An open source tool to estimate regional and field-scale evapotranspiration

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Overview

- Two-Source Energy Balance (TSEB)
- ALEXI
- DisALEXI
- PyDisALEXI
- Conclusions
Two Source Energy Balance (TSEB)

- Treats soil/plant-atmosphere coupling differences explicitly.
- Uses land surface temperature (LST) as a surrogate to soil-moisture content.
- Accommodates off-nadir thermal sensor view angles.
- Provides information on soil/plant fluxes and stress.

\[ ET = (R_{NET} - G) - H \]
Atmosphere Land Exchange Inverse (ALEXI)

- Time of Day:
  - Sunrise
  - Local Noon
  - Daytime LST
  - Nighttime LST

- Land Surface Temperature:
  - Morning LST Rise: ALEXI Window
  - VIIRS Nighttime LST
  - VIIRS Daytime LST
ALEXI: GOES Evapotranspiration

mm/d

0 2 4 6
ALEXI: Polar orbiters

Current MODIS Capability (1000-m)

VIIRS Capability (375-m)

w/m²
ALEXI: VIIRS 375-m MENA

Development of a High-Resolution (375-m) VIIRS ET Product
An initial guess air temperature map is iteratively altered until the aggregated daytime fluxes retrieved by DisALEXI match the ALEXI fluxes at the scale of the ALEXI grid.
DisALEXI: Downscaling example

GOES (4km)  Landsat (30m)
PyDisALEXI is an open source implementation of the DisALEXI fusion suite. It is primarily composed of the following freely available python modules.

- Continuum’s Anaconda python distribution is used:
  - NumPy
  - SciPy
  - Pandas

- Other important modules
  - Geospatial Data Abstraction Library (GDAL)
  - Pythonic implementation of RTTOV, pyrttov
  - joblib
PyDisALEXI: flowchart

PyDisALEXI

Hourly Soil Fluxes
Daily ET
Hourly Canopy Fluxes
PyDisALEXI: Example

Nile Delta Irrigation  Aug. 9, 2015

Landsat ET

mm/day

- 8.0
- 6.0
- 4.0
- 2.0
- 0.0
Input data: Land Surface Temperature (LST)

Nile Delta Irrigation

Sharpened LST (K)

- LST calculated using the RTTOV atmospheric radiative transfer model to convert Brightness Temperature to LST.

- Landsat 8 TIRS product has a native resolution of 100 m.

- Sharpened to 30 m by the Data Mining Sharpening (DMS) tool using visible (30 m) and TIRS (100 m) data.
Input data: Leaf Area Index (LAI)

Nile Delta Irrigation

Landsat LAI

- 30 m LAI product downscaled LAI from lower resolution instruments (i.e. MODIS 1 km, VIIRS 375 m)

- LAI is downscaled to 30 m by the Data Mining Sharpening (DMS) tool using visible (30 m) and LAI at coarser scales data.
Input data: ALEXI daily ET

Nile Delta Irrigation

VIIRS daily ET mm/day

- Daily ET calculated at VIIRS 375 m data using the ALEXI model.
Initial results: Landsat daily ET

Nile Delta Irrigation

Landsat daily ET mm/d

- Landsat Daily ET downscaled from ALEXI using the PyDisALEXI model.
Conclusions

• Discussed previously developed models ALEXI and DisALEXI.

• PyDisALEXI will allow for more people to use DisALEXI and should be easily portable to apps/online portals.

• The higher resolution ET will allow for:
  • improved accounting of current water use and crop water productivity
  • Monitoring changes in water use with changing climate and land-use
Questions
DisALEXI: Downscaling example