Monitoring and Assimilation of IASI Radiances at ECMWF

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ECMWF
Overview

- Introduction
- Assimilation Configuration
- IASI First Guess Departures
- IASI Forecast Impacts
- The Future
- Conclusions
Introduction
## IASI Timeline

<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
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<tbody>
<tr>
<td>19\textsuperscript{th} Oct. 2006</td>
<td>MetOp Launch</td>
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<td>8\textsuperscript{th} Feb. 2007</td>
<td>First individual orbits available to NWP centres</td>
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<td>27\textsuperscript{th} Feb. 2007</td>
<td>NRT distribution of data to NWP centres via EUMETCAST</td>
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<td>2\textsuperscript{nd} Apr. 2007</td>
<td>Major modification to Level-1c processing at EUMETSAT</td>
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<td>12\textsuperscript{th} June 2007</td>
<td>IASI assimilated operationally at ECMWF</td>
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<tr>
<td>18\textsuperscript{th} Jul. 2007</td>
<td>EUMETSAT declare IASI operational</td>
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Assimilation Configuration
Current Operational Configurations

AIRS
- Operational at ECMWF since October 2003
- 324 Channels Received in NRT
- One FOV in Nine
- Up to 155 channels may be assimilated (CO₂ and H₂O bands)

IASI
- Operational at ECMWF since 12th June 2007
- 8461 Channels Received in NRT
- All FOVS received; Only 1-in-4 used (FOV 1)
- 366 Channels Routinely Monitored
- Up to 168 channels may be assimilated (CO₂ band only)
Assimilation Configuration: Channel Selection
Why Select Channels?

- The volume of IASI data available is such that we do not have the computational resources to simulate and assimilate all these data in an operational timeframe.
- Not all channels are of equal use when assimilated into an NWP system.
- We choose channels that we wish to monitor (often with a view to future use).
- We choose a subset of these channels which we actively assimilate.
IASI Channel Selection

- All IASI channels are distributed to European Users via EUMETCAST. Distribution of IASI radiances via GTS is for 300 channels chosen according to Collard (2007).

- At ECMWF, for IASI we use the 300 channels above plus a further 66 channels.

- These are the channels that are routinely monitored – not all are actively assimilated.

Collard (2007) ECMWF Technical Memorandum 532
Selected Channels (2)
AIRS 324 vs IASI 366

The graph compares the brightness temperature of AIRS 324 and IASI 366 across different wavelengths in microns. The inset highlights specific regions of interest, showing the differences and similarities between the two datasets.
Comparison of Actively Assimilated Channels (1)
Comparison of Actively Assimilated Channels (2)

σ_{obs} = 1.0 K

σ_{obs} = 0.4 K
Jacobians of 15μm CO₂ Band

Active Channels

Passive Channels

Unmonitored Channels

Temperature Jacobian (K/K)

Pressure (hPa)
Assimilation Configuration: Cloud Detection
Cloud detection scheme for Advanced Sounders

A non-linear pattern recognition algorithm is applied to departures of the observed radiances spectra from a computed clear-sky background spectra. This identifies the characteristic signal of cloud in the data and allows contaminated channels to be rejected.
Number of Clear Channels

High Peaking Channels

Window Channels
Cloud Detection Software is Available

- Cloud detection has been re-written to allow greater portability and to allow cloud detection of IASI

- *It is available for all to use from the NWPSAF*

Evolution of Bias Correction

Ch 280 NH

Level 1 Processor Change

Nadir Scanning Mode

Used Data Number
FG or AN Departure (K)

Evnto (DA) : IAS1_Tb Ch 280 Northern Hemisphere
St. dev. and bias (undefined) O3-FG (red) CB-AN (blue) BIASCOR (mean) +0.31

All data

Daily used observations (green) 4 days MA (black)
IASI First Guess Departures
Looking at First Guess Departures

- **Observed Radiances** minus **Radiances Predicted from Short Range Forecast from Previous Cycle**
- **First Guess Departures** drive the increments

In the following slides:
- **Clear-sky first guess departures**
- **The cloud detection uses the operational bias-correction**
- **The first-guess departures are NOT bias-corrected**
First Guess Departure Biases in 15 μm CO₂ Band

Ordered by Wavenumber

Ordered by Jacobian Peak Pressure
First – Guess Departure
Standard Deviations in
15 μm CO₂ Band

Calculated Std. Dev.

Observed Std. Dev.
First Guess Departure Standard Deviations and Biases in the Longwave Window

![Graph showing bias and standard deviation in the longwave window.](image)

- **Active Channels**
- **Passive Channels**
- **Water Vapour Channels**
- **Ozone Channels**

Bias

Standard Deviation
First-Guess Departure Biases in Water Band

- Passive Channels
- Extra Monitoring Channels
- Ozone Channels
- CO Channels
- CH₄ Channels
- N₂O Channels

Bias (K) vs. Wavenumber (cm⁻¹)
First-Guess Departure Standard Deviations in Water Band

![Graph showing standard deviations in water band with different channels labeled: Passive Channels, Extra Monitoring Channels, Ozone Channels, CO Channels, CH₄ Channels, N₂O Channels. The graph compares calculated and observed standard deviations across wavenumbers.]
First-Guess Departure
Standard Deviations in Shortwave Band

Expected Noise (K)

Standard Deviation (K)

Wavenumber (cm⁻¹)

Passive Channels
Extra Monitoring Channels
Water Vapour Channels
CH₄ Channels
N₂O Channels

Observed Std. Dev.

Calculated Std. Dev.
IASI Forecast Scores: 500 hPa Geopot. AC

NH

IASI Better

SH

IASI Worse
Map of RMS Forecast Error Differences
3-Day 500 hPa Geopotential Height (m)

Thursday 8 March 2007 00UTC ECMWF Forecast t+72 VT: Sunday 11 March 2007 00UTC 500hPa **Geopotential***

IASI Worse

3rd March-16th May 2007
Next Steps and Conclusions
Next Steps

- Use the water vapour band
- Use over land
- Review assumed observation errors
- Cloud affected radiances
- Use of compressed data
Conclusions

- IASI is performing as expected
- The initial ECMWF implementation has focussed on the areas most likely to give positive impact (based on AIRS experience)
- IASI is providing positive impact on forecast scores – even using a system where AIRS is already used
Merci