International Use of S-NPP
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Thank you to all contributors

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Overview

How S-NPP is used by the international community for weather forecasting

- Sounder data
  - How ATMS is used
  - How CrIS is used
- Impact assessment
- Correlated Errors
- What next?
  - VIIRS
S-NPP for Numerical Weather Prediction: ATMS
Usage of ATMS

Met Office Processing

• Remapped and spatially averaged in AAPP* using Fourier techniques to improve noise performance and replicate AMSU footprint size (3.3° beamwidth)

• Treated like AMSU/MHS in operational assimilation, but observation errors are slightly increased because of striping

• No need to reject footprints at the edge of the scan (as is done with AMSU)

• Surface-sensitive channels and 183GHz channels are rejected over land and sea-ice

* ATOVS and AVHRR Pre-processing Package
## International Usage of ATMS

<table>
<thead>
<tr>
<th>Country</th>
<th>Status</th>
<th>Channels</th>
<th>Averaging</th>
<th>Remarks</th>
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</thead>
<tbody>
<tr>
<td>Met Office</td>
<td>Operational</td>
<td>6-15, 18-22</td>
<td>3.3° Fourier</td>
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<tr>
<td>BoM</td>
<td>Preparing</td>
<td>6-15, 18-22</td>
<td>3.3° Fourier</td>
<td>Parallel Now, Operational June</td>
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<tr>
<td>NIWA</td>
<td>Operational</td>
<td>6-15, 18-22</td>
<td>3.3° Fourier</td>
<td></td>
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<tr>
<td>DMI</td>
<td>Operational</td>
<td></td>
<td>3.3° Fourier</td>
<td>Local only</td>
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<td>ECMWF</td>
<td>Operational</td>
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<td>3 x 3 pixels</td>
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<tr>
<td>Météo-France</td>
<td>Operational</td>
<td>6-14, 18-22</td>
<td>3 x 3 pixels</td>
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<td></td>
<td>Parallel Summer, Operational Fall</td>
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<tr>
<td>NRL</td>
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<td></td>
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<tr>
<td>NCEP</td>
<td>Operational</td>
<td>1-15, 17-22</td>
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<tr>
<td>DWD</td>
<td>Operational</td>
<td></td>
<td>T sounding</td>
<td></td>
</tr>
</tbody>
</table>
S-NPP for Numerical Weather Prediction: CrIS
Usage of CrIS

Met Office Processing

• Treated similarly to IASI but observation errors are lower
  • Operationally, IASI is assimilated with a full error covariance matrix, CrIS is still a diagonal matrix (see later slides)

• Start from NESDIS 399 channel set
  • Remove channels sensitive to trace gases, etc.
  • Remove adjacent channels in B2 to reduce inter-channel correlations
  • Reject all Band 3 channels

• Assimilate channels that peak above the cloud top

• Surface sensitive channels are rejected over land, all channels rejected over sea-ice
# International Usage of CrIS

<table>
<thead>
<tr>
<th></th>
<th>Status</th>
<th>Channels</th>
<th>Remarks</th>
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<td></td>
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<tr>
<td>BoM</td>
<td>Preparing</td>
<td>T: 76 Surf:13 WV: 45</td>
<td>Parallel Now, Operational June</td>
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<tr>
<td>NIWA</td>
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<td>T: 76 Surf:13 WV: 45</td>
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<tr>
<td>DMI</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<tr>
<td>ECMWF</td>
<td>Operational</td>
<td>T/Surf/O$_3$: 71 WV: 7</td>
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<tr>
<td>Météo-France</td>
<td>Operational</td>
<td>T: 68</td>
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<td>Preparing</td>
<td>T: 35 Surf: 26 WV: 29 SW: 13</td>
<td>Parallel Summer, Operational Fall</td>
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<td></td>
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<td>Also used for NH$_3$ retrievals</td>
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<tr>
<td>NRL</td>
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<td>B1: 84 B2: 49</td>
<td>Parallel Summer, Operational Fall</td>
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<tr>
<td>NCEP</td>
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<td>T/Surf: 84</td>
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<tr>
<td>DWD</td>
<td>Evaluating</td>
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Impact of S-NPP: Observing System Experiments

• All centres report positive impact from assimilation of both ATMS and CrIS

• Met Office:
  • CrIS 1-2% improvement in RMS Error for PMSL* in NH and SH
  • ATMS 2% improvement in RMS Error for PMSL in SH; 1% improvement in RMS Error for 500hPa Geopotential in SH

• ECMWF:
  • ATMS 1% improvement in RMS Error for 500hPa Geopotential at 7-8 days in NH, 2% at 1-2 days in SH
  • CrIS beneficial in absence of AIRS

* Pressure at Mean Sea Level
Impact of S-NPP: Met Office

Forecast Sensitivity to Observations

Total impact (J/kg)

-40.00 -30.00 -20.00 -10.00 0.00

-40.77 -27.18 13.59 0.00 27.18 40.77

2 x IASI 5 x AMSU-A 4 x MHS 2 x HIRS

AIRS ATMS CrIS
Impact of S-NPP: Meteo-France

DFS part for each observation type
conventional and satellite observations
accumulation of DFS over the period 2015021300 - 2015021318 : 488659

Degrees of Freedom for Signal
Correlated Errors
Correlated Errors - CrIS

• Techniques such as that of Desroziers et al. (2005) can be used to estimate observation error covariances within an NWP system
  
  • Note that “observation error” includes forward model error and scale mismatch between the observation and grid of the assimilating model

• Recent trials at the Met Office of a diagnosed full error covariance matrix for CrIS give a positive impact
  
  • Significant improvements on forecasts of geopotential height in the Northern Hemisphere winter season
  
  • Small improvements in sea level pressure forecasts
  
  • Fit of the model to other observation types is improved by up to 2%
  
  • Similar impact seen when correlated errors were introduced for IASI
Higher Correlations for Temp. Channels in CrIS than AIRS because other sources of error dominate over (diagonal) instrument noise.
Correlated Errors - ATMS

• It’s not just CrIS that may benefit from inclusion of correlations in the observation error term

• ATMS demonstrates correlations between adjacent channels
  • Related to striping

• NRL have been trialling a new Desroziers-derived error covariance for ATMS
  • Significant positive impact on 3-4 day forecasts of wind and height
  • Note experiment also includes adjustments to the diagonal term
Correlated Errors – ATMS (2)

Met Office diagnosed correlation using Desrozières technique

Note log scale!
Correlations between ATMS 7/8/9 of about 0.4
Correlated Errors: In progress

- Met Office
  - CrIS ready for parallel suite
- NRL
  - ATMS ready for transition to operations
- CMC
  - CrIS/ATMS to go live this autumn
What next
Most centres are aiming for increased usage

- For both CrIS and ATMS most centres report their plans include
  - Assimilation of water vapour channels
  - Use of land surface emissivity retrieval/atlas + assimilation of surface sensitive channels
  - General increase in the number of CrIS channels assimilated
  - Lower observation errors/ introduction of correlated errors
  - Investigations into cloud-cleared CrIS radiances
Cloud-cleared radiances results from Jun Li (SSEC)

Impact of cloud-cleared radiances on Hurricane Sandy track and windspeed errors

Hurricane Sandy (2012) track and maximum wind speed (SPD) forecast RMSE from two experiments in WRF-ARW.

Data are assimilated every 6 hours with assimilation window of 3 hours from 2012-10-25-06 UTC to 2012-10-27-00 UTC, followed by 72 hour forecasts after each assimilation.
VIIRS AMVs / SSTs

- Atmospheric Motion Vectors
  - Better geographical coverage compared to MODIS AMVs from Aqua and AVHRR AMVs from NOAA-15,-18,-19.
  - Assimilated operationally at NRL
  - Monitored at ECMWF
  - Plans to evaluate at the Met Office

- Sea Surface Temperatures
  - Assimilated at CMC for SST analysis
VIIRS imagery

- VIIRS imagery forms part of the suite of data from polar orbiting satellites passed to forecasters to observe meteorological features

- Day/Night Band provides supplemental information that is not available elsewhere
  - Next slide shows a composite image at 2am
    - D/N Band (yellow) combined with
      - 10.8µm channel (blue)
    - D/N Band captures low cloud over France, not visible in 10.8µm image
Thank you for listening!
• **Met Office**: UK
• **BoM**: Australian Bureau of Meteorology
• **CMC**: Canadian Meteorological Centre
• **DMI**: Danish Meteorological Institute
• **DWD**: Germany, Deutscher Wetterdienst
• **ECMWF**: European Centre for Medium-range Weather Forecasts
• **Météo-France**: France
• **NCEP**: USA, National Centres for Environmental Prediction
• **NIWA**: New Zealand, National Institute for Water and Atmospheric Research
• **NRL**: USA, Naval Research Laboratory
• **SSEC**: Space Science and Engineering Center, University of Wisconsin
• **met.no**: Norwegian Meteorological Institute
• **SMHI**: Swedish Meteorological and Hydrological Institute