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Decadal sea-level changes in the Indian Ocean

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While the Interdecadal Pacific Oscillation (IPO) has been identified as the main driver of natural decadal sea-level variations in the Pacific, Indian Ocean natural decadal sea-level variability remains a largely uncharted territory. In this study, we analyse Indian Ocean natural decadal sea-level variations from a large set of observational products, CMIP3 and CMIP5 pre-industrial simulations.
The various observational products display very consistent patterns of decadal sea-level variability in the Pacific, but not in the Indian Ocean, most likely because of sparse observational coverage in the IO. In contrast, almost all CMIP simulations display two very consistent patterns of Indian Ocean decadal sea-level variability, which explain a large part of the total sea-level variance in this basin. The first mode consists of a dipolar sea-level pattern, with negative signals in the eastern Indian Ocean from the west coast of Australia to the northern Bay of Bengal and positive signals northeast of Madagascar. This mode is largely driven by the wind variability related to the decadal variations of the Indian Ocean Dipole, which is partly independent from decadal climate variability in the tropical Pacific. The second mode is completely independent from decadal Pacific variability, and consists of a broad sea-level pattern east of Madagascar. This mode is excited by decadal wind variations in the subtropical Indian Ocean, most likely associated with fluctuations of the Mascarene high.
The two decadal modes identified in CMIP models are broadly consistent with those deduced from the relatively short altimeter dataset or from the longer ORA reanalysis. Sea-level reconstructions generally reproduce the dipolar mode but do not capture the decadal sea-level variability east of Madagascar, presumably because of the absence of long tide-gauge records in this region. This study hence illustrates that CMIP simulations can provide some guidance for identifying robust modes of decadal sea-level variability in regions that are not well sampled by observations.