# Destriping of MODIS L1B 1KM Data for Collection 5 Atmosphere Algorithms

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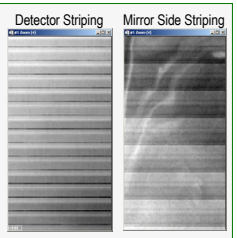
## MODIS Destriping Algorithm Overview

The Moderate Resolution Imaging Spectroradiometer (MODIS) on the NASA Terra and Aqua platforms employs a cross-track scanning double-sided mirror with linear arrays of detectors arranged in the along-track direction. Consequently, the instrument acquired multiple samples of earth view data on each mirror scan. The MODIS spatial resolutions of 1000, 500, and 250 meters are acquired by 10, 20, and 40 detectors, respectively. Striping is a consequence of the calibration algorithm, where each detector is calibrated independently. If the instrument were characterized perfectly, there would be no striping. However, it was not possible to characterize the instrument perfectly because of time, cost, and schedule constraints. As a result, striping artifacts are introduced by the two-sided scan mirror; by dhttp://campus.esri.com/campus/library/OtherMaterials/documentation/hp/hp_print04.pdfetectors whose behavior changes in orbit; and by noisy detectors. The challenge is to design a destriping algorithm which is effective, fast, and does not compromise the radiometry or spatial integrity of the data. Our approach is based on

***Weinreb et al., 1989***: "Destriping GOES Images by Matching Empirical Distribution Functions". Remote Sens. Environ., 29, 185-195.

## Algorithm Details:




1. MODIS is treated as a 20 detector instrument in the emissive bands (10 detectors on each mirror side).
2. Accounts for both detector-to-detector and mirror side striping.
3. The empirical distribution function (EDF) is computed for each detector (i.e., cumulative histogram of relative frequency).
4. The EDF for each detector is adjusted to match the EDF of a reference in-family detector (a non-noisy detector is chosen as the reference).
5. The algorithm operates on MODIS L1B HDF scaled integers (0-32767).
6. The median scaled integer value of the original data is restored following destriping to retain radiometric integrity.

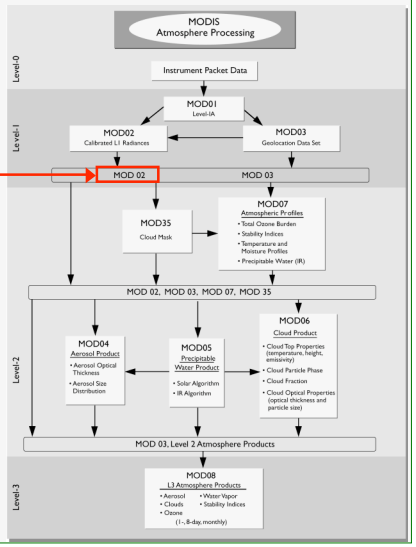
## Implementation for Collection 5:

1. FORTRAN-90 for Terra and Aqua L1B 1KM files; granule based.
2. Requires less then 60 seconds to run for each granule.
3. Correction LUT is created for each individual granule.
4. Uncorrected scaled integers are replaced with corrected scaled integers.
5. All thermal IR bands are destriped (20-25, 27-36) and band 26.
6. For Terra MODIS, noisy detectors in some bands are replaced with neighbor after destriping:
   27 (dets 0, 6); 28 (dets 0, 1); 33 (det 1); 34 (dets 6, 7, 8)
7. For Aqua MODIS, no detectors are replaced.

## Atmosphere Processing Chain

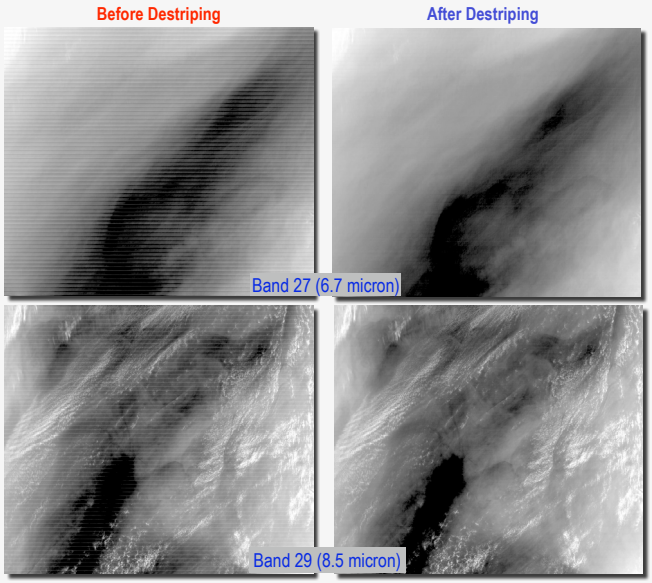
A copy of the L1B 1KM file is made before the science algorithm begins. The copy is destriped, and the algorithm chooses which version of the L1B 1KM file to use for science processing. The following algorithms require the destriped version for Collection 5:

MOD35: Cloud Mask
MOD07: Atmospheric Profiles
MOD06: Cloud Top Properties



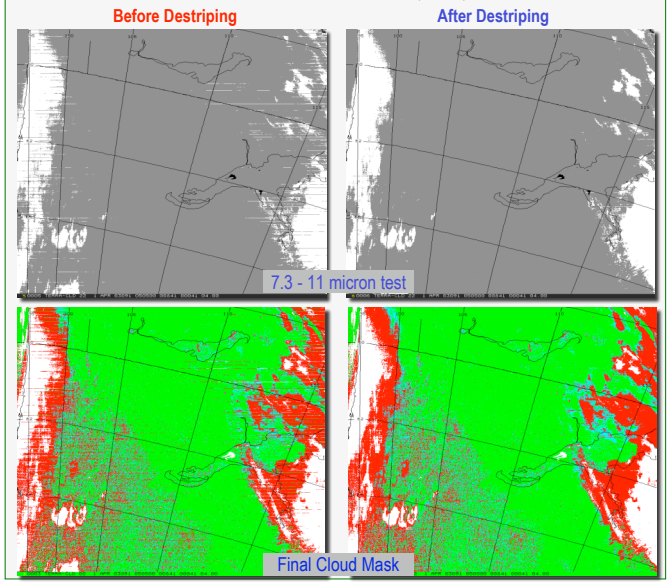

## Impact on MODIS L1B 1KM Images

Terra MODIS L1B 1KM 2003094 (April 4) 06:05




## Impact on MODIS L2 Cloud Mask Product

Terra MODIS L2 MOD35 2003091 (Apr. 1) 05:05

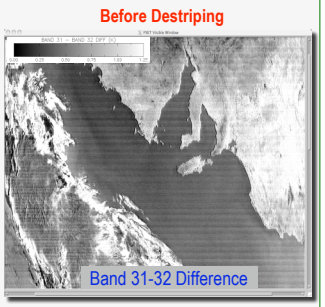



## Impact on Bands 31 and 32

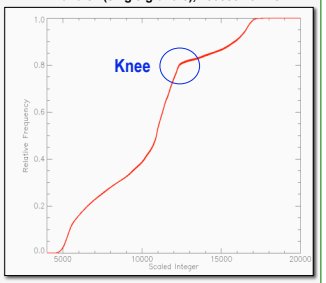
**Rationale for Destriping Bands 31 and 32**
Bands 31 and 32 on Terra and Aqua show the least amount of striping of any of the MODIS bands. Striping is not noticeable until a difference between bands 31 and 32 is computed. This difference (in brightness temperature units) is used by the MODIS cloud mask and IR cloud phase algorithms, and also as a water vapor correction by the SST algorithm. Striping can be observed over land, water, and cloud scenes when the difference is displayed. For this reason, bands 31 and 32 are destriped operationally as part of the Collection 5 Atmosphere processing chain.

**Potential for Artifacts in Band 31 - 32 Difference**
While the current granule-based destriping algorithm improves the Band 31 - 32 difference in most case, some scenes are problematic. In particular, it has been found that scenes with high temperature contrast (e.g. land vs. water) cause the empirical distribution function to have a "knee", which makes it difficult to fit each striped detector to the reference detector. As a result, in the transition zone between the contrasting regions, artifacts can be introduced.

**Removal of Artifacts in Band 31 - 32 Difference**
To remedy the appearance of artifacts, an entire day of L1B 1KM granules was used to build the empirical distribution function for each detector in bands 31 and 32, and the subsequent function was applied to the L1B data. The artifacts disappear as a result. For future processing, (e.g. Collection 6), this may be the recommended method for destriping all MODIS IR bands.




**Empirical Distribution Function for Terra MODIS Band 32 (single granule), 2000337 01:15**




## Impact on MODIS L2 Cloud Mask Product

Terra MODIS L2 MOD35 2000337 (Dec. 2) 01:15