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China-Indonesia Joint observation in Indonesian seas during the past decades

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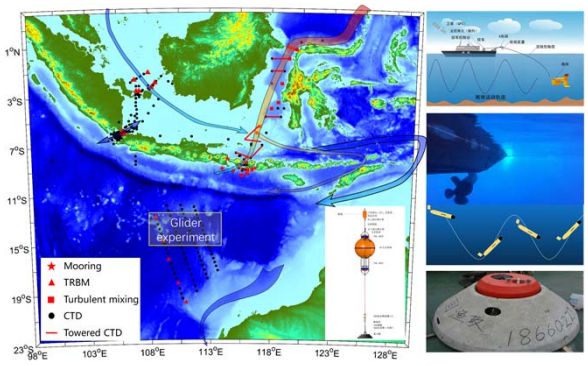
In 26 October 2006, Researchers from China, Indonesia and US signed the MoU of "the South China Sea-Indonesian seas Transport/Exchange (SITE), and Impact on Seasonal Fish Migration", marked the initiation of China-Indonesia joint observation in the Indonesian seas. The China-Indonesia collaboration has continued for 15 years, and is still ongoing.

Timeline of the Joint Observation

- Phase 1 (2007 - 2008): Two SITE joint cruises in Karimata Strait
- Phase 2 (2008 - 2016): Extended SITE survey to Sunda Strait, 17 cruises been completed
- Phase 3 (2015 - 2018): Activate TIMIT[1] joint survey in Lombok and Makassar Strait, 3 cruises been completed
- Phase 4 (2019 - present): Started TRIUMPH[2] joint research and survey, ITF inflow and outflow straits and regions, 4 cruises been completed

[1] TIMIT: Transport, Internal Waves and Mixing in the Indonesian Throughflow regions and Impacts on Marine Ecosystem
[2] TRIUMPH: Transport Indonesian Seas, Upwelling and Mixing Physics

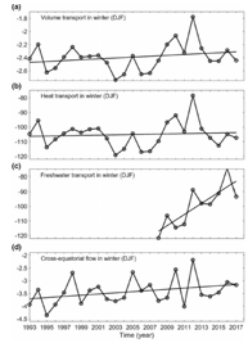


A large amount of in situ observations were obtained

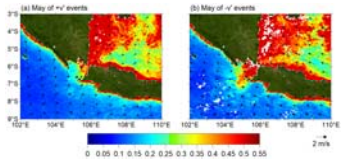
- Longterm time series of temperature, salinity, velocity profile in Karimata, Sunda, Makassar, Lombok, Alas and Bandung Straits measured by moorings and TRBMs
- Temperature and salinity measured by CTD
- Turbulent mixing measured by microstructure profiler (A 15-days observation of 3-hourly repeatedly measurements in the south of Lombok Strait)
- Towered CTD sections along and across the ITF routes, giving multi-parameter of marine environment
- Coordinated Synchronous Observation Experiment of Underwater Glider in the outflow region of the ITF

Towards better understanding on throughflow dynamics

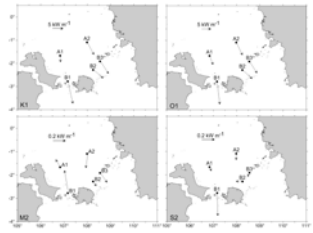
- **Karimata Strait Throughflow** is monsoon driven, from SCS to Java Sea in winter (1.98 Sv), and from Java Sea to SCS in summer (0.47 Sv); is an important contributor for inter-ocean heat transport (0.21 PW in winter, equivalent to 35% of ITF) and freshwater transport (100 mSv in winter, equivalent to 44% of rainfall input to then entire Indonesian seas); is not significantly correlated to IOD and ENSO; shows significant decrease trends in volume (0.26 Sv/decade), heat (7.8 TW/decade), and freshwater (15.4 mSv) transports; strongly modulates the ITF by "freshwater plug" and "salinity effect" on seasonal and decadal time scale, respectively.
- **Sunda Strait Throughflow** is monsoon driven, from Indian Ocean to Java Sea in winter (0.01 Sv), and from Java Sea to Indian Ocean in summer (0.72 Sv); shows strong intraseasonal variability (ISV), which is induced by local wind driven Ekman transport and remote wind driven Kelvin waves; is responsible for marine primary productivity variation in the south of the strait at intraseasonal time scale.
- **Karimata Tidal waves** are dominant by diurnal tides with the largest amplitude >50 cm for K_1 constituent, and <5 cm for M_2 constituent M2; the tidal currents are rectilinear type in the strait.; the diurnal tidal energy flows from the SCS to the Java Sea. The semi-diurnal tidal energy flows from the SCS to the Java Sea through the Karimata Strait and flows from the Java Sea to the SCS through the Gaspar Strait; these characteristics imply that the Karimata Strait locate in the anti-nodal band of the diurnal tidal waves and in the nodal band of the semidiurnal tidal waves.



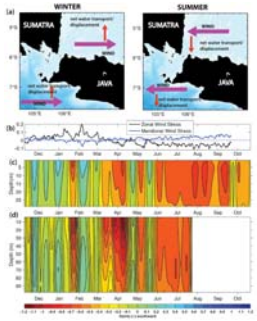
Karimata Strait Throughflow: (a) Volume, (b) Heat, and (c) freshwater transport of the Karimata Throughflow in boreal winter; (d) Cross-equatorial flow index in winter over the period of 1993–2017. Straight lines indicate the trends. Cited from Xu et al. (2021).



Sunda Strait Throughflow ISV: Chla and wind stress during (a) northward ISV and (b) southward ISV events. Cited from Xu et al. (2018)



Karimata Tidal Wave: Horizontal tidal energy flux density for K_1, O_1, M_2, S_2 constituents. Cited from Wei et al. (2016).



Sunda Strait Throughflow: (a) Schematic of monsoon driven Ekman transport; (b) Averaged zonal wind stress; (c) Along-strait velocity profile in the Sunda Strait from November 2008 to July 2009. Cited from Susanto et al. (2016).

Selected Published Papers

1. Fang GH, et al. 2005: A note on the South China Sea shallow interocean circulation. Advances in Atmospheric sciences, 22(6), 946–954.
2. Fang GH, et al. 2010: Volume, heat and freshwater transports from the South China Sea to Indonesian seas in the boreal winter of 2007-2008. Journal of Geophysical Research, 115, C12020
3. Li SJ, et al. 2018: Observations of intraseasonal variability in the Sunda Strait throughflow. Journal of Oceanography, 2018, 74(5): 541–547.
4. Susanto RD, et al. 2010: New surveys of a branch of the Indonesian Throughflow. Eos Transactions AGU, 91(30), 261–263.
5. Susanto RD, et al. 2013: Observations of the Karimata Strait Throughflow from December 2007 to November 2008. Acta Oceanologica Sinica, 32(5), 1–6.
6. Susanto RD, et al. 2016: Oceanography surrounding Krakatau Volcano in the Sunda Strait, Indonesia. Oceanography, 29(2).
7. Wang Y, et al. 2019: Seasonal variation of water transport through the Karimata Strait. Acta Oceanologica Sinica, 38(4), 47–57.
8. Wei ZX, et al. 2016: Tidal elevation, current, and energy flux in the area between the South China Sea and Java Sea. Ocean Science, 12, 517–531.
9. Wei ZX, et al. 2019: An overview of 10-year observation of the South China Sea branch of the Pacific to Indian Ocean throughflow at the Karimata Strait. Acta Oceanologica Sinica, 38, 1–11.
10. Xu TF, et al. 2018: Intraseasonal flow and its impact on the chlorophyll-a concentration in the Sunda Strait and its vicinity. Deep-Sea Research I: Oceanography Research Papers,136, 84–90.
11. Xu TF, et al. 2021: Observed water exchange between the South China Sea and Java Sea through Karimata Strait. Journal of Geophysical Research: Oceans, 126, e2020JC016608.
12. Xu TF, et al. 2021: Satellite-Observed Multi-Scale Variability of Sea Surface Chlorophyll-a Concentration along the South Coast of the Sumatra-Java Islands. Remote Sensing, 13, 2817.

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