



Response of Atmosphere-Ocean System to Latitudinal Shifts of the North Pacific Subarctic Frontal Zone: A Coupled GCM Experiment

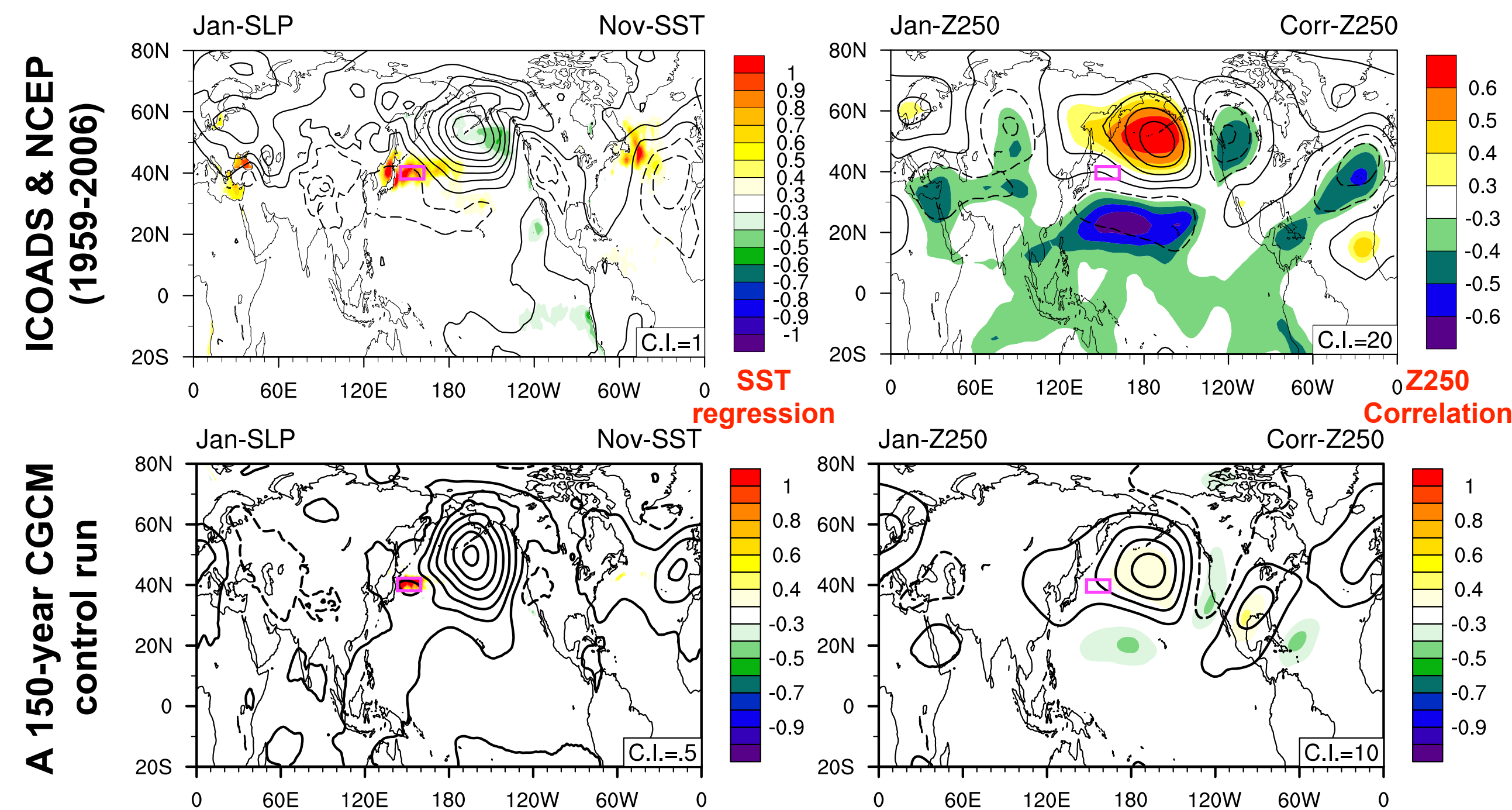


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1. Introduction

Regressed SLP and Z250 anomalies in January on decadal SST variations in SAFZ in preceding November

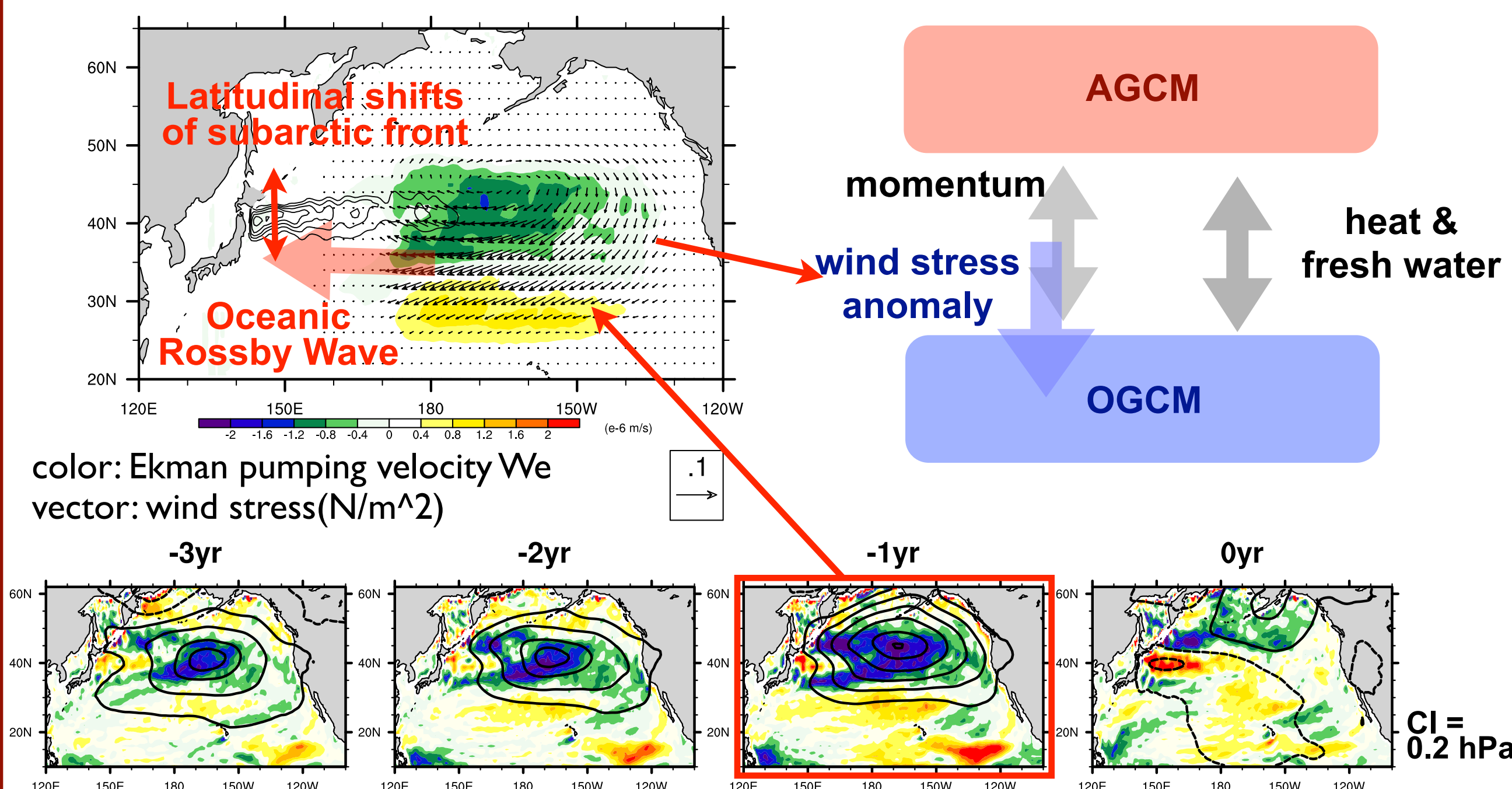


✓warm SAFZ → weakened Aleutian Low & PNA-like pattern in upper troposphere
 Taguchi et al. (2012, J. Climate) see also Frankignoul et al. (2011, J. Climate)
 Observational & CGCM studies suggest possible atmospheric influences of decadal, oceanic frontal variability but their diagnostic approach could not directly address the causality.
Objective of this study: To address the large-scale atmospheric response to ocean frontal variability & its feedback on the ocean by performing a coupled GCM experiment

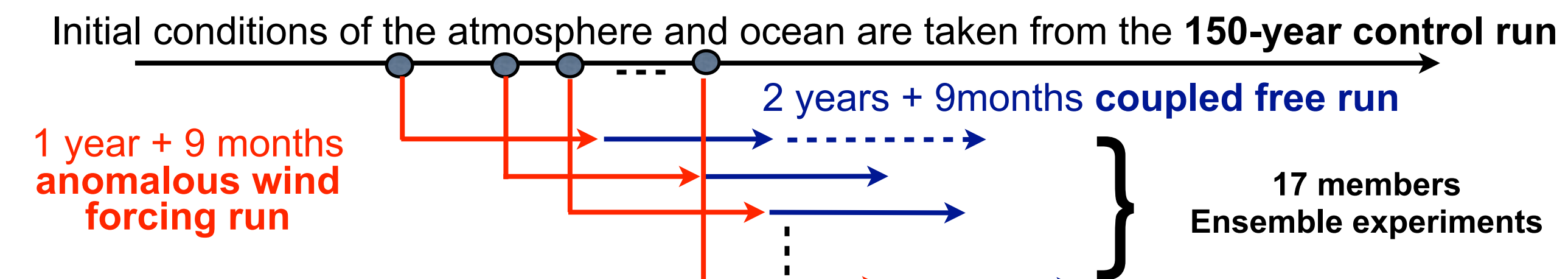
2. Model & experimental design

- **CFES (Coupled GCM for Earth Simulator, Komori et al. 2008)**
 A: AFES based on CCSR/NIES AGCM 5.4.02, O: OFES based on GFDL MOM3.0
- **A long-term CFES control integration**
 with resolution of A:T119 truncation (~100km) 48 σ -levels O: 0.5° 54 z-levels integrated for 150 years with present day GHG
- **CFES sensitivity experiment**

latitudinal shifts of the simulated subarctic front are deliberately induced by imposing idealized wind stress anomaly in the central North Pacific

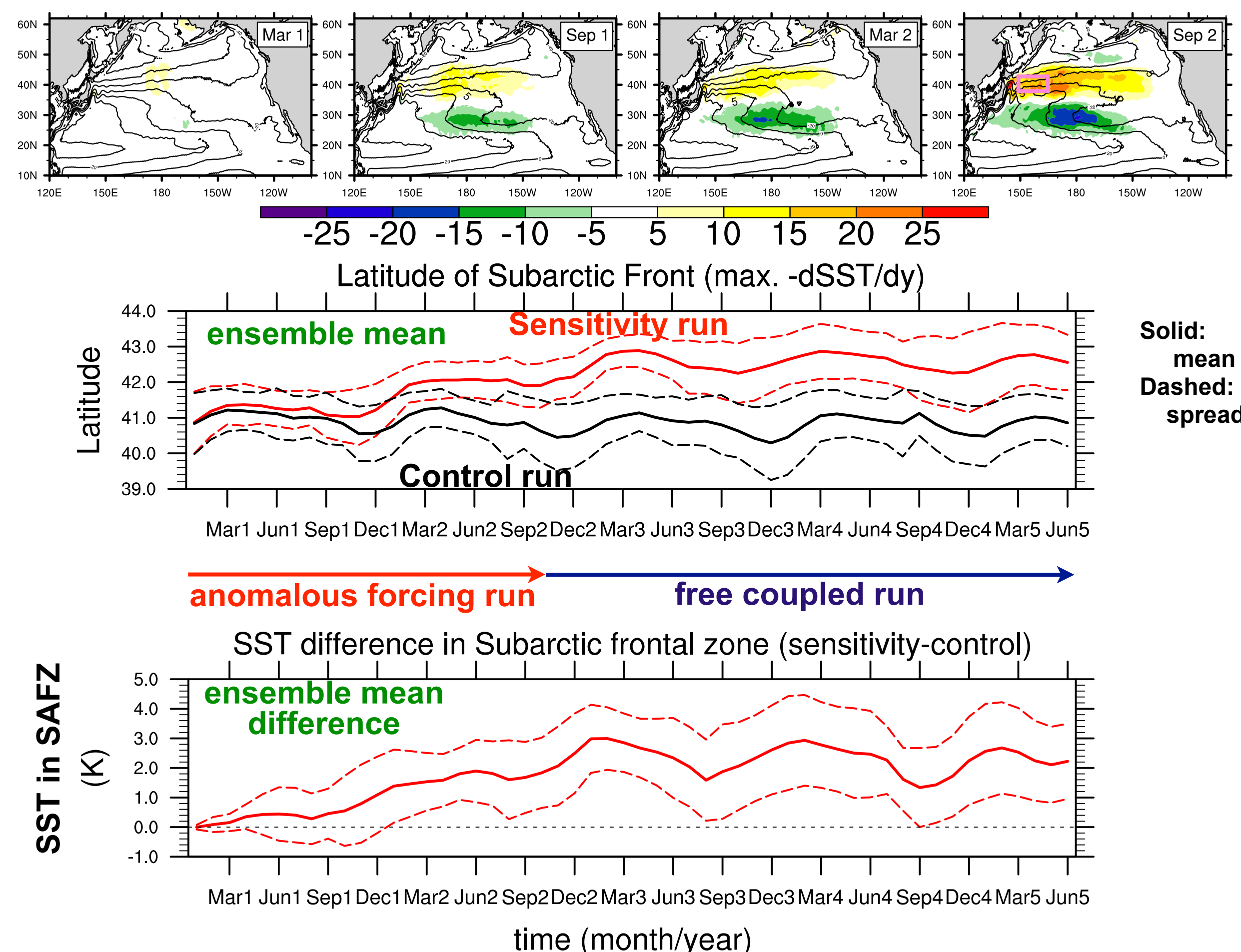


color: Ekman pumping velocity We vector: wind stress (N/m^2)



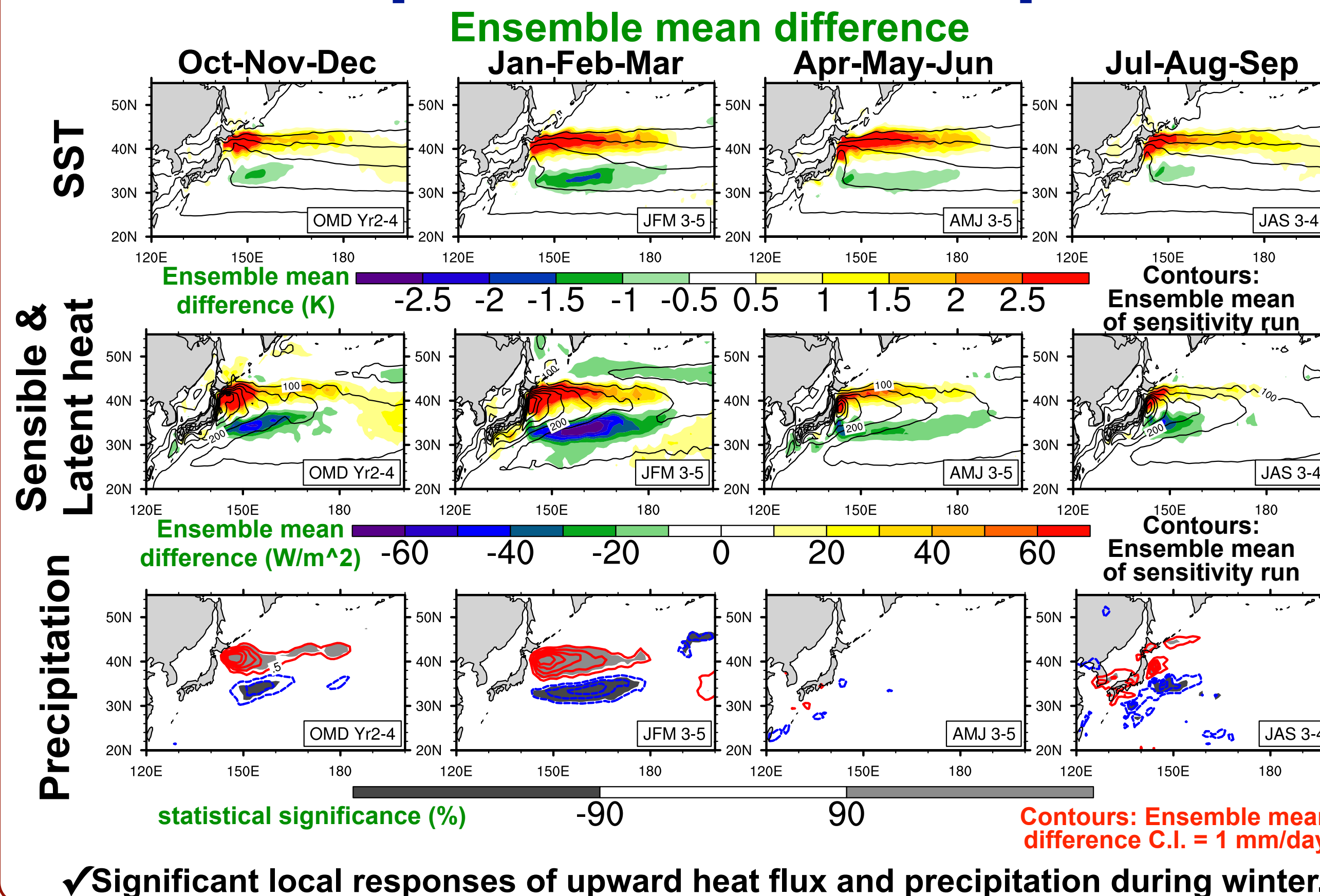
3. Oceanic response

SSH: Ensemble mean difference (Control-Sensitivity runs)



✓Subpolar gyre spin-down → Northward shift of SAF → Warming in SAFZ

4. Atmospheric local response



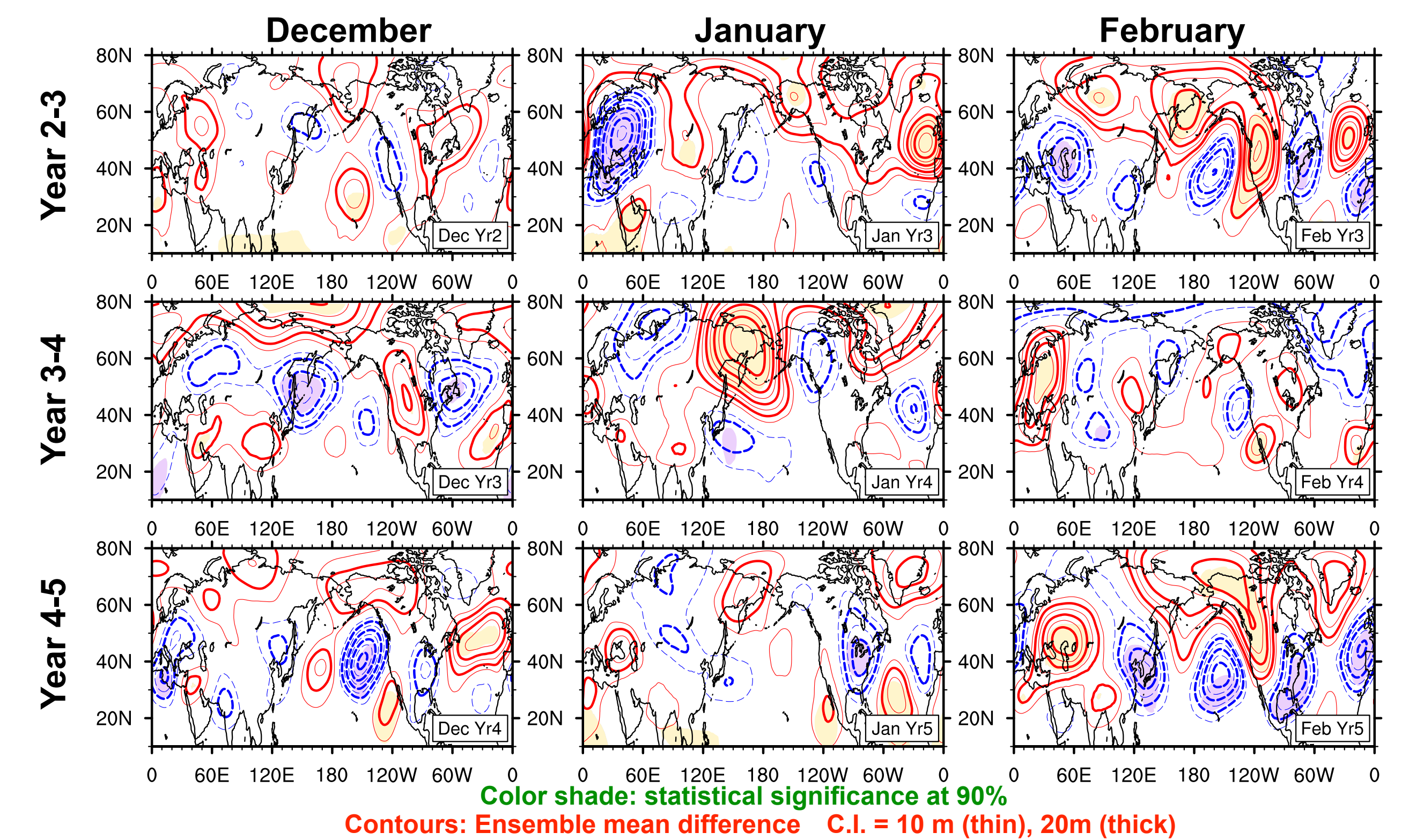
✓Significant local responses of upward heat flux and precipitation during winter.

8. Summary & Discussion

- Latitudinal shifts of the North Pacific subarctic front (SAF) is deliberately induced in a CGCM integration and responses of ocean-atmosphere system are examined.
- Atmospheric response exhibits a robust local responses during winter along the northward-shifted SAF, whereas basin-scale atmospheric circulation response is not persistent throughout the season and not coherent from one year to another.
- So far, no clear feedback on the ocean of the ocean front-induced atmospheric circulation changes is detected on the ensemble mean but such feedback may be operative differently across ensemble members, a subject of ongoing investigation.

5. Upper tropospheric response

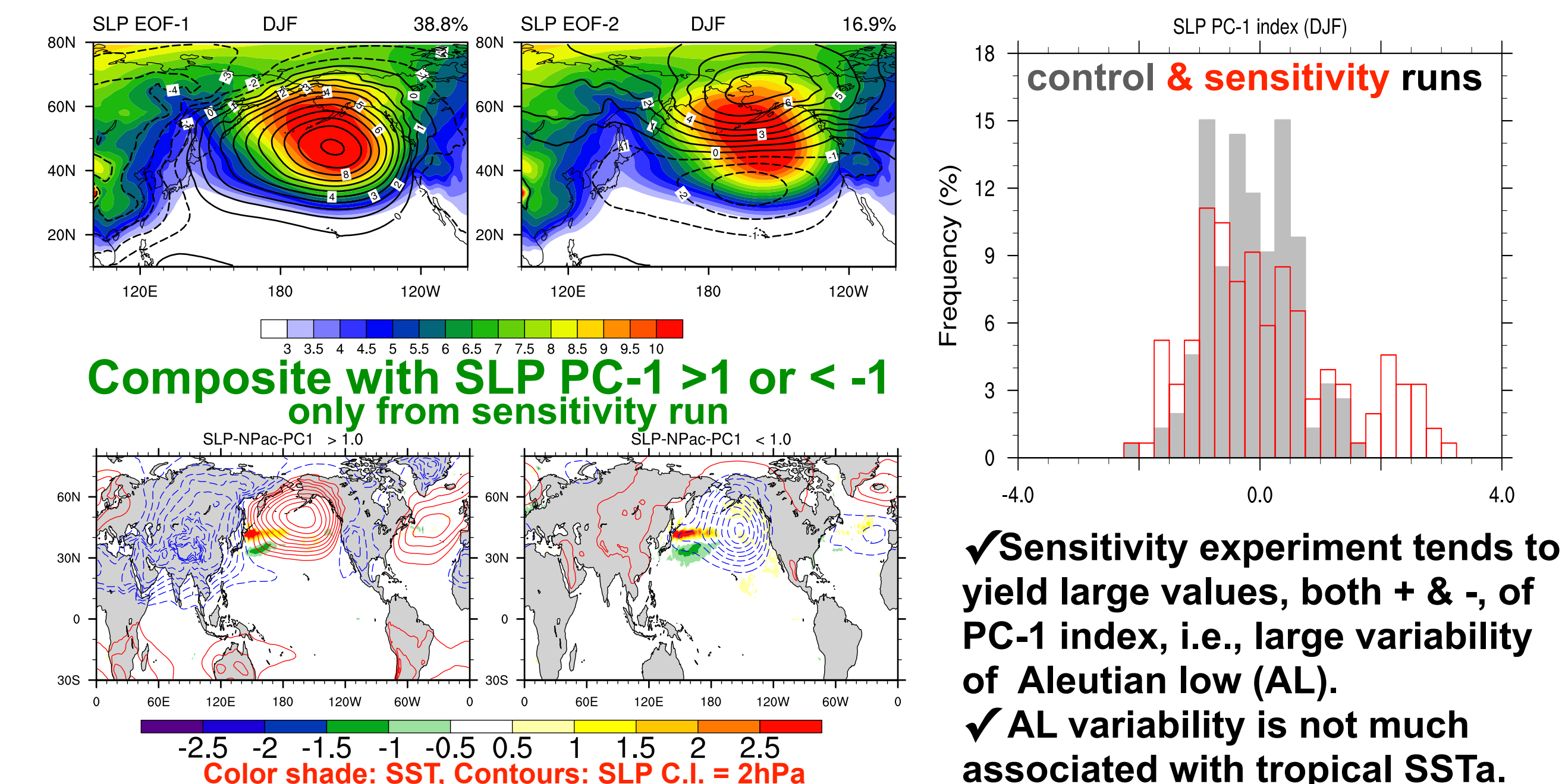
Z250: Ensemble mean difference (Control-Sensitivity runs)



✓January 4th year yields Pacific North American pattern-like anomaly, though large-scale atmospheric response is not coherent from month (year) to month (year).

6. North Pacific SLP: Probability

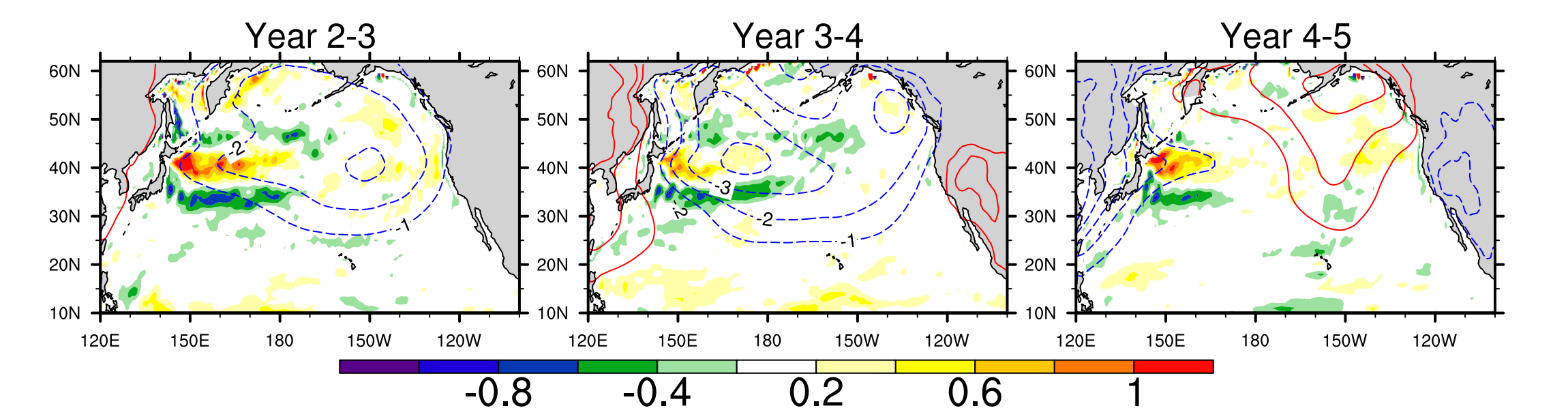
EOF of SLP (3 months, 3 winters, 17 ensembles, control+sensitivity)



✓Sensitivity experiment tends to yield large values, both + & -, of PC-1 index, i.e., large variability of Aleutian low (AL).
 ✓AL variability is not much associated with tropical SSTs.

7. Feedback on the ocean

July-June annual mean We & SLP ensemble mean difference (Control-Sensitivity)



✓No obvious basin-scale Ekman pumping (We) feedback found. Positive We associated with local response may act to damp SST anomaly generated by SAF shift.