Current use of satellite data in the Met Office Global NWP model

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ITSC15

Outline

- Overview of our assimilation/forecast system

- Major changes to satellite data assimilation since ITSC-14
  - Main focus on microwave data. Advanced IR sounders follows this talk.
  - NAE improvements covered in a poster *B03*

- Planned improvements for the coming year

Our Assimilation/Forecast System

- The global model is non-hydrostatic, with a finite difference lat-long grid, resolution N320 (~40km), with 50 levels (hybrid in height) and model top at 60km.
- The operational suite contains 4 update assimilation cycles for 6-hour data windows, with 2 main 6-day forecasts run daily from 00Z and 12Z.
- Assimilation algorithm: 4D-Var. Inner loops contain linear Perturbation Forecast (PF) model.
- Timeliness is critical: the main forecasts have a data cut-off at T+2 hours; and T+7 hours for update runs.

Motivation for changes

I. Take advantage of developments in space hardware to obtain new measurements of the atmosphere.

II. Increase redundancy in system by introducing similar instruments to those already providing forecast impact

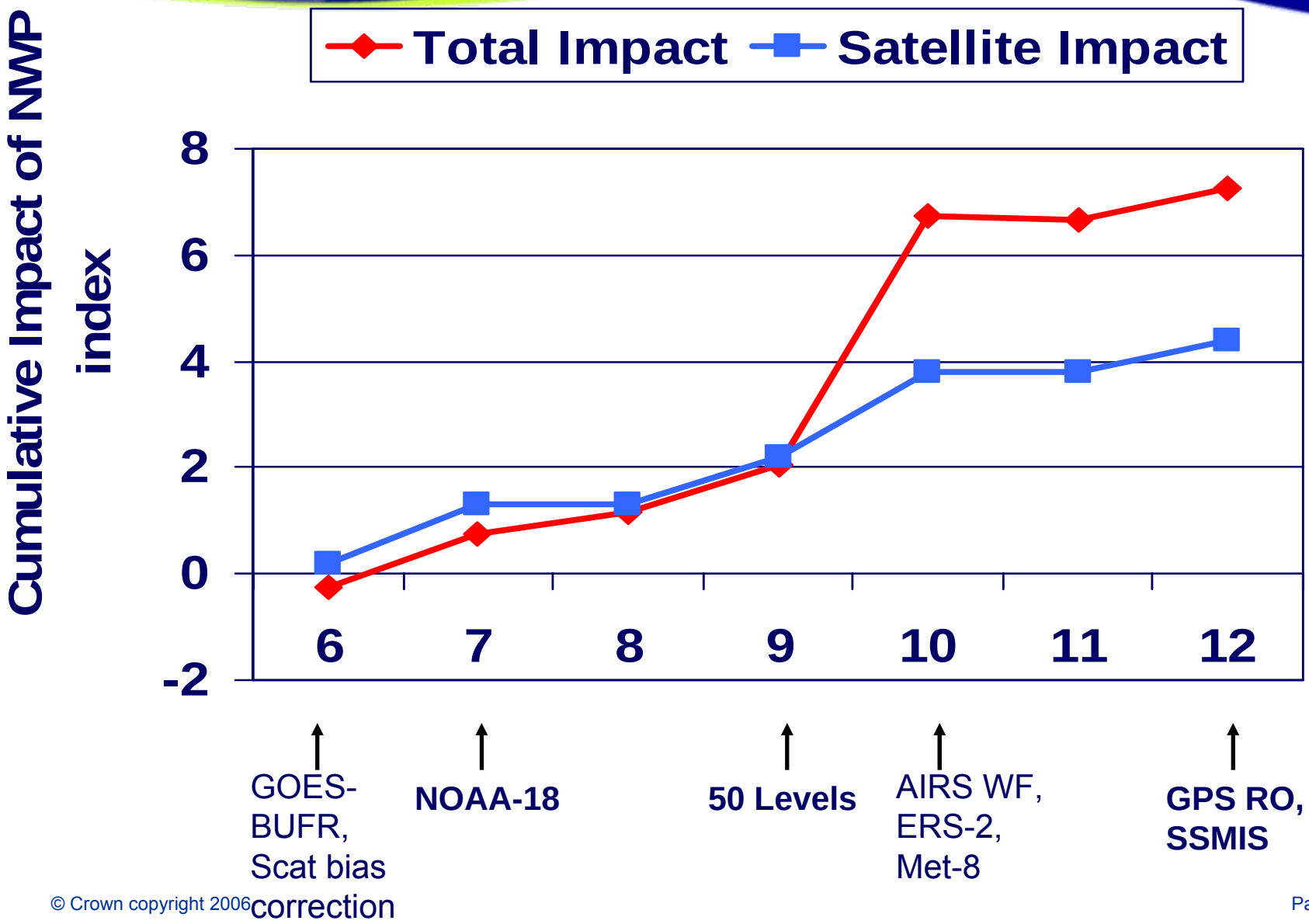
III. Use existing observations in ‘difficult’ areas by improving the forward modelling and or taking advantage of developments in remote sensing science

….with the constraint that the system must run within a certain time

Summary of Satellite Data Usage

	Last Conference	This Conference
ATOVS	NOAA-15 AMSU (4-10,18,20) NOAA-16 AMSU (4-8,10,18-20) EOS Aqua AMSU (4-6,8-10)	NOAA-15 AMSU (4-5,7-10,12,13,18) NOAA-16 AMSU (4-8,10-14,18-20) NOAA-18 AMSU (4-14,18-20)
AIRS	EOS Aqua Central field (50 channels)	EOS Aqua Warmest field (50 channels)
SSM/I	F13 & F15 windspeeds	F13 only
Scatterometer	QuikScat ambiguous winds	QuikScat ambiguous winds ERS-2 (North Atlantic only)
AMVs	Meteosat-5,7 GOES-9,10,12, MODIS	Meteosat-5,8 GOES-11,12 MTSAT, MODIS
SSMIS		F16 (2-7,23)
GPS Radio Occultation		CHAMP/GRACE refractivity profiles

Forecast Improvements since ITSC-14



NOAA-18 Introduction

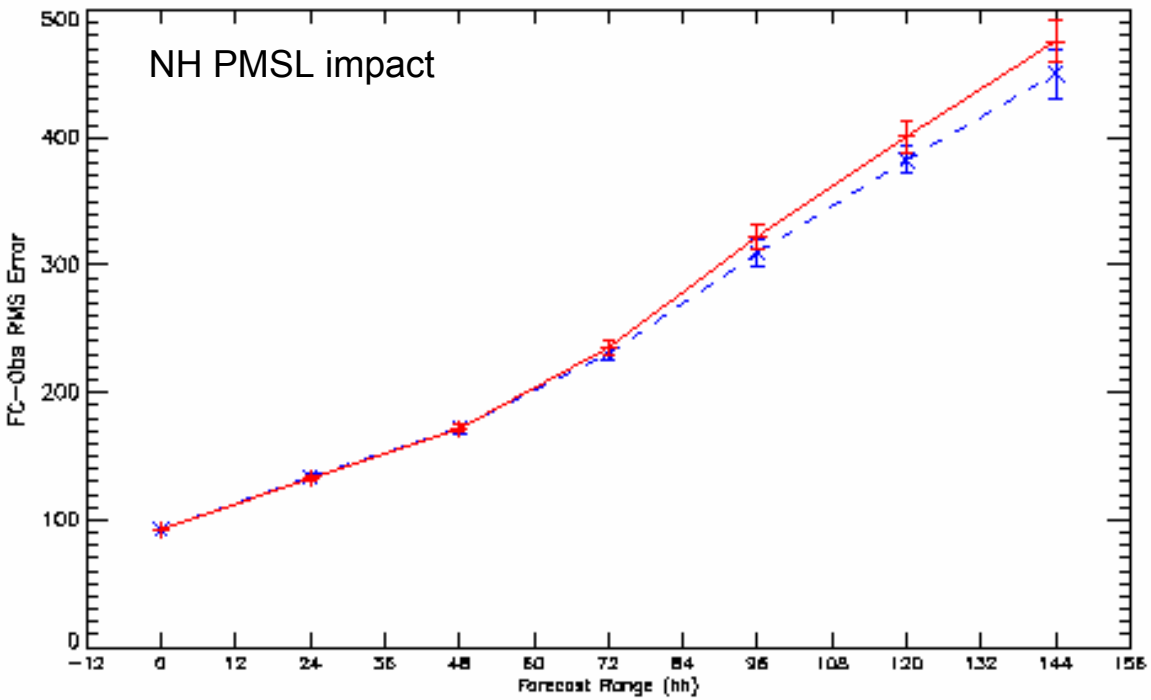
NOAA-18 strategy

- Introduce NOAA-18 AMSU-A, MHS and remove Aqua AMSU-A.
- Data received via local antenna allowed us to get a head start. Fed results back to the NOAA-18 project team at NESDIS

- First use of generic radiance pre-processing code ‘SatRad’ which performs QC, channel selection and 1D-Var for a range of instruments (both operational and research)
- Operational: ATOVS (AMSU-A, B, HIRS), SSMIS
- Development: SSM/I, IASI, Geostationary radiances,…

NOAA-18 Impact

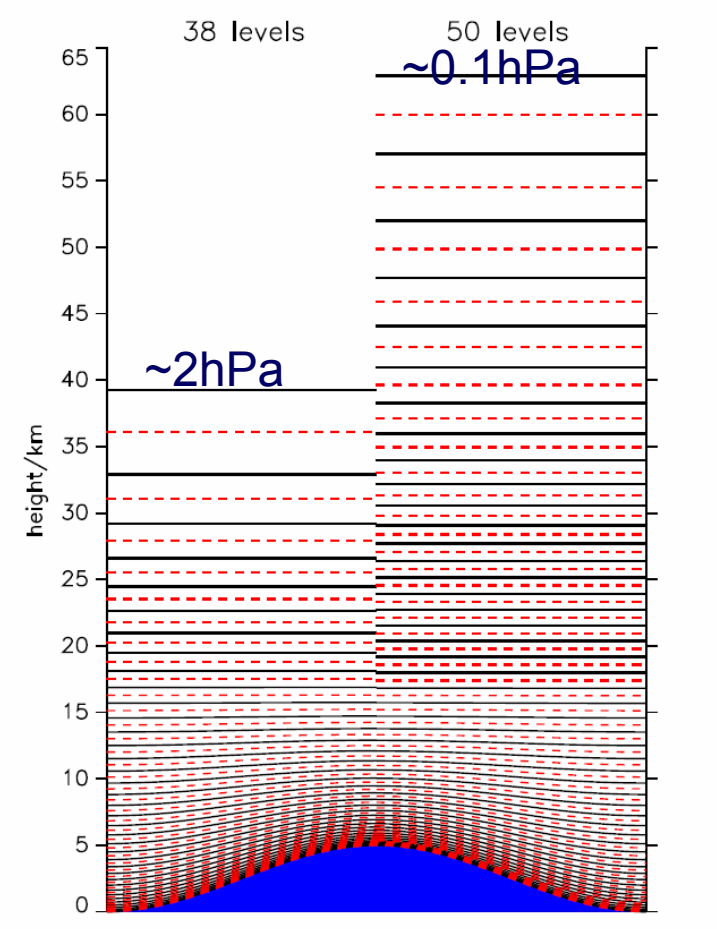
PMSL improved globally



- Mid tropospheric humidity also improved by up to 4%
- NOAA-18 into operations with four months from first local data overpass

Raising the model top and introducing AMSUA 12-14

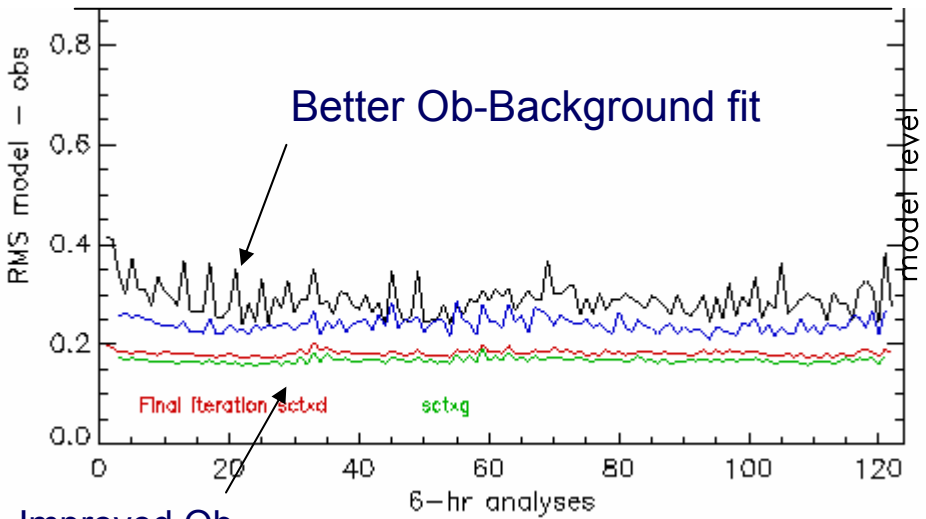
50 Level model



- Removes need for separate stratosphere model
- Main level increase in stratosphere
- Better dynamical coupling between stratosphere/troposphere
- Better use of AMSU-A channels, including introduction of 12-14.

Analysis Diagnostics

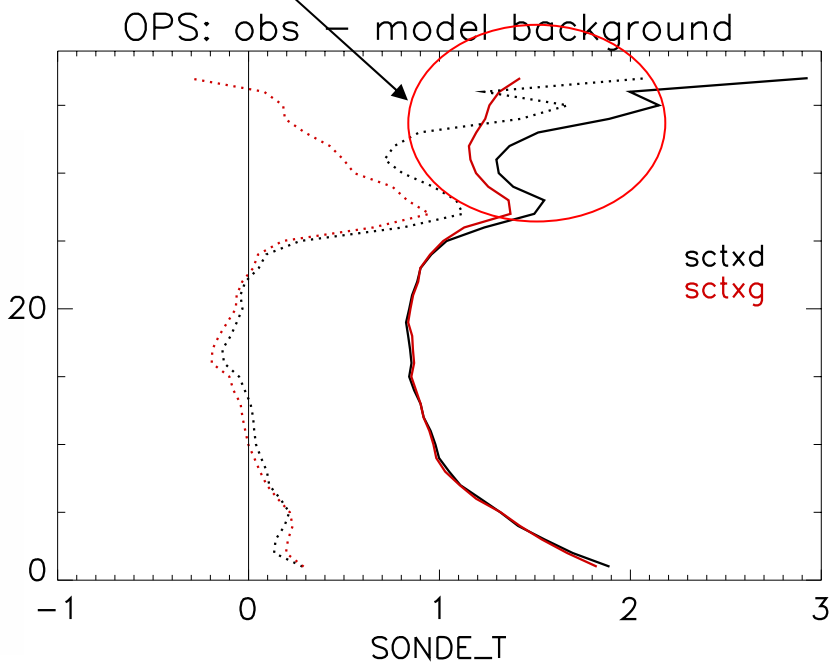
NOAA-16 ATOVS channel 10



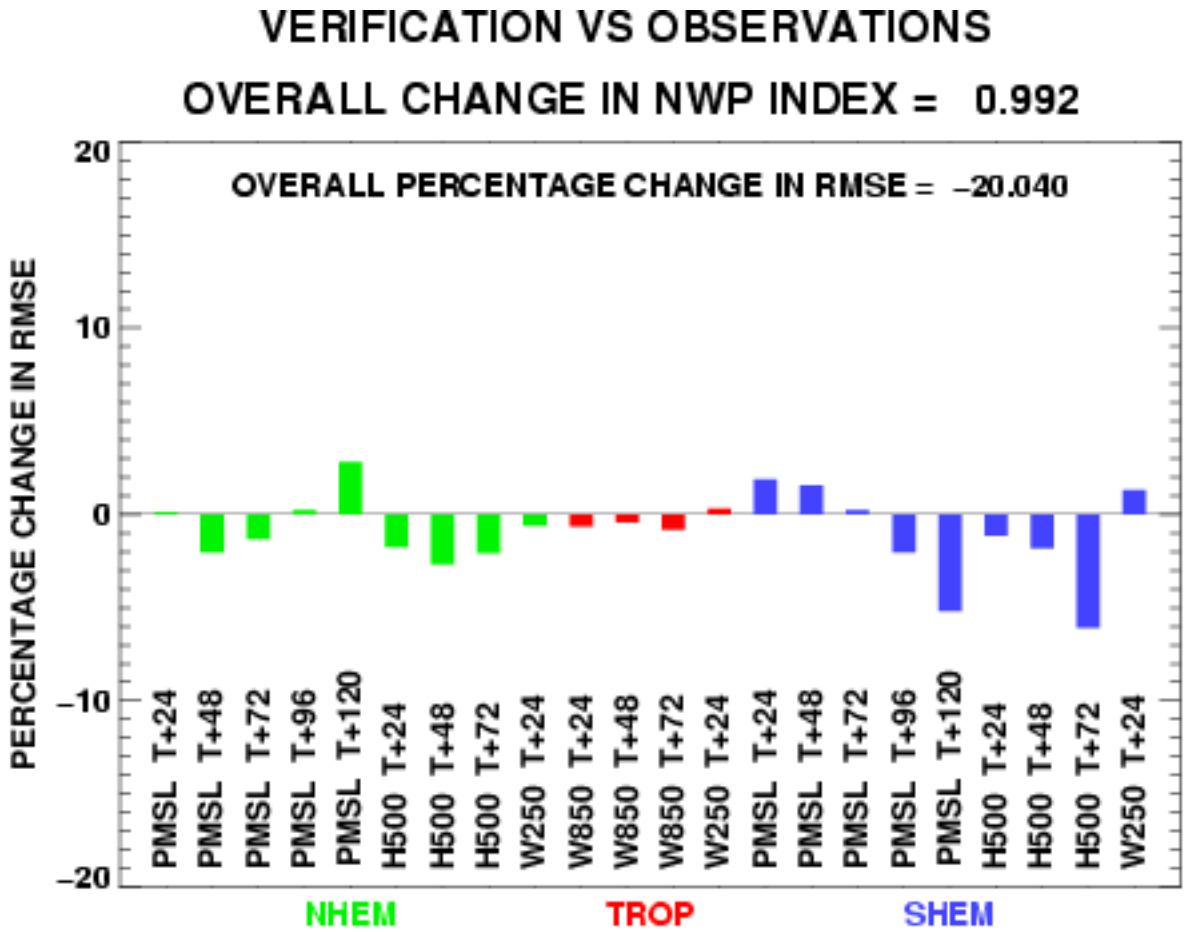
Improved Ob-Analysis fit

Sonde Temperatures

Improvements above ~100hPa



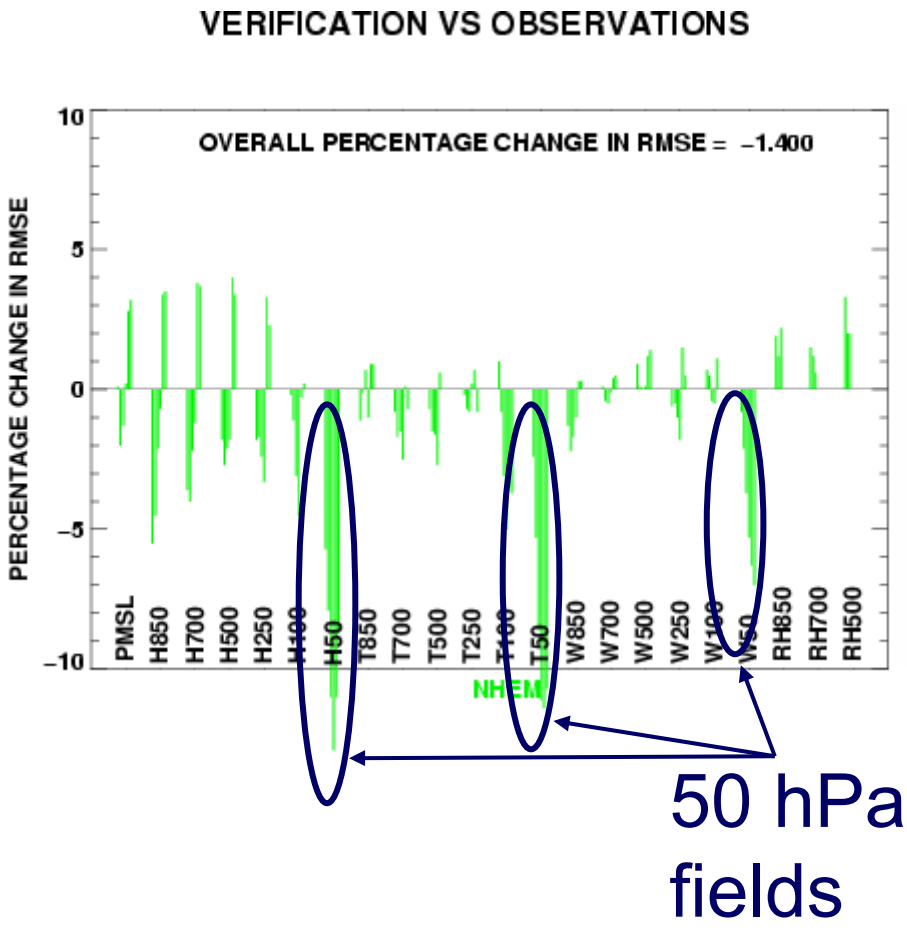
Forecast Verification



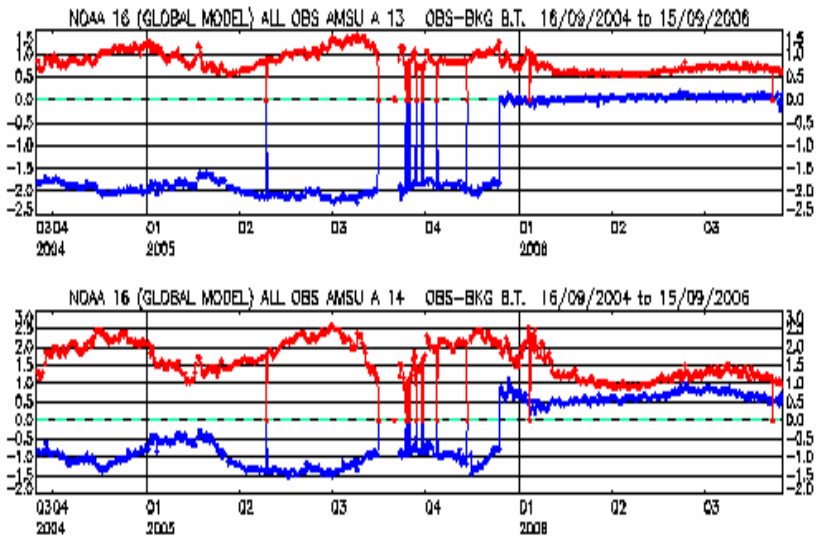
Worse

Better

Forecast Verification II

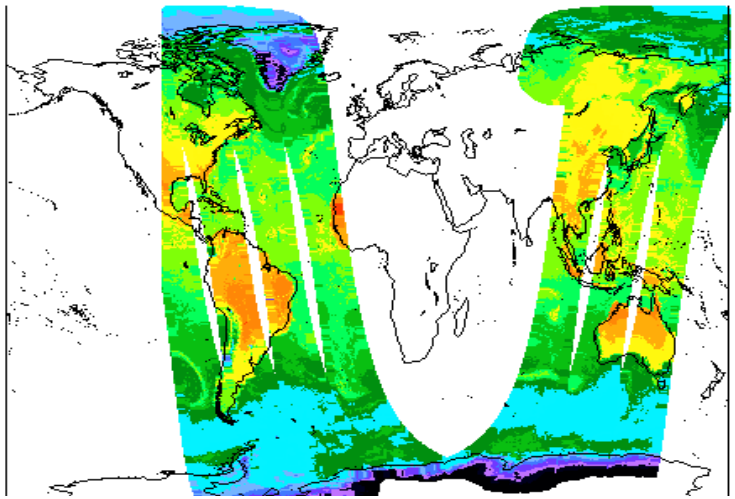


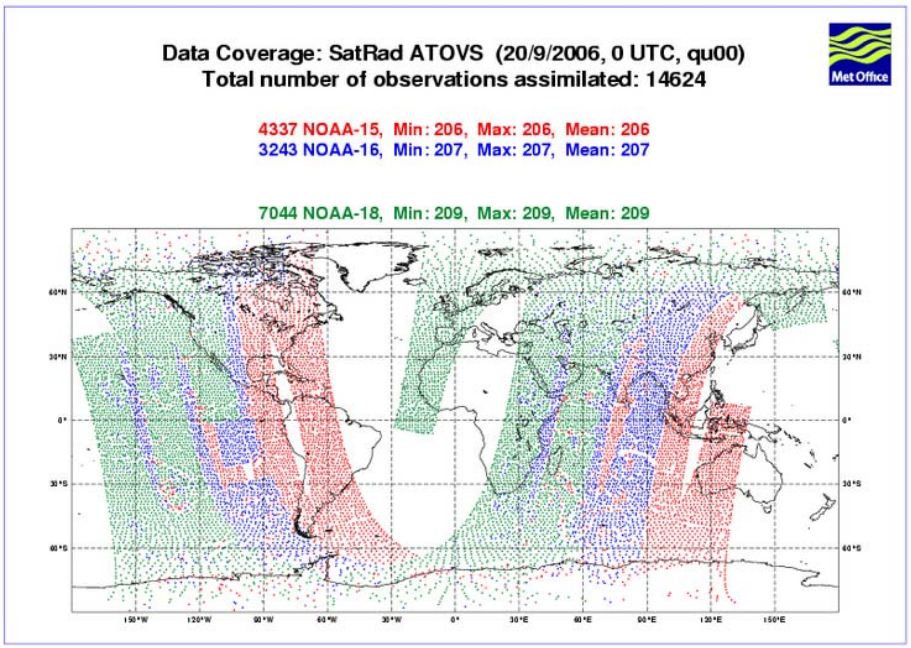
In Operations

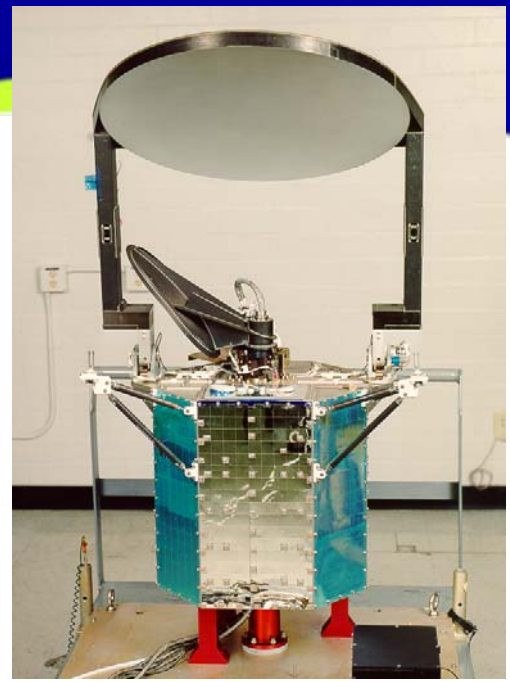


Introduction of GPS RO & SSMIS

SSMIS





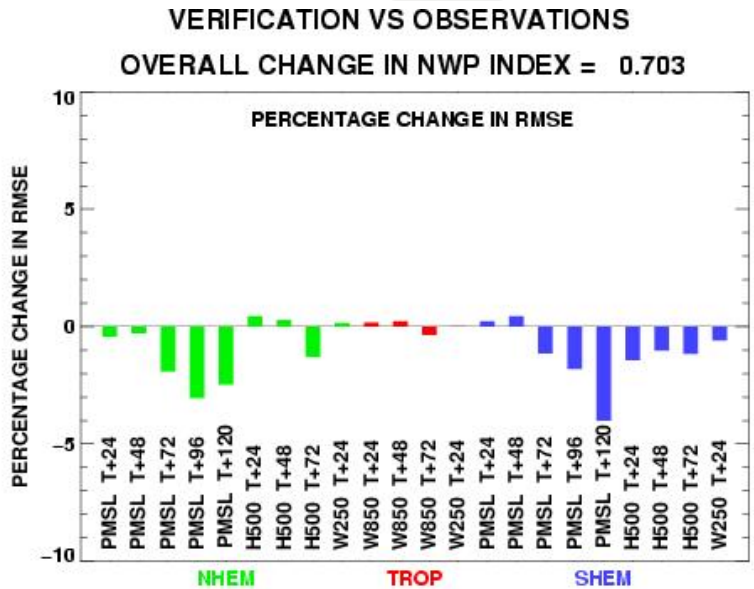


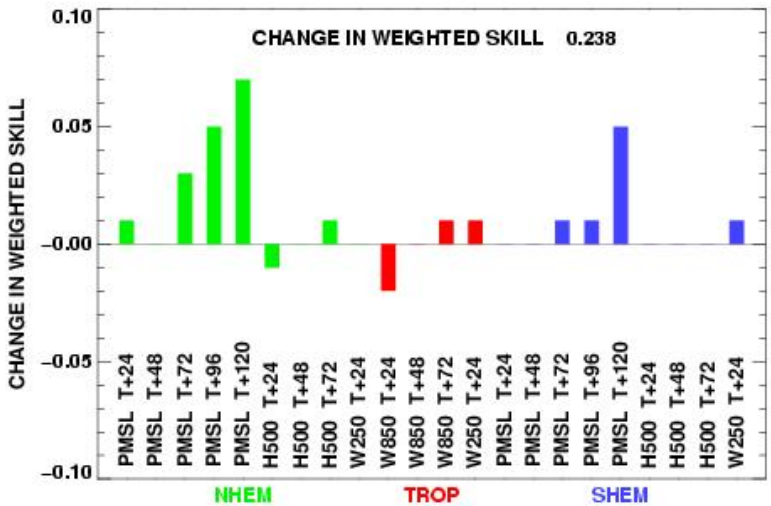
- Initially concentrate on AMSU-A equivalent channels 2-7,23
- Considerable work on instrument biases see *A12 Poster by Swadley*
- Preprocessing to regrid instruments and perform spatial averaging
- Channel selection for assimilation based on ATOVS methods e.g. Rain flagging using 91/183 GHz scattering

GPS Radio Occultation

- Research trials using refractivity profiles from the CHAMP mission showed forecast improvements to temperature fields in upper tropopause *Healy et al., GRL 2005*
- Data is now available in real time ~40 profiles per six hour cycle. Also using occultations from GRACE mission
- COSMIC (and then GRAS on METOP) will increase the amount of data

RO & SSMIS Package Performance





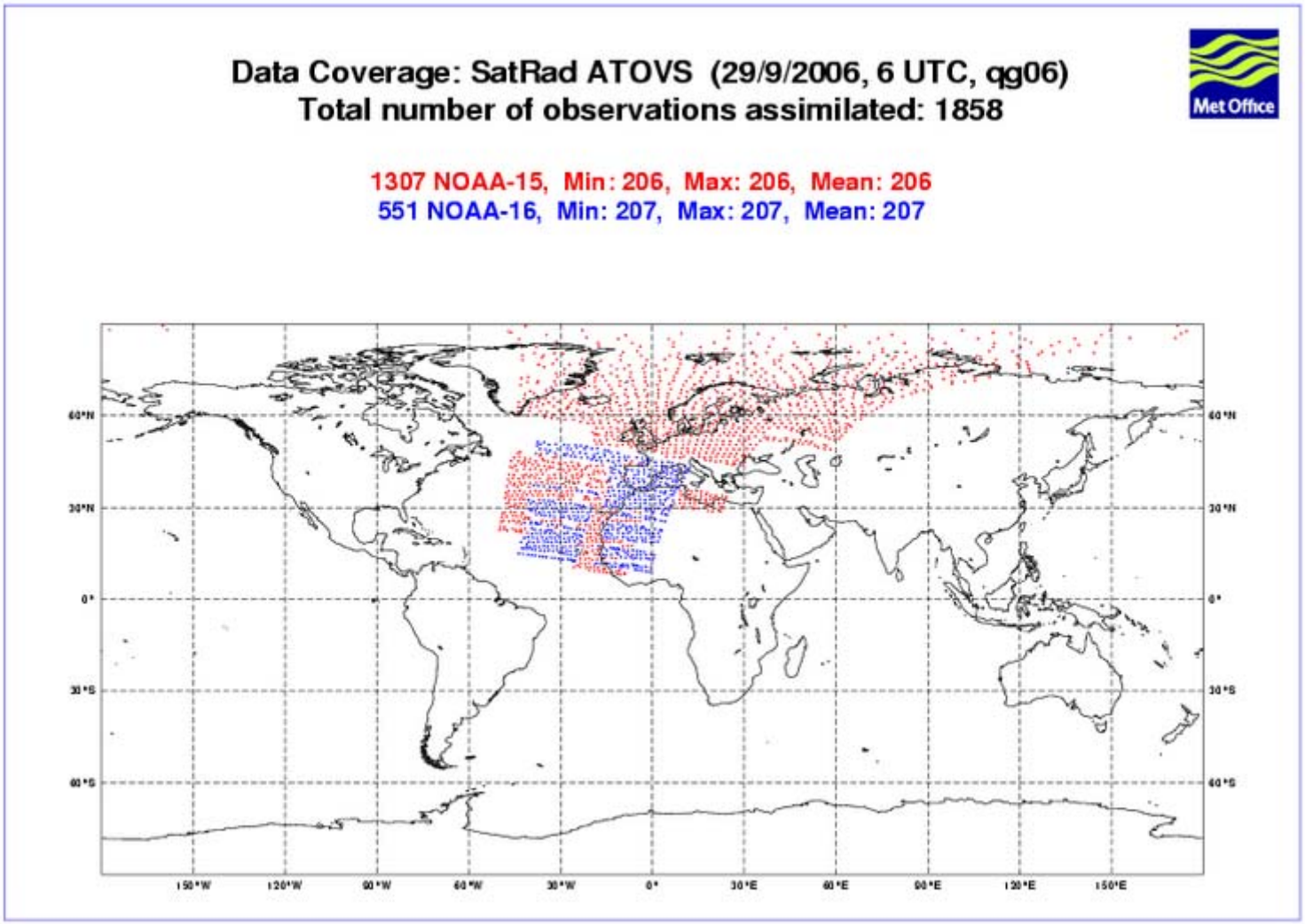
- Shows modest improvement in PMSL forecasts in SH and NH
- 33 days verification
- Switched to operations 26th September

What's Next

- Analysis of cloud using AMSU-A window channels and use of sounding channels in the presence of cloud (see poster A3 *English et al.*)
- Introduce METOP ATOVS into system & RARS
- Reintroduce HIRS (N17 HIRS is showing humidity benefits)
- Take advantage of the imaging channels on SSMIS and assess F17 *(launch date Nov)*

Usefulness of EARS retransmission

External company outage of Comms link ~12 hours



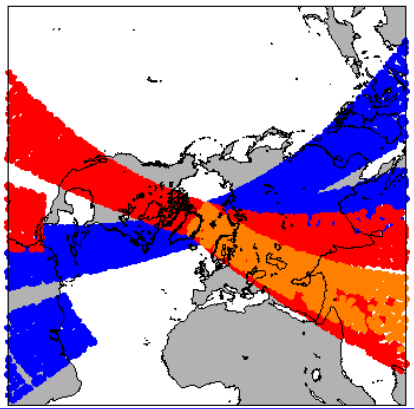
Conclusions

- Introduced three two new sounding satellites SSMIS F16 & NOAA-18 to the operational system with resulting improvements to forecast accuracy.
- Robustness and timeliness still important
- For the first time we have exploited GPS data operationally at the Met Office
- Future upgrades will seek to use more sounding data in difficult regimes

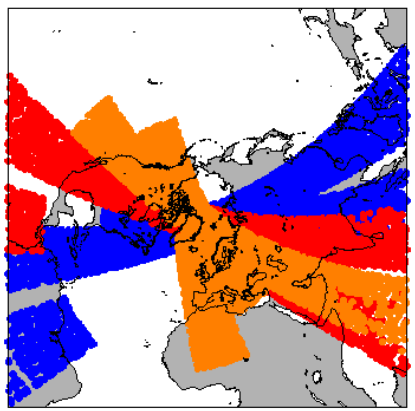
Additional Slides

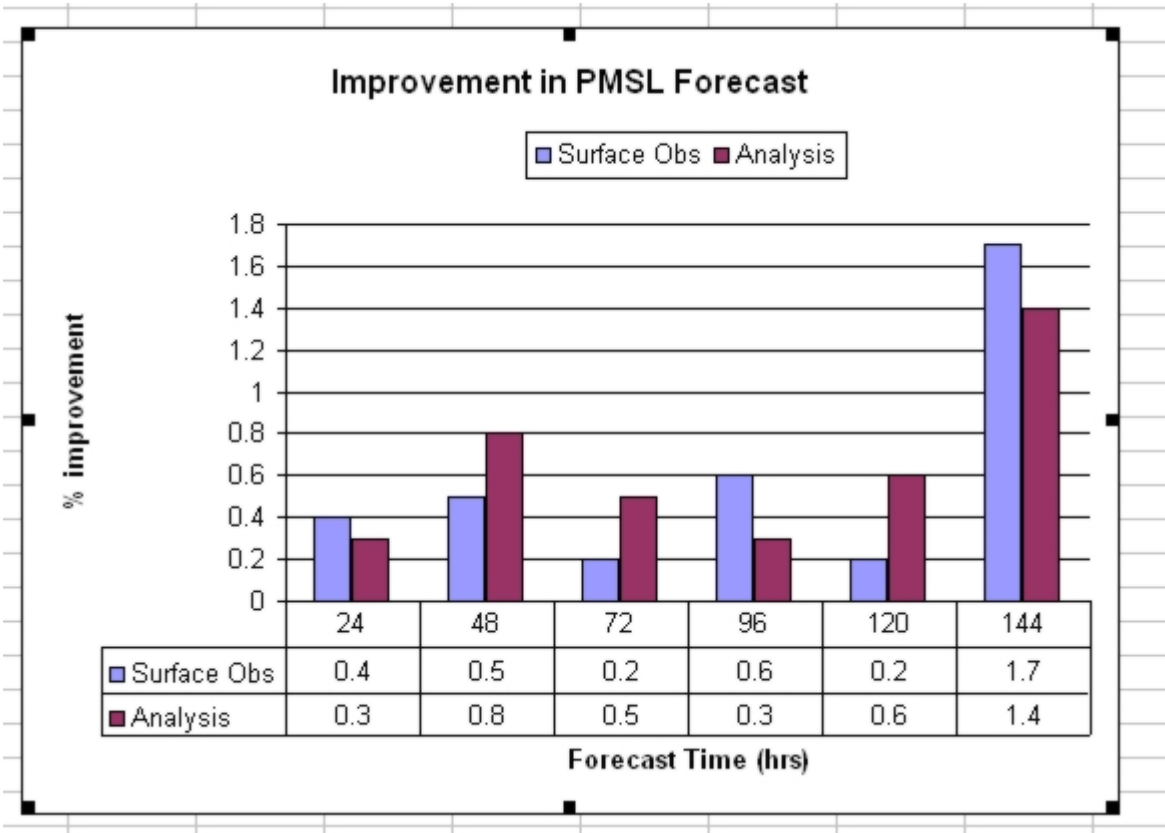
Increase of Local Data

Control



Exp



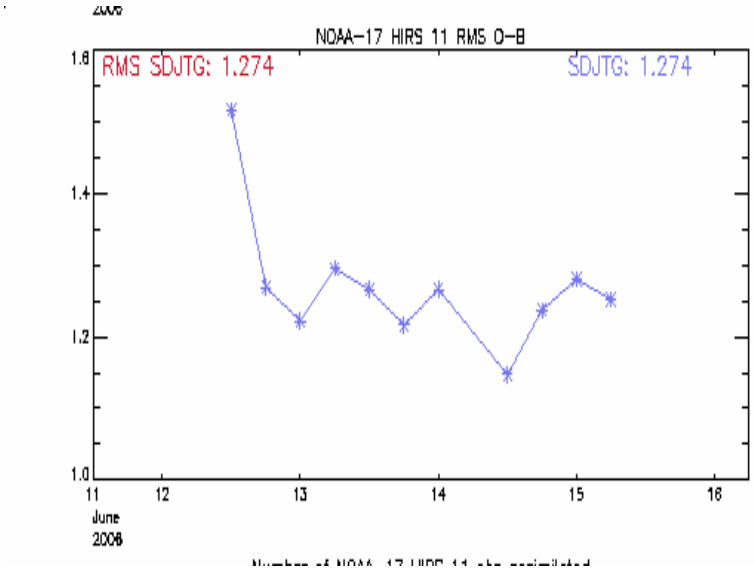


	24	48	72	96	120	144
Surface Obs	0.4	0.5	0.2	0.6	0.2	1.7
Analysis	0.3	0.8	0.5	0.3	0.6	1.4

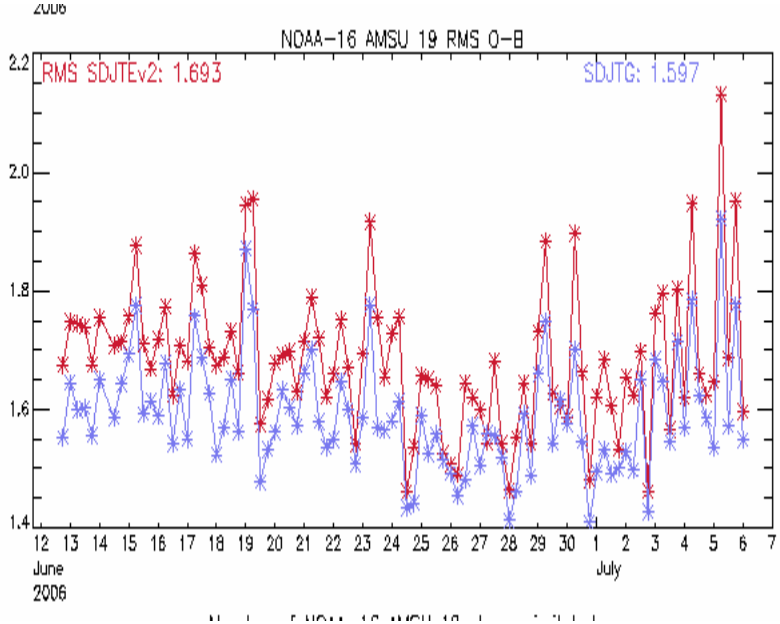
Initial Results NOAA17 (4x ATOVS)

- Neutral on index
- Sufficient time left over to process 5 ATOVS
- Humidity impacts…..

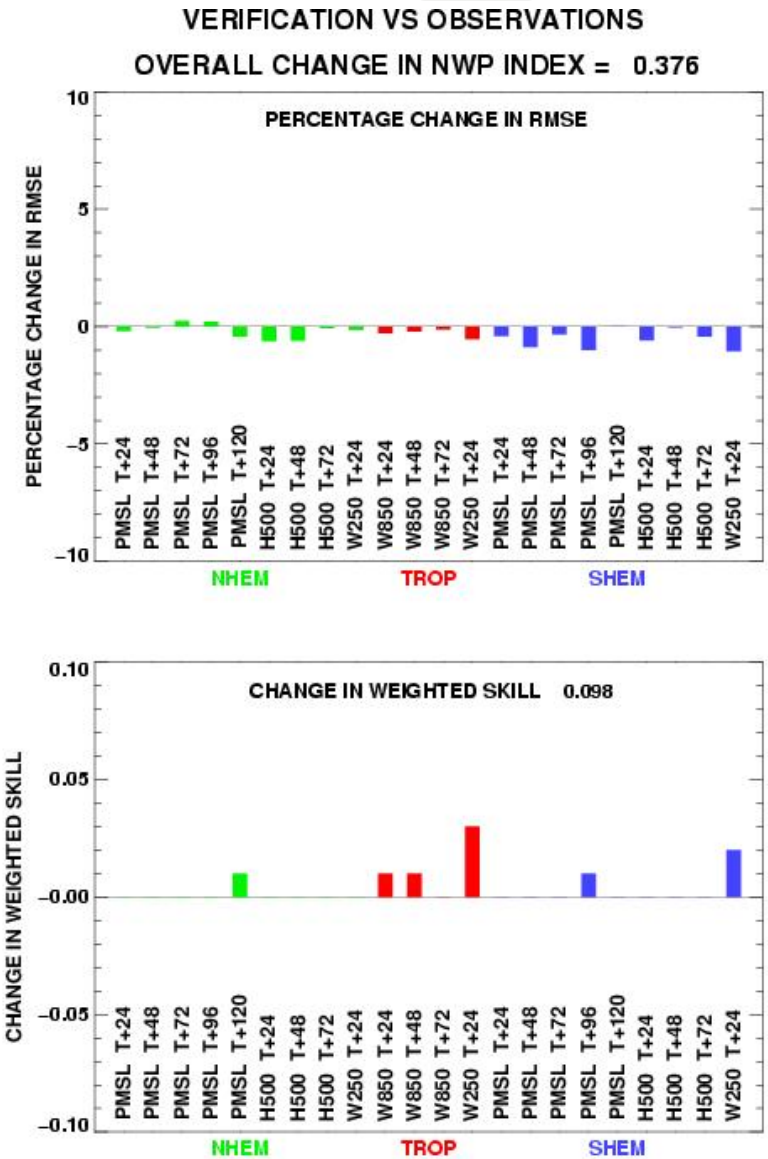
N17 HIRS humidity fit



N16 AMSU-B fit



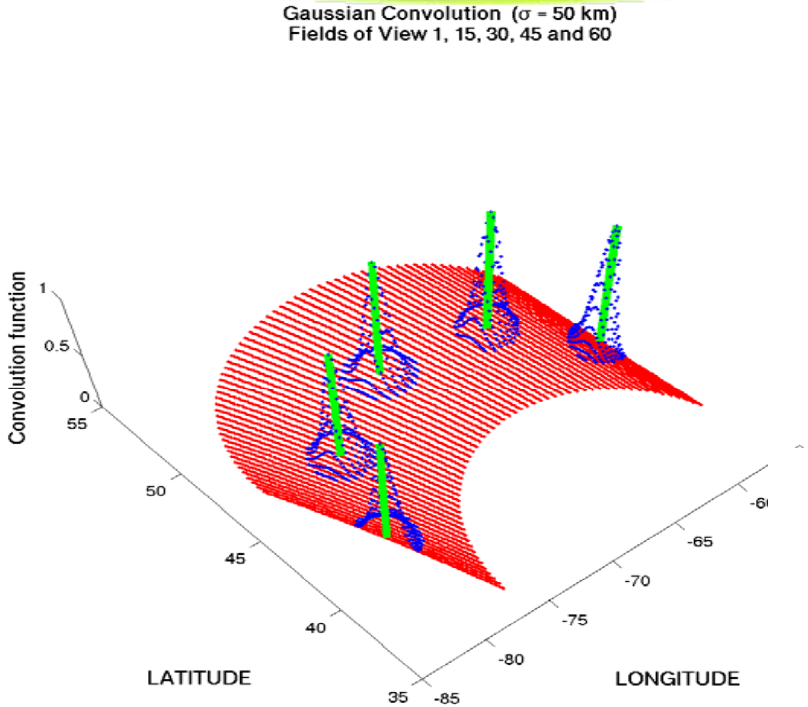
MO 4DVar N320 trials: winter 2005/06



- Modest, but consistent, reduction in SH PMSL (~1%)

- Subsequent summer 2006 ‘package’ (SSMIS+GPSRO) trial more mixed

Averaging

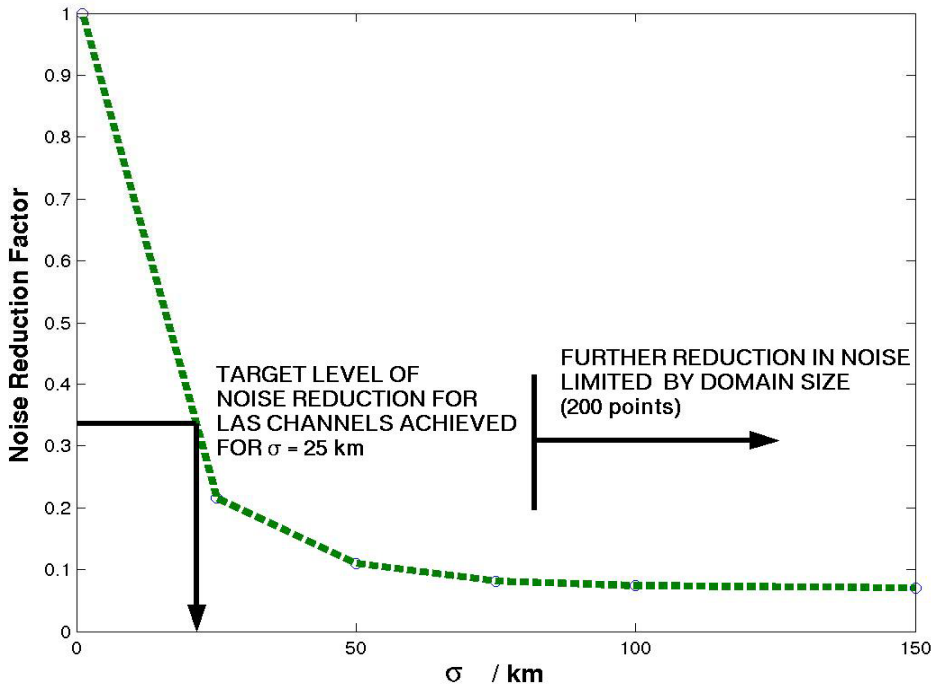


- NEΔT for LAS channels is ~0.3K

⇒require averaging to achieve NEΔT$_{eff}$ = 0.1K

- Also benefit from improved scale matching?

- Operational preprocessor uses σ = 50km (FWHM = 118km)
- NEΔT$_{eff}$ ~ 0.03K
- Processing time ~ 1 minute/ orbit



Background: Accuracy Requirements and Initial Performance