Assimilation of CrIS data at the Met Office

Andrew Smith, Amy Doherty, Nigel Atkinson, Bill Bell

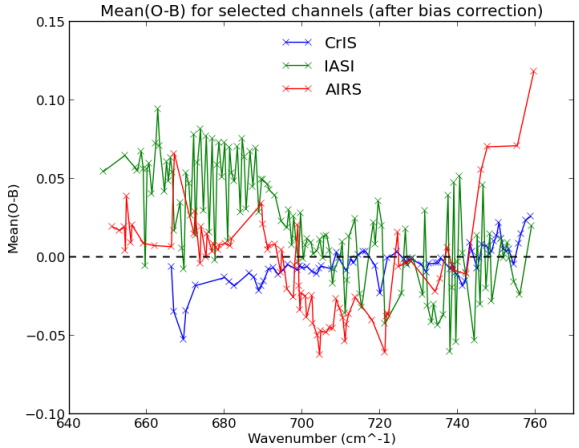
Suomi NPP Science and Products Review 18/12/2013

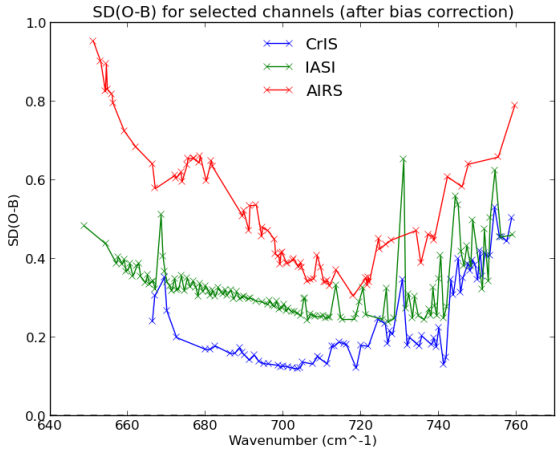
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Outline

- CrIS data quality
- Channel selection
- Observation errors
- Assimilation experiments & FSO diagnostics
- Summary & Future Work

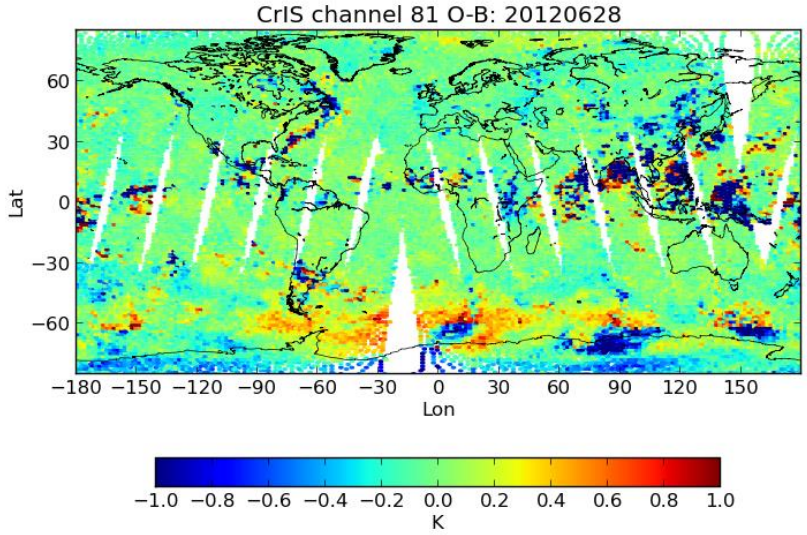
CrIS data quality - comparison with NWP model background and AIRS/IASI for LW CO_2/Temperature channels



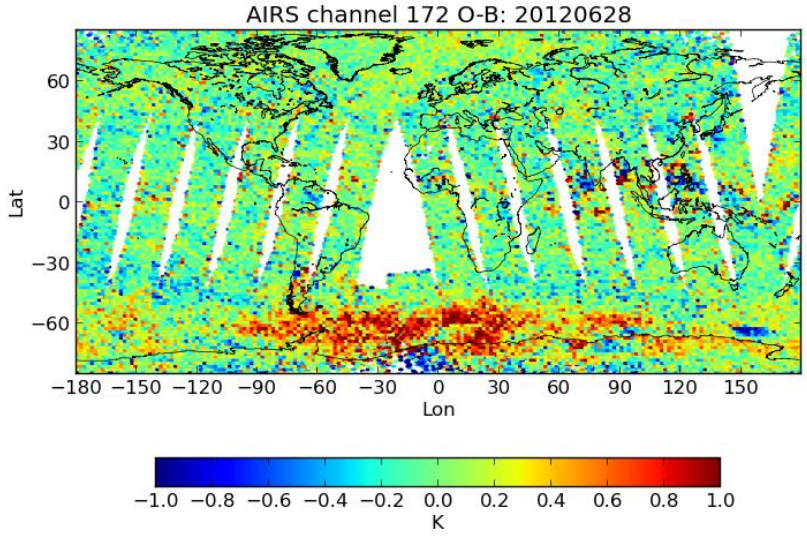


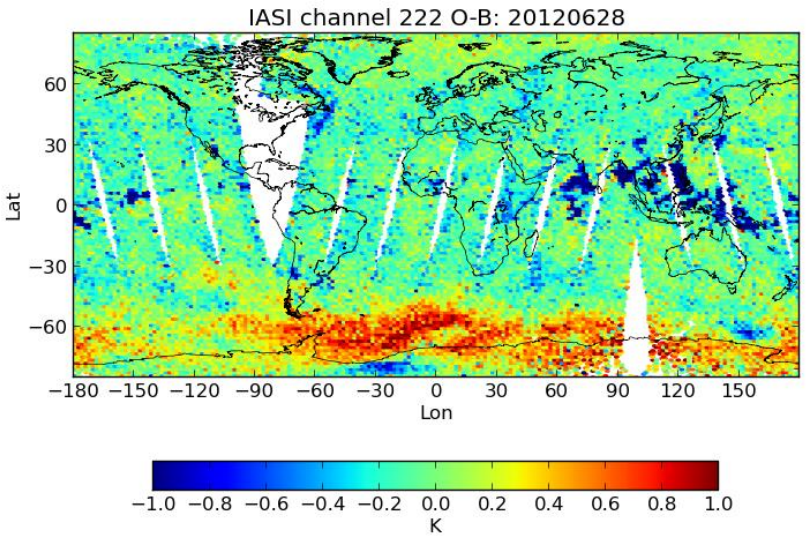
- Bias corrected data aggregated over a 3-month period.
- Very small residual biases
- Unusual negative bias at low wavenumber (upper-level sounding channels)
- O-B as low as 0.15K in some channels, half that of IASI.
- Instrument noise very low

CrIS data quality - comparison with NWP model background and AIRS/IASI

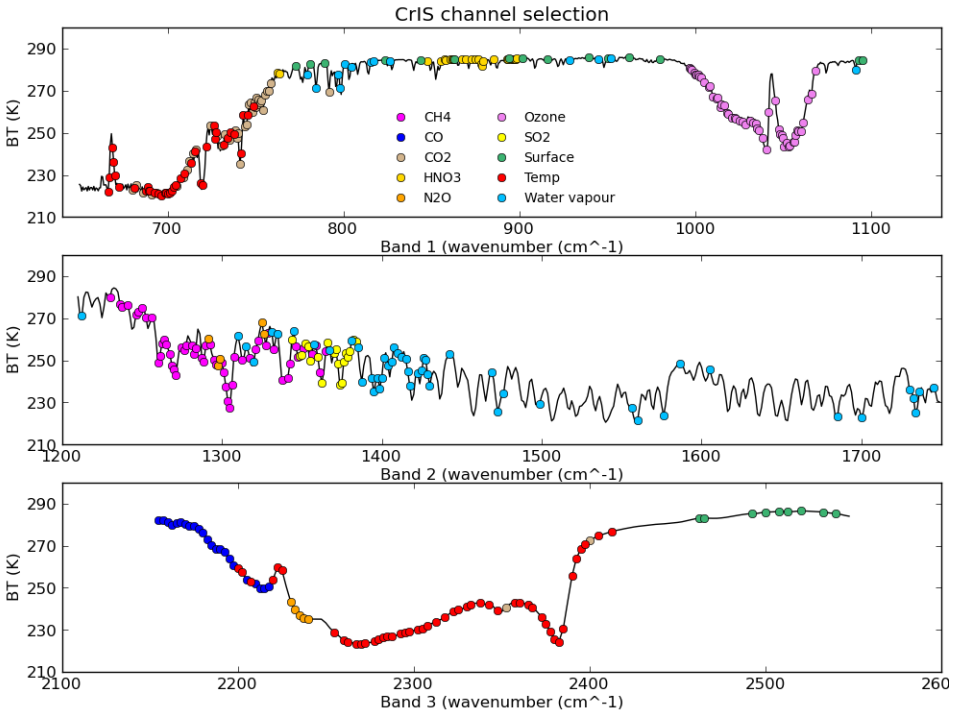


- Global maps of bias corrected O-B
- Select ‘clean’ channels with similar weighting functions peaking around 14km
- Clear demonstration of CrIS low-noise performance



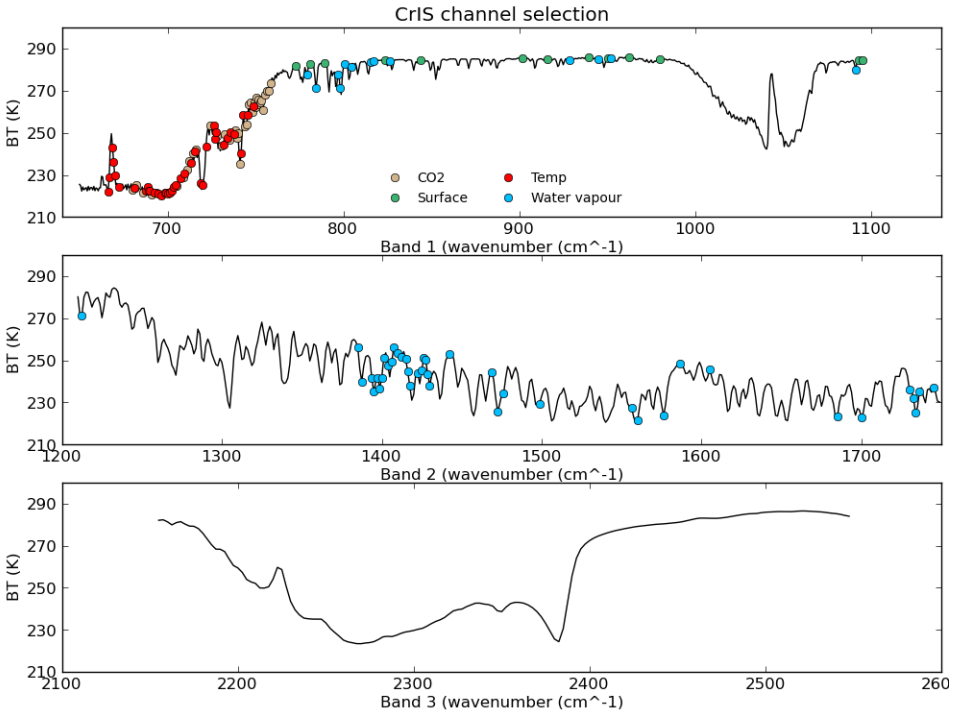


CrIS channel selection



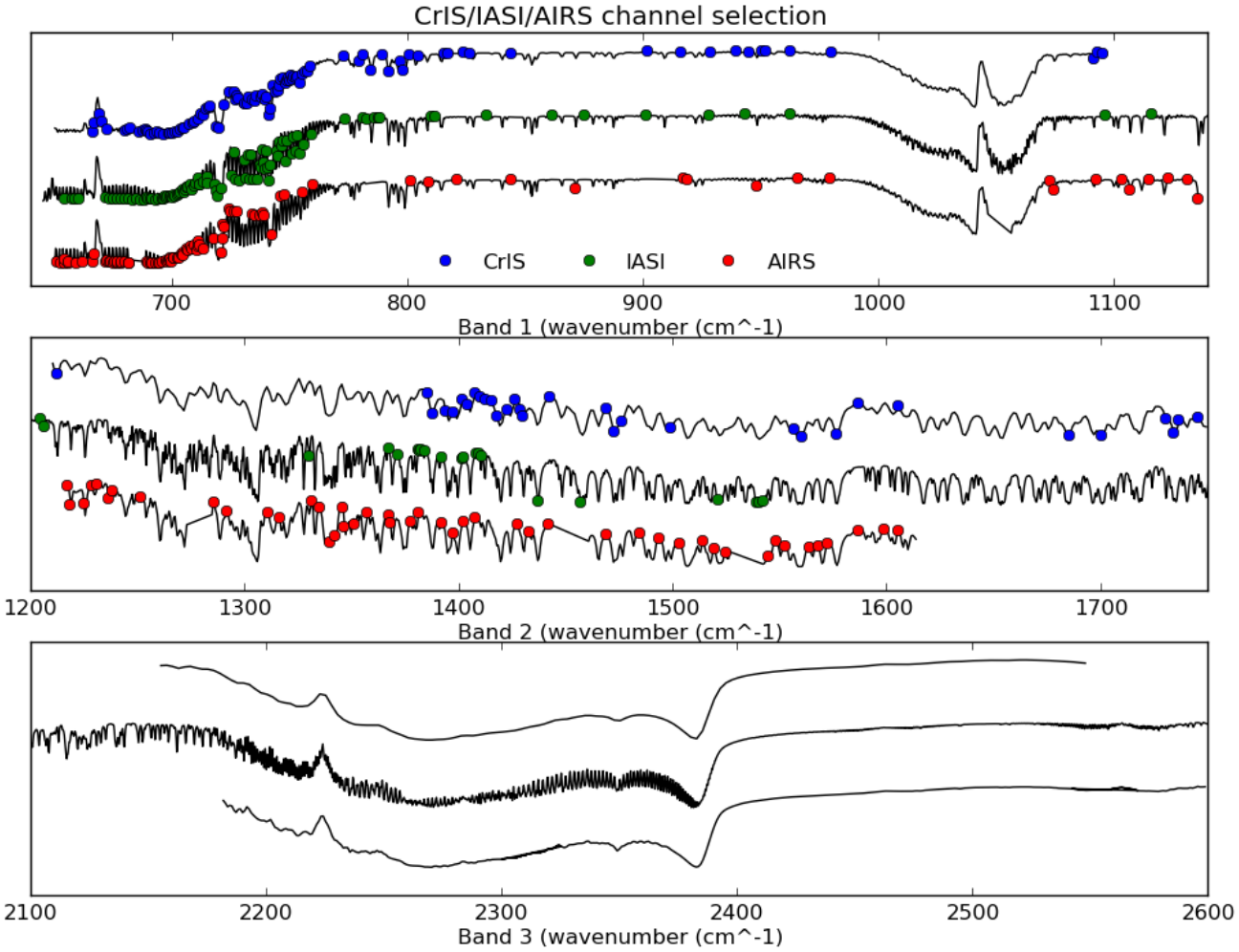
- 399 channels stored from the total of 1305 (NESDIS selection)
- Expensive to process, redundancy
- IASI selection for assimilation
  - 138 channels, including 87 temperature, 21 surface, 30 water-vapour.
- Only around half are ‘NWP channels’ (T, q, surf)
  - Half sensitive mainly to trace gases

CrIS channel selection



- Reject channels
  - Sensitive to trace gases
  - That are noisy, or have large forward model errors (e.g., band-3)
  - That are adjacent in water-vapour bands to reduce the amount of inter-channel correlation.
  - Over land if sensitive to the surface - emissivity retrieval not included
- 134 channels remaining
  - 76 temperature
  - 45 water-vapour
  - 13 surface

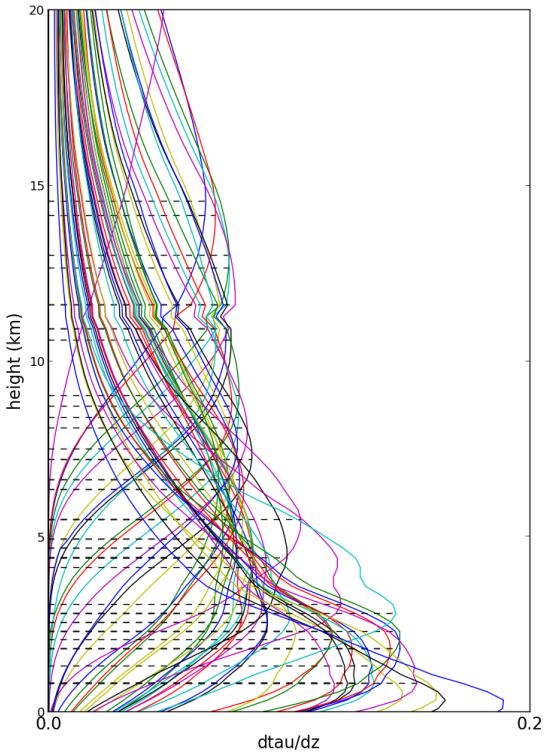
CrIS channel selection – comparison with AIRS/IASI



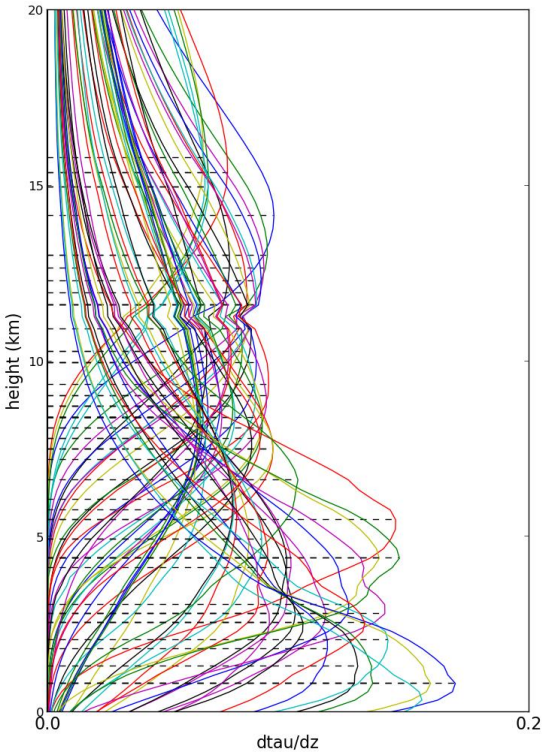
- Similar sets of temperature and surface sensing channels.
- Variation in selection of band-2 water-vapour channels.
- No channels from band-3 (noisy, RT errors).

Weighting Functions for Assimilated Low-Peaking T channels

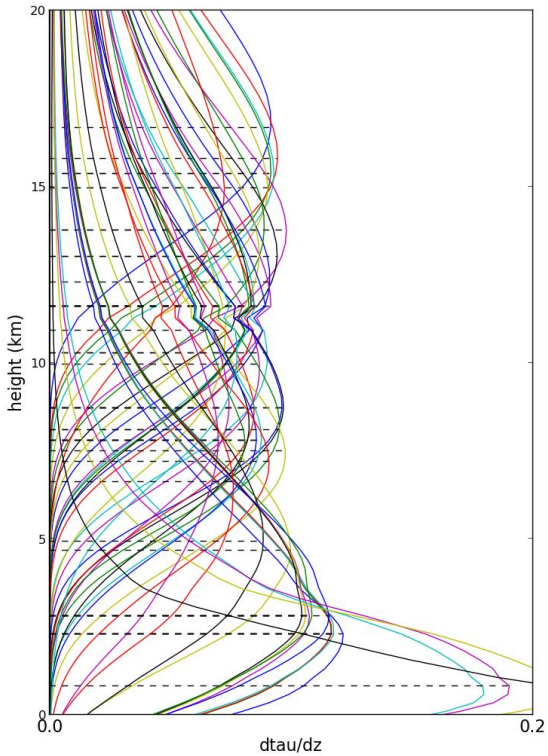
CrIS Weighting Functions: Assimilated Low-peaking T-channels



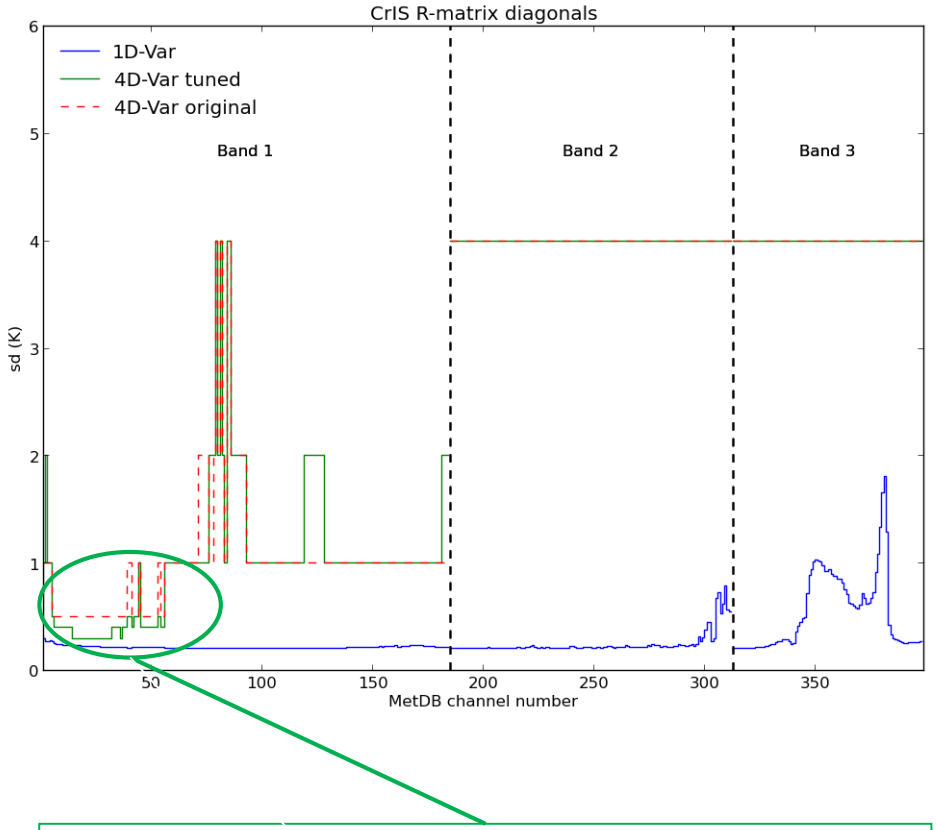
IASI Weighting Functions: Assimilated Low-peaking T-channels



AIRS Weighting Functions: Assimilated Low-peaking T-channels



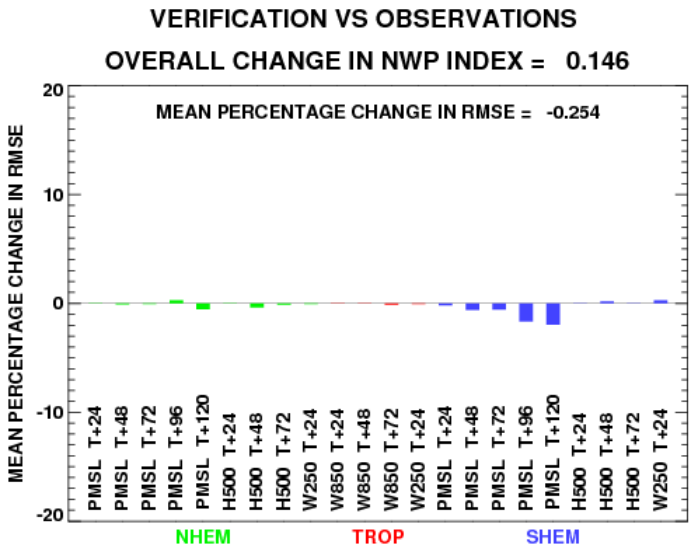
Observation errors

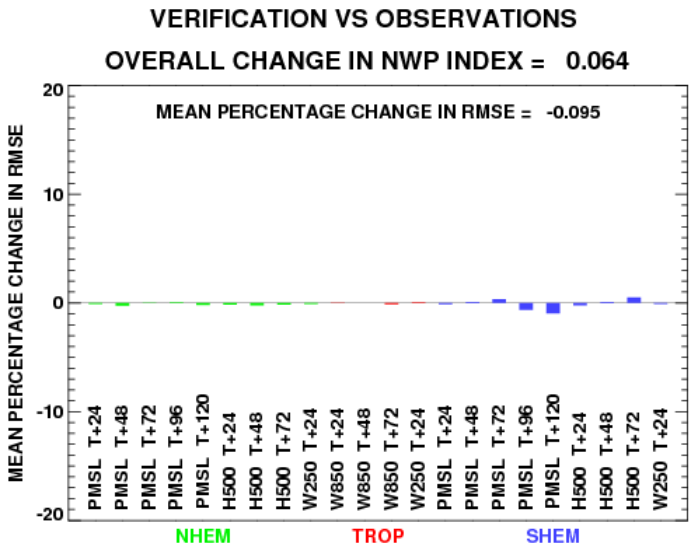


CrIS has very low noise signal – experiment with lower obs errors ~ 2 x stdev(C-B).

- 1D-Var
  - NeΔT + 0.2K RT error. Reduce by factor ~ 1.5 to account for apodisation.
- Assume observation errors are uncorrelated
  - Can diagnose a full covariance matrix later with a statistical analysis (now implemented operationally for IASI).
- Inflate for 4D-Var
  - Representativeness error
  - Inter-channel correlations
- Use ‘rounded’ values of 0.5K, 1.0K, 4.0K as with IASI

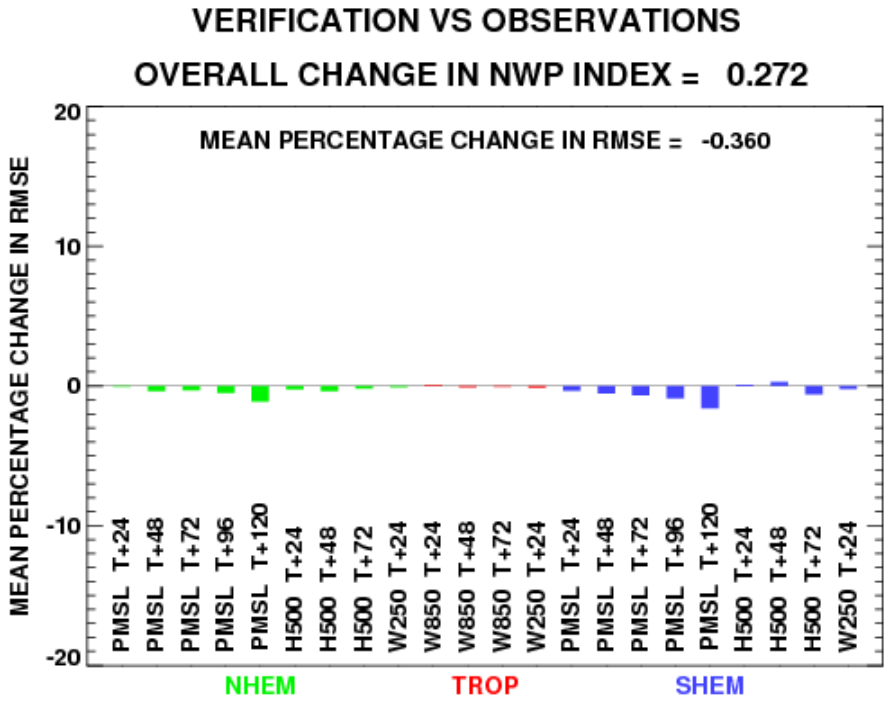
CrIS forecast impact experiments – water vapour channels





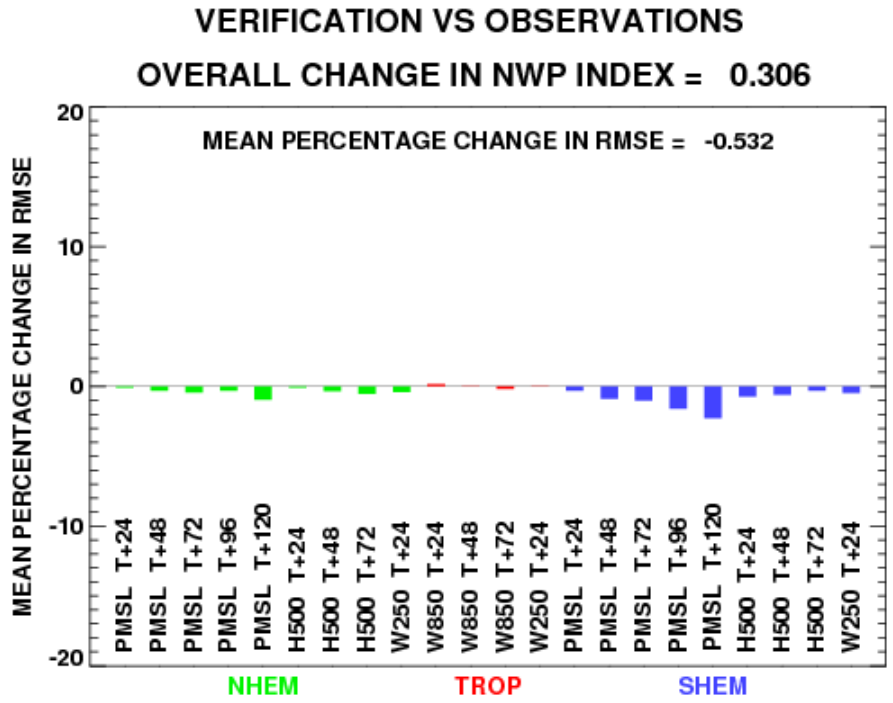
- Standard configuration
  - 134 channels
  - Sea observations only
  - Similar obs errors to IASI
  - 1D-Var pre-processing for QC and retrieval of cloud top height
  - Improvements seen in SH PMSL fields, particularly at long range
- Reduce number of water vapour channels to 26
  - Lower impact.
  - Removing all water-vapour channels reduces the impact further
  - Very little impact from temperature channels

CrIS forecast impact experiments – reduce observation errors



- Configuration – the same 134 channels with reduced observation errors for temperature channels.
- Small improvements seen across a range of fields in both NH and SH.
- Further reductions may be possible but need to take account of correlations.

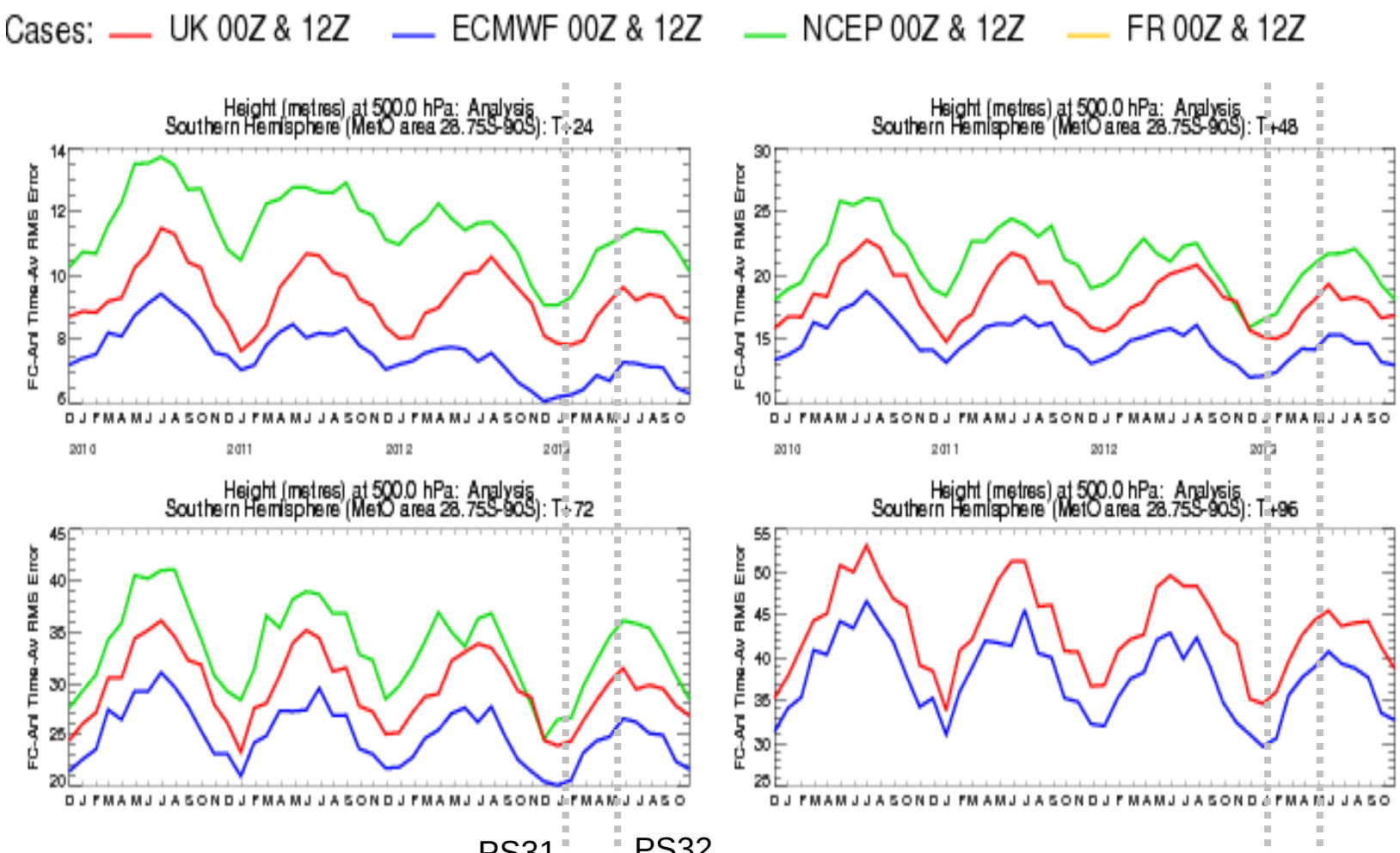
CrIS + ATMS forecast impact experiment



- Rerun CrIS low obs error experiment with ATMS added
- Improvement in SH analysis on top of CrIS only results

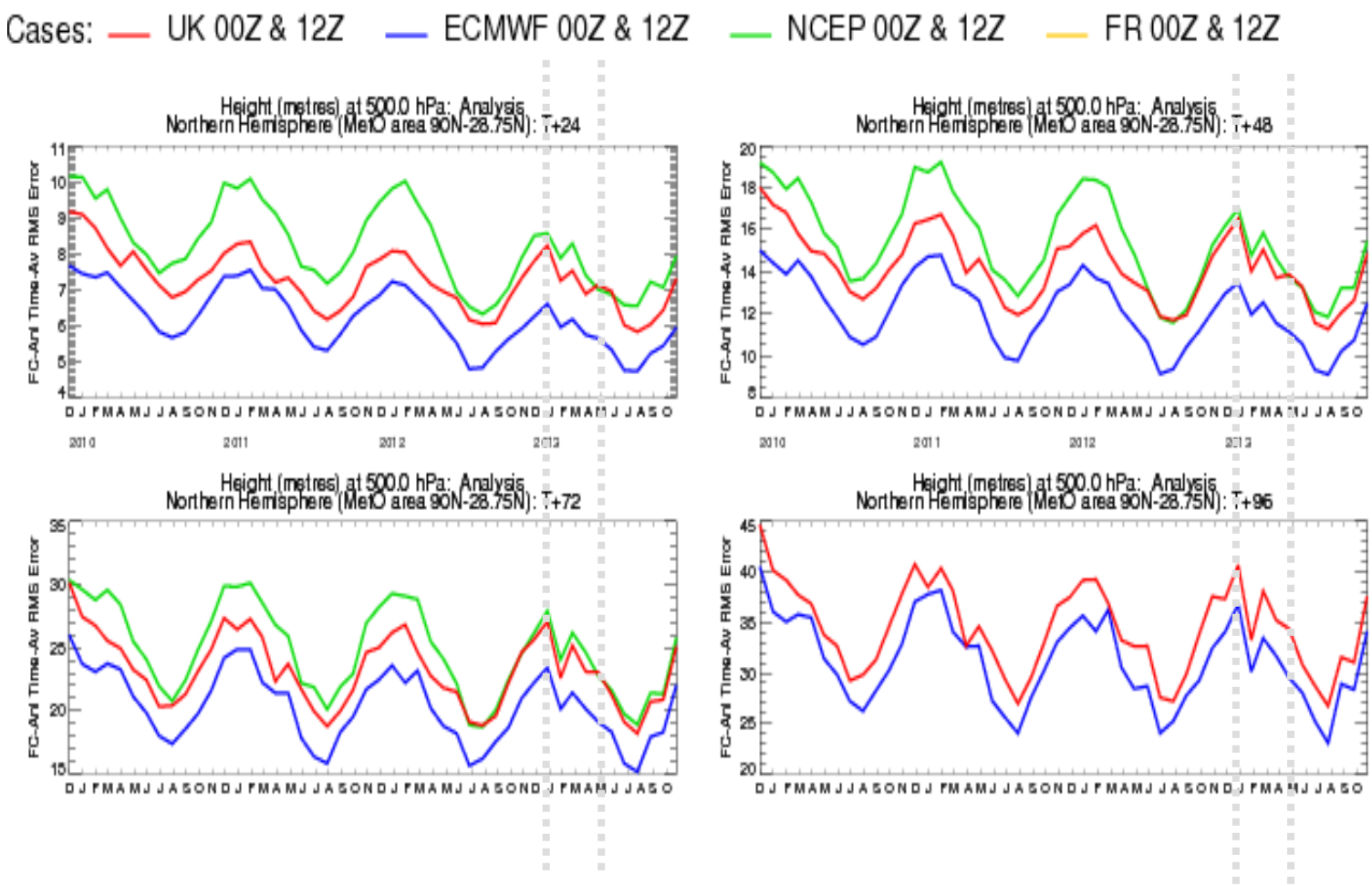
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SH H500 (*vs* Analysis)

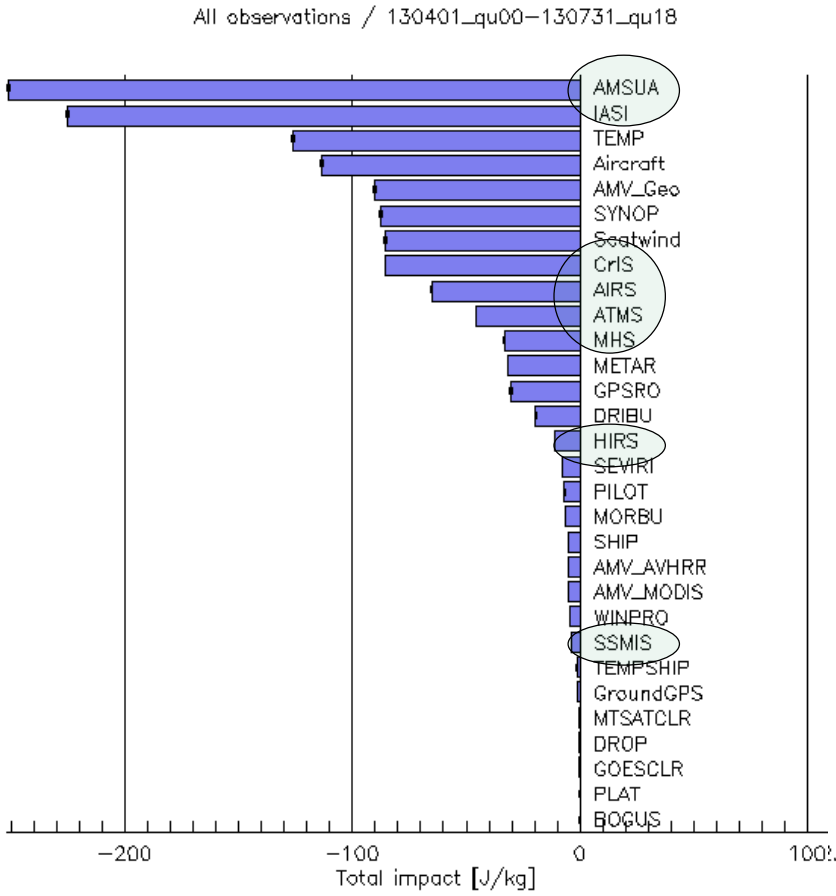


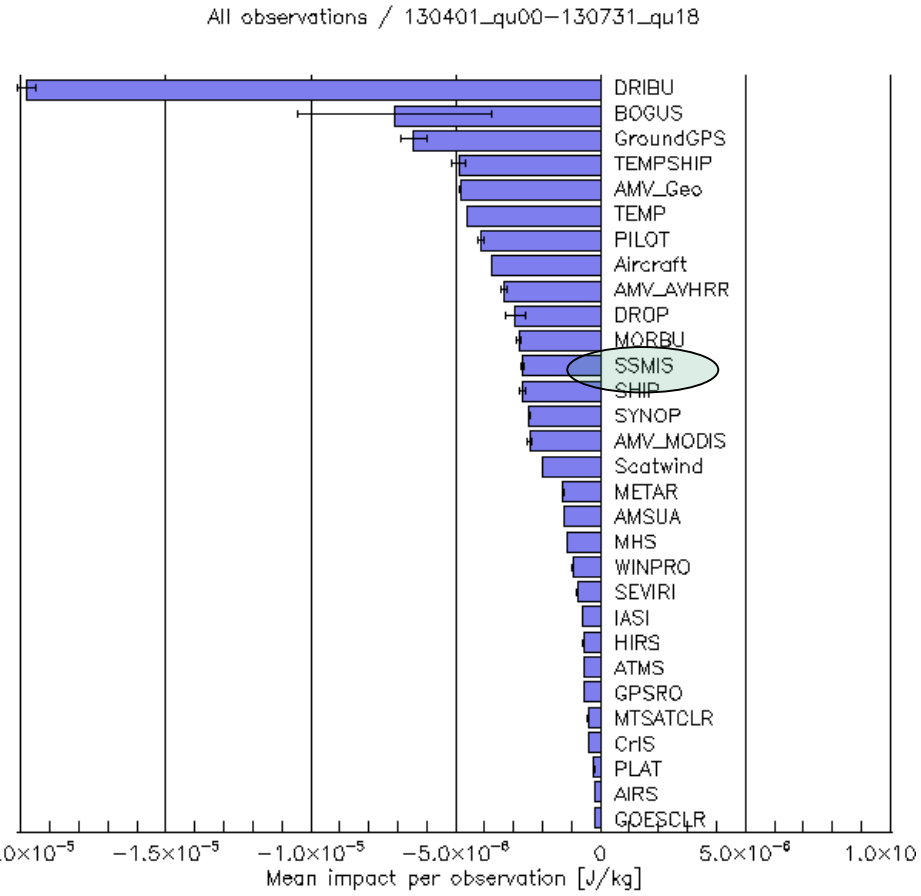
PS31 PS32

NH H500 (*vs* Analysis)



FSO: OS32- April - July 2013





Summary of ‘Day 1’ Suomi-NPP Assimilation Experiments

- ATMS and CrIS data quality has been assessed by comparison with model fields and similar instruments
  - Radiometric performance of both instruments is excellent
  - Striping signal seen in ATMS data requires the data to be ‘underweighted’ when assimilated
- Forecast impact experiments have been run for both instruments, showing reductions in forecast error in both cases.
  - Inclusion of ATMS gives significant improvement in SH analysis fields
  - Inclusion of CrIS gives modest improvements in both hemispheres. Impact is less than that originally obtained with IASI but…
    - Only sea observations included (addition of land data is now being trialled and showing further improvements).
    - Observation error analysis and retuning may give further improvement
    - More comprehensive observing system
- **Both instruments assimilated operationally from April 2013**

Current Work

- Add data over land
  - Original implementation plan was deliberately conservative so only sea obs are currently assimilated
  - Emissivity retrieval (used operationally for AIRS/IASI)
  - Assimilation experiments without emissivity retrieval already completed
- Diagnose a full covariance matrix
  - CrIS is low-noise but has high inter-channel correlations
  - Used for assimilation of IASI

CrIS over land – assimilation experiment results

