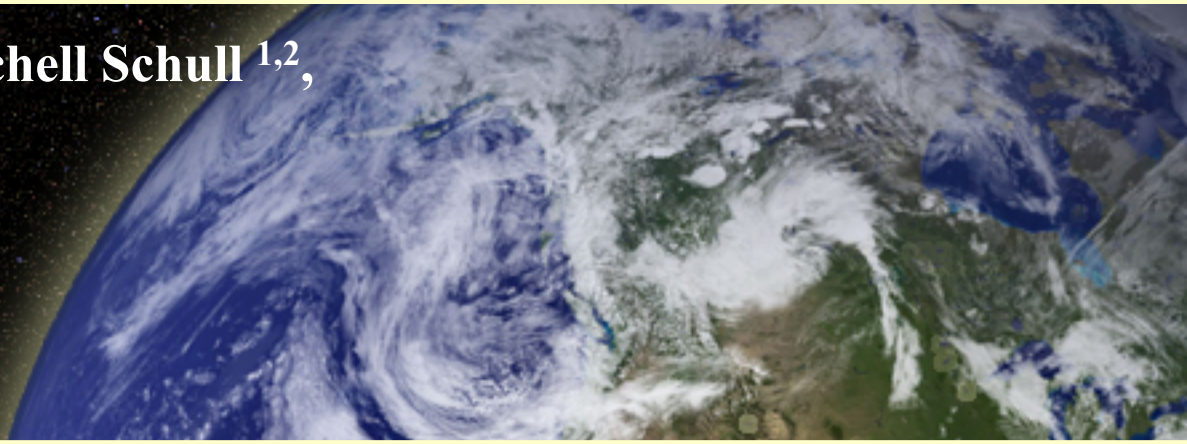
CISESS Science Meeting, UMD, 2019

Evapotranspiration Data Product from NESDIS GET-D System Upgraded for GOES-16 ABI Observations

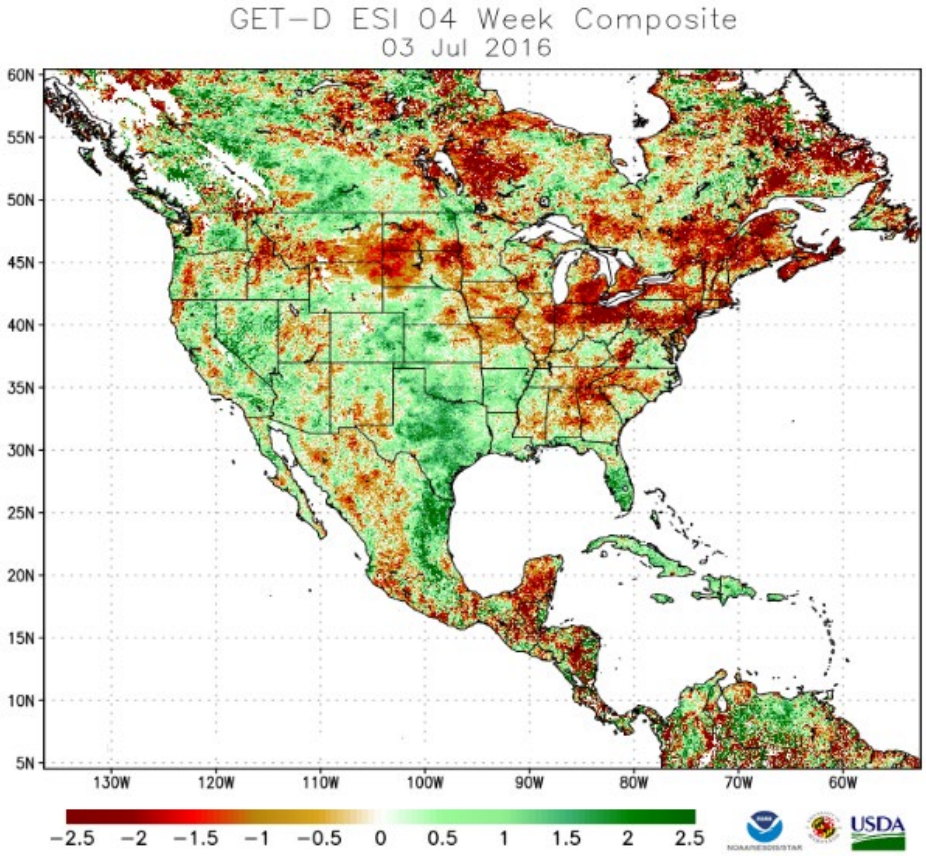
Li Fang [1,2,*], Xiwu Zhan [2], Mitchell Schull [1,2],
Jifu Yin [1,2], Satya Kalluri [2]
Peng Yu [1,2], Istvan Laszlo [2]
Corinne Carter [1,2]
Christopher Hain [3]
Martha Anderson [4]



[1] UMD-ESSIC Cooperate Institute Of Satellite Earth System Studies (CISESS)
[2] NOAA NESDIS Center For Satellite Applications And Research
[3] NASA Marshall Space Flight Center
[4] USDA-ARS Hydrology And Remote Sensing Laboratory

Background & Objectives

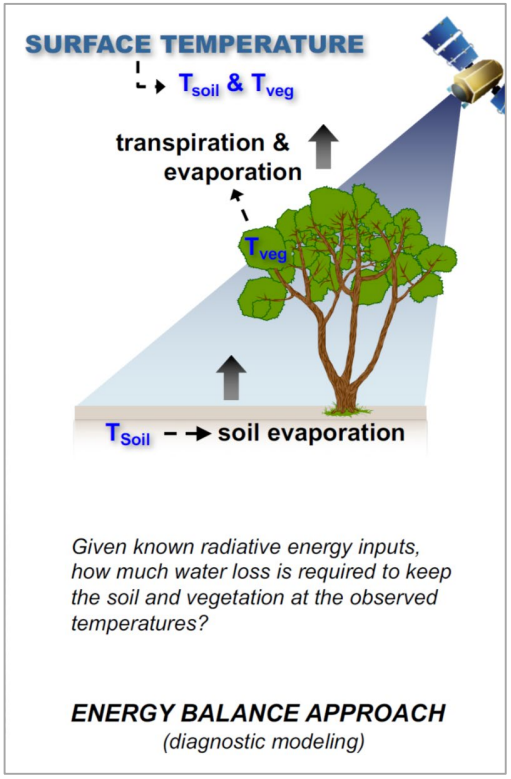
- Accurate estimates of evapotranspiration (ET) are critical for numerical weather and climate prediction models
- GOES Imager-based ET and Drought (GET-D) product system has been operational since September 2016
- Continuation of GET-D operation using the current high-resolution GOES-R series satellites is in high demand
- GET-D system will be upgraded to ingest ABI from GOES- 16 and GOES 17

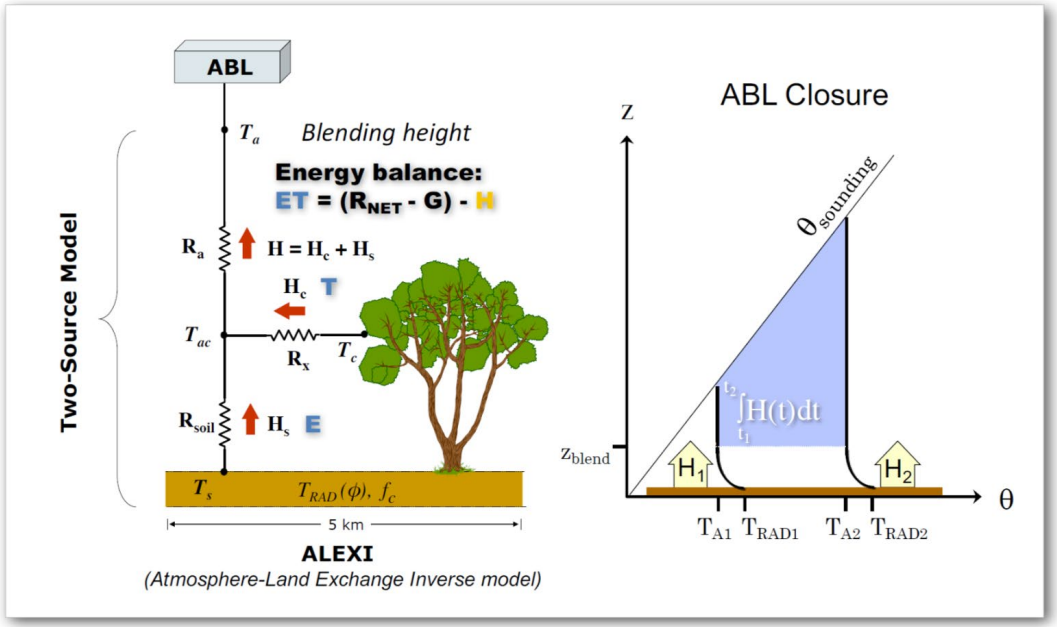


Outline

- Background & Objectives
- **Theoretic Basis of ALEXI Model**
- **Upgraded GET-D System**
- **ET product & Product Consistency**
- **Validation**
- **Summary & Future work**

Theoretic Basis-ALEXI Model





Regional scale

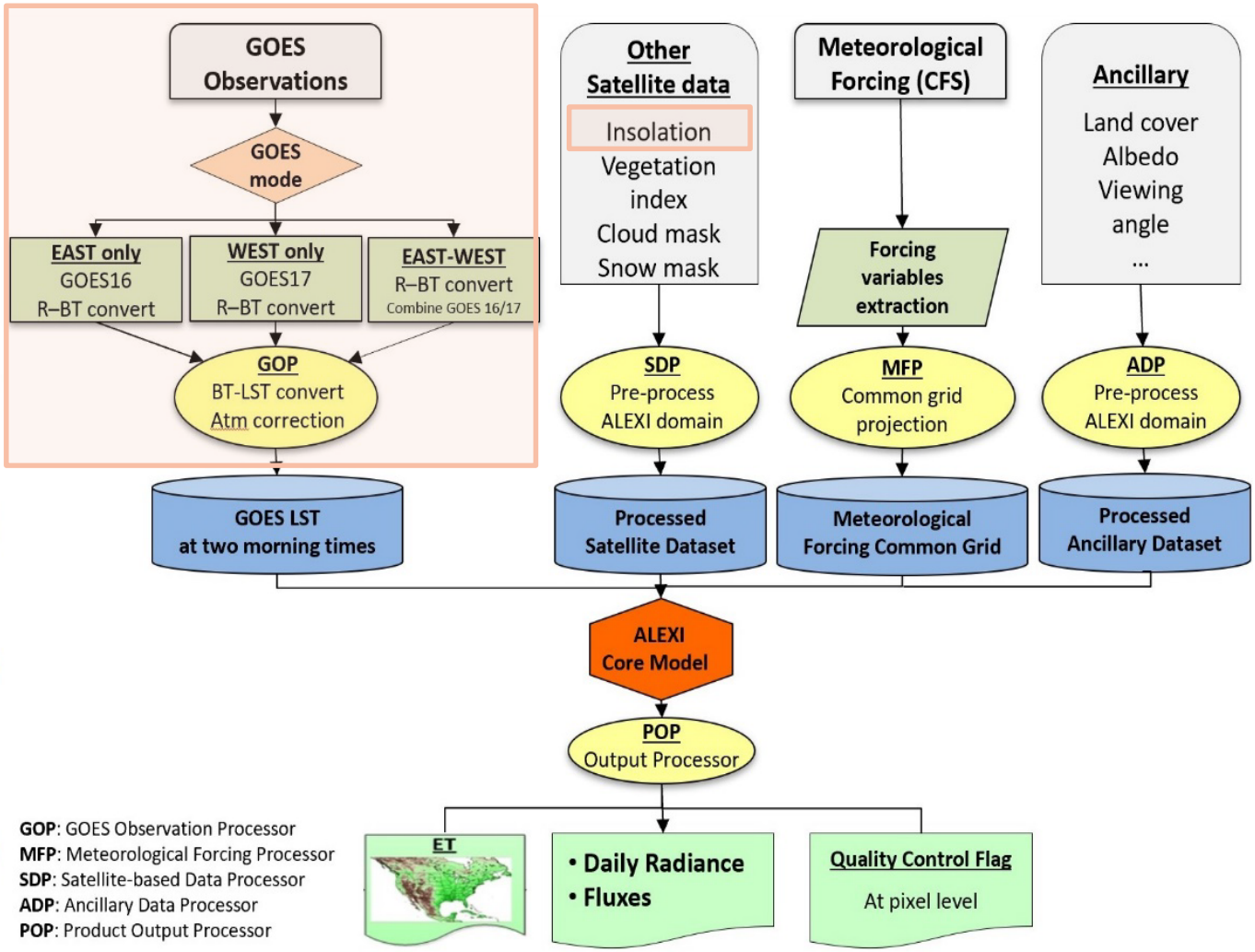
Surface temp: ΔT_{RAD} - Geostationary
Air temp: T_a - ABL model

Anderson et al. 1997, 2007

- Atmosphere-Land Exchange Inversion (ALEXI) model exploits the mid-morning rise in LST from GOES to deduce the land surface fluxes, including evapotranspiration (ET)
- Implementation of the two-source energy balance model which balances components of energy budgets for the soil and canopy components separately

Upgraded GET-D System for GOES-16

- Background
- ALEXI
- **GET-D**
- ET product
- Validation
- Summary & Future work



System Inputs of Upgraded GET-D

- Background
- ALEXI
- **GET-D**
- ET product
- Validation
- Summary & Future work

Name	Data Source	Resolution	Spatial Coverage	Description
GOES IR	GOES-R	2km	Full Disk / CONS	Primary option: Channel 13 of GOES-16 and GOES-17 ABI L1b Radiance product (ABI-L1b-RadF) Second option: GOES LST product (OR_ABI-L2-LSTC)
Clear Sky Mask	GOES-R	2km	Full Disk	GOES-R Clear Sky Mask product (OR_ABI-L2-ACMF)
Insolation	GSIP	0.125 degree	North America	GSIP L2 real time insolation;
Vegetation Index	VIIRS	1 km	Global	NESDIS GVF (inverted to LAI)
Air temperature	NARR/CFS	0.3/0.5 degree	NA/Global	Surface and pressure level profiles
Specific humidity	NARR/CFS	0.3/0.5 degree	NA/Global	Surface and pressure level profiles
Geopotential height	NARR/CFS	0.3/0.5 degree	NA/Global	Surface and pressure level profiles
Wind speed	NARR/CFS	0.3/0.5 degree	NA/Global	Surface
Downwelling longwave radiation	NARR/CFS	0.3/0.5 degree	NA/Global	Surface
Solar zenith	GOES-R	2km	Full Disk	GOES-R solar zenith angles
View zenith	GOES-R	2km	Full Disk	GOES-R view zenith angle
Snow Mask	IMS	24 km	Northern Hemisphere	NOAA IMS Daily Northern Hemisphere Snow and Ice Analysis

System Outputs of Upgraded GET-D

- Background
- ALEXI
- **GET-D**
- ET product
- Validation
- Summary & Future work

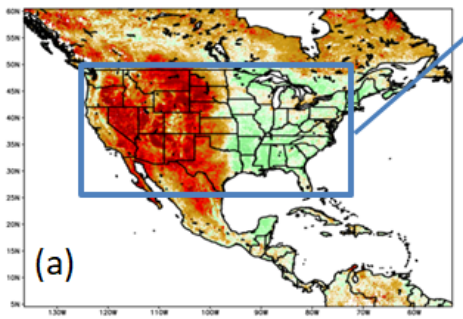
Description of Upgraded GET-D Outputs

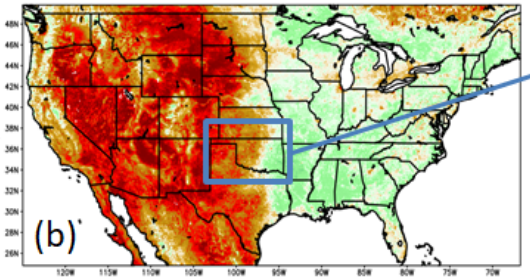
Variables	Spatial Resolution	Unit	Format	Description
ET	2km	mm day^{-1}	NetCDF, GRIB2, PNG	Daily ET
QC for ET	2km	--	NetCDF, GRIB2	Quality control flag for retrieved ET
Fluxes	2km	W m^{-2} day^{-1}	NetCDF, GRIB2, PNG	Daily short wave down, long wave down, long wave up and net radiation
QC for flux	2km	--	NetCDF, GRIB2	Quality control flag for retrieved fluxes

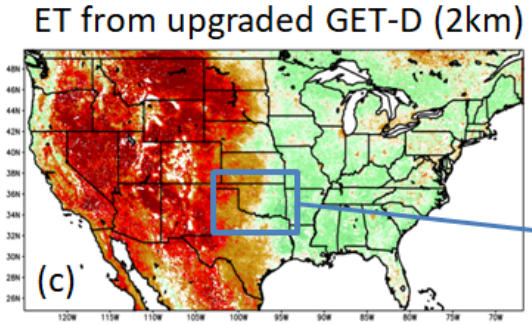
Design of quality control flags at pixel level

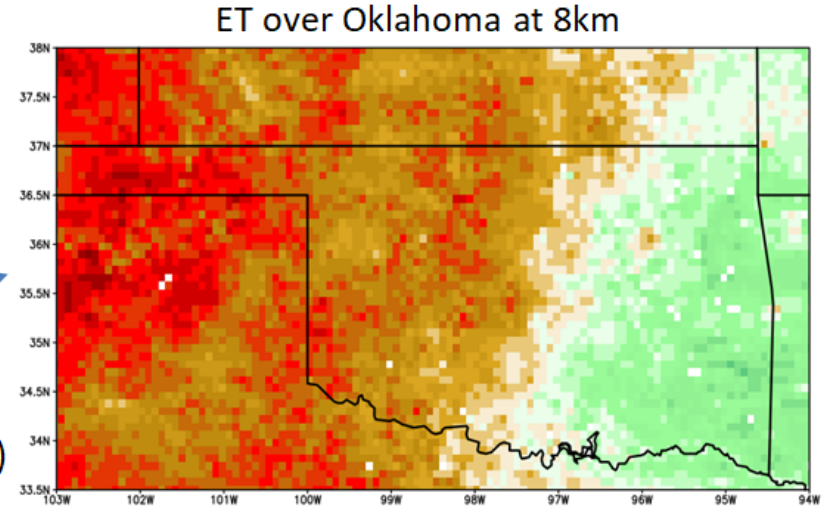
Bit	Source	Descriptions
0	Overall Product Quality	0=retrieved, 1= not retrieved,
1	Land cover	0 = land, 1 = water/sea
2	GOES Data Availability	0=normal, 1=bad data
3	View Angle	0=normal, 1=large view angle (LZA>55 deg)
4	Meteorological Data	0=normal, 1=bad data
5	Vegetation Data Availability	0=normal, 1=bad data
6	Cloud	0=clear, 1=clear
7	Snow	0=snow free, 1=snow contamination

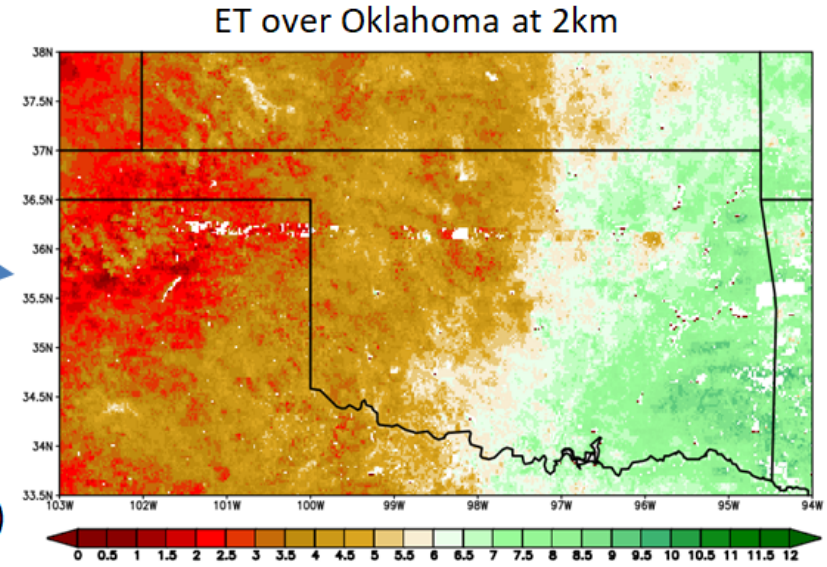
ET from GET-D Based on GOES-16 ABI Data







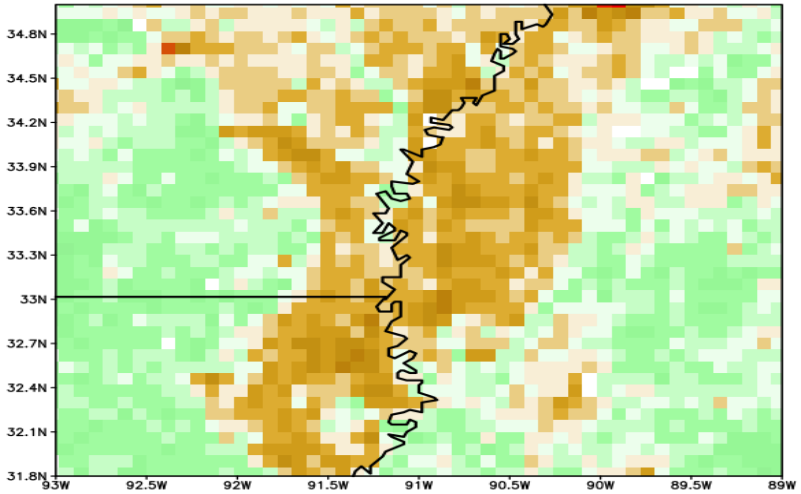




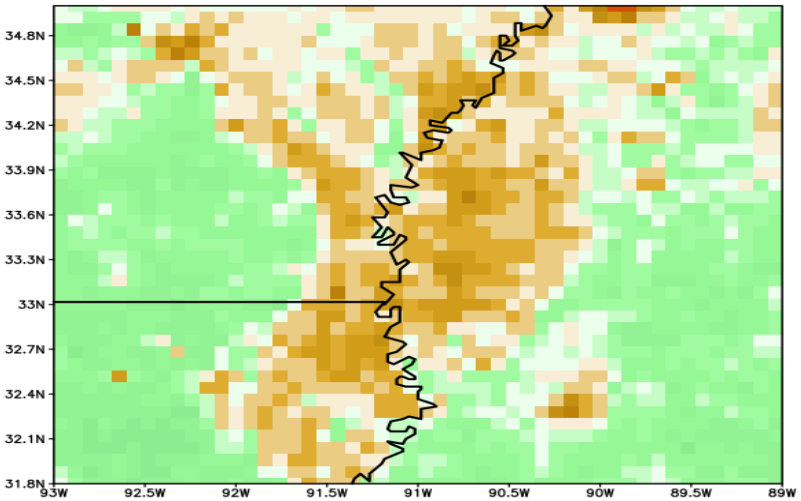
ET retrieval comparison between operational GOES13 based 8km product and upgraded GOES 16 LST based 2km product; Monthly composite of July 2017 (mm/day)

ET from GET-D Based on GOES-16 ABI Data

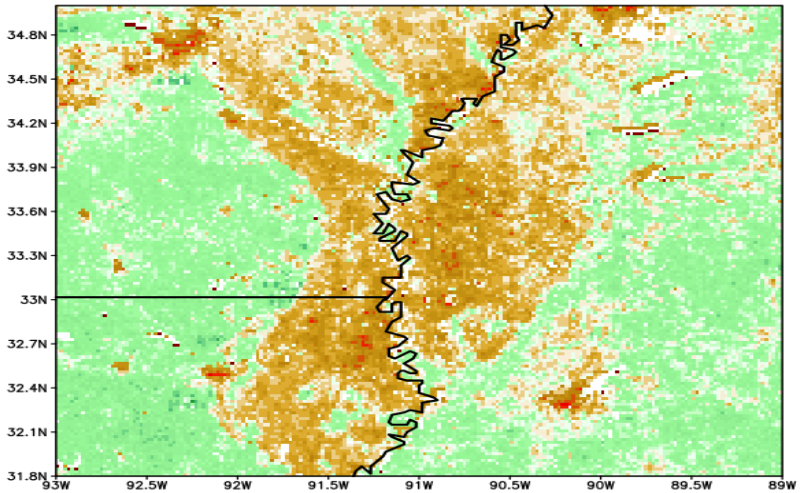
GOES-13/15 based -- 8 km

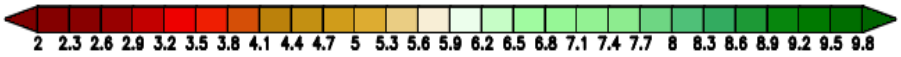


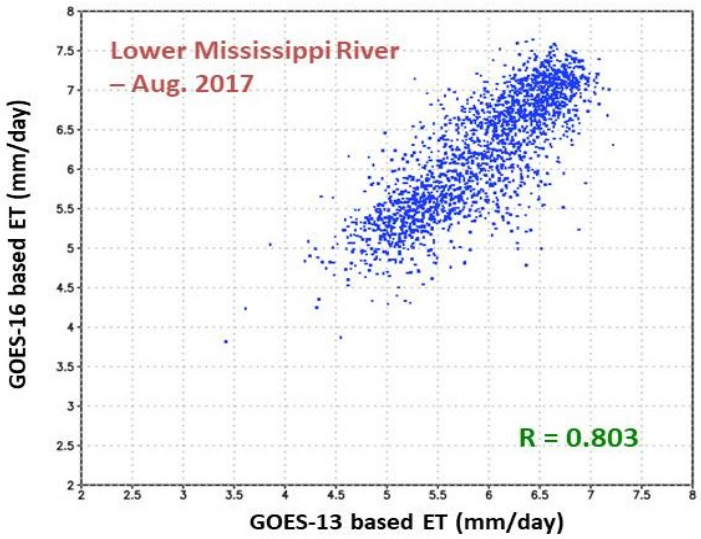
GOES-16 based 8 km; aggregated from 2km



GOES-16 based -- 2 km

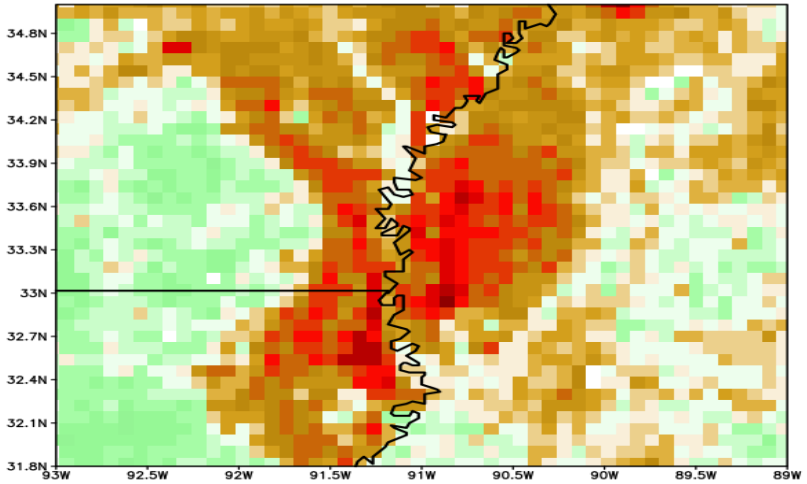




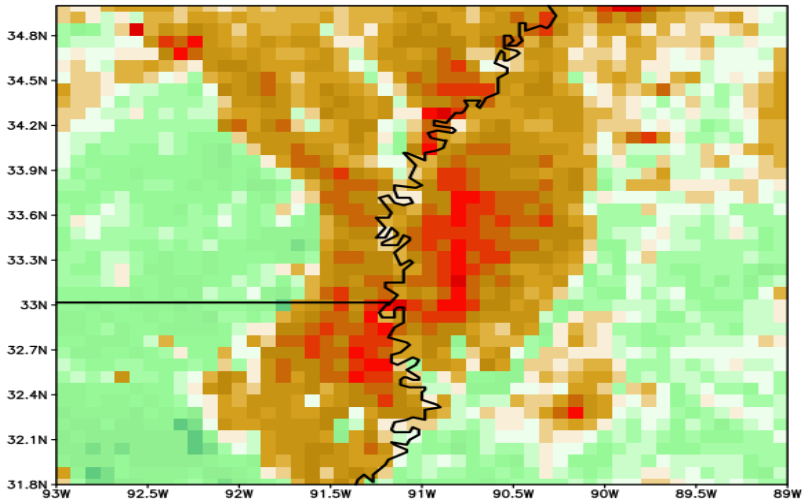


ET from GET-D Based on GOES-16 ABI Data

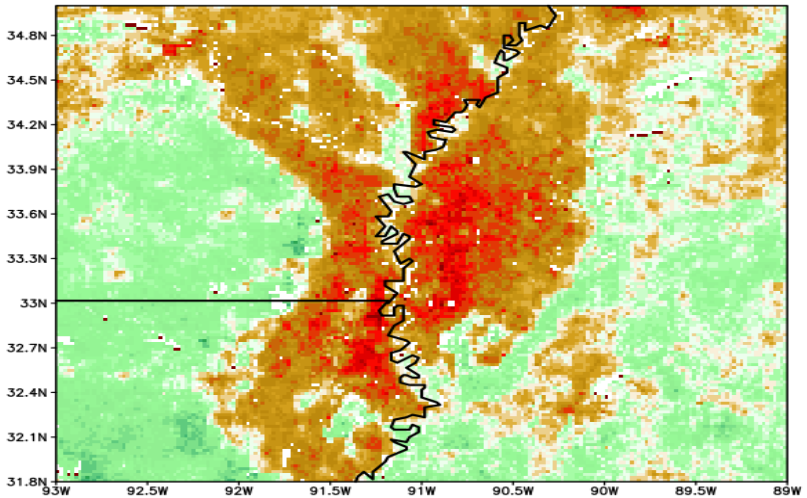
GOES-13/15 based -- 8 km

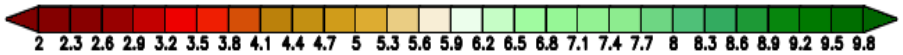


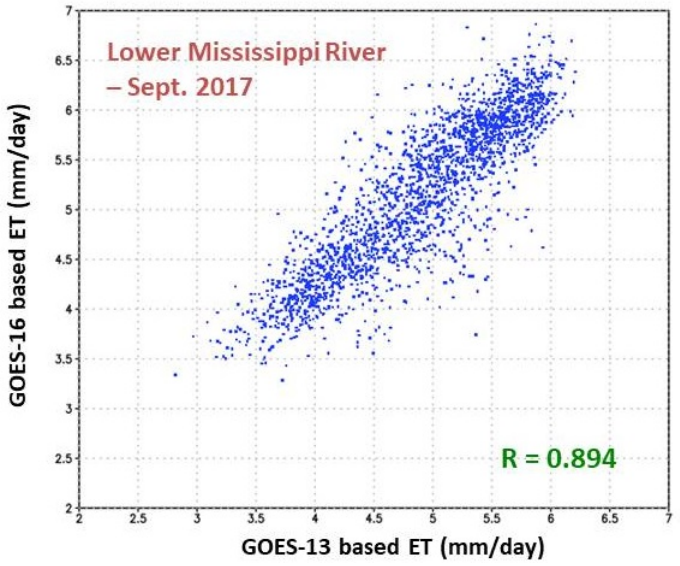
GOES-16 based 8 km; aggregated from 2km



GOES-16 based -- 2 km

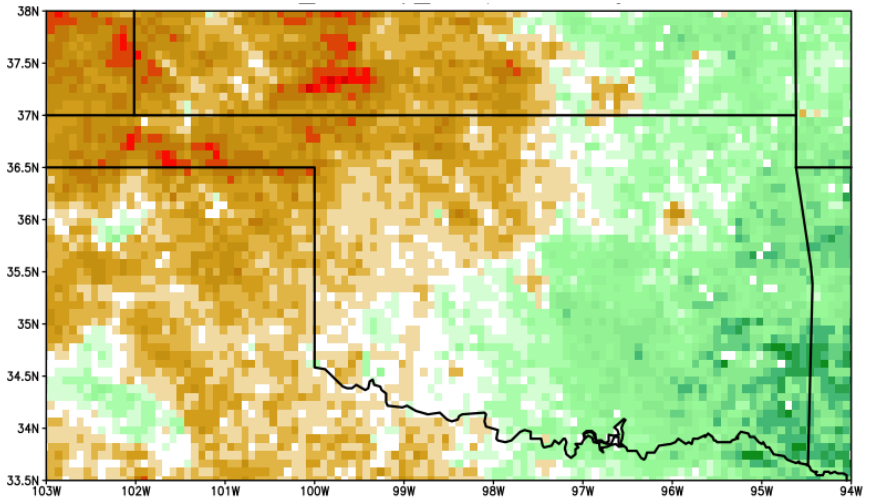




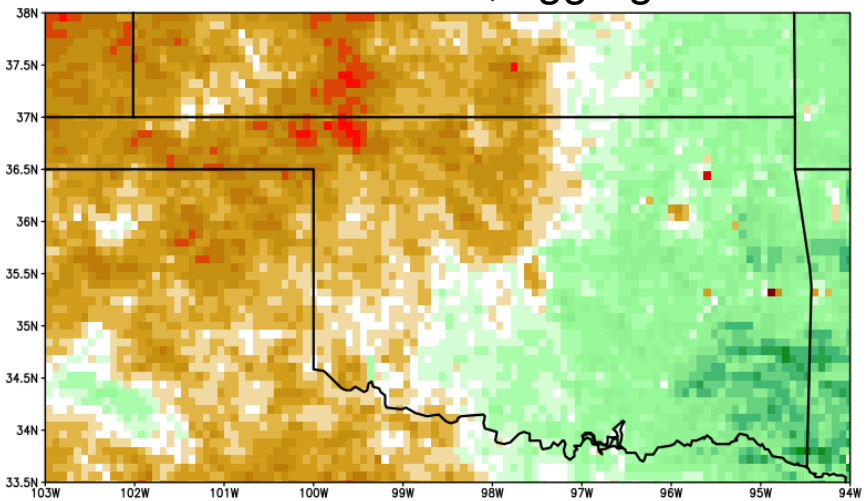


ET from GET-D Based on GOES-16 ABI Data

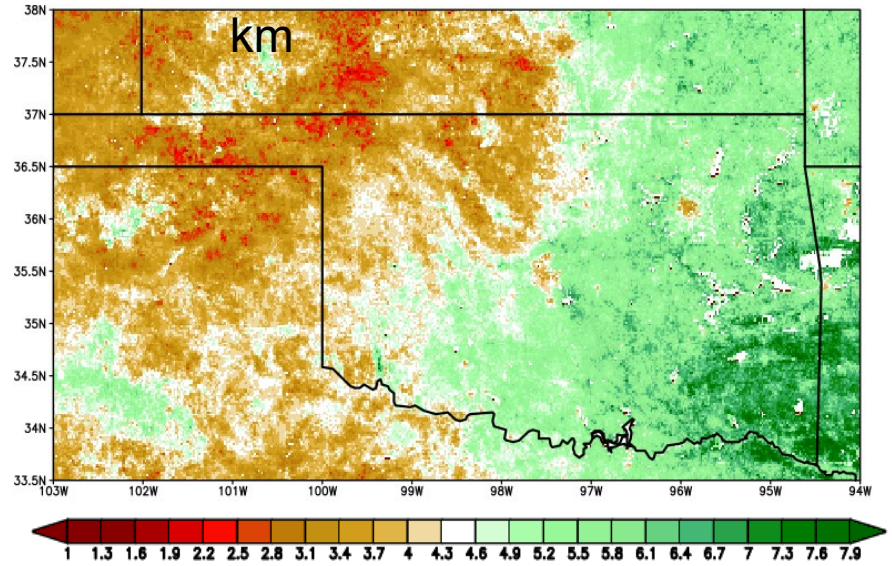
GOES-13/15 based -- 8 km

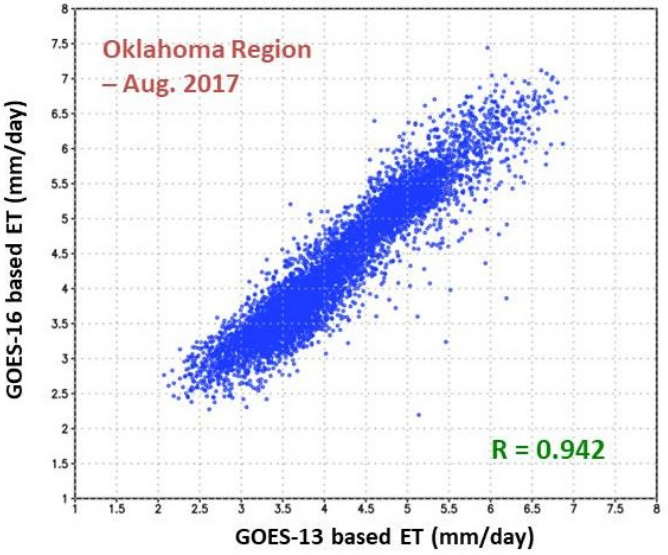


GOES-16 based 8 km; aggregated from 2km



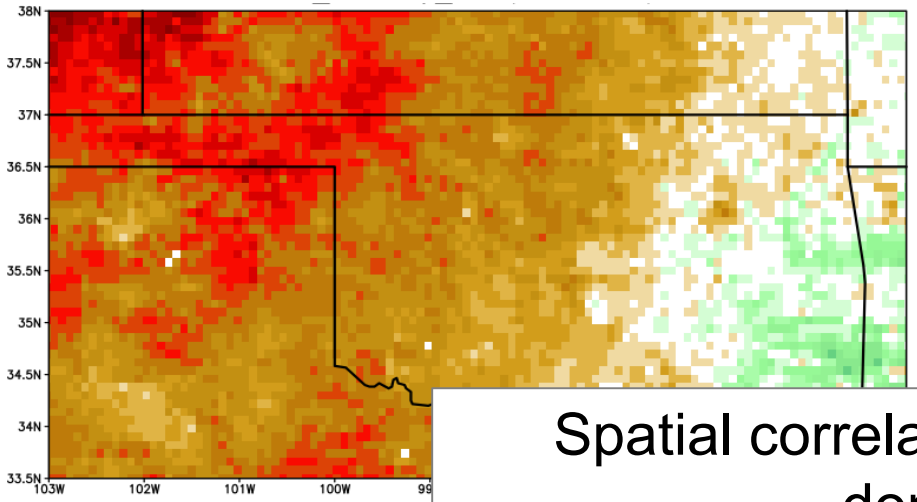
GOES-16 based -- 2 km



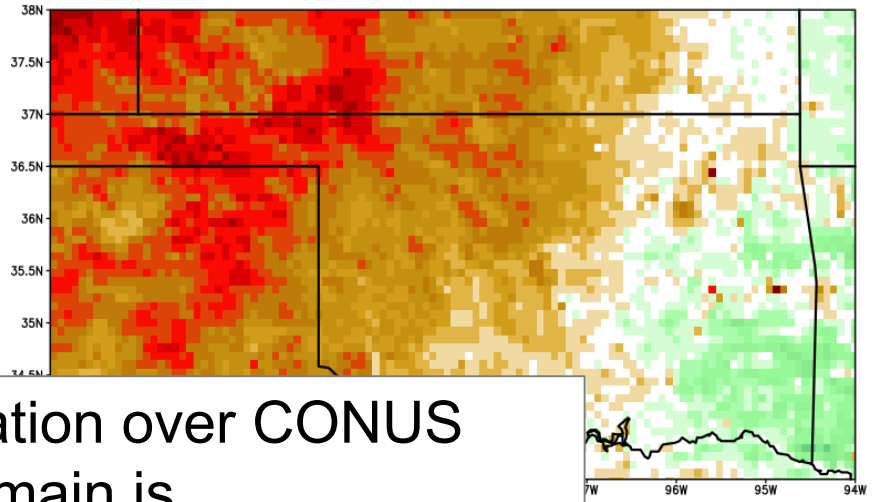


ET from GET-D Based on GOES-16 ABI Data

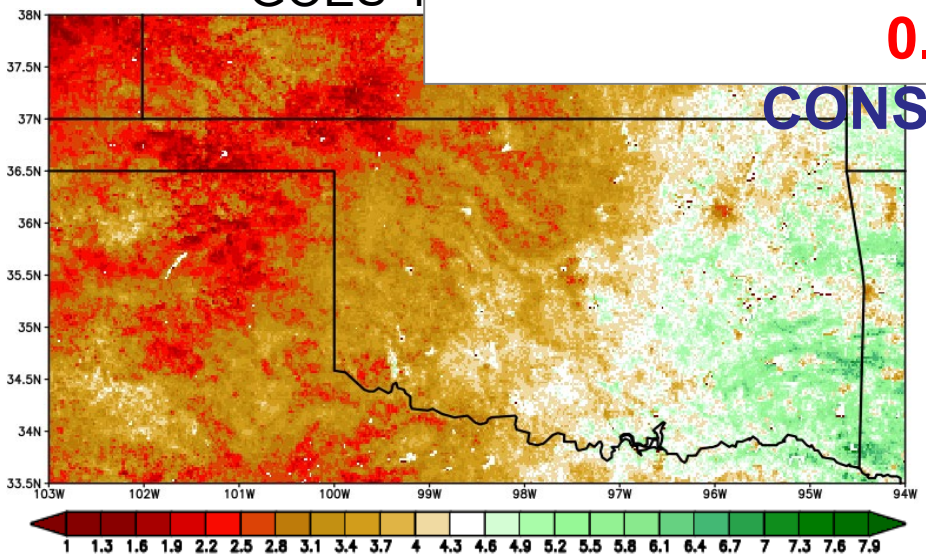
GOES-13/15 based -- 8 km



GOES-16 based 8 km; aggregated from 2km



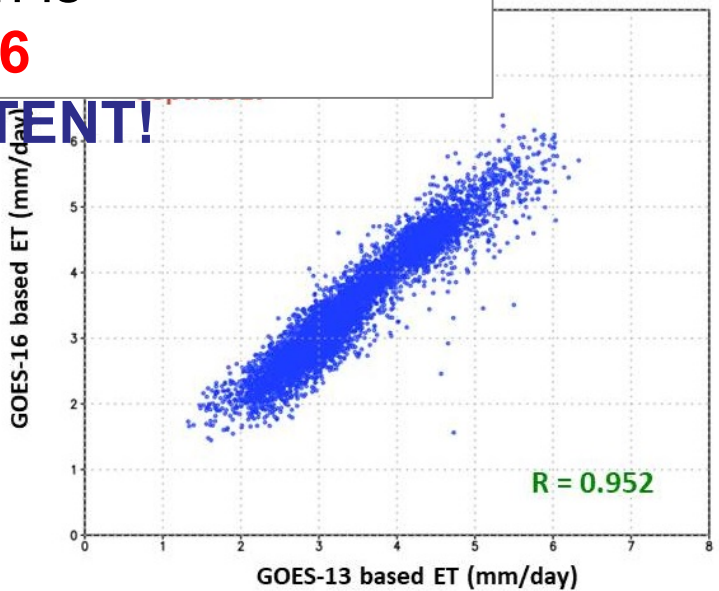
GOES-1



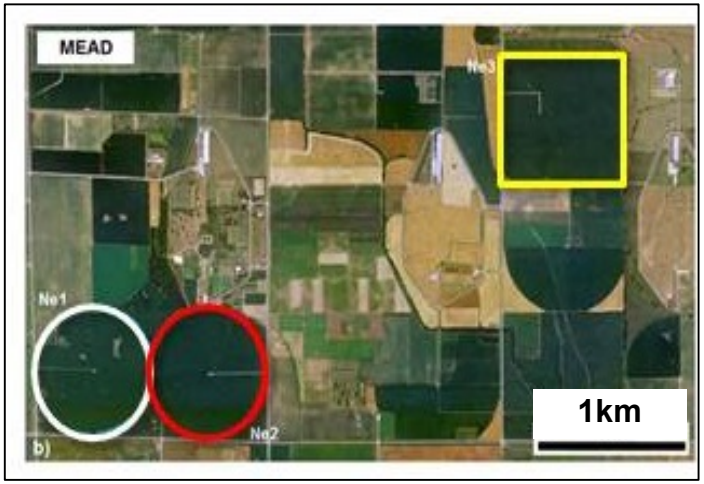
Spatial correlation over CONUS domain is

0.946

CONSISTENT!

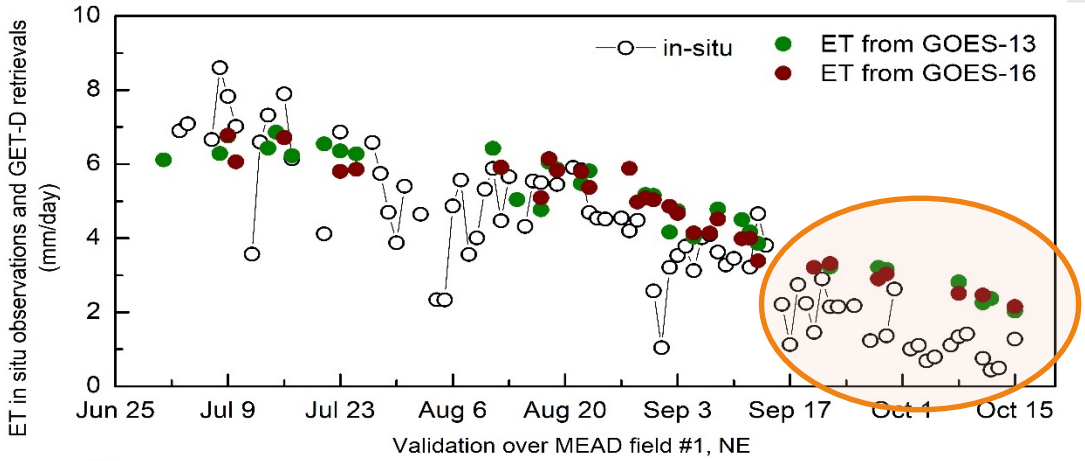


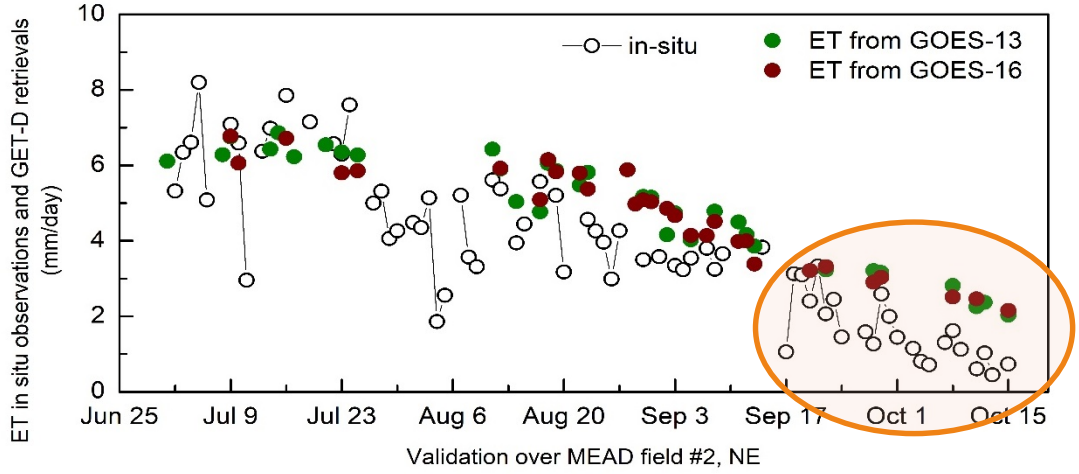
Validation over MEAD, NE

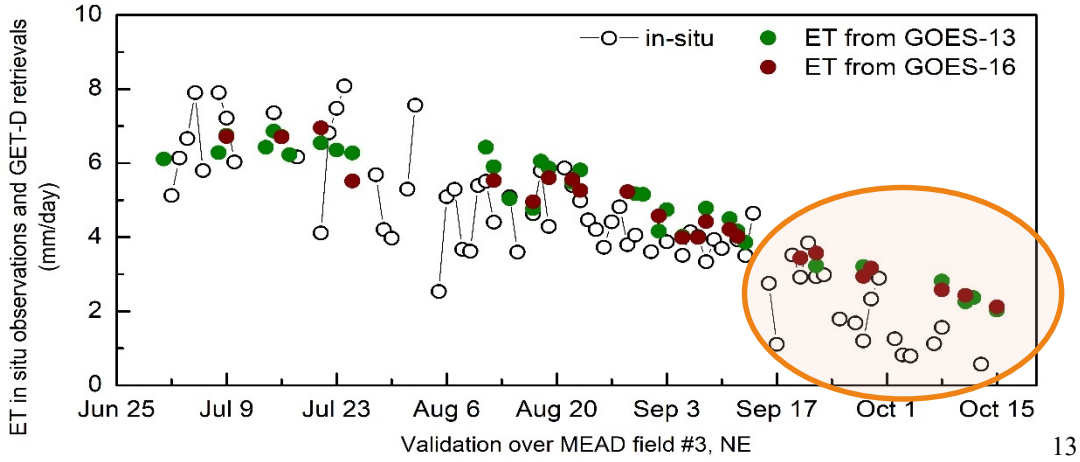


MEAD, NE Ameriflux site (S. Verma, 2010)
Rainfed and irrigation corn and soybean

Field #1: 41°09'54.2''N, 96°28'35.9''W
Field #2: 41°09'53.5'' N, 96°28'12.3'' W
Field #3: 41°10'46.8'' N, 96°26'22.7'' W







Suyker, A.E.; Verma, S.B. Coupling of carbon dioxide and water vapor exchanges of irrigated and rainfed maize–soybean cropping systems and water productivity. *Agric. For. Meteorol.* **2010**, *150*, 553–563.
Agricultural Research and Development Center, University of Nebraska.

Validation over MEAD sites, NE

- Background
- ALEXI
- GET-D
- ET product
- **Validation**
- Summary & Future work

Error statistics of GET-D ET estimates (mm/day) validated against in situ measurements in MEAD, NE

	Bias		RMSE		Correlation		N
	GOES-13 based	GOES-16 based	GOES-13 based	GOES-16 based	GOES-13 based	GOES-16 based	
MEADsite1	0.555	0.601	1.318	1.215	0.887	0.885	26
MEADsite2	0.561	0.546	1.094	0.906	0.860	0.885	23
MEADsite3	0.754	0.617	1.132	1.023	0.949	0.974	21
Average	0.623	0.588	1.181	1.048	0.899	0.914	

GOES-13 based

GOES-16 based

Summary

Conclusion

- GET-D is upgraded successfully to generate ET at 2km spatial resolution using GOES-16 ABI observations
- Upgraded ET product is validated against independent data sets (MEAD in situ observations)
- GOES-16 based ET product is **consistent** with current operational GOES-13 based product
- GOES-16 based GET-D ET has **finer spatial resolution** (2km vs 8km) and **higher correlation** with *in situ* ET measurements compared to GOES-13 based one

Future Work

- **GOES-17** ABI data will be tested with the upgraded GET-D software
- **Combined** GOES-16 and -17 ABI observations will be used in the system
- **Comprehensive validation** of ET from the upgraded GET-D system with more in situ measurements
- Build GOES-16/17 based ET **climatology** together with the legacy GOES-13/15 ET
- Evaporative Stress Index (**ESI**) will be computed from the GET-D ET and its climatology for drought monitoring

The end

Evapotranspiration Data Product from NESDIS GET-D System Upgraded for GOES-16 ABI Observations

Li Fang *, Xiwu Zhan, Mitchell Schull, Satya Kalluri

Istvan Laszlo, Peng Yu, Corinne Carter

Christopher Hain, Martha Anderson

Li Fang li.fang@noaa.gov

Acknowledgments: Research reported in this paper was supported by the NOAA NESDIS GOES-R Risk Reduction (GOES-R3) program for project #488