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Opposing influences of Arctic sea-ice loss on Californian and Mediterranean rainfall

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Modeling approaches aimed at isolating the climate impacts of sea-ice loss often tend to impose non-physical energy flux perturbations in order to achieve the changes in sea-ice cover. This makes it difficult to discern if the observed climatic response really originates from the sea-ice cover changes or if it is altered by the imposed energy flux perturbations. Here we illustrate a new approach that is both energy conserving and physically realistic and discuss the isolated impacts of Arctic sea-ice loss on Mediterranean and Californian rainfall.

Our method employs small perturbations to selected sea-ice physics parameter values that result in substantial sea-ice cover changes. The sea-ice physics parameter perturbations are imposed only within their respective expert defined ranges, allowing for a physically realistic experimental design. Importantly, this approach does not require any kind of artificial alteration of high latitude energy fluxes to achieve the sea-ice cover changes ensuring energy budget conservation.

We find that the loss of Arctic sea-ice cover imposes opposite influences on Californian and Mediterranean winter rainfall. In the case of California, the sea-ice loss results in precipitation decrease. In a two-step teleconnection, sea-ice changes lead to reorganization of tropical convection that in turn triggers an anticyclonic response over the North Pacific. This North Pacific geopotential ridge stirs the winter storms northward and away from California, resulting in significant drying over the American southwest. In contrast, over the Mediterranean region, we see an increase in winter rainfall that is in large part associated with the weakening of the Icelandic low and more negative NAO conditions. While the influence of Arctic sea-ice loss on Californian rainfall is mediated via tropics through a two-step teleconnection, its impact on Mediterranean rainfall is exerted more directly.

We conclude that the Arctic sea-ice loss is an important driver of low-latitude precipitation changes. Importantly, since the described atmospheric teleconnections are susceptible to alteration of surface energy fluxes in the high latitudes, they can be influenced by the choice of method for isolating the impacts of sea-ice loss.