Will Arctic changes lead to mid-latitude weather impacts in the coming decades?

Attribution is Controversial. Worth further investigation, especially with continued Arctic external forcing

Shepherd (2014) notes that thermodynamic aspects of change (temperature, water vapor, sea ice) tend to be robust, while dynamic aspects are not so robust. For atmospheric circulation, chaotic internal variability dominates over multiple external sources.

Null hypothesis versus risk: We are already in a new world. As noted by Trenberth (2011), Sources of uncertainty in the observational record or models should not be preferentially assigned toward underestimating the human (or Arctic change) component.

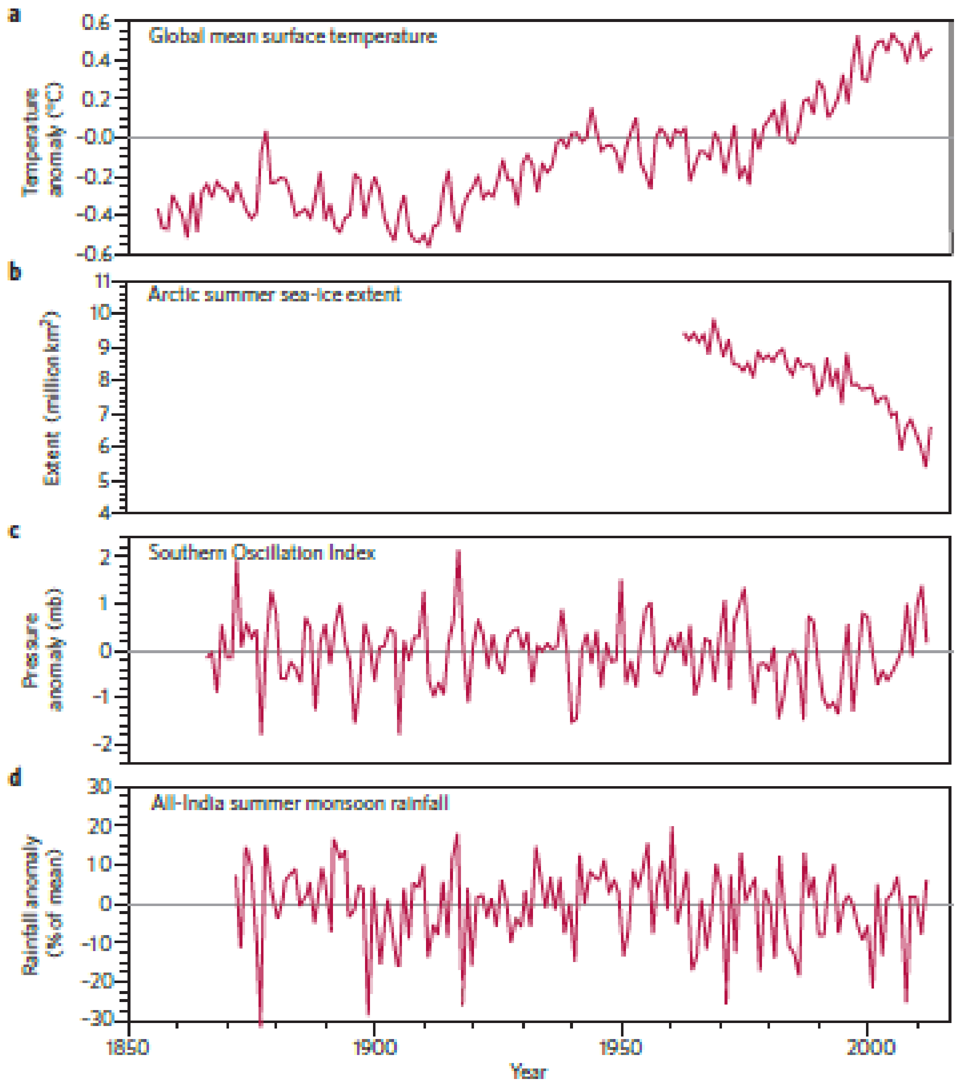
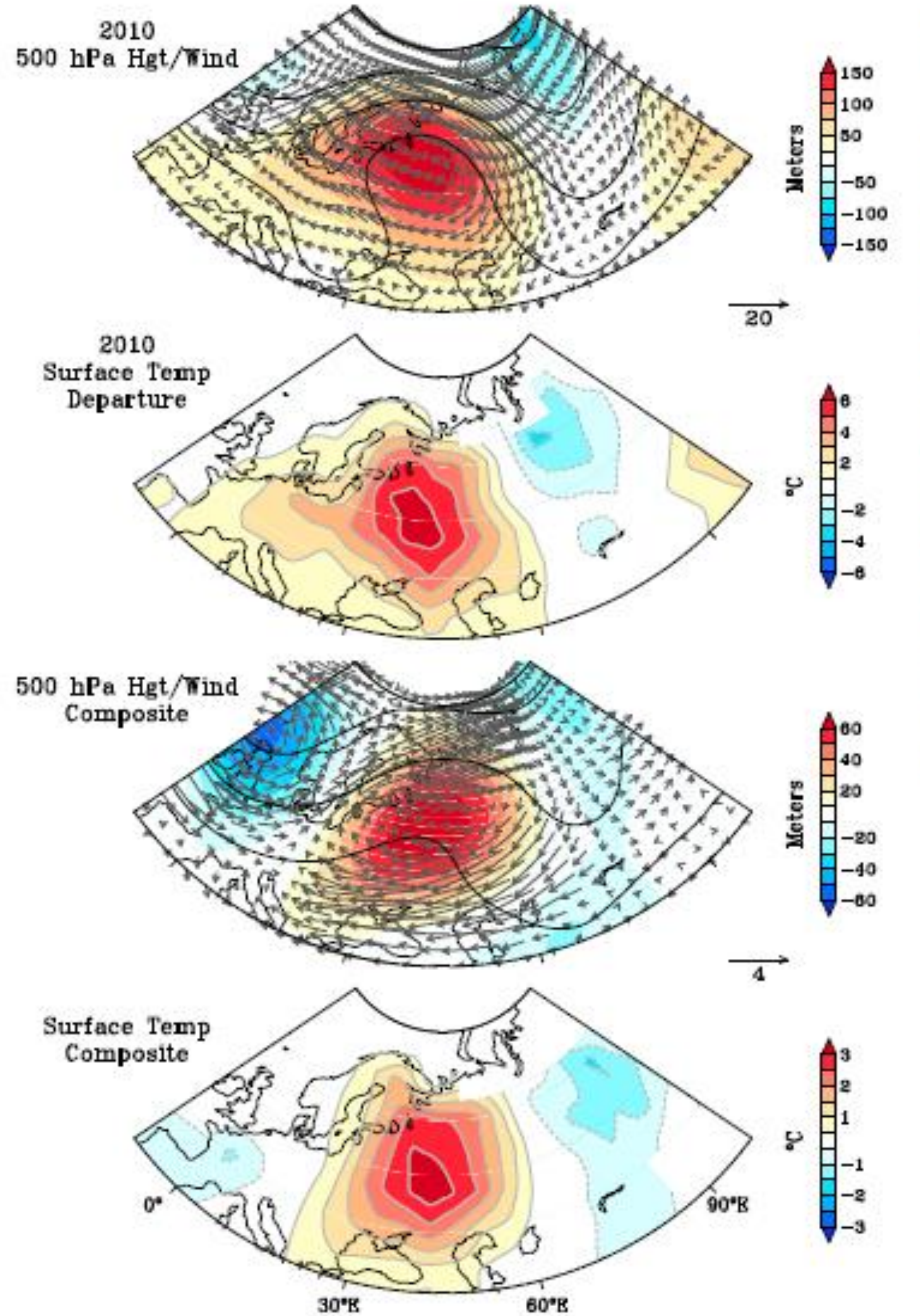


Figure 1 | Contrast between the robustness of observed changes in thermodynamic and dynamic aspects of climate. a, Global annual mean surface temperature anomaly. **b**, Arctic summer sea-ice extent. **c**, Annual mean Southern Oscillation (El Niño/Southern Oscillation) Index derived from surface pressure measurements at Tahiti and Darwin. **d**, All-India summer monsoon rainfall anomaly. See Methods for data sources.

Otto et al (2012), Reconciling two approaches to attribution of the 2010 Russian heat wave:

Dole et al. (2011) report the 2010 Russian heat wave was "mainly natural in origin" whereas Rahmstorf and Coumou (2011) write that with a probability of 80% "the 2010 July heat record would not have occurred" without the large-scale climate warming since 1980



Trenberth et al (2014) In most of these case [studies], the result will be a description of the large-scale patterns, the anomalous SSTs, and the relationships between the atmospheric circulation, storm tracks, blocking, temperatures and precipitation, and perhaps extremes. If considered, these studies will undoubtedly conclude that greenhouse-gas forcing or aerosols played little or no role in the circulation changes, although claims otherwise are sometimes made

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Instead, with regard to climate change, the questions to be answered could be:

Given the weather pattern, how were the temperatures, precipitation and associated impacts influenced by climate change?

Given a drought, how was the drying (evapotranspiration) enhanced by climate change, and how did that influence the moisture deficits and dryness of soils, and the wildfire risk? Did it lead to a more intense and perhaps longer-lasting drought,

Given a heat wave, how was that influenced by drought, changes in precipitation (absence of evaporative cooling from dry land) and extra heat from global warming?

Given extreme snow, where did the moisture come from? Was it related to higher than normal SSTs off the coast or farther afield?

Given an extreme storm, how was it influenced by anomalous SSTs and ocean heat content (OHC), anomalous moisture transports into the storm, and associated rainfall and latent heating? Was the storm surge worse because of high sea levels?

Random Circulation with additional reinforcement

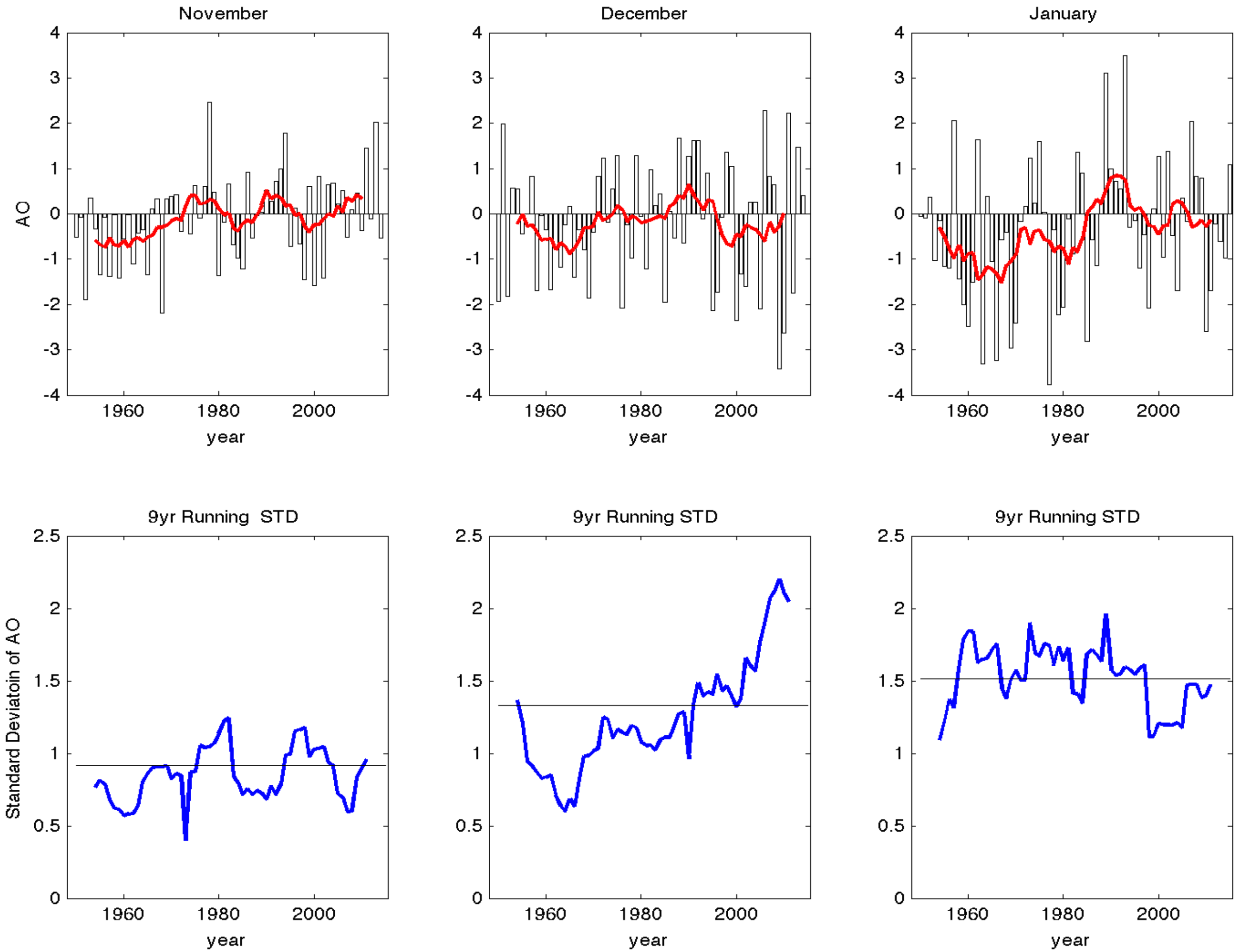
Snow Armageddon 2009 Cold air meets ENSO
And moisture from warm N Atlantic SST

Boulder Flood Sept 2013 Atmospheric River
And moisture source from sub tropics

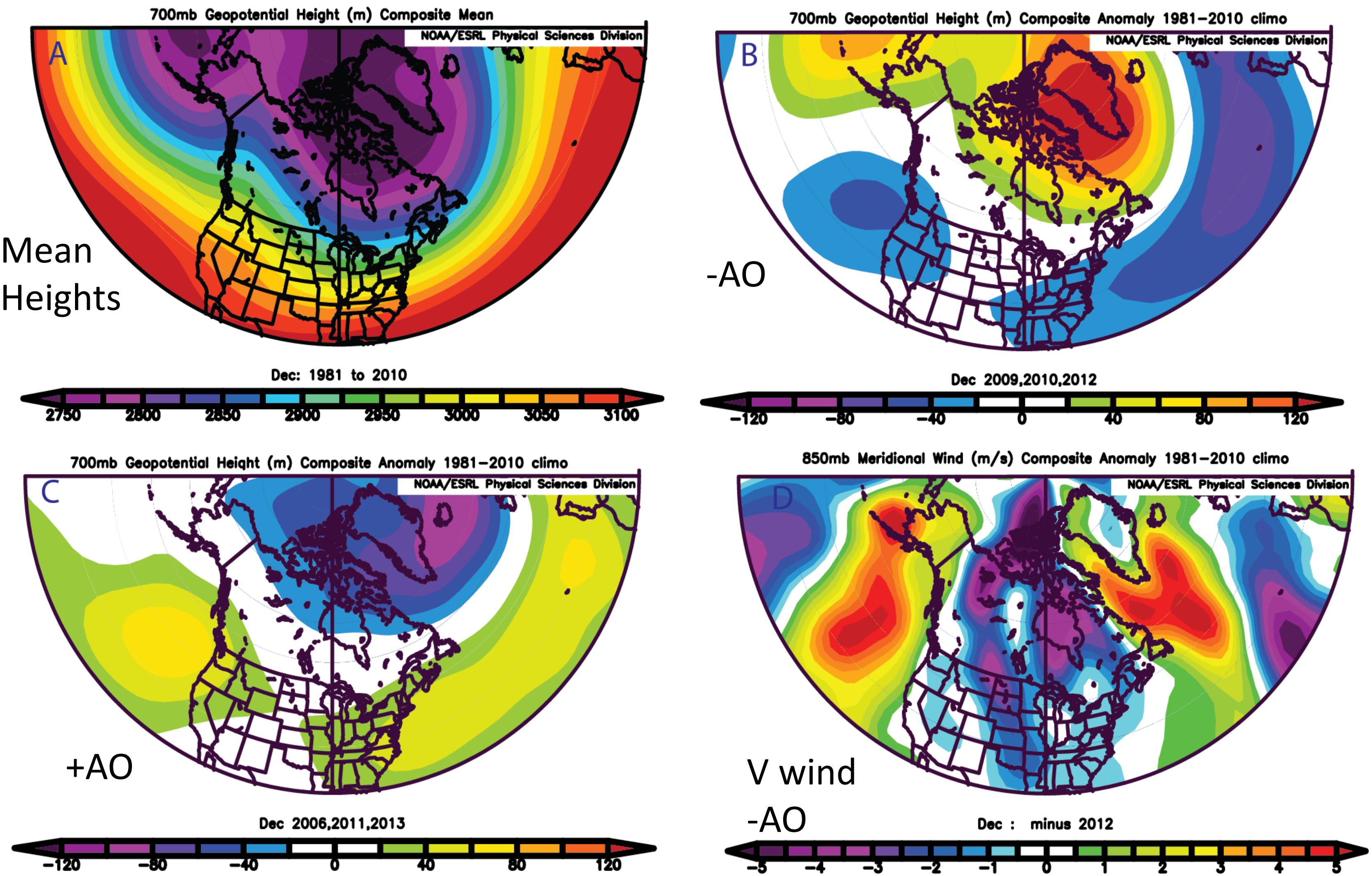
California Drought 2014 N Pacific SST/ West coast Ridging
And ground preconditioning

Hypothesis
Impact of external forcing is conditional on circulation type & state dependent

Increased December Arctic Oscillation (AO) index Variability
Lower curves are 9 year running standard deviation
AO- in 2009, 2010, 2012; AO+ in 2006, 2011, 2103

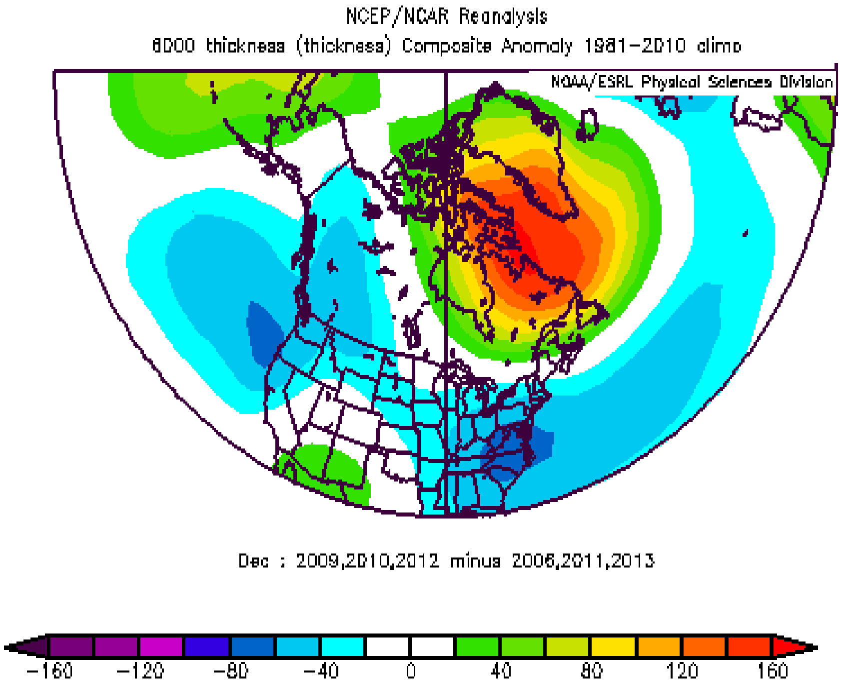


A) December climatic mean of 700 hPa geopotential heights over North America.
(B &C) Composite of height anomalies for three months of recent AO- (Dec. 2009, 2010 and 2012) and AO+ (Dec. 2006, 2011, 2013).
(D) Meridional 850 hPa wind component showing a “wavy” pattern for Dec 2012

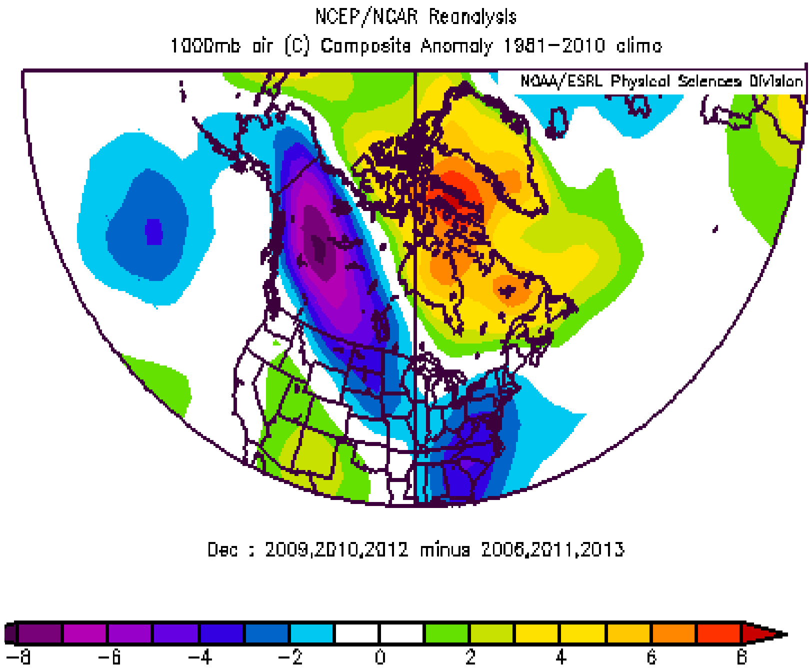


Composite of geopotential thickness (m) and near surface (1000 hPa) air temperature anomalies and for three -AO –(+AO) Decembers. Maximums are over Baffin Bay and Hudson Bay in excess of +4°C.

Thickness



Near Surface Temperature



Null hypothesis vs risk avoidance
Short Record
Type I versus Type II Errors
Priors
Non-linear,conditional responses

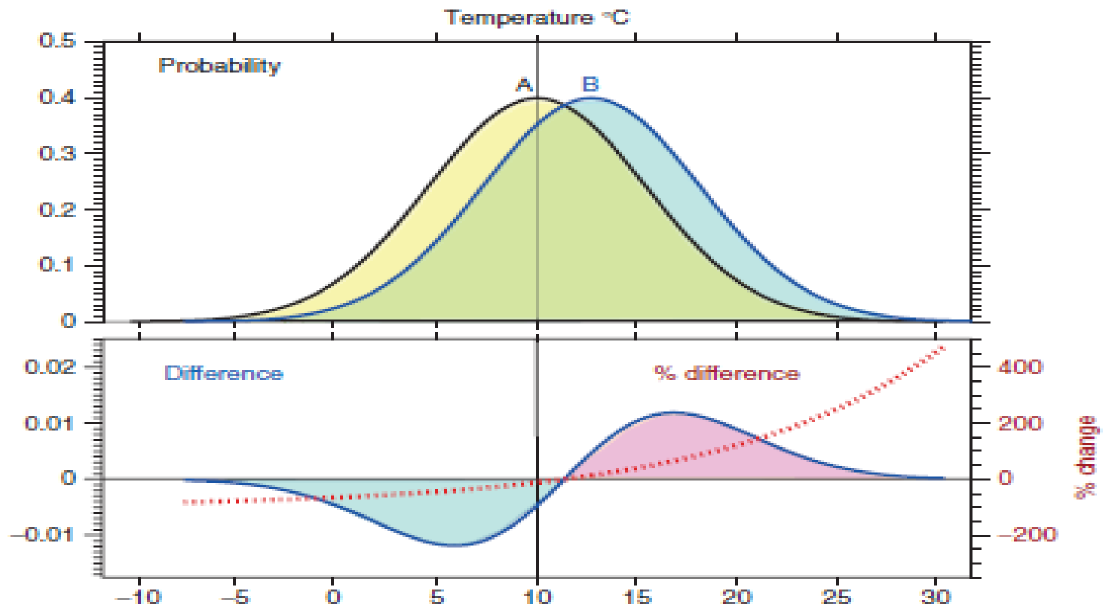


FIGURE 1 | A small change in the average temperature value can have a large effect on extremes. Top: The probability of different temperature readings when the mean temperature is 10°C and SD 5.6°C (black curve, A), and when the mean temperature rises 2.8°, to 12.8°C (blue curve, B) with the same spread. Bottom: the solid blue curve (scale left) is the difference in probability and the dashed red curve (scale right) is the percentage change.

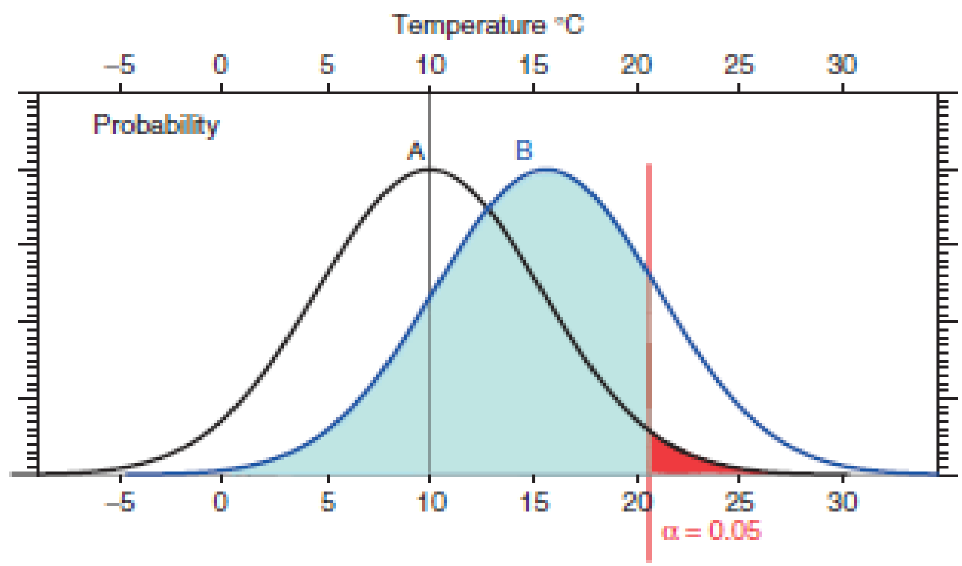
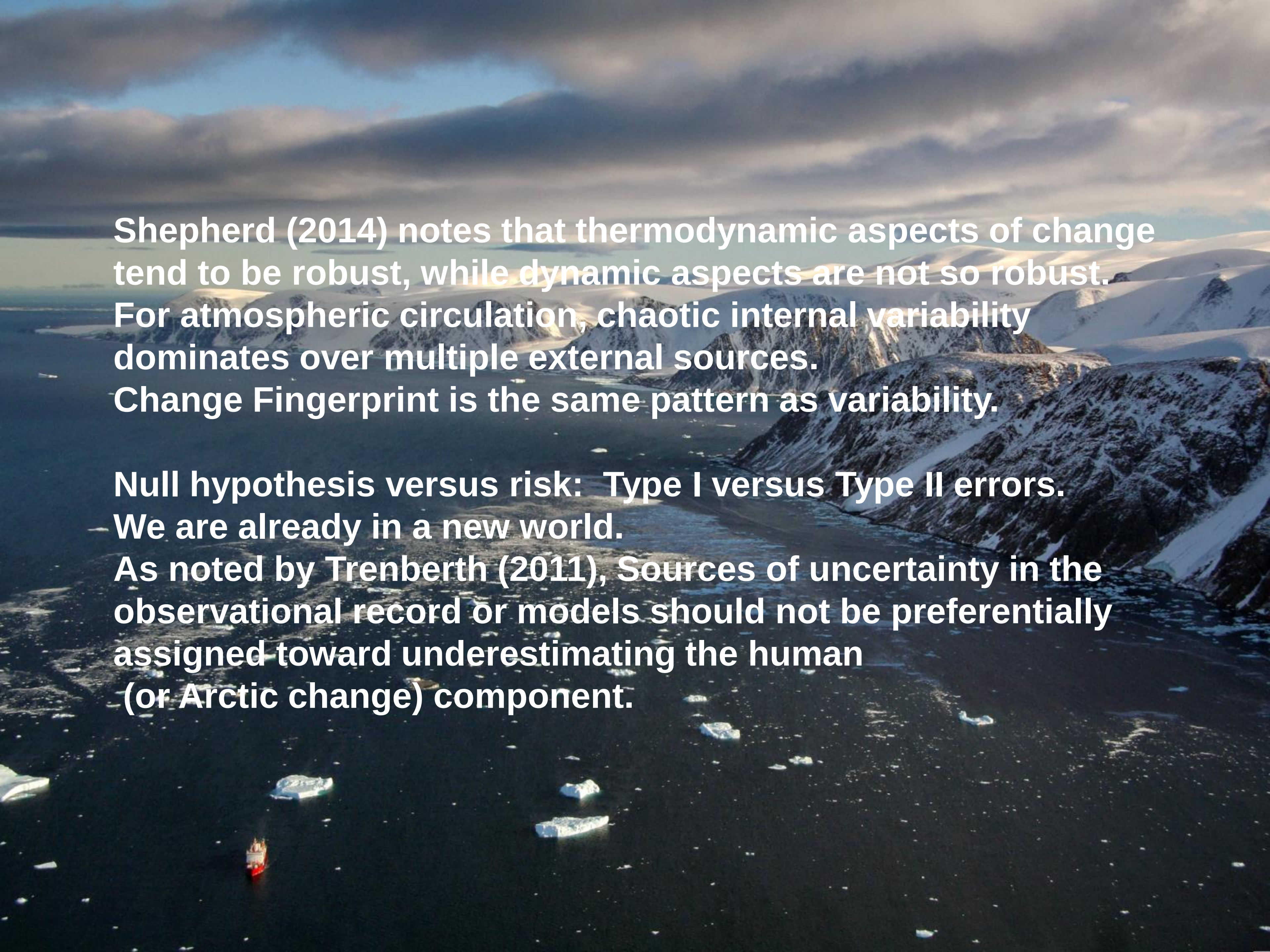


FIGURE 2 | For a 1 SD (5.6°C) shift in the distribution (due to climate change) from A to B, only values of B to the right of the two-tailed 5% significance level ($\alpha = 0.05$ in red) would be considered significant under a null hypothesis of no change. All the values in the blue area of the B distribution would not.



Shepherd (2014) notes that thermodynamic aspects of change tend to be robust, while dynamic aspects are not so robust. For atmospheric circulation, chaotic internal variability dominates over multiple external sources.
Change Fingerprint is the same pattern as variability.

Null hypothesis versus risk: Type I versus Type II errors.
We are already in a new world.
As noted by Trenberth (2011), Sources of uncertainty in the observational record or models should not be preferentially assigned toward underestimating the human
(or Arctic change) component.