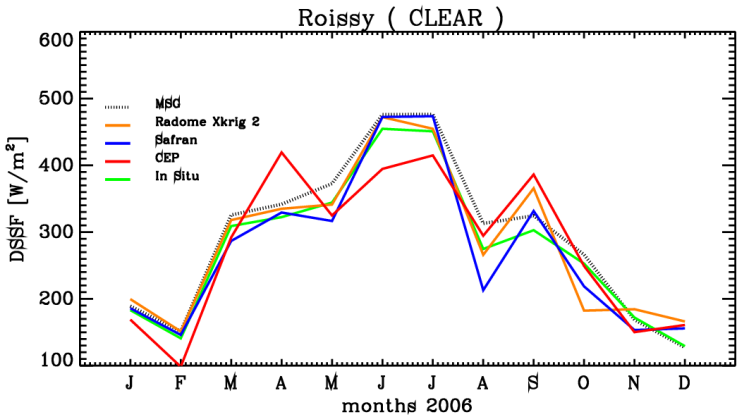


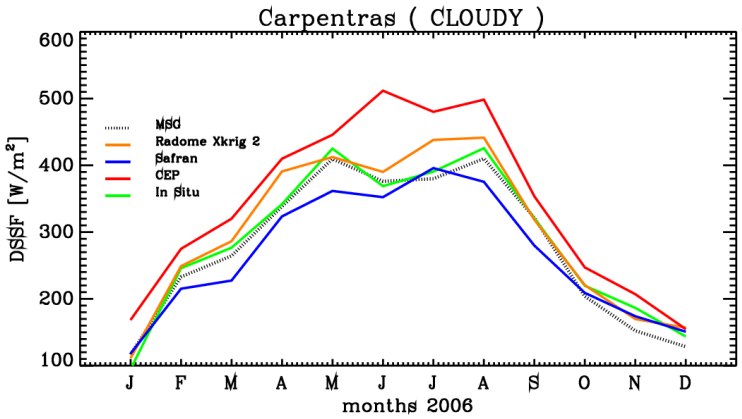


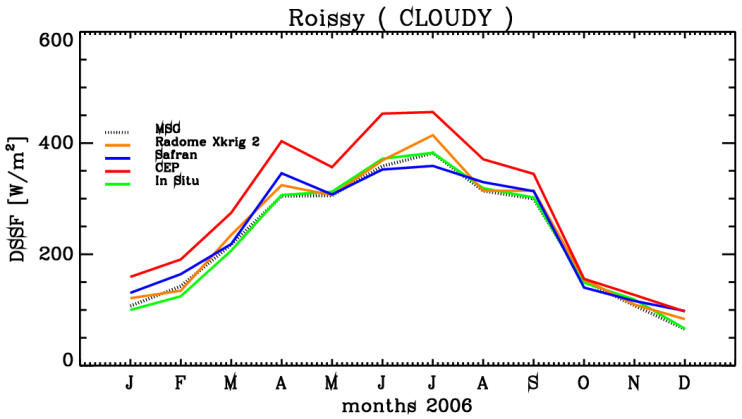
Yearly profile (2006) of DSSF for 2 contrasted sites

Carpentras (Provence) & Roissy (Paris airport)









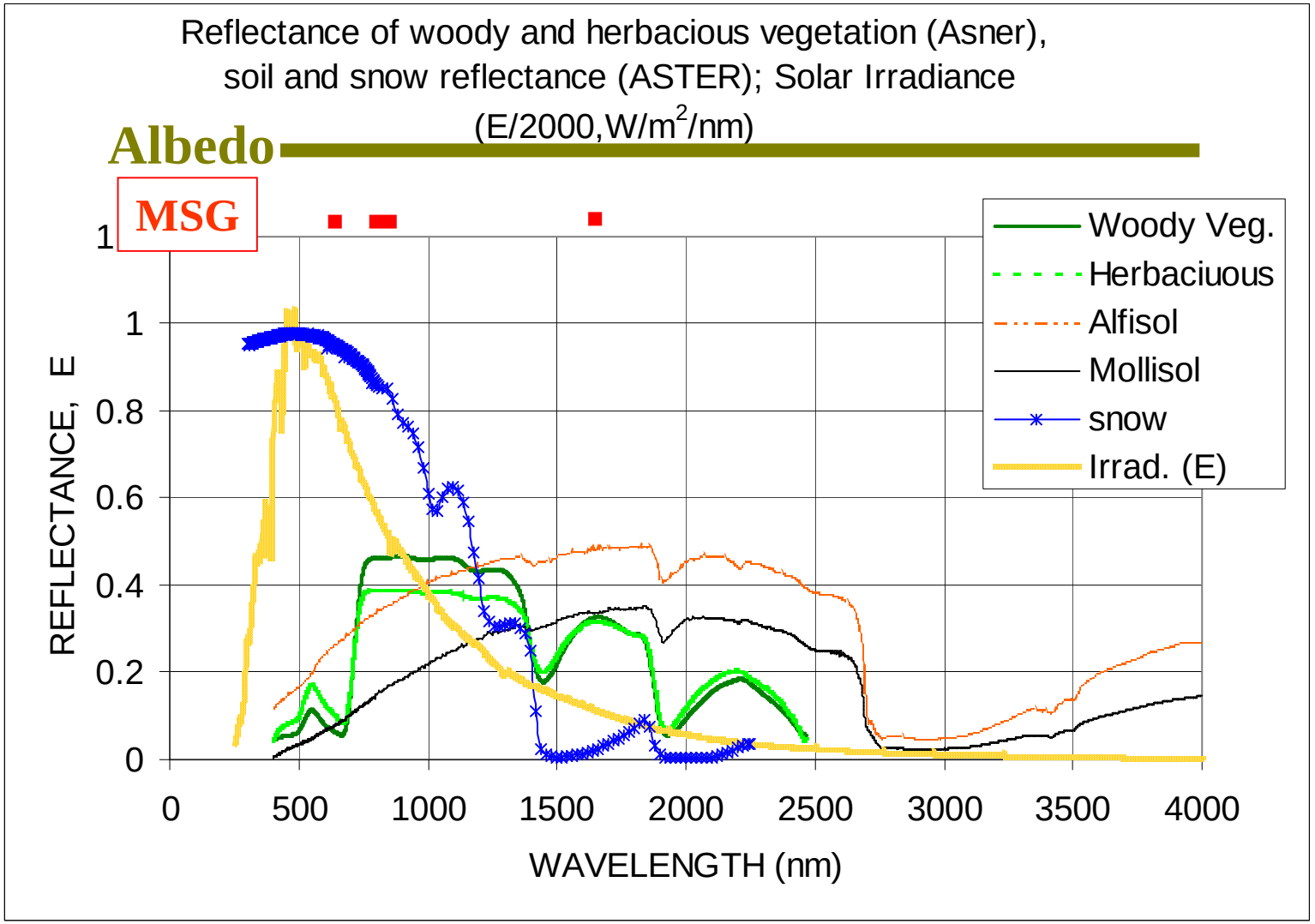
ECMWF: ***-> under-estimate (clear) & over-estimate (cloudy) /DSSF***

Albedo products

Outline

- Current family of AL products
- Characteristics
- Algorithm overview
- Validation effort
- Status of the products during CDOP
- Foreseen activities during CDOP-2

Narrow-to-broadband conversion



Current family of AL products (1/2)

➢ Content of the SP surface albedo product files

✓ **Albedo products in SEVIRI bands : VIS006, VIS008, IR016**

AL-SP-BH **ALbedo SPectral Bi-Hemispherical**

AL-SP-BH-ERR

AL-SP-DH **ALbedo SPectral Directional-Hemispherical**

AL-SP-DH-ERR

✓ **internal products not disseminated, nor subject to review**

Current family of AL products (2/2)

➢ Content of the BB surface albedo product files

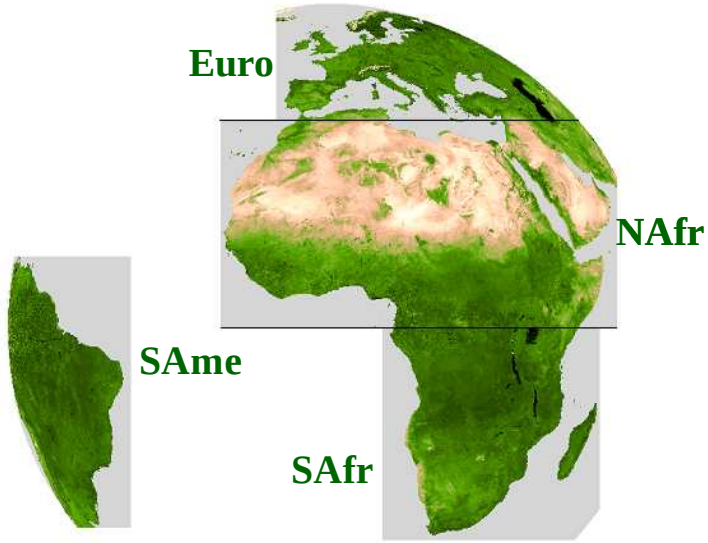
✓ **Albedo products in large bands : VIS,NIR,SW**

AL-BB-BH	**ALbedo BroadBand Bi-Hemispherical**
AL-BB-BH-ERR	
AL-BB-DH	**ALbedo BroadBand Directional-Hemispherical**
AL-BB-DH-ERR	
AL-NI-DH	**ALbedo Near-Infrared Directional-Hemispherical**
AL-NI-DH-ERR	
AL-VI-DH	**ALbedo Visible Directional-Hemispherical**
AL-VI-DH-ERR	

✓**products disseminated, subject to review**

Characteristics

➢ Spatial Coverage



The LSA SAF geographical areas for SEVIRI-based products.

Characteristics

➢ Generation frequency and temporal resolution

SAF on Land Surface Analysis (LSA)

Product-Identifier	Product Name	Product acronym	Product type (product, software, dataset)	Characteristics and Methods	Input Satellite data	Dissemination type (NRT/off-l)	Dissemination Means	Format	Timeliness	spatial coverage	generation frequency	spatial resolution	threshold accuracy	target accuracy	optimal accuracy	Verification method
LSA-01	MSG Daily Surface Albedo	MDAL	product	5-day composites of spectral & broad-band AL	MSG	NRT/off line	EUMETCast /web	HDF5	3 h	MSG disk	1 day	MSG pixel resolution	20%	AL>0.15: 20% AL<0.15: 0.03	7,5%	BSRN data / MODIS AL
LSA-02	MSG 10-day Surface Albedo	MTAL	product	30-day composites of spectral & broad-band AL	MSG	NRT/off line	EUMETCast /web	HDF5	3 h	MSG disk	10 days	MSG pixel resolution	20%	AL>0.15: 10% AL<0.15: 0.015	5%	BSRN data / MODIS AL
LSA-03	EPS Surface Albedo	EAL	product	30-day composites of spectral & broad-band AL	EPS	NRT/off line	EUMETCast /web	HDF5	3 h	Europe & High Latitudes	1 day	1'	20%	AL>0.15: 10% AL<0.15: 0.015	5%	BSRN data / MODIS AL

Beginning of time series: Sep. 05 (MDAL), Jan. 09 (MTAL), not started (EAL)

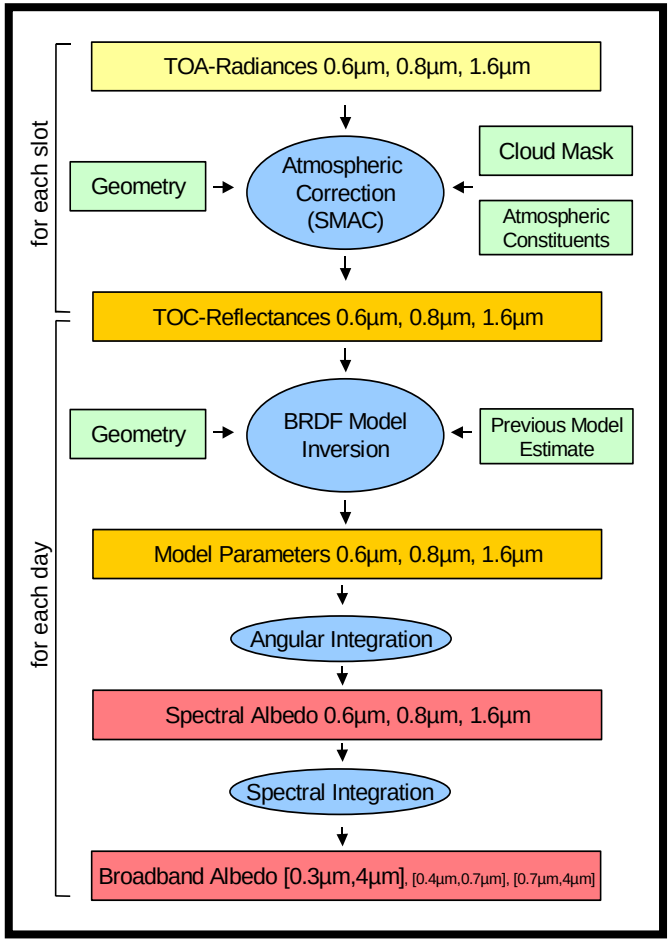
Data Requirements for GCOS

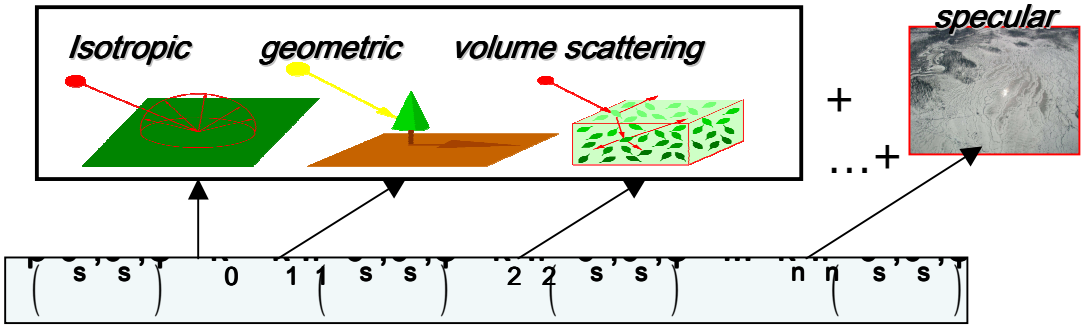
														Opt.	Target	Thresh.
Albedo	TOPC	1 km	2 km	10 km				1 d	3 d	30 d	30 d	45 d	90 d	5 % (Max)	7 % (Max)	10 % (Max)

ALBEDO INPUT DATA

- MSG Data: 0.6µm, 0.8µm, 1.6µm
- Solar and View Angles
- Land/Sea Mask
- Cloud Mask (SAF-NWC software)
- Total Column Water Vapour, and Pressure (ECMWF)
- Ozone Content (Climatology)
- Aerosol Optical Thickness (Climatology)

➢ Algorithm overview





BRDF

k_0 : Lambertian coefficient

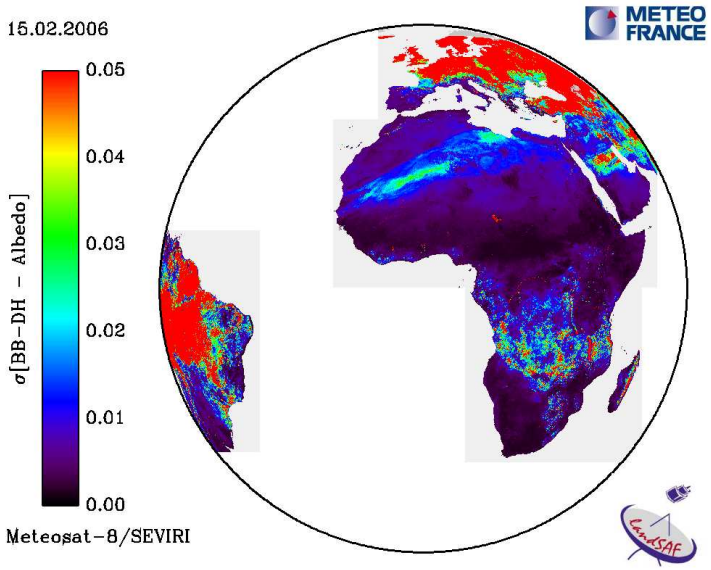
k_1 : roughness coefficient

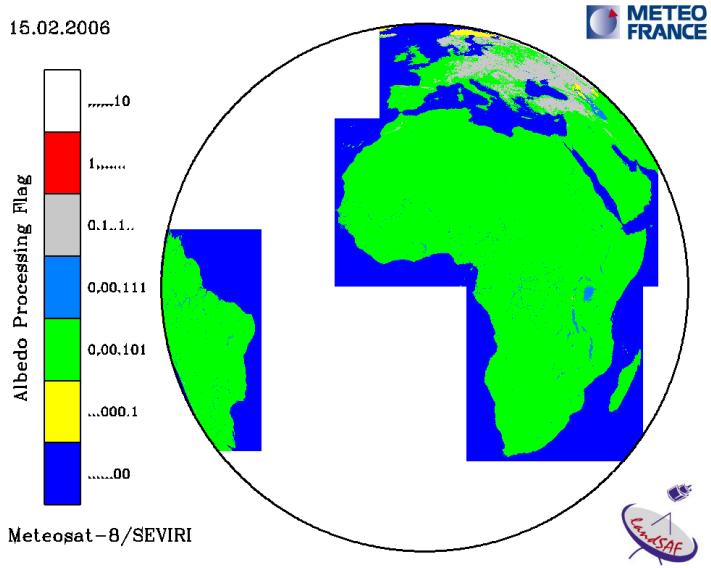
k_2 : volume scattering coefficient

…

k_n : specular coefficient (snow)

Uncertainty Estimates and Processing Flag





- **Uncertainty estimates = non-correlated (random) errors.**
- **Depend on number of observations, estimated TOC-reflectance errors, and angular configuration.**
- **Quality flag includes:**
  - **the land/water mask**
  - **processed/unprocessed pixels**
  - **instruments used (MSG, EPS)**
  - **snow flag from NWC cloud mask**

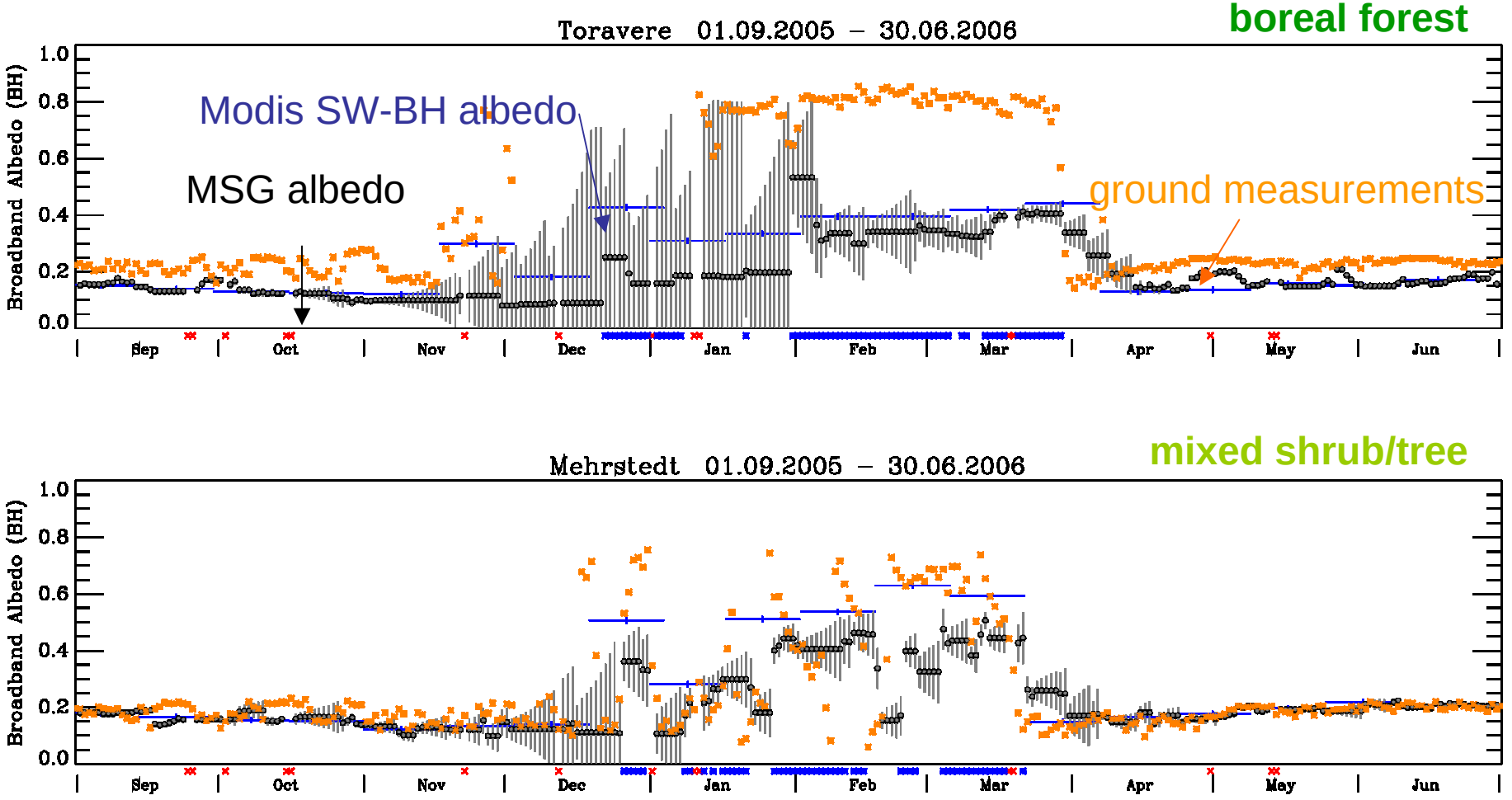
- Status of MDAL => PRE-OPERATIONAL

  - **Aerosol input (real-time) is lacking for atmospheric correction (climatologic-based aerosol correction)**
    - ✓ **MACC products (type, load) to be considered (operational since 2010)**

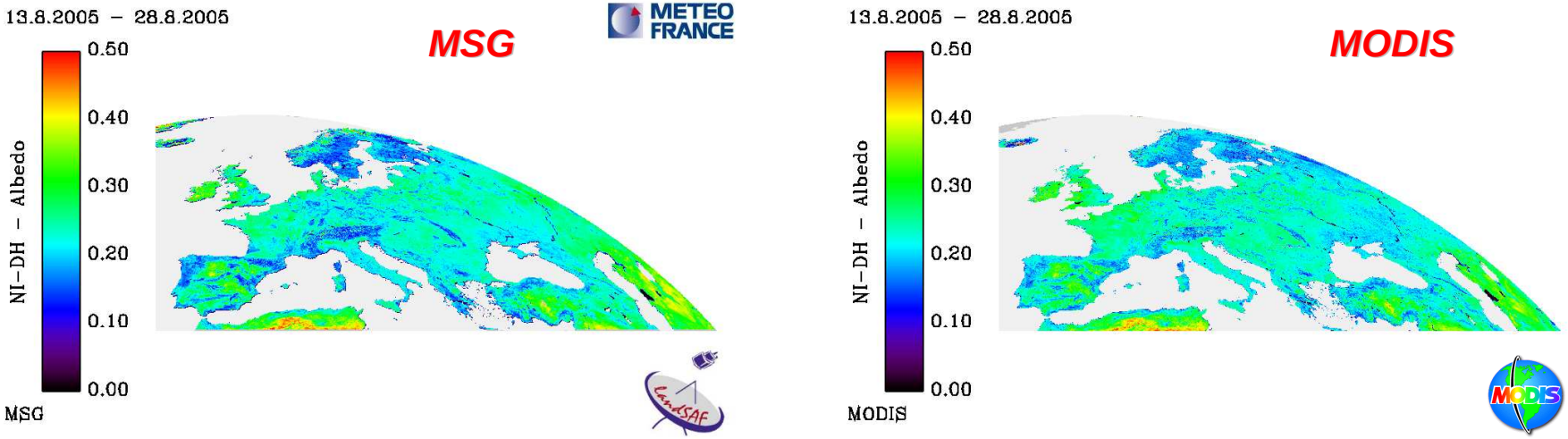
... BUT ALBEDO IS DISSEMINATED ...

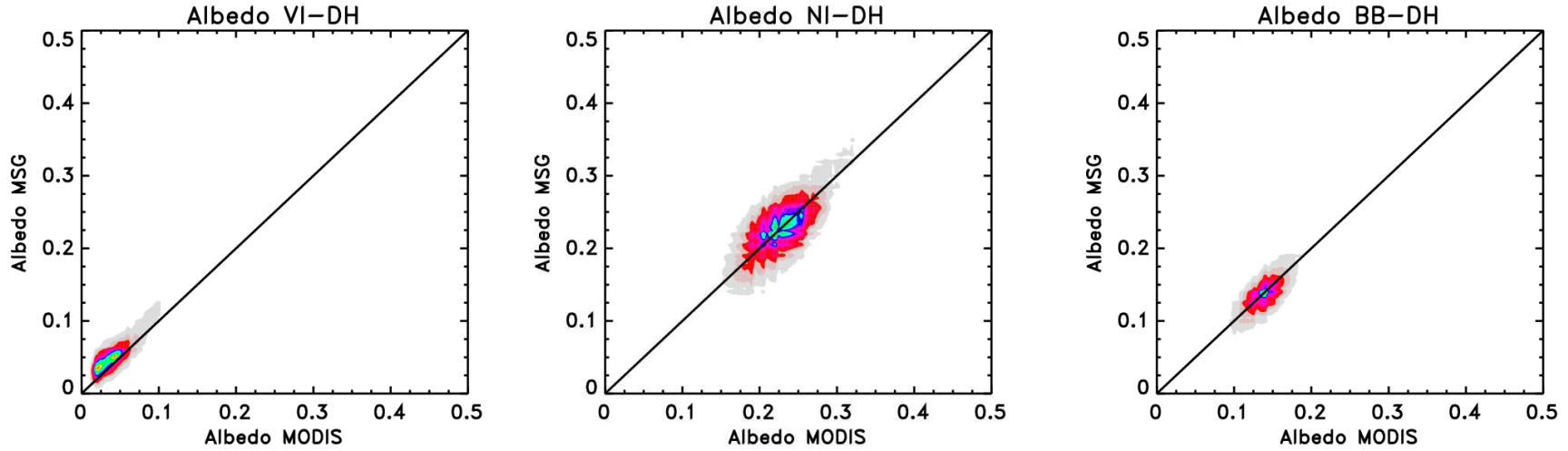
  - **Positive users feedbacks through projects**
    - ✓ **AMMA (AfricanMonsoon Multidisciplinary Analysis)**
    - ✓ **etc ...**

ALBEDO TIME SERIES (snowfall episodes)



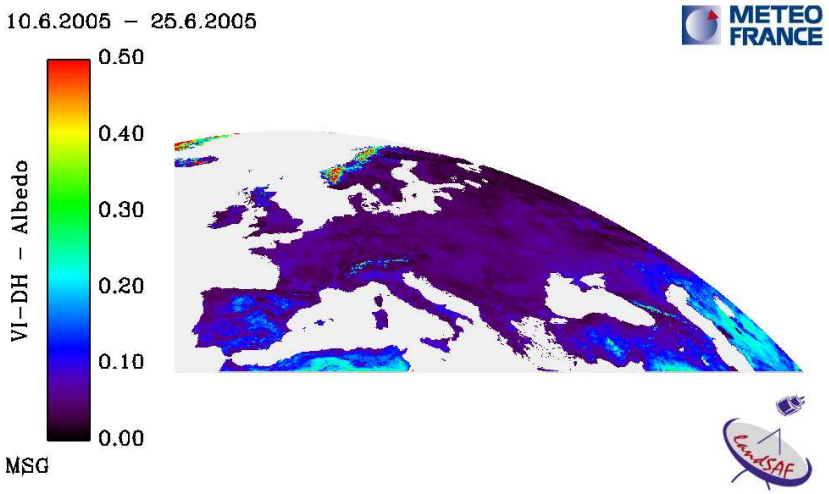
Comparison MSG with MODIS



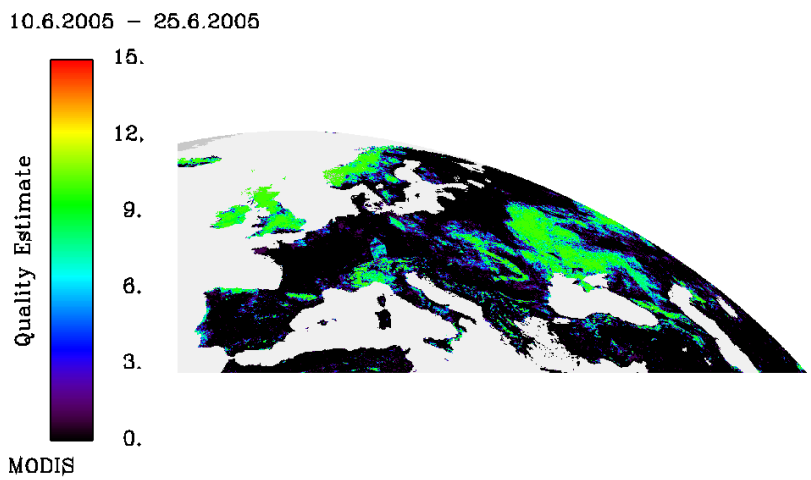


VISIBLE Broad-Band

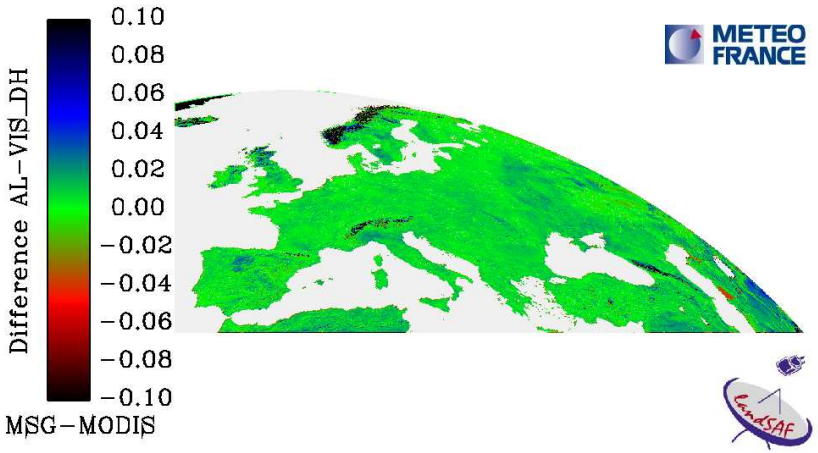
MSG – VIS-DH



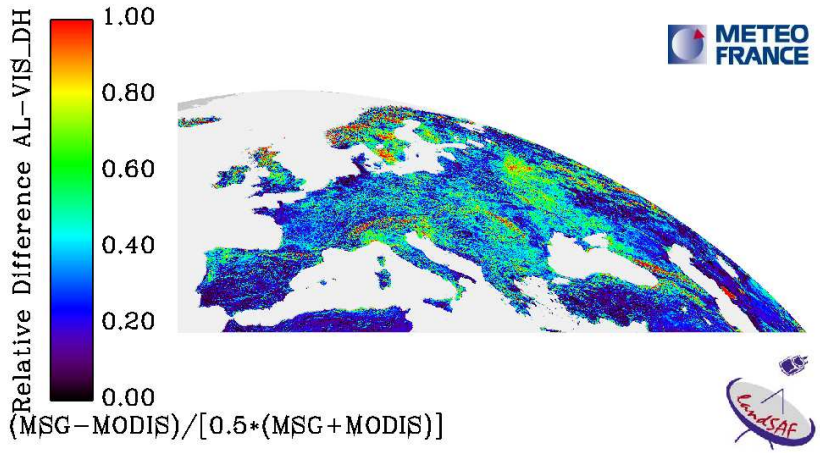
SAF Land – Quality Flag



MSG – MODIS : absolute difference

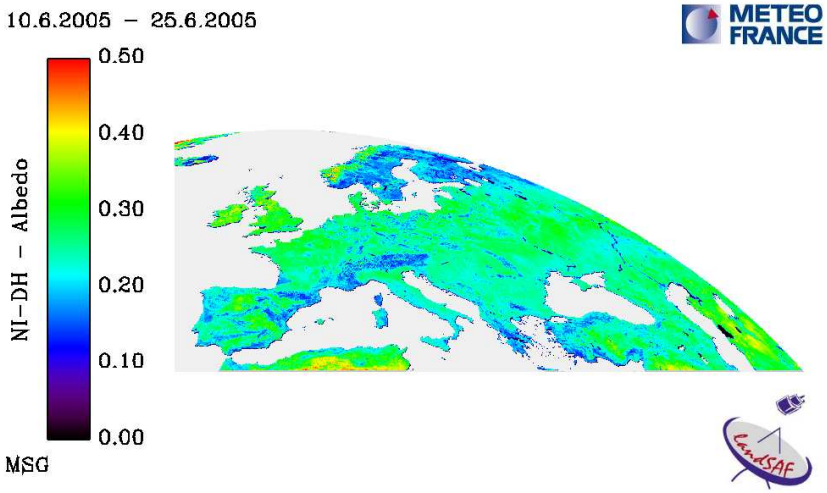


MSG – MODIS : relative difference

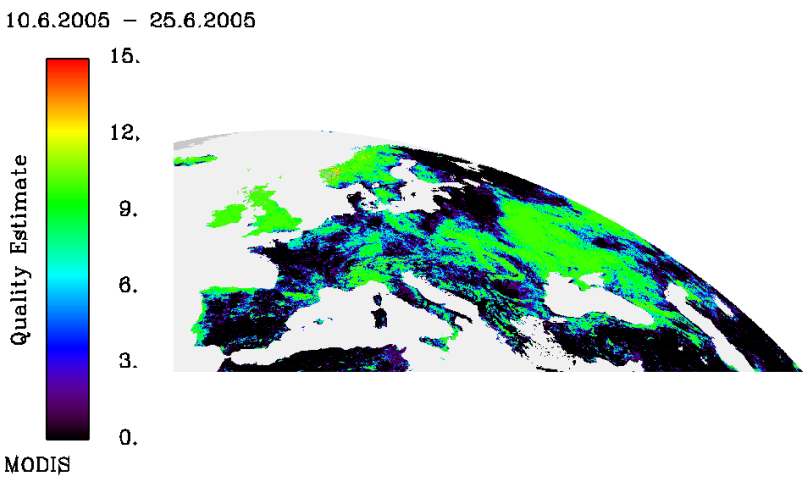


NIR Broad-Band

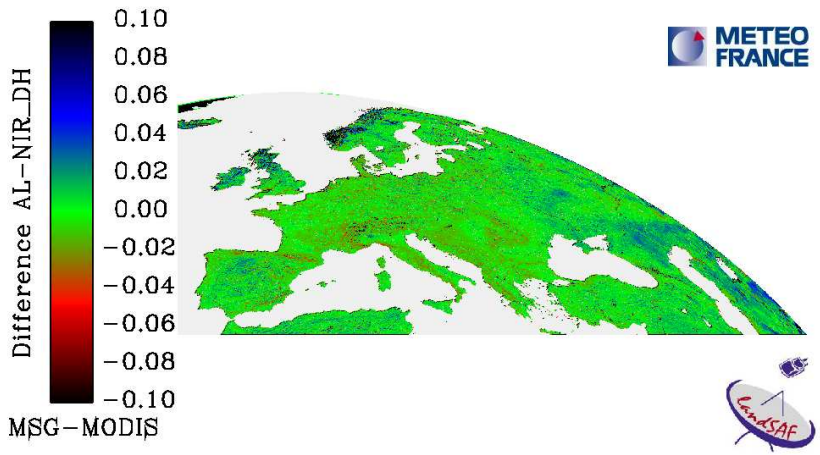
MSG – NIR-DH



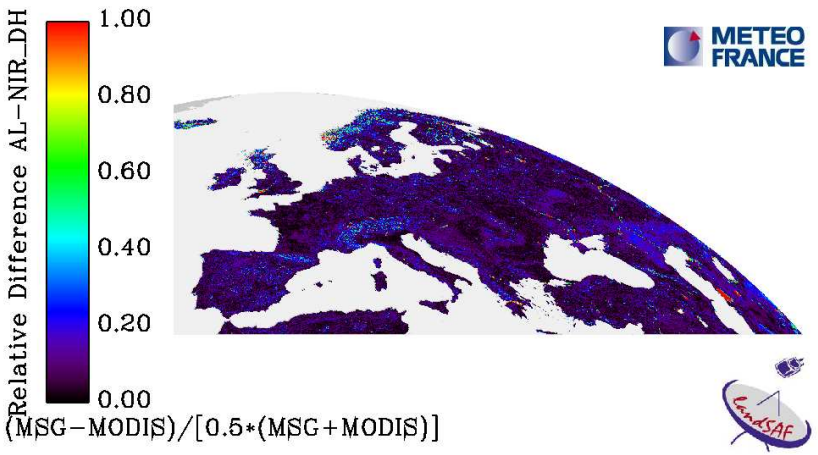
SAF Land – Quality Flag



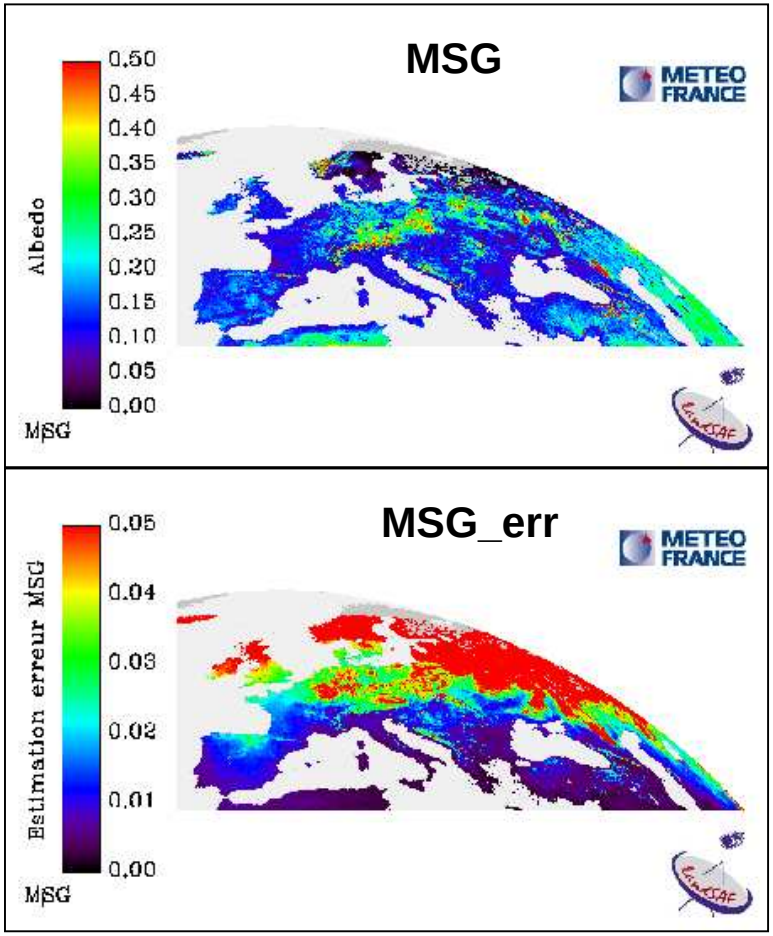
MSG – MODIS : absolute difference

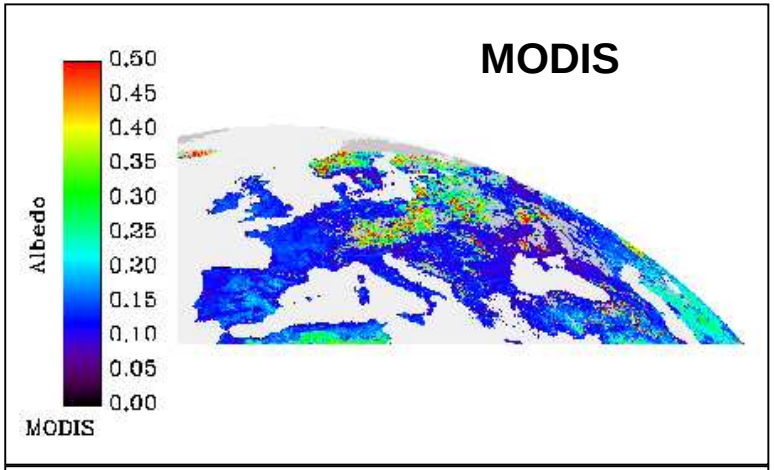


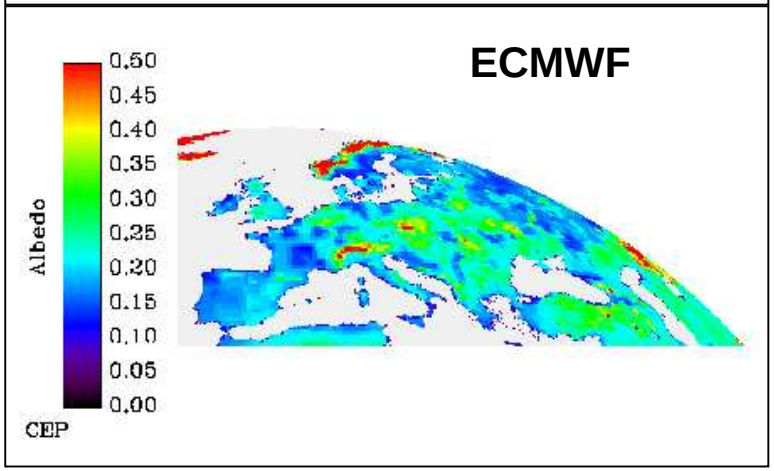
MSG – MODIS : relative difference



SW broadband albedo







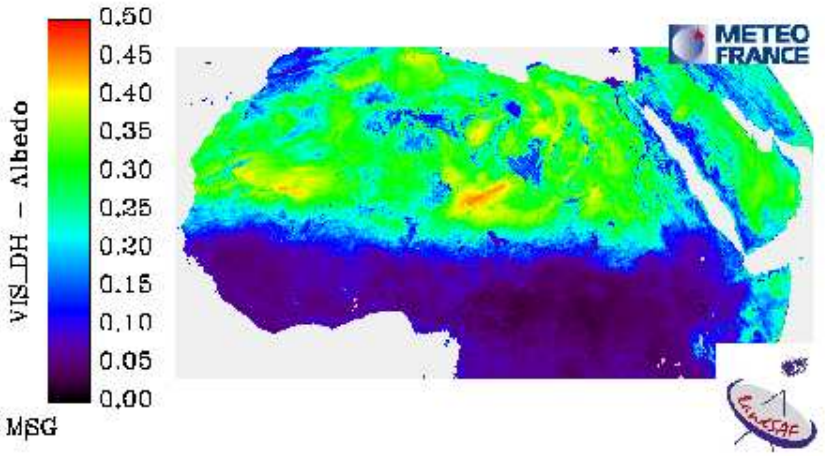
SW broadband albedo estimates for the period Nov. 17 to Dec. 2.

(Land-SAF uncertainty estimates are very high at Northern latitudes due to the unfavourable angular conditions at that time of the year.)

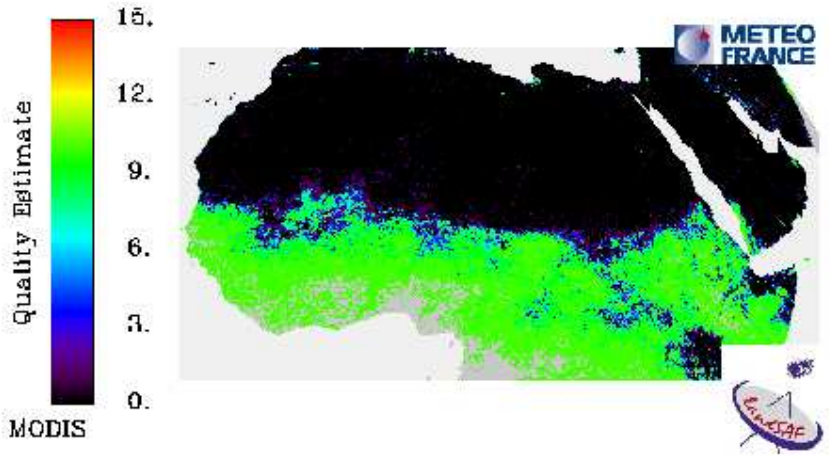
VISIBLE Broad-Band

July 19, 2006

MSG – VIS-DH

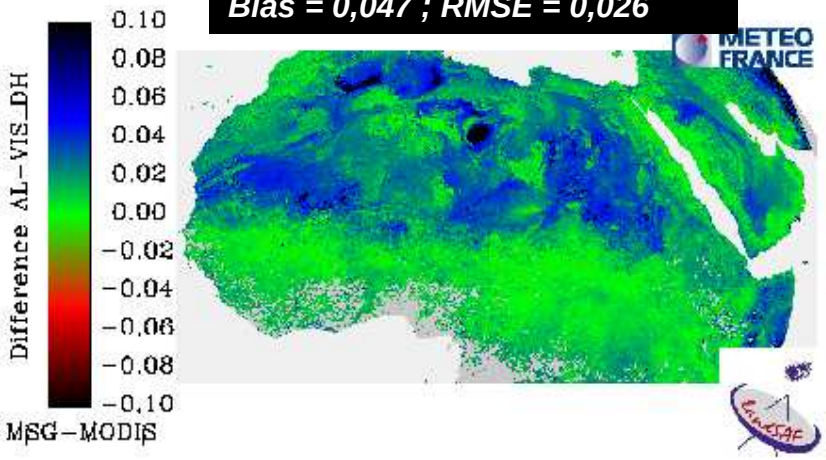


SAF Land – Quality Flag

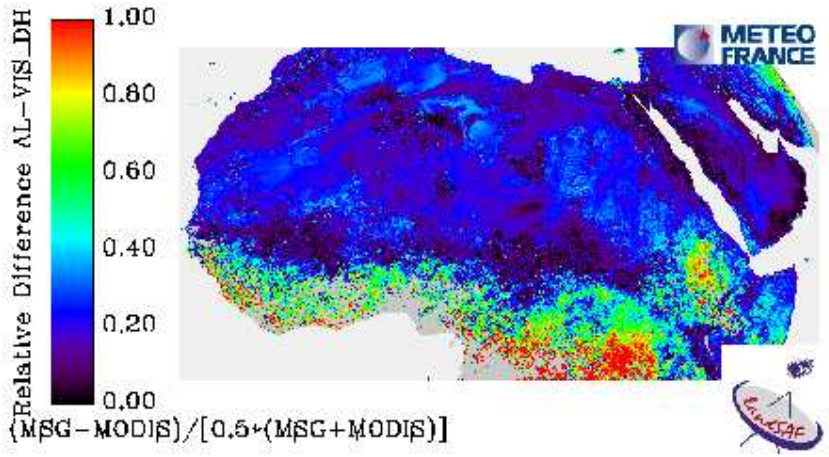


MSG – MODIS : absolute difference

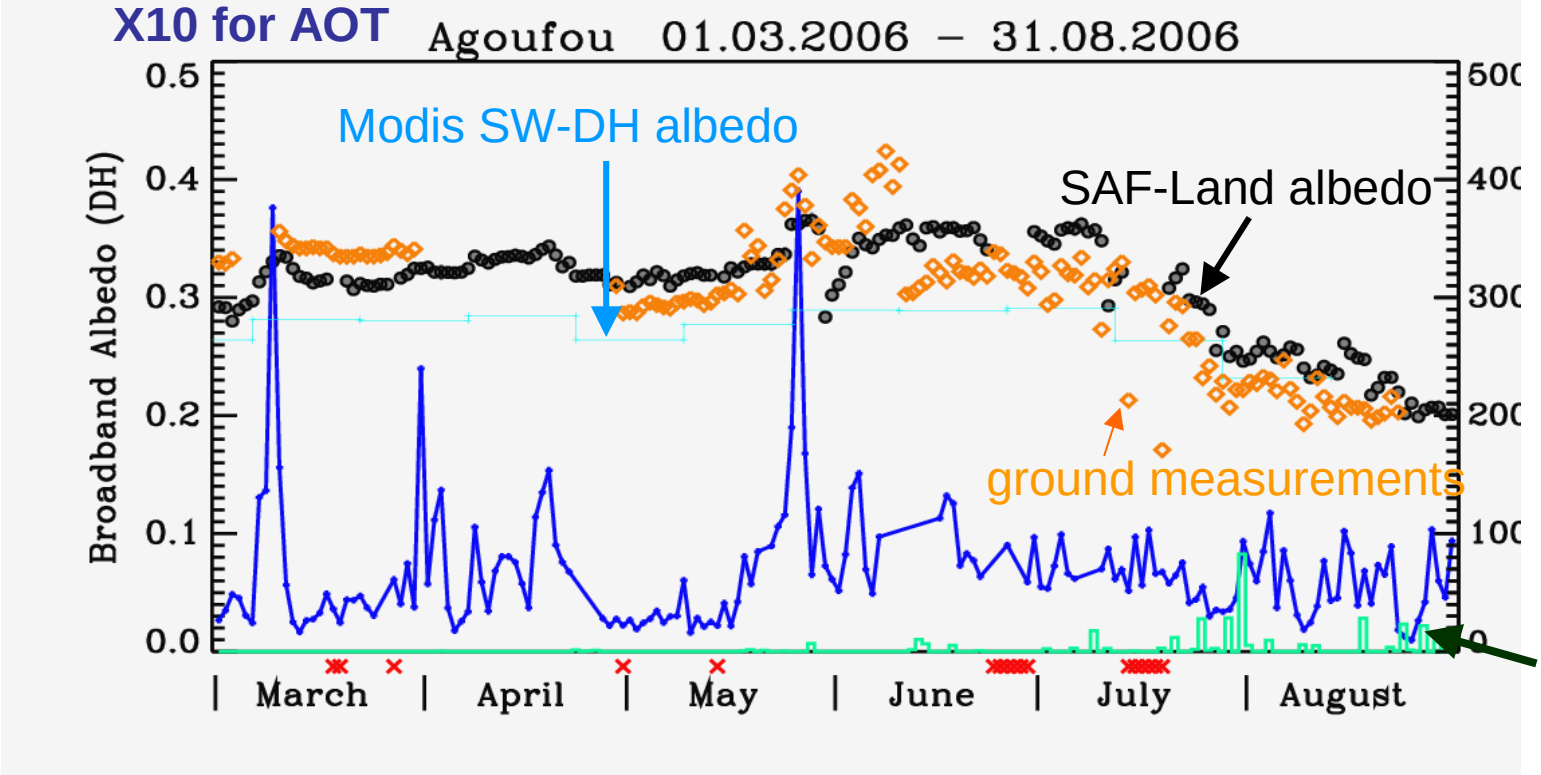
Bias = 0,047 ; RMSE = 0,026



MSG – MODIS : relative difference

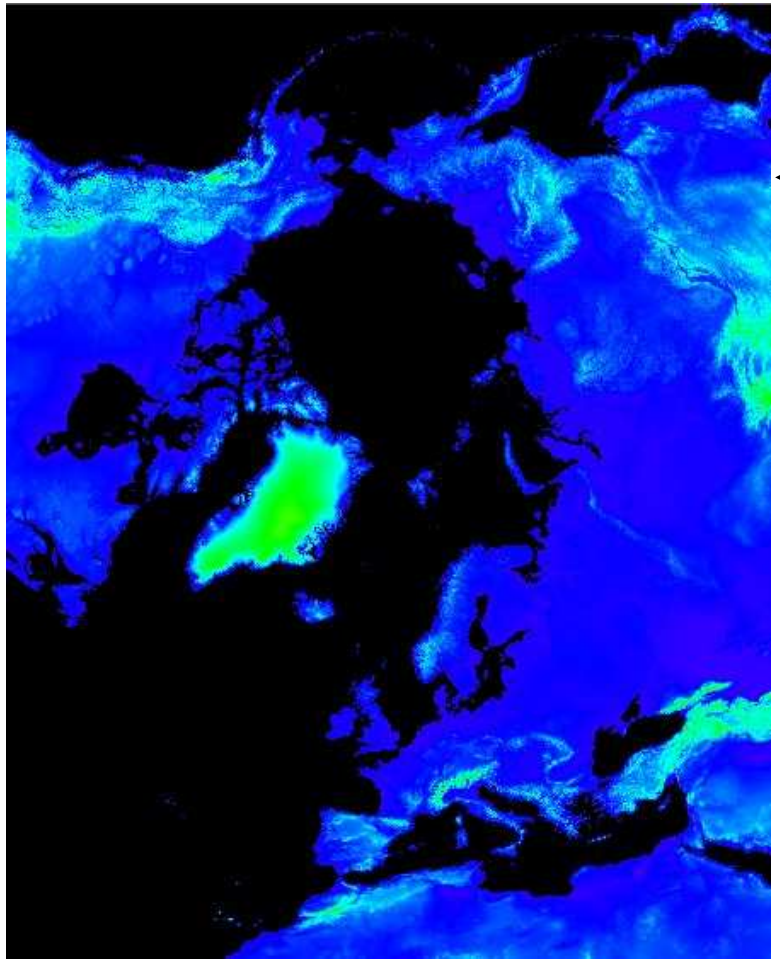


ALBEDO TIME SERIES (aerosol events)



- Temporal evolution of the albedo estimate is influenced by rainfall.
- 'Spurious' fluctuations appear to be caused by aerosol effects.

EPS/AVHRR *(under development)*



← Selected zone

– « High latitudes North » extended

– Projection LAEA (Lambert Azimutal Equal Area)

- Resolution 2.5 km

• Sea Ice albedo mapped

- Algorithm is the same for MSG
- Data reprocessing since march 2010.

- Status of daily albedo (MDAL) => key issues
  - **Validation with ground data (BSRN, FLUXNET)**
    - ✓ tower fluxes are not representative
    - ✓ delayed time to access data sets (data policy, data check)
  - **Validation with other sensors**
    - ✓ MODIS and PARASOL BRDFs show discrepancies however!
    - ✓ PARASOL to be considered soon (available in summer 2010)
  - **Comparison with NWP models (forecast product)**
    - ✓ ECMWF overestimates SAF albedo by 0.1 (winter in Europe)

Issues to be adressed during CDOP-2 (1/2)

- **Present specifications for daily albedo to be reviewed**
- **Merging MSG & METOP data (for northern extension)**

Consistency *(between)*

- ✓ **Snow albedo and Snow Coverage**
- ✓ **Vegetation albedo and leaves phenology**
- ✓ **Surface albedo and land cover maps**
- ✓ **Soil albedo (including wetness), e.g. explore µWave data**

Snow

- ✓ **Snow+ forests (boreal) yield a complex albedo**
- ✓ **BRDF varies during the day for snow & wet soil …**

Issues to be adressed during CDOP-2 (2/2)

- Validation / Case studies
  - ✓ To speed up the access to ground data
  - ✓ Airborne campaigns (boreal forests)
  - ✓ Link to applications (NWP, GMES, …) – Assimilation in models
- Miscellaneous topics
  - ✓ Anomaly indices (<BRDF/veg. Albedo vs stress)
  - ✓ Identify projects for test-bed (HYMEX,…)
- Reprocessing
  - ✓ Homogeneites of time series of data
  - ✓ MSG-1 & MSG-3 merged=> improve pixel resolution in Eastern Europe

Shortwave Radiation Products

➢ New Algorithms / Products

- Distinct soil / vegetation **Albedos**
- Broadband **Albedo** (e.g., PAR)
- 'Blue' albedo (direct+diffuse)
-

from MTG
(to serve NWP, sfc modelling needs)

➢ Improvement of aerosol corrections – impact on short-wave radiation & vegetation products.

- simultaneous retrieval of BRDF and aerosol load
- 3-Hourly aerosol product *(further used to derive Diffuse Radiation)*
- Reprocessed time series of surface albedo from previous Meteosat
- Dissemination of BRDF?

➢ Future missions (MTG, Sentinel, ...)

➢ MTG/FCI (MODIS like)

✓ Maintain an R&D activity allowing the development and the adaptation to FCI/MTG of the existing Land SAF algorithm

➢ Sentinel-3/MERIS (/GEOLAND-2, GMES service elements)

✓ Adaptation to Sentinel-3/MERIS of the existing Land SAF algorithm

✓ Use NPOES images (coll. with US teams)

THANK YOU FOR YOUR ATTENTION !

METEO FRANCE
Toujours un temps d'avance