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A coupled perspective on the Atmosphere-Sea-Ice variability

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The variability of the ice cover in the Arctic Ocean is deemed to be a driver of changes in the midlatitude circulation. Sea ice is an excellent insulator and prevents heat exchange between the ocean and the atmosphere. Changes in the environment of the Arctic can induce a response in the atmospheric flow through changes in the surface heat fluxes and the dynamical response of the atmosphere can potentially induce a detectable change of the circulation at lower latitudes. The latter potential impact is widely but controversially discussed in literature, still evidence suggests the low ice conditions are coincident with an equartorward shift of the atmospheric jet.
The complexity of the proposed linkages fosters the need of appropriate diagnostics: in particular, time scales involved range from sub-seasonal to multi-decadal and they are entangled in the coupled ice-atmosphere interaction. We propose an analysis of this interaction in the Northern Hemisphere winter focusing on the link with the midlatitudes. The analysis is carried out using data of ice cover, surface fluxes and atmospheric fields from ERA-Interim and CMIP5 historical runs. The proposed diagnostics is able to capture the coupled variability of the ice-atmosphere system on a seasonal time scale and to identify how this variability is modulated on a decadal or longer time scale. More specifically we compute monthly tendencies of sea-ice and atmospheric indices as functions of the value of the indices, in a way that resembles the canonical phase space in dynamical systems. CMIP5 decadal experiments have been analysed to investigate potential multi-annual predictability.
Results highlight an atmospheric preconditioning of the link and the dependence of the coupled interaction on the atmosphere state and the ice state. The presented diagnostics can identify windows of opportunity, when the Arctic sea-ice is more sensitive to the state of the atmospheric circulation and vice versa. The interpretation of these results can help us exploit predictability associated with the Arctic environment and to define appropriate, relevant metrics. This study is supported by the Blue Action Project funded by the EU Horizon 2020 Programme.