

Interactive comment on “Revisiting the humid Roman hypothesis: novel analysis depict oscillating patterns” by B.J. Dermody et al.

Anonymous Referee #1

General comment

The paper “**Revisiting the humid Roman hypothesis: novel analysis depict oscillating patterns**”, by **B.J. Dermody et al.** investigates the mechanisms responsible for the transition from a humid climate in the Mediterranean before large scale deforestation during the Roman period to a more arid present climate. In principal the hypothesis that large scale deforestation caused the aridification of the Mediterranean climate is contrasted with the hypothesis that changes in large scale atmospheric circulation patterns are responsible for this climate transition. Based on modeling experiments it is concluded that changes in large scale atmospheric circulation are mainly responsible for aridification in the Mediterranean. The pattern of atmospheric circulation anomaly related to changes in climatic humidity in the Mediterranean, referred to as the “Centennial North Atlantic Oscillation (CNAO)” is forced by SST anomalies in the North Atlantic. Large scale deforestation plays a minor role in the aridification of Mediterranean but potentially leads to climatic aridification in Central and Northern Europe.

The topic of the Dermody et al. manuscript is definitely relevant to the Paleoclimate. Analysis of archaeological, historical and proxy data as well as climate modeling experiments leads not only to an improvement of our knowledge on physical mechanisms responsible for climate changes in the Mediterranean but also relates these climate modifications with evolution of social, political and economical life in that region.

Whereas, the paper is original and brings interesting information, there is some room for improvement I'll describe bellow.

Specific comments

-The authors name the atmospheric circulation anomaly pattern associated to changes in the Mediterranean climate during Roman period as “Centennial North Atlantic Oscillation “(CNAO). This name suggests immediately a strong resemblance between CNAO and NAO from interannual to decadal time scales. But we can see many differences between the CNAO (Fig. 6) and the NAO. In fact the pattern is very similar with the East Atlantic-Western Russia (EA-WR) pattern (Barnston and Livezey, 1987) which is related with interannual to decadal precipitation variability in the Mediterranean (Krichack et al. 2002; 2005; Ziv et al. 2006) and was related to temperature variability in ice caves from the southern Europe (Rimbu et al. 2011). I suggest discussing the possibility that CNAO to be a superposition of different climatic patterns like NAO and EA-WR.

-The authors choose the Roman period (RP) as 2400-500 BP time interval. Other authors consider for the RP different time intervals. A motivation for choosing the 2400-500 yr BP for RP would be helpful.

-In the paper there are comments related to different cities or regions like Palmyra and Petra, Tell Leilan, Gorgo Basso Lake, Fertile Crescent, etc. A geographical map with these regions clearly represented would help the reader to have a clear picture of the geographical region discussed in the paper. Or maybe just add the name of some representative cities/regions on the maps represented in Figs 1 or 2.

-In section 2.1.2 it is mentioned that the simulation was made by prescribing a forested fraction of potential vegetation from 27.5N to 55N ; 15W to 50E. The potential vegetation was derived from initializing the model with a map of modern day above ground biomass (AGB). The authors conclude that this forcing leads to a minor aridification of the Mediterranean but the response is more important in the Central and Northern Europe. Is the atmospheric circulation anomaly pattern associated to this forcing different from CNAO?

-In section 2.2.2 (page 2366) it is mentioned that the model was forced with the North Atlantic SST anomalies of the 1904-1914 and 1984-1994. The SST anomaly maps of these two periods (figures bellow) show important anomalies not only in the Atlantic region but also in the Pacific and other regions.

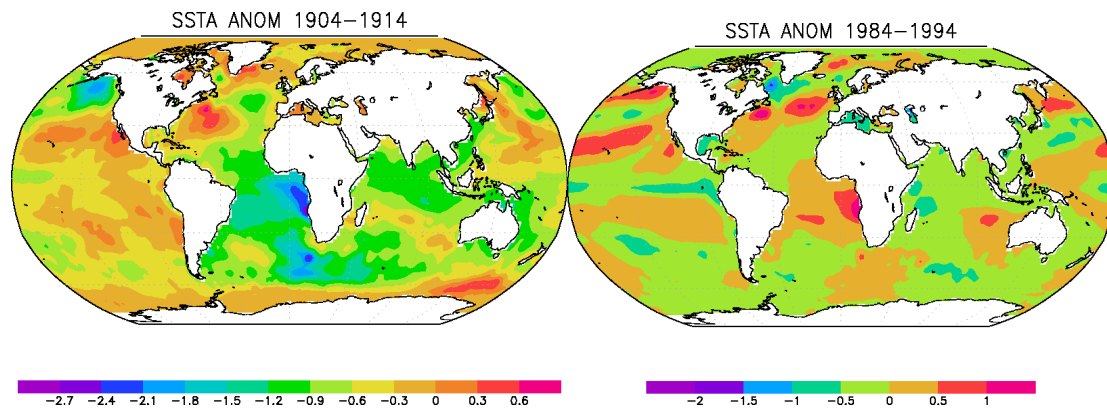


Figure 1. SST anomalies for the period 1904-1914 (left) and 1984-1994 (right). SST anomalies are from ERSST V3 b data set.

Important SST anomalies are seen not only in the North Atlantic region but also in the Pacific and other regions. The Mediterranean climate anomalies can be related not only with SST anomalies from the North Atlantic, as discussed in the paper, but also with SST anomalies from other regions via atmospheric teleconnections. Also NAO can be forced by SST anomalies from the Indian Ocean, for example. Possible effects of SST anomalies from outside the North Atlantic region on Mediterranean climate and on the NAO should be discussed in the paper.

-The authors concluded that the North Atlantic SST anomalies are the main cause of CNAO pattern. A discussion of possible causes of these SST anomalies, in particular the solar forcing, would improve the paper.

-In section 3.1 it mentioned that analysis of archeological and historical data leads to the identification of areas (A and B rectangles) with most abandoned sites. These regions are relatively small (rectangles A and B) which suggests that the abandoned sites were not directly related with climatic forcing, i.e. CNAO. As mentioned in section 4.3, the CNAO forcing contributed to societal changes in the region throughout the Late Holocene. Population increase during high humid periods is associated with increase in land degradation and high aridity which is a negative feedback. Although the forcing is large-scale (i.e. CNAO), the response pattern could have small scale features due to social, political and economical factors. This is a very interesting point of view and should be discussed into a broader context of anthropogenic climate changes.

-Composite pictures represented in Fig. 5 are a little bit noisy. An Empirical Orthogonal Function (EOF) analysis of the normalized proxy time series used in this study could lead to an improvement of both

spatial and temporal patterns represented in Figure 5. As shown in previous studies (e.g. Rimbu et al. 2004) NAO (or CNAO as referred in this study) shows not only trends during the Holocene, i.e. a decrease in the NAO index from early to late Holocene with a slight reversal about 1000-2000 yr BP, but also millennial scale oscillations. The Holocene NAO shows a stable cycle of about 900 yr. A ~700 yr cycle characterize the tropical climate. The proxy data used in composite analysis covers the period 3000 yr BP – 1000 yr (4 kyr) so that millennial scale oscillations are better identified comparative with trends. I suggest to discuss the results of composite analysis or EOF analysis of proxy data set used in this study in relation with observed millennial scale variability during the Holocene, in particular with the identified ~900 yr and ~700 yr cycles.

Technical details

-Time is not mentioned in the same way in the paper. For example 2400 yr. BP (page 2357, line 1), 4.2 KA (page 2359, line 22), 3500 BP-2500 BP (page 2360, line 14), etc...Please mention the time in the same way , i.e. yr. BP.

-Page 2360, line 1. *To determine the impact of SLP oscillations on climate.* The use of term oscillation can create misunderstandings. I think a term *SLP anomaly patterns (or seesaw)* is more appropriate comparative with *SLP oscillations*.

-Page 2364, line 5. *We use a gridded data set of average yearly precipitation.* Several details related to the quality of the precipitation in such arid conditions should be included.

References

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