Radiometric inter-comparison of IASI : IASI-A / IASI-B, IASI / AIRS, IASI / CrIS

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OUTLINE

- Introduction / objectives
- IASI / AIRS, IASI / CrIS: Methodology and results
- IASI-A / IASI-B: Methodology and results
- Conclusions

Introduction

- **Objectives of the radiometric inter-comparison**
  - For the IASI TEC: External monitoring of the IASI calibration
    - » Participation to the IASI-B in-flight commissioning
  - For the users (GSICS):
    - » To ensure the consistency of the IASI calibration with the TIR sensors community
    - » Checks the long term data quality (climatology)

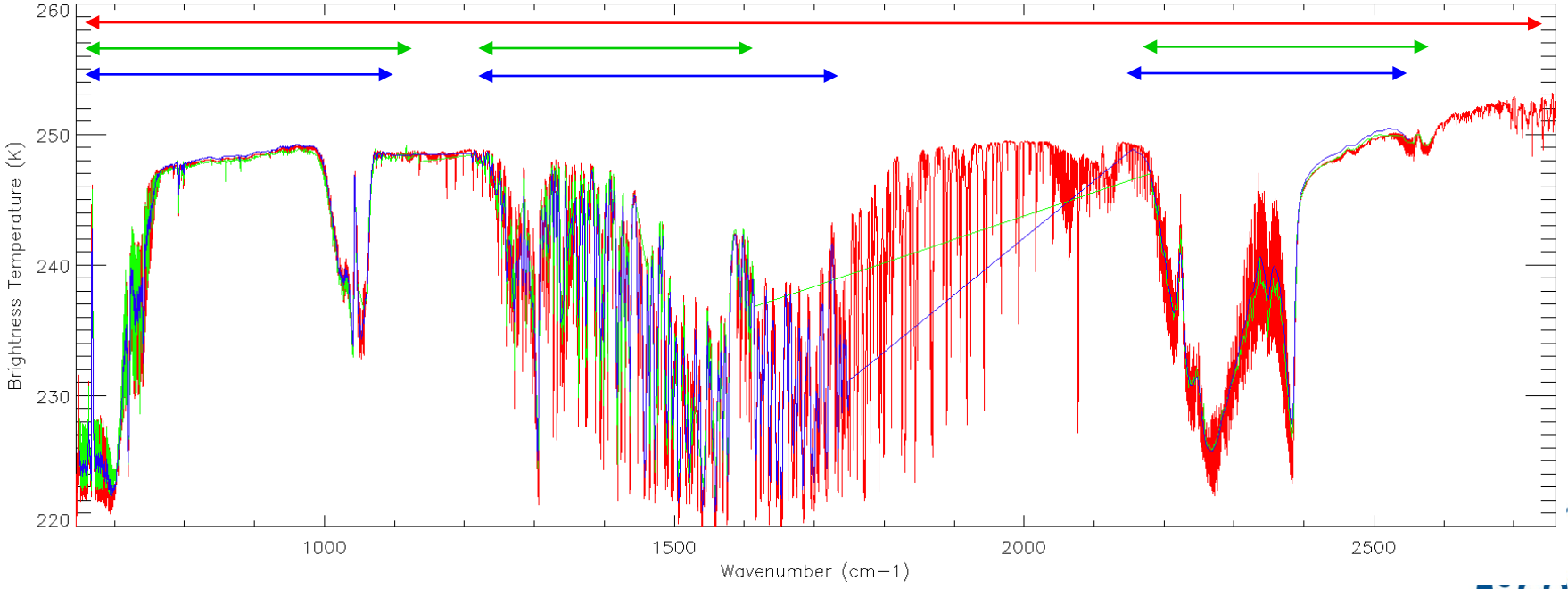
- **Principles:**
  - Statistics (biases) on a very large dataset
  - Work by couples :
    - » **IASI-A / AIRS, IASI-B / AIRS, IASI-A / CrIS, IASI-B / CrIS, IASI-A / IASI-B**
  - Observations in normal operations (IASI L1C)
  - Focus on same geophysical scenes observed by the two sensors (same place, same time, same viewing conditions)

    ➔ Check the calibration differences only
  - No correction of spectra by simulation

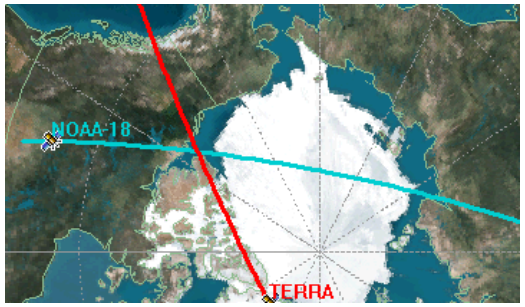
Reminder of AIRS, IASI, CrIS characteristics

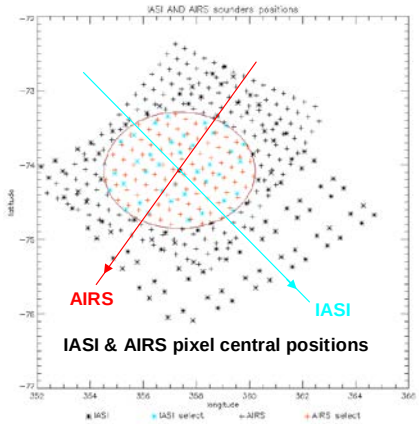
Instrument	**IASI-A**	**IASI-B**	**AIRS**	**CRIS**
Satellite	Metop-A	Metop-B	Aqua	NPP
Launch date	2006	2012	2002	2011
Local time	21h30		13h30	
Techno	FTS		Grating	FTS
Spatial resolution (nadir)	12 km		14 km	
Spectral range	645 – 2760 cm^{-1} / 3.62 – 15.5 µm			
Number of channels	8461		2378	1305
Spectral coverage	Continuous		Partial	
Spectral resolution	0.5 cm^{-1}		0.4 – 2.1 cm^{-1}	0.625 – 2.5 cm^{-1}

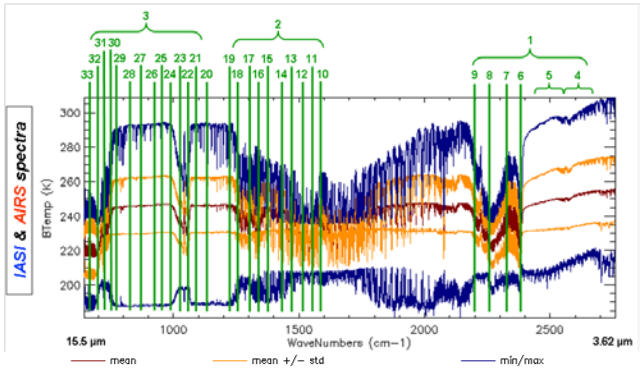
Typical IASI, AIRS and CRIS spectra



Methodology for IASI / AIRS, IASI / CrIS







- **Similar scenes: SNOs** (Simultaneous Nadir Overpasses)
  - Tolerance in simultaneity : 20 min
  - ~30 scenes every 3 days for IASI / AIRS (12000 in 5 years)
  - Always at high latitudes

- **Spatial match:**

  No collocation, differences in spatial sampling

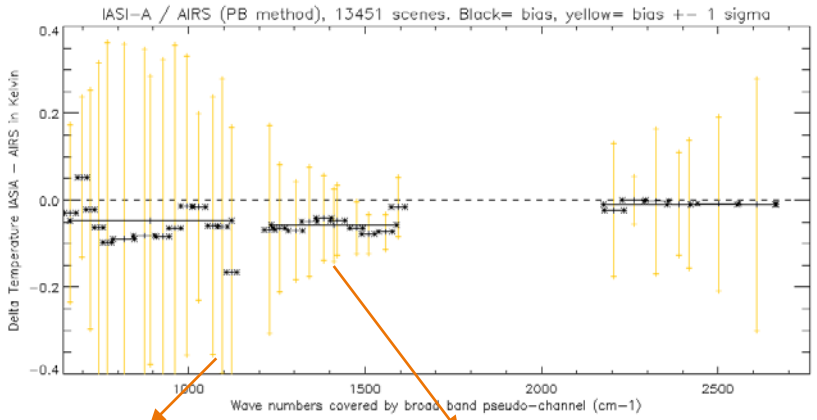
  ➔Regional averaging of the soundings pixels over a 300 km × 300 km area around the orbit crossing point

- **Spectral match:**

  Differences in spectral resolution and sampling
  - Construction of 33 broad pseudo-bands, each PB ~100 elementary channels averaged
  - The AIRS missing channels are considered when calculating the IASI coefficients

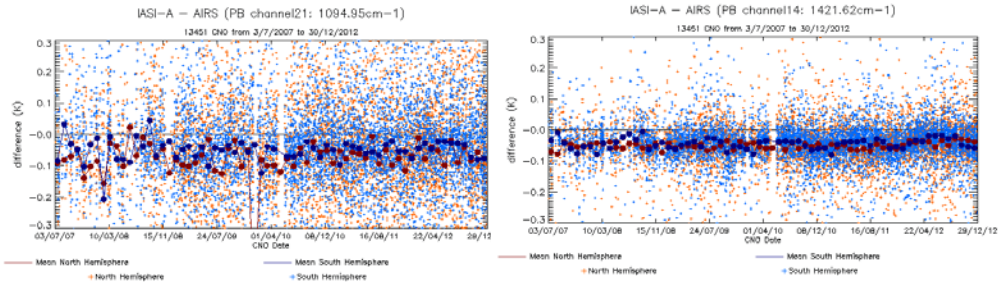
- **For each pseudo-band,** $\Delta T = \left(L_{IASI} - L_{AIRS}\right) \Big/ \frac{\partial L_\sigma}{\partial T}(\sigma, 280K)$

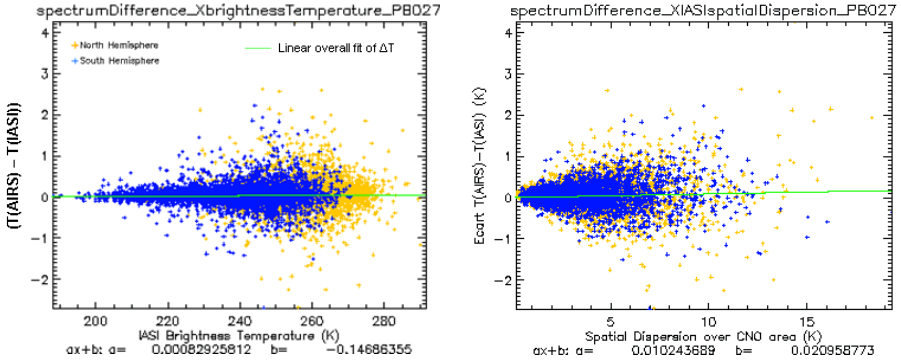
Long term IASI-A / AIRS inter-comparison



Surface pseudo-band

Atmosphere pseudo-band

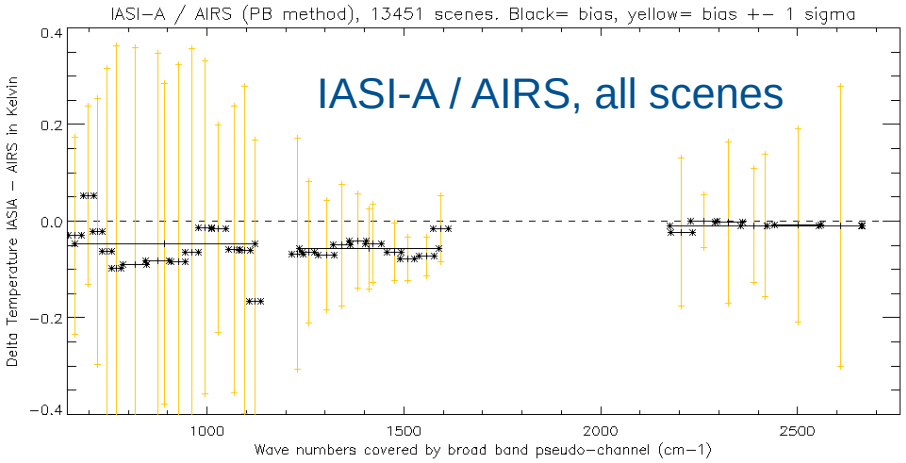


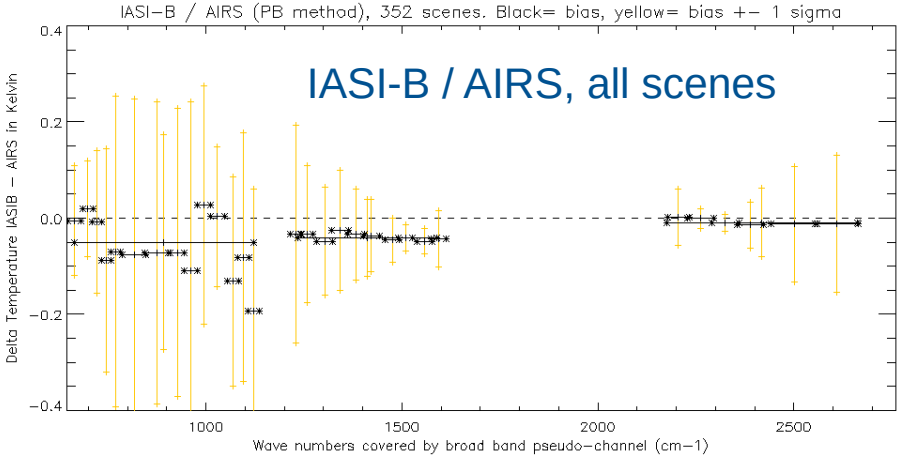


- **Bias and deviation over 5 years:**
  - AIRS & IASI radiometric calibrations are very close (|ΔT| < 0.1 K)
  - Largely < absolute radiometric calibration specification (0.5 K for each)
  - Small differences under investigation
- **Temporal monitoring**
  - IASI & AIRS are stable
  - No seasonal or inter-annual effect
- **Study of the correlation of ΔT with:**
  - Scene temperature (surface or atmosphere)
    - » Small trend: non-linearity in one instrument?
  - Scene temperature non-uniformity :
    - » Increase in dispersion
    - » Effect on input dataset
  - Etc.

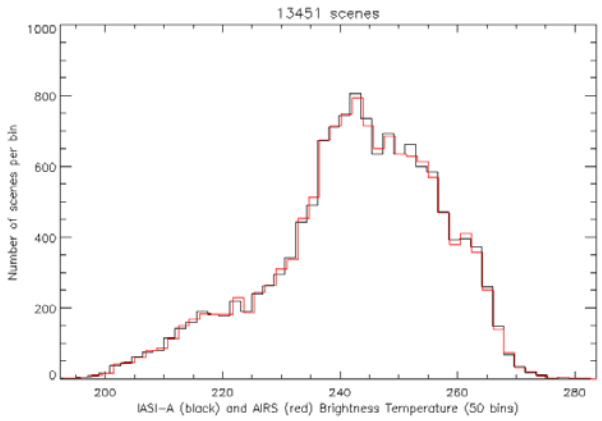
IASI-A / AIRS & IASI-B / AIRS inter-comparison

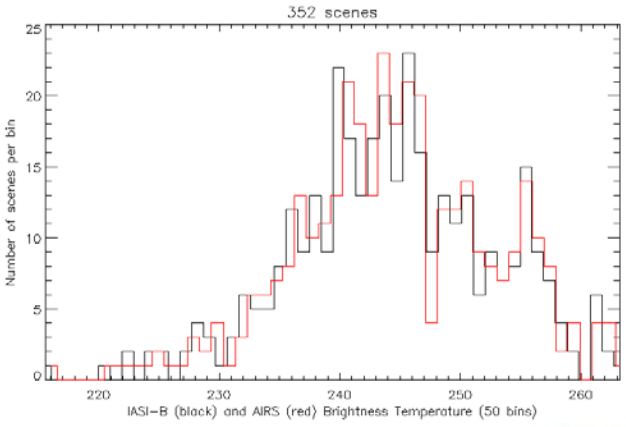
- Biases and standard deviations





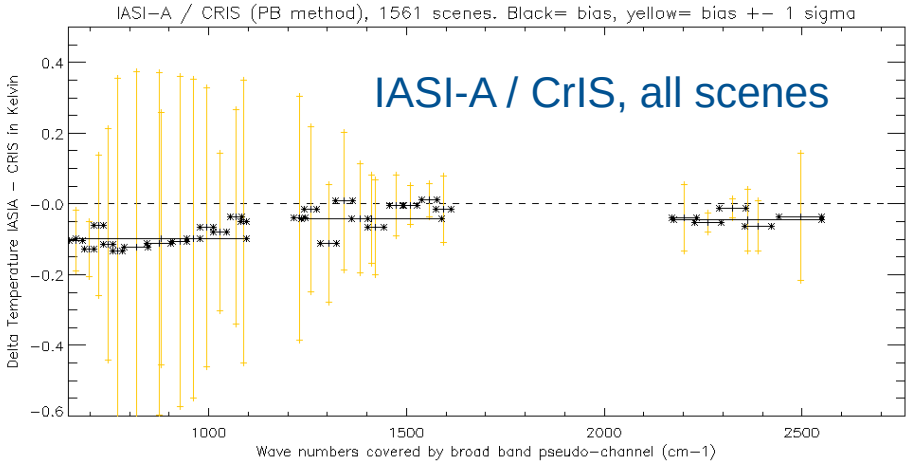
- Biases < ~0.1 K ➔ Very well cross calibrated
- Same patterns
- Similar datasets:

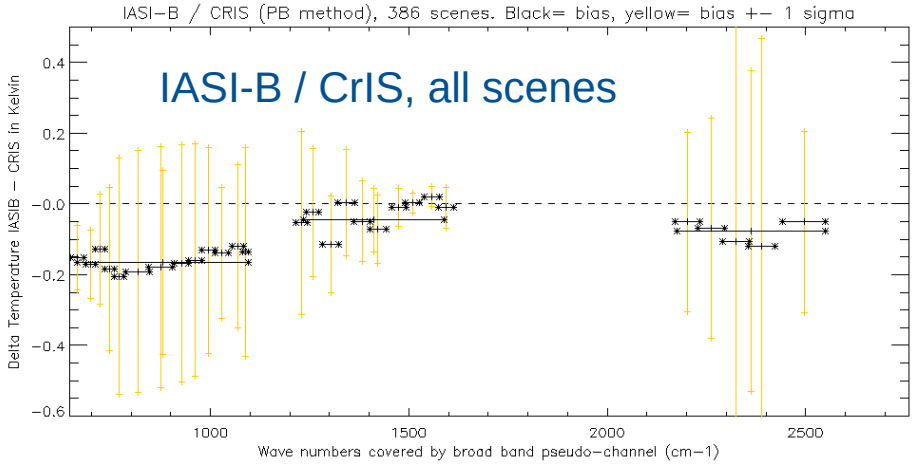




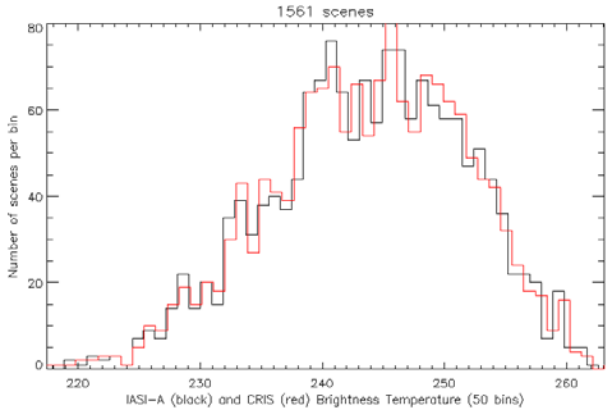
IASI-A / CrIS & IASI-B / CrIS inter-comparison

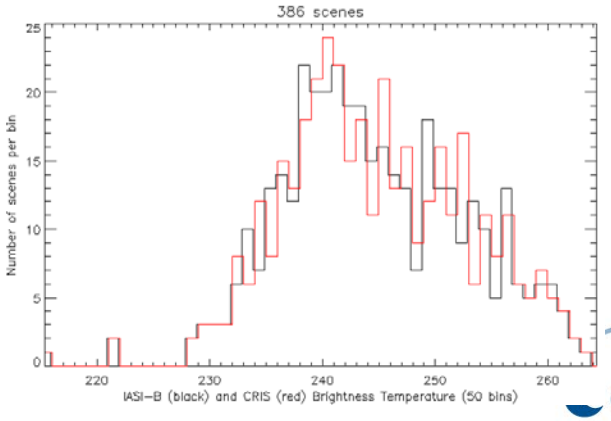
- Biases and standard deviations





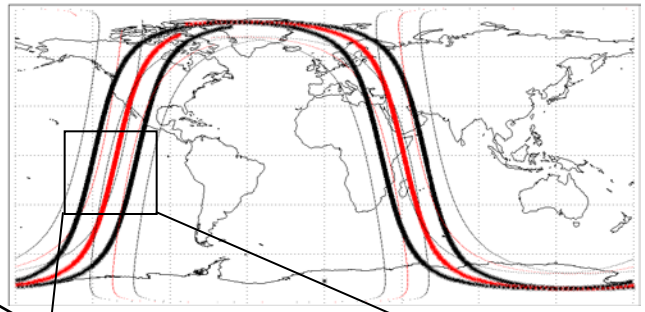
- Biases < ~0.2 K ➔ Very well cross calibrated
- Amount of data still to increase
- Similar datasets:

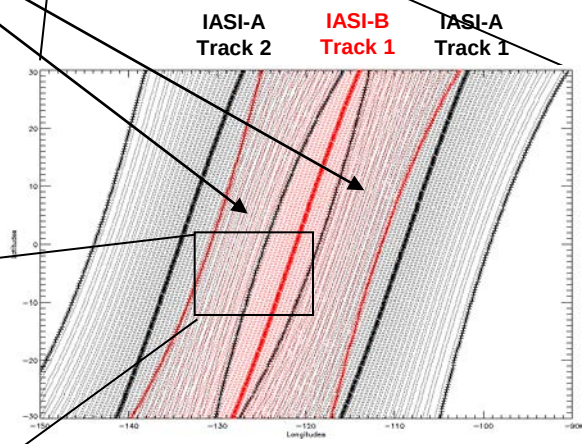




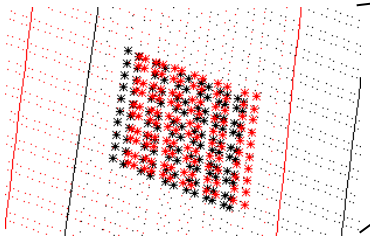
Methodology for direct IASI-A / IASI-B

- **Similar scenes:**
  IASI-A and B are on the same orbit with a 180° shift
  ➔ Numerous common observations between 2 consecutive tracks, but:
  - » never simultaneous: ~50 min temporal shift
  - » off-nadir: from 0° to 39°, opposite angles



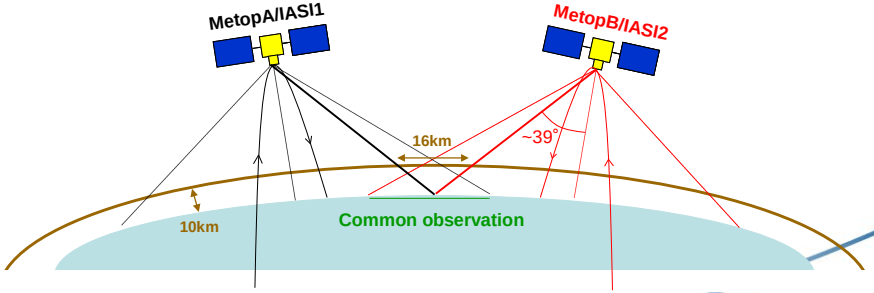


- **Selection on the most relevant scenes**
  - ✦ Dedicated tool (next slide)
  - ✦ 20 scenes per day in routine



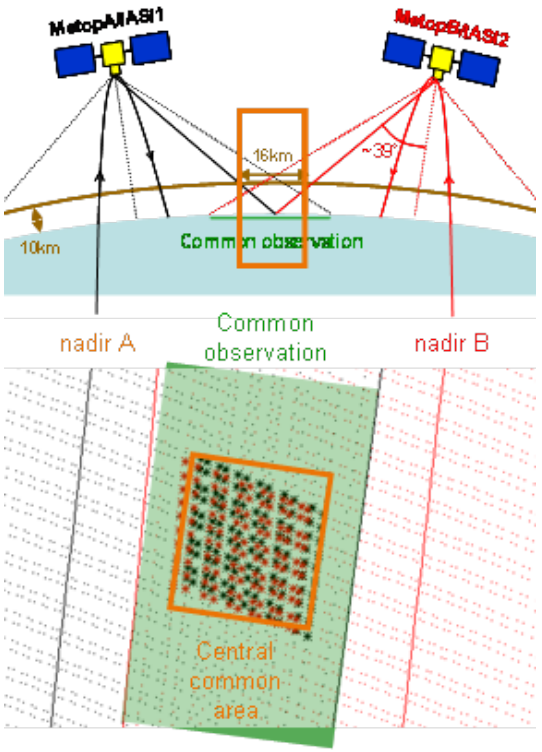
- **Spatial match:**
  - ✦ Regional averaging of the soundings (area 300 × 300km or less)

- **Spectral match:**
  - ✦ ΔT calculated at
    - » Elementary channel level
    - » Broad pseudo-band level (same as IASI/AIRS or IASI/CrIS)

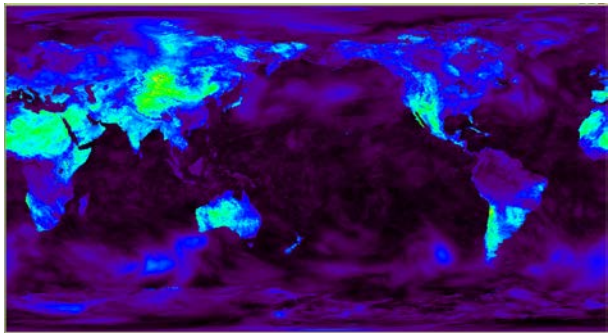


IASI-A / IASI-B : selection of scenes

- **Selection aims at reducing the effects of :**
  - **Off-nadir geometry** = The lines of sight A & B are always different
    - » Focus on the central area ➔ same atmospheric thickness
    - » Need for homogeneous atmospheres (typical size ~16 km)
  - **50 min time delay**
    - » Need for stable scenes
    - » Need for homogeneous atmospheres (same atmosphere even if moving)



- **Selection tool computes a quality index**
  - Based on external data
  - **Homogeneous scenes:**
    - » Low inter-pixel and intra-pixel variance of the IIS for A & B
    - » Clouds & snow: none or full in A & B
  - **Stable scenes:**
    - » Focus on oceans at night
    - » Low differences in IIS A & B temperatures
    - » Clouds & snow: same amount between A & B
    - » Low variations in ECMWF profiles (“geophysical NeDT”)

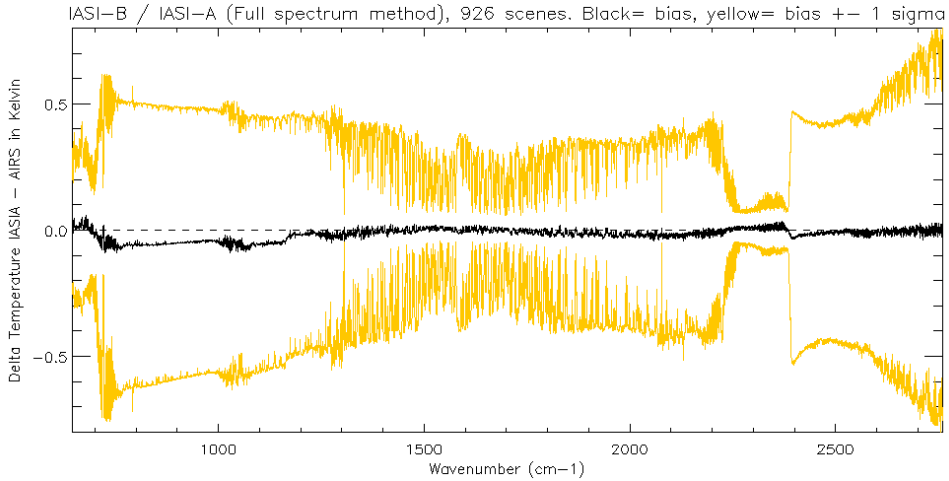


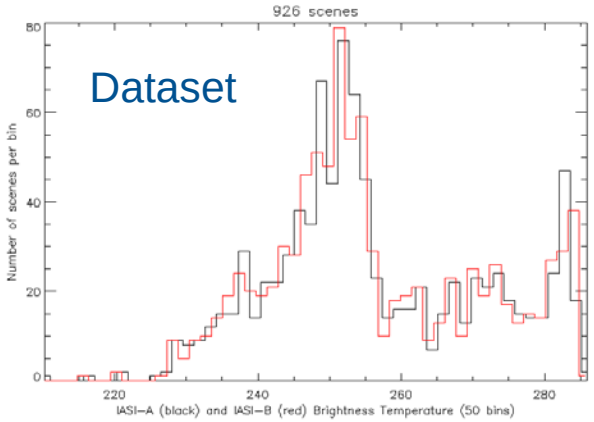
“Geophysical” daily NeDT

0.74 K **19.92 K**

Direct IASI-A / IASI-B inter-comparison

- Biases over a relevant dataset (homogeneous and stable scenes, night)

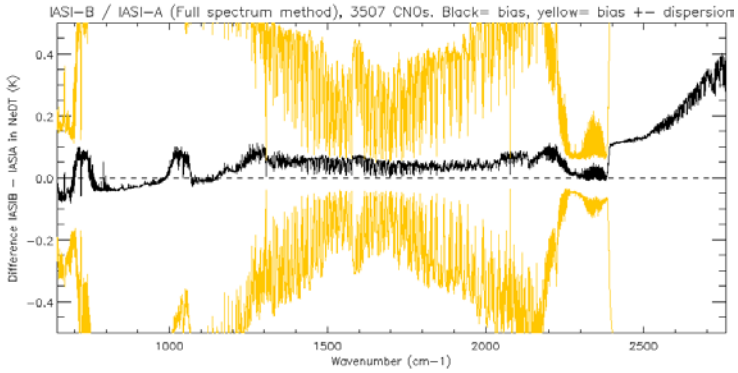


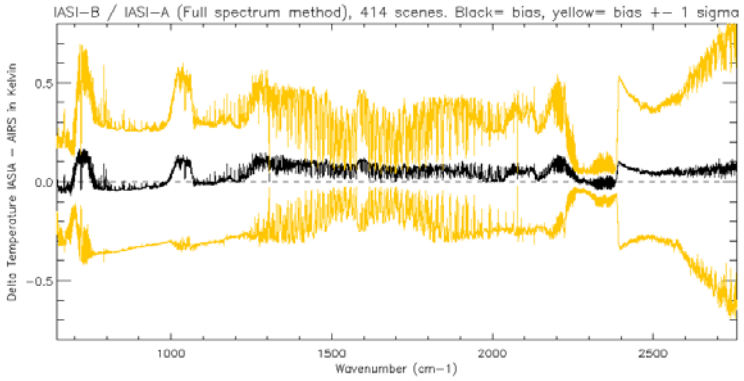


- Biases < ~0.1 K ➔ Very well cross calibrated
- Standard deviations mainly due to geophysics
- Impact of the dataset selection:

More stringent quality index, but
75% delay A/B > 0
25% delay A/B < 0

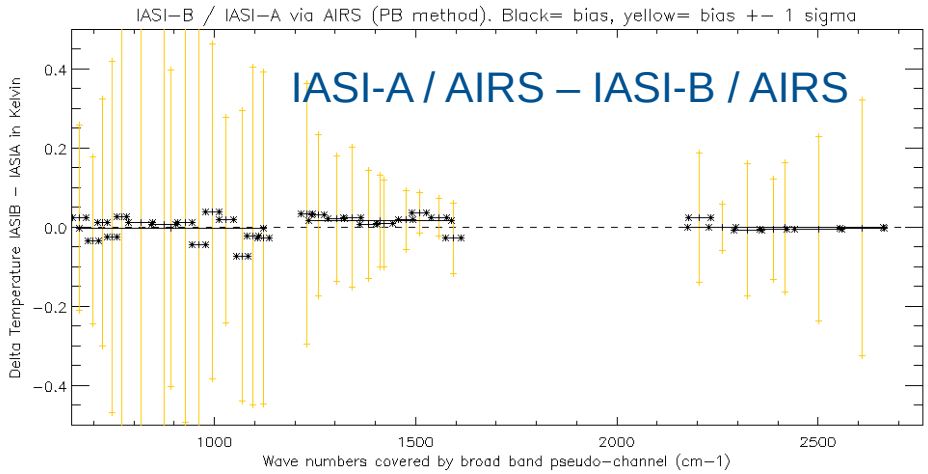
With diurnal data

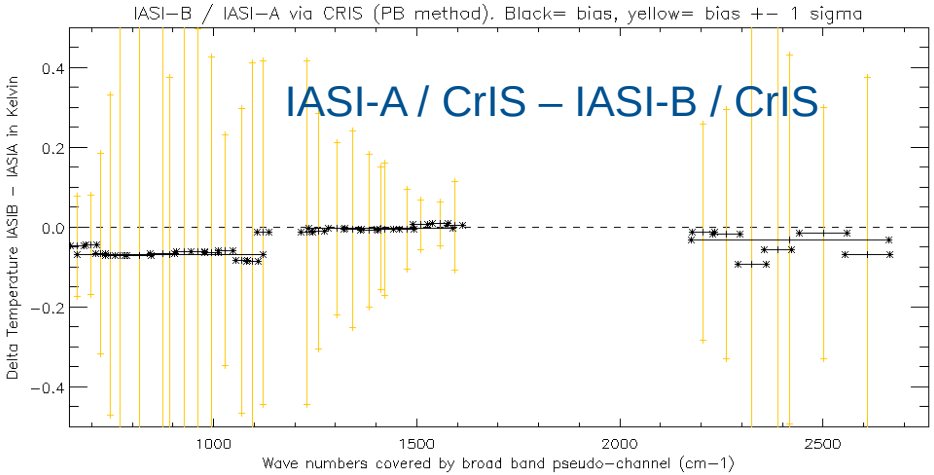




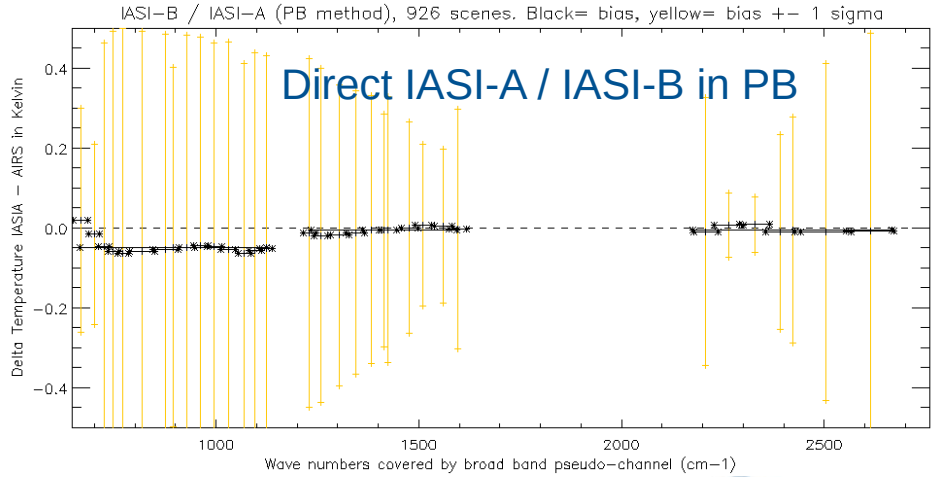
IASI-A / IASI-B through AIRS and CrIS

- Combination of IASI / AIRS and IASI / CrIS for IASI-A / IASI-B





- Biases < ~0.1 K ➔ Very well cross calibrated
- Confirmation of the direct comparison
- Effect on B1?
- Small differences: dataset selection?



CONCLUSIONS

- **The tool for inter-comparison is operational for the 5 couples of sensors:**
  IASI-A / AIRS, IASI-B / AIRS, IASI-A / CrIS, IASI-B / CrIS, IASI-A / IASI-B

- **Major result: very accurate cross-calibration!**
  - **Bias entre between 0 K and 0.2 K, < radiometric absolute specification of 0.5 K**
  - **IASI-B very close to IASI-A (bias ~0.1 K) ➔ continuity of the IASI mission**

- **Work on-going:**
  - **Increase the size and relevance of the dataset**
  - **Go further in the interpretation of small differences**
  - **Perform IASI / AIRS and IASI / CrIS at high spectral resolution**
  - **Perform a spectral inter-calibration?**

- **The tool should be operational for a long time (decades for climatic studies)**
  ➔ Inclusion of the future sensors (IASI-C, IASI-NG, etc.)