On the Importance of a Midlatitude Oceanic Frontal Zone for the Baroclinic Annular Mode

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Large-scale tropospheric variability in the extratropical Southern Hemisphere is characterized by two major modes. One is the well-known Southern Annular Mode (SAM), which represents meridional shifts of the eddy-driven polar-front jet (PFJ). The other mode, “Baroclinic Annular Mode (BAM)”, represents pulsing of stormtrack activity, which is well reproduced in a perpetual aqua-planet atmospheric general circulation model (AGCM) experiment where frontal sea-surface temperature (SST) gradient is realistically prescribed at 45º latitude. The BAM variability is greatly weakened in another aqua-planet AGCM experiment where the frontal SST gradient is artificially removed. The weakening is particularly marked in the variability of low-level poleward eddy heat flux. Our experiments suggest that the midlatitude oceanic frontal zone enhances and anchors the BAM variability by strengthening stormtrack activity through maintaining near-surface baroclinicity and moisture supply to cyclones. Specifically, anomalous sensible heat flux around the SST front acts to restore meridional gradient in surface air temperature (SAT) efficiently under continuous modifications added by BAM activity through anomalous meridional eddy heat flux, and this effect is enhanced enormously around the frontal SST gradient.

In addition, the two of our AGCM experiments indicate that BAM accompanies modest but robust meridional shift of PFJ. Unlike in any previous studies, this study suggests a certain level of co-variability between BAM and SAM which is supported by significant correlation and coherence between their time series. In both experiments, BAM spectra indicates its quasi-periodic behaver as the internal mode of atmospheric variability. These results in our AGCM expriments are generally consistent with those observed.

Keywords: annular mode, oceanic frontal zone, stormtrack

