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

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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

\[ u = \frac{\partial \Psi}{\partial y} + \frac{\partial^2 \Phi}{\partial x \partial z}, \quad v = -\frac{\partial \Psi}{\partial x} + \frac{\partial^2 \Phi}{\partial y \partial z}, \]

\[ \Delta \Psi = -\zeta \]

\[ \Delta \Phi = -\omega \]
Optimal Spectral Decomposition

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


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)

- \( n_0 \sim 0 \)-current reversal
- \( n_1 \sim 1 \)-current reversal
- \( n_2 \sim 2 \)-current reversals
- \( m \sim \) all realizations

\[
P_0(T) = \frac{n_0}{m}, \quad P_1(T) = \frac{n_1}{m}, \quad P_2(T) = \frac{n_2}{m},
\]
Fitting the Poison Distribution

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

\[ k=0, 1, 2 \]

\( \mu \) is the mean number of reversal for a single time interval

\( \mu \sim 0.08 \)
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

<table>
<thead>
<tr>
<th>EOF</th>
<th>Variance (%)</th>
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<tr>
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<td>01/21/93-05/21/93</td>
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<tr>
<td>1</td>
<td>80.2</td>
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<tr>
<td>2</td>
<td>10.1</td>
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<tr>
<td>4</td>
<td>1.4</td>
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<tr>
<td>5</td>
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<td>6</td>
<td>0.7</td>
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</table>
Mean and First EOF Mode

$$\tilde{u}(x, y, t) = \bar{u}(x, y) + A_1(t)u_1(x, y),$$
Mean Circulation

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

\[ \eta = \frac{A_1^2}{\sum_{n=2}^{6} A_n^2} \]

- \( U_{als} \sim \) alongshore wind
Morlet Wavelet

\[ A_1(t) \]

\[ U_{als} \]

\[ \Phi(t) = \pi^{-4} \exp(\text{i}mt - t^2/2), \quad m = 6 \]
Regression between $A_1(t)$ and Surface Winds

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

$$A_1(t) = \alpha[U(t) - \bar{U}] + \beta[V(t) - \bar{V}] + \gamma$$
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 cannot cause the synoptic current reversal.