ESTIMATING GROSS PRIMARY PRODUCTION OF FORESTS USING MODIS PRODUCTS

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1. INTRODUCTION

Gross Primary Production (GPP) is an important component of global carbon cycle. Accurate estimation of GPP is imperative for future projection of carbon cycle and climate change, but global estimation of GPP still includes a lot of uncertainty and needs more investigations. It was reported that the Enhanced Vegetation Index (EVI) from MODIS, which is an optimized vegetation index developed from NDVI [1], showed strong seasonal correlation with GPP [2-5]. However, there still remains one question whether the spatial extension of the relationship between GPP and EVI is also superior to any other satellite metrics (NDVI, EVI, and FPAR), though the seasonal correlations of GPP with EVI were well examined at each site. We then examined how well seasonal and annual GPP can be estimated by 4 MODIS products (NDVI, EVI, LAI and FPAR).

2. DATA AND METHOD

2.1. MODIS land products subsets

Distributed Active Archive Center (DAAC) at Oak Ridge National Laboratory (ORNL) provides Collection 5 MODIS land product subsets. We retrieved the Collection 5 data of MOD13Q1 (NDVI and EVI products), MOD15A2 (LAI and FPAR products), and MOD17A2 (GPP and NPP products). Then, the pixel which includes the flux tower was picked as the representative of flux tower footprints to get time series of MODIS products from 2001 to 2008. We use only years which have more than 80% valid values.

2.2. FLUXNET dataset

We used the Level 4 data, which is the FLUXNET standardized dataset provided by AmeriFlux and CarboEurope. From available data of AmeriFlux and CarboEurope, we picked forest sites which satisfied following requirements: (1) The tower has at least 500m spatial extent of homogeneous land cover. (2) MODIS subset is available for the corresponding years. (3) The gap-filled ratio is less than 20% for all the 12 months in a year. To analyze tropical forests with sufficient data, we added 4 AsiaFlux tropical sites into this analysis.

2.3. Linear regression

We employed the linear regression analysis between FLUXNET GPP and MODIS data products. The regressions were evaluated by r^2 and p-value. We analyzed the relationship between MODIS products and flux tower GPP at seasonal and annual timescales.

3. RESULTS AND DISCUSSION

3.1. Seasonal analysis between MODIS products and flux tower GPP

MOD17 GPP showed the best correlation with seasonal GPP ($r^2 = 0.73$). EVI showed higher correlation ($r^2 = 0.63$) than NDVI ($r^2 = 0.56$), LAI ($r^2 = 0.53$), and FPAR ($r^2 = 0.53$). Those results are consistent with the reports [2-5].

3.2. Annual analysis between MODIS product and flux tower GPP

LAI showed the highest correlation ($r^2 = 0.86$) with annual GPP among the 4 MODIS products. The more leaf area forests have, the more carbon can be absorbed, and also the more carbon assimilated, the more carbon can be allocated to leaf production. Seasonal discrepancies between GPP and LAI were canceled by annual calculations. Poor correlation between EVI and annual GPP meant that the conversion factor from EVI to GPP was not constant even in the same forest category. Vegetation indices are just kinds of metrics which are theoretically proportional to leaf amount at single point, and there is no clear physical reason that the ratio of GPP/VI is constant. MOD17 had lower ($r^2 = 0.72$) correlation than LAI, however further tuning of MOD17 algorithm may overcome these deficiencies.

4. CONCLUSION

We analyzed the correlation of MODIS products with seasonal and annual GPP measured at flux towers. EVI is very powerful tool to analyze seasonal variation in GPP. However, we need to be cautious about mapping geographic patterns of annual GPP when using EVI. Annual mean LAI is the best metric to estimate spatial patterns of annual GPP because LAI and GPP are biophysically tightly related.

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6. REFERENCES

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