Abstract

The spectral characteristics of hourly and 1-km resolution coastal/sur- face currents are investigated in a coastal region of eastern Korea. The coastal region on the East Coast of Korea are described in the fre- quency and wavenumber domains. The second harmonic of the ob- served surface currents for a period of one year appears in the low- frequency range. The spatial coherence of the clockwise near-inertial surface cur- rents is monitored and discussed. The Ekman layer thickness is defined as the floor level at the Nyquist frequency (12 cpd). The spatial coherence of the clockwise near-inertial surface currents is observed to be higher in winter than in summer because of the relatively weaker wind conditions and a shal- lower mixed layer during the winter. The spectral characteristics of the surface currents associated with the seasonal mixed layer. The low-seasonal and persistent regional mesoscale currents and their branches near the coast may affect the generation of sub- mesoscale frontogenetic.

Observations

Hourly averaged surface currents on a grid with a 1 km spatial resolu- tion over the continental shelf (Immon, Republic of Korea) for a period of one year (2010) have been obtained by two phased-array HF radars (Well- lington (WFR) / KAIST (KFR) system) in Immon North (INW), and Immon South (IMNS, IC2). Although the WERA-derived radial velocities are typically reported on a Cartesian coordinate grid for the conven- ience of vector current mapping, we internally modify and obtain the radial velocities reported on the pole coordinate grids of individual HF radars, which allows us to investigate the characteristics of the radial velocities more clearly. The spatial coherence of the radial velocities is defined as the floor level at the Nyquist frequency (12 cpd), which is directly related to the kinematic and dynamic quanti- ties (e.g., stream function, velocity potential, divergence, vorticity, and stream function derivative and integrated quantities, respectively, the spatial structure and variability pattern). The low-frequency surface currents are relatively enhanced offshore (Figure 3b) are coherent with the enhanced amplitudes at the coast (Figure 3a) and the clockwise in the near-inertial band (1< k< 1.1 cpd). The bottom bathymetry is continuous at 50 m, 100 m, 200 m, 300 m, and 400 m. The near-inertial surface currents in the study domain are charac- terized with dominant clockwise super-inertial variance (Figure 1a), which is consistent with the observed near-inertial currents from the coastal in-situ buoy located at approximately 50 km northwest of the study area (Figure 2). These super-inertial currents have been intro- duced as the onshore propagating (internal) near-inertial waves which are generated offshore. The magnitudes of the clockwise near-inertial surface currents are reduced near the coast and enhanced offshore, which is associated with the influence of coastal boundaries (e.g. bottom bathymetry and coastline) on the near-inertial motions called coastal “embryon” (Figure 3a).

The low-frequency surface currents are relatively enhanced offshore and reduced near the coast (Figure 3b), which is similar to the standard deviation of the surface currents (Figure 3a), reflecting the coastal boundary effects on the sub-inertial surface currents (Figure 3c). The weak variance at the eastern boundary of the study domain is caused by the reduced radial noises. The magnitudes of the clockwise surface currents are enhanced near the coast and decreased away from the coast (Figure 3b), which is closely related to the development of the marine boundary layer associated with diurnal land-sea breeze.

Variances in the wave number domain

Overall, the wave number-domain energy spectra of surface currents have been investigated for the along- (Figure 2a and 6c) and cross- (Figure 2b and 6b) direction with slight differences in the averaging direction, consistent with the en- ergy spectra of the submesoscale processes. To further analyze, we analyti- cally evaluated wavenumber-domain spectra have slightly deeper spectral decay rate (kg = -2) away from the coast (Figure 6b and 6d), which is observed as a result of the bottom mixed layer. The low-seasonal and persistent regional mesoscale currents and their branches near the coast may affect the generation of sub- mesoscale frontogenetic.

Concluding remarks

We examined the spectral contents of the hourly surface currents over a 1 km spatial resolution in the frequency and wavenumber domain. The surface currents observed for a period of one year ex- hibit the dominant variance in the low-frequency (less than 2 days), diurnal, and near-inertial frequency bands. The low-frequency surface currents have more consistent variability with regional geostrophic flow in summer (less than 10 days), while the stronger wind conditions and weaker mixed layer have been observed during the winter. The diurnal surface currents contain components coherent with diurnal wind flow associated with the development of the diurnal marine boundary layer. Additionally, super-inertially shifted clockwise surface currents exhibit the near-inertial phase propagation along with decreasing amplitudes as a partial coastal influence due to coastal boundary effects on the surface currents. The wave number-domain energy spectra of surface currents have deep decay slopes between 1 and 2. Their seasonal decay slopes are slightly deeper in winter than in summer, which can be interpreted as the influence of both surface fronts and baroclinic instability associated with the seasonal mixed layer and vertical stratification modulated by harmonic frequencies.

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Spectral descriptions of submesoscale surface circulation in a coastal area of the East Coast of Korea

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References
