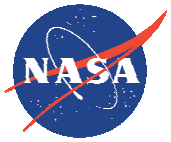

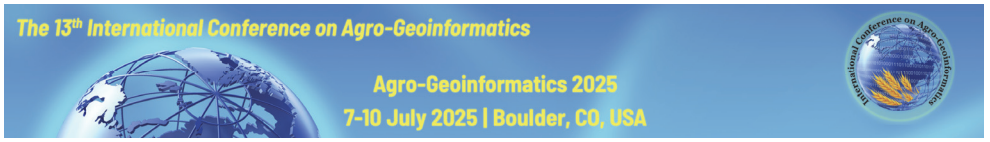

Rapid Agricultural Impact Mapping of Hurricanes Using Open-Source Tools

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Outlines

- Introduction: challenges
- Methodology
- Workflow
- Use cases
- Conclusion
  - Findings
  - Workflow & its reusability
  - Future directions

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Introduction: The Challenge

- Hurricanes pose significant threats to agriculture, causing substantial damage to crops, soil, and infrastructure
- Annual agricultural losses from hurricanes can reach billions of dollars
- Rapid assessment is crucial for effective disaster response and recovery
- Vulnerable rural communities often face disproportionate impacts

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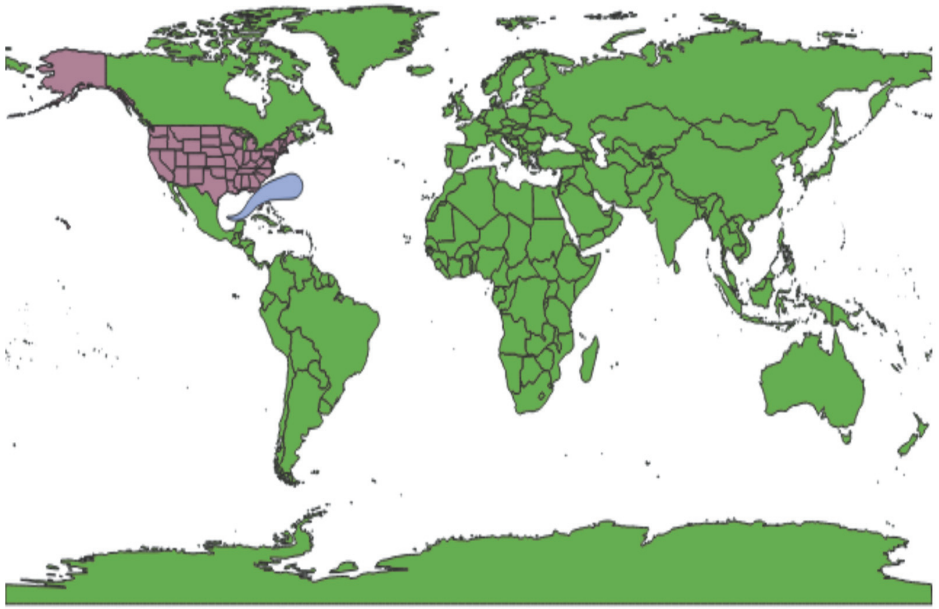
Deal with the Challenge: An Open-Source Workflow

- Open-source workflow leveraging QGIS and Jupyter Notebooks
- Rapid assessment of hurricane impacts on agricultural areas
- Automated integration of publicly accessible datasets
- Comprehensive analysis through geospatial techniques



Openness, Accessibility, Reproducibility, and Collaboration

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The Library

- To support the retrieval and ingestion of diverse dataset, we have implemented a library.
  - To be released at the github repo of eugenegesdisc/hurricane-impact-assessment
- What are the implementation technical stacks of the library?
  - Python
  - GDAL is the core for data reading, ingesting, and transform
- What does the library do?
  - Retrieval of data from different source
  - No code, low code to use the library by configuration
  - Convert the data
  - Able to communicate with Giovanni programmatically

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Data Sources - weather

- National Hurricane Center (NHC)
  - Provides hurricane track data, wind patterns, and intensity measurements essential for mapping hurricane paths and impact zones
- NOAA Office of Water Prediction (OWP)
  - Supplies observed and forecasted precipitation data critical for flood risk assessment and water-related impact analysis
- NASA IMERG Precipitation Data
  - Integrated Multi-satellite Retrievals for Global Precipitation Measurement (IMERG) provides high-resolution precipitation estimates from NASA's GES DISC

Data Sources – Agricultural & Data Integration

- USDA Cropland Layers (CDL)
  - Detailed agricultural land use data identifying crop types, distribution, and acreage for precise impact assessment
- USDA Agricultural Statistics
  - Quick Stats (https://quickstats.nass.usda.gov/)
  - Field crops and their expected productivity
- US Census Bureau Socioeconomic Data
  - Critical demographic economic indicators to identify and prioritize vulnerable rural communities for targeted disaster response
- Data Integration
  - Combing these datasets enables comprehensive analysis and more accurate identification of at-risk agricultural areas

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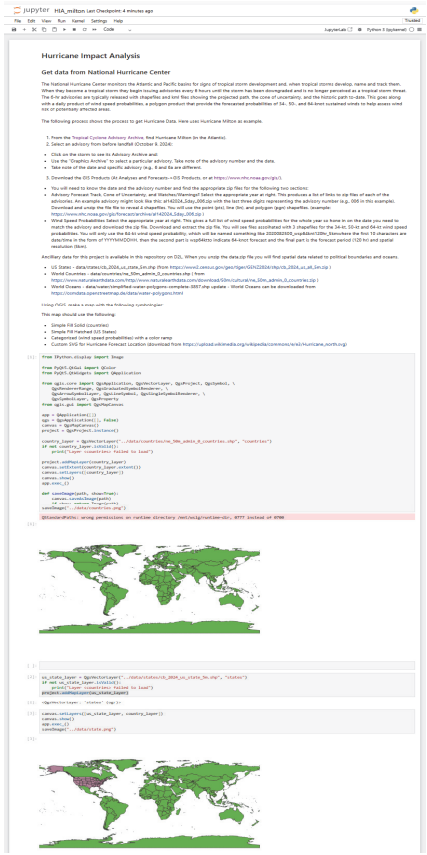
Core workflow: Data Integration & Analysis

- Data Collection & Preprocessing
  - Automated retrieval and standardization of diverse data sources into compatible formats
- Hurricane Wind Pattern Mapping
  - Analysis of wind speed, direction, duration using NHC data
- Flood Risk Assessment
  - Identification of potential flood zones and estimation of inundation depth
- Precipitation Analysis
  - Calculation of cumulative precipitation using both IMERG data and NOAA estimations



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Core workflow: Impact Assessment

- Soil Erosion Modeling
  - Estimation of soil loss using precipitation data, topography, and soil characteristics
- Crop Loss Estimation
  - Application of hurricane damage indices (e.g. Hurricane Composite Intensity Index) to estimate agricultural losses
- Vulnerability Assessment
  - Integration of socioeconomic data to identify vulnerable communities and prioritize response
- Comprehensive Impact Analysis
  - Synthesis of all analyses to provide a complete assessment of hurricane-induced damage

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Key Features and Benefits of the Geospatial Workflow

- Rapid Assessment
  - Timely and accurate identification of affected agricultural regions, enabling quick response, and resource allocation.
- Community Prioritization
  - Identification of vulnerable rural communities for targeted disaster response based on socioeconomic indicators
- Reproducibility
  - Standardized workflow that can be consistently applied across different hurricane events and geographic regions
- Comprehensive Integration
  - Seamless combination of ground observations, model outputs, satellite imager, and advanced GIS capabilities
- Open-Source Accessibility
  - Freely available tools and methodologies that can be adapted and improved by the broader community
- Data-Driven Decision Making
  - Quantitative analysis supporting evidence-based resource allocation and policy development

Decision-Ready Infographics

- Spatial Joins and Overlay Analysis
  - Combining all aligned data layers to create comprehensive spatial representations of hurricane impacts
- Interactive Mapping
  - Development of queryable dynamic maps that allow stakeholders to explore specific impact areas
- Visual Data Summaries
  - Creation of charts, graphs, and statistical summaries that quantify damage across different agricultural sectors
- Decision Support Reports
  - Automated generation of concise reports highlighting priority areas for intervention and resource allocation

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Reproducibility & Accessibility

- Open-Source Repository
  - The complete workflow, including reproducible notebooks and tutorials, will be released on GitHub to serve as a valuable resource for the community
    - Github repo: eugenegesdisc/hurricane-impact-assessment
  - Detailed documentation and step-by-step guides to empower users to implement the workflow in their own contexts
  - Well-commented code and Jupyter notebooks that can be easily understood and modified
  - Community collaboration platform for continuous improvement and innovation
  - Educational resources for researchers, practitioners, and policymakers

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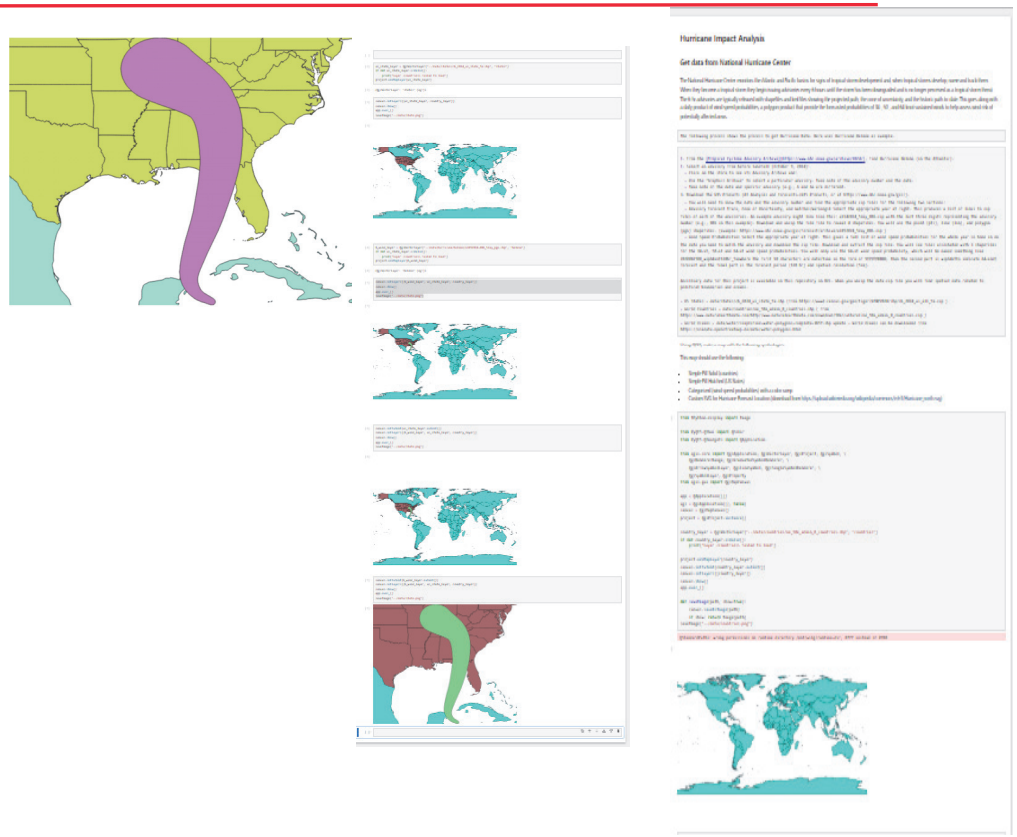
Case Study: Hurricane Helene (2024)

- Southern United States
- Crops affected: cotton, peanut, and pecan crops
- Agricultural losses: estimated more than $10 billion (link, Georgia, North Carolina)
- Key Outcomes
  - Rapid identification of priority areas enabled targeted deployment of emergency agricultural support



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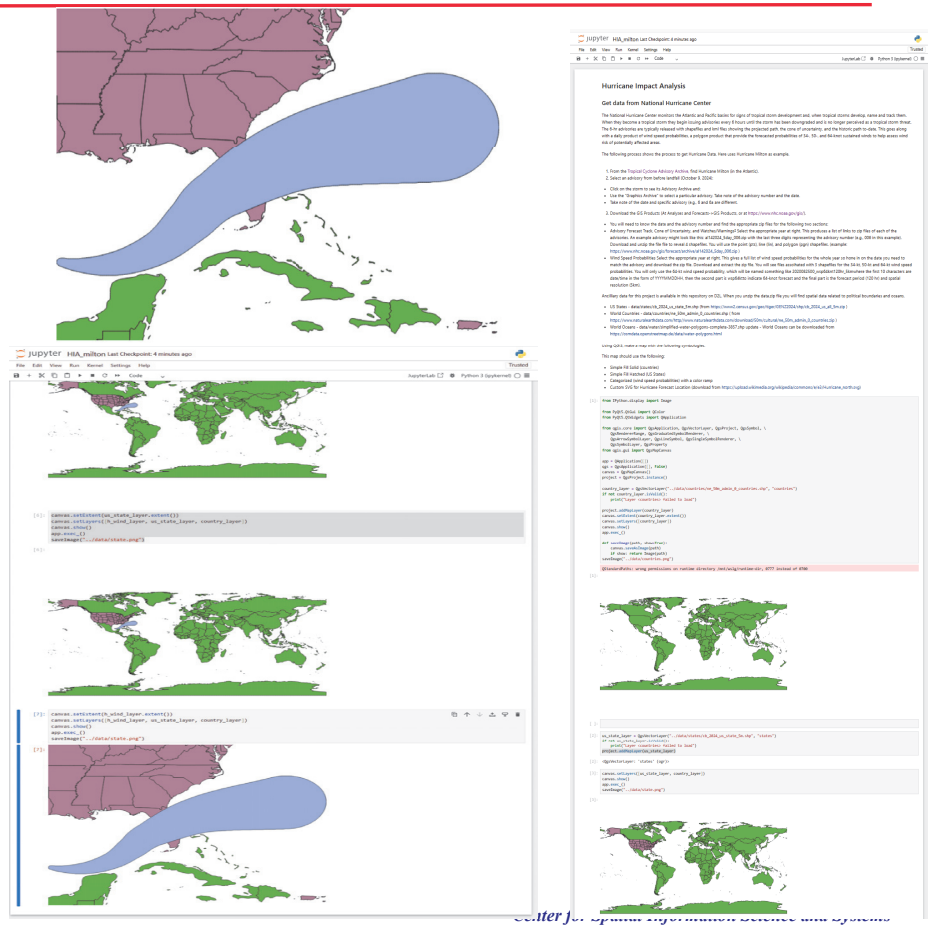
Hurricane Milton (2024)

- Florida Peninsula
- Crops affected: citrus groves and vegetable farms
- Agricultural losses: estimated more than $1.5 billion (link)
- Key Outcome
  - Predictive modeling allowed for pre-positing of resources and targeted evacuation
  - Monitoring the hurricane via time-triggering event to re-run the workflow



Conclusion and Future Directions

- Contributes to agricultural resilience and disaster preparedness through accessible geospatial technology
- Demonstrates the power of leveraging open geospatial web services and open data for comprehensive hurricane impact analysis
- Prioritizes disaster response to mitigate adverse effects on agriculture
- Promotes sustainable recover efforts and long-erm agricultural planning in hurricane-prone regions
- Future directions
  - Leverage large models (language and vision) for improved automation of workflow creation, execution, and curation
  - Adopt standard interfaces and integrate with existing workflow flatform, e.g. Galaxy workflow platforms

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