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

DJF v300 trend & variability in CCSM3

700-yr control

CMIP3 analysis:
Meehl and Teng (2007)
Brandefelt and Kornich (2008)
V300 Trend & Variability in Reanalysis

NCEP DJF v300 1958-2011

climo+trend

EOF1(15%)
EOF2(13%)
Cor<PC1,PNA>= 0.84

Wallace ‘s COWL
Chang and Fu (2002) storm track mode
Normalized Wave3 and NAM(AO) Index

Wv3 trend 1958-2002: 1.6 stddev per 50 yrs (sig at 99%)
1958-2011: 0.6 stddev per 50 yrs (sig at 84%)
unit for Z500 is x10m
Normalized Wave3 and NAM(AO) Index

Wv3 trend 1958-2002: 1.6 stddev per 50 yrs (sig at 99%)
1958-2011: 0.6 stddev per 50 yrs (sig at 84%)
Multidecadal Variability in the NAtl

3-yr running mean

Levitus upper300m T

EOF1 27%

EOF2 9%
Multidecadal Variability in the NPac.
40yr: 5-6%
50yr: 2-3%
80yr: 0%

Chance to get a trend $\geq 1$ stddev per 50 yrs:
CCSM3 700yr control
NCEP 1958-2011
CCSM3 700yr control
CAM3 12,000 yr run

Other notes:

- DJF v300 leading EOFs
- WV3
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)