Preliminary reconstruction of martian atmospheric structure from Phoenix entry measurements

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Abstract P54B-08

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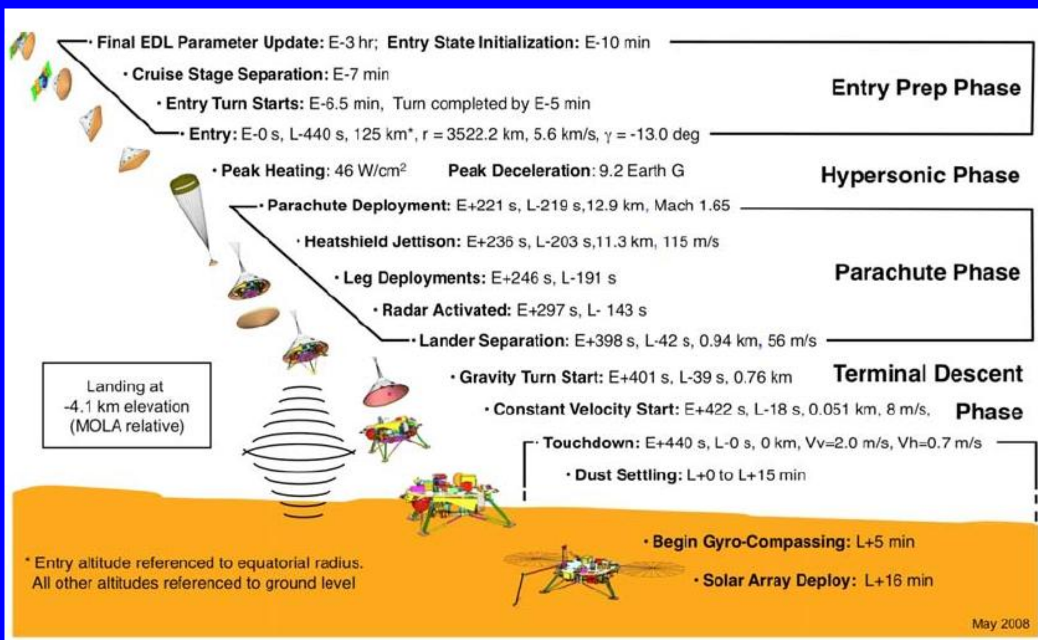
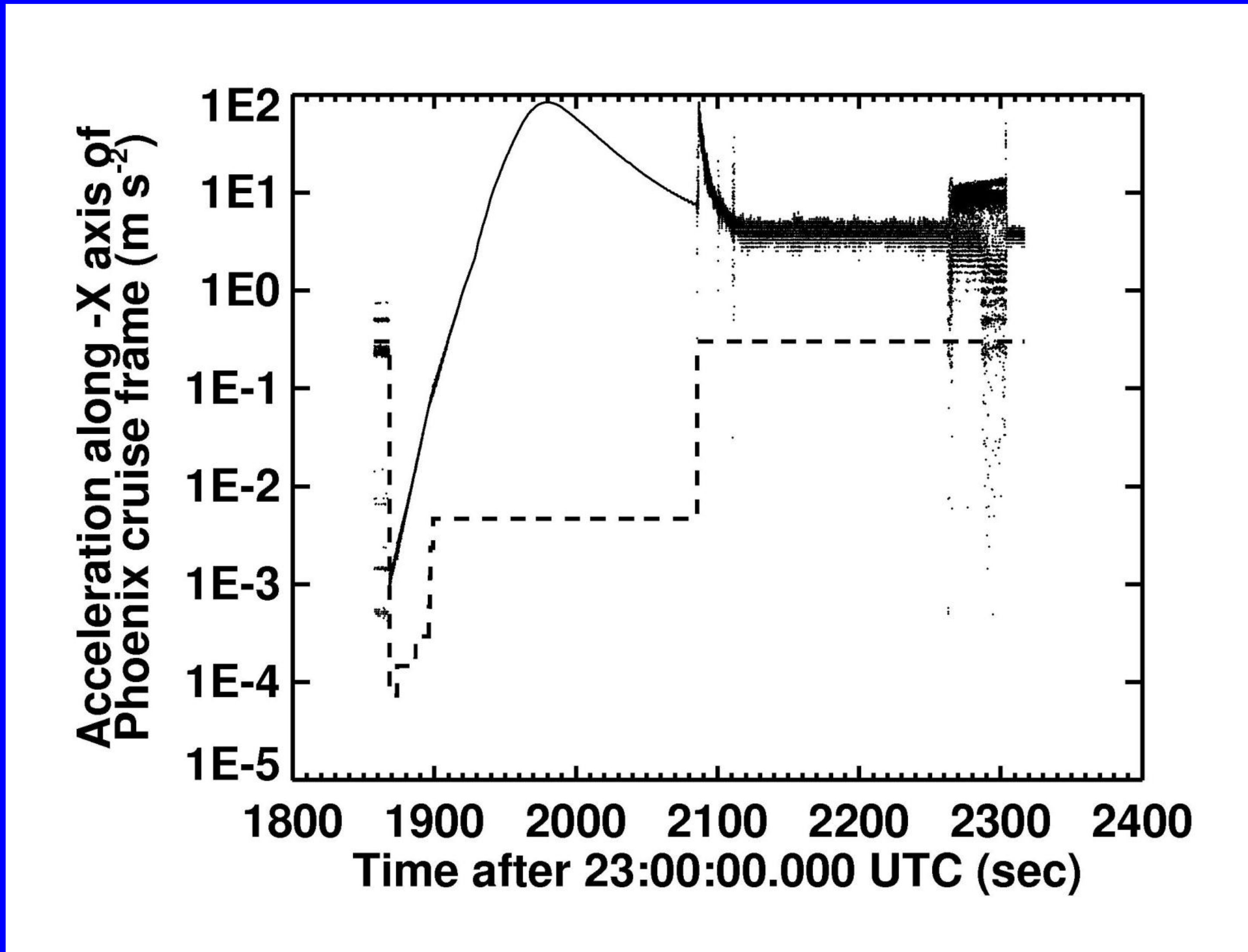
Phoenix atmospheric entry



JPL figure

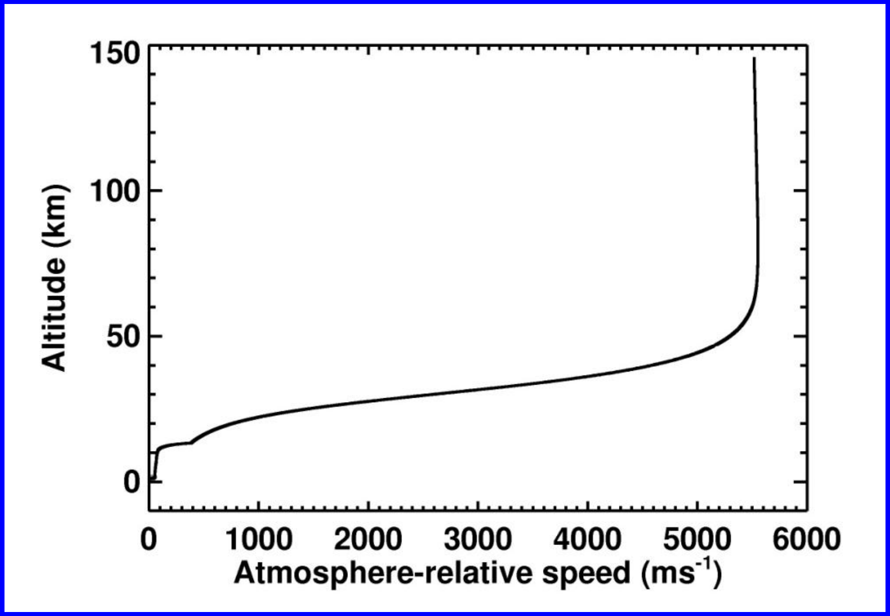
- 25 May 2008
- Landing site at
  - 68.2N, 234.3E
  - -4.1 km (MOLA)
- Ls=77, LST ~16:30
- Ballistic entry with many similarities to Pathfinder and MER
- Accelerometers and gyroscopes on board

Smoothed axial accelerations



WARNING – Currently archived PDS data contain small, but significant, error
Please ask for details

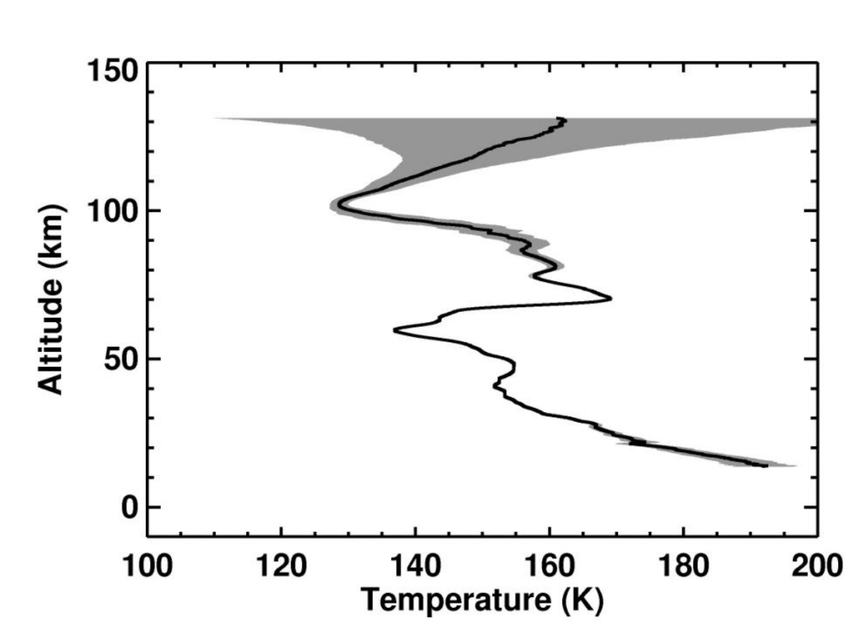
Trajectory reconstruction

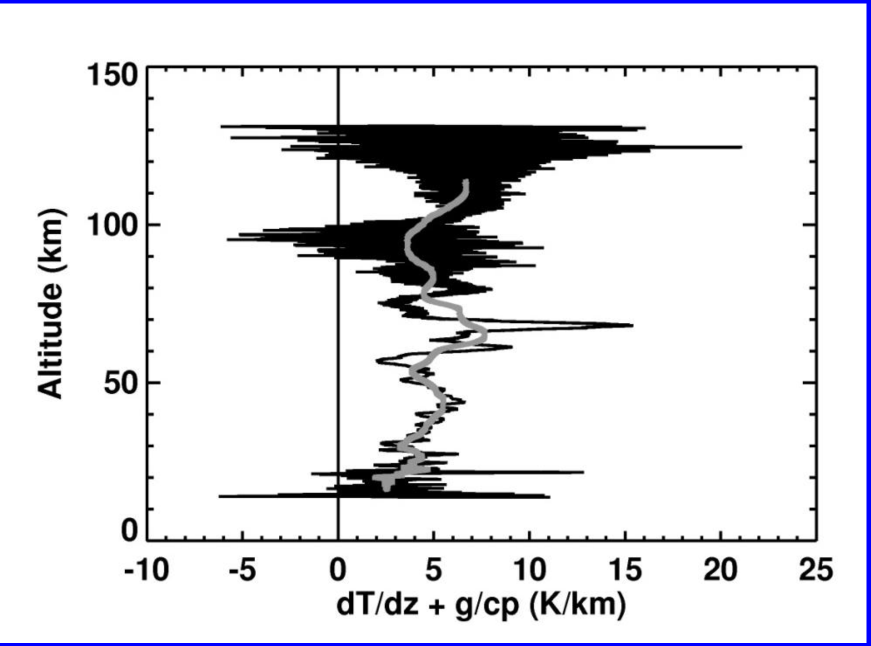


Reconstruction process essentially same as used for Spirit and Opportunity, with exception of gyroscope data

- Attitude found directly using gyroscopes, angle of attack is well behaved
- Parachute deployment at 13.5 km and 391 m/s (Mach 1.7)
- First ground contact at 1.10 +/- 1.49 km above ground level and 6.1 +/- 3.6 m/s

Atmosphere reconstruction

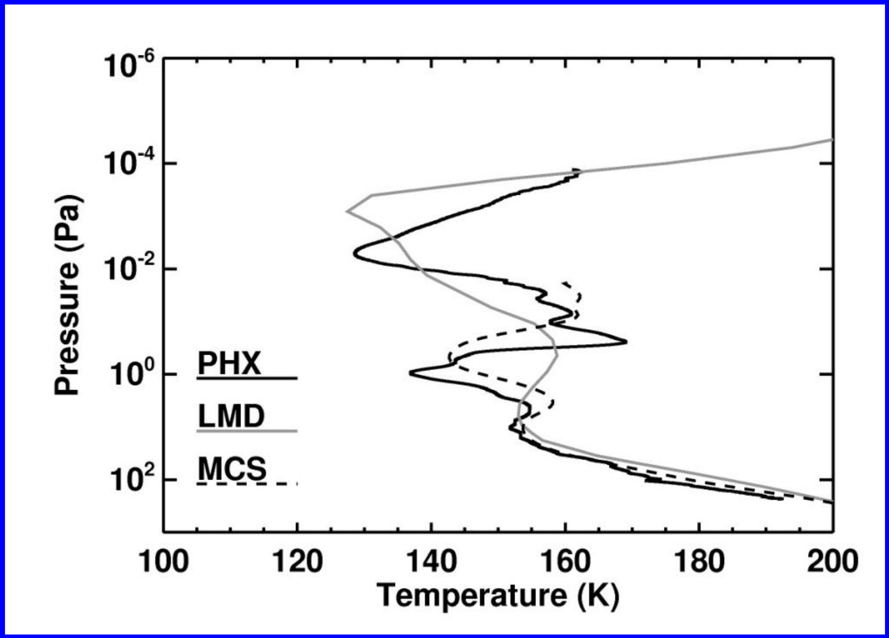


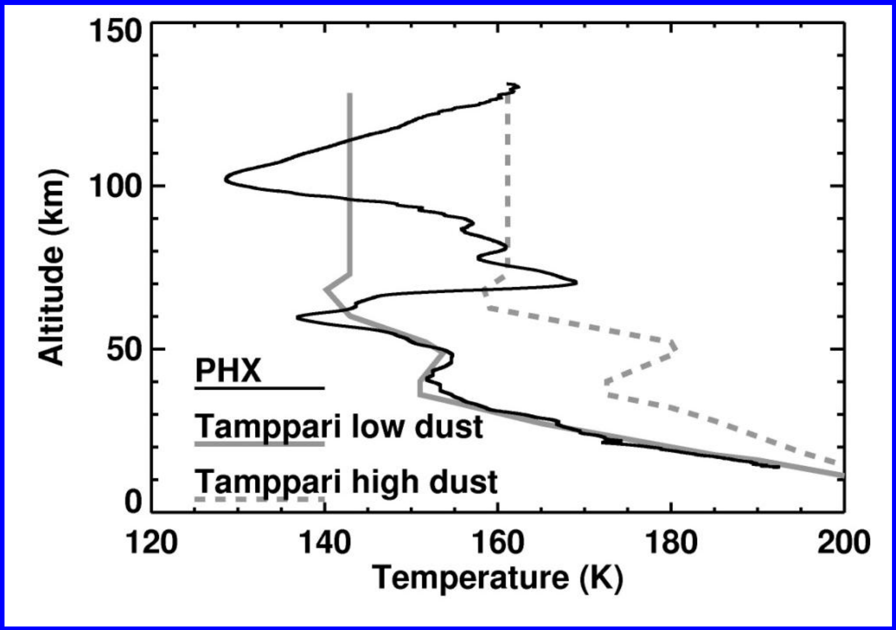


Reconstruction process essentially same as used for Spirit and Opportunity, but with updated aerodynamics and known attitude

Static stability indicates that atmosphere is generally stable, especially around 70 km

Comparison to data/models





MCS profile provided by David Kass, LMD profile from online Mars Climate Database
Low dust and high dust engineering models published by Tamppari et al. (2008)

Agreement with MCS profile is generally good

Both observed T(p) in middle atmosphere differ significantly from LMD prediction

Tamppari low dust model is very similar to Phoenix profile below 60 km

Archiving status

- Data processing has stabilized and hopefully no further revisions are needed
- Ancilliary files produced and everything formatted for PDS
- Data processing documentation written
- Currently inspecting dataset for any problems, hoping to deliver to PDS in early 2010

Conclusions

- Trajectory and atmospheric structure from Phoenix entry reconstructed successfully
- Trajectory appears consistent with previous engineering reconstructions and independent checks
- Large temperature gradients in middle atmosphere
- Atmosphere is stable
- Atmospheric profile is broadly consistent with near-simultaneous MCS observations
- Engineering atmospheric model (low dust case) was very accurate
- LMD model was accurate in lower, but not middle, atmosphere

Backup

Problem with current PDS archive

- Basic data products at PDS are:
  - Vector accelerations and angular velocities in a specific spacecraft-fixed frame
- Data reached Earth in instrument frame, were later transformed into a spacecraft frame for archiving
- A preliminary version of transformation matrix was used here, corresponding to the spacecraft as designed, not as built
- Actual matrix differs slightly in third decimal place, which is actually important
- Straight-forward to correct archived data by multiplying by another matrix
- PDS Atmosphere Node is working on erratum notice