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Proof-of-Concept Study for Ground-based Millimetre-wave Observations of Horizontal Winds in the Polar Stratosphere and Mesosphere

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We demonstrate the feasibility of stratosphericmesospheric zonal and meridional wind observations using ground-based passive millimetrewave radiometry with lownoise receivers and high-resolution spectrometers. Detailed observations of winds in the Polar Regions are essential to understand chemical transport, atmospheric dynamics, waves and tides, and improve knowledge of polar and global climate systems. Measurements in the altitude range 2070 km would fill the 'radar gap' and address the current sparse wind observations for the upper stratosphere and mesosphere that limits our understanding of vertical wave propagation and its impact on planetaryscale circulation.

The Atmospheric Radiative Transfer Simulator (ARTS) and Qpack retrieval code is used to retrieve vertical wind profiles from simulations of lineofsight Doppler-shifted atmospheric emission lines above Halley station (75°37'S, 26°14'W), Antarctica. The ozone lines centred at 231.28 GHz, 249.79 GHz, and 249.96 GHz and the 230.54 GHz carbon monoxide line are used. The effect of clearsky winter/summer conditions, zenith angle, system temperature (T_{sys}), and spectrometer frequency resolution on the altitude coverage, measurement uncertainty, and height and time resolution of the retrieved wind profiles is presented. For radiometric observations of Dopplershifted ozone emission lines arising from horizontal winds in the range 1040 m s^{-1}, and with T_{sys} = 1400 K, we estimate that daily mean zonal and meridional wind profiles covering the altitude range 2575 km with typical measurement uncertainty of 5 m s^{-1} and vertical resolution of $\sim$12 km could be achieved.