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Inferring the stable boundary layer depth at the South Pole using short tower data

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A series of studies on the Antarctic high plateau over the last ten years have revealed a highly chemically active boundary layer where the depth of the boundary layer is a critical factor in explaining and modeling the chemical observations. Sodars, operating in the monostatic mode, have proven quite useful for detecting the depth of this stable boundary layer (SBL) at the South Pole. Due to the slowly evolving nature of these SBLs, automatic depth detection methods using time averaged profiles have proven quite useful (Neff et al., 2008, Atmos. Env.) and show a reasonable level of skill when compared with simple scaling laws (using static stability and surface stress). For chemical modeling exercises, however, it would be useful to estimate the boundary layer depth from simple near surface measurements of wind speed, direction, temperature, and the change in temperature over a short tower. Such data in combination with sodar measurements are available for most of 1993 and then from late November through December 2003. Supporting data during December 2003 included tethered balloon profiles and well as near-surface turbulence measurements. Sodar data in 1993 were obtained with a Doppler sodar so the boundary layer depth measurements were fairly coarse because of the longer transmitted pulse: in this case a correction was applied because of the inherent overestimate of boundary layer depth due to the long acoustic pulse. In 2003, a high-resolution minisodar was used in a simple monostatic mode. In this initial study, a multiple linear regression approach was applied to the 1993 data to develop best fit coefficients. These were then applied to the data from 2003. The reverse procedure was used going from the best fit 2003 parameters to predicting the 1993 depths. These results were then applied to data obtained during the spring and early summer months of 2006 when sodar data were not available but boundary layer depth estimates were needed to perform chemical box model calculations. The results show quite good agreement for shallow boundary layers whereas deeper boundary layers are under-predicted, suggesting more complex meteorological factors at work than those reflected in surface measurements.