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International Centre for Theoretical Physics**



**1968-35**

**Conference on Teleconnections in the Atmosphere and Oceans**

*17 - 20 November 2008*

**Inter-basin link between the North Pacific and North Atlantic in the upper  
troposphere: Its dominance and seasonal dependence**

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# Inter-basin link of variability in the tropospheric circulation over the North Atlantic and North Pacific: Its interdecadal modulations and seasonal dependence

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(FRCGC/JAMSTEC, Japan)

<sup>\*</sup> Also Doshisha University <sup>\*\*</sup> Also University of Tokyo

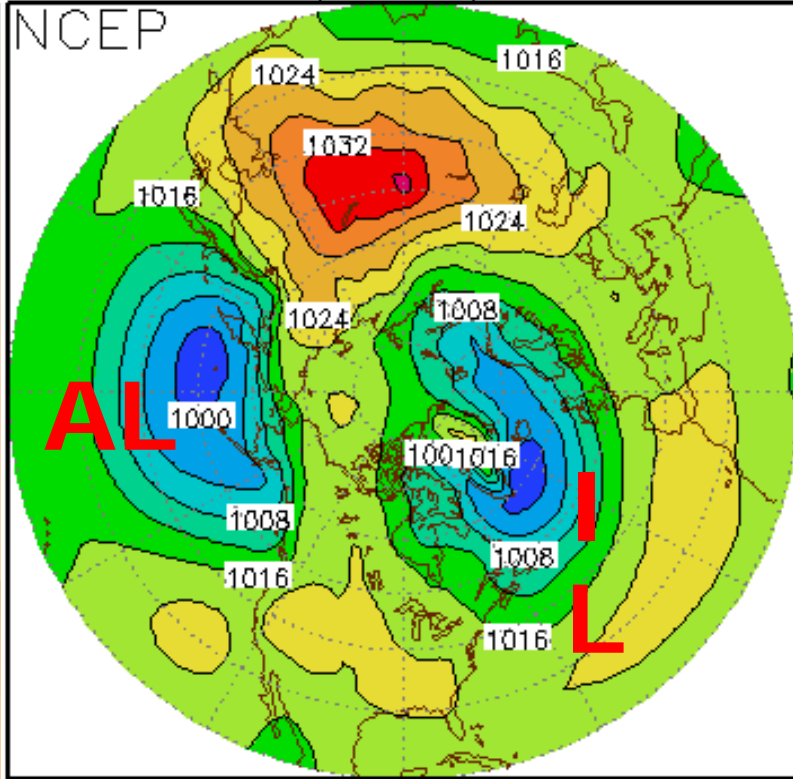
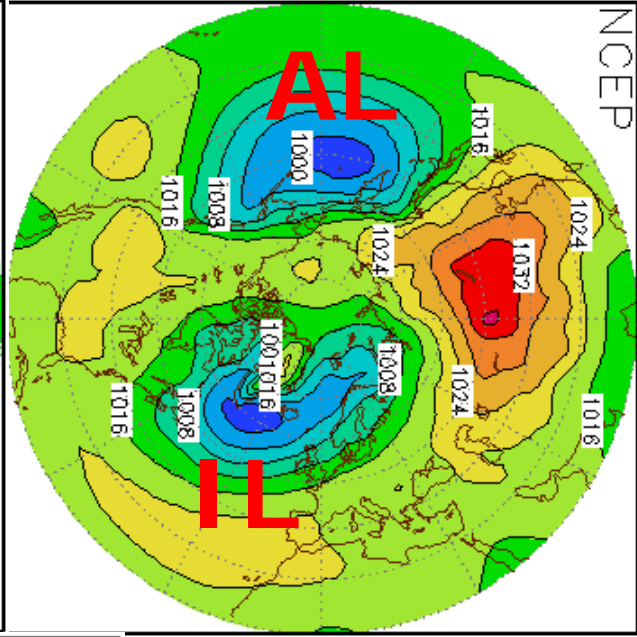
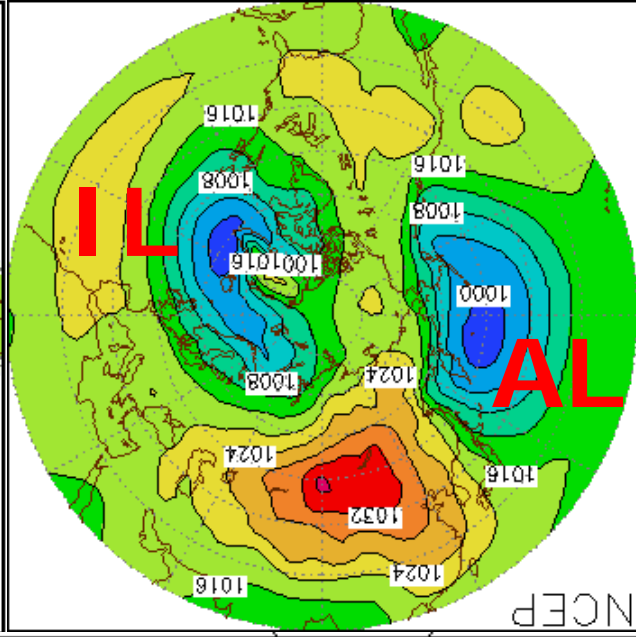
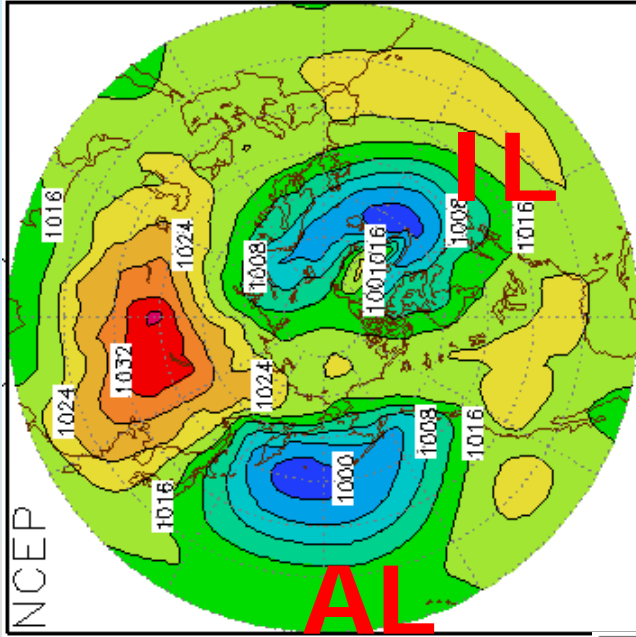
Honda, M., S. Yamane, and H. Nakamura (2007), *J. Meteor Soc. Japan*, 85, 899-908.

Corresponding e-mail: [meiji@jamstec.go.jp](mailto:meiji@jamstec.go.jp)

URL: <http://www.jamstec.go.jp/frcgc/research/p1/meiji/index.html>

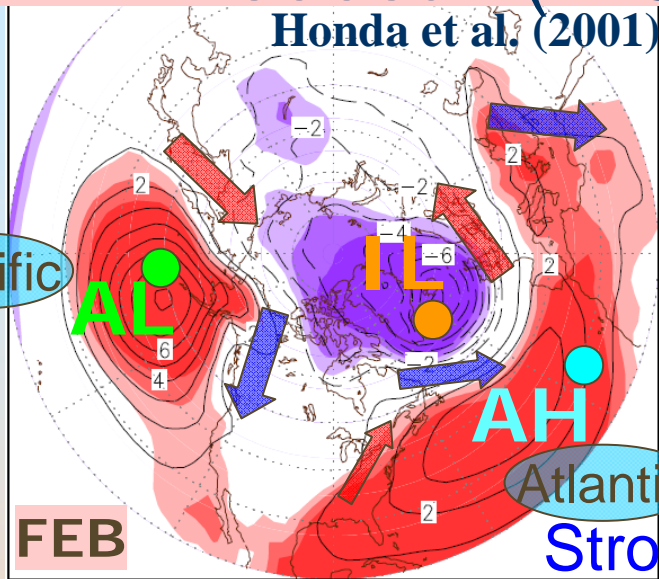
19 November, 2008

Conference on Teleconnections in the Atmosphere and Oceans  
ICTP, Trieste, Italy

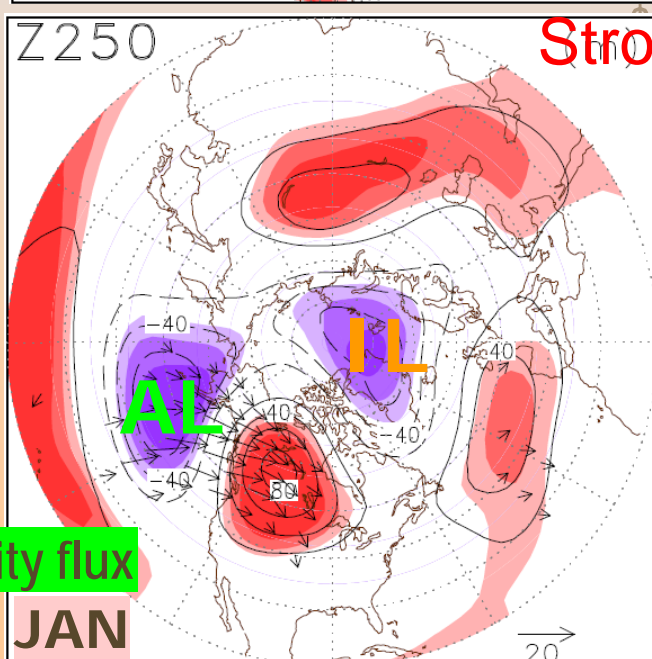
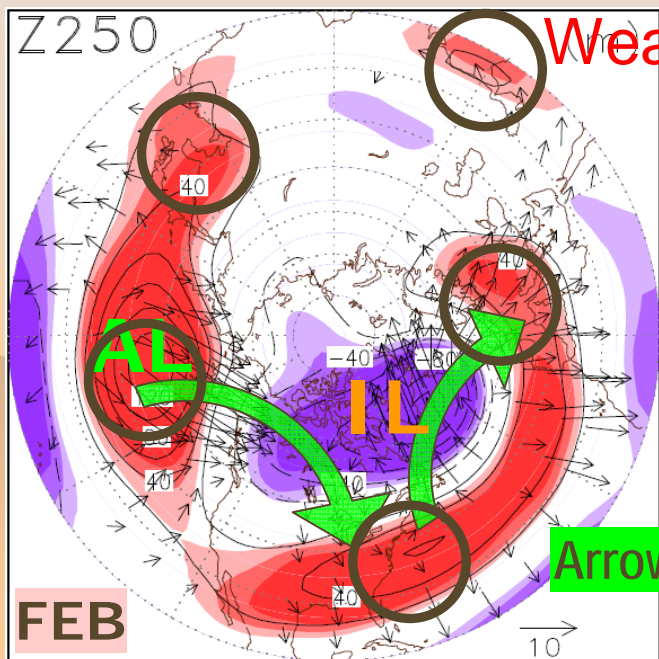
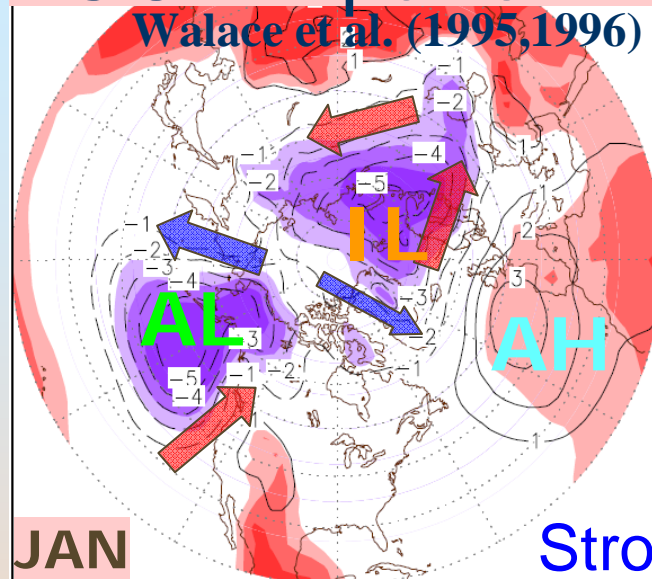


# Inter-basin link between NA and NP

## AL-IL seesaw (AIS)

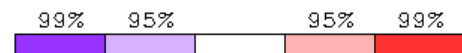
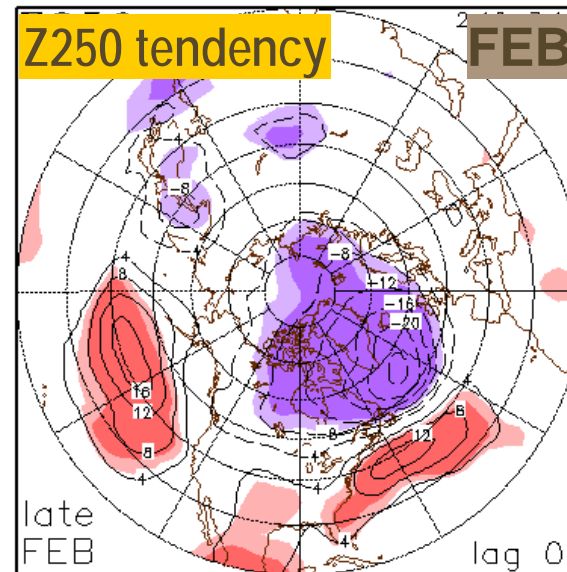
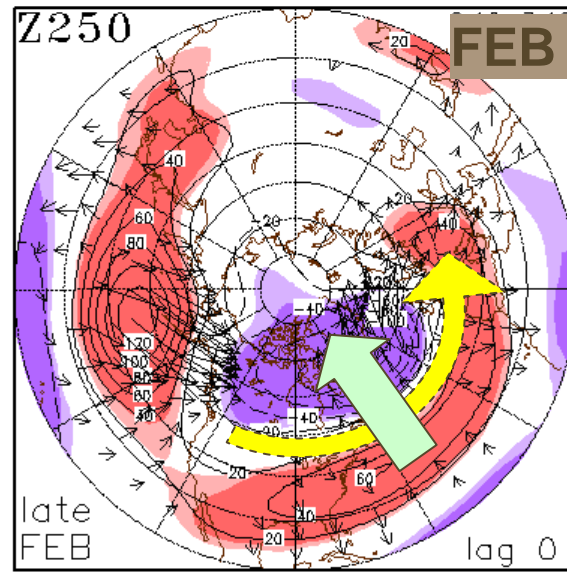
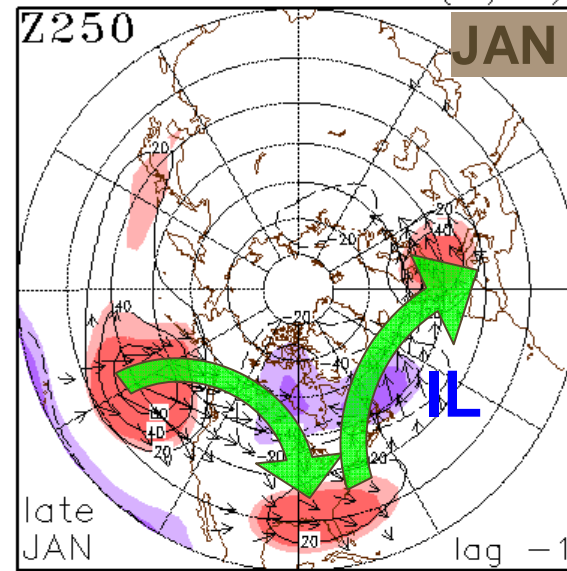
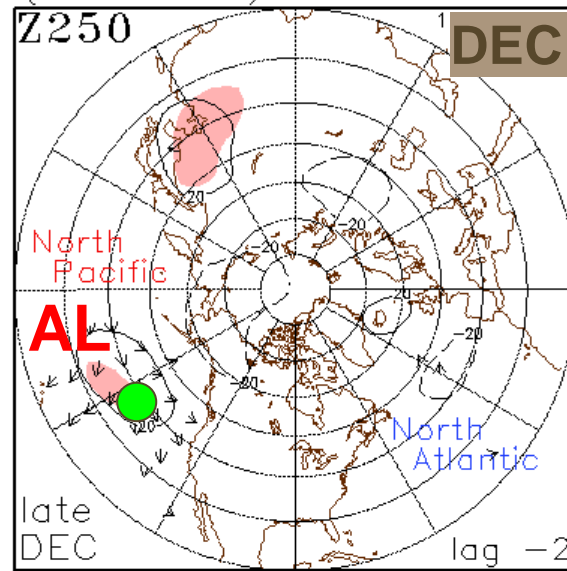


## COWL pattern



# AIS formation (Z250 lag regression on FEB AIS index)

Wave activity



Feedback from stormtrack

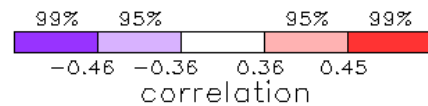
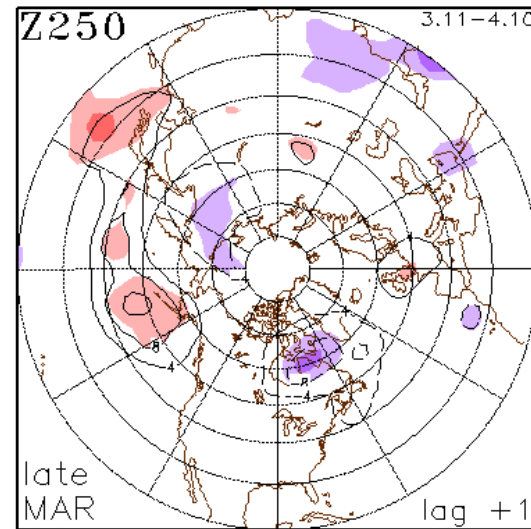
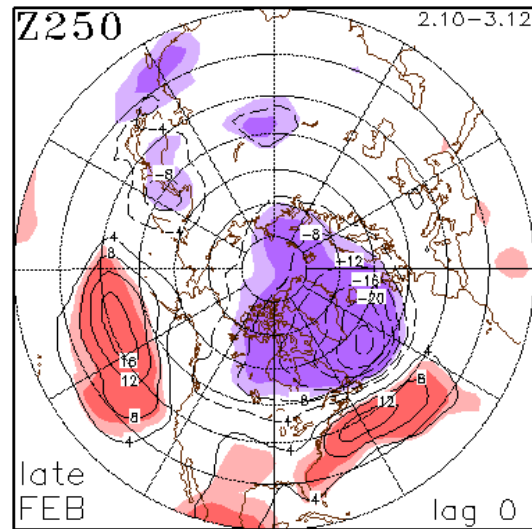
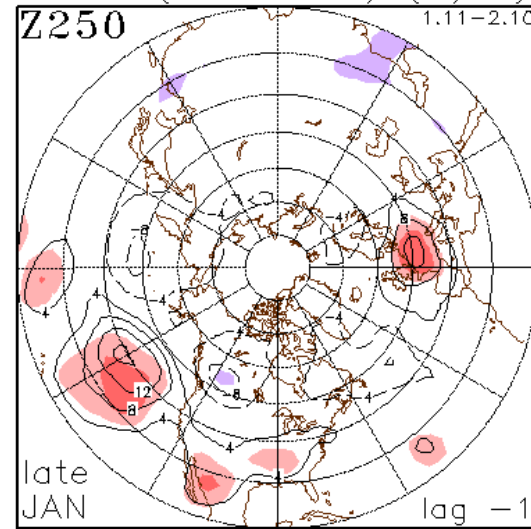
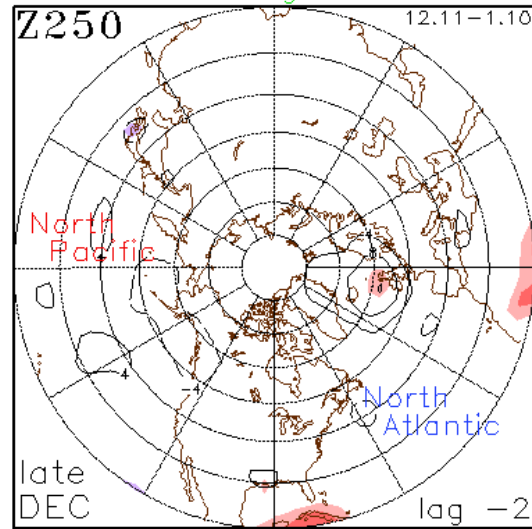
stormtrack

vorticity flux

Arrows: Wave activity flux (Takaya and Nakamura 2001) Honda et al. (2001)



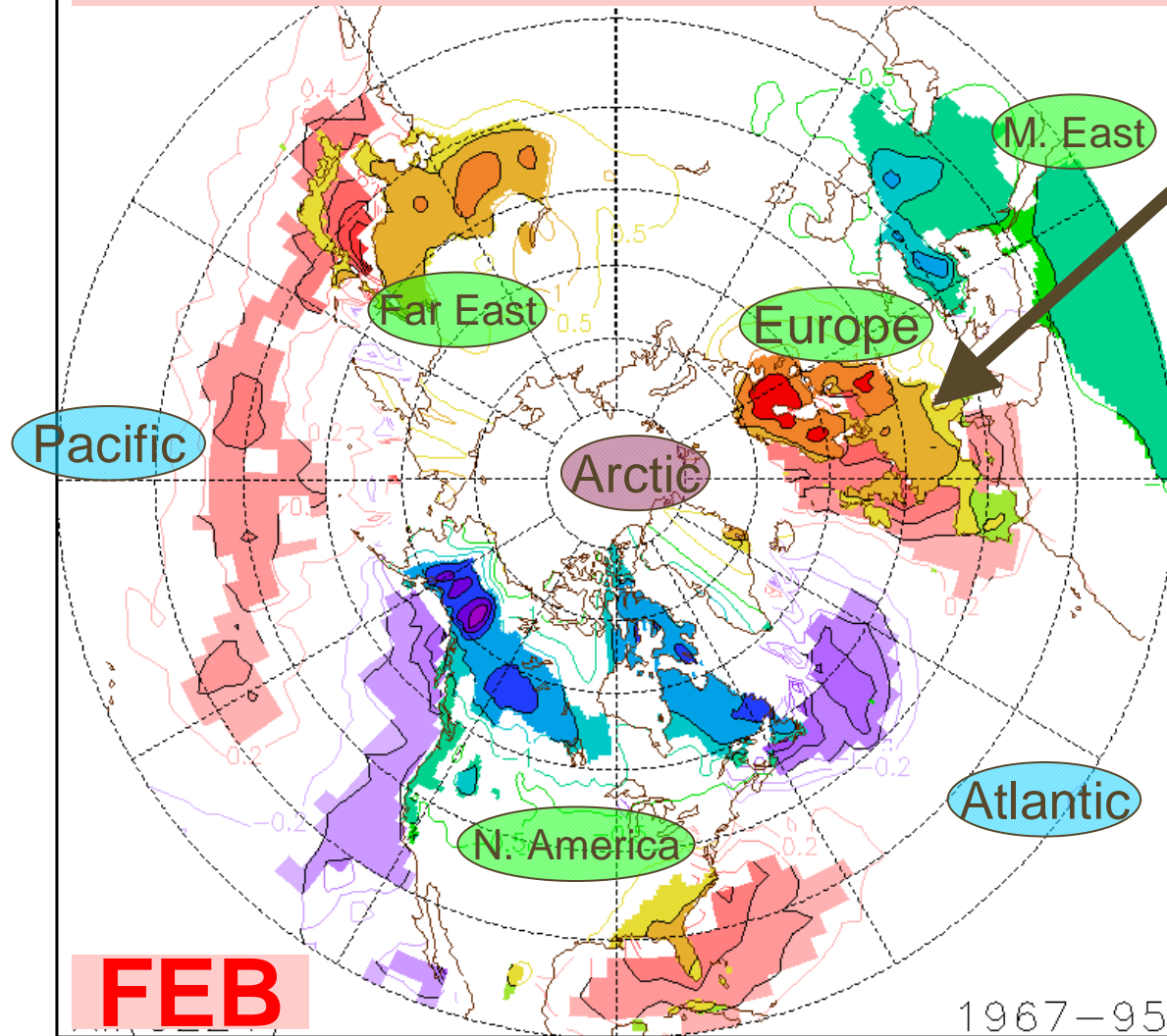
$dz/dt$  linearly (lag) regressed on AII for late FEB  
 feedback forcing from stormtrack (1967-1997) (m/day)



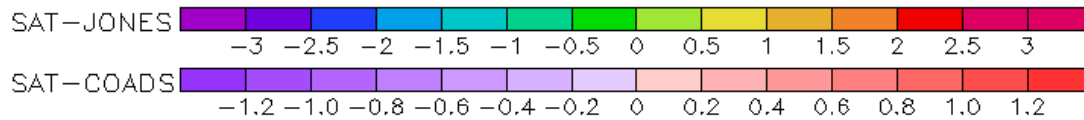
stormtrack:  
 high frequent transient eddies  
 (8-day high-pass filtered)

# AIS impacts on surface climate

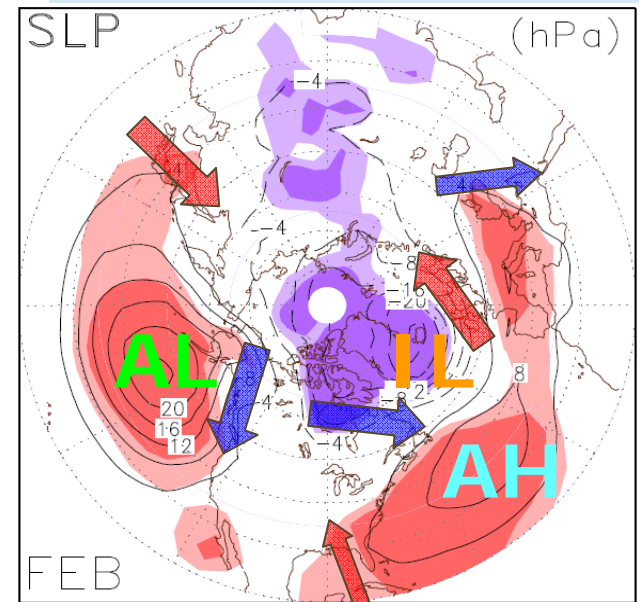
SAT (JONES) SAT (COADS) (K) Compo. Diff.



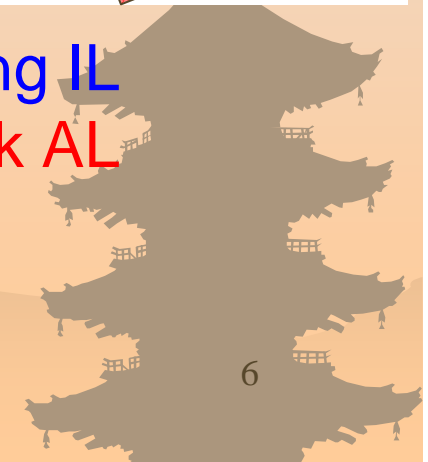
shaded 95% ( $|r| > 0.367$ )  $f=27$



## Trieste

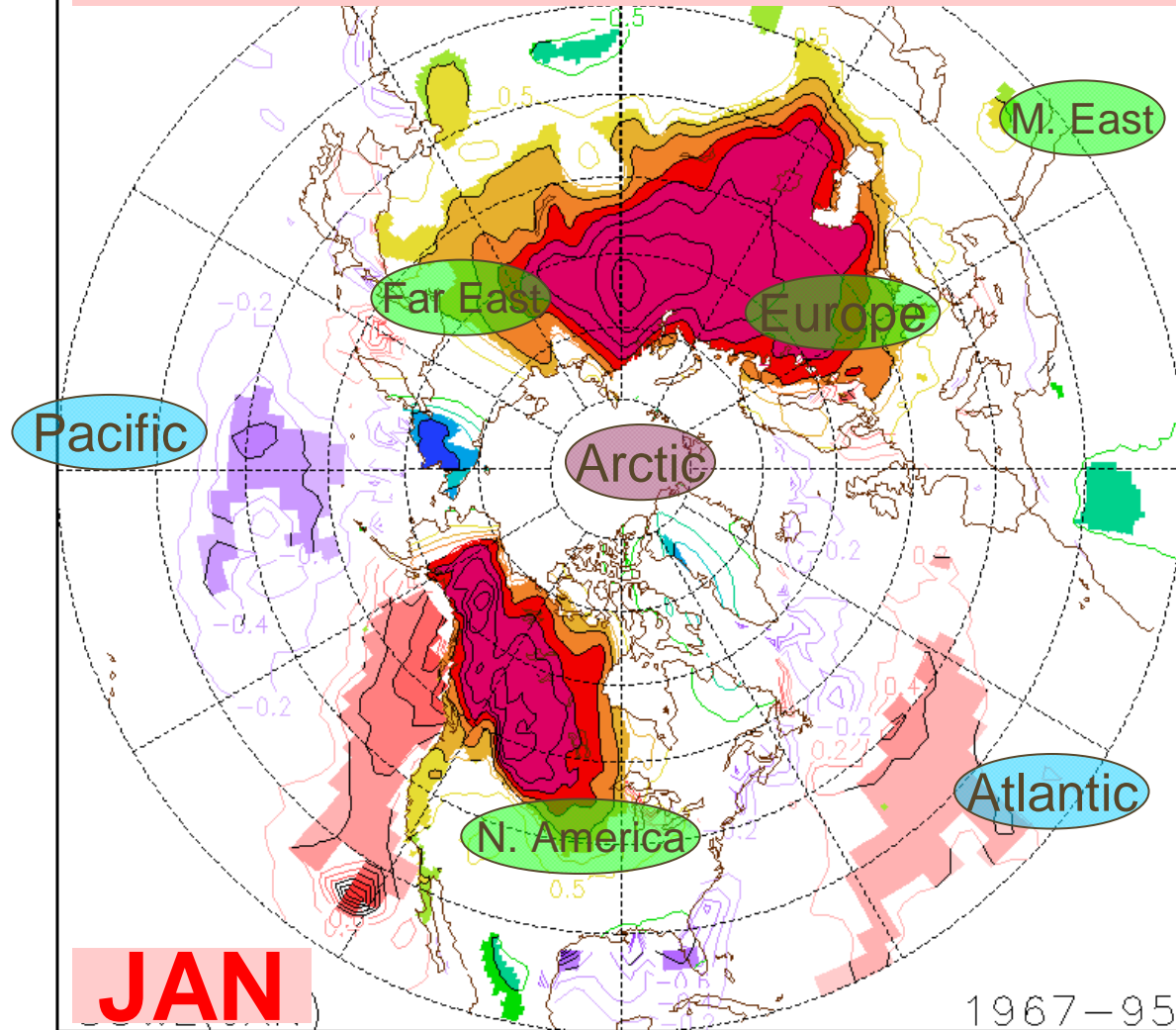


Strong IL  
Weak AL

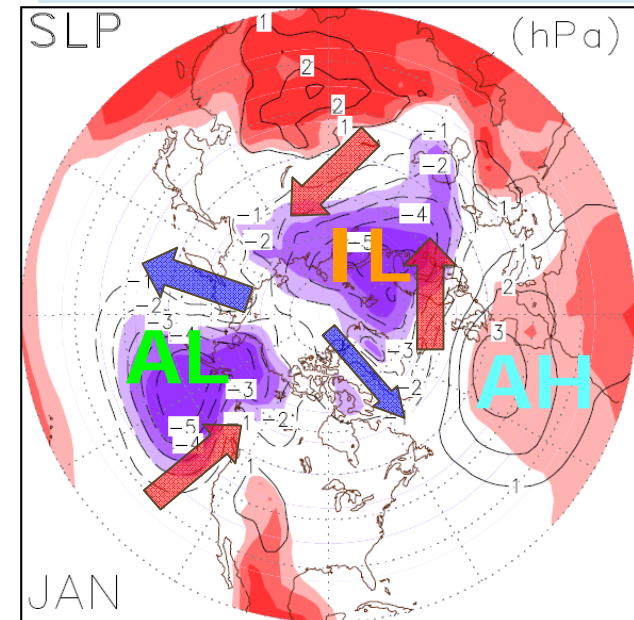
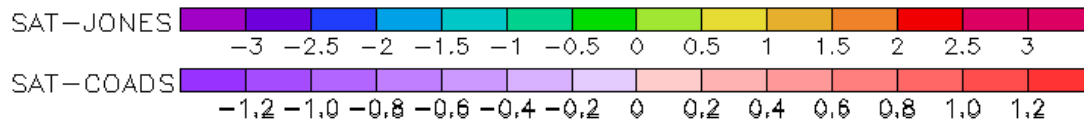


# COWL impacts on surface climate

SAT (JONES) SAT (COADS) (K) Compo. Diff.



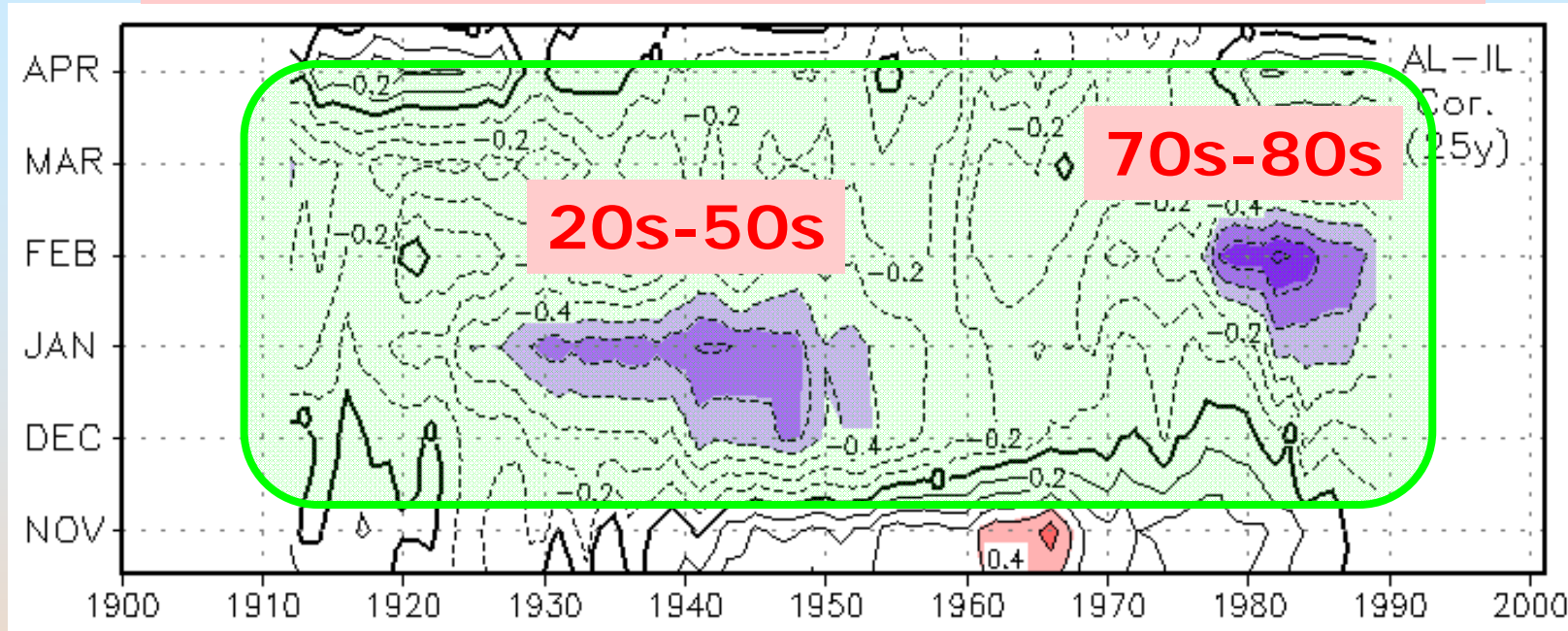
shaded 95% ( $|r| > 0.367$ )  $f=27$



Strong IL  
Strong AL

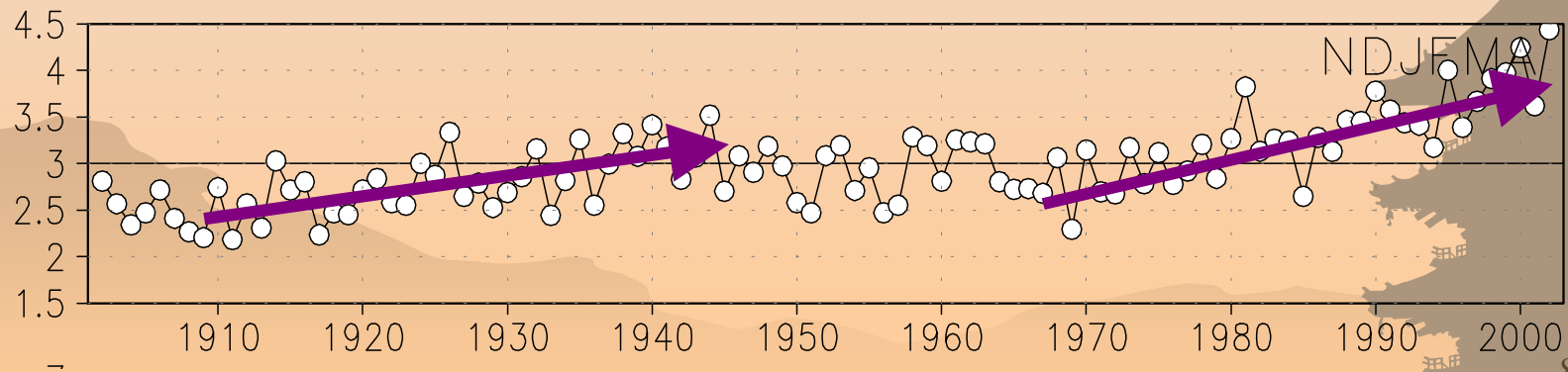


## Multidecadal modulation of AIS (AL-IL Corr.)



## Multidecadal modulation of COWL

COWL00 (SAT over NH land) winter 1901/02–2001/02



## The AL-IL Seesaw (AIS) Honda et al. (2001)

- AIS is triggered by circulation anomalies over NP (AL)  
Stationary Rossby wave propagation from NP into NA  
Development through feedback forcing from stormtrack
- Large impact on surface weather over NH extensively  
Europe, Far East, southeast US, Alaska, Canada, Middle East
- Multidecadal variability of the AL-IL seesaw  
active periods: 20s-40s (January) 70s-80s (February)  
weak negative corr. through the 20th century

## The COWL pattern Wallace et al. (1995, 1996)

- Thermally equilibrium pattern...  
Differential heating between land and ocean  
May be related to recent NH SAT trend
- Deepening tendencies of the AL and IL in the 20th century
- Significant upward trend: 10s-40s, 70s-00s

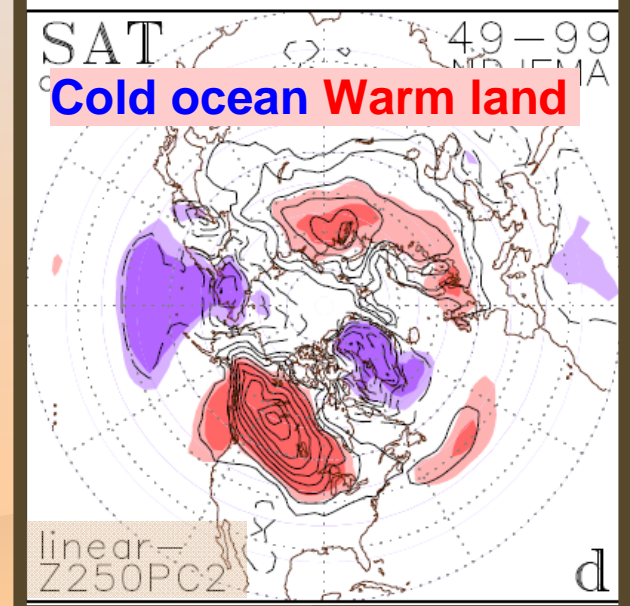
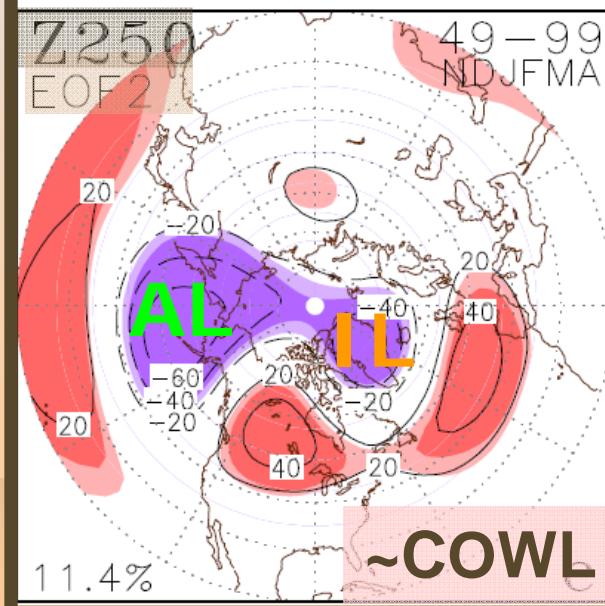
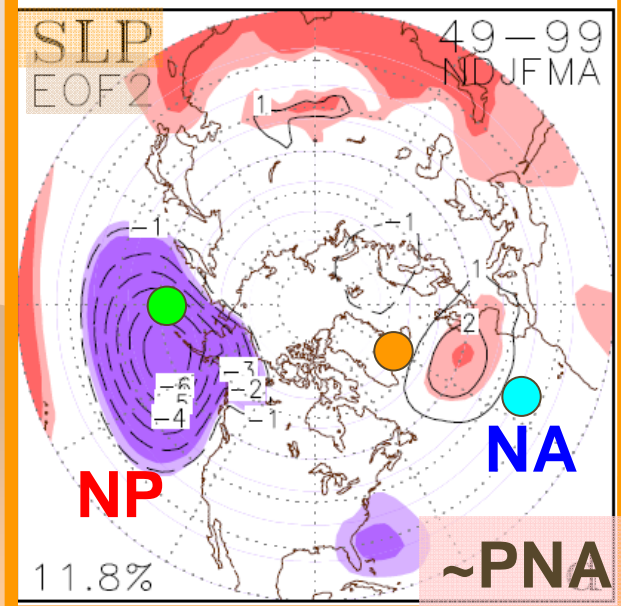
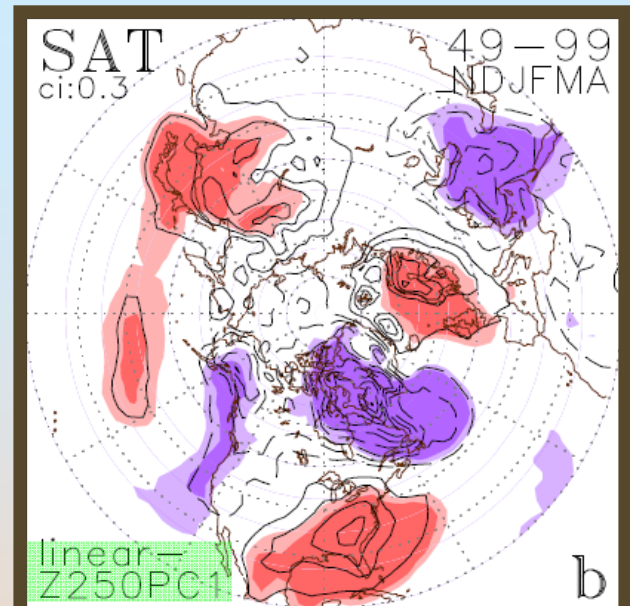
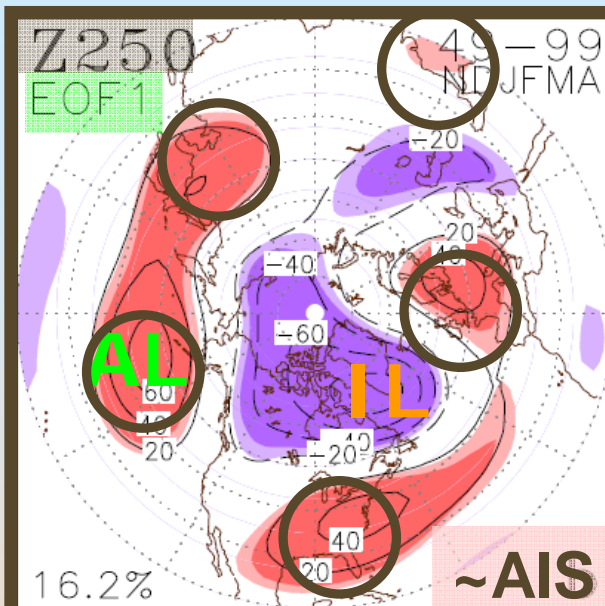
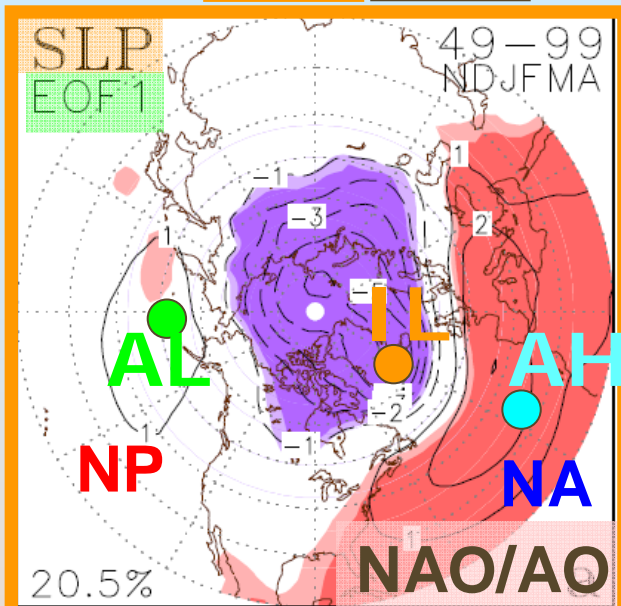


# AIS and COWL Signatures in Dominant Variability in the Wintertime Northern Hemisphere



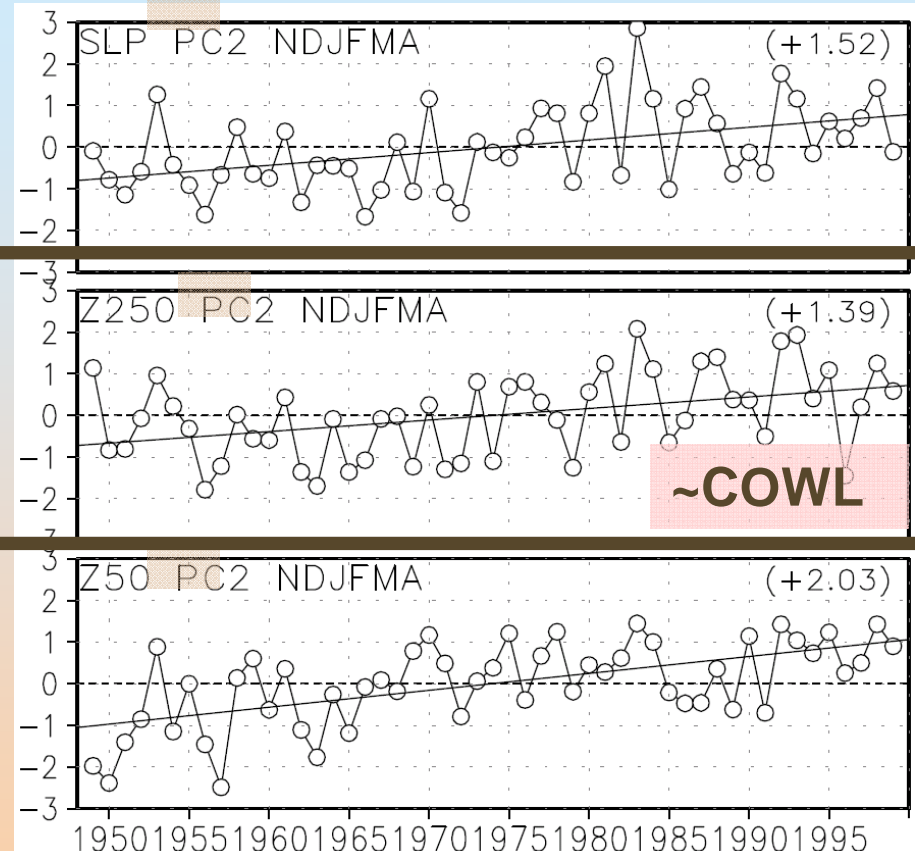
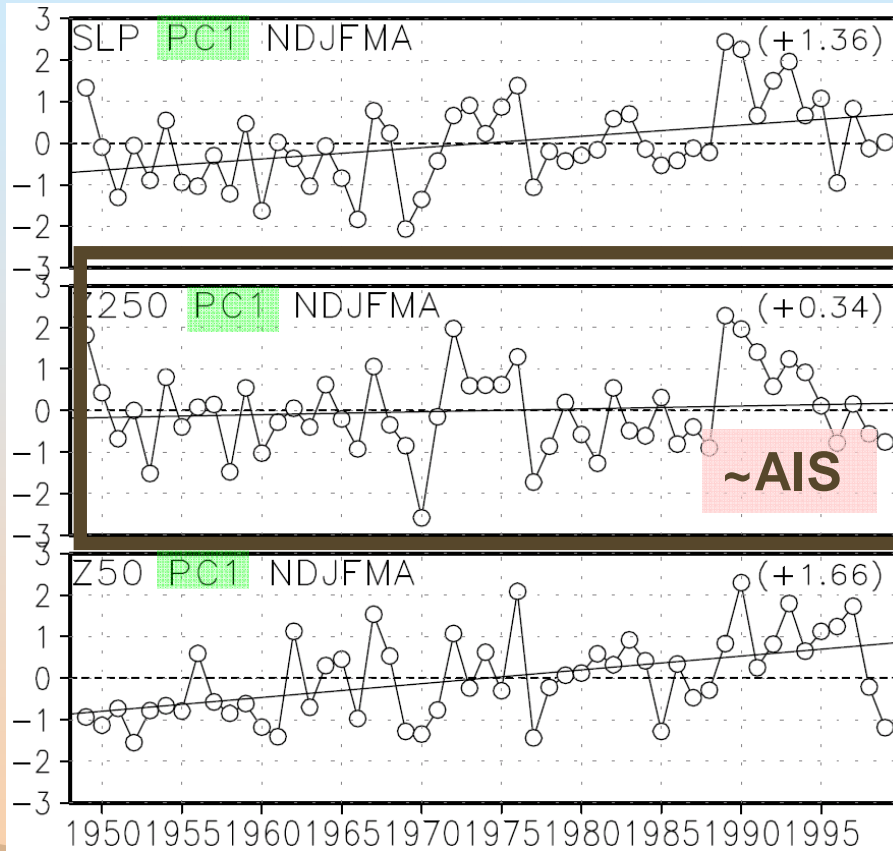
# NCEP-NCAR 1948/49-98/99

SLP Z250 EOF1 EOF2 SAT linear-Z250 PC1 PC2

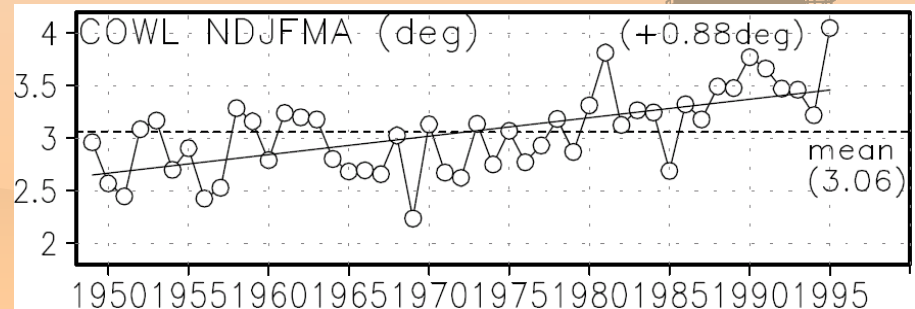


Wintertime monthly

# Winter **mean** PC time series (normalized) (49-99)

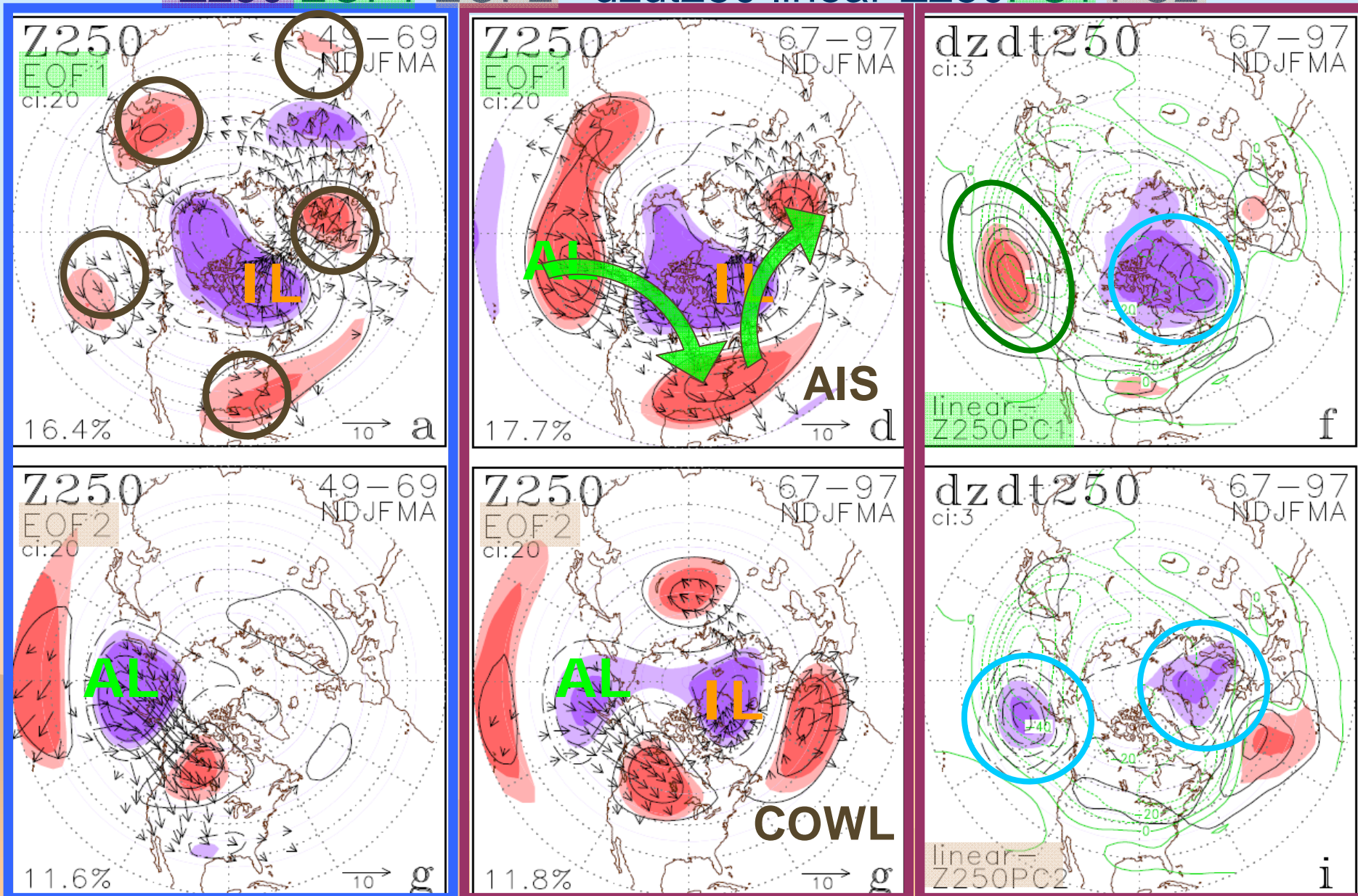


## Winter **mean** COWL index (49-95)



NCEP-NCAR 1948/49-68/69 1966/67-96/97

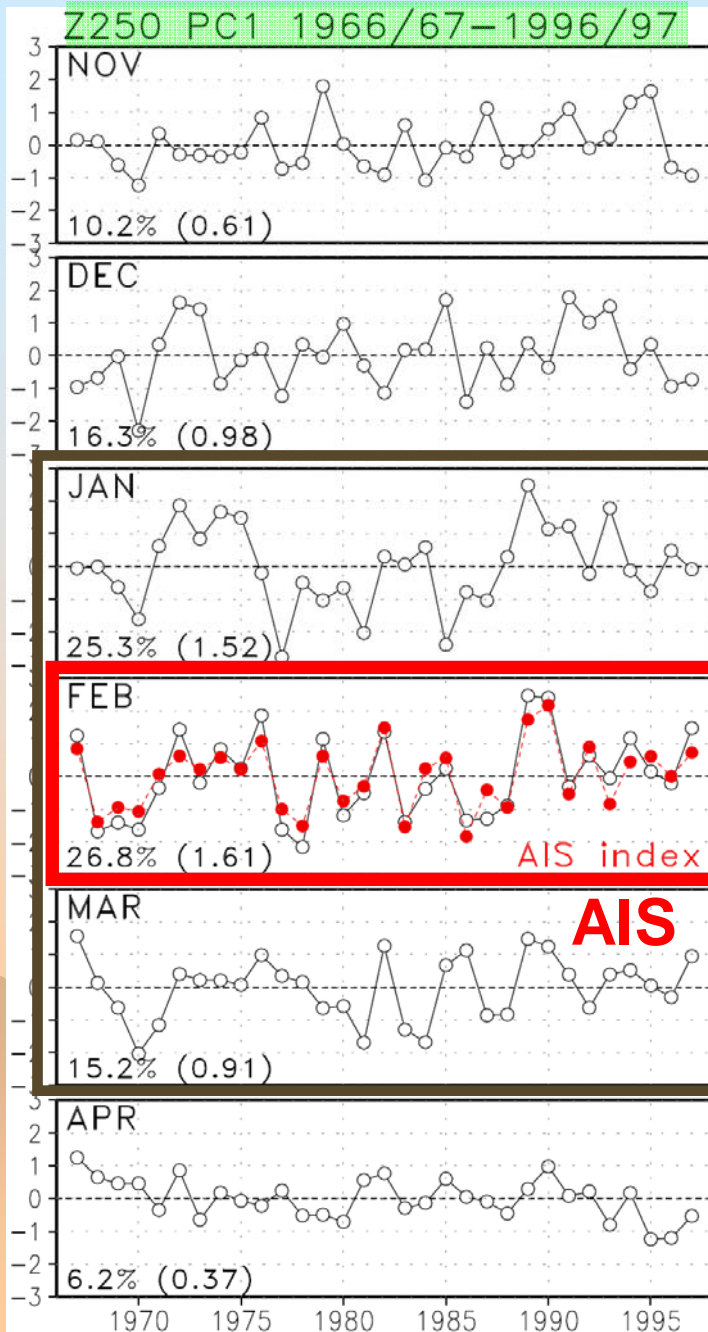
Z250 EOF1 EOF2 dzdt250 linear-Z250PC1 PC2



Arrows: Wave activity flux (Takaya and Nakamura 2001)

Wintertime monthly

# Z250 PC1 and PC2 for each month (66/67-96/97)



NOV

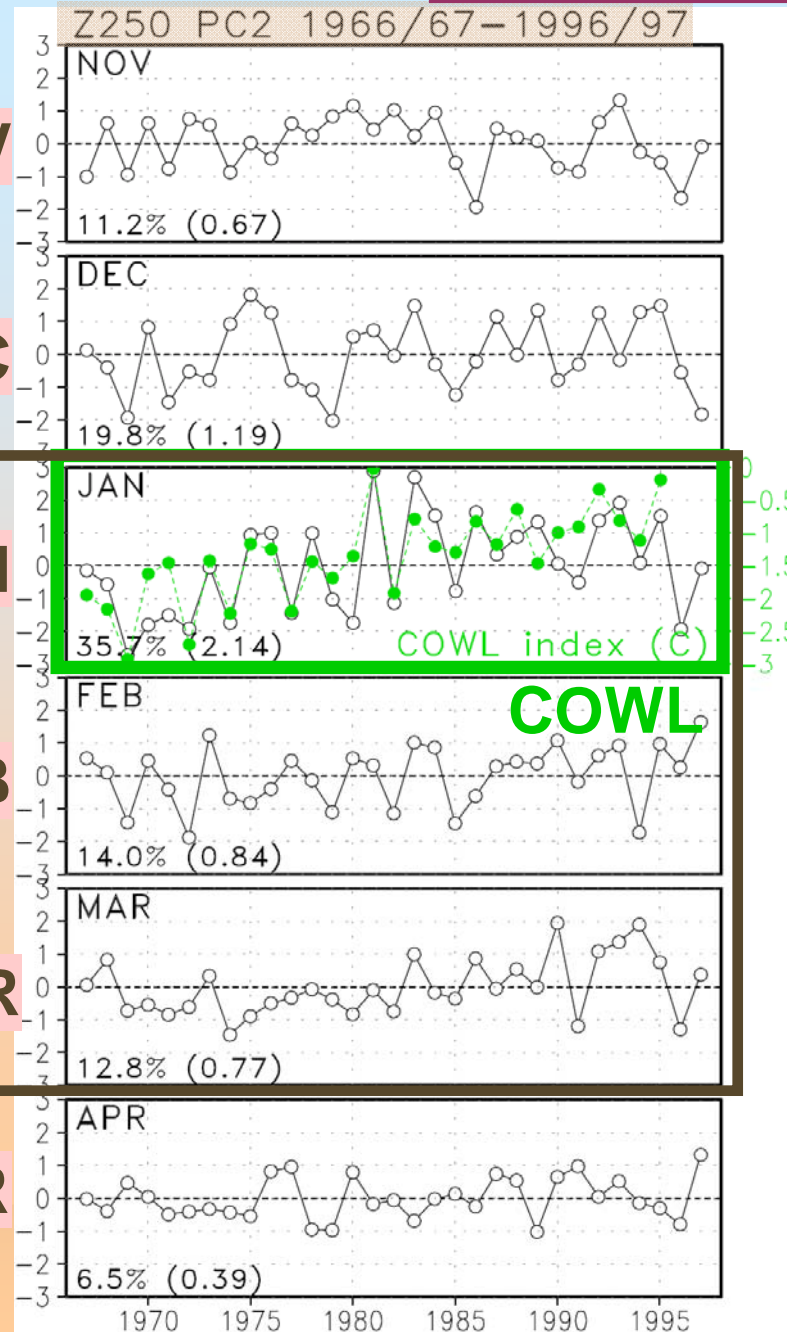
DEC

JAN

FEB

MAR

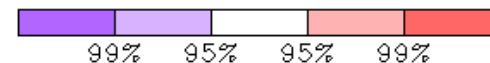
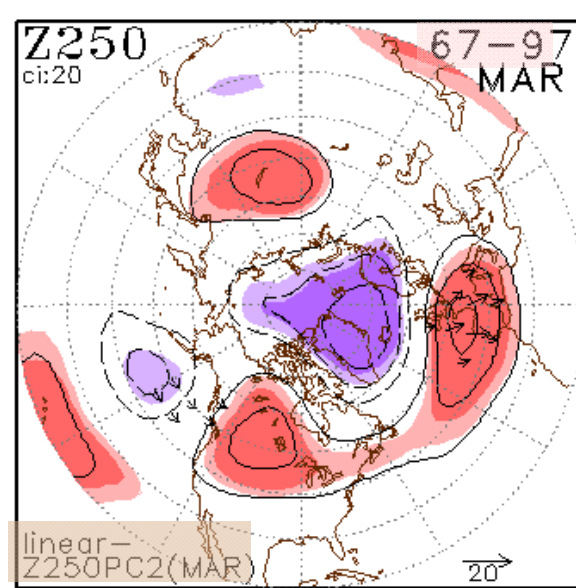
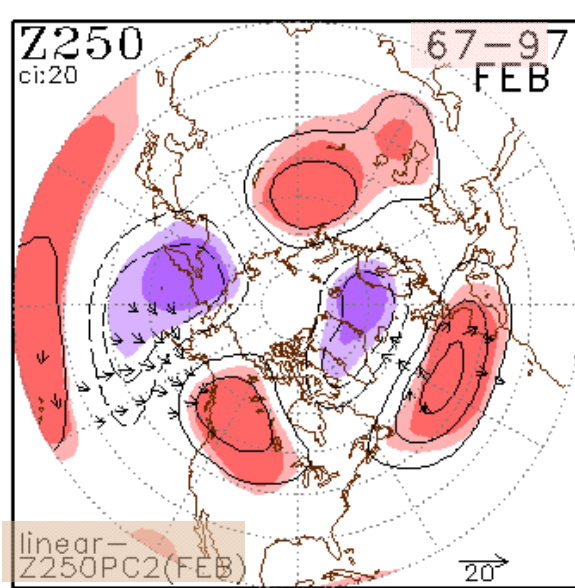
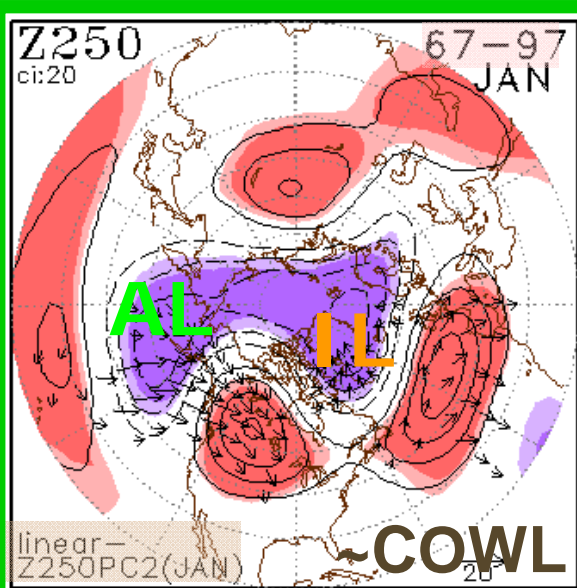
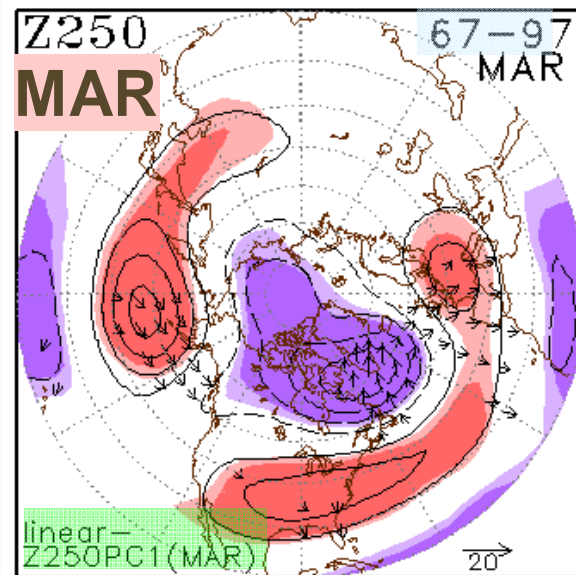
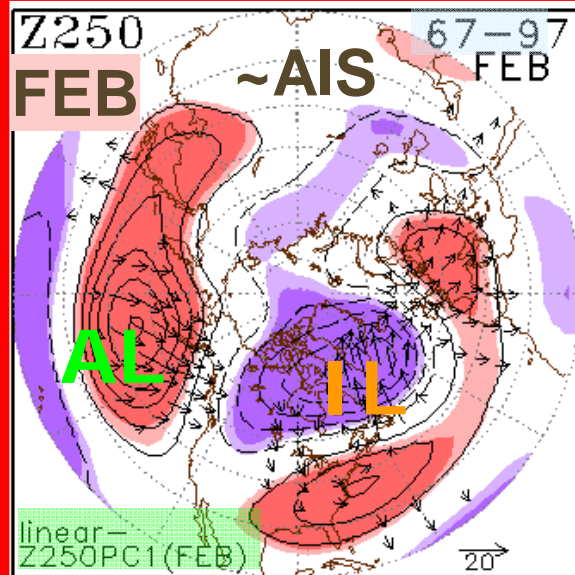
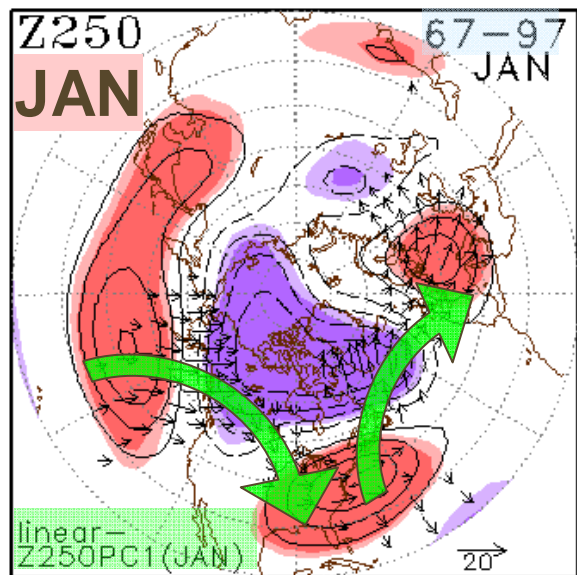
APR



COWL index (C)

COWL

NCEP/NCAR Reanalyses 1966/67–96/97  
 Z250 linear-Z250PC1 and PC2 (JFM: each month)



Arrows: Wave activity flux (Takaya and Nakamura 2001)



# Summary

- Dominant variability over the wintertime NH for 50 years

**SLP:** EOF1~NA (AO or NAO?), EOF2~NP (PNA?)

**Z250:** EOF1~**AL-IL seesaw** (no trend)

EOF2~**COWL** (upward trend)

More hemispheric signatures in the leading Z250 EOFs

→ stronger inter-basin dynamical linkage in the upper trop.

- Decadal modulation and seasonal dependence (**Z250 EOFs**)

50s~60s: EOF1~NA (annular-like), EOF2~NP (AL?)

70s~90s: EOF1~typical evolution of AL-IL seesaw (DJF)

EOF2~COWL in JFM with trend

Modulation of inter-basin dynamical linkages

**AIS** ~ Local amplification of circumglobal waveguide pattern?

- Dominance of AIS and COWL in the wintertime NH

→ modulation of the tropospheric leading EOFs

- Tropospheric leading EOF ~~→~~ AO/NAM