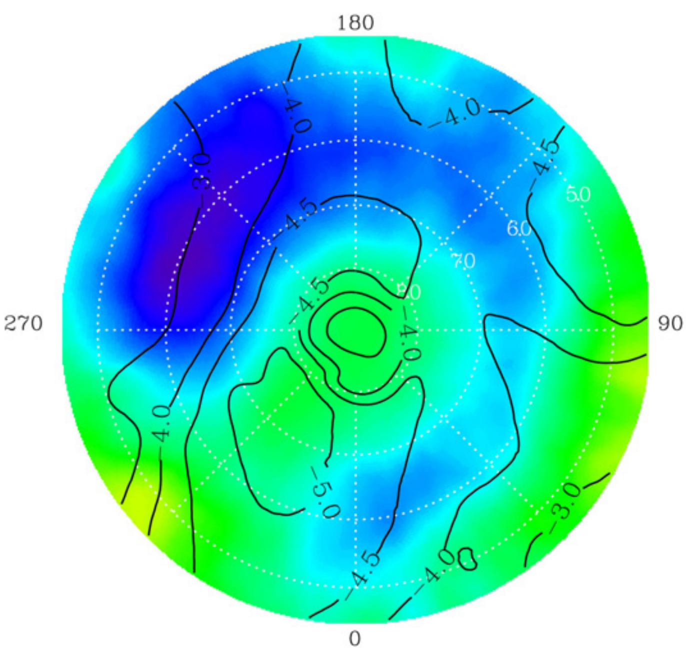
GROWTH OF CO_2 FROST THICKNESS NEAR CHASMA BOREALIS DURING NORTHERN WINTER AND SPRING. W.C. Feldman[1], W.V. Boynton[2], T.H. Prettyman[1], N. Kelly[2], S. Maurice[3], and M. Mellon[4], [1]Los Alamos National Laboratory (Los Alamos, NM 87545 USA; wfeldman@lanl.gov),. [2]Lunar and Planetary Laboratory (University of Arizona, Tucson, Az), [3]Observatoire, Midi-Pyrenees (31500 Toulouse, France), [4]University of Colorado (Boulder, Co).

Epithermal neutron fluxes measured using the Neutron Spectrometer component of the Mars Odyssey Gamma-Ray Spectrometer suite of instruments were studied to determine the spatial and temporal dependence of CO_2 frost cover of the north polar cap for L_s between 329° and 99° areocentric longitude. This time period spans the late northern winter through summer solstice. In the absence of a CO_2 cover, the entire basement terrain poleward of about +55° latitude is very rich in H_2O. The consequent enhanced abundance of hydrogen in near-surface soils leads to an anomalously low flux of outwardly leaking epithermal neutrons, which is a prominent signature of epithermal neutron maps measured after about L_s = 90°. Because the epithermal neutron flux rises monotonically with increasing thickness of the CO_2 frost cover, it provides a robust measure of the CO_2 thickness in space and time.

Eight epithermal neutron maps were constructed from time series data between 18 Feb. and 26 Nov., 2002. Each map had an equal area 2° x 2° equatorial bin size. These maps were first smoothed and then interpolated to 32 time steps to make a movie of the changing appearance in epithermal neutrons of both the northern and southern polar caps. The original time-series data were also combined into eight digitized arrays at roughly equal L_s intervals of 15° areocentric longitudes, and a bin size of 5° latitude by 10° longitude. This spatial bin size is close to the 10° of arc spatial resolution of the measurements.

The northern portion of one of the movie frames for data measured just before the Vernal equinox, L_s=0°, is shown at the left in Fig. 1. Shown at the right is an albedo image of the north polar cap. Two slices of the digitized data corresponding to longitudinal variations of measured epithermal neutron counts in 19.8 s time intervals as a function of latitude at L_s=336° and as a function of areocentric longitude at 77.5° latitude, are shown in Fig. 2.



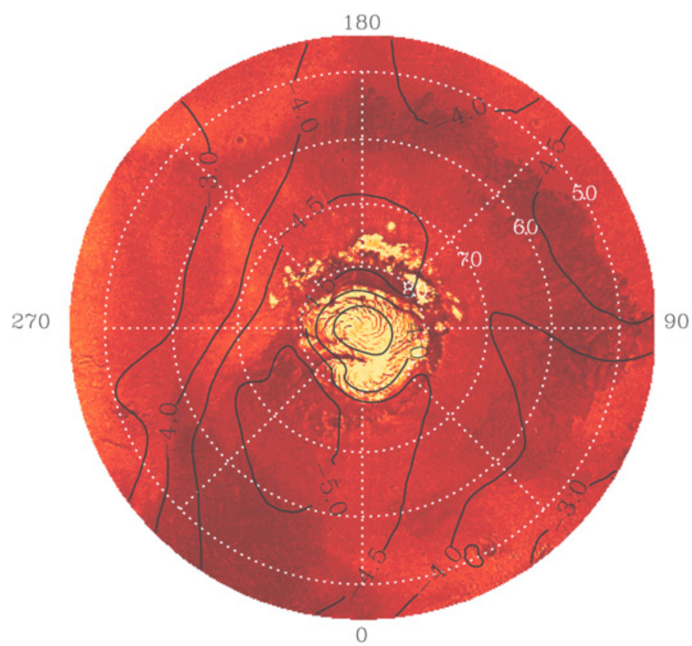


Figure1: Orthographic projections of epithermal neutron counting rates (left panel) and the visible albedo (right panel) of the north pole of Mars. In the epithermal neutron map, lowest counting rates are deep blue and highest are yellow, which correspond to the thinnest and thickest CO_2 frost covers, respectively. Contours of topography are superimposed on both maps.

Starting first with the epithermal neutron map in Fig. 1, a horse-shoe shaped equatorial margin of the water-rich polar terrain (colored deep blue) is visible because both the central portion of the cap and a meridional lane centered on about -45° East longitude are covered with a thick deposit of CO_2 frost (colored green). At this time, the thickest portion of the deposit consists of two meridional lanes centered on about -45° and 0° East longitude, respectively that connect through Chasma Boreale.

The time dependence of this pattern is shown in the left-hand panel of Figure 2 at a latitude of 77.5°. As time increases, a peak in the epithermal counts (corresponding to the thickest portion of the CO_2 deposit) appears first at 310° longitude at L_s=336°, grows in height and width at L_s=354°, and then diminishes to a double peak with maximum at 335° longitude at L_s=45.3°. The latitudinal dependence of this pattern is shown in the right-hand panel of Figure 2 at L_s=336°. Here we see that the thickest portion of the entire northern polar cap at this time is between 70° and 80° latitude and about 310° East longitude. Although not shown here, at later times, the thickness of CO_2 at the north pole overtakes that at lower latitudes, until both eventually sublime completely to replenish the atmosphere by L_s=99°.

We note that the build up of CO_2 frost occurs first at the deepest portion of the Vastitas Borealis formation where the atmosphere is thickest. It then proceeds poleward through Chasma Boreale (also corresponding to the thickest atmosphere at that latitude) eastward to its head before proceeding northward to the pole. This behavior can be explained by the higher CO_2 frost point temperatures (the temperature at which CO_2 vapor will begin to condense) at the higher pressures that exist within, and just beyond the mouth of Chasma Boreale. We estimate that the frost-point temperature in northern Acidalia near the mouth of Chasma Boreale (at a mean altitude of about –5 km relative to the Martian mean radius) is about 0.7 K above that poleward of 85° latitude (at a mean altitude of -3.8 km).

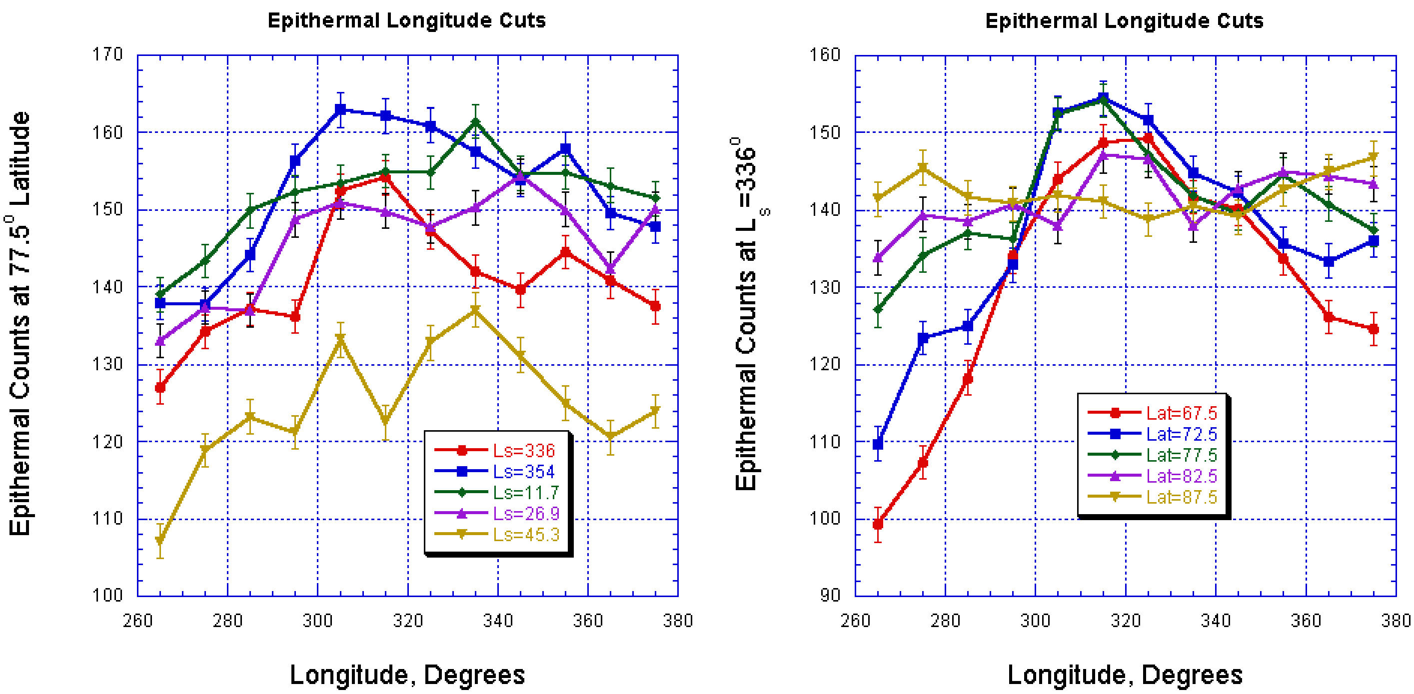


Figure 2: The longitudinal dependence of epithermal neutron counts for different areocentric longitude, L_S, intervals (left-hand panel) and at L_S = 336 degrees for different latitude bands (right-hand panel).