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Long-term O_2 nightglow observations in the polar night on Mars by SPICAM/MEx

A. Fedorova (1), S. Guslyakova (1), F. Lefèvre (2), F. Montmessin (2), D. Churbanov (3), O.I. Korablev(1), J-L. Bertaux(2)
(1) Space Research Institute (IKI), Moscow, Russia (fedorova@iki.rssi.ru / Fax: +7-495-333-21-02),
(2) CNRS LATMOS, 11 Bd d'Alembert, 78280 Guyancourt, France
(3) Moscow Institute of Physics and Technology (MIPT), 9 Institutsky dr., 141700 Dolgoprudny, Moscow Region, Russia

1. Introduction

The oxygen nightglow is a sensitive tracer of the thermospheric circulation. In contrast to the $O_2(a^1\Delta_g)$ dayglow that results from the ozone photodissociation on Mars, the $O_2(a^1\Delta_g)$ nightglow is a product of the recombination of O atoms formed by CO_2 photolysis on the dayside at altitudes higher than 80 km and transported downward above the winter pole by the Hadley circulation. The first direct observation of the night-side emission were provided at limb geometry by the OMEGA spectrometer on the Mars-Express orbiter in 2010 (3 vertical profiles have been detected) [1] and confirmed and studied later by CRISM on Mars-Reconnaissance-Orbiter [2] and SPICAM on Mars-Express [3]. The first detections indicate that the emission is about two orders of magnitude less intense than the dayglow. All observations related to Southern and Northern poles at polar night.

2. Observations

The infrared AOTF spectrometer SPICAM IR sounds the Martian atmosphere in the near-IR range (1-1.7 μm) with the spectral resolution of 3.5 cm^{-1} in nadir, limb, solar and star occultation modes since January 2004 [4]. It allows to perform measurements of the O_2 emission with rather high spectral power (~2200) and has obtained the first seasonal map of the oxygen emission on the dayside of Mars [5]. FOV of spectrometer at nadir and limb is 1°. Since 2010 the spectrometer began continuous monitoring of the O_2 nightglow in Mars' polar regions. In 2010-2015 SPICAM IR provided ~260 limb observations on the night side and ~1400 stellar occultations in IR. About 500 resulting vertical profiles of the oxygen nightglow have been obtained in both hemispheres. (fig.1).

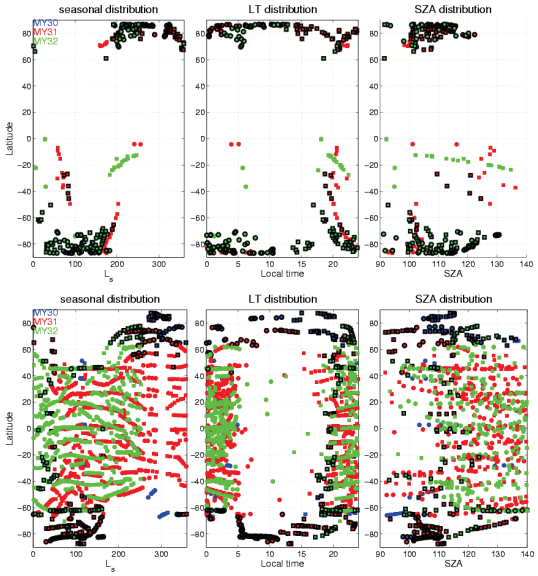

Figure 1. Distribution of limb observations (top) and stellar occultations (bottom) with season, local times and SZA for MY30-32. The black signs mark orbits where the emission has been detected.

3. Results and discussion

We will present preliminary results of the O_2 nightglow observations in Northern and Southern hemispheres at different Martian years. Vertically integrated intensity of the emission varies from 0.15 to 0.5 MR. For the North pole the emission peak locates at 35-42 km that is lower than 40-55 km for the South pole and the emission rate is a more intense for the North compared with the South. As the emission is a result of atomic oxygen recombination in descending branch of the Hadley cell, it should be strongly sensitive to a transport of these atoms to the polar region of Mars. In this connection a comparison of the received profiles with the three-dimensional general circulation model of Mars is important [6]. In this work the seasonal variations of the vertically integrated emission rate and altitude variations of the peak intensity for the slant emission in comparison with the LMD GCM will be presented.

In case of stellar occultation, observations of the atmospheric density by SPICAM UV [7, 8] allow to retrieve temperature profiles in Southern and Northern polar regions. As shown in [3], the simultaneous observations of the nightglow and temperature-density profiles can help to retrieve the atomic oxygen profiles at altitudes from 40 to 70 km.

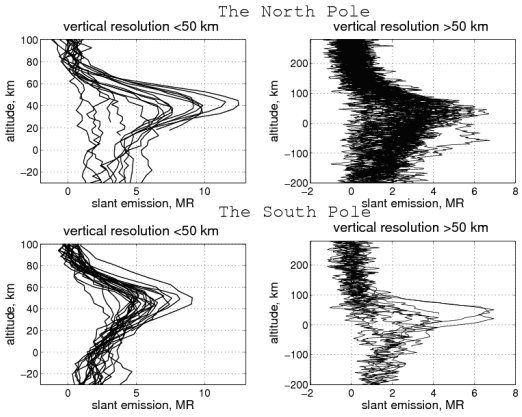

Figure 2. Vertical profiles of the $O_2(a^1\Delta_g)$ nighttime emission rate for several observations at the North and South poles.

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