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High-precision measurements of Southern Indian Ocean seawater isotopes ($\delta^{18}O$) using laser absorption spectroscopy

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Measurement of stable oxygen isotope ratios ($\delta^{18}O$) in water has been an important tool for understanding both modern and past climate and environmental conditions, particularly in terrestrial hydrologic systems.$\delta^{18}O$ in the ocean is controlled by Rayleigh fractionation during evaporation and precipitation that is strongly governed by temperature, making $\delta^{18}O$ a conservative interior water mass tracer. Seawater $\delta^{18}O$ data is relatively sparse, especially from the Indian and Southern Ocean. The assumption that seawater isotope variability throughout the global oceans is negligible in addition the the time and cost of analyzing hundreds of samples using traditional isotope ratio mass spectrometry (IRMS) have been mitigating factors in minimizing data collection.

The development and improvement of laser-based gas analyzers based on off-axis integrated cavity output spectroscopy (OA-ICOS) and cavity ring-down spectroscopy (CRDS) over recent decades has provided an opportunity for relatively low-cost, high-precision $\delta^{18}O$ measurements of natural waters to be analyzed without the time, expense and overhead of traditional IRMS. Previous studies have compared the precision and reproducibility of laser-based spectroscopy with IRMS techniques and found measurements of fresh waters using OA-ICOS and CRDS to be comparable to IRMS with a higher throughput and lower cost. This has drastically increased the data available for modern and paleoclimate water cycle interpretations. However, the feasibility of using laser absorption spectroscopy, particularly using OA-ICOS, for seawater samples has remained understudied.

Using a systematic cleaning routine, sample analysis, and data normalization approach, we present seawater $\delta^{18}O$ data from the Southeastern Indian Ocean from November-December 2018 and show that measurement accuracies of ± 0.1‰ for $\delta^{18}O$ are achievable using OA-ICOS. We find a > 1.0‰ range in $\delta^{18}O$ values between surface and bottom water samples and an average $\delta^{18}O$ difference between subtropical and Antarctic waters of 0.36‰.