



MODIS C6 and C6.1

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C6 MODIS Land Processing

- Standard Products
- Lessons Learned
- NRT Products
- GIBS Images
- C61 Reprocessing
 - L1B Calibration changes
 - Polarization Correction for Terra MODIS
 - C6 Product specific changes
 - Reprocessing Plan
- Beyond C61
 - Product Maintenance
 - C7 Reprocessing





- C6 MODIS land in forward processing since Jan 2016, with the leading edge one or two days behind current data day.
- C6 reprocessing run in two block of products
 - Teir1 Block: Included most of the products from C5. Land Surface Reflectance (MxD09), Vegetation Index (MxD13), LAI/FPAR (MxD15), GPP(MxD17), Sea-Ice (MxD29), Active Fire (MxD14), BRDF-Albedo (MCD43) and Land Surface Temperature (MxD11).
 - Tier2 Block: Included C5 annual products and new products. Snow (MxD10), Evapotranspiration (MxD16), VCF (MOD44B), MAIAC (MCD19), LST (MxD21) from JPL, Burned Area (MCD64A1), Land Cover (MCD12Q1), Land Cover Dynamics (MCD12Q2), Daily Radiation and PAR (MCD18)
- Reprocessing of Tier1 started in Feb 2015, completed in Aug 2016.
- Reprocessing of Tier2 started in June 2016 expected to complete by the end of 2018
 - JPL's LST (MxD21), and Phenology (MCD12Q2) currently in processing.
 - Annual GPP/NPP (MxD17A3) and Evapotranspiration (MxD16A3) products using gap filled LAI/Fpar is under evaluation.
- C6 products available to public from NASA DAACs
- C5 reprocessing discontinued in Mar 2017, and C5 products decommissioned in April 2018.



C6 MODIS Land Processing Lessons Learned



- C6 Reprocessing Why it took us so long?
 - Not really. Most of Tier1 reprocessing for 30 years of mission (Terra and Aqua) completed within a year and were in forward processing by Jan 2016, with the exception of BRDF/Albedo (MCD43) and LST (MxD11)
- Annual products
 - Development and test of annual products in Tier2 required large volume of C6 operational data Anticipated
- Transitioning the experimental products to operation
 - Science teams not resourced at the level needed to complete the timely transition of the science code to operational PGE.
 - Significant effort required to configure process for operational processing.
 - Too many incremental revisions and science tests needed to verify the global production of the data and assess quality of the science product.
 - Errors in science code transfer Guidelines for software delivery not strictly followed – update every document, deliver source code package and test samples.
 - Science teams need to review and evaluate their data products from operational processing prior to public release of data.





- Products produced within 2 to 2.5 hours of acquisition of the instrument data with the exception of L3 products
- L3 products are produced a few hours after the end of the day.
- C6 Land products generated using C6.1 L1B
- Products include all L2 land products, L3 LSR, VI and BRDF-Albedo produced daily.
- NRT land products are of nearly same science quality as operational products.
 - Products from processing of maneuver periods
 - L3 products from use of different data day periods in composite.
 - Minor difference from using C61 L1B





- Generate global images of product at the native product resolution and deliver to GIBS
 - Images of select datasets generated from L2 and L3 products
 - Images generated in geographic and polar projection
 - Uses color LUT used in global browses generated at LDOPE
- Land GIBS Status
 - Images of L2 product generated using the C6 operational data from beginning of mission through Aug 2018.
 - L3 GIBS images tested and verified. Processing expected to start in Oct/Nov 2018.
 - Images from Tier2 products yet to be planned.





- Calibration inconsistencies and inaccuracies in the C6 L1B, both Terra and Aqua
- Issues with the Polarization correction for Terra
- Known issues in land products bug fix put in C6 forward processing only





- Changes to L1B
 - Change to Response-versus-Scan angle (RVS) approach that affects reflectance bands for Aqua: A change in the RVS approach that uses fixed desert sites was implemented in C6 for Terra MODIS from the beginning of the Terra mission and for Aqua MODIS from 27 July 2016 onwards. The C6.1 reprocessing applied this change in RVS approach to calibration of reflectance bands from the beginning of the Aqua mission.
 - Correction to adjust for the optical crosstalk in Terra MODIS Infrared (IR) bands: The C6 Terra MODIS products, especially cloud products were negatively impacted by the optical crosstalk in IR bands (B27 B30). Though the crosstalk issue was present from the beginning of the mission, its impact on the product wasn't significant until after year-2009 and even more significant following the MODIS Terra safe hold in February 2016. The C6.1 reprocessing implemented an approach to correct this crosstalk in the calibration from the beginning of the mission.
 - Correction to the Terra MODIS forward Look-Up Table (LUT) update for the period 2012 – 2017: The C6 Terra L1B data products from the period 1 January 2012 (2012 001) through 11 February 2017 (2017 042) were generated using faulty calibration LUTs because of an error in the process generating the routine forward LUT updates by the MODIS Characterization Support Team (MCST). This error, which was fixed in January 2017, affected bands 1 and 2 only.

C61 MODIS Land Reprocessing Polarization Correction of Terra and Aqua MODIS

• Polarization Correction in C6

- Land reprocessing started with characterization and correction for polarization until 2014. There after no incremental assessment or update put in operation.
- Aqua
 - Polarization correction performed using pre-launch coefficients
 - Detrending applied for bands 1-4, 8, 9, and 10
- Terra
 - Polarization correction performed for bands 3, 8, 9, and 10.
 - Detrending applied for bands 1-4, 8, 9, and 10
 - Gain adjustments to bands 1, 2 and 4.

Polarization Correction in C61

- MCST to implement incremental assessment and update for polarization correction
- Aqua
 - Polarization correction performed using pre-launch coefficients for 3, 8, 9 and 10.
 - Detrending applied for bands 1- 10.
- Terra
 - Polarization correction performed for bands 1, 3, 4, 8, 9, 10, 11 and 12
 - Detrending and gain adjustments applied for bands 1 10.





- C61 L1B Reprocessing of Terra MODIS completed in Nov, 2017 and Aqua MODIS in March 2018
- Vegetation Index
 - Products from the last 16-day period of the year contained spatial gaps with no retrieval
 - Spikes of high NDVI values
 - Error in some of the quality flags
- Vegetation Continuous Field
 - Error in the Land water mask in some tiles of the intermediate product
- Burned Area
 - Burned grid cells in columns 0 and/or 2399 of certain MODIS land tiles incorrectly relabeled as unburned
- DSR/PAR
 - Discrepancy from failure to read water vapor data, and incorrect use of L1B data
 - Change in product resolution 5km to 1km
 - New CMG products : MCD18A1C and MCD18A2C





- Snow
 - Minor change to test thresholds and QA flags
 - New product MxD10A1F: L3 daily cloud gap filled Snow product
- GPP/NPP
 - Use of Climatology LAI/Fpar as back up for the operational LAI/Fpar product
- Evapotranspiration
 - Use of Climatology LAI/Fpar as back up for the operational LAI/Fpar product

• LST (MxD21)

- Use of near real time GEOS-5 in place of MERRA2 (in standard product) and NCEP (in NRT product)
- New CMG products: MxD21C1/C2/C3: (daily, 8-day, monthly)





- Verification of Polarization correction (Oct 2018)
 - Generated four years of LSR CMG (2014 2017) using polarization corrected C61 L1B
 - Evaluation in progress.
- Land Chain tests: Generated global data from two 16-day period for Aqua and Terra
 - Chain Test 1 (Sept 2018): Verification of migration of C6
 PGEs to C61
 - Chain Test 2 (Oct/Nov 2018): Verification of C61 PGEs with polarization corrected L1B
 - PGE Specific Science Tests (In progress): Snow, VCF, DSR/PAR, GPP/NPP, ET
 - Chain Test 3 (Nov 2018): Verification of final code changes





- Tier 1 (Nov/Dec 2018): Products include PGEs with
 - No code changes from C6
 - Code changes already verified in C61, or more likely to be verified by Nov 2018.
- Tier 2: Annual products, and products currently in testing at MODAPS and SCF.
 - LST (MxD21)
 - GPP/NPP (MxD17)
 - ET (MxD16)
 - MAIAC (MCD19)
 - LC (MCD12Q1/C1)
 - Phenology (MCD12Q2)
 - VCF (MOD44B)
- C6 processing to be discontinued after the C61 has caught up to the leading edge.
 - Many of the C61 changes to land product and some of C61 calibration changes are already operational in the C6 forward processing
 - Overall impact on downstream from other calibration changes isn't expected to be significant.





- Maintenance of Algorithms/Products
 - LST (MxD11 suite)
 - LST (MxD21 suite)
 - Land Cover
 - LAI/Fpar
 - GPP/NPP and ET
- C7 reprocessing
 - Migrate processes to generate products in HDF5/netcdf4/HDF5-EOS
 - Use of new Land Water Mask product (Annual product)
 - Calibration changes
 - Product Algorithm Changes/Enhancements
 - Products in additional map projection (polar and geographic)