ITSC-22
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Establishing times series of essential climate variables from 3 successive Metop/IASI

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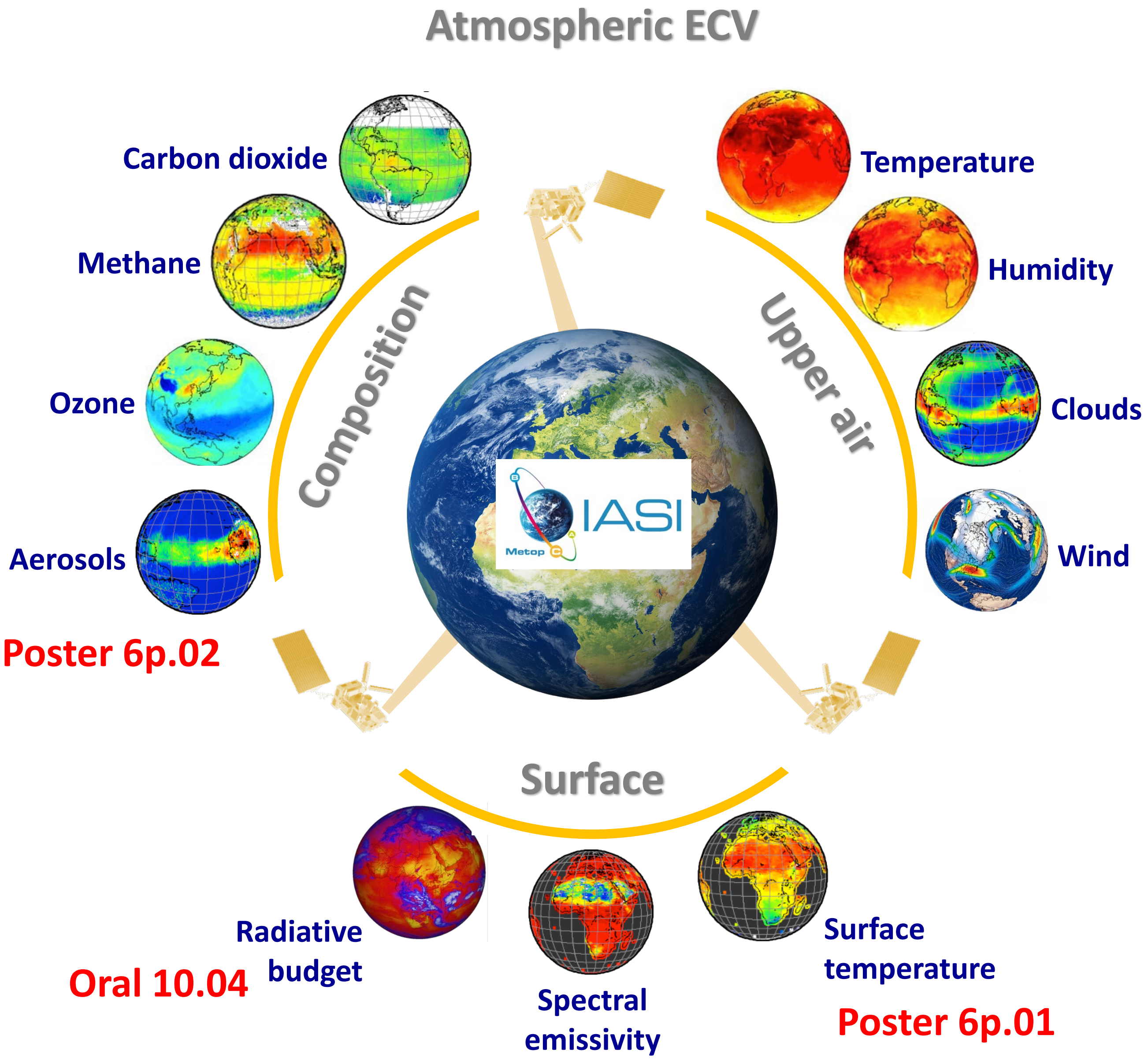
http://ara.abct.lmd.polytechnique.fr

Essential Climate Variables retrieved from IASI



Poster 6p.02

Oral 10.04

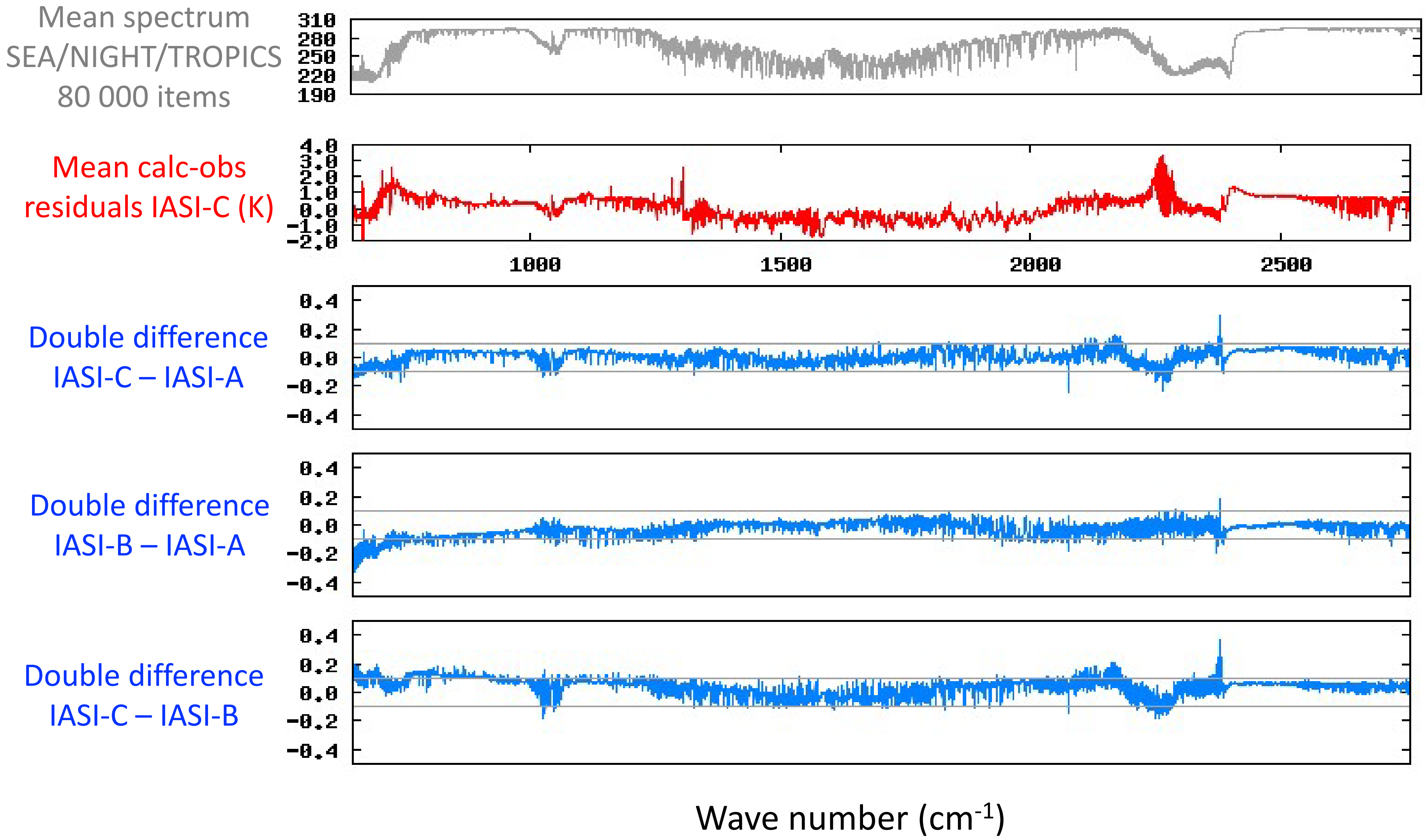
Poster 6p.01

- 3 IASI instruments flying onboard Metop-A (2006-), Metop-B (2012-) and Metop-C (2018-)
- 13 out of 16 of GCOS Essential Climate Variables for Atmosphere are observed simultaneously with IASI.
- Requirements to study climate:
  - Stability of each IASI.
  - Consistency between the successive IASI.
  - At both level1 (radiances) and level2.

Monitoring of IASI L1 with a stand-alone approach during IASI-C commissioning phase

Comparison of BT 'calc-obs' residuals for IASI/Metop-A, B and C

calc = 4A/OP with ECMWF analyses as inputs
obs = IASI-A/B/C

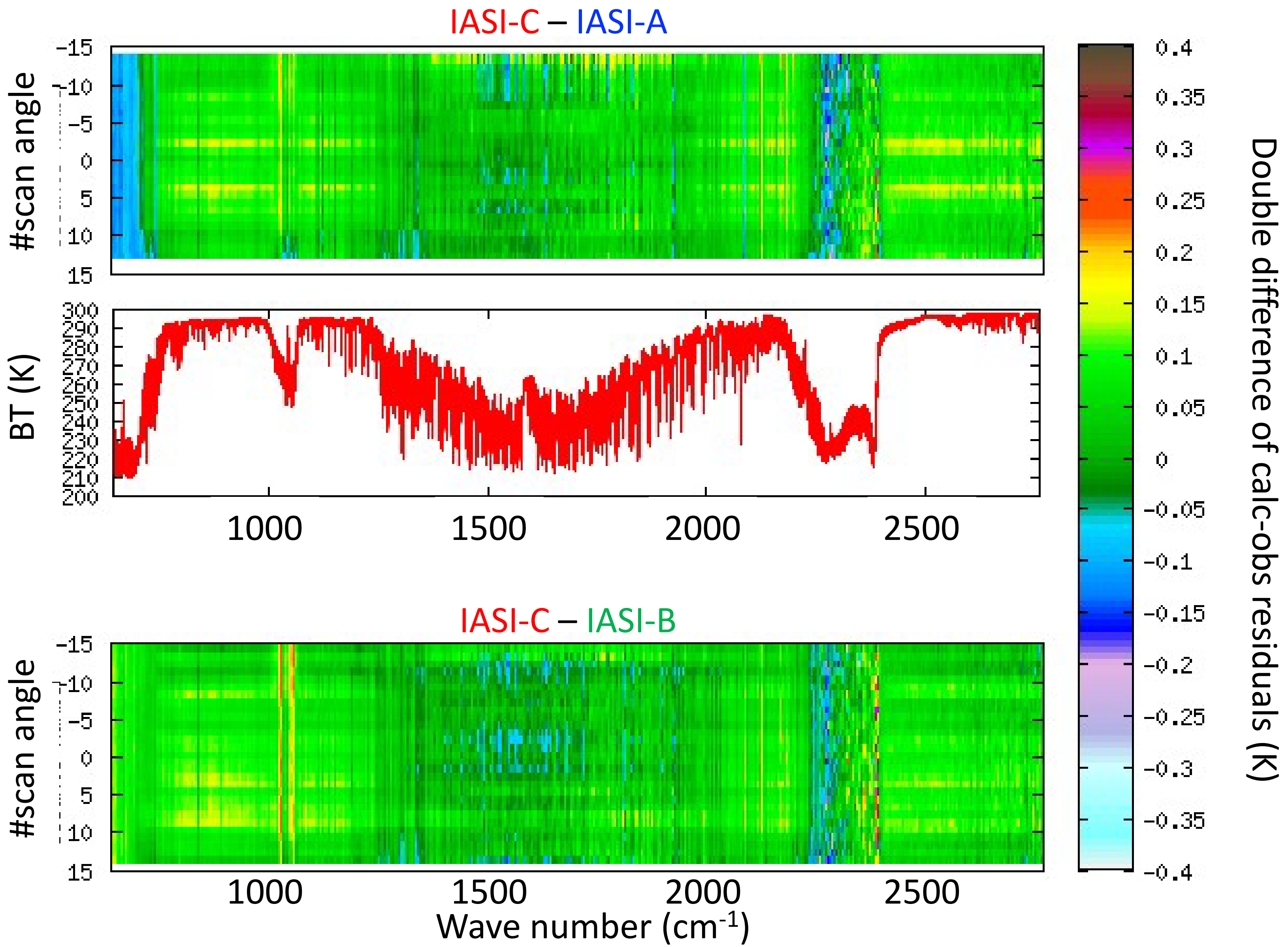


- **Objectives:**
  - identify which instrument might deviate from the other(s).
  - compare wide ranges of BT.
  - study each channel of each instrument, independently.

- **Complements satellite inter-calibration approaches.**

Monitoring of IASI L1 with a stand-alone approach during IASI-C commissioning phase

Hovmöller diagram of Double Differences of 'calc-obs' residuals with scan angle



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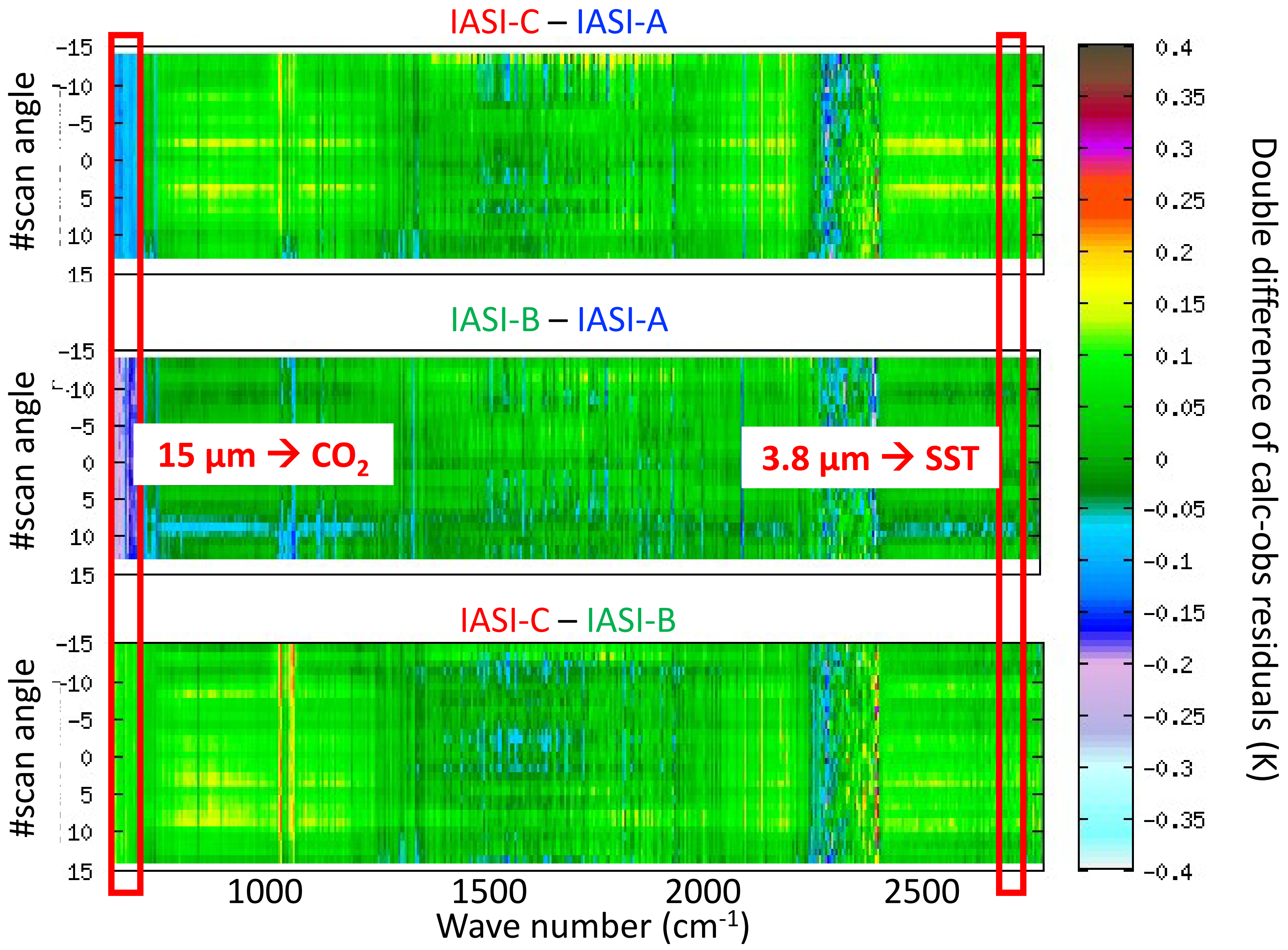
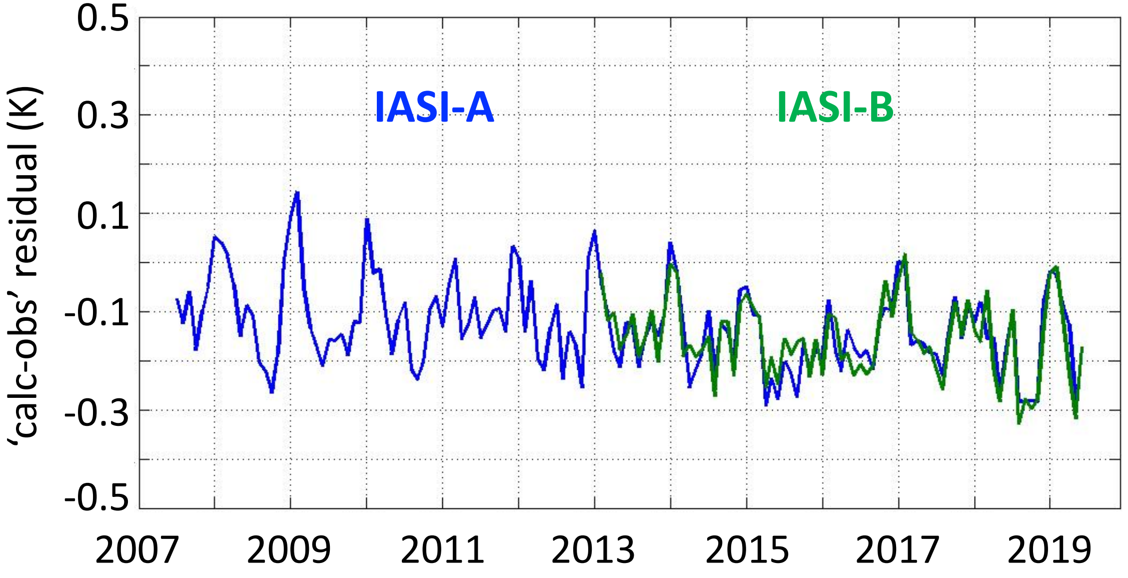
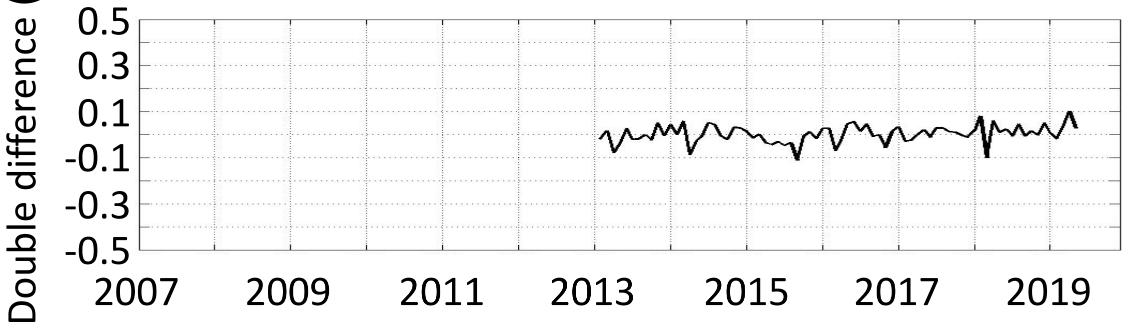


Use of IASI channels @3.8 µm to retrieve Sea Surface Temperature (SST)

'calc- obs' residuals for IASI channel @2700.00 cm^{-1}

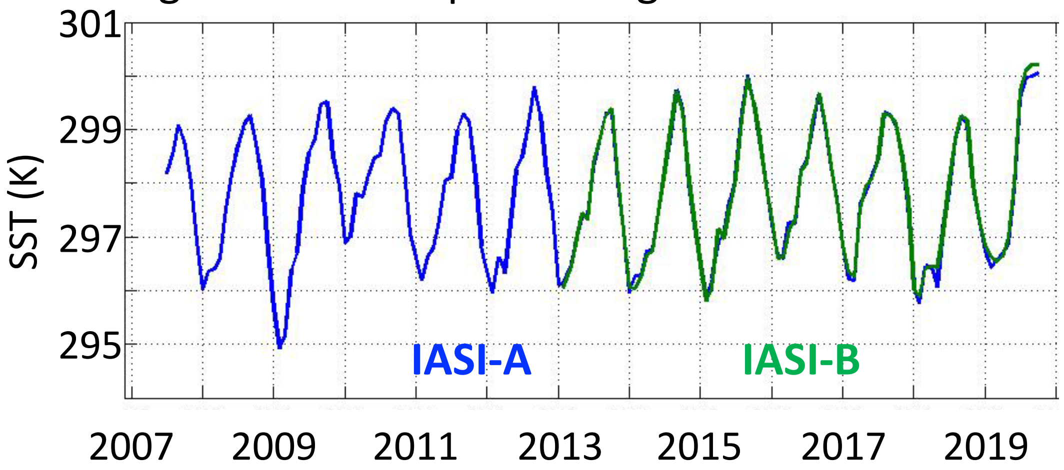


Double difference IASI-A – IASI-B



Sea surface temperature retrieved from 3.8 µm channels

Average over the tropics for nighttime observations



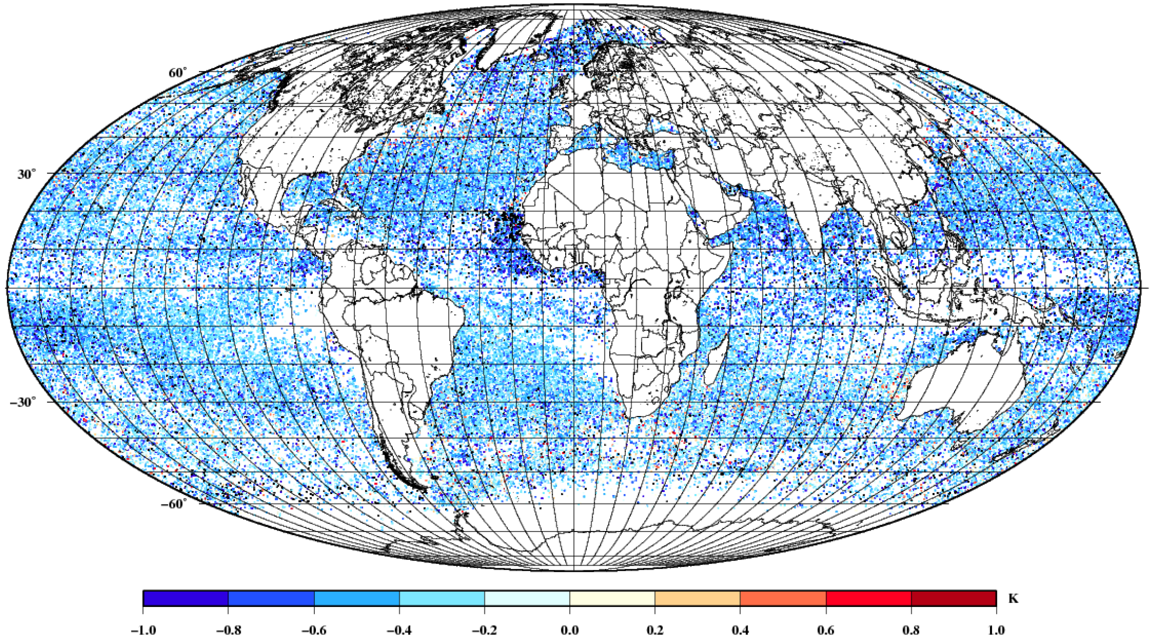
Methodology: Full-physics retrieval

$$T_s = B^{-1}\left(\frac{I_{sat}(\lambda_0,\theta) - \int_{\tau_s(\lambda_0,\theta)}^{1} B[\lambda_0, T(\tau(\lambda_0,\theta))]\,d\tau - (1-\varepsilon_s(\lambda_0))\,\tau_s(\lambda_0,\theta)\int_{\tau_s(\lambda_0,\theta)}^{1} B[\lambda_0, T(\tau'(\lambda_0,\theta))]\,d\tau'}{\varepsilon_s(\lambda_0)\,\tau_s(\lambda_0,\theta)} \right)$$

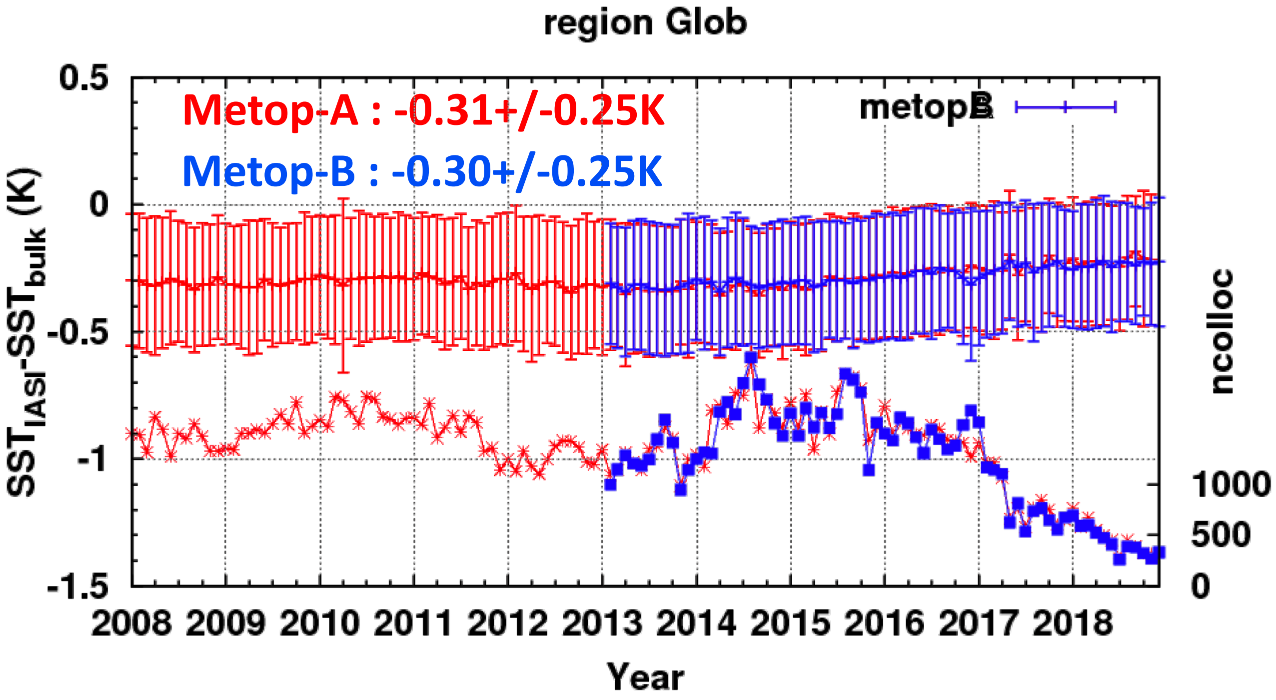
See poster 6p.01 by Virginie Capelle

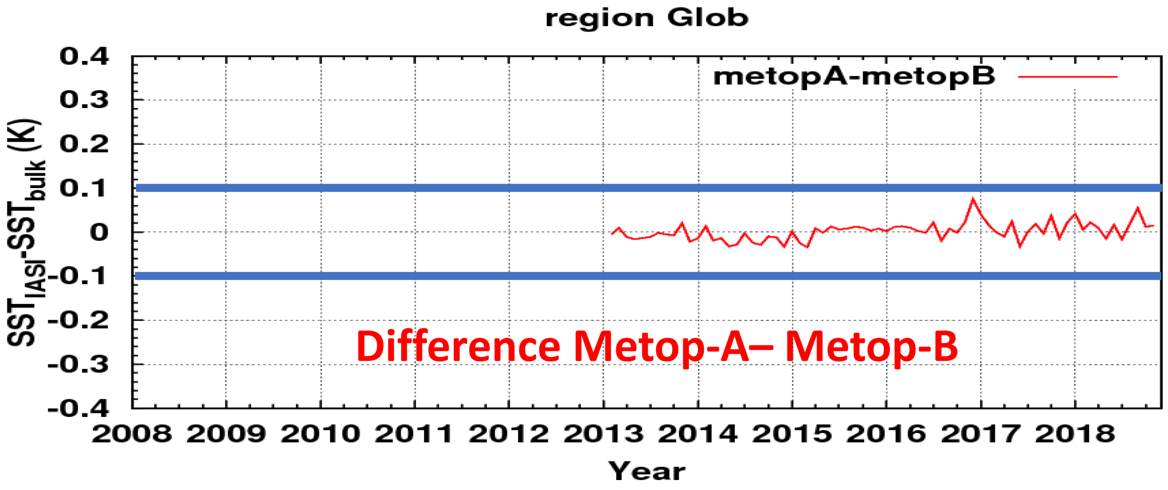
Evaluation of IASI SST against bulk SST from buoyes

~300.000 colocations over 2008-2018 between IASI-A/B and NOAA IQUAM buyoes (night, clear, nadir)



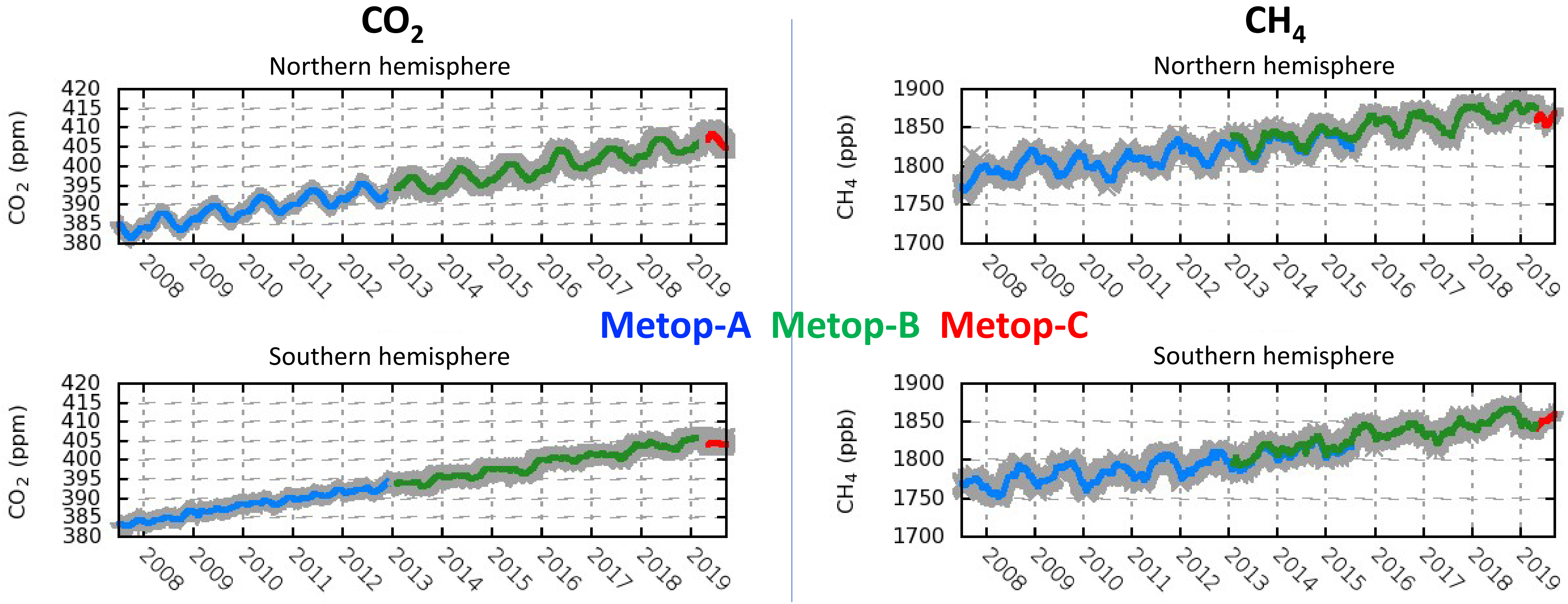
SST_IASI - SST_bulk





Capelle et al., in prep.

Monitoring of anthropogenic greenhouse gases



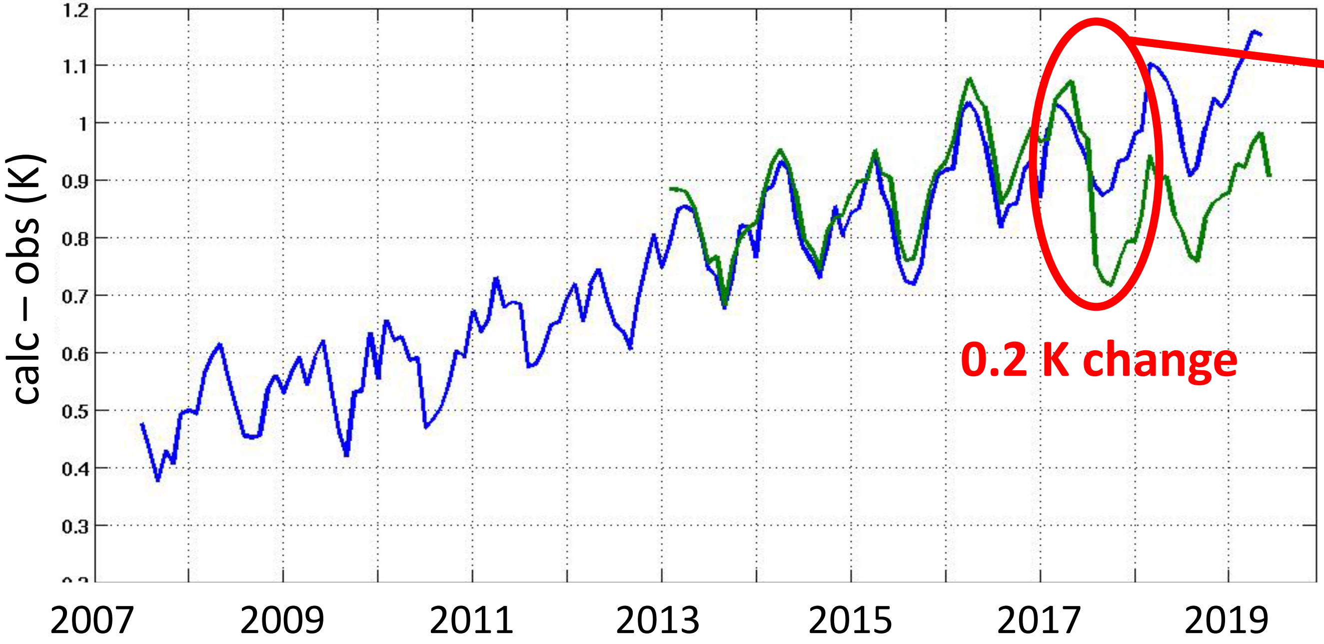
- Methodologie: non linear inference scheme (Crevoisier et al., 2009, 2018)
- 12 year trend for:
  - CO_2: +2.1 ppm yr^{-1}
  - CH_4: +8.2 ppb yr^{-1}
- Excellent agreement with in-situ measurements

A somehow unexpected event

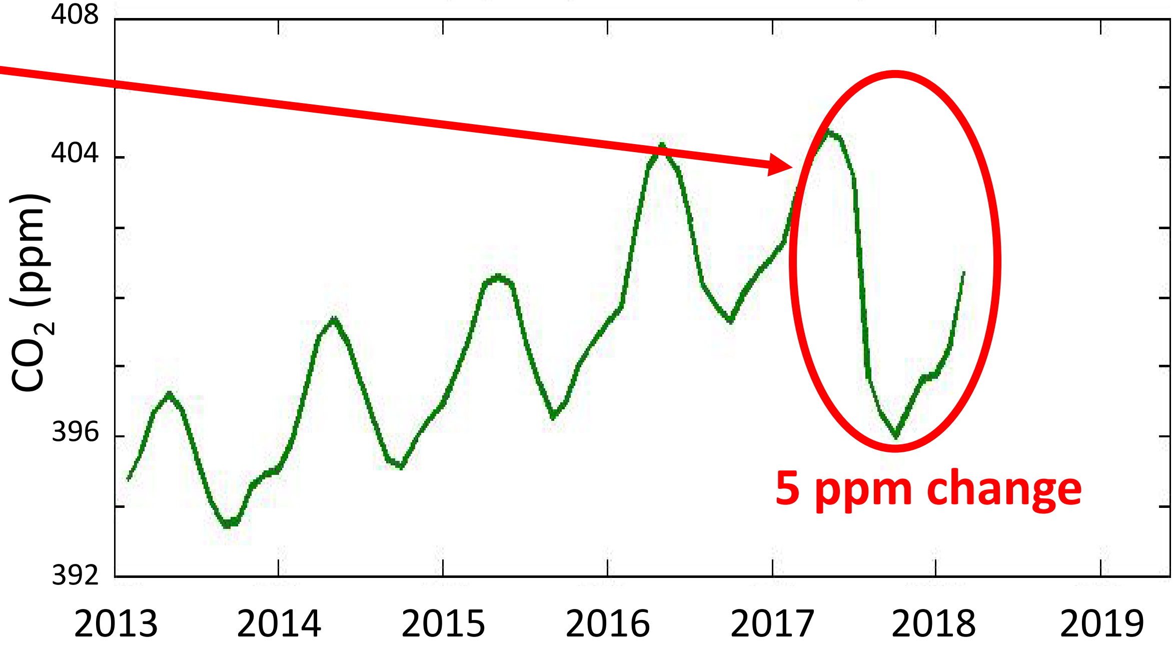
Monitoring of Metop-B IASI channel at 691.00 cm^{-1}

Calc = 4A + radiosoundings (ARSA database) + fixed CO_2

Obs = IASI-A and IASI-B



Mid-tropospheric CO_2 from IASI/Metop-B



- **2nd August 2017**: change in the correction of the non linearity of IASI/Metop-B detectors
- Bias of 0.2K for 15µm CO_2 channels → a 5 ppm bias on CO_2 !!
- A 'NL Task Force' was put in place by ISSWG in 2017 to fully characterize the change.

  → Computation of radiative biases to take into account the change in IASI-B.

Note: same correction applied to IASI/Metop-A on Sept. 30th 2019 and to IASI/Metop-C before launch.

A somehow unexpected event

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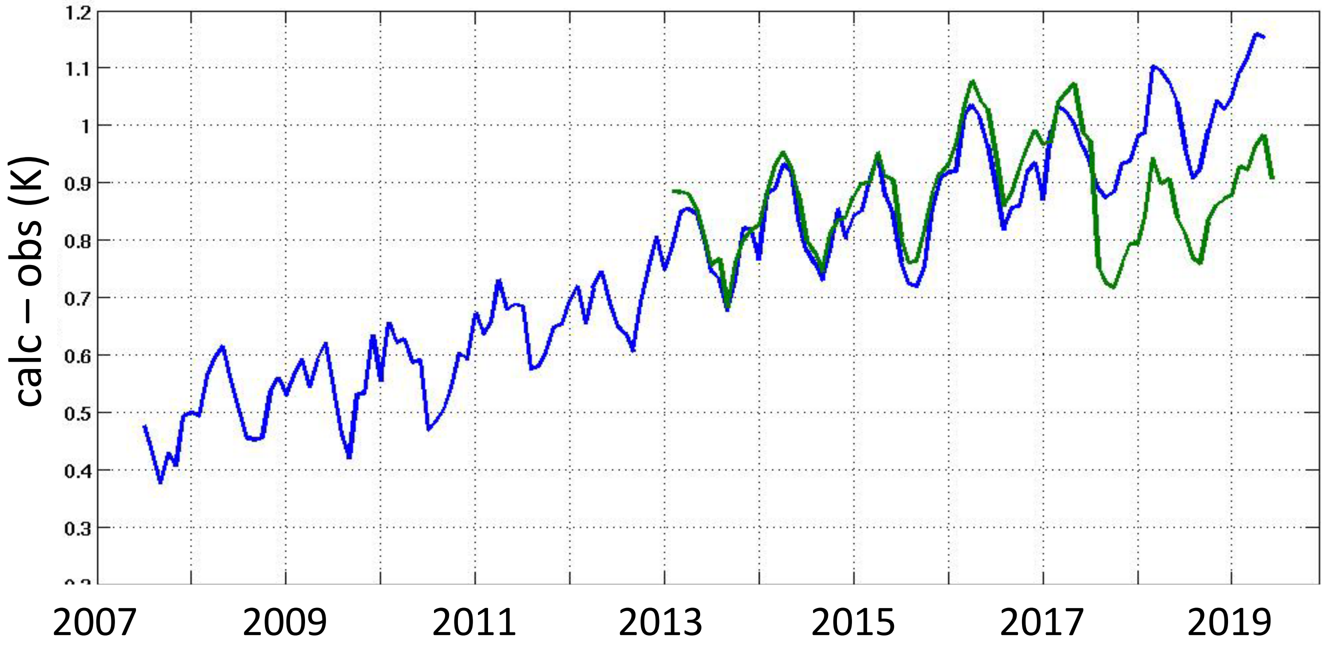

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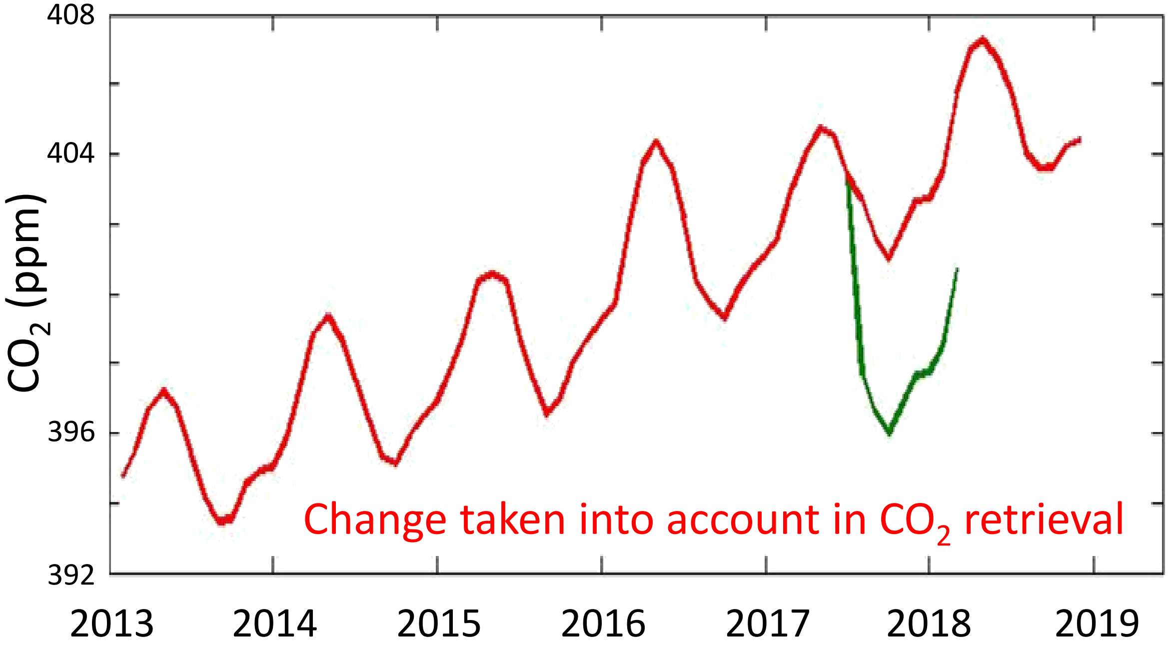

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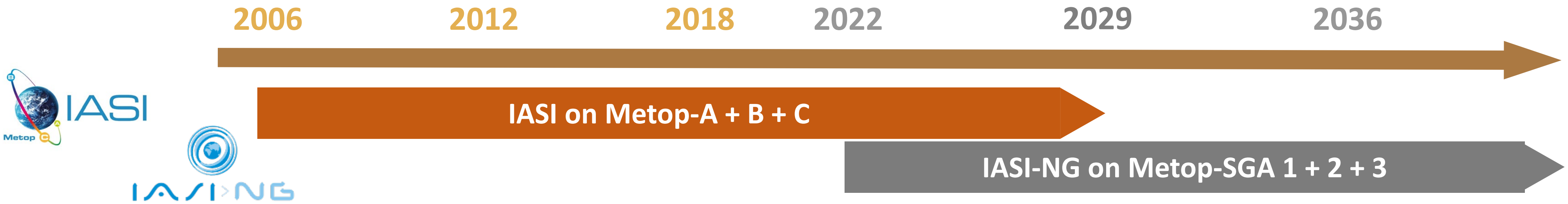
Conlusion

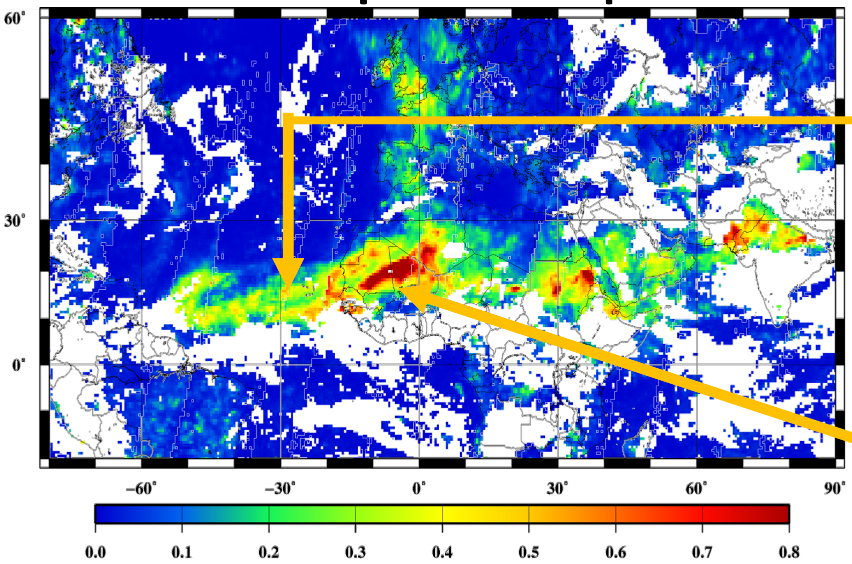
- The IASI instruments have shown exceptional radiometric and spectral stabilities, with an agreement between the 3 instruments within 0.15 K at level 1.
- Homogeneous time series of ECVs between the 3 IASI.
- However, keeping with these performances requires:
  - the continuous monitoring of the instruments:
    - through the association of stand-alone, inter-calibration and double differences approaches to identify unexpected or undesired radiance behaviours.
    - Needs: permanent validation of all the steps involved in these procedures (RT code, spectroscopy, cal/val datasets, etc.).
  - the documentation and archiving of all relevant information on calibration changes.

- Providing IASI-NG displays similar outstanding characteristics, this opens the way to more than 40 years of monitoring of ECVs at the accuracy required for climate studies.

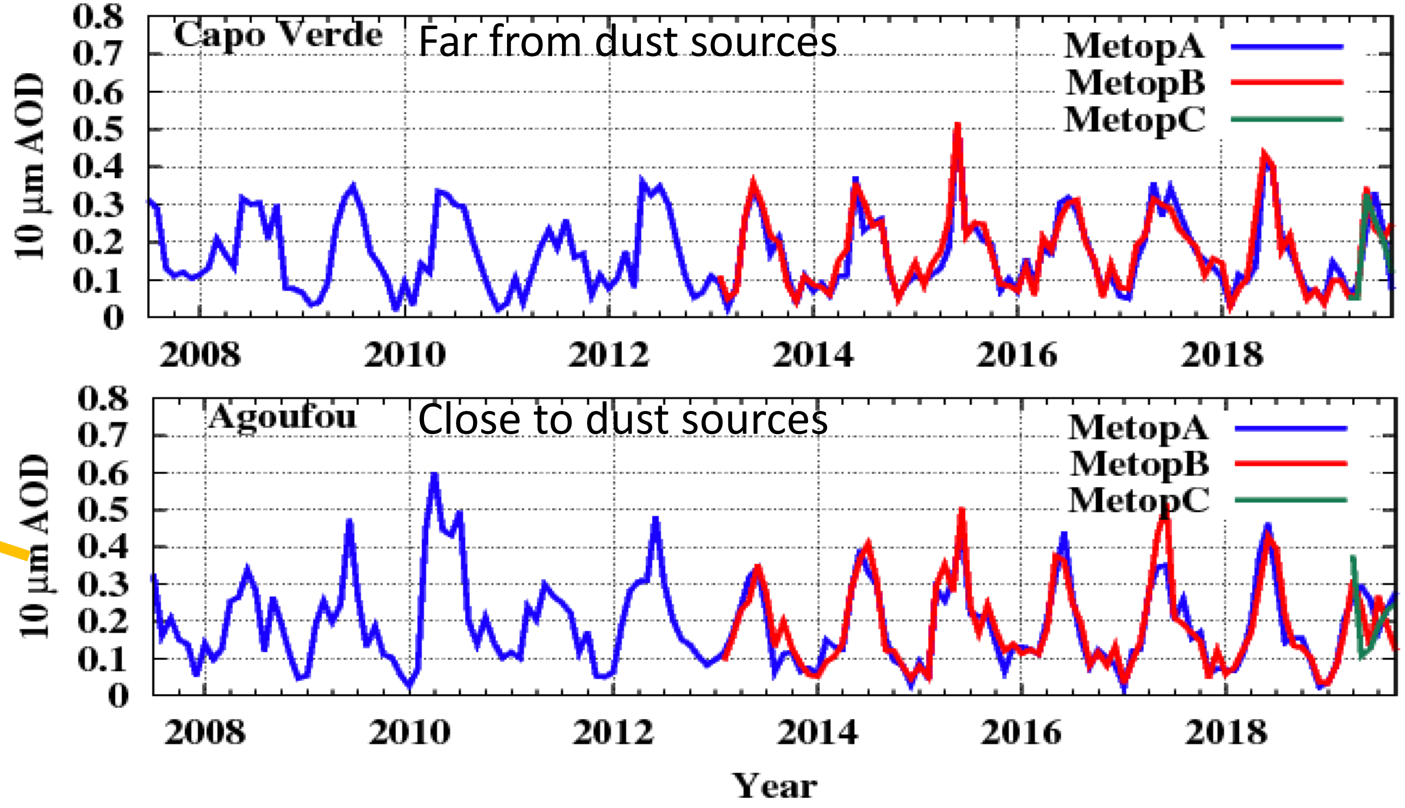


Dust aerosols: An example of the impact of a shift in orbit

Metop-B + Metop-A



Dust AOD at 10µm from IASI-A, IASI-B and IASI-C



- Excellent agreement between the 3 IASIs far from large dust sources.
- Some differences can be seen when looking at regions of major sources

  → This comes from the different orbits of Metop-B compared to Metop-A and C.