Anomalous circulation in the Indonesian Seas during the CINDY/DYNAMO field campaign

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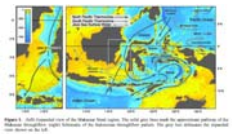
Abstract: The remote ocean response to the Madden-Julian Oscillation (MJO) events observed during the CINDY/DYNAMO field campaign is investigated using the global eddy-resolving HYbrid Coordinate Ocean Model (HYCOM). We use the version of global HYCOM with horizontal resolution 1/12 deg. with 32 layers in the vertical. The model is integrated with archived operational forcing from the Navy Operational Global Atmospheric Prediction System (NOGAPS) for the period 2011-2012 that covers the field phase of CINDY/DYNAMO.

During the intensive observation period of CINDY/DYNAMO field campaign, three active episodes of large-scale convection associated with the MJO passed eastward across the tropical Indian Ocean. Surface westerly winds near the equator were particularly strong during the events in late November and late December, exceeding 10 m/s. These westerlies generate strong eastward jets (>1m/s) on the equator, and downwelling near the eastern boundary. These equatorial jets are realistically simulated by HYCOM. The analysis of the model output demonstrates that anomalous positive SSH at the eastern boundary propagates along the coast of Sumatra and Java as coastal Kelvin waves, which largely reduces the Indonesian Throughflow transport at Makassar Strait during January-February.

Indonesian Throughflow

Gordon et al. 2008



~80% of ITF transport pass through Makassar Strait

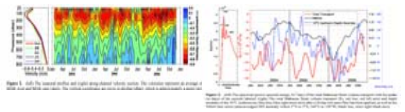
Important part of the global thermohaline ("conveyor belt") circulation carrying upper ocean waters from Pacific to the Indian Ocean

Global atmospheric circulation is extremely sensitive to SST in the Maritime Continent .

➔ Important region for global coupled model forecast

Seasonal variation of the Indonesian Throughflow

International Nusantara Stratification and Transport (INSTANT) observations (Gordon et al. 2008)

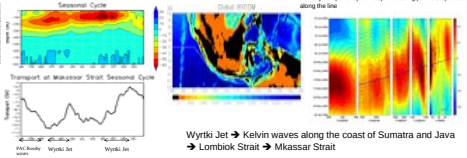


Reduction of ITF transport occurs in May and October-November.

The variation of upper ocean (1-300m) currents is mostly responsible for the reduction.

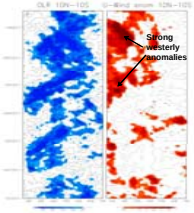
Modeling (Shinoda et al. 2012)

HYCOM is able to simulate seasonal variation of ITF



Wyrtki Jet ➔ Kelvin waves along the coast of Sumatra and Java ➔ Lombiok Strait ➔ Mkassar Strait

MJO events during CINDY/DYNAMO



Strong westerly winds associated with MJO events were observed in in central Indian Ocean during CINDY/DYNAMO.

How do these strong MJO events impact the Indonesian Throughflow?

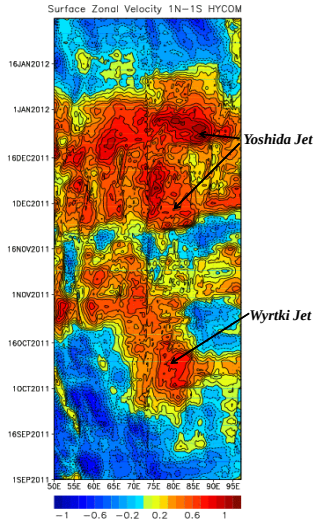
Model

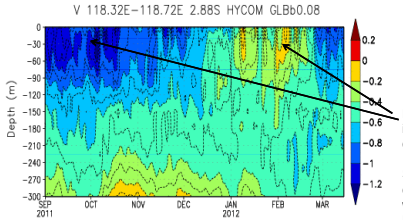
Global Hybrid Coordinate Ocean Model (HYCOM)

Horizontal resolution: 1/12º

Period: 2008-2012

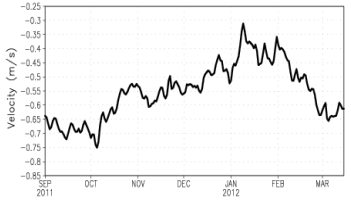
Surface forcing fields: NOGAPS



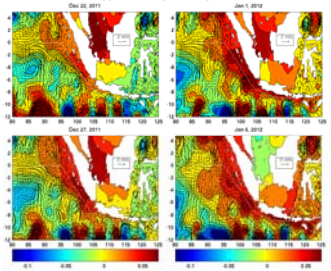


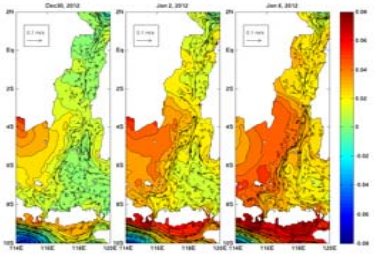
Large changes in upper ocean currents

Southward current is very weak in Jan.-Feb. in contrast to the seasonal cycle (rapid recovery of southward currents in Jan.-Feb.)



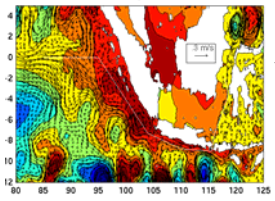
Anomalous upper ocean (50-150m) current and SSH

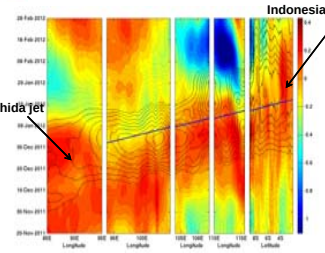




As SSH near the Lombok Strait increases, northward anomalous currents are accelerated

Yoshida Jet ➔ Increase of SSH at the eastern boundary ➔ Propagation along the coast of Sumatra and Java ➔ Lombok Strait ➔ Makassar Strait





Anomalous northward currents in the Indonesian Sea in January can be traced back to the Yoshida Jet generated by the MJO

Conclusion

Because of strong MJO events in late November and December 2011, the Indonesian Throughflow is largely influenced through the generation of strong Yoshida jet and the propagation of Kelvin waves.

Ongoing study ➔ Thorough comparison of HYCOM results with DYNAMO observations