Validation of the IASI ozone columns using data assimilation

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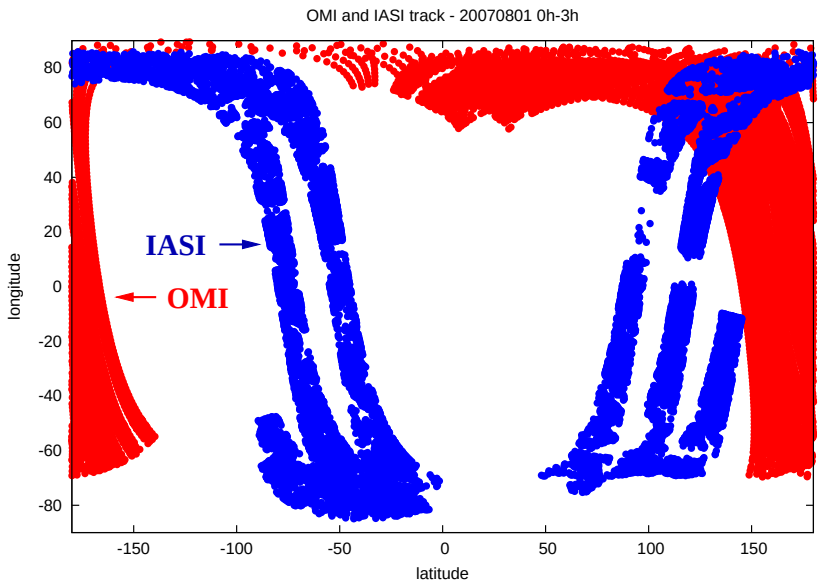
1. How to validate a new data set ?
   - Context
   - Validation using independent data sets
   - Validation using a numerical model
2. Validation of the IASI total ozone columns from the LATMOS
   - Methodology
   - Results
3. Assimilation of the IASI total ozone columns
   - Method and results
4. Conclusions

How to validate a new data set ?

Detailed comparisons with independent data sets :

- wide spread
- ”easy”
- useful

- *Example of IASI and OMI tracks - 1st August 2008 between 0h00 and 3h00 UTC*



Validation using independent data sets

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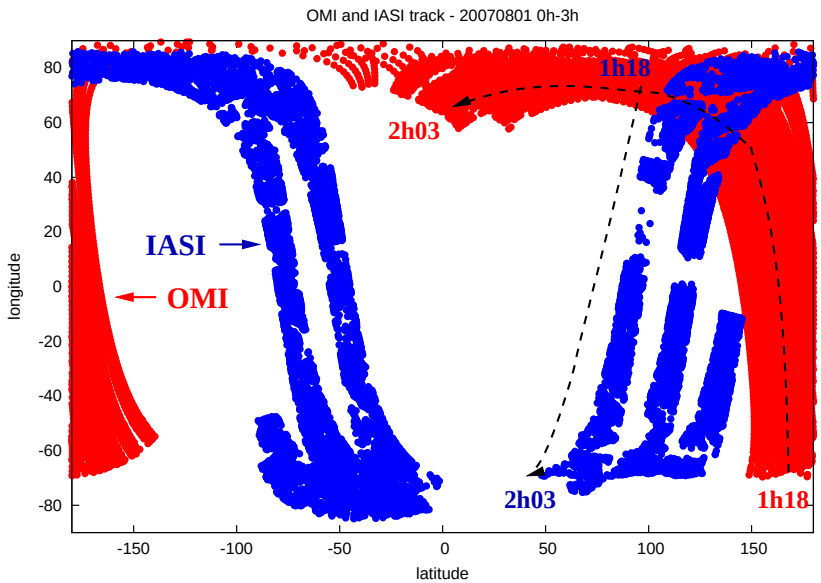


Validation using independent data sets

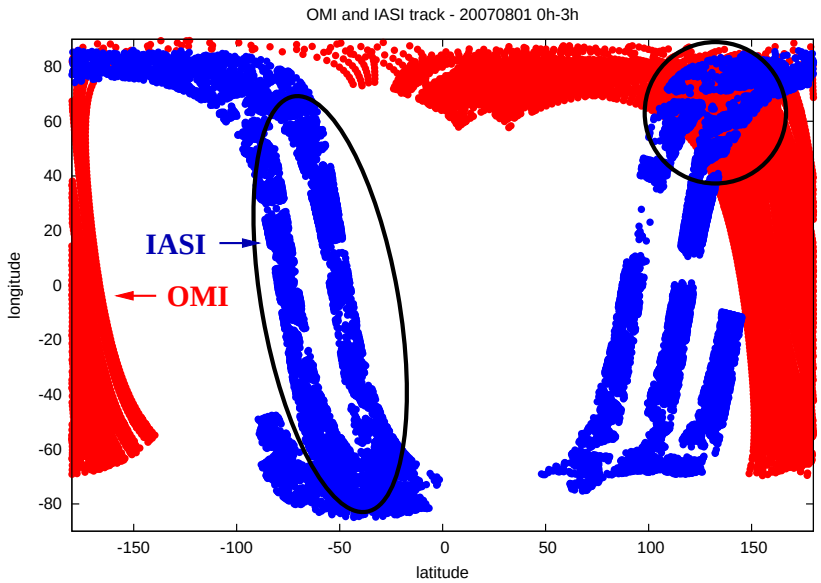
Detailed comparisons with independent data sets :

- wide spread
- ”easy”
- useful

... but :

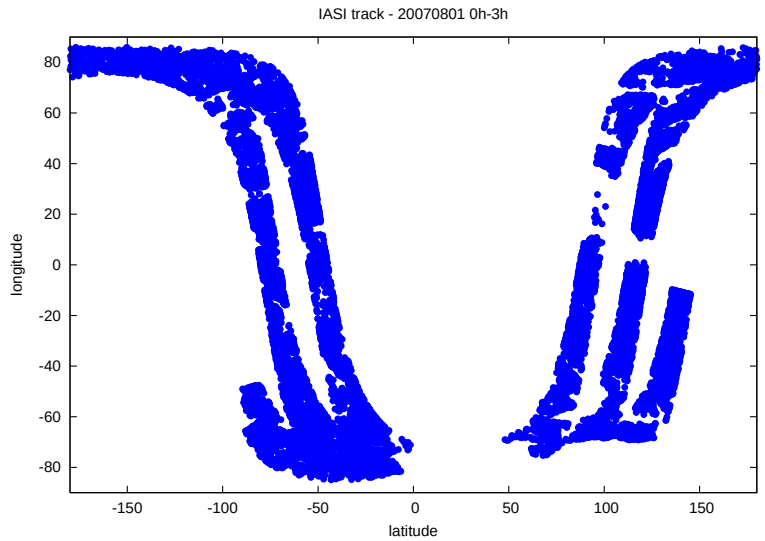
- close but different times and locations
- regions without any intersection
- different data characteristics
- non-negligible errors

- *Example of IASI and OMI tracks - 1st August 2008 between 0h00 and 3h00 UTC*

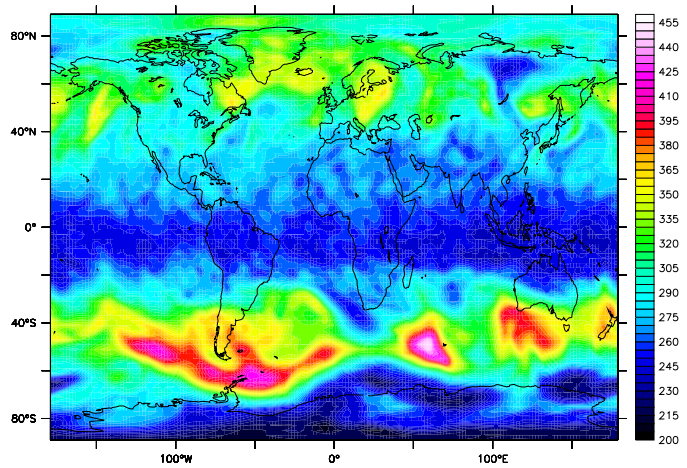


Validation using a numerical model

- *IASI tracks*



- *Total O_3 column from a CTM*

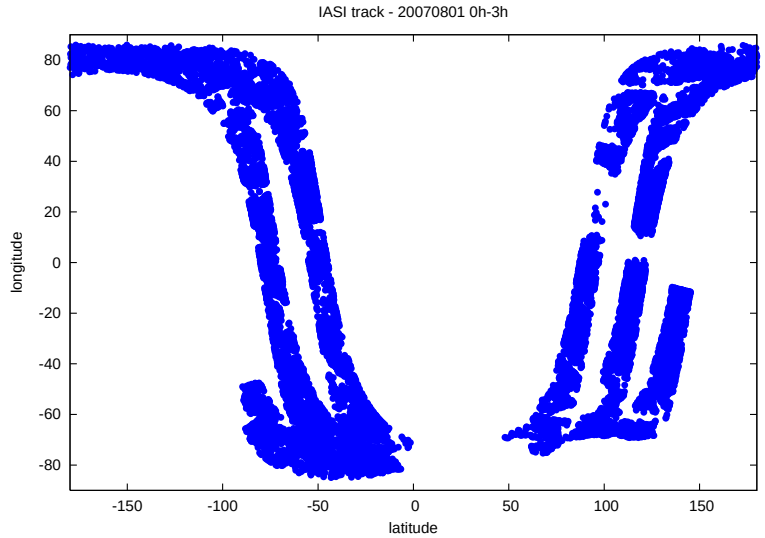


Comparison with a model

+ interpolation within the model time/space resolution
- additional error due to model inaccuracy

Validation using a numerical model

- *IASI tracks*



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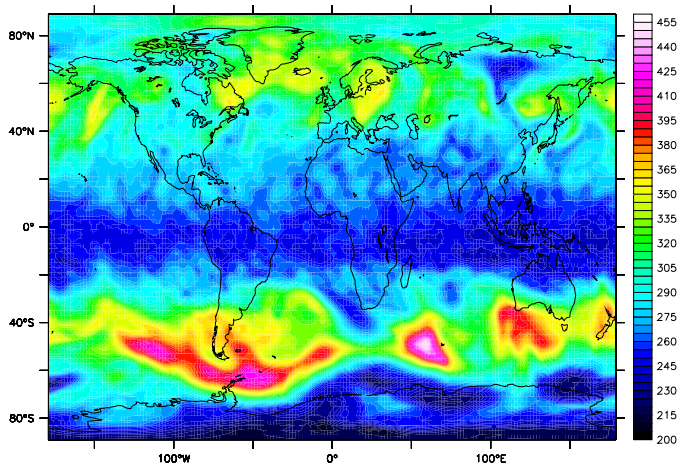

comparison with a model

+ interpolation within the model time/space resolution
+ **accurate model**

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Methodology applied to the IASI ozone data

Accurate model

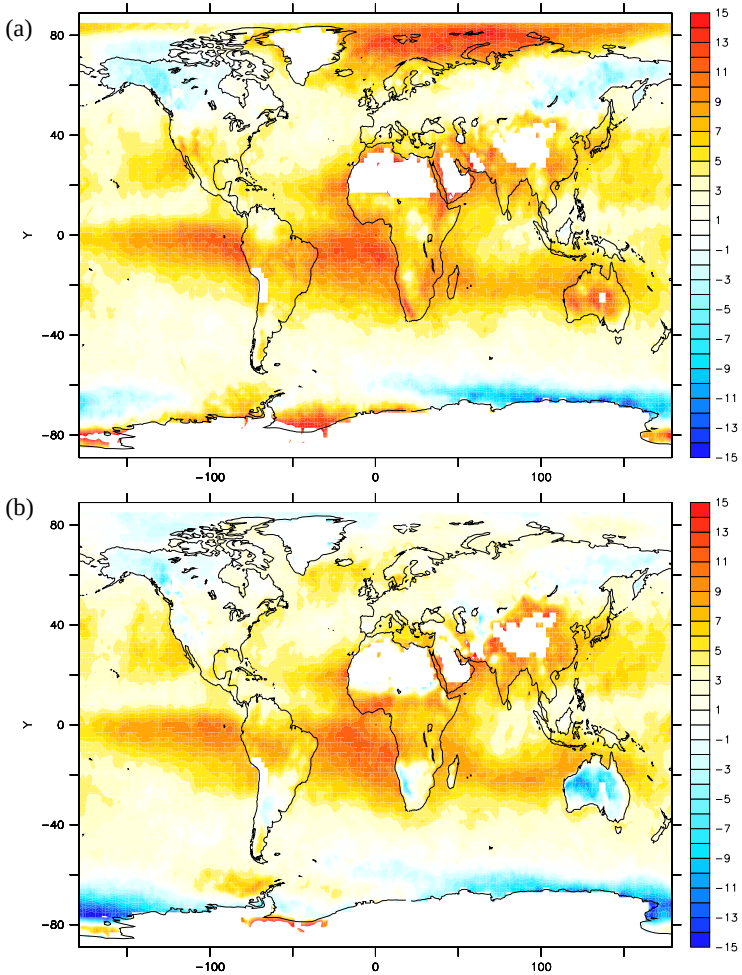
- MOCAGE CTM (Météo-France) with the VALENTINA assimilation suite
- linear ozone schem (Cariolle)
- assimilation of MLS ozone profiles and SCIAMACHY total ozone
- special effort to produce as accurate as possible analyses
- hourly analyses with a resolution of $2^\circ x 2^\circ$
- validation with ozonesondes and OMI data

Experiment :

- IASI total ozone columns from the LATMOS (*C. Clerbaux*)
- comparison with the model at the observation spatial resolution
- average and standard deviation computed at a $2^\circ x 2^\circ$ spatial resolution
- statistics over a 5 months period (Aug-Dec 2007)
- differentiation according to the ground emissivity and the day/night data

Estimation of IASI ozone total columns bias

- night data bias



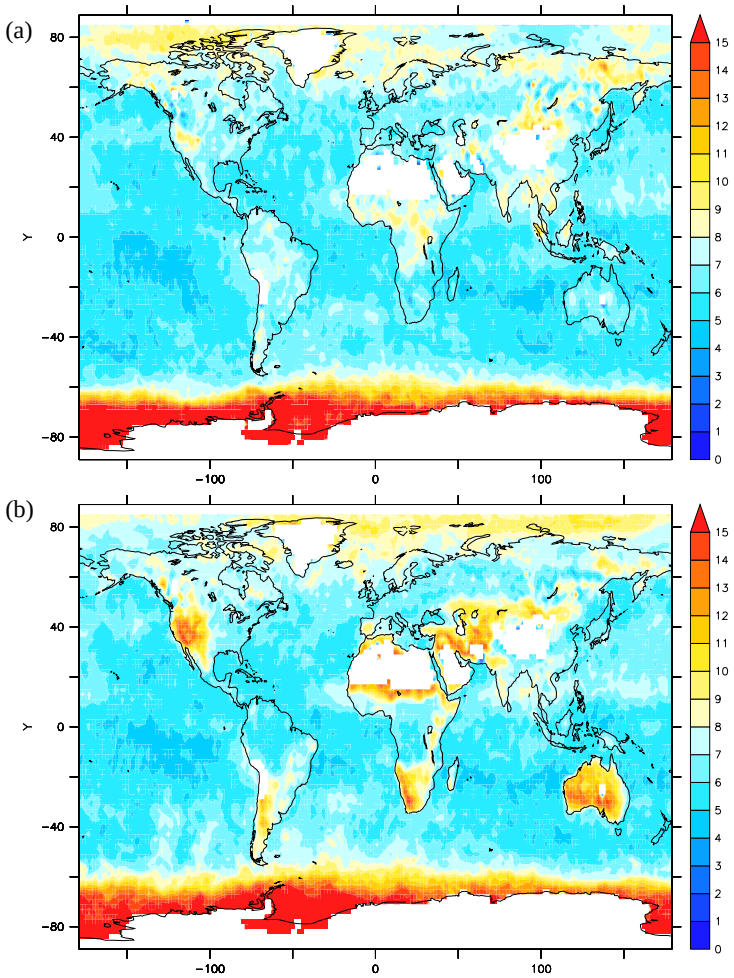
- day data bias

Synthesis (Aug-Dec 2007) :

- an overestimation of 6% in average (consistent with Boynard *et al.*, 2009)
- similar trends for the daytime and the nighttime data (except over Australia), even if the bias is lower for daytime measurements.
- largest biases at low and mid-latitudes : presence of aerosols ?
- large overestimation in the vicinity of the desert regions of the North Africa and the Persian Gulf : ground emissivity
- over icy region : weak IR signal
- over ocean : weak thermal contrast

Estimation of IASI ozone total columns standard deviation

- night data std. dev.



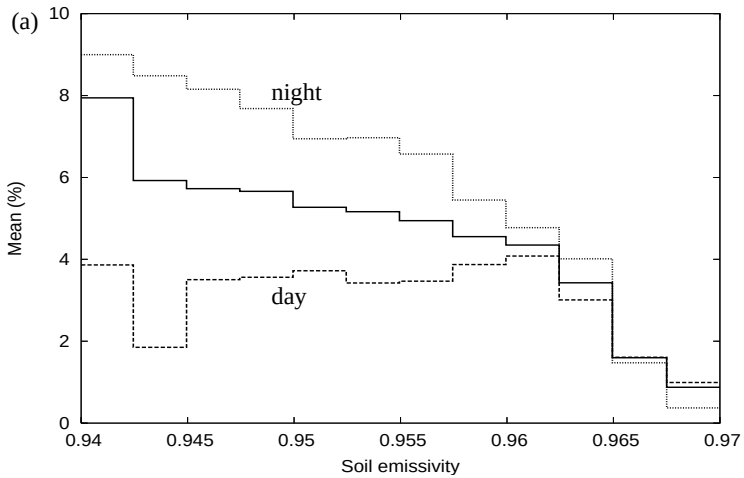
- day data std. dev.

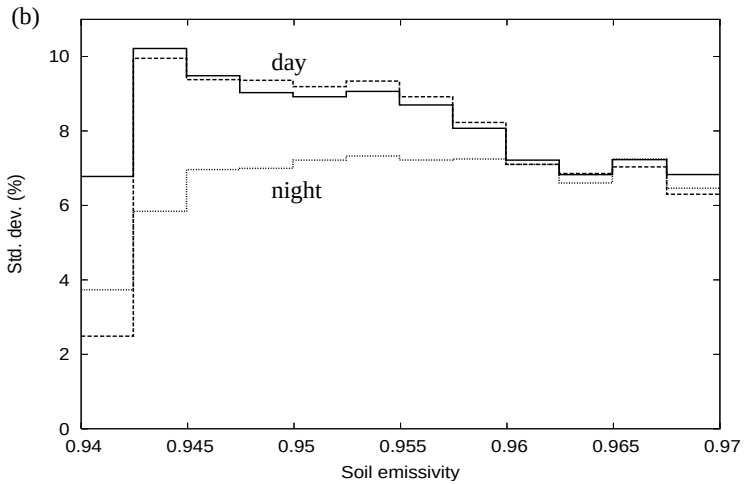
Synthesis (Aug-Dec 2007) :

- average random observation error : 7%
- similar trends for the daytime and the nighttime data but several differences (especially over dry and polar regions)
- largest error over dry regions
- in the South Polar region :
  - the error seems to match the distribution of the ice caps
  - the NN algorithm gives large weight to the climatological O_3 profiles (weak and noisy IR signal due to low ground temperatures and low O_3 concentrations)

Classification by ground emissivity

- bias





- standard deviation

Experiment :

- surface emissivity derived from a climatology based on the MODIS sensor
- classification from 0.94 to 0.97 (0.05)
- for each class, we calculated the average of the biases and the std. dev.

Synthesis :

- the bias $\uparrow$ as the emissivity deviates from 0.9813 : mainly for the nighttime data
- the standard deviation $\uparrow$ but mainly for the daytime measurements
- results for low emissivities are not significant (the population is too low)

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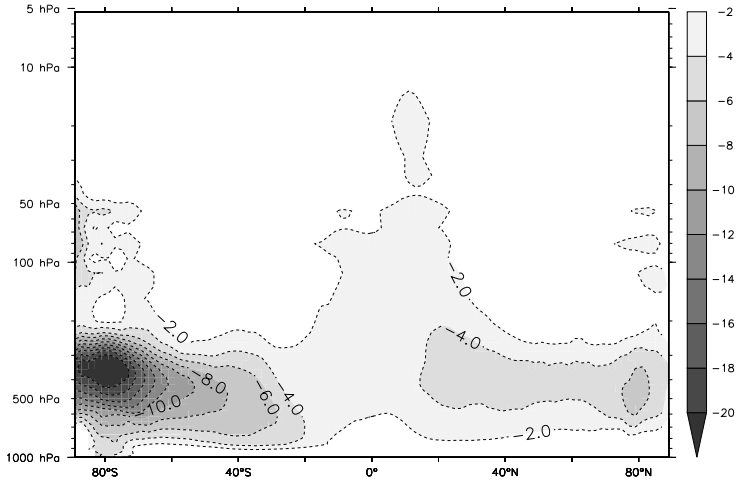
Combined assimilation of IASI and MLS data

Experiment :

- assimilation of IASI columns (instead of SCIAMACHY) and MLS profils
- IASI bias reduction according to the previous validation
- covariance matrix of the IASI observation error : diagonal, variances from the previous validation
- **no IASI averaging kernels**

- *Average difference (in %) between IASI and SCIAMACHY analyses*



Results :

- the two analyses differ
  - in the troposphere
  - over polar regions
- stratosphere mainly constrained by MLS
- IASI bring (tropospheric) information over the polar regions during wintertime

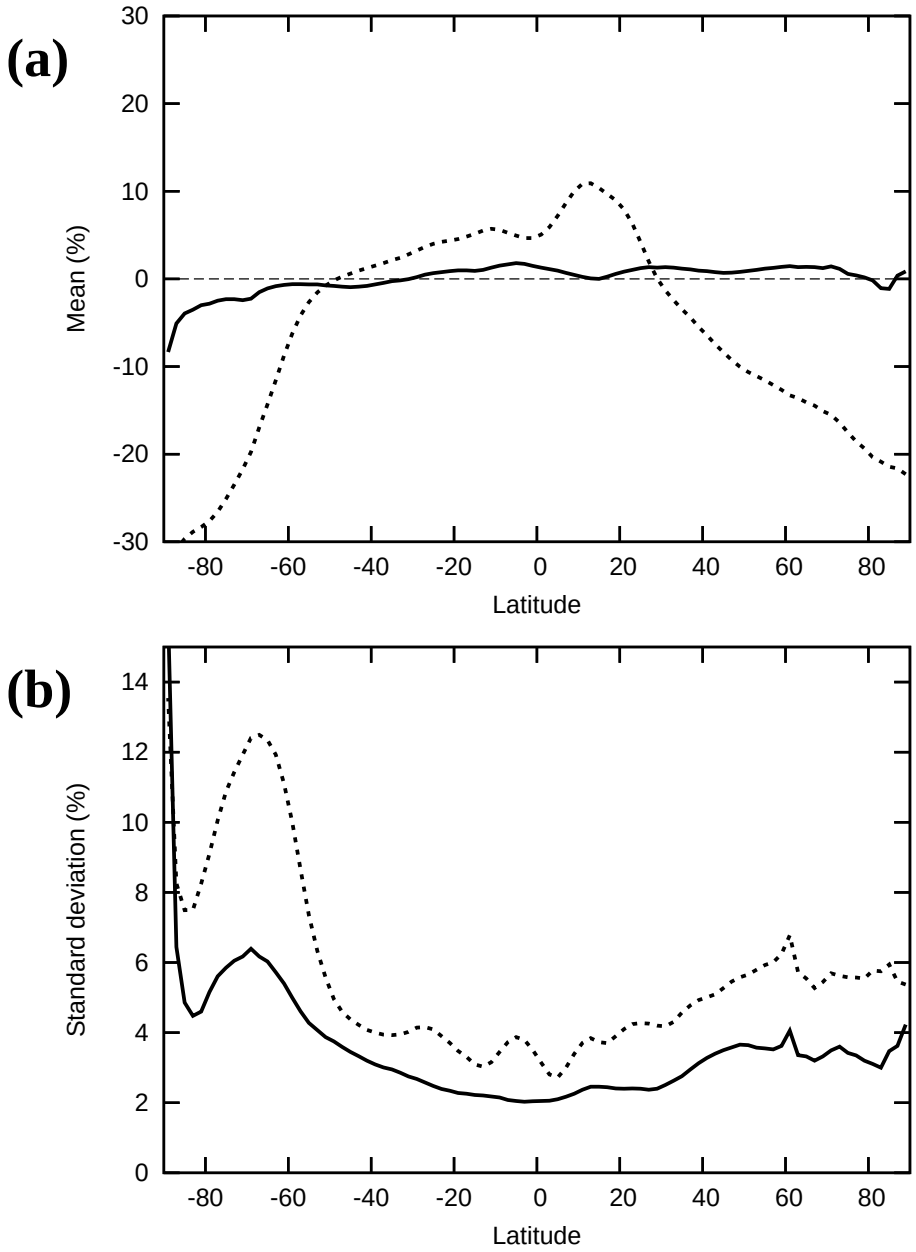
Conclusions

- using a numerical model that includes the assimilation of independant data sets is a powerful methodology to validate new data sets
- IASI total ozone columns validation
  - results in a good agreement with other studies (b $\approx$ +6%, $\sigma \approx$ 7%)
  - source of errors : aerosols, low thermal constrast, low concentrations, ground emissivity, AK
  - largest errors are found over sandy or icy regions
- IASI total ozone columns assimilation
  - preliminary work to be continued (AK, profils, larger periods, ...)
  - lagest differences located in the polar troposphere due to the caracteristics of IASI compared to SCIAMACHY
- the model horizontal resolution is a limitation

Reference :

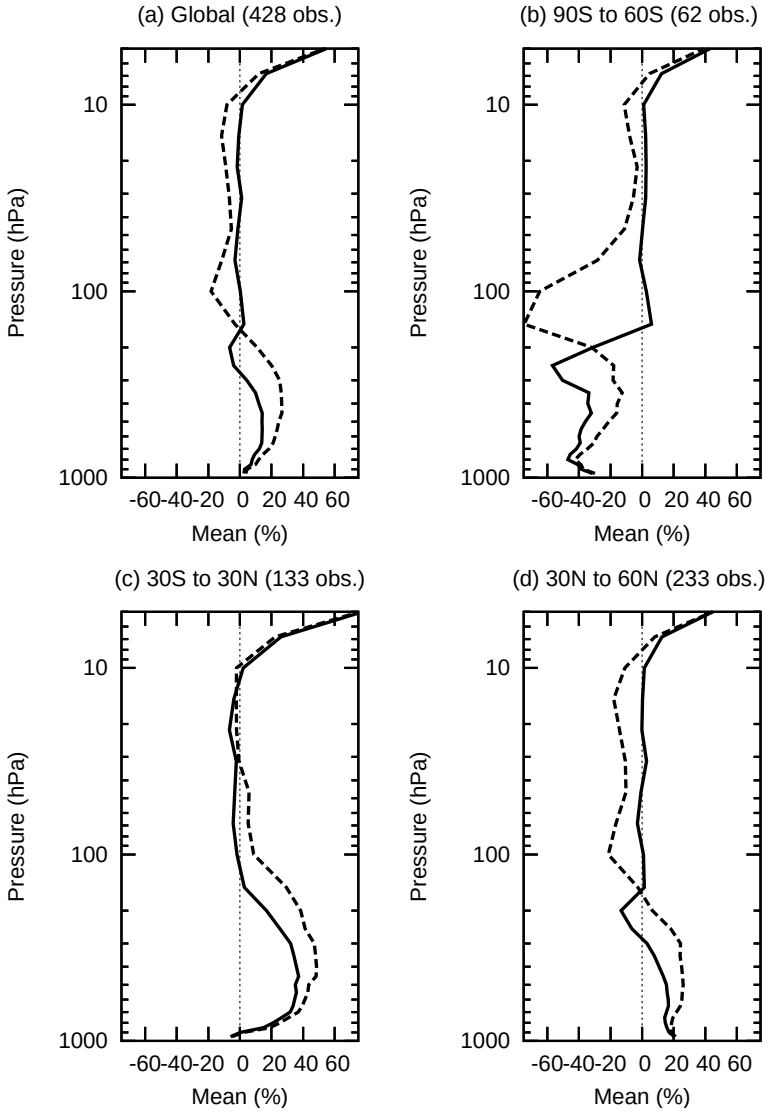
IASI special Issue of ACP, 2009

Validation of the analysis against OMI data

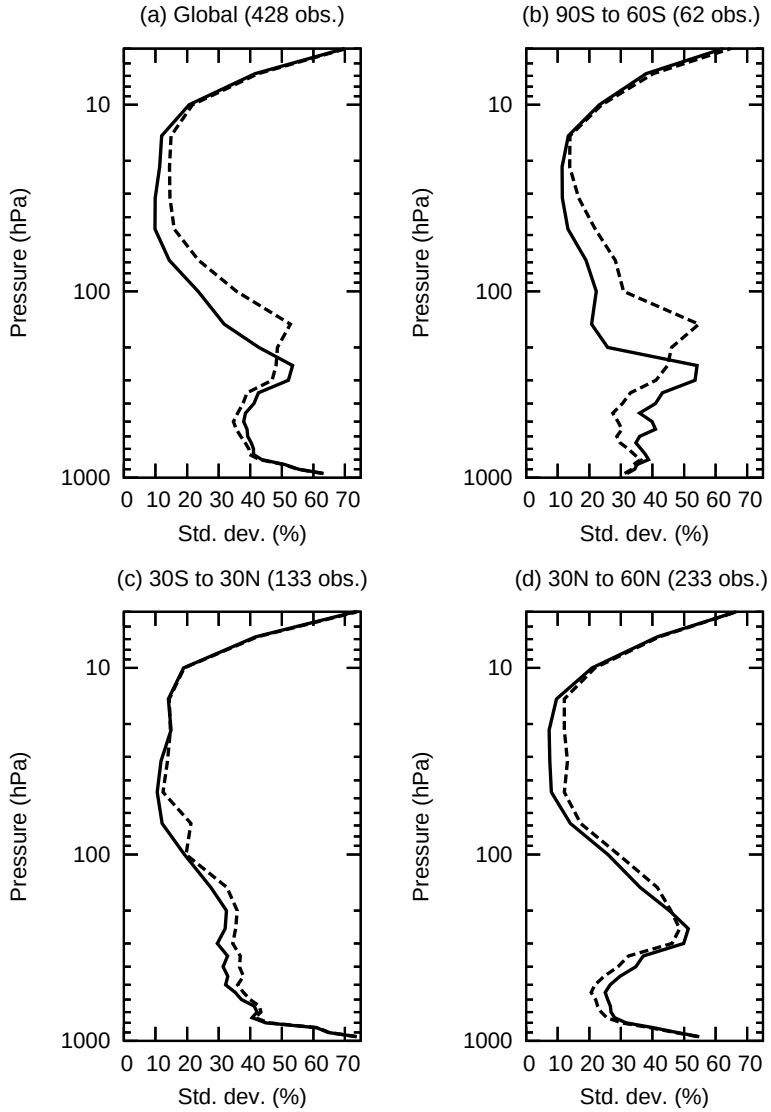


Validation of the analysis against ozonesondes data

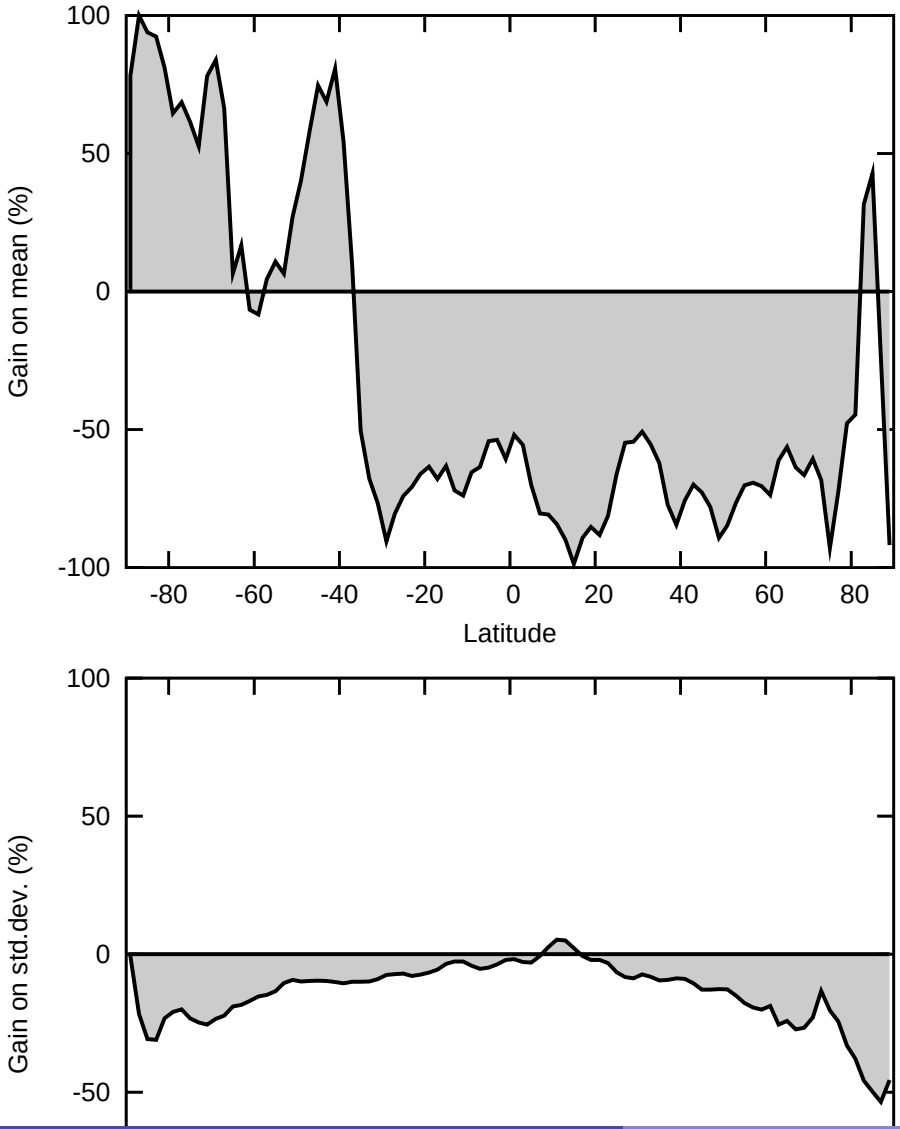
- bias



- standard deviation



IASI/SCIAMACHY + MLS analyses against OMI



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IASI/SCIAMACHY + MLS analyses against ozonesondes

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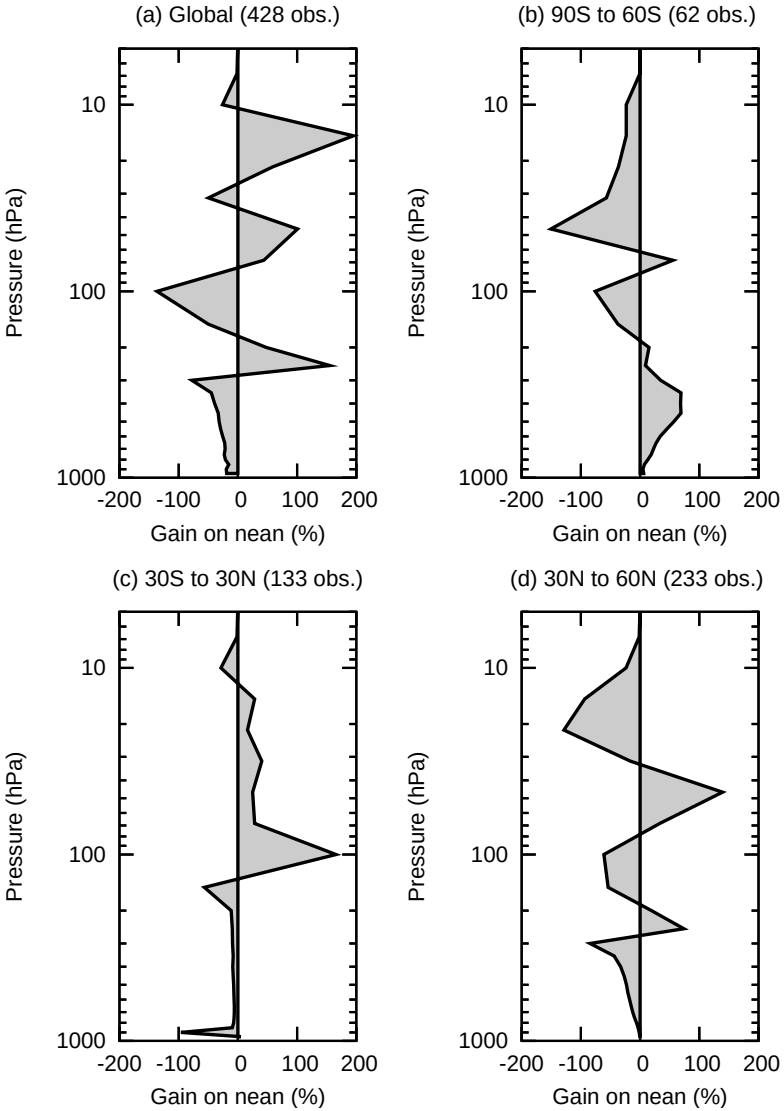

- standard deviation