Evaluation of Flow Features Responsible for Extreme Events at a Potential Ocean Current Energy Extraction Locations within the Gulf Stream

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Understanding the progression of flow features to better interpret extreme ocean current events, helping lay the foundation for accurate prediction of such events.

INTRODUCTION

•Ocean current energy has the potential to provide the southeast US with a major source of electrical power, with top locations for extracting this energy being off the east coast of Florida and North Carolina.

•Using bottom mounted acoustic Doppler current profiler (ADCP) data, this study identifies extreme ocean current events (5 strongest and 5 weakest currents) that have affected proposed ocean current energy production sites off Florida over the past 15 years.

•Understanding the correlation between flow features and these extreme events can help lay the foundation for extreme ocean current event prediction.

•Sea surface temperature data and Canny edge detection are used to map the flow features associated with these events.

EXTREME EVENT DETECTION

•ADCP deployment locations (Fig 1) and the five strongest and weakest currents measured by these instruments at a depth of 75 m (Table 1).

•Interestingly, only 1 out of these 10 extreme currents appear to be associated with a hurricane. This is the 9/11/2017 current (Fig. 2-Left) that appears to be impacted by hurricane Irma.

•Ten days of flow speed including strongest and weakest events shown in Fig. 2.

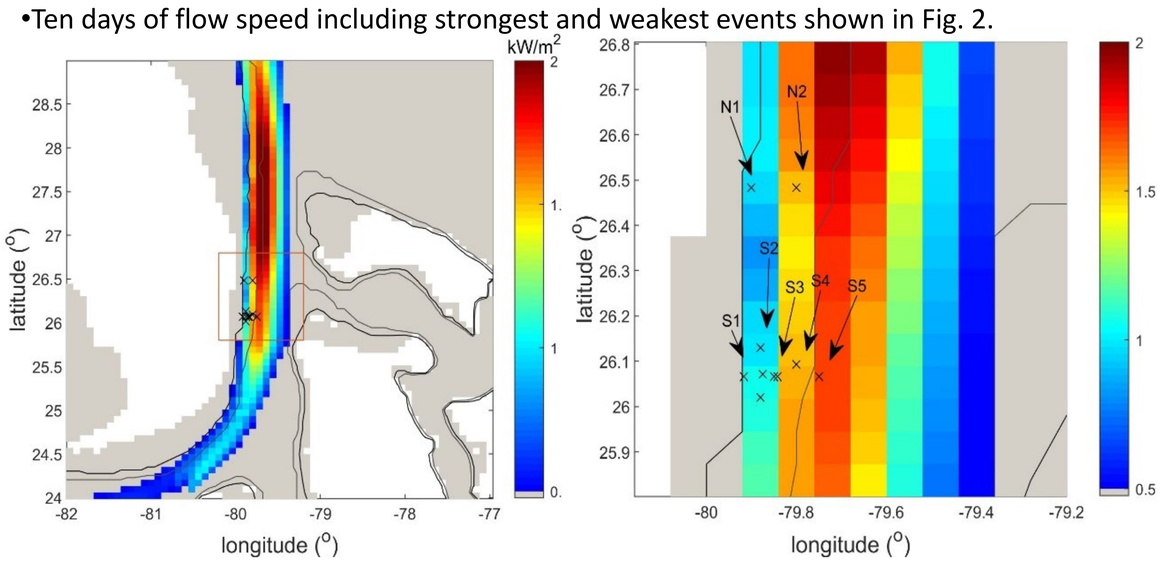

Fig. 1: Locations of bottom-mounted ADCPs used in this study (represented as "x") and buoy groups of nearly constant longitude indicated by text plotted atop of HYCOM-based average KEF (kW/m2) to show relative proximity to the resource.

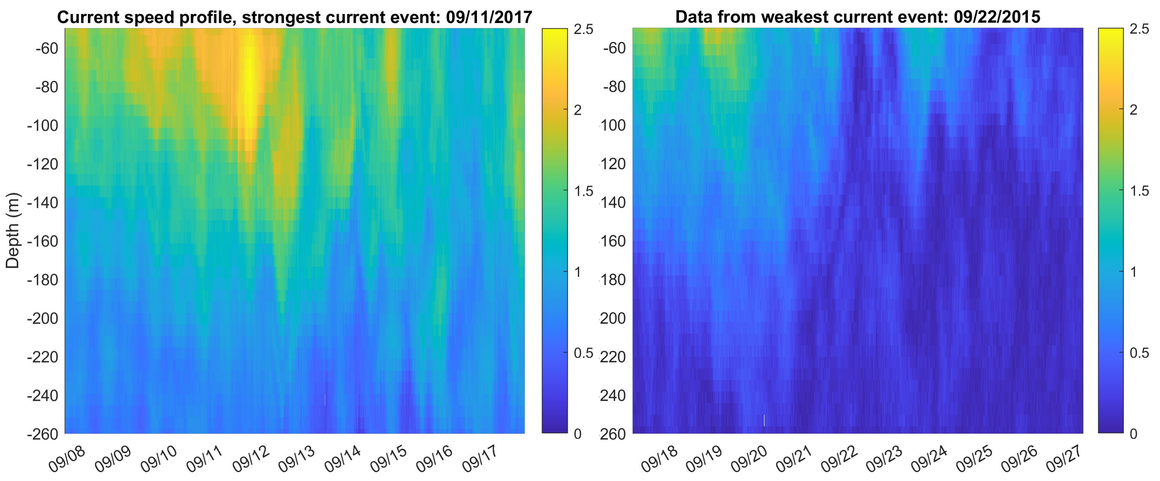

Fig.2: ADCP plots of the strongest (left) current event on 09/11/2017, and weakest (right) current event on 09/22/2015.

Table 1: Locations and dates of the 5 strongest and 5 weakest currents found within the processed ADCP data sets

Speed Rank	Latitude	Longitude	Water Depth	Date	Time	Speed
Strongest	26° 05.6' N	79° 48.0' W	500 m	9/11/17	4:50 PM	2.583 m/s
2nd Strongest	26° 29.0' N	79° 48.0' W	425 m	9/11/15	10:15 PM	2.541 m/s
3rd Strongest	26° 29.0' N	79° 54.0' W	290 m	7/25/16	1:45 PM	2.509 m/s
4th Strongest	26º 04.3' N	79º 51.0' W	320 m	7/23/13	12:15 AM	2.500 m/s
5th Strongest	26º 01.2' N	79º 52.8' W	290 m	7/22/13	11:30 PM	2.482 m/s
Weakest	26° 29.0' N	79° 54.0' W	290 m	9/22/15	3:30 AM	0.003 m/s
2nd Weakest	26º 04.3' N	79º 55.0' W	260 m	11/17/14	12:29 AM	0.026 m/s
3rd Weakest	26º 01.2' N	79º 52.8' W	290 m	2/27/14	10:15 PM	0.026 m/s
4th Weakest	26º 04.3' N	79º 55.0' W	260 m	11/1/11	8:05 AM	0.040 m/s
5th Weakest	26º 04.3' N	79º 51.0' W	320 m	5/25/12	9:50 PM	0.135 m/s

SEA SURFACE TEMPERATURE BASED EVENT ANALYSIS

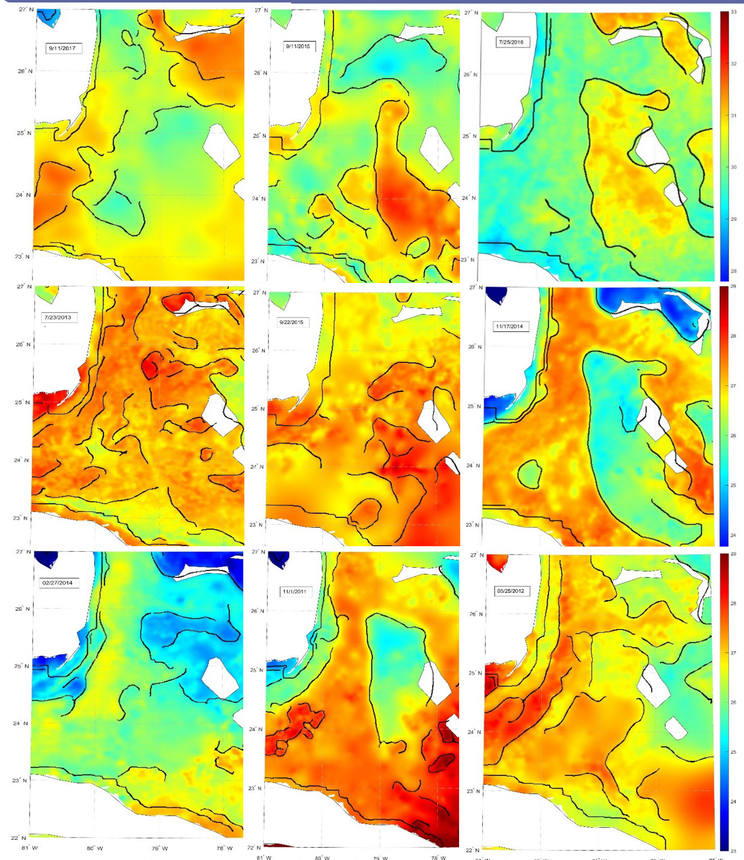

Fig. 3: Sea surface temperature during five strongest/weakest currents: Strongest (top-left), 2nd Strongest (top-center) and 3rd Strongest (top-right), 4th & 5th Strongest (middle left), Weakest (middle-center), 2nd weakest (middle-right), 3rd weakest (bottom-left), 4th weakest (bottom-center), and 5th weakest (bottom-right).

•Sea surface temperature perturbations appear to show small-scale eddies near the western edge of the Florida Current for most of the days analyzed, such as the current on September 11, 2015 (top-center).

•Meandering characteristics are apparent at both the western and eastern edges of the Florida Current, with the western further from shore for the weaker currents (last 5 images).

•Other noticeable characteristics involve the latitudinal and longitudinal coordinates of the western edge of the Florida Current upstream, with a more streamlined boundary near the shore of Florida on days with the strongest current speeds.

CONCLUSION

- Sea surface temperature perturbations from satellite technology appear to show small-scale eddies near the western edge of the Florida Current during most of the evaluated extreme events.
- Meandering characteristics have been observed at both the western and eastern edges of the Florida Current, with the western edge showing a more consistent boundary.
- Noticeable characteristics involve the latitudinal and longitudinal coordinates of the western edge of the Florida Current upstream, with a more streamlined boundary near the shore of Florida on days with the strongest current speeds.

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