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

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ITSC14

GLOBAL MODEL ONLY!

Outline

- Major changes to satellite data assimilation since last ITSC
  - 4D-Var
  - Use of EOS Aqua data (AIRS, AMSU, MODIS winds)
  - EARS
  - RTTOV 7
  - More ATOVS data over high land
  - No longer assimilating HIRS data for technical reasons
- Comment on late ATOVS data
- Planned improvements for the coming year
  - System changes
  - New data sources
- MetOp

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Changes to Satellite Data Assimilation

4D-Var Implementation

- Data Assimilation algorithm changed from 3D-Var to 4D-Var on 5th October 2004: ONLY change was in algorithm → clean comparison
- The global model is non-hydrostatic, with a finite difference lat-long grid, resolution N216 (~60km), with 38 levels (hybrid in height) and model top at 40km.
- 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.
- Inner loops with linear Perturbation Forecast (PF) model as opposed to full tangent linear.
- Non-linear updates every 10th iteration.
- Timeliness is critical: the main forecasts have a data cut-off at T+2 hours; and T+7 hours for update runs.

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4D-Var v 3D-Var performance

- Very significant improvements in NWP index (basket of scores):
  - +2.57 vs Observations;
  - +1.14 vs Analyses
- Biggest differences in winter storm tracks
- Fewer ‘busts’
- Signal from upper troposphere ATOVS
- Fit of observations to background improved

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May 2004 Upgrade to Satellite Data Assimilation

- Package of changes including
  - Use of AIRS data
  - Use of EOS Aqua AMSU data
  - EARS data included in assimilation
  - More ATOVS data over high land
  - RTTOV 7 for ATOVS
- Impact expected overall…
  - …on the basis of component tests +2.2

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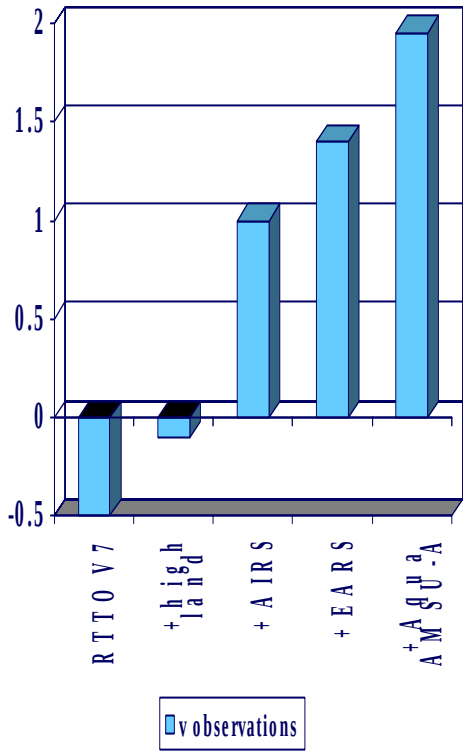
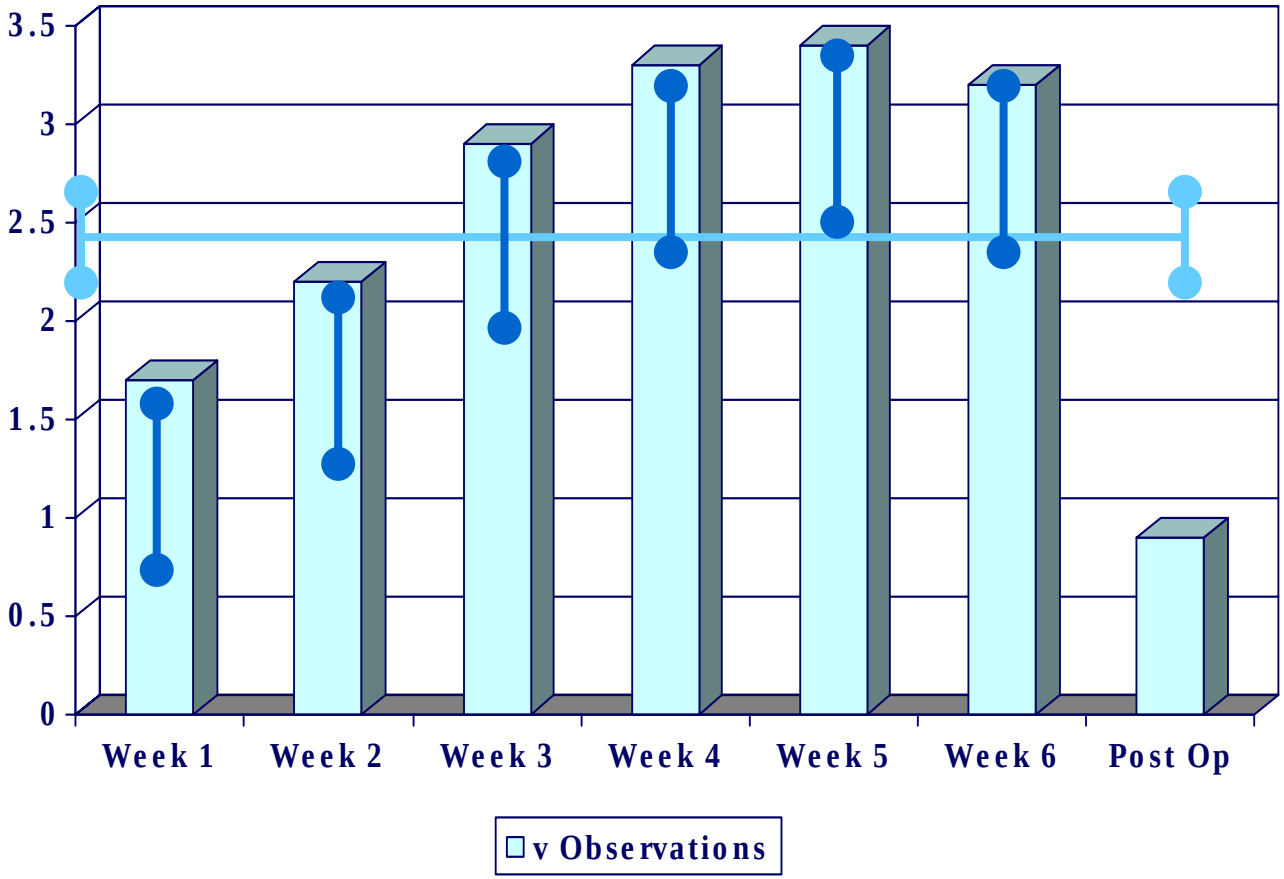
May 2004 Upgrade:
Package Trial Verification – weighted global score





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May 2004 Upgrade: Tropical Cyclone Verification

- We found major positive impact
  - positions 10% better, intensity increased, picked up more quickly and developed more rapidly (well before TC bogus kicks in).
- First TC post upgrade was superbly forecast (again well analysed before TC bogus).
- Combined with ECMWF experience (step improvement when AIRS and Aqua AMSU-A went in) we can say with reasonable confidence that AIRS has an important impact on TC forecasts.

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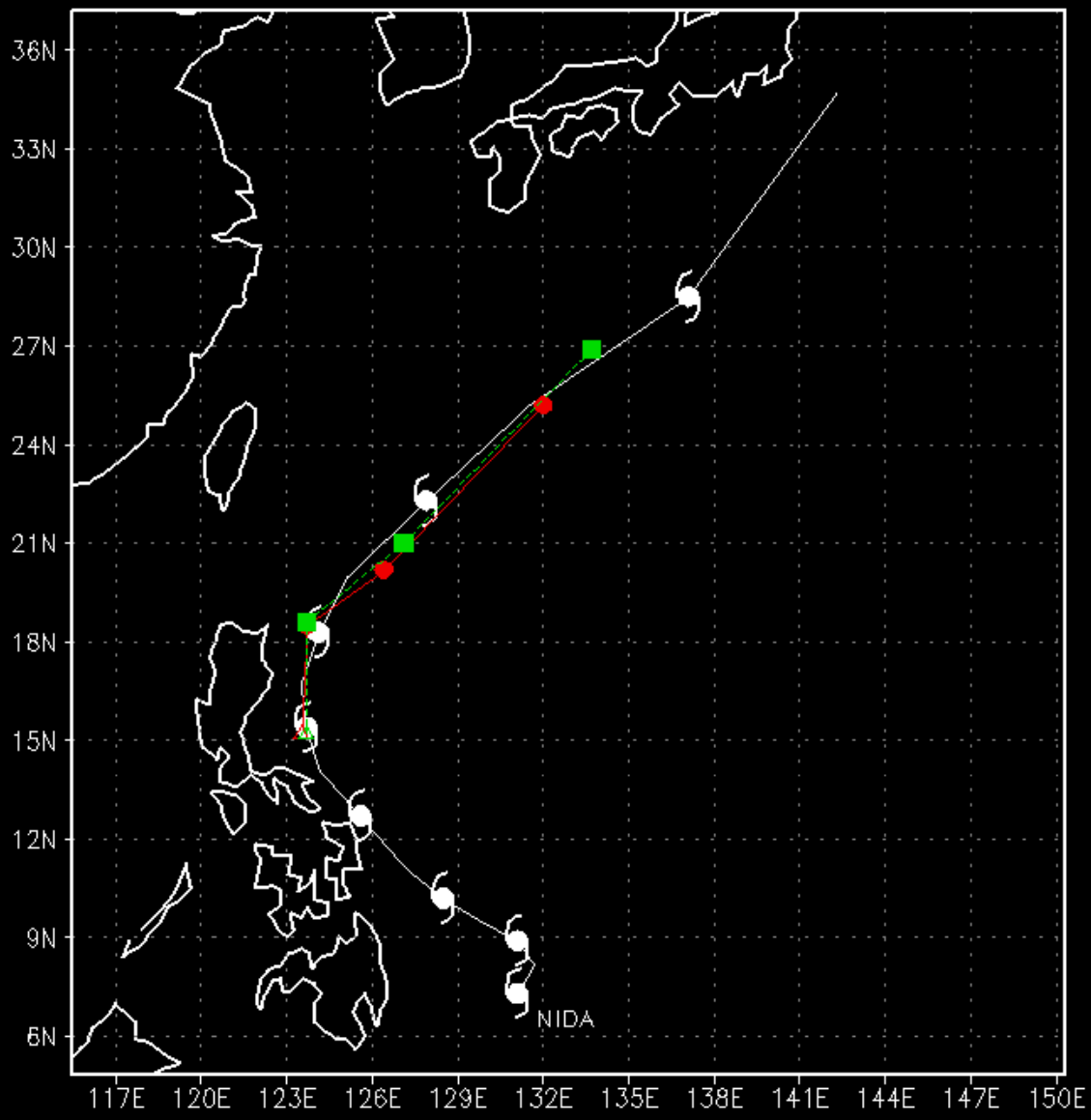
CONTROL and TRIAL

FORECAST TRACKS of SUPER TYPHOON NIDA



CN 20040517 TR 20040517

KEY to FORECAST TRACKS

(Triangles denote analysed positions)

24 HOURLY REAL TIME OBSERVED POSITIONS

DATE/TIME OF FIRST SYMBOL 12Z 13 MAY 2004

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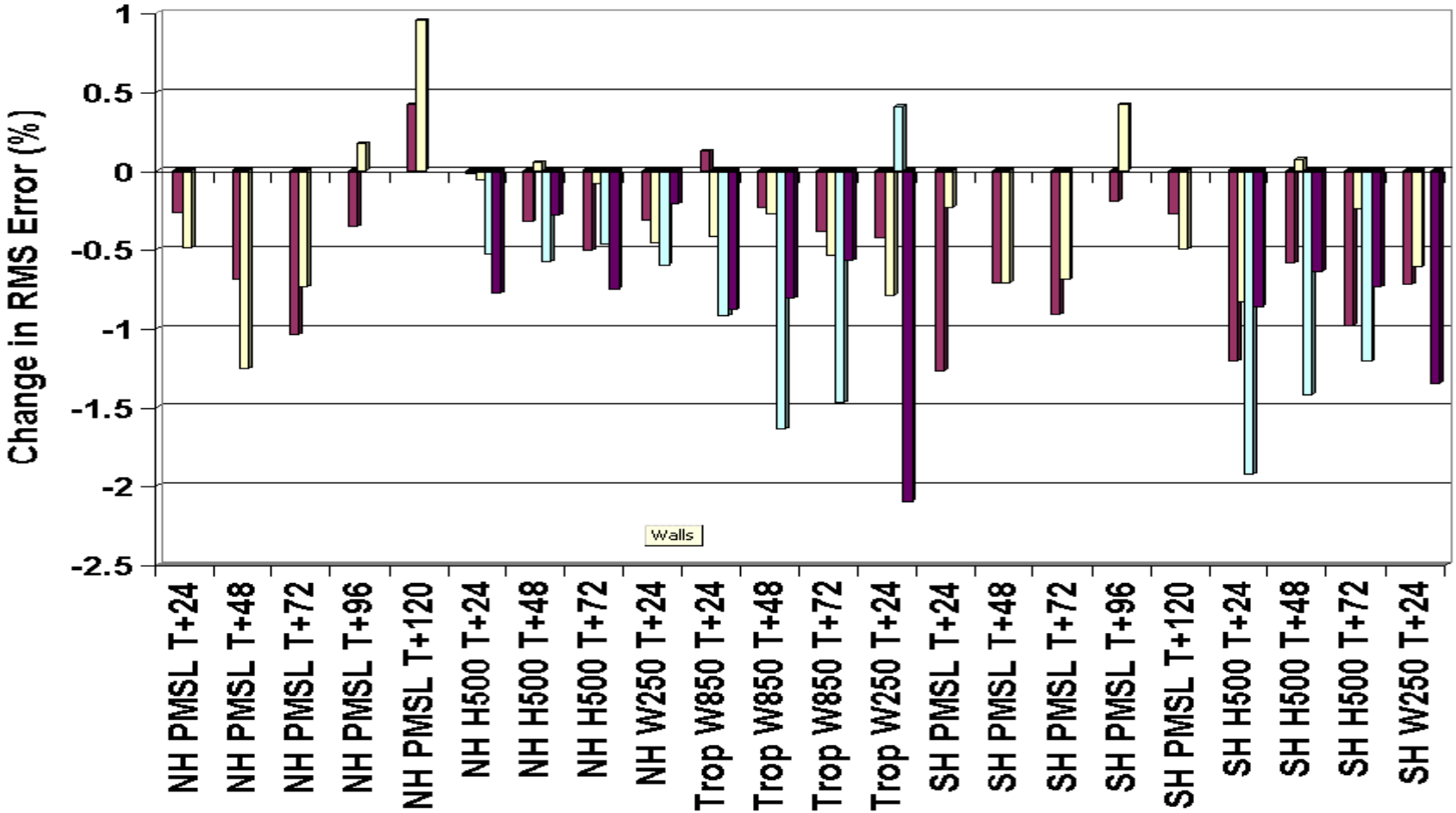
AIRS Impact – See poster by Cameron et al.

Impact of AIRS trial: +0.4/0.5 on NWP Index



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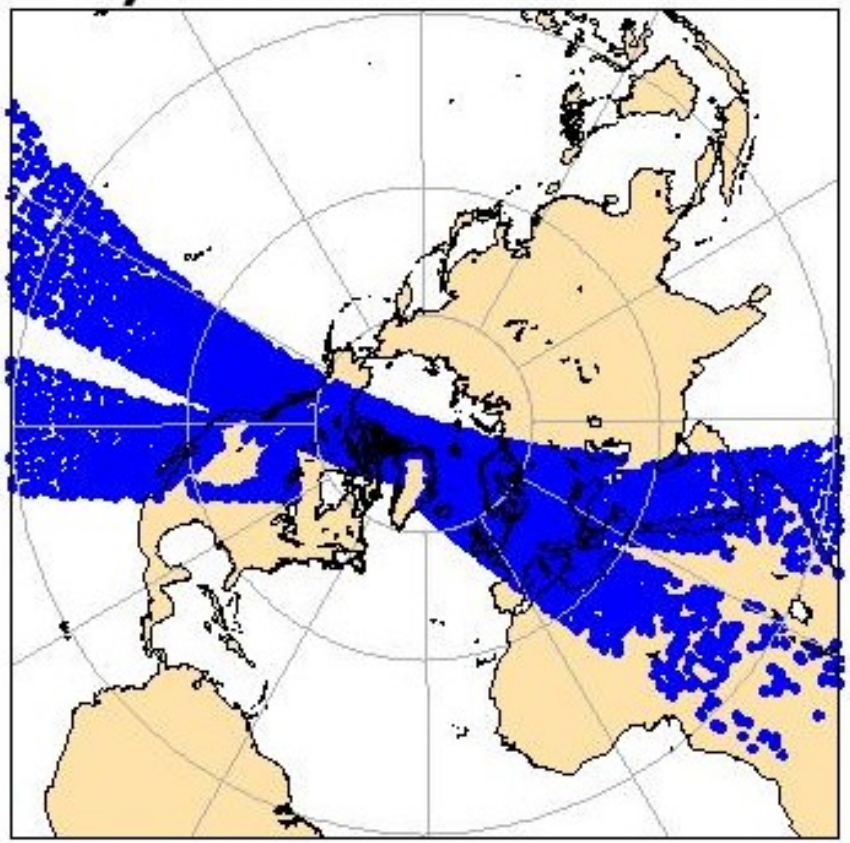
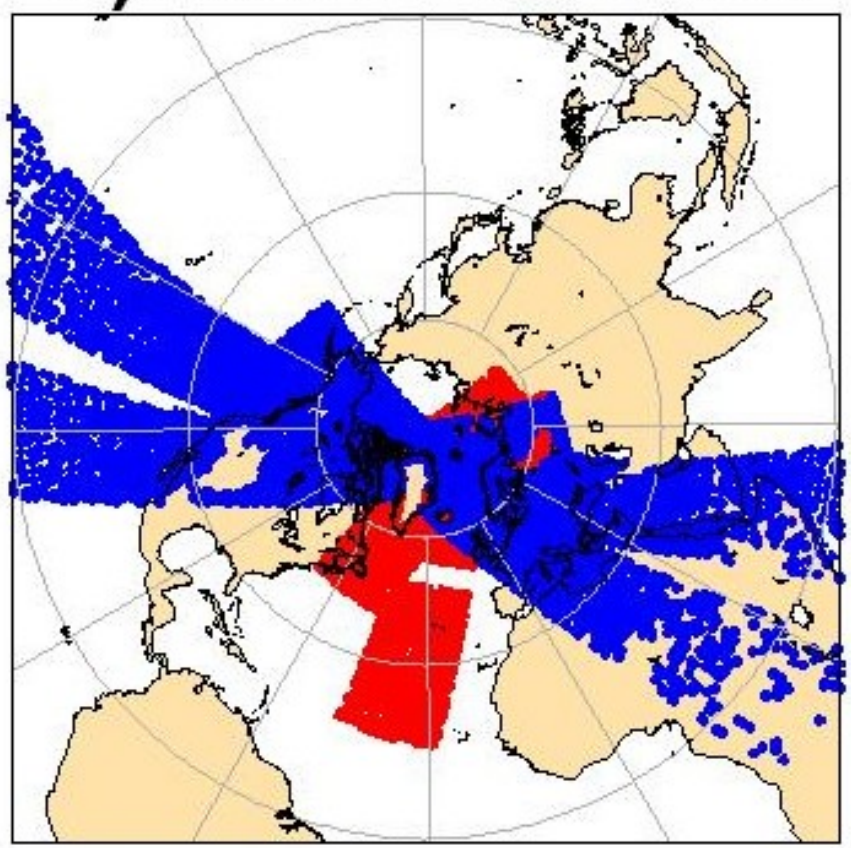
Extra ATOVS data from EARS





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Use of MODIS Data

Extract all NESDIS MODIS winds valid from 9z – 15z

1. Blacklisting

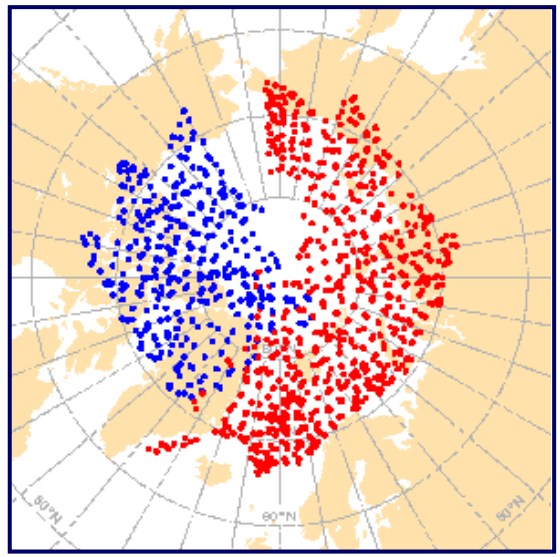
- All winds below 400 hPa over Greenland and Antarctica
- WV and CSWV below 600 hPa everywhere
- IR below 600 hPa over land and sea ice

2. Thinning

- one wind per 200 km x 200 km x 100 hPa box.

3. Background check

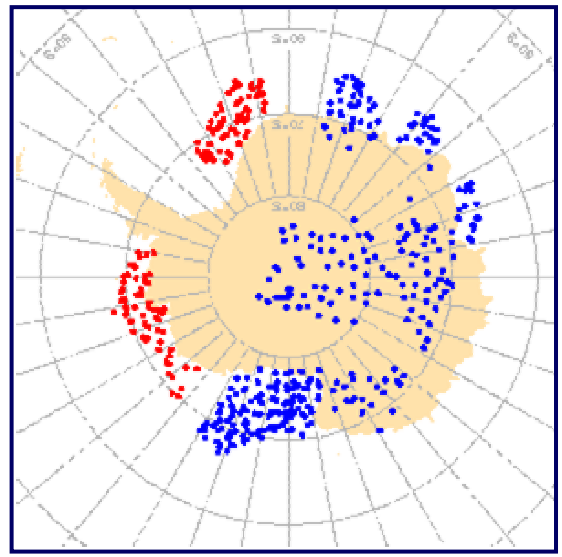
NH



1041

5%

SH



454

5%

Red = TERRA Blue = AQUA

Only use in update runs due to data timeliness issues

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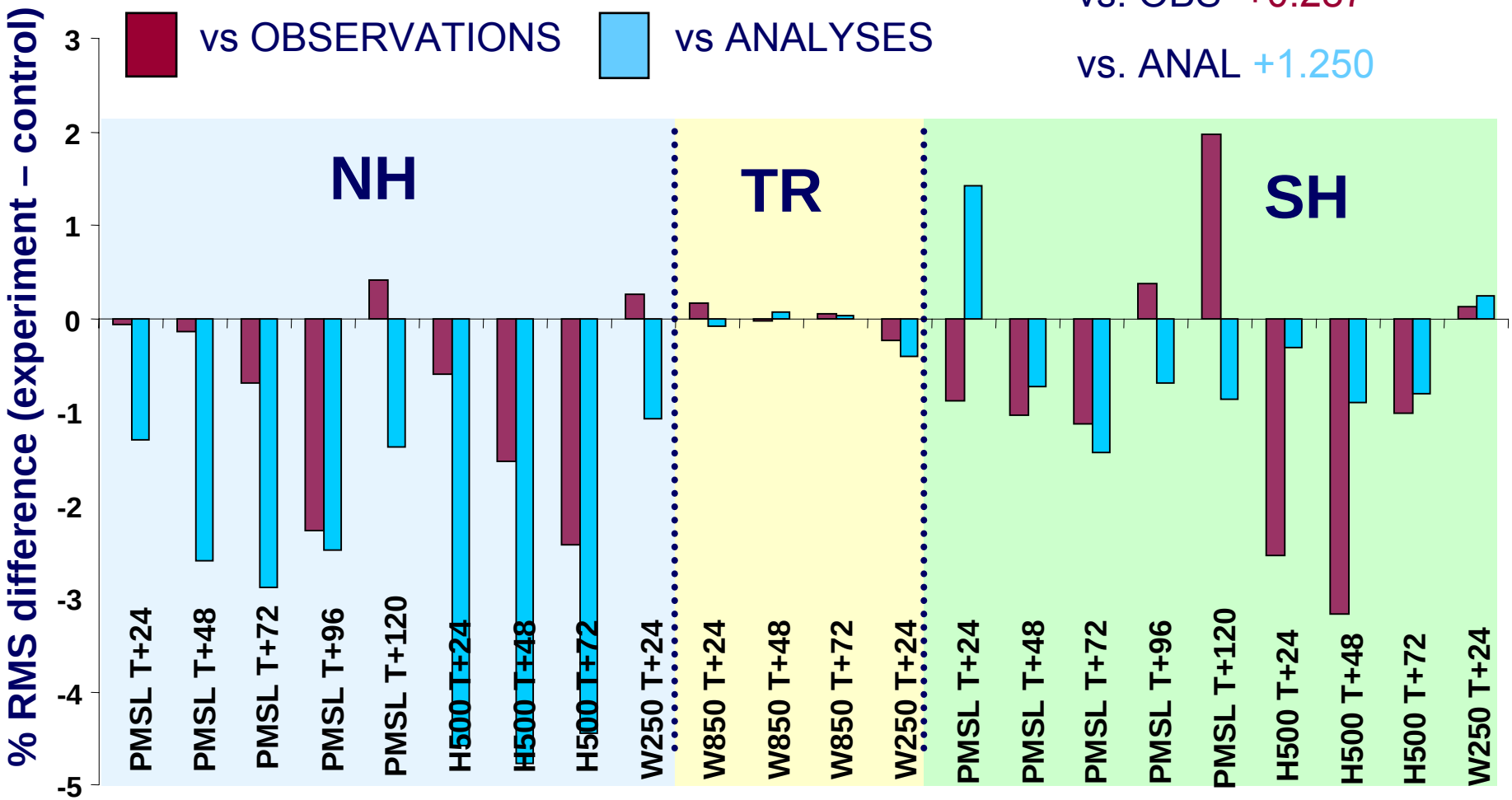
MODIS Impact

22nd Jul – 19th Aug 2004

NWP Index

vs. OBS +0.287

vs. ANAL +1.250



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Summary of Satellite Data Usage (GLOBAL Model!)

	Last Conference	This Conference
ATOVS	NOAA-15 AMSU (4-10,18,20) NOAA-16 HIRS (4-8,10-12,15), AMSU (4-8,10,18-20) NOAA-17 HIRS (4-8,10-12,15), AMSU (4-6, 8-10,18-20)	NOAA-15 AMSU (4-10,18,20) NOAA-16 AMSU (4-8,10, 18-20) EOS Aqua AMSU-A (4-6,8-10)
SSM/I	F13 and F15 windspeed	F13 and F15 windspeed
AIRS		EOS Aqua subset of 324 channels; clear sea only
MODIS		EOS Aqua and EOS Terra

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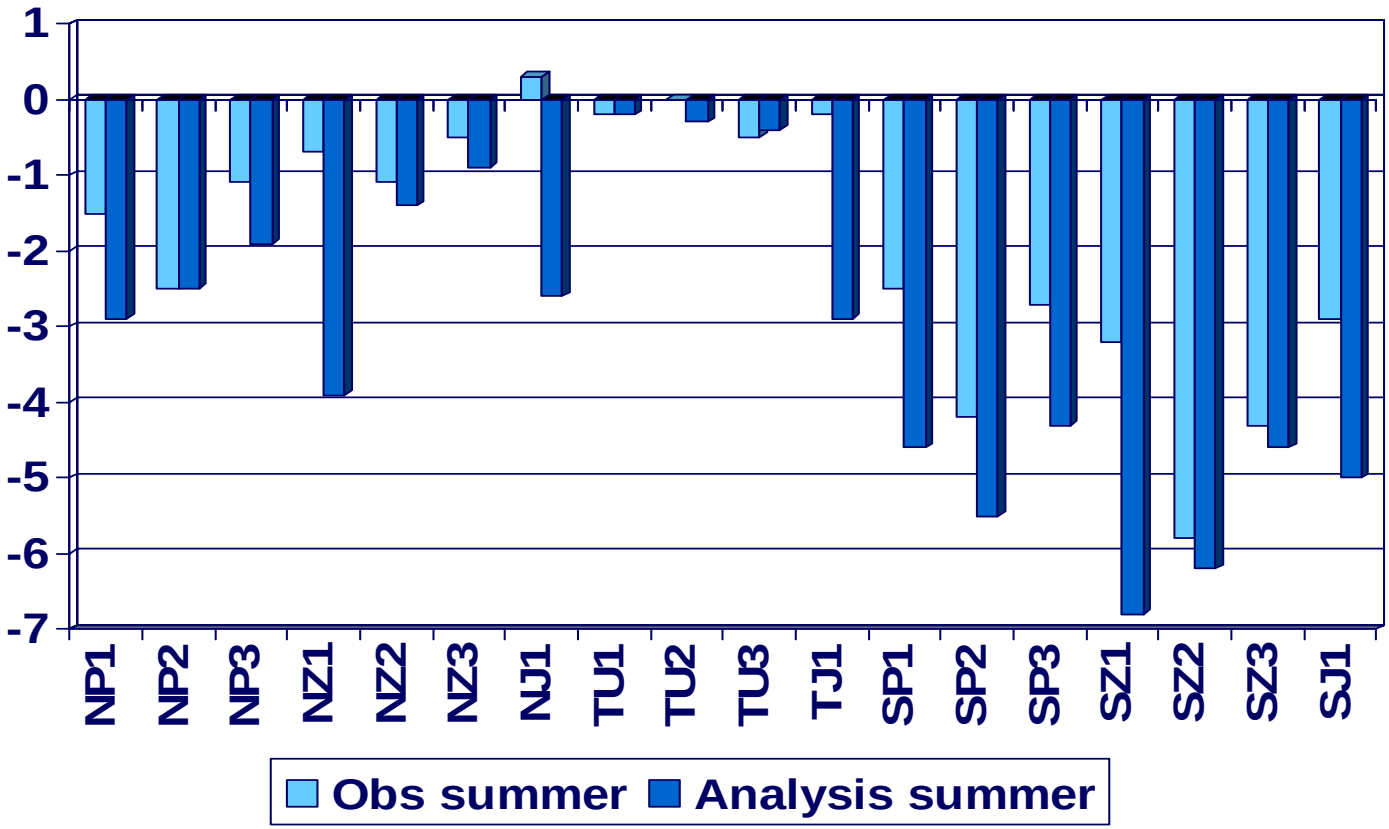
Timeliness of ATOVS Data

Impact of Late ATOVS Observations

As with MODIS winds, we would expect increased benefit from assimilation of ATOVS observations if data were more timely



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Planned Improvements for the Coming Year

System Changes

- Model Resolution Improvements by end of 2005
  - 40km horizontal resolution
  - 50 vertical levels
- 4D-Var background error covariance tuning
- Improved observation selection in 4D-Var
- Upgrade ATOVS processing to RTTOV8

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Satellite Data Changes

- NOAA-18
  - Assimilation ASAP instead of Aqua/N16 once monitoring stable
  - Priority of N18 v N16
- SSMIS (See poster by Bell et al.)
  - Obs need correction and QC before 1D-Var
  - Trialling of QC'd radiances to begin this summer
- Alternative AIRS datasets
  - Warmest FOV

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Met Op Plans

METOP Implementation Plans for ATOVS and IASI

- We intend to process ATOVS data separately as HIRS-1d
- Differences between IASI and current ATOVS/AIRS processing:
  - We will not store all the data and will subset obs/channels before 1D-Var.
  - Aim to store PCS and use reconstructed radiances ASAP.
  - Data stored will already be subject to gross QC and cloud tests.
- Future directions include:
  - Exploring options for less conservative use of IASI data, e.g.:
    - Using cloudy data
    - Assimilating as principal components.

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Summary

- Major changes since last conference
  - 4D-Var Assimilation
  - Use of EOS Aqua data
  - Use of EARS data
  - RTTOV 7
- Coming changes
  - Higher resolution model
  - Use of NOAA-18, SSMIS
  - RTTOV 8
- Preparing for METOP
- Need Timely Data!

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Any Questions?