RESTORATION AND REEXAMINATION OF APOLLO LUNAR DUST DETECTOR DATA FROM ORIGINAL TELEMETRY FILES. Marie J. McBride[1], David R. Williams[2], and H. Kent Hills[2], [1]Florida Institute of Technology, 150 W. University, Box 6647, Melbourne, FL 32901, mmcbride2009@my.fit.edu, [2]NSSDC, Code 690.1, Goddard Space Flight Center, Greenbelt, MD 20771, david.r.williams@nasa.gov, howard.k.hills@nasa.gov.

Introduction: We are recovering the original telemetry (Figure 1) from the Apollo Dust, Thermal, Radiation Environment Monitor (DTREM) experiment, more commonly known as the Dust Detector, and producing full time resolution (54 second) data sets for release through the Planetary Data System (PDS). The primary objective of the experiment was to evaluate the effect of dust deposition, temperature, and radiation damage on solar cells on the lunar surface. The monitor was a small box consisting of three solar cells and thermistors mounted on the ALSEP (Apollo Lunar Surface Experiments Package) central station. The Dust Detector was carried on Apollos 11, 12, 14 and 15. The Apollo 11 DTREM was powered by solar cells and only operated for a few months as planned. The Apollo 12, 14, and 15 detectors operated for 5 to 7 years, returning data every 54 seconds, consisting of voltage outputs from the three solar cells and temperatures measured by the three thermistors. The telemetry was received at ground stations and held on the Apollo Housekeeping (known as "Word 33") tapes, made available to the National Space Science Data Center (NSSDC) by Yosio Nakamura (University of Texas Institute for Geophysics). We have converted selected parts of the telemetry into uncalibrated and calibrated output voltages and temperatures.

Conversion of Raw Telemetry: The Word 33 telemetry data contained 90 engineering channels, 6 of these channels were allocated to the DTREM experiment (3 solar cell outputs, 3 thermistor outputs). The telemetry tapes did not have information on the translation of raw telemetry into output voltages and temperatures, but microfilm archived at NSSDC contained times and raw and calibrated output voltages and temperatures for Apollo 14 and 15 at the 54-second resolution. The translation from telemetry to raw output was accomplished by aligning the collection times from the digital telemetry and the microfilm and creating a translation table. (A translation table was necessary because there was not a simple correlation equation.) Through further analysis of the archived microfilm, pages containing keys to the data calibration were found and applied to the raw data to digitally recreate the microfilm data. The translation tables and calibrations have been applied to a subset of the digital data. We do not currently have the information to complete translations and calibrations on the Apollo 11 and 12 data but will be releasing the raw data soon.

Previous Studies: Much work was done on these data originally [1, 2]. The data from the Apollo 14 and 15 dust detectors (P.I. Jim Bates) was archived at NSSDC in the form of computer printouts of time and raw and calibrated voltages and temperatures which were filmed and stored on 38 reels of microfilm. These were later scanned and saved as digital image files as part of the PDS Lunar Data Node effort at NSSDC. The original P.I. magnetic tapes were misplaced before they could be archived [3]. The only digital forms of the DTREM data in existence are the raw telemetry and a set of 7-track magnetic tapes with some of the Apollo 11, 12, and 14 data held by the Apollo 12 instrument P.I., Brian O'Brien [4]. O'Brien is currently attempting to read the data from these tapes, and also has paper charts which were plotted in 1969 and 1970 with a lower time resolution (3.6 minutes) which he has recently re-examined and drawn some conclusions about effects of rocket exhaust and natural forces on the behavior of dust.

Examination of Restored Data: With our higher resolution digital data we plan to examine some of these effects and extend the analysis of the dust detector data beyond what was possible previously. For example, we have looked at the effects of the Apollo 12 Lunar Module ascent using the new data. The Apollo 12 dust detector was configured differently from the other monitors. It had three identical solar cells facing in different directions, one horizontal cell facing upward and two vertical cells, one facing east and one facing west. At LM ascent the 54-second data (Figure 2) clearly show the "cleansing" effect of the LM ascent on the horizontal cell, as seen by O'Brien [4] in the 3.6-minute data plots. The output jumps by 4 counts from immediately before LM ascent to immediately after. The 1-count rise that occurs 7 minutes later appears to be the natural rise due to the increase of the Sun's elevation angle, judging from subsequent behavior of the data, and not a further post-ascent cleansing of the cell as previously posited [4]. Other properties of the dust and the solar cells, such as deposition, electrostatic effects, and radiation and thermal damage, can be examined in more detail using the full time-resolution dataset.

Future Plans: We will present other results from analysis of the restored subset of the data we currently have. Eventually we will convert all the Apollo 14 and 15 Dust Detector telemetry into calibrated temperature and voltage data and archive and release these through the Lunar Data Node of the Planetary Data System. We will also release the raw Apollo 11 and 12 data through PDS, and in the future we hope to obtain the translation and calibration information necessary to fully restore these data as well.

References: [1] Bates, J.R., et al. (1969) Apollo PSR, NASA SP-214, 199-201, 1969. [2] O'Brien, B. J., et al. (1970) J. Appl. Phys., 41, 4538–4541, 1970. [3] Bates, J.R., and Fang, P.H. (2001), Solar Energy Mat. and Solar Cells, 68, 23-29. [4] O'Brien, B.J. (2009) Geophys. Res. Letts., 36, L09201, DOI: 10.1029/2008GL037116.

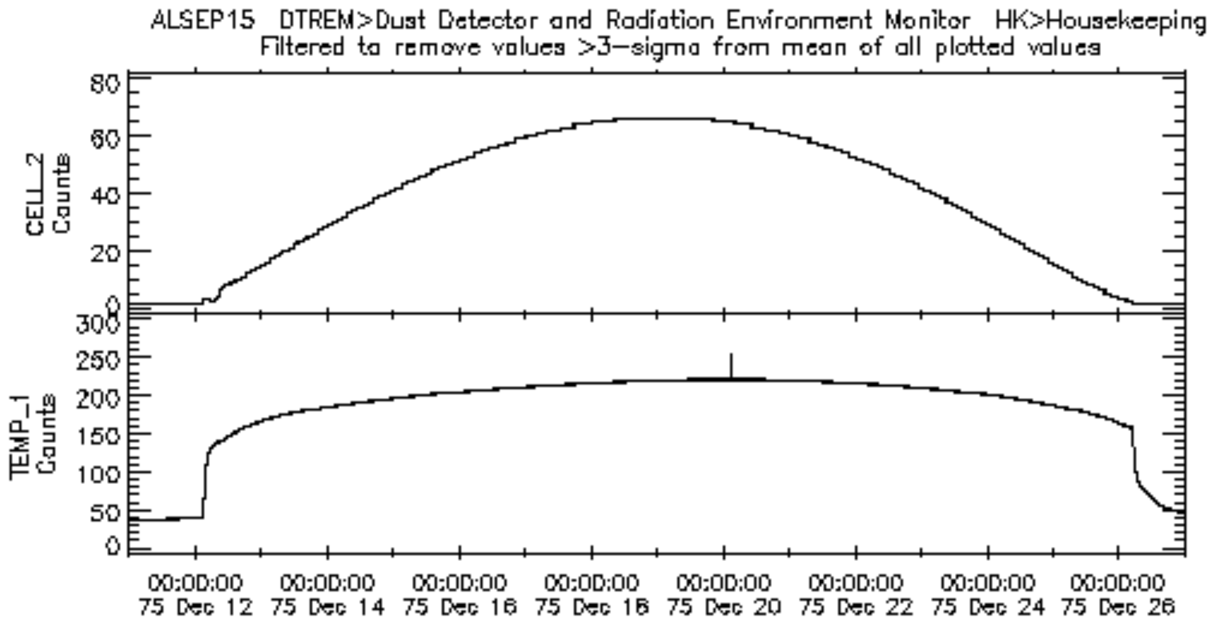

Figure 1 – Sample output of the raw telemetry data from the Apollo 15 DTREM showing solar cell and temperature counts measured in December 1975.

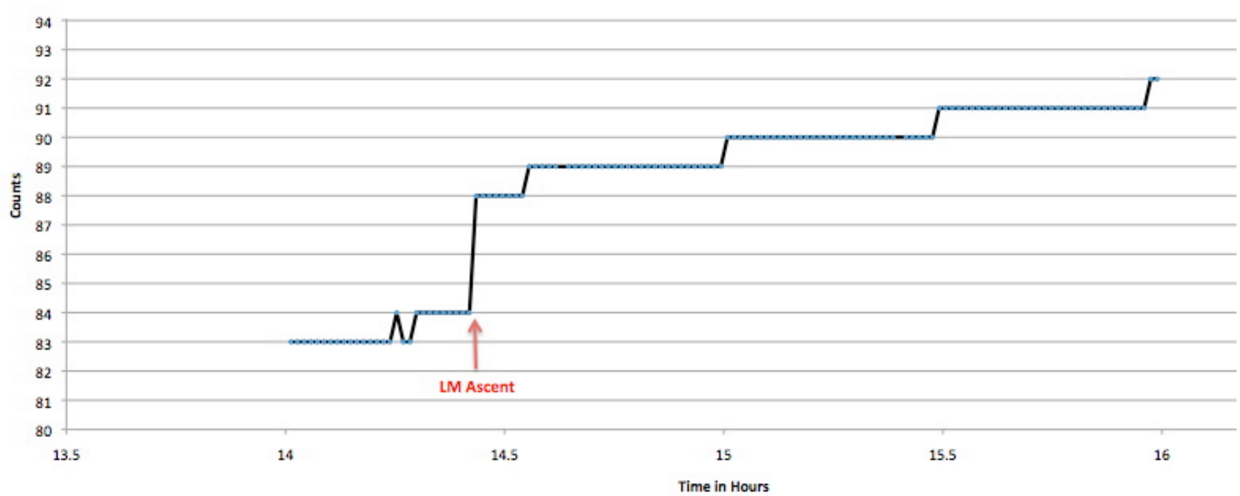

Figure 2 – Output from the Apollo 12 horizontal (upward-facing) solar cell in raw telemetry counts representing measured voltage at the time of the Lunar Module ascent (1969 November 20 14:25:47 UT) showing the sudden increase at the time of ascent, followed by a steady rise as the solar elevation increases.