**NASA DEVELOP National Program**

**Fall 2015 Project Proposal**

NASA Jet Prolusion Laboratory

**New Mexico Water Resources & Agriculture II**

Investigating Rangeland Conditions in New Mexico Using MODIS-Derived Evapotranspiration Products

**Objective:**

To automate MODIS data acquisition for, and to streamline evapotranspiration product generation and delivery to, the New Mexico Office of the State Engineer. These products will then be disseminated to decision-makers in the ranching, drought assessment and fire-response communities in the Eastern Plains Region of New Mexico through an easily accessed online interface.

**Community Concern:**

The eastern portion of New Mexico has suffered consistent drought conditions throughout the last decade, negatively impacting agriculture, ranching, and the gas and oil industries. These conditions are expected to continue and possibly to worsen due to climate change in the coming century, putting further stress on an already strained water community. Decision makers such as agricultural producers, ranchers, fuel producers, emergency assistance organizations and fire responders need tools that facilitate accurate and timely rangeland condition assessments to help guide water use and land use decisions. Evapotranspiration (ET) products can provide important information about water use efficiency and vegetation conditions in rangeland and farmland. ET is measureable on the ground over small areas, but is complicated to measure via remote sensing on the scale needed for land and water management in this region. There is a need for remotely-sensed products that are easily accessible and provide ET information in a friendly format. Such tools could aid decision makers in land use and irrigation decisions, assist land managers applying for national governmental assistance programs, and possibly provide lead-time to fire managers on potential grassland fire conditions.

**Partner Organizations:**

New Mexico Office of the State Engineer (NMOSE) (End-User/Boundary Organization, POC: John W. Longworth, P.E., Chief of Water Use and Conservation Bureau)

Contact among John Longworth of NMOSE, Dr. Fisher of JPL, and DEVELOP has been established through email communication and telecons. After a few brainstorming sessions, a project has been chosen that will address the immediate needs of the NM Great Plains community by producing near-real-time ET visualizations from MODIS data. These data products will be distributed to the ranching community and other decision-makers within NM by NMOSE.

**Letters of Support:** New Mexico Interstate Stream Commission, Amy Hass, Acting Director

**Decision Making Process:**

Knowledge of rangeland conditions is necessary for decisions regarding cattle management, emergency response for rapid rangeland and farmland deterioration, fire management risk decisions, and determining drought severity. New Mexico land managers and decision-makers currently assess rangeland conditions using spatially-limited *in-situ* spot checks which give useful, but limited, information. Additionally, weekly NDVI products for New Mexico counties are generated by the New Mexico Department of Agriculture from data supplied through the USDA Forest Service. However, this information is not widely distributed nor easily accessible. Some ET products are generated with the Mapping EvapoTranspiration at high Resolution with Internalized Calibration (METRIC) method and Landsat data. The low temporal resolution and large file size of Landsat scenes and the proprietary nature of METRIC obstruct the flow of products from this process.

**Earth Observations:**

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| **Platform** | **Sensor** | **Geophysical Parameter** |
| Aqua & Terra | MODIS | Evapotranspiration – MOD16 |

**NASA Earth Observations Highlighted:**

Dr. Joshua Fisher of NASA-JPL has devised and published a method to create ET products in near-real-time using MODIS data. This method has advantages in temporal resolution and coverage over Landsat-based methods such as METRIC. Streamlining the production of easily accessible, operational, and digestible ET products using this method will empower rangeland decision-makers in eastern New Mexico.

**Ancillary Datasets:**

* ArcGIS - Raster Manipulation/Analysis, Image Enhancement & Map Creation of Aqua/Terra MODIS, NPP VIIRS
* Matlab – Calculations for ET Products
* Java - Creation of Data Pipeline between JPL and NMOSE

**Models:**

Priestley–Taylor based Evapotranspiration method (PT–JPL ET method) (POC: Dr. Joshua Fisher, JPL)

**Decision Support Tools & Analyses:**

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| --- | --- | --- |
| **Proposed End Products** | **Decision to be Impacted** | **Current Partner Tool/Method** |
| ET-Based Rangeland Health Maps | Land use and water use decisions | Spatially-limited spot checks, METRIC method |
| ET Product Access Interface | Land use and water use decisions | None |

*ET-Based Rangeland Health Maps* – MODIS data and the PT-JPL ET method will be used to generate rangeland health maps for the plains region of New Mexico. The methodology will be transferred to NMOSE so that map creation will continue after the conclusion of the project.

*ET Product Access Interface* – A data pipeline will be established allowing the NMOSE to access MODIS data and data products quickly and efficiently, as well as to disseminate them to decision-makers. This pipeline will be accessible through the website of the New Mexico State Climatologist. \*Note a journal publication at the end of the second term is also feasible based on the ET rangeland maps and methodologies used.

**Project Details:**

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

**Source of Project Idea:** This project arose out of communications initiated at the Western States Water Council’s Water Management Workshop, Special Remote Sensing Science Session, at the Jet Propulsion Laboratory in August 2014. At this meeting, Dr. Fisher presented the results of his work on MODIS evapotranspiration calculations. Mr. Longworth of NMOSE became interested in learning more about this approach to help potentially address several NM water resources questions. The DEVELOP JPL Center Lead (Christine Raines) also attended the meeting and introduced Mr. Longworth to DEVELOP. In subsequent communication via email and telecons, several ideas were vetted regarding potential project ideas. The idea of having a reliable, fast and cheap ET visualization product via the method that Dr. Fisher had presented led to the proposed collaboration among DEVELOP, Dr. Fisher, and NMOSE.

**Study Location:** Plains region, New Mexico

**Period being Studied:** 2000 to Present

**Advisor:** Dr. Joshua Fisher (JPL)

**Participants Requested:** 3

**Project Timeline:** 2 Terms: 2015 Summer to 2015 Fall

**Multi-Term Objectives:**

* **Term 1** – This term focused on transitioning the research-mode processing workflow to an operational-mode workflow. During the term, participants learned how to produce the ET product, and developed code for near-real-time automated data downloading and processing within JPL’s supercomputing environment via the JPL Climate Center. Software release protocols were initiated with NASA and JPL export control guidelines. FTP access to the ET products was established.
* **Term 2 (Proposed Term)** – This term will focus on creating public access to the products and creating meaningful products that best suit the needs of local users. An initial outflow will be constructed from the Climate Center to a website hosted by the New Mexico State Climatologist, and a simple website will be created displaying the maps. Participants will work closely with the Office of the State Engineer to determine what standardized form for the product is most useful and most easily understandable by the community. The results will be presented to local decision-makers.

**Previous Related DEVELOP Work:**

Summer 2014 (NASA Langley Research Center) - Peru Water Resources: Integrating NASA Earth Observations into Water Resource Planning and Management in Peru’s La Libertad Region

Summer 2014 – Spring 2015 (NASA Langley Research Center) - Coastal Mid-Atlantic Water Resources: Developing a Water Budget Using Evapotranspiration Measured with the METRIC Model and Groundwater Storage Data in the Coastal Plain of Maryland, Virginia, and North Carolina

**Software & Scripting Requested:**

* ArcGIS - Raster Manipulation/Analysis, Image Enhancement & Map Creation of Aqua/Terra MODIS, NPP VIIRS
* Matlab – Calculations for ET Products
* Java - Creation of Data Pipeline between JPL and NMOSE

**Notes:**

This is a stand-alone project that will not otherwise be implemented. Although the methodology has been validated and published, the product was built for science as part of a research project, and has not yet been applied for the benefit of a community. It is hoped that this project will lay the foundation for a ROSES proposal for ongoing support of the product’s application in NM and eventual complete transference to the New Mexico Office of the State Engineer.

**Reference:**

Joshua B. Fisher, Kevin P. Tu, Dennis D. Baldocchi, Global estimates of the land–atmosphere water flux based on monthly AVHRR and ISLSCP-II data, validated at 16 FLUXNET sites, Remote Sensing of Environment, Volume 112, Issue 3, 18 March 2008, Pages 901-919, ISSN 0034-4257, http://dx.doi.org/10.1016/j.rse.2007.06.025.

(<http://www.sciencedirect.com/science/article/pii/S0034425707003938>)