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The wave-induced fluctuations in intensity and rotational temperature of OH(6-2) and O_2 airglow emissions observed from ground-based spectrometer

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The OH(6-2) and O_2(0-1) bands nightglow emissions are observed using ground-based spectrometer at Xinglong, China (40°24'N, 117°35'E) from December 2011 to 2014. The airglow intensity and rotational temperature are derived from the airglow vibration-rotational spectra. The gravity waves, tides and planetary waves are extracted from the intensities and temperatures, and then Krassovsky's ratio η is calculated. As a complex quantity, the absolute value of η represents the relative intensity fluctuation to temperature's, and the phase contains responding time scales of the dynamic and photochemistry to the perturbations. From the ground-based observation, the wave periods can be accurately calculated, so the relations between η and wave periods are analyzed. The results indicate that for wave periods less than 12-hour, $|\eta|$ of O_2 is in the range of about ∼0.5 to ∼10.0 and increases with periods increasing, and the phase differences between the intensity and temperature fluctuations are almost negative for the 5∼12 hour waves, i.e., the temperature leads to intensity. $|\eta|$ of OH(6-2) is also in the range of about ∼0.3 to ∼10.0, but does not vary clearly with periods, and the phase is nearly less than 0 for the 5∼12 hour waves. This is in agreement with the previous observation, but the observed Krassovsky ratio in the tides period is not consistent with the theoretical model of the tide. For periods in the range of 2 to 20 days, $|\eta|$ of O_2 increases from ∼6 to ∼14 with period increasing, and that of OH(6-2) is in the range of ∼6 to ∼9 without obvious changing with the period. The mean phase is close to 0 for both O_2 and OH, but with high standard deviation which means there are large variations of η in the planetary wave periods. The observed η in the range of tides and planetary waves still cannot be explained using the available theoretical models. Then our observation provides a basis to the theoretical study in the dynamics-photochemistry coupling.