Role of the East Sea SST variability in the atmospheric circulation in the North Pacific.

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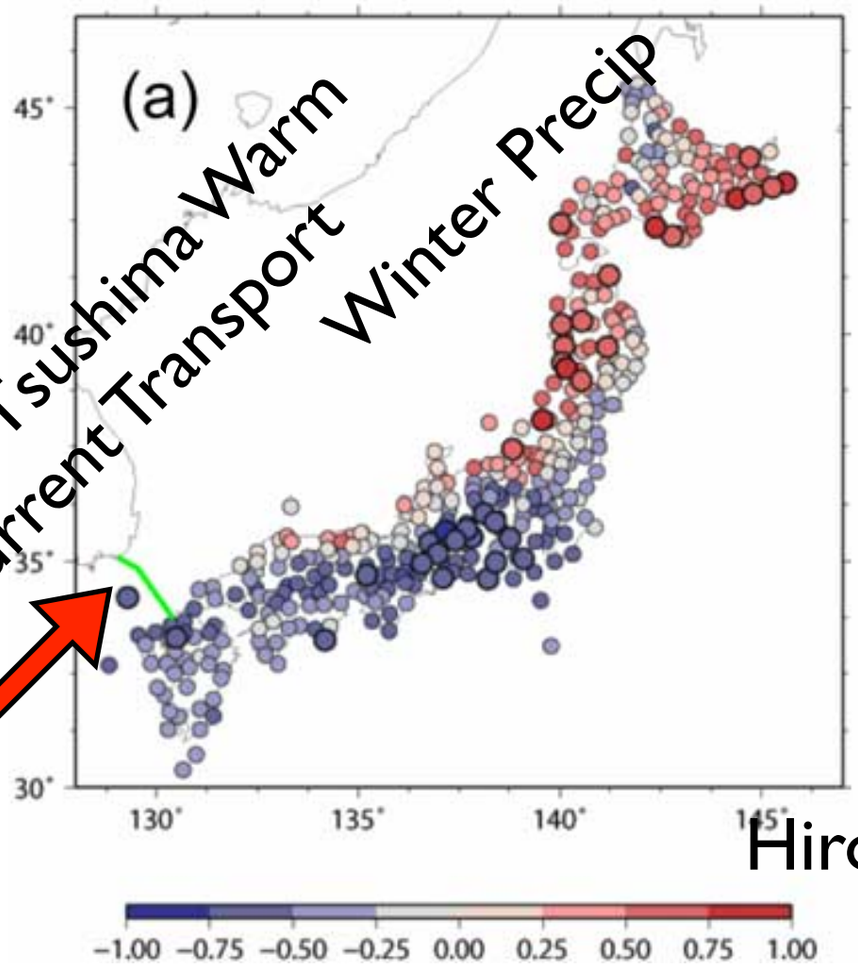
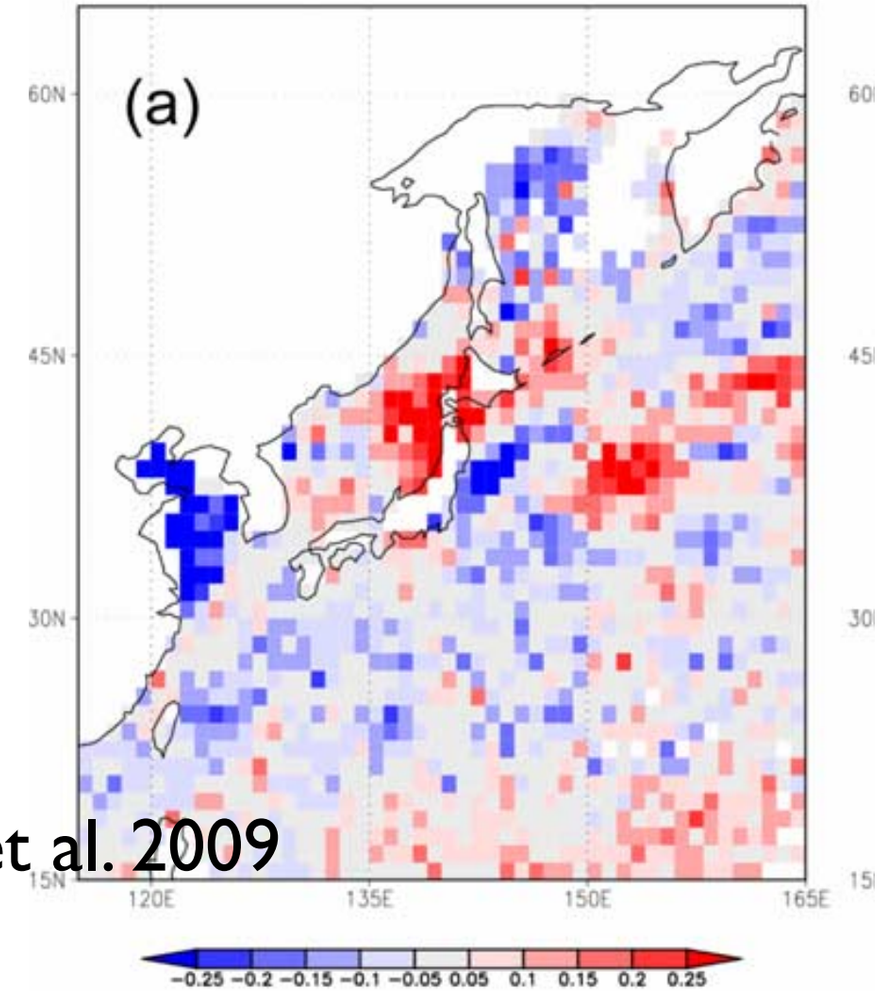
KORDI-WHOI Workshop,
Cheju, Korea, May 25 2012

SST variability in the East Asian Marginal Seas is important for regional weather. In the East/Japan Sea, the warm transport by the Tsushima Warm Current influences wintertime SST and precipitation.

Correlation
SON TWC Transport and DJF Precip.



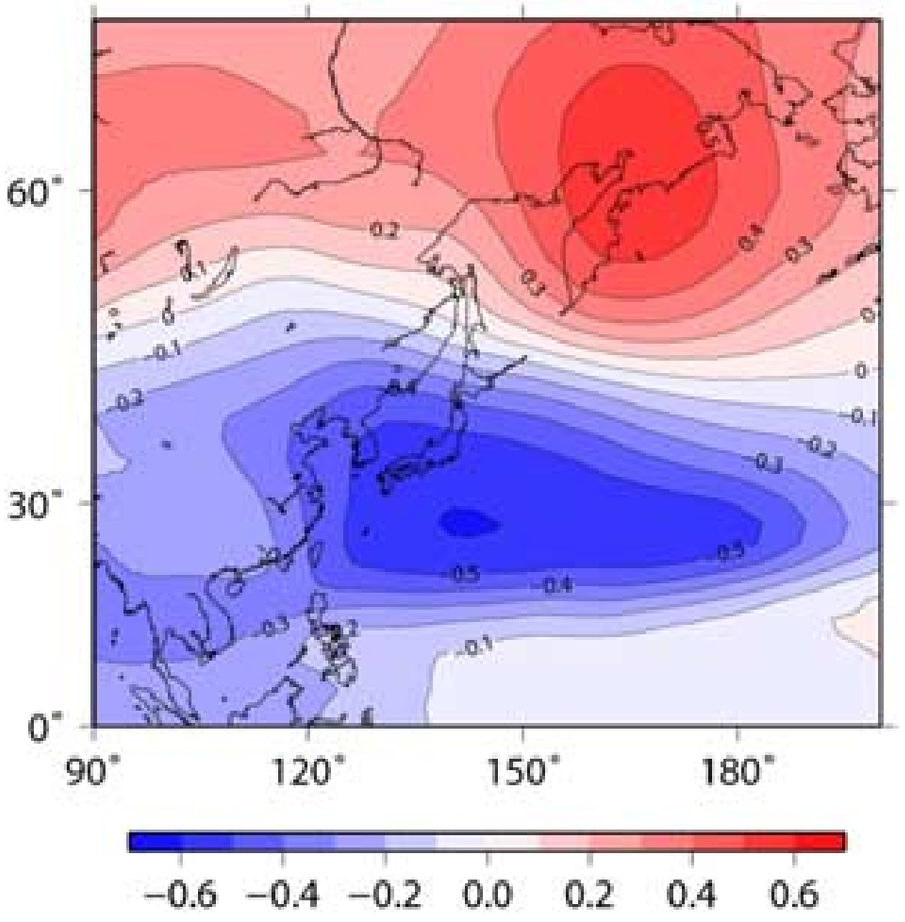
Correlation
SON TWC Transport and DJF SST



Hirose et al. 2009

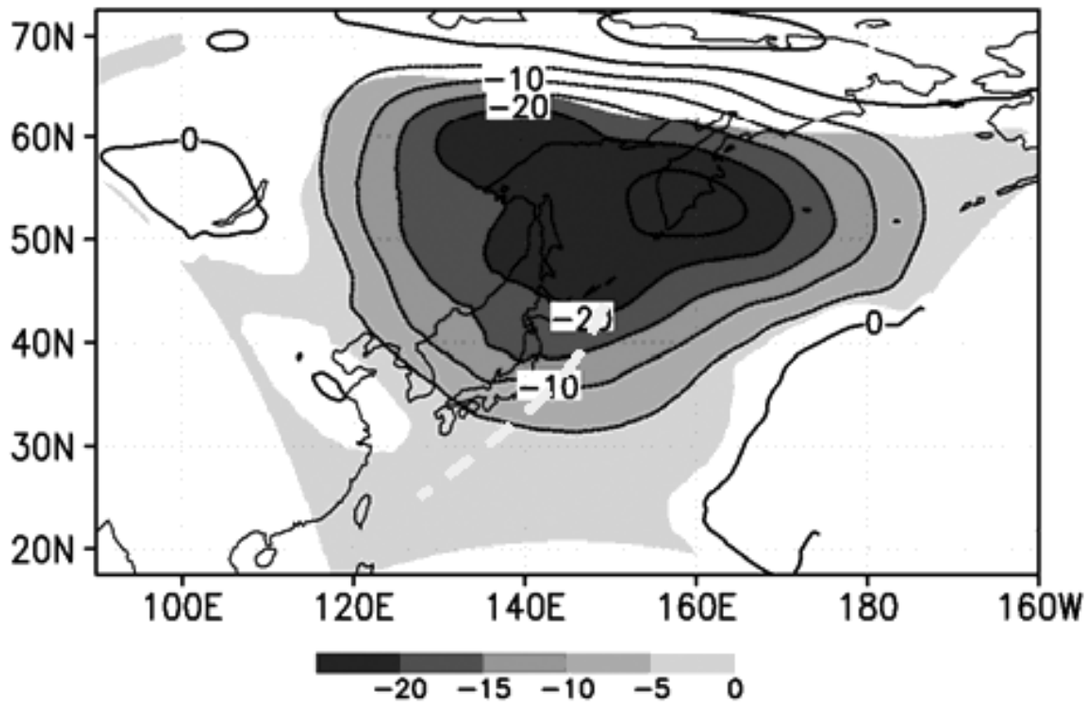
Presumably, the marginal sea processes would also play some role in the downstream North Pacific circulation.

Correlation
SON TWC transport and HGT 500mb



Hirose et al. 2009

HGT500mb response
2003 (cold) minus 2005 (warm) EJS SST

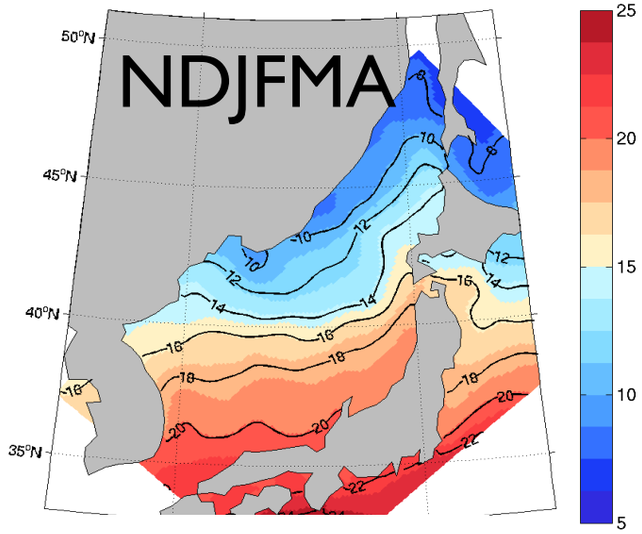


Yamamoto and Hirose 2011

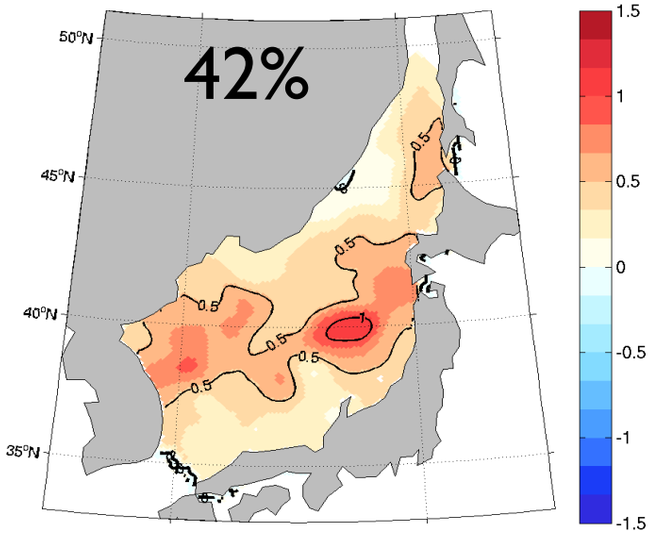
TWC and its representation on SST have some connection to the large-scale atmospheric circulation pattern.

Dominant modes of wintertime SST variability identified from the NOAA OISST (25 km, daily, 1982-2010)

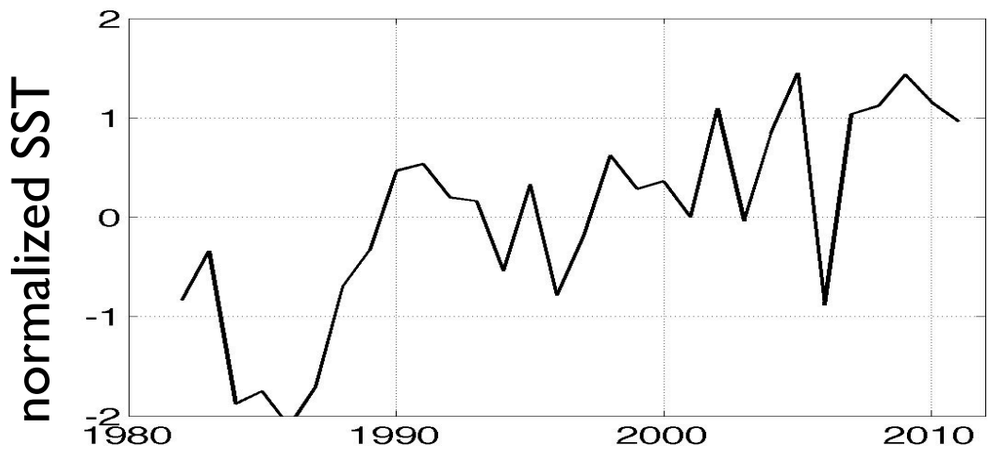
Climatology



EOF1

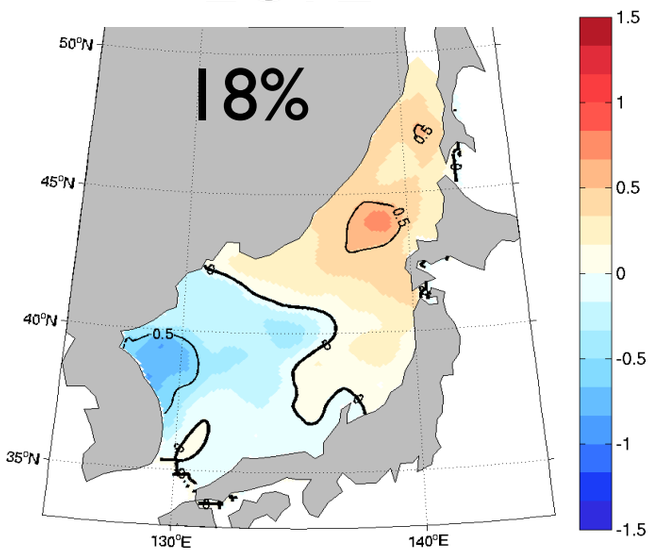


PC1



- Basin-wide warming/ cooling and a shift in front ≈ **Interannual 1st CEOF** in Minobe (2004)

EOF2



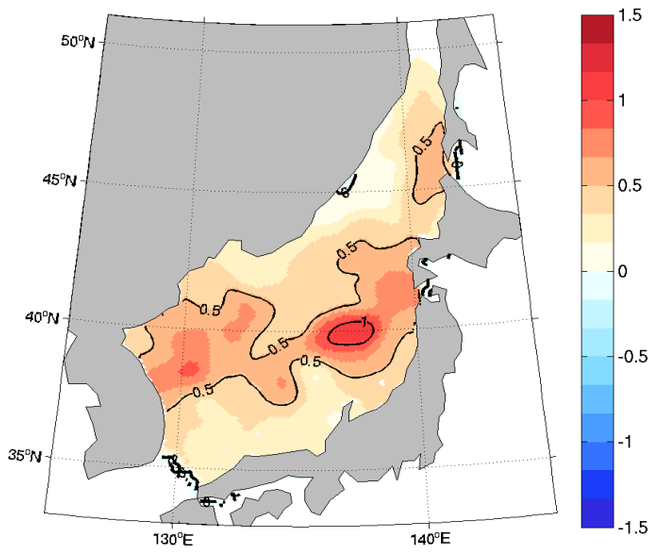
PC2

- Dipolar pattern in SST anomalies ≈ **Decadal 1st CEOF** in Minobe (2004)

Main question:

How will these two dominant modes of SST anomaly patterns

EOF1



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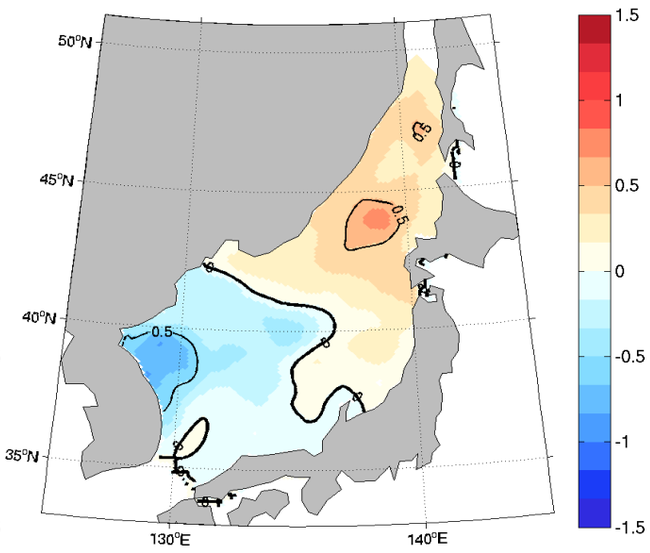


impact the regional and large-scale circulation patterns?

And are the circulation response symmetric with respect to the sign of SST anomaly pattern?

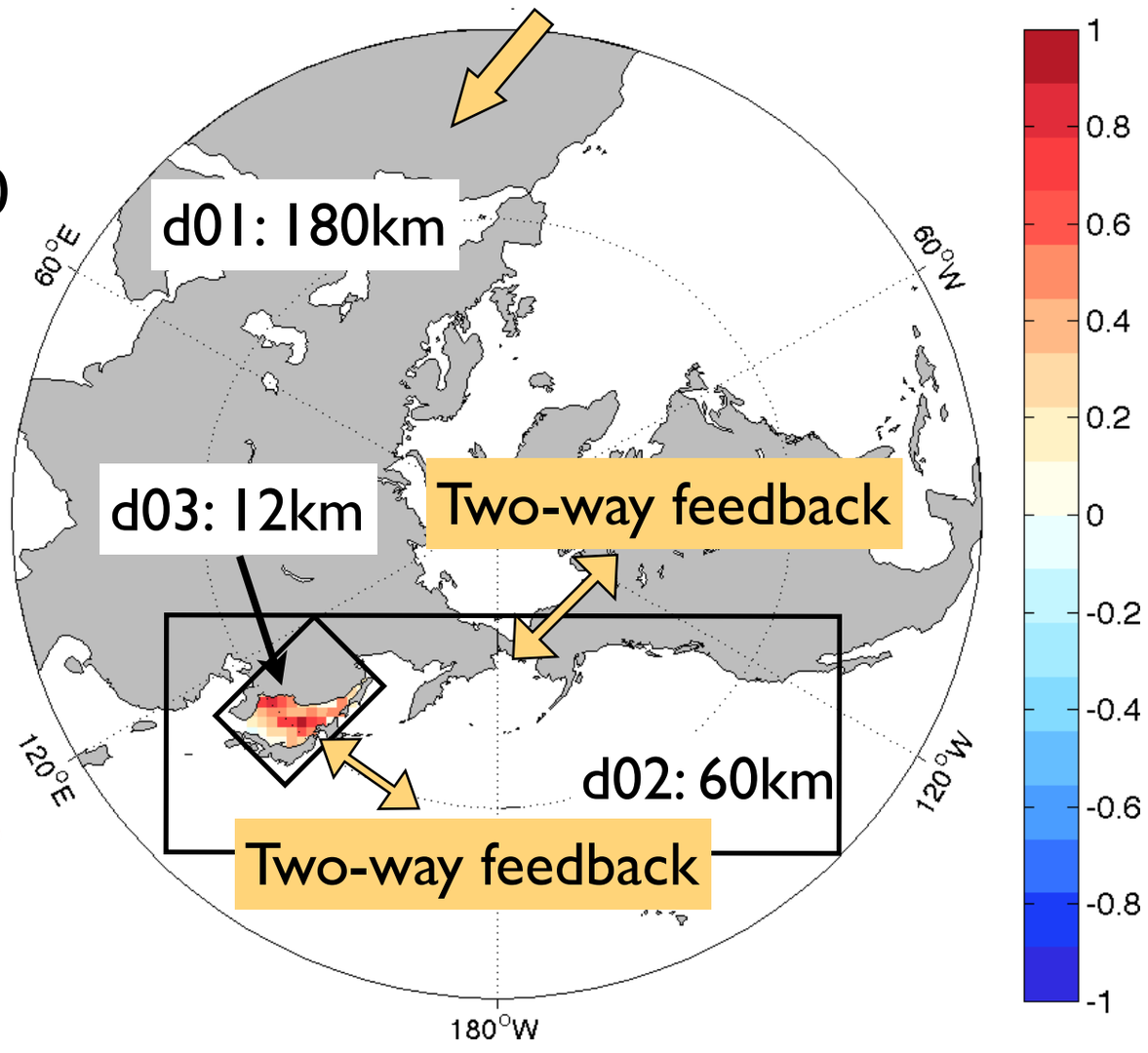
Regional atmospheric model simulation

- <u>Model: WRF 3.3</u>
- Lower BC:
  - NOAA daily climatology 1982-2010
- Lateral BC:
  - NCEP 6-hourly climatology 1980-2010
- 6 month integration: Nov.-Apr.

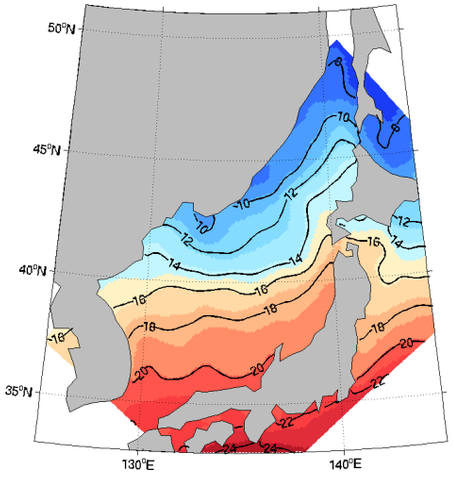
- CTL, EOF1P, EOF1M: **40-member**
- EOF2P, EOF2M: **20-member**

- Focus on November-January ***response***
  - Initial adjustment period
  - Quasi-equilibrium state

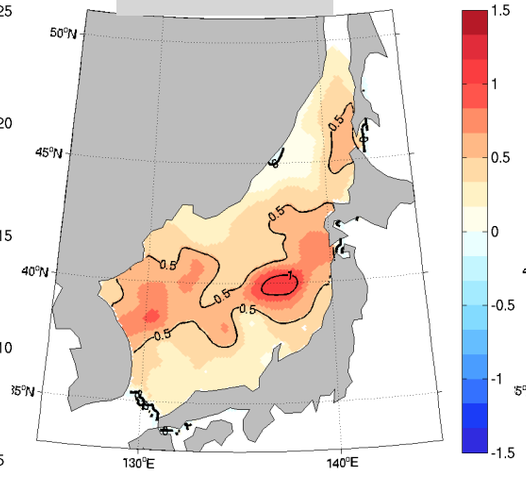
<u>Lateral BC</u>: NCEP 6-hourly climatology



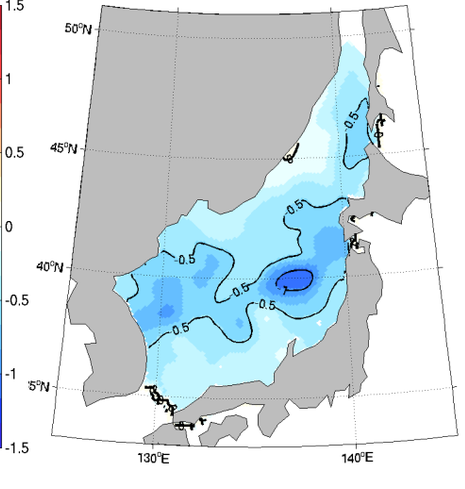
CTL



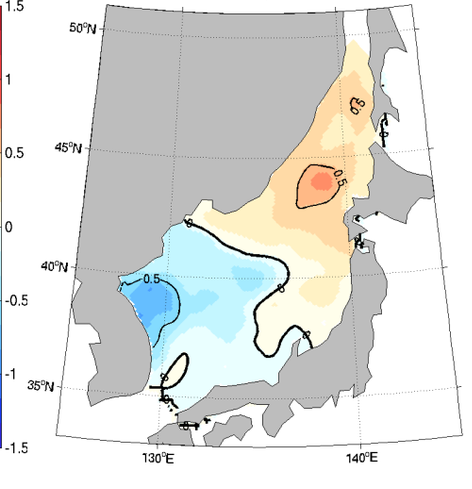
EOF1P



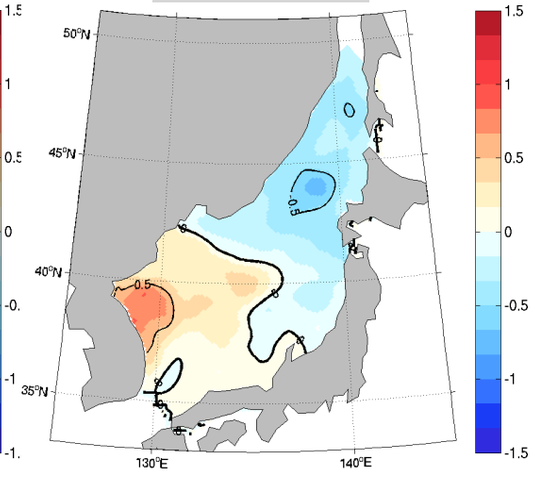
EOF1M



EOF2P

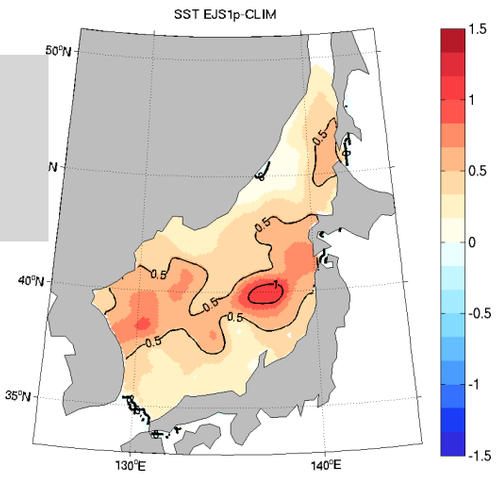


EOF2M



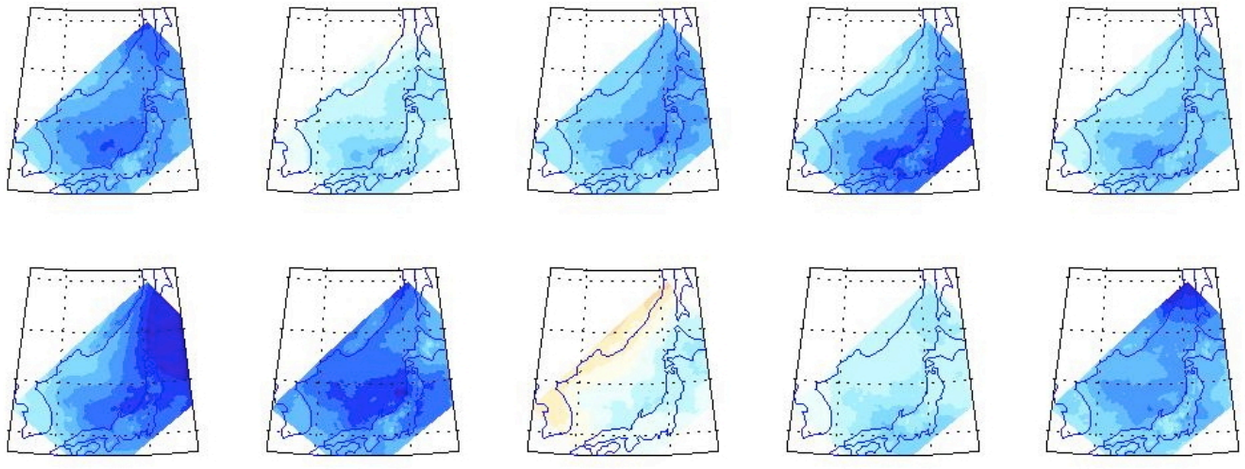
1. SLP responses for the different time-scale and ensemble averaging

A deterministic SLP response to the diabatic forcing in 1-14 days

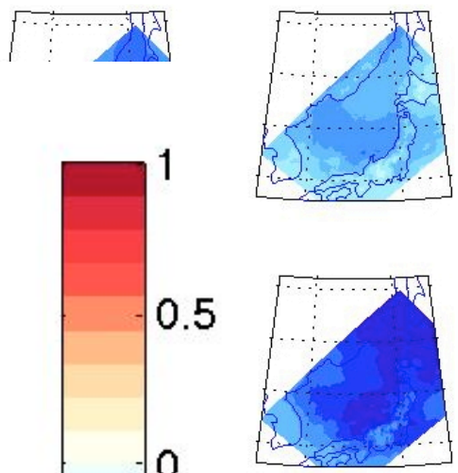


EOF1P-CTL

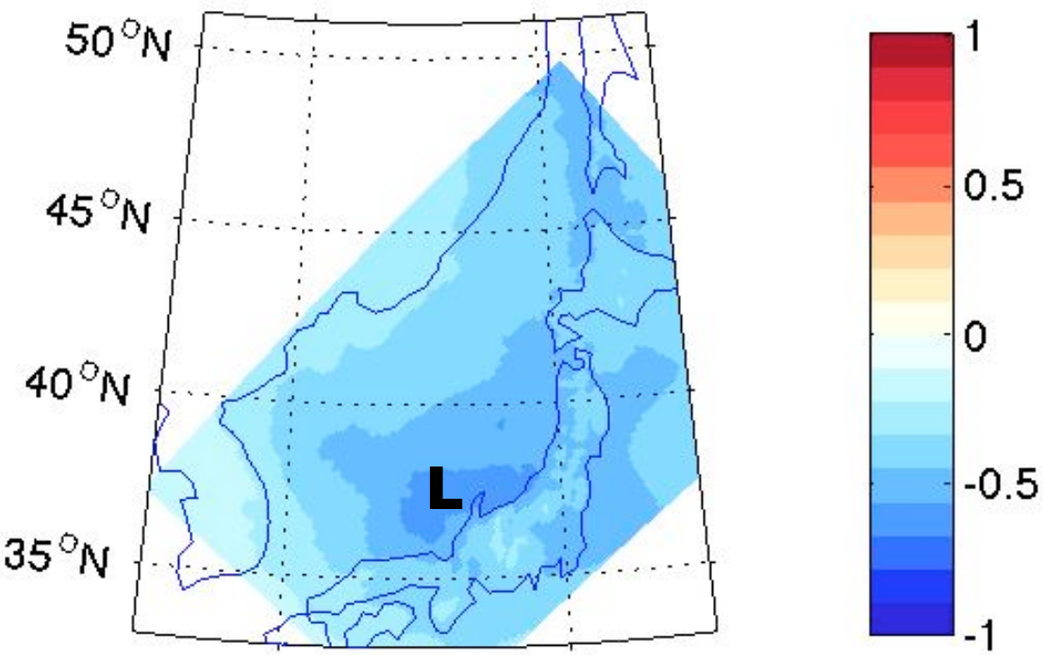
Ensemble member 1-10



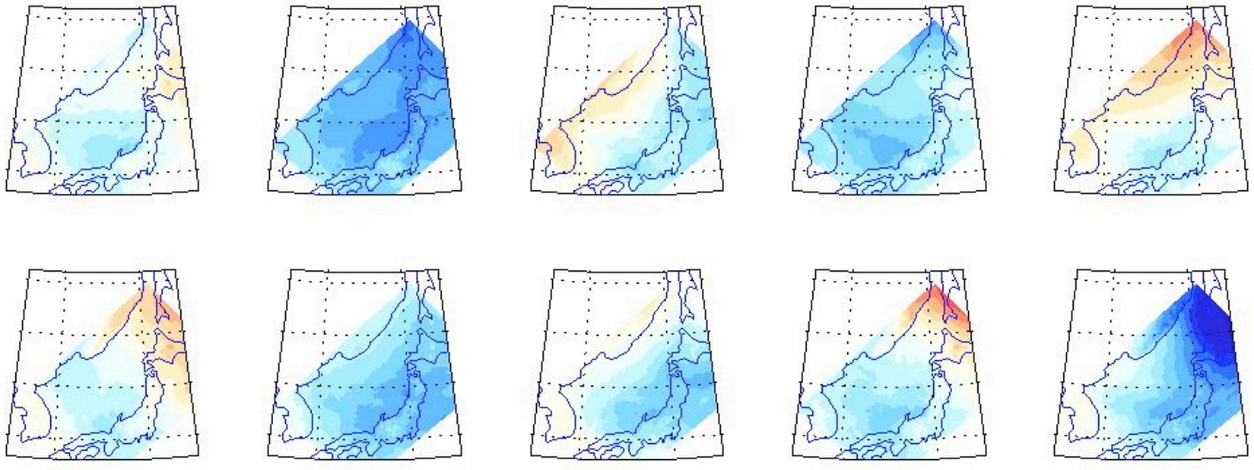
Ensemble member 11-20

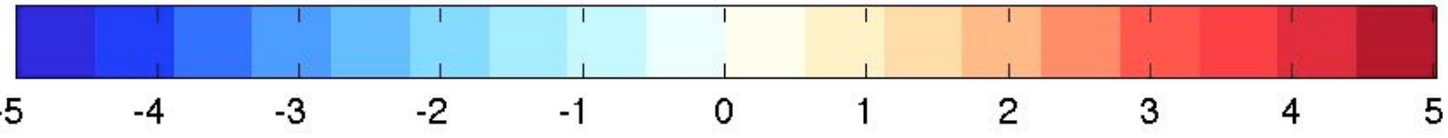


Ensemble mean 1-40

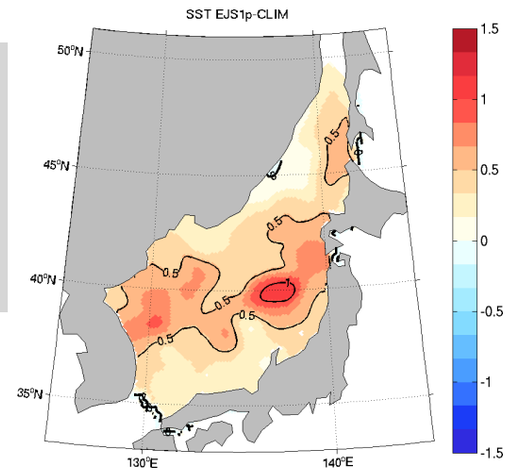


Ensemble member 21-30



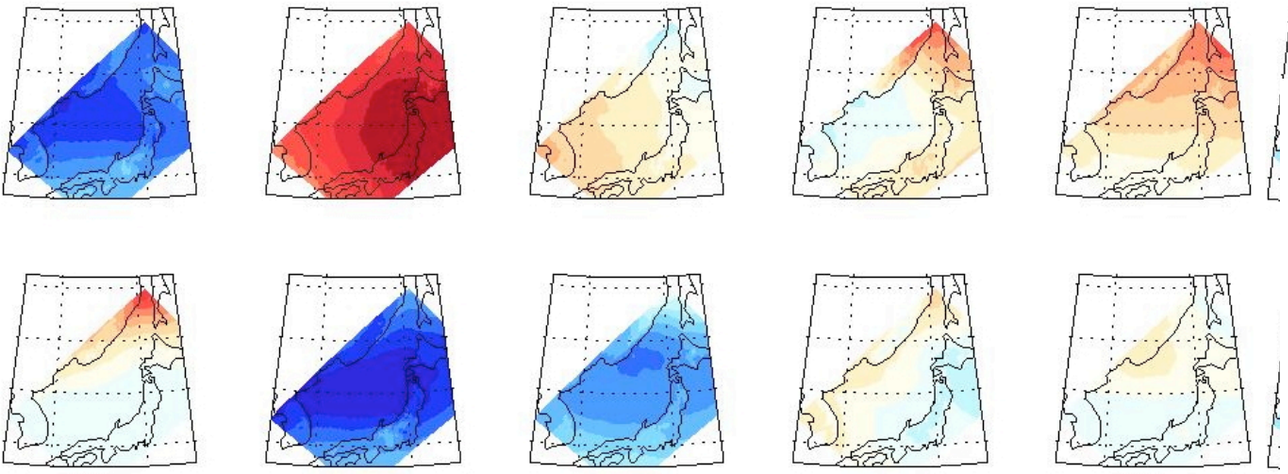


A chaotic quasi-equilibrium response in 15-91 days due to the circulation change.

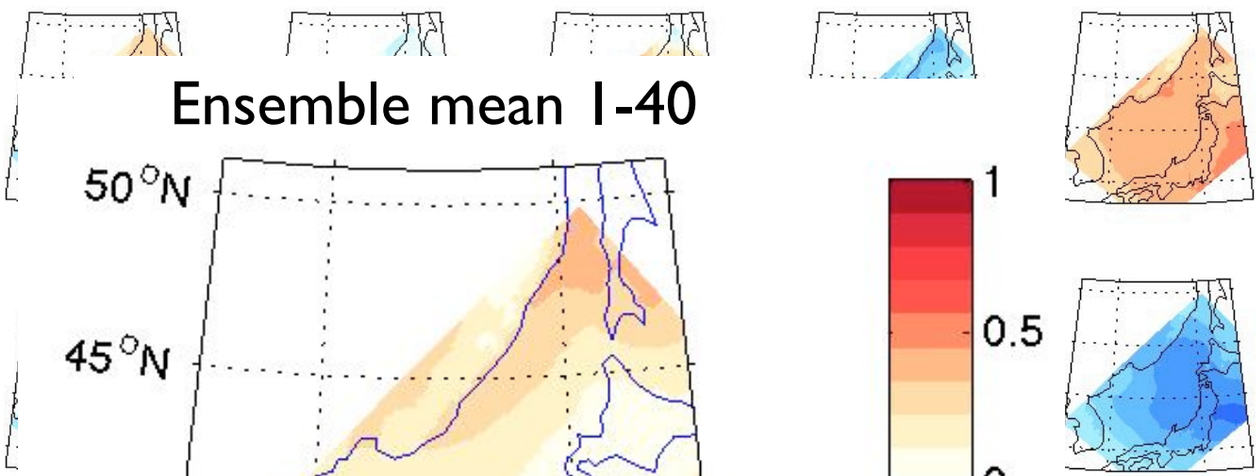


EOF1P-CTL

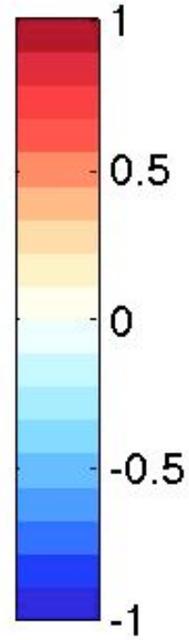
Ensemble member 1-10



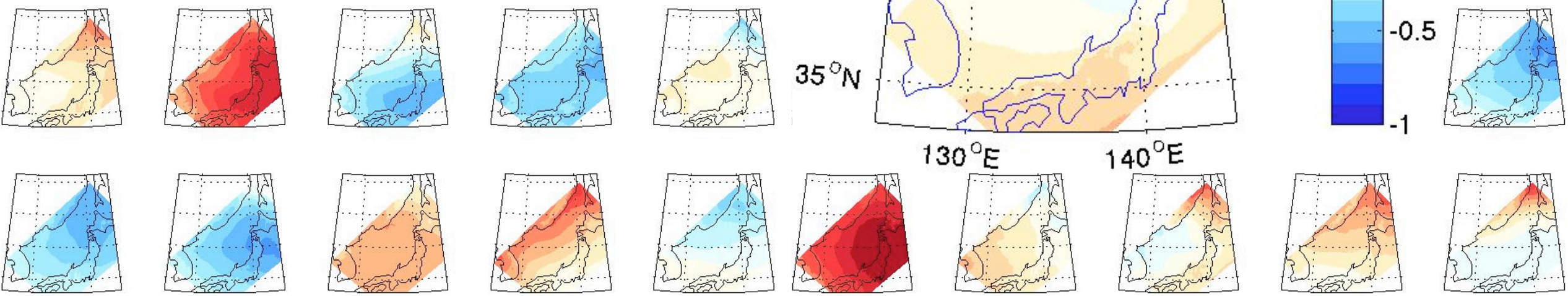
Ensemble member 11-20

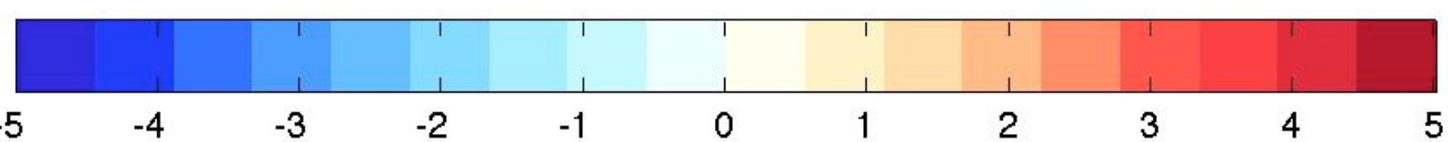


Ensemble mean 1-40



Ensemble member 21-30





[mb]

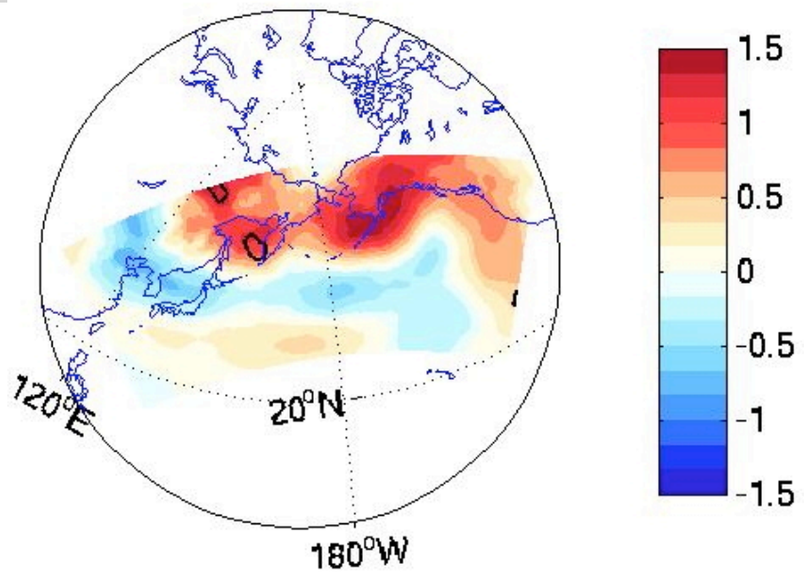
Some robust and significant SLP response emerge as more ensemble members are used for averaging.

EOF1P-CTL

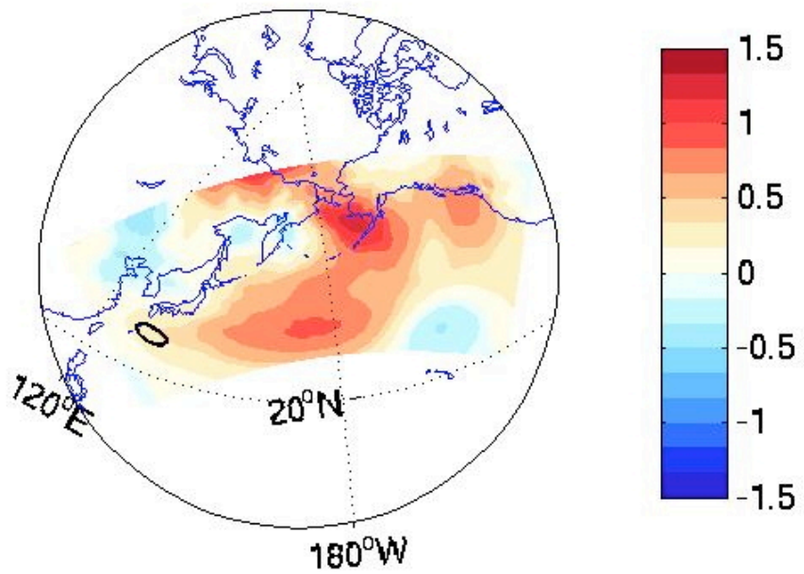
15-91 day

Black contours: significant at 95%

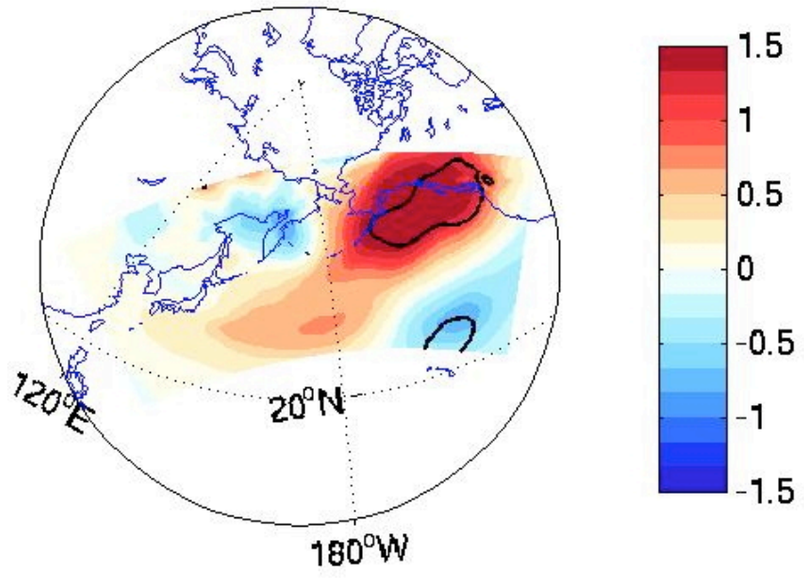
1-10 member mean



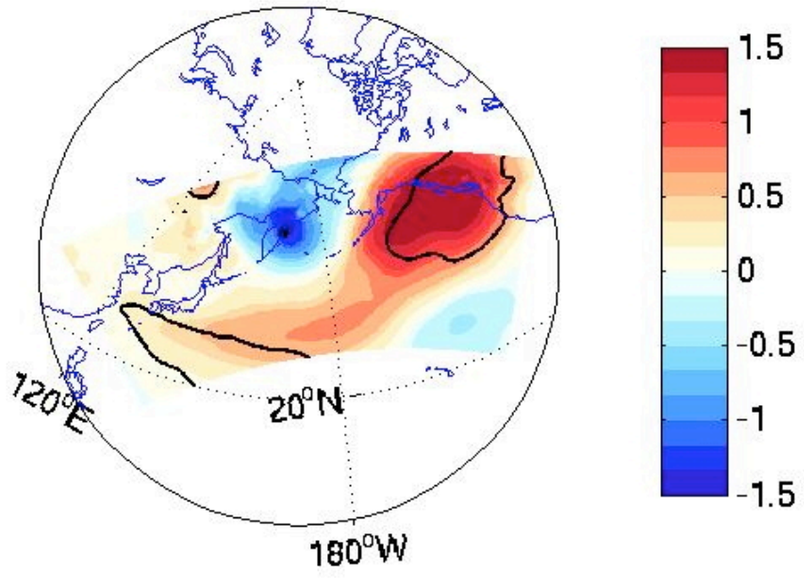
1-20-member mean



1-30 member mean



1-40 member mean

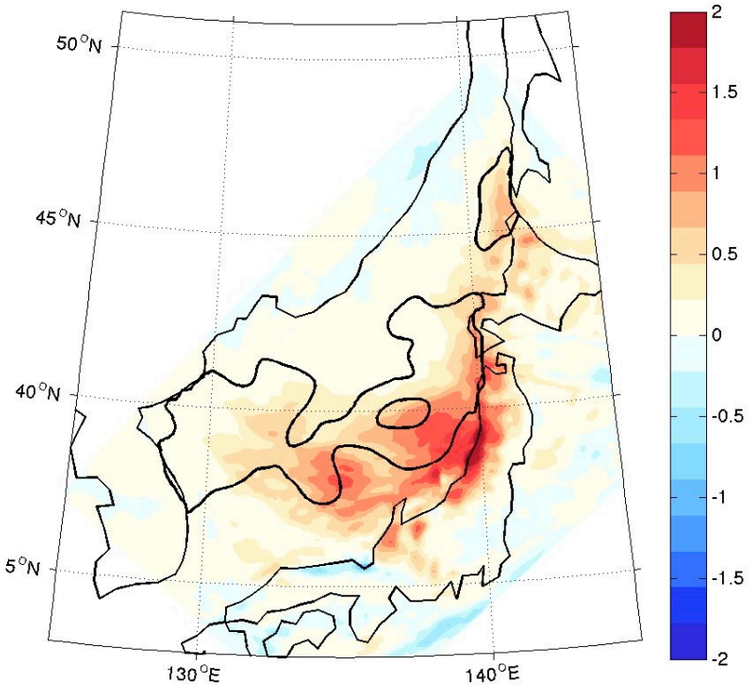


2. Local response in precipitation in NDJ (15-91 day)

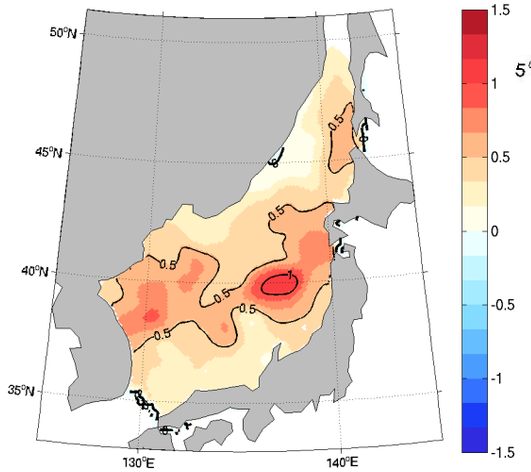
15-91 day averaged responses in precipitation, SLP, and surface wind

EOF1P-CTL

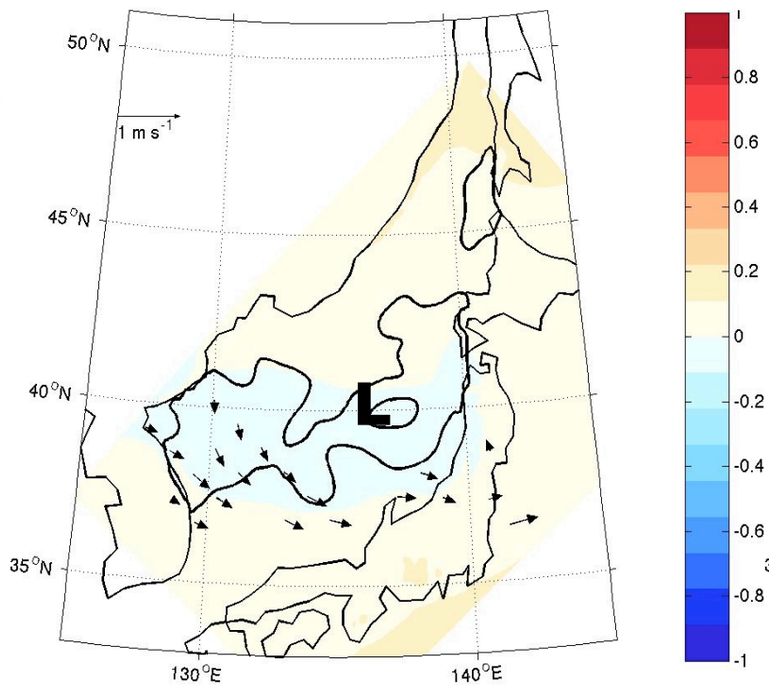
PRECIP mm/day



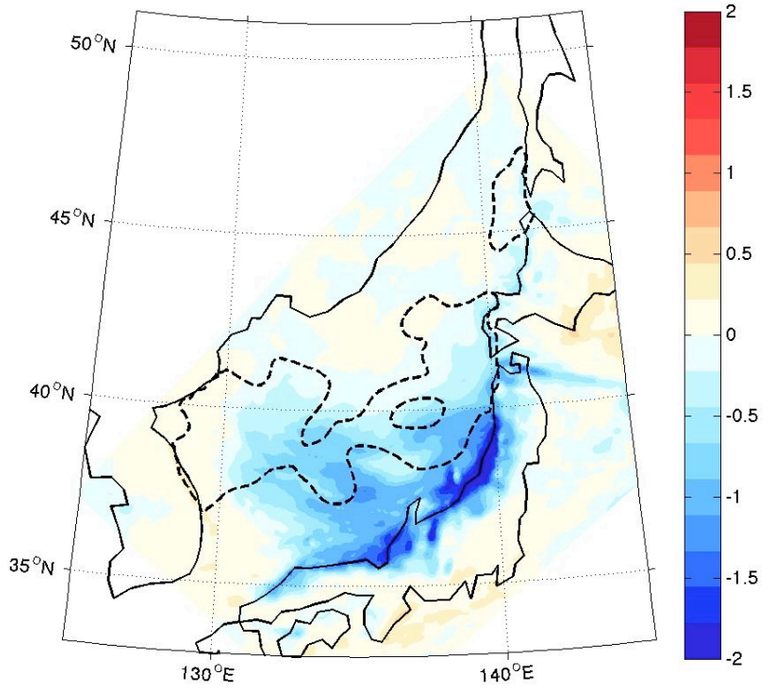
SST



SLP/WIND mb

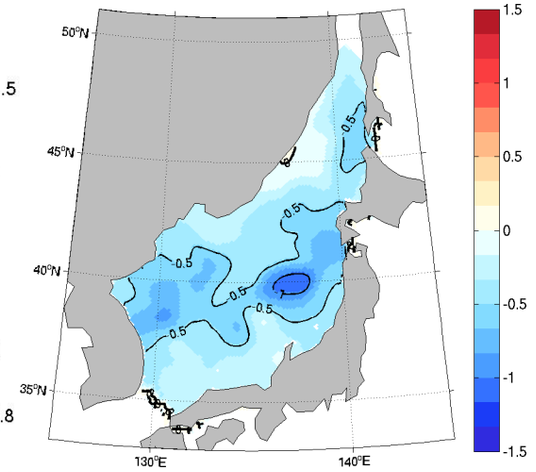


PRECIP mm/day

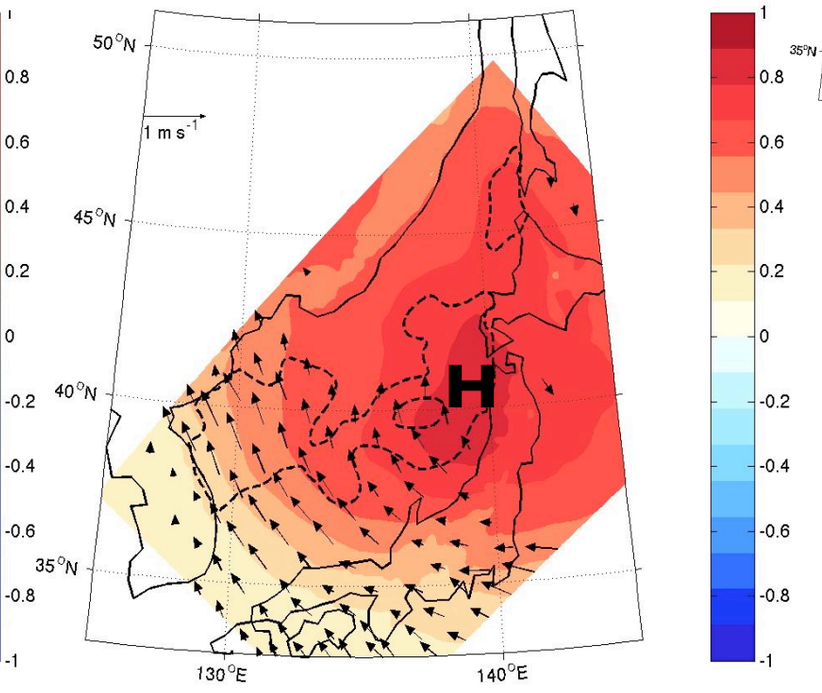


EOF1M-CTL

SST



SLP/WIND mb

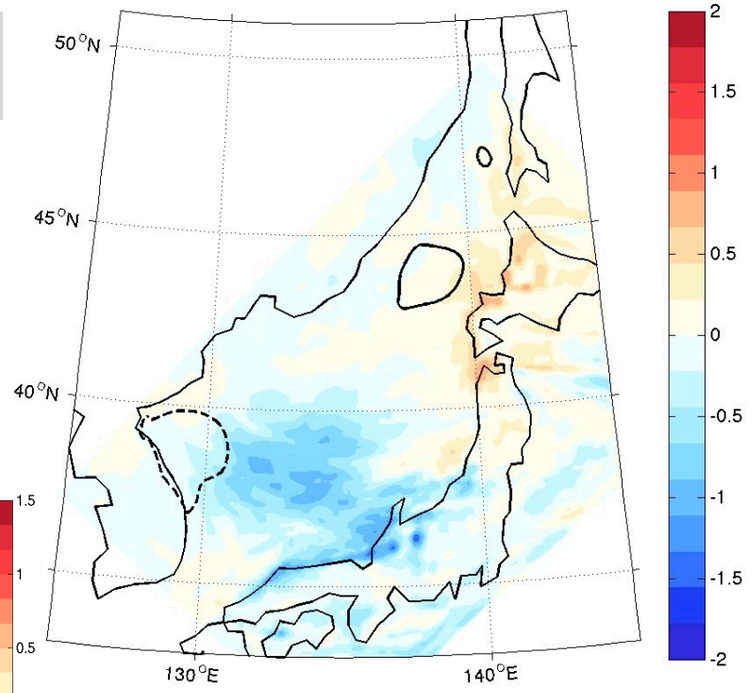


A symmetric rainfall response to the polarity of rainfall, but not in SLP.

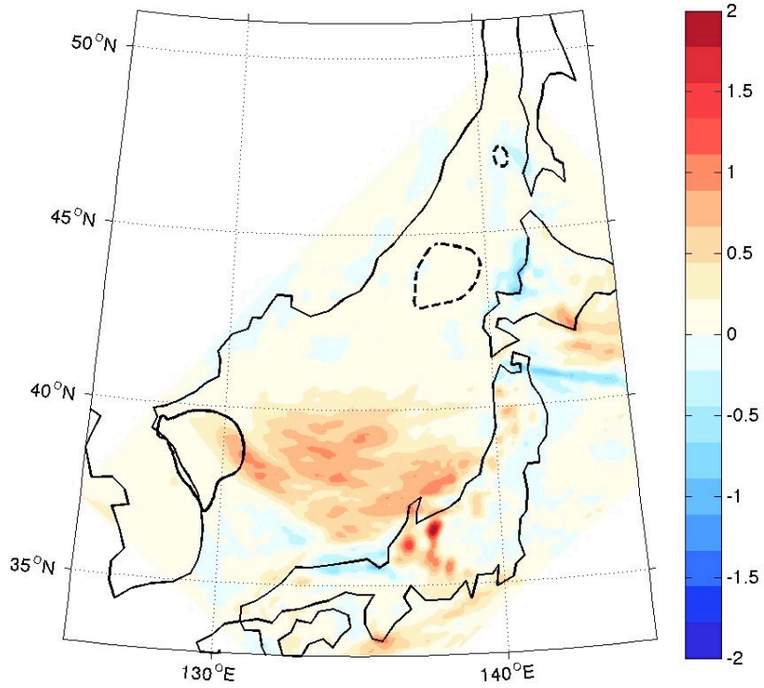
15-91 day averaged responses in precipitation, SLP, and surface wind

EOF2P-CTL

PRECIP mm/day

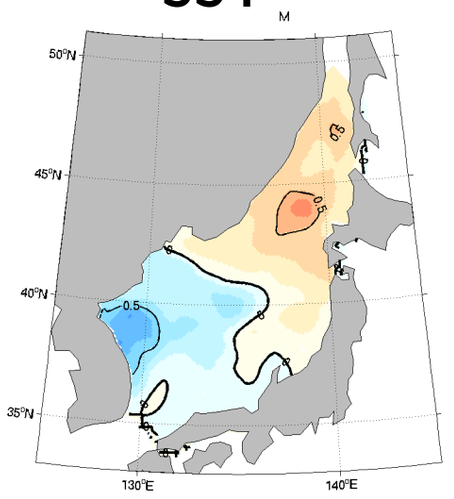


PRECIP mm/day

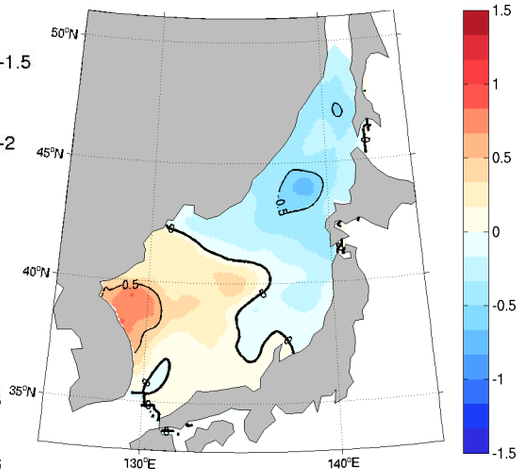


EOF2M-CTL

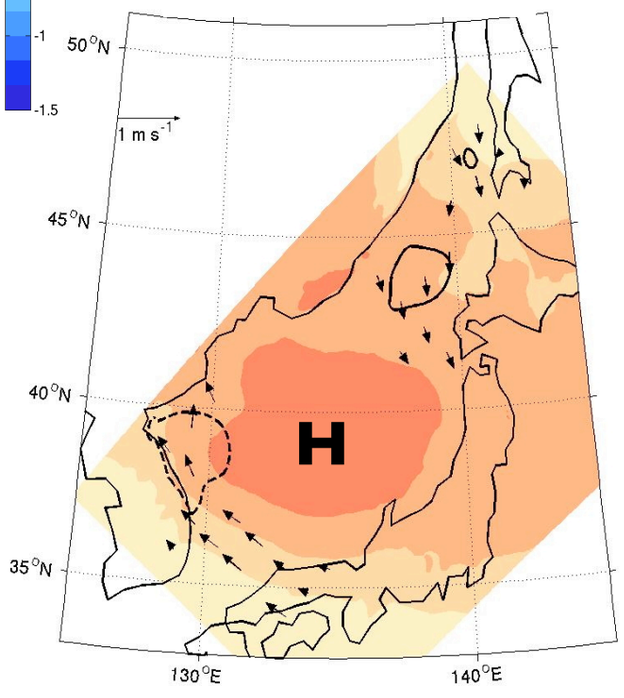
SST M



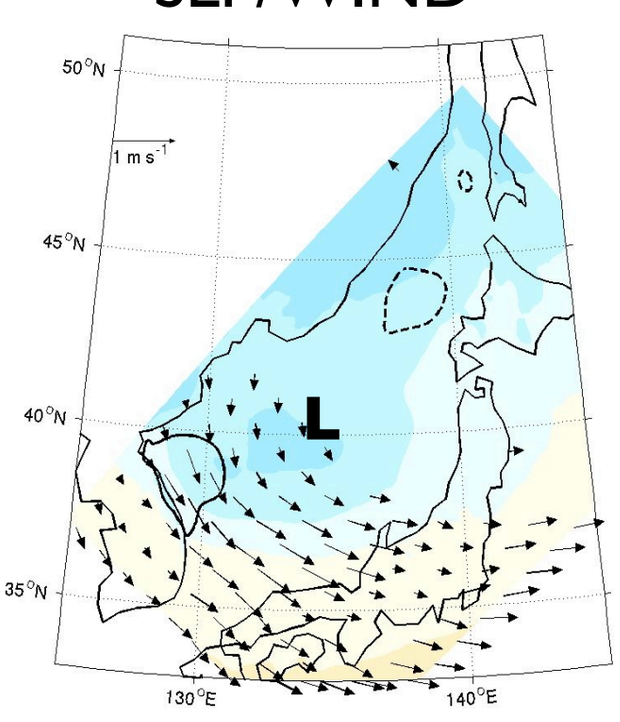
SST



SLP/WIND mb



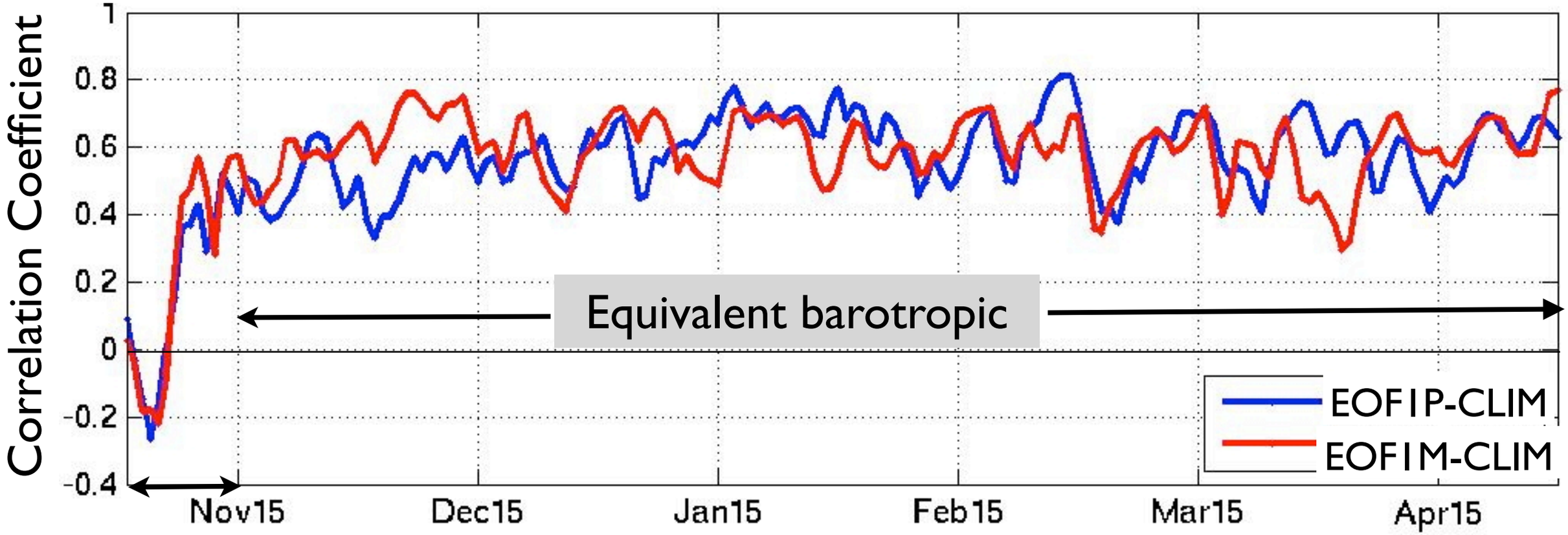
SLP/WIND mb



3. Downstream responses in atmospheric circulation

The initial baroclinic response is followed by an equivalent barotropic structure

Time-series of pattern correlation in geopotential height anomaly at 200mb and 850mb



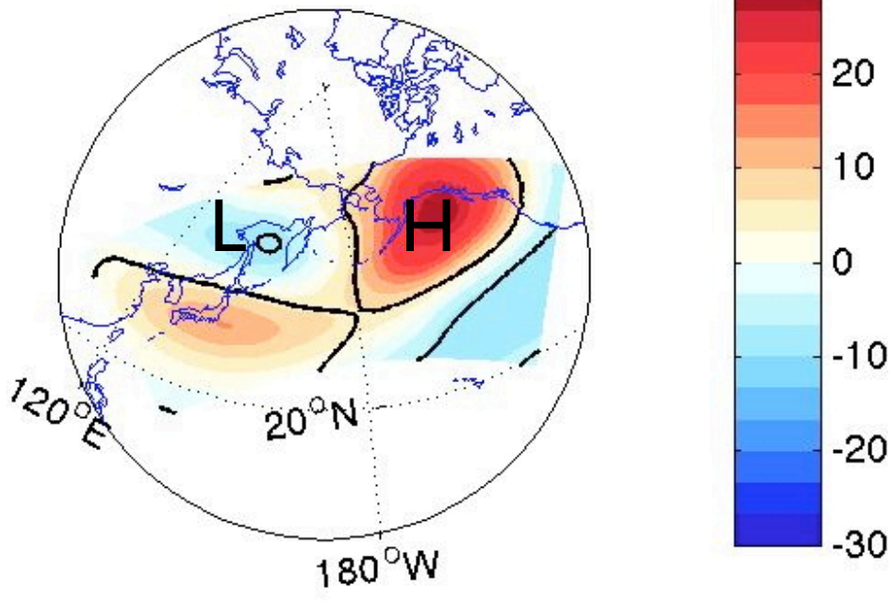
14 days

Baroclinic initial response and a fast transition toward the barotropic structure

An equivalent barotropic height response

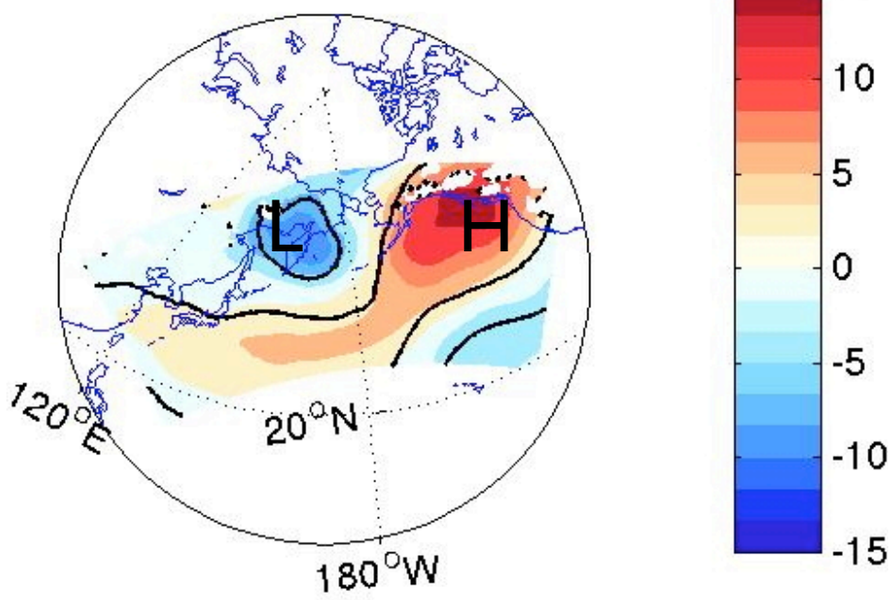
EOF1P-CTL

200 mb HGT



- High in the Pacific Northwest.
- Low over Kamchatka Peninsula

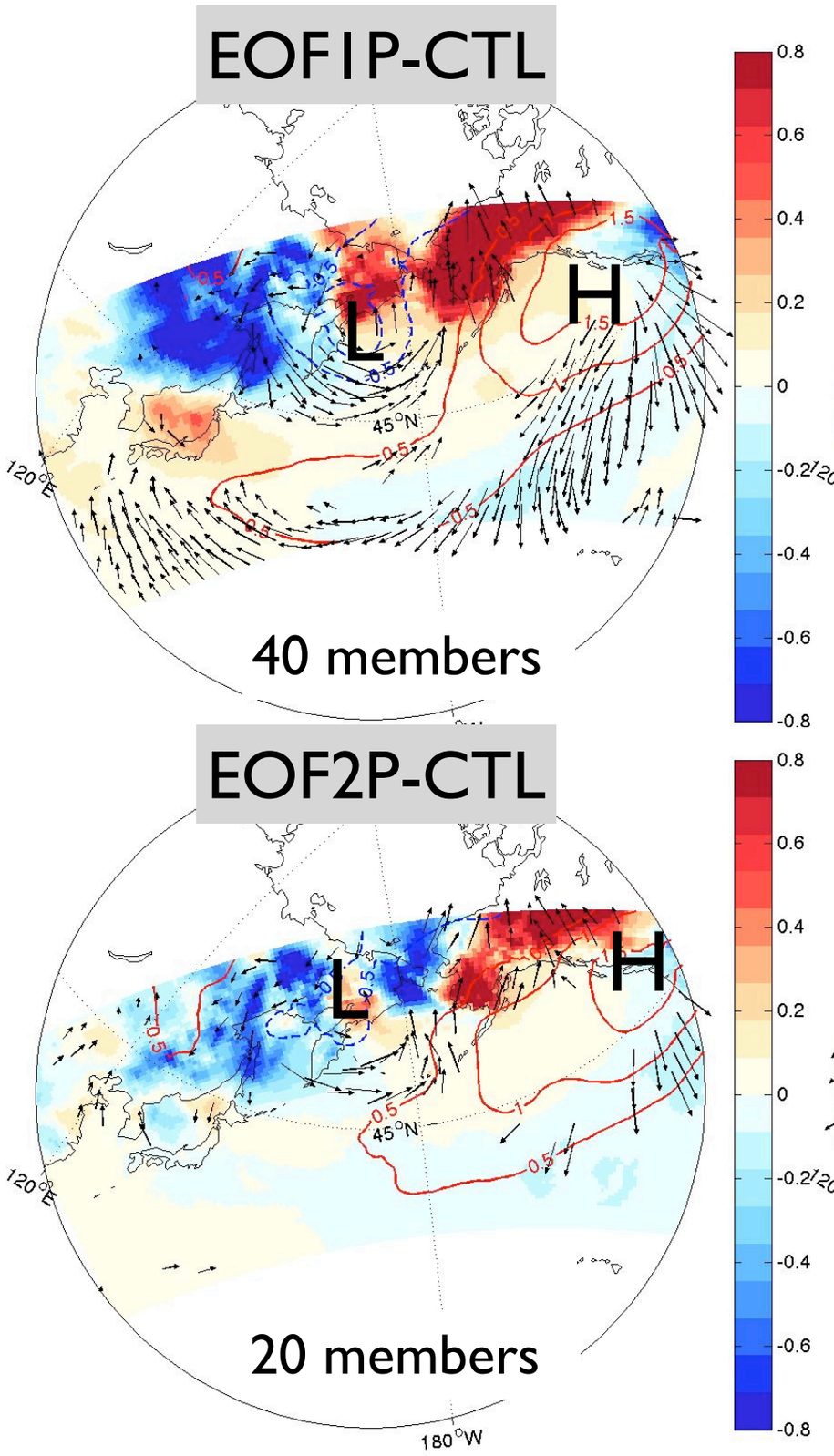
850 mb HGT

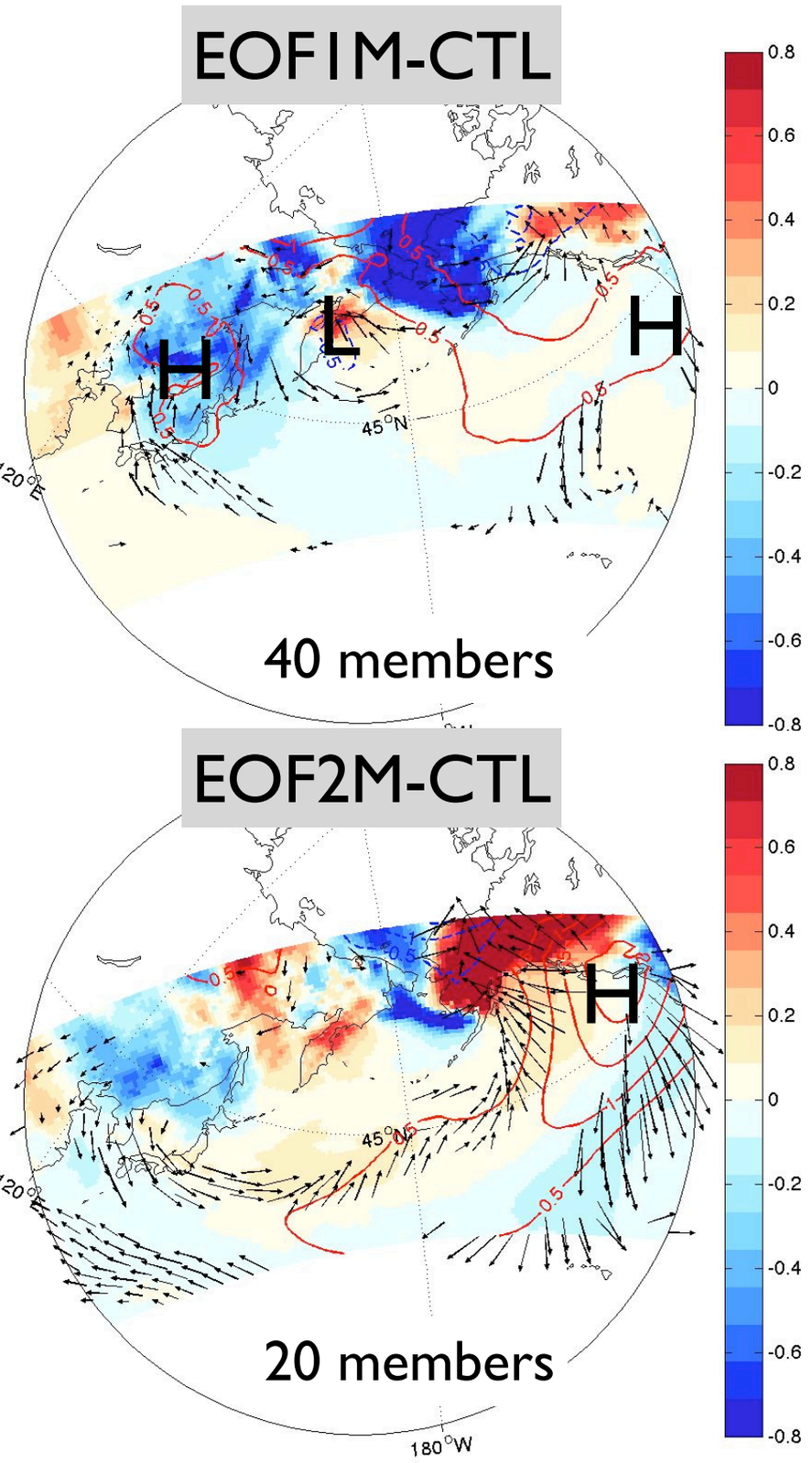


40-member ensemble mean

Black contours: significant at 95%

There are common circulation responses regardless of the SST forcing.





Showing responses in Tair, 10m-wind and SLP

- Responses are distinct over forcing region, depending on the sign of diabatic forcing.

- SLP High in the Pacific NW and Low over the Kamchatka Peninsula are shown as somewhat common feature.

Summary

- Two dominant modes of wintertime SST variability produce differing circulation responses during the two periods of
  - *Initial adjustment*: a deterministic and baroclinic response to the diabatic forcing
  - *Quasi-equilibrium*: a chaotic circulation response with an equivalent barotropic vertical structure
    - A statistically significant response pattern is identified after averaging 40 ensemble members.
- Precipitation response is largely symmetric with respect to the polarity of prescribed SST anomalies.
- SLP High in the Pacific Northwest and Low over the Kamchatka Peninsula tend to commonly appear regardless of the sign/pattern of the SST anomalies.

Thanks