# In-Flight Performance of the Infrared Atmospheric Sounding Interferometer (IASI) on METOP-A

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# Outline

- Measured performances
  - Radiometry
  - Spectral
  - Geometry and Field Of View
  - Stray light
  - First feedback from end users (NWP)

- Summary

# CNES Team

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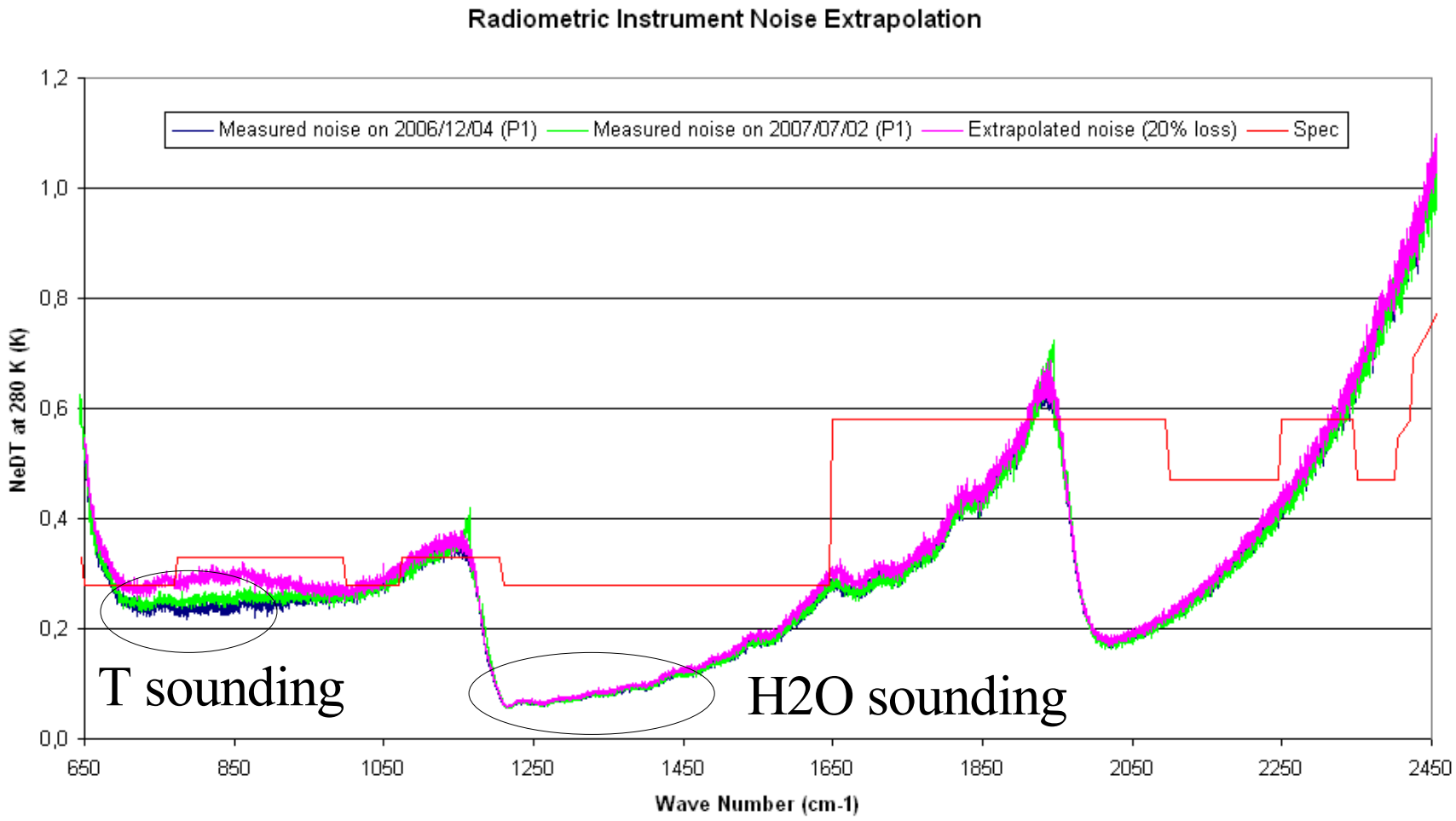
Thanks to Florent Prel for his work on AIRS data

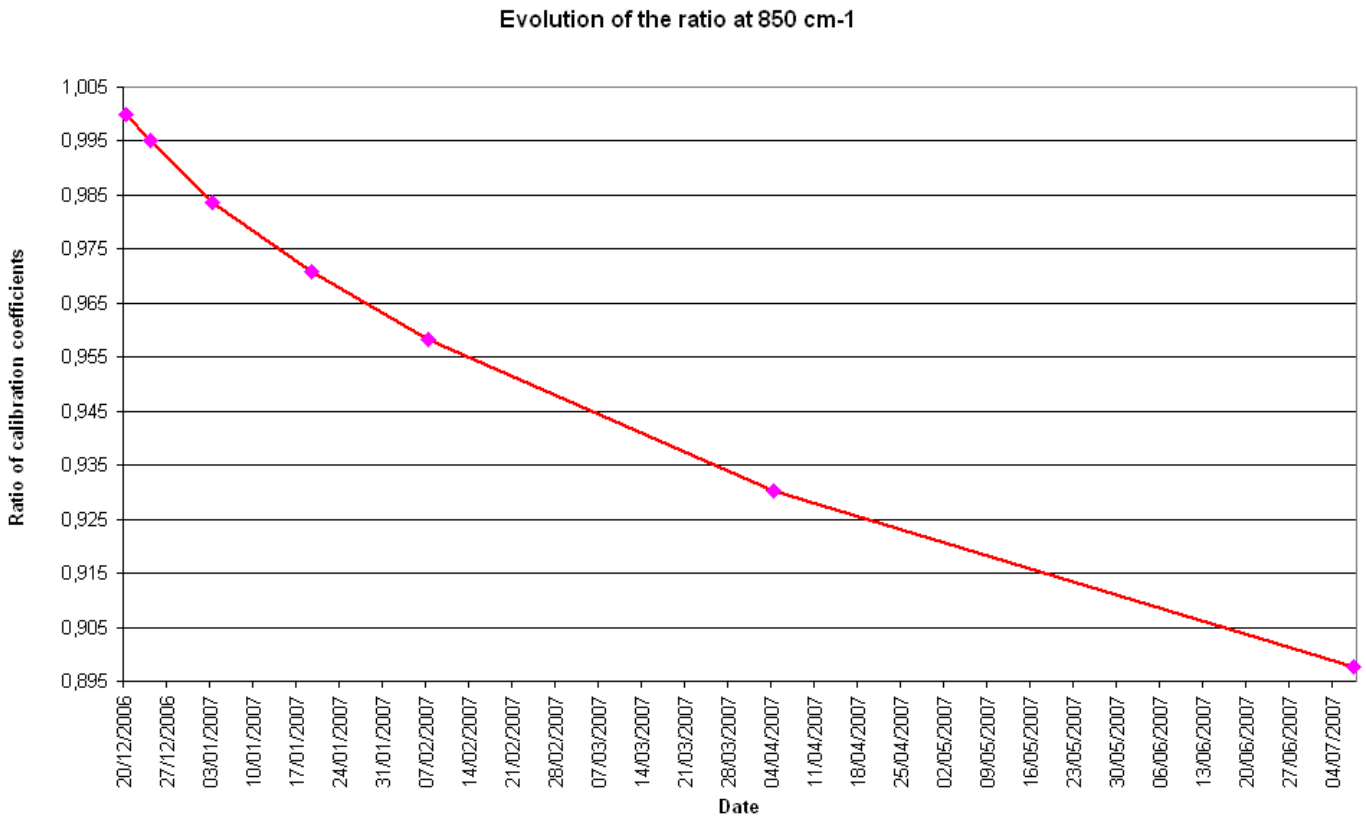
# Radiometry — Instrument radiometric Noise

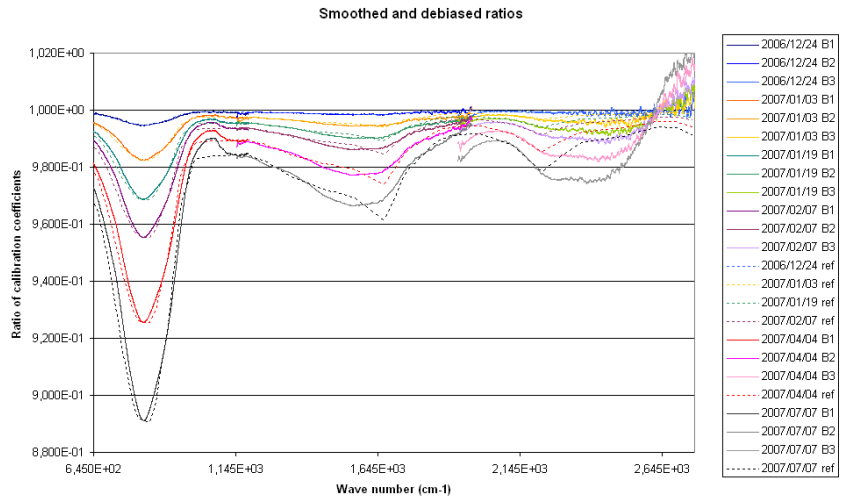
- Non apodised spectra
- Measured on Black Body at 293 K : specified at 280 K



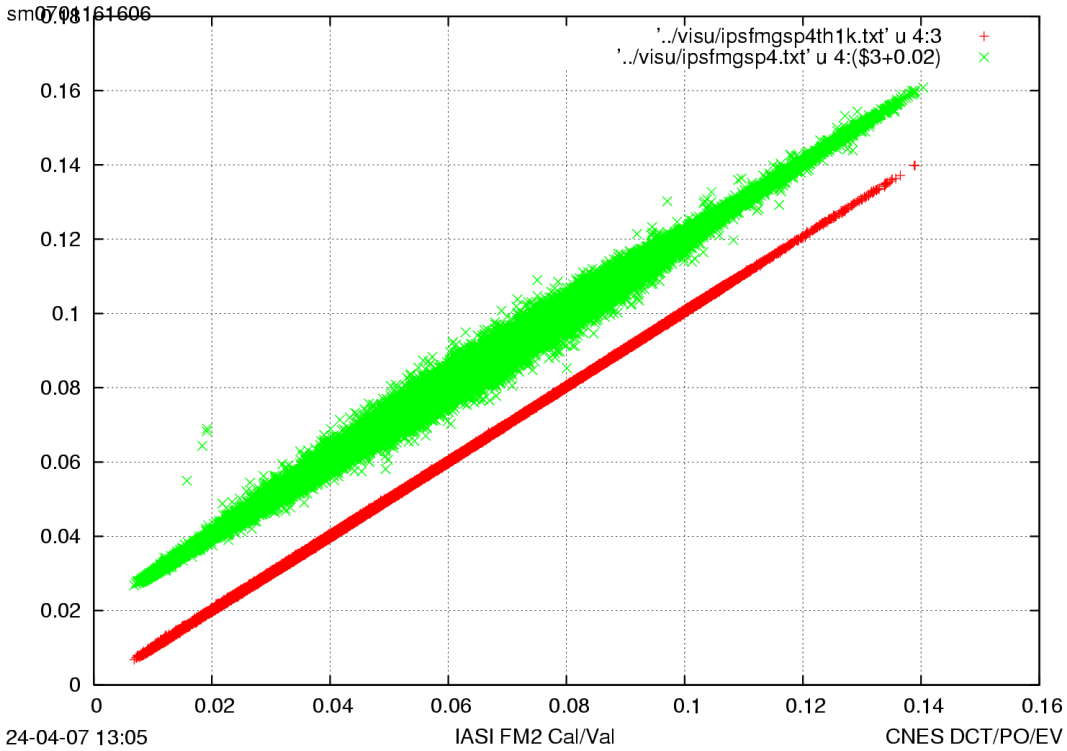
# Radiometry — Ice contamination

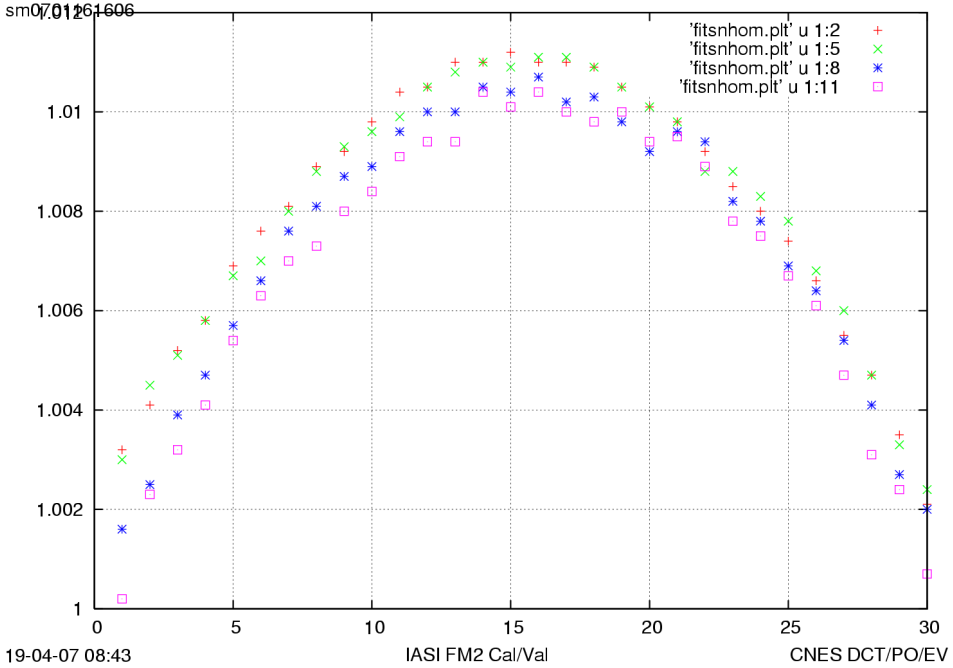
- Very low evolution with time
- Loss of transmission December 2006 – July 2007
  - 11 % at the maximum
- No need for a decontamination before early 2008



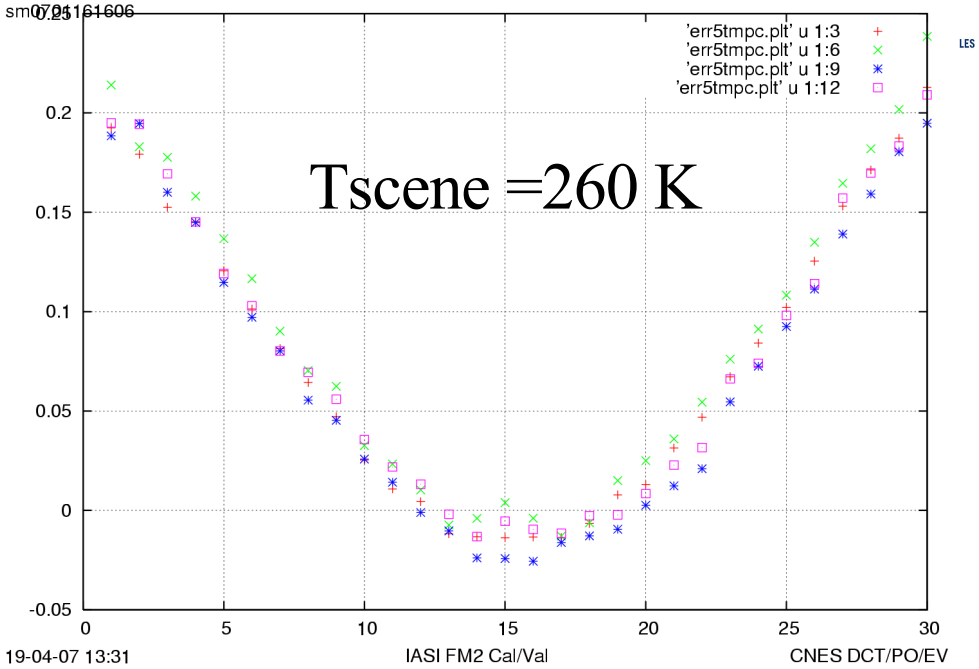
- Method
  - Compute slope of AVHRR (ch4) vs IASI radiances
  - Analysis of slopes vs IASI scan angle
    - Good fit with cos (scan angle)
    - Polarization of AVHRR scanning mirror ?
    - IASI effect : slight asymmetry

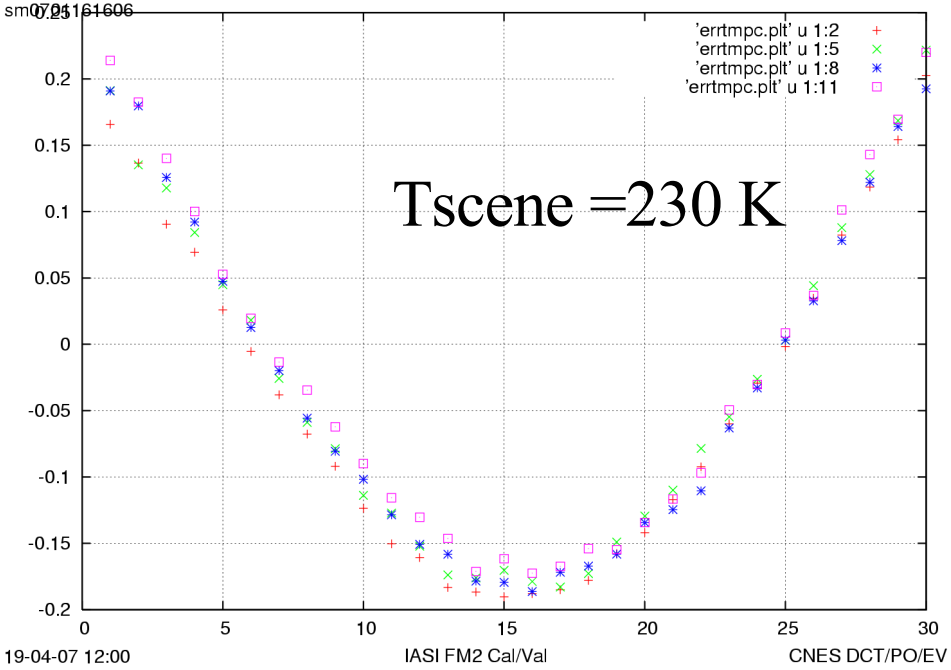


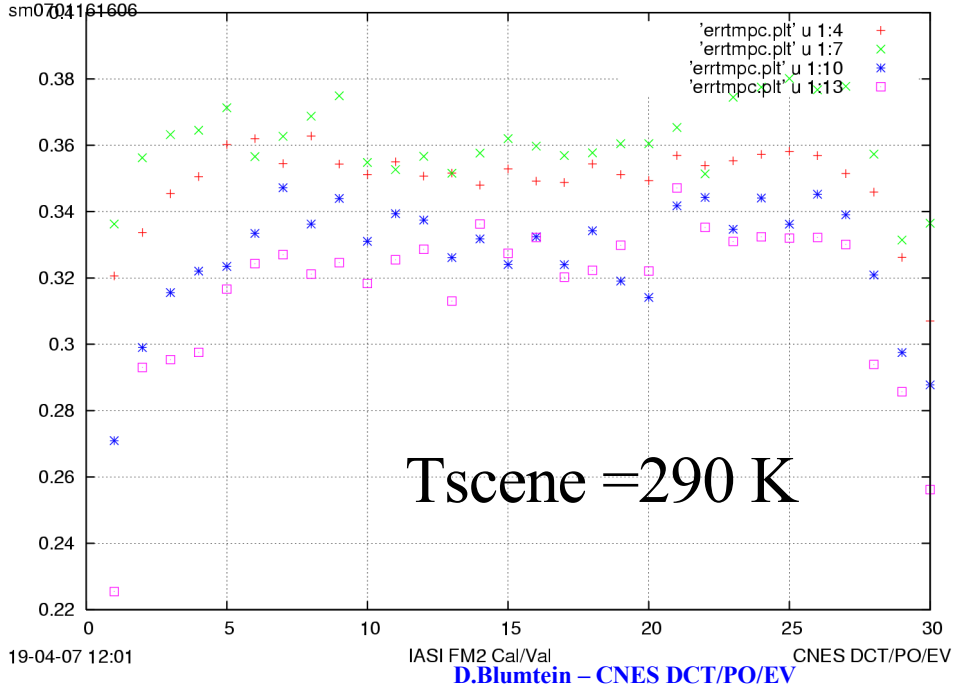



# Results

- Reminder : IASI spec (absolute)
  - 0.5 K at 280 K
- Small discrepancy
  - -0.2 K < DT < 0.4 K (scaled at 280 K)
- IASI interpixel calibration error
  - A few 0.01 K (typ. 0.05 K)

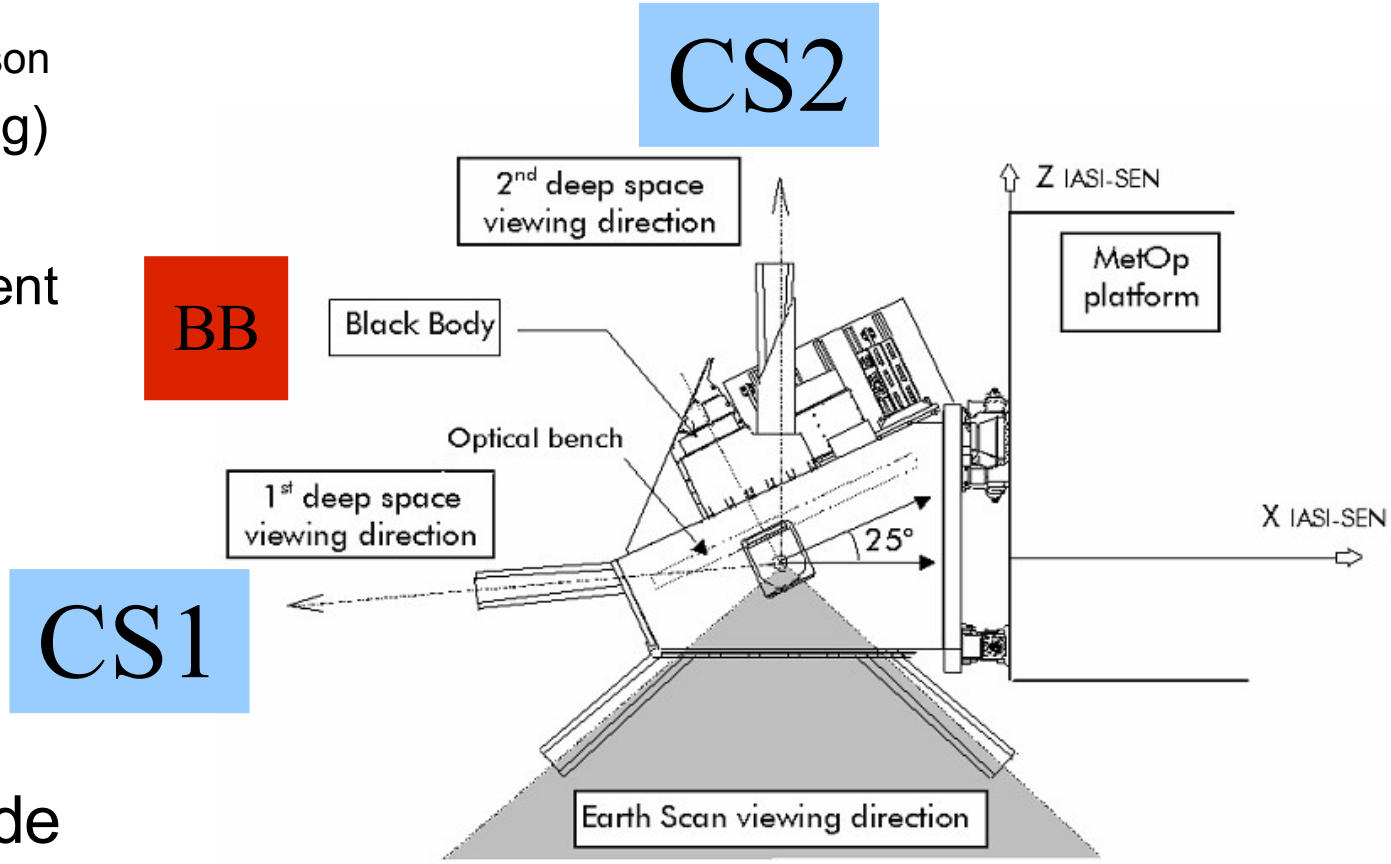


# Method

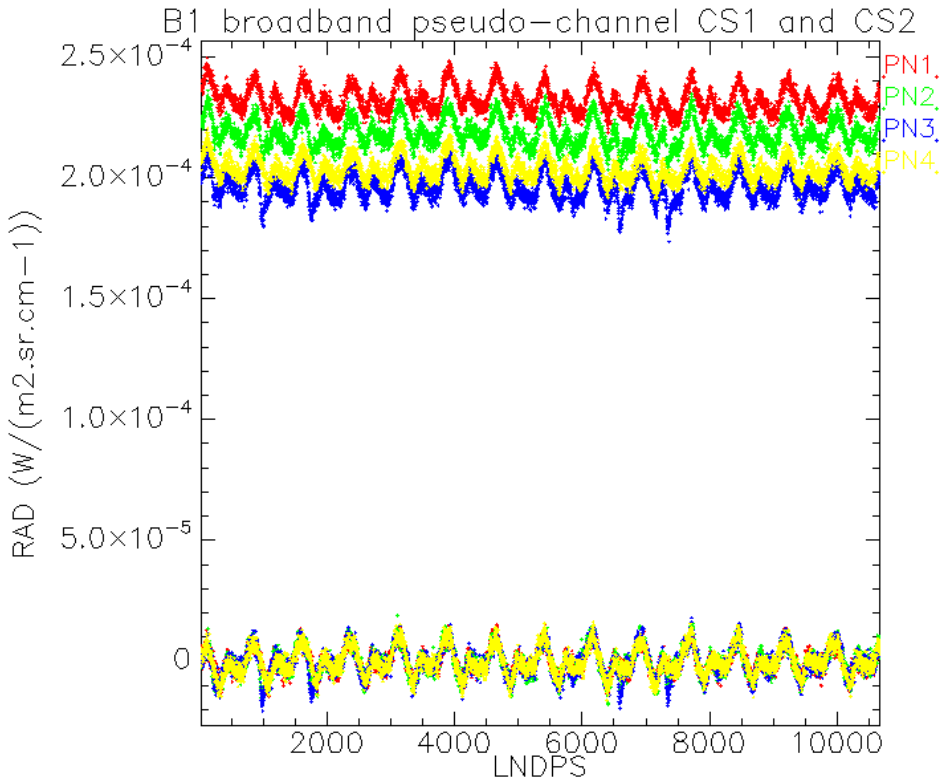
- First component
  - Offset calibration coefficient
  - Cold Space views (CS1)
  - Lack of parasitic flux
    - CS1 vs CS2 comparison
  - Temporal stability (filtering)
- Second Component
  - Slope calibration coefficient
  - Black Body views (BB)
  - Lack of sensitivity to BB environment
  - Temporal stability (filtering)

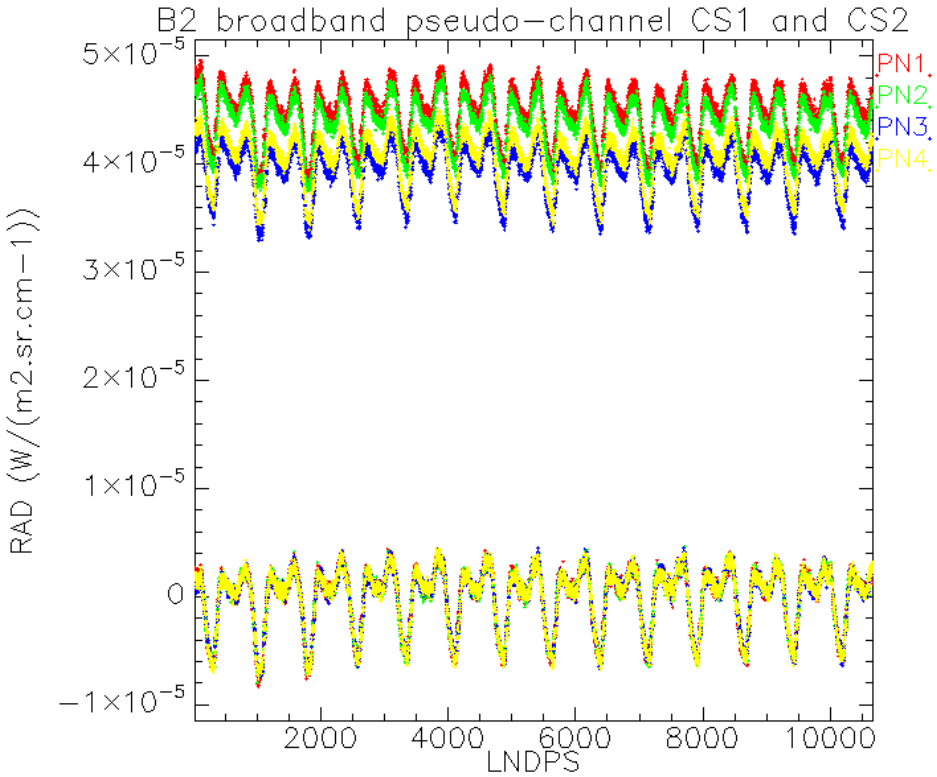



- External Calibration Mode
- Broadband pseudo-channels

# Results on Offset calibration coefficient (14 consecutive orbits)

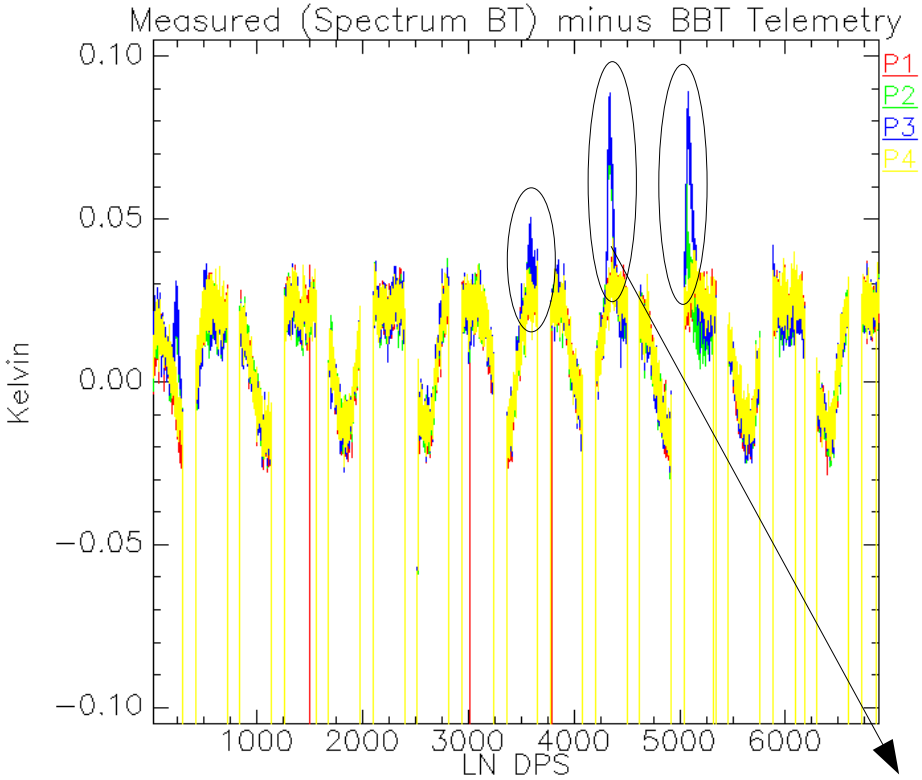
- Observation : No Parasitic flux in CS1 or CS2
- Orbital fluctuations caused by lag on filtered parameters
  - Today : 0.02 K (B1), 0.03 K (B2), 0.04 K (B3) peak to peak
  - Reduced to : 0.008 K (B1), 0.012 K (B2), 0.016 K (B3) after 27th of June
- Reminder : specification +/- 0.15 K (scaled to 280 K)

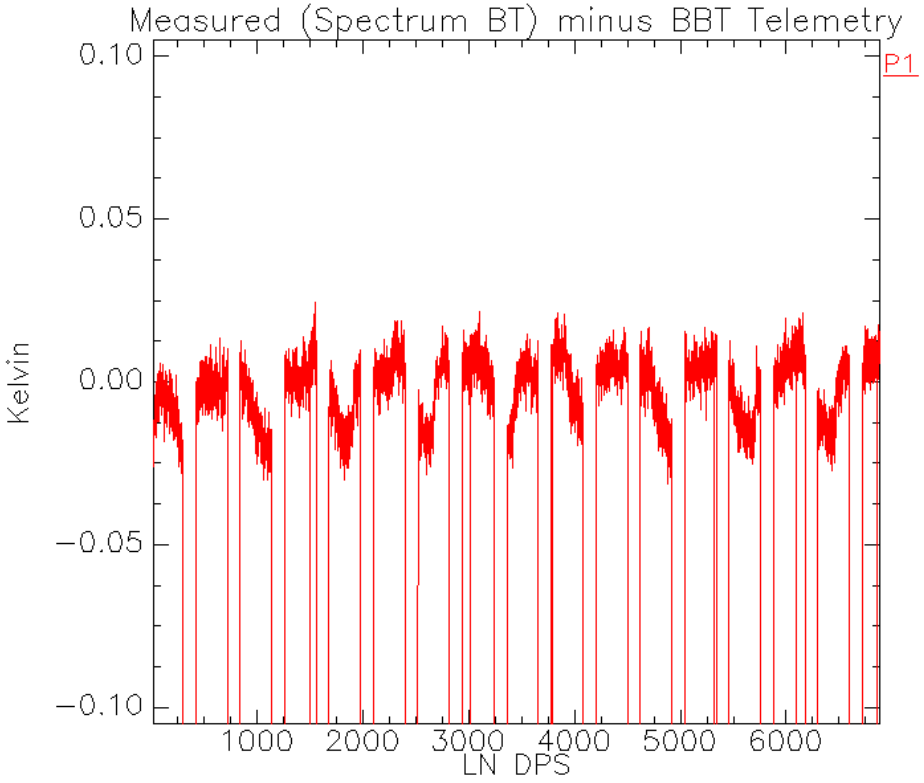


- Results on Slope calibration coefficient (9 consecutive orbits)
  - spectrum brightness temperature – BB temperature telemetry

- Orbital fluctuations caused by lag on filtered calibration coefficient
  - Today — B1: 0.1 K (P1 & P4), 0.06 K (P2 & P3), B2: 0.04 K, B3: 0.05 K (B3) p-p
  - Reduced to : 0.04 K (B1), 0.024 K (B3), 0.016 K (B3) after 27th of June




SAA crossing effect (very small impact in B1 band)

# Radiometric calibration — orbital stability

- 3rd analysis : Results on Slope calibration coefficient
  - 9 consecutive orbits
  - BB « High » emissivity - « Low » emissivity channels
- No rapid variation of the calibration BB thermal environment
- Estimated effect : < 0.09 K p-p for worst case IASI channels

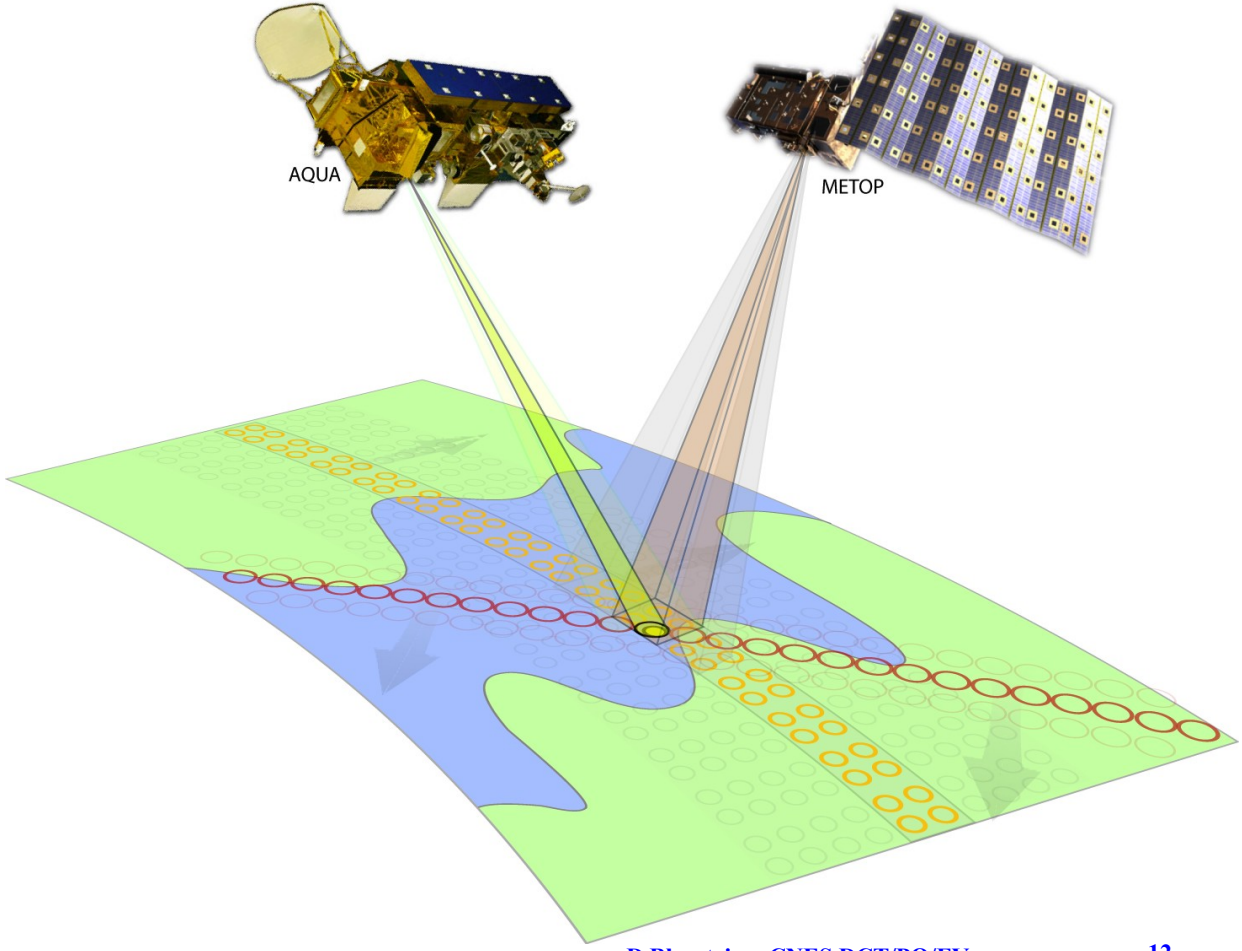
- Conclusion
  - Radiometric calibration stability on mid-term temporal range very good
  - In particular, no impact of
    - Beginning / End of eclipse
    - Terminator crossing
    - etc.

# Radiometric calibration — IASI versus AIRS

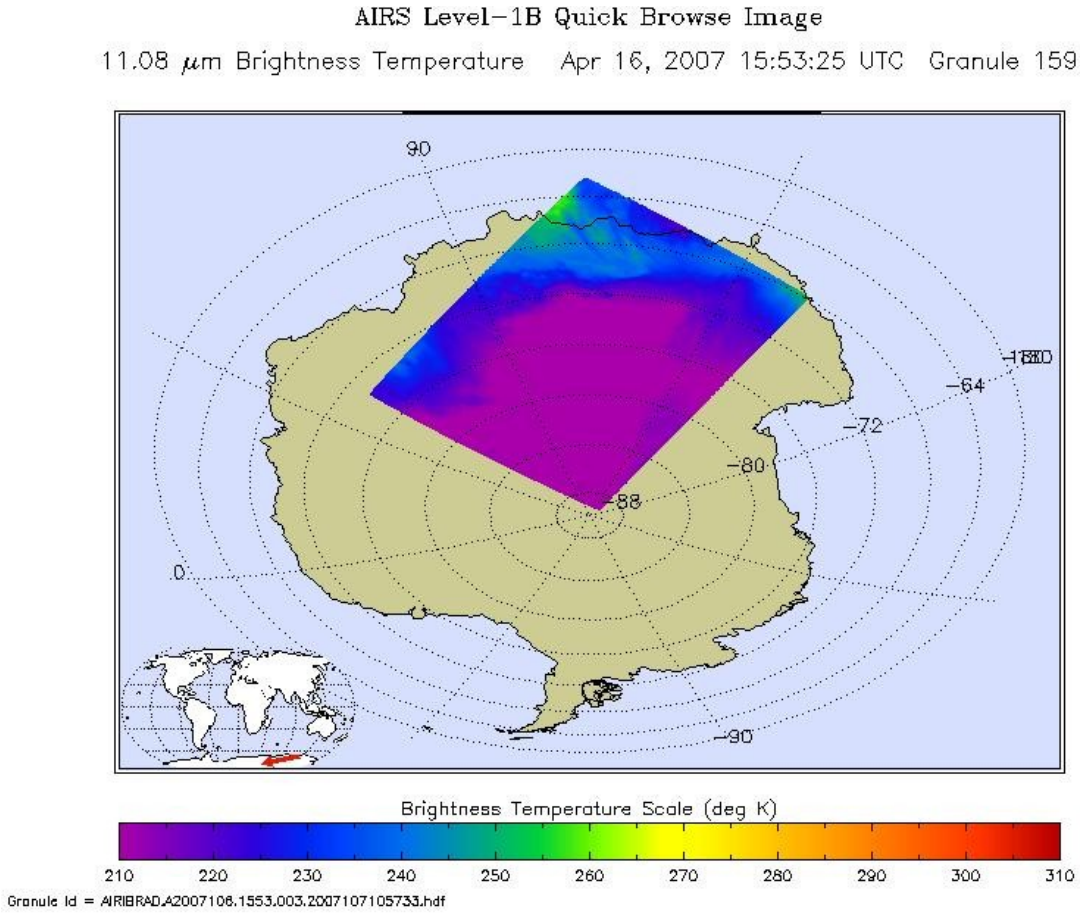
- At orbit crossing points : high latitudes only (Nord and South 73 deg)

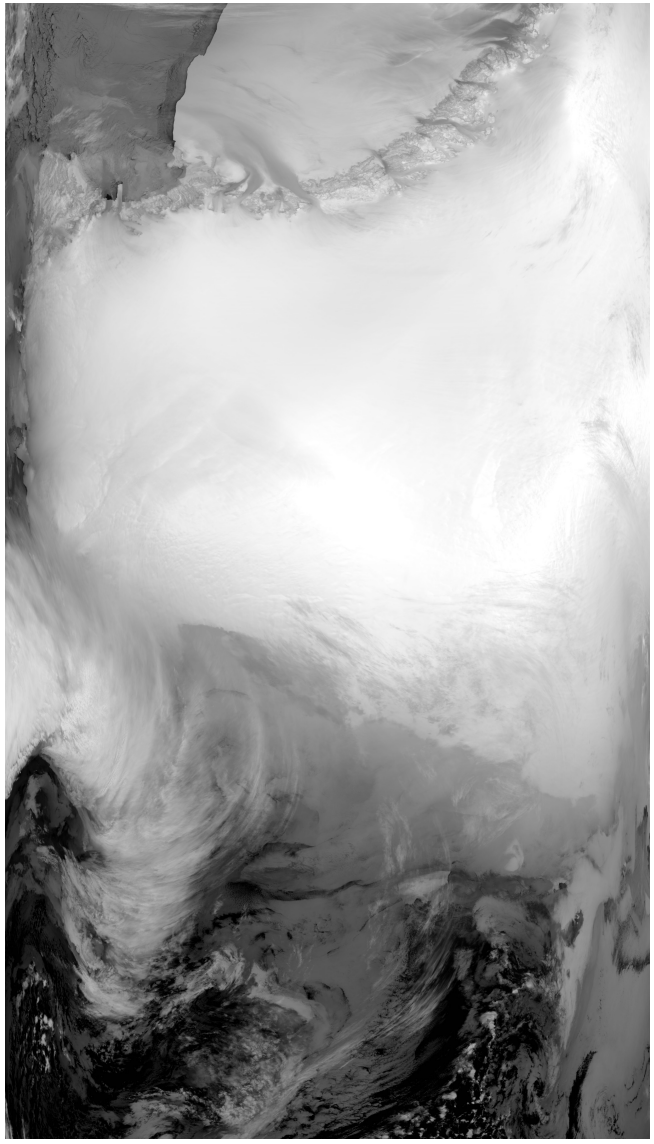
- Difficulties
  - Pixel size
    - AIRS : 13.5 km, IASI : 12 km
  - Missing AIRS channels
  - Spectral response function
    - first order effect : resolution

- Work around
  - Comparison of IASI and AIRS broadband pseudo-channels
  - Selection of scenes with good spatially uniformity



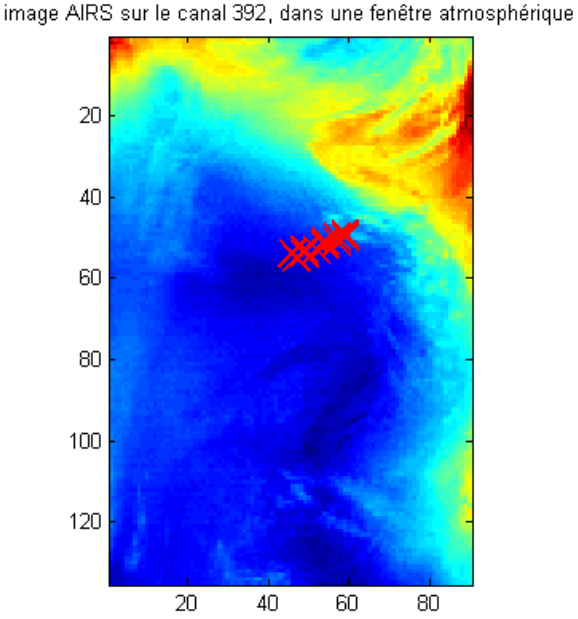
# Situation : 16th April 15:53

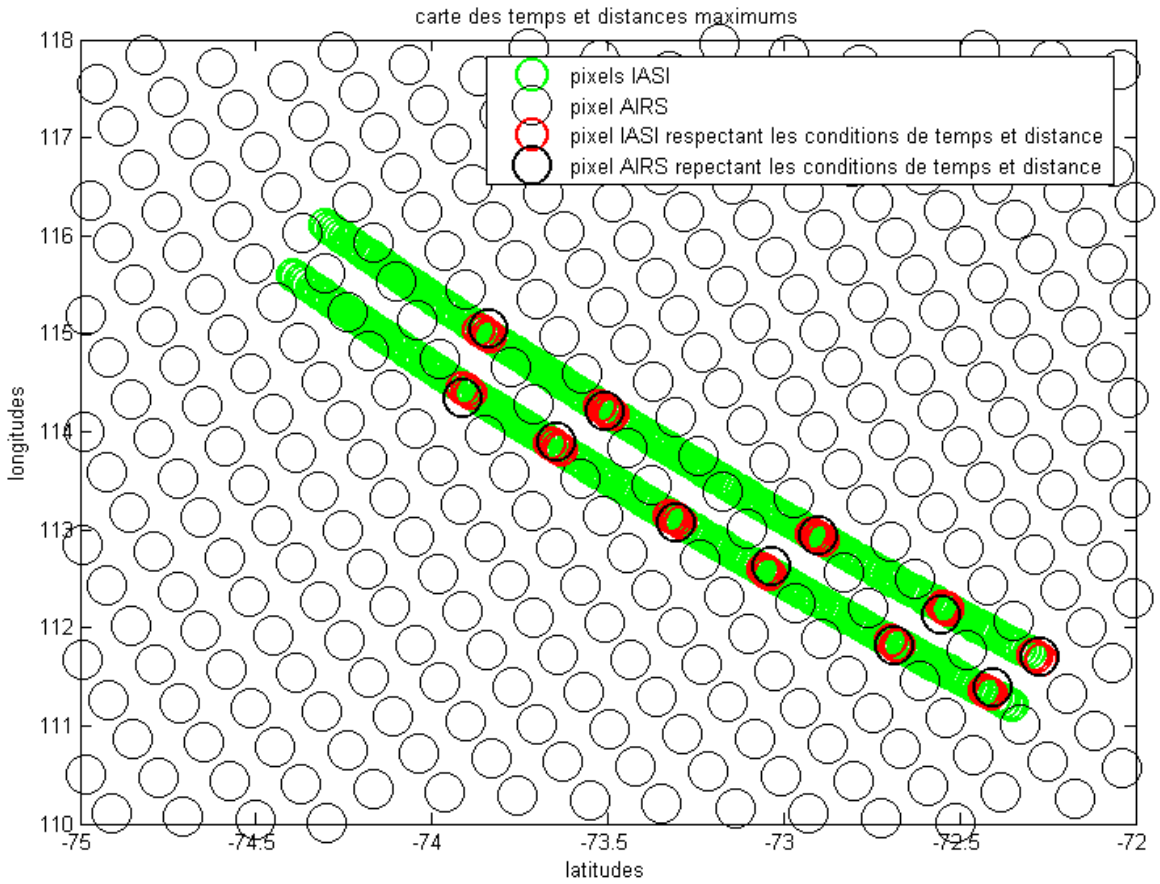


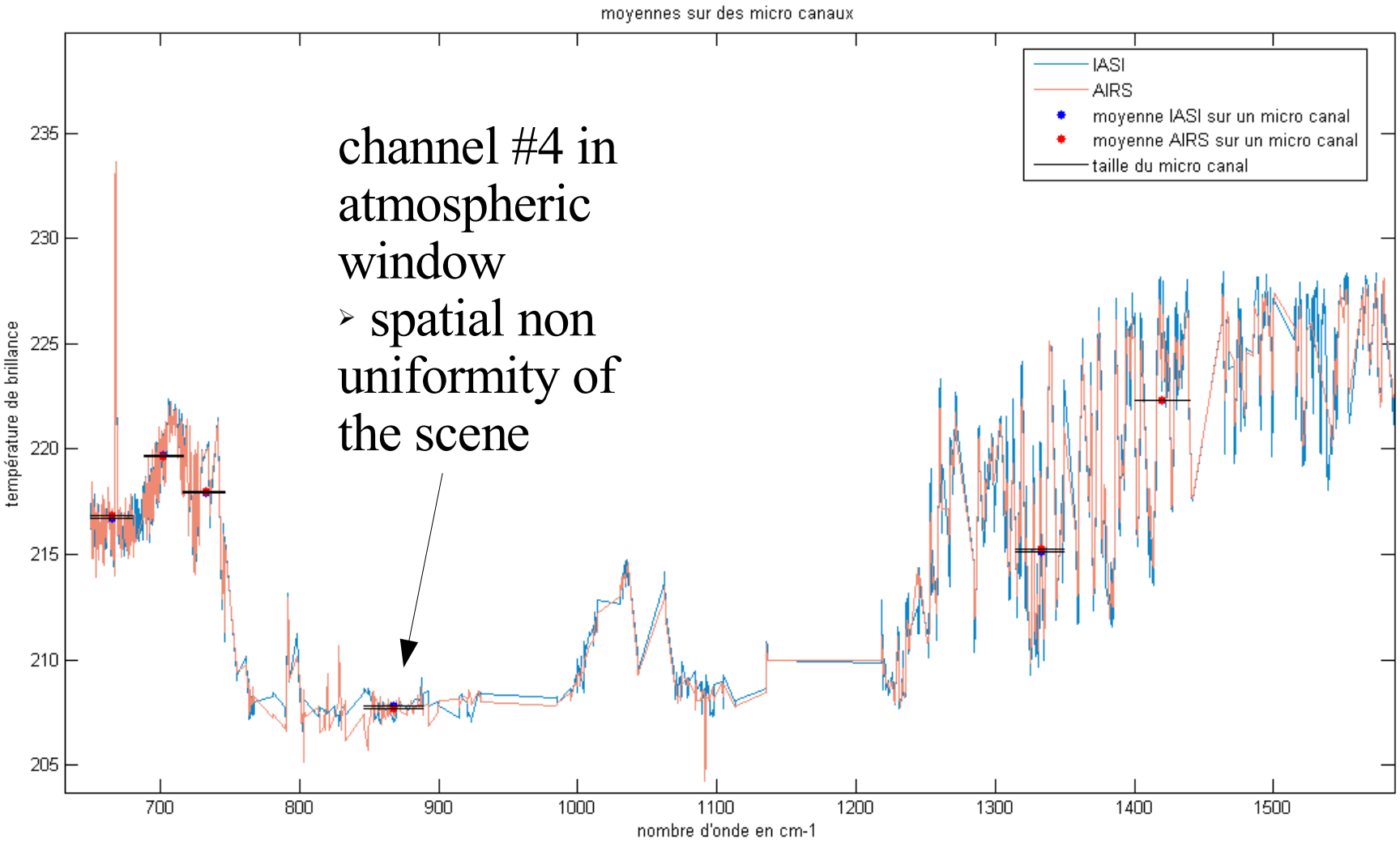
# Situation 16th of April

- IASI in External Cal.
  - Close to nadir
- Many comparison opportunities
  - 49 used
- Good uniformity
  - Cold scene



# Pseudo-channels

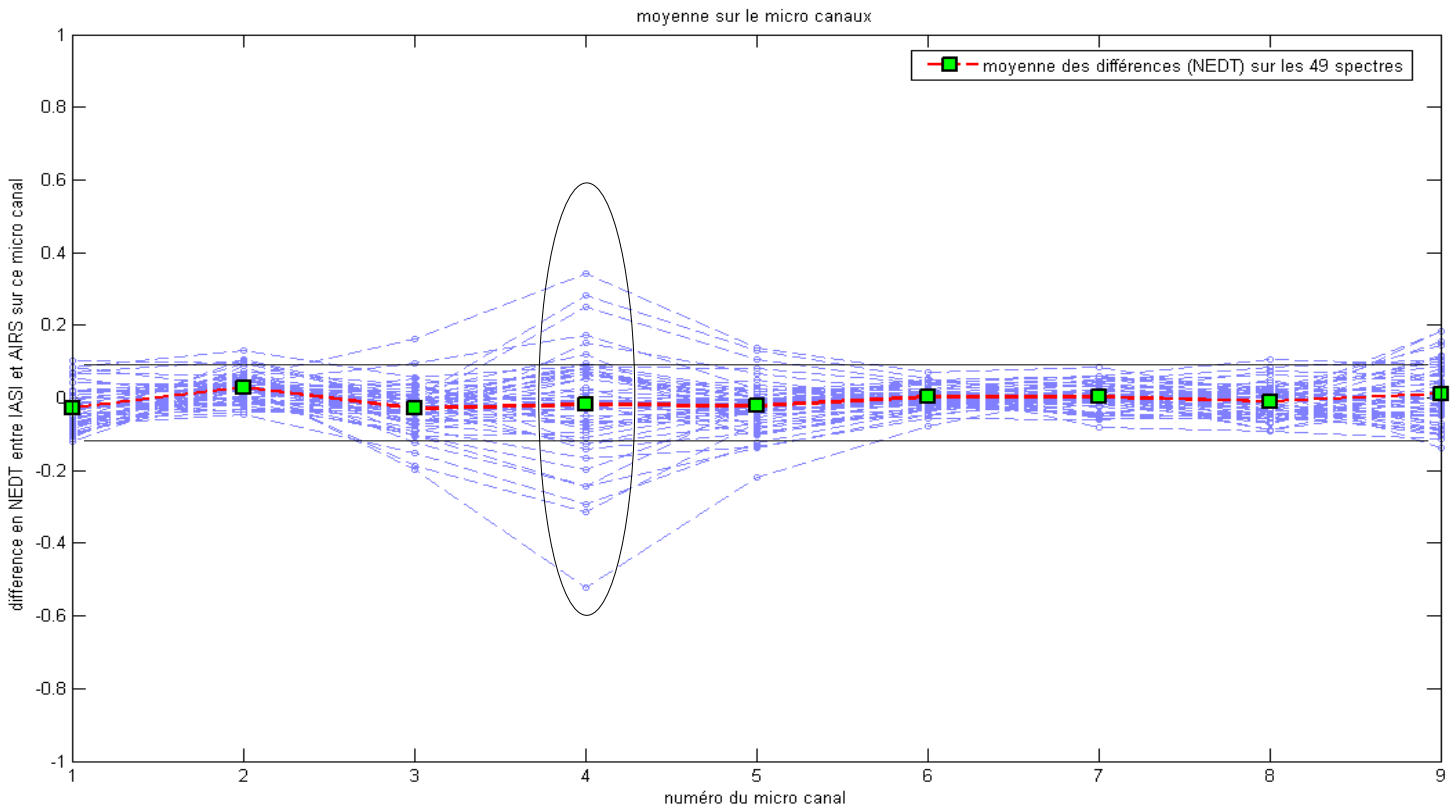



channel #4 in atmospheric window

- spatial non uniformity of the scene

# Summary results (case 16th of April 2007)

- IASI External Calibration Mode. Very uniform situation
- 9 pseudo-channels / 49 soundings / 210 K in atmospheric window
- Differences scaled to 280 K reference temperature



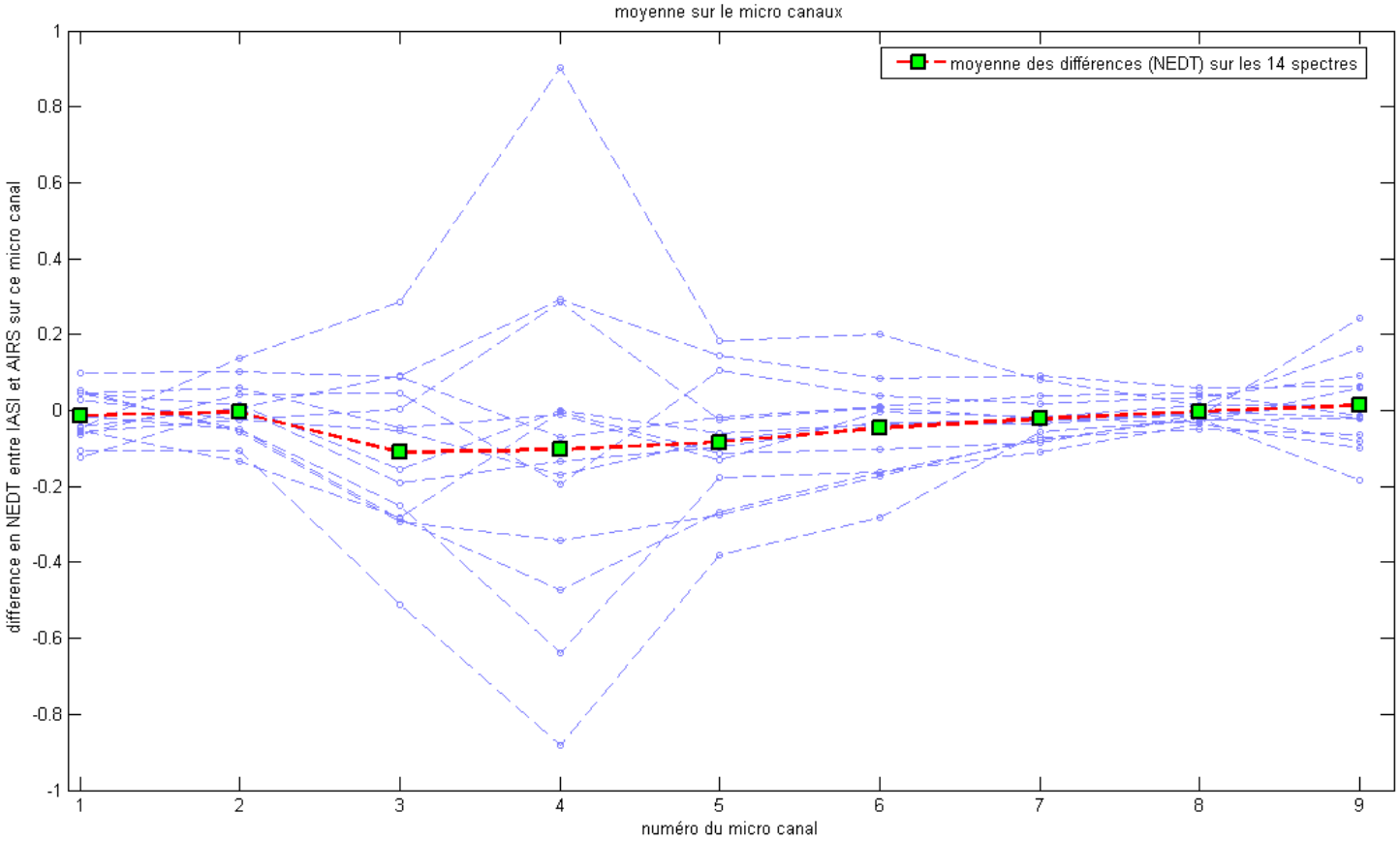

Channel #4 in atmospheric window

- spatial non uniformity of the scene

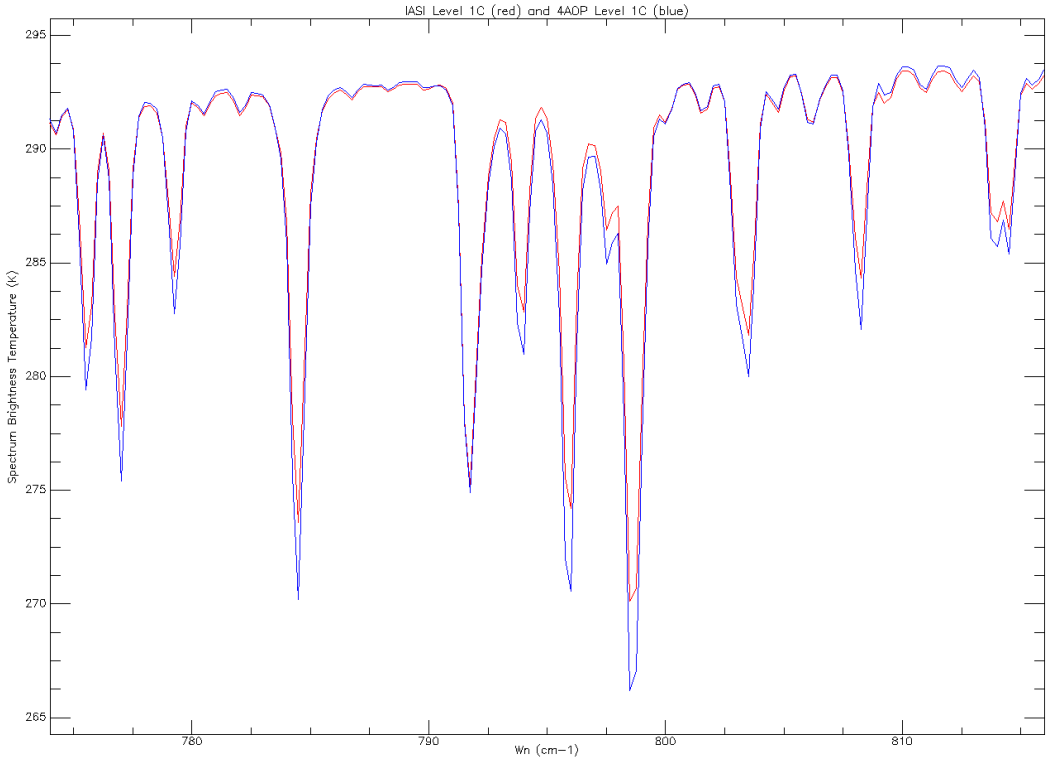
- Intercalibration error << 0.1K (average of the 49 soundings)

# Summary results (case 19th of April 2007)

- IASI Normal Operation Mode , Not very uniform situation
- 9 pseudo-channels / 14 soundings / 245 K in the atmospheric window
- Differences scaled to 280 K reference temperature



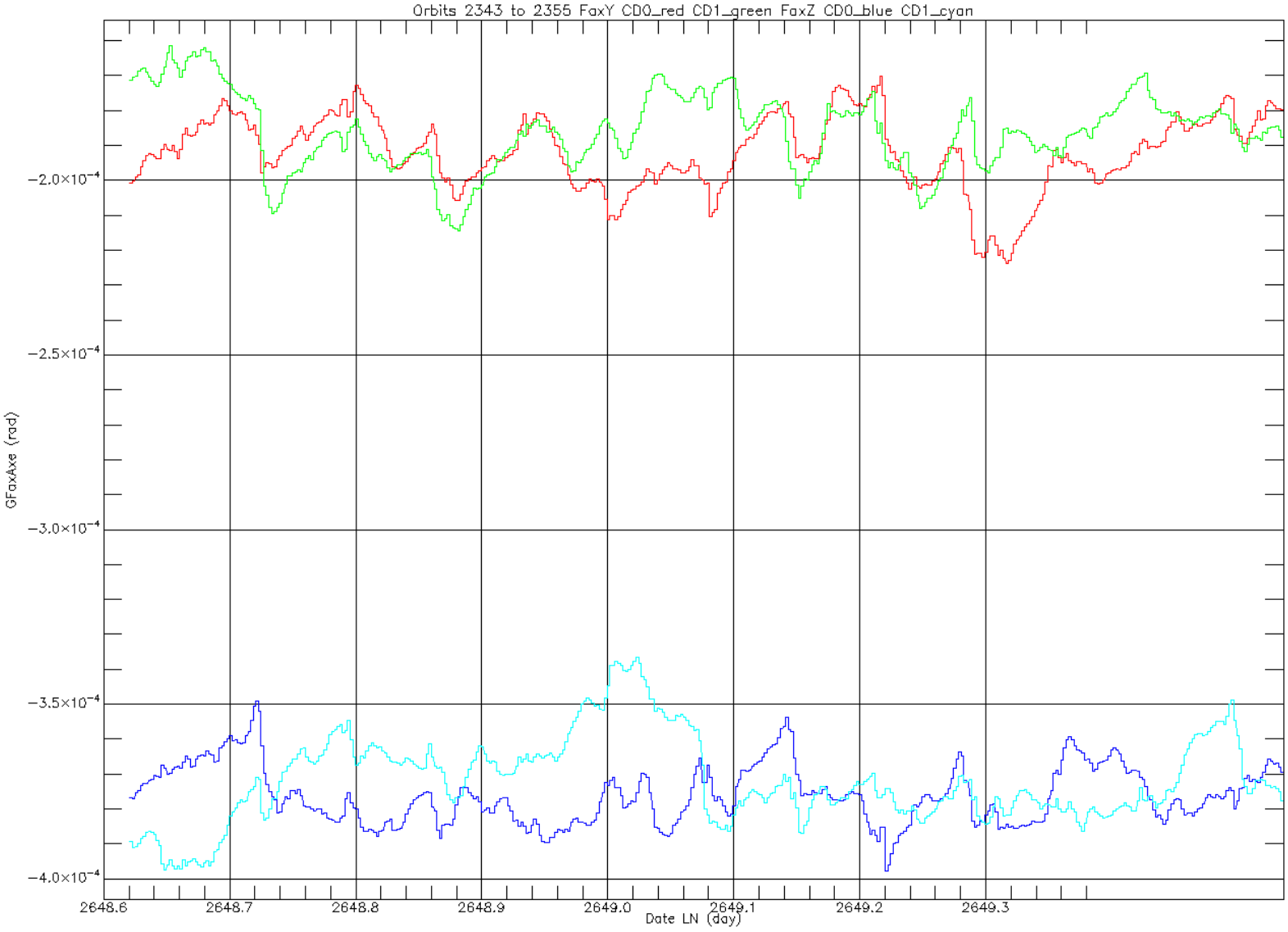
# Spectral




- Introduction of pressure shifts in Radiative Transfer Model (4A-OP)
  - Impact at the level of the specification (2.0 10-6)

| Central wave number in cm-1 | Without pressure shifts | With pressure shifts |
|---|---|---|
| 790 | -2.5 10-06 | -0.6 10-06 |
| 1125 | 3.1 10-06 | +0.4 10-06 |

- Stability of the interferometric axis position
  - 50 µrad equivalent to 7.5 $10^{-7}$ ($\Delta\nu/\nu$)
  - Average in rad
  - In January
    - Y = -170 $10^{-6}$
    - Z = -360 $10^{-6}$
  - In April
    - Y = -190 $10^{-6}$
    - Z = -380 $10^{-6}$
  - Small evolution beginning of July (Spectral Data Base update)



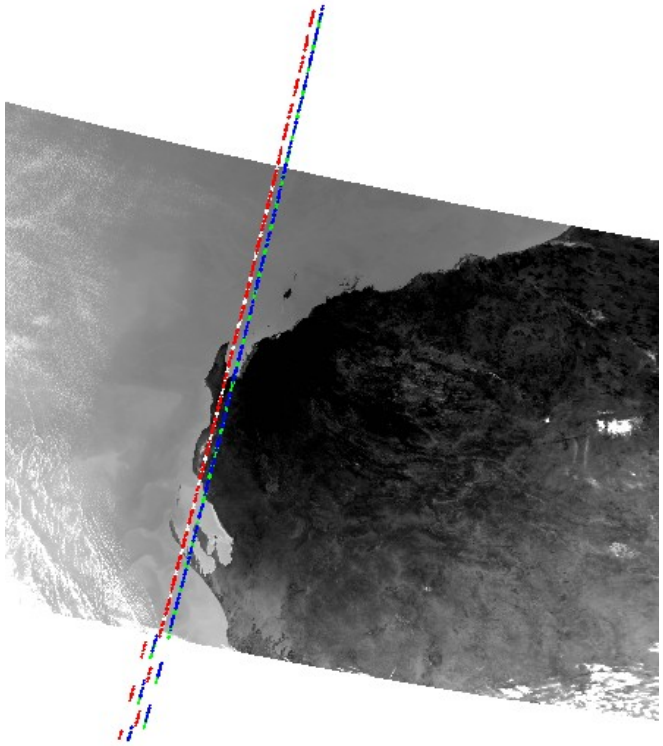
- Validation by correlation between simulated and measured spectra
  - Use of 4A / GEISA for radiative transfer model. Results presented per orbit
  - Use of homogeneous situations (around 5000 spectra averaged for 100 situations)
  - Requirement : relative error on spectral calibration = 2.0 10-6 (2 ppm)

| | | PN1 | PN2 | PN3 | PN4 | ALL PN |
|---|---|---|---|---|---|---|
| January | 701161106 | 6.1E-8 | -4.9E-8 | 5.6E-7 | 1.7E-7 | 1.8E-7 |
| | 701161427 | 3.0E-7 | -9.0E-8 | 3.7E-7 | 3.6E-7 | 2.3E-7 |
| | 701161745 | 7.3E-8 | -6.0E-7 | 3.6E-7 | 3.0E-7 | 3.3E-8 |
| | 701161927 | 3.9E-7 | -1.1E-7 | 6.5E-7 | 6.8E-7 | 4.0E-7 |
| | 701162109 | -6.0E-8 | -6.1E-7 | 4.9E-7 | 6.3E-7 | 1.1E-7 |
| April | 704130054 | 2.0E-7 | 2.9E-7 | 8.0E-7 | 6.3E-7 | 4.8E-7 |
| | 704130236 | 5.7E-7 | 3.4E-7 | 5.3E-7 | 8.3E-7 | 5.7E-7 |
| | 704130421 | 1.8E-7 | -2.6E-7 | 6.4E-7 | 7.4E-7 | 3.3E-7 |
| | 704130603 | 3.5E-7 | -1.7E-7 | 6.5E-7 | -6.1E-7 | 5.3E-8 |
| | 704130745 | 4.8E-7 | -4.8E-8 | 7.2E-7 | 8.5E-7 | 5.0E-7 |
| | 704130927 | 9.0E-7 | -8.5E-8 | 7.7E-7 | 6.9E-7 | 5.7E-7 |
| | 704131106 | 1.3E-7 | -4.1E-7 | 4.7E-7 | 6.2E-7 | 2.0E-7 |
| | 704131248 | 2.5E-7 | -3.4E-7 | 7.2E-7 | 7.8E-7 | 3.5E-7 |
| | 704131427 | 7.4E-8 | -4.7E-7 | 7.1E-7 | 7.2E-7 | 2.6E-7 |
| June | 706041451 | 3.5E-7 | -1.4E-7 | 5.3E-7 | 7.7E-7 | 3.8E-7 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Global | Average | 2.8E-7 | -1.8E-7 | 6.0E-7 | 5.4E-7 | 3.1E-7 |
| Global | STD | 4.9E-7 | 4.6E-7 | 3.5E-7 | 5.6E-7 | 3.3E-7 |

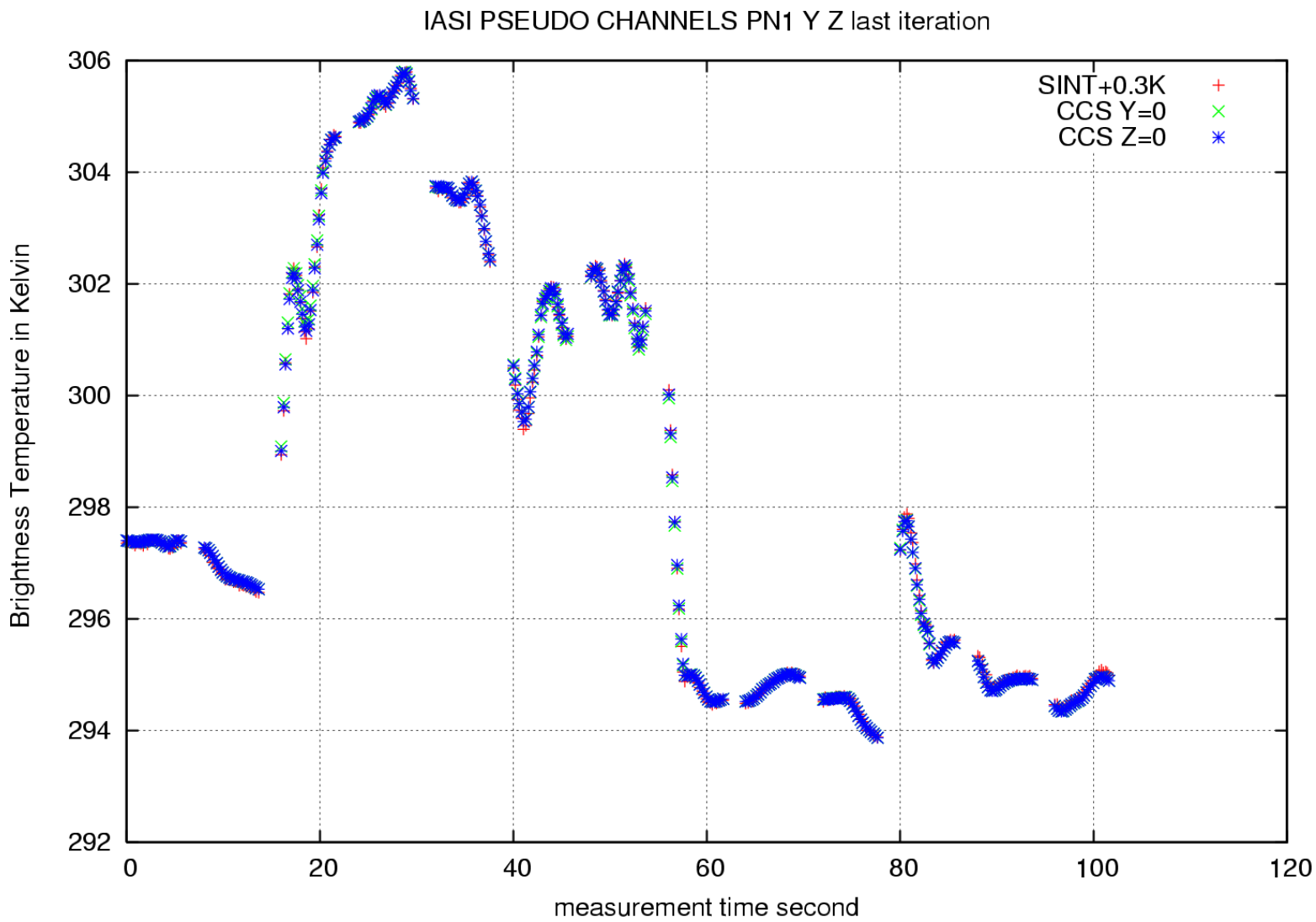
# Method : Computation of

- accurate integration of AVHRR radiance inside IASI IPSF
  - through the Radiance Analysis Algorithm (OPS task CCS)
  - IASI like pseudo channel (CCSpsch)
- integral of IASI spectrum on the AVHRR channel SRF (SINTpsch)
- Maximization of the correlation between CCSpsch and SINTpsch
  - varying position of COG of the IPSF
  - for a large set of suitable situations
    - clear sky
    - high landmark contrast
  - Other parameters can be optimized
    - Pixel size
    - “sharpness” of pixel boundary



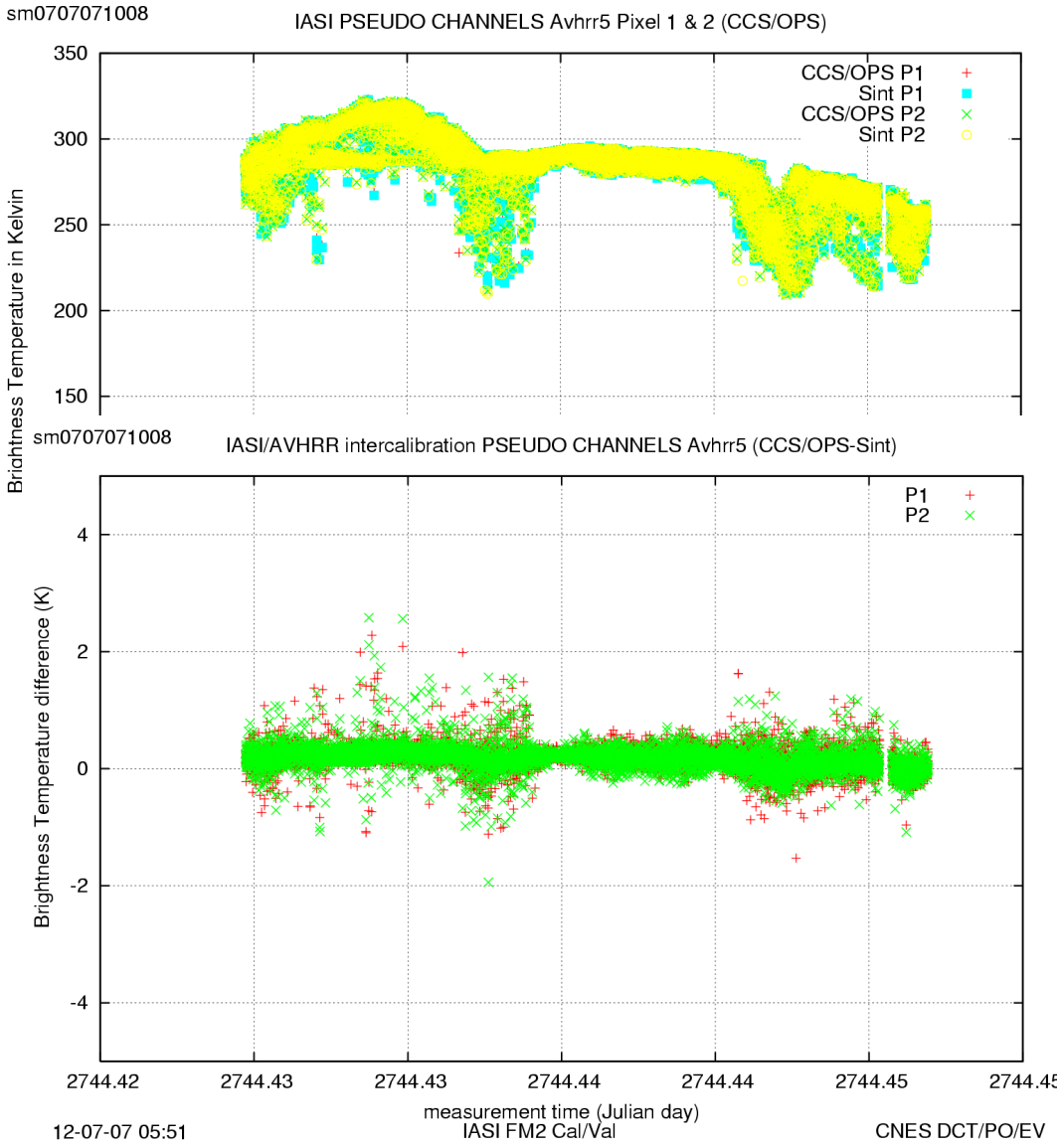
# Results

- Comparison of CCSpsch and SINTpsch after optimization of IPSF position

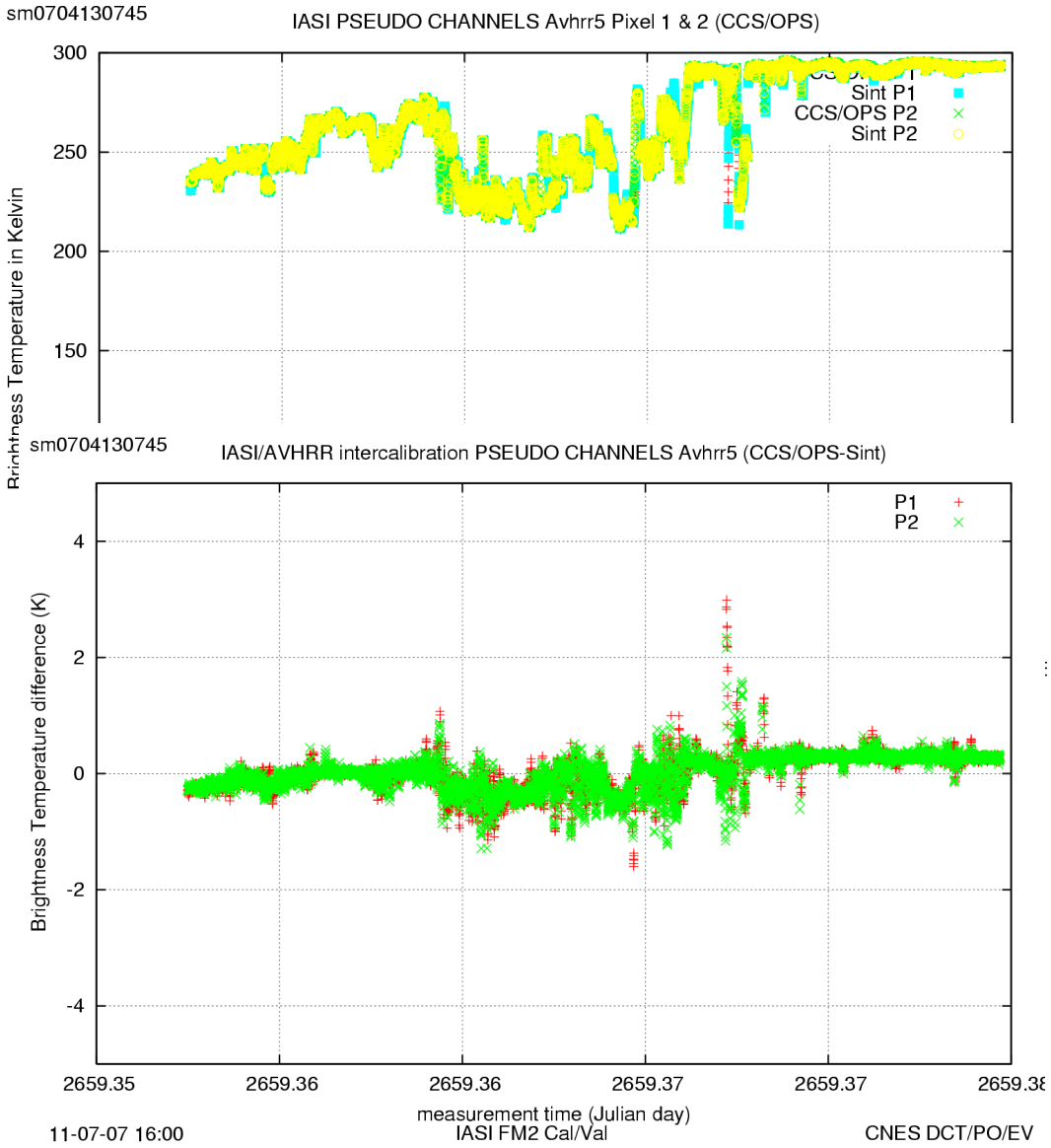


# Geometry — Fine IPSF characterisation from L1 Processing (EPS)

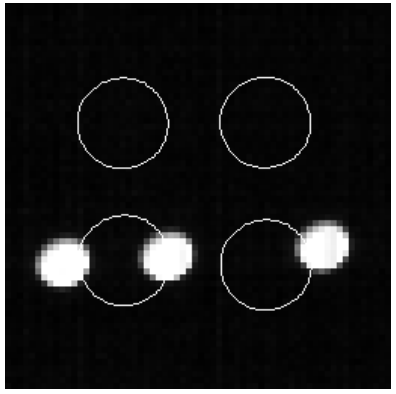
## Normal Operation Mode (June)




## External Calibration (April)

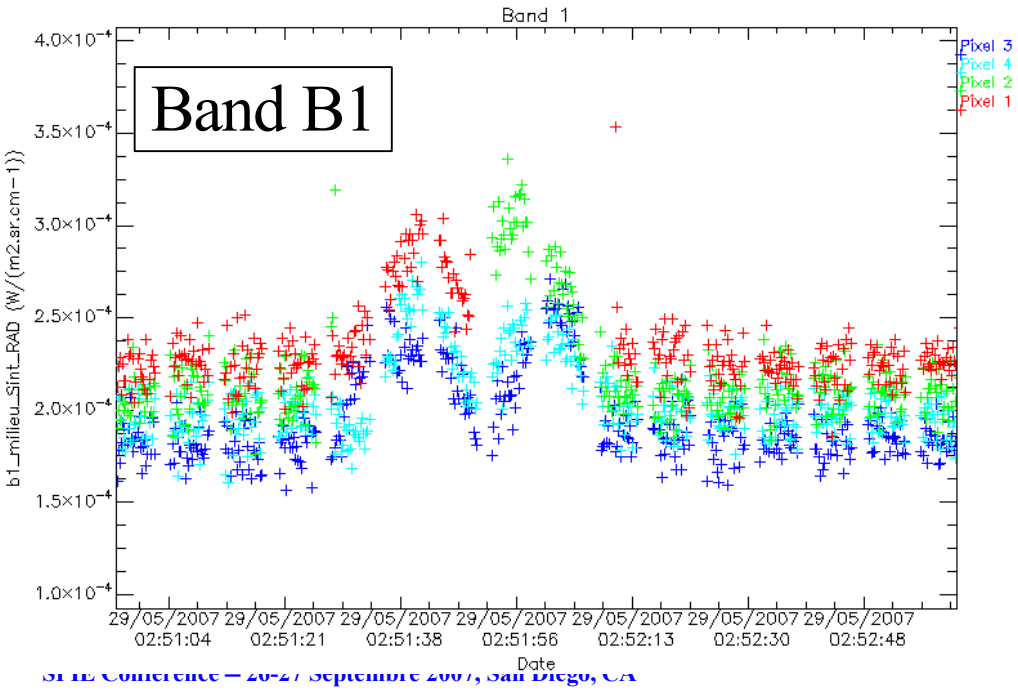


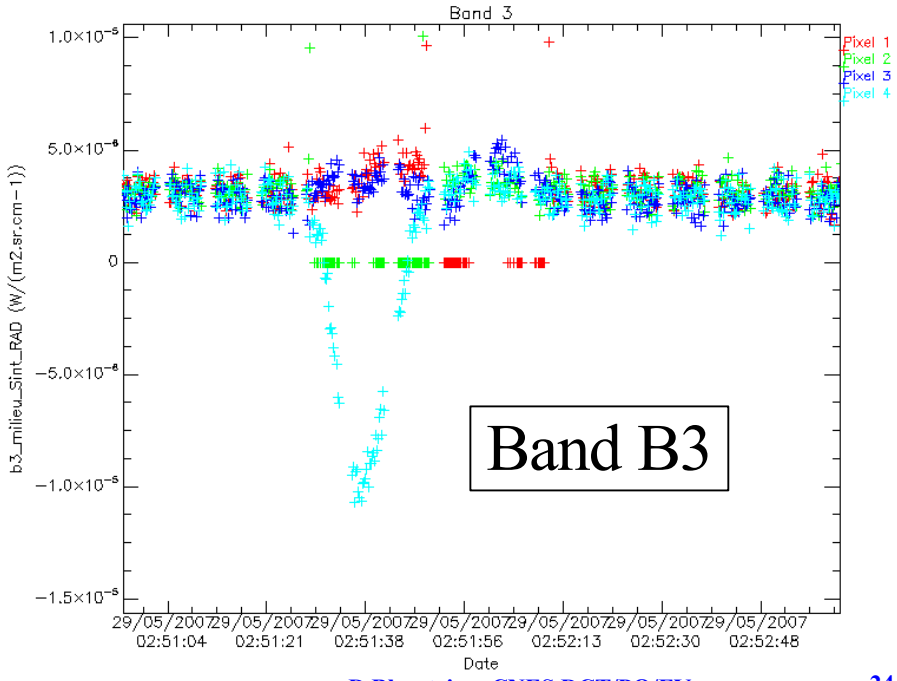
- Use of Moon pass inside Cold Space Field of View (CS2)



Moon in IIS

- Level lower than observed during ground testing
  - Closer to the predictions performed before the test
- B1 : 0.17 % of input signal
- B1 : 0.11 % of input signal (no measure on ground)
- B3 : 0.3 % of input signal
  - Main impact between P2 and P4



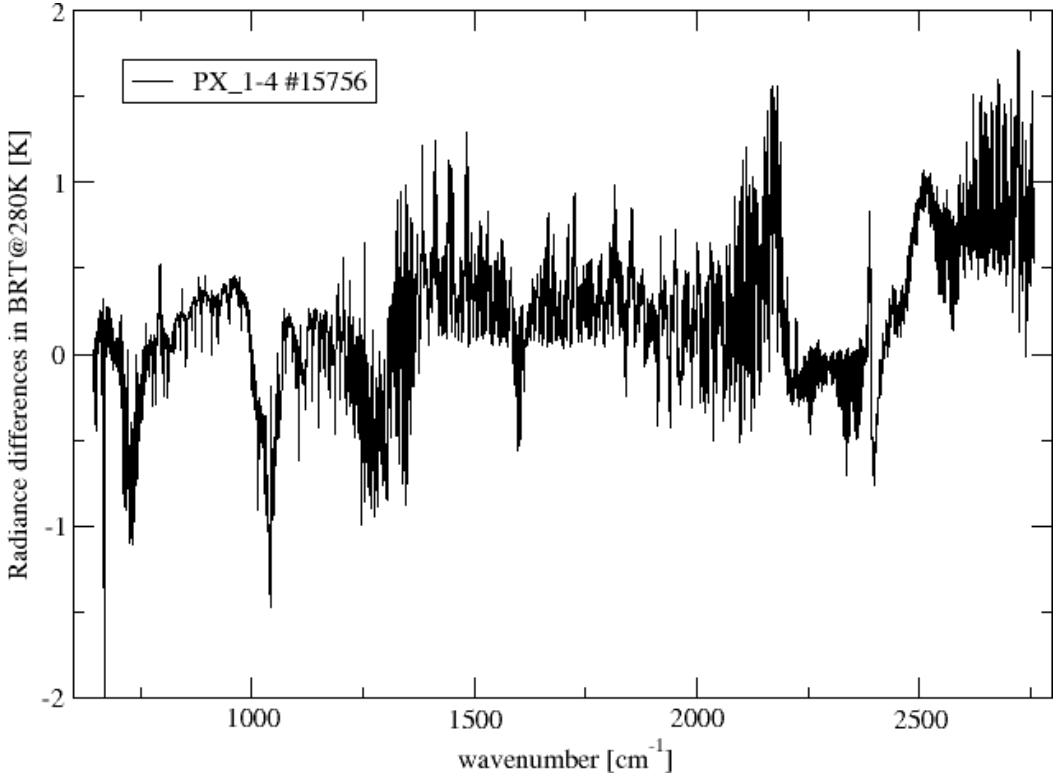
# Preliminary feed-back from End Users

## (NWP Centers and EUMETSAT)

# Feedback from Bias Monitoring by end users

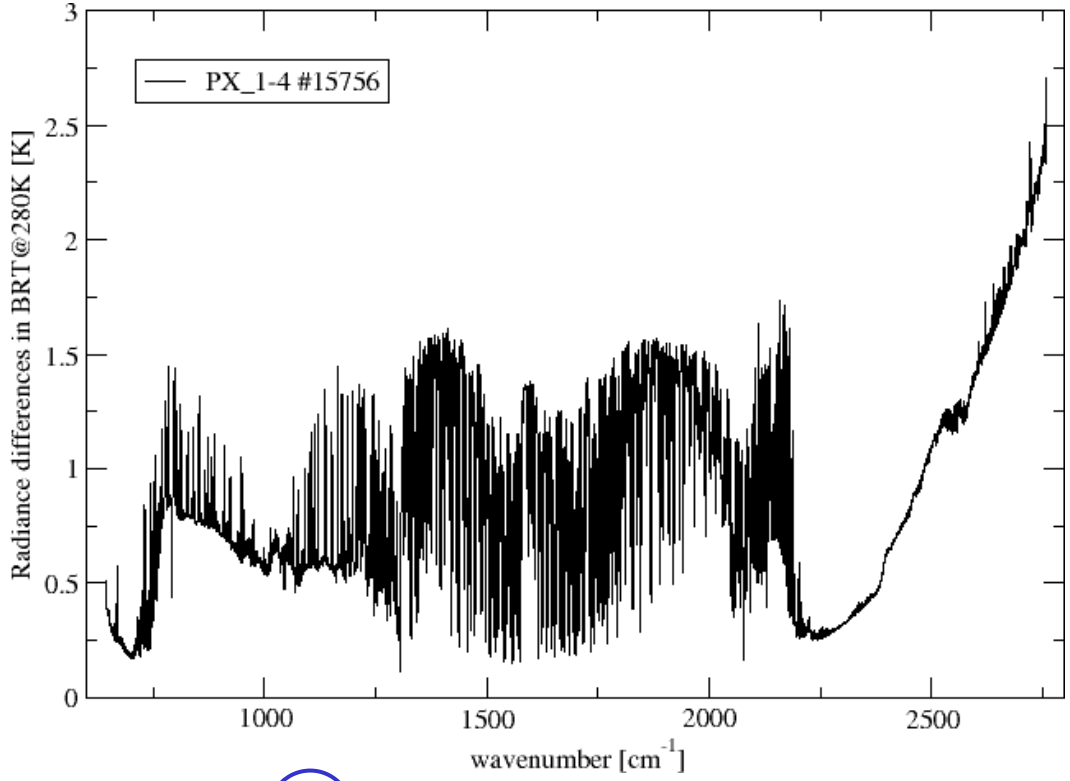
- Taken from IASI L1 NRT monitoring at EUMETSAT Headquarter
- Between 08/04/2007 – 01/06/2007
- Clear sky over sea at night
- 15756 cases

L. Fiedler




Bias

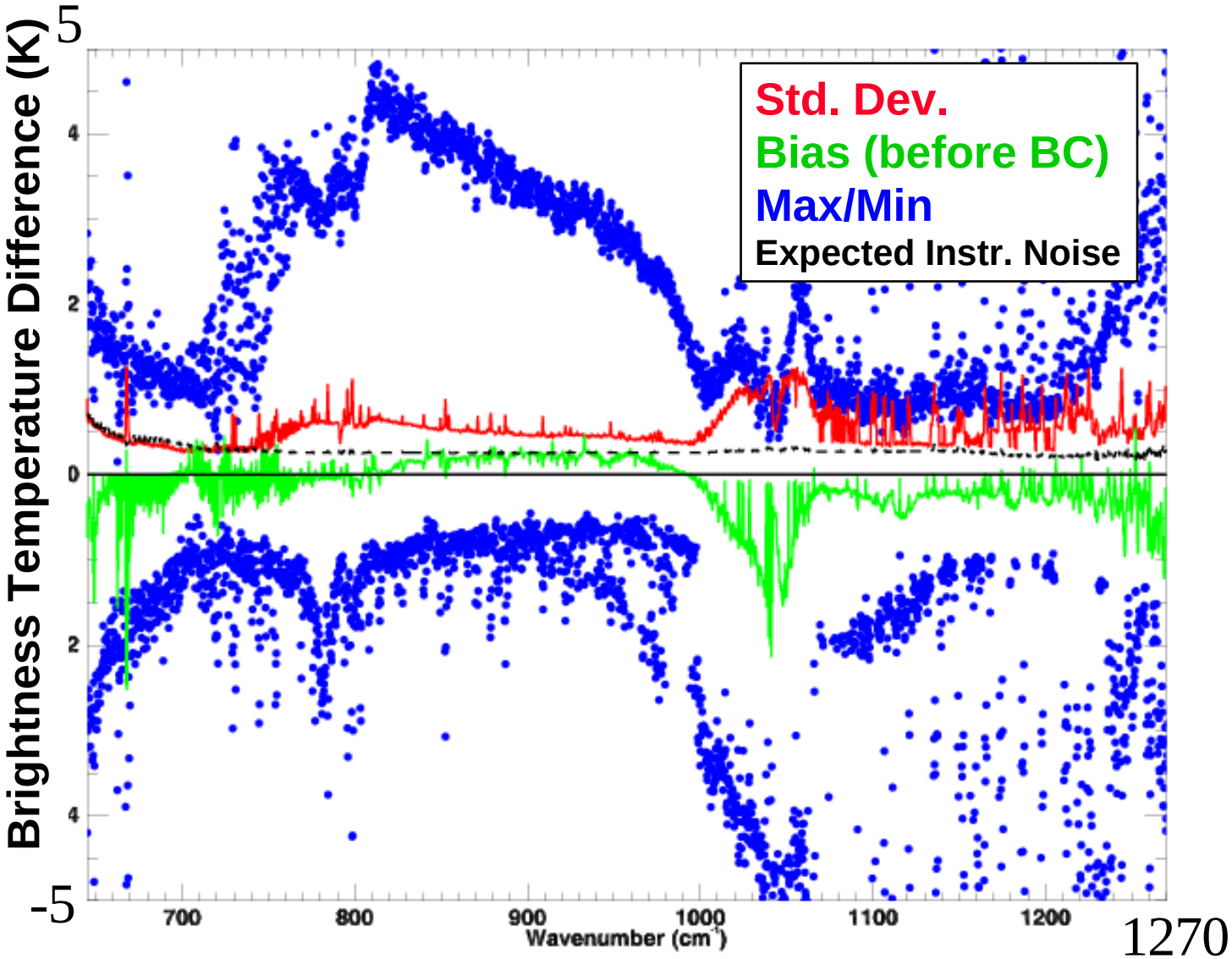
Std. dev.



# Feedback from Bias Monitoring by end users

Full IASI Spectrum – Longwave Band

**Clear Data**

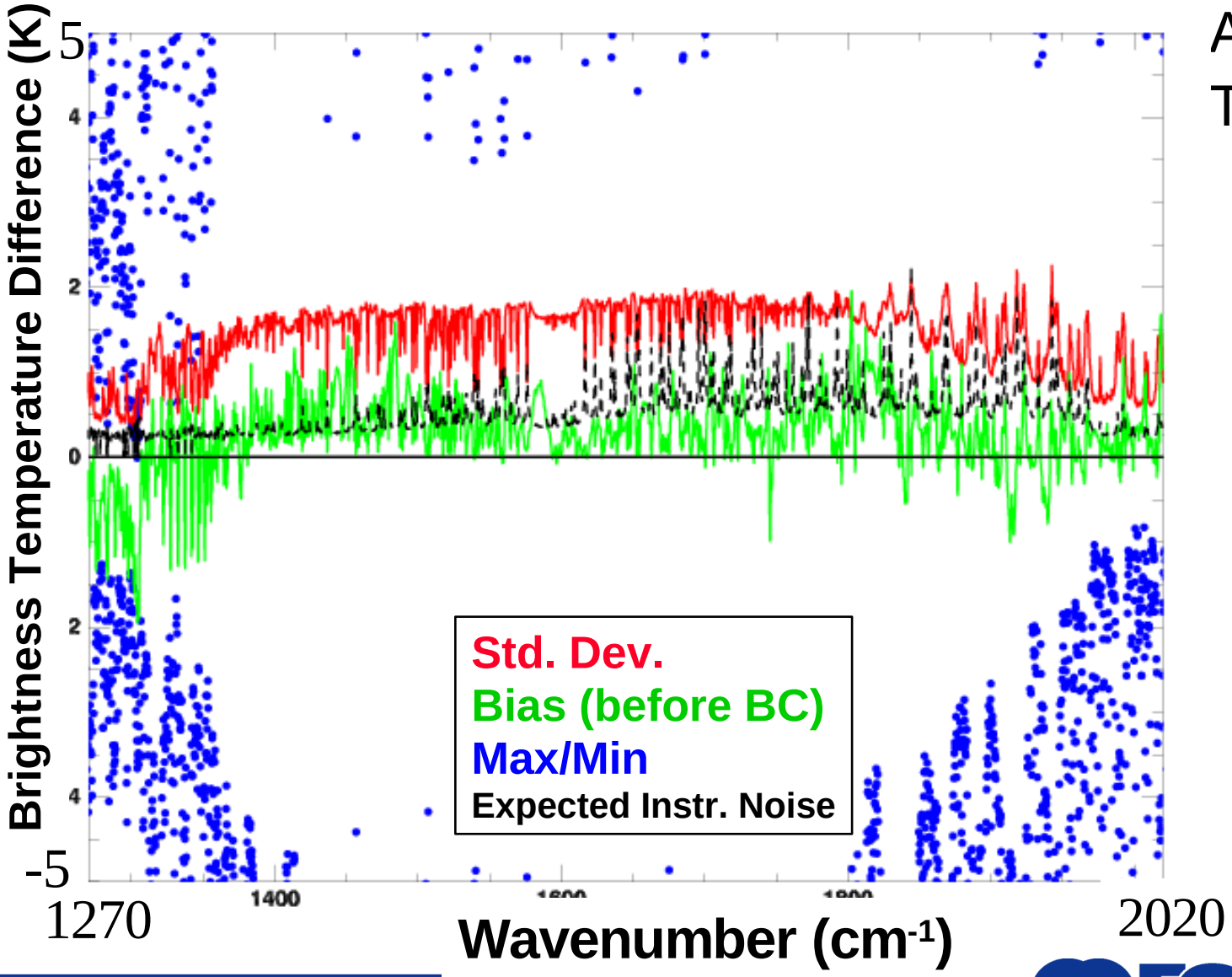



A. Collard
T. McNally

# Feedback from Bias Monitoring by end users

Full IASI Spectrum – Water Band

**Clear Data**

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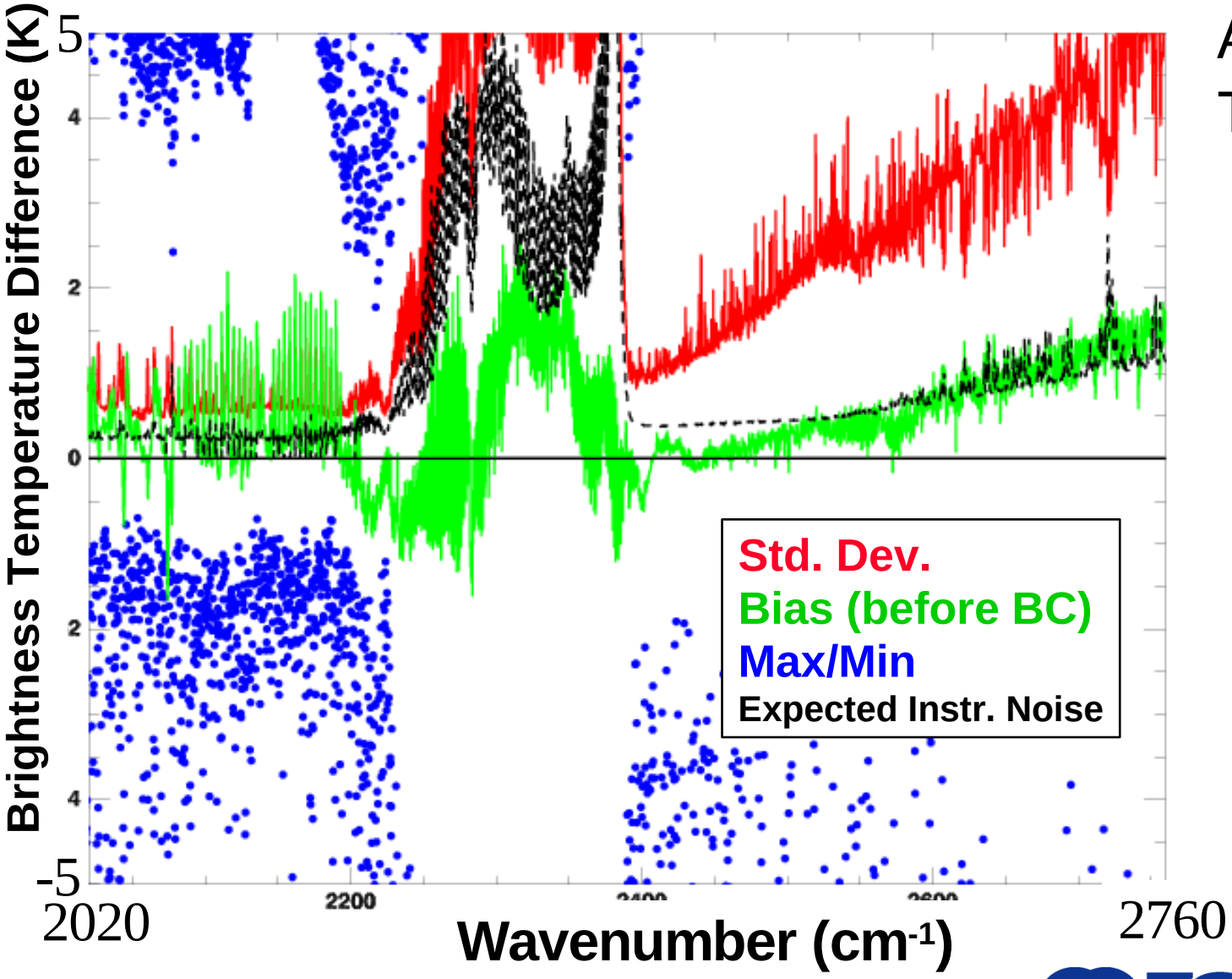
T. McNally

# Feedback from Bias Monitoring by end users

Full IASI Spectrum – Shortwave Band

**Clear Data**




A. Collard
T. McNally

# Conclusion

- After more than 9 months in orbit
  - IASI is performing very well (all mission requirements are met)
  - Instrument and processing
- All performances very stable in the long term
  - Radiometry, spectral, geometry
- L1 commissioning using mainly IASI, AVHRR & HIRS data
  - Some controls done with respect to AIRS and IASI Balloon data
- During the routine phase, IASI Technical Expertise Center (IASI TEC) located in CNES/Toulouse will take care of
  - Performance monitoring
  - Processing parameters updating

In parallel with the short term monitoring performed by the EUMETSAT EPS/CGS

# Backup Slides

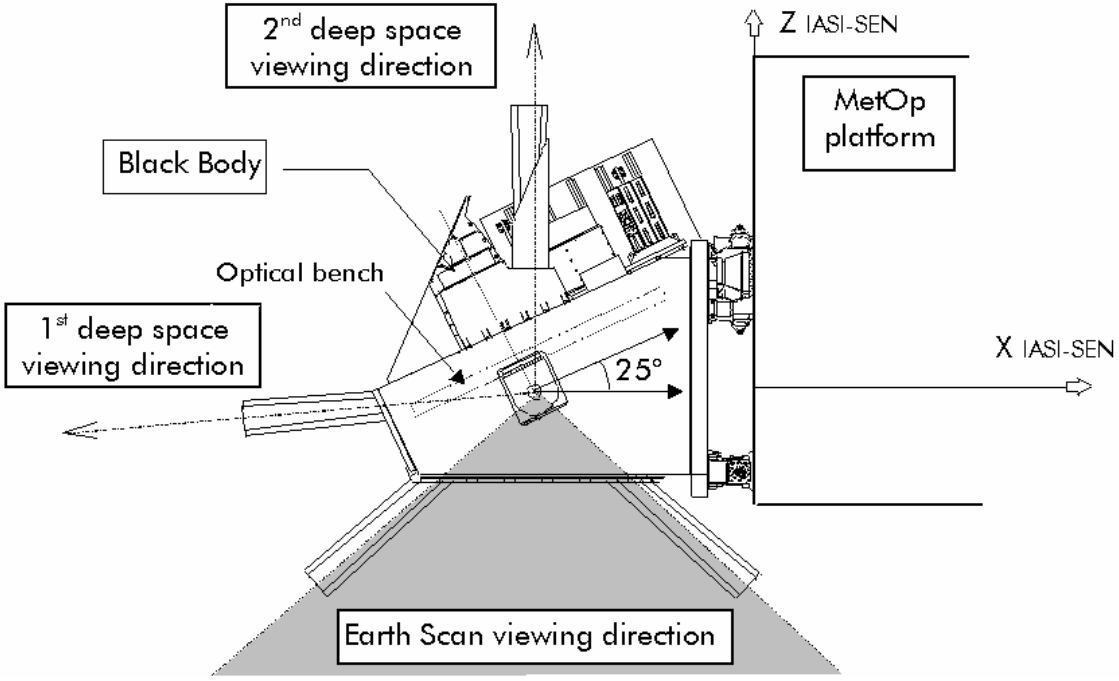
# IASI Radiometric Calibration

Internal Black Body Subsystem

- Effective emissivity :0.996
- Predicted in-flight temperature
  - 295 K +/- 4 K
- Very low earth viewing factor
- Stability of temperature reading (main contributor to performance)
  - 0.05 K

(courtesy Alcatel-Alenia Space)

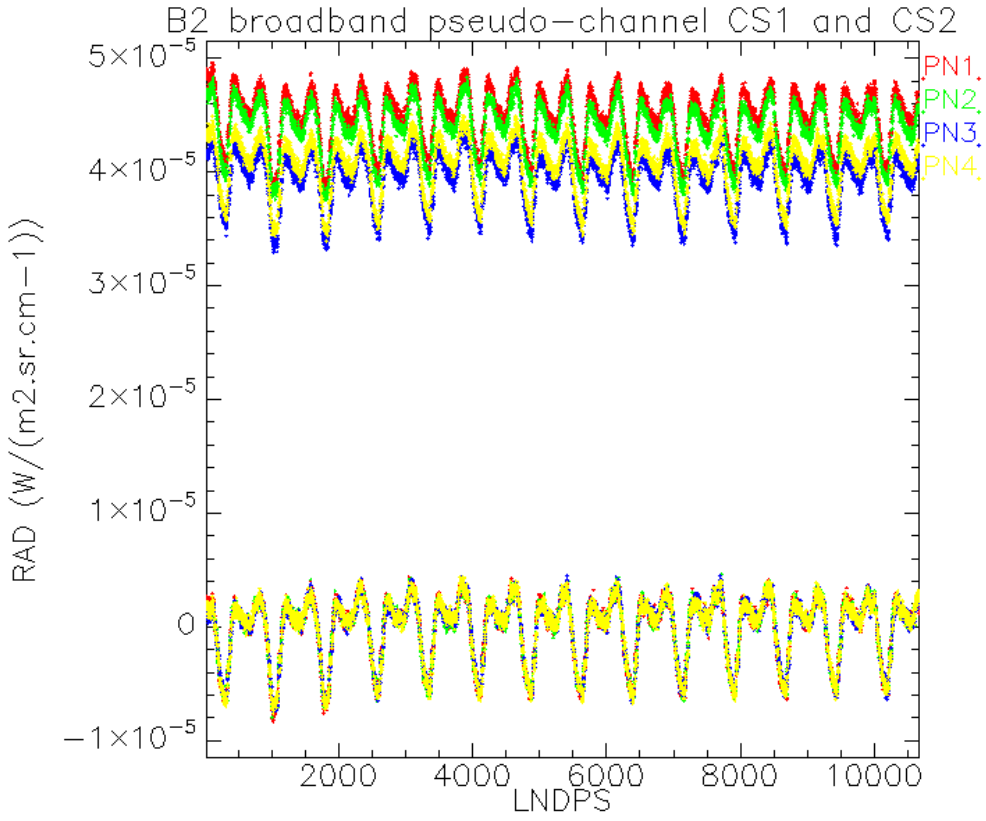
- Calibration period
  - 1 Cold Space view
  - 1 Black Body view
  - every scan line (8 sec)



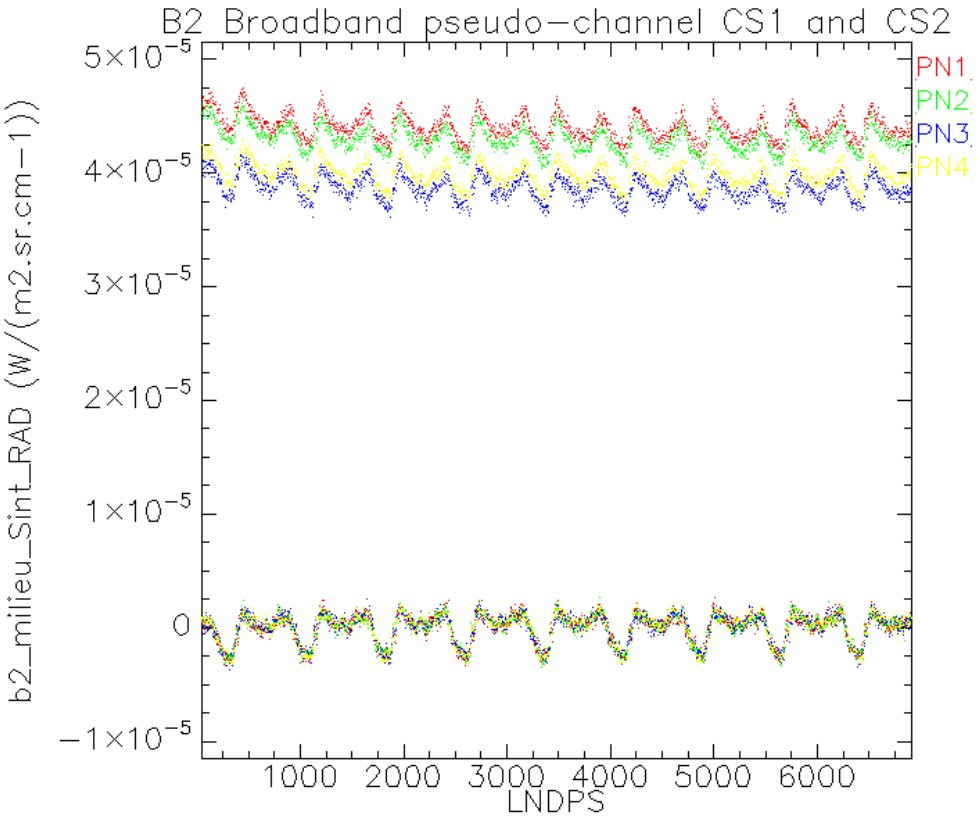

(courtesy Alcatel-Alenia Space)

- Effect of processing parameters update (27th June)

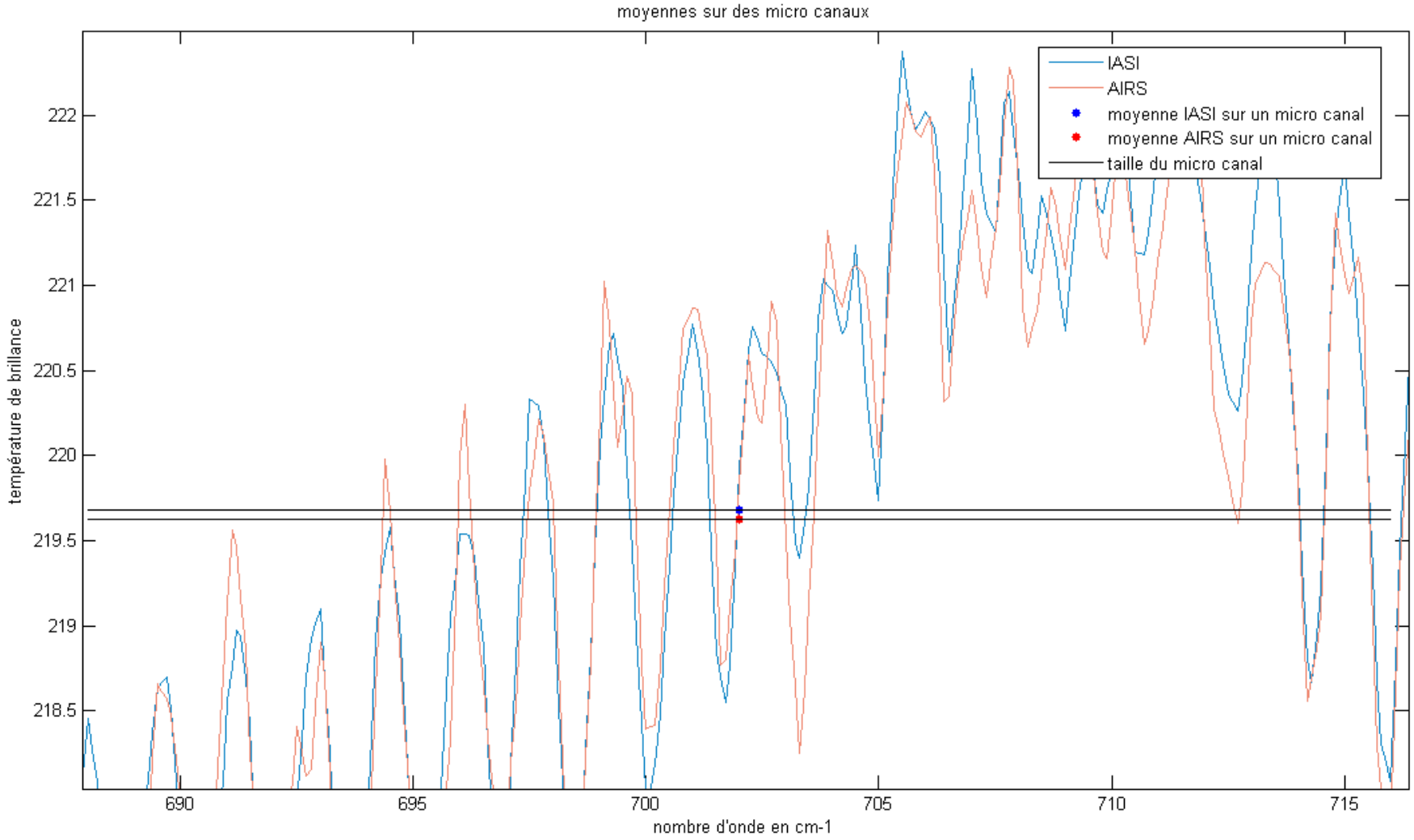
Before




After



# Pseudo-channels : zoom on CO2



# End of Cal/Val A results

- 1st Improvement needed
  - 790, 1125 cm-1
  - H2O low tropo
  - Introduction of pressure shift in 4A-OP
- 2nd improvement
  - IPSF fine characterization
  - On-going (see geometry presentation)