The testing and planned implementation of VarBC at the Met Office

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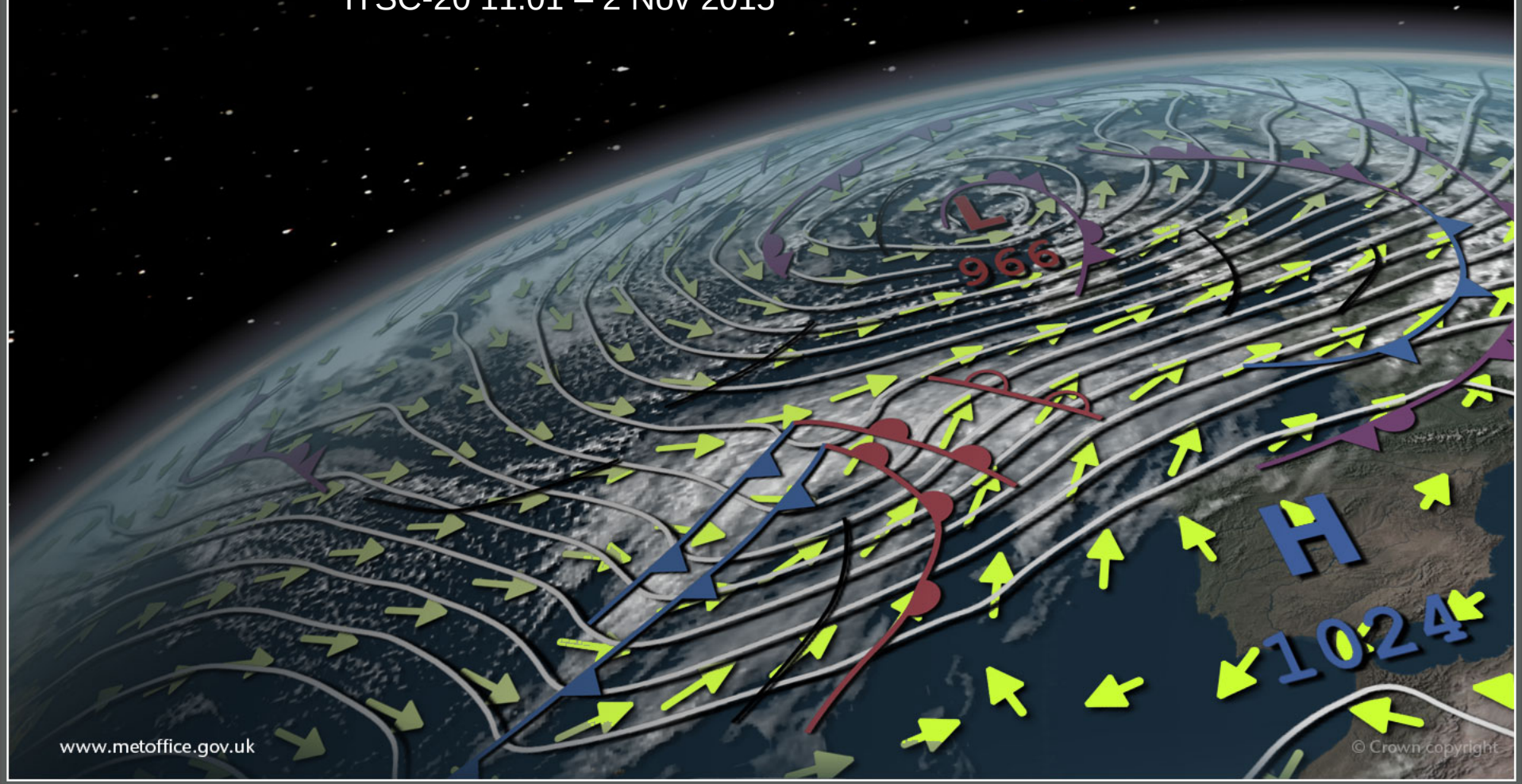

Acknowledgements

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Anna Booton	Orbital predictors for SSMIS.

Synopsis

- Variational bias correction (VarBC) is system for continuously updating the bias correction applied to observations.
- VarBC has not yet been used operationally at the Met Office.
- Now extensively tested for satellite radiance observations.
- Results are excellent.
- Planned to become operational in spring 2016.

Talk Outline

- Outline of the VarBC scheme.
- Testing of VarBC.
- Summary

Outline of the VarBC scheme.

Current ‘static’ bias correction

- Based on method of Harris+Kelly.
- Bias model consists of:
  - A constant offset.
  - A scan bias correction.
  - Two thickness bias predictors.
- Fitted using ~ a month’s worth of data.
- Updated infrequently.

$$y_k^o := y_k^o - \left(c_k + s_k + \sum_{i=1}^{I_k} \beta_i^b p_{k,i} \right)$$

VarBC

- The bias correction is applied in our 1D-Var pre-processor.
- In DA an increment to the predictor coefficients is derived from the control vector:

$$\beta' = \mathbf{U}_\beta \mathbf{v}^\beta$$

- Observation penalty:

$$J_o = \frac{1}{2} \sum_k \left(\left(y_k + \sum_{i=1}^{I_k} \beta'_i p_{k,i} - y_k^o \right) R_k^{-1} \left(y_k + \sum_{j=1}^{I_k} \beta'_j p_{k,j} - y_k^o \right) \right)$$

- The amount the coefficients can change by is limited by a background term:

$$J_\beta = \frac{1}{2} \sum_{i=1}^{I_k} \beta_i'^T V_{(\beta_i)}^{-1} \beta'_i$$

N_{bgerr} and the bias halving time

The background error is set such that:

Weight of current cycle / Weight of prior = m_{cycle} / N_{bgerr}

At the Met Office:

$$N_{bgerr} = \mathtt{MAX}(m_{avg}, m_{min}) \left(\frac{1}{2^{\frac{1}{n}} - 1} \right)$$

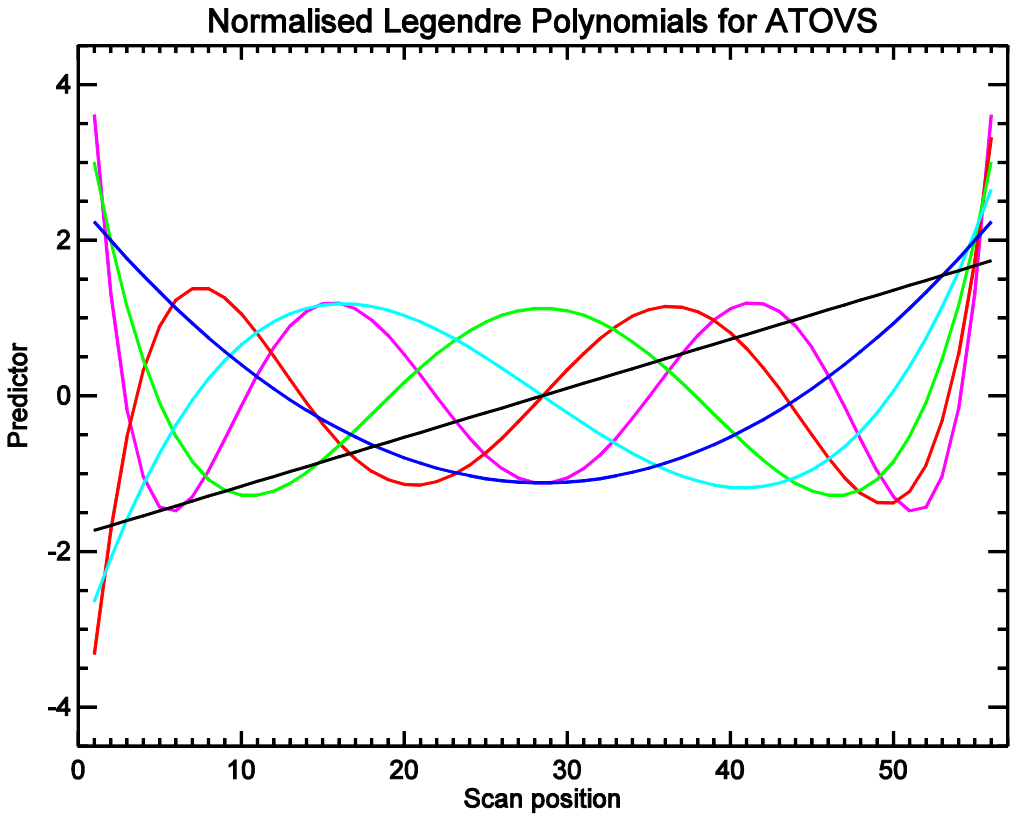
Testing with m_{min} = 1000 and n = 8 (2 days)

Corresponds to minimum N_{bgerr} of about 11,000

c.f. Patrik Benáček 11p.07

Constants and predictors

- Retaining point-by-point scan bias correction, (still need the static scheme to generate it.)
- Constant predictor (1).
- Two thickness predictors.
- 6 Legendre Polynomials in scan position. (4 will be used operationally)
- 10 pairs of orbital bias predictors (see next talk).



Limitations

- ‘Passive’ channels.
- Point-by-point scan bias correction.
- Observation selection.
- Currently only applies to satellite observations.
  - No plans to extend to other ob types for now.
  - Un-bias-corrected anchor observations important for excluding model bias.

Testing of VarBC

FY3C MWHS2-11

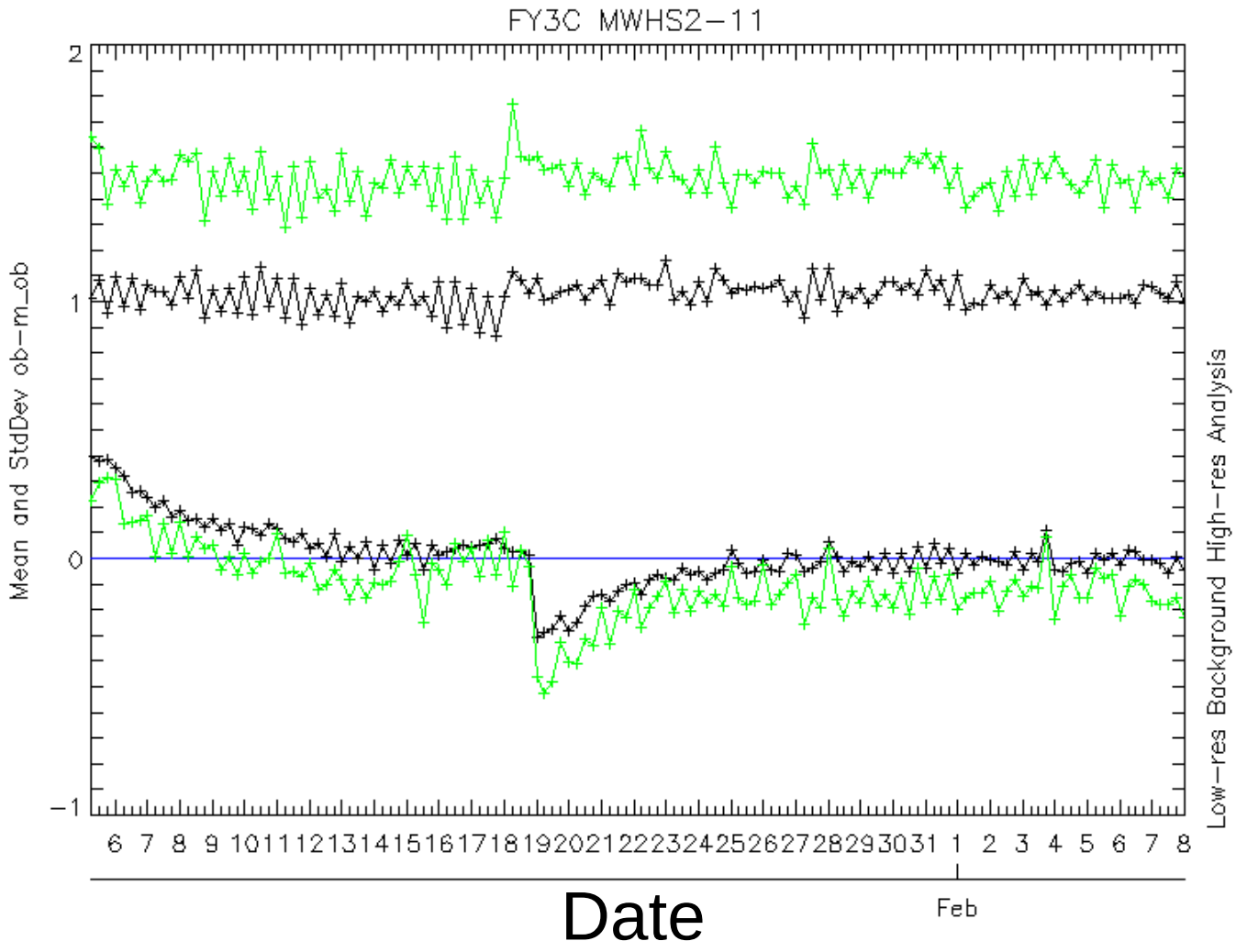
Observed-Background & Observed-Analysis

StdDev O-B

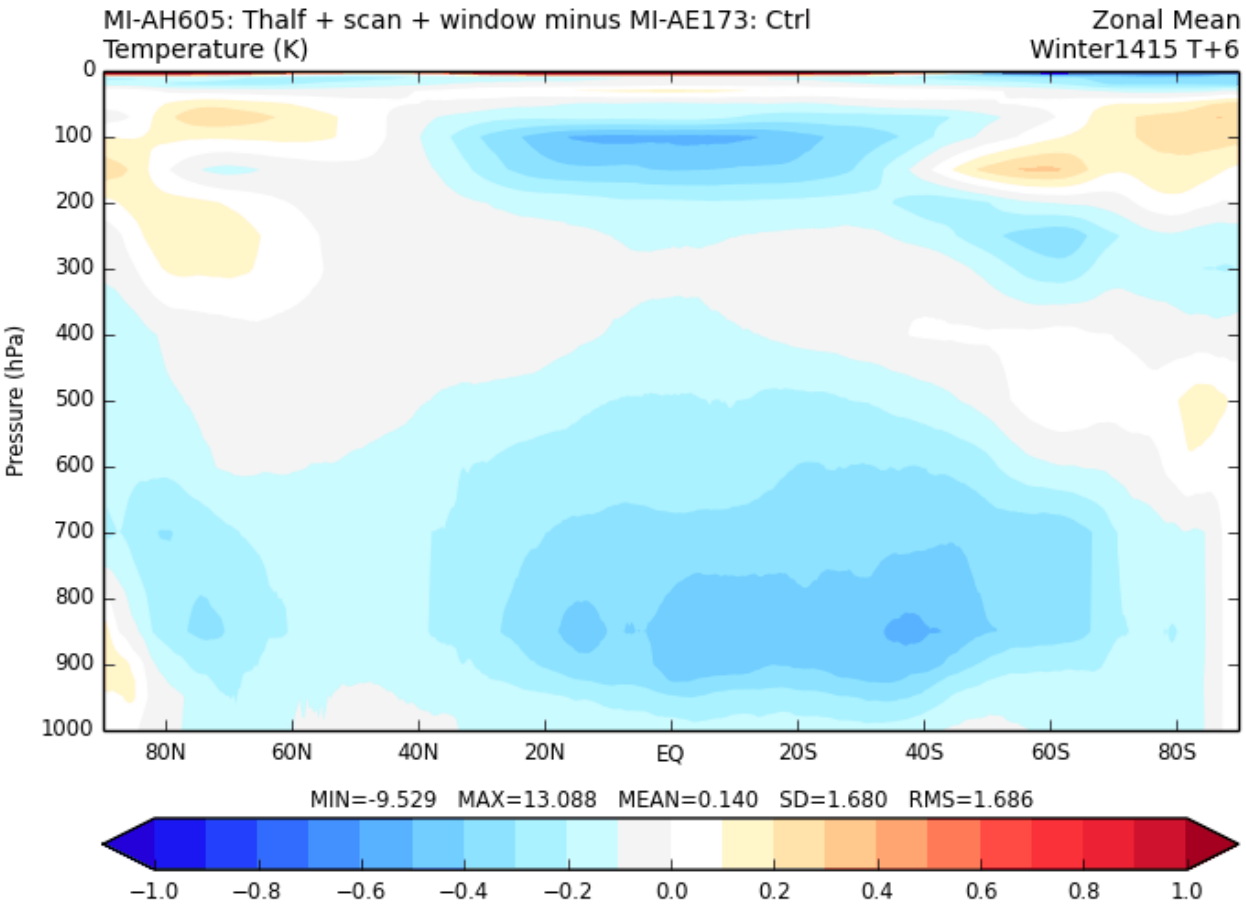
StdDev O-A

Mean O-B

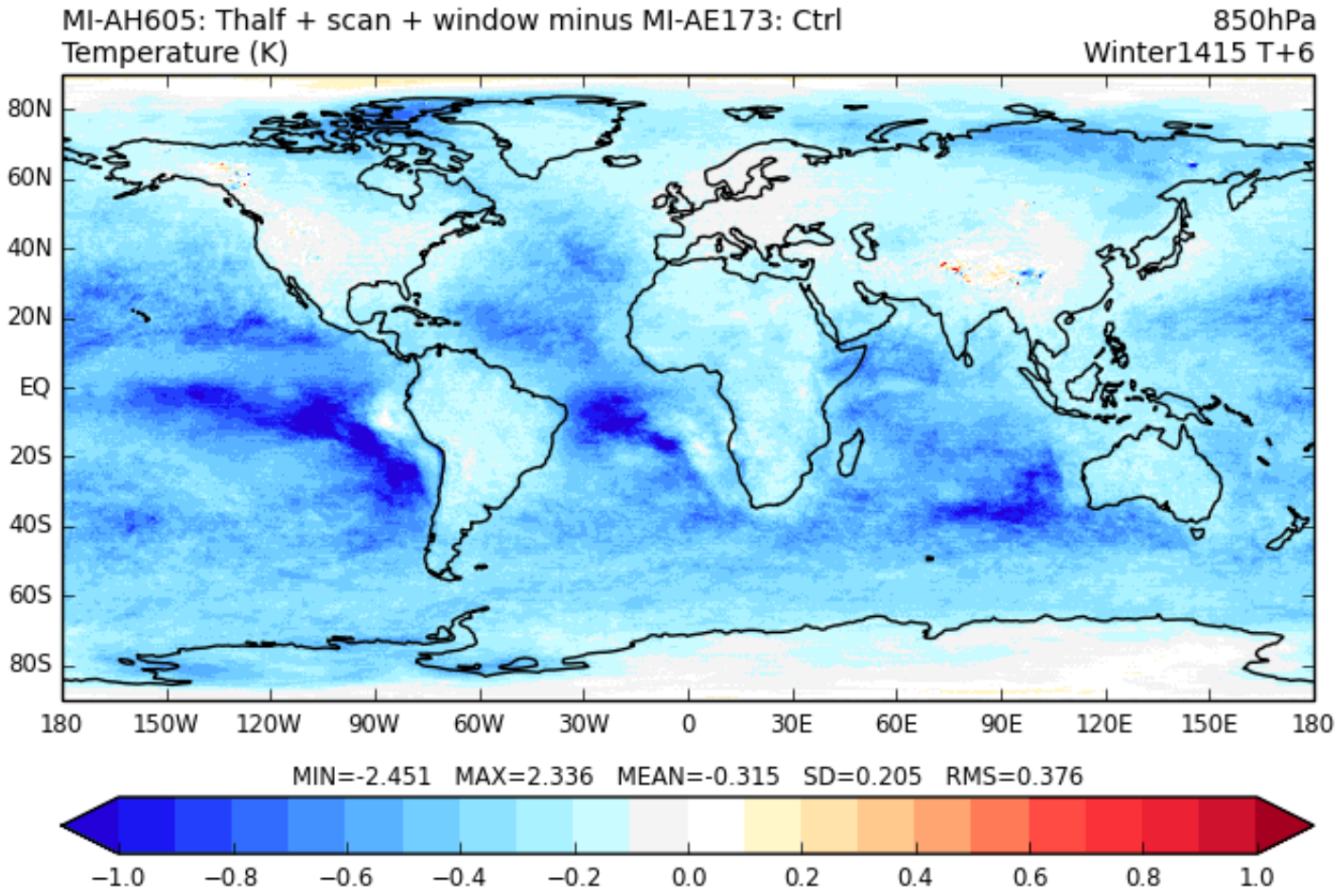
Mean O-A



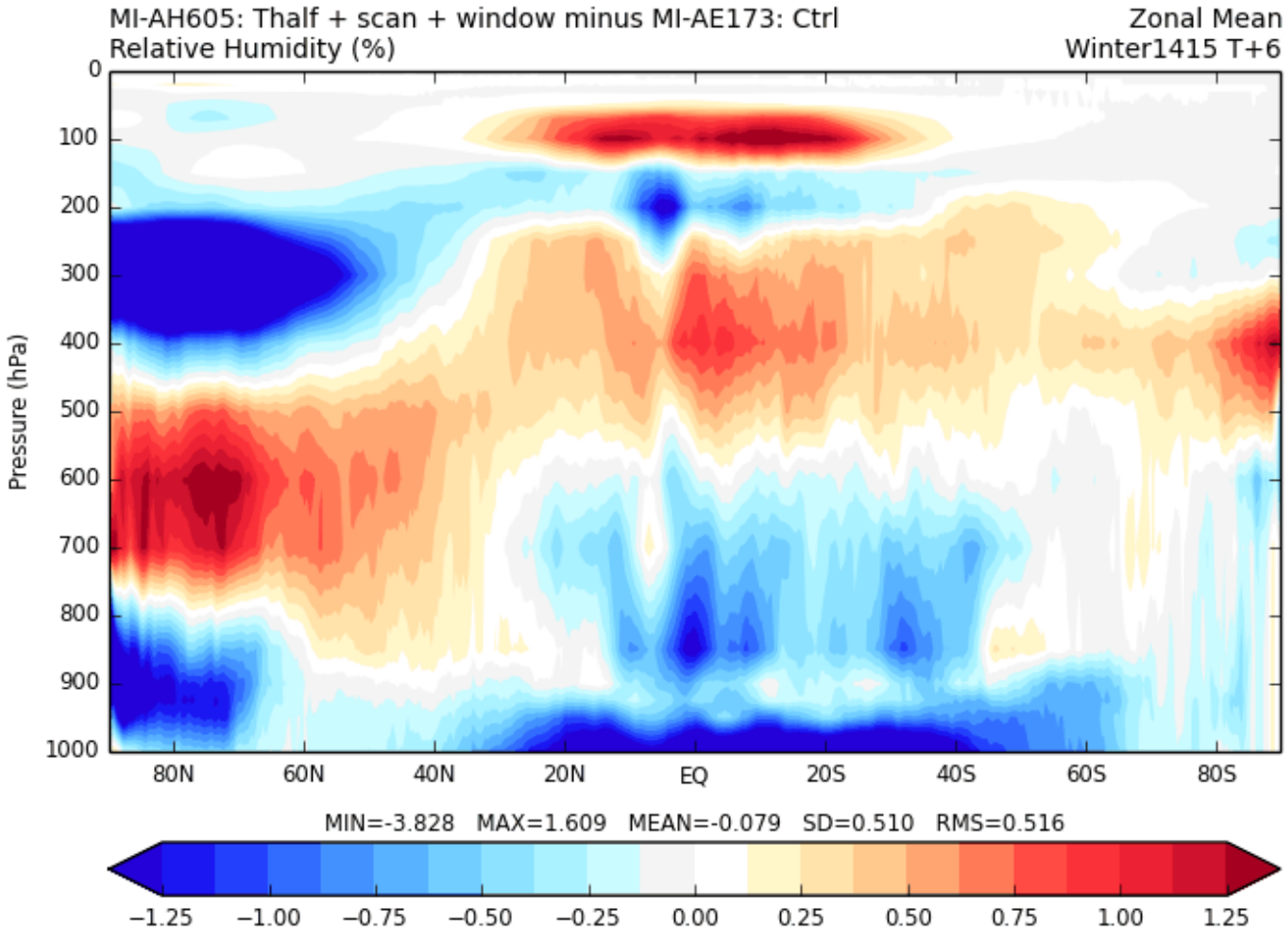
T+6 zonal temperature difference



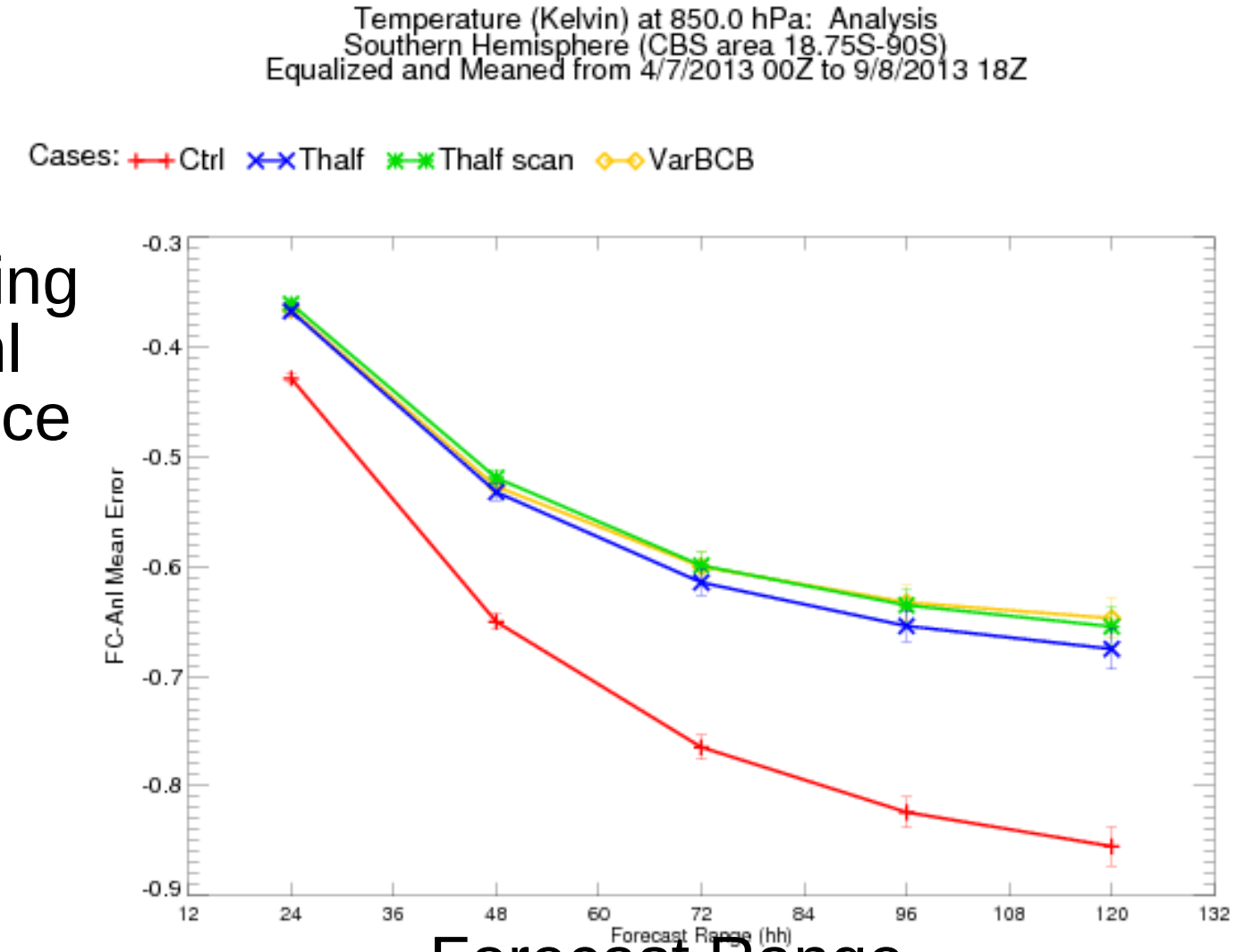
850 hPa temperature difference



Zonal relative humidity difference



Reduction in Spin Down T850 SH



Increasing Fc-Anl difference

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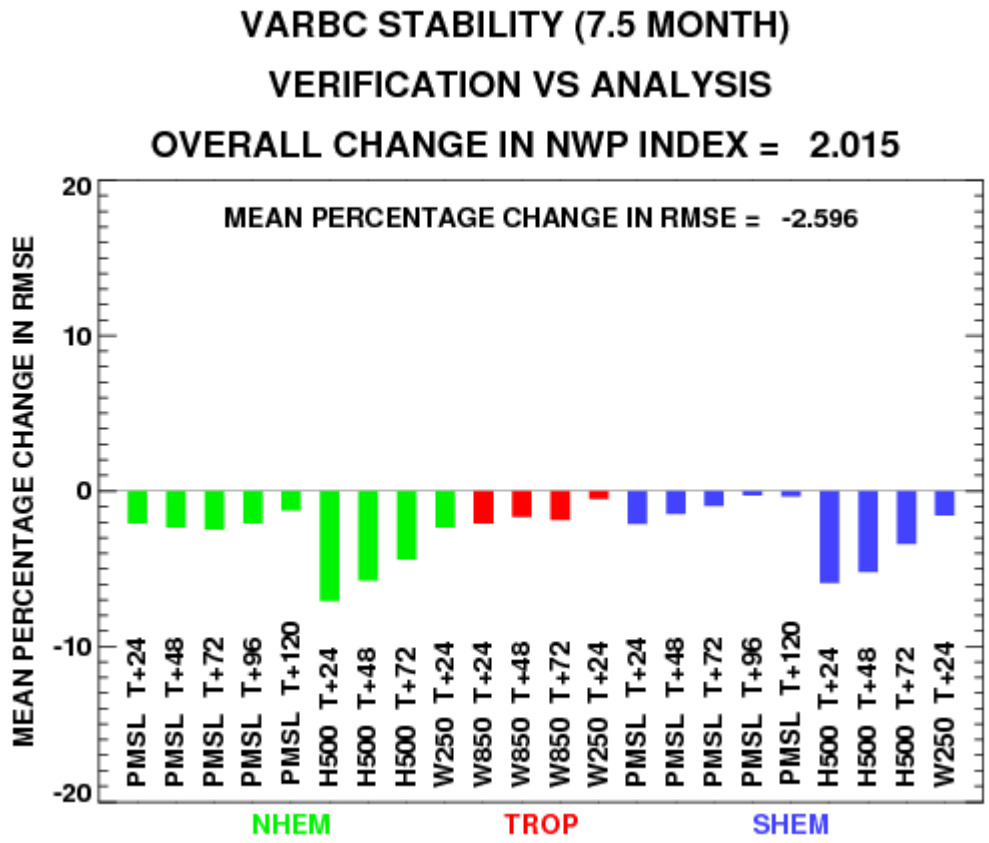
Forecast Range

7.5 month VarBC trial and control Verification vs Analysis

T+24 H500 **-7.1%** in NH and **-5.9%** in SH

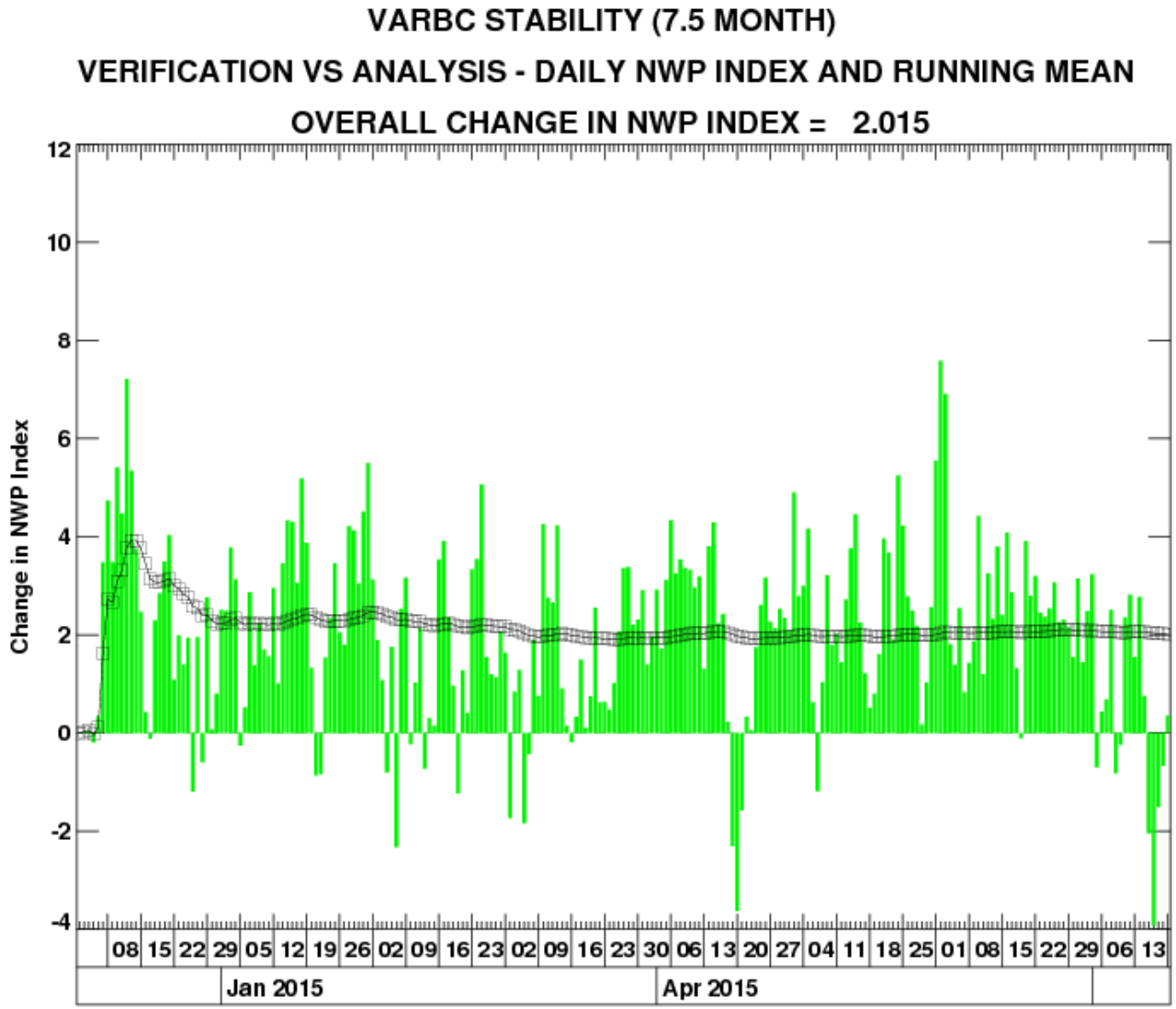


UK index:

- +0.1 UK index NH
- +0.1 UK index SH
- **+0.3** UK index British Isles
- **+0.3** UK index stations

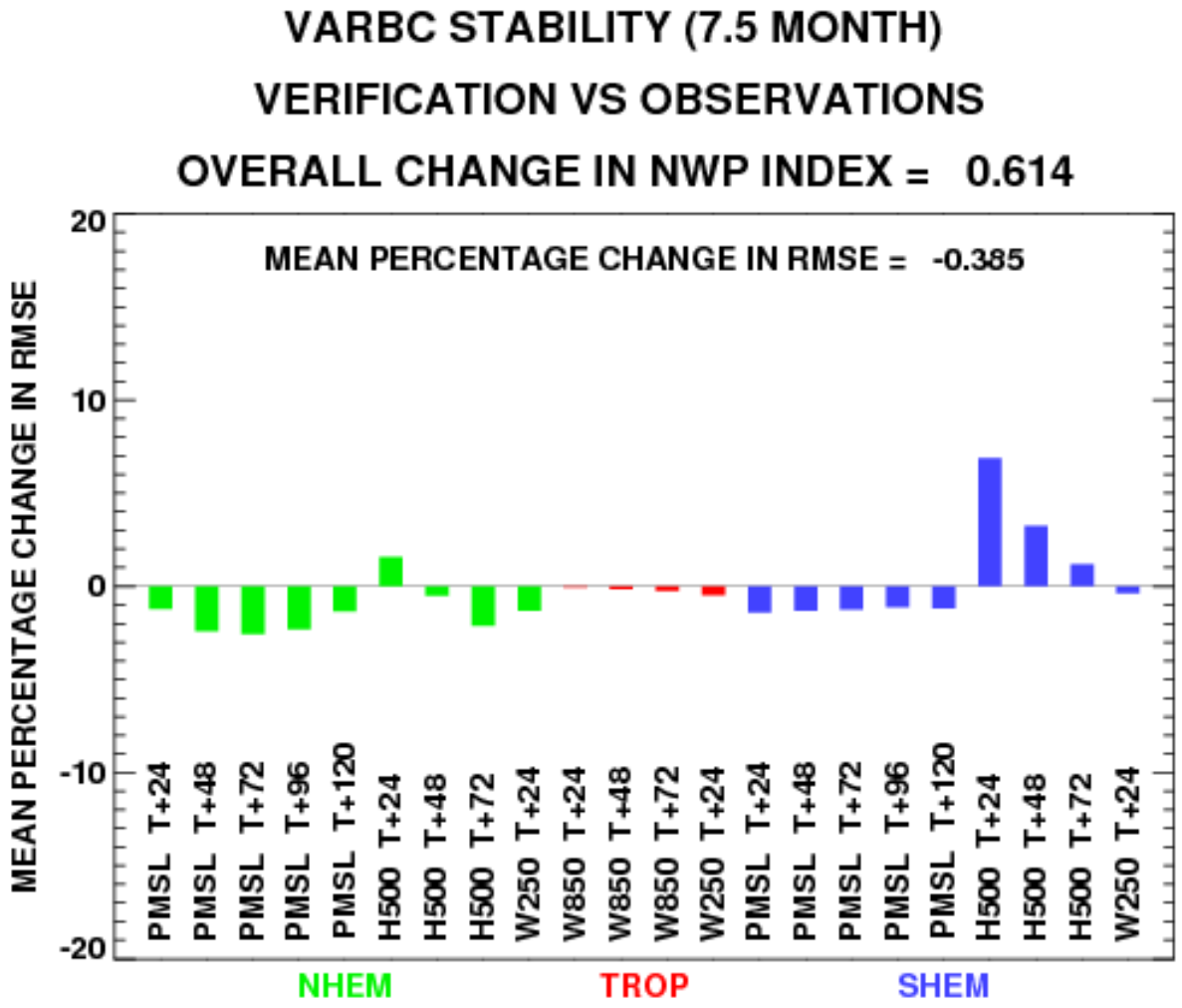
(scoring on 6hr Precip Accum)

Daily verification against analysis + running mean

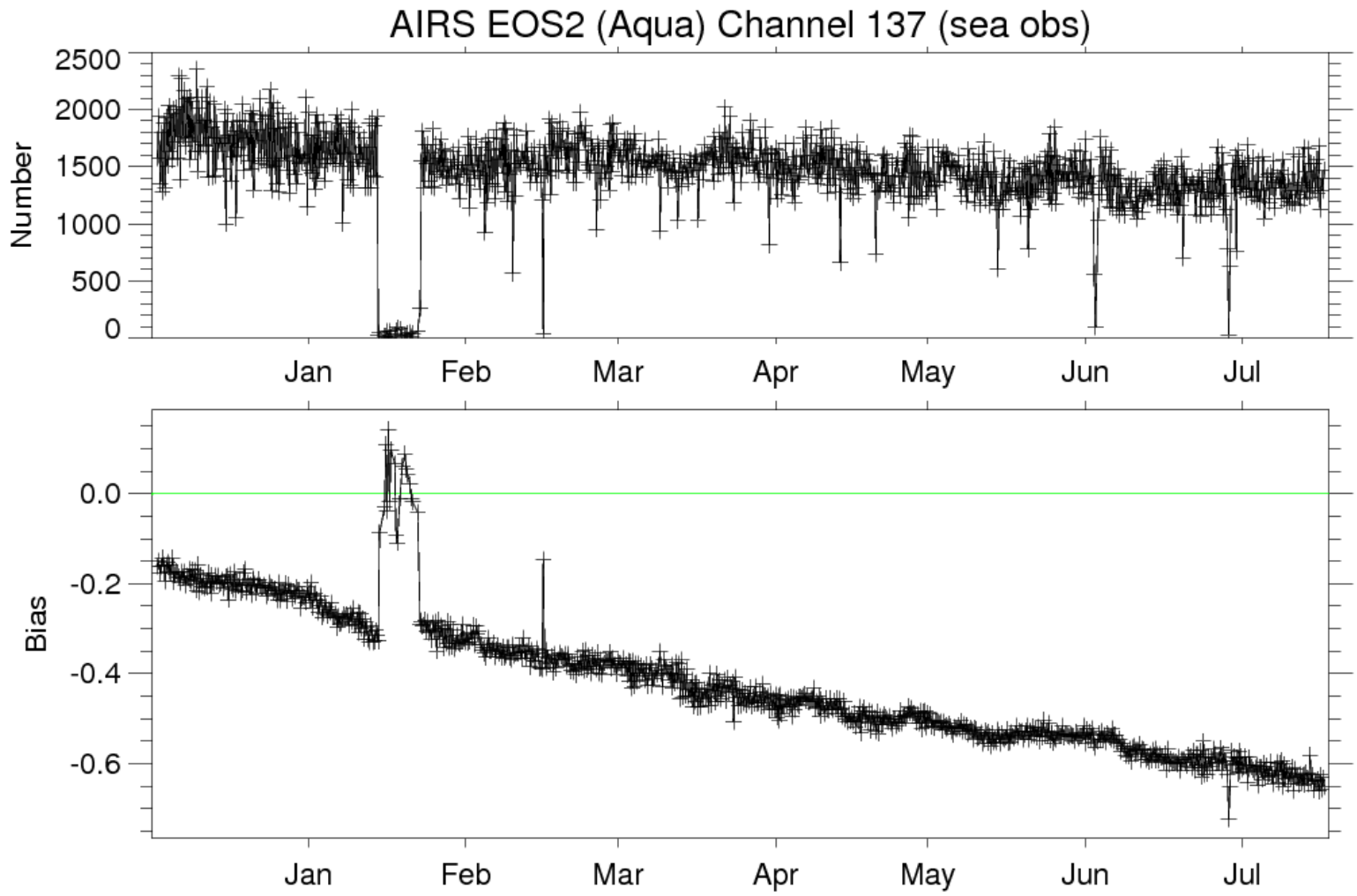


7.5 month trial
Verification against Observations

The apparent degradations in H500 are due to cooler analyses and an increase in bias, but these are within the uncertainty of radiosonde height measurements.



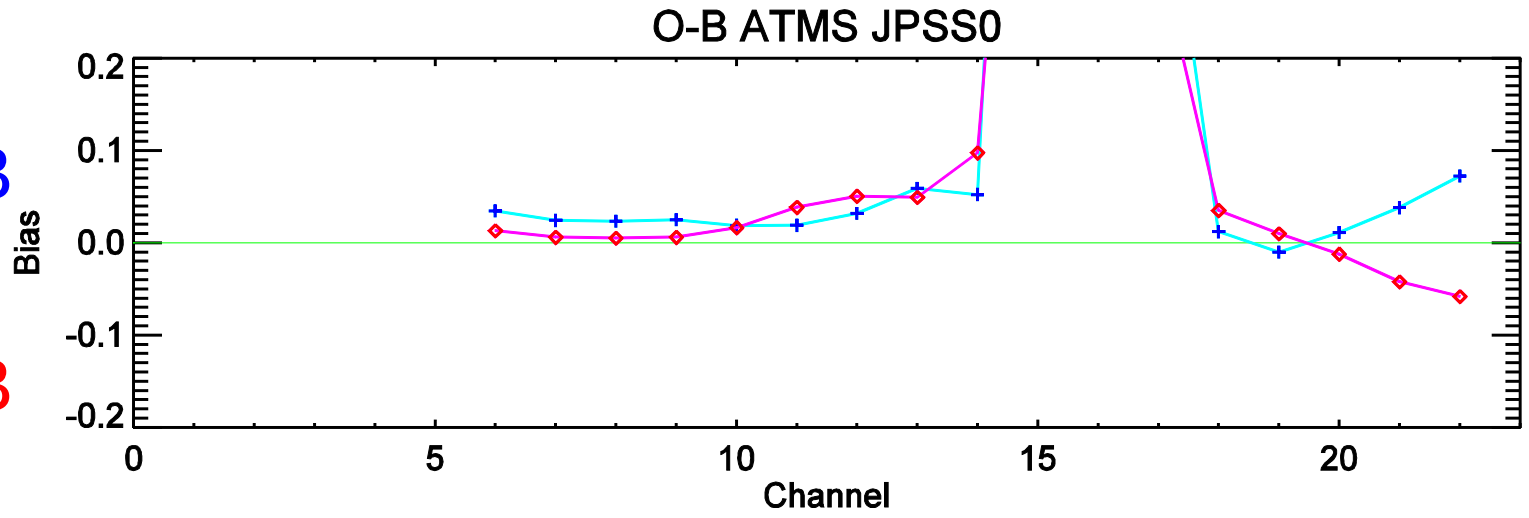
AIRS window channel
Applied Bias has drifted 0.5K!



ATMS Mean O-B and Mean O-A

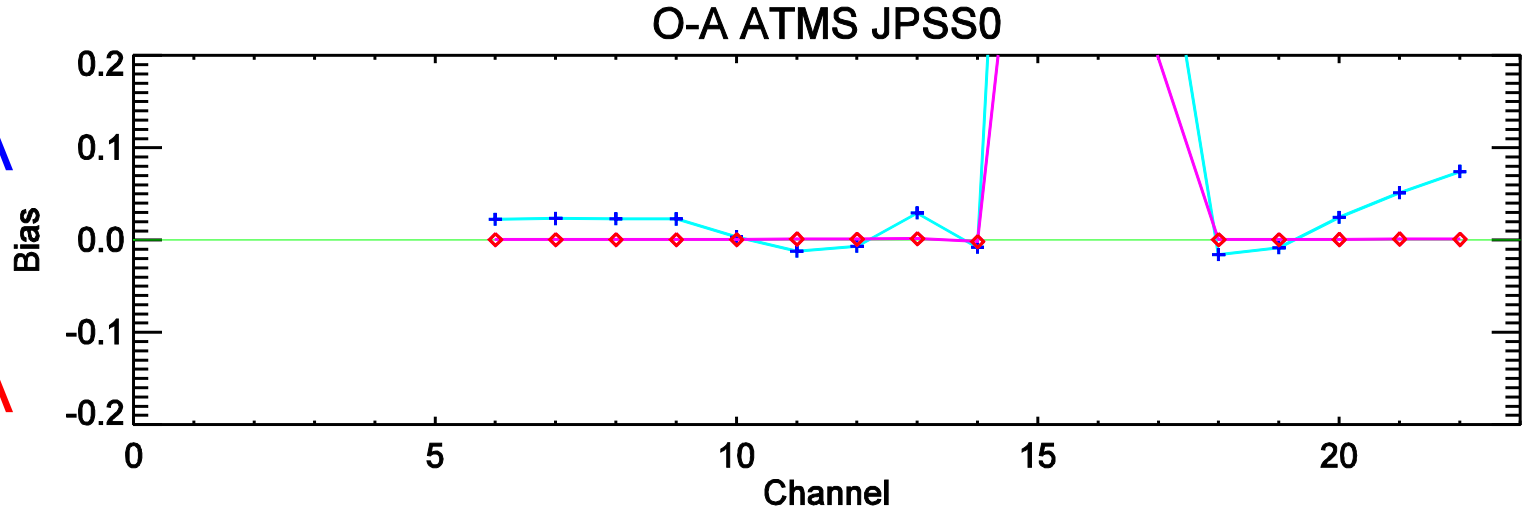
Static Mean O-B

VarBC Mean O-B



Static Mean O-A

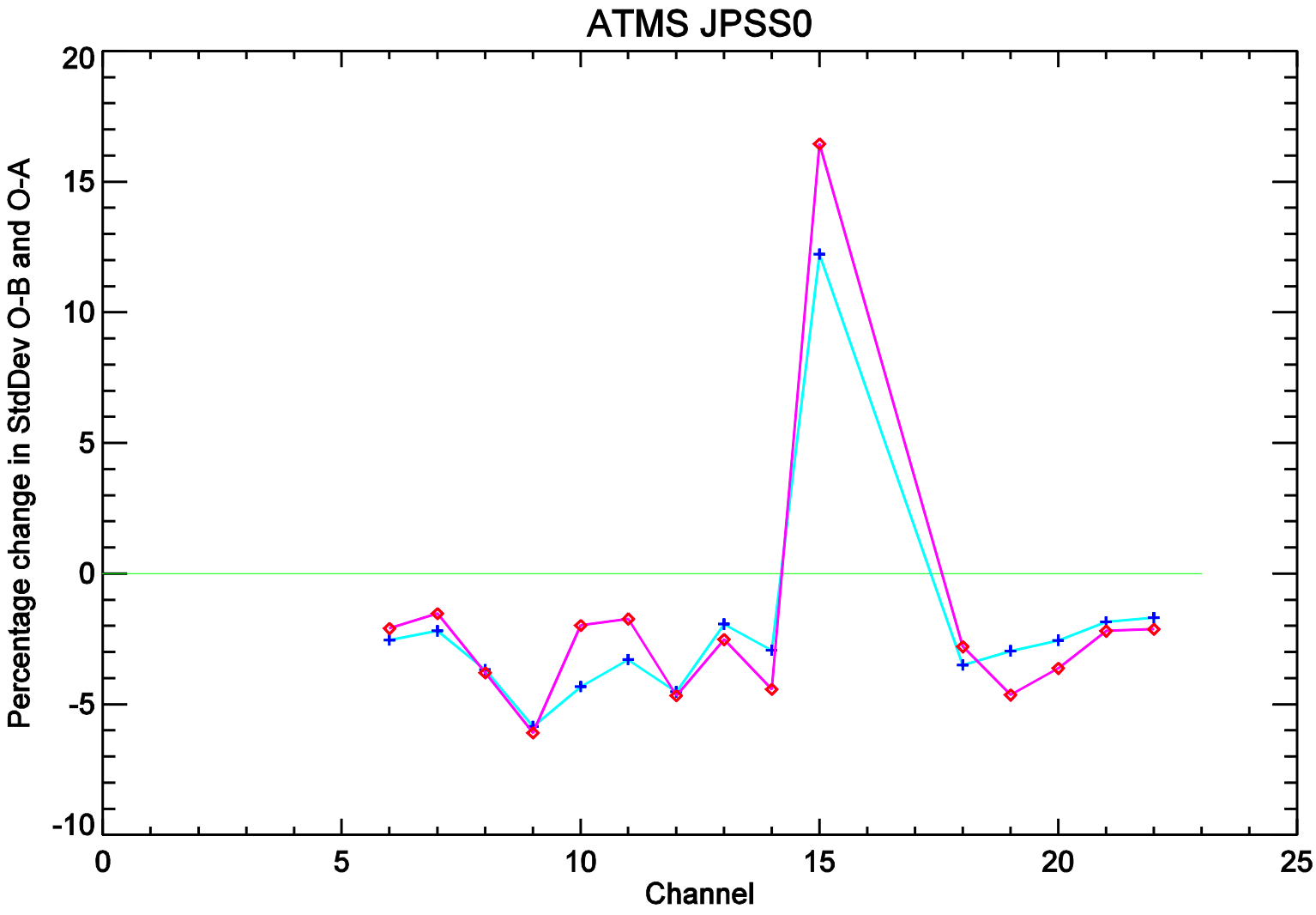
VarBC Mean O-A



ATMS
Change in StdDev O-B and O-A

O-B

O-A



Summary

Distinctive features:

- Orbital bias predictors.
- Legendre Polynomial scan bias predictors.
- Bias halving time.

Results:

- Strong positive impact at the Met Office.
- Colder, drier analyses with less spin-down.
- Planned implementation in spring 2016.

Still lots to do:

- Regional models.
- Passive channels.
- Observation selection.
- Update of position-by-position scan bias.

Met Office

Questions