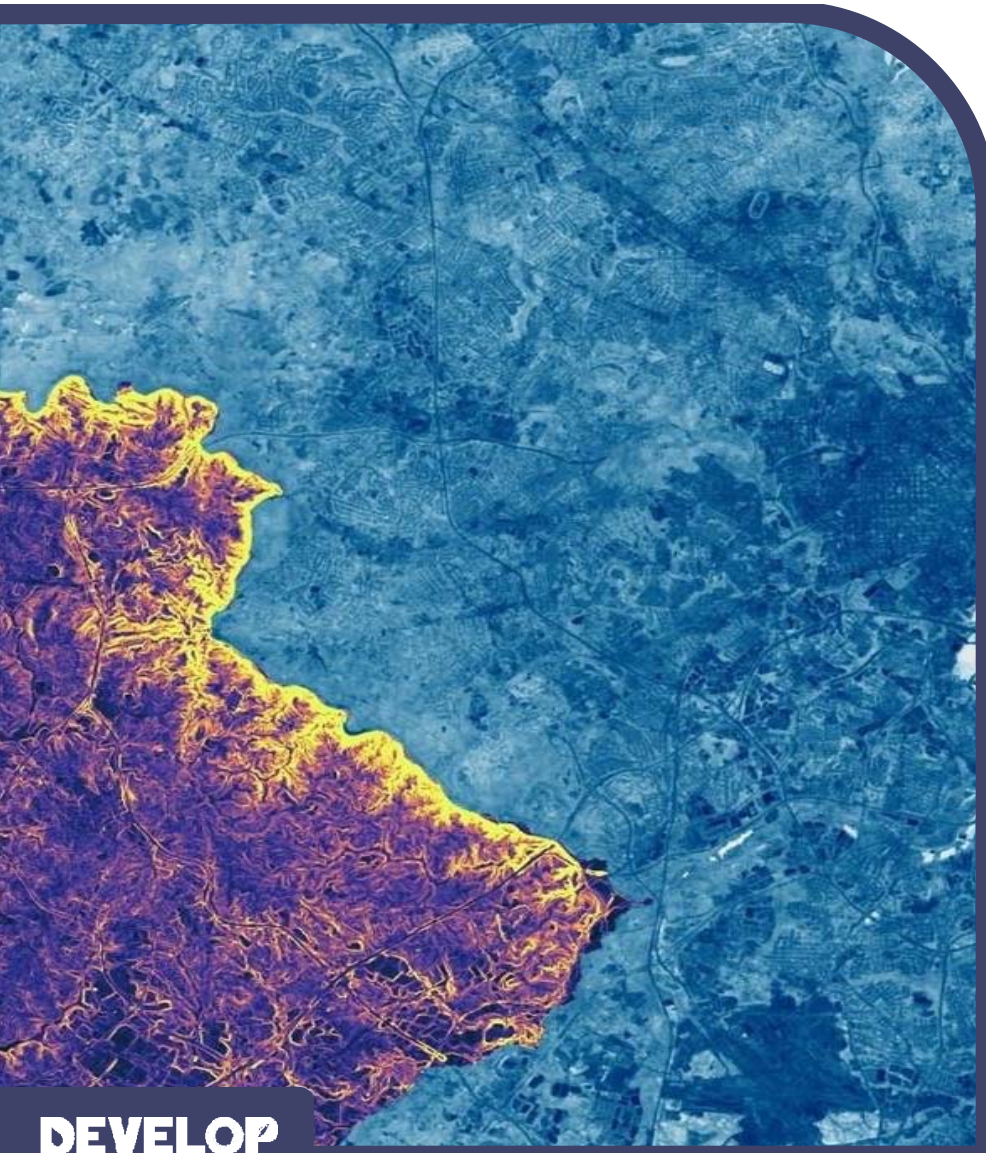


National Aeronautics and Space Administration

Ellicott City

Disasters II

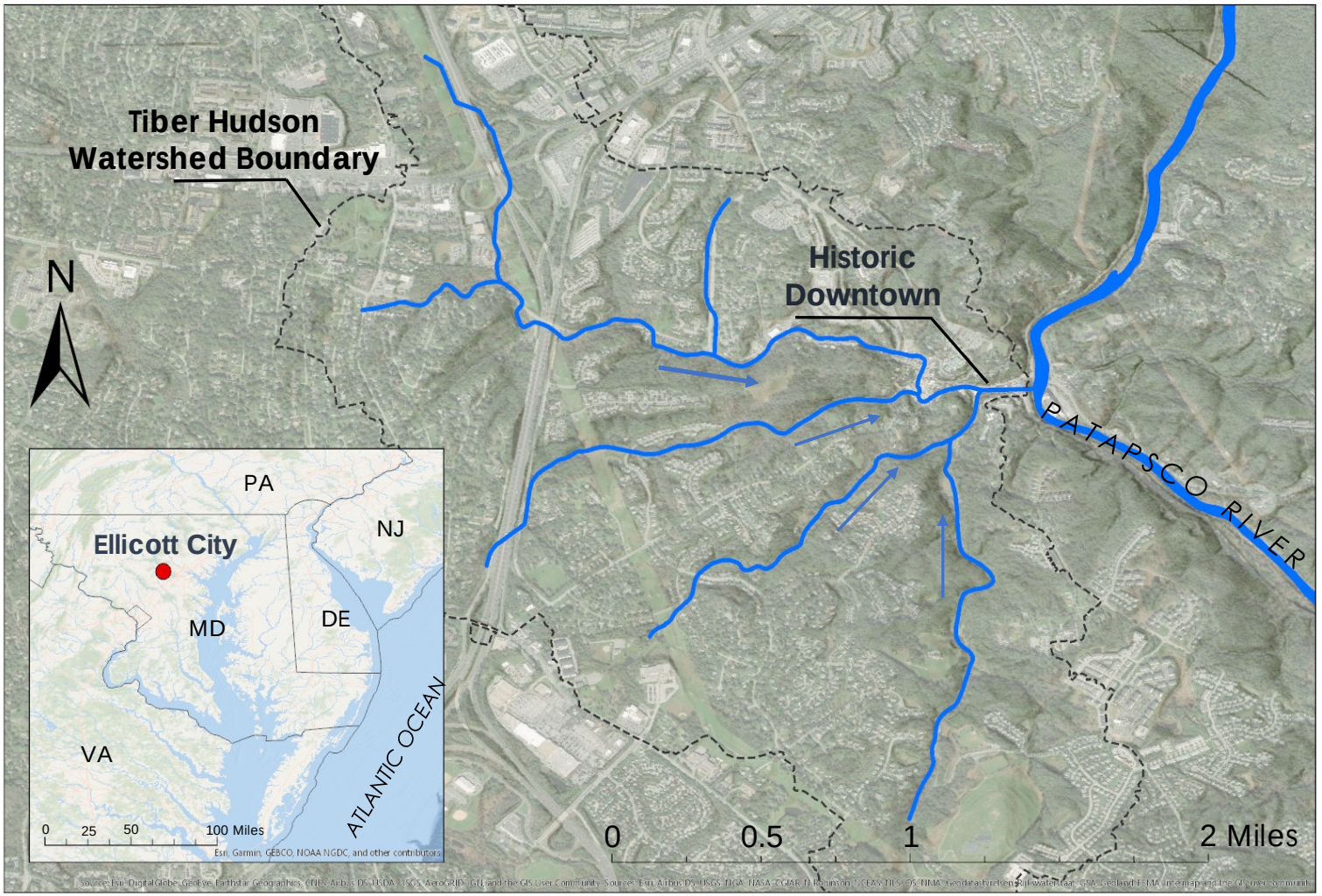
Enhancing a Statistical Flood Risk Model to Continue Improving Early Warning Systems and Public Safety in Ellicott City, Maryland

Alina Schulz, Scott Cunningham, Jonathan Donesky, & Matthew Pruett

DEVELOP

ELLICOTT CITY, MARYLAND

- Located on the Patapsco River in Howard County, MD
- City population ~65,000 in 2010
- 1,000 residents in Historic Downtown



Source: DEVELOP Team

COMMUNITY CONCERNS

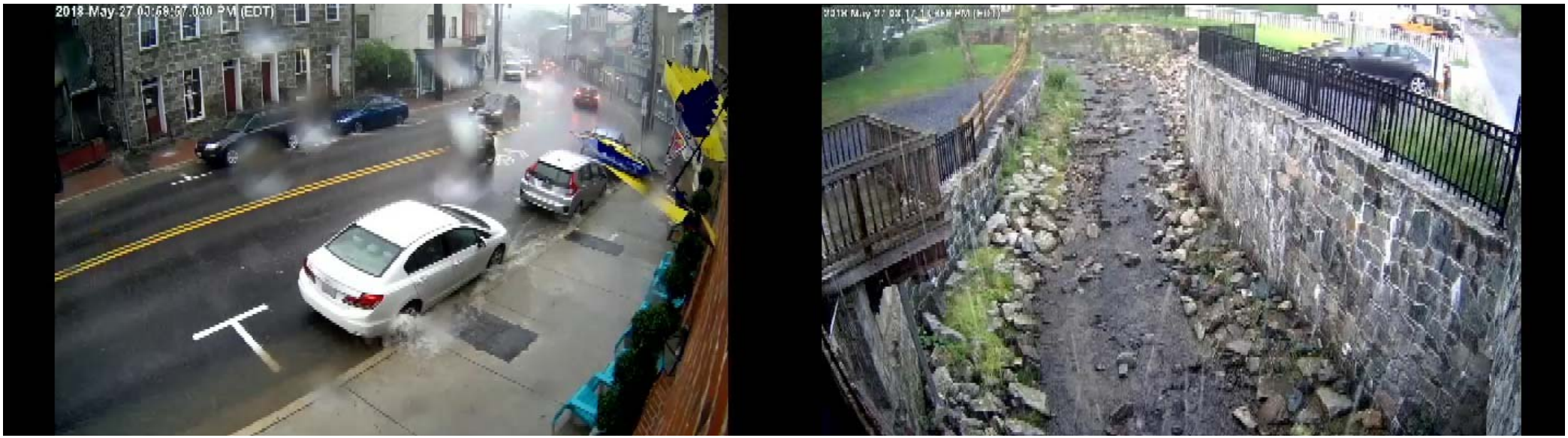
Severe flooding over the past decade

Effective use of data for **proactive** emergency management

Increasing warning time before a flood can **save lives** and money

Source: Howard County Gov't , DEVELOP Team

DOWNTOWN IN DANGER



May 2018 Flood
2 hour time lapse

Source: Ron Peters

PARTNERS

Howard County Government

Office of Emergency Management

Stormwater Management Division

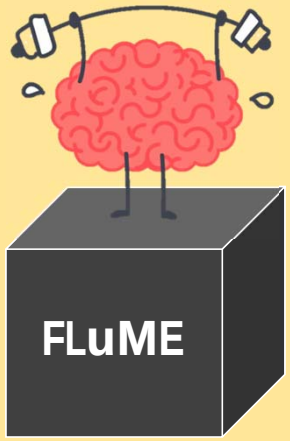
NOAA – NWS

Baltimore-Washington Weather Forecast Service

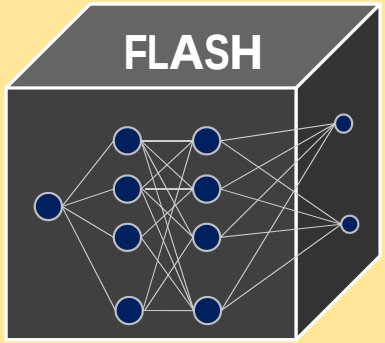
Source: DEVELOP Team, NOAA, NWS

A THREE-TERM PROJECT

Machine Learning
NASA Earth Observations
Identify Data Gaps



Deep Learning Model
Fill Data Gaps
Evaluate Model



Integrate Model into Partner's Decision Making Process

Image credit: DEVELOP Team, NextAvenue, Max Pixel

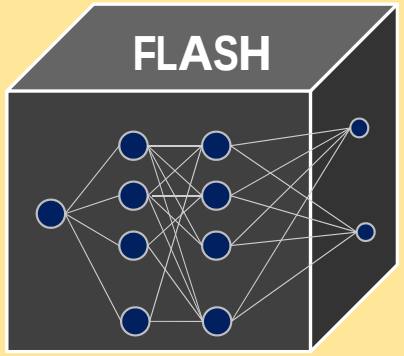
OBJECTIVES

Improve FLASH with Long Short-Term Memory (LSTM) framework

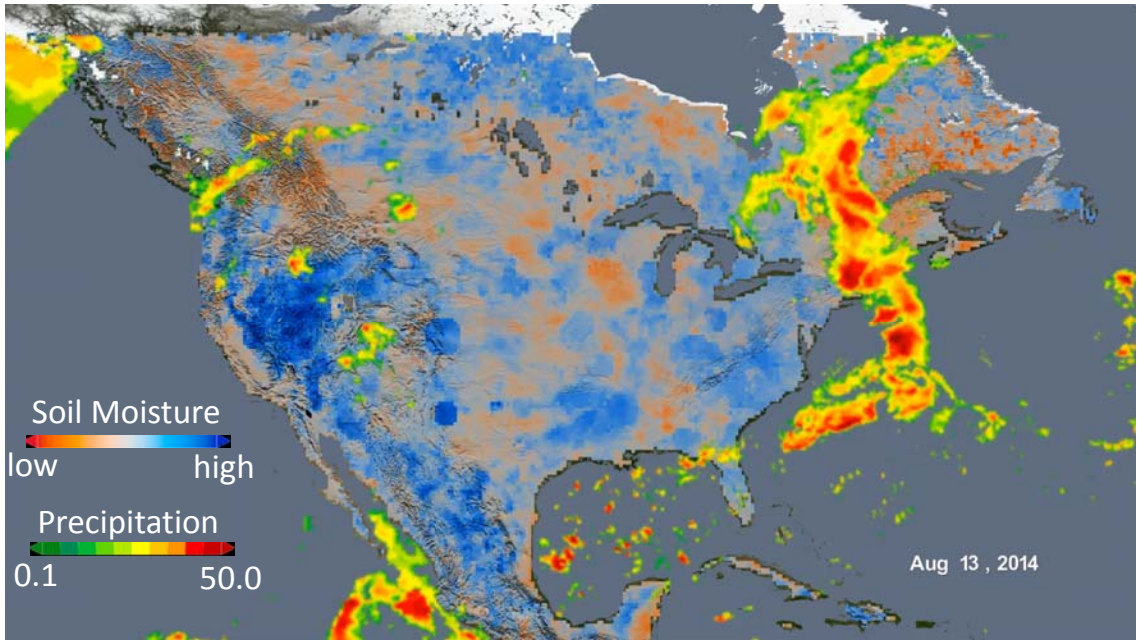
Utilize new datasets to improve FLASH accuracy

Determine the importance of each input variable for best performance

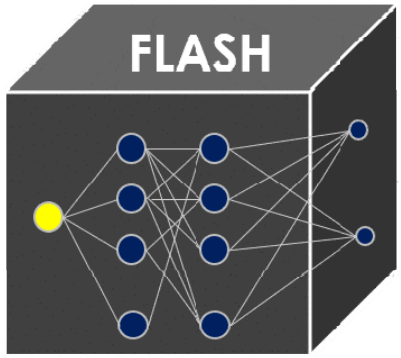
Improved Model Performance



THE DEEP LEARNING APROACH



A Landscape with Memory:
Soil Moisture and Precipitation



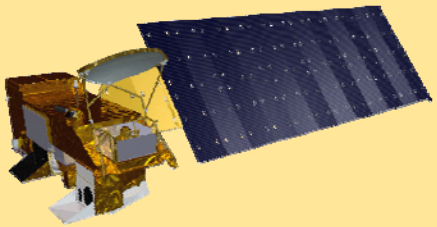
Long Short-Term Memory
Deep Learning
Architecture

Video Credit: NASA's Science Visualization Studio

RESOURCES USED
NASA Earth Observations

Satellites

TRMM
TMI



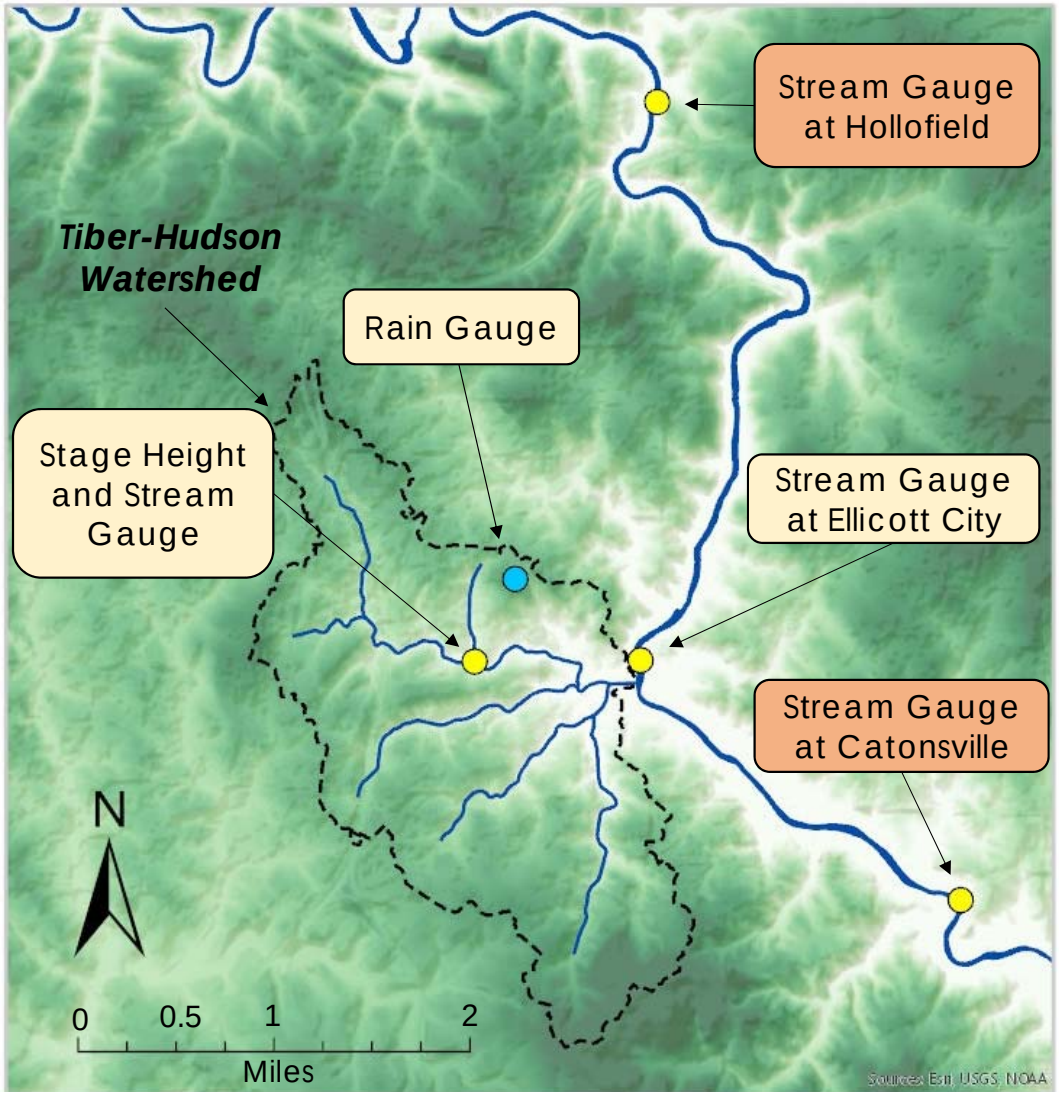
Aqua
AMSR-E

Model

NLDAS-2

RESOURCES USED
Gauge Data

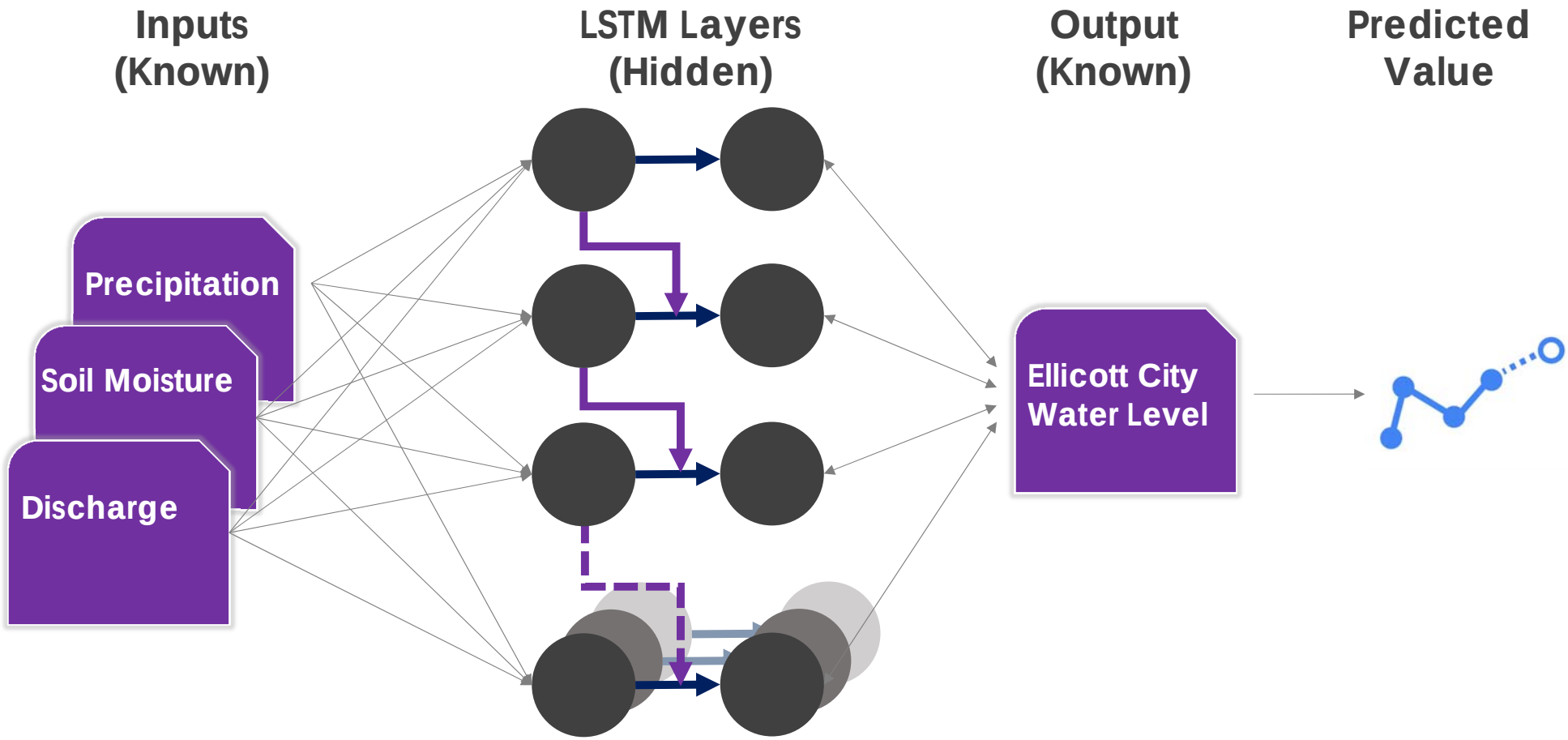
- Howard County Gauges (3)
  - Precipitation
  - Stream height in City
  - Discharge
- USGS Gauges (2)
  - Discharge



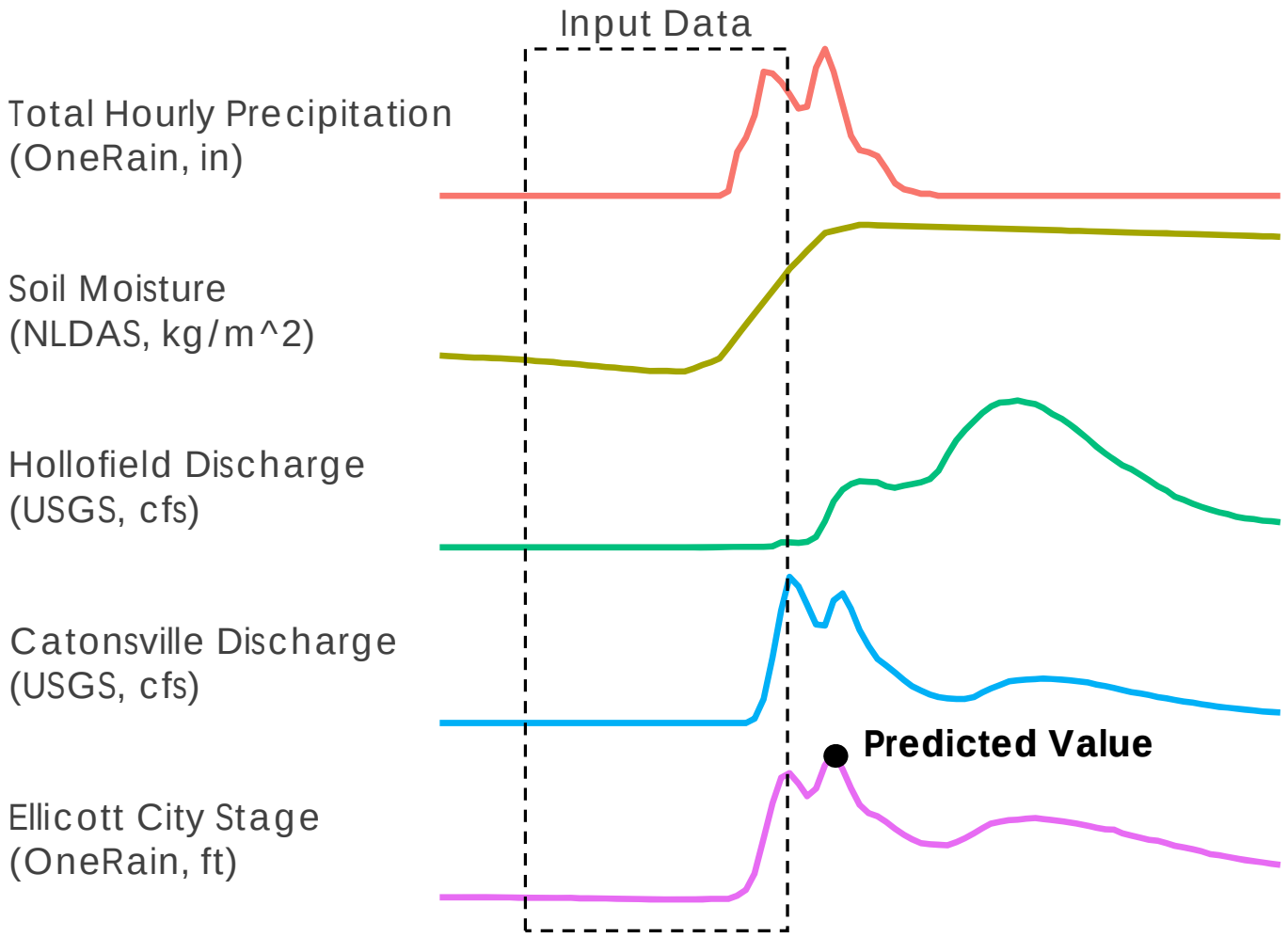
METHODOLOGY – Framework

Source: DEVELOP Team, Behance

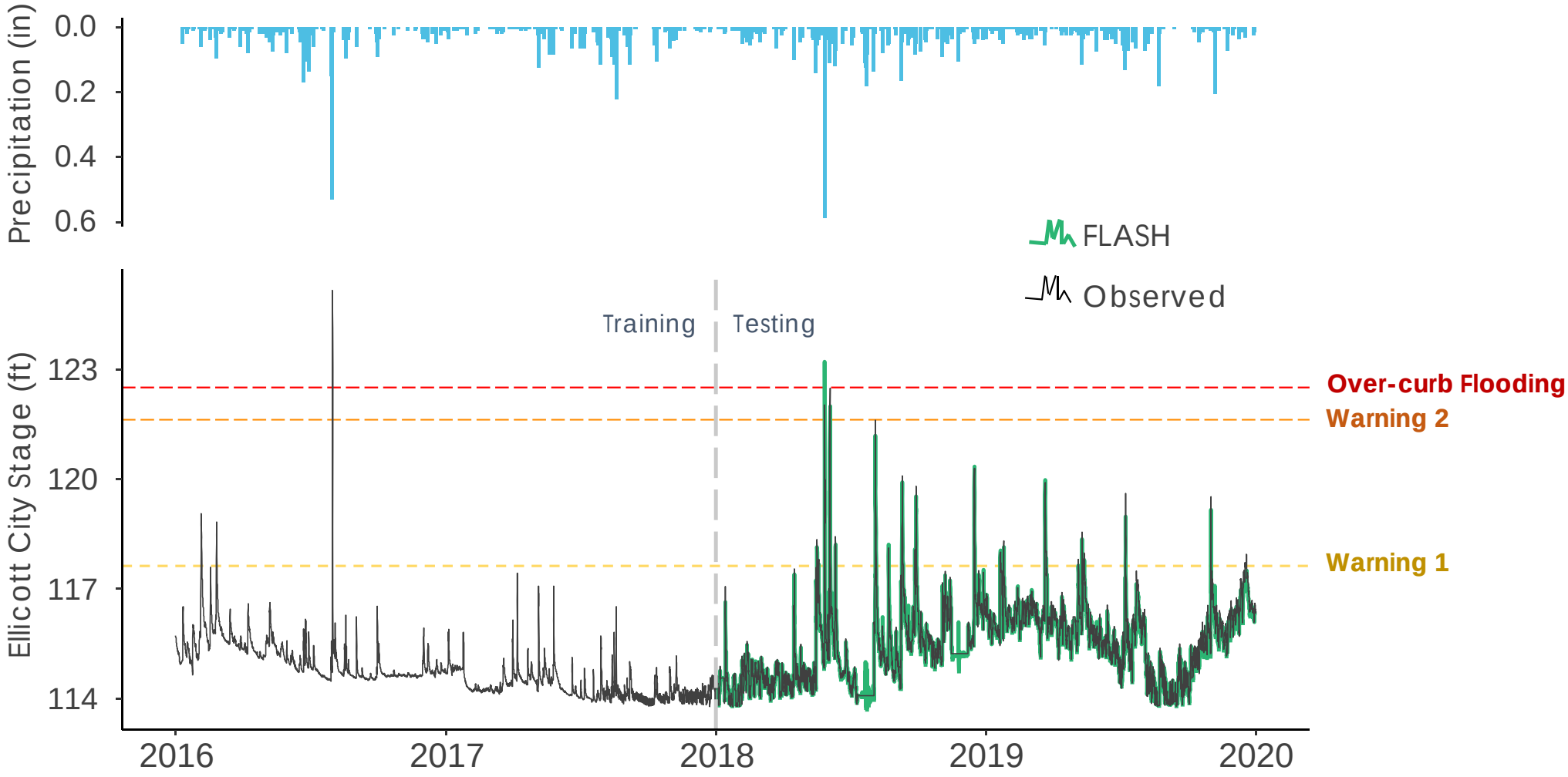
METHODOLOGY – Deep Learning



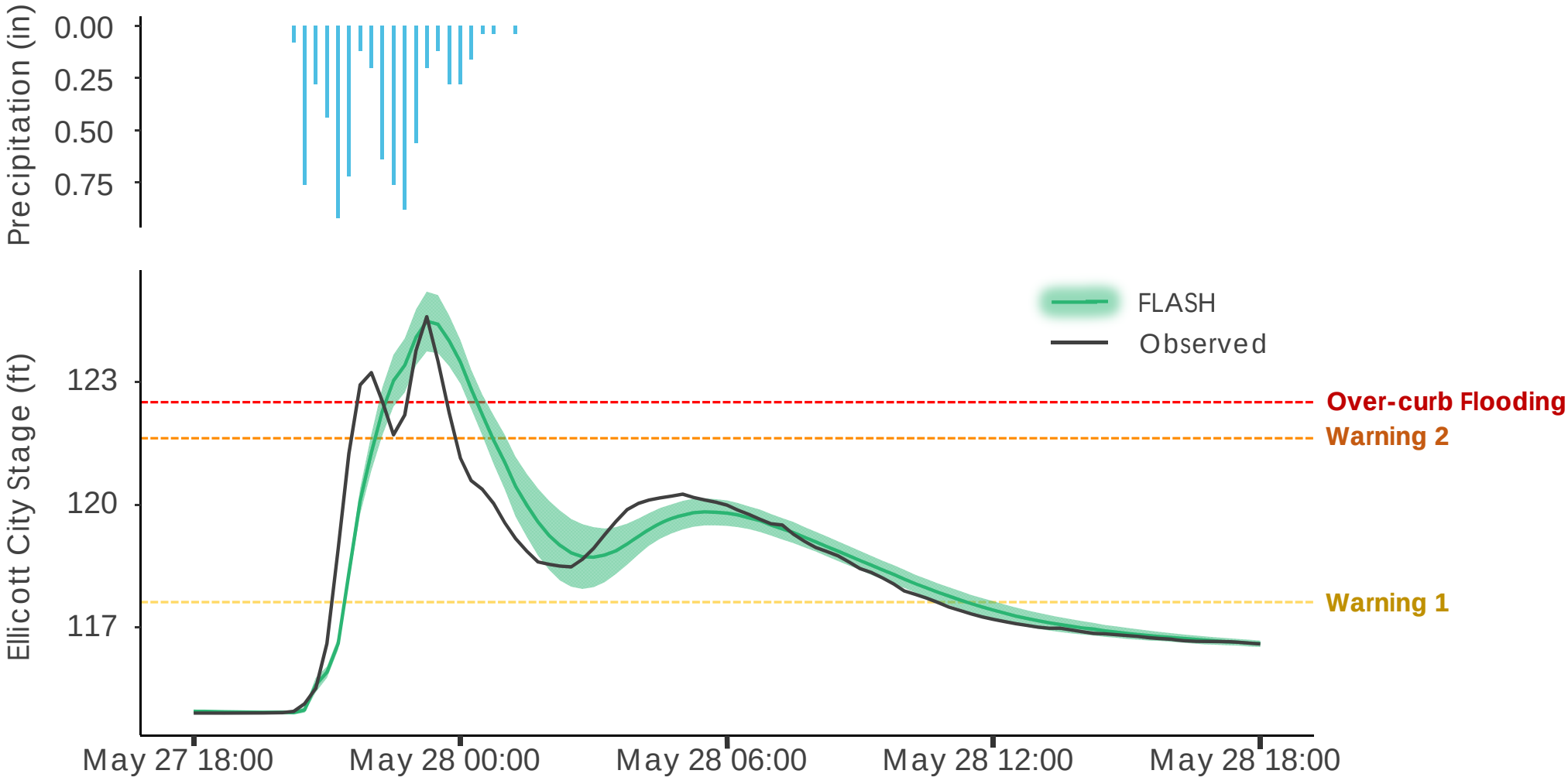
MAKING PREDICTIONS



FLASH Model Performance (2016-2020)



2018 Flood Event: FLASH Model Performance with 95% CI



CONSIDERATIONS

- The model's predictions are only as good as the data it is provided.
- Accuracy evaluations are only relevant at stream gauges used for calibration.
- Currently, weights are randomly initialized; therefore, model output quality can vary.

CONCLUSIONS

1. The **LSTM** deep learning framework improved the model's performance.

2. The model's **predictive capability** was developed.

3. **NASA Earth observations** coupled with well documented **ground data** bolstered model performance.

NEXT STEPS

- Enhance model's prediction accuracy using data from **other flood-prone watersheds**
- Integrate **socio-economic data** to represent the impacts of predicted flood levels on different parts of the community
- Create an simple, intuitive **graphical user interface** for end users

Source: DEVELOP Team

ACKNOWLEDGEMENTS

DEVELOP

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  - **Dr. John Bolten**, NASA GSFC Lead Science Advisor
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- **Darcy Gray**, GSFC Center Lead
- Ellicott City Disasters I Team, NASA GSFC
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- Howard County Government
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- **Christopher Strong**, Baltimore-Washington Weather Forecast Office of NOAA-NWS Warning Coordination Meteorologist

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