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Potential Importance of a Midlatitude Oceanic Frontal Zone in the Annular Variability of the Westerlies and its Vertical Connectivity

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Annular-mode variability in the extratropical atmosphere is a manifestation of latitudinal shifts of an eddy-driven polar-front jet (PFJ) and associated stormtrack, both of which climatologically form slightly poleward of a midlatitude oceanic frontal zone that maintains a surface baroclinic zone against poleward eddy heat transport. "Aquaplanet" AGCM (atmospheric general circulation model) experiments with zonally-uniform sea-surface temperature (SST), which mimics the Southern Hemisphere, reveal certain sensitivity of the nodal latitude of anomalous westerlies associated with the annular mode to the latitude of frontal SST gradient. The sensitivity is evident for its positive phase, where PFJ is situated systematically poleward of the SST front wherever it is located. Insensitively to the frontal latitude, by contrast, PFJ for the negative phase resides near 40° latitude, which nearly corresponds to the climatological PFJ axis that is realized without frontal SST gradient. The annular mode can therefore be interpreted as wobbling of the atmospheric circulation system between a regime dominated by thermodynamic influence of frontal SST gradient and that by atmospheric internal dynamics, which is useful, for example, for understanding inter-basin differences observed in the Southern Annular Mode (SAM) signature. Implications for the tropospheric westerly response to the stratospheric ozone depletion are also discussed.