A Zonal Wavenumber-3 Pattern of Northern Winter Circulation:

Linking Interannual Variability & Trend

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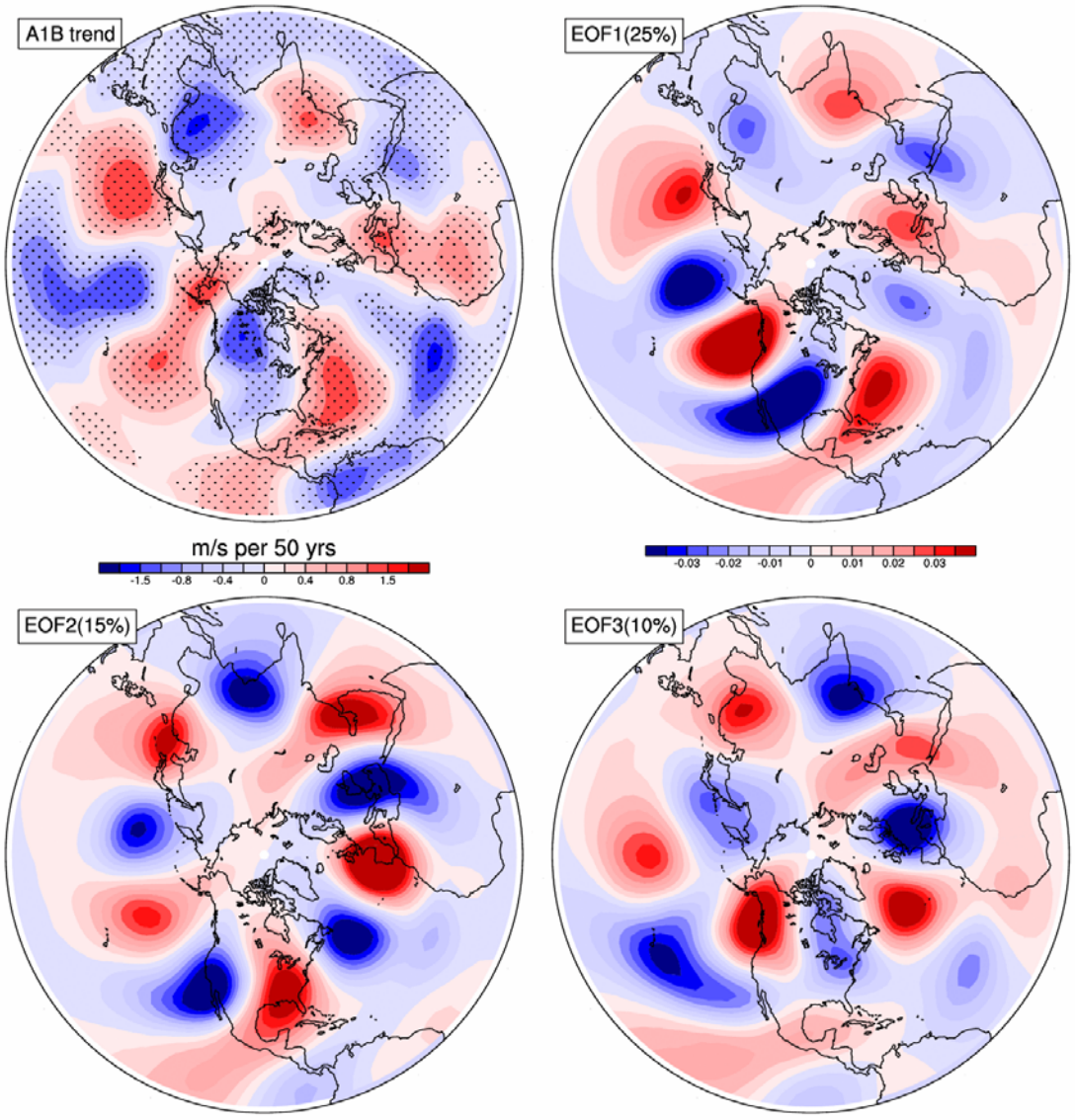
How do northern winter stationary waves change under future warmer climate?

40-member
A1B CCSM3
large ensemble

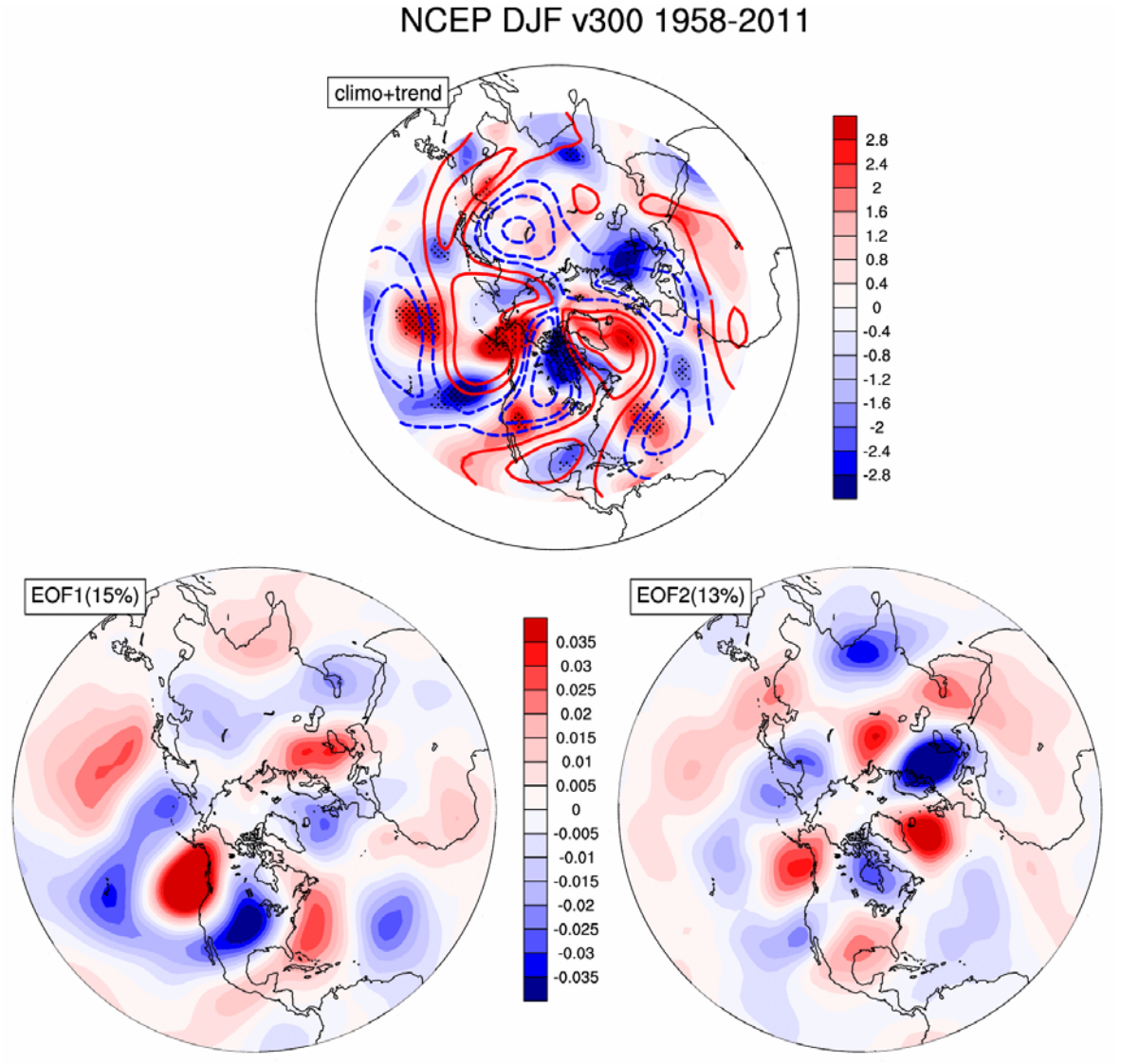
700-yr control



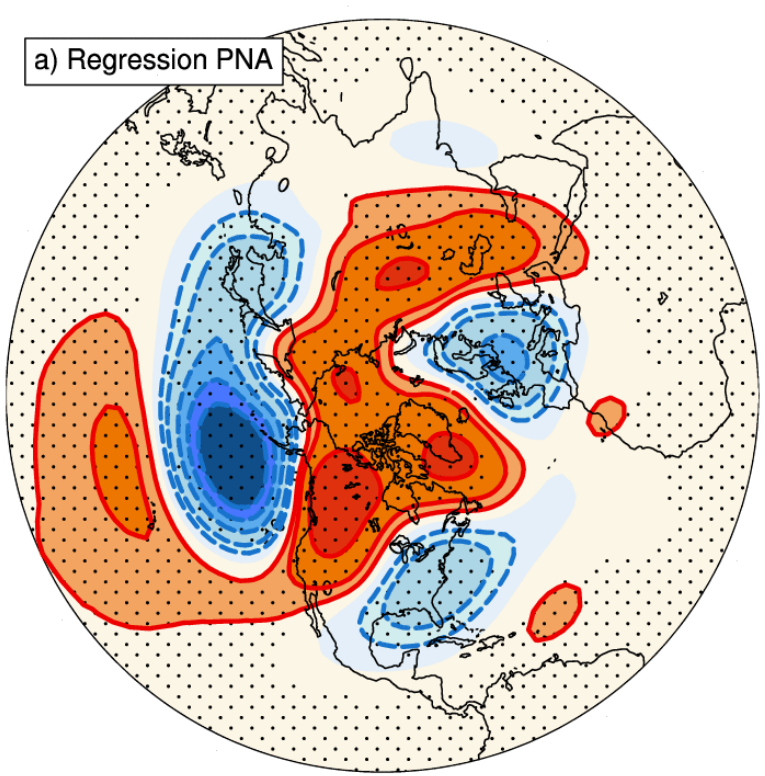
DJF v300 trend & variability in CCSM3

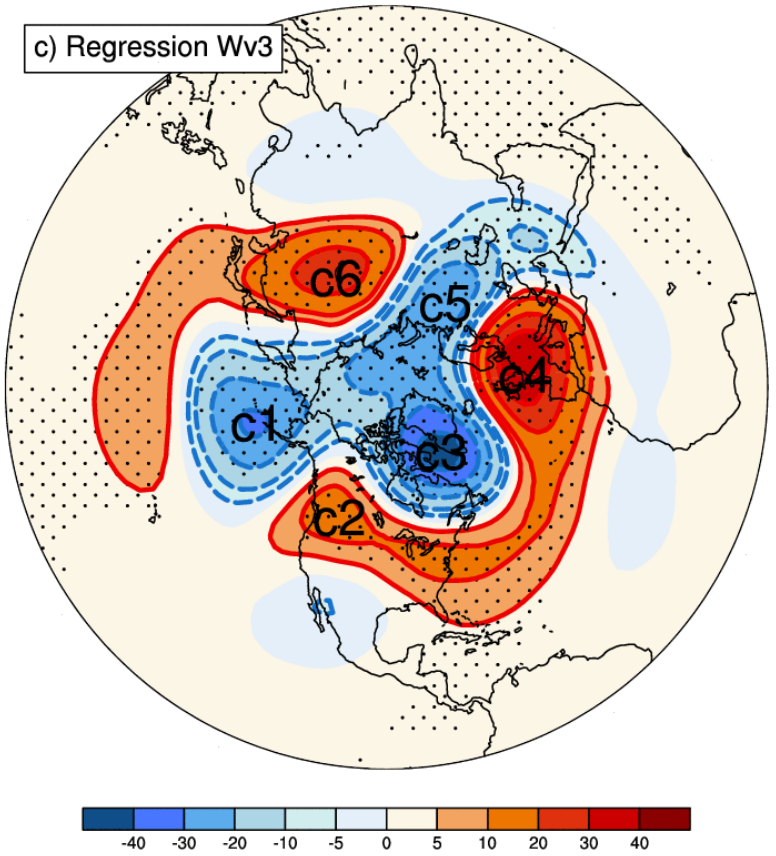
CMIP3 analysis:
Meehl and Teng (2007)
Brandefelt and Kornich (2008)

V300 Trend & Variability in Reanalysis



Z500 regression

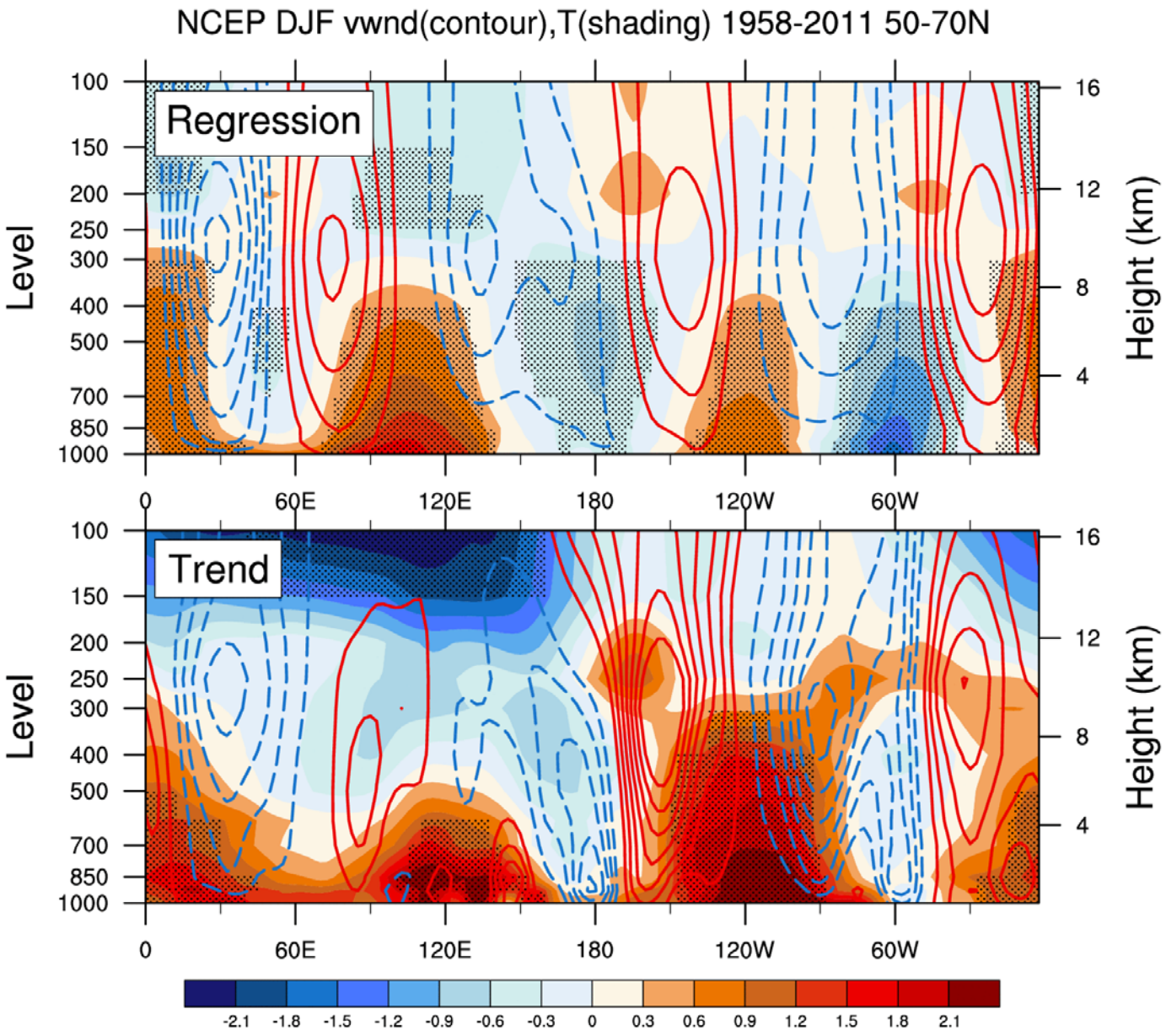




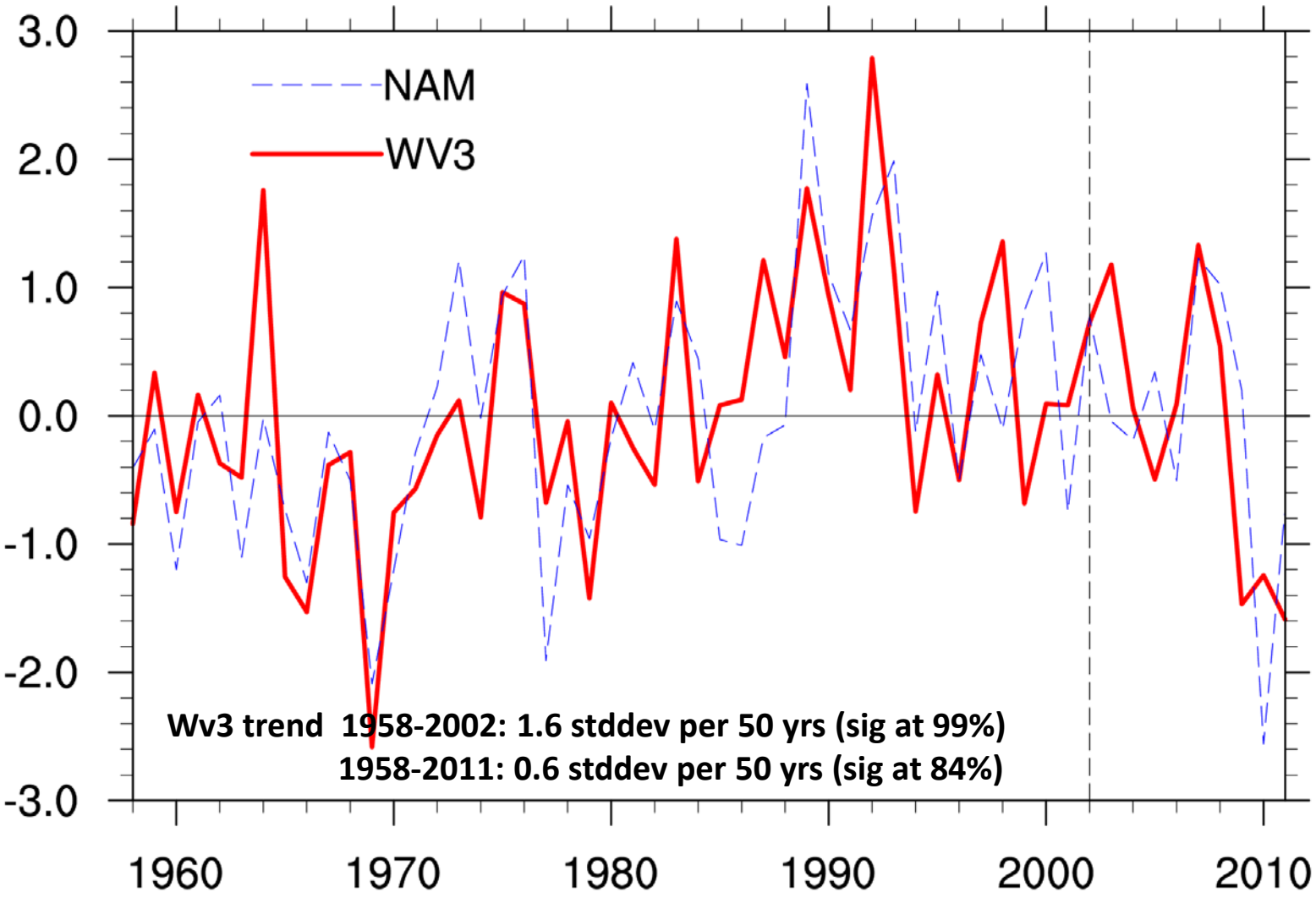
Cor<PC1,PNA>= 0.84

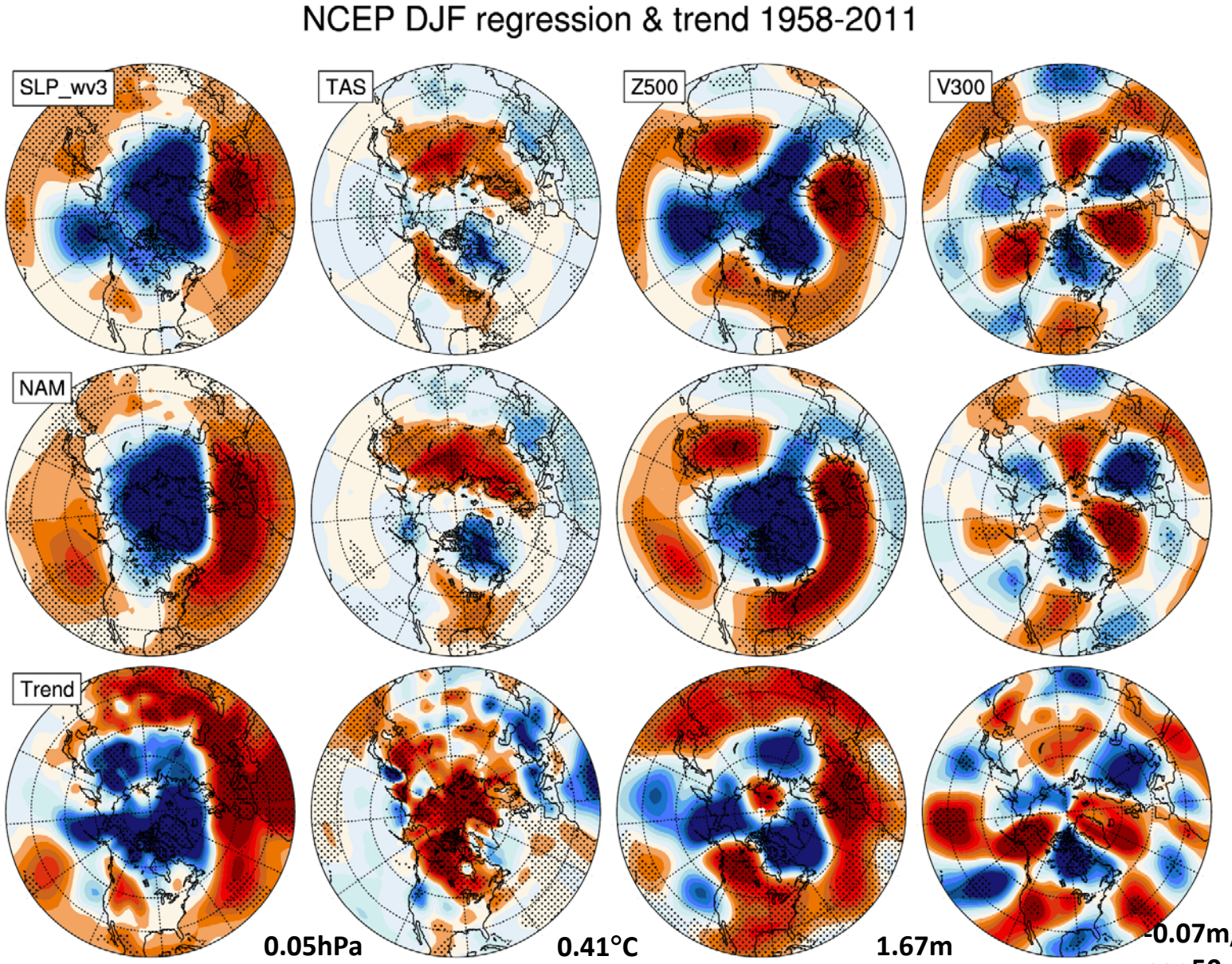
Wallace ‘s COWL

Chang and Fu (2002) storm track mode


NCEP DJF vwnd(contour),T(shading) 1958-2011 50-70N
Regression
Trend
Level
Height (km)
100
150
200
250
300
400
500
700
850
1000
16
12
8
4
0
60E
120E
180
120W
60W
-2.1
-1.8
-1.5
-1.2
-0.9
-0.6
-0.3
0
0.3
0.6
0.9
1.2
1.5
1.8
2.1

Normalized Wave3 and NAM(AO) Index

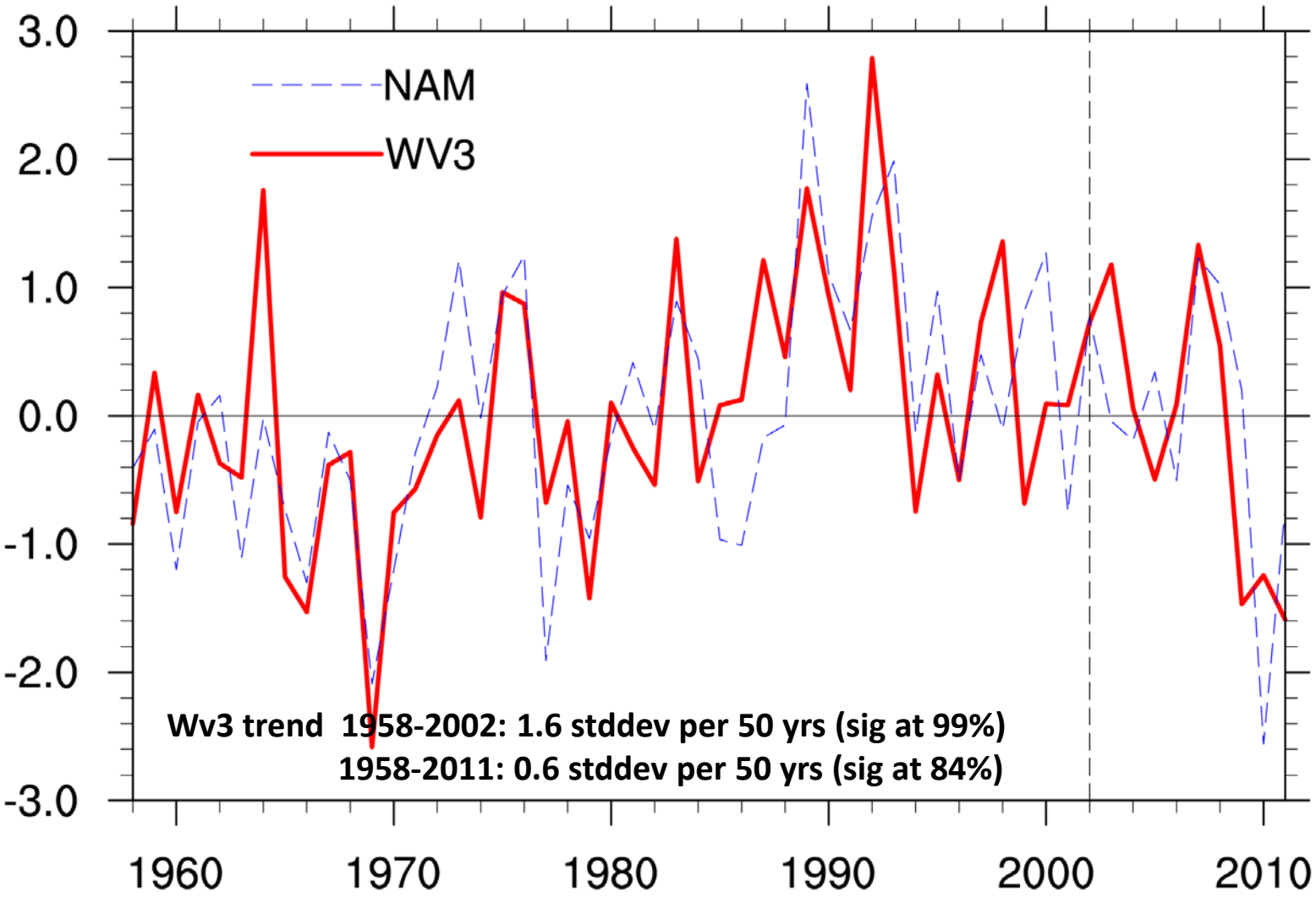




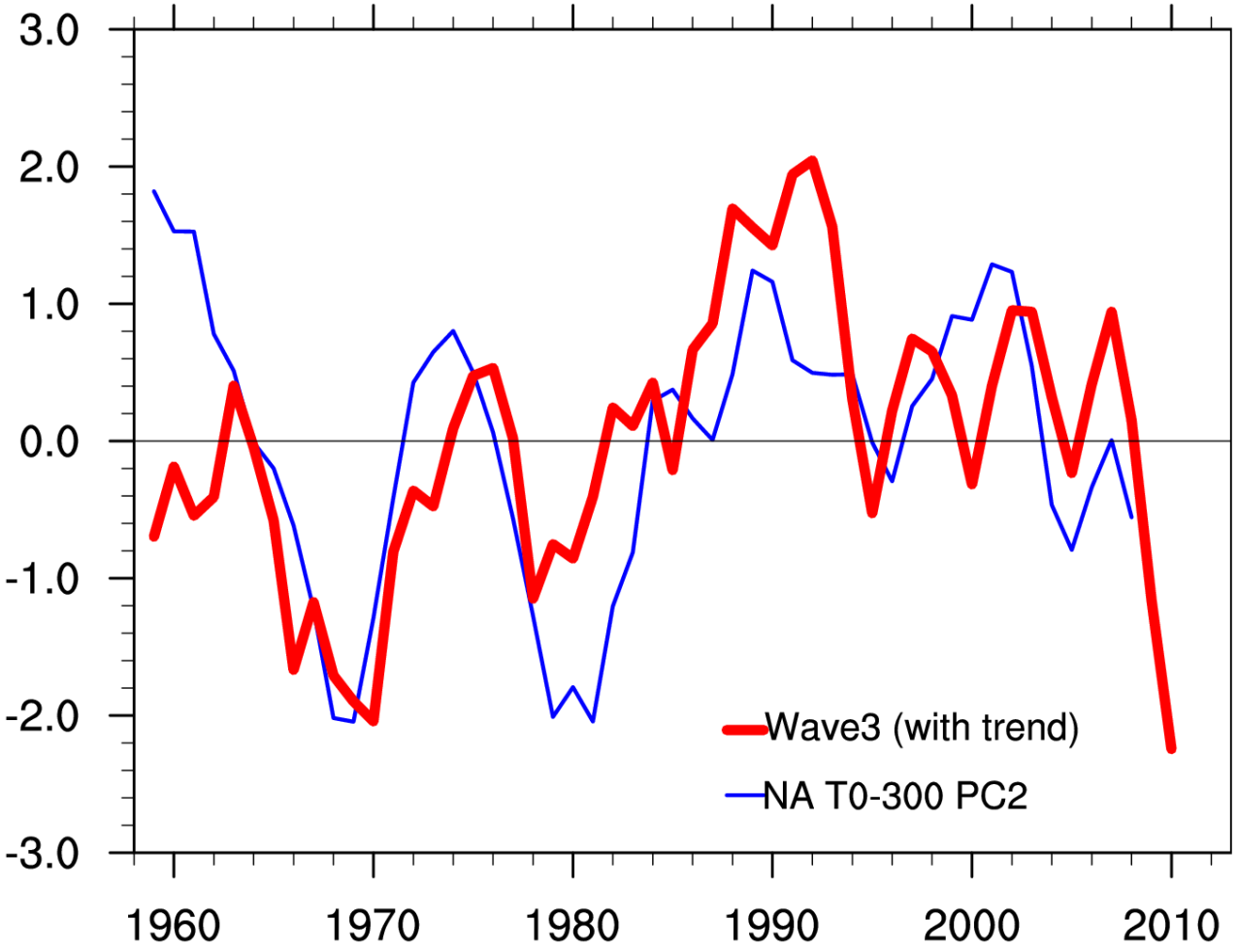
Gavg= **0.05hPa** **0.41°C** **1.67m** **-0.07m/s per 50yrs subtracted from trend**

unit for Z500 is x10m

Normalized Wave3 and NAM(AO) Index

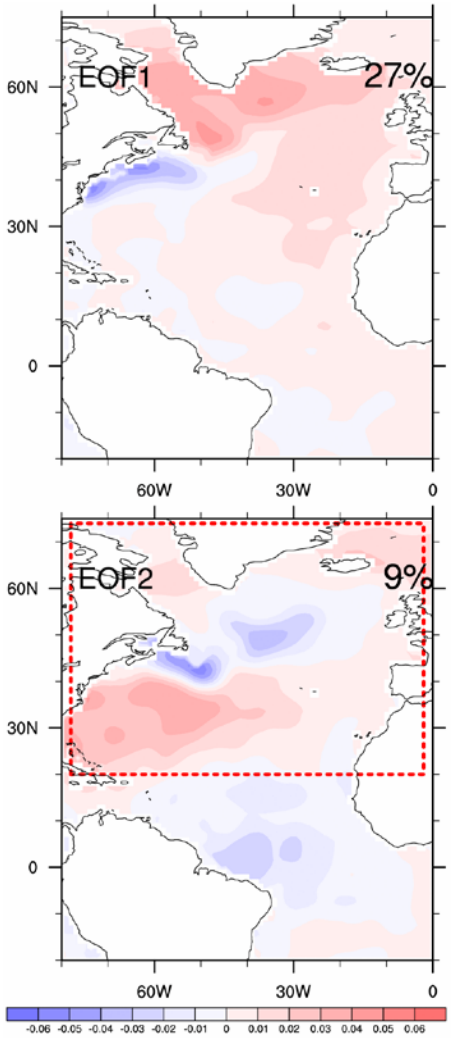


Multidecadal Variability in the NAtl .

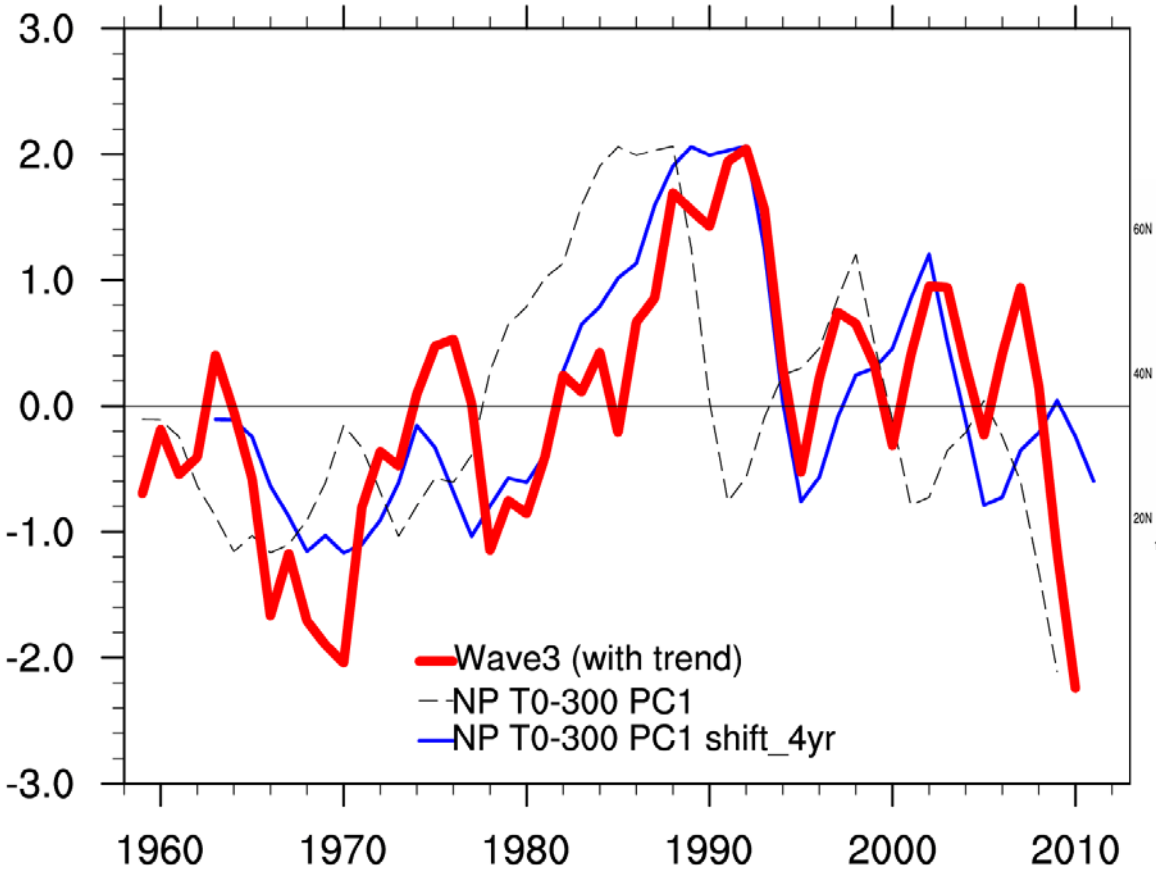


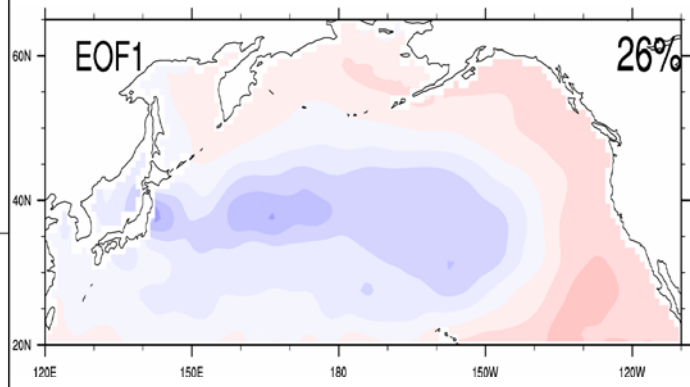
3-yr running mean

Levitus upper300m T

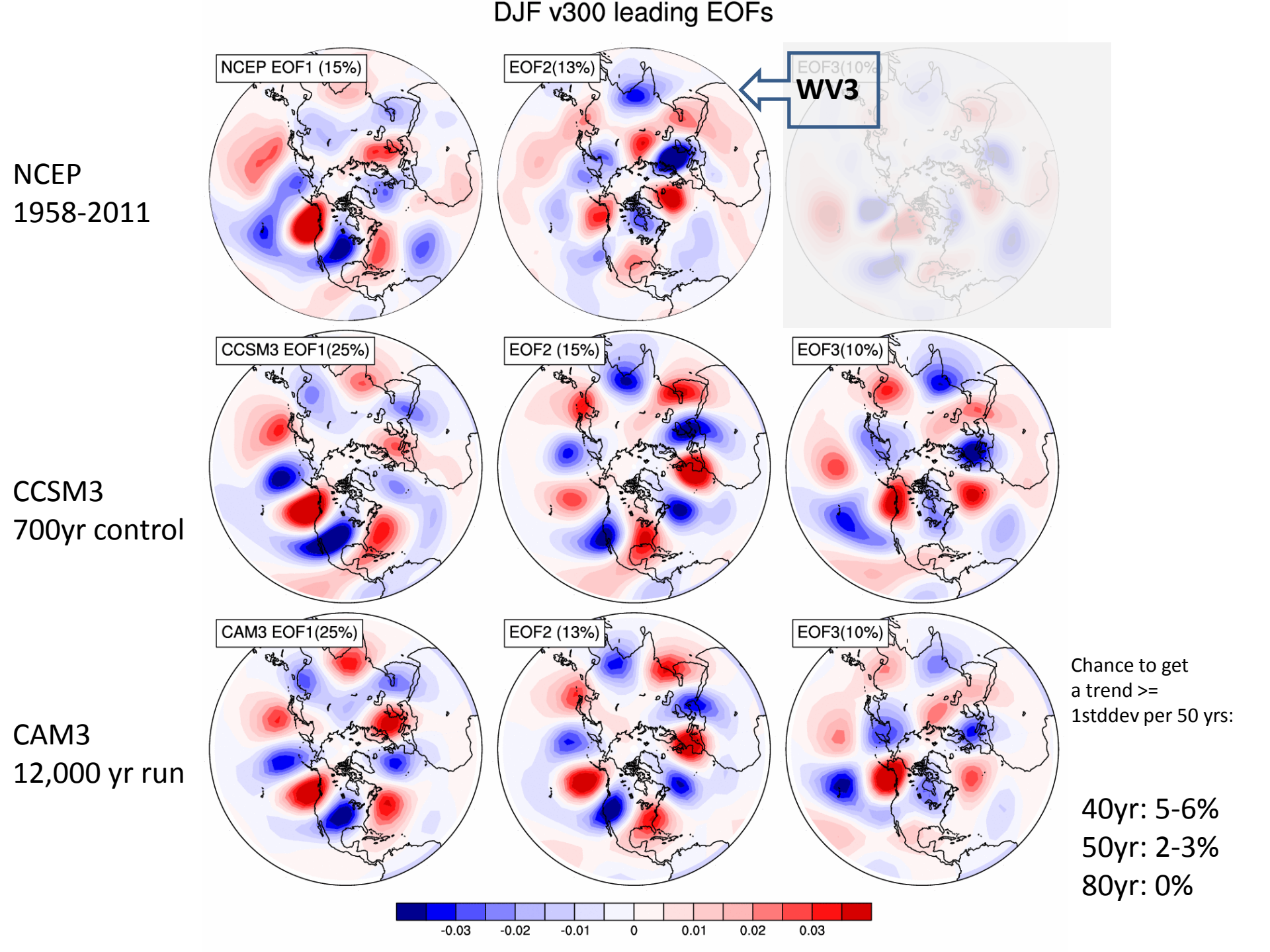


Multidecadal Variability in the NPac .

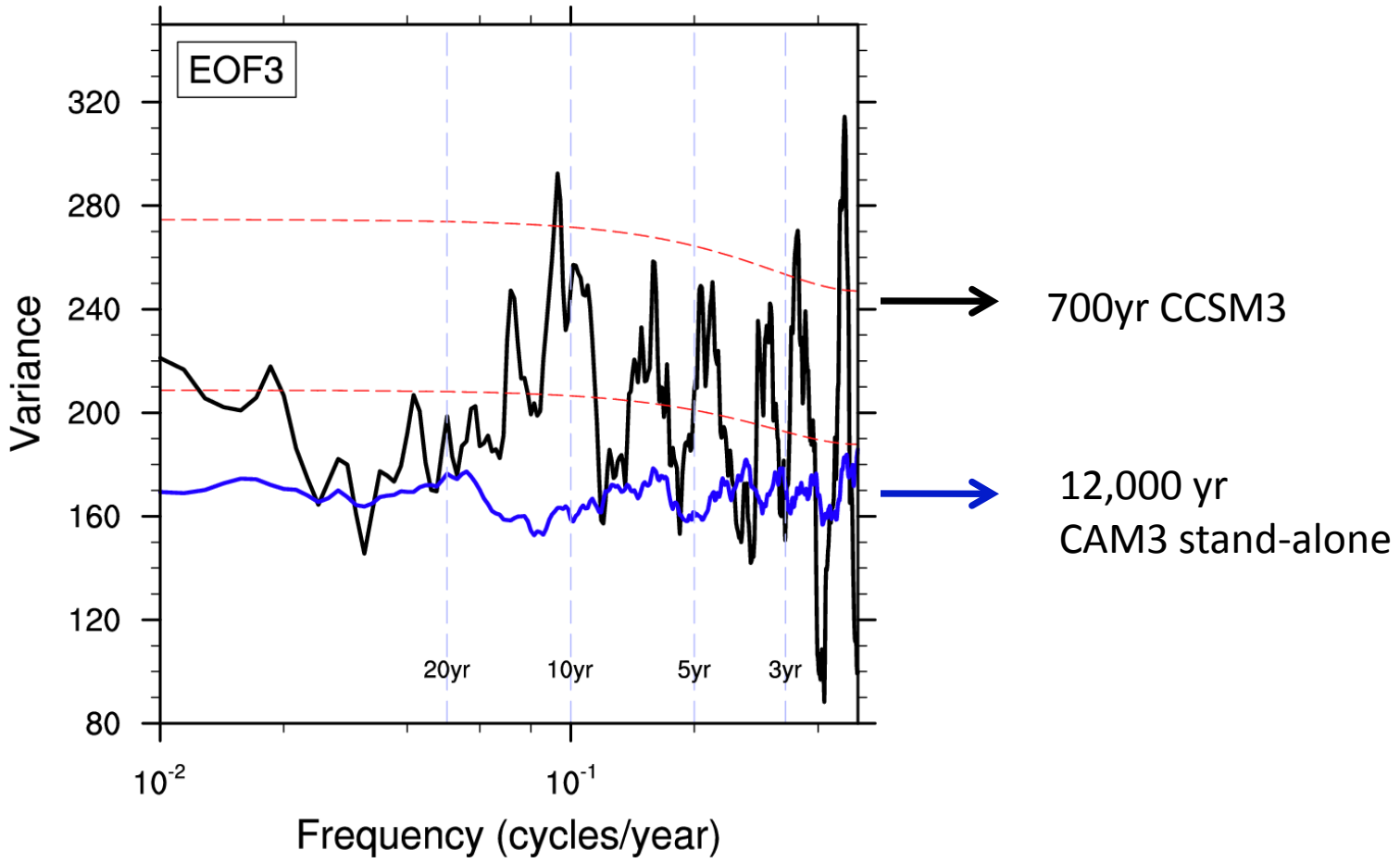




3-yr running mean

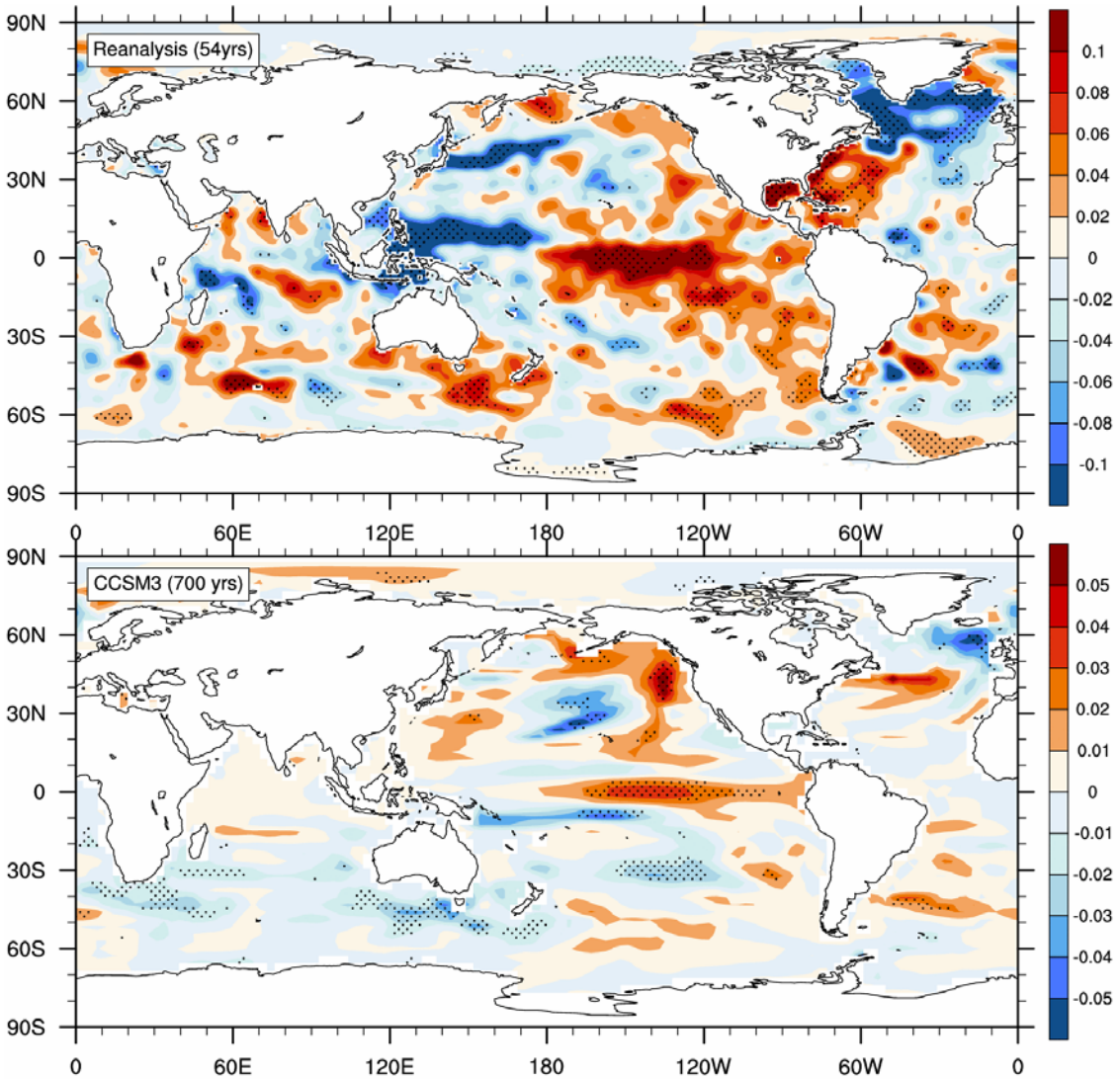

DJF v300 leading EOFs
NCEP EOF1 (15%)
EOF2(13%)
EOF3(10%)
WV3
NCEP
1958-2011
CCSM3 EOF1(25%)
EOF2 (15%)
EOF3(10%)
CCSM3
700yr control
CAM3 EOF1(25%)
EOF2 (13%)
EOF3(10%)
CAM3
12,000 yr run
-0.03
-0.02
-0.01
0
0.01
0.02
0.03
Chance to get
a trend >=
1stddev per 50 yrs:
40yr: 5-6%
50yr: 2-3%
80yr: 0%

Air-sea coupling enhances the Wave3 mode



total variance increases 17%

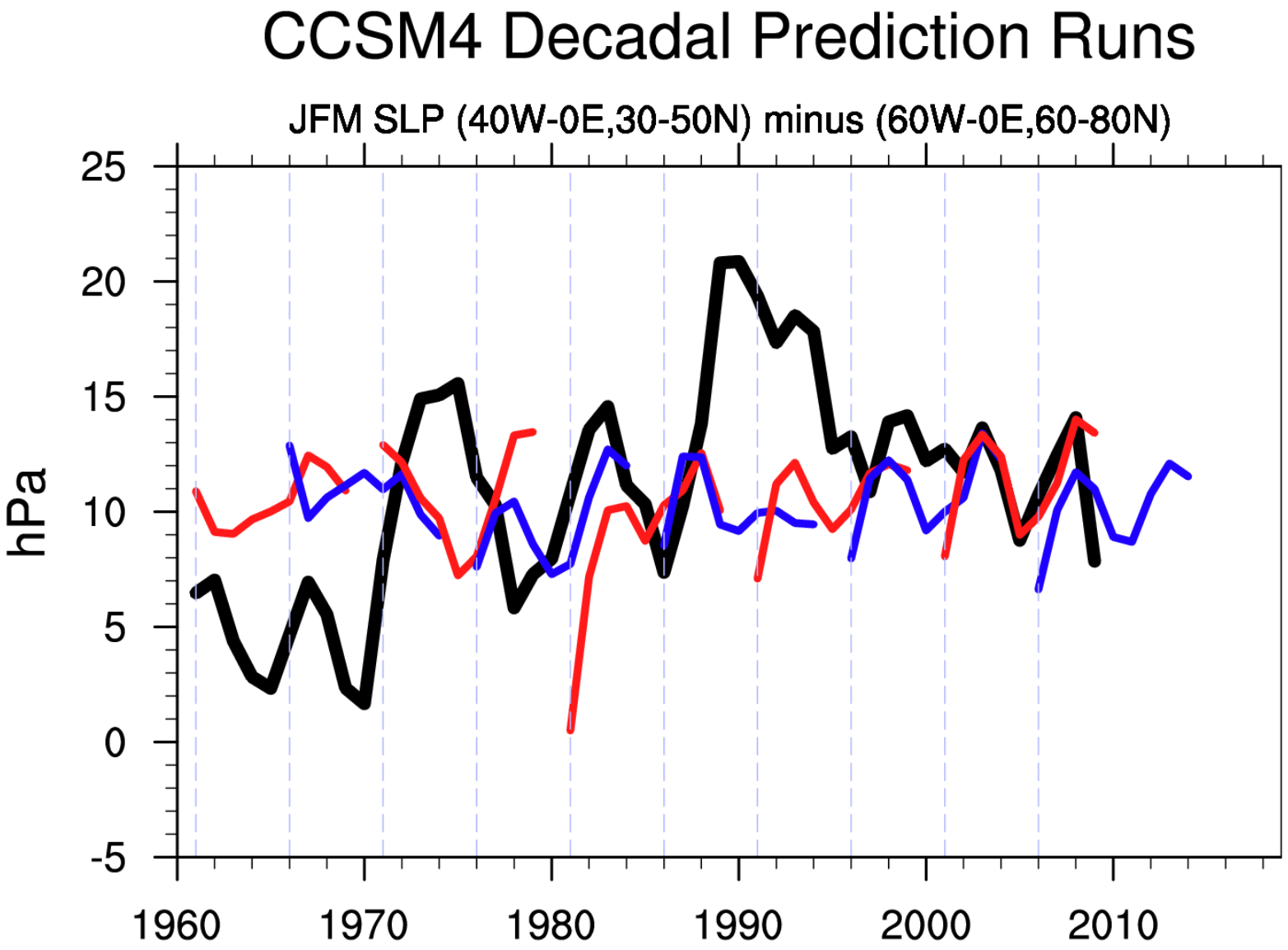
Regression of T0-300(-1yr ANN)



Summary

- While many **CMIP3 models** including CCSM3 simulate a **wavenumber-5** trend in the subtropics in NH wintertime circulation under future warmer climate, the **observed** trend in the past 50 years or so exhibits a **wavenumber-3** structure.
- The observed wavenumber-3 **trend** bears closer resemblance to a zonal wavenumber-3 **pattern of variability** than to NAM.
- The wavenumber-3 pattern is a prominent pattern in both CCSM3 and CAM3 stand-alone runs. **Air-sea coupling** enhances the mode variability.
- We are **uncertain** whether the observed wavenumber-3 50-year trend is actually **multidecadal variability**.

Can our model dance the waltz?


CCSM4 Decadal Prediction Runs
JFM SLP (40W-0E,30-50N) minus (60W-0E,60-80N)
hPa
25
20
15
10
5
0
-5
1960
1970
1980
1990
2000
2010