IASI INSTRUMENT STATUS AND PERFORMANCE

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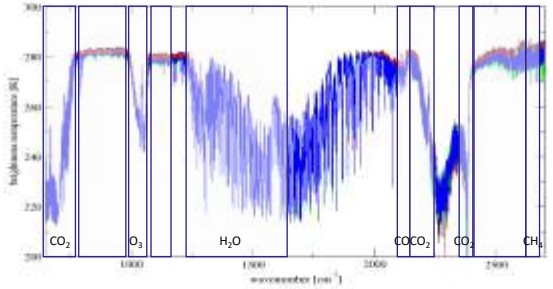
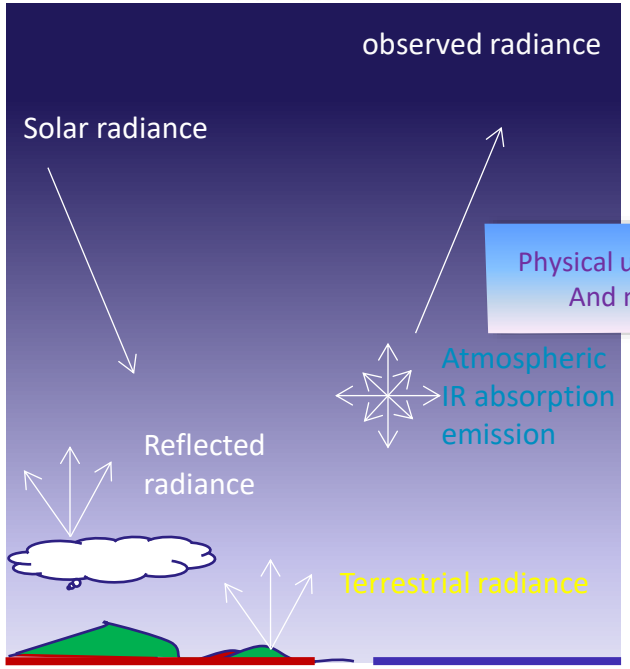
IASI CONFERENCE - NANCY
02-06/12/2024

THE IASI SYSTEM



IR spectra, cleaned
from Instrumental effects



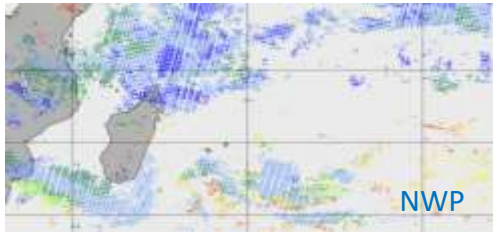
Physical understanding
And modelling

Assimilation / Retrieval processes

Radiative Transfer codes

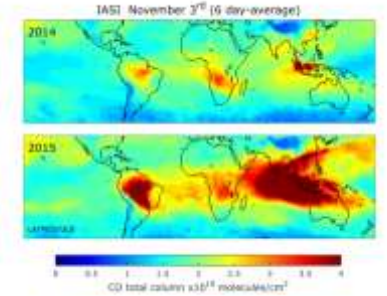
Spectroscopic Data Base

Validation / Calibration !

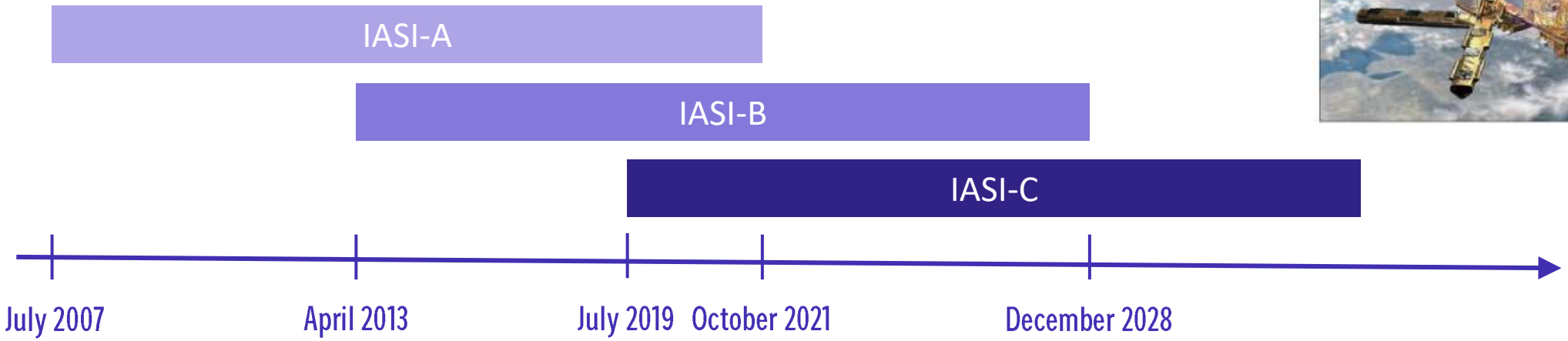


Operational applications

Chemistry, Physics, Properties Climate Studies & monitoring



THE IASI ONBOARD METOP SATELLITES MISSION



- The first IASI entered in service in July 2007 for a total of ~14 years of service (initially specified for 5 years!).
- IASI-B is scheduled to be decommissioned around the end of 2028.
- The duration of the IASI mission is expected to cover more than 25 years in total.

IASI INSTRUMENT AND PERFORMANCES MONITORING

MONITORING AT TEC

- **IASI monitoring at CNES is performed at the IASI Technical Expertise Center (TEC) in Toulouse**

Flags monitoring

- On-board and on-ground flags at L0 and L1 levels
- Monitored daily, ensuring a permanent overview of the instrument performance and data quality

Radiometric routine monitoring

- Radiometric calibration
- Post calibration process (e.g. scan mirror reflectivity)
- Reduced spectra
- Ice contamination monitoring

Spectral routine monitoring

- Spectral calibration accuracy

Geometric routine monitoring

- Imager radiometric monitoring
- Coregistration monitoring

Radiometric and spectral inter-comparisons

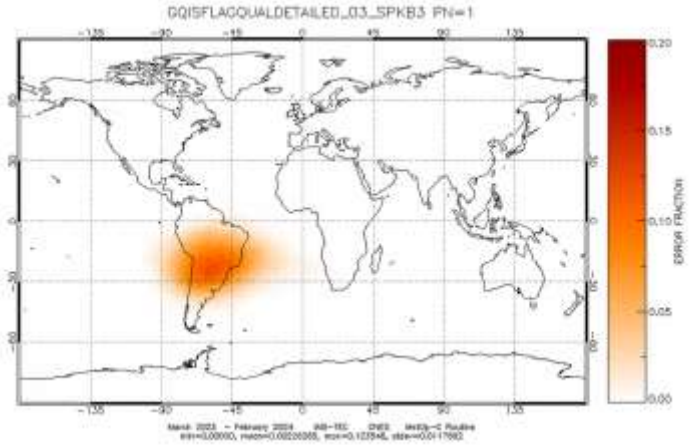
- IASI-B Vs IASI-C
- IASI Vs CrIS-N20 (NOAA)
- IASI Vs CrIS-N21 (NOAA)

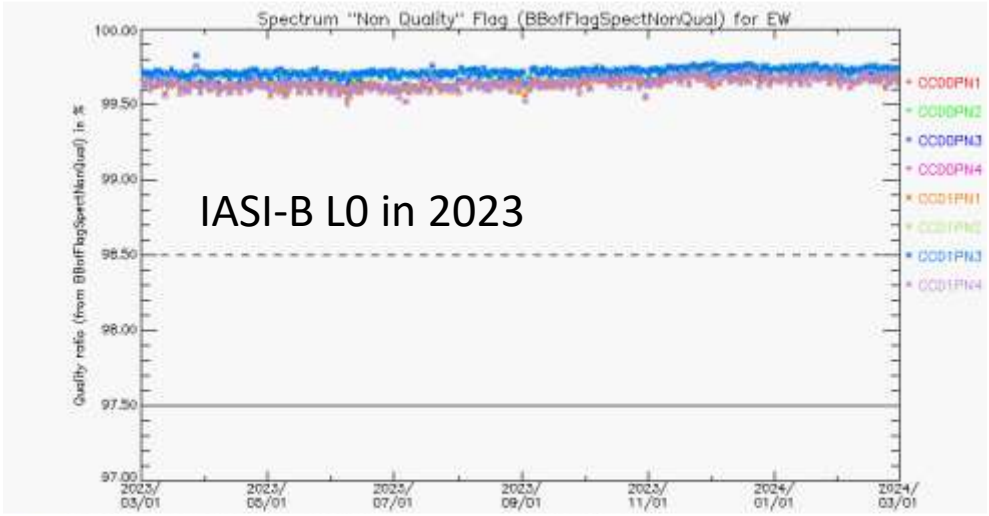
IASI STABILITY

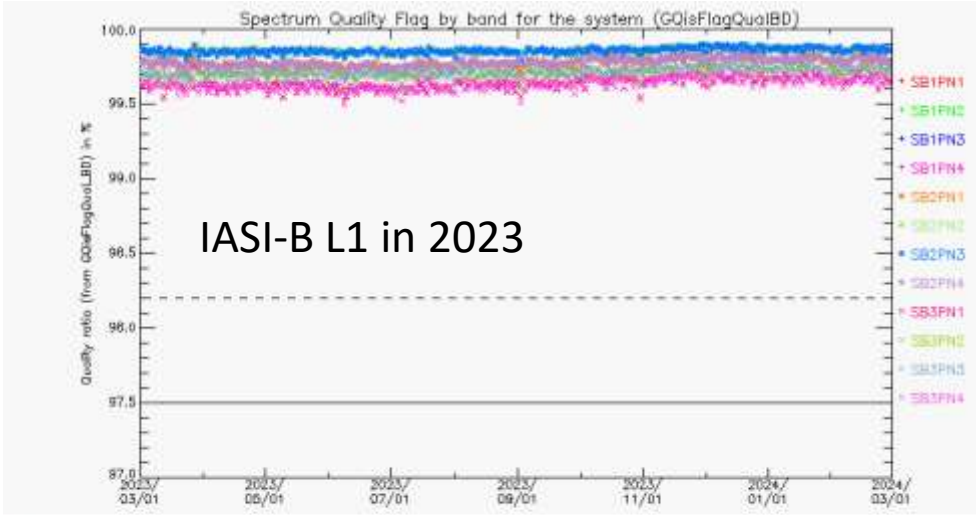
IASI DATA QUALITY AND AVAILABILITY

L0 AND L1 LEVEL

- Data availability is constantly >97% for both instruments.
  - Planned operations (calibrations, decontaminations) are the main factors for outages/non-availability of data.
- L0 and L1C data quality constantly >99 %.
- Very slightly lower quality for B3 which is more sensitive to spikes, predominantly over the South Atlantic Anomaly area (weaker magnetic field).





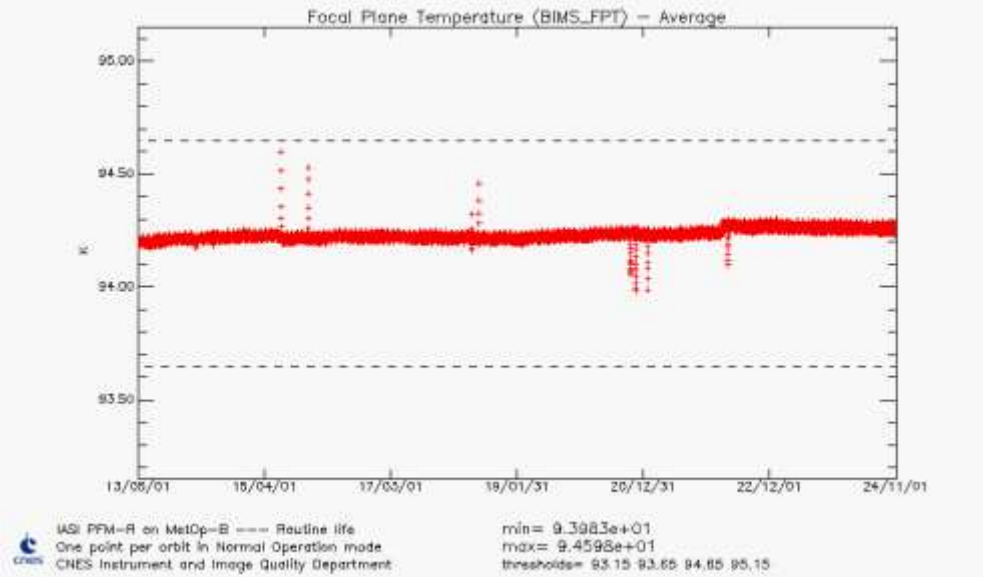


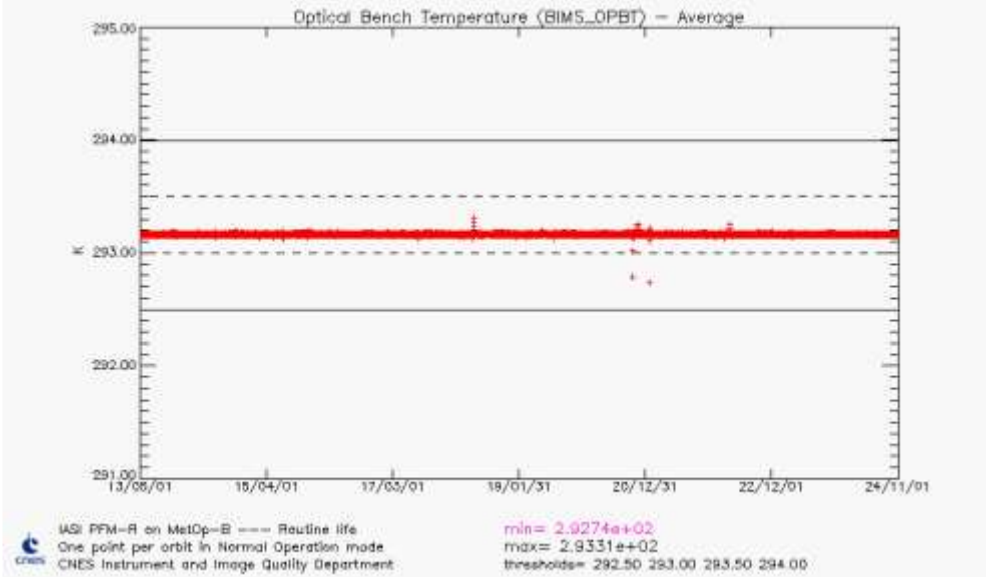
IASI INSTRUMENT STABILITY

TEMPERATURES MONITORING

- IASI-B/C focal plane temperature and optical bench temperature lifetime variations < 0.1K
- Internal black body temperature also stable.

IASI-B lifetime plots



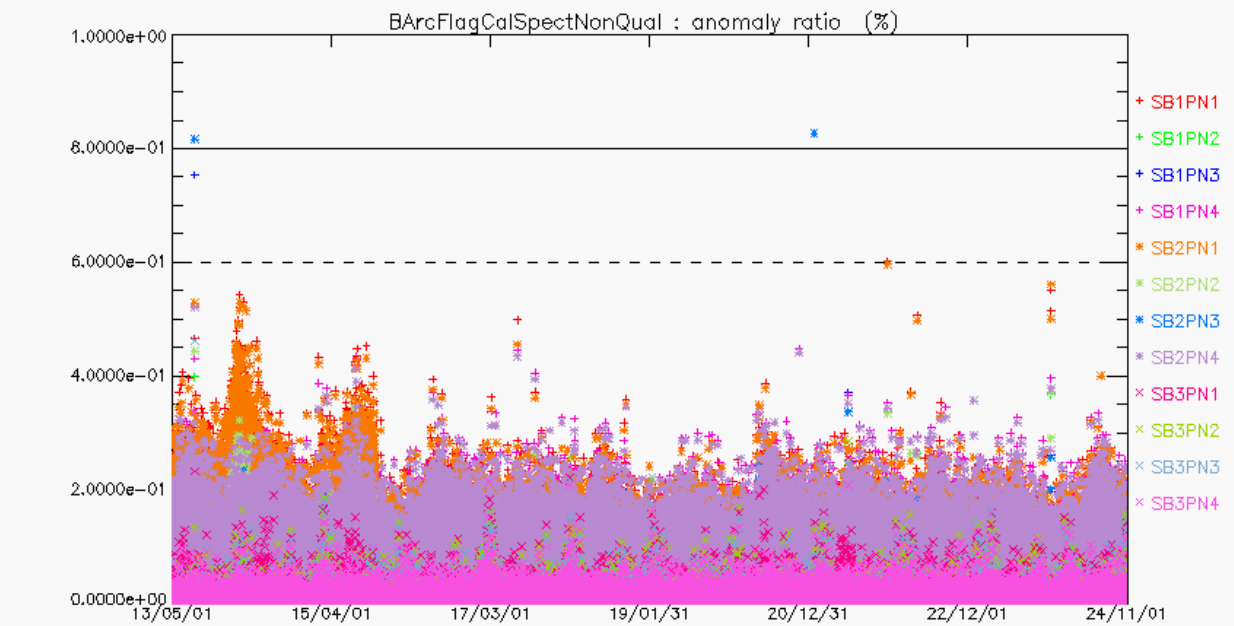


IASI PERFORMANCES STABILITY

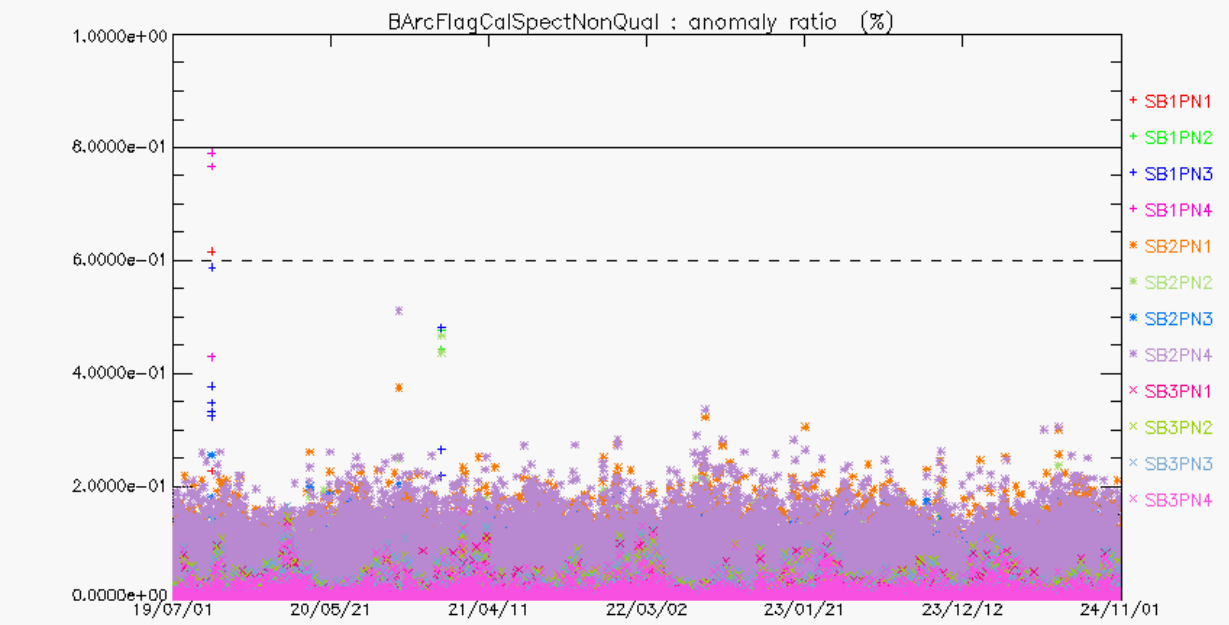
RADIOMETRIC CALIBRATION

- Monitored through a quality flag linked to the residual imaginary part of the spectra:

IASI-B lifetime plot



IASI-C lifetime plot

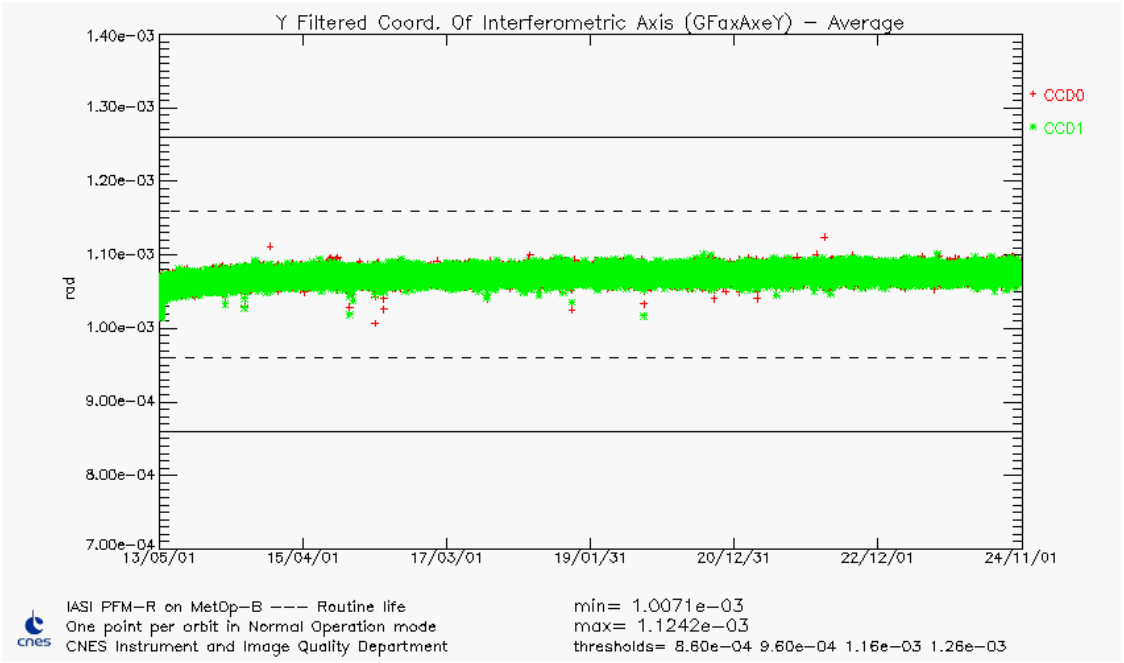


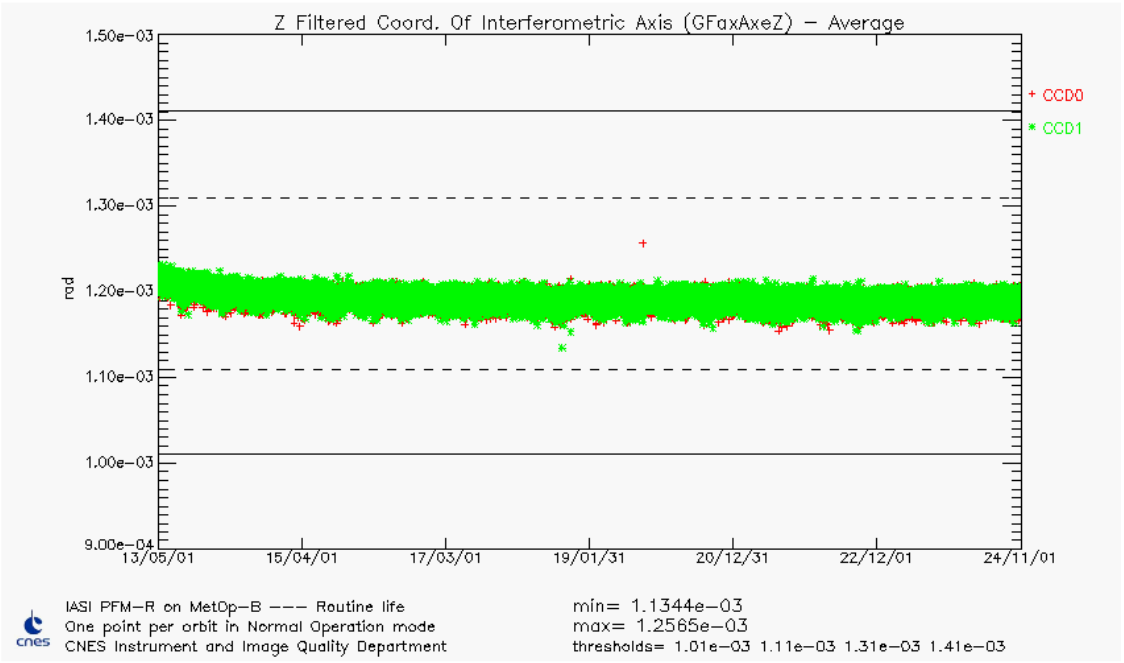
IASI PERFORMANCES STABILITY

SPECTRAL CALIBRATION

- Stability monitored through the filtered position of the interferometric axis:

IASI-B lifetime plots



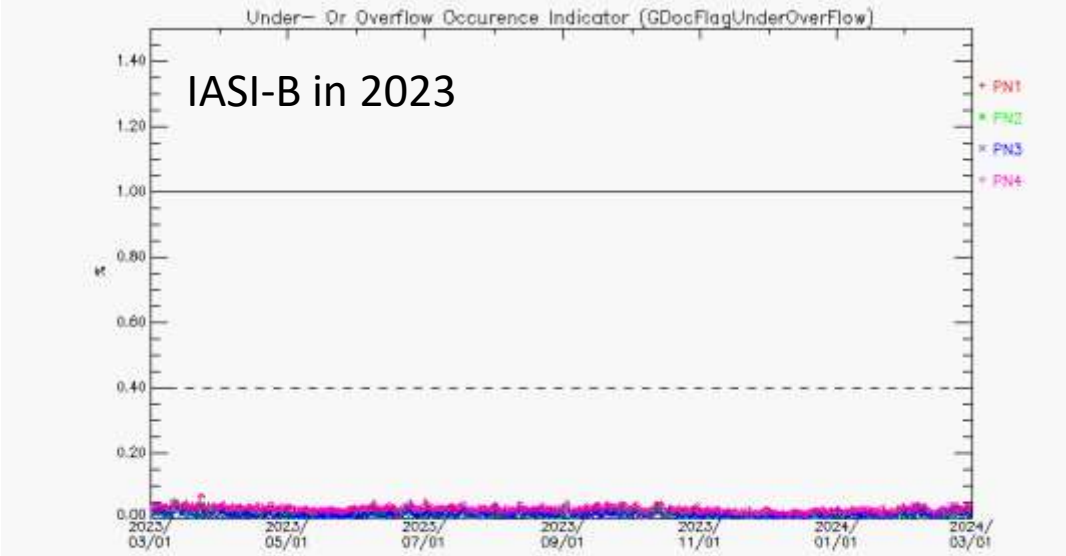


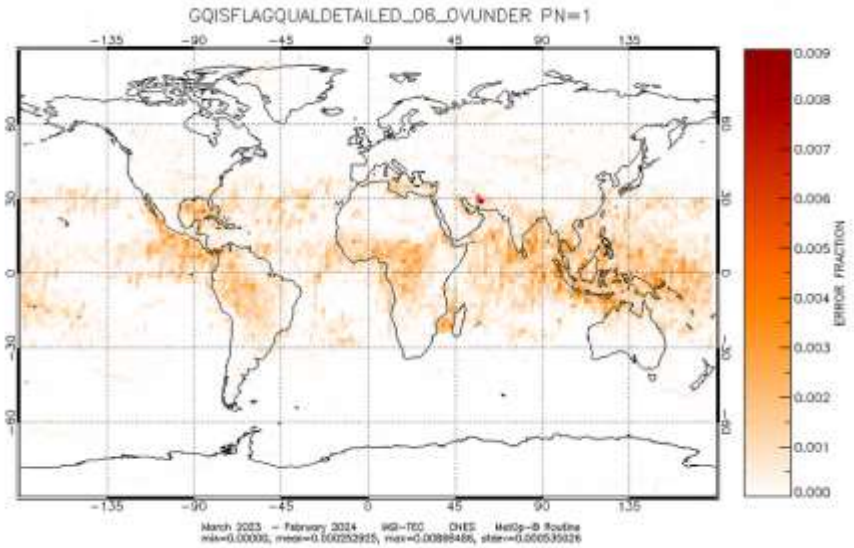
IASI PERFORMANCES

IASI PERFORMANCES

OVERFLOWS AND UNDERFLOWS

- Due to limited bandwidth the spectra are encoded using coding tables before transmitted to ground.
- The coding tables are designed to reflect typical conditions in the Earth's atmosphere.
- However, unusual conditions can cause over/underflows.
- In general these cases are rare, <0.05% per day, mostly due to sun reflection on high clouds around the tropics.

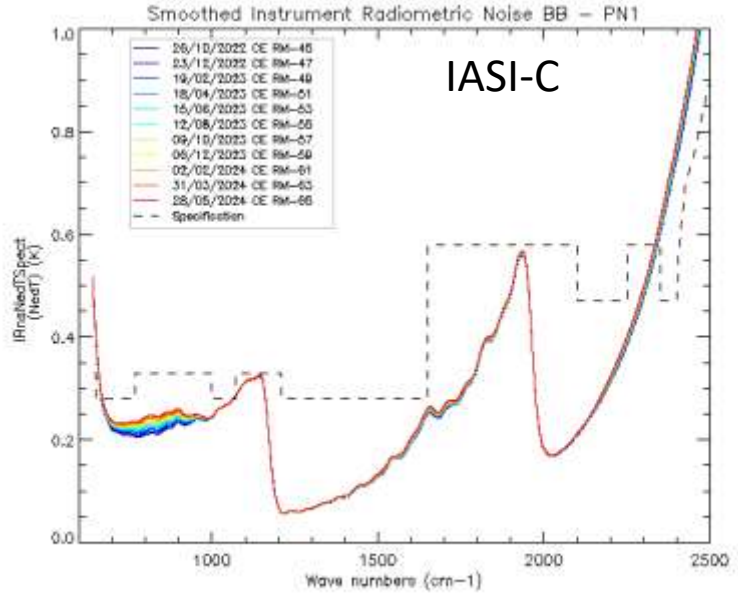




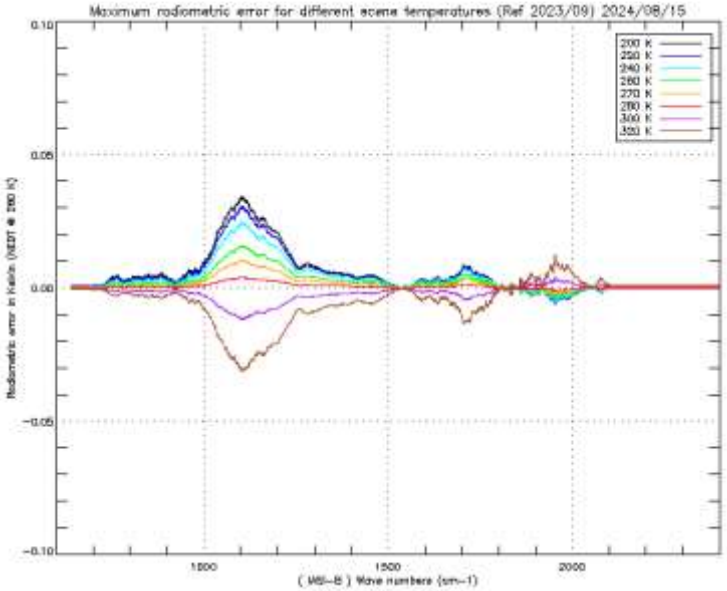
IASI PERFORMANCES

RADIOMETRIC PERFORMANCES

- Radiometric noise calculated every 2 months during external calibration.
- Particularly stable except a part of B1 around 850cm^{-1} -> Loss of instrument transmission due to ice contamination.
- In order to remove the ice, a decontamination is performed before the transmission loss reaches 20%.



- The effect of the evolution of scan mirror reflectivity due to scan mirror ageing (material desorption, molecular contamination, polymerization due to UV reflected by Earth) is also estimated.
- The impact of the scan mirror reflectivity angular variation law is corrected during on-ground processing. An update is made before the maximum radiometric error for different scene temperatures reaches 0.1K.

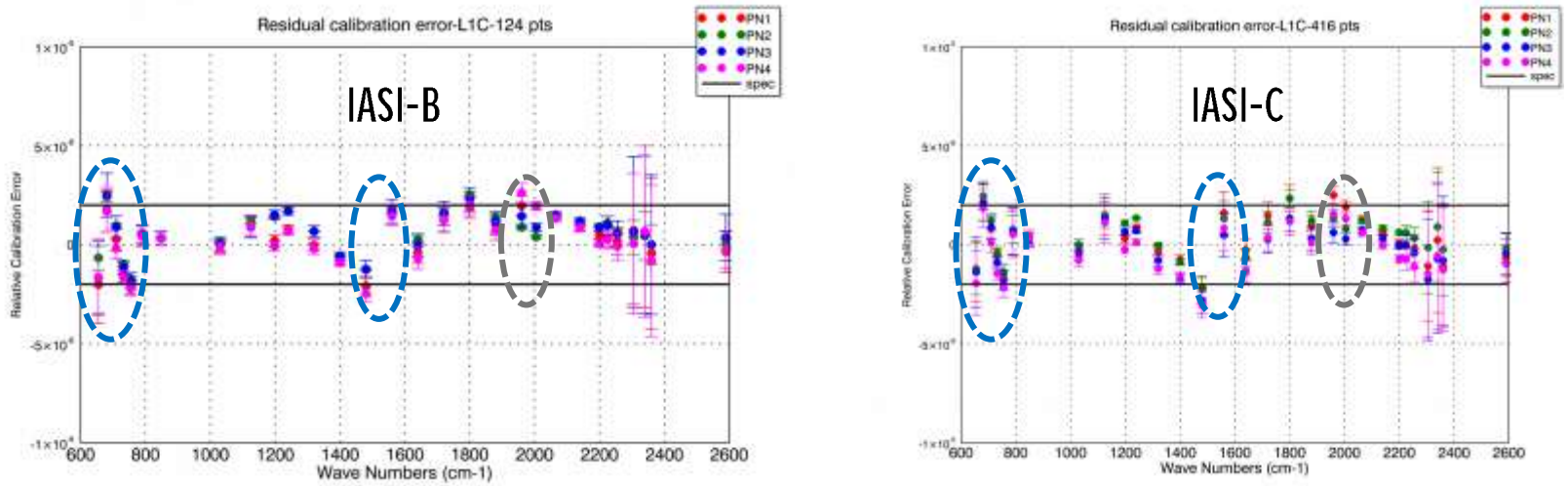


IASI PERFORMANCES

SPECTRAL CALIBRATION MONITORING

❖ <u>Verification of spectral calibration on L1C products:</u>

- Performed annually on homogeneous scenes, warm and clear during a routine external calibration close to nadir.
- Compared to a simulation of a perfectly calibrated spectrum, giving the residual relative spectral shift ($\Delta\nu/\nu$)



Residual spectral shift stable and globally within the specification (2.10^{-6}):
Model errors : spectroscopy, gas absorption (CO_2, H_2O)
Sharp gradient of the spectral filters (transmission function) at the edge of spectral bands (interband B2/B3)

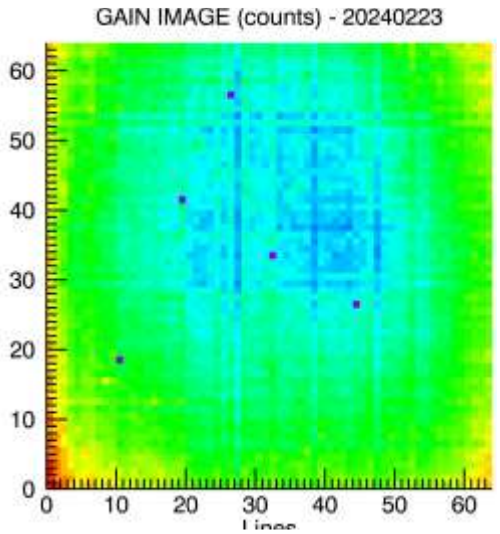
IASI PERFORMANCES

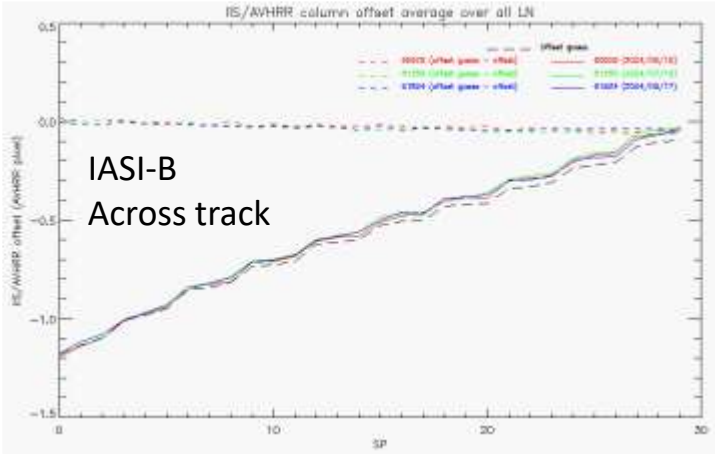
GEOMETRIC PERFORMANCES MONITORING

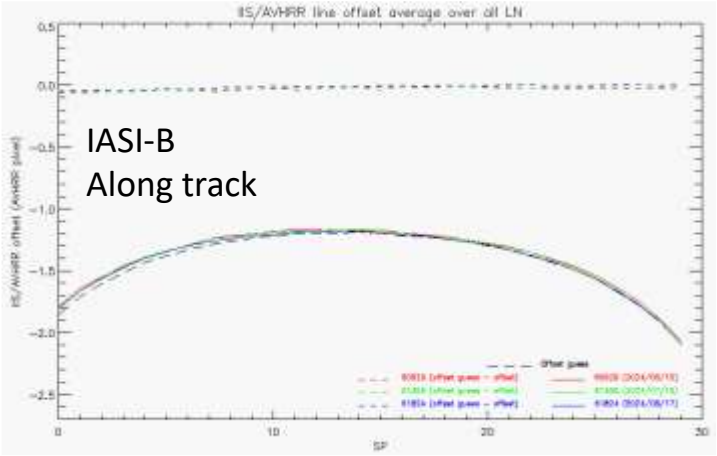
- IASI is equipped with the IIS imager (64x64px).
- The radiometric performances of IIS are routinely monitored at the IASI TEC (stable increase of about 2mK per year).
- 5 total dead pixels on IIS-B, 2 on IIS-C.

- Geolocation is provided by the AVHRR instruments, so IIS mainly serves in order to translate between the IASI and AVHRR reference frames.
- IASI-IIS coregistration is tuned during Cal/Val and is then very stable because mechanically linked (verified annualy).
- IIS-AVHRR coregistration is computed in real time by L1 processing by correlating images over the same area, ensuring a permanent good reference frame alignment.

IASI-B







IASI INTERCOMPARISONS

IASI INTERCOMPARISONS

PRINCIPLES

- Independent monitoring of IASI radiometric and spectral calibration.
- Ensure the consistency of IASI calibration with the TIR sensors community (GSICS group).
- Check of the long term data quality.
- Principles:
  - Statistics on a very large dataset to detect calibration biases.
  - Observations in normal operations (IASI L1C).
  - No correction of spectra by simulation.

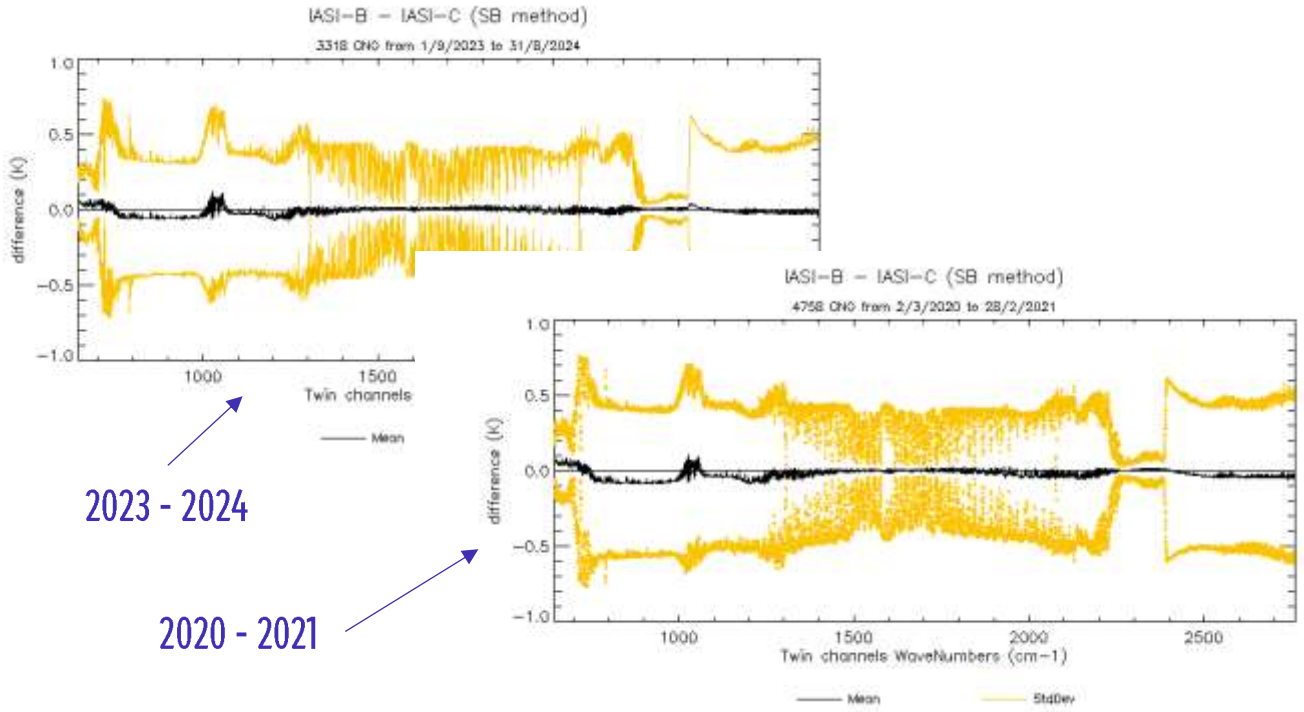
- Between IASI:
  - Only Common Nadir Observation between 2 consecutive tracks for IASI couple: temporal shift of 50min
  - Off-Nadir : from 0° to 39° opposite angles.
  - Homogeneous scenes

- Between IASI and CrIS:
  - Simultaneous observations (20min temporal shift allowed).
  - Homogeneous scenes

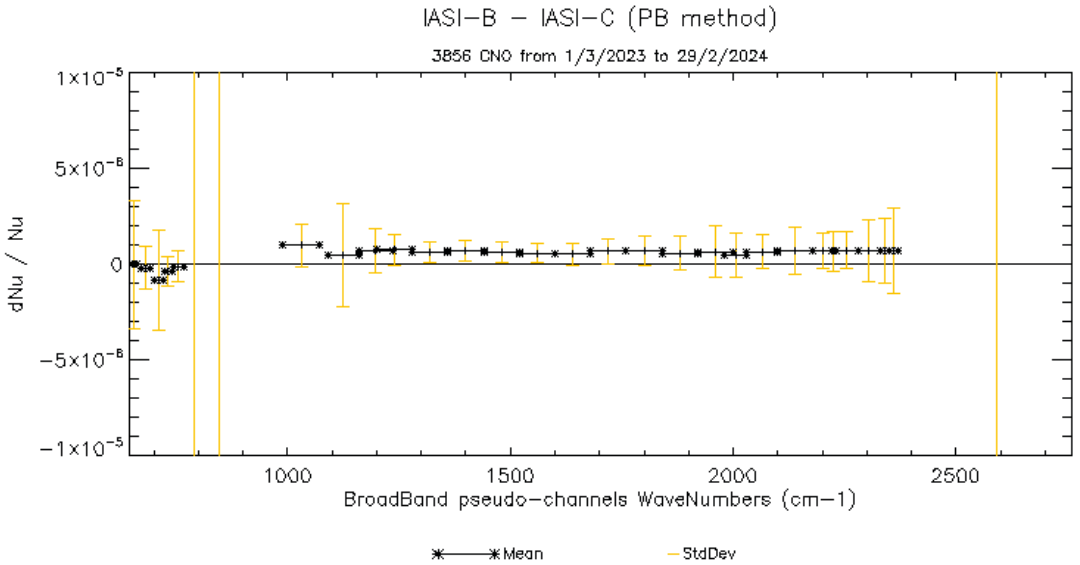
IASI INTERCOMPARISONS

IASI-B VS IASI-C

- Radiometric bias ≤ ±0.1 K
- Remarkably stable, ensures mission continuity.



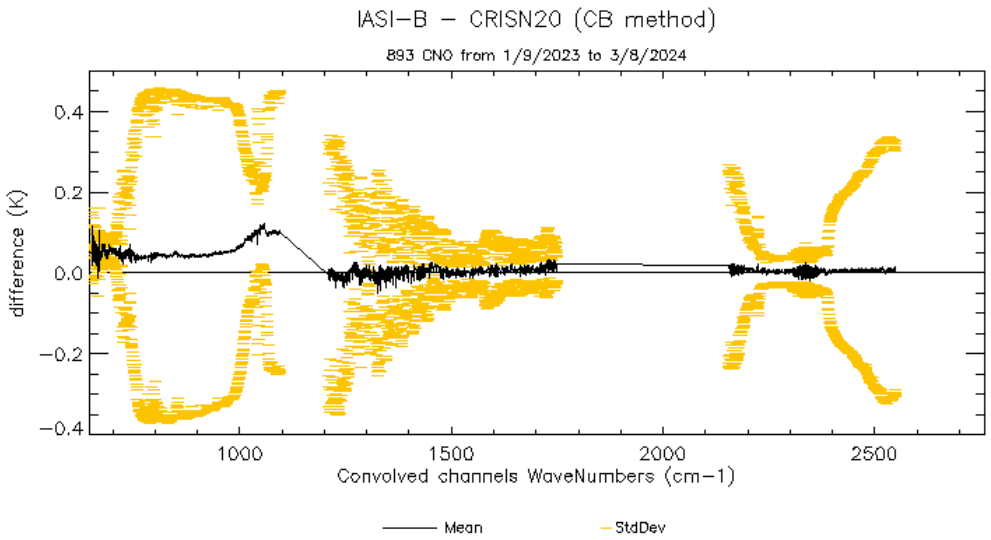
- Spectral intercomparison also stable.
- Bias within ± 1ppm (requirement 2ppm).



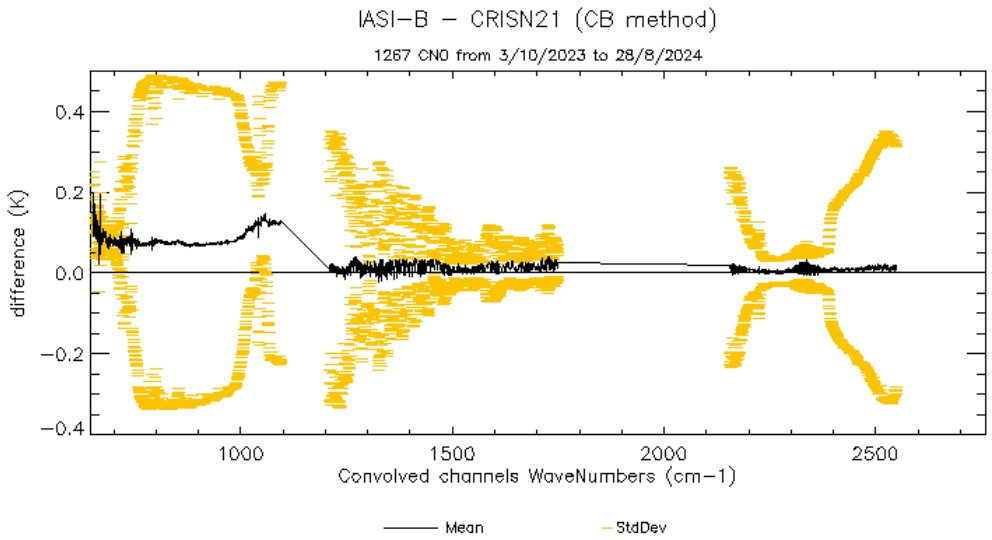
IASI INTERCOMPARISONS

IASI VS CRIS-N20 AND CRIS-N21

- Maximal biases:
  - < 0.1 K between IASI-B and CrIS-N20/N21
  - < 0.05 K between IASI-C and CrIS-N20/N21



- Consistently stable intercomparison results.
- Slightly higher bias in the beginning of IASI B1 when comparing to N21.



CONCLUSIONS

- Both IASI instruments in operation today are functioning nominally and within specifications.
- IASI performances continue to be remarkably stable, providing high-quality and longterm data to users and the scientific community.
- The performances are permanently monitored at IASI TEC. Routine operations are regularly carried out by CNES and EUMETSAT teams to ensure the instrument good health and performances.
- This makes IASI a reference instrument in its domain.
- Next milestones:
  - Tandem flight between IASI-C and IASI-NG
  - Then the end-of-life of IASI-B