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# Causal evaluation of Arctic-midlatitude processes in CMIP6 model simulations

**Evgenia Galytska**[1,2], Katja Weigel[1,2], Jakob Runge[3,4], Dörthe Handorf[5], Ralf Jaiser[5], Raphael Köhler[5], and Veronika Eyring[1,2]

[1]University of Bremen, Institute of Environmental Physics, Bremen, Germany
[2]Deutsches Zentrum für Luft- und Raumfahrt (DLR), Institut für Physik der Atmosphäre, Oberpfaffenhofen, Germany
[3]Deutsches Zentrum für Luft- und Raumfahrt (DLR), Institut für Datenwissenschaften, Jena, Germany
[4]Technische Universität Berlin, Berlin, Germany
[5]Alfred Wegener Institute, Potsdam, Germany

The impact of various mechanisms that link Arctic and midlatitude processes occurring in conditions of amplified Arctic warming is still under debate. Observational and model studies lead to divergent conclusions. This has spurred a number of research activities aiming to apply innovative approaches to improve process understanding. Therefore, to identify robust relationships in the complex Arctic-midlatitude linkages, we apply a novel method that goes beyond simple correlation analysis, known as Causal Networks or Causal Discovery. This allows us to analyze, characterize, and quantify key processes that contribute to the linkage between the Arctic and midlatitudes on a monthly timescale. In particular, we focus on the causal connections among key actors, such as Arctic near-surface temperature and sea ice, near-surface pressure over central Asia, vertical wave propagation, and its further link to the stratospheric polar vortex. Additionally, we analyze the contribution of remote large-scale processes, such as El Niño–Southern Oscillation, Quasi Biennial Oscillation, and North Atlantic Oscillation. In this study, we summarize the comparisons between historical Coupled Model Intercomparison Project Phase 6 (CMIP6) model runs and observational data. On the one hand, our analysis shows that the majority of historical CMIP6 models agree with observations on the significant causal connection between near-surface air temperature and sea ice extent in the Arctic region. These model results also capture the tropospheric-stratospheric coupling and downward impact from the stratosphere to the troposphere shown by observations. On the other hand, we also focus on discrepancies between model simulations and observations and provide possible explanations of investigated differences. These outcomes provide the basis to investigate changes in the links between Arctic and midlatitudes for simulations with various forcings and future scenarios.