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HDO/H_2O, CO_2 isotopic ratio, and CH_4 distributions on Mars observed by SUBARU/IRCS

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We report the latitudinal and local time variations of HDO/H_2O, CO_2 isotopic ratio, and CH_4 on Mars from ground-based observations using the Infrared Camera and Spectrograph (IRCS) installed at the Subaru Telescope. The distributions of the isotopic ratios enable to visualize the water and carbon dioxide cycle on Mars. Furthermore, the recent discovery of CH_4 on Mars has led to much discussion on its source and sink. However, they are still less investigated. We performed observations of these trace gases with SUBARU/IRCS on 30 November 2011 (Ls=37°), 4-5 January 2012 (Ls=52°), and 12 April 2012 (Ls=96°). We used the cross-dispersed echelle spectroscopy of IRCS with high spectral resolution (R∼20,000) in order to detect narrow Martian lines. Our observations were covered the five spectral bands, 2.85-2.93 μm, 3.01-3.10 μm, 3.28-3.36 μm, 3.48-3.57 μm, and 3.71-3.81 μm. This allows us to do simultaneous observations of multiple lines of H_2O, HDO, CO_2 (628), CO_2 (627), CO_2 (626), and CH_4. Our data sets can be used for investigating (1) the latitudinal distribution of the trace gases at different seasons (including local summer), and (2) their local time dependence (and/or longitudinal distributions). The observation on April is joint one with the Planetary Fourier Spectrometer onboard Mars Express. Such simultaneous observations of CH_4 between ground-based telescopes and a spacecraft are quite essential for the verification of its controversial existence.
In order to determinate the amounts of the trace gases, the contributions between terrestrial and Martian lines should be separated. Although our observations were performed when the Doppler shift between Mars and Earth was relatively large (> 10km/s), the Martian lines are still inside of the deep terrestrial lines. For separation, we developed a radiative transfer model with line-by-line method. The model is taken account into the terrestrial H_2O, O_3, CH_4 and their isotope lines, the Martian H_2O, HDO, CO_2 and CH_4 lines, solar lines, and the instrumental line shape function.
Using the model, we derived HDO/H_2O distributions. Our preliminary results at Ls=52° suggest that (1) the latitudinal distribution shows increase around sub-solar latitude (∼20°N), and (2) the local time (or longitudinal) dependence is not clearly appeared. In addition, we detected the enhancement of HDO amount at high latitudes from the data observed at Ls=96°. It would be due to sublimation of the north polar cap, and the HDO/H_2O ratio will be discussed.