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Coral-Based Reconstruction of Salinity and Temperature Variability in the Southern Makassar Strait

Coral-based reconstruction of salinity and temperature variability in the southern Makassar Strait and its Influence on the Indonesian Throughflow

Intellectual Merit: As the only low latitude interocean conduit, the Indonesian Throughflow (ITF) annually transports surface and thermocline depth water from the Pacific Ocean north of the equator to 12°S in the Indian Ocean and may be influential to global thermohaline circulation. Today, the net result of the ITF is a cooling and freshening of the Indian Ocean thermocline. Gordon et al. (2003) observed that the seasonal influx of low salinity surface water from the South China and Java Seas into the Makassar Strait generates a northward pressure gradient during the NW monsoon that seasonally inhibits the flow of warm surface water in the far western Pacific Ocean from freely flowing southward into the Indian Ocean. Although we now have a more complete understanding of interannual variations in this "headwater" region of the ITF over the last several ENSO cycles, little is known about longer term, lower frequency Makassar Strait salinity, temperature and related ITF variations. Relatively low resolution results from sediment cores in the Makassar Strait indicate that during the Little Ice Age (LIA), salinity and SST in the strait were both reduced (Newton et al., 2006; Oppo et al., 2009; Linsley et al., in review).

Here we are proposing to use *Porites sp*. coral cores from Kapoposang in the southern Makassar Strait near S.W. Sulawesi and from Gili Meno in the Lombok Strait near Bali to develop near-monthly resolution Sr/Ca and $\delta^{18}O_{sw}$ records spanning the last 250 years into the LIA. Coral cores from these and other nearby sites have been previously collected and some preliminary $\delta^{18}O$ and radiocarbon results generated (Moore, 1995; Fairbanks et al., 1997; Moore et al., 1997; Charles et al., 2003; Fallon and Guilderson, 2008; Guilderson et al., 2009). We recently completed monthly resolution analyses of a short section of *Porites* core from Kapoposang collected by T. Rixen in 2004. These results demonstrate that the 2-3 p.s.u. salinity reduction during December-February is recorded in Makassar Strait coral $\delta^{18}O$. In addition we show that coral Sr/Ca variability accurately tracks the annual bi-modal SST cycle where SSTs peak in ~May and then again in ~November. The fact that coral Sr/Ca at this site records the subtle bi-modal SST changes attests to the fidelity of this tracer at this location. Here we are proposing to extend our Sr/Ca record back to 1750 AD at Kapoposang and back ~170 years in the Gili Meno core. We also propose to partially replicate existing $\delta^{18}O$ series at each site to rigorously evaluate the significance of $\delta^{18}O$ trends. Our goals are to better understand salinity and SST variability in this critical strait in order to constrain ITF variability over the last 250 years. Changes in the freshwater budget of the southern Makassar Strait are expected to alter the intensity of the "freshwater plug", with lower salinity in the Makassar Strait surface layer leading to a cooler ITF (Gordon et al., 2003).

Broader Impacts: The "reach" of the ITF and potential downstream effects in the Indian and perhaps Atlantic Oceans underlies the importance of understanding what drives interannual to interdecadal variability of this current. A stronger southern Makassar "freshwater plug" would reduce the transfer of warm water from the WPWP into the Indian Ocean, with possible feedbacks to ENSO and the Indian Ocean dipole. This research would lead to increased collaboration between Dr. Linsley and Dr. Tim Rixen (Leibniz Center for Tropical Marine Ecology in Bremen, Germany), Dr. Jamaluddin Jompa (Center for Coral Reef Research in Makassar, Indonesia), and Dr. Chris Charles (Scripps Instit. of Oceanography). A postdoctoral associate would receive valuable training as part of this research. Research supported by undergraduates would be an integral part of this project. The results of this project would also add valuable environmental base-line data related to changes in the reef/ocean environment in the "coral triangle", a region of Indonesia and the western Pacific with high coral diversity that has been targeted for research by several US federal agencies and independent environmental organizations.