Validation of Coupled Probabilistic Rip Current Model and the Nearshore Wave Prediction System (NWPS) Across Southeast Florida

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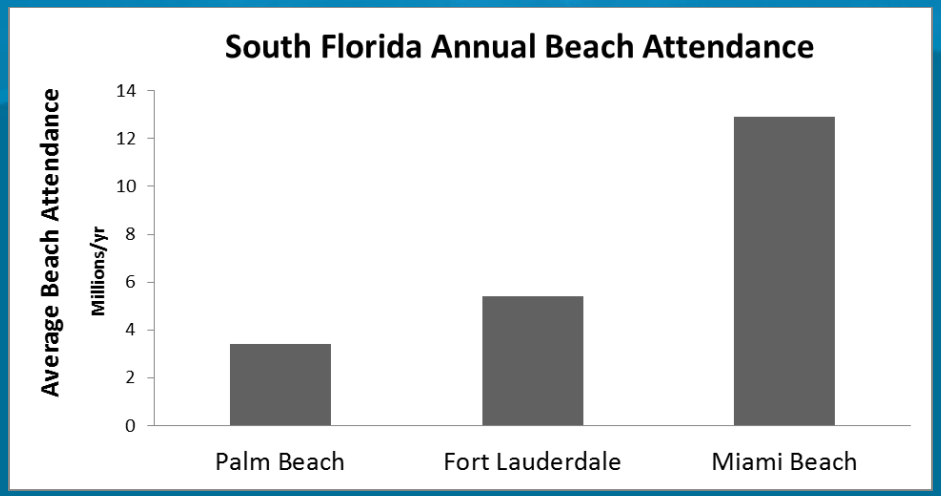
AMS 95th Annual Meeting, 13th Symp on Coastal Environment, Phoenix, AZ 2015

Outline

1. Motivation for implementation
2. NWPS
3. Coupled NWPS and Rip Current Forecast Model (RCFM)
4. Validation (Methodology and Preliminary Results)
5. Future Goals

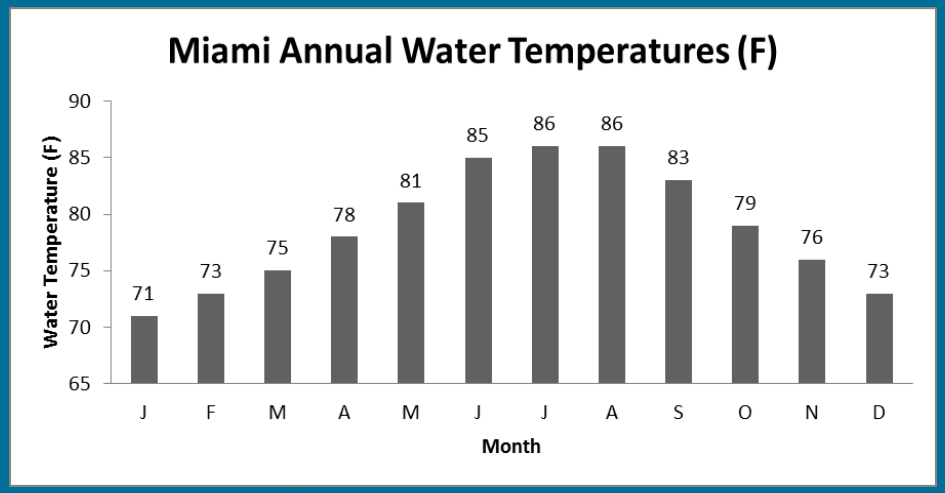
Motivation

- ***Leading cause of fatalities/ rescues along US beaches.***

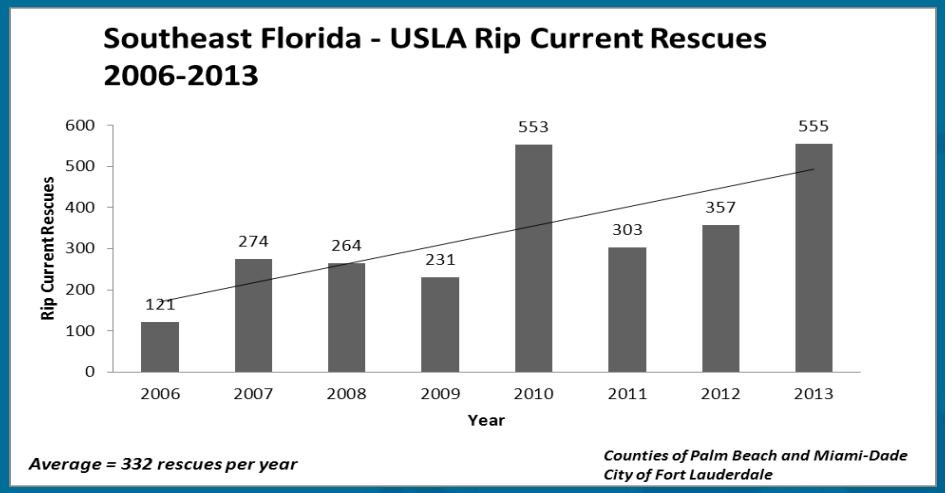


- ***Can we provide an accurate statistical forecast relying on numerical wave and water level models?***

Southeast FL: Millions transit by on a yearly basis.



All year around



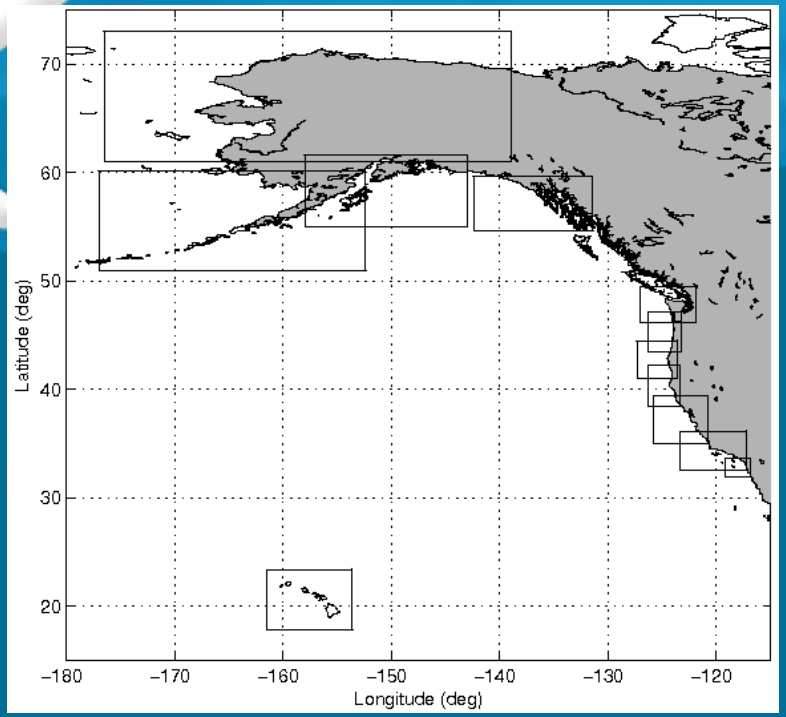
Rip Currents Threat

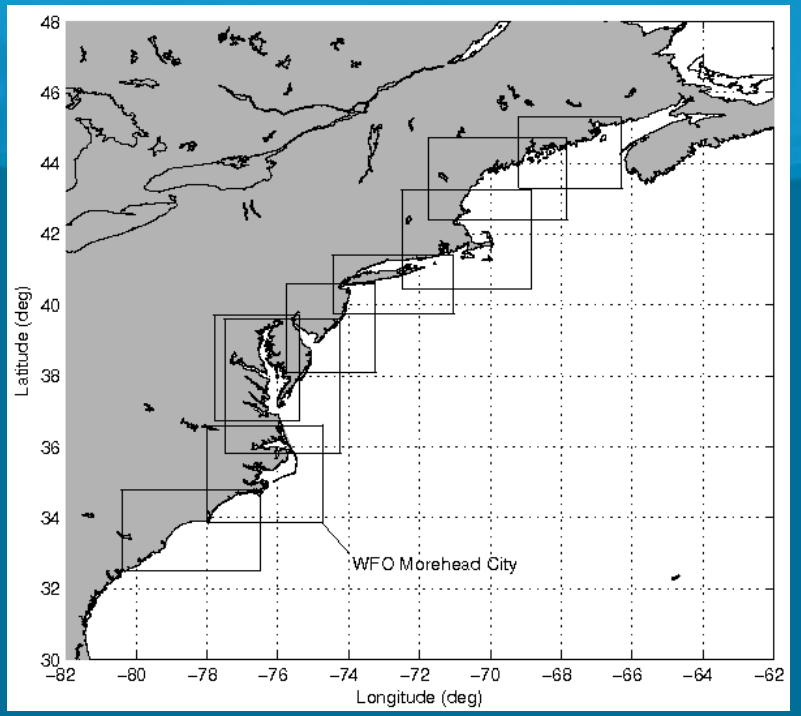
The Nearshore Wave Prediction System (NWPS*)

- Run routinely/on-demand, using SWAN or nearshore WW3
- Driven by forecaster-developed winds from GFE (AWIPS2), and other NCEP forcings (e.g. WW3, RTOFS/ESTOFS).
- Intended to include in the AWIPS2 baseline for sustainability.
- Addresses region-specific physical processes in the nearshore (wave-current interaction, ice interaction, high res bathymetry, etc.).
- Include wave partitioning (separate wave field into component systems).
- Future two-way coupling to coastal circulation model (ADCIRC).

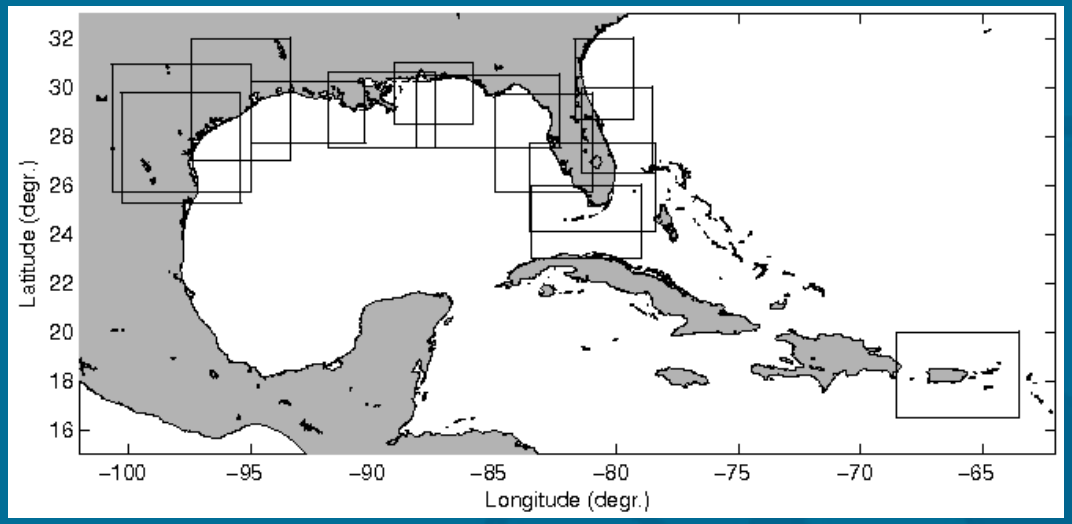
* Van der Westhuysen et al. 2013, 2014

NWPS





- **Configured and run by WFOs**
- **GFE forecast:** Wind forcing
- **Global WW3:** Wave BCs
- **NHC/TAFB:** BCs
- **RTOFS Global:** Surface currents
- **ESTOFS/P-Surge:** Water levels
- **Output:** Significant Wave Height, Peak Period and Direction, and partitioned wave groups height, period and direction tracked in space and time.



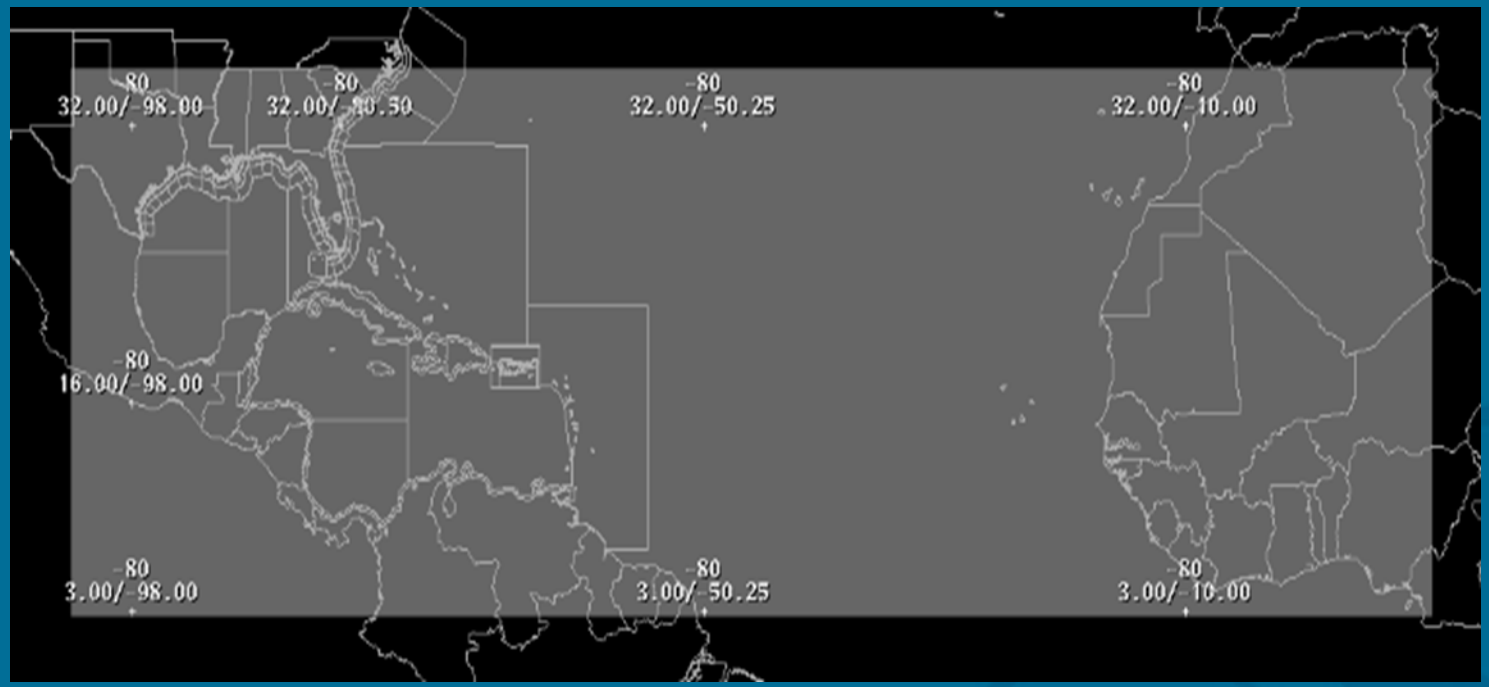
* Van der Westhuysen et al. 2013, 2014

NHC/TAFB's local NWPS domain

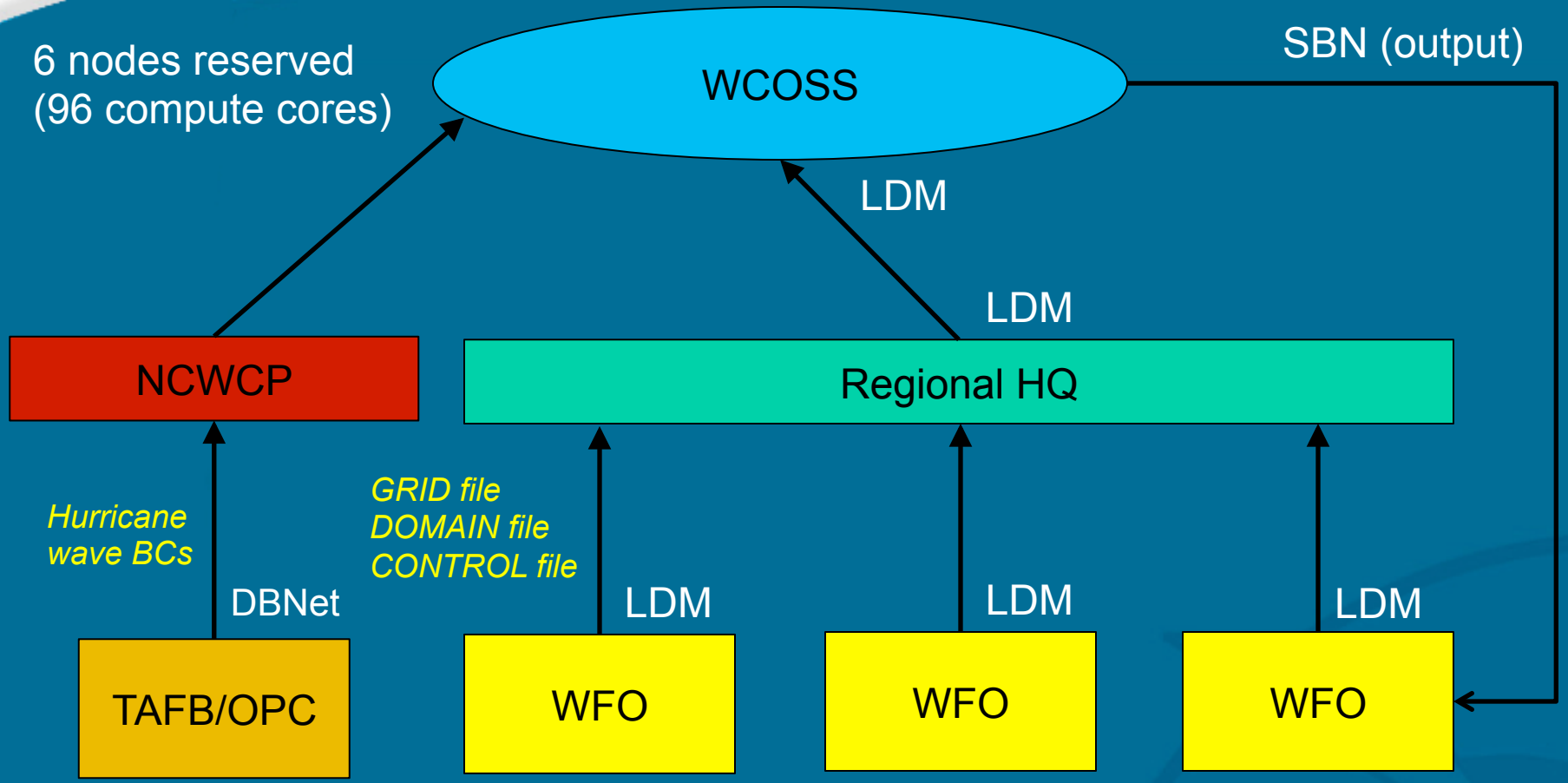
Run operationally on a 24-core cluster at NHC. Future candidate for WCOSS (along with an OPC domain)

Model Domain:

SW LAT= 3.00
SWLON= -98.00
NELAT= 32.00
NELON= -10.00

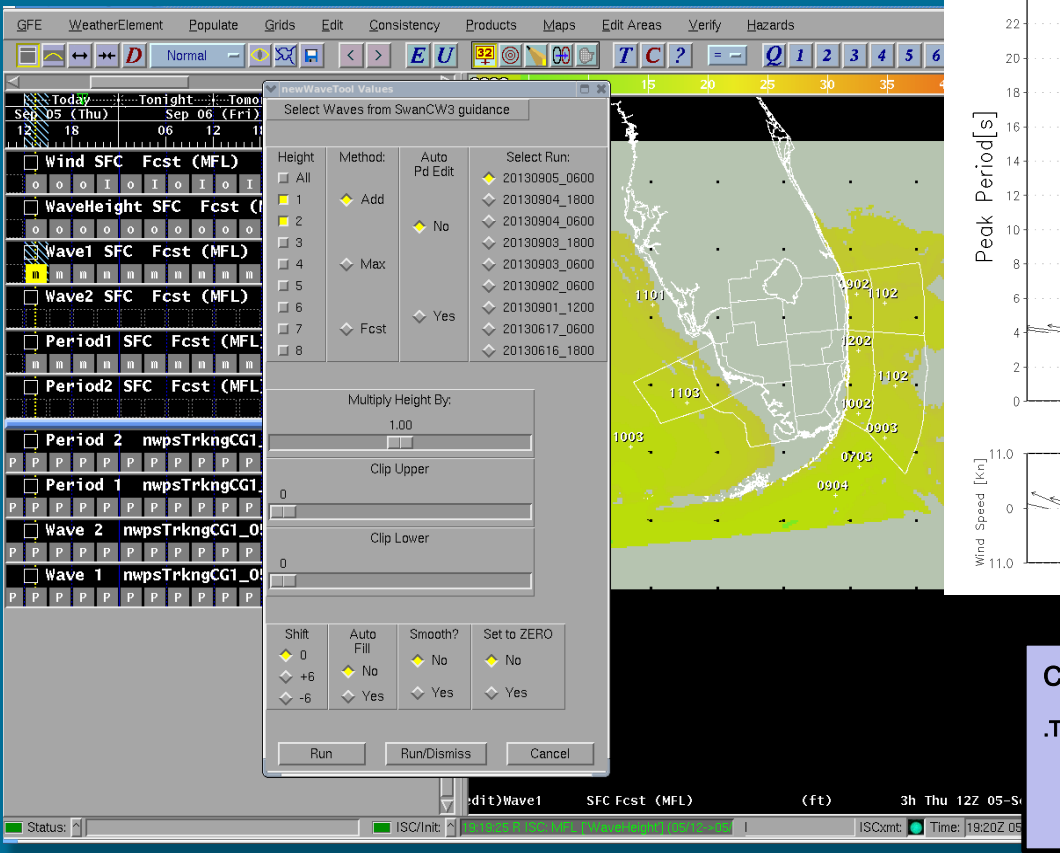


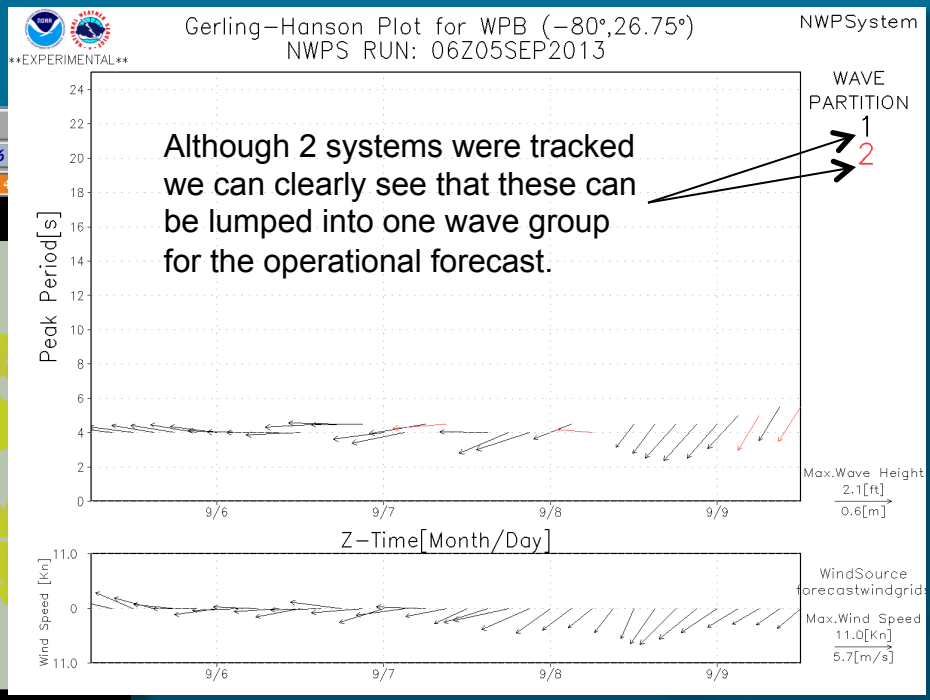
NWPS Data upload and run triggering



Guidance in GFE, incl. tracking output

WAVE1-2: Height + Direction



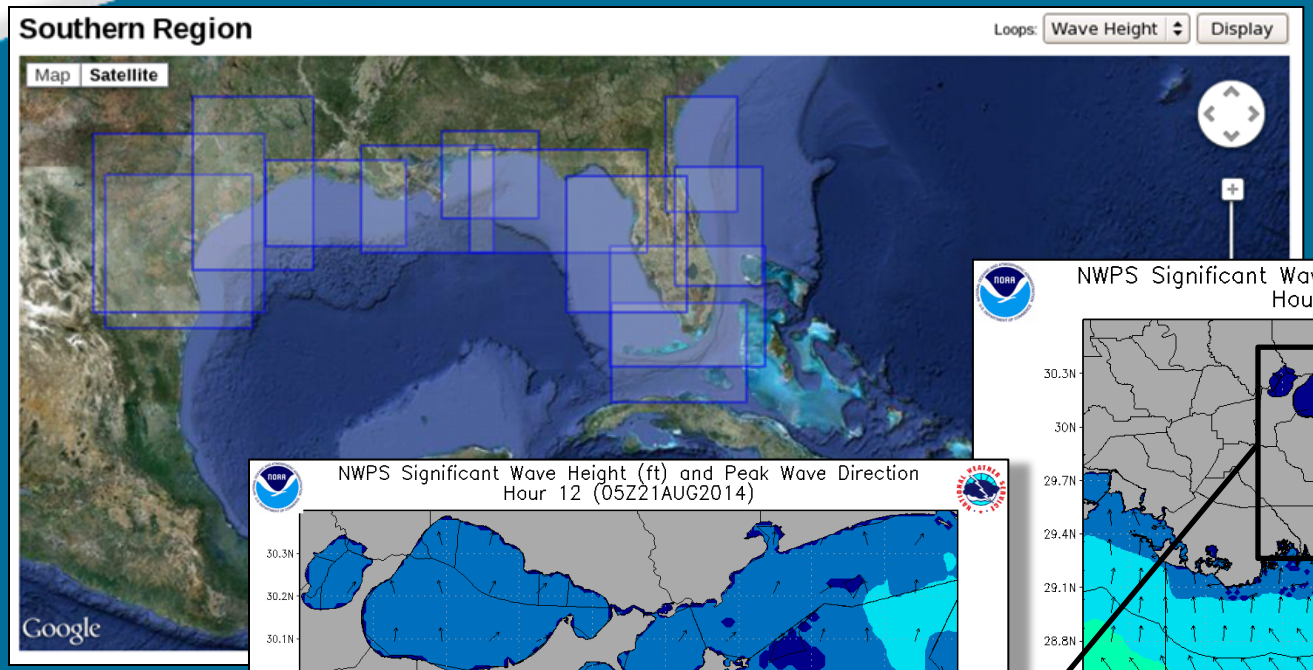


Coastal Waters Forecast Example:

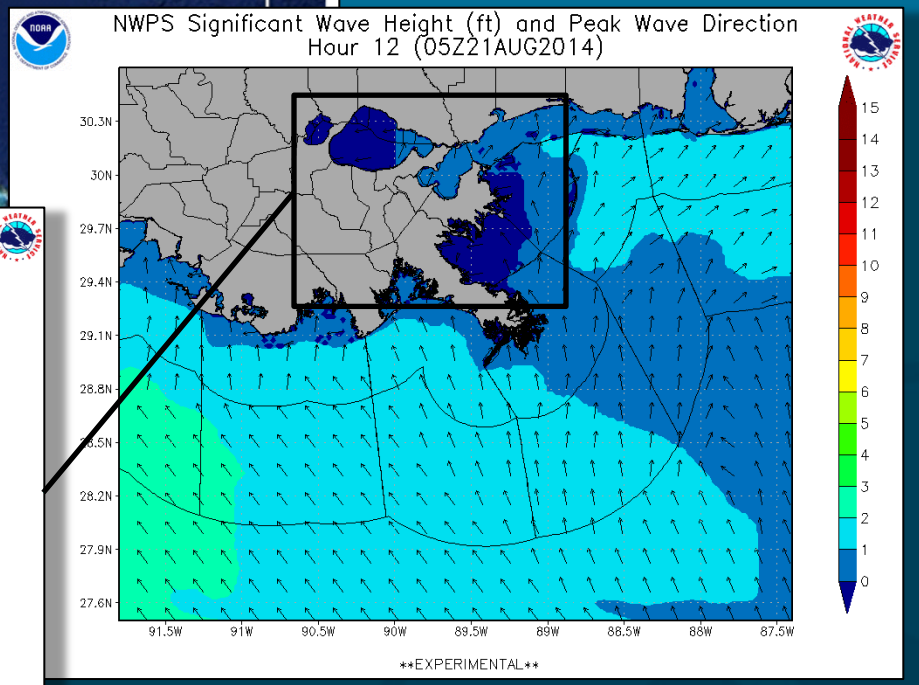
.TODAY...EAST WINDS AROUND 10 KT. SEAS EAST 1 TO 2 FT AT 4 SECONDS.

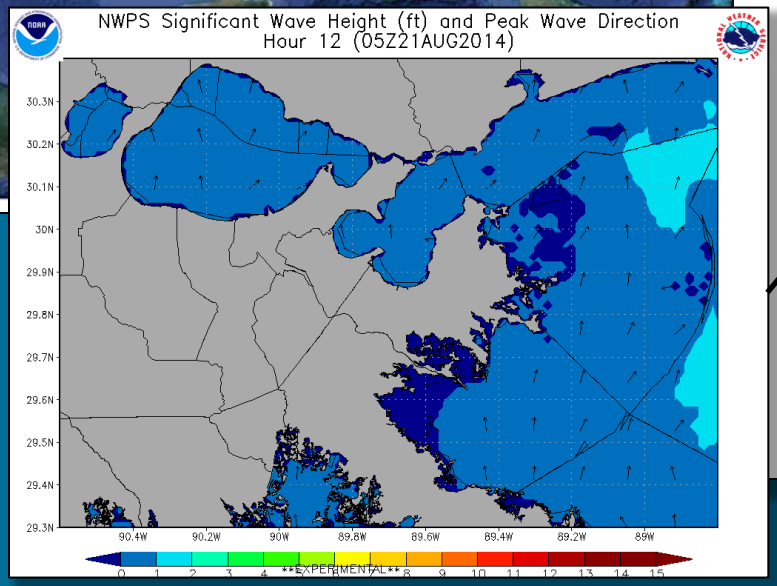
Example output for WFO New Orleans

http://innovation.srh.noaa.gov/nwps/



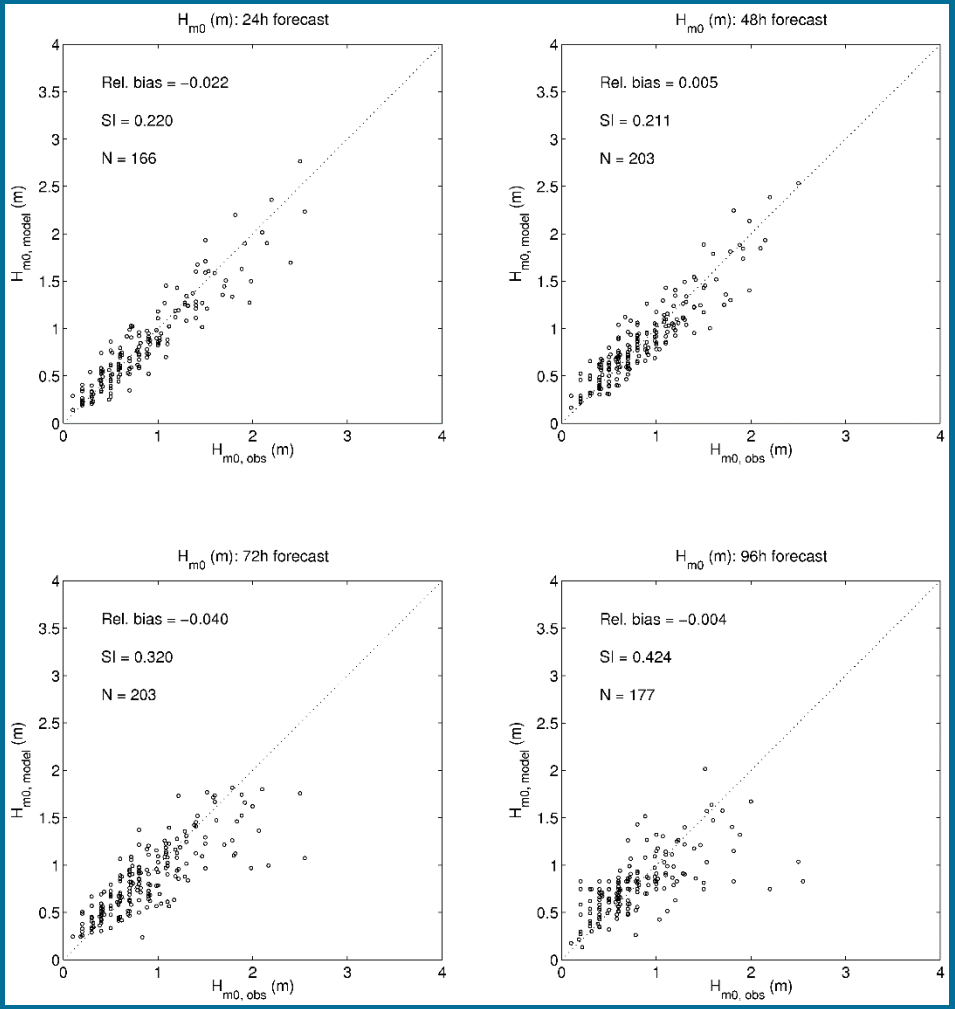
WFO LIX, CG1

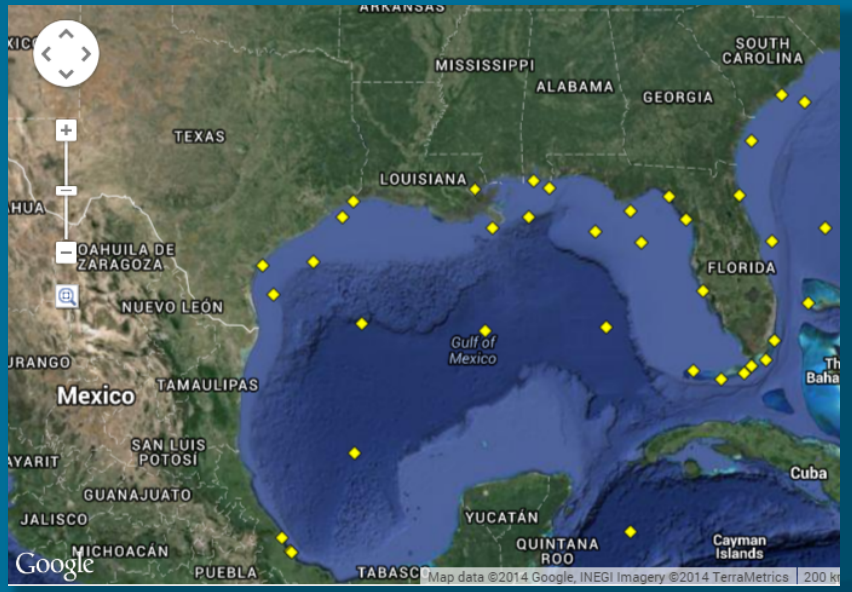




CG2

Validation

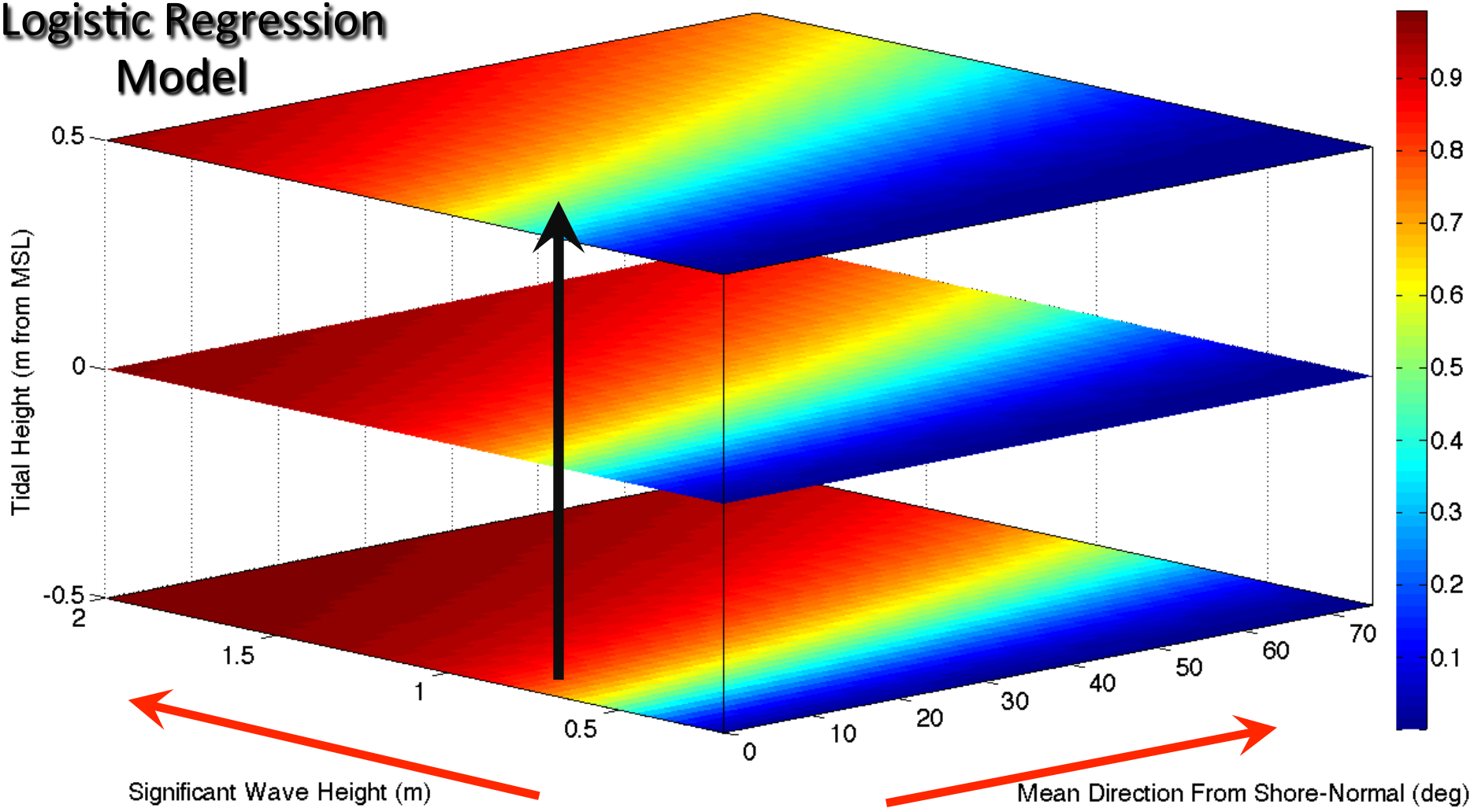




SR WFO output compared to shelf/nearshore NDBC buoys - October 2014

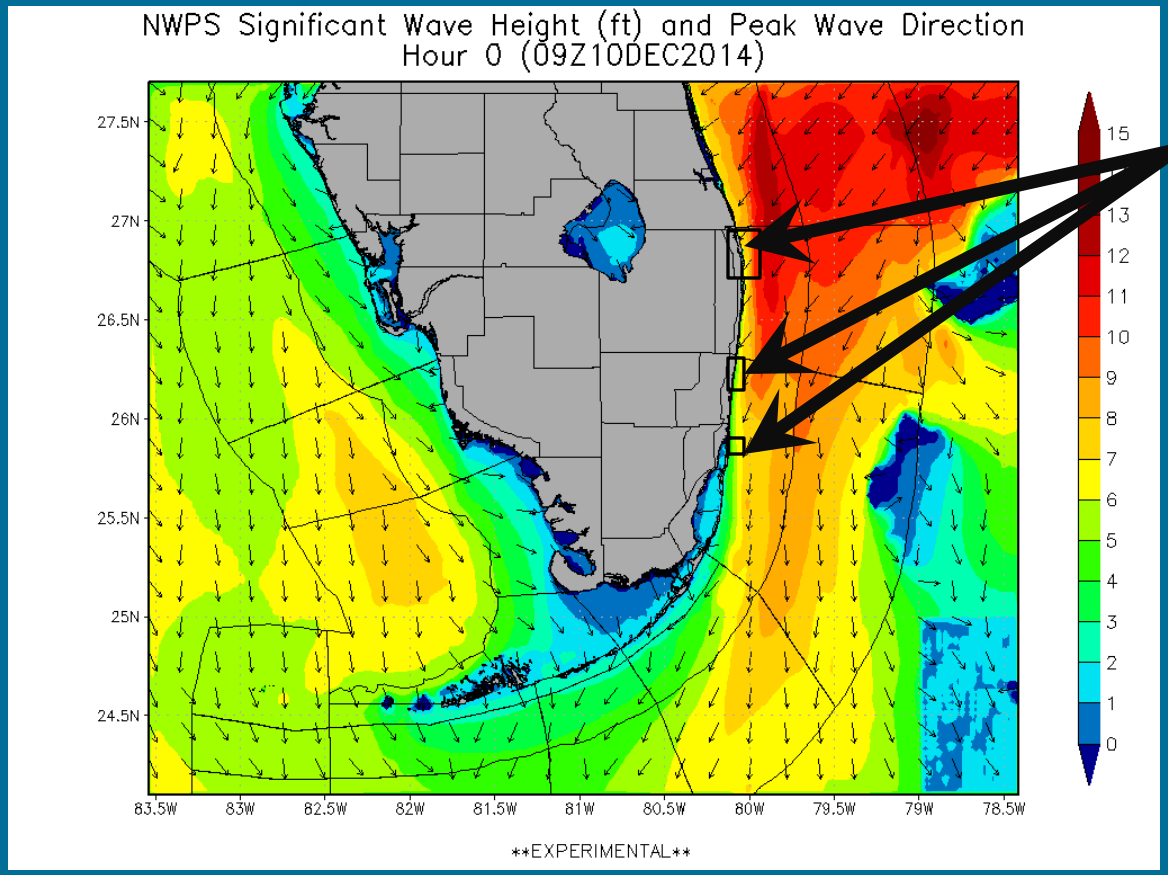
Rip Current Forecast Model

Logistic Regression Model



Dusek and Seim, 2013

Coupled NWPS and RCFM South Florida



- 1.8 Km Outer Domain.
- 3 nested nests along SE coast 100m resolution each.
- Currents: RTOFS
- Water levels: ESTOFS/Psurge
- Runtimes: Twice a day out 102 HR; 3 hrly output

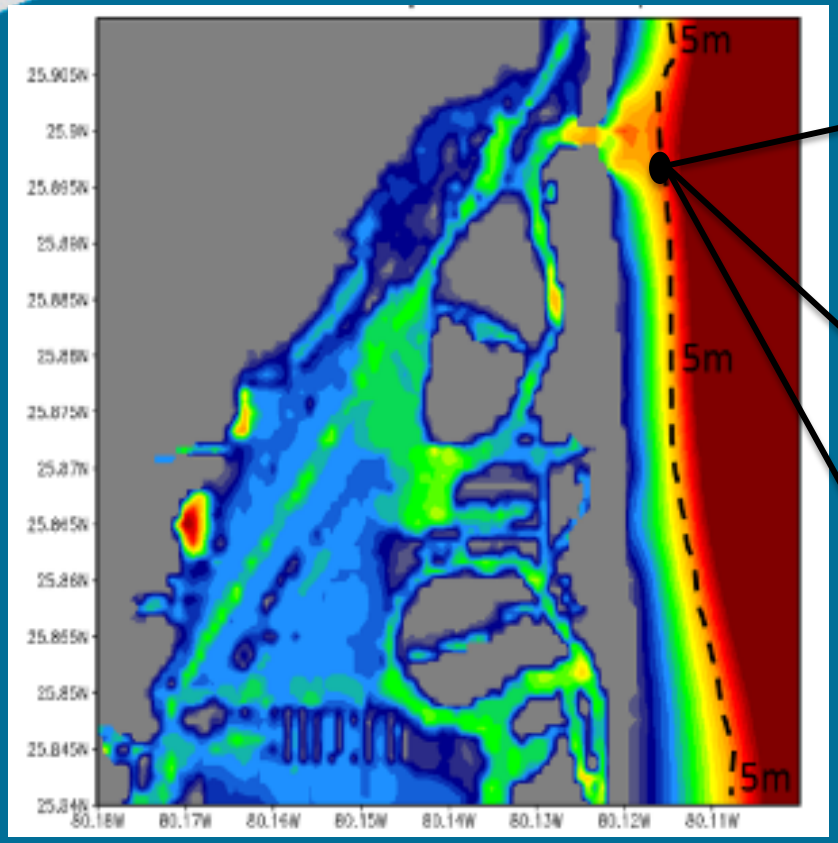
Coupled NWPS and RCFM South Florida

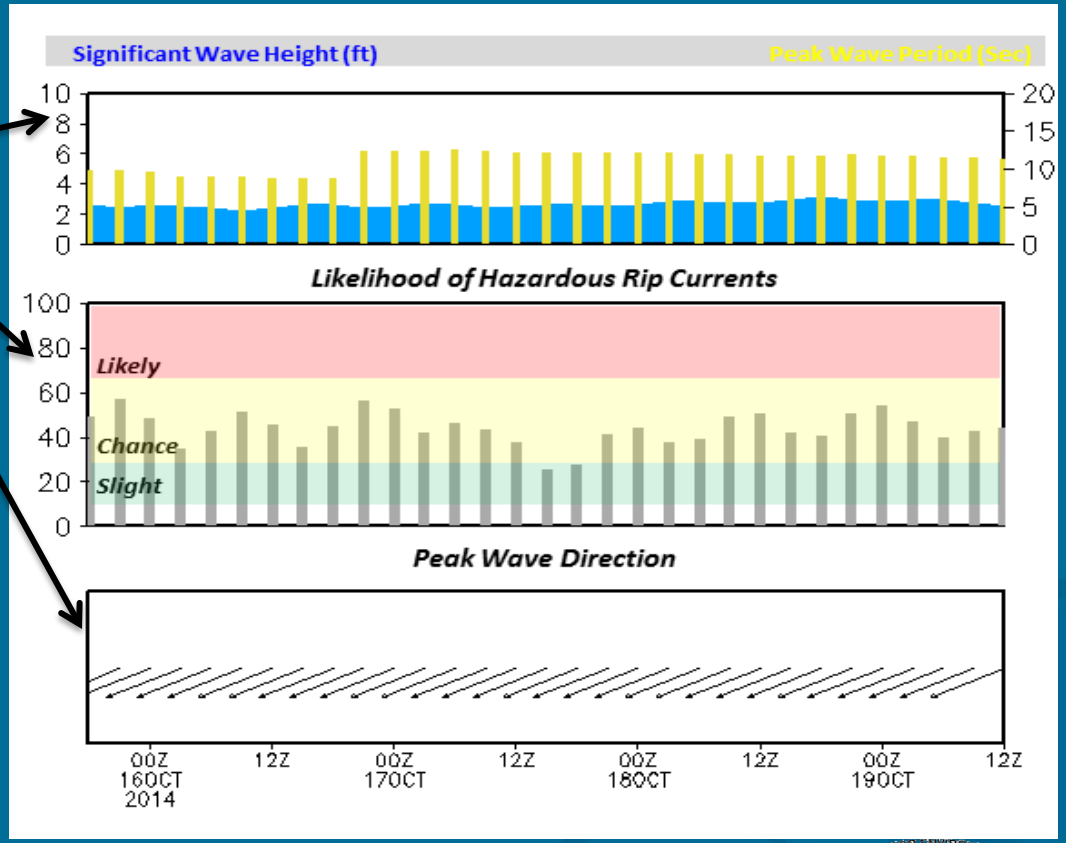
- Logistic regression model that uses for input the following NWPS output along 5m isoline:
  - Significant wave height
  - Mean wave direction from normal
  - Water level
  - Post-event (bathymetry proxy)

Model Output

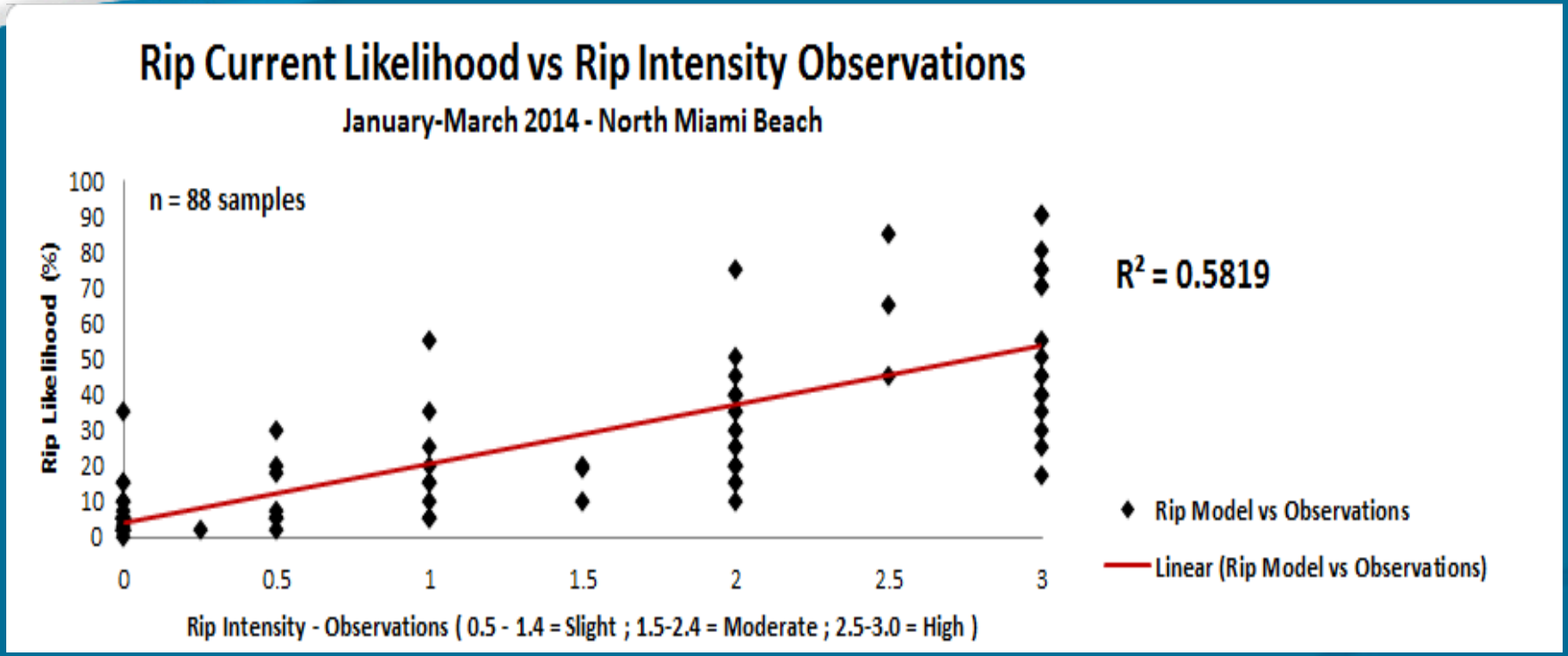
- Hazardous Rip Current Likelihood (0-1)

Coupled NWPS and RCFM South Florida





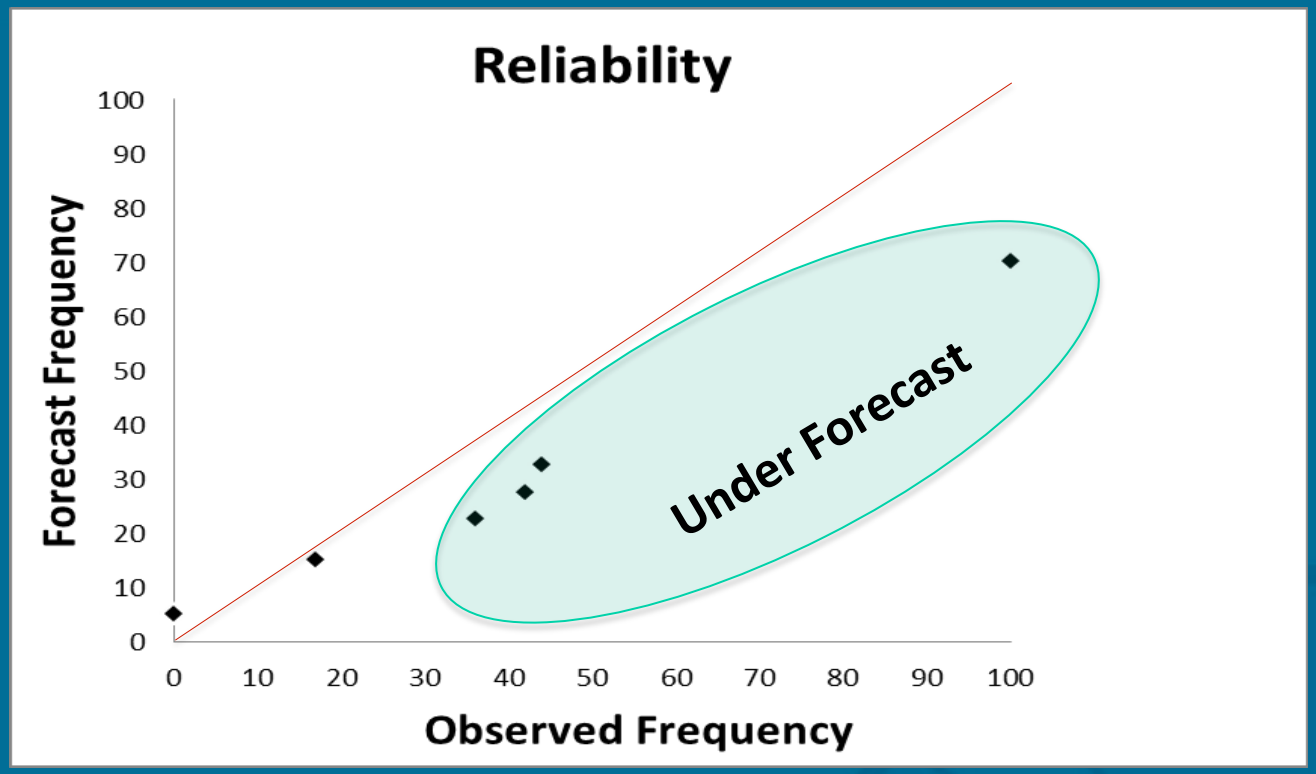
Validation/Preliminary Results



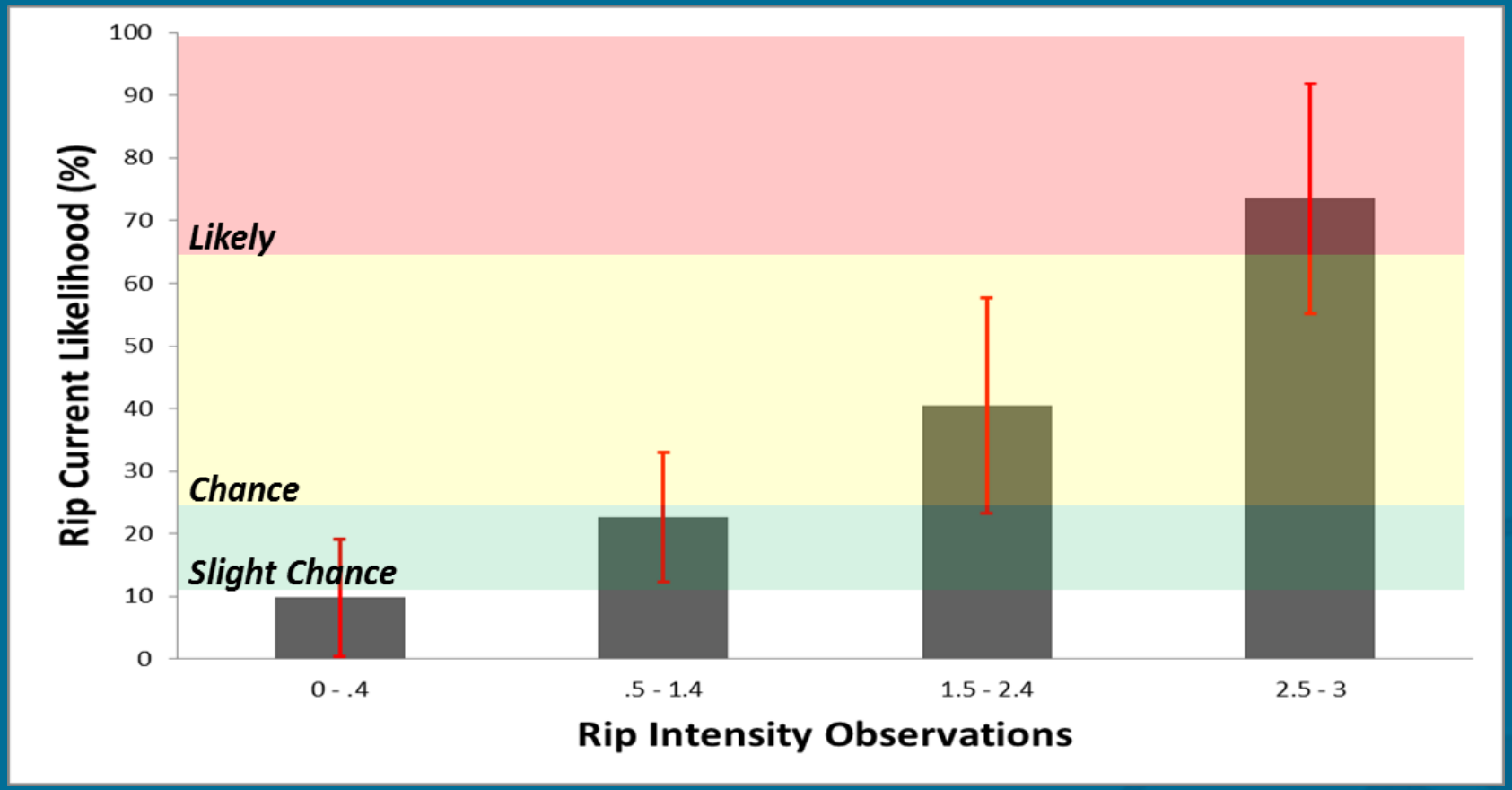
- Daily observations of rip currents intensity (0-3) correlated to model likelihood for periods of Jan-Mar and June to August of 2014. Moderate correlations observed.
- Most events occurred during winter.

Reliability

- Forecast probabilities grouped into bins and compared against observed frequency.
- Reliable low end w/ low bias mid/high range.
- But sample too small.



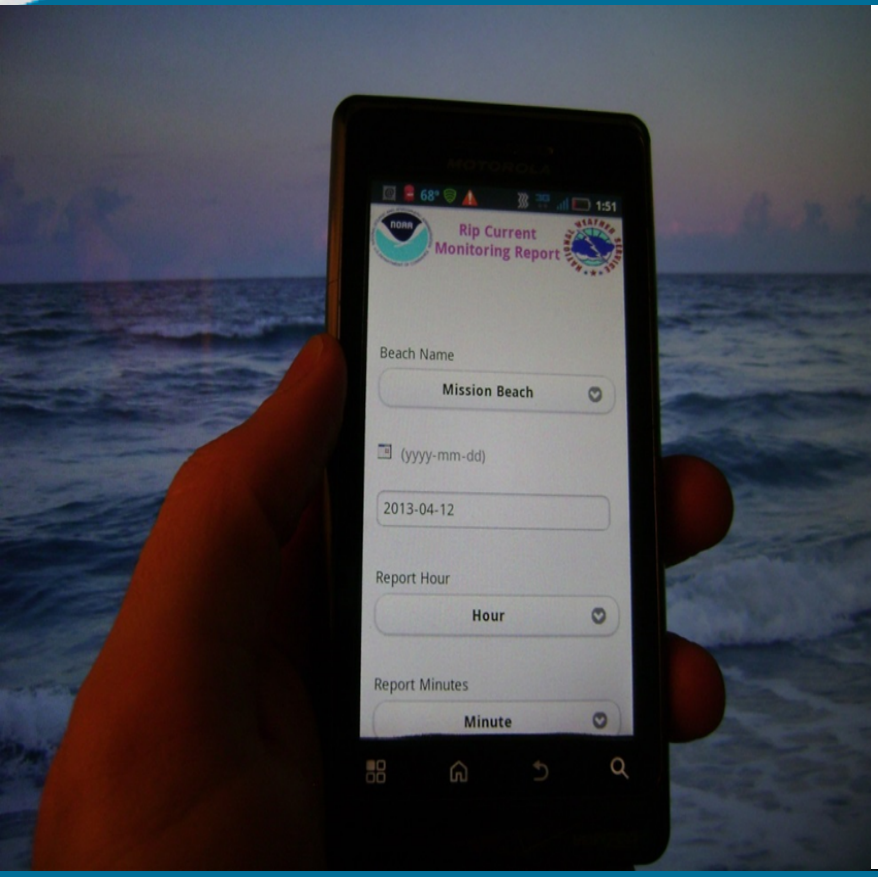
Intensity Obs vs Likehood



Future Goals

- Expand data collection and validation efforts to generate more statistically significant results.
  - Incorporation of Ocean Rescue and Lifeguard observations through online reports they can submit with smart devices. Means for them to submit such reports already developed by Meteorological Development Lab (MDL)
- Use results to develop new Rip Current web based products. National team in place taking leadership on this following on experiments currently ongoing at Morehead City, NC and Miami, FL.
- Social Science to play key role on this.

Future Goals

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SXUS83 KMFL 101343
OMRMFL

OTHER MARINE REPORTS
NATIONAL WEATHER SERVICE MIAMI/SOUTH FLORIDA
0745 AM EST WED DEC 10 2014

BEACH NAME:  Nikki Beach
LOCATION:  Lat: 25.81351  - Lon: 80.11189
OBSERVATION TIME (Z):  2014-12-10T12:45:00
RIP STRENGTH:  Strong
SURF HEIGHT (FEET):  2-3
TODAY'S RESCUE ACTIVITY:  None
WATER ATTENDANCE:  Low
COMMENTS:  Surf height subsiding, some larger
sets, strong swell still, very cold air/NNW 15, full sun,
high 1040
REPORTER ID:  Leigh Emerson Smith Lifeguard Lieutenant

.A MFL 20141210 DH1245 / RS Strong / HS 2-3

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Future Goals

National Weather Service Weather Forecast Office
Miami - South Florida

Home | Site Map | News | Organization | Search for: NWS All NOAA

National Weather Service Miami - South Florida
Beach Forecast

Click on the beach umbrellas for the detailed beach forecast

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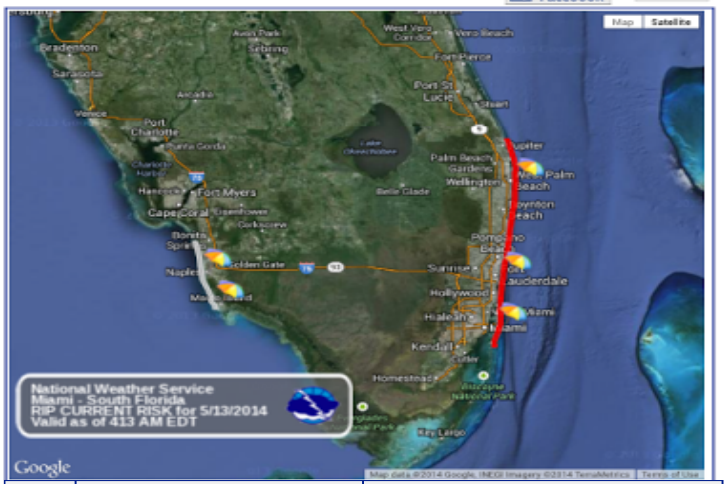
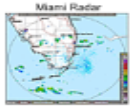
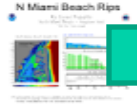


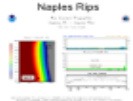
Miami Radar



N Miami Beach Rips

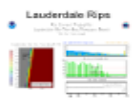


Naples Rips

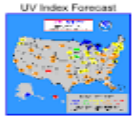


Juno Beach Rips

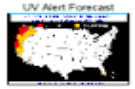
Lauderdale Rips



UV Index Forecast



UV Alert Forecast



Risk Level	Description	Click on shaded areas for more detail
None	No Risk of Rip Currents	
Slight	Weak Rip Currents Possible; Isolated, weaker but potentially dangerous rip currents can still occur. Weak swimmers stay in shallow water	The map above is color-coded to indicate the forecast rip current risk level. Click on the beach area of your choice for more information. **Rip currents** are powerful, channeled currents of water flowing away from shore. They typically extend from the shoreline, through the surf zone, and past the line of breaking waves. Rip currents can occur at any beach with breaking waves. If caught in a rip current, swim parallel to the beach and you will eventually swim out of the outgoing current. Remember to heed the advice of the local beach patrol and flag warning systems.
Moderate	Rip Currents Likely; Wave and/or tidal conditions support stronger or more frequent rip currents. Weak swimmers should not enter surf above knees	
High	Strong to very Strong Rip Currents Likely; Wind, wave, and tidal conditions support the development of dangerous rip currents. All swimmers stay out of surf	

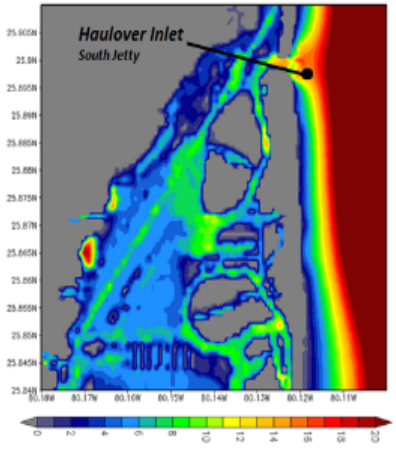
YouTube Rip Current Safety Videos

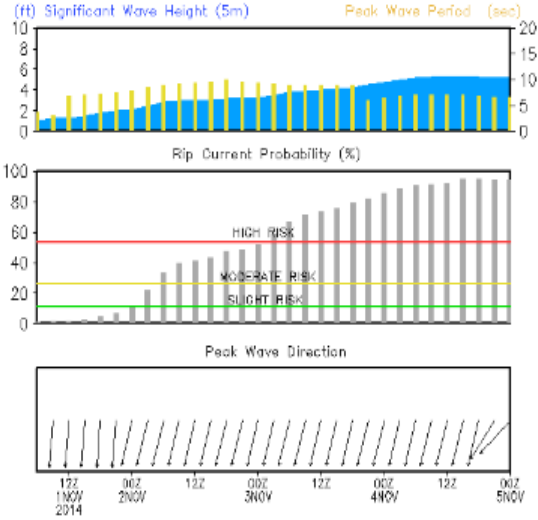
Click here for the Surf Zone Forecast

UV Index Scale		
2 or less	Low	**Low danger from the sun's UV rays for the average person.** Wear sunglasses on bright days. If you burn easily, cover up and use sunscreen.
3 - 5	Moderate	**Moderate risk of harm from unprotected sun exposure.** Take precautions, such as covering up, if you will be outside. Stay in shade near midday when the sun is strongest.
6 - 7	High	**High risk of harm from unprotected sun exposure.** Protection against sunburn is needed.

Rip Current Probability
North Miami Beach – Haulover Inlet
90 hr Forecast

North Miami Beach (Depth–ft)





Under Development: The accuracy or reliability of these forecasts are not guaranteed nor warranted in any way. These forecasts should not be used as the sole resource for decision making. These graphics may not be available at all times and may not reflect the official forecast displayed on the main South Florida beach page.

QUESTIONS!!

REFERENCES

- Dusek, G. and Seim, H., 2013: A probabilistic rip current forecast model. Journal of Coastal Res. 29 (4). 909-925.

- Dusek, G., H. Seim, S. Kennedy, A. J. Van der Westhuysen, A. Gibbs, R. Padilla-Hernandez , 2014. An Operational Assessment of a New Probabilistic Rip Current Forecast Model. Proc. 94th AMS Annual Meeting, Am. Meteor. Soc., Atlanta, GA.

- Van der Westhuysen, A. J., R. Padilla-Hernandez, P. Santos, A. Gibbs, D. Gaer, T. Nicolini, S. Tjaden, E. M. Devaliere and H. L. Tolman, 2013. Development and validation of the Nearshore Wave Prediction System. *Proc. 93rd AMS Annual Meeting*, Am. Meteor. Soc., Austin, TX.

- Van der Westhuysen, A. J., A. Taylor, R. Padilla-Hernandez, A. Gibbs, P.Santos, D. Gaer, H. Cobb, J. Lewitsky, and J. Rhome, 2014. Enhancements to NWPS to provide coastal and overland hurricane wave guidance. *Proc. 94rd AMS Annual Meeting*, Am. Meteor. Soc., Atlanta, GA.

AMS 95th Annual Meeting, 13th Symp on Coastal Environment, Phoenix, AZ 2015