Upper-lower layer coupling in Loop Current Eddies Ekman and Franklin

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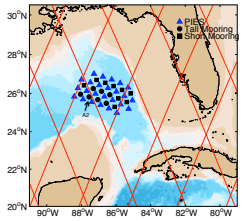
1. Dynamics of the Loop Current Experiment

Goals: Increase dynamical understanding of Loop Current, eddy-shedding mechanisms, and genesis of lower-layer flows.

Elements: Moored arrays of current and temperature and bottom-mounted pressure equipped inverted echo sounders (PIES) together with remote-sensing and numerical-modeling approaches.

Deployment: April 2009
Rotation: July & November 2010
Recovery: November 2011

Here we show results from the first 15 months: May 2009 to July 2010.



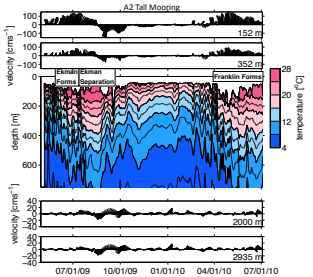
Array placed where historical analysis indicated eddy separation was most likely to occur and designed to encompass the Loop Current from east to west.

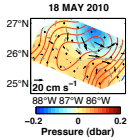
2. Circulation dominated by interaction between the Loop Current and Eddies Ekman and Franklin

Temperature and velocity measurements from the nine tall moorings resolve the full water column structure.

Meanders (~ 7 day period) along the Loop Current periphery precede Loop Current Eddy formation.

Upper-layer Loop Current flows are not visually coherent with lower-layer flows.

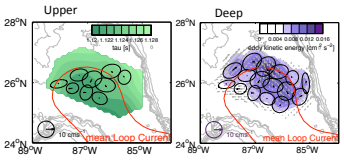




Upper-layer and lower-layer coupling revealed from mapped bottom pressure (shaded color contours) and currents (gray vectors) as well as measured deep currents (black vectors).

Mapped round-trip travel acoustic travel time (thick lines) with a contour interval of .002 s comparable to ~9 cm in sea surface height.

3. Upper and Deep Statistics



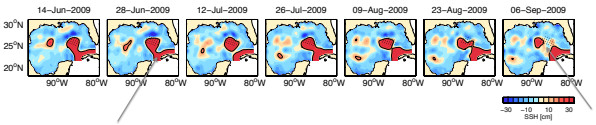
Principal axes of the standard deviation ellipses and the mean vectors are not aligned with those of the upper layer (~200 m depth).

In lower layer, mean circulation shows an west-east pattern of anticyclone-cyclone pair.

Deep eddy kinetic energy is high along the northeastern periphery of the mean Loop Current position.

4. Loop Current Eddies Ekman and Franklin

Eddy Ekman

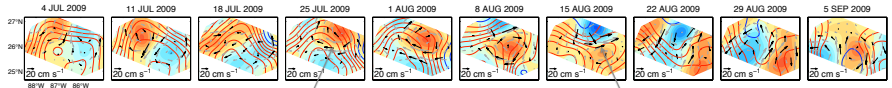


The 17 cm contour (black) denotes the location of the Loop Current and Loop Current eddy fronts in the altimeter-derived sea surface height.

Initial detachment (June-July) occurs when a trough forms in the southeast edge of the Loop Current. The trough expands and ultimately causes detachment.

Separation occurs when a frontal cyclone along the northern Loop Current strengthens and moves southward.

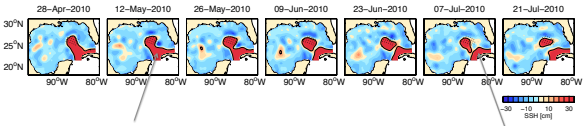
After the initial detachment meanders develop (~300 km wavelength) along the Loop Current.



A northward shift (meander crest) of the Loop Current, lower-layer thickness decreases, and deep anticyclonic vorticity develops to conserve potential vorticity. With favorable vertical offset, a lower-layer anticyclone leads a meander crest, upper-layer and lower-layer eddies grow.

Joint development also occurs when a southward shift (meander trough) increases lower-layer thickness and generates a deep cyclone that leads the upper trough.

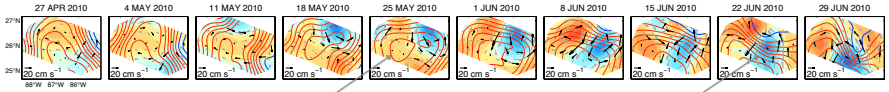
Eddy Franklin



Eddy Franklin underwent five detachment/reattachment cycles until final separation in late September 2010.

Similar to Eddy Ekman, a growing and southward propagating meander along the west Florida slope initiates the first detachment.

Also similar to Eddy Ekman, a second detachment occurs when a frontal cyclone along the northern Loop Current strengthens and moves northward.



A deep anticyclone is offset from an upper crest, a deep cyclone offset from upper trough and deep anticyclone offset from upper crest.

A strong deep cyclone with swirl speed in excess of 20 cm/s develops leading an upper trough, the pair jointly intensify, move south and Eddy Franklin detaches from the Loop Current.

- Preliminary investigations show strong interaction of upper-layer flows with deep currents.
- Upper and lower-layer responses during Ekman and Franklin detachments are organized and suggestive of baroclinic instability.
- Loop Current meanders are an important mechanism to transfer energy to the lower layer.
- Four Loop Current Eddies formed in the Gulf of Mexico during the 30-month observational time-frame, analysis is ongoing.

We acknowledge support from BOEMRE contract M08PC20043.

See related posters:
Rosburg, K., Performance evaluation of HYCOM in GOM, B1333
Hamilton, P., Loop Current Eddies Ekman and Franklin, A historical perspective, B1322