Response of the Indonesian Throughflow and its properties to different high resolutions and different bathymetries: a model case study

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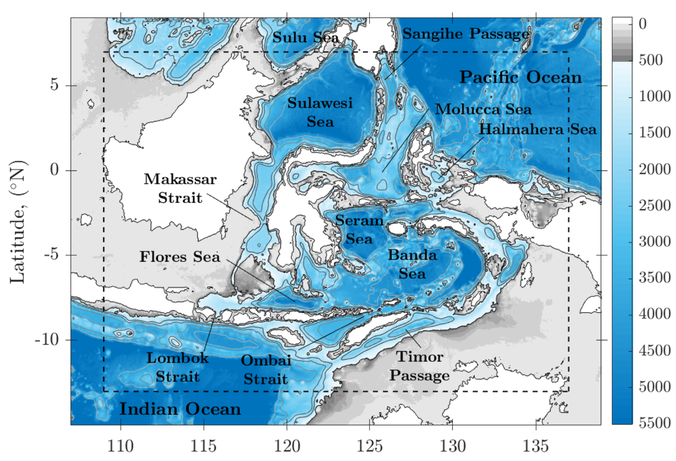
Context: Global climate and oceanic numerical models with a horizontal resolution smaller than 1/10º are poorly resolving the circulation through the Indonesian Seas due to the complex topography of the region, characterized by narrow straits and deep seas and the constraints of the topography on the circulation (Chassignet et al. 2020, Kiss et al. 2020). Is this discrepancy related to a misrepresentation of the complex bathymetry (roughness, size of the straits) or is it due to not resolving dynamical small scales (mixing)?

Model: Regional 3D simulations with MITgcm

- Boundary forcing: ACCESS-OM2-01 RYF 1990-91
- Surface forcing: JRA55-do (bulk formula)
- Bathymetry: SRTM30-PLUS (~1/100º)
- Vertical resolution: 2.1m (surf.) to 263m (bot.) - 100 levels
- Horizontal resolutions: 1/10º, 1/25º and 1/100º
- Bathymetry simulations: 1/25º (rough bathymetry) and HYBRID = 1/25º with 1/10º bathymetry (smooth bathy.)



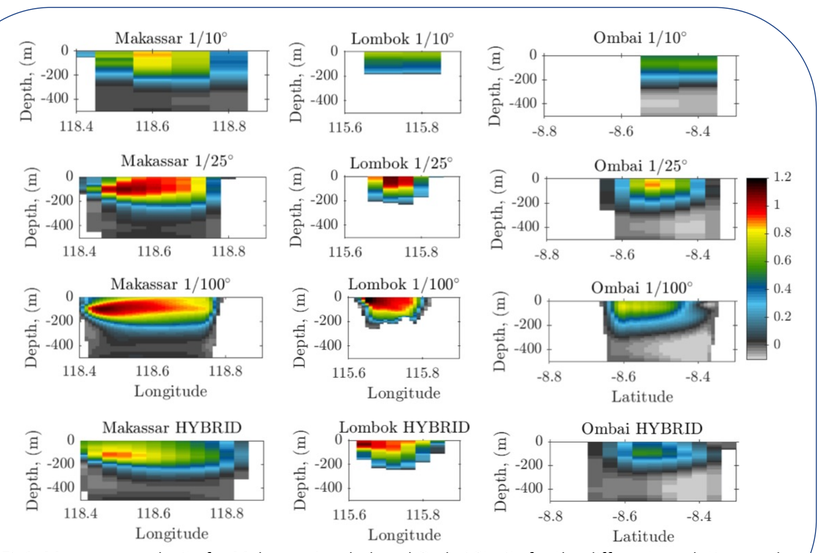


Fig1: Mean cross-velocity for Makassar, Lombok and Ombai Straits for the different resolutions and bathymetries.

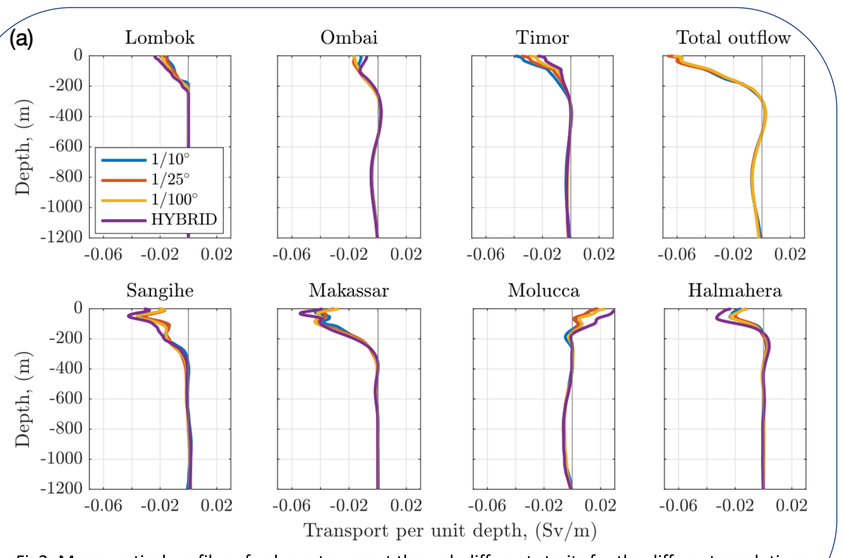


Fig2: Mean vertical profiles of volume transport through different straits for the different resolutions and bathymetries.

Results:

- High resolution: small scales, boundary layers, jets.
- Reso. & bathy.
  - change magnitude of the flow, not the vertical structure
  - More water along western route (Makassar) and less along eastern route (Molucca, Halmahera)

BATHYMETRY

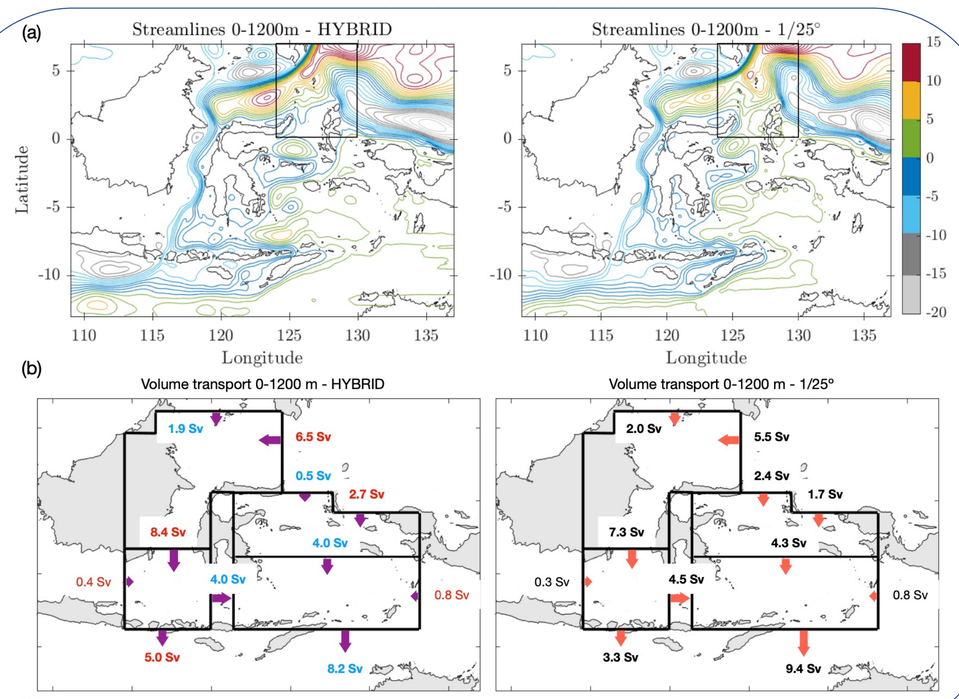


Fig3: (a) Mean circulation for the first 1200m. (b) Integrated transport through the box boundaries.

HORIZONTAL RESOLUTION

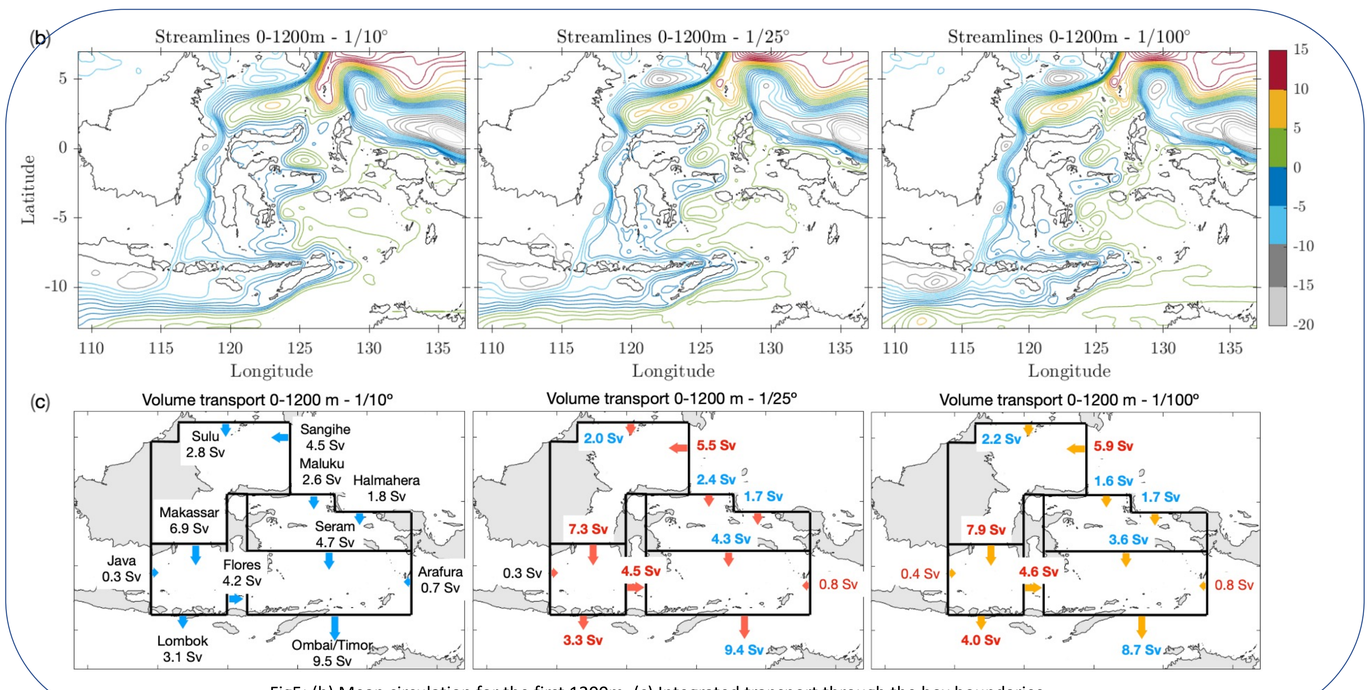


Fig5: (b) Mean circulation for the first 1200m. (c) Integrated transport through the box boundaries.

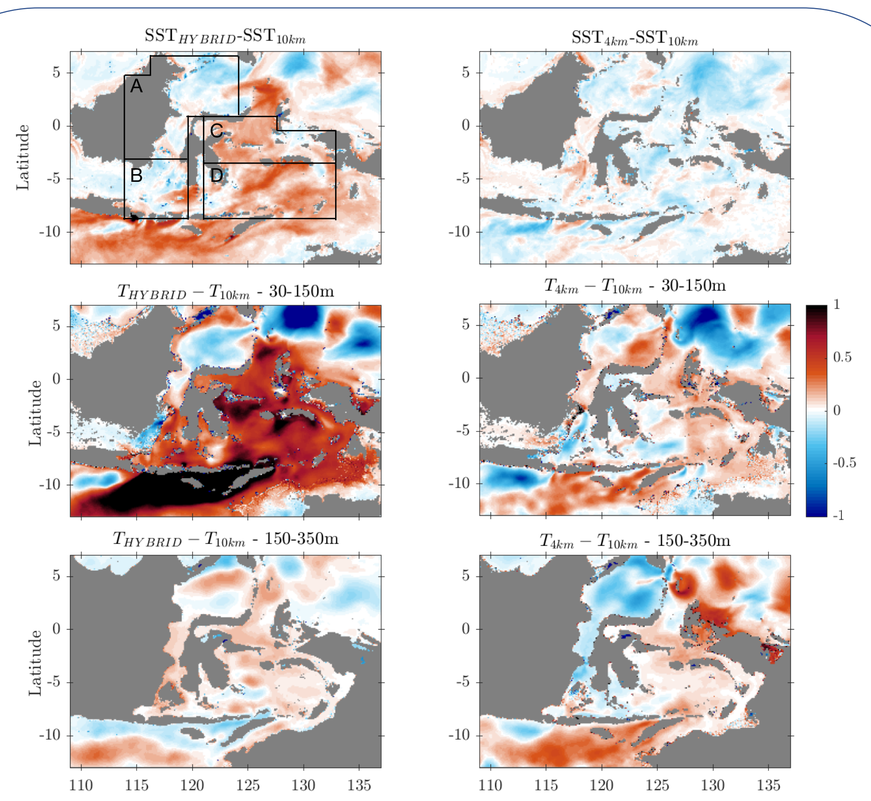


Fig4: Mean temperature difference for different layers (ºC)

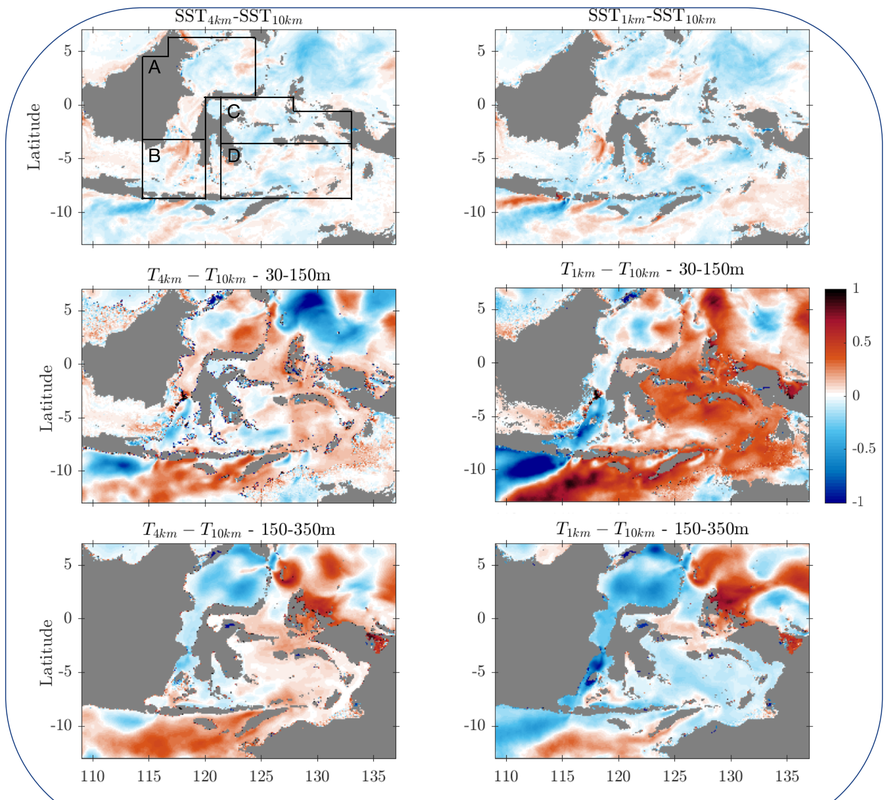


Fig6: Mean temperature difference for different layers (ºC)

Further work:

- Explore why the temperature change with resolution and bathymetry.
- Understand what matters the most (mixing, roughness, size of the straits, resolution, etc)