Estimation of mesospheric gravity wave momentum flux using Hybrid Doppler Interferometry

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A number of studies have recently been published concerning the use of specular scatter from all-sky interferometric meteor radars, for estimation of the gravity wave-driven vertical fluxes of horizontal momentum in the Mesosphere Lower Thermosphere/Ionosphere (MLT/I; ~ 80-100 km altitude). These studies have been motivated by the long-standing need for improved spatial coverage in the parameterization of gravity waves and their associated momentum transport in climate models of the whole atmosphere. They largely follow the work of *Hocking* [2005], which was the first study to suggest that these relatively low-cost radars can be used to make these measurements accurately.

Ever since they were first made in an atmospheric context by *Vincent and Reid* [1983] (using a large-aperture partial reflection MF radar) there have been concerns over the accuracy and precision of momentum flux measurements. The main concern is that for an unbiased estimate of the wind field covariance, the wind and wave field must be stationary over the volume spanned by the scatterer distribution used to acquire the radial velocity estimates required for momentum flux estimation. Furthermore, this scatterer distribution must be symmetric in azimuth, or else the covariance estimates will only converge to the true values for horizontal wave scales much larger than the scatterer distribution size. This is presents a problematic situation for all-sky meteor radars, which have an observation volume spanning several hundred kilometres in the MLT/I, and whose scatterer distributions may not necessarily be symmetric in azimuth. This momentum flux estimation technique clearly needs to be tested experimentally to add more weight to the results produced to date.

Multi-receiver, small-aperture MF radars which transmit a wide vertical beam and image the scattering brightness function using interferometry have long since been used successfully for estimating winds in the MLT/I, and may now also present an alternative low-cost way to estimate momentum fluxes in this region. In this study, we use multi-beam and vertical beam returns from the Buckland Park MF radar in an attempt to validate vertical beam momentum flux measurements. Hybrid Doppler Interferometry is applied on reception to account for the aspect sensitivity and brightness distribution of the scatterers, which, other than in a pioneering study by *Thorsen et al.* [1997], has not been performed in the context of MLT/I momentum flux estimation before. Results of tests of the validity of the techniques using a simple radar model incorporating gravity wave-induced wind perturbations will be shown first. These will be followed by a presentation of several multi-day Buckland Park MF radar momentum flux measurement campaign results, conducted between July 1997 and June 1998.