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An integrated view of Southern Ocean cyclones from WindSat

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In this study, we use the WindSat satellite dataset to form an integrated view of the characteristics of extra-tropical cyclones over the Southern Ocean. WindSat polarimetric microwave radiometer measurements of brightness temperature at a variety of frequencies and polarisations can be used to derive sea-surface temperature, near-surface horizontal wind velocities, total column water vapour, cloud liquid water content and rain rate over the ocean surface and are not presently assimilated into reanalyses. Thus, this dataset provides a powerful way to examine the strengths of reanalyses' representations of cyclones.

To examine cyclones over the Southern Ocean statistically, we transform the satellite data into a cyclone centred coordinate system by forming composites of data based on cyclone positions ascertained from the ERA-Interim reanalysis surface pressure field; composites are derived using all cyclone centres between 40 and 60°S for the period 2007 to 2012. The composites are shown to match well with composites formed from other satellite datasets, namely AMSR-E and NVAP-M, and confirm the quality of the WindSat dataset. We then compare the WindSat composites with those derived from the ERA-Interim output to examine the similarities and differences between these composites. Our results suggest that the mean cyclone composite horizontal wind field observed by WindSat and ERA-Interim matches rather well, providing an independent validation of the ERA-Interim output. However, inspection shows that the two datasets' velocity distributions are quite different in some quadrants of the cyclone composite, suggesting that a simple analysis of mean patterns around the cyclone can hide relevant detail. Comparisons between the two composites for the total column water vapour show larger differences, with the largest differences (roughly 10%) being observed near the cold frontal region. The correspondence becomes still poorer when the cloud liquid water content and rain rate fields are intercompared, with relative differences being as large as 30%. This provides an independent analysis suggesting that the cloud field related to cyclones in the reanalysis contain significant flaws over the Southern Ocean, as might be expected from previous studies. Examination of the differences between the ERA-Interim and WindSat composites are also shown to increase as the cyclone evolves suggesting errors accumulate as the system develops.