Implementation of Electronic Crosstalk Correction to Terra PV LWIR Bands in Collection 6.1

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In support of the upcoming Collection 6.1 reprocess, MCST applied a correction for the electronic crosstalk (Xtalk) contamination in the Terra MODIS photovoltaic (PV) long-wave infrared (LWIR) bands 27-30. Using scheduled lunar observations, the correction coefficients are derived and applied to the on-board calibrator (OBC) data and Earth-view (EV) data to correct the L1B calibrated radiance for bands 27-30. This results in a significant reduction in the image striping and radiometric biases in the L1B data. This document summarizes the relevant changes introduced in C6.1 L1B look-up-table (LUT) production as compared with C6. The changes are exclusively on bands 27-30, and other thermal emissive bands (TEB) are not affected.

Inclusion of PV LWIR coefficient:

A new PV LWIR coefficient PVLW_XT_coeff, is introduced into C6.1 LUT to provide the linear correction coefficient $c_{i,j}$. Each detector in bands 27-30 has a unique set of coefficients that relate to the amount of contamination sent from all 40 detectors of bands 27-30. The coefficients are derived from near-monthly lunar observations. The LUTs are, however, only updated if the change in the crosstalk contamination induces a sufficiently large change in the trending value of b_1, the linear calibration coefficient of TEB detectors derived from the on-board blackbody (BB) observations. This ensures that the variation in the derived coefficients from lunar observations is associated with actual changes in the level of contamination, and thus reduces the number of coefficient updates for each individual detector.

TEB non-linear coefficient:

The non-linear calibration coefficients, a_0, and a_2 of MODIS TEB detectors are routinely calculated using the quarterly scheduled BB warmup-cooldown (WUCD) measurements and updated in the LUT under certain criteria. In C6.1, the Xtalk correction is applied to the WUCD data for bands 27-30, without changing the rest of the C6 a_0, and a_2 algorithm. The sigma_a_0 and sigma_a_2 LUTs account for the uncertainty of a_0, and a_2 by taking the differences between the LUT values with the values derived from individual WUCD. The LUTs are also recalculated for bands 27-30 after Xtalk correction.

The time stamps of the generated LUTs are unchanged in C6.1 as compared with C6. This strategy ensures the L1B products of bands 20-25, 31-36 are unaffected by the C6.1 update.

Quality assurance (QA):

MCST has been continuously monitoring the status of each MODIS detector and updated the detector quality flag (DQF) in the QA LUT that provides information of the detector quality to the users of MODIS L1B products. The DQF is detector dependent and its on-orbit updates occur when a detector becomes either non-functional (“inoperable”) or “noisy”.

The implementation of the Xtalk correction not only changes the calibrated radiance level in the L1B products, but also the noise-equivalent differential temperature (NEdT) used as the input for MCST to characterize a detector’s QA status. For many detectors, their NEdT decreases as a result of the correction. Therefore, the DQF of bands 27-30 detectors have been re-assessed in C6.1. In C6.1, the QA status of 16 detectors of bands 27-30 are adjusted. There are a total of 18 “noisy” detectors and 1

“inoperable” detector (band 36 detector 7) in Terra C6.1 QA LUT. This can be compared with 31 “noisy” detectors and 4 “inoperable” detectors in C6 QA LUT.

The C6.1 QA reassessment strategy allows an “inoperable” detector to be adjusted to “noisy” or “operable” (no flag) after its image quality restores to a defined level. Three detectors currently flagged as “inoperable” in C6, band 29 detector 6 and band 30 detectors 4 and 8 (product order), are either “operable” (no flag) or “noisy” in C6.1. Four time stamps are added into QA LUT to reflect these changes. Other QA LUT time stamps are unaffected. The C6/6.1 L1B algorithm does not produce calibrated radiance for “inoperable” detectors. It means that the L1B products of these detectors will not be available for the periods when they are flagged as “inoperable” in C6 but will have radiance values in C6.1.

Uncertainty Penalty:

The Xtalk correction affects the uncertainty index (UI) in the L1B product, which is a measure of the radiance uncertainty on the pixel level. In C6, the uncertainty of the TEB calibrated radiance is calculated using a perturbation method, which varies each of the input parameters of the radiance equation by their associated uncertainty in order to determine the change in the radiance.

In C6.1, an additional uncertainty penalty is added to the original uncertainty in order to account for any uncorrected drift in the radiance. The uncertainty penalty is calculated for each pixel throughout the mission, by making the penalty proportional to the size of the corrected signal. Atlantic Ocean data from after the 2016 safe-mode anomaly was used to calculate the linear coefficient used in the LUT. For bands 27-30, the uncertainty penalty coefficients are 0.025, 0.04, 0.095, and 0.021 respectively. For detectors 1, 2, 9, and 10 of band 27, an additional 50% penalty is imposed, since there is some out-of-