

# **Infrared continental surface emissivity spectra and skin temperature retrieved from IASI observation**

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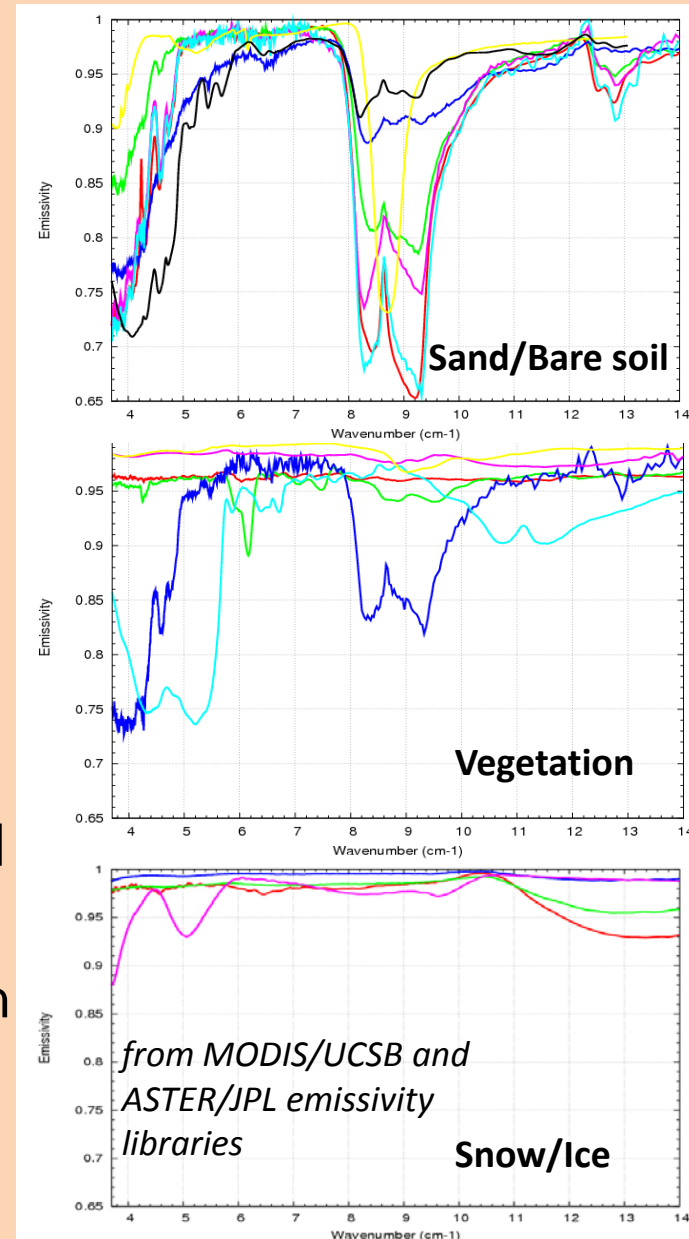
# Introduction

## Why Focusing on $T_s$ and $\epsilon_s$ ?

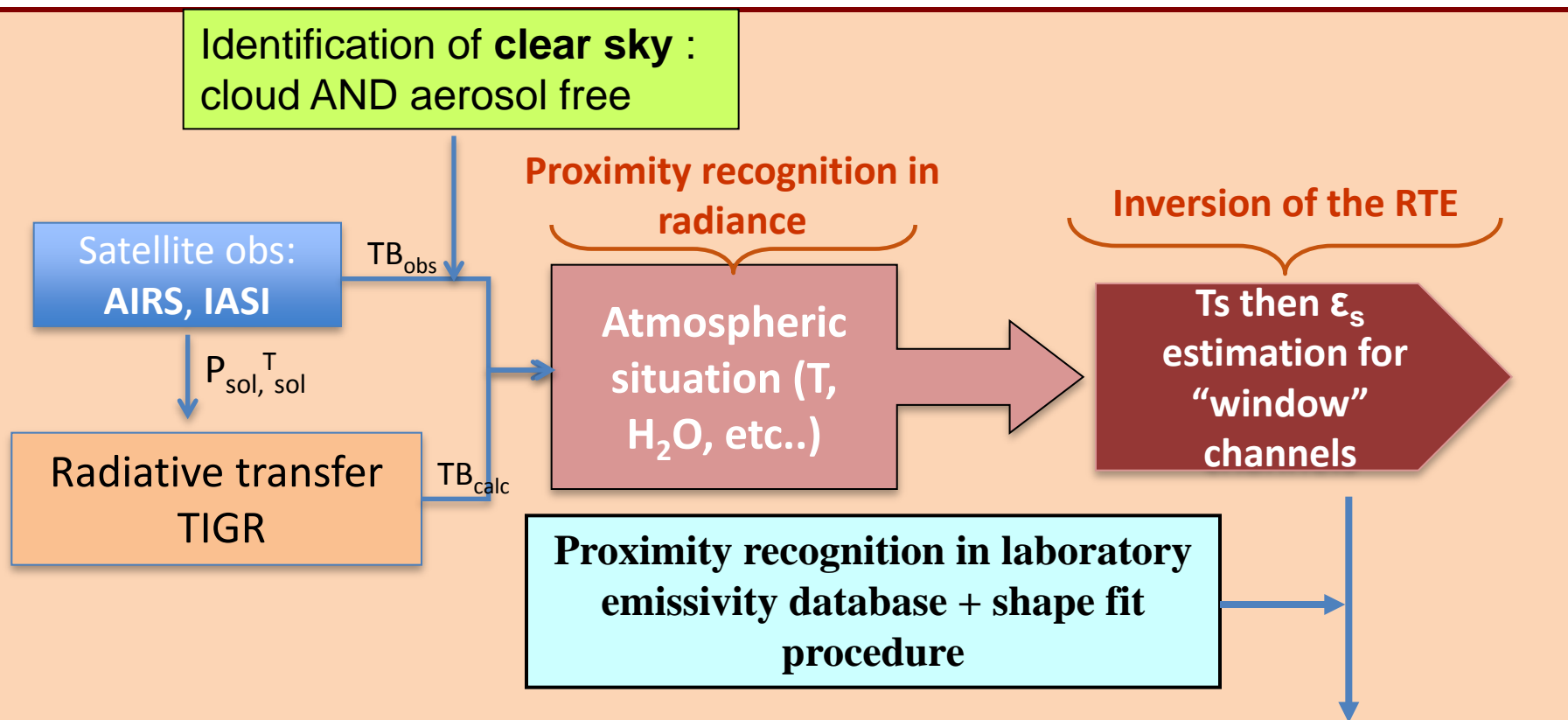
- To improve the determination of the troposphere properties:
  - ✓ Thermodynamic properties ( $T$ ,  $H_2O$ , etc...)
  - ✓ aerosols
  - ✓ Trace gases concentration
- Essential to estimate the radiative budget
- Necessary to have an accurate spectral estimation of emissivity (emissivity often considered as constant).

## Advantage of using 2<sup>nd</sup> generation infrared sounders (AIRS, IASI) ?

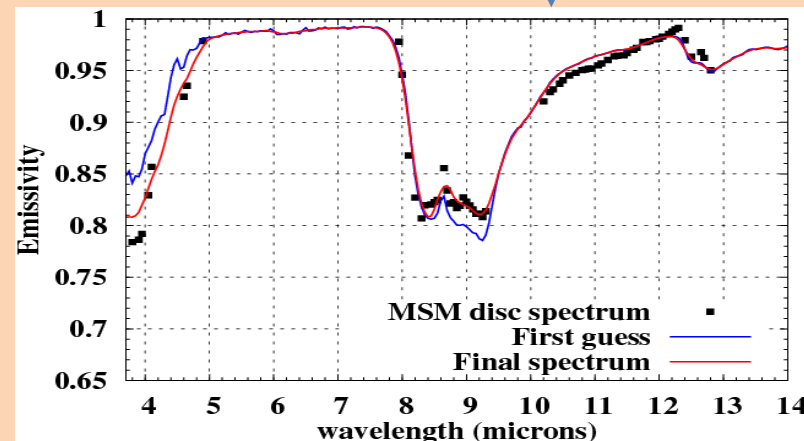
- Can provide emissivity spectra at high resolution
- Global view and long-term monitoring of continental surfaces (e.g.: Sahel evolution)



# Multi Spectral Method (MSM)

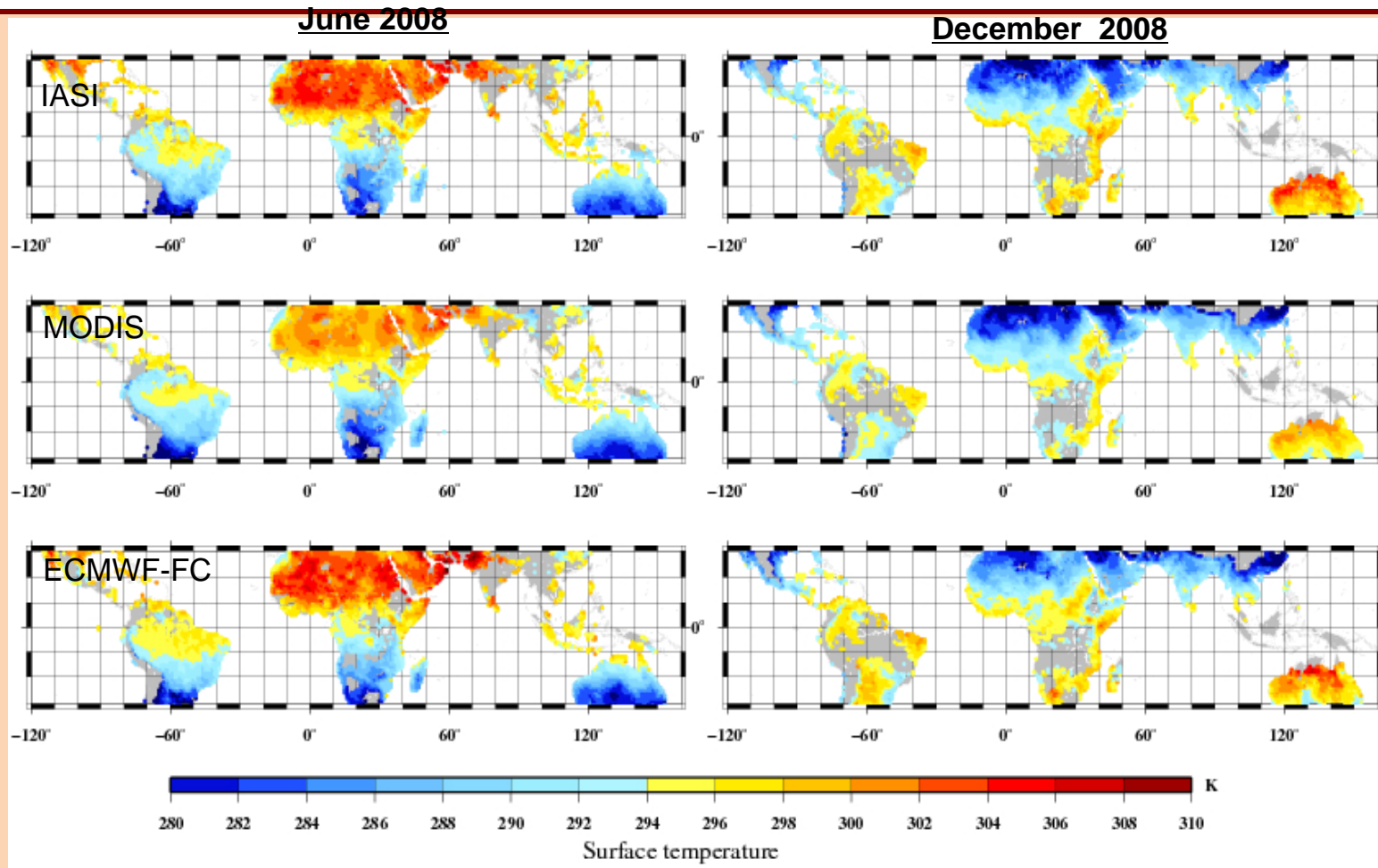


→ Monthly grid ( $1^\circ \times 1^\circ$ ) of **skin temperature and emissivity continuous spectrum** at  $0.05 \mu m$  resolution between  $3.7$  and  $14.0 \mu m$  for AIRS and IASI



# Results for surface temperature:

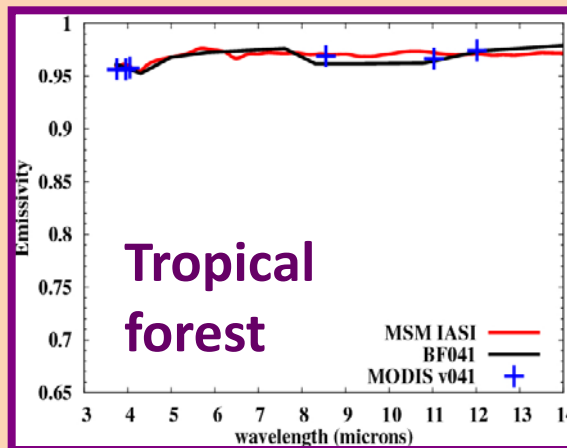
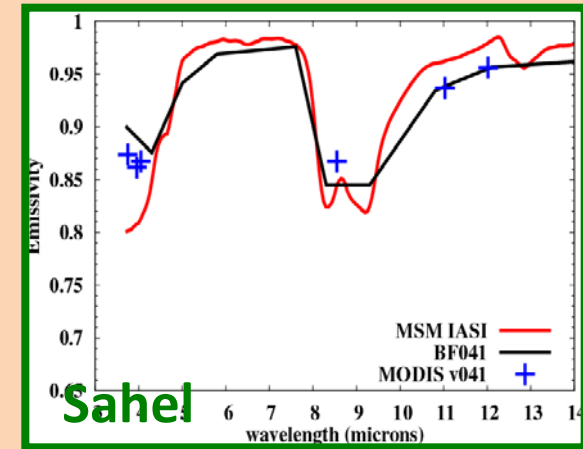
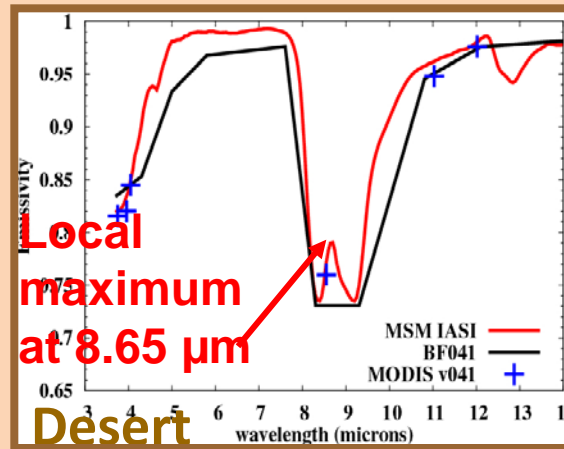
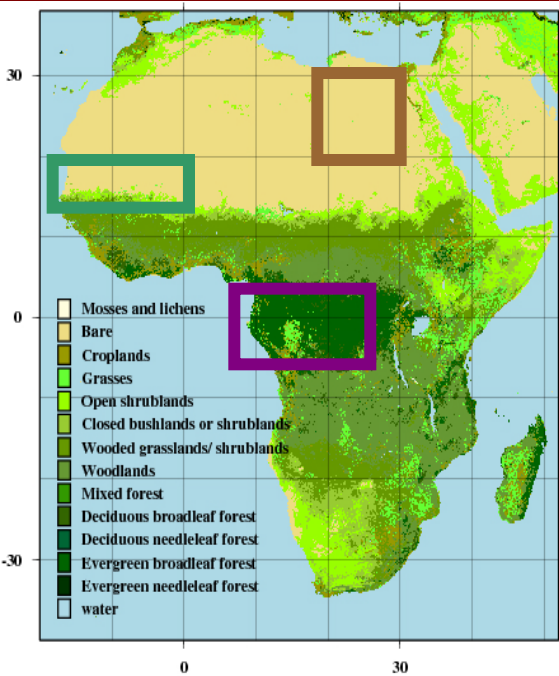
## Comparison with MODIS and the ECMWF forecast data



IASI-MODIS:  $0.8 \pm 1.3$  K after removing the diurnal effect of about 1 K in summer  
IASI-FC:  $-0.4 \pm 2$  K (better in summer than in winter)

see Capelle et al., JAMC, 2012

# Results for the infrared surface emissivity spectrum: comparison with MODIS and the UW baseline fit database



- The **accurate** shape of the spectrum characterizes the observed surface (high resolution in the quartz reststrahlen 8  $\mu$ m band is important)
- In general, good agreement with MODIS low resolution emissivities
- The **high-spectral resolution** (0.05  $\mu$ m from 3.7 to 14  $\mu$ m) IASI/MSM method actually reproduces the local maximum of emissivity at 8.65  $\mu$ m observed in the high spectral resolution laboratory spectra for sand soil.

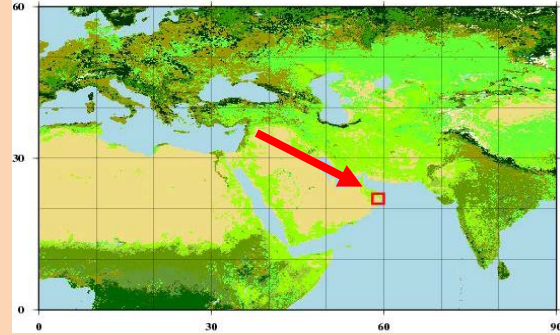
# Application of the IASI-MSM at local scale:

Comparison with ARIES emissivity from the MEVEX Oman campaign, May 2009

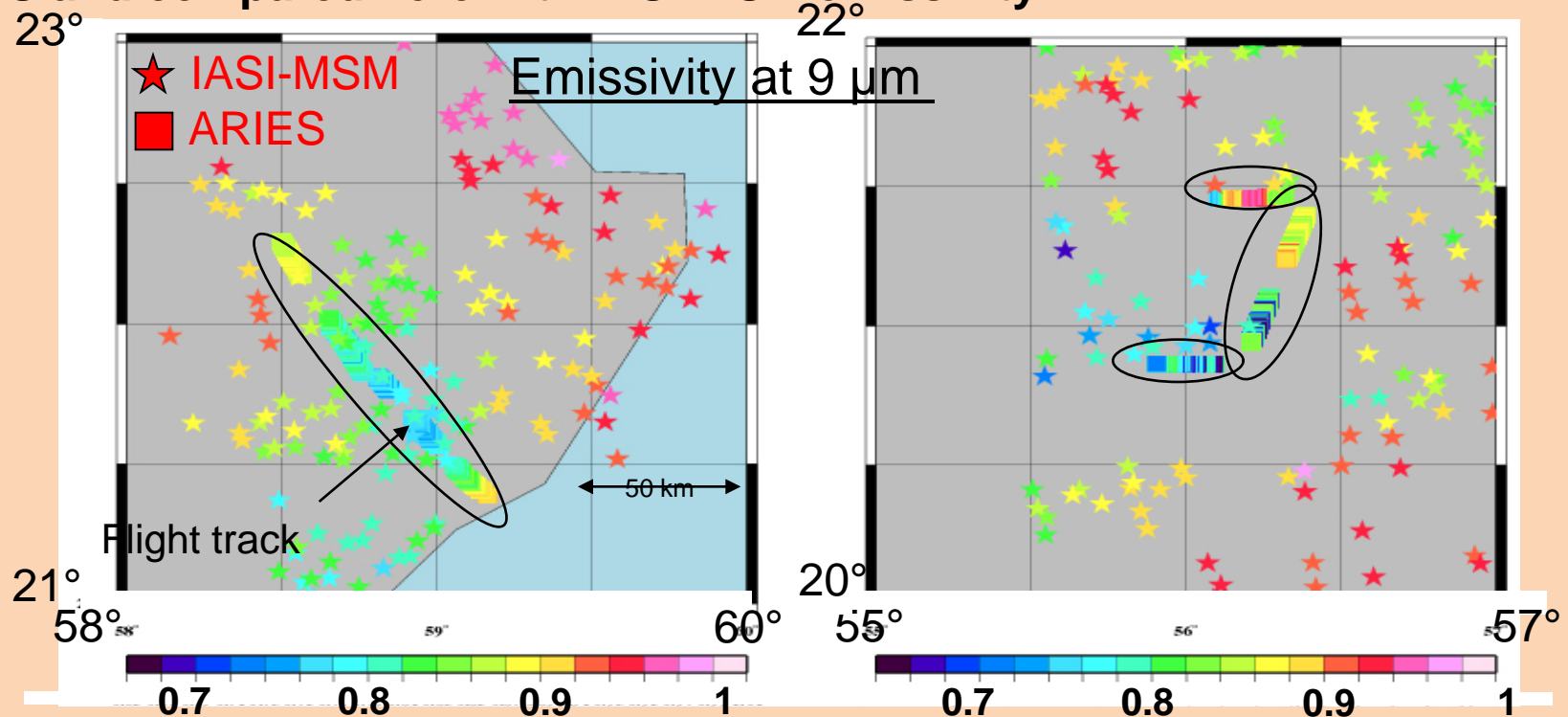
## Emissivity measurements during the aircraft MEVEX campaign:

IR radiances collected by ARIES interferometer on-board the FAAM BAe146-301 Atmospheric Research Aircraft

- During low-level flights, the surface emissivity can be derived directly from the hyperspectral data.

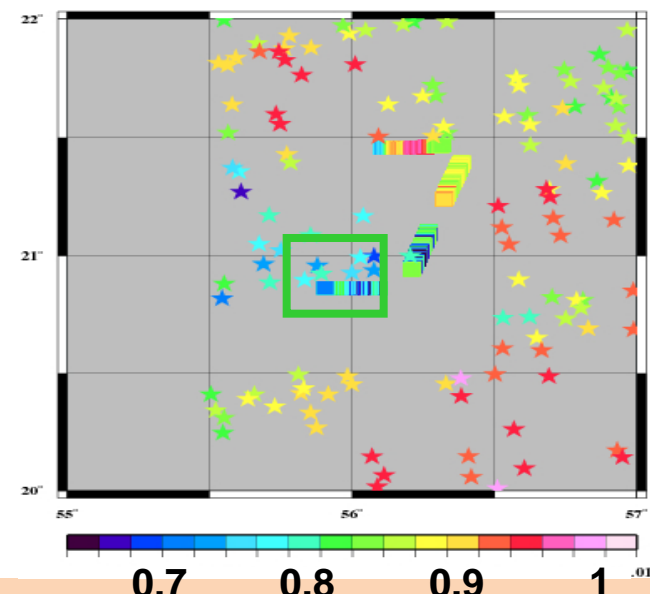
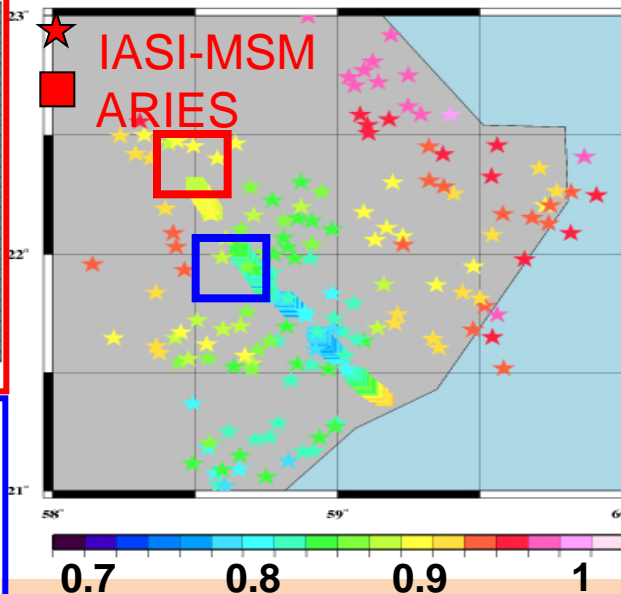
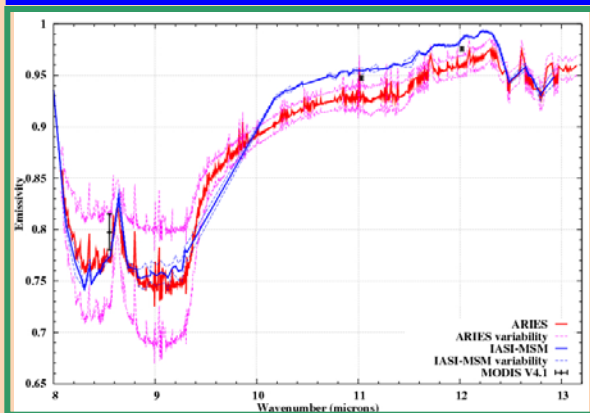
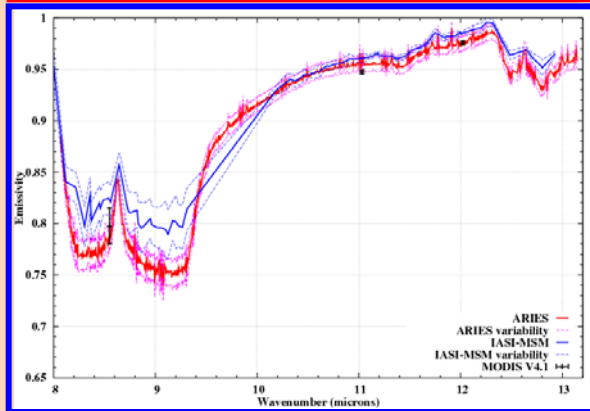
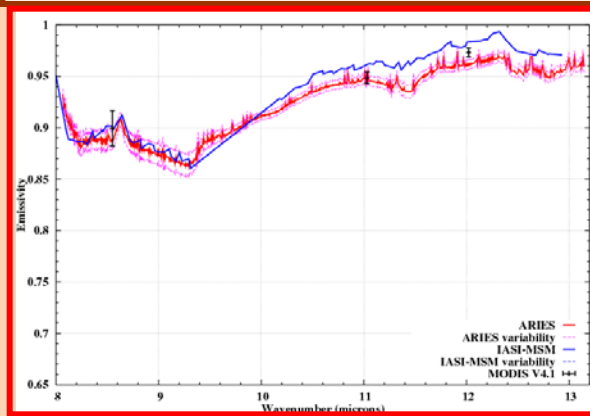


=> Two flights at low-level were selected as suitable for emissivity retrieval from ARIES and compared here with IASI-MSM emissivity.



# Application of the IASI-MSM at local scale:

Comparison with ARIES emissivity from the MEVEX Oman campaign, May 2009



⇒ In general, good agreement IASI-MSM local with ARIES

⇒ Large spatial variations of emissivity at very local scales consistent between ARIES and IASI-MSM.

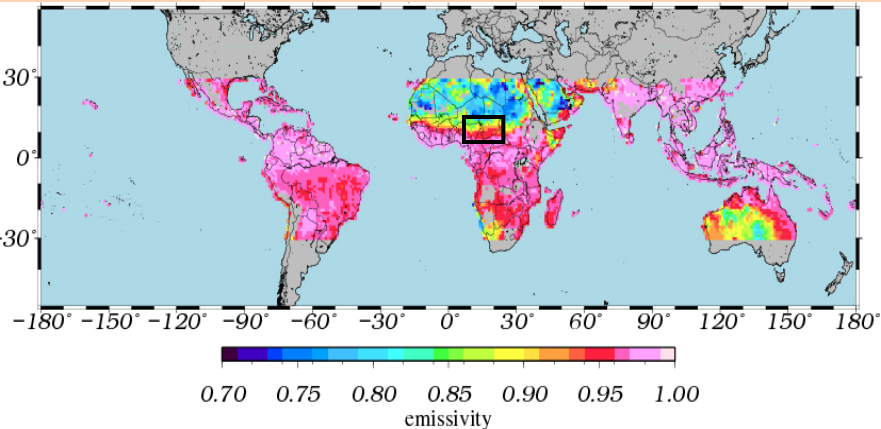
➤ Ex: 10% variation for an area  $< 0.5^\circ$

⇒ At 12  $\mu\text{m}$ , differences  $< 0.02$ , but IASI-MSM always greater than ARIES. MODIS in-between.

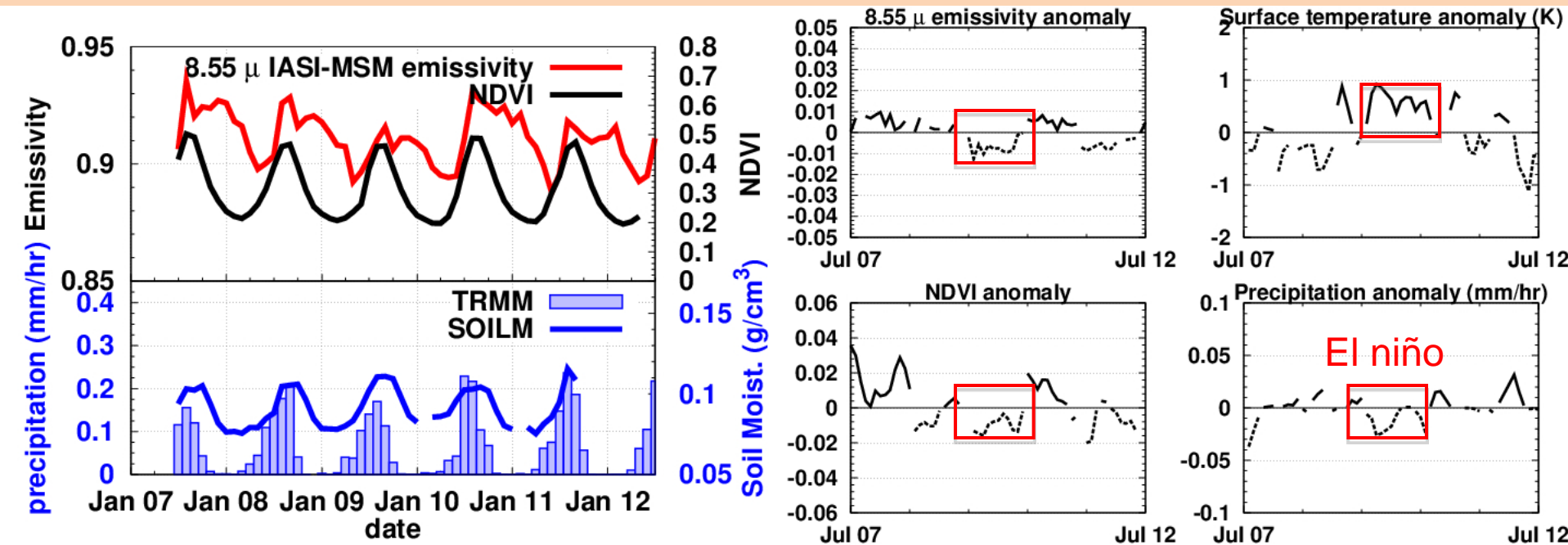
⇒ At 8  $\mu\text{m}$ , in general, differences  $< 0.04$ . Largest differences might be due to our  $0.25^\circ$  box averaging given the large local variations of emissivity at this wavelength.

# Application of the IASI-MSM: monitoring of semi-arid continental surfaces

## Case of Sahel

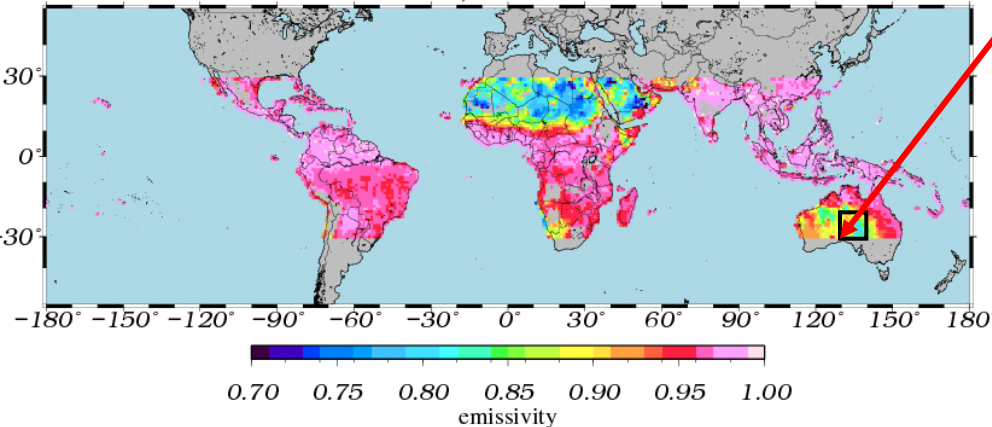


- Emissivity correlates with the NDVI / soil moisture / precipits : emissivity increases with vegetation and/or the soil water content + anti correlation  $T_{\text{surf}} / \epsilon_{\text{surf}}$
- Opportunity of long-term monitoring of continental surfaces (MetOp1, 2, 3, etc...) at global scale.
- Anomaly  $< 0$  for  $\epsilon_{\text{surf}}$ , NDVi, precip (and  $> 0$   $T_{\text{surf}}$ ) during El Niño Spring 2009- Spring 2010.

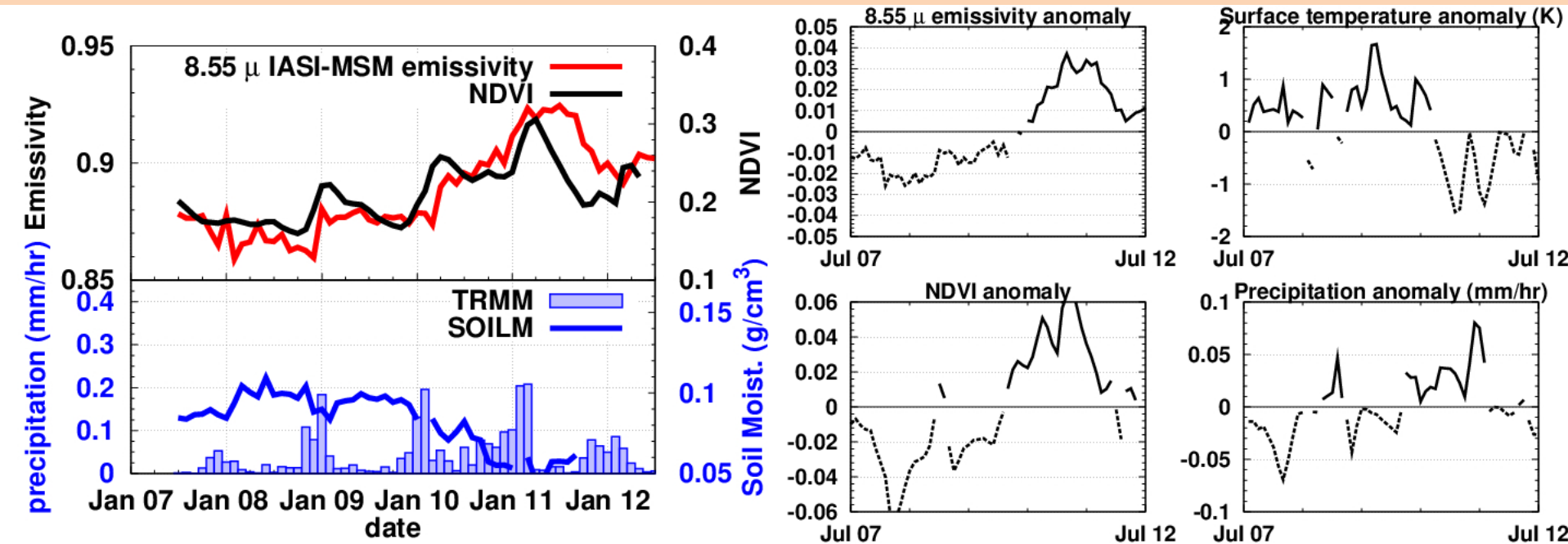


# Application of the IASI-MSM: monitoring of semi-arid continental surfaces

## Case of Australia



- Example of a drastic change: severe drought until 2009, followed by 3 large rainfall seasons in 2009, 2010 and 2011, causing a net increase in the vegetation (and thus, of emissivity).
- The change in precip. anomaly  $< 0$  in 2009, and  $> 0$  in 2010/2011 corresponds to the succession between El Niño/La Niña event.



# Application of the IASI-MSM: Dust properties retrieval over continents

Emissivity database plays an important role in the determination of dust properties:

- ❖ In the cloud/aerosol flag elaboration:

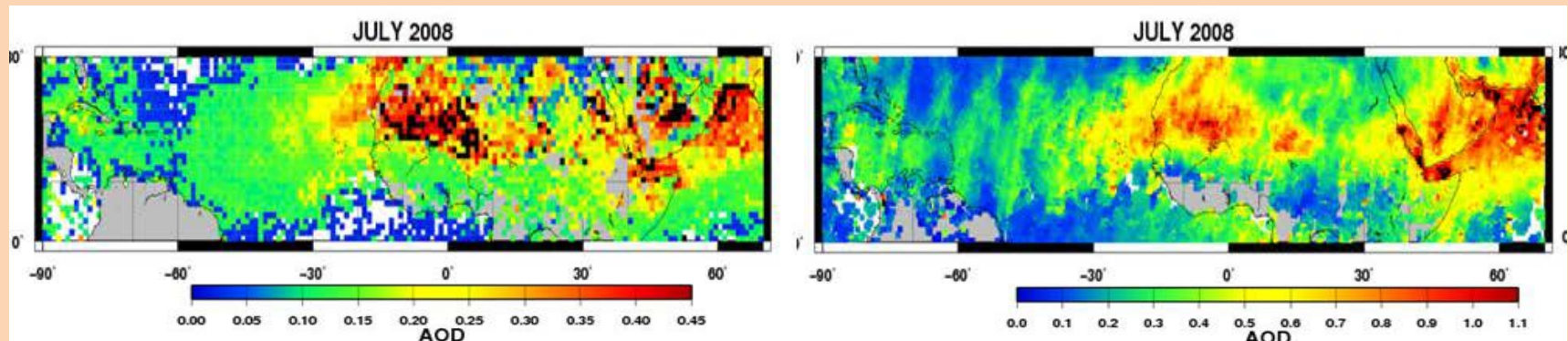
  - ⇒ The flag is based on BT differences and application of thresholds: each of them depends on the surface emissivity of the channel considered.

- ❖ In the dust aerosol inversion itself, especially over desert:

  - ⇒ The channels sensitive to dust are also sensitive to surface properties ( $T_{\text{surf}}$  /  $\epsilon_{\text{surf}}$ )

  - ⇒ An error of 5% on the emissivity can lead to an error of more than 0.2 in AOD.

## Comparison between 10 $\mu\text{m}$ coarse-mode IASI AOD and MISR 0.55 $\mu\text{m}$ AOD



# Conclusions

- **Final product:** High spectral resolution continental surface emissivity spectra (0.05  $\mu\text{m}$  from 3.7 to 14  $\mu\text{m}$ ), and surface temperature from July 2007 to December 2012 (continuing).
- **Results at global scale :**
  - Comparisons of  $T_s$  with MODIS and ECMWF fcst and of emissivity with MODIS have been performed with good results.
  - The resulting emissivity spectra well reproduce small spectral variations, observed in the laboratory spectra.
- **Results at local scale:**
  - Good agreement with *in situ* measurements from ARIES
  - IASI-MSM emissivity reproduces the large local variations seen by ARIES over small area

## Perspectives

- **Improvement of the studies at local scale:**
  - Why IASI-MSM emissivity is in general slightly greater than the ARIES one at 12  $\mu\text{m}$  (<0.02)?
  - Comparison with other validation campaign, if available
- **Monitoring of continental surfaces (vegetation cover, drought..):**
  - Using the strong correlation between soil properties (vegetation, moisture) and emissivity to follow the evolution of the surface properties
- **Extension of the database to the mid-lat:**
  - The cloud/aerosol flag is under validation for mid latitude regions
  - The database will be soon prepared and started to validate.