Short Range Systematic Errors in the NCEP GFS

by

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*I'm responsible for this presentation;
The others are responsible for the GFS*

GFS Global Forecast System

64 sigma layers

T382 to 180 hours, T190 to 384 hours 4 times a d

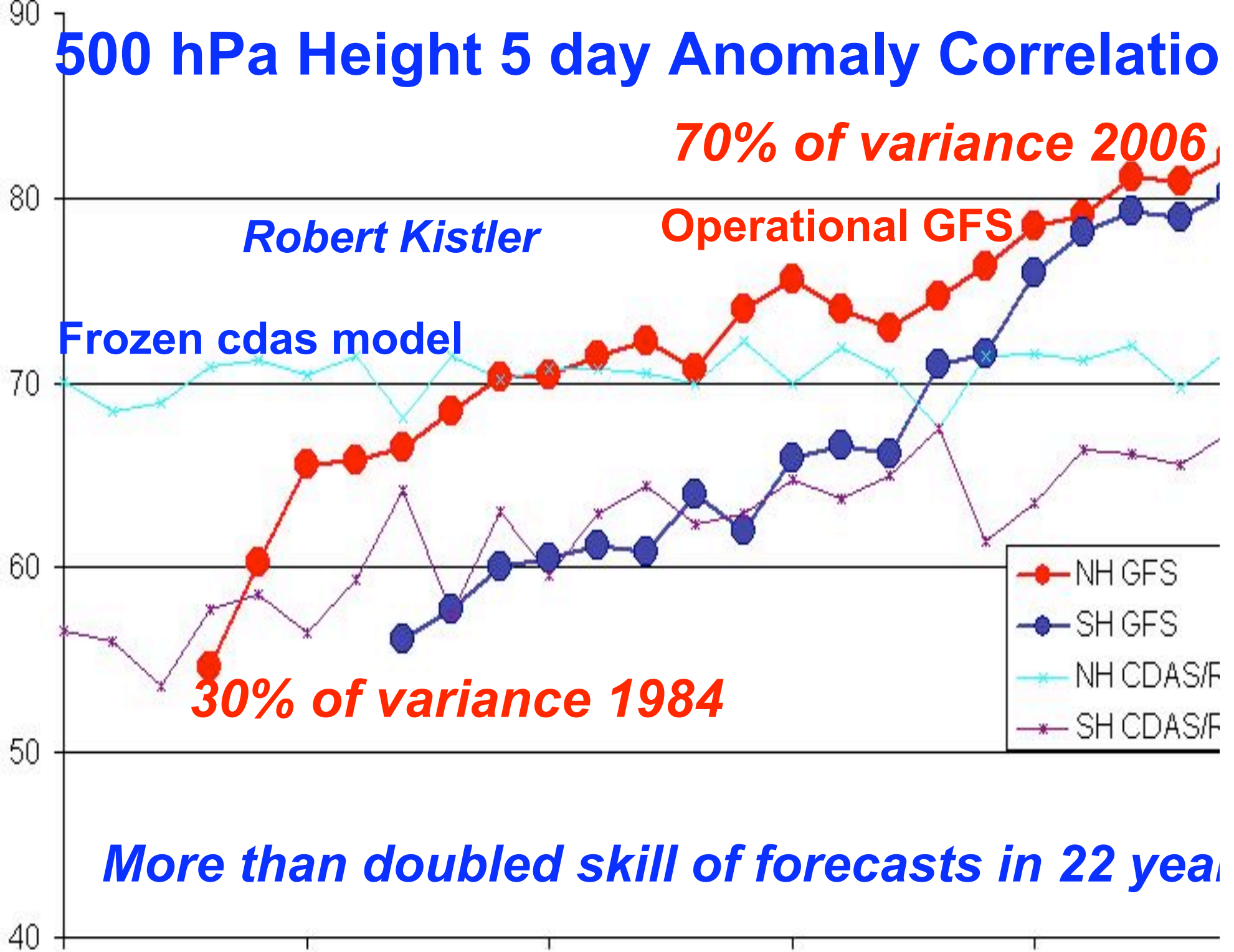*Guidance for NWS aviation, hurricane, medium a*
extended range forecasts (12 hours-9 months)

Atmospheric model used in NWS Climate Foreca
System for monthly, seasonal forecasts

GDAS Global Data Assimilation System

SSI Spectral Statistical Interpolation 3DVAR—us
as initial and boundary conditions for other syste

500 hPa Height 5 day Anomaly Correlatio

70% of variance 2006

Robert Kistler

Operational GFS

Frozen cdas model

30% of variance 1984

More than doubled skill of forecasts in 22 year

Legend:
- NH GFS
- SH GFS
- NH CDAS/F
- SH CDAS/F

Y-axis: 90, 80, 70, 60, 50, 40

My web page:
http://wwwt.emc.ncep.noaa.gov/gmb/noor/oct98op/text.h
--monthly, seasonal systematic errors in GFS 9/1998 on
--monthly comparison of GFS and other NWP centers 9/2003 on

Today will discuss using short-range errors (day or less) to diagnose GFS
--comparison to other centers
--"transplant" experiments—running GFS model from ECMWF Analyses and ECMWF model from GFS analyses

Poster Thursday on long range errors using multi decadal ocean-atmosphere coupled integrations to diagnose GFS

Major implementation May 31, 2005

--higher resolution 50 km to 35 km

--improved analysis

--new sea-ice, land-surface models

--enhanced orographic height by 10% of mountain variance in calculation of mountain blocking dissipative forces

--reducing both background diffusion in free atmosphere and turbulent diffusion length from 1 to 30 m in stable cases

Last two tested (and tuned) in 1-day experiments winter cases 2004-2005 (emphasized period in Feb 2005 where our skill dropped off relative to ECMWF and found to work together to improve forecasts

Bias in 200 hPa Wind speed 24 hr forecasts Jan 2005
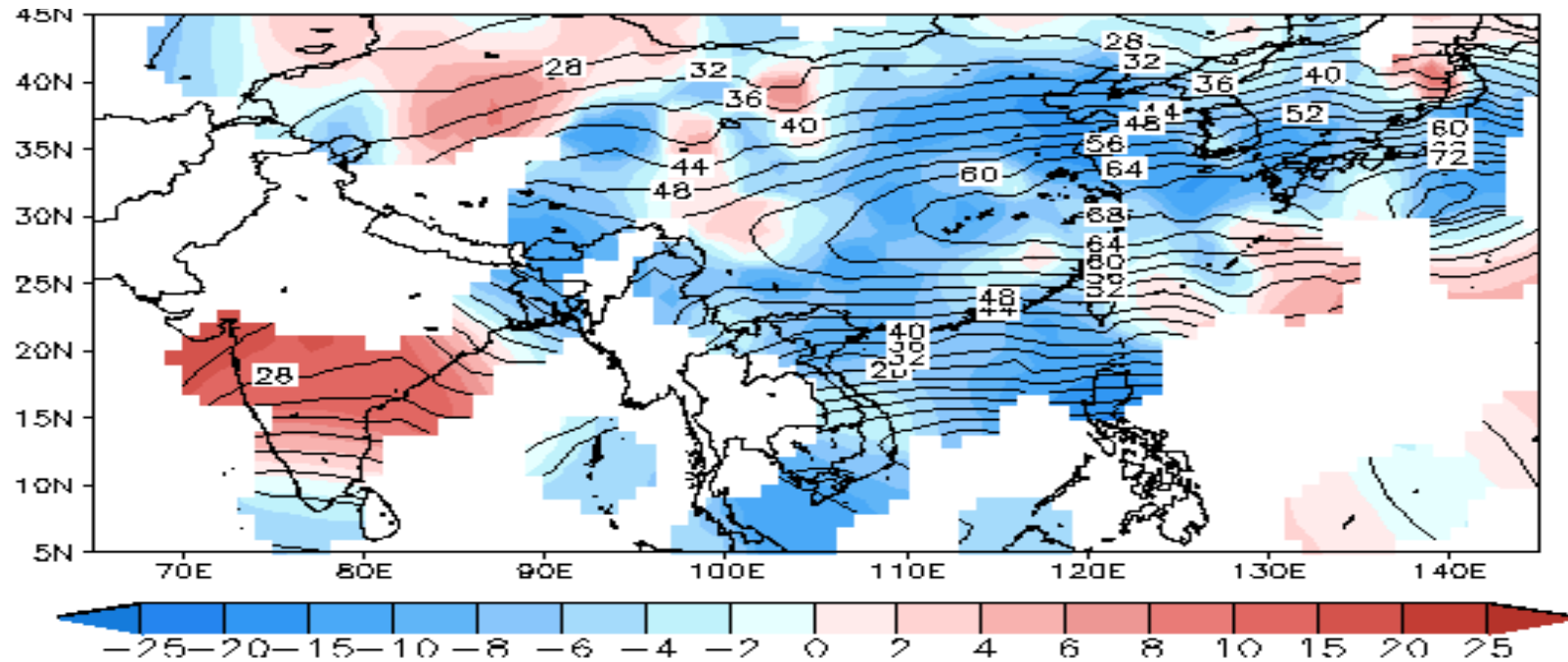
SURANJANA SAHA, GMB/EMC/NCEP/NWS/NOAA

Black Isolines are from actual observa

Negative bias in GFS Asian jet compared

observations

This suggested too much diffusion

Reducing diffusion did not eliminate bias

Zonal mean 5day error in temperature
47 day means Dec.-Jan

old

new
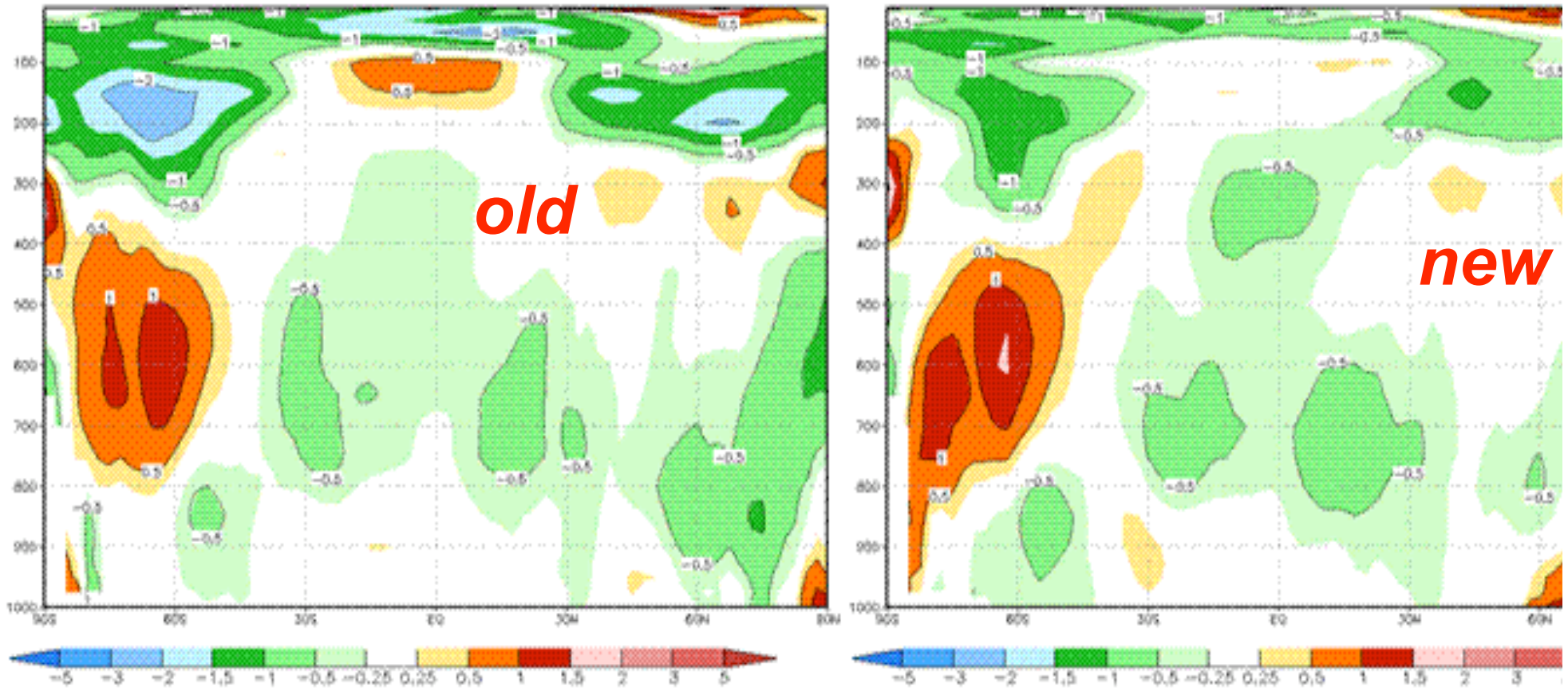
Reducing diffusion produces drier, warmer stratosphe

Day 1 error in 500 hPa height 47 day mean Dec-

OLD

NEW
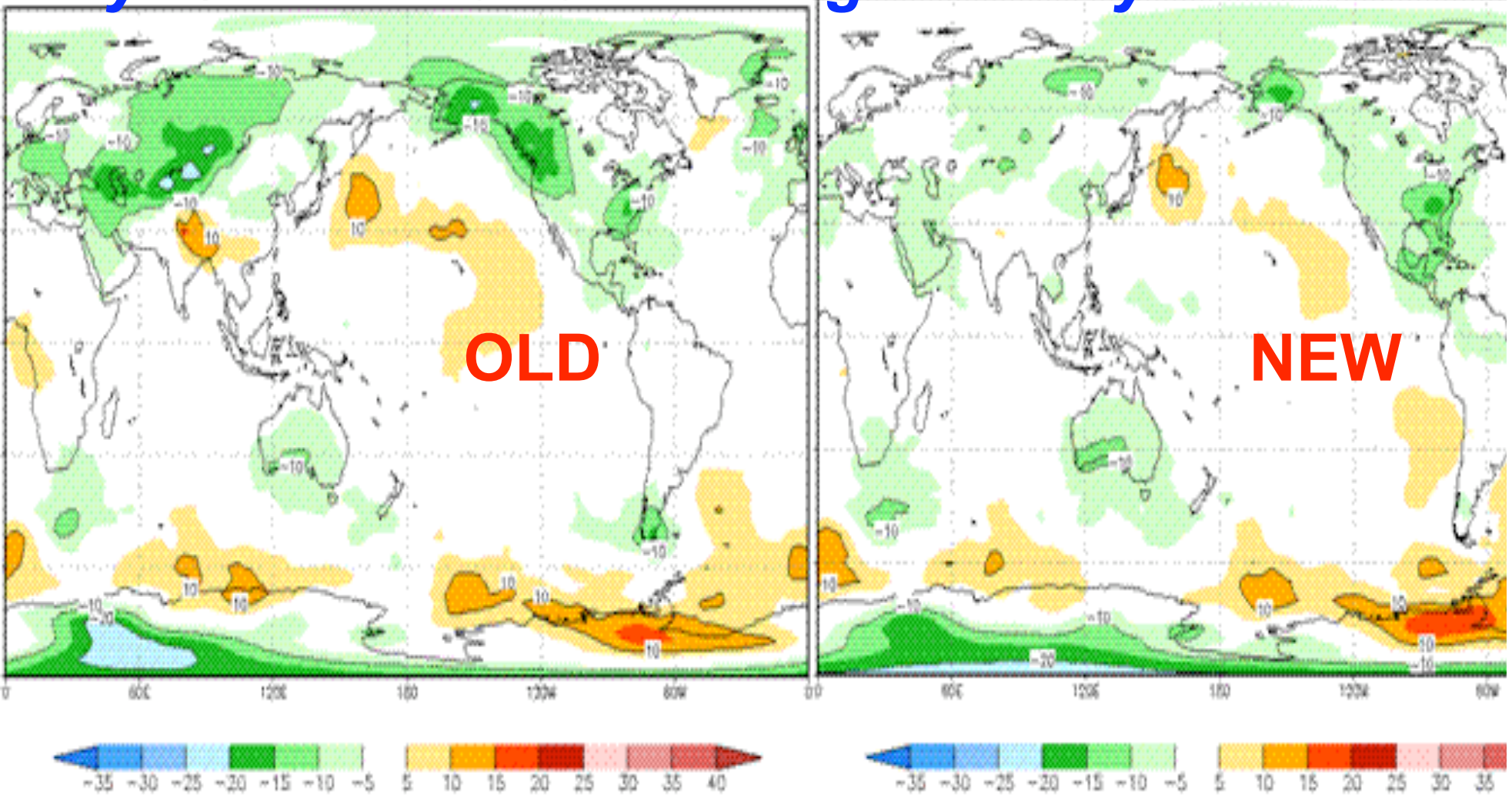
Day 1 error (left) implies problem with orograph

Enhanced mountain blocking reduced error ove Himalayas. Rockies

RMSE 1 day error 500 hPs height 47 days Dec.-Jan.

OLD

NEW-OLD
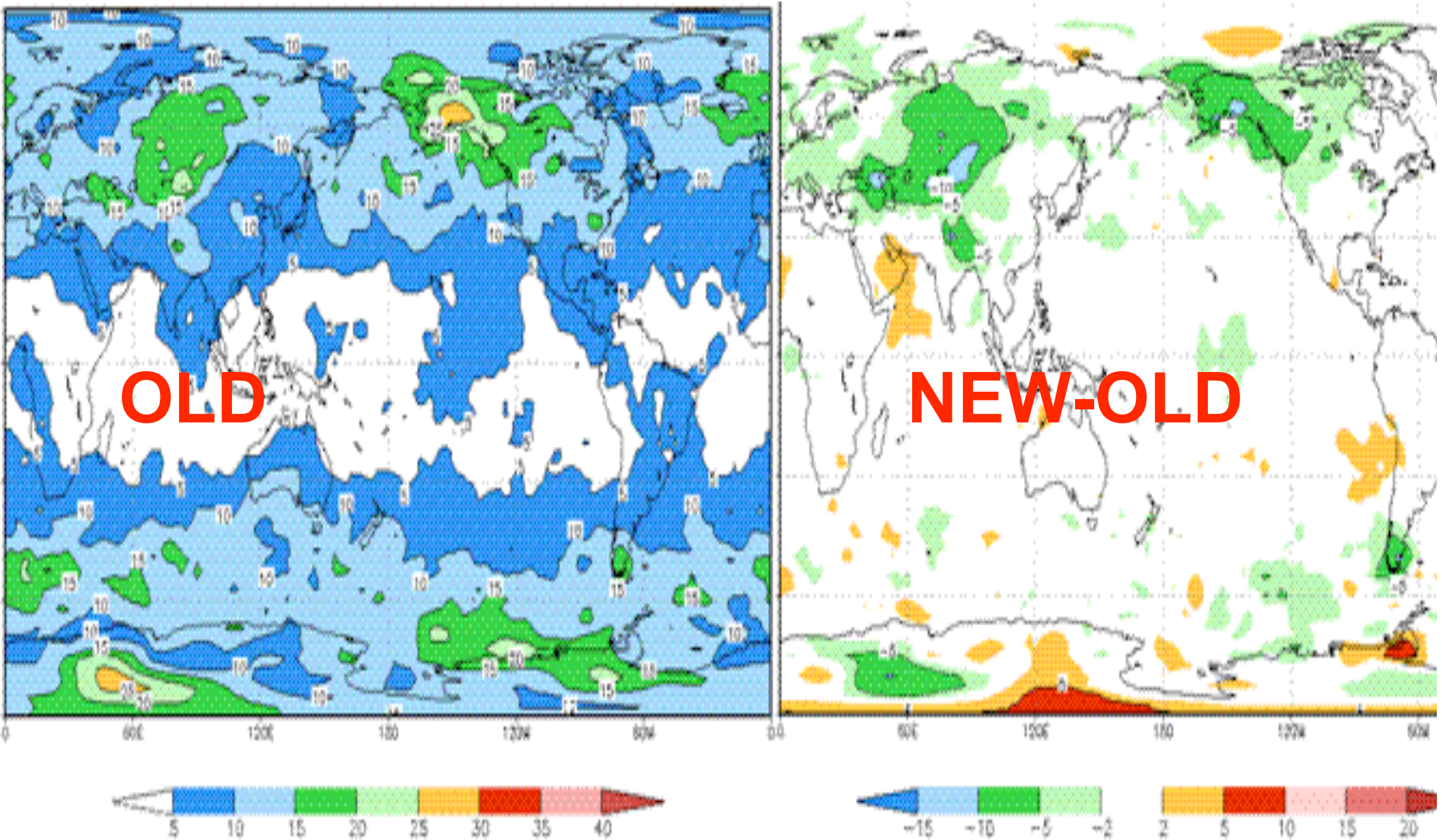
Day 1 rms height error reduced over mountai

April 21-June 4, 2005
20-80N 500 hPa height
Anomaly correlation

	Day 3	Day 5	Day 7
Old GFS	.950	.815	.587
New GFS	.958	.844	.635
ECMWF	.967	.868	.693

Examining day 1 errors indicated areas of concern in gfs.

Reducing day 1 errors improved medium-range forecasts.

Non-linear processes less time to act in shorter-range forecasts; source of error may be clearer.

Northern Hemi
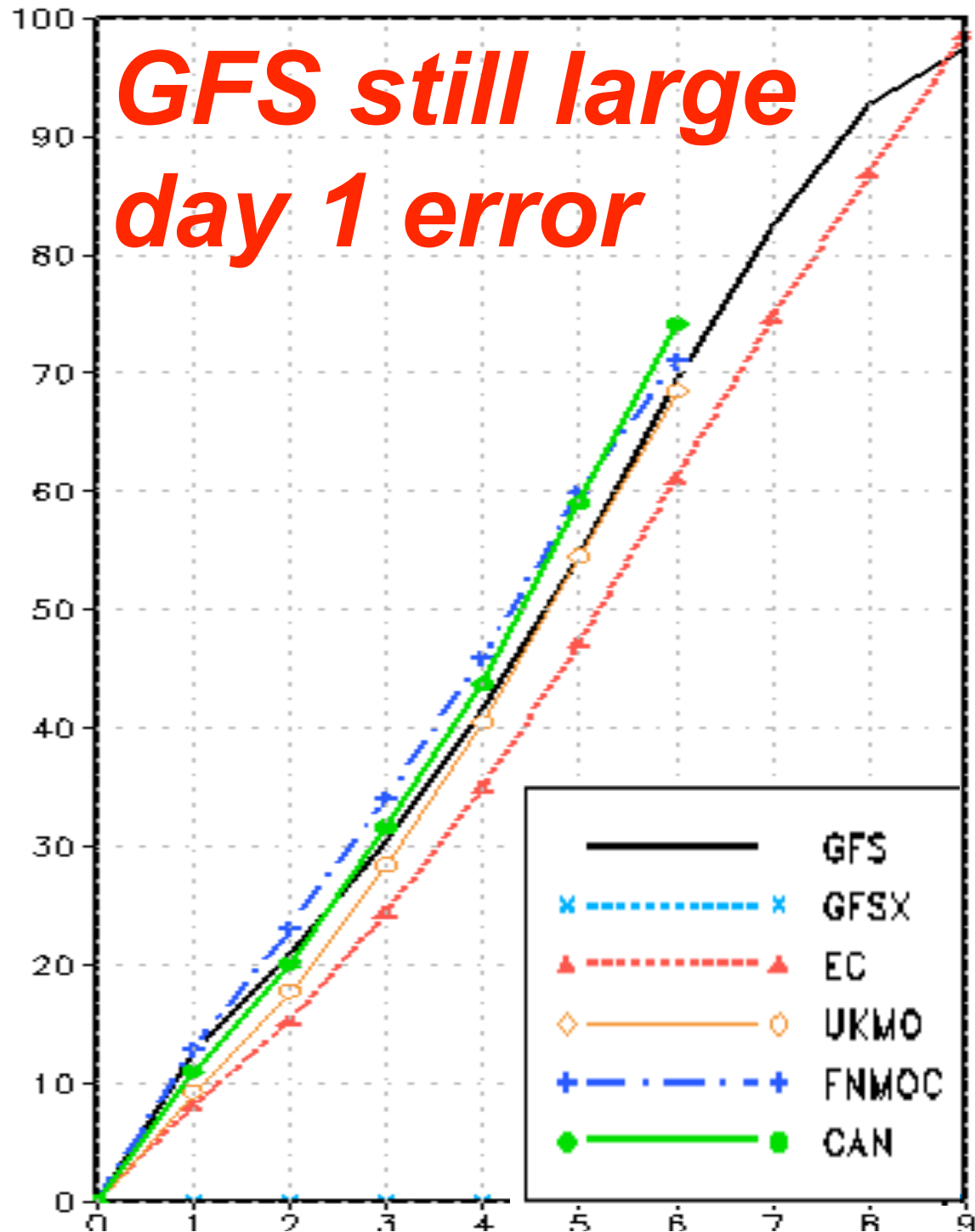
GFS still large day 1 error

RMS Error vs forecast time Z 500 hPa Dec. 2006

GFS error against own analysis grow rapidly first 2 hours; More slowly beyond day 1

rms height error

GFS

GFSX

EC

UKMO

FNMOC

CAN

Day 1 "errors" against own analyses comparable to analysis differences between different nwp centers December 2006

Day 1 error against own analyses

Legend (left panel):
- can (black)
- gfs (red)
- ec (green)
- mo (blue)
- fnmoc (cyan)

Differences in analyses

Legend (right panel):
- gfs-can (black)
- gfs-ec (red)
- gfs-fnmo (green)
- gfs-mo (blue)
- ec-can (black dotted)
- mo-can (red dotted)
- mo-ec (blue dotted)
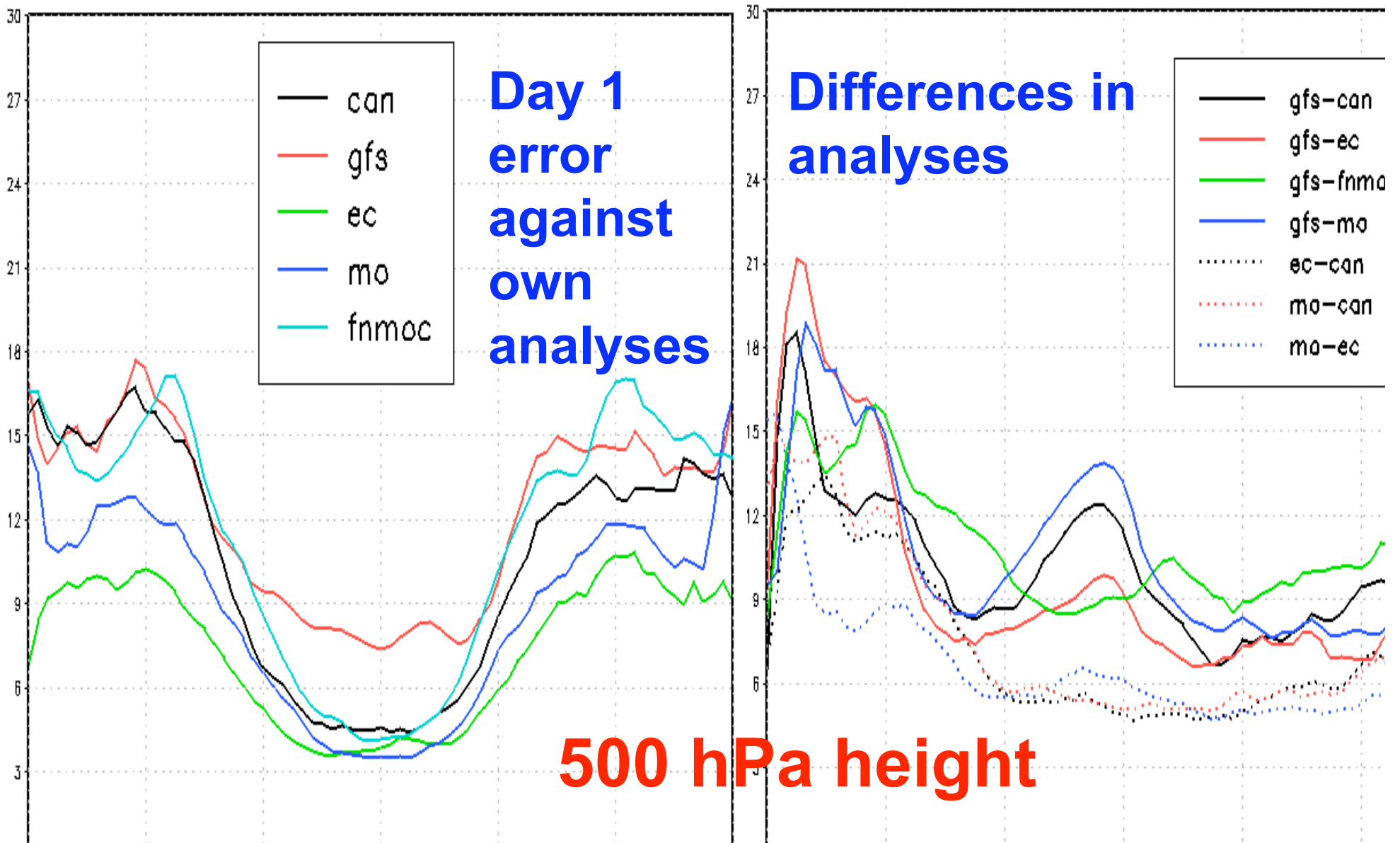
500 hPa height

GFS-Canada   500 hPa height   GFS-ECM
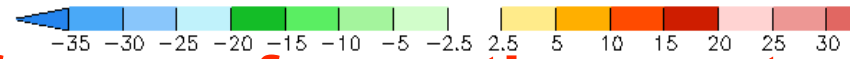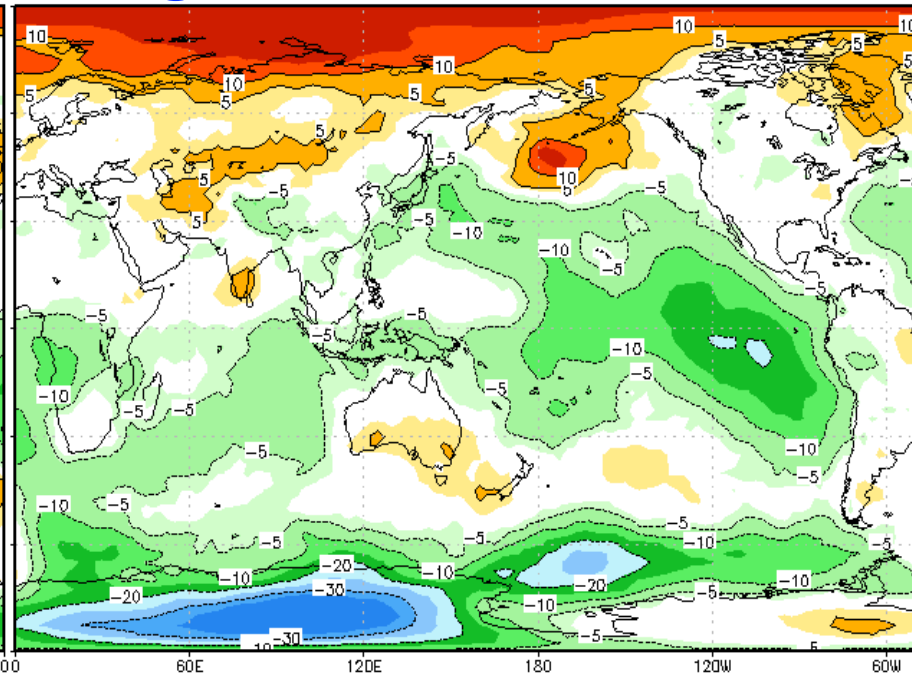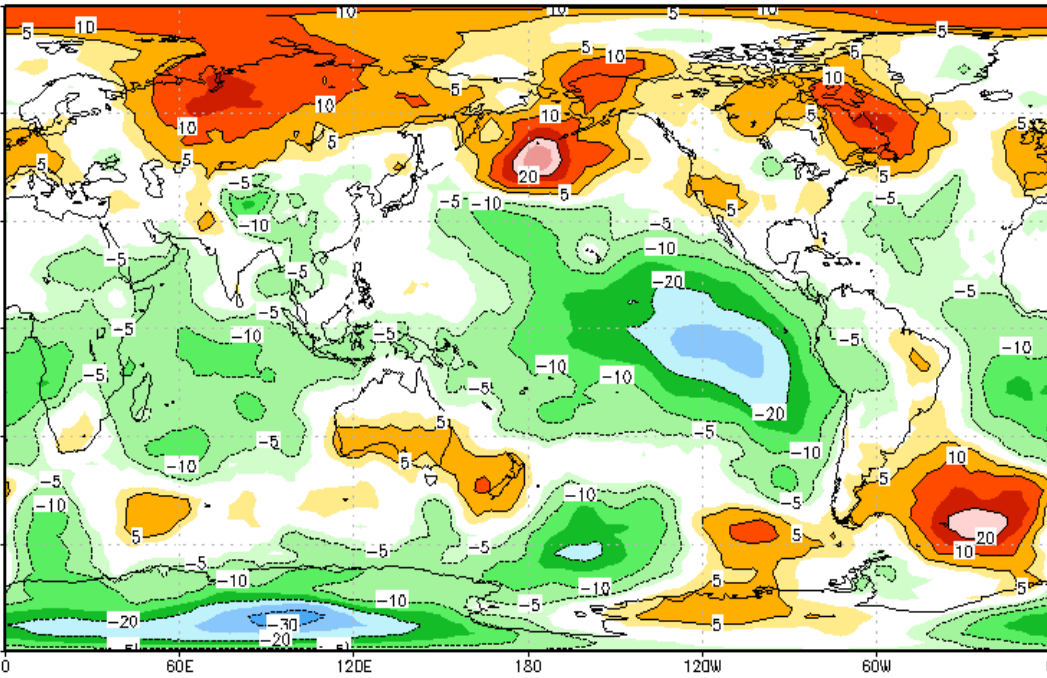
Monthly mean GFS analysis difference from other center

GFS-FNMOC   December 2006   GFS-Met Of
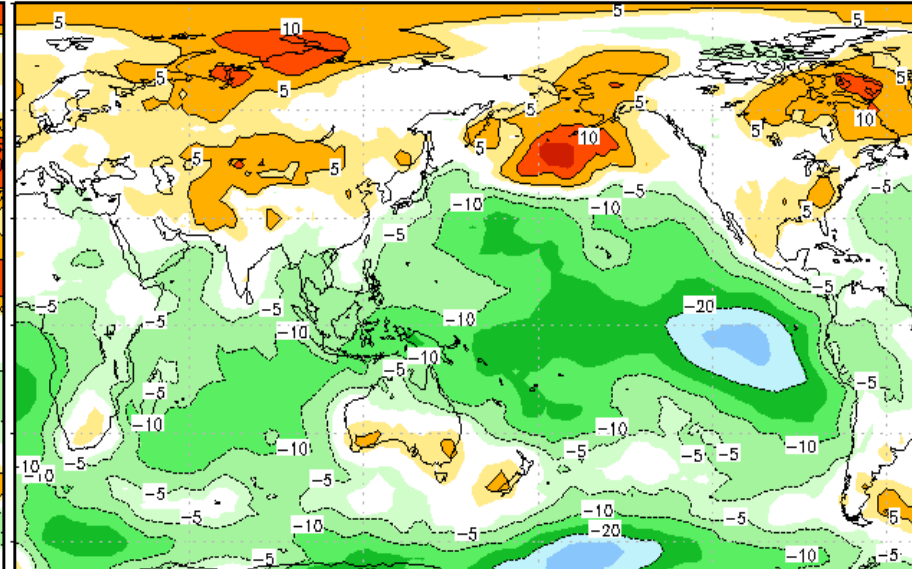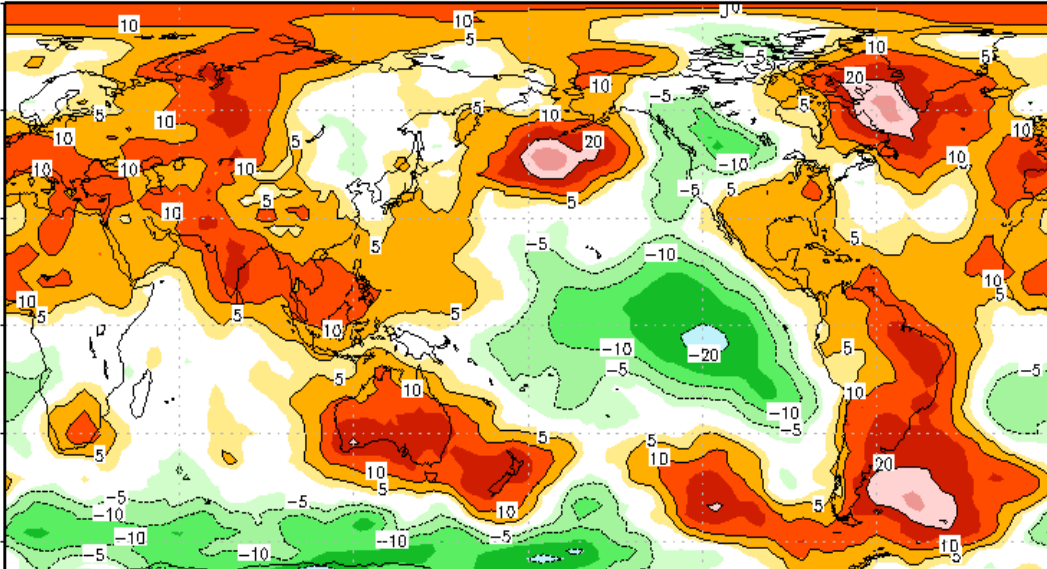
GFS-EC analysis **500 hPa Height** GFS 12hr e
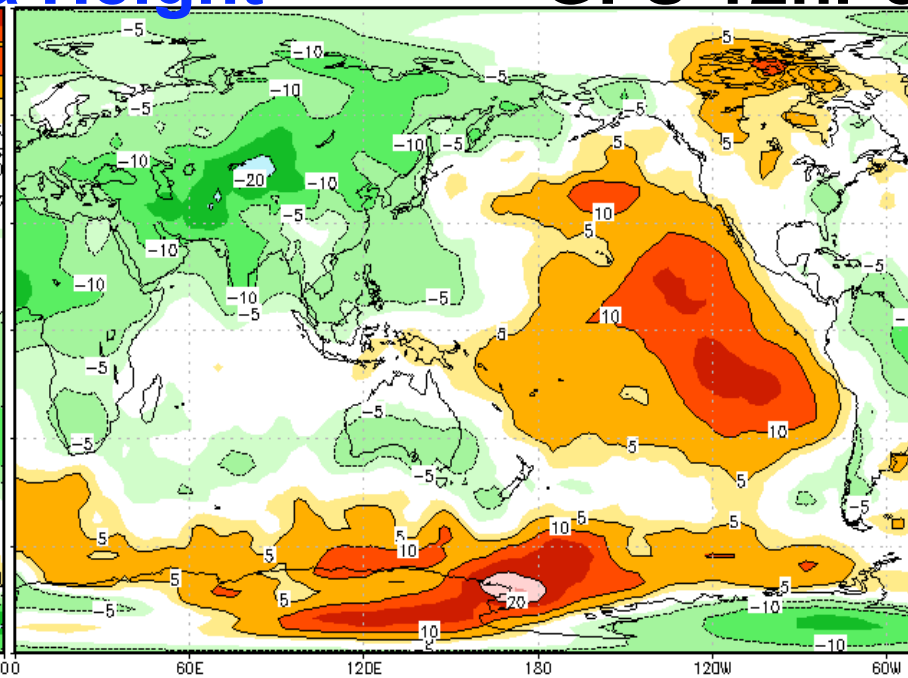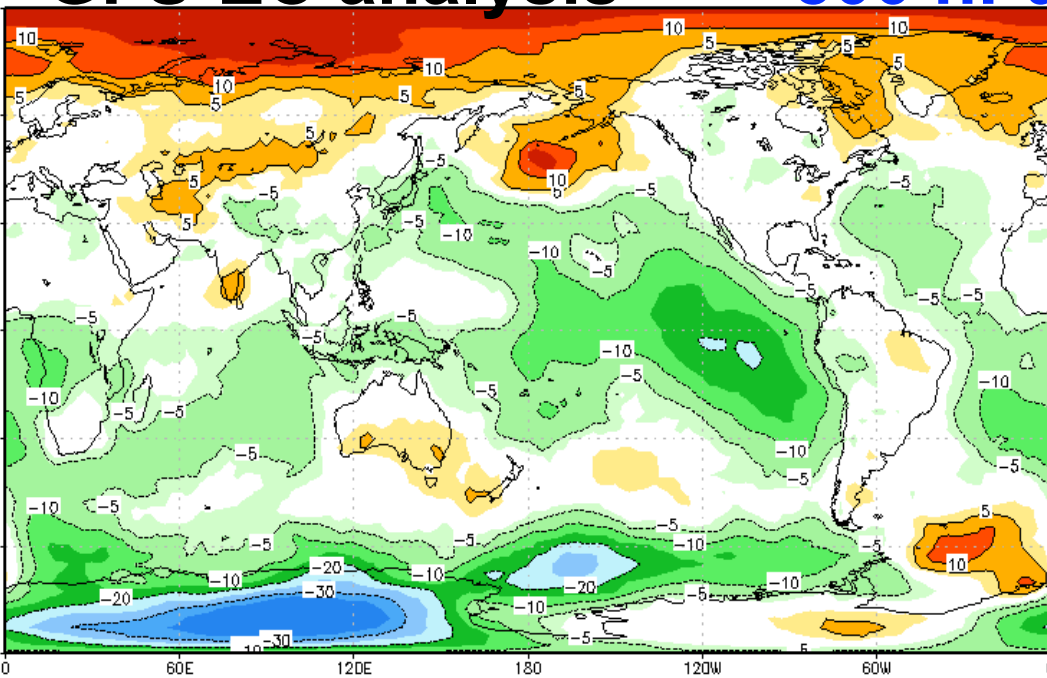
GFS-EC 12 hr RMSE **December 2006** GFS 1day e
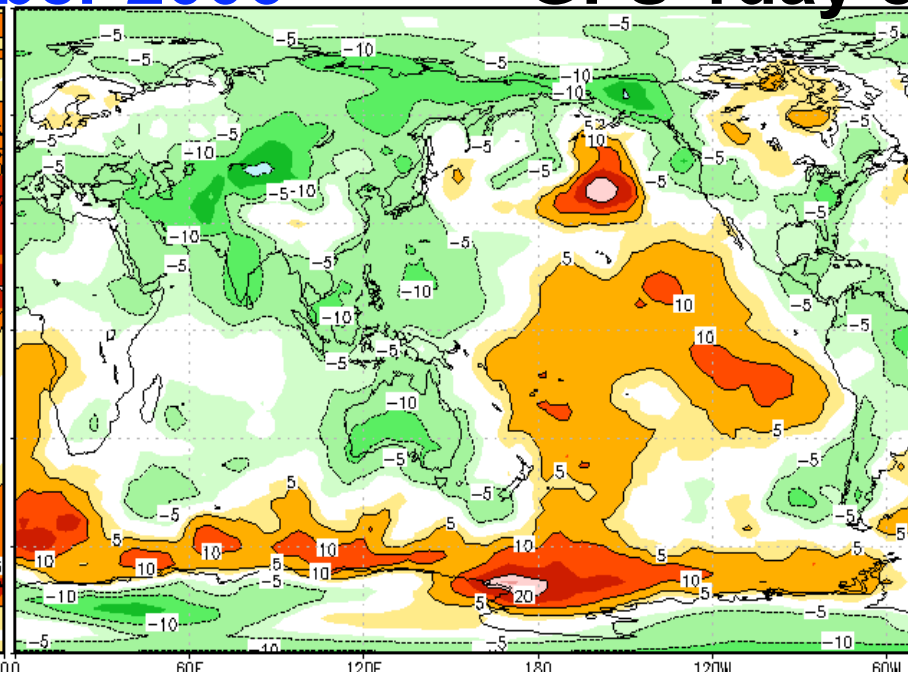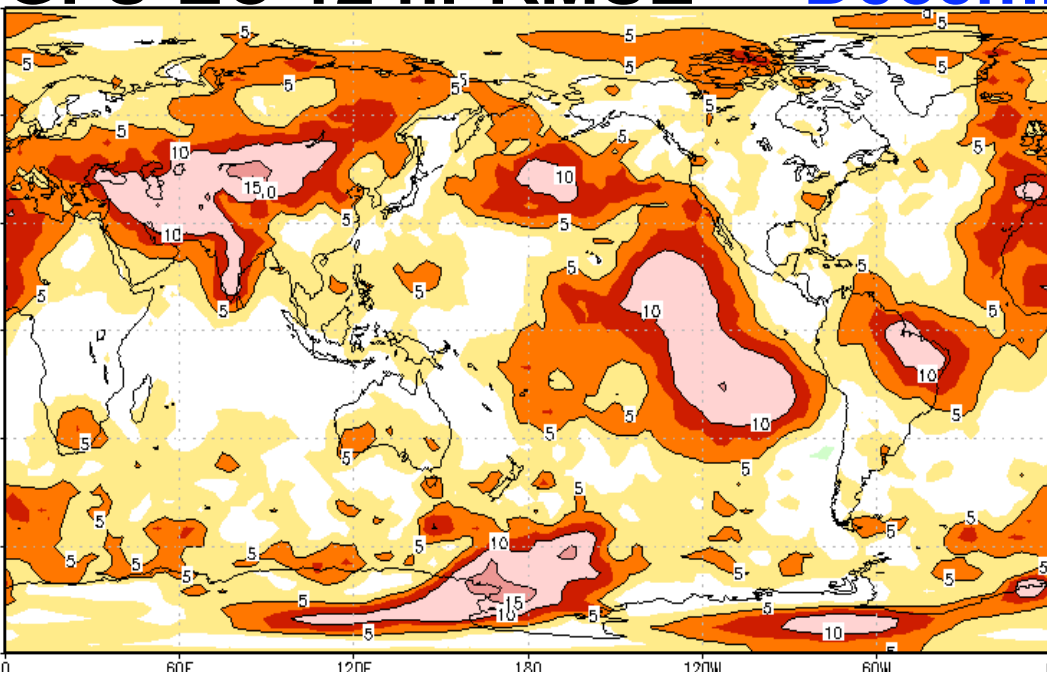
GFS analysis doesn't agree with other centers' analyses

GFS forecast model doesn't agree with GFS analysis

GFS 1 day forecasts try to remove analysis differences from other centers

New GSI analysis appears to agree more with other analyses

GSI/Hybrid

Hope to implement this spring
gridpoint statistical interpolation and
hybrid sigma pressure vertical
coordinate
Grid space definition of background
error
Improved balanced equations
Beats operational GFS at day 1;
day 5 ?

Aug15-Sep7 2006 — **500 hPa height** — *GSI-G*

GSI-GFS
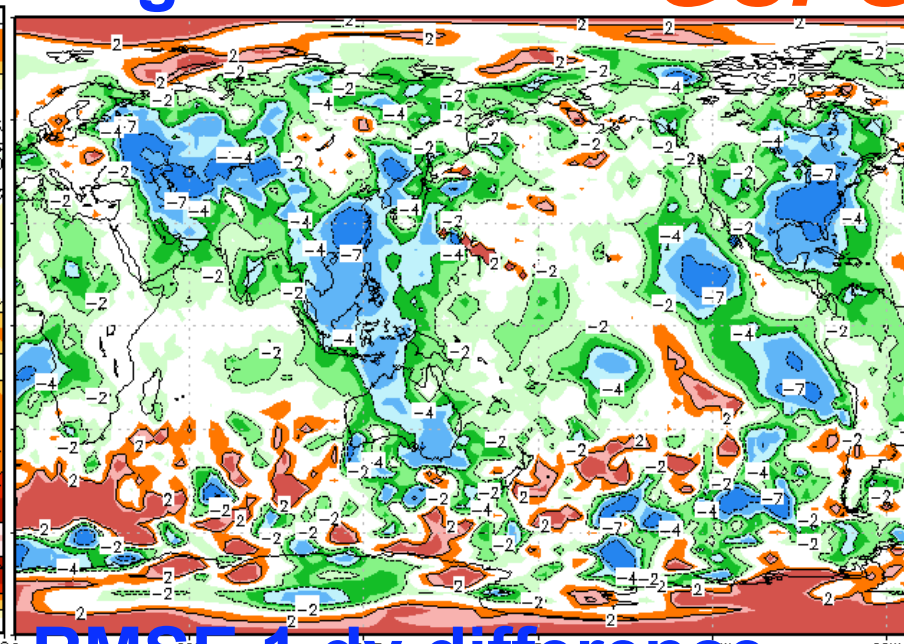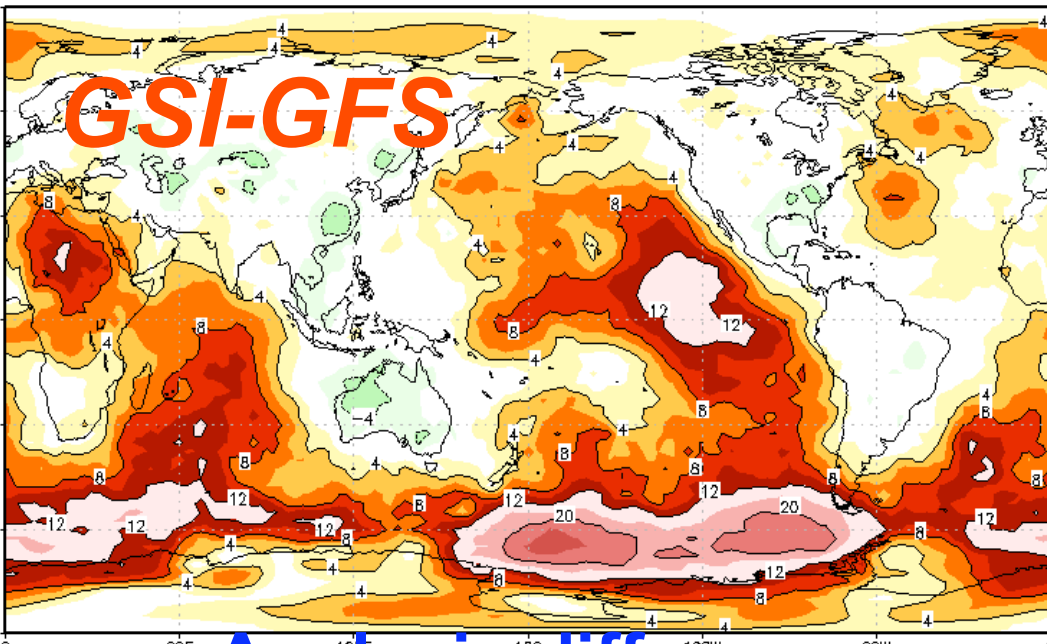
Analysis difference

RMSE 1 dy difference

August 2006 — *GFS-*

GFS-EC

GFS

GSI
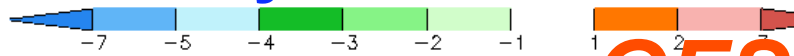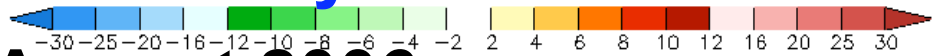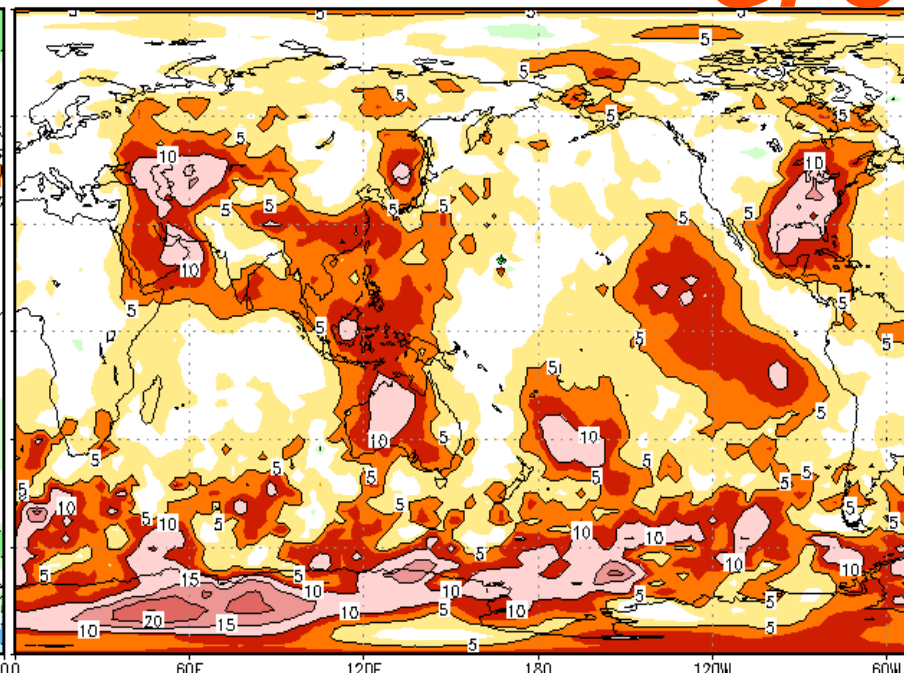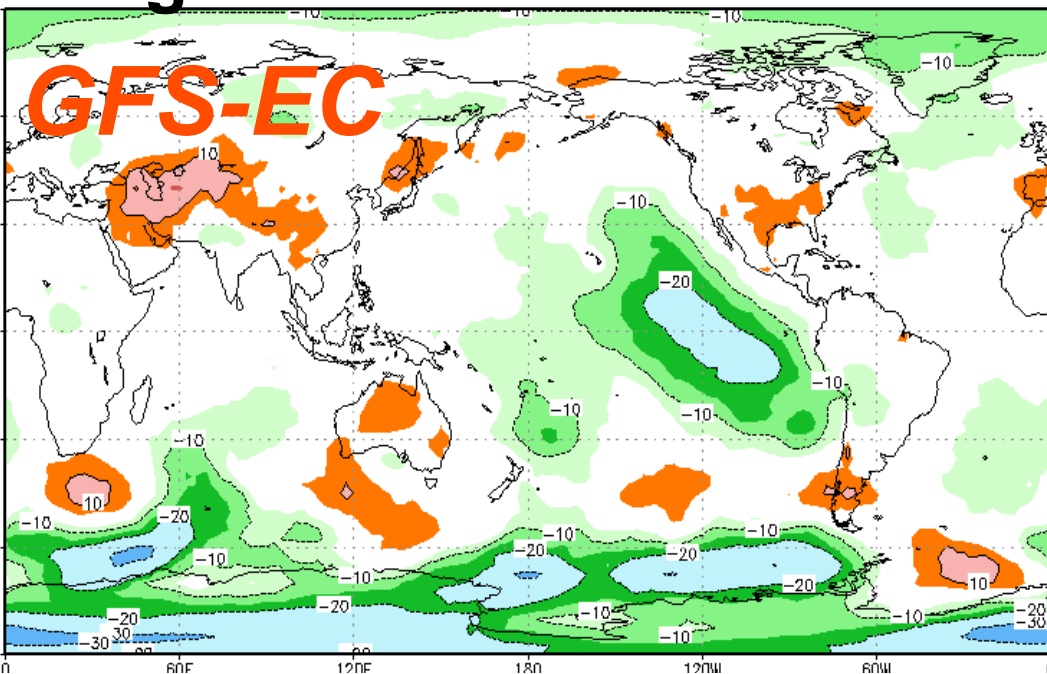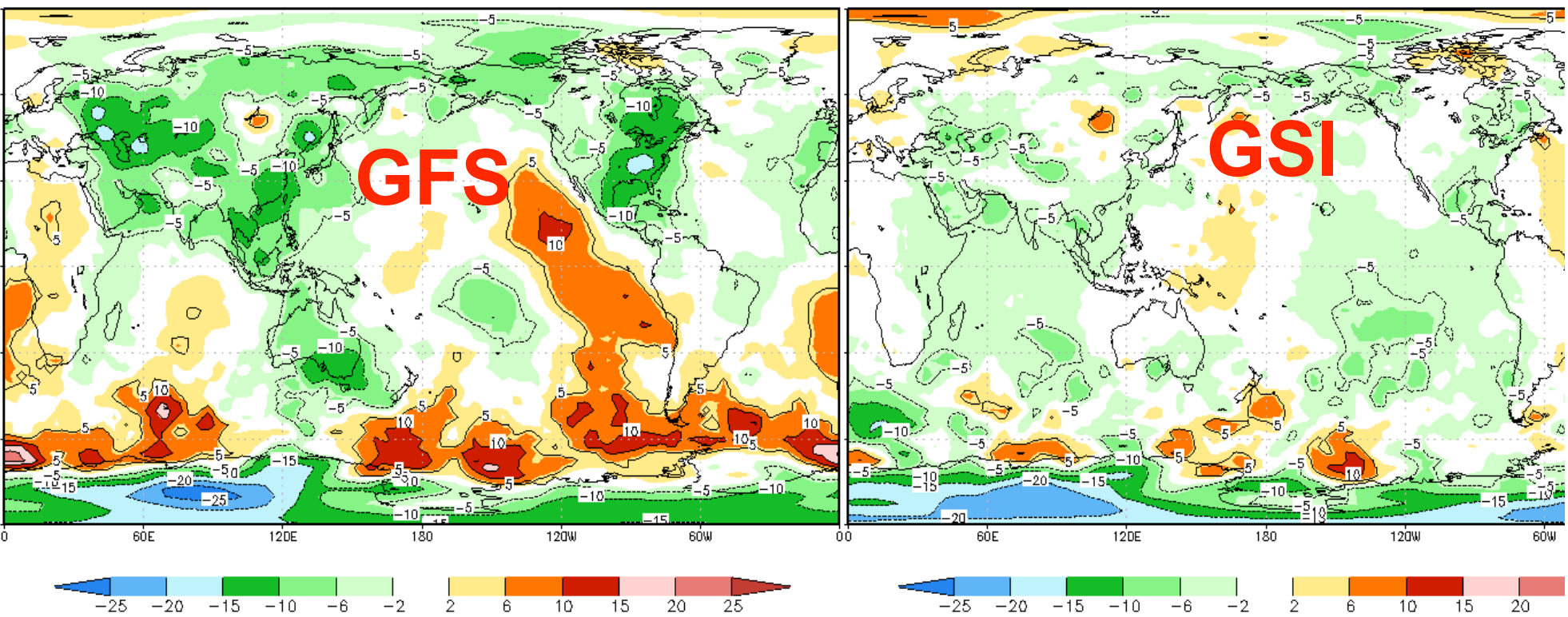
1 day error 500 hPa hgt 500 Aug 15-Sep 7 20[0

New analysis has much less day one err[

Transplant experiments

--EC analyses and forecasts from 000 UT

--GFS analyses and forecasts from 000 UT

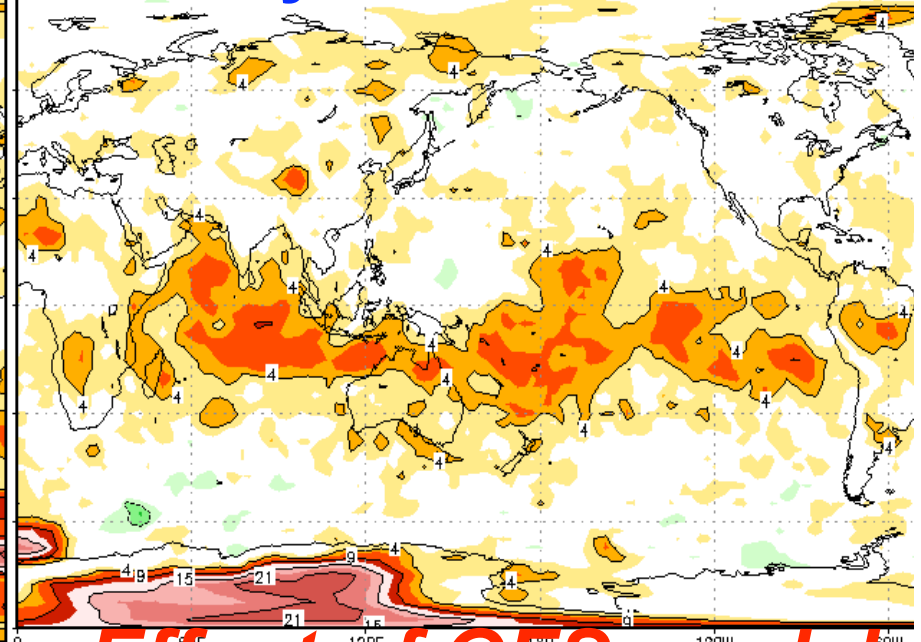*--ECGFS: EC analyses to GFS model from 000 UT (Treat EC analyses as observations*

--EC analyses and forecasts from 1200 UT

--GFS analyses and forecasts from 1200 UT

--GFSEC: GFS analyses to EC model from 1200 UT

--Are differences due to analysis or model?

GFS minus ECGFS effect of GFS assimilation

GFS-EC
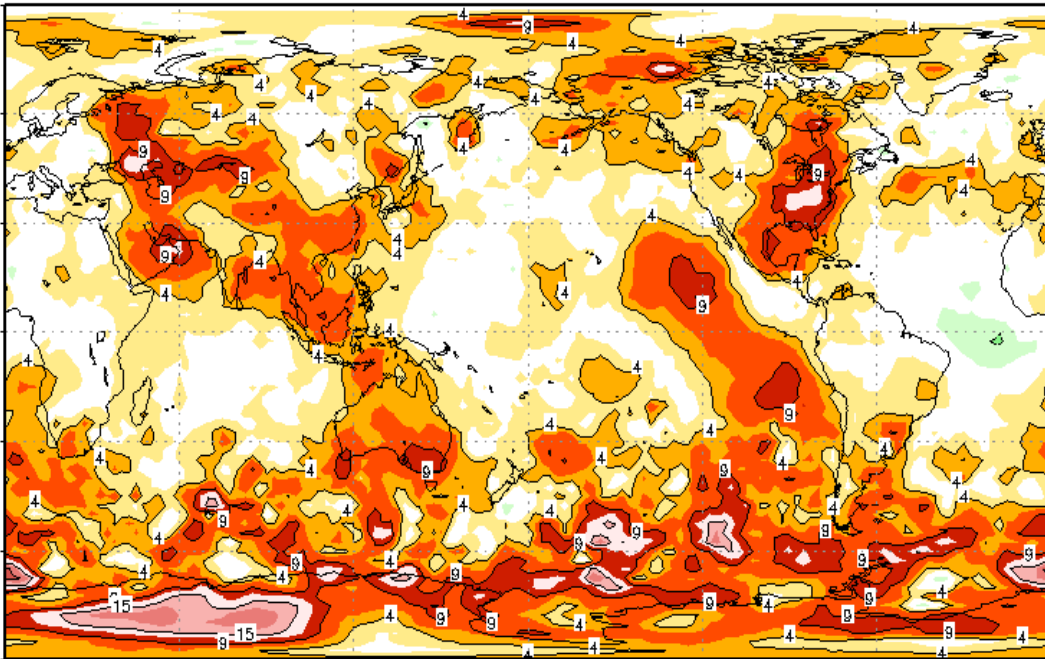
EC analysis GFS model-EC

Effect of GFS model

| −15 | −12 | −9 | −6 | −4 | −2 | 2 | 4 | 6 | 9 | 12 | 15 | 18 | 21 |

GFS-EC analysis GFS model

RMSE 1 dy 500 height Aug 2006

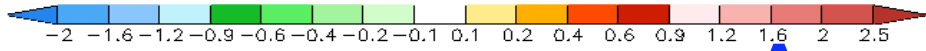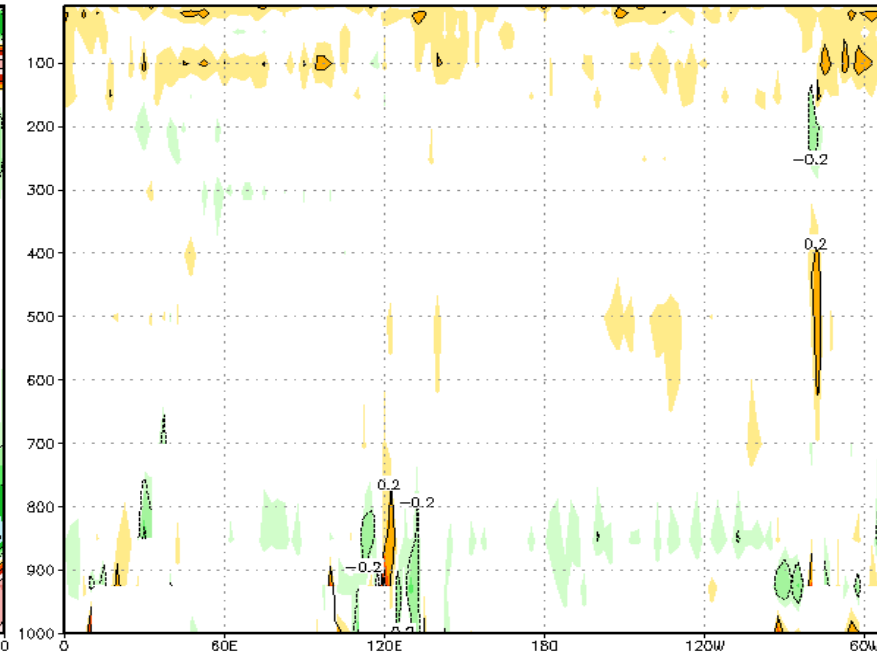*Much of day 1 error in 500 hPa height in GFS appears to come from GFS assimilation, not from GFS model*
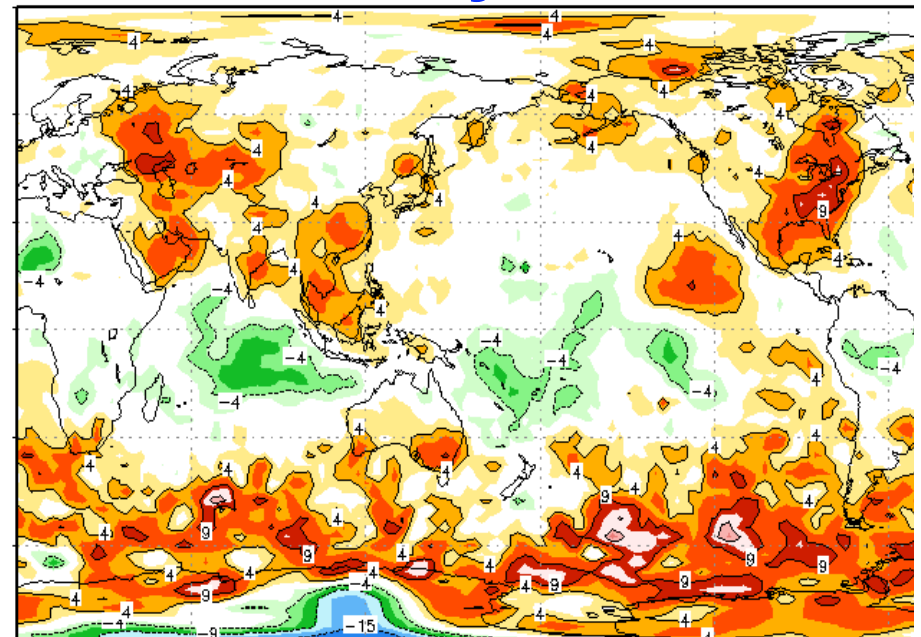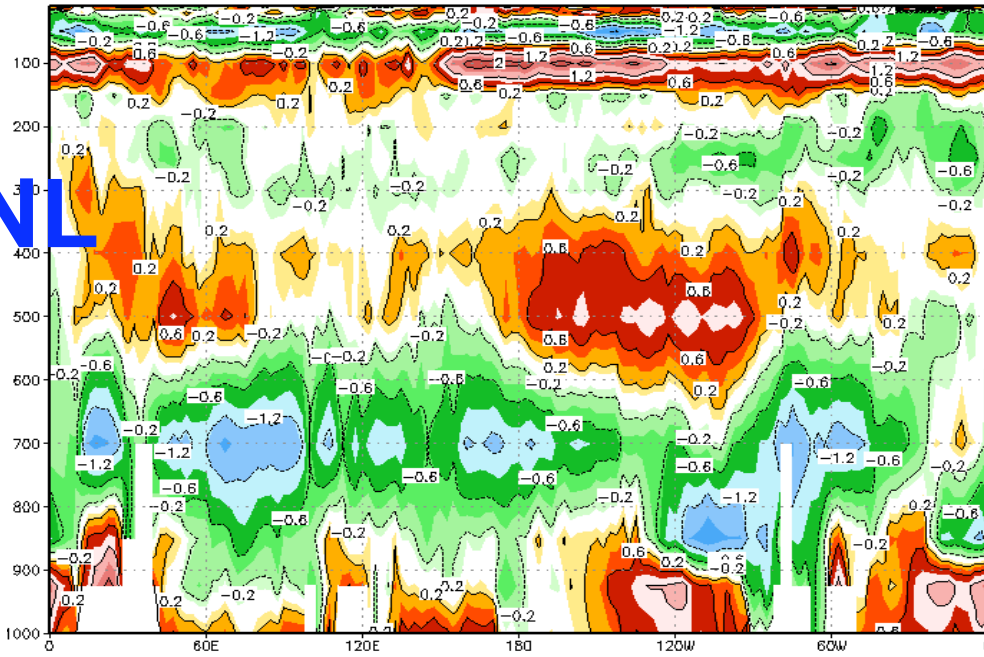
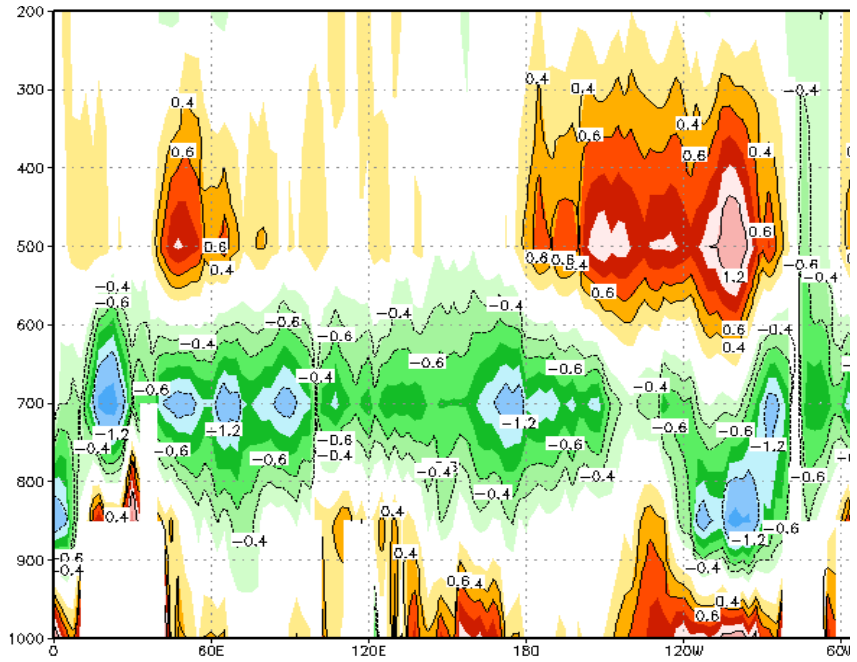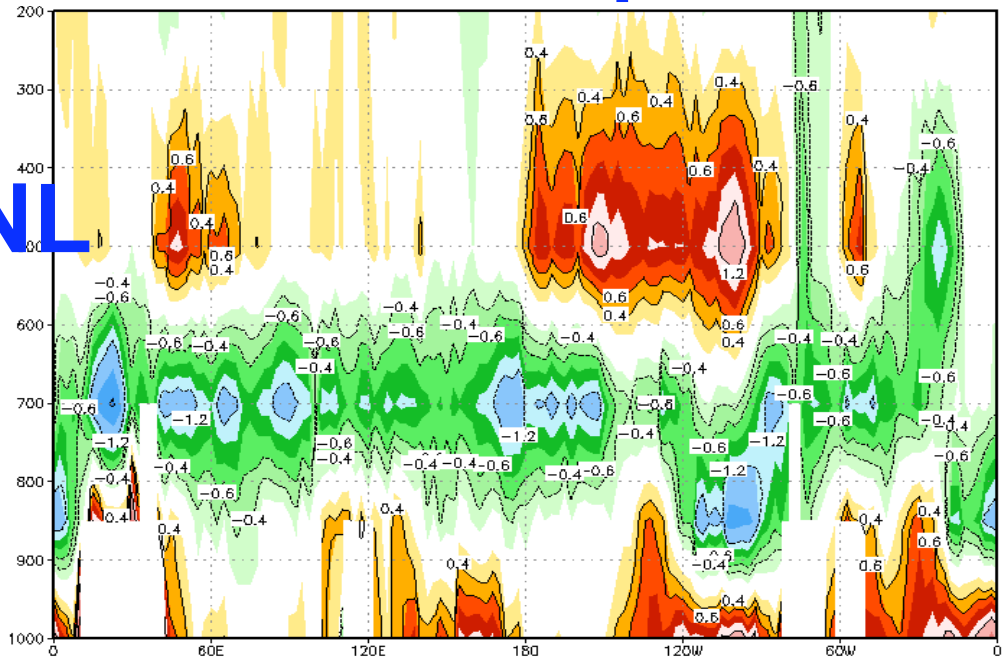GFS-EC T equator EC analysis GFS model

ANL
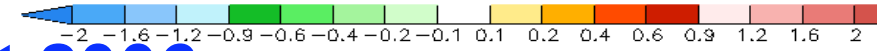
1day

August 2006
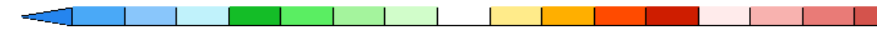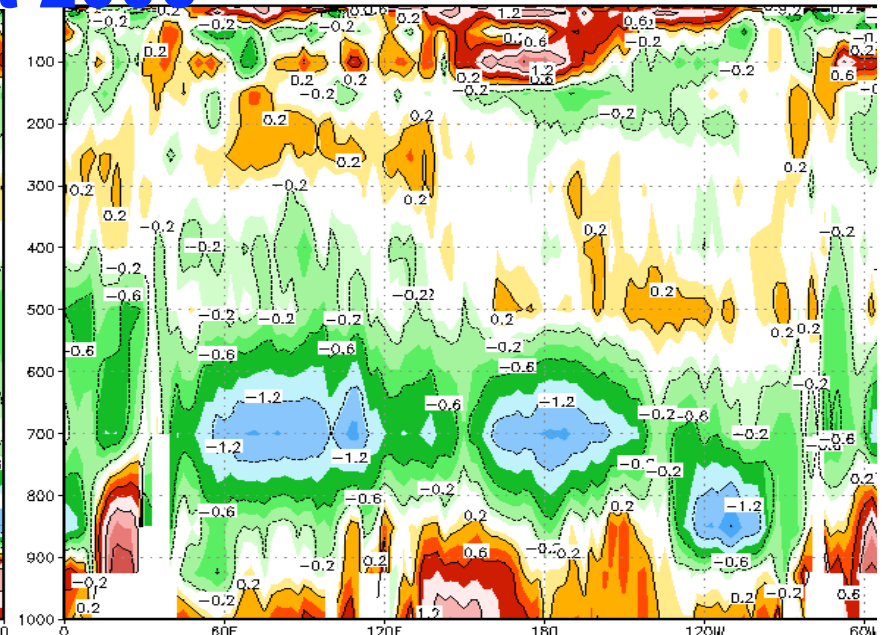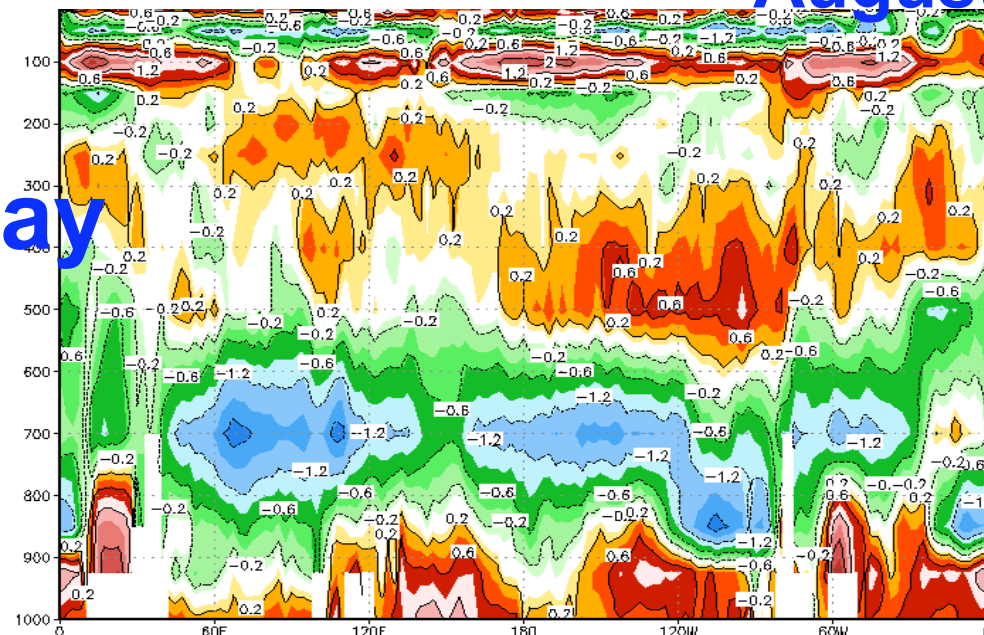
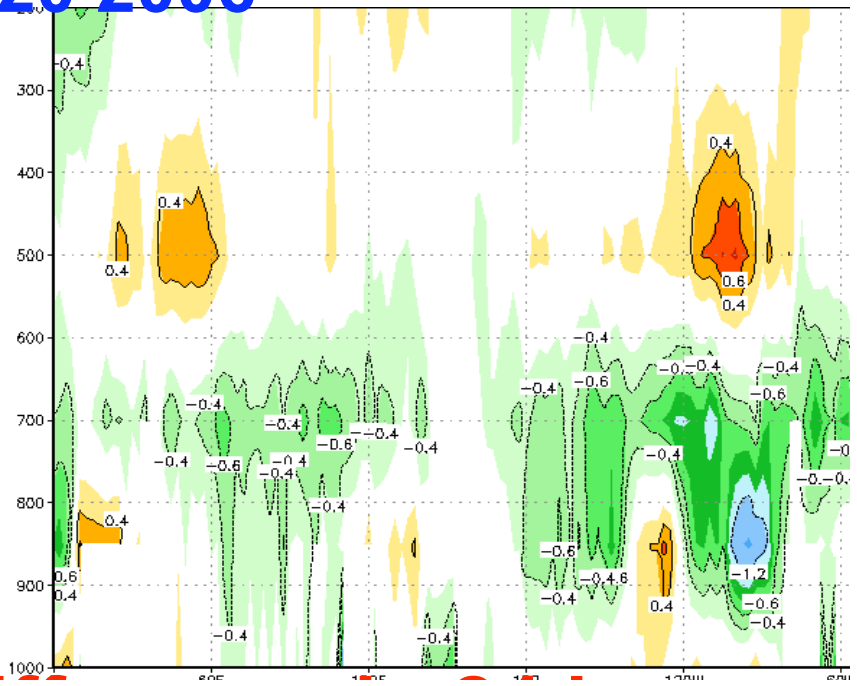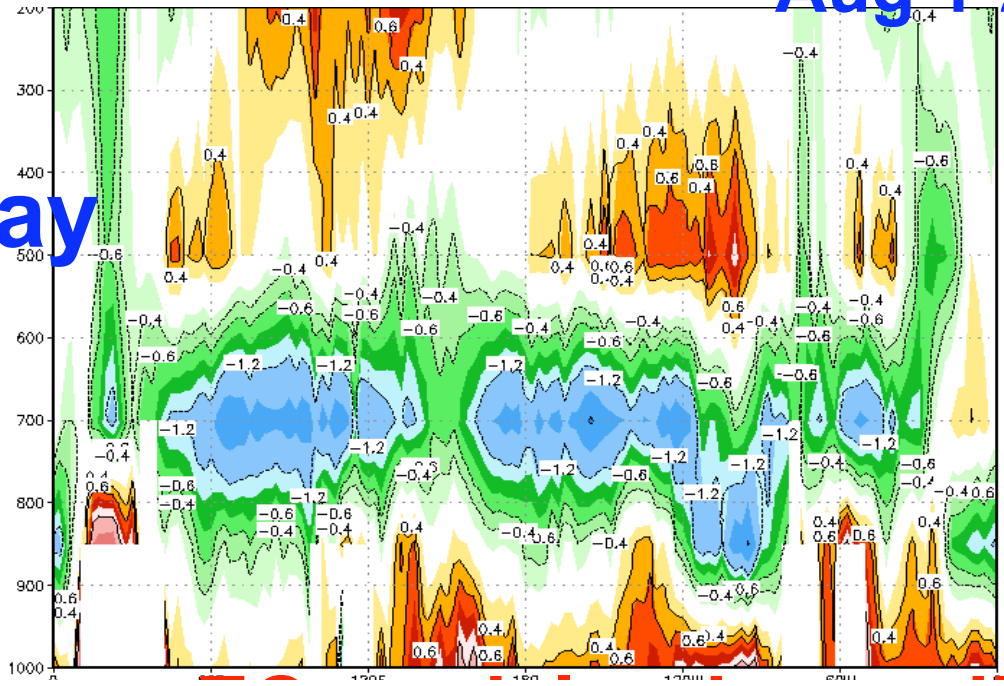GFS-EC   T equator   GFS analysis EC model

ANL

1day

Aug 1-20 2006

--Differences in height appear largely due to assimilation

--Differences in equatorial temperature structure reflect model differences

--Examination of short-range errors can help identify specific problems; need to determine whether assimilation or model to blame

--Reducing day 1 errors *MAY* reduce medium range errors