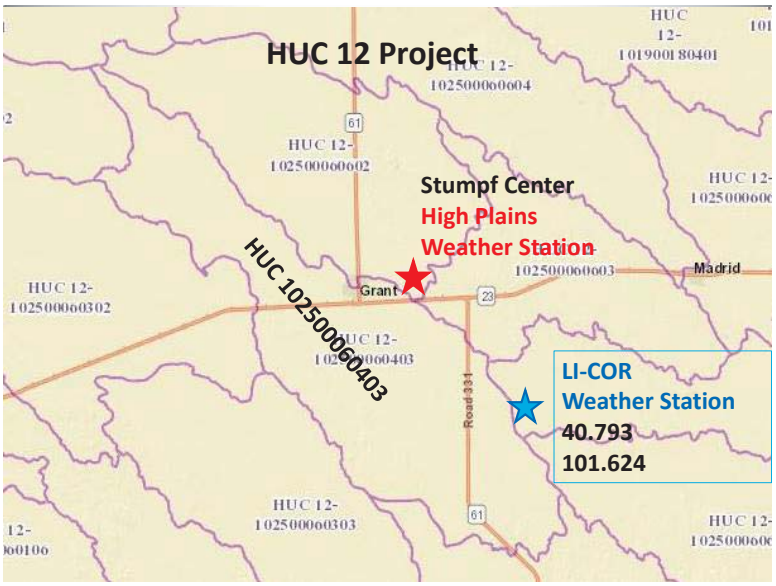
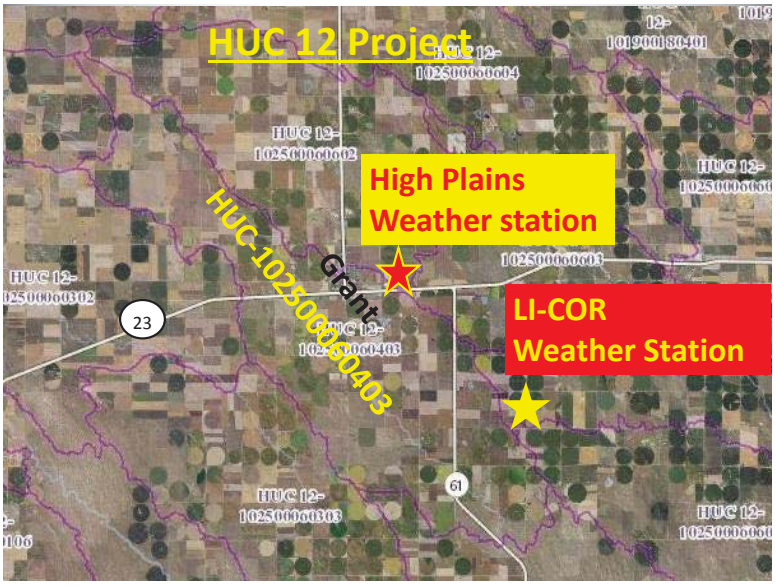
HUC 12 Project Update

FEB 20 2020
CAMBRIDGE , NE





Objectives

1. To accurately measure and quantify daily vegetative consumptive water use in the HUC 12 watershed.
2. Make the data available for satellite Imagery
3. Develop consumptive water use projections by crop for the next 7 days and post on the URNRD website.

The rest of the program will be conducted by Dayle McDermitt and Christopher Neal

Long-Term Vision: What?

- Provide accurate & easy-to-use ET data
  - Year round
  - For agricultural crops and natural ecosystems
  - Dry land and irrigated
  - To support optimal crop and watershed management
  - Based on comprehensive water balances
  - At the field and watershed levels

Long-Term Vision: Who?

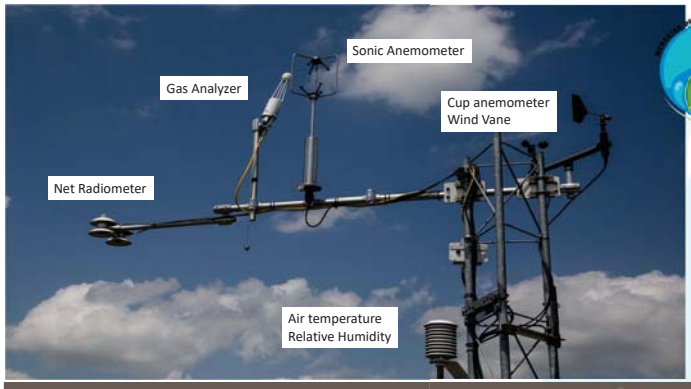
- NEWBA facilitate effective collaboration among
  - Growers and grower organizations
  - UNL Daugherty Water for Food Global Institute
  - UNL Extension
  - State and local agencies: NRDs, NET, DNR, commodity boards, others
  - Federal agencies: NRCS, Bureau of Reclamation, others
  - Industry technology developers: soil moisture, weather, areal remote sensing, information systems, etc.
  - Other stakeholders

Wind blowing across the landscape creates turbulence …

… and turbulence transports matter and energy to the surface and away from the surface

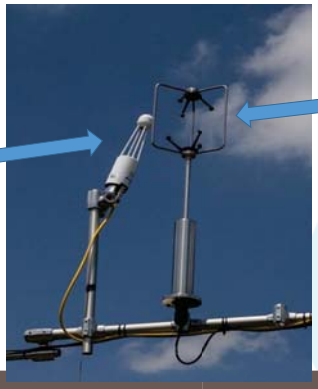
Eddy covariance

Courtesy of LI-COR, Inc. Used with permission.



CO_2 and water vapor analyzer

CO_2 and water vapor concentrations simultaneously 10 times / s



3D Sonic Anemometer

Wind speed in 3 dimensions 10 times / s

Soil temperature
Soil moisture
Tipping bucket rain gauge

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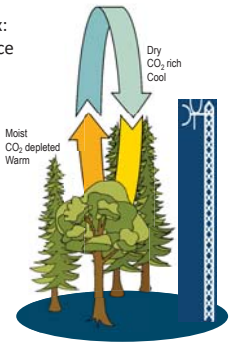
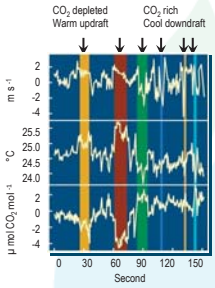
Ecosystem flux:
Eddy covariance



Courtesy of Dr. Hank Margolis
Laval University



$F_{CO_2} = \overline{w'CO_2'}$

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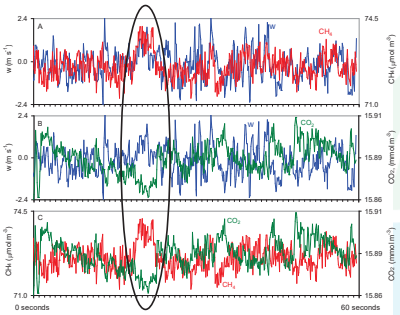
Pacific Mangrove
Baja California



- Source for CH_4
- Sink for CO_2
- CH_4 and CO_2 anti-correlated

Figure 23. Example of raw instantaneous 10 Hz *w* and CH_4 (A), *w* and CO_2 (B) during a transitional time, **1.5 hr after sunrise** when the mangrove ecosystem was taking up CO_2 from the atmosphere while releasing CH_4. For comparison, CH_4 and CO_2 signals were plotted again in panel C to show the anti-correlation. (Courtesy of LI-COR, Inc. Used with permission.)

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How is ET measured by eddy covariance (EC) different from ET reported by weather stations?

- Eddy Covariance
  - Actual ET measured at the site
  - Regardless of crop
  - Regardless of stage
  - Regardless of soil water status
  - Irrigated or unirrigated
  - Agricultural and natural ecosystems
  - All seasons
- Weather station
  - ET of a theoretical well-watered reference crop estimated from weather data. Reference ET (ET_{ref}) – Penman-Monteith Equation
  - Crop ET estimated from ET_{ref} and a crop coefficient (K_c) for a given crop
  - Assumes crop stage is known
  - Assumes soil water is not limiting
  - Assumes theoretical K_c is suitable to local conditions

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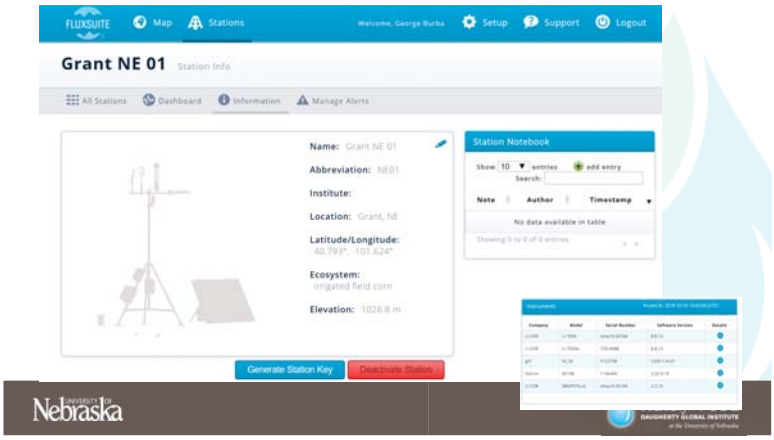
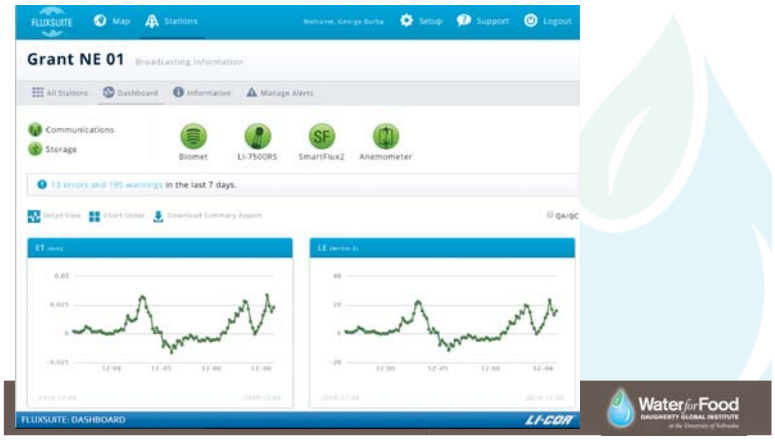
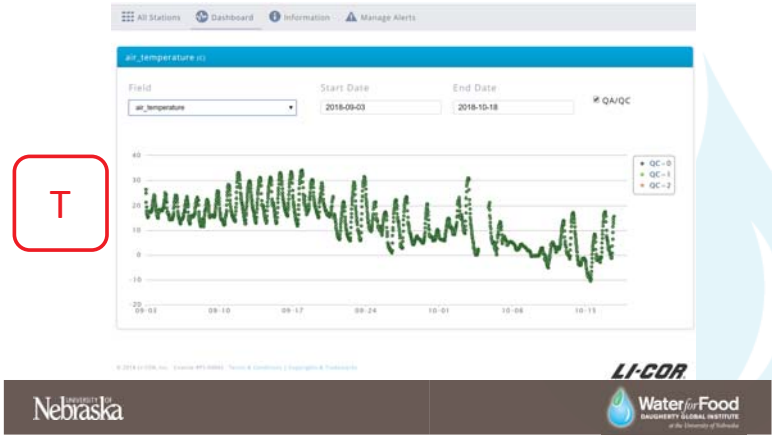
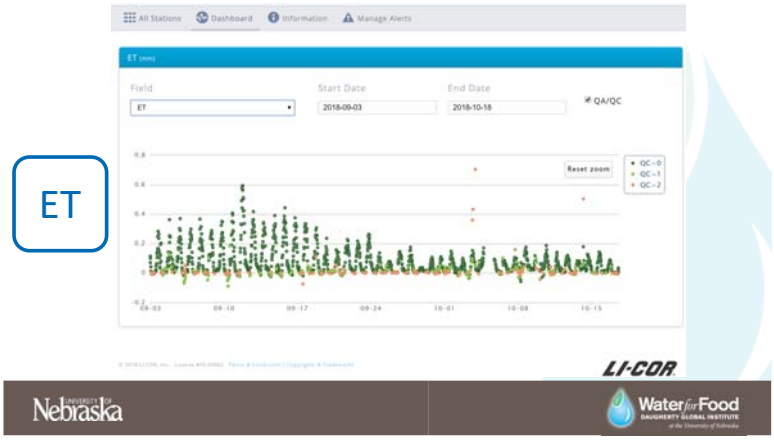
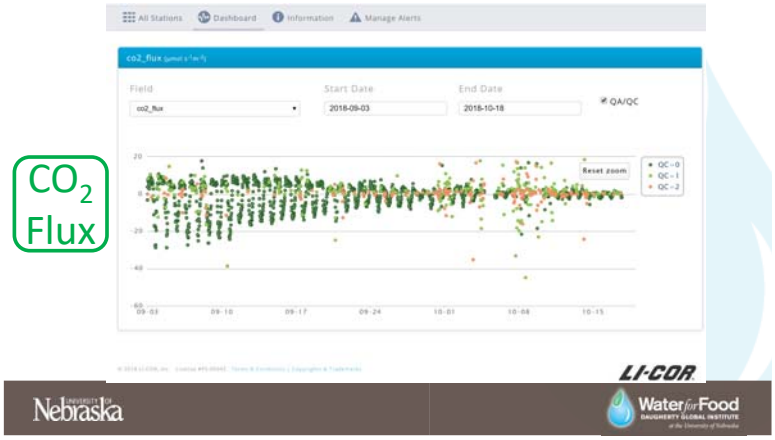

FLUXSUITE
Map
Stations
Setup
Support
Logout
Grant NE 01
Station Info
All Stations
Dashboard
Information
Manage Alerts
Name:
Abbreviation:
Institute:
Location:
Latitude/Longitude:
Ecosystem:
Elevation:
Station Notebook
Generate Station Key
Deactivate Station
Nebraska
Water for Food


FLUXSUITE
Map
Stations
Setup
Support
Logout
Grant NE 01
Broadcasting Information
All Stations
Dashboard
Information
Manage Alerts
Communications
Storage
Biomet
Li-7500RS
SmartFlux2
Anemometer
in the last 7 days.
FLUXSUITE: DASHBOARD
LI-COR
Water for Food

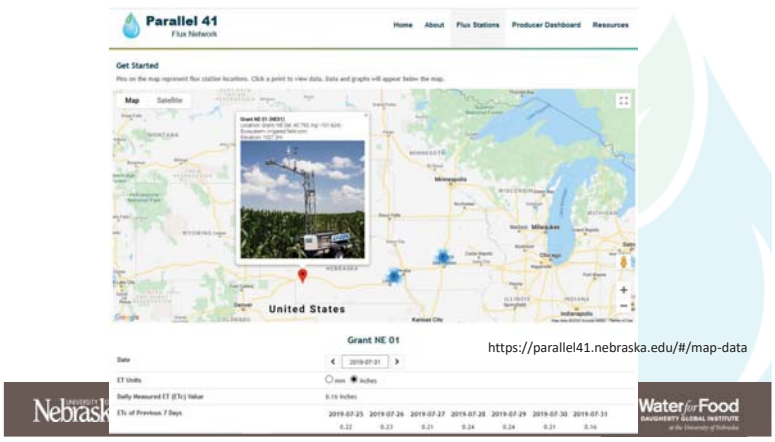
Station snapshot
Flux details
Quality-controlled fluxes
FLUXSUITE EXAMPLES
LI-COR
Water for Food

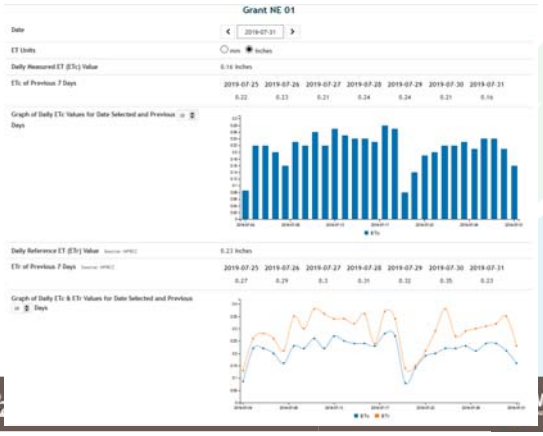

T
All Stations
Dashboard
Information
Manage Alerts
air_temperature
Field
Start Date
End Date
air_temperature
2018-09-03
2018-10-18
QA/QC
LI-COR
Nebraska
Water for Food


ET
All Stations
Dashboard
Information
Manage Alerts
Field
Start Date
End Date
QA/QC
Reset zoom
LI-COR
Nebraska
Water for Food

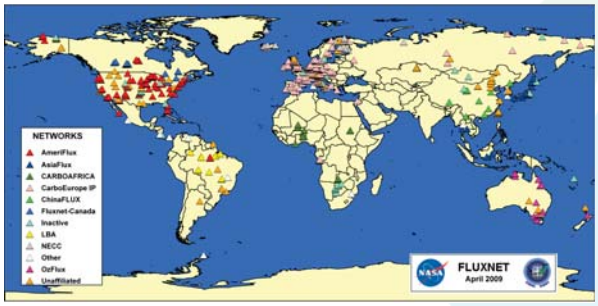

CO_2 Flux
All Stations
Dashboard
Information
Manage Alerts
Field
Start Date
End Date
QA/QC
Reset zoom
LI-COR
Nebraska
Water for Food

Wind Rose (Grant,NE)
Legend
Google Earth
Nebraska
Water for Food


Parallel 41
Flux Network
Home
About
Flux Stations
Producer Dashboard
Resources
Get Started
United States
Grant NE 01
https://parallel41.nebraska.edu/#/map-data
Nebraska
Water for Food



Fluxnet 2009: 576 towers worldwide



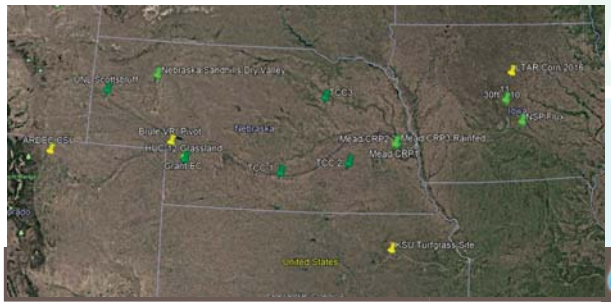
Parallel 41 Flux Network

- DWFI is leveraging funding from FFAR through the Irrigation Innovation Consortium (IIC), in-kind support from LiCOR, and project grant funds 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

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

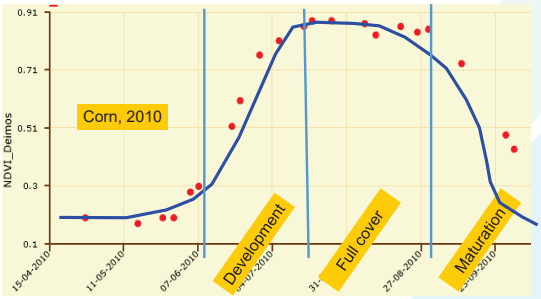
Parallel 41 Flux Network: Ground Truthing of Spatial ET

- Year 1: 7 Eddy Covariance Flux stations with SmartFlux and FluxSuite
- Year 2: 4 stations
- Year 3: 5 additional stations from TCC



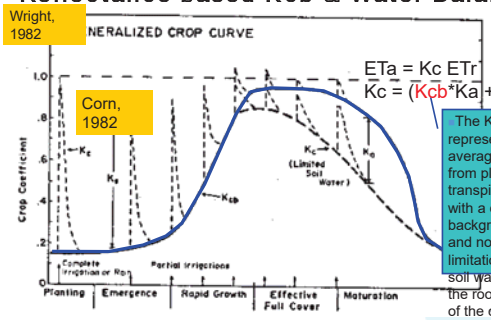
https://parallel41.nebraska.edu/#/

Evolution of Reflectance-based Crop coefficient (Kcbrf)



Reflectance-based Kcb & Water Balance

Wright, 1982



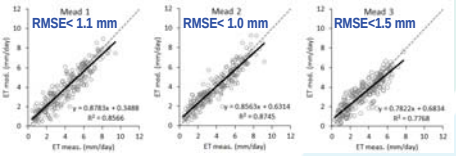
ETa = Kc ETr
Kc = (Kcb*Ka +Ks)

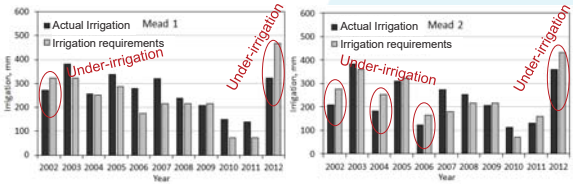
The Kcb represents the average ET from plant transpiration with a dry soil background and no limitation of soil water in the root zone of the crop (From FAO56)

Neale, C. M. U., W.C. Bausch and D.F. Heermann. 1989. Development of reflectance based crop coefficients for corn. Transactions of the ASAE.Vol. 32(6):1891-1899

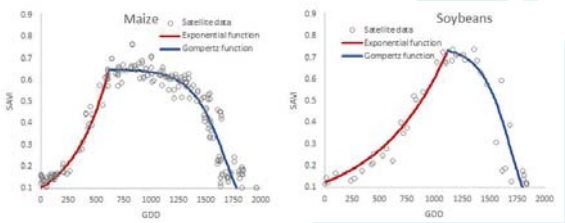
New Reflectance based Kcb for Corn and Soybeans

Application for ET and Irrigation requirements for Corn and Soybeans





New Reflectance based Kcb for Corn and Soybeans

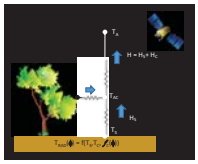


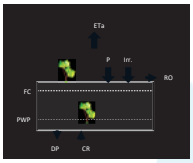
Reflectance-based Crop Coefficients Redux: For Operational Evapotranspiration Estimates In The Age Of High Producing Hybrid Varieties. 2017. Isidro Campos; Christopher M.U. Neale; Andrew E. Suyker; Timothy J. Arkebauer; Ivo Z. Gonçalves. Agricultural Water Management.. Vol. 187, Pages 140-153. http://dx.doi.org/10.1016/j.agwat.2017.03.022

The Hybrid ET model[1]

Diagnostic SVAT Scheme
The Two-Source Energy Balance Model (TSEB)[2,3]

Prognostic Modified FAO-56[4] water balance of the root zone





$ET_a = K_c . ET_0$

$K_c = K_{cbrf} . K_s + K_e$

Series Resistance Formulation
$LE = Rn - G - H$

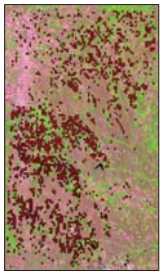
Modified with reflectance - based basal crop coefficient (Kcbrf)[5]

[2] Norman and Kustas (1995), [3]Li , et al.(2005)

[4] Allen et al. (1998), [5]Neale et al. (1989)

[1]Neale et al. (2012), Soil water content estimation using a remote sensing based hybrid evapotranspiration modeling approach. In Advances in Water Resources.

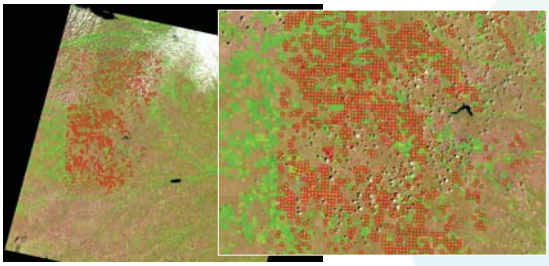
Example of Application in Nebraska



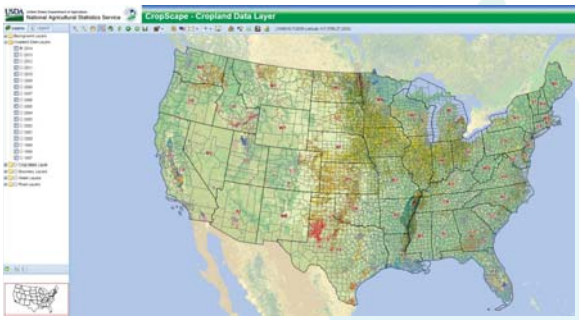
• Center Pivots

Location of the Upper Republican River Basin in southwest Nebraska

UPPER REPUBLICAN RIVER BASIN



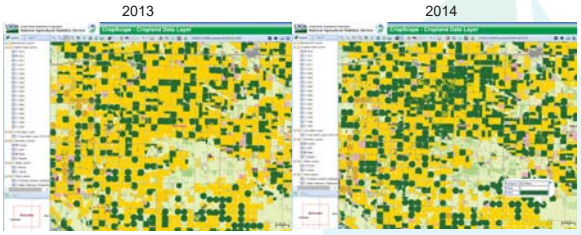
Geo-spatial Data: Crop Classification Layers



Provided by USDA NASS, based on Landsat Thematic mapper and other satellite image data

Northeastern Nebraska Corn/Soybean Rotation

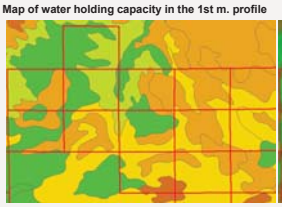
2013 2014



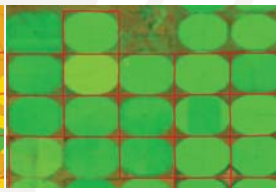
Many satellite-based evapotranspiration models require the knowledge of the crop type at the surface

Digital Soil Survey Information

Map of water holding capacity in the 1st m. profile



RGB color composition, L8 Date 07/19/2913



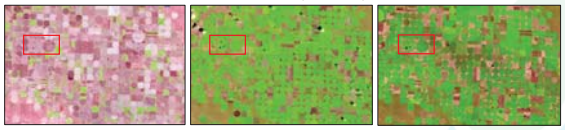
Source: USDA Natural Resource Conservation Service
(http://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx)

Variables include: Soil type, texture, depth, layers, water holding capacity, infiltration rates, organic matter content etc.

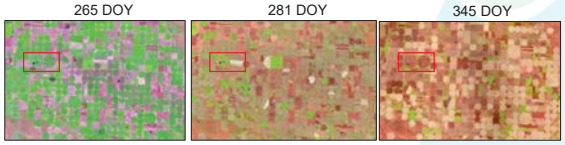
University of Nebraska | waterforfood.nebraska.edu

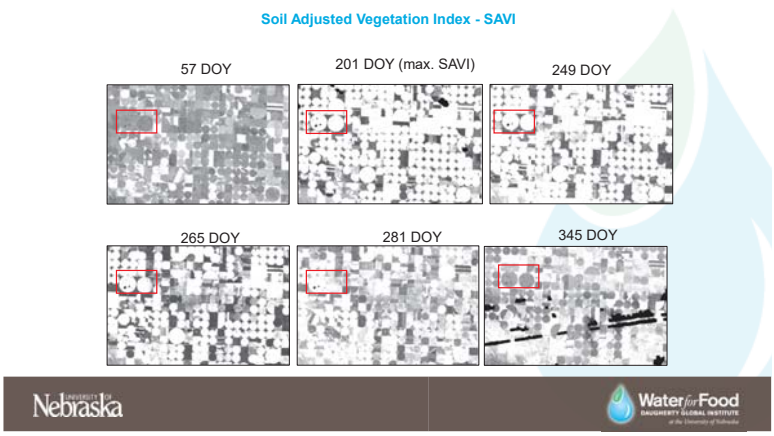
UPPER REPUBLICAN RIVER BASIN

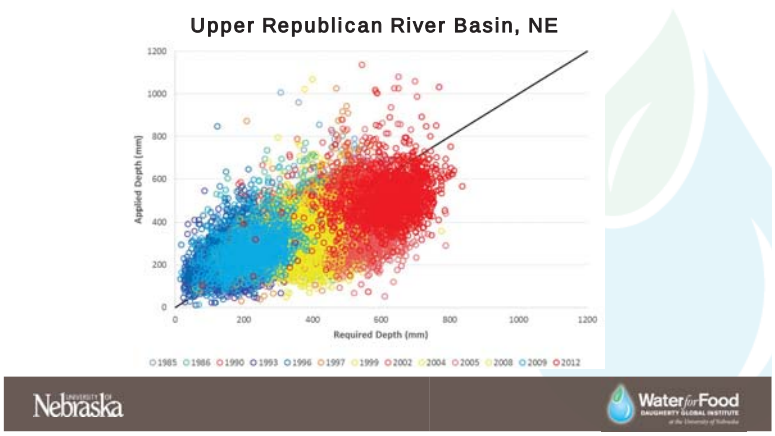
57 DOY 201 DOY (max. IAF) 249 DOY

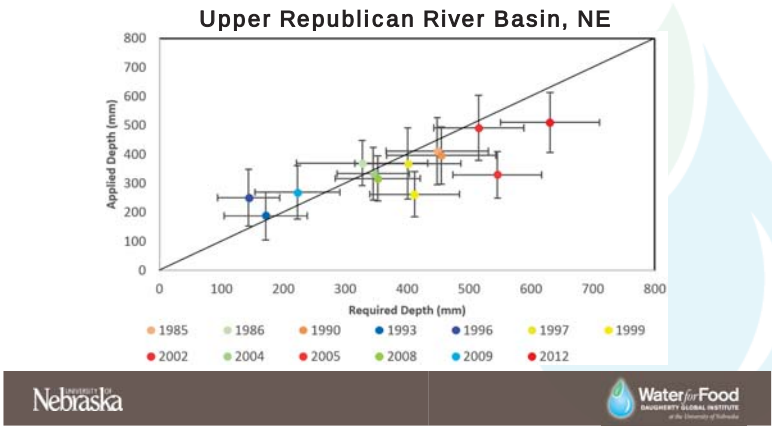


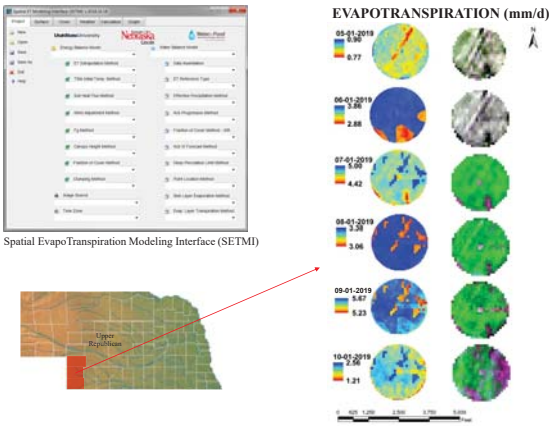
265 DOY 281 DOY 345 DOY

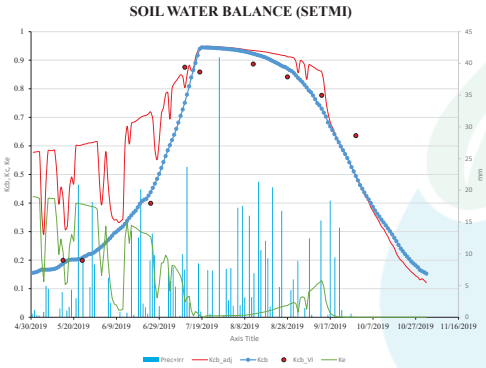


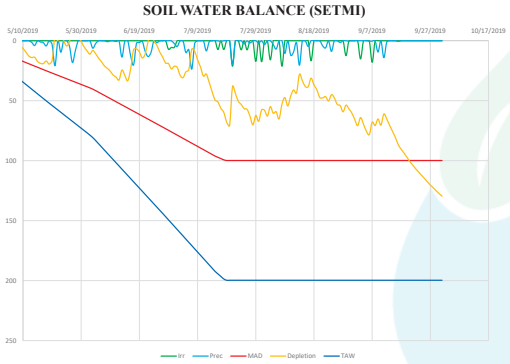

Soil Adjusted Vegetation Index - SAVI
57 DOY
201 DOY (max. SAVI)
249 DOY
265 DOY
281 DOY
345 DOY
Nebraska
Water for Food


Upper Republican River Basin, NE
Applied Depth (mm)
Required Depth (mm)
1985 1986 1990 1993 1996 1997 1999 2002 2004 2005 2008 2009 2012
Nebraska
Water for Food


Upper Republican River Basin, NE
Applied Depth (mm)
Required Depth (mm)
1985 1986 1990 1993 1996 1997 1999
2002 2004 2005 2008 2009 2012
Nebraska
Water for Food


Spatial EvapoTranspiration Modeling Interface (SETMI)
EVAPOTRANSPIRATION (mm/d)
Upper Republican





VIIRS Satellite Global Daily ET Product (GLODET) WEB Interface

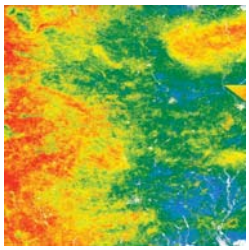
- Users will register to view and download the product https://glodet.nebraska.edu/index.html#/
- Updates, track the applications and research using the product

GloDET Dataset

DWFI is partnering with USDA, NASA, University of Maryland, and the National Drought Mitigation Center (with funding from USAID), to produce satellite-based spatial ET datasets at ~100ft resolution.

Map of "Tile 54" over U.S.

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

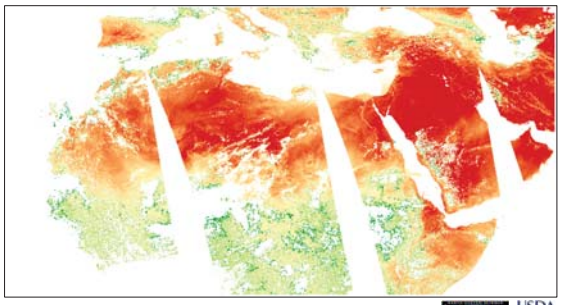


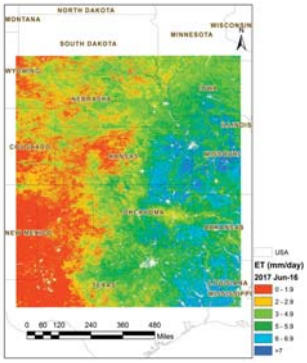
ET results from Tile 54 on Day 212 in 2016

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

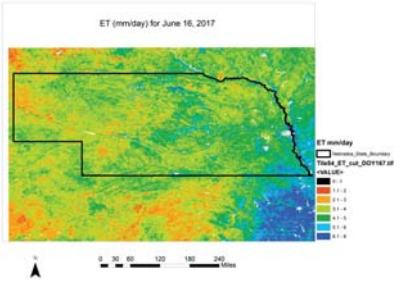
Clear Sky Land Surface Temperature from VIIRS

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.





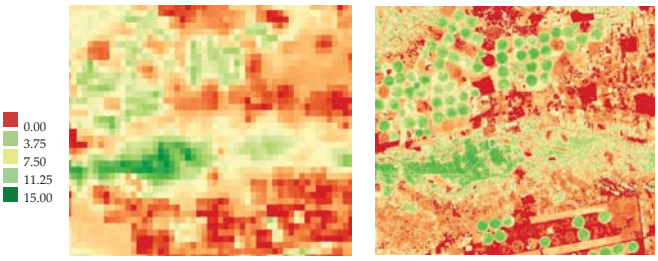
VIIRS ALEXI Daily ET for Tile 54 at 400 m pixel resolution



Nile Delta Irrigation
VIIRS daily ET mm/d

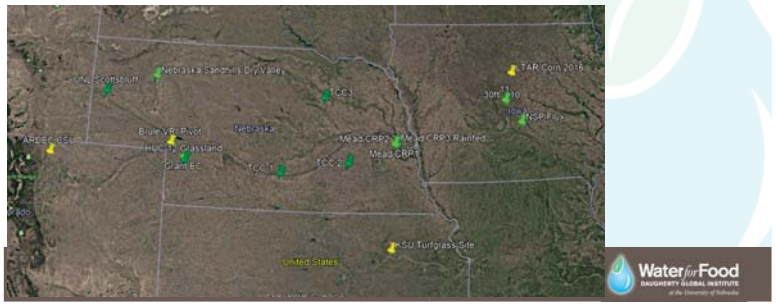
Daily ET calculated at VIIRS 375 m using the ALEXI model.

Daily ET downscaled 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 FluxSuite
- Year 2: 4 stations
- Year 2: 5 additional stations?



Status of the Parallel 41 Flux Network

- 6 towers operational
- 5 additional towers to be installed during the 2020-2021 seasons
- Additional activity for 2020: improve web interface to provide real-time information for water managers and farmers.
- Install additional towers in KS, CO and IA
- Develop method for anchoring remote sensing estimates and provide spatial ET through online and cell phone app

Goal: Install additional flux towers in different locations around the state partnering with NRD's