# Assimilation of surface data in mountainous regions

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ICAM, Aviemore, 27 May 2011

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This presentation covers the following areas

- Height adjustment
- Performance and diagnostics
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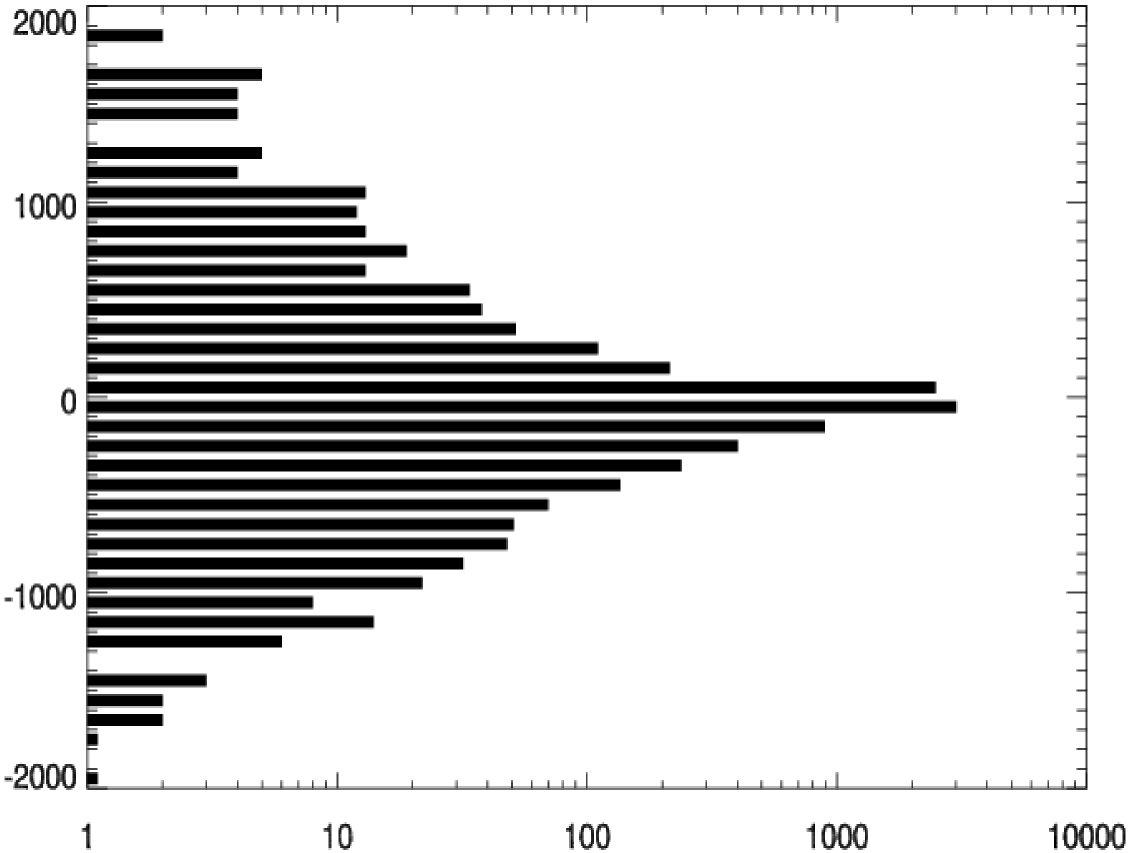
# Height adjustment

# Model ➔ Observation

- Boundary layer: ➔ T/RH 1.5m screen, u/v 10m
- Horizontal interpolation to report location
- Time interpolation from T+3/6/9 to ob. time: Background = short range forecast
- Adjustment from Zstn to Z*, very important for P/T especially in mountainous regions

- Observation-Background
- O-B = observation error + background error assumed independent

# Station – global model height

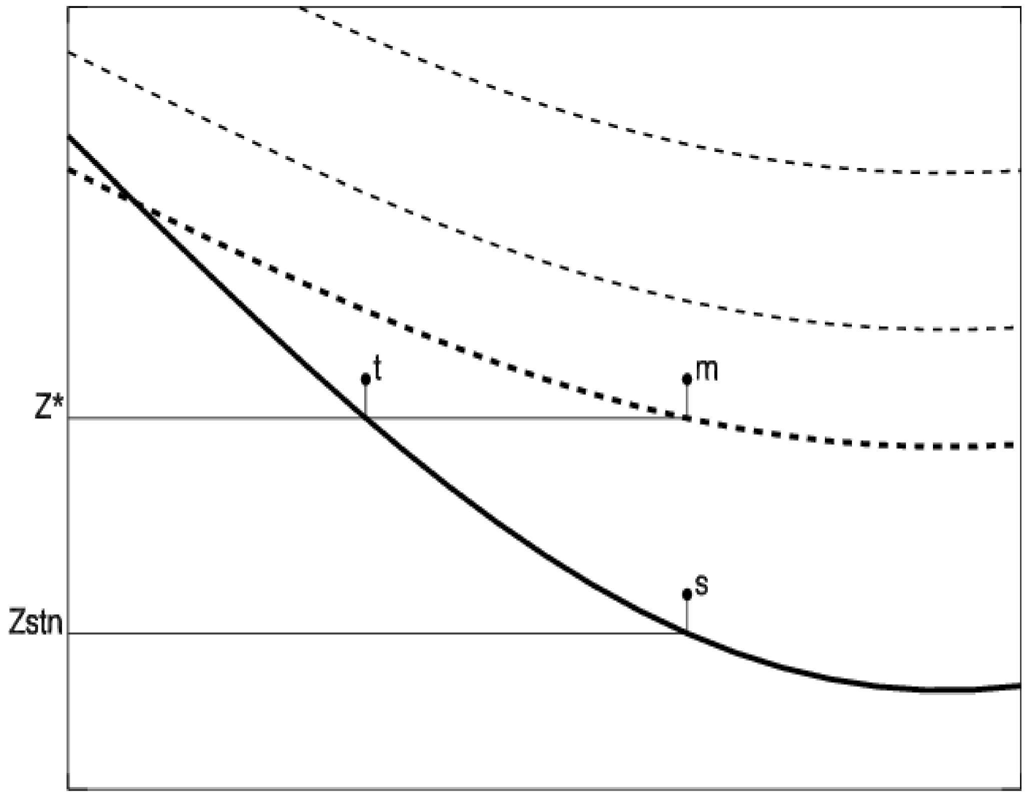



- 25 km global model
- Mean -53m, SD 231m
- Most stations on low ground. Some of the highest are in Tibetan valleys! (Pepin and Seidel, 2005)
- Don't use surface data if $|\Delta z| > 500$m
- For T/RH/wind night-time limit is $500 < \Delta z < 250$ m

# Pressure conversions

- Pstn (measured variable) preferred to Pmsl – but we need correct Zstn (from WMO Pub 9A)
- Pstn accuracy ~0.3 hPa; want Zstn accuracy better than 3 m to match this
- Unfortunately wrong heights are still a source of error (cf Ingleby, 1995, W&F). P correction applied when |O-B| > 1.5 hPa. Stations with large SD(O-B) are rejected (updated monthly).
- We convert Pstn (or Pmsl) to P* - pressure at model surface

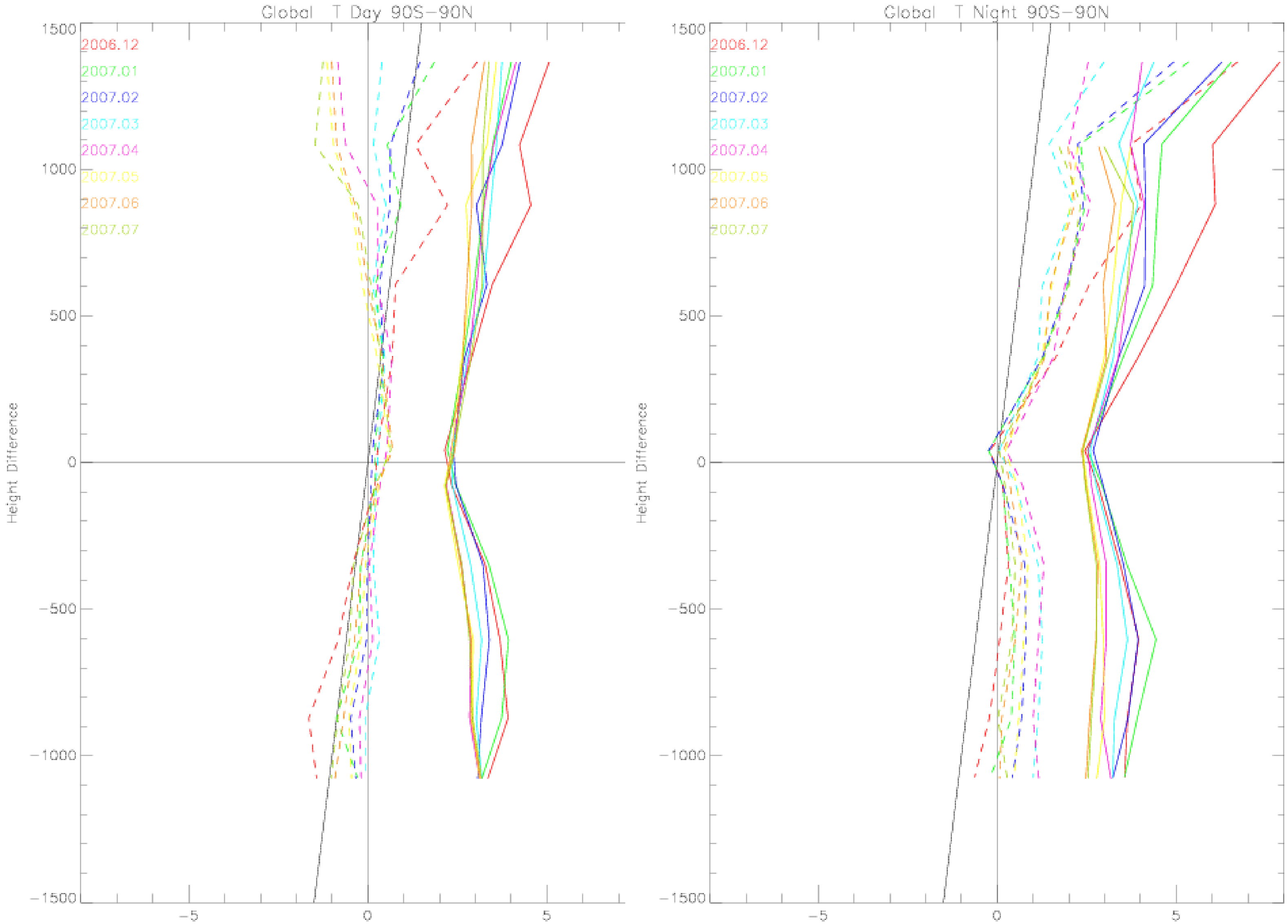
# Schematic of T adjustment




- Model levels – dashed, real surface – solid line
- Lowest T/q level is 20m (global model), 2m T calculated using similarity theory
- Then we adjust for Zstn-Z* using 6.5°/km
- McCutchan (1983): lapse rate up mountain slope ≠ free air lapse rate (we want former)

# Tadj vs dht: Day and Night

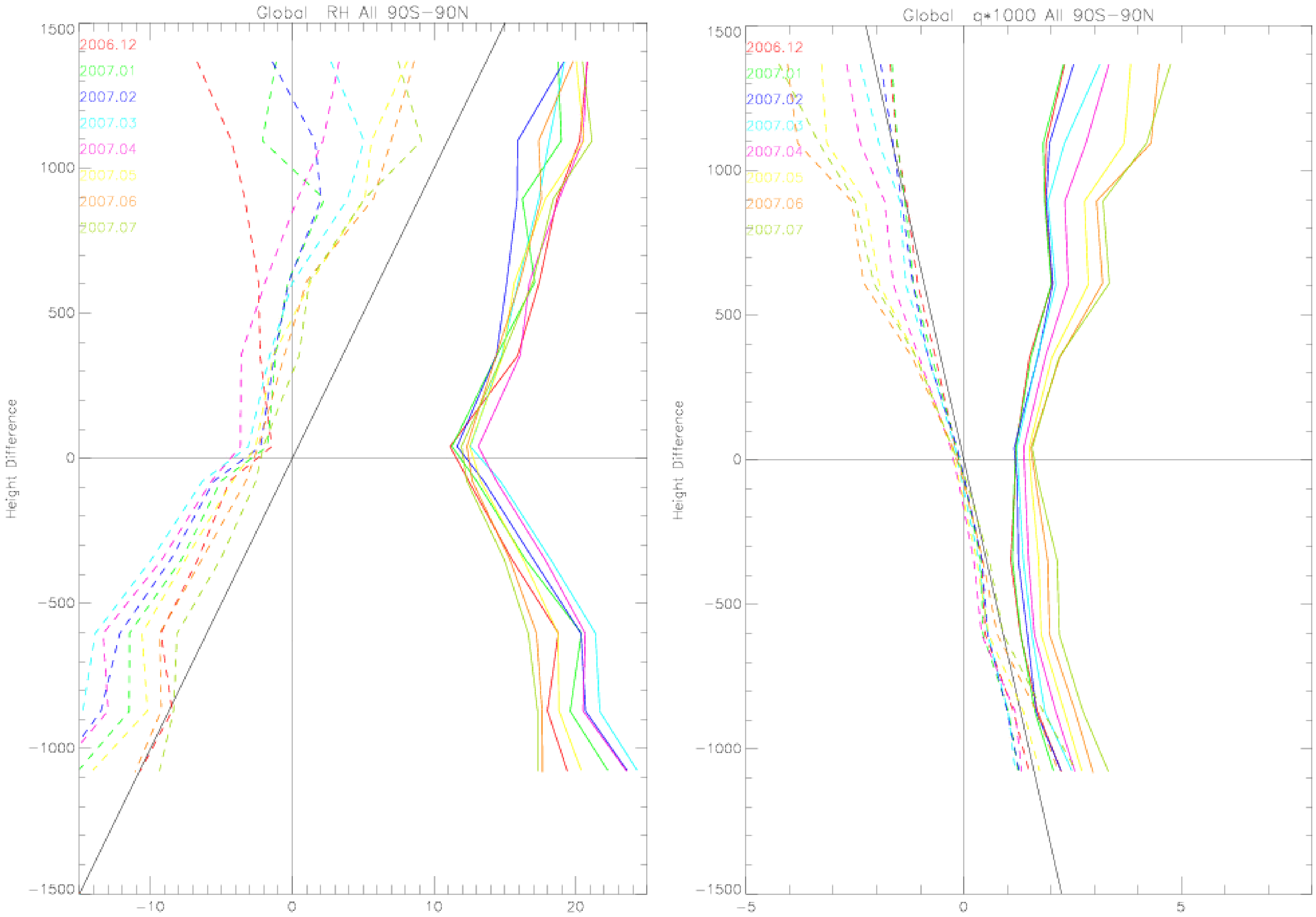
## seasonal variation - try UKPP solution



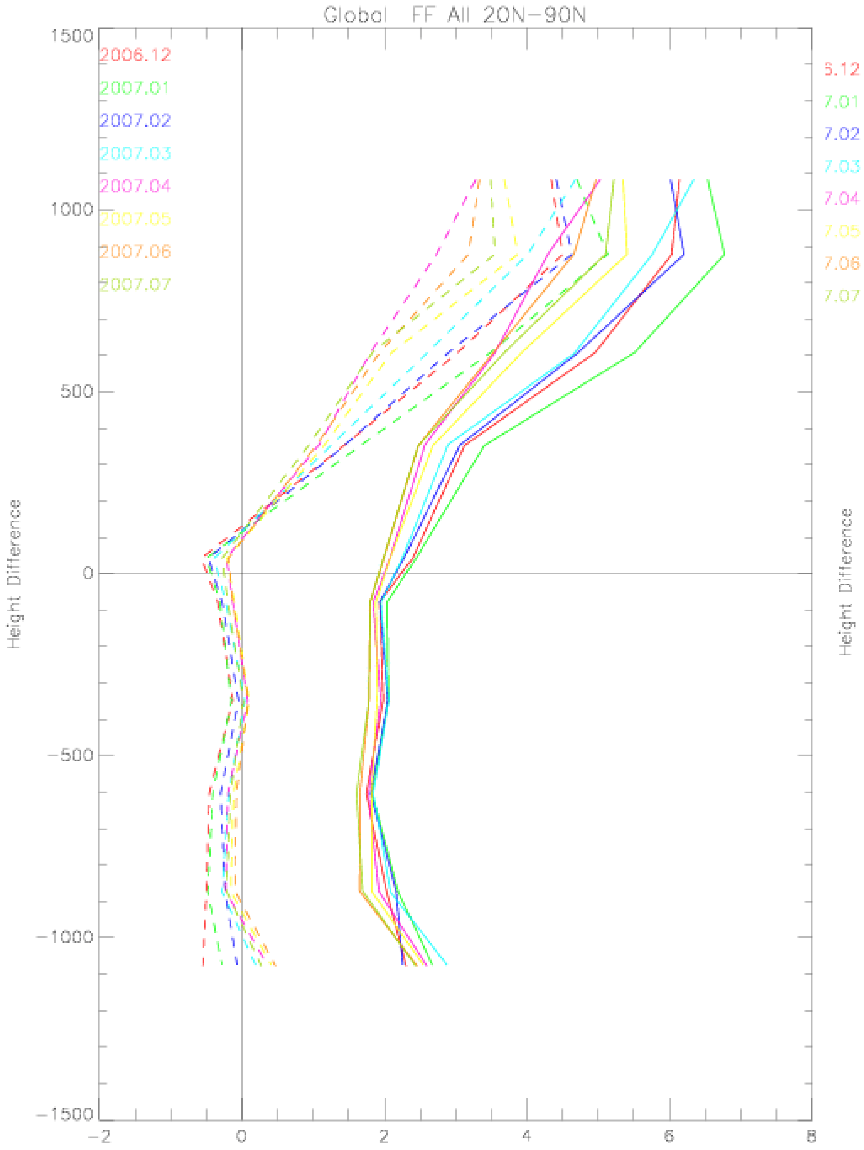
# Adjustments applied

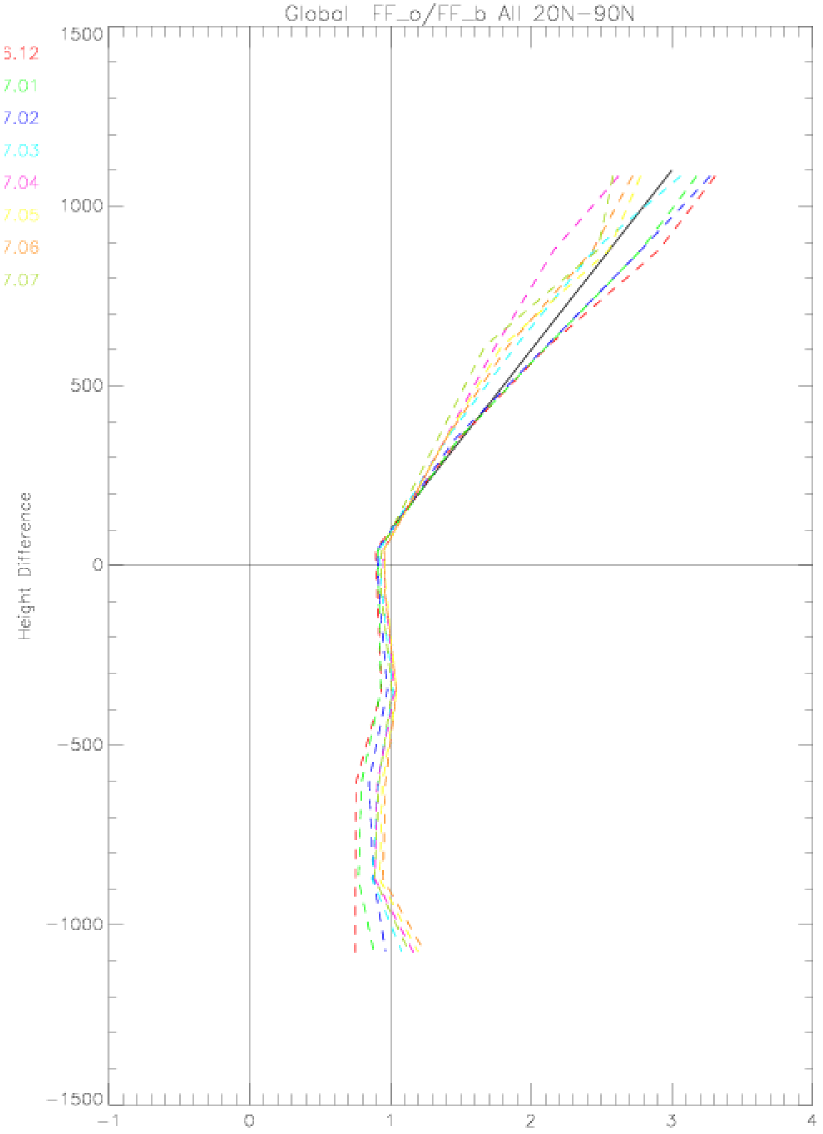
- T – climatological lapse rate 6.5°/km – good average figure, less appropriate at night/winter
  - Started calculating/storing lapse rate estimated from regression of model T20m vs Z* (Sheridan et al, 2010) preliminary results mixed
- RH – adjustment of 10%/km *(model dependent)*
  - Background slightly wet – too much pptn (especially over mountains)
- Wind speed – scaled down for $\Delta z > 100$m (max factor 3 for $\Delta z = 1600$m)
  - cf Howard & Clark (2003, 2007 Met Apps)
  - some stations report too many calm winds?

# RH & q vs dht.  New RH adj.



# Wind speed vs dht



# Performance and diagnostics

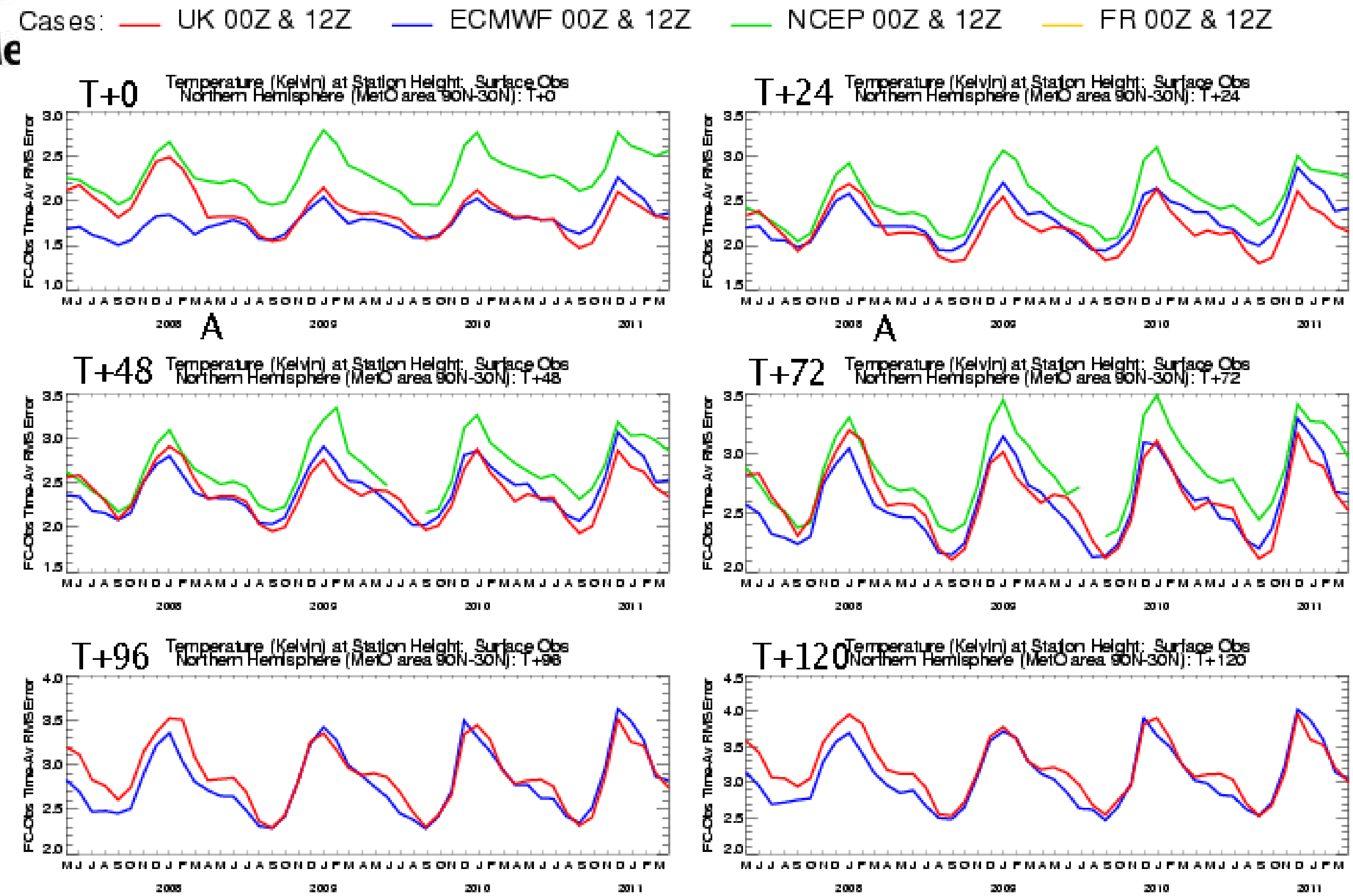
Changes 2008-2011

Met Office

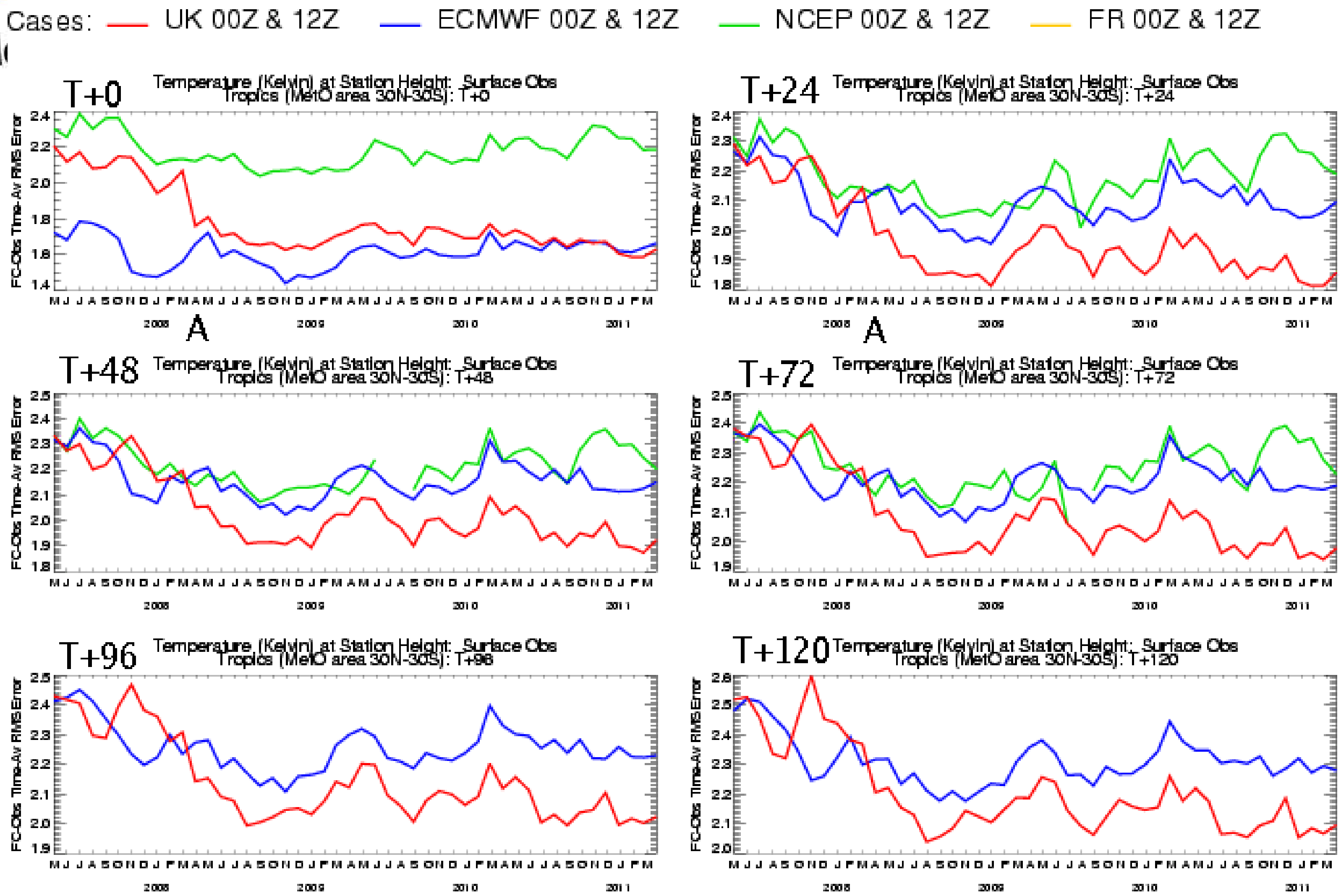
# Global model changes

- **April 2008: improved soil properties (Dharssi et al, 2011), assimilation of surface T/RH/wind,** height adjustment for RH/wind
- Nov 2008: snow analysis, BL improvements
- March 2009: Mobile Synops assimilated
- March 2010: resolution improvement, use of ‘extra’ RH2 data, improved QC of marine data
- July 2010: use of ASCAT soil wetness
- July 2011: Metars to be assimilated

# Screen T verification - NH



# Screen T verification - TR

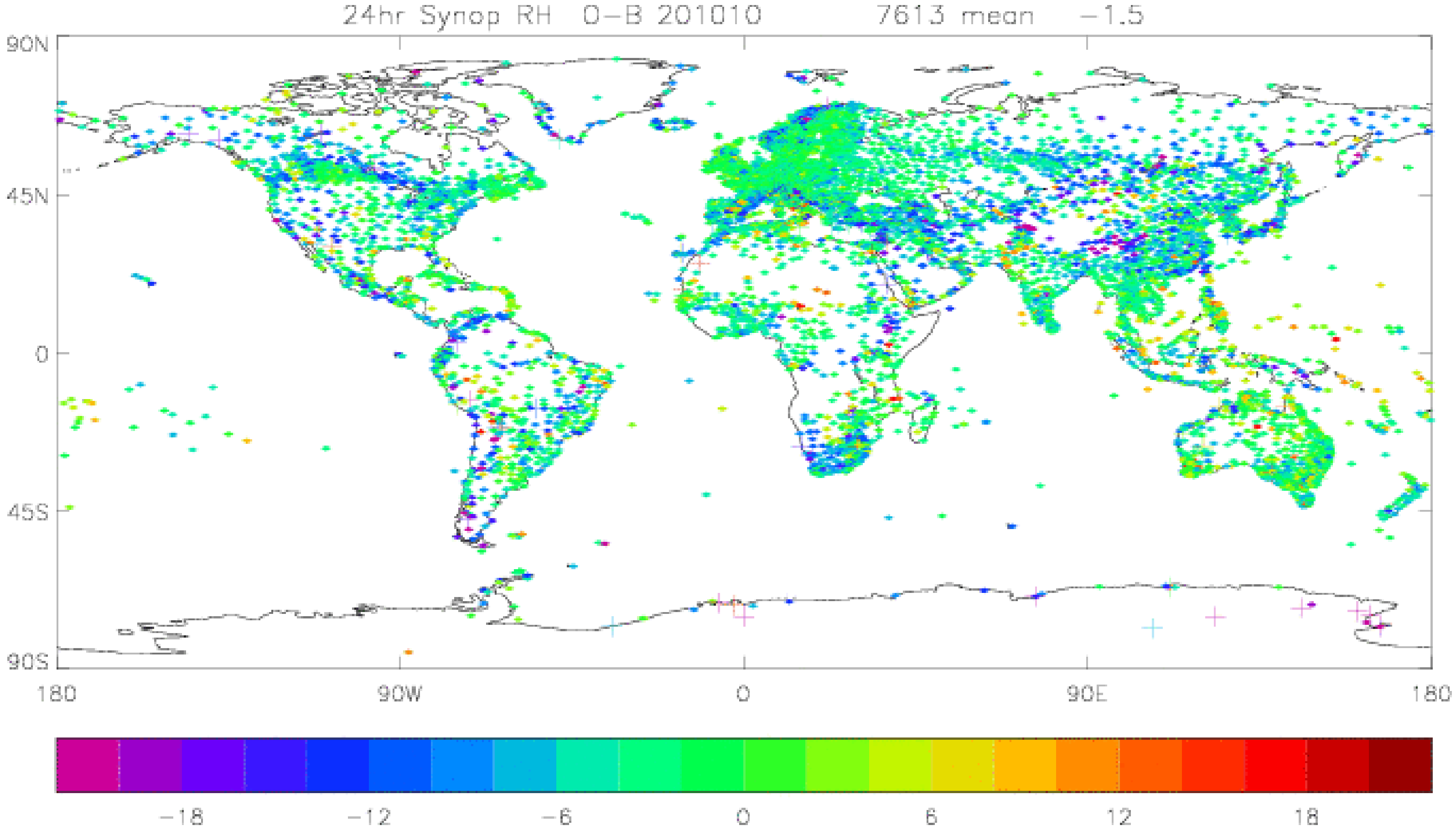


# Solar heating - land screens?

- Possible problems in high insolation and weak winds (counts the UK out then)
- Up to 1C Hubbard et al (2004) – comparison with aspirated screen (US Climate Reference Network)
- Larger errors over snow (extra reflection), Lin et al (2005) suggest 2-3C extra, Arck and Scherer (2001) up to 6C total!
- Will look at this further decide whether to correct (or reject) data – need to know if stations are aspirated (very few)

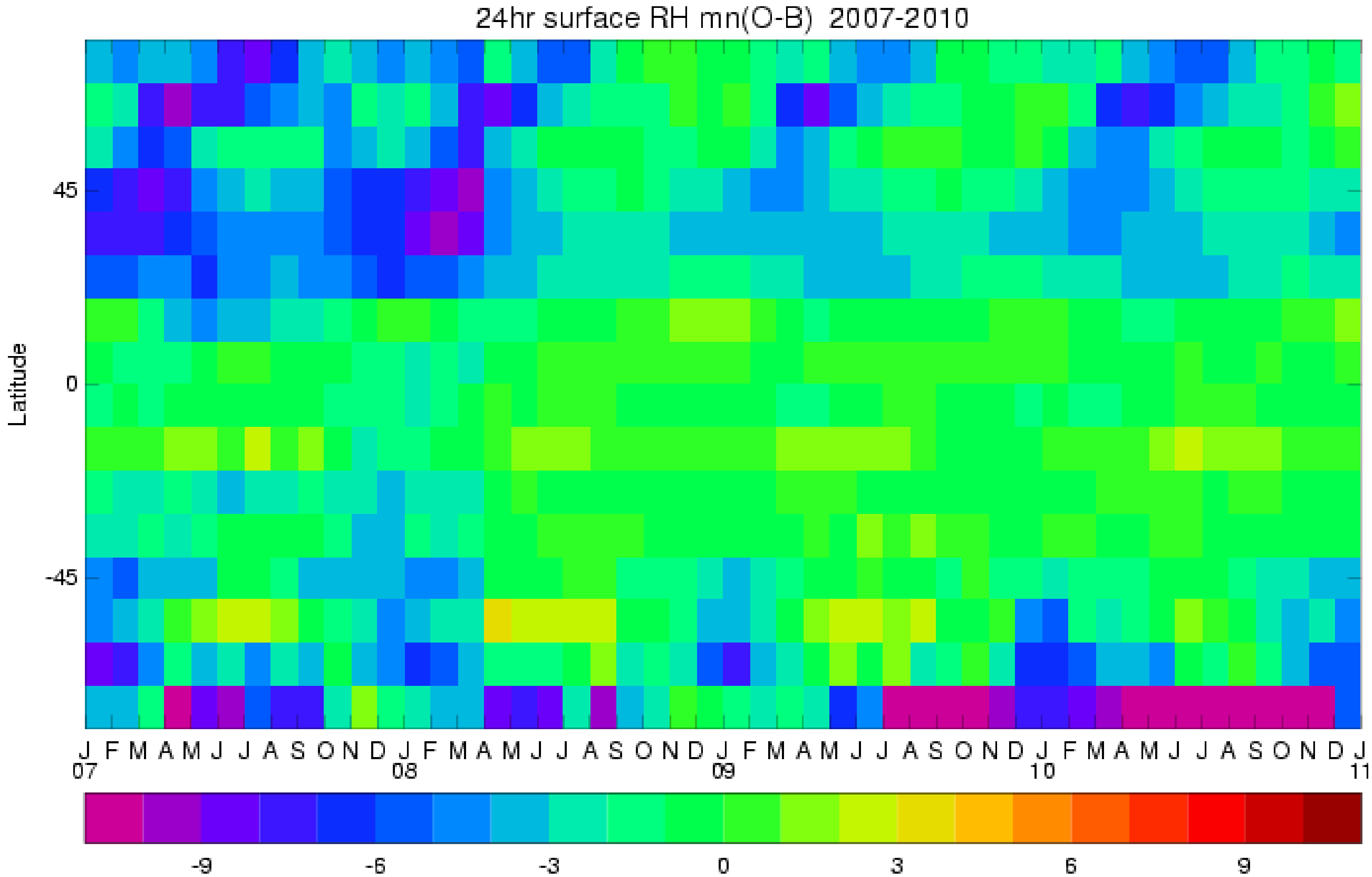
# RH O-B Oct 2010

## B too wet in mountains

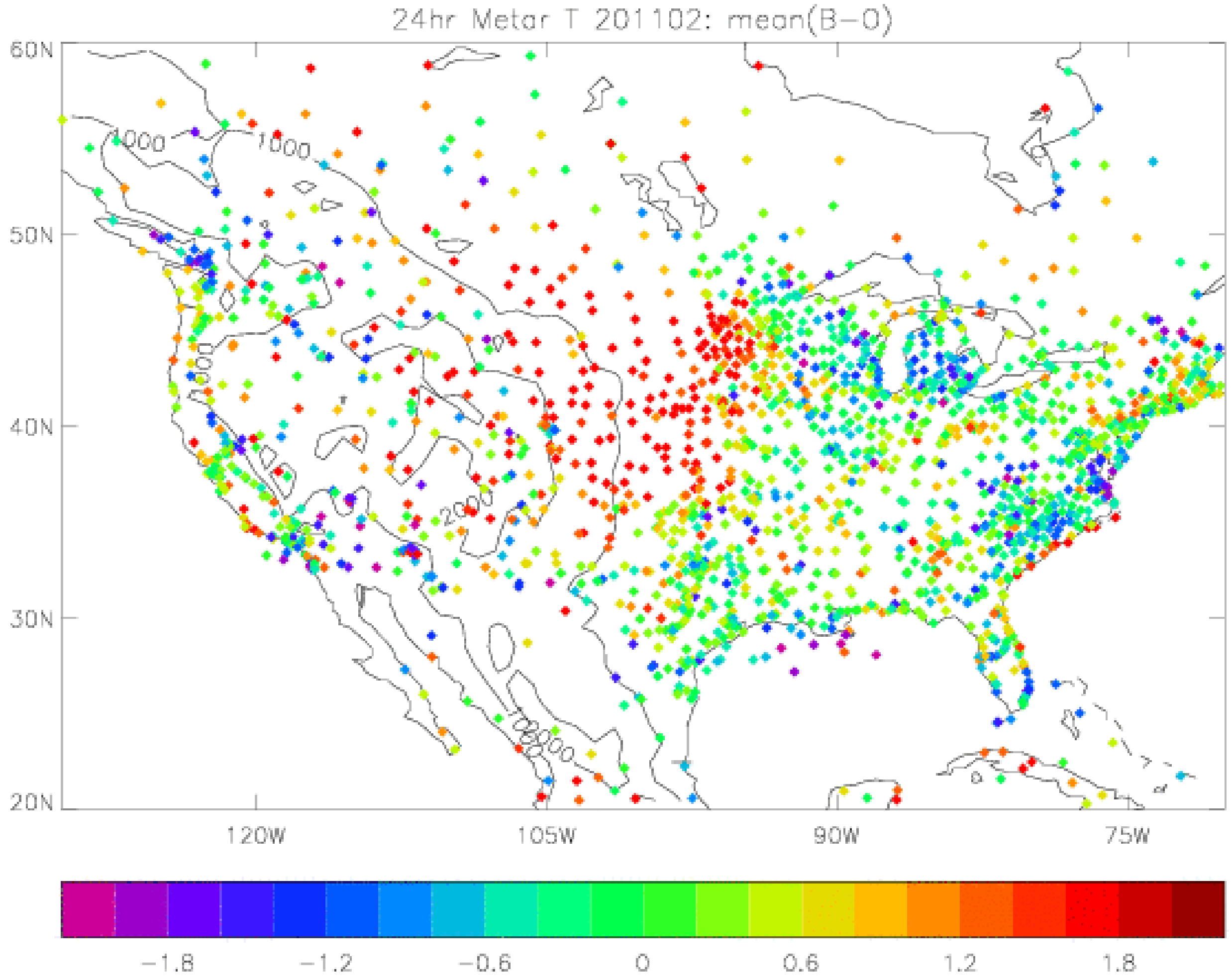



©

# RH O-B: latitude vs month



# T B-O Feb 2011 Metars



# Summary

# Summary

- Met Office global/regional surface data assimilation is state-of-the-art. Uses more data than most other global NWP systems.
  - Positive impact of P/T/RH – less for wind
  - Soil moisture, BL and resolution all important
  - Lots of attention to detail needed
- Importance of height adjustment and monitoring
  - Looking at synoptic dependent lapse rate
  - Need correct station heights!!! (within a few m for P)
- Importance of monitoring and meta-data
- Links to post-processing, verification, diagnosis of model errors

# Questions and answers