Use of IASI products for Climate models and monitoring

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OUTLINE

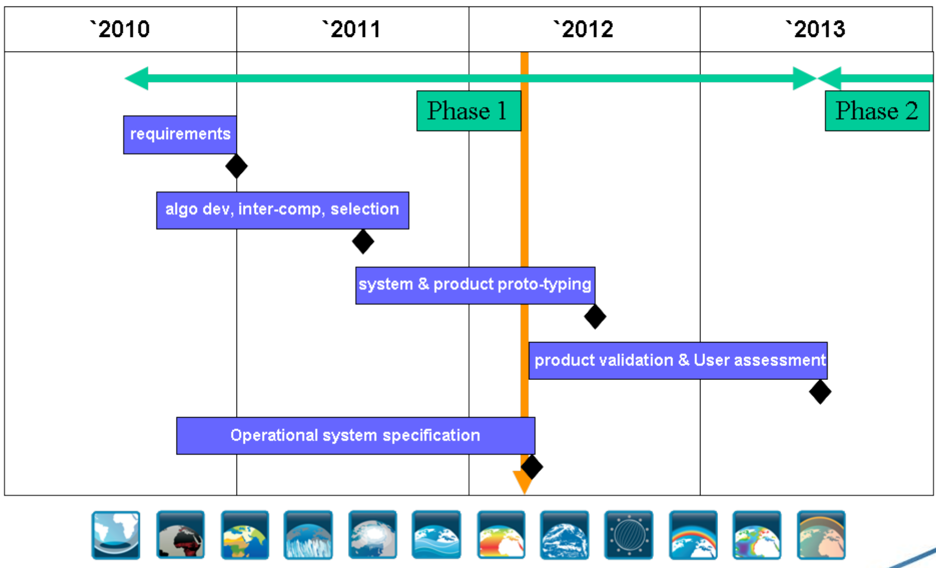
- CCI Project and the CMUG
- Focus on Ozone from IASI
  - Use for model assessment
  - Ozone Role : Forcing on Radiative flux
    - Important to monitor ozone hole and recovery
    - Tropospheric ozone
    - Assessment of projections (CMIP5) and regional climate models
- Why IASI in Climate studies?
  - Level 3 products
  - IASI Level 1C as a FCDR
  - SST Proxy
- Conclusions

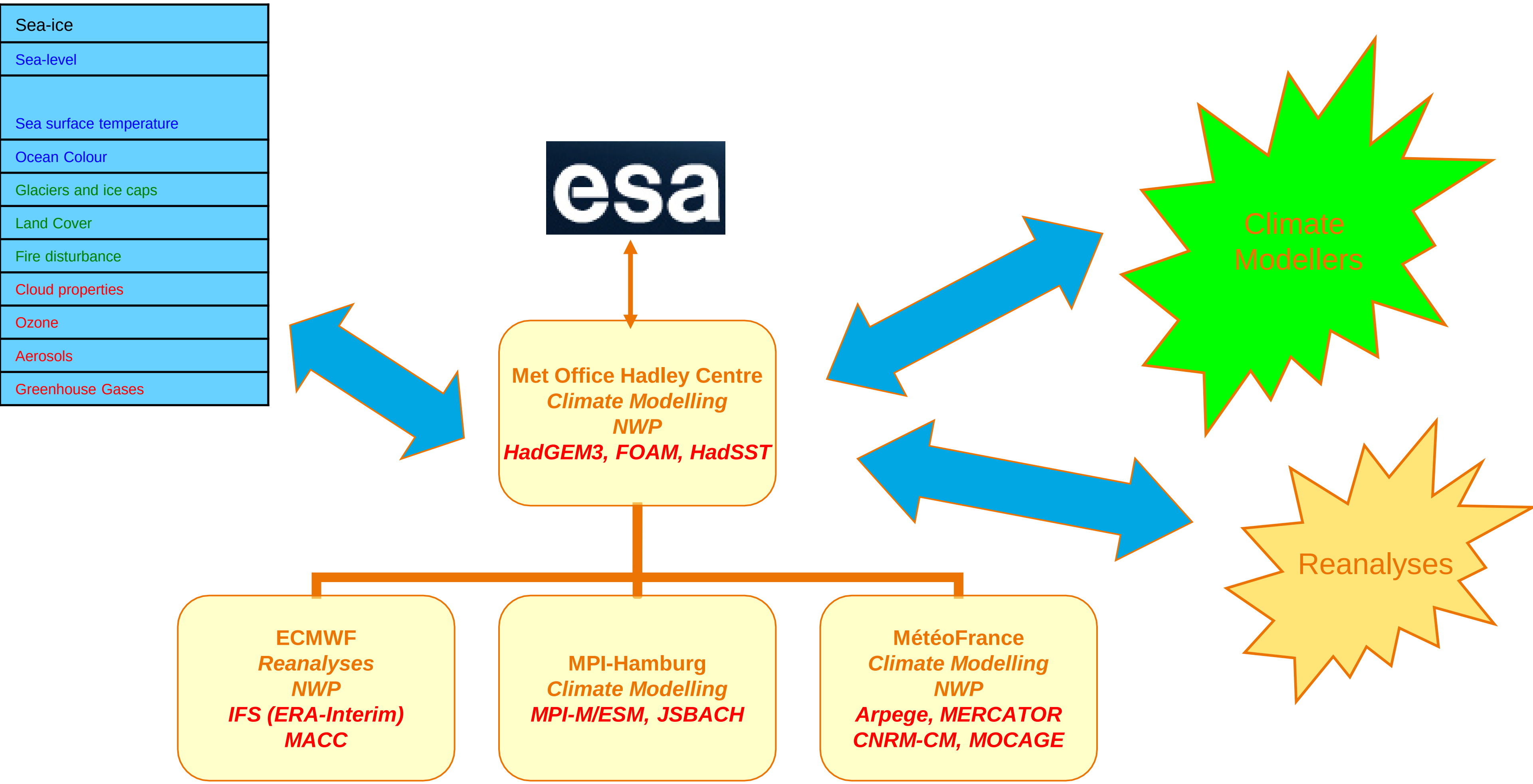
CCI : GOALS AND ACTIVITIES

- Climate Change initiative is a project of 6 years (3 phases) to provide products of ‘climate quality’ to model scientists.
- 75 M€
- 14 ECVs (as defined by CEOS), 15 teams
- Each ECV ←→ Consortium with EO scientists, Climate research Group, System Engineering team. They have to propose algorithms and compare their performances to <u>reprocess</u> global observations from ESA or 3rd Party satellites to deliver products compliant with User requirements from Global Climate community

ECV	Science Leader
cloud_cci	***DWD***
ozone_cci	***BIRA***
aerosol_cci	***DLR/FMI***
ghg_cci	***U Bremen***
sst_cci	***U Edinburgh***
Land_cover_cci	***UCL***
Sea_level_cc	***CLS***
Ocean_colour_cci	***PML***
glaciers_cci	***U. Zurich***
fire _cci	***U.Alcala***
CMUG	***UKmetO - Hadley Centre***
Sea_Ice_cci	***NERSC***
Soil_Moisture_cci	***TU Wien***
Ice_Sheet_cci	***DTU Space***

CCI Status March 2012





- **CCI Web site: www.esa-cci.org**

Main Activities of CMUG

Done

Refining of scientific requirements derived from GCOS for climate modellers.

Provide technical feedback to CCI projects

Provide reanalysis data to CCI projects

On-going

Assess the global satellite climate data records (CDRs) produced from the 10 CCI consortia

Start with precursors then prototypes

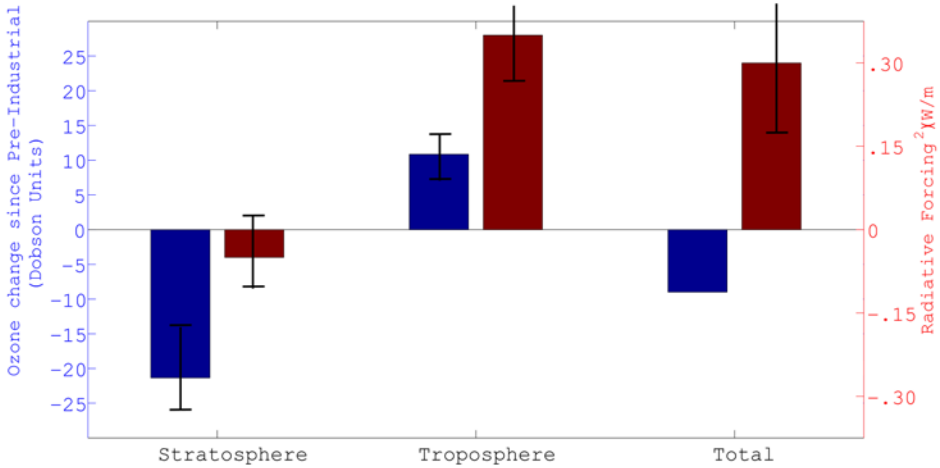
Look specifically at required consistencies *across* ECVs from a user viewpoint.

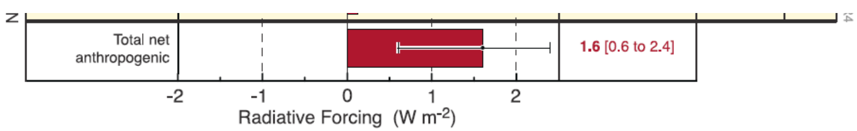
Continuous

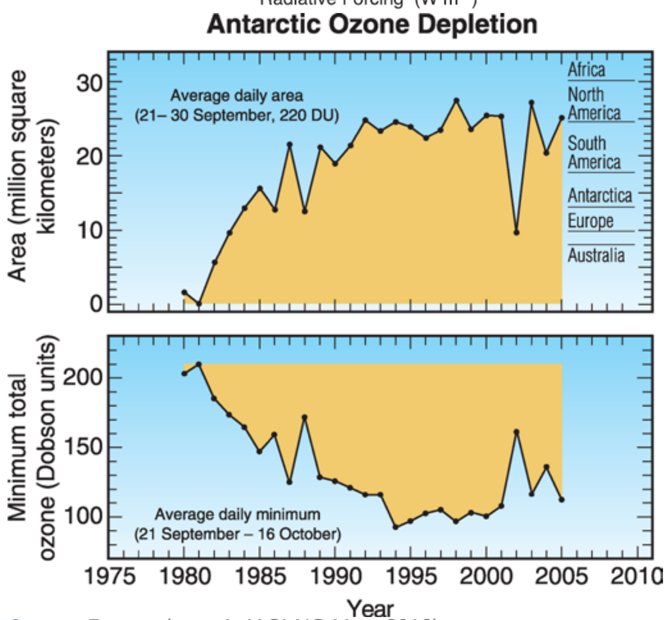
Promote and report on the use of the CCI datasets by modellers

Interact with related climate modelling and reanalysis initiatives.

Ozone







Very important role of Ozone in Climate:

- through the radiative forcing
- Through the role of O3 , precursor of OH which interacts with CH4 and CFCs
- Through Climate/chemistry interactions

Monitoring requirements

- Global distribution to be monitored
- Ozone hole depletion
- Ozone at UTLS

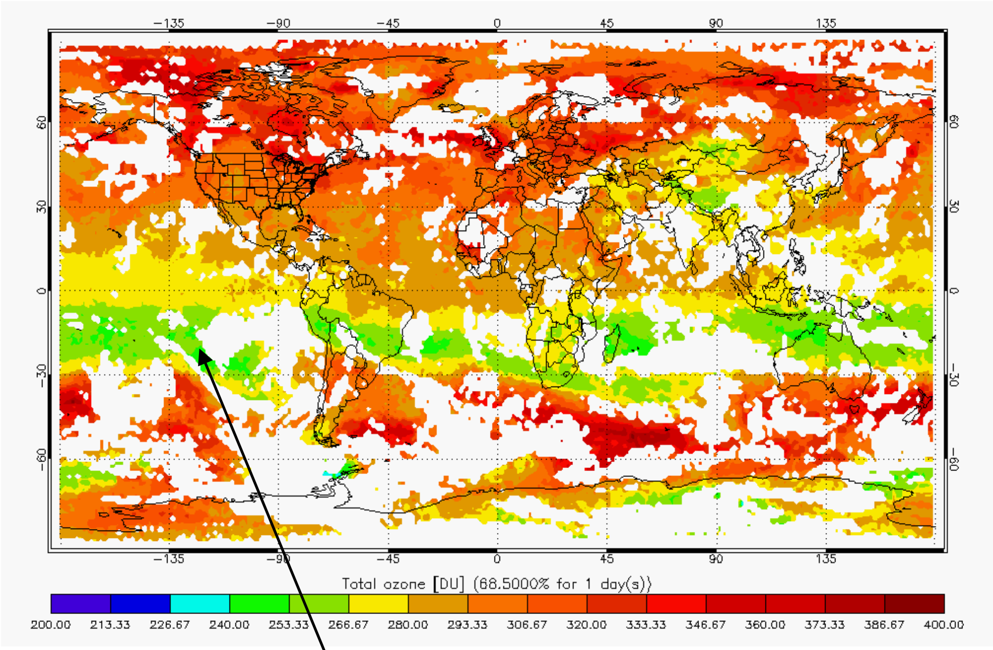
Models

CNRM CCM with interactive chemistry in stratosphere

MOCAGE : CTM + ARPEGE or IFS

OZONE data

- IASI level 3 products
  - ✦ Computed from day-2 level 2 Eumetsat products (Thanks!)
  - ✦ From sept 2008 to Aug 2009
  - ✦ **Cloud-screened data only**
  - ✦ **TC + subcolumns 0-6 km, 0-9, 0-12 km derived from profiles using retrieved temperature**
  - ✦ **Mean values in a grid of 1.4 ° (T)**
  - ✦ **Monthly means**
  - ✦ **Evaluation of uncertainties (not delivered with the products) through comparison with LATMOS**

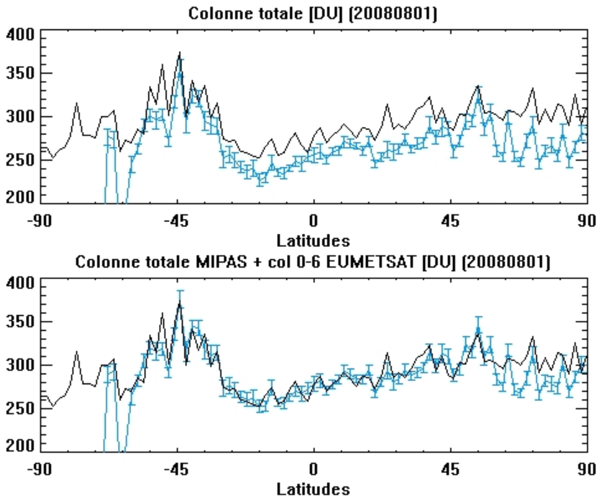


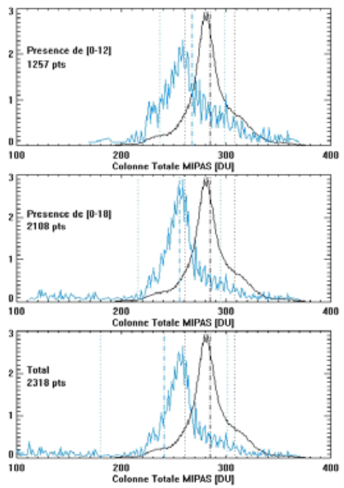
Average over at least 10 days to reduce cloud gaps.

Waves of about 14 days can be observed

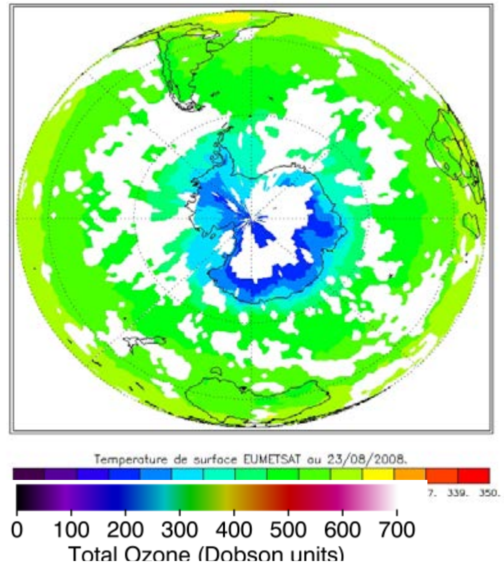
IASI Ozone product assessment

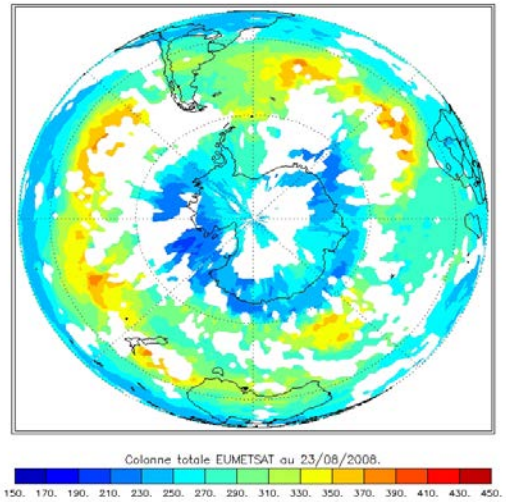
Comparison with MIPAS :



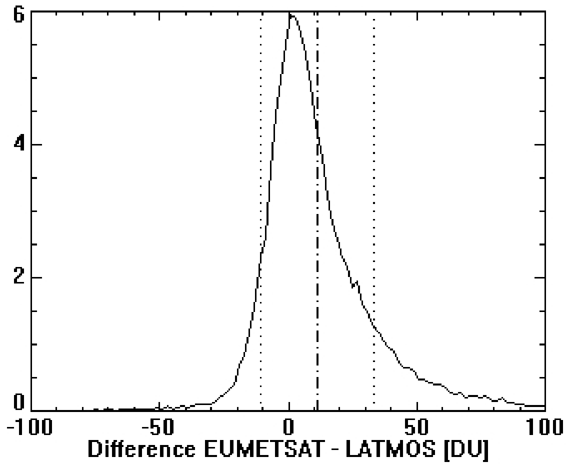


Comparison with OMI

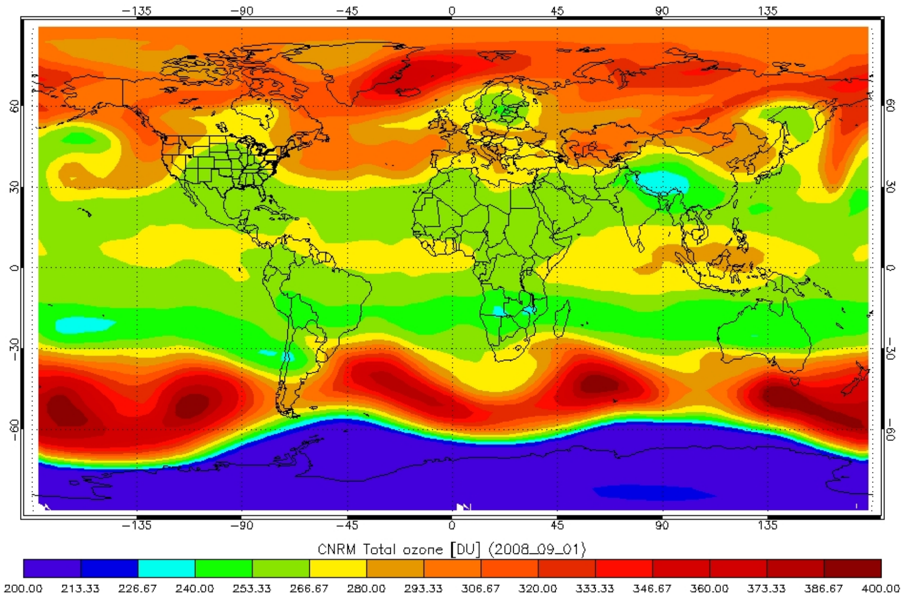


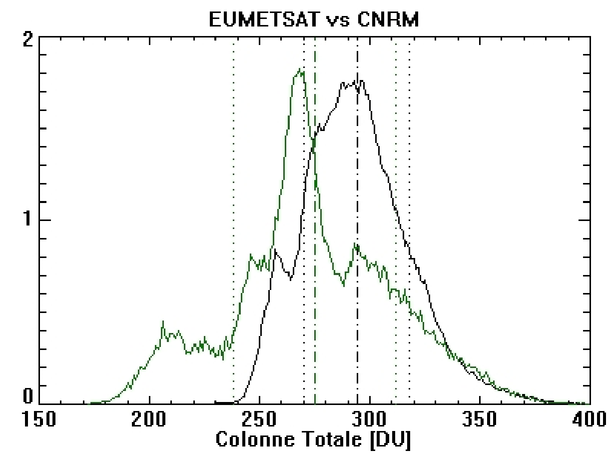


Comparison with LATMOS

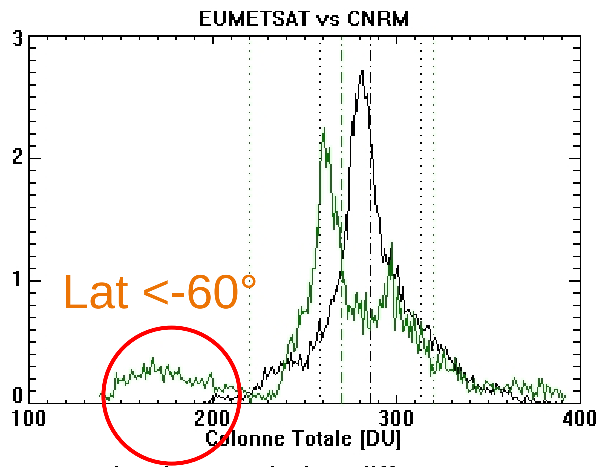


Comparison with CNRM-CCM Ozone

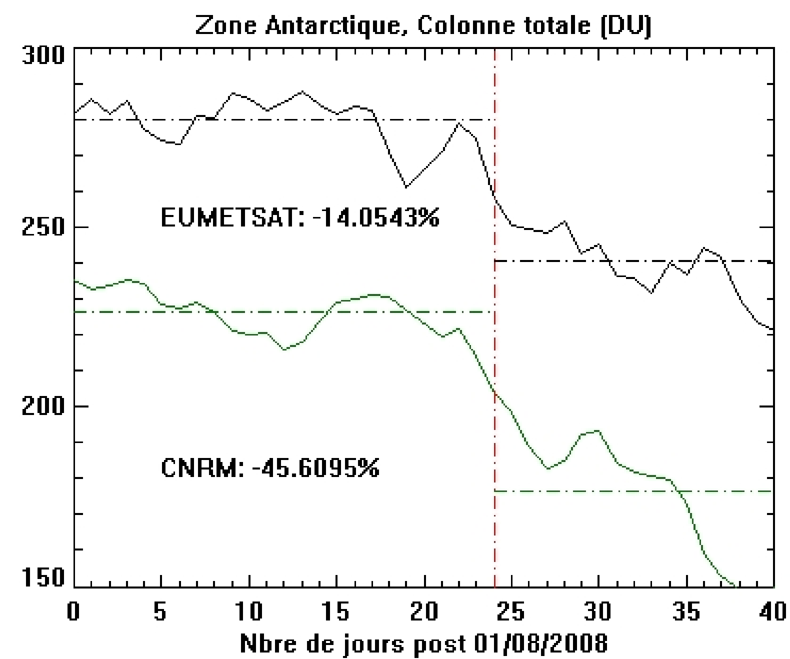




Global total column in August 2008. Monthly average or decadal average give the same PDF. Mean discrepancy around -3%.

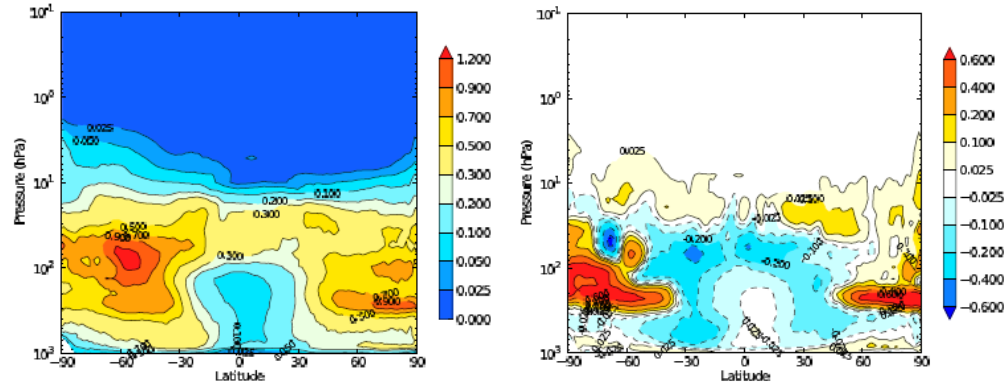


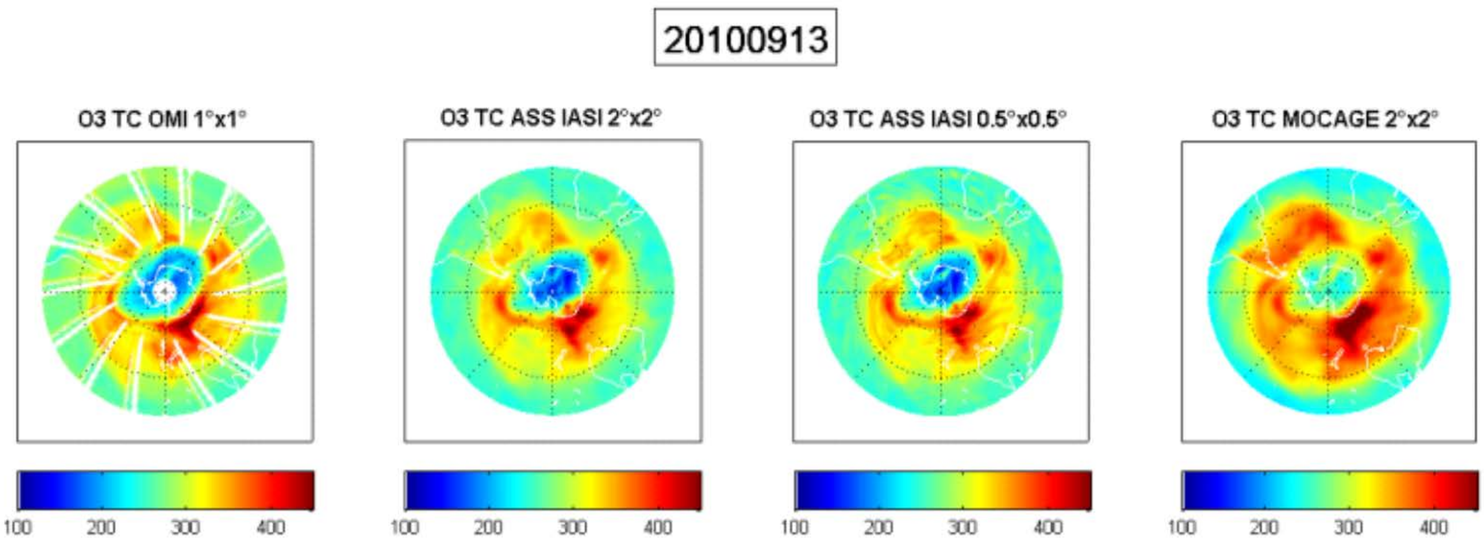
Total column relative difference < 6%
Note that consistency for Sub column [0-12] is good, but [0-6] and [0-18] show large discrepancies with respectively 18% and



More results

- Assimilation of IASI in MOCAGE
- Test of high resolution IASI profiles in MOCAGE
  - ✦ Over Antarctica (L. ElAmraoui, 2011))
  - ✦ Global and over Antarctica (B.Pajot, 2011)





Total O3 Column over Antarctic on 13 Sept. 2010 : a) MOCAGE 2°x2°), with IASI assimilated at 0.5°x0.5°, IASI assimilated at 2°x2°and OMI at 1°x1°

These studies show that in an assimilation scheme IASI products bring some useful information and especially when used at high resolution.

Conclusion for Ozone

The current IASI products look overestimated wrt the model especially over Antarctica. This may be due to the strong temperature inversion observed over the plateau. Differences with the UV Ozone are also observed. Global bias may also be due to spectroscopy.

Assimilation of IASI data brings some information to improve Ozone monitoring.

More work to be done. Especially with upgraded IASI products and the Ozone ECV products from the CCI.

Why using IASI for Climate studies

- Very stable
- Very well calibrated → a reference for re-calibration of infrared sensors

(WMO’s GSICS)

- 15 years of data and more with the continuation with IASI-NG

1. High information content (continuity of spectral coverage, spectral resolution, radiometric performances)

IASI is well designed to deliver FCDR and TCDR for Climate monitoring.

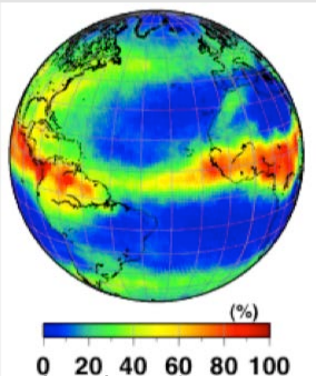
It is also used in study of processes.

Climate studies with MetOp IASI/AMSU

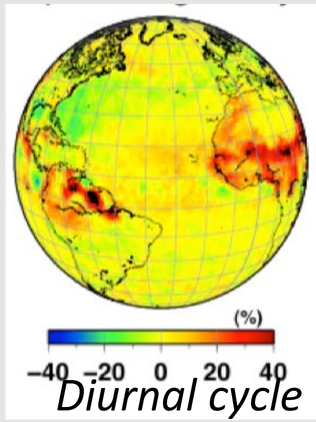
LMD

•IASI contributes to the monitoring of several Essential Climate Variables.

Cloud coverage and microphysical properties

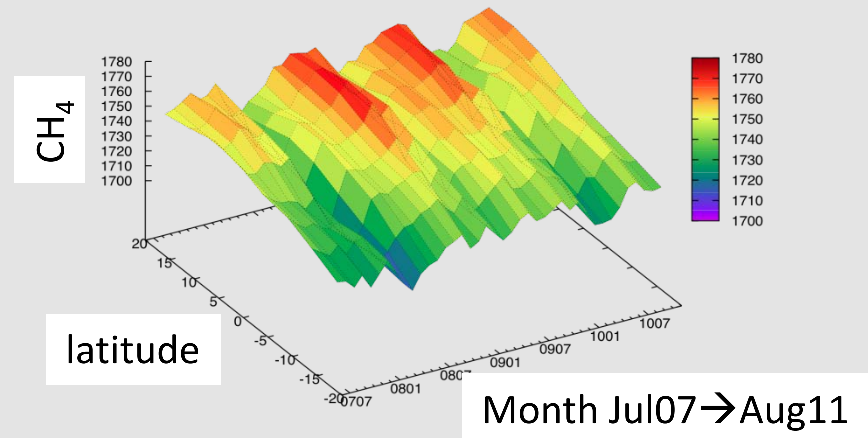


High Cloud Amount

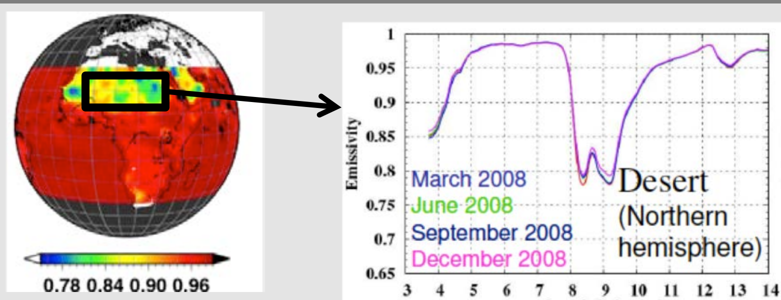


Diurnal cycle

Greenhouse gases (CO_2, CH_4)

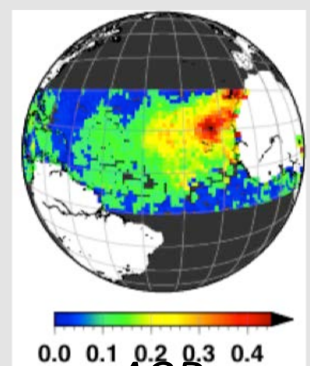


Surface characteristics

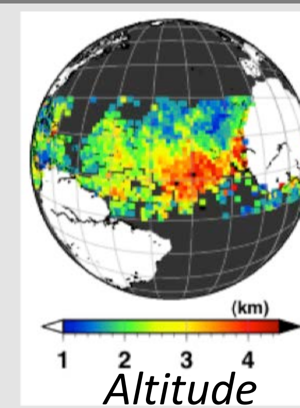


Spectral emissivity of continental surfaces

Dust Aerosols

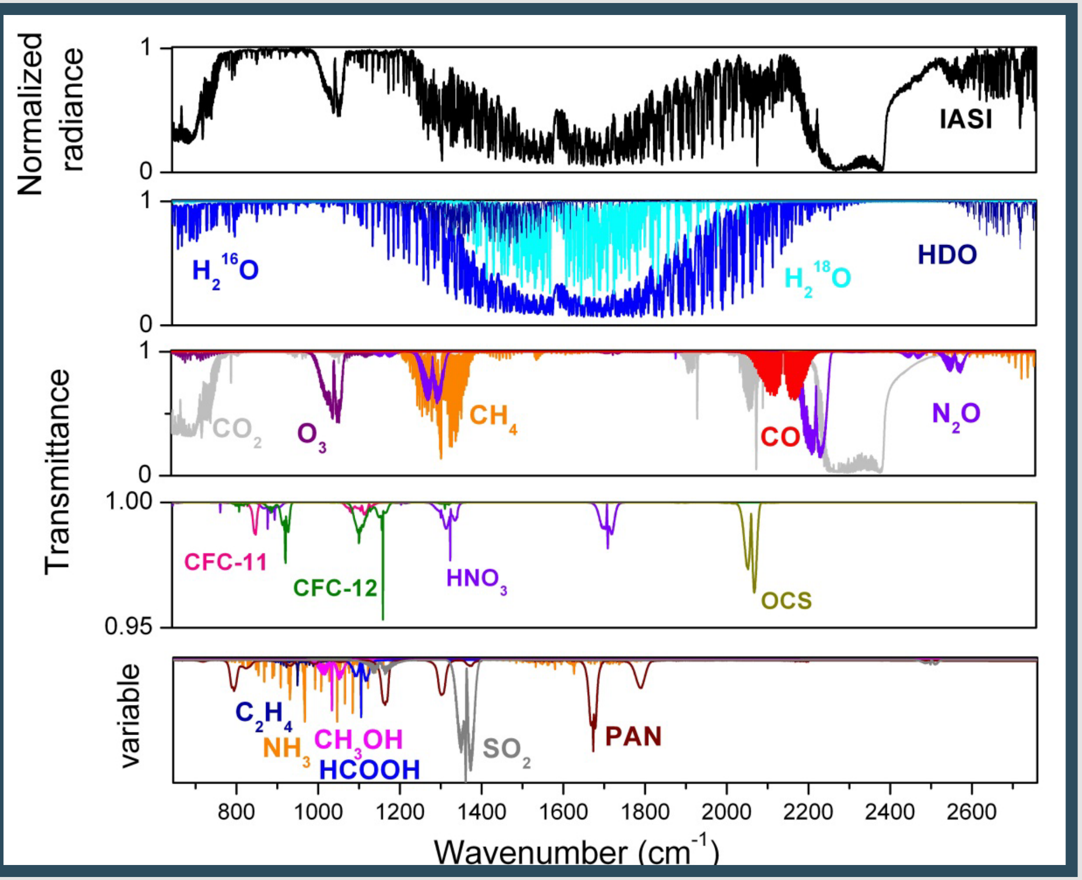


AOD



Altitude

Crédit: LMD, Cyril Crevoisier



Atmospheric composition measurements

Climate gases monitoring
Understand atmospheric chemistry
Study AC /climate interactions

Species detected with IASI:
H_2O CO_2 N_2O O_3 CO HNO_3 HDO NH_3 PAN HONO C_4H_4O CH_4 C_2H_2 C_2H_4 C_3H_6 CH_3OH HCOOH CH_3COOH CH_3CHO CFC-11 CFC-12 HCN OCS SO_2 H_2S

bonus 3/ Operational applications

Eg fires detection, volcanic plumes

T + 2.5 heures

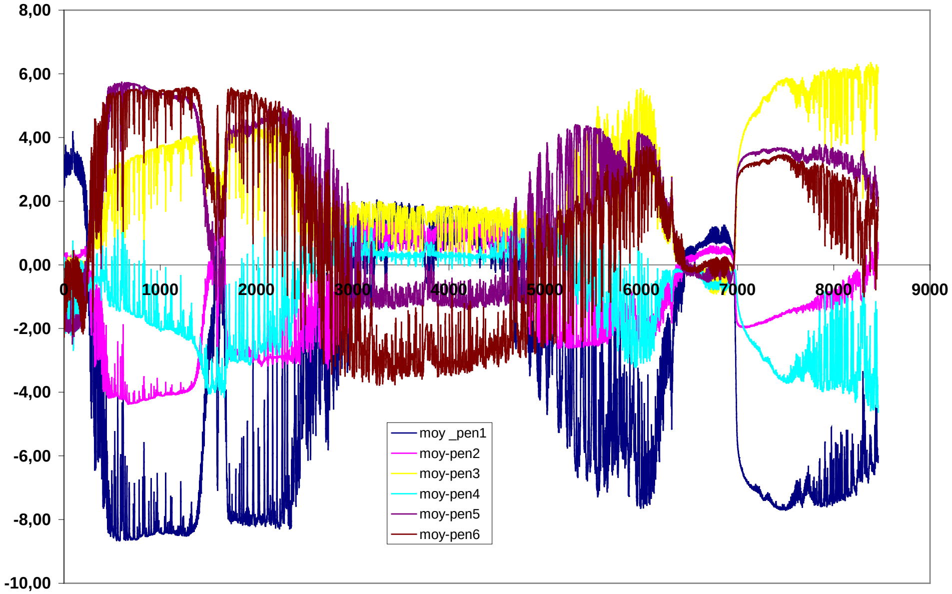
IASI Level 1C as a FCDR

IASI spectra being stable and well calibrated some information can directly be inferred from Level1C 8461 channels

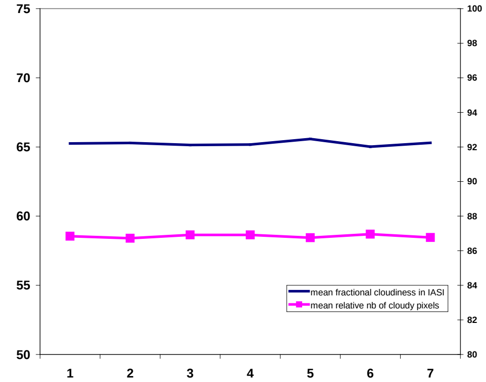
-Long time series of IASI level 1 Monitoring mean IASI spectra at global scale (or zonal)

-Channel selection to get proxy of ECV : the case of SST

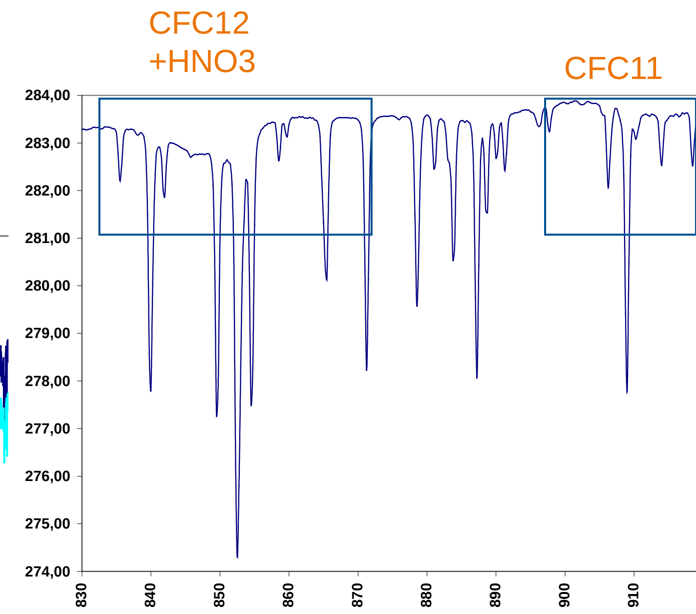
- Goals are :
  - Define representative spectra for studies in definition of new missions (HRS or imagers)
  - Study the average global equilibrium of the Earth
    - Solar signal (day/night comparison)
    - Land/sea
    - Mean Cloud cover
  - How long is needed to get stable spectra?
  - Mean cloud cover
  - Signature of deviation from equilibrium state
  - Monitoring of some GHG mean spectra.



8,00
6,00
4,00
2,00
0,00
-2,00
-4,00
-6,00
-8,00
-10,00
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
moy _pen1
moy-pen2
moy-pen3
moy-pen4
moy-pen5
moy-pen6



75
70
65
60
55
50
100
98
96
94
92
90
88
86
84
82
80
1
2
3
4
5
6
7
mean fractional cloudiness in IASI
mean relative nb of cloudy pixels



CFC12
+HNO3
CFC11
284,00
283,00
282,00
281,00
280,00
279,00
278,00
277,00
276,00
275,00
274,00
830
840
850
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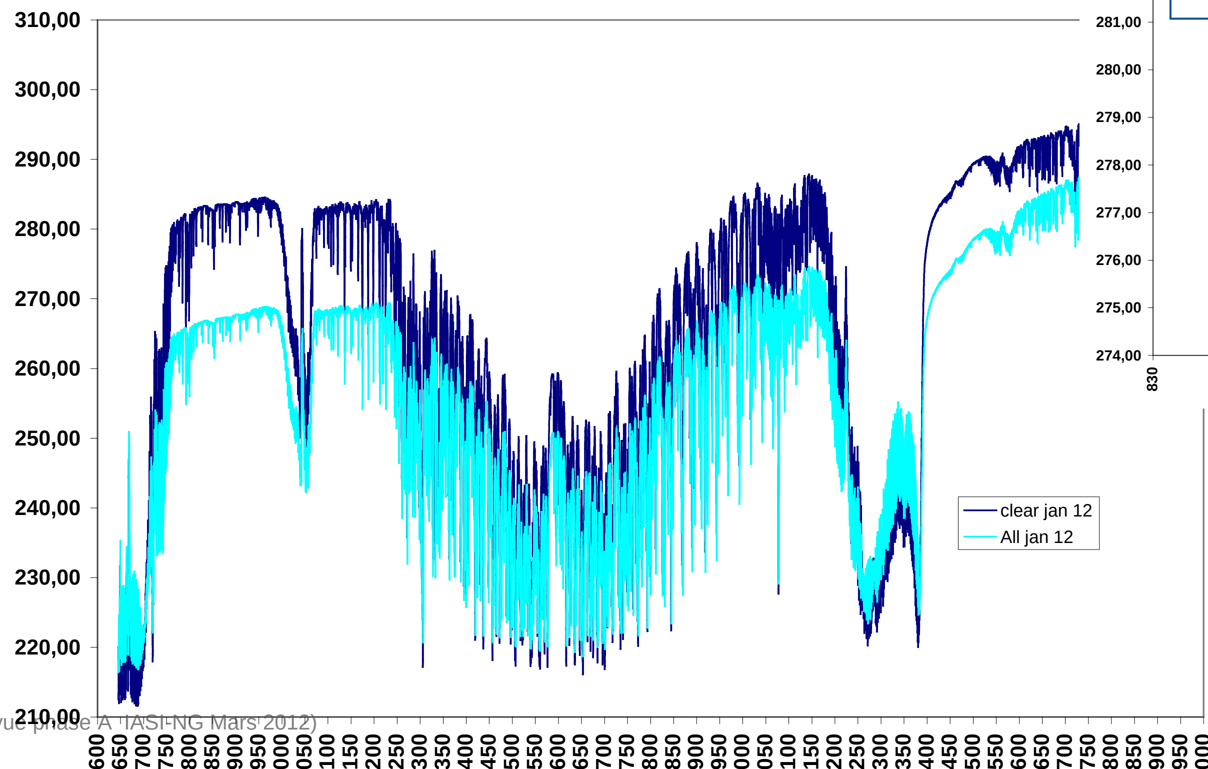
870
880
890
900
910



310,00
300,00
290,00
280,00
270,00
260,00
250,00
240,00
230,00
220,00
210,00
clear jan 12
All jan 12

SST from IASI

The IR atmospheric spectra exhibit very transparent microwindows in the shortwave infrared.

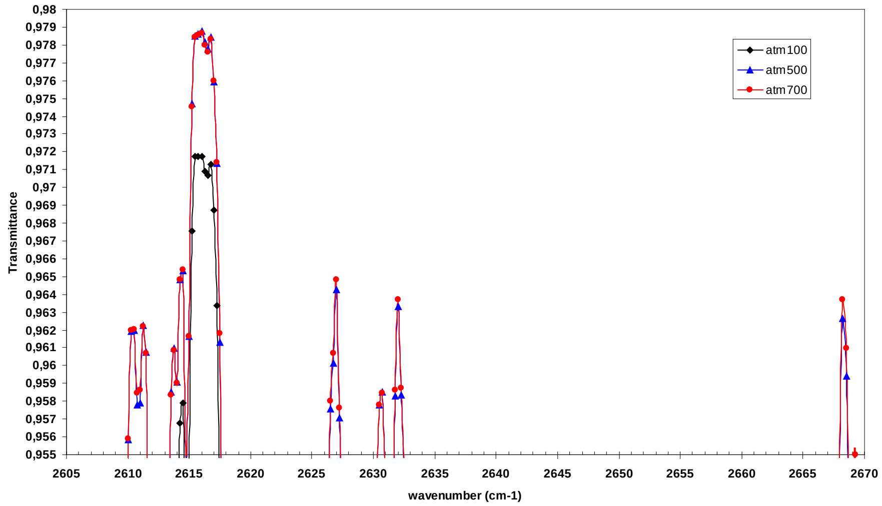
For at least 20 IASI channels the transmittance is higher than 0.94.

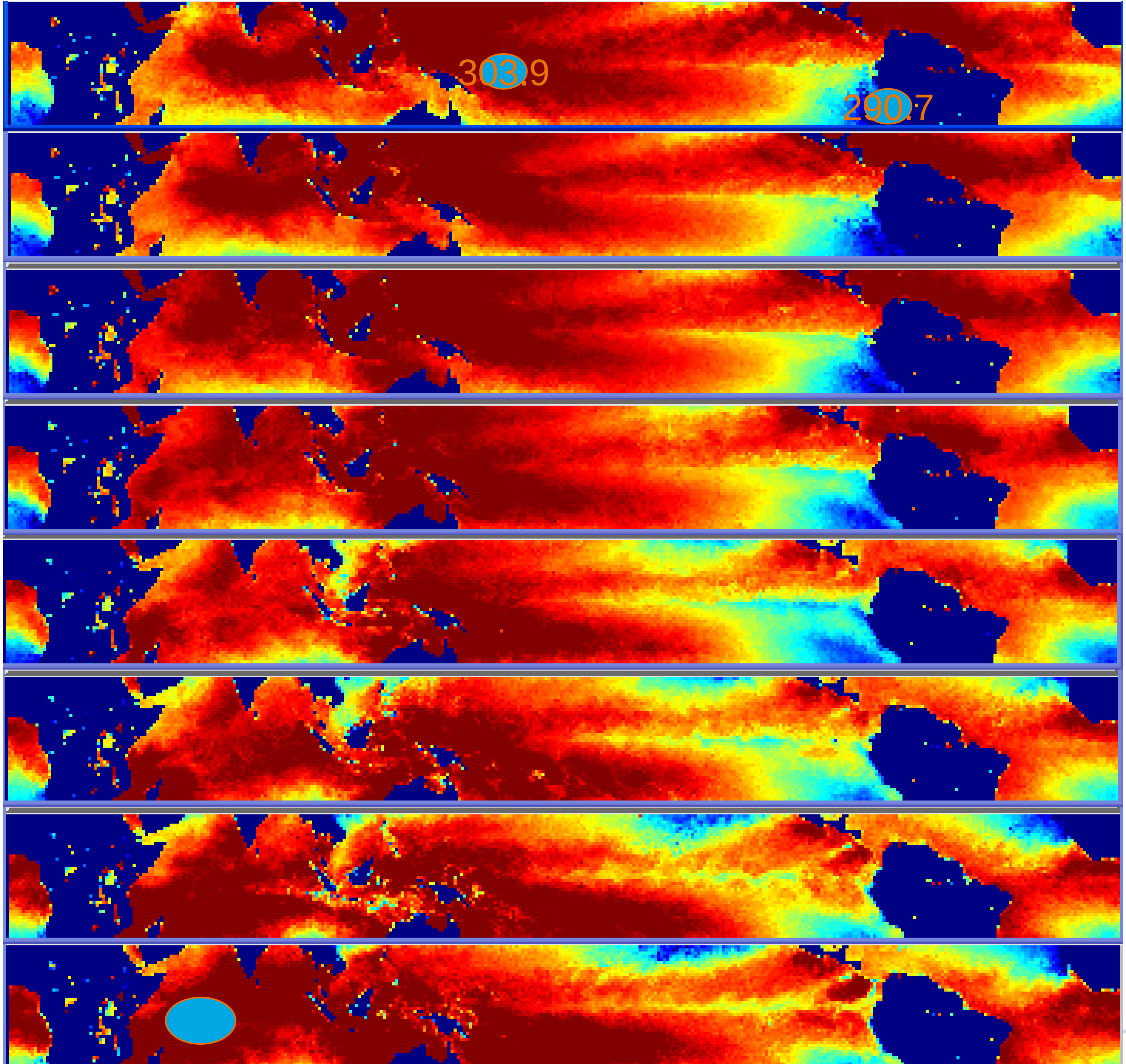
SST can thus be derived directly from the measurements without any atmospheric correction, only a low bias function of secΘ.

The advantage is that it does not need any upgrade of processing and data are ready to be used for Climate analysis

Nevertheless the noise is such that even after averaging the 20 radiances, there remains a small noise on the products.

Statistics over channels are established -→ level3 products





Aug 08

Sep 08

Oct 08

Nov 08

Dec 08

Jan 09

Feb 09

Mar 09

Perspectives

•The analysis will continue with production of long time series in a grid of 0.5° and decadal SST

•Subskin temperature

•Comparison with Seviri, and MetOP AVHRR and IASI L2 product.

CONCLUSIONS

Use of IASI for Climate monitoring has just started while its quality, its stability and the programme duration (more than 30 years) make it a very useful observation instrument for climate monitoring.

The Ozone IASI product is very useful to document the upper troposphere. Work has been started to confront the columns and subcolumns to climate model outputs. Overestimation of Ozone total column have to be understood. Assimilation of high resolution IASI in CTM is very promising.

Level 1c spectra climatology has started. Information content is very high. Tools are to be developed to extract it.

SST can be retrieved using microwindow channels at 2600 cm-1. Uncertainty with respect to other methods and instruments will be quantified.