Ocean Surface Current multiscale Observation Mission (OSCOM): Status and Progresses

Yan Du[1], Xiaolong Dong[2], Xingwei Jiang[3], Yuhong Zhang[1], Di Zhu[2], Wen Chen[4] et al.

1. South China Sea Institute of Oceanology , Chinese Academy of Sciences 2. National Space Science Center, Chinese Academy of Sciences 3. National Satellite Ocean Application Service 4. Innovation Academy for Microsatellites, Chinese Academy of Sciences

Major Scientific Contexts

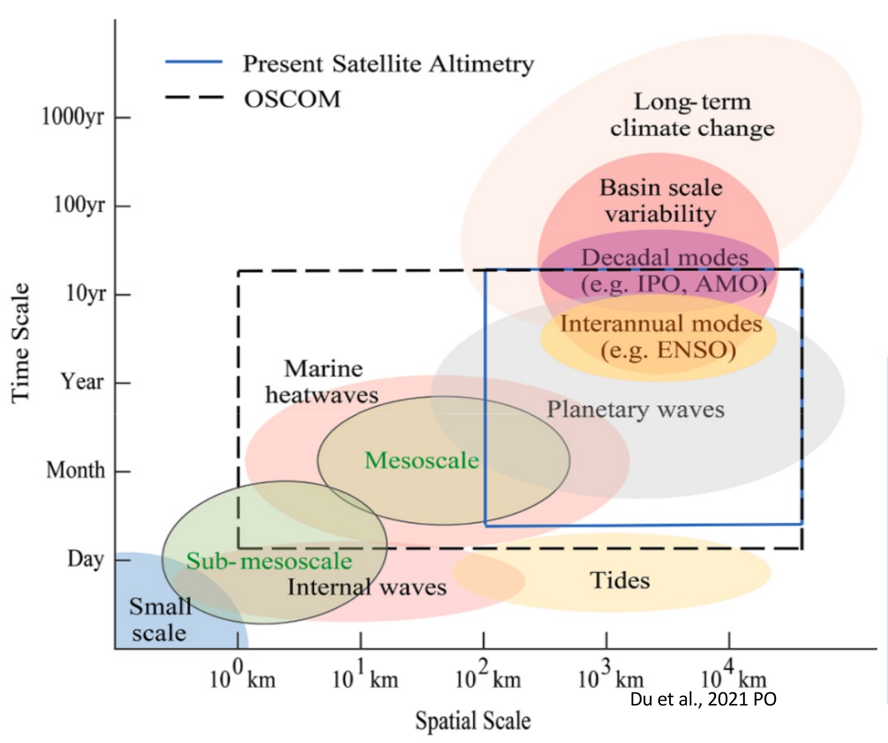


Fig1. Schematic diagram of multiscale ocean dynamics.

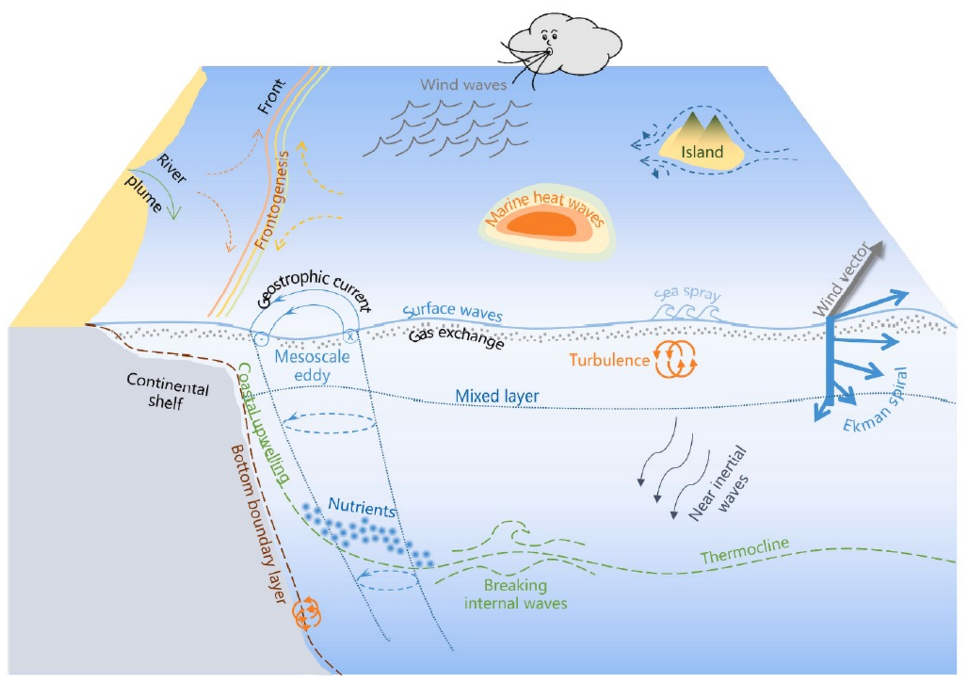


Fig2.Schematic representation of the fundamental state of motion in the ocean.

Ocean current is one of the major drivers of water mass, energy, and biogeochemical cycles in the global ocean–atmosphere boundary layer and also a key variable in the formation of extreme climate events (e.g., El Nino). Ocean near-surface current has enormous energy, involving processes in multiple spatial and temporal scales. Nearly 90% of ocean kinetic energy clusters in mesoscale and sub-mesoscale.

No direct observation of the global ocean surface current now.

Current satellite measurements are unable to acheive the the global ocean water motions in non-equilibrium states, such as submesoscale processes.

Key Scientific Objectives

- To directly observe global OSC at o (1 km) scale (5~10 km), filling the gap of OSC observation in the space measurements;
- To advance the research of ocean sub-mesoscale dynamics, multiscale processes, mass/energy exchanges between ocean and atmosphere, and biogeochemical cycles, promoting the development of theoretical research on ocean science and climate change;
- To establish the foundation for numerical simulation of ocean non-equilibrium processes, providing theoretical and technical support for earth system modelling and earth observation applications.

Scientific Requirements

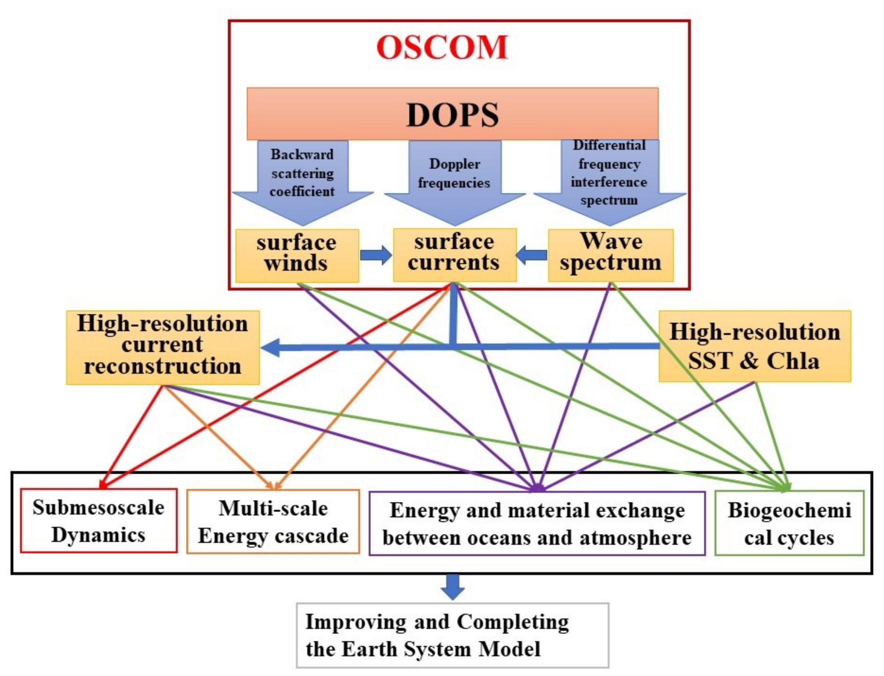


Fig. 3. Payloads, data products, and their contribution to scientific objectives.

Table 1. Measurement Requirements for Global OSC, OSVW, OSWS Observations

Variables	Spatial resolution	Accuracy/precision		Swath/temporal coverage
		Speed accuracy	Direction accuracy	
OSC	≤10 km	≤0.1 m/s	≤15°	≥1000km/ ≤3 days globally
OSVW	≤10 km	≤2 m/s	≤20°	
OSWS	≤10 km	≤10%@50-500 m wavelength		

The quasi-geostrophic current in the middle and high latitudes has a scale of 20~100 km, and the ageostrophic and non-equilibrium processes in the tropical oceans can reach ~10 km. The sub-mesoscale dynamics vary rapidly, typically with a time scale of O (1 day)

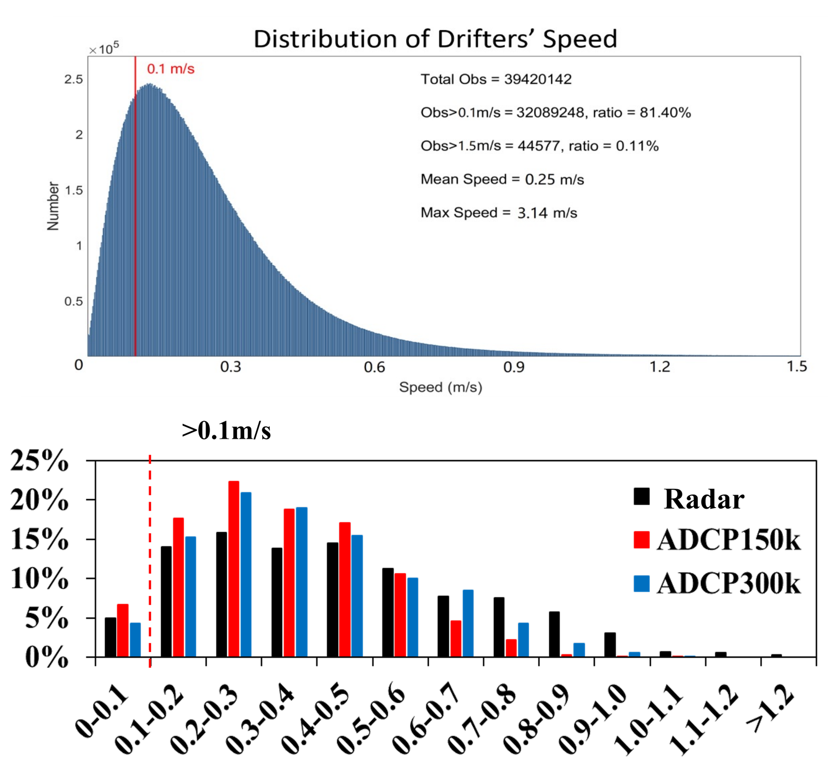


Fig. 4. Observed current speed of drifters, radar and ADCP.

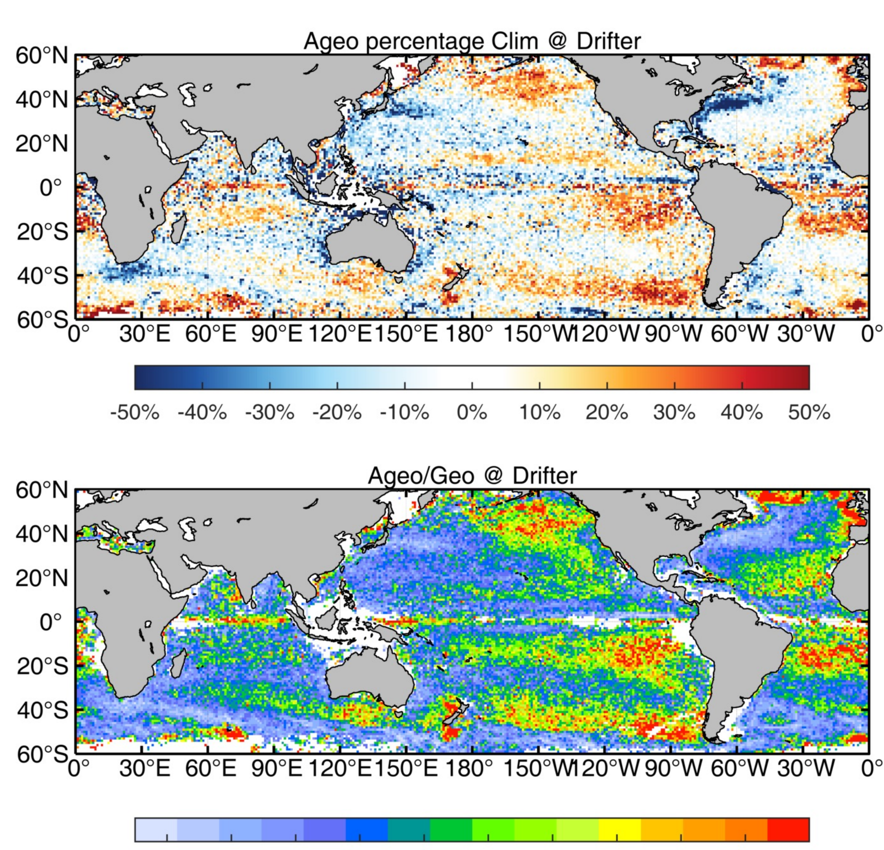


Fig. 5. Global distribution of ratio of ageostrophic current to geostrophic current calculated by drifters.

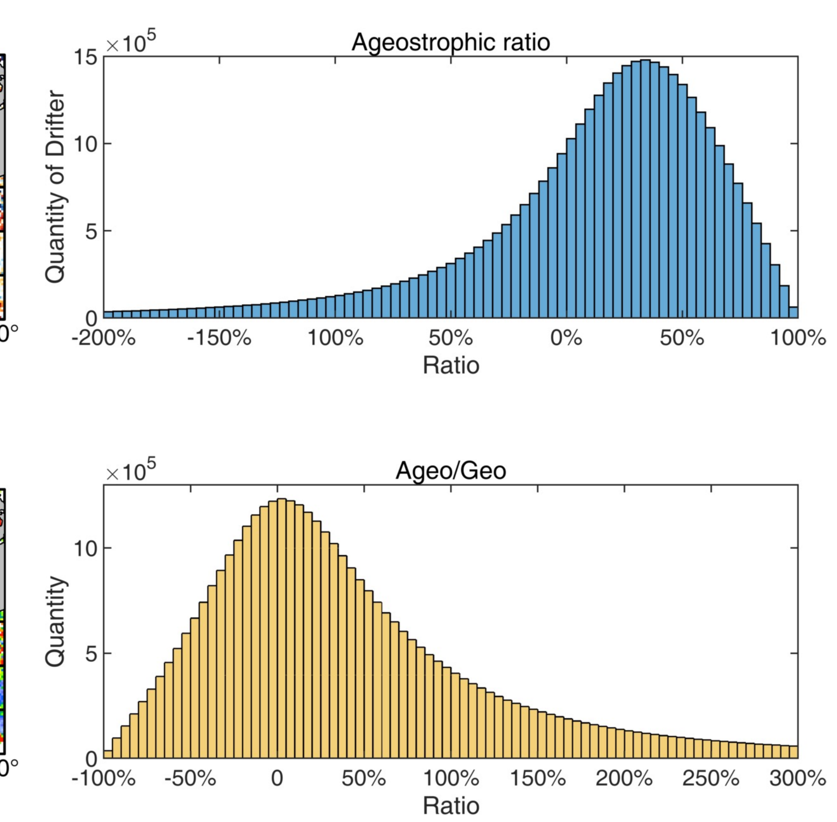
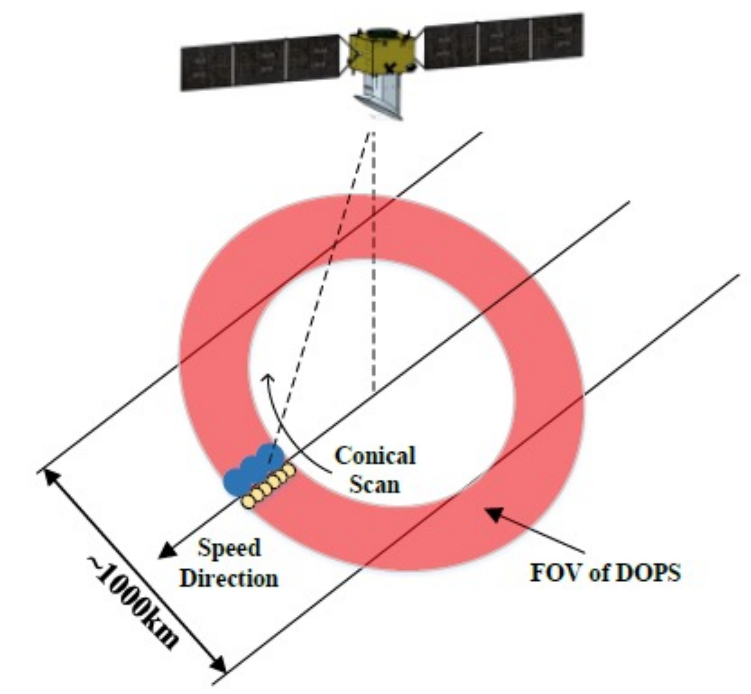


Fig 6. Ratio histogram of ageostrophic current to geostrophic current calculated by drifters.

In the global oceans, the drifter-observed 6-hour mean currents with speed larger than 0.1 m/s account for ~81% of total currents. This value rises to ~95% of in-situ observations in the South China Sea. The kinetic energy of the currents with speed larger than 0.1 m/s accounts for more than 99% of all kinetic energy in both data.

The non-geostrophic currents determine the directions of the total currents in the near-equatorial trade winds and mid-latitude westerly winds prevailing regions, where the maximum non-geostrophic speed can reach twice the geostrophic speed and exceed 60% of the total current.

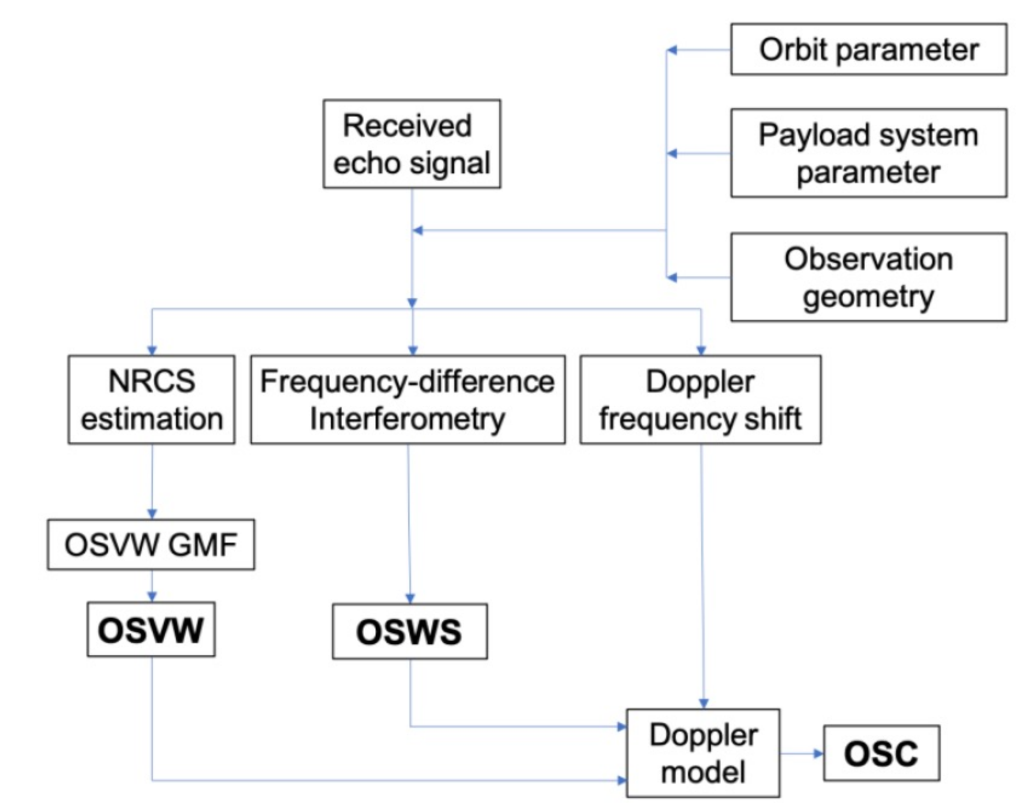
Proposed Payload



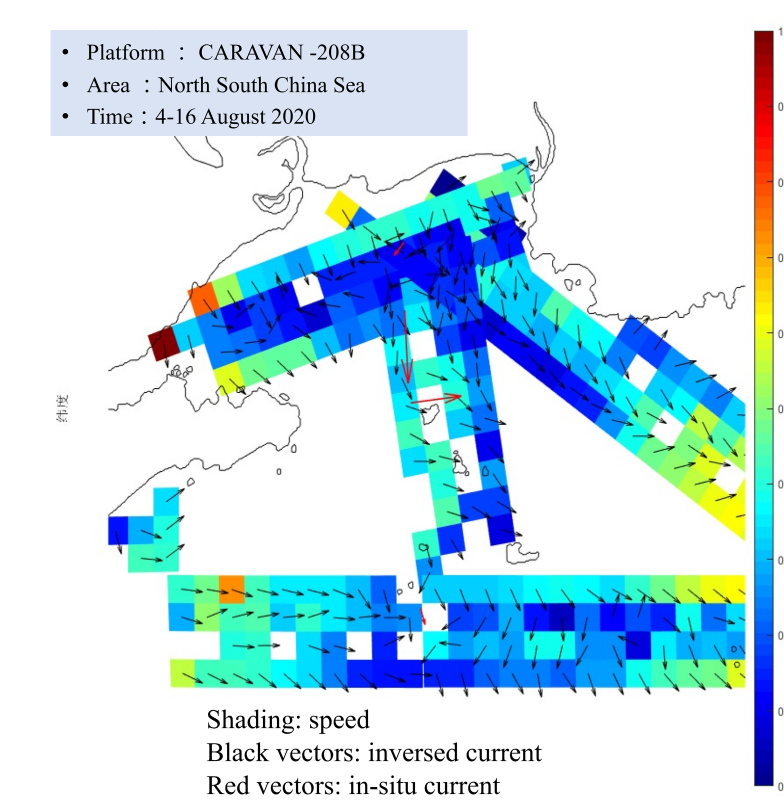
Parameter	Values
Wave band	Ka+Ku
Polarization mode	Ka：VV Ku：HH、VV
Swath	＞1000km
Resolution	5km（OSC, OSVW） 10km（OSWS）
Accuracy	0.1m/s（OSC） 1.5m/s（OSVW） 15°（OSC，OSVW）
Rotating speed	~15rpm
Antenna diameter	1.5m

OSCOM will launch a satellite equipped with a Doppler Scatterometer to directly measure ocean surface currents with a very high horizontal resolution of 5–10 km and a 3-day global coverage. The accuracy of currents is 0.1m/s in speed and 15° in direction.

Retrieval Procedures



Flight experiment of Ka-band Doppler scatterometer



The currents inversed from Ka-band Dops are consistent with the in-situ observations

Status and Progresses

Research and development of the payload technology of Doppler scatterometer started in 2013; the Ka-band prototype completed and airborne campaign conducted in August, 2020;

The intensive study as a candidate mission of the Strategic Priority Program (SPP) on Space Sciences supported by Chinese Academy of Sciences from 2019; three payloads, including Doppler scatterometer, IR and Microwave radiometer, considered for the mission;

Only Ku+Ka Doppler scatterometer proposed in the final mission proposal; IR and microwave measurements for SST to obtained by other satellites (FY-3 Early morning satellite and HY-2 polar orbit satellite);

Mission selection review started from February 2022, and to be concluded in August 2022;

The Proposed mission development period 2022-2025; planned launch date is end of 2025 or beginning of 2026 if selected for implementation.

Du, Yan*, Xiaolong Dong*, Xingwei Jiang , Yuhong Zhang, Di Zhu, Qiwei Sun, Zhenzhan Wang, Xinhua Niu, Wen Chen, Cheng Zhu, Zhiyou Jing, Shilin Tang, Yineng Li, Ju Chen, Xiaoqing Chu, Chi Xu, Tianyu Wang, Yinghui He, Bing Han, Ying Zhang, Minyang Wang, Wei Wu, Yifan Xia, Kun Chen, Yu-Kun Qian, Ping Shi, Haigang Zhan, Shiqiu Peng, 2021, Ocean surface current multiscale observation mission (OSCOM): Simultaneous measurement of ocean surface current, vector wind, and temperature. *Progress in Oceanography*, 193, 102531. DOI: https://doi.org/10.1016/j.pocean.2021.102531.