

Investigating Temperature Trends Across the Southern High-Latitudes

Megan E. Jones, David H. Bromwich, Julien P. Nicolas, and Sheng-Hung Wang

Byrd Polar and Climate Research Center

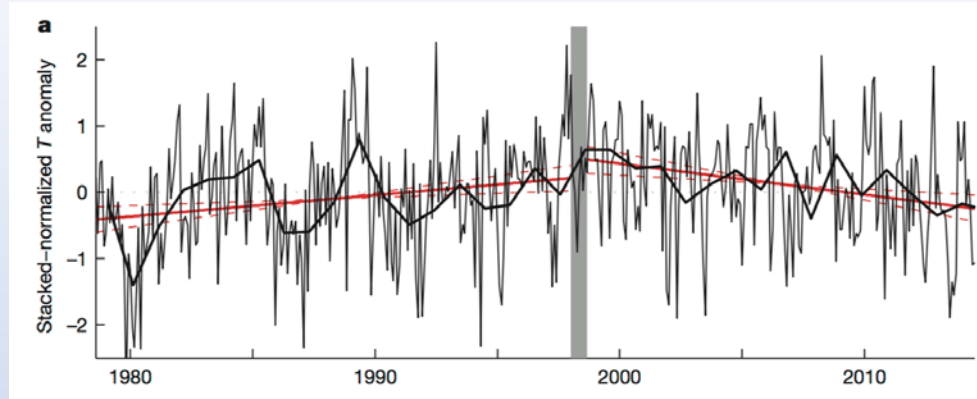
The Ohio State University

Objectives

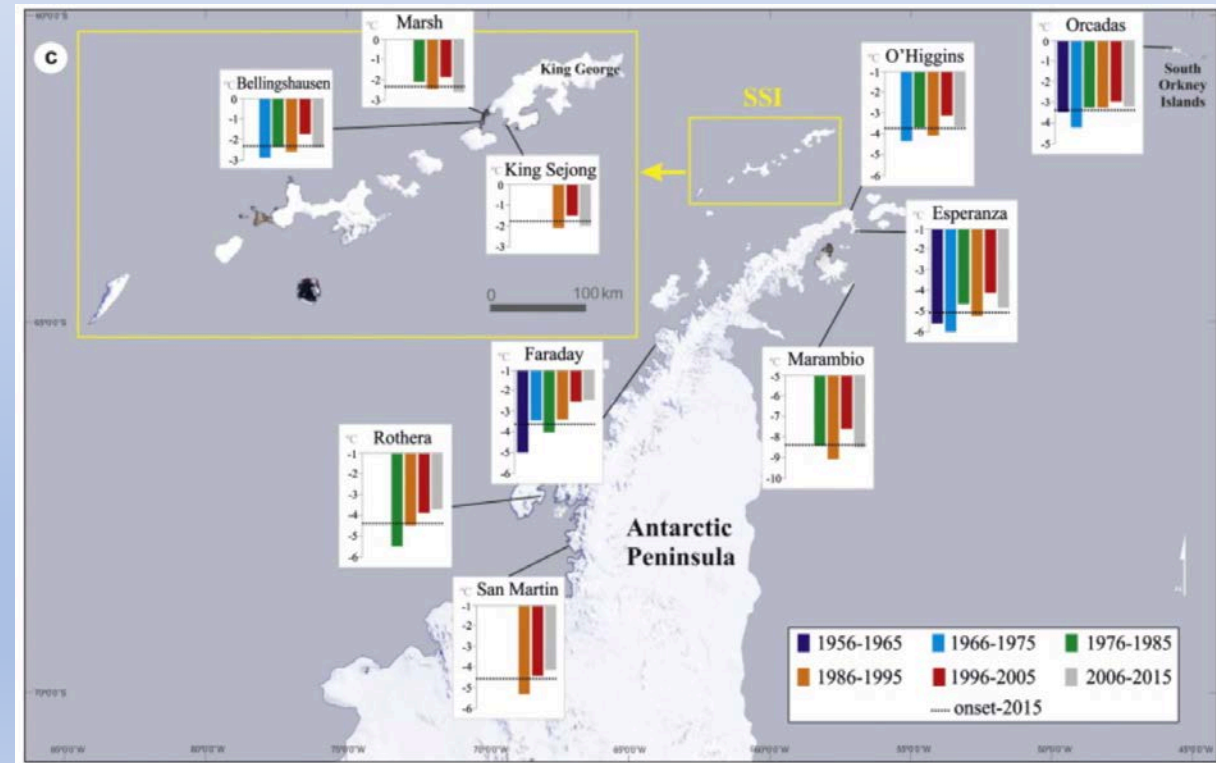
- Looking at circumpolar trends of station and sea surface temperature
 - Antarctica, New Zealand, South America, mid-latitude islands
- Put warming in West Antarctica and Antarctic Peninsula into “big picture”, both spatially and temporally
- Expanding on multiple previous studies
- Determine driver of temperature trends

Previous Studies

- Turner et al. (2016)
 - 6 peninsula stations 1979-2014
 - Warming 1979-1997, cooling 1999-2014
- Oliva et al. (2016)
 - 10 peninsula stations 1950-2015
 - Southwest peninsula stations are the only ones warming consistently
- Richard et al. (2012)
 - Circumpolar trends 1973-2002
 - Warming on mid-latitude islands and peninsula, stationary temperatures in East Antarctica



From Turner et al. (2016)



From Oliva et al. (2016)

- Nicolas and Bromwich (2014)
 - Reconstructed temperature trends 1958-2012
 - Warming on peninsula and West Antarctica, insignificant trends in East Antarctica
 - Review paper
- Jones et al. (2016)
 - Continental trends 1979-2014
 - Warming on peninsula, stable temperature trends in East Antarctica
 - Review paper

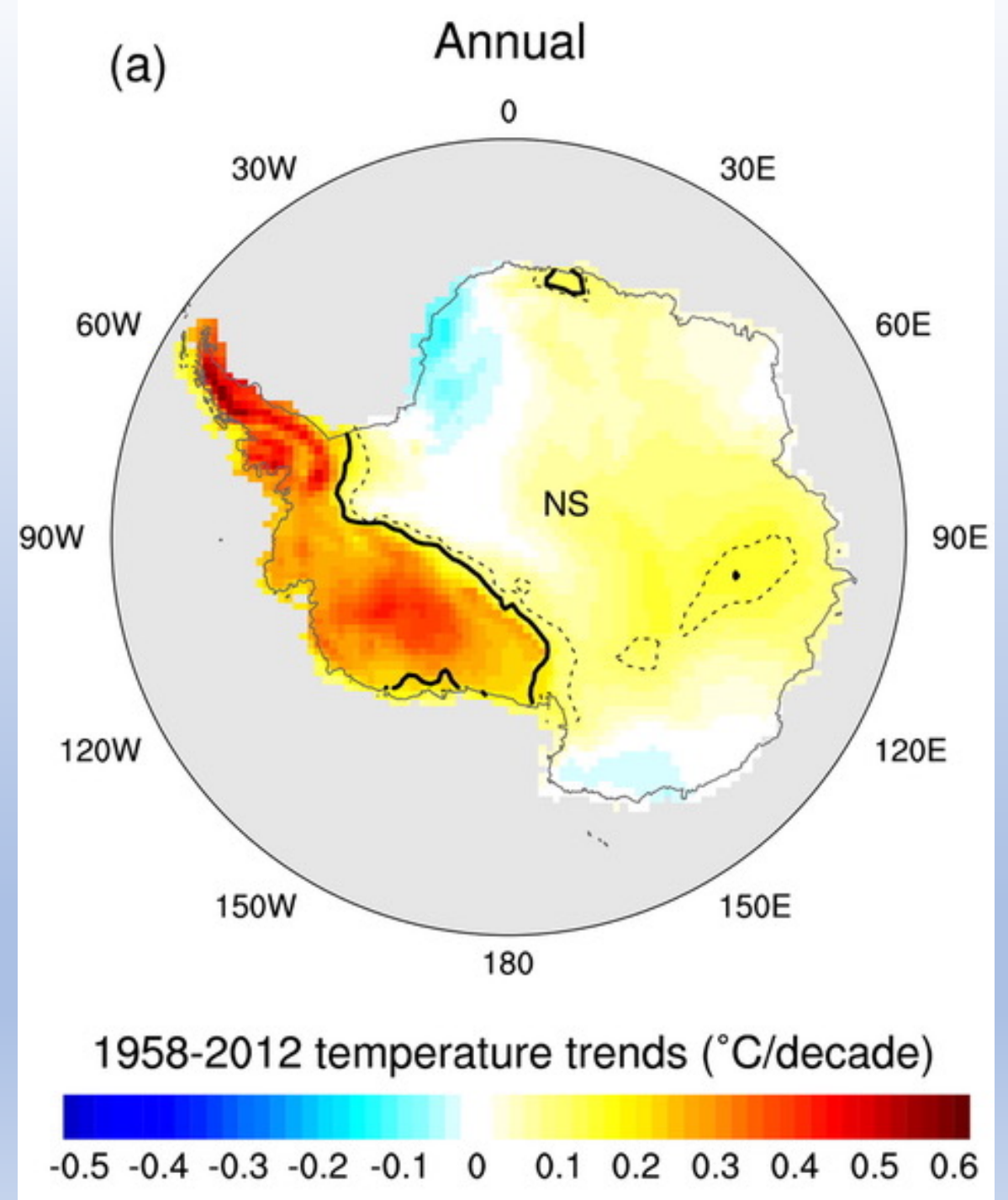
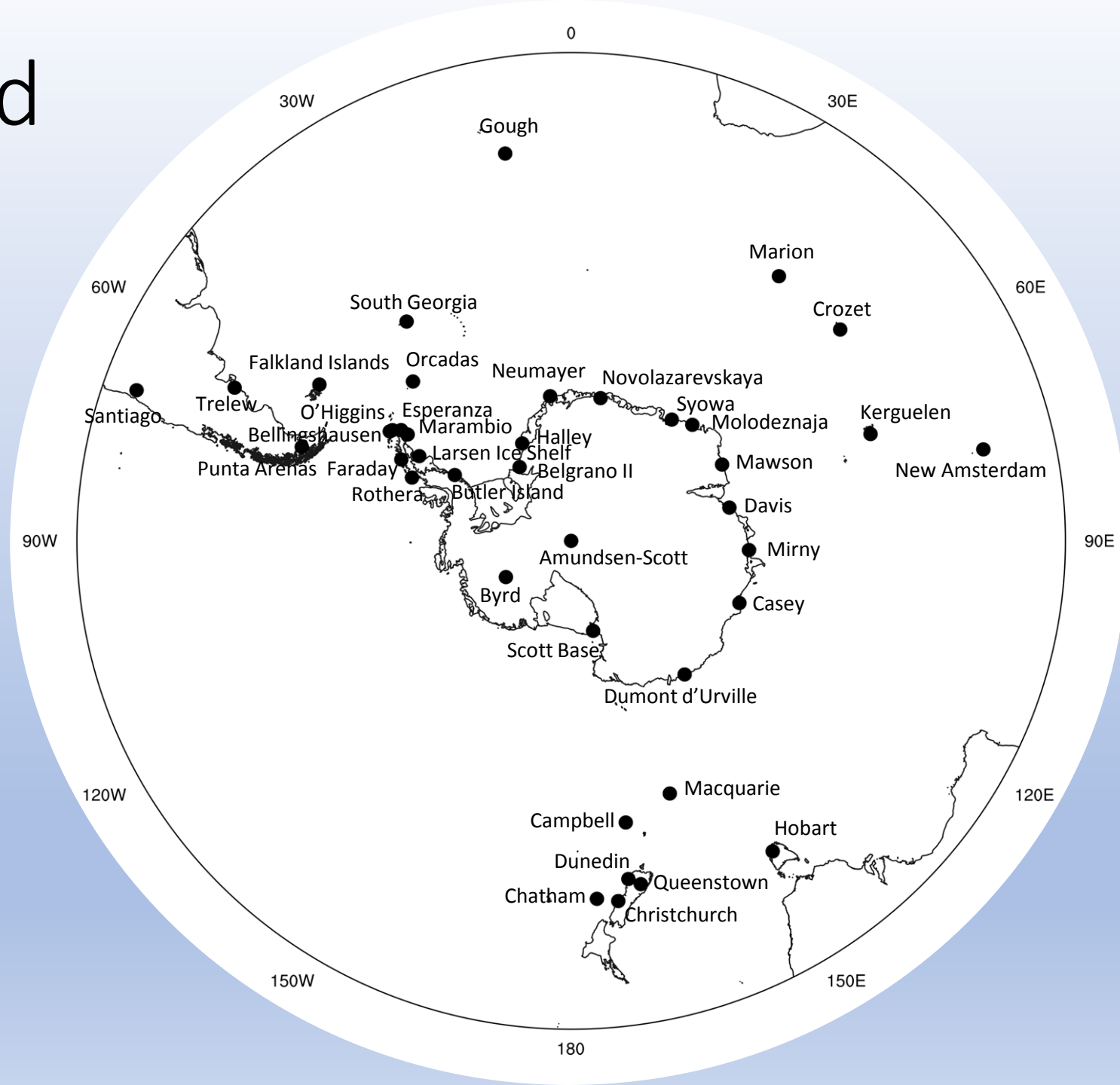


Figure from Nicholas and Bromwich (2014)

Stations Used

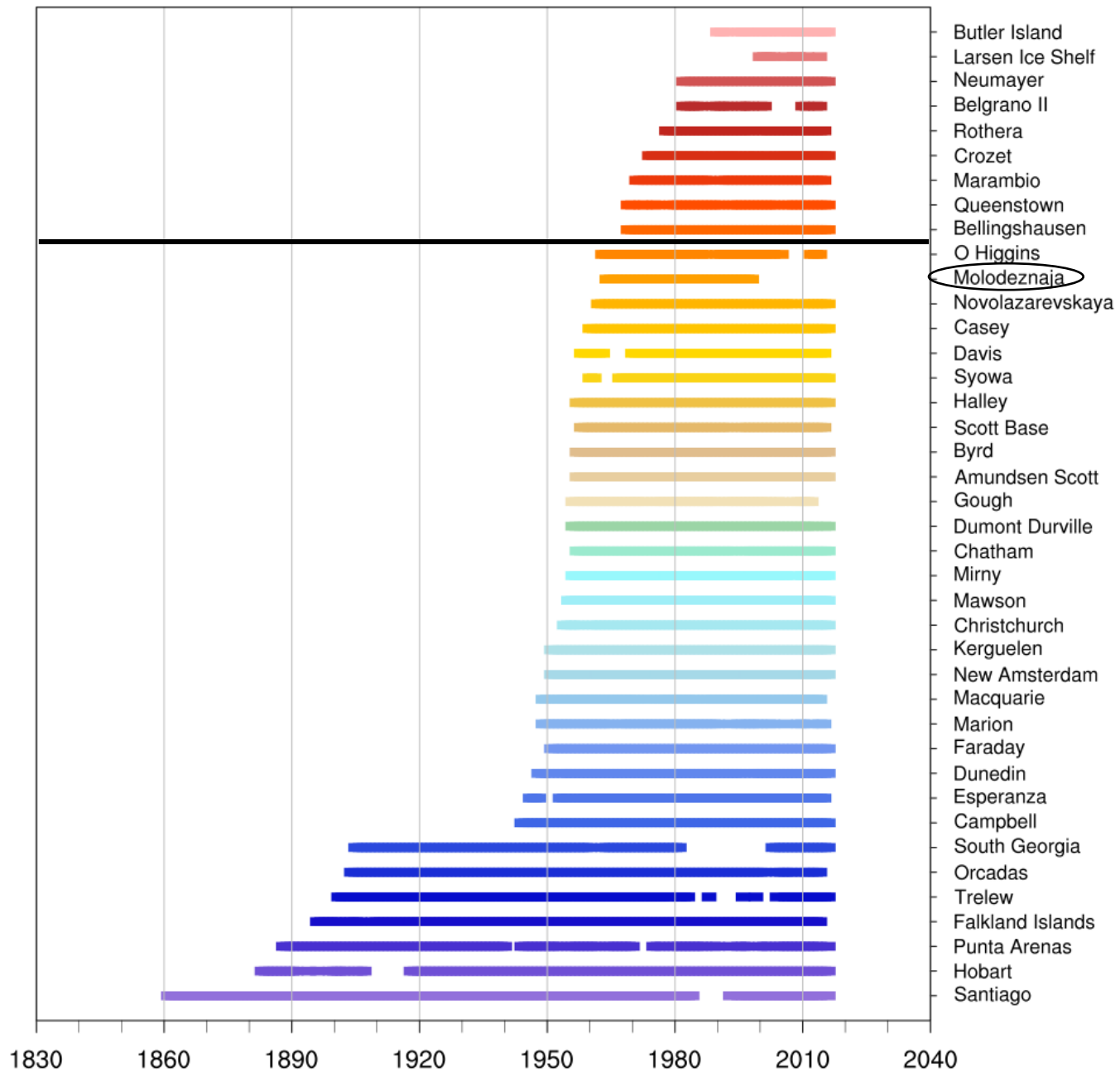


Data

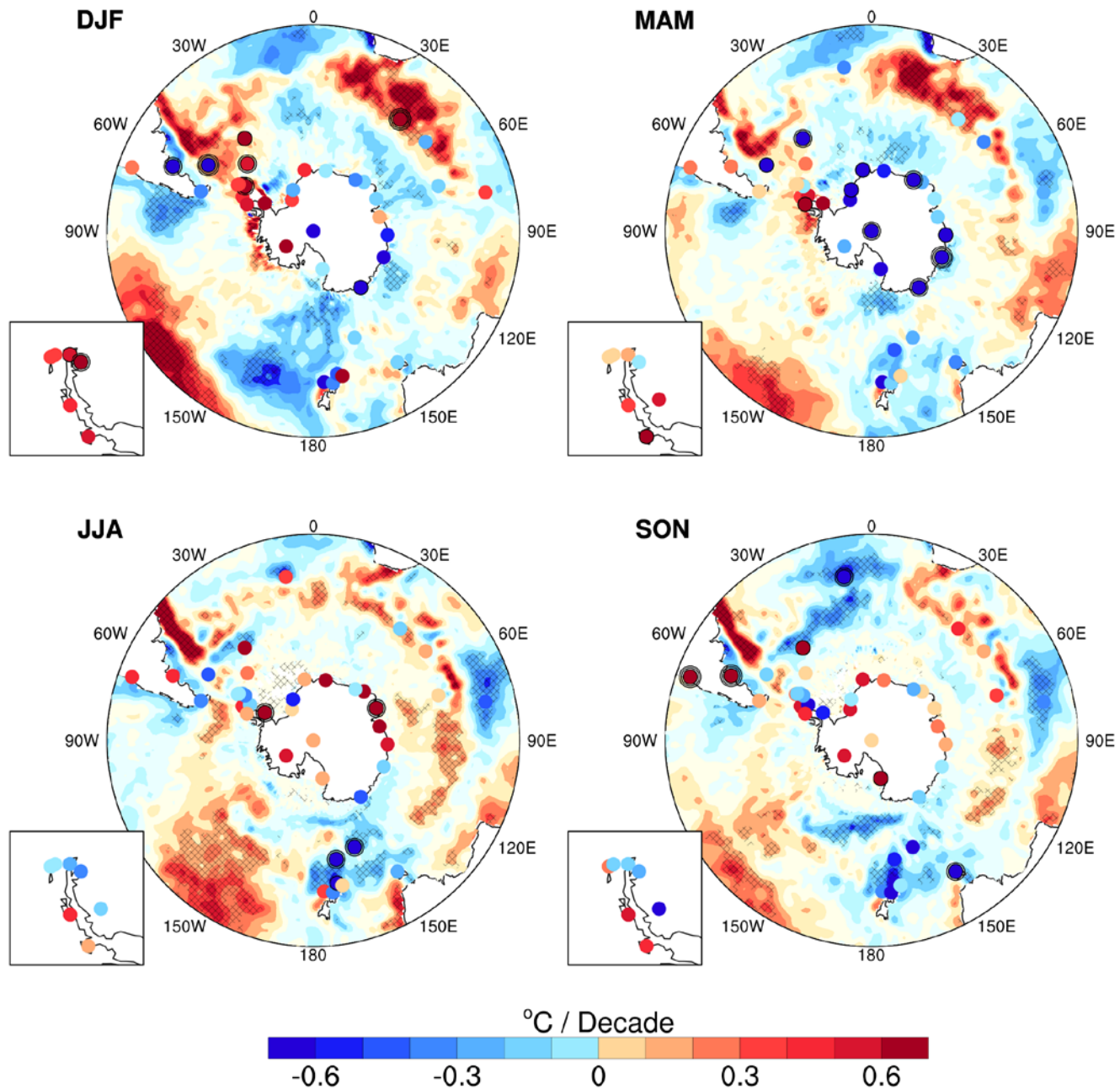
All preliminary data

- READER archive (all months 85% and above complete)
- NCAR Research Data Archive ds 570.0
- New Zealand National Climate Database
- NOAA NCEI
- Meteo-France
- Lister and Jones (2016)
- HadISST1 for sea surface temperature gridded dataset
 - Satellite data included starting in 1979, mostly ship data before 1979

Antarctic and subantarctic stations data coverage (ANN)



1979-1997 Temperature Trends



Strong summer warming on peninsula

Strong cooling in fall on entire continent except peninsula

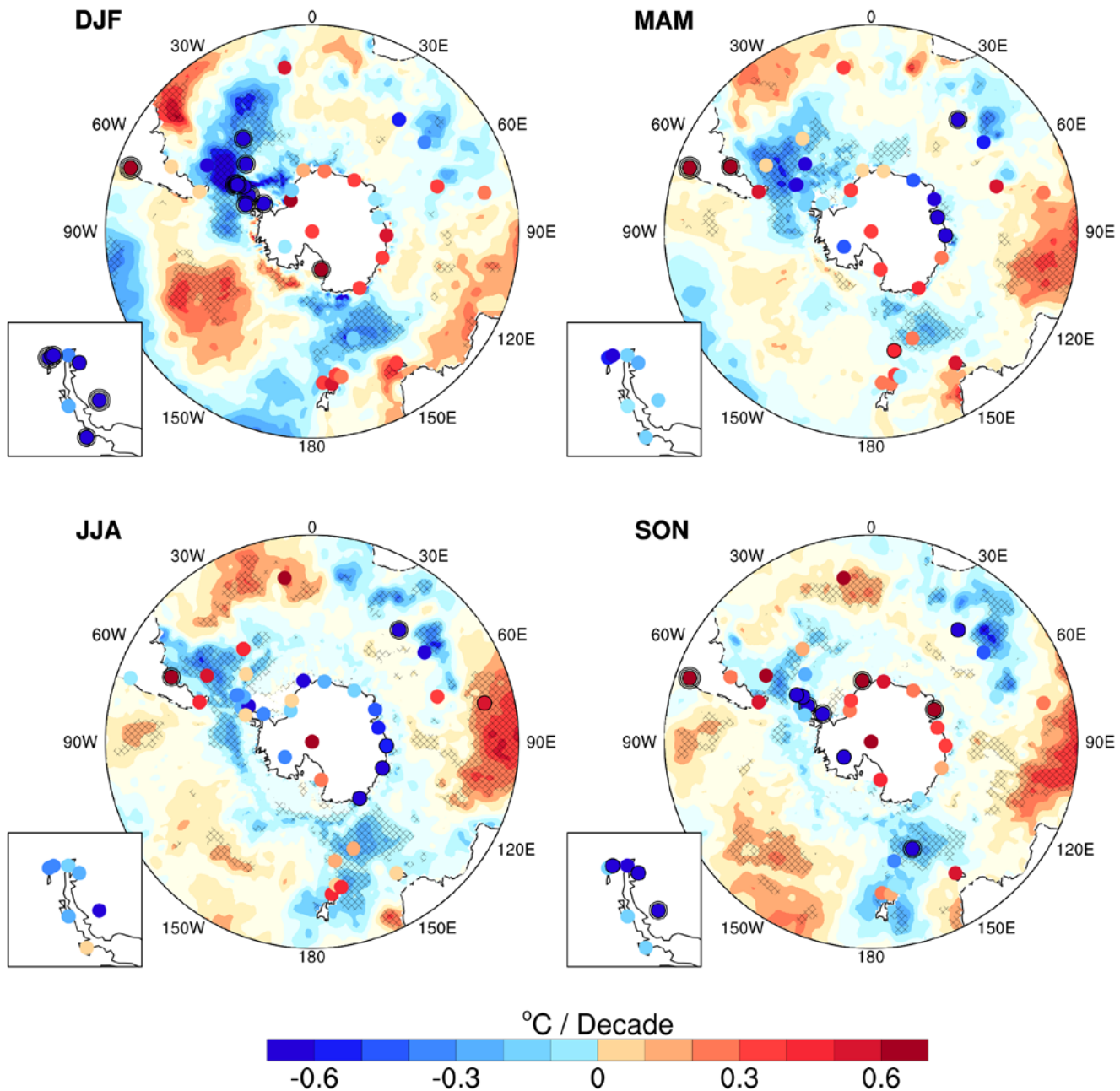
Variable trends in winter and spring

Large areas of SST warming in summer, mid-latitude islands don't always match up

Turner et al. (2016) found largest warming during summer

Richard et al. (2012) period of study was 1973-2002 and they found "recent warming" on the peninsula, strongest in the summer

1999-2016 Temperature Trends



Strong summer and spring cooling on peninsula

Strong summer and spring warming on east coast

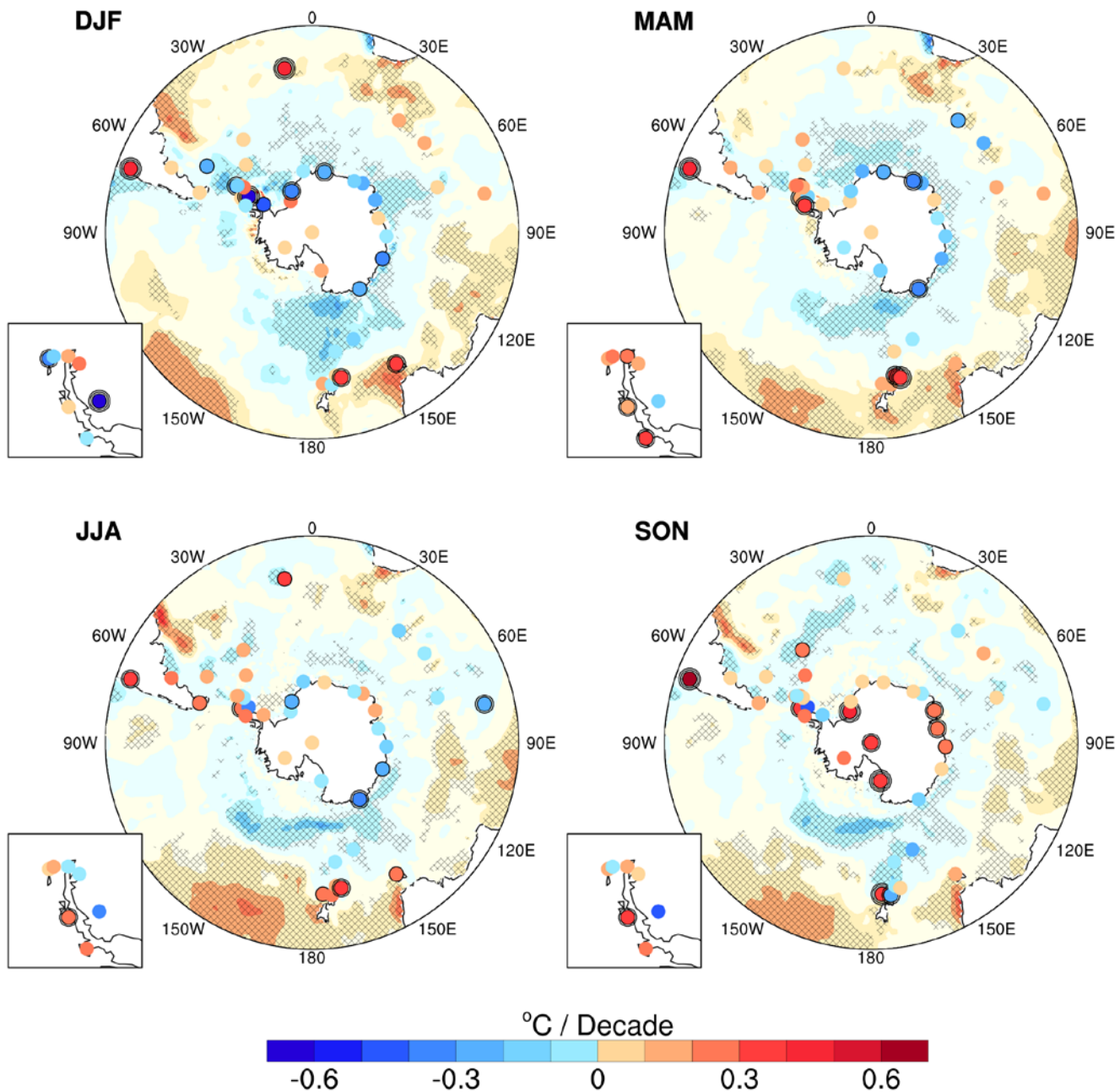
Both station and SST trends pretty opposite of those from 1979-1997

SST cooling in peninsula area

Turner et al. (2016) found greatest cooling in summer, associated with a strengthening mid-latitude jet

Oliva et al. (2016) also sees cooling in recent years for peninsula, although they have different time periods

1979-2016 Temperature Trends



Peninsula and surrounding stations warming somewhat inconsistently between seasons and stations, but overall is warming

East coast mostly cooling

Warming most pronounced in spring

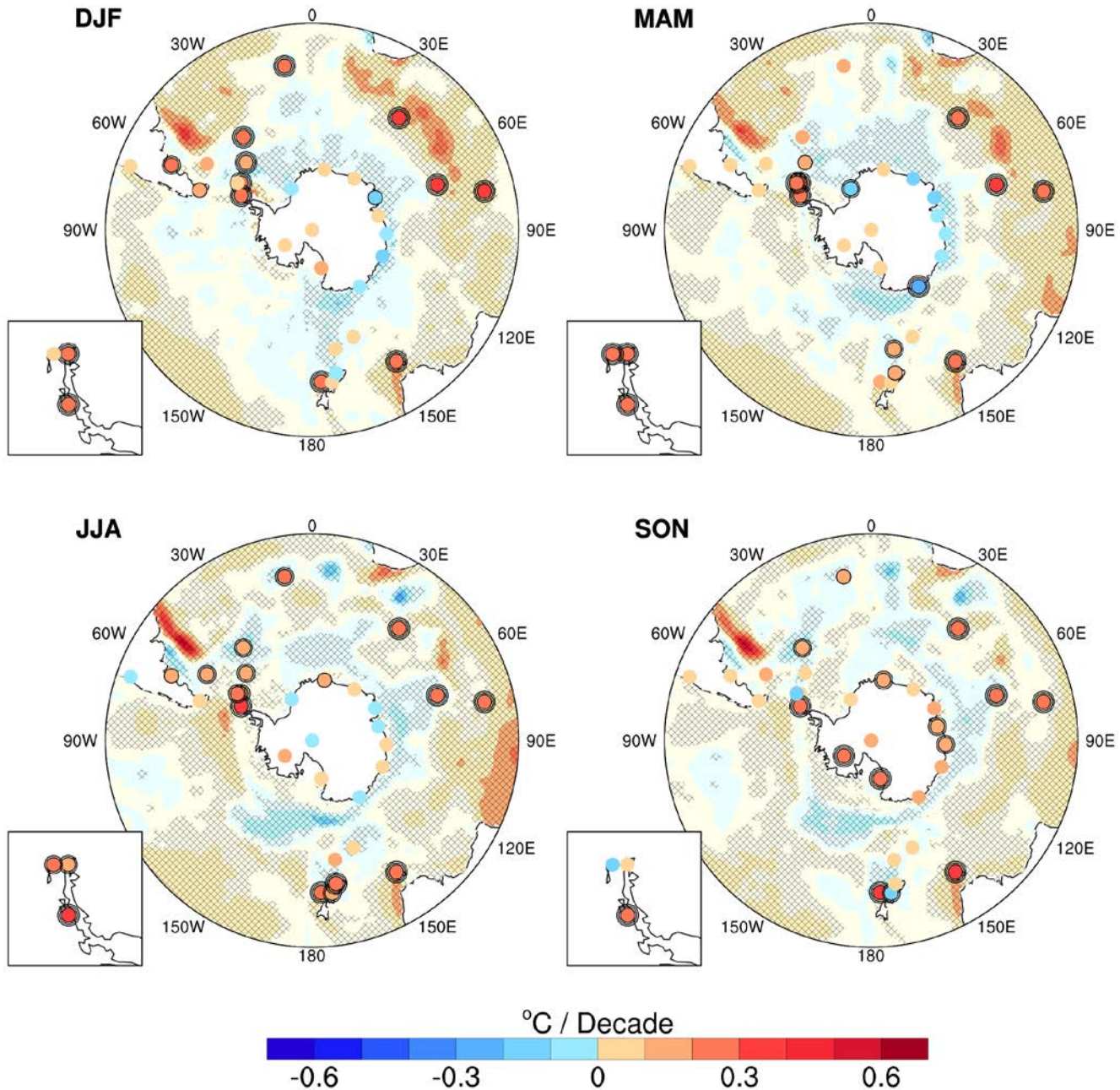
Trends muted due to opposing trends between 1979-1997 and 1999-2016

SSTs match up pretty well with island stations

Nicolas and Bromwich (2014) has peninsula and West Antarctica warming, with cooling outside of central East Antarctica

Richard et al. (2012) finds more long-term warming in summer in the mid-latitude island stations

1957-2016 Temperature Trends



Strong warming across the continent in spring

Continental trends more muted in all other seasons

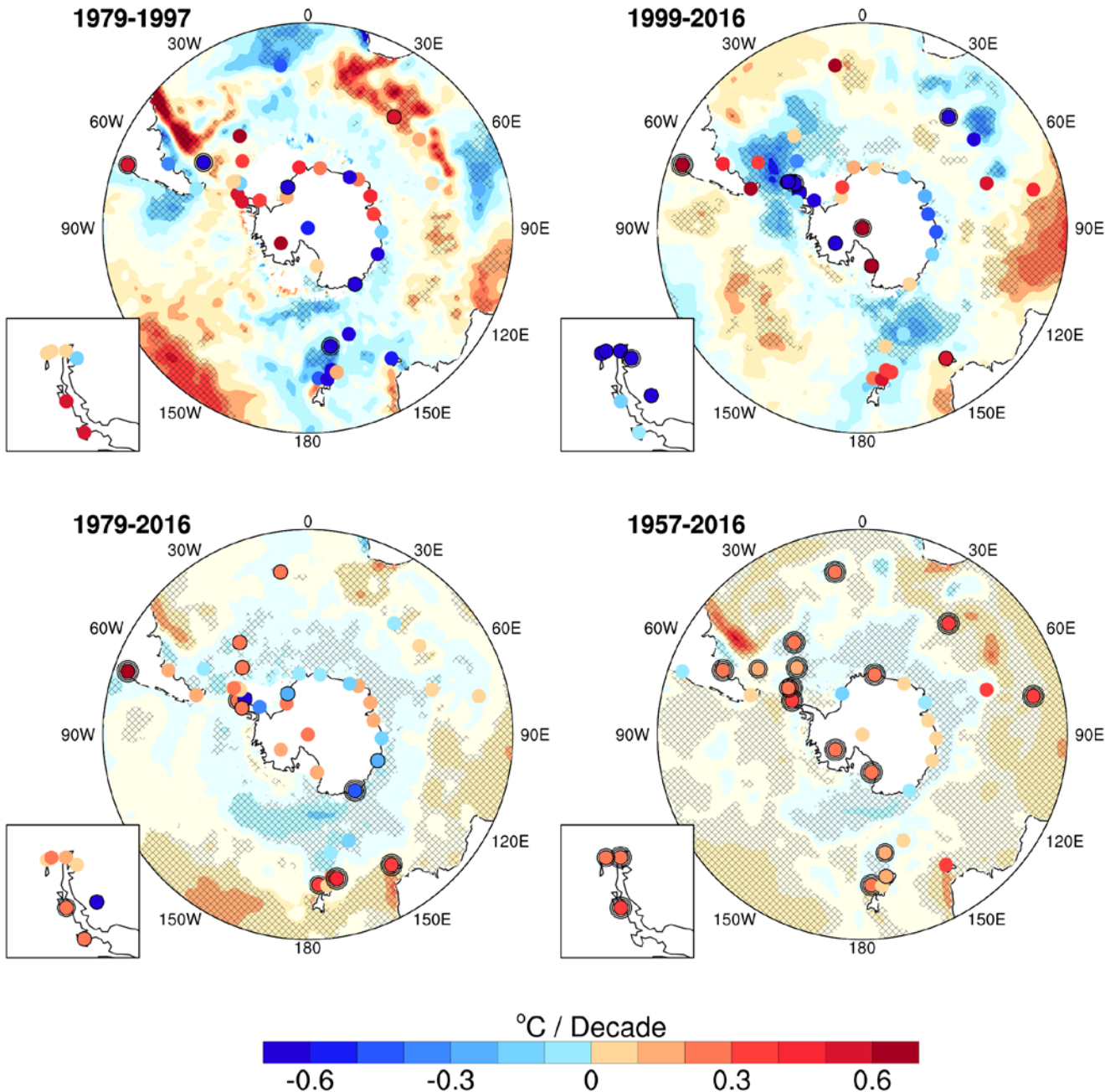
Peninsula and surrounding area are warming most in summer and winter

Be cautious about HadISST1 sea surface temperature trends for this time period in high-latitudes, but more confidence in mid-latitudes

Matches well with reconstructed temperature trends from Nicolas and Bromwich (2014)

Oliva et al. (2016) has varying temperature trends between seasons and regions of the peninsula

Yearly Temperature Trends



Peninsula switches from warming to cooling between 1979-1997 and 1999-2016

1979-2016 shows peninsula and West Antarctica warming, although without much statistical significance

1957-2016 shows more widespread, significant warming around the peninsula and in the mid-latitudes, but not in East Antarctica

SSTs match up better with yearly trends

Oliva et al. (2016) has peninsula stations warming long-term, with Vernadsky and Rothera having the strongest trends

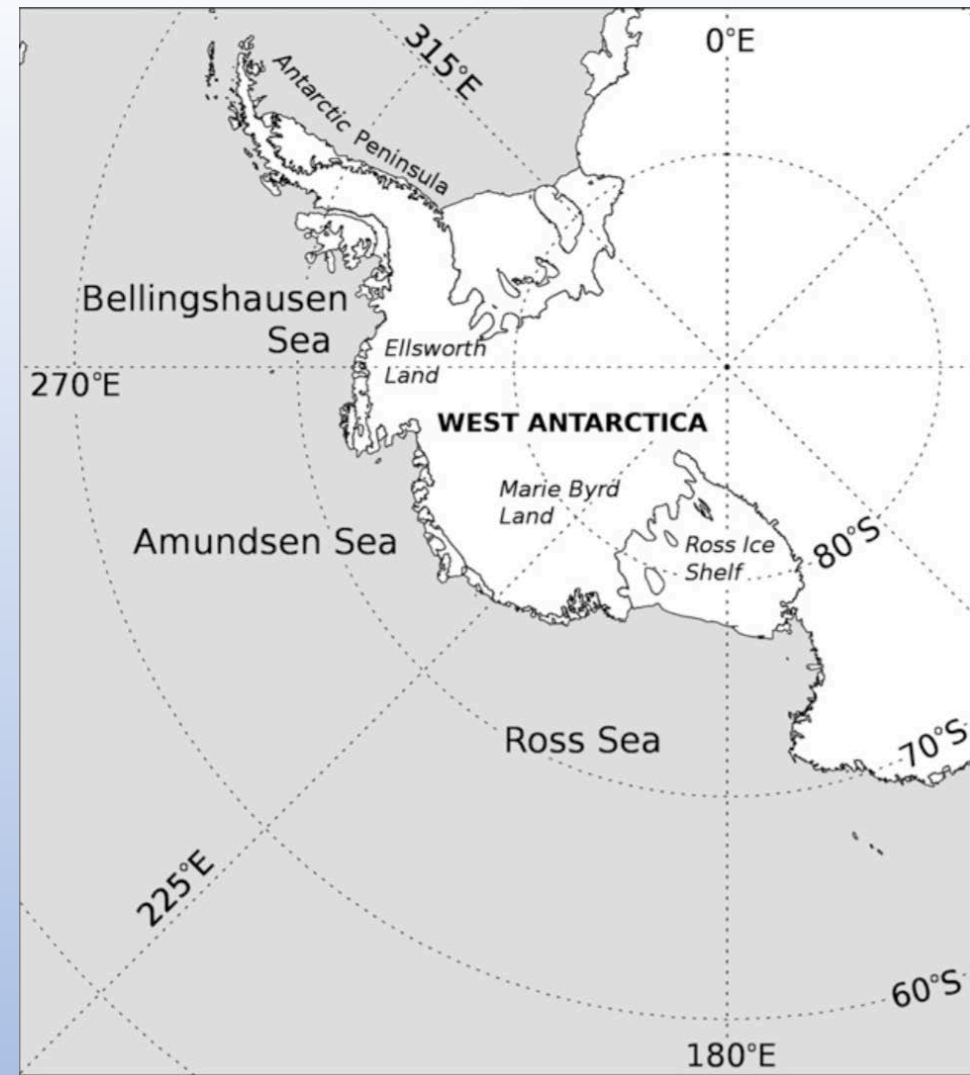
Richard et al. (2012) finds warming on the peninsula and throughout the mid-latitude island stations, along with stable temperatures on the east coast, although trends end in 2002

Initial Conclusions

- Peninsula and surrounding area is warming throughout time, and although it is cooling in recent years (in agreement with Turner et al. (2016) and Oliva et al. (2016) studies), it doesn't seem to offset overall warming trend
- East Coast temperatures are pretty stable, in agreement with Richard et al. (2012) and Jones et al. (2016)
- Mid-latitude island stations are warming, in agreement with Richard et al. (2012), although data ends in 2002
- Continental trends agree with Nicolas and Bromwich (2014) temperature reconstructions
- Temperatures seem to have strongest trends in spring and summer

Possible Drivers

- Trend towards positive SAM phase and La Nina
 - Leads to lower pressure, higher temperatures and increased strength of the westerlies (Jones 2016)
- Deeper Amundsen-Sea Low (Jones et al. (2016), Raphael et al. (2015))
 - Creates northerly flow over the Antarctic Peninsula
 - Peninsula warming most pronounced in DJF
 - Increase in moisture and therefore precipitation
- Possible inflection point in 1998 (Turner et al. (2016))
 - Caused by strong ENSO event and PDO phase change



Taken from Hosking et al. (2013)

Future Work

- Add in a few more stations in Australia and South Africa, as well as Vostok
- Use reanalysis to compute circulation trends
- More in-depth quality control for observation data
- Include sea ice data from HadISST1
- Consider snowfall accumulation, i.e. Thomas et al. (2009, 2015)
- Analysis on drivers of trends for both yearly and seasonal trends

Questions?

Jones.5837@osu.edu

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