Improvement, validation and uncertainties of MODIS terrestrial GPP/NPP (MOD17A2,A3)

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Introduction

MOD15A2 (8-day Fpar/LAI inputs) product has been improved from Collectio3 to Collection4, and DAO (daily meteorological inputs) has been greatly enhanced from GEOS3 to GEOS402. As a result, we have been able to improve estimates of MOD17 (global 1km 8-day GPP/PsnNet and annual GPP/NPP) data from Collection4 (C4) to Collection5 (C5). Compared with C4 MOD17, C5 MOD17 is improved as follows:

1, Nonlinear, spatial interpolation of coarse resolution (1.0*1.25 deg) DAO to 1-km pixel level.
2, Linear temporal filling of missing and cloud-degraded MOD15A2.
3, updating of BPLUT, which was calibrated based on some recent summaries of global NPP, and GPP derived from some eddy-covariance flux tower measurements.
4, Addition of annual GPP and meaningful QA to MOD17A3.

Here we present how we improve MOD17 to Collection5, its validation and its uncertainties (esp. from meteorological data sets).

1. Spatial Interpolation of DAO

Method:
Select the surrounding 4 DAO cells

•The non-linear distances

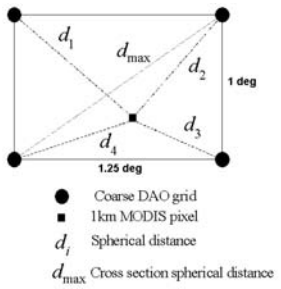
$$D_i=\cos^4((\pi/2)*(d_i/d_{\max})) \qquad i=1,2,3,4$$

•The weight values

$$W_i=D_i/\sum_{i=1}^{4} D_i$$

•Interpolated DAO variables

$$V=\sum_{i=1}^{4}(W_i*V_i)$$



2. Temporal Linear Filling of Unreliable MODIS Fpar/LAI

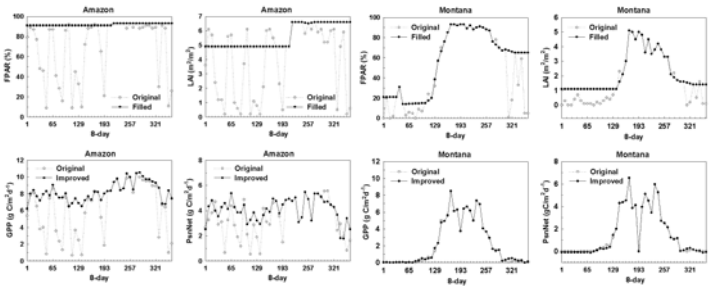


Fig.2.1 An example for a pixel in Amazon with EBF

Fig.2.2 An example for a pixel in Montana with ENF

Method:

For a given MODIS pixel, linear filling of unreliable MOD15A2 8-day periods (mostly cloud-contaminated, with questionable QC label)

Results:

Compared with C4 which ignored MOD15A2 quality, this filled Fpar/Lai greatly enhances C5 MOD17

3. How These 2 Methods Work Together

•Spatially interpolating DAO eliminates DAO boundary and improves its accuracy

•Temporally filling unreliable MOD15 enhances Fpar/Lai, and hence, MOD17

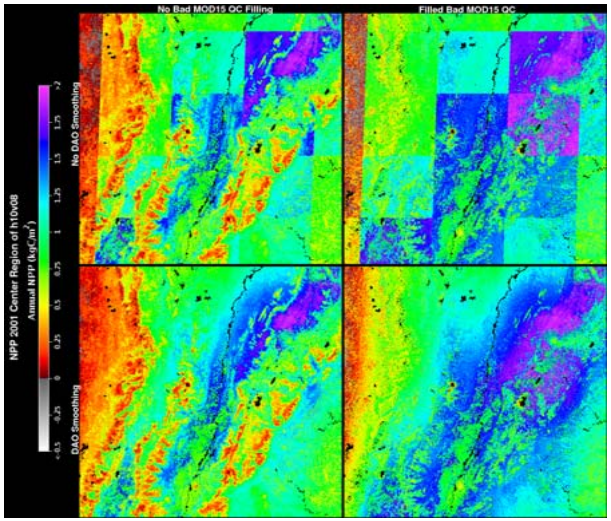


Figure 3.1. One example of how spatial DAO interpolation/non-interpolation, and temporal filling/non-filling MOD15A2 influence MOD17. This tile (h10v08) is located near Amazon basin, and Evergreen Broadleaf Forest (EBF) is the dominant biome type

4. Validation of C5 MOD17 GPP/NPP

Fig.4.1 Participating AmeriFlux sites (15 sites, 38 site years)

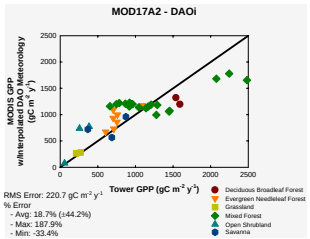


Fig.4.2 C5 MOD17 annual GPP vs. GPP from flux tower

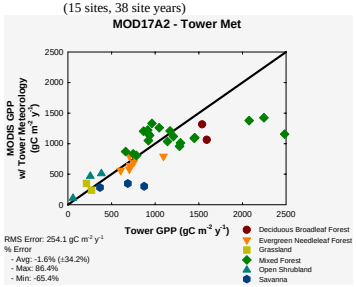


Fig.4.3 MOD17 annual GPP driven by tower meteorological data vs. GPP from flux tower

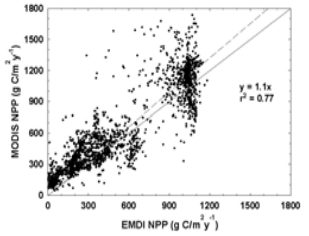
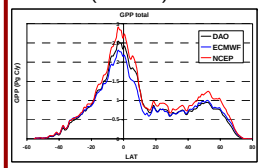


Fig.4.4 C5 MOD17 mean (2001-2003) vs. EMDI NPP

5. Uncertainties of MOD17 GPP/NPP

The uncertainties from upstream inputs, such as land cover (MOD12Q1), 8-day Fpar/Lai (MOD15A2), and daily assimilated meteorological data (DAO), can introduce uncertainty to MOD17 data set. Among them, we found that MOD17 is very sensitive to meteorological data sets. Here we present official DAO driven MOD17 compared with MOD17 driven by ECMWF (ERA-40) and NCEP/NCAR.



Global annual total GPP & NPP (2000 ~ 2001) in Pg C

Met. Data	GPP	NPP
DAO	109.59	56.90
ECMWF	104.04	48.20
NCEP	189.52	74.79

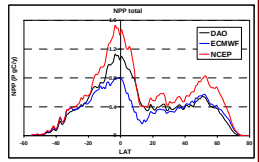


Figure 5.1. Annual GPP zonal total

Figure 5.2. Annual NPP zonal total

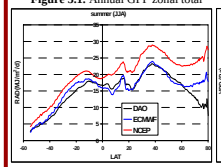


Figure 5.3. solar radiation zonal mean

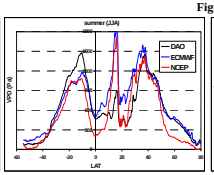


Figure 5.4. VPD zonal mean

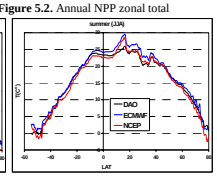


Figure 5.5. Temperature zonal mean

- NCEP has highest downward solar radiation, lowest VPD, lowest average temperature. All these make NCEP produce highest GPP, lowest respiration, and consequently, highest NPP.
- ECMWF is more accurate in magnitude than NCEP by comparison with SSE surface radiation, and CRU temperature, VPD. But in tropical region, its radiation tends to be lower.
- DAO value is close to ECMWF, and its radiation has highest accuracy. Maybe DAO is the best in Magnitude, and the interannual variability need to be studied in the future.
- Tropical region contains larger uncertainties than other areas.

6. Images of Global Collection5 MOD17A3 (mean of 2001 ~ 2003)