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Climate of the Past
Discussions

Interactive comment on "Western Mediterranean hydro-climatic consequences of Holocene iceberg advances (Bond events)" *by* Christoph Zielhofer et al.

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Dear Editor, Anonymous Referee #1 [Review, 16th September 2018] suggested comparing our Sidi Ali δ18O record with a NAO record to support the hypothesis that the Sidi Ali δ18O signal represents a proxy for winter precipitation. We added in our first reply [Reply letter, 13th October 2018] the NAO record by Olsen et al. (2012) that covers the last 5.3 ka. However, due to the higher resolution of the NAO record a direct comparison between the NAO (Olsen et al., 2012) record and our Sidi Ali δ18O record seems to be difficult. In the current reply letter, we added a 500 yr lowpass filter for the NAO record to facilitate a direct comparison (Fig. 2h). Although a direct comparison

between the filtered records (NAO and Sidi δ18O, Fig. 2d and 2h) remains challenging due to the different resolution and scattering of the original datasets, similarities might be noticeable:

a) Both filtered records (NAO and Sidi Ali δ18O) reveal troughs around 4.2, 3.3, and 2.7 cal ka BP that can be interpreted as increases in south-western Mediterranean winter precipitation. A generally cool and humid interval that is probably in phase with negative-NAO like pattern in the south-western and north-central Mediterranean basin around 4.2 cal ka BP (Bond event 3) is supported by a currently published manuscript by Di Rita and Magri (2018, this issue).

b) Both filtered records show a general transition from a more winter arid Medieval Climatic Anomaly (MCA) to a more winter humid Little Ice Age (LIA). This is in agreement with available NAO records from Mediterranean North Africa (Trouet et al. 2009, Wassenburg et al. 2013).

Regarding the first half of the Holocene, a currently published manuscript about the prominent Padul record in SW Spain (Ramos-Romána et al., 2018) supports our suggestion for Early to Mid-Holocene millennial cyclic fluctuations (cf. Fig. 2d, Sidi Ali δ18O) in the south-western Mediterranean hydro-climate.

Finally, we slightly add and correct the captions (see below) of new figures 1 and 2 that were already provided in our previous reply letter [cf. Reply letter, 13th October 2018].

Olive bars in Fig. 1 indicate that Cedrus peaks at Sidi Ali correspond with Holocene summer cooling intervals in the sub-tropical belt. Therefore, we assume that maxima in the occurrence of Cedrus pollen might be mainly in line with summer cooling and less with variation in winter precipitation. This is also indicated by the sometimes-weak coincidence between Sidi δ18O and the Cedrus record at multi-centennial to millennial time scales (e.g. at 1.8 cal ka BP, Fig. 1). In contrast, the comparison of the filtered (500 yr lowpass) haematite-stained grain record from the North Atlantic (Bond et al., 2001) with the filtered (500 yr lowpass) Sidi Ali δ18O record (this study) indicate noticeable similarities. Red numbers and pale red bars in fig. 2 indicate North Atlantic cooling events and dry Western Mediterranean winters in the first half of the Holocene. However, there seems to be a significant hydro-climatic shift at around 5 cal ka BP in the Western Mediterranean basin. Blue numbers and pale blue bars in fig. 2 indicate North Atlantic cooling events and wet Western Mediterranean winters in the second half of the Holocene.

Kind regards Christoph Zielhofer, William Fletcher, Steffen Mischke et al.

Figure captions

Figure 1. Holocene sub-tropical summer temperature record versus Sidi Ali Cedrus record and Western Mediterranean (Sidi Ali) winter rain record: A) Improved Sidi Ali δ18O record from closely related species Fabaeformiscandona sp. and Candona sp. (Zielhofer et al., 2017 and this study). The grey line represents the original data. The black line shows results of lowpass filter (1000 year) removing centennial to multi-centennial variability. Red numbers indicate major dry winter phases in the Western Mediterranean; B) Hallstatt cyclicity based on 10Be sunspot number reconstruction (secondary singular spectrum analysis component [SSA2], Usoskin et al. 2016); C) Sidi Ali Cedrus pollen record (Campbell et al. 2017). Olive numbers and pale olive bars indicate synchronous phases of summer cooling in the Middle Atlas (Sidi Ali) and reduced summer SST in the subtropical North Atlantic; D) Summer sea surface temperature (SST) at Hole 658C (deMenocal et al., 2000). The grey line represents the original data. The black line shows results of lowpass filter (1000 year) removing centennial to multi-centennial variability.

Figure 2. Holocene North Atlantic ice-rafted debris record versus Western Mediterranean (Sidi Ali) winter rain record: A) Total solar irradiance (ΔTSI, Steinhilber et al., 2009); B) Holocene Bond events 0 to 8 derived from Bond et al. (1997, 2001); C) Ice-rafted debris (IRD) record based on hematite stained grains of stacked MC52 and VM29-191 cores from the subpolar North Atlantic (Bond et al. 2001), the black line

shows results of lowpass filter (500 year) removing centennial variability; D) Improved Sidi Ali δ18O record from closely related species Fabaeformiscandona sp. and Candona sp. (Zielhofer et al., 2017 and this study). The grey line represents the original data. The black line shows results of lowpass filter (500 year) removing centennial variability. Blue/red numbers and pale blue/orange bars indicate North Atlantic cooling events and wet/dry winters in the Western Mediterranean; E) Modelled ages with 2 sigma ranges (Fletcher et al., 2017); F) Summer insolation (65°N, June, Berger, 1978) (note reversed axis); G) Sidi Ali pollen record (Campell et al., 2017) with 500 year lowpass filter; H) Palaeo-NAO record (Olsen et al., 2012) with 500 year lowpass filter.

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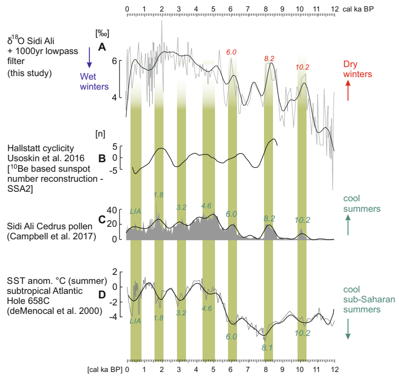

Fig. 1. Holocene sub-tropical summer temperature record versus Sidi Ali Cedrus record and Western Mediterranean (Sidi Ali) winter rain record (see text file for more details)

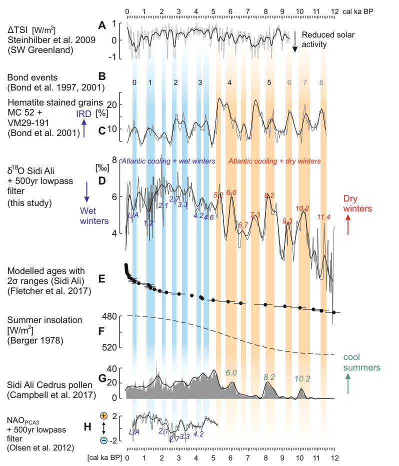

Fig. 2. Holocene North Atlantic ice-rafted debris record versus Western Mediterranean (Sidi Ali) winter rain record (see text file for more details)