

# ***Issues in Evaluating ET Model Output Using Measurements and Model Inter-comparisons***

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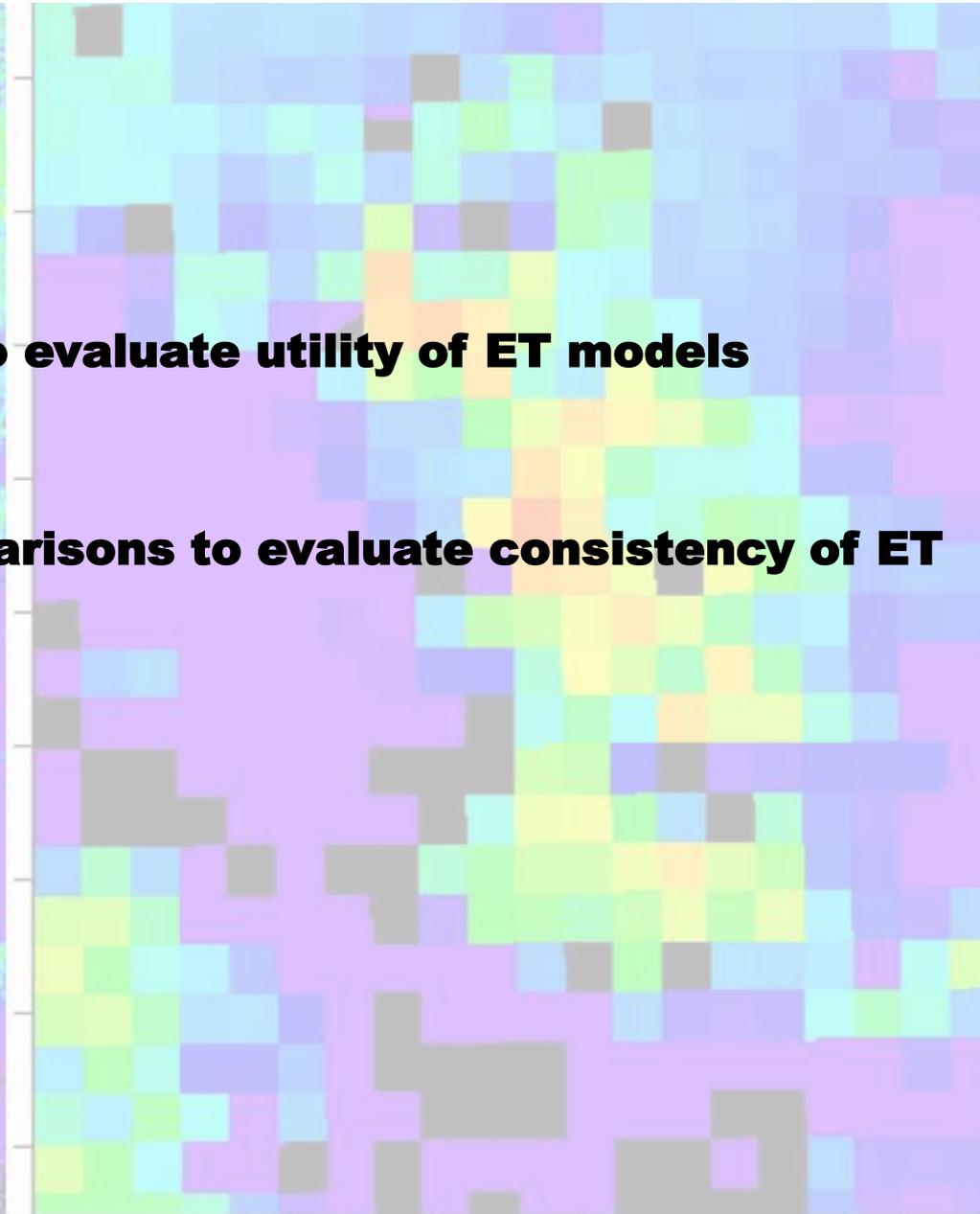
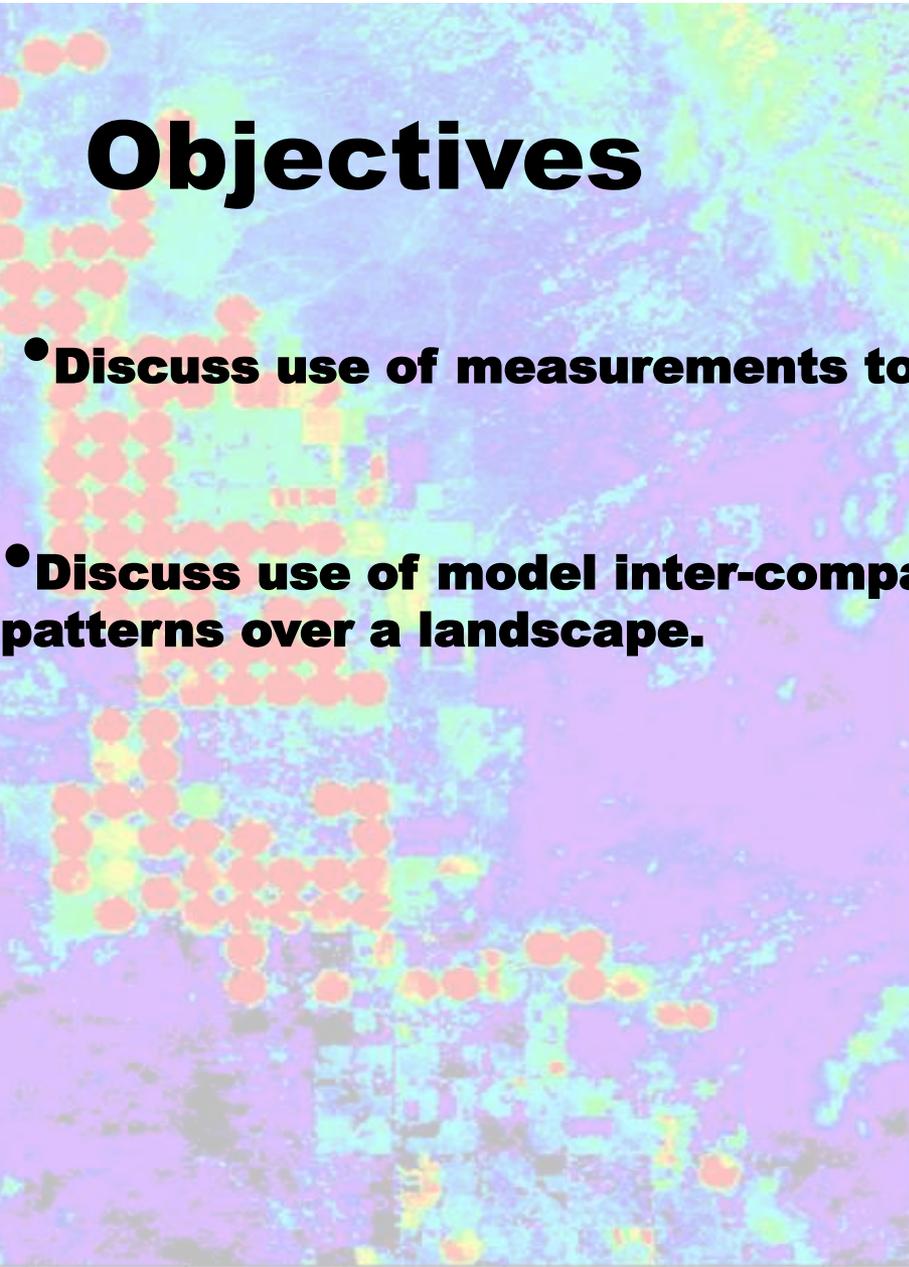
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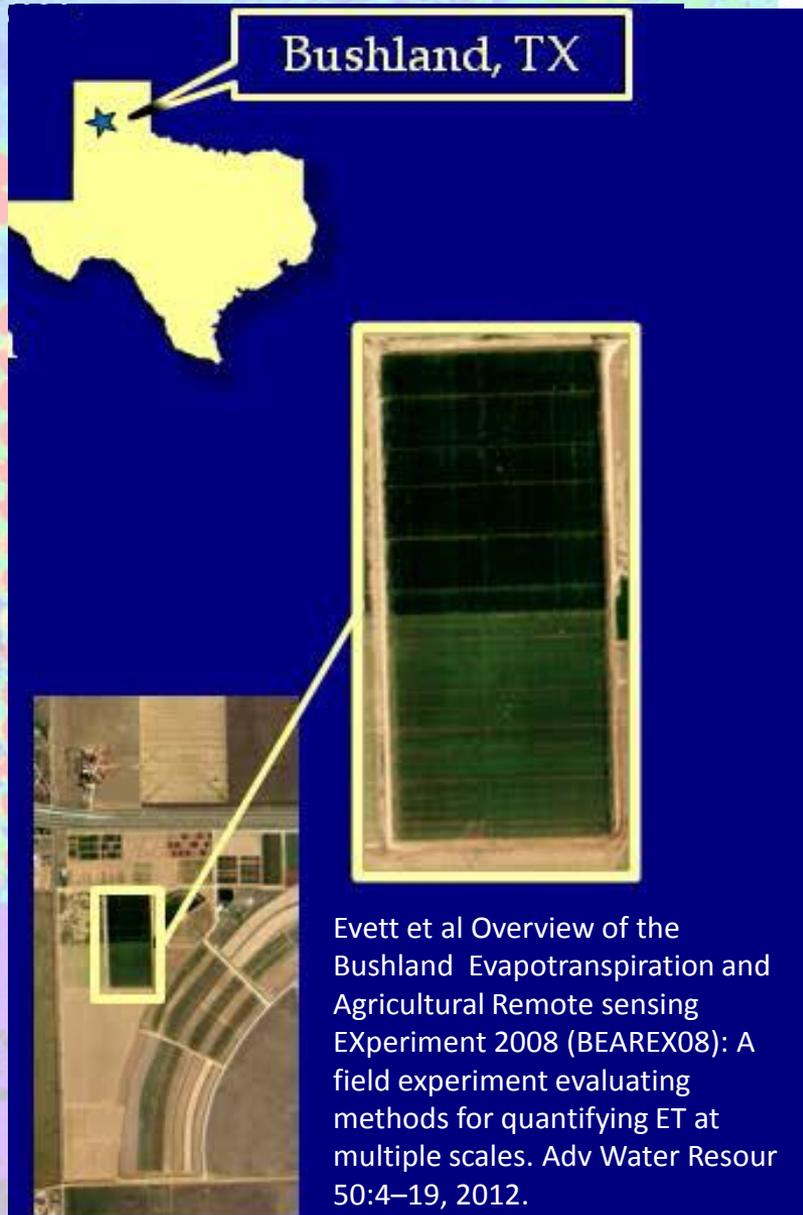
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## **Objectives**

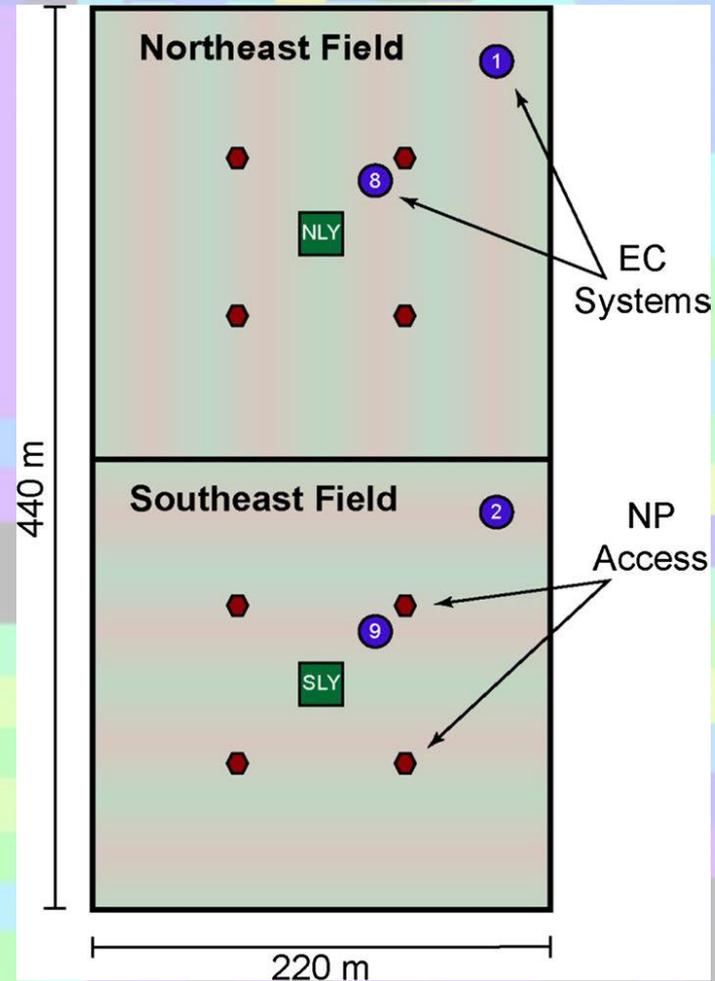
- **Discuss use of measurements to evaluate utility of ET models**
- **Discuss use of model inter-comparisons to evaluate consistency of ET patterns over a landscape.**



# Issues in Evaluating ET Model Output Using Measurements and Model Inter-comparisons



**Measurement Uncertainty**  
**NP: Neutron Probe**  
**LY: Lysimeter**  
**EC: Eddy Covariance**



# ***Issues in Evaluating ET Model Output Using Measurements and Model Inter-comparisons***



**End of June**



**End of July**



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For EC, measurement uncertainty often assessed via energy balance closure and quantified in terms of a ratio of the sum of the turbulent fluxes to available energy  $(H+LE)/(RN-G)$ .

This ranged from 74% for EC2 to 87% for EC8, 84% for EC1, and 85% for EC9.



This site also had significant advection. Based on lack of closure and estimated advective effects yielded estimated “errors” on hourly ET fluxes of  $\sim 100 \text{ Wm}^{-2}$  which translates to  $\sim 0.15 \text{ mm}$  water. So on a daily basis 1-2 mm error



For LY, accuracy assessed based on depth of water equivalent to mass measurement accuracy which for these large (3 x 3 m) monolith lysimeters is  $\sim 0.05 \text{ mm}$ —not a rate of change or flux accuracy but a absolute mass measurement accuracy. ET accuracy on a daily basis  $\sim 0.5\text{-}1 \text{ mm}$



For NP WB, accuracy is much more difficult to assess---estimates are weekly or longer. Based on long term LY measurements magnitude of error or uncertainty was estimated to be  $\sim 5\text{-}10 \text{ mm}$  so on a daily basis  $\sim 1\text{-}2 \text{ mm}$  error.



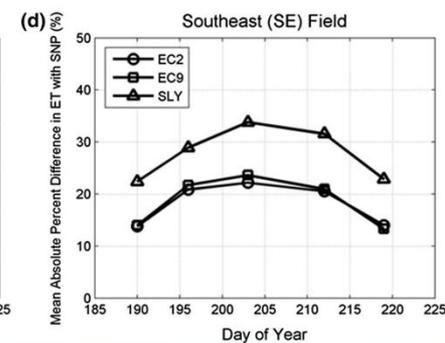
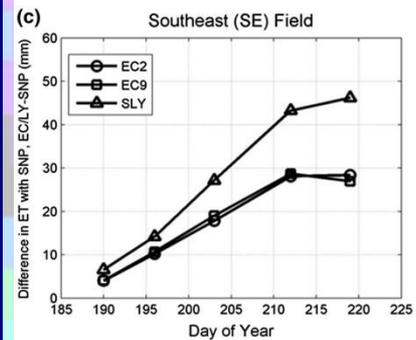
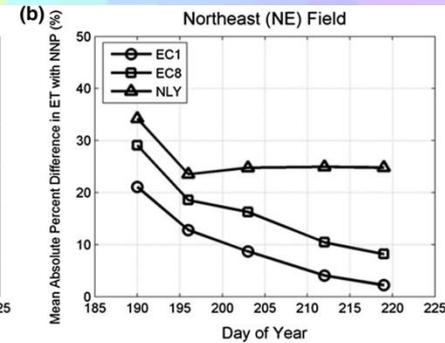
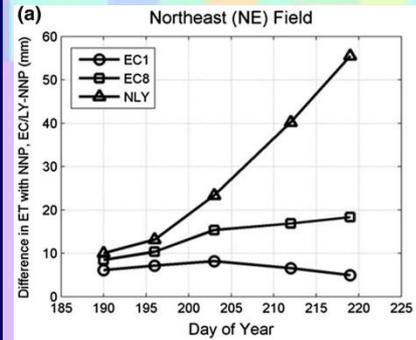
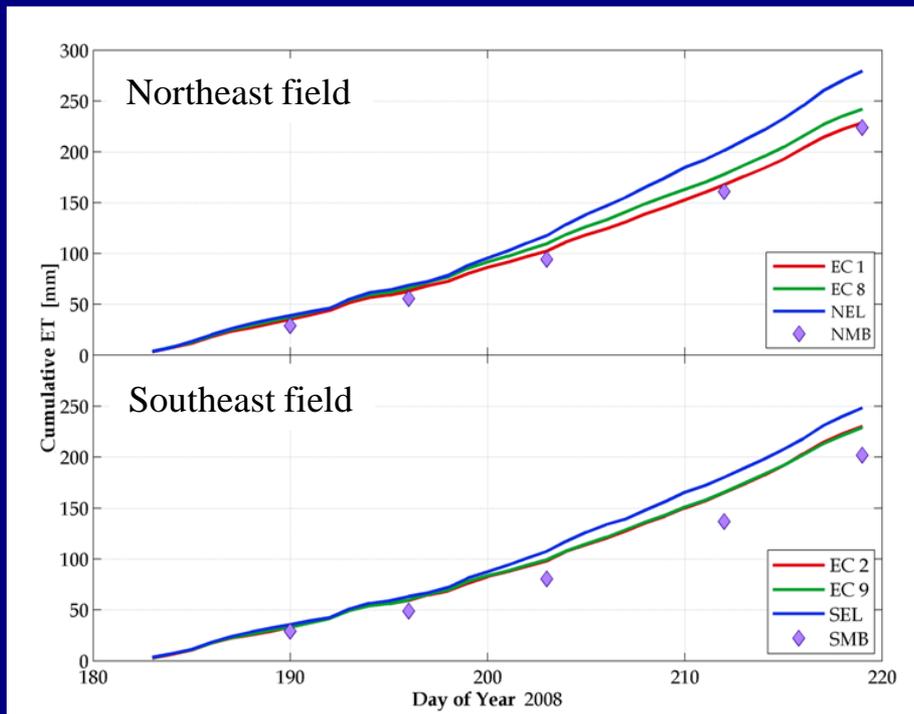
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## Measurement Uncertainty – Differences between NP water balance and

□ **Lysimeters**

□ **Eddy Covariance/Flux towers**

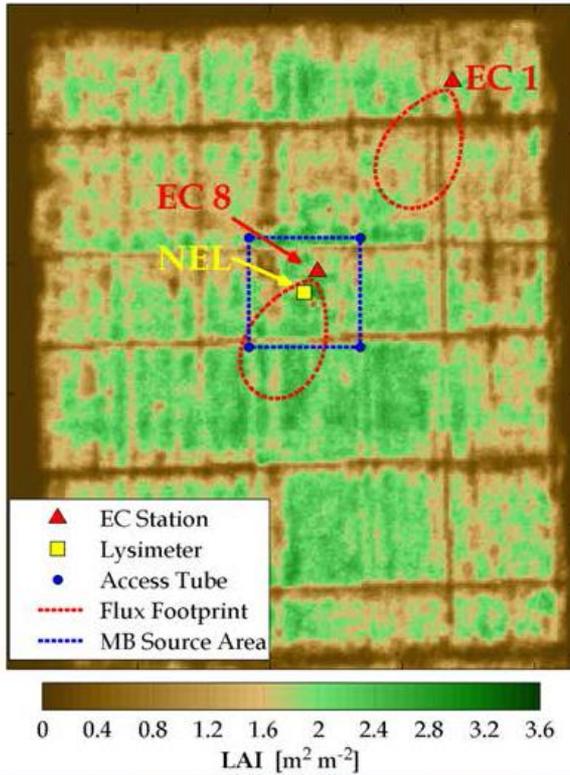
## Cumulative Evapotranspiration



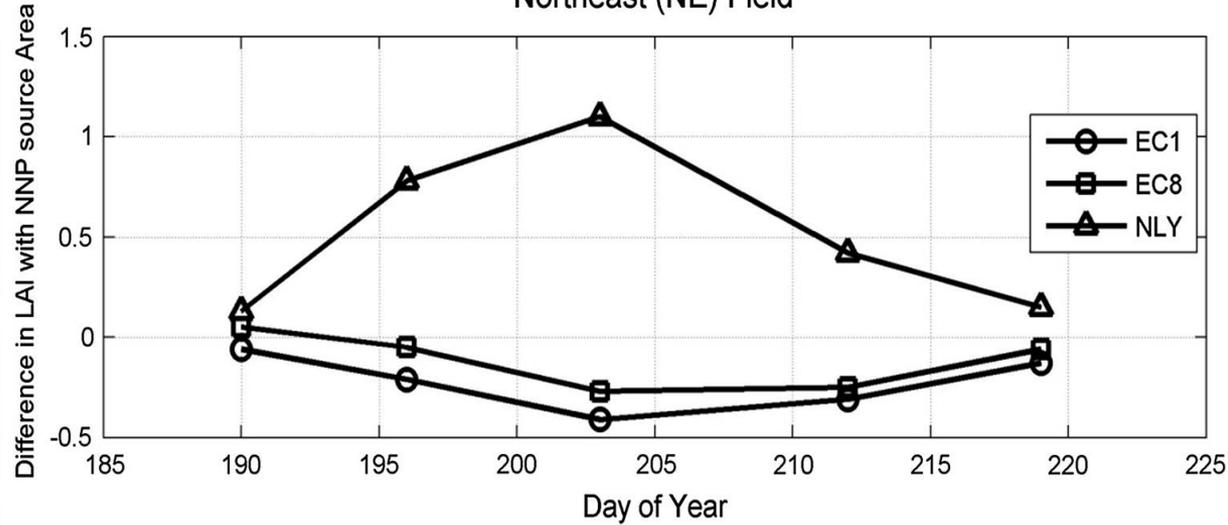
# Issues in Evaluating ET Model Output Using Measurements and Model Inter-comparisons

## Variation in source area/flux footprint affecting the measurements by NP, LY and EC systems

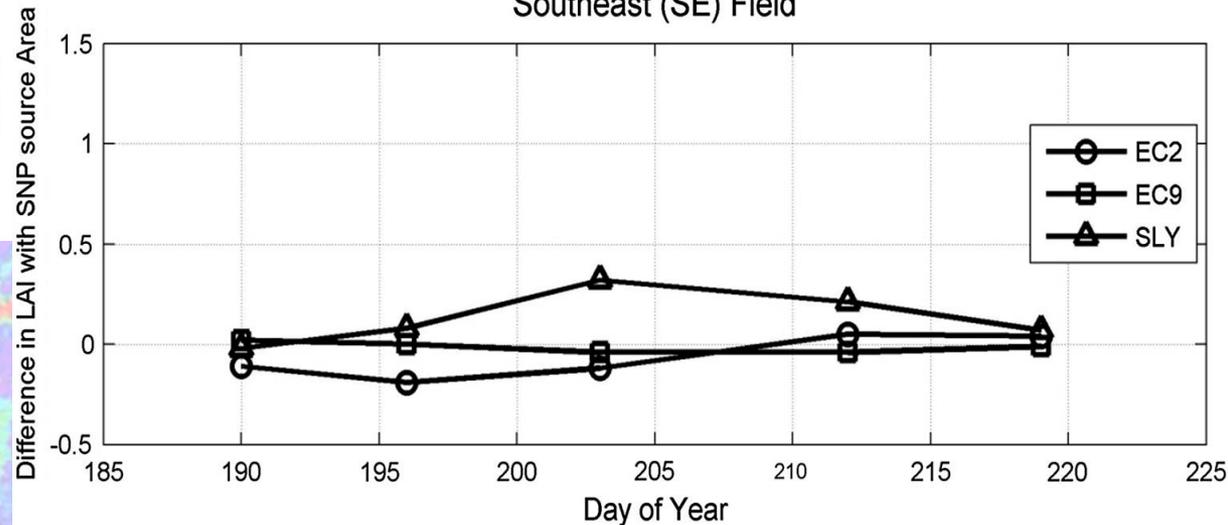
Northeast field



Northeast (NE) Field



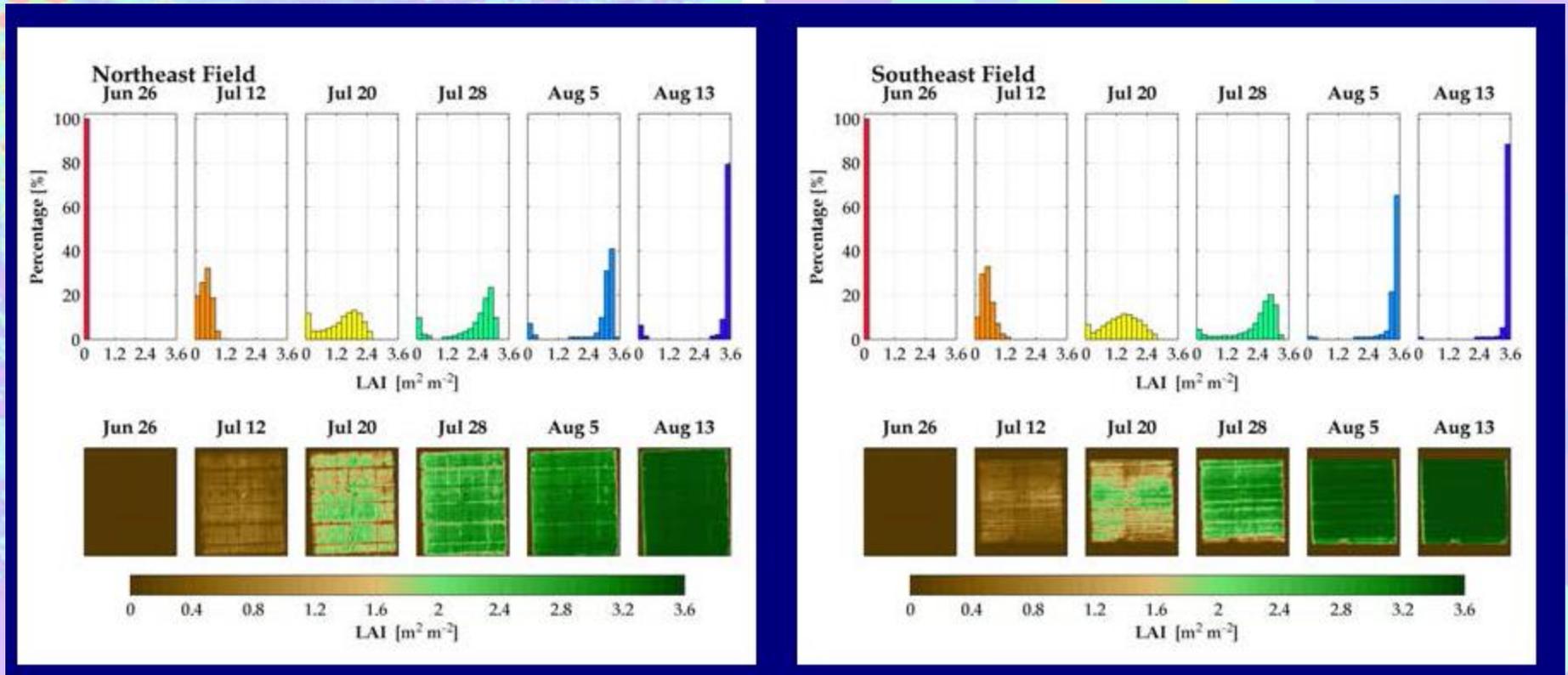
Southeast (SE) Field



# Issues in Evaluating ET Model Output Using Measurements and Model Inter-comparisons

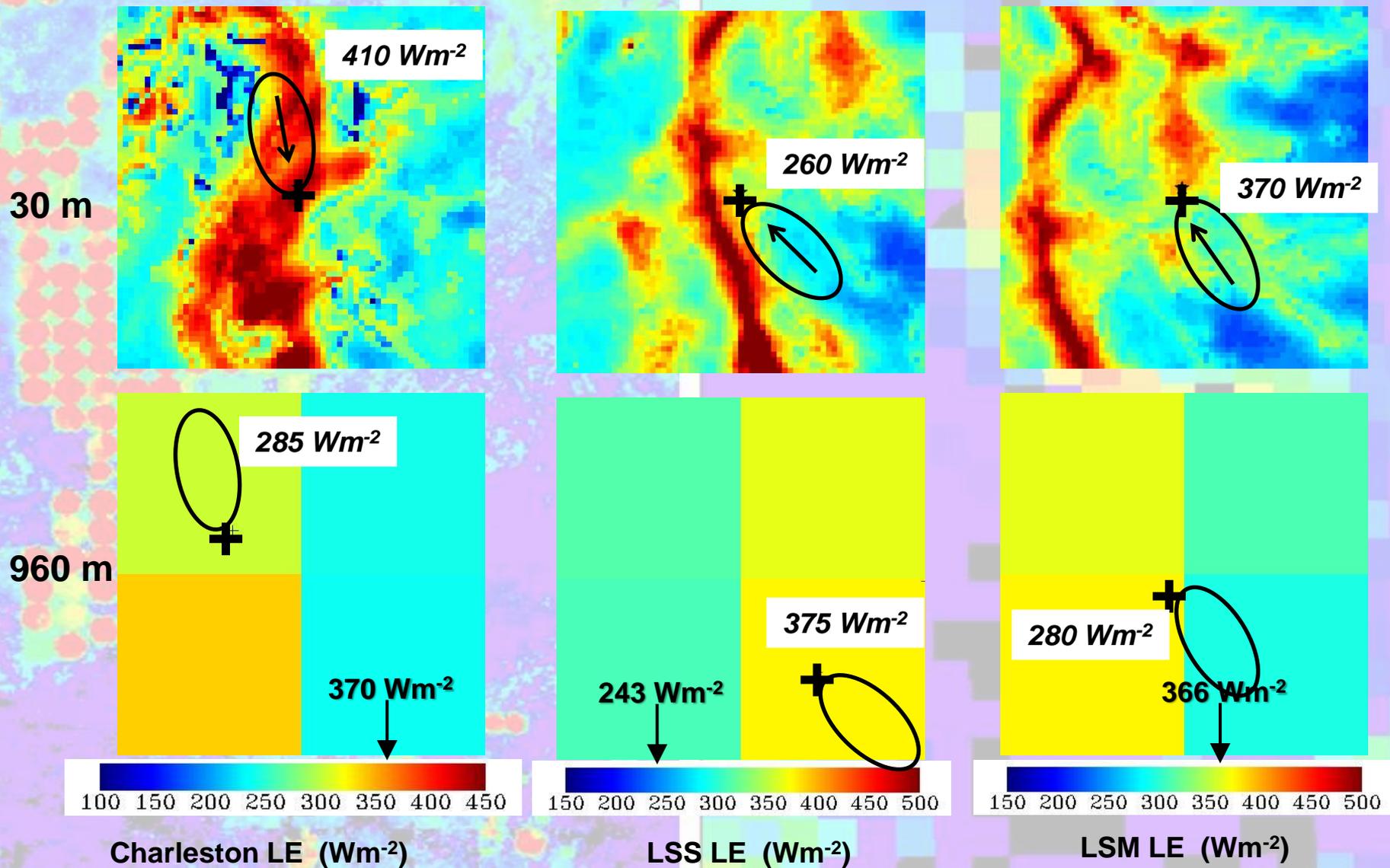
Spatial and temporal variation in cover affecting the measurements by NP, LY and EC systems

From 1 meter resolution airborne data



# Issues in Evaluating ET Model Output Using Measurements and Model Inter-comparisons

Mismatch in model/pixel resolution and source area affecting flux measurements



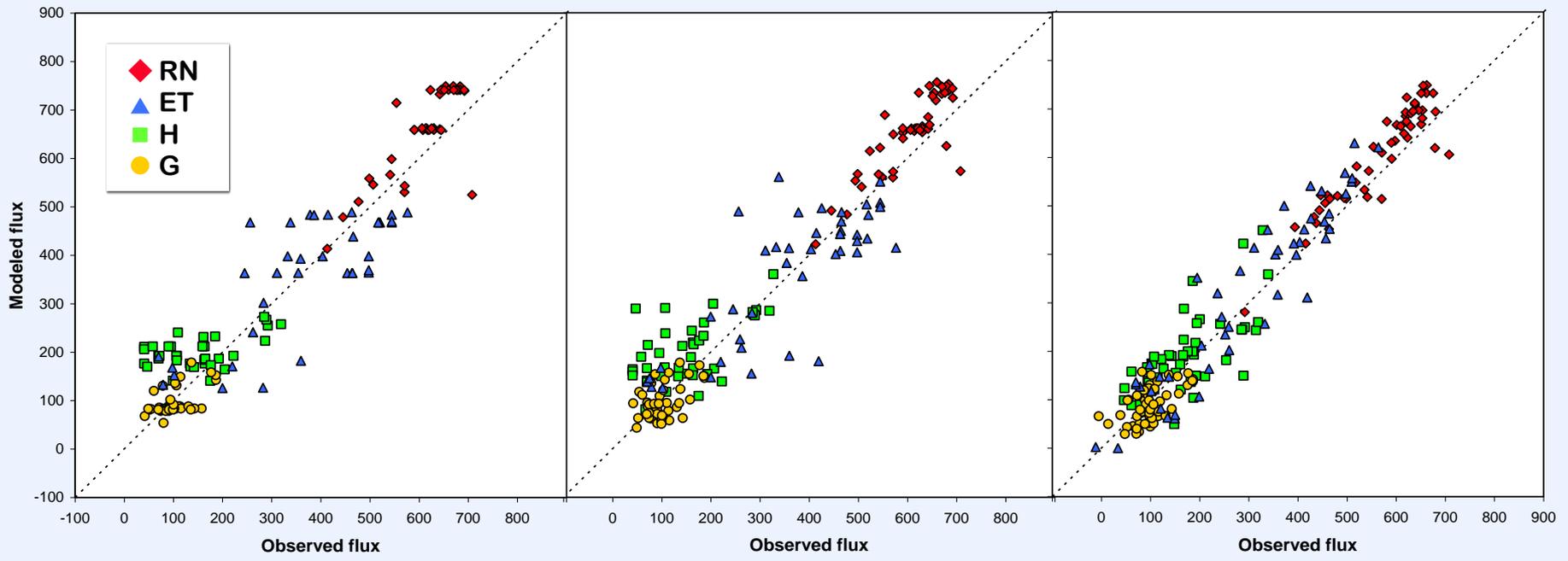
# Issues in Evaluating ET Model Output Using Measurements and Model Inter-comparisons

Mismatch in model/pixel resolution and source area from 10 km to 100m

**GOES (10 km)**

**MODIS (1 km)**

**Landsat (~100 m)**



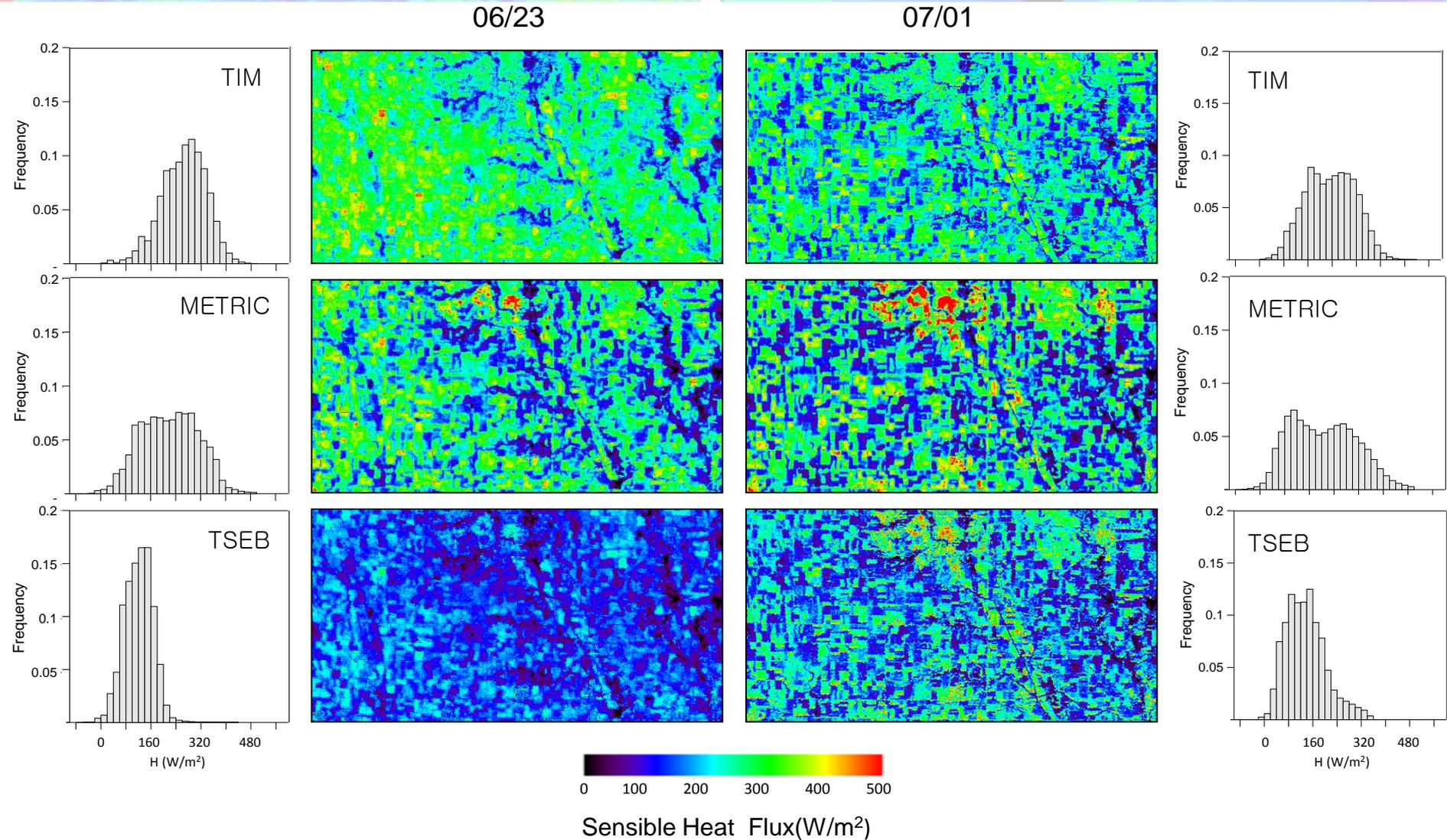
**MAD: ~75 Wm<sup>-2</sup> (25%)**

**MAD: ~60 Wm<sup>-2</sup> (20%)**

**MAD: ~50 Wm<sup>-2</sup> (15%)**

# Issues in Evaluating ET Model Output Using Measurements and Model Inter-comparisons

## Model inter-comparisons: evaluating spatial distributions and patterns in fluxes

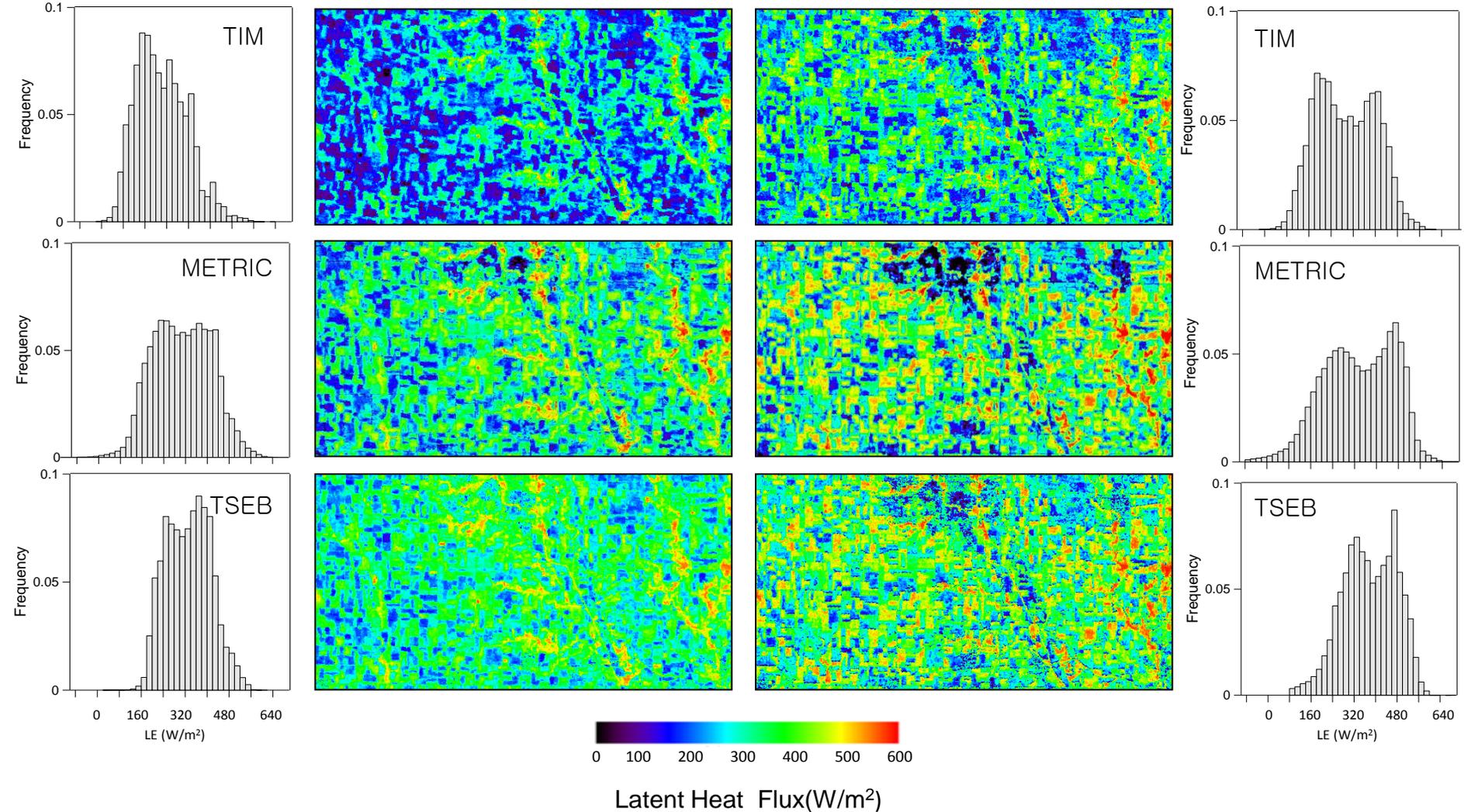


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## Model inter-comparisons: evaluating spatial distributions and patterns in fluxes

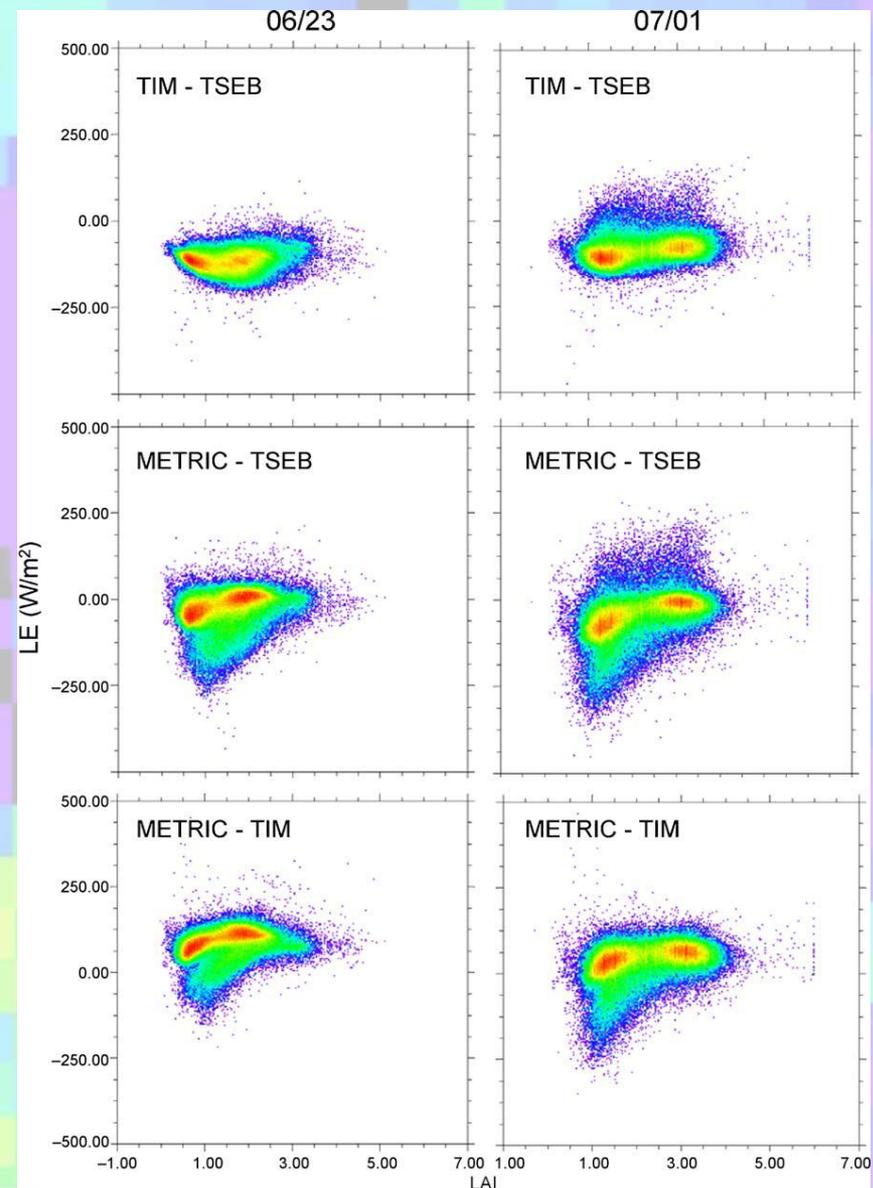
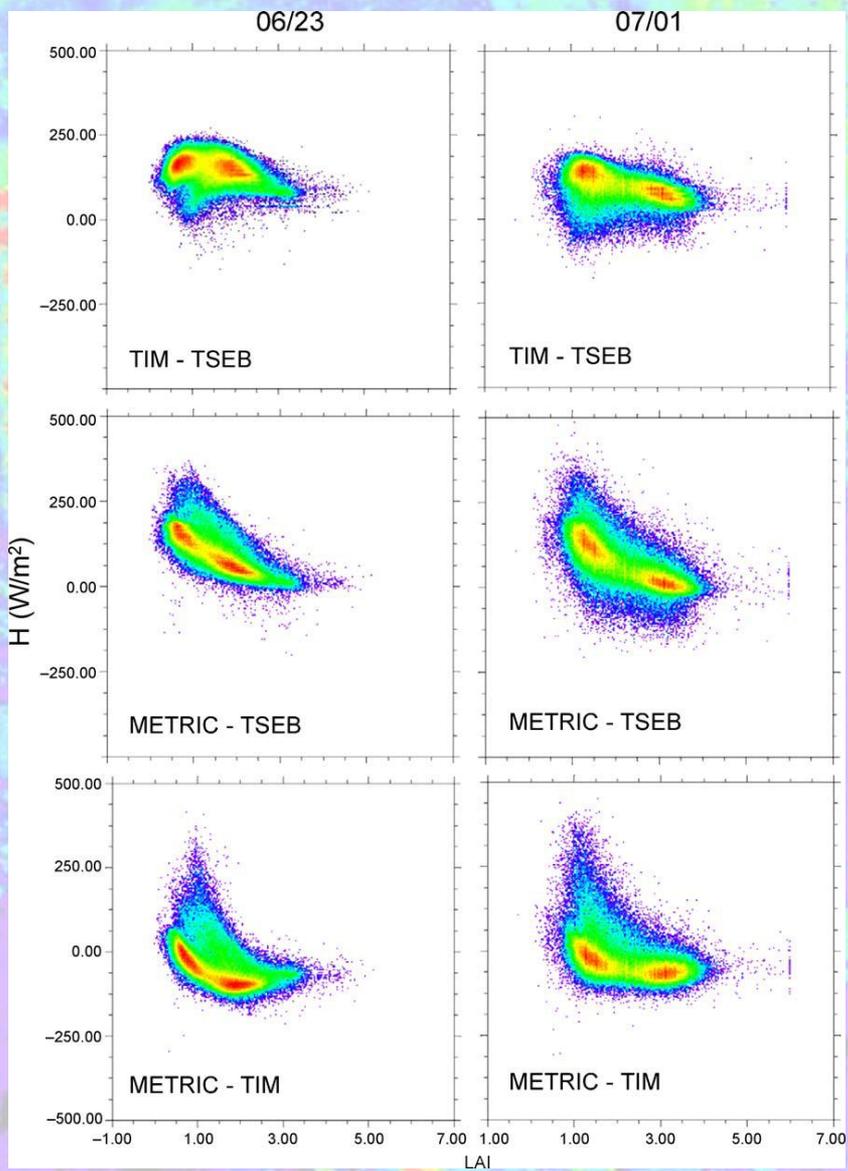
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# Issues in Evaluating ET Model Output Using Measurements and Model Inter-comparisons

Model inter-comparisons: Do model flux differences relate to surface properties?



# ***Issues in Evaluating ET Model Output Using Measurements and Model Inter-comparisons***

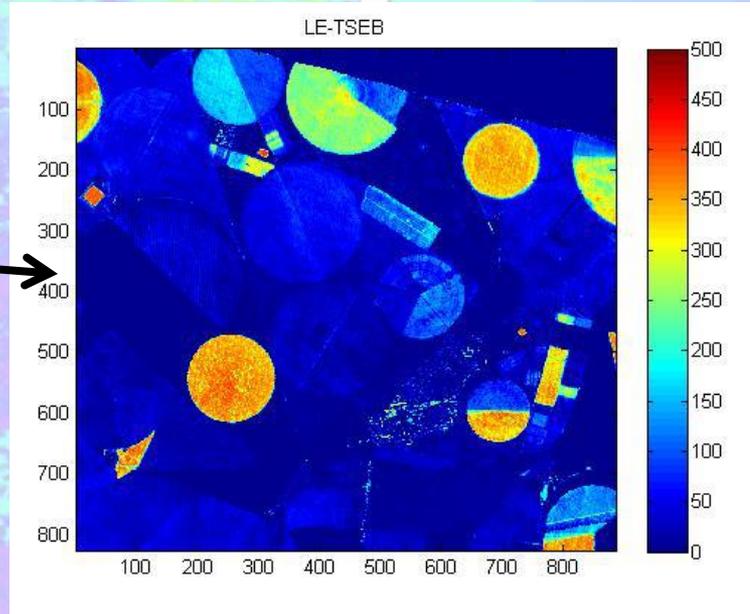
## ***Model inter-comparisons: Sensitivity to model inputs...is more complex better?***

Necessary input	TSEB	ALEXI	SEBS	SEBAL	SSEBop	DATTUTDUT
<b>In-situ / Ancillary data:</b>						
Solar radiation, or:	√	√	√	√		
Atmospheric transmittance, or	√	√	√	√		
Elevation					√	
Atmospheric pressure	√		√			
Wind speed	√	√	√	√		
Air temperature	√		√	√	√	
Relative humidity	√		√	√		
Sensor viewing angle	√	√				
Radiosounding		√				
Reference ET					√	
<b>Remote sensing / Spatial data:</b>						
Reflectance			√	√	√	
NDVI/LAI	√	√	√	√	√	
Surface temperature	√	√	√	√	√	√
Landcover, or:	√	√				
Aerodynamic properties	√	√	√			
<b>User expertise:</b>						
Wet pixel selection				√		
Dry pixel selection				√		
NDVI end-member bare soil	√		√			
NDVI end-member full vegetation	√		√			

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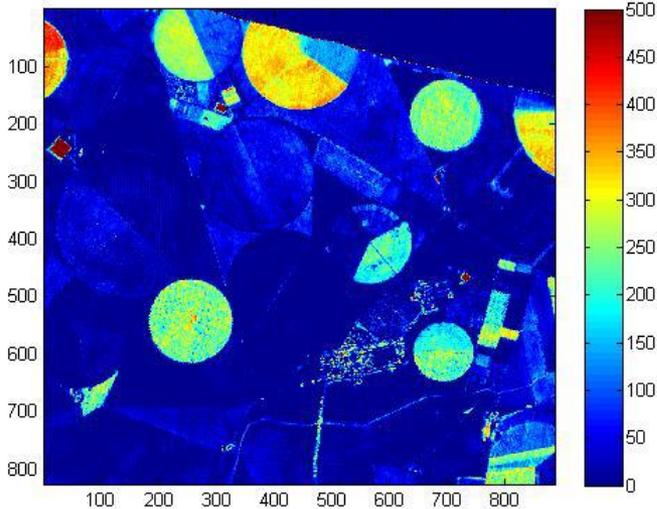
## Model inter-comparisons: Differences in magnitude and spatial patterns

Generally smaller differences in LE but low spatial correlation ( $R \sim 0.4$ )



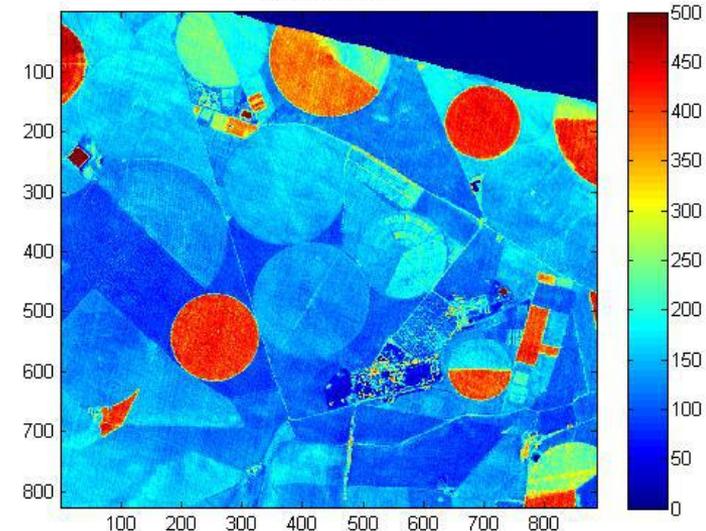
Significant differences in LE ( $> 150 \text{ Wm}^2$ ) but high spatial correlation ( $R \sim 0.9$ )

LE-SEBAL



Significant differences in LE ( $> 150 \text{ Wm}^2$ ) and low spatial correlation ( $R \sim 0.4$ )

LE-DATTUTDUT



# ***Issues in Evaluating ET Model Output Using Measurements and Model Inter-comparisons***

## ***Concluding remarks....***

- ❑ ET measurements have a level of uncertainty/error due to the technique and to the unique conditions and properties of the contributing source-area.***
- ❑ ET model output should be at a spatial resolution that integrates up to the source-area/flux footprint of the measurement system to ensure both are sampling the same contributing area.***
- ❑ ET model output evaluated at several points does not guarantee the ET patterns are reliable over the whole scene which often contain a wide range of surface conditions-ET model inter-comparisons illustrate this.***
- ❑ ET model inter-comparisons need to be conducted evaluating the spatial patterns over whole scenes and determine the primary factors causing major discrepancies.***
- ❑ ET models have a wide range in complexity and required inputs as well as the level of sensitivity to these inputs. As a result, the performance of the various ET models are likely to depend upon the land use, environmental conditions and ground data available – the impact of these factors on different ET models needs to be identified.***
- ❑ The ET community needs to consider ensemble modeling – running multiple ET models and evaluating output both from individual models and the ensemble, and using ET measurements where available – weather forecasting/climate and hydrological communities have found it quite useful to use ensemble modeling for improving predictions.***