**NASA DEVELOP National Program**

Langley Research Center

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**Coastal Mid-Atlantic Water Resources**

*Using the METRIC Model to Estimate Evapotranspiration in the Coastal Mid-Atlantic Region*

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Coastal Mid-Atlantic Water Resources Team Summer 2014

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**Applied Sciences National Applications Addressed:**

Water Resources, Agriculture

**Study Area:** Coastal Plain of Maryland, Virginia, and North Carolina

**Study Period:** April 2013 - June 2014

**Partners/Collaborators**

Virginia Secretary of Natural Resources: Molly Ward, Secretary

Virginia Secretary of Technology: Karen Jackson, Secretary

Virginia Secretary of Agriculture & Forestry: Todd Haymore, Secretary

Virginia Department of Environmental Quality: David Paylor, Director, Scott Kudlas, Director of Office of Water Quality

Digital Harvest: Young Kim, General Manager; Ed Hassell, Agronomist

**80-100 Word Blurb**

Crop irrigation accounts for a considerable amount of US water consumption, making it crucial to maximize agricultural water-use efficiency. Irrigation is a massive expense for farmers and accounts for 70% of agricultural productivity. In this study, Landsat 8 and Automated Weather Observing System (AWOS) observations were used as inputs in the Measuring Evapotranspiration at High Resolution with Internalized Calibration (METRIC) model to contribute toward a more accurate evapotranspiration (ET) estimation. METRIC will allow farmers to make decisions regarding irrigation that are more cost efficient. This model can also provide state policy makers with a means of assessing drought conditions.

**Community Concerns**

* Current regulations of water resources are not monetarily efficient. Improvements are needed for determining when irrigation is necessary based on ET rates.
* Irrigated agriculture accounts for 80-90% of water consumption nationwide and at least half of U.S. irrigated cropland relies on traditional, less efficient irrigation systems, despite technological advances.
* State officials need more accurate models for analyzing drought conditions in order to make more informed decisions regarding water-usage policies.
* Global demand has stressed the agricultural industry, making efficiency and productivity of upmost importance.

**Current Management Practices & Policies**

Currently, crop irrigation needs are monitored through identifying areas of heat stress. When heat stress becomes apparent, irrigation is deemed necessary. Using METRIC-derived ET rates to assess crop conditions would allow farmers to irrigate before heat stress occurs. Current water-allocation decisions for each state are based on weather station precipitation measurements. State officials would benefit from having broad ET estimates for drought monitoring and making water-allocation decisions rather than relying on sparsely distributed weather stations.

**Abstract**

Crop irrigation accounts for a considerable amount of water use in the Coastal Mid-Atlantic region. Better understanding of how much water farmers need to irrigate their fields will help decrease both water waste and the economic burden for farmers. The Mapping Evapotranspiration at High Resolution with Internalized Calibration (METRIC) model is a powerful tool that calculates evapotranspiration (ET) based on localized data. Executable from a Python script, the model can be used as a decision support tool that allows farmers to make more informed decisions about when irrigation is necessary. METRIC estimates ET using a series of equations where local input variables are acquired from Landsat 8 sensors, a United States Geological Survey (USGS) survey based Digital Elevation Model (DEM), and local weather conditions. While METRIC derived ET estimates are beneficial for irrigation purposes, it can also provide state officials with a useful means of drought monitoring. Utilizing data from NASA Earth observations in the Coastal Mid-Atlantic region will contribute to a large-scale, more-complete, understanding of the water consumption behavior in an area that can be used for both policy and individual agricultural decisions.

**Decision Support Tools**

* Python script in ArcGIS that calculates ET using the METRIC model
* Maps of ET rates based on METRIC model output

**Benefit to End-User:**

* Digital Harvest: Mapping ET using Landsat 8 will enable end-users to take measurements of agricultural fields when weather conditions prevent them from flying UAVs to collect data.
* Maryland and Virginia state agencies: ET mapping will provide a more accurate depiction of the water demand for farmers.
* An improved understanding of the water budget will benefit state officials making policy decisions concerning water rights and conservation efforts.
* METRIC software will be developed to make the code open-source and operational for agricultural businesses and policy makers.

**Earth Observations & Parameters**

Landsat 8, OLI/TIRS – Evapotranspiration, Land Cover

Aqua, MODIS – Evapotranspiration

TRMM, PR - Precipitation

Terra, ASTER - Evapotranspiration, Land Cover, DEM

**Future Applicable NASA Missions**

Soil Moisture Active Passive (SMAP) – Soil moisture, terrestrial water cycle

**Models Utilized**

Mapping Evapotranspiration with high Resolution and Internalized Calibration (METRIC) (POC: Dr. Richard Allen, University of Idaho)

**Ancillary Datasets Utilized**

USDA National Cropland Data Layer – Land cover

USGS National Land Cover Dataset – Land cover

USGS GTOPO30- Digital Elevation Model

NOAA/AgriMet- Weather Data

**Software Utilized**

ArcGIS:

* ArcMap – Processes METRIC output for map creation, enhancement, and analysis
* Python – Processes Landsat 8 and AWOS data to develop a raster layer of ET