# Mapping of High-Resolution Crop Evapotranspiration Using Fused Remote Sensing Imagery: Validation Against OpenET

Gloria Ramos and Vaishali Sharda

Carl and Melinda Helwig Department of Biological and Agricultural Engineering, Kansas State University, Manhattan, Kansas 66506

## Introduction

- Accurate estimation of crop evapotranspiration (ETa) is vital for sustainable agriculture under growing climate and water challenges.
- Traditional field methods are limited, making remote sensing a powerful alternative.
- UAVs provide high spatial detail but limited coverage, while PlanetScope offers frequent, large-area observations at coarser resolution.
- This study integrates UAV and PlanetScope imagery to enhance both spatial and temporal resolution for precise ETa estimation, supporting improved crop water management.

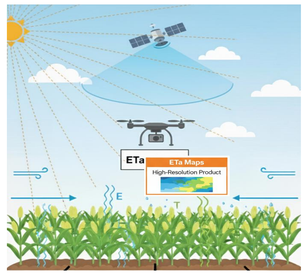
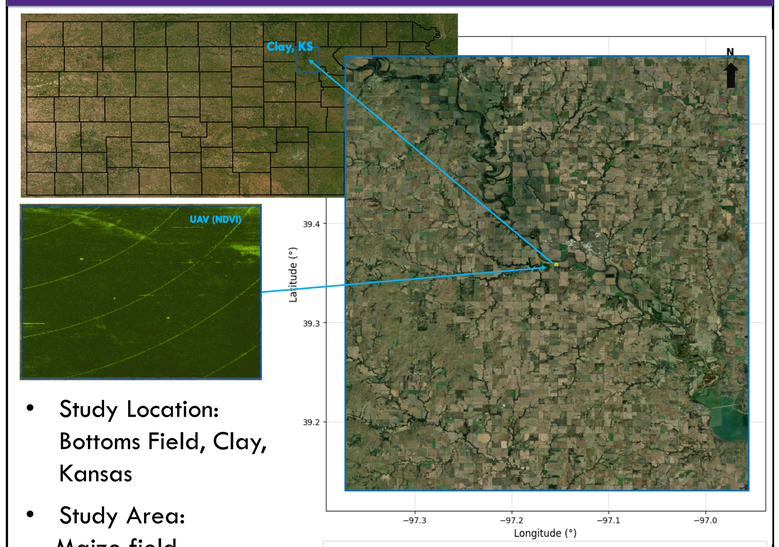



**Figure 1.** Conceptual illustration of UAV and satellite image acquisition over crop fields, highlighting the influence of climatic drivers on daily ETa processes

## Objectives

- Combine the spatial and temporal advantages: improve the resolution of PlanetScope and close observation gaps between UAV flights.
- Generate accurate ETa maps by leveraging time-series continuous data with high spatial and temporal resolution.

## Study Site




- Study Location: Bottoms Field, Clay, Kansas
- Study Area: Maize field

**Figure 2.** The location of the study area in Clay, KS

## Methods

### Data Acquisition and Processing

- UAV images were collected using a quadcopter (DJI Matrice 100) and processed in Agisoft Metashape to generate georeferenced orthomosaics.
- PlanetScope Super Dove images with 3-meter resolution were downloaded from the Planet Explorer website.
- Meteorological data were requested from the Kansas Mesonet

### Data Fusion

- Spatiotemporal fusion using the *SwinSTFM* model, to fill observation gaps between UAV flights using temporally dense PlanetScope data.

### ETa Estimation

- ETa mapping and estimation using the High-Resolution Mapping of Evapotranspiration (HRMET) model

### Model Evaluation

- Evaluate SwinSTFM performance using image quality assessment metrics.
- Comparison of HRMET-derived ETa with *OpenET METRIC using performance metrics.*

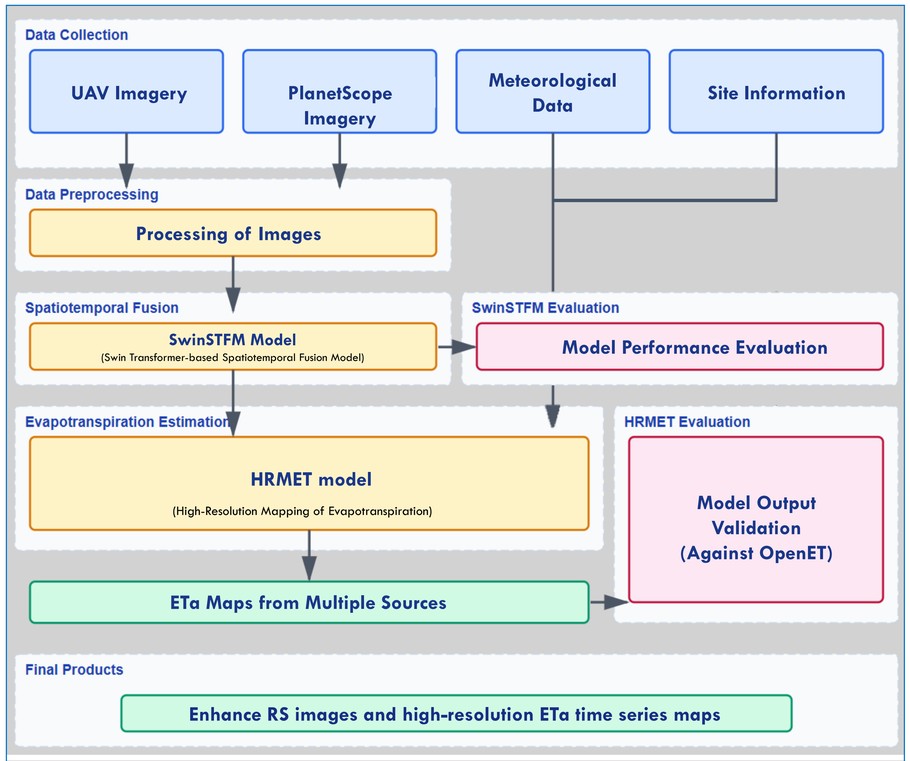



**Figure 3.** The study framework shows the five sequential phases: (1) Data collection, (2) Data preprocessing, (3) Data fusion, (4) Evapotranspiration mapping, and (5) Output validation

## Preliminary Results

- UAV – and PlanetScope-derived ETa show absolute differences
- PlanetScope underestimating UAV ETa
- These preliminary results highlight the need for spatiotemporal fusion to produce high-resolution, continuous ETa maps

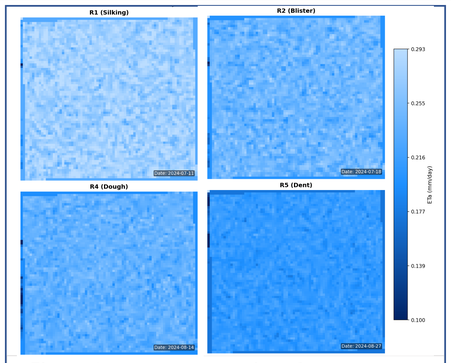



**Figure 4.** ETa maps using PlanetScope imagery

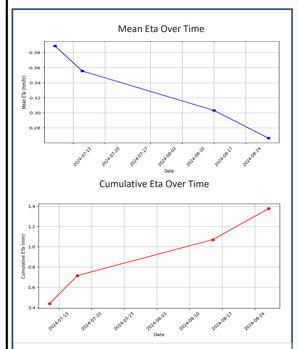



**Figure 5.** Mean and cumulative ETa values using UAV imagery

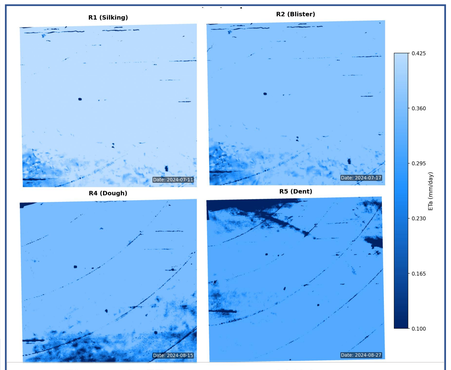



**Figure 6.** ETa maps using UAV imagery

**Table 1.** Statistical comparison of UAV- and PlanetScope-derived (ETa) estimates.

| Date (UAV vs. PS) | RMSE (mm/day) | MAE (mm/day) | Bias |
|---|---|---|---|
| 2024-07-11 | 0.858 | 0.176 | −0.162 |
| 2024-07-17 (UAV) vs 2024-07-18 (PS) | 0.856 | 0.154 | −0.140 |
| 2024-08-15 (UAV) vs 2024-08-14 (PS) | 0.107 | 0.099 | −0.070 |
| 2024-08-27 | 0.856 | 0.140 | −0.113 |

## Anticipated Outcomes

- Produce near-Daily, UAV-like imagery with high spatial and spectral fidelity
- Generate high-resolution, continuous evapotranspiration (ETa) datasets with detailed spatial coverage.

## Future Directions

- Advance toward yield prediction by combining the fused ETa and vegetation data with machine learning models.

# Workflow of the study entitled: Mapping of High-Resolution Crop Evapotranspiration: Validation Against OpenET