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Interferometric studies of the lower and upper atmosphere and near space environment

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VHF Radar techniques for wind profiling the troposphere and lower stratosphere are well established [3], as are meteor detection techniques for measurement of the neutral wind in the mesosphere [1]. More recently it has been shown VHF wind profiling radars are also capable of detecting satellites [2] and thus present an opportunity to use existing systems for space domain awareness.

Buckland Park (BP) is a field station located approximately 40 km North of the city of Adelaide, South Australia. BP houses a 55 MHz Stratospheric Tropospheric (ST) radar, consisting of 144 Yagi antennas arranged on a 12 x 12 square grid. The BPST uses phase delays to steer its 6-degree beam vertically and 15 degrees off vertical in the cardinal directions, and utilizes the Doppler Beam Steering technique to estimate horizontal and vertical winds in the region between 500-m and 20 km [3]. An adjacent meteor transmit antenna, and 5-antenna receive array configured in a Jones cross arrangement [4] share the same hardware and can estimate neutral horizontal winds from meteor detections in the mesosphere and lower thermosphere (~70 to 110 km). The shared hardware operates at 48-kW peak power.

The BPST/meteor radar has recently been modified to explore additional capabilities. The antenna field has been reconfigured into a central 6 x 6 transmit/receive array, retaining the beam steering capabilities of the full array. The remaining antennas are arranged in 12 3 x 3 subgroups. Decreasing the central array aperture to 36 antennas broadens the beam, permitting the illumination of a larger region of sky. A 15-channel receiver has been added, allowing all 5 of the meteor channels, plus 10 of the 13 available ST channels to be connected at any given time. A 6-channel remote receiving site which is GPS time and frequency locked to the main transmit site has been established 100 km from BP for bi-static meteor work, replacing an earlier site located 55 km from BP [5]

The interferometer plus 15-channel receiver permit additional experiments not possible on the standard ST/meteor set up. Routine remote sensing of satellites becomes possible, including a variation on the well-established meteor technique to determine the angle of arrival of the RF return. Detection and analysis of meteors on the ST array itself is possible and using processing techniques designed to detect satellites facilitates the detection of meteor head echoes. The Full Correlation Analysis [6] and other multi-receiver based wind determination techniques can be directly compared to the Doppler technique on a single system. Further, several of these signal processing techniques can be combined for more efficient analysis. For example, horizontal winds from the upper Troposphere upwards can be retrieved within the same dwell as both satellite and meteor head detections.

This paper will discuss various experiments in space domain awareness, meteor tracking and comparison of wind retrieval techniques conducted on the BP interferometer, and the associated signal processing required to retrieve multiple parameters simultaneously. We will also discuss next steps in the development of the system to a multi-purpose instrument.

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