Dr. Christopher Shuman

Email exchange June 8th - June 9th, 2017

Questions

1) In the Forbes article, you stated that the Larsen C rift differs from the rifts of Larsen A and B, because this one has been growing during a period of cooling relative to previous decades. It is my understanding that the annual mean temperature of the Antarctic Peninsula has decreased at a statistically significant rate since the late 1990s, but that this decrease is not reflective of the continent as a whole, and furthermore, that "decadal temperature changes in this region are not primarily associated with the drivers of global temperature change but, rather, reflect the extreme natural internal variability of the regional atmospheric circulation" [Turner et al, 2016]. Is this understanding correct, and is there anything you would add to clarify/expand?

2) We would also like to understand what, if any, warming water temperatures or changing ocean circulation (including salinity) may be underway in the region of Larsen C. Are changing water temperatures and/or changing circulation playing a role in the formation of this rift? We have noted Schmidtko et al (2014) found that temperatures in the West Antarctic Amundsen Sea and the Bellingshausen Sea have warmed significantly since the 1990s; Wouters et al (2015) concluded that the recent acceleration of ice mass loss of the marine-terminating glaciers in the Southern Antarctic Peninsula points to an oceanic driving mechanism; and Cook et al (2016) identified a strong correspondence between mid-depth ocean temperatures and glacier-front changes along the peninsula's western coastline. Unfortunately, it seems that none of those findings exactly apply to Larsen C!

3) In this larger context, is the coming event illustrative of any larger trends that may be driven by climate change, or is this really a mechanism of ice shelf loss that climate change doesn't affect at all?

Answers

Even though the temperature data is not perfect, the northern Antarctic Peninsula is fairly well known in terms of its temperature history going back to the mid-1940s, especially compared to other parts of the polar regions. The signal is fairly clear relative to the noise as a result, showing both long-term warming (multi-decadal), some 'no change', and a recent slight cooling (~decadal) depending on where you pick the inflexion.

https://en.wikipedia.org/wiki/Operation_Tabarin

https://public.wmo.int/en/media/press-release/wmo-verifies-highest-temperatures-antarctic-region

However, although Turner et al and Oliva et al (2017) believe that the cooling initiated in the late 1990s, it is spatially variable (from Oliva paper abstract).

Our results also indicate that the cooling initiated in 1998/1999 has been most significant in the N and NE of the AP and the South Shetland Islands (> 0.5 °C between the two last decades), modest in the Orkney Islands, and absent in the SW of the AP. Note, I'm not sure how they define 'SW' exactly and there is not much data from the Larsen C area ('SE'?) in part because of how large it is (~420 km, ~260 mi

in width north to south) and how far it stretches south (to ~70°S) and thus how far it is from most of the bases where the temperature data are being acquired, basically for logistics reasons. Just the north to south distance is roughly Pittsburgh to Washington DC and I really doubt we'd like their weather (except in the summer).

So, the point I'm really trying to make is that even recent 'decades' of little change or slight cooling have not prevented the Larsen C from responding to much longer-acting forces including the generally warming atmosphere and especially ocean temperatures. Note, I suspect that ocean temperature data is even less extensive than the data from stations on land due to both sea ice and ice bergs coming up the Peninsula out of the Weddell Sea so I'll point you to multiple studies showing surface melting and net thinning of the floating ice in the shelf as proxies for what appears to be effectively weakening the Larsen C (see Pritchard, Rignot, Paolo etc... papers).

Your last question is the hardest to answer right now as even the USGS 2600B map only gives us a sense of the ebb and flow of the Larsen C's extent over the whole period. What we can say now is that this will be the furthest inland that the Larsen C has retreated during the period where humans have been mapping the area. Although the Larsen C could advance, especially if conditions continue to 'cool' in the region, my best guess is that the overall area will return to warming and this 'initial loss' of shelf area will be followed in the years to come by much more retreat of the ice in the Larsen C area just as happened after the initial losses in the Larsen A (late 1980s) and Larsen B (mid 1990s).