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Variability in the mesospheric sodium D2/D1 dayglow intensity ratio: First results

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Airglow emissions that are faint radiations originating from the planetary upper atmospheres are crucial tracers of the state of the atmospheres therein. Sodium airglows are generated by the neutral atomic Na layers in the terrestrial upper mesosphere/lower thermosphere (MLT) region. The Na airglow emissions and their intensity ratio ($R_D = I_{D1}/I_{D2}$) data are poised to play important role in the investigation of energetics, dynamics and chemistry of the mentioned atmospheric region.

There were several earlier works involving this intensity ratio R_D; and the accepted view was that this ratio was 2.0, as expected on the statistical grounds. In the recent past, Slanger et. al. [1] has shown that R_D is quite variable, lying between 1.2 to 2.0. However, all these studies have been in the night time. It can be noted that the ground based Na airglow measurements during the daytime are difficult and requires specialized techniques. The inherent difficulties have been overcome and regular systematic measurements of terrestrial Na daytime airglow have been made possible for the first time using a high resolution scanning grating spectrometer [2]. The present study involves measurements of both the daytime Na 589.6 (D_1) nm and 589.0 (D_2) line emissions using an advanced version of the spectrometer (resolution~ 0.03 Å) compared to that of Hossain et al. [2].

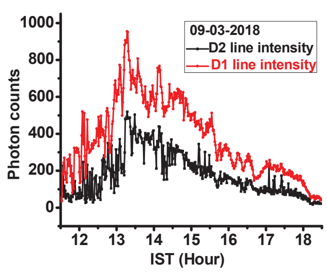

Figure 1(a). Variability of daytime Na D_1 and D_2 airglow emission intensities on march 9, 2018.

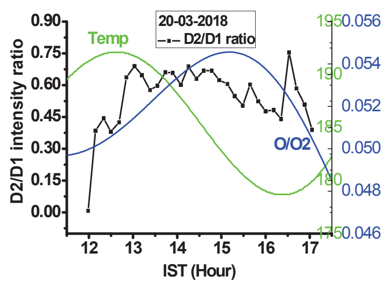

Figure 1(b). Variability of R_D with MSIS model derived temperature and [O]/[O2] ratio.

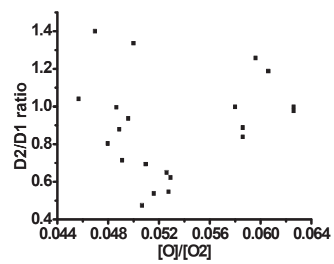

Figure 1(b). Scatter plot of R_D versus [O]/[O2] ratio.

Figure 1(a) shows the variability of the daytime Na D_1 and D_2 airglow emission intensities on march 9, 2018. As obvious, the measured emission intensities exhibit significant temporal variability within that day. Over 3 months of data considered in this work shows that the D_1 and D_2 emission intensities vary significantly from one day to another. As seen from the present data set, R_D ratio varies between 0.65 – 1.7, unlike 1.2 to 2.0 in night-time as reported in [1]. It seems that in addition to the modified Chapman chemical scheme, resonant scattering also plays important role in controlling the R_D ratio. Figure 1(b) shows the variability of R_D with the MSIS model derived temperature and [O]/[O2] ratio in the MLT region on march 20, 2018. As is seen from the current data set, R_D correlates better with [O]/[O2] than temperature. Figure 1(c) also corroborates this observation. Since R_D during daytime correlates better with [O]/[O2] than temperature; and R_D range is different from that in nighttime, it seems that the daytime variation in R_D arises from a combined effect of both the chemistry and the resonance florescence.

1. T. G, Slanger, P. C. Cosby, D. L. Huestis, A. Saiz-Lopez, B. J. Murray, D. A. O'Sullivan, J. M. C Plane, C. A. Prieto, F. J. Martin-Torres, and P. Jenniskens, "Variability of the mesospheric nightglow sodium D2/D1 ratio", *J. Geophys Res.* 110, 2005, D23302, 1-8, doi:10.1029/2005JD006078.

2. M. M. Hossain, T. K Pant, C. Vineeth, S. G. Sumod, R. Sridharan, "Daytime sodium airglowemission measurements over Trivandrum using a scanning monochromator: first results", *Ann Geophys.* 28, 2010, 2071–2077, doi:10.5194/angeo-28-2071-2010.