ノルウェー・トロムソの OH 大気光画像から導出した中間圏大気重力波の伝搬方向に関する研究

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Propagation direction of the mesospheric gravity waves derived from OH airglow images at Tromsø, Norway

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An important aspect of the wind dynamics in the mesosphere is to know characteristics of the atmospheric gravity waves, such as propagation direction, horizontal wavelength, phase speed, and wave amplitude, because it is widely known that the atmospheric gravity waves transport momentum from the lower atmosphere to the upper atmosphere. Statistical analysis of the OH airglow images measured with all-sky cooled-CCD imagers suggest seasonal and geographical dependencies, in particular, of the wave propagation direction. For example, northward or northeastward propagations are predominant in summer at Rikubetsu (43.5ºN, 143.8ºE) and Shigaraki (34.9ºN, 136.1ºE), Japan; but westward and southwestward propagation are predominant in winter at Rikubetsu and Shigaraki, respectively. Another statistical result at equatorial region suggests that eastward and westward directions are predominant in winter and summer, respectively, at Kototabang (0.2ºS, 100.3ºE), although the propagation direction can be found in all directions. These seasonal, geographical dependencies are controlled by wind filtering, ducting processes, and relative location to the wave source in the lower atmosphere. However, there are not so many measurements of the mesospheric gravity wave in the northern Europe, and characteristics of the propagation direction has not been fully understood yet in this region.

An all-sky imager was installed at the Tromsø EISCAT (European Incoherent Scatter) radar site in Norway (69.6ºN, 19.2ºE) in January 2009. The imager has six optical filters (557.7 nm, 630.0 nm, near-infrared OH band, 589.3 nm, 572.5 nm, and 732.0 nm), and this study focuses on the OH airglow images to study the mesospheric gravity waves in winter (from October to March). A typical emission layer of the OH band may be located around 85 km height. Statistical analysis has been made of data for 48 nights with clear sky and no auroral emissions, selecting gravity waves with horizontal wavelength of 20-100 km. The statistics suggest that propagation directions are predominantly north-to-northeastward, southeastward, and southwest-to-westward. Of particular interest in this statistical result is dependence of the propagation direction on the horizontal wavelength. Gravity waves propagating north-to-northeastward and southwest-to-westward are more clearly seen with decreasing the horizontal wavelength; by contrast, those of southeastward-propagating component becomes more noticeable with increasing the horizontal wavelength. Winds from a collocated MF radar below 85 km height show gaps of the direction in northeast and southwest, mainly flowing east-to-southeastward (for reference, winds from NCEP below ~50 km have smaller wind speeds than the MF-radar winds). This result suggests that the wind-filtering effect plays an important role to decide the propagation direction of the gravity waves with relatively shorter horizontal wavelengths. The horizontal phase speed of the gravity wave with relatively longer horizontal wavelengths tends to be larger than the MF radar winds. In this case gravity waves can reach the upper mesosphere even if the propagation direction is identical to the background-wind direction. This may be the case for the derived gravity waves with longer wavelengths.