NASA MODIS/VIIRS Science Team Meeting

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MAPPING WATER USE, PHENOLOGY AND PRODUCTIVITY IN AGRICULTURAL LANDSCAPES BY FUSING MULTI-SENSOR DATA PRODUCTS

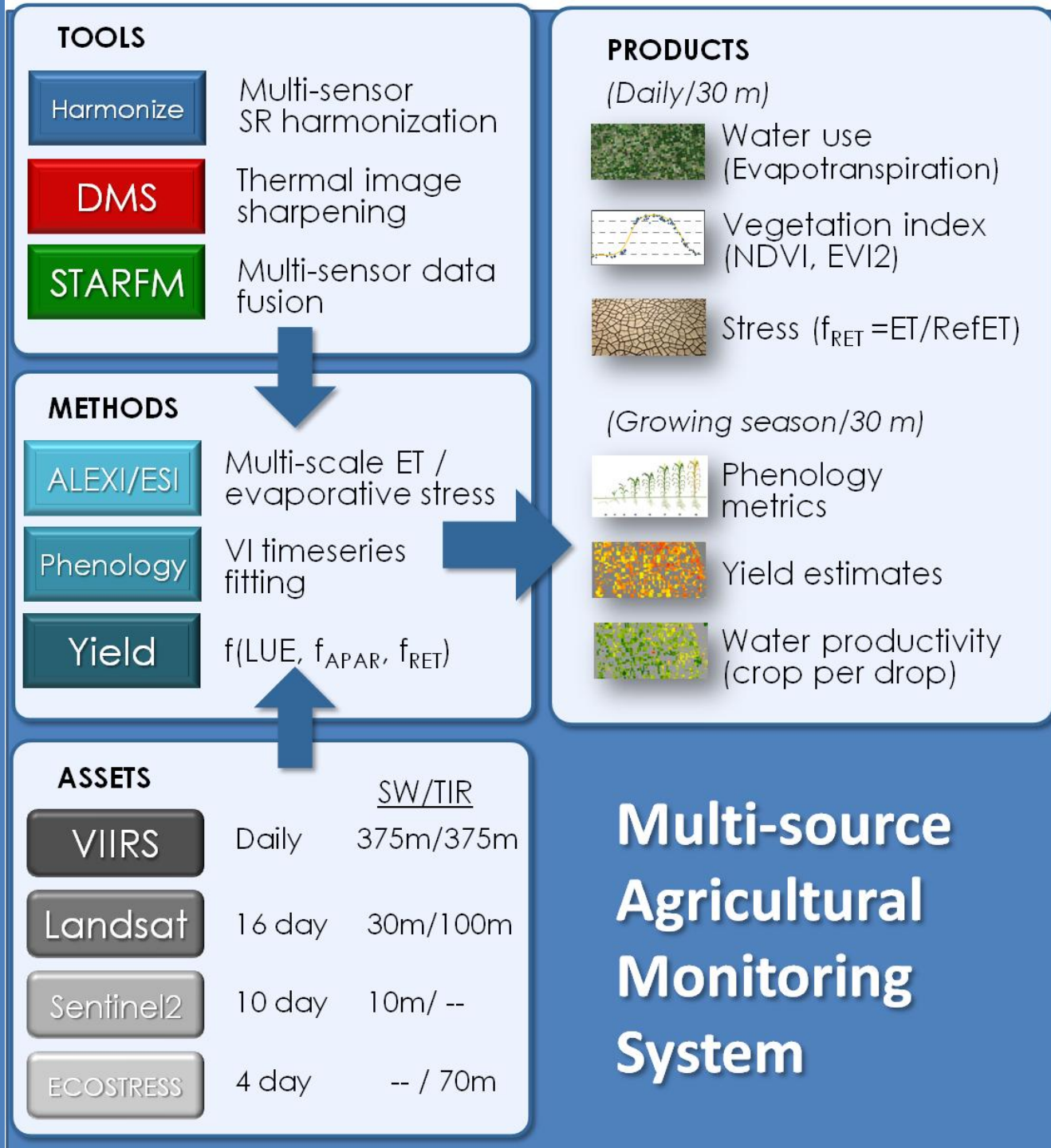
P.I.:	Feng Gao, Hydrology and Remote Sensing Lab, USDA-ARS
Science P.I.:	Martha Anderson, Hydrology and Remote Sensing Lab, USDA-ARS
Co. I:	Bill Kustas, Hydrology and Remote Sensing Lab, USDA-ARS
Co. I:	Joe Alfieri, Hydrology and Remote Sensing Lab, USDA-ARS
Co. I:	Christopher Hain, NASA-Marshall Space Flight Center
Co. I.:	Jason Otkin, University of Wisconsin
Co. I.:	Hadi Jaafar, American University of Beirut

Objectives:

Prototype methods for routine production of high spatiotemporal resolution

- evapotranspiration
- vegetation index
- phenology
- yield products

using a multi-sensor data fusion approach



Summary of Previous Work

- Surface Reflectance Data Fusion System
  Landsat, MODIS
- Evapotranspiration Data Fusion System
  GOES, MODIS and Landsat
- Crop Phenology Mapping
  retroactive phenology using full year of Landsat and MODIS
- Yield Anomaly and ESI

Proposed Improvements

- Surface Reflectance Data Fusion System
  Landsat, MODIS, Sentinel-2, VIIRS
- Evapotranspiration Data Fusion System
  Landsat, Sentinel-2, VIIRS, ECOSTRESS
- Crop Phenology Mapping
  real-time crop growth stages using partial year of L8, S2, MODIS/VIIRS
- Yield Products using VI, ET and phenology

Technical Approach

- Extend applications to more crop types (e.g., wheat, cotton, hay, vineyards etc.)
- Adapt ET and SR data fusion system to rangeland and pasture ecosystems
- Focus primarily on the USDA-ARS LTAR sites
- Supply irrigation management for vineyard operation in California (GRAPEX experiment)
- Collaborate on international studies (Czech Republic, Lebanon, Brazil and Spain)
- Utilize cloud computing (USDA-ARS SCINet, Google Earth Engine, Amazon Web Services etc.) for large area mapping

Agricultural sites

Rangeland sites

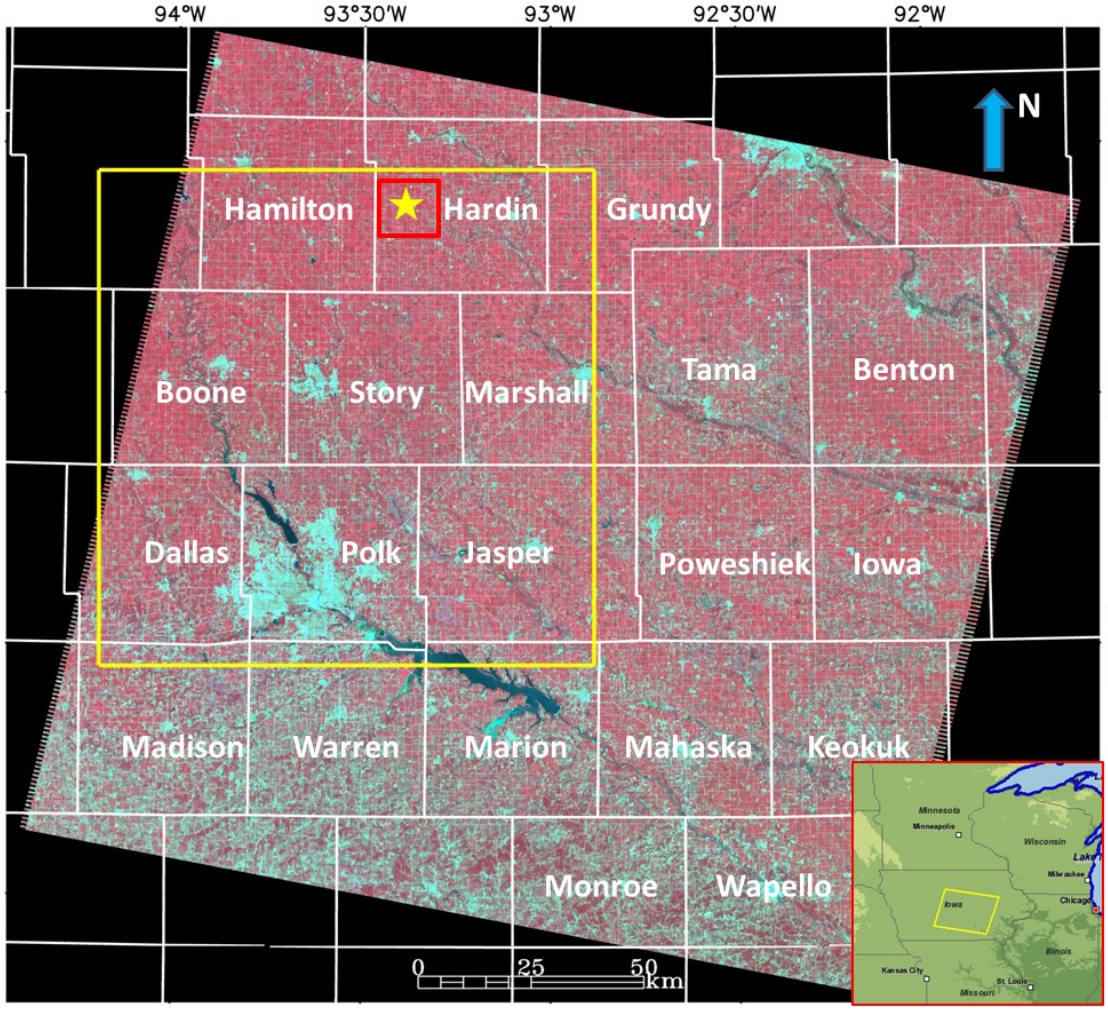
Long-Term Agro-ecosystem Research Sites and Farm Resource Regions

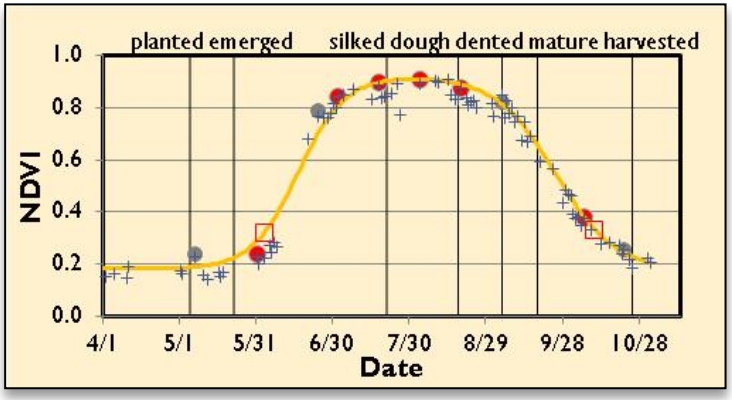
	Cropland				Rangeland			U Sao Paulo	CzechGlobe	AUB
	UMB	PRHPA	LCB	CA	CPER	Jornada	SD	Brazil	Czech Rep	Lebanon
Met data	x	x	x	x	x	x	x		x	x
Flux sites	SF, WC, BV, Rosemount	Mead	Choptank, OPE3	GRAPEX	NEON	LTER				
LST	x	x	x	x	x	x				
LAI	x	x	x	x	x	x		x	x	x
Yield/biomass	field/NASS	field/NASS	field/NASS	field/NASS	field	field	field	field/muni/state	field/district	field
Phenology	field/NASS	field/NASS	field/NASS	field/NASS	field/NASS	field/NASS	field/NASS	field	field	field
Landcover	Rainfed corn, soybean	Rain/irr corn, soy, grassland	Rainfed corn	Irrigated vineyards	Rangeland	Semi-arid rangeland		Agro-pastoral-silvaculture	Wheat, Barley, Canola	Irrigated crops

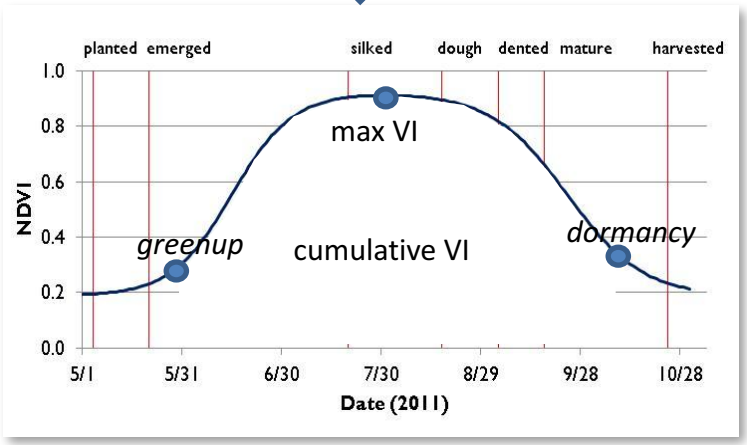
First Year Progress

- Refine tools and methods for new data products
  - VIIRS
  - Sentinel-2
  - ECOSTRESS
- Apply data fusion results for assessing
  - yield variability
  - water productivity
  - Land use and water use change

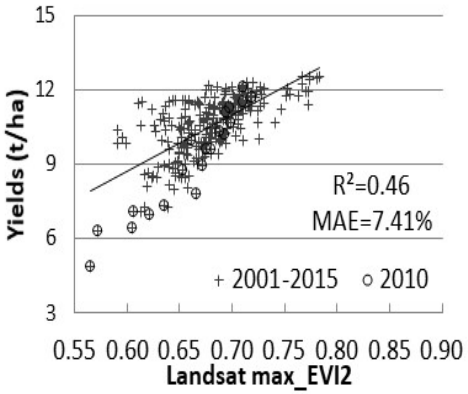
Assessing the Variability of Corn and Soybean Yields in Central Iowa

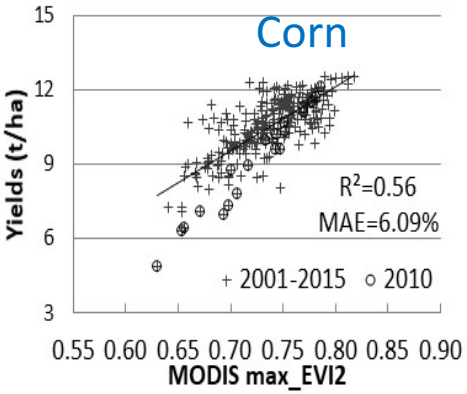


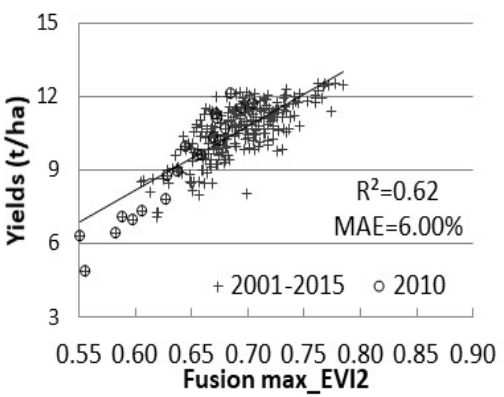




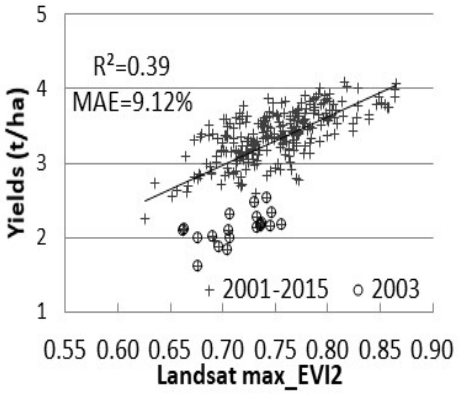
Added-value from Landsat-MODIS data fusion



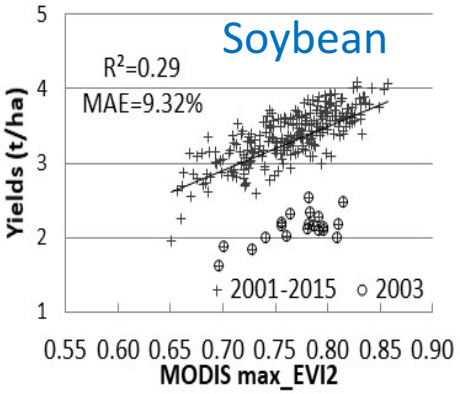




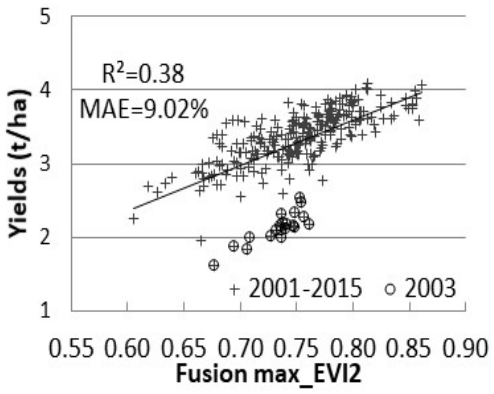
Landsat



MODIS

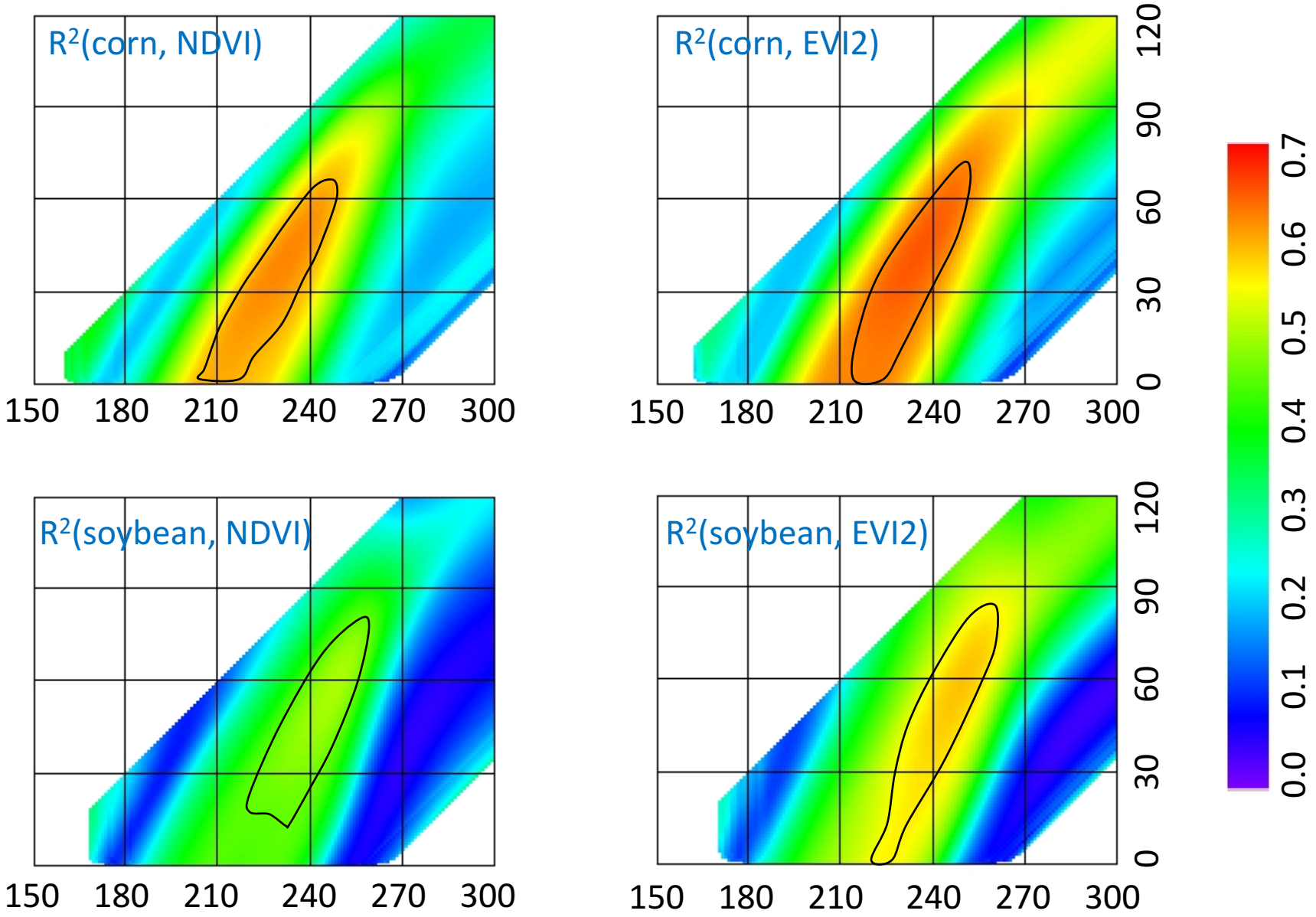


Landsat-MODIS Data Fusion

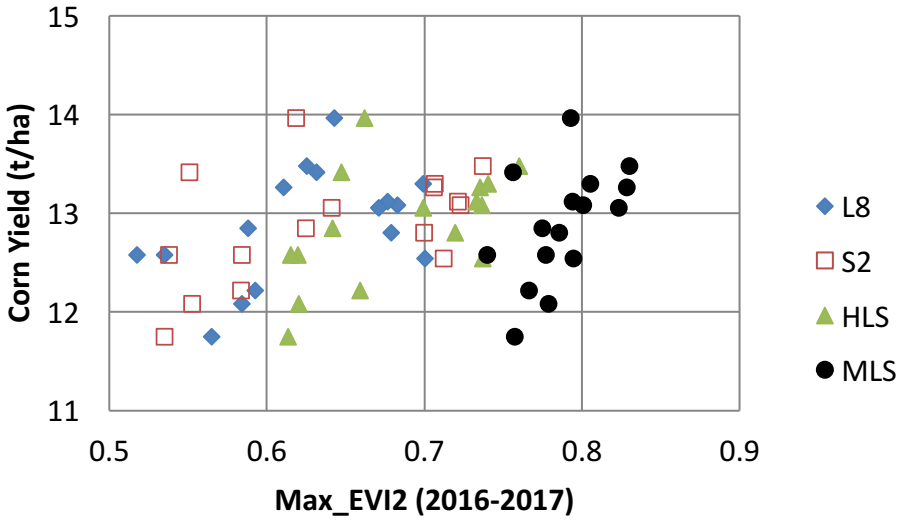


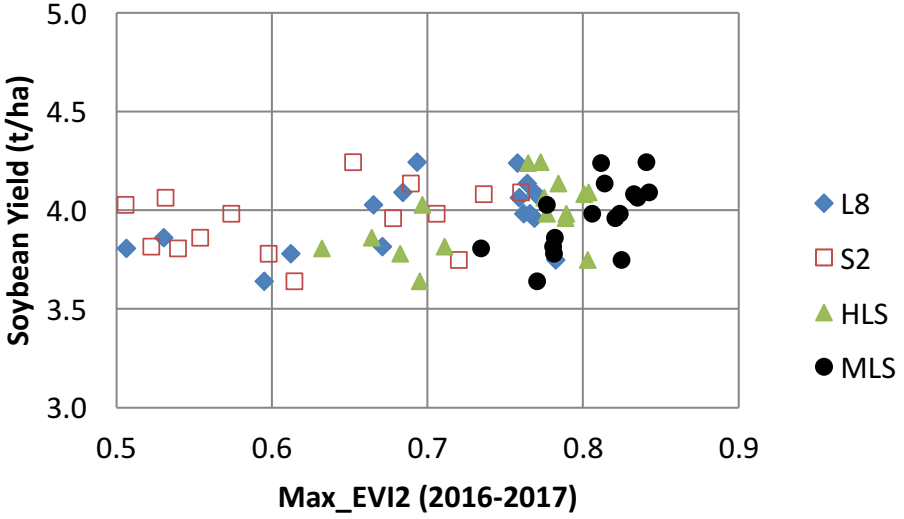
Dataset	R²_t	RMAE_t
	Corn (2001–2015)	
Landsat	0.46	7.41
MODIS	0.56	6.09
Landsat–MODIS	0.62	6.00
	Soybean (2001–2015)	
Landsat	0.39	9.12
MODIS	0.29	9.32
Landsat–MODIS	0.38	9.02
	Soybean (2001–2015, excluding 2003)	
Landsat	0.47	6.14
MODIS	0.63	5.28
Landsat–MODIS	0.58	5.45
	Soybean (2003 only)	
Landsat	0.34	6.49
MODIS	0.46	5.65
Landsat–MODIS	0.72	3.82

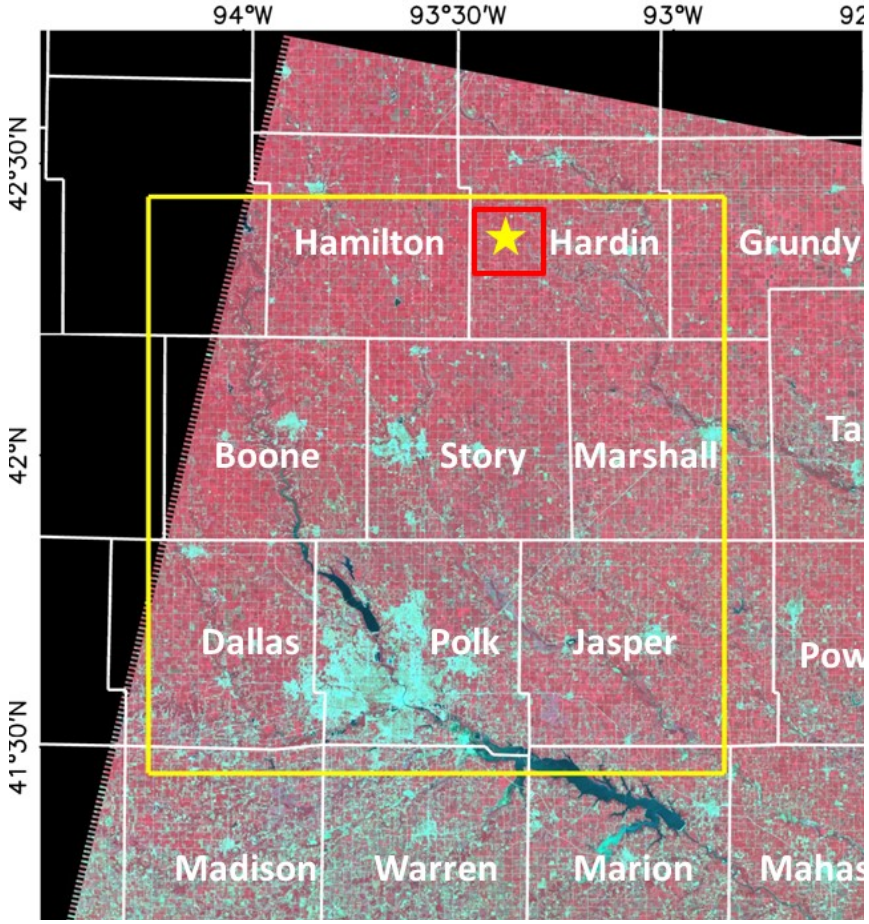
Optimal Time Window for Yield Prediction



Fusing Landsat, Sentinel-2 and MODIS/VIIRS

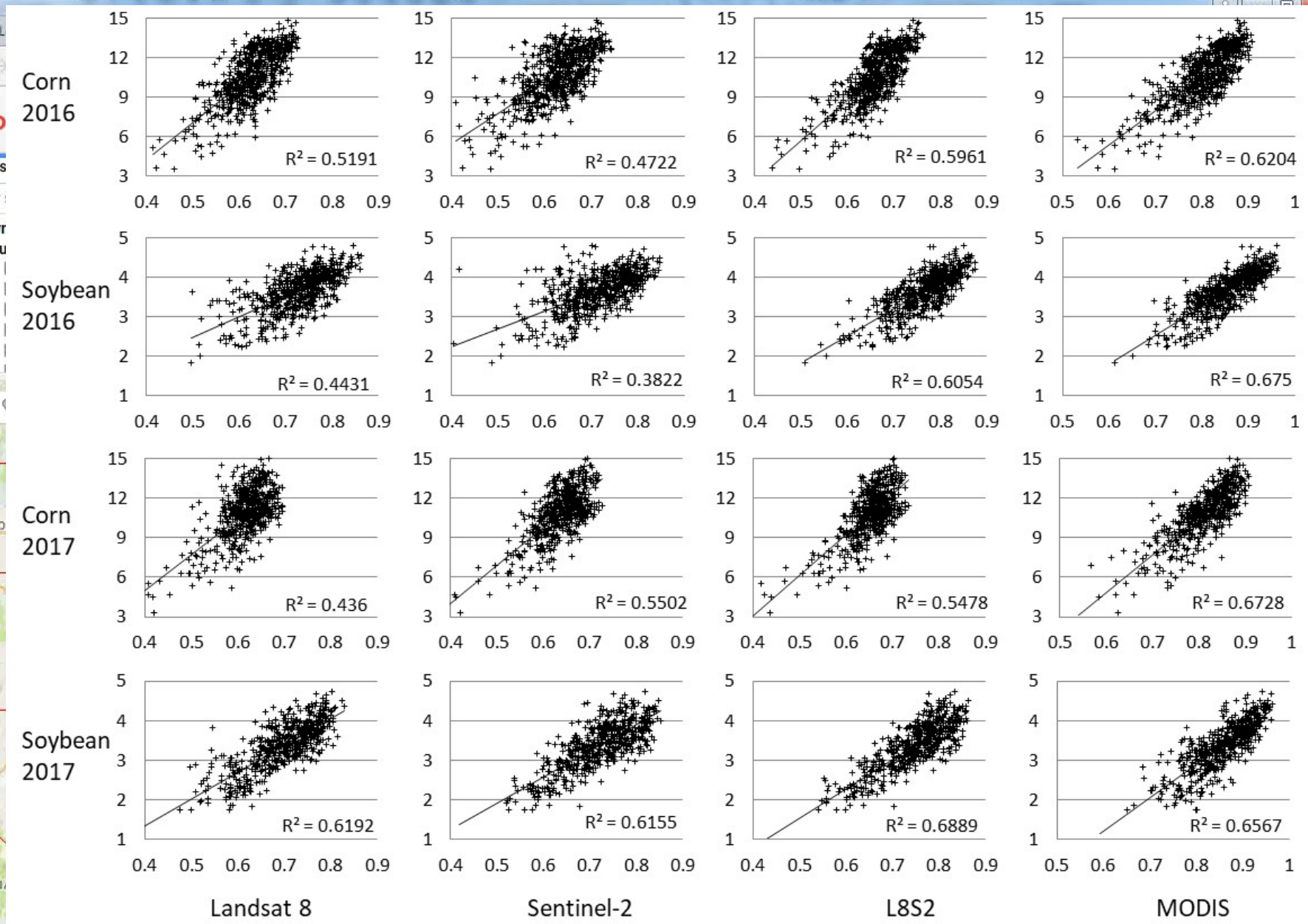




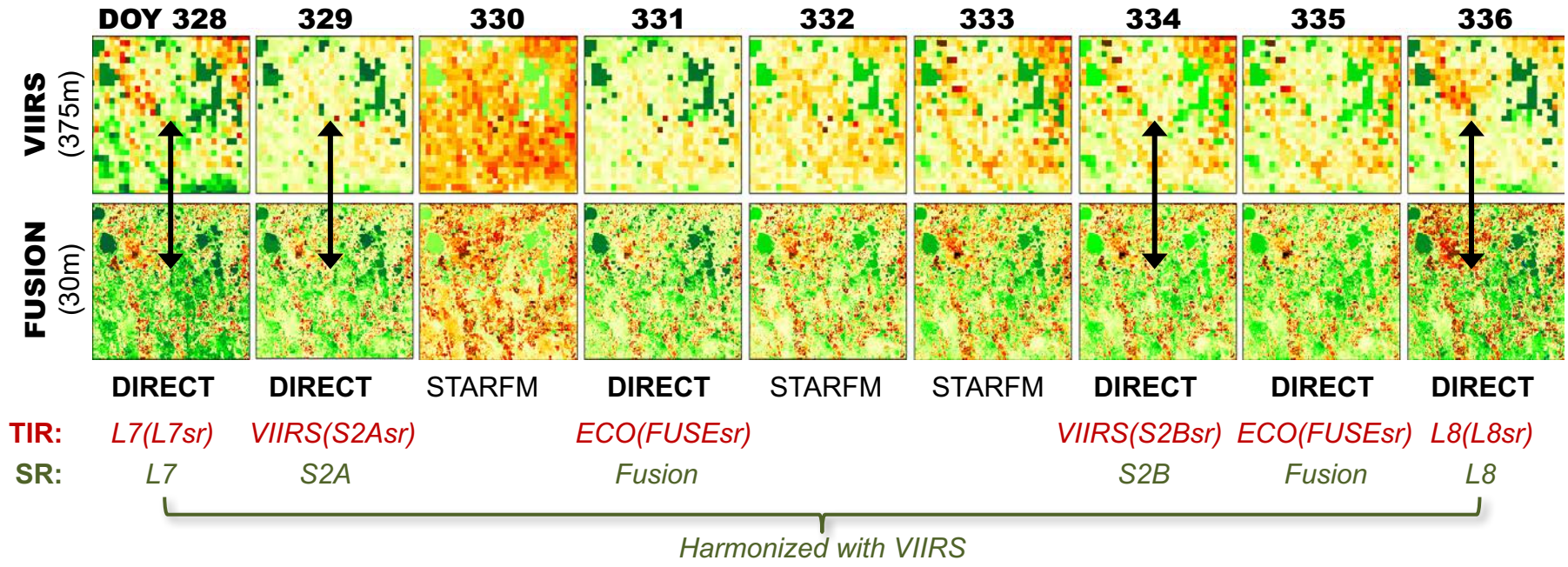


Polk: 23% corn; Others: 38-55%

Yield Variability from Landsat-8, Sentinel-2 and MODIS (GEE)



Daily ET at 30m resolution by fusing VIIRS/Landsat/S2/ECOSTRESS



Daily ET – Orlando, FL

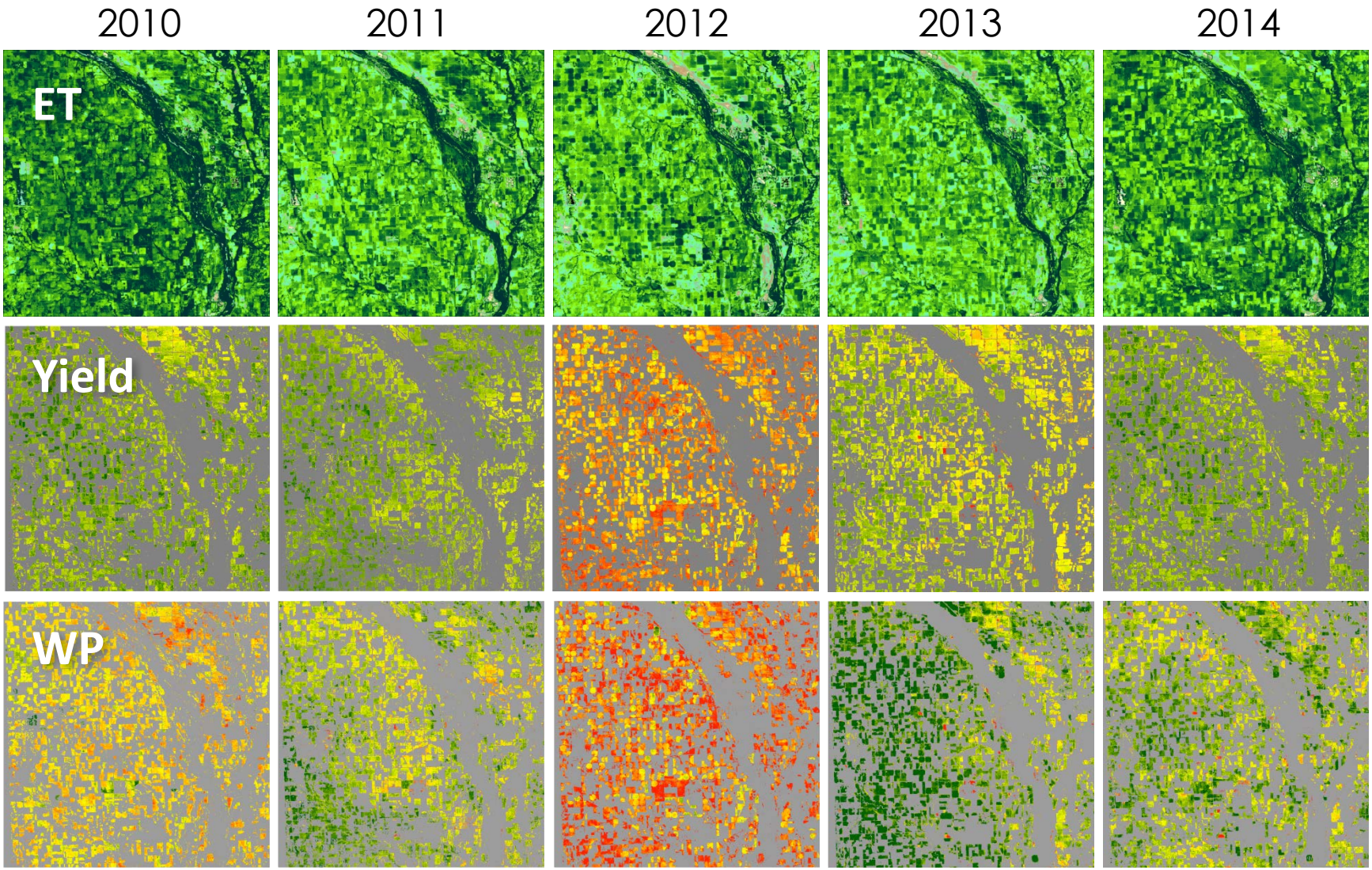
ECOSTRES and Sentinel-2

- ECOSTRESS: 5 TIRS bands, no VNIR, ~3 days repeat at ~60m
- Sentinel-2: no TIRS, 13 VNIR and SWIR bands, 5 days repeat at 10-20m
- Combining ECOSTRESS and Sentinel-2 data allows more frequent ET estimation at field scales
- Sharpening LST imagery using VNIR and SWIR images (modified Data Mining Sharpening approach)

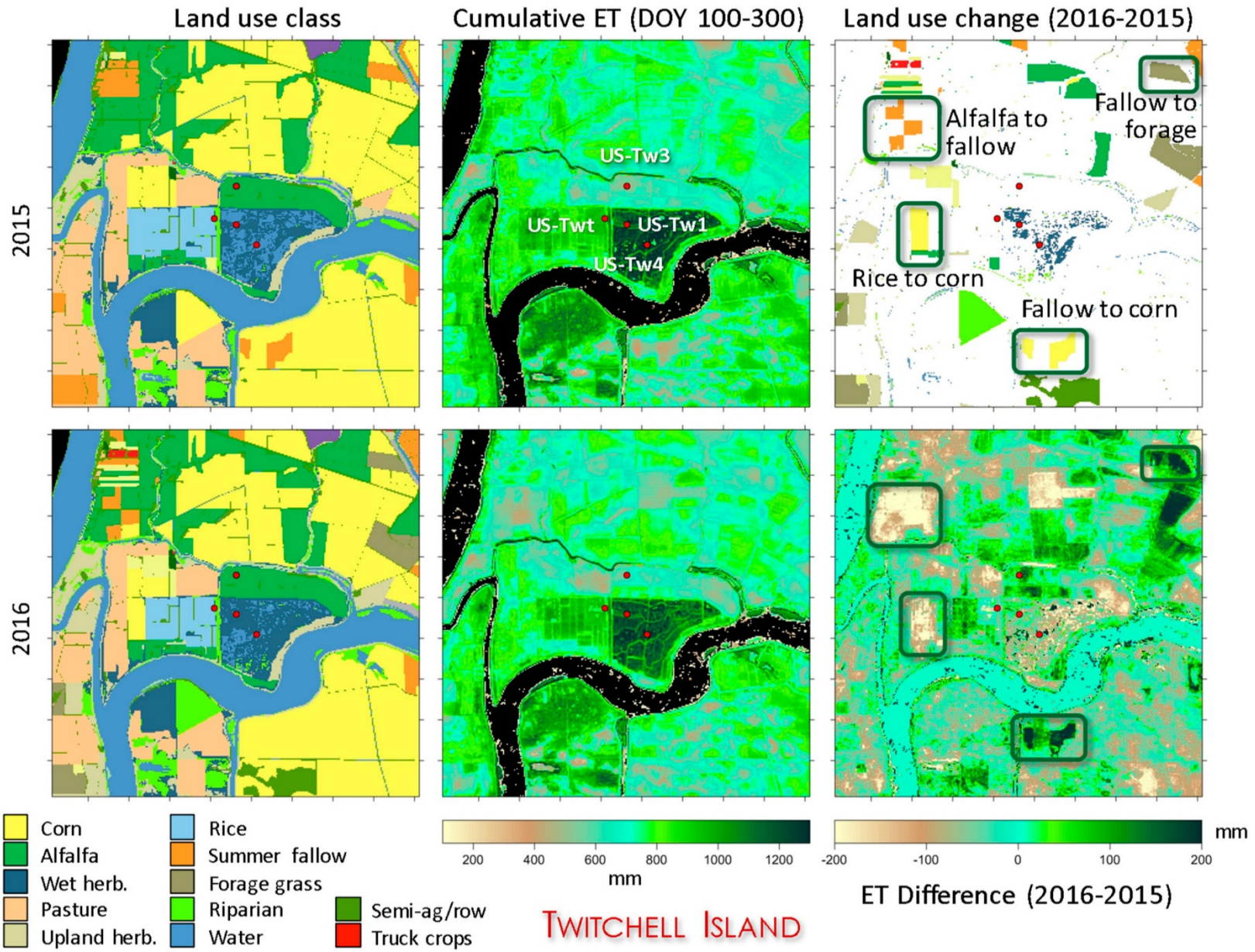
ECOSTRES LST (GRAPEX Ripperdan site)

Sharpened LST (30m)

Yield and Water Productivity



Land-use & Water-use Change



Expected Contributions to MOIDS/VIIRS

- Demonstrate synergistic value of multiple sensors for research and operational uses
  - Daily 30-m SR and VI, combining Landsat, S2 and MODIS/VIIRS SR data
  - Phenology extraction tools for crop and rangeland
  - A streamlined 30-m, daily ET and water stress mapping algorithm, utilizing sharpened TIR products from Landsat, MODIS/VIIRS and ECOSTRESS
  - A prototype field-scale yield mapping tool, combining information from the phenology, VI, ET and water stress datacubes
  - Field-scale water productivity maps for evaluating crop water use efficiency and yield gaps over agricultural landscapes
- Provide inputs to the MODIS/VIIRS program relevant for agricultural applications