Historical-Climatological Information from the Time of the Byzantine Empire (4th-15th Centuries AD)

Ioannis G. Telelis

Centre for the Research of Greek and Latin Literature,
Academy of Athens, Greece

Among the sources for natural climate variability in the past, modern paleoclimatic research is obliged to pay attention to non-instrumental man-made paleoclimatic evidence, as well as to proxy evidence obtained from natural archives. The role and the value of documentary paleoclimatic data derived from historical texts of pre-instrumental era have been emphasized during the last three decades.[1] Direct and indirect observations of meteorological parameters (temperature, precipitation, snow-cover, cloudiness, wind etc.) in terms of narrative descriptions and/or early instrumental measurements are being systematically surveyed and analyzed. Studies have been produced that exploit a wide range of documentary sources of the European Middle Ages in the field of historical climatology. The recent developments in this discipline have pointed out the need of temporal and geographical expansion of the documentary paleoclimatic research.[2]

The literary paleoclimatic material built in Byzantine historical texts (written in Greek language) remained until recently unexploited -though not neglected- as fieldwork for paleoclimatic research. The well known "weather compilations" of Rudolf Hennig [1904], Cornelis Easton [1928] and Kurt Weikinn [1958],[3] where extreme weather events from the Antiquity through the early 20th century are catalogued, have included citations of accounts derived from the ancient Greek literature, as well as from some scattered Byzantine sources. Nevertheless, this material, derived from the Greek literary tradition, is far from systematic and complete. It is obvious that the geographical focus of those authors was the medieval Northern, Western and Central Europe. As a consequence, the Byzantine historical sources had not been investigated so far from a historical-climatological point of view.[4] Documentary sources of the Byzantine period were neglected by the researchers of historical climatology. Consequently, a considerable amount of documentary paleoclimatic data relevant to the Late Holocene climate history of the Eastern Mediterranean and the Middle East was neglected from the interdisciplinary paleoclimate research.[5] The idea of reconstructing the climate history of Byzantium has attracted the interest of specialists in Byzantine history as early as in the 1980s. Recently, the climate history of the Byzantine Empire (AD 324-1453) has become a topic of modern historical research.[6]

The bulk of documentary weather and climate information concerning the above mentioned geographical, chronological and cultural framework is contained mainly in the Byzantine narrative texts. Such texts are dispersed in numerous manuscripts kept in libraries all over the world. For the needs of this research I drew on texts that have been published in current critical editions.[7] A selection of sources based upon qualitative philological criteria was necessary so that the possibility of uncovering as much as possible meteorological text passages was the higher. For the purpose of this research the most informative genres of the Byzantine narrative sources were surveyed:

i. Historians
ii. Chronographers who wrote universal chronicles starting from the Creation of the World up to their day.
iii. Church historians.
iv. The biographers who compiled Saints' Lives (Vitae Sanctorum) of the Byzantine Church.

The contribution of each genre of sources to the obtained paleoclimatic evidence is not the same. The role of the chronographic sources was decisive for the documentation of the research. More than the half of the almost 1083 collected meteorological text passages belongs to the chronography (58%), while 19% to actual historical writers, 16% to Saints' Lives and only 7% to church historians. The documentation for the period AD 300 to 1500 is not uniform. The number of sources that provide meteorological text passages is higher for the Early Byzantine period (4th-6th centuries) because of the existence of a flourishing Late Roman historiographical tradition and due to the composition of early ecclesiastical texts. The 8th century is a period of a well know gap in literary tradition. The revival of the 9th-11th centuries is attributed to the compilation of universal chronicles and to the systematization of the production of Saints' Lives. During the Later Byzantine era (12th-15th) lengthy works in historiography were written.[8]

The researcher who attempts to reconstruct the climate history of the Eastern Mediterranean and the Middle East on the basis of documentary evidence derived from Byzantine sources should be familiar with certain methodologies of historical research. Several chronological styles were in use during the Byzantine period. The most common was the "indiction style," in which the New Year began at September 1st. Most sources provide just one year to date to events. Then it must be decided from the context or from other sources, whether the "old" or the "new" year is meant.[9]

The form of information is mainly narrative. The dominant mode in which the Byzantine authors used to incorporate paleoclimatic information in the sources is that of mentioning the phenomena by the use of qualitative terms (e.g. "winter severe," "cold harsh" etc.). Numerical documentary proxy data (e.g. dates on which the harvest was opened, volume of grape harvest etc.) are absent, but there are cases in some narrative reports where some numerical data are contained (e.g. "it rained for 5 days"). The authors were not always contemporary to the events they described. For the Byzantine period we have to deal with meteorological evidence that is not strictly contemporary in the sense that the events were recorded during or shortly after their occurrence. Most of the surviving reports may have been copied once or several times and, consequently, in some cases the year to which an event is attributed may be only approximately calculated. The meteorological observations are of sporadic and general character and in most cases contain chronological inaccuracies. In many cases the analysis cannot determine about the

months of the year during which the occurrence of cold/hot or dry/wet took place. On the other hand, grape harvest dates or phenological observations are absent.

In general, the approach of the Byzantine man towards the natural phenomena was determined by social and religious preconceptions. For the chronographers meteorological phenomena were nothing more than curiosities or marvels that were mirroring the Divine Will. Weather and climate were not approached from any proto-scientific point of view by the Byzantine intellectuals (e.g. clergymen, early scientists), so they did not make any systematic attempts to explore the working of weather phenomena by compiling weather diaries or early instrumental measurements in order to make reliable weather predictions.[10] As may be expected, the explicit weather observations are scanty. References to sunny or cloudy days are extremely sparse. Information on precipitation, severe heat, cold (not to speak of 'normal' temperatures) or snow and ice cover –though existent– lose from their climatological value because of low chronological and geographical precision. Generally speaking, the paleoclimatologist is obliged to extrapolate climatic fluctuations from crude documentary reports about extreme events. But, despite these shortcomings the task of uncovering and analyzing all available meteorological evidence concealed in the Byzantine documentary sources was worth undertaking.

Documentary paleoclimatic information derived from the Byzantine texts can be classified into three categories following the meteorological data that they include:[11] (i.) Meteorological information about phenomena of long duration (weeks, months, years): e.g. severe winters, droughts, continuous rainfalls etc. This type of record is the most comprehensive in paleoclimatic information and allows for further interpretation; (ii.) Meteorological information about meteorological phenomena of short duration (e.g. gales, hailfalls, blow of winds etc.); (iii.) Information about flood events of unspecified cause / river's Nile flood anomalies.

Table 1. Distribution of documentary paleoclimatic information derived from Byzantine sources (AD 300-1500)

Meteorological phenomena of long duration		Meteorological phenomena of short duration		Flood events	
Freezing of water (rivers, lakes, sea etc.)	59	Snow much	14	Floods of unknown cause	40
Snow much	57	Blow of wind/s	100	River's Nile flood anomaly	41
Blow of wind/s	19	Cold harsh	23		
Cold harsh	59	Cloudy sky	6		
Drought	183	Flood	36		
Flood	18	Fog	2		
Heatwave	13	Heatwave	12		
Lack of rain	159	Hailfall	35		
Rainfall(s) heavy	42	Rainfall(s)	1		
Rainfall(s) normal	4	Rainfall(s) heavy	86		
Rainstorm	3	Rainstorm	51		
Summer rainy	1	Thunderbolt	32		
Various meteorological phenomena (cited in general)	3	Various meteorological phenomena (cited in general)	8		
Winter mild	5	Whirlwind	2		
Winter rainy	7				
Winter severe (cold)	91				

The thorough study of the Byzantine documentary sources from a paleoclimatological point of view brought a relatively low amount of meteorological text passages in comparison with the total textual production of the Byzantine era. A general overview of the different types of meteorological information and the frequency of their reference in the Byzantine sources is shown in Table I.

The obtained paleoclimatic data apply within a large geographical area. This fact begs the problem of interpolation in space and reduces the reliability of the estimates, in particular for the variables of temperature and precipitation. A realistic estimate of these two significant meteorological variables on the basis of the obtained documentary data could not be based on the widely accepted classification of documentary paleoclimatic evidence according to the methodology of developing monthly and seasonal semi-quantitative thermal and wetness indices.[12] Thus, the collected historical-climatological information from the time of Byzantine Empire (4th-15th centuries AD) does not encourage the application of sophisticated statistical methods for ambitious paleoclimatic reconstructions. Deduction of weighted or simple thermal/wetness monthly indices and summation of them in seasonal or annual scale is not feasible. This assumption has forced towards the adoption of a simple statistical method for interpreting the obtained paleoclimatic data. The use of an empirical "impressionistic" approach was necessary so that we could exploit the available data and might extract indications for possible climatic fluctuations, with -of course- all appropriate caution.

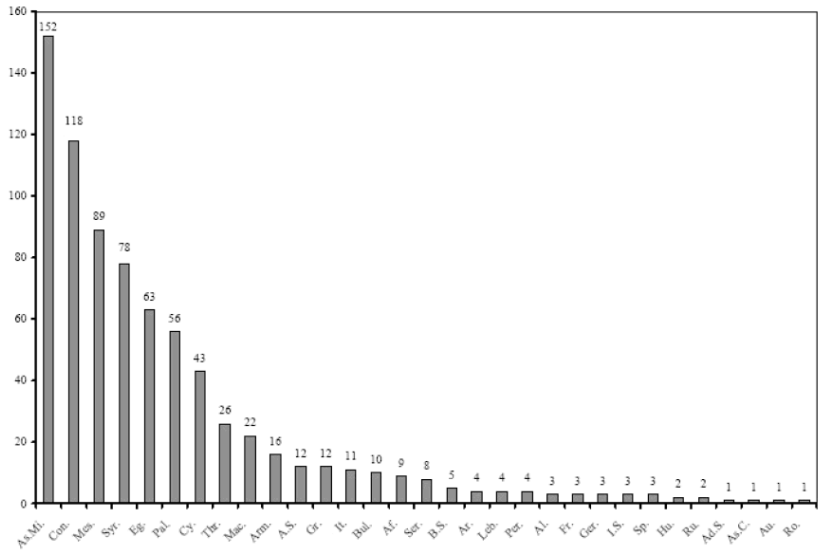

Fig. 1. Geographical distribution of all meteorological text passages from Byzantine documentary sources (AD 300-1500). Legend in alphabetical order: A.S.: Aegean Sea; Ad.S.: Adriatic Sea; Af.: Africa; Al.: Albania; An.: Anatolia (Asia Minor); Ar.: Arabia; Arm.: Armenia; As.C.: Asia Central; Au.: Austria; B.S.: Black Sea; Bul.: Bulgaria; Con.: Constantinople ; Cy.: Cyprus isl.; Eg.: Egypt; Fr.: France; Ger.: Germany; Gr.: Greece; Hu.: Hungary; It.: Italy; I.S.: Ionian Sea; Leb.: Lebanon; Mac.: Macedonia; Mes.: Mesopotamia; Pal.: Palestine; Per.: Persia; Ro.: Romania; Rus.: Russia; Ser.: Serbia; Sp.: Spain; Syr.: Syria; Thr.: Thrace.

The scheme of data classification had to be adapted to the low density and quality of data. An index of two discrete levels (-1, +1) was attributed to the phenomena of long duration, irrespective of emphasis and intensity that was given by the authors. By the use of this simple index, decadal frequencies of the meteorological anomalies were converted into an ordinal scale. Then, by calculating decennial moving averages, it was possible to process the data in a broad semi-quantitative way.

Another problem was that of the regional composition of the data. The investigation of the sources revealed that the obtained paleoclimatic records were referring to wide geographical areas around the Mediterranean basin. The regional composition of all meteorological evidence recorded in the Byzantine sources for the period AD 300-1500 is shown in Figure 1. Anatolia, Constantinople (Istanbul), Mesopotamia and Syria possess the lion's share of the references.

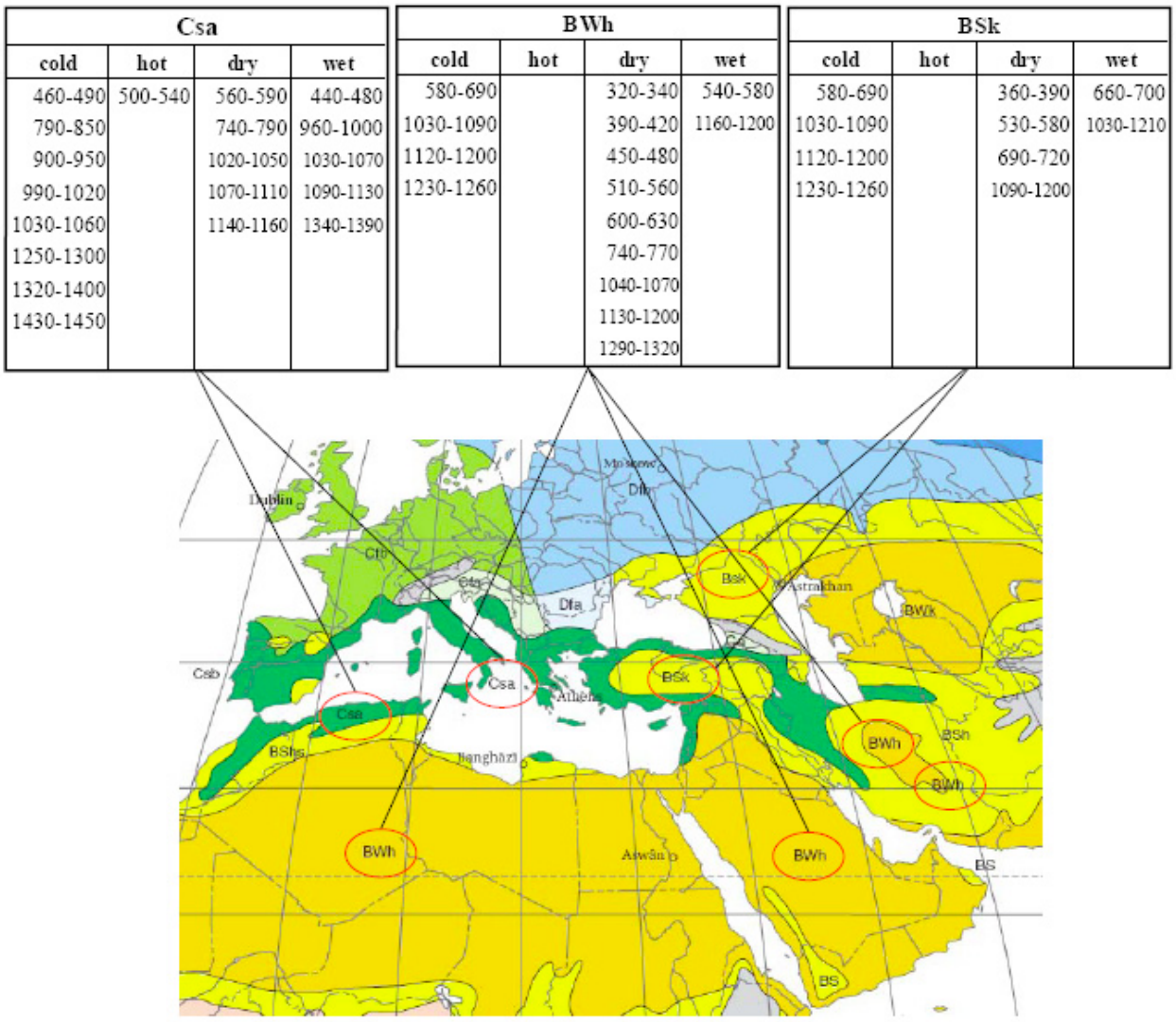

Fig. 2. Periods of climatic anomaly for the period AD 300-1500 as projected in various Mediterranean regions. The time periods are defined by the decennial frequencies occurrence of temperature (warm / cold) and rainfall (dry / wet) anomalies reported in the Byzantine documentary sources (cf. Figure 7). The map shows the location of climatic areas around the Mediterranean Sea according to the Wladimir Koeppen (1931) climate classification system as modified by Glenn Trewartha (1981). Letter symbols in use: B= Dry (Arid and semi-arid) climates [BSk= temperate semi-arid; BShs= semi-arid; BWh= desert; BWk= temperate arid]. C= Temperate/mesothermal climates [Cfa= humid subtropical; Cfb= maritime temperate; Csa, Csb = Mediterranean]. D= Continental/microthermal climates [Dfa= hot summer continental; Dfb= warm summer continental or hemiboreal].

On the other hand, paleoclimatic data should be treated in such a way, so that the high geographical dispersion might not prohibit the statistical elaboration. In order to include the parameter of climatic variability and consider the spatial variability of the evidence, we regrouped the data set on the basis of features taken from physical geography. We identified groups of data according to the Wladimir's Köppen[13] scheme of climatic regions as modified by Glenn Trewartha.[14] This scheme, based on average monthly temperature and precipitation values of wide geographical regions, is the most widely used today for the classification of the climatic

regions and respects spatial variability, which is the dominant characteristic of the Mediterranean climate. With this procedure we handled our dispersed data on the basis of an analogously wide-range geographical criterion and, then, by applying a broad semi-quantitative statistical analysis it was possible to trace the possibility of some climatic fluctuations for the period and area under discussion.

Fruit of this procedure was the construction of time-series of cold/hot and dry/wet decades applying to the wide geographical-climatic regions defined by Trewartha. Though the geographical scale in the statistical elaboration of the data is very wide, some observations for possible climatic trends can be adduced from Figure 2:

1. Temperate semi-arid [BSk], desert [BWh], and Mediterranean [Csa] climatic regions around the Mediterranean Sea concentrate the highest amount of documentary meteorological data derived from Byzantine sources. Data available for semi-arid [BShs], humid subtropical [Cfa], maritime temperate [Cfb, Csb], hot summer continental [Dfa] and warm summer continental or hemiboreal [Dfb] regions cannot support any hypothesis because of the extremely low amount of the relevant evidence.

2. From available data for specific areas around the Mediterranean Sea we obtain the following trends:

   (i.) Periods of higher frequency of cold episodes, i.e. with more than two cold events of long duration per decade– appear to be:
   - for the temperate semi-arid regions [BSk]: AD 580-690, 1030-1090, 1120-1200, 1230-1260;
   - for the Mediterranean regions [Csa]: AD 460-490, 790-850, 900-950, 990-1020, 1030-1060, 1250-1300, 1320-1400, 1430-1450.

   (ii.) Periods of higher frequency of hot episodes (more than two hot events of long duration per decade) appear to be:
   - for the Mediterranean regions [Csa]: AD 500-540.

   (iii.) Periods of higher frequency of dry episodes (more than two dry events of long duration per decade) appear to be:
   - for the temperate semi-arid regions [BSk]: AD 360-390, 530-580, 690-720, 1090-1200;
   - for the desert region [BWh]: AD 320-340, 390-420, 450-480, 510-560, 600-630, 740-770, 1040-1070, 1130-1200, 1290-1320;
   - for the Mediterranean regions [Csa]: AD 560-590, 740-790, 1020-1050, 1070-1110, 1140-1160.

   (iv.) Periods of higher frequency of wet episodes (more than two wet events of long duration per decade) appear to be:
   - for the temperate semi-arid regions [BSk]: AD 660-700, 1030-1210;
   - for the desert region [BWh]: AD 540-580, 1160-1200;
   - for the Mediterranean regions [Csa]: AD 440-480, 960-1000, 1030-1070, 1090-1130, 1340-1390.

This short wandering throughout historical-climatological information from the time of Byzantine Empire (4th-15th centuries AD) may let us conclude that from a paleoclimatological point this type of evidence includes significant drawbacks. The relevant records often emphasize extreme conditions and they are biased by the selective perception of the observers. The structure of the meteorological information is discontinuous and heterogeneous and, consequently, it reduces the statistical analysis to simple techniques. Despite the wealth of the Byzantine literary tradition, documentary climate-related accounts are scanty. The paleoclimatologist cannot reconstruct detailed climatic fluctuations on the basis of this type of documentary meteorological data alone and faces difficulties in shaping long-term trends of temperature or precipitation. Besides, he must be cautious in his interpretations as the data are characterized by chronological inaccuracy and geographical uncertainty. These characteristics force towards the modification of methodologies standardized by modern historical climatology, so that the researcher can drain as much as possible from the statistical information of the available data. Whether the reconstructed fluctuations are an effect of a changing density of records rather than the product of changing climate parameters is a question that should remain open. In any case, further research might be carried out for the enrichment of the existing database by the investigation of unexploited genres of Byzantine documentary sources.

Endnotes

1. The first systematic methodological observations about the use and the trustworthiness of documentary paleoclimatic evidence derived from European medieval and modern historical sources have been made by M. J. Ingram, D. J. Underhill, and G. Farmer, "The use of documentary sources for the study of past climates," in *Climate and History: Studies in past climates and their impact on Man*, T. M. L. Wigley, M. J. Ingram, and G. Farmer, eds., 1981, Cambridge University Press, Cambridge, London, New York, New Rochelle, Melbourne, Sydney, 180-213.

2. For a discussion of the state of the research in historical climatology and a detailed presentation of its development with special focus to methodological principles for data elaboration and interpretation of the European climate history one can now consult: R. Brázdil, C. Pfister, H. Wanner, H. von Storch, and J. Luterbacher, 2005, "Historical Climatology in Europe - The State of the Art," *Climatic Change*, 70 (3): 363-430.

3. Discussion about faults and drawbacks of these "weather compilations" was conduced since early 1980s. See Ingram *et al*., *op. cit.*

4. This gap in the European historical climatology has been mentioned by C. Pfister, 2002, "The potential of documentary data for the reconstruction of past climates in Europe," in *Discussion Papers ESF-OLIVAR Workshop*, Lammi, Finland.

5. For the reasons of this "exclusion" of the paleoclimatic evidence built in the Byzantine documentary sources from the focus of historical climatology, see I. Telelis, 2000, "Medieval Warm Period and the beginning of the Little Ice Age in Eastern Mediterranean. An approach of physical and anthropogenic evidence," in *Byzanz als Raum. Zu Methoden und Inhalten der historischen Geographie des Östlichen Mittelmeerraumes*, K. Belke, F. Hild, J. Koder, and P. Soustal, eds., Kommission für die Tabula Imperii Byzantini, Wien, 223-243.

6. There exist some papers that concern either the analysis of meteorological events *per se* or the inclusion of climatic factors as agents of historical or cultural change. For a presentation of the bibliography on this topic and a synthesis that covers the entire Byzantine period from AD 300 through 1500 from the point of view of historical climatology see I. Telelis, 2004, *Meteorological Phenomena and Climate in Byzantium*, Ponimata No. 5, Academy of Athens, (in Greek with English summary), Athens.

7. A good starting reference book about Byzantine history is C. Mango, 1980, *Byzantium the Empire of New Rome*, Weidenfeld and Nicolson, London. For an overview of the existing editions of the Byzantine sources see H. Hunger, 1978, *Die hochsprachliche profane Literatur der Byzantiner. Erster Band, Philosophie, Rhetorik, Epistolographie, Geschichtsschreibung, Geographie*, Byzantinisches Handbuch V/1, Beck Verlag, München; J. Karayannopoulos and G. Weiß, 1982, *Quellenkunde zur Geschichte von Byzanz (324-1453)*, Schriften zur Geistesgeschichte des Östlichen Europa No. 14, Harrassowitz, Wiesbaden, 2 vols.

8. J. Karayannopoulos, and G. Weiß, *op.cit.*

9. For the dating styles during the Byzantine period see F. Dölger, 1949, *Das Kaiserjahr der Byzantiner*, Sitzungsberichte der Bayerischen Akademie der Wissenschaften Philosophisch-Historische Klasse No. 1, Verlag der Bayerischen Akademie der Wissenschaften, München.

10. Analysis on the nature and form of meteorological references derived from the Byzantine sources is now available in I. Telelis, *Meteorological Phenomena and Climate in Byzantium*, *op.cit.* p. 780-782.

11. This classification is partly based on C. Pfister, 1999, *Wetternachhersage. 500 Jahre Klimavariationen und Naturkatastrophen (1496-1995)*, Verlag Paul Haupt, Bern, Stuttgart, Wien, 14-19.

12. R. Brázdil, and O. Kotyza, 1995, *History of Weather and Climate in the Czech Lands I (Period 1000-1500)*, Zürcher Geographische Schriften No. 62, Verlag Paul Haupt, Zürich; A. Ogilvie, and G. Farmer, 1997, "Documenting the Medieval Climate," in *Climates of the British Isles: Present, Past and Future*, K. Hulme, and E. Barrow, eds., Routledge, London, New York, 112-133; C. Pfister, J. Luterbacher, G. Schwarz-Zanetti, and M. Wegmann, 1998, "Winter air temperature variations in western Europe during the Early and High Middle Ages (AD 750-1300)," *The Holocene*, 8: 535-552.

13. W. Koeppen, 1931, *Klimakarte der Erde. Grundriss der Klimakunde*, De Gruyter, Berlin, Leipzig, 2nd edition.

14. G. T. Trewartha, 1981, *The Earth's Problem Climates*, University of Wisconsin Press, London, 2nd edition.