LTES Donaldjohanson PDS-SBN Review

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1. Overview

This is a data review of the L'TES observations of asteroid Donaldjohanson. Section 2 covers the S/W tools and methodology that I used for the review. Section 3 is my review of the documentation. Section 4 covers the review of the data, including recreating the calibration pipeline based on the SIS. I will point out that my familiarity with the calibration process of other TES family instruments helped expedite the review. Section 5 is a summary of answers to the PDS suggested questions and a list of my recommendations.

2. Methodology

The data review and analysis were conducted on a Windows OS platform using the Windows PDS4_Viewer and my own IDL v8.9 code. I conducted manual cross-referencing checks between labels and values form the PDS4_Viewer and IDL results using pds_read.pro. My replication of the calibration pipeline was conducted in IDL, using a slightly modified version of the pipeline code I used for the Dinkinesh review. In cases where the IDL could not be read (the calibrated data file), I used the PDS4_Viewer view-label function to identify data offsets, type and sizes. I then used IDL functions that read binary data to import data for processing.

3. Documentation

Documentation was not formally part of this review. However, the July 2024 version of the SIS could use some updates. For example, Table 3-4 identified Local Time as stream text. In the PDS4_Viewer, it's identified as an ASCII table. The version of the PDS4_Viewer that I was using could not read the ASCII table. However, I was able to extract the data using the data offset, extracting the data as bytes, and converting to string. All local times stored were "99:99:99." I also had to use this work-around to read the UTC table.

4. Data

4.1. Raw HK data only.

I was able to validate that IDL and the PDS4 Viewer could read, access, and display the data.

4.2 Raw data

I was able to validate that IDL and the PDS4 Viewer could read, access, and display data.

4.3 Calibrated data

The major issue here is that IDL was unable to read the science data file. Attempts to use IDL pds_read.pro resulted in a "End of file encountered" error suggesting there is missing data somewhere in the file. While this was inconvenient, I was still able to proceed with testing the documented calibration pipeline. The PDS4_VIEWER was able to read and export all data arrays

that I tried except the local_time and utc arrays (tables). The local_time and utc arrays (tables) was not crucial to my review and analysis. I know that PDS no longer supports IDL and I have a viable work-around. I may have an older version of PDS4_Viewer, but I would like to think it should be able to view the table formats. I was unable to find if there is a more current version due to webpages being migrated. I suspect that the PDS4_Viewer is a PDS lien, not an LTES instrument team lien.

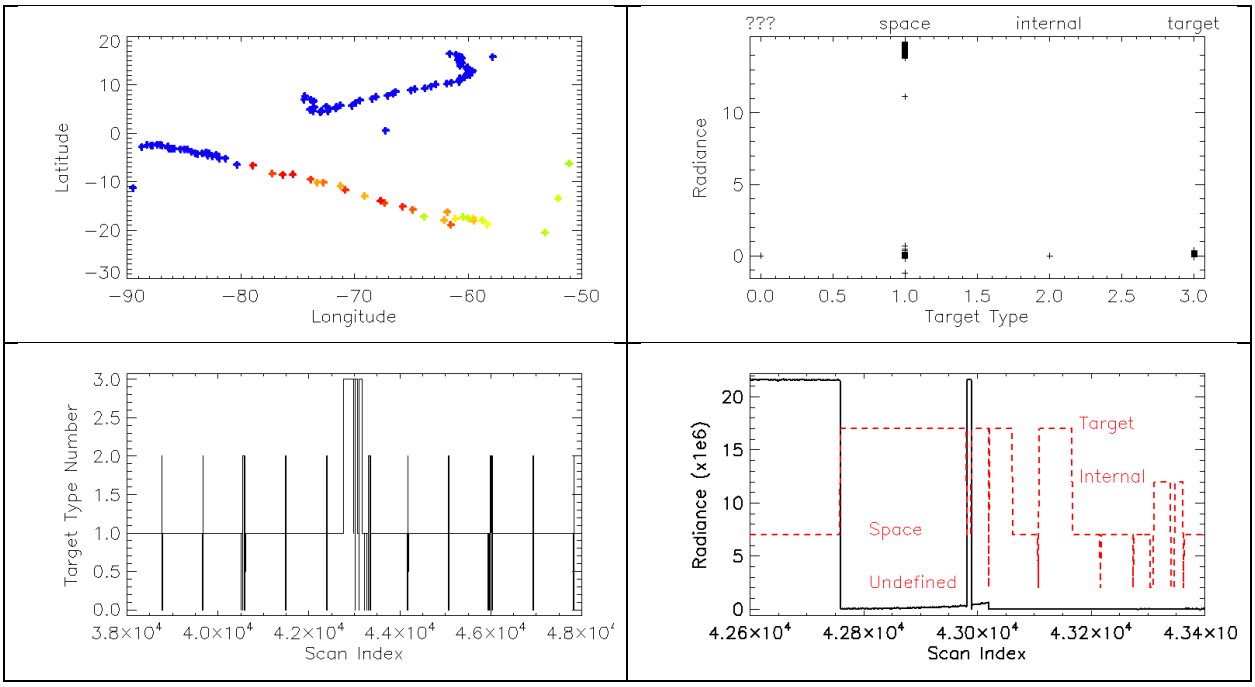

Figure 1: Four panel view of calibrated radiance and target type number. (UR) Latitude v. longitude. Color indicates radiance at index 60, with warm colors hot and cool colors cold. The dark blue is zero radiance. (UR) Radiance (index 60) v. target type number. Why are there hot space looks? (LL) Target type number v. time (scan index). (LR) Radiance (index 60) v. time (scan index). The red dashed lines show target type. There are several observations of target type 0, which is not defined in the SIS. There is also hot and cold space looks, as well as target observations with no valid calibrated radiance.

Geometry and target type data were very useful in identifying what the LTES instrument was observing. Fig.1 is a four-panel figure that shows both hot and cold space looks. How does one get a "hot" space look? Fig. 1 also shows that only some of the target observations have valid calibrated radiance. The departure target observations do not have associated calibrated radiance, even when voltage spectra were available. Were these data somehow contaminated? Target type number definitions are not in the PDS labels, you must go to the SIS. Observation type =0 was never identified as to what LTES was observing.

The calibration pipeline appears valid. Fig. 2 shows a comparison of a calibrated radiance spectrum using my pipeline (black) and the LTES pipeline (red). They match within the level of the noise. The calibrated spectrum is also reasonable with a T~260K and a FOV fill fraction of 6%. The fill fraction for an 8 km x 3.5 km rectangle at the same distance as LTES is from Donaldjohanson would be ~8%. Given that the asteroid is a peanut, not a rectangle, and that the surface has a range of temperatures, a 6% fill factor seems reasonable.

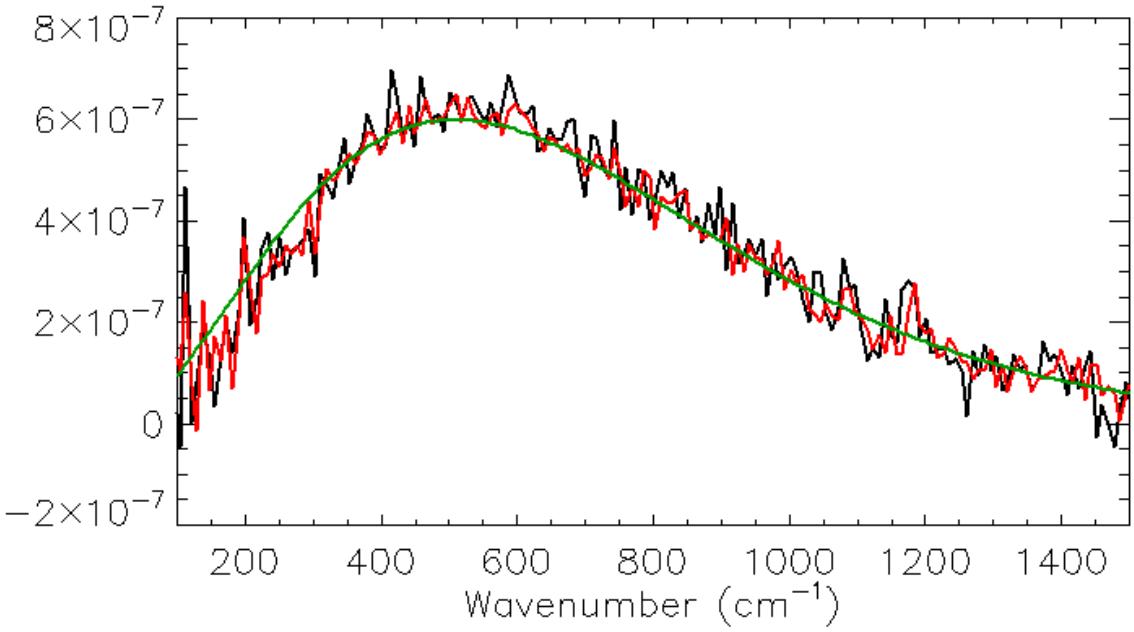

Figure 2: Calibrated Radiance vs. wavenumber for SCLK = 798443149. The black curve was generated using my IDL pipeline using a single space look (798443089) and a single calibration look (798441913). The red line is the LTES pipeline calibrated spectrum. The green line is my "eyeball" fit Planck curve for T=260 K with a FOV fill fraction of 6%.

The "hot" space looks bothered me. Fig. 3 shows an example of one of them (SCLK = 798441111). The calibrated spectrum is consistent with "seeing" a T=270K object that fills 50% of the FOV. What is LTES looking at? Is this the same reason the departure observations were not calibrated? Is the scene being contaminated by the spacecraft being in the FOV?

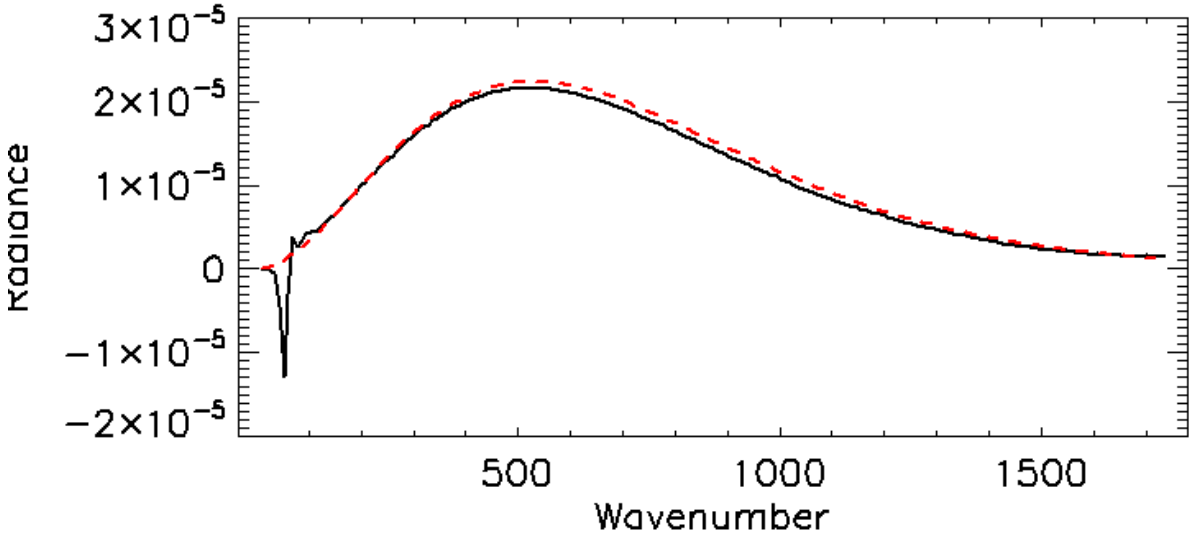

Figure 3: Radiance v. wavenumber for a "hot" space look (SCLK = 798441111). Black is the calibrated spectrum and red is an "eyeball" fit to a Planck function with T~270K and FOV fill factor of ~50%. Is LTES "seeing" part of the spacecraft?

5. Summary

5.1 PDS Labels and Meta Data

- Are the descriptions and scientific content contained inside the PDS labels sufficient to understand their corresponding data products?
    - Generally yes, but target_type_number needs additional documentation. Perhaps "hot" space needs its own number. Also – zero is never defined.
- Is all significant meta data included directly in the PDS labels?
    - Yes
- Do the labels provide all essential descriptions of data values directly in the label, instead of deferring them to external references or documentation?
    - Target type number is not sufficiently defined in the labels.
- Can the data be read programmatically using only the information contained in the PDS labels?
    - Yes – thank goodness

5.2 Data

- Does the data look physically reasonable when examining it by eye or via a display tool?

    - Yes
- When displaying the data as plots or images, are there any unexpected deviations?
    - There is for target_type_numbers. There is “Hot” space and “Cold” (as in no calibrated data) target observations.
- Formulate a scientific inquiry and attempt to use the data to answer the inquiry.
    - Temperature (260 K) and fraction (6%) of FOV for a calibrated fit appear reasonable.
    - Hot space looks like T~270 at ~50% of FOV – are we looking at something on the instrument or spacecraft?
    - Target data that does not have calibrated radiance – is this because the FOV contains part of the spacecraft?
- If reviewing both raw and calibrated data, attempt to calibrate a raw data file.
    - Yes – example provided.

5.3 My Issues

- Cannot read in using IDL read_pds, likely because of the local time and UTC tables.
    - The version of pds4_reader (may be an older version) cannot access local time or UTS tables either
    - The work-around is either use the pds4_reader to export the data (except for the tables) or use pds4_reader to identify offset and data type, size to read in just that portion of the calibration file.
    - This may be a lien for the PDS SBN node.
- Target_Type_Number appears to have issues.
    - Target type 0 is not defined.
    - Target type 1 is space looks, some of which appear hot. Somewhere this should be explained. Maybe “hot” space needs its own target type number.
    - Target type 2 is internal calibration looks.
    - Target type 3 (target) where there is both calibrated data and not calibrated data. Somewhere this should be explained.
    - This is likely a lien for the LTES team.

5.4 Final comments

- Calibration pipeline looks great! No issues here.