Winter warming events at the North Pole and the 2017 collapse of the Beaufort High. Responses to thinning and retreating sea ice?

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

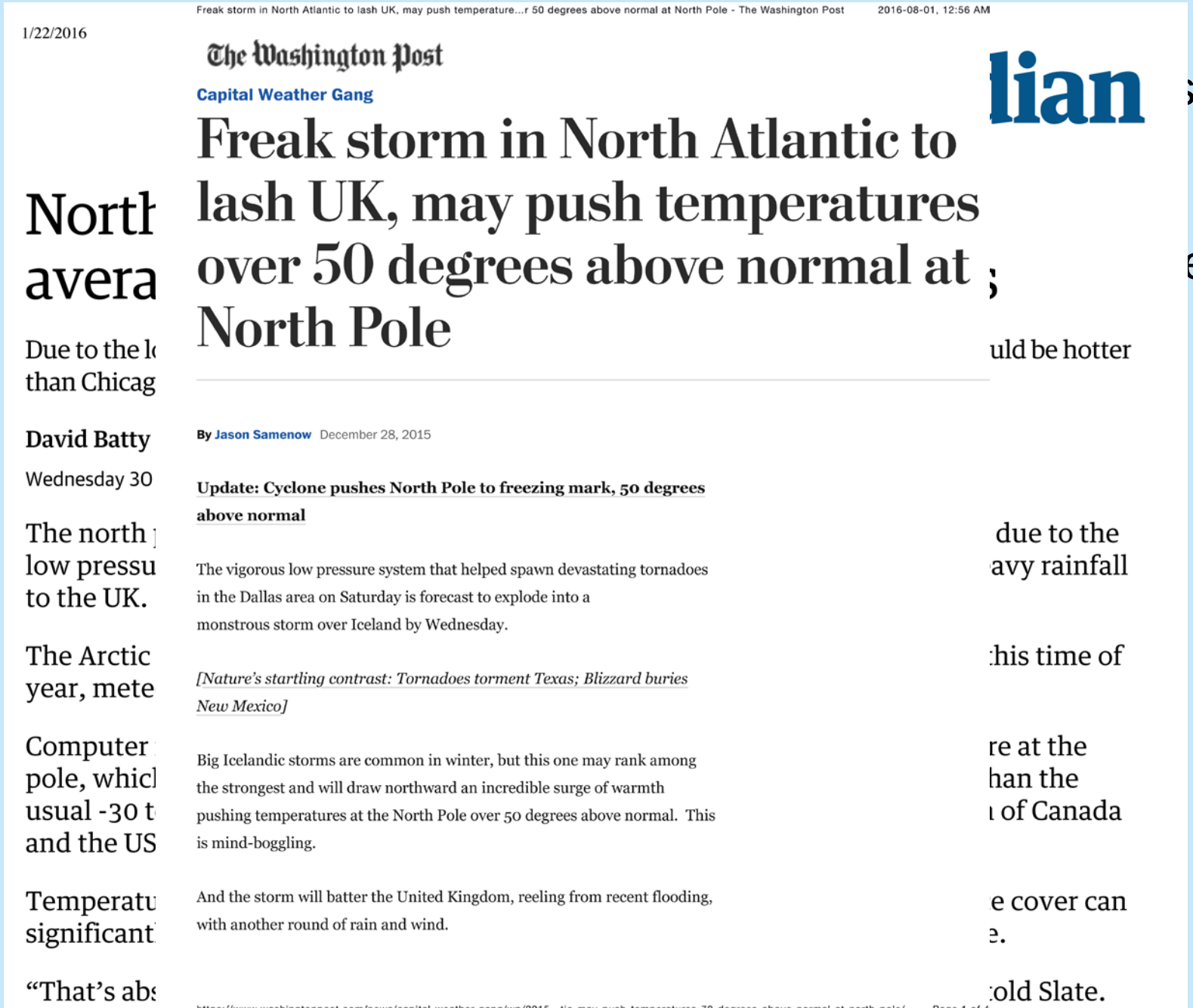
Wasif Malik / Flickr

Overview

- In this lecture, I will discuss two recent (and maybe new) phenomena that have occurred in the Arctic:
  - The occurrence of events in mid winter, during which above-freezing surface air temperatures were observed at the North Pole.
  - The collapse of the Beaufort High during the winter of 2017.
- Both are indicators of a change in the winter climate of the Arctic that may the result of the thinning and retreat of sea ice.

Overview of midwinter warming events

- 1/22/2016



Freak storm in North Atlantic to lash UK, may push temperature...r 50 degrees above normal at North Pole - The Washington Post 2016-08-01, 12:56 AM

The Washington Post

Capital Weather Gang

Freak storm in North Atlantic to lash UK, may push temperatures over 50 degrees above normal at North Pole

By Jason Samenow December 28, 2015

Update: Cyclone pushes North Pole to freezing mark, 50 degrees above normal

The vigorous low pressure system that helped spawn devastating tornadoes in the Dallas area on Saturday is forecast to explode into a monstrous storm over Iceland by Wednesday.

[Nature's startling contrast: Tornadoes torment Texas; Blizzard buries New Mexico]

Big Icelandic storms are common in winter, but this one may rank among the strongest and will draw northward an incredible surge of warmth pushing temperatures at the North Pole over 50 degrees above normal. This is mind-boggling.

And the storm will batter the United Kingdom, reeling from recent flooding, with another round of rain and wind.

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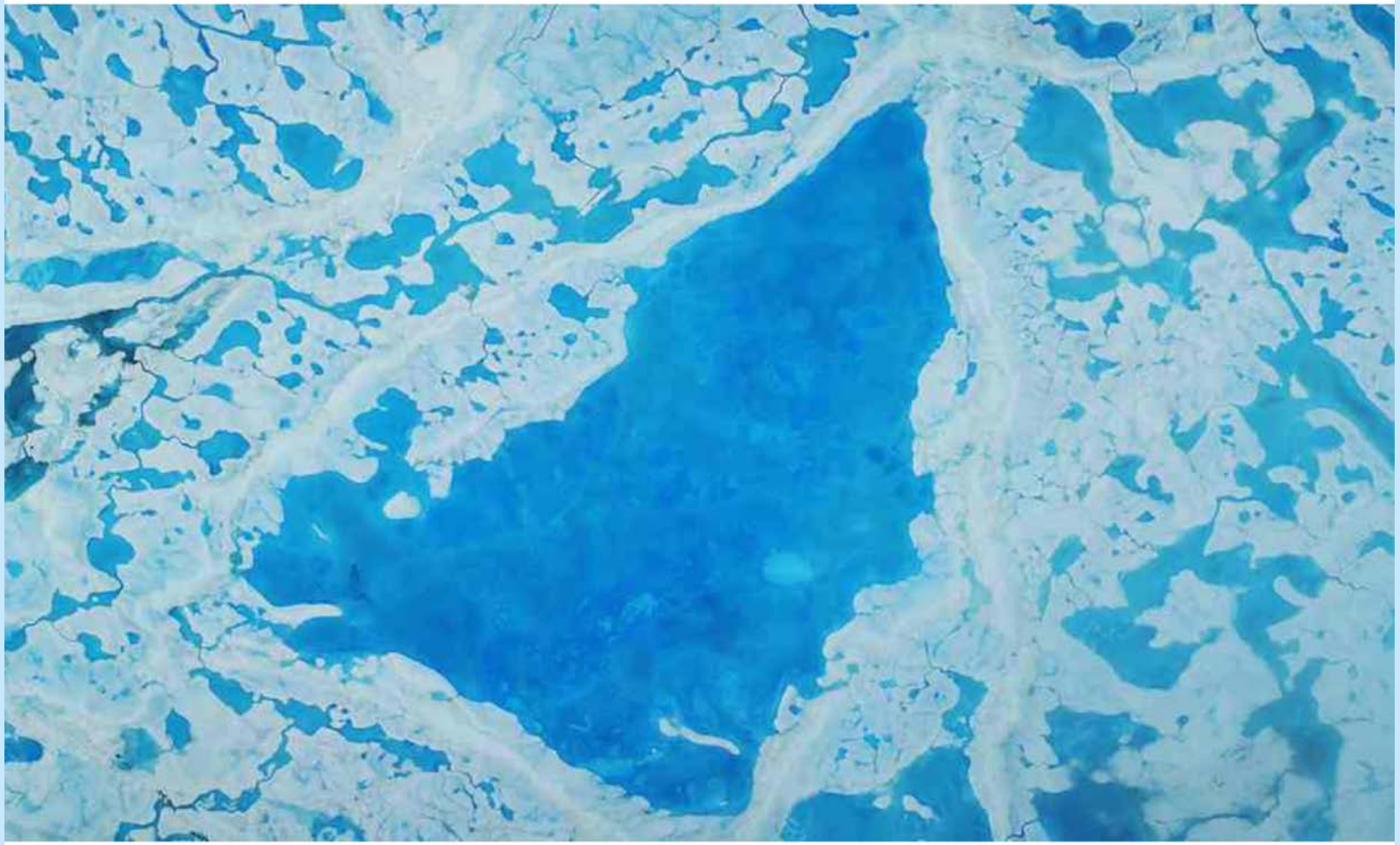
Overview of midwinter warming events

- Ice-melting temperatures forecast for Arctic midwinter

Temperatures in parts of the Arctic are expected to rise above 0C for the second winter in a row

- 

A large pool of meltwater over sea ice in the Beaufort Sea in July. Scientists say parts of the Arctic will climb above water's freezing temperature over the next few days. Photograph: Operation IceBridge/Nasa

Michael Slezak

Wednesday 21 December 2016 15.00 GMT

Overview of midwinter warming events

- I decided to investigate some of these hyperbolic claims (for the Dec 2015) event and along the way, I identified some interesting new physics.

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SCIENTIFIC REPORTS

OPEN

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

G. W. K. Moore

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.

Data

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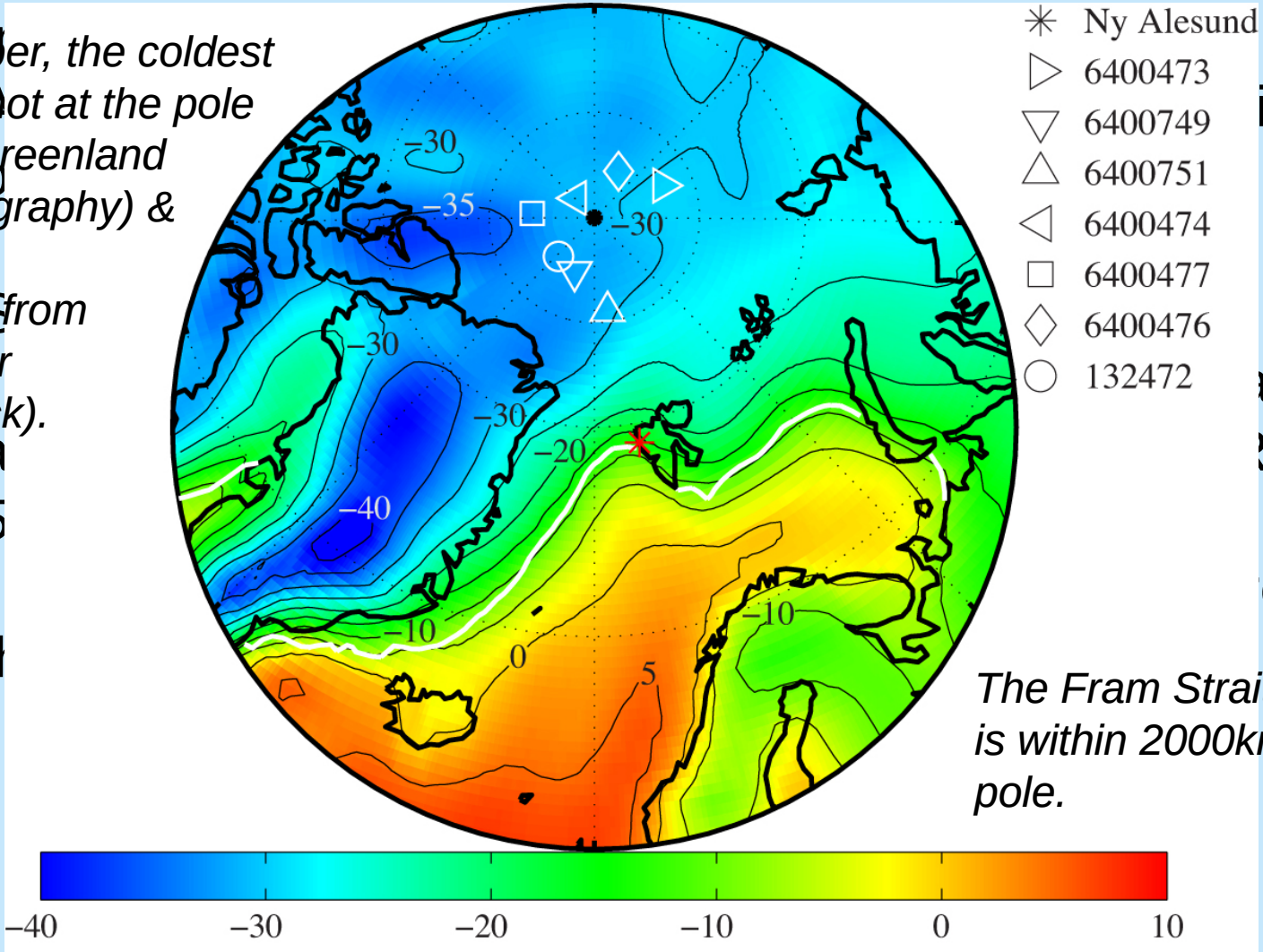
In December, the coldest SATs are not at the pole but over Greenland (high topography) & Ellesmere Island (far from open water /storm track).



The Fram Strait ice edge is within 2000km of the pole.

The December mean surface air temperature (ºC- 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 IABP buoys situated near the pole in 2015 are indicated as is the location of the radiosonde station at Ny Alesund.

Data

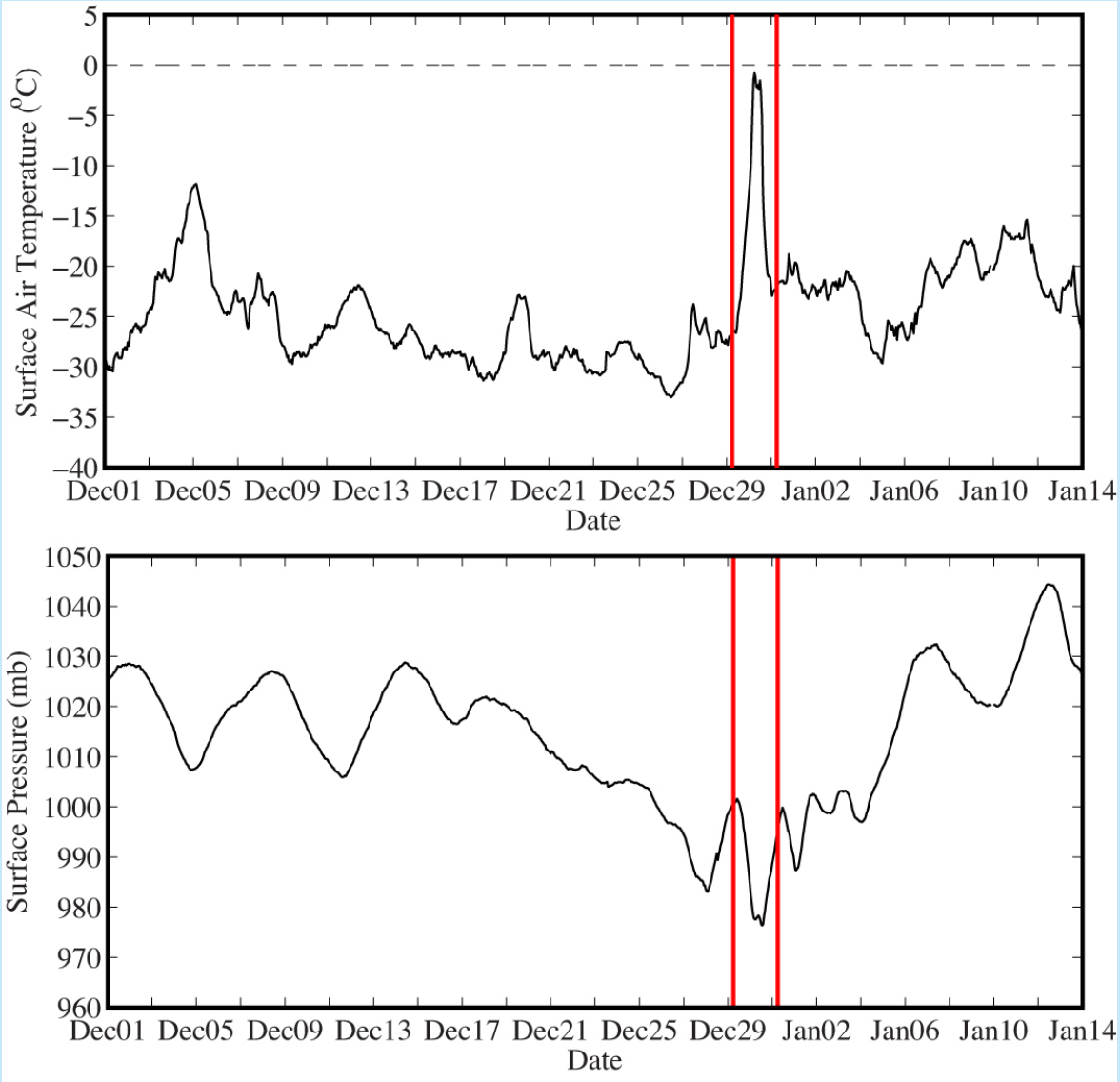
US Coast Guard deploying a met buoy at the North Pole August 26 2015

Data

US Coast Guard deploying a met buoy at the North Pole August 26 2015

2015 Results

IABP data Interpolated to the North Pole.

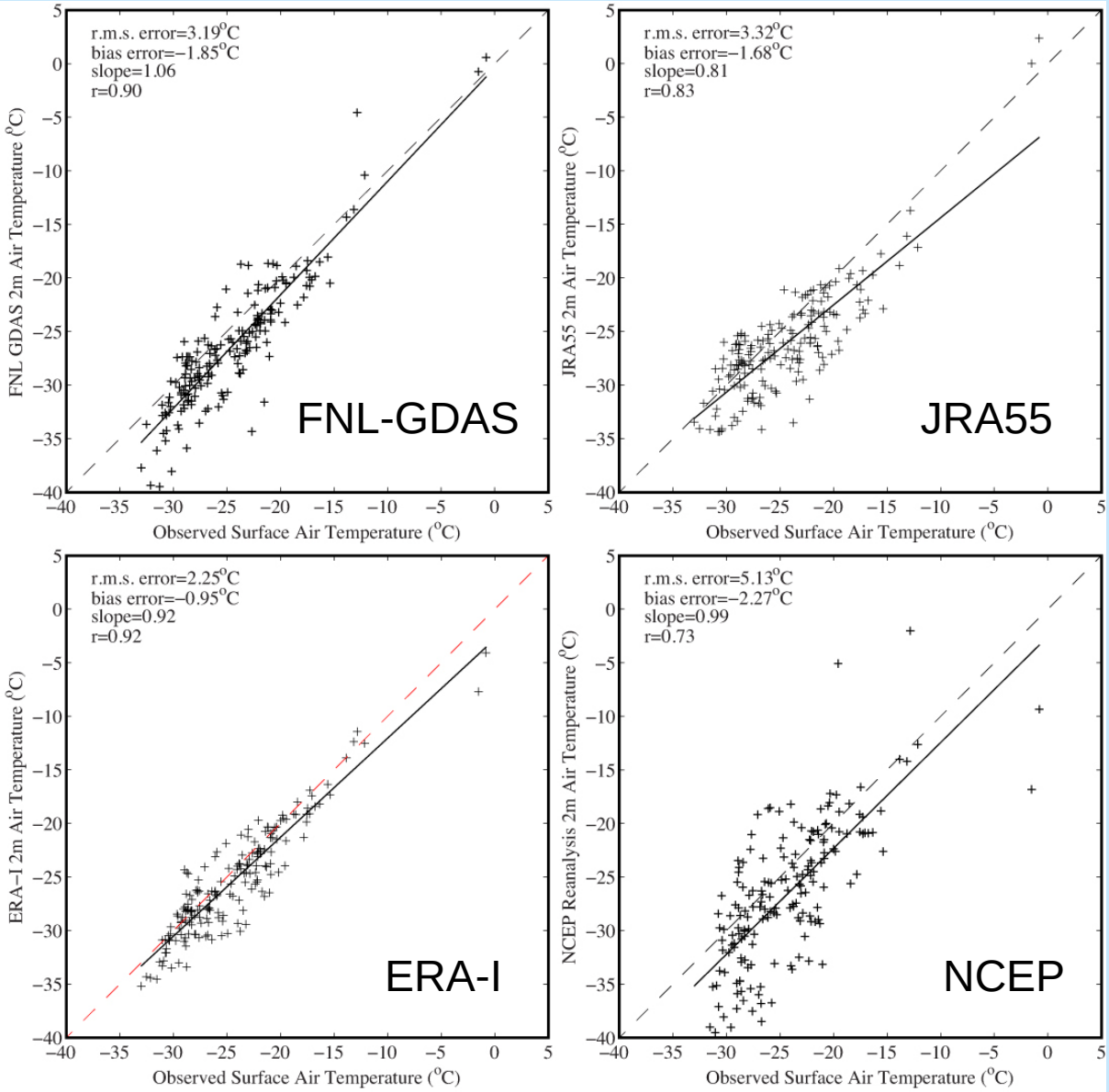


SAT rose by ~28°C between the 29th and 30th.

Warming associated with a minimum in sea-level pressure. Deepening rate >24mb/24hrs.

Surface air temperature (°C - upper) and sea-level pressure (mb - lower) at the North Pole 1 December 2015-14 January 2016

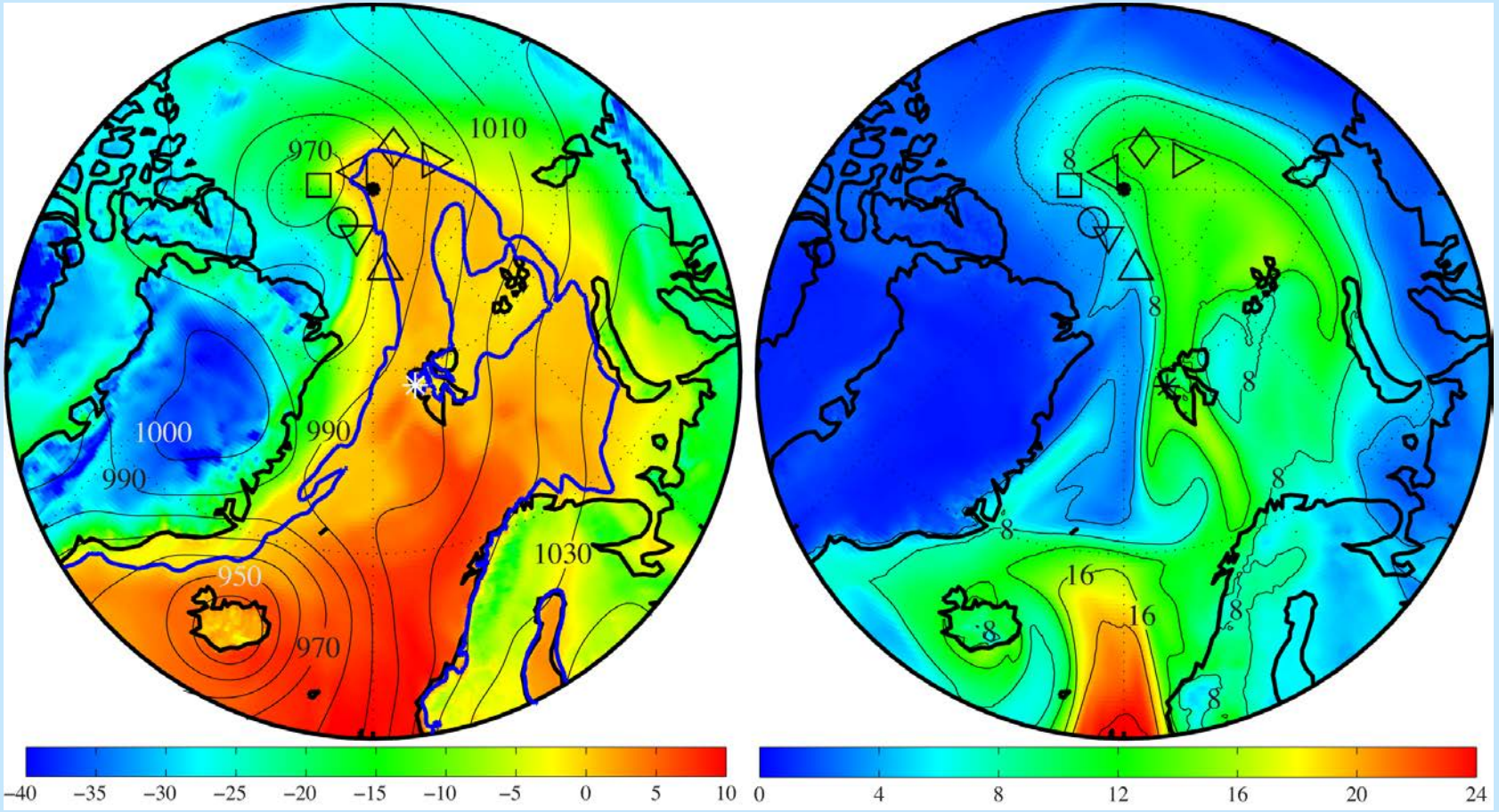
2015 Results



- *ERA-I has smallest rms error.*
- *JRA-55 & FNL-GDAS have comparable rms errors.*
- *NCEP Reanalysis has largest rms error.*
- *All have cold bias of ~1-2 °C.*
- *JRA55 too warm for extreme events/ERAI too cold.*

Scatterplots of observed vs model surface air temperature at the North Pole
1 December 2015 – 14 January 2016

2015 Results



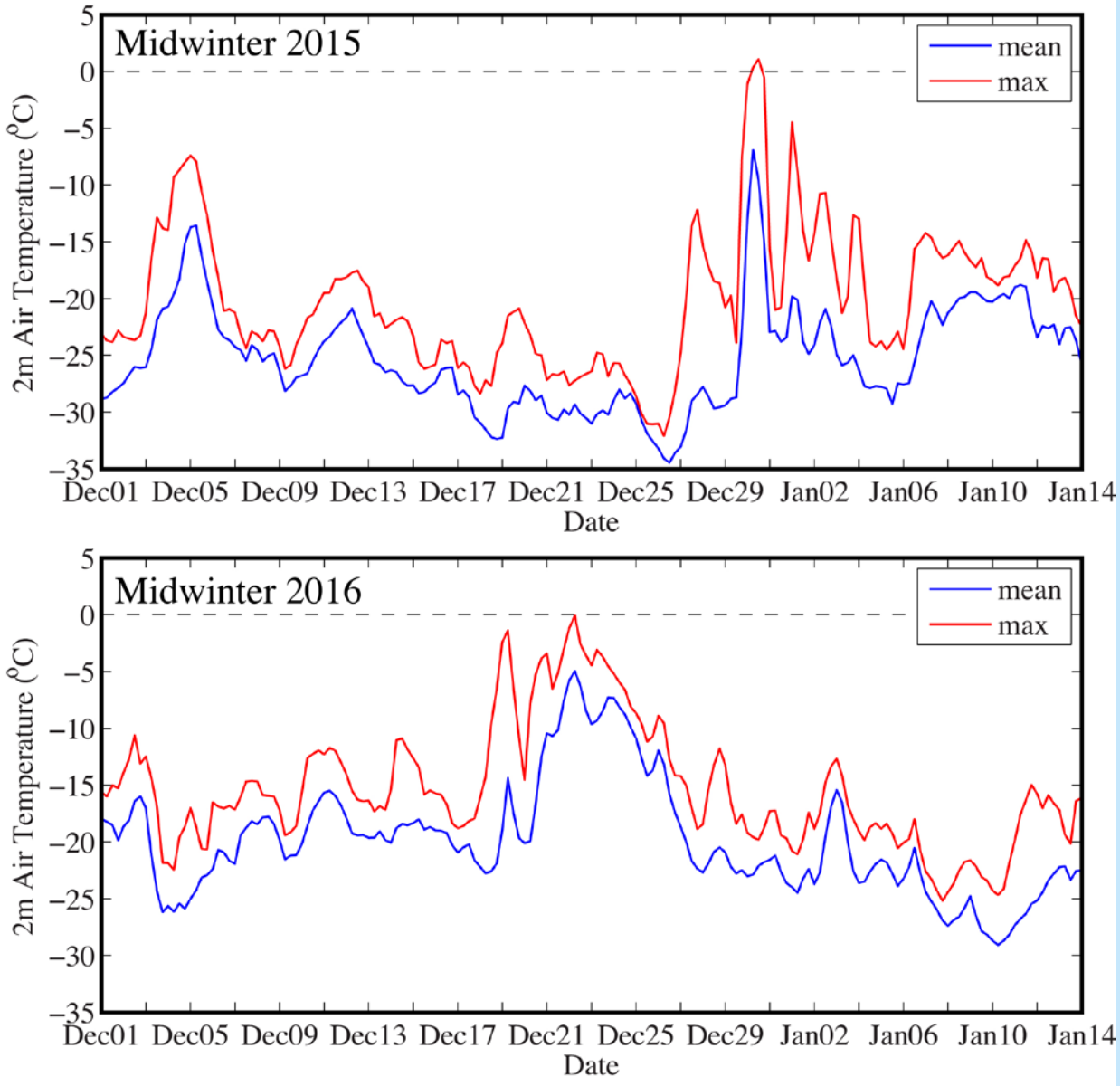
Sea-level pressure (mb – contours) and 2m air temperature (°C – shading) at 06 GMT 30 December 2015

0°C isotherm in blue

Precipitable water (mm – contours & shading) at 06 GMT 30 December 2015

All fields from the FNL-GDAS

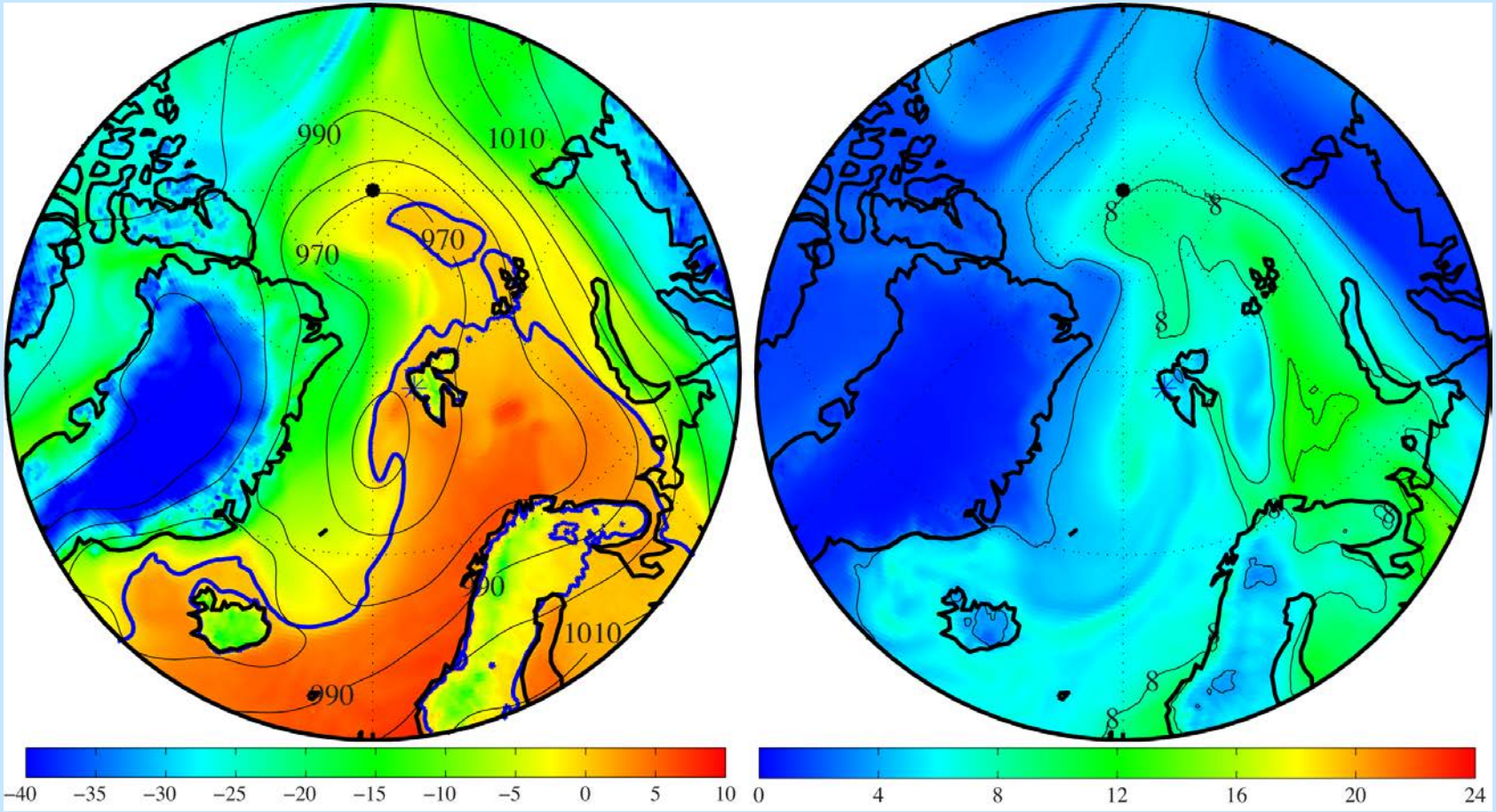
2015/2016 Results



- *2015 midwinter period colder then 2016 midwinter period.*
- *Nature of warming event different between the 2 winters.*
- *2015 more transient.*
- *2016 more persistent.*

Mean (blue) and maximum (red) 2m air temperature (°C) from the ERAI within 3° of the North Pole during the 2015 (upper) and 2016 (lower) midwinter period

2016 Results



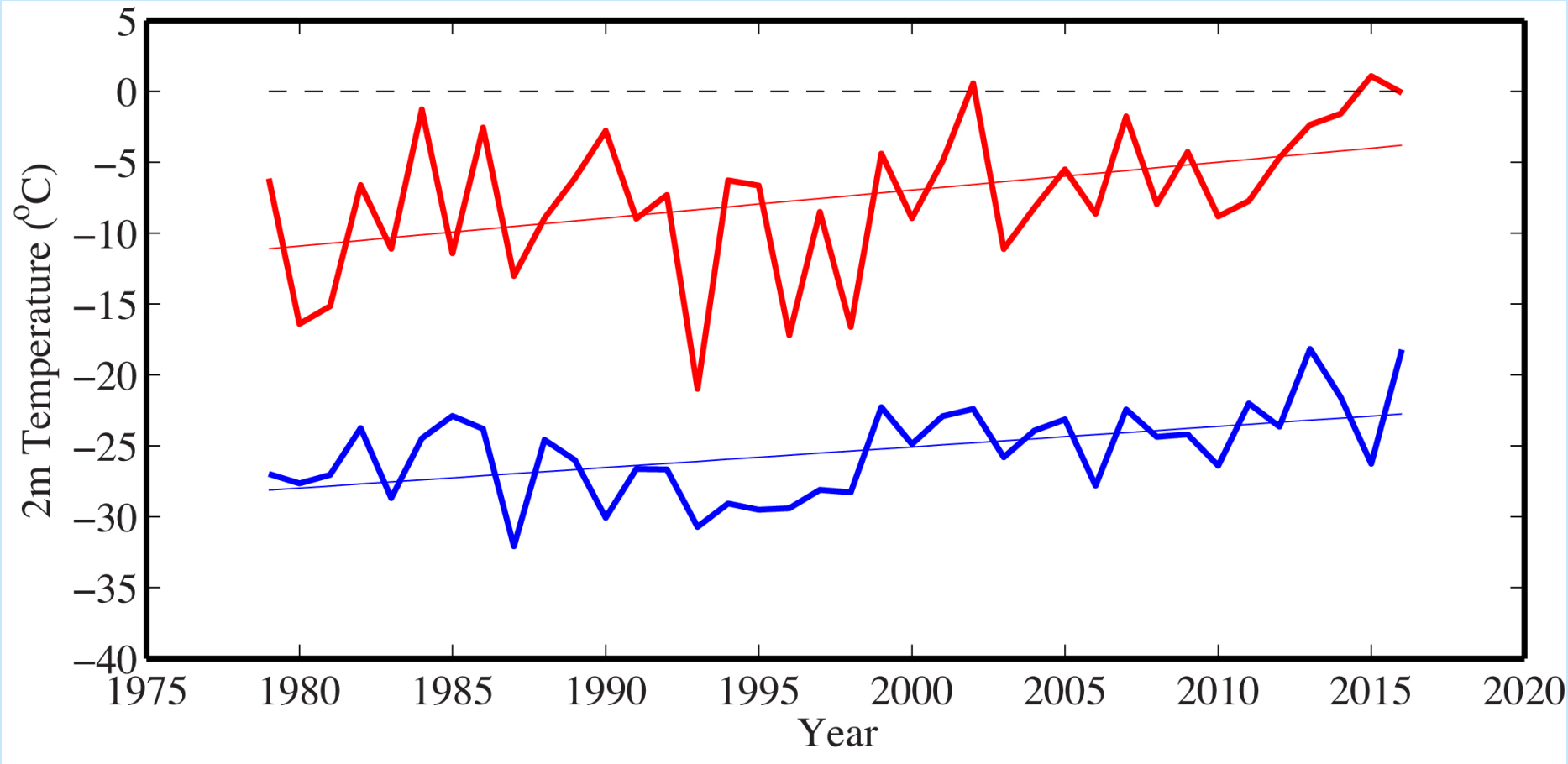
Sea-level pressure (mb – contours) and 2m air temperature (°C – shading) at 06 GMT 22 December 2016

0°C isotherm in blue

Precipitable water (mm – contours & shading) at 06 GMT 22 December 2016

All fields from the FNL-GDAS

Results



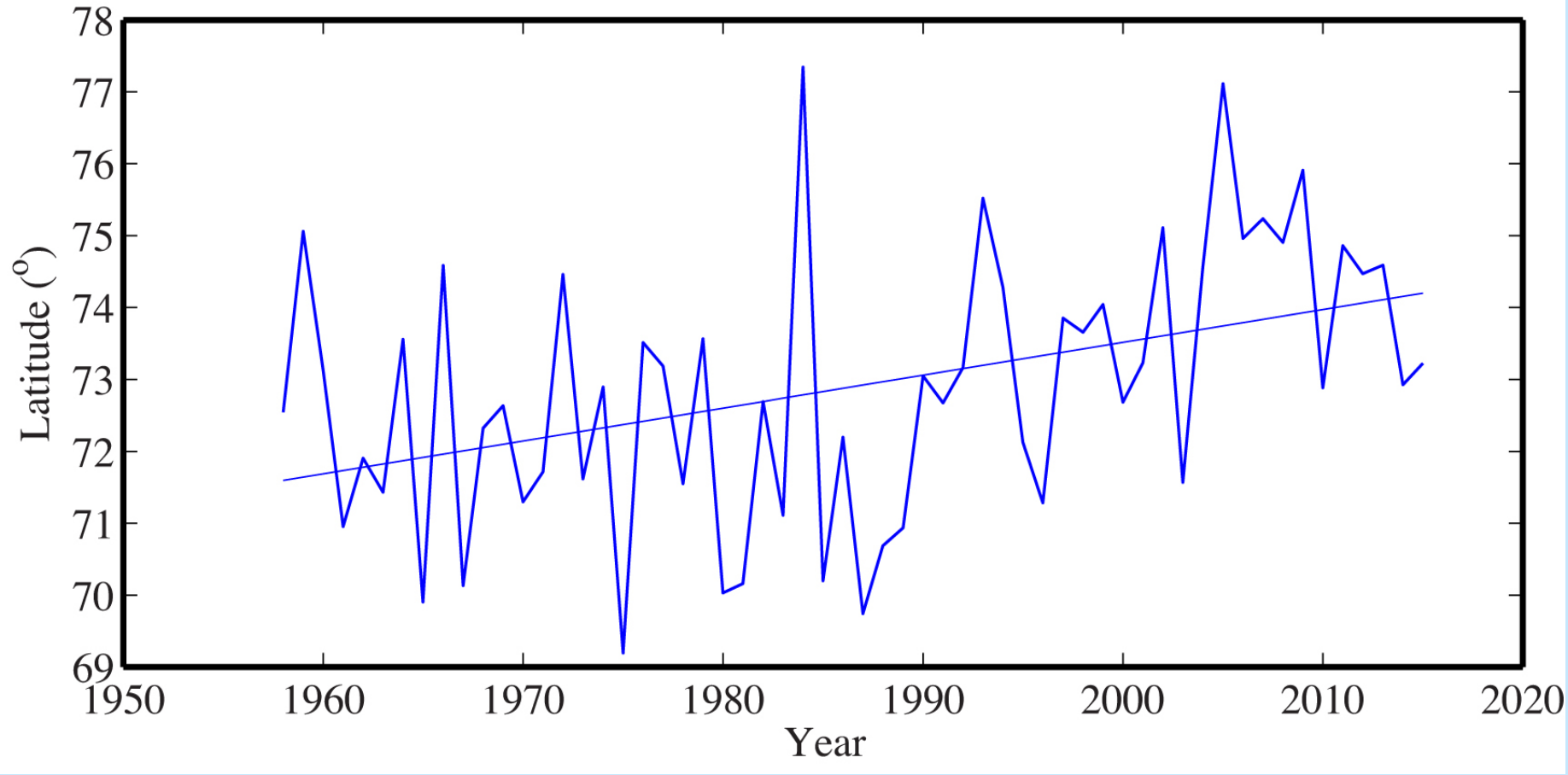
Time series of mean (blue) and extreme (red) 2m air temperatures during December near the North Pole from the ERAI 1979-2016

⇒ *Extreme 2m air temperatures increasing at a rate 50% higher then mean 2m air temperatures.*

⇒ *Last 4 years have had extreme temperatures above the trend line.*

⇒ *Evidence of change in nature of extreme events?*

Results



Time series of latitude of the December mean 0°C isotherm in the vicinity of Fram Strait from the JRA55 1958-2015

⇒ *Latitude is moving northwards at ~0.5°/decade.*

Overview of Beaufort High Collapse

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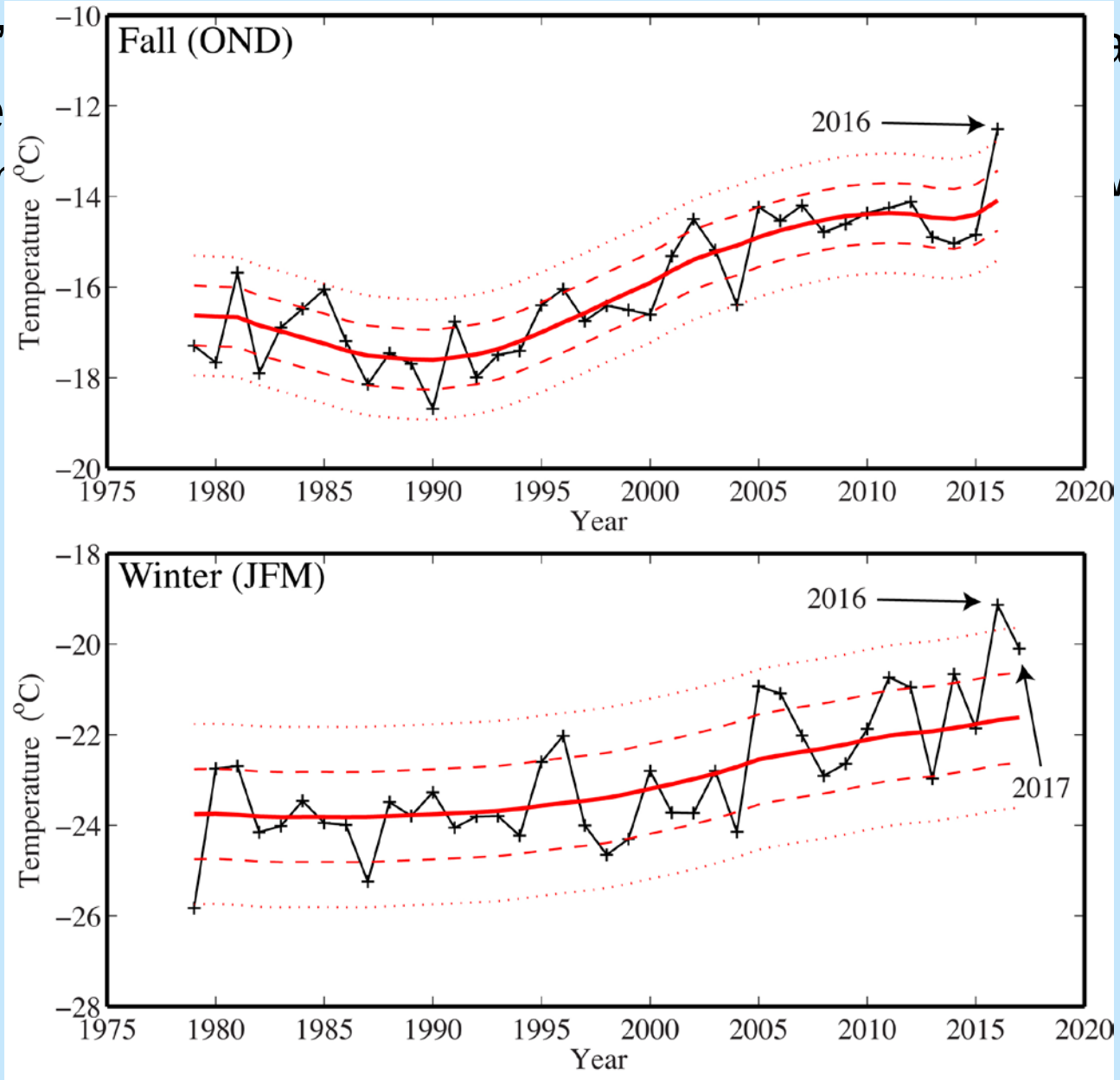
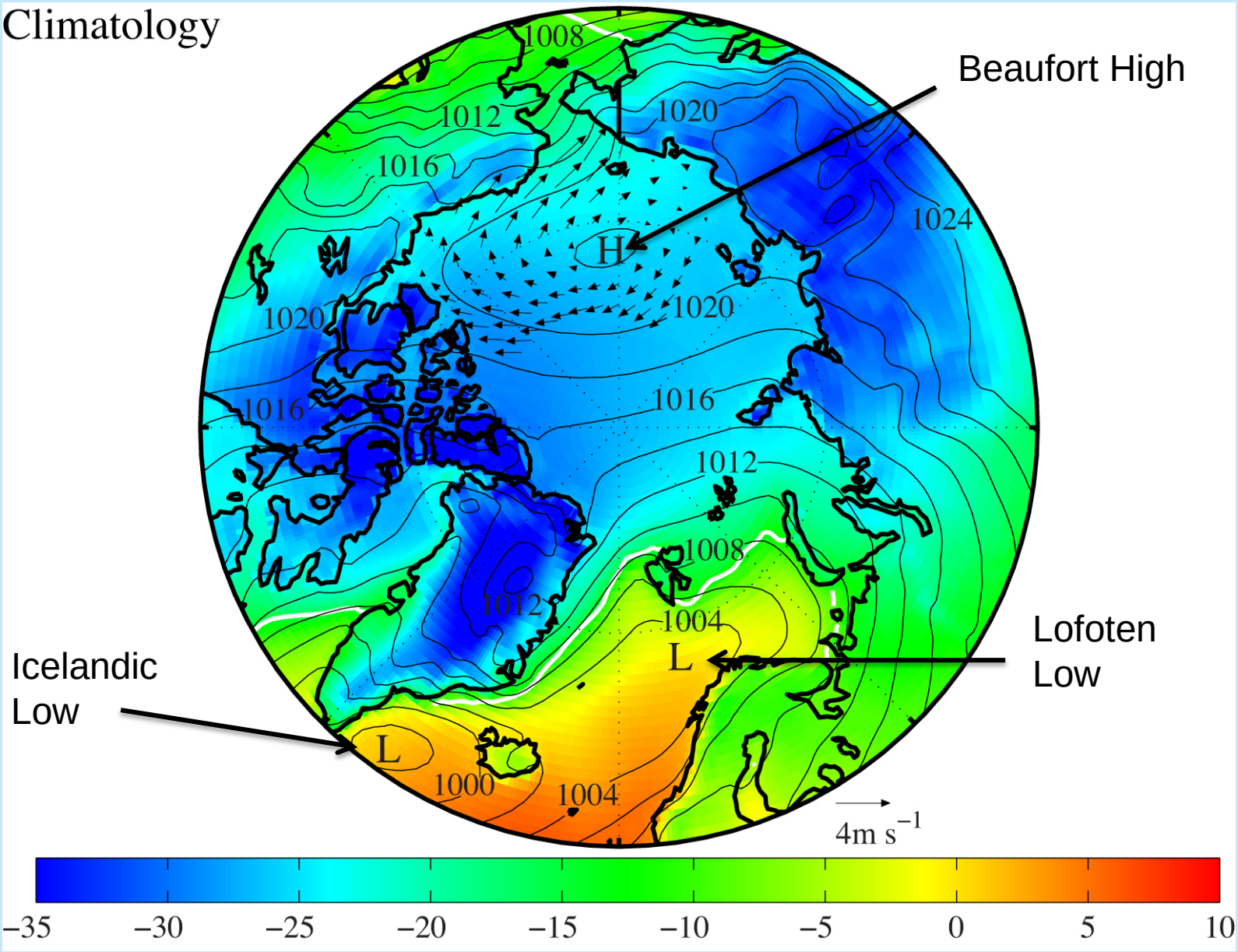


Seasonal mean surface air temperature (°C) in the Arctic from the ERAI

Overview of Beaufort High Collapse

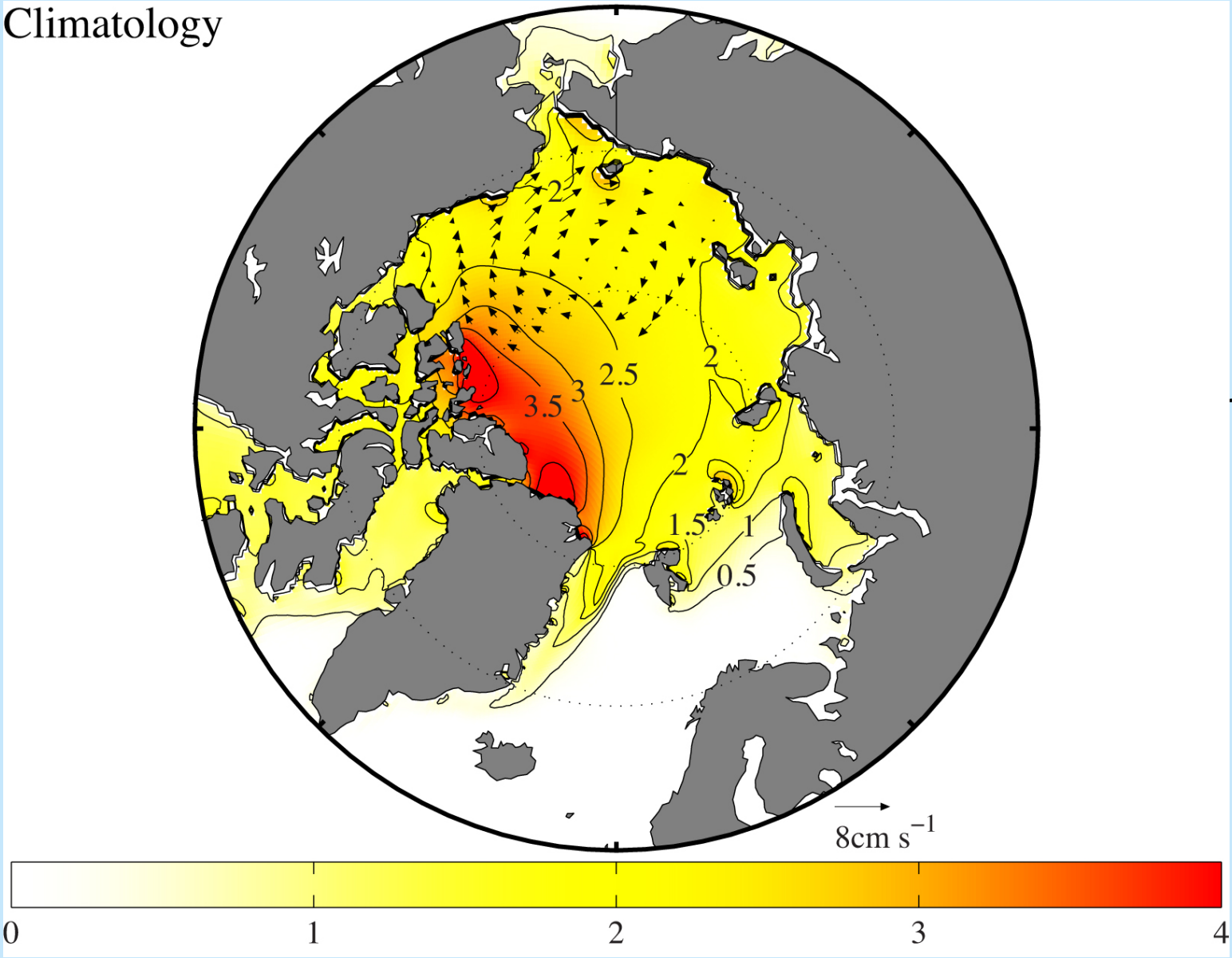
- Climatology



Climatological mean winter sea-level pressure (mb-contours), 2m air temperature (°C-shading) and 10m wind (vectors- m/s) in the Arctic from the ERAI

Overview of Beaufort High Collapse

- Climatology



Climatological mean winter sea ice thickness (m-contours& shading) and ice motion (vectors- cm/s) in the Arctic from the PIOMASS Sea Ice Reanalysis

Overview of Beaufort High Collapse

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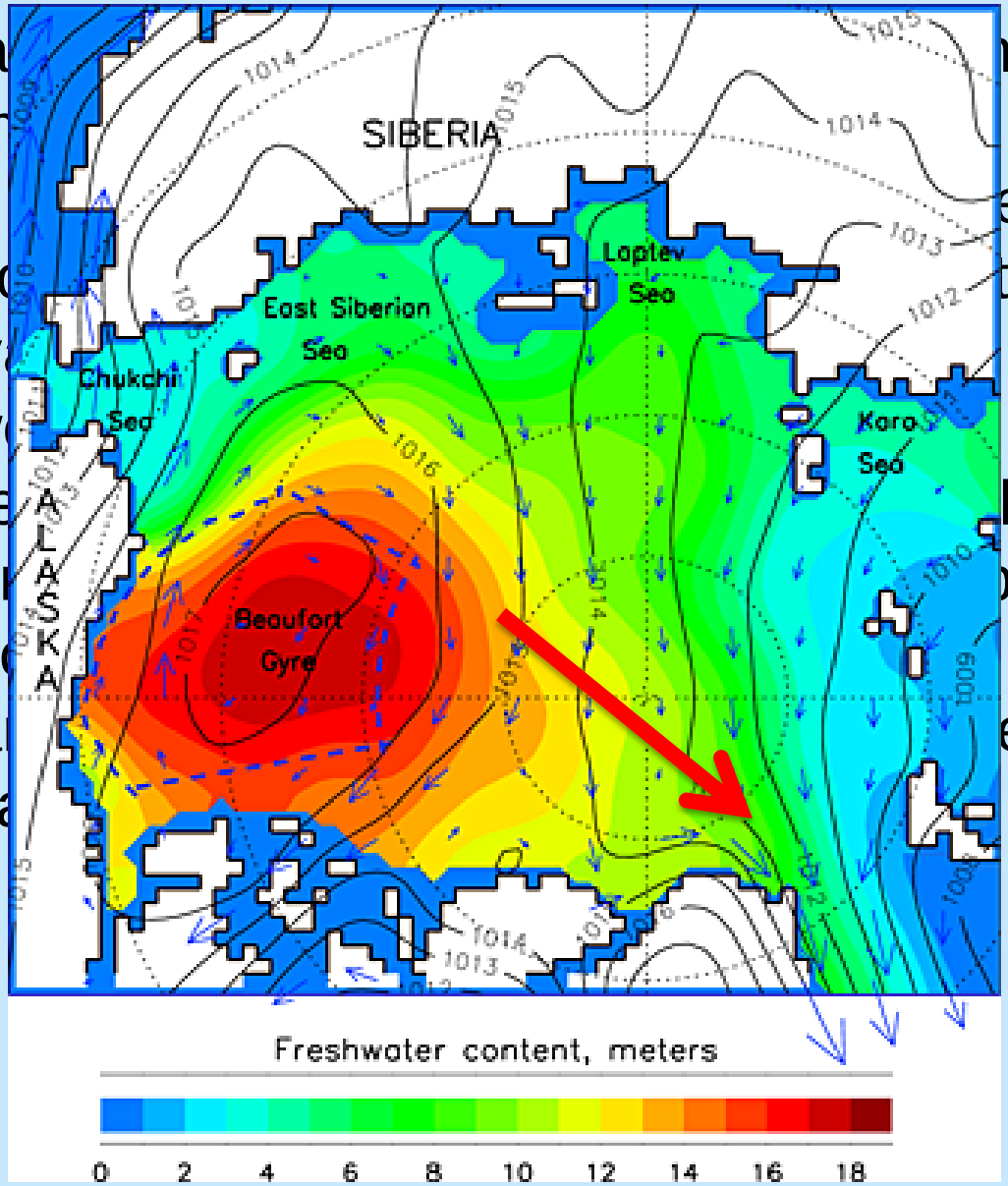
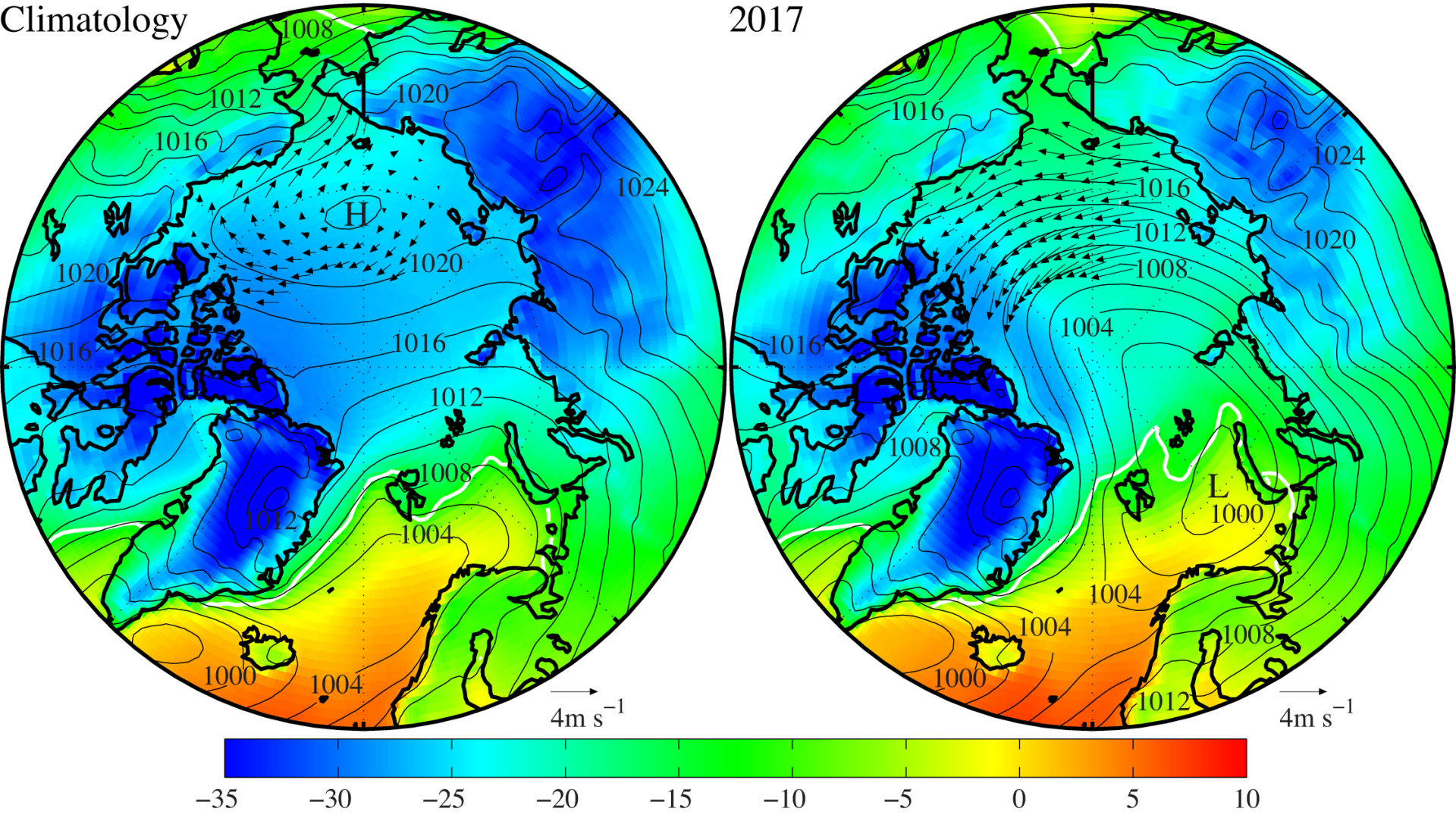


Fresh water content of the Arctic Ocean (m) along with sea-level pressure and surface geostrophic winds. Figure courtesy of A. Proshutinsky.

The Beaufort High Collapse



Climatological and 2017 mean winter sea-level pressure (mb-contours), 2m air temperature (^{o}C-shading) and 10m wind (vectors- m/s) in the Arctic from the ERAI.

The Beaufort High Collapse

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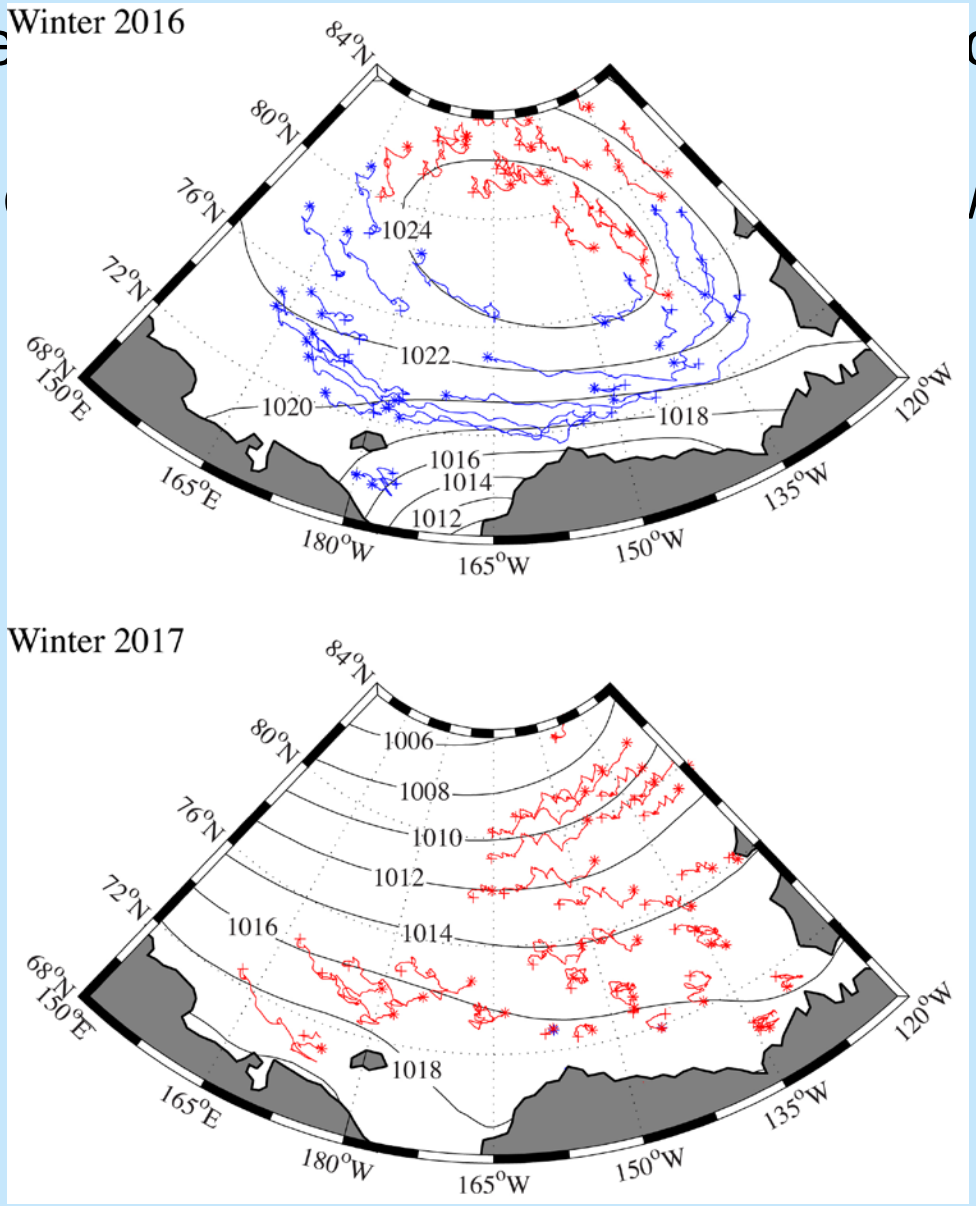

Winter of 2016 typical with anti-cyclonic ice motion around region of high pressure

Winter of 2017 anomalous with cyclonic ice motion around region of low pressure

IABP buoy tracks during the winter of 2016 and 2017 and winter mean SLP from ERAI
Red tracks: eastward motion. Blue tracks westward motion.

The Beaufort High Collapse

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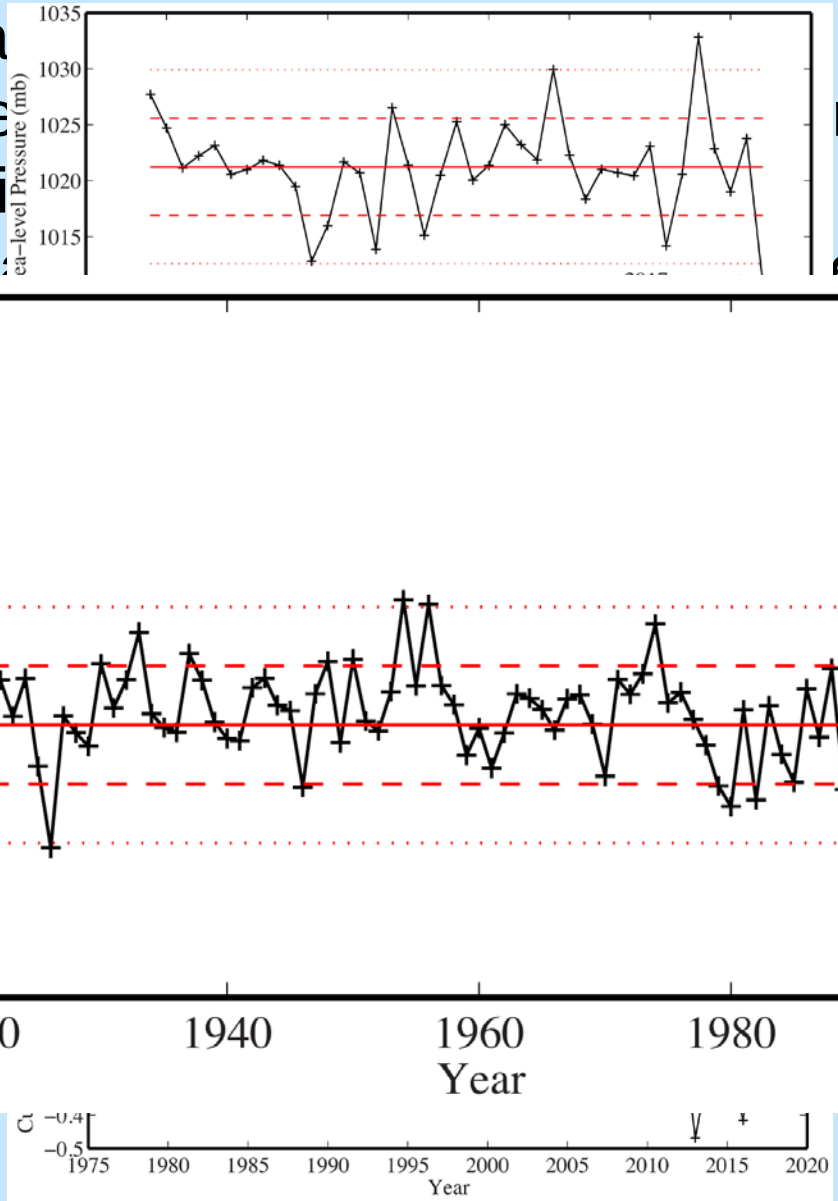
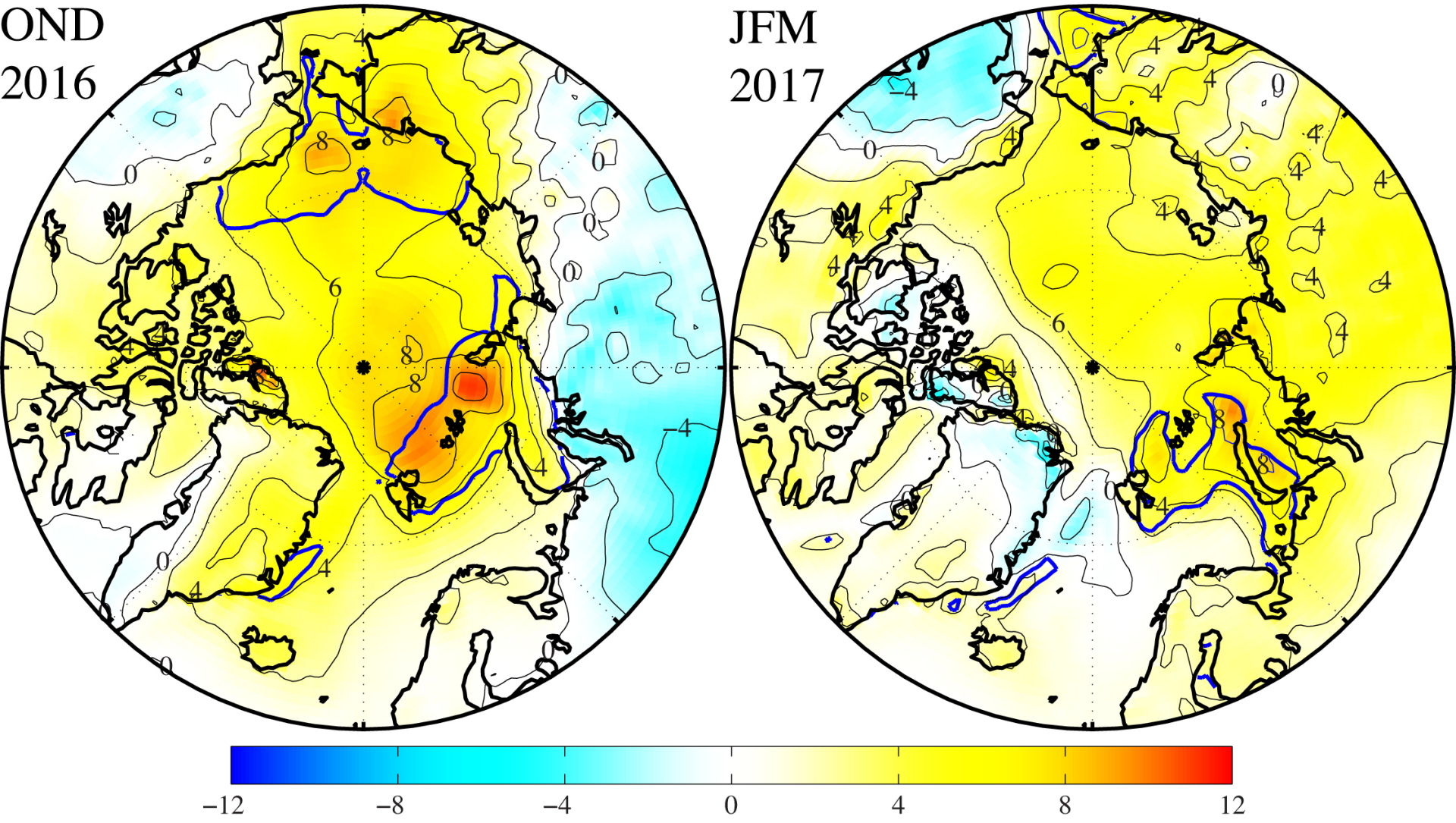


Time series of winter sea level pressure, ice motion (PIOMAS), 10m wind (both from ERAI) and curl of sea ice motion (PIOMASS).

The Beaufort High Collapse

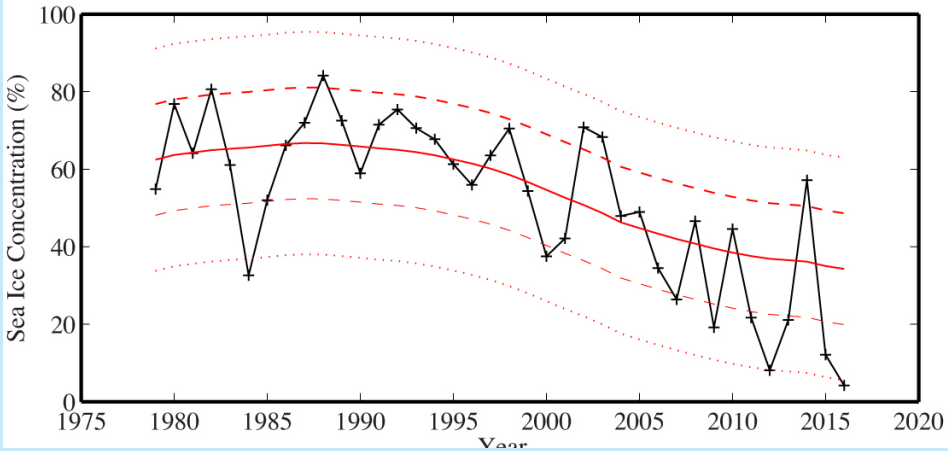


2m air temperature anomaly (°C) during fall 2016 and winter 2017.
Anomalies with respect to 1979-2016/7.
Blue curve shows sea ice concentration anomaly.

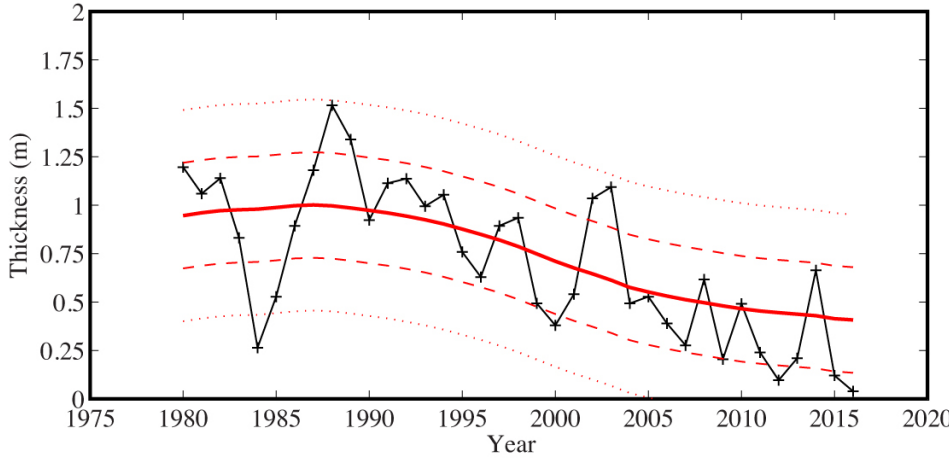
The Beaufort High Collapse

- What caused the collapse?
  - The warmth during the fall of 2016 resulted in record low ice growth (extent and thickness) that persisted into the winter of 2017.

Sea ice concentration



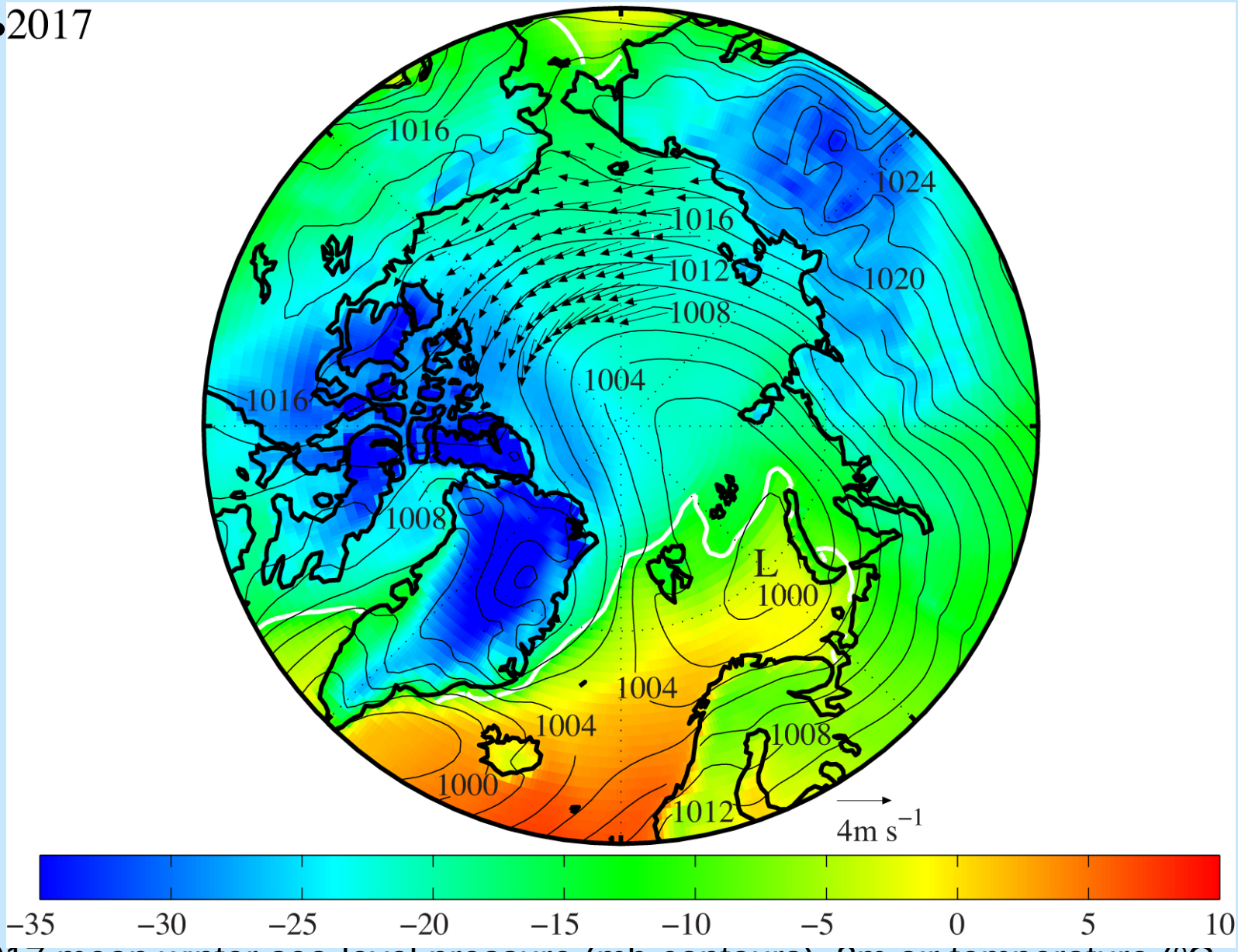
Sea ice thickness



Time series of seasonal mean (fall) sea ice concentration (Bootstrap-%) and thickness (PIOMASS-m) over the Barents Sea 1979-2016/7.

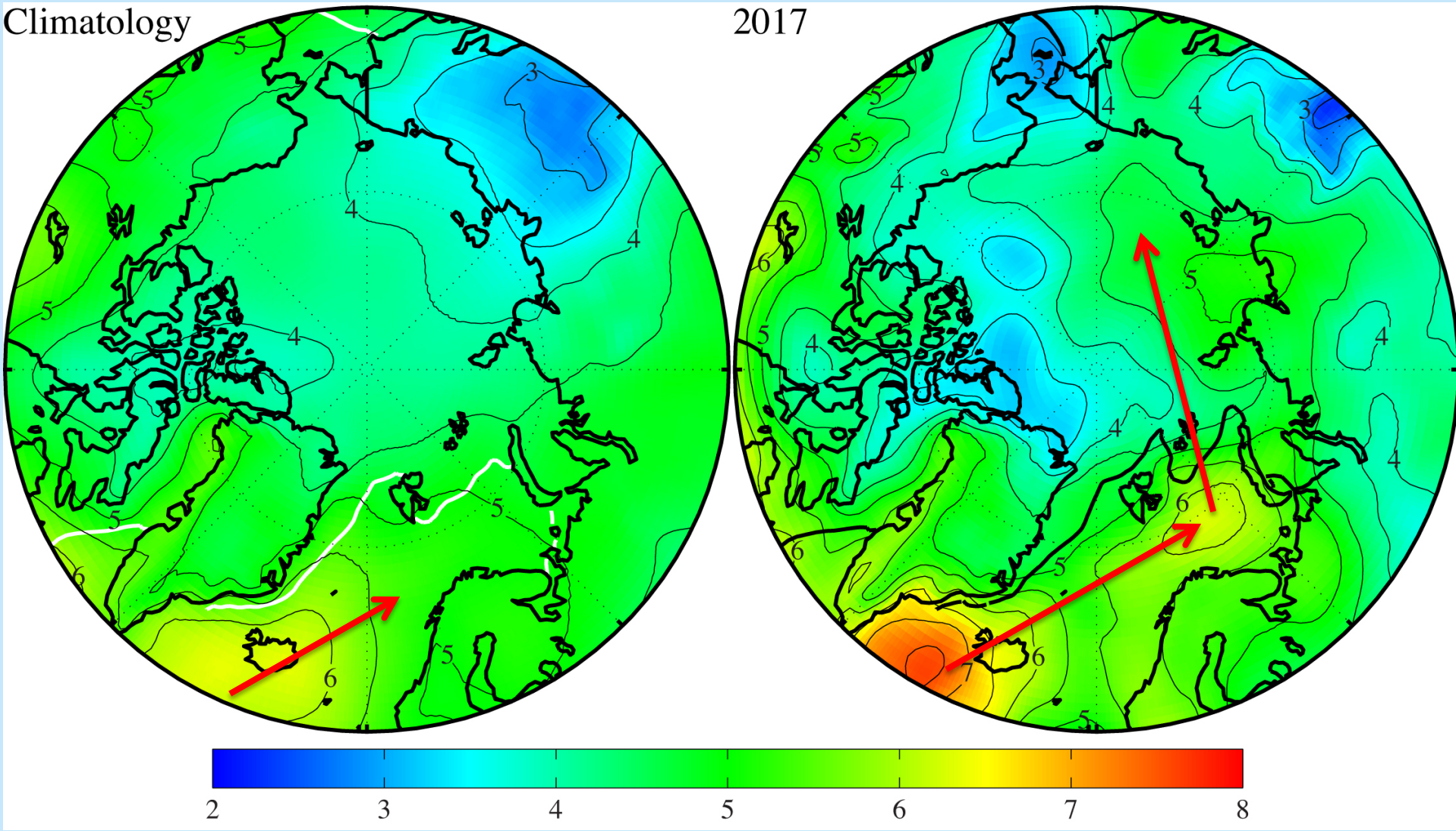
The Beaufort High Collapse

- 2017



2017 mean winter sea-level pressure (mb-contours), 2m air temperature (ºC-shading) and 10m wind (vectors- m/s) in the Arctic from the ERAI

The Beaufort High Collapse



Climatological and 2017 mean winter 2-6 day band-pass filtered sea-level pressure (mb) in the Arctic from the ERAI.
Proxy for storm track

The Beaufort High Collapse

Sea-level pressure (mb) from the ERAI

Conclusions Part 1

- The 2015 and 2016 midwinter warming events at the North Pole were both associated with a deep low pressure system that was situated to the east of the pole as well as a highly perturbed polar vortex (not shown).
- As a result, the pole was in the cyclone's warm sector during both events.
- SATs in the North Pole region during December 2016 ~5^{o}C warmer then in 2015.
- However 2015 event more intense with a deeper low that was associated with more moisture transport towards the pole.

Conclusions Part 1

- For the past 4 winters, extreme temperatures at the pole have been all above the long-term trend.
- Perhaps evidence that the nature of these warming events has changed.
- May be related to retreat of sea ice in the Fram Strait area that is moving the reservoir of heat over the Nordic Seas closer to the pole.
- However, midwinter warming events back as far as 1959 have been identified.
- Thus these events are not uncommon but what may be changing is the frequency of occurrence.

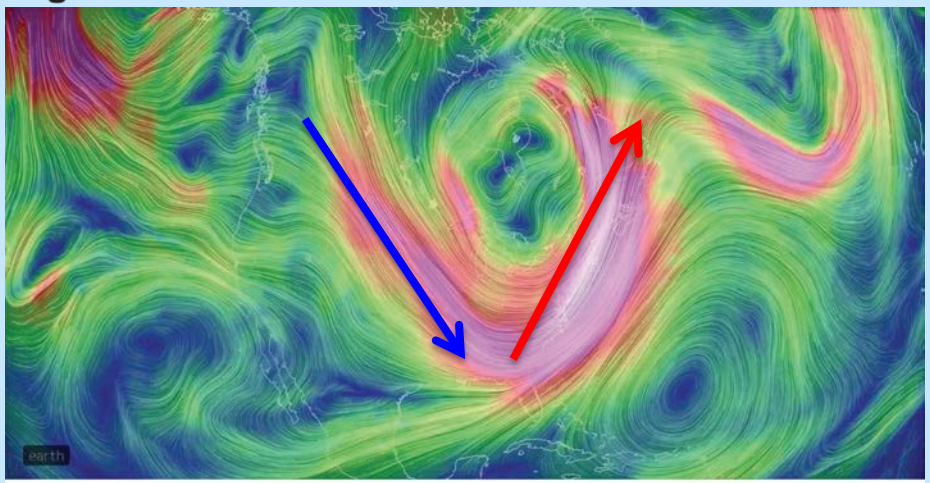
Conclusions Part 1

- Much of the focus of research on the connection between Arctic Amplification and the polar vortex has focused on southerly perturbations that bring cold temperatures to mid-latitudes.
- This work shows that there is also extreme weather associated with the northerly perturbations as well.

LETTERS

edited by Jennifer Sills

Global Warming and Winter Weather



Icy blast. Arctic winds flowed down to North America in January, causing record-breaking cold temperatures. Image shows streamlines of wind at the 500 mbar level at 1:00 a.m. Eastern Standard Time on 7 January 2014. Red indicates faster speeds.

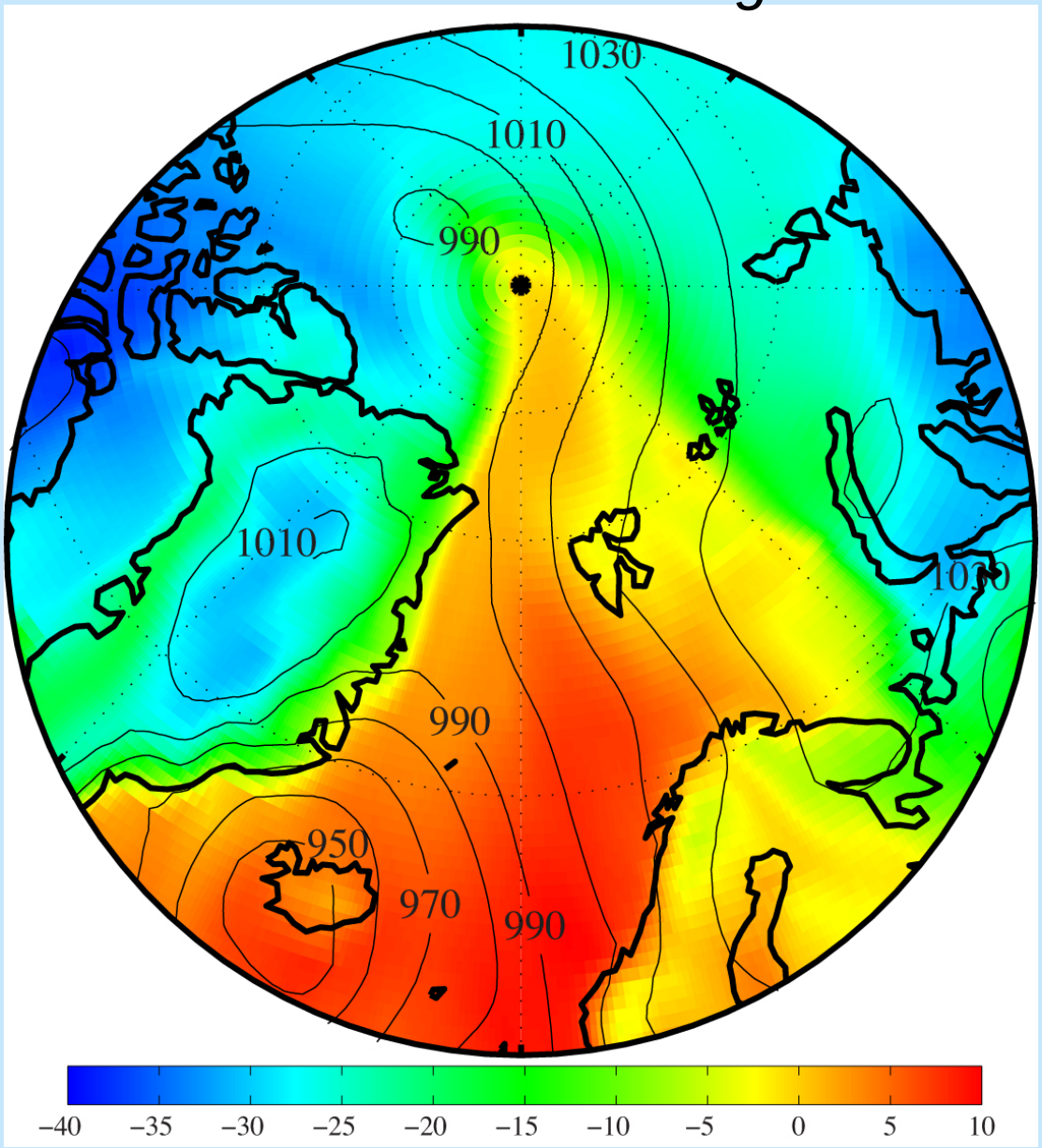
Conclusions Part 2

- The fall of 2016 was the warmest on record in the Arctic.
- This resulted in reduced ice growth that persisted into the winter of 2017.
- The thin and reduced ice cover in the Barents Sea allowed for the enhanced surface heating that resulted in the formation of a thermal low in the region and the downstream propagation of cyclones into the western Arctic.
- This resulted in the collapse of the winter Beaufort High and the reversal of the winds and sea ice motion in the Beaufort Sea.
- Such reversals have been observed in the summer but never in the winter.
- They may become more common as sea ice continues to thin.

Conclusions Part 2

- This may ultimately impact the Beaufort Gyre, an important ocean gyre in the western Arctic that contains a large amount of fresh water.
- There is some coupling between the two phenomenon in that anomalous advection of North Atlantic cyclones into the Arctic played a key role in both.

The 1959 Midwinter Warming Event



Thank-You