**NASA DEVELOP National Program**



Wise County / City of Norton Clerk of Court’s Office

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East African Great Lakes Weather

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

 **Technical Report**

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# I. Abstract

**Keywords**

Earth Observations, Weather, MERRA, Hazardous Storms

# II. Introduction

The East African Great Lakes region spans eastern Africa’s tropical rift valleys, including parts of the sovereign states of Kenya, Tanzania, Uganda, Burundi, Rwanda, and the Democratic Republic of the Congo. Here, the large freshwater lakes (the biggest among them being Lake Victoria and Lake Tanganyika) influence regional climate conditions and play a vital role in the economic livelihood of millions of people; 30 million of whom live along the coasts of Lake Victoria alone. Almost 1/3 of this population’s food supply is drawn from the lake by more than 200,000 fishermen. The provinces surrounding the lake constitute one of the most productive agricultural realms in East Africa.

While much is already known about how these large lakes regulate climate and contribute to the diurnal cycles of lake/land breezes and the thermal gradient surrounding the lake, less is understood about the provenance of hazardous weather events in the lakes’ immediate vicinity. Part of this is due to the area’s tropical conditions, where tumultuous storm events arise suddenly and are not always accompanied by larger, more comprehensive storm movements. Thunderstorms that arise over these lakes (esp. Lake Victoria) are severe; their convective activity commonly approaching depths of 6km, producing gale-like conditions of high winds, and having some of the densest and most frequent lightning strikes in the world. It is estimated that around 5,000 fisherman die every year on the lake as a result these storms.

This project aims to better understand the meteorology of these storm events by analyzing atmospheric conditions that surrounded some of the most severe storms during the study period (2005 – 2013). Data compiled into the Hazardous Storm Event Database over the African Great Lakes region was utilized for this research. The Hazardous Storm Event Database is a directory of pixels that have been classified as ‘overshooting tops’ by a detection algorithm developed by NASA Applied Sciences and the GOES-R Aviation Algorithm Working Group. The designation of ‘overshooting tops’ refers to the convective phenomenon in which strong updraft currents punch through into the lower stratosphere, above the storm equilibrium level. Storm events that feature overshooting tops yield especially hazardous conditions at ground level. Employing infrared brightness temperatures from the SEVIRI sensor onboard EUMETSAT’s METEOSAT satellite, this algorithm analyzed 15 minute geostationary images during the aforementioned time period, and thus set the terms for the temporal study area by nature of what was included in the database.

The partners for this project are from the Kenya Meteorological Department (KMD), whose mission is “To facilitate accessible meteorological information and services and infusion of scientific knowledge to spur socio-economic growth and development”. The KMD is a new partner to DEVELOP, but it has worked closely with NASA SERVIR in the past. NASA’s Short-term Prediction Research and Transition Center (SPoRT) worked with the KMD on inserting data from NASA LIS into KMD weather prediction models. SERVIR has previously had a presence at the department, helping to train KMD personnel on use of NASA imagery and to better integrate model changes.

This project will assist both the project partners and the researchers at NASA Applied Sciences by expanding on the knowledge associated with the detection of overshooting tops. Thus, this project could fall into any of 3 NASA Application areas. Since this initial term deals more with research and analysis of storm observations and derived datasets, it is appropriately assigned to the Weather application area in the title. However, subsequent terms might be better classified within Disasters or Ecological Forecasting application areas; depending on the direction of the project.

# III. Methodology

Data which spanned from 2005 – 2013 was acquired from the Hazardous Storm Event Database. Each row in the data corresponded to a pixel that had been classified from the SEVIRI images as an ‘overshooting top’ by the detection algorithm mentioned in the introduction. The rows were set up with 7 columns with the following information:

* Column 1: YYYY-MM-DD-HHmm, Y=4 digit year, M=month of year, D=day of month, HHmm=time of satellite scan in UTC
* Column 2-3: Latitude/Longitude of pixel with storm detection
* Column 4: Satellite-observed infrared temperature of pixel
* Column 5: The temperature difference between the pixel with a storm detection and the surrounding cirrus anvil cloud.
* Column 6: A quality control parameter
* Column 7: The “ID number” for the storm detection within the satellite image at a particular date and time.   There are multiple pixels within each storm and the ID number helps one to cluster them together.

MATLAB r2015a was used to compile the raw data from the Hazardous Storm Event Database. The initial data contained multiple OT detections for almost every day over the 9 year study period, totaling tens of millions of data points. This data was imported into MATLAB and summarized by day, reducing the amount of data points to fewer than 3,500.

After processing in MATLAB, the data was imported into Microsoft Excel for further statistical analysis. Using the Percentile function within Excel, days that recorded within the 99th percentile were extracted from the database’s temporal span. The same was done at the 50th percentile to use as a baseline for comparison. From these subsets , 10 days were randomly chosen amongst the group to use as study cases.

From the GES – DISC Mirador Data Holdings, 2 MERRA products were downloaded as zipped NetCDF files for each study case at the 99th and 50th percentile study cases.

This data product information is described below. Additional information on the included variables can be found in the link.

1. inst6\_3d\_anaNP

 short name: *MAI6NPANA*

long name: *MERRA DAS 3d analyzed state on pressure*

*variables*:

1. tavg1\_2D\_slv\_Nx

short name: *MAT1NXSLV*

long name: *MERRA IAU 2d atmospheric pressure single level diagnostics*

variables:

# IV. Results & Discussion

# V. Conclusions

# VI. Acknowledgments

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Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Aeronautics and Space Administration.

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# IV. Appendices

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