Arctic, Antarctic, and Alpine Research, Vol. 34, No. 2, 2002, pp. 230–232

Book Reviews

INTERHEMISPHERIC CLIMATIC LINKAGES. Edited by Vera Markgraf. San Diego: Academic Press, 2001. 454 pp. $99.95. ISBN 0124726704.

During the past decade or so, the International Geosphere Biosphere Program-Past Global Change Project (IGBP-Pages) sponsored various efforts to collate and synthesize paleoclimatic information at global scales. One such effort is a series of Pole-Equator-Pole (PEP) transects (the Americas, Austral-Asian, and Afro-European transects), under the auspices of the Paleoclimate of the Northern and Southern Hemispheres (PANASH) Project, to document the sequence and phasing of climatic fluctuations, identify a hierarchy of climatic controls and investigate possible mechanisms for interhemispheric linkages.

Interhemispheric Climatic Linkages represents the most recent synthesis for the Americas transect (PEP 1), which given the modest similarity between North and South American landmasses and the pole-to-pole boundary with the Pacific, is at least physically the most symmetrical of the three transects. The editor of this comprehensive volume is Vera Markgraf, who served as ringleader for the Americas transect from the first meeting in 1993 held in Panama City to the last gathering in Merida, Venezuela, in 1998. This book reflects Markgraf's ability to forge international collaborations and cajole participants at her workshops into writing thoughtful syntheses and original contributions.

Because I work in both North and South America and tend to relate one to the other, I was primarily interested in seeing the answers to three questions. First, is climate variability in the two hemispheres synchronized at a range of time scales? If synchronized, is the phasing at the various sites and the reconstructed climatic fields consistent with modern synoptic climatology, or is there little similarity between modern and past climates? And third, is there something about the patterns of synchroneity and cross-equatorial symmetries and asymmetries at millennial time scales that discriminates climatic forcing by seasonal insolation variations, ocean heat transport (thermohaline circulation), or dynamic interactions with the Pacific (El Niño-Southern Oscillation (ENSO) or ENSO-like phenomena)?

Interhemispheric Climatic Linkages includes some truly seminal chapters on interannual and decadal-scale variability in the modern and historical climate (Chapters 1–4, 8–10) that set the stage for the rest of the book. Many of these chapters are apt to be cited frequently and widely. For the sake of brevity and in the interest of capturing the flavor of the book, I will focus on only a few highlights.

In Chapter 1, Dettinger et al. show remarkable cross-equatorial symmetries in modern global sea surface tempratures (SSTs), atmospheric circulation and hydroclimatic responses linearly associated with ENSO-like variations. This symmetry occurs at both interannual (ENSO) and decadal (Pacific Decadal Oscillation, or PDO) scales. The strong spatial similarity makes the two dominant modes of Pacific climate variability indistinguishable in the fossil record. On the other hand, other forms of climatic variation, such as the multidecadal North Atlantic Oscillation (NAO), may be separated from ENSO-like variability by their asymmetrical effects across the equator. Asymmetry may not always rule out ENSO-like variability, however. For example, polar air outbreaks and their attendant freezes (and precipitation events) are occasionally invoked in the paleoclimatic literature, particularly for South America, to explain equatorward expansions of temperate flora or winter precipitation in summer monsoonal areas. Marengo and Rogers (Chapter 3) show no relationship between these cold surges and ENSO in South America, but citrus freezes in Florida tend to cluster in periods with positive PDO.

In Chapter 2, Enfield and Mestas-Nuñez examine residual modes of global SST variability after removing the global ENSO-mode from the instrumental record. They quantify what all of us suspect intuitively—that SST is the least understood yet most critical atmospheric boundary condition for understanding and simulating past climate. I was particularly interested to see that the decadal mode of SST anomalies at high latitudes of both the Pacific and Atlantic seems to be tropospherically linked through fluctuations in the polar vortex. Could this mean, for instance, that when the pole-equator temperature gradient decreased in the past, changes in the frequency of cold fronts in the Southern Ocean could affect the flow of cold thermocline water to upwelling areas of the tropics? Enfield and Mestas-Nuñez are skeptical about using modes (ENSO, PDO, NAO) identified in the instrumental record as templates for the behavior of climate at longer time scales. Again, physical processes and interactive feedbacks that might differ between interannual and decadal time scales are sure to differ at millennial ones.

Enfield and Mestas-Nuñez speculate that early to middle Holocene climate may have been stabilized by smaller pole-to-equator temperature contrasts and reduced ENSO variability. Say, for example, that ENSO variability develops aperiodically to remove excess heat that builds up in the tropical Pacific and transfer it to the poles. A smaller meridional temperature contrast in the past would reduce the need for the poleward transport presently accomplished during El Niños. This would tend to mute ENSO-like features such as intensified trade winds, the warm pool in the western Pacific, large zonal SST gradients, and the strong, eastward uptilt in the thermocline. Much of the cross-equatorial symmetry would either disappear or morph into a less familiar spatial pattern.

Given this detailed, comparative analysis of modern climate, what does the patchy and uneven fossil record have to say about past climates across the Americas? On the high-resolution end, Evans et al. (Chapter 4) use reduced set Objective Analysis (OA) to reconstruct climate fields from sparse observations in an objective and verifiable way. This methodology was applied to a network of tree-ring chronologies along the Pacific coasts of North and South America and the resulting 1000-yr reconstruction of gridded Pacific basin SST reported in Chapter 10 (Villalba et al.). The OA method verified the decadal ENSO-like pattern in the SST field reconstructions reported by Villalba et al. and suggested ways in which the reconstruction could be further strengthened.

The Villalba et al. chapter shows remarkable interhemispheric symmetry in the tree-ring response to Pacific climate at decadal scale. Moreover, the tree-ring data used in this chapter indicate a more energetic decadal mode from 1600–1850, when North and South America were also better teleconnected. The interannual mode was dominant from 1850 to 1976, when Pacific climate shifted back to decadal mode and tighter teleconnections. The authors suggest that these shifts between decadal and interannual modes may reflect major reorganizations in Pacific circulation. So, could such reorganizations have played a role in the Little Ice Age across the Americas, and perhaps even further afield? In Chapter 8, Luckman and Villalba show broad synchroneity in the initiation and timing of LIA glacial events along the PEP 1 transect, particularly during the period 1600–1850 and the glacial recessions that followed soon thereafter. As is the theme throughout *Interhemispheric Climate Linkages,* all eyes should stay glued to the tropical Pacific.

The remaining chapters of the book (Chapters 5–7, 11–22) canvas the paleoclimate record at century to longer time scales, and include syntheses of the glacial, eolian, limnologic, vegetation, and archeological evidence throughout the Americas. Included are some very comprehensive, insightful, and up-to-date reviews of the continental record. Some highlights include broad agreement between full to late glacial trends at western mid-latitudes (Whitlock et al., Chapter 21), antiphased in the northern tropics (Behling and Hooghiemstra, Chapter 18). The signal in most of these records is greater effective moisture than modern, with few opportunities to discriminate between temperature and precipitation effects. Both the synchroneity and symmetry of glaciers (Clapperton and Seltzer, Chapter 11), lakes (Bradbury et al., Chapter 16; Fritz et al., Chapter 15) and lower elevation limits for vegetation could result entirely from global cooling; the book includes a nice summary of last glacial maximum (LGM) paleotemperature estimates from tropical and subtropical lowlands (Bush et al., Chapter 17). The synchrony could also involve a more complex match between temperature forcing of hydrology in one hemisphere and precipitation forcing in the other, without implying the same causality (Bradbury et al., Chapter 16). Some of the chapter authors see less interhemispheric linkage than others. Ledru and Mourgiart (Chapter 20) reviewed 28 pollen records from Alaska to Tierra del Fuego and saw little synchroneity or symmetry during the late glacial. For the last glacial period, paleorecords are not always in agreement with results from general circulation model experiments. For example, paleowind indicators in the mid-contintent of North America suggest predominant westerly or northwesterly winds, while the strong glacial anticyclone centered over the Laurentide ice sheet should have generated strong northeasterly winds to the south (Muhs and Zarate, Chapter 12).

One of the more interesting outcomes of the interhemispheric comparison is the apparent continental-scale drought that affected both North (mid-latitudes) and South America (middle and low latitudes) during the middle Holocene (~8–4 cal ka), while the Northern Hemisphere tropics remained wet. This mid-Holocene megadrought shows up in both limnological (Fritz et al., Chapter 15) and vegetation records (Grimm et al., Chapter 19), and it is attributed to increased insolation (warmer summers, more northerly jet stream) in the Northern Hemisphere and decreased insolation (weakened monsoonal circulation) in the Southern Hemisphere. Interestingly, the instrumental record includes no comparable single year or decade of continental-scale drought in both hemispheres, suggesting that the mid-Holocene has no modern analog. Grimm et al. (Chapter 19) suggest that North and South America may have been synchronized to large-scale drought by reduced north-south migration and more northerly position of the Intertropical Convergence Zone. Frankly, I find it hard to reconcile hydrological drought in the southwestern U.S. and the central Andes, where winter precipitation increases and summer precipitation decreases, respectively, during El Niño. One explanation may involve reduced ENSO variability, for which there is currently both marine and terrestrial evidence, though there is disagreement whether the tropical Pacific was generally warm or cold.

This leads us to Peteet's (Chapter 22) overview of GCM experiments for late glacial climates. Modeling groups that use the time slice approach (the COHMAP/CLIMAP approach) focus on gradual forcing of changes in ice sheet and insolation (with fixed SST's or fixed-ocean heat transport), while those performing sensitivity tests emphasize changes in ocean temperatures and thermohaline circulation. I would argue that a similar division is developing in the ways that geologists interpret their paleorecords. This raises a critical question about the importance of SST and heat transport parameters in forcing both long-term climate variability and interhemispheric linkages. Such ocean-atmosphere forcing and the resulting teleconnections will soon be addressed using coupled atmospheric-ocean GCM experiments.

Finally, despite the impressive multiproxy approach, I came away from my quick read of the long-term paleorecord uncertain about the calendar of events and the reconstructed climate fields, much less any sure verdict about symmetry or asymmetry of climate change across the Americas (Markgraf and Seltzer, Chapter 23). This is no fault of the book, or of its authors, but it does pose a challenge to paleoclimatologists working at longer time scales and lower resolution. How do we improve our records to really disentangle interhemispheric climate linkages and drivers on some par with the instrumental record and interannually-resolved proxies?

If there is a weakness to *Interhemispheric Climatic Linkages,* it probably lies in consideration of the human dimension. Three chapters cover limited aspects of the cultural prehistory of the Americas. In Chapter 5, Sheets infers cultural adaptation and resilience to explosive volcanism in middle America. Brenner et al. (Chapter 6) examine asynchronous climate changes and cultural collapses on the Maya Lowlands of Central America and the Bolivian Altiplano. Nuñez et al. (Chapter 7) focus on human responses to early Holocene aridity in southern South America. These chapters are not comprehensive and perhaps suggest a topic for a future workshop and another volume. For example, can we use interhemispheric comparisons to deconvolve climatic from land use effects in regions that are climatically antiphased (why did Pleistocene megafauna go extinct simultaneously in one place that got drier and in another that got wetter?). Perhaps more importantly, today we are linked by international trade, banking, and politics, all of which surely respond, albeit in complex ways, to interannual and interdecadal climate variability. The contemporary human dimension of interhemispheric climatic linkages in the Americas was neglected in the book. All in all, however, I found *Interhemispheric Climatic Linkages* a fascinating read and a valuable blueprint for things to come.

Julio L. Betancourt
Desert Laboratory, U.S. Geological Survey
1765 W. Anklam Rd. Tucson, Arizona 85745, U.S.A.

Physiographie, Vegetation und Syntaxonomie der Flora des Páramo de Papallacta (Ostkordillere Ecuador). By W. Lauer, M. Daud Rafiqpoor, and I. Theisen. Erwissenschaftliche Forschung, volume XXXIX, Stuttgart: Franz Steiner Verlag, 2001. 140 pages, 2 maps and tables. ISBN 3-515-07915-7.

Following a volume on Mexico and Bolivia, this volume is the third monographic study in a series on comparative geo-