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Polar climate sredictability Seasonal to multi-decadal: Impact of the 2007 Arctic sea ice reduction in coupled ocean-atmosphere autumn hindcasts

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The Arctic sea ice extent has rapidly been decreasing in all seasons since monitored from space in the late seventies, and the highest negative trend is observed in late summer. Superposed on this negative trend, there is considerable inter-annual variability and marked reductions were observed in recent years. In summers with reduced sea ice extent, the lowered albedo over ice-free areas allows warming of the surface waters, and the upper ocean hence stores heat. Re-analysis data show that, in the following autumns, a large surface heat flux from the open waters to the cooling atmosphere above leads to an anomalous warming of the lower Arctic atmosphere. We characterise the autumn and early winter atmospheric response to low summer Arctic sea ice extent, and examine whether this influence extends beyond the boundaries of the Arctic Ocean. To this end, we performed hindcasts with prescribed sea-ice with the state-of-the-art coupled ocean-atmosphere seasonal forecast model from ECMWF. We focus on summer 2007, when Arctic sea-ice extent reached a record low. The 5-member ensemble hindcasts have a high atmospheric resolution (T159), and are initialized with atmospheric and ocean analyses valid for 1 October 2007. We also investigate the sensitivity of the response to various sea ice forcings. Robust, warm autumn anomalies over the Pacific and Siberian sectors of the Arctic, as high as 10C at the surface, are found in the hindcasts using the 2007 sea ice. In December, a regime change is occurring, and hindcast anomalies consist of weaker temperatures extending through the troposphere, deeper Aleutian and Icelandic Lows, and intensified upper-level jets over both oceanic sectors, but especially over the Pacific Ocean. On the American and Eurasian continents, intensified surface Highs weaken and shift the jets southwards and are associated with anomalous advection of cold polar air on their eastern sides, along the Asian Pacific coast and Northeastern North America. A potential predictability analysis indicates that the sensitivity of surface temperatures along the Pacific coast of Asia is the strongest impact outside of the Arctic Ocean, in December. A slowly evolving component of the Earth's climate system, sea-ice is indeed important for seasonal forecasting at high latitudes. When realistic 2007 sea ice extent is prescribed, a higher correlation of surface temperatures with meteorological analyses is found at high latitudes, lasting for about a month.