MSL/REMS MEASUREMENTS OF CONDITIONS DURING MSL/SAM ATMOSPHERIC INGESTION EVENTS. Michael H. Wong[*,1,2], Matthew LeFavor[3], Claire Newman[4], Benito Prats[3], Henrik Kahanpää[5], Maria Genzer[5], Eduardo Sebastian[6], Alain Lepinette[6], Osku Kemppinen[5], Ari-Matti Harri[5], Javier Gómez-Elvira[6], Felipe Gómez[6], David Martin[3], Paul R. Mahaffy[3], Heidi Manning[7], and the MSL Science Team.
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Introduction: The MSL/REMS[†] package recorded environmental conditions at or near the times of 7 of the 8 atmospheric observations conducted by the MSL/SAM[†] instrument suite in the first 100 sols. In this presentation we will give timing information for each SAM atmospheric observation, along with REMS pressure and temperature conditions at the times of each ingestion of an atmospheric sample. These data are crucial for estimating relative humidities from SAM/TLS[†], and for estimating SAM/QMS[†] count rates as a function of variable atmospheric pressure.

SAM Observations: Times for each atmospheric sample intake are given in Table 1. Two intake ports were used [1]. One port allows atmospheric gas to flow only to the TLS instrument. Atmospheric gases introduced through the other port can flow to both the QMS and TLS instruments. Microvalves along the gas manifold are used to direct and control the flow of this gas to the specific instruments. The first SAM experiment (Sol 18 21:00–23:00) is not listed, because REMS was powered off and there were no REMS observations within 10 hours of the Sol 18 ingests.

REMS Observations: We used coincident REMS measurements or interpolated data separated by no more than an hour from the ingest events. Table 1 lists preliminary REMS measurements of pressure, air temperature, and ground temperature for each event.

Uncertainties quoted in Table 1 are subjective estimates taking into account statistical errors, systematic errors, and interpolation error, especially given the transient variability seen at the typical times of SAM sample ingests. At these cold times of night, the REMS air temperature sensor often experiences electronic noise. REMS data product versions used in this analysis ranged from version 1 to version 4; further gains in accuracy are expected as improvements are made in REMS calibration.

Table 1: SAM atmospheric ingest events and REMS environmental conditions.

SAM TID	SAM Ingest start (LMST)	Ingest duration (mm:ss)	Ingest destination	REMS Pressure (mbar)	REMS Air Temp. (°C)	REMS Ground Temp. (°C)
25009	Sol 27 23:03	00:45	TLS	7.58 ± 0.05	-62 ± 3	-72 ± 5
	Sol 28 01:34	29:10	QMS	7.66 ± 0.07	-69 ± 3	-79 ± 5
	Sol 28 02:29	01:01	TLS	7.69 ± 0.05	-70 ± 3	-81 ± 5
	Sol 28 02:31	01:01	TLS	7.69 ± 0.05	-70 ± 3	-81 ± 5
	Sol 28 02:33	01:01	TLS	7.69 ± 0.05	-70 ± 3	-81 ± 5
	Sol 28 02:35	01:01	TLS	7.69 ± 0.05	-70 ± 3	-81 ± 5
	Sol 28 04:36	04:26	TLS	7.70 ± 0.06	-74 ± 3	-83 ± 5
25012	Sol 45 22:43	00:31	QMS	7.71 ± 0.07	-59 ± 3	-72 ± 5
25014	Sol 52 20:37	01:07	TLS	7.59 ± 0.07	-52 ± 5	-62 ± 7
	Sol 52 21:51	00:31	TLS	7.70 ± 0.05	-52 ± 3	-64 ± 5
	Sol 52 21:53	00:32	TLS	7.70 ± 0.05	-51 ± 3	-64 ± 5
	Sol 53 00:20	20:03	TLS	7.79 ± 0.06	-62 ± 3	-74 ± 5
25026	Sol 73 20:44	00:31	TLS	7.86 ± 0.05	-50 ± 3	-64 ± 5
	Sol 73 20:46	00:32	TLS	7.86 ± 0.05	-49 ± 3	-64 ± 5
	Sol 73 23:18	20:02	TLS	8.04 ± 0.06	-62 ± 6	-76 ± 7
25027	Sol 77 21:08	00:31	QMS	7.93 ± 0.05	-54 ± 3	-66 ± 5
	Sol 77 22:42	00:31	QMS	8.06 ± 0.05	-56 ± 3	-73 ± 5
25028	Sol 79 20:25	00:31	TLS	7.89 ± 0.05	-50 ± 3	-60 ± 5
	Sol 79 20:26	00:32	TLS	7.89 ± 0.05	-48 ± 3	-60 ± 5
	Sol 79 23:00	20:02	TLS	8.09 ± 0.06	-62 ± 4	-74 ± 5
25029	Sol 81 18:06	00:31	TLS	7.71 ± 0.05	-38 ± 3	-44 ± 4
	Sol 81 18:08	00:31	TLS	7.72 ± 0.05	-36 ± 3	-44 ± 4
	Sol 81 21:18	20:02	TLS	8.03 ± 0.08	-55 ± 6	-68 ± 6

[†]MSL = Mars Science Laboratory; REMS = Rover Environmental Monitoring Station; SAM = Sample Analysis at Mars instrument suite, TLS = Tunable Laser Spectrometer; QMS = Quadrupole Mass Spectrometer

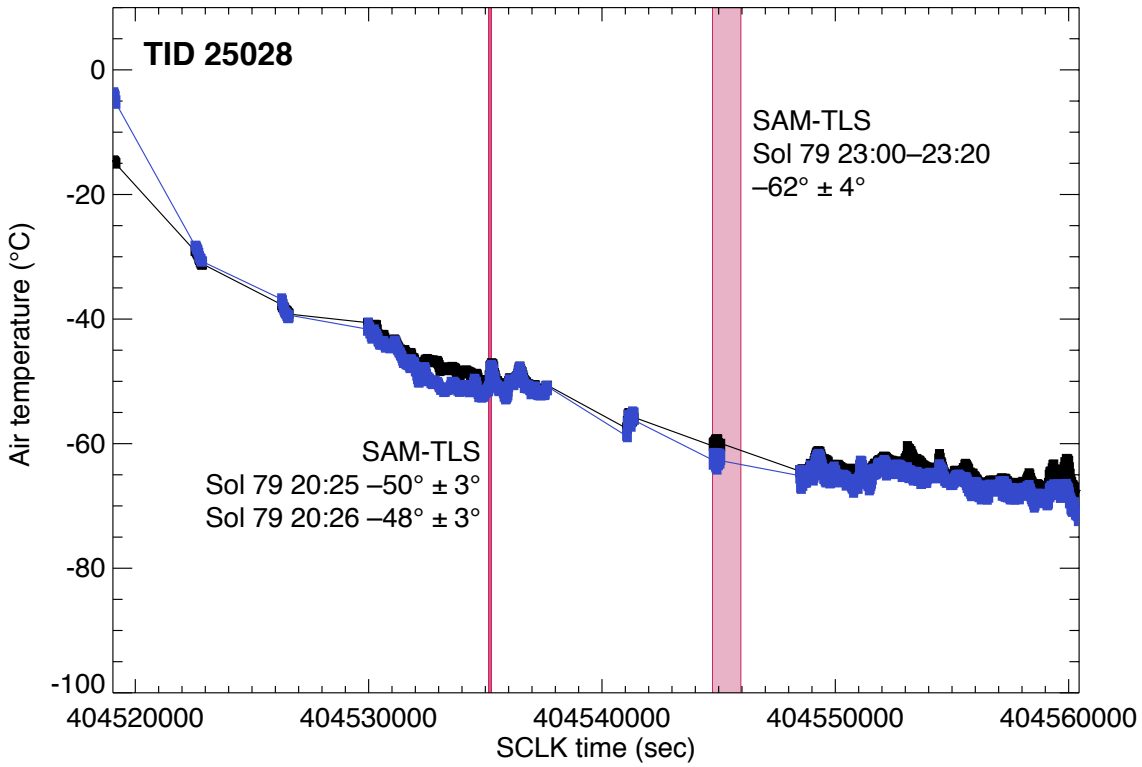

Figure 1. REMS data for the two air temperature sensors, compared with SAM/TLS atmospheric intakes (vertical bars). X-axis is spacecraft clock time in seconds; each ingest event is also labeled with its time in LMST.

Figure 1 shows a representative data set from Sol 79 of REMS air temperature measurements from the two temperature sensors as a function of time during a SAM experiment. Ingest times are marked as vertical pink bars. Our presentation will include pressure/temperature data for all SAM atmospheric measurements through Sol 100 of the MSL landed mission.

Ground temperature sensor (GTS) data were further processed by omitting the first 60 seconds of each measurement block, and smoothing with a 10-sec moving average. Data from GTS channel A are used in Table 1. Air temperature data from sensors 1 and 2 are shown in Fig. 1; Table 1 lists mean values from the two sensors, with uncertainties spanning the difference between readings of the two sensors. Pressure readings in Table 1 are also averages of data from two Barocap pressure sensors [2]. Uncertainties include interpolation error (when REMS data are not acquired exactly during SAM intake events).

Applications: Ingest atmospheric conditions are useful both for interpreting SAM measurements, as well as for planning future observation sequences. For example, water vapor mixing ratios derived from SAM can be converted to relative humidities, using the REMS pressure/temperature data. These data will be complementary to REMS humidity data. Initial analysis of SAM and REMS water vapor data suggests that significant systematic sources of error can be investigated by comparing data from both instruments [3].

The sample pressure of a SAM/QMS atmospheric aliquot can be reduced by performing volume expansions within the gas handling system prior to measurement. This approach is valuable when trying to measure signals at m/z values where the full atmospheric pressure saturates the detector. But seasonal change causes Mars pressure levels to vary, and SAM measurements are planned for different points during the diurnal cycle [3]. A roughly linear relationship between atmospheric pressure and count rate can therefore be used to determine optimal volume expansion ratios needed to prevent SAM/QMS measurements from saturating.

References:

[1] Mahaffy, P.R. et al. (2012) *SSR* 170, 401–478.
[2] Gómez-Elvira, J. et al. (2012) *SSR* 170, 583–640.
[3] Harri, A.-M. et al. (2013) *LPS XLIV*.