The December 2015 North Pole Warming Event and the Increasing Occurrence of Such Events

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In late December 2015, widespread media interest revolved around forecasts that the surface air temperature at the North Pole would rise above freezing. Although there has been significant interest in the enhanced warming that is occurring at high northern latitudes, a process known as arctic amplification, remarkably little is known about these midwinter warming events at the pole including their frequency, duration and magnitude as well as the environmental conditions responsible for their occurrence. Here we use buoy and radiosonde data along with operational weather forecasts and atmospheric reanalyses to show that such events are associated with surface cyclones near the pole as well as a highly perturbed polar vortex. They occur once or twice each decade with the earliest identified event taking place in 1959. In addition, the warmest midwinter temperatures at the North Pole have been increasing at a rate that is twice as large as that for mean midwinter temperatures at the pole. It is argued that this enhanced trend is consistent with the loss of winter sea ice from the Nordic Seas that moves the reservoir of warm air over this region northwards making it easier for weather systems to transport this heat polewards.

The Atlantic

The Storm That Will Unfreeze the North Pole

It caps off a month—and year—of weird weather.

Arctic sea ice in the spring

Wasif Malik / Flickr

Media attention in late December 2015 was focused on the prospect that the surface air temperature at the North Pole would rise above freezing. This event was reported to be unprecedented in the instrumental record of the International Arctic Buoy Program (IABP). It was the final extreme weather event in a year that had many such events and reports of causal connections between the warming event at the pole and severe weather that occurred during the preceding days in Texas and the United Kingdom were made.

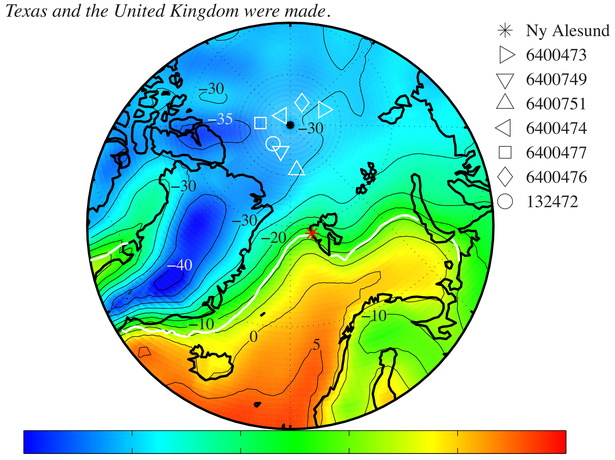

Figure 1) The December mean surface air temperature (°C- shading and contours) from the NCEP Reanalysis 1958-2015 with the 50% sea ice concentration indicated by the thick white contour. The locations of the 7 meteorological buoys situated within 500 km of the pole during this period are indicated as is the location of the radiosonde station at Ny Alesund. *The reservoir of warm air to the south of the ice edge is within 2000km of the pole.*

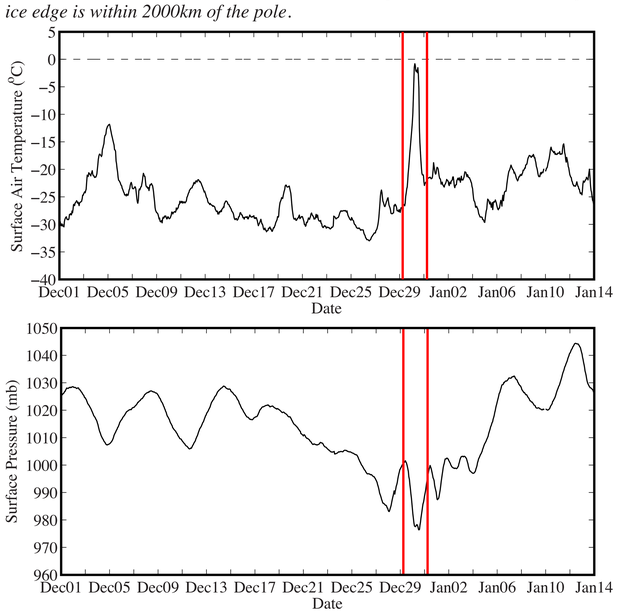

Figure 3) The: surface air temperature (°C) and surface pressure (mb) at the North Pole during midwinter 2015/2016 based on the data from the 7 IABP meteorological buoys. The period of the late December 2015 warming is indicated by the red lines. *The JRA55, ERA-I and FNL-GDAS were all able to capture the variability in the surface meteorology of the North Pole region.*

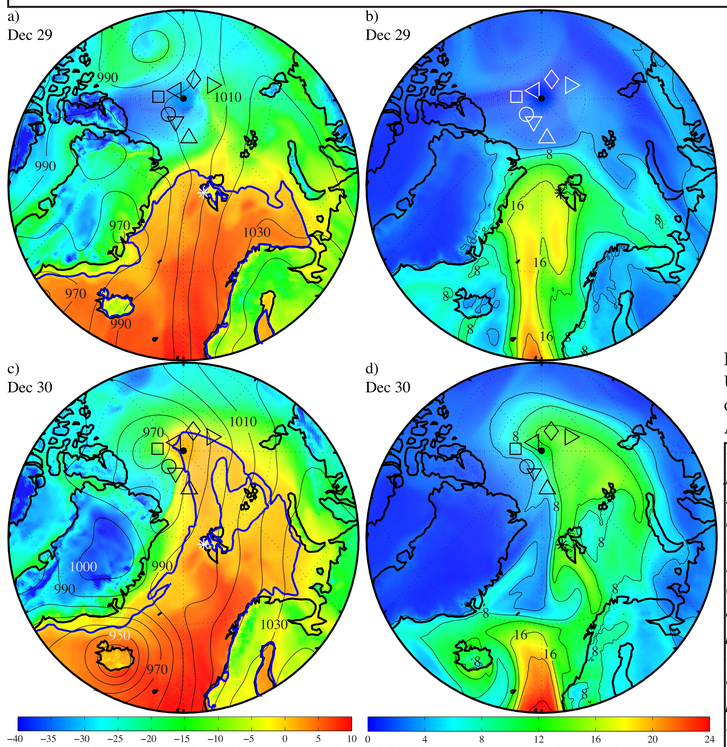

Figure 3) Meteorological conditions during the 2015 midwinter warming. The sea-level pressure (mb-contours) and surface air temperature (contour-°C) at 06 UTC on: a) 29 December and c) 30 December 2015. The precipitable water (mm-contours and shading) at 06 UTC on: b) 29 December and d) 30 December 2015. The locations of the 7 reporting meteorological buoys in the vicinity of the North Pole are indicated. The 0°C isotherm is indicated by the blue contour. All fields from the final analysis of the NCEP Global Data Assimilation System.

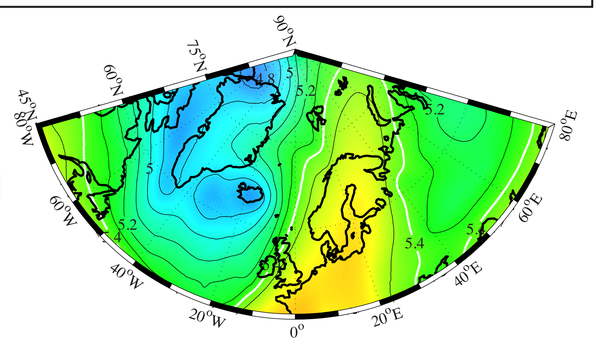

Figure 4) The 500mb geopotential height (km-contours and shading) at 06 UTC on 30 December 2015. The 5.6 km isocontour, an indicator of the location of the jet stream and the polar vortex, is indicated by the thick white contour. All fields from the final analysis of the NCEP Global Data Assimilation System.

On the 29th, there was a pronounced zonal gradient in the sea-level pressure field over Fram Strait that resulted in moist southerly flow over the region (Fig 3a&b). At this time, the 0°C isotherm was situated over the northern Fram Strait and Barents Sea .

Twenty-four hours later, the low that had been over northeast Greenland was now situated to the west of the North Pole and had a central pressure of 965 mb (Fig 3c). This resulted in a further northward advection of the warm and moist air into the region near the pole with above freezing surface air temperatures present in the warm sector of the low.

On 30 December, there was a second deep low, central pressure < 950 mb, centered over Iceland (Fig3c). This low was also associated with another pulse of warm and moist air that is clearly distinct from that associated with the warming at the pole (Fig 3d). This low was responsible for flooding in North England and Scotland and was named 'Storm Frank'. It originated over the Texas on 26 December where it was associated with a deadly outbreak of tornados.

The 500mb geopotential height on 30 December indicated the presence of large amplitude planetary wave (Fig 4) with its trough extending southeastwards from the Labrador Sea towards the Irminger Sea and Iceland. The corresponding ridge along with the jet stream and the polar vortex was displaced to the northeast of Svalbard.

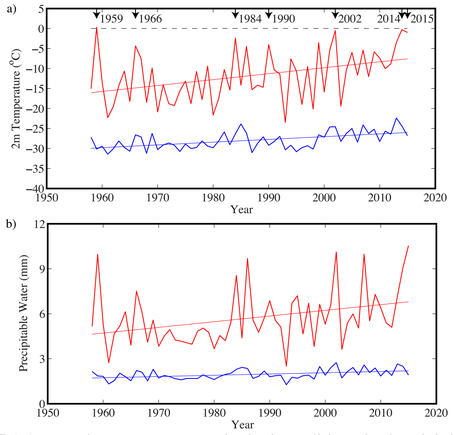

Figure 5) Mean and extreme meteorological conditions in the vicinity of the North Pole during December 1958-2015 from the JRA55 Reanalysis. Time series of mean (blue curves) and 99th percentile (red curves) for: a) surface air temperature (°C), b) precipitable water (mm). Years during which the 99th percentile 2m air temperature approached 0°C are indicated. Linear least squares fits to the time series are also shown. All trends are statistically significant with a test that takes into account the red noise characteristics of the time series. *Both the mean and extreme values are increasing with the extreme values increasing 2-4 times faster than mean values.*

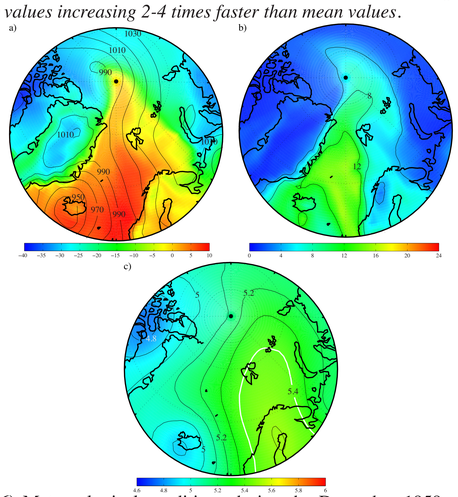

Figure 6) Meteorological conditions during the December 1959 warming. The: a) sea-level pressure (mb-contours) and surface air temperature (contour-°C), b) the precipitble water (mm-contours and shading) and c) the 500mb geopotential height (km-contours and shading) at 00 UTC on 3 December 1959. In c) the 5.6 km isocontour, an indicator of the location of the jet stream, is indicated by the thick white contour. All fields from the JRA55 Reanalysis. *The 1959 warming event shared many of the characteristics of the 2015 event.*

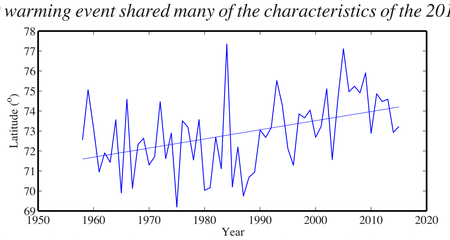

Figure 7) The latitude of the 0°C isotherm in the vicinity of Fram Strait during December with the linear least squares fit to the time series shown. The trend is statistically significant with a test that takes into account the red noise characteristics of the time series. *The ice edge is retreating northwards at ~0.5°/decade.*

Conclusions:

- **It is proposed that this enhanced trend in extreme warmth and moisture at the pole is associated with the loss of winter sea ice from the adjoining Greenland and Barents Seas that is moving the reservoir of warm and moist air that exists over the Nordic Seas closer to the pole allowing for a greater efficiency of cyclones in transporting this heat and moisture polewards.**
- **The December 2016 event may have had a similar evolution/cause.**