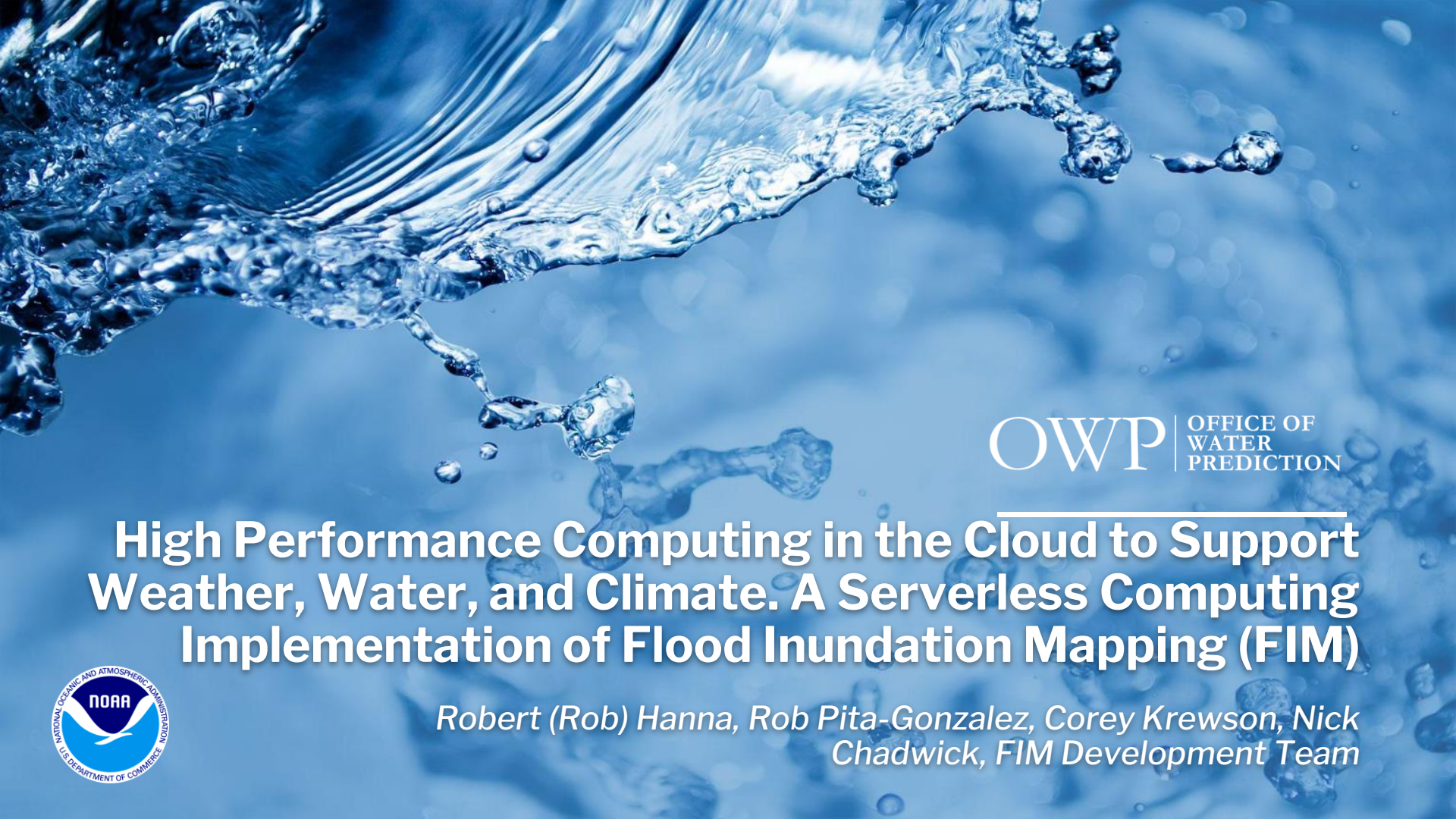
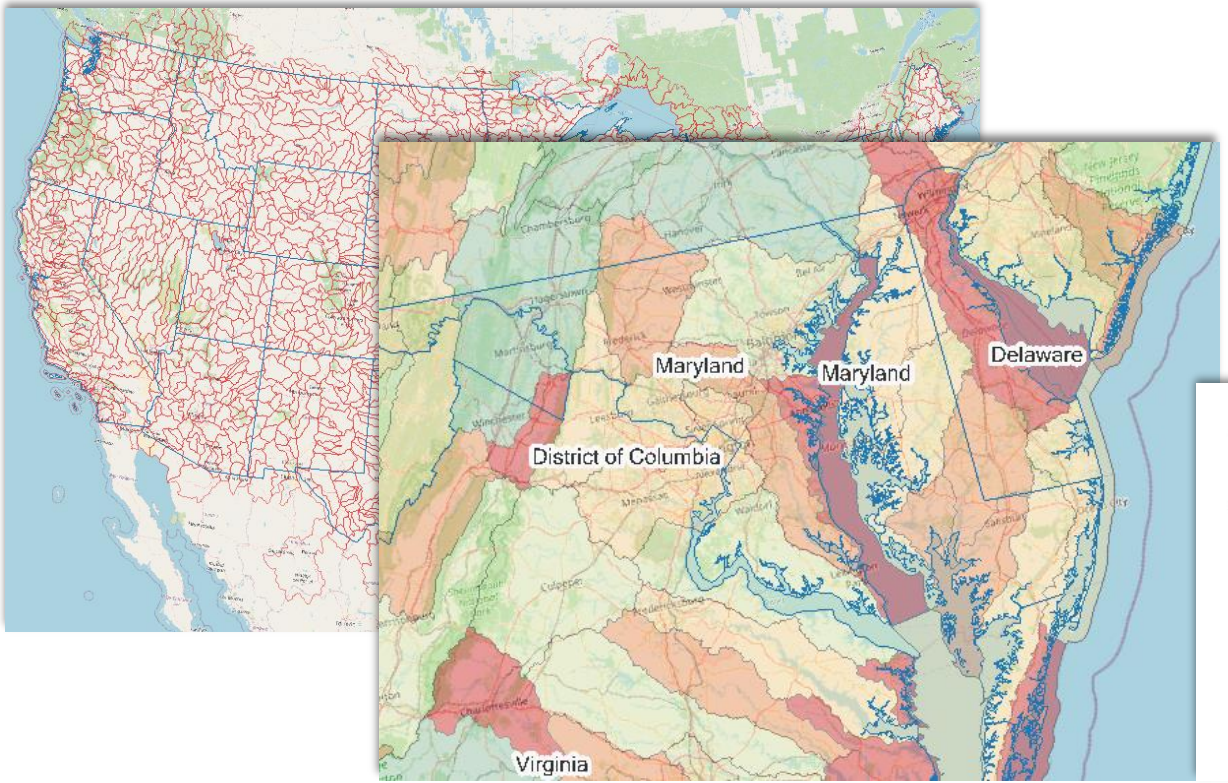


OWP | OFFICE OF WATER PREDICTION

High Performance Computing in the Cloud to Support Weather, Water, and Climate. A Serverless Computing Implementation of Flood Inundation Mapping (FIM)

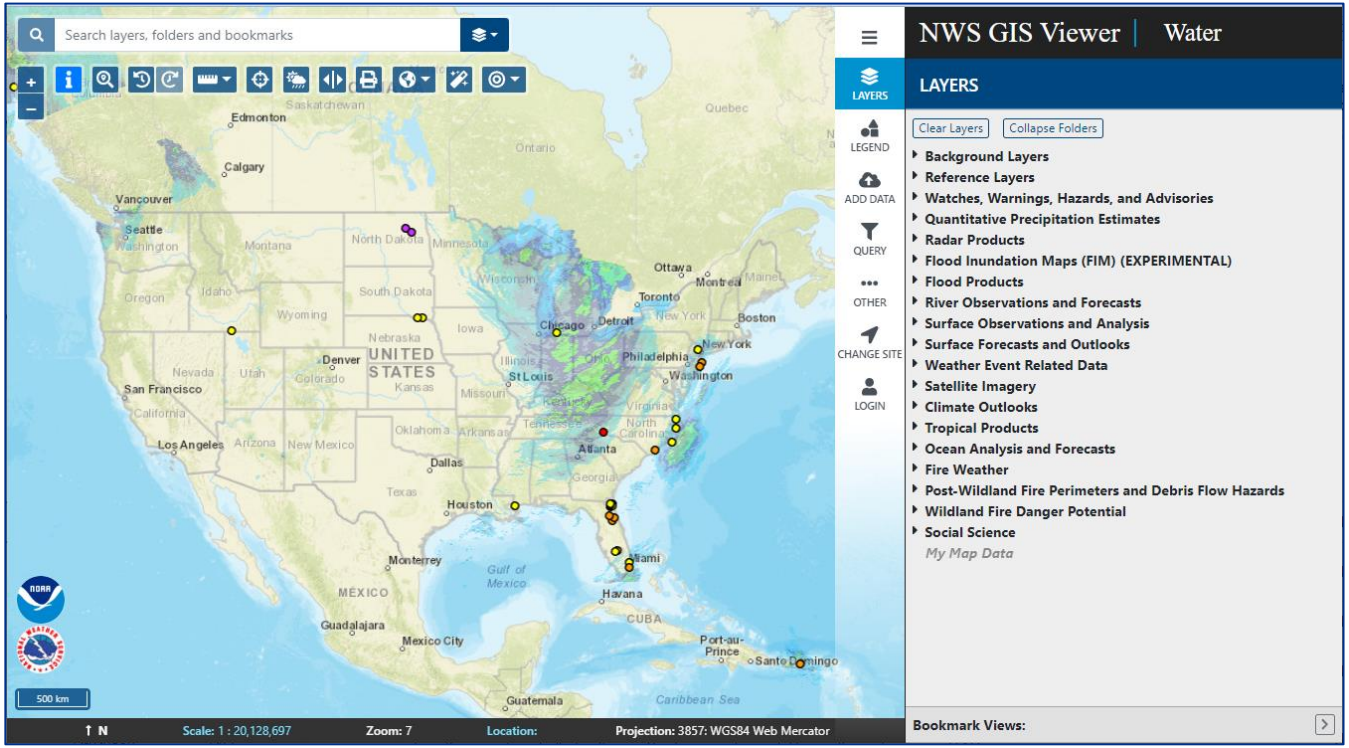
Robert (Rob) Hanna, Rob Pita-Gonzalez, Corey Krewson, Nick Chadwick, FIM Development Team

HUC8'S, Rivers, DEMs and Rating Curves



The data created during this process supports a wide range of products and services for NOAA/OWP and various affiliates

National Weather Service GIS Viewer



https://viewer.weather.noaa.gov/water

Complex Workflow

Primary Processing (4 Major Steps)

Originally

59 Hours

500 gb RAM

80 CPU Cores

Step 1: unit pre-processing

Step 2: unit processing

- 2,148 units (multi-processing)
  - 47 sub-steps
  - 29 average number of branches (child unit) = each 34 steps
- 58,000 branches total

Step 3: Post-processing

Step 4: Automated Testing Scripts

Complex Workflow

Secondary Processing

Originally

57 Hours

Minimal Multi Processing

Other Steps:

- Docker image builds
- Copying to other environments / departments
- Creating secondary data
- Cleanup

Total Hours = 116 (in parts ~7 days)

Output Sizes = 2.9 TB

Serverless Computing Advantages

- Highly Parallelizable
  - Concurrent Processes via Fargate at Unit Level
- Reliable
- Serverless Architecture
- Scalable
- Cost Effective
- Terraform

Primary Processing = 59 hours -> 9 hrs (so far)

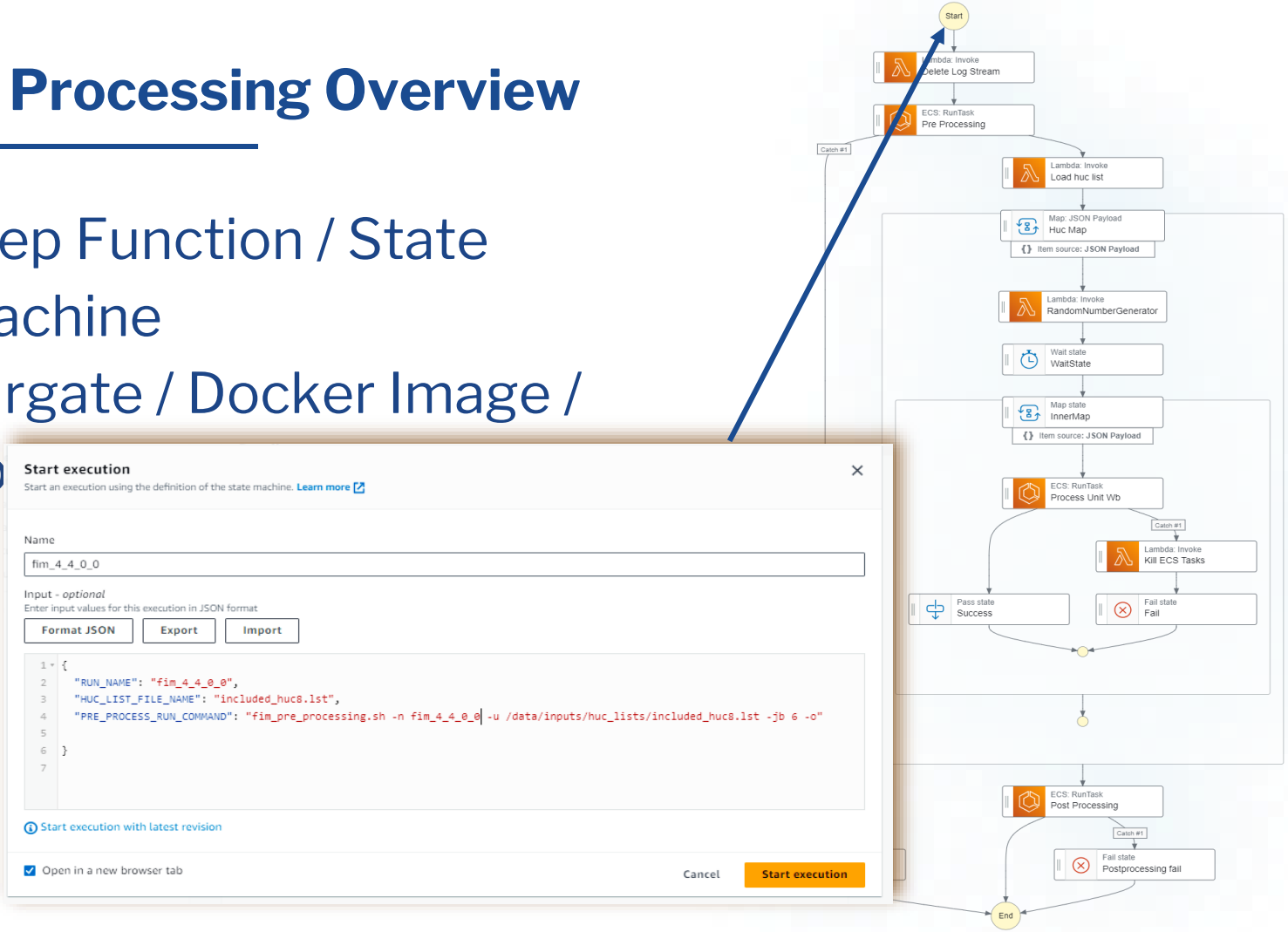
Secondary Processing = 57 hrs (WIP)
expected to drop to approximately 12 hrs or less

Overview of Cloud Resources

- AWS Step Functions - Resource Orchestration
- AWS Elastic File System (EFS) - Inputs and Outputs
- AWS Elastic Container Service (ECS- Fargate) - Compute Environments
- AWS Lambda - Serverless Functions to Perform Auxiliary Steps
- AWS CloudWatch - Logging
- AWS Cost Explorer - Calculate Costs
- AWS EC2 - Development Environments and a Production EC2 for Larger Tasks

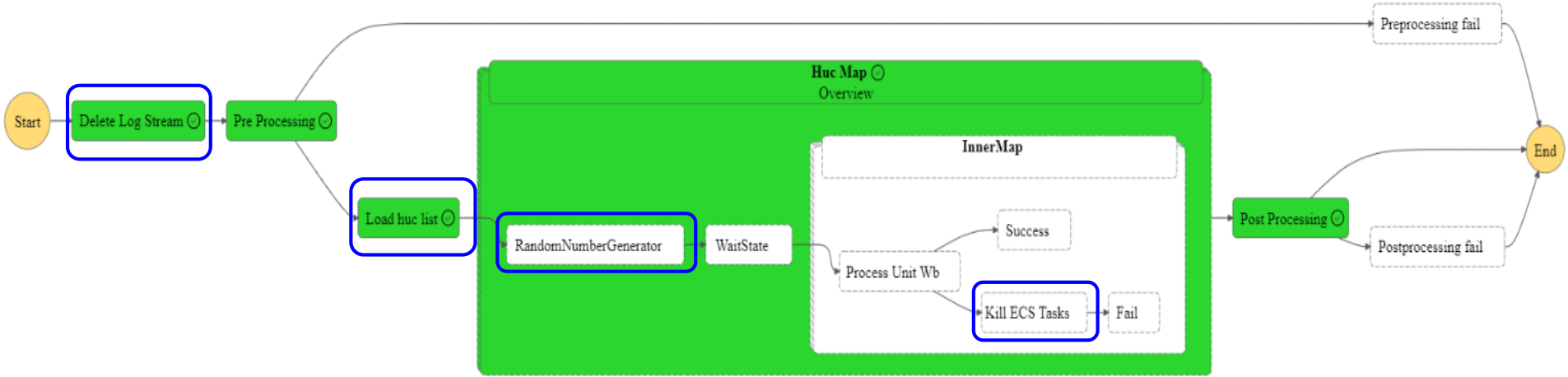
AWS Processing Overview

- Step Function / State Machine
- Fargate / Docker Image / Ep



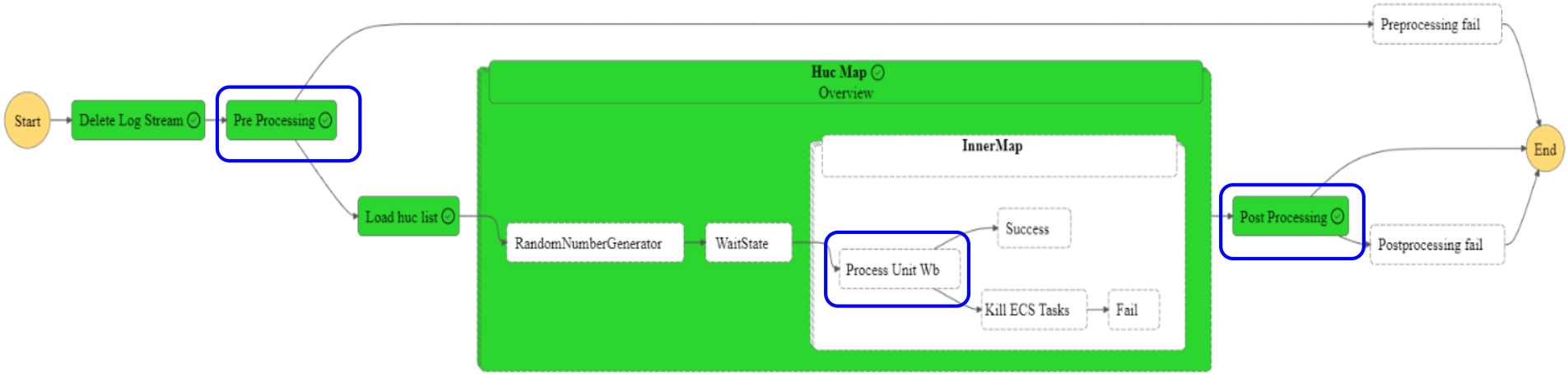
Step Function State Machine - Workflow

Lambda



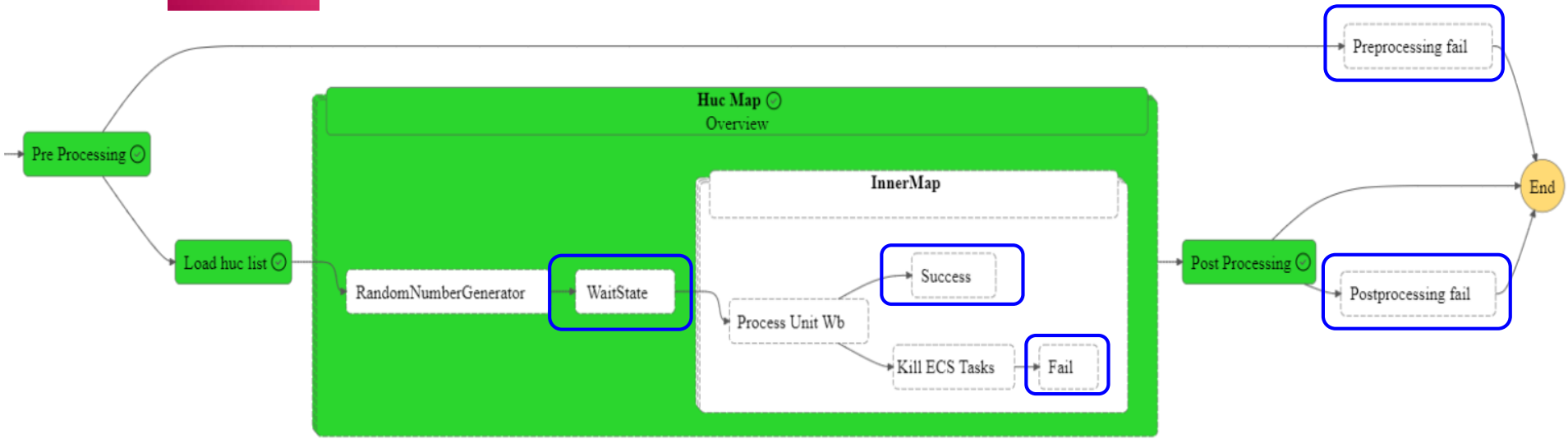
Step Function State Machine - Workflow

ECS Task Definition (Fargate)



Step Function State Machine - Workflow

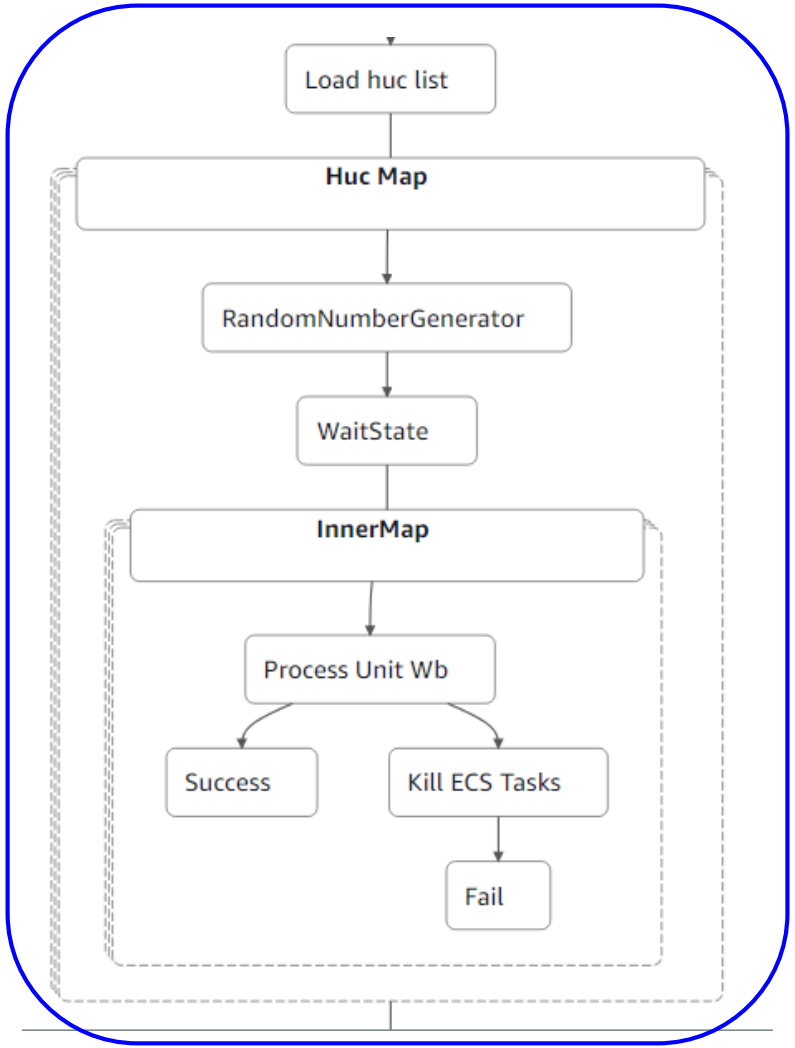
State Machine
Control Flow



Step Function State Machine

Outer Huc Map

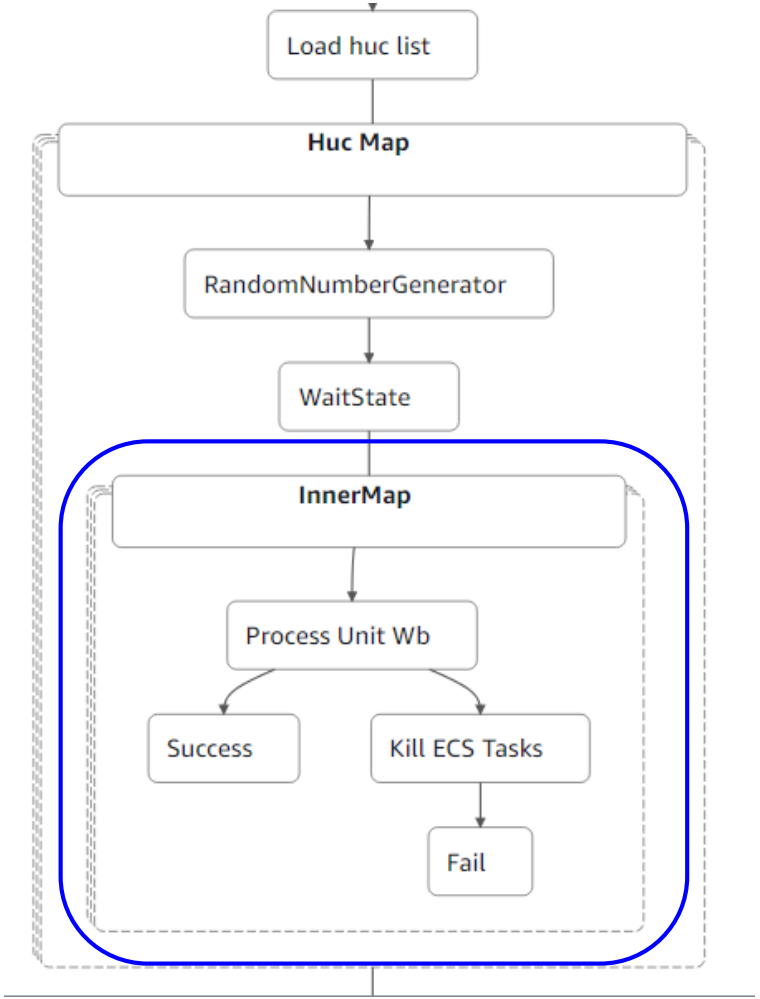
- Load HUC list
- 40 Units at a time (until all 2,138 done)
- Random Number Gen
- Wait
- Inner Map



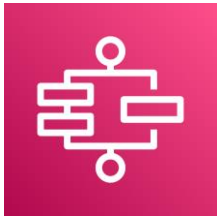
Step Function State Machine

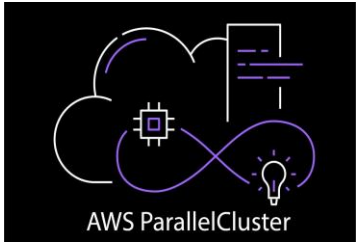
Inner Map

- Process Unit WB
- 40 Units at a time
- Each is an ECS Fargate / Docker Image



Why Step Functions and ECS over AWS Parallel Cluster?





- The FIM computations rely heavily on writing and reading files passed from subroutine to subroutine
- Nested parallelization (Units → Branches)
- Refactor Time
- External Collaborators (Universities, Students, Scientific Community)

Open Source

- Code contributions, public GitHub repo
- Code can be run without AWS
- Leverages Docker technology

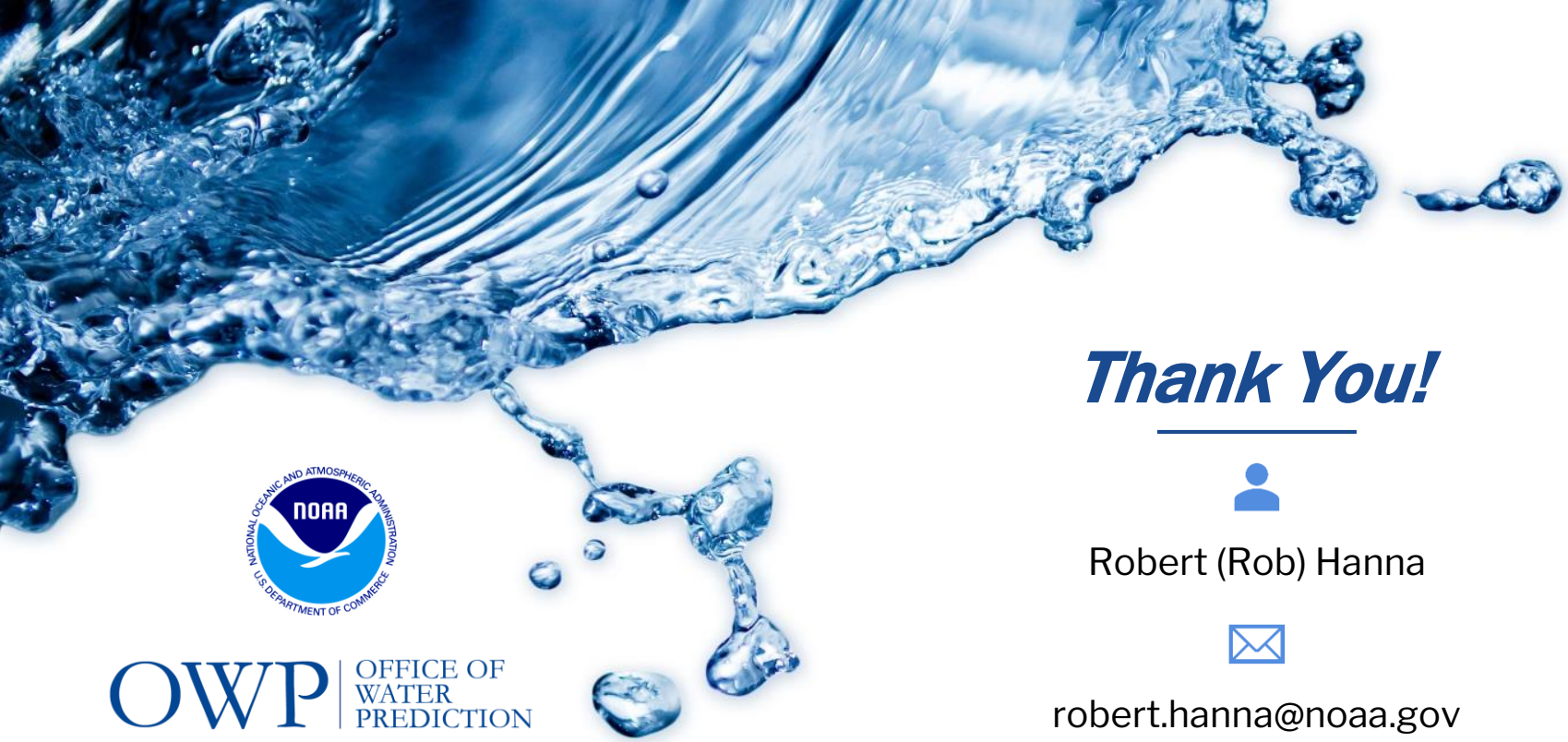
https://github.com/NOAA-OWP/inundation-mapping

Next Steps

- **Primary Processing**
  - Performance 59 Hrs → 9 hours → goal of 2 hours
  - Add Post Processing optimizations
  - Automated Testing System
- **Secondary Processing**
  - Performance 57 Hrs → goal of 12 hours
  - Creating Secondary Data
  - Copying / Cleanup

Future Opportunities

- 10 meter to 3 meter resolution
  - 9x processing and output volume. AWS can easily scale up
- Code Optimization (memory objects)
- AWS Batch
- AWS RDS
- AWS EC2 Processing
- S3 Direct Integration
- DevOps / Github integration



Thank You!

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https://water.noaa.gov

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