Observation Methodologies for NOAA Operational Rip Current Forecast Models

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Introduction: Rip Currents

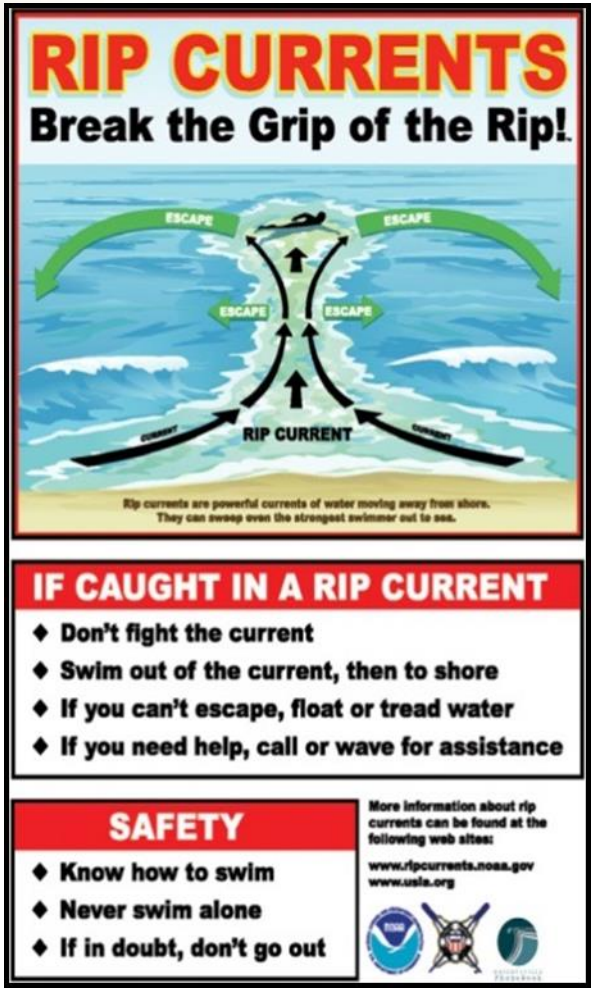
Rip currents are relatively narrow offshore directed jets of water that begin in the surf zone

Why Forecast Rip Currents?

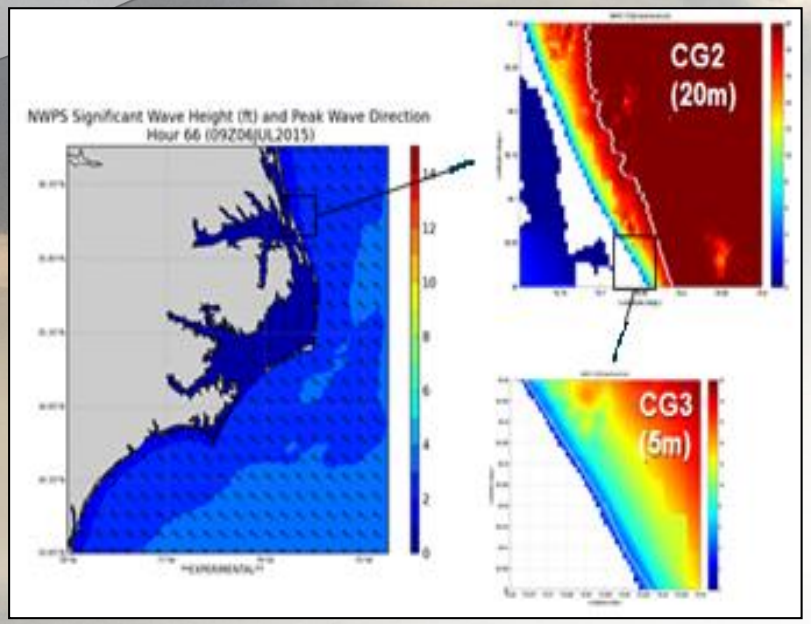
Rip currents are the number one public safety risk at the beach

About half of the 94,920 recorded beach rescues in 2015 were caused by rip currents (ULSA)

(http://arc.usla.org/Statistics/current.asp?Statistics=Current)

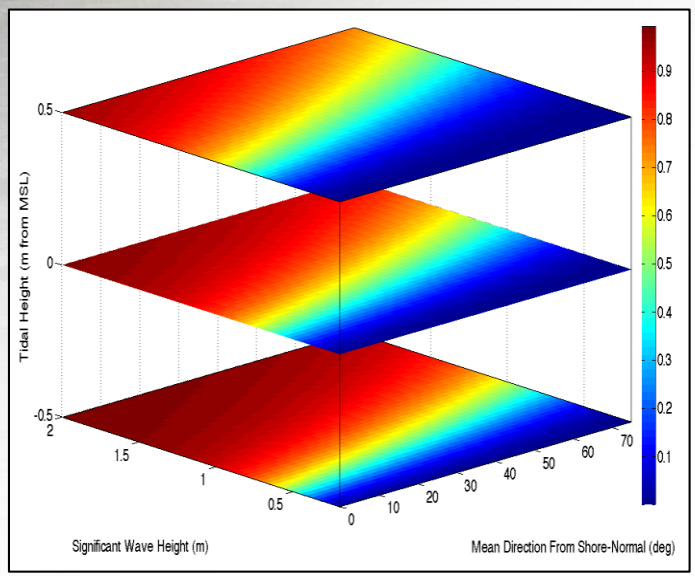


Developing the Forecast Model



The logistic regression model predicts the probability of occurrence of hazardous rip currents given four inputs (Dusek & Seim, 2013):

- Significant Wave Height
- Mean Wave Direction
- Water Level
- Bathymetry Proxy (Wave event occurrence)

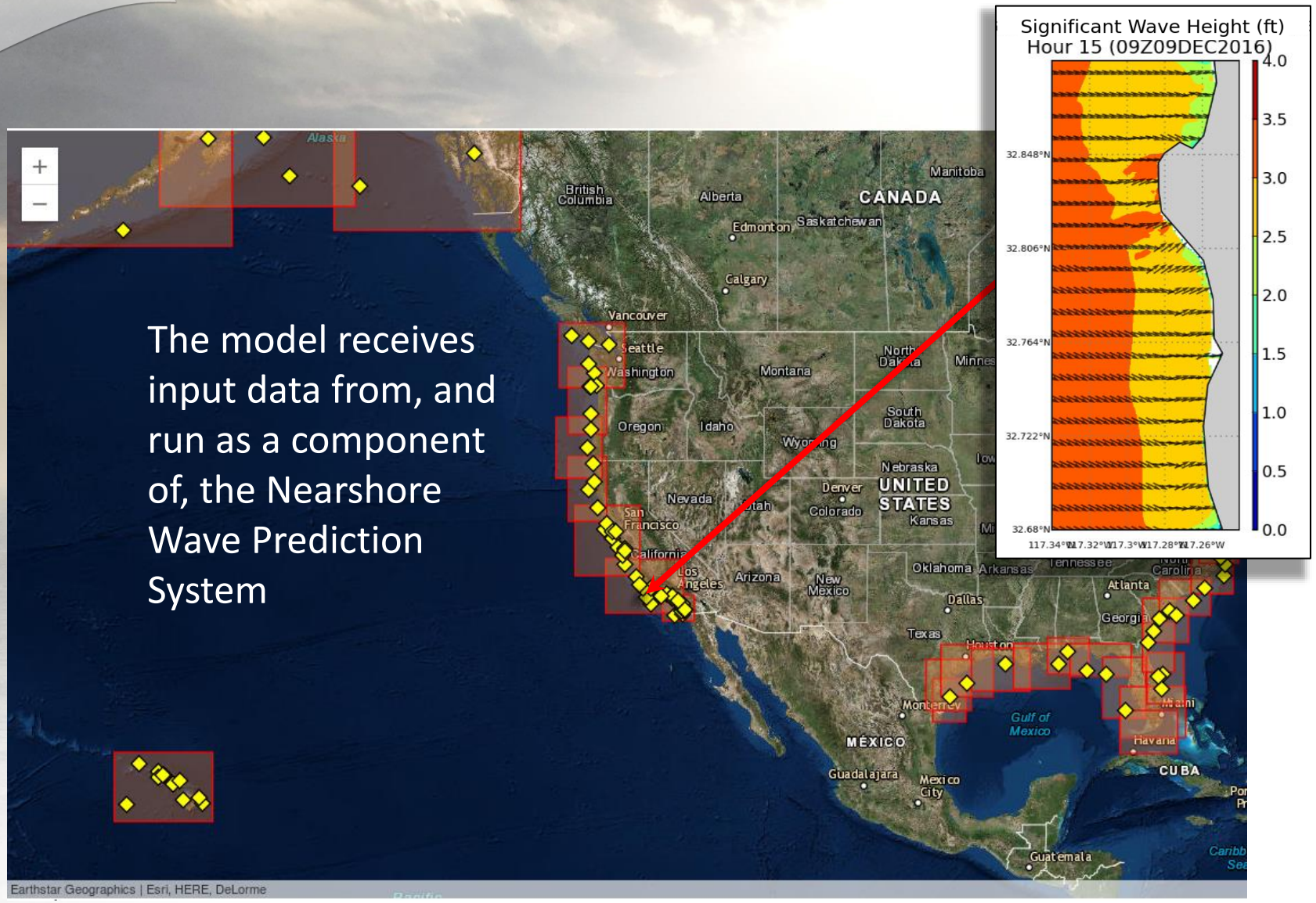


Model output is created on demand, in hourly forecast intervals up to 144 hours

Model is on Research-To-Operations (R2O) path to staged implementation at NWS coastal offices across the US

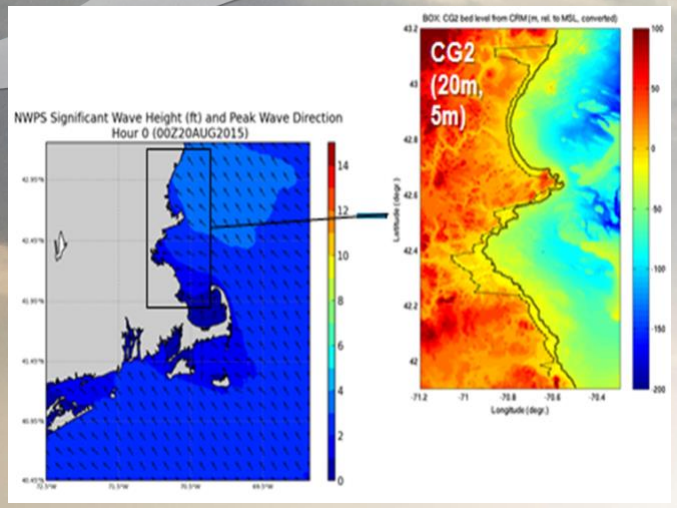
Developing the Forecast Model

The model receives input data from, and run as a component of, the Nearshore Wave Prediction System



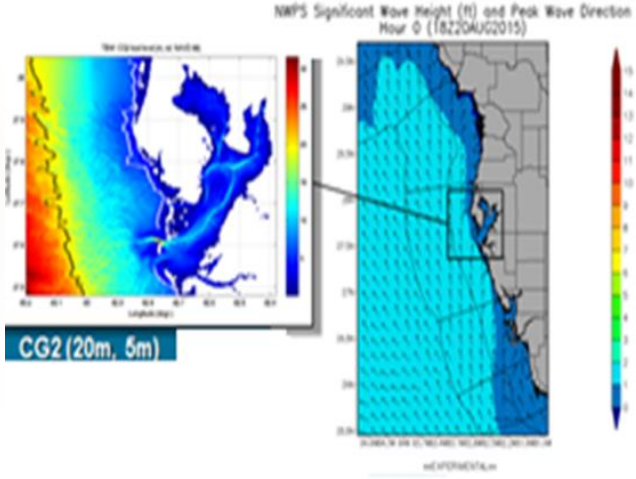
http://polar.ncep.noaa.gov/nwps/viewer.shtml

Role of Observations in Validating the Forecast Model

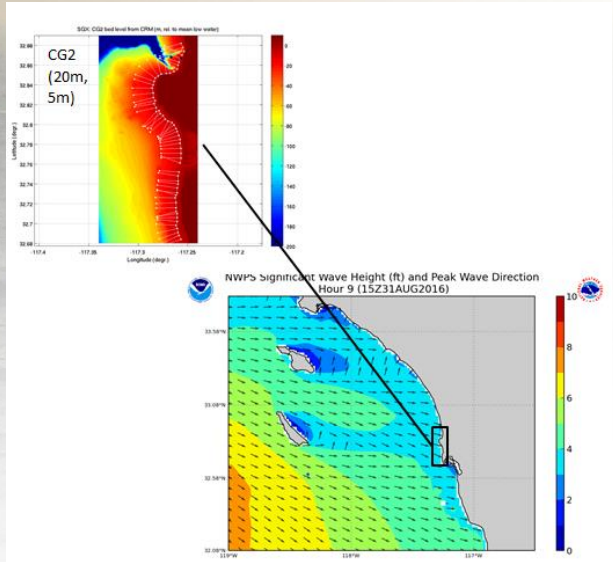


NWS Taunton, MA WFO

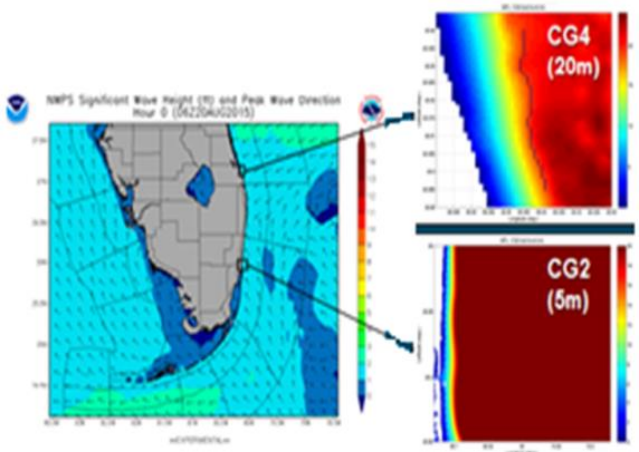
1. NWPS output along the 5 m depth contour
2. Lifeguard rip current observations collected
3. The model output compared against rip observations



NWS Tampa Bay Area, FL WFO



NWS San Diego, CA WFO



NWS Miami – South Florida WFO

Collecting Rip Current Observations

Lifeguards at target beaches are reporting rip current activity daily via web forms. Information includes:

- Date/Time
- Location
- Surf Height
- Rip Strength
  - **None**
  - **Weak** -- Some low intensity rip currents present, may be hazardous to some swimmers.
  - **Moderate** -- Medium to strong rip currents present, will likely be hazardous to swimmers.
  - **Strong** -- Very strong rip currents present, hazardous conditions.
  - Number of rip – related rescues.

Collecting Rip Current Observations
Challenges

Lifeguards in different regions may observe rip currents differently. We can present local definitions of rip strength. Augmented definitions (below in red) are in use at Mission Beach, CA.

- Rip Strength
  - None
  - Weak -- Some low intensity rip currents present, may be hazardous to some swimmers. **Rip current barely noticeable. Hard to identify.**
  - Moderate -- Medium to strong rip currents present, will likely be hazardous to swimmers. **Rip current makes it into the intermediate part of the surf zone.**
  - Strong -- Very strong rip currents present, hazardous conditions. **Rip current makes it to the outside of the surf zone with a visible mushroom head. Easily identifiable.**

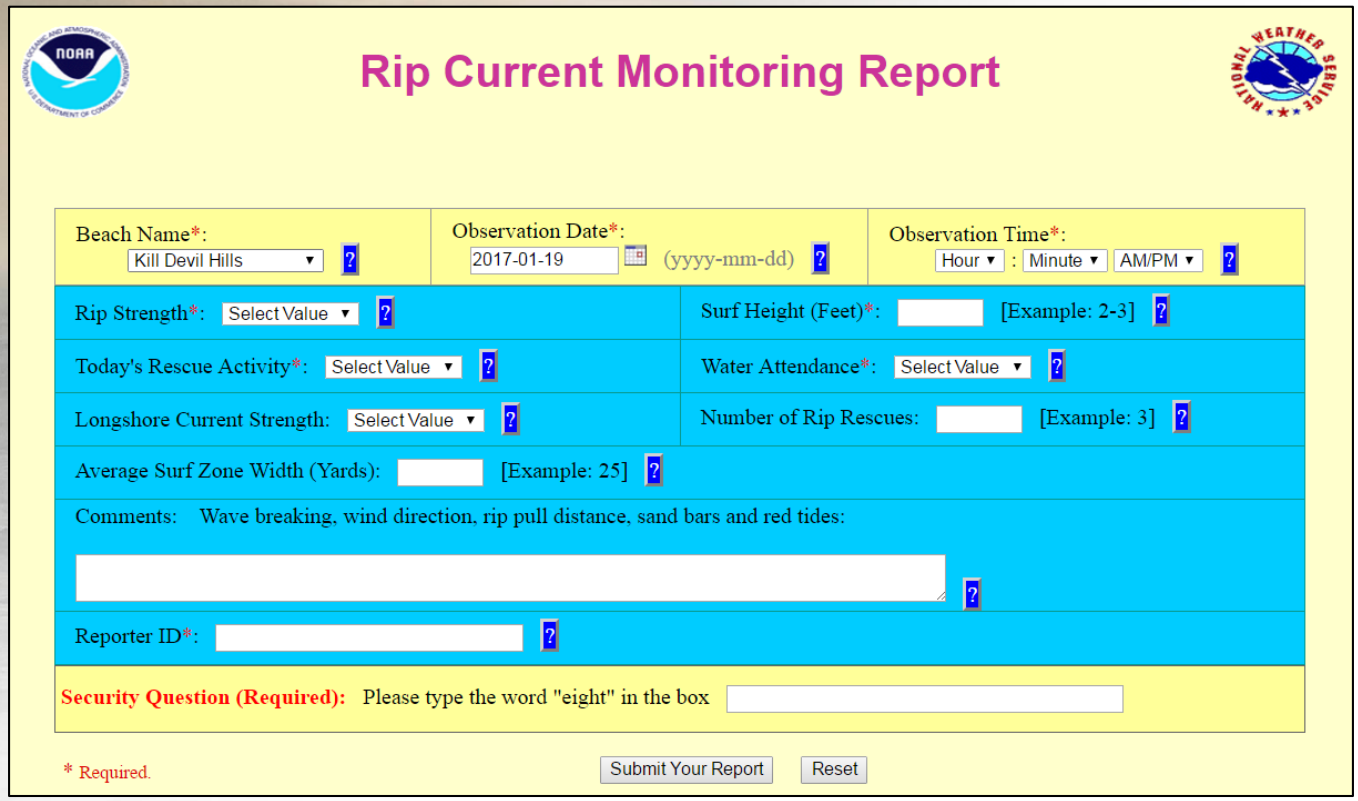
Collecting Rip Current Observations
Challenges

Structural currents and longshore currents in locations like the Great Lakes

Collecting Rip Current Observations

Challenges

Other sources of rip current observations are being evaluated



Rip Current Monitoring Report

Beach Name*: Kill Devil Hills

Observation Date*: 2017-01-19 (yyyy-mm-dd)

Observation Time*: Hour : Minute AM/PM

Rip Strength*: Select Value

Surf Height (Feet)*: [Example: 2-3]

Today's Rescue Activity*: Select Value

Water Attendance*: Select Value

Longshore Current Strength: Select Value

Number of Rip Rescues: [Example: 3]

Average Surf Zone Width (Yards): [Example: 25]

Comments: Wave breaking, wind direction, rip pull distance, sand bars and red tides:

Reporter ID*:

Security Question (Required): Please type the word "eight" in the box

* Required.

Submit Your Report Reset

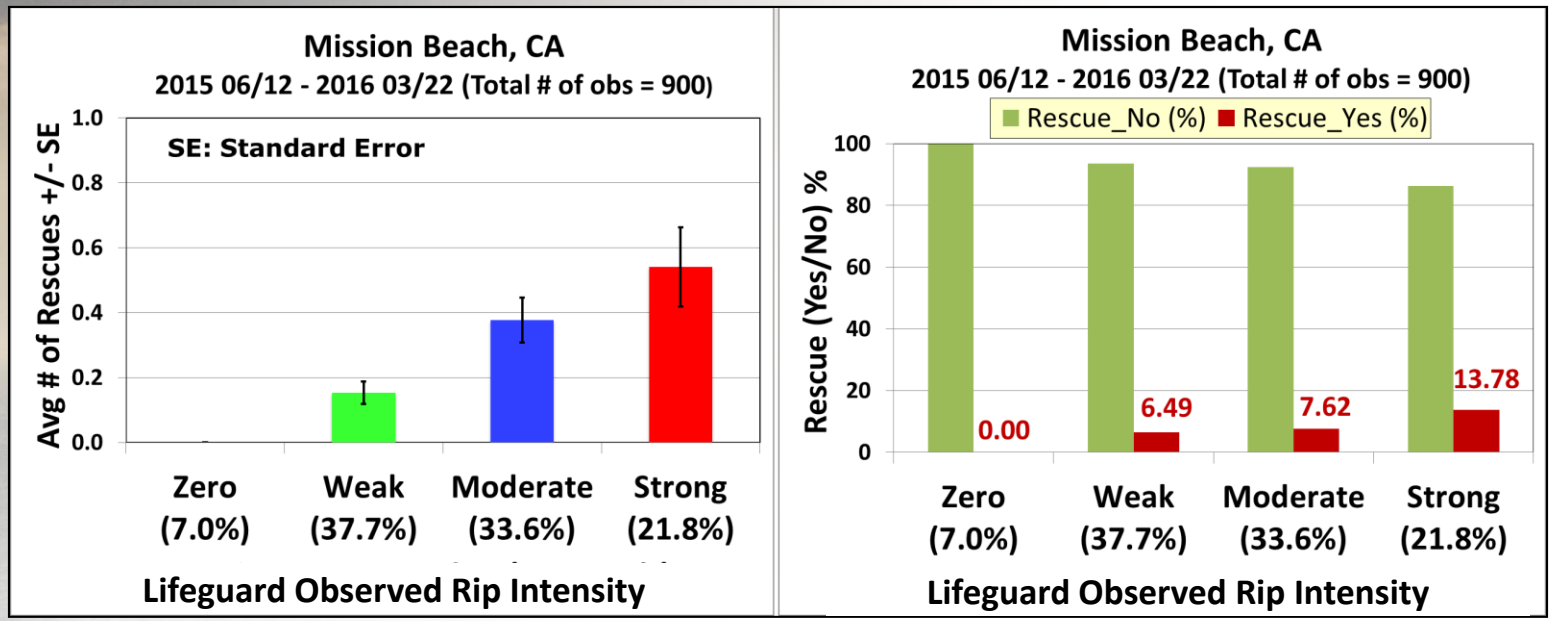
- Complementary NWS MDL forms provide archive of reports
- Balance level of information requested
- Additional NWS and affiliated efforts also being evaluated

Collecting Rip Current Observations
Challenges

Other sources of rip current observations are being evaluated

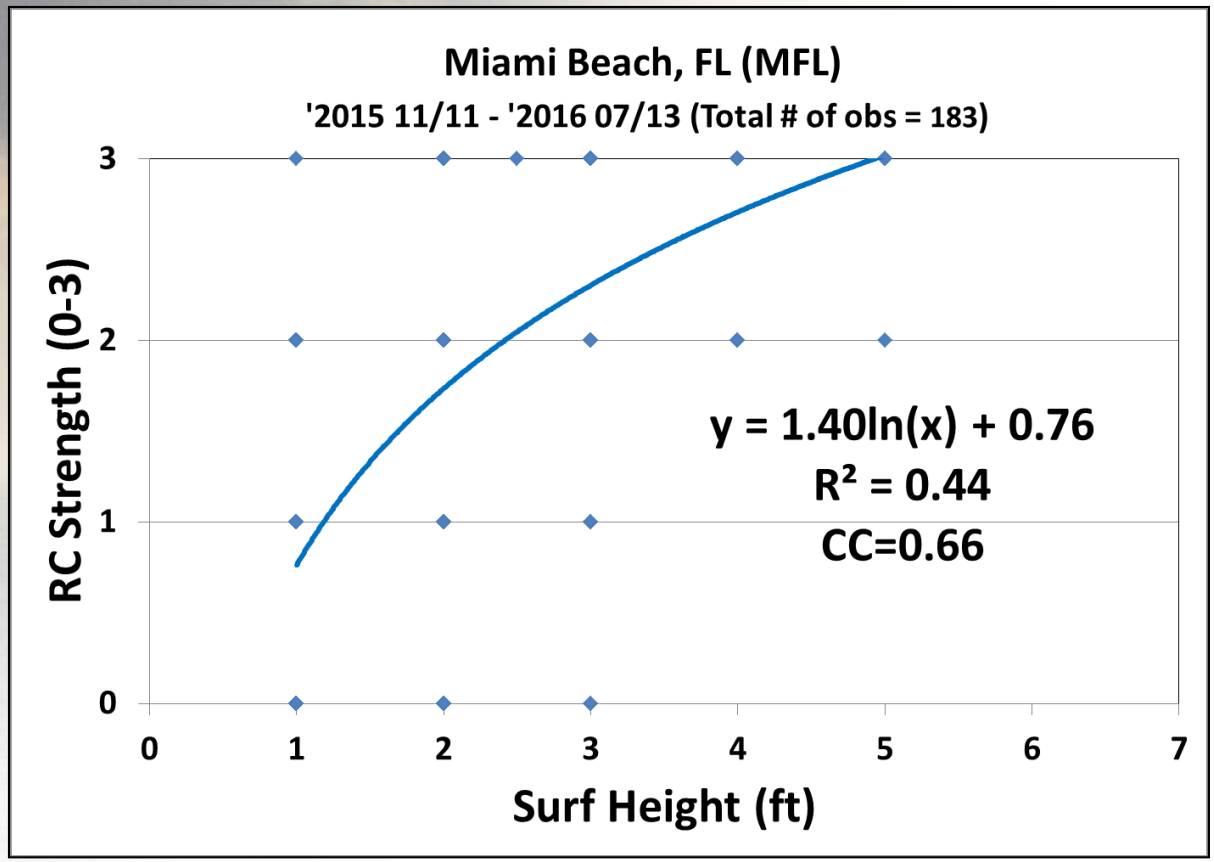
- Camera observations when visual observations aren't available
- Difficult to consistently identify rip currents in images

Assessing Quality of Rip Current Observations



- Do lifeguard visual observations agree with rip current rescues?

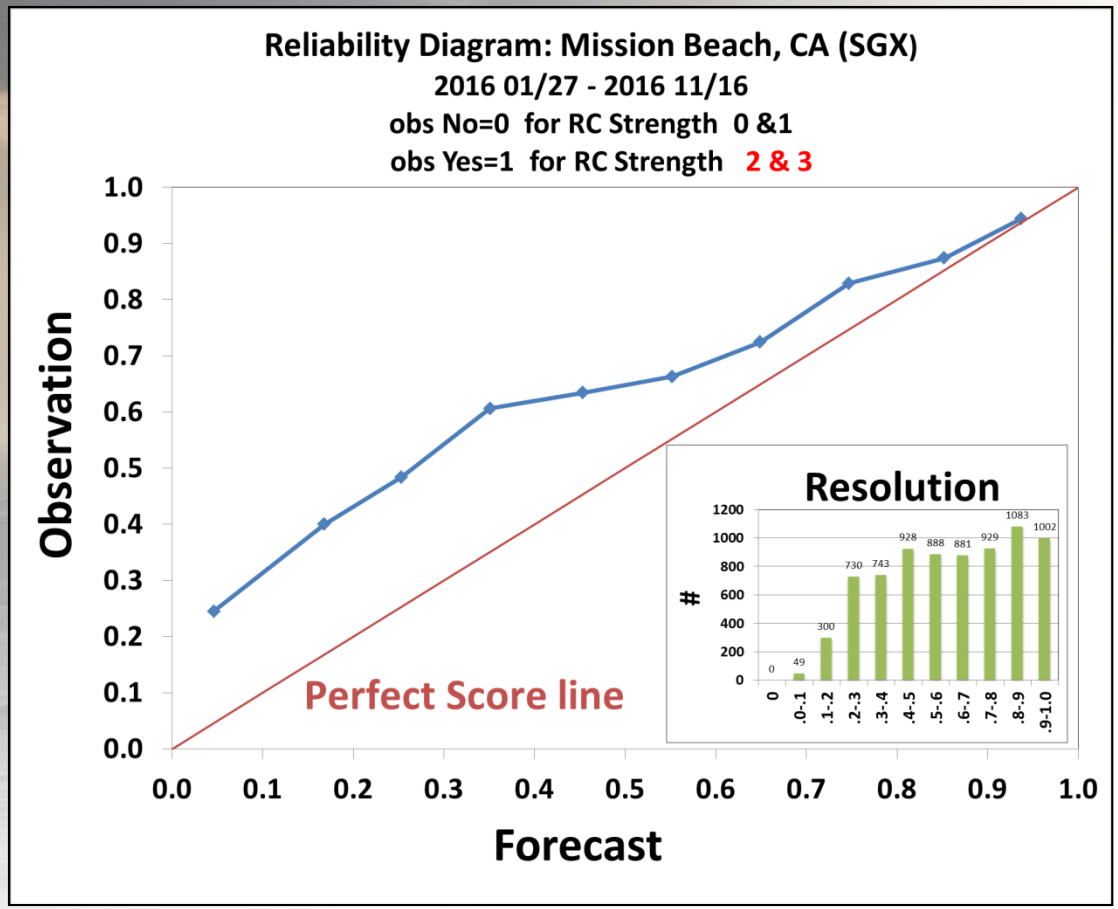
Assessing Quality of Rip Current Observations



- Comparing observed rip strength to observed surf height
- Preliminary results for Miami Beach show expected results

Validating the Forecast Model:

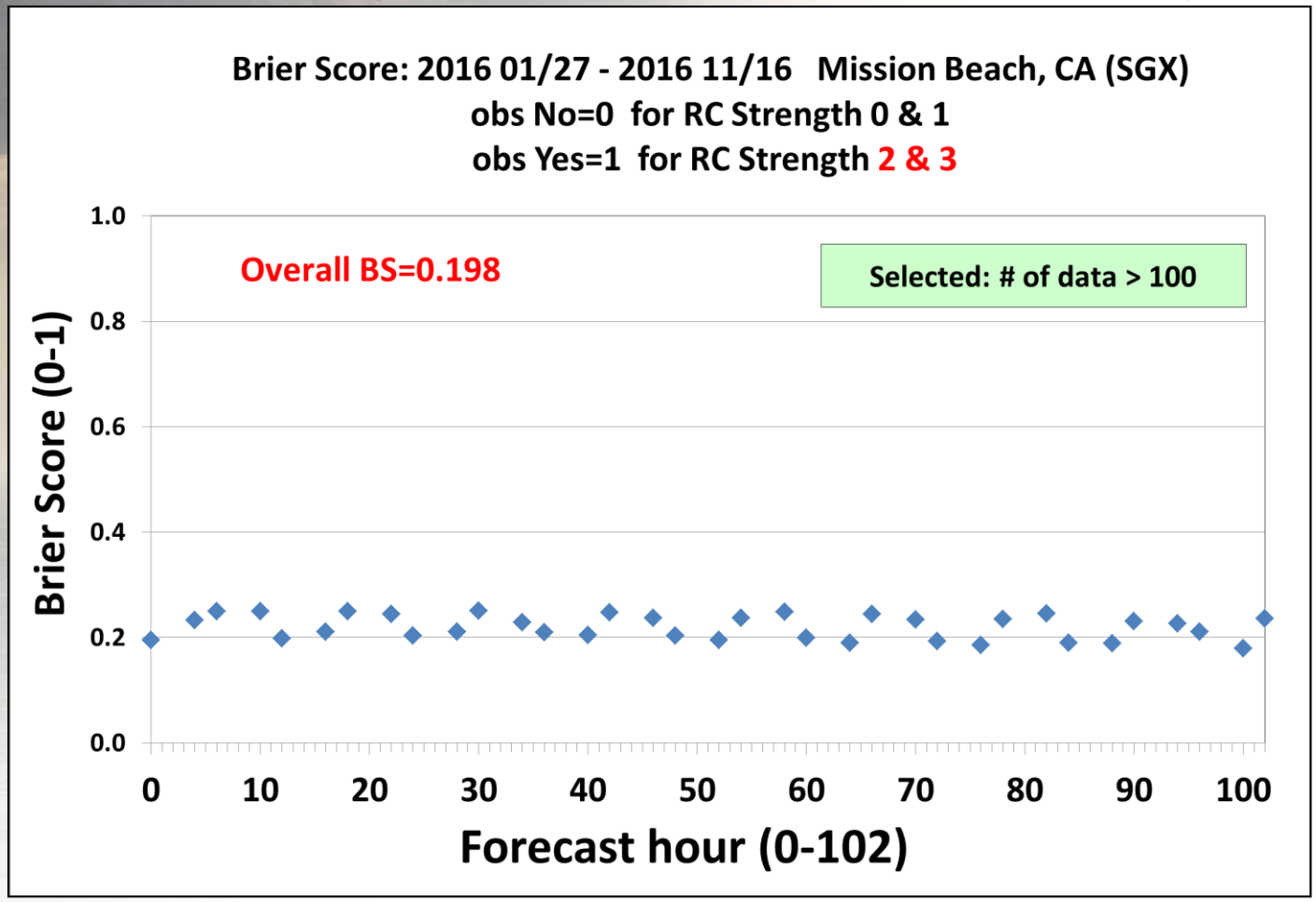
Comparing Observations to Model Output



- Observations compared to forecast output
- Results show good initial agreement but consistent under-forecast
- Inserted resolution chart shows good resolution of forecast ranges

Validating the Forecast Model:

Comparing Observations to Model Output



Analysis of the Brier Score results at Mission Beach shows encouraging scores, influenced most strongly by tide level.

Future Plans

The probabilistic rip current model shows promise as a forecast tool that the NWS can use to improve beach safety. Before national implementation, the following tasks must be completed:

- Expand the probabilistic rip current forecast model to additional coastal WFOs, and to the Great Lakes [FY17-FY19]
- Validate the rip current forecast model at additional coastal locations, and the Great Lakes; re-calibrate the model as necessary[est. FY17-FY20]
- Determine the most effective means for visualizing model output and communicating the associated risks [est. FY17]
- Develop a training module for NWS forecasters [est. FY18]
- Transition the probabilistic rip current forecast model to NWS operations nationally [est. FY18-FY20]

Conclusions

1. Observations (or networks) that are needed to benefit your future research, application or product development
   - Rip current and nearshore wave observations

2. Recommended instruments that are needed to make these observations
   - Trained observers (i.e., lifeguards and others)
   - Nearshore buoys/ADCPs (to validate shallow water NWPS model output)
   - Beach cameras, Unmanned Arial Vehicles (UAV's), flow-speed sensors

3. Your view on the greatest observational needs for your discipline in general
   - Overcoming general scarcity of rip current observations
   - Overcoming inherit subjectivity of human reports, especially as rip current regimes vary by region