Coupled changes in Antarctic sea ice and cyclones on the daily time scale

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Many studies have explored to association Antarctic sea ice and large-scale atmospheric circulation features (e.g., Pezza et al.), but most of these focus on scales longer than the synoptic time scale. Because of inherent nonlinearities there is an argument to be made for examining those links on daily timescales. Here we identify cyclones with the Melbourne University algorithm (see Grieger et al. (2018)) and apply it to the ERA-I reanalysis (Dee et al., 2011). Sea ice data are taken from the NSIDC NASA Team passive microwave data. The mean seasonal sea ice edge from these data are shown in Fig. 1.

We split the Southern Ocean (south of 55°S) into nine 40°-wide sectors (indicated in Fig. 1). For each sector we calculate the ice extent (SIE). To investigate its day-to-day variability we define ΔE as the daily change in anomalous SIE (that is, with respect to the mean for that calendar day), namely

$$\Delta E_i = \delta SIE_{i+1} - \delta SIE_i$$

where i denotes the day number and δ refers to anomalies. (Defining ΔE in this way eliminates the seasonal cycle and background conditions from the consideration of daily changes in SIE.) An analogous metric, ΔA, was defined for changes in ice *area*. ΔE and ΔA were calculated for every day in JJA between 1979 and 2016.

As a measure of winter subantarctic cyclone activity we identified all cyclones that occurred on each day in each sector. We then summed their 'depths' (represented as SD), and achieved a metric which represents the net vigour or influence of all cyclones on that day. We then found all zero-cyclone days and split SD into quartiles (from the least to most intense). Fig. 2 shows a clear upwards trend in ΔE and ΔA as summed cyclone depth increases in almost every sector. This means that, overall, more cyclone activity corresponds to increases in SIE and SIA on daily timescales. Further details of this research are presented in Thorn et al. (2019).

References

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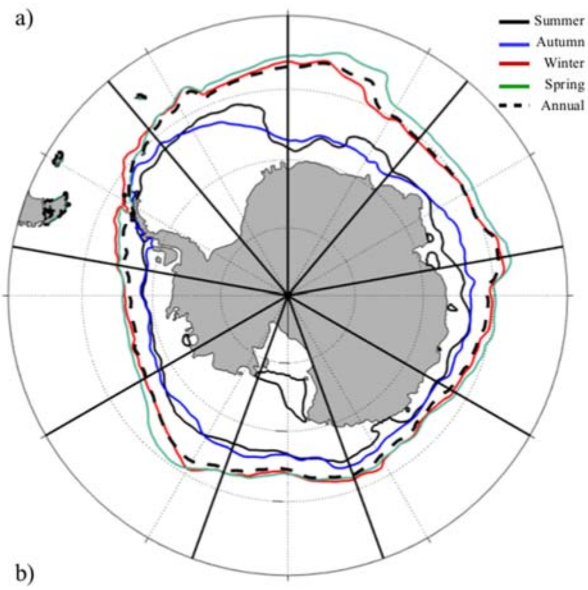

Fig. 1: Climatological sea ice edge for the seasons of summer (DJF), autumn (MAM), winter (JJA) and spring (SON) for 1979-2016. (Ice extents are from NSIDC NASA Team passive microwave data. These data were unavailable for December 1987-January 1988, so the DJF 1978-88 entry was computed by linearly interpolating anomalies from the adjacent months as in Simmonds (2015).)

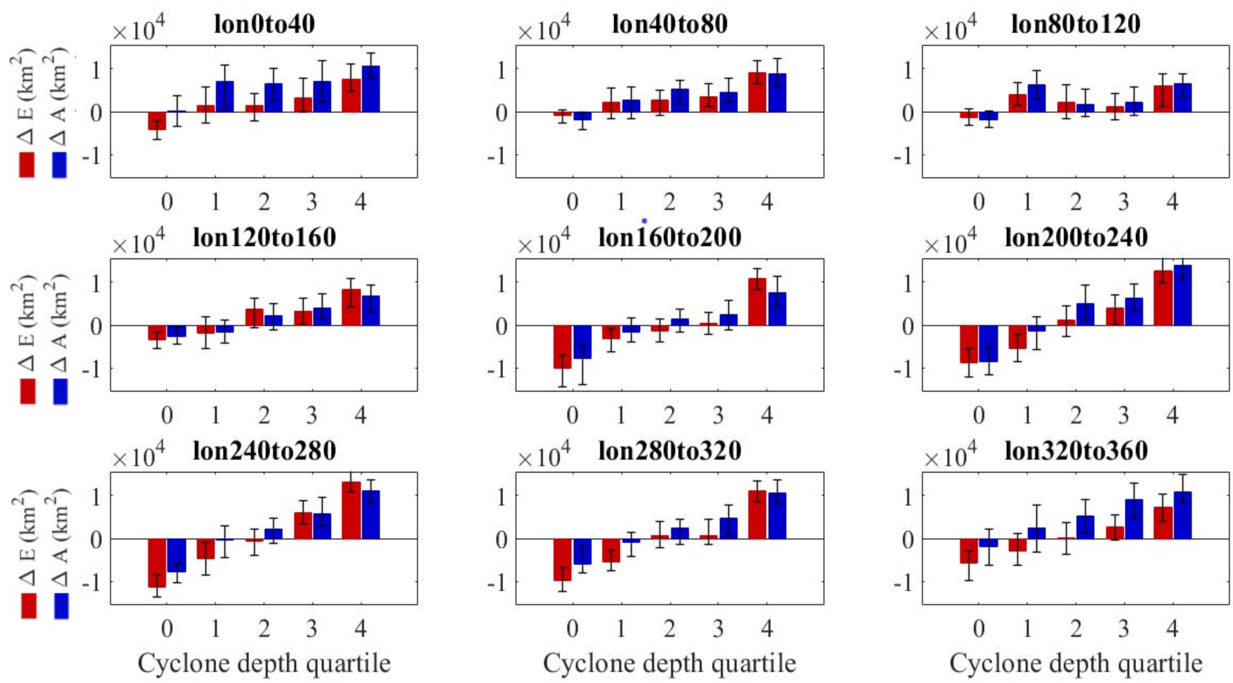

Fig. 2: Medians of ΔE (red) and ΔA (blue) in km^2 for each SD 'quartile'. Note that 'quartile zero' represents days with no cyclones. Whiskers represent the bootstrapped uncertainties (5-95th percentile)