**NASA DEVELOP National Program**

****NASA Langley Research Center

**Spring 2015**

**Coastal Mid-Atlantic Water Resources**

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

**Project Team:**

Kent Sparrow (Project Lead), kent.h.sparrow@nasa.gov

Jamie VanderHeiden

**Advisors & Mentors:**

Dr. Kenton Ross (NASA DEVELOP National Program)

Jamie Favors (NASA DEVELOP National Program)

**Past or Other Contributors:**

Brice Kaw-uh

Kelsey Renoll

Abigail Hollbrock

Catherine Steenholt

Steve Podgul-Vasquez

Lydia Cuker

Jelly Reickel

Zak Boston

Liafa Porbenni

Cassandra Morgan

Lance Watkins

Kenton Ross

Scott Baron

Christopher Ferraro

Nathan Owen

**Partner Organizations**

Virginia Secretary of Natural Resources, Boundary Organization, POC: Secretary Molly Ward

Virginia Secretary of Technology, Boundary Organization, POC: Secretary Karen Jackson

Virginia Secretary of Agriculture & Forestry, Boundary Organization, POC: Secretary Todd Haymore

Virginia Department of Environmental Quality, Boundary Organization, POC: Director David Paylor

Virginia Department of Environmental Quality, Boundary Organization, POC: Director of Office of Water Quality, Scott Kudlas

Digital Harvest, Collaborator and End User, POC: General Manager Young Kim

Digital Harvest, Collaborator and End User, POC: Agronomist Ed Hassell

**Applied Sciences National Applications Addressed:**

Water Resources, Agriculture

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

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

**Earth Observations & Parameters**

Landsat 8, OLI/TIRS – Evapotranspiration, Land Cover

Aqua/Terra, MODIS – Evapotranspiration

TRMM, PR – Precipitation

EO-1, Hyperion – Evapotranspiration, Land Cover

Terra, ASTER - Evapotranspiration, Land Cover, DEM

**80-100 Word Objectives Overview**

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.

**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.

**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.

**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.

**Models Utilized**

* Idaho Department of Water Resources/University of Idaho, Mapping Evapotranspiration with high Resolution and Internalized Calibration (METRIC), Allen et. al (2007)

**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 - Raster Manipulation/Analysis, Image Enhancement & Map Creation of Landsat 8 OLI/TIRS, Aqua/Terra MODIS, Terra ASTER, EO-1 Hyperion, and TRMM PR

ArcMap – Processes METRIC output for map creation, enhancement, and analysis

Python – Processes Landsat 8 and AWOS data to develop a raster layer of ET