

**Hybrid Wind Stress Anomalies and Their Impacts
on the Global HYCOM Simulations ?**

By

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MOTIVATION

- **0.72° Global HYCOM**
 - **Climatologically–forced simulations**
 - **ECMWF wind stress anomalies for various periods**
- **Impact of different anomaly periods on global simulations**
 - **Sea surface temperature (SST)**
 - **Mixed layer depth (MLD)**
 - **For Atlantic only and global ocean:**
 - **Depth of max. of overturning streamfunction**
 - **Max. transport of overturning streamfunction**

WIND STRESS ANOMALIES

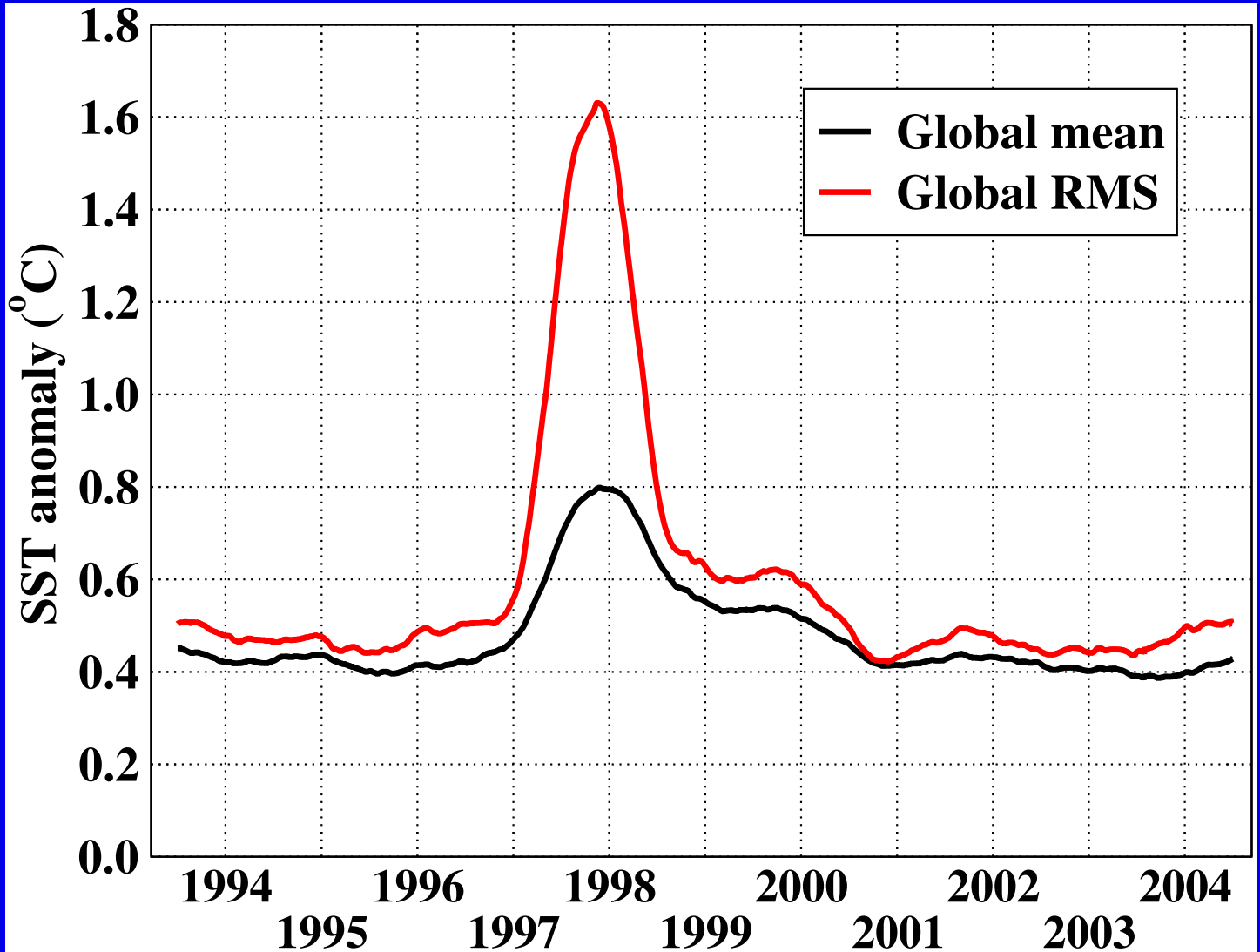
- We would like to use a time period,
- representing a **climatological normal year**:
- For historical reasons HYCOM used: Sep94–Sep95
- Other candidate time periods
 - Sep95–Sep96
 - Apr97–Apr98
 - Jan98–Jan99
 - Aug00–Aug01
 - Aug01–Aug02

The question is:

Which time interval for wind stress anomalies
is appropriate for realistic HYCOM simulations?

First, why did we choose those time periods above?

SST ANOMALY OVER THE GLOBAL OCEAN



- Use daily MODAS SSTs from 1993 through 2004
- Form daily anomalies (Interannual- Climatology)
- Calculate square of anomaly fields
- Apply 1-year running average

Note that we also selected the 1997–98 ENSO period.

A MOVIE FOR WIND ANOMALIES

- **Use ECMWF wind stresses**
- **6 hourly anomalies added to monthly means**
- **This is done for each time period**
- **A movie of wind speed**
 - **at each 6 hour time intervals**

GLOBAL HYCOM DESCRIPTION

- **0.72° fully global model**
 - 0.36° near equator
 - Arctic bipolar patch
- **26–layer HYBRID**
- **Initialization: Navy GDEM3 T/S climatology**
- **Monthly river discharge from NRL database**
- **Sea surface salinity relaxation to monthly PHC**

PHC: Polar science center Hydrographic Climatology

Atmospheric forcing is from ERA–15

- **Bulk formulation for sensible and latent heat fluxes**
- **Shortwave and longwave radiation from ERA–15**
- **Water turbidity based on SeaWiFS ocean color data**

HYCOM SIMULATIONS

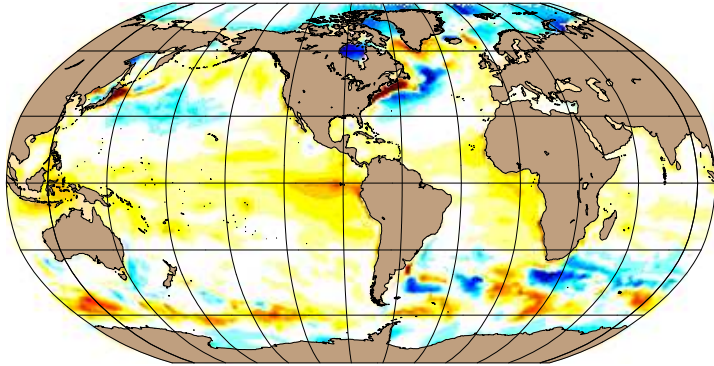
- Use KPP mixed layer model
- Perform climatologically–forced simulations

There is NO data assimilation or relaxation to SST climatology

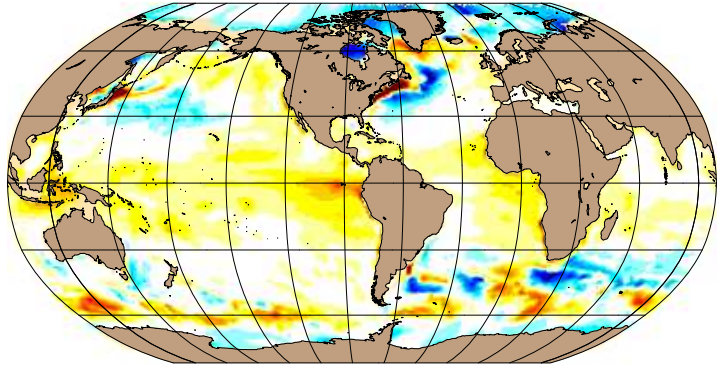
- All simulations are identical except wind anomalies

ANNUAL MEAN HYCOM SST BIAS

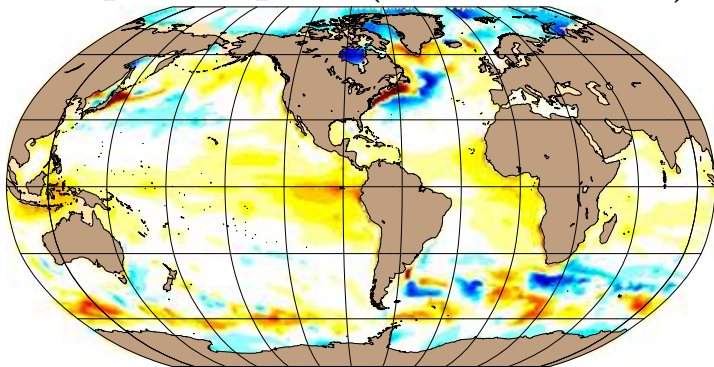
Sep94–Sep95 (BIAS = 0.4°C)



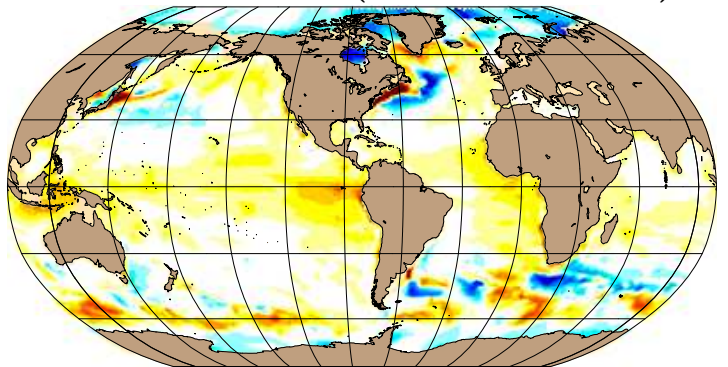
Feb95–Feb96 (BIAS = 0.4°C)



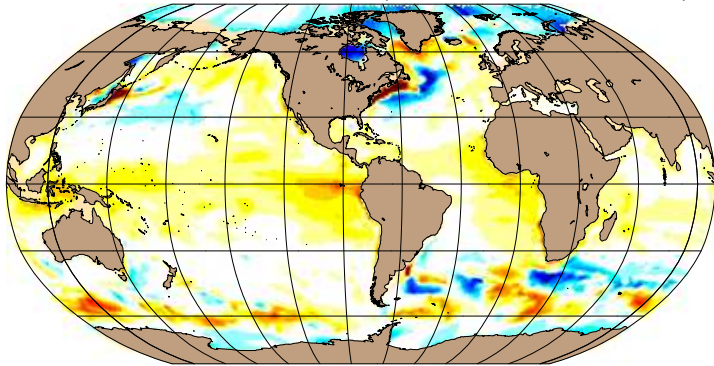
Apr97–Apr98 (BIAS = 0.4°C)



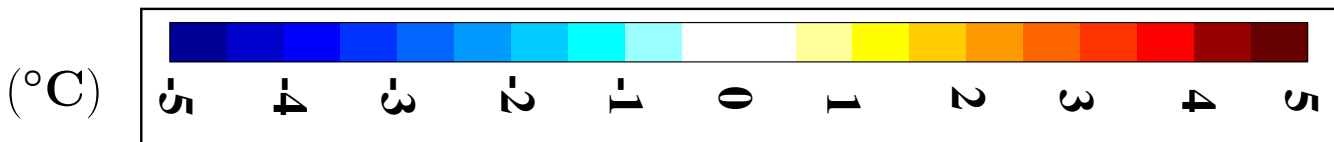
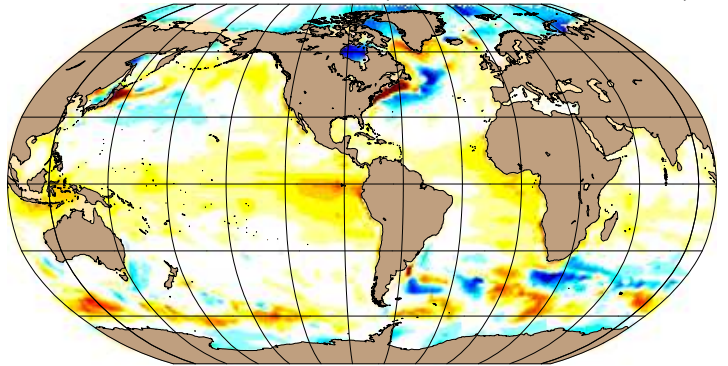
Jan98–Jan99 (BIAS = 0.4°C)



Aug00–Aug01 (BIAS = 0.4°C)



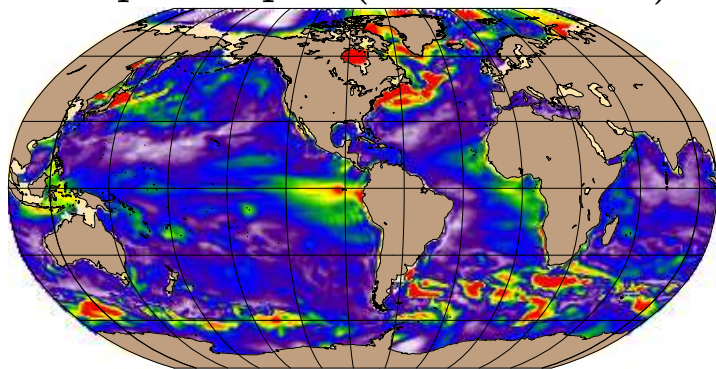
Aug01–Aug02 (BIAS = 0.4°C)



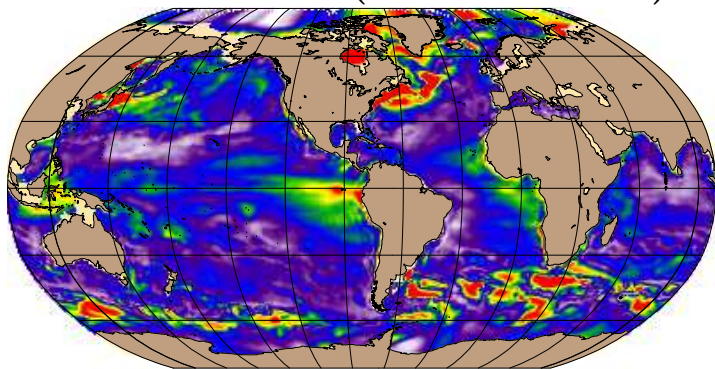
HYCOM bias is with respect to NOAA SST climatology

RMS DIFFERENCE: HYCOM vs NOAA SST

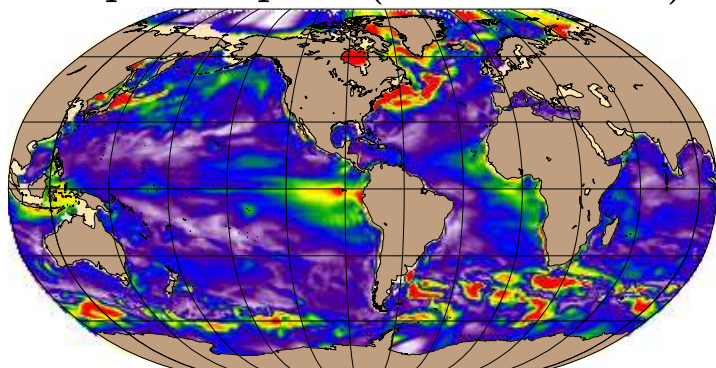
Sep94–Sep95 (RMS = 0.9°C)



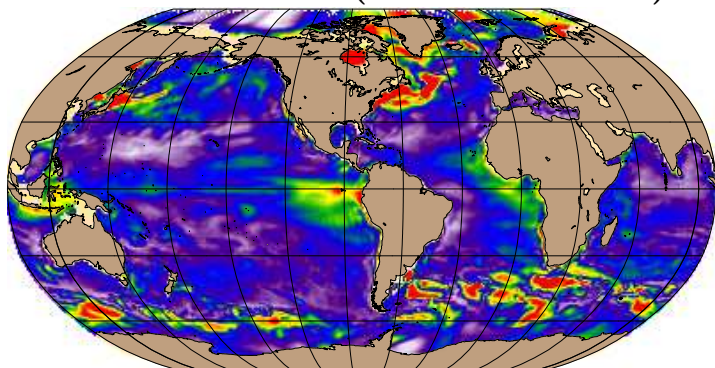
Feb95–Feb96 (RMS = 0.9°C)



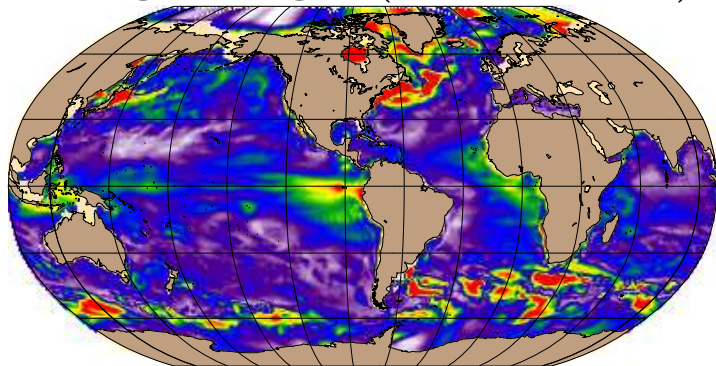
Apr97–Apr98 (RMS = 0.9°C)



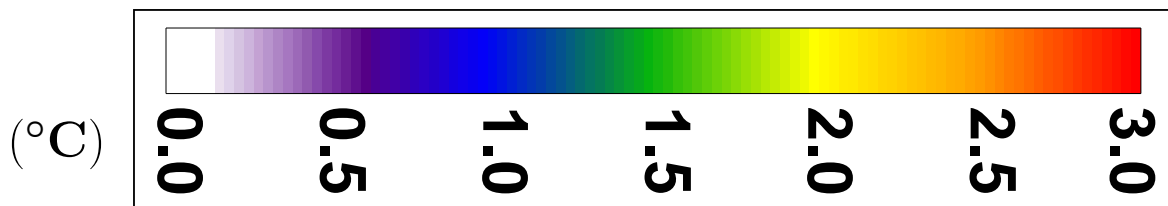
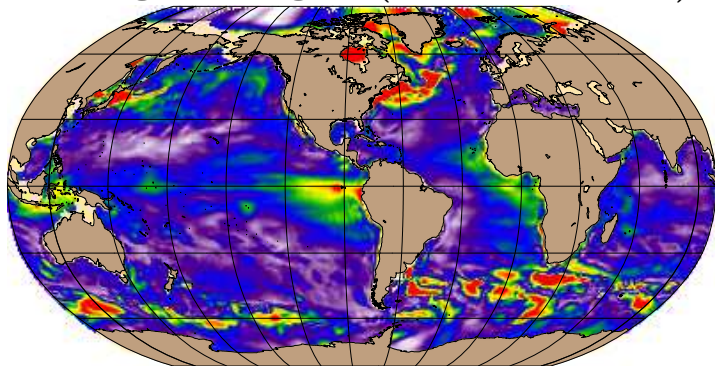
Jan98–Jan99 (RMS = 0.9°C)



Aug00–Aug01 (RMS = 0.9°C)



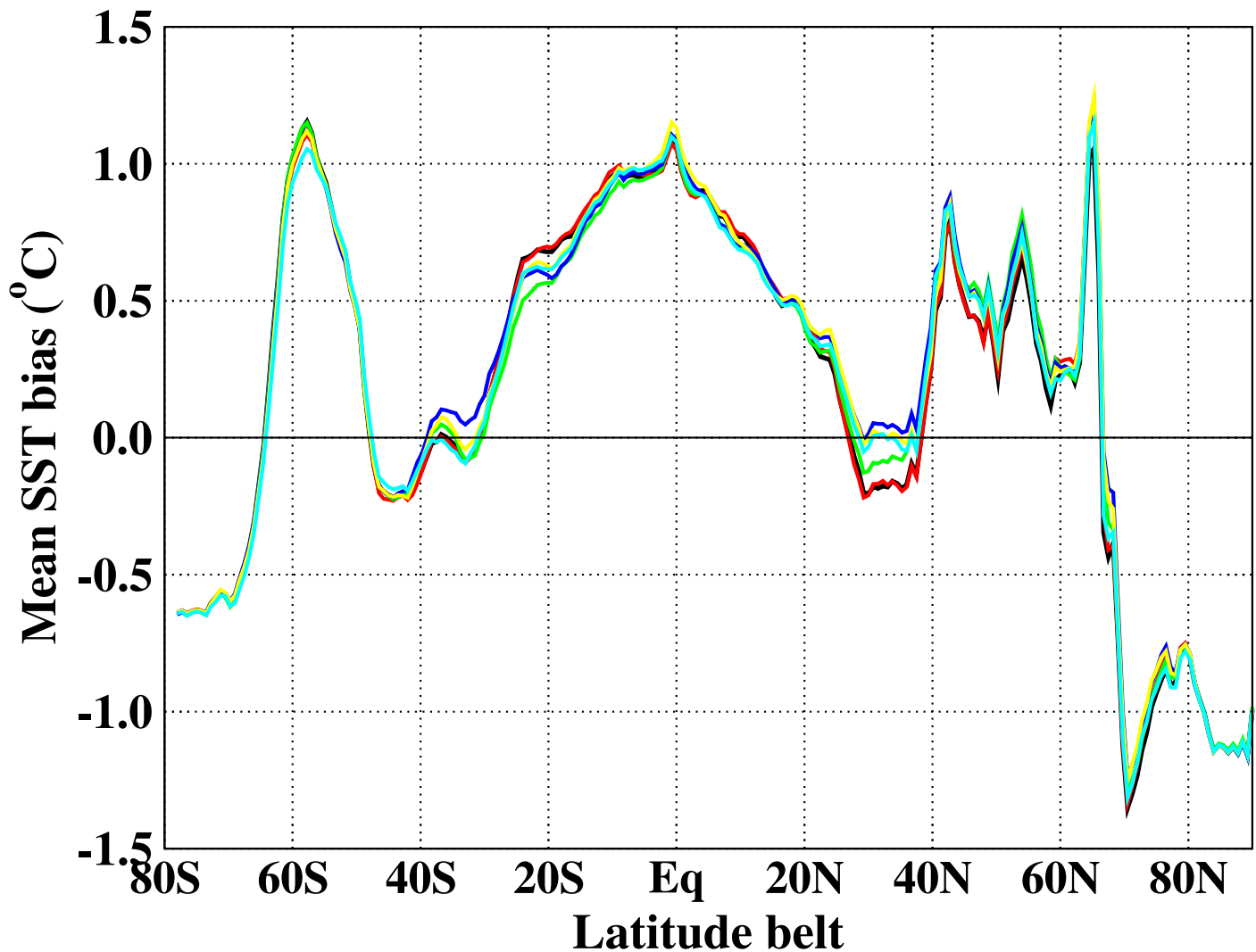
Aug01–Aug02 (RMS = 0.9°C)



RMS is calculated over the seasonal cycle

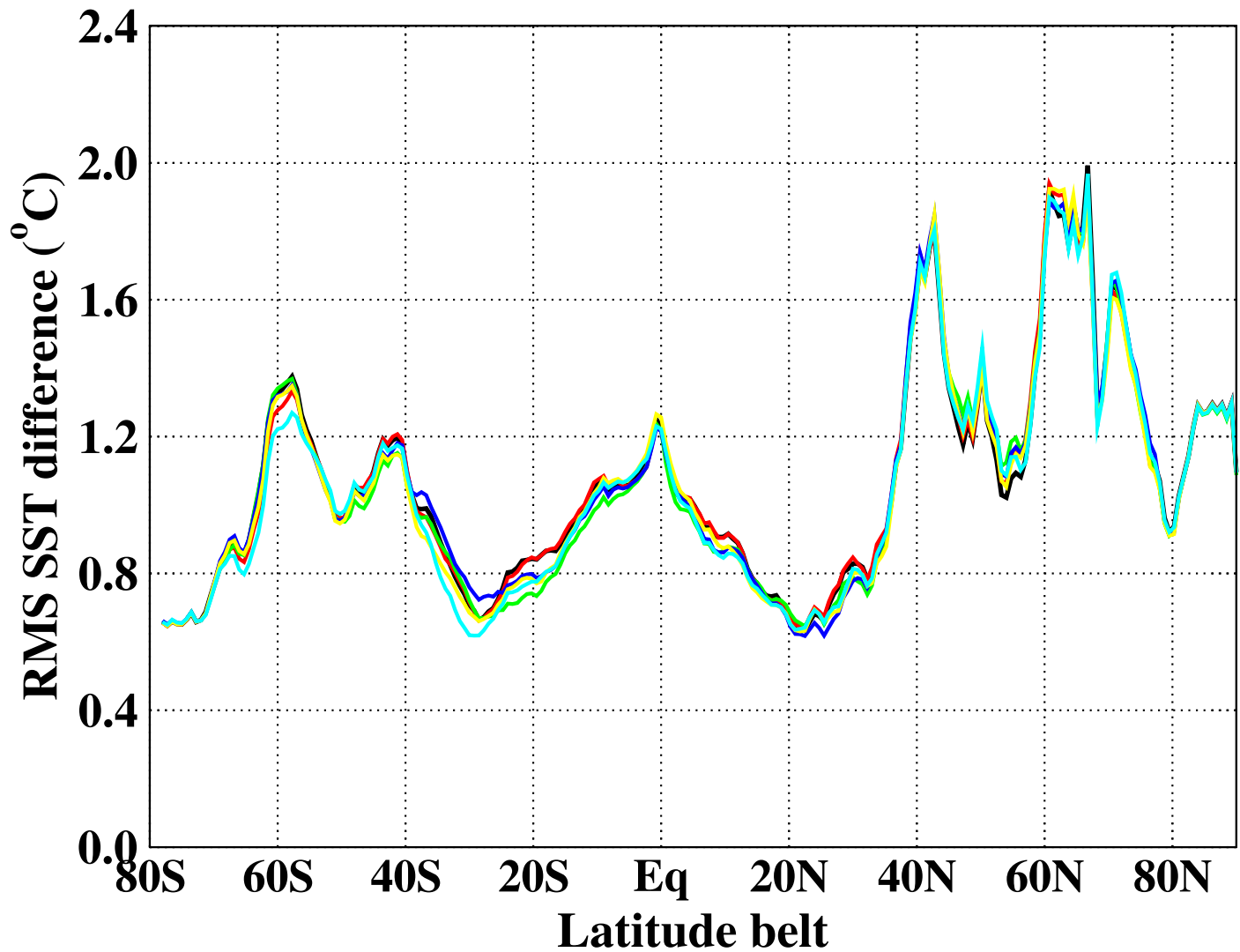
ZONAL AVERAGES FOR SST BIAS

- (1): *standard simulation: Sep94 - Sep95*
- (2): **twin of (1) but Sep95 - Sep96**
- (3): **twin of (1) but Apr97 - Apr98**
- (4): **twin of (1) but Jan98 - Jan99**
- (5): **twin of (1) but Aug00 - Aug01**
- (6): **twin of (1) but Aug01 - Aug02**

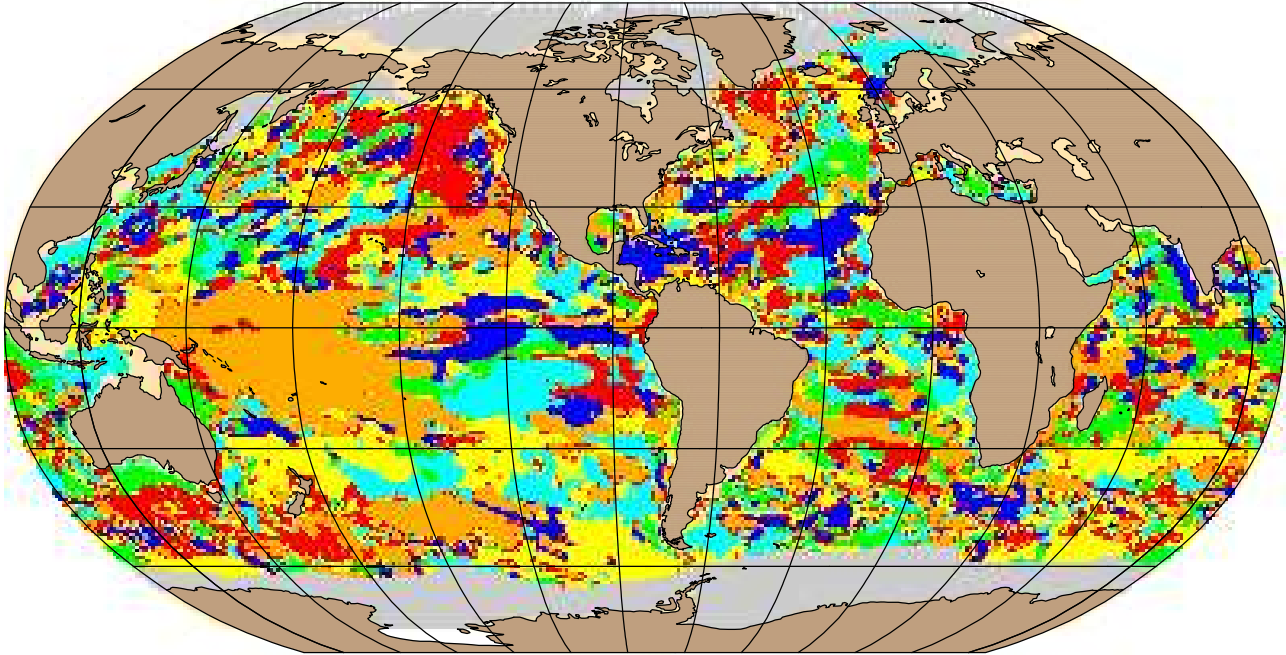


ZONAL AVERAGES FOR RMS DIFFERENCES

- (1): *standard simulation: Sep94 - Sep95*
- (2): **twin of (1) but Sep95 - Sep96**
- (3): **twin of (1) but Apr97 - Apr98**
- (4): **twin of (1) but Jan98 - Jan99**
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- (6): **twin of (1) but Aug01 - Aug02**



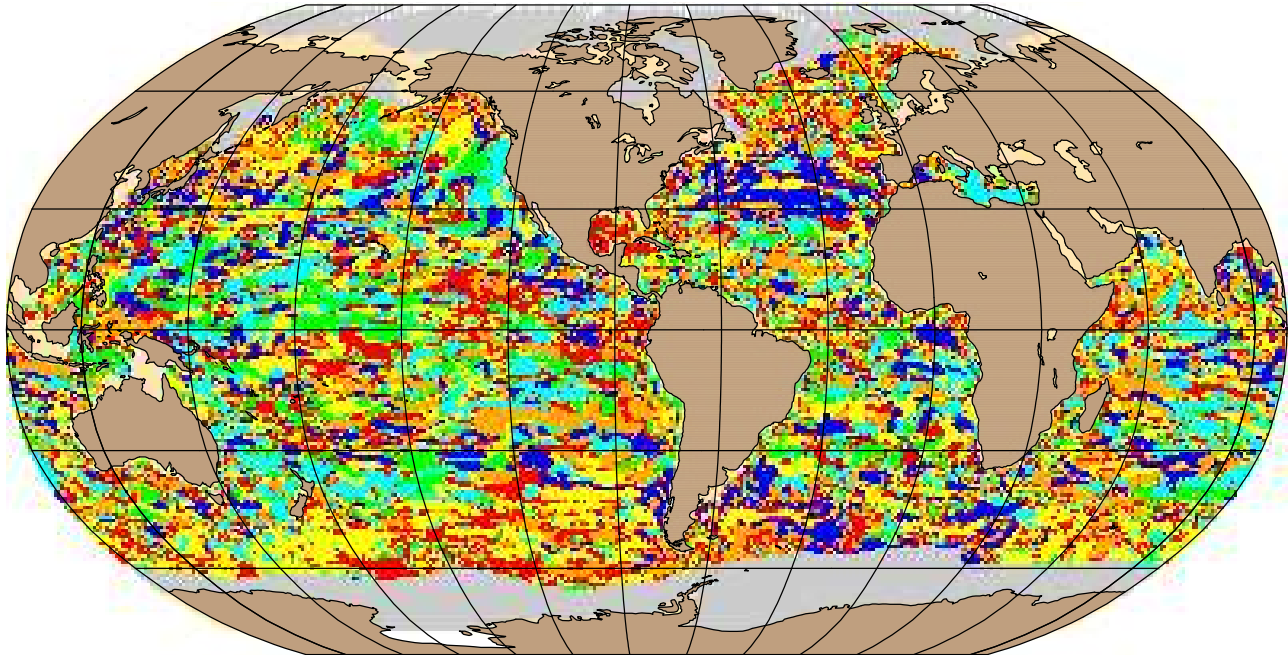
LOWEST RMS SST DIFFERENCES



Percentage of global ocean coverage:

Anomaly	Percentage	Rank
Sep94-95	14.2%	4
Feb95-96	12.1%	6
Apr97-98	22.6%	1!!
Jan98-99	13.7%	5
Aug00-01	17.9%	3
Aug01-02	19.5%	2

LOWEST RMS MIXED LAYER DEPTH DIFFERENCES

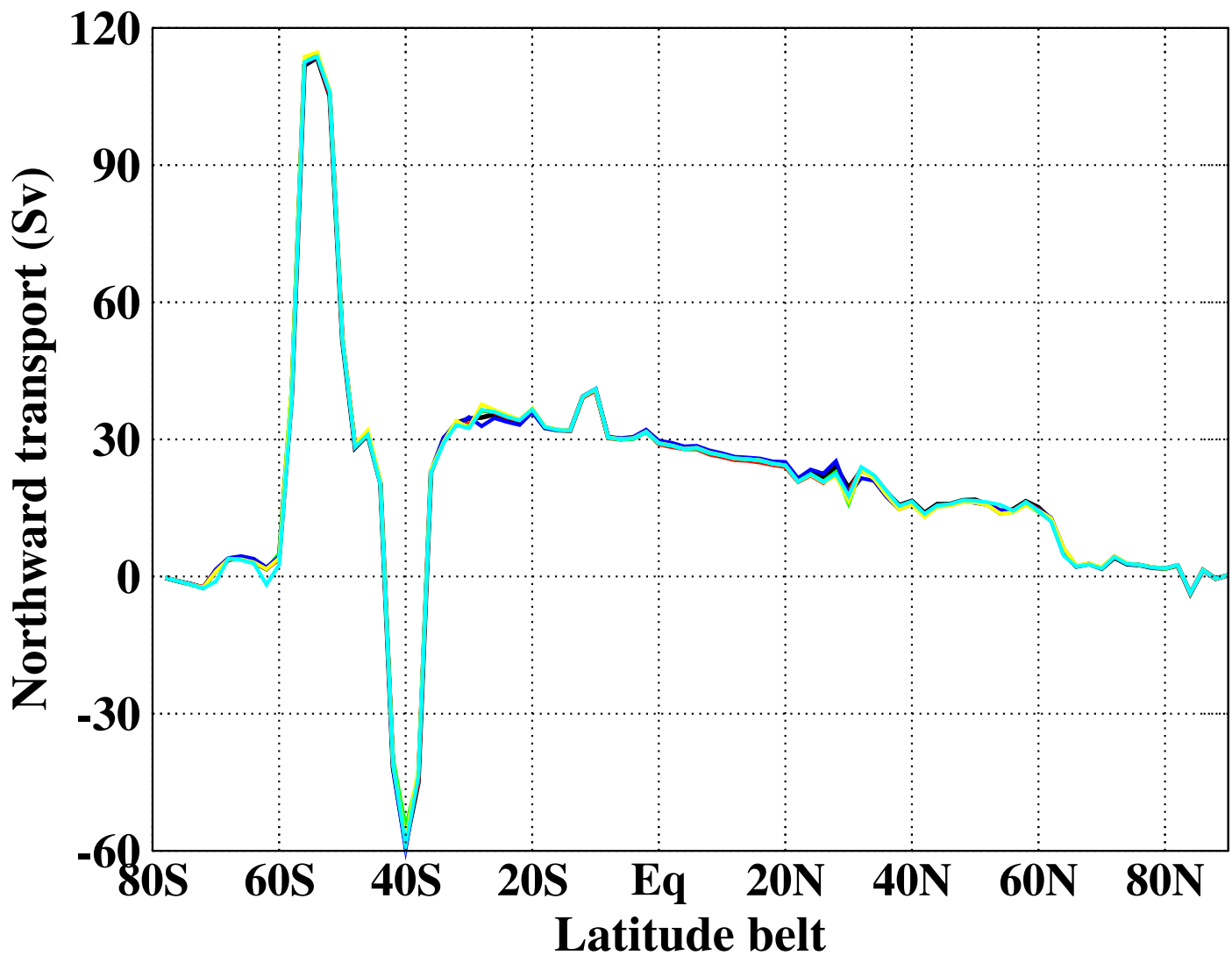


Percentage of global ocean coverage:

Anomaly	Percentage	Rank
Sep94-95	12.3%	6
Feb95-96	13.5%	5
Apr97-98	17.3%	4
Jan98-99	17.7%	3
Aug00-01	19.0%	2
Aug01-02	20.2%	1

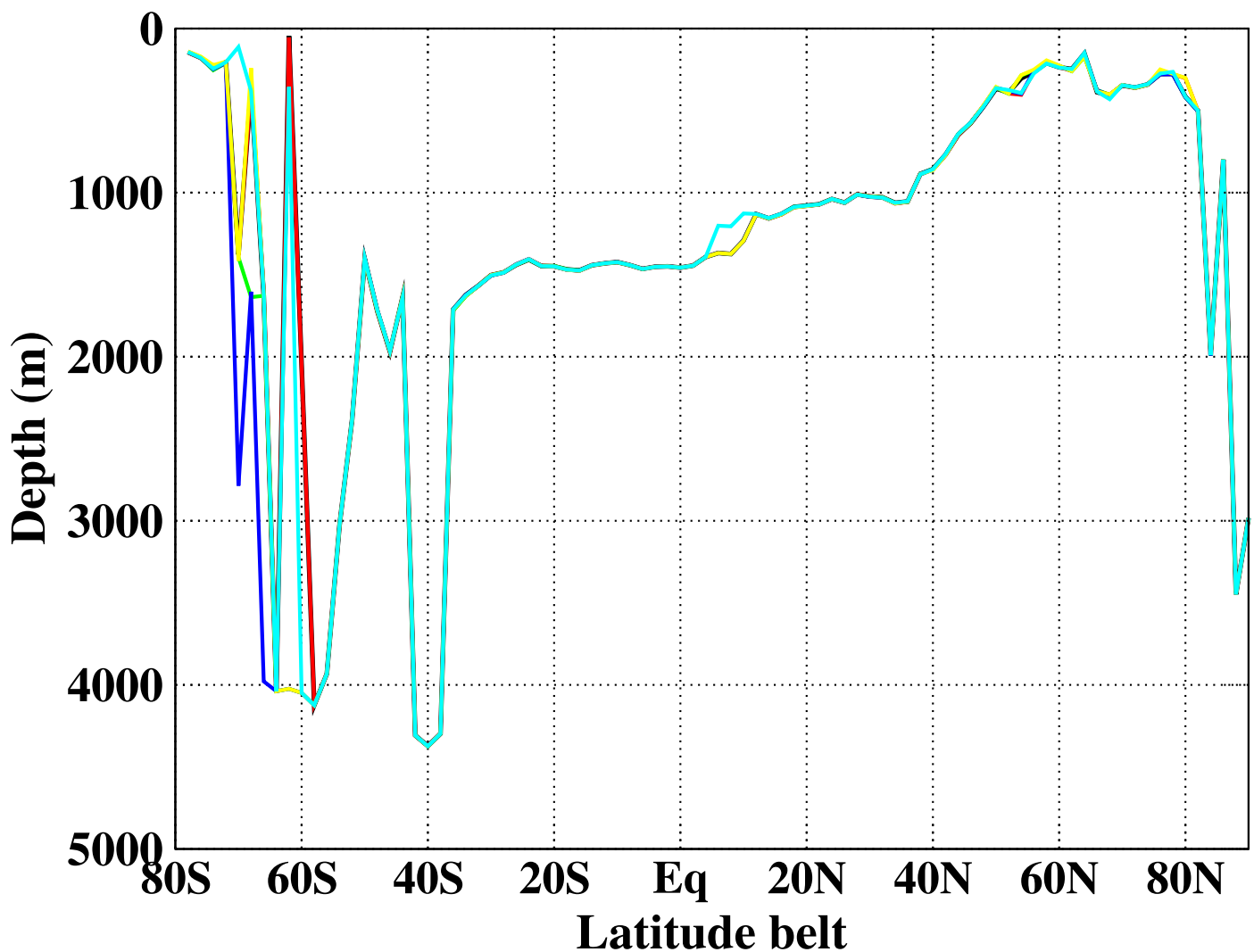
MAXIMUM OF ATLANTIC OVERTURNING

- (1): *standard simulation: Sep94 - Sep95*
- (2): *twin of (1) but Sep95 - Sep96*
- (3): *twin of (1) but Apr97 - Apr98*
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- (6): *twin of (1) but Aug01 - Aug02*



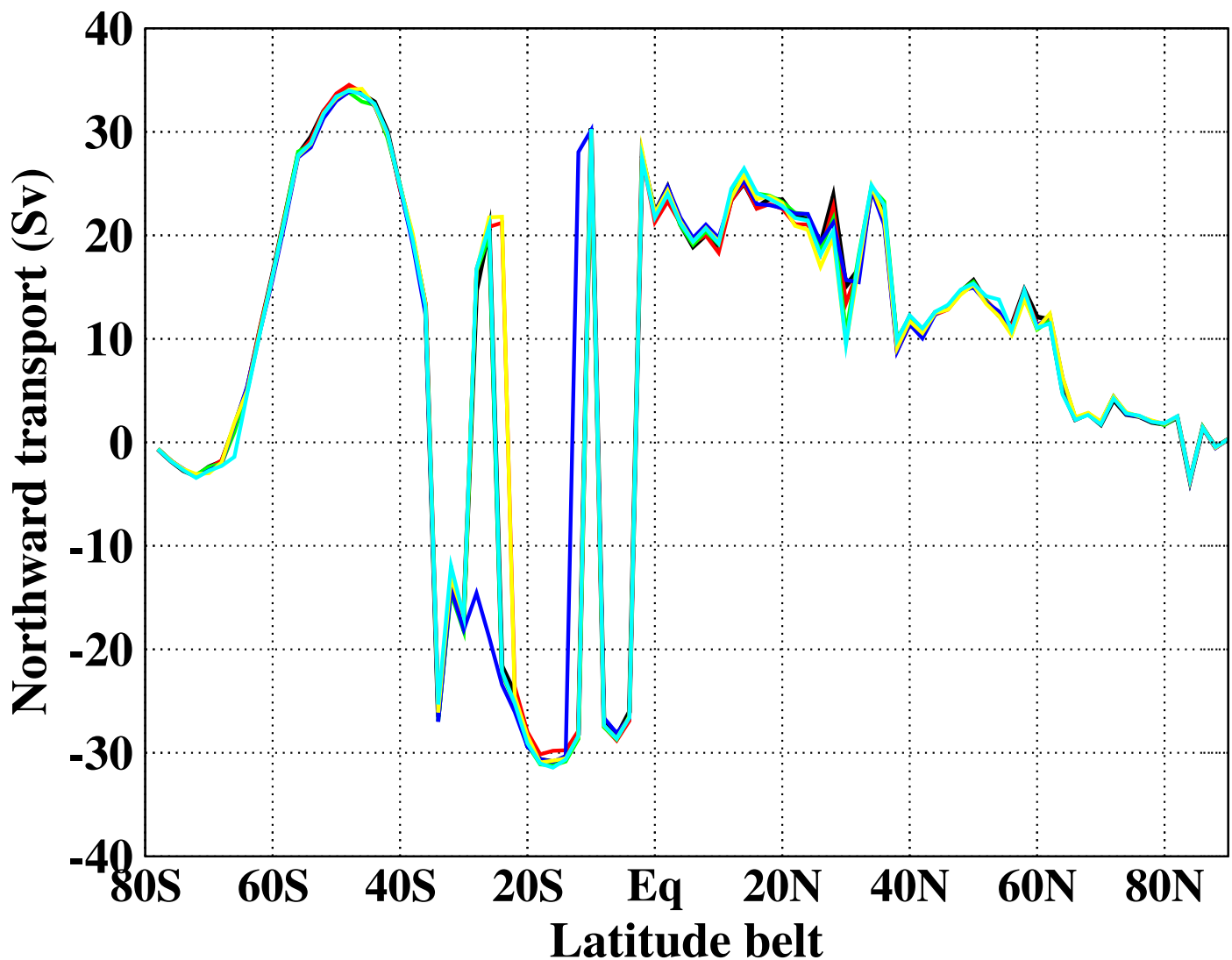
DEPTH OF MAX. OF ATLANTIC OVERTURNING

- (1): *standard simulation: Sep94 - Sep95*
- (2): *twin of (1) but Sep95 - Sep96*
- (3): *twin of (1) but Apr97 - Apr98*
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- (5): *twin of (1) but Aug00 - Aug01*
- (6): *twin of (1) but Aug01 - Aug02*



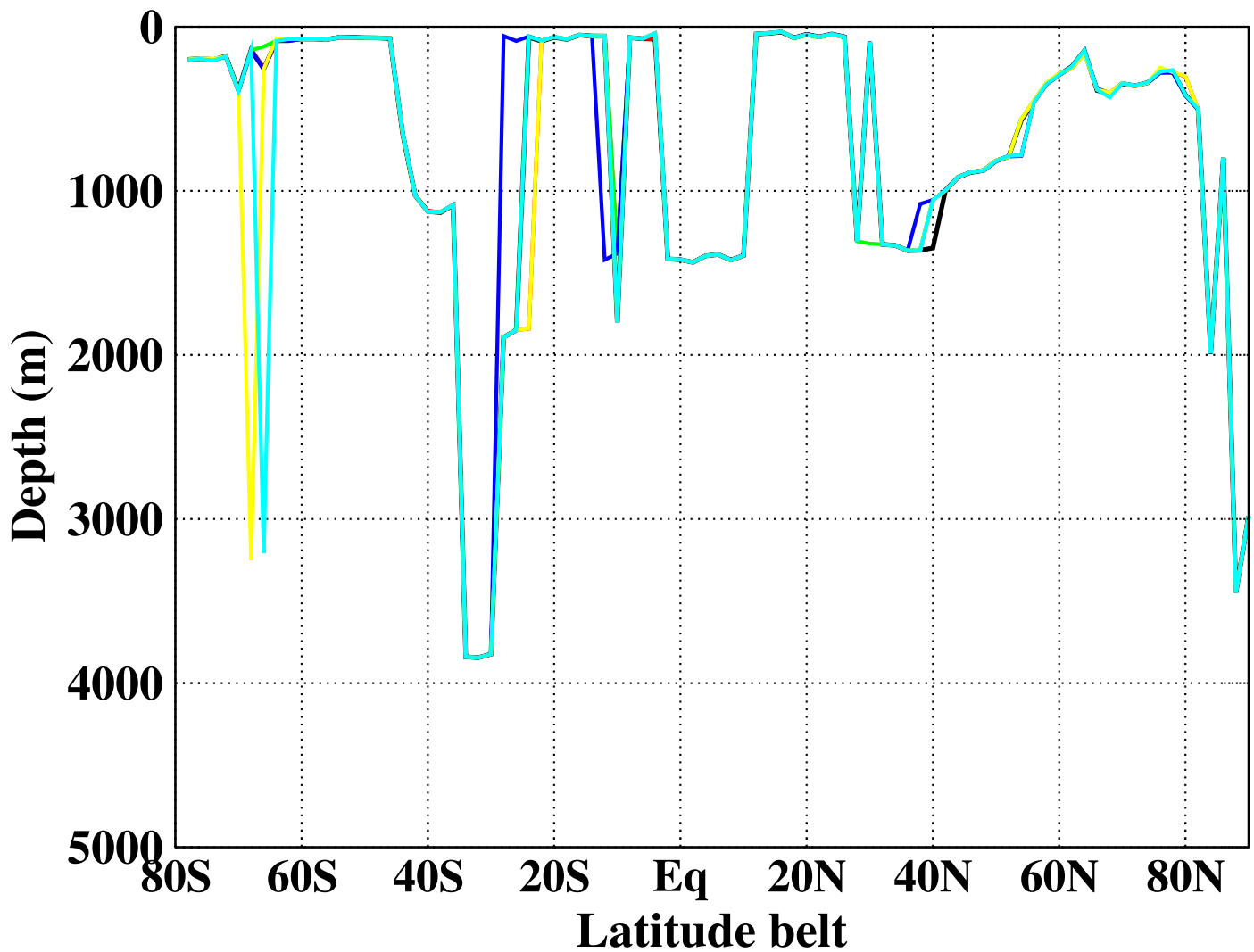
MAXIMUM OF GLOBAL OVERTURNING

- (1): *standard simulation: Sep94 - Sep95*
- (2): **twin of (1) but Sep95 - Sep96**
- (3): **twin of (1) but Apr97 - Apr98**
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- (5): **twin of (1) but Aug00 - Aug01**
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DEPTH OF MAX. OF GLOBAL OVERTURNING

- (1): *standard simulation: Sep94 - Sep95*
- (2): *twin of (1) but Sep95 - Sep96*
- (3): *twin of (1) but Apr97 - Apr98*
- (4): *twin of (1) but Jan98 - Jan99*
- (5): *twin of (1) but Aug00 - Aug01*
- (6): *twin of (1) but Aug01 - Aug02*



CONCLUSION

- **Any anomaly time period can be used**
- **No significant change is noted in the HYCOM results**
 - **(1) climatological means of SST and MLD**
 - **(2) northward transport**
 - **(3) depth of overturning streamfunction**
- **However, we typically use snapshots for a daily output**
- **The period could be important for 3 hourly model analysis**
- **HYCOM now uses 6-hrly anomalies from NOGAPS in 2003**