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

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Essential Climate Variables retrieved from IASI

- 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

\[ \text{calc} = \frac{4A}{OP} \text{ with ECMWF analyses as inputs} \]
\[ \text{obs} = \text{IASI-A/B/C} \]

- **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.**

Mean spectrum
SEA/NIGHT/TROPICS
80,000 items

Mean calc-obs residuals IASI-C (K)

Double difference
IASI-C – IASI-A

Double difference
IASI-B – IASI-A

Double difference
IASI-C – IASI-B

Wave number (cm\(^{-1}\))
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

- IASI-C – IASI-A
- IASI-C – IASI-B

BT (K)

Wave number (cm\(^{-1}\))

Double difference of calc-obs residuals (K)
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Hovmöller diagram of Double Differences of ‘calc-obs’ residuals with scan angle

- IASI-C – IASI-A
- IASI-B – IASI-A
- IASI-C – IASI-B

### Wave number (cm⁻¹)

- 1000
- 1500
- 2000
- 2500

### Scan angle

- -15
- -10
- -5
- 0
- 5
- 10
- 15

### Double difference of calc-obs residuals (K)

#### 3.8 µm → SST

#### 15 µm → CO₂
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

\[
T_s = B^{-1} \left( I_{\text{mt}}(\lambda_0, \theta) - \frac{\int B[\lambda_0, T(\tau(\lambda_0, \theta))]d\tau}{r_s(\lambda_0, \theta)} - (1 - \varepsilon_s(\lambda_0)) \tau_s(\lambda_0, \theta) \int B[\lambda_0, T(\tau'(\lambda_0, \theta))]d\tau' \right) - \varepsilon_s(\lambda_0) \tau_s(\lambda_0, \theta)
\]

See poster 6p.01 by Virginie Capelle
~300,000 colocations over 2008-2018 between IASI-A/B and NOAA IQUAM buoys (night, clear, nadir)

SST_IASI - SST_bulk

Capelle et al., in prep.
Monitoring of anthropogenic greenhouse gases

- Methodology: 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\(^{-1}\)

\[\text{Calc} = 4A + \text{radiosoundings (ARSA database)} + \text{fixed CO}_2\]

\[\text{Obs} = \text{IASI-A and IASI-B}\]

- **2\text{nd} 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. 30\text{th} 2019 and to IASI/Metop-C before launch.
A somehow unexpected event

Monitoring of Metop-B IASI channel at 691.00 cm⁻¹

Calc = 4A + radiosoundings (ARSA database) + fixed CO₂
Obs = IASI-A and IASI-B

- 2nd August 2017: change in the correction of the non linearity of IASI/Metop-B detectors
- Bias of 0.2K for 15µm CO₂ channels → a 5 ppm bias on CO₂ !!
- 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.
• 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

- 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.