How ocean dynamics modulate the climate response to one hemispheric subpolar cooling?

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Cross-equatorial atmospheric transport of energy offers a predictive view of how climatic asymmetry develops in response to interhemispheric difference in energy flux into the coupled ocean-atmosphere system. Indeed, anthropogenic aerosols mostly concentrated in the Northern Hemisphere force an interhemispheric Hadley circulation displacing the ITCZ southward. Confusions arise, however, from recent experiments using realistic dynamical oceans; changes in surface heat flux into the Southern Ocean fail to displace the ITCZ. Using a hierarchy of coupled models, here we identify two hitherto unknown factors important for tropical response to subpolar heat flux forcing. First, the northward displaced mean ITCZ creates a strong asymmetry b/w a subpolar cooling in NH and SH. The ITCZ effectively blocks the NH cooling from intruding across the equator with the a strong displacement of the ITCZ towards the unforced hemisphere while the SH cooling penetrates across the equator exciting a symmetric response across the equator. Second, the upwelling of deep water in the Southern Ocean mutes the vertical energy flux into the atmospheric column, reducing the response to a SH forcing while the dynamical ocean damping on the flux forcing is much weaker. In addition, Bjerknes feedback amplifies the symmetric, upward-amplified temperature response in the tropical troposphere. These results advance the energetic framework by highlighting the importance of the mean ITCZ asymmetry and dynamical ocean damping on subpolar TOA radiative forcing.