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Prediction of synoptic current reversals on the Louisiana-Texas continental shelf

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Prediction of Synoptic Current Reversals on the Texas-Louisiana Continental Shelf

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Reference

- Chu, P.C., L.M. Ivanov, and O.V. Melnichenko, 2004: Fall-winter current reversals on the Taxes-Lousiana continental shelf, Journal of Physical Oceanography, in press.

Ocean Velocity Data

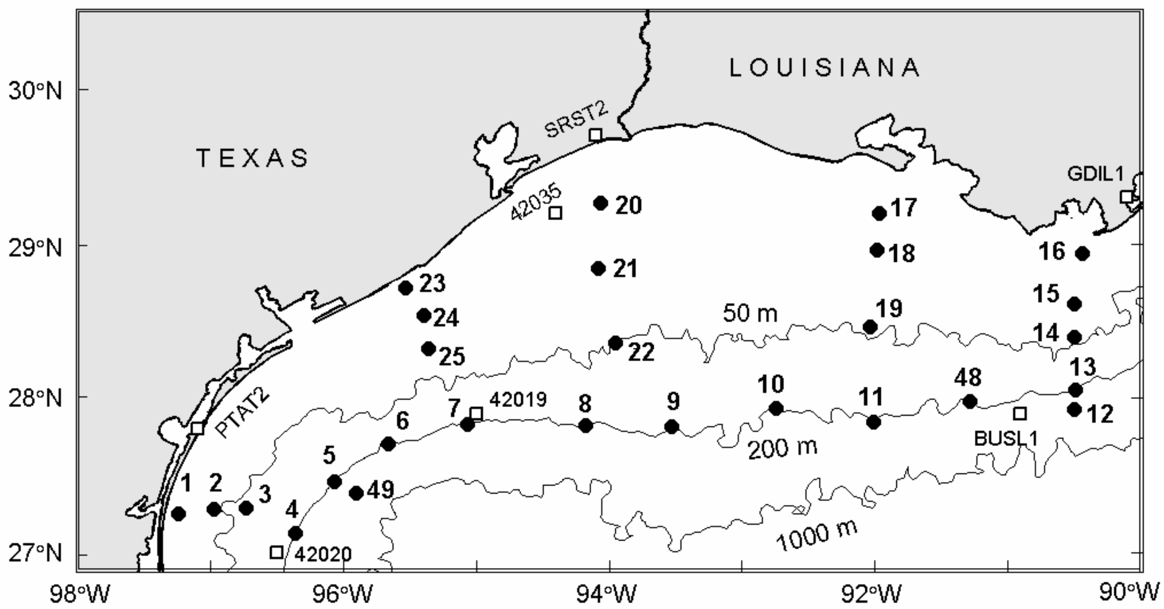
- 31 near-surface (10-14 m) current meter moorings during LATEX from April 1992 to November 1994

- Drifting buoys deployed at the first segment of the Surface Current and Lagrangian-drift Program (SCULP-I) from October 1993 to July 1994.

Surface Wind Data

- **7 buoys of the National Data Buoy Center (NDBC) and industry (C-MAN) around LATEX area**

Moorings and Buoys



Flow Decomposition

$$u = \frac{\partial \Psi}{\partial y} + \frac{\partial^2 \Phi}{\partial x \partial z}, \qquad v = -\frac{\partial \Psi}{\partial x} + \frac{\partial^2 \Phi}{\partial y \partial z},$$

- $$\Delta \Psi = -\zeta$$

$$\Delta \Phi = -w$$

Optimal Spectral Decomposition

$$c(\mathbf{x}, z_k, t) = A_0(z_k, t) + \sum_{m=1}^{M} A_m(z_k, t)\ \Psi_m(\mathbf{x}, z_k),$$

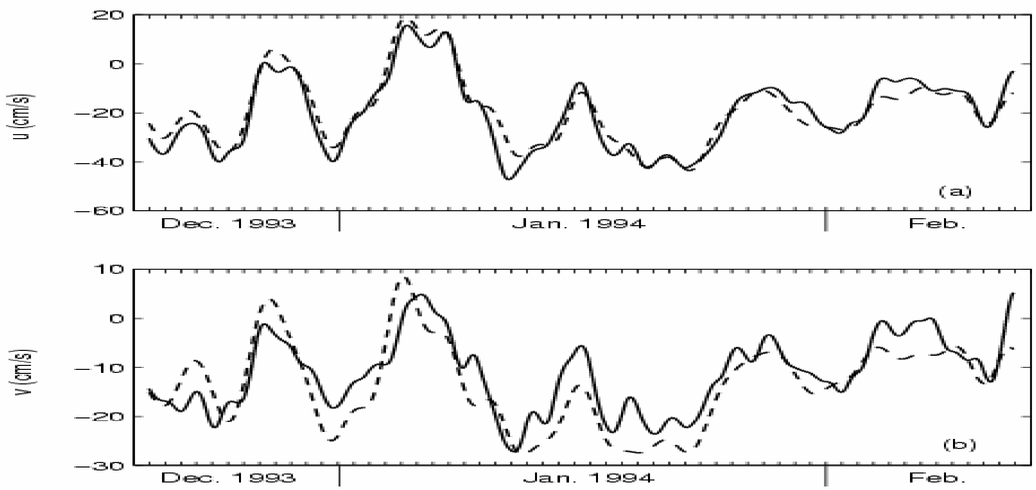
References

- Chu, P.C., L.M. Ivanov, T.P. Korzhova, T.M. Margolina, and O.M. Melnichenko, 2003a: Analysis of sparse and noisy ocean current data using flow decomposition. Part 1: Theory. Journal of Atmospheric and Oceanic Technology, 20 (4), 478-491.

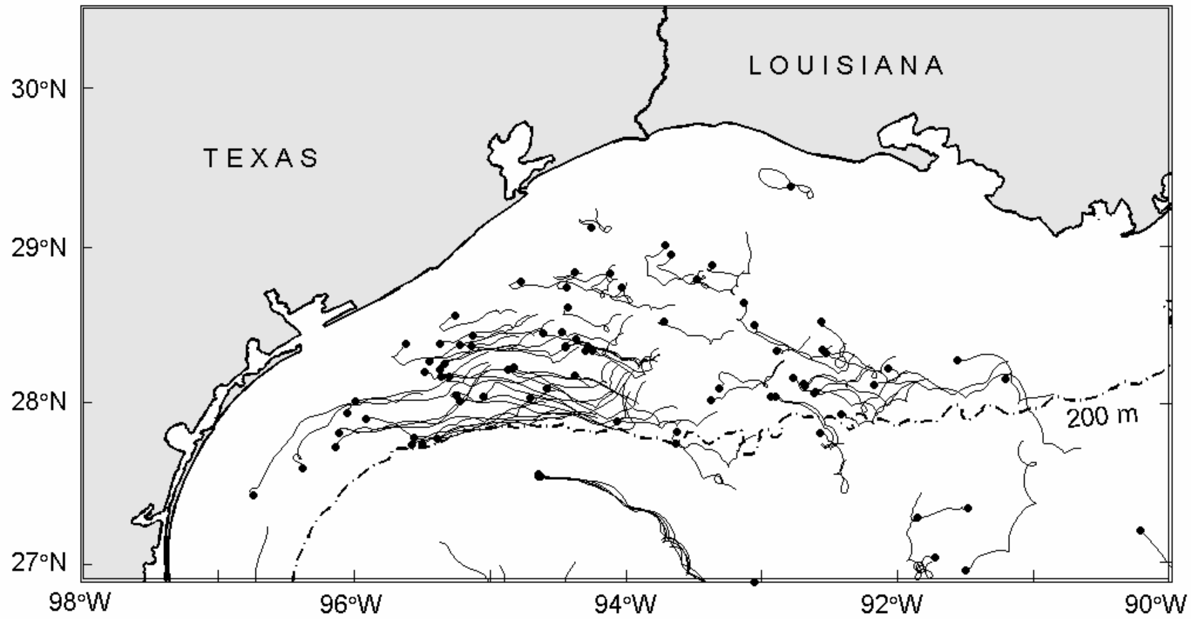
- Chu, P.C., L.M. Ivanov, T.P. Korzhova, T.M. Margolina, and O.M. Melnichenko, 2003b: Analysis of sparse and noisy ocean current data using flow decomposition. Part 2: Application to Eulerian and Lagrangian data. Journal of Atmospheric and Oceanic Technology, 20 (4), 492-512.

- Chu, P.C., L.M. Ivanov, and T.M. Margolina, 2004: Rotation method for reconstructing process and field from imperfect data. International Journal of Bifurcation and Chaos, in press.

Reconstructed and observed circulations at Station-24.

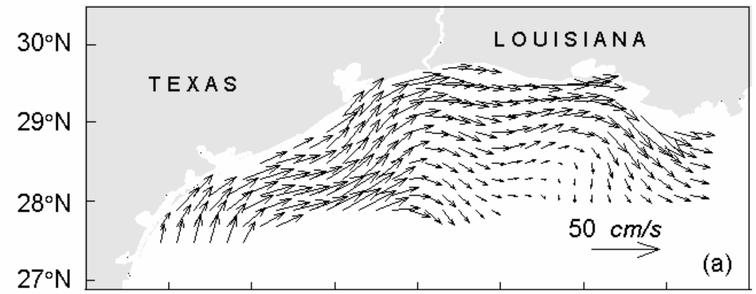


TLCS current reversal detected from SCULP-I drift trajectories.

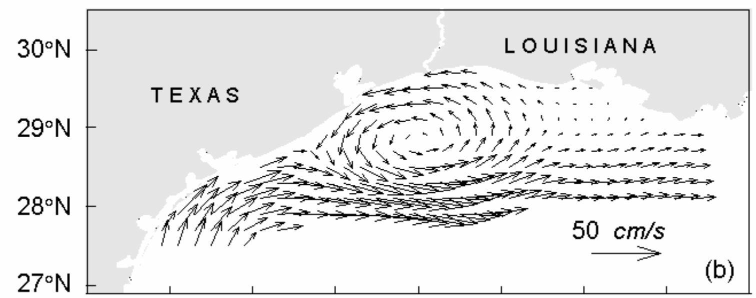


TLCS current reversal detected from the reconstructed velocity data

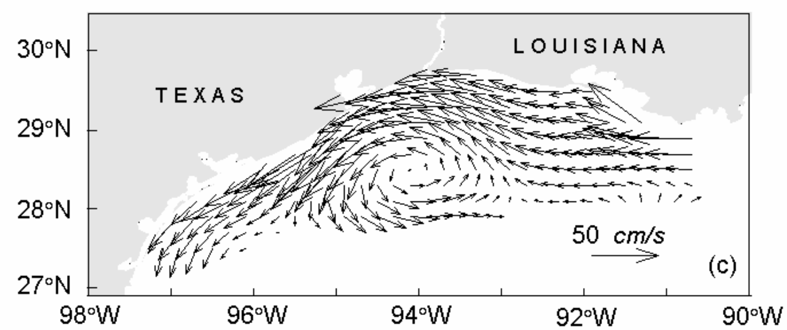
December 30, 1993



January 3, 1994



January 6, 1994



Probability of TLCS Current Reversal for Given Period (T)

- n_0 ~0-current reversal
- n_1~ 1-current reversal
- n_2~ 2-current reversals
- m ~ all realizations

$$P_0(T) = \frac{n_0}{m}, P_1(T) = \frac{n_1}{m}, P_2(T) = \frac{n_2}{m},$$

Fitting the Poison Distribution

$$P_k(T) = \frac{1}{k!}(\mu T)^k \exp(-\mu T)$$

$$k=0, 1, 2$$

μ is the mean number of reversal for a single time interval

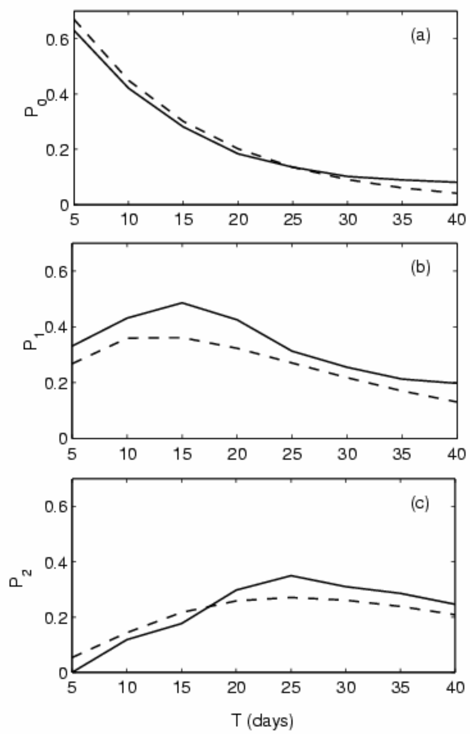
μ ~ 0.08

Dependence of P_0, P_1, P_2 on T

For observational periods larger than 20 days, the probability for no current reversal is less than 0.2.

For 15 day observational period, the probability for 1-reversal reaches 0.5

Data – Solid Curve
Poison Distribution Fitting – Dashed Curve



Time Interval between Successive Current Reversals (not a Rare Event)

$$p(\tau) = \mu \exp(-\mu\tau)$$

EOF Analysis of the Reconstructed Velocity Filed

EOF	Variance (%)		
	01/21/93-05/21/93	12/19/93-04/17/94	10/05/94-11/29/94
1	80.2	77.1	74.4
2	10.1	9.5	9.3
3	3.9	5.6	6.9
4	1.4	3.3	4.6
5	1.1	1.4	2.3
6	0.7	1.1	0.8

Mean and First EOF Mode

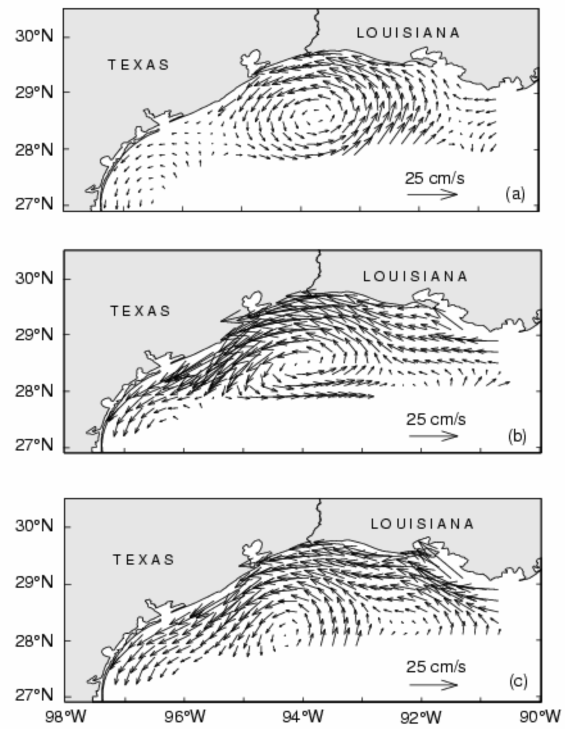
$$\tilde{\mathbf{u}}(x, y, t) = \overline{\mathbf{u}}(x, y) + A_1(t)\mathbf{u}_1(x, y),$$

Mean Circulatio

1. First Period (01/21-05/21/93)

2. Second Period 12/19/93-04/17/94)

3. Third Period (10/05-11/29/94)

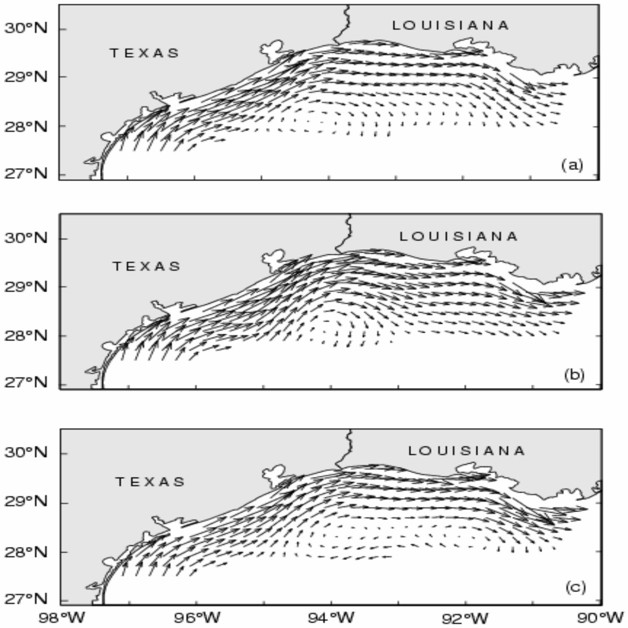


EOF1

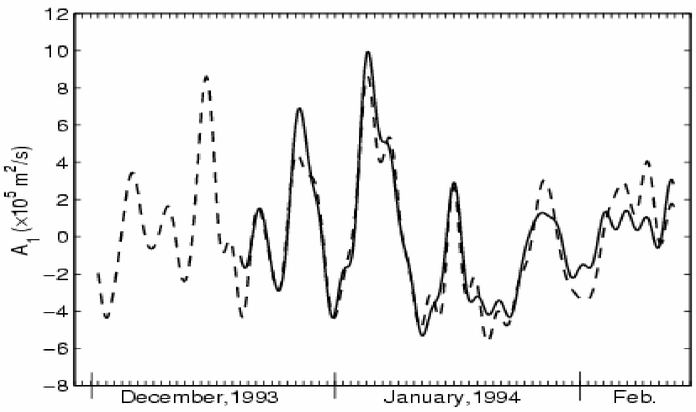
1. First Period
(01/21-05/21/93)

2. Second Period
12/19/93-04/17/94)

3. Third Period
(10/05-11/29/94)



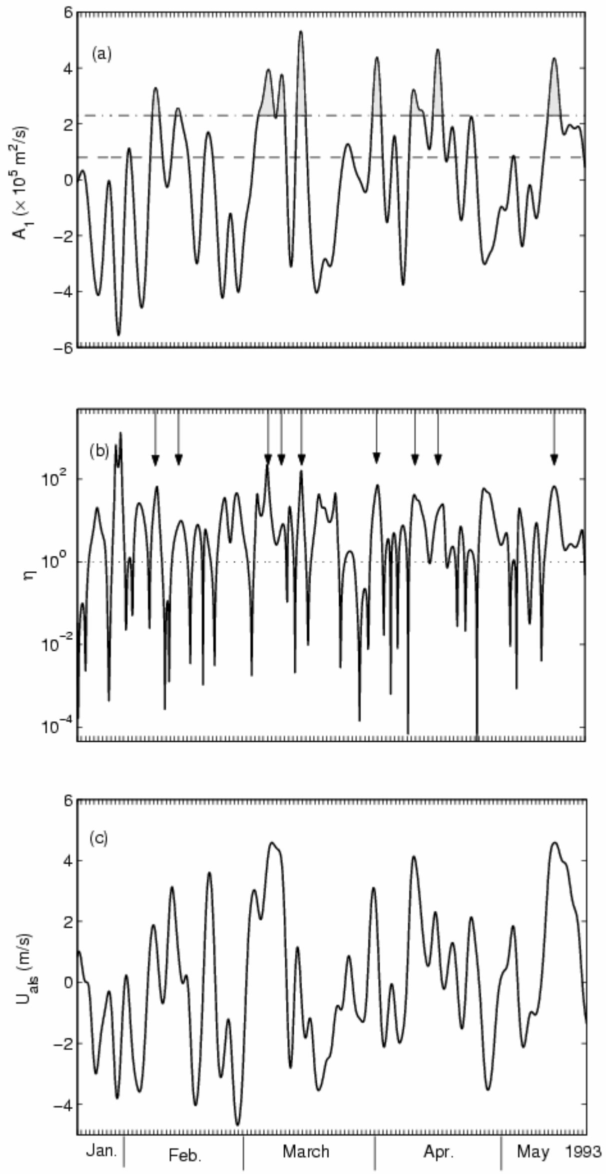
- Calculated $A_1(t)$ Using Current Meter Mooring (solid) and SCULP-1 Drifters (dashed)



- 8 total reversals observed

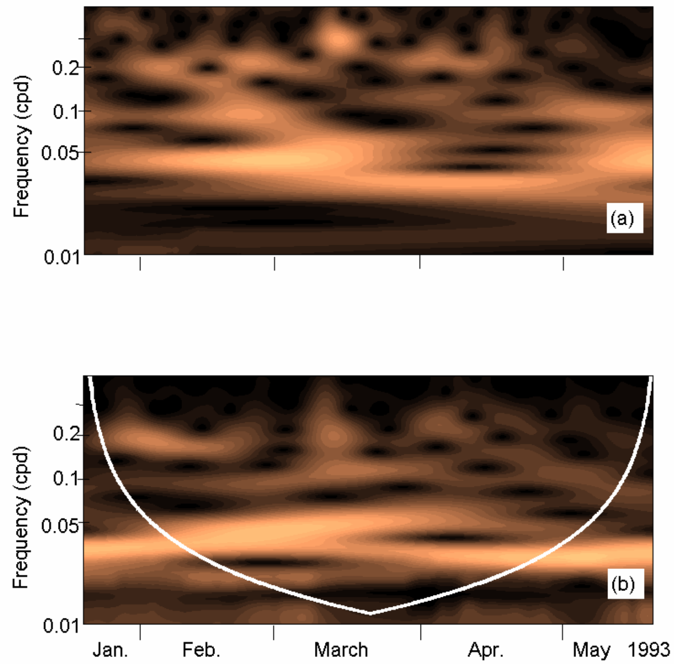
$$\eta = A_1^2 / \sum_{n=2}^{6} A_n^2$$

- U_{als} ~ alongshore wind



Morlet Wavelet

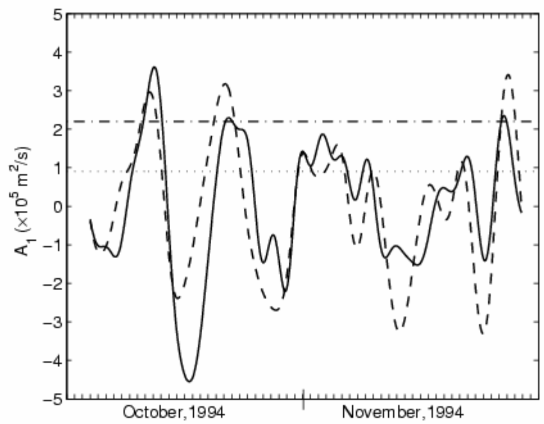
- $A_1(t)$
- Uals



$$\Phi(t) = \pi^{-4} \exp(imt - t^2/2), \quad \mathrm{m} = 6$$

- Regression between
- $A_1(t)$ and Surface
- Winds

- Solid Curve (reconstructed)
- Dashed Curve (predicted using winds)



$$A_1(t) = \alpha\left[U(t) - \overline{U}\right] + \beta\left[V(t) - \overline{V}\right] + \gamma$$

Conclusions

- Alongshore wind forcing is the major factor causing the synoptic current reversal.

- Other factors, such as the Mississippi-Atchafalaya River discharge and offshore eddies of Loop Current origin, may affect the reversal threshold, but can not cause the synoptic current reversal.