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Mid- to Late Holocene Indian Ocean Monsoon variability recorded in four speleothems from Socotra Island, Yemen

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Since the Mid-Holocene, the summer position of the Intertropical Convergence Zone (ITCZ) is gradually moving south due to the diminishing boreal summer insolation (Wanner et al., 2006). Understanding this behavior for the Indian Ocean Monsoon (IOM) and its northeast and southwest subsystems is of major importance, especially since further drying is predicted (Fleitmann et al., 2007). To investigate how precipitation from the northeast IOM subsystem is evolving since the mid Holocene, we sampled four stalagmites on Socotra, an island in the northern Indian Ocean. On Socotra, rain is delivered at the start of the southwest IOM in May-June and at the start of the northeast IOM from September to December. The Haggeher Mountains, reaching up to 3000m altitude in the middle of the island, act as a barrier forcing rain delivered by northeast winds to fall on the eastern side of the island, where the studied caves are located. δ18O and δ13C and Mg/Ca and Sr/Ca signals in the stalagmites are interpreted as indicators of wetter or drier conditions created by the northeast IOM. The stalagmite records suggest a weakening of the northeast precipitation between 6.0 and 3.8 ka. After 3.8 ka precipitation intensities remain constant with two superimposed drier periods, between 0 and 0.6 ka and from 2.2 to 3.8 ka. A similar δ18O record to that of eastern Socotra occurs in Northern Oman stalagmites after 6.2 ka. At this time, the summer ITCZ moved south of Northern Oman making precipitation from northeast winds the only moisture source available. A drying around 6 ka is also seen in sedimentary records from the Arabian Peninsula (Lezine et al., 2010; Parker et al., 2006), which nowadays are located outside the migration pathway of the ITCZ. Records on the Arabian Peninsula that today are still within the ITCZ migration belt, and thus receive rain by both the northeast as the southwest IOM, display a gradual drying after the wet Holocene optimum at 8.0 ka. In contrast to the stable northeast rainy season suggested by the records in this study, speleothem records from western Socotra indicate a wettening of the southwest rainy season on Socotra after 4.4 ka. The local wettening of western Socotra could related to a more southerly path (more over the Indian Ocean) taken by the southwest winds. This local effect shows that in a generally drying pattern, smaller-scale regional changes towards wetter conditions can occur.

Fleitmann et al., 2007, QSR; Lezine et al., 2010, Global Planet Change; Parker et al., 2006, Quaternary Research; Wanner et al., 2006, QSR