

The LSA-SAF Albedo products

G. Jacob, D. Carrer & J.-L. Roujean

CNRM-GAME, Météo France, Toulouse

Outline

■ ***Method for retrieval***

- Theoretical Framework
- Available Input
- BRDF Inversion
- Algorithm overview
- Algorithm output

■ ***Products***

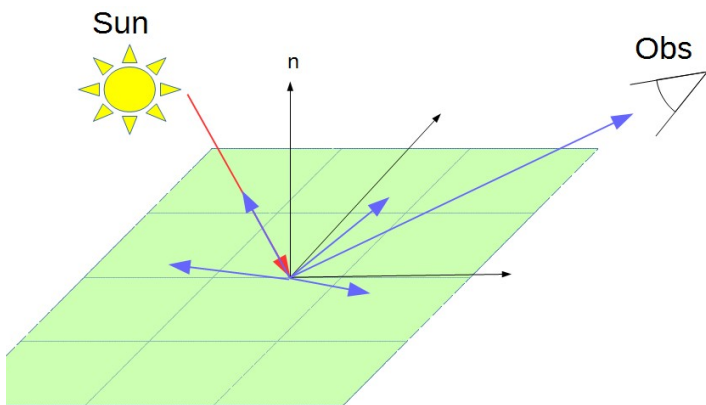
- Products Overview
- MDAL
- ETAL

■ ***Perspectives & Further developments***

- Preparation for next generation instruments
- Aerosol-Albedo product development

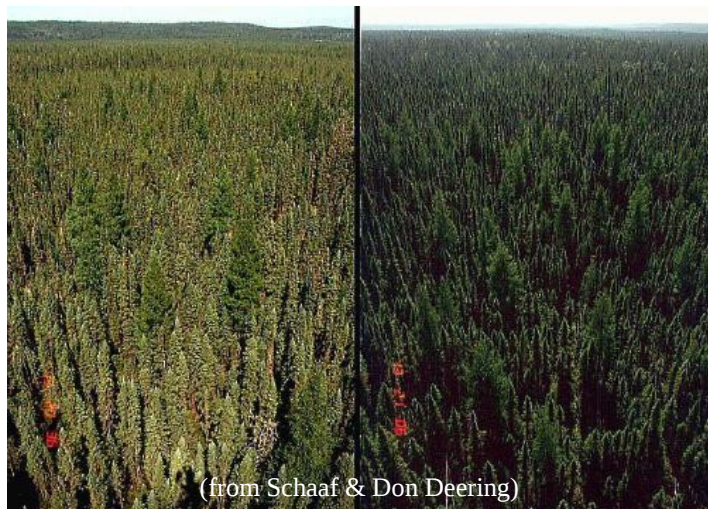
Method For Retrieval

Theoretical Framework



Albedo

$$a = \frac{\text{up-welling radiation}}{\text{down-welling radiation}}$$



Method

- Estimate the atmospheric effects
- Determine directional properties of surface reflectivity

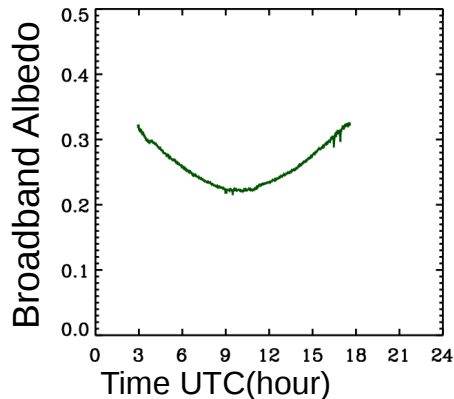
$$L^{\uparrow}(\lambda, \theta_{out}, \varphi_{out}) = \frac{1}{\pi} \int_{2\pi} R(\lambda, \theta_{out}, \varphi_{out}, \theta_{DH}, \varphi_{DH}) \cdot L^{\downarrow}(\lambda, \theta_{in}, \varphi_{in}) \cos \theta_{in} d\Omega_{in}$$

R : Bi-Directional Reflectance Distribution Function (BRDF)

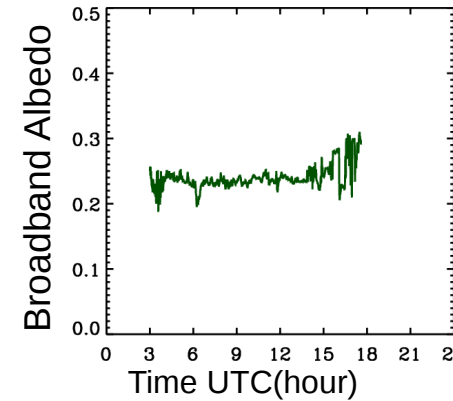
describes how terrestrial surfaces reflect solar radiation
[Ross (1981); Walthall et al. (1985), Roujean et al. (1992)]

Theoretical Framework

Only direct illumination



Only diffuse illumination :



Directional-Hemispherical (black-sky) Albedo

$$\alpha^{DH}(\lambda, \theta_{DH}, \varphi_{DH}) = \frac{1}{\pi} \int_{2\pi} R(\lambda, \theta_v, \varphi_v, \theta_{DH}, \varphi_{DH}) \cdot \cos(\theta_v) \cdot d\Omega_v$$

Bi-Hemispherical (white-sky) Albedo

$$\alpha^{BH}(\lambda) = \frac{1}{\pi} \int_{2\pi} \alpha^{DH}(\lambda, \theta_s, \varphi_s) \cdot \cos(\theta_s) \cdot d\Omega_s$$

Approximated true (blue-sky) surface albedo :

$$\alpha(\lambda) = [1 - f_{dif}] \cdot \alpha^{DH}(\lambda, \theta_s, \varphi_s) + f_{dif} \cdot \alpha^{BH}(\lambda)$$

Diffuse fraction

Retrieve albedo ⇔ know BRDF for each angular configuration

Available Input Data

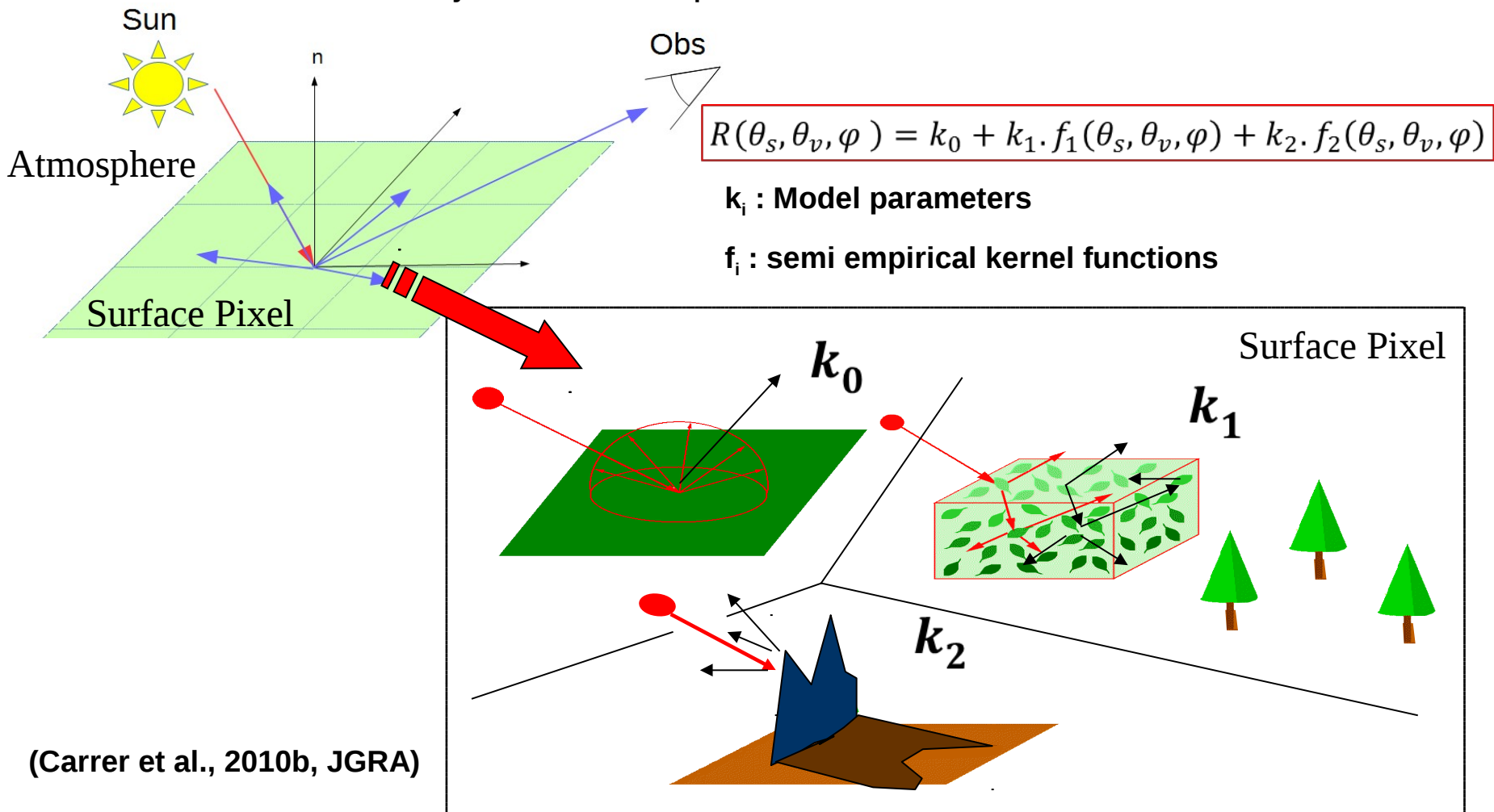
- Top of Atmosphere Radiances
- View and Solar angles
- Land/Sea Mask and cloud Mask
- Atmosphere properties :
 - O_3 & H_2O contents (ECMWF or climatology)
 - Pressure (ECMWF)
 - Aerosol Optical Thickness (Climatology or ECMWF)

TOA-Radiances Wavelengths		
Domain	MSG/SEVIRI	MetOp/AVHRR
Visible	0.6 μm	0.63 μm
	0.8 μm	0.865 μm
Near-Infrared	1.6 μm	1.61 μm

We need an inversion model to retrieve BRDF from Radiances

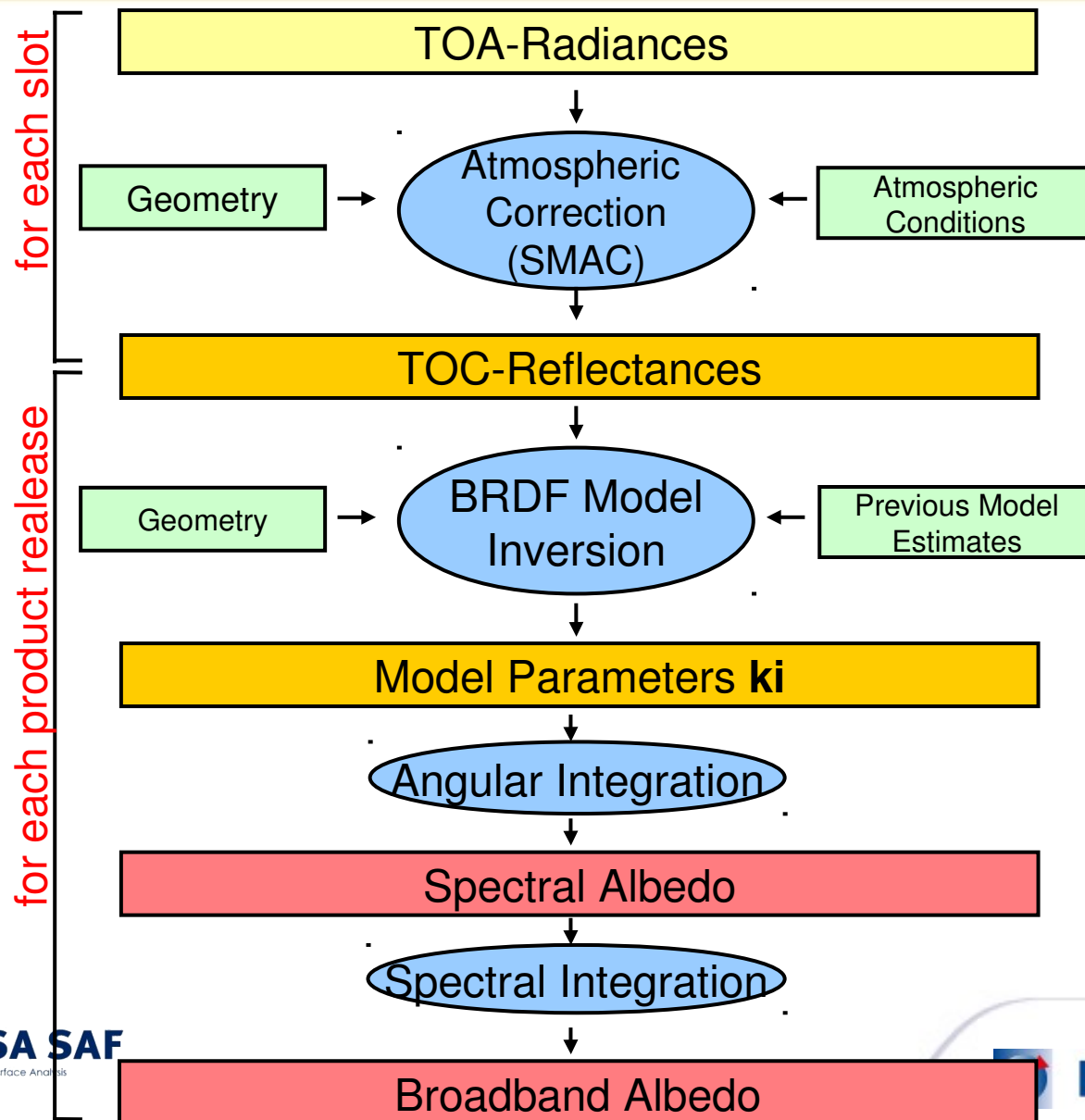
BRDF Inversion Method

Roujean Semi-empirical kernel-based model



(Carrer et al., 2010b, JGRA)

Algorithm Overview



Algorithm output

- Spectral Albedo products in Visible and Near Infrared bands :
 - **AL-SP-DH** : ALbedo SPectral Directional-Hemispherical
 - **AL-SP-BH** : ALbedo SPectral Bi-Hemispherical

- Broadband Albedo products :
 - Visible Domain : $[0.4\mu m - 0.7\mu m]$
 - **AL-VI-DH** : ALbedo VIisible Directional-Hemispherical
 - Near Infrared Domain: $[0.7 \mu m - 4\mu m]$
 - **AL-NI-DH** : ALbedo Near-Infrared Directional-Hemispherical
 - Shortwaves domain (Broadband) : $[0.3\mu m - 4\mu m]$
 - **AL-BB-DH** : ALbedo BroadBand Directional-Hemispherical
 - **AL-BB-BH** : ALbedo BroadBand | Bi-Hemispherical

Products



Products Overview

Product Acronym	Product Name	Description	Product Status
MDAL	MSG Daily Albedo	5 days composite albedo daily updated	Disseminated since 2005
MTAL	MSG 10-Days Albedo	30-days composite of albedo	Disseminated since 2009
MDAL-SVS	MSG Soil/Vegetation/Snowfree Daily Albedo	MDAL + soil/vegetation/snow partition of the albedo	Planned for 2017
MTAL-R	MSG 10-Days Albedo Reprocessed	MTAL reprocessing for 2004-2013	Planned for end of 2015
MTDAL	MTG Daily Albedo	Same as MDAL	Planned for 2019
MTTAL	MTG 10-Days Albedo	Same as MTAL	Planned for 2019
ETAL	EPS 10-Days Albedo	30-days composite of albedo	Planned for the end of 2015
ETAL SG	EPS SG Albedo	Same as ETAL	Planned for 2022

Product Status :



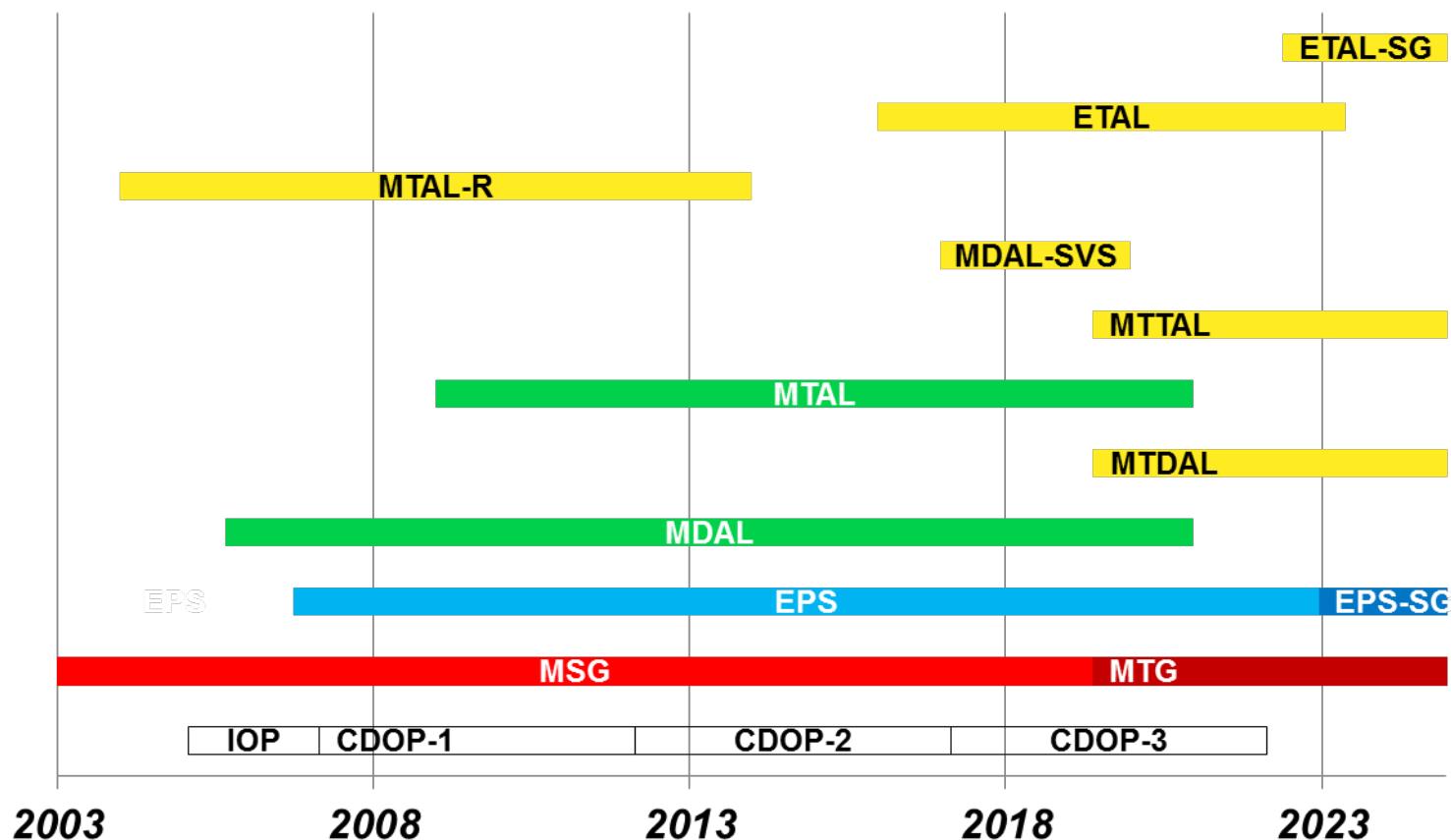
Operational



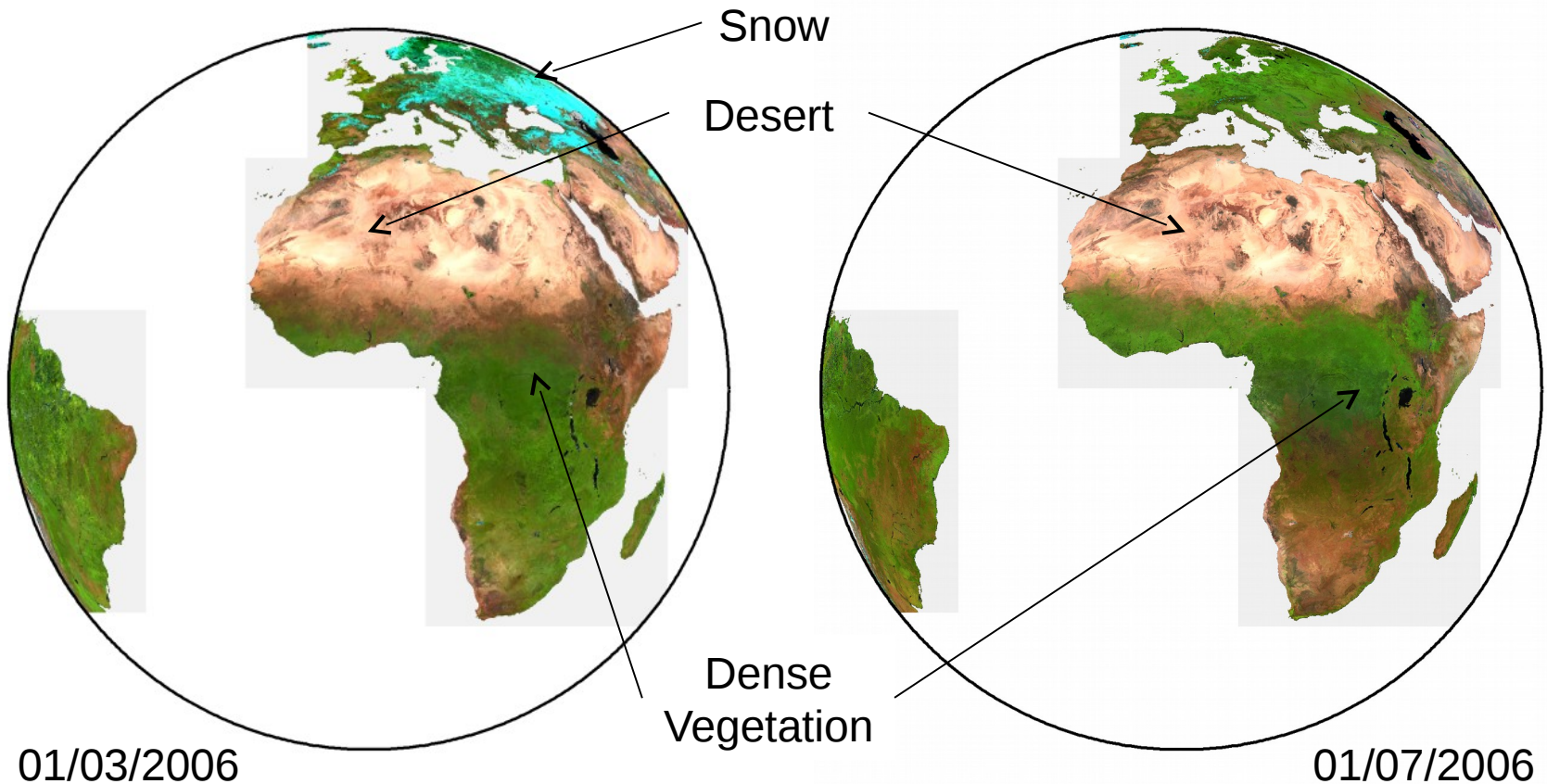
In development

Products Overview

LSA-SAF Albedo Products Timeline

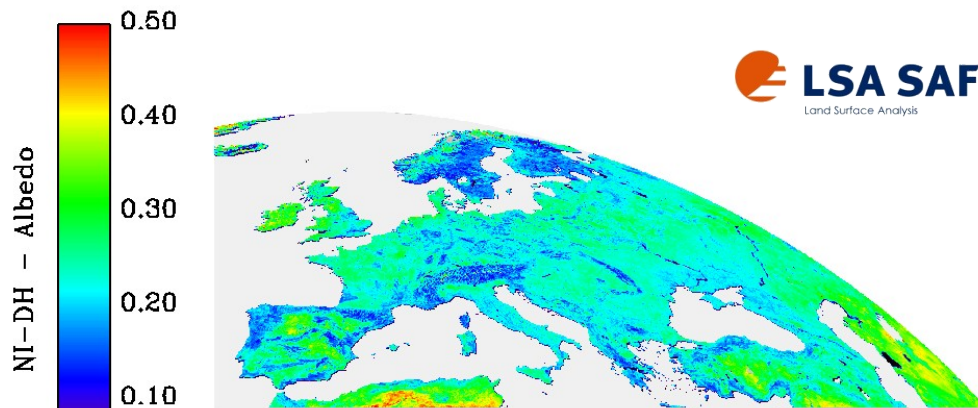


MDAL : Example

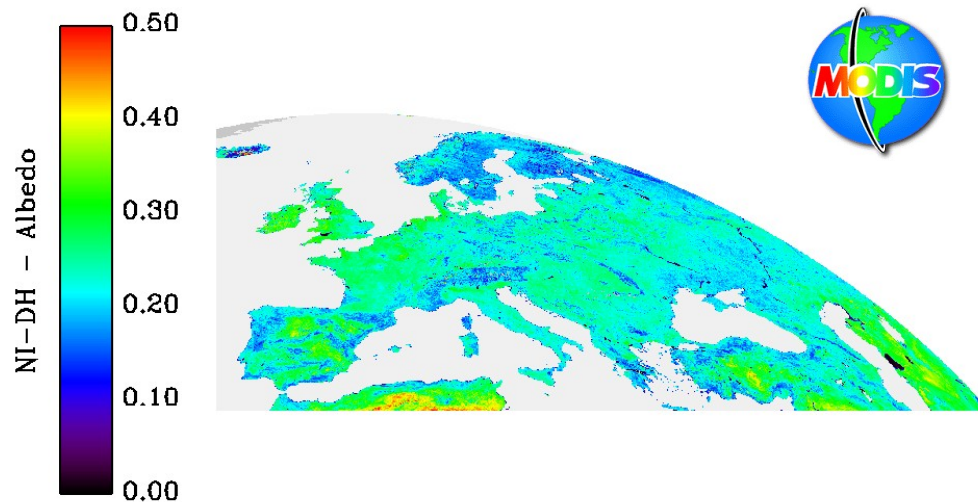


MDAL Spectral Albedo color composite
Red : 1.6µm, Green : 0.8 µm, Blue : 0.6 µm

MDAL : MDAL vs. MODIS ALBEDO : Europe



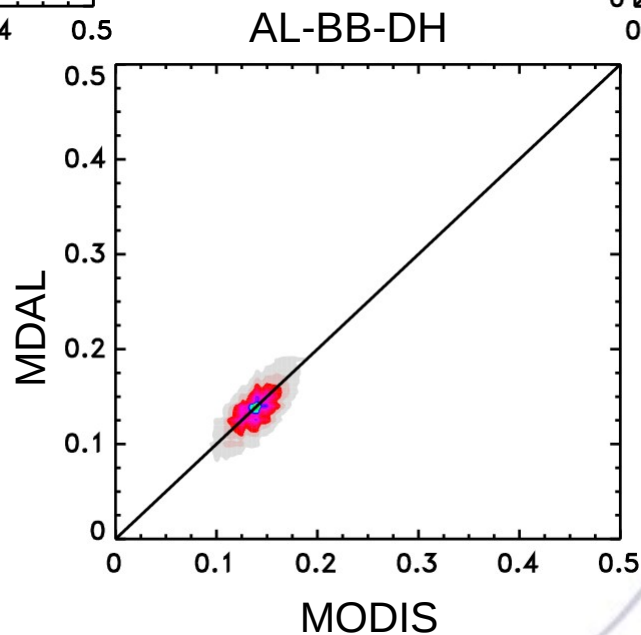
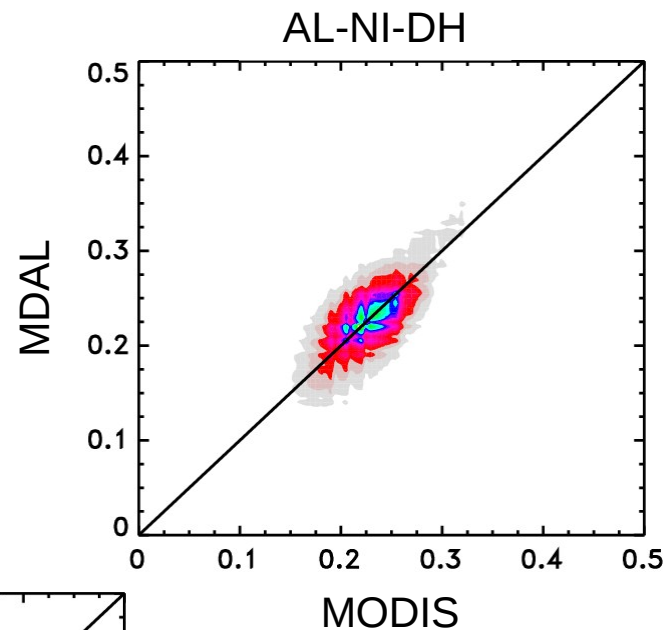
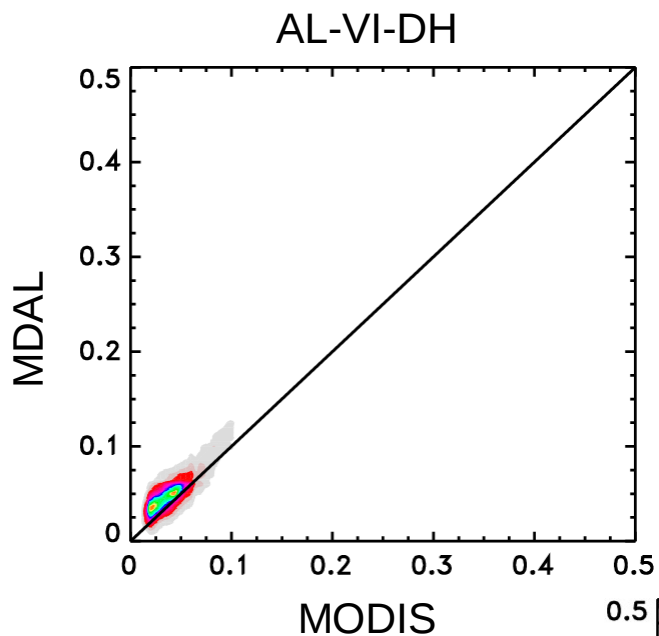
MDAL : 13-28 of August 2005 (average)



MODIS albedo : 13-28 of August 2005
(reprojected on MDAL Grid)

(Carrer et al., 2010b, JGRA)

MDAL : MDAL vs. MODIS ALBEDO : Europe



Top left : VIS albedo
Top right : NIR albedo
Bottom : BB albedo

(Carrer et al., 2010b, JGRA)

MDAL vs MODIS over
Europe for 13-28
August 2005 period

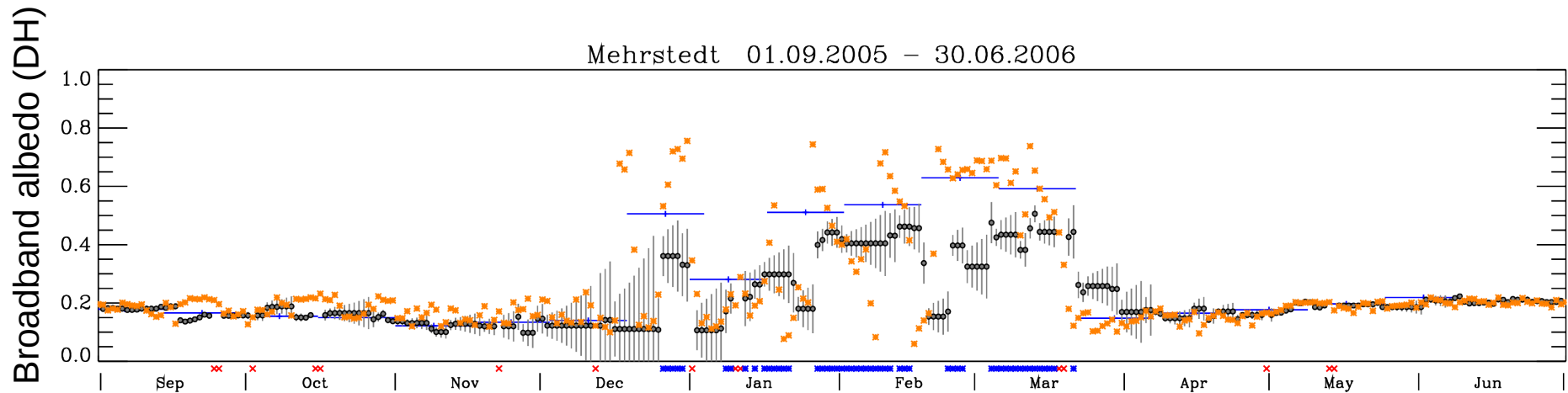
MDAL : Performances Summary

Over mid-latitude region (Europe):

- Bias between MDAL and MODIS albedo
 - Near Infrared and Broadband albedo :
 - Less than 5% in relative units (except for snow/ice pixels)
 - Below 0.01 in absolute unit
 - Visible albedo : 20% in relative units (potentially due to the use of different BRDF models and aerosol corrections)
- Standard deviation :
 - Near Infrared & Broadband albedos : 0.030
 - Visible albedo : 0.015

More information available in the Validation Report and Product User Manual

MDAL : Albedo Time-series



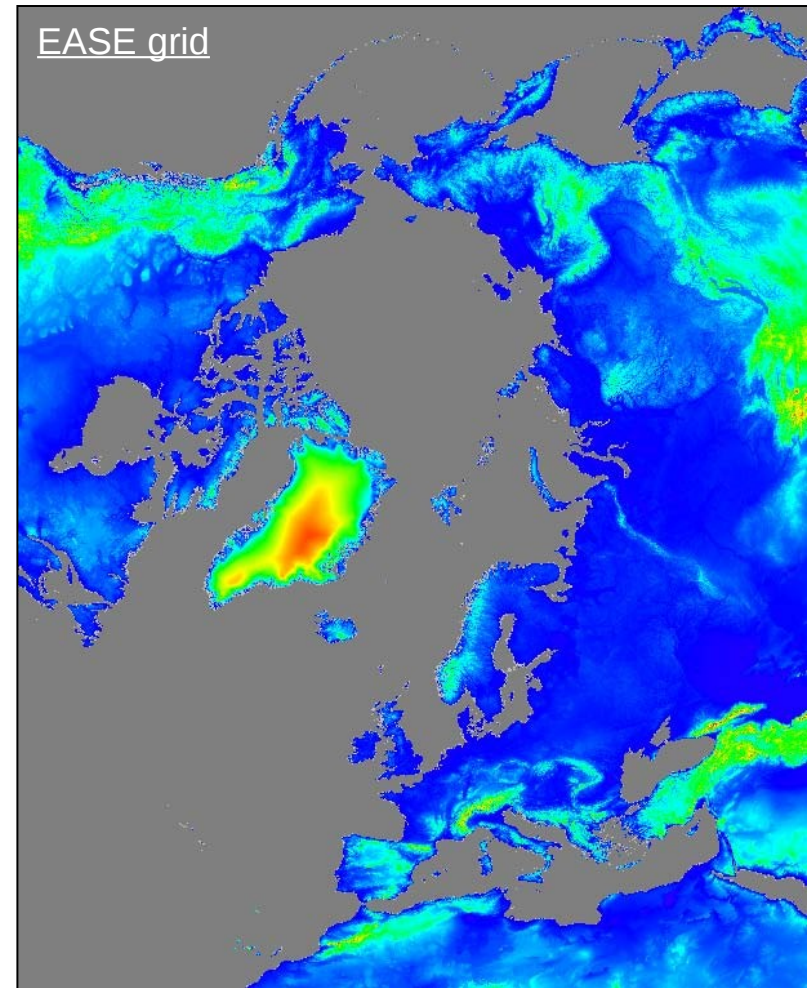
Broadband DH albedos for the Mehrstedt site (Germany)

- Orange dots : ground measurements
- Black dots : MDAL broadband albedo (DH)
- Blue solid line : MODIS broadband albedo (DH)
- Blue crosses on x-axis : snow flag occurrence

(Carrer et al., 2010b, JGRA)

ETAL

- EPS albedo product
- 10-Days Albedo product
 - Composite period: 30 days
 - Synthesis period: 10 days
 - Coverage: global
- Prototype Processing Chain in test phase



Perspectives & Further Developments

Preparation for the next generation instruments

■ 2019 : MTG

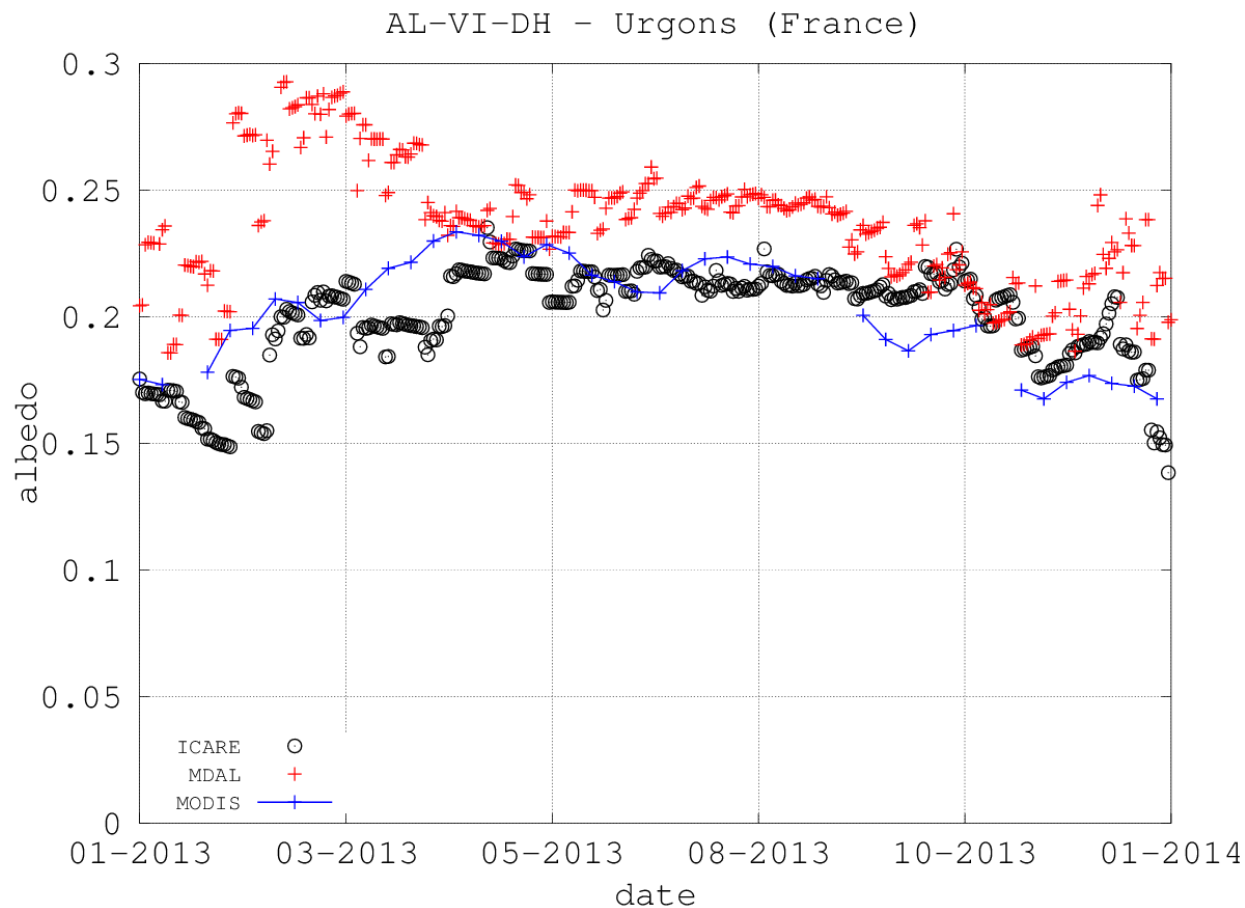
- Flexible Combined Imager (FCI): successor of SEVIRI with :
 - Better spectral resolution (5 VIS bands and 3 NIR bands)
 - Better Spatial resolution (1km a sub-satellite point)
 - Better repetivity (an aquisition every 10 minutes)

■ 2022 : EPS-SG

- Visible/Infrared Imager (VII) : successor of AVHRR
- Multi-viewing, Multi-Channel, Multi-Polarization Imager (3MI) : POLDER Heritage

Future Products			
Product Acronym	Product Name	Description	Expected start
MTDAL	MTG Daily Albedo	5 days composite albedo	2019
MTTAL	MTG 10-Days Albedo	30-days composite of albedo	2019
ETAL-SG	EPS-SG 10-Days Albedo	30-days composite of albedo	2022

Aerosol-albedo product Development



For more information about ICARE aerosol product : see Dominique Carrer's presentation at 16:45

Thank You



