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Drivers of the Spatial Pattern of Arctic Sea Ice Response to Arctic Cyclones

Robin Clancy, Cecilia Bitz, Ed Blanchard-Wrigglesworth, and Marie McGraw
University of Washington, Seattle, USA

The effects of Arctic cyclones on sea ice are the subject of many papers, however aside from individual case studies, few address the heterogeneity in the spatial pattern of the sea ice response.

We composite atmospheric conditions from ERA5 reanalysis and satellite sea ice concentrations on Arctic cyclones using a storm-centered approach to reveal the typical atmosphere and sea ice responses at different bearings and distances relative to an Arctic cyclone.

Asymmetry in the pattern of the sea ice concentration response to cyclones is revealed, with increased growth/reduced melt to the west of cyclones and decreased growth/increased melt to the east.

In part, this is explained by heterogeneity in the spatial patterns of atmospheric temperature and cloud fraction associated with cyclones, which result in heterogeneity in patterns of the surface energy fluxes.

Using the CICE sea ice model forced with prescribed atmospheric reanalysis from the Japan Meteorological Agency, we reveal the relative importance of the dynamic and thermodynamic forcing of cyclones on sea ice, as well as the spatial patterns of each. The dynamic and thermodynamic responses of sea ice concentration to cyclones are comparable in magnitude, however dynamic processes dominate the response of sea ice thickness.

These results highlight and explain important details often missed when answering “do cyclones cause an increase or decrease sea ice?”, as it appears the answer is both.