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Climatology of mesoscale perturbations of OH and O_2 rotational temperature in Rikubetsu, Shigaraki and Sata

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The method of digital difference filters was applied to the analysis of OH and O_2 rotational temperature observations in years 2010-2018 at altitudes of 85-90 km by photometers installed in Rikubetsu (43.5N, 143.8E) Shigaraki (34.8N, 136.1E) and Sata (31.0N, 130.7E) in Japan. Seasonal variations in the monthly-average values of rotational temperature and variance of perturbations with periods of 0.7 – 11 hours, which may be associated with internal gravity waves in the mesopause region, have been studied. Seasonal variations in the relative standard deviation of rotational temperature near the mesopause have maxima in winter and summer, also minima in spring and autumn. The details of the changes in the rotational temperature of OH and O_2 may differ. This may be due to the different heights of the luminous layers.

Currently, much attention is being paid to the study of internal gravity waves (IGWs). Their sources are mainly located in the lower layers of the atmosphere and, propagating upwards, IGWs are able to transfer energy and momentum into the middle and upper atmosphere, thus influencing the thermodynamic regime and dynamics of the atmosphere. Measuring the intensity and rotational temperature of nightglows is one of the ways to monitor the thermodynamic regime and composition of the upper atmosphere.

In this work, the rotational temperature of hydroxyl and molecular oxygen at altitudes of 85-90 km is analyzed, which is obtained from measurements with photometers installed in Rikubetsu (43.5N, 143.8E) Shigaraki (34.8N, 136.1E) and Sata (31.0N, 130.7E) in Japan in 2010-2018. A detailed description of used instruments is given in [1].

A method for estimating the intensity of mesoscale disturbances near the mesopause was described in [2,3]. The initial data are taken from the registration of night glow characteristics at time t_i, which are averaged by the device over the accumulation time δt. Numerical filtering is used to estimate the monthly standard deviations δ_f of mesoscale variations by determining the differences between the recorded values spaced over time intervals Δt.

One of the reasons of mesoscale nightglow variations may be IGW propagating in the emission layers of the upper atmosphere. The polarization relations of the atmospheric IGW theory [4] allow us to obtain the following formulas for the relationship of the wave variations of the horizontal velocity amplitudes U and the potential wave energy E_p with mesoscale temperature standard deviation δT.

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