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Probing the Mars upper atmosphere through simultaneous NOMAD/UVIS observations of the NO ultraviolet and O_2 visible nightglow

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While extensive studies have been conducted on Mars' dayside airglow emissions using instruments of various missions (Mariner, Mars Express, MAVEN, TGO and EMM), only the ultraviolet and infrared emissions have been investigated on the nightside (MEx and MAVEN). The middle ultraviolet spectrum is dominated by the v′=0 δ and γ bands of nitric oxide excited by radiative association of nitrogen and oxygen atoms. Although this emission is present at all latitudes and local times, extensive mapping has shown that it is enhanced in winter at high latitudes in both hemispheres (Schneider et al., 2020). This seasonal brightening at high latitudes is the signature of the global transport of O and N atoms ascending from the sunlit summer polar regions that are carried downward by vertical winds and diffusion to the 40-60 km region of the dark winter hemisphere. The O_2 nightglow at 1.27 µm has already been monitored as well (Bertaux et al., 2012). However, nightglow emissions in the visible domain have begun only very recently with the NOMAD-UVIS instrument, which can, for the first time, simultaneously monitor the UV and visible domains in the Martian atmosphere. Gérard et al. (2023) have discovered the presence of the (0,5) to (0,11) bands of the O_2 Herzberg II system between 400 and 650 nm in the nightglow. We present here a comprehensive statistical analysis of this nightglow based on a dedicated NOMAD-UVIS campaign of 30 orbits acquired between May and October 2023 in the southern hemisphere during the winter season. Combining both the inertial and limb tracking modes allows for intensity retrieval, latitudinal variability analysis, and the generation of limb profiles.

The O_2 emission is expected to solely originate from the three-body recombination of O atoms O + O + M -> O_2* + M. The oxygen density can therefore directly be retrieved from the Herzberg II observations. Furthermore, simultaneous NO nightglow observations with NOMAD-UVIS combined with the retrieved oxygen density, allows to calculate the nitrogen density and its downward flux. As atomic oxygen serves as a precursor to both NO and O_2 nightglows, arising from O atom recombination with either oxygen or nitrogen, this dual investigation presents a remarkable opportunity to unravel their shared characteristics (stemming from oxygen density) and their distinguishing features (emanating from nitrogen), including variations in brightness and altitudes. It will provide valuable constraints for improving 3-D models that simulate global circulation and dynamic processes. In particular, it will help solving the current discrepancy between the predicted and modeled altitude distribution of the NO nightglow, a proxy of insufficiently vigorous downward transport of N atoms.

References:

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