NASA DEVELOP National Program
Spring 2016 Project Proposal

NOAA National Centers for Environmental Information (NCEI)
Levant & Central American Climate I
Heavy Precipitation and Drought Monitoring and Prediction in the Levant and Central America

Project Overview

Objective: Optimize the U.S. Air Force 14th Weather Squadron's Heavy Precipitation and Drought Monitor/Forecast for Department of Defense.

Community Concern: Drought and heavy precipitation are major concerns for many areas within Central America and the Levant. Heavy precipitation causes flooding, water contamination, and landslides. Drought exacerbates water supply and agricultural insecurity and causes livestock mortality and the migration of people.

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 U.S. Department of Defense and Intelligence Community understand the relationship between conflict and extreme precipitation or drought events. Understanding the spatial and temporal variations in precipitation is of 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, and Agriculture

Study Location: The Levant, made up of Syria, Lebanon, Israel, Iraq, and Jordan.
Central America, including Honduras, El Salvador, and Guatemala.

Study Period: January 1982 – December 2015 (will vary with satellite and *in situ* data products)

Advisors: Major Ryan Harris (14th Weather Squadron), Raymond Kiess (14th Weather Squadron), DeWayne Cecil (Global Science & Technology, Inc.), Rob Blevins (Meteorological Connections, LLC)

Source of Project Idea: The communication about this project first began with Lance Watkins and Major Ryan Harris of the U.S. Air Force 14th Weather Squadron housed at NOAA NCEI 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:
14th Weather Squadron (Boundary organization and End-User; POC: Major Ryan Harris, Operations Officer)

End-User Current Decision Making Process:
14th Weather Squadron collects, protects, and exploits, authoritative climate data in order to optimize military and intelligence operations and planning. The Squadron currently ingests 4TB 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 Intelligence Community 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.

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 Support:
14th Weather Squadron – The 14th Weather Squadron will be acting as an end-user for the project. As end-user, members of the Squadron will work directly with the team in an advisory role as well as to help determine methods used for the project. The DEVELOP team will work with members of the Squadron to ensure the project results can be easily adapted into the current operational procedures.

Communication Plan & Transition Approach:
The team will have in-person meetings with either Major Harris or other members of the 14th Weather Squadron twice a month to discuss progress. The team will also set up meetings with scientists within the building that are developing the satellite products.

The transition approach to the end-user will be in person because the 14th Weather Squadron is located within the building. They will then share it with other personnel in the Department of Defense and Intelligence Community as needed. Currently, they plan on integrating the final products into their current operational procedures.

End-User Benefit:
The team will provide many products to the 14th Weather Squadron including maps and figures of the long-term climatology of precipitation (satellite and *in situ)* and vegetation for the study areas. These long-term climatologies will be used to determine the spatial and temporal extent of typical precipitation and vegetation patterns. These will be used in conjunction with recent in situ observations to identify monitoring areas that are experiencing anomalously heavy precipitation and drought. Most importantly, the script to make these figures, maps, and statistical analyses will be provided to the 14th Weather Squadron so they can incorporate them into their current procedures and decision making.

Earth Observations Overview

Earth Observations:

Platform	Sensor	Geophysical Parameter
CMORPH-CDR	IR Band	Precipitation Estimate
PERSIANN-CDR	GridSat-B1 IR Window Channel	Precipitation Estimate
GPM	Merged Product	Precipitation Estimate
TRMM	TMI	Precipitation Estimate
Terra	MODIS	NDVI

NOAA-7,-9,-11,-14,-16,-17,-18	AVHRR	NDVI
GRACE		Groundwater

NASA Earth Observations Use:
GPM – This merged product will provide precipitation estimates at a high temporal (30 minute) and spatial resolution (0.1 degree). Unfortunately, data is limited to March, 2014 to present. It will be used to show the near present conditions which will be compared to PERSIANN and CMORPH.

TRMM – This product will provide long-term daily precipitation estimates from 1998 to 2015 for the study regions.

Terra MODIS – This product will provide high resolution NDVI from 2000 to present for the study regions.

NOAA AVHRR – This collaborative NOAA and NASA product will provide a NDVI product from 1989 to present for the project which will be used to look at seasonal changes and long-term changes in vegetation.

GRACE– GRACE will provide a look at the estimated groundwater supply in the study regions since 2002.

NOAA Climate Data Records Use:
CMORPH-CDR – This 8km product will provide daily high resolution precipitation for the region. Additionally, it can offer near-real time precipitation if proves valuable.

PERSIANN-CDR – This is a 0.25 degree daily precipitation product that extends from 1984 until present. This long temporal timeframe will provide 30 year climatology for the study regions. This precipitation product provides the longest timeframe of all the precipitation products used.

Ancillary Datasets:
Global Historic Climate Network precipitation network stations will provide *in situ* precipitation for the study regions; Historical records for drought and agricultural failure (TBD)

Decision Support Tool & End-Product Overview

Proposed End Products	Decision to be Impacted	Current Partner Tool/Method
Drought and Heavy Precipitation Monitoring Tool	Identify climate "hot spots" to DoD and IC partners that could prompt regional stability concerns.	Drought monitor using SPI derived from CMORPH and other datasets
Long-term Climatology	First step to determine baseline normals for the regions	Spatial climatology using surface datasets (Worldclim, GHCN, in-house climate summaries, CFSR, etc)

Maps & Figures	Where and when resources are allocated for extreme precipitation events	ArcGIS

Drought and Heavy Precipitation Monitoring Tool - Script that downloads and analyzes datasets to produce maps and figures for the study regions. The script will use the precipitation data, NDVI, evapotranspiration and groundwater data as available.

Climatology – Developing a long-term climatology will be the first step in determining the areas and times that experience abnormally high or low precipitation or changes in NDVI. It will provide the base to model and map the data. Comparisons to the 14th Weather Squadron's existing spatial climatologies will help refine current global climate analyses.

Maps & Figures – Maps showing differences, extremes, and percentiles of precipitation and NDVI for the study regions will be made using the Drought Monitoring Tool made by the team. This will show the capabilities of the tool as well as highlight some of the results. These are the products that can be used to determine the areas and times when resources should be allocated.

Project Timeline & Previous Related Work

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

Multi-Term Objectives:

- **Term 1 (Proposed Term)** – The goal of the first term is to provide a drought and heavy precipitation monitoring tool to the 14th Weather Squadron that they can use to determine areas and times that will be influenced by drought or heavy precipitation. Once this tool is developed, it will be used for subsequent terms.

- **Term 2** – The second term of the project will modify the drought and heavy precipitation monitoring tool to look at other areas and possibly other datasets such as NDVI to make a more robust connection with precipitation anomalies and vegetation health. Additionally, the 14th Weather Squadron will be able to offer suggestions to make the tool better. These suggestions will be incorporated into the tool.

Previous Related DEVELOP Work:

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 U.S. Affiliated Pacific Islands (USAPI)

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

Project Needs/Requests

Participants Requested: 4 Participants

Software & Scripting:

Python, ArcGIS, and R

References:

Kelly, C.P., S. Mohtadi, M.A. Cane, R. Seager and Y. Kushnir (2015) Climate change in the Fertile Crescent and implications of the recent Syrian drought. *PNAS*. 112 (11): 3241-3246.
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