Initial results from using ATMS and CrIS data at ECMWF

Niels Bormann¹, William Bell¹, Anne Fouilloux¹, Tony McNally¹, Ioannis Mallas¹, Nigel Atkinson², Steve Swadley³

¹ ECMWF, ² Met Office, ³ NRL
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**ATMS**

- Microwave sounder combining AMSU-A and MHS heritage channels, with 3 new channels.

- Temperature sounding channels compared to AMSU-A:
  - Higher noise
  - Smaller footprint
  - Oversampled

### Frequency Table

<table>
<thead>
<tr>
<th>Channel number</th>
<th>Frequency [GHz]</th>
<th>Polarisation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>23.8</td>
<td>QV</td>
</tr>
<tr>
<td>2</td>
<td>31.4</td>
<td>QV</td>
</tr>
<tr>
<td>3</td>
<td>50.3</td>
<td>QH</td>
</tr>
<tr>
<td>4</td>
<td>51.76</td>
<td>QH</td>
</tr>
<tr>
<td>5</td>
<td>52.8</td>
<td>QH</td>
</tr>
<tr>
<td>6</td>
<td>53.596 ± 0.115</td>
<td>QH</td>
</tr>
<tr>
<td>7</td>
<td>54.4</td>
<td>QH</td>
</tr>
<tr>
<td>8</td>
<td>54.94</td>
<td>QH</td>
</tr>
<tr>
<td>9</td>
<td>55.5</td>
<td>QH</td>
</tr>
<tr>
<td>10</td>
<td>57.29</td>
<td>QH</td>
</tr>
<tr>
<td>11</td>
<td>57.29±0.3222±0.217</td>
<td>QH</td>
</tr>
<tr>
<td>12</td>
<td>57.29±0.3222±0.048</td>
<td>QH</td>
</tr>
<tr>
<td>13</td>
<td>57.29±0.3222±0.022</td>
<td>QH</td>
</tr>
<tr>
<td>14</td>
<td>57.29±0.3222±0.010</td>
<td>QH</td>
</tr>
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<td>15</td>
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<td>QV</td>
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<tr>
<td>17</td>
<td>165.5</td>
<td>QH</td>
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<tr>
<td>18</td>
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<td>QH</td>
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<tr>
<td>19</td>
<td>183.31±4.5</td>
<td>QH</td>
</tr>
<tr>
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<td>183.31±3</td>
<td>QH</td>
</tr>
<tr>
<td>21</td>
<td>183.31±1.8</td>
<td>QH</td>
</tr>
<tr>
<td>22</td>
<td>183.31±1</td>
<td>QH</td>
</tr>
</tbody>
</table>
Outline

1) Analysis of departure statistics
2) Preliminary assimilation experiments
3) Conclusions
ATMS data: First impression

- Assessments based on ATMS data before antenna pattern correction.
- Mostly based on 3x3 averaged data for channels 3-22.
- Larger swath for ATMS = better spatial coverage.
- Better scanbiases than AMSU-A.
- ATMS data look generally ok.
Scan bias: Comparison to NOAA-18

Initial results from using ATMS data at ECMWF, ITSC-18, Toulouse, March 2012

Data for 10 Nov 2011, over sea, no QC, no bias correction
Standard deviations and averaging...

Data for 20-29 Dec 2011, over sea, after QC and bias correction
Data for 20-29 Dec 2011, over sea, after QC and bias correction
Comparison to AMSU-As (for ATMS 3x3)

Initial results from using ATMS data at ECMWF, ITSC-18, Toulouse, March 2012

Data for 10 Nov 2011, over sea, no QC, scanbias removed, "bias corrected" = air-mass dependent biases removed

(Departure statistics for data after QC, 20-29 Dec 2011; global over sea)
Day-to-day stability

Channel 11, tropics:

- Obs - FG
- Obs – Analysis
- Bias correction – 0.29 K

Initial results from using ATMS data at ECMWF, ITSC-18, Toulouse, March 2012
Inter-channel error correlation diagnostics

(based on Desroziers et al. 2005)

ATMS (3x3):

NOAA-18 MHS:
Inter-channel error correlation diagnostics
(based on Desroziers et al. 2005)

ATMS (3x3):

NOAA-18 AMSU-A:
Variability by scanline

• Variability of biases by scanline appear higher for ATMS than for AMSU-A.
• Room for improvement in calibration for ATMS?
Outline

1) Analysis of departure statistics
2) Preliminary assimilation experiments
3) Conclusions
Preliminary assimilation experiments

- Period: 15 Dec 2011 – 6 Feb 2012
- Resolution: T319 (~60 km)
- ATMS data: 3x3 averaged for channels 3-22
- Quality control for ATMS:
  - Use data only over open sea
  - Use all scan positions
  - Use channels 6-15 & 18-22
  - Screening for cloud/rain:
    - \(| (\text{Obs-FG})_{\text{ch}3} | > 5 \text{ K} \) for ch 6-8; 18-22
    - LWP > 0.12 kg/m² for ch 6, 7, 18; > 0.15 kg/m² for ch 8
    - Scatter index (89/165 GHz) > 10 for channels 18-22
  - Observation error for channels 7-11: 0.35 K

Initial results from using ATMS data at ECMWF, ITSC-18, Toulouse, March 2012
Improvements for short-term humidity forecasts

Standard deviation of FG departures for all used MHS data combined:

Similar improvements for humidity channels from HIRS, AIRS, IASI.
Forecast impact

Normalised difference in RMSE for 500 hPa geopotential, verified against own analysis (46-54 cases), with 95 % confidence intervals:

- **Z: 20° to 90°, 500hPa**
- **Z: −90° to −20°, 500hPa**

Initial results from using ATMS data at ECMWF, ITSC-18, Toulouse, March 2012
Preliminary conclusions

- Scan-biases for ATMS look smoother than for AMSU-A even without an antenna pattern correction applied to ATMS data.

- Noise performance of temperature sounding channels against short-term forecasts looks good:
  - (At least) comparable to AMSU-A after 3x3 averaging.
  - However, some errors appear correlated; possibly room for improvement for calibration?

- Preliminary assimilation experiments suggest:
  - Positive impact on humidity analyses.
  - Positive forecast impact over the Southern Hemisphere.

Initial results from using ATMS data at ECMWF, ITSC-18, Toulouse, March 2012
Averaging...

Initial results from using ATMS data at ECMWF, ITSC-18, Toulouse, March 2012
Comparison to AMSU-As

Initial results from using ATMS data at ECMWF, ITSC-18, Toulouse, March 2012

(Departure statistics for used data, 20-29 Dec 2011; global over sea)
Histograms of Obs-FG: Effect of averaging

Channel 12

Channel 22

(Statistics for used data, 20-29 Dec 2011; global over sea, after bias correction)

Initial results from using ATMS data at ECMWF, ITSC-18, Toulouse, March 2012