

Detecting the onset of rice field inundation in the Lower Mississippi River Basin via Harmonized Landsat Sentinel-2 (HLS) satellite time series

Yawen Deng, Bin Peng, Kaiyu Guan, Benjamin Runkle, et al. ISPRS Journal of Photogrammetry and Remote Sensing 228, 28–43.

<https://doi.org/10.1016/j.isprsjprs.2025.07.003>

Science Question

- How can we effectively combine temporal and spectral features from time-series satellite data to predict field-level start date of inundation (SDI) in rice fields?
- What are the spatial and temporal patterns of predicted SDI across the LMRB? which environmental factors possibly drive the spatial and temporal variability of SDI?

Analysis

- To capture field-level SDI, We developed an adaptive and scalable rule-based algorithm (**PHASE** - Phenology, Hydrology, and Spectral Evaluation) by combining phenological and spectral features using time-series Harmonized Landsat and Sentinel-2 (HLS) satellite data. This method was validated against a field database of 52 calibration site-years (2018–2022) and 18 test site-years (2023).

Results

- The PHASE method achieved superior accuracy in detecting inundation onset dates, with a MAE of 4.51 days for calibration and 4.92 days for test site-years, outperforming threshold-based methods (MAE $\approx$ 5–8 days) and machine learning models (MAE > 9 days). This improved performance is primarily attributed to the integration of stable phenological features and the sensitivity of SWIR2 spectral changes to flooding signals.
- We applied PHASE to the LMRB and generated an unprecedented annual field-level SDI estimation for the region spanning 2018 to 2023. The average predicted SDI ranged from DOY 162 to 175 during 2018-2023, with earlier SDIs observed in the southern regions compared to regions.
- The spatial and temporal variability in SDI is primarily driven by temperatures in April and May, spring precipitation, and soil moisture conditions.

Significance

- The PHASE method presents promising potential for applications in other rice-growing regions globally.
- The generated field-scale rice SDI dataset can support crop stage tracking, yield prediction, optimization of water and fertilizer management, assessment of GHG emissions, and informed planting and irrigation decisions.

Acknowledgements

This research was primarily supported by the NASA Carbon Monitoring System (ROSES 2020) Award 80NSSC21K1002

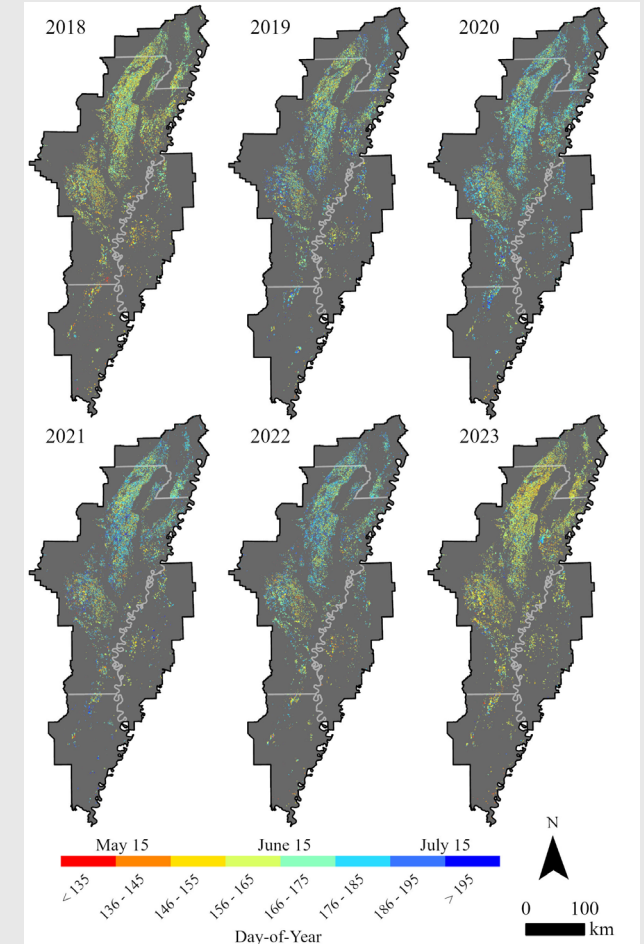


Figure 1. Spatial pattern of field-level SDI in the LMRB from 2018 to 2023.