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The influence of regional Arctic sea-ice decline on stratospheric and tropospheric circulation

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Arctic sea-ice extent has rapidly declined over the past few decades, and most climate models project a continuation of this trend during the 21st century in response to greenhouse gas forcing. A number of recent studies have shown that this sea-ice loss induces vertically propagating Rossby waves, which weaken the stratospheric polar vortex and increase the frequency of sudden stratospheric warmings (SSWs). SSWs have been shown to increase the probability of a negative NAO in the following weeks, thereby driving anomalous weather conditions over Europe and other mid-latitude regions. In contrast, other studies have shown that Arctic sea-ice loss strengthens the polar vortex, increasing the probability of a positive NAO. Sun et al. (2015) suggest these conflicting results may be due to the region of sea-ice loss considered. They find that if only regions within the Arctic Circle are considered in sea-ice projections, the polar vortex weakens; if only regions outwith the Arctic Circle are considered, the polar vortex strengthens. This is because the anomalous Rossby waves forced in the former/latter scenario constructively/destructively interfere with climatological Rossby waves, thus enhancing/suppressing upward wave propagation. In this study, we investigate whether Sun et al.'s results are robust to a different model. We also divide the regions of sea-ice loss they considered into further sub-regions, in order to examine the regional differences in more detail. We do this by using the intermediate complexity climate model, IGCM4, which has a well resolved stratosphere and does a good job of representing stratospheric processes. Several simulations are run in atmosphere only mode, where one is a control experiment and the others are perturbation experiments. In the control run annually repeating historical mean surface conditions are imposed at the lower boundary, whereas in each perturbation run the model is forced by SST perturbations imposed in a specific region (one perturbation experiment combines all regions). These regions correspond to sea-ice loss hotspots such as the Barents-Kara Seas and the Bering Sea. The differences between the control and perturbation runs yields the effects of the imposed sea-ice loss on the polar vortex. To detect and count SSWs for each run, we use the World Meteorological Organisation's definition of an SSW (a reversal in zonal mean zonal wind at 10 hPa and 60˚N, and a reversal in zonal mean meridional temperature gradient at 10 hPa between 60˚N and 90˚N). The poster will present and discuss the initial results of this study. Implications of the results for future change in the lower latitude mid-troposphere will be discussed.

References

Sun, L., C. Deser, and R. A. Tomas, 2015: Mechanisms of Stratospheric and Tropospheric Circulation Response to Projected Arctic Sea Ice Loss. *J. Climate*, **28**, 7824–7845, doi: http://dx.doi.org/10.1175/JCLI-D-15-0169.1.