



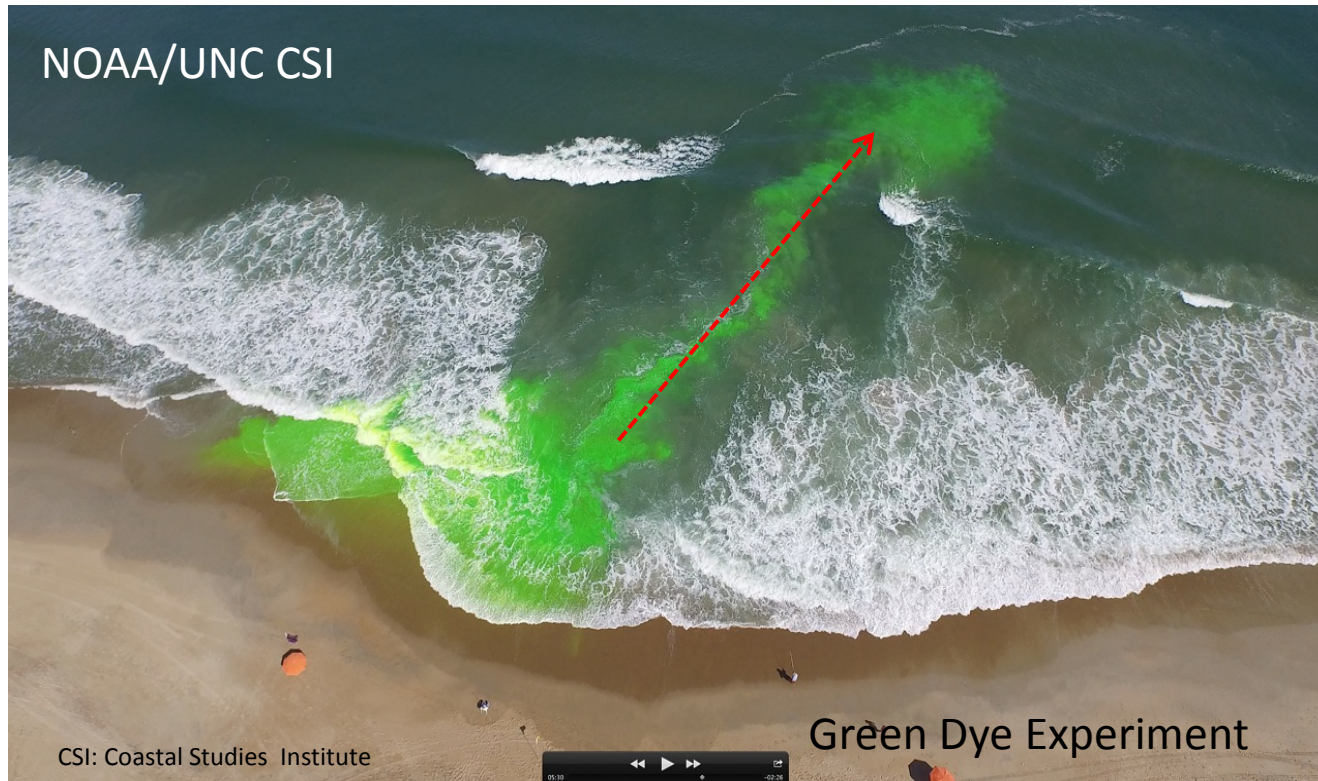
Evaluation of NOAA Probabilistic Rip Current Forecast Model in the Nearshore Wave Prediction System (NWPS) for NWS WFO Pilot Beaches

Jung-Sun Im¹, Michael Churma¹, Stephan Smith¹,
Gregory Dusek², Pablo Santos³, John Kuhn⁴,
Andre van der Westhuysen⁵, Roberto Padilla-Hernandez⁵,
Dennis Atkinson⁶

¹NWS/OSTI/MDL, ²NOS/CO-OPS, ³NWS/WFO, ⁴NWS/AFSO, ⁵IMSG@NWS/NCEP/EMC, ⁶NWS/OSTI

35th Conf. on Environmental Information Processing Technologies
January 06-10, 2019, Phoenix, AZ

What is a Rip Current (RC)?



- **Rapid offshore-directed jets of water that originate in the surf zone.**
- **Mostly caused by alongshore variations in breaking waves.**
- **RCs are the number one public safety risk at the beach.**

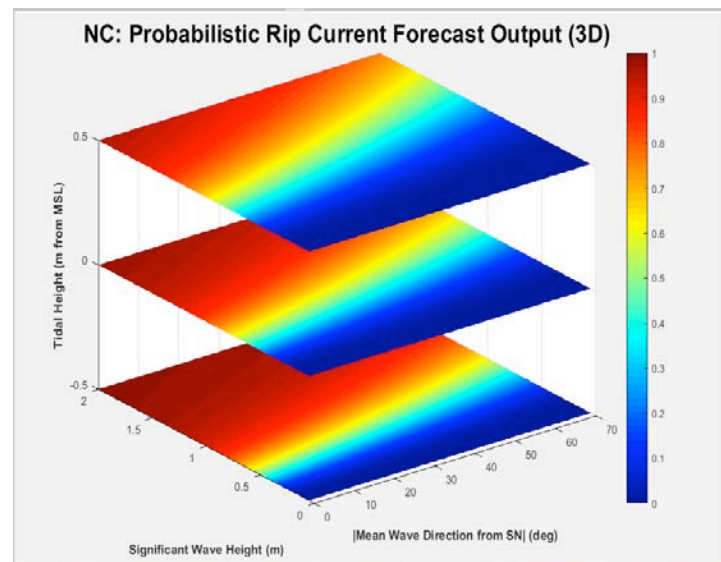
Current Status of NOAA Probabilistic RC Forecast Model

NWS is implementing a real-time short-range forecast system for hazardous RCs based on a statistical model developed using lifeguards' observations, nearshore wave measurements, and tidal elevation.

- Goal: National implementation of the NOAA probabilistic forecast model**
- Current Status: Running experimentally in NCEP's Nearshore Wave Prediction System (NWPS) for Weather Forecast Office (WFO) pilot sites along the US coasts.**

Current NOAA Probabilistic RC Forecast Model

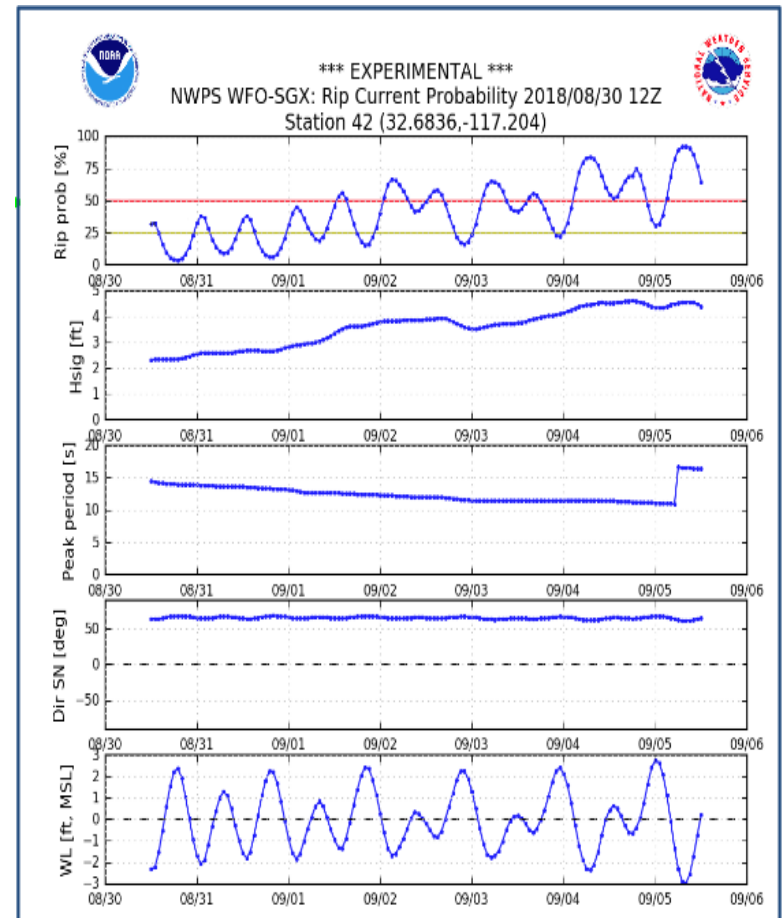
- Logistic regression model
 - Developed using lifeguards' rip current observations (predictand) and predictors of the observations for
 - Significant Wave Height
 - Mean Wave Direction
 - Tide Water Level
 - Previous Wave Event
- at Kill Devil Hills, NC
(i.e., Perfect prog model*)



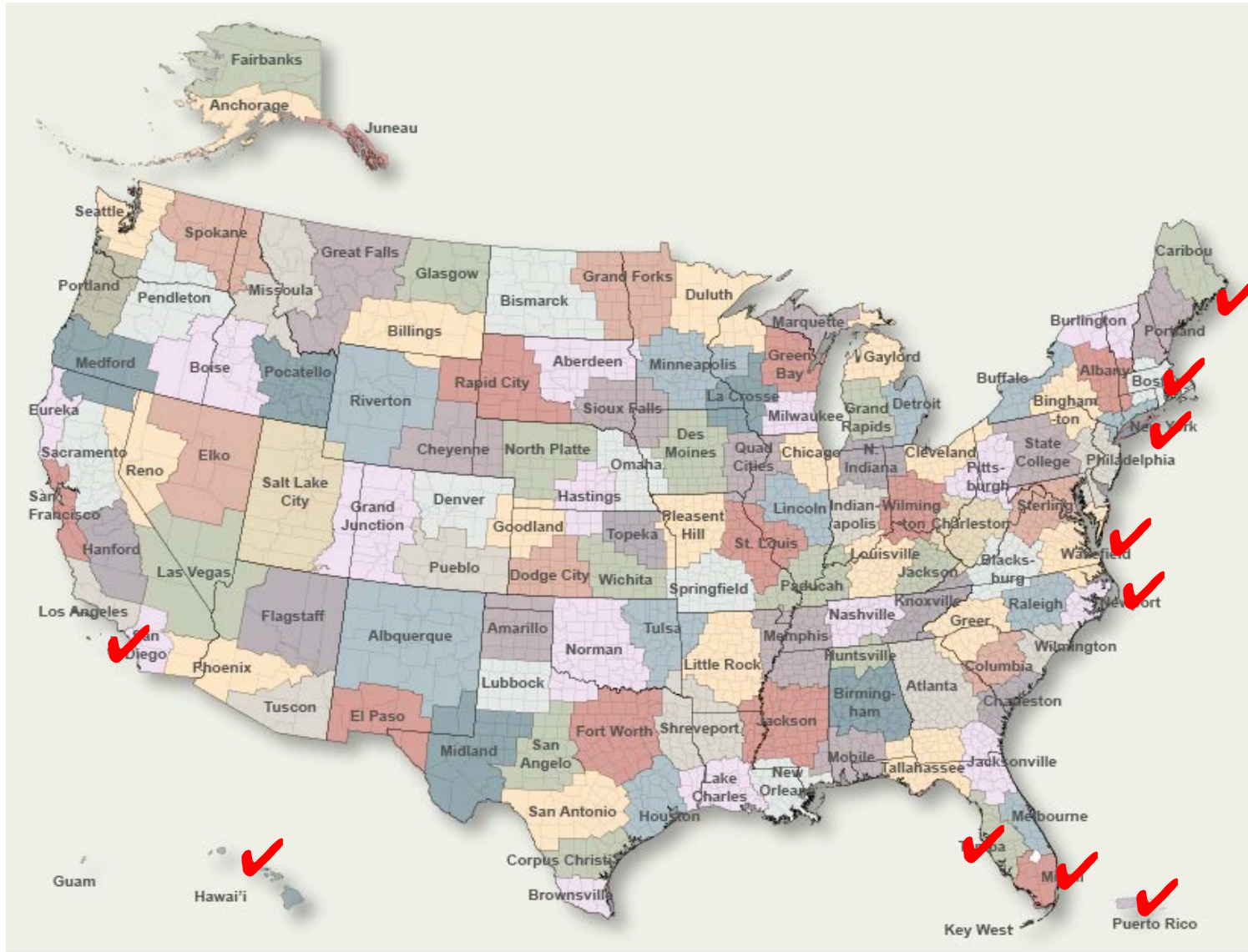
***Perfect prog model:** Makes no attempt to correct for possible Numerical Weather Prediction (NWP) model errors or biases, but makes an assumption that NWP forecasts are perfect.

Real-Time Probabilistic RC Forecasts in the Nearshore Wave Prediction System

- **Output: Probabilities of occurrence of hazardous rip currents computed using NWPS's wave parameter and tide water level forecasts**
- **Forecast projections: hourly 0-144 hours**
- **Running experimentally at 10 NWS WFOs**
- **Using the regression coefficient parameters developed for NC**



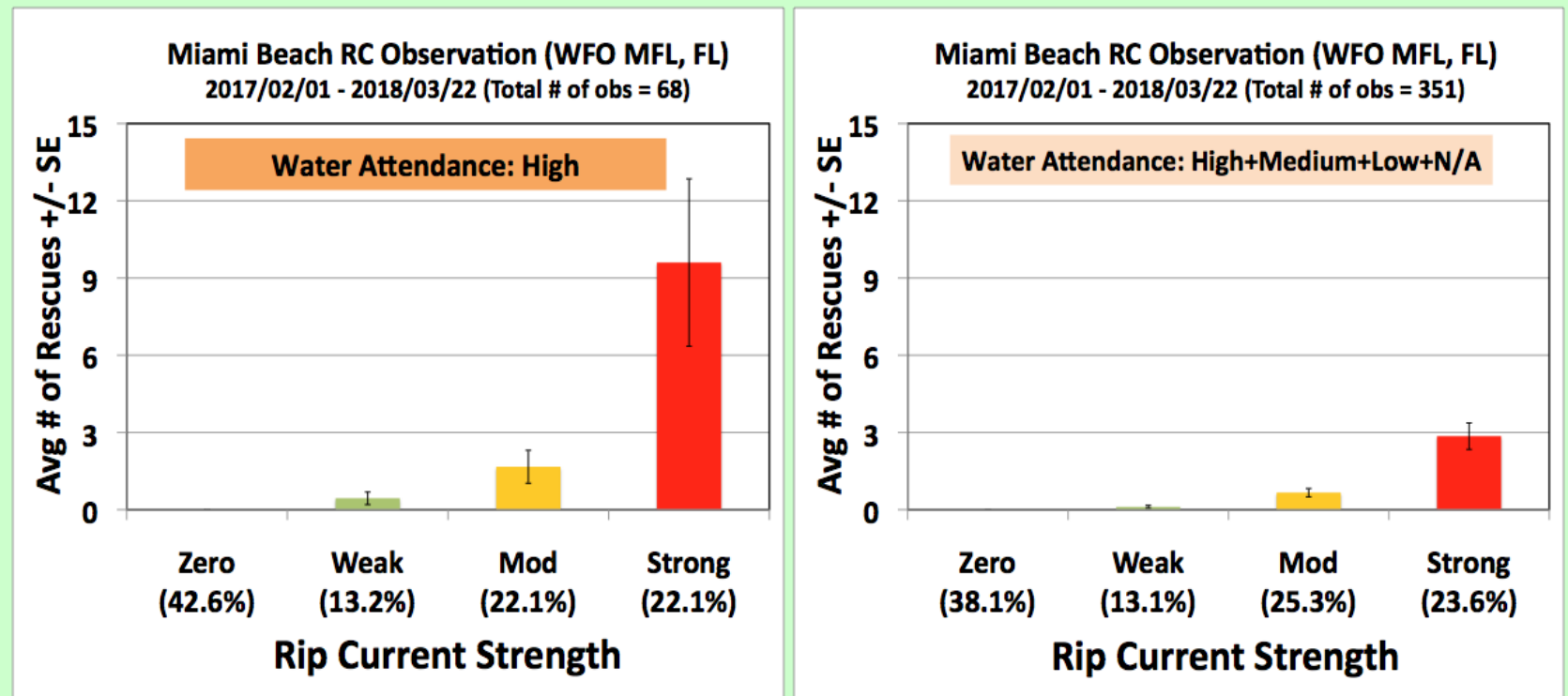
Current 10 WFO Pilot Sites



Validating the Model

Assessing the Quality of the RC Observations

(Is RC strength observed by lifeguards reliable enough to be used to compute model verification statistics? Yes!)



Verification

Comparisons of NWPS RC to WFO Official RC Forecasts

NWPS RC forecasts

(Probabilistic 0-23 hr forecasts)

to

WFO Official RC Forecasts

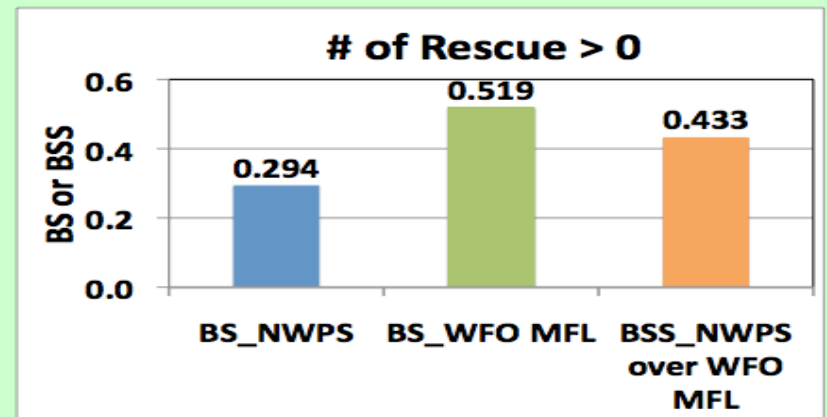
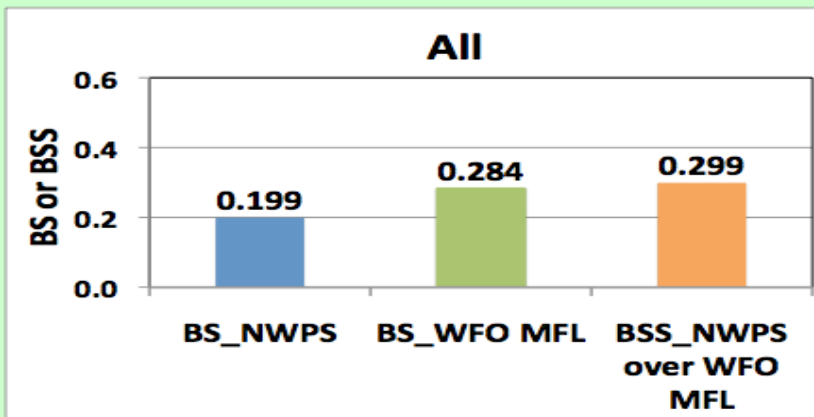
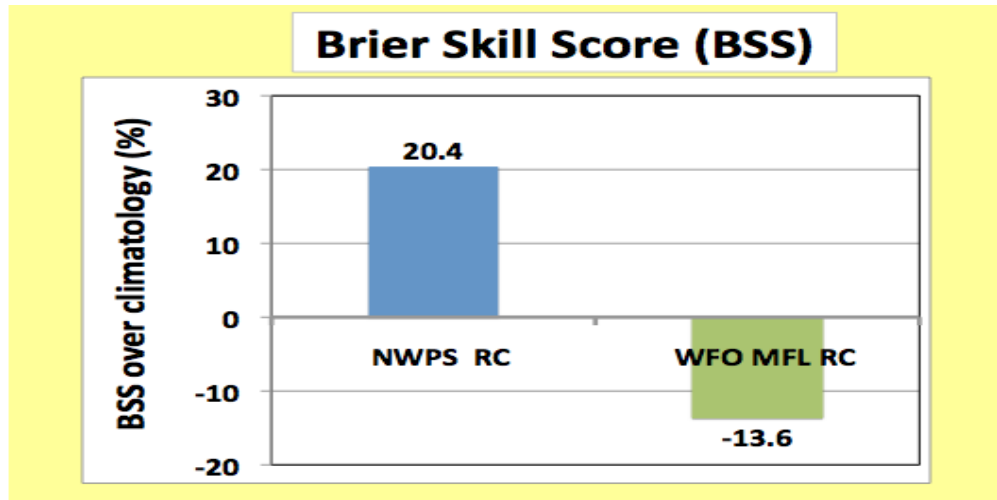
(Deterministic Index-based Day 1 forecasts)

MFL (Miami/Palm beaches, FL) during Feb. 2017 – Mar. 2018

SGX (Mission beach, CA) during May 2017 – Sep. 2018

NWPS RC <-> WFO Official RC

Miami & Palm Beaches (MFL, FL)




Physical meaning:
29.9% improvement with NWPS RC forecasts over WFO MFL's official forecasts

43.3% improvement


NWPS RC <-> WFO Official RC

Mission Beach, SGX, CA

	Warm Season	Cool Season
BS_NWPS	0.217	0.243
BS_WFO/SGX	0.298	0.223
BSS	0.271	-0.088



NWPS RC model
made 27.1%
improvement over
SGX official
forecasts.



8.8% decline.
SGX official
forecasts were 8.8%
better than NWPS
RC forecasts.

Benefits of Model Output Statistics (MOS) Model*

➤ Current Experimental Model

- ✓ 1) Uses one regression equation developed at Kill Devil Hills, NC
- ✓ 2) Implicitly assumes the NWPS forecasts are perfect (Perfect Prog Model)

➤ To address these issues:

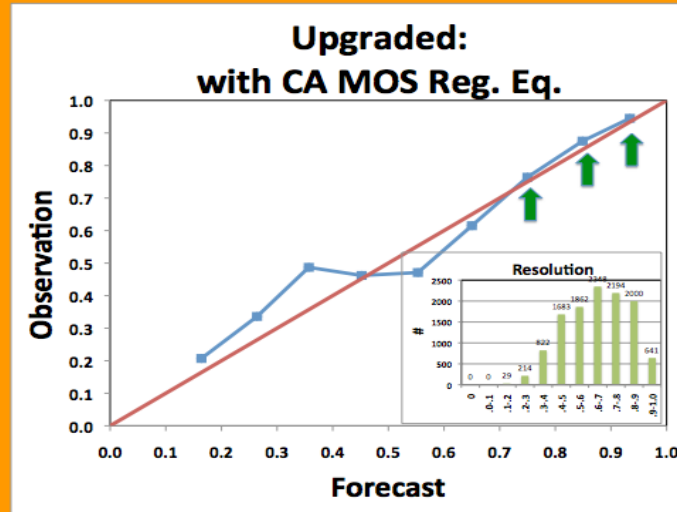
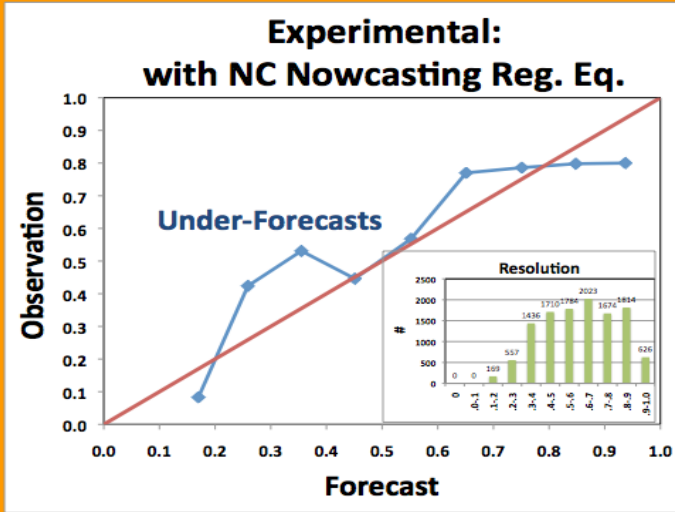
MOS approach is applied, which directly computes the logistic regression between NWPS model forecasts (predictors) and RC obs (predictand).

***MOS model:** Determines a statistical relationship between NWP model output at a given time frame (i.e., forecast projection) and observations at that time, and thus can correct for biases of the NWP model.

Improvements with MOS Model

(0-144 hrs, May 2017 – Sep. 2018, Mission Beach, WFO SGX, CA)

Warm Season



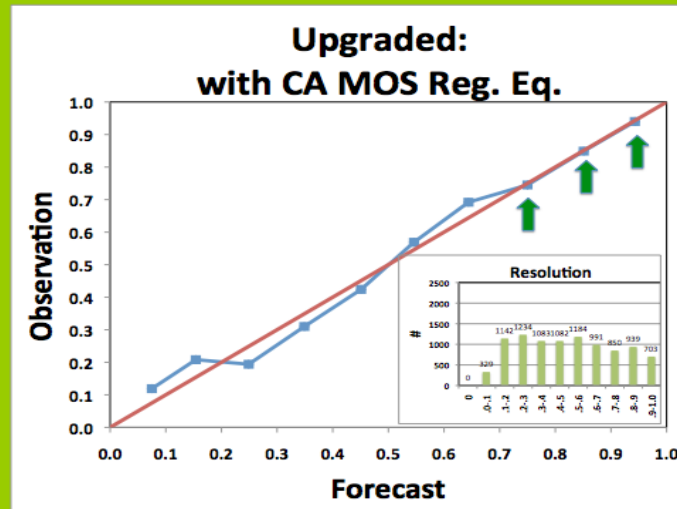
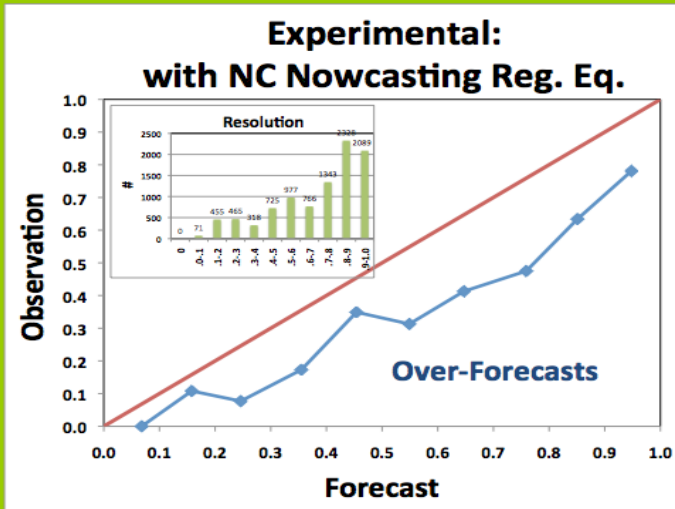
$BSS_{Exp.overClim} = 0.074$

$BSS_{Upg.overClim} = 0.122$

$BSS_{Upg.overExp.} = 0.052$

(Upg. made 5.2% improvement over Exp.)

Cool Season



$BSS_{Exp.overClim} = 0.037$

$BSS_{Upg.overClim} = 0.268$

$BSS_{Upg.overExp.} = 0.241$

(Upg. made 24.1% improvement over Exp.)

NWPS RC (0-23 hrs) <-> WFO Official RC (Day 1)

Mission Beach, WFO SGX, CA

Experimental:

with NC Nowcasting Reg. Eq.

	Warm	Cool
BS_NWPS	0.217	0.243
BS_WFO/SGX	0.298	0.223
BSS	0.271	-0.088

Upgraded:

with CA MOS Reg. Eq.

	Warm	Cool
BS_NWPS	0.202	0.188
BS_WFO/SGX	0.298	0.223
BSS	0.323	0.157

MOS model made 32.3% and 15.7% improvements over SGX official forecasts during warm and cool seasons, respectively.

Summary

- **The NWS and the National Ocean Service (NOS) are collaboratively transitioning the NOAA probabilistic rip current forecast model into NWS operations.**
- **The NWS Meteorological Development Laboratory (MDL) is responsible for the evaluation of the model before its national implementation.**
- **Initial evaluation results are encouraging, and as always, there is room for improvement.**
- **Upgraded products using the Model Output Statistics (MOS) model made improvements over the current experimental products.**

Future Research Plans

with a Focus on Operational Implementation

More improvements can be made by

- **Developing a hybrid model by combining Logistic Regression and Naïve Bayesian techniques**
- **Testing with additional predictors (e.g., swell) from NWPS and/or other available models**
- **Obtaining more predictand data such as high-resolution digital video camera observations in addition to lifeguards' observations**
- **Obtaining predictor data from retrospective NWPS runs**
- **Developing threshold probabilities to provide deterministic (yes/no or high/moderate/low) forecasts along with probabilistic forecasts**
- **Developing dynamically-updating equations**

Acknowledgements

Special thanks to

- Lifeguards**
- Noel Isla, Ivory Small, and Dan Gregoria
(NWS San Diego, CA)**
- Anthony Reynes and Arlena Moses (NWS Miami, FL)**
- Hayden Frank (NWS Taunton, MA)**
- Charles Paxton (NWS Tampa, FL)**
- Scott Kennedy and Tom Lonka
(NWS Morehead City, NC)**

Questions?

Jung-Sun.Im@noaa.gov