

# Magnitude, drivers, and patterns of gross primary productivity of rice in Arkansas

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## Science Questions

How accurately the Vegetation Photosynthesis Model (VPM) estimate rice gross primary productivity (GPP) at field and regional scales in Arkansas?

Which factors: agronomic (enhanced vegetation index (EVI), land surface water index (LSWI)) or climatological (temperature, photosynthetic active radiation (PAR)) better explain spatial variation in rice GPP?

How do mixed land cover pixel and site-specific calibration influence the accuracy of VPM-derived GPP estimates and relationship between GPP and yield?

## Analysis

The VPM estimates GPP as  $\text{light use efficiency} \times \text{absorbed PAR}$ , where  $\text{APAR} = \text{PAR} \times \text{fraction PAR}$ .

MODIS satellite imagery was used for EVI and LSWI estimation, in-situ meteorological data and gridded climate reanalysis data were used for estimating model inputs (temperature and water stress factor), CropScape cropland data layer was used for rice land cover, and yield data were derived from USDA National Agricultural Statistics Service.

## Results/Significance

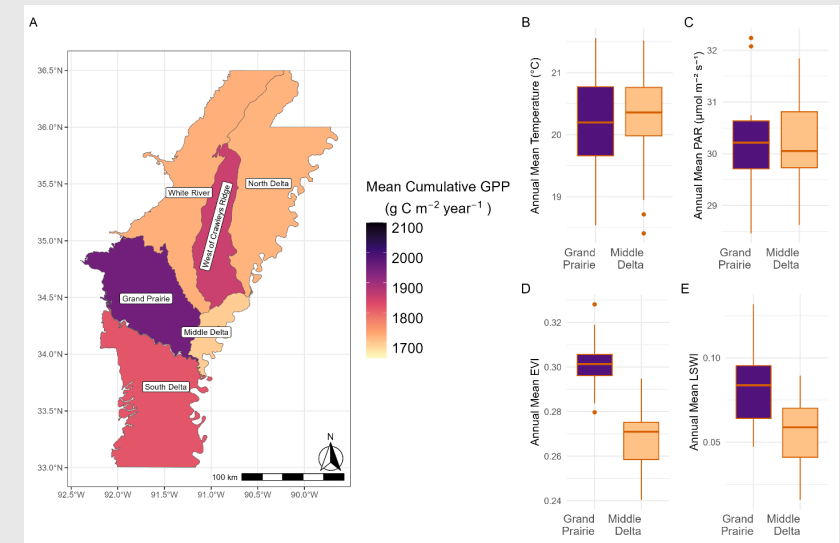
The VPM at the site scale showed an  $R^2$  of 0.6, mean absolute error (MAE) of  $3.68 \text{ g C m}^{-2} \text{ day}^{-1}$ , and a bias  $-0.33 \text{ g C m}^{-2} \text{ day}^{-1}$ , with plant growth information linearly related to model residuals.

Rice fields between  $34.2\text{--}34.6^\circ \text{ N}$  and  $91\text{--}92^\circ \text{ W}$ , in the Grand Prairie zone, exhibit the highest cumulative GPP in Arkansas ( $1950 \pm 295 \text{ g C m}^{-2} \text{ year}^{-1}$ ).

Site-specific calibration and  $\geq 50\%$  rice-covered pixels improved the GPP-yield relationship, with stronger correlations in counties with larger planting areas.

## Acknowledgements

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**Figure 1.** (A) The figure illustrates the spatial distribution of cumulative GPP across Arkansas' rice production zones, highlighting the variation in GPP between regions such as Grand Prairie and Middle Delta.

Figure (B) compares the annual mean temperature, (C) the annual photosynthetically active radiation (PAR), (D) the annual mean Enhanced Vegetation Index (EVI), and (E) the annual mean Land Surface Water Index (LSWI) between these regions.