Statistical Characteristics of Mesoscale Eddies in the South China Sea from Satellite Altimetry Data

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Abstract
Mesoscale eddies are rotating coherent structures of ocean currents, which generally refer to ocean signals with spatial scales from tens to hundreds of kilometers and temporal scales from days to months. Eddy properties in the South China Sea (SCS) are studied from satellite altimetry data using a sea level anomaly (SLA)-based eddy identification. A series of statistical analysis methods were used to study the statistical characteristics of the mesoscale eddies in the region, e.g., eddy number and lifetime, geographical distribution of eddies and their properties, and seasonal variation of eddy activities.

Data & Eddy Identification
Altimetry data: daily SLA fields with spatial resolution of 0.25°, from 1 Jan. 1993 to 31 May 2018.
Eddy identification: A purely geometric algorithm for eddy identification based on the outermost closed contour of SLA.

Eddy Trajectories, Origins and Terminations
Fig. 1. An identification case of eddies based on gridded SLA data. Small squares with color represent 0.25° grid points of SLA data. Black points represent the cores of eddies. The blue/red thick line represents the boundary of a cyclonic/anticyclonic eddy.

Fig. 2. The trajectories of cyclonic (blue lines) and anticyclonic (red lines) eddies over the 25-year period January 1993–May 2018 for (a) lifetimes ≥ 30 days and (b) lifetimes ≥ 30 days for only those eddies for which the net displacement was eastward.

Eddy Trajectories, Origins and Terminations
Fig. 3. Census statistics for eddies with lifetimes ≥ 30 days showing the positions of (left panel) eddy origins and (right panel) eddy terminations region over the 25-year period. The eddies with long lifetime ≥ 90 days show that eddy terminations are more frequent near the eastern region of the Taiwan Island and the Luzon Strait, while eddy origins occur near the western region of the Luzon Strait. This means that some eddies (maybe as meanders that pinch off of the Kuroshio current) can enter the South China Sea through the Luzon Strait.

Eddy Characteristics
Fig. 4. Census statistics for numbers of cyclonic (a) and anticyclonic (b) eddies with lifetime ≥ 30 days, and their polarity (c) for each 1° × 1° region. Eddy polarity P indicates that a region prefers anticyclonic (P>0) or cyclonic (P<0).

Fig. 5. The mean amplitude, radius and EKE of cyclonic (top) and anticyclonic (bottom) eddies with lifetime ≥ 30 days for each 1° × 1° region. The large-amplitude eddies occur in the relatively confined regions of highly unstable currents such as the western and northeastern of the SCS.

Seasonal Variation of Eddy Activities
Fig. 6. The detection results of cyclonic (top) and anticyclonic (bottom) eddies based on monthly-averaged SLA data for the different seasons. The dot sizes correspond to the eddy scale, the colors correspond to the eddy amplitude. The results show that there is the obvious seasonal variation of the eddy activities in the SCS.

Conclusions
- Mesoscale eddies occur primarily in the western and northeastern of the SCS, and most mesoscale eddies propagate westward.
- Eddies with long lifetime terminate more frequent near the eastern region of the Luzon Strait, while eddy origins occur near the western strait.
- The large-amplitude eddies occur in the western and northeastern of the SCS, and this latitudinal dependence of eddy scale is evident.
- There is the obvious seasonal variation of the eddy activities in the SCS.

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Major references