Characteristics of Atmospheric Gravity Waves in the Middle Atmosphere Observed with Radars and GPS Radio Occultation

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Interaction of various atmosphere waves with the background mean zonal winds is known to produce interesting wind variabilities in the middle atmosphere (10-100 km). In particular, atmospheric gravity waves (GWs) play an important role in transporting momentum flux from the lower atmosphere to the middle atmosphere. This paper is concerned with our recent studies on the behavior of GW; (i) a global distribution of vertical wave number spectrum using GPS radio occultation (GPS-RO) data, and (ii) zonal momentum flux at 90 km altitude observed with meteor radars in Indonesia.

GWs are often observed as superposition of many waves, so, GWs are studied well by a spectral analysis. In particular, the vertical wave number spectrum is explained by a saturated GW model [Smith et al., 1987], assuming wave dissipation by convective instability. We analyzed a global distribution of vertical wavenumber spectra using high resolution temperature profiles observed with the COSMIC GPS-RO mission. Spectral parameters correlated well with the background mean zonal winds and topography.

In the equatorial atmosphere, the wave-mean flow interaction generates the stratospheric QBO as well as semi-annual oscillations of zonal winds in the upper stratosphere (S-SAO) and mesosphere (M-SAO). Peculiar behavior of M-SAO was found such that its westward winds in Feb.-Apr. sometimes became enhanced every two or three years, which is called M-QBO or M-QB Enhancement (M-QBE). Medium frequency (MF) radar observations showed coincidence of M-QBE with high activities of the short period (20-120 min.) GWs, suggesting effects of GWs on M-QBE. In order

to understand the effects of GWs, we analyzed the vertical flux of zonal momentum (u'w') with a meteor radar [Hocking, 2005], and found a semi-annual cycle of u'w' at 86-94 km.