Surface layer NOn-Doppler Acoustic Radar

AN ACOUSTIC RADAR TO MEASURE ATMOSPHERIC TURBULENCE ON THE ANTARCTIC PLATEAU

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ABSTRACT

Given that state-of-the-art telescopes are now costing hundreds of millions of dollars, it is crucial that they are located at the best possible site to optimise observations. UNSW’s Astrophysics group is at the forefront of Antarctic astronomy. Since 2002 they have been site testing along side French astronomers at the Antarctic French & Italian base located at Dome C. Dome C is at a height of 3200m on the Antarctic plateau, and could potentially produce astronomical images that rival the Hubble Space Telescope at 10% of the cost. As the height and intensity of atmospheric turbulence can seriously degrade astronomical images, it is of particular concern when selecting observing sites. At Dome C, the atmospheric turbulence close to the earth’s surface has proven difficult to accurately measure. It is the purpose of this thesis to develop a new site-testing instrument called SNODAR (Surface layer NOn-Doppler Acoustic Radar) to measure the height and intensity of the atmospheric boundary layer, which has a large influence on the quality of an observing site.

The atmospheric boundary layer is the very turbulent portion of the atmosphere closest to the earth’s surface. At Dome C the atmospheric boundary layer can range anywhere from ~30m to above 200m. SNODAR works by sending an intense acoustic pulse of 122db-SPL into the atmosphere and listening for backscatter off inhomogeneities in temperature and wind speed, as shown to the left. Although acoustic radars are commonly used to probe the atmospheric boundary layer, none of the existing instruments have the spatial resolution or range limits required for measuring the atmospheric boundary layer at Dome C (picture below).

A fast-style plot of data collected in Sydney is shown above, left. A change in the atmosphere’s structure can be observed between 75m and 125m. Data from 18:00, 21:35 and 23:05 (bottom, left) better illustrates the change in the atmosphere’s structure. The gradient of the detected signal is consistent with the theoretical atmospheric attenuation of -45dB/200m and a constant $C_{n}^{2}$. A time series plot of a 6ms pulse is shown bottom right, this plot illustrates SNODAR’s spatial resolving power at low-altitudes. These initial tests indicate that SNODAR meets all design requirements, the true testing will occur when SNODAR is deployed to Antarctica in the 2007/2008 summer.