

Collection 6.1 Change Summary for the MODIS Cloud Optical Property (06_OD) Algorithm

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BACKGROUND

On 18 February 2016, the Terra spacecraft, and therefore MODIS, unexpectedly entered safe hold mode during an inclination adjustment maneuver (IAM). After resuming operation on 24 February 2016, several infrared (IR) channels exhibited significant degradation, namely increased electronic cross talk in the 8.5 μ m (Band 29) and immediately surrounding channels. This cross talk, manifesting as a “warming” of Band 29, exacerbated a previously identified Band 29 “warming” (cross talk) trend that caused a spurious cloud mask trend over the tropics starting around 2010. Following extensive analysis, a cross talk correction was developed for the affected IR channels, and the decision was made to reprocess the entire Terra-MODIS L1B record to include this fix. The Atmosphere Team subsequently decided to piggyback the Terra-MODIS L1B reprocessing effort to implement numerous low-impact updates to the C6 atmosphere products.

CHANGE DETAILS

C6.1 changes for the cloud optical property retrievals are low-impact, and are limited primarily to ancillary product usage, the Quality Assurance (QA), and handling of cloud top (CT) properties fill values; no updates to retrieval science are implemented.

- The metadata descriptions of several multi-bit QA values reported in the *Quality_Assurance_1km* SDS were found to be in error, i.e., the listed bit ordering was inconsistent (reversed) with the values actually reported. The affected QA values are the *Retrieval Phase* bits (specifically bits 6, 5, and 4) listed in QA bytes 6, 7, and 8.
- A new *Surface type used by the OD code* QA field has been added that explicitly alerts users which surface type (land, ocean, snow/ice) was used in the optical properties retrievals. Previously users were pointed to the *Band Used for Optical Thickness Retrieval* QA value for this information, but in some cases this QA was inconsistent with expectations (e.g., 0.66 μ m channel used over ocean when 0.86 μ m saturates). The *Land or Water Path* flag in the 35_L2 cloud mask is also often inconsistent with 06_OD surface assumptions; this commonly occurs for coastal and island scenes and where seasonal snow is present.
- The C6 Terra+Aqua gap-filled spectral surface albedo has now been implemented to replace the previous C5 version. In addition, whereas the C5 albedo was processed only

through 2013 (i.e., 06_OD processing post-2013 used the 2013 albedo), the C6 dataset now runs through 2016. The impacts of this change are shown Figs 1 and 2 below.

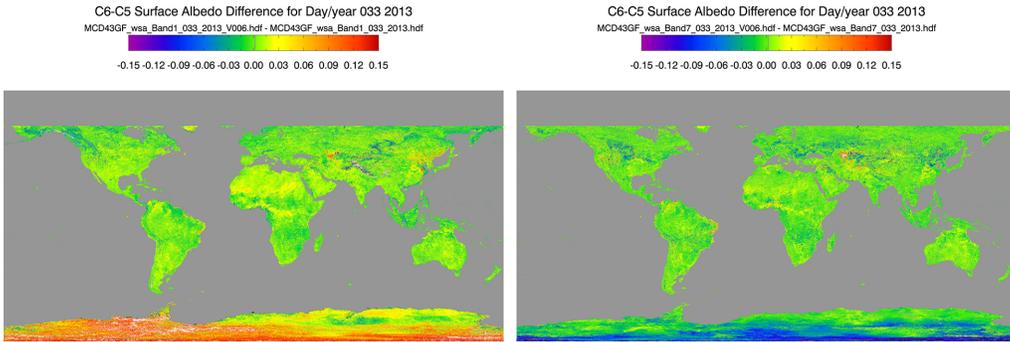


Fig. 1. C6 – C5 ancillary surface albedo differences for the 0.66µm (left) and 2.13µm (right) channels for the eight-day period centered at 2 Feb 2013.

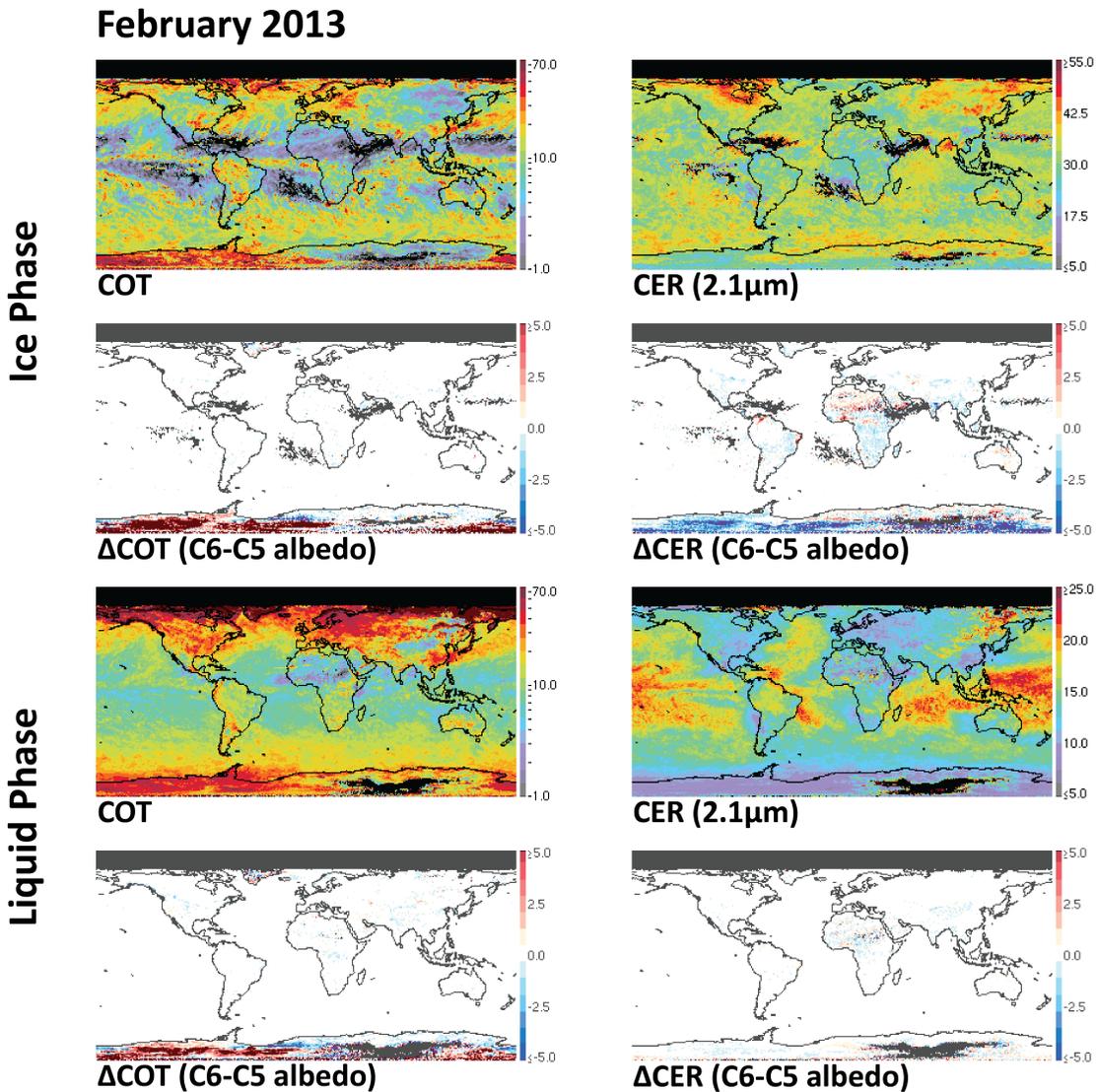


Fig. 2. Feb 2013 monthly mean ice and liquid phase optical property retrieval differences resulting from the ancillary surface albedo update to C6.

- All cloud optical property SDSs are now assigned fill values when the 1km CT product is also fill; previously the O6_OD algorithm defaulted to the surface temperature for above-cloud atmospheric corrections. The impacts of this change are primarily to the region around southern Africa and the southern Indian Ocean where an onboard black body warm up/cool down issue is known to intermittently cause CT retrieval failures – see the Known Issues post “MOD06 (Aqua 5km Cloud Top Properties) Occasional chunks of missing CT data around Southern Africa in a 3 hour time window only (occurring only intermittently)” here: <https://modis-atmosphere.gsfc.nasa.gov/data-issues/cloud>.

Fig. 3 shows C6 (top left) versus C6.1 (top right) cloud optical thickness retrievals from an Aqua granule over the affected region on 13 November 2014 (11:15 UTC); the bottom two panels show the 5km (left) and 1km (right) cloud top pressure retrievals. As expected, for C6.1, the cloud optical property retrieval coverage decreases when appropriately accounting for cloud top property retrieval failures (though again note that this is an intermittent, regionally-limited issue). This granule example also illustrates a related issue, namely that the 5km CT retrieval coverage over this region is less than that of the 1km CT retrieval, highlighting the fact that the 1km and 5km CT retrievals are independent of each other. Because the cloud optical property retrievals use the 1km CT retrievals, over the affected region (southern Africa, southern Indian Ocean) their Level-3 aggregated statistics will at times be inconsistent with the aggregated CT statistics, which are computed from the 5km CT product.

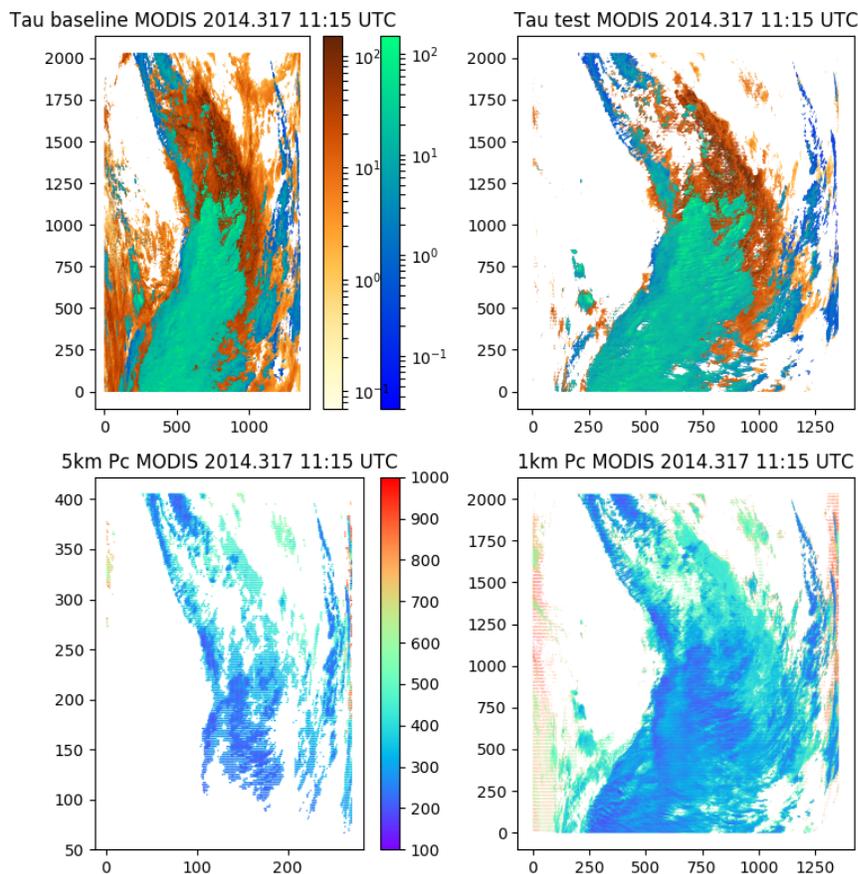


Figure 3: Aqua MODIS granule from 13 November 2014 (11:15 UTC) illustrating the impacts on the cloud optical property retrievals of appropriately considering 1km cloud top property retrieval failures. The top two panels show C6 (left) and C6.1 (right) cloud optical thickness retrievals; the bottom two panels show the 5km (left) and 1km (right) cloud top pressure retrievals. Previously for C6, cloud optical property retrievals defaulted to the surface temperature when the corresponding 1km CT retrieval failed; for C6.1 these optical retrievals are now fill values.