

ECOSTRESS METRIC EVAPOTRANSPIRATION ALGORITHM

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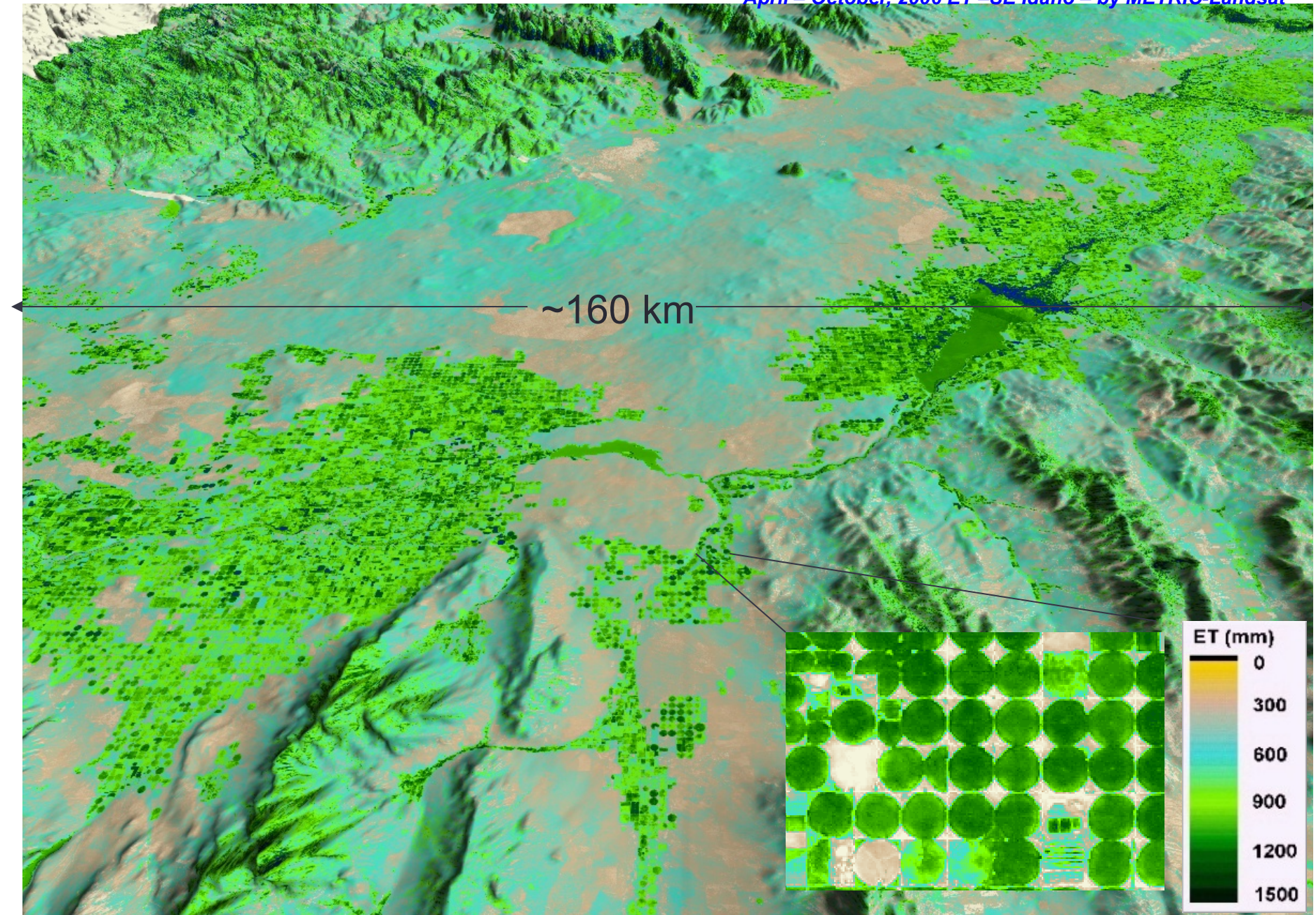
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Samuel Ortega, Univ. Nebraska-Lincoln

2017 EcoSTRESS Workshop, Davis, CA

ET is needed at the field scale and for historical and present

April – October, 2006 ET –SE Idaho – by METRIC-Landsat



Close up Orbit -- 420 km

International Space Station



METRIC/EEFLUX-ECOSTRESS

Porting Algorithms

EEFlux – Landsat-based (30 m) ET mapping on Google Earth Engine

Secure | <https://eeflux-level1.appspot.com>

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EEFLUX

This is beta version 1.0.0 of EEFlux level 2, where automated calibration of ETrF is still evolving. The last calibration update was Jan. 15, 2017. See FAQ's.

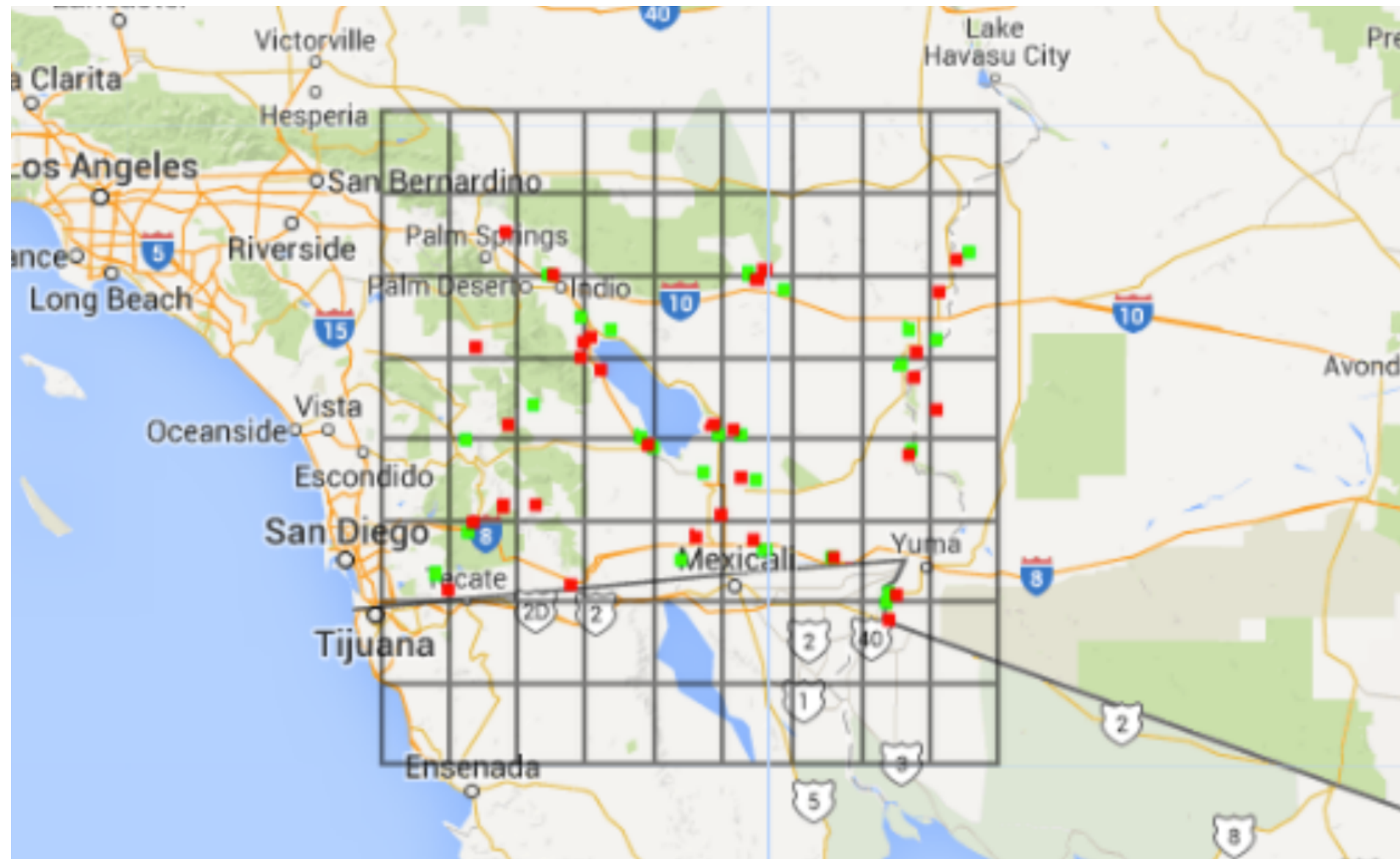
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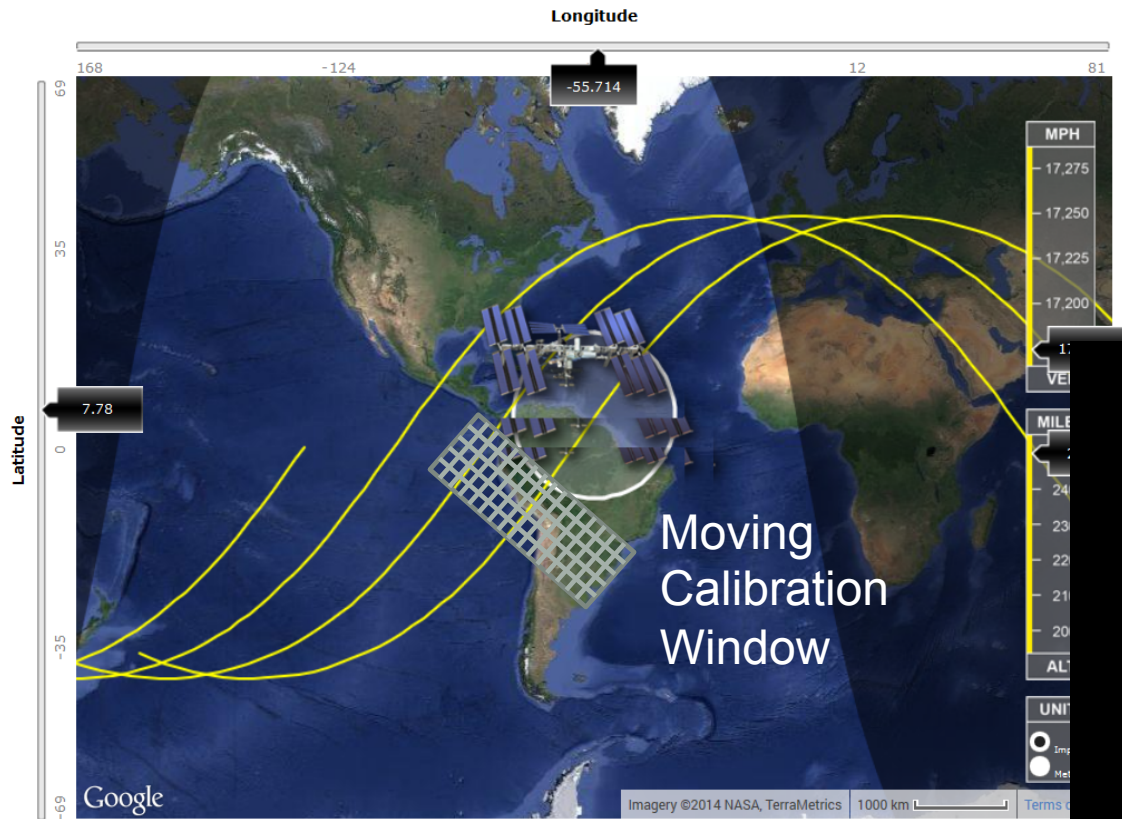
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ET _r F (default)	Download
ACTUAL ET (default)	Download

Gridded Calibration of Energy Balance in EEFlux – Using Near-Endpoints in Thermal



I.S.S. TRACKER



Orbital speed
17000 mph
7660 meters/second

Altitude: 420 km



Sun angle continually changing
Land / precipitation conditions continually changing

CALIBRATION OF METRIC/EEFLUX:

$$\text{bias}_{R_n-G} \rightarrow \text{bias}_{H-\text{cal}} \rightarrow \text{bias}_{dT} \rightarrow \text{bias}_{H-\text{pixel}} \rightarrow \text{LE}$$

unbiased

The Sensible Heat (H)
Function with end-member LST
calibration calibrates around
Biases in many of the
Energy balance components:

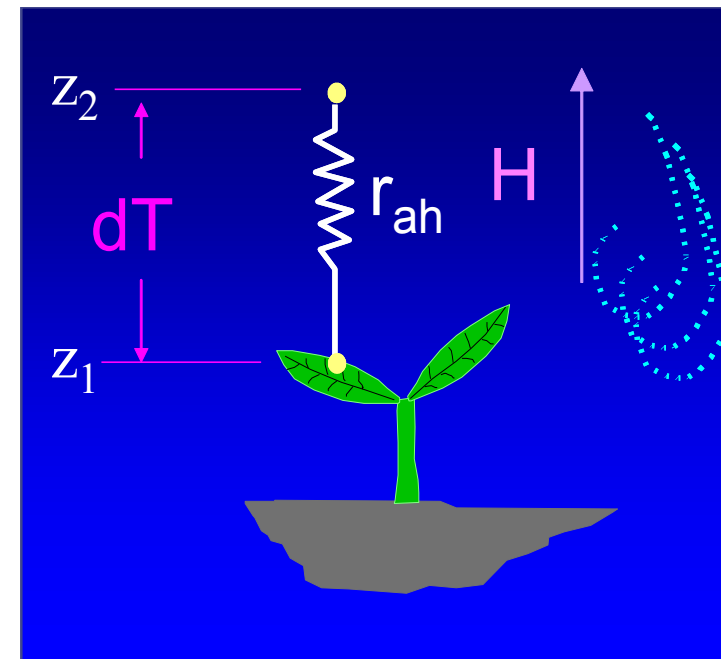
(Biases exist in: net radiation, soil heat flux, aerodynamic stability, aerodynamic roughness, absolute surface temperature, atmospheric correction)

$$H = R_n - G - LE \quad (\text{for calibration})$$

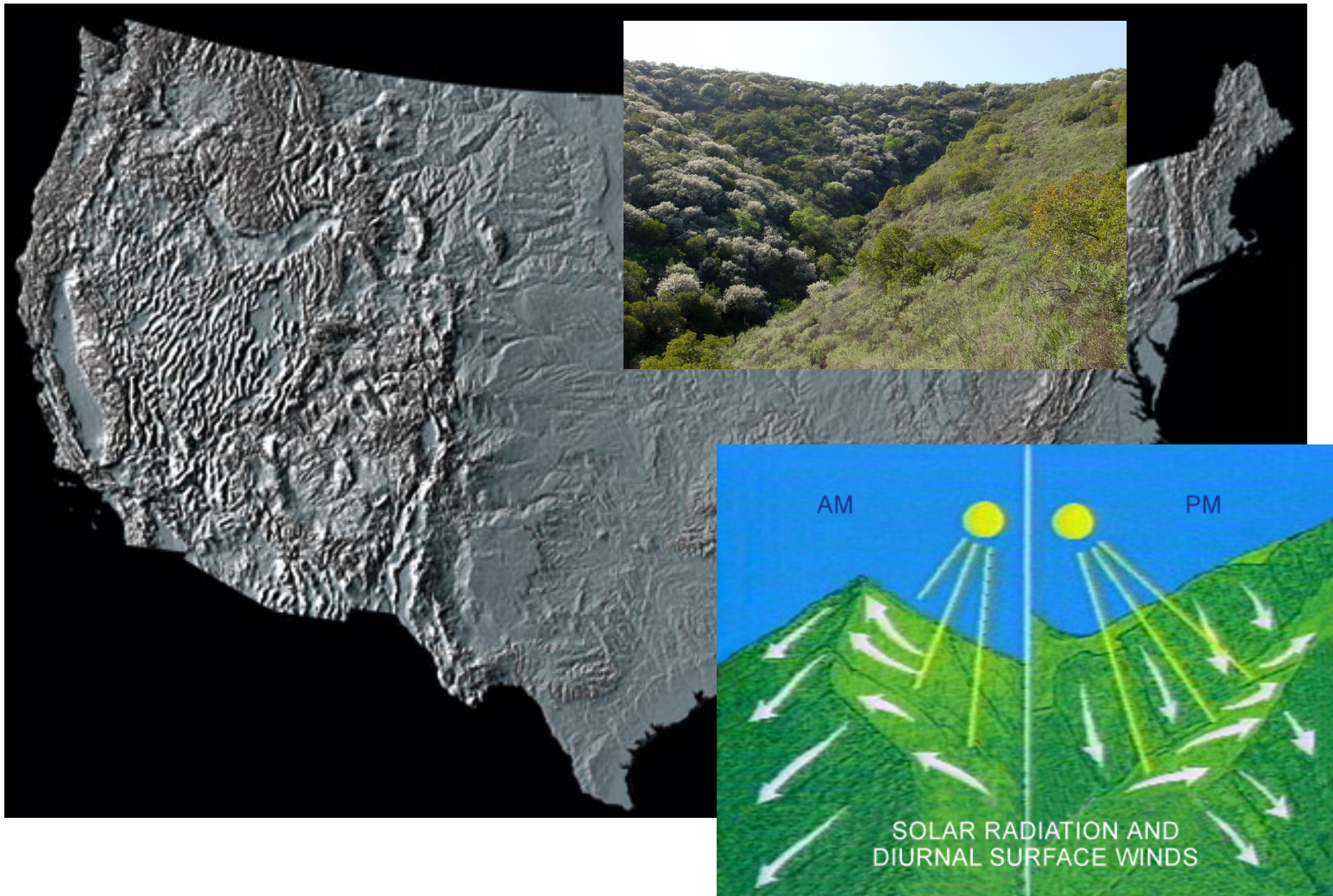
any biases

$$LE = R_n - G - H \quad (\text{during application})$$

Biases cancel out



Topography of the United States and World is Complex – impacting solar radiation balance



METRIC includes radiation algorithms for slopes and terrain roughness algorithms

Data Sources

Albedo and Vegetation Indices

- From Landsat, Sentinel II Images Closest/Bracketed in time

Wind Speed, Humidity, Reference ET

- From CFSV2 or GLDAS2 Gridded Weather Data

Science Questions

- How does the ET_rF (ET as a fraction of Reference ET) vary during the day for:
 - Irrigated Crops
 - Rainfed Crops
 - Riparian Systems
 - Rangeland
 - Forest
- How does variation in ET_rF impact time-integrated ET estimation (which often assumes constant ET_rF)?

METRIC-ECOSTRESS

Student Collaboration

Student Collaboration

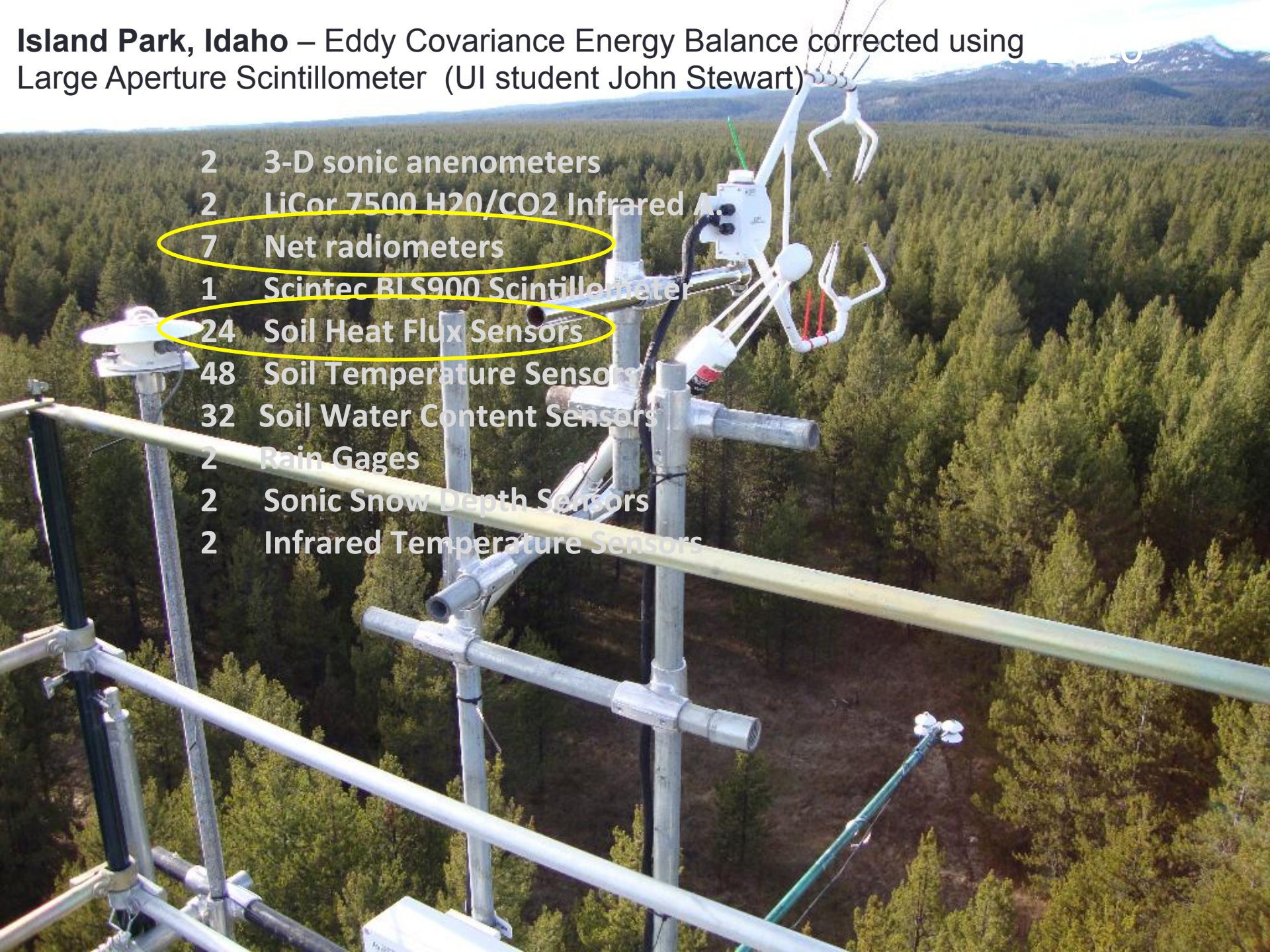
- Participation in development of strategies and coding and testing of algorithms for applying a moving window-based calibration scheme to develop endmember based calibration points for the surface energy balance employed in the METRIC ET process.
- Students will conduct **algorithm development** and testing pre-launch using an extensive archive of METRIC-based ET imagery retrieved from Landsat-based processing since 2000.
- Two NSF-supported energy and CO₂ **flux systems in Idaho** will provide ground data to students for testing the moving window-based calibration against challenging targets of energy balance and ET retrieval from sagebrush and lodgepole pine.
- Post launch testing of algorithms and calibration strategies will be shared with students, as will extension of early ET results with real-time water resources processes in Idaho, California and Nevada, where state Departments of Water Resources will be invited to explore ingestion of ET data into their water operations.

Available Ground Data - Island Park, Idaho Lodgepole Pine

- Installed 2010 – Univ. Idaho



Island Park, Idaho – Eddy Covariance Energy Balance corrected using Large Aperture Scintillometer (UI student John Stewart)

- 
- 2 3-D sonic anemometers
2 LiCor 7500 H2O/CO2 Infrared Analyzers
7 Net radiometers
1 Scintec BLS900 Scintillometer
24 Soil Heat Flux Sensors
48 Soil Temperature Sensors
32 Soil Water Content Sensors
2 Rain Gages
2 Sonic Snow Depth Sensors
2 Infrared Temperature Sensors

Hollister Sage Brush site

– Installed Feb. 2010

Best combination of 16 Soil Heat Flux sites optimized by UI student Jeremy Greth

- 3 3-D sonic anemometers
- 1 LiCor 7500 H₂O/CO₂ Infrared A.
- 3 Net radiometers
- 1 Scintec BLS900 Scintillometer
- 16 Soil Heat Flux Sensors
- 32 Soil Temperature Sensors
- 20 Soil Water Content Sensors
- 7 Soil Water Potential Sensors
- 2 Rain Gages
- 2 Infrared Temperature Sensors

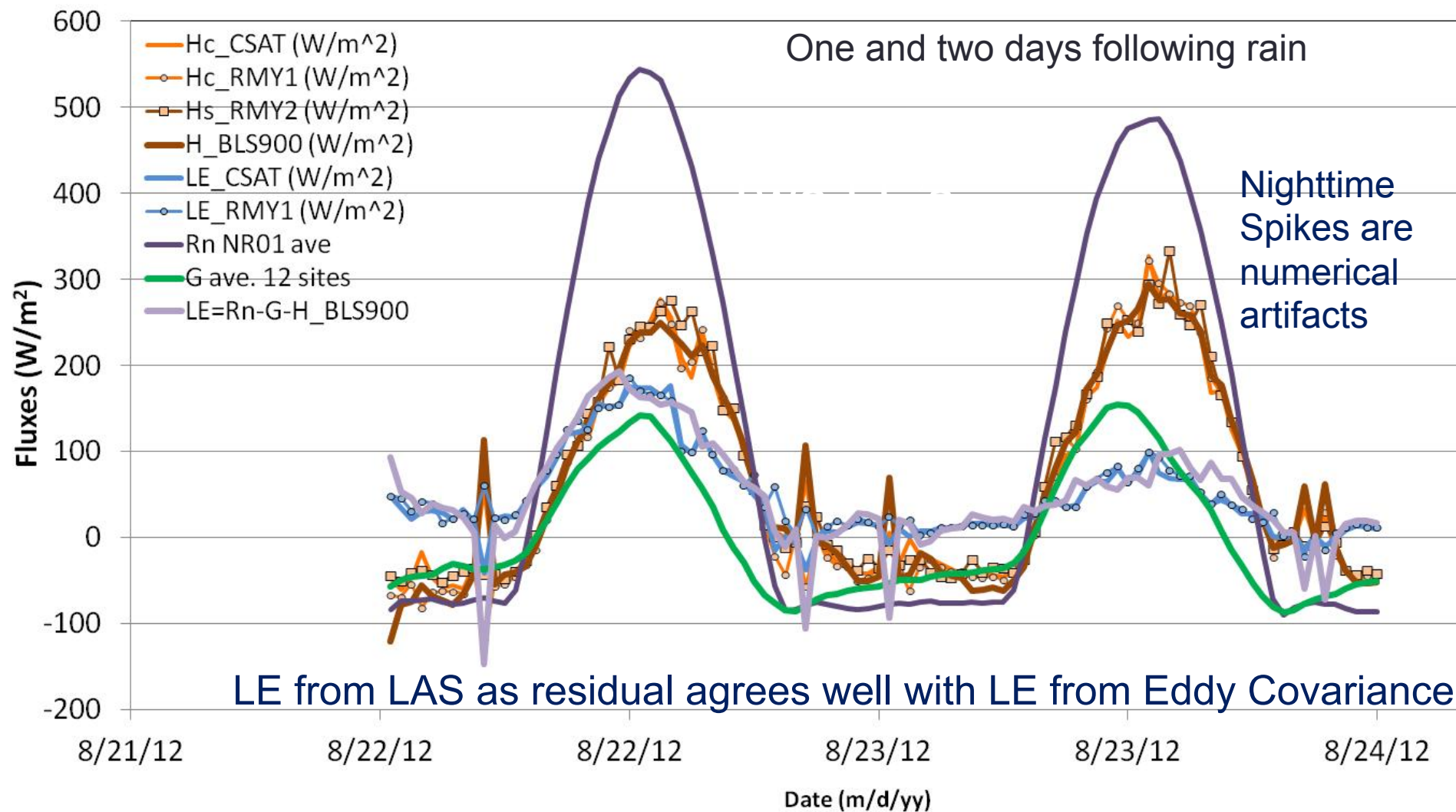
“Sensor Redundancy”



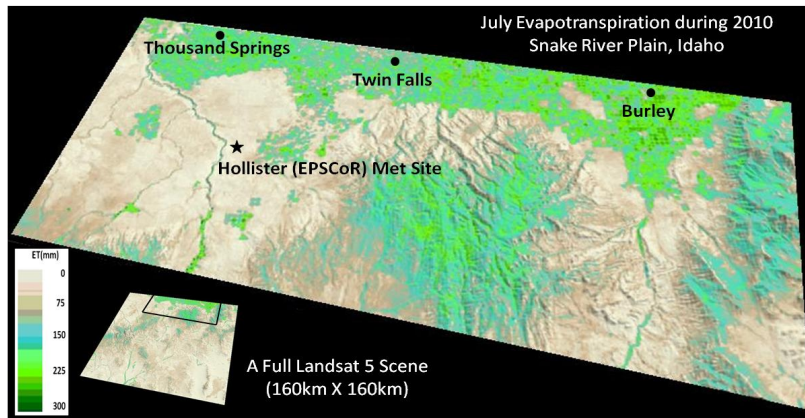
Scintec LAS
transmitter



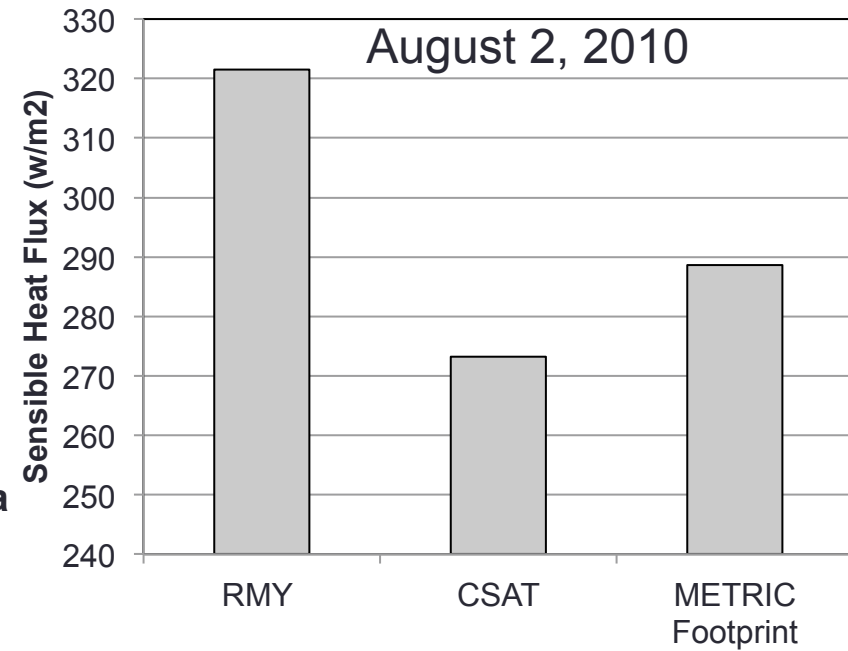
EB Components - Hollister Sage Brush Flux Site



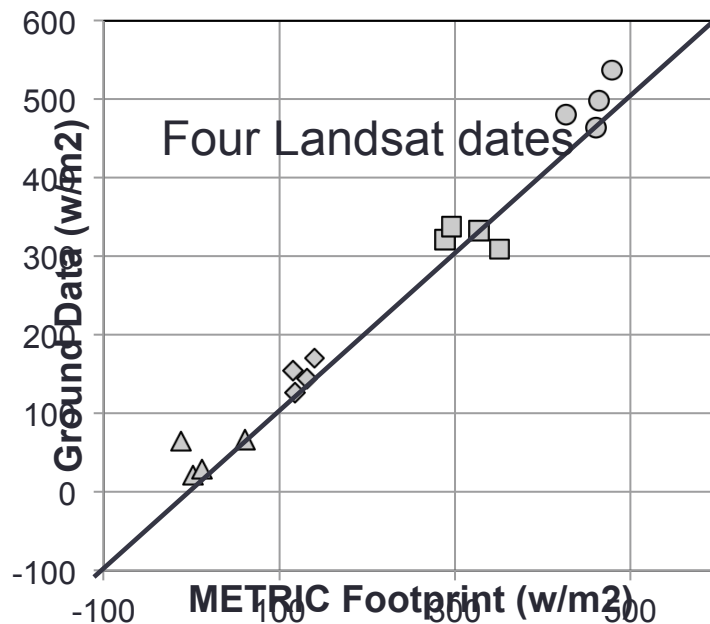
Student-based accuracy assessments



Sensible Heat Flux (H)



Integrated METRIC Estimations VS. Ground RMY Data




- ◇ Soil Heat Flux (G)
- Sensible Heat Flux (H)
- △ Latent Evaporation (LE)
- Net Radiation (Rn)

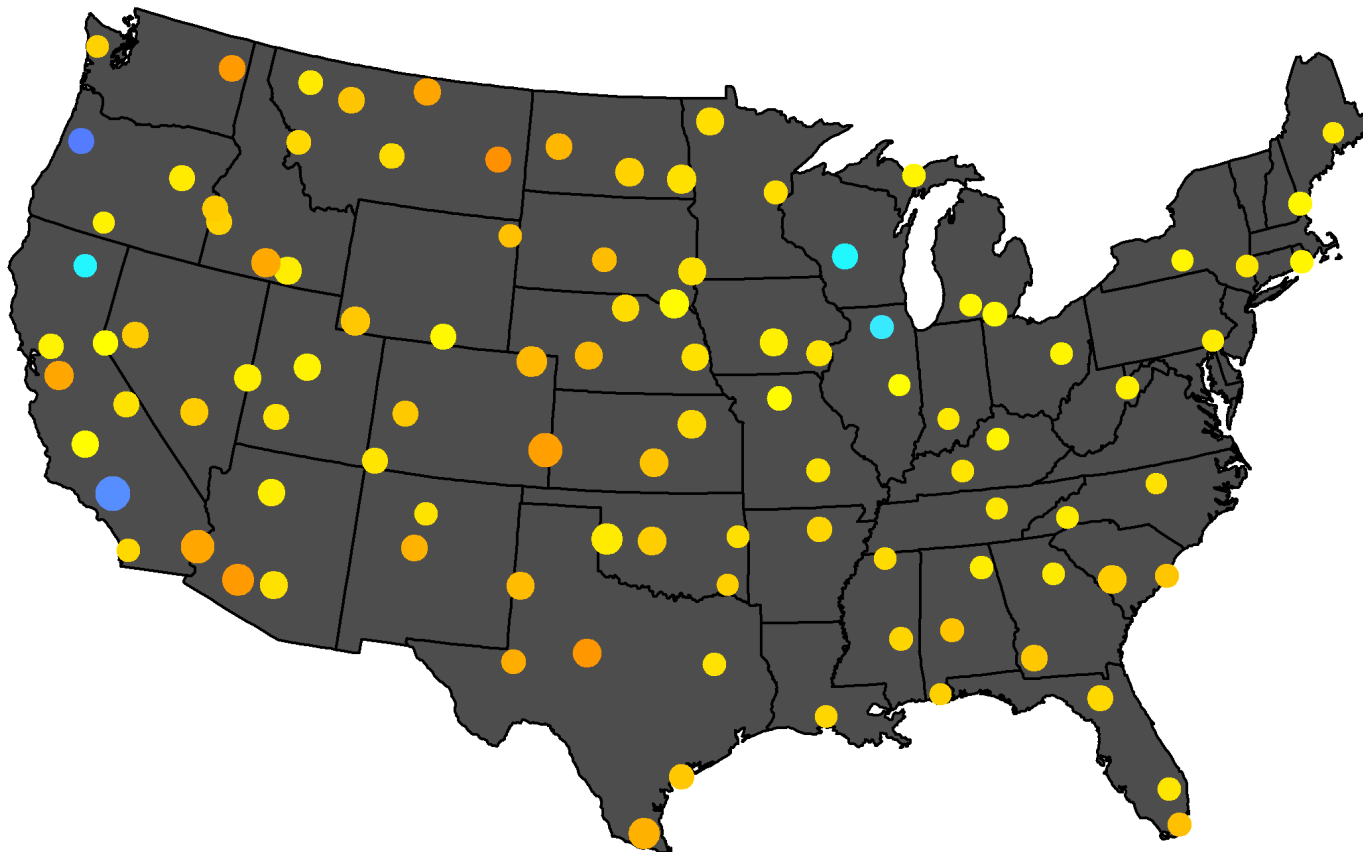
Hollister Sagebrush site, 2010

Gridded Comparisons with Agricultural Measurements: Alfalfa Reference ET (ET_r)

Station Data Used to Create Gridded Data • FALSE

Standard Deviation of Error mmday^{-1} • 0.0 ● 0.5 ● 1.0 ● 1.5

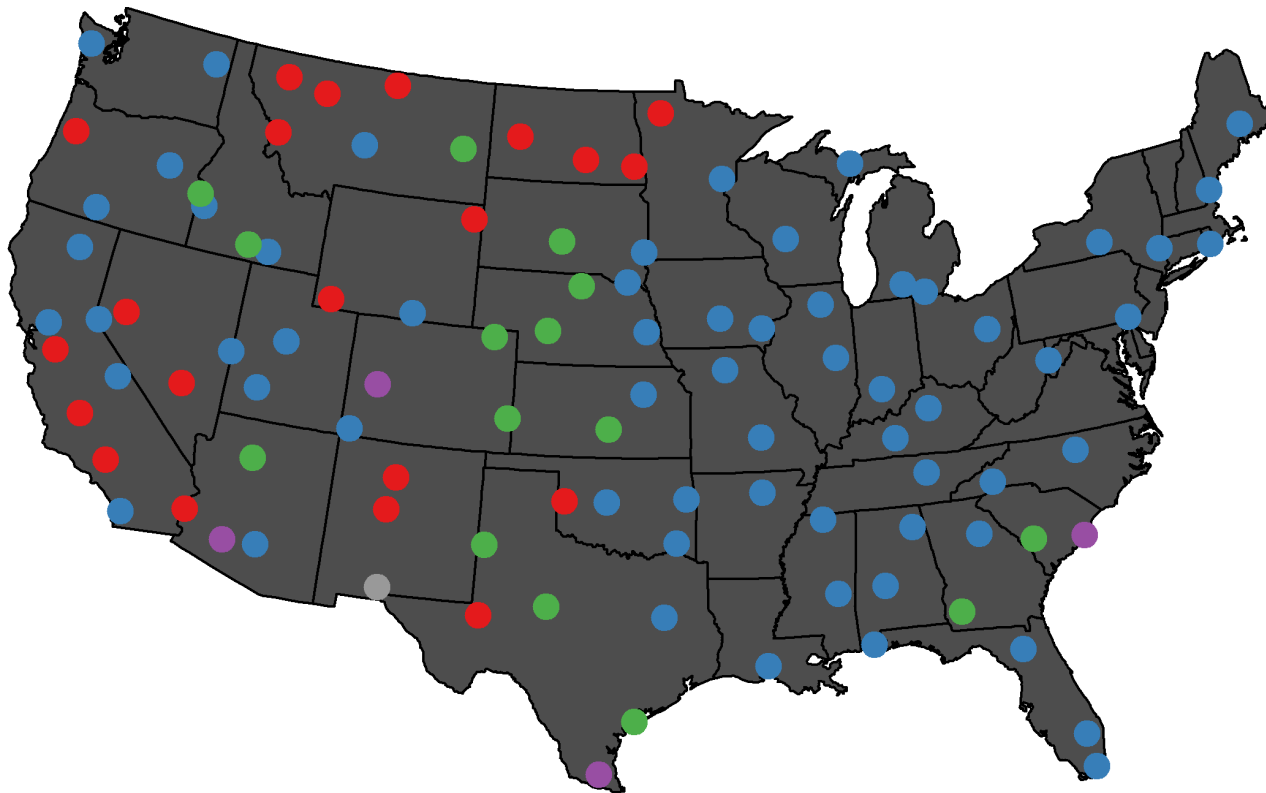
GLDAS ET_r July Mean Bias mmday^{-1}  0 2 4 6



Philip Blankenau, MS Student, UNL – Dr. Ayse Kilic, Advisor

Best Gridded Data sets for Least Bias in Reference ET (ET_r)

Best Analysis Data Set for ET_r in Summer by KGE ● CFSv2 ● GLDAS ● GRIDMET ● NLDAS ● No Data

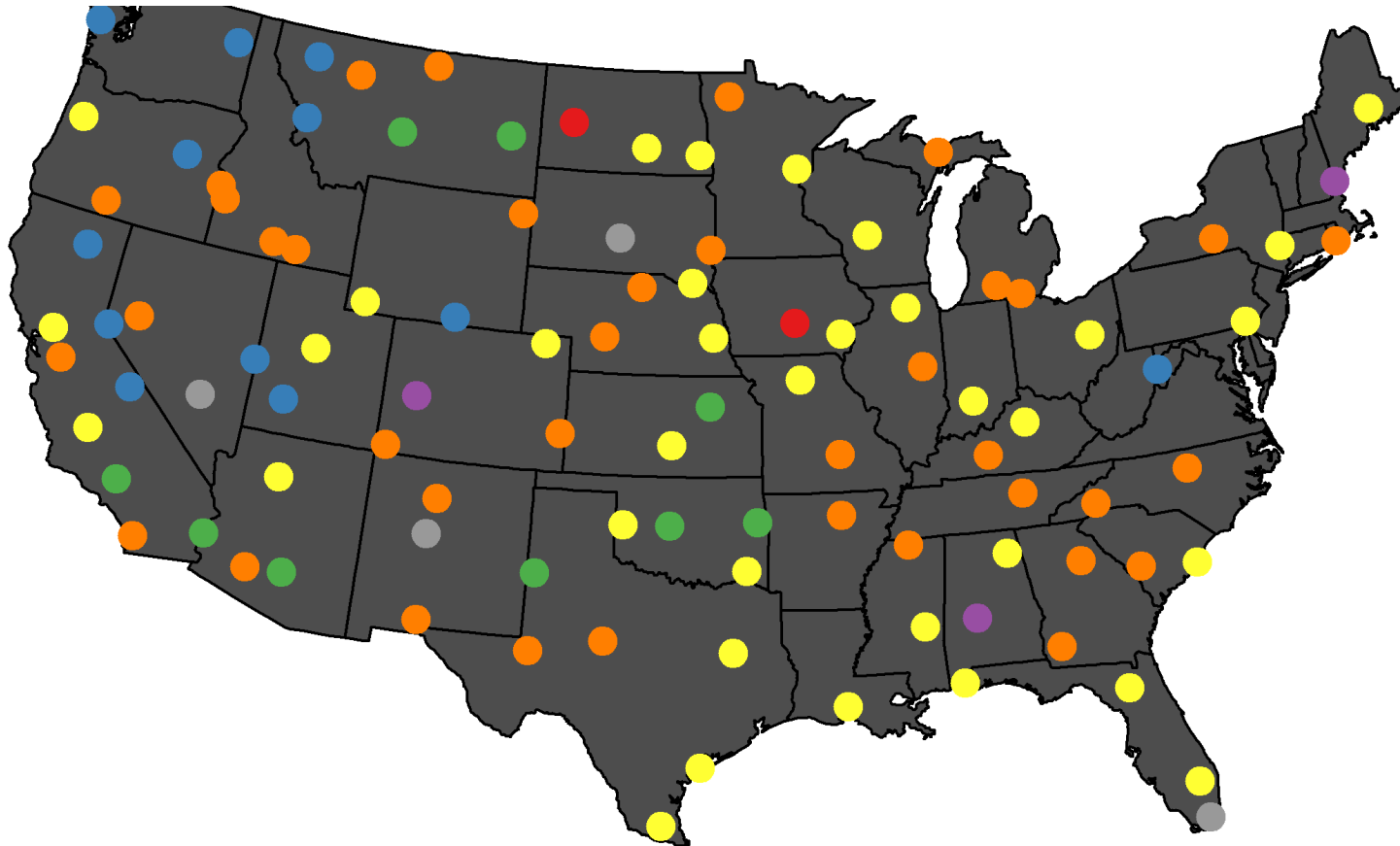


Philip Blankenau, MS Student, UNL – Dr. Ayse Kilic, Advisor

Best Gridded Data sets for Least Bias in Reference ET (ET_r)

Best Analysis Data Set for ET_r in Summer 2015 by KGE

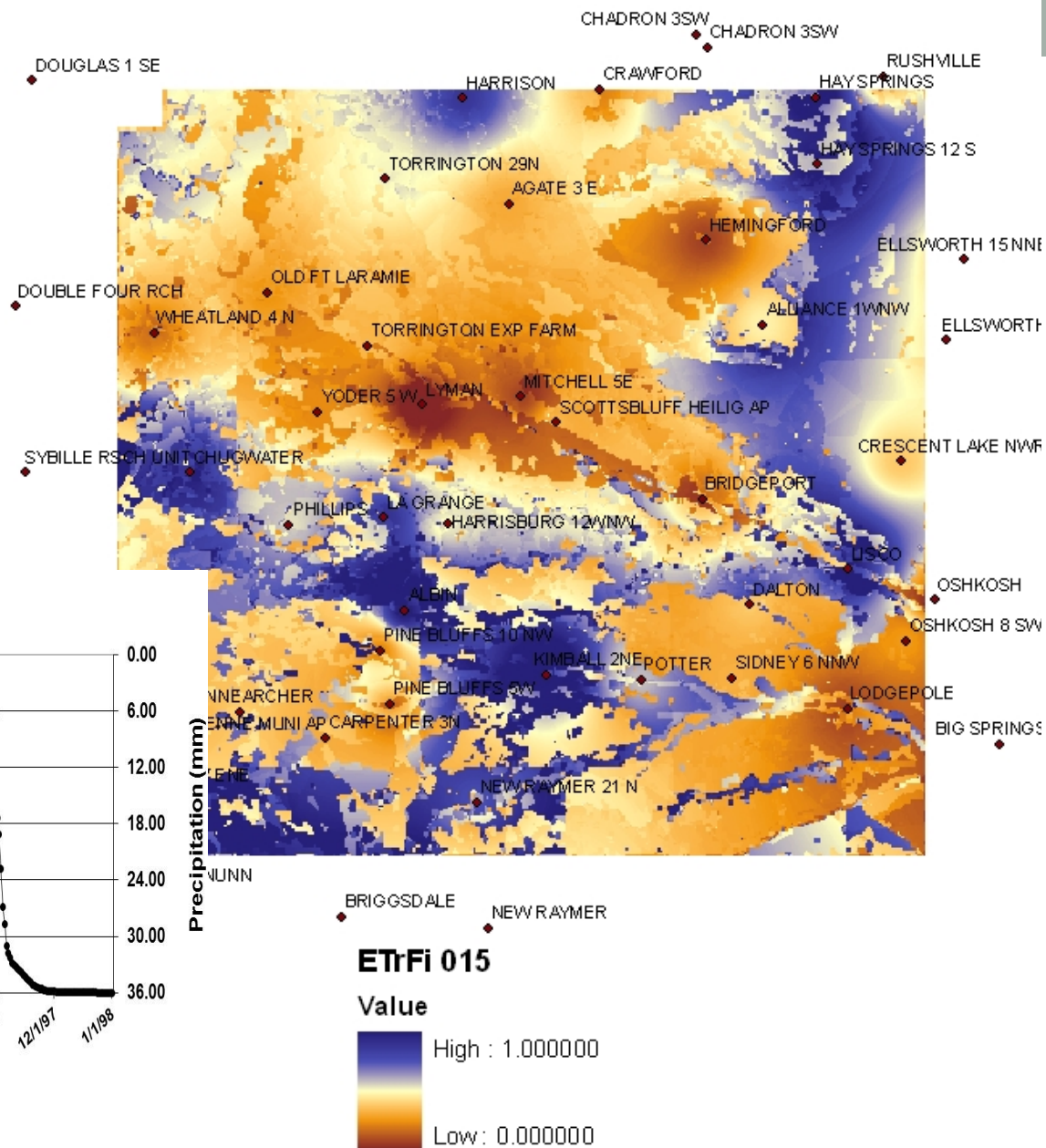
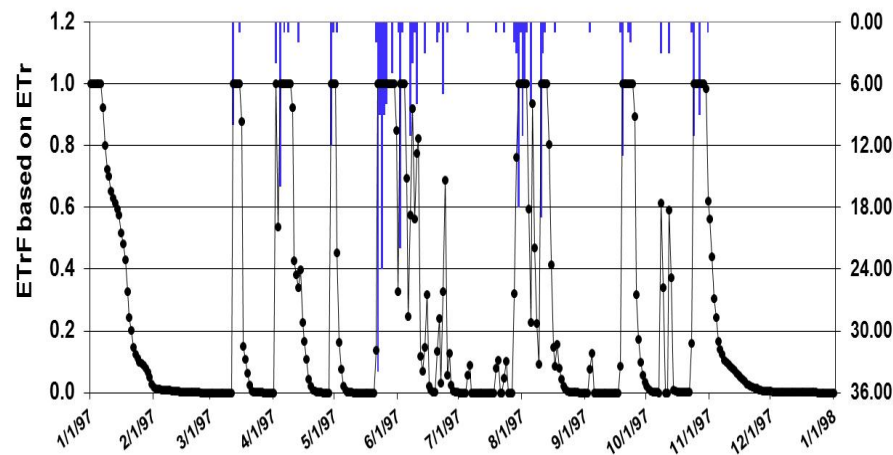
Legend: CFSv2 (red), GRIDMET (green), RTMA (Doorenbos & Pruitt) (orange), No Data (grey), GLDAS (blue), NLDAS (purple), RTMA (Perez et al.) (yellow)



Daily water balance
using gridded weather
and precipitation

EcoEEFlux will use bare
soil evaporation from
CFSV2 or GLDAS

Water balance for bare soil





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Apps | Google Maps | NFL Watch NFL Games | New Tab | yahoo mail - Google | METRIC-EEFLUX | Google Scholar | Google Calendar - Mc

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Instructions | FAQ

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Products

Download Tiff

BASE MAP

TRUE COLOR

FALSE COLOR (4, 3, 2)

FALSE COLOR (7, 5, 3)

ALBEDO

NDVI

DEM

LAND COVER

SURFACE TEMPERATURE

ALFAFA REFERENCE ET (ETr)

GRASS REFERENCE ET (ETo)

ETrF (default)

ACTUAL ET (default)



Phil_Blankenau_s....pptx



Marlow_Allen_Mer....pdf



nracs141p2_017641.pdf



program.pdf

Show all



Slide 3 of 3

Notes

56%

EEFLUX

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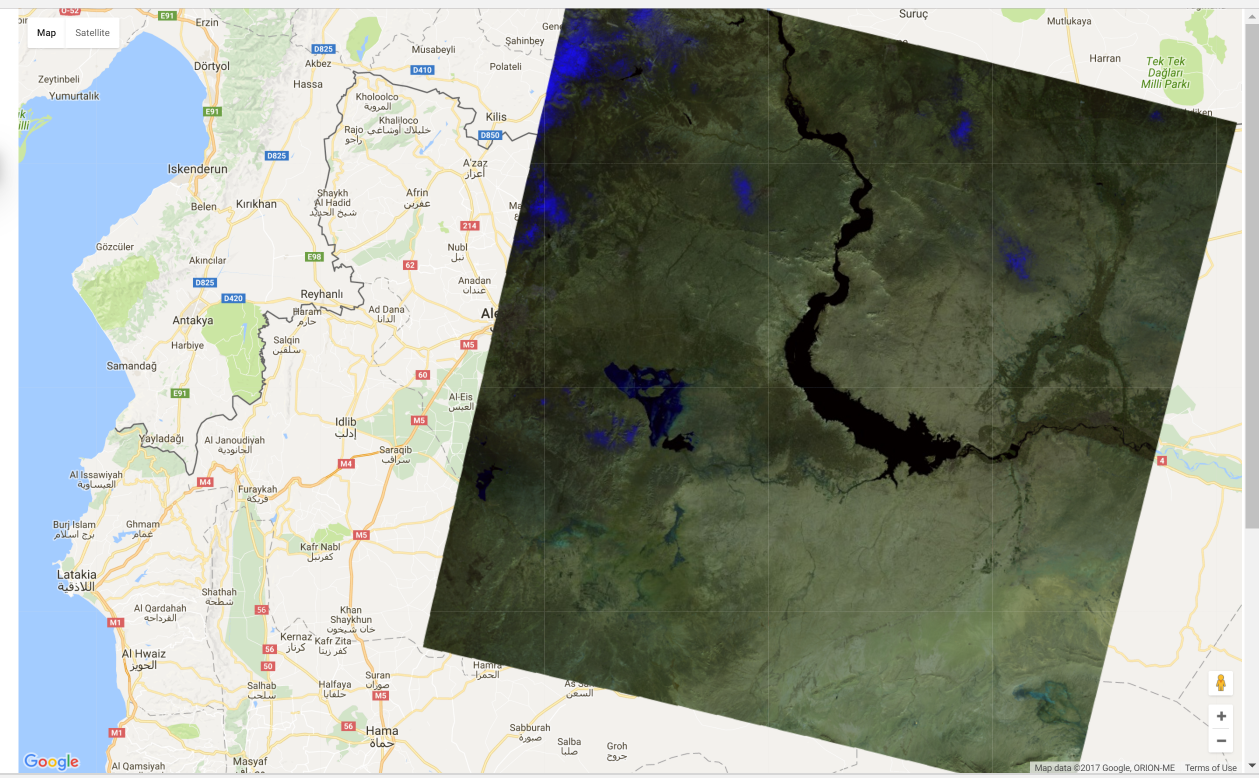
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TRUE COLOR	↓
FALSE COLOR (4, 3, 2)	↓
FALSE COLOR (7, 5, 3)	↓
ALBEDO	↓
NDVI	↓
DEM	↓
LAND COVER	↓
SURFACE TEMPERATURE	↓
ALFAFA REFERENCE ET (ETr)	↓
GRASS REFERENCE ET (ETo)	↓
ETrf (default)	↓
ACTUAL ET (default)	↓



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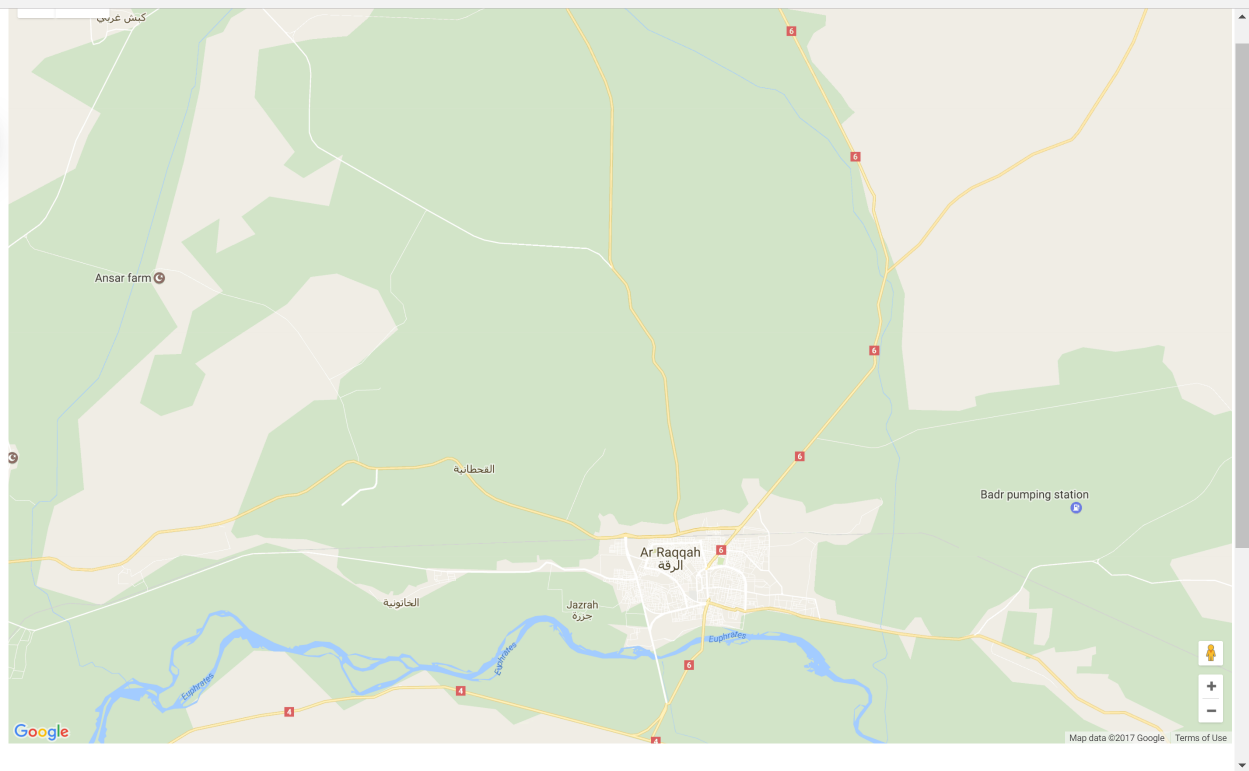
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DEM	Download
LAND COVER	Download
SURFACE TEMPERATURE	Download
ALFAFA REFERENCE ET (ETr)	Download
GRASS REFERENCE ET (ETo)	Download
ETrF (default)	Download
ACTUAL ET (default)	Download



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Products

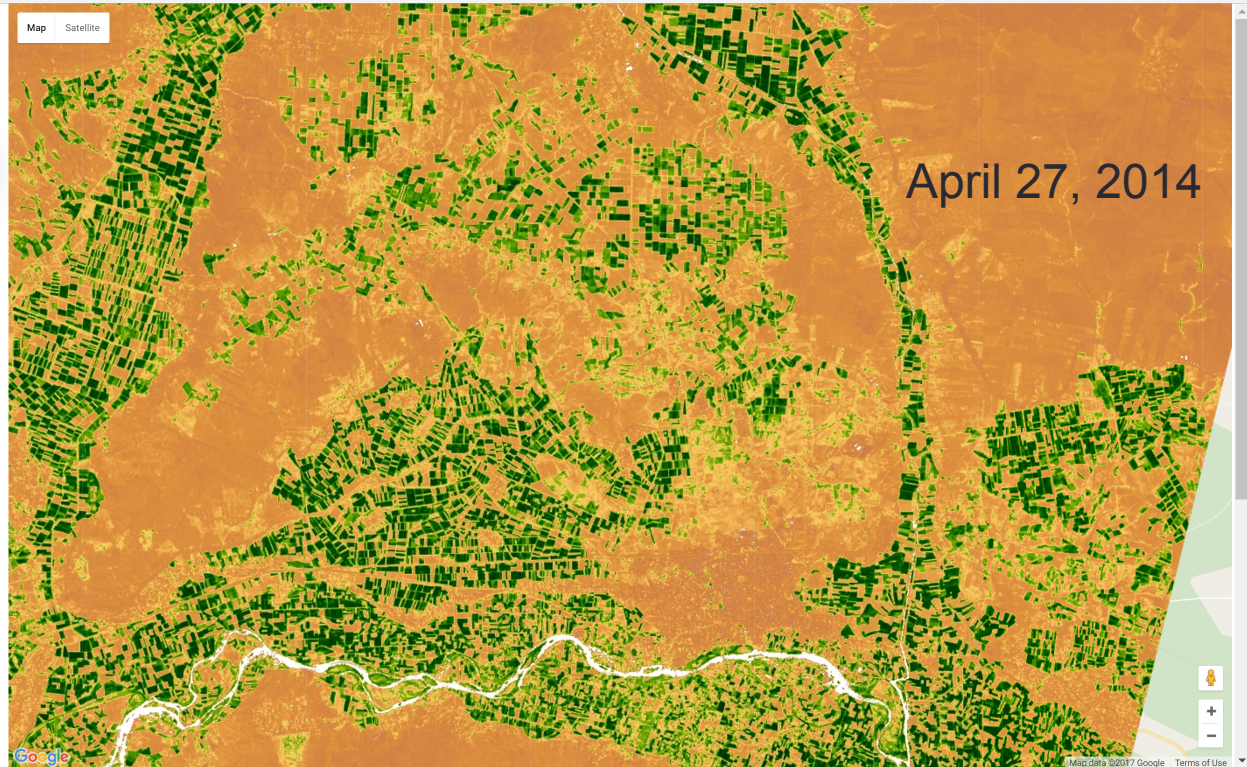
[Download Tiff](#)

BASE MAP

NDVI



ETrE (default)



The image is a screenshot of a web browser window displaying the EEFlux Level 1 interface. The browser's address bar shows the URL <https://eeflux-level1.appspot.com>. The page features a sidebar on the left with a navigation menu containing 'Instructions' and 'FAQ'. Below this, a date and location string '2017-01-29 / LC81730352017029LGN00 / Cloud 2%' is visible. A 'Products' section lists various data layers for download, each with a corresponding download icon: 'BASE MAP', 'TRUE COLOR', 'FALSE COLOR (4, 3, 2)', 'FALSE COLOR (7, 5, 3)', 'ALBEDO', 'NDVI', 'DEM', 'LAND COVER', 'SURFACE TEMPERATURE', 'ALFAA REFERENCE ET (ET_r)', 'GRASS REFERENCE ET (ET_o)', and 'ET5 (default)'. A color scale for NDVI is shown, ranging from 0 (brown) to 1 (dark green). The main area of the browser displays a large satellite map of a landscape with a river, overlaid with a color-coded map. The date 'Jan 29, 2017' is prominently displayed on the map. The bottom of the screen shows a Windows taskbar with several open files: 'Phil_Blankenau_s....pptx', 'Marlow_Allen_Mer....pdf', 'nracs141p2_017641.pdf', and 'program.pdf'. A 'Show all' button is also present. The bottom left corner of the taskbar indicates 'Slide 8 of 8'.

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Products

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BASE MAP

ALBEDO

LAND COVER

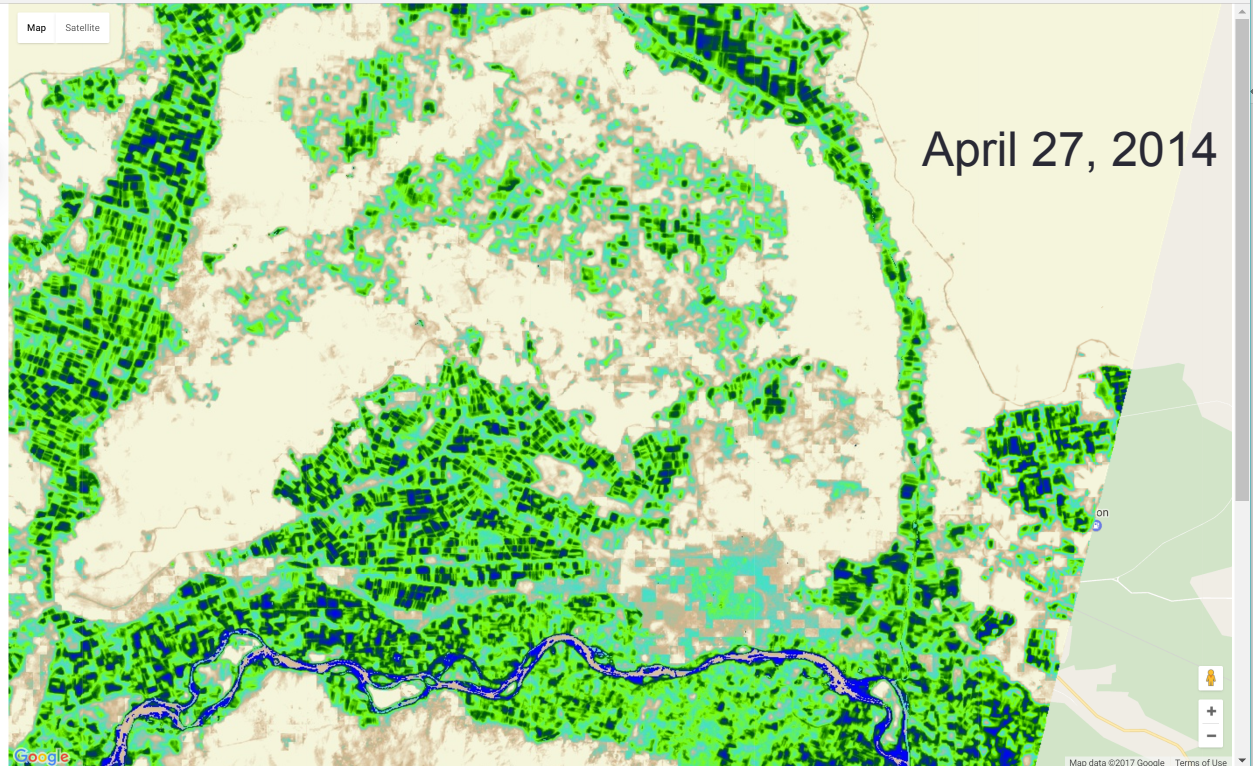
SURFACE TEMPERATURE

ALFAFA REFERENCE ET (ETr)

GRASS REFERENCE ET (ET₀)

ETrF (default)

ETrF



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Thank you

Extra Slides