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Macrophysical modeling of climatic variability in the Pontic Basin

Abstract

Goals
For this exploratory study we have compiled several macrophysical climate models to model mid-late Holocene temperature and precipitation in the Eastern Mediterranean and Pontic basins. These models have been developed by Dr Reid Bryson and his staff at the Center for Climatic Research, at the University of Wisconsin-Madison. The goal of this study is to model climate variation across space from point to point through the past to estimate and compare the local response to changes in circulation. For example, we are interested in asking how droughts or pluvial events (periods of enhanced precipitation) were regionally distributed. Did the circulation patterns that brought drought to the Attic plane enhance the rainfall in Messenia? Did cold or arid intervals on the Pontic steppe correspond to similar or different conditions in Eastern Turkey, Bulgaria or the Caucasus? We are also interested in chronology however the resolution of the current model is limited.

Methods
To this end, thirteen site-specific models were prepared using temperature and precipitation averages (30-year monthly normals) as input. Six of these sites ringed the Aegean, six bordered the Black Sea coast and one was situated in the uplands of eastern Turkey (Fig. 1). These site specific, hierarchical models provide 200 year average temporal resolution. This resolution should improve as the models are refined.

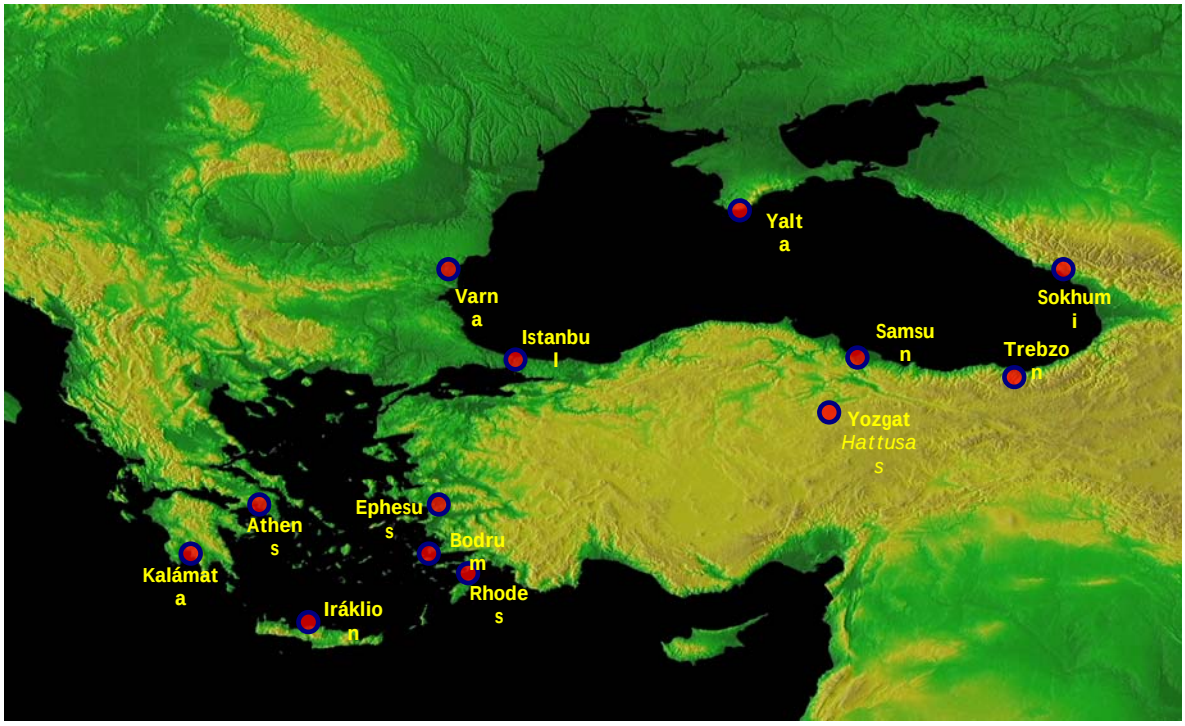


Fig. 1. Weather stations selected for the models

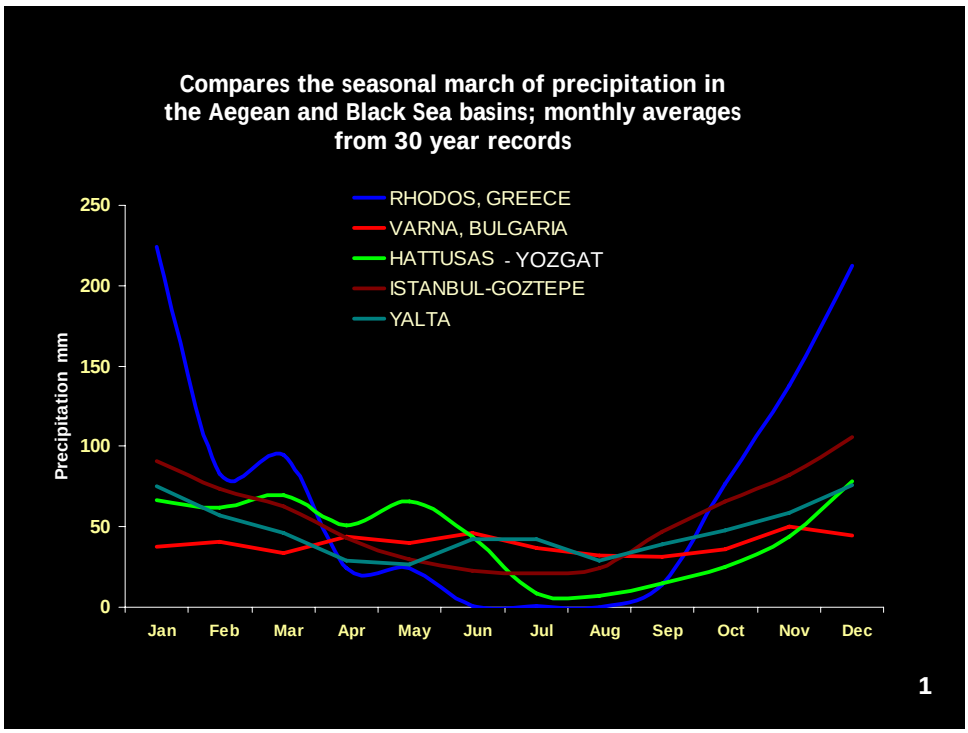
Marcophysical modeling attempts to generate hypotheses independent of the geological, archaeological and biotic proxy (against which they can later be tested). For climate models to be useful to archaeologists they must have higher special and temporal resolution that can be obtained with GCMs. Human societies are impacted most by climate change on a century scale or less.

Unlike Global Circulation Models (GCMs) which, calculate a series of self referencing iterations to simulate the variability in weather, these models attempt to describe the boundary conditions in which the weather could fluctuate during the different temperature regimes of the past (Bryson 1997). These boundary conditions have changed since the Pleistocene as the earth's albedo (ice area, snow fields and deserts), radiation (Kroll-Milankovitch cycles) and atmospheric reflectivity due to volcanism have changed. We calculate how variation in these factors would affect the hemispheric temperature gradient and thus the positions of the major features of atmospheric circulation (i.e. the latitude of the inter-tropical convergence zone or ITCZ, the Atlantic and Pacific high-pressure cells and the jet stream itself).

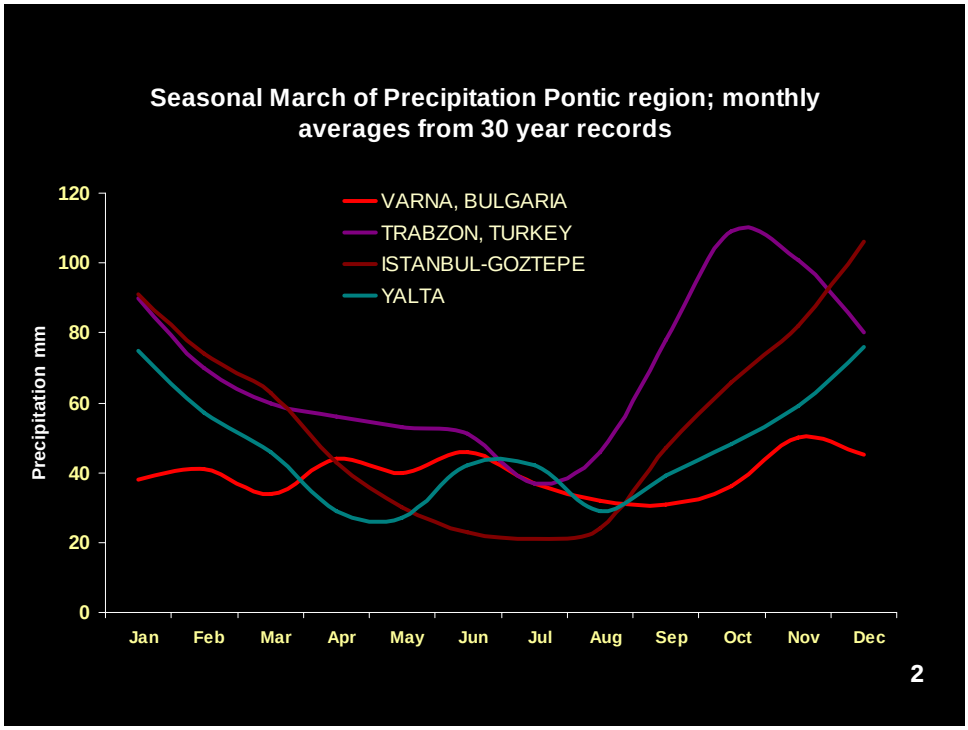
Like any model, these simulations do not constitute evidence. They are meant only to function as detailed and informed hypotheses about the paleoclimate of the selected regions. They require detailed paleoenvironmental research to confirm or refute their retrodictions.

Graphs

1-2)



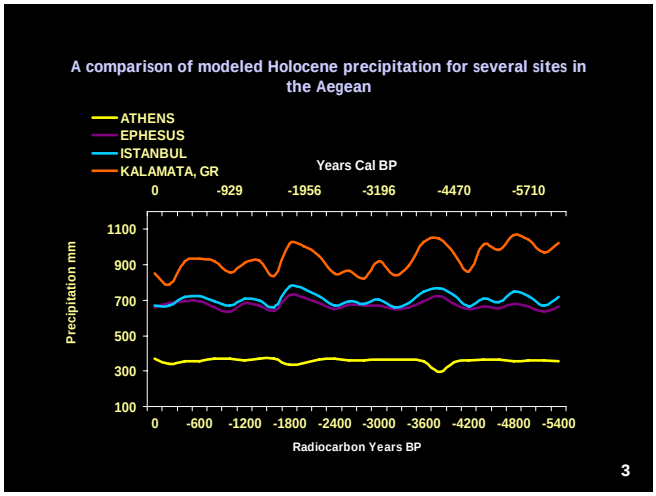
Graph 1

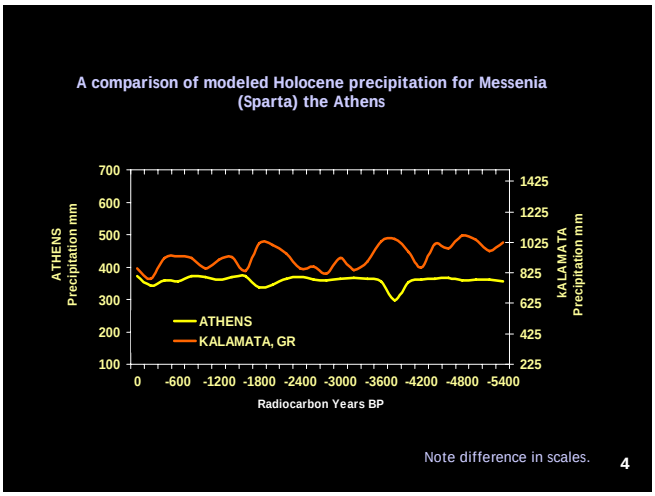


Graph 2

These first graphs simply compare the average monthly precipitation for sites in the Aegean and Black Sea. Rhodes has a typical Mediterranean climate with very dry summers and wet winters. Sites in the Pontic Basin typically receive much less winter precipitation. Greek colonists in the Pontus had to adjust to a very different precipitation regime.

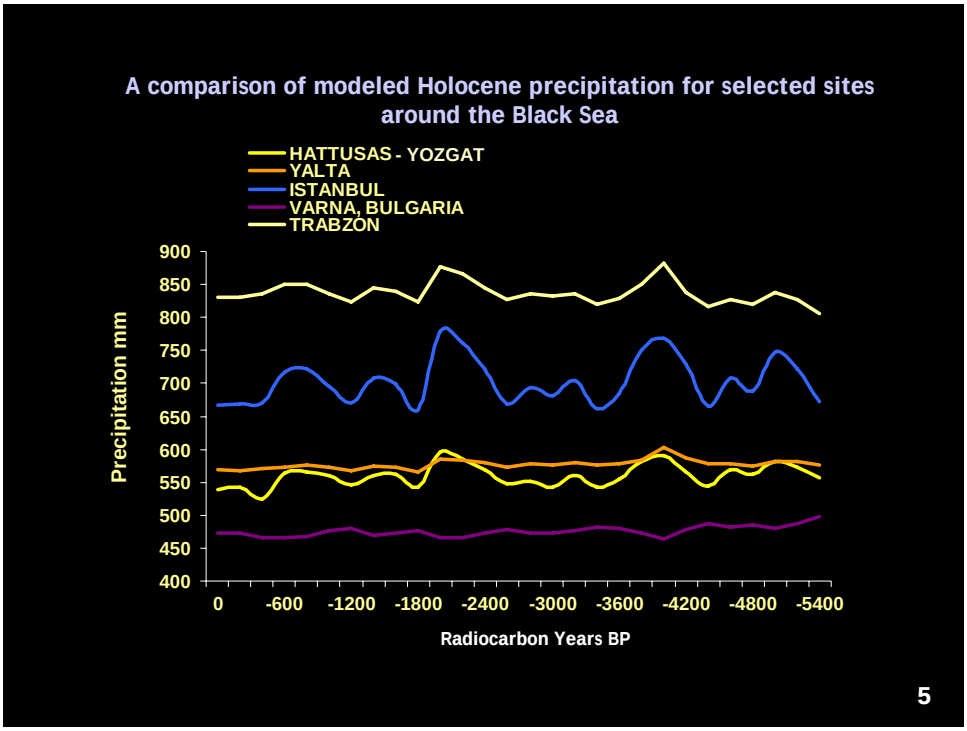
There is significant variability within the Black sea region. Istanbul has the rainfall regime most like the eastern Mediterranean while Varna to the north has its precipitation more evenly distributed throughout the year, with significant rain in the summer, a pattern typical of central Europe. Trabzon on the southwestern coast of the Black Sea has most of its precipitation in the fall.





Graphs 3 and 4

Graphs 3 and 4 compare the modeled late Holocene annual precipitation for several sites in the Aegean. Of these, Kalamata near ancient Sparta consistently received the greatest precipitation but also had the most pronounced response to changes in circulation. All sites were correlated except Athens. Though only 160 km to the northeast, the Attic plane lies in the rain shadow of the Peloponnesus and received far less precipitation than Messenia. According to the model the circulation patterns that increased the winter rain in Messenia and elsewhere in the Aegean brought even less rain to Athens. Athenian droughts may have corresponded with good years in Sparta. The archaeologist Rhys Carpenter noted this correlation as well (1966).



Graph 5

The last diagram (Graph 5) compares the modeled late Holocene annual precipitation for several sites around the Black Sea. Sites along the southern coast are correlated. Even the precipitation at Yozgat, the site of the ancient Hittite capital Hattusas in the mountainous interior of Eastern Turkey was apparently in phase with sites on the southern coast. Sites in the north and east cost of the Pontus show a much weaker response to changes in circulation and Varna appears to be out of phase. The relatively stabile precipitation regime retrodicted for the northern regions is not consistent with many paleoecological studies from those regions and the model may fail to capture some of the variability there.

These models were developed by Dr. Reid Bryson at the Center for Climatic Research, Gaylord Nelson Institute for Environmental Studies, University of Wisconsin-Madison in affiliation with CPEP: The Bryson Interdisciplinary Climate, People, and Environment Program. I compiled this brief study and am responsible for any errors. General questions and comments can be addressed to me, Anthony Ruter (ahruter@.wisc.edu) or Reid Bryson at (rabryson@.wisc.edu).

References (general description and other applications of the macrophysical model)

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