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Influence of mid-latitude oceanic fronts on the atmospheric water cycle

Fumiaki Ogawa[1,2] and Thomas Spengler[1,2]
[1]University of Bergen, Geophysical Institute, Bergen, Norway (fumiaki.ogawa@gfi.uib.no)
[2]Bjerknes Centre for Climate Research, Bergen, Norway

Midlatitude oceanic fronts play an important role in the air-sea coupled weather and climate system. Created by the confluence of warm and cool oceanic western boundary currents, the strong sea-surface temperature (SST) gradient is maintained throughout the year. The climatological mean turbulent air-sea heat exchange maximizes along these SST fronts and collocates with the major atmospheric storm tracks. A recent study identified that the air-sea heat exchange along the SST front mainly occurs on sub-weekly time scales, associated with synoptic atmospheric disturbances. This implies a crucial role of air-sea moisture exchange along the SST fronts on the atmospheric water cycle through the intensification of atmospheric cyclones and the associated precipitation.

In this study, we investigate this influence of the SST front on the atmospheric water cycle by analyzing the atmospheric response to different prescribed SST in the Atmospheric general circulation model For the Earth Simulator (AFES). Changing the latitude of the prescribed zonally symmetric SST in aqua-planet configuration, we find a distinctive response in convective and large-scale precipitation, surface latent and sensible heat fluxes, as well as diabatic heating and moistening with respect to the latitude of SST front. Upward surface latent heat flux and convective precipitation always maximize along the equatorward flank of SST front. On the other hand, large-scale precipitation is always located on the poleward flank of the SST front, in correspondence with the maximum atmospheric moisture flux convergence. The moisture flux convergence is mainly associated with midlatitude eddies and not with the time mean transport. This highlights the influence of mid-latitude SST fronts on the atmospheric water cycle through the organization of atmospheric storm track.