NASA's Gap-Filled Collection 6 MODIS Evapotranspiration Data Products, MOD16A2GF, MOD16A3GF, MYD16A2GF and MYD16A3GF

1. Introduction

Starting from the Collection 6 (C6), NASA MODAPS is generating the year-end gap-filled MODIS 500m Evapotranspiration (ET)/ Potential Evapotranspiration (PET) data products, using the same science algorithm that is used to generate the Collection 5.5 (C5.5) improved 1km MOD16 by the Science Computing Facility (SCF) at the Numerical Terradynamic Simulation Group (NTSG) in University of Montana. Due to limited resources, NTSG has no plan to extend or update the C5.5 MOD16 data from 2014 onwards and the C5.5 NTSG version will be decommissioned in the future, once the MODAPS C6 version becomes available through the DAACs. This document provides general information on the major differences between the two and known issues, to facilitate the user community. Users are requested to read this document and familiarize themselves with the MODAPS C6 version of the gap-filled M*D16 products that are further discussed below and make plans to switch to this version. Section 2 describes the MODAPS version of the gap-filled M*D16GF data products, while section 3 lists the major differences between the NTSG and MODAPS M*D16GF and their causes, and finally, section 4 highlights the known issues in MODAPS C6 version of the products and any science updates planned for C6.1. To be concise, we use M*D to refer to MOD or MYD, and M*D16 refers to both 8-day M*D16A2 and annual M*D16A3. For more details on the data products, users are encouraged to read the user guide for the C6 MOD16 (Running et al., 2019), available at https://landweb.modaps.eosdis.nasa.gov/QA_WWW/forPage/user_guide/MOD16UsersGuideV2.2June2019.pdf

2. Year-end Gap-filled C6 M*D16A2GF and M*D16A3GF

The C6 non-gap-filled operational M*D16 products from MODAPS pose an issue for users as the ET estimate leaves out all pixels, flagged with bad input FPAR/LAI data quality. For all such pixels, an output fill value, denoting barren land cover type, is given out even though the pixels may not be barren. In order to alleviate this problem, associated with too many non-retrievals because of bad input data quality, NTSG had adopted the method proposed by Mu et al., 2007 and Mu et al., 2011, to generate the improved C5.5 version of year-end gap-filled M*D16 variations. This variation of the operational MxD16, produced at MODAPS, was developed at the SCF in NTSG. At MODAPS, the same process is employed to generate the year-end gap-filled variations (M*D16GF). At the end of each year, when the entire 8-day operational M*D15A2H are available, an independent process first generates the gap-filled FPAR/LAI (M*D15A2HGF). The process is based on the method proposed by NTSG (Zhao et al., 2005) and employs a temporal gap-filling algorithm to fill in all pixels with bad FPAR/LAI data quality for any 8-day period. Then, this M*D15A2HGF is used as input to the M*D16 algorithm to generate the M*D16A2GF (8-day) and the M*D16A3GF (annual) gap-filled variations. As the gap-filled FPAR/LAI product (M*D15A2HGF) filled those FPAR/LAI flagged with bad-quality, the 8-day M*D16A2GF have more valid retrievals for ET and PET (Figure 1).

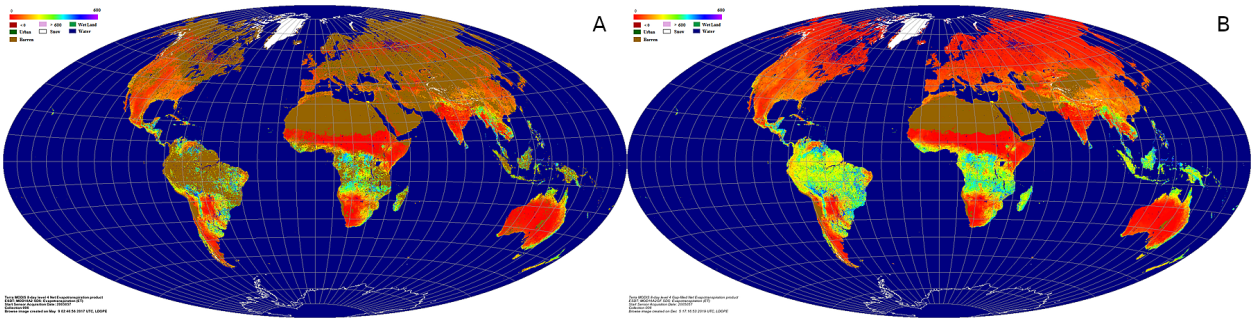

Figure 1. The global browser images of MODIS ET for 8-day 2005057 from the operational C6 MOD16A2 (A) and gap-Filled C6 MOD16A2GF (B). Data gaps due to FPAR/LAI with bad quality in C6 MOD16A2 are calculated and output as valid ET/PET using gap-filled FPAR/LAI as input in the C6 gap-filled MOD16A2GF.

3. Differences between the C6 M*D16GF and the NTSG improved C5.5 MOD16

There are some obvious and expected differences between the MODAPS M*D16GF and the NTSG C5.5 MOD16 products that are caused by differences in inputs and resolutions. Some of these are listed below that are known to cause major differences between the MODAPS gap-filled C6 M*D16GF and the NTSG's C5.5 improved MOD16:

1) M*D16GF products are produced for both Terra (MOD) and Aqua (MYD) satellites whereas NTSG MOD16 is only produced for Terra.
2) M*D16GF is using operational global meteorological data generated by the GEOS system at GMAO/NASA, whereas NTSG's MOD16 used MERRA global meteorological reanalysis data from GMAO/NASA as weather input.
3) M*D16GF is using MCDLCHKM, a quasi 3-year 500m land cover data as input whereas NTSG MOD16 used a fixed Collection 4 MODIS land cover (MOD12Q1) across the entire data periods.
4) M*D16GF uses the gap-filled MODIS 500m FPAR/LAI (M*D15A2HGF*) products that are in-turn based on C6 8-day 500m M*D15A2H and hence are current up to 2019 and will be updated in future, whereas NTSG used C5 1km MODIS FPAR/LAI (MOD15A2) data as input and ended in 2014.
5) The broadband shortwave albedo, an important input to M*D16, are processed differently between the two. Because of the critical role of albedo in land surface energy balance and hence MODIS ET estimates, the difference in handling this critical component is further outlined below.

   NTSG C5.5 used Collection 4 CMG MOD43C1 (because of unavailability of C5 CMG MOD43C1 then) and a temporal gap-filling was applied to fill the albedo with bad quality, in a similar way as is done for the gap-filled FPAR/LAI. Currently, MODAPS C6 does not do any gap-filling for albedo but albedo with fill value or bad quality are simply replaced with 0.4 for vegetated pixels, which we have found to be too high for vegetated pixels over the cloudy areas, such as Amazon (Figure 2). This is a major reason responsible for lower

C6 gap-filled ET (and LE) compared to NTSG's (Figure 3) over regions with severe cloudiness.

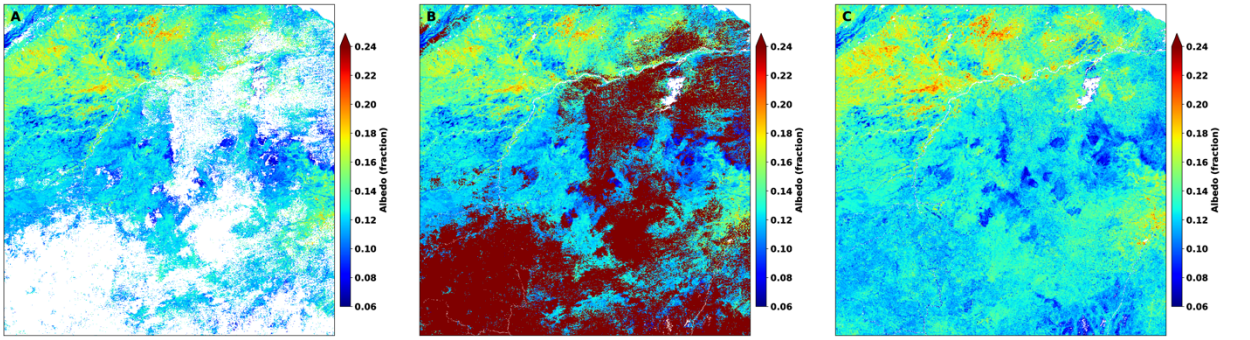

*Figure 2. The original blue-sky shortwave albedo from C6 MCD43A3 on 2005057 for tile h11v08, covering large part of Amazon (A), the albedo using 0.4 to replace fill value (bad quality) for gap-filled C6 M*D16GF, and albedo from gap-filled MCD43GF (C). Clearly, 0.4 is too higher (B) compared to that from MCD43GF (C). This is the major reason responsible for some underestimate ET from gap-Filled M*D16GF compared to NTSG's over some areas with severe cloudiness.*

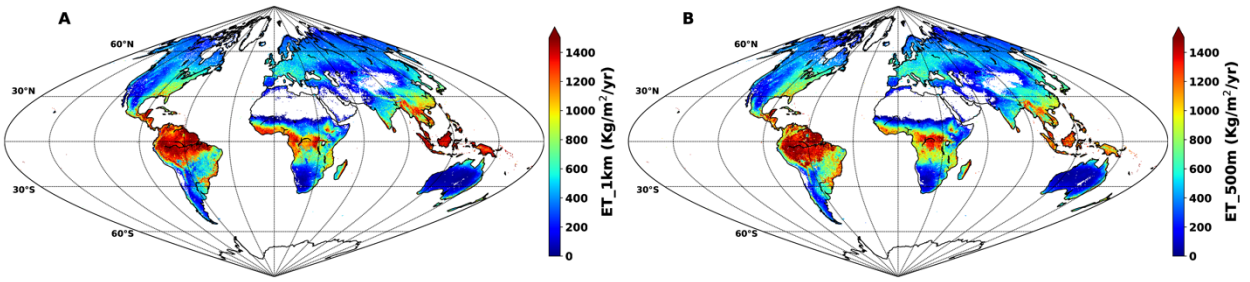

Figure 3. Comparison of annual total 1km MODIS ET for year 2005 from C5.5 NTSG MOD16A3 (A) and annual total 500m ET from gap-filled C6 MOD16A3GF of year 2005. The mean ET is 567.4 Kg/m²/yr from C5.5 NTSG's 1km MOD16A3 and 572.6 Kg/m²/yr from C6 500m MOD16A3GF, respectively.

4. Known issues of C6 M*D16GF and Plan for C6.1

As discussed above, the major issue with the C6 M*D16GF is a uniform albedo value of 0.4 that is used when the albedo has bad quality (Figure 2), resulting in underestimated ET over areas with frequent cloudiness (Figure 3). This limitation will be solved in the next C6.1 process. The C6.1 will use the gap-filled broadband albedo from MCD43GF (Sun et al., 2017) as backup when the regular albedo has bad quality for both operational C6.1 M*D16 and year-end M*D16GF products. Moreover, a climatology FPAR/LAI intermediate product (MCD15A2HCL*) will be used as backup to replace all pixels with bad FPAR/LAI data quality for operational C6.1 M*D16 whereas year-end C6.1 M*D16GF will still use the gap-filled M*D15A2HGF* at the end of each year.

*Note that the M*D15A2HGF and the MCD15A2HCL, discussed in this document are intermediate products and are currently not distributed to general users.

References:

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