Sectorial variations in the Antarctic circumpolar trough and inferences for the Ekman transport of sea ice

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Since satellite records commenced in 1979 the total Antarctic sea ice extent has exhibited variability and trends (and reached a new annual-mean low record in 2017). We are exploring the extent to which the variability can be related to the large-scale SH atmospheric drivers and, in particular, the Semiannual Oscillation (SAO). This mode arises because the thermal inertia of the Southern Ocean and of the Antarctic continent are very different, and hence the cycle of atmospheric temperature in the midlatitudes differs from that at high latitudes. A consequence of this is that the mid- and high-latitude temperature difference exhibits a strong temporal wavenumber 2 over the year (the SAO). Hence there is strong SAO signal in baroclinicity and in the strength and location of the Circumpolar Trough (CPT) (van Loon 1967, Simmonds and Jones 1998, Walland and Simmonds 1999, Simmonds 2003, Simmonds and King 2004).

Fig. 1 shows the mean (1979-2017) annual cycle of the latitudes of the zonal-average sea ice edge and the CPT (from ERA-Interim). For summer and autumn the ice edge is poleward of the CPT, and hence the marginal ice zone (MIZ) is overlaid by easterlies. As a consequence, the Ekman ice transport is to the south, a factor which associated with sea ice extent (SIE) reduction. The opposite holds during winter and spring. Hence SIE variations are strongly influenced by the relative positioning of the CPT and MIZ (Watkins and Simmonds, 1998).

Fig. 2 displays plots analogous to that in Fig. 1, but for the averaged longitude sectors of 30-60ºE, 120-150ºE, 210-240ºE, and 300-330ºE. In contrast to the zonally-averaged case note that over 120-150ºE the ice is to the **south** of the trough in almost all months. The **opposite** is true for the 210-240ºE sector, meaning that the meridional Ekman forcing is in opposite directions in these two sectors throughout the year. Also note that the interannual range of sea ice implies that the direction of Ekman ice forcing in the MIZ for a given calendar month depends on the ice amount present.

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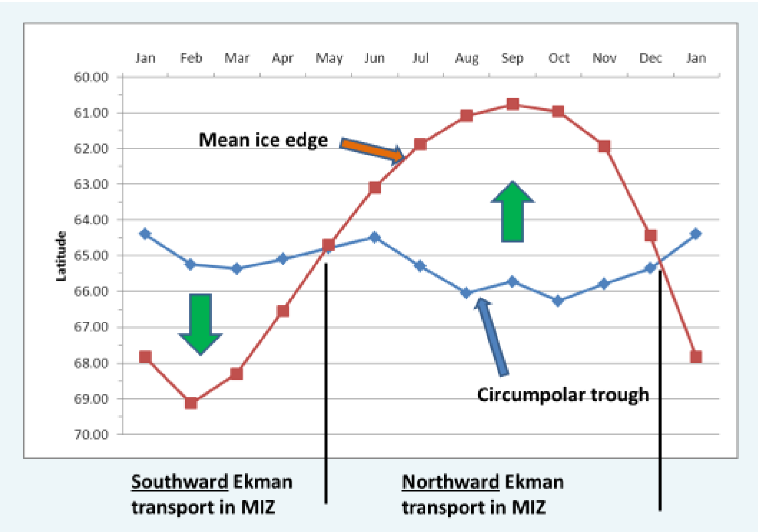
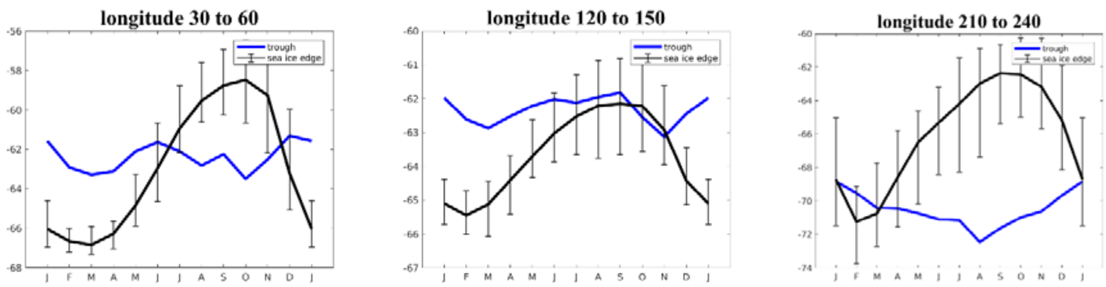


Fig. 1: Mean annual cycle of the latitudes of the zonal-average sea ice edge and the CPT.



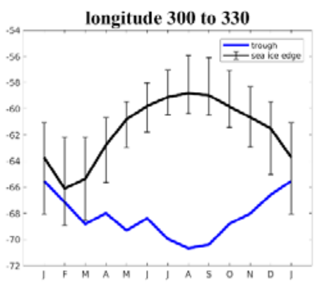


Fig. 2: As for Fig. 1, but for four Antarctic sectors. (Also indicated is the maximum and minimum ice edge over the record for each calendar month.)