VERTICAL DISTRIBUTION OF AEROSOLS AND WATER VAPOR USING CRISM LIMB OBSERVATIONS

Michael D. Smith, NASA Goddard Space Flight Center, Greenbelt, MD, USA
Michael J. Wolff, R. Todd Clancy, Space Science Institute, Boulder, CO, USA.

Near-infrared spectra taken in a limb-viewing geometry by the Compact Reconnaissance Imaging Spectrometer for Mars (CRISM) on-board the Mars Reconnaissance Orbiter (MRO) provide a useful tool for probing atmospheric structure. Specifically, the observed radiance as a function of wavelength and height above the limb allows the vertical distribution of both dust and ice aerosols to be retrieved. These data serve as an important supplement to the aerosol profiling provided by the MRO/MCS instrument allowing independent validation and giving additional information on particle physical and scattering properties through multi-wavelength studies.

A total of at least ten CRISM limb observations have been taken so far covering a full Martian year. Each set of limb observations nominally contains about four dozen scans across the limb giving pole-to-pole coverage for two orbits at roughly 100 and 290 W longitude over the Tharsis and Syrtis/Hellas regions, respectively. At each longitude, limb scans are spaced roughly 10 degrees apart in latitude, with a vertical spatial resolution on the limb of roughly 800 m.

Radiative transfer modeling is used to model the observations. We compute synthetic CRISM limb spectra using a discrete-ordinates radiative transfer code that accounts for multiple scattering from aerosols and accounts for spherical geometry of the limb observations by integrating the source functions along curved paths in that coordinate system. Retrieved are 14-point vertical profiles for dust and water ice aerosols with resolution of 0.4 scale heights between one and six scale heights above the surface. After the aerosol retrieval is completed, the abundances of CO2 (or surface pressure) and H2O gas are retrieved by matching the depth of absorption bands at 2000 nm for carbon dioxide and at 2600 nm for water vapor. In addition to the column abundance of water vapor, limited information on its vertical structure can also be retrieved depending on the signal available from aerosol scattering.

Significant differences are seen in the retrieved vertical profiles of dust and water ice as a function of season. Dust typically extends to higher altitudes during the perihelion season. Ice aerosols are often observed to cap the dust layer during all seasons. Water vapor is observed to be deeply mixed in the perihelion season and confined near the surface in the aphelion season. The CRISM limb-geometry observations support the quantitative retrieval of aerosol and gas vertical profiles. These quantities cannot be retrieved using nadir observations, and they enable the study of important new science questions. The CRISM limbs also serve as a valuable supplement to the MRO/MCS limb profiles, enabling validation and multi-wavelength comparisons. Additional CRISM limb-geometry sets will continue to be taken approximately every two months (~30 degrees of Ls) as operations allow.