



# The Use of Remote Sensing Data to improve the modelling of Skin Temperature

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## Scope of Presentation

### **I – Remote Sensing & Modelling of Skin Temperature**

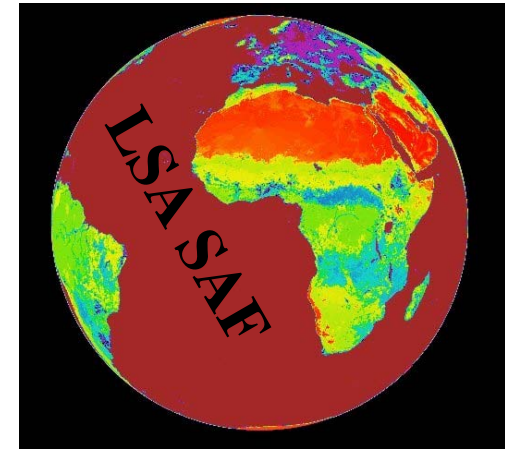
- **Diagnostic of ECMWF LST**
- **Sensitivity Experiments**
- **Diagnostic of Revised Surface Scheme**



## Scope of Presentation

### II – SAF for Land Surface Analysis

- **Concept and Products**
- **Schedule**
- **Beta-Users**





# Comparison of Meteosat and ECMWF brightness temperatures

Window Channel (10.50 – 12.50  $\mu\text{m}$ )

**METEOSAT – 7 clear sky** .... Tb\_OBS

**ECMWF model equivalent** .... Tb\_ECMWF

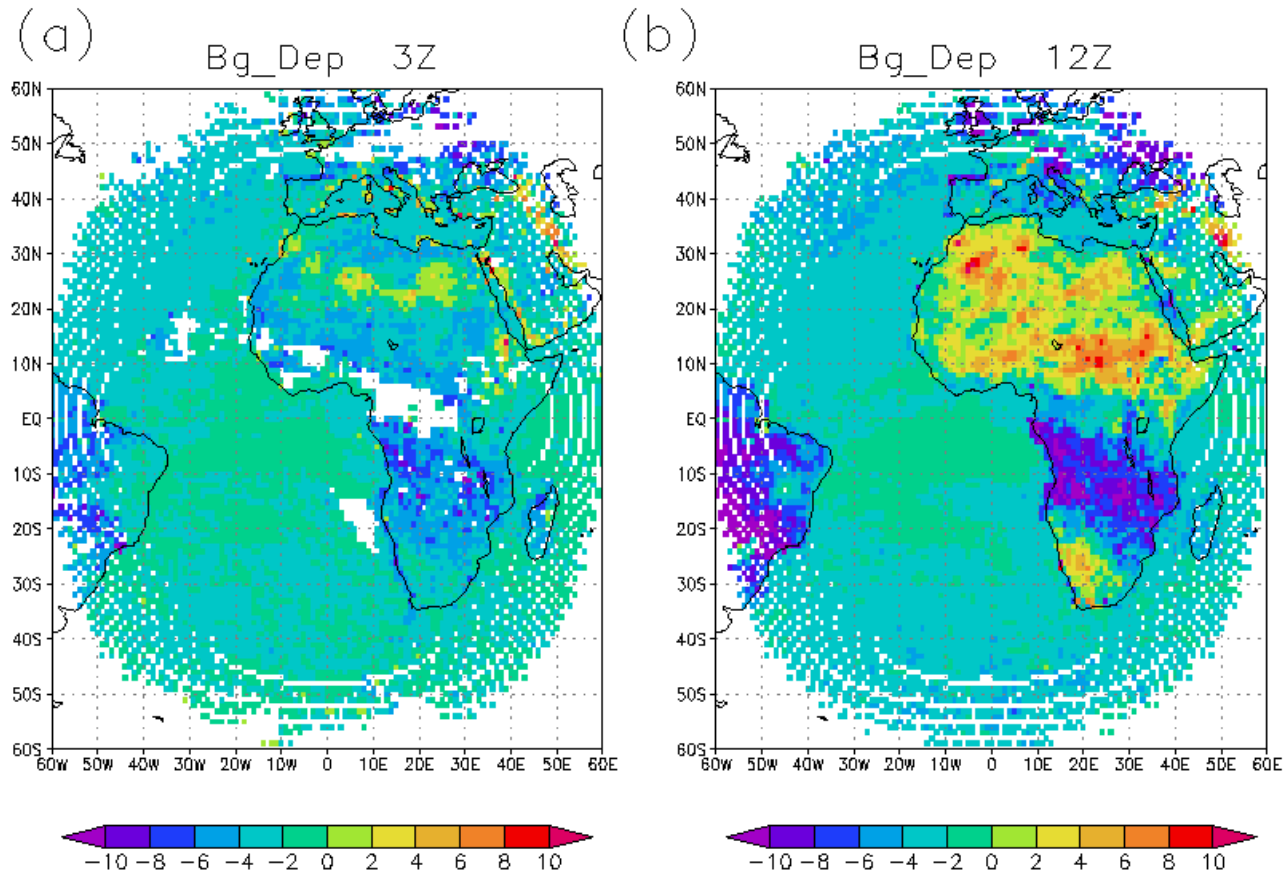


To assess the  
quality of modelled  
land surface  
temperature.

To monitor the quality of the  
observations by identifying  
gross errors / systematic  
problems in the data.



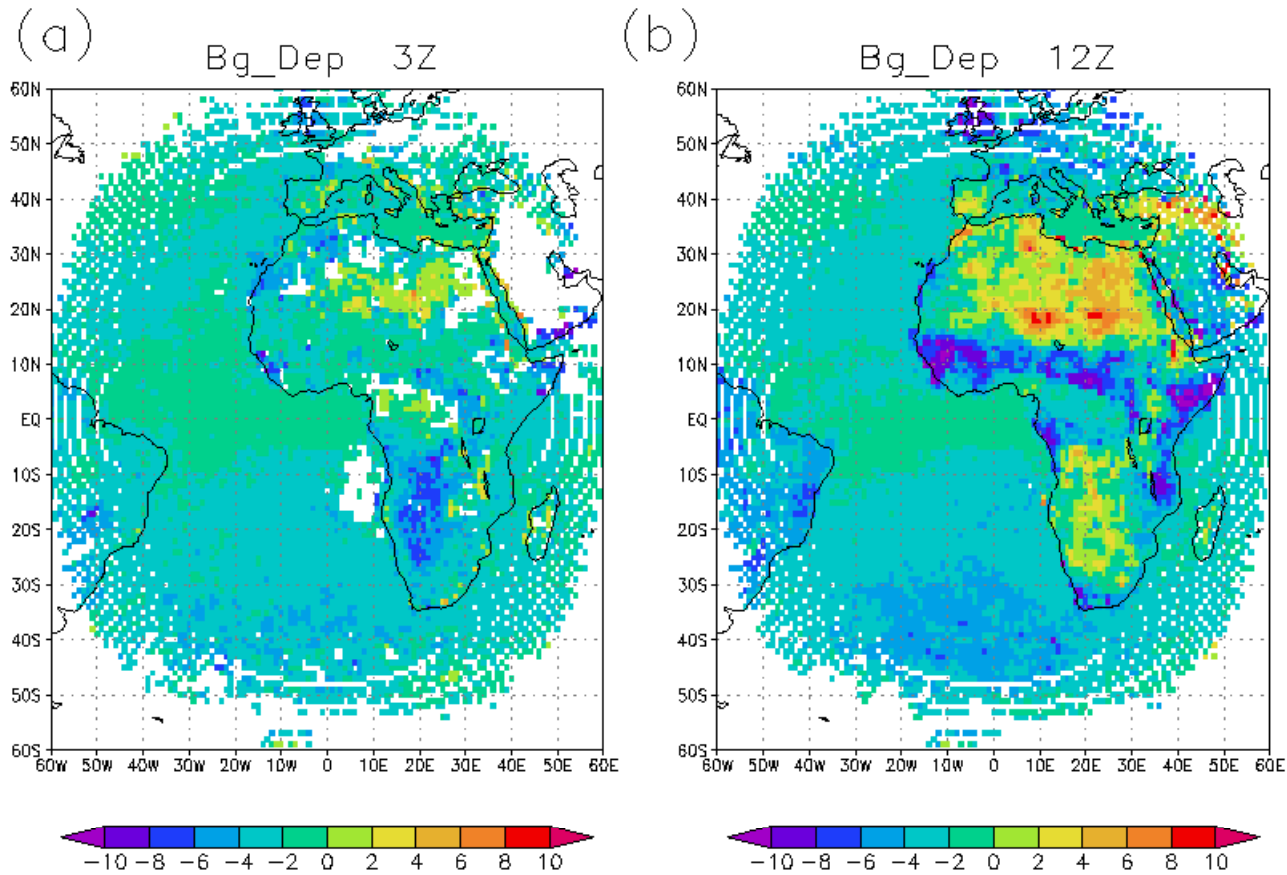
1-15 Feb 2001



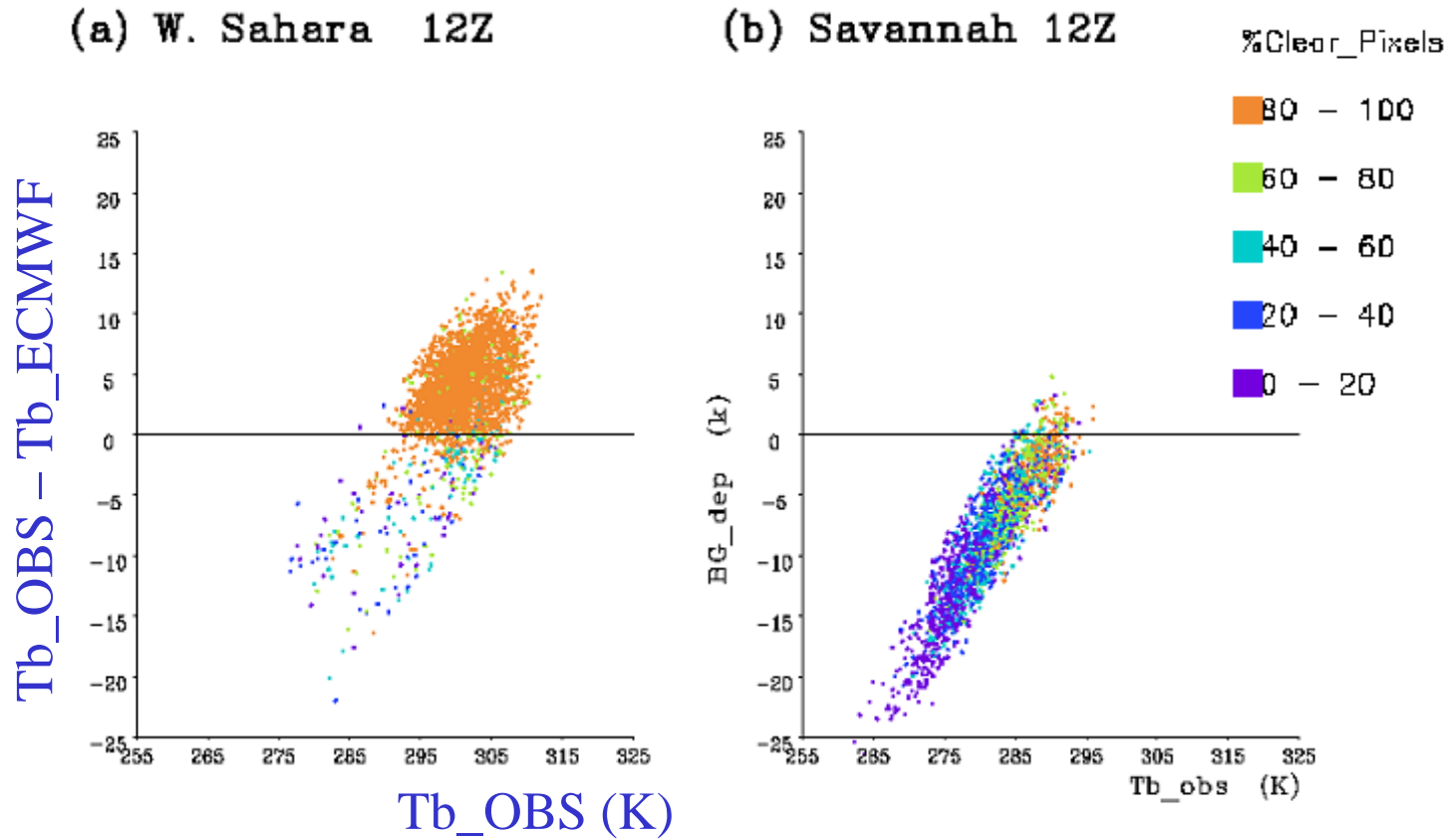
$Tb_{obs} - Tb_{ECMWF}$   
Averaged for **1-15 Feb 2001**



1-15 Jul 2001



$Tb_{obs} - Tb_{ECMWF}$   
Averaged for 1-15 Jul 2001





## Sources of Window channel Tb Systematic Errors

(i) cloud screening of the **observations** ...



- threshold for the %Clear Sky pixels;
- MSG allows more accurate cloud masks.

(ii) **underestimation** of **modelled** diurnal amplitudes of Tb\_ECMWF in clear sky conditions



underestimation of **LST diurnal cycle**  
(particularly over arid and semi-arid regions)



## Sensitivity Experiments using ECMWF 1-column Model

Sensitivity of the model **T<sub>b</sub> amplitude** to  
surface parameters / variables:

- albedo
- emissivity
- skin layer conductivity
- roughness length for mom.
- **roughness length for heat**
- soil moisture (\*)
- soil temperature

→ Impact on T<sub>b</sub> amp.:  
negligible  
small  
moderate/high

(\*) impact on the phase ; BL humidity ; ...

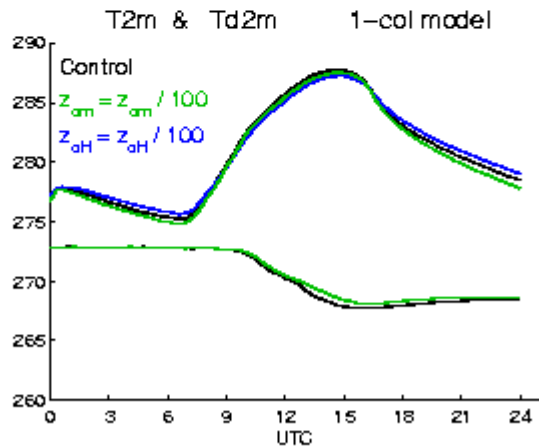
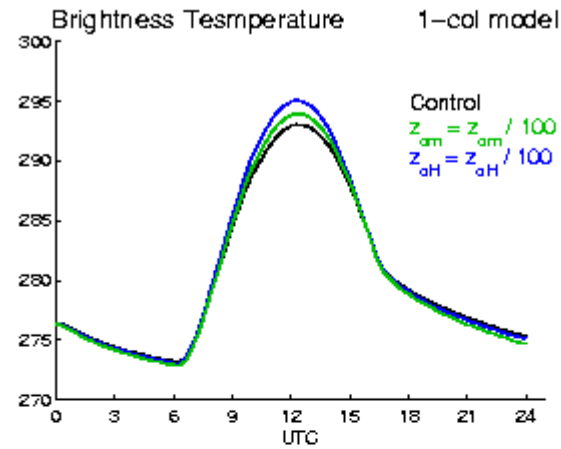
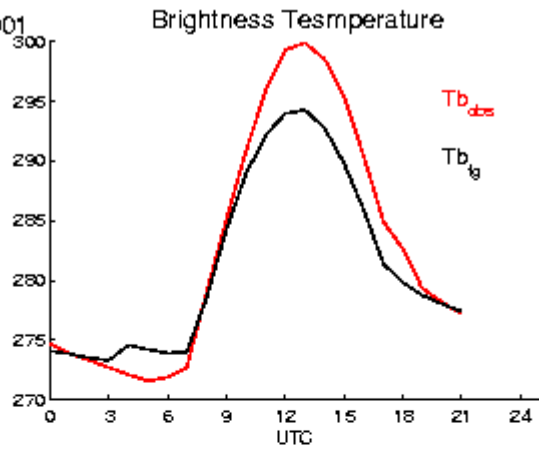


ECMWF 1-col model :  $Z_{oM} = Z_{oM} / 100$

$Z_{oH} = Z_{oH} / 100$

I

W. Sahara  
3Feb2001



## Impact of $Z_{oM}$ and $Z_{oH}$

	Amp_Tb	T_2m	Td_2m
$Z_{oM} / 100$	1K	< 0.5K	< 0.5K
$Z_{oH} / 100$	2K	< 0.5K	< 0.5K



Sensitivity experiments of **T<sub>b</sub> amplitude** to  
surface parameters / variables point to  
adjustments to **Z<sub>oH</sub>**

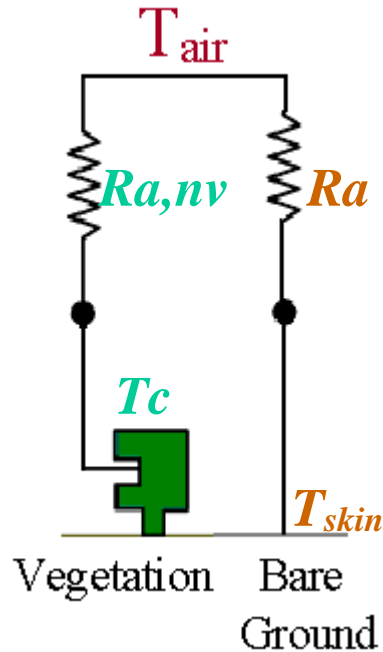


Model deficiencies in the  
**LAND – ATMOSPHERE**  
**Aerodynamic Coupling**



# ECMWF Land Surface Model - TESSEL

I



Dry, Snow Free Surfaces:

$$H = f_{lowV} H_{lowV} + f_{highV} H_{highV} + (1 - f_{lowV} - f_{highV}) H_{bare\_g}$$

Bare Soil Tile:

$$H_{bare\_g} = \rho c_p \frac{T_{air} - T_{skin}}{R_a}$$

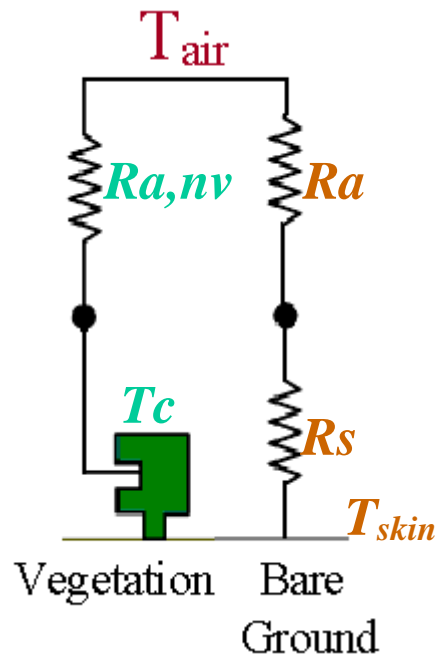
$R_a$  does not take into account the wind shielding effect of surrounding vegetation.

$H_{bare\_g}$  is overestimated, particularly over sparsely vegetated areas.





# Revised Surface Coupling



$R_s$  – Resistance to turbulent heat transfer within the under canopy layer.

- sparseness of the vegetation;
- canopy height;
- ...

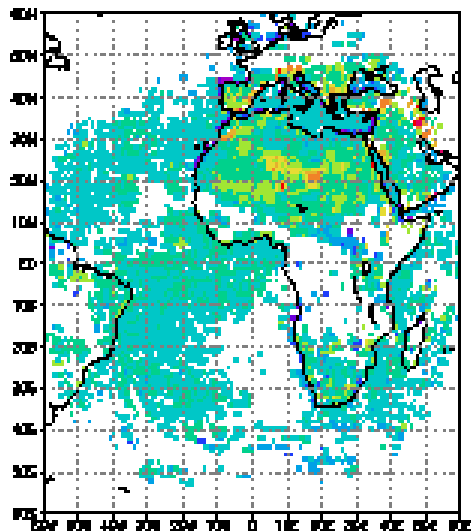
$$H_{bare\_g} = \rho c_p \frac{T_{air} - T_{skin}}{R_a + R_s}$$

$$R_s = \frac{1}{a + bu_*^2}$$

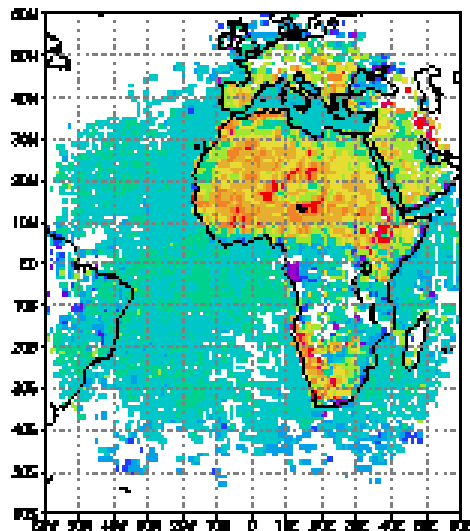


[Tbobs - Tb] Expver = Control

3 UTC

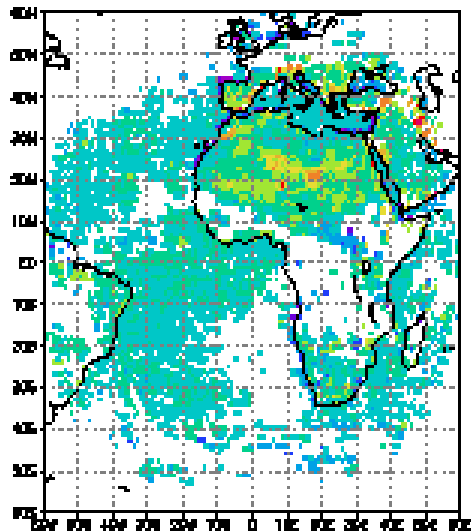


12 UTC

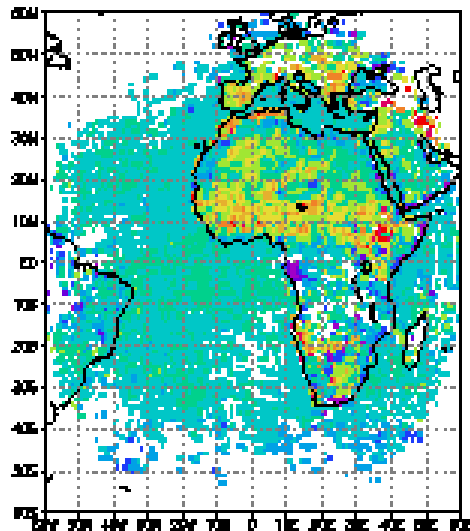


[Tbobs - Tb] Expver = ejrq

3 UTC



12 UTC



1-15 Feb 2002 I

Control

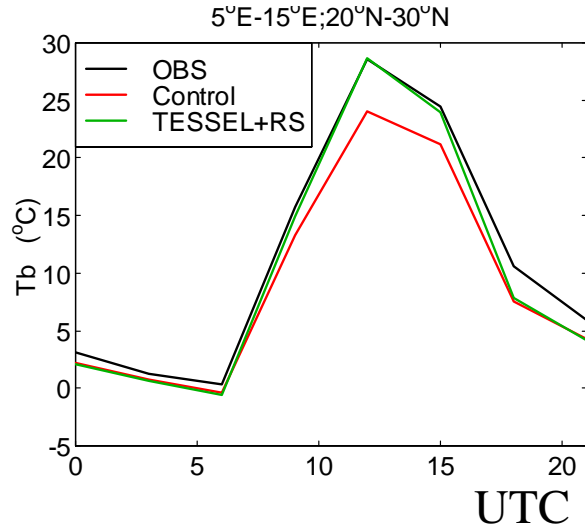
$[Tb_{obs} - Tb_{ECMWF}]$

ClearSkyPx  $\geq 90\%$

TESSEL + Rs

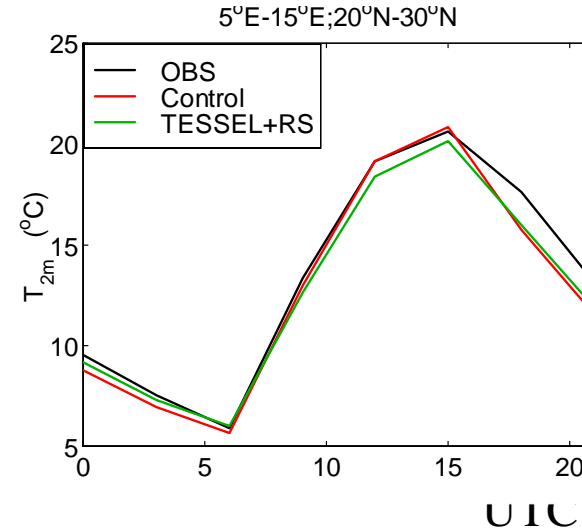


### Tb

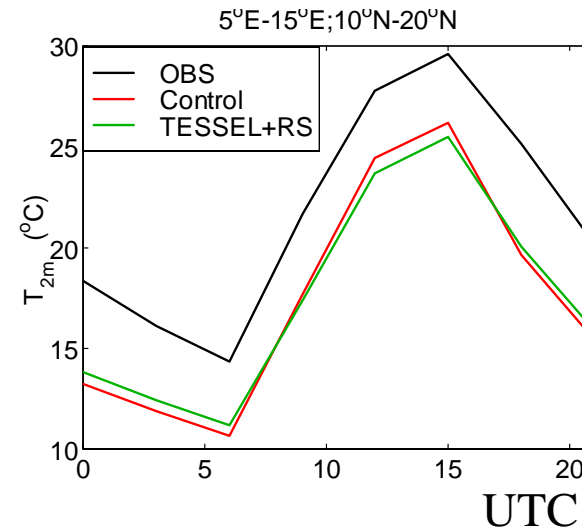
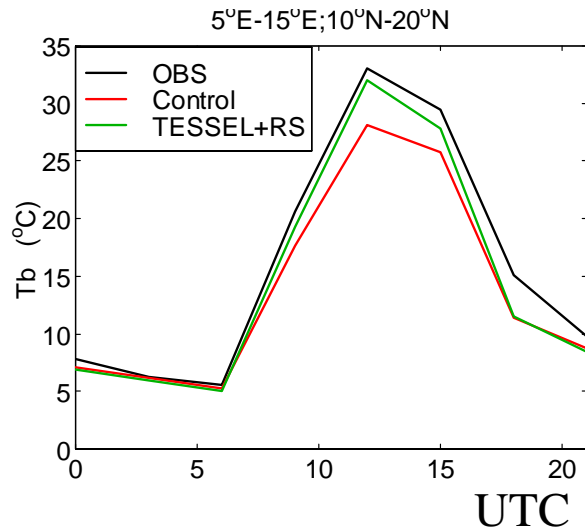


## Sahara

### T2m



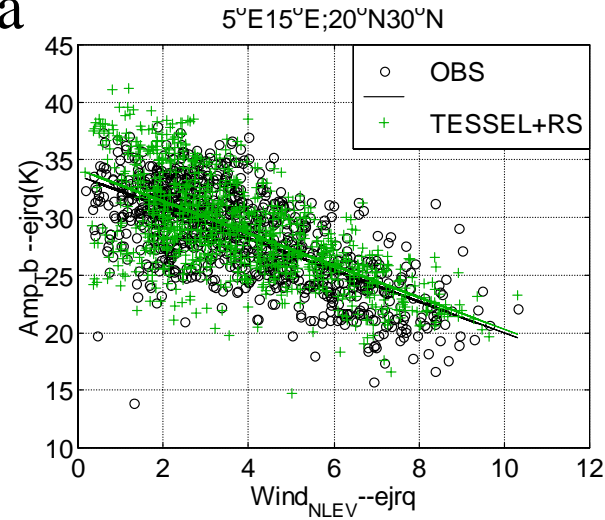
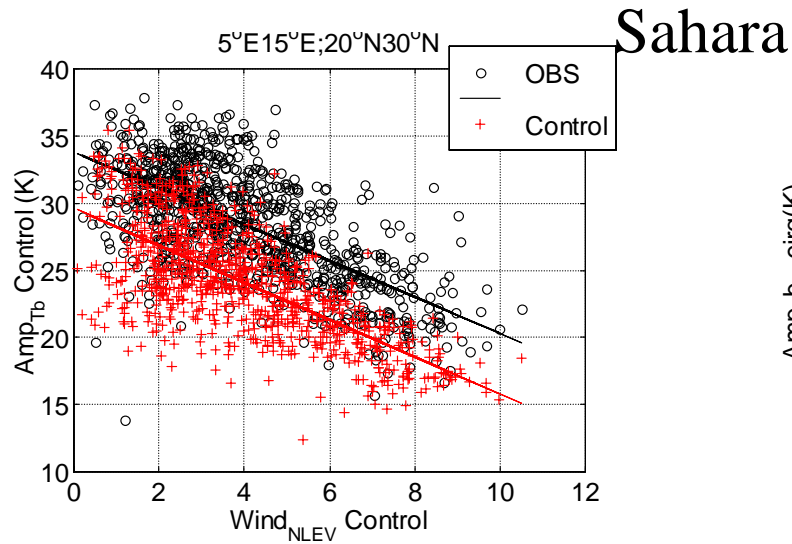
## Sahel





# Tb\_Amplitude versus Wind\_10m

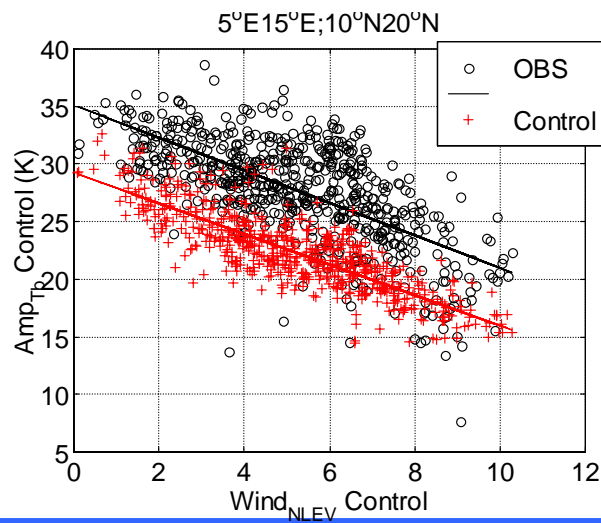
I



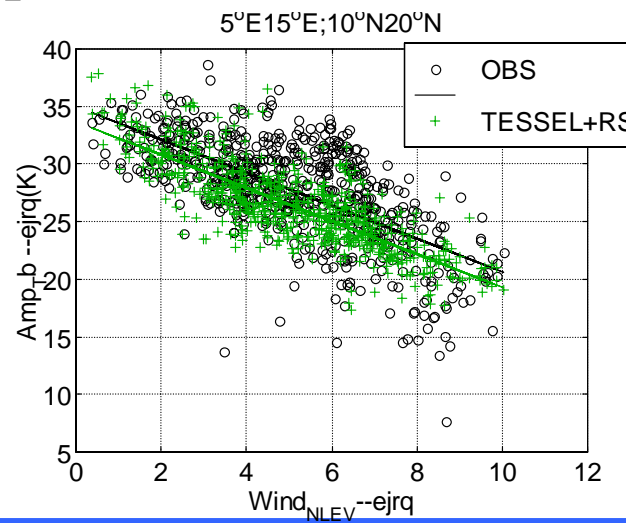
Amp Tb Bias

CTRL: 4.3 K

T+Rs: -0.5 K



### Sahel



Amp Tb Bias

CTRL: 5.4 K

T+Rs: 1.3 K



## Summary

- The comparison of Meteosat-7 window channel  $T_b$  (clear sky) with  $T_b_{ECMWF}$  shows that the modelled  **$T_{skin}$  diurnal** cycle is **underestimated** over arid / semi-arid regions.



Limits assimilation of LST & Channels that peak in the lower troposphere.

- Sensitivity experiments point to deficiencies in the Land Surface – Atmospheric aerodynamic coupling.



# Summary

I

- TESSEL **Bare Ground** Tiles ignore **wind shielding** effect of the **surrounding vegetation**.
- Introducing an extra resistance  **$R_s$**  to turbulent heat transfer within the canopy layer **substantially reduces** the ECMWF **cold bias of  $T_b$  daily amplitudes**.
- The impact of  **$R_s$**  on other model variables (including  $T_{2m}$ ,  $Wind_{10m}$ ) is small.



## II – Land Surface Analysis SAF

### Satellite Application Facilities

**Development & Processing Centres** within the **EUMETSAT** Applications Ground Segment:

- Meteorological products
- Software Packages

Using **MSG** and **EPS** data.





## LSA SAF

**AIM** → Develop techniques that allow an **effective** use of **MSG** and **EPS** data related to:

- **LAND**
- **LAND-ATMOSPHERE Interactions**
- **BIOSPHERIC Applications**

→ **Provide Products**

+

**User Support**



**LSA SAF**

**Development  
Phase**

**Initial  
Operational  
Phase - IOP**

**Operational  
Phase**

**II**

1999 2000 2001 2002 2003 2004 2005 2006 2007 2008

- Consortium of 13 organisations/  
8 member states

- Host Institute: **IM**

**IM**

**M-F, RMI, FMI**

**IMK, UV, ICAT,  
BfG**



PORTUGAL  
INSTITUTO DE METEOROLOGIA



## LSA SAF

### Initial Operational Phase – January 2005

#### OPERATIONAL PRODUCTS

Land Surface Temperature	IM
Broad – Band Albedo	M-F
Snow Cover	FMI
Downwelling Short Wave Surface Fluxes	M-F
Downwelling Long Wave Surface Fluxes	IM



## Initial Operational Phase – January 2005

### INTERNAL OPERATIONAL PRODUCTS

Emissivity	ICAT / IM
Snow Albedo	M-F
BRDF	M-F
Thermal Surface Parameters	IMK

### DEMONSTRATION PRODUCTS

Vegetation: FVC, LAI, (fAPAR)	UV
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### EXPERIMENTAL PRODUCTS

Evapotranspiration	RMI
Soil Moisture	BfG

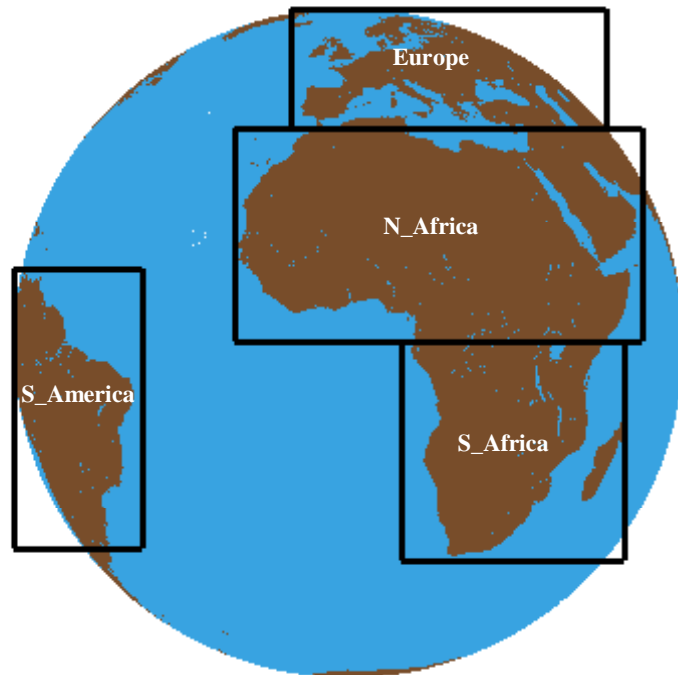


# LSA SAF

## Geographical Areas

**Europe** → 1<sup>st</sup> Priority - Jan 2005

**Northern Africa** → 2<sup>nd</sup> Priority



**Southern Africa**

**Southern America**

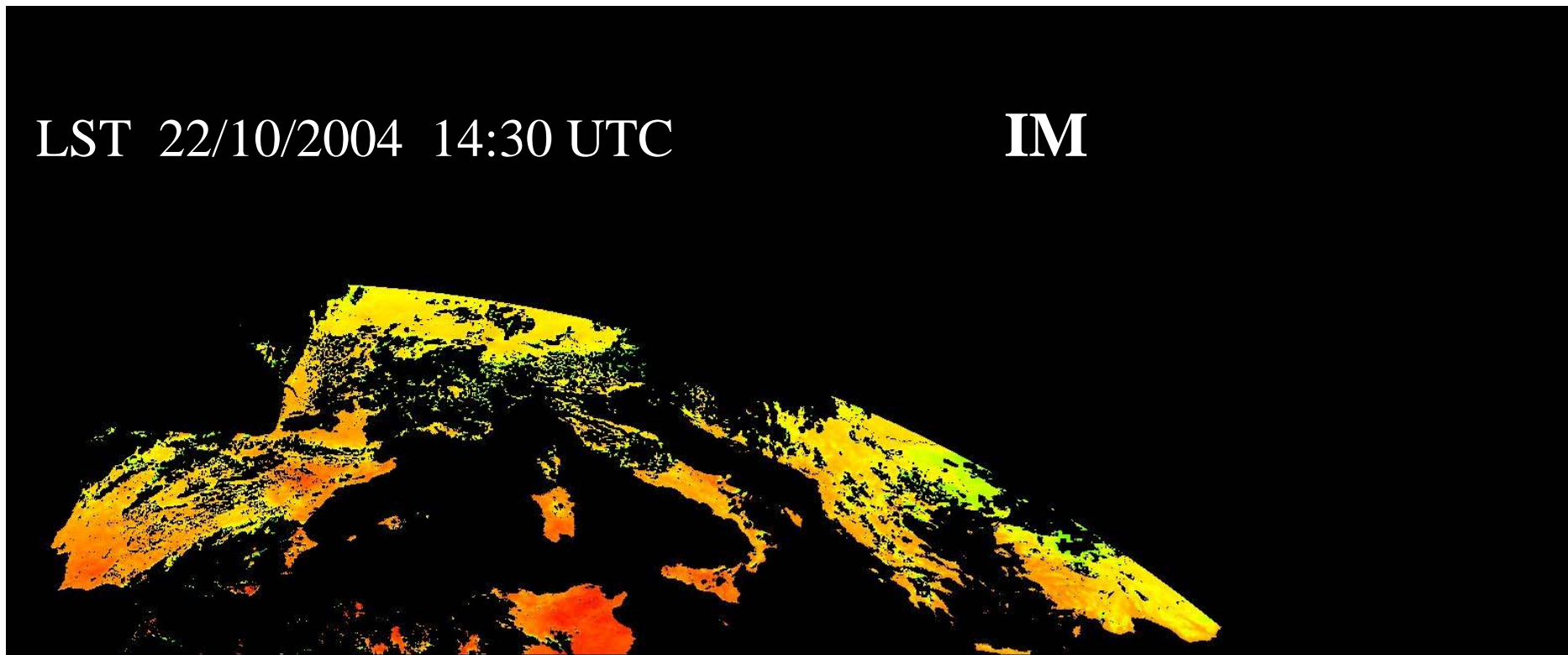


# LSA SAF – Land Surface Temperature

II

LST 22/10/2004 14:30 UTC

IM



Available for **LSA SAF** Geographical Areas:

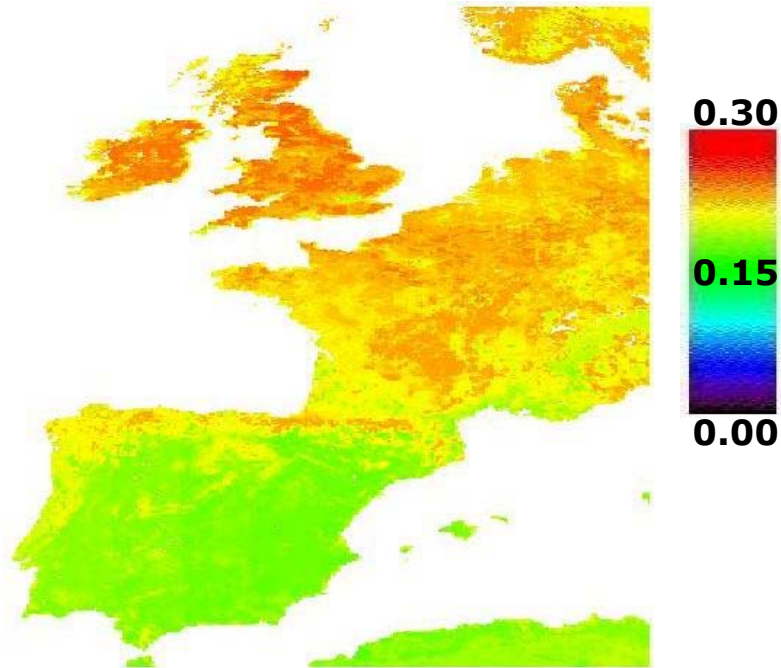
- MSG Projection
- 15 min



# LSA SAF – Albedo

M-F

Broadband Albedo



**Content:**

Spectral

VIS 0.6; VIS 0.8; IR 1.6

Broadband

300-4000 nm; 400-700nm;  
700-4000nm

Available for **LSA SAF** Geographical Areas:

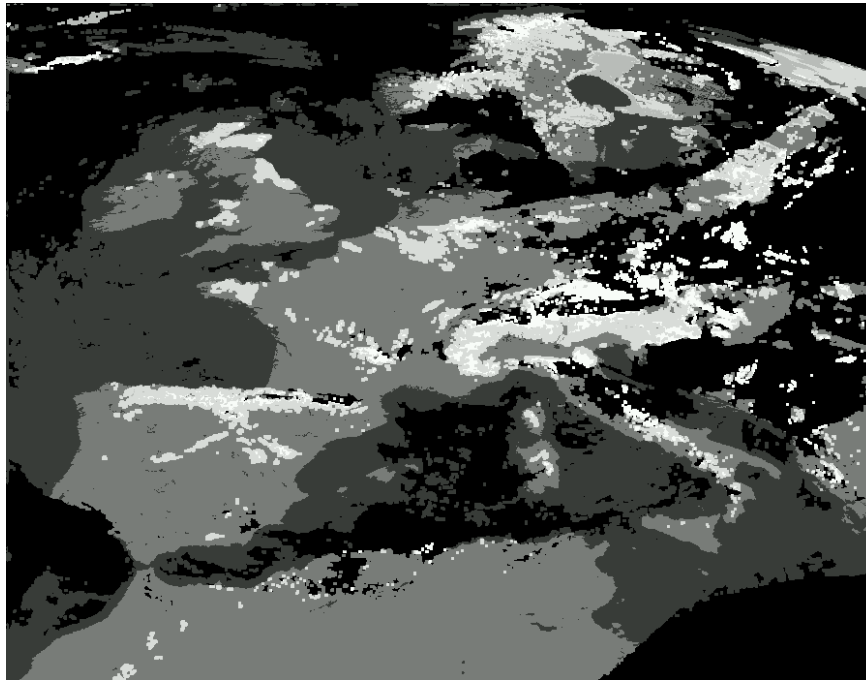
- MSG Projection
- 1-day & 10-day composites



## LSA SAF – Snow Cover

SMHI / FMI

1 March 2004



Available for **LSA SAF**  
Geographical Areas:

- MSG Projection
- daily maps

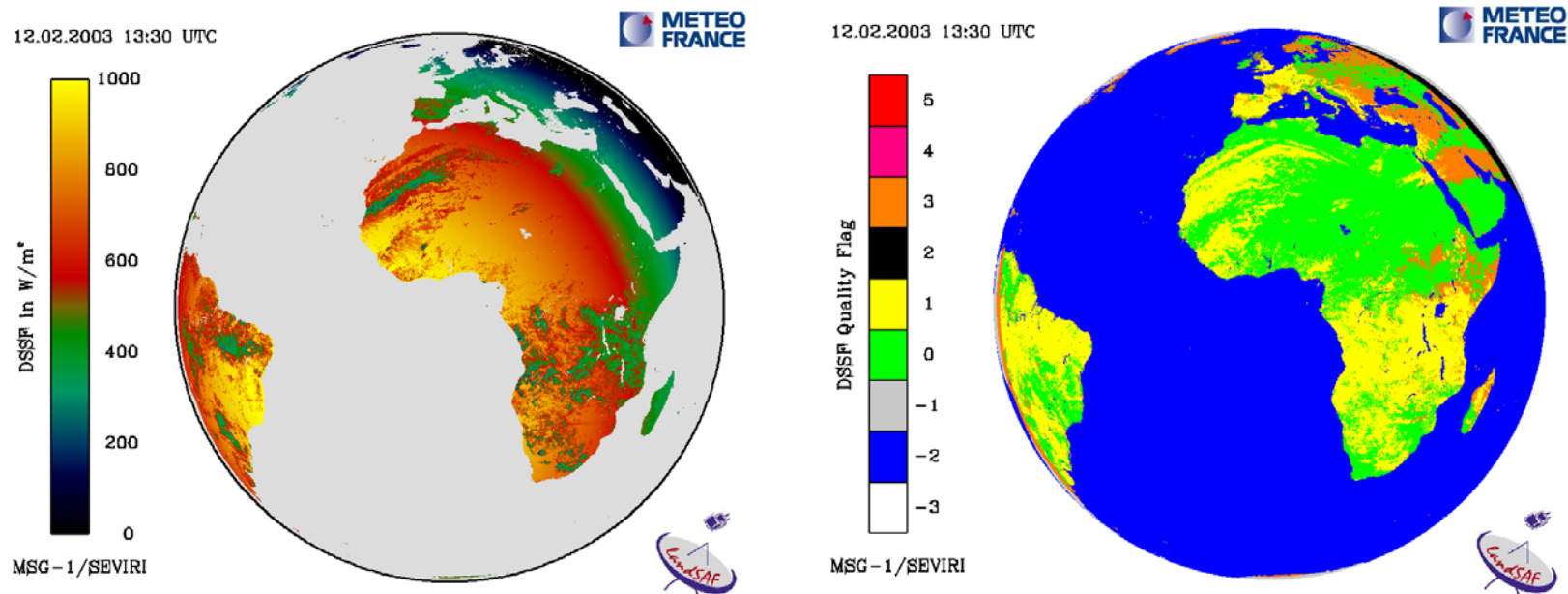
Grey Scale (from white to Black):

**Snow** (white), **Partial Snow**, **Sea Ice**, **Snow Free Land**, **Ice Free Sea**, **Clouds / Out of Disk** (Black)



## LSA SAF – Downwelling Sfc SW Flux

### M-F



Available for **LSA SAF** Geographical Areas:

- MSG Projection
- 30 min

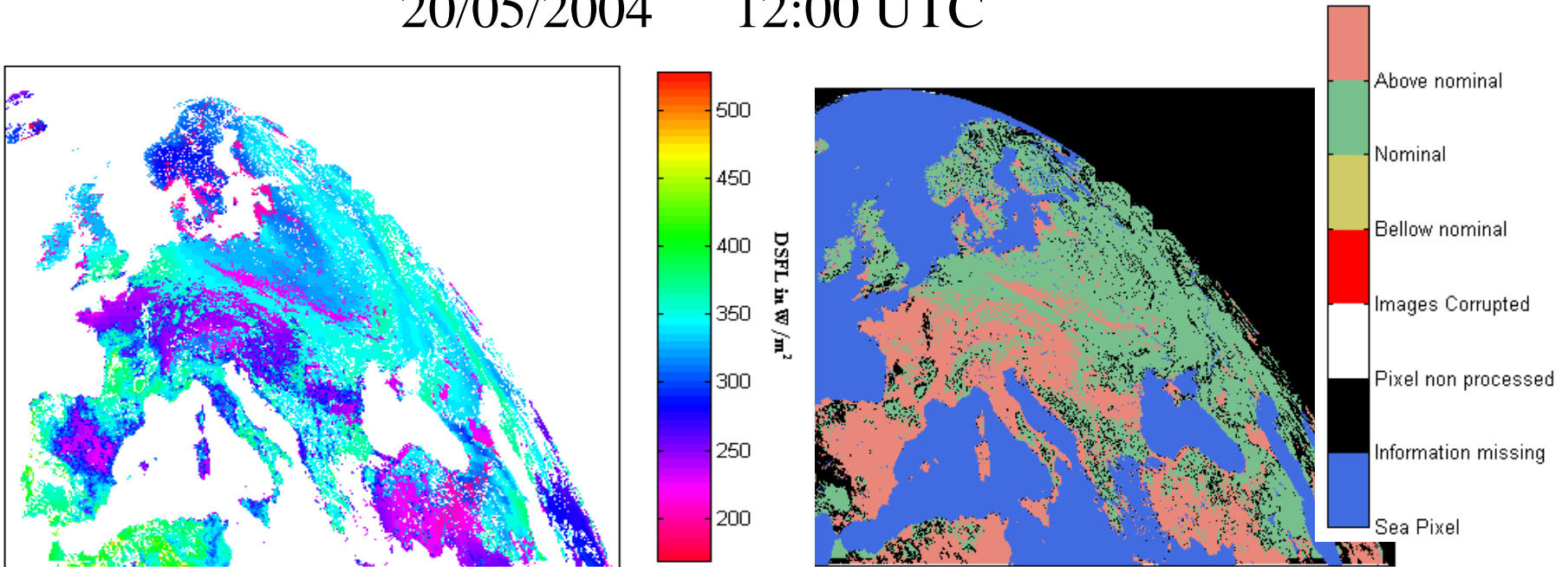


## LSA SAF – Downwelling Sfc LW Flux

### IM

20/05/2004

12:00 UTC



Available for **LSA SAF** Geographical Areas:

- MSG Projection
- 30 min

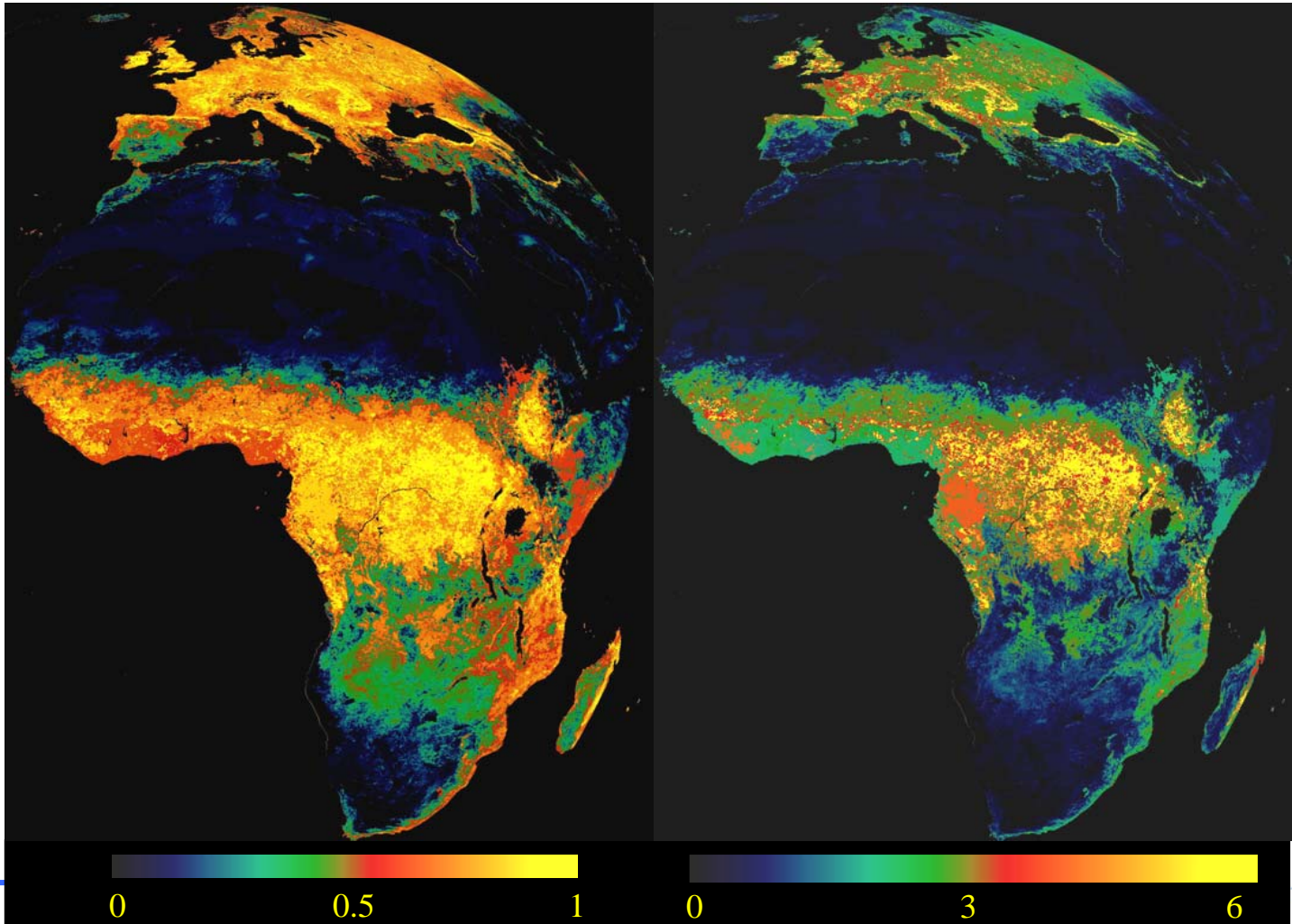


# LSA SAF – Vegetation

UV  
/IbiMet

FVC

LAI



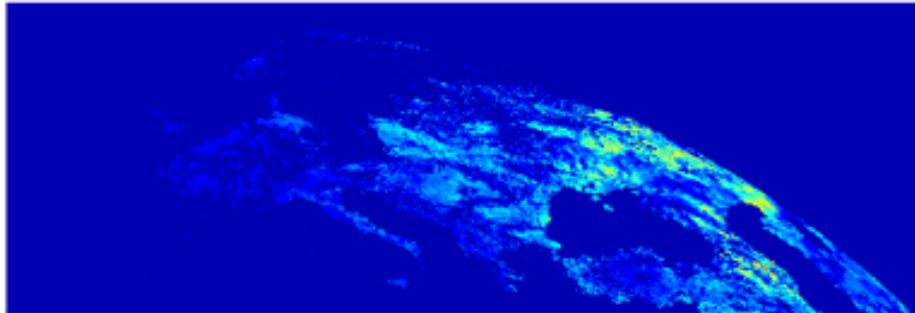


# LSA SAF – Evapotranspiration

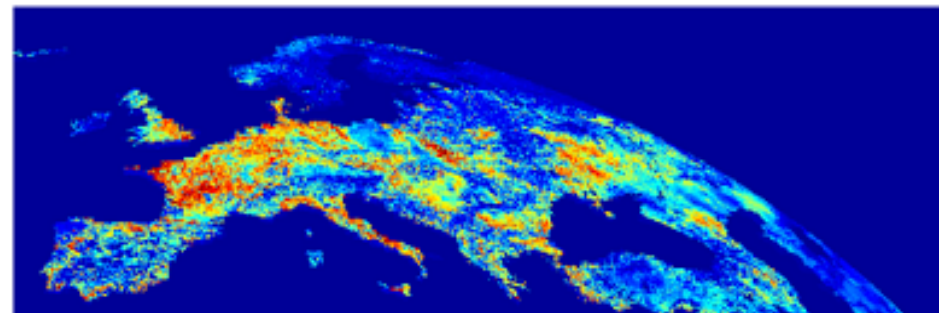
RMI

28/07/2003

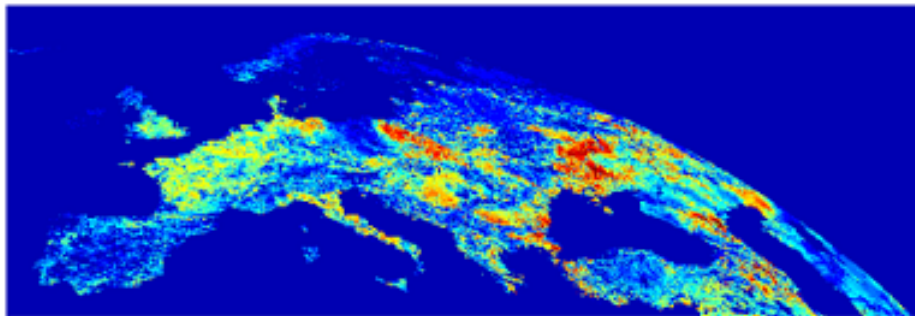
ET (mm/h) over Europe at 06:00 UTC for the day 28/07/2003



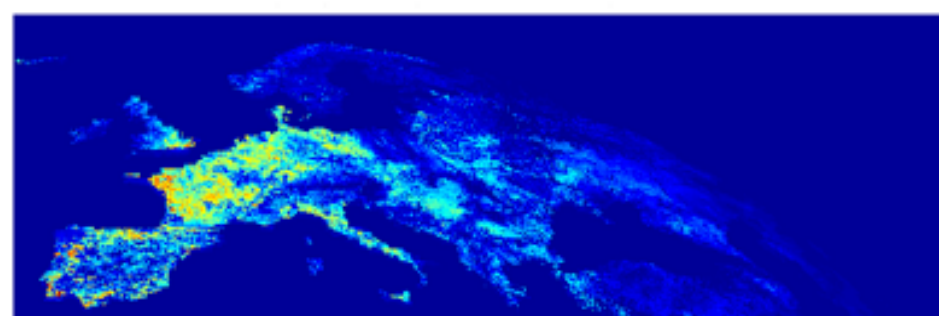
ET (mm/h) over Europe at 12:00 UTC for the day 28/07/2003



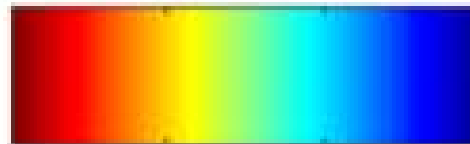
ET (mm/h) over Europe at 09:00 UTC for the day 28/07/2003



ET (mm/h) over Europe at 15:00 UTC for the day 28/07/2003



0.6 0.4 0.2 0 (mm/h)





Access **LSA SAF** Products during IOP

NRT / Off-Line



**BETA - USERS**



Assess the potential use of **LSA SAF Products** in different fields of **Applications**;

- Accuracy
- Spatial Coverage & Projection
- Frequency & Timeliness