Permian (251 Ma) Climate Variability: The North Panthalassic Oscillation

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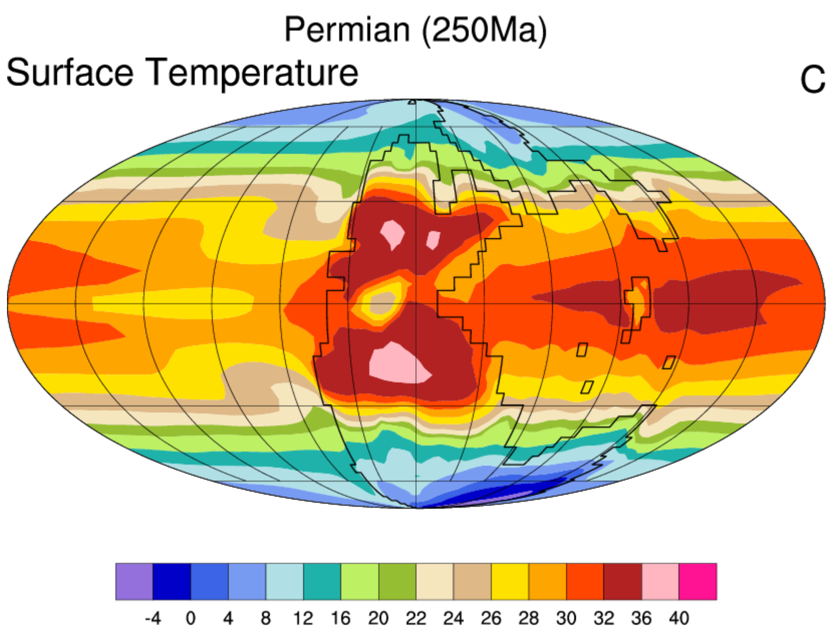
NCAR/CGD/CCR/Paleo

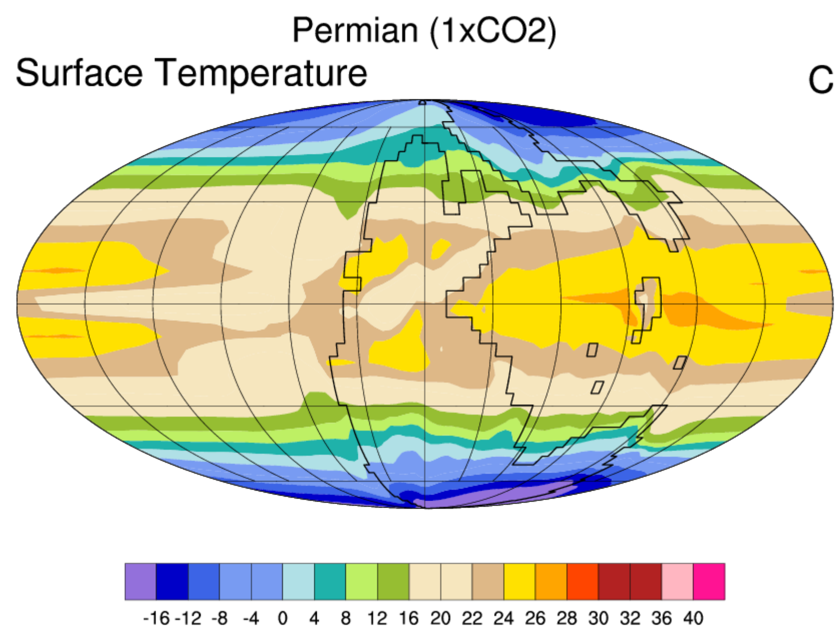
Many thanks to Clara Deser, Jeff Yin, and Bob Tomas for insightful discussions…

Permian Simulations

10X CO_2 Fully Coupled CCSM3, T31_gx3v5, 2700 Yrs of simulation

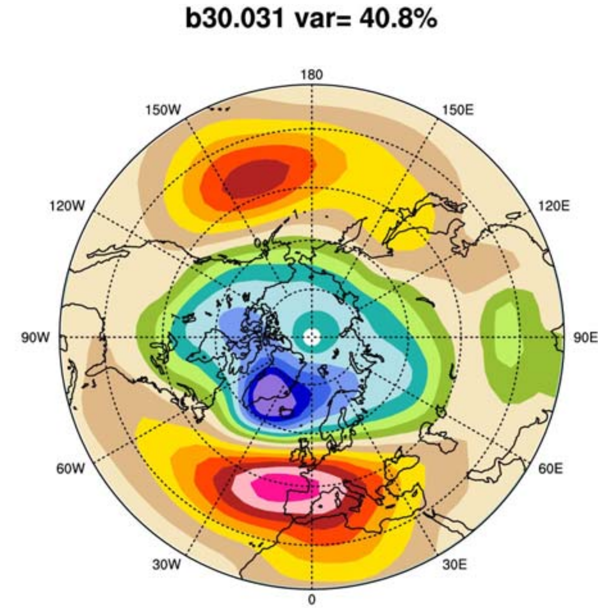
1X CO_2 Fully Coupled CCSM3, T31_gx3v5, 2050 Yrs of simulation



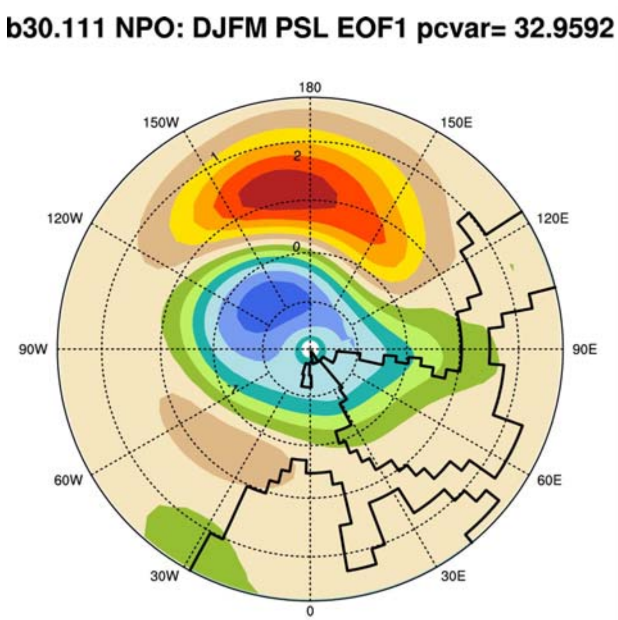


PSL EOF1 DJFM

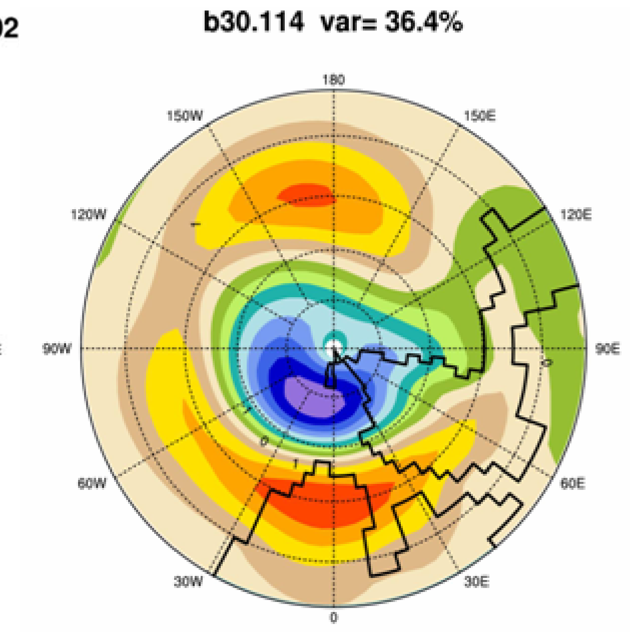
Present Day Control Yrs 200-880

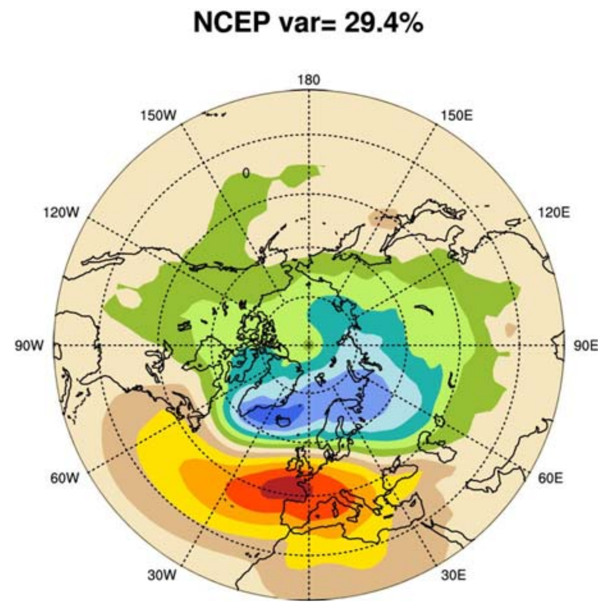


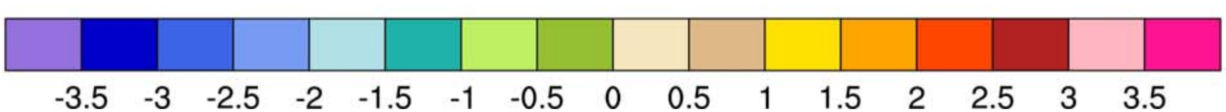
10X Yrs 200-2600



1X Yrs 250-2050

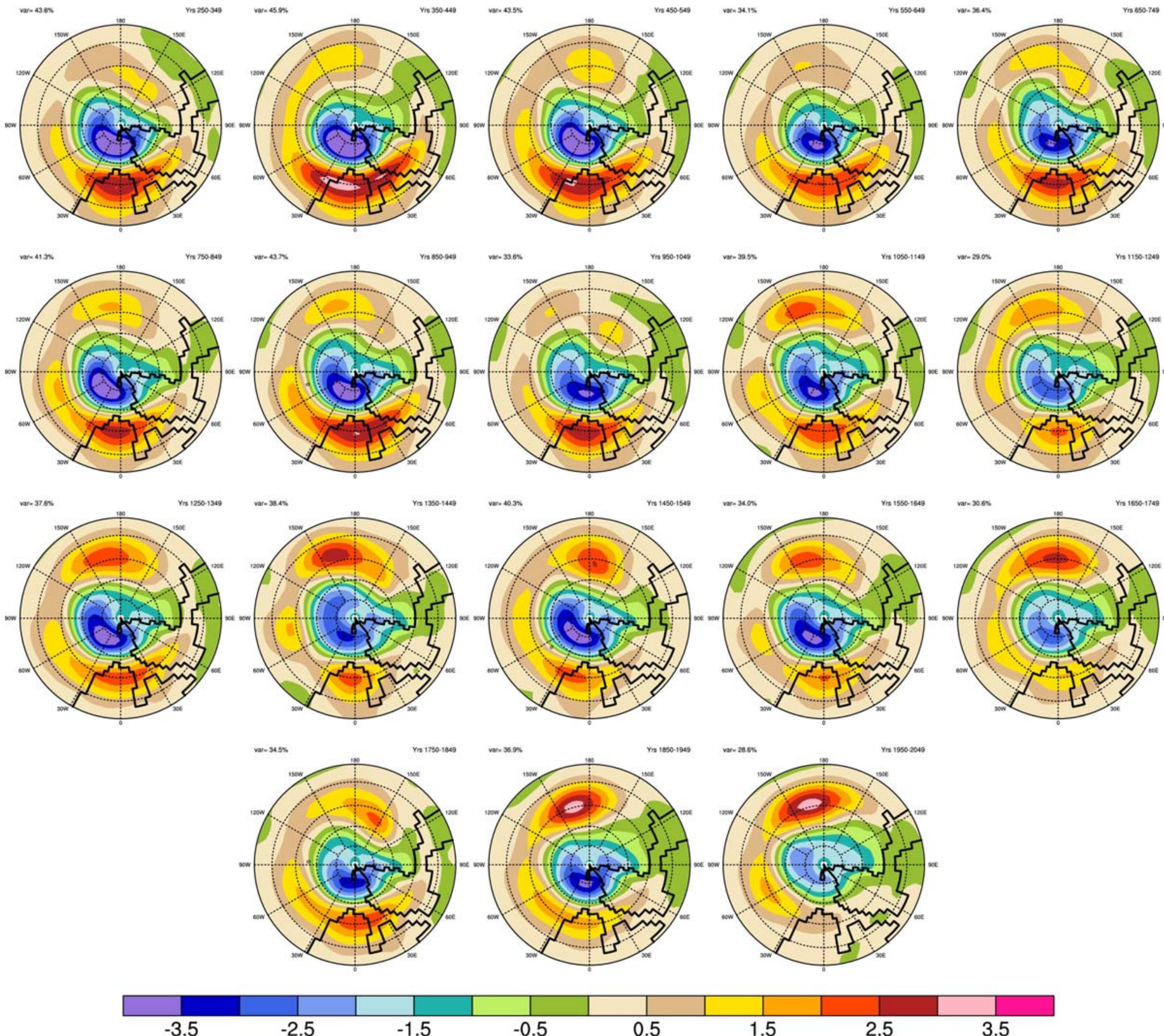






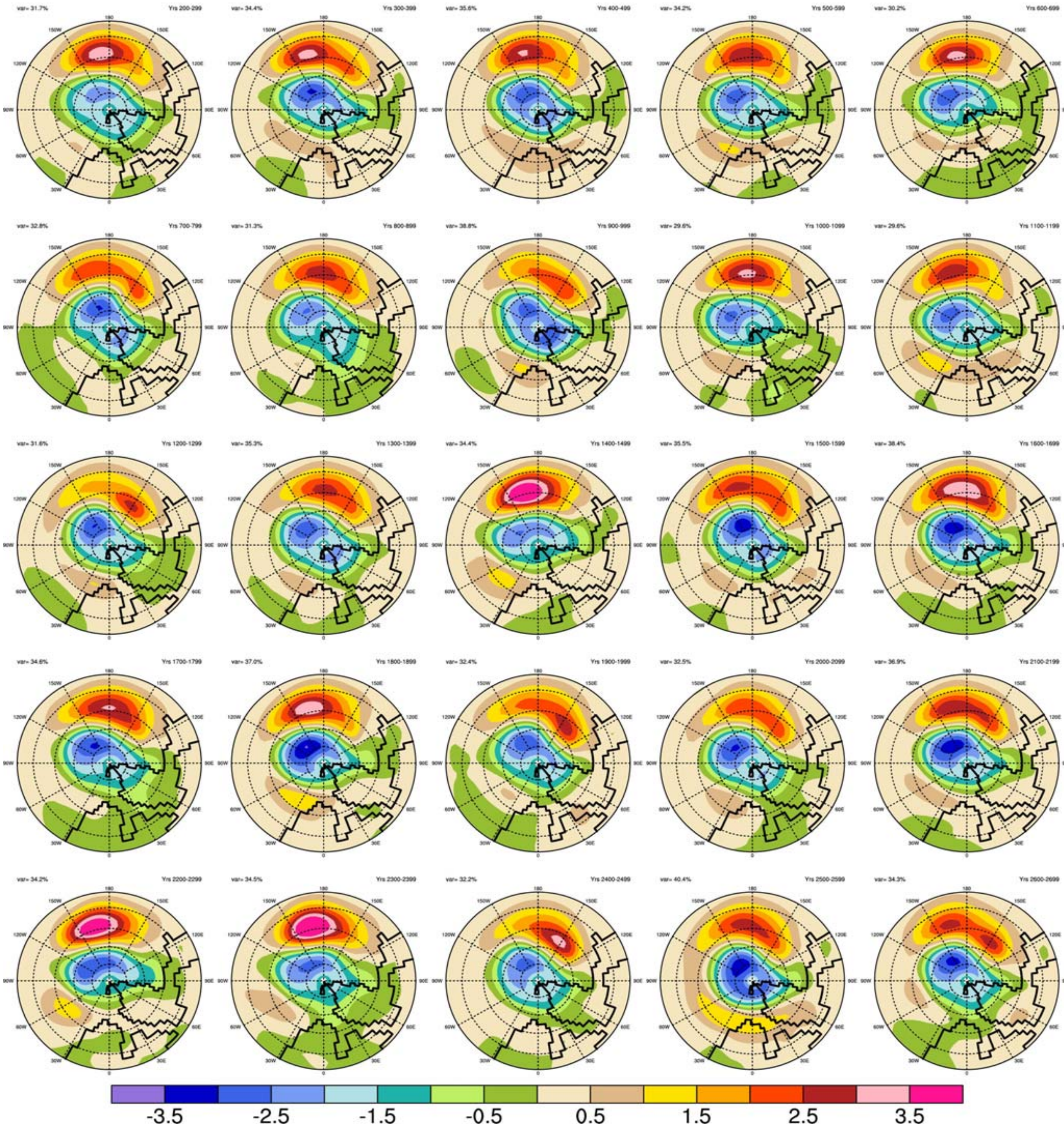
1X
Permian

DJFM
PSL
EOF1

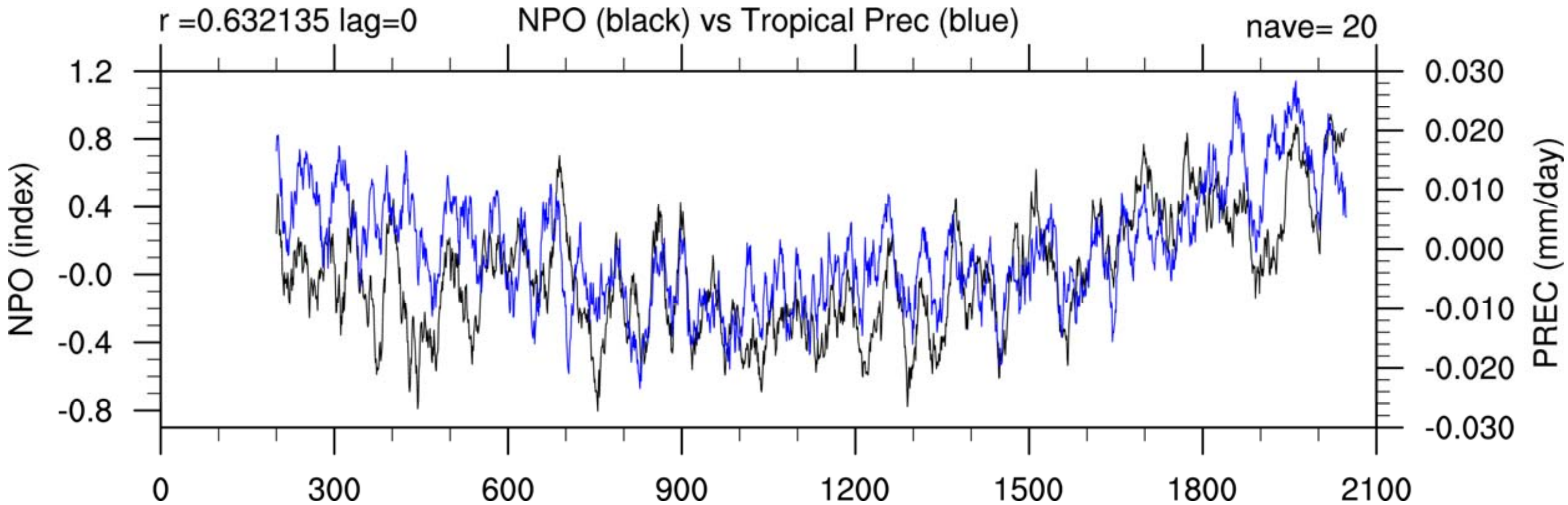


10X
Permian

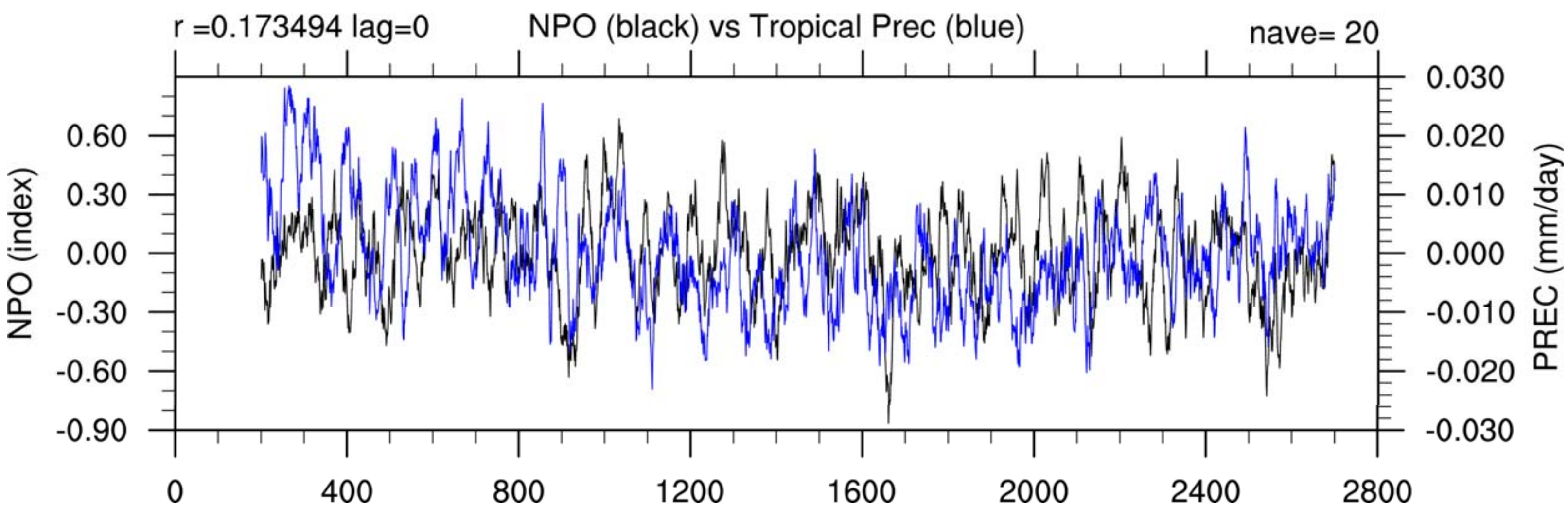
DJFM
PSL
EOF1



1X

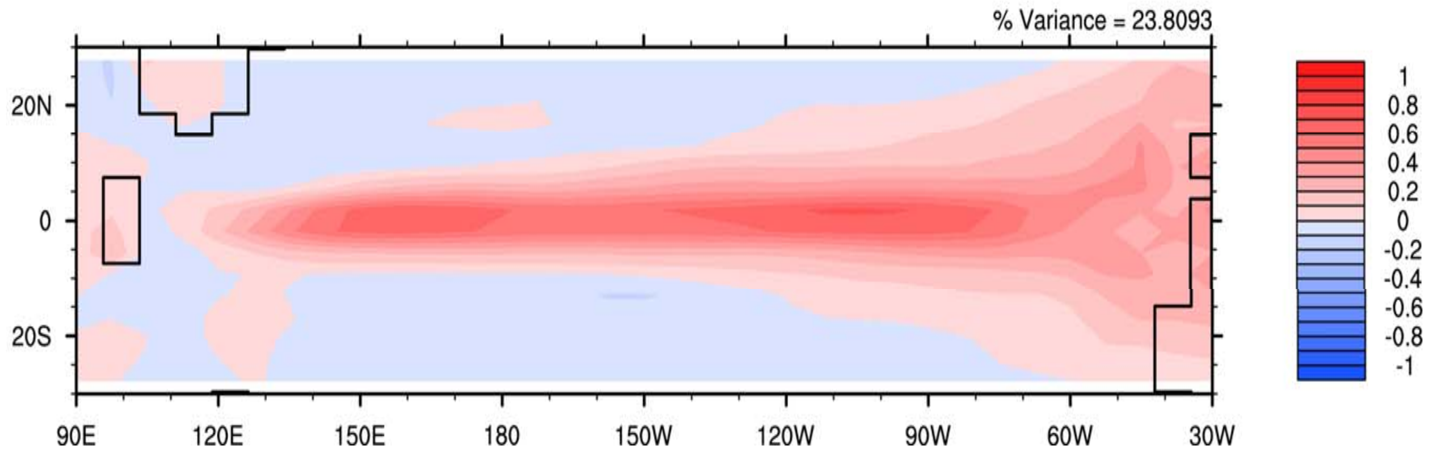

r =0.632135 lag=0
NPO (black) vs Tropical Prec (blue)
nave= 20
NPO (index)
1.2
0.8
0.4
-0.0
-0.4
-0.8
PREC (mm/day)
0.030
0.020
0.010
0.000
-0.010
-0.020
-0.030
0
300
600
900
1200
1500
1800
2100

10X

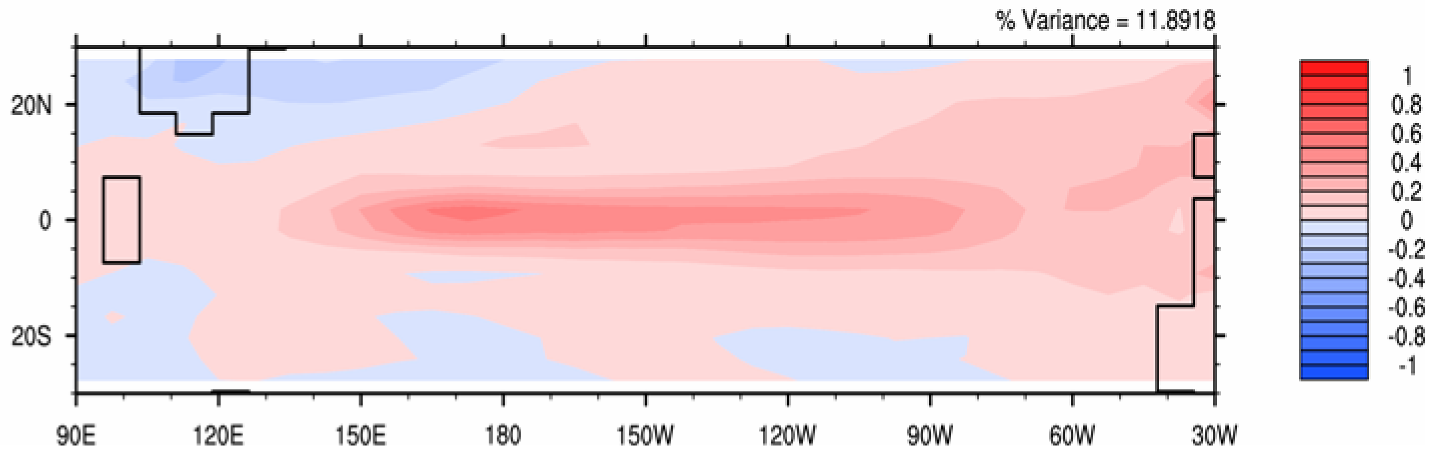

r =0.173494 lag=0
NPO (black) vs Tropical Prec (blue)
nave= 20
NPO (index)
0.60
0.30
0.00
-0.30
-0.60
-0.90
PREC (mm/day)
0.030
0.020
0.010
0.000
-0.010
-0.020
-0.030
0
400
800
1200
1600
2000
2400
2800

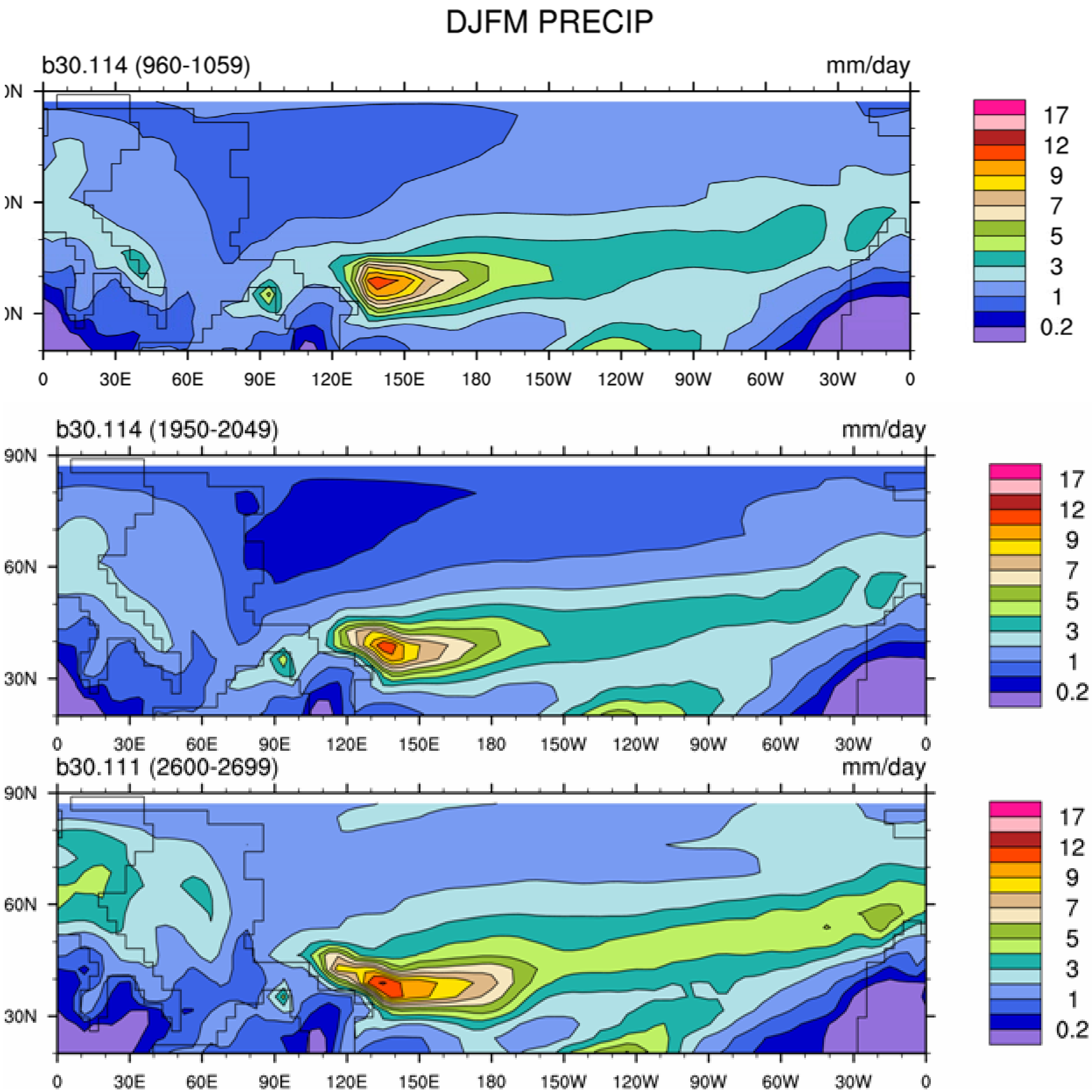
TS EOF1 last 100yrs of simulation

1X case



10X case



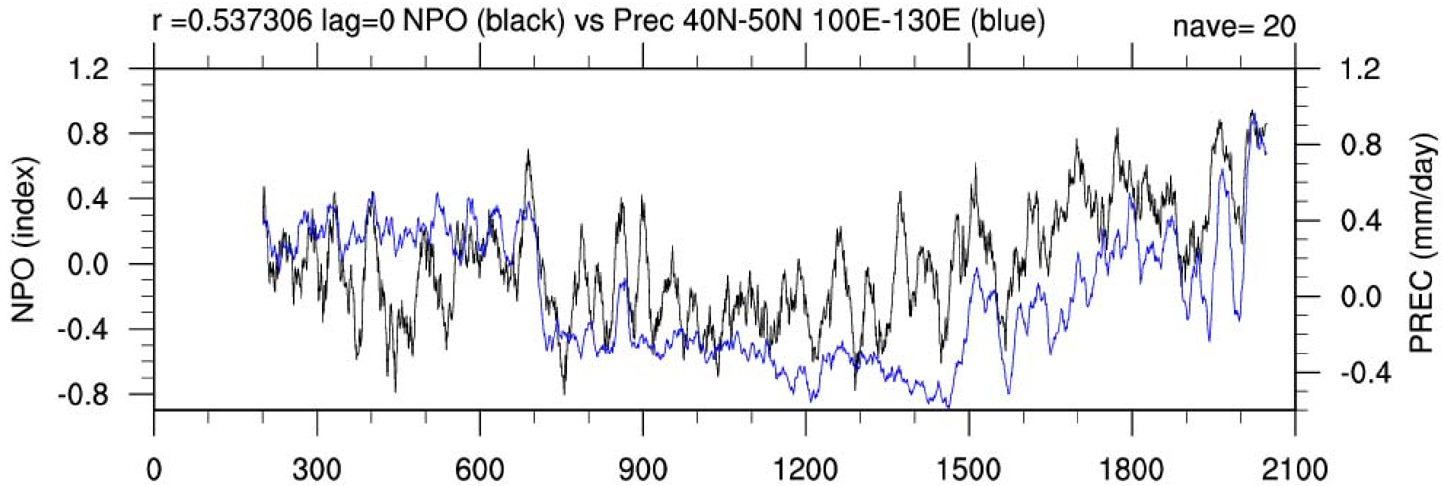


1X case mid-run (NPO in “east” mode)

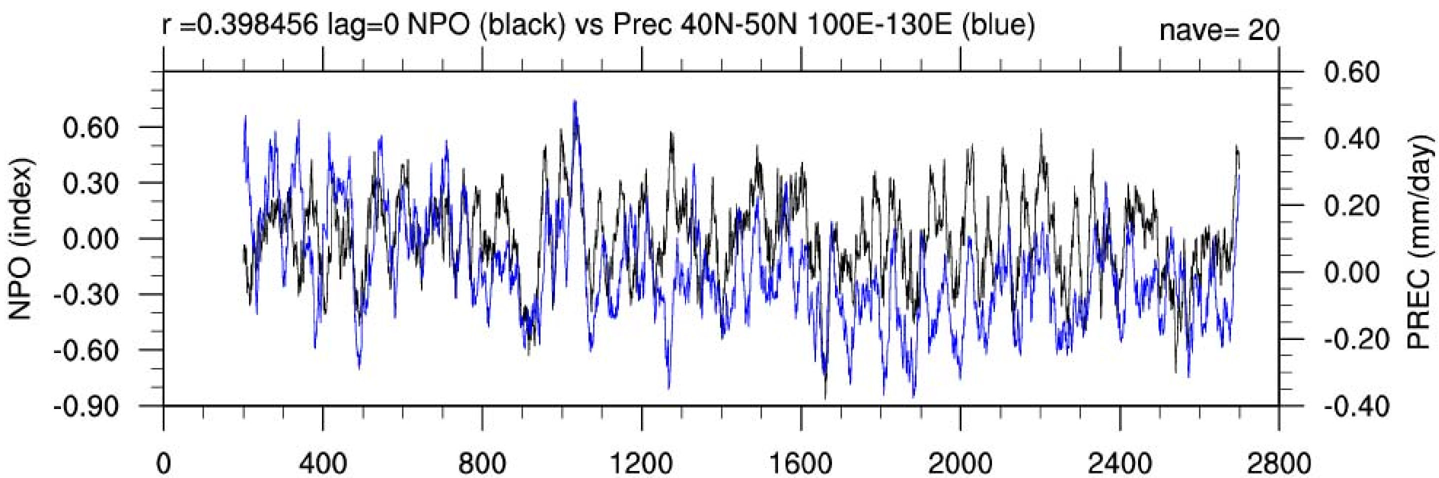
1X case end-run (NPO in “west” mode)

10X case mid-run (NPO in “west” mode)

1X case

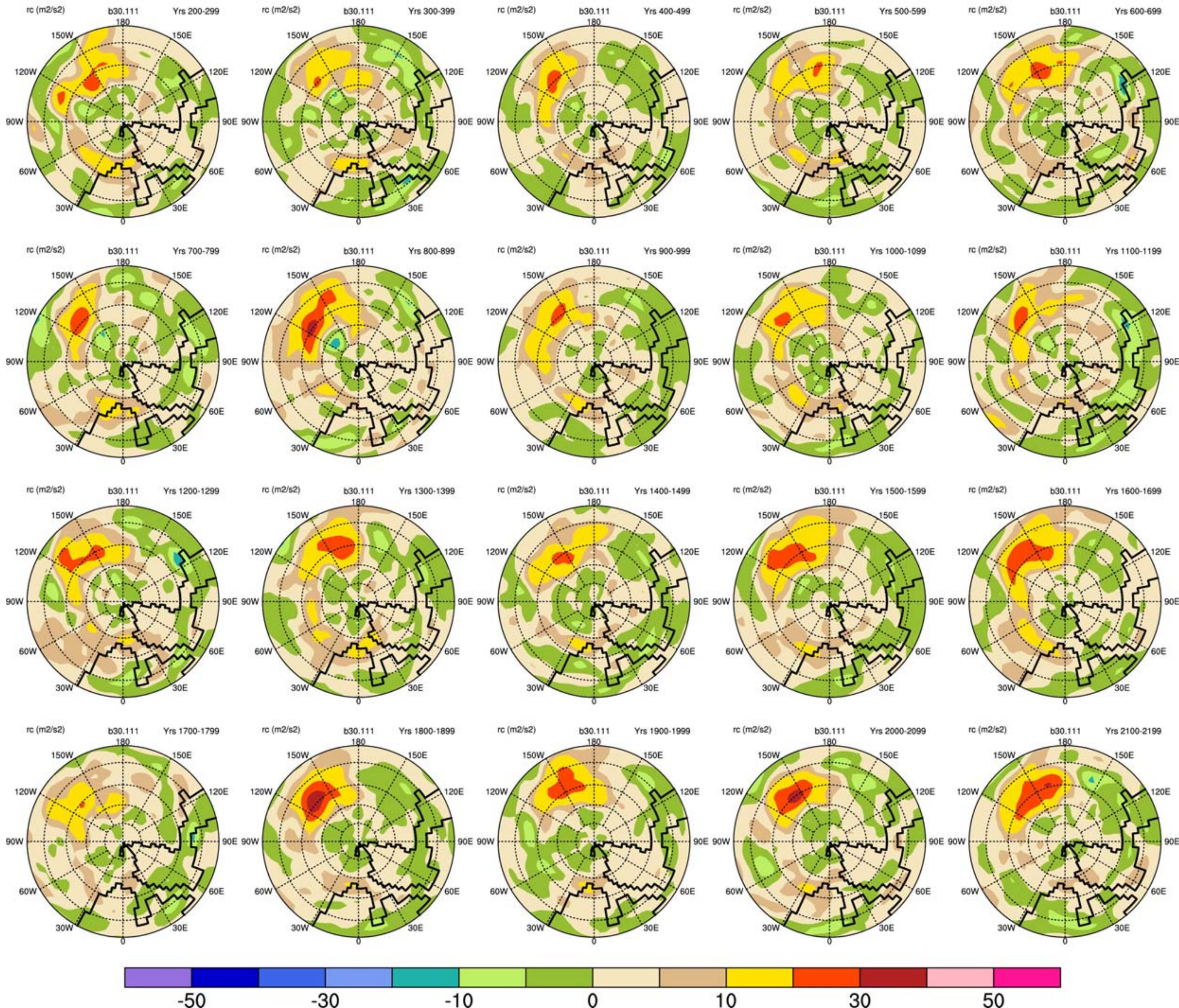


10X case



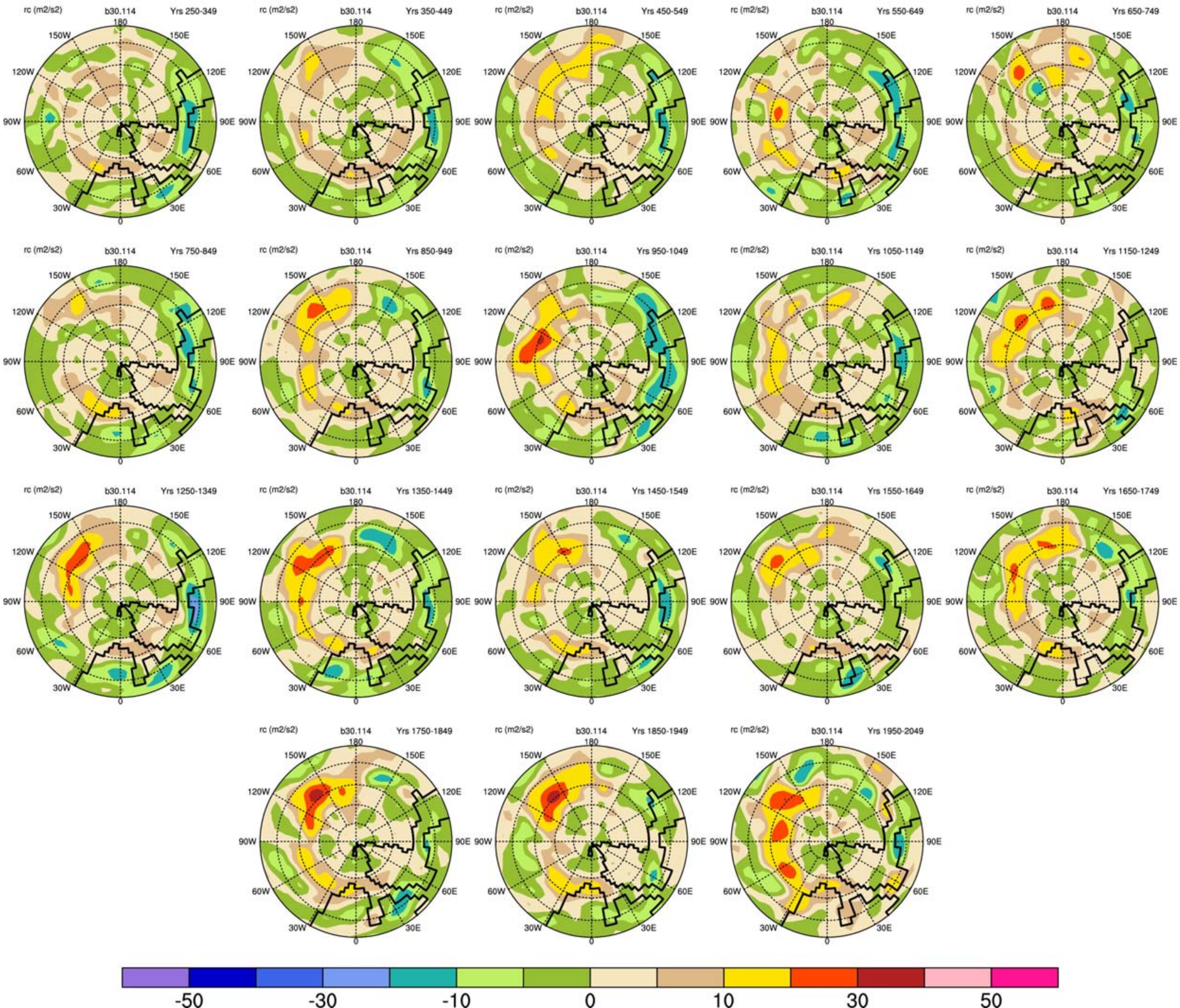
DJFM NPO regressed onto VU-V*U 250mb

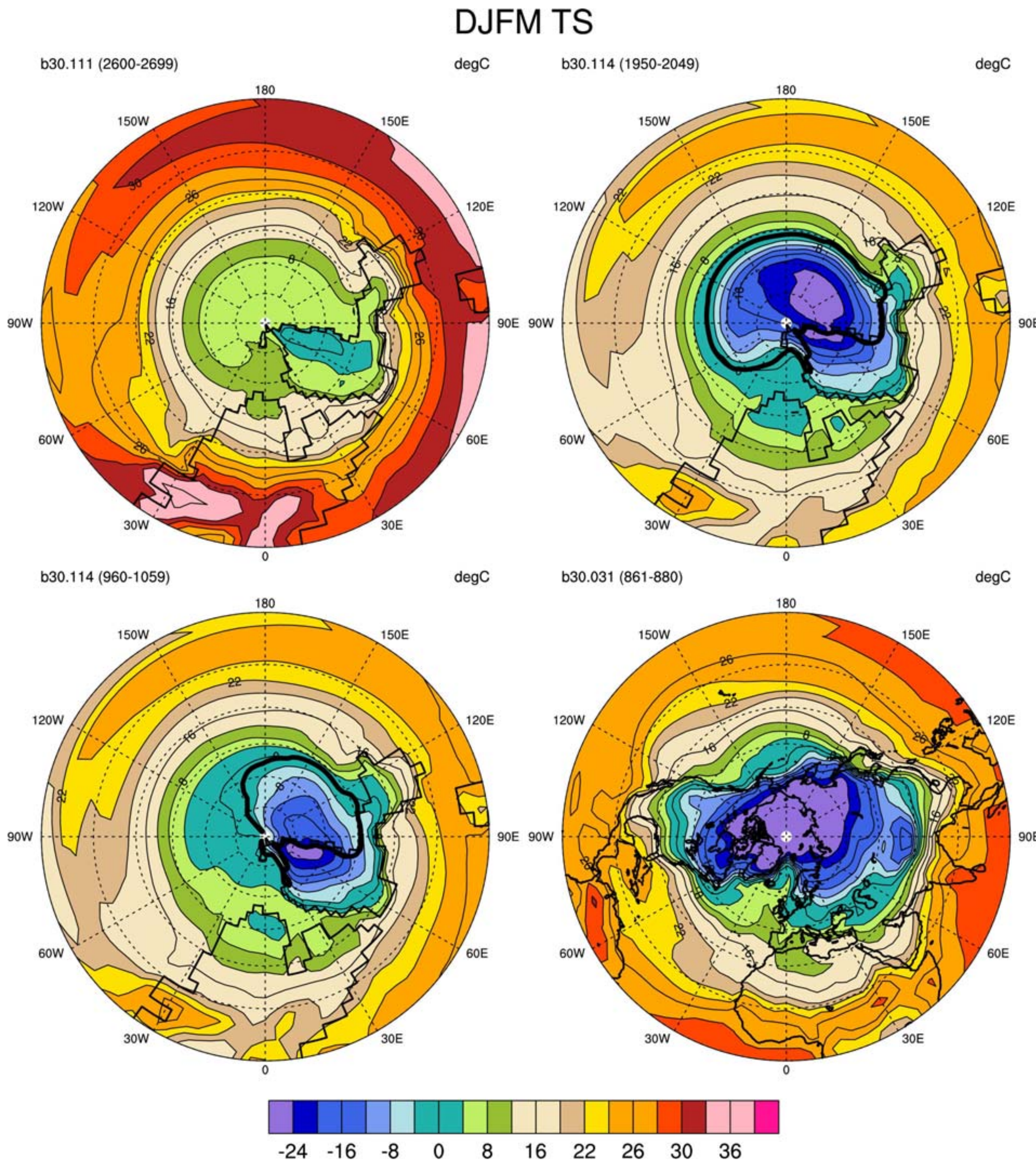
10X case



DJFM NPO regressed onto VU-V*U 250mb

1X
case





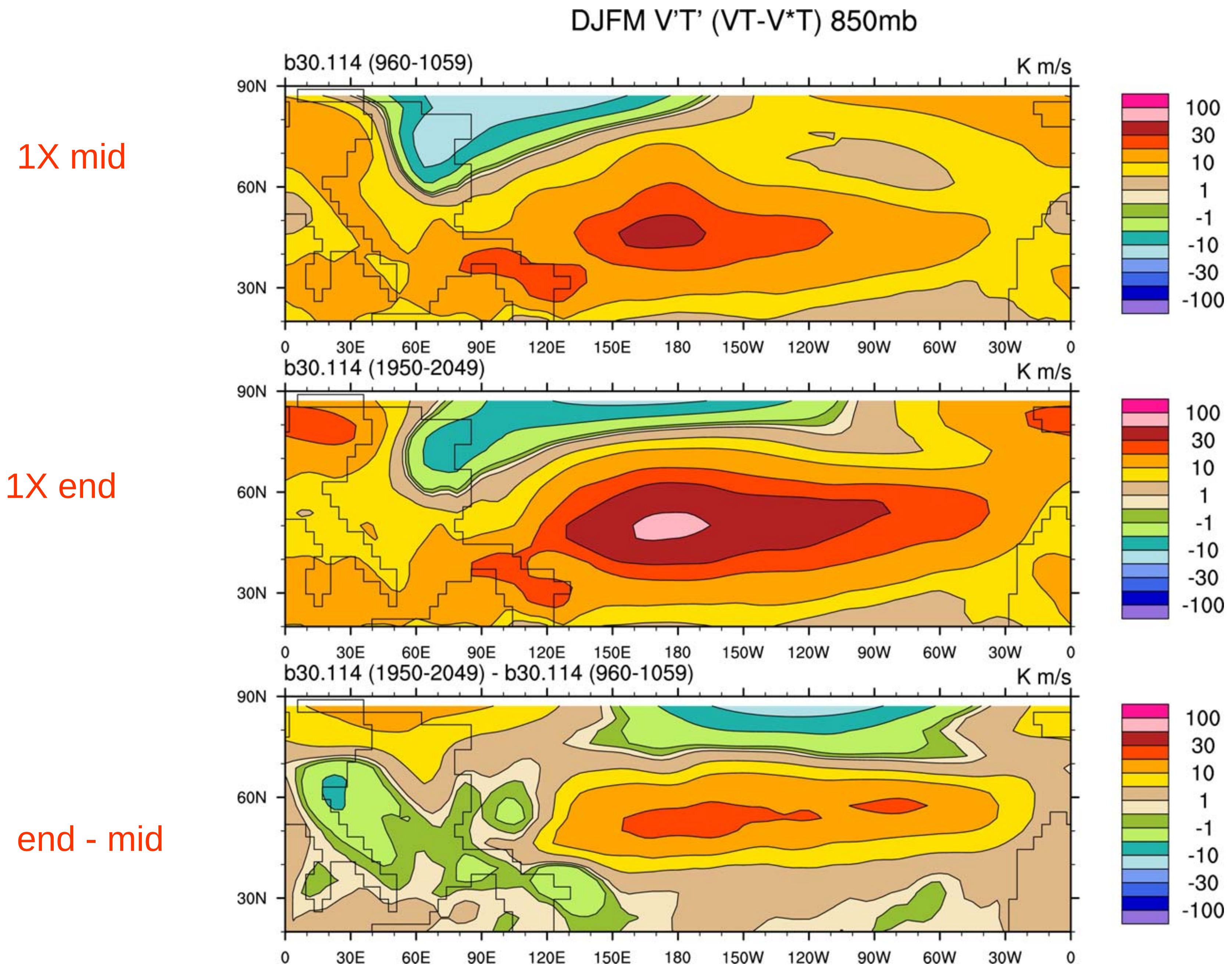
10X

1X end

1X mid

PD control

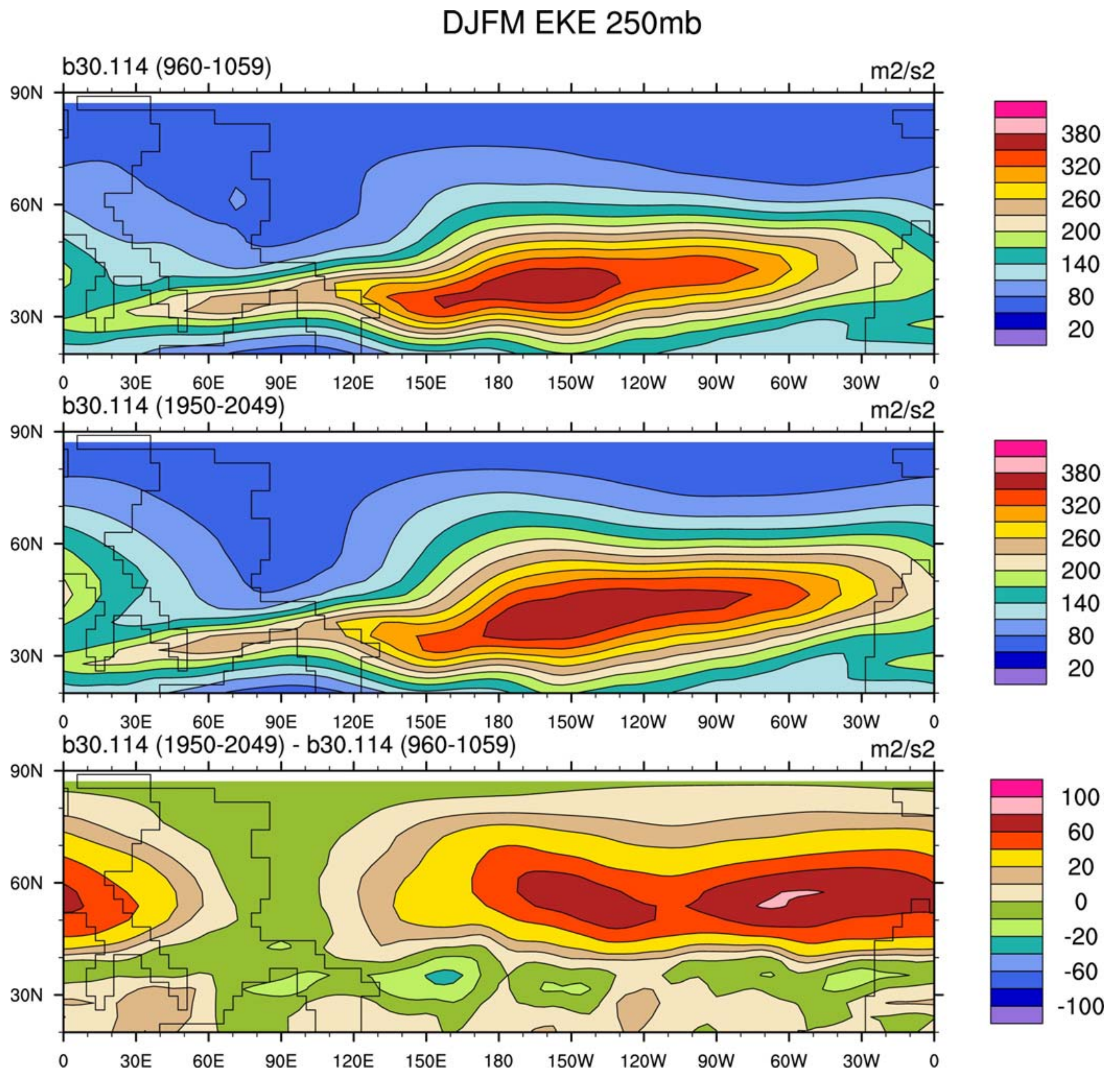
The thick black line drawn on the 1x cases is the 10% ice concentration contour.


DJFM V'T' (VT-V*T) 850mb
1X mid
b30.114 (960-1059)
K m/s
1X end
b30.114 (1950-2049)
K m/s
end - mid
b30.114 (1950-2049) - b30.114 (960-1059)
K m/s
90N
60N
30N
0
30E
60E
90E
120E
150E
180
150W
120W
90W
60W
30W
0
100
30
10
1
-1
-10
-30
-100

1X mid

1X end

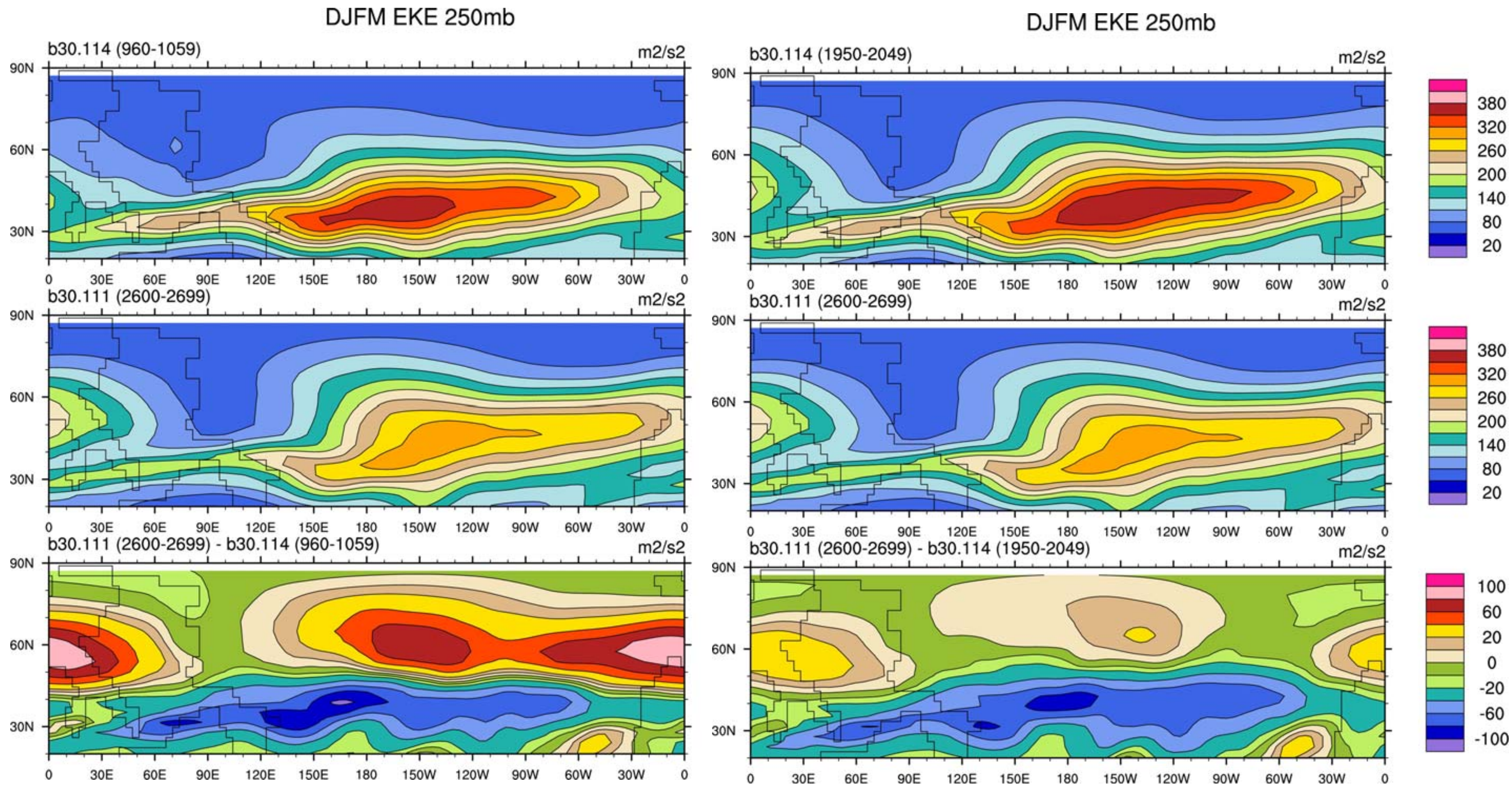
1X end - mid



Winter Eddy Kinetic Energy 250mb

1Xmid, 10X, 10x – 1Xmid

1Xend, 10X, 10x – 1Xend



Conclusions

1) NPO/AO can shift modes, i.e. area of maximum PSL variability, in CCSM3 given:

a) changes in storm track and/or
b) decrease in connection to tropics, (i.e, tropical rainfall)

2) For the PT CCSM3 simulations specifically

a) 10x NPO "west" mode driven by *poleward* shift in storm tracks and a weak tropical connection

b) 1X NPO mode shifts from "east" to "west" due to a *poleward and eastward migration* of maximum EKE and baroclinic zones

c) 1X shift in storm tracks primarily forced by increased temperature gradients. Increased t-grads a response from expanded ice edge into mid-latitudes, most notably across the entire Panthalassic Ocean.

THE END