The Indian Ocean Dipole and great earthquake cycle: long-term perspectives for improved prediction

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Climatic extremes in the densely populated tropical Indian Ocean region are controlled by the interplay between the El Niño-Southern Oscillation (ENSO), Asian monsoon and Indian Ocean Dipole (IOD). Reliable instrumental records of the IOD only cover the last 50 years. To better understand IOD variability, we use a suite of *Porites* coral $^{18}O/^{16}O$ records to extend the basin-wide index of IOD behaviour back to 1846 AD. Our analysis reveals a 3-fold increase in the frequency of IOD events since 1960, accompanied by the development of feedbacks between the IOD and Asian monsoon. We also use coupled Sr/Ca and $^{18}O/^{16}O$ analysis of fossil corals to examine the character of prehistoric eastern IOD upwelling events. During the mid-Holocene, when the Asian monsoon was relatively strong and ENSO was weak, IOD events were characterised by more protracted cooling and droughts in the eastern Indian Ocean [1]. Together, the results suggest that any strengthening of the Asian monsoon in the future will lead to opposing east-west trends in rainfall across the Indian Ocean, with more severe IOD droughts in western Indonesia.

An unanticipated "spin-off" of this work is the finding that skeletal $^{13}C/^{12}C$ in *Porites* corals records vertical crustal deformation during earthquakes, such as the 2004 and 2005 events in Sumatra. Water column light intensity and skeletal $^{13}C/^{12}C$ in symbiotic corals are inextricably linked. Our records show that $^{13}C/^{12}C$ is sensitive to the increase in ambient light intensity when corals rise to shallower water during co-seismic uplift. We now have coral $^{13}C/^{12}C$ time-series showing crustal deformation before, during, and after the 1797, 1907 and 1935 AD earthquakes in Sumatra. With further refinement, the coral "chemo-geodesy" technique could shed light on the recurrence intervals of great submarine earthquakes and tsunamis in island arc subduction zone settings throughout Australasia and the tropical western Pacific region.

[1] Abram *et al*. (2007) *Nature* **445**, 299-302.