Loop Current Cycle:
Coupled response of Loop Current with deep flows

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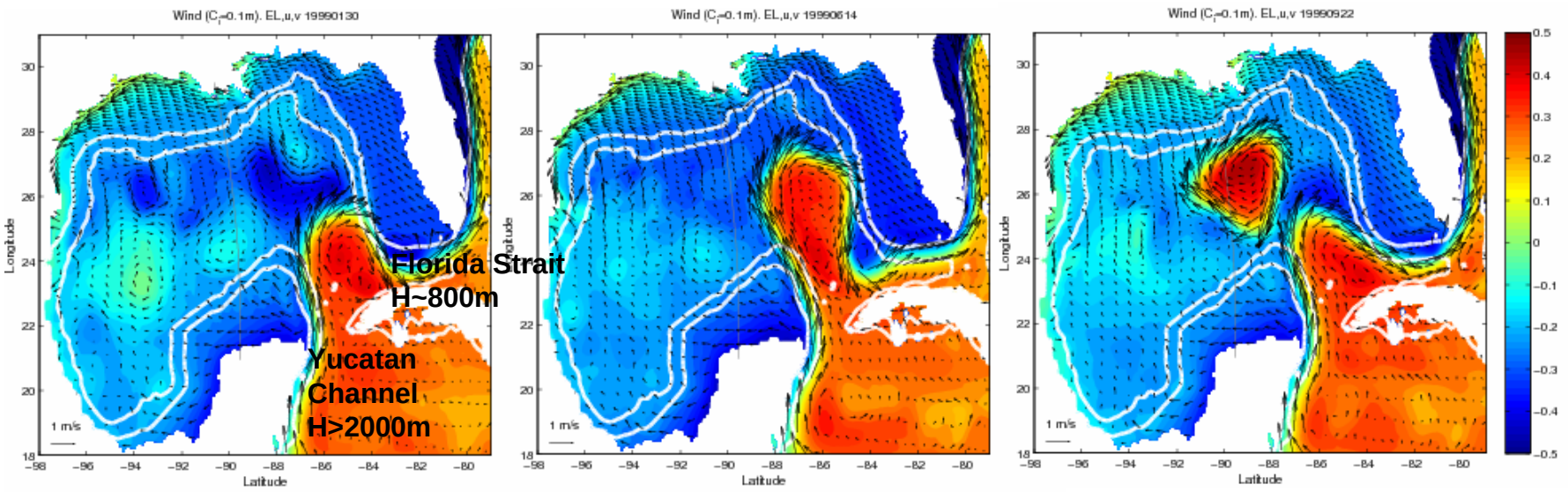
Loop Current Cycle



- Loop Current is confined in the upper 1000m.

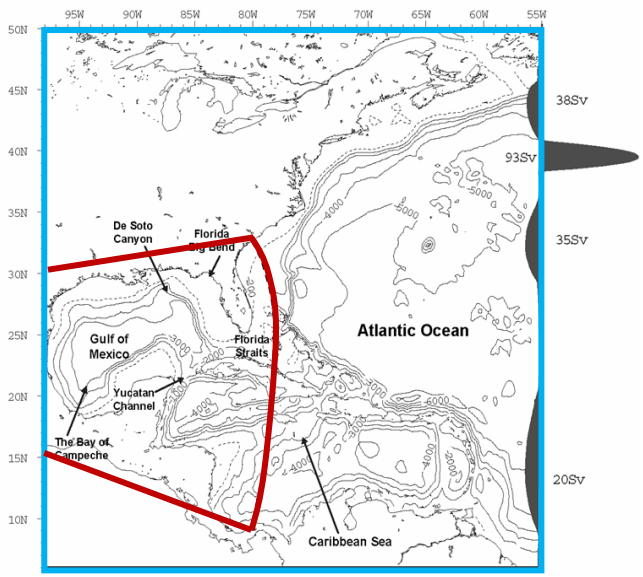
Maul (1977): deep outflow is part of the adjustment process associated with eddy formation.

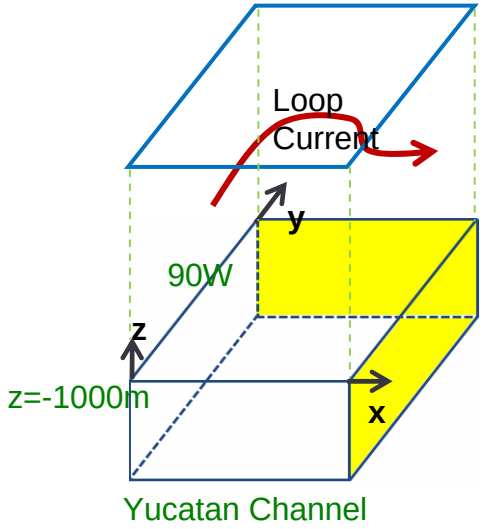
Bunge et.al (2002) and Ezer et al (2003):

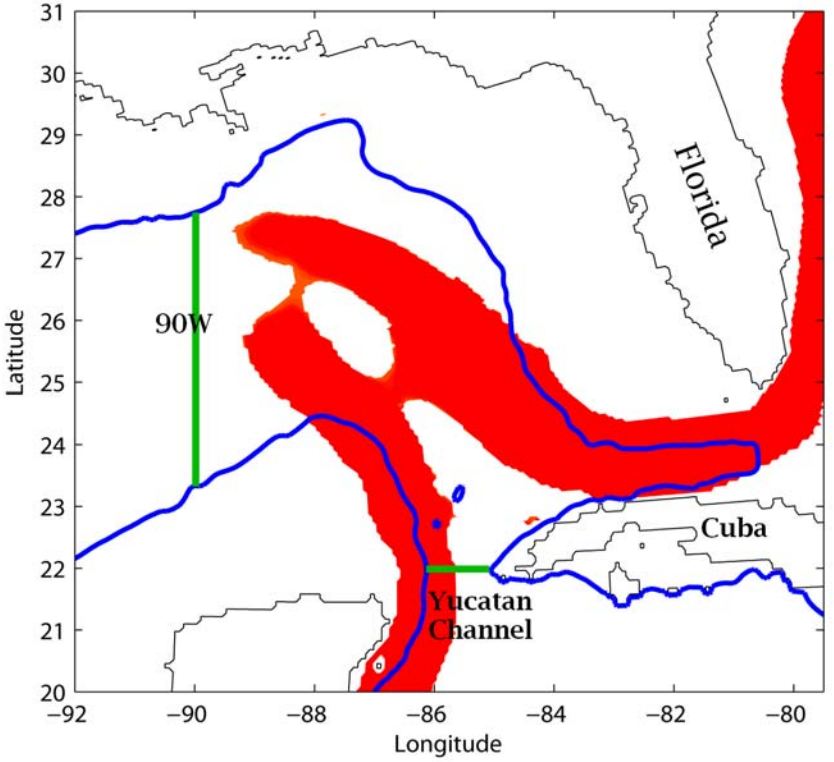
correlation between LC expansion and Yucatan deep outflow

- How do Loop Current and eddies couple with deep flow?

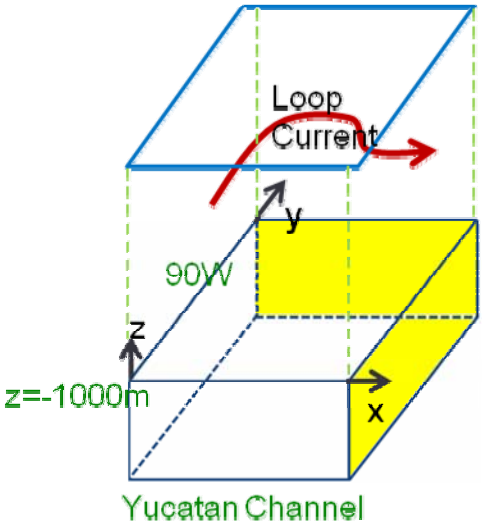
Method

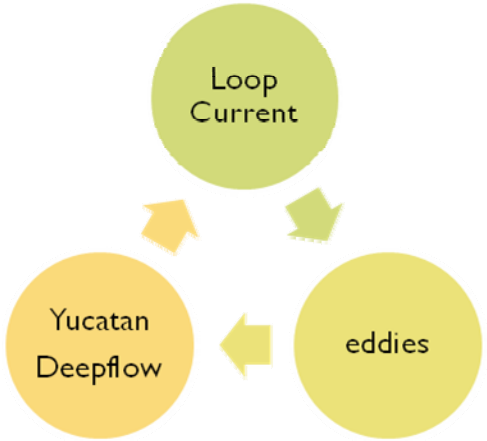


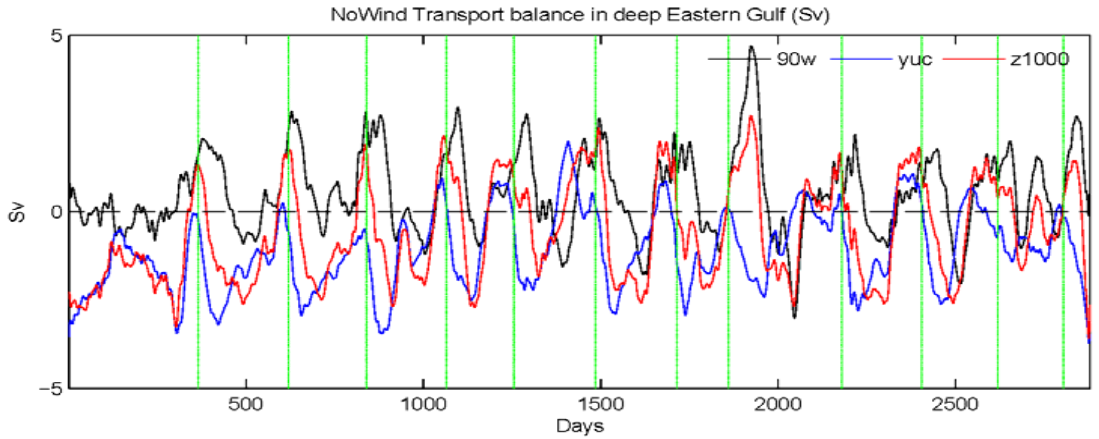


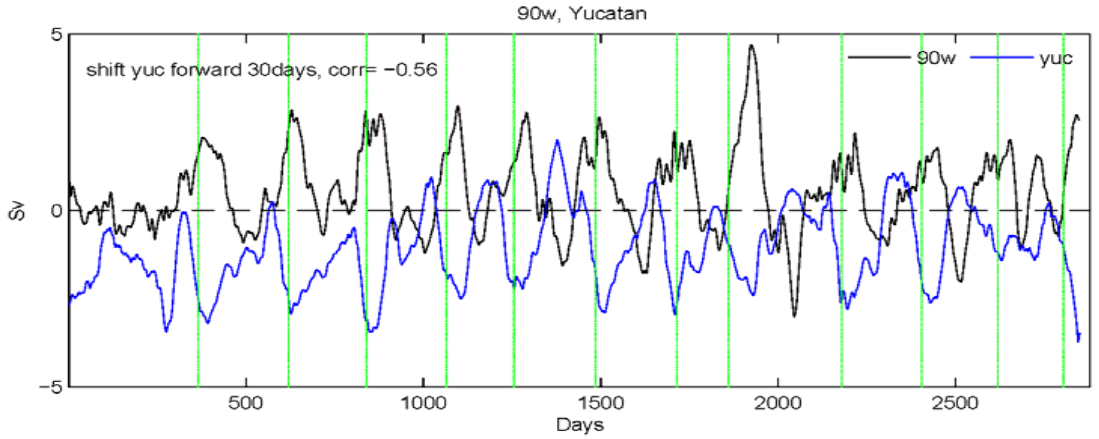


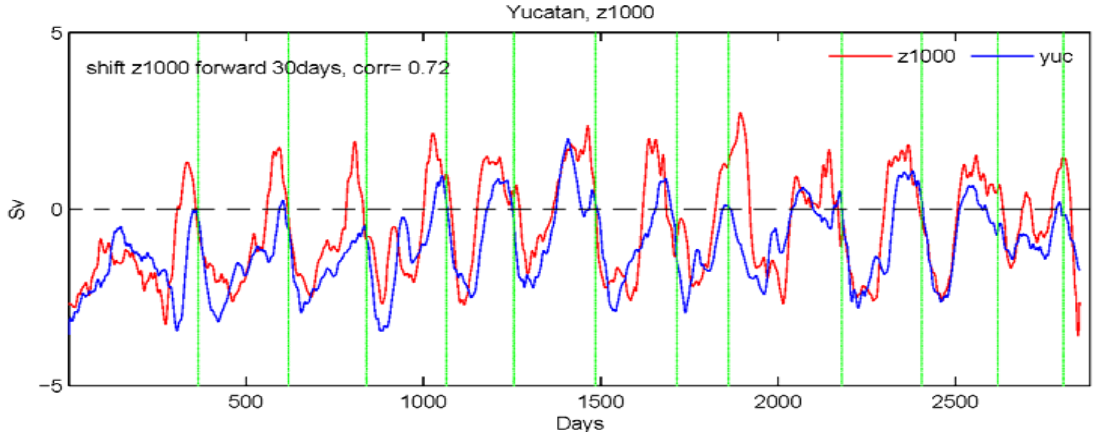
- Resolution:5km, 25 σ levels
- 8 years simulation
- No wind, no surface fluxes
- Eddy shedding: ~Every 8 months

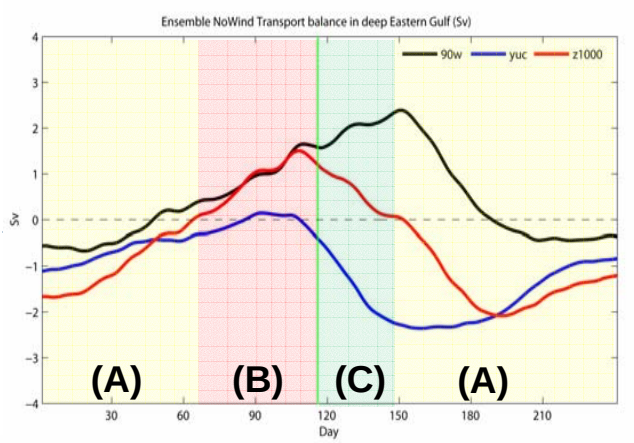

Loop
Current
y
90W
z
z=-1000m
x
Yucatan Channel

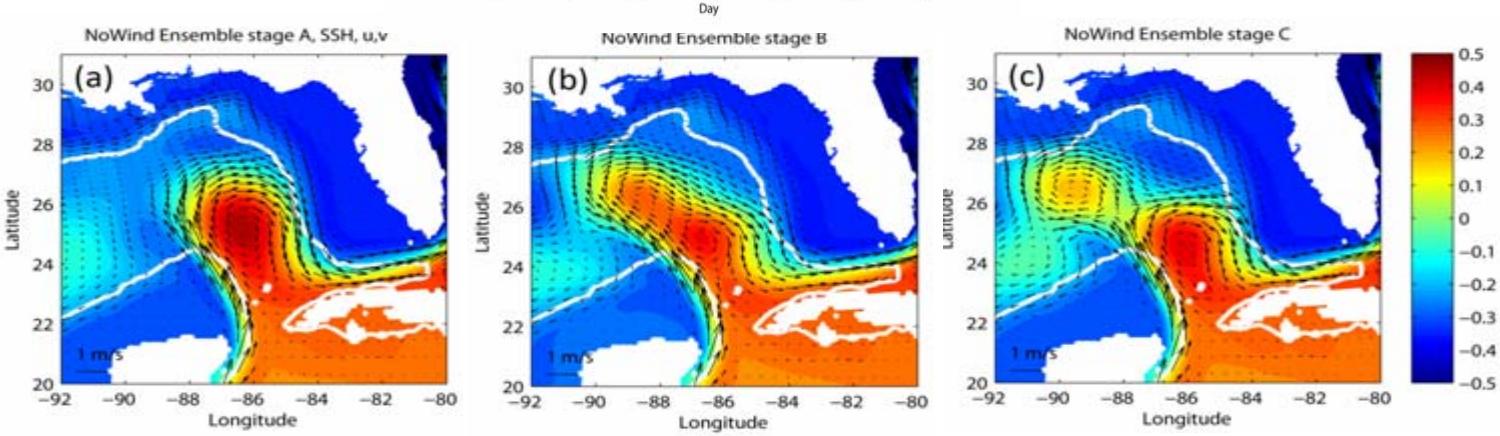

Loop
Current
Yucatan
Deepflow
eddies

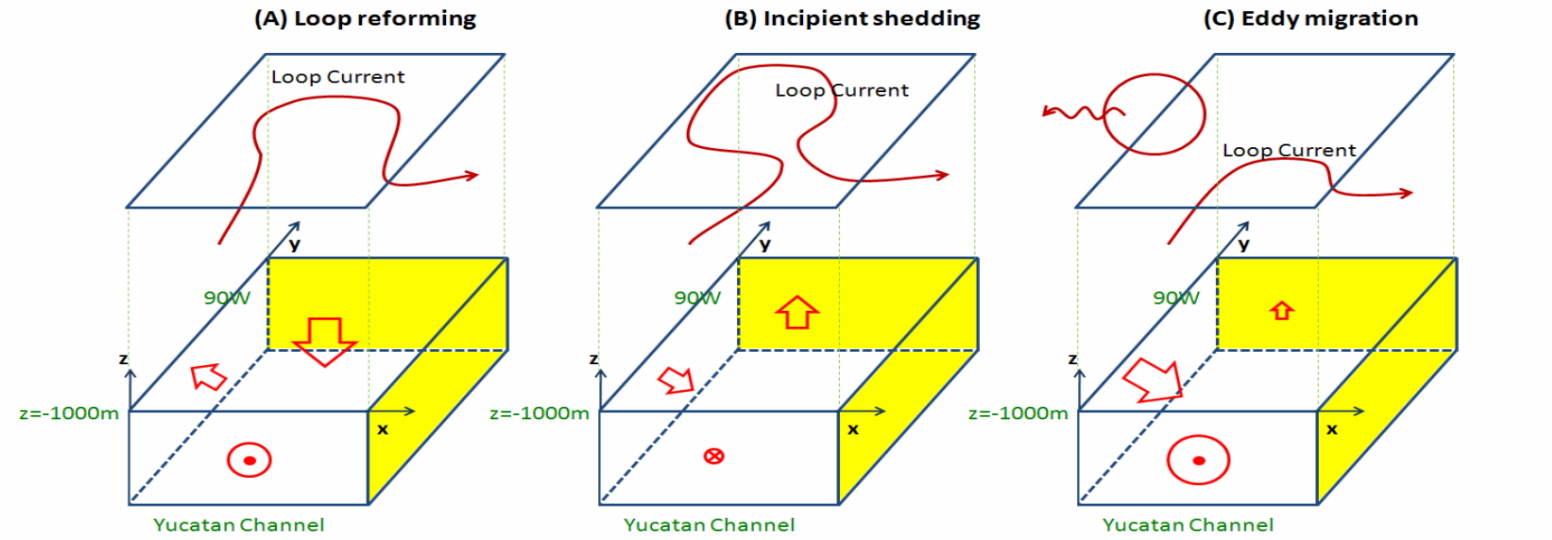

NoWind Transport balance in deep Eastern Gulf (Sv)
90w
yuc
z1000
Sv
Days


90w, Yucatan
shift yuc forward 30days, corr= −0.56
90w
yuc
Sv
Days


Yucatan, z1000
shift z1000 forward 30days, corr= 0.72
z1000
yuc
Sv
Days


Ensemble NoWind Transport balance in deep Eastern Gulf (Sv)
90w
yuc
z1000
Sv
Day
(A)
(B)
(C)
(A)

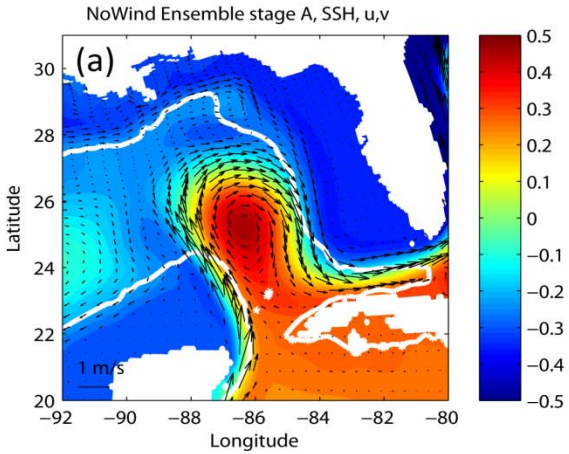

NoWind Ensemble stage A, SSH, u,v
NoWind Ensemble stage B
NoWind Ensemble stage C
(a)
(b)
(c)
Latitude
Longitude
1 m/s

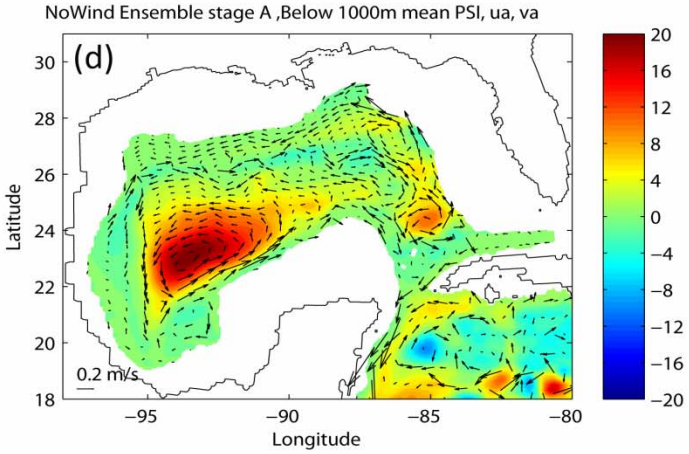

(A) Loop reforming
(B) Incipient shedding
(C) Eddy migration
Loop Current
90W
z=-1000m
Yucatan Channel

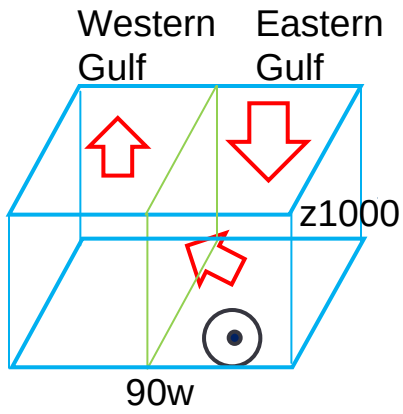
A

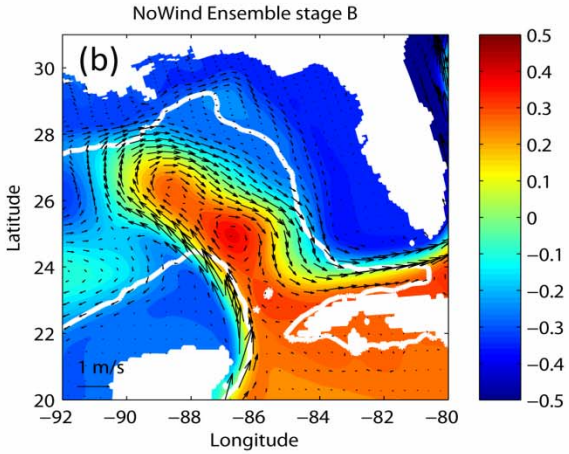
B

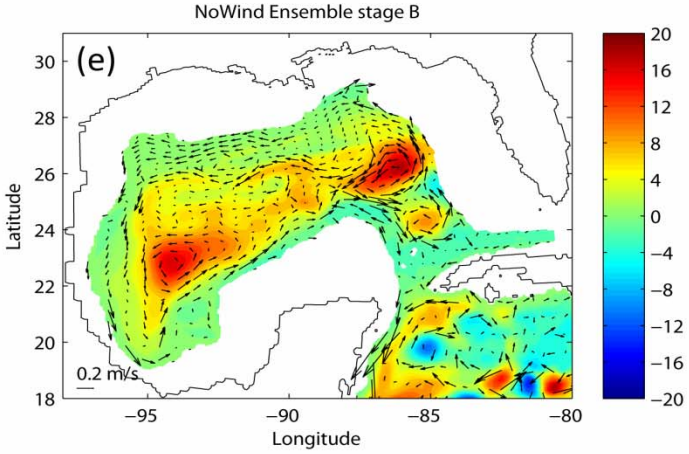
C

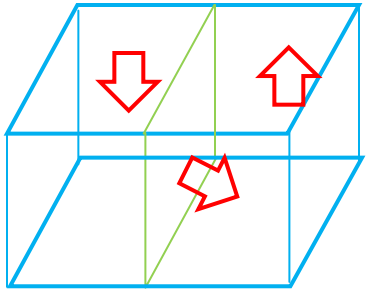

NoWind Ensemble stage A, SSH, u,v
(a)
1 m/s
Latitude
Longitude

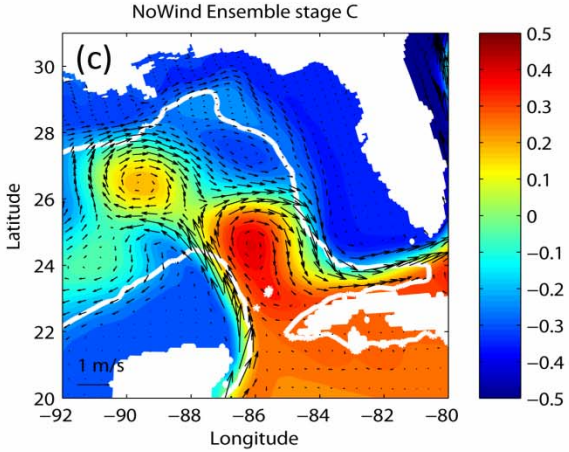

NoWind Ensemble stage A ,Below 1000m mean PSI, ua, va
(d)
0.2 m/s
Latitude
Longitude

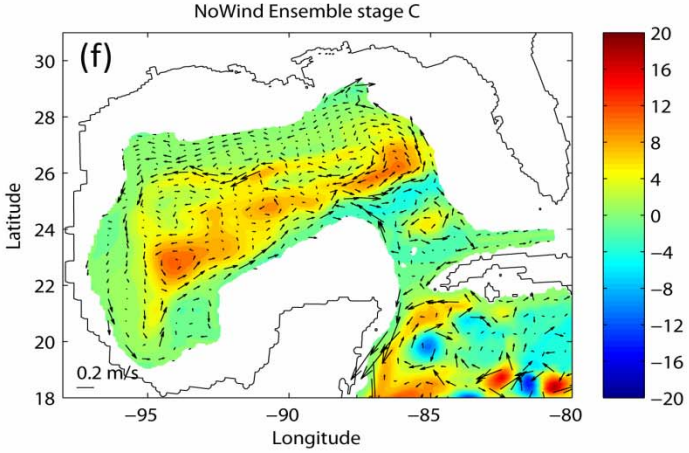

Western Gulf
Eastern Gulf
z1000
90w


NoWind Ensemble stage B
(b)
1 m/s
Latitude
Longitude


NoWind Ensemble stage B
(e)
0.2 m/s
Latitude
Longitude




NoWind Ensemble stage C
(c)
1 m/s
Latitude
Longitude

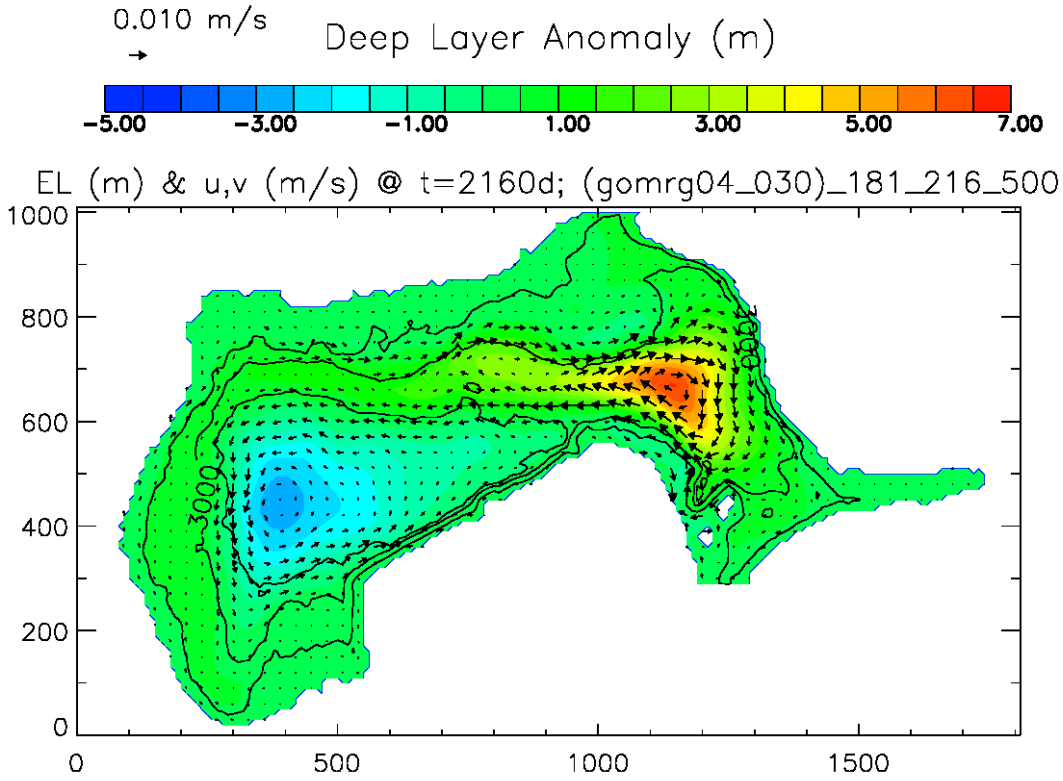

NoWind Ensemble stage C
(f)
0.2 m/s
Latitude
Longitude

Why is the deep mean circulation cyclonic?

$$\oint \boldsymbol{U}_h . \boldsymbol{n} \left(\frac{f+\zeta}{H+\eta} \right) ds = -r \oint (\boldsymbol{u}_h . \boldsymbol{l}) ds$$

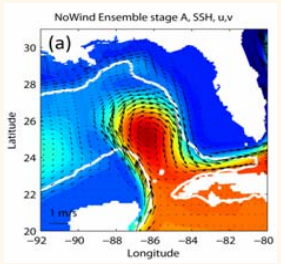
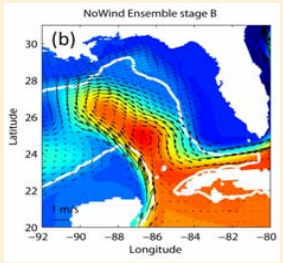
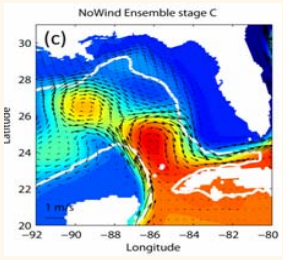
$$0 \qquad -r \iint \zeta dx dy = 0$$

Yang and Price (2000)



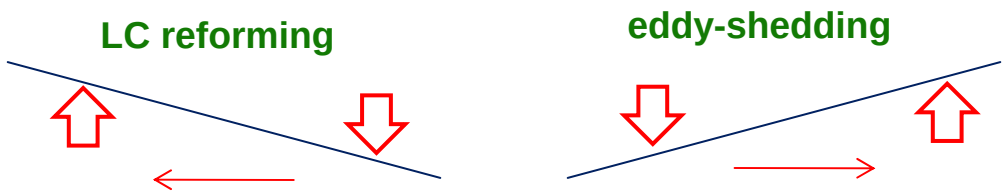
Summary-1

- Loop Current cycle:

A		Loop Current reforming	downward flux	divergent flow southward into Yucatan Channel and westward into central Gulf.
B		incipient-shedding	increasing upward flux	Deep convergence with water being drawn from central Gulf.
C		eddy-migration	decreasing upward flux	As eddy migrates westward, deep flow from central Gulf to Yucatan Channel develops.

Summary-2

- Oscillator: east-west coupling
- The coupled surface and deep motions in the Gulf resulting from Loop Current and eddies behave as a west-east oscillator.



- Cyclonic deep circulation is a coupled response of Loop Current cycle.