Long-term statistical analysis of horizontal phase velocity distribution of mesosphere and ionosphere waves in airglow images at Rikubetsu and Shigaraki, Japan

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Atmospheric gravity waves (AGWs) transport momentum from the troposphere into the mesosphere and the thermosphere. The momentum deposit through wave breaking causes the large-scale pole-to-pole circulation. The vertical propagation of AGWs depends on the horizontal phase velocity. Thus, investigation of the horizontal phase-velocity characteristics of AGWs helps us to understand the dynamical variation of middle and upper atmosphere. On the other hand, the propagation direction of medium-scale traveling ionospheric disturbances (MSTIDs) seems to be different at different latitudes. However, the cause which determines their propagation direction has not been understood.

A new spectral analysis method has been developed to obtain power spectra in the horizontal phase velocity by using the 3-D FFT technique [Matsuda et al., JGR, 2014]. Takeo et al. (submitted to JGR, 2017) studied horizontal parameters of AGWs and MSTIDs over 16 years by using airglow images at wavelengths of 557.7 nm (emission altitude: 90-100 km) and 630.0-nm (200-300 km) obtained at Shigaraki, Japan (34.8N, 136.1E) which is located at the middle part of Japan.

In this study, we have applied the same spectral analysis technique to the 557.7-nm and 630.0-nm airglow images obtained at Rikubetsu, Japan (43.5N, 143.8E), which is at the northern edge of Japan, for 16 years from 1999 to 2014. We examined similarities and differences of horizontal wave spectra between Shigaraki and Rikubetsu over 16 years to see their dependence on locations.

The propagation direction of AGWs is northeastward in summer and southwestward in winter at both Shigaraki and Rikubetsu, but yearly variation of power spectral density is different between these two stations. In summer, the propagation direction of AGWs is northeastward irrespective of the phase velocity, probably due to wind filtering of these waves by the mesospheric jet. However, in winter, low phase-velocity waves (20-100 m/s) propagate to southwest, but high phase-velocity waves (100-150 m/s) propagate to southeast at both Shigaraki and Rikubetsu, suggesting reflection of westward high-velocity waves at both stations by the mesospheric jet. For MSTIDs, there is a negative correlation between yearly variation of powers spectral density and F10.7 flux at both sites. Propagation direction is southwestward in all season at both Shigaraki and Rikubetsu. The sub-peak at northeastward MSTIDs is larger in Rikubetsu than in Shigaraki. This may suggest latitudinal dependence of northeastward-moving MSTIDs, though further analysis will be needed for data at different stations.

Keywords: AGWs, MSTIDs, spectral analysis

