Improved Use of AIRS Data at ECMWF

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Contents

- Better Spatial Use of the data
  - Warmest FOV
- Better Spectral Use of the Data?
  - Reconstructed Radiances
- Bonus slide on IASI Channel Selection
Warmest Field of View Experiments
Warmest vs Central Field of View

Many more observations used in low-peaking channels.
Upper channels almost unchanged.

10 days’ data. 22nd-31st December 2004

Higher bias in water vapour channels
All other stats are very similar between the warmest and central FOVs
Increased Yield with Warmest FOV

Background: Cloud Fraction from MODIS (black = clear)

Red Spots: Clear Obs for Central FOV dataset (23)

Green Spots: Clear Obs for Warmest FOV dataset (59)

AIRS Channel is 787 (10.9µm)
Warmest FOV: Forecast Impact
Reconstructed Radiances
Spectral data compression with PCA*

The information content of the complete AIRS spectrum can be conveyed using a truncated principal component analysis (e.g. 200PCAs vs 2300 rads)

Leading eigenvectors (200, say) of covariance of spectra from (large) training set

\[ p = V^T (y - \bar{y}) \]

Mean spectrum

Original Spectrum

Coefficients

To use PCs in assimilation requires an efficient RT model to calculate PCs directly

• PCs are more difficult to interpret physically than radiances

N.B. This is usually performed in noise-normalised radiance space

*Principal Component Analysis
Reconstructed Radiances

The information content of the complete AIRS spectrum can be conveyed using a smaller number of reconstructed radiances from truncated principal components.

Leading eigenvectors (200, say) of covariance of spectra from (large) training set

\[ p = V^T (y - \bar{y}) \]

Reconstructed spectrum

\[ y_R = \bar{y} + Vp \]

Each reconstructed channel is a linear combination of all the original channels with reduced noise but increased inter-channel correlations.

N.B. This is usually performed in noise-normalised radiance space
Reconstructed Radiances’ Correlations

N.B. 1688 out of 2378 Channels Used in RR calculation
Reconstructed Radiances’ Correlations

Channels assimilated at ECMWF (157)
Assimilating Reconstructed Radiances – Linear Theory
More structure when using correlations?

Vertical profile of temp 20050128 2100 step 0 Expver emjg point (-50.0,-139.0)

Diagonal Noise
Correlated Noise
RR Forecast Impact – NH 500hPa Geopot.

FORECAST VERIFICATION
500 hPa GEOPOTENTIAL
ANOMALY CORRELATION FORECAST
AREA=N.HEM TIME=12 MEAN OVER 30 CASES
DATE1=20050129/... DATE2=20050129/... DATE3=20050129/...

![Graph showing forecast verification for NH 500hPa geopotential with anomaly correlation. The graph plots anomaly correlation against forecast day, with lines for Normal, RR, and RR with Corr.]
RR Forecast Impact – SH 500hPa Geopot.

FORECAST VERIFICATION
500 hPa GEOPOTENTIAL
ANOMALY CORRELATION
AREA=S.EM  TIME=12 MEAN OVER 30 CASES
DATE1=20050129/...  DATE2=20050129/...  DATE3=20050129/...

Anomaly Correlation

% 100
90
80
70
60
50
40
0 1 2 3 4 5 6 7 8 9 10
Forecast Day

Non-RR
RR
RR Correlated
Conclusions

- AIRS impact can be improved through improved use of data
  - Spatial frequency
    - Allow more clear fields of view
  - More spectral information
    - Reconstructed radiances
    - Correlated Errors

- Other issues being addressed
  - Observation errors
  - Cloud detection
  - Bias correction (see talk by Thomas Auligné)
IASI Channel Selection for NRT Dissemination

- Full IASI Spectrum to be distributed to NWP Centres in Europe and the US
- Other users of near-real-time data will initially receive a subset of channels via GTS
- A channel selection method for this purpose is described in the poster by Collard and Matricardi.
- Main features:
  - Attempt to define a robust global data set
  - Pre-screening of channels with trace gas contamination and other forward modelling issues
  - Use Rogers’s method of channel selection based on information content
    - *A priori* data from NWP 6 hour forecast