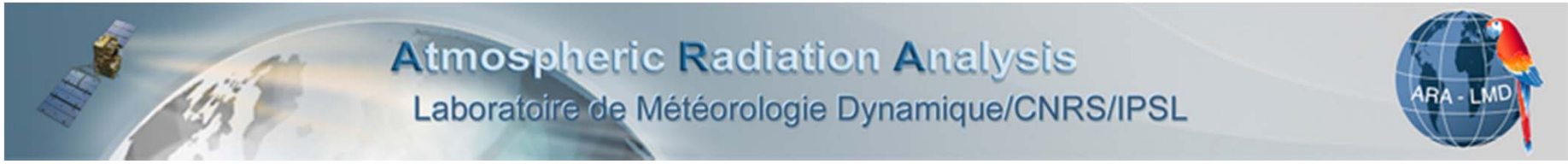


Assessing the accuracy of the line-by-line 4A/OP model through comparisons with high spectral resolution IASI observations

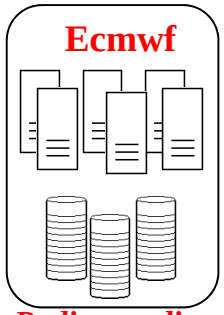
R. Armante (1), V. Capelle (1), N.A. Scott (1) A. Chedin (1), L. Chaumat (2), B. Tournier (2), C. Pierangelo (3),

(1) Laboratoire de Météorologie Dynamique (LMD) / IPSL, Ecole Polytechnique, Palaiseau, France, (2) NOVELTIS, Ramonville-Saint-Agne, France, (3) CNES, Toulouse, France

Plan

- The validation chain at LMD
- Results and analysis of the bias
- Conclusions and outlook

The validation chain at LMD



Radiosoundings

Reanalysis

(ERA-40)

- Quality control of the Radiosoundings
- Add missing parameters

« Clean « radiosoundings ARSA

L1B/L1C

Cloud detection

Collocation (100km, 3h)

Spectroscopic Database (GEISA 2011)

P,T H_2O, O

L1B L1C clear

Radiative Transfer Algorithms (4AOP, Stransac)

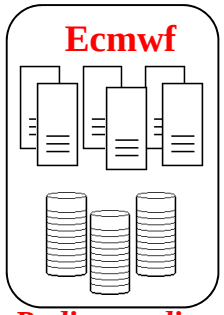
Calculated minus observed Brightness Temperatures Statistics (deltacs) (per month, Land/sea, Day/night, Airsmass)

n-D var applications

Inversion Algo.

- ✓ *E_s,T_s (V. Capelle, Monday)*
- ✓ *Cloud (C. Stubenrauch, Monday)*
- ✓ *GHG (T. Thonat, Monday)*
- ✓ *Aerosol (V. Capelle, poster session 9.8)*

The validation chain at LMD



Radiosoundings

Reanalysis

(ERA-40)

- Quality control of the Radiosoundings
- Add missing parameters

« Clean « radiosoundings ARSA

L1B/L1C

Cloud detection

Collocation (300km, 3h)

P,T H2O, O3

L1B L1C clear

Biais/Standard Deviation analysis

Spectroscopic Database (GEISA 2011)

Main objective

Radiative Transfer Algorithms (4AOP, Stransac)

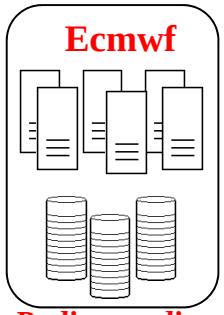
validation

Calculated minus observed Brightness Temperatures statistics (per month, Land/sea, Day/night, Airsmass)

n-D var applications

Inversion Algo.

The validation chain at LMD



Radiosoundings

Reanalysis

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L1B/L1C

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P,T H2O, O3

L1B L1C clear

Radiative Transfer Algorithms (4AOP, Stransac)

Spectroscopic Database (GEISA 2011)

Biais/Standard Deviation analysis

Calculated minus observed Brightness Temperatures statistics (per month, Land/sea, Day/night, Airsmass)

n-D var applications

Inversion Algo.

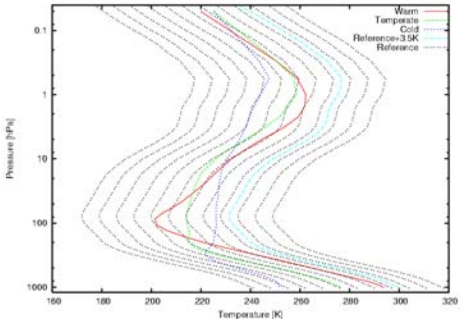
Study of the various biases: spectroscopy, RT, obs, etc.

Radiative Transfer Model : 4AOP

4A is based on the calculation of atlases of optical thicknesses :

See Chaumat et Al, poster session 8.3

✓for up to 53 atmospheric molecular species of the GEISA database (http://ether.ipsl.jussieu.fr ;
- ✓ for 12 nominal atmospheres temperature profiles representative of the T variation in the atmosphere);
- ✓ for a set of 44 pressure levels between surface and top (100km) of the atmosphere;
- ✓ for a 5 10^{-4} cm^{-1} nominal spectral step (lower if necessary) ;



4A allows accurate and fast (50 times faster) computations

NOVELTIS is in charge of the industrialization and the distribution of 4A, in accordance with a convention signed between CNES, LMD/CNRS and NOVELTIS, and the LMD is in charge of the update of the physics and the validation which are needed.

Main options :
- Radiance, transmission function and jacobians outputs
- Regular updating and improvements (line mixing CO2, continua, …)
- all various instruments could be simulated (HIRS, AIRS, IASI, IIR, Modis, Seviri, …)
- Limb simulations
- solar contribution
- Coupling 4AOP and Disort to take into account the diffusion
- Website http://www.noveltis.fr/4AOP/

New updates :
- Scattering for cloud (cirrus…) contribution
- New atlases of absorption optical thicknesses:

✓Improvement of CO2 line-mixing
✓New GEISA 2009 spectroscopy
✓Pressure shift for H2O, CO2 and N2O
✓Update reference gas mixing ratio profile
✓Improved TIPS' formulation

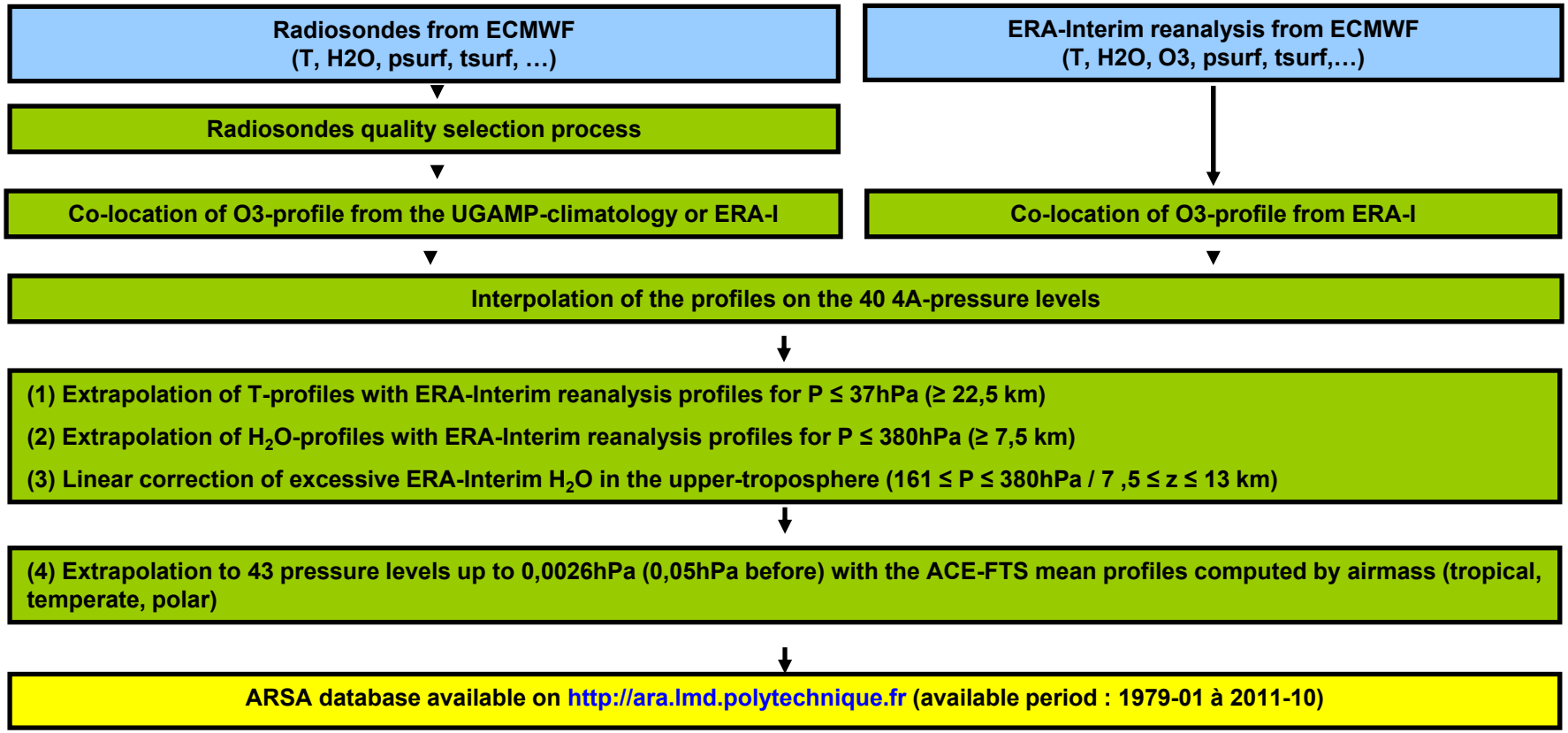
Coming …
- Extension to the *SWIR : Merlin (CH4) and Microcarb(CO2)*

ARSA (Analyzed RadioSoundings Archive)

Scott et al, in preparation

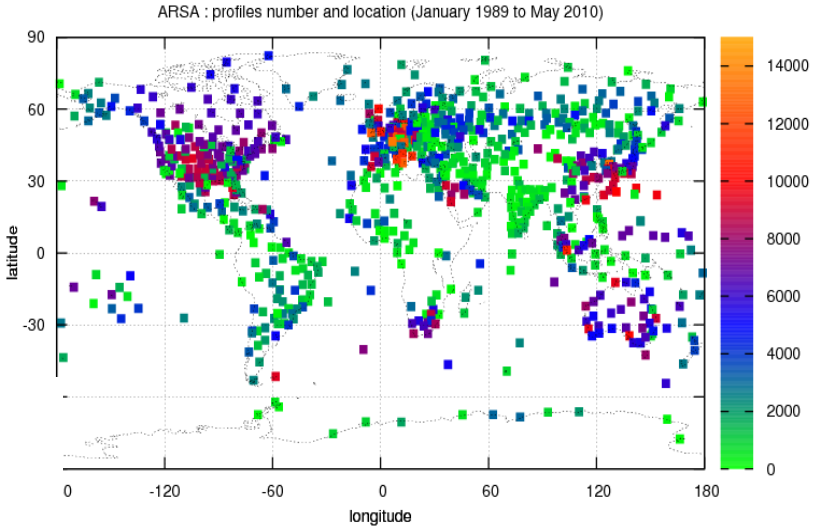
- Database gathering **radiosondes** (lat, lon, t, altitude, etc) and the corresponding thermodynamic parameters : (T, H2O) profiles, psurf, etc + O3 profile **ERA_INTERIM**

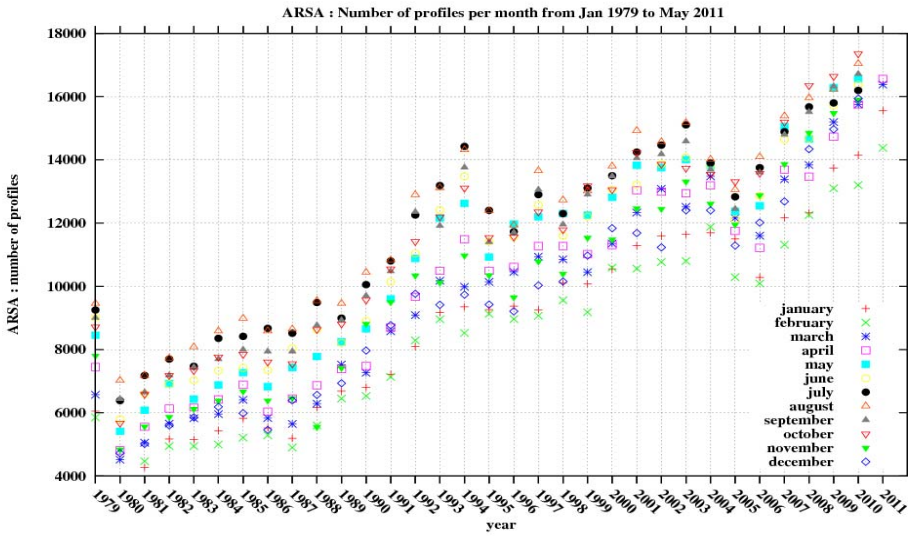
- **Process chain** :



ARSA (2/2)

From January 1979 onwards (Jan 2012) ~
TOTAL > 4,000,000
~ 1,100,000 tropics
~2,600,000 midlatitudes
~ 330,000 polar



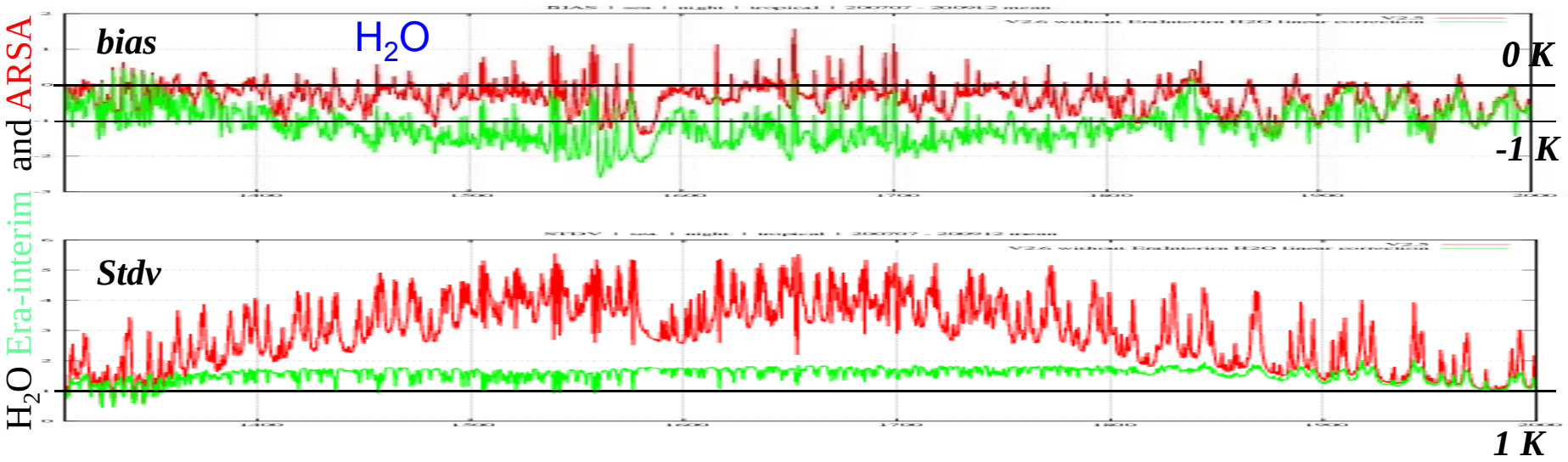


➔ **More than 5000 collocations *IASI/ARSA***

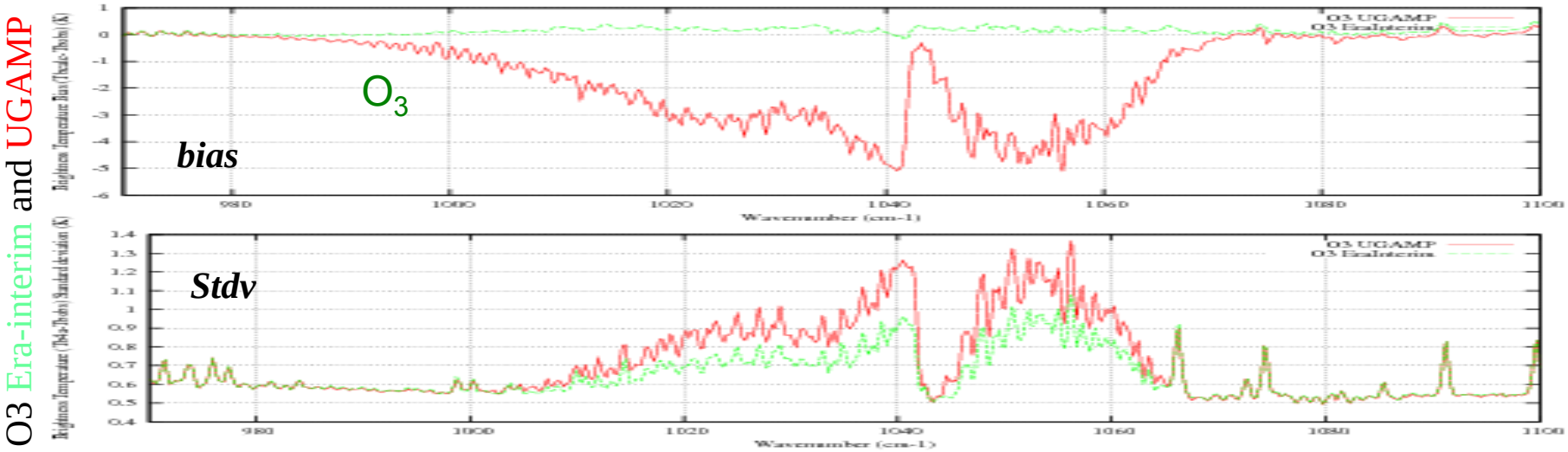
- ***Sea***
- ***Night***
- ***Tropical***
- ***Clear***

Bias due to the thermodynamical profiles (H_2O and O_3)

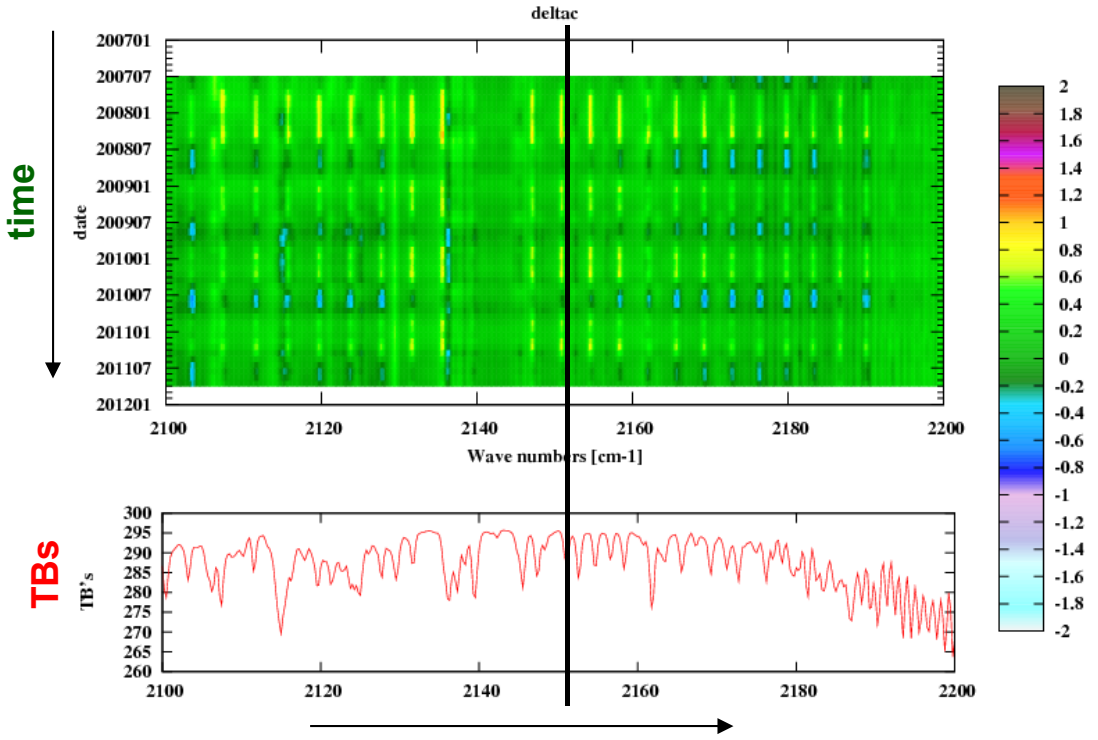
H_2O Era-interim and ARSA



O3 Era-interim and UGAMP



« Natural » bias due to the seasonal variation of CO



simulated-observed as a function of the time for the 2150.25 cm-1 channel sensitive to CO

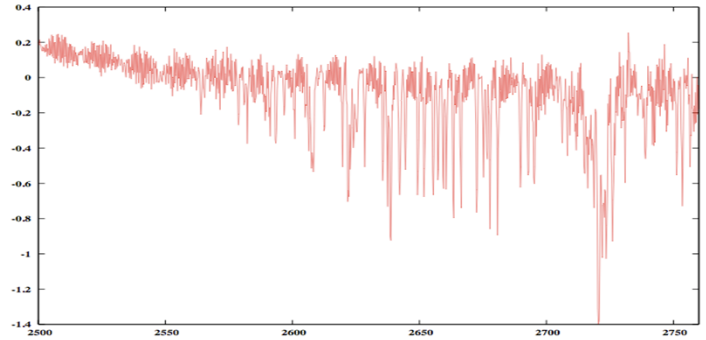
➔ Constant CO profile used in 4AOP ➔ seasonal variation of CO observed

See Thonat on monday

Jul 07 **time** **Oct 11**

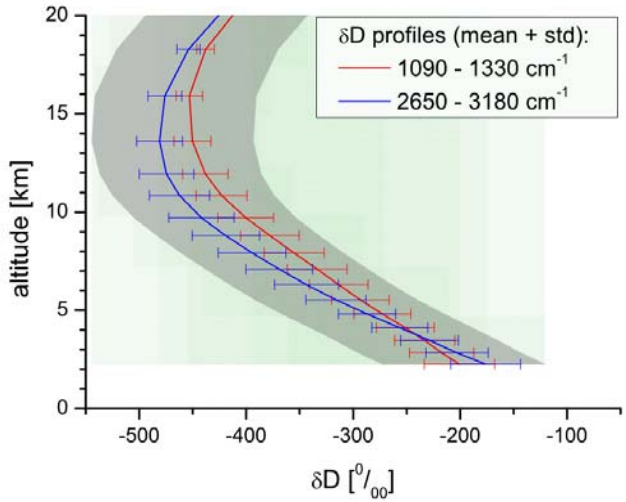
Results : In the 2500-2760 cm-1 region negative bias ➔ thermodynamical profiles (HDO/H_2O mixing ratio)

Bias between simulated and observed brightness temperatures may be as high as 1.5 K especially in the 2720. – 2730 cm-1 spectral region. Sign is negative, indicating too high an absorption in this region.
Main absorber HDO or H2O? From Geisa-09 ➔ HDO.

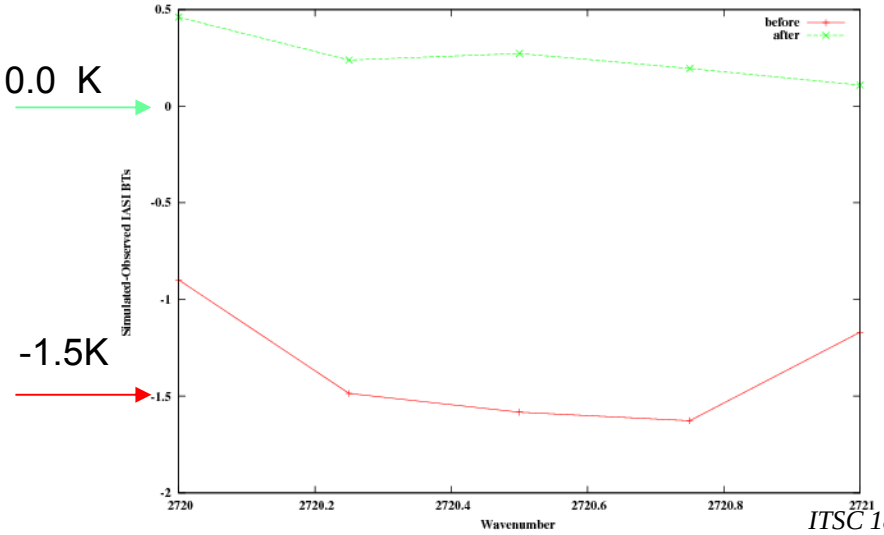


Several works indicate a vertical variation of the δD value
$\delta D = 1000 \times ([HD^{(16)}O]/[H_2{}^{(16)}O] / SMOW - 1)$, with Standard Mean Ocean Water SMOW = 3.1152×10^{-4}

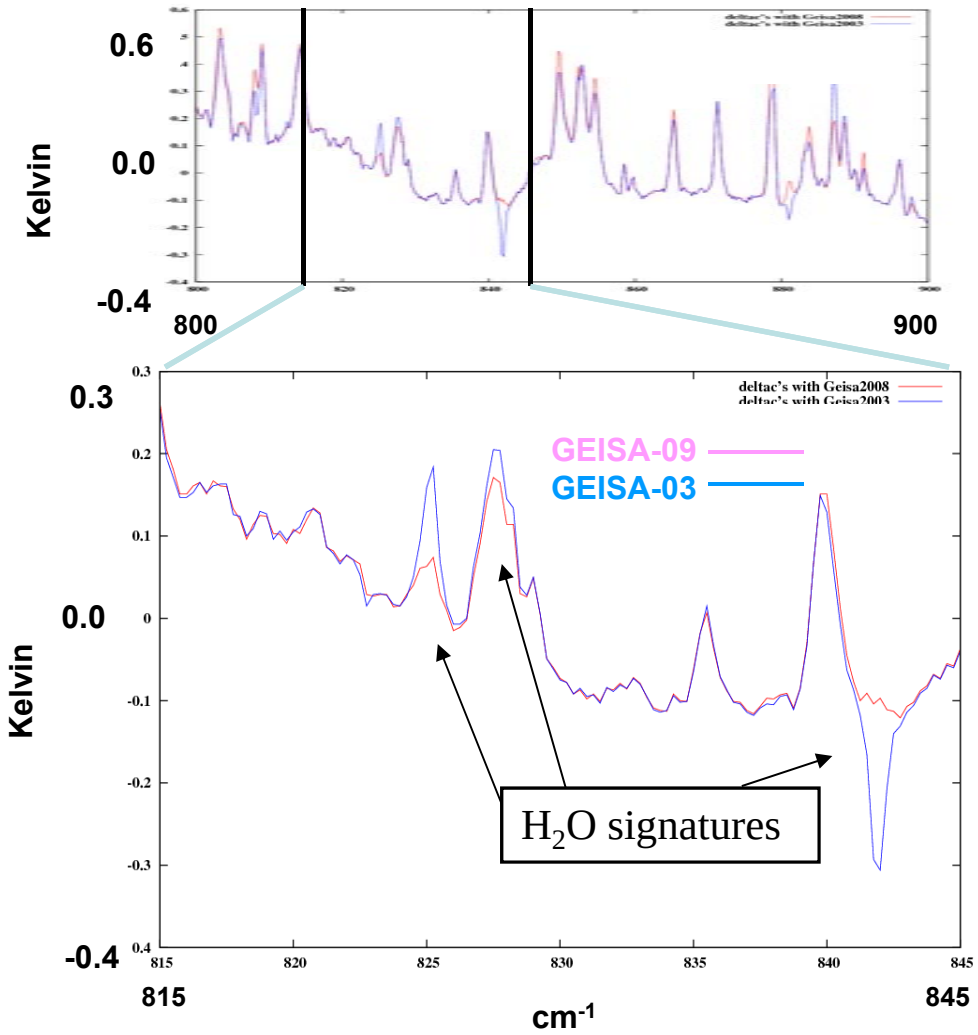
Vertical variation of the δD value :
Impact on Simulated vs Observed
Red = Before / Green = After



from Schneider et al, 2010.



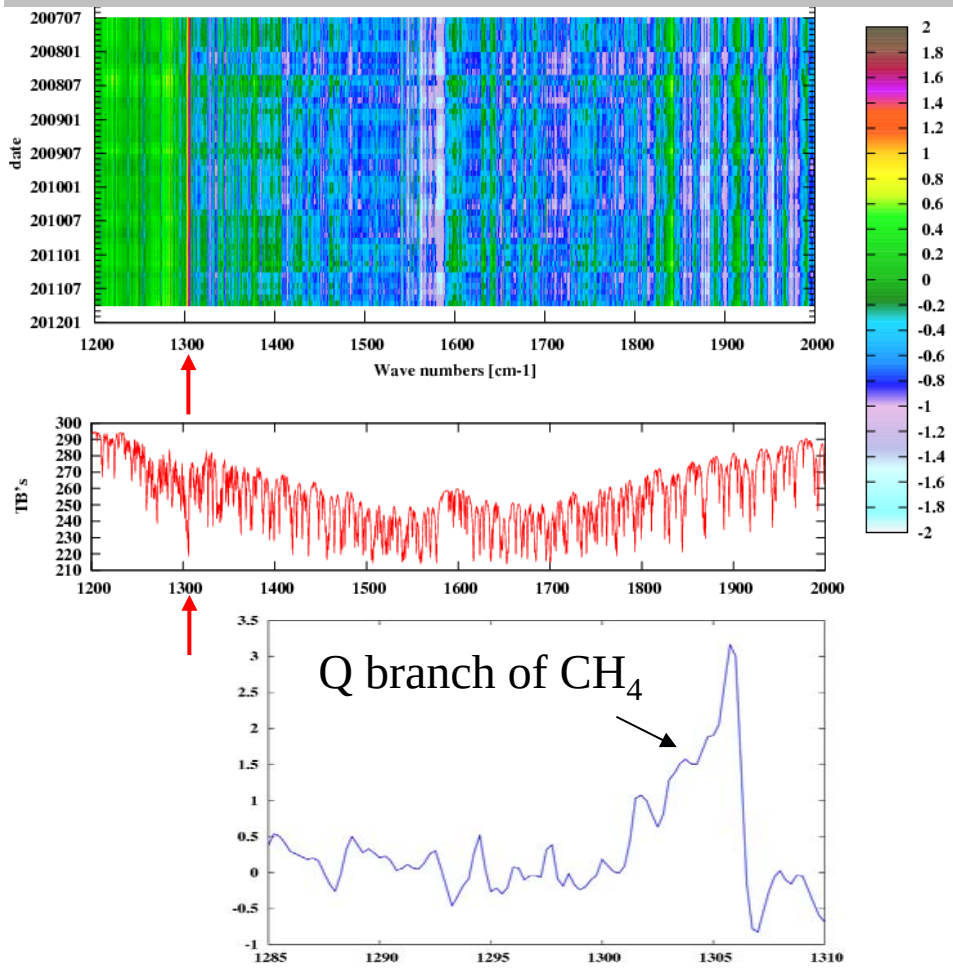
Question: is the bias due to spectroscopic parameters ?

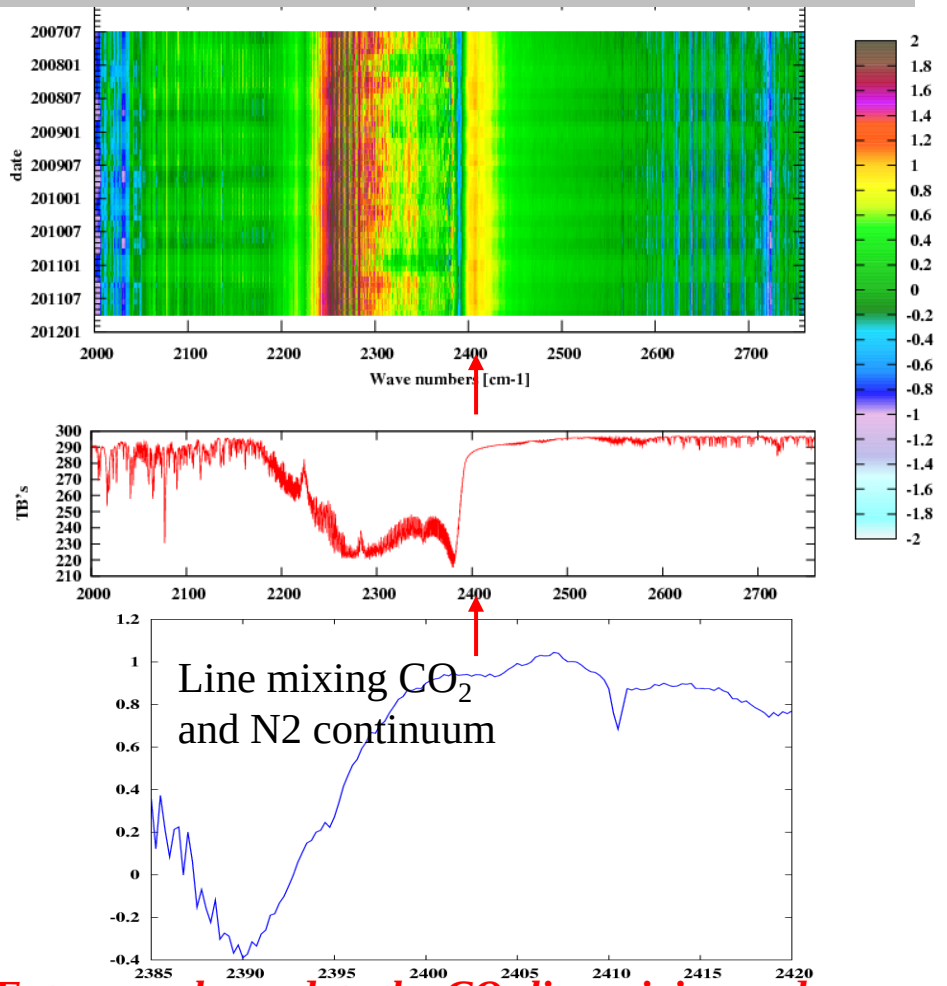


YES ➔ Corrected with the updated GEISA-09 version

Bias due to the radiative transfer algorithm (line modelling)

CH_4 (7µm) and CO_2/N_2 (4 µm)

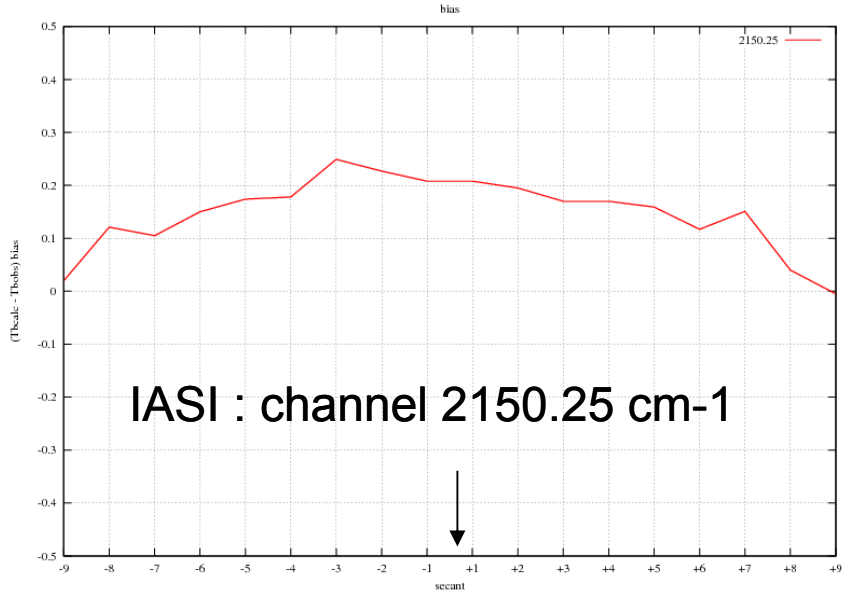




➔ *Current work : introduction of the line mixing (Hartmann and al)*

➔ *Future work : update the CO_2 line mixing and eventually the N2 continuum (coll. Hartmann)*

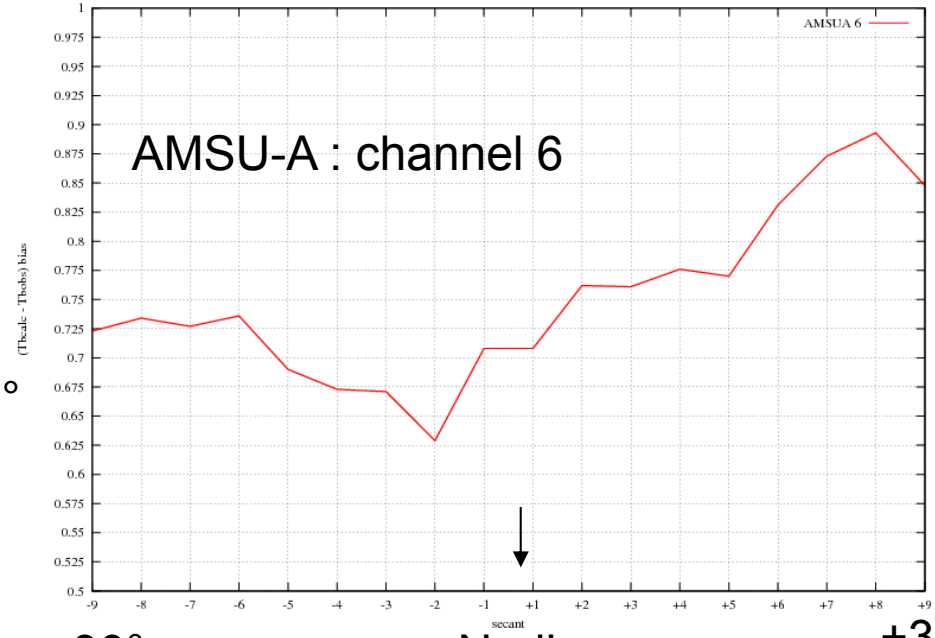
Bias due to the instrument (viewing angle effetcs)



IASI : channel 2150.25 cm-1

-30° Nadir +30°

← Viewing angle →



AMSU-A : channel 6

-30° Nadir +30°

← Viewing angle →

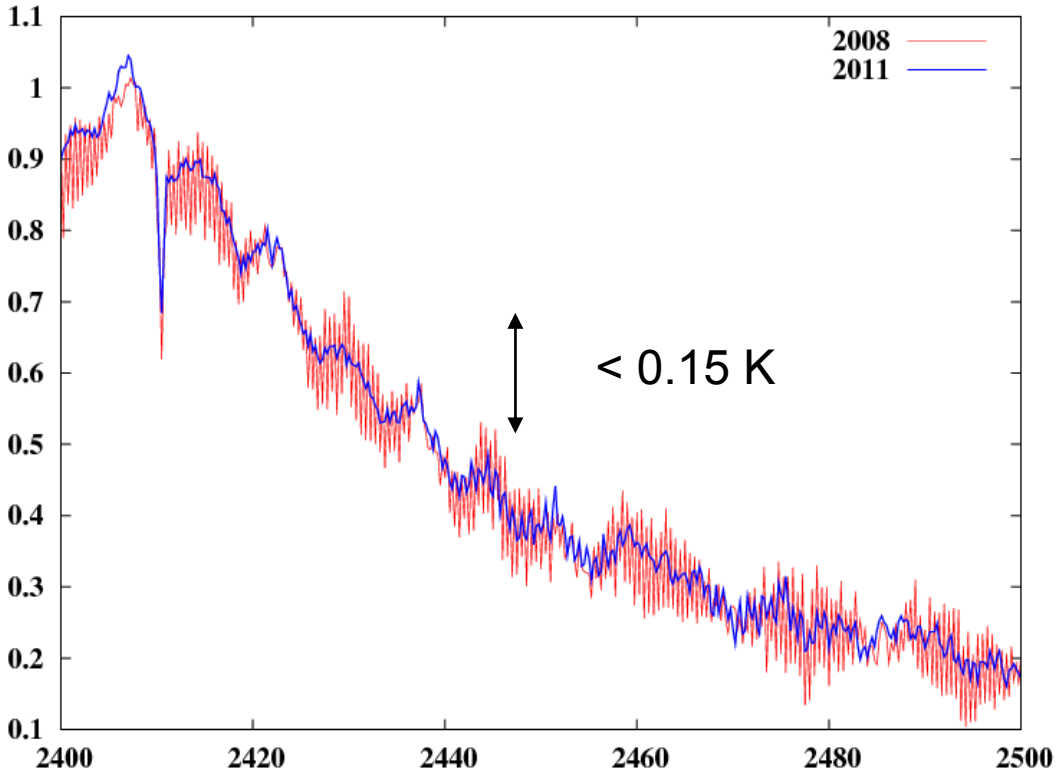
➔ GSICS activities

Bias due to the data processing

➔ *Even if distance of the collocation (3h, 100 km) is important, validation with radiosoundings allow identifying small features*

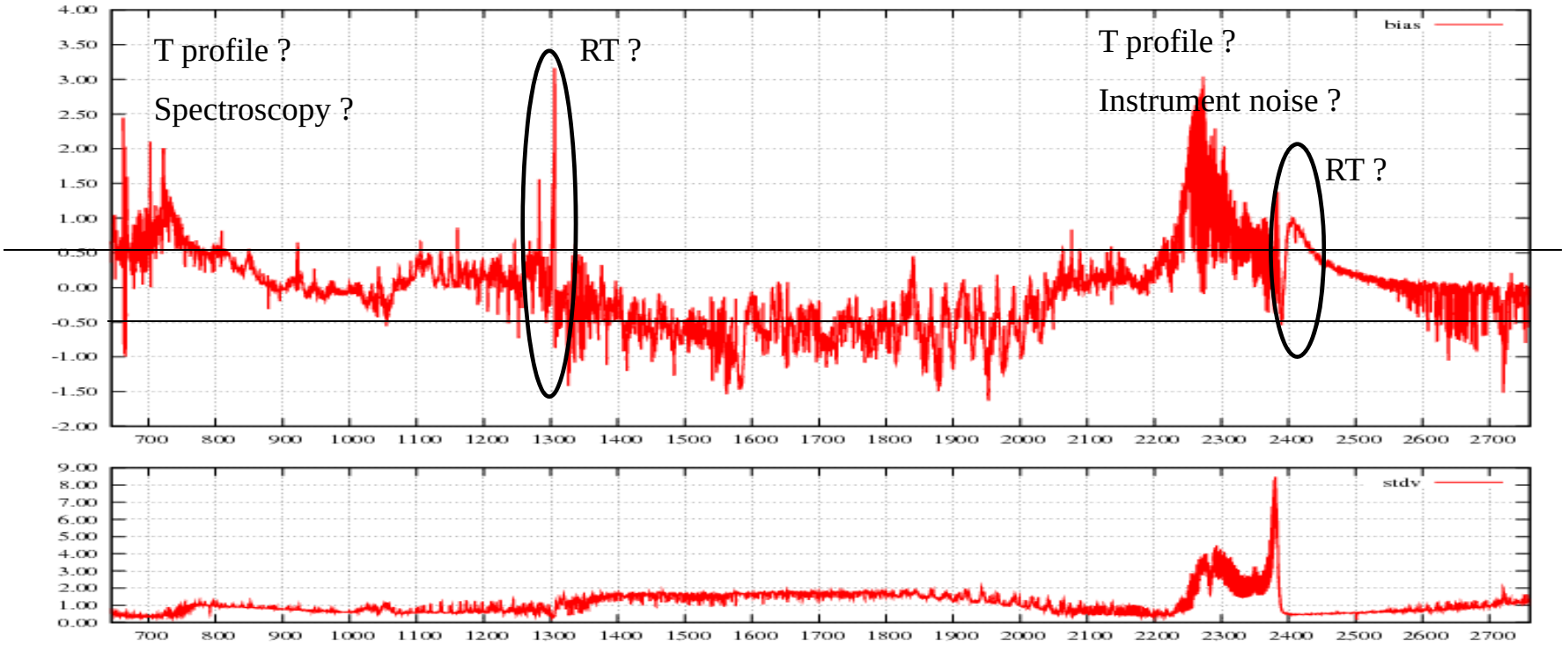
Numerical error during the data processing due to the passage of the level1a to the level1b (Gibbs effects)

Corrected by the TEC (Toulouse) in 2010



Conclusions and future work

Biases and standard deviations are systematically investigated in order to unambiguously identify the origin of the discrepancies : natural (e.g. seasonal variations, unexpected emissions of “pollutants”, …) , spectroscopic, instrumental, thermodynamical, …



➔ The new generation of instruments (IASI-NG, Crevoisier et al, Wednesday), it would be possible to assess the accuracy of some of the spectrocopic parameters