Global *EddyGraph*: Tracking Mesoscale Eddy Splitting and Merging Events

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Introduction

Mesoscale eddies are coherent rotating water body with radial scales ranging from tens to hundreds of kilometers and lifetimes ranging from tens to hundreds of days. They are widespread movement form in the ocean and play a dominant role in the transfer and exchange of kinetic energy and material. Eddies sometimes interact with each other. Splitting and merging processes, the typical behaviors of eddy-eddy interaction, are the prevalent research focus in oceanography. An automatic algorithm named *EddyGraph* for global eddy splitting and merging events based on sea level anomaly (SLA) data is proposed and the corresponding dataset is provided here. Based on multisource remote sending data, the composite analysis of typical events verify the reliability of this dataset and the effect of the interaction between eddies on marine material distribution.

EddyGraph

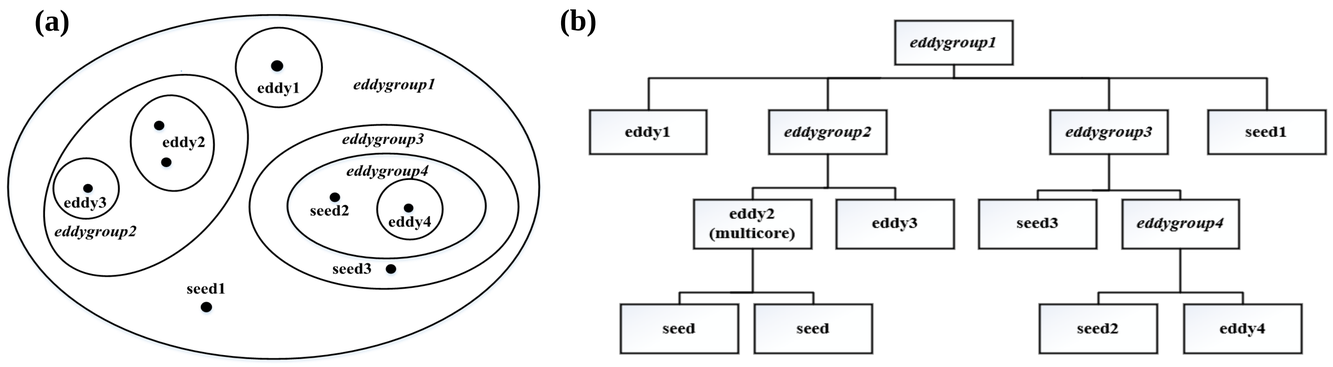


Fig.1 Diagram of (a) *eddygroup* and (b) *eddytree*. Seeds are the local SLA maximum or minimum points. Eddies are the closed SLA contour with only seeds contained. *Eddygroups* are the closed SLA contours with eddies, seeds or eddygroups contained. *Eddytrees* are the topological relationships between eddy seeds, eddies and eddygroups.

For a daily global SLA data, after detecting the seeds, eddies and eddygroups are identified by some criteria and the inclusion relationship between the closed SLA contours and seeds as well as eddies. Based on the inclusion relationship between them, the parent-child relationship is built. Then all the root eddygroups without parent are selected to be the root nodes of eddytrees. According to the parent-child relationship level by level, eddytrees are built by traversing nodes from root eddygroups to leaf nodes without children.

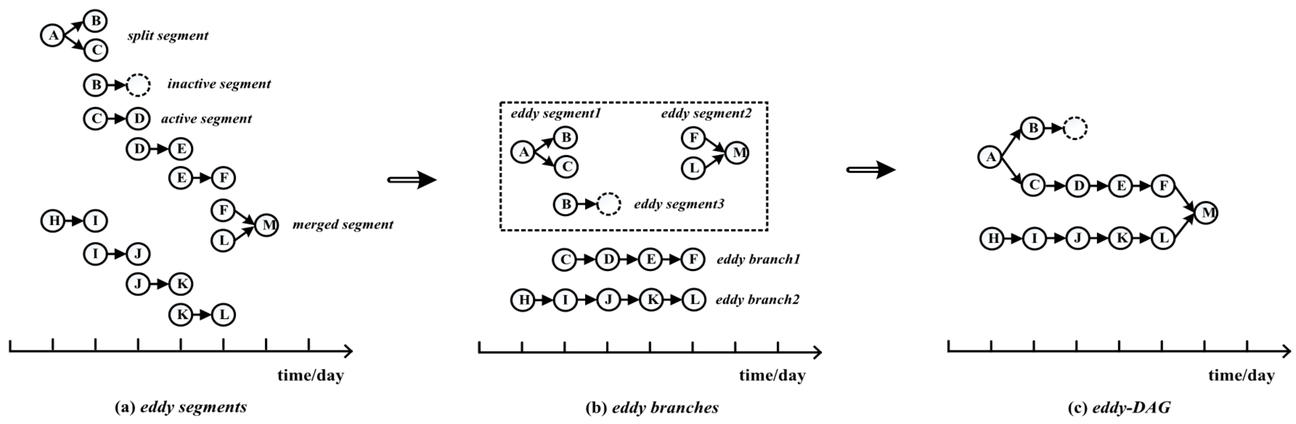


Fig. 2 Diagram of the eddy segment, eddy branch and eddy-DAG. Circles with letters are eddies or eddy seeds.

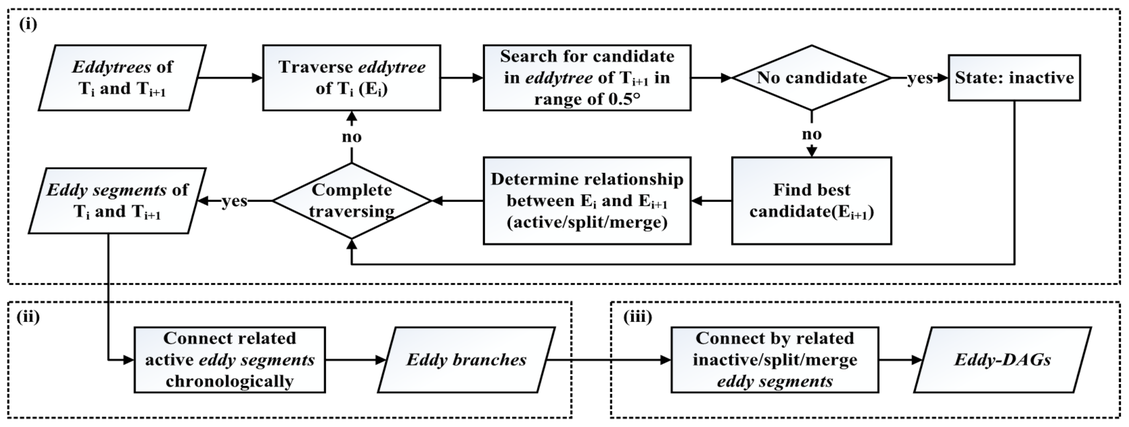
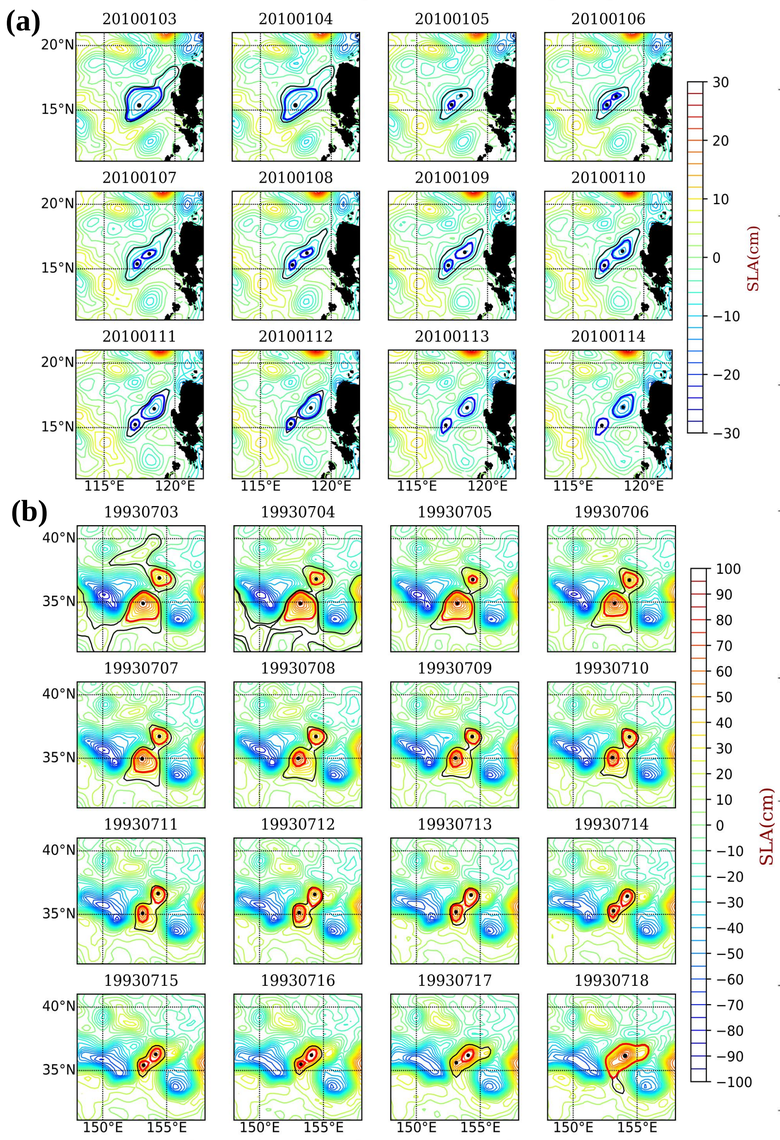


Fig. 3 Flow chart of the tracking algorithm.

The tracking of eddy splitting and merging is divided into three levels: (i) eddy segment, (ii) eddy branch and (iii) eddy directed acyclic graph (eddy-DAG) . Here, eddy segment is the relationship between two eddies or eddy seeds with continuous time steps, including active, inactive, splits, and mergers; eddy branch is a linear structure formed by connecting several active eddy segments; eddy-DAG is a complex topological structure that is composed of several eddy branches and their related inactive, split or merged eddy segments.

Results

◆The eddy splitting and merging events



◆Validation with SSTA and SSSA data

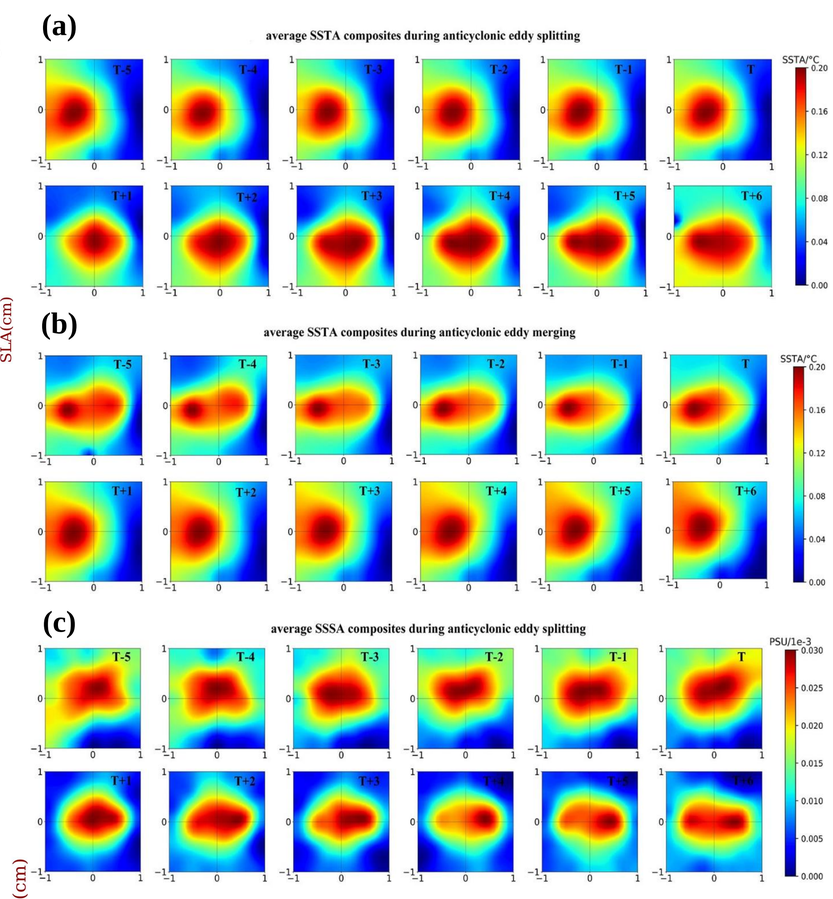


Fig.4 Examples of (a) splitting and (b) merging events. Anticyclonic/cyclonic eddies and eddygroups are blue/red and black lines, respectively.

Fig.5 The average composite of SSTA during anticyclonic (a) splitting events and (b) merging events and of SSSA during anticyclonic (c) splitting events and (d) merging events.

Conclusions

- ◆Based on SLA data, a multilevel complex topological relationship between eddygroups and eddies is established by eddytrees, which provides a basis for tracking eddy splitting and merging events. A 28-year long (1993-2020) global eddy splitting and merging events dataset has been provided(DOI:10.12237/casearth.63369940819aec34df2674d8).
- ◆The average composite of sea surface temperature anomaly (SSTA) and sea surface salinity anomaly (SSSA) for typical events to verify the accuracy of this dataset. The degeneration pattern in which eddies in the same eddygroup merge into an eddy and the evolution pattern in which an eddy splits into eddies within the common parent eddygroup confirm the validity of our algorithm as well as the wrapping and transport mechanisms eddies exert on temperature and salinity.