Strait and Inter-Ocean Transport Estimation Using Altimetry SSH and Gravimetry OBP

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Introduction: Strait and inter-ocean transports are of fundamental interest to physical oceanography and ocean climate considerations, but are poorly understood because long-term and continuous measurements of strait circulations remain logistically challenging. We hypothesize that the magnitude and variability of strait transport varies with sea-surface height (SSH) and ocean bottom pressure (OBP) gradients between two inter-connected oceans. Recently, we have developed a theoretical method based on the combination of the "geostrophic control" and the "hydraulic control" principles—allowing the use of SSH and OBP variables for estimating inter-ocean transport and separating the transport into surface and bottom fluxes [*Song, JGR, 2006*]. This work is to test this theoretical method on estimation of the Indonesian Throughflow (ITF) transport by combining the satellite SSH and OBP data and verify the results with in-situ measurements.

Data used in this study are:

- AVISO
- GRACE (Gravity Recovery and Climate Experiment)
- INSTANT (International Nusantara Stratification and Transport)
- SITE (South China Sea – Indonesian Seas Transport/Exchange)

1. Theory and Methodology

Based on the "geostrophic control" formulation of Garrett and Toulany [1982] and the "hydraulic control" theory of Whiteheat et al. [1974], the strait or inter-ocean transport (anomaly) can be estimated by altimetry SSH and GRACE OBP data:

$$Q=\begin{cases}\dfrac{g}{f}\left\{H_1\Delta\eta+0.5H_2(\Delta p_b-\Delta\eta)\right\} & for \quad W>R \\ \dfrac{g}{f}H_1\Delta\eta+\kappa\left(\dfrac{2}{3}\right)^{3/2}H_2W\sqrt{g\,|\Delta p_b-\Delta\eta|} & otherwise\end{cases}$$

Notations:

Q --- strait transport

Δη --- SSH difference between two basins

Δ*Pb* --- OBP difference between two basins

H1, H2, W, R --- strait depth, width, Rossby radius of deformation

2. Transport Estimated from AVISO and GRACE

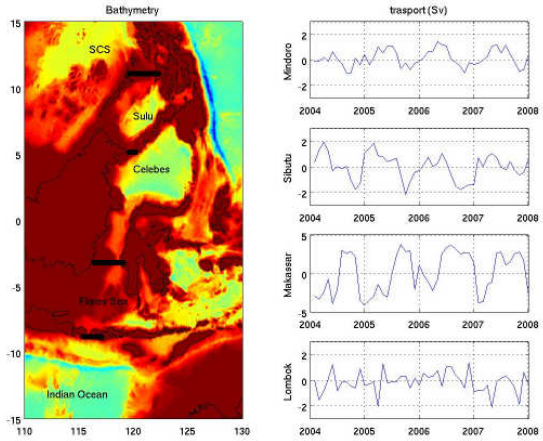

Figure 1: Transport (anomaly) estimated for Mindoro, Sibutu, Makassar, and Lombok Strait (preliminary result).

3. In-Situ Measurement and Model Development

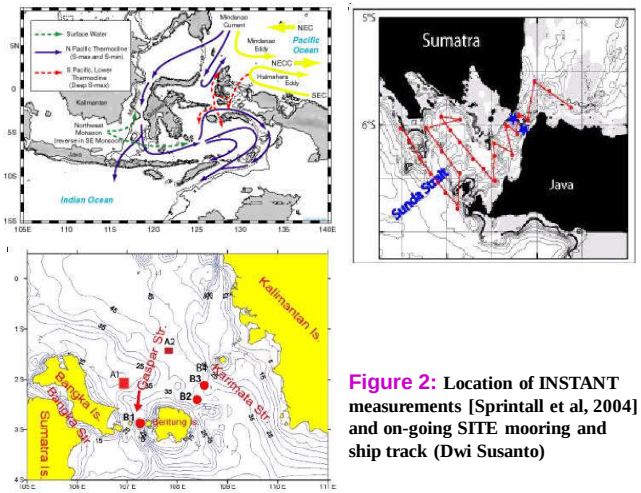

Figure 2: Location of INSTANT measurements [Sprintall et al, 2004] and on-going SITE mooring and ship track (Dwi Susanto)

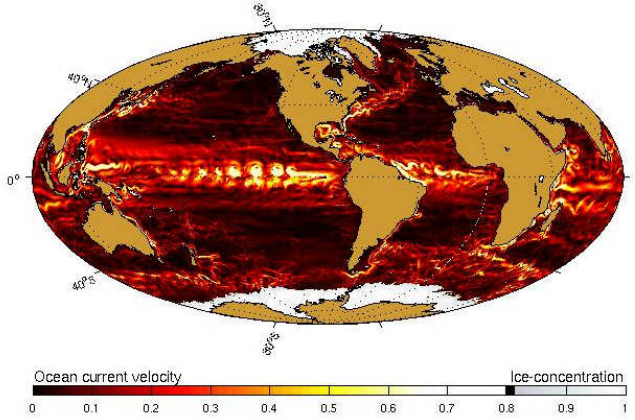

Figure 3: Coupled ice-ROMS for the global ocean: a snapshot of model ice concentration (white in the Arctic and Antarctic oceans) and ocean current speed (red).

Future Work will focuses on the following tasks:

- **Improve the theoretical method for estimating strait and inter-ocean transports based on along-track altimetry data**
- **Include ocean's mean dynamic topography and compare with in-situ measurements**
- **Compare with ocean circulation models**
- **Identity the controlling mechanisms of the ITF and the SCS through flow**

Reference:

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Sprintall, J., and coauthors, INSTANT: A New International Array to Measure the Indonesian Throughflow, *EOS Trans.*, VOL. 85, NO. 39, PAGE 369, 2004.

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