Dynamics of Regional Heat Convergence and Deep-Ocean Warming in the subtropical South Pacific and Indian Oceans

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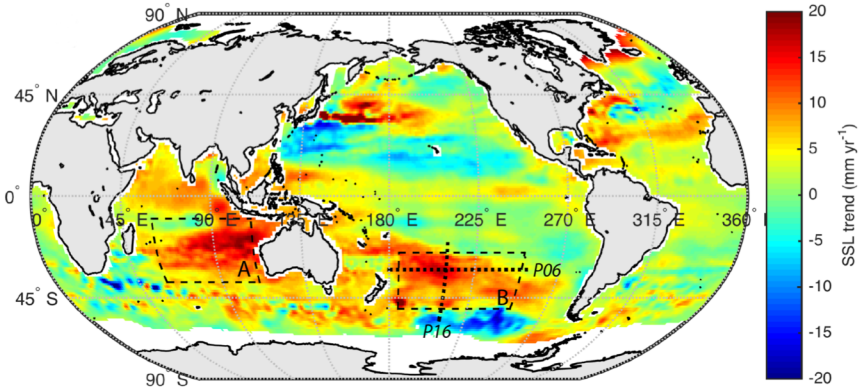
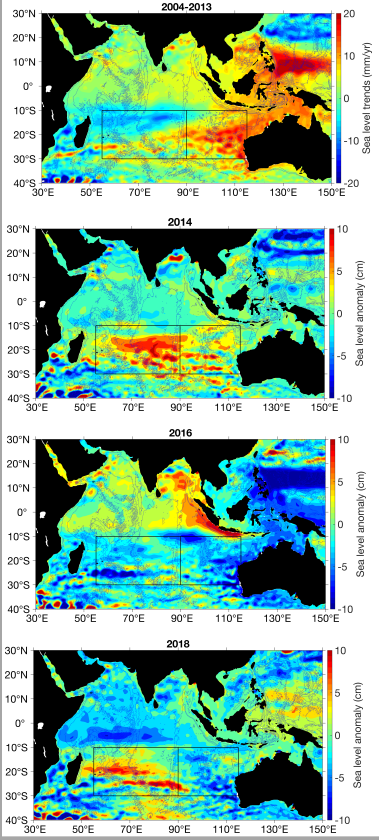
The overarching goal of the project (NNX17AH59G**):** To monitor and analyze the mechanisms of heat accumulation in the subtropical South Pacific and Indian Oceans.

Science questions addressed: (i) Does the observed accumulation of heat in the South Pacific extend below 2000 m depth? (ii) What physical processes and mechanisms are responsible for the observed variability of heat content? (iii) How did the 2014-2016 El Nino event affect the heat South Indian Ocean heat content?

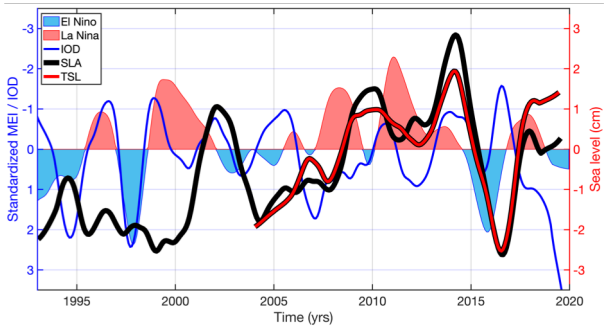
Work in progress: (i) The 2014-2016 El Nino effect on the deep-ocean heat content in the South Pacific; (ii) Investigating whether the 2014-2016 El Nino was the onset of a long-term cooling trend or it was a transient negative anomaly; (iii) Exploring the impact of cooling in the South Indian Ocean in 2014-2016 on heat content and transport in the South Atlantic.



South Indian Ocean (SIO) (see presentation by Volkov et al. in Science II)



Following the onset of the very strong El Niño, the decade-long upper-ocean warming in the SIO in 2004-2013 ended with an unprecedented cooling in 2014-2016, followed by a quick recovery during the weak 2017-2018 La Niña

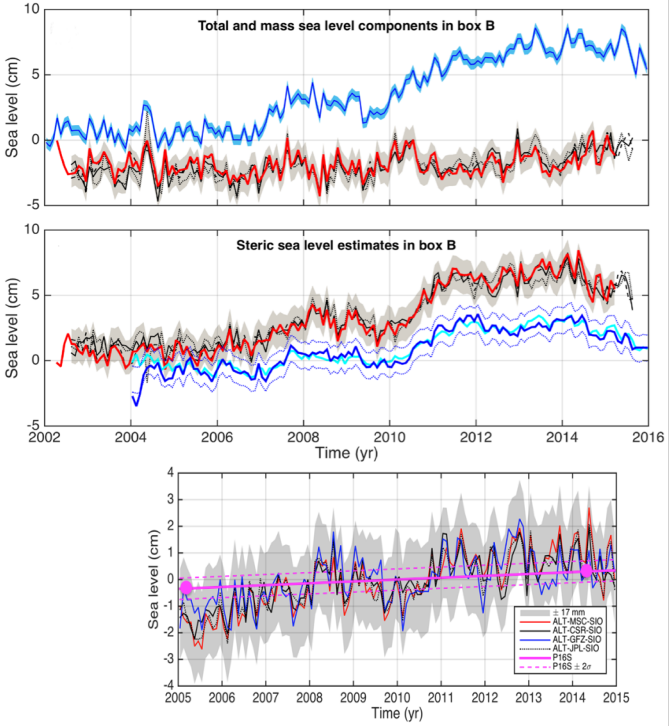


- The 2014–2016 El Niño contributed to the observed cooling through an unusual combination of both the reduced heat advection from the Pacific (dominant in the eastern SIO) and the basin-wide cyclonic wind anomaly that led to shoaling of isotherms (dominant in the western SIO)
- The ensuing recovery was mainly forced by an anticyclonic wind anomaly associated with stronger trade winds that caused deepening of isotherms and upper-ocean warming, effectively suppressing the 2014–2016 cooling signal propagating from the eastern boundary.
- The interannual variability of sea level and heat content in 1993-2019 was dominated by the local wind forcing in the western SIO and by the eastern boundary (remote, originated in the Pacific) forcing in the eastern SIO

Volkov D.L. , S.-K. Lee, A.L. Gordon, M. Rudko (2020), Unprecedented reduction and quick recovery of the South Indian Ocean heat content and sea level in 2014-2018, *Science Advances*, 6(36), eabc1151, https://doi.org/10.1126/sciadv.abc1151.

South Pacific Ocean

- By combining altimetry, GRACE, and Argo measurements, we report on consistency between the indirect and direct estimates of the deep-ocean (>2000 m depth) warming in 2005-2014 in the subtropical South Pacific
- The directly and indirectly inferred deep-ocean warming was consistent with the upper-ocean warming, and likely driven by persistent wind-driven convergence intrinsic to La Niña-like conditions



Volkov, D. L., S.-K. Lee, F. W. Landerer, and R. Lumpkin (2017), Decade-long deep-ocean warming detected in the subtropical South Pacific, *Geophys. Res. Lett.*, 44, 927–936, doi:10.1002/2016GL071661.