MODIS Terrestrial Primary Production, Evapotranspiration and Disturbance Index Data Sets

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Abstract: The Numerical Terradynamic Simulation Group (NTSG) at the University of Montana is officially responsible for two EOS standard MODIS products, namely, terrestrial Gross and Net Primary Production (GPP/NPP) and surface Evapotranspiration (ET). We have also developed a simple, robust algorithm to detect ecosystem disturbances. This poster summarizes the results of these datasets and their relevant information.

1. MODIS primary production (GPP/NPP)

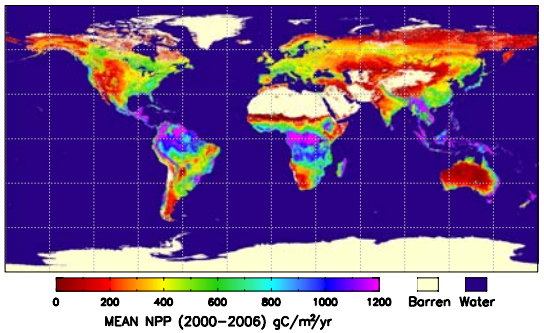

Figure 1.1. Seven-year (2000-2006) mean improved Collection 4.8 (C4.8) MODIS NPP at 1-km spatial resolution.

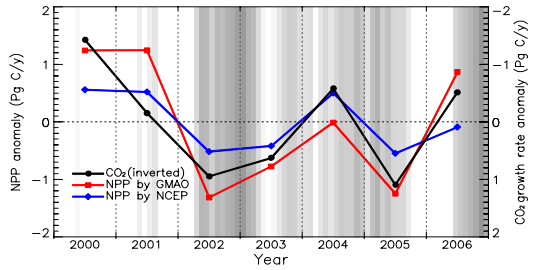

Figure 1.2. Interannual variations in global total C4.8 MOD17 NPP driven by NCEP and GMAO respectively, in relation to inverted atmospheric CO2 interannual growth rate. A Multivariate ENSO Index (MEI) is shown in gray scale, where darker shades represent higher MEI values.

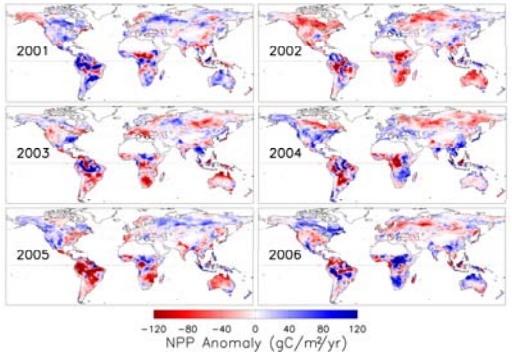

Figure 1.3. Spatial pattern of C4.8 MODIS NPP anomalies from 2001 to 2006

2. MODIS Evapotranspiration (ET)

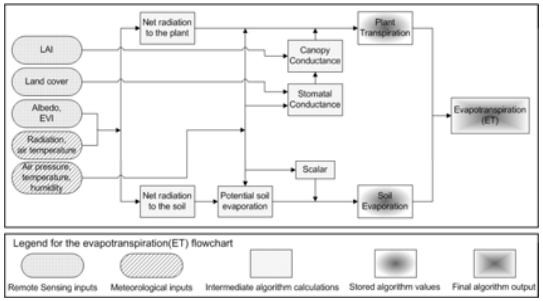

Figure 2.1. MODIS ET is based on the Penman-Monteith equation. ET is the the sum of water lost to the atmosphere from the soil surface through evaporation and from plant tissues via transpiration. The vegetation cover fraction is estimated with the MODIS Enhanced Vegetation Index (EVI) data, and MODIS albedo is the surface physical variable used to calculate the net absorbed shortwave radiation. MODIS LAI is the biophysical variable to scale up the conductance from leaf to the canopy level, and leaf conductance is strongly controlled by air temperature and water availability.

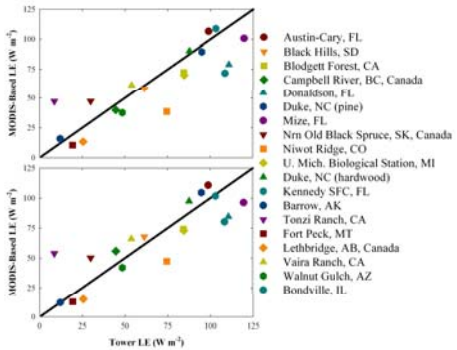

Figure 2.2. Comparison of annual latent heat flux (LE) observations from the flux tower sites and the ET estimates averaged over the MODIS 3×3 km cutout. These data were created using (upper panel) tower-specific meteorology and (low panel) the global GMAO meteorology.

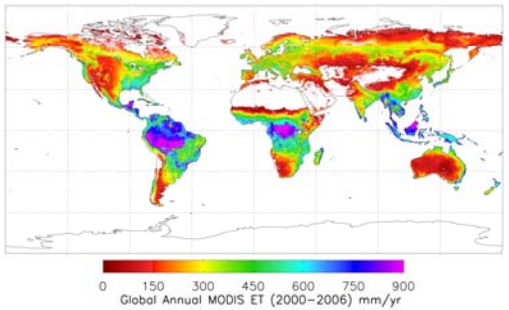

Figure 2.3. Spatial pattern of seven-year (2000-2006) mean MODIS ET. Vegetated regions are shown in color, while regions in white are barren or sparsely vegetated areas and non-vegetated areas, including water bodies, snow and ice, and urban areas.

3. MODIS Disturbance Index (DI)

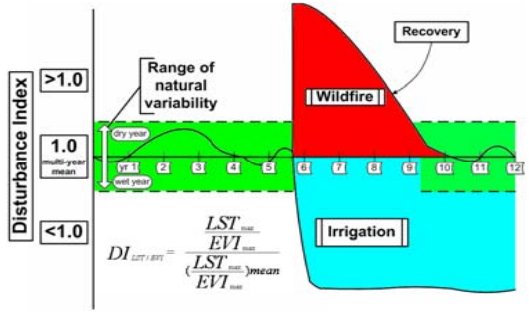

Figure 3.1. The $DI_{LST/EVI}$ algorithm (where DI is the disturbance index, LST is the land surface temperature, and EVI is the Enhanced Vegetation Index, both of which are from the Aqua satellite) with a conceptual model illustrating the energy balance of a given land area through time. Under normal conditions, the current-year LST_{max} and EVI_{max} values will be similar to the multiple-year mean-maximum values, indicated by the multiyear mean of 1.0. Normal conditions exist within a range of natural variability that is defined by fluctuations between wet and dry years (green zone). Disturbance causes changes in the current-year LST_{max} and/or EVI_{max} values. In the case of wildfire, the LST_{max} increases and the EVI_{max} decreases, resulting in a larger current-year ratio relative to the multiyear mean and a divergence from the range of natural variability (red zone). If the LST_{max} decreases and the EVI_{max} increases from irrigation, the current-year ratio will become smaller than the multiyear mean, resulting in divergence from the range of natural variability (blue). The bidirectional aspect of the DI allows for the tracking of recovery as the maximum LST/EVI ratio returns toward the multiyear mean.

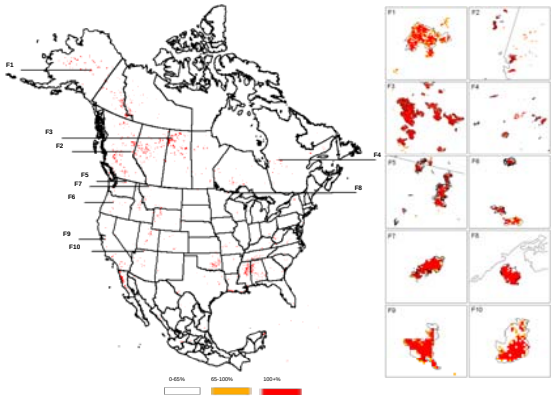

Figure 3.2. Wildfires and other major disturbances, such as forests damaged by hurricanes, are detected by our DI algorithm over North America in 2006. Here we validate the detected fires (red pixels) through comparison with the fire perimeters obtained from a variety of aerial and field-based methods (polygons around the detected fire scars).

4. Key References

Zhao, M., F. A. Heinsch, R. R. Nemani, and S. W. Running, (2005). Improvements of the MODIS terrestrial gross and net primary production global data set. *Remote Sensing of Environment.* 95: 164–176.

Mu, Q., F. A. Heinsch, M. Zhao, S. W. Running, (2007). Development of a global evapotranspiration algorithm based on MODIS and global meteorology data. *Remote Sensing of Environment*. 111: 519-536.

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