IASI-4 Conference
Juan-les-Pins, 11-15 April 2016

Scientific perspectives and challenges for IASI-NG

Cyril Crevoisier and Fiona Smith

on behalf of the
IASI(/IASI-NG) Sounding Science Working Group (ISSWG)
&
groupe Mission d'Experts Internationaux pour IASI-NG (MENINGE)

The IASI-NG mission

- **Objectives of the mission:**
  - To assure the continuity of IASI for NWP, atmospheric chemistry and climate applications.
  - To improve the characterization of the lower part of the troposphere, the UT/LS region and, more generally, of the full atmospheric column.
  - To improve the precision of the retrievals and to allow the detection of new species.

- **Characteristics**:

-spectral coverage: 645 - 2760 cm^{-1}

-spectral resolution: 0.25 cm^{-1} after apodisation (*0.50 cm^{-1} for IASI*)

-spectral sampling: 0.125 cm^{-1} (*0.25 cm^{-1} for IASI*).

-reduction of the radiometric noise by at least a factor of ~2 as compared to IASI.

-spatial sampling: 12km FOV.

Studies design

•During Phase-0/A/B, several studies have been performed within the framework of the MENINGE and then ISSWG groups to evaluate the impact of IASI-NG radiometric and spectral specifications on the retrieval of several atmospheric and surface variables.

•Three communities were involved:

- •Numerical Weather Prediction: T and WV (1Dvar & 4Dvar).
- •Atmospheric composition: CO, O_3, SO_2, NH_3.
- •Climate: CO_2, CH_4, surface emissivity and temperature.

•Six scenarios have been studied (Crevoisier et al., AMT, 2014):

Spectral resolution	IASI noise	IASI noise /2	IASI noise /4
0.5 cm^{-1}	IRS1a=IASI	IRS1b	IRS1c
0.25 cm^{-1}	IRS2a	IRS2b	IRS2c

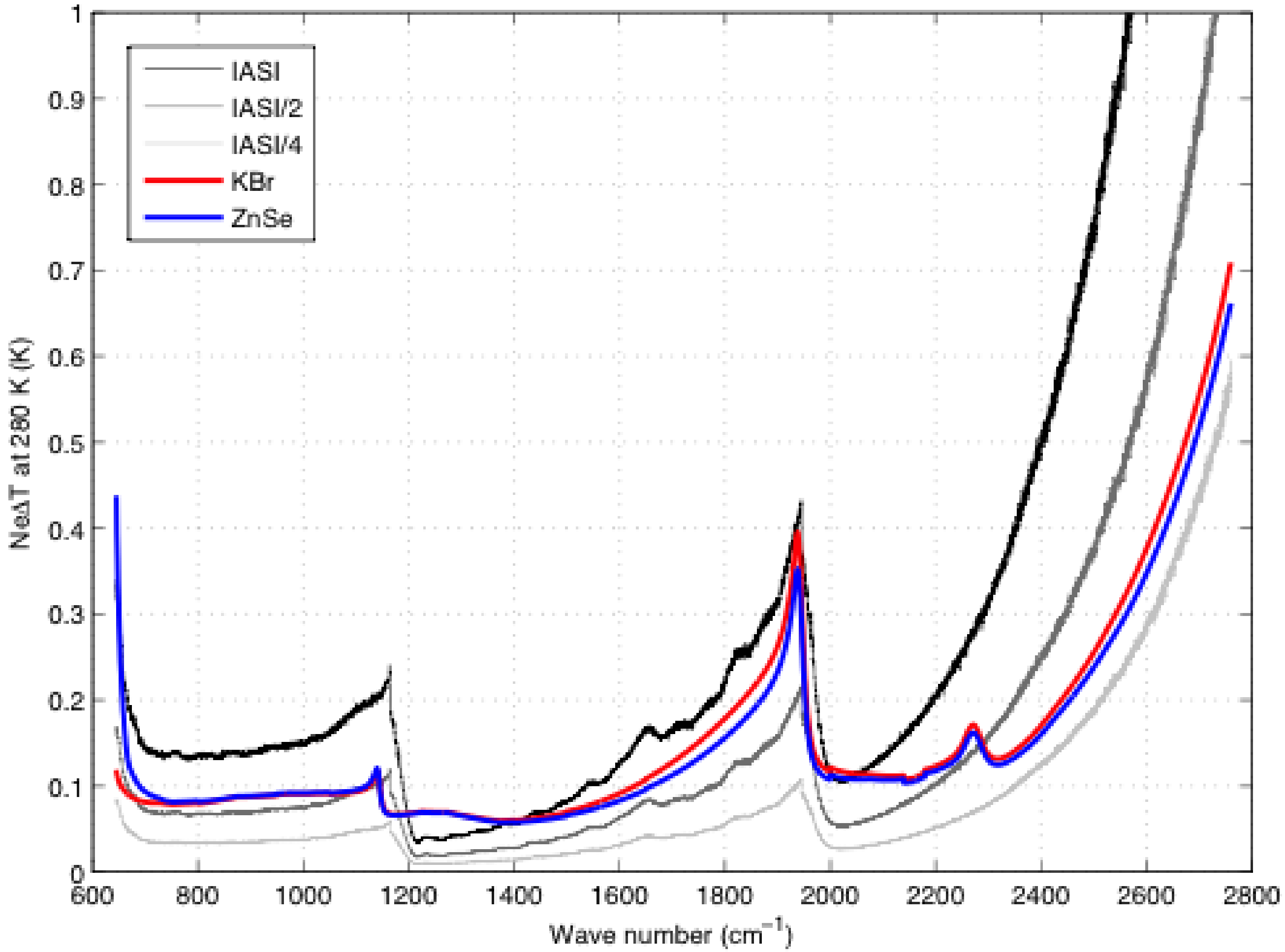
•After the choice of the instrumental concept, the studies have been extended to 2 new scenarios: KBr or ZnSe

→**Discussions and recommandations at ISSWG on the NedT acceptability.**

… and other specifications

IASI-NG: a few scenarios

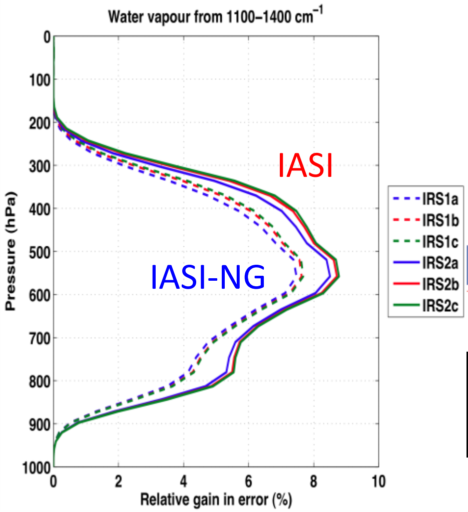
Spectral resolution	IASI noise	IASI noise /2	IASI noise /4
0.5 cm^{-1}	IRS1a=IASI	IRS1b	IRS1c
0.25 cm^{-1} KBr ZnSe	IRS2a	IRS2b	IRS2c



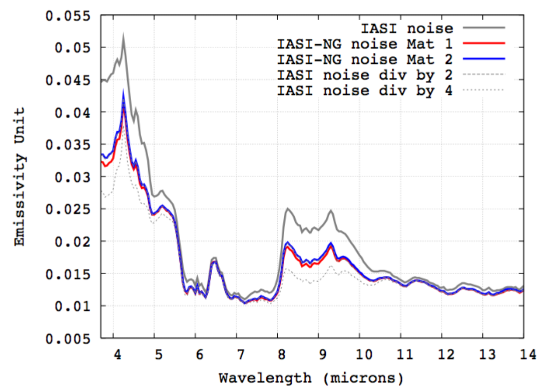
Specifications from CNES 2012 ITT

Impact of KBr vs. ZnSe on atmospheric and surface variables

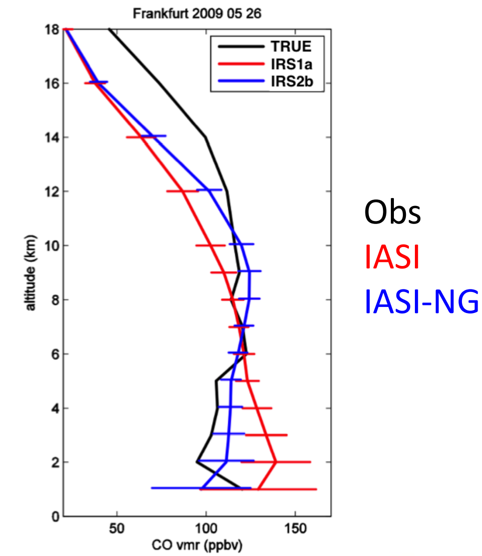
For most of the atmospheric species, there is no difference between KBr and ZnSe scenarios.



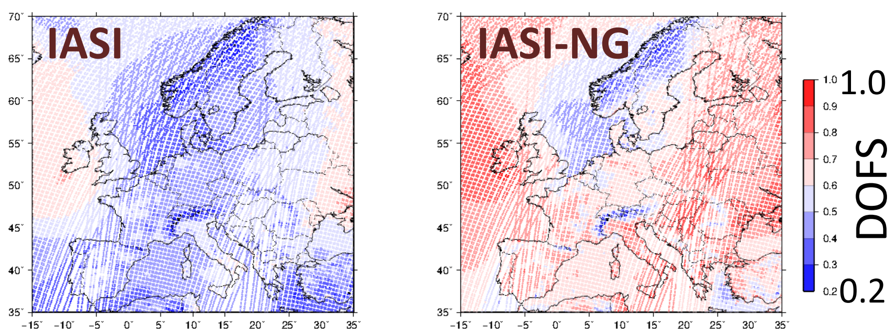
H_2O: it is mostly the spectral resolution that matters



Surface emissivity



Carbon monoxide



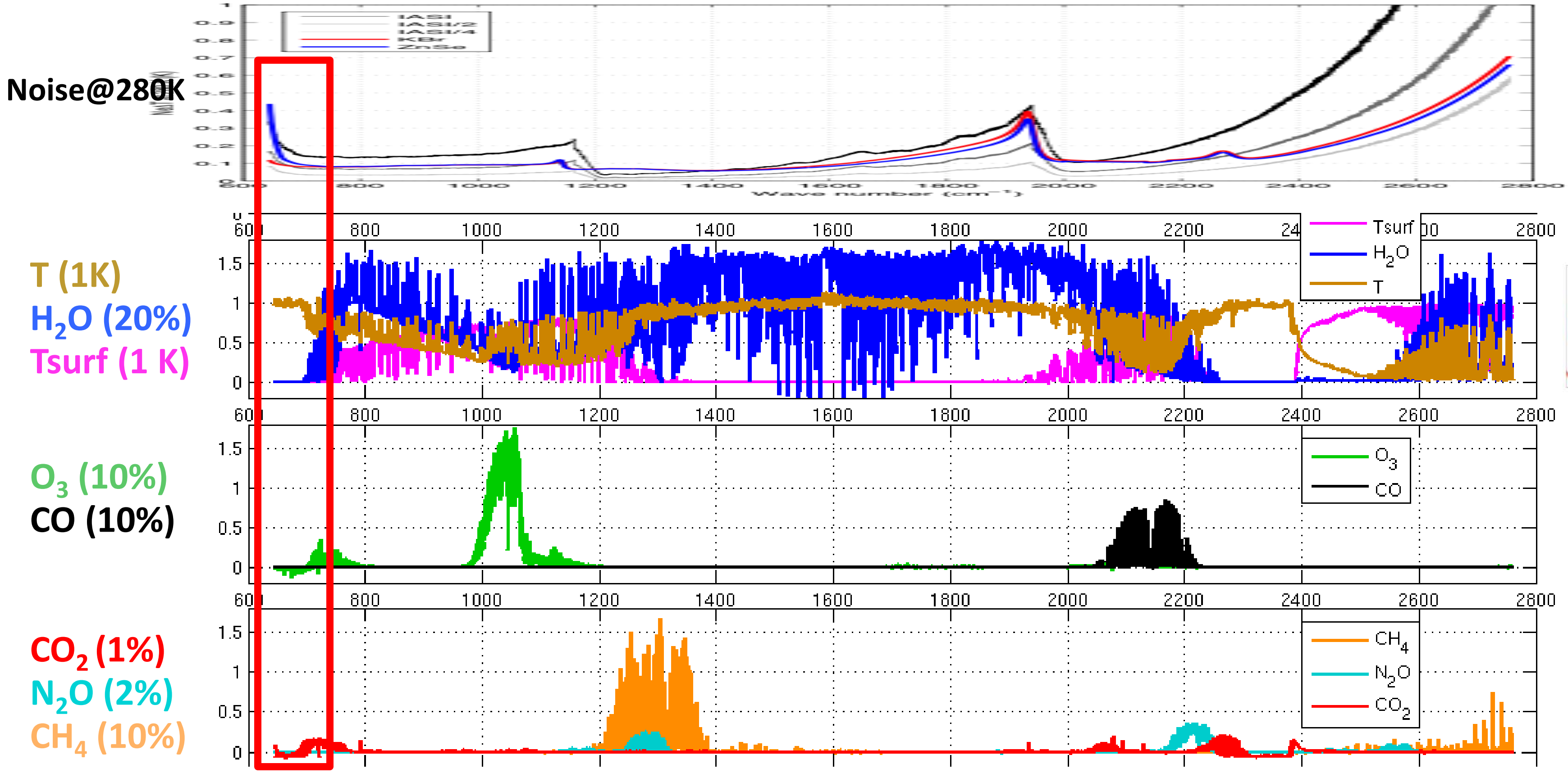
Ozone (0-6 km)

Noise	Improvement of the CH_4 precision
IASI	39 %
KBr	20 %
ZnSe	20 %

Methane

Crevoisier et al., AMT, 2014

Sensitivity of the channels to atmospheric variables

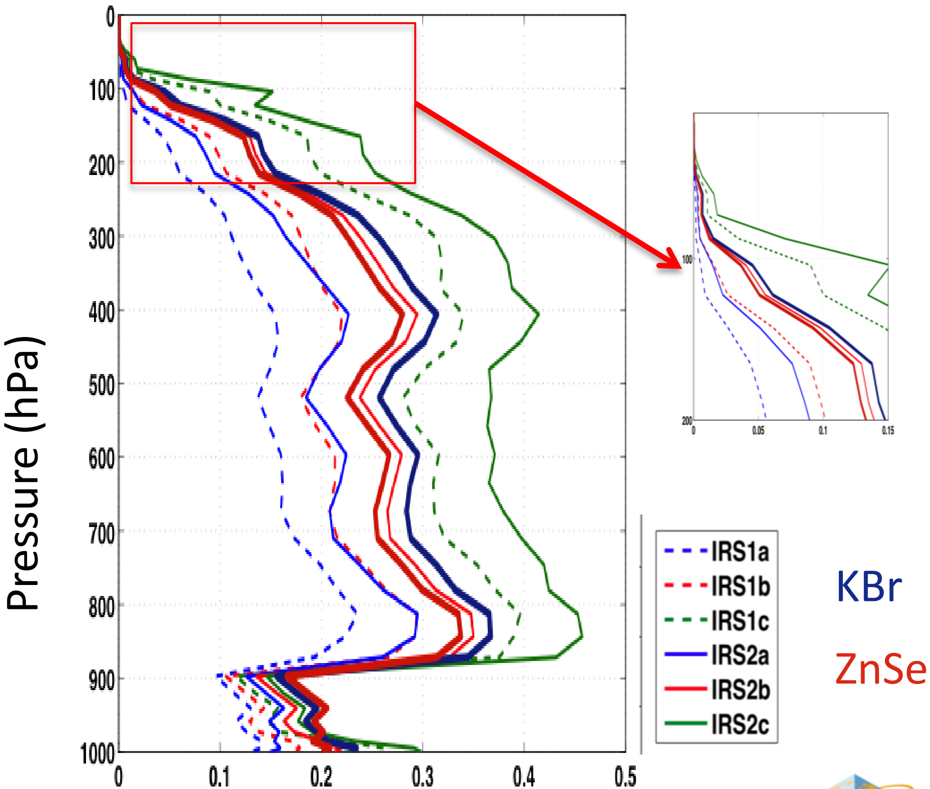


Its is mostly CO_2 (and hence temperature) that is concerned →

Spectral bands for IASI-NG	Noise	Improvement of the CO_2 precision
15 µm	IASI/2 KBr ZnSe	30 %| 28 % | 21 %
4.3 µm		0 % | 5 % | 5 %
15 + 4.3 µm		45 % | 50 % | 50 %

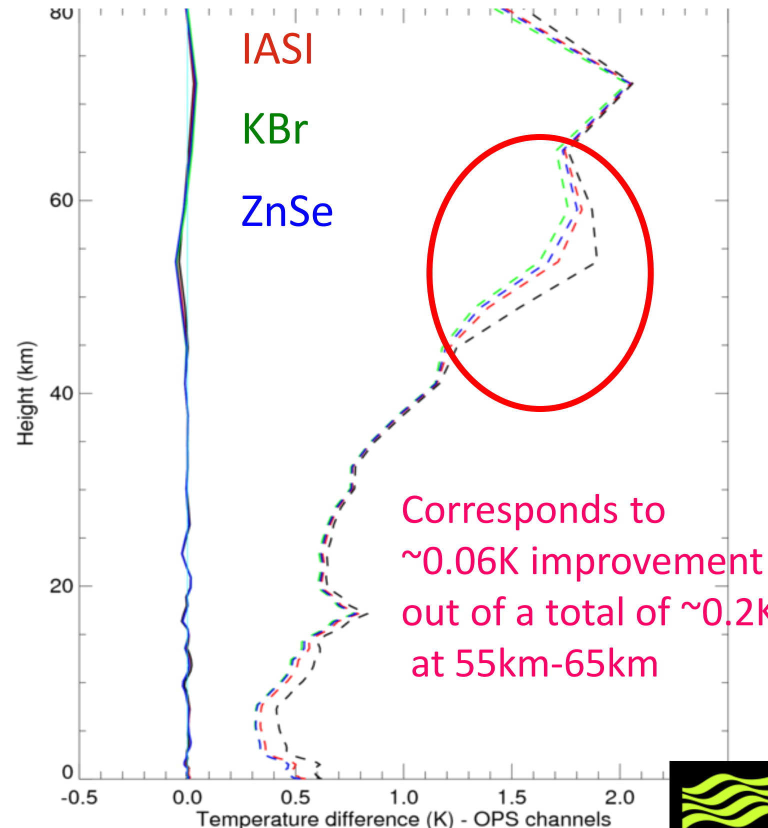
Impact of KBr vs. ZnSe on temperature

1Dvar simulation with full 15µm band for each scenario



Relative gain of each scenario
(a posteriori-a priori)/(a priori)

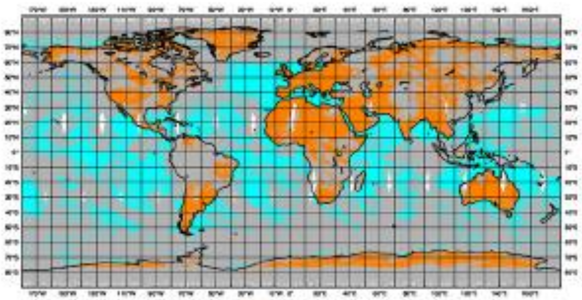
1Dvar for IASI assimilation spectral resolution, and current channel selections in use at the Met Office



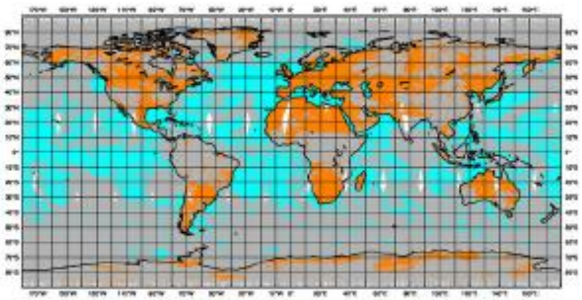
KBr better than ZnSe especially in the stratospheric part.

Observing System Simulation Experiments (OSSEs)

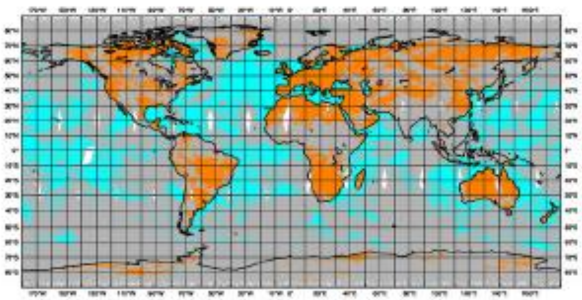
Objectives: evaluate the impact of IASI-NG (with the latest specification) in NWP assimilation while giving the opportunity to evaluate retrievals of atmospheric species and climate variables in realistic situations.



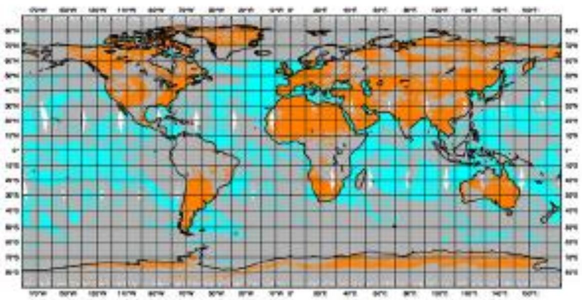
(a) February 4^{th}, 2013



(b) May 6^{th}, 2013



(c) August 6^{th}, 2013

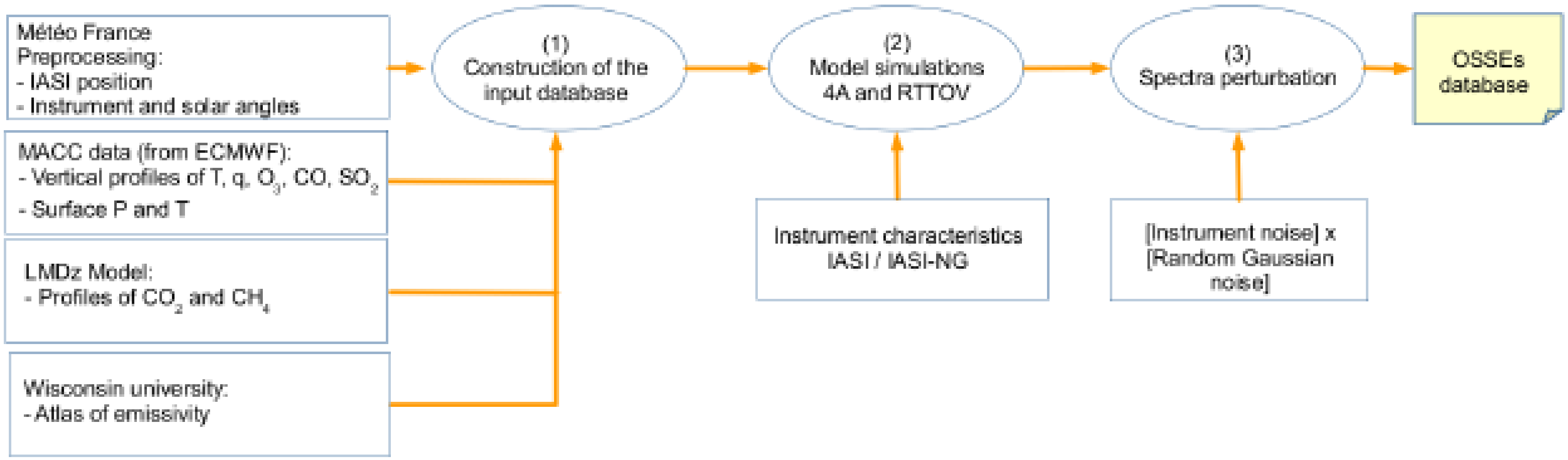


(d) November 4^{th}, 2013

All observation: 5 241 953
Sea/clear: 418 400
Land/clear: 354 993

Observing System Simulation Experiments

Overall scheme

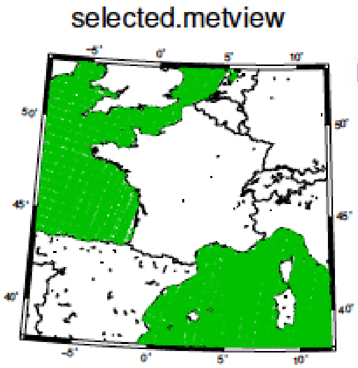


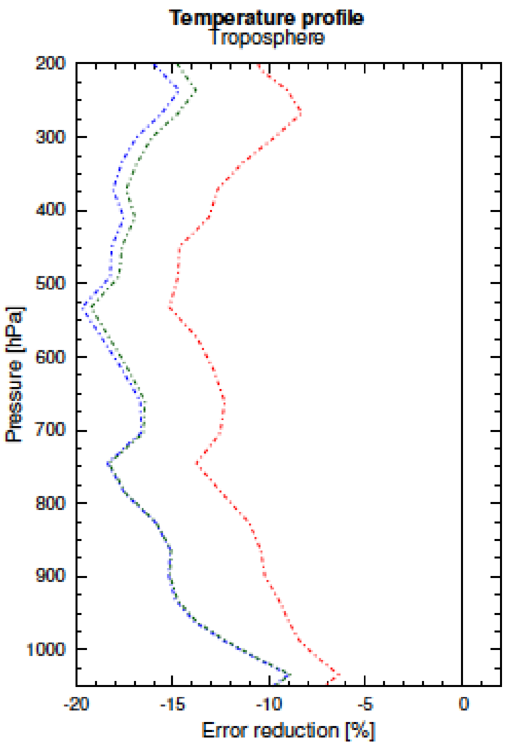
For each model, the simulated data has been divided into 96 uncompressed NetCDF files, corresponding to one hour. Each one of these hour files weights around 11 GB and can be downloaded from the *Pôle Atmosphere* FTP server.

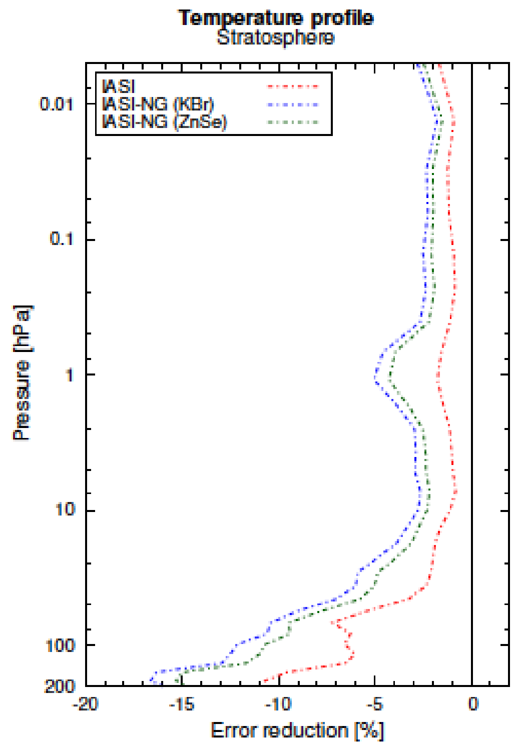
Everyone is welcome to join exploiting the dataset!

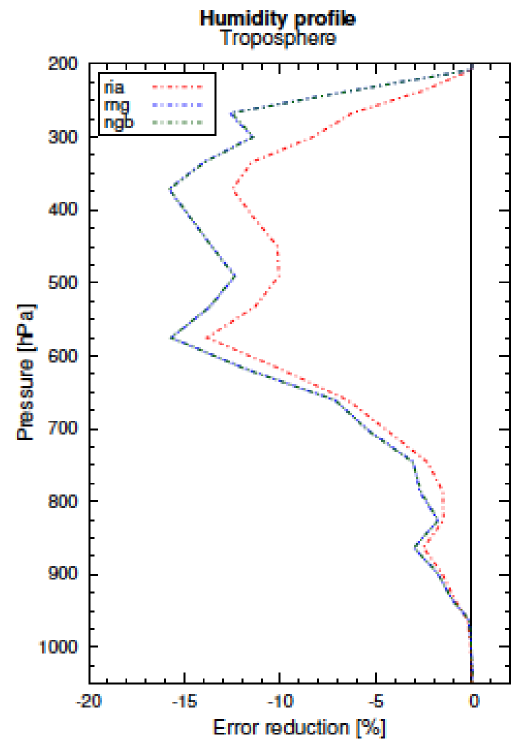
1D-Var retrievals in AROME France model

Observing System Simulation Experiments (OSSEs).



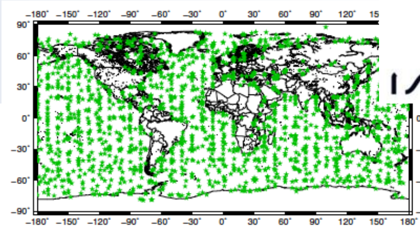


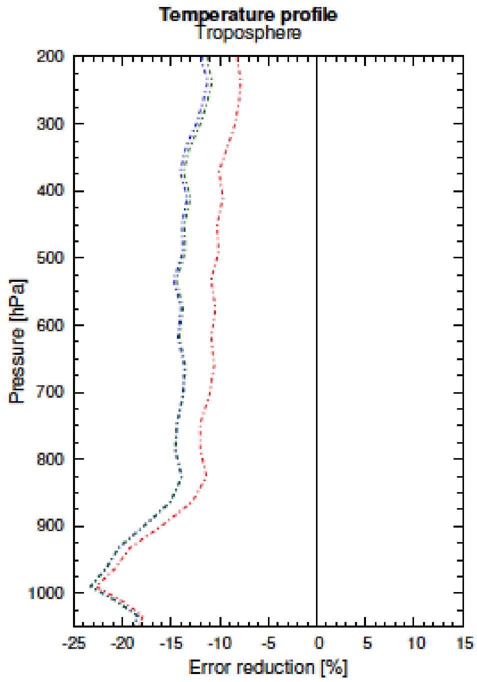


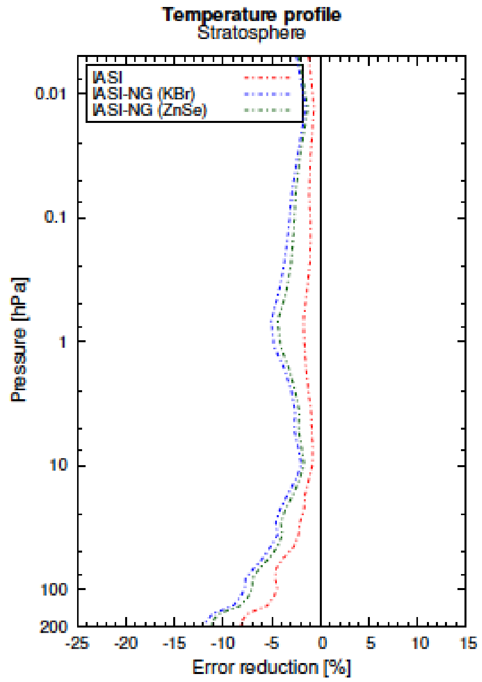


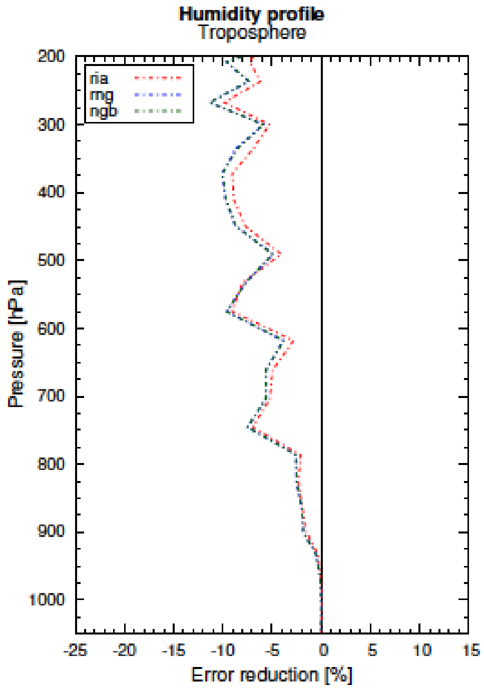
1D-Var retrievals in ARPEGE global model

Observing System Simulation Experiments (OSSEs).

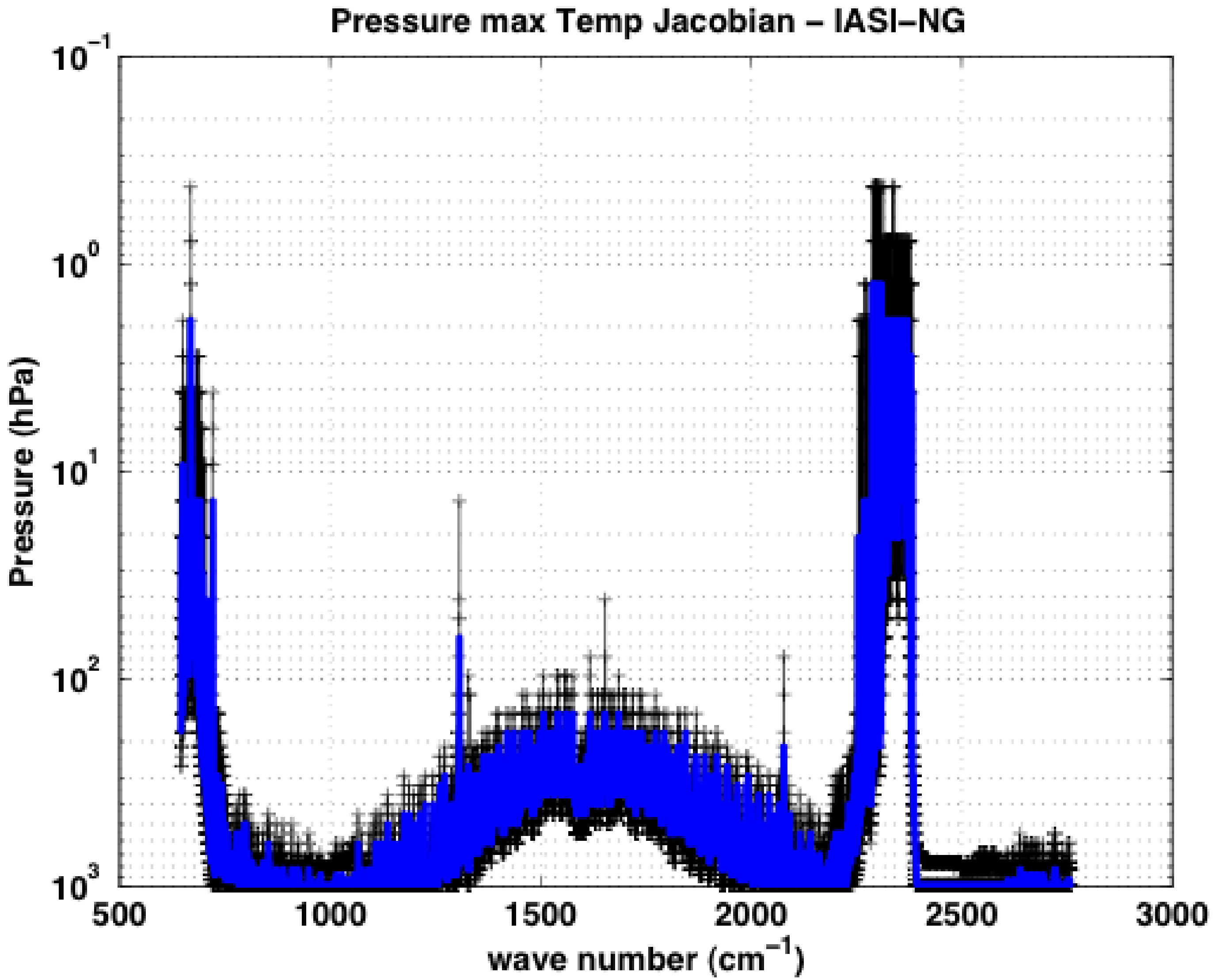






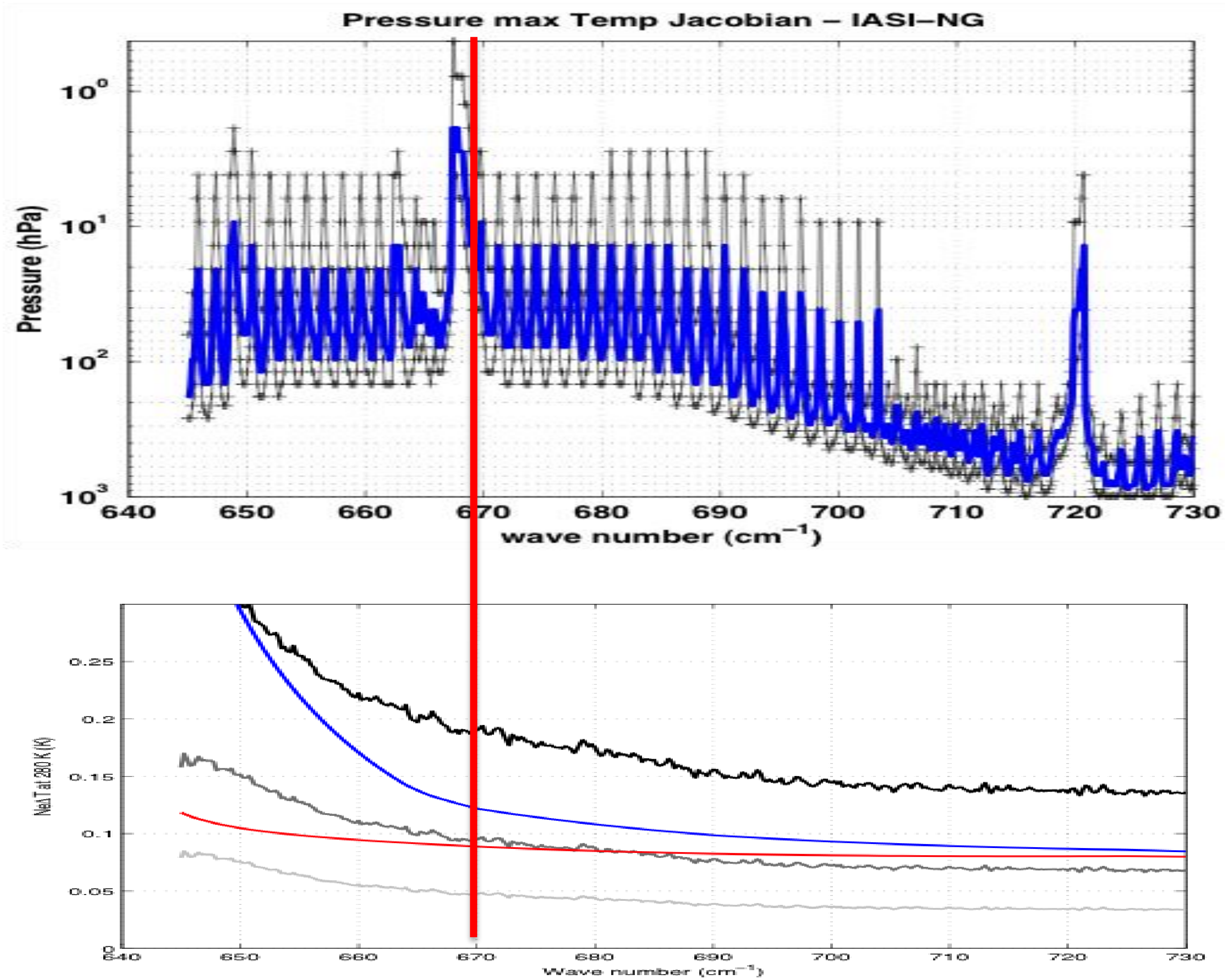


Why the stratosphere?



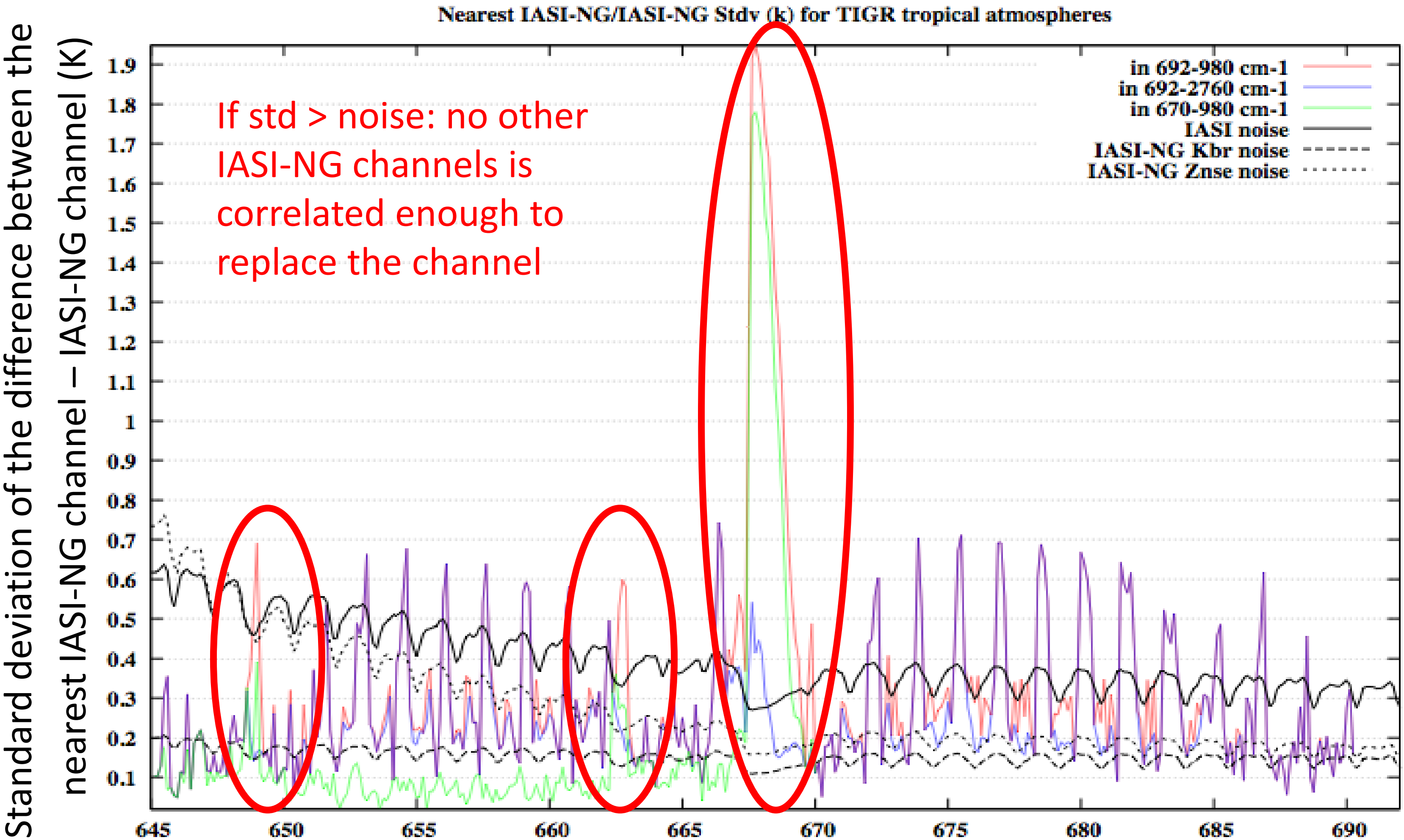
Average over the whole TIGR database atmospheric situations

Why the stratosphere?



Importance of the 648 cm^{-1} region

Standard deviation of the difference between the nearest IASI-NG channel and each IASI-NG channel (K)



Summary

•For most of the atmospheric variables (especially in atmospheric composition studies), KBr and ZnSe display similar performances.

•Main differences found for CO_2 and mostly temperature.

•It particularly matters for stratospheric channels.

→impact on monitoring of mid-/upper-stratospheric temperature.

→channel at 648 cm^{-1} has no other correlated channels.

•Although high-peaking channels are not assimilated in NWP systems, they are used in 1D-Var to determine stratospheric temperature:

→This is used to fill in above the model top

→A very important part of processing in limited area models with low model top.

→The top of the model will increase in height in the coming decades (e.g. space weather prediction).

→Although improvements are small, KBr does seem to offer benefit for NWP over ZnSe

•Discussions and recommandations of ISSWG on the 645-655 cm^1 NedT acceptability:

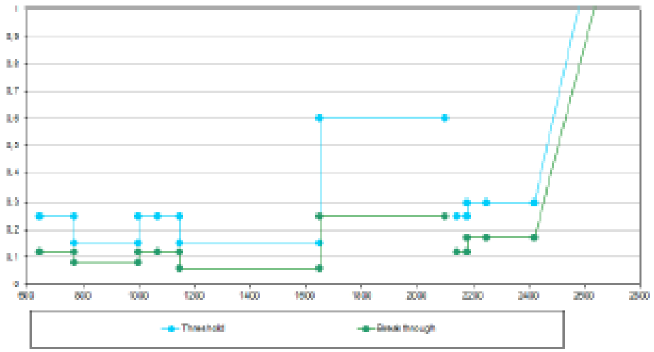
•The ISSWG recognizes the importance of channels around 648 cm^{-1}.

•The ISSWG recommends the relaxation of the noise requirements such that both KBr and ZnSe materials meet user requirement in beginning of B1 and end of B4.

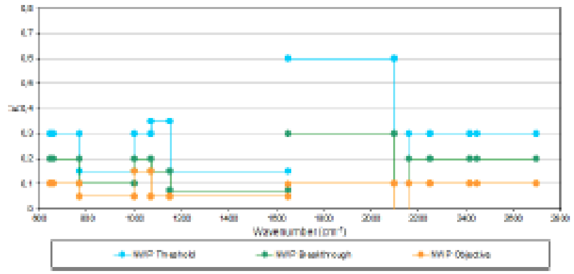
•The ISSWG recommends considering the stability of the noise performances throughout the mission lifetime in the choice of the material.

Evolution of documentation…

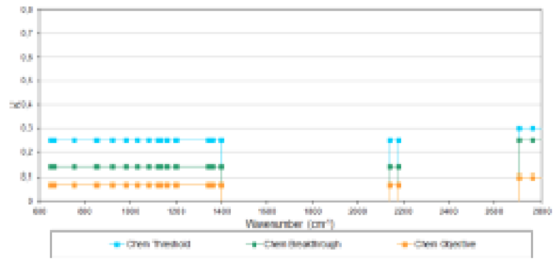
MRRD (apodised L1C, 2 levels)



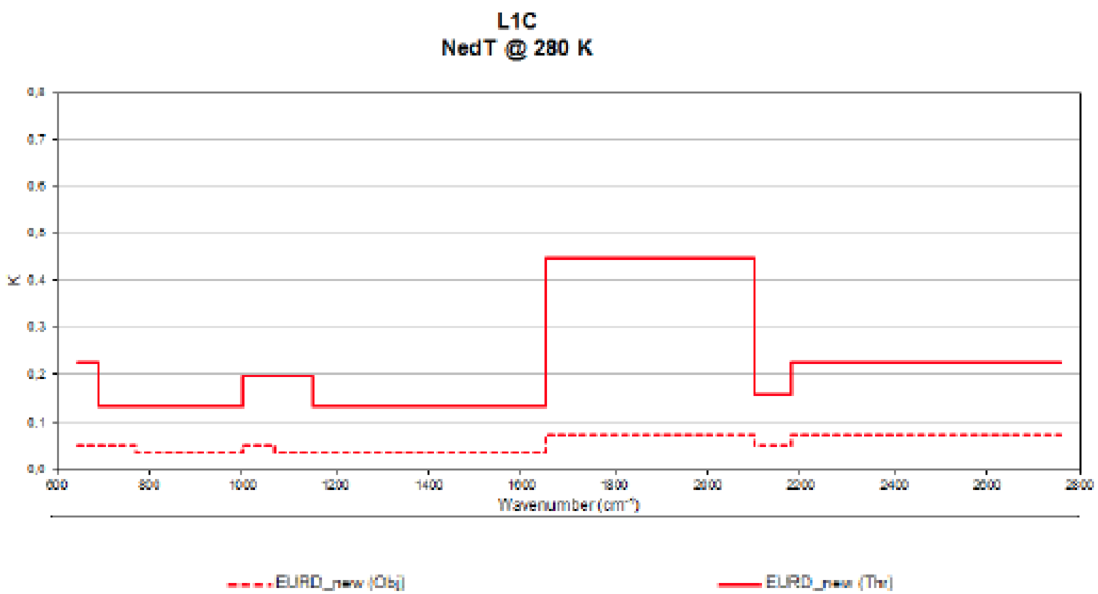
EURD NWP (L0, 3 levels)



EURD Chem (L0, 3 levels)

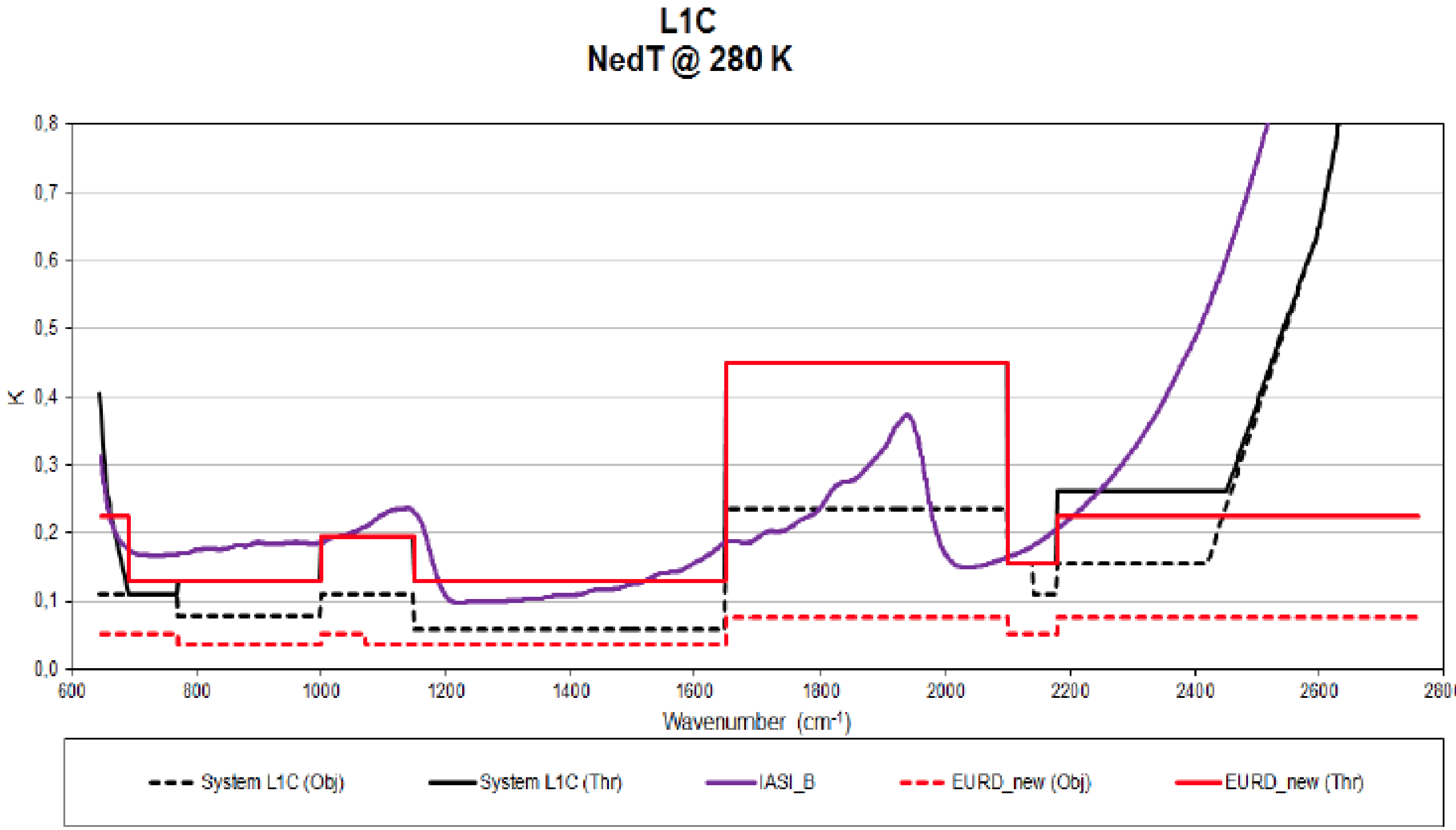


New mission requirement (L1C, 2 levels)



Evolution of documentation…

Comparison with IASI 1st generation



Evolution of documentation…

- MRRD specific needs are now included in EPS-SG SRD

=> a single mission requirement document

- Consensual definition of the user product level L1C
- Requirements for the IAS mission are given at the user product level 1C

=> clarification of the interface between IASI-NG mission and system in particular for radiometric and spectral performance evaluation

"L1C corresponds to geo-located atmospheric spectra, spectrally and radiometrically calibrated, after equalization of the instrument spectral response function and numerical apodisation with a truncated Gaussian function with a full-width half maximum of 0.25 cm^{-1}" (DCR-070)