SPARC Workshop SHARP2016

Importance of mid-latitude oceanic frontal zone and associated baroclinic eddies on the ozone-induced stratosphere/troposphere coupling

Dr. Fumiaki Ogawa[1], Dr. Nour-Eddine Omrani, Dr. Kazuaki Nishii, Prof. Hisashi Nakamura, Prof. Noel Keenlyside

[1] University of Bergen

fumiaki.ogawa@gfi.uib.no

The late 20th century was marked by a significant summertime trend in the Southern Annular Mode (SAM), the dominant mode of tropospheric variability in the extratropical Southern Hemisphere (SH). This trend with poleward-shifting tropospheric westerlies was attributed to downward propagation of stratospheric changes induced by ozone depletion. However, the role of the ocean in setting the SAM response to ozone depletion and its dynamical forcing remains unclear. In this study, we conducted idealized aqua-planet AGCM experiments with prescribed zonally symmetric SST profile to show that the ozone-induced SAM response in the troposphere occurs only in the presence of oceanic frontal zone through enhanced vertical coupling of SAM as observed. Oceanic frontal zone is critical for the climatological mean eddy-driven westerlies in the troposphere by activating synoptic-scale eddies through strengthening the surface baroclinicity. As the dominant variability of the eddy-driven jet, the SAM and its stratosphere/troposphere coupling cannot be simulated realistically without the oceanic front. The realistic representation of the tropospheric SAM with the oceanic frontal zone enhances the persistence of the tropospheric westerly anomalies, leading to the reproduction of the ozone-induced westerly response. The oceanic frontal zone activates not only the synoptic-scale waves but also the planetary-scale waves presumably through non-linear interactions among the synoptic-scale waves. The importance of waves in the stratosphere/troposphere coupled response to the ozone depletion in the presence of oceanic front is consistent with previous findings. Furthermore, analysis of IPCC climate simulations suggests that the simulated SH ozone-induced climate changes are sensitive to the representation of oceanic front in those models.