MU radar observations of Kelvin-Helmholtz billows at 16-17 km altitude with range imaging mode

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The Kelvin-Helmholtz (KH) instability is likely to be ubiquitous in the Earth's atmosphere from the boundary layer up to the lower thermosphere, and is one of the most important sources of clear-air turbulence in the lower and middle atmospheres. It produces billows that act to mix and transport heat and materials vertically in the stably stratified atmosphere. Billows can also dissipate energy so that they strongly affect the larger-scale dynamics. However, only a few direct observations have been reported in the Upper Troposphere - Lower Stratosphere (UTLS). In the present talk, we show for the first time very detailed observations of these structures around 16 - 17 km altitude with the MU radar (34.85N, 136.10E) owing to an improved height resolution obtained with a range-imaging technique and the Capon processing.

The so called cat's eye structures of about 0.5-1 km in thickness are clearly delineated. A horizontal wavelength of about 5.3 km was estimated from the observed period of about 2 min. The extremely high resolution plots also revealed how KH instabilities affect their nearby stable environment.

The analysis of wind and temperature profiles measured by radiosondes launched from nearby meteorological stations indicated presence of a dominant inertia-gravity wave (IGW) with vertical and horizontal wavelengths of 3.5 and 600 km, respectively, and a period of about 12 hours superimposed to the background wind field in the upper part of the jet-stream. The IGW is considered to play a major role in the onset of the KH instabilities.