Empirical predictions of martian surface pressure in support of the landing of Mars Science Laboratory

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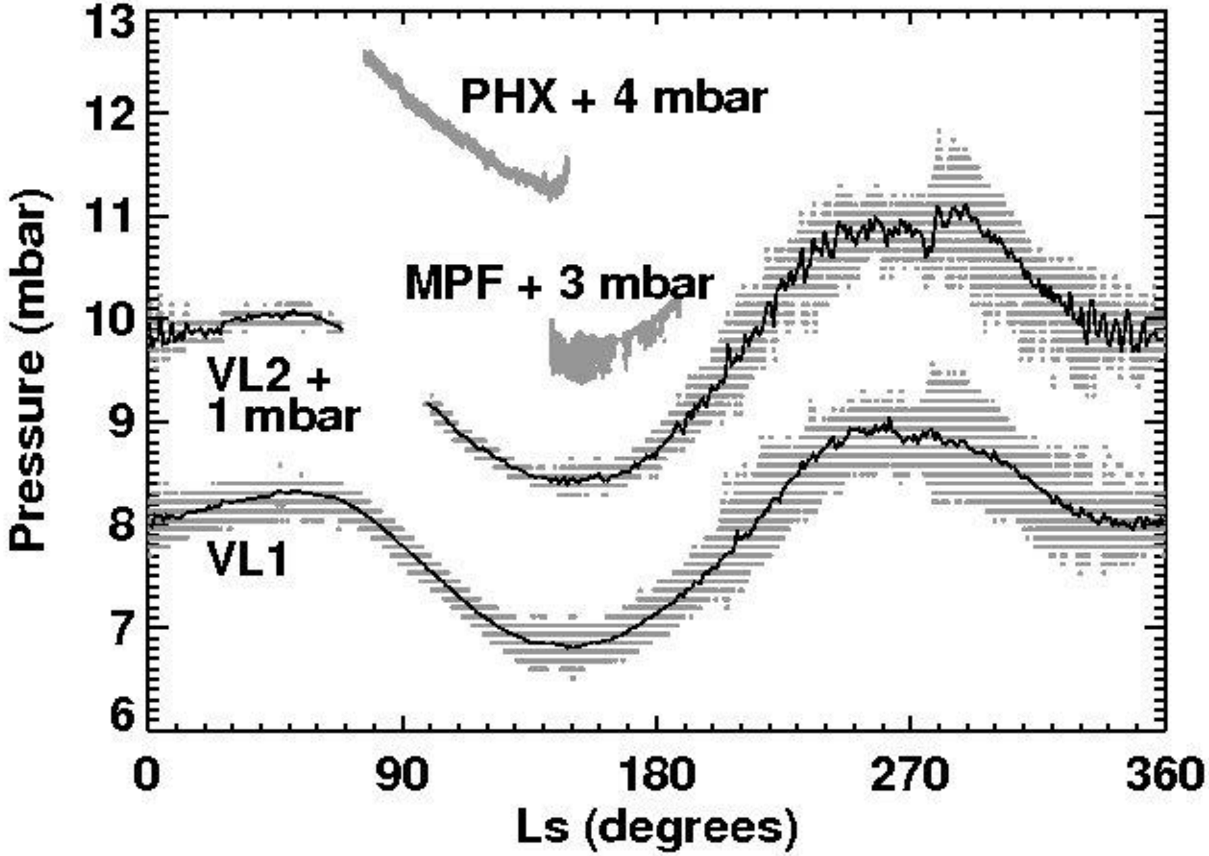
Surface pressure depends on altitude and season

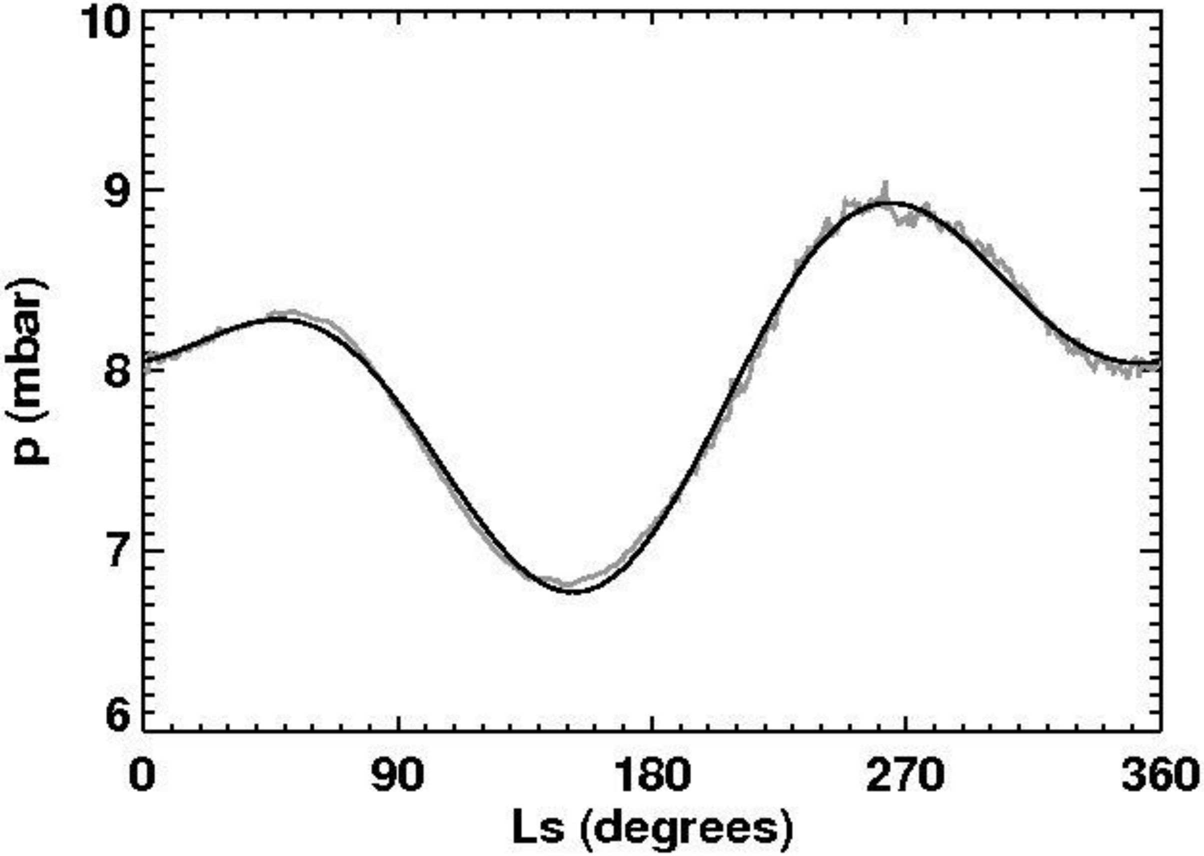
Everything else is secondary

Can an empirical model that depends on only Ls and z perform well?



VL1 data have simple seasonal trend

This fit is p = p0(1 + s1sin(Ls) + c1 cos(Ls) + s2 sin(2Ls) + c2 cos(2Ls)) where p0 = 7.792 mbar, s1 = -0.069, c1 = 0.060, s2 = 0.045, and c2 = -0.050

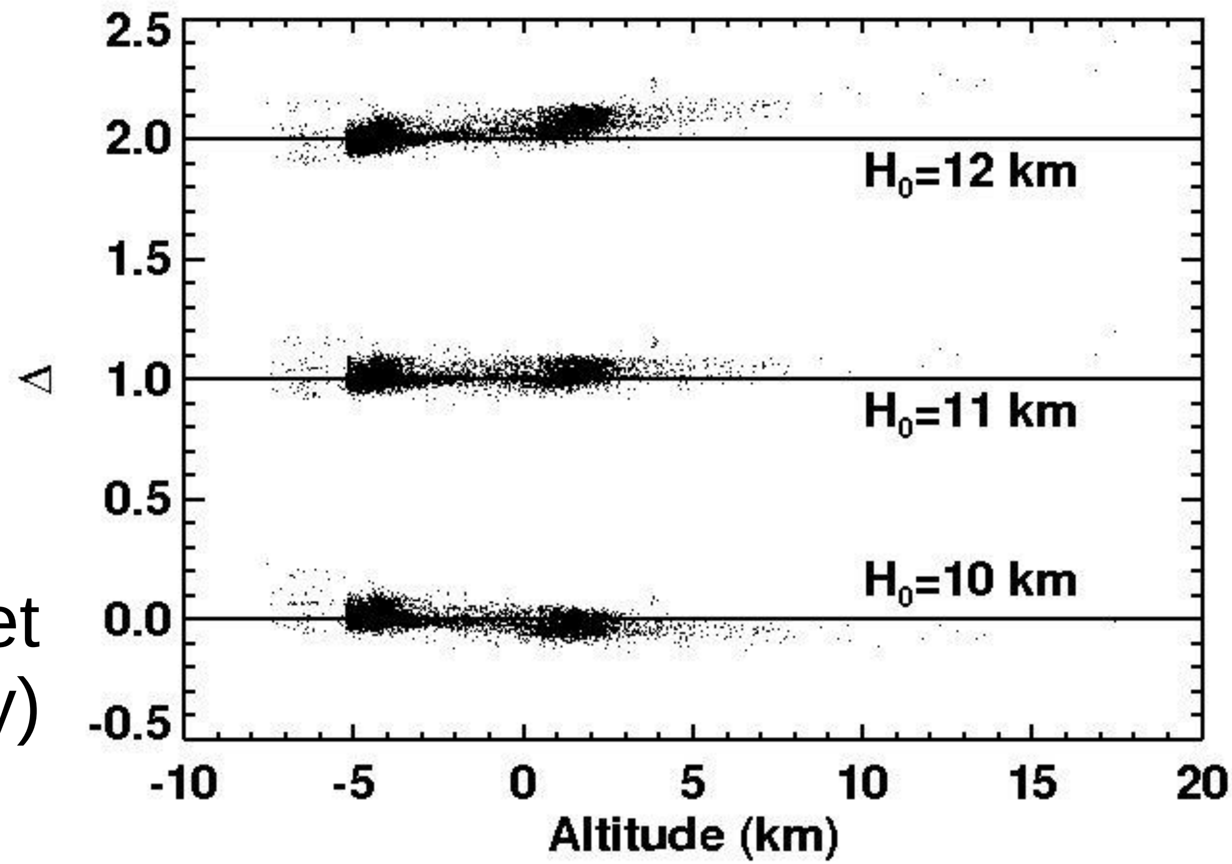


Ppred = P(VL1 fit) x exp(-z/H)

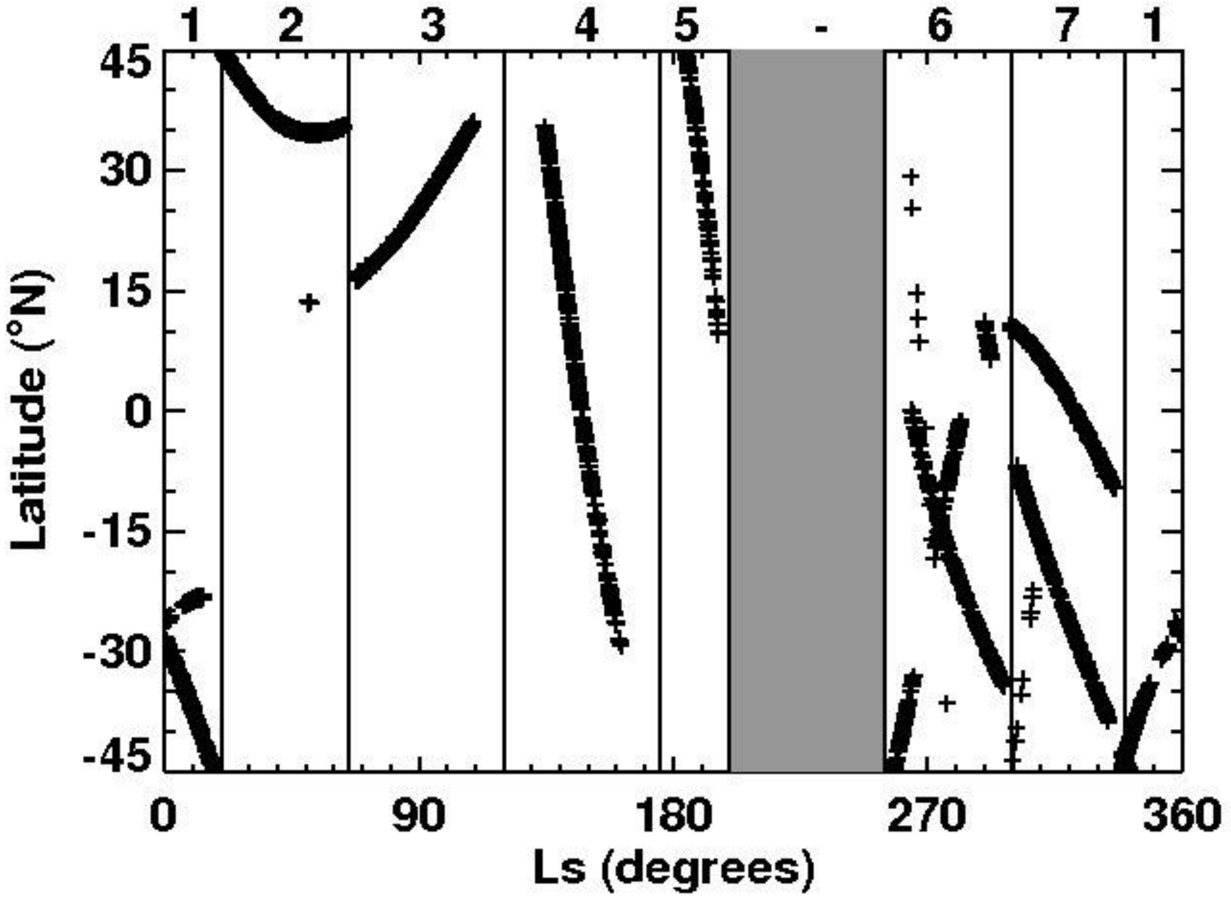
Test above function using thousands of MGS radio occultation surface pressure measurements for various H
H = 11 km works well

Delta =
(Ppred – Pmeas) / Ppred

(Plotted values offset by 1 and 2 for clarity)



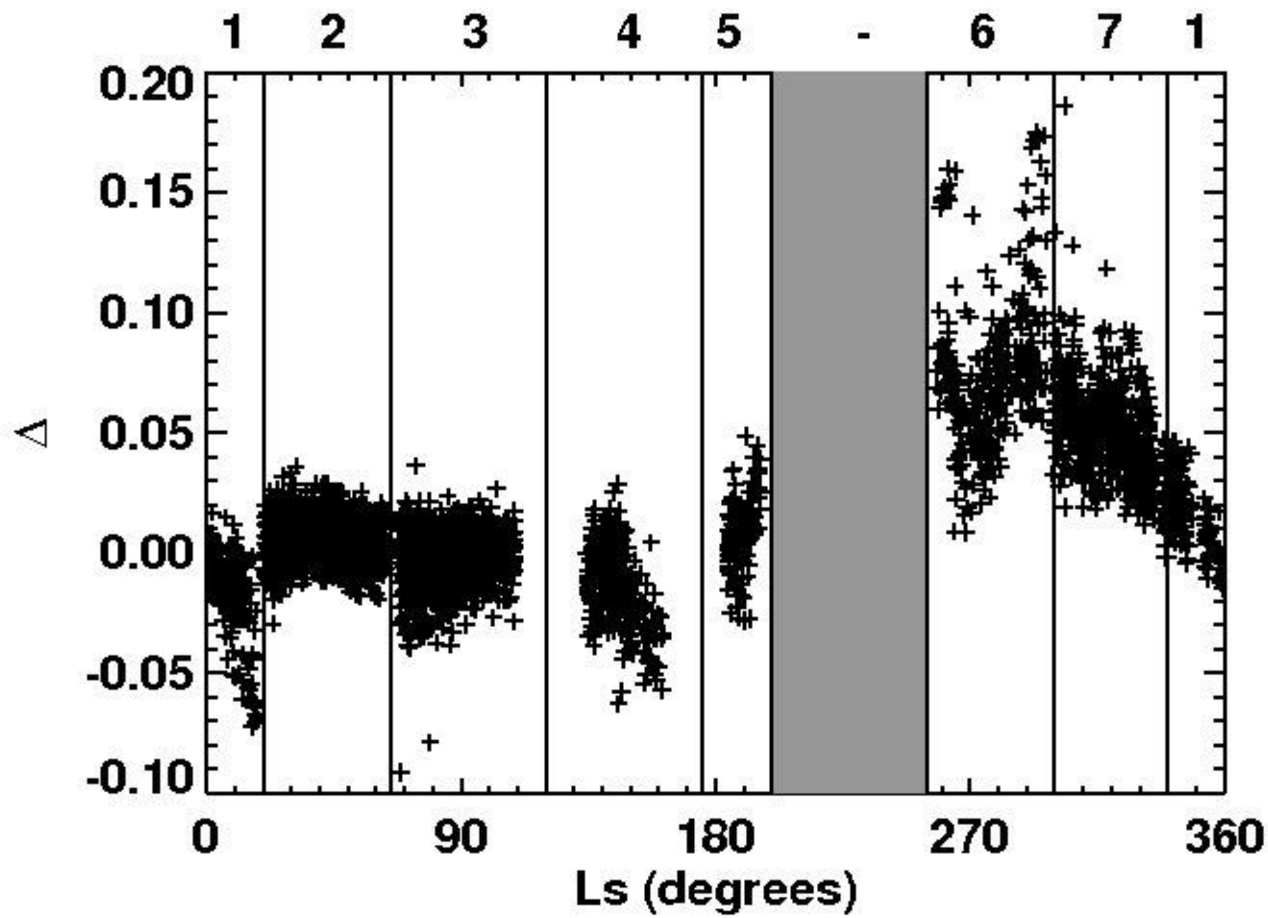
Latitudes and seasons of MGS data



Predictions for MGS data are very good at Ls=150, MSL EDL season

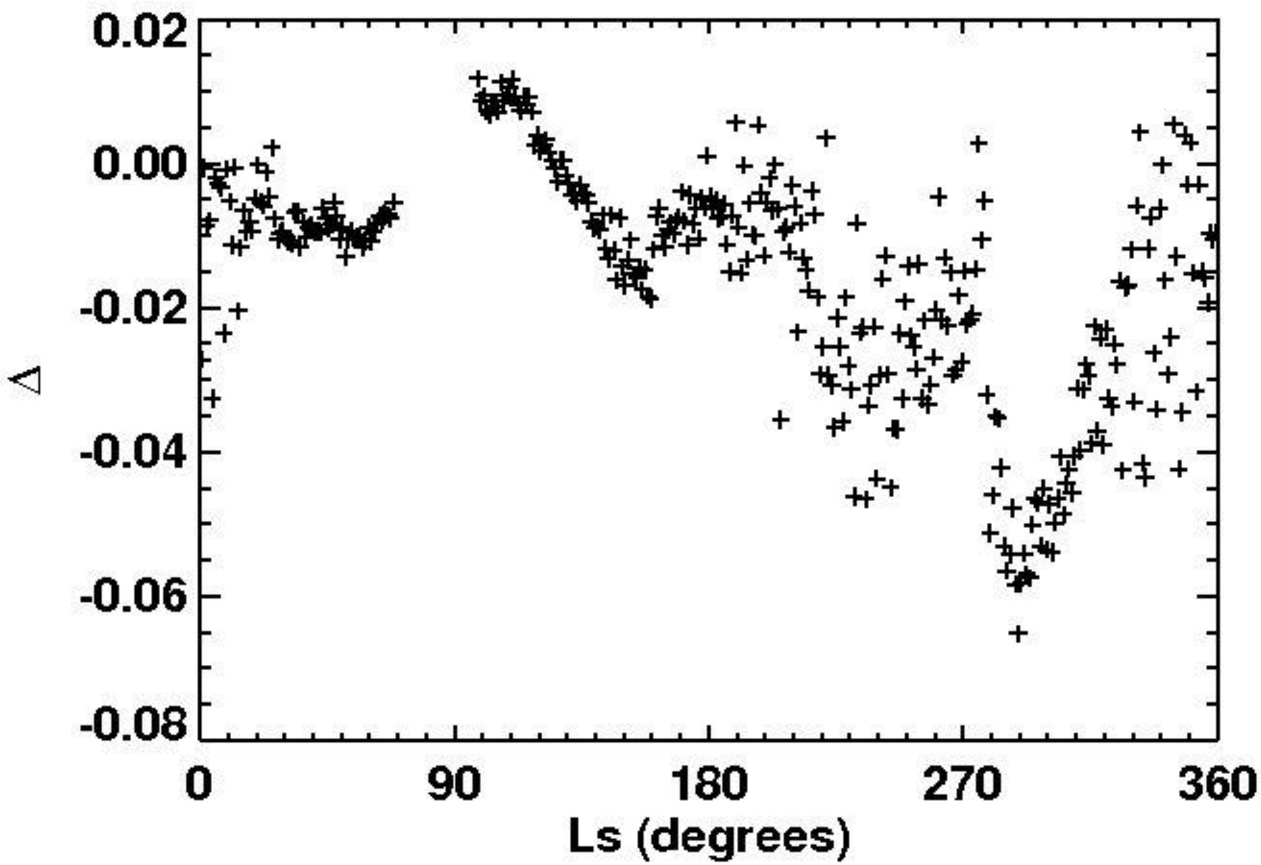
Predictions are less good during Ls=255-340 when dust storms are common

Delta = (Ppred – Pmeas) / Ppred



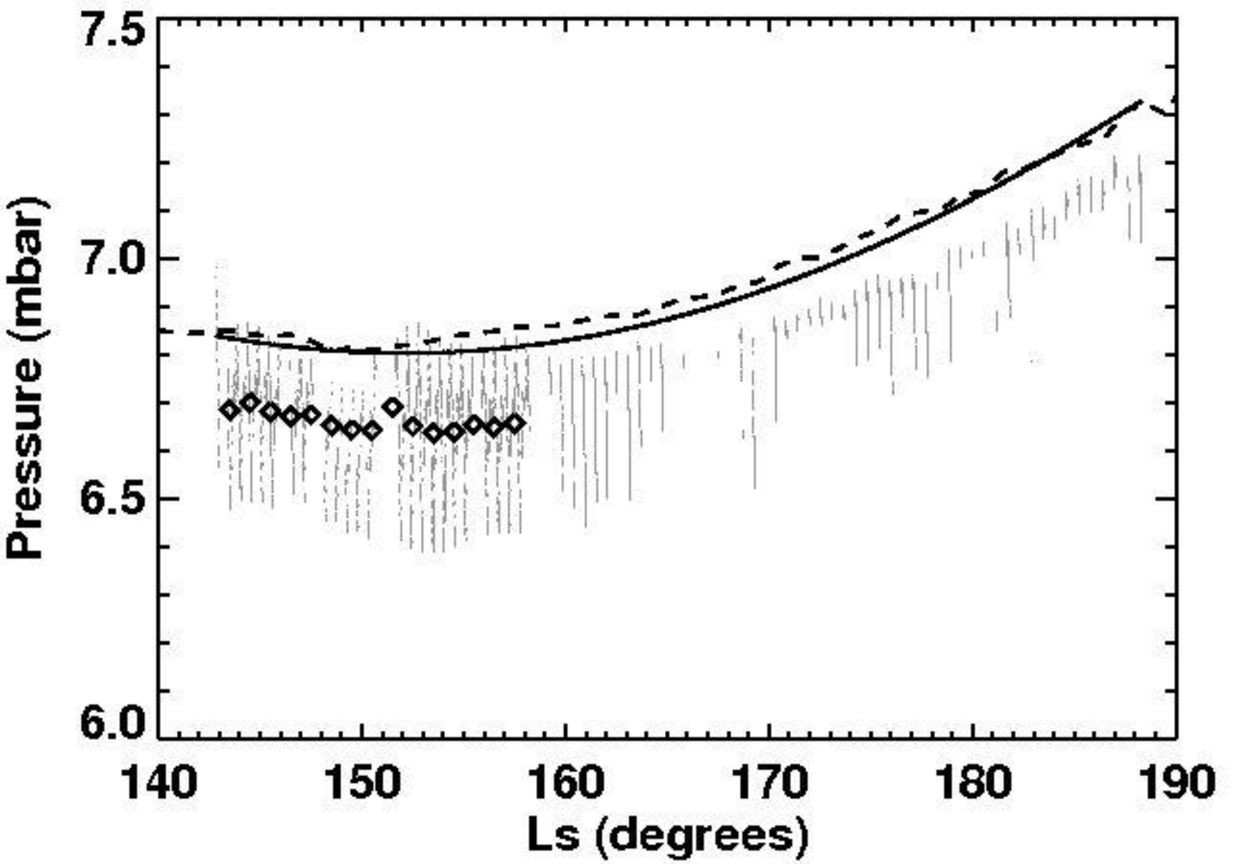
Predictions are good for VL2 data

Delta =
(Ppred – Pmeas) /
Ppred

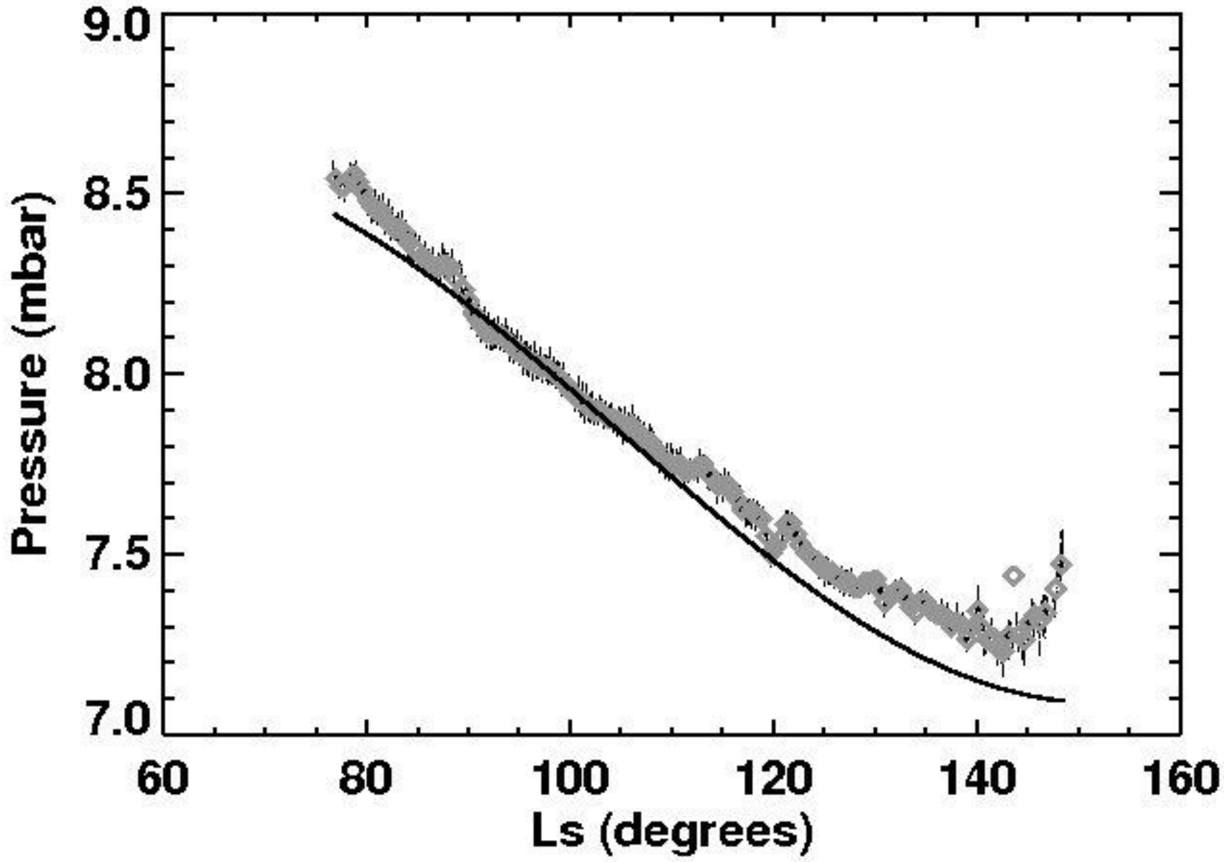


Predictions are OK for MPF, considering calibration issue

MPF surface pressures are consistently smaller than expected by 0.1 mbar due to a calibration issue
Diamonds and grey points are data, solid line is predictions, dashed line is VL1 data at near-identical z



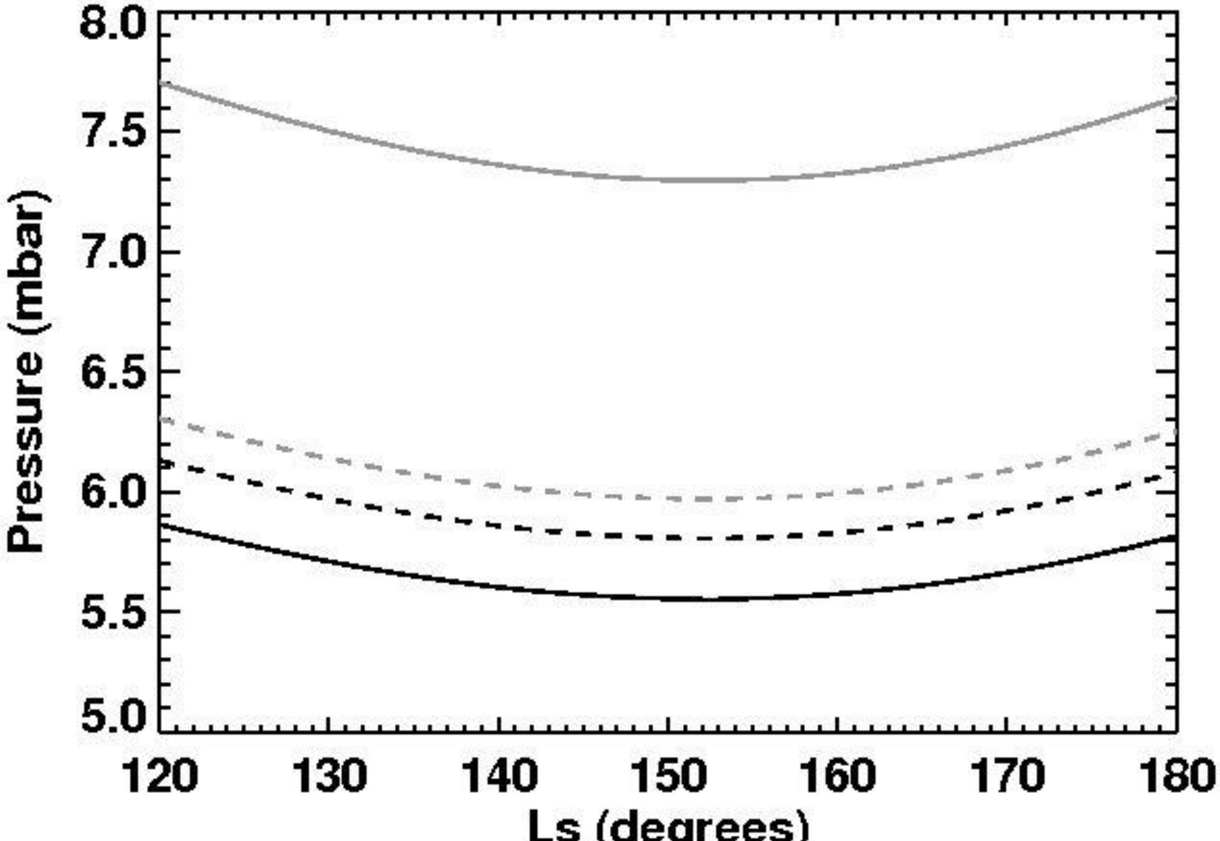
Predictions are good for Phoenix



Predictions for MSL will be tested

Eberswalde: black solid line, Holder Crater Fan: black dashed line, Mawrth Vallis – Site 2: grey dashed line

MSL will land at Gale Crater (grey solid line) at Ls=150



Conclusions

Surface pressure is crucial for safe EDL on Mars

Complicated models are complicated, here we develop a simple empirical prediction as a sanity check

We estimate a diurnal mean surface pressure of 7.30 mbar at Gale Crater with a 1-sigma confidence interval of 2%

The main weakness in this work is the limited local time coverage of the MGS data that constrained H to be 11 km