Loop Current Dynamics -- UGOS1 Modeling Meeting

Randy Watts -- Nov 21, 2019 -- UCSD

Univ. Rhode Island

Project Director:
Kathleen Donohue
Co-PI:
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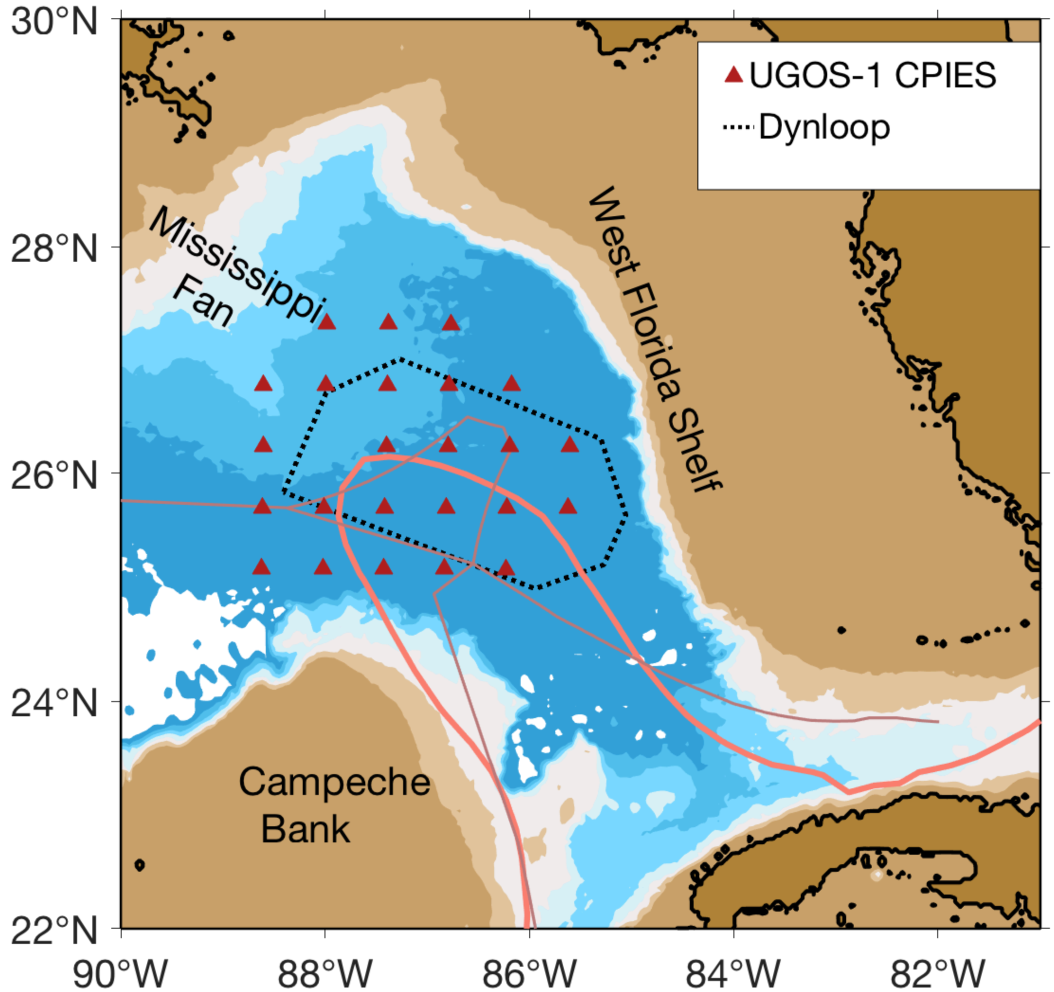
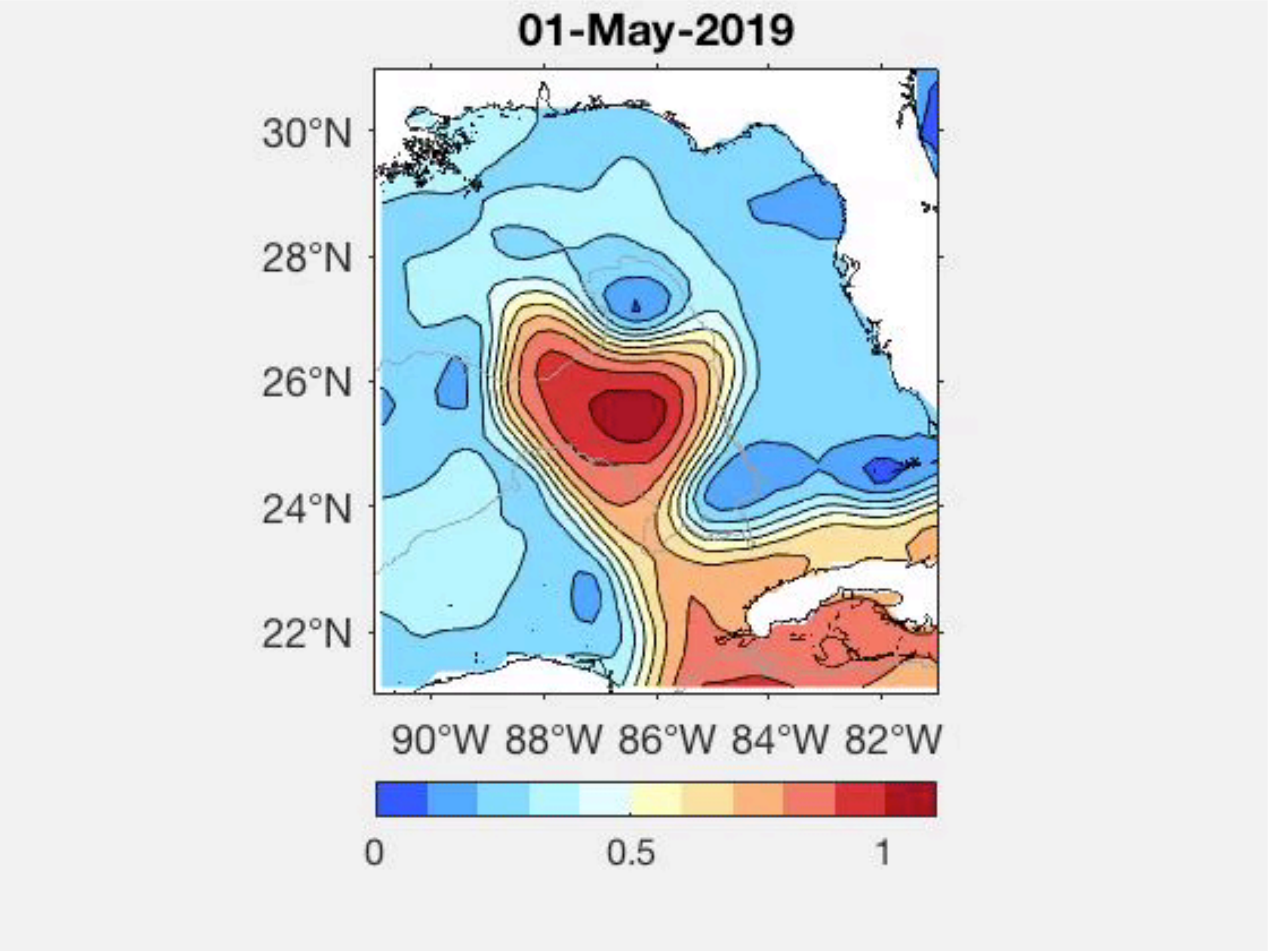
Funding: NAS



Typical mean LC path

for context: AVISO near-real-time SSH



Overview -- CPIES Array Results

Successful

– deployment cruise Jun-Jul 2019

– telemetry cruise Sep-Oct 2019

– beautiful high quality data set,
  bottom Pressure, deep currents, vertical acoustic travel time

– similar to DynLoop,
  find strong deep currents (35 cm/s) and
  high EKE = $\frac{1}{2} \langle (u'^2 + v'^2) \rangle$, preceding & during LCE separation

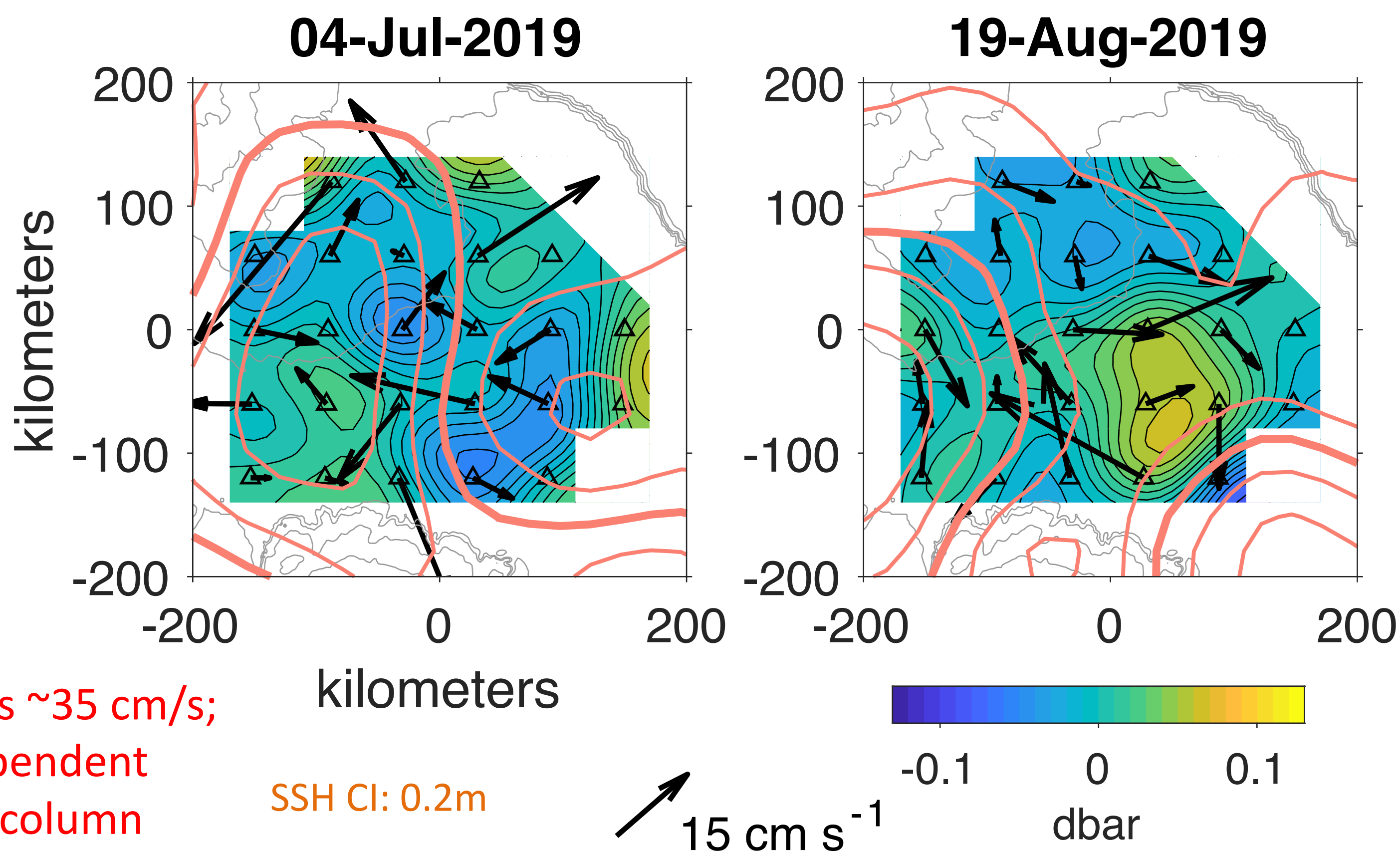
– larger region,
  Campeche Bank to Mississippi Fan and W. Florida Shelf

Two snapshots from CPIES telemetered data

7/04 just before LCE separated

8/19 deep anti-cyclone as LC advances

Mapped P_{bot}
Measured currents
Bathymetry
Aviso nrt_SSH



SSH CI: 0.2m

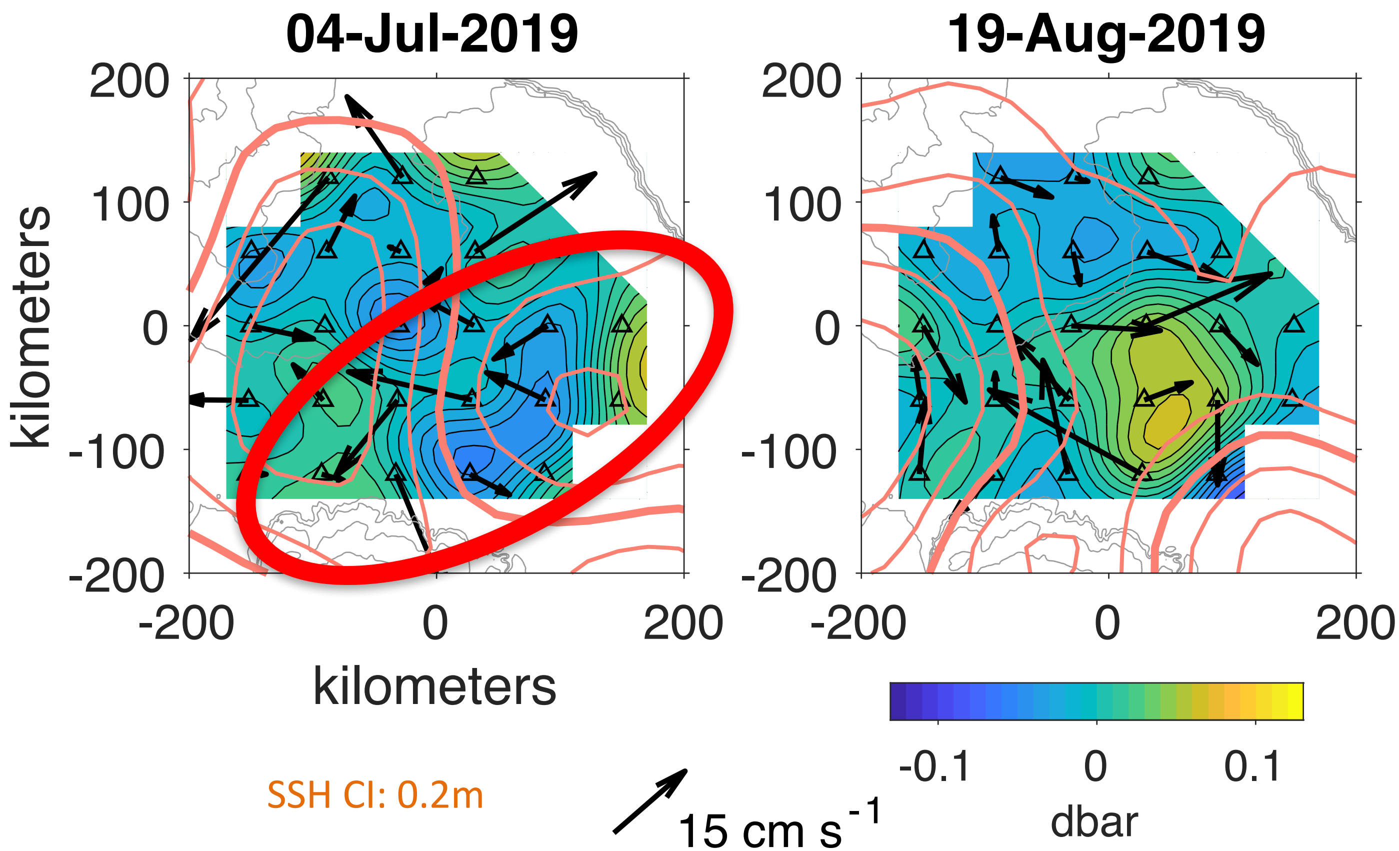
Deep current peaks ~35 cm/s; nearly depth-independent through full water column

Two snapshots from CPIES telemetered data

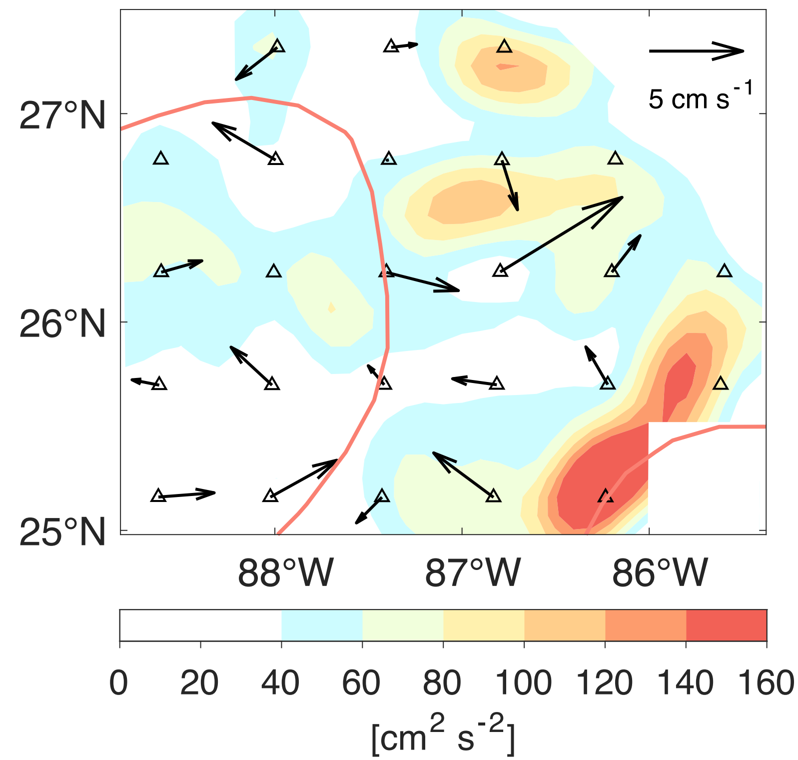
Mapped P_{bot}
Measured currents
Bathymetry
Aviso nrt_SSH

7/04 just before LCE separated, **deep cyclone currents intensify LC trough**

8/19 deep anti-cyclone as LC advances



EKE at 3000 m

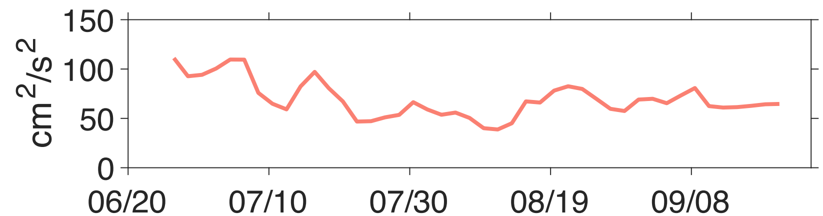


Mean EKE 6/26-9/20/2019

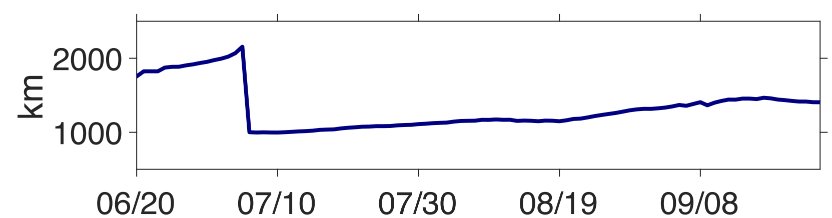
(mean SSH contour 0.6 m)

(mean currents only 2-3 cm/s)

Array EKE time series



LC path length



DynLoop Comparison
because 2009-2011 is a proposed focus of UGOS1 modeling efforts

collaborators:

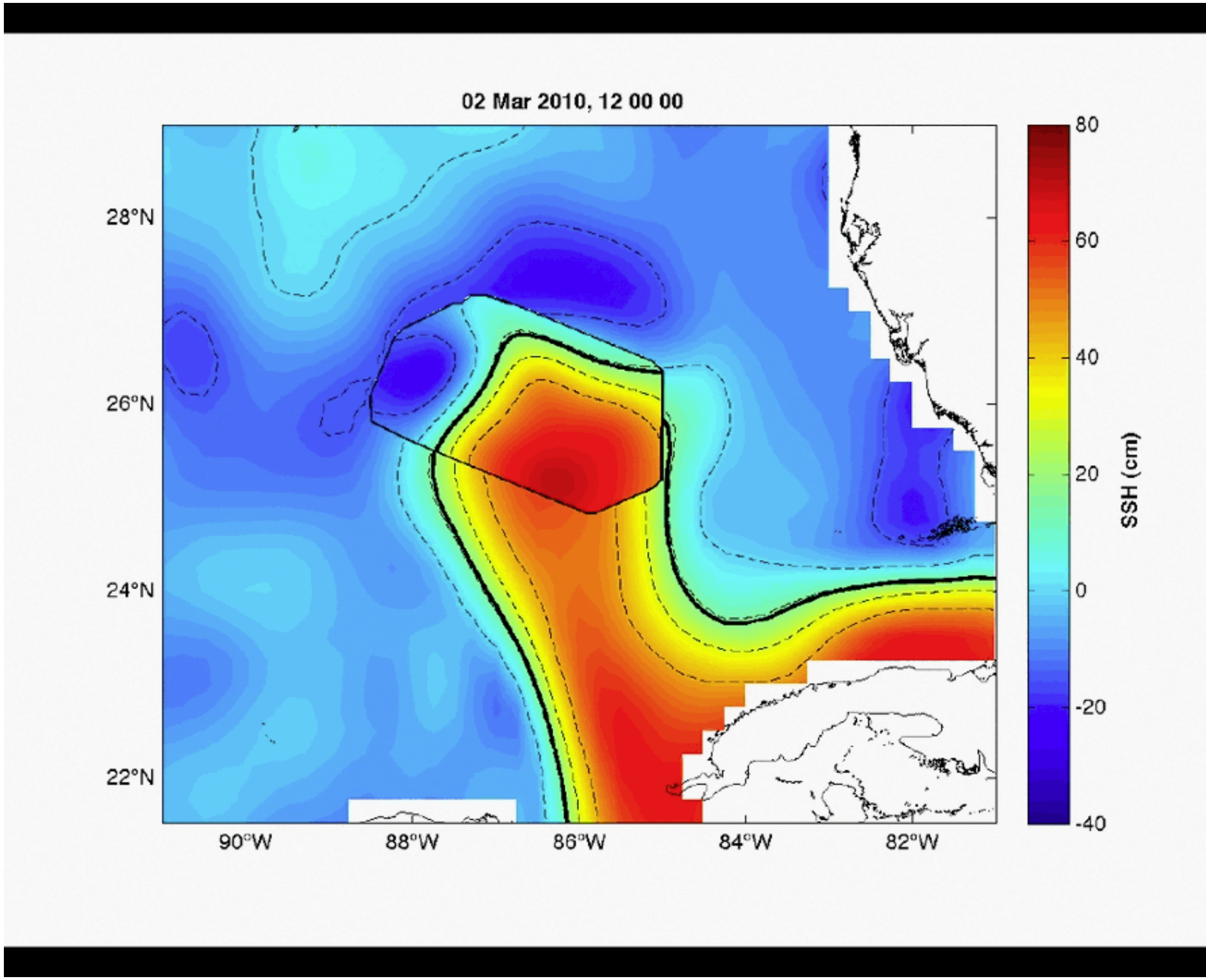
Kathleen Donohue,
Randy Watts,
Maureen Kennelly
University of Rhode Island

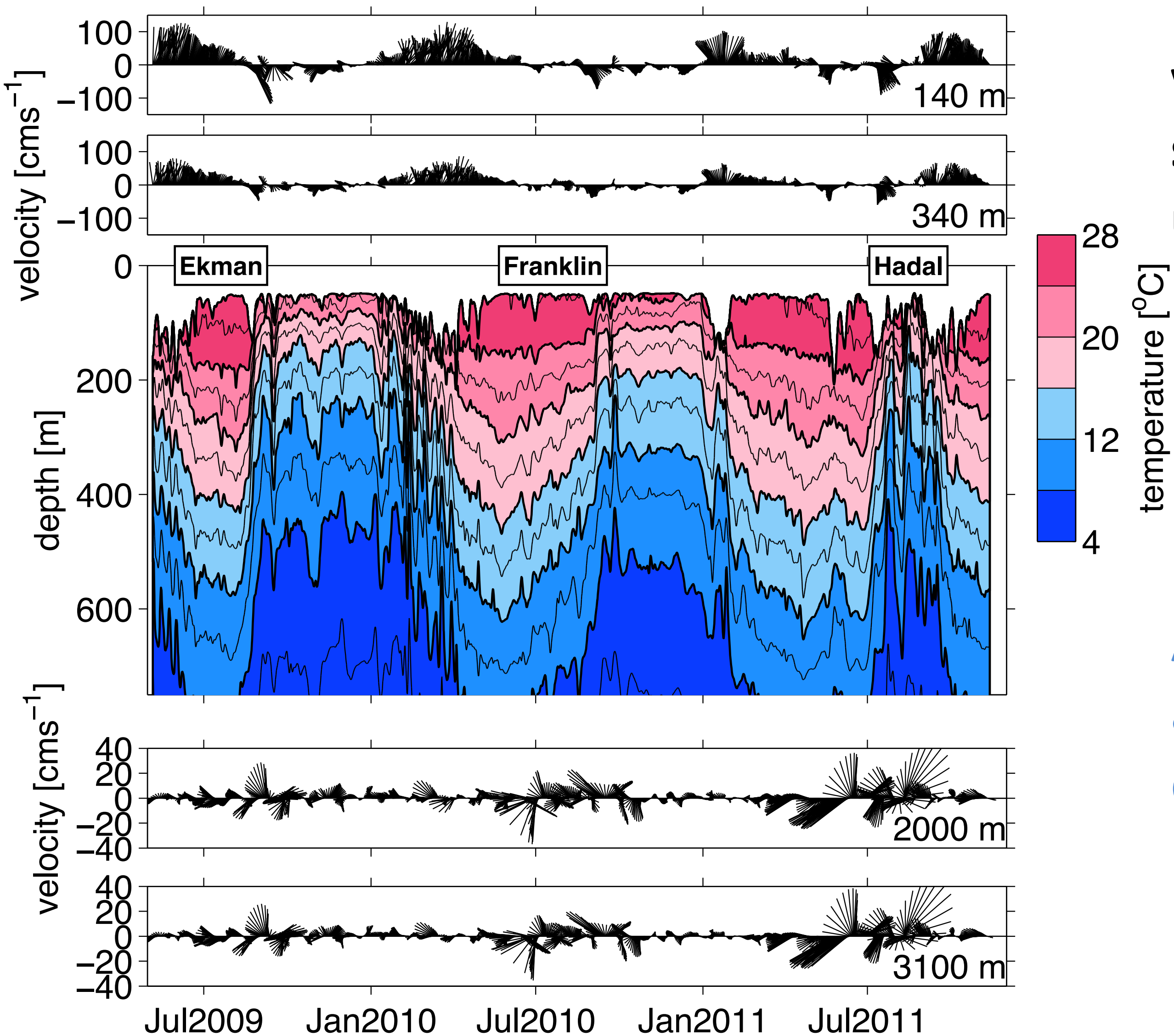
Peter Hamilton
Leidos Inc., Raleigh

Robert Leben
University of Colorado

➔ 4 papers in DAO 2016

Funding: BOEM





Upper and deep velocities appear, at a single mooring, to be uncoupled.

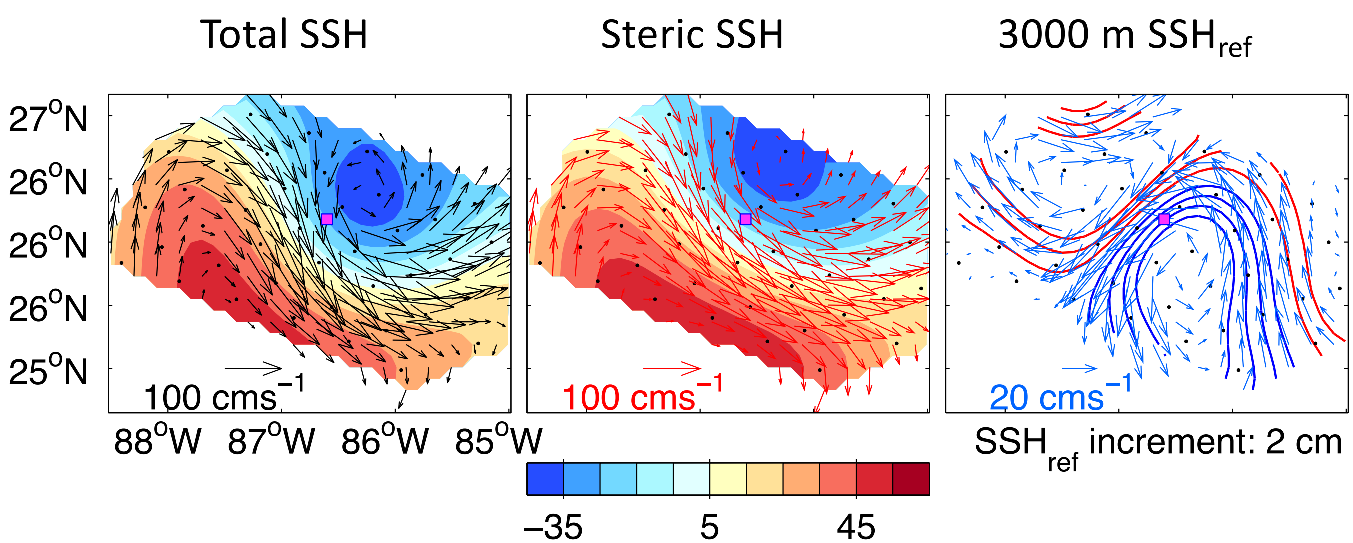
A mesoscale-resolving array reveals vertical coupling & signature of baroclinic instability.

The two modes observed by CPIES –

– exhibit two separate contributions to SSH

– and account for ~95% of total EKE

example snapshot:



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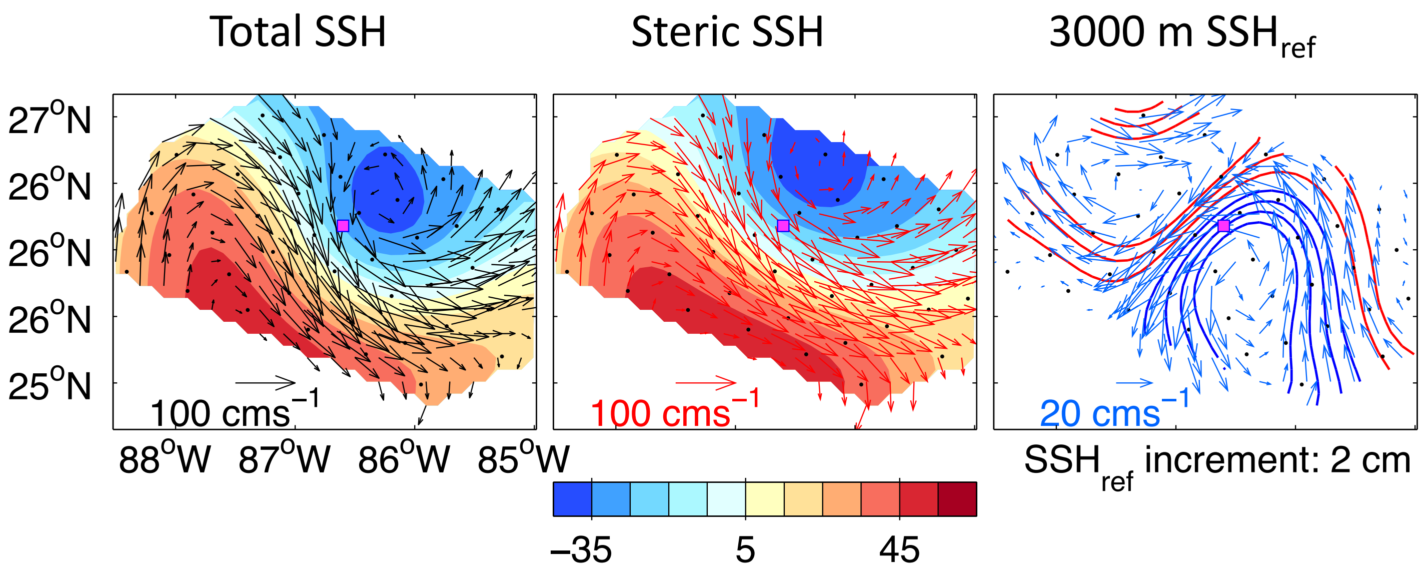
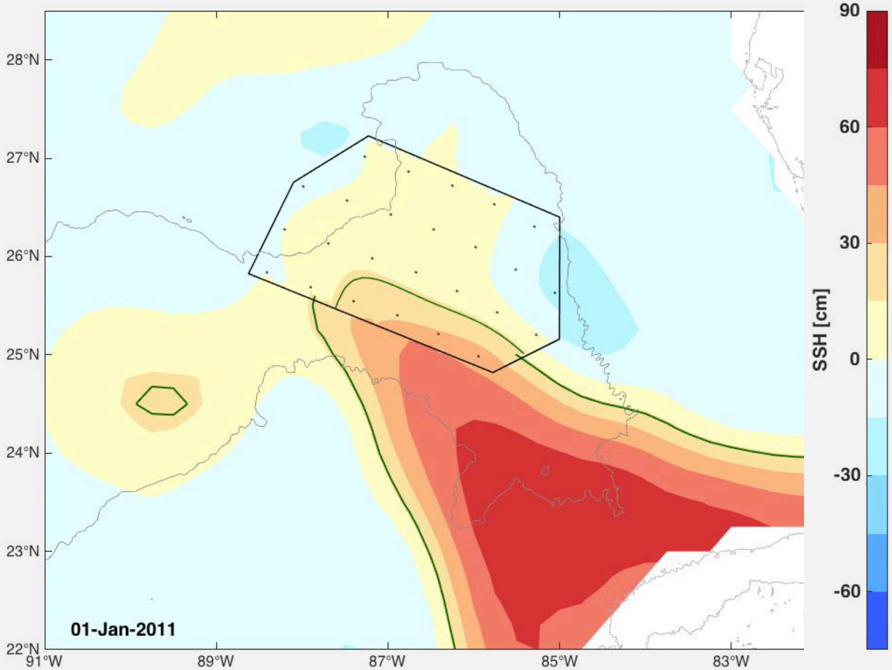
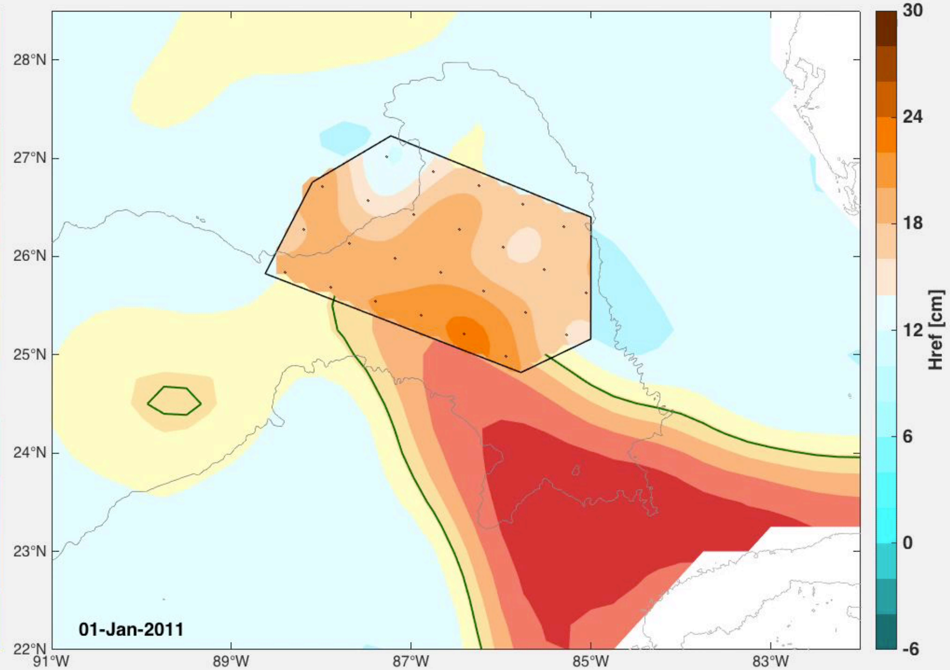


Upper and Deep fields interact strongly

context SSH & inset: steric SSH



context SSH & inset: 3000 m SSH_{ref}



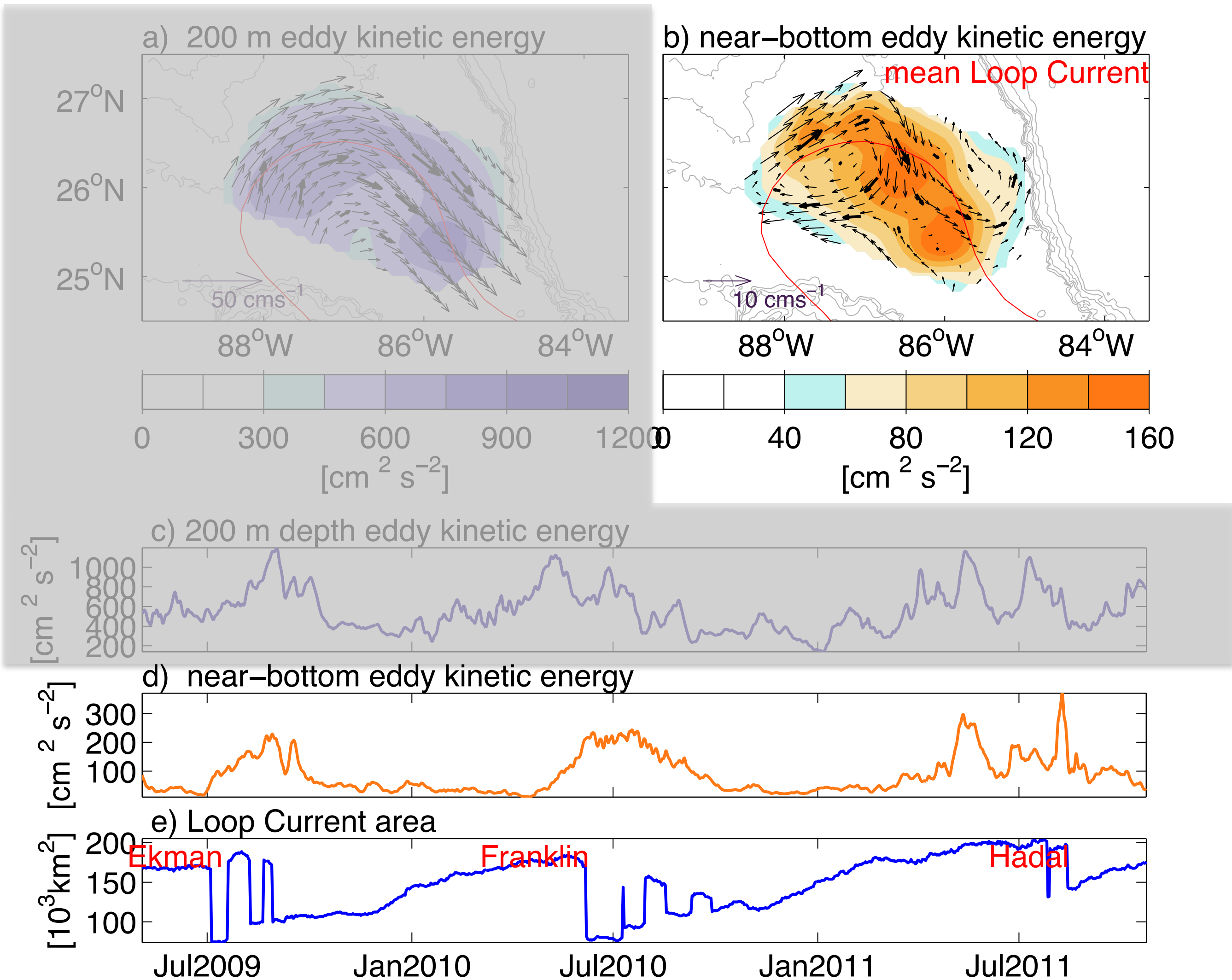
The upper steric SSH accounts for
~80% of total SSH signal
~20% of depth-weighted EKE

Train of meanders grows along eastern LC path prior to LCE detachment

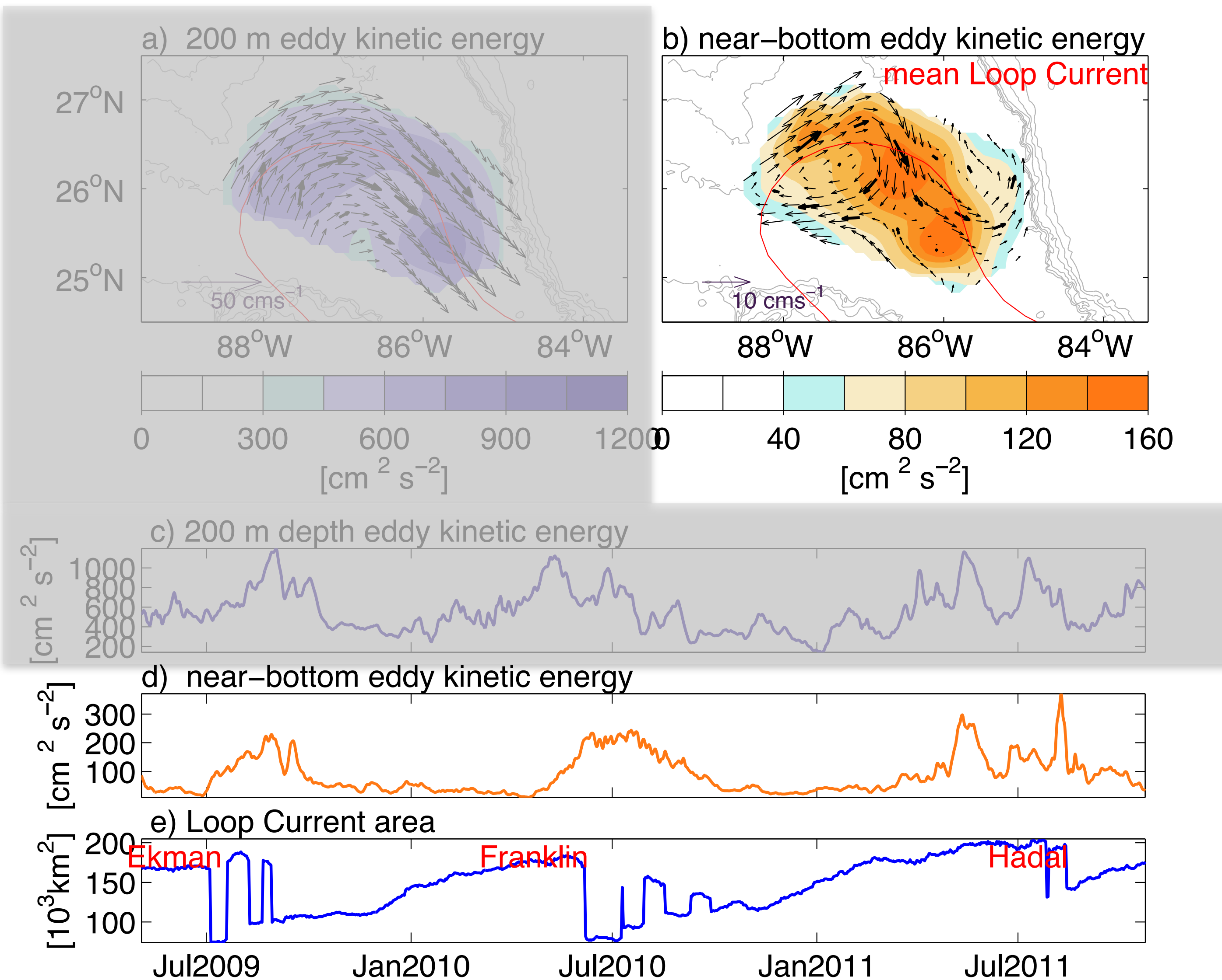
The deep ref field accounts for
~20% of total SSH signal
~80% of depth-weighted EKE

Deep eddies lead upper meanders, signature of BC instability.

Preceding & during LCE formation, marked increase in deep EKE



Preceding & during LCE formation, marked increase in deep EKE



TAKEAWAYS…

- Deep EKE is a KEY METRIC to judge model performance
    - Map time-average EKE
    - Time-series regional average deep EKE, preceding & after LCE formation

- 4D observations with mesoscale resolution in space & time

  ➔ essential role of upper-deep coupling
    - Baroclinic instability
    - *Need to know* both sides of vertical coupling to improve forecast modeling
    - upper LC and LCEs steered by deep current field (large scale, slowly-varying)
    - radiated bursts of strong currents (TRWs)
    - Oh, and did I remember to mention, deep EKE is an essential metric !
    - Could we take time to discuss how to make deep EKE comparisons with models?

END