**NASA DEVELOP National Program**

**Summer 2016 Project Proposal**

**NASA Jet Propulsion Laboratory**

**Costa Rica Agriculture**

Mapping Trends in Vegetation Water Stress (Evapotranspiration) over a Daily Cycle to Help 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. This knowledge can inform irrigation practices so that water resources can be used more efficiently. Our partners in Costa Rica at EARTH University, whose campus includes 5000 hectares of agricultural lands, are interested in using remotely sensed data to understand rates of evapotranspiration to manage resources for their crops more efficiently.

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

***Study Location:*** Costa Rica

***Study Period:*** 2012

***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 is pursued as part of ECOSTRESS Mission Applications.

**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 1 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:***

Andrew French – USDA – Andrew is on the ECOSTRESS Science Team and may potentially 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 a globally known institution in 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 these data will be integrated into their irrigation practices.

**Earth Observations Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameter(s)** | **Use** |
| **Suomi-NPP VIIRS**  **(I5 band, 375 m)** | 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**  **(Bands 10-14, 100 m)** | 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:***

Stanford and Lawrence Berkeley National Lab - Eddy Fluxnet Sites – cal/val

EARTH University – *In situ* data (sample data) – cal/val

***Models:***

Priestly-Taylor-Jet Propulsion Laboratory Evapotranspiration algorithm (POC: Josh Fisher, JPL)

**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 partner as useful resource for informing irrigation practices | This product will utilize the simulated Level 2 products, visible and near infrared data from Landsat, 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) we will work with our partners to determine how this data can be used to optimize irrigation practices, which will save water and cost, and allow them to allocate resources elsewhere; and (2) capacity building, as the partner will become even more familiar with data processing, management, and other related techniques associated with remote sensing datasets.

**Project Timeline & Previous Related Work**

***Project Timeline:* 3** Terms: Summer 2016 (Start) to Spring 2017 (Completion)

***Multi-Term Objectives:***

* **Term 1 (Proposed Term):** 2016 Summer (JPL) – Mapping Trends in Vegetation Water Stress (Evapotranspiration) over a Daily Cycle to Help Inform and Optimize Irrigation Practices, Part 1
  + 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:** 2016 Fall (JPL) – Mapping Trends in Vegetation Water Stress (Evapotranspiration) over a Daily Cycle to Help Inform and Optimize Irrigation Practices, Part 2
  + 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
* **Term 3:** 2017 Spring (JPL). Mapping Trends in Vegetation Water Stress (Evapotranspiration) over a Daily Cycle to Help Inform and Optimize Irrigation Practices, Part 2
  + Execute scenarios in which ECOSTRESS ET products are applied to irrigation schedule and evaluate impacts/benefits
  + Work with partner to have them independently apply ECOSTRESS data to their decision contexts

***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

**Project Needs/Requests**

***Participants Requested:*** 3

***Software & Scripting:***

ArcGIS – visualize data

Matlab – analyze data

**Notes & References:**

***References:***

ecostress.jpl.nasa.gov

**Jamie’s Comments**:

I’m excited to see how this project turns out, and I know HQ will be really supportive and excited, too.

**Lauren’s Comments:**

I like the use of future sensor data, although I found this proposal a bit unclear in some of its writing and I don’t understand the details behind it being a two term project. The details and objectives of the follow-on term were unclear and did not seem any different from the first, bolster the writing if it really needs to go into a second term. Is EARTH University really a decision-making entity or a research entity? Perhaps they are more of a collaborator/boundary organization? This should be rebranded as an Ag project due to the fact that the focus is impact to farming practices.

**Dr. Ross’s Comments:**

EARTH University emphasizes agriculture and seems to have their own farms. Are the fields where the ET products are to be demonstrated managed by the University? If so, I think we could think of Earth University as an end user in itself. If not, perhaps the farm or entity managing the farm should be added as a partner. I think it should be a stated goal of the project to engage additional decision makers like a government agency or a farmers cooperative to strengthen its impact. I think the argument for a second term to go from producing ET products to using them in irrigation planning is consistent with our philosophy or focusing later work on partner hand-off. I agree with Lauren that the writing needs to be strengthened and particularly the objectives need to be clear.