**NASA DEVELOP National Program**

**Fall 2016 Project Proposal**

**NOAA National Centers for Environmental Information**

**Levant & Central America Climate II**

Enhancing Drought Monitoring and Prediction Capabilities by the US Air Force, 14th Weather Squadron in Levant and Central America

**Project Overview**

***Objective:*** Optimize the US Air Force, 14th Weather Squadron’s Drought Monitor/Forecast for the Department of Defense.

***Community Concern:*** Drought and heavy precipitation are major concerns for many areas around the globe, including the Levant region and Central America. Drought exacerbates water supply, agricultural insecurity, as well as causes livestock mortality and the migration of people. The Levant region, including Syria, Lebanon, Jordan, Israel, and Iraq, are suffering from increased drought episodes. At the same time, a so-called Dry Corridor in Central America has experienced a similar increase in extreme weather events, and stretches across Guatemala, El Salvador, Honduras, and Nicaragua. This region of Central America is heavily influenced by El Niño Southern Oscillation (ENSO) events that cause either extreme drought, such as the drought of 2014, or heavy precipitation and flooding events.

Many recent events within the Middle East have further highlighted the influence that drought has on communities within vulnerable countries. For example, the drought beginning in 2006 in Syria has been linked to civil unrest because of agricultural failures. As many as 1.5 million people migrated from rural farming communities to urban areas following agricultural collapse. The US Department of Defense (DoD) and the Intelligence Community understand the relationship between conflict and extreme precipitation or drought events. Understanding the spatial and temporal variations in precipitation is of the utmost importance in being able to understand, and even help predict, conflict and civil unrest in these vulnerable areas.

***National Application Areas Addressed:*** Climate, Water Resources, Agriculture, and Disasters

***Study Location:*** Syria, Lebanon, Israel, Iraq, and Jordan,

Honduras, El Salvador, Guatemala, Nicaragua, Costa Rica, Panama, Colombia, and Venezuela.

***Study Period:*** January 1981 – March 2016

***Advisors:*** Raymond Kiess (14th Weather Squadron), Major Jason Scalzitti (14th Weather Squadron), Dr. L. DeWayne Cecil (Global Science & Technology, Inc.)

***Source of Project Idea:*** The communication about this project first began with Lance Watkins (NASA DEVELOP) and Major Ryan Harris of the US Air Force, 14th Weather Squadron housed in the same building as NOAA’s National Centers for Environmental Information in Asheville, NC. Lance told Major Harris about the type of projects DEVELOP conducts and offered collaboration. Since Major Harris works with the Department of Defense to monitor areas around the world, he had many projects in mind that could be made into DEVELOP projects, including this one.

**Partner Overview**

***Partner Organization:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| 14th Weather Squadron | Major Jason Scalzitti, Operations Officer | End-User | Yes |

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

The US Air Force, 14th Weather Squadron collects, protects, and exploits authoritative climate data in order to optimize military and intelligence operations and planning. The squadron currently ingests 4 TB of weather and climate data each year to feed various tailored statistical and geospatial climate summaries. Each year, 600 custom products are generated and 500K web hits help to inform acquisition of multi-billion dollar Defense programs, tactical and operational military planning, strategic basing decisions around the world, and more. Many recent supports have helped to inform the Intelligence Community’s human geography analyses, as climate variability is seen by the DoD as a threat multiplier to national security. While some remote sensing data are incorporated into some 14th Weather Squadron datasets, the unit is looking to leverage more robust datasets for some products to support the DoD and Intelligence Community. Recently, the 14th Weather Squadron started using a Standardized Precipitation Index (SPI) to monitor drought conditions. The 14th Weather Squadron is currently working on incorporating Normalized Difference Vegetation Index (NDVI) climatologies and 30-year trends from the first term of this project into their drought and heavy precipitation monitor.

***NASA Earth Observations Capacity:***

14th Weather Squadron is familiar with both remote sensing federal Climate Data Records (CDRs) as well as NASA Earth observations. While many personnel have used these datasets on an ad hoc basis, the organization does not currently take advantage of data created from NASA Earth observations.

***Collaborator & Boundary Organization Overview***

***Boundary Organization Dissemination:***

14th Weather Squadron – The 14th Weather Squadron will act primarily as an end-user. They will also share the results with other personnel in the DoD and Intelligence Community as needed. Currently, they plan on integrating the final products into their current operational procedures.

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

The team will have in-person meetings with Mr. Kiess and members of his team weekly to discuss progress. The team will also set up meetings with scientists within the building that are developing the satellite products.

***Transition Approach:***

The transition approach to the end-user will be in person because the 14th Weather Squadron is located within the same building as NCEI DEVELOP. Processed data and results will be transferred over google drive and the DoD’s large file transfer system.

**Earth Observations Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameters** | **Use** |
| **Terra & Aqua** MODIS | NDVI, EVI | Provide high resolution NDVI and EVI from 2000 to 2016 |
| **NOAA-7,-9,-11,-14,-16,-17,-18** AVHRR | NDVI | Provide a NDVI product from 1981 to 2016 to examine seasonal and long-term changes in vegetation |
| **Terra & Aqua** MODIS | LST | Provide high resolution LST from 2000 to 2016 |

***Ancillary Datasets:***

14th Weather Squadron & Global Precipitation Climatology Center (GPCC) – SPI and SPEI as well as precipitation data used by our partners

Levant & Central America Climate I project – AVHRR NDVI climatologies and NDVI trends

Global Historic Climate Network (GHCN) and Global Precipitation Climatology Center (GPCC) – precipitation network stations – will provide *in situ* data for the study regions

TBD – Historical records for drought and agricultural failure

***Software & Scripting:***

Python, ArcGIS, and R

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

|  |  |  |  |
| --- | --- | --- | --- |
| **End Products** | **Partner Use** | **Datasets & Analyses** | **Software Release Category** |
| Correlation Statistics between NDVI and SPI during Drought Periods – Maps & Figures | Will either support or highlight the limitations of using vegetation data as a drought indicator. | AVHRR NDVI, MODIS NDVI & EVI compared to 9 month and 24 month SPI  Correlation and Regression analyses | N/A |
| Vegetation Drought Index / Scaled Drought Condition Index (SDCI) | Will identify any indicating trends in vegetation that can be used as signals for agricultural drought | AVHRR NDVI, MODIS NDVI & EVI, MODIS LST, precipitation estimates  Calculating severity of anomalous vegetative health events to analyze agricultural drought | N/A |
| Script Packages | Will allow end-users to perform Indicative Vegetation Trends analyses and Comparative Analyses real-time analyses | AVHRR NDVI, MODIS NDVI & EVI  Analyses mentioned in previous end products | III |
| Maps & Figures | Where and when resources are allocated for extreme weather events | AVHRR NDVI, MODIS NDVI & EVI, SPI  Analyses mentioned in previous end products | N/A |

***End-User Benefit:***

The team will provide several products including script packages to perform near-real time analyses as well as maps and figures of vegetation trends that indicate oncoming drought. NDVI The team will use NDVI climatologies, created by the previous team, to analyze the correlation between NDVI and SPI, which is currently used as a drought indicator by the end-users, during historic drought events. These correlations will identify the strengths and limitations of using NDVI to assess drought as well as highlight any lags between the two indices.

Standardized Precipitation Index (SPI), provided by the 14th Weather Squadron, and possibly Standardized Precipitation Evapotranspiration Index (SPEI) or Evaporative Stress Index (ESI) will be incorporated into anomaly analyses performed by the team to make the found trends more robust. The team will also try and incorporate a more robust drought index into the end-users current processes that can be used by the 14th Weather Squadron in the future. Possible indices to incorporate could be a Scaled Drought Conditions Index (SDCI) by scaling and combining vegetation indices, MODIS LST, and precipitation estimates to monitor agricultural drought, SPEI, or ESI. Methods, script packages, as well as maps and figures will be provided to the 14th Weather Squadron so that they can integrate these results and methods into their current drought and heavy precipitation monitor.

**Project Timeline & Previous Related Work**

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

***Multi-Term Objectives:***

* **Term 1:** 2016 Spring (NCEI) – Levant & Central American Climate
  + The first term provided daily and monthly NDVI climatologies based on NOAA AVHRR NDVI data from CDRs to the 14th Weather Squadron. Monthly, 33 year trends and periods of interest anomaly maps were also created for the 14th Weather Squadron to incorporate into future drought forecasting tools. The results produced by the first term will be used to enhance the end-user’s drought monitor.
* **Term 2 (Proposed Term):** 2016 Spring (NCEI) – Levant & Central American Climate II
  + The second term of the project will perform exploratory anomaly analyses to try and discover correlation values between NDVI and SPI during drought events. The team will also create a drought index using vegetation indices (AVHRR NDVI, MODIS NDVI, and MODIS EVI) or an SDCI using the same vegetation indices combined with scaled MODIS LST and scaled precipitation estimates (provided by the 14th Weather Squadron).

***Related DEVELOP Work:***

Summer 2016 (Marshall Space Flight Center) – Mekong River Basing Agriculture: Utilizing NASA Earth Observations to Enhance Drought Management Decisions within the Mekong River Basin's Agricultural Fields

Spring 2016 (NOAA NCEI) – Levant and Central American Climate I: Heavy Precipitation and Drought Monitoring and Prediction in the Levant and Central America

Fall 2015 (NOAA NCEI) – Missouri River Climate: Utilizing NASA Earth Observations and NOAA Climate Data Records to model runoff in the Upper Missouri River Basin

Summer 2015 (NOAA NCEI) – Pacific Water Resources: Using NOAA CDRs and Satellite Data to Connect Phases of the El Niño Southern Oscillation (ENSO) with Precipitation across Hawaii and the US Affiliated Pacific Islands (USAPI)

**Notes & References:**

***References:***

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