K-means cluster analysis of the Arctic sea ice and the Northern Hemisphere climate variability and change

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The rapid decline of the Arctic sea ice cover, observed with high precision over the modern satellite era, is one of the most striking aspects of climate change with severe regional repercussions in socio-economic terms and global influence. This study applies the K-means cluster analysis of Arctic sea ice and crucial climate fields to investigate mechanisms governing sea ice cover and its impacts on the Northern Hemisphere (NH) climate. We determine the key modes of Arctic sea ice cover variability since 1958 in observations and reanalysis products, and perform compositing analysis of the associated climate variability and change in the NH extratropics. The spatial patterns of the modes of variability are chosen to minimize the variance between elements of a mode and to maximize the variance between the average spatial patterns of different modes. This nonhierarchical clustering framework is free from undelaying assumptions and limitations of the principal component analysis. The Arctic sea ice and climate variability on interannual and longer timescales is represented as transition between a limited numbers of recurrent patterns. Much higher similarity is evident between the clusters of sea ice thickness in growing and melting season than between the clusters of sea ice concentration. This points to a more consistent influence of the ocean heat transport in contrast to highly variable impact of the atmospheric surface heat fluxes that are strongly controlled by internal variability (Arctic Oscillation) and crucial feedbacks.