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MSL/SAM Measurements of Non Condensable Volatiles, Comparison with Viking Lander, and Implications for Seasonal Cycle

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The first measurements of the composition of the Martian atmosphere above Gale Crater by the Sample Analysis at Mars (SAM) instrument on Curiosity Rover revealed that although the volume mixing ratios (vmr) of the gases are generally similar to those measured by the Viking Lander 2 (VL2) thirty five years ago [2], they are notably different for N2 and 40Ar [1]. SAM finds a vmr of 1.9% each for N2 and Ar, so that N2 is 30% lower while Ar is 21% greater than the corresponding VL2 values, resulting in a 40% lower N2/Ar ratio compared to the VL2 result. The Ar/N ratio is used to assess the degree of mixing between the Martian atmosphere and the internal gas component of Mars meteorites due to the shock of impact ejection [e.g. 3].

The above differences in N2 and 40Ar seem to result either from different instrument characteristics or time variable atmospheric phenomena or both. The VL2 data were taken during northern summer (48°N, Ls=135°), whereas the SAM measurements correspond to the beginning of spring season (4.5°S, Ls=182-190°). Previous observations by Mars Odyssey Gamma Ray Spectrometer over three years have shown that the Ar mixing ratio increased by a factor of 6 over the south polar region in the winter [4]. However, the data are controversial for the equatorial region, ranging from no seasonal change [4] to as much as a 35% change [5]. No significant change was seen between the equator (SAM) and the midlatitude northern summer (VL2), however [4]. Thus the difference between the SAM and VL2 Ar does not appear to be related to different seasons. On the other hand, the vmr's of non-condensable volatiles (NCV), N2, Ar and CO, at any latitude are expected to vary seasonally due to the annual, global CO_2 cycle. Diurnal changes are not expected, considering the long lifetimes of NCV's that exceed the martian year [6]. In addition to Ar, seasonal changes have been recorded in CO from ground-based [7] and MRO/CRISM observations [8], but show a much smaller increase of a factor of 2-3 over south polar region in the winter. No data exist on the seasonal behavior of N2. For the first time, SAM will monitor the seasonal behavior of N2 over the two-year prime mission of Curiosity, together with other NCV's, Ar and CO, which will reveal whether they track one another, as expected, and whether the present SAM ratio of N2/Ar =1 holds up over the seasons at roughly one-half the value obtained by Viking. These data will in turn provide crucial constraints to climate evolution and general circulation models of Mars. (www.umich.edu/∼atreya).

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