Variability of polarization fronts and submesoscale eddies in a semi-enclosed bay

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Outline

• A study domain
• An overview on the surface circulation
  • Energy spectra of surface currents
  • Correlations and variance ratios
  • Tidal ellipses and phases
    • Surface and subsurface currents
    • Temporal variability of surface currents
  • Statistics of submesoscale eddies
• Summary
• Studies of tidal and residual circulation in a semi-enclosed bay using observations of coastal radar-derived surface currents (1 km hourly) and numerical simulation outputs (MOHID; 1.5 km D3 hourly;)
• CTD stations (C1, C7, and C8)
• Transects on an along-channel (AC) and two cross-channel (XC1,XC2)
Study domain

- Studies of tidal and residual circulation in a semi-enclosed bay using observations of coastal radar-derived surface currents (1 km hourly) and numerical simulation outputs (MOHID; 1.5 km D3 hourly;)
- CTD stations (C1, C7, and C8)
- Transects on an along-channel (AC) and two cross-channel (XC1, XC2)
Dominant variance of surface currents

- Purely tide-dominant variance (M2, S2, and K1) in the observed and simulated surface currents
An overview on the surface circulation

- Correlations of current components (top, $\rho$) and dominance of variance of the current components (bottom, $\delta$)
- Channel following flows
- Offshore circulation

\[
\rho = \frac{\langle uv^\dagger \rangle}{\sqrt{\langle u^2 \rangle} \sqrt{\langle v^2 \rangle}}, \\
\delta = \frac{-\langle u^2 \rangle + \langle v^2 \rangle}{\langle u^2 \rangle + \langle v^2 \rangle},
\]
An overview on the surface circulation

- Correlations of current components (top, $\rho$) and dominance of variance of the current components (bottom, $\delta$)
- Channel following flows
- Offshore circulation

$$\rho = \frac{\langle uv^\dagger \rangle}{\sqrt{\langle u^2 \rangle \sqrt{\langle v^2 \rangle}}}$$

$$\delta = \frac{-\langle u^2 \rangle + \langle v^2 \rangle}{\langle u^2 \rangle + \langle v^2 \rangle}$$
Tidal ellipses and phases (surface currents)

HFR-derived surface currents

M2

S2

K1
Tidal ellipses and phases (surface currents)

HFR-derived surface currents

MOHID-simulated surface currents

M2

S2

K1
Tidal amplitudes and phases (M2 subsurface currents)

- M2 amplitudes and phases of subsurface currents along AC, XC1, and XC2
- Polarization front along the AC (sign changes in the minor amp.)
Tidal amplitudes and phases (S2 subsurface currents)

- Polarization front
Temporal variability of M2 and S2 surface currents

- Consistent temporal variability in surface current observations and numerical simulations
- Polarization fronts rarely migrate along the channel except for the summer (high inputs of riverine fresh water)
- Potential relevance to the internal tides...
Temporal variability of M2 and S2 surface currents

- Consistent temporal variability in surface current observations and numerical simulations
- Polarization fronts rarely migrate along the channel except for the summer (high inputs of riverine fresh water)
- Potential relevance to the internal tides...
Skill of harmonic analysis

\[ \kappa = 1 - \frac{\langle u_R^2 \rangle}{\langle u^2 \rangle} \]
Statistics of identified submesoscale eddies
Surface circulation in a semi-enclosed bay is examined with high-frequency radar-derived surface currents and three-dimensional numerical model simulations.

Baroclinicity and barotropicity of tidal surface circulation in a semi-enclosed bay are discerned by the organized structure of tidal phases.

Submesoscale eddies with diameters of 3 to 12 km and magnitudes of the normalized vorticity of 0.2 to 3 migrate onshore and become dissipated within tidal periods.

Clustered rotational tendency in clockwise and counterclockwise appears persistently as the polarization front with seasonal enhancement within the channel.
Thank you!

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