**NASA DEVELOP National Program**

**2020 Spring Project Proposal**

**North Carolina – NCEI**

**Ohio River Basin Water Resources**

*Monitoring Flash Drought Potential and Quantifying the Hydrologic Impacts in the Ohio River Basin*

**Project Overview**

***Project Synopsis*:** The objective of the project is to use a combination of gauge-based and remote sensing data products to study which drought indicators best represent observed drought impacts in the Ohio River Basin. The team will analyze the impacts of rapid onset drought conditions, or ‘flash droughts’, on hydrological processes across the region. The team will use ECOSTRESS, GPM IMERG, and Evaporative Demand Drought Index (EDDI) to measure flash drought potential based on precipitation and evapotranspiration anomalies. The hydrologic impacts of interest include water quality and soil moisture retrieved from Landsat 8 OLI and SMAP, respectively. Understanding which measures of flash drought best anticipate impacts on hydrologic processes will help hydrologists and other resource managers better identify and communicate drought risk in the region on an actionable time frame.

***Community Concern:*** The Ohio River Basin covers 204,000 square miles of the United States and is home to approximately 27 million people. The Ohio River and its tributaries provide freshwater resources to manufacturing, energy, and agricultural industries. In the past several decades, this region has experienced cycles of drought and excess moisture. For example, September 2019 was the driest September on record of the state of Kentucky, following an anomalously wet summer, which resulted in declines in soil moisture and growth of algal blooms in rivers. Climate models project this cycle to intensify with more frequent drought and flood events. Currently, the Ohio River Forecast Center and Kentucky Climate Center do not employ flash drought indicators in their dissemination of water resources information to stakeholders.

***Source of Project Idea:*** The NOAA National Weather Service, Ohio River Forecast Center reached out to regional coordinators from NOAA’s National Integrated Drought Information System. The regional coordinators put the Ohio River Forecast Center in contact with leadership at the NASA DEVELOP North Carolina node, with an interest in exploring the relationship between meteorological drought and hydrologic drought using remote sensing.

***National Application Area Addressed:*** Water Resources

***Study Location:*** OH, KY

***Study Period:*** January 2000 – October 2019

***Advisor:*** Ronald Leeper (NOAA National Centers for Environmental Information, North Carolina Institute for Climate Studies)

**Partner Overview**

***Partner Organization:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| **NOAA National Weather Service, Ohio River Forecast Center** | James Noel, Service Coordination Hydrologist  | End User | Yes |
| **Kentucky Climate Center** | Stuart Foster, Kentucky State Climatologist  | End User | Yes |
| **NOAA Earth System Research Lab, Physical Sciences Division** | Michael Hobbins, Research Hydrologist | Collaborator | No |

***End User Overview***

***End User’s Current Decision-Making Process:***The NOAA National Weather Service, Ohio River Forecast Center calculates and disseminates hydrologic data to stakeholders in the Ohio River Basin. These data include streamflow measurements, hydroclimate forecasts, and flood and drought warnings. The center assists stakeholders in decision making processes regarding water supply. This assistance includes working with agricultural producers to identify drought risk and develop best practices for water management. Similarly, the Kentucky Climate Center works with stakeholders, such as agriculture extension specialists, to communicate climate information and provide climate information services. The Kentucky Climate Center manages and produces the Kentucky Mesonet data, a system of gauge-based climate and weather observations for local and state-wide coverage.

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

*NOAA National Weather Service, Ohio River Forecast Center* – The Ohio River Forecast Center has partnered with DEVELOP projects in the past, so they are familiar with the usage of NASA Earth observations. Additionally, they employ specialists and researchers with expertise in geospatial data analysis and hydrology. They have yet to use Earth observations to study the impacts of flash droughts in their region.

*Kentucky Climate Center* – The Kentucky Climate Center operates and produces the Kentucky Mesonet datasets, which include soil moisture observations and vegetation greenness, among other climate and weather parameters. While they have a strong understanding of climate services, they are interested in leveraging federal resources like Earth observations with state datasets to create value-added products.

***Collaborator & Boundary Organization Overview***

***Collaborator Support:***

*NOAA Earth System Research Lab, Physical Sciences Division* – NOAA Earth System Research Lab, Physical Sciences Division develop various drought indices, including EDDI. They will provide guidance on its usage and application in relation to hydrologic drought.

***Dissemination by Boundary Organizations*:**

*NOAA National Weather Service, Ohio River Forecast Center* – The Ohio River Forecast Center produces hydrologic data and forecasts on its website and offers web tools to access and visualize the data. The Ohio River Forecast Center also works directly with stakeholders, such as agricultural extension agencies and research groups to develop best management practices regarding water availability.

***Project Communication & Transition Overview***

***In-Term Communication Plan*:** The node leadership and Project Lead will establish recurring meeting times for partner engagement and feedback. The partners expect to meet on a bi-weekly basis over the phone to discuss project updates, methods, and end product specifications.

***Transition Plan*:** The team will deliver the handoff package through an interactive presentation to the partners at the end of the term, in which all stakeholders will discuss results and lessons learned. They will conduct the presentation over video chat and transfer the data products to the partners via Google Drive.

**Earth Observations Overview**

***Earth Observations:***

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| --- | --- | --- |
| **Platform & Sensor** | **Parameter** | **Use** |
| **GPM IMERG** | Precipitation | The team will calculate meteorological drought using precipitation anomalies, as a flash drought indicator.  |
| **SMAP L-band** | Root Zone Soil Moisture | The team will measure water availability in soil moisture and soil moisture anomalies as a component of hydrologic drought.  |
| **ECOSTRESS** | Evaporative Stress Index (ESI) | The team will use ESI as one of the flash drought indicators based on observations of evapotranspiration.  |
| **Landsat 8 OLI** | Chlorophyll-α  | The team will measure the presence of algal blooms using chlorophyll-α measurements, as a short-term drought impact.  |

***Ancillary Datasets:***

* NOAA Earth System Research Lab Evaporative Demand Drought Index (EDDI) – The team will use EDDI to measure flash drought potential based on evaporative demand anomalies and compare to the indicators of hydrologic drought. The data are derived from the NASA National Land Data Assimilation Systems (NLDAS-2).
* Kentucky Mesonet – The team will use gauge-based observations from the Kentucky Mesonet as ground-truthing measurements for root zone soil moisture.

***Software & Scripting:***

* ESRI ArcMap – map generation, raster analysis, land cover classification
* Google Earth Engine – data acquisition, raster processing
* R – data analysis and visualization
* Python – data analysis and visualization

**Decision Support Tool & End Product Overview**

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Product** | **Partner Use** | **Datasets & Analyses** | **Software Release Category** |
| **Flash Drought Index Analysis**  | The analysis will demonstrate which of the selected flash drought indices best indicate potential drought impacts in advance. The partners can then use the indices as measures of drought potential before the onset of impacts.  | The team will use GMP IMERG and ECOSTRESS to calculate drought indices. The team will compare the indices to observable drought impacts, including Landsat 8 OLI for water quality and SMAP for soil moisture decline.  | N/A |
| **Water Resource Anomaly Calculation Tutorial**  | The partners will learn how to access and process remote sensing measurements of water resources and calculate anomalies in precipitation, soil moisture, and evapotranspiration to identify drought risks.  | The team will use GPM IMERG, SMAP, and ECOSTRESS to calculate anomalies at various time scales for precipitation, soil moisture, and Evaporative Stress Index.  | N/A |

***End User Benefit*:** Currently, the Ohio River Forecast Center outputs drought risk and prediction information, and the Kentucky Climate Center provides climate services to stakeholders throughout the state. They are interested in learning how to use Earth observations to calculate flash drought indices and working with the DEVLEOP team to conduct an analysis on which indices best anticipate or represent specific drought impacts, such as soil moisture decline or growth of algal blooms in rivers. This information will give the end users an understanding of applications of the indices for drought risk monitoring and the subsequent mitigation of drought impacts. Using Earth observations in conjunction with gauge-based data will provide the end user value-added products that demonstrate the collaboration between federal and state agencies.

**Project Timeline & Previous Related Work**

***Project Timeline:*** 1 Term: Spring 2020

***Related DEVELOP Work:***

2017 Summer (GSFC) – Niger Water Resources: Implementing a Global Tool for Mercy Corps Based on Spatially Continuous Precipitation Analysis for Resiliency Monitoring and Measuring at the Community-Scale

2018 Spring (VA) – Fremont River Basin Water Resources: Water Availability Assessment from Annual Snowpack in the Fremont River Basin Based on NASA Earth Observations and In Situ Data

**Notes & References:**

***References:***

Haslinger, K., Koffler, D., Schöner, W., & Laaha, G. (2014). Exploring the link between meteorological drought and streamflow: Effects of climate-catchment interaction. *Water Resources Research*, *50*(3), 2468–2487. https://doi.org/10.1002/2013WR015051

Hobbins, M. T., Wood, A., McEvoy, D. J., Huntington, J. L., Morton, C., Anderson, M., & Hain, C. (2016).

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