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Wind shear and the atmospheric boundary layer over the Southern Ocean

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The Southern Ocean is a remote area, with the overlying atmosphere being unique due to high winds, waves and sea spray. The region has been relatively poorly studied by the meteorology community, even though is a growing body of evidence that suggests the clouds over the Southern Ocean are poorly represented in climate models. The focus of this study is on the structure and dynamics of the lower atmosphere over the Southern Ocean.

High resolution sounding data from Macquarie Island were analysed to determine the structure of the boundary layer, and the statistics were compared to the Year of Tropical Convection (YOTC) reanalysis data. The mean and variance of a number of thermodynamic variables was computed and YOTC reproduces the soundings well, but significantly underestimates wind shear over all levels. Different boundary layer types were identified in the soundings, including a decoupled boundary layer and a 'buffer layer'. The occurrence of these boundary layer types was quantified for the two data sets. Interestingly, Ekman Spirals are commonly observed in the atmospheric soundings, indicating the boundary layer is principally driven by wind shear.

Statistics for cloud vertical structure and wind shear at cloud interfaces were computed. The peak in the frequency of occurrence of cloud is 912.5 hPa for the two data sets, and cloud commonly resides outside the boundary layer in the buffer layer. Strong wind shear was found to occur with greater frequency over cloud base, rather than top. This was consistent between the data sets, however, YOTC underestimates the magnitude of shear. These results suggest the boundary layer and the clouds over the Southern Ocean are quite unique and important features are poorly modelled.

WRF simulations of ACE 1 Lagrangian experiments are being undertaken to study the evolution of the boundary layer and the relationship between wind shear and clouds.