**NASA DEVELOP National Program**

**Fall 2016 Project Proposal**

**NASA Jet Propulsion Laboratory**

**Costa Rica Agriculture II**

Mapping Trends in Vegetation Water Stress (Evapotranspiration) over a Daily Cycle to Inform and Optimize Irrigation Practices

**Project Overview**

***Objective:*** To utilize simulated ECOSTRESS data products to estimate the changes in water stress in crops over a daily cycle using the Priestly-Taylor-JPL model and to evaluate the utility of future ECOSTRESS data streams for supporting agricultural water resources management.

***Community Concern:*** Agriculture represents over 70% of the consumptive use of water worldwide. Satellite based remote sensing provides an opportunity to help optimize water use by improving understanding of water stress conditions in croplands. The data acquired will inform irrigation practices so that farmers can use water resources more efficiently. The project partners in Costa Rica at EARTH University, whose campus includes 5,000 hectares of agricultural lands, are interested in using remotely sensed data to understand rates of evapotranspiration to manage these resources for their crops effectively.

***National Application Areas Addressed:*** Agriculture, Ecological Forecasting, Water Resources

***Study Location:*** Guanacaste, Costa Rica

***Study Period:*** January 2008 – December 2009

***Advisors:*** Christine Lee (NASA Jet Propulsion Laboratory), Joshua Fisher (NASA Jet Propulsion Laboratory), Glynn Hulley (NASA Jet Propulsion Laboratory), Johan Perret (EARTH University)

***Source of Project Idea:*** Dr. Johan Perret and Christine Lee co-developed a concept paper describing the potential benefit of having access to evapotranspiration data for managing several agricultural decisions such as irrigation scheduling. If funded, this partnership will be the first of several Early Adopters activities that we will pursue as part of ECOSTRESS Mission Applications. This project is a carry-over from the summer of 2016.

**Partner Overview**

***Partner Organizations:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| EARTH University | Dr. Johan Perret, professor | End-User | Yes |
| USDA-ARS U.S. Arid Land Agricultural Research Center | Dr. Andrew French, physical scientist | Collaborator | No |

***End-User Overview***

***End-User’s Current Decision Making Process:***

Farmers are willing to take on their share of the responsibility for sustainable water management in agriculture but they need adequate information in order to make these decisions. They require good knowledge of soil water characteristics and crop water requirements but they also need to be able to identify “hotspots” in the field where an action is necessary. EARTH University currently utilizes georeferenced and in-field soil-plant-water variable measurements to inform agricultural sector management practices, primarily through teaching and consulting activities. These data, however, are limited in their spatial resolution (i.e., generally one sampling point per hectare, or less) and still require significant processing to visualize regions that may require additional attention.

***End-User’s NASA Earth Observations Capacity:***

EARTH University – our partner has some familiarity with NASA Earth observations, primarily because JPL hosted a detailee from EARTH in late 2015. During this time, Dr. Perret gained exposure to the ECOSTRESS mission as well as calibration/validation (cal/val) activities on site at Russell Ranch and Lake Tahoe. During this time, we confirmed and elaborated ideas for collaborating on applications projects. There is a definite interest to investigate how Earth observations (and other remote sensing data) could be of use to their agricultural management.

***Collaborator & Boundary Organization Overview***

***Collaborator Support:***

USDA-ARS – Andrew is on the ECOSTRESS Science Team and may assist in some of the product and model evaluation work in the US.

***Boundary Organization Dissemination:***

EARTH University will be able to disseminate results to a broader agricultural practices community. Furthermore, EARTH University is an institution known globally for fostering scientific exchanges and networks and building a network of scientists and experts in agricultural management. EARTH has been a venue for bringing together multiple tiers of water resources and agricultural stakeholders in Latina America, including policy makers, practitioners, and students. EARTH has helped mobilize these communities to discuss and develop strategies for adapting to climate change.

***Project Communication & Transition Overview***

***In-Term Communication Plan:***

We will set up, at a minimum, biweekly or weekly teleconferences to share updates in addition to a webinar presentation once per month (synchronized with the DEVELOP deliverables schedule). We will also look for opportunities to develop joint deliverables, such as reports, presentations, and visualizations.

***Transition Approach:***

We will deliver all products (simulated, model outputs, and tower site data) available to the partner in a format compatible with ArcGIS and possibly MATLAB or ENVI. Since this is a two-term project, our partner will be working for at least 20 weeks so that transition of data will also occur over that timeframe. We will also develop a joint report with our partner on assessing how we will integrate these data into their irrigation practices.

**Earth Observations Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameter(s)** | **Use** |
| **Suomi-NPP VIIRS** | Land Surface Temperature (LST) | We will use this data to generate the simulated ECOSTRESS L2 LST as the primary input into determining evapotranspiration (L3 product). |
| **ASTER GED** | Emissivity, NDVI | We will use this data to generate the simulated ECOSTRESS L2 Wide-band Emissivity data as required by the L3 product, and to downscale the VIIRS LST from 375 m to ECOSTRESS 70 m resolution. |
| **Aqua & Terra MODIS** | Cloud Mask | We will use this data to generate the simulated ECOSTRESS L2 products as well as an input into the model used to assess trends in vegetation water stress. |

***Ancillary Datasets:***

EARTH University Shapefiles: study area, EARTH University *in situ* data: crop type, Aster Global Emissivity Dataset (GED) version 3: emissivity, La Thuile Synthesis Dataset, National Centers for Environmental Prediction (NCEP) Daily Long Term Mean Minimum, Temperature, National Centers for Environmental Prediction (NCEP) Daily Long Term Mean Maximum Temperature.

***Models:***

Forest Light Environmental Simulator (FLiES), Breathing Earth Systems Simulator (BESS), Priestley-Taylor Jet Propulsion Laboratory (PT-JPL)

***Software & Scripting:***

MATLAB - Producing net radiation data using FLiES and BESS, analysis, Python - Preprocessing MODIS data for net radiation, producing PT-JPL data, analysis, R - data analysis and visualization, ArcGIS - data analysis and visualization, QGIS - data analysis and visualization.

**Decision Support Tool & End-Product Overview**

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Product** | **Partner Use** | **Datasets & Analyses** | **Software Release Category** |
| Simulated ECOSTRESS Data Product – Evapotranspiration (ET) | ET Maps have been identified by the partner as a useful resource for informing irrigation practices | This product will utilize the simulated Level 2 products, MODIS PT-JPL, and meteorology from NCEP and will be determined at multiple time points to establish understanding of a ET variability over a daily cycle. | 1 |

***End-User Benefit:***

This project will benefit the end user in two ways: (1) optimize irrigation practices, which will save water and cost, and allow them to allocate resources elsewhere, and (2) increase capacity building with the partner to ensure a further familiarity with data processing, management, and other related techniques associated with remote sensing datasets.

**Project Timeline & Previous Related Work**

***Project Timeline:*** 2 Terms: Summer 2016 (Start) to Fall 2016 (Completion)

***Multi-Term Objectives:***

* **Term 1:** 2016 Summer (JPL) – Costa Rica Agriculture
  + Develop simulated ECOSTRESS ET product utilizing the L2 simulated product to model diurnal changes in evapotranspiration for two agricultural field sites: US and Costa Rica. Build capacity of partner to begin working with ECOSTRESS data.
* **Term 2 (Proposed Term):** 2016 Fall (JPL) – Costa Rica Agriculture II
  + Evaluate simulated ECOSTRESS products and/or model outputs with calibration/validation field data over diurnal cycle. Continue to build capacity of partner to work with ECOSTRESS data and tailor model outputs into actionable formats

***Related DEVELOP Work:***

Summer 2015 (JPL) -- New Mexico Water Resources I: Investigating Rangeland Conditions in New Mexico Using MODIS-Derived Evapotranspiration Products

Fall 2015 (JPL) – New Mexico Water Resources II: Investigating Rangeland Conditions in New Mexico Using MODIS-Derived Evapotranspiration Products

**Notes & References:**

***References:***

ecostress.jpl.nasa.gov