A Simple Method For Supporting Future Landers By Predicting Surface Pressure on Mars

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Accurate prediction of martian surface pressure is important for the successful landing of spacecraft on Mars. This presentation will develop and validate a simple empirical expression that can be used to predict martian surface pressure. Surface pressure depends on season, altitude, latitude, longitude and time of day. The most important variables are season, because the total mass of the martian atmosphere varies by 30% over a martian year as carbon dioxide cycles between the atmosphere and polar caps, and altitude, because the range of martian topography exceeds two scale heights.

Two types of instruments have measured martian surface pressure. They are pressure sensors on landers, including Viking Lander 1, Viking Lander 2, Pathfinder and Phoenix, and radio occultation experiments on orbiters, including Mariner 9, Viking Orbiter 1, Viking Orbiter 2, Mars Global Surveyor and Mars Express. The landed datasets, particularly the multi-year Viking Lander 1 (VL1) measurements, show that the variation of surface pressure at a fixed location with season can be represented by a harmonic series. The orbital datasets, particularly the extensive Mars Global Surveyor (MGS) measurements, show that the variation of surface pressure at a fixed season with altitude can be represented by an exponential function. Equation 1 shows a good functional form for an empirical expression.

$$p_s = p_{0,VL1} \exp\left(-\left(z - z_{VL1}\right)/H_0\right) \times \left(1 + s_{1,VL1}\sin\left(1L_s\right) + c_{1,VL1}\cos\left(1L_s\right) + s_{2,VL1}\sin\left(2L_s\right) + c_{2,VL1}\cos\left(2L_s\right)\right) \qquad (1)$$

Best-fit values of the parameters in this expression will be reported, and predictions from this expression will be tested with a specific focus on landing conditions for NASA's Mars Science Laboratory (MSL). Predictions for MSL are estimated, at the 1-σ confidence level, to be accurate to 3%. Simple predictions of martian surface pressure can also be used to support scientific investigations, such as studies of the martian gravitational field and rotational state.