A pythonic implementation of the ALEXI/DisALEXI modeling suite

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Overview

• Background
• Two-Source Energy Balance (TSEB)
• ALEXI
• DisALEXI
• PyDisALEXI
• Future Directions/Conclusions
Background

• Middle East North Africa (MENA) stakeholders are interested in knowing about their water consumption and water use efficiency.

Goals

• Develop regional and field-scale capability for water use mapping.
• Develop an easy to use freely available open-source tool for local stakeholders to use.
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.
Atmosphere Land Exchange Inverse (ALEXI)

- Time of Day
- Land Surface Temperature
- Local Noon
- Sunrise
- Morning LST Rise: ALEXI Window
Daily Evapotranspiration from GOES

Spatial distribution of daily ET on July 10-24, 2017
produced by the ALEXI model at ~2 km resolution
Atmosphere Land Exchange Inverse (ALEXI)

Time of Day

Land Surface Temperature

Local Noon

Morning LST Rise: ALEXI Window

VIIRS Nighttime LST

VIIRS Daytime LST

Sunrise
Daily Evapotranspiration from VIIRS

Spatial distribution of daily ET on July 1, 2018
produced by the ALEXI model at ~400 m resolution
Development of a High-Resolution (375-m) VIIRS ET Product

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

Annual ET estimated from integrating daily values for 2018
Disaggregated ALEXI (DisALEXI)

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.
PyDisALEXI

PyDisALEXI is an open source implementation of the DisALEXI fusion suite. It is primarily composed of the following freely available python modules.

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

- Other important modules
  - rasterio
  - Pythonic implementation of RTTOV, pyrttov
  - pyModis
  - USGS’s Landsat-api
  - joblib
PyDisALEXI: flowchart
PyDisALEXI: Saudi Arabia, irrigation

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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/d](image)

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

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Initial results: Landsat daily ET

Nile Delta Irrigation

Landsat daily ET mm/d

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

• PyDisALEXI is being tested and validated against fluxes over well characterized flux towers in the MENA region and in the US.

• Building a front-end using Dash to make a modern GUI for users to more easily use PyDisALEXI.

• PyDisALEXI will be distributed to our stakeholders in the MENA region for use on the ground.

• The PyDisALEXI framework is currently be ported to the Google Engine as part of the OpenET project.
Conclusions

• Developed a regional daily ET product for the MENA region.
• Created an open-source tool, PyDisALEXI, that will allow for us to easily and freely distribute DisALEXI to our stakeholders to use.

• The higher resolution ET will allow for:
  • improved accounting of current water use and crop water productivity.
  • Monitoring changes in water use with a changing climate and land-use.
Questions
Tunisian Agriculture, July 17th, 2015