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Mars Atmosphere Argon Measurement with the Alpha Particle X-Ray Spectrometer on MER Mission.

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The Alpha Particle X-ray Spectrometer (APXS) on both rovers on the MER mission, in addition to the ability to determining the chemical composition of the Martian surface samples, is also capable of determining the abundance of the element Argon in the Martian atmosphere with high accuracy.
To a good approximation, the APXS count rate is proportional to the number of Argon atoms in the sensing volume, and hence measures the atmospheric density of Argon, [U+F072]Ar, which is proportional to the partial pressure of Argon and inversely proportional to the temperature: [U+F072]Ar ∼[U+F020]PAr/T. The APXS Argon experiment thus gives a direct measurement of the local mixing ratio at the near-surface at the MER landing sites.
Although the total Ar in the atmosphere is constant, the amount of carbon dioxide changes by as much as 30% due to condensation and sublimation of CO2 in the polar regions during the Martian winters and summers, respectively. A high Ar mixing ratio indicates that the local atmosphere is depleted of CO2, while a low local mixing ratio indicates that the atmosphere is locally enriched of CO2.
Polar condensation of CO2 causes massive movement of atmosphere from the equatorial regions. As the CO2 freezes, the remaining air is enriched in argon (and nitrogen). The GRS experiment on the Odyssey orbiter around Mars has observed a six-fold enrichment in the Ar/CO2 mixing ratio in the South Pole region during the winter period. In the summer season, the opposite occurs: sublimating CO2 lowers the local Ar/CO2 mixing ratio and pushes the air mass with enriched Ar fraction towards the equatorial regions. The measurement of the Ar mixing ratio at the Spirit and Opportunity landing sites is thus a direct probe of the global circulation between the polar CO2 sources/sinks and the equatorial regions.
Over a period of 3 Martian years the APXS has been measuring the change of density of the Argon in the Martian atmosphere at both, Spirit and Opportunity, sites on Mars. In both cases the local Ar/CO2 mixing ratio follows generally the change of the Martian atmosphere change as functions of the season, but with an offset of about one and a half season. There are however some variations between the two sites, perhaps due to the variation in the global territory. Some variations from year to year have also been observed. Observations are still in progress.
The MER mission APXS Ar data results provide a good ground truth for the orbital instruments measuring the global variations of the Ar in the Martian atmosphere from the orbit. Presently, we are in the process to fit these results to the Mars General Circulation Model.