Climate Variability in the Northern Arabian Sea During the Holocene

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Context & Objectives

The Arabian Sea is a highly dynamical climate system characterized by a pronounced seasonal reversal in monsoonal winds and precipitations. Currently, there are limited studies from the northern Arabian Sea that reconstruct high-resolution hydroclimatic and terrestrial environmental changes during the Holocene. In this study we use a multi-proxy approach of a partially laminated marine sediment core in the upper part of the Makran accretionary prism in order to investigate:

(i) the hydroclimate dynamics of the region during the Holocene
(ii) a potential relationship between climate variability on the development of regional human societies.

Study Area

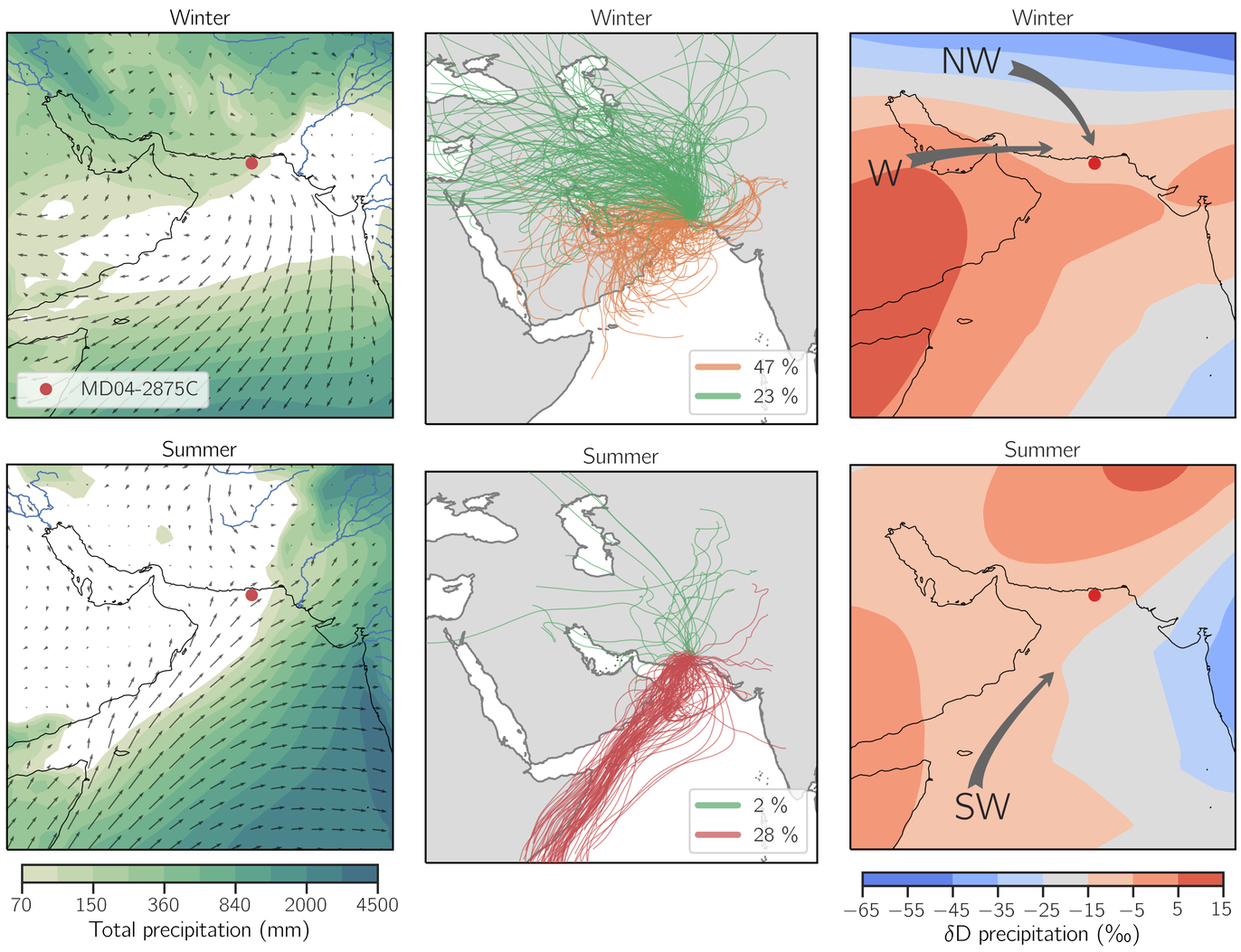

Figure 1 – Modern seasonal hydrological setting. Winter (Nov-Apr) and summer (May-Oct) **(left)** mean accumulated precipitation and wind fields (ERA-Interim reanalysis 1979-2010), **(middle)** cluster analysis of humid backward trajectories indicating percentage of annual precipitation (HySPLIT model [1]; NCEP/NCAR reanalysis 1996-2000) and (**right**) stable hydrogen isotopic composition of precipitation (IsoMAP model [2]; jobs 74671, 74680, 74682) show marine sediment core MD04-2875C being situated in a transition zone of summer and winter precipitation. On-shore river run-off is mainly fed by winter westerlies (W) and north-westerlies (NW) with less impact from summer south-westerlies (SW).

Results

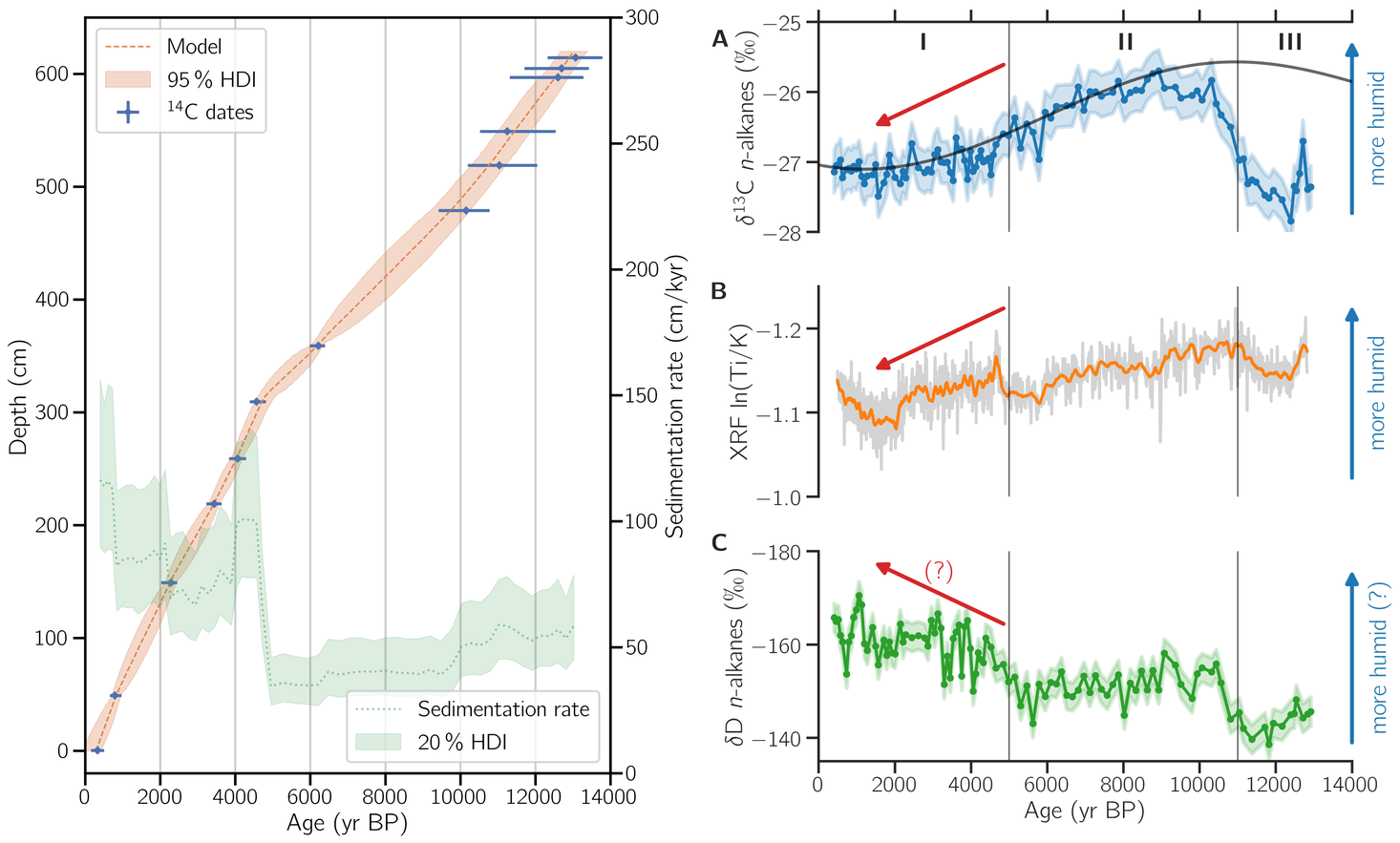

Figure 2 – (Left) Age model of MD04-2875C based on software Bacon [3] assuming local reservoir age $\Delta R = 160 \pm 30$ (470 ± 250) yr for < 6 (> 6) kyr BP **(Right)** XRF and plant leaf wax analyses show aridification and moisture source changes.

Discussion

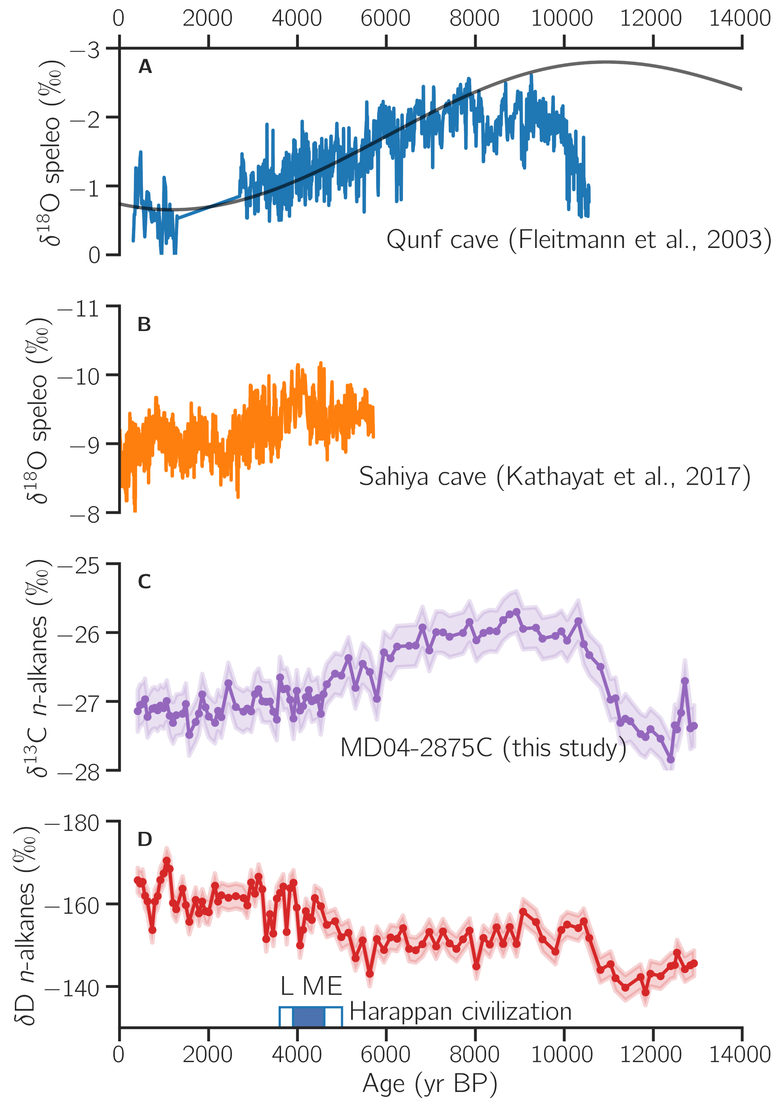

Figure 3 – Hydroclimatic changes around the Arabian Sea. Speleothem records [4,5] in comparison to this study suggest global aridification and transition from a summer to a winter precipitation system (Fig. 1, right) coinciding with the rise and fall of the Harappan civilization (e.g. [6]).

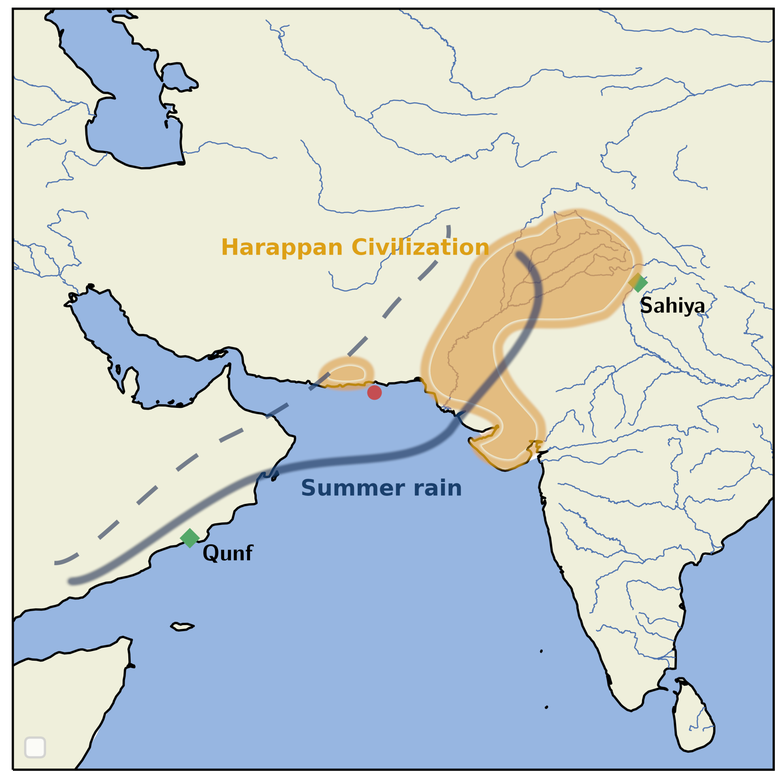

Figure 4 – Arabian Sea and the Harappan Civilization. Shifting summer rain belt to a more south-eastern position could have favoured more intense NW intrusions altering summer-winter-rain distribution and thus local subsistence of human civilizations.

Conclusion & Perspective

(i) The Arabian Sea seems to have suffered from an aridification during the Holocene potentially driven by decreasing maximum summer insolation.
(ii) Results suggest a modification in seasonal precipitation patterns at around 5 kyr BP coinciding with the development of the Harappan civilisation.
(iii) Numerical experiments with isotope-enabled circulation models are planned to test the hypothesis of switching summer-winter precipitation conditions.

References

[1] Draxler and Hess, 1998, *AMM*; [2] IsoMAP, 2015, http://isomap.org; [3] Blaauw and Christen, 2011, *Bayesian Analyses*; [4] Fleitmann et al., 2003, *Science*; [5] Kathayat et al., 2017, *Science Advances*; [6] Sarkar et al., 2016, *Science Reports*