Expanding the Parallel 41 Flux Network in the Republican River Basin to Support Real-time Evapotranspiration Estimates for Irrigation Water Management and Water Balance Estimates

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Parallel 41 Flux Network Concept

- A network of Eddy Covariance Flux towers to provide real-time energy balance fluxes and evapotranspiration of different crops and vegetated surfaces, to be used for water balance and crop water productivity estimates in different watersheds and agricultural systems.
- Provide real-time crop actual evapotranspiration for irrigation water management to farmers and water managers
- Use the data for improving the accuracy of spatially distributed satellite-based estimates of evapotranspiration

Parallel 41 Flux Network

- DWFI is leveraging funding from FFAR through the Irrigation Innovation Consortium (IIC), in-kind support from LiCOR, and project grant funds and equipment from The Climate Corporation (TCC) to expand the Parallel 41 Flux Network.
  - Equipment for networking 6 Stations was acquired through IIC
  - 1 Station at Grant NE in partnership with URNRD
  - TCC has donated 5 additional stations in 2020, 1 was set up in URNRD in HUC-12, 1 installed in Holbrook in LRNRD and third will be installed in MRNRD. Location has been determined

https://parallel41.nebraska.edu/#/

FFAR

IRRIGATION INNOVATION CONSORTIUM

THE CLIMATE CORPORATION

LI-COR®

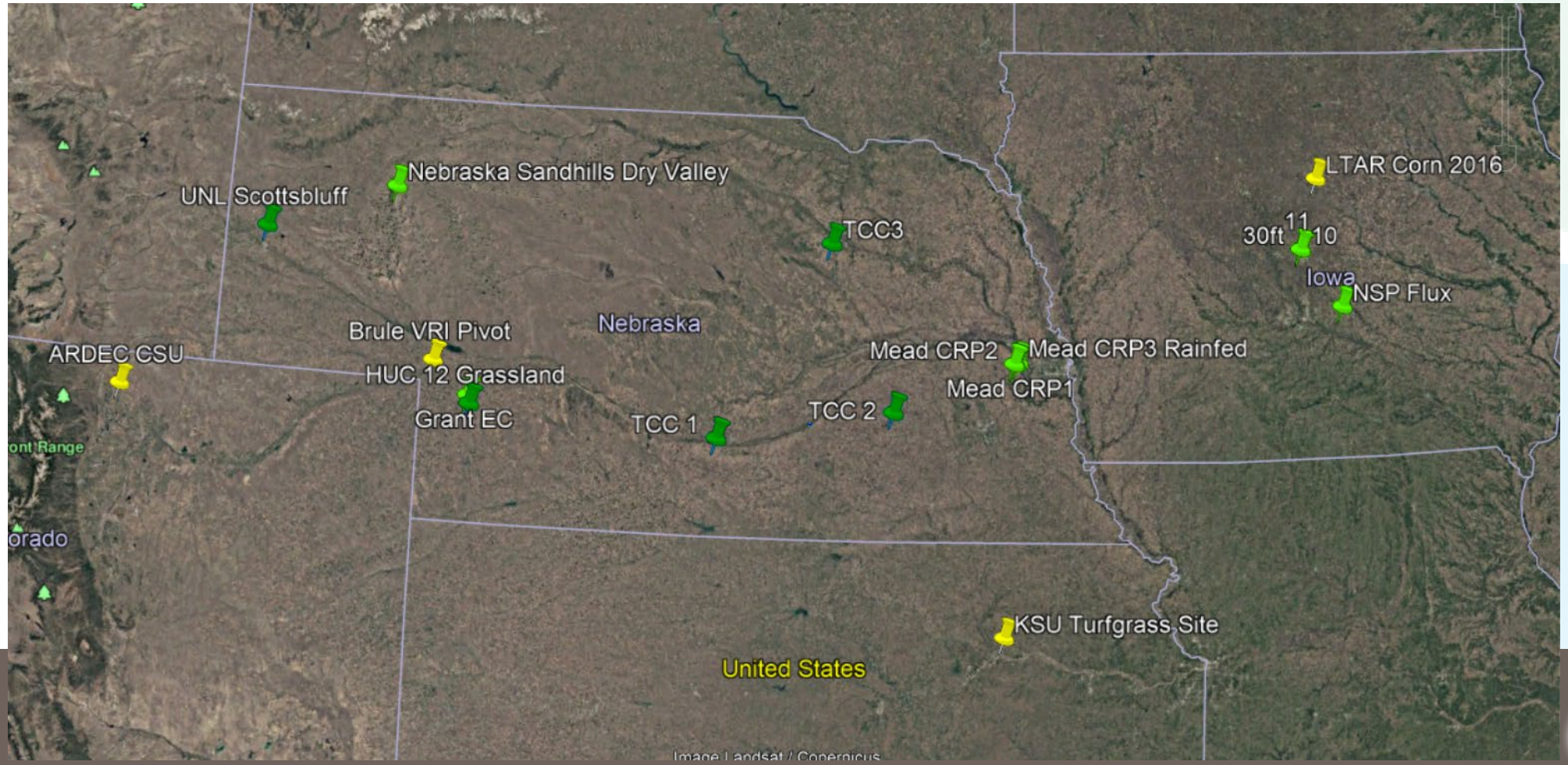
UPPER REPUBLICAN NRD

NEBRASKA WATER BALANCE ALLIANCE

USDA

Parallel 41 Flux Network: Real Time Crop Evapotranspiration

- Year 1: 7 Eddy Covariance Flux stations with **SmartFlux** and networked with **FluxSuite**: 5 in NE, 2 in IA
- Year 2: 3 stations: 1 NE, 1 IA, 1 KS, 1 CO
- Year 3 & 4: 5 additional stations from The Climate Corporation, location to be determined



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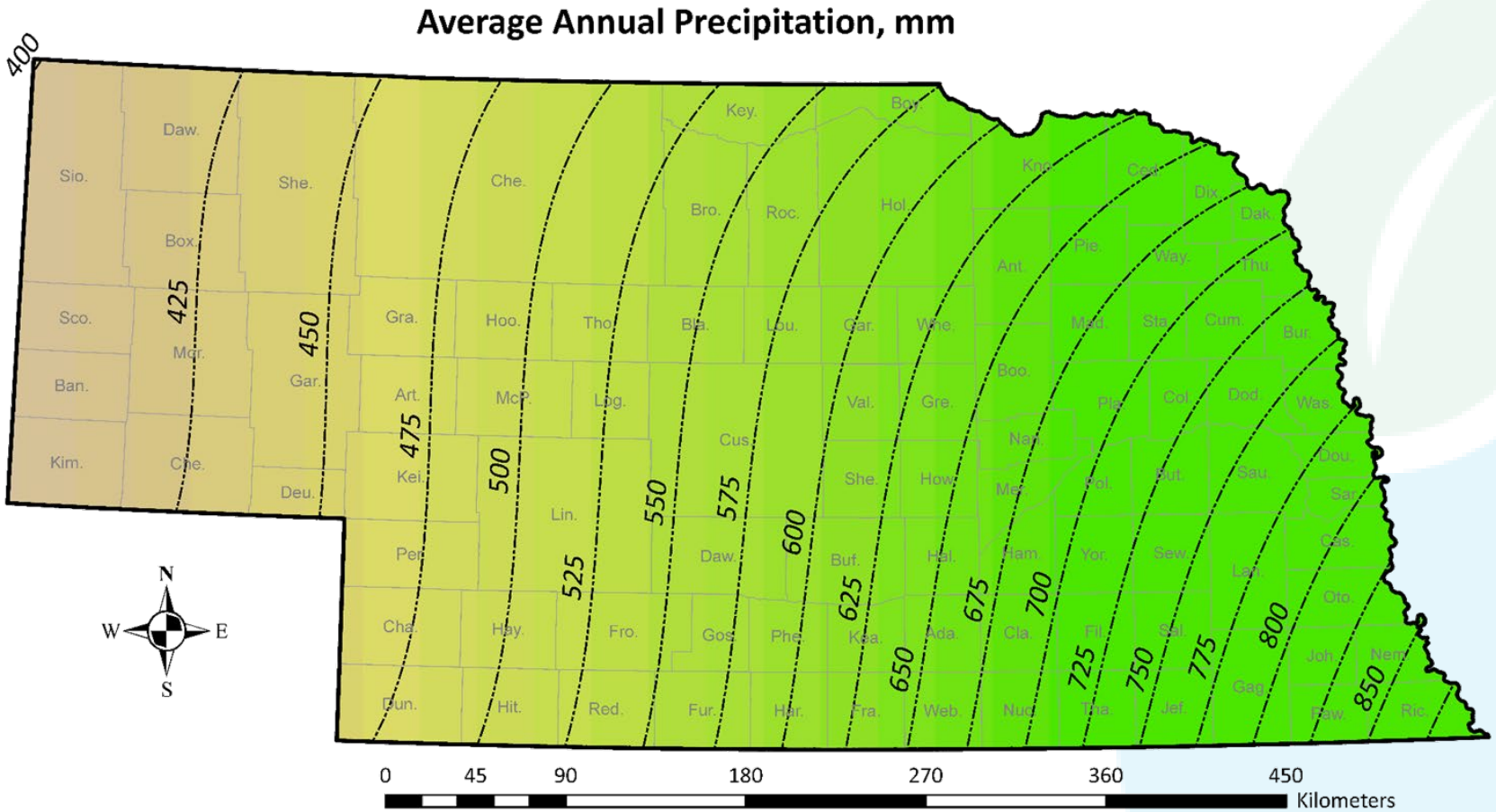
Precipitation is the Ultimate Water Source



Average Annual Precipitation Increases at About 75 mm per 100 km from West to East

Parallel 41 Flux Network Details

- The Eddy Covariance Flux towers are equipped with the LiCOR SmartFlux system, that runs EddyPro in real time and conducts all the necessary corrections to the time-series data.
- Towers are networked together with FluxSuite software, through cell phone modems, allowing for real-time quality control of data and to provide estimates of ET
- Public access through the Parallel 41 website.
- Present crops being monitored:

IA: Rainfed corn/soybean rotation

NE: Irrigated and rainfed corn/soybean rotation (east), natural short grass prairie, irrigated corn (central and west)

KS: turfgrass, sorghum

CO: TBD

FLUXSUITE | Map | Stations | Welcome, George Burba | Setup | Support | Logout

Grant NE 01 Station Info

All Stations | Dashboard | Information | Manage Alerts

Name: Grant NE 01

Abbreviation: NE01

Institute:

Location: Grant, NE

Latitude/Longitude:
40.793°, -101.624°

Ecosystem:
irrigated field corn

Elevation: 1026.8 m

Station Notebook

Show 10 entries | add entry

Search:

Note	Author	Timestamp
No data available in table		

Showing 0 to 0 of 0 entries

Generate Station Key | Deactivate Station

Instruments

Posted At: 2018-10-18 10:40:06 (UTC)

Company	Model	Serial Number	Software Version	Details
LI-COR	LI-7550	smart3-00184	8.8.15	
LI-COR	LI-7500A	75D-4088	8.8.15	
gill	hs_50	Y122708	2329-114-01	
Sutron	9210B	1106494	3.22.0.19	
LI-COR	SMARTFlux2	smart3-00184	2.2.16	

FLUXSUITE | Map | Stations | Welcome, George Burba | Setup | Support | Logout

Grant NE 01

Broadcasting Information

All Stations | Dashboard | Information | Manage Alerts

Communications

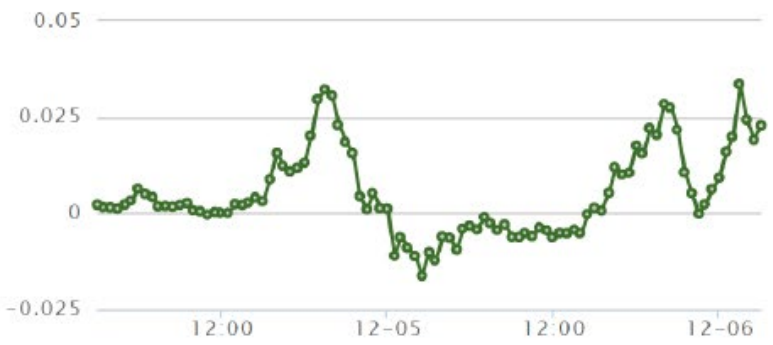
Storage

Biomet | LI-7500RS | SmartFlux2 | Anemometer

13 errors and 195 warnings in the last 7 days.

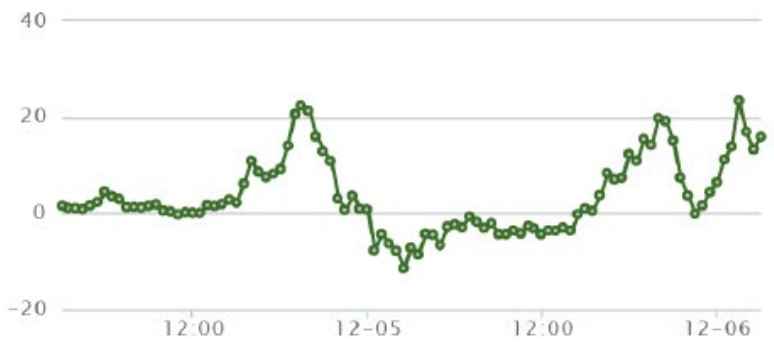
Detail View | Chart Order | Download Summary Report | QA/QC

ET (mm)



2018-12-04 2018-12-06

LE (W+1m-2)



2018-12-04 2018-12-06

FLUXSUITE: DASHBOARD

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All Stations | Dashboard | Information | Manage Alerts

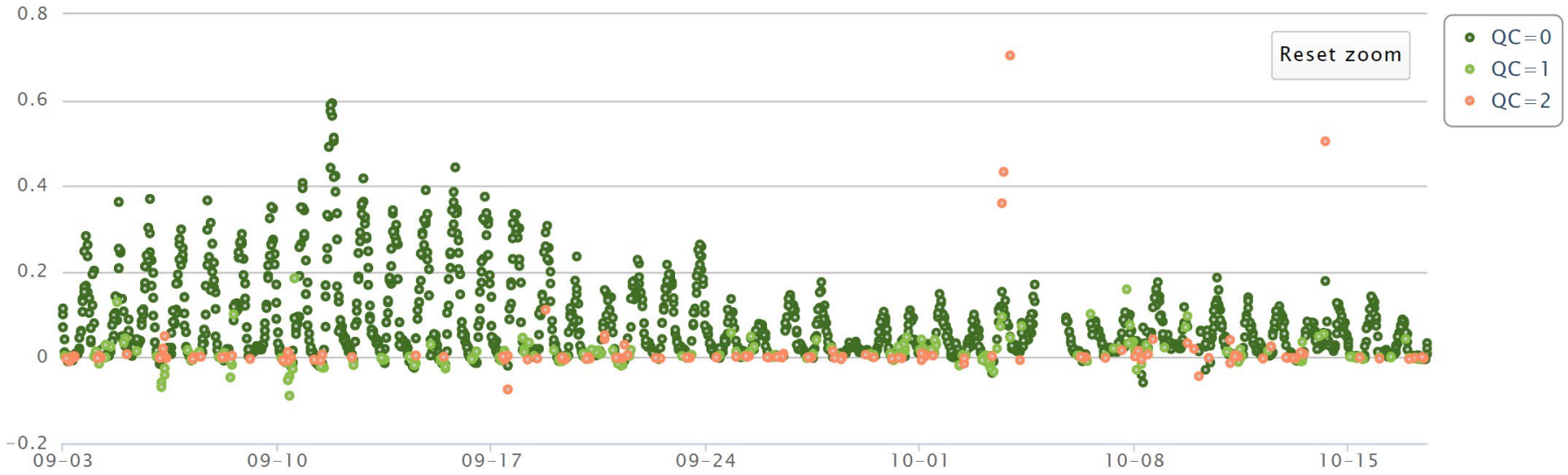
ET (mm)

Field: ET

Start Date: 2018-09-03

End Date: 2018-10-18

QA/QC



ET

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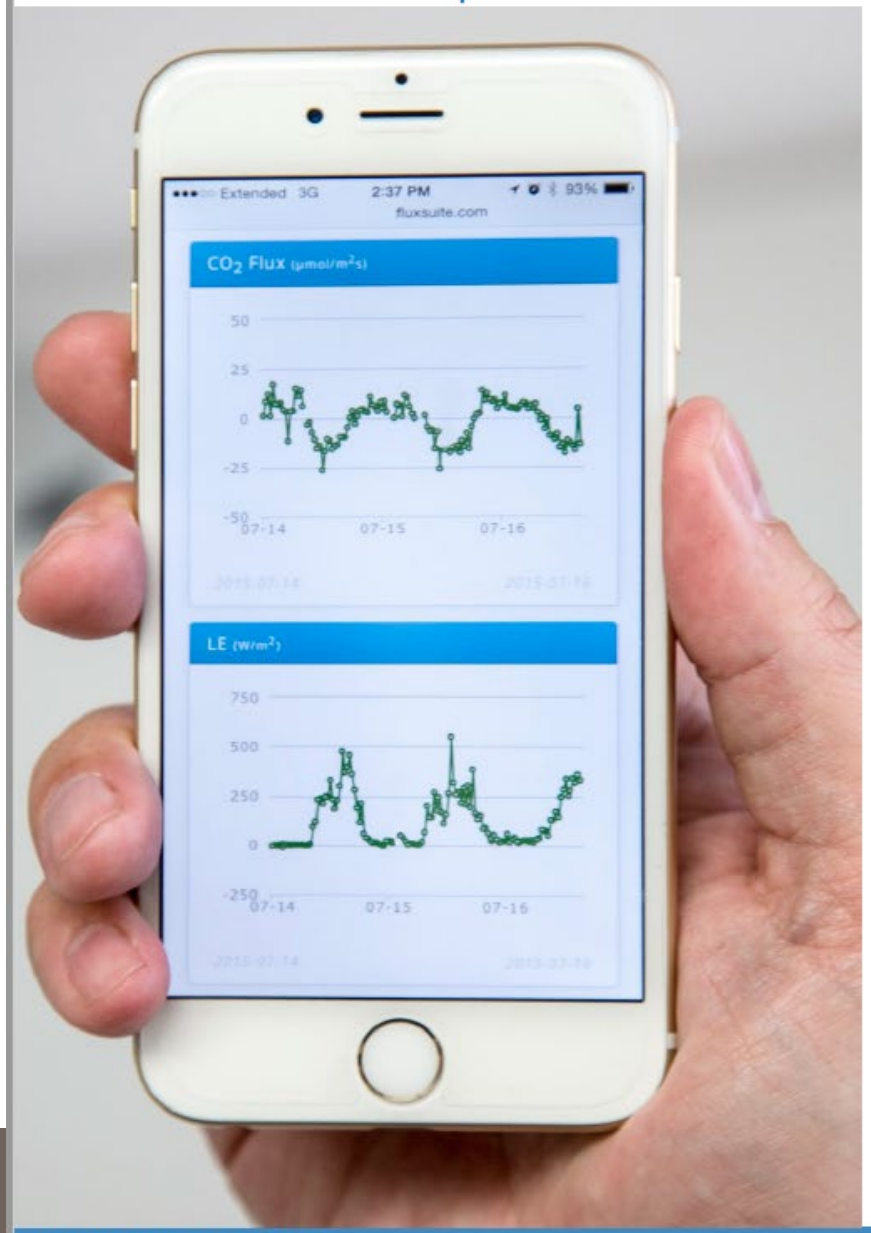
Station snapshot



Flux details

Quality-controlled fluxes

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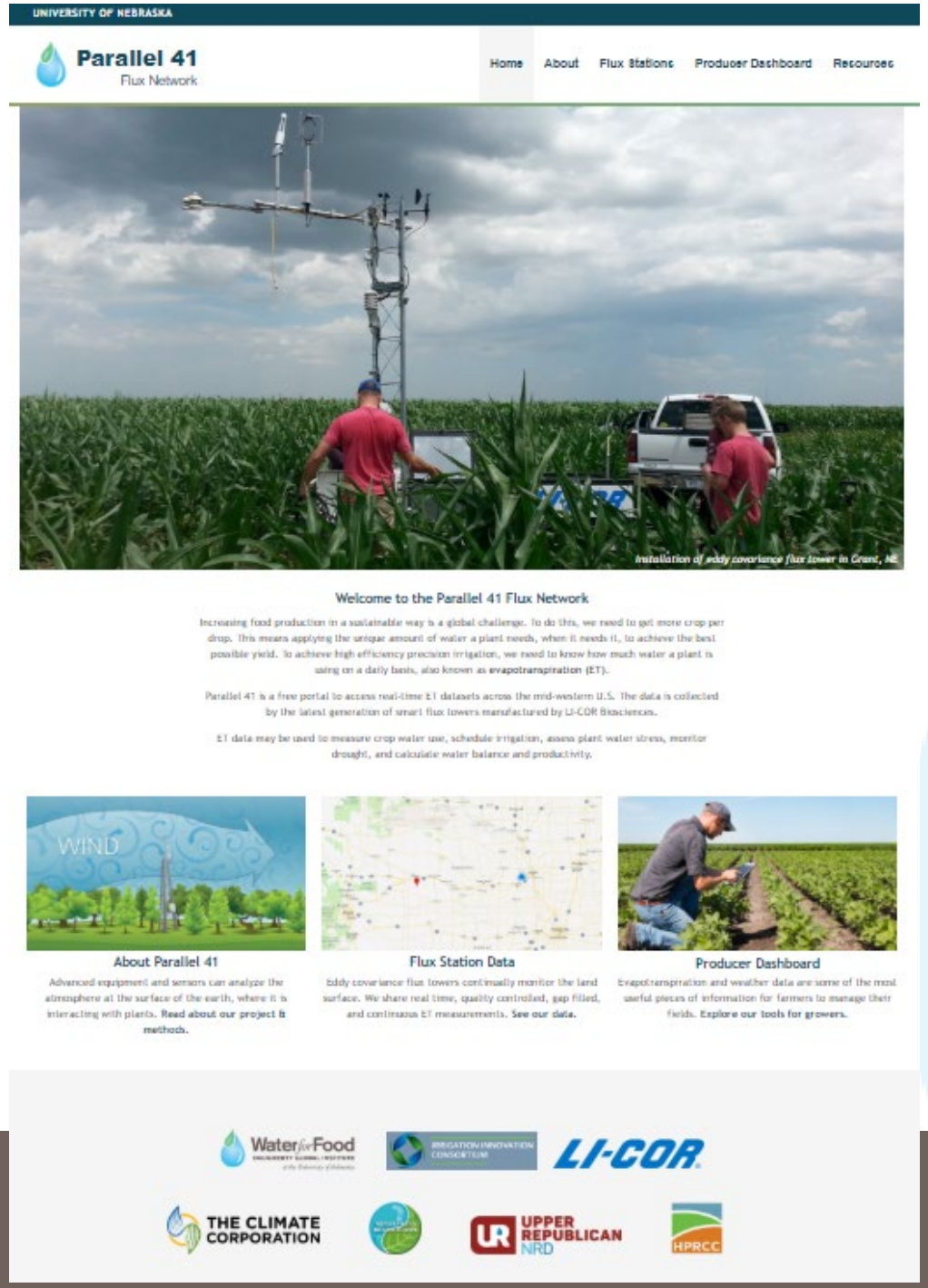
https://parallel41.nebraska.edu/#/

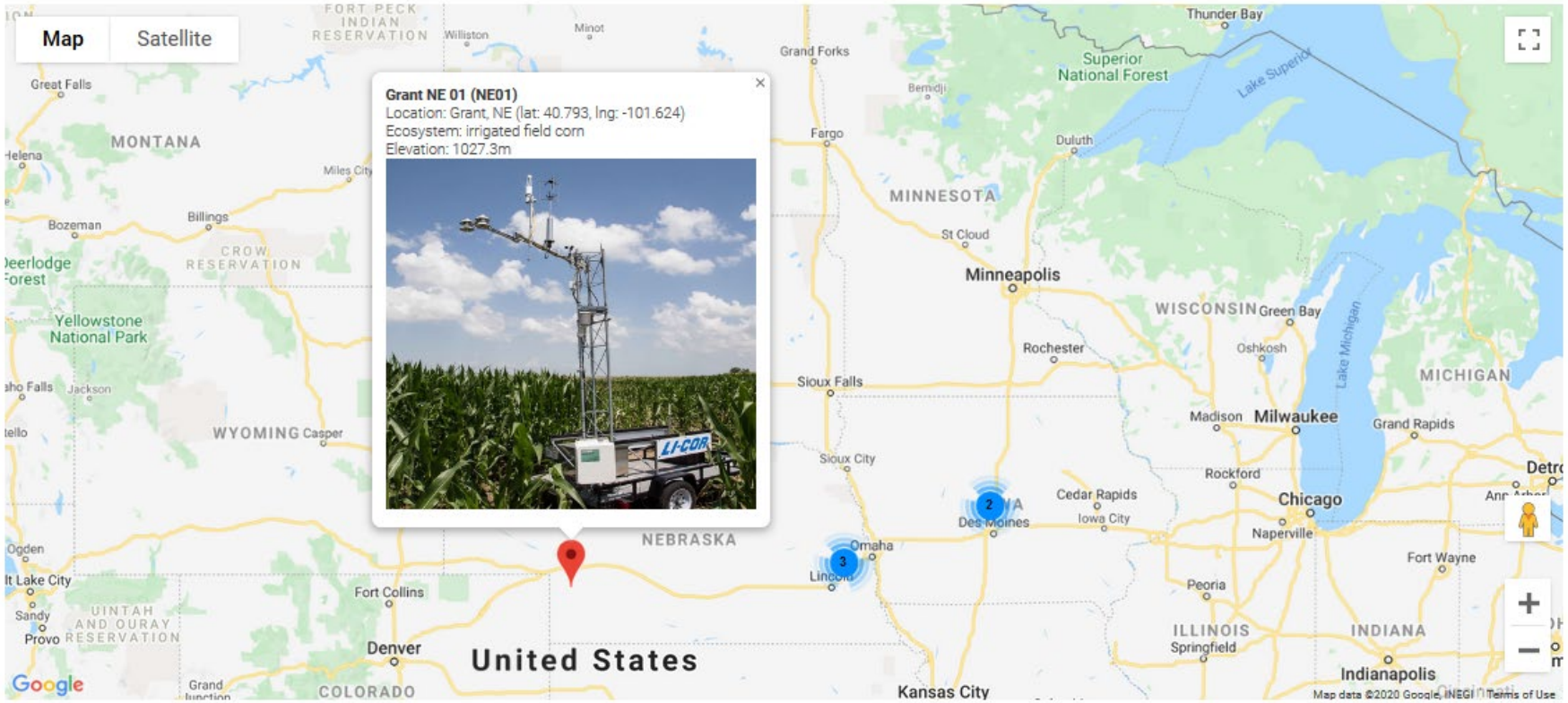


Parallel 41
Flux Network

Home | About | Flux Stations | Producer Dashboard | Resources

Get Started

Pins on the map represent flux station locations. Click a point to view data. Data and graphs will appear below the map.



Lincoln to Grant: 480 Km

https://parallel41.nebraska.edu/#/map-data

Grant NE 01

Date	2019-07-31
ET Units	mm / inches
Daily Measured ET (ETc) Value	0.16 inches

ETc of Previous 7 Days	2019-07-25	2019-07-26	2019-07-27	2019-07-28	2019-07-29	2019-07-30	2019-07-31
	0.22	0.23	0.21	0.24	0.24	0.21	0.16

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Wind Rose (Grant,NE)
Legend
> 7
1 - 2
2 - 3
3 - 4
4 - 5
5 - 6
6 - 7
Grant
N40°47'42"
Grant
W101°37'30"
Road 333
Google Earth
N
2000 ft

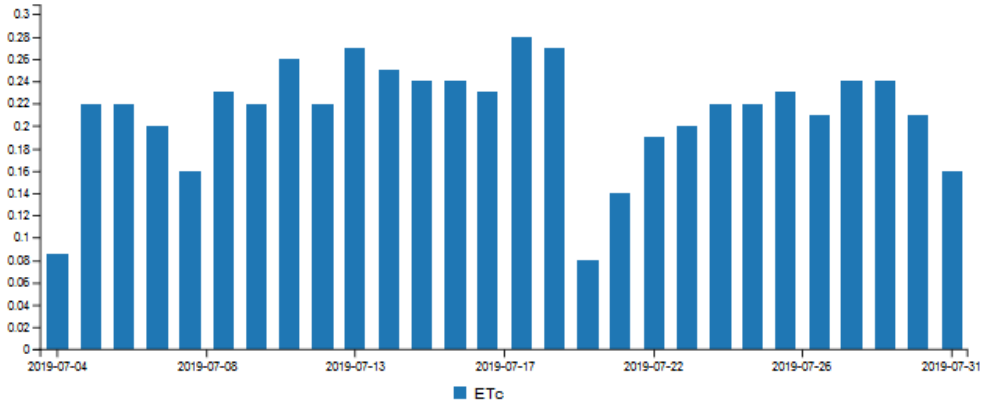
Grant NE 01

Date	2019-07-31
ET Units	○ mm ◉ inches
Daily Measured ET (ETc) Value	0.16 inches

ETc of Previous 7 Days

2019-07-25	2019-07-26	2019-07-27	2019-07-28	2019-07-29	2019-07-30	2019-07-31
0.22	0.23	0.21	0.24	0.24	0.21	0.16

Graph of Daily ETc Values for Date Selected and Previous 28 Days

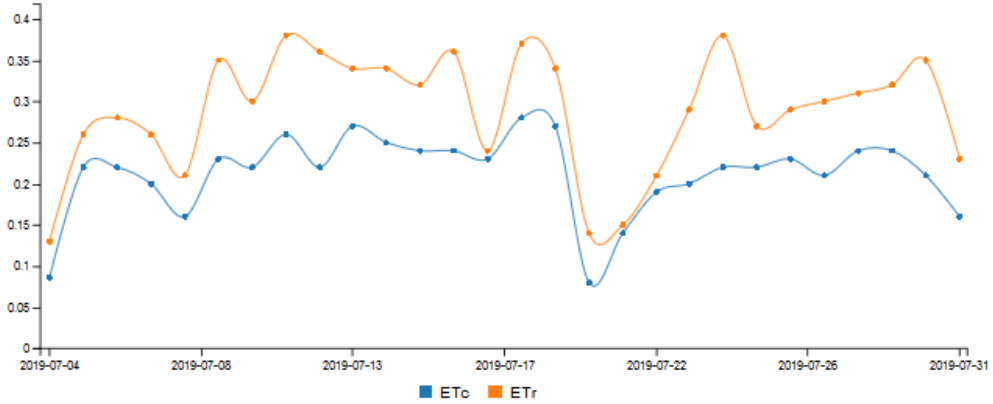


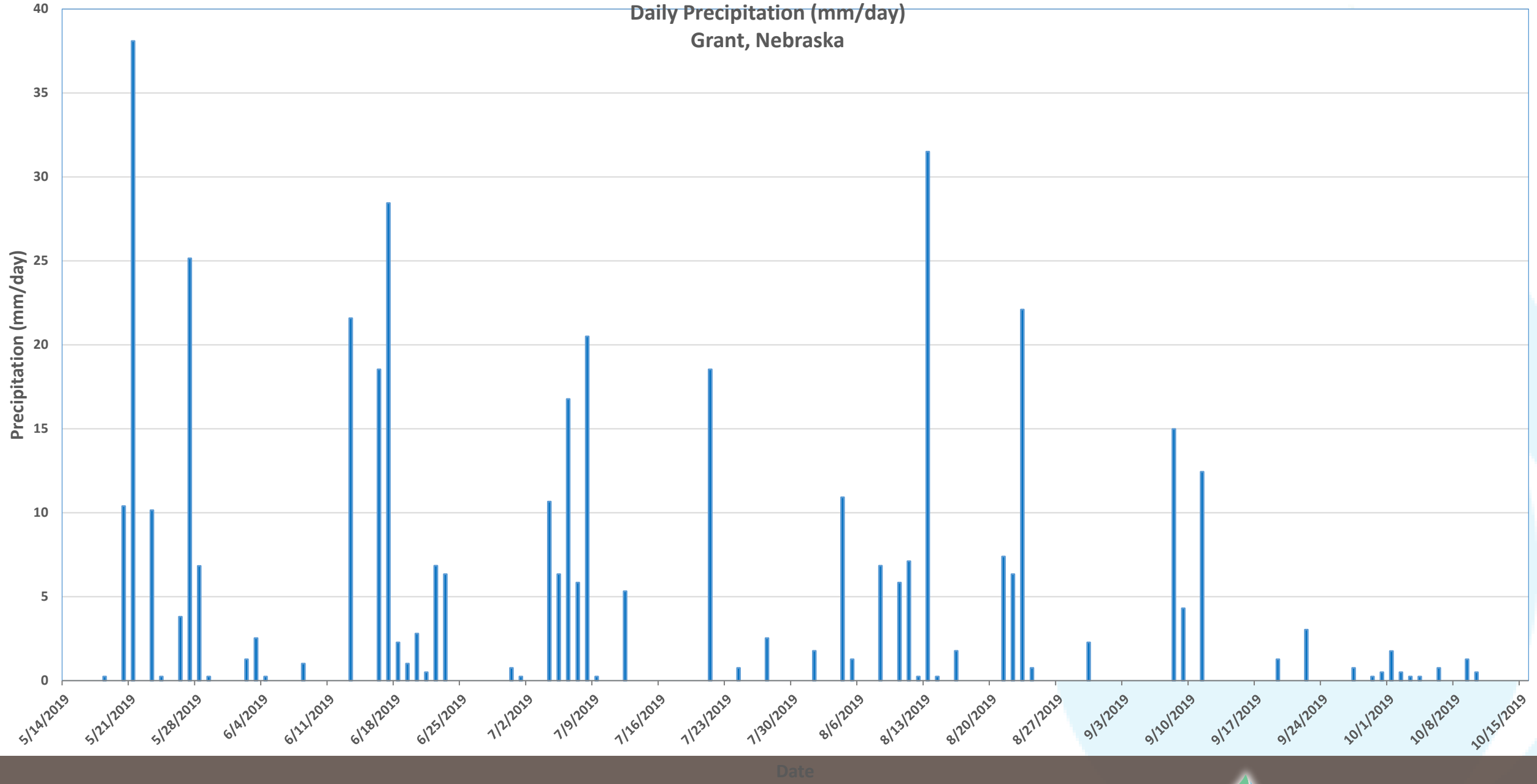
Daily Reference ET (ETr) Value Source: HPRCC	0.23 inches

ETr of Previous 7 Days Source: HPRCC

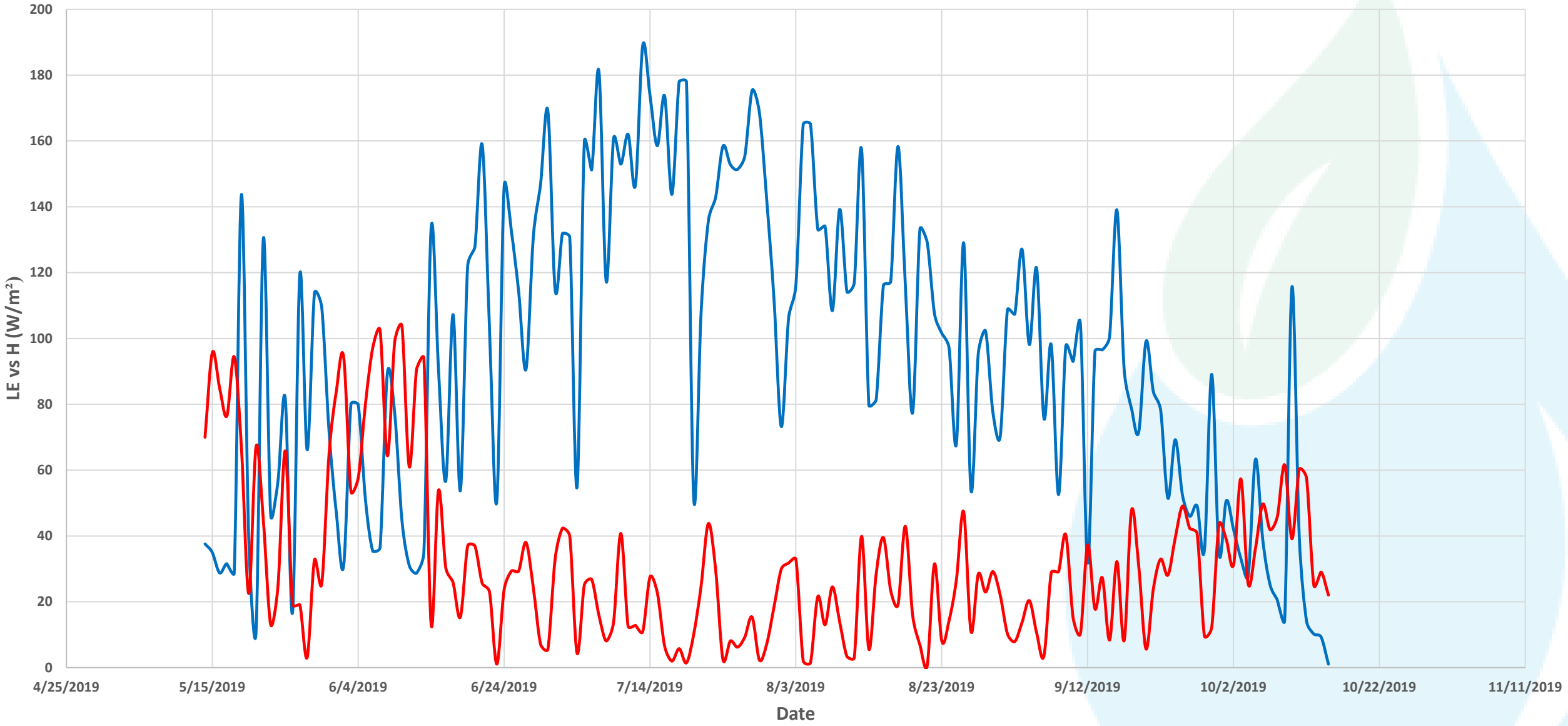
2019-07-25	2019-07-26	2019-07-27	2019-07-28	2019-07-29	2019-07-30	2019-07-31
0.27	0.29	0.3	0.31	0.32	0.35	0.23

Graph of Daily ETc & ETr Values for Date Selected and Previous 28 Days




Daily Precipitation (mm/day)
Grant, Nebraska
Precipitation (mm/day)
40
35
30
25
20
15
10
5
0
5/14/2019
5/21/2019
5/28/2019
6/4/2019
6/11/2019
6/18/2019
6/25/2019
7/2/2019
7/9/2019
7/16/2019
7/23/2019
7/30/2019
8/6/2019
8/13/2019
8/20/2019
8/27/2019
9/3/2019
9/10/2019
9/17/2019
9/24/2019
10/1/2019
10/8/2019
10/15/2019
Date

Daily Average Latent Heat (LE) vs Sensible Heat (H) Fluxes Measured above Irrigated Maize (Grant, Nebraska)



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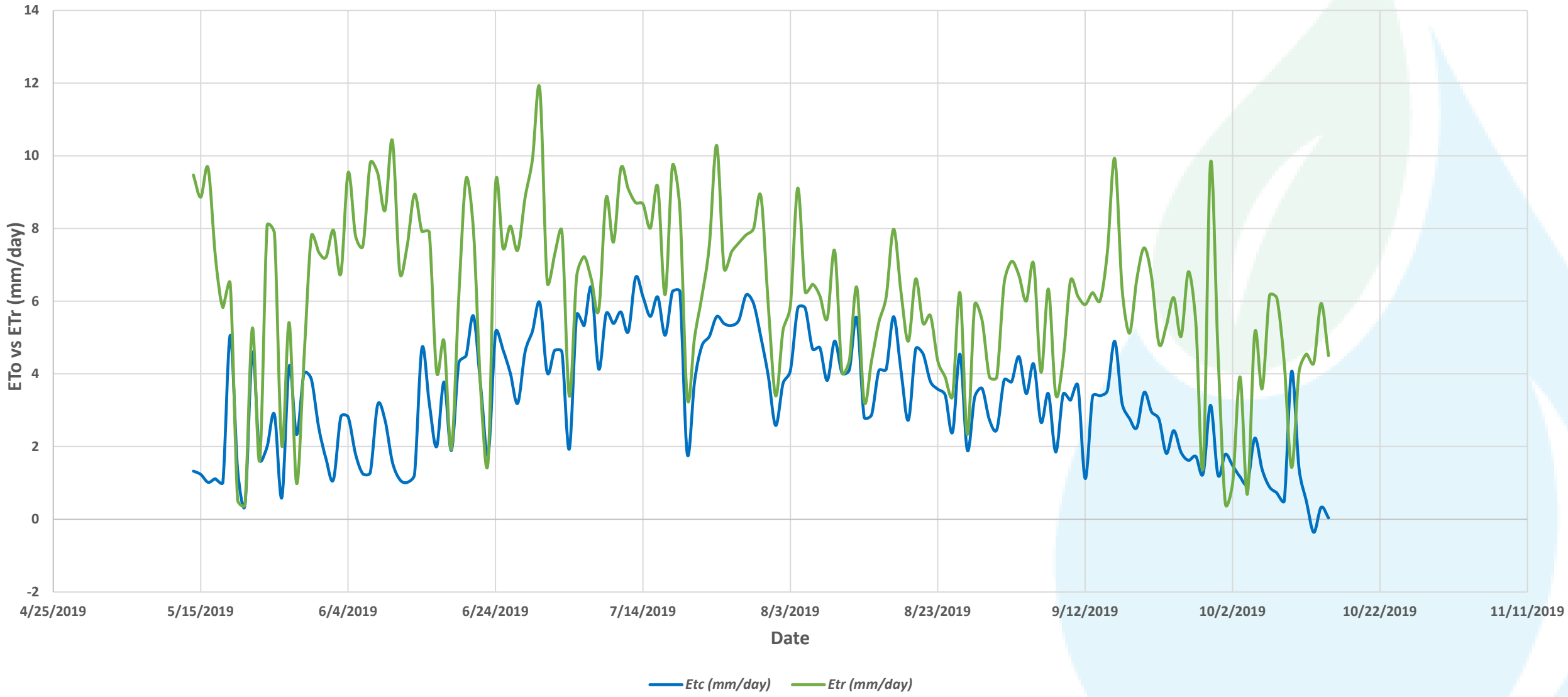
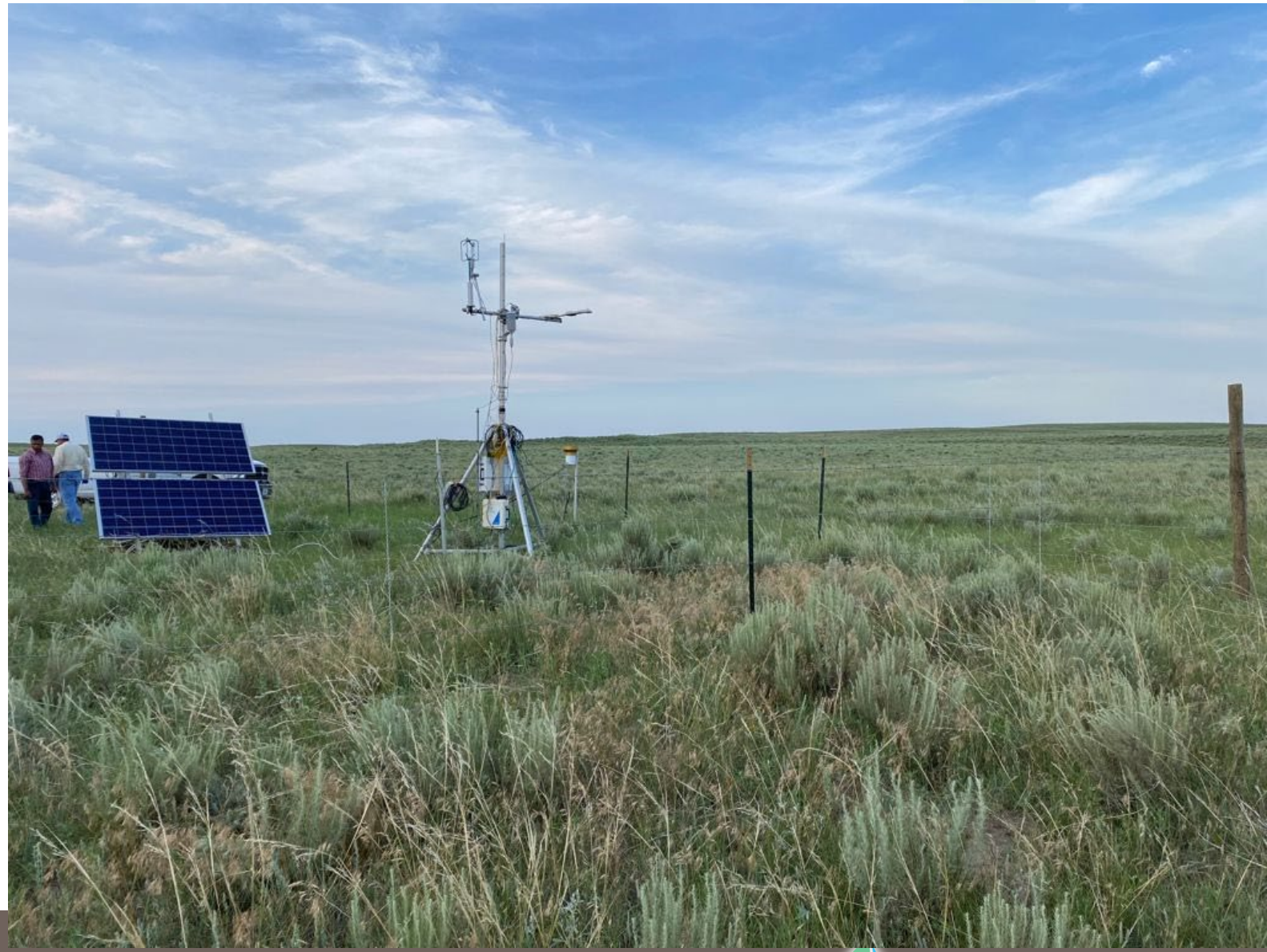
Daily Average Actual Evapotranspiration (ETc) vs Reference Evapotaranspiration (ETr) (Grant, Nebraska)

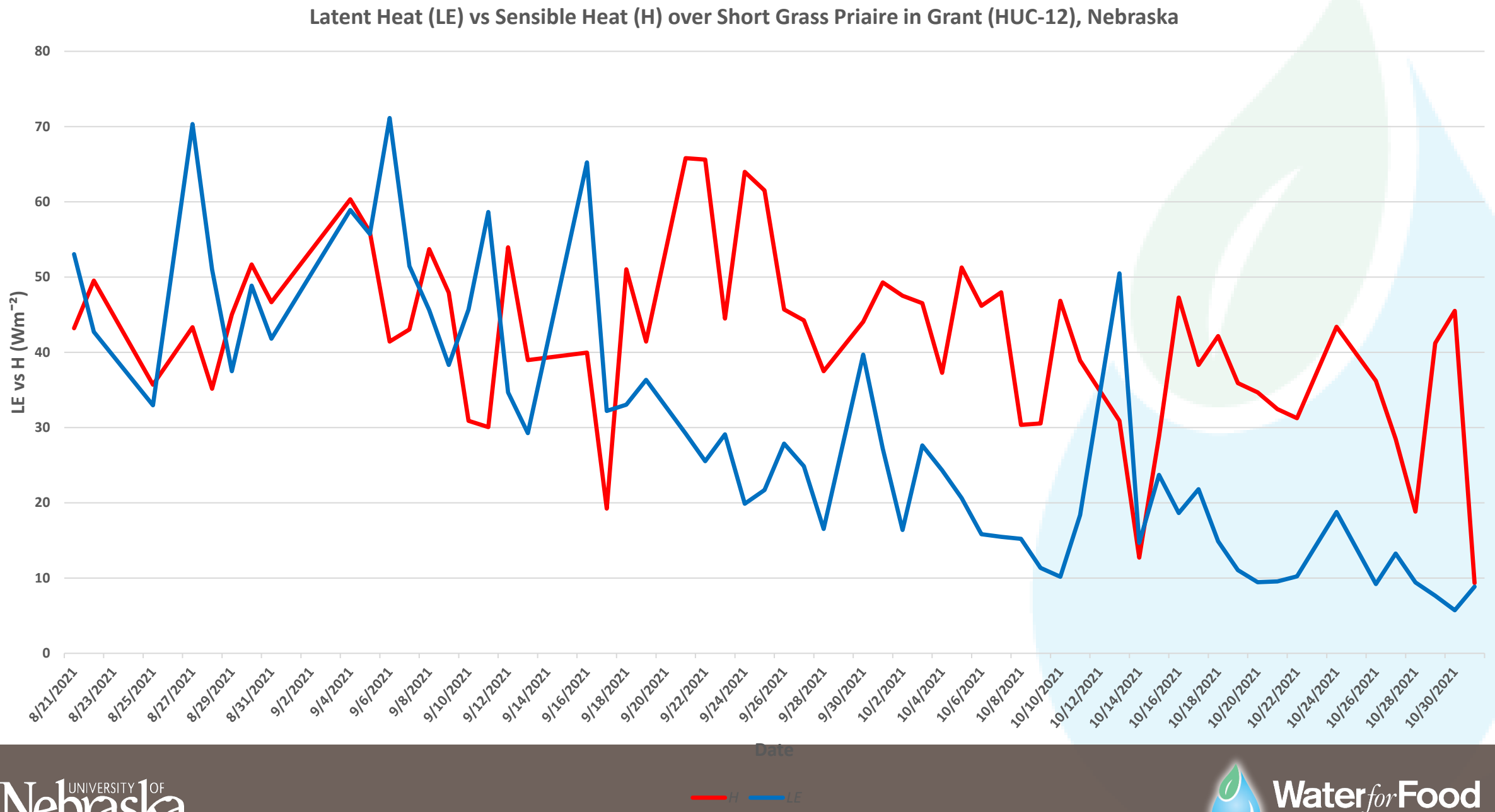


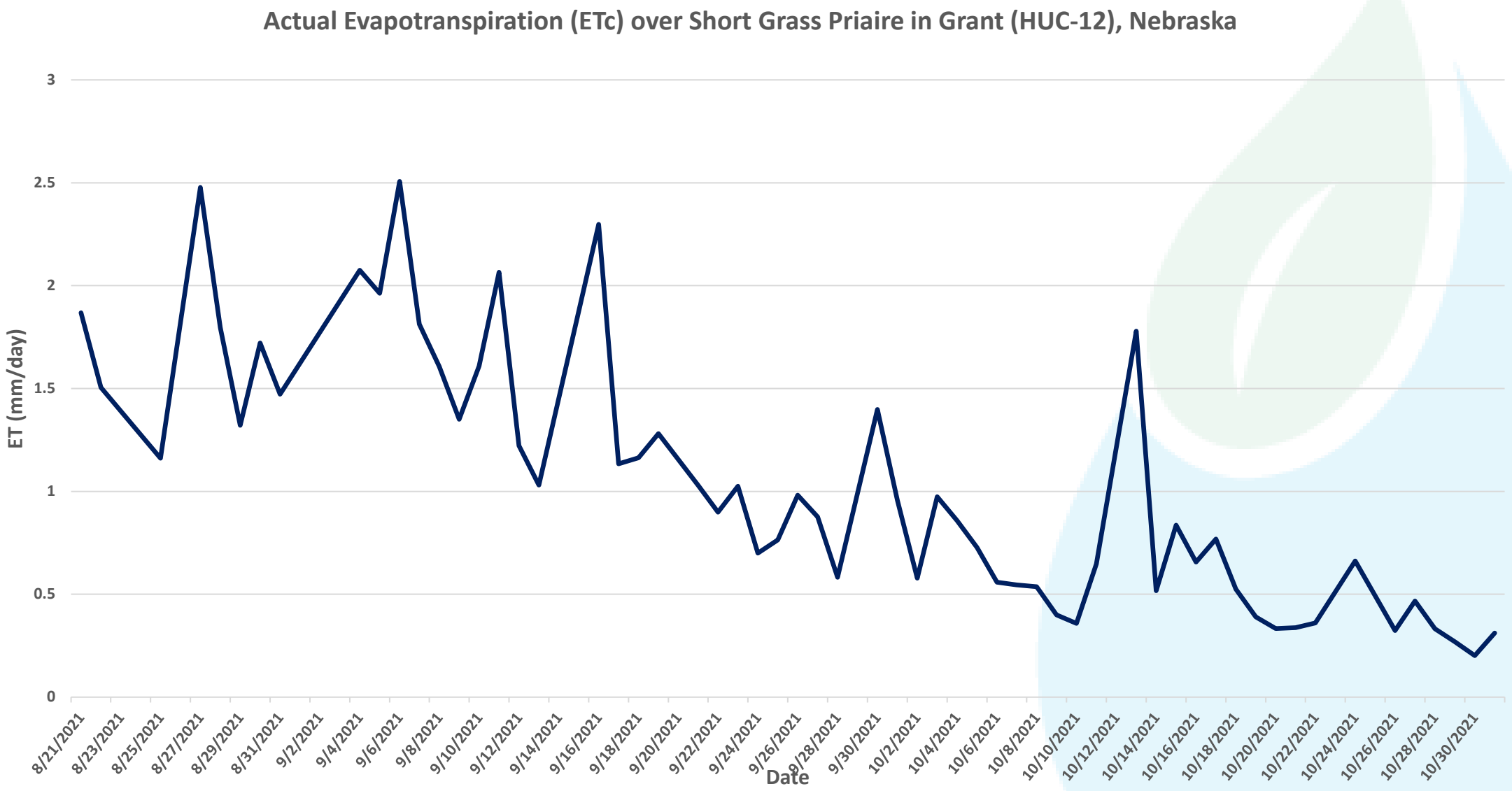
HUC-12 Tower Installation on Short Grass Prairie
Operational since July 1, 2021

South View

North View




Latent Heat (LE) vs Sensible Heat (H) over Short Grass Priaire in Grant (HUC-12), Nebraska
LE vs H (Wm⁻²)
80
70
60
50
40
30
20
10
0
8/21/2021
8/23/2021
8/25/2021
8/27/2021
8/29/2021
8/31/2021
9/2/2021
9/4/2021
9/6/2021
9/8/2021
9/10/2021
9/12/2021
9/14/2021
9/16/2021
9/18/2021
9/20/2021
9/22/2021
9/24/2021
9/26/2021
9/28/2021
9/30/2021
10/2/2021
10/4/2021
10/6/2021
10/8/2021
10/10/2021
10/12/2021
10/14/2021
10/16/2021
10/18/2021
10/20/2021
10/22/2021
10/24/2021
10/26/2021
10/28/2021
10/30/2021
Date
H
LE


Actual Evapotranspiration (ETc) over Short Grass Priaire in Grant (HUC-12), Nebraska
ET (mm/day)
3
2.5
2
1.5
1
0.5
0
8/21/2021
8/23/2021
8/25/2021
8/27/2021
8/29/2021
8/31/2021
9/2/2021
9/4/2021
9/6/2021
9/8/2021
9/10/2021
9/12/2021
9/14/2021
9/16/2021
9/18/2021
9/20/2021
9/22/2021
9/24/2021
9/26/2021
9/28/2021
9/30/2021
10/2/2021
10/4/2021
10/6/2021
10/8/2021
10/10/2021
10/12/2021
10/14/2021
10/16/2021
10/18/2021
10/20/2021
10/22/2021
10/24/2021
10/26/2021
10/28/2021
10/30/2021
Date

Lower Republican River NRD Holbrook EC Tower Installation on Irrigated Corn/Soy rotation. Operational since August 11, 2021

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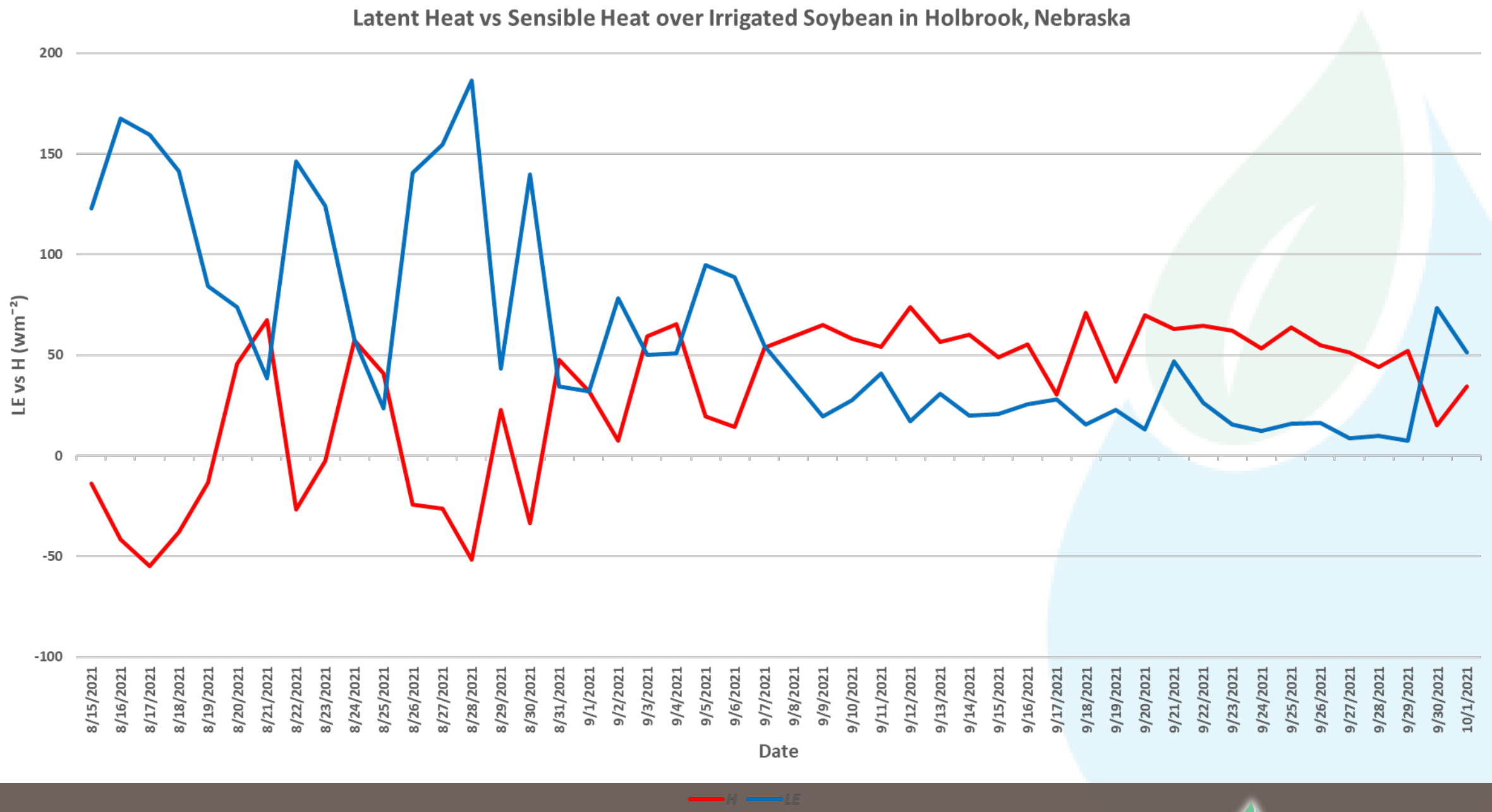
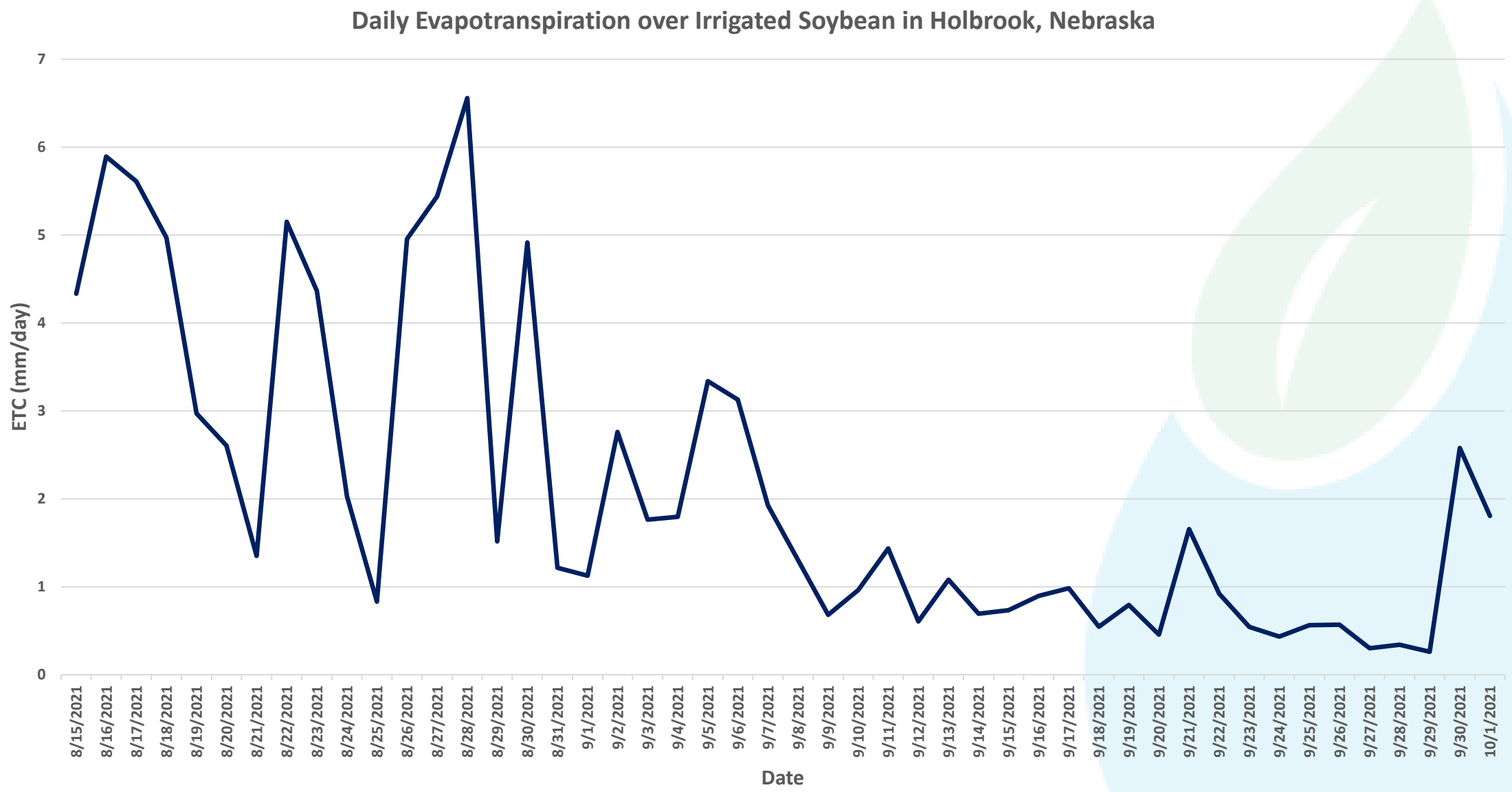

Latent Heat vs Sensible Heat over Irrigated Soybean in Holbrook, Nebraska
LE vs H (wm⁻²)
200
150
100
50
0
-50
-100
8/15/2021
8/16/2021
8/17/2021
8/18/2021
8/19/2021
8/20/2021
8/21/2021
8/22/2021
8/23/2021
8/24/2021
8/25/2021
8/26/2021
8/27/2021
8/28/2021
8/29/2021
8/30/2021
8/31/2021
9/1/2021
9/2/2021
9/3/2021
9/4/2021
9/5/2021
9/6/2021
9/7/2021
9/8/2021
9/9/2021
9/10/2021
9/11/2021
9/12/2021
9/13/2021
9/14/2021
9/15/2021
9/16/2021
9/17/2021
9/18/2021
9/19/2021
9/20/2021
9/21/2021
9/22/2021
9/23/2021
9/24/2021
9/25/2021
9/26/2021
9/27/2021
9/28/2021
9/29/2021
9/30/2021
10/1/2021
Date
H
LE


Daily Evapotranspiration over Irrigated Soybean in Holbrook, Nebraska
ETC (mm/day)
0
1
2
3
4
5
6
7
8/15/2021
8/16/2021
8/17/2021
8/18/2021
8/19/2021
8/20/2021
8/21/2021
8/22/2021
8/23/2021
8/24/2021
8/25/2021
8/26/2021
8/27/2021
8/28/2021
8/29/2021
8/30/2021
8/31/2021
9/1/2021
9/2/2021
9/3/2021
9/4/2021
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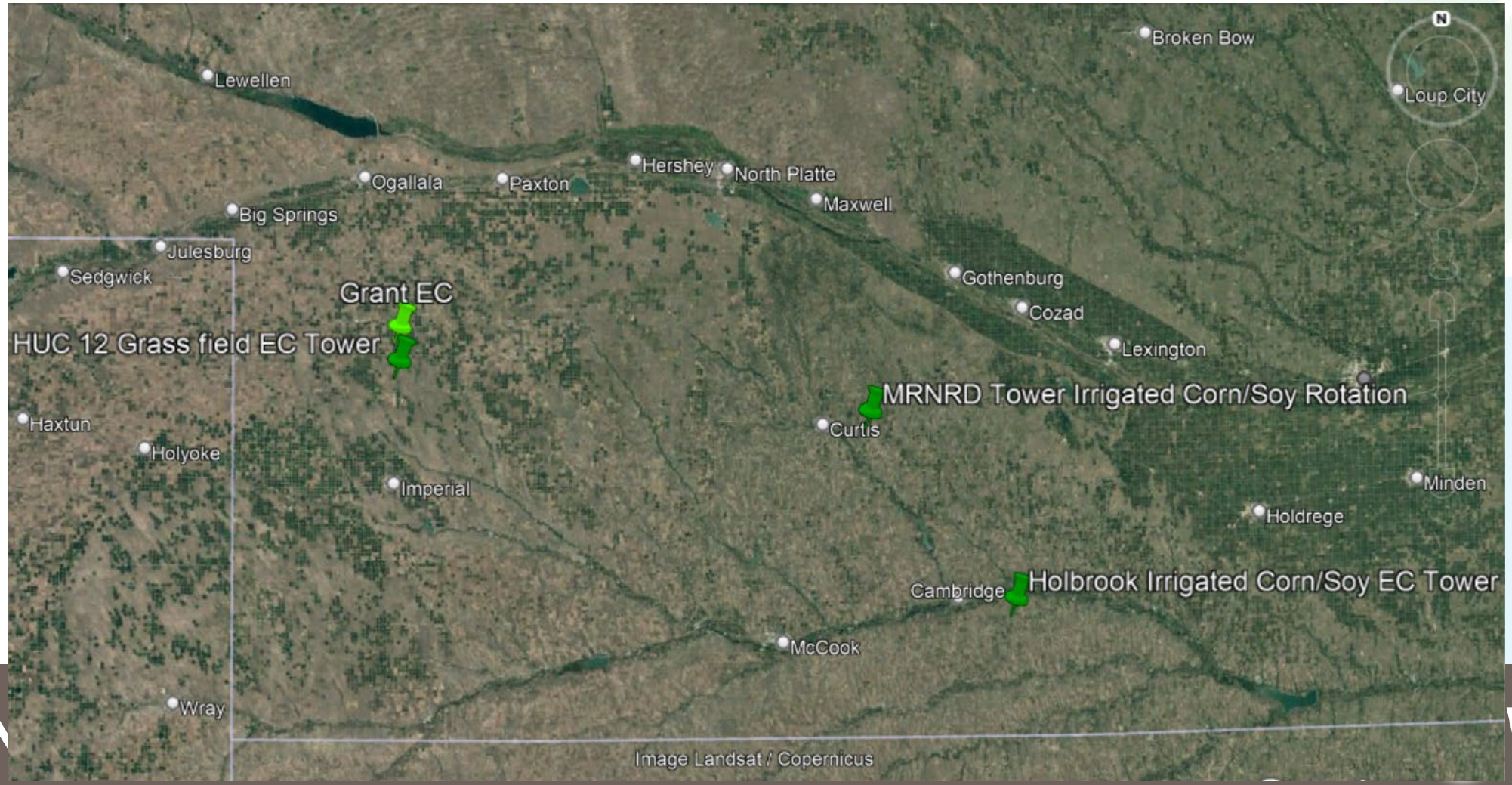
9/6/2021
9/7/2021
9/8/2021
9/9/2021
9/10/2021
9/11/2021
9/12/2021
9/13/2021
9/14/2021
9/15/2021
9/16/2021
9/17/2021
9/18/2021
9/19/2021
9/20/2021
9/21/2021
9/22/2021
9/23/2021
9/24/2021
9/25/2021
9/26/2021
9/27/2021
9/28/2021
9/29/2021
9/30/2021
10/1/2021
Date

Parallel 41 Flux Network: Ground Truthing of Spatial ET

- Year 1: 7 Eddy Covariance Flux stations with **SmartFlux** and networked with **FluxSuite**: 5 in NE, 2 in IA
- Year 2: 3 stations: 1 NE, 1 IA, 1 KS, 1 CO
- Year 3 & 4: 3 additional stations from The Climate Corporation, in the Republican River Basin in NE



Operational Evapotranspiration Determination in the NENA Region for Evaporative Stress Index and Water Productivity

Christopher Neale
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Christopher Hain
NASA Marshall Spaceflight Center, Huntsville, Alabama

Martha C. Anderson
USDA-Agricultural Research Service, Hydrology and Remote Sensing Laboratory

Mitch Schull, Yun Yang
ESSIC, University of Maryland

Sami Akasheh
Daugherty Water for Food Global Institute

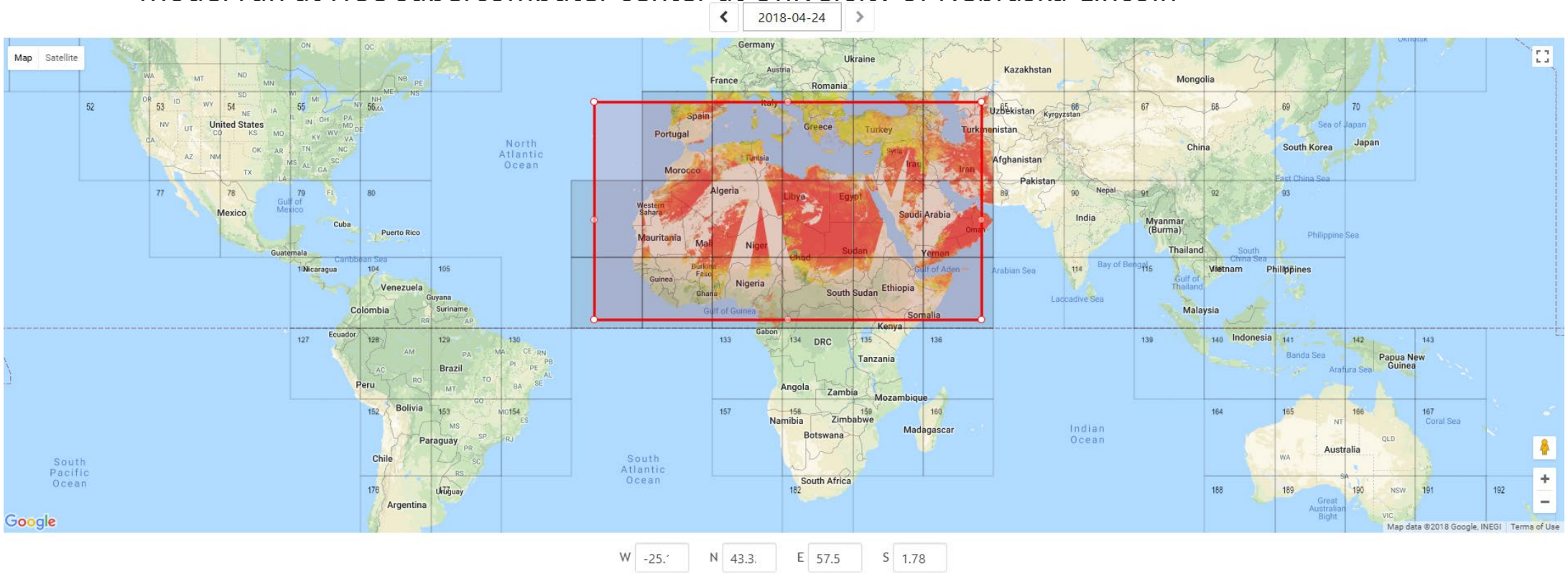
Screenshot of daily ET overlaid on map for Spain (7/18/17)

NATIONAL DROUGHT MITIGATION CENTER UNIVERSITY OF NEBRASKA · UNIVERSITY OF Nebraska · UNIVERSITY OF MARYLAND · IWMI · ICBA · FAO · USAID FROM THE AMERICAN PEOPLE · Water for Food DAUGHERTY GLOBAL INSTITUTE at the University of Nebraska

ALEXI/VIIRS Satellite Global Daily ET Product (GLODET) WEB Interface

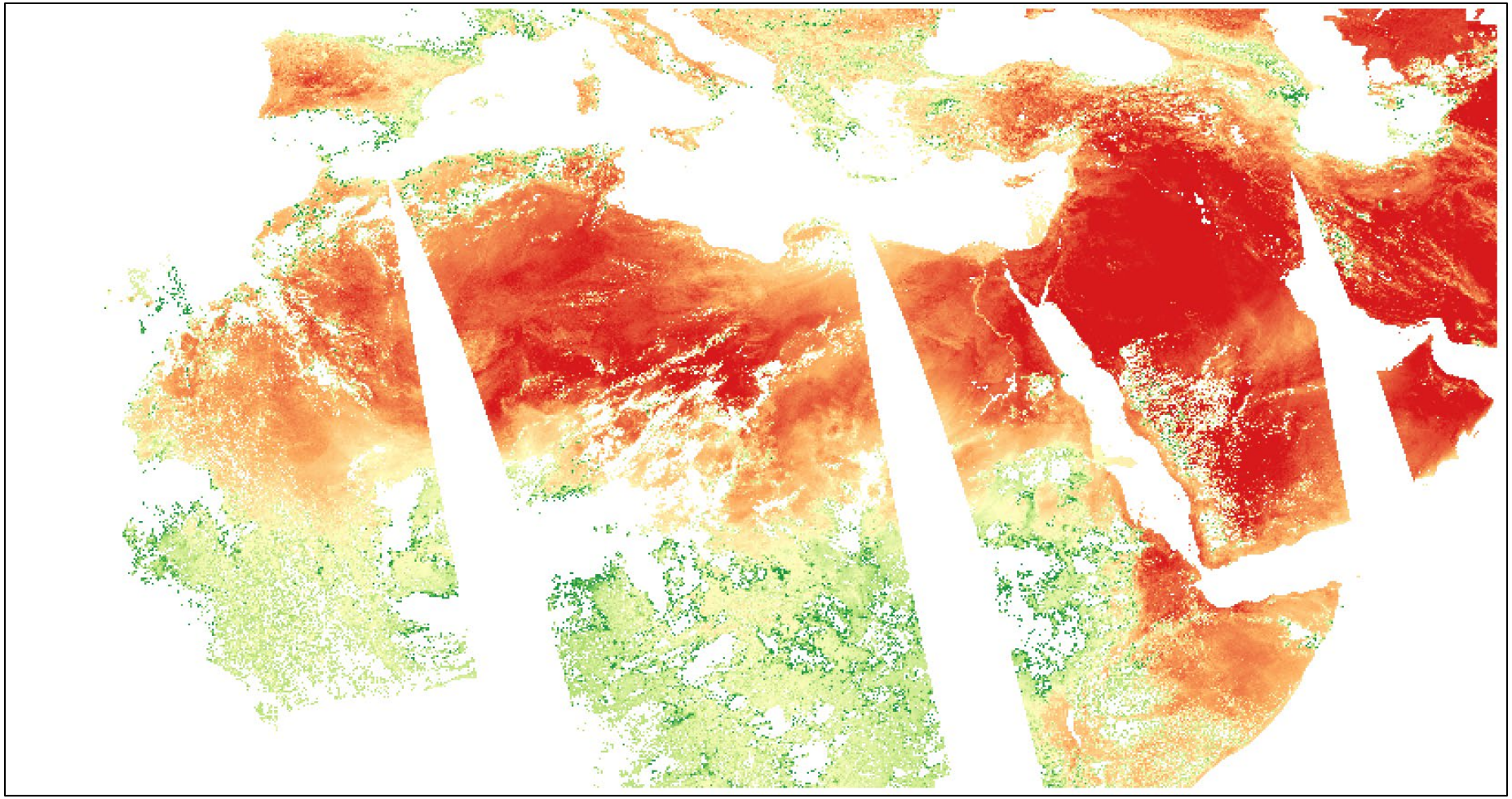
- Users will register to view and download the product
- Updates, track the applications and research using the product
- Model run at HCC supercomputer center at University of Nebraska-Lincoln

https://glodet.nebraska.edu/index.html#/



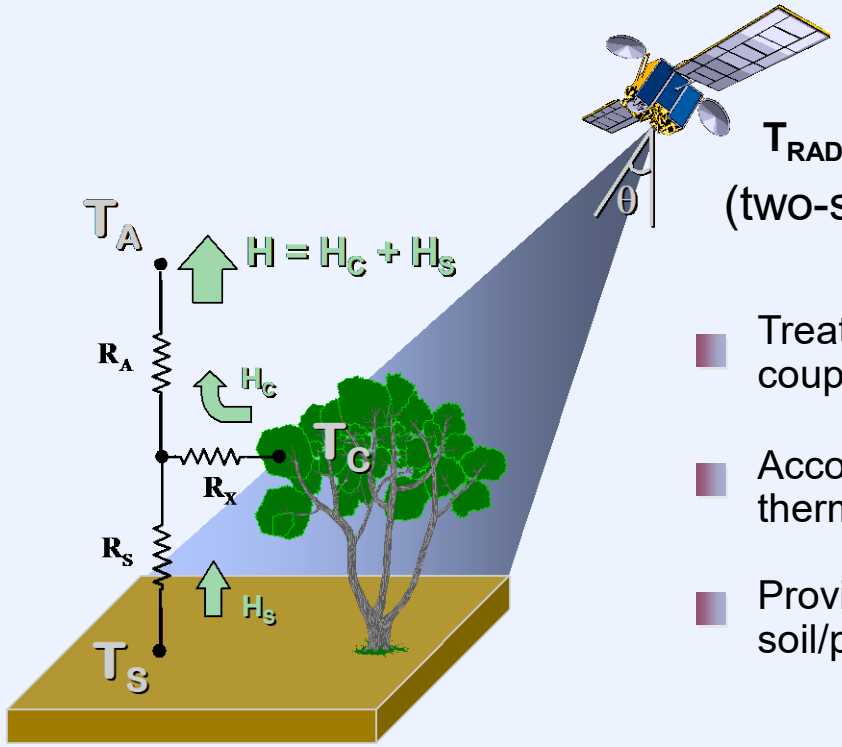
Clear Sky Land Surface Temperature from VIIRS

Clear-sky land surface temperature valid at 0900 UTC on 1 August 2015. LST and cloud masks were generated from VIIRS I5 BT band. LST was computed using a single channel retrieval based on an atmospheric correction of the I5 band with CFSR atmospheric water vapor data. Thermal IR band spatial resolution is 375 m.



The ALEXI model runs the TSEB

Two-Source Energy Balance Model (TSEB)



$$T_{RAD}(\theta) \sim f_c(\theta)T_c + [1-f_c(\theta)]T_s$$

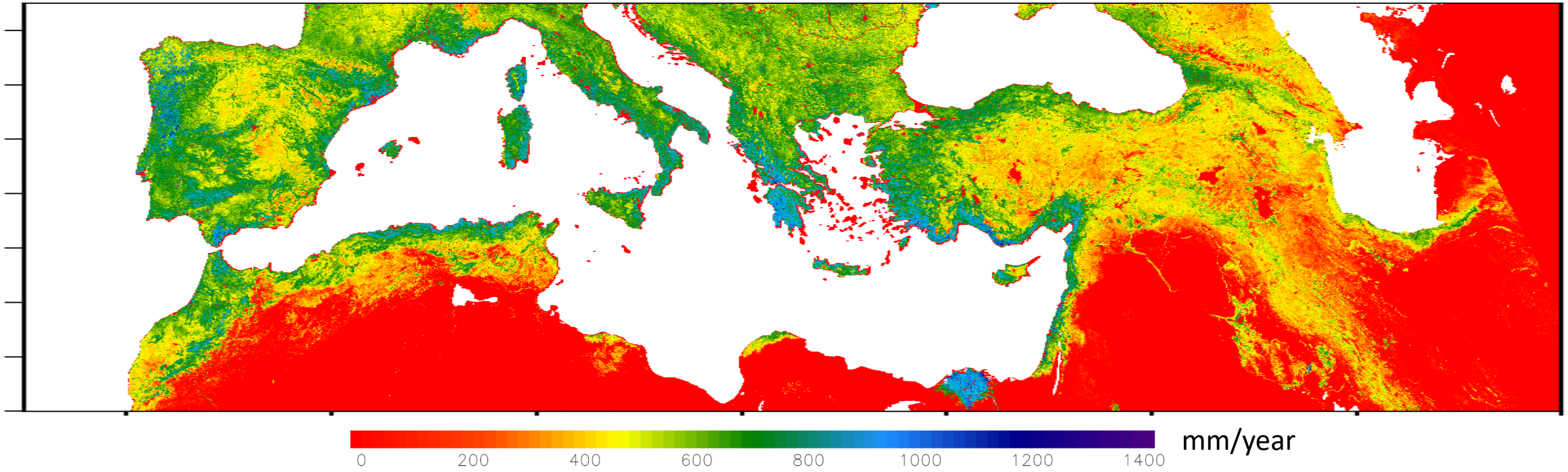
(two-source approximation)

Norman, Kustas et al. (1995)

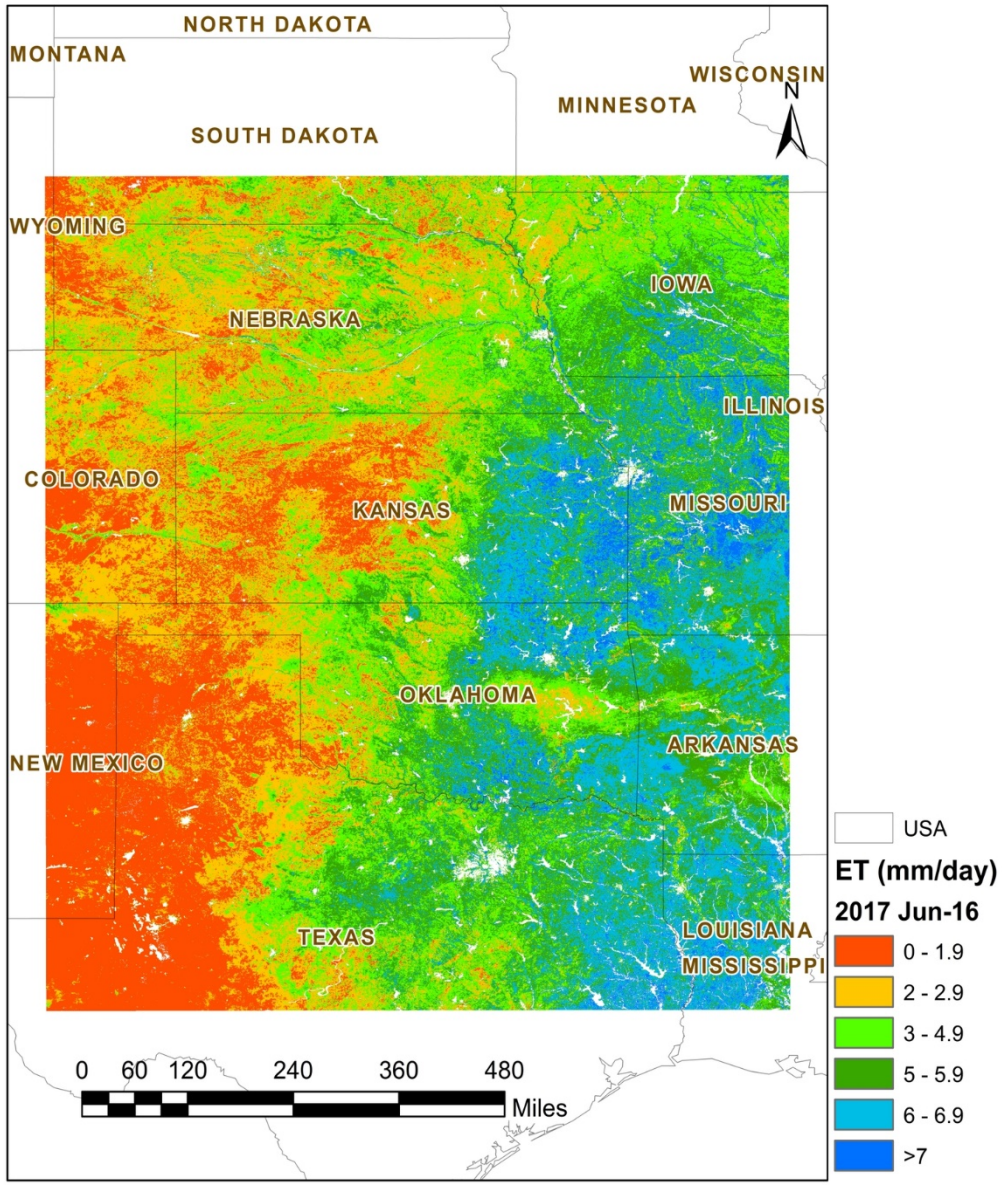
- Treats soil/plant-atmosphere coupling differences explicitly
- Accommodates off-nadir thermal sensor view angles
- Provides information on soil/plant fluxes and stress

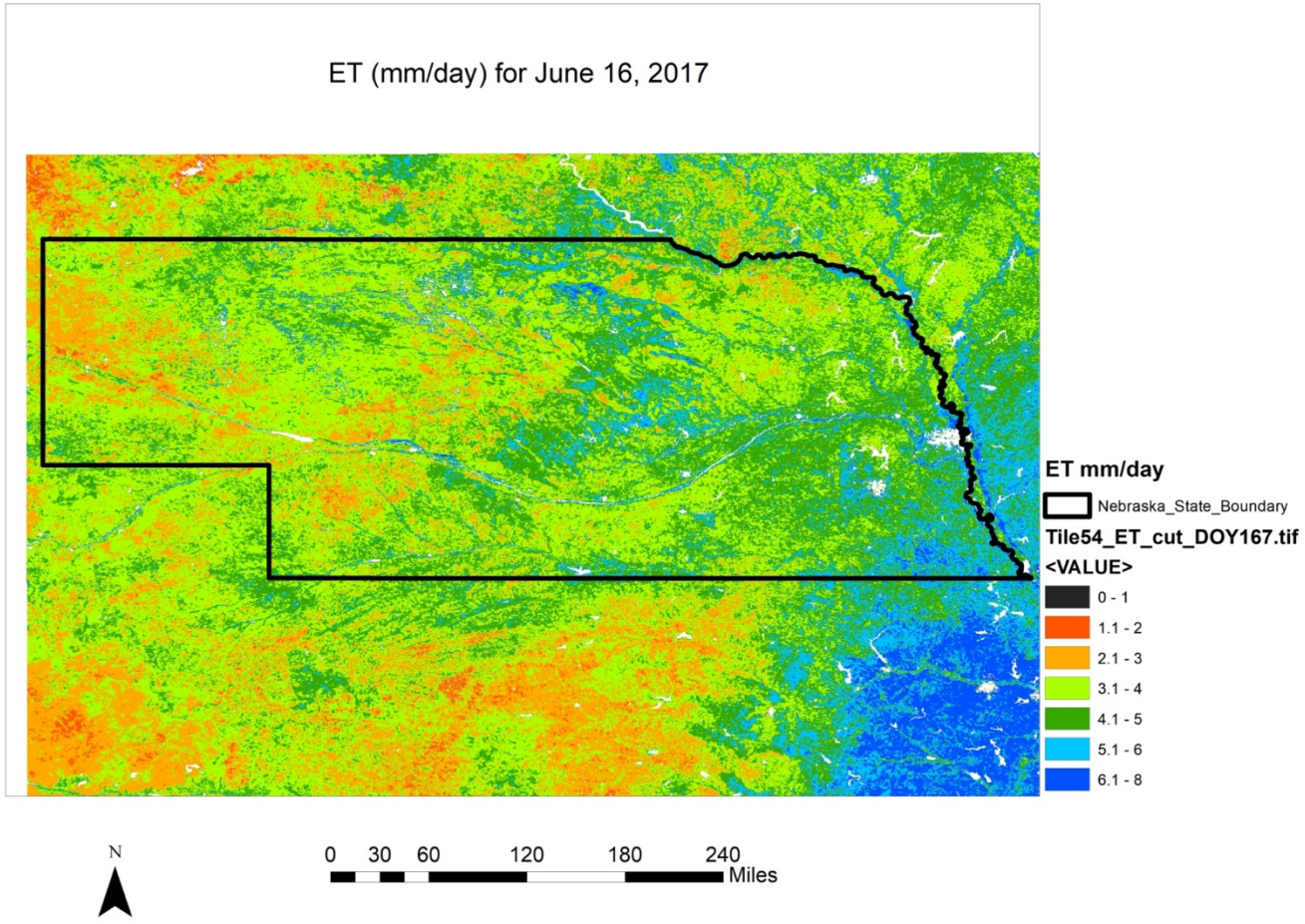
Development of a High-Resolution (375-m) VIIRS ET Product

Annual ET estimated from integrating daily values for 2018

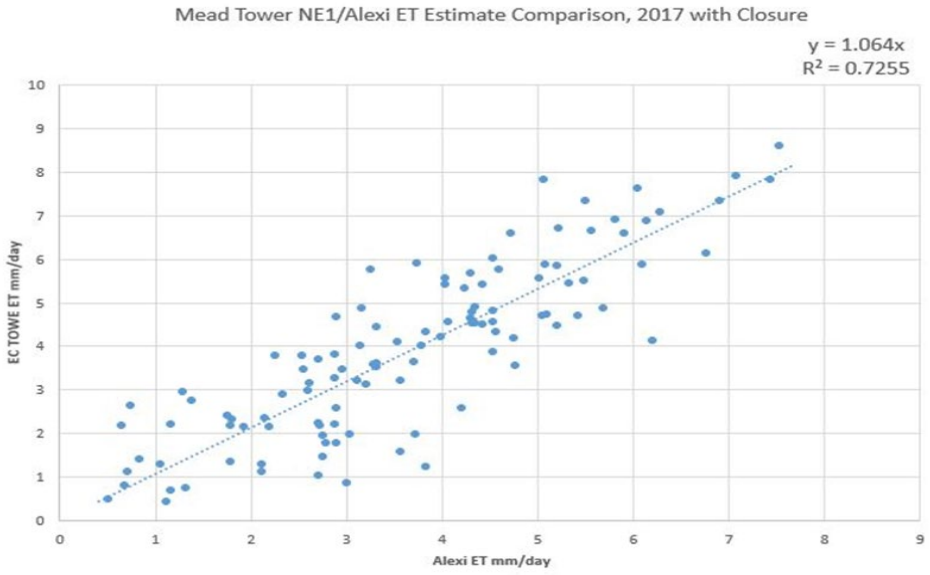


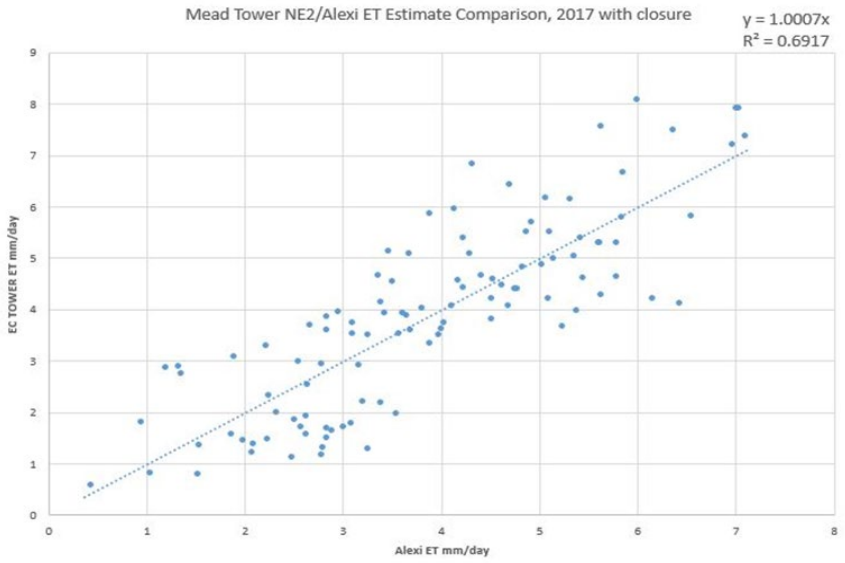
VIIRS ALEXI Daily ET for Tile 54 at 400 m pixel resolution

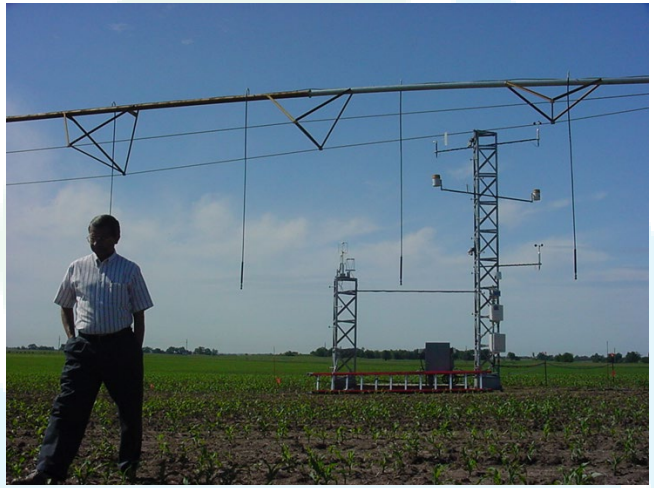


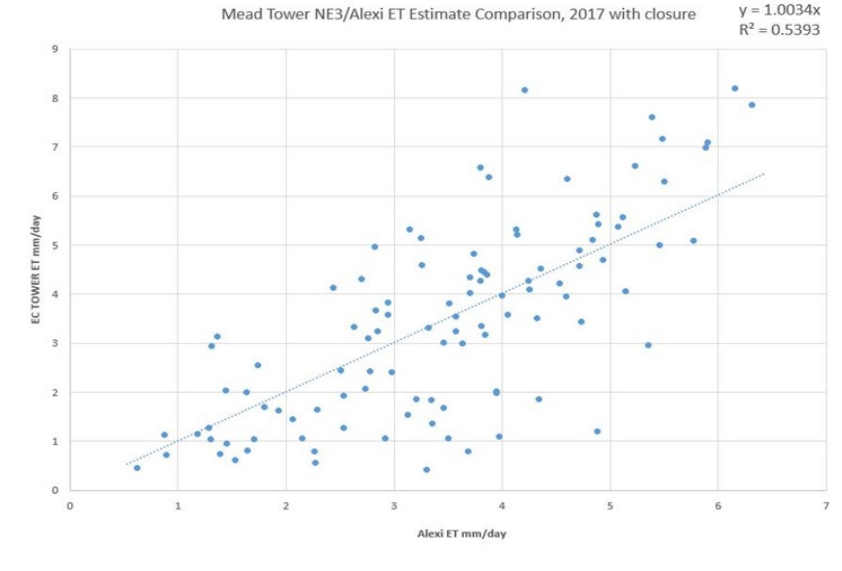


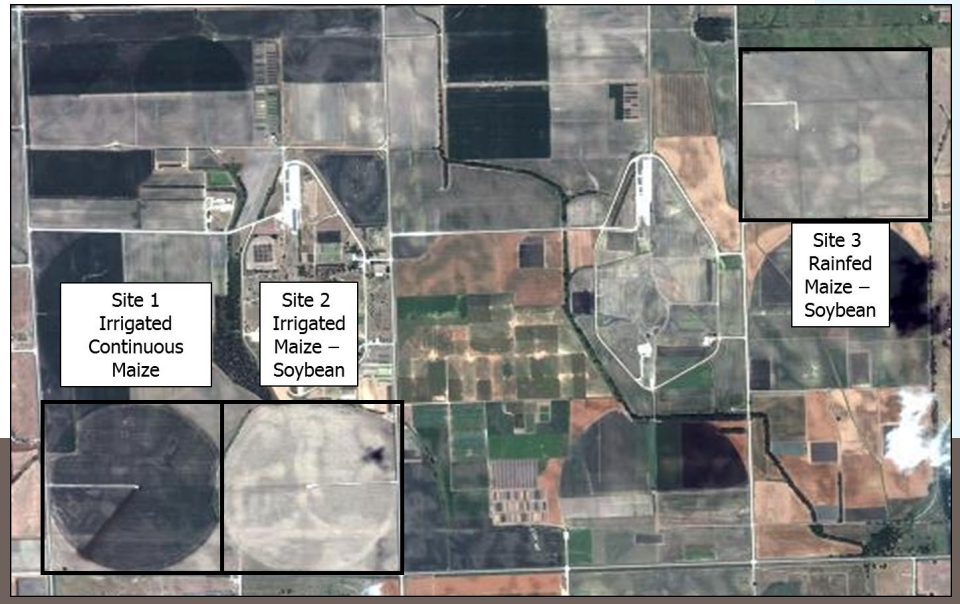
Preliminary Ground Verification of ALEXI VIIRS ET Values @375 m, Tile 54, Carbon Sequestration Ameriflux Site, Mead NE











NE1 Continuous maize crop: RMSE= 1.09, MAE=0.87;
NE2 Soybean/Maize rotation with Maize:
RMSE= 1.0, MAE=0.81
NE3 Rainfed Soybean/Maize rotation with Maize:
RMSE= 1.34, MAE=1.03.

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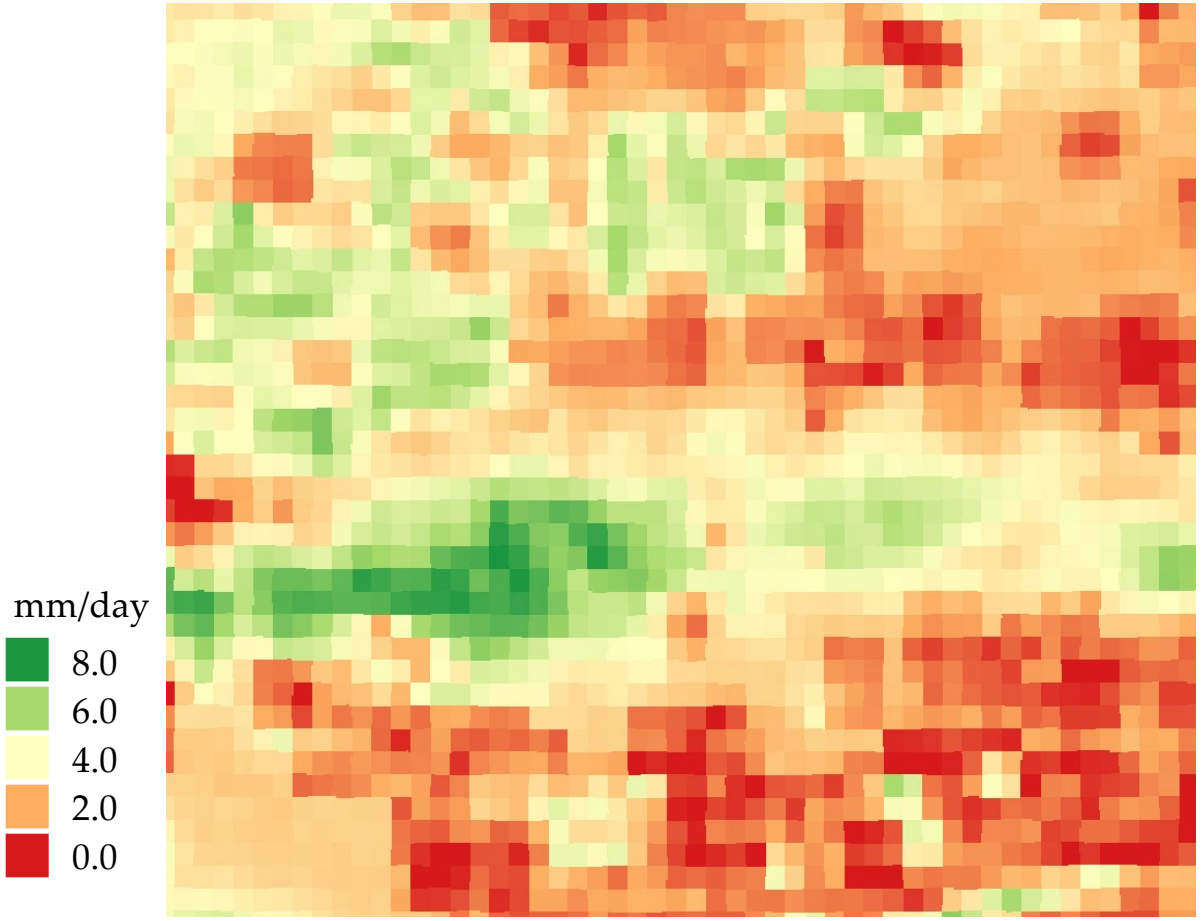
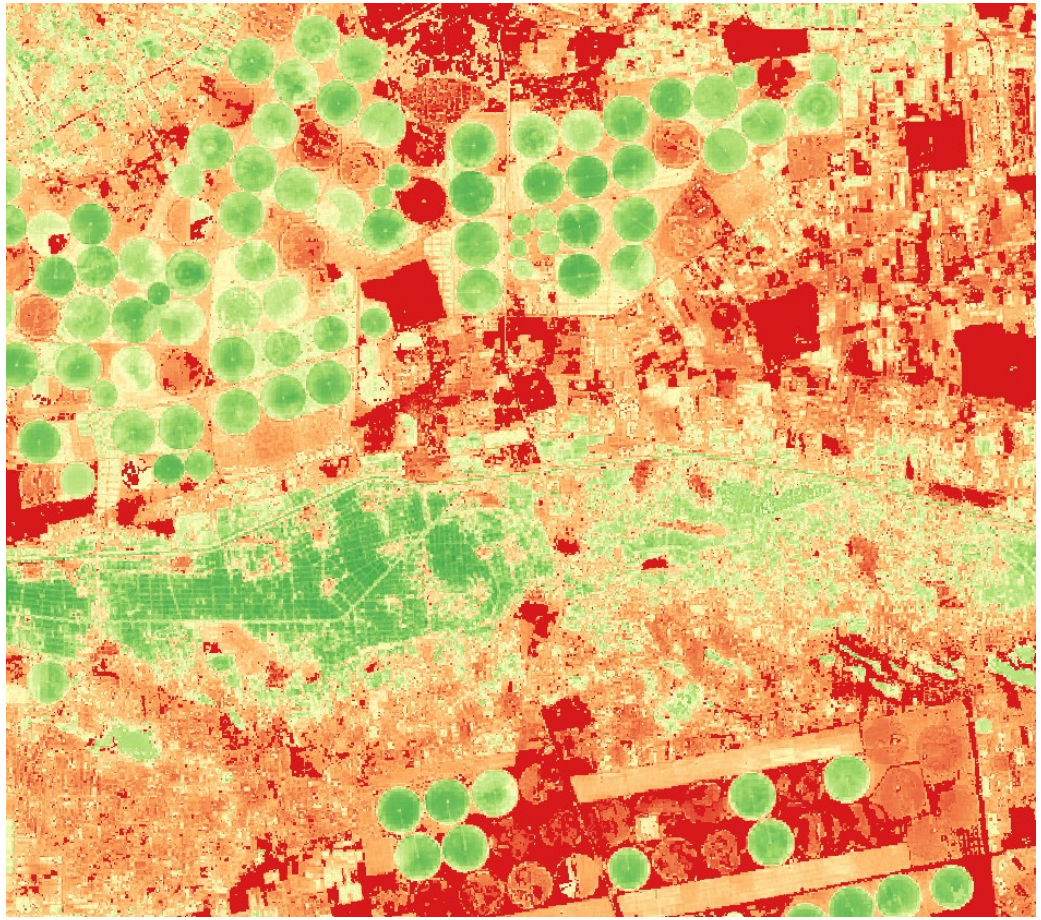
Nile Delta Irrigation

VIIRS daily ET mm/d

Daily ET calculated at VIIRS 375 m using the ALEXI model.

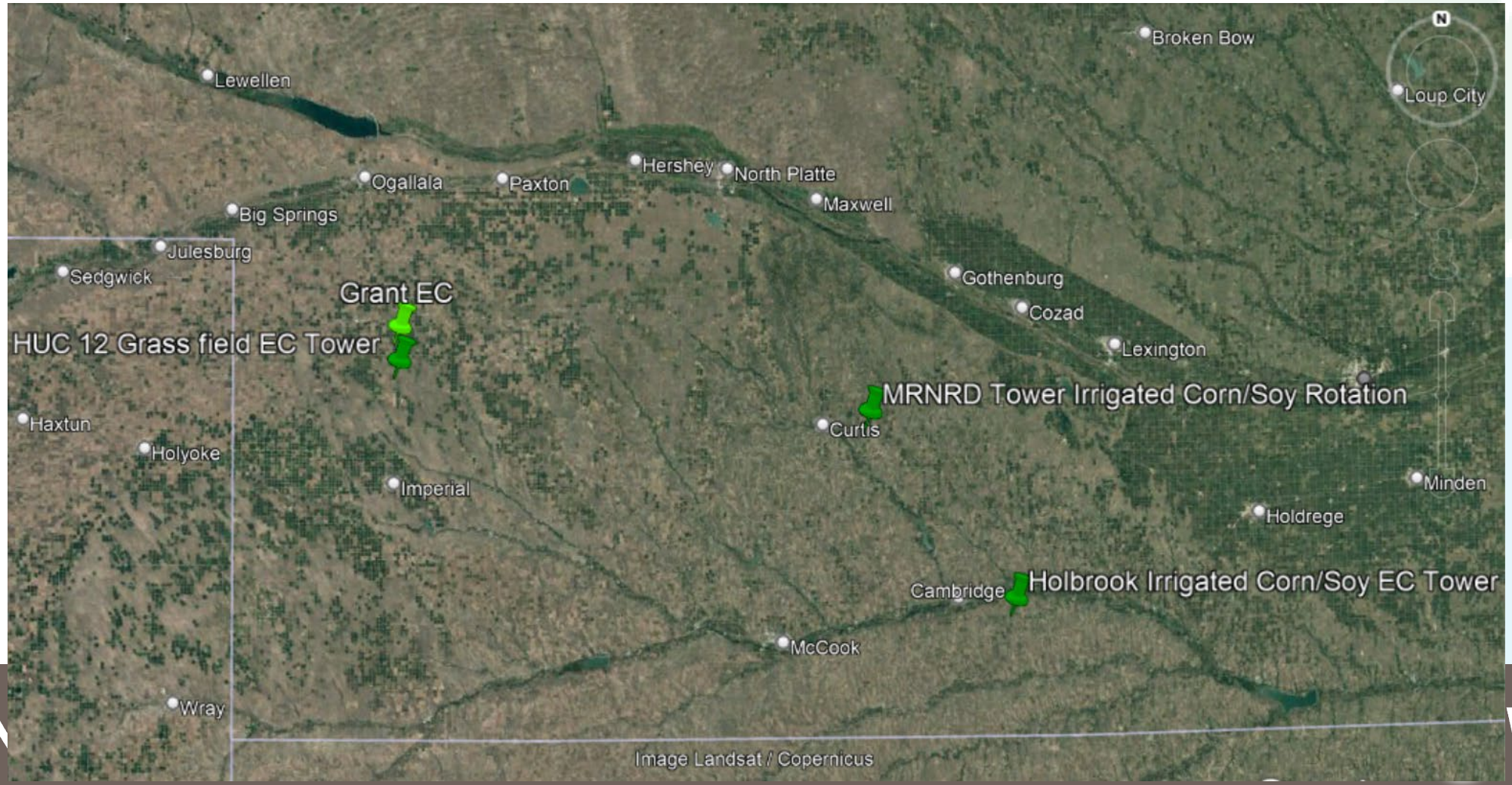


Daily ET downscaled from ALEXI using the PyDisALEXI model and Landsat Imagery.



Parallel 41 Flux Network: Ground Truthing of Spatial ET

- Year 1: 7 Eddy Covariance Flux stations with **SmartFlux** and networked with **FluxSuite**: 5 in NE, 2 in IA
- Year 2: 3 stations: 1 NE, 1 IA, 1 KS, 1 CO
- Year 3 & 4: 3 additional stations from The Climate Corporation, in the Republican River Basin in NE



Final Comments

- 8 towers operational in Parallel 41, three in Republican River Basin
- 1 additional towers to be installed in MRNRD during the 2022 season from TCC contribution
- Add additional towers in KS, CO and IA
- Develop method for anchoring remote sensing estimates and provide spatial ET through online tools and cell phone app

Goal: Install additional flux towers in different locations around the state of NE partnering with Natural Resource Districts

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Thank you

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