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Exceptional Arctic warmth of early winter 2016 and attribution to global warming

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The dark polar winters usually sport the coldest extremes on Earth, however this winter, the North Pole and the surrounding Arctic region have experienced record high temperatures in November and December, with daily means reaching 15 ºC (27 ºF) above normal and a November monthly mean that was 13 ºC (23 ºF) above normal on the pole. November also saw a brief retreat of sea-ice that was virtually unprecedented in nearly 40 years of satellite records, followed by a record low in November sea ice area since 1850. Unlike the Antarctic, Arctic lands are inhabited and their socio-economic systems are greatly affected by the impacts of extreme and unprecedented sea ice dynamics and temperatures, such as for example, the timing of marine mammal migrations, and refreezing rain on snow that prevents reindeer from feeding.

Here we report on our multi-method rapid attribution analysis of North Pole November-December temperatures. To quantify the rarity of the event, we computed the November-December averaged temperature around the North Pole (80–90 ºN) in the (short but North-pole covering) ERA-interim reanalysis. To put the event in context of natural variability, we use a longer and closely related time series based on the northern most meteorological observations on land (70–80 ºN). This allows for a reconstruction of Arctic temperatures back to about 1900. We also perform a multi-method analysis of North Pole temperatures with two sets of climate models: the CMIP5 multi-model ensemble, and a large ensemble of model runs in the so-called Weather@Home project. Physical mechanisms that are responsible for temperature and sea ice variability in the North Pole region are also discussed.

The observations and the bias-corrected CMIP5 ensemble point to a return period of about 50 to 200 years in the present climate, i.e. the probability of such an extreme is about 0.5% to 2% every year, with a large uncertainty. The observations show that November–December temperatures have risen on the North Pole, modulated by decadal North Atlantic variability. For all phases of this variability, a warm event like the one of this winter would have been extremely unlikely in the climate of a century ago. Both sets of models also give very comparable results and show that the bulk of the arctic temperature increase is due to anthropogenic emissions. This also holds for the warm extremes caused by the type of circulation present in the early winter of 2016.