Climate memory of the Eurasian land process for the Arctic amplification

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Amplified warming over the Arctic region, so called Arctic amplification (AA), and its relevance to the mid-latitude cooling in winter have recently been intensively studied. Recognizing rapid decline of the Arctic sea ice as to coincide with AA, sea ice-climate impacts have been examined in both observational and modeling studies. However, there is a serious gap between diverged simulation results among models/studies and observational evidence showing strong relevance of sea ice variation to AA signals on the interannual to decadal timescales. To fill the gap, we assume the climate memory effect of the land process that achieves amplification and recurrence of the sea ice-climate impacts. Here we designed and performed a set of general circulation model experiments that is able to extract the memory effect of land process. The memory of the northern Eurasian cooling anomalies that originally induced by sea ice loss are stored as snow amount and soil temperature. Memorized anomalies could induce the atmospheric circulation resembling the negative Arctic oscillation and amplify the Arctic warming in the later years. Estimated atmospheric circulation change due to this memory effect is comparable with that directly induced by sea ice loss. Reducing uncertainty of the land process operated in the climate models, which is expected to have large model dependency, would be a major choice to achieve the robust simulation results to evaluate sea ice-induced AA.

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