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Study of the oxygen day glow in the Martian atmosphere with nadir data of PFS-MEX

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Abstract

The photo-dissociation of CO_2 in the Martian atmosphere produces free oxygen atoms which can produce molecular oxygen and ozone (O_3). Ozone, which is one of the minor constituent of the Martian atmosphere, is also dissociated by solar UV producing molecular oxygen in an excited state, together with a minor component of the O2(b) and O2(X) states. The O_2 ($a^1\Delta_g$) state may be de-excited by collisions or emitting radiation. Deactivation through collision with CO_2 dominates at altitude below 20 km where the CO_2 concentration is high. Above 20 km the rate constant for this reaction is small ($k<2\cdot10^{-20}$ cm^3 $molecule^{-1}$ s^{-1} [2]) and the reaction is negligible. Infact, above 20 km of altitude O_2 ($a^1\Delta_g$) decays emitting radiation at 1.27 μm (the so called Infrared Atmospheric System of O_2 day-glow) and at 1.58 μm. This last band should be about 45 times weaker than the band at 1.27 μm [8] and it is very difficult to observe.

In this work we study the nadir observations of oxygen glow at Mars with the Planetary Fourier Spectrometer on board the Mars Express ESA mission (PFS-MEX [5]). The goal of this study is to map this glow over the planet during three Martian years. Nadir data, spanning all over the planet, are used for a statistical study of the oxygen emission. We compute the oxygen emission at 1.27 μm for the dayside observations and we take into account the correction for air mass and for the ground reflection using the formula of [6]:

$$4\pi I = \frac{4\pi I_m}{\frac{1}{\cos\psi} + \frac{2\pi r_h^2 I_c}{I_0 \cos z}} \qquad (1)$$

where ψ and z are the emission and incidence angles respectively. I_0 = 22.5 [erg/cm^2 sec sr cm^{-1}] is the solar radiation at 1.27 μm [4], I_c the continuum radiation, r_h = 1.5 AU the heliocentric distance of Mars. Our results, essentially in agreement with similar previous results [3],[7],[1] indicates that the maximum oxygen emission occurs at equinoxes over the polar regions.

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