

IASI non-linearity correction : impact of the change on IASI-B

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GSICS web meeting

OUTLINE

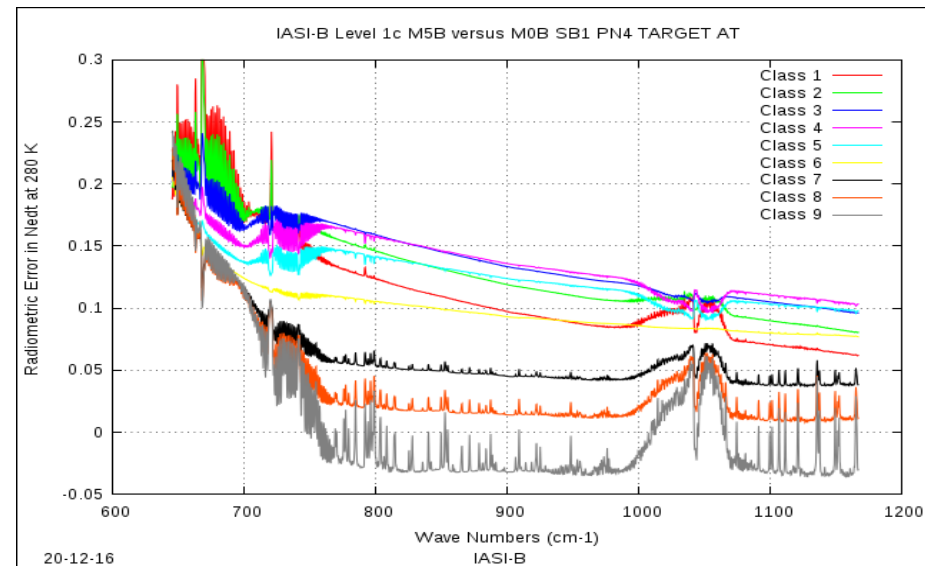
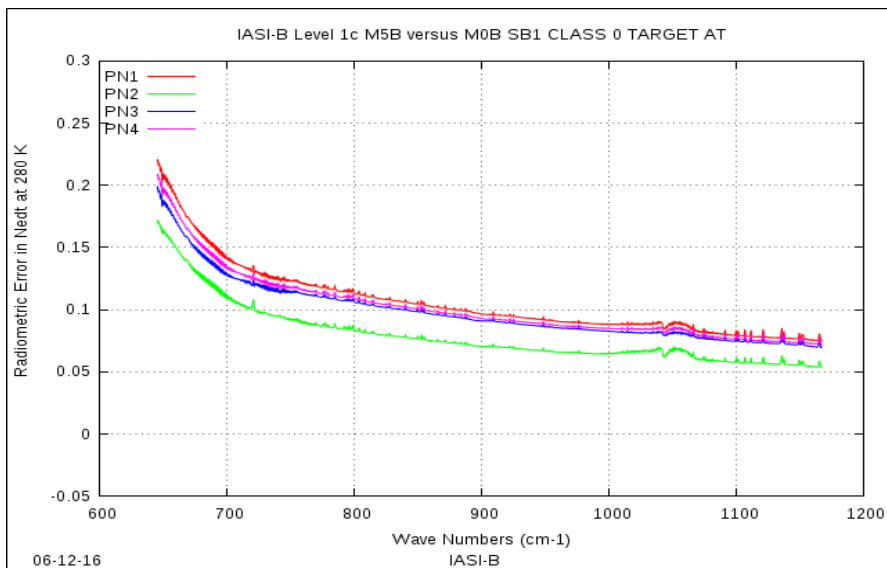
- 1 – IASI-B tables change
- 2 – IASI-B inter-comparison results
- 3 – On-going studies
- 4 – IASI-A status
- 5 – Conclusion
- 6 – ISSWG feedback

1 - IASI-B tables change

- New IASI-B non linearity correction tables were uploaded on **2nd August 2017** (PTSI 13).
- Expected differences wrt. the previous correction (new-old):

For a mean scene temperature of 263 K

For different scene temperatures



Error higher at the beginning of B1 and scene temperature dependent

- | | | |
|----------------|----------------|----------------|
| 1: < 220 K | 4: 240 – 250 K | 7: 270 – 280 K |
| 2: 220 – 230 K | 5: 250 – 260 K | 8: 280 – 290 K |
| 3: 230 – 240 K | 6: 260 – 270 K | 9: 290 – 300 K |

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2 – Recall of the 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 (CO) between 2 consecutive tracks, but:

- » never simultaneous: ~50min temporal shift
- » off-nadir: from 0° to 39°, opposite angles

- **Selection on the most relevant scenes**

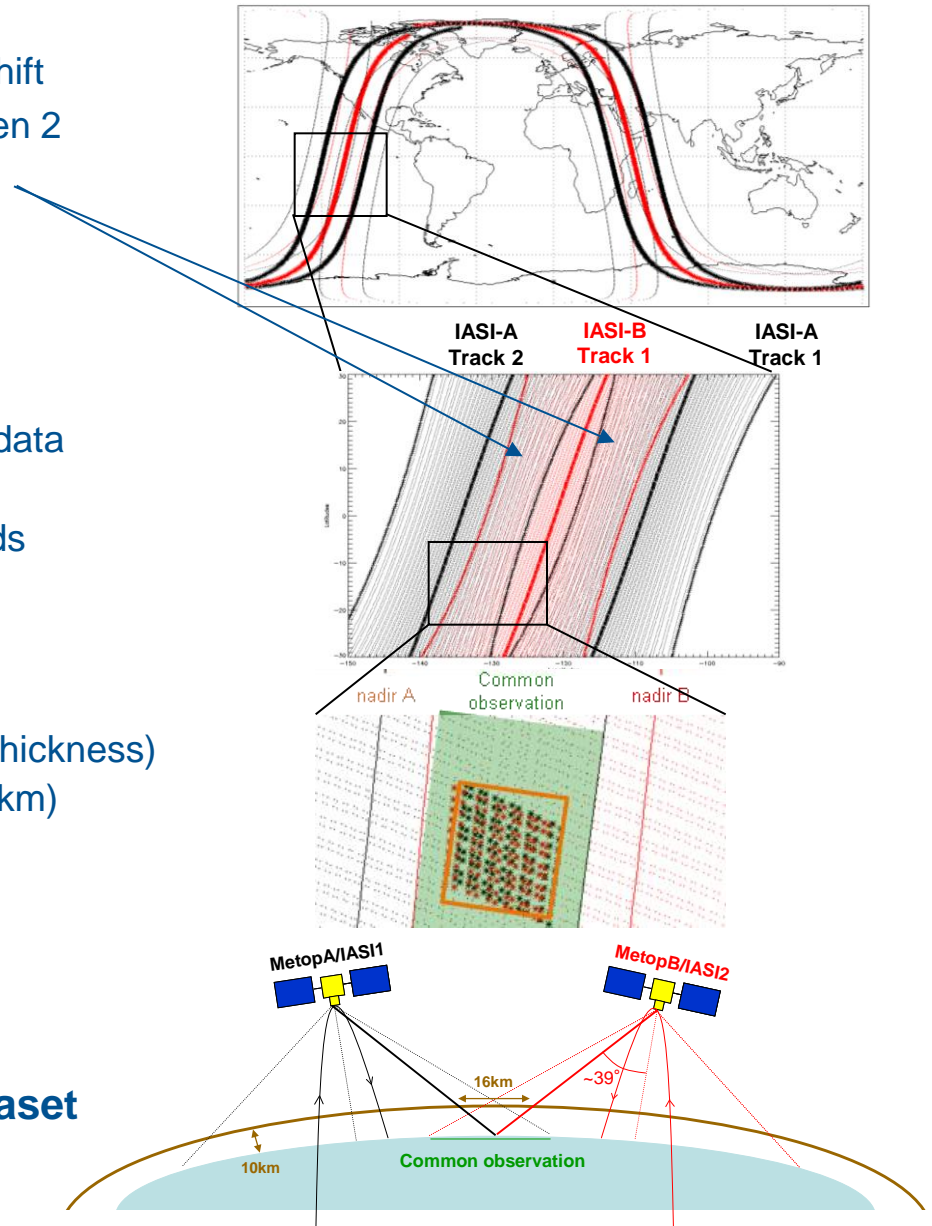
- ◆ Use of geoloc., geom., IIS, AVHRR, ECMWF data
- ◆ Focus on stable and homogeneous scenes
 - = Night, mostly oceans, 0% or 100% clouds
- ◆ Balance “A before B” and “A after B”

- **For each common observation**

- ◆ Focus on the central area (same atmospheric thickness)
- ◆ Regional averaging of the soundings (300*300km)
- ◆ ΔT calculated at elementary channel level

$$\Delta T = \frac{(L_{IASI-B} - L_{IASI-A})}{\frac{\partial L_{\sigma}}{\partial T}(\sigma, 280K)}$$

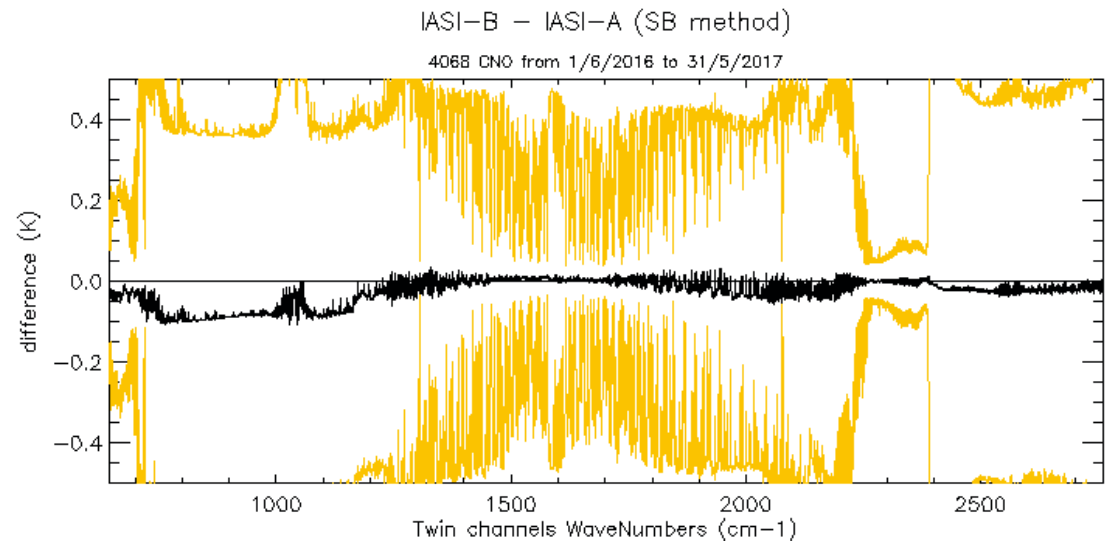
- **Mean and stdev computed over the dataset**



2 – IASI-A/IASI-B inter-comparison results

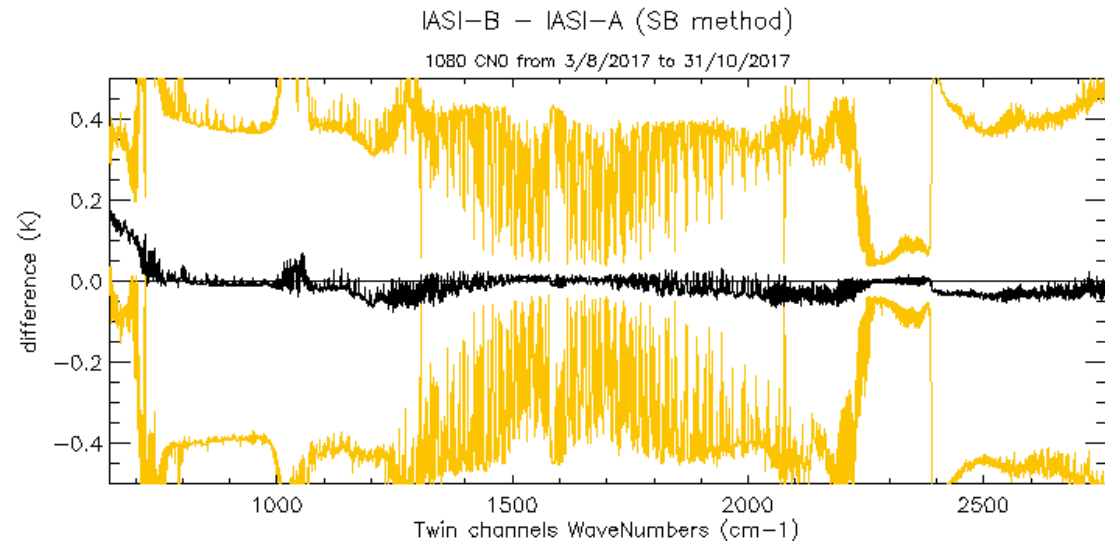
- IASI-B – IASI-A

Before the change of non linearity correction tables



- After the change

- Difference null ! Except in CO₂ and O₃ bands



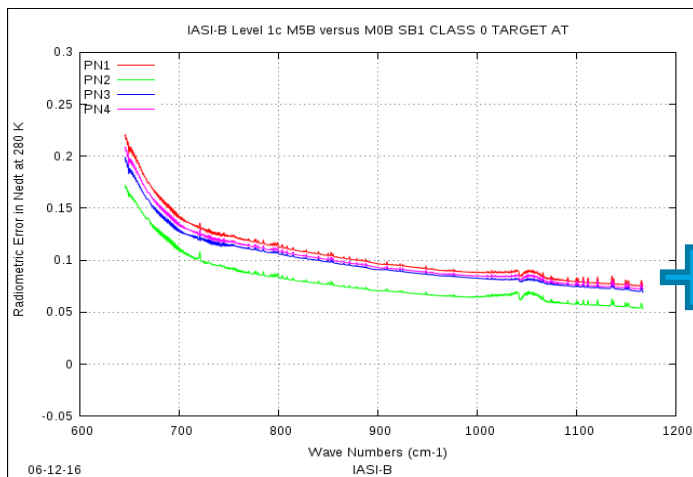
— Mean

— StdDev

2 – IASI-A/IASI-B inter-comparison results

IASI-B – IASI-A

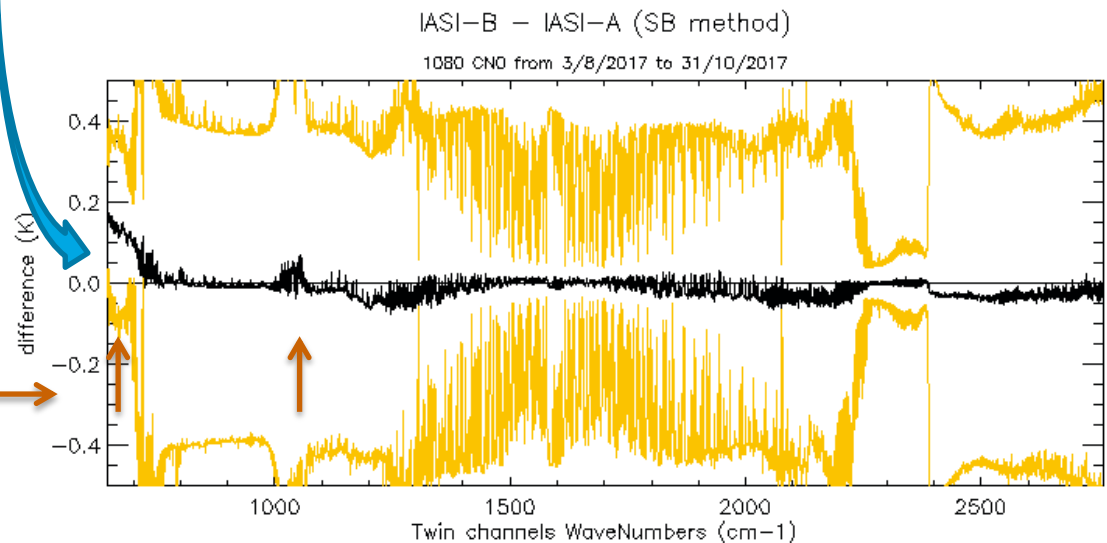
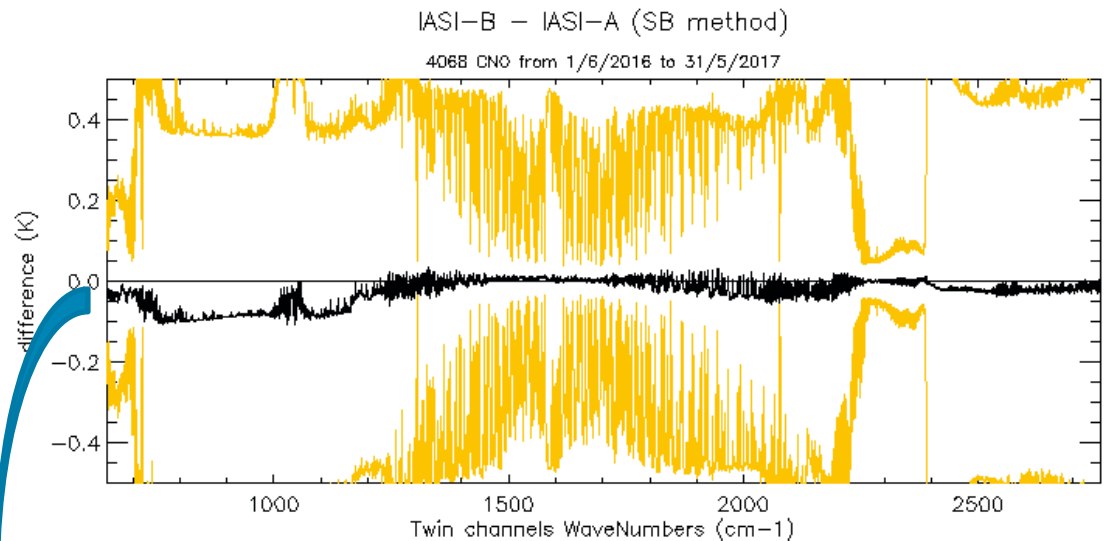
Before the change of non linearity correction tables



After the change

Difference null ! Except in CO₂ and O₃ bands

Hypotheses discussed in §3



— Mean

— StdDev

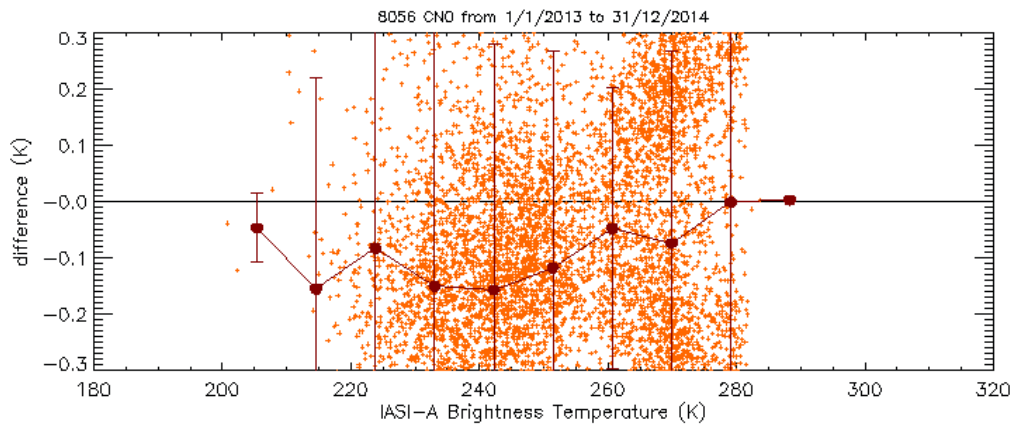
2 – IASI-A/IASI-B - Scene temperature dependence

- ✓ Classification of the bias with the **scene temperature**

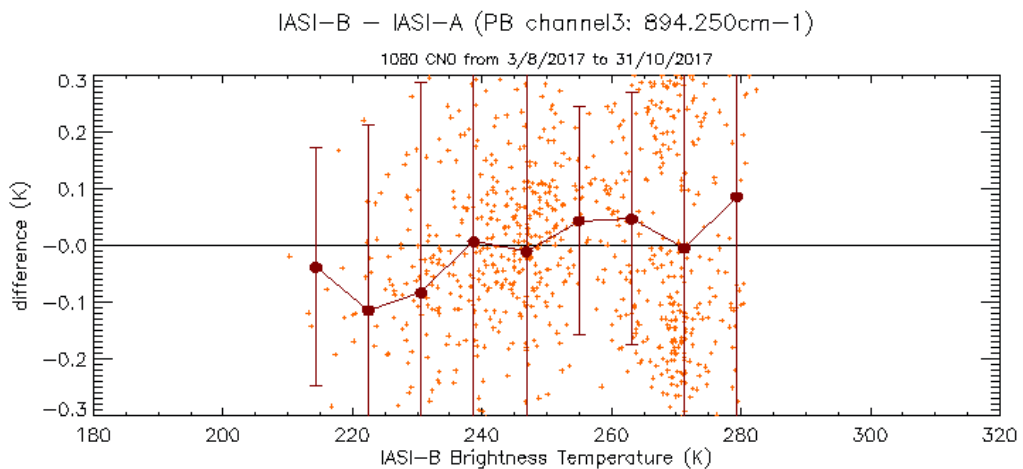
Plot of NedT vs BT (spectrally integrated in B1) + Sliding means

Amplitude -0.1K (cold scenes) to 0 (warm scenes, close to the black body target temperature (293 K))

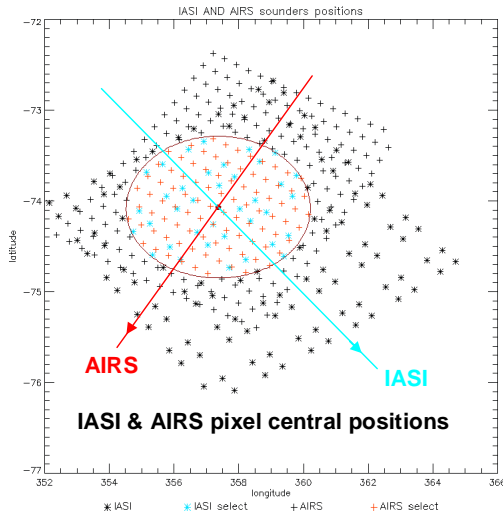
- Before the change of non linearity correction tables



- After the change
- **Dependence wrt scene temperature reduced** (curve flattened)
- Residuals maybe due to IASI-A non linearity



2 – Recall of the 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:**
 - ➔ Regional averaging of the soundings pixels over a 300km*300km area around the orbit crossing point

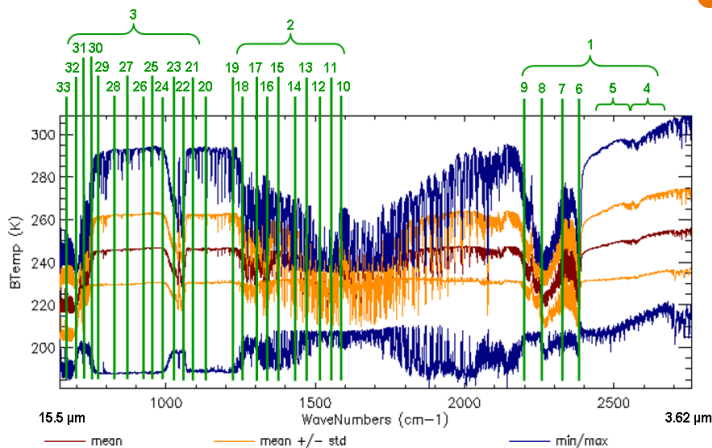
- **Spectral match:**

Construction of 33 broad pseudo-bands

- ◆ Each PB = intelligent averaging of ~100 elementary channels to get the similarity of the PB spectral functions
 - ◆ The AIRS missing channels and varying spectral resolution are considered when calculating the IASI coefficients
- NB: the convolution of IASI by the CRIS or AIRS SRFs has been performed but is still under exploitation

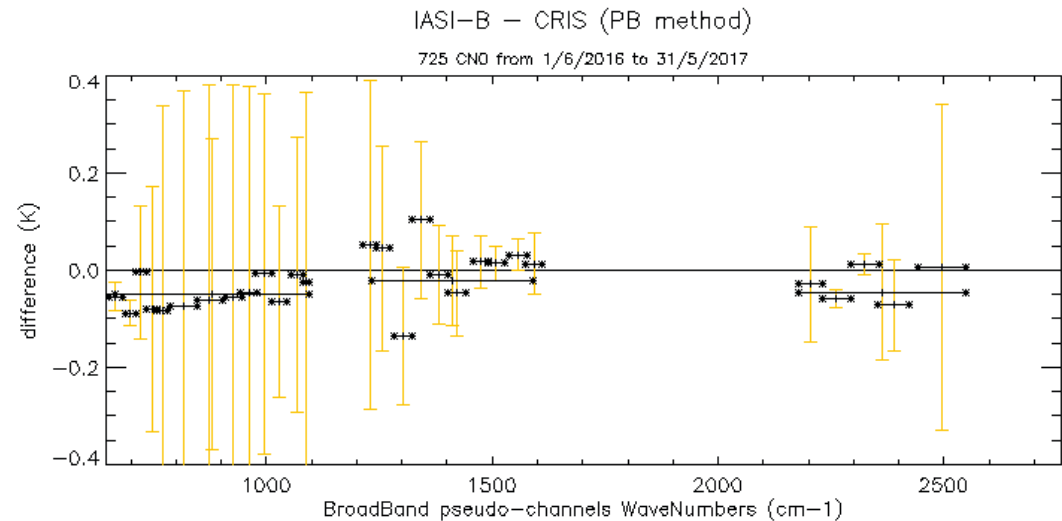
- **For each pseudo-band,**

$$\Delta T = \frac{(L_{IASI} - L_{AIRS})}{\frac{\partial L_{\sigma}}{\partial T}(\sigma, 280K)}$$

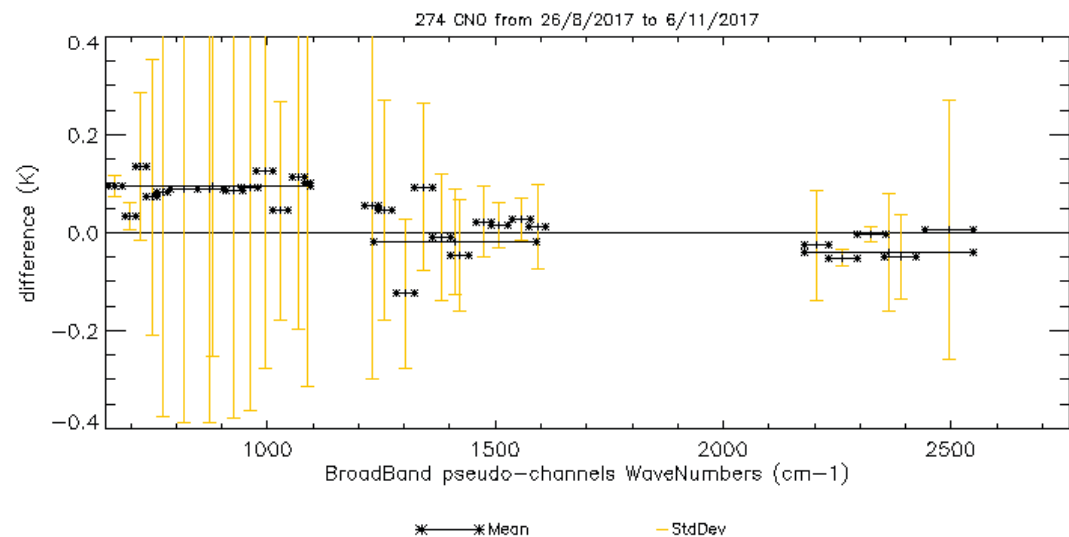


2 – IASI-B/CrIS inter-calibration results

- Before the change of non linearity correction tables

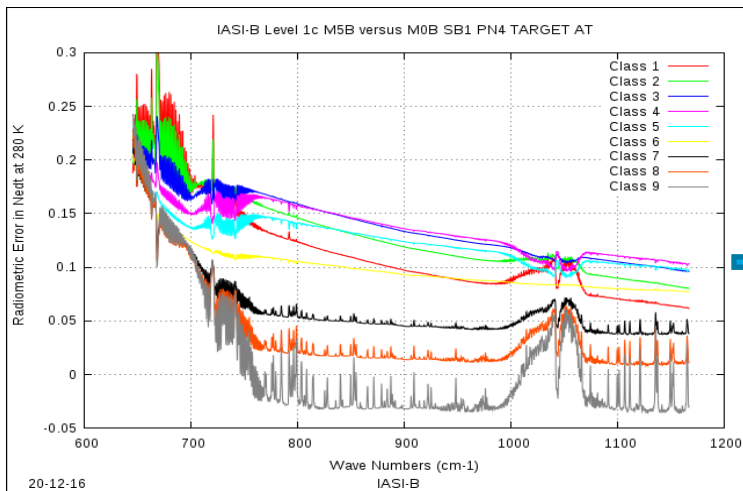


- After the change
- Offset of $\sim +0.15$ K
- Comparison is done on cold scenes (gaussian distribution around 245 K)
- Question: did IASI was used as a reference for CrIS non linearity correction ?



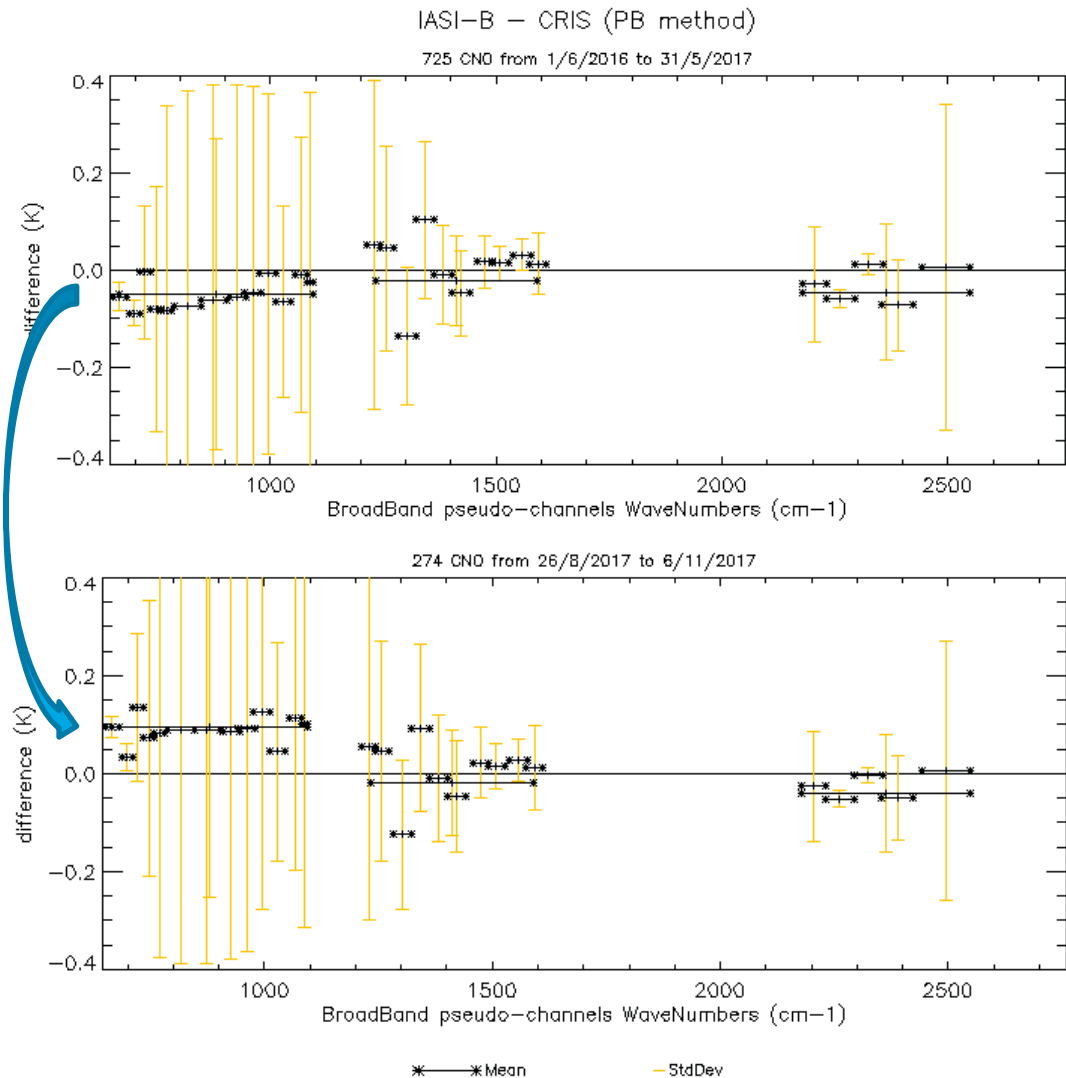
2 – IASI-B/CrIS inter-calibration results

- Before the change of non linearity correction tables



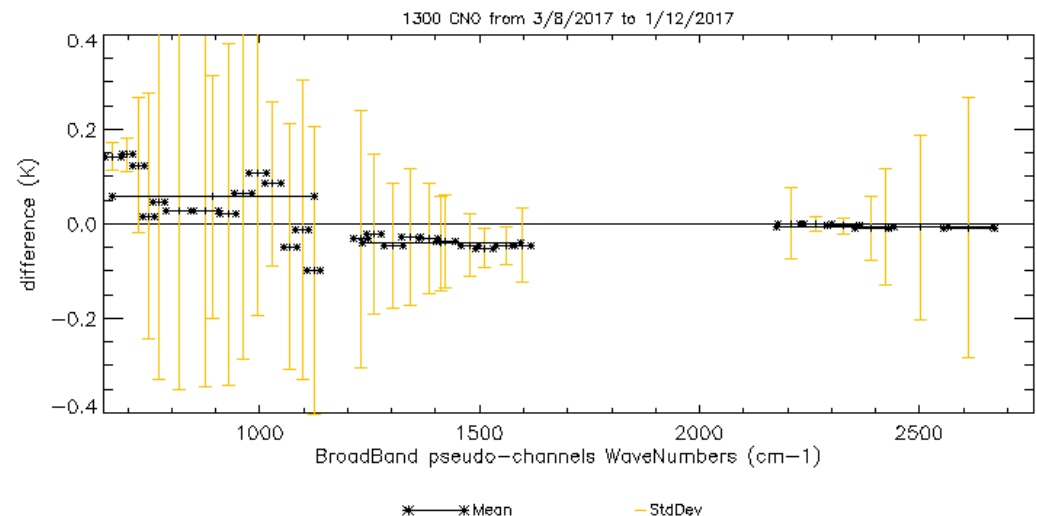
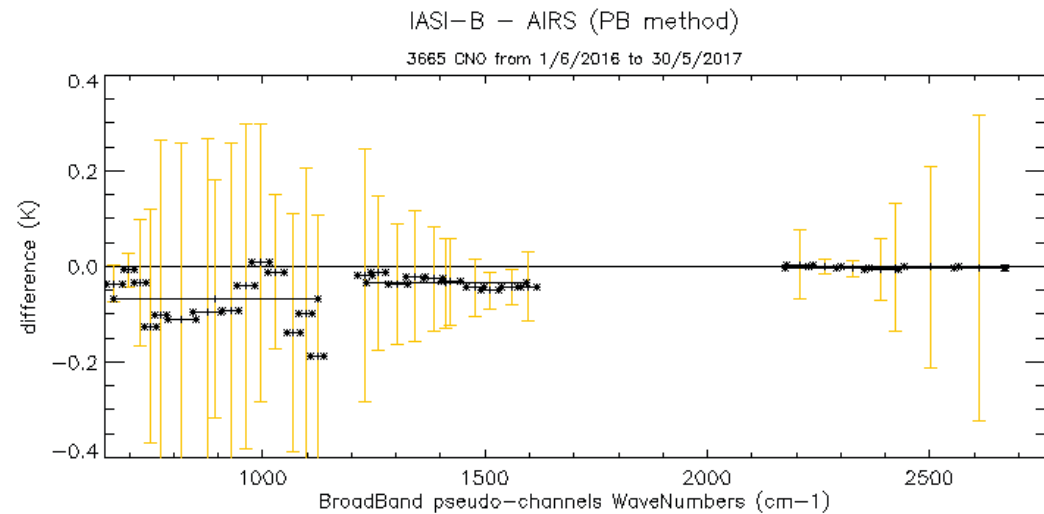
4: 240 – 250 K

- After the change
- Offset of $\sim + 0.15$ K
- Comparison is done on cold scenes (gaussian distribution around 245 K)



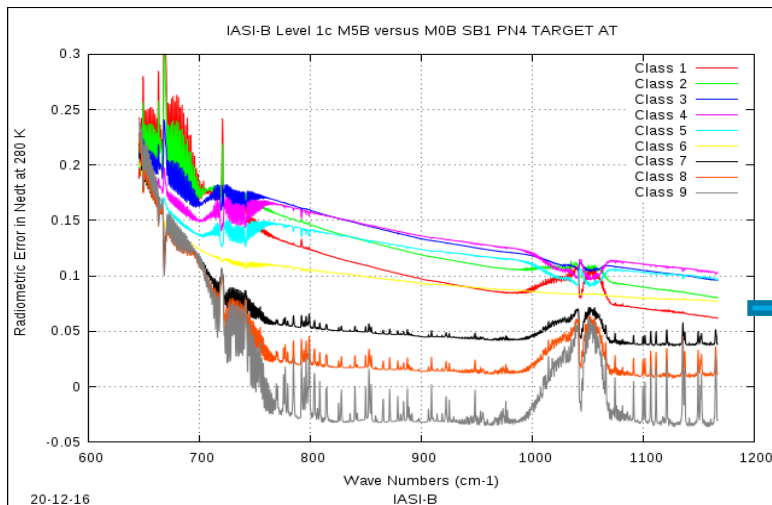
2 – IASI-B/AIRS inter-calibration results

- Before the change of non linearity correction tables
- After the change
- Offset of $\sim +0.15$ K
- Spectral signature close to IASI-A / IASI-B comparison
- Window channels closer to zero
- Comparison is done on cold scenes (gaussian distribution around 245 K)



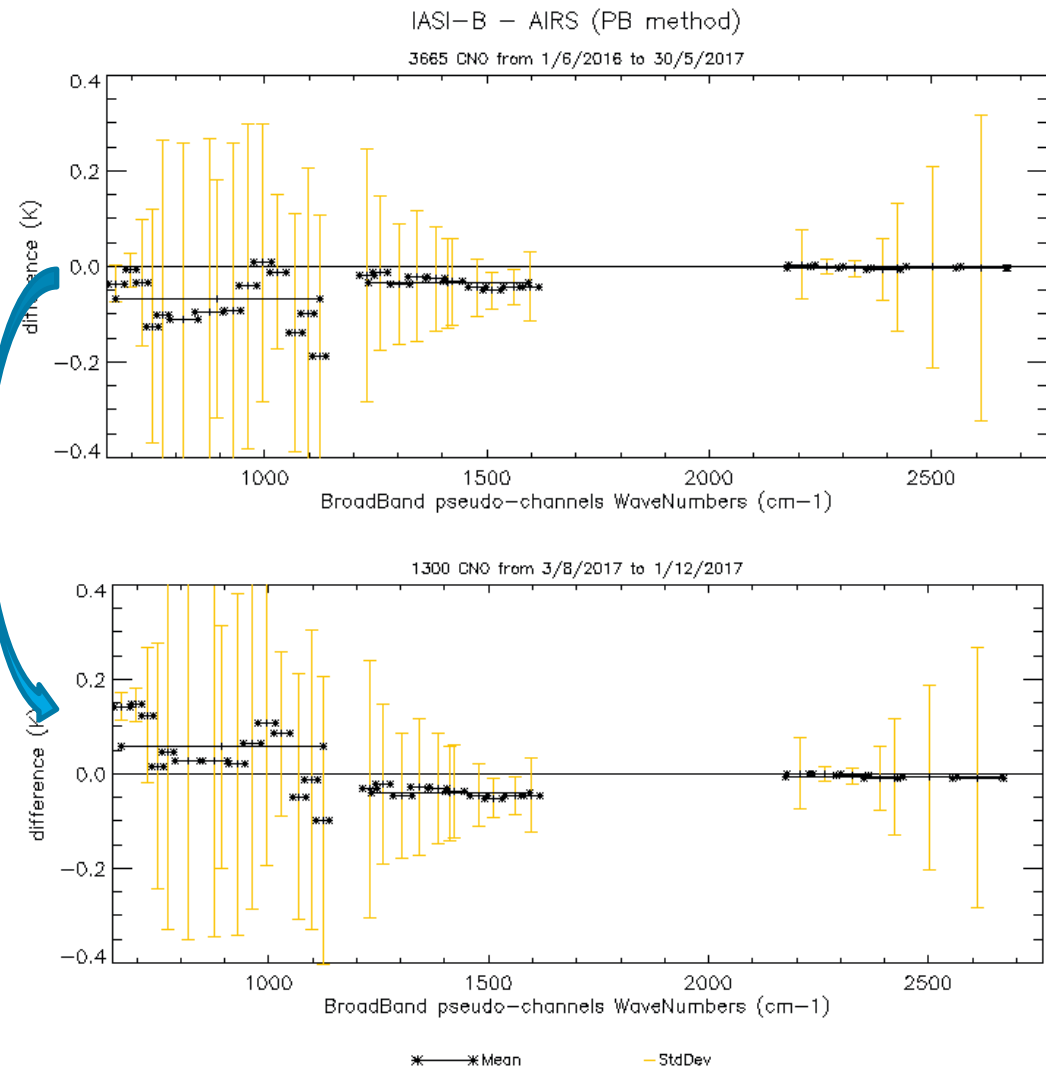
2 – IASI-B/AIRS inter-calibration results

- Before the change of non linearity correction tables



4: 240 – 250 K

- After the change
- Offset of $\sim + 0.15$ K
- Spectral signature close to IASI-A / IASI-B comparison
- Window channels closer to zero



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3 – On-going studies

- In order to document and understand all these comparisons, some assumptions are currently studied.

=> Understand why CO₂ and O₃ bands behavior is different from the rest of band 1 (already the case before the change).

IASI-A/IASI-B intercalibration results are on the night soundings (~21:30), with the number of soundings “IASI-A before IASI-B” equivalent with “IASI-A after IASI-B”.

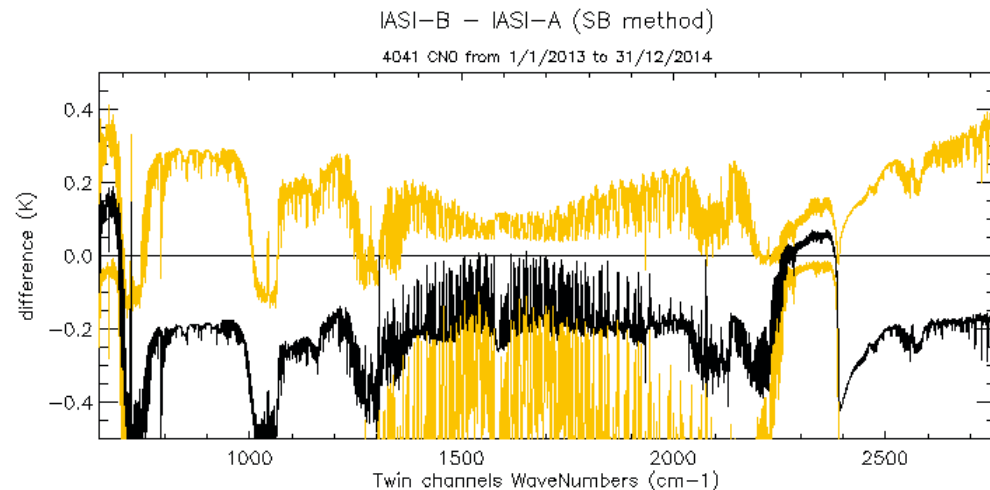
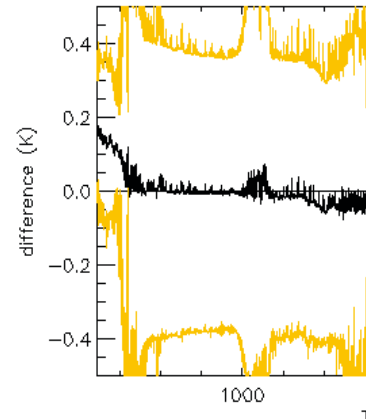
Effect of the time gap between IASI-A and IASI-B

In the case of the use of the soundings only with the case “IASI-A before IASI-B”, we had (before the change) this kind of bias:

Negative bias : IASI-A spectra, measured first, is warmer than IASI-B spectra.

Surface channels: the surface is getting colder (start of the night).

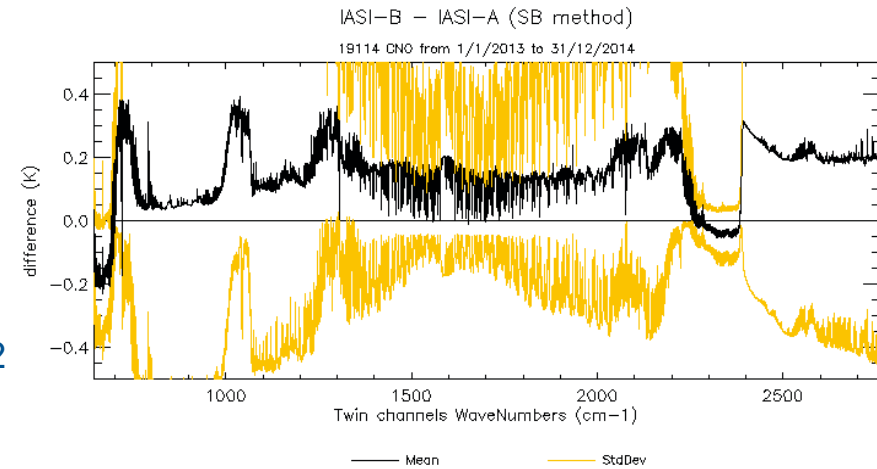
In CO₂ channels (stratosphere) in band 1 and 3: opposite effect: stratosphere is getting warmer.



3 – On-going studies

In the case of the use of the soundings only with the case “IASI-A after IASI-B”, we had this kind of bias
Positive bias : almost the opposite than in the case “IASI-A before IASI-B”, IASI-B spectra being acquired first.

- When we take into account an equal number of the 2 cases, we have the mean of these 2 curves.
- When we have a temporal difference of 50 minutes between the 2 IASI (on a 100 minutes orbit), the geophysical bias is canceled.
- But, in real life, the temporal difference between the 2 IASI is not exactly 50 minutes. When this delay increases, for example 55 minutes for “IASI-A before IASI-B”, and 45 minutes for “IASI-A after IASI-B”, the final inter-calibration curve shows the instrumental bias + the atmosphere variation in $55 - 45 = 10$ minutes.
- During ~10 minutes, do the stratosphere temperature evolves enough to lead to a spectrum variation of ~0,15 K in CO₂ band beginning of band 1, and around 0,05/0,1 K in O₃ band ? Or can it be due to concentration variations of these gases (ozone concentration linked with UV) ?



3 – On-going studies

- We are currently working on the following axis:
 - Study of the time delay of “IASI-A before IASI-B” and “IASI-A after IASI-B”, that is evolving due to the MetOp-A orbit drift.
 - Study of the scenes used for CO and SNO: lat/lon distribution and evolution of the stratosphere temperature in these areas, mean temperature of these scenes.
 - Study of IASI-A/IASI-B inter-calibration using massive means.

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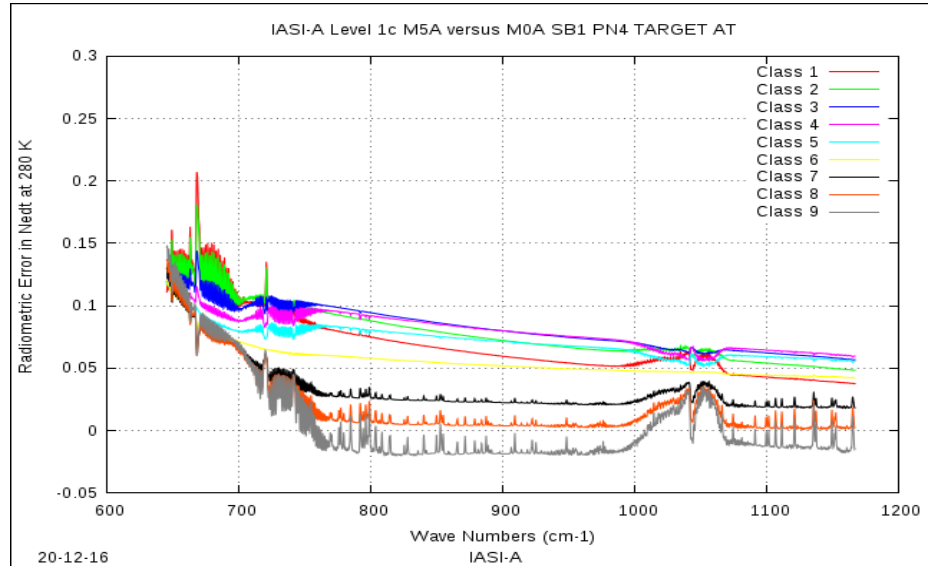
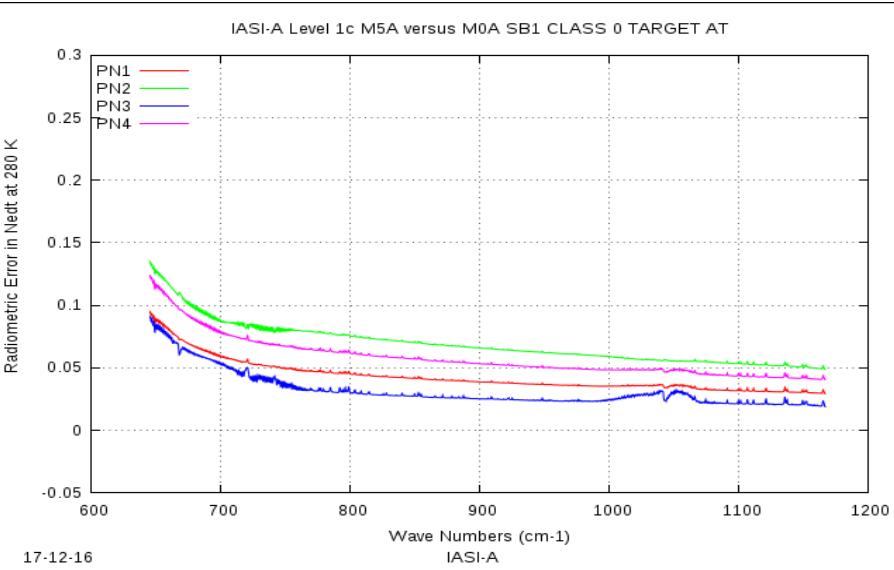
4 – IASI-A status

- For IASI-A, the update of non linearity tables was proposed for February 2019 (6 months later than IASI-B)

The mean radiometric error between proposed new NL correction and the operational one, expressed in NedT @ 280 K, for all the pixels

For a mean scene temperature of 263 K

For different scene temperatures

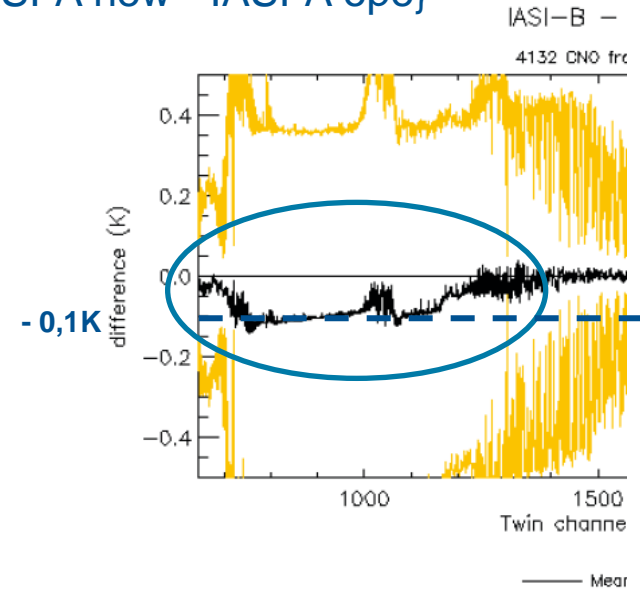
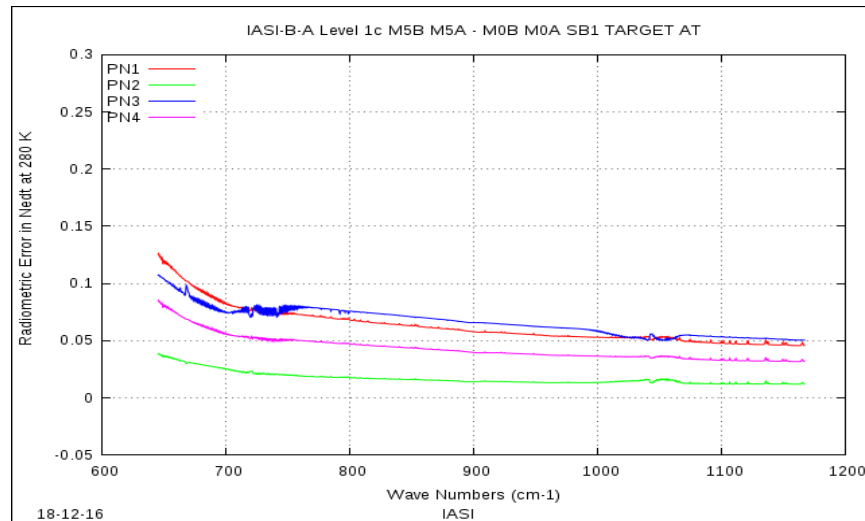


Error between 0.13 K and 0.02 K

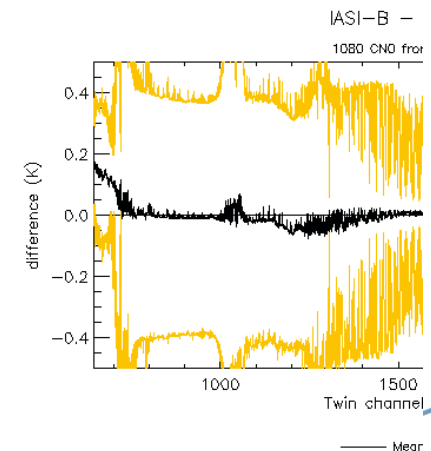
- | | | |
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4 – IASI-A status

- ✓ Double difference: {IASI-B new - IASI-B ope} – {IASI-A new - IASI-A ope}



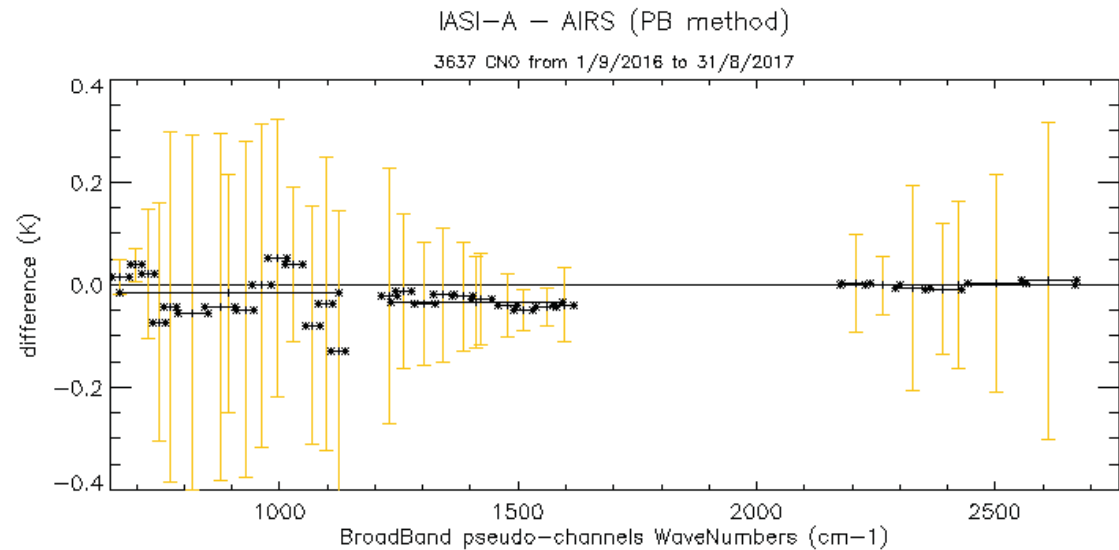
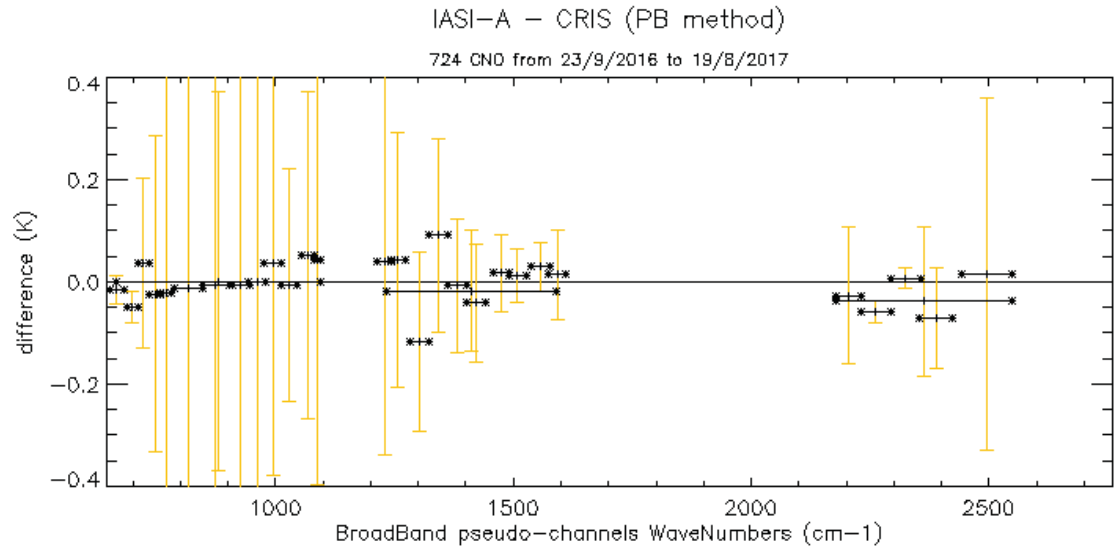
- The difference between the 2 corrections of IASI-B and IASI-A is around 0.1 K, but not exactly, **it depends on the wavenumber and scene temperature.**
- If we change IASI-A, the inter-calibration bias between IASI-A and IASI-B will decrease from ~ 0 to ~ -0.05 K.
- So, IASI-A change is still a question mark...



4 – IASI-A status

- IASI-A/CrIS inter-calibration in band 1 is perfect

- IASI-A/AIRS inter-calibration has a small bias ~0.05 K in band 1 (except in CO₂ and O₃ bands)



— Mean — StdDev

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5 – Conclusion

- The theoretical study on non-linearity has been validated in flight with IASI-B observations: differences in accordance with the study
- The current results of inter-calibration between IASI-A and IASI-B are satisfactory in band 1; the CO₂ and O₃ bands have a different pattern that need to be deeper analysed and are supposed to be geophysical effects.
- The theoretical study on non-linearity encourages us to change the correction tables on IASI-A too.
- If we change IASI-A, the inter-calibration with IASI-B and CrIS will be worse (with its limitation, we have no absolute reference, what is the reality ?)
- The difference between new and operational correction tables for IASI-A is low
- We can wonder if it is worth to change IASI-A, as it is a reference since 11 years, and the current inter-calibration with other sounders is satisfactory.

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6 – ISSWG feedback

- These results have been presented at the last ISSWG in December 5th.
- ISSWG have created a “task force” to better analyse the change on IASI-B and try to understand the signatures seen in CO₂ and O₃ bands.
- The 1st meeting of this task force will be held in March 2018.
- An action has been raised to ask CNES to exchange informations on IASI non linearity with CrIS team.
- The update of IASI-A non linearity tables is postponed, and will be considered again after the conclusions of ISSWG task force.