

Retrieval of vertical aerosol and gas profiles considering multiple scattering from Martian limb observations by MRO/CRISM

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Mars must somehow have lost most of its atmosphere and water. The evolution of the Mars environment is thought to have proceeded by atmospheric escape to space. In the last decades, there have been a renewed interest from lower to upper atmosphere to understanding the Martian climate. Vertical profiles of atmospheric gases and aerosols are thus the primary information for key processes in energy and mass transport into the upper atmosphere from below. Thanks to the aggressive explorations by MRO and MEx missions, there have been a lot of dataset of limb-viewing observations that can add new restrict the history of the Martian environment. However, these limb datasets haven't started on the retrieval due to their computational costs in the process of radiative transfer calculations.

JACOSPAR is a fast RT code that considers multiple scattering that simulates the radiance and Jacobians in the fully spherical geometry, which has been developed for the terrestrial atmosphere. We have newly developed the retrieval code by applying JACOSPAR for Martian limb observation. For the first step to apply JACOSPAR to Martian limb observation, we modified two points for RT simulations to be optimized. First, we implemented a uniform distribution of line of sight within the field of view (FOV) in order to reduce the resultant variance of the calculated radiance along line of sight in the FOV. Second, we also optimized the threshold of Russian roulette method for the efficient calculation in the Monte Carlo simulation.

The evaluation results of Jacobians calculated by JACOSPAR showed the agreements accurate within 2% and 10% for absorption and scattering, respectively, in almost cases. In order to evaluate our retrieval code and its proper implementations, we have applied our retrieval code for the MRO/CRISM limb observations. We conducted spectral fitting to retrieve vertical profiles of number density of CO₂, H₂O, dust, and water ice for the observed spectra by CRISM in the altitude range from 0 to 20 km. Here we newly attempted to retrieve the mean radius, and its variance of aerosols for the two cases of difference a priori conditions for the variance of aerosols' radius of 0.5 and 1.2. We, however, still found the discrepancy of spectral slope and intensity between retrieved spectra and measured spectra. It is also noted that the repetitive variations of fitting profiles do not converge during the iterations. The possible explanation for the discrepancy of the spectral slope and intensity might be due to the treatments of aerosol properties. One of the solutions is to apply modified-gamma distribution for size distribution function, instead of log-normal distribution function applied for this study.

More precise and accurate treatment of size distribution function is required as a next step. The repetitive variations of fitting profiles might be caused by the sensitivity of the retrieval. The detailed evaluation of the retrieval sensitivity should also be required for the future work.

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