

# Data assimilation of IASI radiances over land.

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# IASI data assimilation over land at Météo-France

## IASI and the limits of the use its data over land

### The IASI (Infrared Atmospheric Sounding Interferometer) sounder

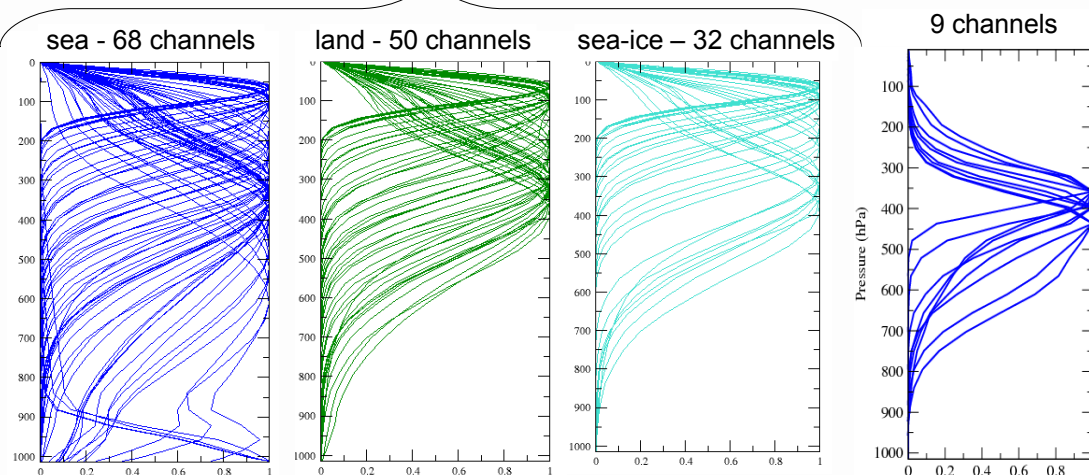
- 8461 channels => Atmospheric spectrum : from 3,62  $\mu\text{m}$  to 15,5  $\mu\text{m}$ .
- Accurate information about temperature, humidity and surface parameters.

### The limits

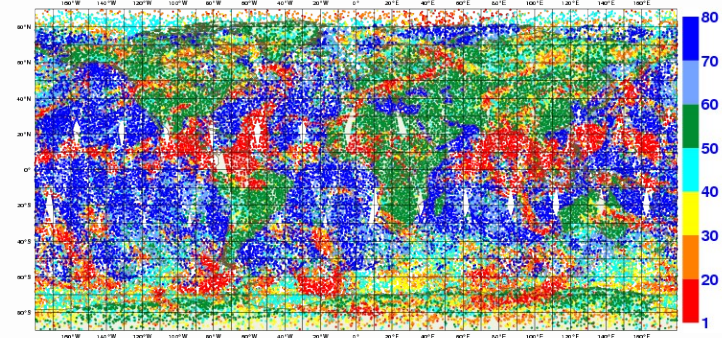
- Important radiative impact of clouds on infrared radiances that limits the information from advanced sounders => use of radiances in clear sky conditions for the retrievals.
- Uncertainty on emissivity and surface temperature.
- Good use of these data over sea but limited over land => less IASI data used in NWP over land.

Temperature

Water vapor



Number of assimilated channels in each IASI pixel



ARPEGE : typical daily coverage

3 Figures : Weighting functions of IASI channels assimilated over sea (a), over land (b), over sea-ice (c) for temperature and weighting functions of IASI channels assimilated over sea, land and sea-ice for water vapor (d).

# IASI data assimilation over land at Météo-France

## Importance of surface parameters

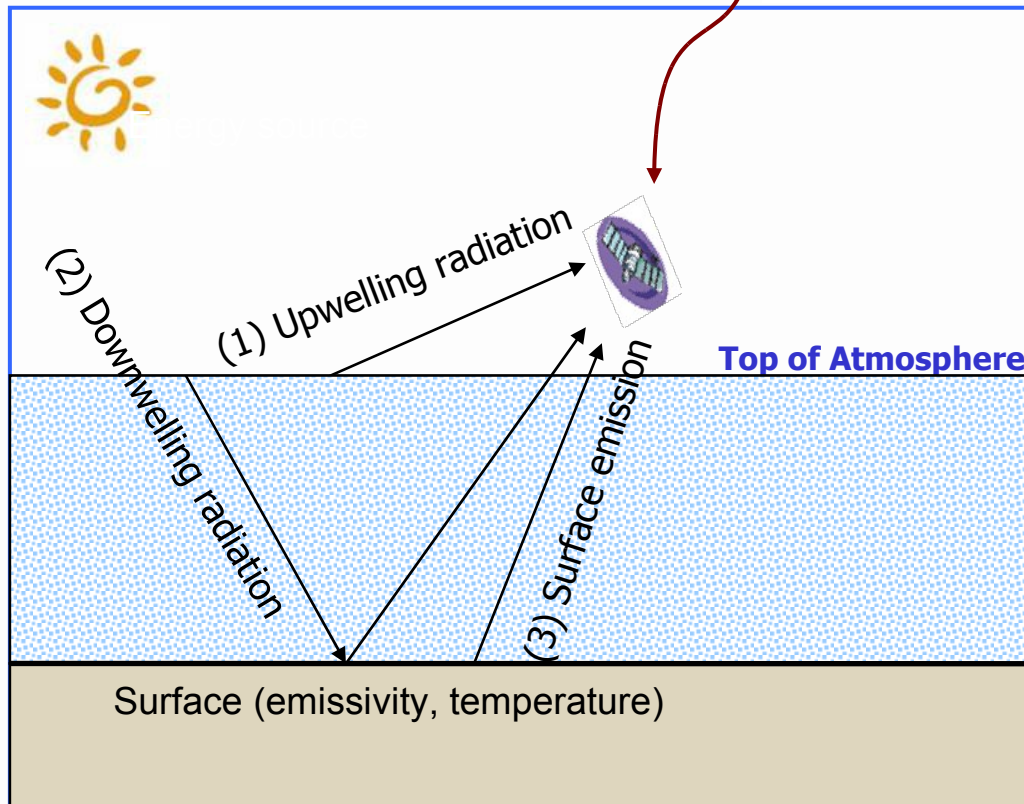
**Measurements at infrared frequency:** Instruments receive an electromagnetic signal.

**Observed brightness temperature ( $\nu$ ):**  $T(\nu) = \epsilon(\nu) T_s \tau + (1 - \epsilon(\nu)) \tau T(\nu, \downarrow) + T(\nu, \uparrow)$

Emissivity

Surface temperature

**RT model:** T, Q forecasts or radiosoundings or re-analyses



In operations :  
 $\epsilon$  constant and  $T_s$  bad estimated

# Towards a better knowledge of surface parameters

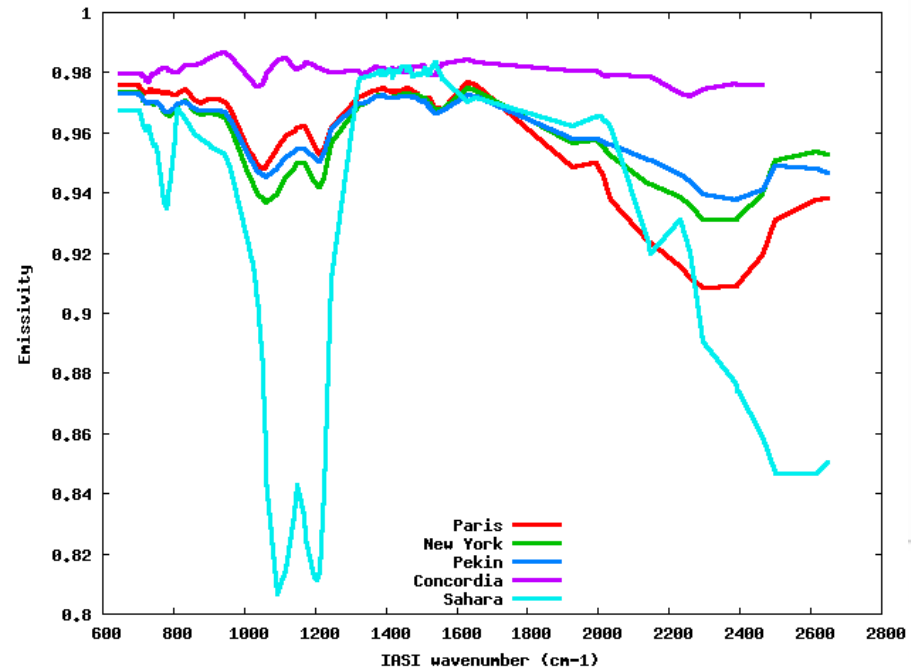
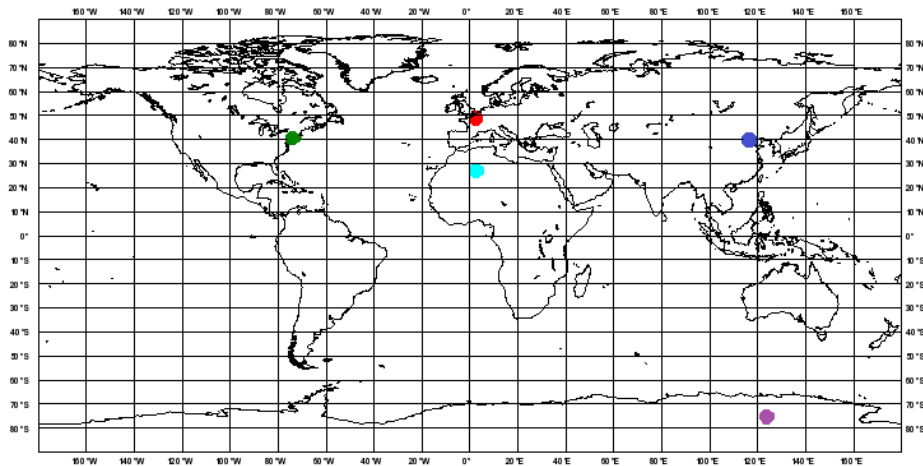
First step : to take surface emissivity variations into account

- At the moment, in Météo France operational NWP models,  $\epsilon=0.98$  over land and channels contaminated by surface are not assimilated.
- Over land, emissivity varies in time and space, and with surface types, roughness and moisture content.
- Use of the emissivity atlas calculated from MODIS (Moderate Resolution Imaging Spectroradiometer) products of surface emissivity over land and IASI L2 products from EUMETSAT.

# Towards a better knowledge of surface parameters

Atlas derived from MODIS (Seemann et al, 2007)

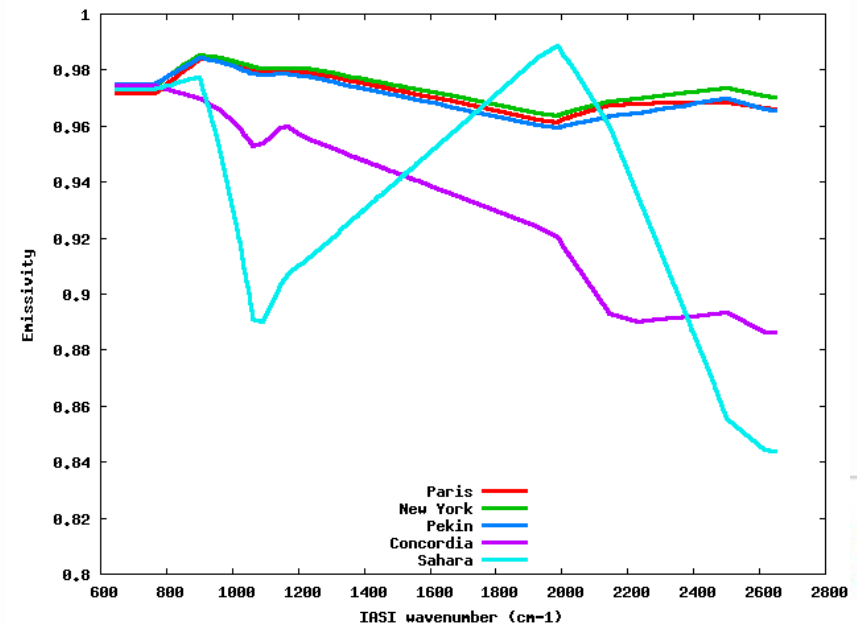
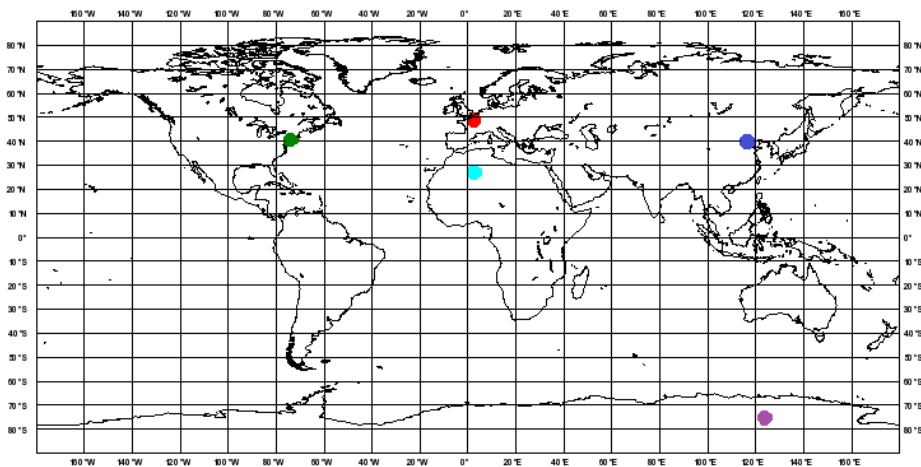
- Emissivity derived from the MODIS operational land surface emissivity product (MOD11)
- 6 available MOD11 wavelengths => baseline fit method to fill in the spectral gaps.
- Emissivity in the database is available at 10 wavelengths with  $0,05^\circ$  spatial resolution.
  - + high spectral resolution laboratory measurements of selected materials
  - = HSR global land surface infrared emissivity database at 416 wavenumbers (PCA regression).
- Reconstitution of the atlas with  $0,5^\circ$  spatial resolution in order to be acceptable by the model



# Towards a better knowledge of surface parameters

## IASI L2 products from EUMETSAT (Surface Emissivity within IASI L2 PPF v5, 2010)

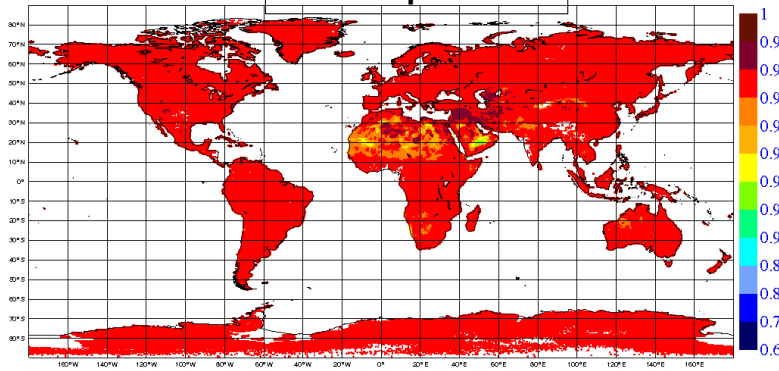
- Retrievals of geophysical parameters from the radiance measurements and in particular surface emissivity.
- Linear regression scheme with 29 principal components scores computed from the radiances in 5410 channels as predictors.
- Emissivity provided at 12 selected wavenumbers => definition of the whole IASI spectrum by bands.
- Study on July 2011.



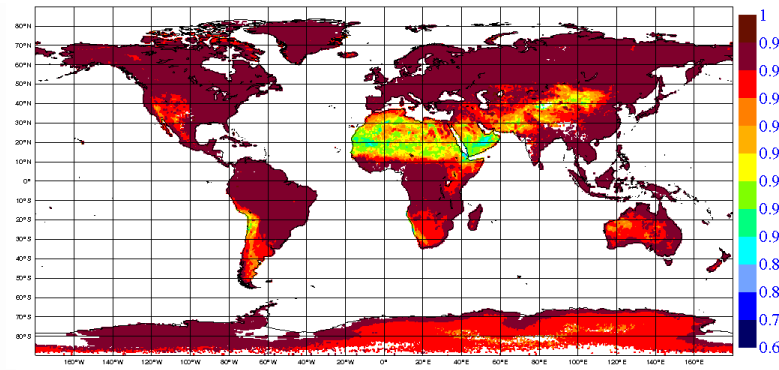
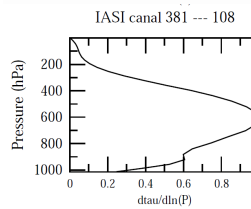
# Towards a better knowledge of surface parameters

Comparison : IASI L2 products and atlas calculated from MODIS

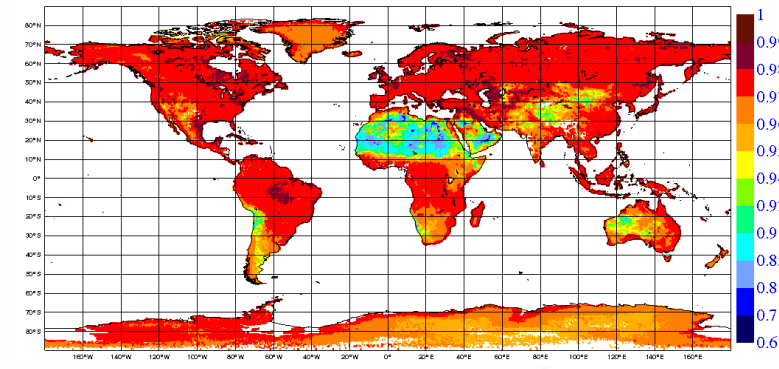
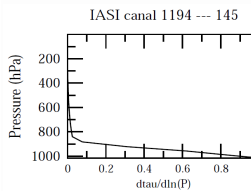
IASI L2 products



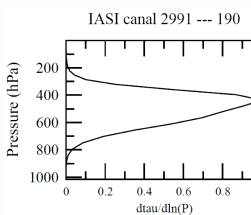
740cm-1



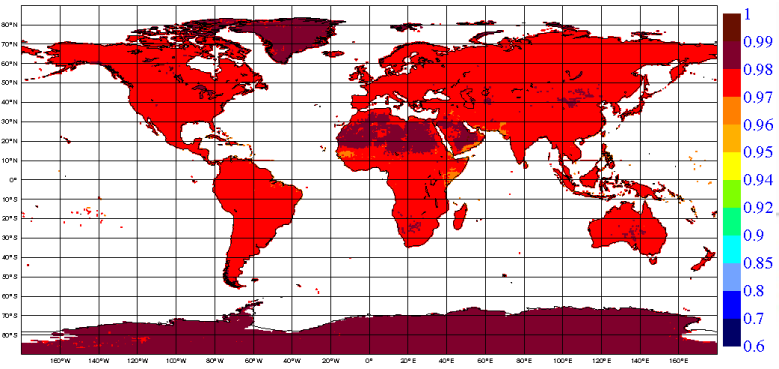
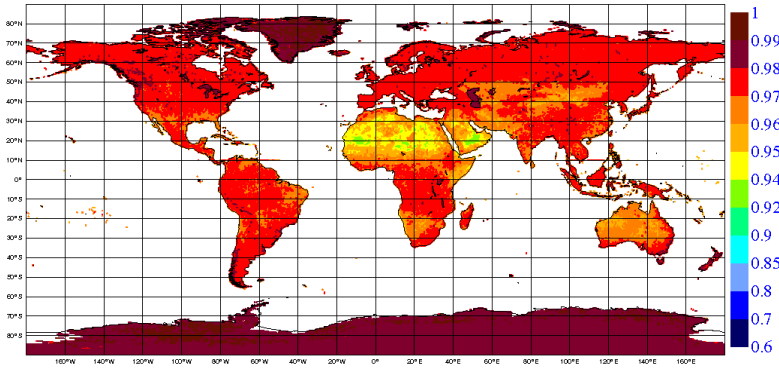
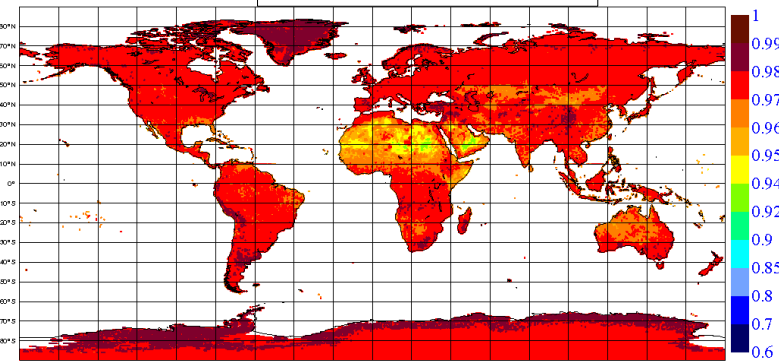
943cm-1



1392.50cm-1



Atlas from MODIS





# Towards a better knowledge of surface parameters

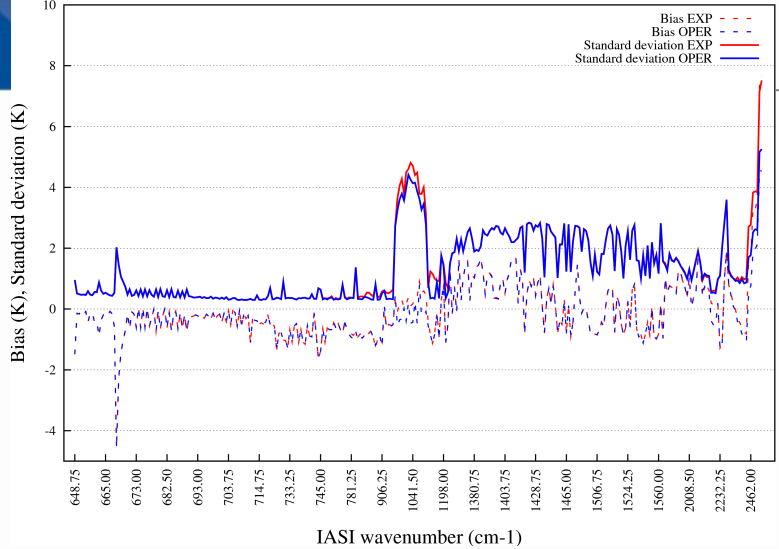
## Comparison : IASI L2 products and atlas calculated from MODIS

- Study on 1 month : July 2011.
- Calculations of the difference between observation and simulation for the background and for the atlas in order to estimate the impact of an accurate emissivity on the radiative transfert model for clear sky cases (according to cloud detect method, Mc Nally and Watts 2003).
- Study on the subset of 314 IASI channels.

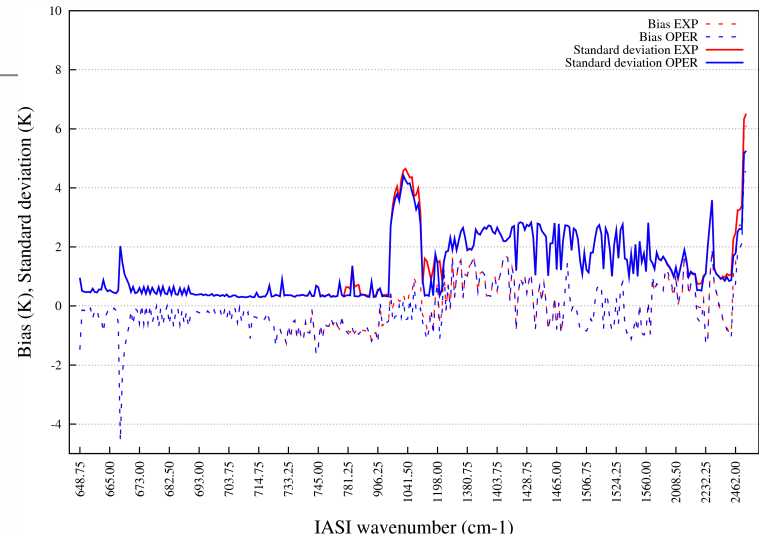
# IASI L2 products

# GLOBE

# Atlas calculated from MODIS



DAY

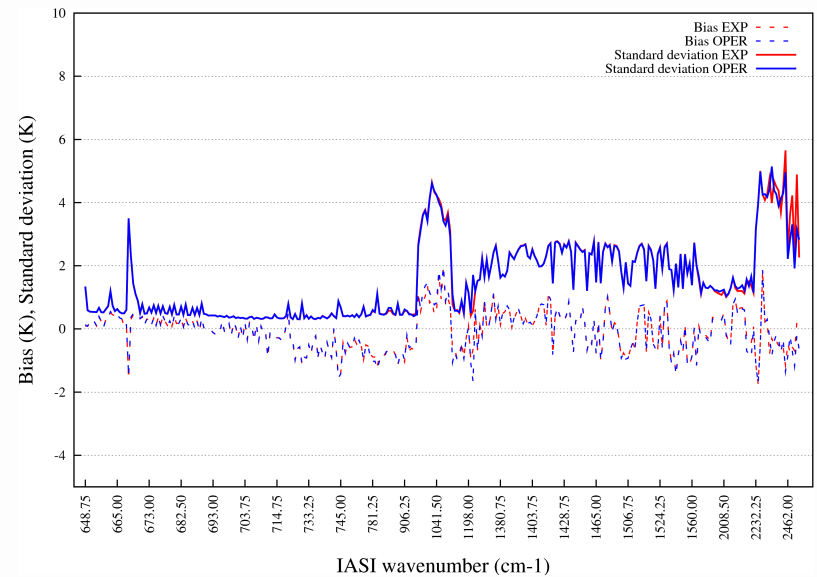


OPER

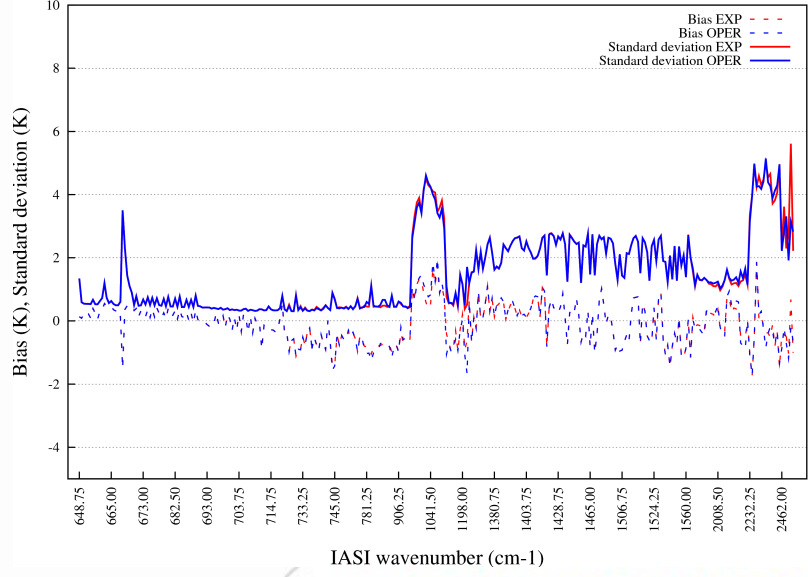
Mean bias=-0.0400 K  
 Mean standard deviation=1.384 K

Mean bias=-0.116 K  
 Mean standard deviation=1.310 K

Mean bias=-0,0623 K  
 Mean standard deviation=1.371 K



NIGHT



OPER

Mean bias=-0.0780 K  
 Mean standard deviation=1.490 K

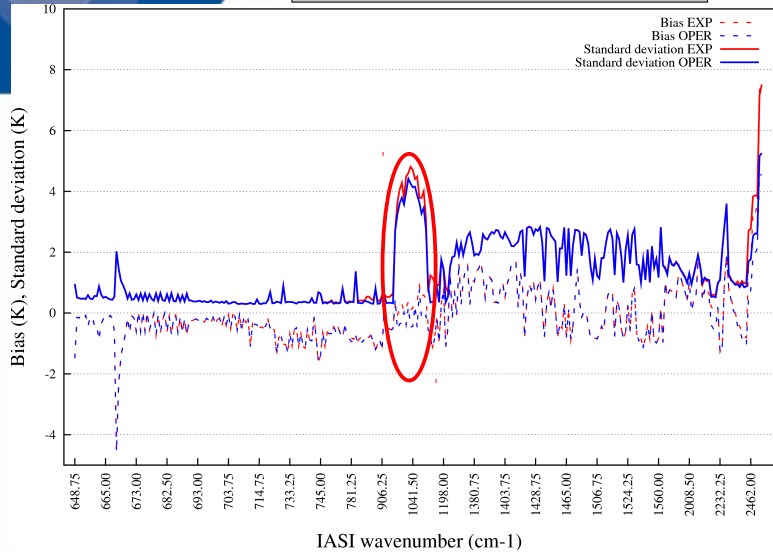
Mean bias=-0.0849 K  
 Mean standard deviation=1.482 K

Mean bias=-0.0792 K  
 Mean standard deviation=1.485 K

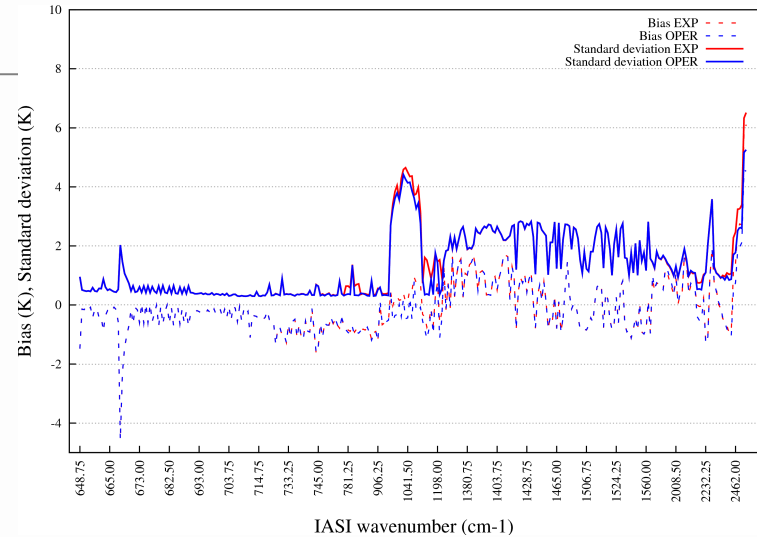
# IASI L2 products

# GLOBE

# Atlas calculated from MODIS



DAY

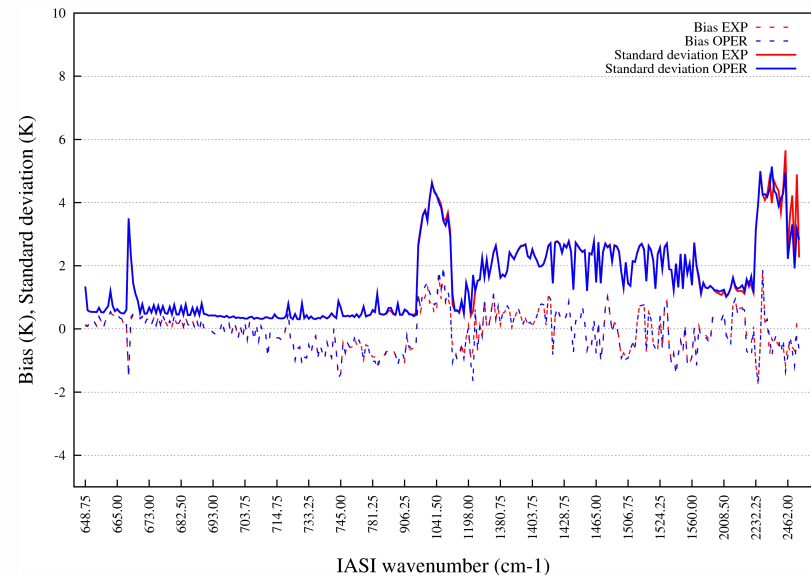


OPER

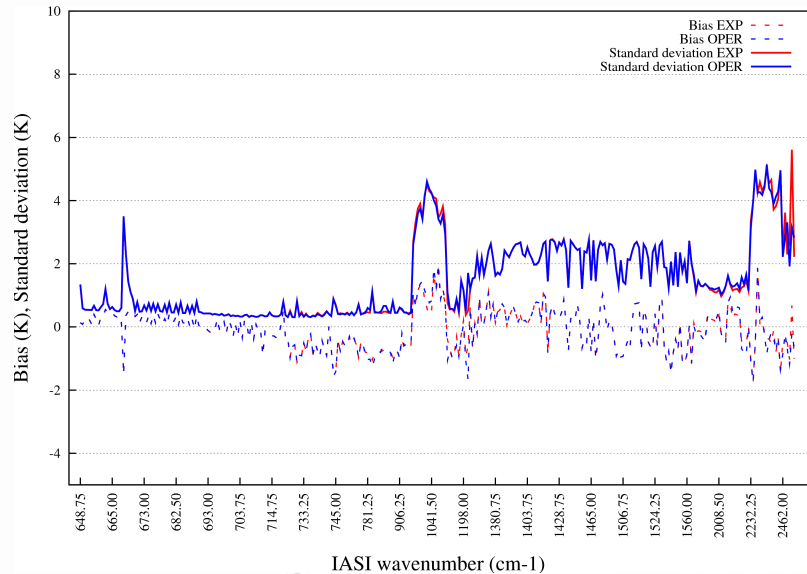
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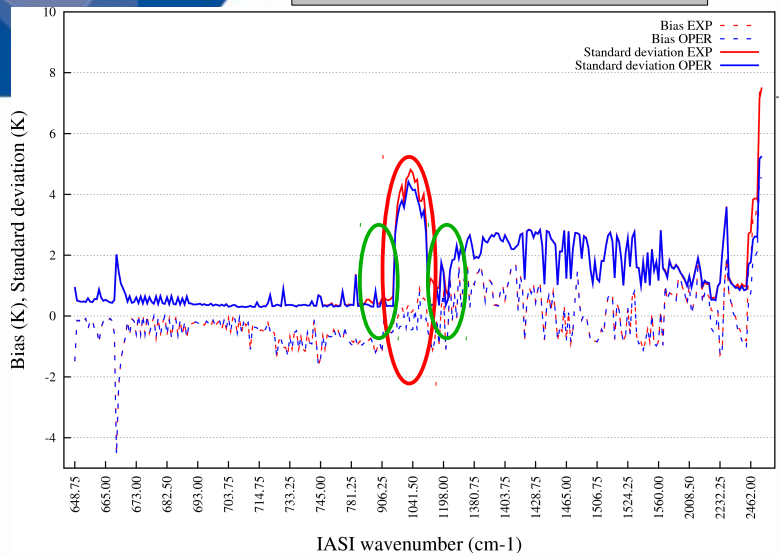
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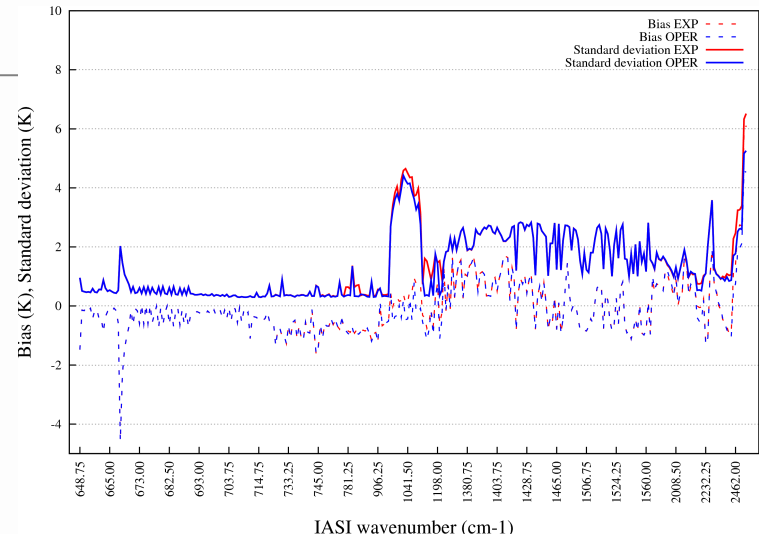
# IASI L2 products

# GLOBE

# Atlas calculated from MODIS



DAY

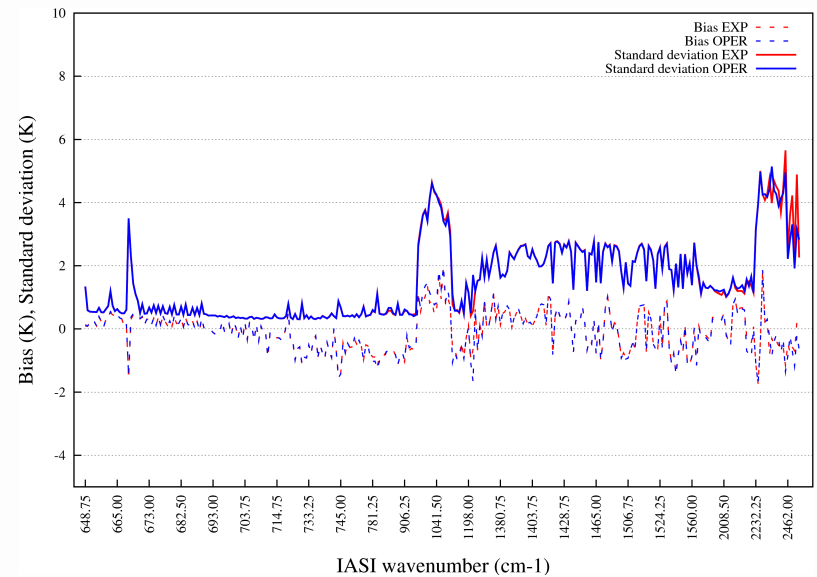


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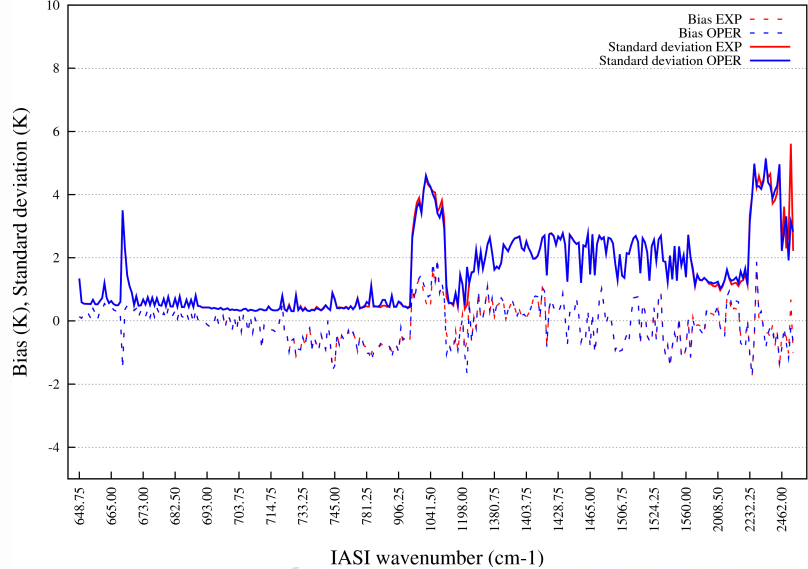
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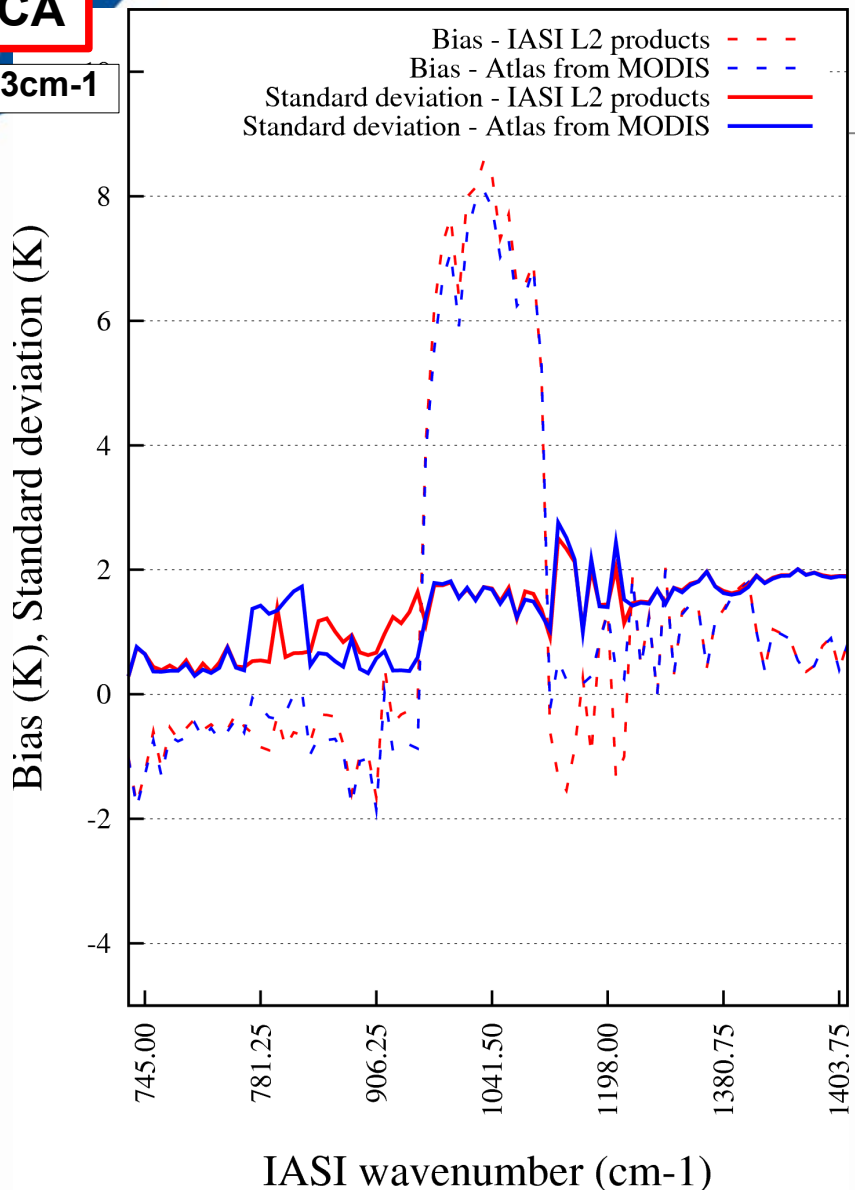
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# AFRICA

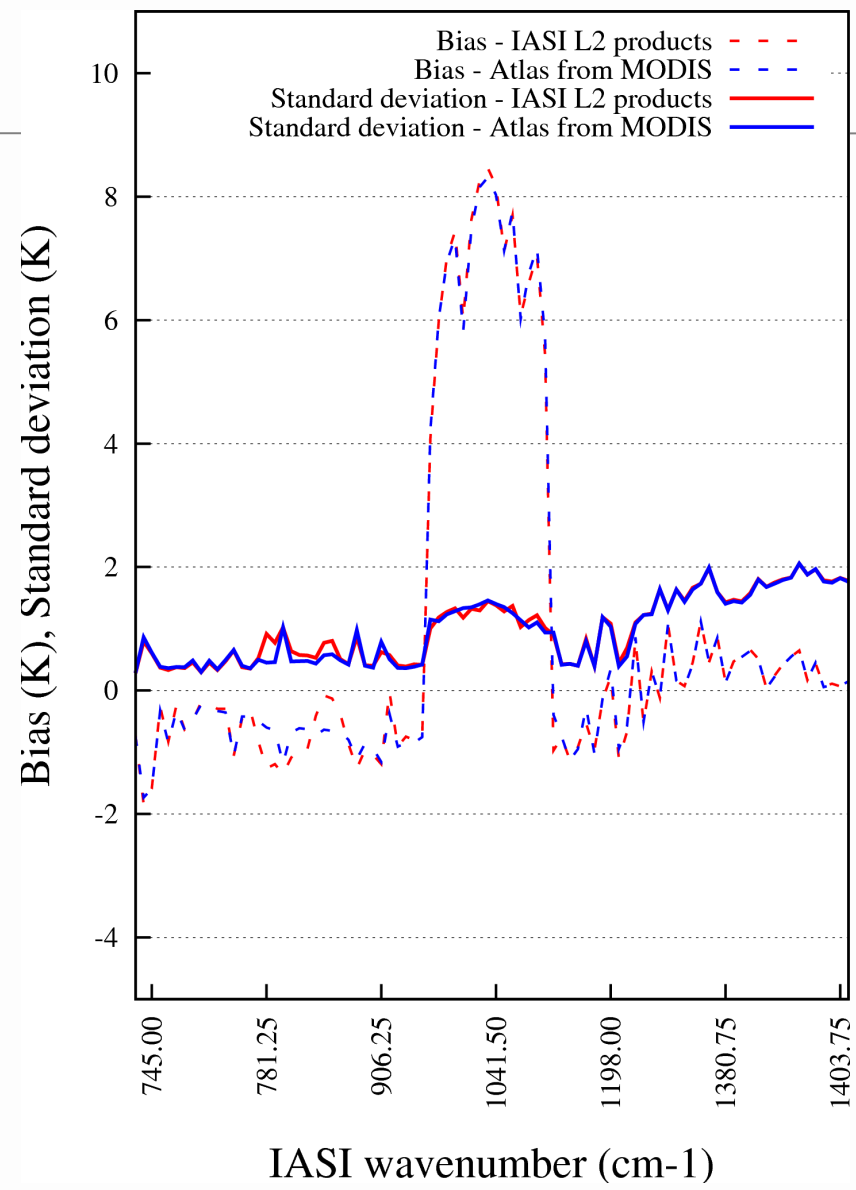
745-1403cm<sup>-1</sup>



DAY

IASI L2 product  
Mean bias=0.276 K  
Mean std=1.145 K

Atlas derived from MODIS  
Mean bias=0.243 K  
Mean std=1.149 K



NIGHT

IASI L2 product  
Mean bias= 0.156 K  
Mean std= 0.987 K

Atlas derived from MODIS  
Mean bias=0.146 K  
Mean std=0.978 K

### Second step : retrievals of surface temperature

- According to previous studies (Karbou et al., 2006 ; Pequignot et al, 2007 ; Guedj et al., 2011), the use of an emissivity atlas combined with Ts retrievals is beneficial to the process of radiance assimilation.
- The use of satellite observations depends on surface temperature. High impact in the assimilation process.
- Sensitivity study to determine how the models are wrong in Ts compared with various existing Ts products (SEVIRI, AVHRR, LandSAF, EUMETSAT,...).
- Dynamical calculation of Ts inverting the equation of radiative transfer from a single IASI channel. Comparison with existing Ts products.

### Future works

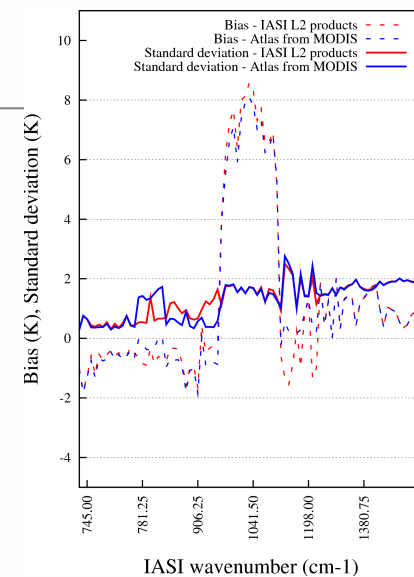
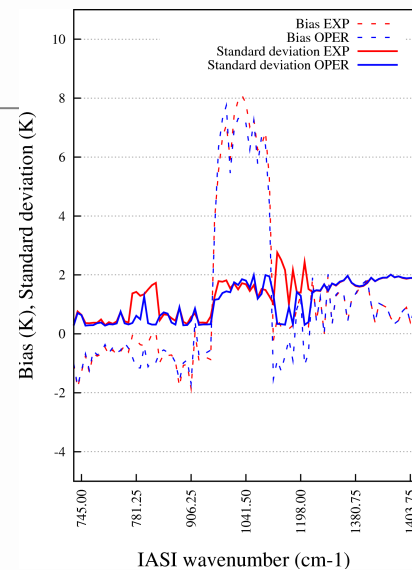
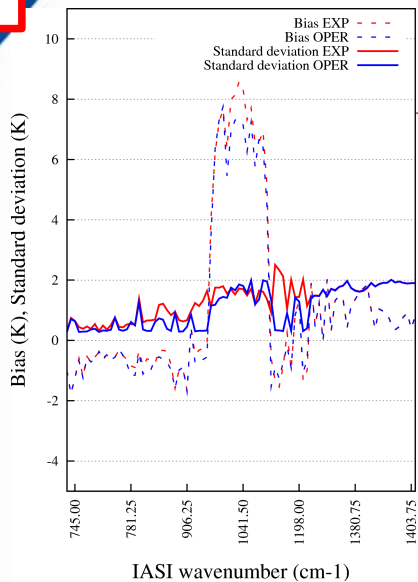
- Comparison of results with atlas calculated from MODIS and IASI surface emissivity products from EUMETSAT : no major impact of accurate emissivity on simulation => Integration of Ts retrievals into ARPEGE.
- Interpolation of the emissivity of IASI L2 products in order to estimate the land surface emissivities at a high spectral resolution compatible with IASI channels.
- Simulation of BT over land and after assimilation with channel selection.
- Validation of the method applying the same calculations over sea and sea-ice.





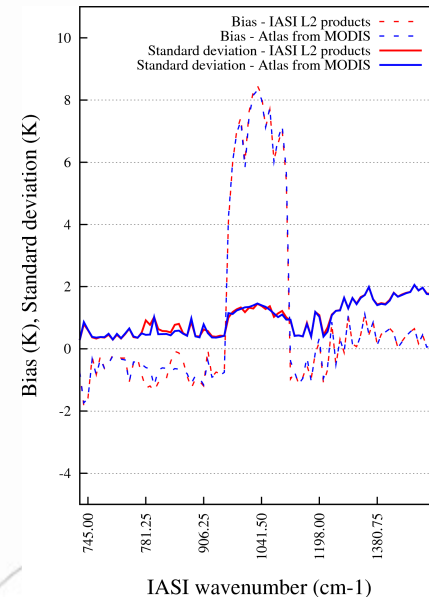
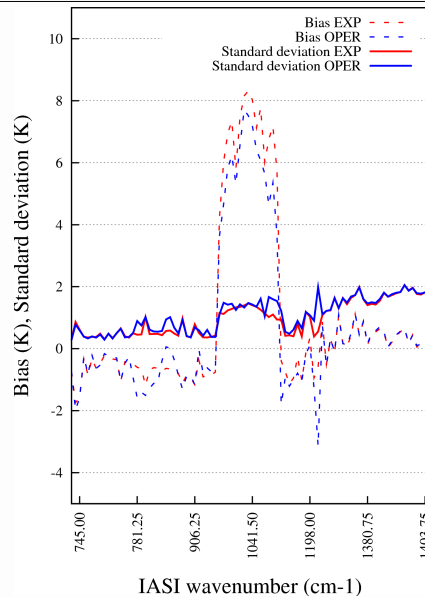
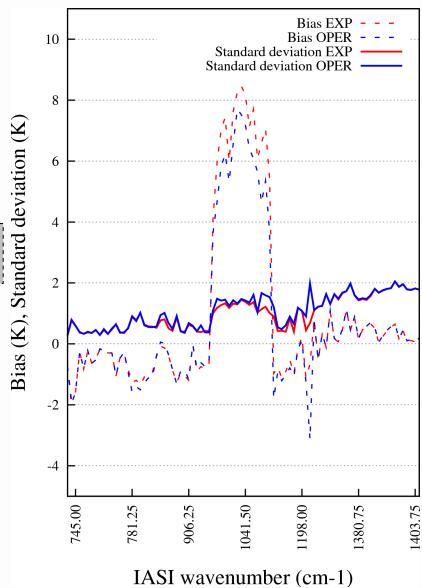
Thank you for  
your attention...  
any questions?



**DAY**

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