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Outstanding Student & PhD candidate Presentation contest

Interannual variability of the 12-hour tide in the mesosphere and lower thermosphere in 15 years of meteor-radar observations over Rothera (68°S, 68°W)

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NATURAL ENVIRONMENT RESEARCH COUNCIL

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Motivation

- **Atmospheric tides dominate the wind field** of the mesosphere and lower thermosphere (MLT)
- **Key agents in coupling the middle and upper atmosphere** (Lui et al., 2016)
- Tidal amplitudes are seen to **vary year-to year** and may do this is response to inter annual phenomena
- ***However,*** inter annual variability of the polar 12-hour tide is **poorly characterised and understood**….

Monthly 12-hour tidal amplitudes

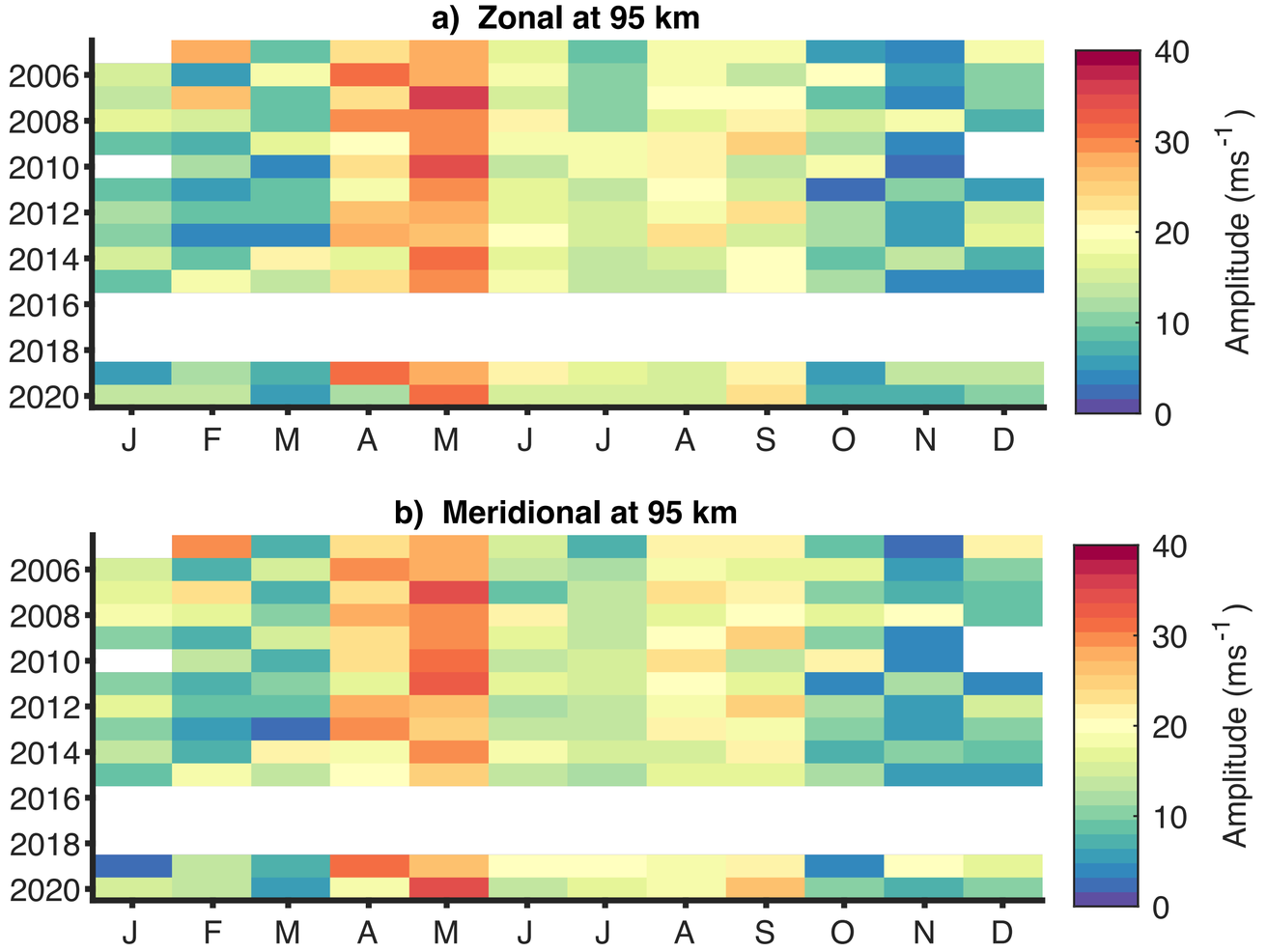


Figure 1: Monthly 12-hour tidal amplitudes in the a) zonal and b) meridional at 95 km. Each pixel represents the tidal amplitude for the month and highlights the inter annual variability present in the dataset

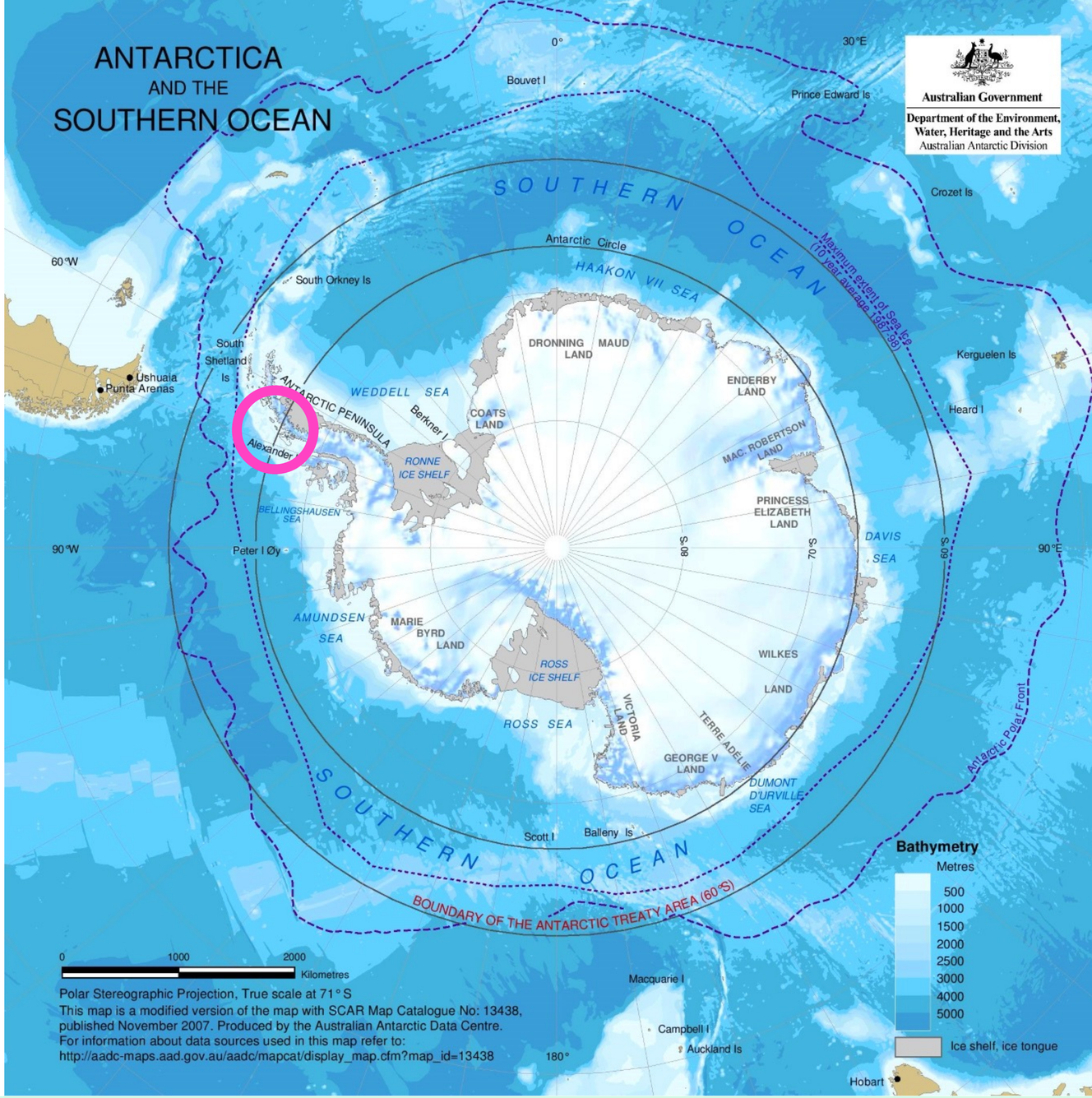
How?

- We use **linear regression analysis to investigate the interannual variability of the tides**

- We use the linear model with the following climate indices: **F10.7 Solar Flux, ENSO, QBO10, QBO30, SAM** and any linear trends in 12-hour tidal amplitudes

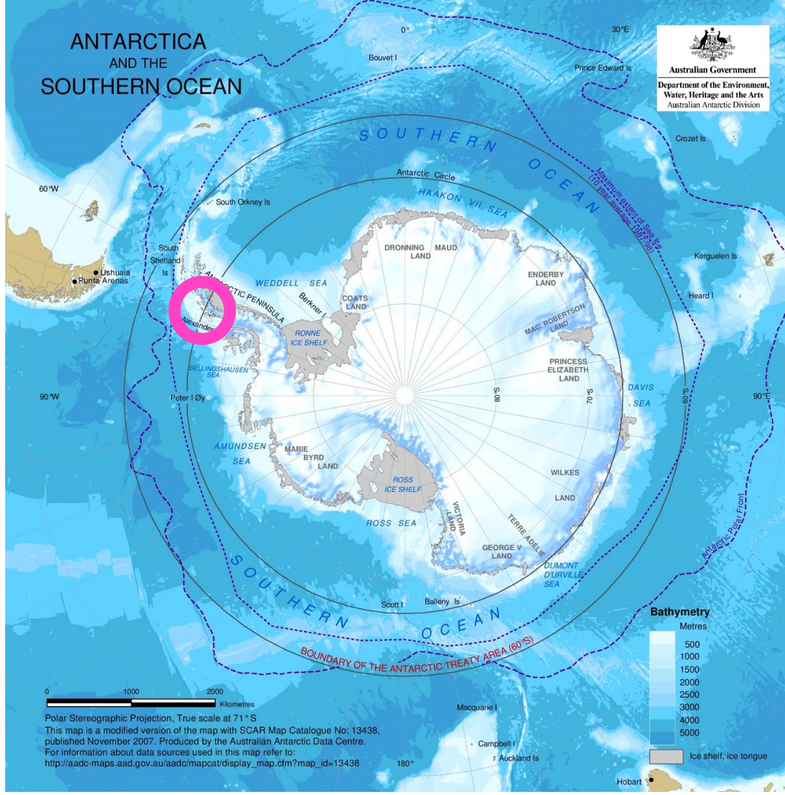
- The **12-hour tide maximises around 60S** (e.g. Teitelbaum et al., 1989; Younger et al., 2002; Du and Ward, 2010).

- We use **12-hour tidal amplitudes** from **meteor-radar** horizontal winds from **Rothera**, (68°S, 68° W) (pink circle) at heights of **80 km to 100 km** over the time period **2005 to 2020.**



How?

- We use **linear regression analysis to investigate the interannual variability** of the 12-hour tide
- Model to determine A'_{12}**: the monthly 12-hour tidal amplitude minus the seasonal cycle**
- We have **included time** in this linear regression to **investigate any linear trends in the data**



$$A'_{12} = \beta_0 + (\beta_1 F10.7) + (\beta_2 ENSO) + (\beta_3 QBO10) + (\beta_4 QBO30) + (\beta_5 SAM) + (\beta_6 Time)$$

- Due to time, we will consider only solar and ENSO, but if you would like to know more, see the link to the preprint on the last slide.

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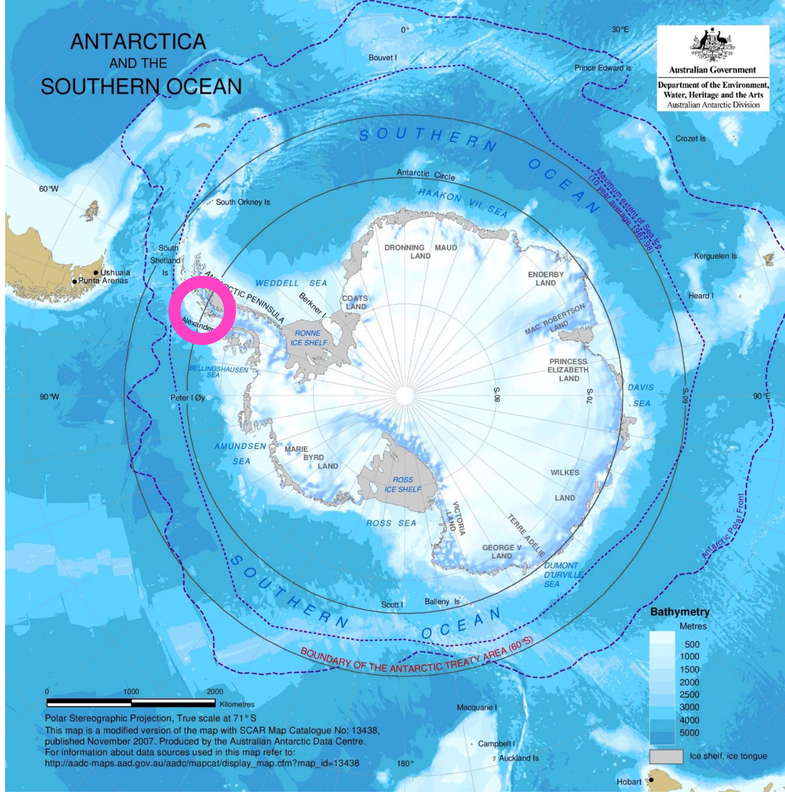

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Results - F10.7 Solar Flux

$\alpha = 57.6\ SFU$

- Tides can be **excited by the solar heating of ozone and water vapour** in the lower atmosphere
- So **changes in solar flux may cause variability** in the 12-hour tidal amplitudes
- We see **large regions of significance in summer** (December to February) with contribution of -4 ms^{-1} per 57.6 SFU

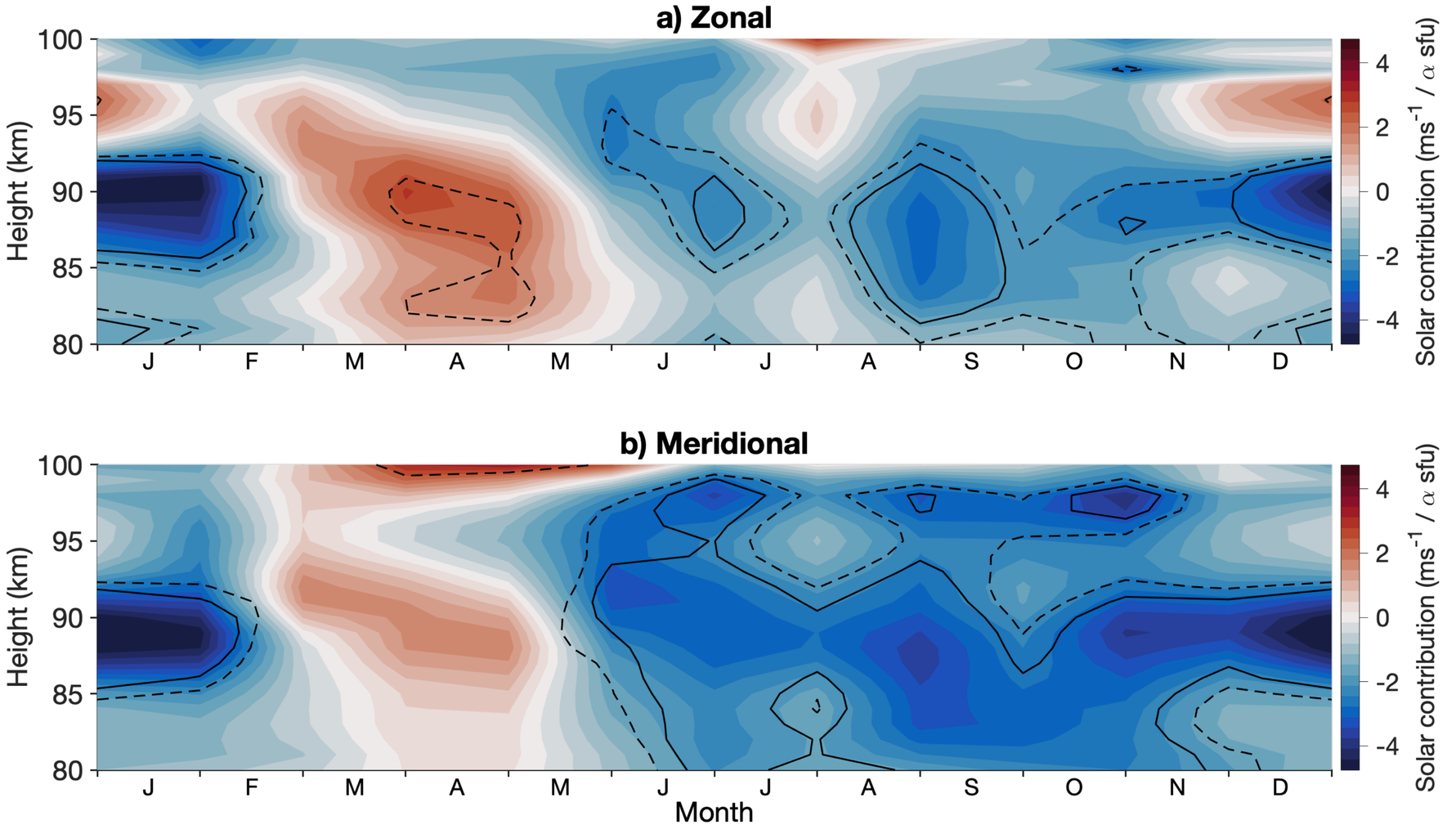

Figure 2: 12-hour tide F10.7 solar flux correlation to tidal amplitudes over 80 to 100km, for 2005 to 2020

Results - ENSO

$$\alpha = 2.67\ K$$

- **ENSO causes large-scale changes in tropospheric convection** (K. E. Trenberth, 2002; Lieberman et al., 2007).
- These **changes modify the tidal forcing in the troposphere**, resulting in significant 24-hour tidal variability in the MLT.
- We find that the **12-hour tide shows limited correlation** with ENSO

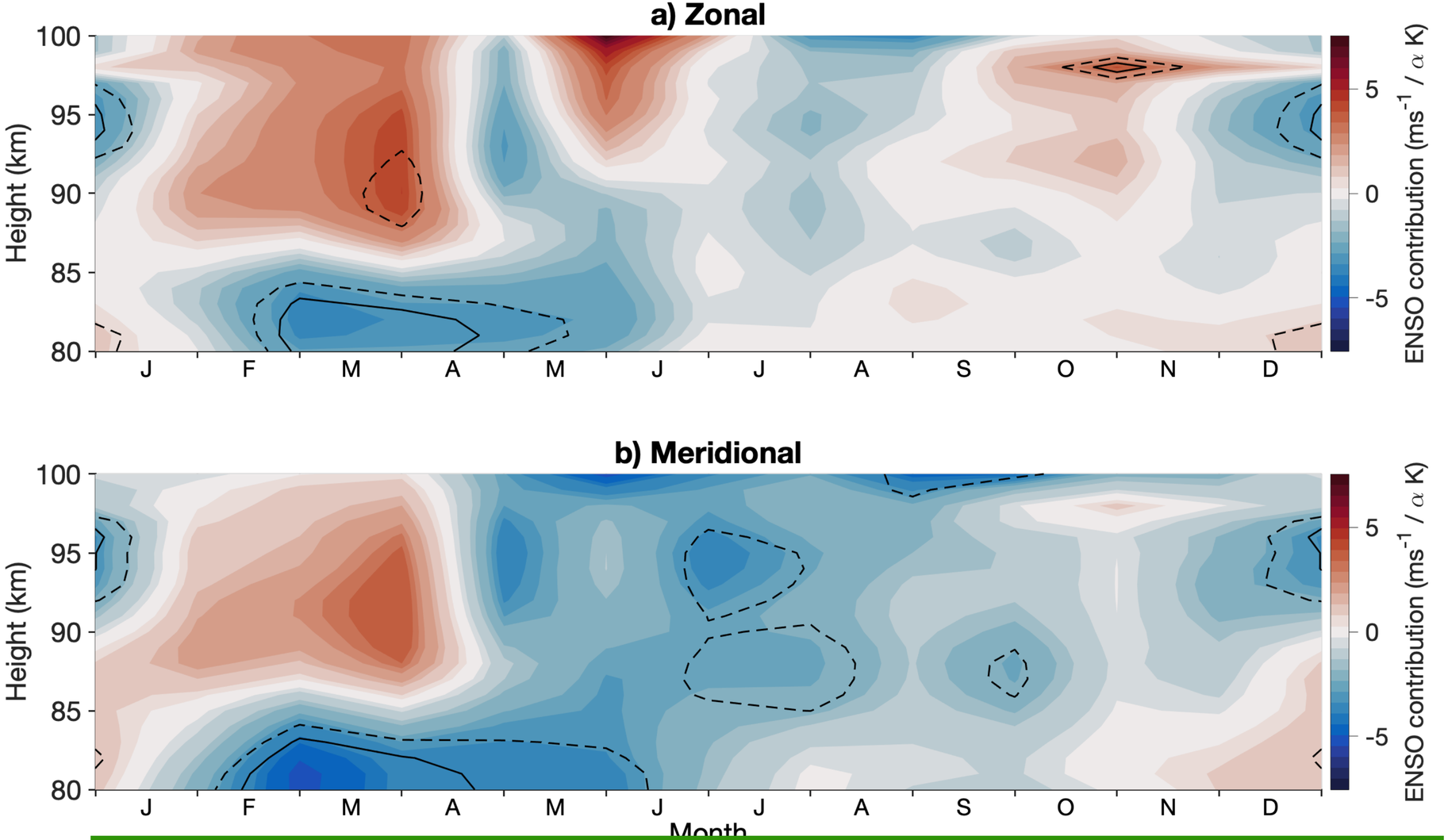

Figure 2: 12-hour tide ENSO correlation to tidal amplitudes over 80 to 100km, for 2005 to 2020

Summary

- We found there is **considerable interannual variability in the 12-hour tidal amplitudes** of the Antarctic MLT

- **Solar flux shows significant correlation with the 12-hour tide** with the largest contribution of -4 ms^{-1} per α SFU (α = 56.7 SFU).

- **ENSO does not show a considerable significant correlation**

- For more, including QBO10, QBO30, SAM and linear trends, please see the preprint - https://tinyurl.com/RotheraTideLR

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