Interannual variability of the Gulf of Mexico loop current and eddies from models and satellite observations

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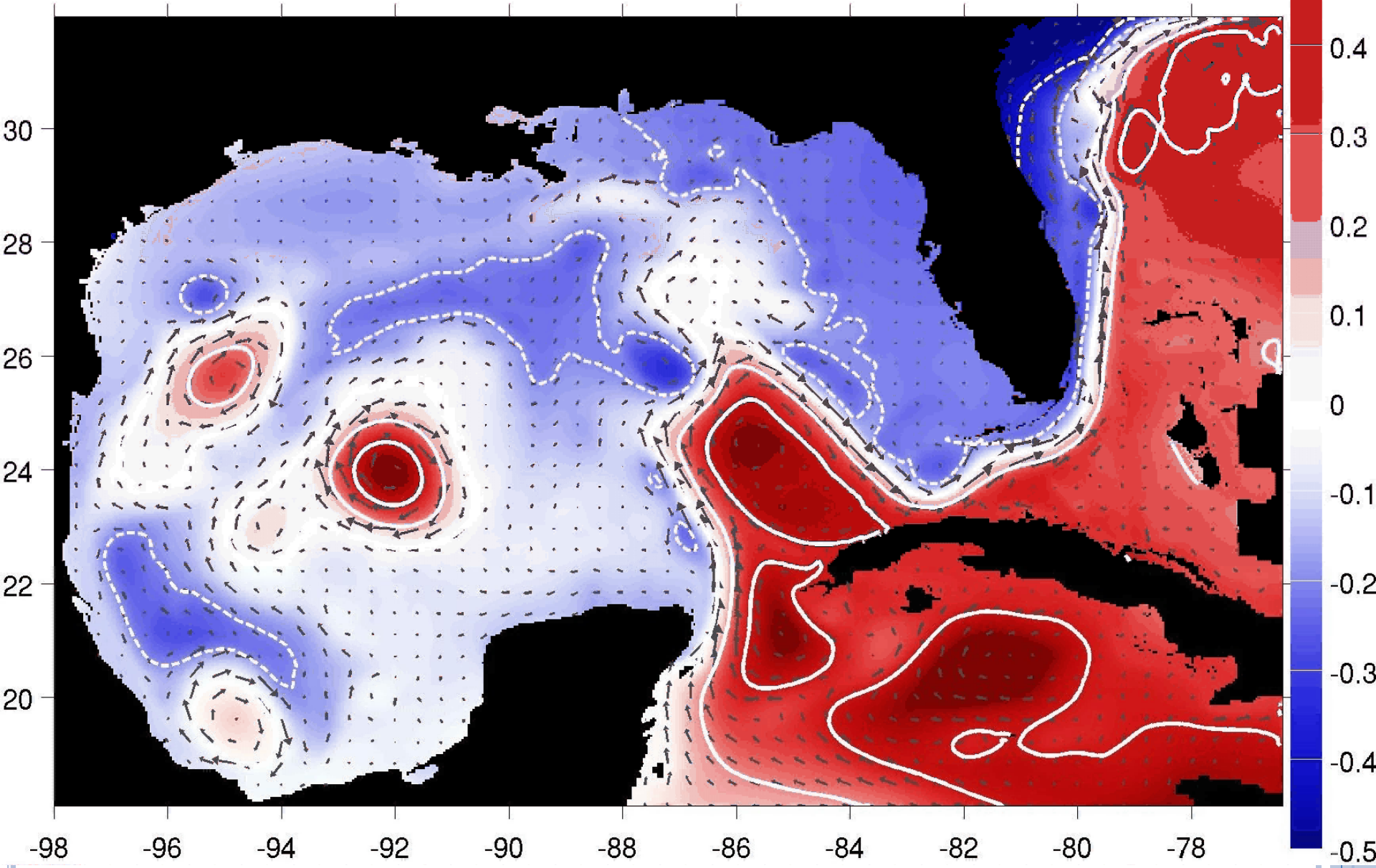

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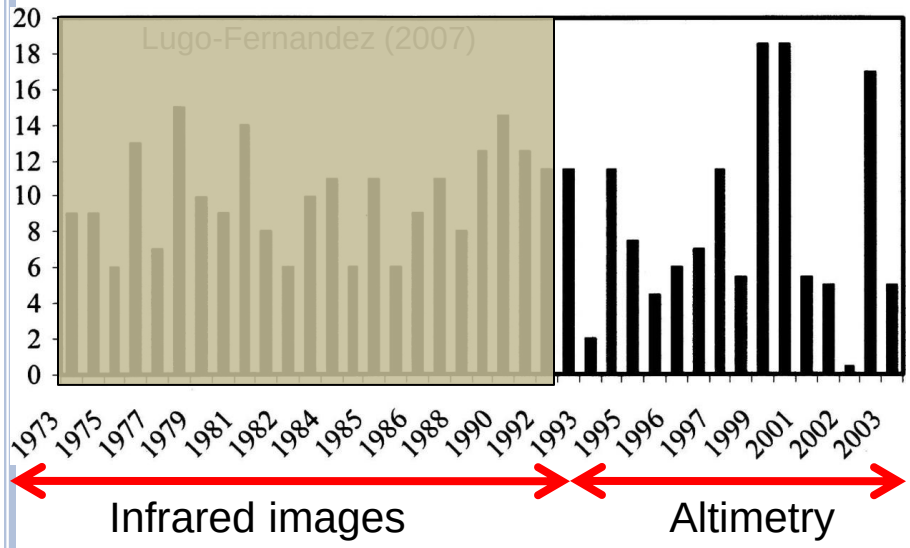
1/25° (~ 4km) HYCOM Gulf of Mexico CFSR atmospheric forcing

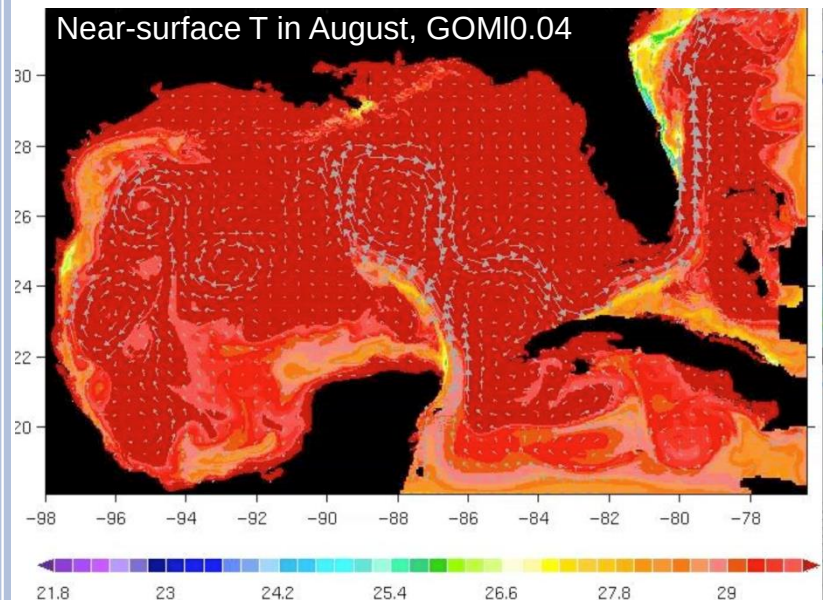
Loop Current Variability from Observations

LCE Shedding Period from Satellites

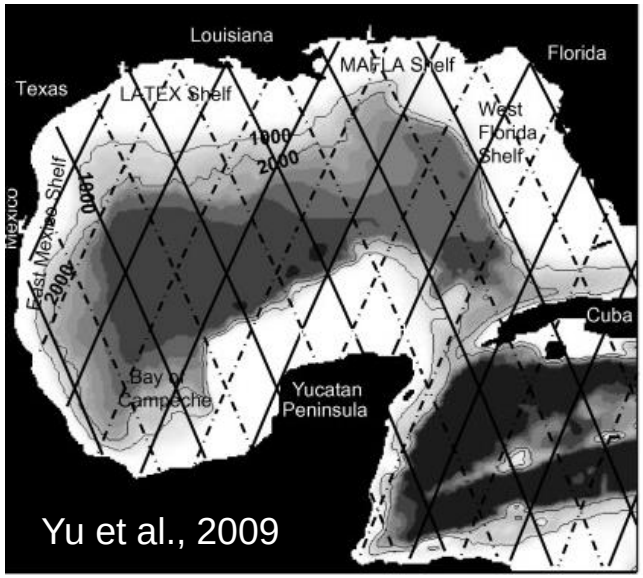


Issues

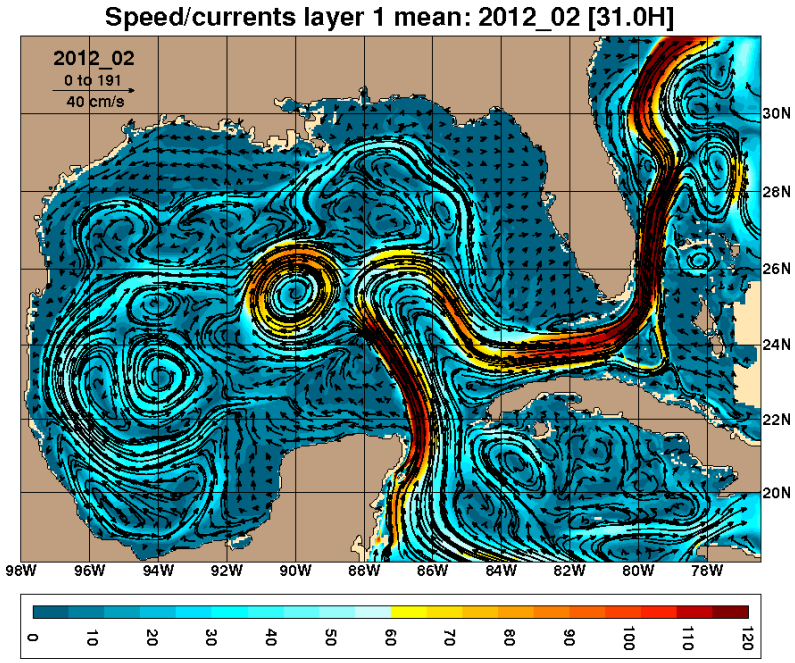
1. Only ~20 years of reliable satellite observations
2. Is the spatial and temporal satellite coverage sufficient for an accurate tracking of the Loop Current and eddies?
3. Can we quantify the errors in interpolation techniques used in the generation of SSH gridded products (CCAR, AVISO)?
4. How robust are the methods used to identify and track Loop Current eddies?



T/P and Jason 1 ground tracks in the Gulf of Mexico



MULTI-DECADAL HYCOM SIMULATION OF THE GULF OF MEXICO (1/25°)



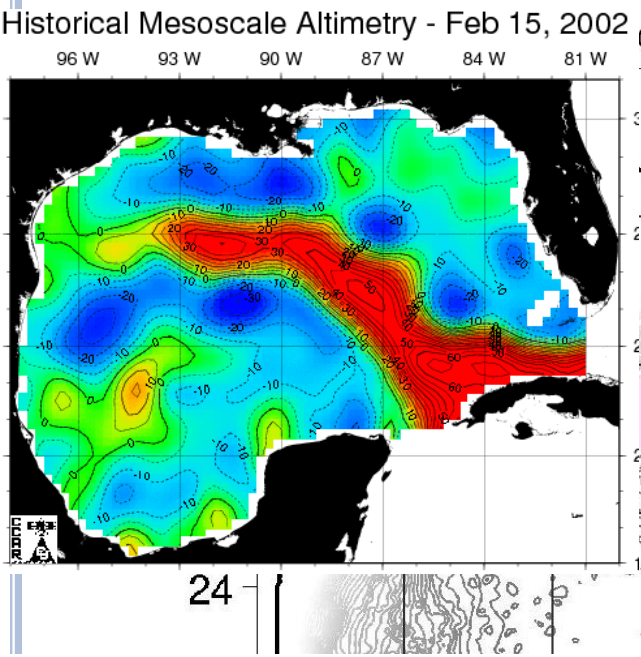
Atmospheric forcing: CFSR 1hr fields, 1992- 2009

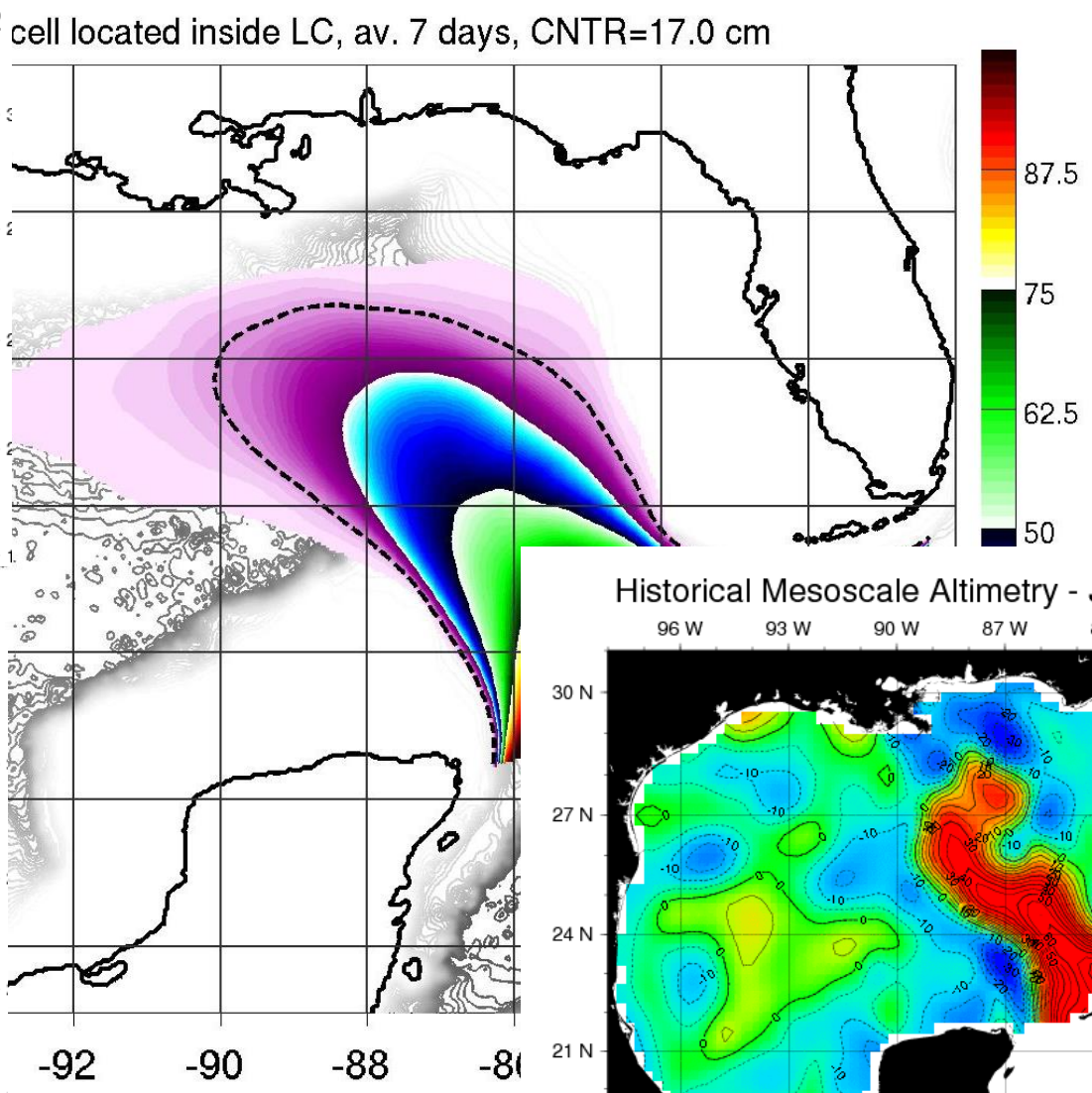
- 2-m air temperature
- specific humidity
- radiative fluxes (net sh/wave – net longwave)
- penetrating shortwave
- wind stress
- wind speed

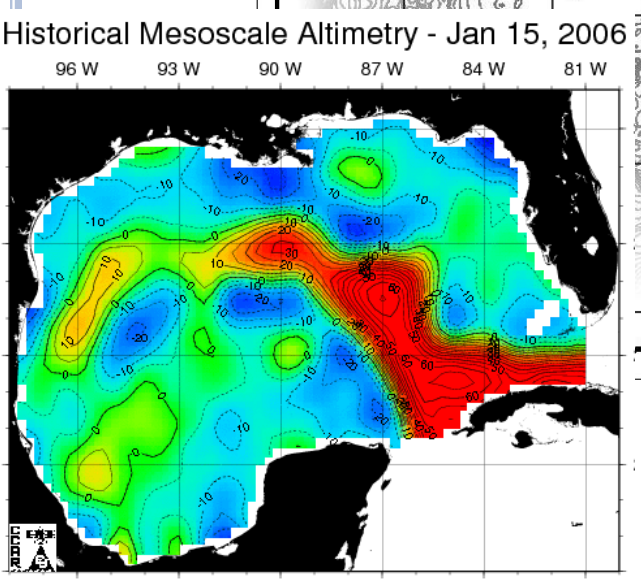
Lateral OB forcing: monthly mean fields from a near-real time nowcast/forecast 1/12° North Atlantic HYCOM, 2000-2003

Model Initialization: Levitus climatology
Spin-up: 2 cycles of 2002-2005 with CFSR forcing
54-year run: 3 cycles with 1992-2009 CFSR

Occurrence Probability Map of Loop Current Penetration from the 54-year HYCOM Simulation







LOOP CURRENT METRICS

- Shedding Event: when an eddy detaches from the Loop Current and does not reattach
- Separation Period: Time in between two shedding events.
-

HYCOM (54-year simulation) has 63 shedding events with a mean separation period of 10 months

The 18-year altimetry data set has 26 shedding events and a mean separation period of 7.5 months

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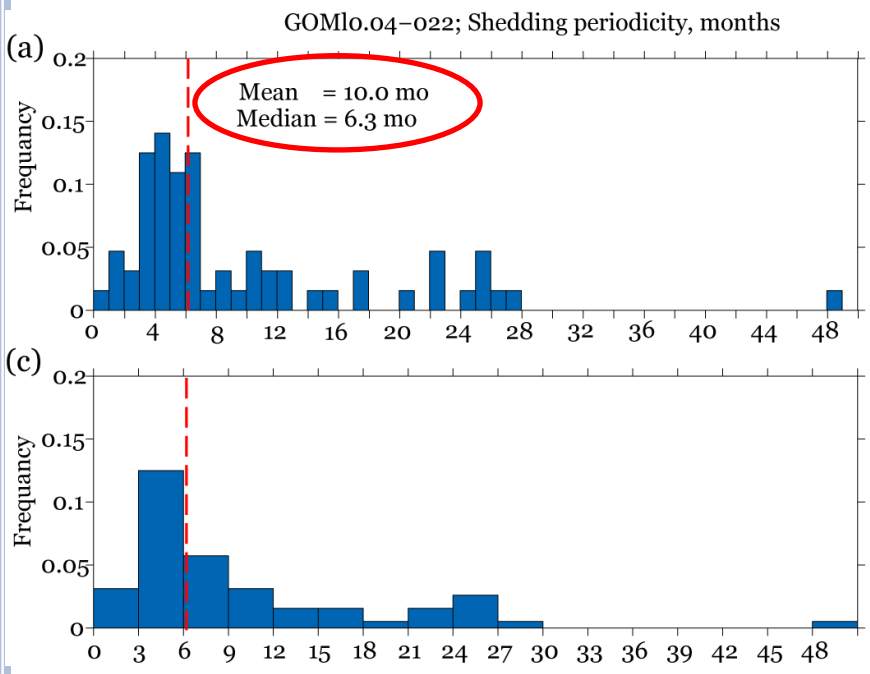
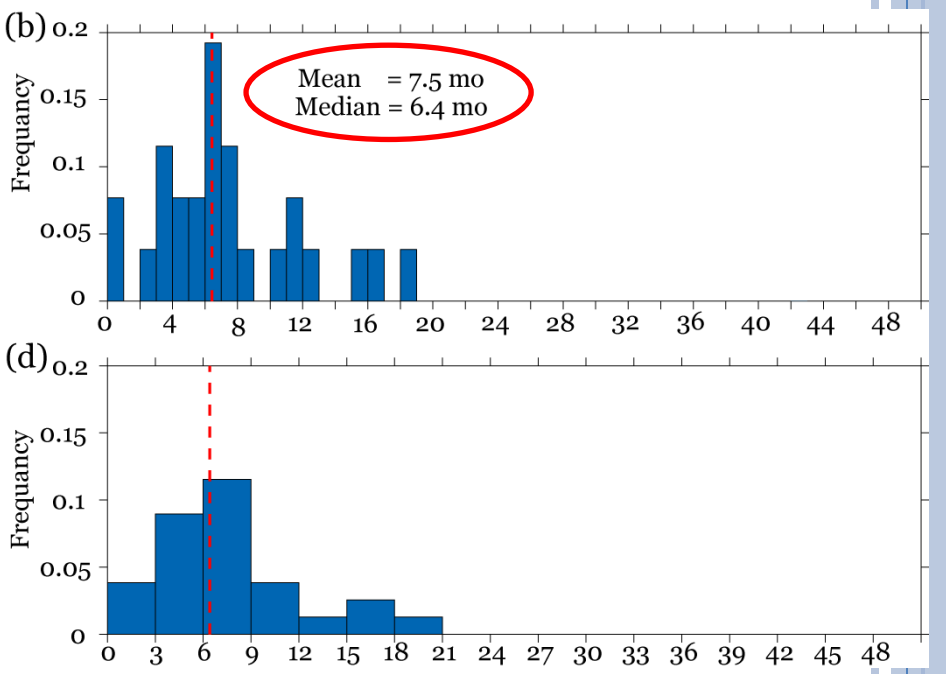
LOOP CURRENT EDDY SHEDDING FROM THE 54-YEAR HYCOM SIMULATION AND ALTIMETER RECORDS

HYCOM



Altimeter Records



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LOOP CURRENT EDDY SHEDDING

- Altimetry separations
  - 18 years (1993 – 2010)
  - 27 total
  - mean separation period: 7.5 months (9.4 mo if infrared observations are included (Leben, 2005))

- HYCOM separations
  - 54 years
  - 63 total
  - mean separation period: 10 months (9.4 months if the 4-year non-shedding event is discarded)

- Satellite (includes infrared obs.) separations (Vukovich, 2007)
  - 32 years
  - 35 total
  - mean separation period: 11 months

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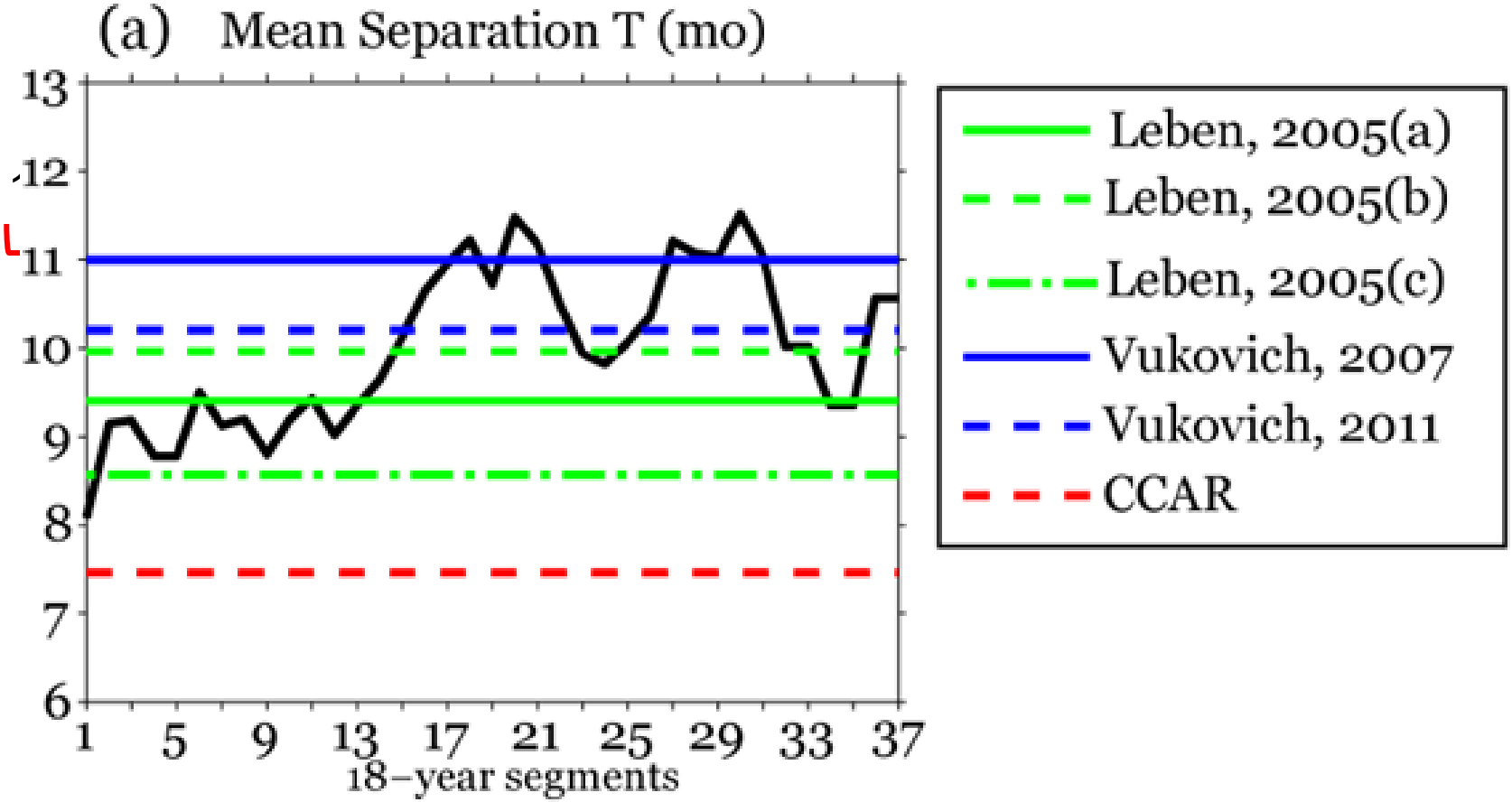
18-year Block Mean Separation Period



Vukovich (2011): "<…> observations obtained in the last decade (2001–2010) indicated that changes in the Loop Current's eddy-shedding cycle have taken place." Average shedding period before 2001 was ~11 months, in 2001-2009 it was ~9 months.

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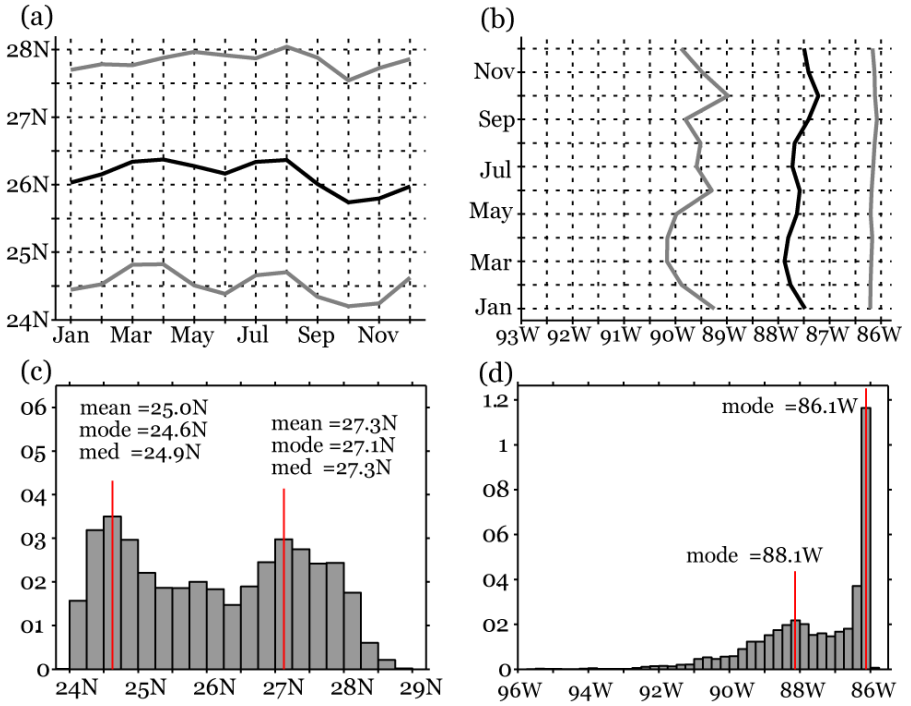
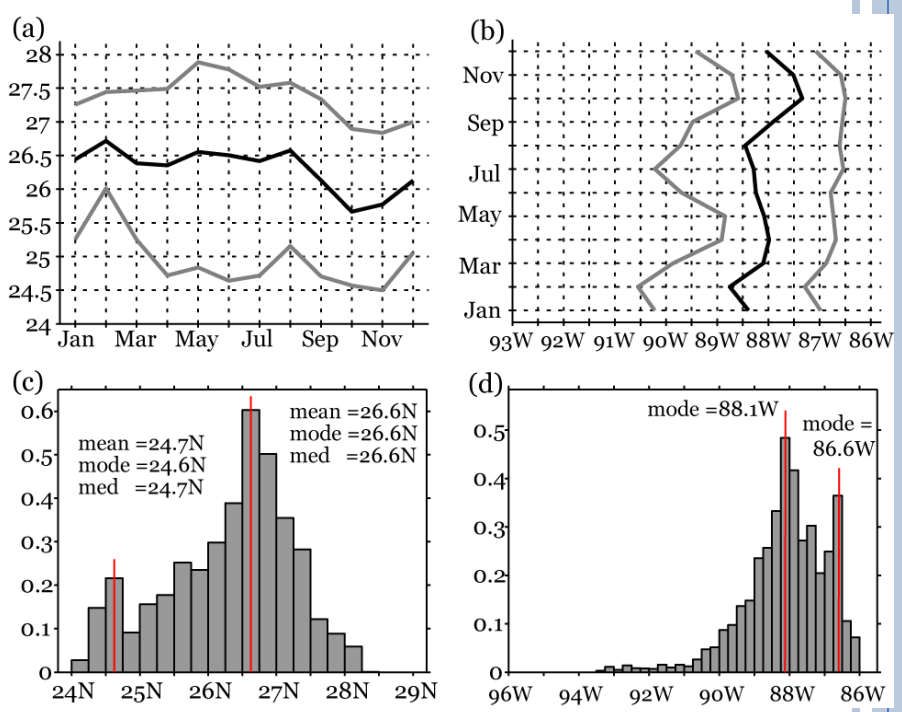
Maximum Northern Latitude and Western Longitude of the Loop Current Front

HYCOM



Altimeter Records



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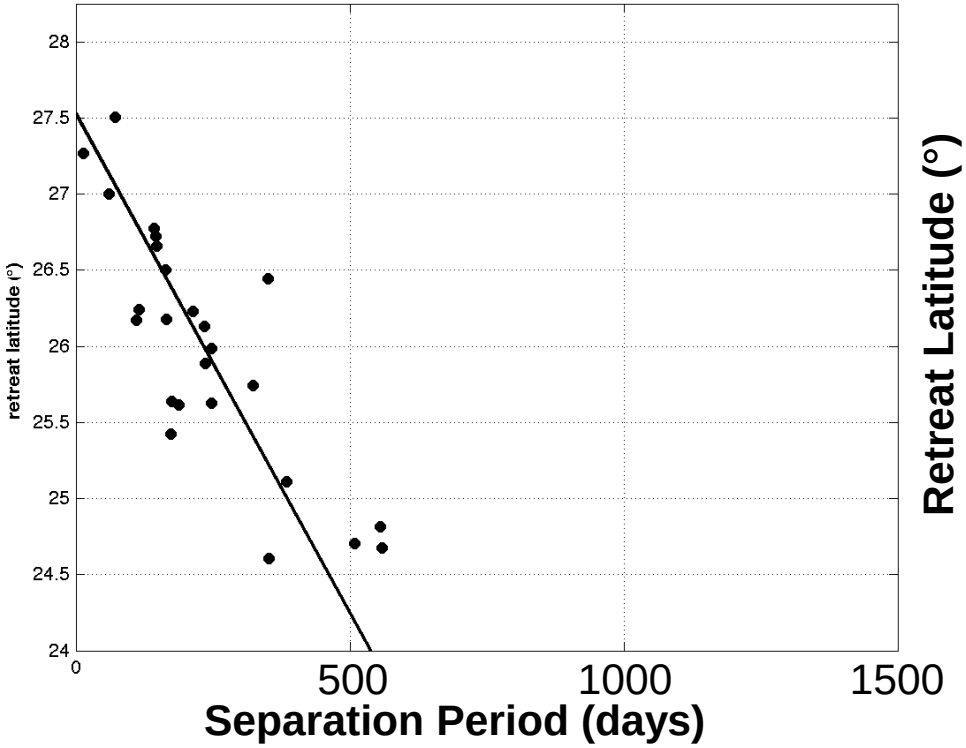
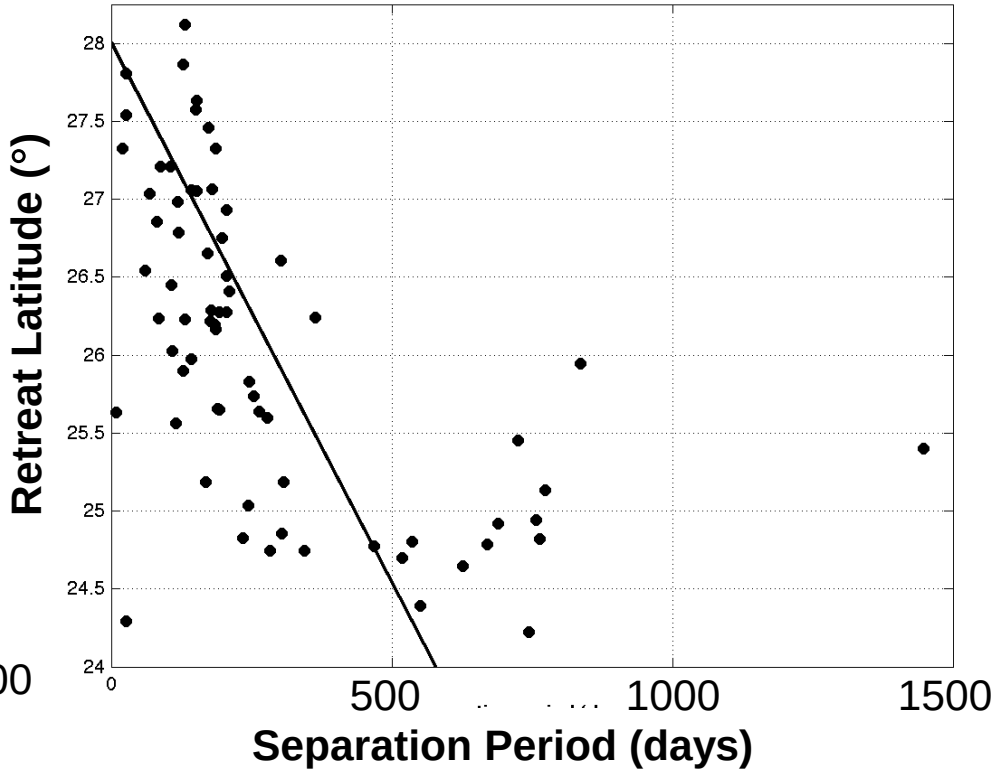
Period-Retreat Regression

Altimetry



HYCOM



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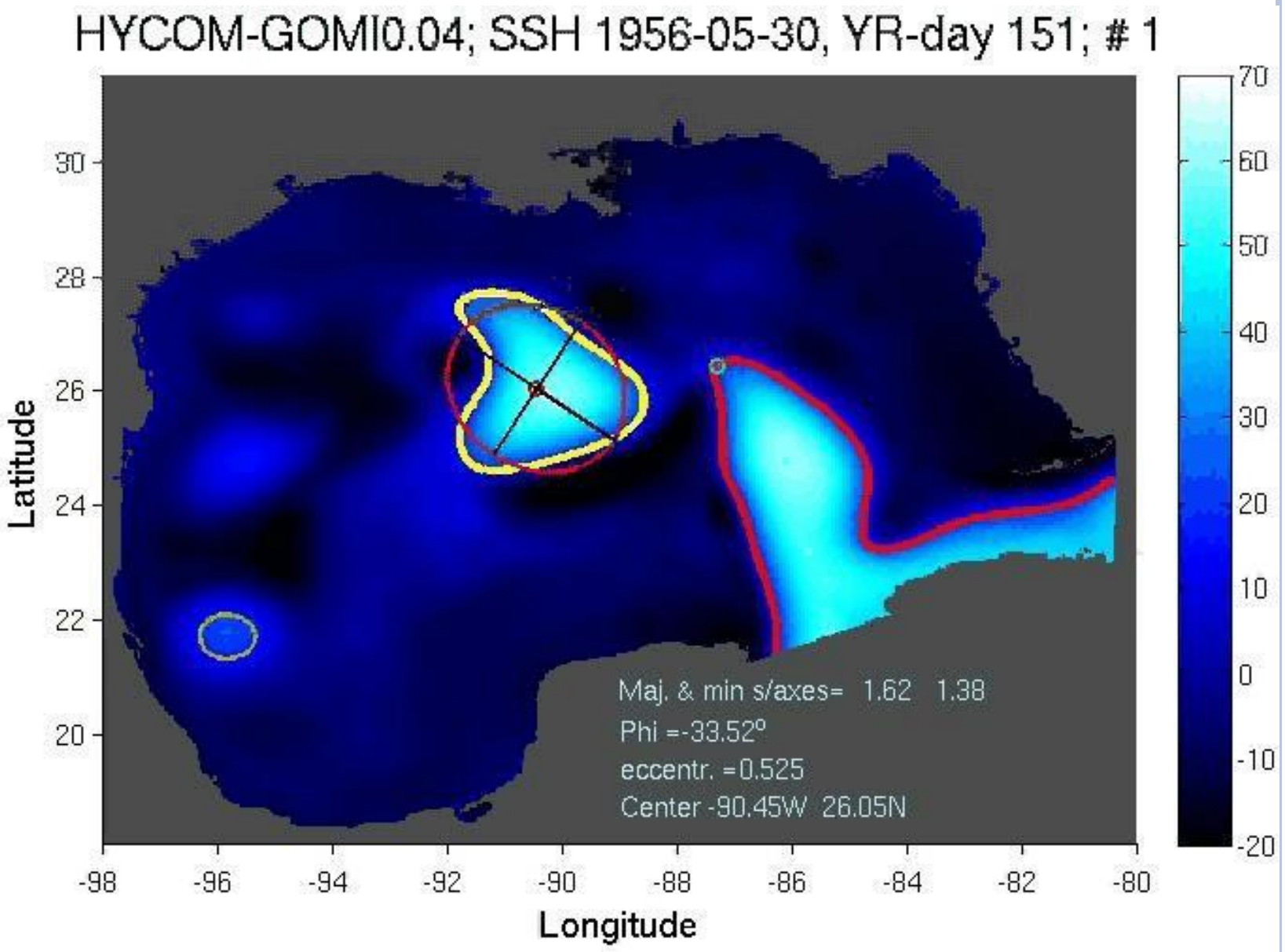
Identification and Tracking of Loop Current Eddiess in SSH Fields



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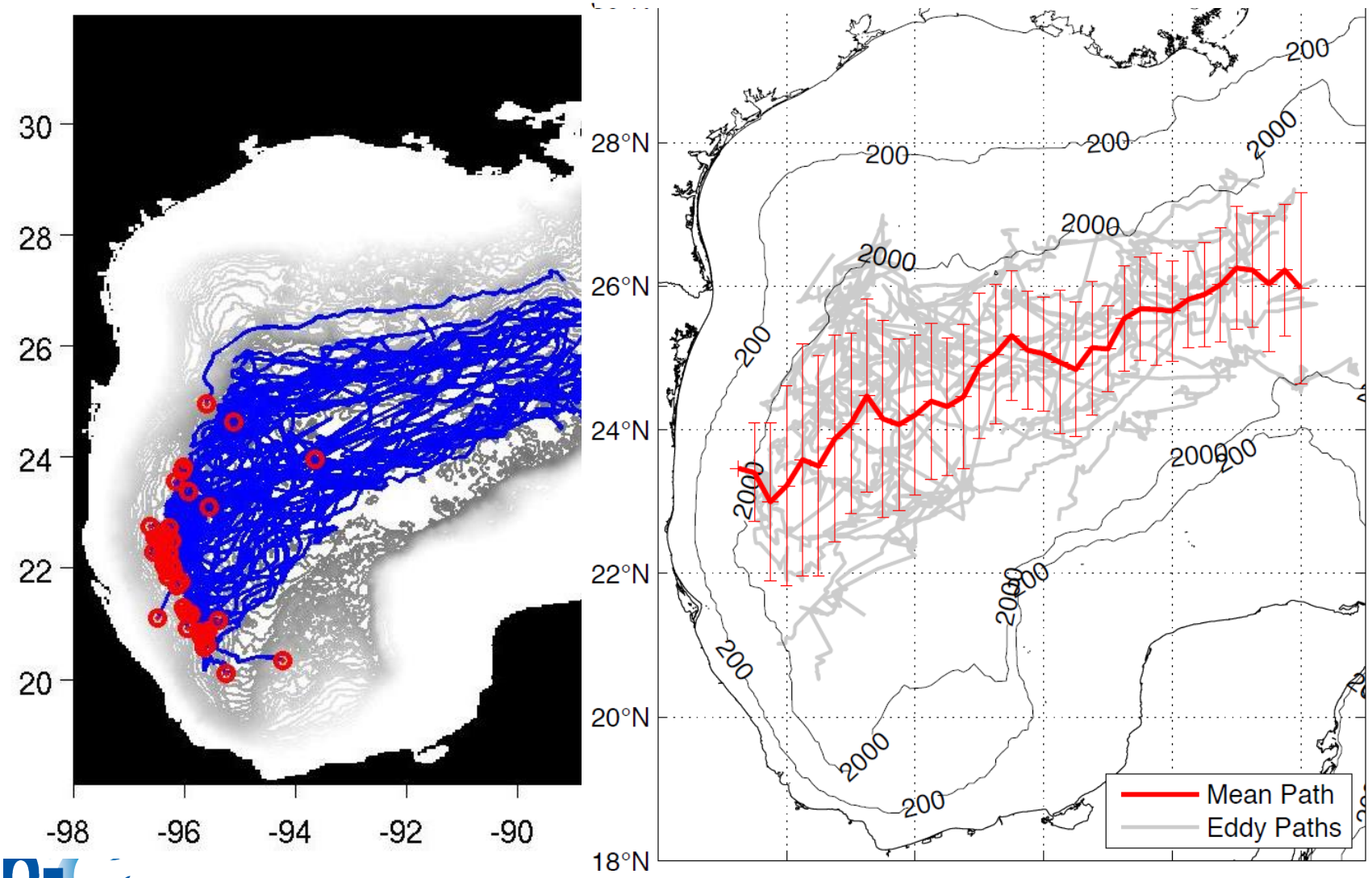
TRAJECTORIES OF LOOP CURRENT EDDIES FROM THE GOM 0.04

The ¼-degree Path-averaged Mean Path Overlaid on Altimeter-Tracked LCE Center Paths



Donohue et al., 2008: "Survey of deepwater currents in the Northwestern Gulf of Mexico", MMS Report

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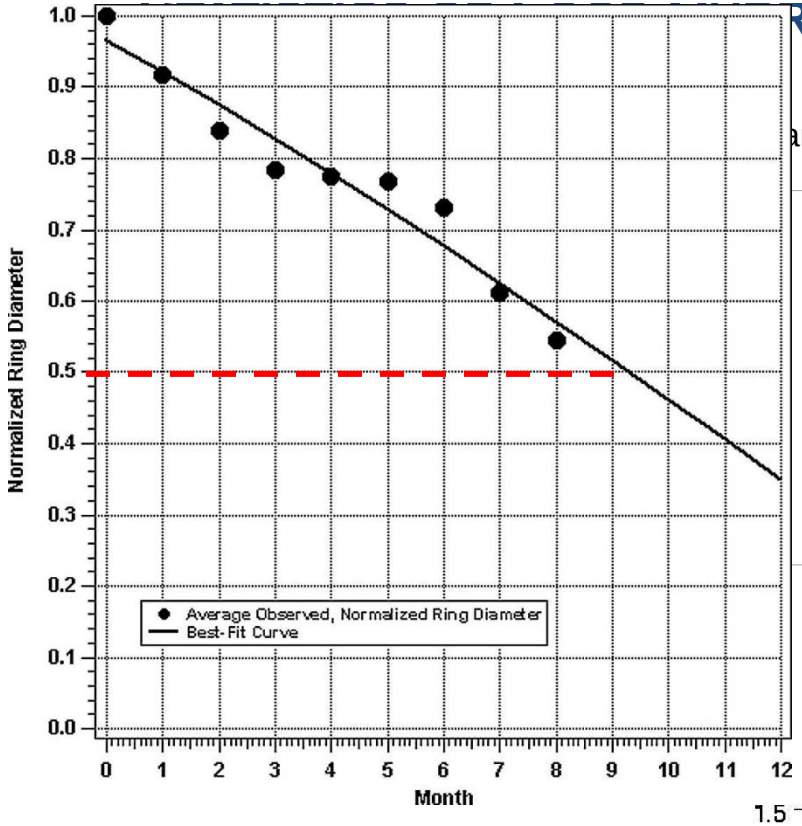
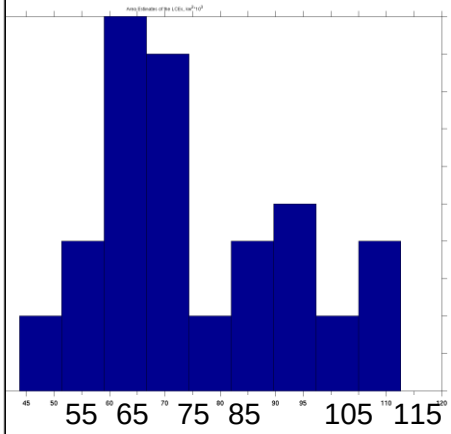
Decay of the normalized diameter of LCEs at the surface over time (Vukovich, 2007)

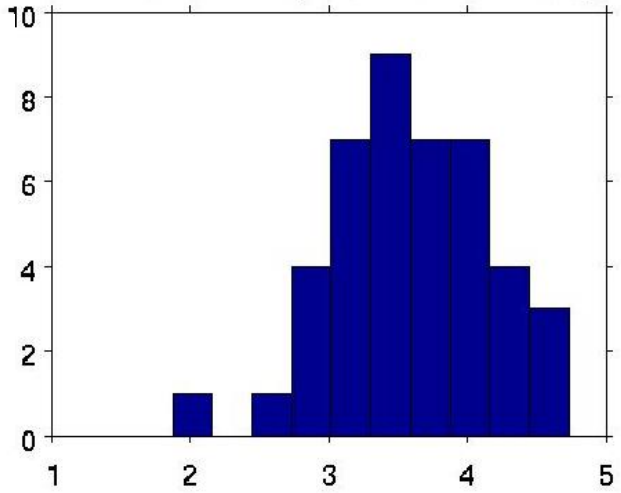
RENT EDDIES FROM THE GOM 0.04



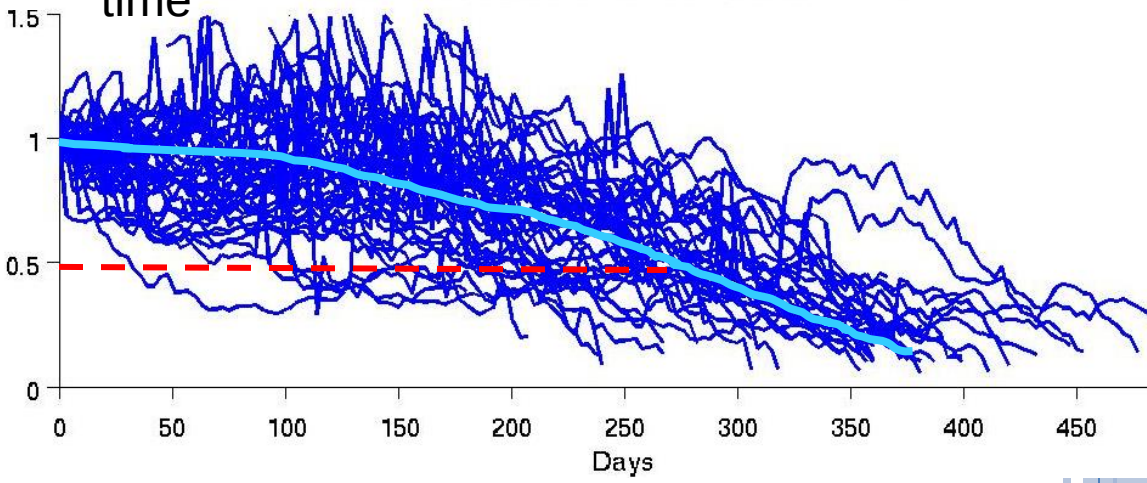
am of the LCE Area, km^2 x 10^3



Mean translation speed of LCEs, km/day



Decay of the normalized area of LCEs over time



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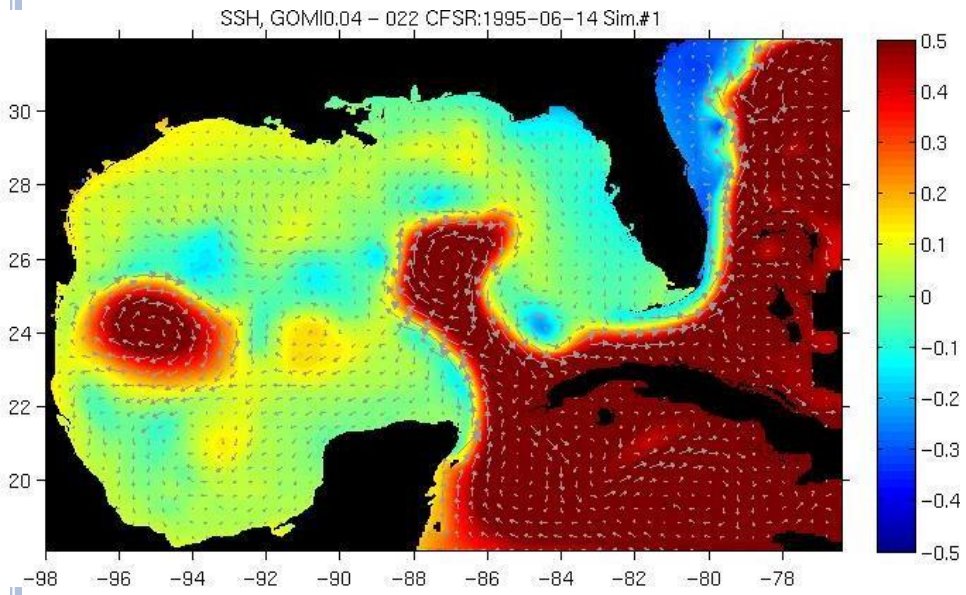
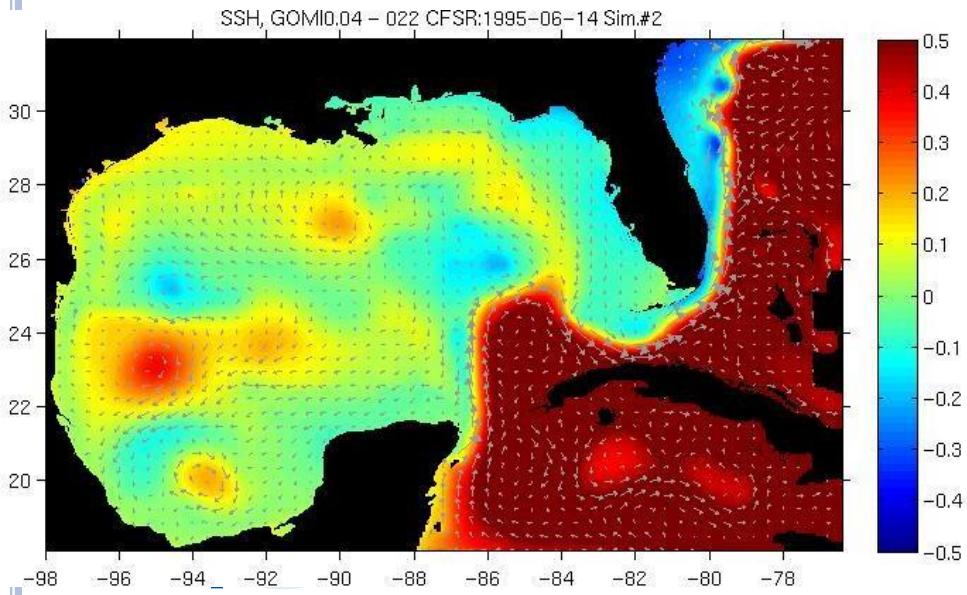
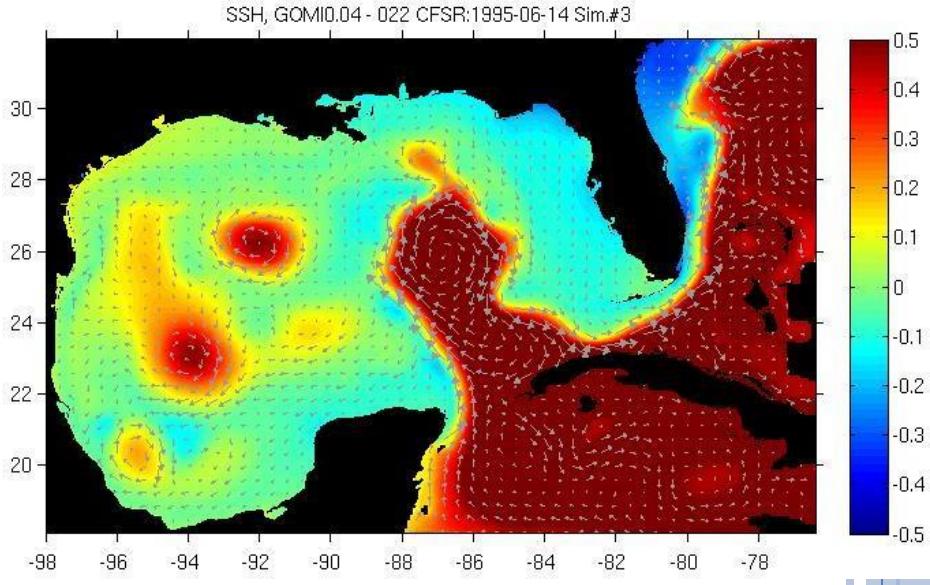
SSH Fields from GOMl0.04 on the Same Forcing Date (06/14/1995) but Different 18-year Cycles



The Loop Current behavior does not show any dependence on the atmospheric forcing





HYCOM HIGH RESOLUTION VERSUS HYCOM 4-SATELLITE SUBSAMPLING

(TOPEX, TOPEX2, GEOSAT, & ENVISAT)

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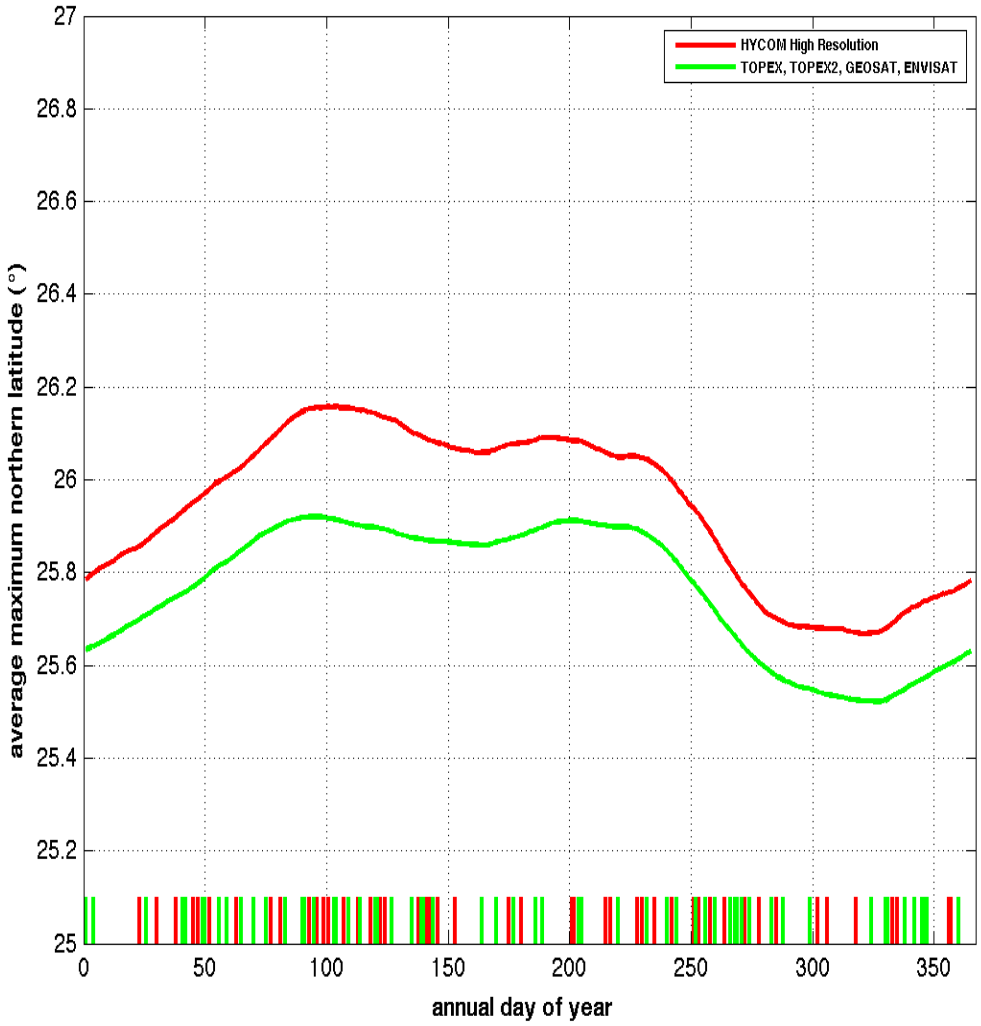
NORTHERN LATITUDE ANNUAL 3-MONTH BOXCAR SMOOTHED – ALL DATA



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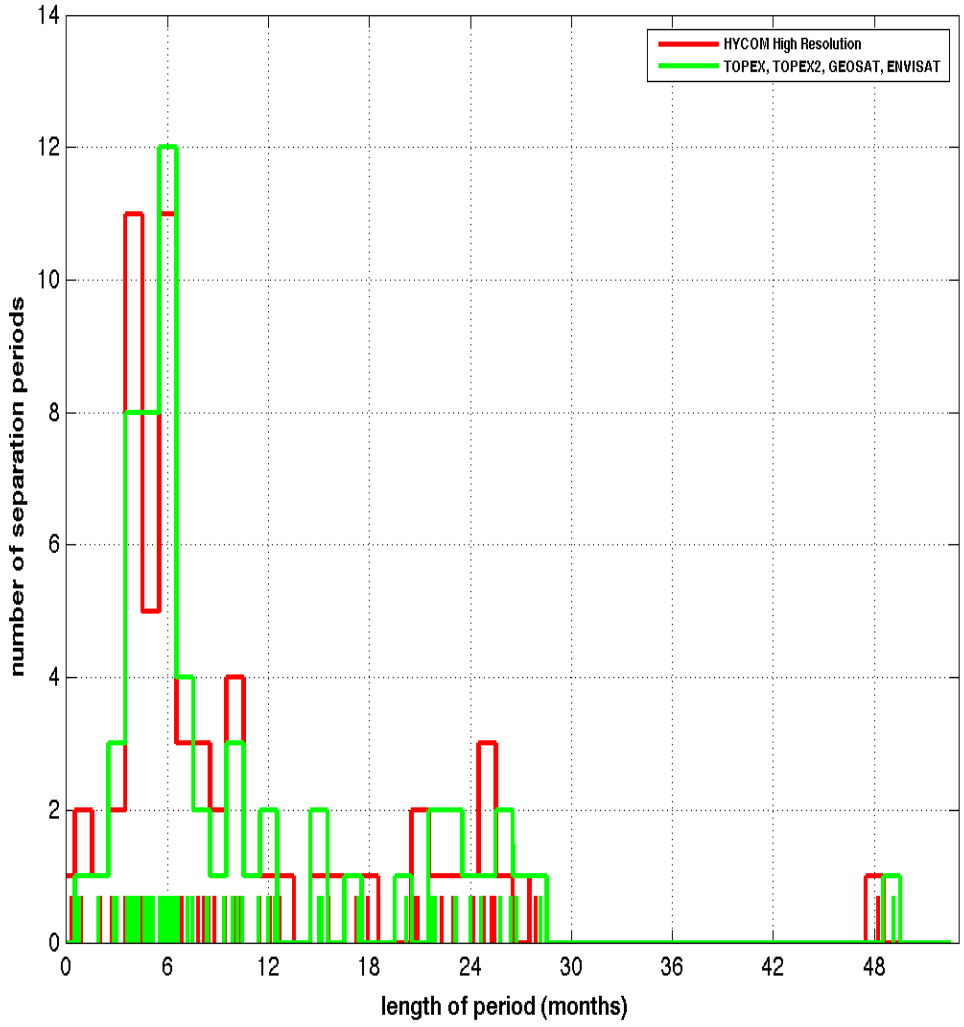
SEPARATION PERIODS
MONTHLY BINNING – ALL DATA



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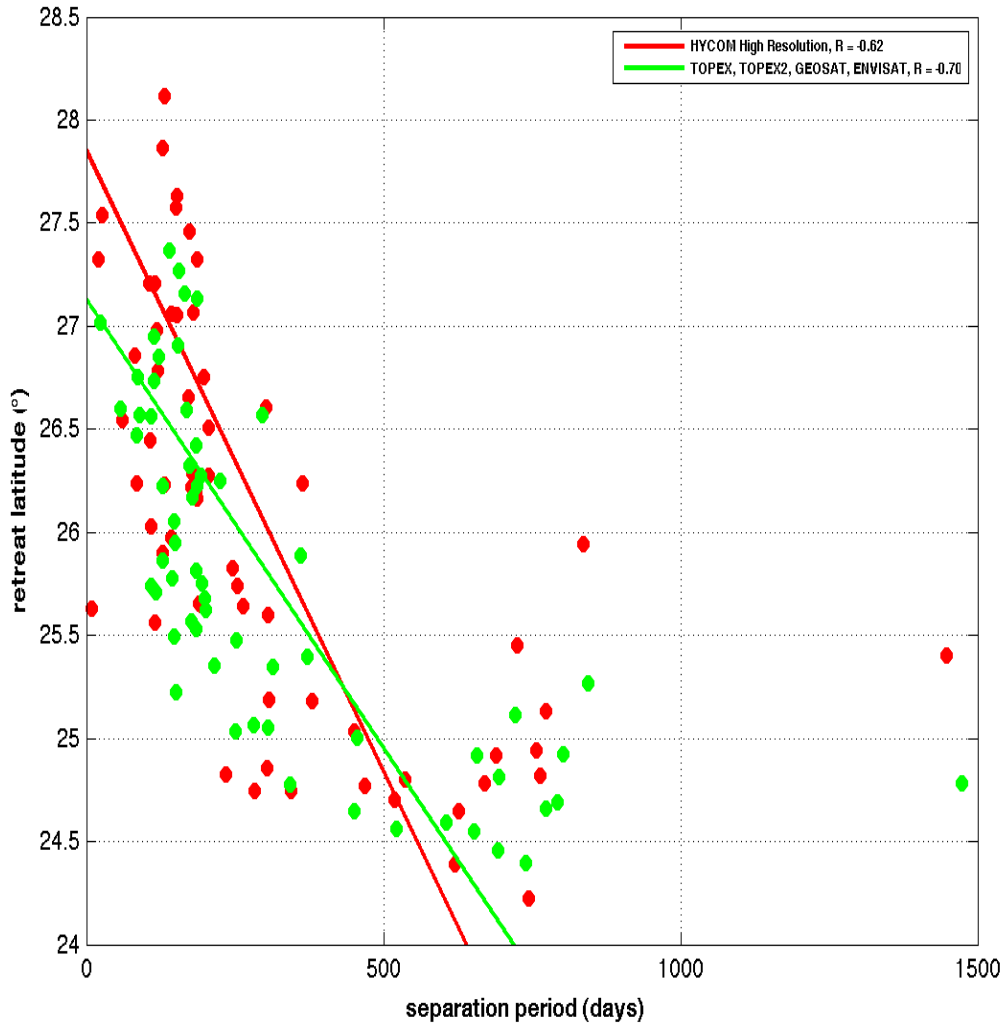
SEPARATION PERIOD VS. LATITUDE RETREAT - ALL DATA



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CONCLUSIONS

- 20-year satellite observation period may not be enough to fully sample the Loop Current behavior
- Subsampling
  - Decrease in resolution caused loss of northern latitude of about 0.15° ➔ 4-satellite line has same shape as HYCOM high resolution line, only translated south
  - Subsampling caused noticeable change in regression slope

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