Near-Surface Humidity at the Phoenix Landing Site as Measured by the Thermal and Electrical Conductivity Probe (TECP). T. L. Hudson[1], A. Zent[2], M. H. Hecht[1], S. Wood[3], D. Cobos[4]; [1]Jet Propulsion Laboratory, 4800 Oak Grove Dr., Pasadena, CA 91109; [2]NASA Ames Research Center, Moffett Field, CA 94035; [3]U. Washington, Seattle WA 98195; [4]Decagon Devices, Pullman WA 99163 (troy.l.hudson@jpl.nasa.gov).

Background: The Phoenix Mars Lander is the first spacecraft to explore a sub-polar latitude on Mars where subsurface ice is present [1]. It is also the first with the ability to do direct measurement of the atmospheric humidity in the boundary layer within 2 meters of the surface [2].

A relative humidity device (GE Panametrics MiniCap 2 polymer relative humidity sensor) in the body of the TECP (Thermal and Electrical Conductivity Probe) permitted frequent monitoring of atmospheric humidity at the end of the Phoenix robotic arm. Relative humidity (RH) and temperature data at the sensor are used to compute vapor pressures. Atmospheric temperature from the meterology (MET) mast can then be used to compute true atmospheric RH. When the TECP is inserted into the soil for thermal properties analysis, the humidity sensor is approximately 5 cm from the regolith surface.

Data & Analysis: Polymer humidity sensors are non-linear in their response to relative humidity close to 0 and 100% [3]. TECP sensor data with a relative humidity (with respect to water) less than 1.6% are not well fit by the calibration function and are rejected. To reduce instrumental noise, individual data points at 1 s intervals are averaged into 10 s bins, comparable to or shorter than the response time of the sensor. These methods result in 1,465 data points taken with the TECP in the soil, and 5,972 points with the TECP in air. Figure 1 shows all data converted into vapor pressure plotted against local mean solar time.

The daytime averaged H_2O pressure is steady throughout the mission (L_S 76 to 147) at ~1.8 Pa. Daytime RH was initially <5%, increasing to ~10% late in the mission. Subsequent to about Sol 70, nighttime condensation was observed by lidar [4] and SSI surface images, consistent with high relative humidities. As the season progressed, temperatures dropped and saturation occurred earlier in the evening.

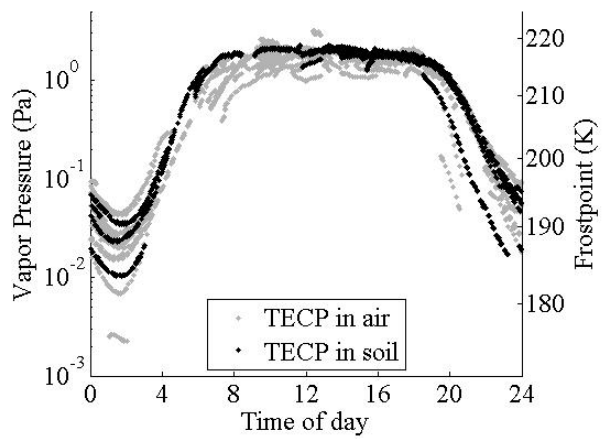

Figure 1: Vapor pressures at Phoenix landing site. Sharp changes occur during twilight hours. Nighttime frost points of 180-195 K are considerably warmer than the mean annual temperature (?? K), suggesting control by vapor pressures lower than that of pure ice (*e.g.*, mineral grain adsorption or hydrated perchlorate salts).

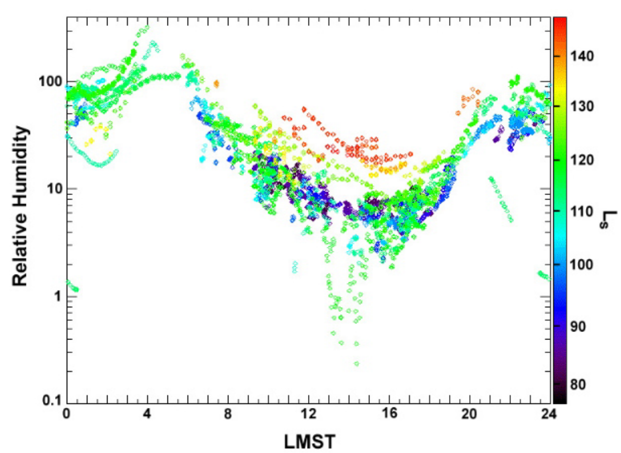

Figure 2: Relative humidity computed using temperatures from unheated TECP needles as a proxy for air temperature. Note that midday RH becomes higher as the season progresses. Excess at 0400h is due to calibration non-linearity near 100% RH.

Comparison with Other Instruments: Figure 3 displays TECP-derived frost points overlain by meteorology (MET) mast temperature data (2 m above surface) for the warmest and coldest days during the mission. The nighttime frost point follows the trend of MET temperatures, suggesting local control of the atmospheric humidity through condensation and adsorption. Mid-day vapor content, however, falls well below the frost point for the coldest day. This is consistent with non-local daytime control of atmospheric vapor such as turbulent column mixing of vapor up to the boundary layer at several km.

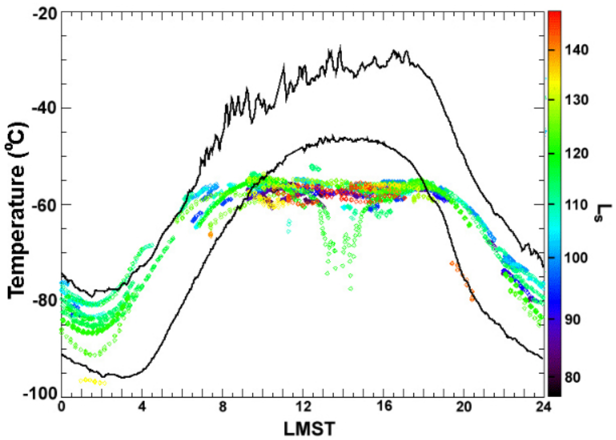

Figure 3: TECP derived frost points (points) overlain by MET temperature data 2 m above surface (lines) for the hottest and coldest days observed.

Despite the reduction in atmospheric vapor content beginning around 1900h, the atmospheric temperature remains above the frost point until several hours later. When the TECP was in-soil and long-term measurements were made during the night, a plateau seen in relative humidity around 2300 – 0000 on sols 55-56 and 70-71 (Figure 4). This is coincident with increased noise in atmospheric temperature data from the MET mast. The TECP and MET systems have entirely separate power and data processing units, so instrumental effects are ruled out. This suggests that it is not until approximately midnight that RH reaches 100% and atmospheric moisture begins to condense.

Low daytime humidities are consistent with mixing of the available moisture through a substantial (a few km) boundary layer. The plateau around midnight is indicative of latent

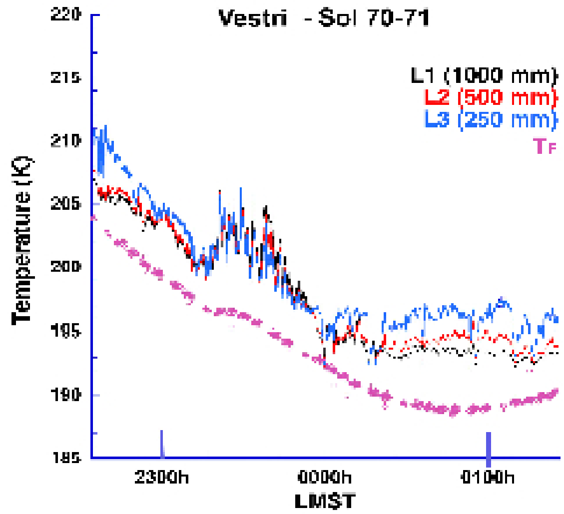

Figure 4: Zoomed data around midnight for Sols 70-71 showing TECP frostpoint data (Lowest line) and MET mast temperatures at three heights. A coincident plateau at 2300-0000h may be due to condensation of atmospheric vapor.

heat release and coincides with radiation fogs in lidar data. The drop in vapor pressure earlier in the evening, before the atmosphere reaches the frost point, suggests that processes besides condensation are taking water out of the atmosphere. Adsorption onto regolith grains may be responsible, but control due to hydrated perchlorate salts cannot be ruled out.

References: [1] Smith et al., JGR, 113, E00A18, doi:10.1029/2008JE003083, 2008. [2] Zent *et al. JGR*, In Press, doi:10.1029/2007JE003052, 2009; [3] Anderson, P.S. (1994), J. Atmos. Oceanic Tech., 12, 662-667; [4] Whiteway et al., LPSC XV, 2009.