Big Data Intelligent Mining and Visual Analysis of Ocean Mesoscale Eddies

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Introduction

As an important oceanic physical process, mesoscale eddies play a key role in the processes of ocean mass transport and energy exchange. A orthogonal parallel algorithm is proposed to identify the global mesoscale eddies based on satellite altimetry data. Furthermore, an integrated marine visualization system, named *i4Ocean*, has been presented for intelligent mining and visual analysis of ocean mesoscale eddies.

Data and Method

Time: 1993.01 ~ ongoing

Domain: global ocean

Sea Level Anomaly: daily, provided by CMEMS

Methods: K–D tree, *EddyGraph,* orthogonal parallel algorithm

Part 1: Mesoscale Eddy Datasets

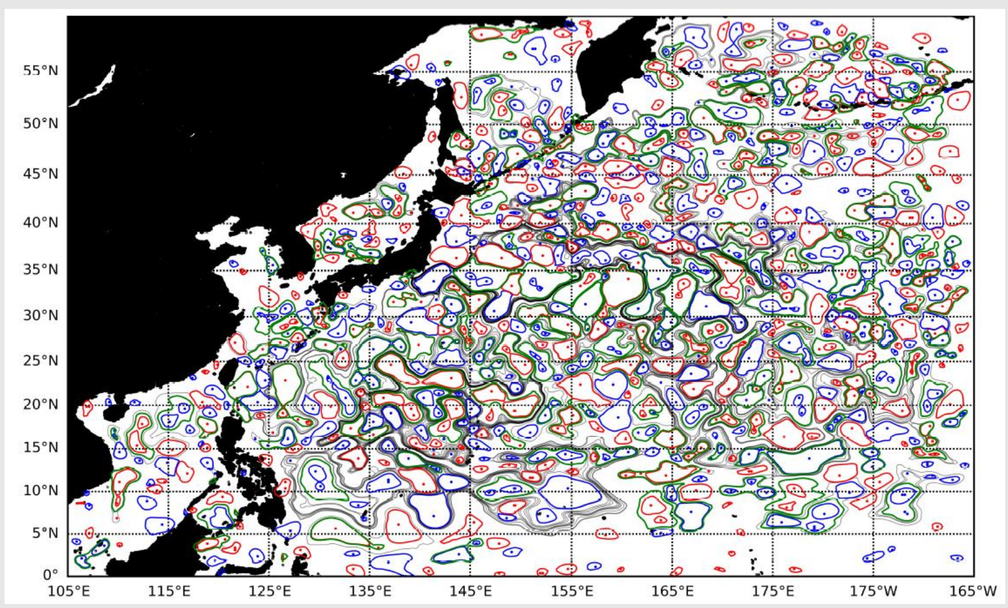

Fig.1 The daily eddytrees detected by *Eddygraph*, including eddies (red and blue lines) and eddygroups (green and black lines).

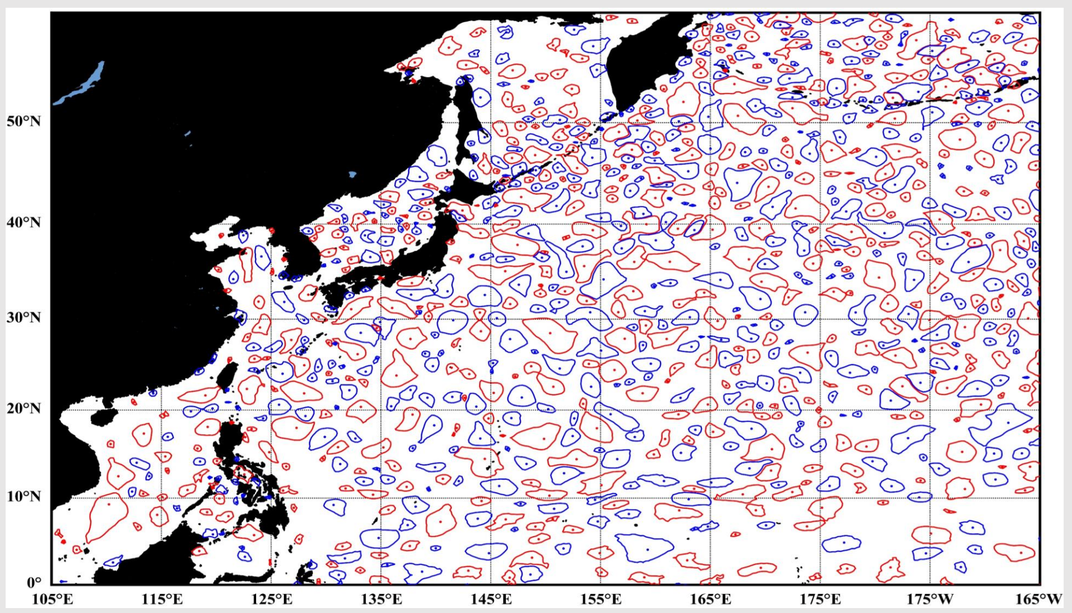

Fig.2 Eulerian eddies in northwest Pacific on 20 Jul 2000.

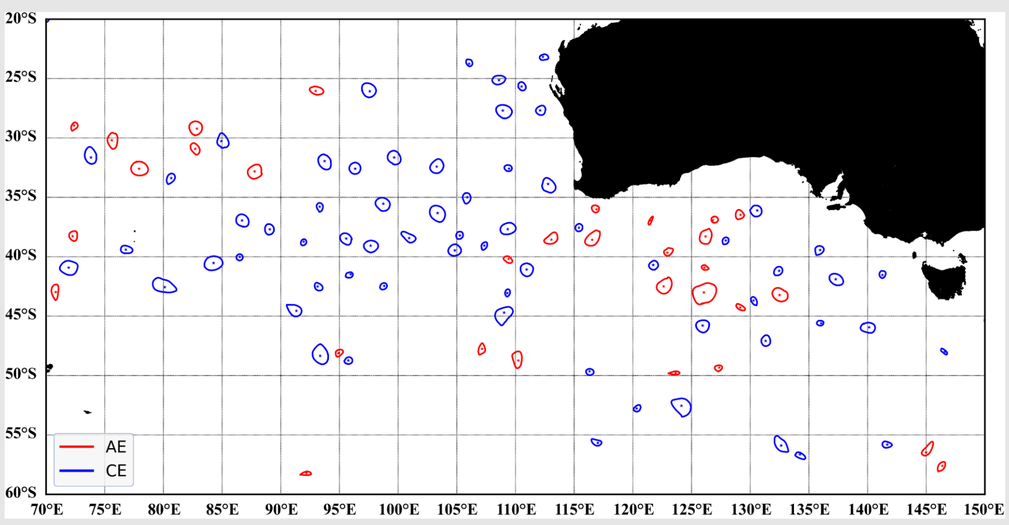

Fig.3 Lagrangian eddies in Eastern Indian Ocean on 1 Jul 2019.

Tab.1 Three datasets of mesoscale eddies.

Dataset Name	Websites
Eddygraph: the tracking data set of mesoscale eddy splitting and merging in northwest Pacific Ocean based on satellite altimeter	https://data.casearth.cn/en/sdo/detail/614c68fe08415d75145c3785
Global rotationally coherent Lagrangian vortices identification and trajectory dataset based on satellite altimeter	https://data.casearth.cn/en/sdo/detail/609b389af55d00002a00509d
Mesoscale eddy identification and tracking dataset based on satellite altimeter	https://data.casearth.cn/sdo/detail/62417e55819aec185b511550

Part 2: Visual Analysis of Ocean Mesoscale Eddies

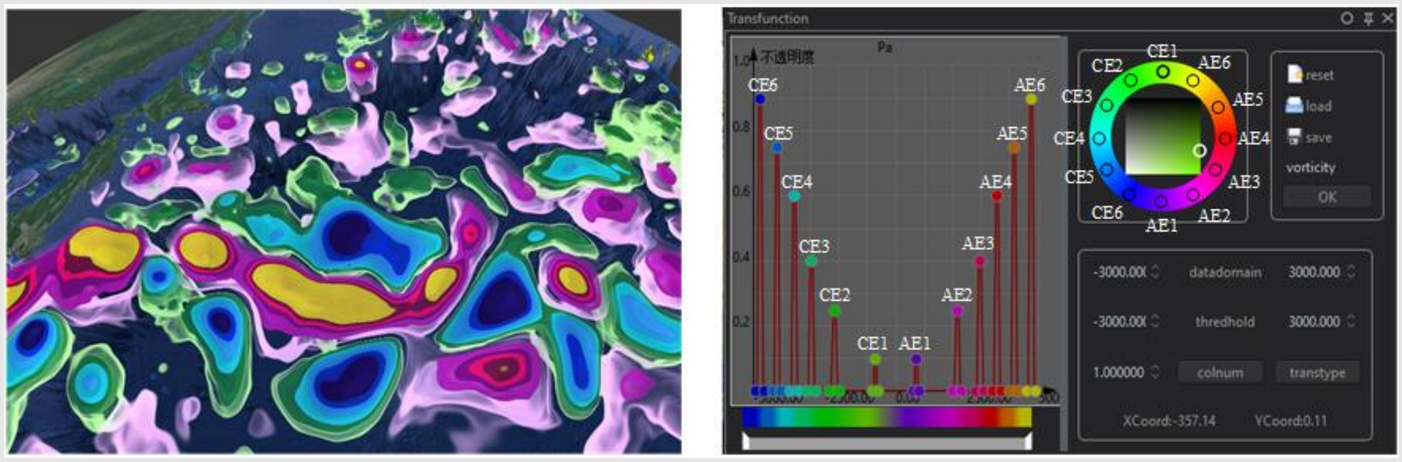

Fig.4 Volume rendering visual effect of mesoscale eddy based on pressure anomaly on 1 Jan 2012.

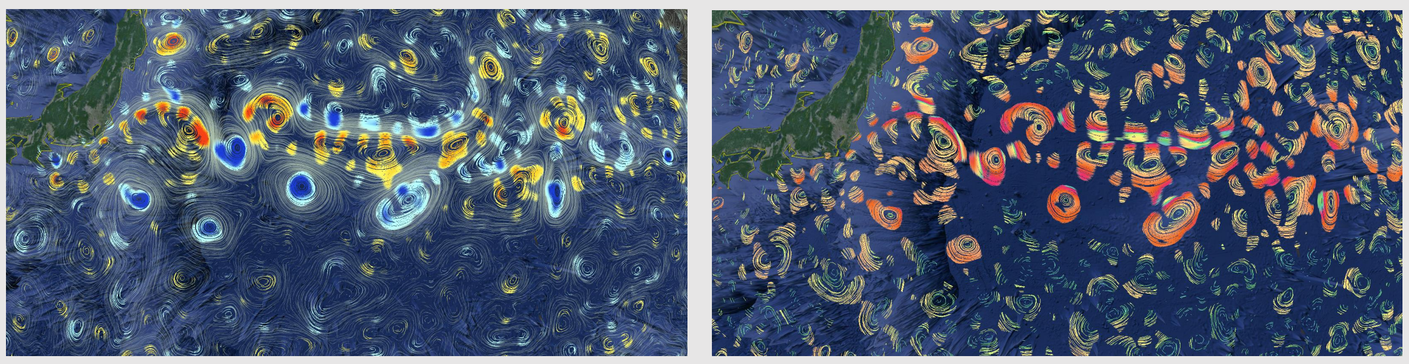

Fig.5 Vector field visualization of mesoscale eddy based on OW feature (left) and velocity (right) in Kuroshio on 1 Jan 2012.

- Notably, these actions are realized by providing various GPU-based interaction and visualization techniques for displaying multidimensional data.
- The system achieves three goals: high visibility, good performance and interactive capabilities.
- The efficient ray sampling technique including a preintegrated transfer function and adaptive sampling methods, increases the rendering efficiency of ocean data. By further introducing a transfer function, users can extract the region of interest in the system and analyze diverse marine phenomena.

- References:

Tian et al., 2021, Haiyang Xuebao, published;
Tian et al., 2021, Remote Sensing, published;
Tian et al., 2021, Haiyang Xuebao, published;
Tian et al., 2022, Journal of Atmospheric and Oceanic Technology, published;
He et al., 2022, Journal of Oceanology and Limnology, published.