CFSv2 Prediction Skill of Stratospheric Temperature Anomalies

Qin Zhang[1], Chul-Su Shin[2], Huug M. van den Dool[1], and Ming Cai[2]

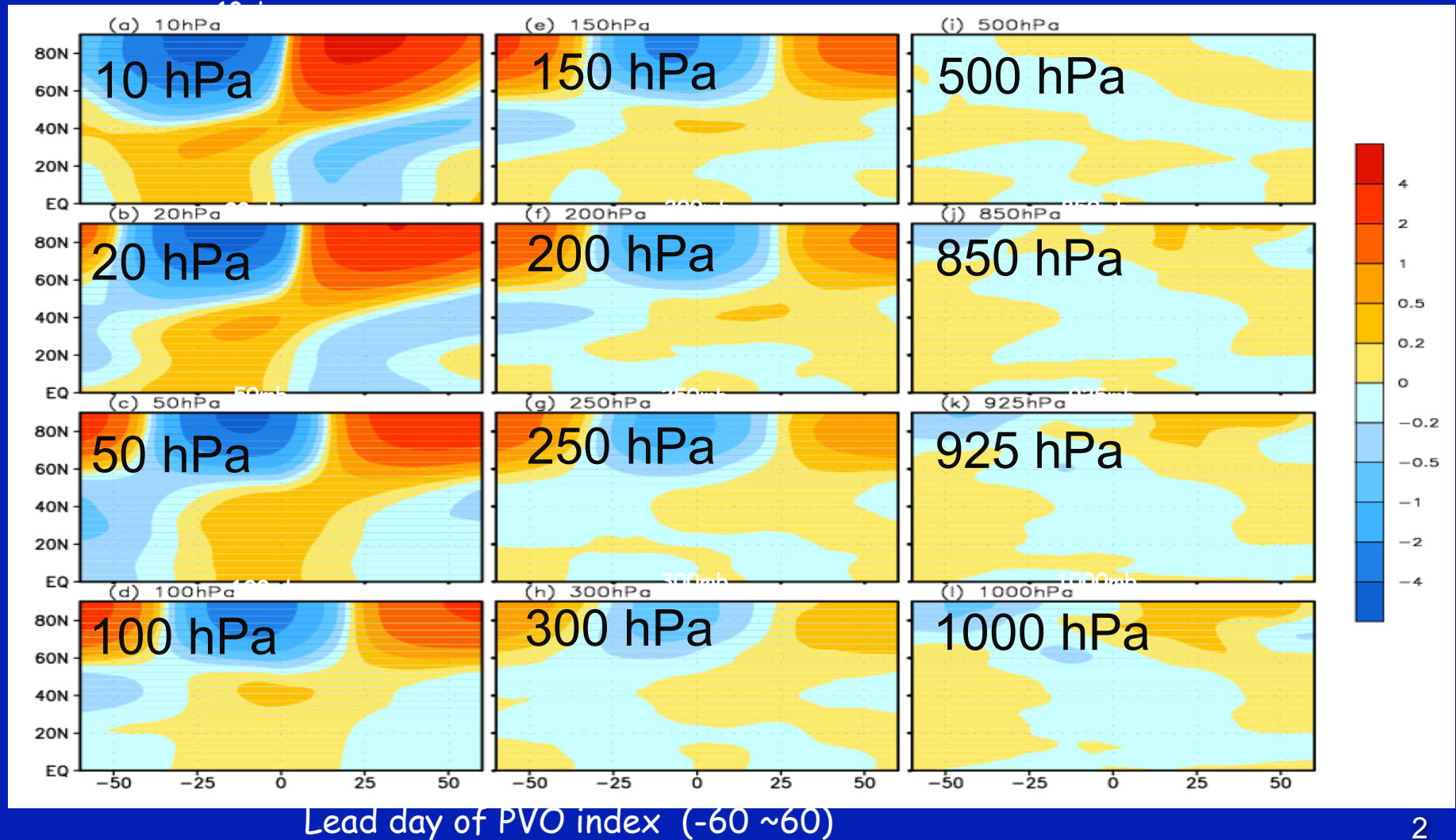[1]Climate Prediction Center, NCEP/NOAA

- [2]Department of Earth, Ocean, and Atmospheric Science, Florida State University

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Meridional propagation of thermal anomalies

Cai and Ren (2006, 2007) and Ren and Cai (2008)

Lead day of PVO index (-60 ~60)

Downward Propagation of thermal anomalies

height

Lead day of PVO index (-60 ~60)
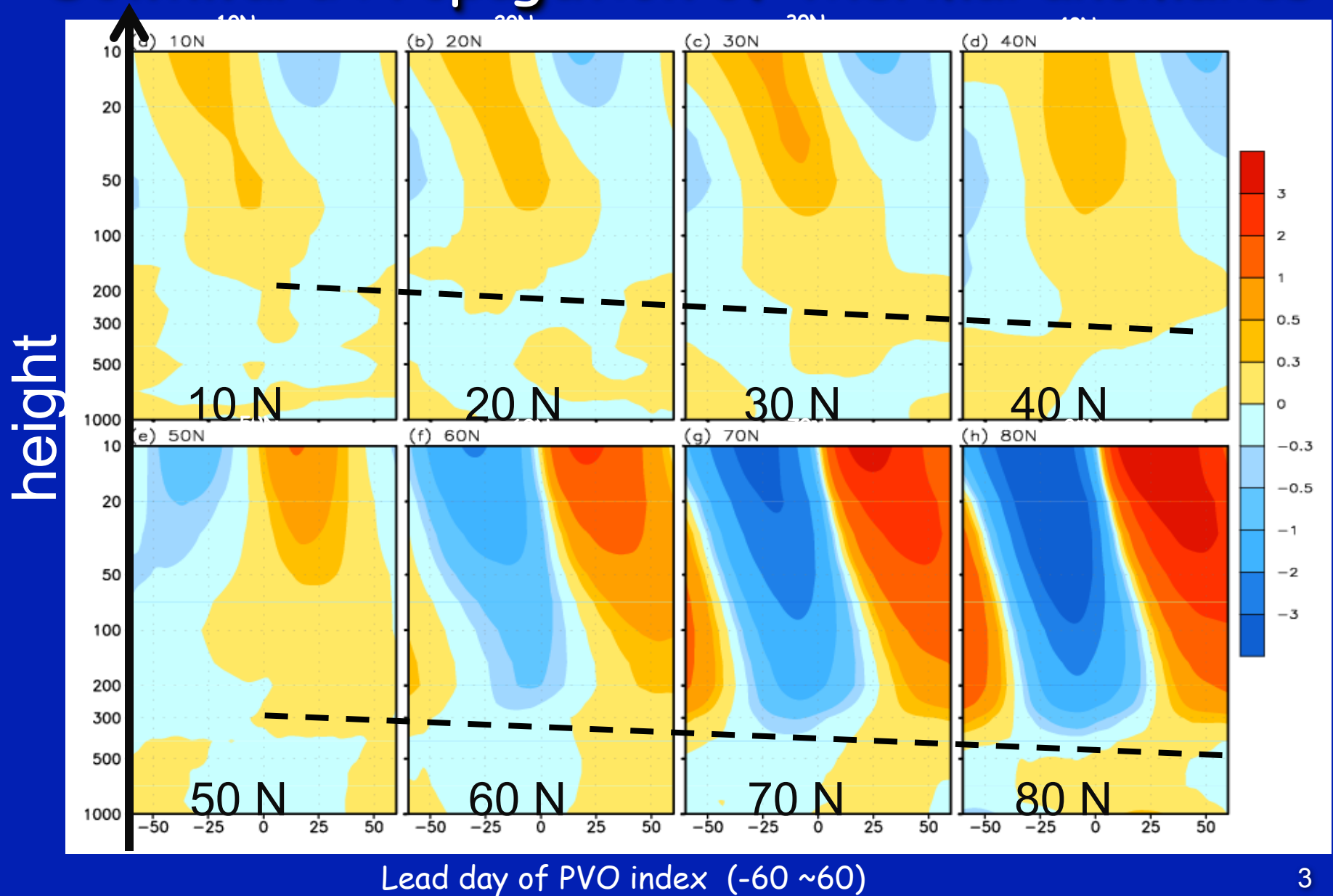
In the extratropics, meridional mass circulation is carried out by baroclinically amplifying (westward tilting) waves (Johnson 1989):
A net poleward (adiabatic) transport of warm air mass aloft and a net equatorward (adiabatic) transport of cold air mass transport below.

Implications for stratosphere predictions:

A numerical model may still have a good skill in predicting stratospheric annular mode variability even when it already loses its skill in predicting the exact locations of individual planetary-scale waves, as long as it can retain the amplitude and westward tilting of these waves.

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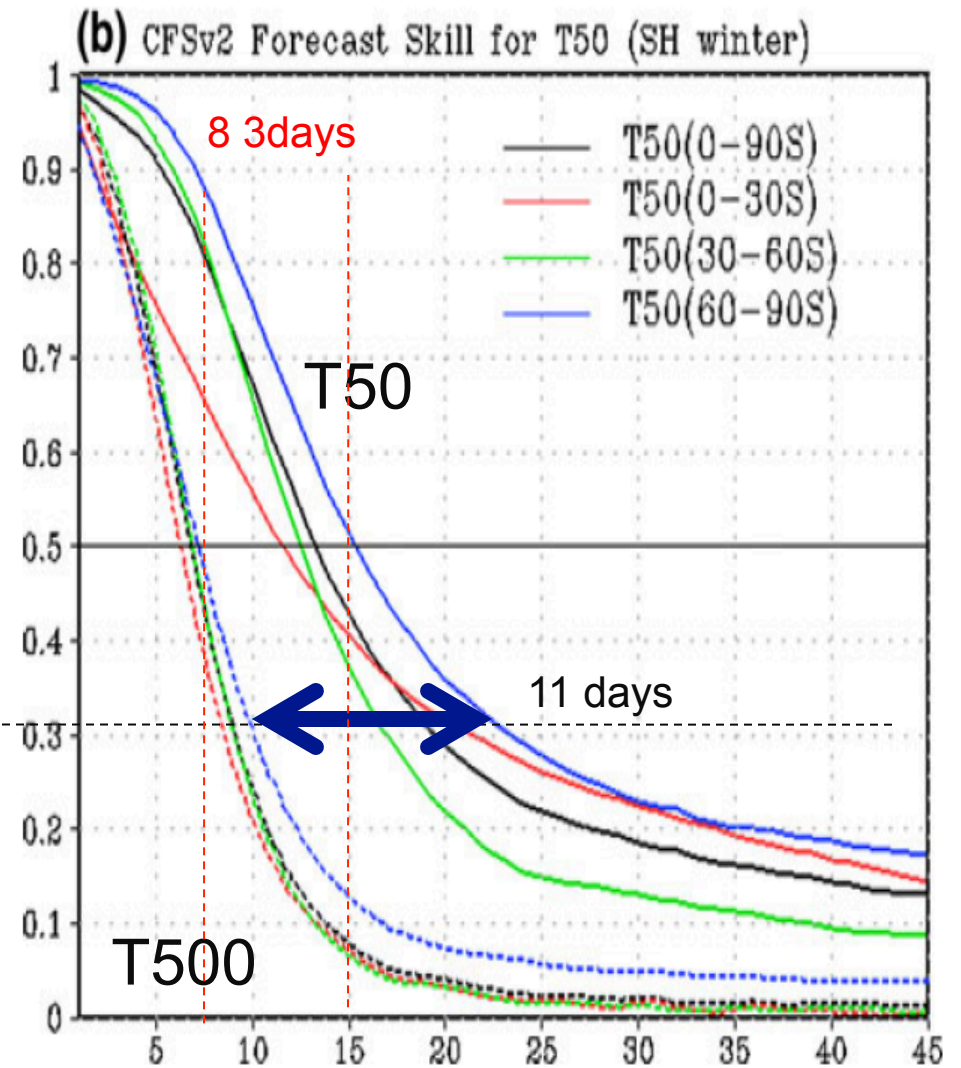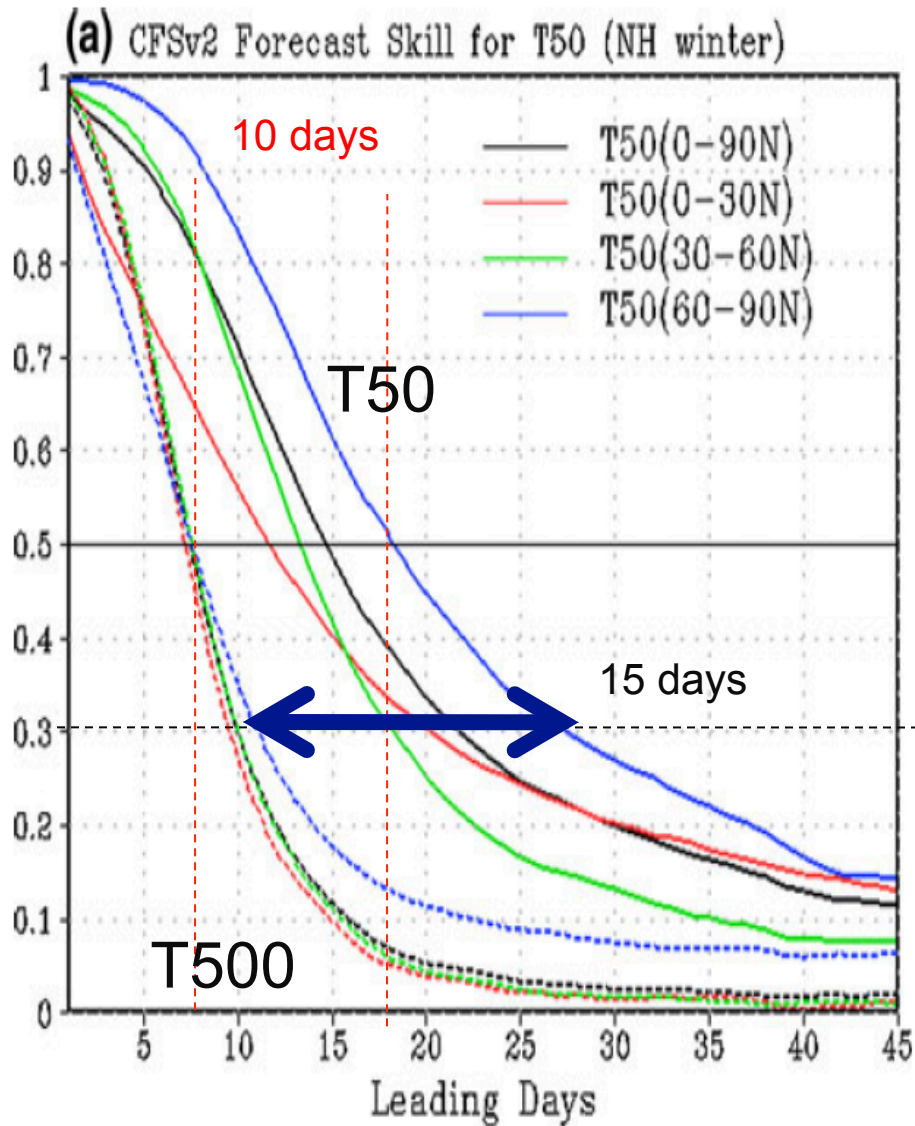# Day 1 through Day 90 forecasts of CFSv2 for the period from January 1, 1999 to December 2010

Forecast evaluation procedure

• Consider Temperature anomalies at 50 hPa (T50 stratosphere) and 500 hp (T500, troposphere) by removing their annual cycles of CFSv2 reanalysis (obs.) from CFSv2 daily forecasts at all lead times.

• Verify anomalies of CFSv2 forecasts against anomalies of CFS reanalysis.

• Use either map correlation for temporal-spatial field or temporal correlation for time series of anomalies to measure the skill of CFSv2 (AC > 0.5 reliable forecasts and AC > 0.3 useful forecasts).
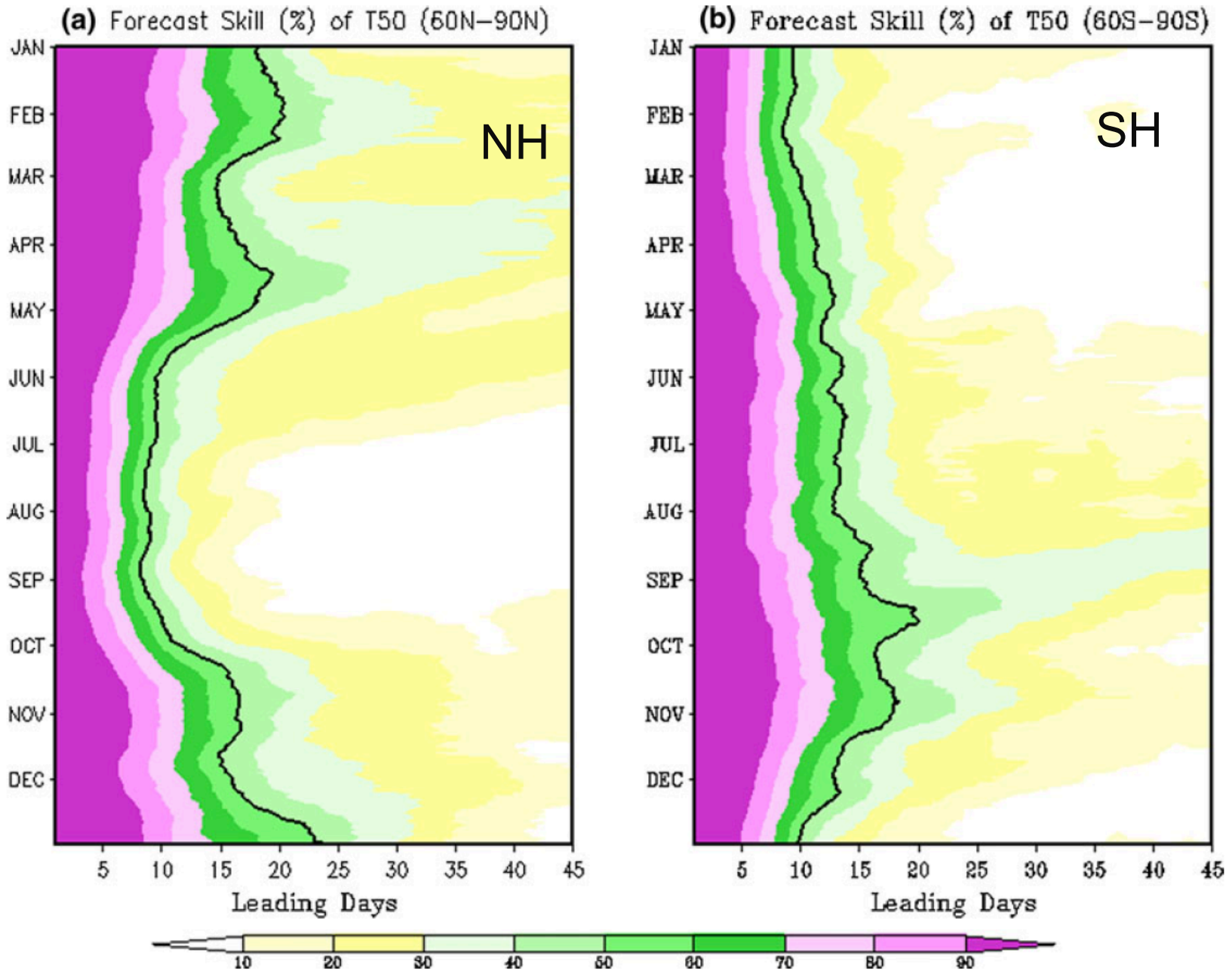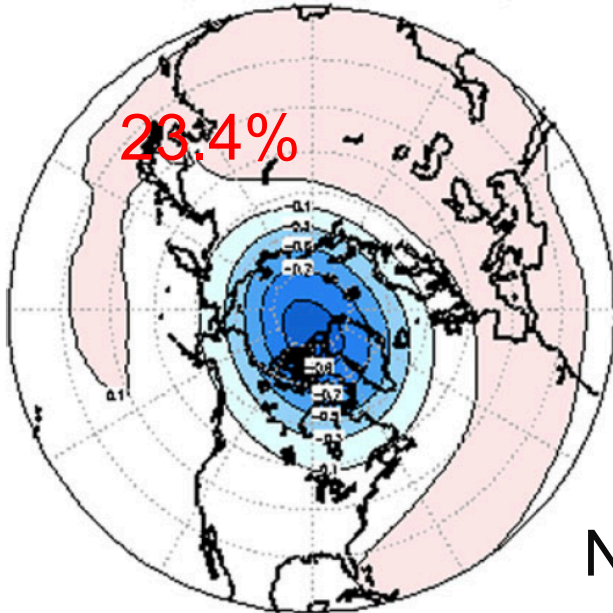
Overall skill (map AC)

NH

SH

(a) CFSv2 Forecast Skill for T50 (NH winter)

10 days

T50(0-90N)
T50(0-30N)
T50(30-60N)
T50(60-90N)

T50

T500

15 days

Leading Days

(b) CFSv2 Forecast Skill for T50 (SH winter)

8 3days

T50(0-90S)
T50(0-30S)
T50(30-60S)
T50(60-90S)

T50

T500

11 days

Seasonal dependency of CFSv2 skill over polar stratosphere

(a) Forecast Skill (%) of T50 (60N-90N) — NH

(b) Forecast Skill (%) of T50 (60S-90S) — SH

EOF1 (23.4 %EV) (seed=none)   EOF2 (18.6 %EV) (seed=none)(partial 1)
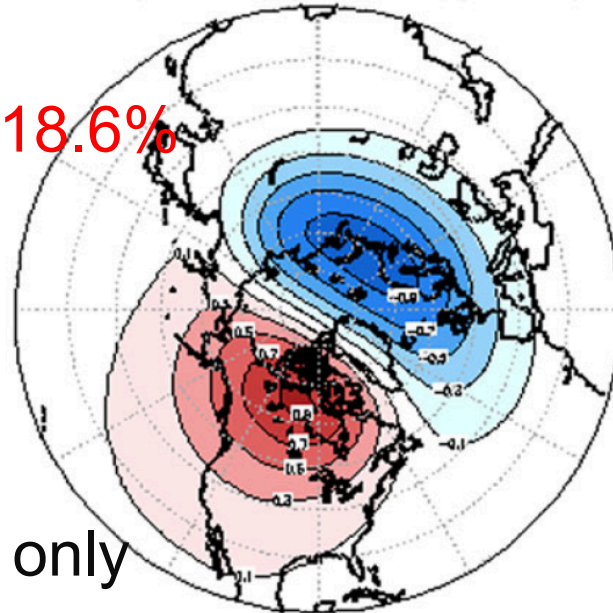
23.4%   18.6%
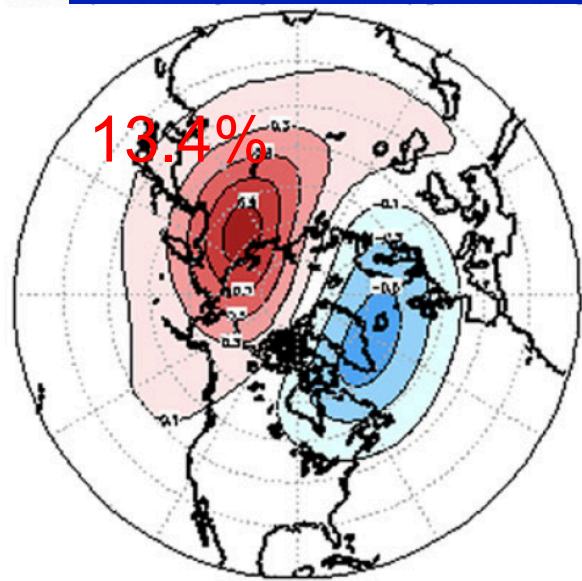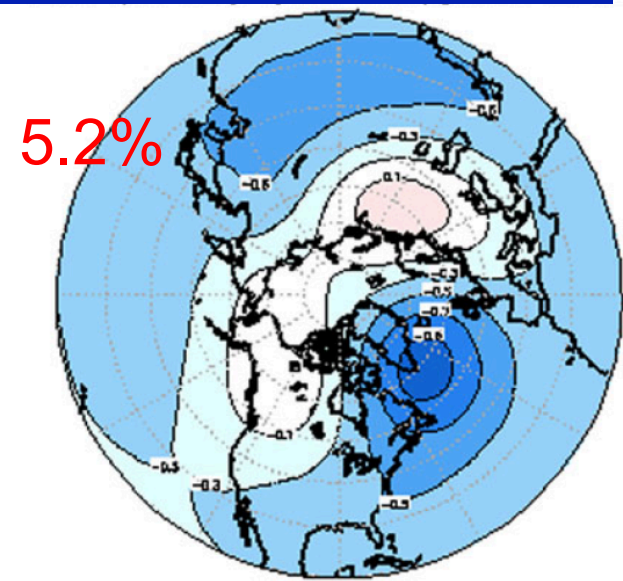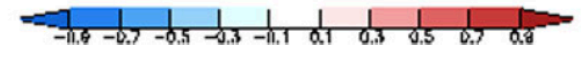
NH only

1st 4 EOF modes of daily T50 anomalies

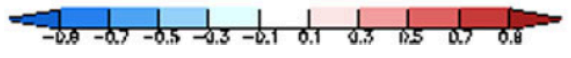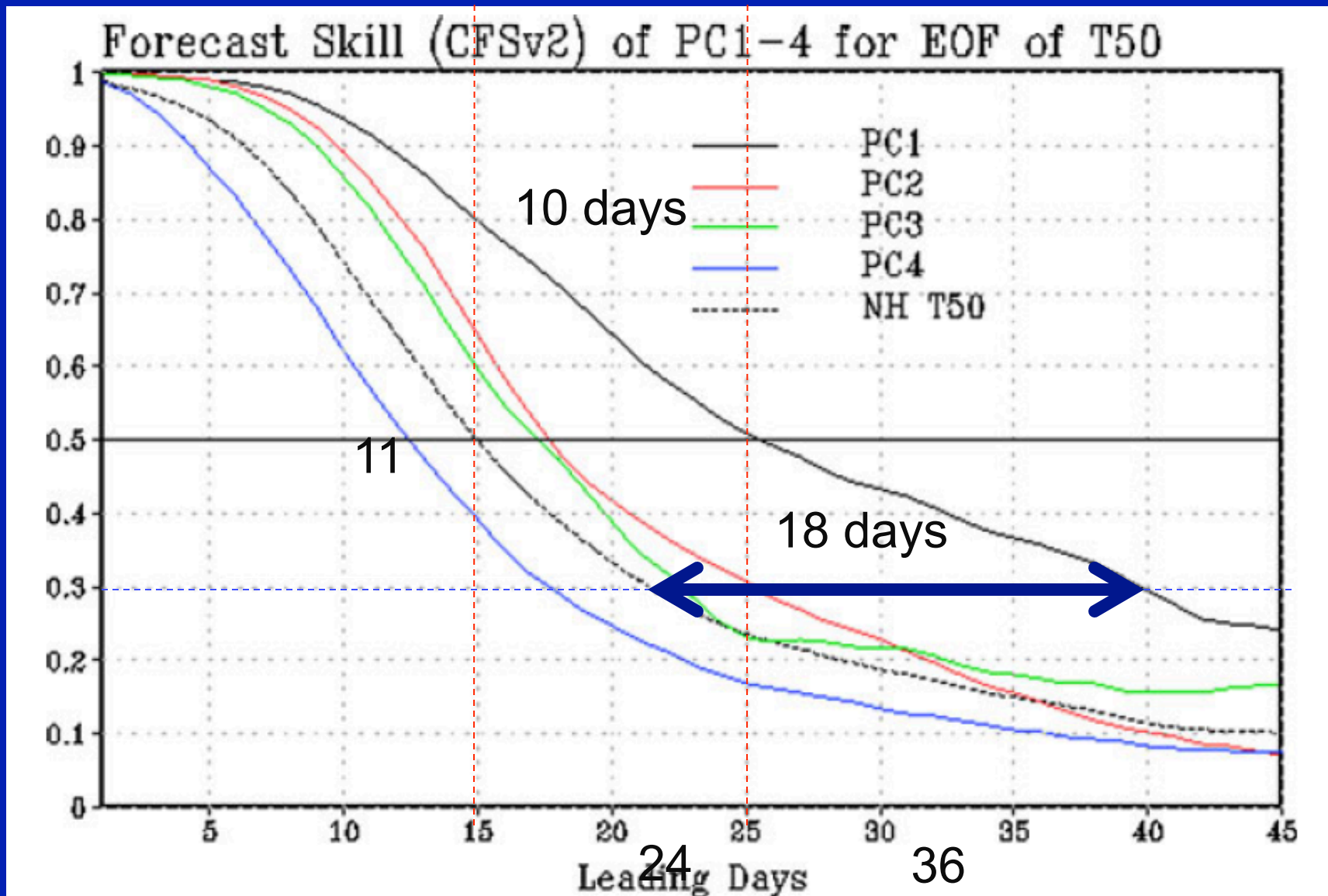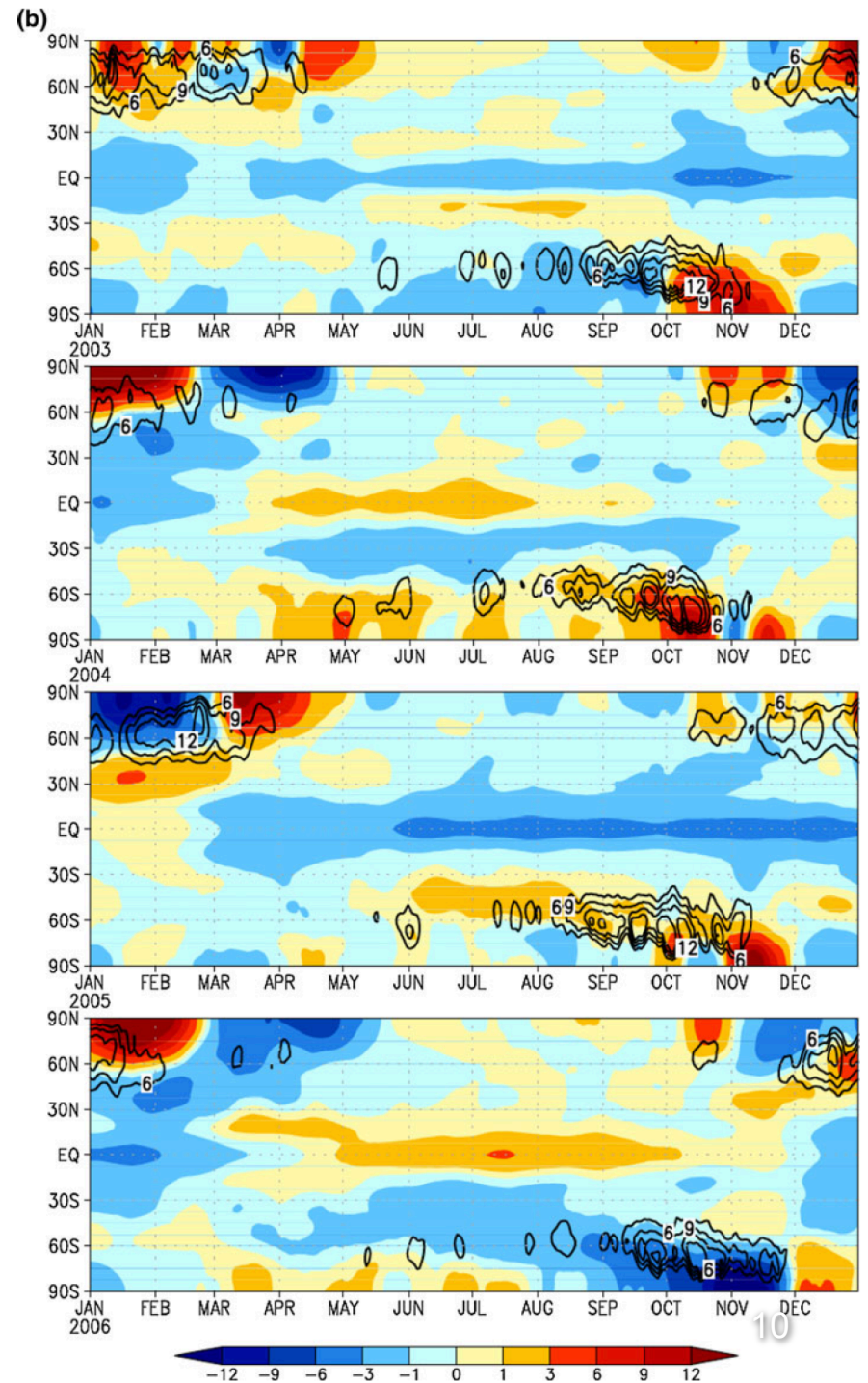EOF3   3)

13.4%   5.2%

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AC skill of predictions of PCs of EOF1-4

Forecast Skill (CFSv2) of PC1-4 for EOF of T50

10 days

11

18 days

PC1
PC2
PC3
PC4
NH T50

24

36

Leading Days

(a)

(b)
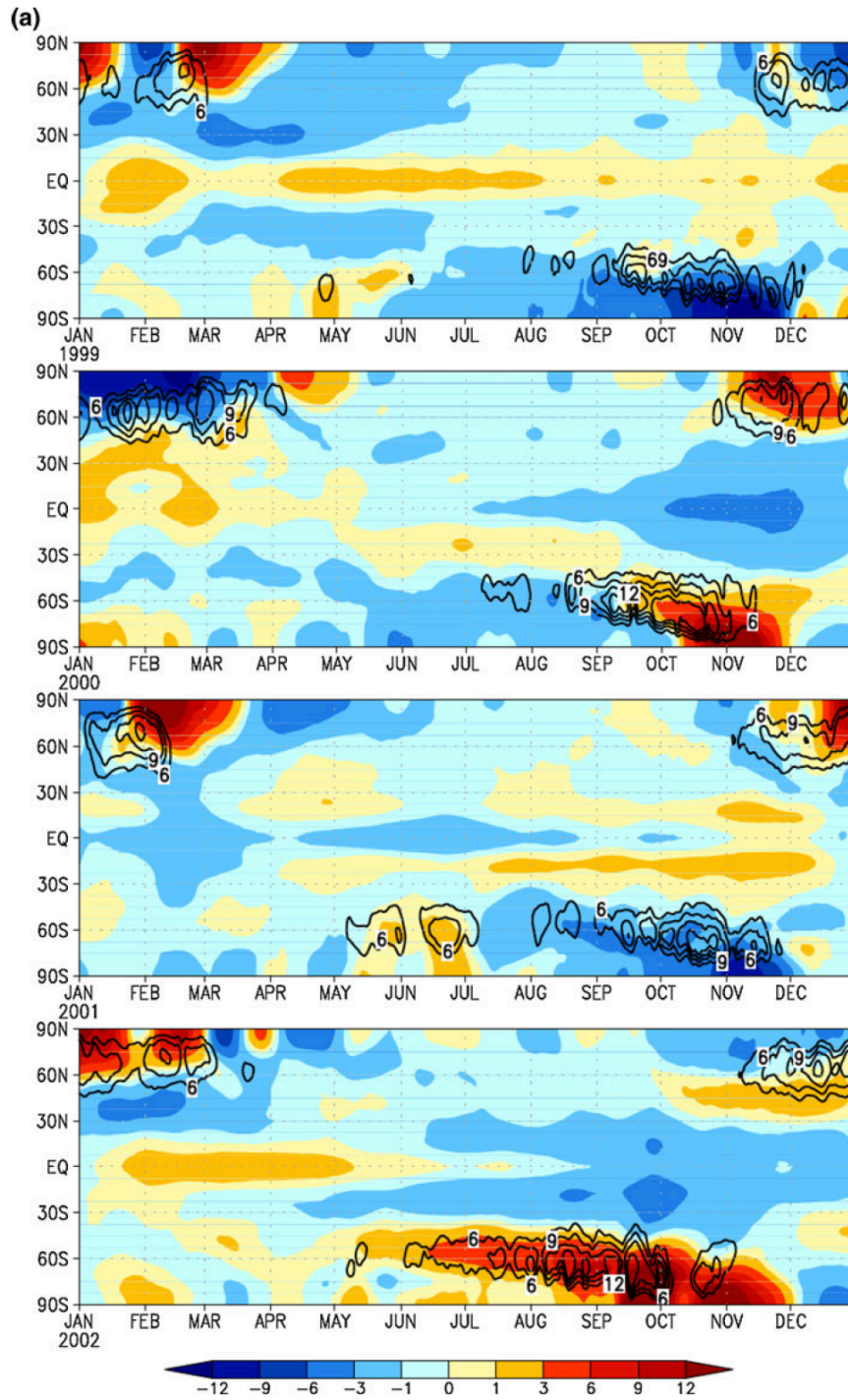
CFSv2 skill for zonal mean of T50 anomalies
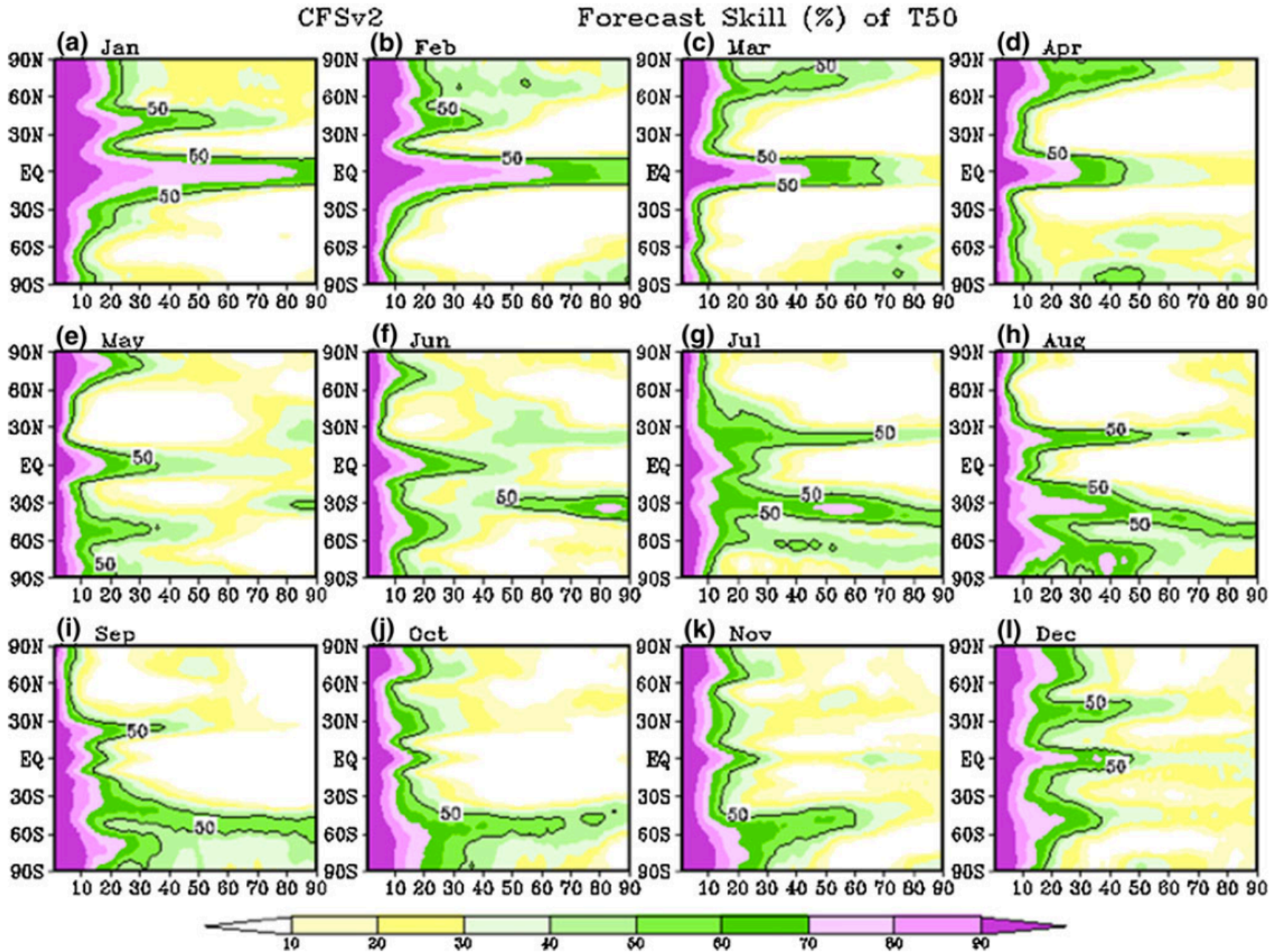
Gain of CFSv2 over persistence forecasts
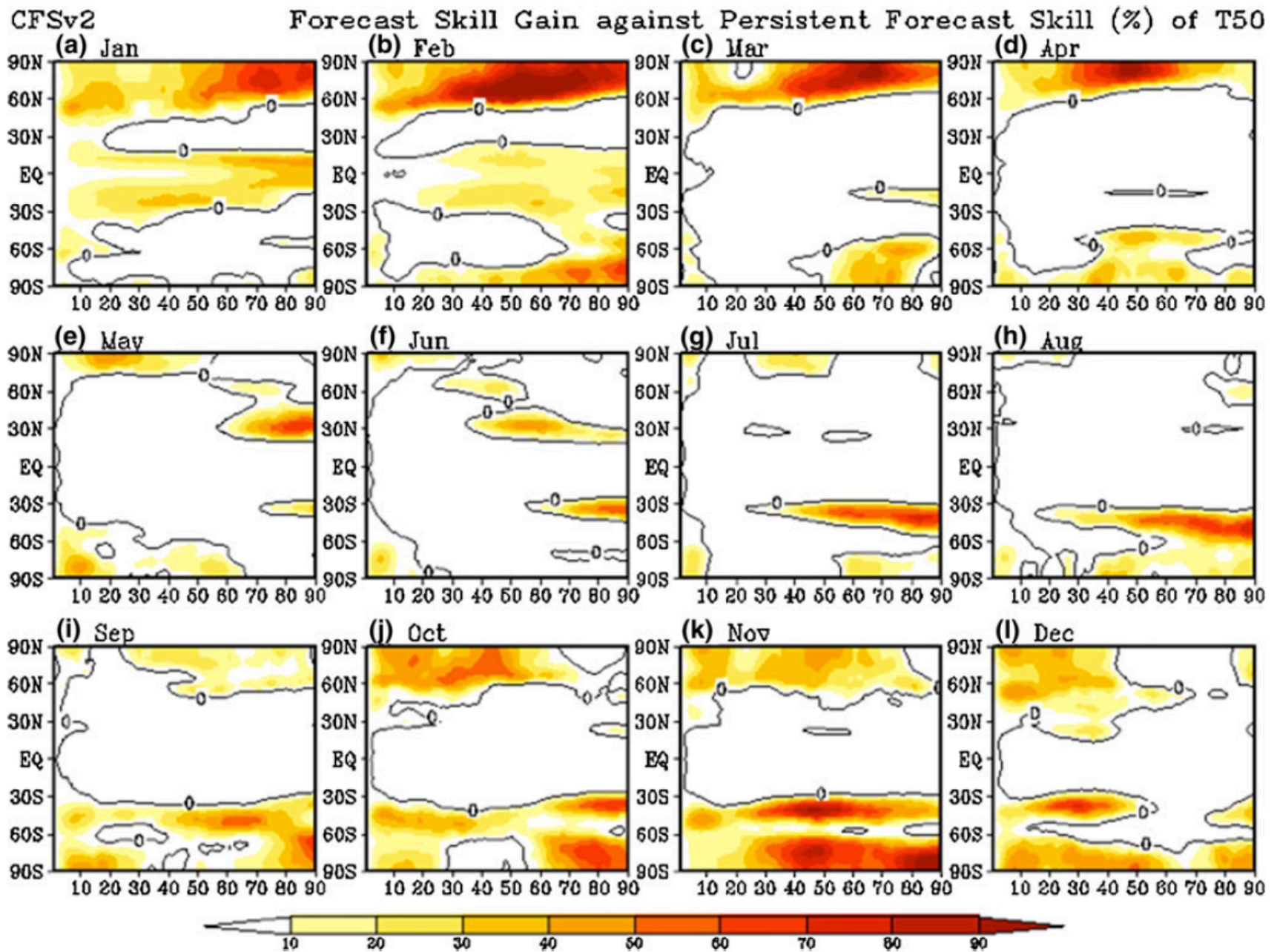

CFSv2   Forecast Skill Gain against Persistent Forecast Skill (%) of T50

Wave Amplitude at 60Nin CFSv2 FCT
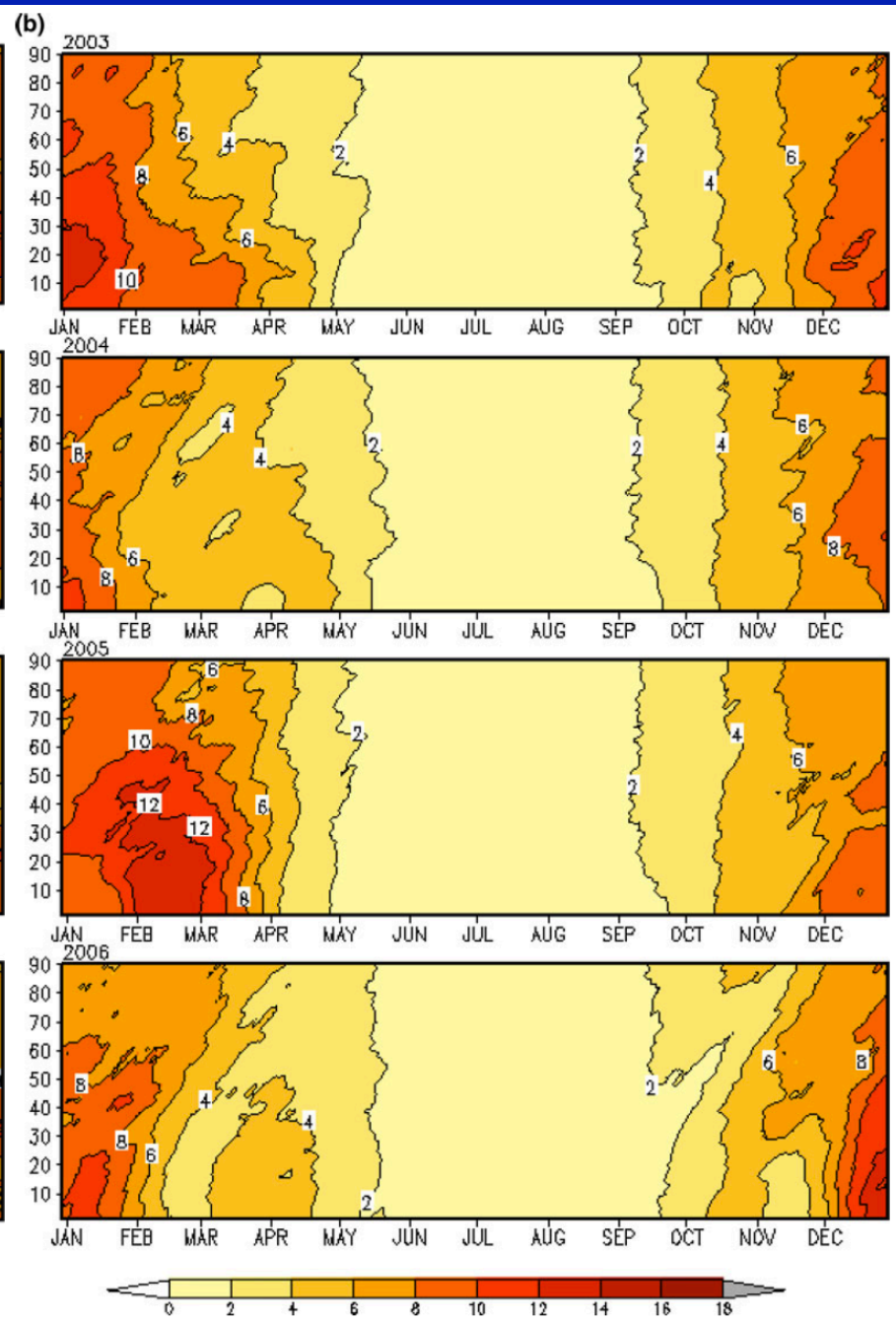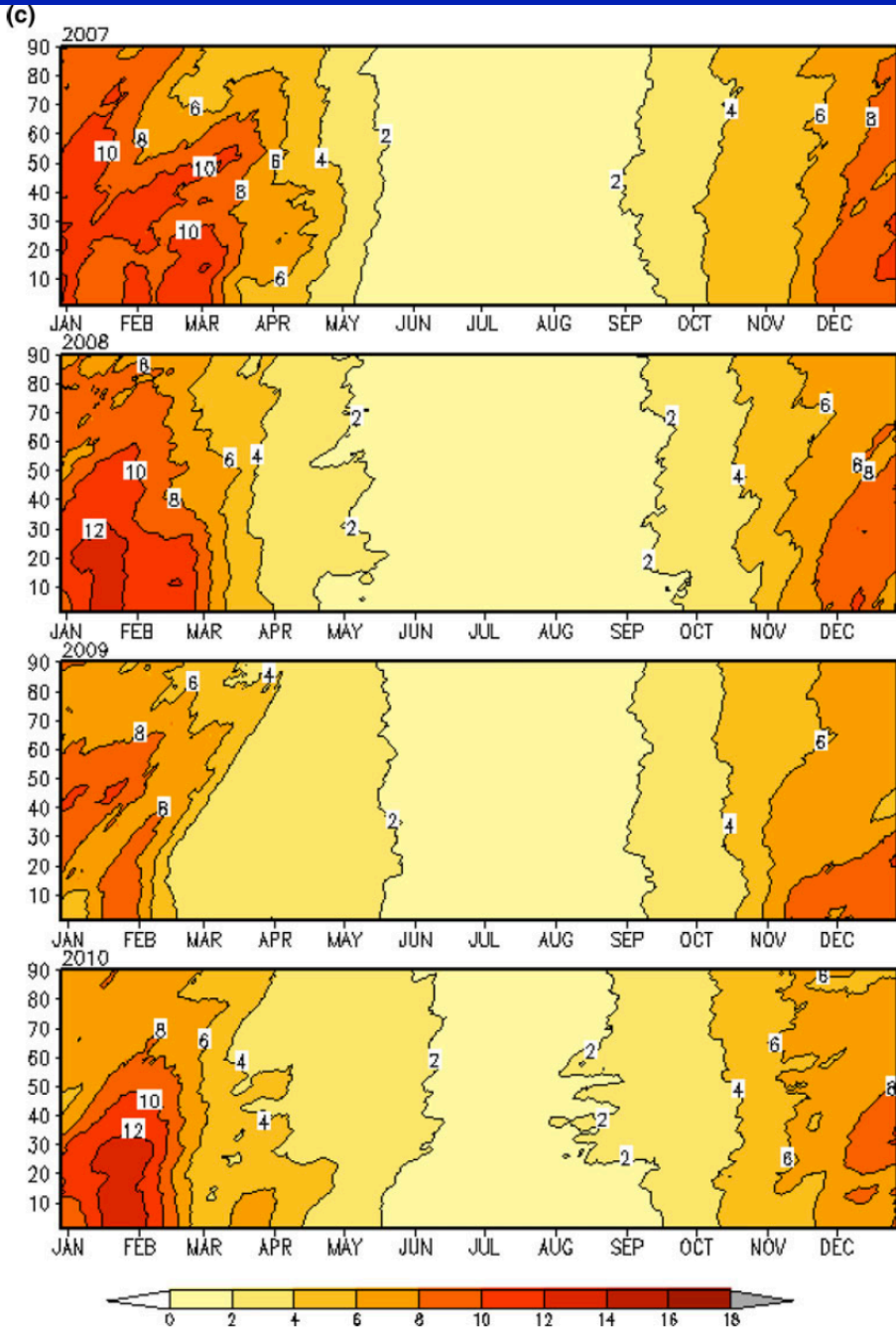
Summary

- The NCEP CFSv2 still has a remarkable skill in predicting mid-winter polar stratosphere warming events and the timing of the yearly final polar stratosphere warming in both hemispheres 3-4 weeks in advance. We also prove that the CFSv2 has a high prediction skill for winter polar stratosphere both in an absolute sense and in terms of gain over the persistence.

- The remarkable skill comes from the signal of systematic poleward propagation of thermal anomalies in the stratosphere associated with the global mass circulation variability (intensity/ time scale).

- As long as the westward tilting of planetary waves in the stratosphere and their overall amplitude can be captured, the CFSv2 forecasts would still be very skillful in predicting zonal mean anomalies even though it cannot do so for the exact locations of planetary waves and their spatial scales.

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