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# Understanding the Structure of Atmospheric Boundary Layer in Response to the Synoptic Forcing over the Southern Ocean

Francisco Lang (1), Steven Siems (1), Yi Huang (1), Michael Manton (1), and Danijel Belusic (2)
(1) School of Earth, Atmosphere and Environment, Monash University, Melbourne, Victoria, Australia (francisco.lang@monash.edu), (2) Swedish Meteorological and Hydrological Institute, Nörrkoping, Sweden

Boundary layer clouds over the oceans are one of the most important contributors to the global radiation budget due to their large shortwave radiative effects. In-situ observations of the atmospheric boundary layer (ABL) over the Southern Ocean (SO) suggest that a complex, multi-level structure is commonly present beneath the free troposphere (e.g. Russell et al., 1998), which presents a challenge to the coarse-resolution climate models and reanalysis data sets. Recent studies (e.g. Bodas-Salcedo et al., 2012; Williams et al., 2013) suggest that the poor representation of ABL and their clouds may be a major contributor to the large shortwave radiative bias in the cold sector of extra-tropical cyclones over the SO. Most studies have used satellite observations to characterize the influence of synoptic meteorology in the ABL (e.g. Huang et al. 2014, Naud et al. 2014). In this research, 16-year high resolution upper air soundings from Macquarie Island (54.62°S, 158.85°E) are used to explore the structure of the ABL over the SO in relation to the synoptic meteorology. Cyclones (Bauer and Del Genio, 2006) and fronts (Berry et al. 2011) identified with the ECMWF ERA-Interim data set are employed for a compositing analysis of ABL height and inversion strength, with a specific focus on the post-cold-frontal environment. Furthermore, thermodynamic profiles from the ERA-Interim reanalysis are compared against Macquarie Island soundings. Cyclone composites of observations indicate that the ABL is higher near/within the fronts and lower in the non-frontal conditions, with the highest heights present in the cold sector, being on average 550 meters higher than the warm sector. Evaluation of ERA-Interim profiles shows that the main temperature inversion heights under the influence of cold front passages are underestimated by the reanalysis data set. As direct consequence, significant differences are found in the moisture profiles within the ABL, under both pre- and post-cold-front conditions. At approximately between 500 and 2000 m, the observed relative humidity is between 8 to 16% higher than ERA-Interim. These results suggest that the ABL in the reanalysis data set is too shallow compared to the observations.