UNC’s Current and Future Work

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STORM Kickoff Meeting 10/22/2014
Forecasting Challenges

Considerably less success cracking operational use of ADCIRC for event based forecasting than for process studies, risk analysis, risk reduction design.
Forecasting Challenges

- (Slow) Speed Kills
  - Algorithm is important – SLOSH is fast....
Forecasting Challenges

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Forecasting Challenges

• (Slow) Speed Kills

  o Algorithm is important – SLOSH is fast....

Accuracy

Forecasting

Risk analysis / design

Process studies / physics evaluation

Run Time
Forecasting Challenges

• Robust Execution
  ○ Automated setup, execution, visualization – ASGS, CERA
Forecasting Challenges

• Robust Execution
  o Automated setup, execution, visualization – ASGS, CERA
  o Pre-empt instabilities

  o What is early pathology of instability?
Forecasting Challenges

- Ensembles
  - Probabilistic – SLOSH products > 10,000 runs
Forecasting Challenges

• Ensembles
  o Probabilistic – SLOSH products > 10,000 runs
  o Scenarios – ~5-10 runs can be very insightful
  o Distributed computing resources – get the community involved – ADCIRC Data Grid
ADCIRC Data Grid

- Build a “data grid”
- Collection of THREDDS Data Servers
- Simple harvester aggregates THREDDS server content into master catalog
- Applications retrieve catalog to get available simulations and metadata
Forecasting Challenges

- Meteorological models
  - Coupling to gridded met models (e.g., North Atlantic Mesoscale Model)
  - Parametric Tropical Cyclone Model

Schematic cross section of a hurricane wind field
Forecast Information
**Storm Parameters every 6 hrs**

- lon, lat of center of eye $\longrightarrow V_{trans}$
- $V_{max}$
- $R_{64}, R_{50}, R_{34}$ in 4 storm quadrants
- $P_c$ - Central Pressure

- $P_n, R_{max}$ - estimated separately

*Schematic of isotach information available in ATCF Best Track or NHC forecast advisories at given time snap*
Generalized Holland Asymmetric Model
ADCIRC Future – An Unstructured Grid Modeling Framework

• Aspire to be WRF (Weather Research and Forecasting) Model
  - Engage & inspire science / engineering community
  - Shorten distance from research to operational use
ADCIRC Future – An Unstructured Grid Modeling Framework

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Framework vs Monolith
Extensibility
Encapsulation
Modules In Progress

• wind.F module
  • module development in progress
  • loosely coupled
  • well-defined interface

• mesh.F module
  • developed and tested
  • decouples reading from initialization
Modules In Progress

- write_output.F
  - Greatly simplified
  - Streamlined for extensibility
- writer.F
  - Renovated for extensibility
  - Aligned with write_output.F
Modules Needed

• Solution initialization
  • Duplicate and near duplicate code: coldstart() and hotstart()
  • Starting CG vs DG vs hp adaptivity
• Parallel frameworks
• GWCE
  • Concise code and description
  • Swap formulations
Modules Needed

• Momentum equations
  • Timestep.F contains 4 separate subs
  • Significant overlap between them

• Wetting/drying
  • Swappable algorithms/multi-algorithms
  • Clean separation/connection to overtopping

• Boundary Conditions
  • Break tight coupling of levees to wet/dry
  • Separate out subs for applying b.c.s
Did we break it?
Manual Testing?
Automated Testing?

• Advantages
  • Comprehensive
  • Collaborative
  • Rigorous
  • During development rather than production

• Disadvantages
  • Automation infrastructure needed
  • Must create tests
  • Time commitment to diagnose/fix issues
Test Workflow

• Input: fort.14, fort.15, fort.22, fort.dg, ...
• Expected output: fort.63, maxele.63, ...
• Variations: parametric, functional, version
• Comparison of actual vs expected
• Reporting and publication
ASGS as Test Driver

ADCIRC Vortex

Hydrograph of Water Level Time Series

IHNC Water Level
ASGS Ideals

- Capable
- Relocatable
- Scalable
- Accurate
- Reliable
- Pluggable
- Collaborative
- Compatible
- Visible
- Flexible
- Credible
Testing / Forecasting Analogies

• Template approach
• Flexible forcing
• Geographic agnosticism
• Platform portability
• Ensemble <-> parameter variations
• Post processing <-> test evaluation
• CERA publication <-> test results report
Progress

• Developed ASGS proof-of-concept
• Xdmf2 branch; quarter annulus
• Writer processors
  • None
  • One
  • Ten
• Output format
  • Ascii
  • NetCDF
ASGS Development Needs

• Download and compile ADCIRC
• HPX
• MPI
• Support DG input files
• Configure solver options
• File management for multiphysics
• Support differences in code function (init)
ASGS Forecasting
Research vs Real Time

• Research
  • Audience of experts
  • Room for debate
  • Time is on our side
  • Inertial credibility

• Real Time
  • Hard numbers
  • Time is up
Forecasting

**The New York Times**

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HURRICANE DRIVES TOWARD NEW YORK WITH DEADLY FURY

Subways Close and Coasts Evacuated as North Carolina Bears First Blast

This article was reported by Kim Severson, Dan Barry and Campbell Robertson and was written by Mr. Barry.

COKINJACK, N.C. — Weakened but unabated, Hurricane Irene moved across coastal North Carolina and Virginia on Saturday as it churned up the Atlantic Seaboard toward a battered-down New York City, where officials had taken what were called the unprecedented steps of evacuating low-lying areas and shutting down the mass transit system in advance of the storm’s expected midmorning arrival on Sunday.

Announcing itself with howling winds and hammering rains, the hurricane made landfall at Cape Lookout, on the Outer Banks of North Carolina, around 7:30 a.m., ending several days of anxious anticipation and beginning what knows how many more days of resistance and cleanup. Downed National Hurricane Center’s early morning decision to downgrade Irene to a Category 1 hurricane, whose maximum sustained winds would reach only — only — 90 miles an hour, with occasional stronger gusts.

The hurricane also quickly contributed to at least five deaths in North Carolina; three men died: one whose car hydroplaned and hit a tree; another who was hit by a falling tree limb and a third who had a heart attack while raking up plywood. Two more people died in Virginia; in Newport News, a fallen tree crushed through the roof of an apartment building and killed an 11-year-old boy, while in Brunswick County, a tree fell on a car and killed a man.

By Saturday evening, the massive storm was pushing back out to sea and continuing north at about 13 miles an hour. Laurie Shagin, a meteorologist with the

People shielded themselves from blowing sand and rain in Kill Devil Hills, N.C., during Hurricane Irene on Saturday. The storm, which is due to reach New York around midmorning Sunday, is blamed for at least five deaths in North Carolina and Virginia.
good as far as rainfall, because it will just sit here and dump us.”

With the first hurricane warnings issued late Saturday, all federal officials issued evacuation orders for about 2.2 million people, according to The Associated Press — from 1 million people in New York, where the governor, Chris Christie, declared an emergency, to several hundred thousand people in New Jersey, where the governor, Phil Murphy, declared an emergency, and to several hundred thousand people in Pennsylvania, where the governor, Tom Wolf, declared an emergency.

The storm, or the anticipation of it, spoiled an otherwise lazy Labor Day in the Northeast, as airlines canceled thousands of flights and governments declared states of emergency. Amtrak cancelled all train service in the Northeast, while airlines canceled more than 3,000 flights. New Jersey Transit and Long Island Rail Road also canceled service.

Major League Baseball postponed games. Broadway shows went dark in deference to nature’s many dramatic productions.

And, if the spirits were down in the Northeast, they were up in Washington. In any marine, liquor stores enjoyed brisk business-related business. “It’s like New Year’s Eve,” bar owner John Lee, who works at the Senate, said. “They’re buying everything. Wine. Beer. Even cigars!”

The Federal Emergency Management Agency, still reeling from a string of disasters in 2016, had already issued a state of emergency for portions of the East Coast, with stocks of food, water and medical supplies already ready to go. The Coast Guard was already drafting plans to deploy a fleet of ships and helicopters to respond.

Kim Simerer reported from Washington, D.C. Brian J. Scully from New York and Caregill Robinson from Charlotte, N.C. Reporting was coordinated by Liran Melcer from Naples, Italy. N.C. Black, Daves from New York, Abby Goodhough from Boston, and Sabrina Tuite and Eric Lichtman from Washington.
Recap

• Modularize ADCIRC
• ASGS Testing
  • Collaborative
  • Rigorous
  • Forecast-ready
• Forecast with ASGS