Recent developments in the use of ATOVS data at ECMWF

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Current use of ATOVS data

Channels used:

HIRS: channel 4-7, 11, 14, 15 over sea; 12 over sea+low orography only
AMSU-A: channels 5,6 over sea+low orography; 7-14 land+sea
AMSU-B/MHS: channel 5 over sea only; 3,4 sea+low orography

<table>
<thead>
<tr>
<th>Satellite</th>
<th>HIRS (2 used)</th>
<th>AMSU-A (5 used)</th>
<th>AMSU-B/MHS (3 used)</th>
<th>EARS (except HIRS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NOAA-15</td>
<td>no: unstable (not ch 6, 11, 14)</td>
<td>yes</td>
<td>no: quality</td>
<td>yes</td>
</tr>
<tr>
<td>NOAA-16</td>
<td>no: unstable (not ch 5-7/8)</td>
<td>yes</td>
<td>no: quality</td>
<td>yes</td>
</tr>
<tr>
<td>NOAA-17</td>
<td>yes</td>
<td>Instrument failed</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>NOAA-18</td>
<td>no: unstable</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>AQUA</td>
<td>n/a</td>
<td>yes (not ch 5-7)</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>METOP-A</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>n/a</td>
</tr>
</tbody>
</table>
Use of METOP-A AMSU-A/MHS data

Impact on 3-day forecast of 500 hPa geopotential: EXP – CTL, 19 cases
Normalised difference in the RMS forecast error for 500 hPa geopotential.

Small positive impact over Southern Hemisphere from adding METOP data as 5th AMSU-A, and 4th AMSU-B/MHS.

METOP AMSU-A & MHS data used operationally since 11 January 2007.
ATOVS developments

In operations:
- Update to AMSU-A RTTOV coefficients (no Zeeman effect)
- Zero bias in AMSU-A channel 14

Under development:
- Improved use of surface-sensitive AMSU-A/B/MHS channels over land (poster by Blazej Krzeminski)
- Revised bias correction for HIRS & AIRS short-wave channels
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1. Update to AMSU-A RTTOV coefficients (no Zeeman effect)
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2. Zero bias in AMSU-A channel 14
3. Revised bias correction for HIRS & AIRS short-wave channels
Transition from SSU to AMSU-A in ERA-40

SSU ch 3 assimilated blacklisted

Weighting functions
Green: SSU3 on NOAA-11
Blue: AMSU-A14 on NOAA-15
Radiance difference between collocated SSU and AMSU-A data

Radiance difference (SSU3 on NOAA-11 - AMSU-A14 on NOAA-15)

Simultaneous observations over Antarctica

Blue: observed differences
Red: computed by RTTOV

Radiance difference between SSU3 on NOAA-11 and AMSU-A14 on NOAA-15 at SNO over Antarctica

Blue: observed differences
Red: computed by RTTOV
Line shapes in the presence of a magnetic field

Attenuation rate (dB/Km) of the O2 microwave line K=11- for the magnetic field strength B=0.6e-4(T)

- 0.001hPa
- 0.010hPa
- 0.100hPa
- 0.290hPa
- 0.690hPa
- 1.420hPa

Frequency (GHz)
Impact of the Zeeman splitting effect on the weighting function

Weighting functions (U.S. Standard Atmosphere 1976)

Weighting functions for AMSU-A channel 14 computed by line-by-line models
Consistency between SSU and AMSU-A

Figure: Radiance difference between SSU3 on NOAA-11 and AMSU-A14 on NOAA-15 at SNO over Antarctic

Blue: observed difference

Red (left): difference computed by old RTTOV

Red (right): difference computed by LBL model without Zeeman effect
Impact of the new RTTOV coefficients on stratospheric temperature analysis

Temperature analysis averaged from 60S to 90S, current RTTOV coefficients for AMSU-A

Old RT

Reduced oscillations

Temperature analysis averaged from 60S to 90S, new RTTOV coefficients for AMSU-A

New RT
ATOVS developments

1. Update to AMSU-A RTTOV coefficients (no Zeeman effect)
2. Zero bias in AMSU-A channel 14
3. Revised bias correction for HIRS & AIRS short-wave channels
Removal of Zeeman effect and zero bias for AMSU-A channel 14 in operations

Departure statistics for used NOAA-18 AMSU-A, NH, June 2007

Old bias correction (after ~1 year of variational bias correction)
New bias correction
Operational since 6 November 2007.
ATOVS developments

1. Update to AMSU-A RTTOV coefficients (no Zeeman effect)
2. Zero bias in AMSU-A channel 14
3. Revised bias correction for HIRS & AIRS short-wave channels
HIRS/AIRS short-wave channels: Day/night biases

Obs-FG biases (K, after bias correction) for July 2007, 9-21 Z only

Day/night bias of about 0.3 K

AIRS channel 1928 (4.464 μm)

METOP-A, HIRS channel 15 (4.47 μm)

NOAA-17, HIRS channel 15 (4.47 μm)
Histogram of FG departures for METOP-A HIRS channel 15 as function of cos(solar zenith angle);
See also McMillin and Crosby (2000).

Updated bias correction for short wave channels for HIRS (ch 14 & 15) and AIRS (ch 1921-1928):
Additional bias predictor, zero during night time, and cos(solar zenith angle) at day time.
HIRS/AIRS short-wave channels

Obs-FG biases (K, after bias correction) for July 2007, 9-21 Z only

Old bias correction
METOP-A, HIRS channel 15 (4.47 μm)

Revised bias correction
AIRS channel 1928 (4.464 μm)
HIRS/AIRS short-wave channels

Impact on mean analyses for 12 Z 500 hPa geopotential [gpm], July 2007:
Revised bias predictors - old
Summary

- Introduction of METOP ATOVS data gave a small positive forecast impact over the Southern Hemisphere.
- New AMSU-A RTTOV coefficients that exclude the Zeeman effect lead to better consistency with SSU data.
- AMSU-A channel 14 is now assimilated without bias correction to prevent variational bias correction to drift in the stratosphere.
- Revised bias correction for HIRS and AIRS short-wave channels reduces previous day/night biases.