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# Recent trends in energy flows through the Arctic climate system

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While Arctic climate change can be diagnosed in many parameters, a comprehensive assessment of long-term changes and low frequency variability in the coupled Arctic energy budget still remains challenging due to the complex physical processes involved and the lack of observations. Here we draw on strongly improved observational capabilities of the past 15 years and employ observed radiative fluxes from CERES along with state-of-the-art atmospheric as well as coupled ocean-ice reanalyses to explore recent changes in energy flows through the Arctic climate system.
Various estimates of ice volume and ocean heat content trends imply that the energy imbalance of the Arctic climate system was >1 Wm-2 during the 2000-2015 period, where most of the extra heat warmed the ocean and a comparatively small fraction was used to melt sea ice. The energy imbalance was partly fed by enhanced oceanic heat transports into the Arctic, especially in the mid 2000s.
Seasonal trends of net radiation show a very clear signal of the ice-albedo feedback. Stronger radiative energy input during summer means increased seasonal oceanic heat uptake and accelerated sea ice melt. In return, lower minimum sea ice extent and higher SSTs lead to enhanced heat release from the ocean during fall season. These results are consistent with modeling studies finding an enhancement of the annual cycle of surface energy exchanges in a warming Arctic. Moreover, stronger heat fluxes from the ocean to the atmosphere in fall tend to warm the arctic boundary layer and reduce meridional temperature gradients, thereby reducing atmospheric energy transports into the polar cap.
Although the observed results are a robust finding, extended high-quality datasets are needed to reliably separate trends from low frequency variability.