**NASA DEVELOP National Program**

**2017 Spring Project Proposal**

**NASA Marshall Space Flight Center**

**Alabama Agriculture**

*Analyzing and Assessing Drought Conditions for Crops Across Alabama Using NASA Earth Observations*

**Project Overview**

**Project Synopsis**: Alabama has a history of drought which has inflicted major stress on agriculture across the state. This project aims to research drought conditions experienced in Alabama to assist in monitoring efforts. A time series of the Normalized Difference Vegetation Index (NDVI) over the state will be correlated with crop models, such as the Gridded Decision Support System for Agrotechnology Transfer (GriDSSAT). Additionally, the project will perform a statistical analysis of drought conditions for particular days compared to the drought conditions from up to 100 years prior. An assessment of several vegetation and drought indices— such as NDVI, the Normalized Multiband Drought Index (NMDI), and the Green-Red Vegetation Index (GRVI)—will be performed to determine the best drought indicator for the study area.

***Community Concern:*** According to the U.S. Drought Monitor, there currently are nearly 5 million people in Alabama live in drought affected areas. As of October 2016, Alabama experienced moderate to extreme drought, with large portions in the East and Northeast experiencing exceptional drought conditions. Consequently, the state has experienced substantial negative impacts on agriculture. A better understanding of drought in Alabama and determining the best methodologies for monitoring them will help farmers and decision makers to adjust accordingly to the changing weather conditions that have been known to severely damage crops in the area.

***Source of Project Idea:*** The idea for this project was derived from several conversations among the Marshall Space Flight Center Center Lead, Maggi Klug, previous Center Lead, Leigh Sinclair, and Cameron Handyside, a Research Engineer at the Earth System Science Center at Marshall.

***National Application Areas Addressed:*** Agriculture, Climate

***Study Location:*** Alabama

***Study Period:*** January 2008 to December 2016

***Advisors:*** Dr. Jeffrey Luvall (NASA at National Space Science and Technology Center), Dr. Robert Griffin (University of Alabama in Huntsville), Leigh Sinclair (University of Alabama in Huntsville/Information Technology and Systems Center), Cameron Handyside (Earth System Science Center)

**Partner Overview**

***Partner Organizations:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| Alabama Office of the State Climatologist (AOSC) | Dr. John Christy, Alabama State Climatologist | End-user | Yes |
| Earth System Science Center (ESSC) at Marshall Space Flight Center | Cameron Handyside, Research Engineer | Collaborator | No |

***End-User Overview***

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

The Alabama Office of the State Climatologist is currently responsible for monitoring, designating, and contributing the United States Drought Monitor (USDM). Currently, the USDM is a weekly map of drought conditions that is produced jointly by the National Oceanic and Atmospheric Administration (NOAA), the U.S. Department of Agriculture, and the National Drought Mitigation Center at the University of Nebraska-Lincoln. In addition, the drought map is utilized by policymakers and the media in discussions of drought and in allocating drought relief. Data provided by the USDM is used to distribute an estimated $1.64 billion budget through the Livestock and Forage Disaster Program and $450 million through the Livestock Assistance Grant Program.

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

Alabama Office of the State Climatologist – The end-user currently utilizes Earth observations from NASA, NOAA, and commercial land remote sensing imagers in their research. This project will build their capacity by developing new products to model and assess drought and vegetative indices which will assist farmers’ decision-making processes concerning irrigation during periods of drought. Effective drought modeling can also support policymakers with implementing operational modifications on a government level.

***Collaborator & Boundary Organization Overview***

***Collaborator Support:***

Earth System Science Center (ESSC) at Marshall Space Flight Center – ESSC currently supports stakeholders (farmers, state and federal agencies, and those who assist in the creation of the drought monitor service) by delivering daily and weekly crop models called GRIDSSAT. ESSC will support the project by providing knowledge and mentorship related to drought indices, GIS, and remote sensing.

***Dissemination by Boundary Organizations:***

The Alabama Office of the State Climatologist (AOSC) will use the tools and methodologies created to enhance their weekly contribution to the USDM. On a broader scale, the enhancements that are contributed to the USDM by the AOSC will disseminate information to farmers, policymakers, and the media to provide more accurate and synoptic drought data.

***Project Communication & Transition Overview***

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

Communication will be initiated during the interim by the MSFC node DEVELOP leadership team. The leadership will establish an initial time and date for the incoming team to conduct their preliminary briefing. The incoming project lead will introduce the team to the partners and determine if there have been any deviations to the desired end-products. The team will then continue meet in person with the ESSC and AOSC throughout the term for their mentorship.

***Transition Plan***: End products will be presented and handed- off to the ESSC and AOSC at MSFC in-person at the completion of the term by giving the project partners a USB drive.

**Earth Observations Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameters** | **Use** |
| **Landsat 5 TM**  | Surface Reflectance | Landsat 5 TM is a 30 m dataset that will be used in discriminating vegetative, crop, and timber types. |
| **Landsat 8 OLI** | Surface Reflectance | Landsat 8 OLI is a 30 m dataset that will be used in discriminating vegetative, crop, and timber types. |
| **Terra and Aqua MODIS** | LST, NDVI | MODIS products will be used for analyzing agricultural drought effects on temperature and vegetation using the Scaled Drought Condition Index (SDCI). |
| **TRMM Precipitation Radar (PR)** | Precipitation  | TRMM PR monthly precipitation accumulation products will be used to analyze agricultural drought using SDCI. |
| **GPM Integrated Multi-satellite Retrievals for GPM (IMERG)** | Precipitation | GPM IMERG daily precipitation accumulation products will be used to analyze agricultural drought using SDCI. |
| **Sentinel – 2 MSI** | Surface Reflectance | Sentinel – 2 MSI will complement the Landsat 8 OLI sensor and increase the temporal resolution of the project. |

***Modelling:***

GRIDSSAT Crop Model (POC: Cameron Handyside, Research Engineer)

***Software & Scripting:***

ESRI ArcGIS – Raster manipulation/analysis, image enhancement and map creation of Landsat 5 TM, Landsat 8 OLI

Exelis ENVI – Raster manipulation/analysis and image enhancement of Terra and Aqua MODIS

R – Statistical correlation of drought conditions

**Decision Support Tool & End Product Overview**

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Products** | **Partner Use** | **Datasets & Analyses** | **Software Release Category** |
| **NDVI Time Series and GRIDSSAT Crop Model Comparison**  | This will allow for analysis of the correlation between NDVI and the project partner’s Crop Model over time. | Landsat 5 TM and Landsat 8 OLI will be used to create the NDVI time series from 2008 through 2016. | N/A |
| **Statistical Analysis of Historical Drought** | The Statistical Analysis of Historical Drought will aid the project partner’s decision- making process by highlighting areas that have experienced severe drought conditions during the study period. | R Statistics will be used to determine the correlation between drought conditions on particular days during the study period and the same day up to 100 years prior. | N/A |
| **Drought and Vegetation Indices Assessment** | This assessment will allow for a comparison among the different indices to determine the most accurate index for monitoring drought in Alabama. | Landsat 5 TM, Landsat 8 OLI, and Sentinel-2 MSI will be used to calculate the Normalized Difference Vegetation Index (NDVI), Normalized Multiband Drought Index (NMDI), and Green-Red Vegetation Index (GRVI). GPM IMERG, TRMM PR, and Terra and Aqua MODIS will be utilized when creating the Scaled Drought Condition Index (SDCI).  | N/A |

***End-User Benefit:***

ESSC at MSFC and the AOSC will use the drought monitoring end-products to compare and amend their own GRIDSSAT and Drought Monitor products. The results from this project will be disseminated to local decision makers and farmers in Alabama to better prepare them for drought-related disasters.

**Project Timeline & Previous Related Work**

***Project Timeline:*** 1 Terms: 2017 Spring

***Related DEVELOP Work:***

2016 Summer (MSFC) – Mekong River Basin Agriculture: Utilizing NASA Earth observations to Enhance Drought Management Decision within the Mekong River Basin’s Agricultural Fields

2016 Spring (NCEI) – Levant & Central America Climate: Monitoring Precipitation and Drought to Enhance U.S. Air Force Predictions and Decision-Making in the Levant and Central America

2015 Spring (IRI) – Uruguay Agriculture: Verifying the Usefulness of a Drought Severity Index that uses Terra MODIS Land Surface Temperature, MODIS Vegetation Indices, and TRMM Precipitation by Comparing Results to Soil Water Balance while Testing a TRMM Replacement

2013 Fall (MX/WC) – Coahuila Agriculture: Using Earth Observing Satellites to Characterize Drought Scenarios in Coahuila, Mexico

**Notes & References:**

***References:***

Martinez, Stephanie. 2016. The Disproportionate Consequences of Climate Change.

National Center for Disaster Preparedness NDCP Earth Institute|Columbia University. http://ncdp.columbia.edu/ncdp-perspectives/the-disproportionate-consequences-of-climate-change/.

MYD11C3 | LP DAAC: NASA Land Data Products and Services. (2014).

https://lpdaac.usgs.gov/dataset\_discovery/modis/modis\_products\_table/myd11c3

"Normalized Difference Vegetation Index (NDVI) Analysis for Forestry Analysis for Forestry and Crop Management and Crop Management." Sim Wright. Web. <http://simwright.com/downloads/SimWright\_NDVI.pdf>.

Rhee, J., Im, J., and Carbone G. (2010). Monitoring agricultural drought for arid and humid regions using multi-sensor remote sensing data, Remote Sensing of Environment, 114, 2875-2887.

“The State of Food Insecurity in the World 2015.” Food and Agriculture Organization of the United Nations. http://www.fao.org/hunger/en/.