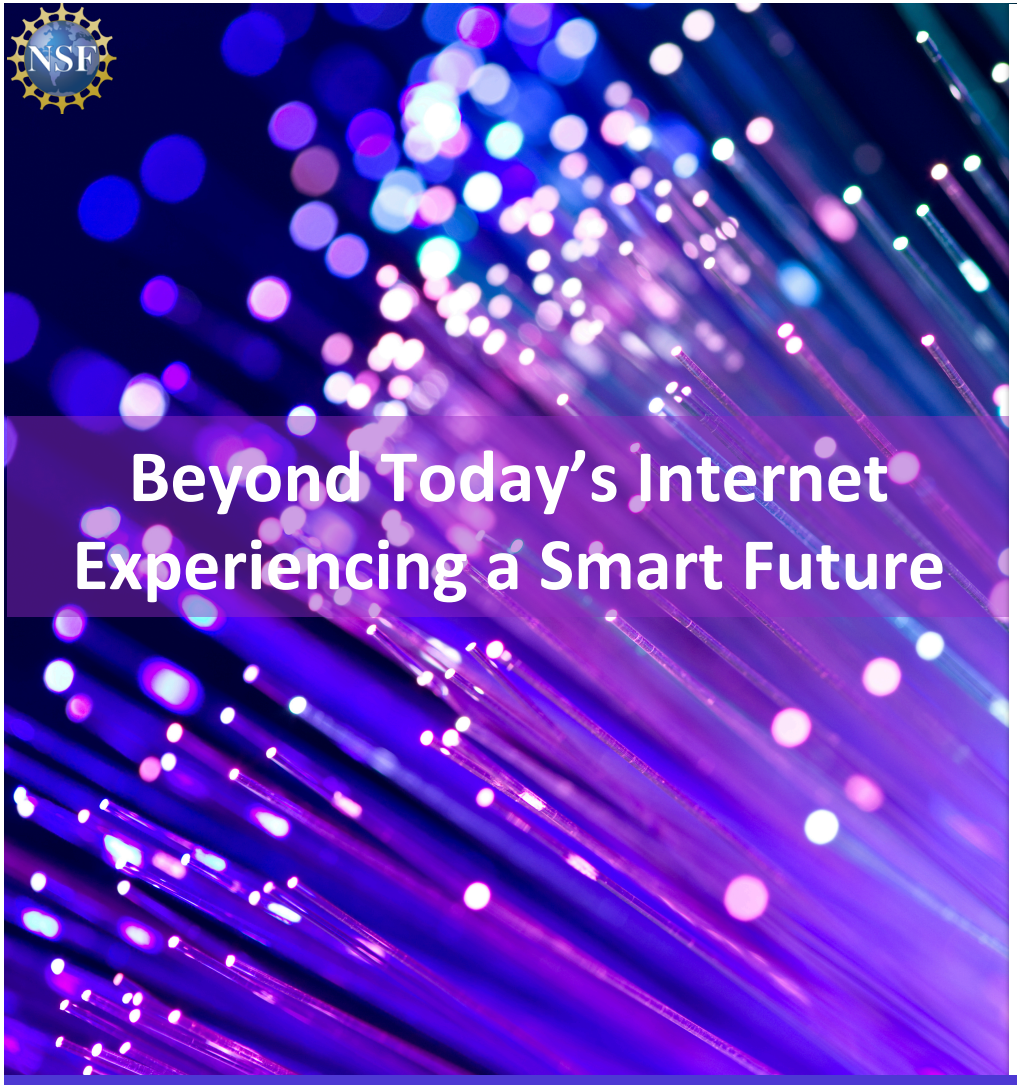


Urgent Computing: Storm Surge Predictions on GENI

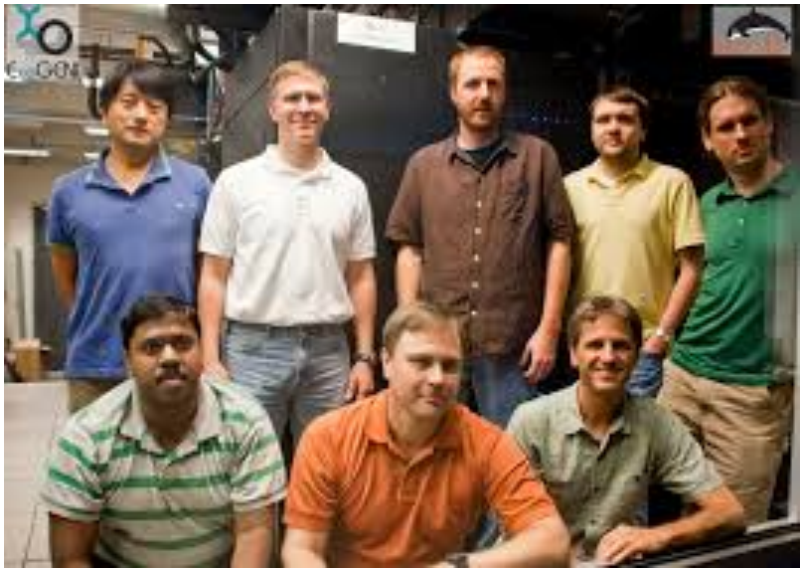
Paul Ruth, Brian Blanton, Anirban Mandal,
Ilya Baldin, Yufeng Xin,Chris Heerman
RENCI

Victor Orlikowski, Jeff Chase
Duke University

Demo support: Marshall Brinn
GPO

Paul Ruth

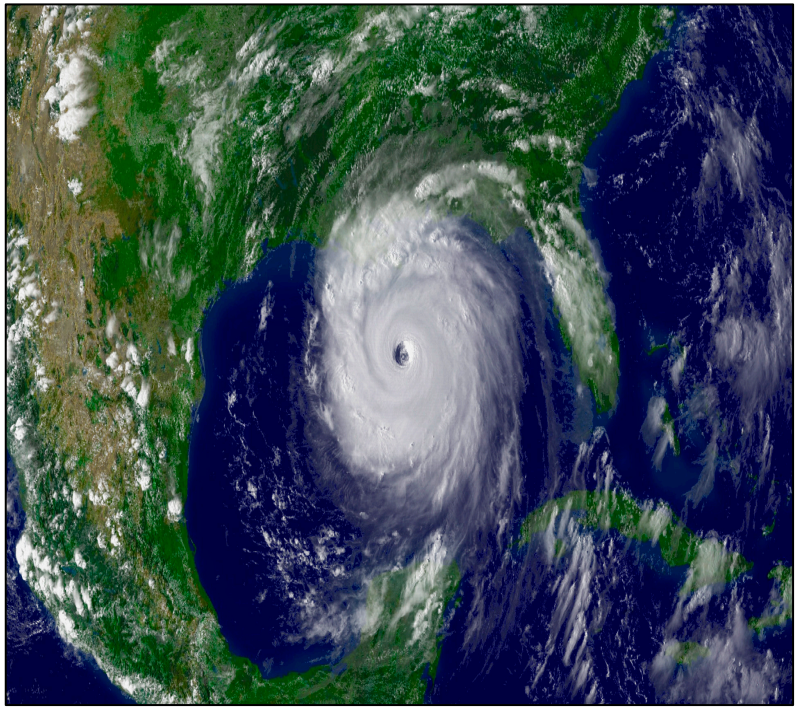
Brian Blanton

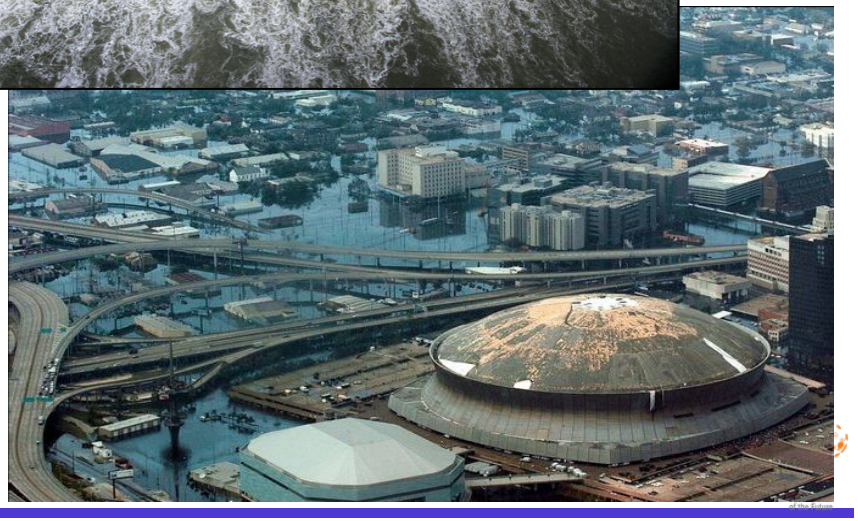


ExoGENI RENCI Team

Motivation

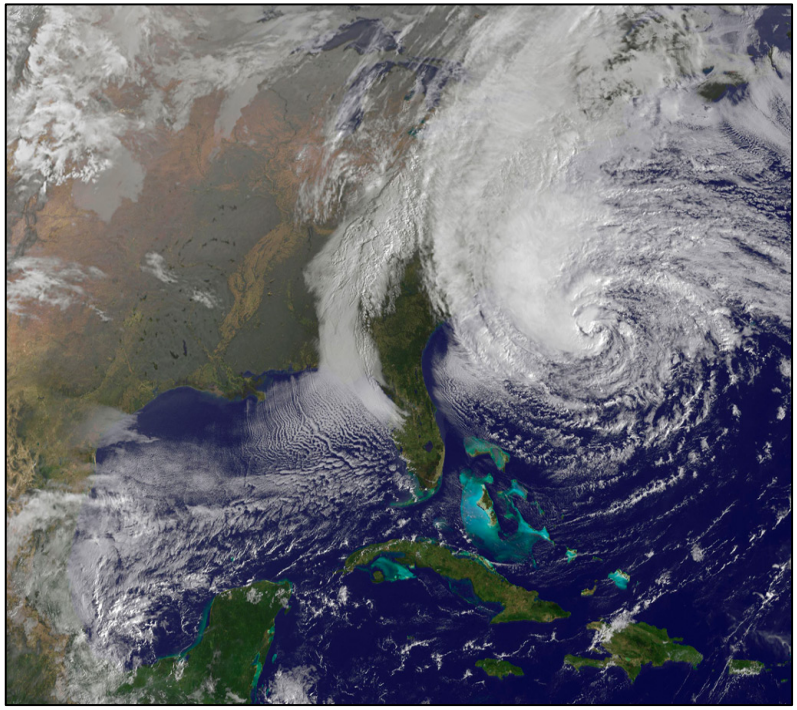
Hurricane Katrina (2005)





Motivation

Hurricane Sandy (2012)



Motivation

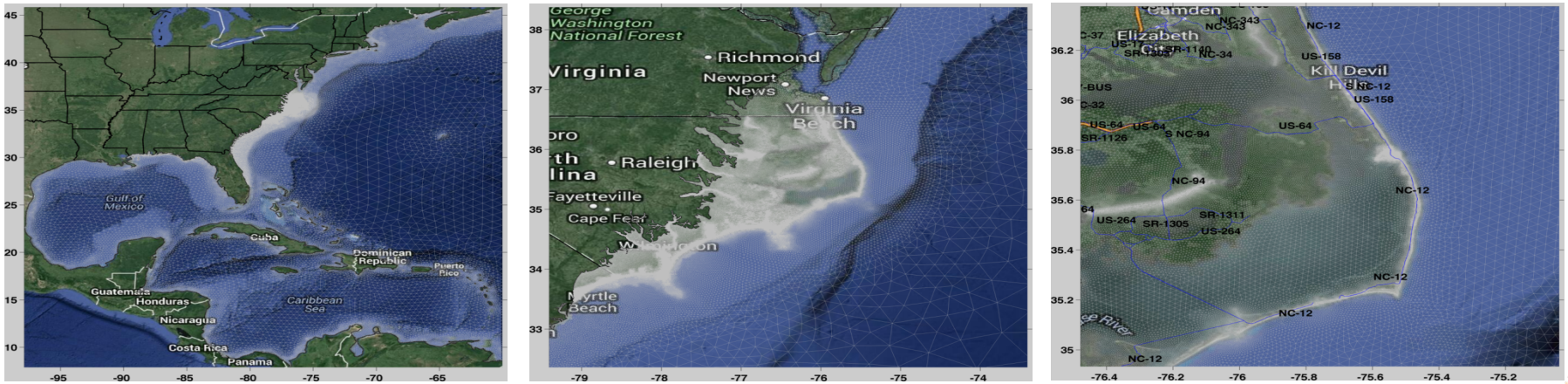
Real-time, on-demand computations of storm surge impacts

- Hazards to coastal areas a major concern
- Hazard/Threat Information needed ASAP (***Urgently***)
- Critical need for:
  - **detailed → high spatial resolution → large compute resources**
- Federal Forecast cycle every 6 hrs
- Must be ***well*** within Cycle to be relevant/useful
- I.e., ***New information at 5:59 is already old!!!***

Computing Storm Surge

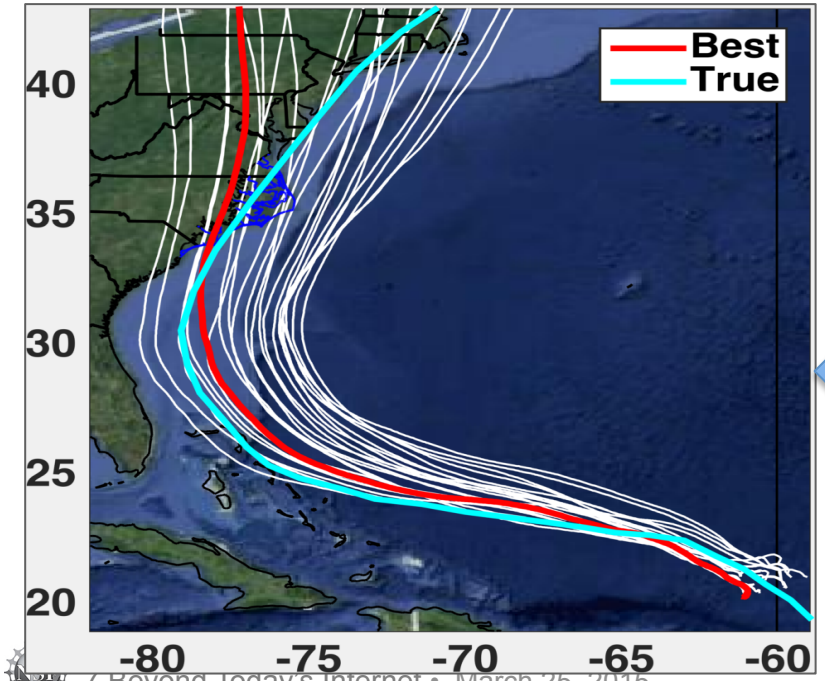
- ADCIRC Storm Surge Model
  - FEMA-approved for Coastal Flood Insurance Studies
  - Very high spatial resolution (***millions*** of triangles)
  - Typically use 256-1024 cores for real-time (one simulation!)

ADCIRC grid for coastal North Carolina



Tackling Uncertainty

One simulation is NOT enough!
Probabilistic Assessment of Hurricanes



Research Ensemble
NSF Hazards SEES project
22 members, H. Floyd (1999)

A "few" likely hurricanes
Fully dynamic atmosphere (WRF)

Using GENI in Urgent Computing

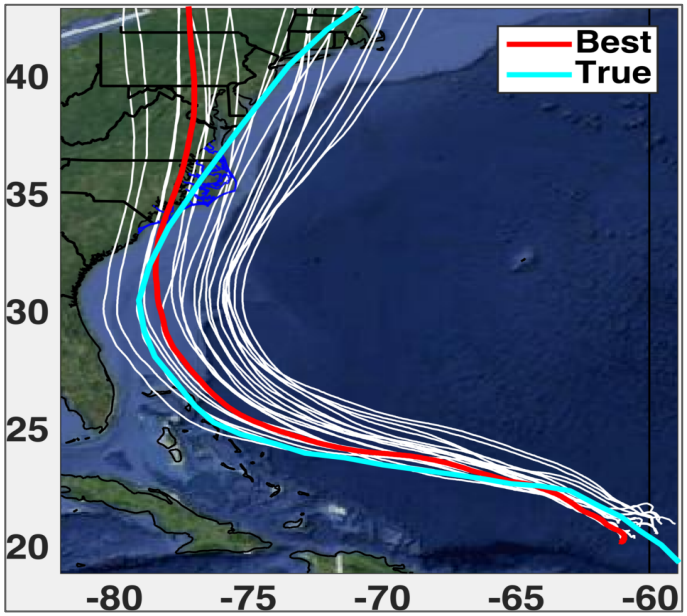
- Current limitations: Real-time demands for compute resource
  - Large demands for real-time compute resources during storms
  - Not enough demand to dedicate a cluster year-round

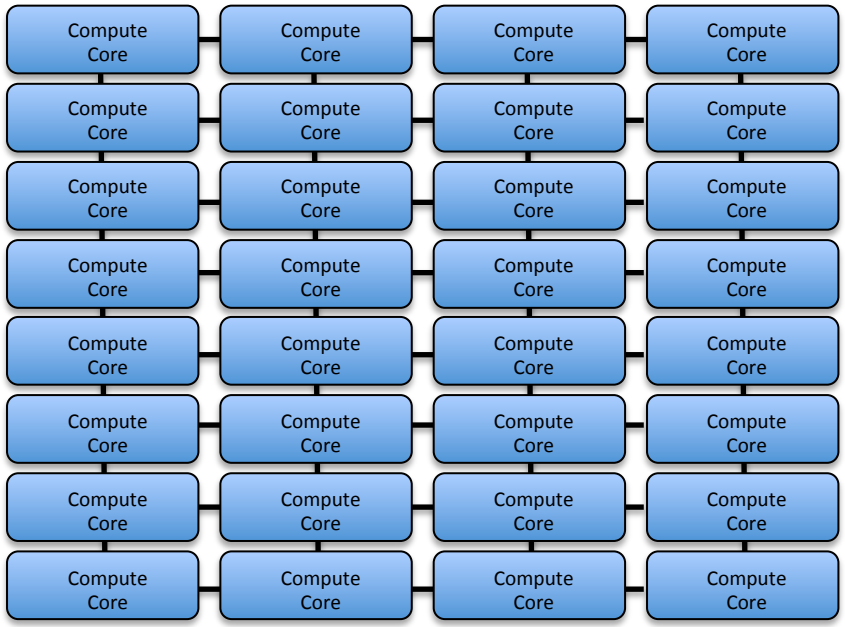
Using GENI in Urgent Computing

- Current limitations: Real-time demands for compute resource
  - Large demands for real-time compute resources during storms
  - Not enough demand to dedicate a cluster year-round
- GENI enables
  - Federation of resources
  - Cloud bursting, urgent, on-demand
  - High-speed data transfers to/from/between remote resources
  - Replicate data/compute across geographic areas
    - Resiliency, performance

Storm Surge Workflow

- Each ensemble member is a high-performance parallel task that calculates one storm

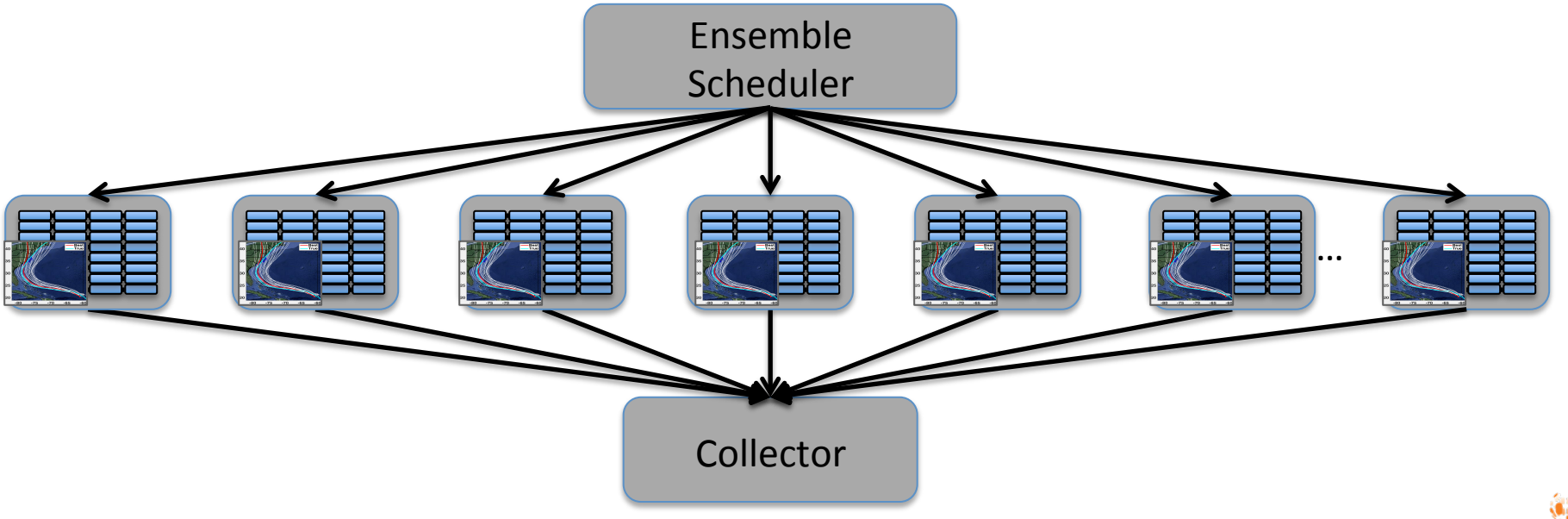




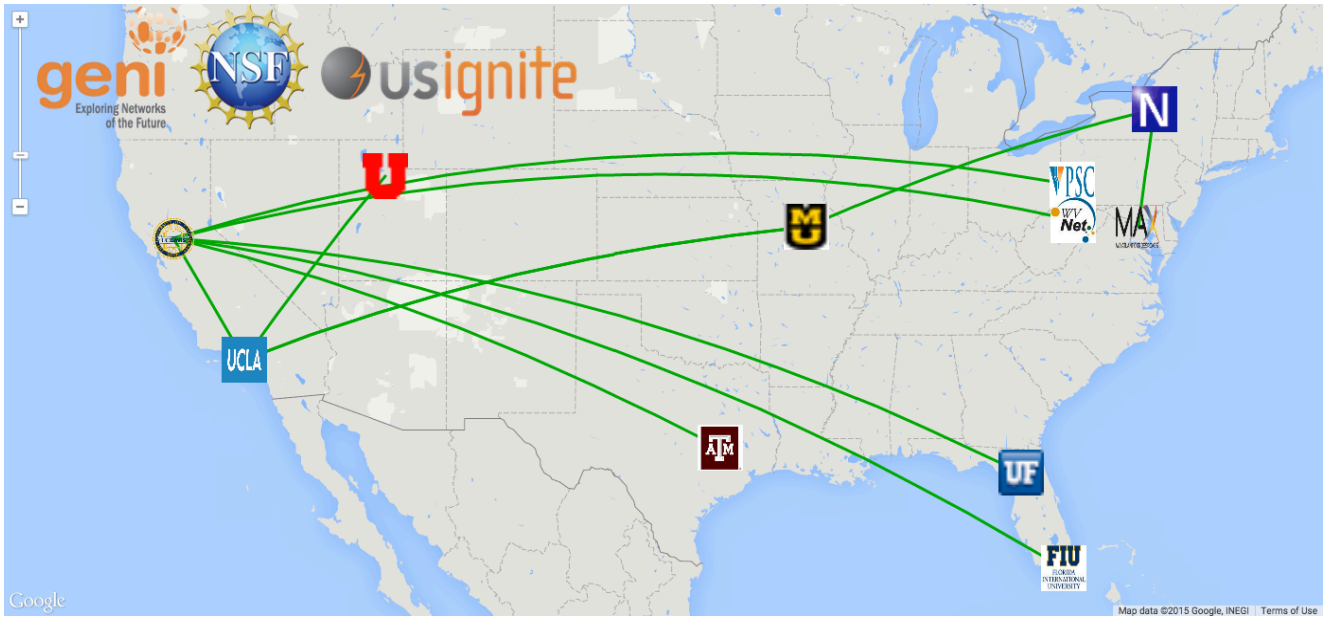
Parallel task (32 Core MPI)

Storm Surge Workflow

- Whole workflow is 22 ensemble members
- Pegasus workflow management system



Slice Topology

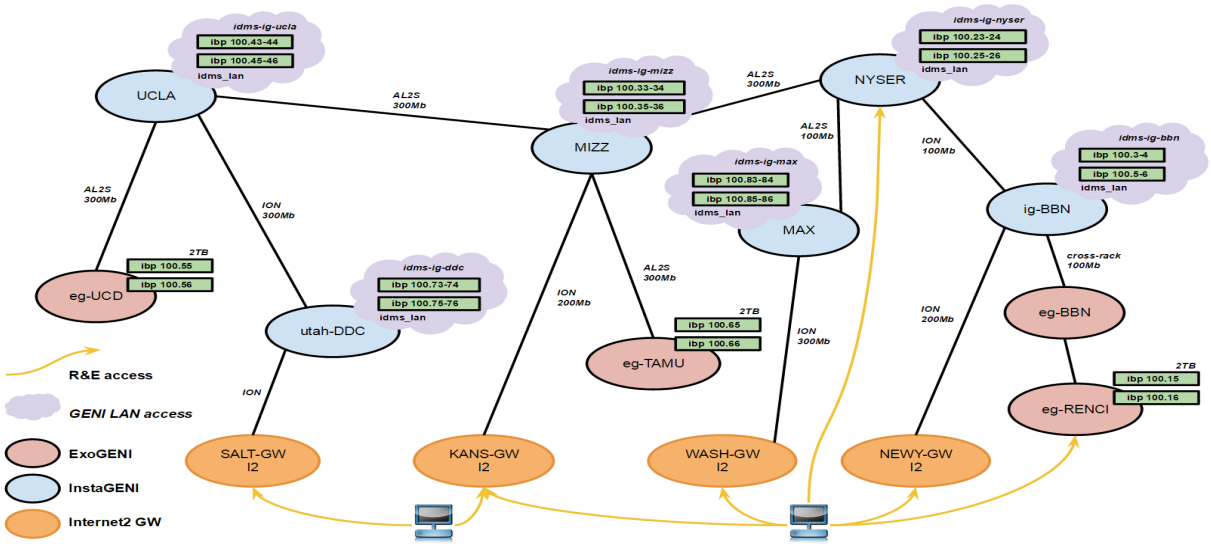


- 11 GENI sites (1 ensemble manager, 10 compute sites)
- Topology: 92 VMs (368 cores), 10 inter-domain VLANs, 1 TB iSCSI storage
- HPC compute nodes: 80 compute nodes (320 cores) from 10 sites

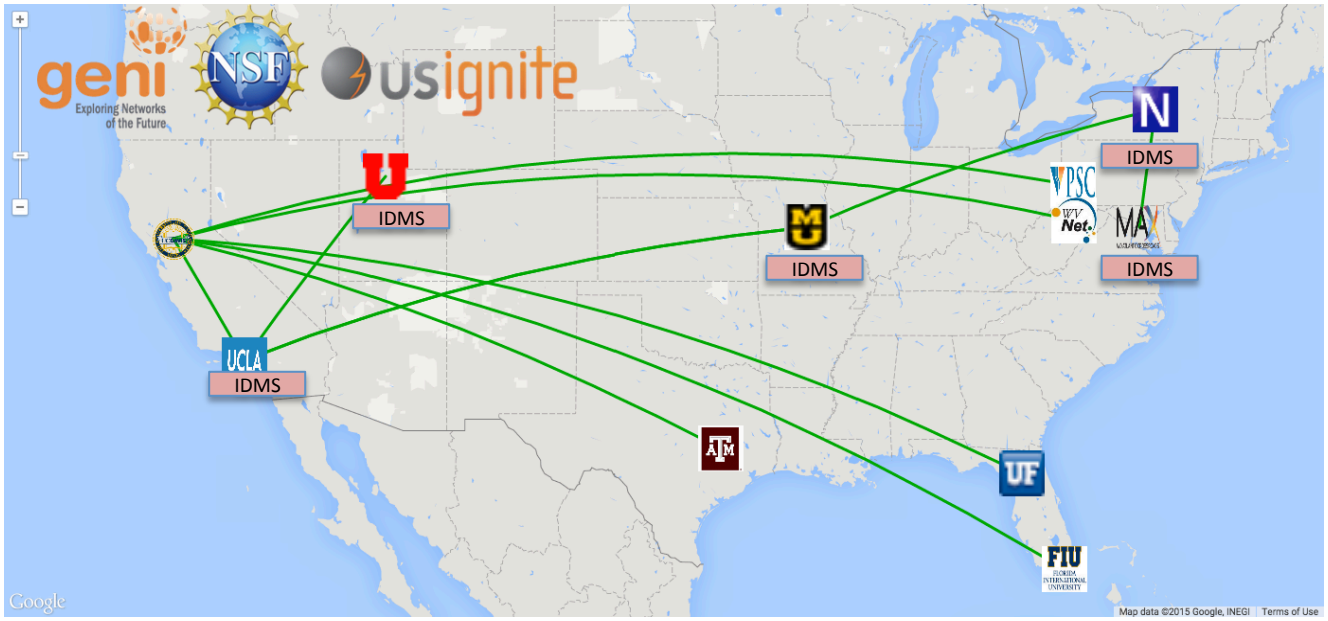
Intelligent Data Movement Service (IDMS)

Cloud storage and content distribution service within GENI

(Ezra Kissel, Indiana University)



Slice Topology with IDMS

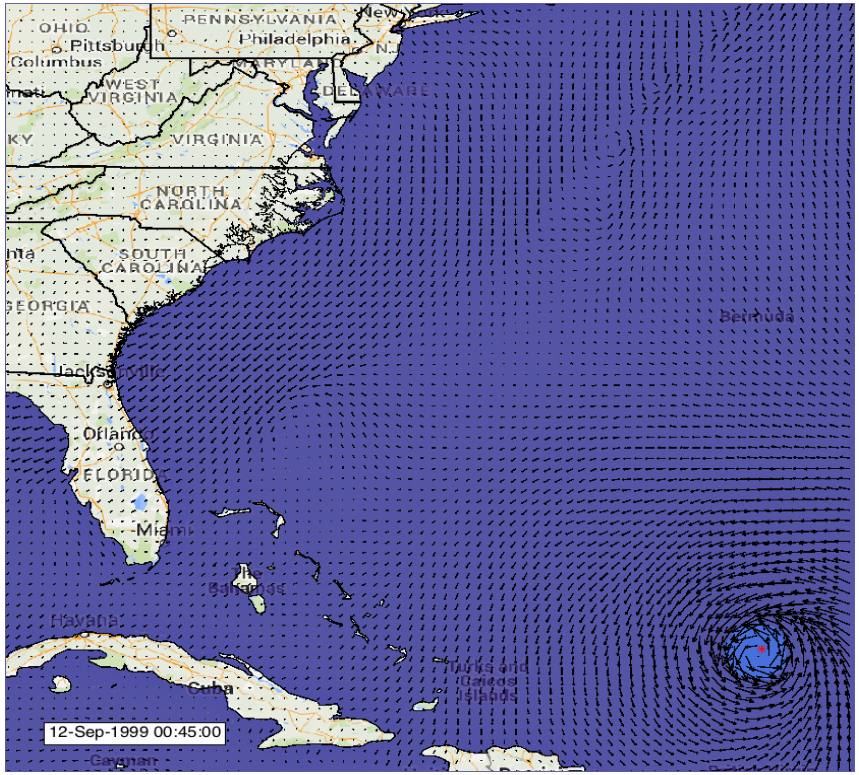


- 11 GENI sites (1 ensemble manager, 10 compute sites)
- Topology: 92 VMs (368 cores), 10 inter-domain VLANs, 1 TB iSCSI storage
- HPC compute nodes: 80 compute nodes (320 cores) from 10 sites
- **IDMS connectivity at 5 compute sites**

Ensemble Member #14

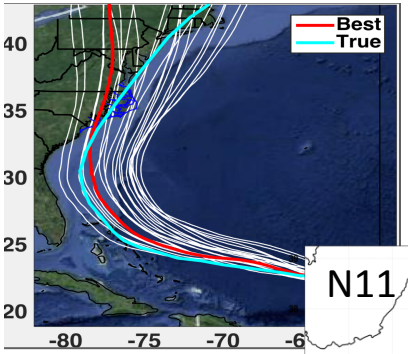
Hurricane Winds (WRF)

Storm Surge (ADCIRC)



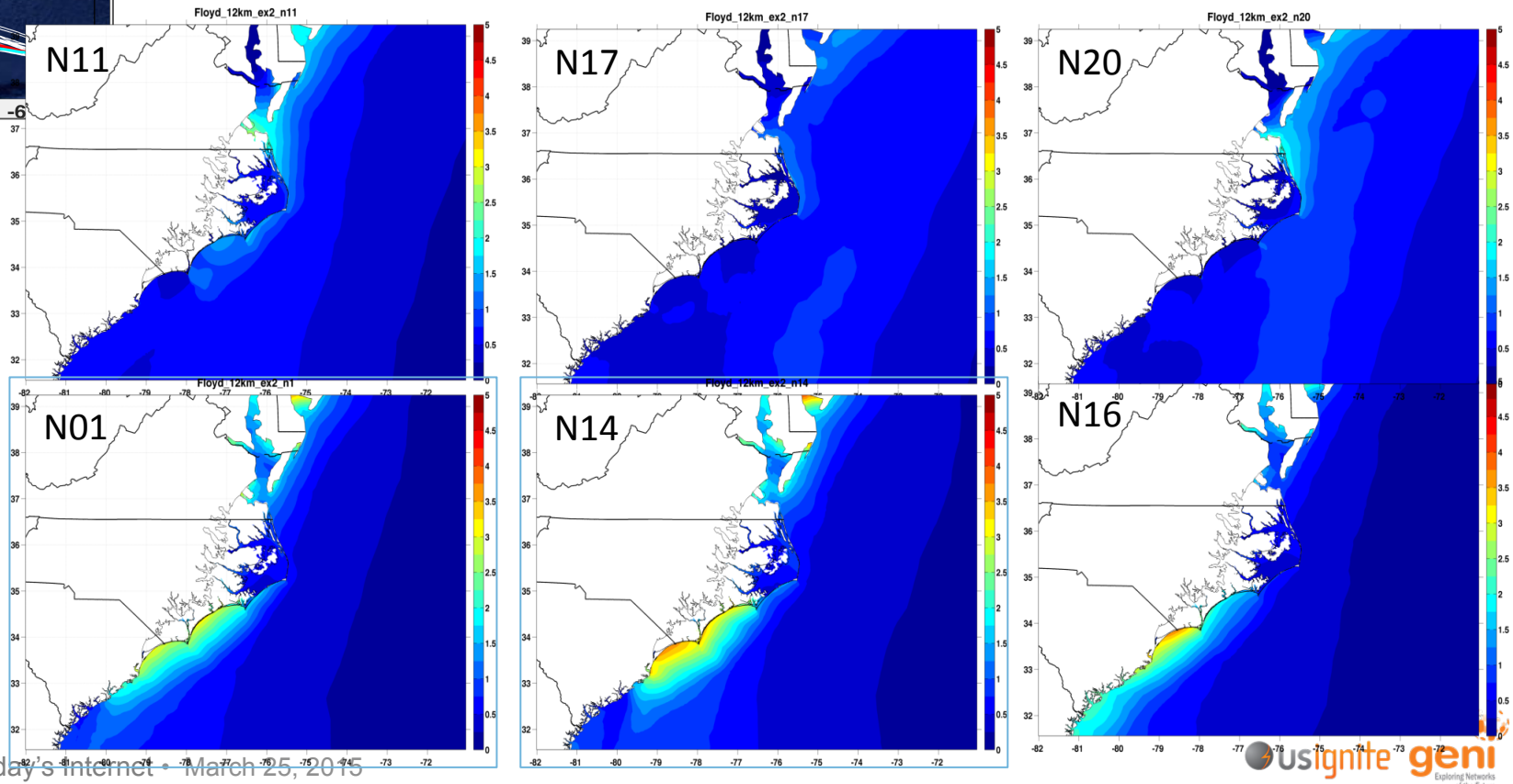
ADCIRC Results from GENI

Storm Surge for 6 simulations



Small Threat

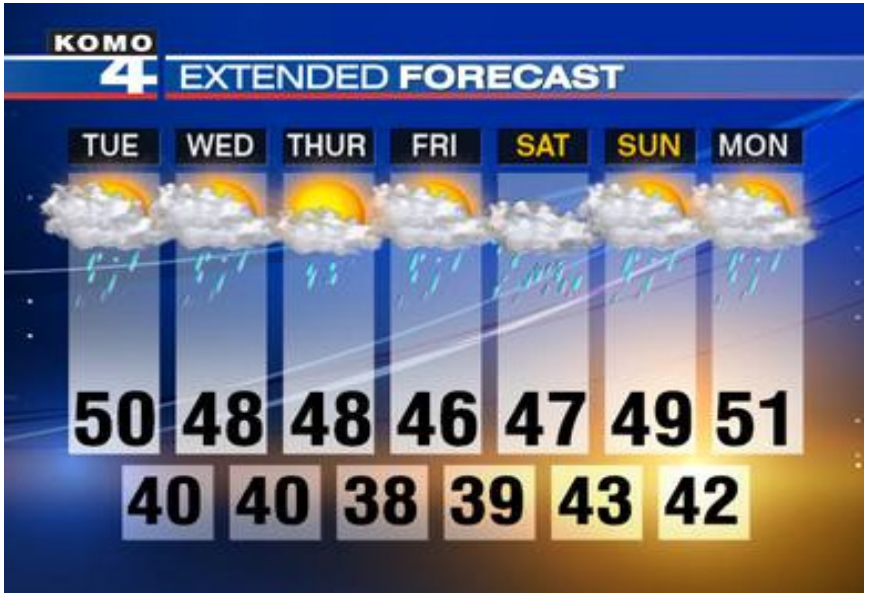
Big Threat



Water Level "Prediction"

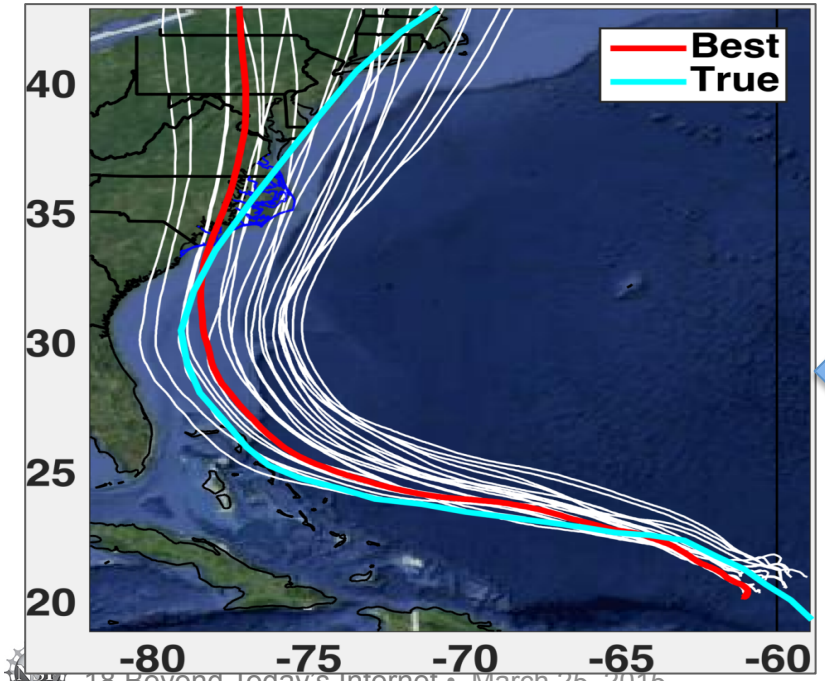
90% Chance of storm surge

90% of rain, 3 inches



Tackling Uncertainty

One simulation is NOT enough!
Probabilistic Assessment of Hurricanes

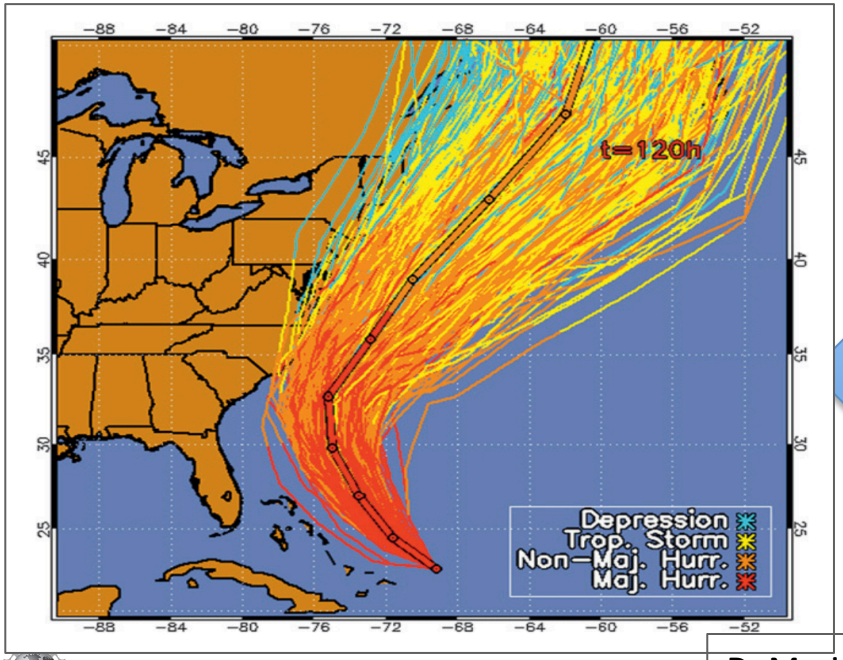


Research Ensemble
NSF Hazards SEES project
22 members, H. Floyd (1999)

A "few" likely hurricanes
Fully dynamic atmosphere (WRF)

Tackling Uncertainty

One simulation is NOT enough!
Probabilistic Assessment of Hurricanes

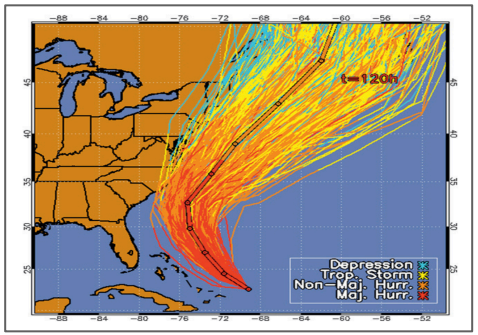


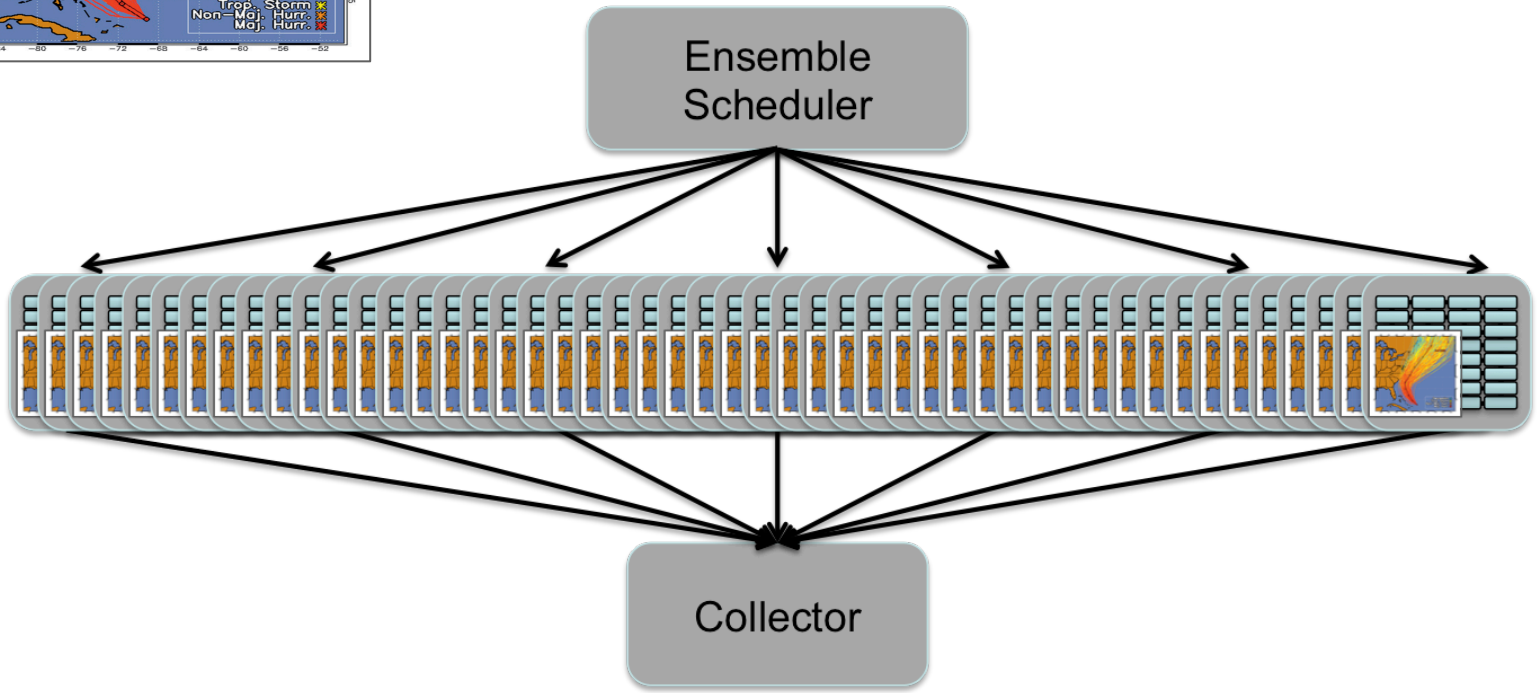
DeMaria et al, 2013

Operational Ensemble
Nat'l Hurricane Center
1000 members, H. Earl (2010)

100-1000s of statistical tracks
Monte Carlo, etc...

Real-time Forecasting





Summary and Future

- ADCIRC storm surge model on GENI
  - One of the largest slices/applications to use GENI
- GENI
  - Testbed for prototyping
  - Using GENI for traditional leadership-class and mid-sized infrastructure
- Other funded RENCI projects linking GENI with domain-scientists
  - Genomics and Astronomy, ADAMANT (NSF CC-NIE)
  - Medical/Health data, RADII (NSF CC-IIE)
  - Climate and Neutron Science, Panorama (DOE)

Thank You

RESEARCH ENGAGEMENT INNOVATION