





Goal: Implement a capability to provide extended range forecast (60 days) in the Gulf of Mexico and the uncertainty about that forecast in an operational environment.

Purpose: Loop Current Eddy shedding prediction, environmental inputs for safety/risk mitigation, rapid response to events, long term optimal planning for at-sea operations.



Demonstration of 60-day forecast skill of the Loop Current eddy separation. Left panel from top to bottom: SSH (17 cm contour) for the analysis on March 10, 2013, the corresponding 2-month forecast of the 32-member ensemble mean SSH (i.e. for May 05), SSH (anomaly) verification from real-time mesoscale altimetry from CCAR, forecast variance of SSH calculated from 32 perturbed ensemble members (black contours are 17 cm SSH from each ensemble member). Right panels are for April 21, 2013 analysis, 2-month forecast (June 16), corresponding SSH anomaly verification from CCAR and forecast variance.

Risk Assessment for Surface Currents

Risk of Occurrence of Strong Currents

Risk of Combined Error in the Forecast



Mar. 30, 2017 2-month forecast



Risk Management RAC Codes		Probability			
		A >0.75	0.75>B>0.5	0.5>C>0.25	0.25>D>0.1
Severity	Level I – Very High	1	1	2	3
	Level II – High	1	2	3	4
	Level III - Medium	2	3	4	5
	Level IV - Minimal	3	4	5	5
1-Critical 2-Serious 3-Moderate 4-Minor 5-Negligible					

Risk Assessment Code. Reds indicate a high probability of a severe event, greens a low probability of a benign event, but the severity of the event is application dependent and chosen by the user.



Rank Histograms are used to assess the spread/uncertainty of ensemble forecasts. A flat distribution indicates the truth is indistinguishable from any ensemble member. It is a necessary but not sufficient for accurate ensemble forecasts. Panels on left are for in situ observations, panels on right for "synthetic" observations generated from statistical relationships between SSHA and SST.

Gulf of Mexico Extended Range Ensemble Forecasting System

P. Hogan, P. Thoppil, Naval Research Laboratory, Stennis Space Center, USA

Latest Analysis and Forecast (31 Jan. 2017)



Ensemble spread (uncertainty, error) (background color) of the SSH in cm for the 27 September 2015 analysis (upper left hand corner) and the corresponding 1-week forecasts. The black lines are the 17 cm SSH contour for each of the 32 ensemble members. The red, green, and grey dashed contours are the control run, ensemble mean, and most likely mode estimate, respectively.

- 32 ensemble members
- NCOM ocean model with 3 km grid / 49 levels (33 sigma, 16 Z) • 27 km COAMPS surface forcing, tides, BC's from global HYCOM 3DVar assimilation via NCODA
- Generates a 60-day forecast once per week Running in real-time since January 2013
- Performed reanalysis from Dec. 2009 through June 2014
- Risk management products part of post-processing suite.
- Automated products posted to website

Weekly analysis ensemble spread (background color) of the SSH in cm starting 19 April 2015 analysis through 27 Sept. 2015. The black lines are the 17 cm SSH contour for each of the 32 ensemble members. The red, green, and grey dashed contours are the control run, ensemble mean, and most likely mode estimate, respectively. The Loop Current Eddy shedding events are indicated.



Probability Maps of Surface Speed Exceeding 1.5 kt Threshold

Risk: % of 32 ensemble members that exceed the threshold (1.5 kts in this case)

Rank Histograms for all observations during July, 2016





Weekly SSH Analyses (ensemble spread with 17 cm SSH contour members)





Mean SSH ensemble analyses and 1-week forecast (out to 4 weeks). Following the diagonal from the upper left hand corner to the bottom right hand corner matches the best analysis for that day with the 1, 2, 3, and 4 week forecast, respectively.



Anomaly correlation of surface, 100 m, and 250 m salinity with the corresponding best analysis (truth) for 2010, 2011 and 2013. The black curves correspond to the anomaly correlation computed around the loop current region (88-82W, 22-26N), using 42, 35, 47 60-day forecasts for 2010, 2011 and 2013 respectively. The red curves show the anomaly correlation assuming a forecast of no change (persistence). The anomaly correlation is calculated based on the long-term analysis mean. An anomaly correlation of 0.6 or greater (indicated by the location of the black arrow) is considered to indicate forecast skill.





Schematic Diagram of the Ensemble System

Ensemble Transform (ET) – Bishop and Tooth (1999

Forecast uncertaint