Modelling and estimating gross primary productivity over conterminous US by differentiating C3/C4 croptypes

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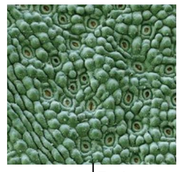
Abstract: Gross Primary Production (GPP), defined as the amount of carbon (energy) sequestered by plant photosynthesis, is the largest flux in the global cycle. Accurate estimation of GPP is a prerequisite to quantify the global carbon cycle and predict the future trajectories of the atmospheric CO2 concentration. However, recent light use efficiency (LUE) models have large uncertainties in estimating GPP, especially in croplands. One main reason is the ignorance of the difference of C3/C4 pathway in these LUE models. We used the modified Vegetation Photosynthesis Model which differentiating C3/C4 croplands, MODIS satellite images and NCEP/NARR climate data to estimate GPP from 2009-2014 in the conterminous US (CONUS), and evaluated the VPM-predicted GPP with the estimated GPP from the CO2 eddy flux tower sites (26 sites). Our results showed the VPM-predicted GPP have a significant improvement in croplands. The VPM-predicted GPP could successfully detect the intra- and inter- annual change. This new GPP product can be helpful in the study of terrestrial carbon cycle.

Data and Methods

VPM model

Model =  + 

Light absorbed by green biomass

Environmental regulation by stomata

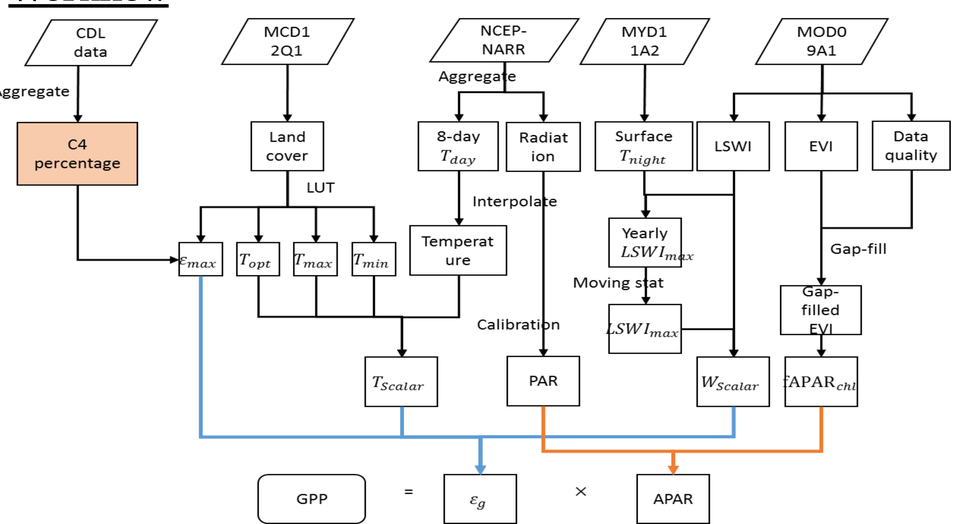
$$GPP = \mathrm{PAR} \times FPAR_{chl} \times \varepsilon_{max} \times T_{scalar} \times W_{scalar}$$

ε_{max}: maximum light use efficiency, which was not differentiated according to C3/C4 croptypes before

Data Sources

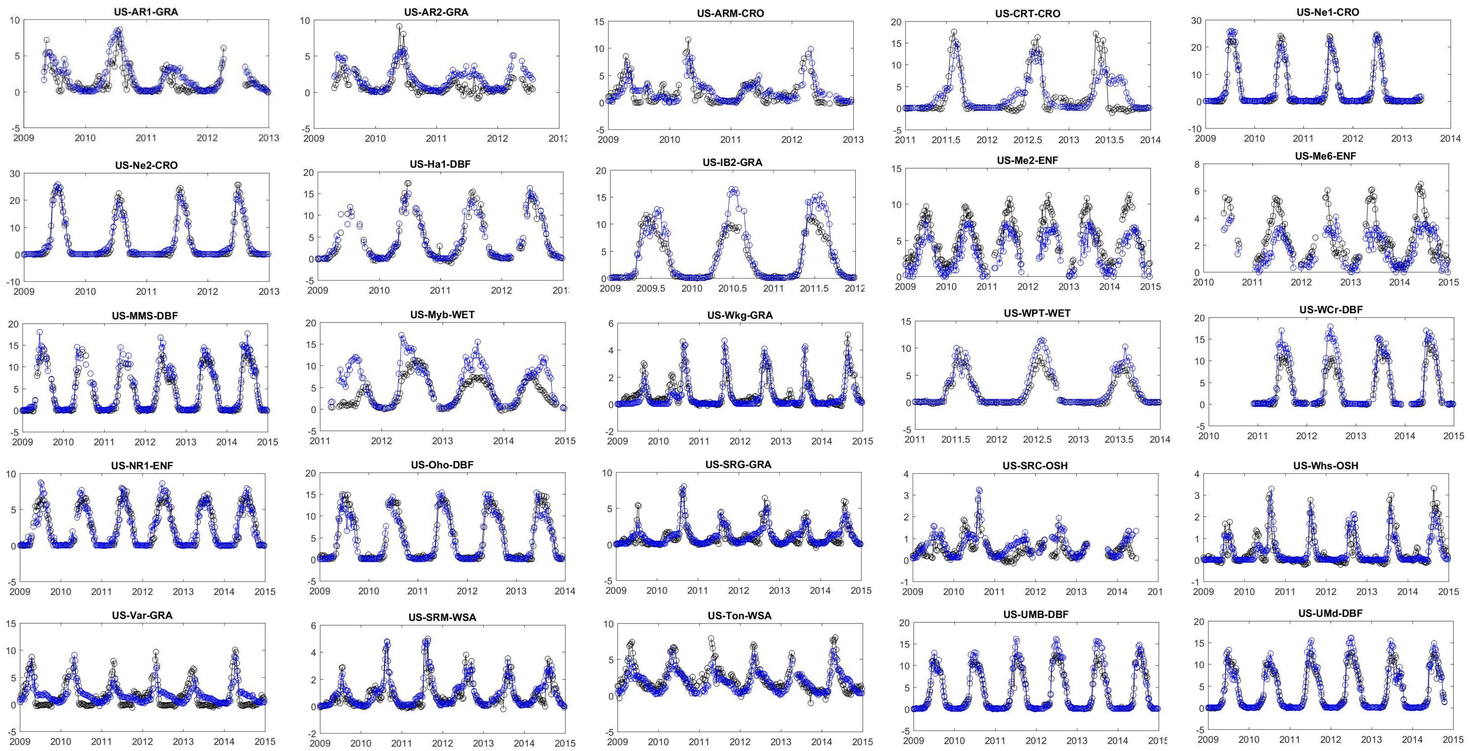
Data	Information	Application
NCEP-NARR air temperature and radiation	Interpolating to 500-m, 8-day	VPM model input
MCD12Q1	landcover, 500-m, annualy	VPM model input
MYD11A2	Surface temperature, 500-m, 8-day	Retrieving LSWImax
MOD09A1	Surface reflectance, 500-m, 8-day	Retrieving fPAR, LSWImax
Cropland data laer	30m, annualy	Deriving C4 percentage
Fluxnet data	Site-level, daily	Validation
SIF	0.5˚, monthly	Validation
MOD17A2H GPP	500-m, 8-day	Validation

Workflow

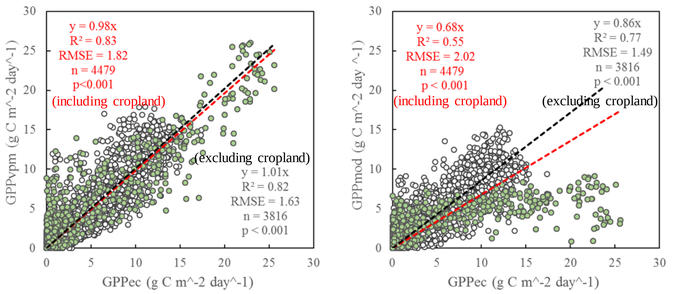


Results

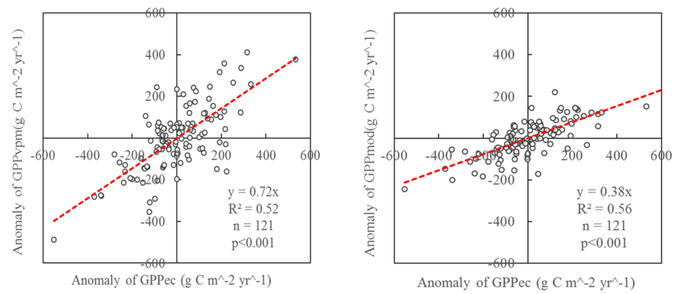
Seasonal dynamics and inter-annual variability (Black dots: GPPec; Blue dots:GPPvpm)



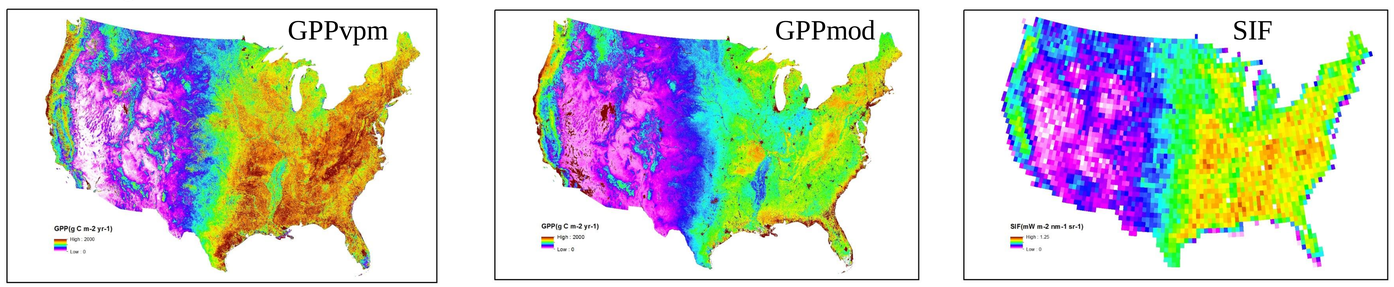
Validation at the 8-day scale (Green dots for cropland)



Validation for the inter-annual change



Comparing with MOD17A2 GPP product and SIF data



Acknowledgements

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