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Frequency dependence of gravity wave energy and momentum flux estimates in the lower atmosphere using Gadanki MST radar observations

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It is now well established that internal gravity waves play a significant role in the momentum and energy budgets of the lower and middle atmosphere. The interaction between vertical flux of horizontal momentum carried by these waves with the mean winds are of great importance. But the relative contribution of different frequencies of gravity waves to the total flux has not been investigated thoroughly and still remains controversial. In fact measurements of the frequency dependence of flux estimates are almost non-existent in the tropical middle atmosphere. This paper presents results of kinetic energy and momentum flux estimates obtained with Mesosphere Stratosphere Troposphere (MST) radar data of Gadanki, India. The radar was operated continuously on four different days (15-16 July, 2004; 18-19 April, 2005; 10-11 December, 2005; 12-13 February, 2006) continuously for 24 hours and more to measure horizontal and vertical winds with very short data gaps ranging between 1.5 to 3.5 minutes and height resolution of 150 m. Altitude profiles of kinetic energy and momentum flux were obtained using these data in two period bands (<2 h and 2 - 8 h). Energy and momentum flux estimates of inertia gravity wave (IGW) were obtained using wind data between 13 and 17 July, 2004 with a data gap of 3 h. Comparisons of simultaneous measurements of kinetic energy and momentum fluxes in different period bands reveal that the shortest period (<2 h) gravity waves transport maximum energy and momentum fluxes in the upper troposphere and lower stratosphere over this tropical station. Oscillations between 60 - 100 minutes are found to be stronger and carry most of the flux estimates whereas for periods <1 h, the flux is more isotropic and contribute little to the mean momentum fluxes. In the 2 - 8 h period band, prominent oscillations between 2.5 - 6 h are found to be isotropic in nature leading to lesser mean flux estimates in the stratosphere. Simultaneous data to study IGW was available only for July 2004 case which shows that the energy and momentum transported by this longest period gravity wave was minimum. Wavelet transforms showed significant variability and localization of the flux estimates with time. The dominant gravity wave momentum fluxes were found to arise from discrete and localized wave packets in frequency and time.