Capability of maize water use efficiency estimation at field scale using Sentinel-2 data

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Introduction

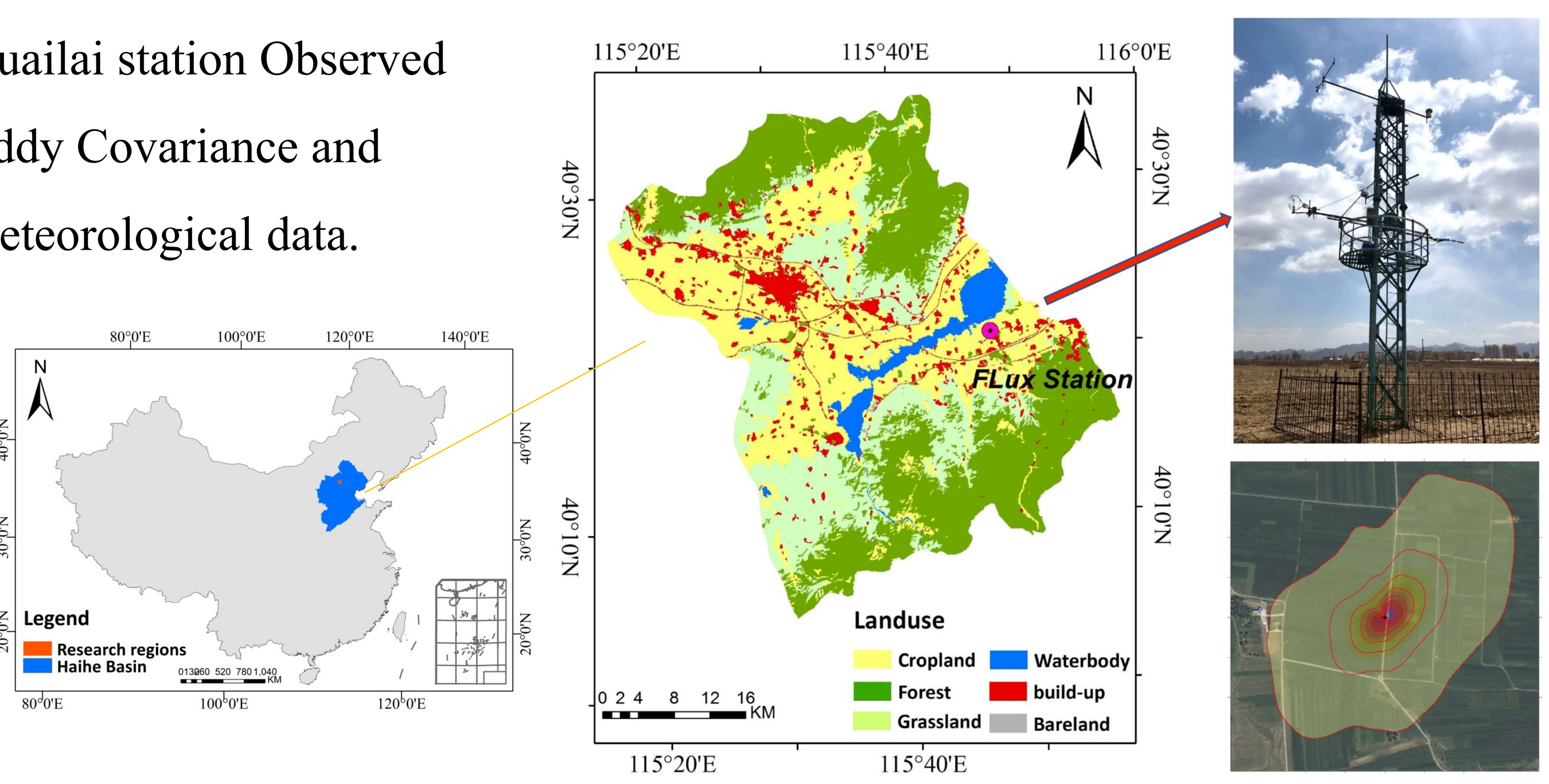
Water use efficiency (WUE) is defined as the ratio between gross primary production (GPP) and evapotranspiration (ET) at ecosystem scale, which can help understand the mechanism between water consumption and crop production in guiding field water management. Water consumption control is important in precision agriculture development. Mapping WUE at field scale using remote sensing data could provide crop water use status at high resolution and acquire the WUE spatial distribution.

In this study we proposed a method to estimate field-scale maize WUE with Sentienl-2 data. The GPP of maize is estimated by a light use efficiency model with RS observed albedo, sunshine radiation, fraction of photosynthetically active radiation (fpar) fitted using in site observation. Maize ET is modelled using FAO-PM model with crop coefficient simulated using vegetation indexes acquired from Sentinel-2 bands.

Data

In site data

Huailai station Observed Eddy Covariance and meteorological data.



Site Information

EC Site	Location	Underlying Surface	Data acquisition period
Huailai	40.35′ N 115.79 E	Maize	2017/1/1-2017/12/31

Maize Phenology

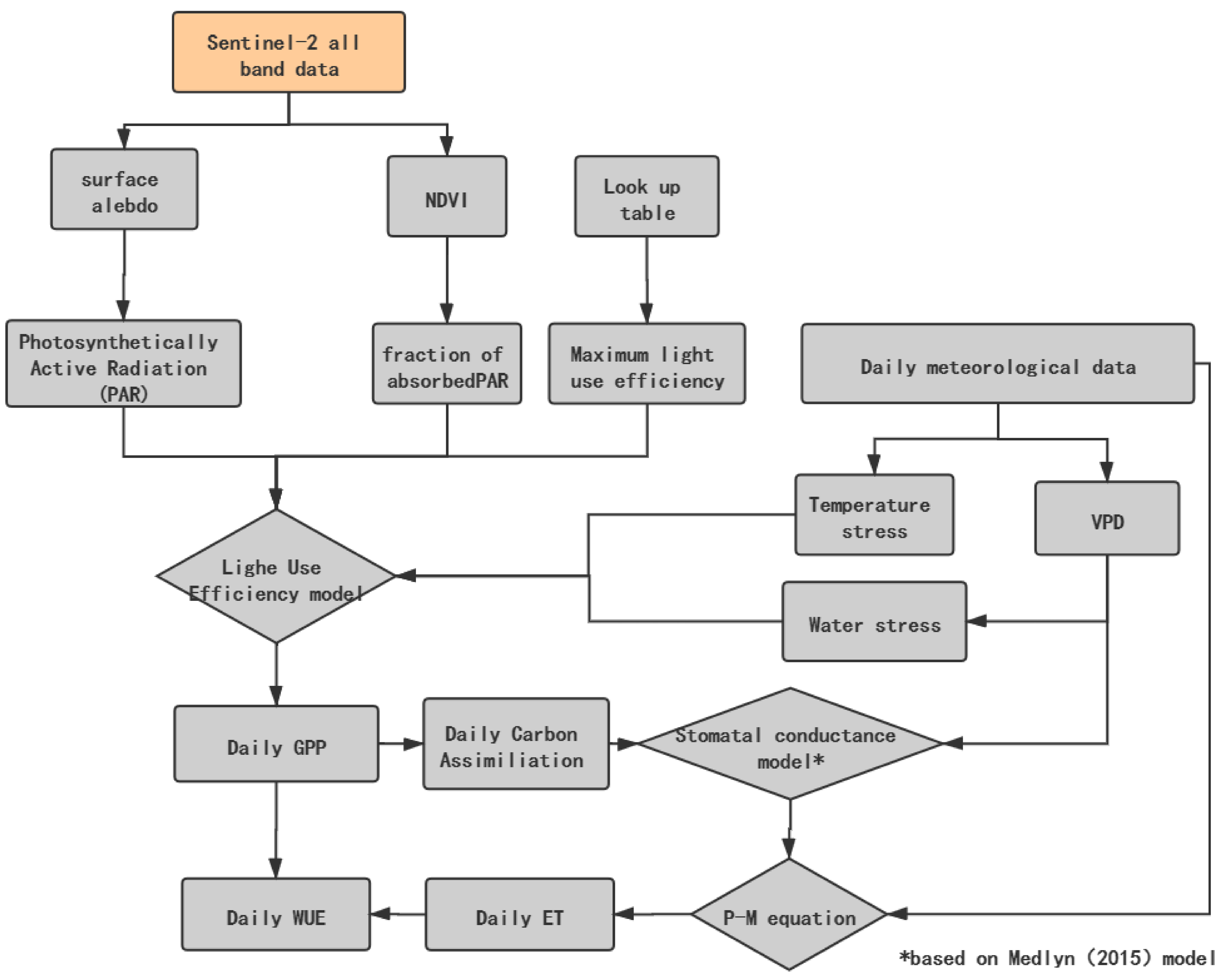
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Summer Maize												

Sowing · Growing · Harvesting

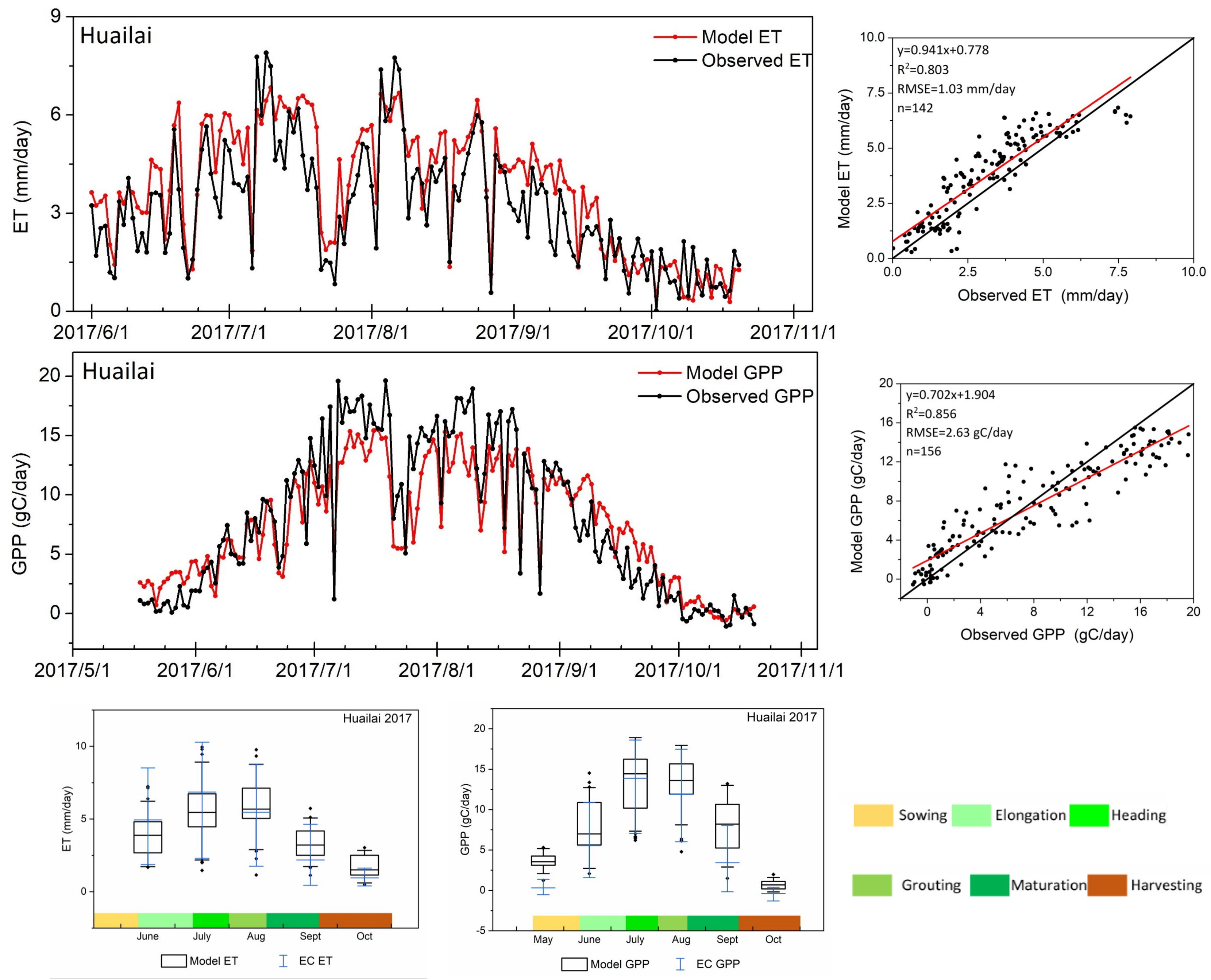
Satellite data

Satellite	Blue	Green	Red	NIR	SWIR1	SWIR2
Sentinel-2	Band 2	Band 3	Band 4	Band 8A	Band 11	Band 12
	448-546	538-583	656-684	848-881	1542-1685	2081-2323

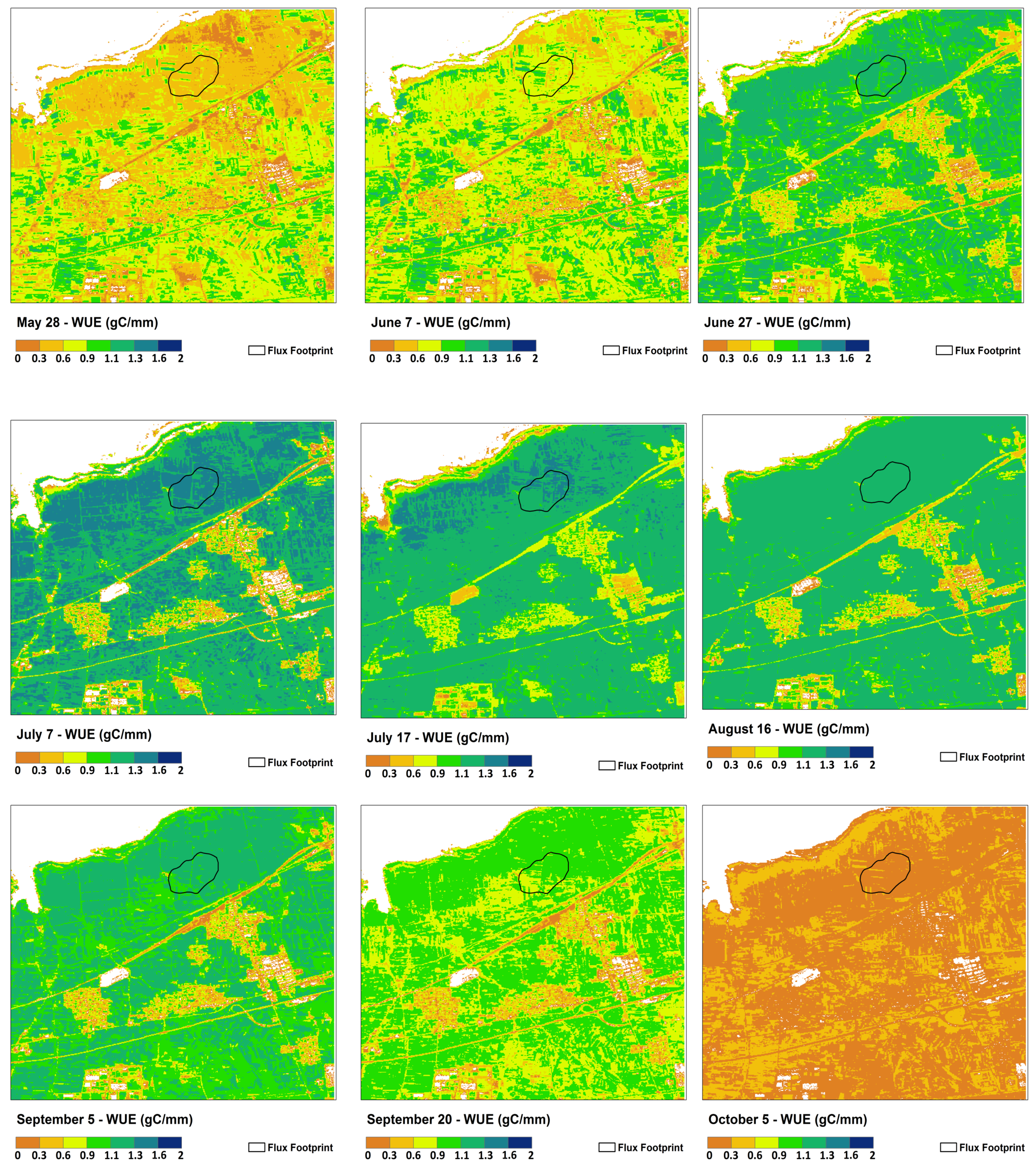
Method



Results



Comparisons of the observed ET, GPP and predicted results



Time series WUE results

Conclusions

1. Combining the phenology development of maize, the temporal characteristics of maize WUE change is associated with phenology. WUE was low after sowing, then increased during Elongation stage. Maize WUE peaked at Heading and Grouting period and decreased in Maturation stage.
2. Our WUE estimation method with high resolution could guide adopting various irrigation strategies based on different WUE conditions at field scale. This research could help shed light on the future WUE development under climate change background and improve our knowledge of precise water management.

Reference

1. Medlyn B E, Duursma R A, Eamus D, et al. Reconciling the optimal and empirical approaches to modelling stomatal conductance[J]. Global Change Biology, 2011, 17(6): 2134-2144.