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CRISM limb observations of Mars dayside O_2 singlet delta emission during 2010-2011

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Abstract

Since July of 2009, the Compact Reconnaissance Imaging Spectrometer for Mars (CRISM) onboard the Mars Reconnaissance Orbiter (MRO) has obtained limb scans over two orbits at solar longitude (L_s) intervals of ~30°. With a spectral resolution of ~12 nm, CRISM visible-to-near IR limb spectra 0.4-4.0 μm) enable vertical profiling of dust and ice aerosols, water vapor, CO, and O_2 singlet delta emission (at 1.27 μm) in the Mars atmosphere [3, 7, 10, 11]. The CRISM limb observations are obtained over a full set of latitudes (~10° intervals) for longitudes centered on 110W (Tharsis) and 300W (Hellas). Initial work on CRISM O_2 singlet delta limb observations has centered on polar nightglow emission associated with atomic oxygen recombination at 40-60 km altitudes [2,3]. The current presentation regards O_2 singlet delta emission associated with ozone photolysis in the dayside atmosphere at 10-40 km altitudes (e.g., [8,9]). This dayside emission provides a key profile observation of dayside ozone photochemistry, and so may reflect upon heterogeneous reactions on Mars aerosols [1,6] proposed (in part) to increase methane destruction rates in the Mars atmosphere.

In figures 1-4, we present latitudinal cross sections of O_2 singlet delta emission (relative units) as observed in CRISM limb spectra for four seasonal (L_s) periods over 2010-2011. Roughly a factor-of-ten variation in O_2 singlet delta emission is represented by the full color range displayed. Peak global O_2 singlet delta emission is observed in the northern spring/summer aphelion season (Ls=40-140°, figures 1 and 2) when low altitudes of water vapor saturation lead to minimum ozone destruction rates by HO_x water photolysis products [4]. Very low O_2 singlet delta global emission rates occur around southern summer/fall (L_s=265°, figure 4) when higher atmospheric temperatures lead to well mixed water vapor up to altitudes above 40km. Very high O_2 singlet delta emission rates at late fall and early spring high-latitudes (figure 3, L_s=195°) correspond to very cold regions where water vapor content is minimal at all altitudes.

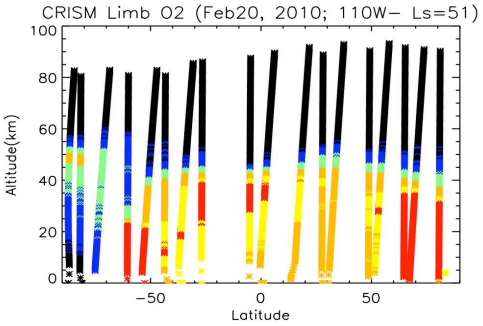

Figure 1. CRISM limb profiles of O_2 singlet delta (λ=1.27 μm) emission obtained on February 20, 2010 during Mars northern spring (Ls = 51°).

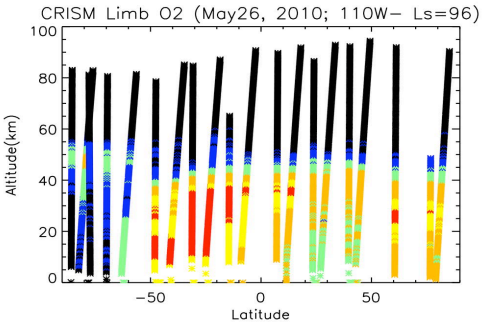

Figure 2. Same as figure 1, for Ls= 96° in May of 2010 (Mars northern summer).

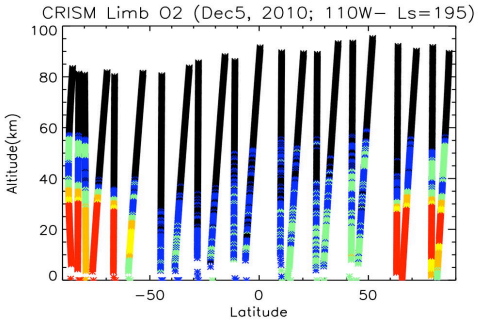

Figure 3. Same as figure 1, for Ls= 195° in December of 2010 (Mars northern fall).

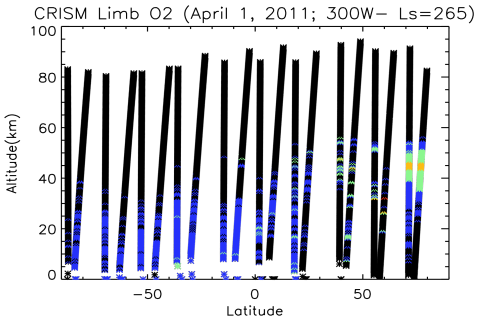

Figure 4. Same as figure 1, for Ls= 265° in April of 2011 (Mars southern summer).

Also apparent in these figures is the higher altitude polar O_2 singlet delta nightglow at 70-90° latitudes. In order to retrieve profiles of dayside O_2 singlet delta volume emission rates from these limb radiance profiles, we are performing spherical, multiple scattering radiative transfer in which self-consistent aerosol extinction is simultaneously retrieved from the full CRISM limb spectral radiances [10]. These retrieved O_2 singlet delta volume emission rates will be compared to LMD GCM simulations that incorporate ozone photochemistry [5] in the context of realistic atmospheric water vapor cycles, including cloud microphysics and potential heterogeneous chemistry on cloud water ice particles [6].

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