MODIS NPP variations and trends from 2000 to 2008 and MODIS Evapotranspiration (ET) and Disturbance Index (DI) datasets

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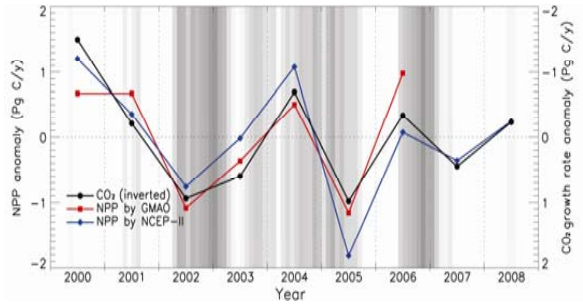
Introduction

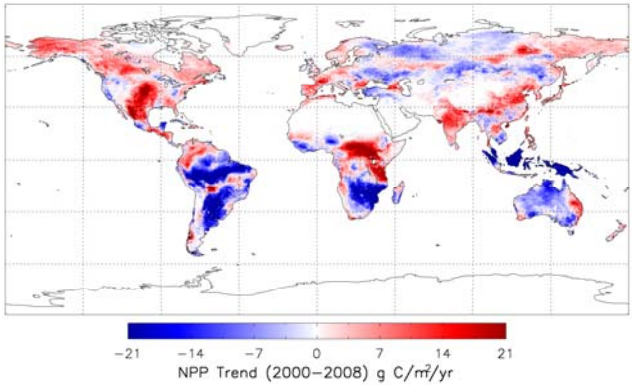
With the Collection5 MODIS FPAR/LAI, we generated the improved Collection5.1 (C5.1) MODIS GPP and NPP. Due to the limitation of the availability of consistent daily meteorological data driver, GMAO/NASA, we now have C5.1 MODIS GPP and NPP (GPP/NPP-GMAO) from 2000 to 2006. To cover the entire period from 2000 to 2008, we used NCEP/DOE reanalysis II (NCEP-II) to drive our MODIS GPP/NPP algorithm. Both global NPP by GMAO and NCEP-II have significantly negative correlation with annual CO2 growth rate , confirming and implying that terrestrial primary production is the major driver of annual CO2 growth rate. From 2000 to 2008, terrestrial NPP reduced. NPP in North Hemisphere (NH) continues increasing, while NPP in South Hemisphere (SH) decreased, counteracting the increasing NPP over NH. A drying trend in SH is responsible for the reduction in NPP in SH. We also have further improved MODIS evapotranspiration (ET) and MODIS Global Disturbance Index (MGDI) datasets to quantify water cycle and to detect ecosystem disturbances at 1-km MODIS pixel level.

1. Global MODIS Total NPP Variation



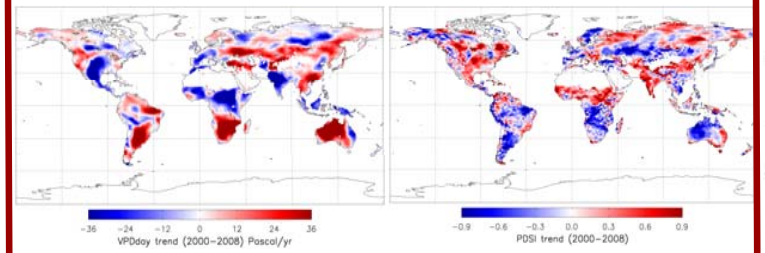
Correlations between NPP and inverted CO2 growth rate are 0.89 for NCEP-II driven MODIS NPP from 2000 to 2008, and 0.85 for GMAO driven.

2. Spatial Pattern of NPP trend



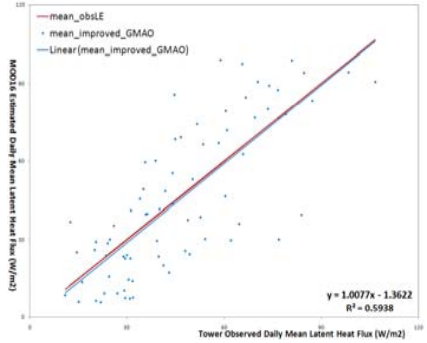
Spatial pattern of NPP trends from 2000 to 2008, with large areas of decreased NPP in the South Hemisphere (SH).

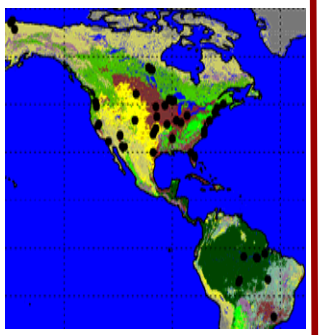
3 . Spatial Pattern of VPD and PDSI trend



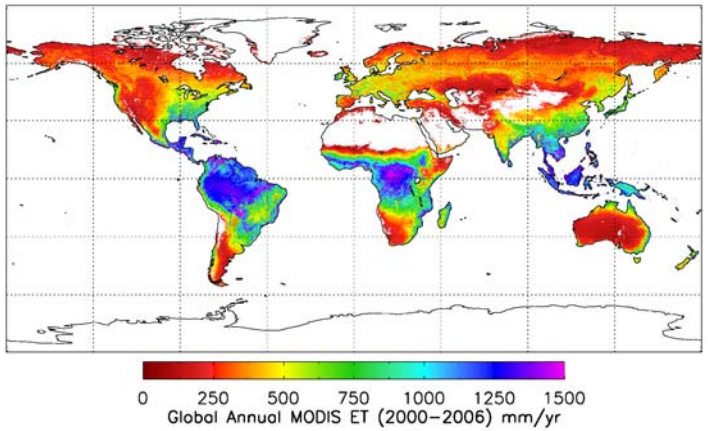
Spatial pattern of trends in Vapor Pressure Deficit (VPD) and Palmer Drought Severity Index (PDSI). Both show a drying trend in SH, leading to the reduction in NPP.

4 . MODIS Evapotranspiration (ET) validation at 76 flux towers

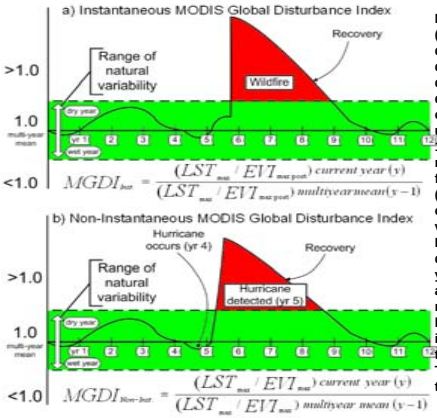




5. Spatial pattern of 7-year mean new version MODIS ET

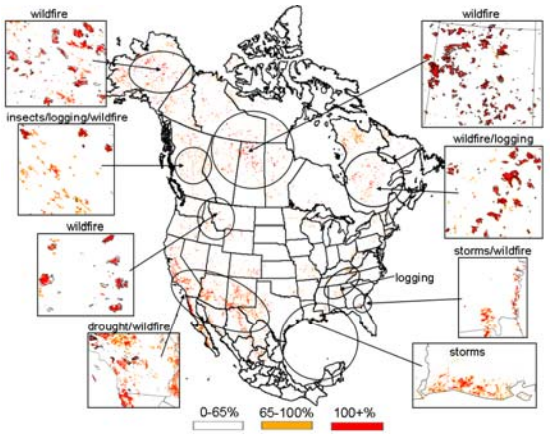


6. MODIS Global Disturbance Index (MGDI)



MGDI algorithms for instantaneous (wildfire) and non-instantaneous disturbance (hurricane) and conceptual diagrams illustrating the impact of disturbances on the LST/EVI ratio over a decadal time scale. Under normal conditions, the MGDI values tend toward unity, indicated by the multiyear mean of 1.0. Normal conditions exist within a range of natural variability defined by fluctuations between wet and dry years (green zone). Disturbance causes changes in the current year LST and EVI values. In the case of wildfire (a), the LSTmax increases and the EVImax post decreases resulting in a larger current year ratio relative to the multiyear mean and a divergence from the range of natural variability (in red). Hurricanes hydrate the land surface dampening an immediate spike in LST and prolonging the die-back of damaged vegetation (b). The MGDI value increases the year after the disturbance event (in red).

7. MGDI results over North America from 2005 to 2008



With MGDI, we can detect major ecosystem disturbances at 1-km scale

Relevant Publications from 2007:

- Zhao, M., S. W. Running, F. A. Heinsch, R. R. Nemani. (2010). Terrestrial Primary Production from MODIS. In *Land Remote Sensing and Global Environmental Change: NASA's EOS and the Science of ASTER and MODIS*.. Edited by C. Justice, M. Abrams, Springer-Verlag, New York (in press).
- Running, S. W., R. R. Nemani, J. R. G. Townshed, and D. D. Baldocchi. (2009). Next-Generation Terrestrial Carbon Monitoring. In *Carbon Sequestration and Its Role in the Global Carbon Cycle, AGU Geophysics Monograph 183*. Edited by B. J. McPherson and E. T. Sundquist. 49-69.
- Mu, Q., L. A. Jones, J. S. Kimball, K. C. McDonald and S. W. Running. (2009). Satellite assesment of land surface evapotranspiration for the pan-Arctic domain. *Water Resources Research*, Volume 45, Number W09420 - 2009 (doi: 10.1029/2008WR007189)
- Montenegro, A., M. Eby, Q. Mu, M. Mulligan, A. J. Weaver, E. C. Wiebe, M. Zhao. (2009). The net carbon drawdown of small scale afforestation from satellite observations. *Global and Planetary Change*, 69: 195-204.
- Mildrexler, D. J., M. Zhao, S. W. Running. (2009). Testing a MODIS Global Disturbance Index across North America. *Remote Sensing of Environment,* 113: 2103-2117.
- Zhao, M., S. W. Running. (2008). Remote Sensing of Terrestrial Primary Production and Carbon Cycle. In *Advances in Land Remote Sensing: System, Modeling, Inversion and Application*. Edited by S. Liang, pp. 423-444, Springer, ISBN 978-1-4020-6449-4.
- 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.
- Mildrexler, D. J., M. Zhao, F. A. Heinsch, S. W. Running (2007). A new satellite-based methodology for continental-scale disturbance detection. *Ecological Applications*, 17: 235-250.