Remote Sensing Estimation of NEP in Europe and Improvement of CASA Model

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ABSTRACT

Net ecosystem productivity (NEP) is an important indicator to describe ecosystem function and the global carbon cycle. In this paper, the Carnegie Ames Stanford approach (CASA) model was optimized, and the NEP value of the European terrestrial ecosystem was estimated by coupling the soil respiration model. The results showed that the R^2 between the estimated value of NEP and the observed value increased and the RMSE decreased after optimizing the maximum light use efficiency (ε) of the CASA model parameters using the vegetation classification data. After further optimizing the optimal temperature, R^2 increased to 0.428, and the RMSE decreased to 63.720 $gC{\cdot}m^{-2}{\cdot}month^{-1}$. These results have shown that it is an effective method to improve the NEP estimation accuracy by optimizing ε_{max} and the optimal temperature to improve the CASA model. On this basis, the spatial and temporal changes in NEP in various regions in Europe were analyzed using the optimization results. The results show that NEP in Europe is in the spatial distribution pattern of Western Europe > Southern Europe > Central Europe > Eastern Europe > Northern Europe. The monthly changes in NEP in all regions show a unimodal curve with summer as the peak, and the annual overall value is positive (i.e., it shows a carbon sink).

INTRODUCTION

NEP is the difference between the net primary productivity (NPP) of the ecosystem vegetation and the soil heterotrophic respiration (Rh).

This paper will combine the optimized CASA model and soil respiration model to estimate and analyze the European NEP through the following steps: (1) select the maximum light use efficiency suitable for different vegetation types in Europe, combined with remote sensing data and meteorological data, estimate the NPP of the European terrestrial ecosystem in 2014; (2) according to the temperature data and NDVI data, improve the optimal temperature estimation NPP of vegetation growth, and further increase the accuracy of the CASA model; (3) the optimized CASA model is used to couple the soil respiration model and Rs-Rh relationship model to realize the estimation of NEP of the European terrestrial ecosystem in 2014 and the analysis of its temporal and spatial changes in different months to provide support for the estimation of the global carbon sink and the study of the carbon cycle.

OBJECTIVE

Study Area: Europe

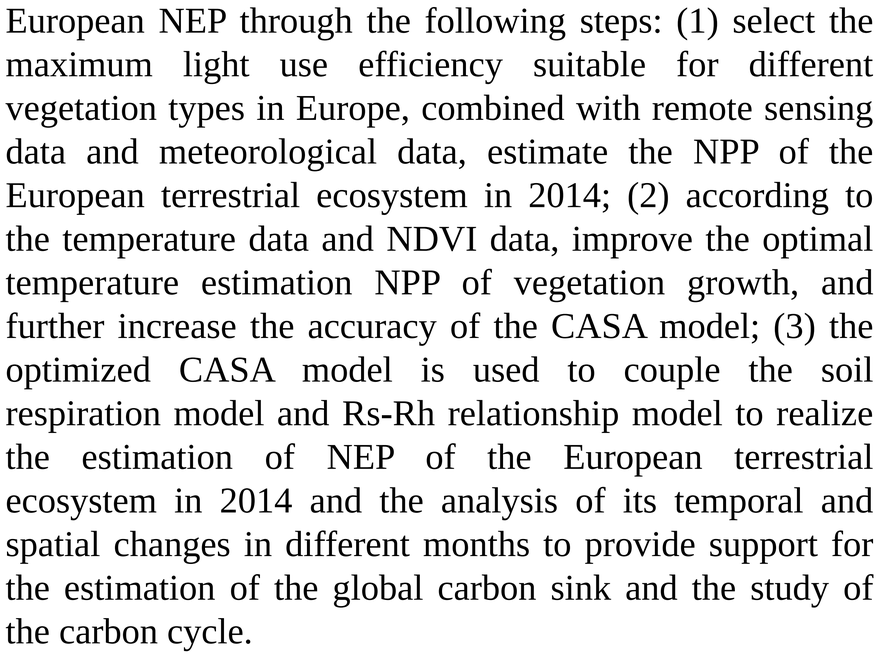

Fig. Land Cover Types and the Distribution of Flux Stations of Study Area.

Objective:

Combine the optimized CASA model and soil respiration model to estimate and analyze the European NEP

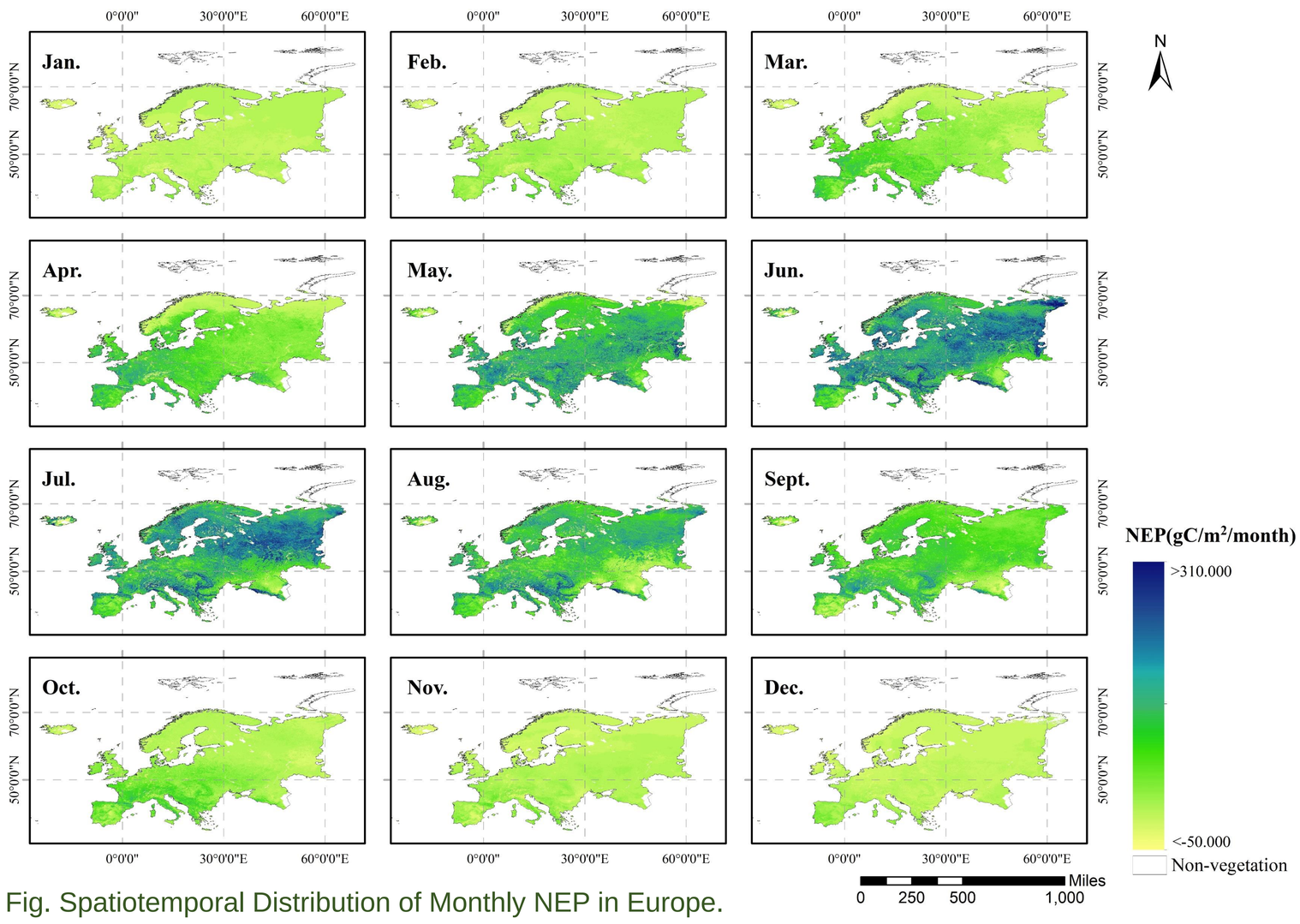

Fig. Spatiotemporal Distribution of Monthly NEP in Europe.

METHODS

- CASA model

$$NPP(x,t) = APAR(x,t) \times \varepsilon(x,t)$$

$$APAR(x,t) = 0.5 \times SOL(x,t) \times FPAR(x,t)$$

- Improvement of CASA Model
  - Maximum Light Use Efficiency
  - Optimum Temperature
- Estimation of Soil Respiration
- Verification Method of NEP Estimation Results

RESULTS

The spatial distribution of NEP was Western Europe > Southern Europe > Central Europe > Eastern Europe > Northern Europe.

Europe is a carbon sink on the whole.

The monthly change in the total NEP value in Europe is a single peak curve, reaching a peak in June.

All regions of Europe was similar, showing a single peak curve of high in summer and low in winter.

The NEP values of different vegetation types are quite distinct.

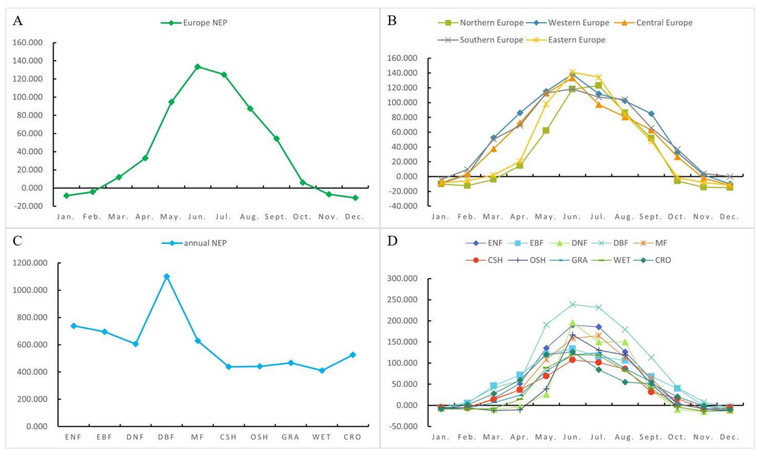

Fig. Monthly NEP Analysis Results of Different Vegetation in Various Regions of Europe in 2014.

DISCUSSION

The determination of the ε_{max} value of the CASA model needs to consider not only different vegetation types but also different geographical regions.

Determine the optimum growth temperature of each vegetation more reasonably based on improving the ε_{max} of the model.

The coupled optimized CASA model, soil respiration and Rs-Rh relationship model can accurately estimate the NEP of European ecosystems and provide a basis for the assessment of carbon sinks and the formulation of carbon balance policies in European regions.

CONCLUSIONS

It is feasible to use the CASA model coupled with the soil respiration model and Rs-Rh relationship model for vegetation carbon sink estimation, and optimizing the model parameters ε_{max} and optimal temperature is an effective method to improve the estimation accuracy.

The NEP in Europe has regional differences, showing a pattern of Western Europe > Southern Europe > Central Europe > Eastern Europe > Northern Europe.

The NEP values of different vegetation types were quite different. Among them, the NEP of deciduous broad-leaved forest is higher, followed by evergreen coniferous forest and evergreen broad-leaved forest, and the wetland is the lowest.

MAJOR REFERENCES

[1] Q.Y. Du, "Study on applicability evaluation of GPP model based on MODIS and European flux observation data," WuHan University. 2018.

[2] Z. J. Liu, J. Y. Liu and Q. Q. Shao, "Optimum temperature for vegetation growth on different land cover types," Journal of Geo-information Science, vol. 16, no. 1, pp. 1-7, Jan. 2014.

[3] C. S. Potter, J. T. Randerson, C. B. Field, et al, "Terrestrial ecosystem production: A process model based on global satellite and surface data," Global Biogeochemical Cycles, vol. 7, no. 4, pp. 811-841, Dec. 1993.