Coupled Wind, Wave, and Surge Modeling

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10th International Wave Conference
12 November 2007

Collaborators

Our Lab is too small to do big projects alone,
so we gratefully acknowledge our collaborators:

Erick Rogers NRL
Dr. Scott Hagen UCF CHAMPS Lab
Taylor Engineering
Dr. T. Krishnamurty Florida State University
NOAA Florida WFOs and Hurricane Center
IHRC and CS Faculty at Florida International U.

Florida Coastal Ocean Wave Modeling

UNF has been working toward coupled modeling since 2005 based upon previous modeling efforts in the area.

Outgrowth of the NOAA Coastal Storms Initiative (CSI) in NE Florida 2003-2005.

Coastal Ocean Wave Observation and Modeling Whitepaper in 2005 layed out a plan of SE Atlantic wave observations, Wellen Radar (WERA)-ADCP wave measurement and comparison

Winds drive the problem

Like rainfall drives the hydrology; winds drive the wave generation, and surface current problem.

At the local nearshore coastal level, high resolution atmospheric winds are "often" NOT the synoptic scale winds…

Florida is perhaps the extreme example with local mesocale winds being dominant for more than half the year…sea-land breezes, squalls, thunderstorm outflows, hurricanes.

Results in context…

Model resolutions are NOT the same

NOAA has broad National operational requirements that local models do not, and very real resource constraints.
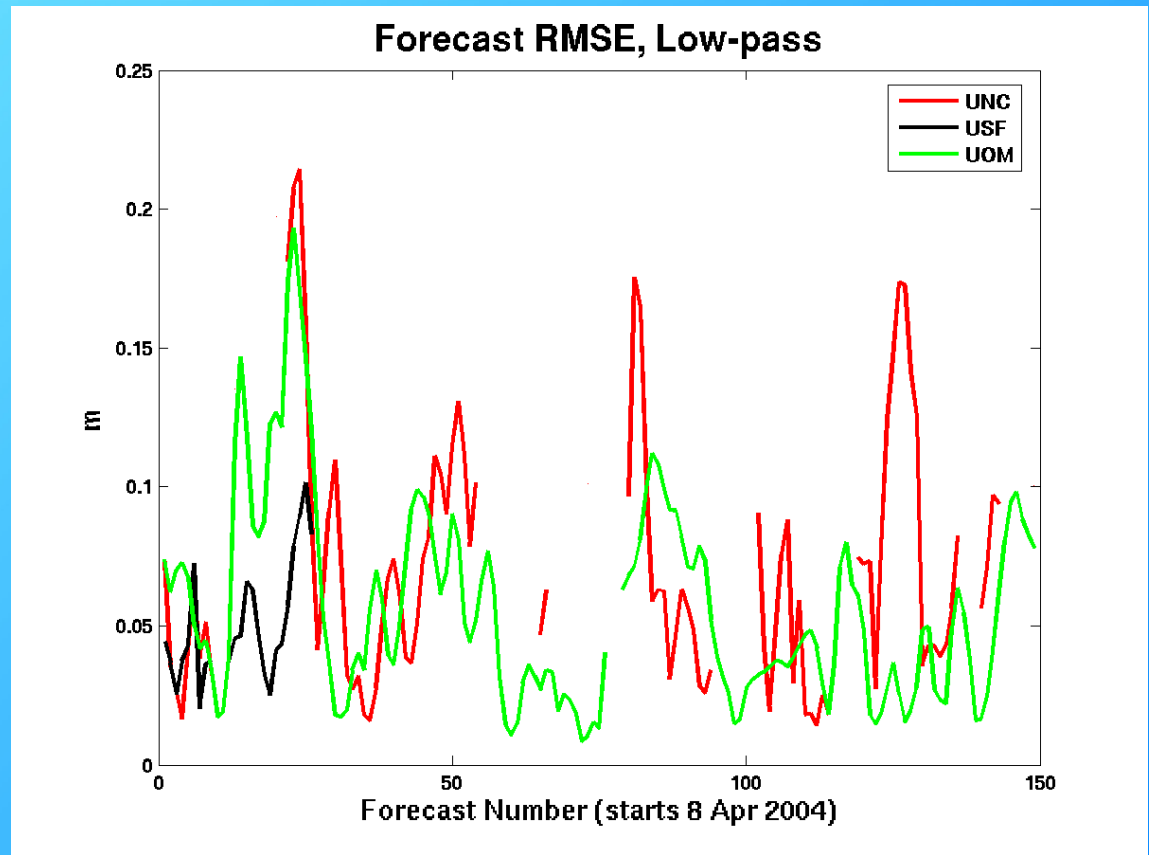
Local models are not operational, and can expend more resources in a limited domain.

NOAA's model results are the boundary conditions for the local modeling effort.

AWISlab

UNF
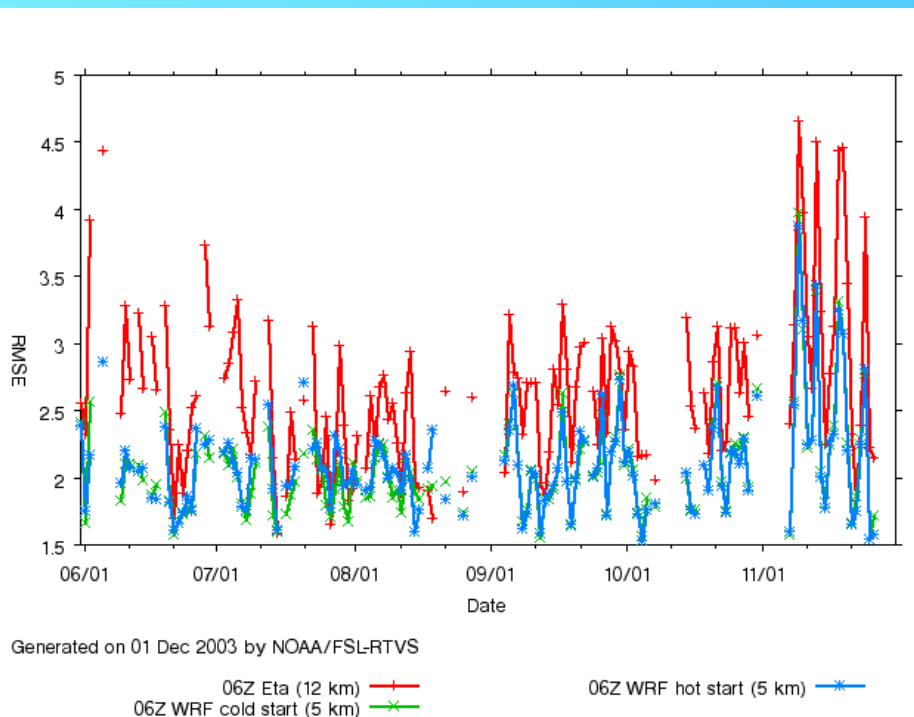
Coastal Ocean Modeling
Winds are problematic in Florida

- Greater than 6 months of the year the ocean models are not consistent…

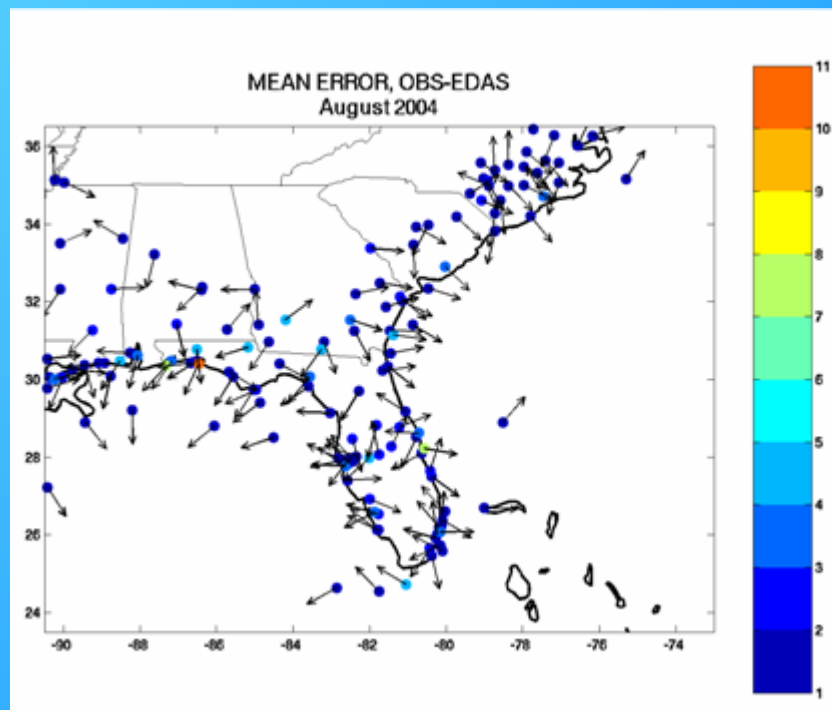Forecast RMSE, Low-pass

Weather Research and Forecast Modeling

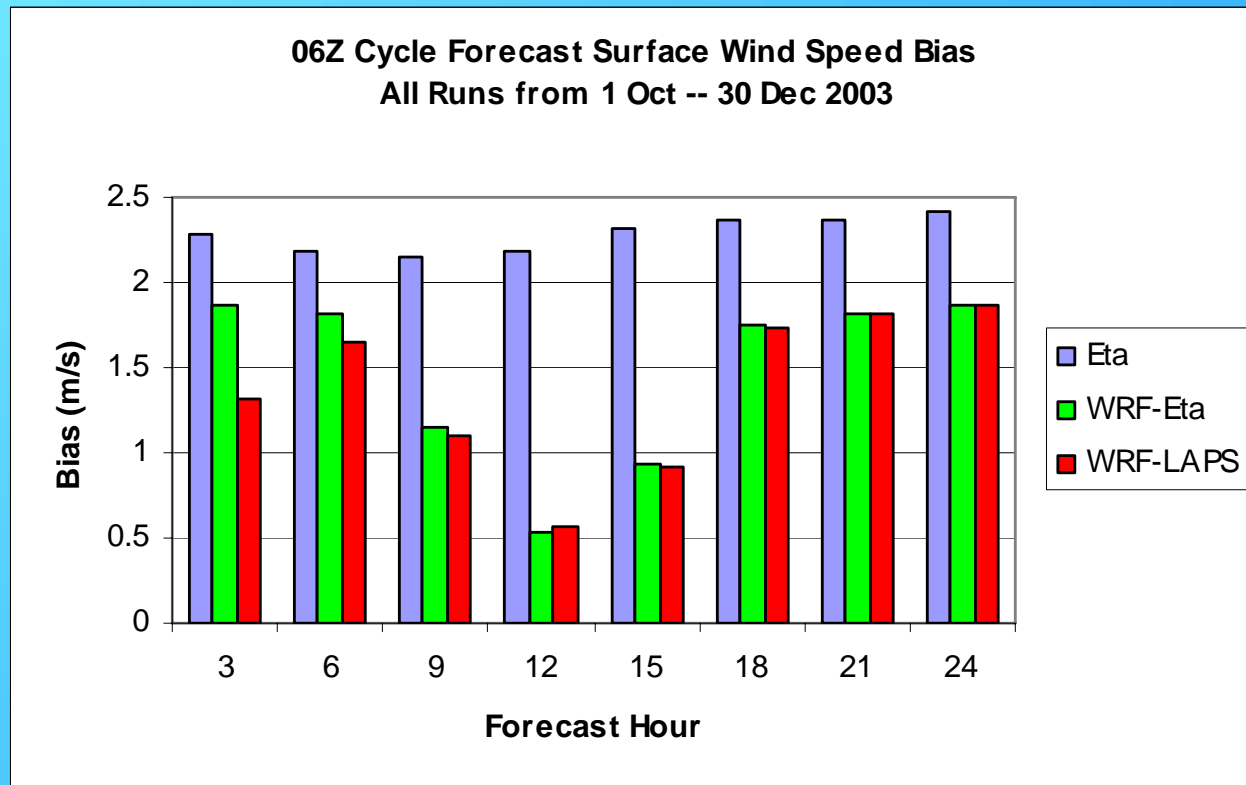## Summer Winds from National Models

2003 Summer ETA vs WRF-ARW   EDAS Wind Initialization Error
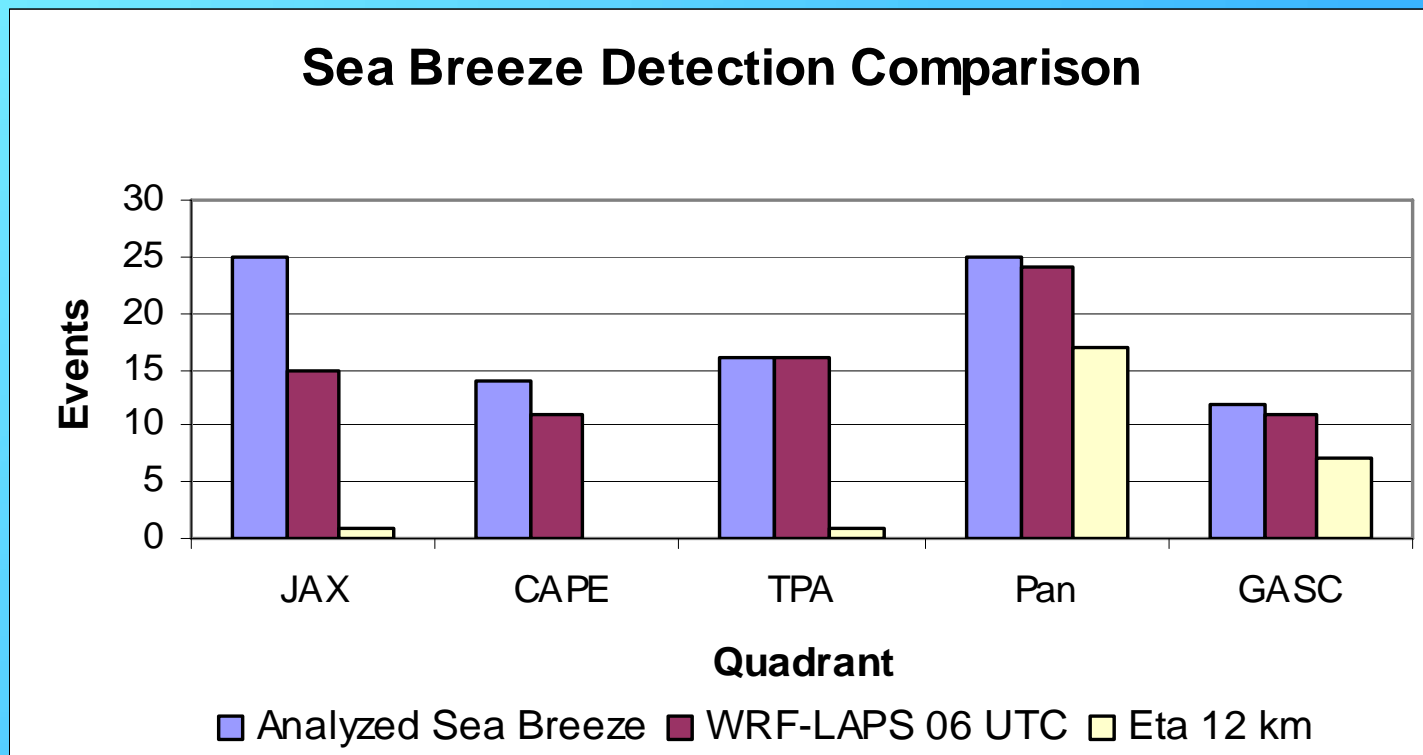
Weather Research and Forecast Modeling

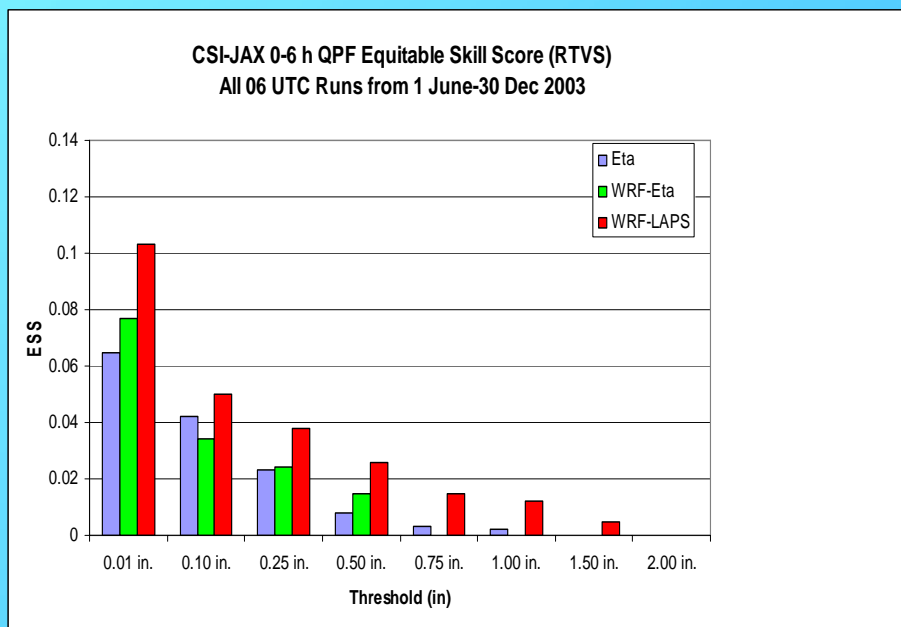Diurnal Wind Cycle Modulation (Shaw 2004)

06Z Cycle Forecast Surface Wind Speed Bias
All Runs from 1 Oct -- 30 Dec 2003

Weather Research and Forecast Modeling

WRF (5 km) detected 84 %   ETA(12 km) 38 % (Bogenschutz 2004)

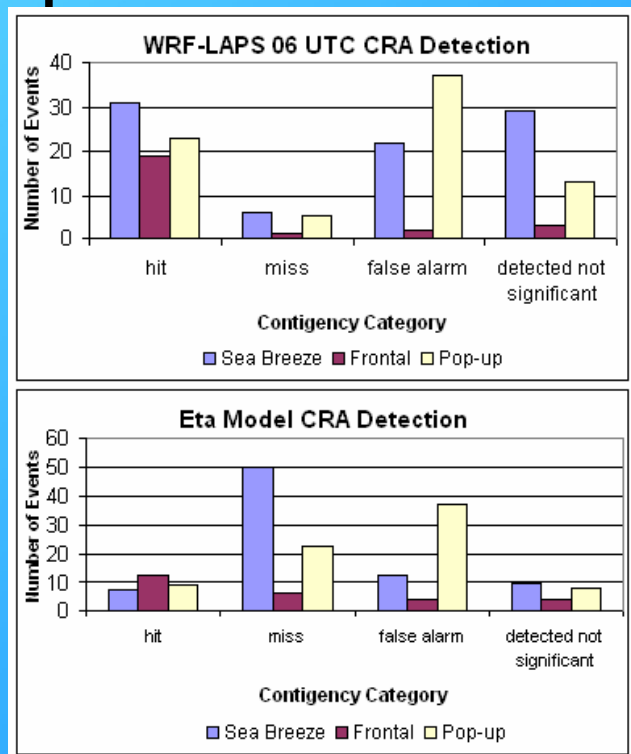
Sea Breeze Detection Comparison

Weather Research and Forecast Modeling

Florida summer rain is driven by land-sea breeze thunderstorms, squalls & hurricanes

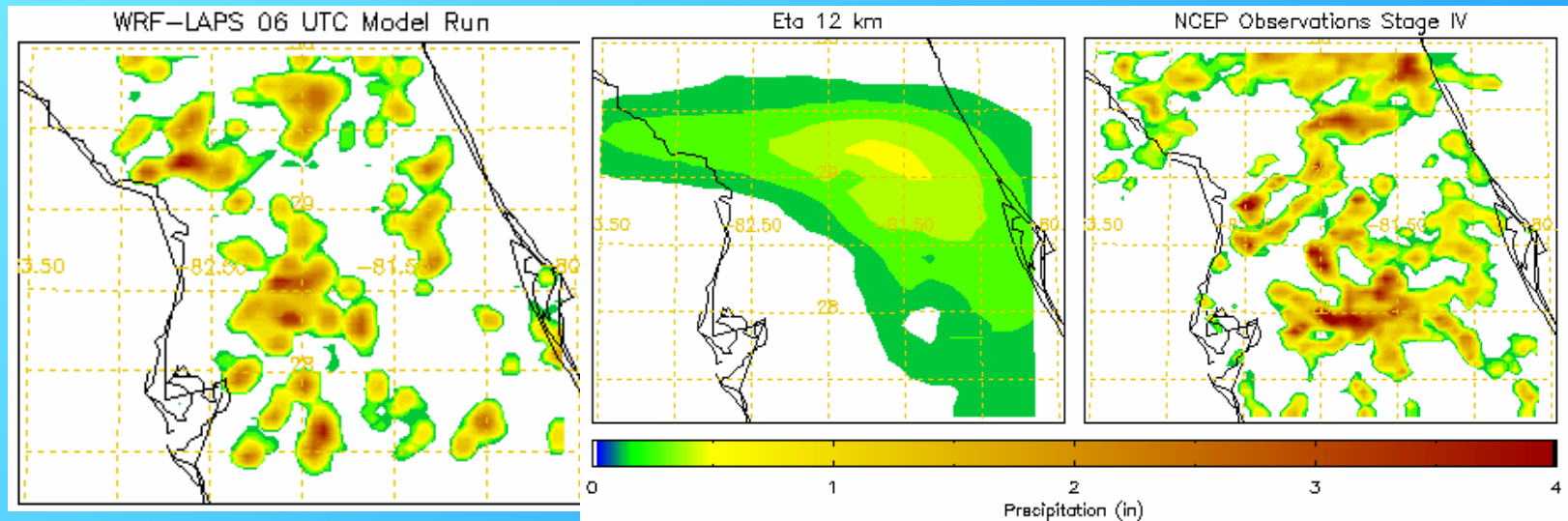

Shaw et al 2004

Bogenschutz 2004

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- National ETA model smooths convective precipitation…WRF errs in space/time
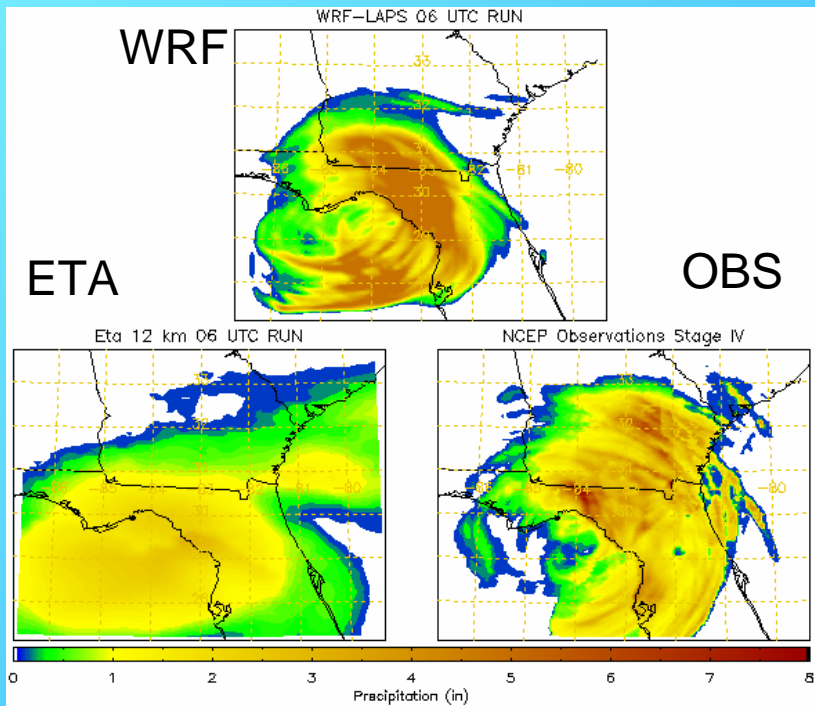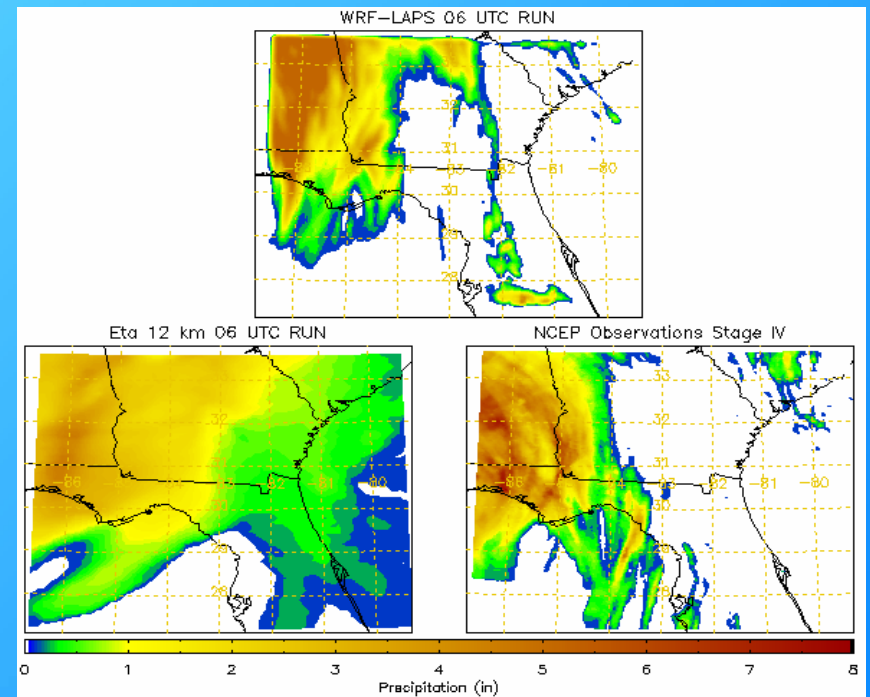
WRF Model   ETA(NAM)   OBSERVED Doppler/Gauge

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- Hurricane rainband structure in WRF (ARW) stands out
- I'd like to show you winds…
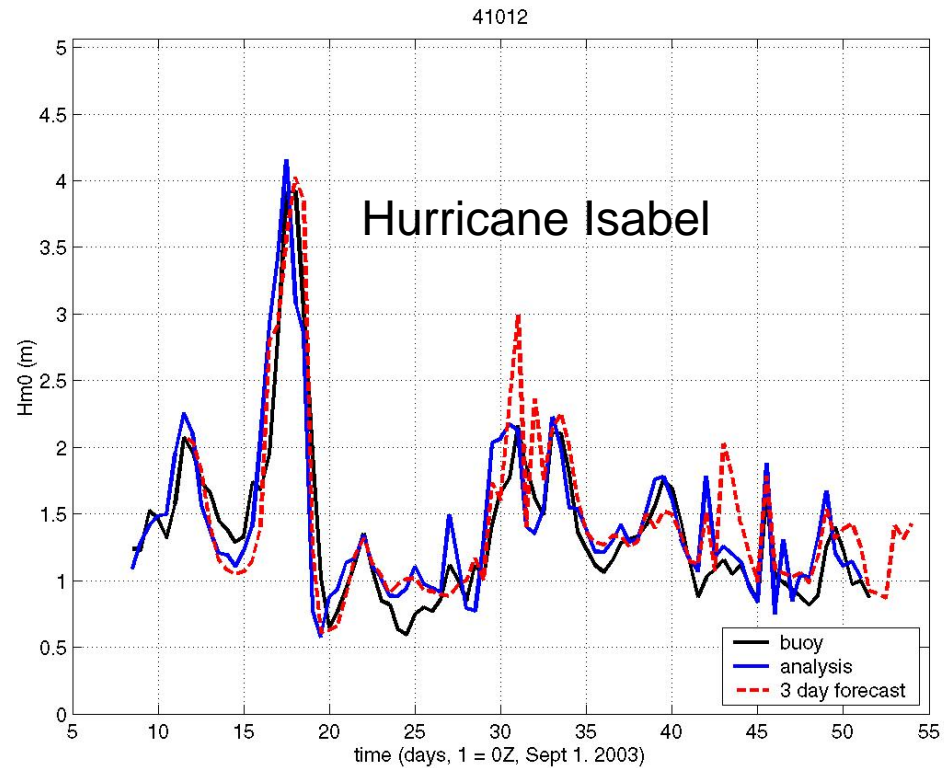
FRANCES 2004

IVAN 2004

CSI Wave forecasts

JAX CSI Significant Wave Forecast for NDFD

Still had (have) a wave verification problem

QuickTime™ and a
TIFF (Uncompressed) decompressor
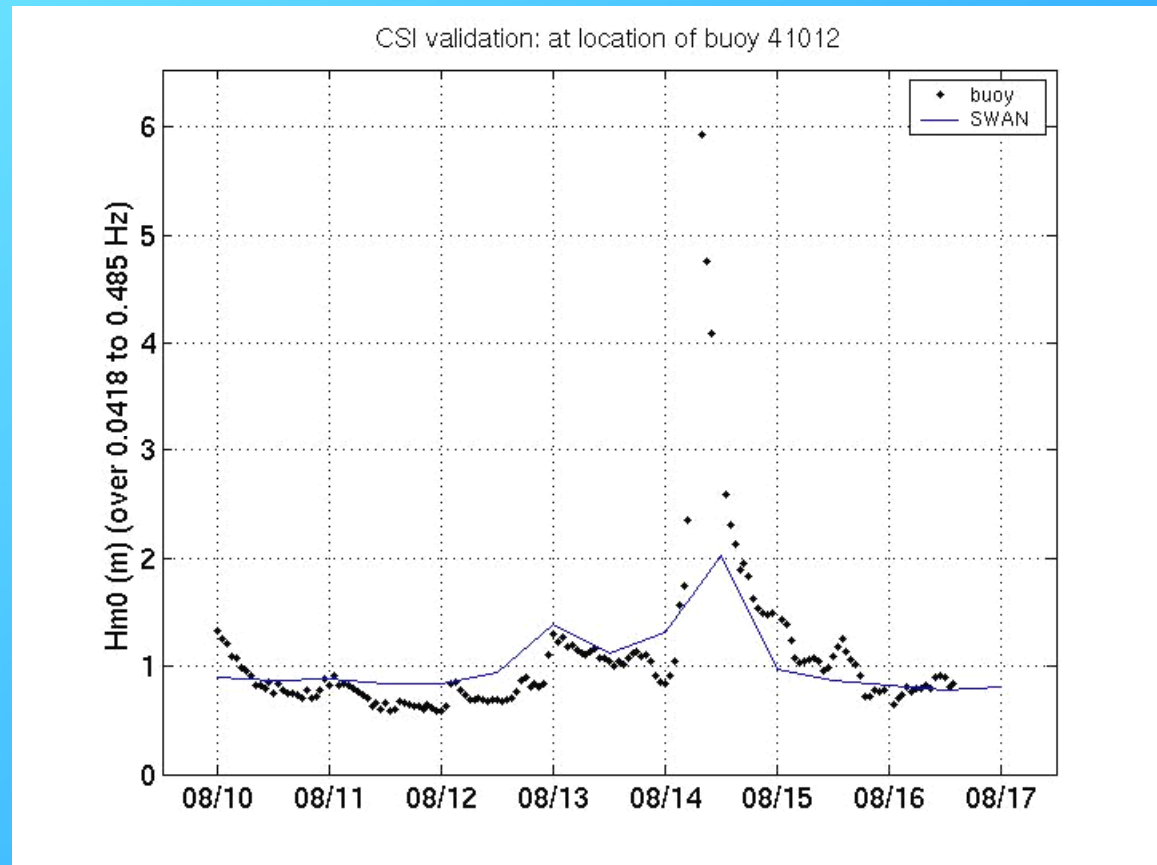are needed to see this picture.

CSI SWAN Model

Based on GFS and WW3 LBCs
Run at NRL SSC (Erick Rogers)

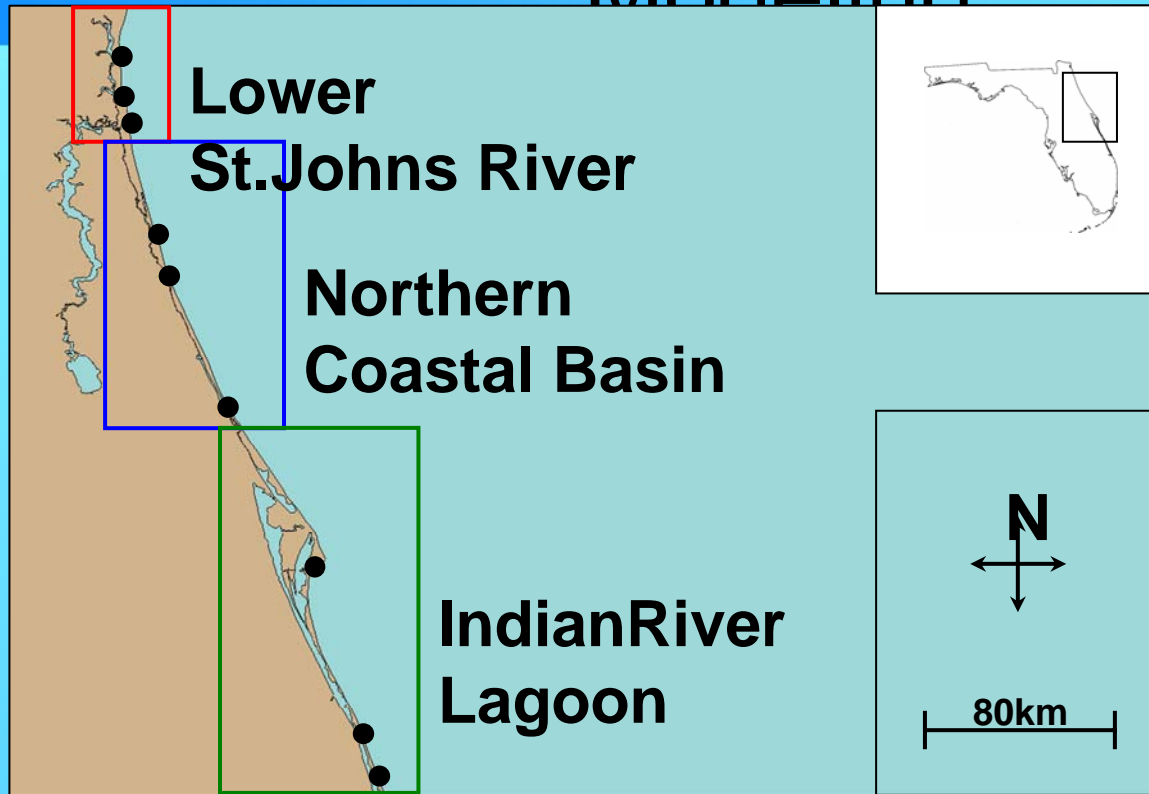# Hurricane Charley SWAN

But when the atmospheric models err…

Coastal Wind, Wave, & Estuary Modeling

Lower
St.Johns River

Northern
Coastal Basin

N

80km

IndianRiver
Lagoon

Coastal sub-domains in Rectangles, with inlets at Black dots

AWISlab

UNF

Coastal inlet modeling grids

Single and two way wave coupling (Funakoshi and Hagen 2006)

Existing WANT model domain

St johns River tides are problematic

Offshore SSTs are problematic

Still have a wave verification problem

Working on both ADCP/WERA for NE FL inshore Waves

QuickTime™ and a
TIFF (LZW) decompressor
are needed to see this picture.

Current efforts

UNF and UCF and others are teaming up to do realtime coupled atmosphere, wave and estuary modeling with WRF (ARW), STWAVE/SWAN, Barotropic coastal and estuary with WANT and ultimately add MORPHOS.

Look at WRF ESMF model structure, fluxes and wind stress parameters coupled to ADCIRC and coastal barotropic modeling as a step toward future MORPHOS coupling.

Understanding the impact of data transfers between (and coupling of) models running different grids…

Future Vision

Produce High-Resolution Weather Model for Florida.

Improve wind and rainfall…and at higher resolution

Incorporate new Land-Surface Model(LSM)…then biome

Couple WRF Hurricane Model and Impact Models

Wave model and estuary model using WRF winds

Surge Model (with wave run-up ?)

Rain Flooding with GIS based water routing

Hurricane wind damage

Contributions limited to date…SYSADMIN and Funding

GOAL: Development of Florida "Hydro-system" Model.

Weather Research and Forecast Modeling