Monitoring the Indonesian Throughflow in Makassar Strait

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Project Summary

The Indonesian Throughflow (ITF) transfers tropical Pacific water into the Indian Ocean, at a rate of ~ 15 million m^3/sec. Strong monsoonal winds and tidal dissipation within the complex sea floor morphology setting alter the velocity, temperature and salinity profiles of the ITF producing a unique Indonesian seas' water column, which is then injected into the Indian Ocean. As the ITF region is at the nexus of El Niño-Southern Oscillation (ENSO), the Indian Ocean Dipole (IOD) and Asian monsoon phenomena, it is highly likely, as indicated by model studies, that the ITF serves as a key component of the larger-scale climate system. Recording the ITF is a cost effective way to monitor an integrating component of the larger-scale ocean and climate system; the ITF may be viewed as a proxy of the larger scale ocean coupling to ENSO, IOD and Asian monsoon. A sustained observational array of moorings for measuring all of the pathways is not financially practical. However, a significant step towards this goal is met by monitoring the throughflow within Makassar Strait, which carries >90% of the thermocline layer component of the ITF (80-85% of the total ITF).

The NOAA/OCO funded Makassar mooring deployed near 3°S in the Labani Channel constriction of Makassar Strait in December 2006, was recovered and re-deployed in 2009, and recovered in August 2011, extending the time series begun with the NSF funded INSTANT program; January 2004 to the end of November 2006, to 7.5 years. In 2008-2009, a La Niña period, the Makassar throughflow profile dramatically changed, with the characteristic thermocline velocity maximum increasing from 0.7 to 0.9 m/sec and shifted from 140 m to 70 m into warmer stratum, amounting to a 47% increase in warm water transport between 50 and 150 m during the boreal summer. We believe that this is a consequence of ENSO sensitive changes of the South China Sea (SCS) throughflow of buoyant surface layer water via the Sulu Sea into the Indonesian seas through the Sibutu Passage: during La Niña SCS throughflow is reduced or reversed, relative to El Niño, allowing tropical Pacific surface flow into the ITF, increasing the flux of warm water available to spread into the Indian Ocean, affecting regional sea surface temperature and climate.

The Makassar time series is of use to climate researchers (for understanding and predictive objectives), to oil industry activities within Makassar Strait as an aid in operations and oil spill issues, and potentially of understanding the marine ecosystem. The Makassar observational time series agrees very well with the HYCOM output, validating that model. The Makassar time series is available at http://www.ldeo.columbia.edu/res/div/ocp/ITF/cm_data/ to February 2009. We make the data public ~12 months after data retrieval from the field, which is roughly every second year. Though if requested we can provide less QC data products.

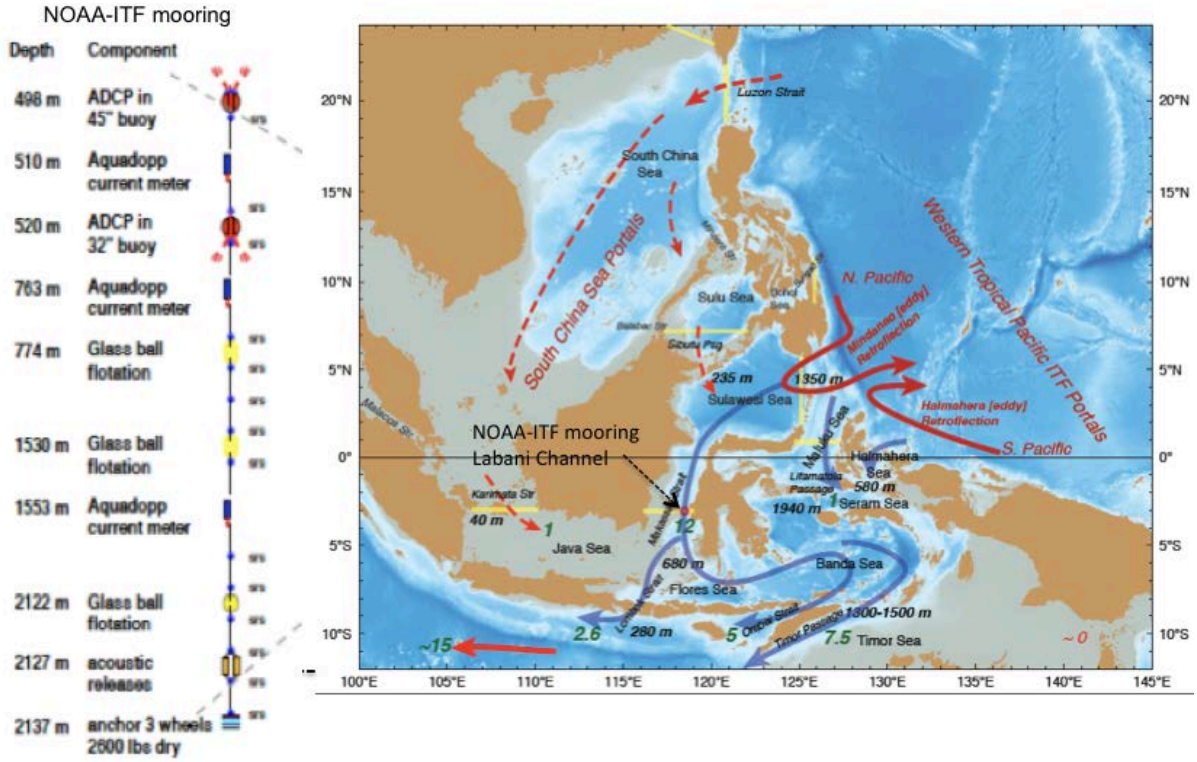

Figure 1. Left Panel*: configuration of the NOAA-ITF mooring;* ***Right Panel****: Schematic of the Indonesian Throughflow circulation. The primary source for the ITF is the western tropical Pacific at ~ 4°N, but additional inflow is derived from the South China Sea, drawn from Luzon Strait. Topographic sill depths are given in black italics. The blue arrows depict the ITF. ITF transports in Sv (10^6 m3/s) are shown for each passage in green [from the INSTANT program, 2004-2006]. Makassar Strait Throughflow NOAA OCO mooring site is identified.*