

# A forecast impact trial with CHAMP radio occultation measurements

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## **Acknowledgements**

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## Outline

- Forward model description.
- 1D-Var Information content.
- Outline the trial period information.
- Preliminary impact trial results from verification package.
- Summary.

## Forward model

We assimilate refractivity derived from CHAMP measurements

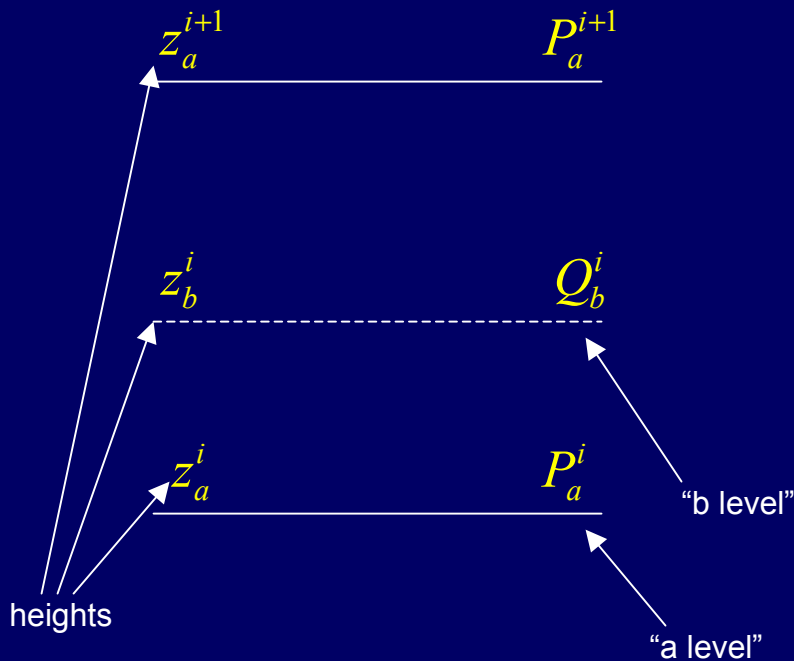
$$N = \frac{aP}{T} + \frac{bP_w}{T^2}$$

The refractivity forward model has been written to be consistent with the Met Office “New Dynamics” forecast model.

The refractivity forward model uses pressure and specific humidity (or relative humidity) on model height levels to simulate the observed refractivity,  $N$ , values at the observation heights.

# Forward Model

Need to be able to calculate refractivity at arbitrary geopotential heights. We have pressure information on “a” levels and humidity information on “b” levels.



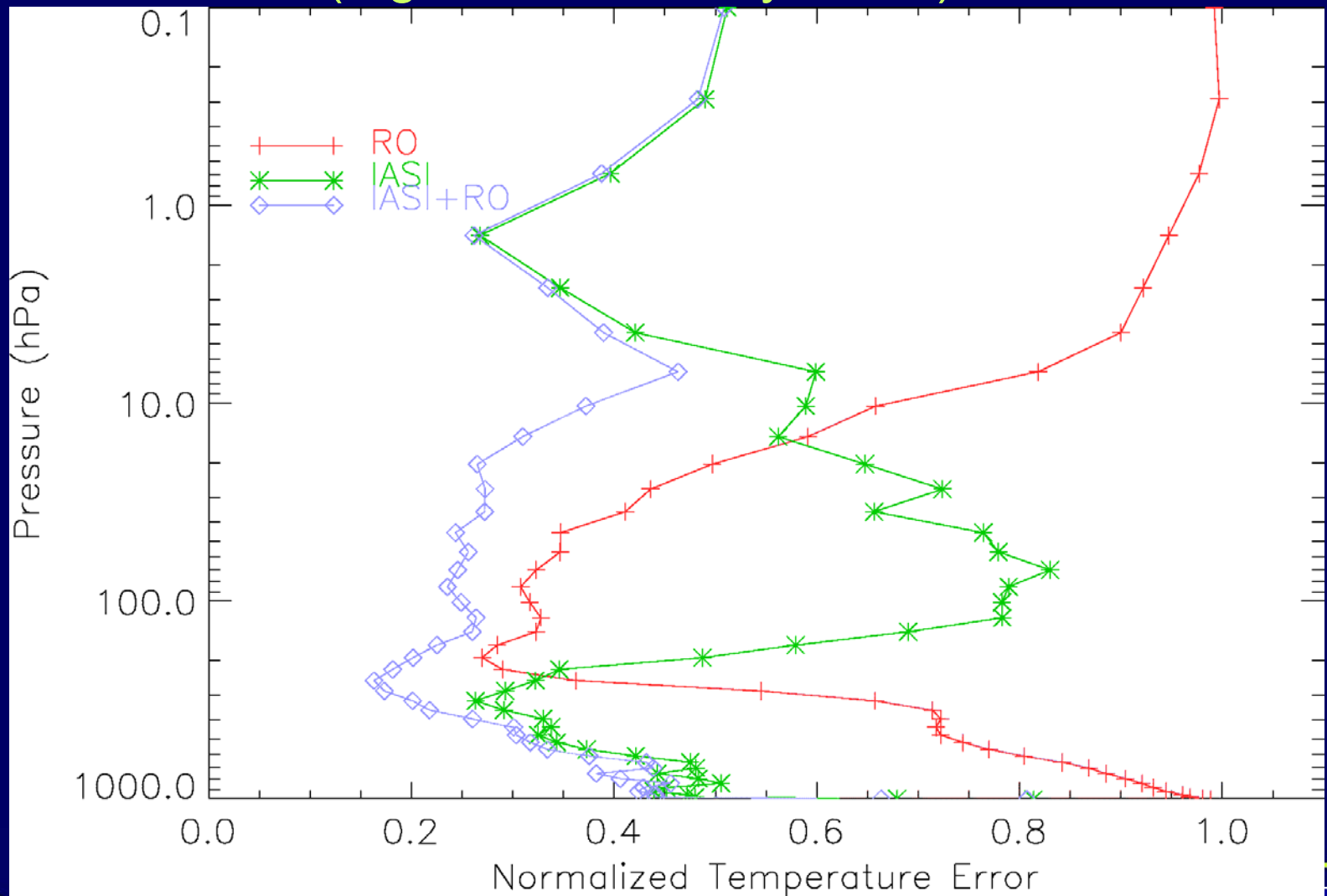
Calculate the temperature on the “b” level using the hydrostatic equation.

Interpolate the (Exner) pressure to the b level

Calculate refractivity on the “b” level.

Interpolate the refractivity to arbitrary observation height. Log (refractivity) varies linearly with height.

# Expected information content from 1D-Var studies (e.g. Collard+Healy, 2003)



## Trial

We are assimilating CHAMP refractivity profiles provided by GFZ, between May 26, 2001 - June 11, 2001. **16, 24 hour forecasts.**

Each profile contains ~120 refractivity values (150 max), with a vertical separation of 200m.

**We do not assimilate refractivity below 4km because of the well known biases.**

Observation errors are based on Kursinski's 1997 estimates, but we have inflated them to 2% at the surface, falling linearly to 0.2% at 10km. "QC" based on a 1D-Var calculation.

**Note, we only obtain ~40 measurements per assimilation cycle.**

## How do we assess the trial?

The Met Office has developed a standard verification (VER) package.

**Control:** Close to operational set-up. Assimilating radiosondes, ATOVS, SSMI, etc....but **no RO data assimilated**.

**Trial:** same as control but **assimilating RO data as well**.

How well do the NWP forecasts fit conventional observations?

E.g., do 24 hour forecasts calculated for the trial fit radiosonde observations better than the control run?

The VER package derives the statistics of the fit and compares **control** and **trial** results.

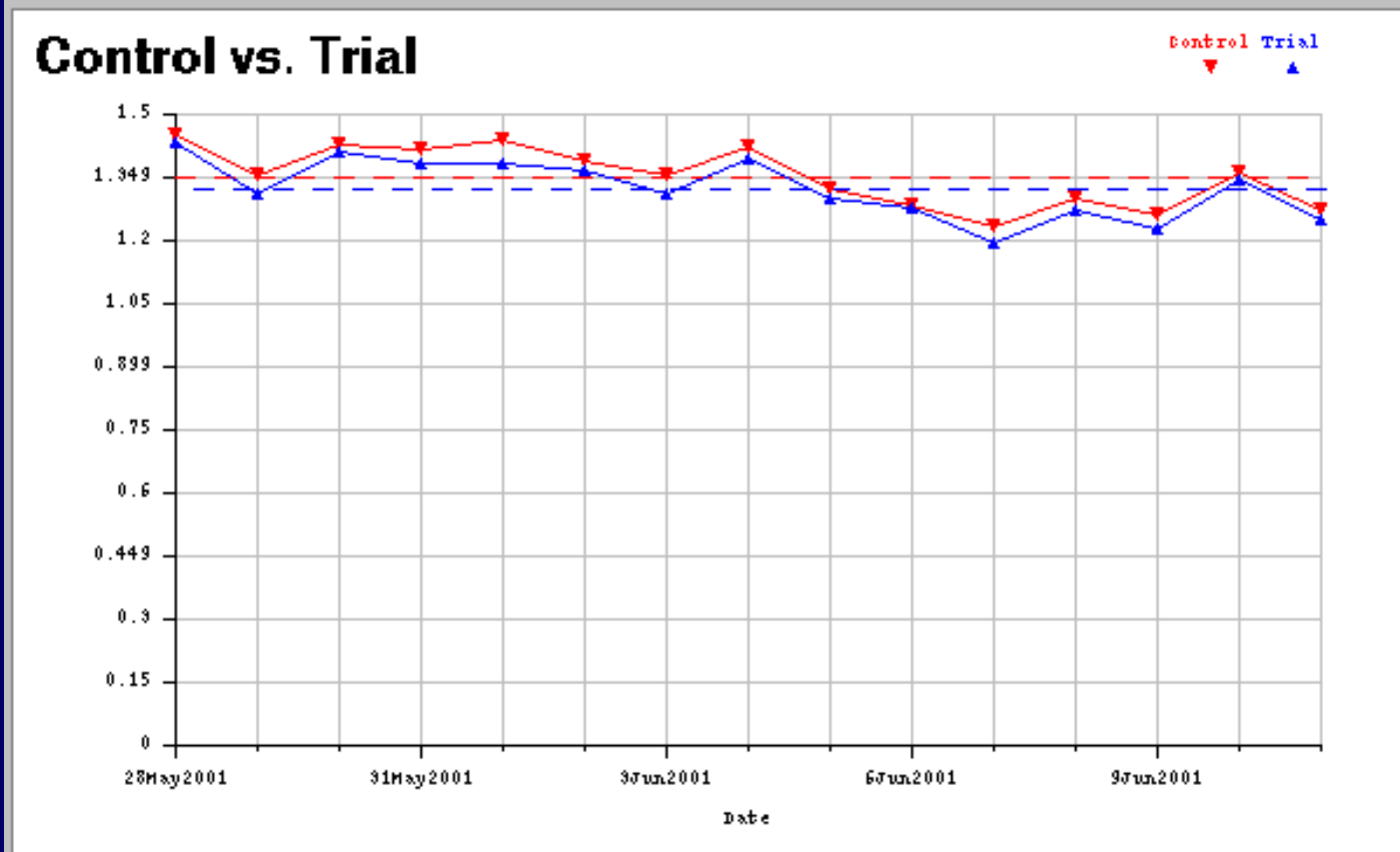
*We have not performed subjective verification.*



# Globally averaged 6 hour forecast temperature differences against radiosonde at 250hPa

## Sonde\_bkr - RTM Statistics Plot

For the period 28May2001 to 11Jun2001



RMS

QU12

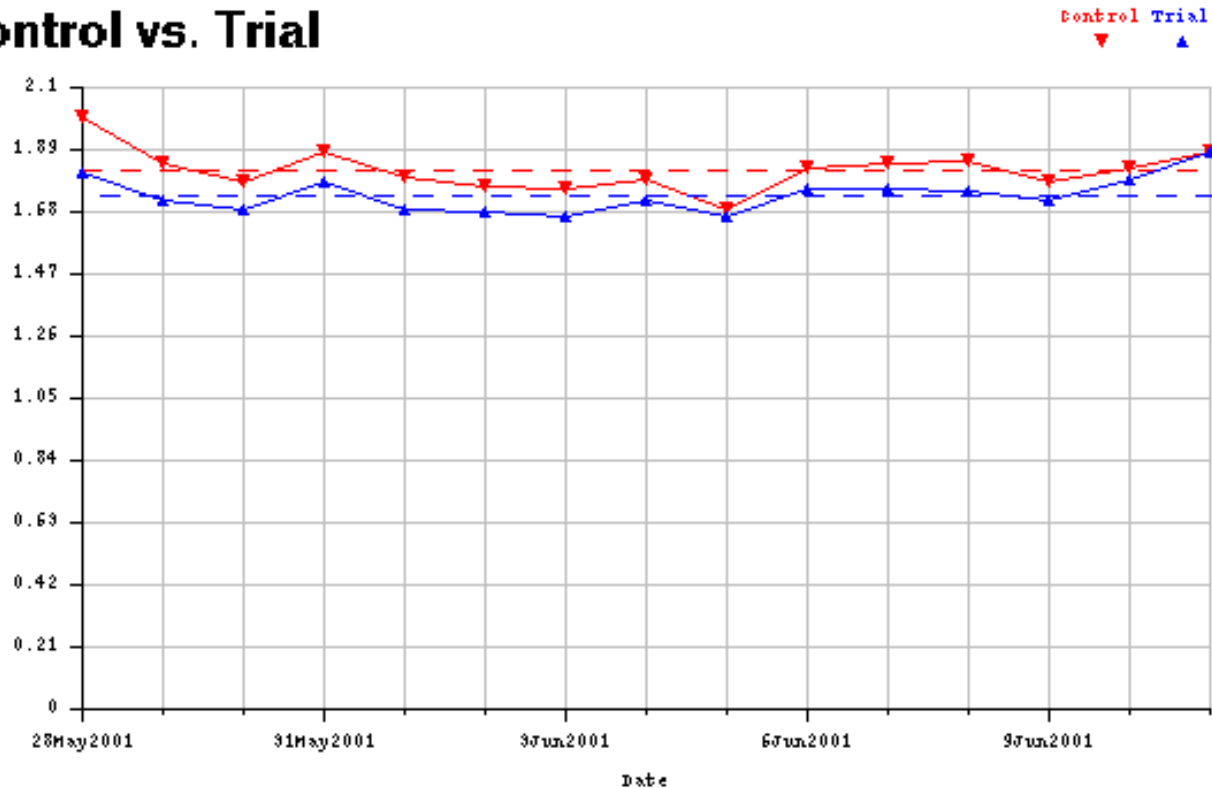
250hPa.TEMP t

# Globally averaged 6 hour forecast temperature differences against radiosonde at 50hPa

## Sonde\_bkr - RTM Statistics Plot

For the period 28May2001 to 11Jun2001

### Control vs. Trial

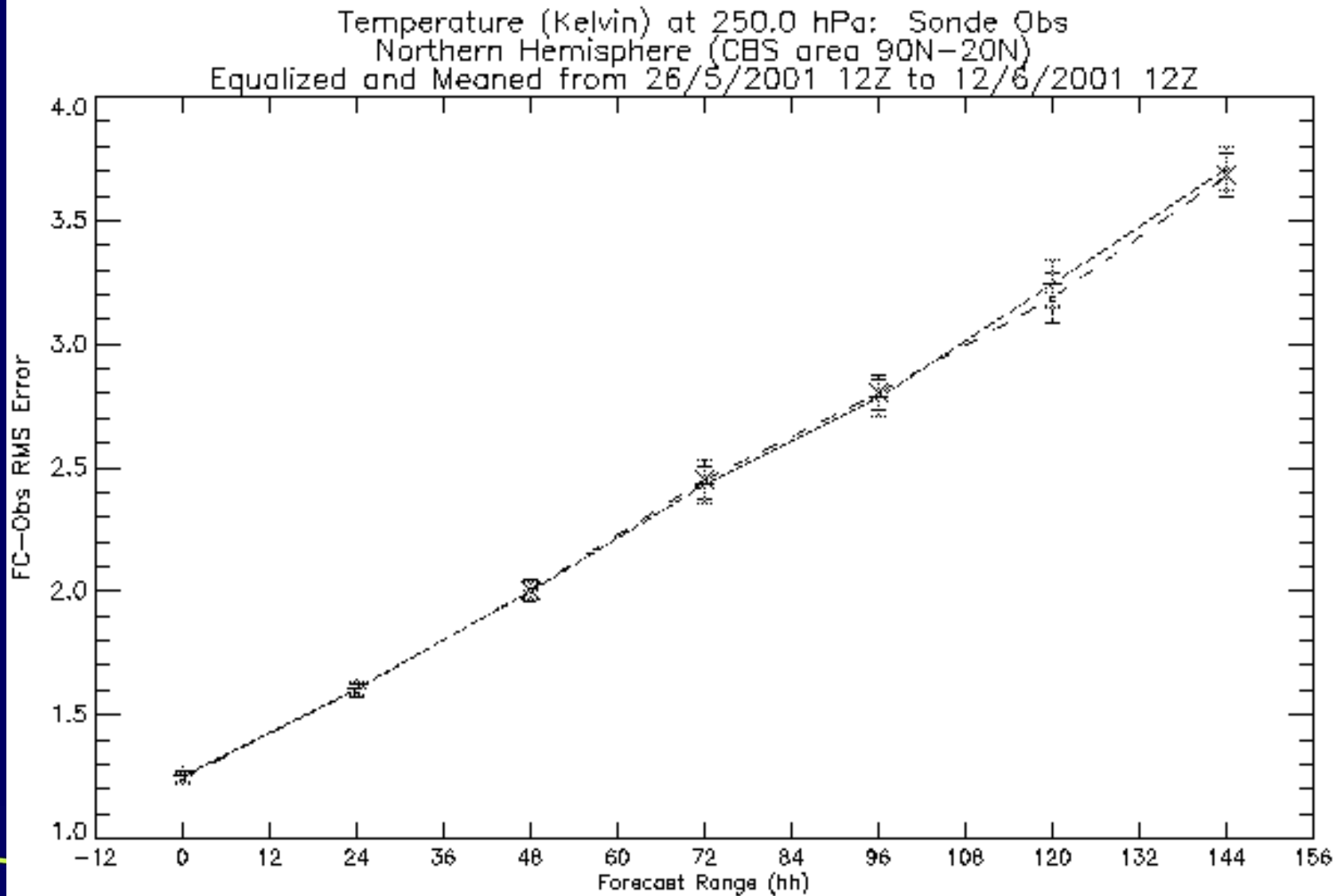


RMS

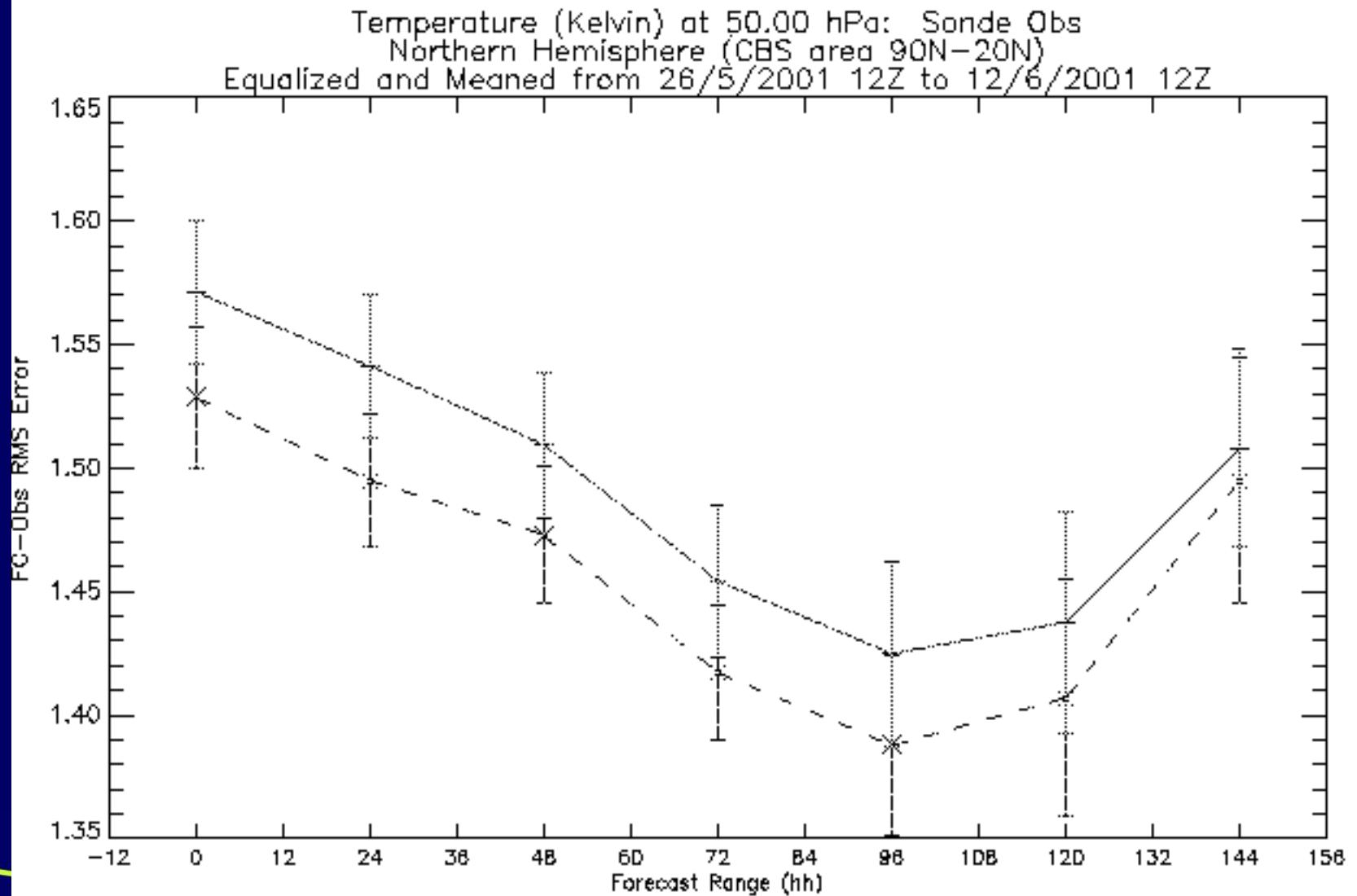
QU00

50hPa TEMP t

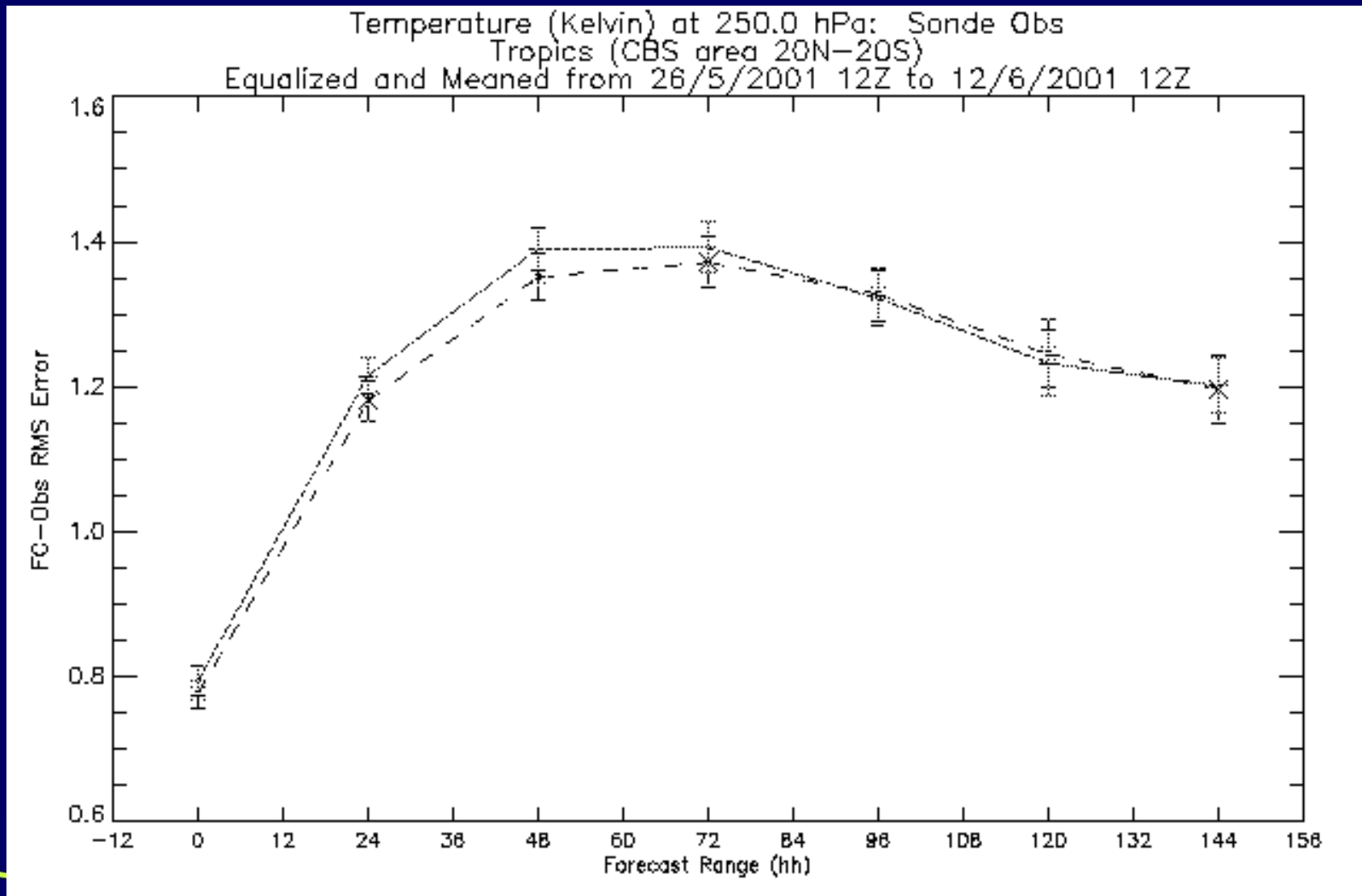
# NWP forecast fit to radiosonde at 250hPa (NH)



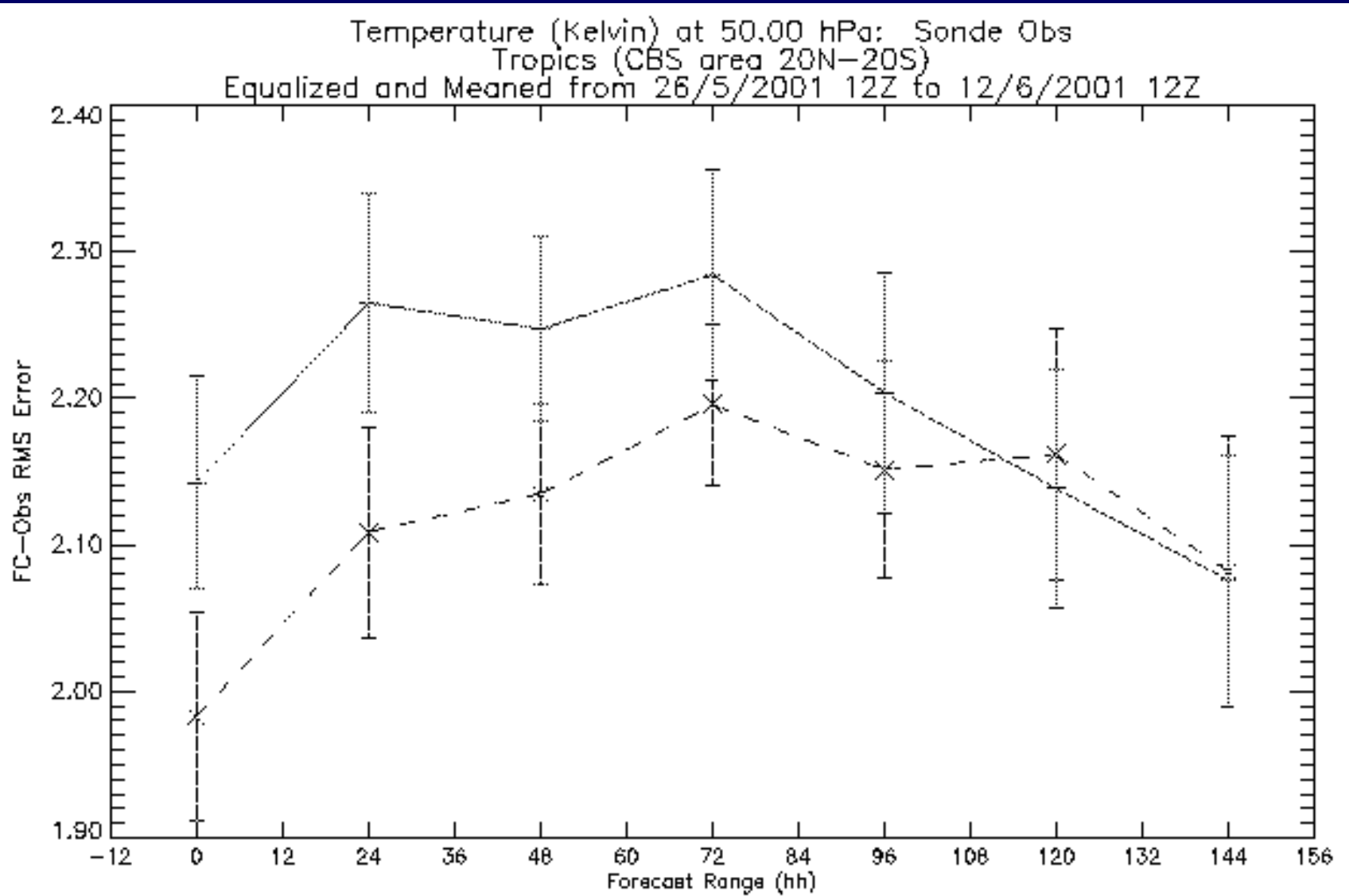
# NWP forecast fit to radiosondes at 50hPa (NH)



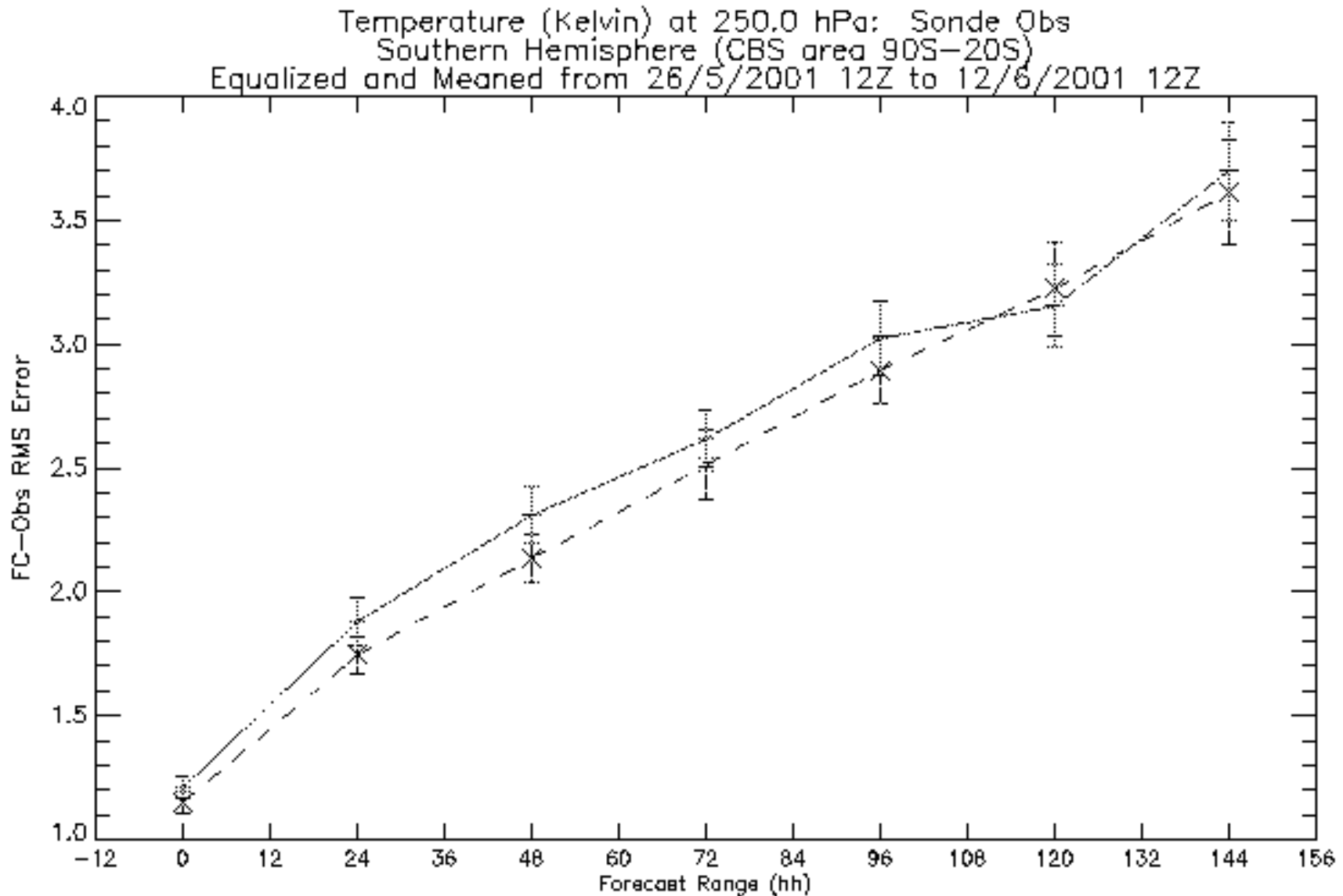
# NWP forecast fit to radiosondes at 250hPa (Trop)



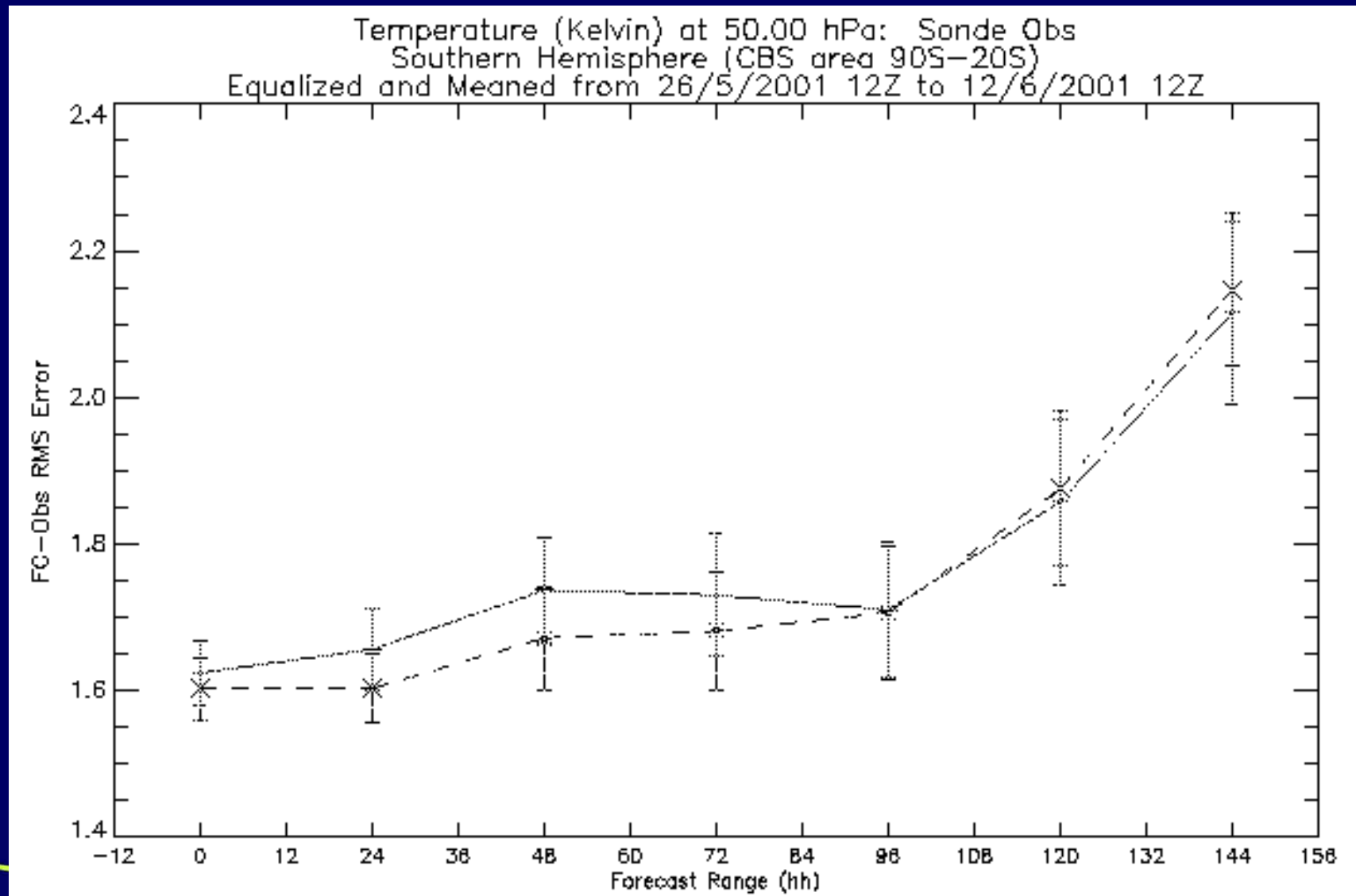
# NWP forecast fit to radiosondes at 50hPa(Trop)



# NWP forecast fit to radiosonde 250hPa (SH)

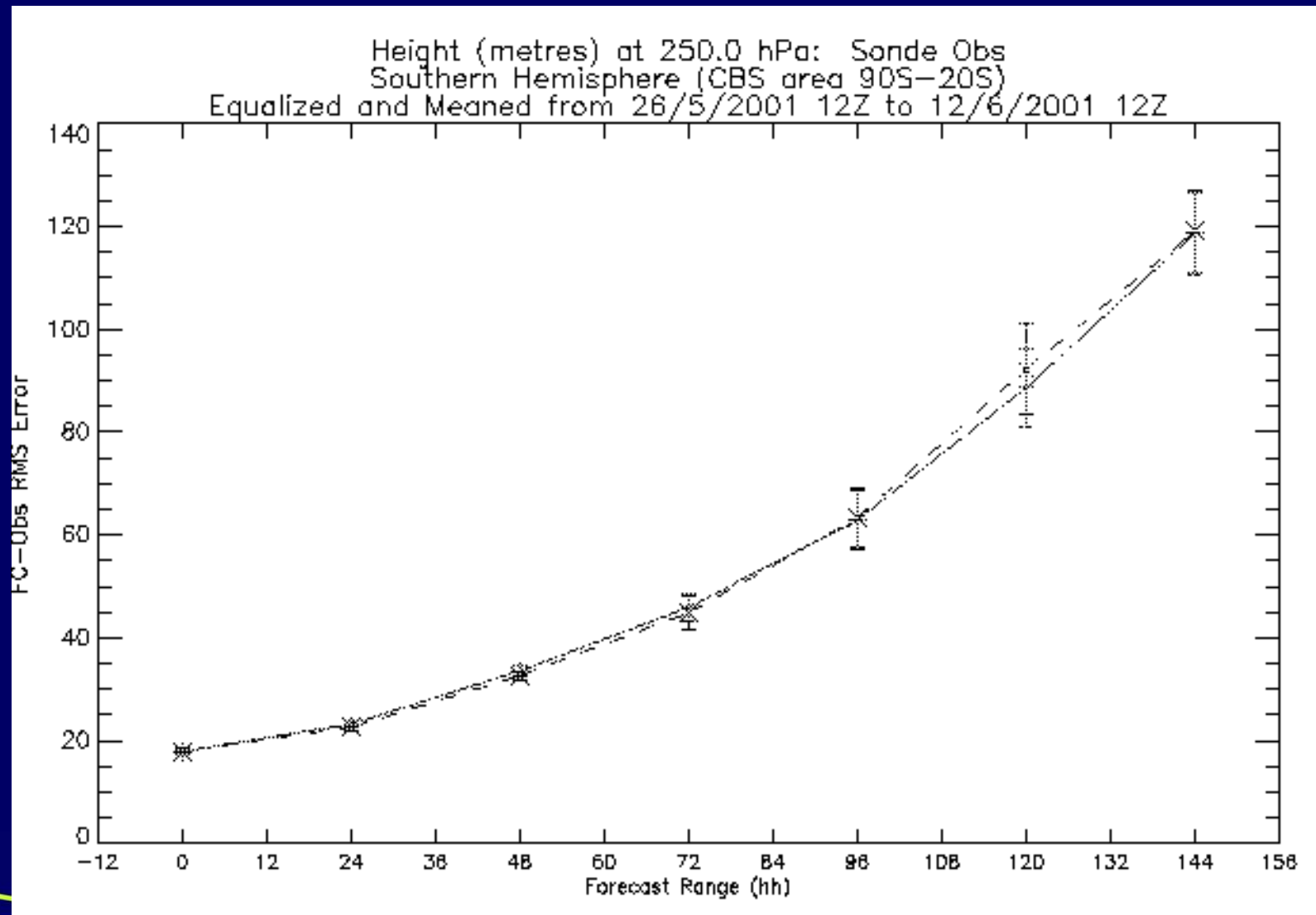


# NWP forecast fit to radiosonde at 50hPa(SH)

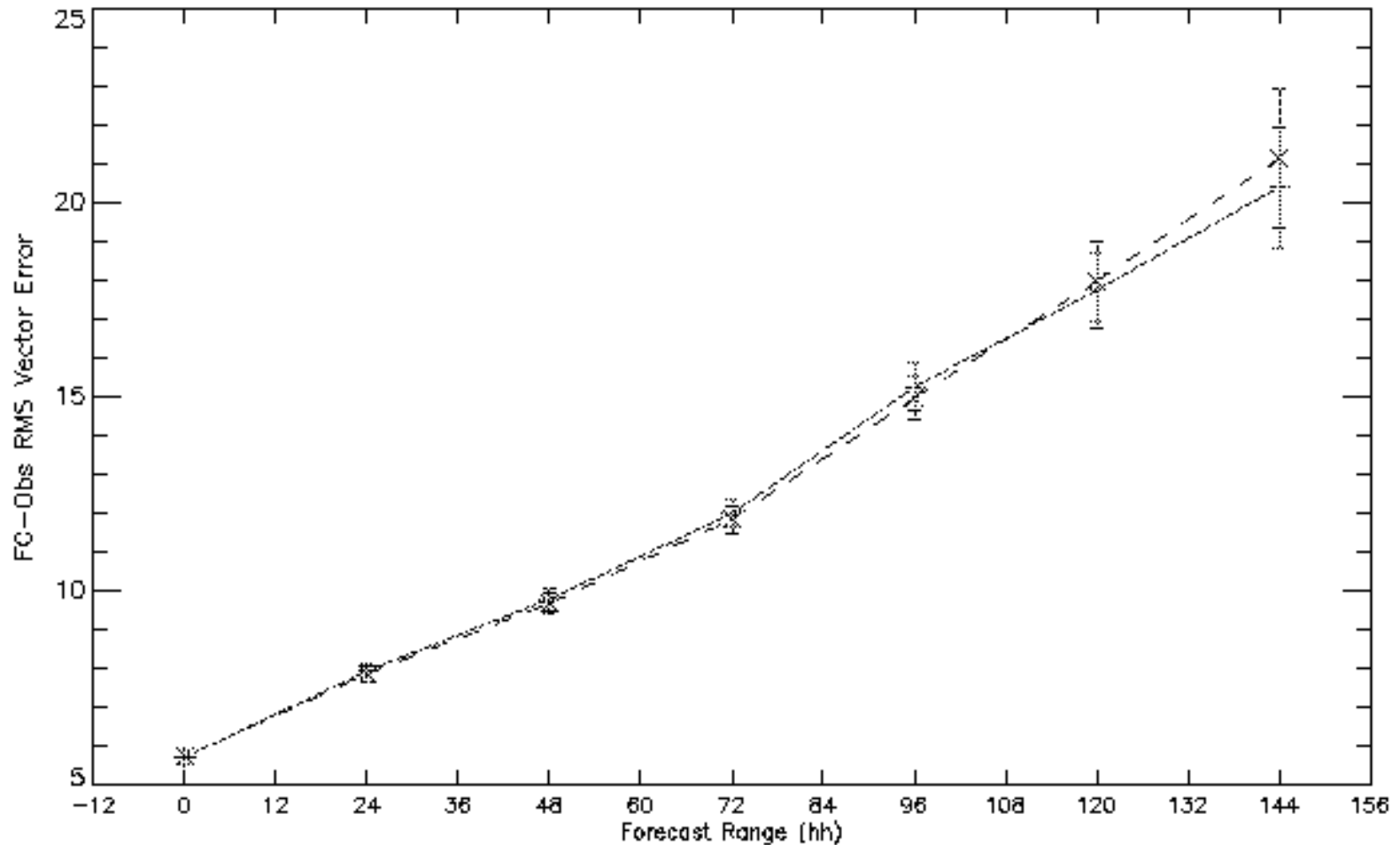




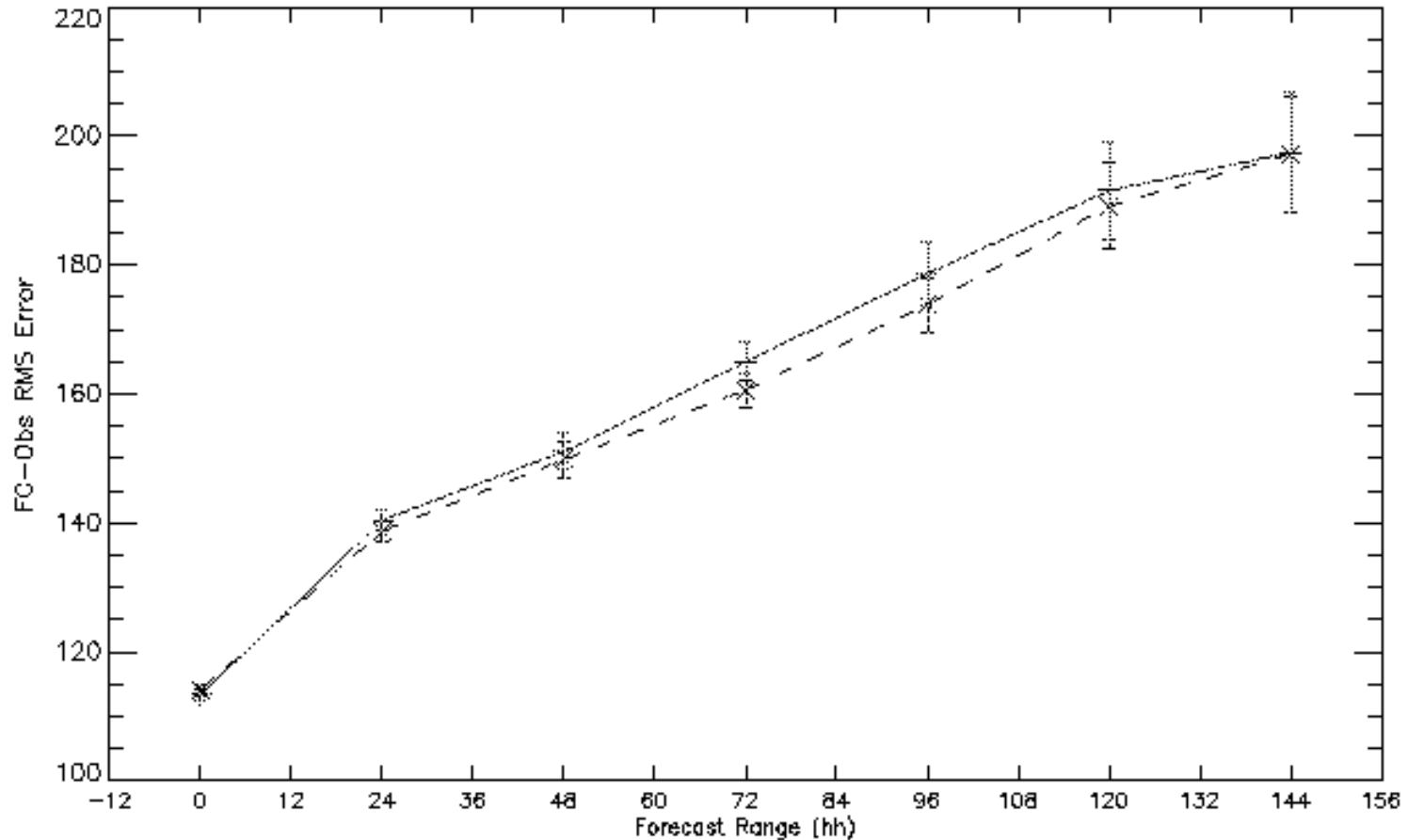
# NWP fit to radiosonde for 250hPa height (SH)



# NWP forecast fit to radiosonde 250hPa wind (SH)



## Some reduction of PMSL error in tropics



Small -ve signal in NH, small +ve signal in SH.

## Summary of trial results from VER packages

Illustrated the fields that show the best improvement, but we are not significantly degrading other fields - neutral in most cases.

**“NWP index”**: *a figure of merit summarising by how much a NWP forecast has been improved/degraded as a result of new observations.*

We find 0.2% improvement **against observations** over the period.

This result would support the case for assimilating the data if it was available operationally.

## Summary

We have performed the 1st impact study with RO data at the Met Office. Given the small number of observations, results are very encouraging.

PMSL in tropics improved, but largest impact seen in the southern hemisphere.

Upper-troposphere and lower stratosphere show improvements in the 250hPa Temp (SH) and 50hPa(all) .

The results would support the case for assimilating RO measurements operationally.

Prospects of obtaining measurements from a constellation (e.g., COSMIC, ACE+) are very exciting in the light of these results.