ECOSTRESS METRIC
EVAPOTRANSPIRATION
ALGORITHM

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Members of the Landsat Science Team

EcoSTRESS Science Support

Support:
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2017 EcoSTRESS Workshop, Davis, CA
ET is needed at the field scale and for historical and present...
Close up Orbit -- 420 km

International Space Station
METRIC/EEFLUX-ECOSTRESS

Porting Algorithms
EEFlux – Landsat-based (30 m) ET mapping on Google Earth Engine
Orbital speed
17000 mph
7660 meters/second
Altitude: 420 km

Sun angle continually changing
Land / precipitation conditions continually changing
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)

any biases

\[ H = R_n - G - LE \] (for calibration)

\[ LE = R_n - G - H \] (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 $\text{ET}_r F$ (ET as a fraction of Reference ET) vary during the day for:
  - Irrigated Crops
  - Rainfed Crops
  - Riparian Systems
  - Rangeland
  - Forest
- How does variation in $\text{ET}_r F$ impact time-integrated ET estimation (which often assumes constant $\text{ET}_r F$)?
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 CO$_2$ 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 A.
- 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

“Sensor Redundancy”

- 3 3-D sonic anenometers
- 1 LiCor 7500 H20/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

Scintec LAS transmitter
Nighttime Spikes are numerical artifacts

LE from LAS as residual agrees well with LE from Eddy Covariance

One and two days following rain
Student-based accuracy assessments

Integrated METRIC Estimations VS. Ground RMY Data

Four Landsat dates

RMY, CSAT, METRIC Footprint

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 ($ET_r$)

Philip Blankenau, MS Student, UNL – Dr. Ayse Kilic, Advisor
Best Gridded Data sets for Least Bias in Reference ET (ET<sub>r</sub>)

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 ETr in Summer 2015 by KGE

- CFSv2
- GRIDMET
- RTMA (Doorenbos & Pruitt)
- No Data
- GLDAS
- NLDAS
- RTMA (Perez et al.)
Daily water balance using gridded weather and precipitation

EcoEEFlux will use bare soil evaporation from CFSV2 or GLDAS
This is beta version 1.0.0 of EEFlux level 2, where automated calibration of ETf is still evolving. The last calibration update was Jan. 15, 2017. See FAQ.

**Products**
- BASE MAP
- TRUE COLOR
- FALSE COLOR (4, 3, 2)
- FALSE COLOR (7, 5, 3)
- ALBEO
- NDVI
- DEM
- LAND COVER
- SURFACE TEMPERATURE
- ALFAFA REFERENCE ET (ETr)
- GRASS REFERENCE ET (ETo)
- ETf (default)
- ACTUAL ET (default)

EEFlux

Instructions
FAQ

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- program.pdf  

Show all
EEFLUX

This is beta version 1.0.0 of EEFLUX level 2, where automated calibration of ETI/ET is still evolving. The last calibration update was Jan. 15, 2017. See FAQs.

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EEFlux

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April 27, 2014
Thank you
Extra Slides