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大気光イメージング観測を用いた中間圏風速の測定

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Measuring Mesospheric Winds Using Airglow Imaging of Atmospheric Gravity Waves

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In this study, we estimated wind speeds near the mesopause by analyzing atmospheric gravity waves observed with airglow imaging. Based on the linear dispersion relation for gravity waves, the vertical wavelength can be derived from the intrinsic horizontal phase velocity (the horizontal phase speed minus the orthogonal projection of the background wind velocity to the phase velocity vector) together with the horizontal wavelength. Airglow imaging enables the direct determination of both the horizontal phase velocity and horizontal wavelength from the images. Assuming that the same wave structure is present in airglow emissions at different altitudes, the ratio of horizontal to vertical wavelength can be obtained from the phase difference between wavefronts observed in two airglow images and the altitude separation of the airglow layers. This approach makes it possible to determine the background wind solely from airglow observations.

On October 1, 2008, clear gravity wave structures were detected with the Optical Mesosphere Thermosphere Imager (OMTI) in OI and OH airglow at Shigaraki. This night coincided with the ANDON campaign, an intensive observation of the mesosphere using airglow imaging, radar, and lidar. The ANDON camera located at Taga had an overlapping field of view with OMTI, which enabled us to calculate airglow layer heights, essential for wind estimation, using triangulation. The airglow heights were somewhat lower than typical values, estimated at 83 km for OI and 74 km for OH. The gravity waves had a horizontal wavelength of 24.5 km and a horizontal phase velocity of 17.4 m/s, propagating toward the north-northwest (121.3° counterclockwise from east). These estimates yielded a background wind of 11.1 m/s in the direction of wave propagation. Simultaneous wind measurements at the OI airglow height with a Fabry-Perot interferometer (FPI) at Shigaraki indicated a wind speed of 13.1 m/s, consistent with our estimation, thereby validating both the results and the estimation algorithm.