Long-term variation of horizontal phase velocity spectra of atmospheric gravity waves observed by an airglow imager at Shigaraki: Comparison between mesopause region and thermosphere

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Atmospheric gravity waves (AGW) generated in the lower atmosphere transport momentum into the upper atmosphere and release it when they break near the mesopause region. The released momentum drives global-scale pole-to-pole circulation in the upper atmosphere, causing global mass transport. The AGW propagation and its momentum transport depend on horizontal phase velocity of AGWs.

We have analyzed the horizontal phase velocity spectra of AGWs by using mesospheric 557.7-nm airglow images (altitudes of 90-100 km in the mesopause region) obtained at Shigaraki MU Observatory (34.8N, 136.1E) of Kyoto University over ~17 years from October 1, 1998 to July 26, 2015 and have compared the spectra with tropospheric re-analysis data. In this study, we also analyzed 630-nm airglow images (altitudes of 200-300 km in the lower thermosphere) for the same ~17 years period. We compare the wave spectra obtained at these two altitudes. In the mesopause region, seasonal variations of propagation direction of AGWs were clearly identified (spring: northeastward and southwestward, summer: northeastward, fall: northwestward, winter: southwestward). We could not find any clear correlation of the spectral variations with sunspot numbers. On the other hand in the thermosphere, major propagation direction is always southwestward with a minor northeastward propagating component. Clear negative correlation was observed between power spectrum density variations and sunspot numbers in the thermosphere.

Key words: mesospheric gravity waves, horizontal phase velocity spectrum, long-term analysis, airglow imager, tropospheric re-analysis data