Analysis of source and generation mechanism of atmospheric gravity waves and MSITDs observed in airglow images in Hawaii

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Atmospheric gravity waves (AGWs) and medium-scale traveling ionospheric disturbances (MSTIDs) are important wave phenomena in the upper atmosphere, since they can control global dynamics of the atmosphere and affect GNSS positioning. Matsuda et al. [JGR, 2014] proposed a method of deriving the horizontal phase velocity and propagation direction of the power spectral density of waves found in images using three-dimensional Fast Fourier transform. However, there has been few report to apply this method to airglow images obtained near the equator except for Perwitasari et al. (AnnGeo, 2018) in Indonesia. In this study, we applied the analysis method of Matsuda et al. [2014] to airglow images obtained at wavelengths of 557.7 nm and 630.0 nm during the three years from 2013 to 2016 at Haleakala (20.7°N, 203.7°E) in Hawaii. We clarified the statistical features of AGWs and MSTIDs over Hawaii, and compared them with features seen in Japan reported by Takeo et al. [JGR, 2017] and Tsuchiya et al. [JGR, 2018], where the latitude, longitude and orography are greatly different those of Hawaii.

The three-year averages of the phase velocity spectra of AGWs observed in airglow images at a wavelength of 557.7 nm show that there was no difference in the zonal propagation between summer and winter. In Japan, however, it is known that the propagation direction is eastward in summer and westward in winter. We reported this result in JpGU2019 and discussed this difference due to latitudinal variation of mesospheric jet wind which controls AGW propagation through wind filtering effect. In the presentation we will discuss the source of atmospheric gravity waves from the tropospheric upward flow and jet using reanalysis data in the troposphere. As a result, the upward flow in the troposphere was not strongly observed in the area where the wave source was expected. This is probably due to the averaging, so we will analyze each observation day.

The MSTIDs observed in airglow images at a wavelength of 630.0 nm show that the power spectral density (PSD) was strongest and the waves propagate mainly in the east-west direction in winter. We reported this result in SGEPSS2019 and discussed a mechanism for generating MSTIDs due to atmospheric gravity waves. We will discuss the source of atmospheric gravity waves related to this mechanism from the tropospheric upward flow and jet using reanalysis data. As a result, the upward flow in the troposphere was not strongly observed in the east-west direction where the wave source is expected. This is probably due to the averaging, so we will analyze each observation day. Regarding the east-west propagation of MSTIDs in winter, we made detailed event study using zonal keogram and wave number spectrum, and compared with MSTIDs observed in Japan.

Keywords: Airglow, MSTIDs, Hawaii, AGWs

