http://ara.abct.lmd.polytechnique.fr/

Lessons learnt from the validation of Level1 and Level2 hyperspectral sounders observations

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Ascertain the quality of “IASI et al” MetOp radiances
A multistep step procedure

Inter-calibration: IASI in synergy with other sounders

➔ Comparison of observed IASI radiances with radiances observed from other sounders

✓ IASI in " stand alone

➔ Comparison of IASI observed BT with simulated BT based on forward RT model + in-situ (R/S) observations

(*) CAL/VAL Metop-B ➔ presentation last ISSWG, Bruges, July 2013

Aim : identify which instrument deviates from the other(s).

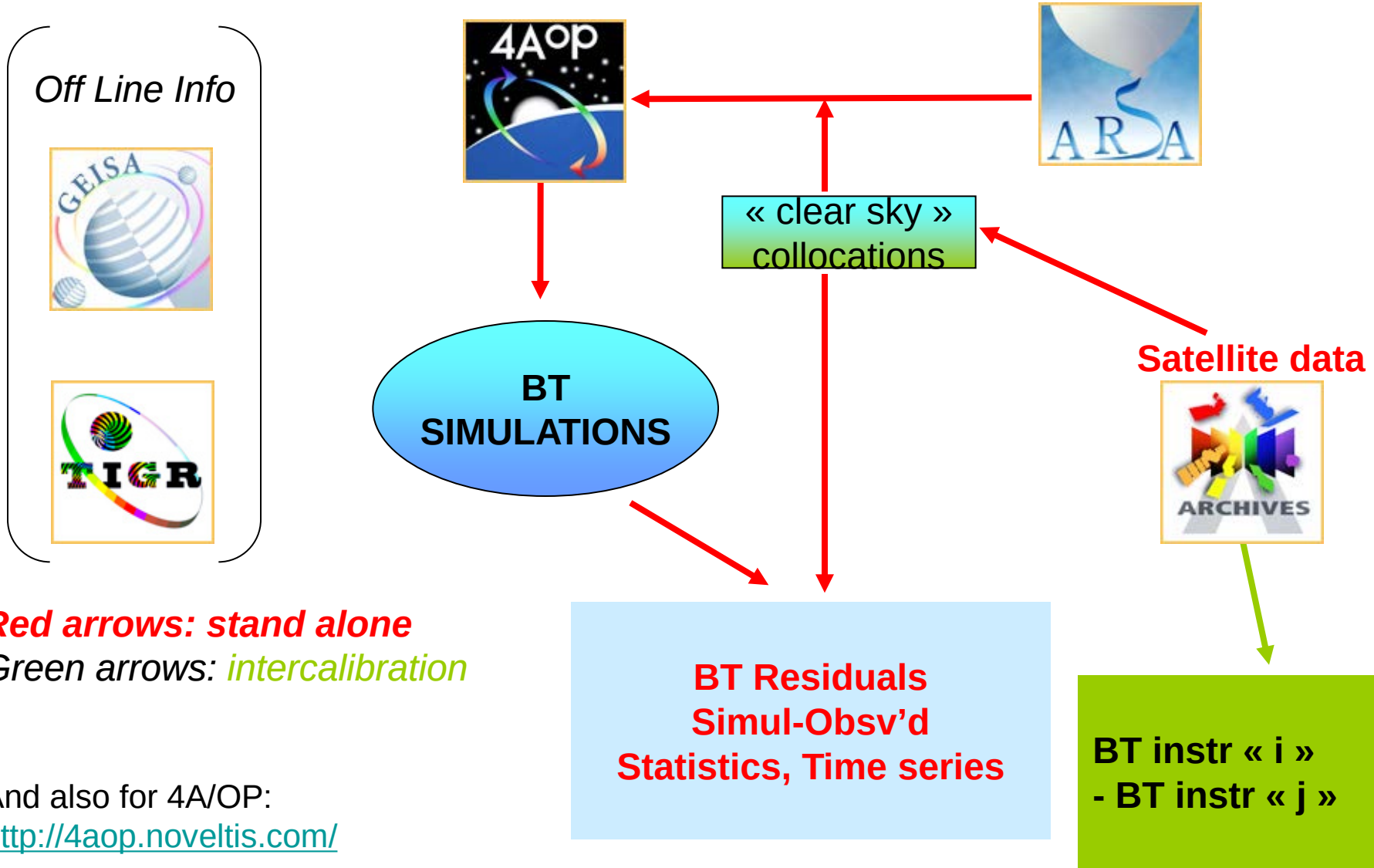
- compare wide ranges of brightness temperatures (clear or cloudy) (inter-calibration)

- study each channel of each instrument, independently of the others (stand alone).

➔*inter-calibration developed at LMD for the calibration of Meteosat, based on space and time collocations with instruments on the NOAA series (J. Appl. Meteor., vol 21, 1982).*

How to identify the possible sources of BTs Residuals "Simulated – Observed "

The LMD STAND-ALONE APPROACH

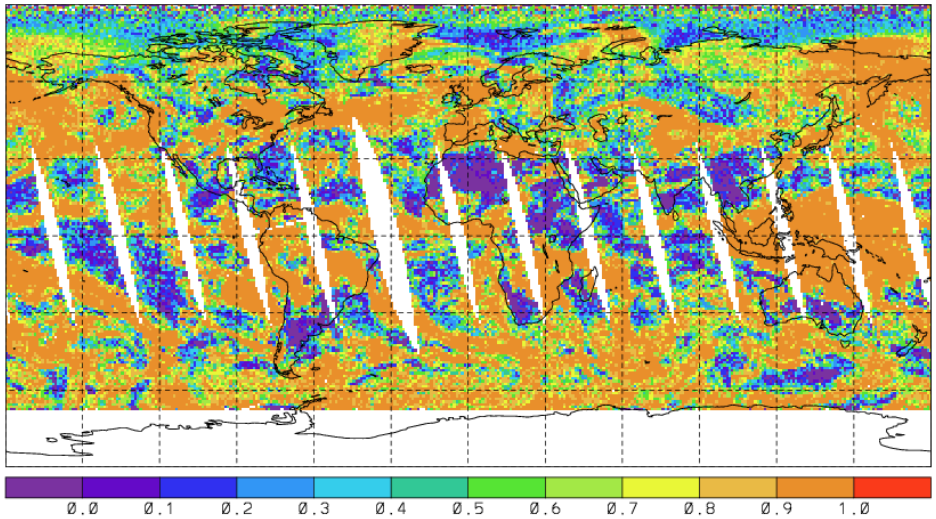


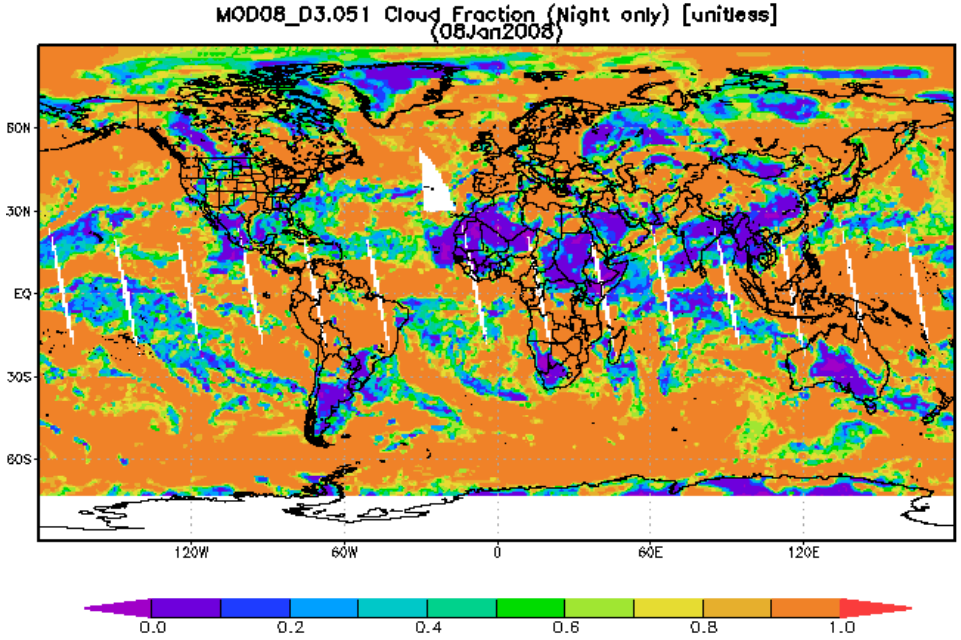
Red arrows: stand alone

Green arrows: intercalibration

And also for 4A/OP:
http://4aop.noveltis.com/

Improving Cloud and Aerosol Detection…





CLOUD/AEROSOL FRACTION

FROM IASI-A

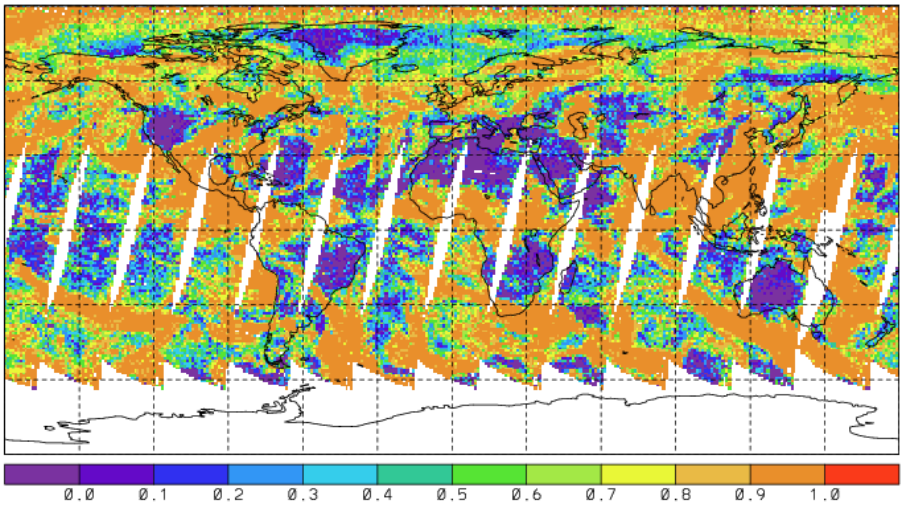
January 8th, 2008

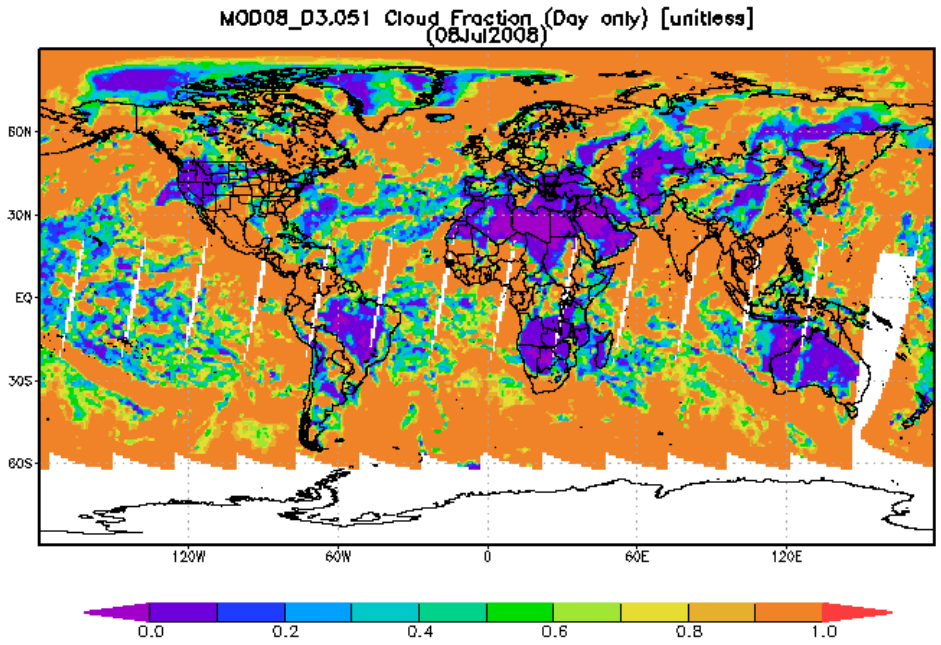
Night scene

CLOUD FRACTION

MODIS/AQUA

Improving Cloud and Aerosol Detection …





CLOUD FRACTION FROM

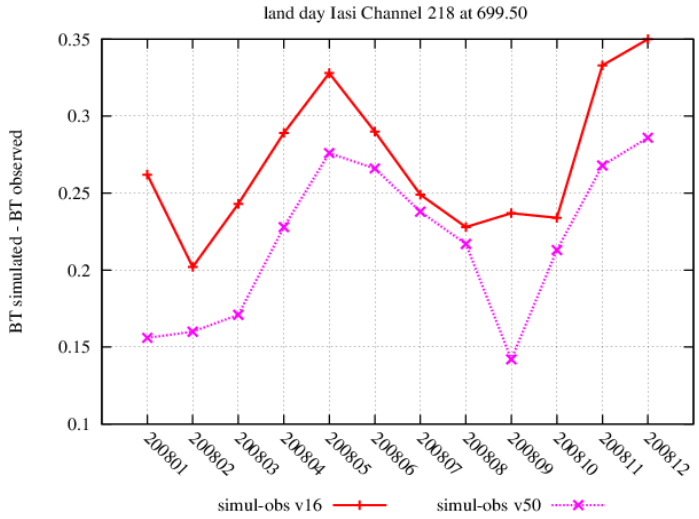
IASI-A

July 8th, 2008

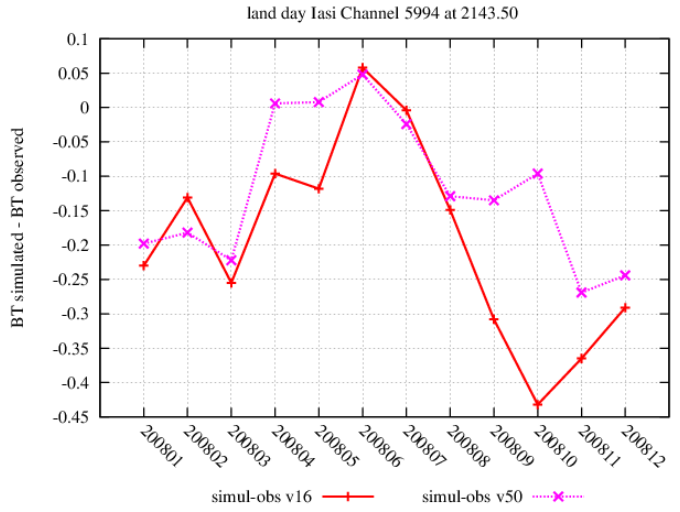
Day scene

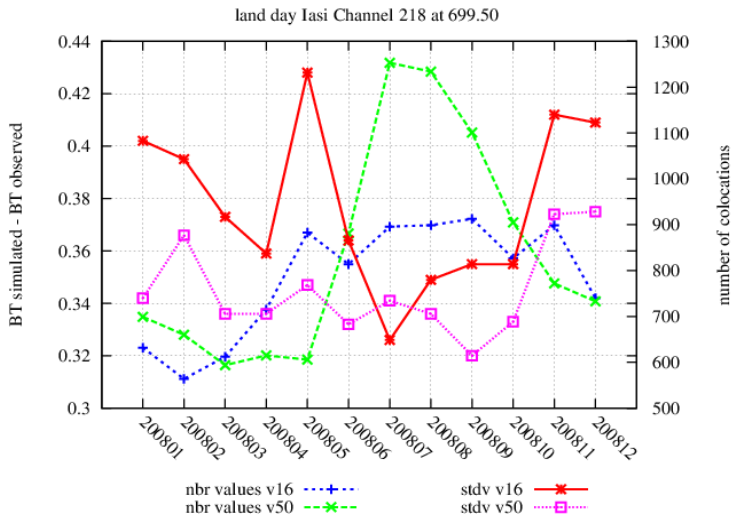
MODIS/AQUA

… Improves the simulated-observed BT residuals

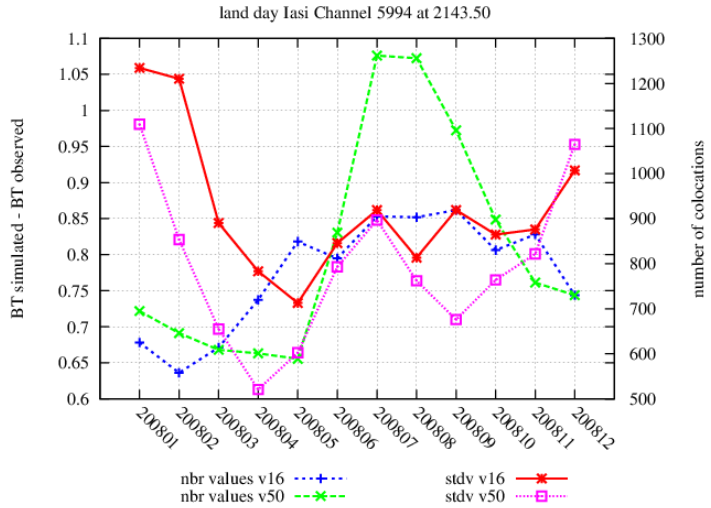


Bias





Stdv



Which in turns helps refining the cloud detection at the altitude of the maximum of the weighting function of the channel considered

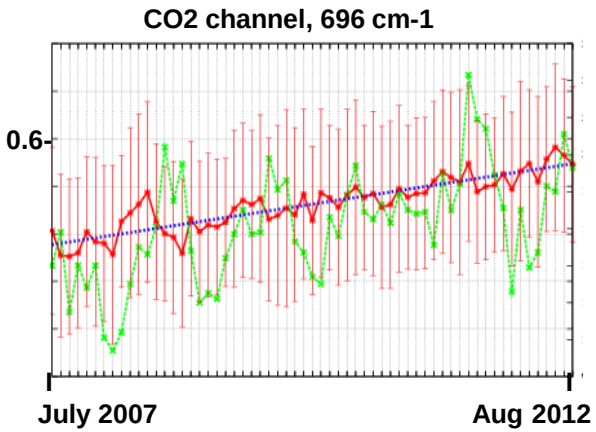
Specification of the atmospheric and surface states

Required: Coherent and exhaustive specification

- Geolocation , SZA
- Scene contamination? : Clear/cloud/Aerosols/Sun glint
- Surface characteristics : type of vegetation/surface/percentage of water

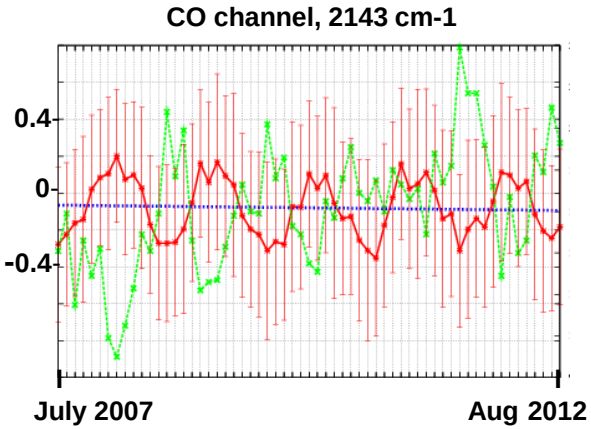
To take into account:

natural trends,



and/or

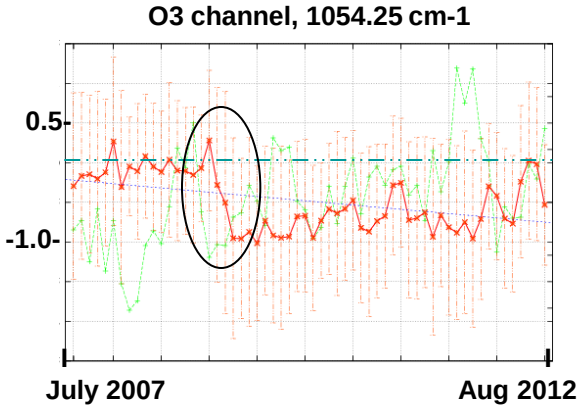
seasonal variations,



and identify

unwanted trends

(eg due to « gaps » in satellite data assimilation in reanalyses)



The Analyzed RadioSoundings Archive (ARSA) database

From raw radiosonde measurements extracted from ECMWF up to the converged ARSA product

➔ several (fully automatized) ***severe quality control*** and ***extrapolation steps***.

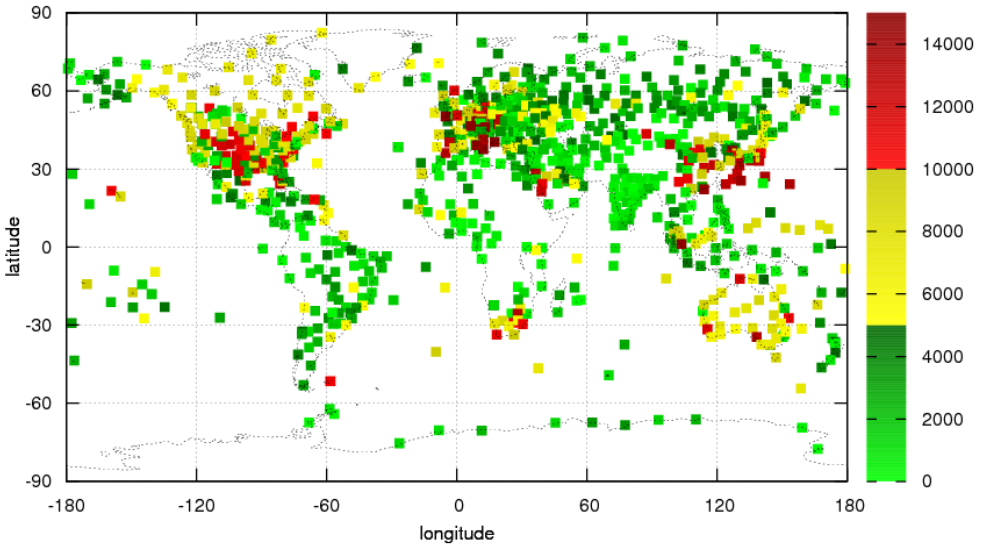
Missing information (ozone profiles, surface temperature, …) is taken from ERA_Interim and ACE_Scisat level 2 products.

➔ Content and coherence Iteratively validated against auxiliary datasets

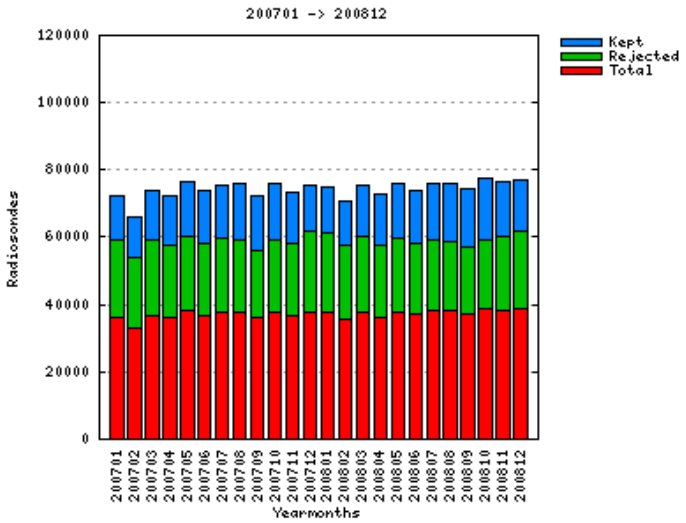
A 43-level description of the atmosphere between surface and 0.0026 hPa including P, T, H_2O, Ozone profiles, Surface temperature, Geolocation + date/time

ARSA starts in January 1979 and is extended onwards on a monthly basis @ LMD

So far: A total of > 4.9 million profiles from a total of ~22 millions considered



ARSA is available upon request at LMD.



The ARSA database : Validation

- Through simulations of IASI BTs and analysis of the residuals

-Against other archives of homogenised (or not) and corrected radiosonde datasets:
- IGRA, homogenised IGRA,
-RAOBCORE/RICH, …

-Frame : ➔ *QUASAR contract (EUMETSAT(CM-SAF) / DWD)*

The ARSA database : Validation

Concerning ***water vapour***:

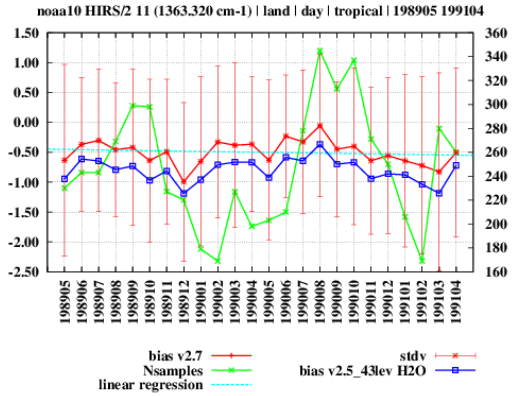
Extension of radiosonde water vapor profiles above 350 hPa using ERA_interim profiles (up to 0.1 hPa) has led to considerably reducing the standard deviation in the 6.3 micron spectral region of IASI MetOpA while introducing a *negative bias*
This *negative bias* indicates too high a quantity of water vapour in the 160 to 380hPa pressure range.

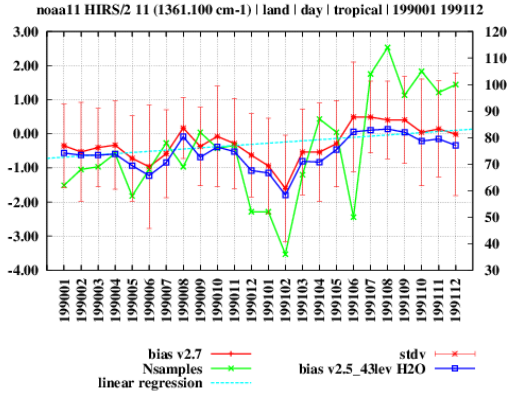
Iterative comparisons between simulated and observed IASI spectra have led to empirical corrections of ERA_Interim water vapor profiles between 350 and 100 hPa.

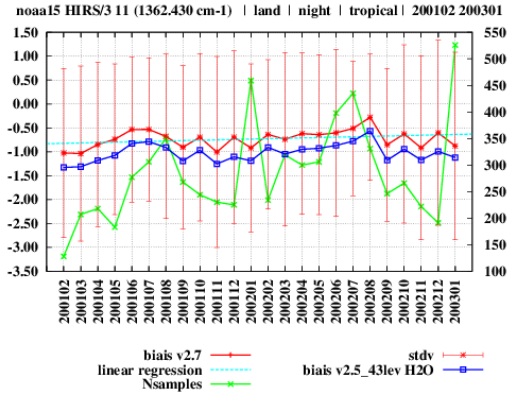
Residuals (simulated_observed) IASI Brightness temperatures obtained after such a correction turn out to be improved both in bias and standard deviation.

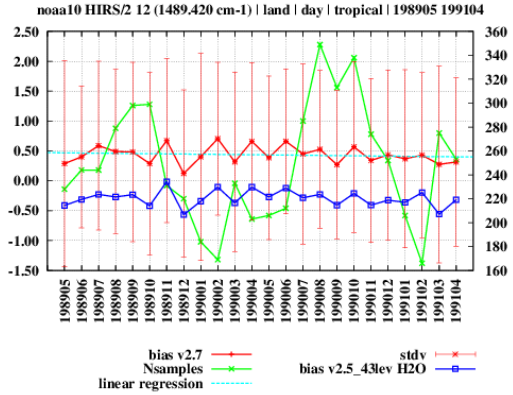
Stability of the Analyzed RadioSoundings Archive (ARSA) database

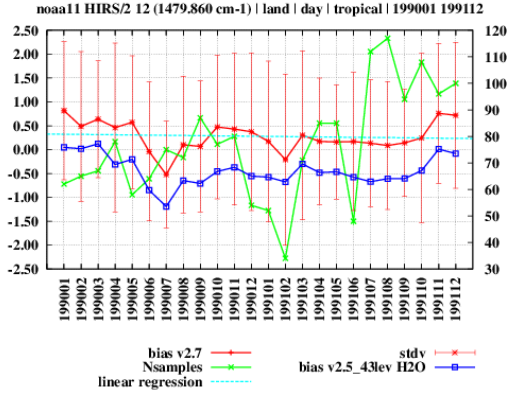
We have verified that the empirical correction (drying) of the ERA_Interim water vapour profiles between 350 and 200 hPa, we had found ***required*** to improve the quality of the IASI/MetOpA (July 2007 ➔ December 2013) residuals in the tropics is also required for other satellites at other periods: from left to right: NOAA10, NOAA11, NOAA15 (HIRS channels 11 and 12)

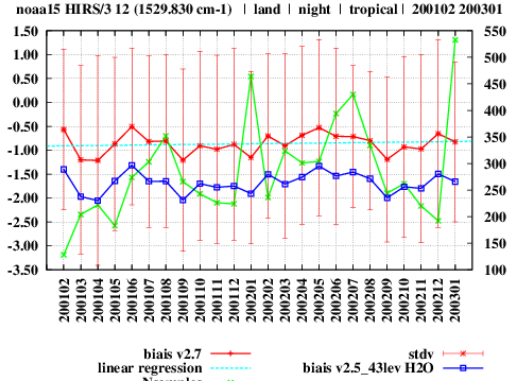












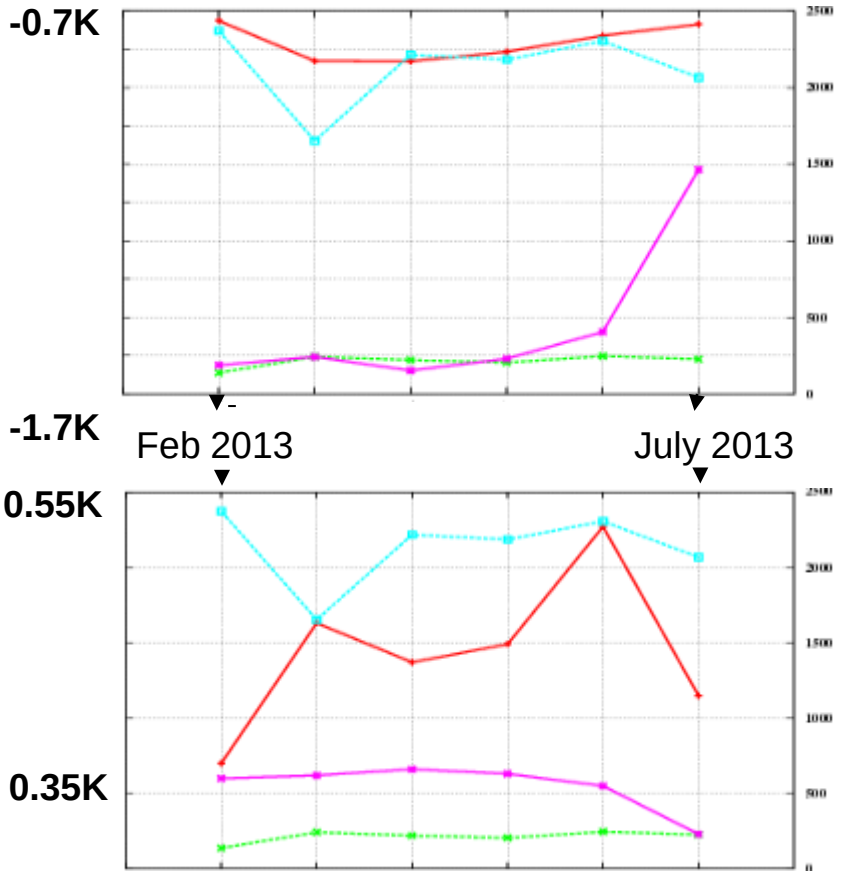
Quality assessment of the extrapolation of temperature profiles up to 0.0026 hPa

ARSA database vs ECMWF Analysis: RED : ARSA PURPLE: ECMWF_ANALYSIS

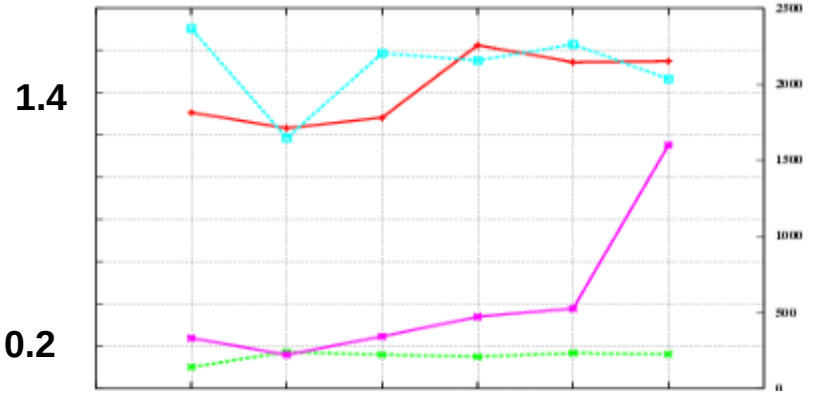
Time series (February 2013 ➔ July 2013) of residuals for IASI-B

Weighting function peaking at
~55hPA, ~ FWHM = 80hPa
channel 666.5 cm^{-1}

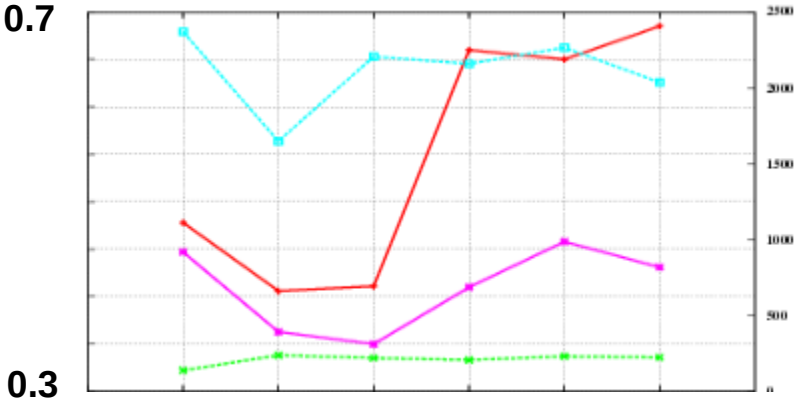
Weighting function peaking at
~2hPA, ~ FWHM = 6hPa
channel 667.75 cm^{-1}



Left y-axis
Residuals
BIAS, K



Left y-axis
Residuals
STDV, K



Right y-Axes = Items/month : ~ 250 from ARSA ; ~2,000 from ECMWF ANALYSIS

- Check and, if needed, refine the water vapor profiles description in the upper troposphere for extra tropical regions

- Homogenise the ozone vertical profiles to cancel the unwanted effects of satellite data assimilation in ERA_Interim Reanalyses.

- Improve (increase, refine) the ***vertical discretization***, and ***extrapolation*** above 30 hPa however in coherence with the vertical resolution of sounders.

Validation

- Through simulations of IASI BTs and analysis of the residuals

- Against other archives of homogenised (or not) and corrected radiosonde datasets: IGRA, homogenised IGRA, RAOBCORE/RICH, …➔ *QUASAR contract (DWD/EUMETSAT(CM-SAF)*

Quality control of MetOp A and MetOp B data @ LMD

Inter calibration and stand alone : BAU for MetOpA and MetOpB from End of January, going onwards

Stand Alone :

- 10 days/month of MetOpA and MetOpB observations collocated with ECMWF analyses (15km space window, LT 3 hours time window)

And in parallel:

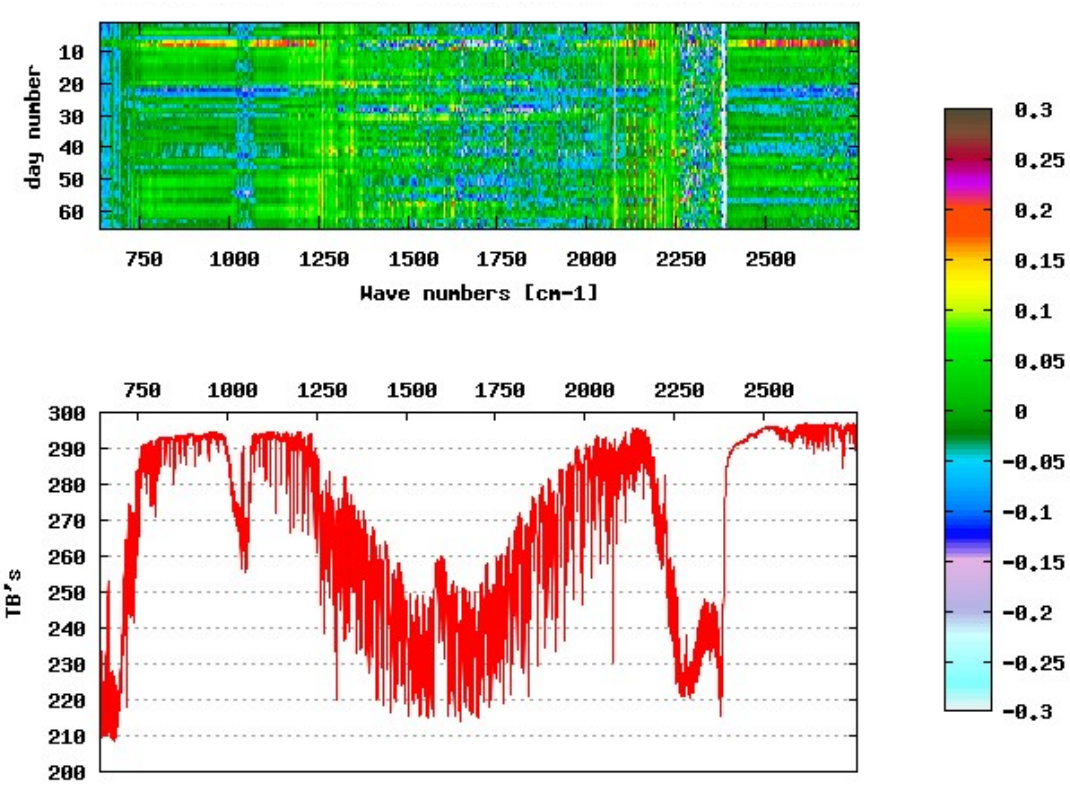
- Every single month: MetOpA and MetOpB observations collocated with ARSA profiles (100km, 3 hours space + time window) processed in stand alone for the 8461 channels, as well as HIRS4, AMSU-A and MHS

Study of double differences of MetOpA and MetOpB brightness temperature residuals: versus scan angle, spectral channels/regions,Time series,…

Results presented at
- IASI Conference, February 2013,
- RQI/CNES/Toulouse, April 15th 2013
- ISSWG, Bruges 2013 : **results updated with new collocations processed**

Stand alone approach : MetOpA vs MetOpB residuals

Hovmöller diagram of Time series (January 23rd, 2013 ➔ June 10th, 2013) of Double Differences of MetOpA and MetOpB BT residuals ~ 200 days of data processed 4A/OP collocated with Ecmwf analysis



Results for > 100 days of Night/Sea/Tropical scenes

Several thousands of items

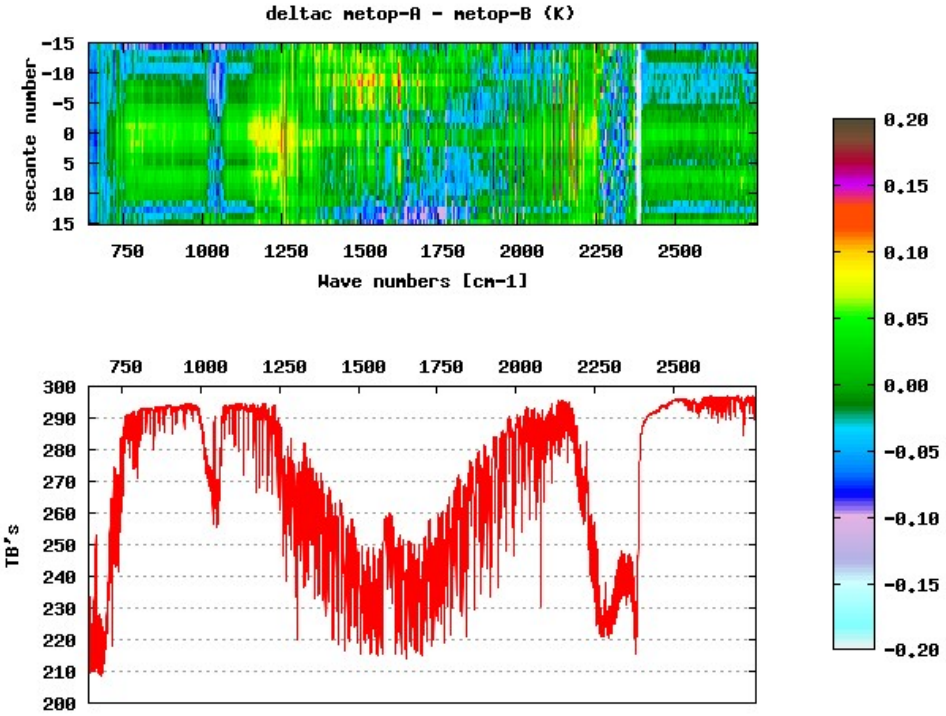
Bottom figure represents a mean IASI-A spectrum to help relating results to the spectral region.

Major result for IASI calval from LMD :

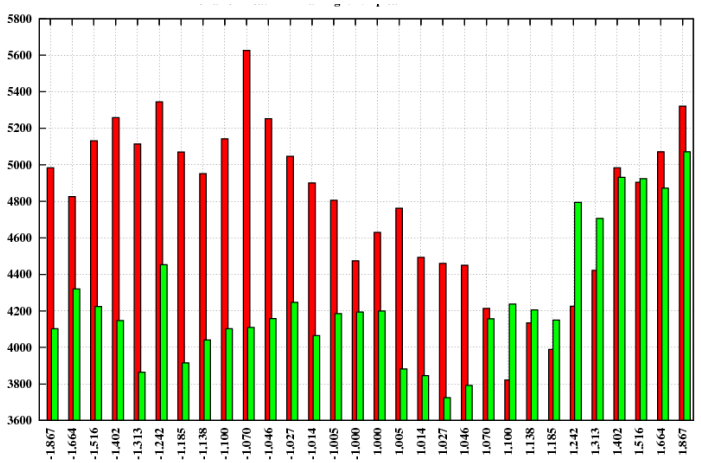
For all viewing angles, the double differences **of MetOpA and MetOpB BT residuals** are within a -0.1K to 0.1K interval

Stand alone approach : Satellite zenith angle dependence?

Hovmöller diagram of Double Differences of MetOpA and MetOpB BT residuals versus the spot position along the scan line
~ 200 days of data processed 4A/OP collocated with Ecmwf analysis



Several thousands (~5,000) of colocations processed per scan angle for MetOpA (green) and MetOpB (red)



Sat Zen Angle (Secant)
Nadir at the centre of the figure

Major result for IASI calval from LMD :

For all viewing angles, the double differences **of MetOpA and MetOpB BT residuals** are within a -0.15K to 0.15K interval

CONCLUSIONS and PERSPECTIVE

- Stand-alone associated to inter-calibration:➔Powerful procedures to identify unexpected or undesired radiances behaviors
- However: requires permanent validation of all the actors (forward models, auxiliary databases) involved in these procedures

- Major result for IASIcalval from LMD double differences:

From 645 to 2760 cm-1, the differences IASI/A-IASI/B is < 0.1 K
For all viewing angles, the differences IASI-A – IASI-B is < 0.15 K

➔ IASI-B and IASI-A very well inter-calibrated

An important result for the cal/val of IASI-A and IASI-B
The LMD approach

- ***Is in agreement with the CNES results concerning the coherence between the two instruments***
- ***Offers an unique way - through the coupling of stand-alone and double differences - to explore the behavior of the instruments along the scanning lines***

Perspective / Applications

- Business as Usual for Level1 and Level2 data processing
- Within the frame of GSICS and Cal/val: discussion and exchange of results and data with CNES and other international participants