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Decadal- to biennial scale variability of planktic foraminifera in the northeastern Arabian Sea during the last two millennia: evidence for winter monsoon forcing mechanisms

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The Asian monsoon system is controlling the hydrologic cycle, and thus the agricultural and economic prosperity of the worlds most densely populated region. Strong and moisture-laden winds from the southwest induce upwelling and significant productivity in the western Arabian Sea during boreal summer. During boreal winter, weaker dry and cold surface winds from the northeast nourish ocean productivity mainly in the northeastern Arabian Sea. Instrumental records spanning the last century are too short to understand how the monsoon system reacts to external forcing mechanisms and to accurately determine its natural variability. Compared to the summer monsoon component, the dynamics of the winter monsoon are virtually unknown, due to the lack of adequate archives that are affected only by winter conditions.

Here we present a decadal- to biennial-scale resolution record of past winter monsoon variability over the last two millennia, based on census counts of planktic foraminifera from two laminated sediment cores collected offshore Pakistan. One shorter box core (SO90-39KG) spans the last 250 years with an average 2-year resolution, whereas the longer piston core (SO130-275KL) spans the last 2,100 years with a 10-year resolution. We use *Globigerina falconensis* as a faunal indicator for winter conditions, a species that is most abundant during winter in the NE Arabian Sea (Peeters and Brummer, 2002; Schulz et al., 2002).

Our results show that during the past 2,100 years *G. falconensis* varied with significant periodicities centered on ~60, ~53, ~40, ~34 and ~29 years per cycle. Some of these periods closely match cycles that are known from proxy records of solar irradiance, suggesting a solar forcing on winter monsoon variability. During the past 250 years *G. falconensis* varied in correlation with the (11-year) Schwabe and the (22-year) Hale solar cycles. Furthermore, a significant ~7 year cyclicity could indicate a teleconnection to the El Niño Southern Oscillation, but is at the edge of the resolution of this record. A significant harmonic 46-year cycle, however, is coherent with the winter Pacific Decadal Oscillation (PDO) index, the leading mode of sea surface temperature (SST) anomalies in the North Pacific. Cold (warm) SST in the North Pacific are associated with higher (lower) abundances of *G. falconensis*. Wavelet coherency analysis revealed increasing coherence on higher frequency timescales since the 1960s, suggesting that global warming could lead to a stronger linkage between winter monsoon and PDO.

References:

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