Deep Impact/EPOXI: Influences of the IR Temperature Measurements on the Calibration Pipeline

By Dennis Wellnitz, Mike A'Hearn, Brian Carcich, Lori Feaga, and Silvia Protopapa
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In the Deep Impact/EPOXI calibration pipeline, two of the temperatures in the FITS header are used for calibrating HRI-IR spectra: OPTBENT [OPTical BENch Temperature] and IRFPAT [IR Focal Plane Array Temperature]. If the externally supplied smoothed version of OPTBENT [SMOBENT] is available, which sometimes has included coherent noise removal, SMOBENT is used in place of OPTBENT in the calibration procedure; a non-negative value of the SMOBENT keyword indicates that SMOBENT is available. Note that only 3-4 decimal places of SMOBENT are saved in the header, which in some cases can introduce a digital precision issue into the calibration. The OPTBENT or SMOBENT temperature is used in the creation of the wavelength map for each spectrum, in the HRI-IR anti-saturation filter flat field, and in the calculation of the calibration constant. The OPTBENT and IRFPAT temperatures are used in the scaling of an appropriate dark frame if a time-adjacent dark is not available. For dark model temperature scaling the bench temperature used (OPTBENT or SMOBENT) is saved in TEMPSIM and the FPA temperature used is saved in TEMPFPA.

These instrument temperatures are encoded to 12-bit resolution by analog to digital converters, with the least significant bit equal to about 0.015 K. In addition to the random noise in these temperature measurements, we see occasional single outliers that are tens of Data Number (DN) away from the surrounding points, as well as more occasionally coherent bi-directional noise signatures with an amplitude of tens of DN persisting for 10-20 seconds. These are both non-physical in that the temperature cannot discontinuously change so rapidly due to the thermal inertia of the instrument components. We see both of these types of noise in all instrument temperature channels, with the coherent bi-directional noise signature marching over hours successively through the various temperature digitization channels, so we conclude that these are noise signatures common to the instrument temperature digitization circuitry and that the coherent bi-directional noise signature is most likely picking up interference from other spacecraft electronic circuitry.

The source files for OPTBENT and the number of observations (not exposure IDs) for which OPTBENT was used are given by the following table.

sourcefile	count	
farnham_f3h.bash	286	Tony, 2006-03-10: 8 ExpIDs from 6002005 to 6002200
hartley2_temps.tsv	52579	Brian, 2014: per-ExpID non-RM OPTBENTs
lunar_temps.tsv	7330	Brian, 2014: per-ExpID non-RM OPTBENTs
new_ir_temps_184.xls	567	Don ca. 2005-11: 20-minute AMMOS RM?
new_ir_temps_185.xls	1235	Don ca. 2005-11: 20-minute AMMOS RM?
T_smooth.idl	4148	Don ca. 2005-11: ?

Note that the IDL outlier-removing filter "resistant-mean" was used for smooothing except where there is a note that non-resistant-mean (non-RM) OPTBENTs were used.

All HRI-IR calibration efforts to date have used OPTBENT and IRFPAT, whether individual values or smoothed values as described above, from the calibration pipeline. We have recently discovered that the long-standing difference of approximately 0.9 K between the calibration pipeline values in the FITS headers and the spacecraft tabulations of the same instrument temperatures (as archived in Hampton, 2007 and Carcich, et al., 2014b) are due to a different DN temperature algorithm encoded in the Advanced Multi-Mission Operations System (AMMOS) spacecraft pipeline. (Carcich, 2014a, describes the two different sets of coefficients used by the calibration pipeline and AMMOS software for converting raw thermal measurements to temperatures.) Since all calibration efforts to date have relied on the temperatures in the pipeline at the science team's Science Data Centers at the University of Maryland and Cornell University, any temperatures used from the tables of spacecraft temperatures (Hampton, 2007 and Carcich, et al., 2014b) should be adjusted downward, i.e., use T_s/c - 0.9K, before applying them in any steps of the calibration process.

References

Carcich, B., 2014a, Deep Impact/EPOXI: Two Domains of Polynomial Coefficients Used To Convert Raw Thermal Measurements To Temperatures, archived in Deep Impact /EPOXI Documentation Set V4.0, DI-C-HRII/HRIV/MRI/ITS-6-DOC-SET-V4.0, NASA Planetary Data System, 2014.

Carcich, B., D. Hampton, and S. McLaughlin, 2014b, EPOXI HRII/HRIV/MRI Instrument Temperatures V3.0, DIF-CAL-HRII/HRIV/MRI-6-EPOXI-TEMPS-V3.0, NASA Planetary Data System.

Hampton, D., 2007, Deep Impact HRII/HRIV/MRI Instrument Temperatures V1.0, DIF-C-HRII/HRIV/MRI-6-TEMPS-V1.0, NASA Planetary Data System.