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Role of the Midlatitude Oceanic Front in the Ozone-induced Climate Change in the Southern Hemisphere as Revealed in Aqua Planet Experiments

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The Southern Hemisphere Annular Mode (SAM) is the dominant mode of low-frequency atmospheric variability in the extratropical Southern Hemisphere, exerting substantial climatic impacts on extensive regions. A decadal trend of SAM observed in the troposphere during the late 20th century is considered to be related to the intensification of the stratospheric polar vortex induced by the ozone depletion. Known as a manifestation of meridional displacements of the eddy-driven polar-front jet (PFJ) and associated storm-track, the tropospheric SAM and its trend may be sensitive to the near-surface baroclinicity associated with the midlatitude oceanic frontal zone. In the present study, aqua-planet experiments with an atmospheric general circulation model are conducted by prescribing two different latitudinal profiles of zonally symmetric sea-surface temperature (SST) with and without frontal gradient in midlatitudes. A comparison of the tropospheric response to the assigned stratospheric ozone depletion between the two SST profiles reveals critical importance of the frontal SST gradient for translating the direct response of the stratospheric polar vortex to the ozone depletion down to the surface by enhancing the SAM variability and allowing the SAM its deep structure into the stratosphere in late spring through early summer.