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A reanalysis of Apollo 15 and 17 surface and subsurface temperature series

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The Apollo Lunar Surface Experiment Package (ALSEP) at the Apollo 15 and 17 sites contained a heat flow experiment that monitored surface and subsurface temperatures. One important result from the analyses of these data is that the heat flow at the Apollo 15 site is apparently significantly greater than at the Apollo 17 site (21 vs. 16 mW m^{-2}). The goal of this project is twofold. First, a reanalysis of the Apollo Heat Flow Experiment data using improved modeling techniques will offer a more precise estimate of the heat flow at the Apollo 15 and 17 sites, which lie within the Procellarum KREEP Terrane and Feldspathic Highlands Terrane, repsectively. Secondly, as a byproduct of analyzing the surface temperatures, we will attempt to constrain variations in the Sun's total irradiance.

In the final publication by the Apollo Heat Flow Experiment team, the heat flow was estimated in a two step approach. First, the thermal diffusivity was estimated by the attenuation with depth of the annual thermal wave. Second, the mean temperature profile was estimated by removing the diurnal, annual, and short-term transient signatures from these temperature series. The heat flow was then obtained by multiplying the temperature gradient by the thermal conductivity.

The above analysis can be improved upon in several ways. Most importantly, when calculating the mean temperature gradient, the measured time series were not corrected for other periodicities, such as the 18.6-year precession of the lunar orbit. We have found that the surface temperature varies with an $\sim$18-year periodicity, and that this significantly modulates the amplitude of the annual signal. In particular, the annual peak-to-peak difference in maximum monthly temperatures varies from $\sim$4 to 8 K, and this will effect the subsurface temperatures over the entire depth range of the

heat flow experiment.

We propose to improve upon the initial analyses by using a forward modeling approach. By use of the JPL ephemerides, and knowledge of the surrounding topography, we will construct a radiation model of the Apollo 15 and 17 sites, solve the time-dependent heat-conduction equation, and determine thermal conductivity profiles and heat flows that are consistent with the ovservations.