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Sea ice trends and cyclone activity in the Southern Ocean

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Significant trends in the extent of Southern Hemisphere sea ice have been noted over the course of the satellite record, with highly variable trends between different seasons and regions. In this presentation, we describe efforts to assess the impact of cyclones on these trends.

Employing a maximum cross-correlation method, we derive Southern Ocean ice-motion vectors from daily gridded SSMI 85.5 GHz brightness temperatures. We then derive a sea ice budget from the NASA-Team 25 km square daily sea ice concentrations. The budget quantifies the total daily change in sea ice area, and includes terms representing the effects of ice advection and divergence. A residual term represents the processes of rafting, ridging, freezing and thawing.

We employ a cyclone tracking algorithm developed at the University of Canterbury to determine the timing, location, size and strength of Southern Hemisphere cyclones from mean sea-level pressure fields of the ERA-Interim reanalysis. We then form composites of the of sea ice budget below the location of cyclones. Unsurprisingly, we find that clockwise atmospheric flow around Southern Hemisphere cyclones exerts a strong influence on the movement of sea ice, an effect which is visible in the advection and divergence terms.

Further, we assess the climatological importance of cyclones by comparing seasons of sea ice advance for periods with varying numbers of cyclones. This analysis is performed independently for each sea ice concentration pixel, thus affording us insight into the geographical importance of storm systems.

We find that Southern Hemisphere sea ice extent is highly sensitive to the presence of cyclones in the periphery of the pack in the advance season. Notably, the sensitivity is particularly high in the northern Ross Sea, an area with a marked positive trend in sea ice extent. We discuss whether trends in cyclone activity in the Southern Ocean may have contributed to sea ice extent trends in this region.