Oceanic fluxes: Boundary currents and Indonesian Throughflow

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Surface circulation pattern in boreal summer

**Indonesian Throughflow**: warm route of global overturning circulation, brings warm, fresh Pacific waters to the IO

**Somali Current system, South Java Current**: meridional exchanges

**Agulhas Current system**: Agulhas leakage contribute to the global overturning

**Leeuwin Current**: Influenced by Pacific-IO waveguide
ITF transport through different channels

Susanto 2016
Estimated global meridional heat transport

Lumpkin and Speer 2007
Indian Ocean overturning streamfunction from OFAM3

Jie Ma

(a) Indian Ocean meridional overturning streamfunction

ITF

Shallow overturning

deep transport

Jie Ma
A simplified version of the shallow overturning cells in the Indian Ocean

Easterly wind

Heat loss to atmosphere

Heat gain by ocean

Westerly wind

0 m

30S  20S  10S  Equator  N

50 m

Ekman flow

Downwelling

Southern cell

Southern upwelling

Thermocline flow

Northern upwelling

Cross-equatorial cell

500 m

Deeper ocean below the thermocline

Lee 2004
Contribution of heat advection into SIO upper 700m
Fast warming trend in the Indian Ocean

SST trend during 1900-2016

Ying Zhang
Indian Ocean observing system
Geostrophic transport of the ITF

Meyers et al. 1995

Wijffels and Meyers 2008
Composite of the ITF transports in El Nino

La Nina

Total ITF

El Nino

Total ITF

Liu, Feng, Wang, Wijffels 2015

Decadal trend

ITF Ano: Yearly Mean

\[ y = 0.093x - 1.442; \quad p = 0.0407 \]

Wijffels et al., 2008

15°S

30°S

100°E

120°E

140°E

160°E
Geographical location and Vertical section of the ACT mooring array

L. Beal
Recommendations

• Maintain the frequently repeated IX1 XBT section across the ITF, and enhance the section with additional salinity measurements by using XCTDs and/or by increasing the density of Argo floats around IX1; There is a need to have more emphasis on the end point measurements of the IX1 section, especially at the northern end of the Sumatra-Java coast to resolve the South Java Current.

• Maintain the frequently repeated IX12 XBT section across the Somali Current system.

• Establish an international alliance to coherently monitor the ITF volume and heat transport as well as biogeochemical fluxes in different inflow and exit channels, to aid the interpretation of the geostrophic transport estimates from the IX01 XBT section.

• Maintain the ASCA mooring array for the Agulhas Current system; Integrated observing systems maintained through regional alliances and combining moorings, gliders, and periodic ship measurements are optimal.
Recommendations

• Establish a boundary current array for the Leeuwin Current to monitor the coastal waveguide along the Australian coast to assess the influences of decadal Pacific climate on the Indian Ocean, and combined mooring and gliders observations will be optimal.

• Maintain the existing network of island and coastal sea level stations and ensure open accessibility of sea level data from this network, so that historical boundary current transports such as the Leeuwin Current as well as the ITF can be estimated using sea level proxies – Fremantle sea level records have been crucial to monitor the Pacific influences on the interannual and decadal variability of the Leeuwin Current and their impacts on the interior southern Indian Ocean, as well as evaluating numerical model performance.

• Maintain satellite altimeter missions to characterize long term variations of mesoscale eddy energetics in the ocean boundary currents in the Indian Ocean.