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Atmospheric Gravity Waves in a General Circulation Model

YOSHIO KAWATANI[1], MASAAKI TAKAHASHI[2], TATSUSHI TOKIOKA[1] and TOSHITAKA TSUDA[3]

[1]*FRCGC/JAMSTEC, Yokohama, Japan*
[2]*CCSR, Univ. Tokyo, Japan*
[3]*RISH, Univ. Kyoto, Japan*

A numerical experiment is conducted using CCSR/NIES/FRCGC Atmospheric General Circulation Model (AGCM) to investigate the distributions of gravity waves (GWs), their sources and 3-dimensional propagation. The activities of GWs are investigated in June, when the Indian summer monsoon is intense. The model simulates realistic distribution of precipitation, such as the separation between ITCZ and SPCZ, and the Baiu front (cf. Kawatani and Takahashi 2003). GWs components are extracted by short-vertical wavelength (<10 km) or short-periods (<30 hours).

The distribution and values of Potential Energy (PE) with short-vertical wavelength is similar to that observed in the GPS/MET experiments (cf. Tsuda et al. 2000) between 20km and 30km. Symmetric structures of PE with respect to the equator are clearly seen. Mixed Rossby-gravity waves are found from Africa to the Atlantic Ocean. Kelvin waves form PE from the eastern coast of African continent to 180°E. The strong sources of Kelvin waves are found around the western part of the Indian Ocean. Eastward moving n=0 inertia GWs are found from 80°E to 120°W. The radius of deformation 1 4 1 2 {R (gh) β } − = of these waves are estimated about ~920-950km, which corresponds to the meridional extent of symmetric PE with respect to the equator.

On the other hand, PE with short-period components distributed locally. Diurnal cycle of cumulus convection is strong over the Bay of Guinea, the Indochinese Peninsula and the South America both observations and model. GWs around these regions are generated over strong diurnal cycle of convection, and propagate both northward and southward with height. Short-period PE over these regions is due to these GWs (cf. Kawatani et al. 2003). GWs around the subtropical jet are also examined (cf. Kawatani et al. 2004).

Dominant GWs are characterized with periods of 10-24 hours relative to the ground, and with horizontal and vertical wavelengths of about 600-700 km and 2.2-4.4km, respectively. These GWs propagate both upward and downward from the jet, and westward relative to the mean zonal wind. Most of the upward propagating waves do not reach the upper stratosphere due to negative vertical wind shear of the zonal wind in the lower stratosphere. Dominant upward fluxes of easterly momentum due to the non-stationary GWs extend zonally along 30ºS above the jet. Remarkable EP-flux convergence due mostly to these GWs is seen around 100hPa at 30ºS, and explains up to 30% of the total EP-flux convergence.