The importance of the stratosphere in operational weather forecasting

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SPARC DA meeting, October 2006

With thanks to many people who contributed to this project

The plan

Merged Global Model

Surprising results from this system

Reasons behind the improvements

Initial problems

The future

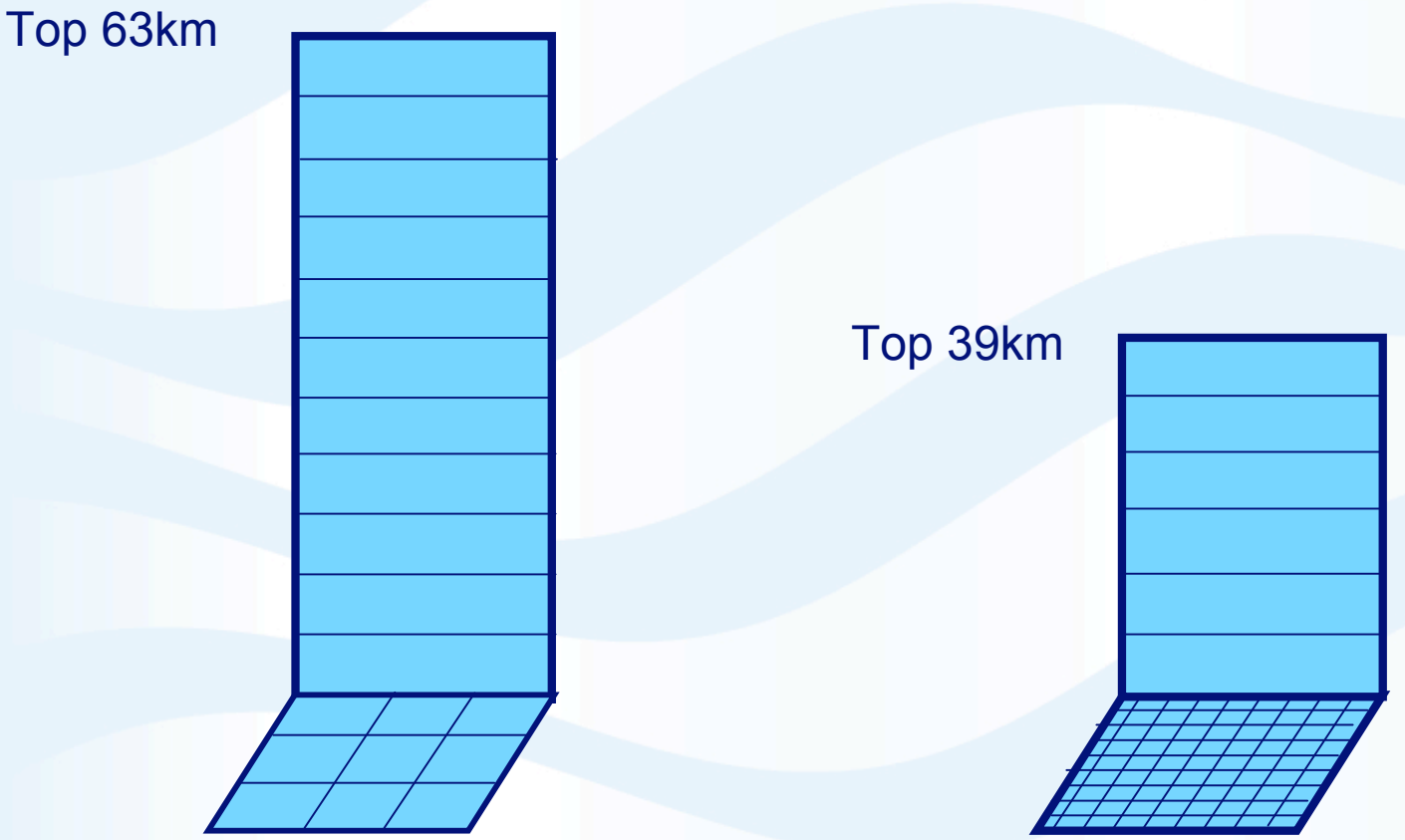
Merged Global Model

=

High horizontal resolution from the "weather forecasting" model

+

High vertical resolution from the "stratospheric" model



Stratospheric model
50 levels, 96 EW x 73NS

Merged global model
50 levels, 640EW x 481NS

Weather forecasting model
38 levels, 432 EW x 325NS

Old Global versus Merged Global

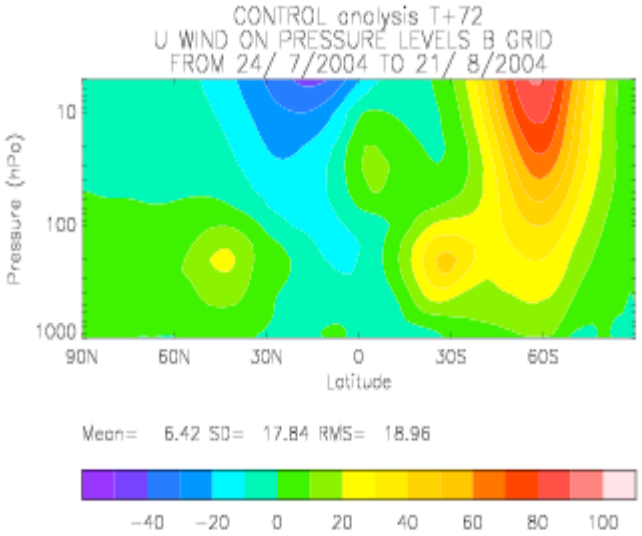
(forgetting the stratospheric model for a while)

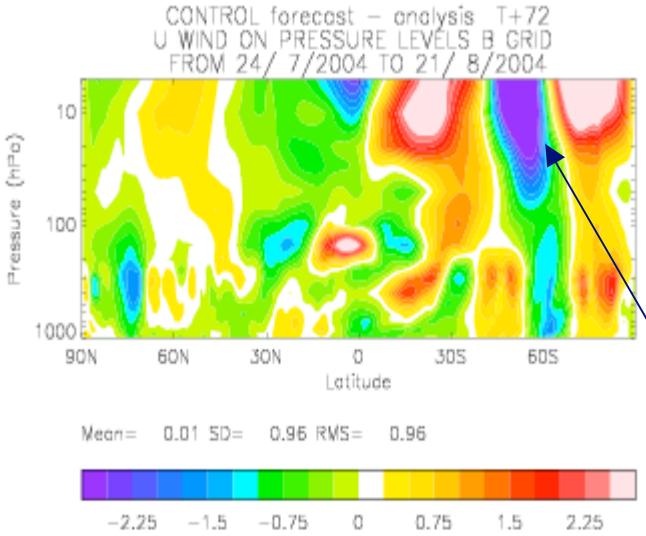
- The merged global shows improvements in "weather forecasts"
- What aspect of the resolution changes does it come from?
- Trials of each of the changes separately indicate that around 80% of the improvement comes from increased vertical resolution.

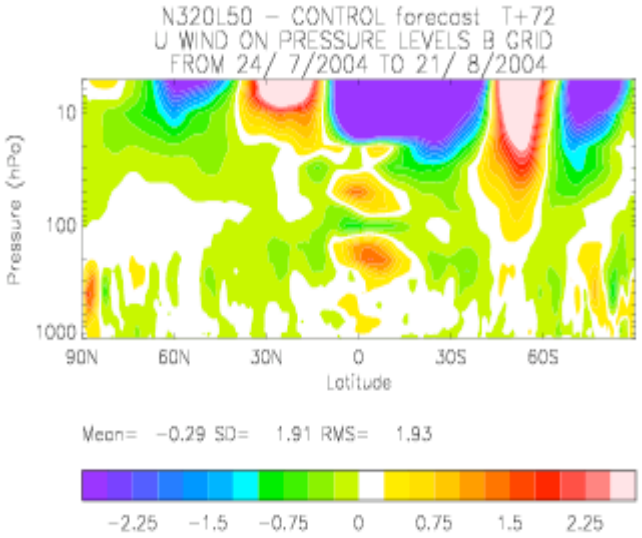
Where does the benefit come from?

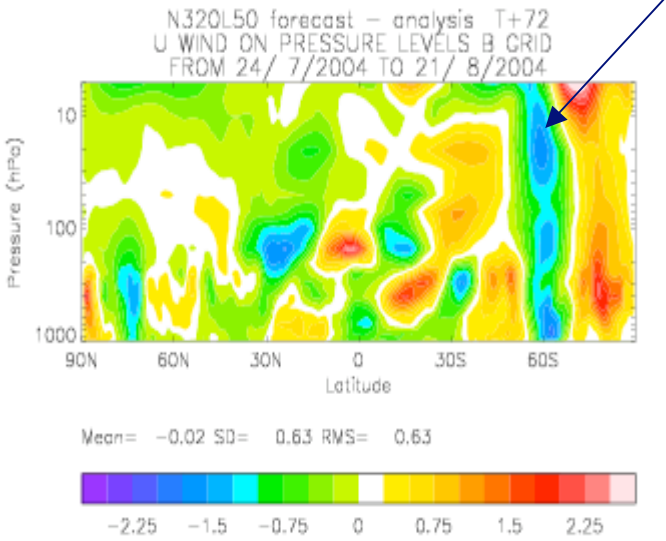
- Better representation of the stratosphere in the model
- Extra stratospheric ATOVS satellite channels
- Significant improvement in assimilation through better use of ATOVS

Impact of 50L on stratospheric winds – Polar night jet





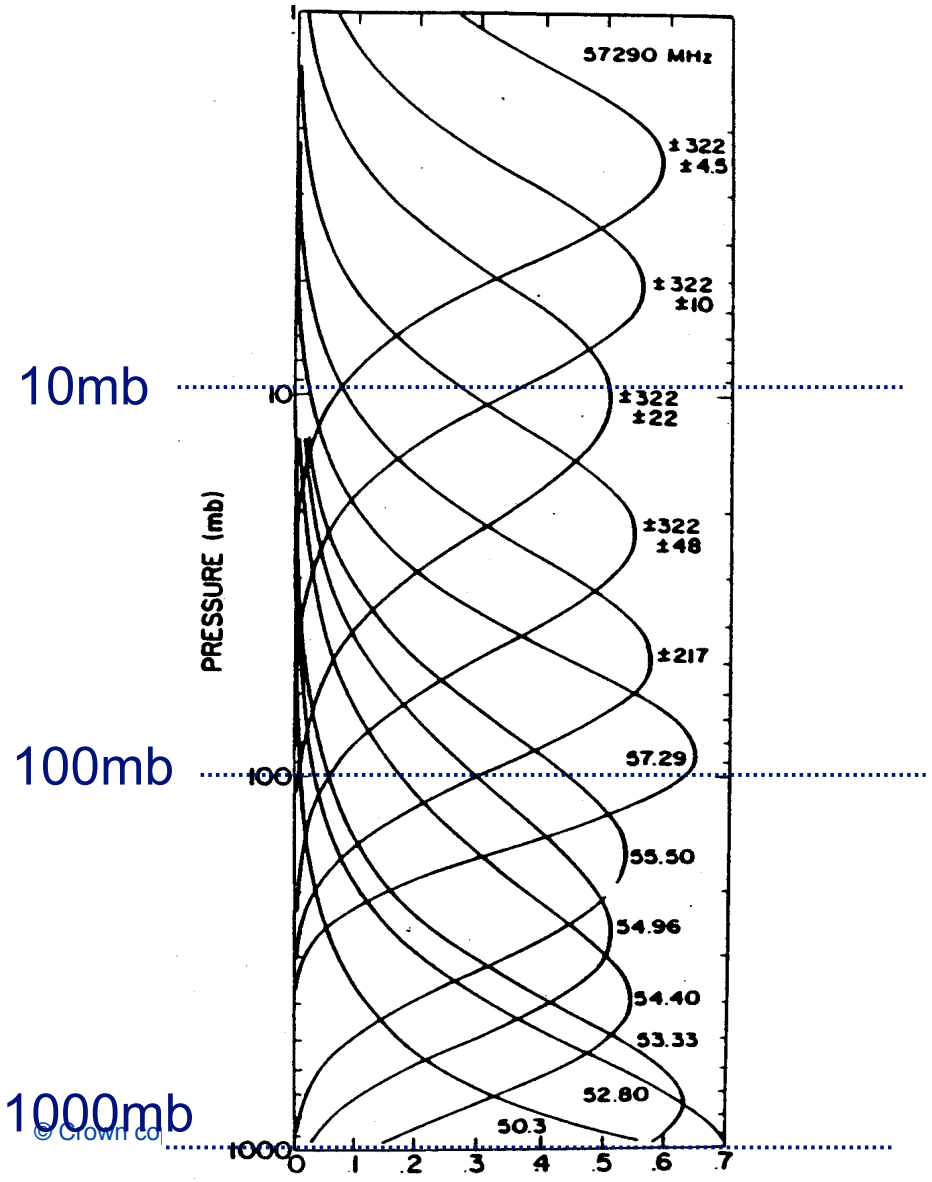




Jul-Aug 2004
4D-Var trial

Reduced systematic biases in Polar Night Jet in lower stratosphere

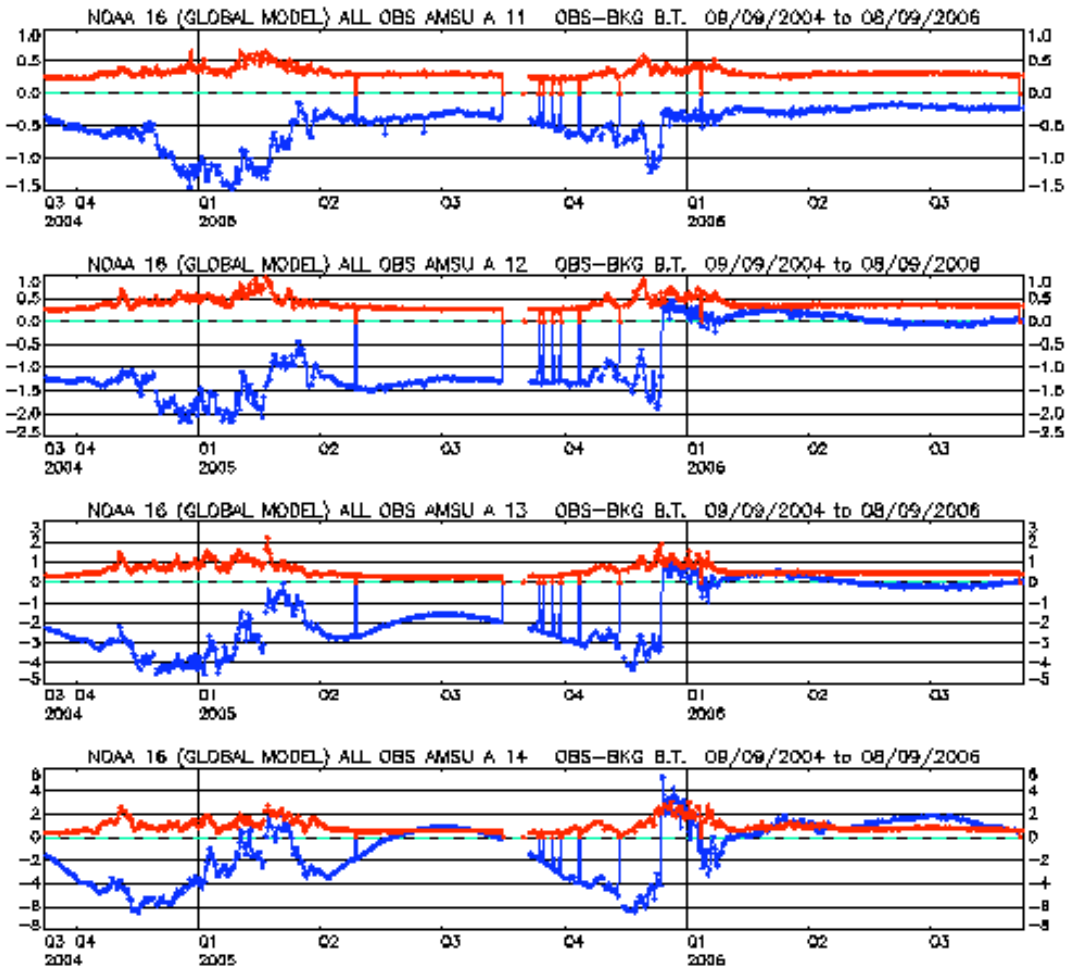
AMSU-A channels 3 to 14 weighting functions



NOAA 16

AMSU-A

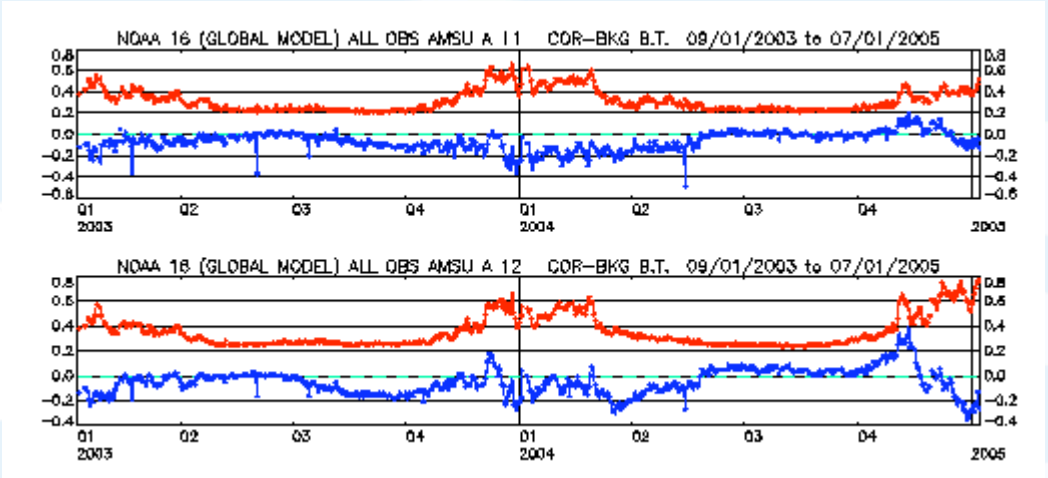
> 70^{o} North



NOAA 16

AMSU-A

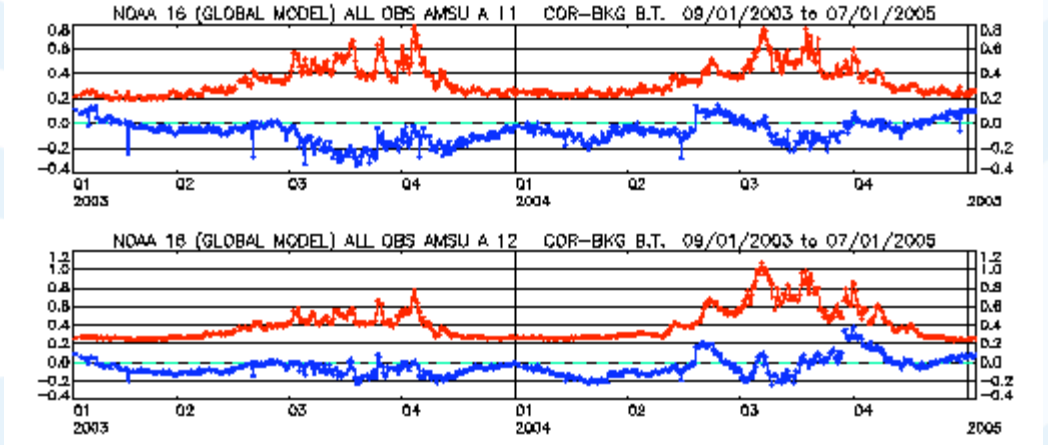
> 70º North



NOAA 16

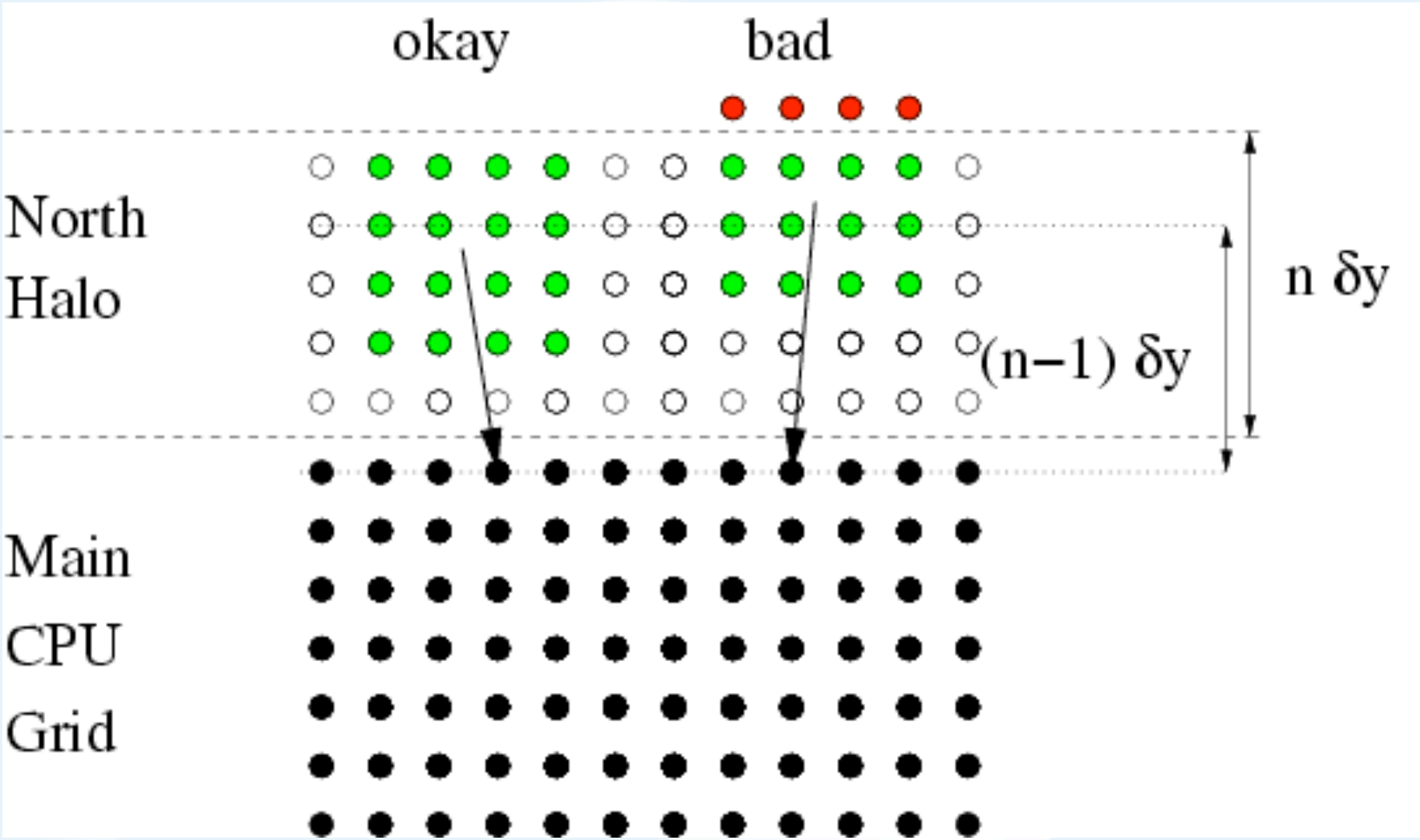
AMSU-A

> 70º South



Initial Problem

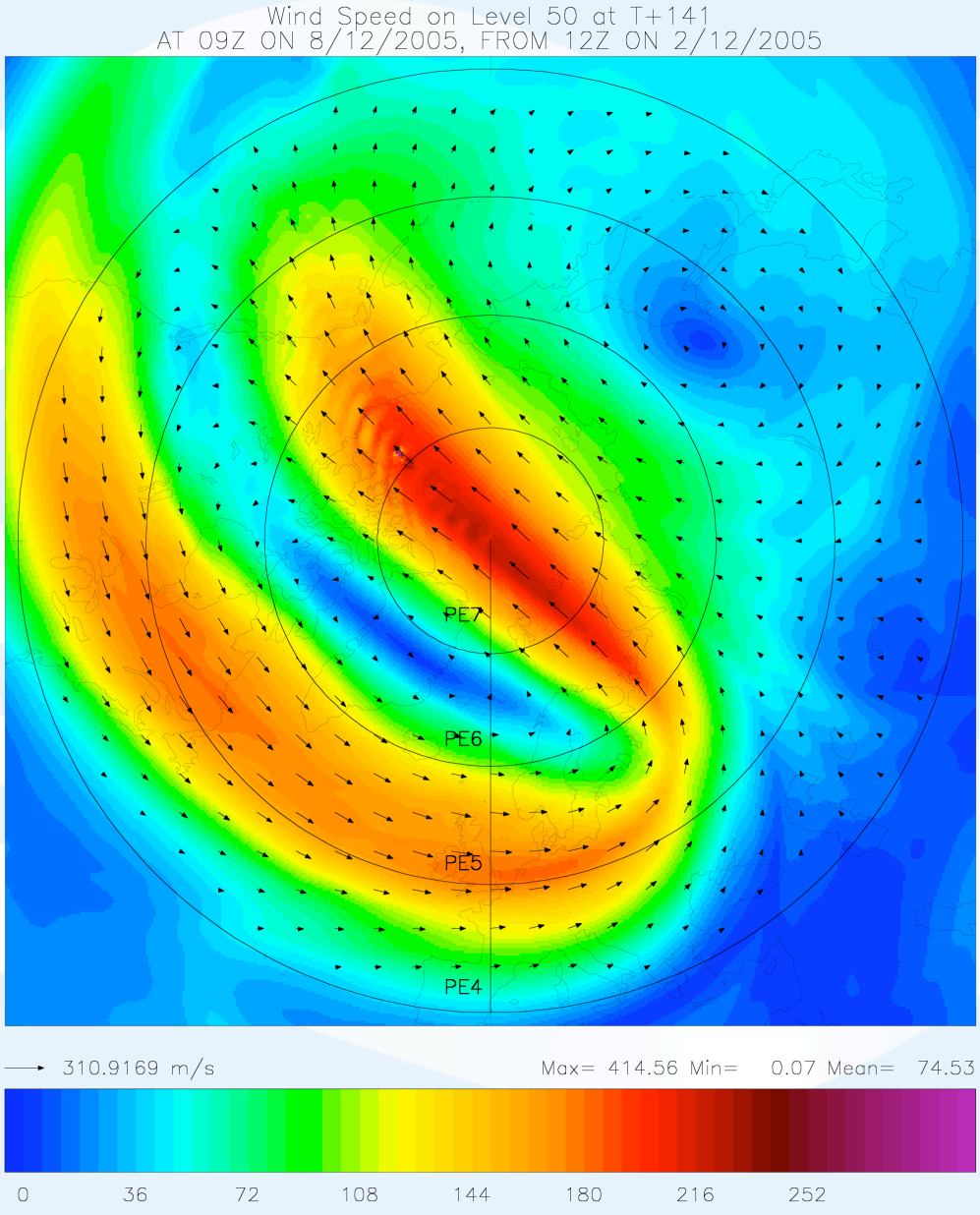
- The strong polar vortex moved over the poles
- The model crashed (a few times)
- Increased diffusion to reduce the instabilities
- The real problem was the communication between processors

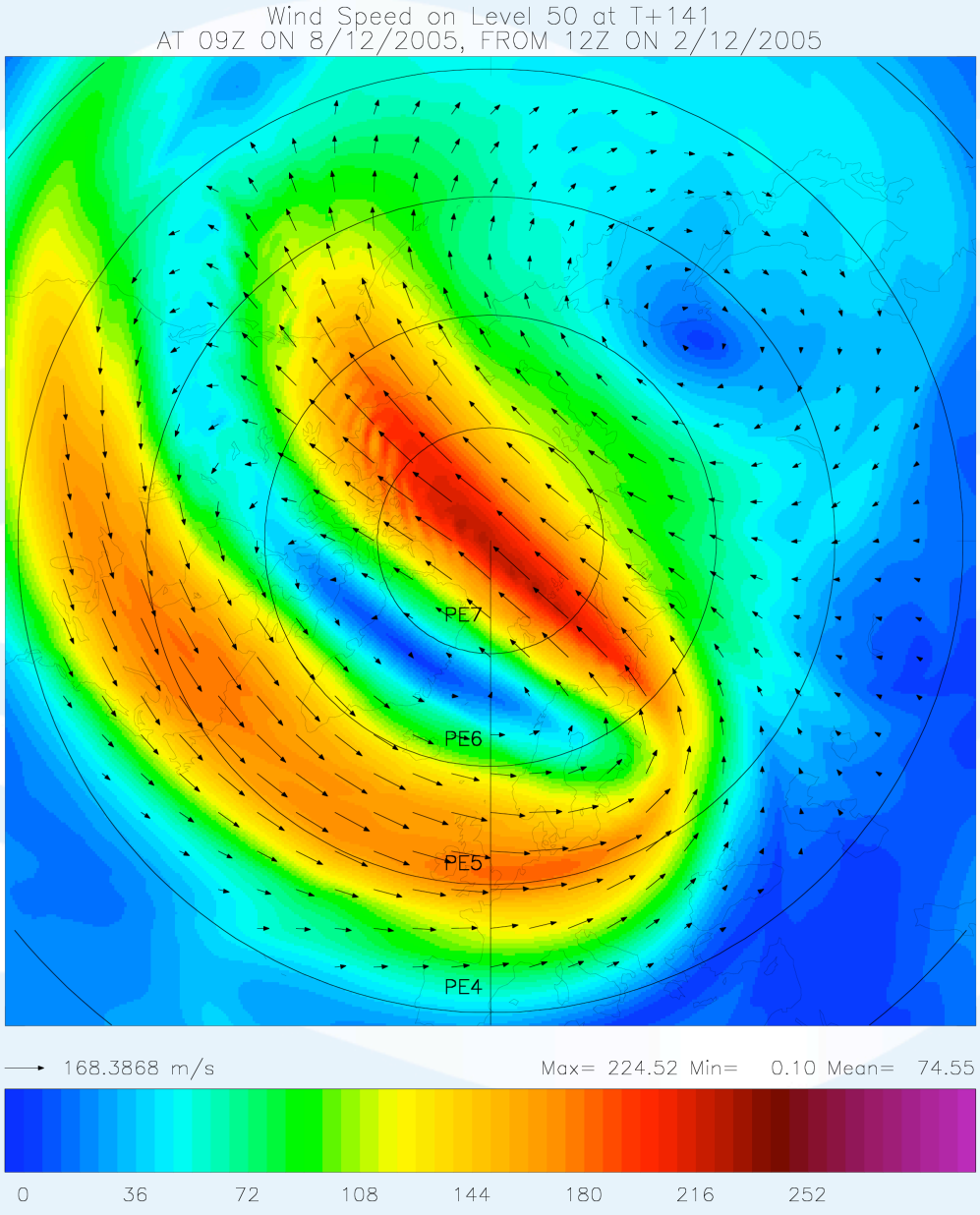

okay
bad
North
Halo
Main
CPU
Grid
n δy
(n−1) δy

Threshold v-compt of velocity

Timestep (mins)	NS Halo Size (points) 5	6	7	8
20	140 m/s	175 m/s	210 m/s	245m/s
15	185 m/s#	230 m/s	280 m/s*	325m/s
12	230 m/s	300 m/s	350 m/s	405m/s
10	325 m/s	350 m/s	415 m/s	485m/s

#original operational settings
* new operational settings


Wind Speed on Level 50 at T+141
AT 09Z ON 8/12/2005, FROM 12Z ON 2/12/2005
PE7
PE6
PE5
PE4
310.9169 m/s
Max= 414.56 Min= 0.07 Mean= 74.53
0
36
72
108
144
180
216
252

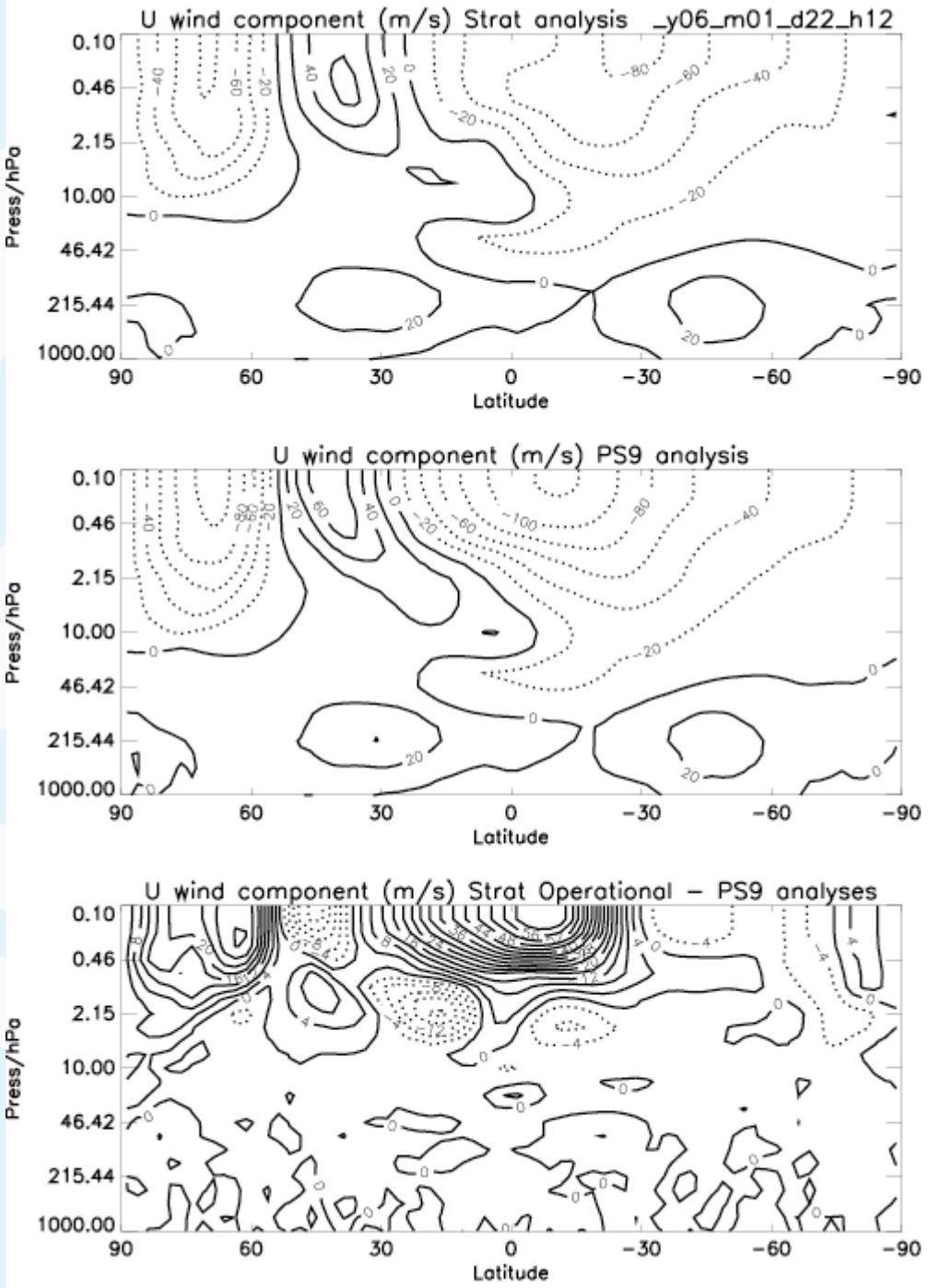

Wind Speed on Level 50 at T+141
AT 09Z ON 8/12/2005, FROM 12Z ON 2/12/2005
PE7
PE6
PE5
PE4
168.3868 m/s
Max= 224.52 Min= 0.10 Mean= 74.55
0
36
72
108
144
180
216
252

Stratospheric Model

Merged Global Model

Differences:

Stratospheric – Merged

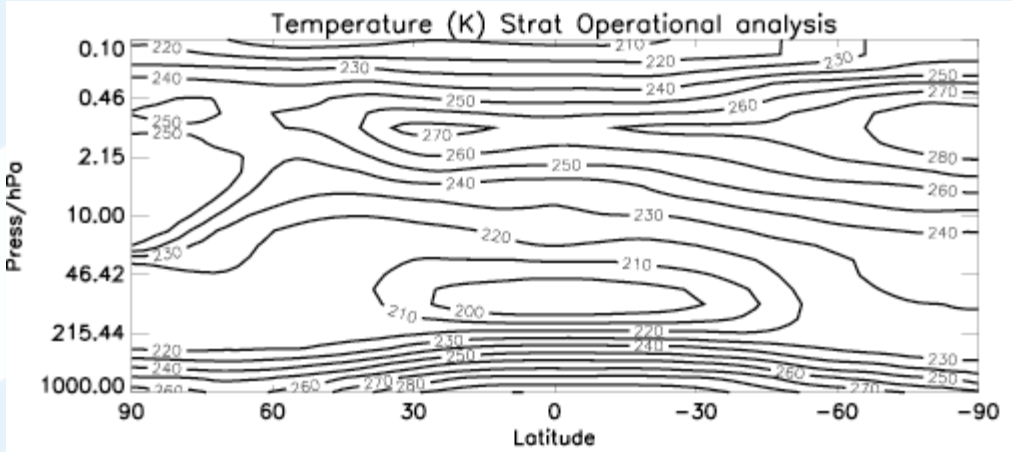


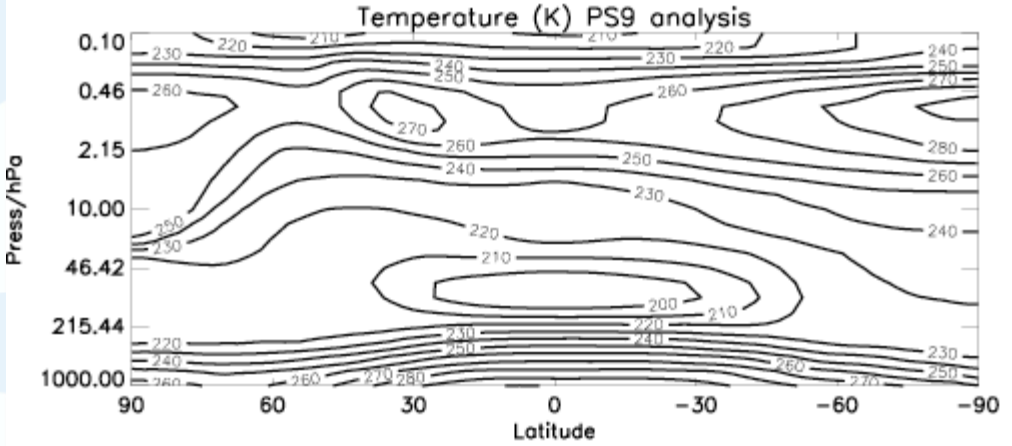
Stratospheric Model

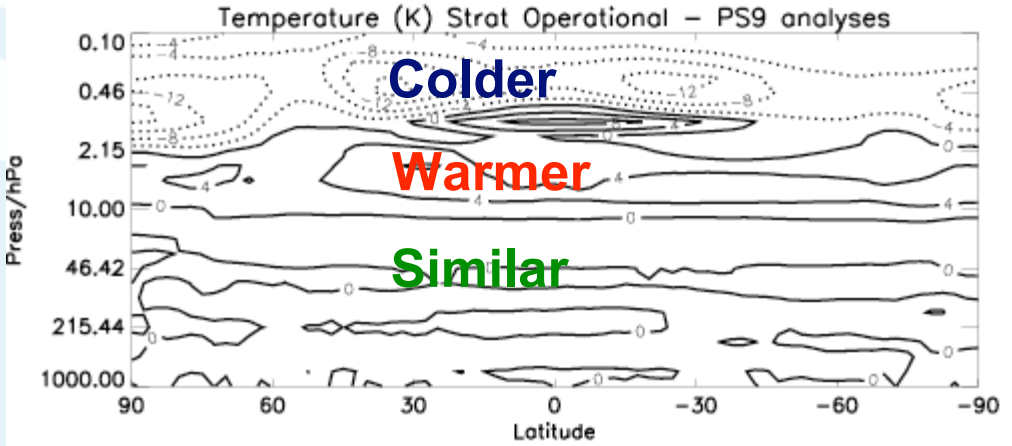
Merged Global Model

Differences:

Stratospheric – Merged







The future…

Many operational met models are pushing beyond the stratosphere

- Met Office model will be extended to around 80km
- USSP GWD scheme will be re-introduced
- Need more observations above 1hPa
- Plan to assimilate mesospheric satellite channels

Summary:

- Merged global model replaced two separate systems
- The extra stratospheric levels improve the weather forecast
  - Better modelling of the stratosphere: improved use of satellite data
  - Extra satellite channels used
- There is still need for improvement above 1hPa

Questions