**NASA DEVELOP National Program**

**Fall 2015 Project Proposal**

**Wise County Clerk of Court’s Office**

**African Great Lakes Weather**

Utilizing NASA Earth Observations to Identify Indicators to Help Predict Deadly Storms over African Great Lakes

**Objective:**

To identify indicators for predicting the creation of powerful storms over the African Great Lakes to help those who use the lake, and countries neighboring it, to prepare for and mitigate damage and casualties.

**Community Concern:**

The African Great Lakes are a major source for food resources for neighboring countries. Population densities are very high along the shoreline with millions of people depending on the lakes for fishing, tourism, and agriculture. However, according to CNN, one of its lakes, Lake Victoria, is considered to be the world’s most dangerous lake. There have been connections made with major weather phenomena sourcing from Lake Victoria and other African Great Lakes. Each year around 5,000 people are killed with little warning from these storms and most of those are fishermen trying to make their livelihood. In addition, these storms gather enough intensity to cover and affect many nearby countries. There is a need for methods to provide early warning to fisherman and citizens in nearby countries.

**Partner Organizations:**

Tanzania Meteorology Agency (TMA) (End-User, Collaborator, Boundary Organization, POC: Dr. Hashim Ng’ongolo, Manager Environment and Research)

Email contact has been made with the partner, Dr. Hashim Ng’ongolo, Manager of Environment and Research for the Tanzania Meteorology Agency. The TMA mission is to provide quality, reliable, and cost effective meteorological services, thereby contributing to their goals of national poverty eradication and the protection of life, property, and the environment. This project will help the TMA toward their goals. Methodologies and results will be handed over through a tech paper and presented during a video conference explaining the research.

**Decision Making Process:**

The strategy of TMA is to take part in a global exchange of meteorological and related data and products for the safety of humankind and to enhance the understanding of the global atmosphere. To provide weather forecasts, climate services, and warnings for the safety of life and property to the general public and to various users including aviation, agriculture and food security, water resources, disaster management, health and construction industry. Currently, they are not using NASA Earth observations to provide any of these services. They depend heavily on *in situ* data from the weather stations, along with climate prediction models and EUMETSAT data (European Organization for the Exploitation of Meteorological Satellites).

**Earth Observations:**

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| **Platform** | **Sensor** | **Geophysical Parameter** |
| **Aqua** | AIRS | Temperature, water vapor, weather forecasting |
| **Aqua/Terra** | MODIS | Surface temperature |
| **Suomi NPP** | VIIRS | Surface temperature, cloud properties |
| **QuikSCAT** | SeaWinds | Sea winds |
| **CloudSAT** | CPR | Cloud classification, cloud optical depth, cloud water content, fluxes and heating rates |
| **TRMM** | PR | Rainfall |
| **GPM** | DPR | Rainfall |
| **CALIPSO** | CALIOP | Vertical profiles of aerosols and clouds |
| **SORCE** | SIM | Measurements of suns output |
| **Aura** | MLS | Upper air temp, water vapor, humidity |
| **NOAA-POES** | AVHRR | Sea surface temperature |

**NASA Earth Observations to be Highlighted:**

*Aqua (AIRS)* – can provide information on the temperature and humidity of the air over the African Great Lakes, which relates to the stability and moisture of air that is important to the creation of storms.

*Aqua/Terra**(MODIS)* – MODIS can provide surface temperatures that are important in discovering information about sea breeze. Because land is heated by solar radiation heat faster than water, sea breeze occurs in the morning as the air flows from the water towards the land where there is less pressure. Surface temperature in combination with water temperature and surface winds can provide information on sea breeze’s part in the development of the storms.

*Suomi NPP (VIIRS) – can provide follow-on data for MODIS and provide data on cloud properties.*

*QuikSCAT (SeaWinds)* – can provide wind information that takes place over Lake Victoria.

*CLOUDSAT (CPR)* – can provide information about the clouds, such as heating rate and extent before and during the reported storm events.

*TRMM (PR)* – precipitation measurements from TRMM will show the amount of rainfall that was experienced in the area for the period available.

*GPM (DPR)* – GPM launched in early 2014 carrying Dual-Frequency Precipitation Radar will provide data for the recent years.

*CALIPSO (CALIOP)* – CALIOP can provide vertical profiles of clouds that will tell how much air was being moved vertically, which indicates the amount instability. This information will be beneficial when compared to the measurements of other environmental aspect in play.

*SORCE (SIM)* – spectral measurements from SORCE characterize the Sun's energy and emissions in the form of color that can then be translated into quantities and elements of matter. Data obtained by the SORCE experiment can be used to model the Sun's output and to explain and predict the effect of the Sun's radiation on the Earth's atmosphere and climate.

*Aura (MLS)*– provides upper air temperature in the upper parts of the troposphere, which can help determine the instability of the air when compared with other temperatures, such as that on the surface; also provides water vapor measurement in the upper parts of the troposphere, which would also take place in the formation of storms.

The combination of the data collected from these satellites can provide a method of discovering the likely environmental setting and contributions that make the weather so deadly over the African Great Lakes.

**Ancillary Datasets:**

* Modern Era Retrospective-Analysis for Research and Applications (MERRA)
* *In-situ* rain, humidity, and temperature from weather stations
* CMORPH and QMORPH data from Climate Prediction Center, NOAA
* Temperature data from Giovanni Database
* ISS Rapidscat data products

**Decision Support Tools & Analyses:**

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| --- | --- | --- |
| **Proposed End Products** | **Decision to be Impacted** | **Current Partner Tool/Method** |
| Density Map | Helping depict the typical location and strength of weather factors  | *In-situ* weather stations and radar |
| Early Warning System | Weather forecasting and warnings to citizens and fishermen | *In-situ* weather stations and radar |

Density Maps – showing where the highest and lowest concentration of individual parameters were

Early Warning – Data from each of the satellites listed above will be studied for patterns, put into charts, and compared to see how they correlate during each weather event. An average range can be taken from each environmental factor to help estimate when another storm may be ready to happen when those factors come into average ranges.

**Project Details:**

**National Application Areas Addressed:** Weather, Disasters

**Source of Project Idea:** Kristopher Bedka from the Climate Science Branch at NASA Langley Research Center is doing a study showing how major storms originate from Lake Victoria and the other African Great Lakes. He suggested that DEVELOP could assist in these efforts by trying to locate indicators that started the storms and helping find a way to estimate from the environment when another storm is in the making and will happen in the very near future.

**Study Location:** African Great Lakes - Lake Victoria, Lake Tanganyika, Lake Malawi, Lake Turkana, Lake Albert, Lake Rukwa, Lake Mweru, Lake Kivu, Lake Edward (Burundi, Democratic Republic of Congo, Kenya, Rwanda, Tanzania, Uganda)

**Period being Studied:** January 2010 – Present: Time segments around major storm events in the African Great Lakes study area

**Advisors:** Dr. Kenton Ross (NASA DEVELOP), Dr. Dwayne Cecil (Global Science Technology Inc.), Mr. Kristopher Bedka (NASA Langley Research Center Climate Science Branch)

**Participants Requested:** 5

**Project Timeline:** 3Terms: 2015 Fall to 2016 Summer

**Multi-Term Objectives:**

* **Term 1 (Proposed Term)** – Participants will determine when major storms took place from historical reports and news, and also through partner inputs. The team will download data for a few days before and during the weather event, and then note or chart the measurements of each environmental aspect before and after the storm. They will try and find correlations between the data collected and try to find the typical range in values present for each environmental aspect that is present before and during each weather event**.**
* **Term 2**. As there are diverse data products that will be used, the team will spend considerable time getting acquainted with each sensor’s unique capabilities and functional requirements. They will look at the typical ranges in measurement for the environmental aspects in play and develop their own model or system that can be used with recent data to see the likelihood of a storm in the near future. The team will look for a model to use in creating an early warning system or create a new model based on findings from term 1.
* **Term 3.** The final term will focus on consolidating all the results into a tangible early warning system that could be utilized by the partners. All the results, along with tutorials will be handed over to the partners through video conferencing. A possibility of arranging a webinar for interested local organizations will be considered.

**Software & Scripting Utilized:**

* ArcGIS - Image enhancement, raster manipulation, and map creation of various data collected from satellites listed above