**Introduction:** The Mars Science Laboratory (MSL) rover, *Curiosity*, has been exploring Gale crater since landing in August of 2012. The rover is equipped with a suite of instruments including an Alpha Particle X-ray Spectrometer (APXS), which provides a number of improvements over its Mars Exploration Rover (MER) predecessor(s). APXS was designed and calibrated for high-precision in situ analyses of geologic materials on Mars. However, it has also proven itself a capable spectrometer for monitoring the condensation flow of the Martian atmosphere (e.g., [1-3]) through repeated assessments of argon density. APXS cannot directly measure elements with Z<11.

*Curiosity* has acquired numerous atmospheric APXS analyses (e.g., Figure 1), initially as engineering/instrument checkouts and later, commencing around sol 2000 (03/2018), as part of a dedicated long-term science campaign with a scheduled cadence (e.g., [3]). This cadence varies over the course of each Mars Year (MY), increasing particularly when a short-lived enrichment in Ar (e.g., Figure 2) is anticipated, around solar longitude (Ls) 150, as first observed by the APXS on Opportunity (MER-B) [2].

**Results:** Argon partial pressure (p_{Ar}) measured at Gale is consistent with measurements conducted at Meridiani Planum after correcting for significant changes in elevation (e.g., Figure 1). Instrument and thermal effects have been mitigated. A rudimentary elevation correction has been applied to all MSL data presented herein outside of Figure 1. Reduced MSL and MER-B p_{Ar} data can be observed in Figure 3, with a focus on the short-term enrichment timeframe (Ls 150-180) in Figure 4. MSL and MER-B p_{Ar} data agree very well. Continued measurements at Gale will further benefit statistics in the MSL data set, which currently totals nearly 800 hours of quality APXS atmospheric measurement time. The MER-B
APXS atmospheric data set contains roughly 2250 hours (i.e., ~94 continuous days) of quality measurement time acquired over the entire course of the mission.

The observed timing of the short-term $p_{Ar}$ enrichment appears consistent between Gale and Meridiani, each at similar latitudes, with Opportunity landing ~3.5° latitude further south. Short-term $p_{Ar}$ enrichment at Gale may occur slightly later than at Meridiani (e.g., Figure 3 and Figure 4). This should be reconciled to an extent when additional data are acquired prior to the presentation of this work. The high-$L_s$ side of the short-lived enrichment is currently somewhat poorly constrained at Gale and the planned increased cadence during this timeframe will greatly improve constraints on the timing at Gale compared to Meridiani.

**Outlook:** APXS will continue to conduct atmospheric measurements with a regular cadence. This cadence will typically consist of 8 hours of nighttime analyses every 4 weeks, most often during the latter sols of a weekend plan. The frequency will be increased during seasonal timeframes when atmospheric phenomenon are anticipated. From $L_s$ 120-180 this will be in the form of a frequency increase of 2-4x.

ChemCam passive sky (CCPS) observations (e.g., [4]) have recently been (and will continue to be) paired to APXS atmospheric measurements as much as possible. APXS (and CCPS) will furthermore continue to be acquired as close as possible to any atmospheric analyses conducted by SAM (e.g., [5]).

**Figure 3:** Reduced $p_{Ar}$ data from Curiosity (blue) and Opportunity (grey) derived from average $p_{Ar}$ values within $L_s$ bins 2.5° wide. Black curve corresponds to a periodic fit of the MER-B data. Statistics significantly improved for the Curiosity data set during MY37 (e.g., Figure 1) due to a dedicated campaign during solar conjunction and the end of year holiday plans (approximately MY37 $L_s$ 124-134 and 168-175 respectively). An increased cadence of APXS atmospheric measurements were conducted to coincide with the seasonal non-periodic $p_{Ar}$ timeframe (Figure 4).

**Figure 4:** Duplicate plot of Figure 3 focusing on the seasonal short-term Ar enrichment at both Gale crater (left) and Meridiani Planum (right). Black curve corresponds to a periodic fit to the MER-B data.

**Summary:** Though not designed nor calibrated for analyses of atmospheric samples, APXS has demonstrated a unique capability to monitor the condensation flow of non-condensable gases through monitoring atmospheric argon density. The true value of these measurement comes from repeated assessments (e.g., Figure 2) which enable a significant improvement in statistics (e.g., Figure 3) compared to individual analyses. High-frequency atmospheric measurements with APXS complement the low-frequency high-accuracy atmospheric analyses conducted by SAM (e.g., [5]) and provide important constraints on atmospheric phenomenon not elucidated through low-frequency analyses or via environmental instrument suites such as REMS or MEDA. Curiosity’s APXS remains the only instrument on the Martian surface currently capable of conducting near-surface high-frequency analyses of a non-condensable gas species on Mars within typical operational constraints.

**References:**

**Acknowledgements:** This work was supported by NASA via Mars Science Laboratory Participating Scientist Grant 80NSSC22K0650 and by the Canadian Space Agency. The authors express great appreciation towards NASA/JPL for their support, dedication, and invaluable expertise during development and operations of the MER and MSL missions.