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Investigation of the FeO pseudo-continuum using astronomical facilities

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Airglow emission probes the dynamics and chemistry of the mesosphere lower thermosphere (MLT). Emission lines of OH, Na and O are frequently used for these investigations. Also airglow (pseudo) continuum emission can be used for that purpose. However, trying to investigate its contribution to the night-sky spectrum is more difficult since it is much fainter than the emission lines. FeO emission is a pseudo continuum feature in the wavelength range from 0.55 to 0.72 μm. Its emission occurs at an altitude of $\sim$90 km and therefore is between the OH ($\sim$87 km) and Na ($\sim$92 km) emission layers. FeO and Na are further linked by their common origin from meteors, and share with OH O_3 as their common reactant.

So far FeO has been studied with the Odin satellite and with ground-based astronomical facilities (ESI/Keck and Kitt Peak). The observed spectral data were compared to laboratory spectra and the diurnal behavior of FeO was studied in comparison to OH, Na and O(5577) with a sample size of nine nights.

For our investigation of the FeO emission we use data provided by the European Southern Observatory (ESO) operating four 8 m sized telescopes in the Chilean Atacama desert at an altitude of 2.635 m. The instrument best suited for our purpose is X-shooter (0.3-2.5 μm, $\lambda/\Delta\lambda$ = 3 000 to 18 000), an echelle spectrograph. Our X-shooter sample consists of 365 spectra taken between October 2009 to March 2013. Furthermore, we use a small sample of UVES spectra (0.3 -1 μm, $\lambda/\Delta\lambda$ = 20 000 to 100 000) to verify our results obtained from X-shooter spectra.

We studied the spectral variation of the FeO pseudo-continuum as well as its diurnal and seasonal variation. Both of the latter studies also consider OH and Na measurements. For the comparison between the observed and theoretical spectrum of Gattinger et al. (2011) we find an overall good agreement, however there are some significant deviations close to the main emission peak of the continuum. Studying the diurnal behavior, we find for three example nights in May and July a decrease in intensity in the first half of the night, and an increase during the second half. Before morning twilight these observations indicate a steep intensity decrease consistent with previous studies. On average the diurnal trend is the same as described above but a steep decrease at the end of the night does not seem to be a general feature of the FeO emission variability. For the seasonal variation we found a prominent semi-annual oscillation in the FeO emission. Its semi-annual amplitude is 37% compared to the annual mean. The annual and the semi-annual phase of the FeO variations are close to the ones derived for Na.