CrIS Data in ECMWF

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Assimilation of CrIS radiances at ECMWF

- Assimilation of CrIS radiances has not yet reached the operational status at ECMWF
- But, progress has been made towards understanding how to make best possible use of data

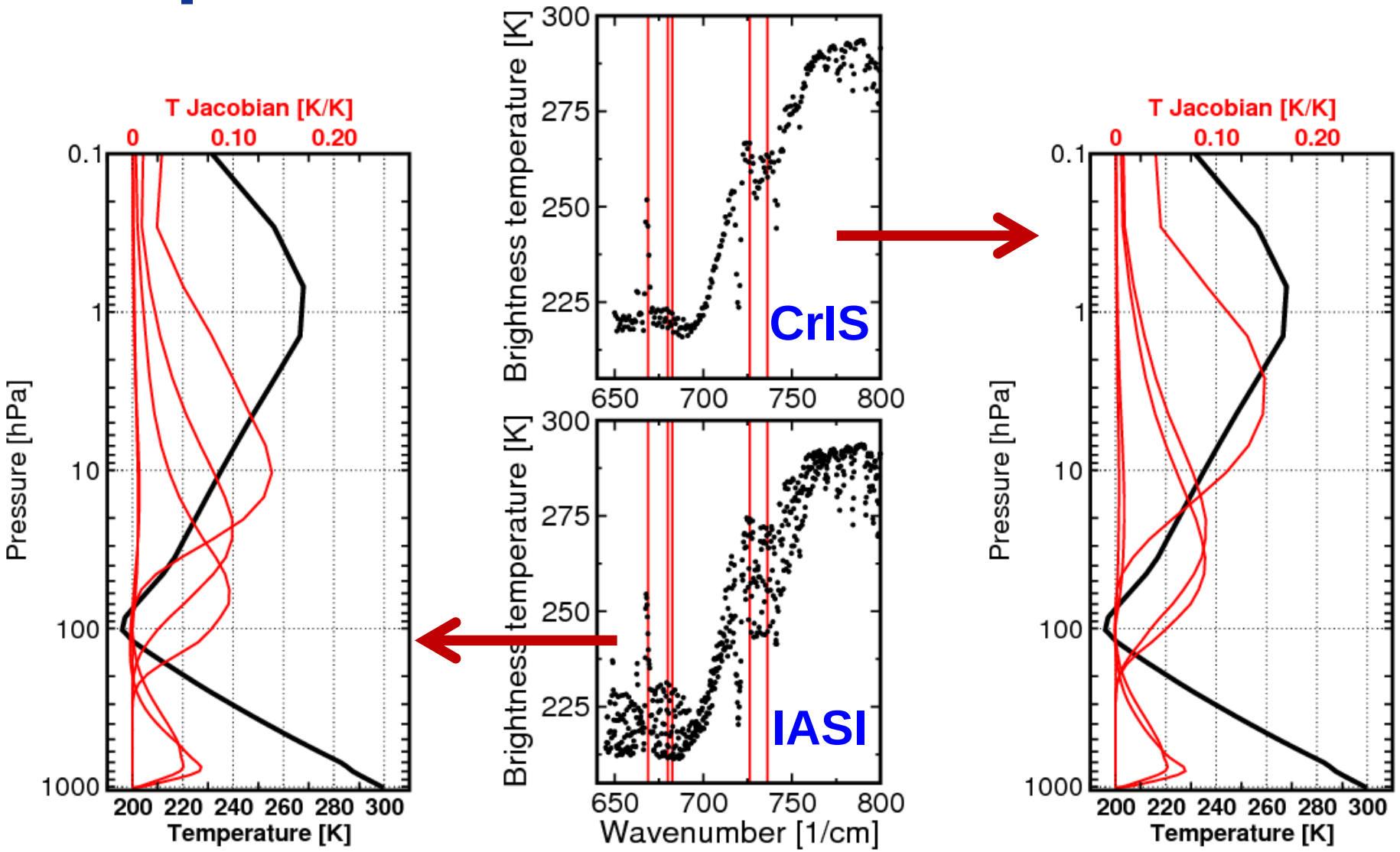
  → Operational assimilation of ~120 long-wave channels is expected to start during the first quarter of 2014

- Starting point for experimenting with CrIS was to replicate the methods applied to AIRS and IASI and hope for the best

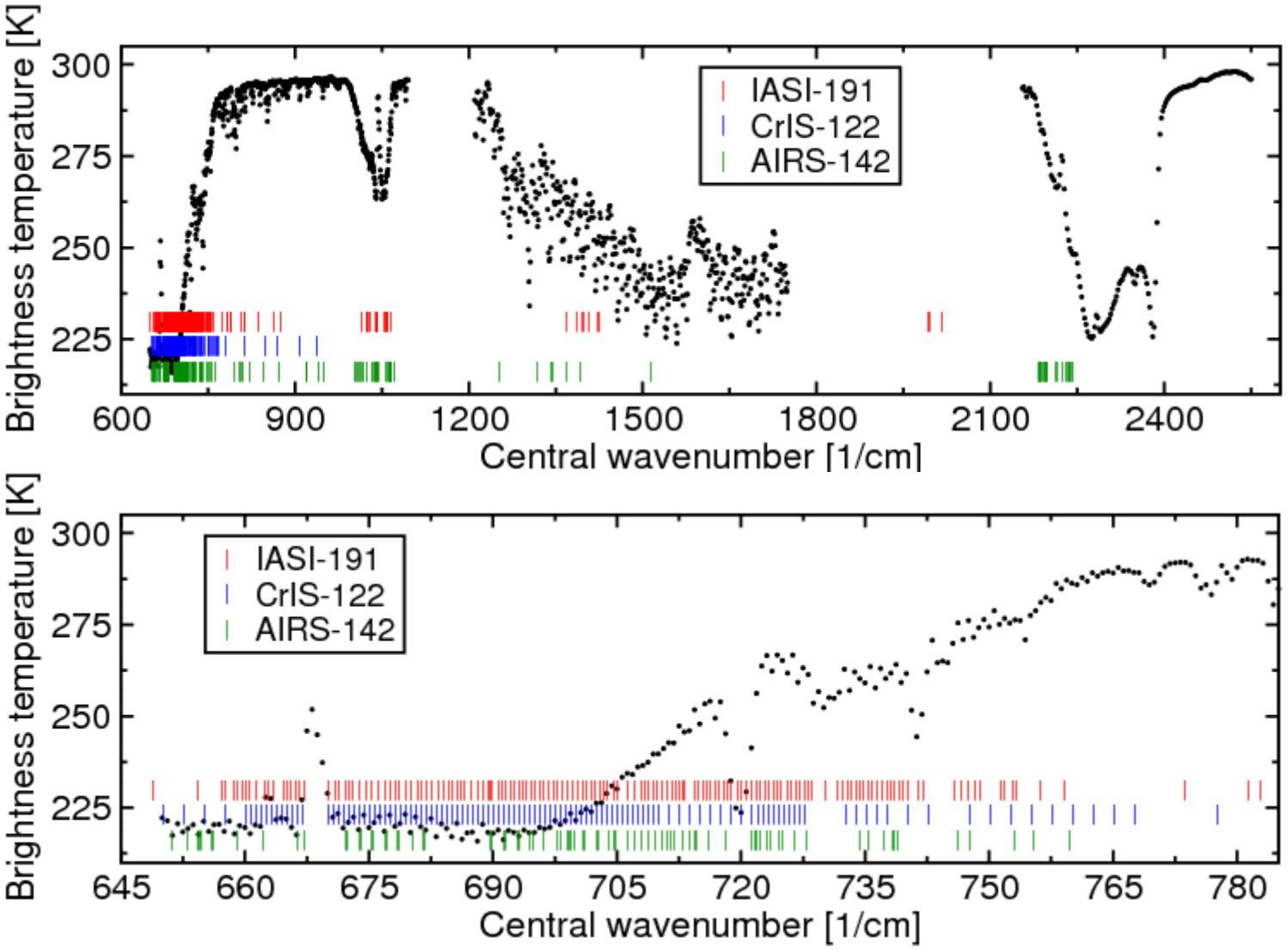
  → This approach has now turned out insufficient

  → A new approach is needed for dealing with spectral characteristics of the CrIS instrument

On spectral resolutions



Selecting channels for the assimilation



Building blocks of the 4D-Var assimilation system for CrIS

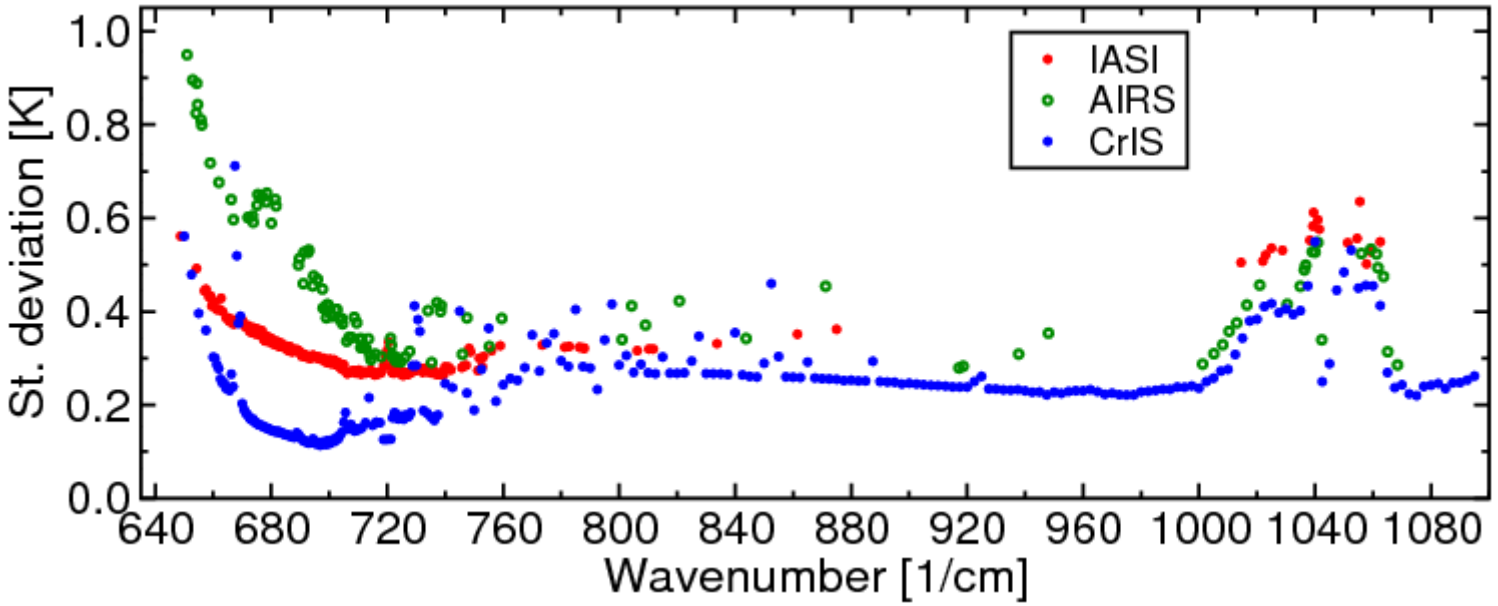
Observation operators
(RTTOV-10)

$$\nabla J_o = -\mathbf{H}^T \mathbf{R}^{-1} (\mathbf{y} - H[\mathbf{x}_B] - \mathbf{H}\delta\mathbf{x})$$

Observation error covariance matrix

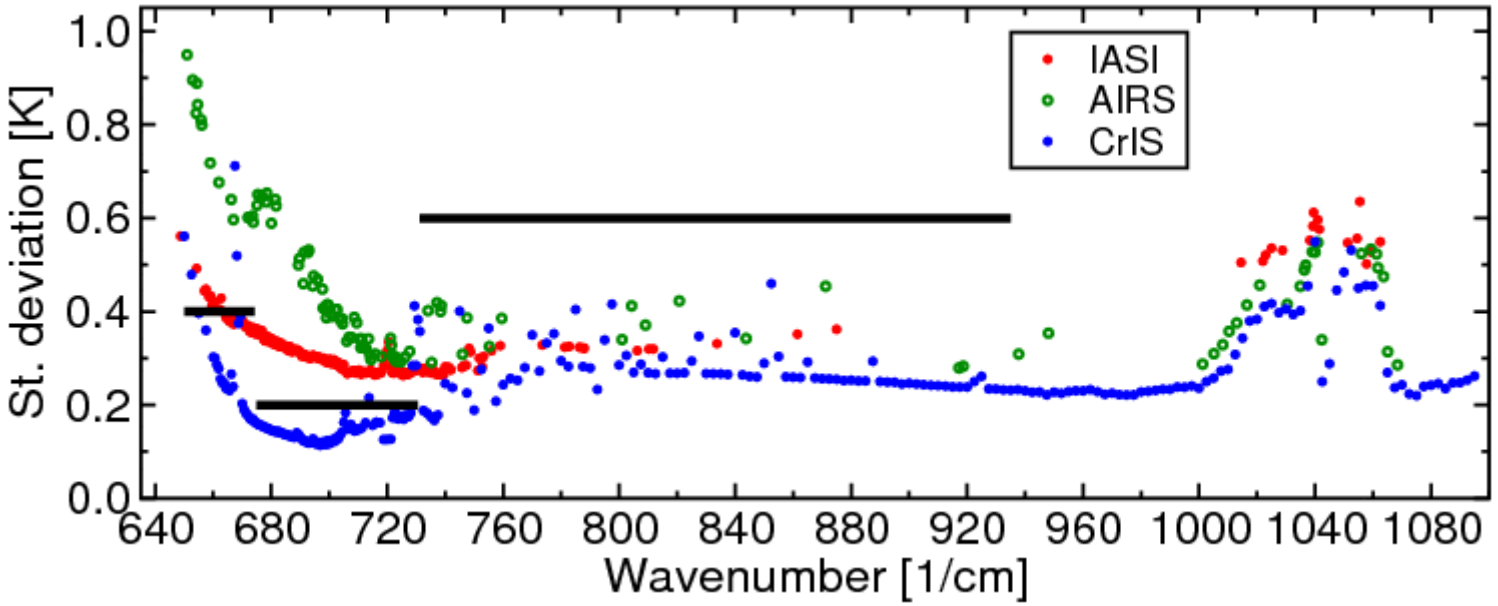
(to be specified according to assumed statistical properties of observation errors)

Observation error covariance specification



Diagonal elements are tuned on the basis of background departure statistics

Observation error covariance specification



Observation error standard deviations are set to 0.4K, 0.2K, and 0.6K on stratospheric-, tropospheric-, and surface-sensitive channels, respectively

(Compare with 1.0K, 0.4K, and 2.0K used on AIRS and IASI channels)

Observation error covariance specification

- Large number of adjacent channel pairs are assimilated for improved spectral sampling

  → Inter-channel error correlations associated with signal apodization call for explicit treatment in the minimization

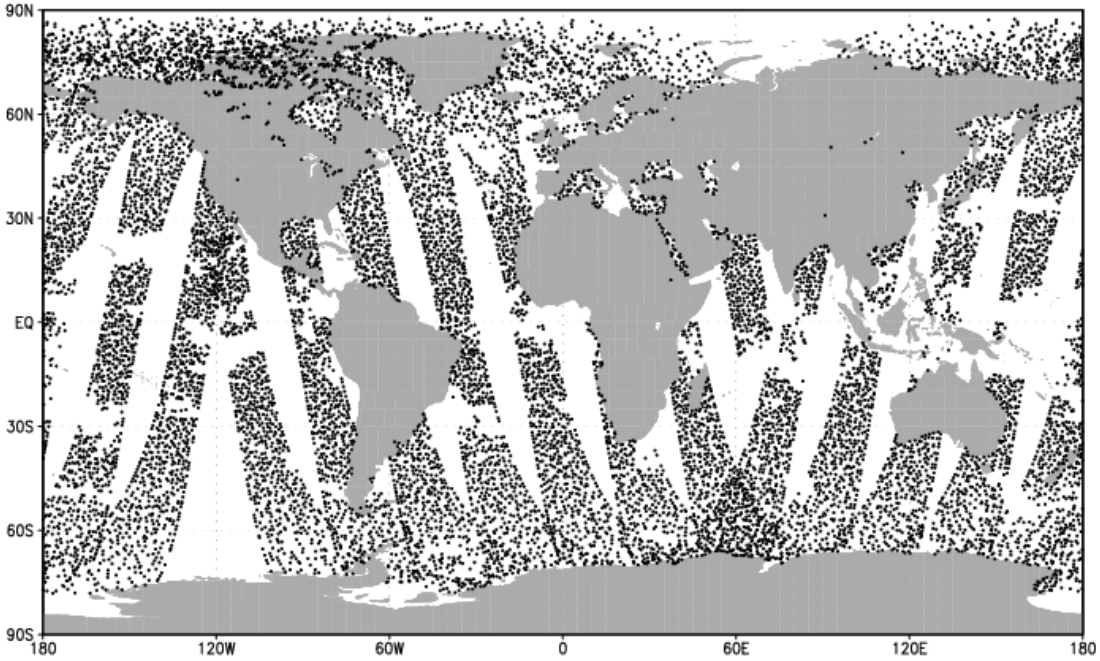
- Other sources of observation error correlation are likely to be significant as well, but they are difficult to diagnose and characterize

  → We use a theoretical error correlation model that is consistent with the Hamming apodization function

  → Error correlations 0.625 (0.133) are assigned for each pair of adjacent (alternate) channels

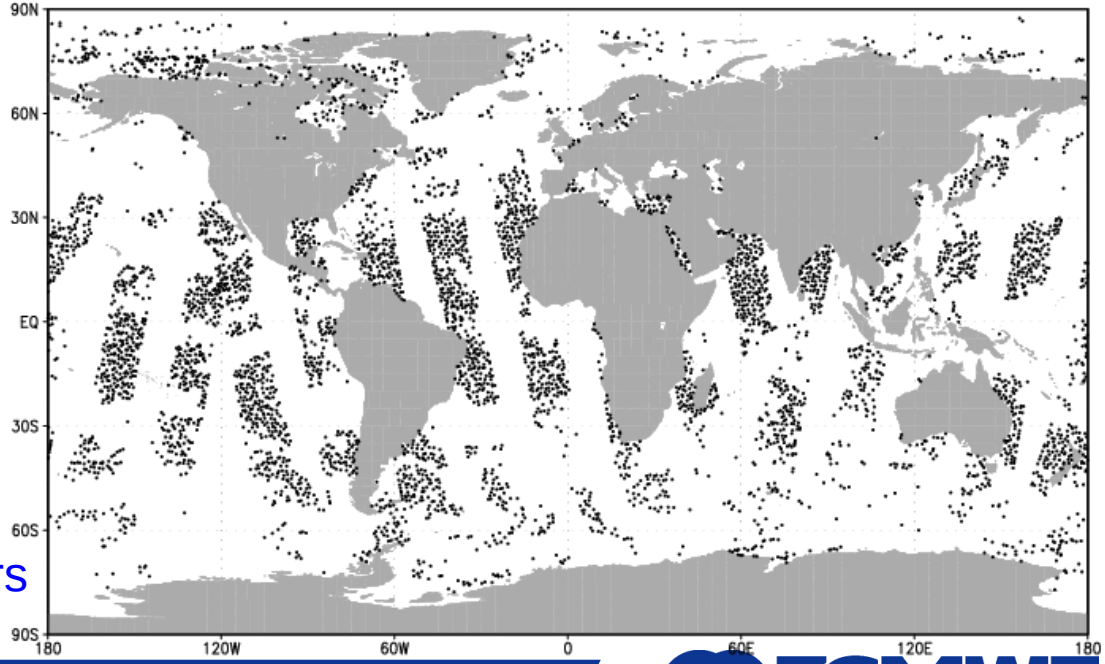
Setup of the experimental assimilation

- Active assimilation of 122 long-wave channels
- Only the middle pixel of each FOR is considered for assimilation
- Variational bias correction is applied with 4 scan-angle-dependent predictors and additional 4 air-mass-dependent predictors on sounding channels
- Only clear channels are assimilated: these are identified using the ECMWF cloud detection algorithm (McNally & Watts, 2003)
- Only one FOV from each thinning box of 1.25^{o} x 1.25^{o} x 30min is assimilated
- No data over land are used
- Three FORs in both ends of each scanline are blacklisted
- The cleanest window channels are also blacklisted over sea ice



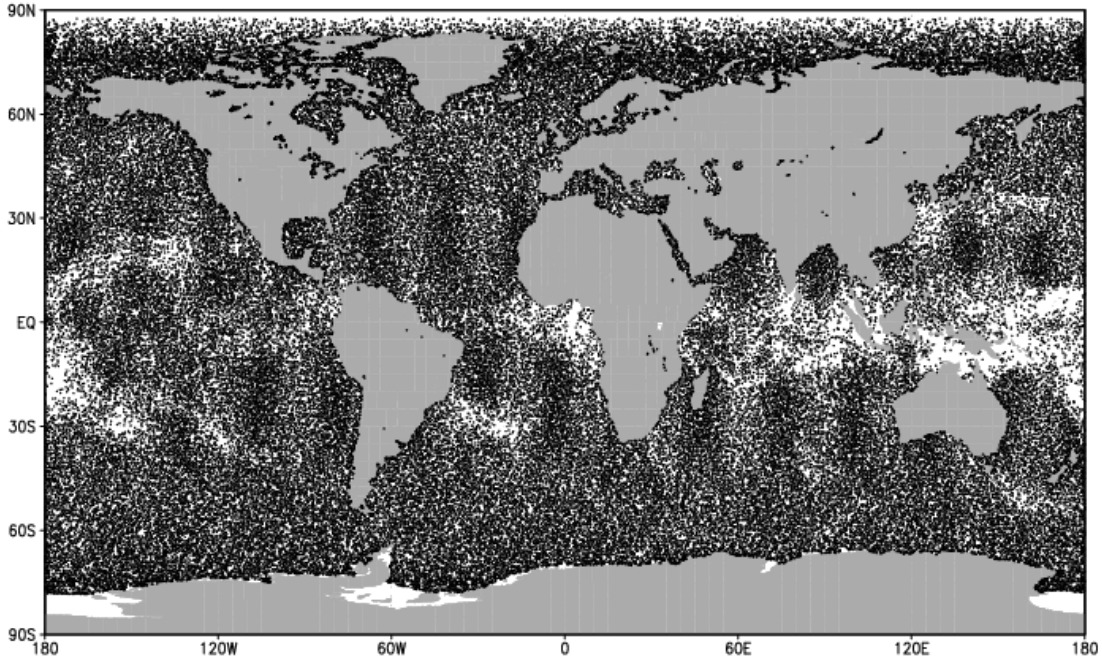
Ch. 70 (693.125 cm^{-1})

13,477 obs. in 12 hours



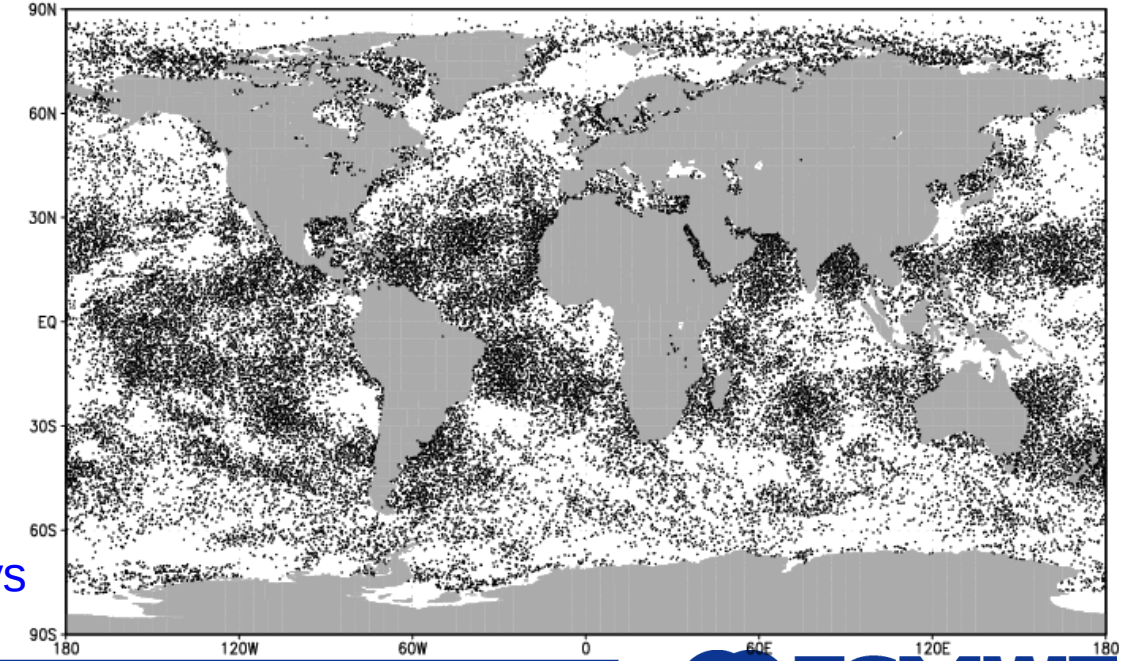
Ch. 145 (740 cm^{-1})

4,806 obs. in 12 hours



Ch. 70 (693.125 cm^{-1})

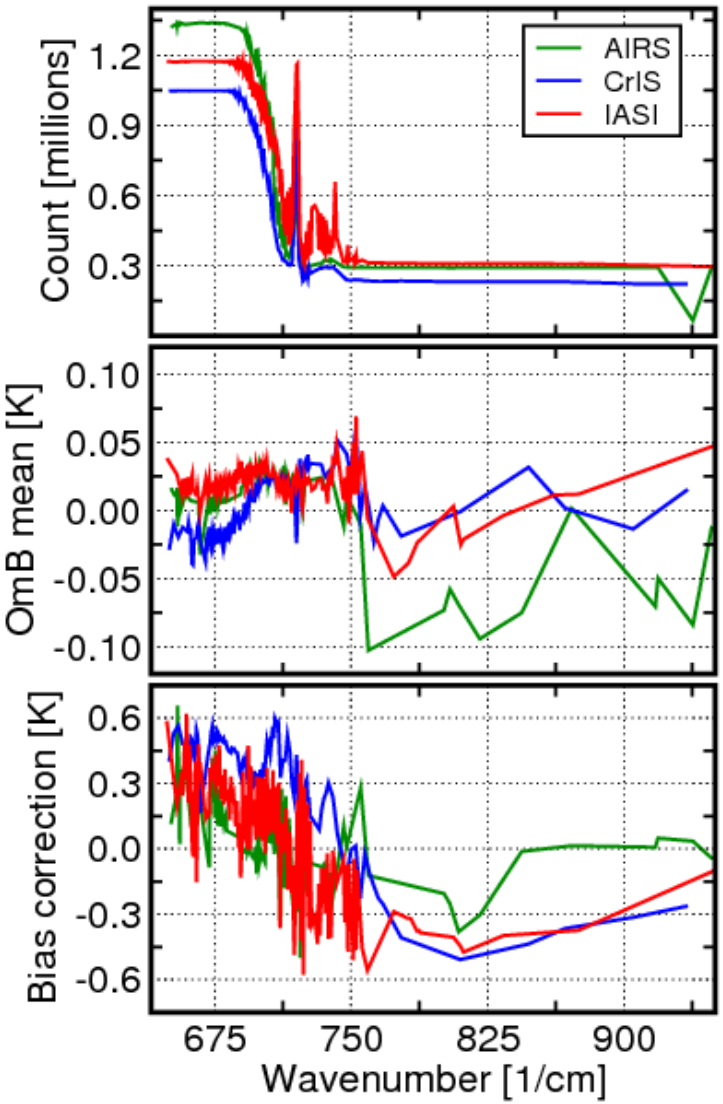
110,714 obs. in 4 days

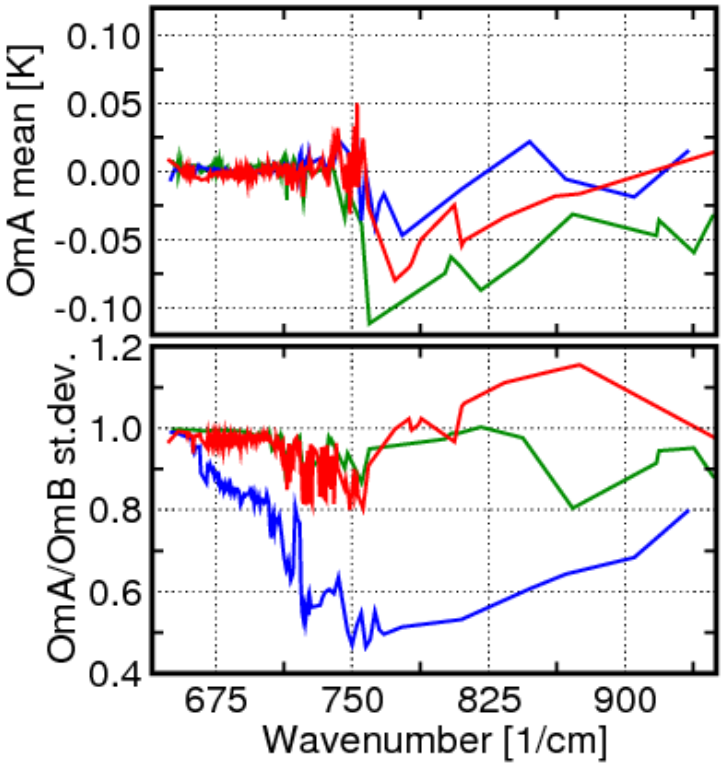


Ch. 145 (740 cm^{-1})

40,474 obs. in 4 days

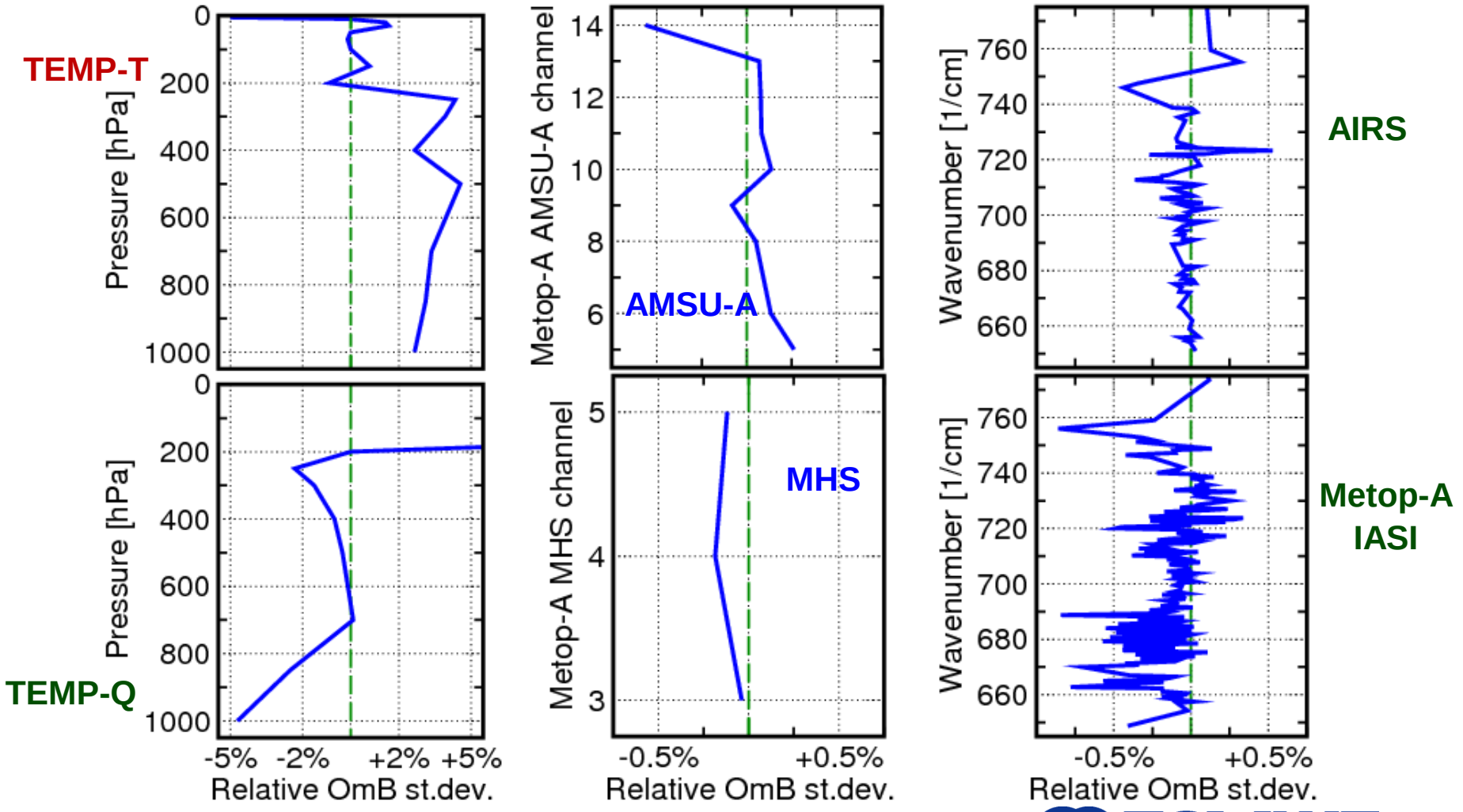
Southern hemispheric diagnostics in a T511 experiment run between 24 January – 23 April 2013



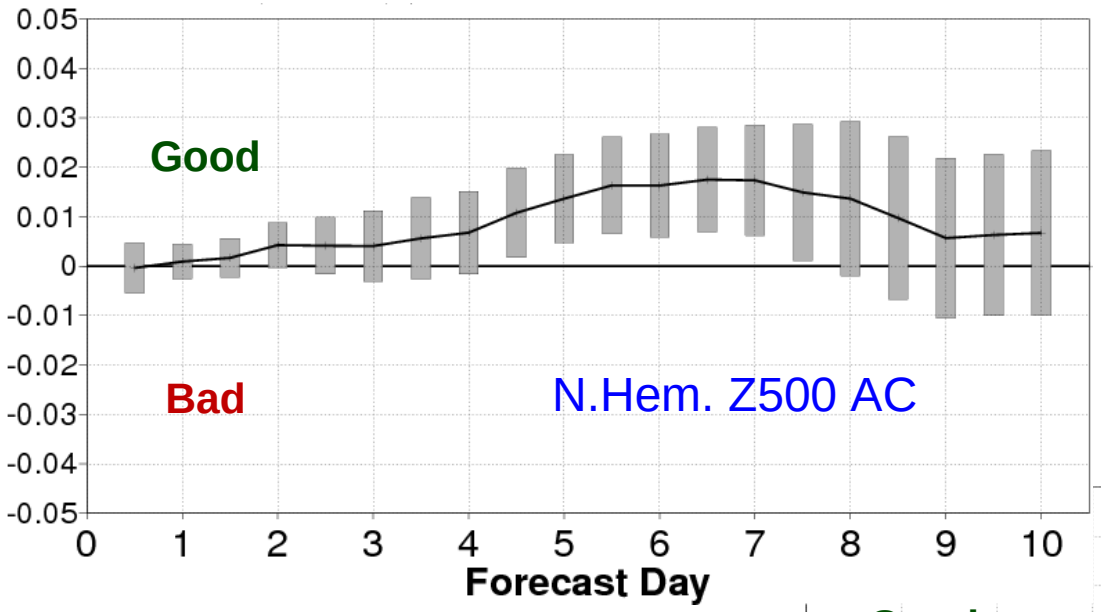


Observation departure statistics

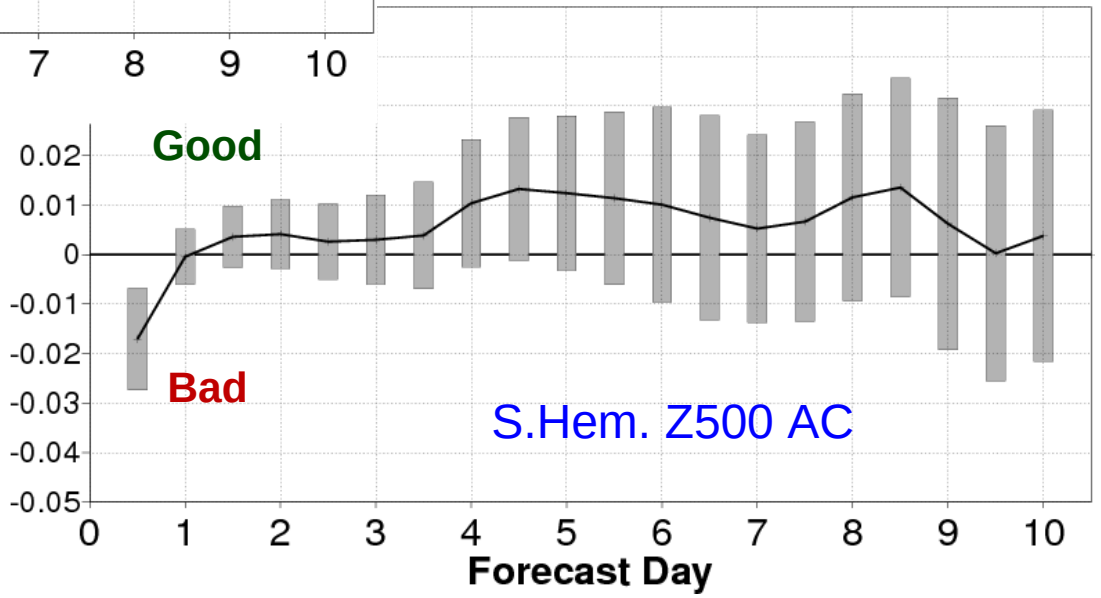
Global statistics; negative values imply improved observation – background fit



T511L91 Forecast verification



Based on IFS cycle 38r2 that was operational from June to November 2013



On-going work and short-term plans

- Reproduction of the positive forecast impact in closer-to-operational resolution using a more recent IFS version
  - Necessary to justify the operational assimilation
- Continue looking for ways to improve the assimilation

  → Use of water vapour channels

  → Better modelling of the scan-angle-dependent bias

  → Assisting the cloud detection by collocated cloud parameters from VIIRS

  → Taking all available input pixels into consideration (currently only middle pixel is used)

  → Assimilation of overcast radiances?

Summary

- Operational assimilation is planned using a configuration consisting of 122 long-wave channels
- A non-diagonal observation error covariance matrix is used to account for error correlations associated with signal apodization
- Observation departure statistics suggest improvements in humidity analysis, but not in temperature analysis
- However, a consistently positive forecast impact is found in mid-resolution assimilation experiments
- Experiments are continued to reproduce the positive forecast impact in higher resolution and in a more recent IFS version
- Areas for further improvements are being studied