ARCHAEOCLIMATOLOGY AND PREHISTORY OF THE WOODBURN-SALEM REGION OF OREGON, USA

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Abstract

A site-specific high resolution climate model of the late-Pleistocene and Holocene is here compared with the Paleoarchaeological field data and cultural history for a site in Oregon's Willamette Valley. The temporally distinct animal assemblages and artifact record appear consistent throughout and suggest that the biotic and human history parallels the water history.

Keywords

[4-6 keywords, taken from most recent American Geological Institute GeoRef Thesaurus]

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INTRODUCTION

In this article we shall explore climatic environments of the past, for a specific place, using the Archaeoclimatic model of Bryson and Bryson as a hypothesis of what the past climate might have been (Bryson, 2004 in press).

The following discussion utilizes a site-specific, high-resolution model for the climate of a place in the Salem, Oregon area. By site-specific we mean the Salem Airport, not the city. By high-resolution we mean 200 year averages of monthly mean values of precipitation, temperature, snowfall, precipitation intensity, potential evapotranspiration, river discharge, etc

We model these aspects of past climate because even in this area thought of as being quite wet, there is still a very dry season, variable in time. The record of change for plants, animals and humans is strongly dependant on water availability and seasonality. Water is the driving force behind a successful existence for nearly all species. Our knowledge of those periods when water is, or is not, available will help us to interpret and even to anticipate culture change.

THE MODELED PALAEOCLIMATE OF SALEM

Our model of past annual and summer rainfall we will take as representing reality for the purpose of this discussion and represents the precipitation affecting the Salem airport (see figure 1). Salem was quite dry in late Glacial time— in other words from 14000 BP to the **b**eginning of the Holocene at about 10800 BP Then there was an early rather dramatic increase in precipitation which then decreased until the end of the Early Holocene at about 8000 BP (Radiocarbon).

Middle Holocene time seems to have had a dramatic and highly significant increase in precipitation. To one familiar with Oregon climate today, a doubling of the annual precipitation and a five-fold increase in July rain must be astonishing, and with considerable cultural importance if correct. Late Holocene time, after 4000 BP, appears to have been very similar to the present. This clear, but standard, division of the Holocene appears in nearly all North American models, but in different ways The dry Latest Pleistocene climate indicated here is what one would expect this close to the ocean on the basis of atmospheric dynamics. The ice covered mountains parallel the open water off shore, and there is little evidence of pack ice, which means that there is a strong contrast of temperature from land to sea. This forces the wind to be dominantly more parallel to the shore along the Northwest Coast from Alaska to California. With rougher land on the left of the wind (standing with one's back to the wind) and the aerodynamically smoother water surface on the right, the air near the coast must be divergent and thus sinking (Bryson and Kuhn, 1961). This suppresses precipitation and appears here as Salem being a dry place in late Pleistocene time.

Of course, the question that immediately arises is whether the low precipitation of the late Pleistocene was ameliorated by an even lower evaporation rate, for this is significant in terms of vegetation and animals. This may be investigated by considering the modeled relation of precipitation to potential evapo-transpiration (figure 2). This figure suggests that the Latest Pleistocene, at Salem, was a time of dry tundra, giving way rapidly at the onset of the Holocene to steppe savanna, and then to full forest conditions at the onset of the Middle Holocene.

The rather long period of near-glacial conditions in the Early Holocene is a consequence of the observed fact that the area of ice and snow cover which prevailed at the end of the Pleistocene diminished by only half at the beginning of the Holocene. The ice area then stayed at that level until it rapidly diminished, almost entirely, between 8000 and 6000 BP. Thus the Early Holocene was really semi-glacial (Bryson *et al*., 1969)..

One might conclude from examination of figure two that the conditions suitable for full forest cover which began with the Middle Holocene continued into the present, though perhaps a little less lush. Figure one warns us to view this with caution however. The excess of Middle Holocene precipitation over the Late Holocene amount was apparently as *summe*r precipitation. This should mean a significant change in the environment and thus in the resources available to the inhabitants.

CULTURAL AND ENVIRONMENTAL CORRELATIVES

The climate and precipitation changes discussed in this article have been field verified within the Willamette Valley. Researchers have found easily defined evidence of floral, faunal, stratigraphic, and material culture change over time. Significantly, the radiocarbon dates for these deposits reflect the same approximate periods of alteration as those suggested by the climate model. The synchronicity of climate shift and material culture change is remarkably consistent (see figure 3).

The Terminal Pleistocene in the Valley is discernible stratigraphically by a layer of caliche, or calcium carbonate, that developed in the period between the last two glacial flood events (Stenger, 2002). The caliche, dating to approximately 12,500 yBP, demonstrates clearly the dry conditions in the region. Within the flood deposits that bracket the caliche are micro-strata of marginally vegetated surfaces. This means that the silts, exposed when the flood waters receded, were briefly able to support vegetation. Seasonal events probably provided the moisture needed to nourish this organic material.

Contained within the flood strata were cultural indicators and megafauna. Cultural material included unrounded flakes of chert, quartzite and jasper. None of the flaked material evidenced the scars of transportation by water, thus suggesting that the lithics were carried into the area by people. Sparse remains of megafauna were also observed within these > 12,200 BP deposits. Faunal remains included big horn sheep *(Ovis canadensis)* and mountain goat *(Oreamnos americanus)*. When considered in conjunction with the caliche, it would seem that a need for water brought these sub-Alpine species into the Valley (Bryson and Stenger, 2003).

Approximately 12,200 BP an A-Horizon began to develop over the flood silts. The result was a vegetated stratum of mixed soil and flood silts (Hibbs, 2000). Importantly, within this stratum are the remains of megafauna, avifauna, cultural material and naturally shed human hair. While the soils continued to build up and support more dense vegetation, the faunal and cultural record continued only until 10,800 BP. At this time, all evidence of megafauna and humans disappears from the paleoarchaeological record in many parts of the Valley. Our precipitation model also suggests these dramatic changes.

The cultural phases of the Terminal Pleistocene and Holocene are well defined by both geologic and cultural periods. Differing climate, precipitation, and evapotranspiration mark these changes. The biotics and fauna reflect a dramatic change in climate, while evidence of changing cultural and occupation patterns becomes profound (see Table 1).

As this data suggests, a dramatic shift occurs in the Middle Holocene, as populations appear to form settled communities (Connolly, 2003). Another change that is documented archaeologically is the development in some areas of a pyro-culture, which defines the intentional use of fire to modify the environment (Gilsen, 2003; Connolly 2003).

SUMMARY

The correlation between culture change and available water is dramatic. Major shifts occur during times of extended drought, or during long periods when water is in abundant supply. Within the same geographic area, the flora and fauna of one period rarely extend far into the next. And, perhaps more importantly, the culture that utilizes an area during one period appears to abandon it when a change in the supply of water occurs.

Archaeologically, population change is indicated with the alteration in house types, changes in lithic forms and materials, and differing uses of resources. Cultural patterns that appear and then stop, which include middens or mounds and dense deposits of herbaceous charcoal, should be considered as part of the argument for a change in populations. The traditions that foster such adaptation would become and remain important to a culture.

It would seem logical that a successful life pattern would not be readily abandoned, and that moving to another area might be preferable to giving up a significant aspect of one's culture, one's sense of place and territoriality. It is the responsibility of the archaeologists, paleoclimatologists and others to interpret the past based not upon emotions, political correctness and putative value systems of the humans involved, but upon the geoarchaeological evidence.

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Table 1: Identified periods of geologic and cultural change

Late Pleistocene		Earliest Americans	>10,800 BP	Large tools & megafauna
Early Holocene		PaleoIndian Earliest Americans	> 8,000 BP	Large tools, megafauna extinct
Mid-Holocene	early	Early Archaic	8,000-6,000 BP	Slightly reduced tools, camas
	late	Middle Archaic	6,000-1800 BP	Mounds (<4,000 BP); communities
Late Holocene	Early	Late Archaic		Pyro-culture (Gilsen); managed land
	late	Late Pre-Hist.	1800-200 BP	Bow and arrow (1700 BP)

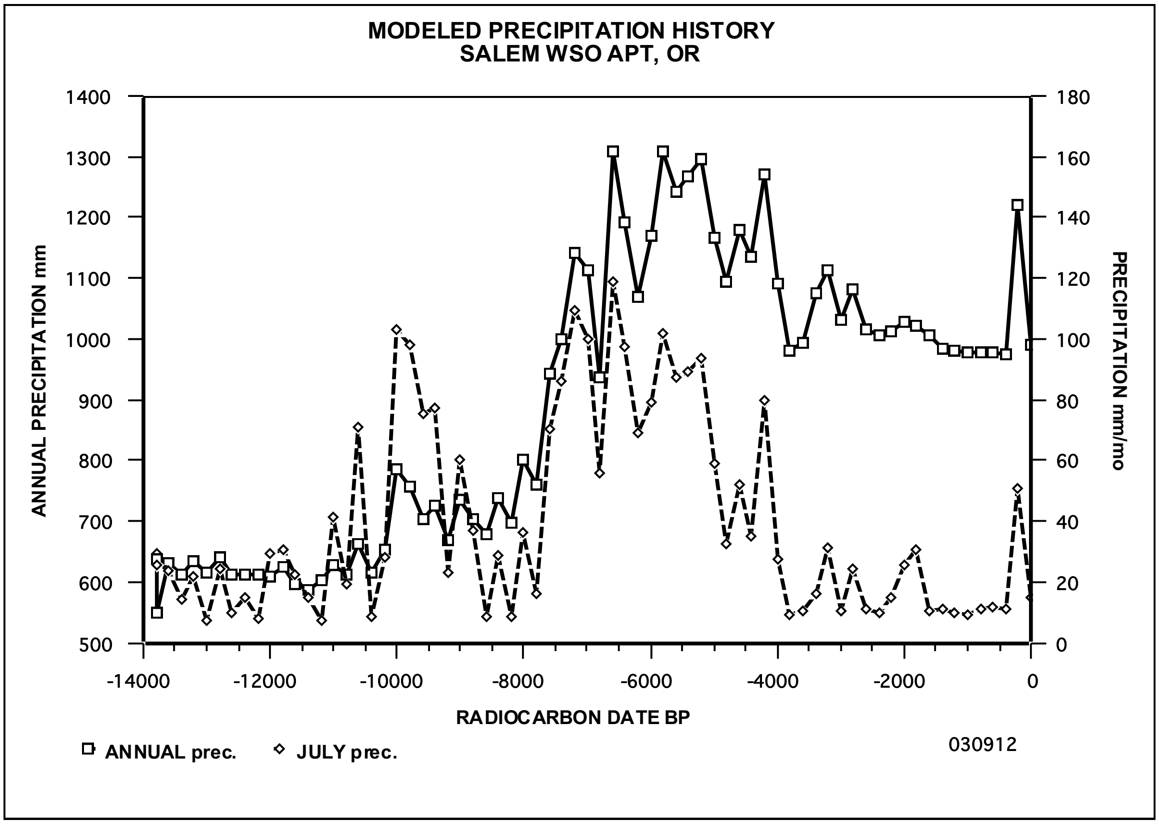
Figure Captions

Fig. 1 Modeled annual and July precipitation for Salem, OR.

Fig. 2 Comparison of modeled precipitation and evapo-transpiration at Salem, Or.

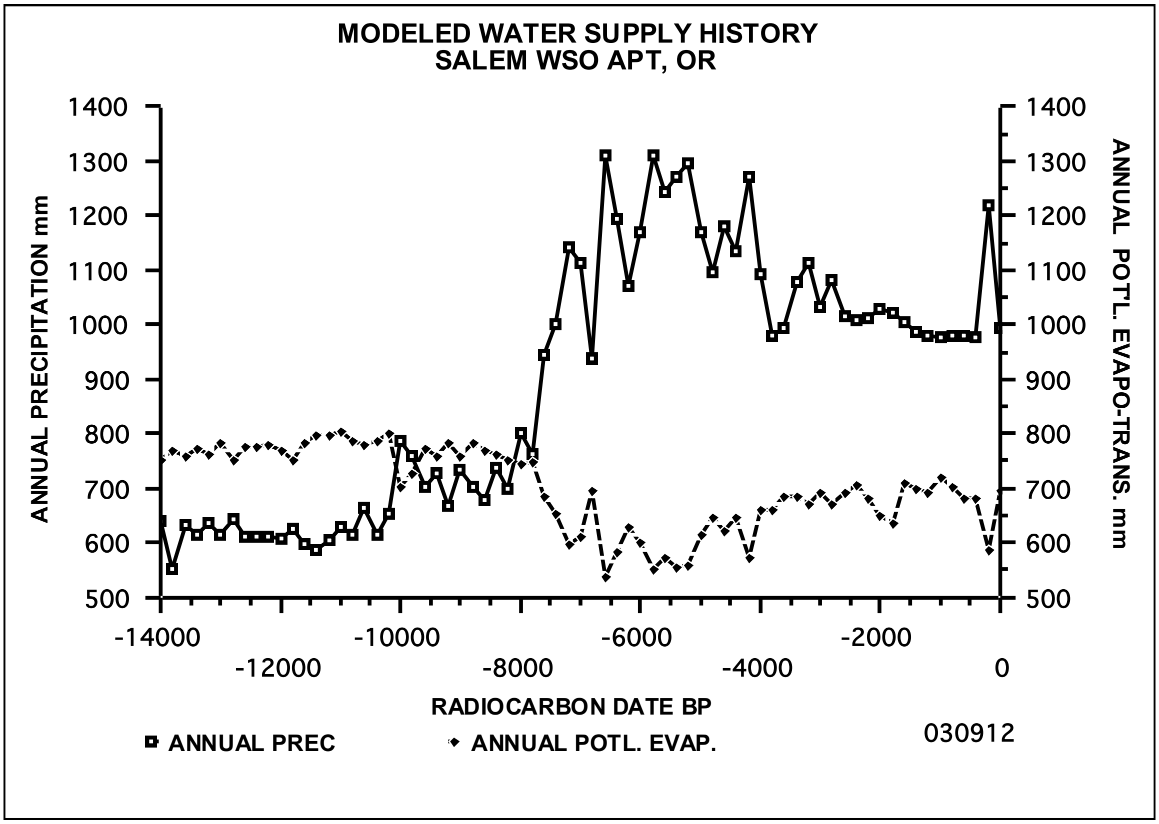
Fig. 3 The periods of change for both climate and cultural phases appear remarkably consistent over time.

Figure 1:



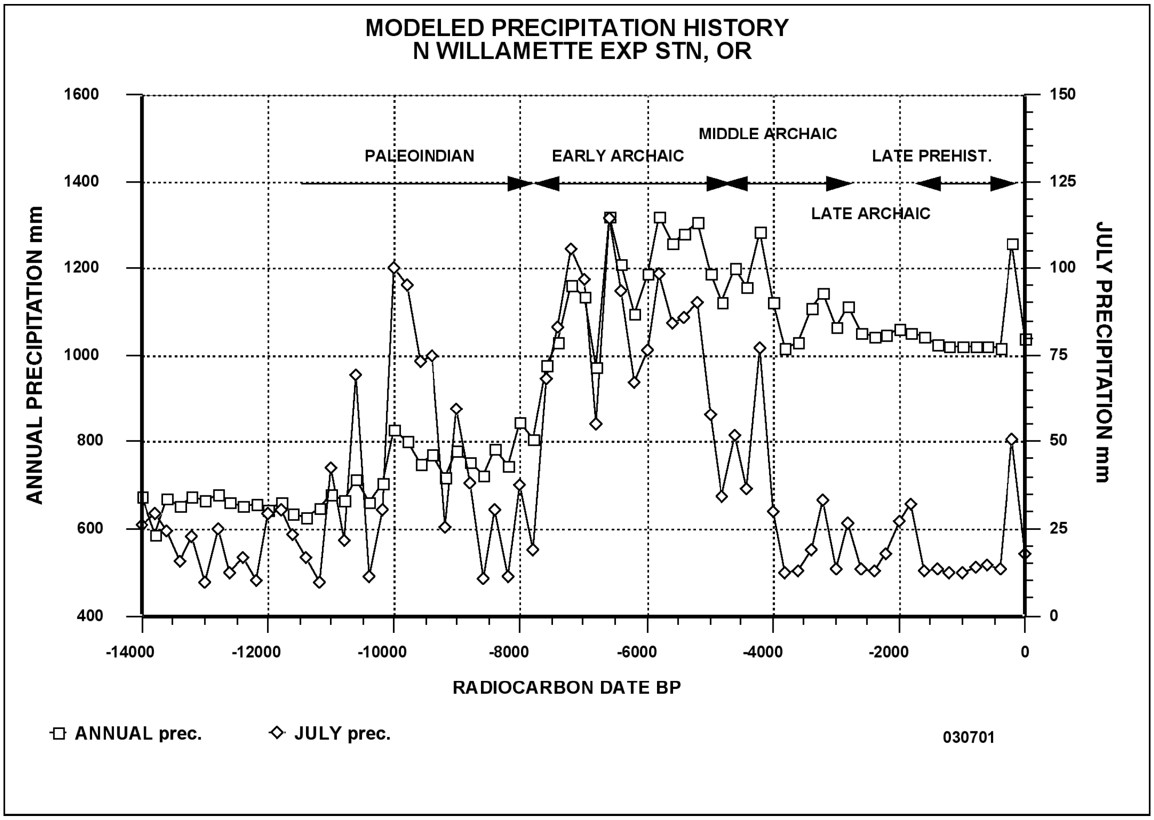
MODELED PRECIPITATION HISTORY
SALEM WSO APT, OR
ANNUAL PRECIPITATION mm
1400
1300
1200
1100
1000
900
800
700
600
500
PRECIPITATION mm/mo
180
160
140
120
100
80
60
40
20
0
-14000
-12000
-10000
-8000
-6000
-4000
-2000
0
RADIOCARBON DATE BP
ANNUAL prec.
JULY prec.
030912

Figure 2:



MODELED WATER SUPPLY HISTORY
SALEM WSO APT, OR
ANNUAL PRECIPITATION mm
ANNUAL POTL. EVAPO-TRANS. mm
1400
1300
1200
1100
1000
900
800
700
600
500
-14000
-12000
-10000
-8000
-6000
-4000
-2000
0
RADIOCARBON DATE BP
ANNUAL PREC
ANNUAL POTL. EVAP.
030912

Figure 3:


MODELED PRECIPITATION HISTORY
N WILLAMETTE EXP STN, OR
ANNUAL PRECIPITATION mm
JULY PRECIPITATION mm
1600
1400
1200
1000
800
600
400
150
125
100
75
50
25
0
PALEOINDIAN
EARLY ARCHAIC
MIDDLE ARCHAIC
LATE ARCHAIC
LATE PREHIST.
-14000
-12000
-10000
-8000
-6000
-4000
-2000
0
RADIOCARBON DATE BP
ANNUAL prec.
JULY prec.
030701