with some of the leadership of AGU, and learn more about AGU's programs for students.

The **Academic Showcase** provides a one-stop shopping venue where students will be able to explore graduate programs, resources, and employment opportunities at 20 different institutions that offer graduate degrees in the Earth and space sciences. The Showcase also provides a great rendezvous site for alumni of the participating institutions. This special section of the 2nd Level Exhibit Hall, located adjacent to the Career Center in Moscone Center West, will be open from Tuesday through Friday, 8:30 AM to 5:00 PM.

The **Education and Student Lounge** will be located adjacent to the Career Center on the 2nd Level Exhibit Hall of Moscone Center West throughout the meeting and serves as a place to relax, meet with colleagues, or recharge your laptop. Brown-bag discussions on important education and career-related topics will be held daily in the lounge and interested AGU members are encouraged to participate in these activities. The Association of Women Geoscientists will convene a discussion on the status of women in geosciences during the Wednesday brown-bag. Program managers from NSF, NASA, and other funding agencies will be available to meet with young professionals to discuss the proposal and grant process during Tuesday lunch. A complete schedule of discussions will be posted at the entrance to the Lounge.

Career Services That Address Shifting Employment Needs

Surveys of employment trends in the Earth and space sciences have shown that, in spite of some softening in today's generally weak economy, job opportunities are abundant in a variety of sectors that employ geoscientists. The **AGU Career Center** will again be the place for job seekers and prospective employers to find each other. Job candidates will be able to view daily postings of employment, post-doc, fellowship, and internship opportunities, and leave their resumes for review by prospective employers, at no cost. Prospective employers can post their job position announcements, review resumes, and schedule interviews with candidates of interest, for a nominal fee. The Career Center will be located in the Moscone Center West Level 2 Exhibit Hall and will be open Monday through Friday from 8:30 AM to 5:00 PM. Current information about employment and salary trends will also be available at the Center. Additional information about registration and fees for the Fall Meeting Career Center is available at www.agu.org/meetings/fm03/outreach.shtml).

A **Career Planning Workshop**, *Completing the Package: Why is it Hard to be Soft?*, will be held in the San Francisco Marriott Hotel (Nob Hill A&B room) on Monday, 8 December from 7:30 PM to 9:00 PM. This panel discussion will explore the additional skills, in addition to solid technical preparation, that are valued by today's employers operating in a variety of career sectors, and strategies for acquiring these skills. In today's economy, having these so-called "soft skills" in your professional toolbox can make the difference in successfully finding your perfect job.

Developing Skills for K-16 Educators

Three **Professional Development Workshops** aimed at enhancing the education-related skills of AGU members working in undergraduate programs will be offered during the Fall Meeting. The *Teaching Excellence Workshop on Testing and Grading Students*, being offered by Tim Slater, Ed Prather, and Mike Zeilik, will offer instruction that helps faculty improve student learning in their courses by focusing on effective testing and grading strategies; implementing these successful strategies even in large enrollment courses; and introducing faculty to innovative assessment approaches that concentrate on engendering meaningful understanding [Monday, 7:00 PM–9:30 PM; San Francisco Marriott Hotel (Nob Hill C&D)].

Strategies and approaches for developing and sustaining research programs at the undergraduate level, with emphasis on preparing new geoscience faculty, is the topic of the workshop *How to Start a Research Program at a Primarily Undergraduate Institution* being convened by Jeff Ryan and Karen Grove and sponsored by the Council on Undergraduate Research [Tuesday, 3:30 PM–6:00 PM; SF Marriott Hotel, Pacific A]. Scientists interested in working with teachers and students in the K-12 science classroom will benefit from lessons and strategies on "inquiry-based" learning in the workshop *Scientific Inquiry in the K-12 Classroom* being offered by the Cooperative Institute for Research in Environmental Sciences (CIRES) [Wednesday, 8:00 AM–12:00 PM; SF Marriott Hotel, Pacific A].

AGU will again sponsor a **Geophysical Information for Teachers (GIFT) Workshop** for middle and high school teachers from the San Francisco Bay region on Tuesday and Wednesday during the meeting. The theme for this year's GIFT workshop, "The Polar Regions: Bellwethers of Change," will focus on recent polar research and its implications for abrupt climate change. CIRES is coordinating this year's workshop program, which brings members of the research community together with teachers from the K-12 community.

Complete information about the education, career, and student programs that will be offered during the 2004 Fall Meeting can be found at http://www.agu.org/meetings/fm03/outreach.shtml.

FORUM

Comment on "On Past Temperatures and Anomalous Late-20th Century Warmth"

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We write in response to the Forum article by Mann et al. (*Eos*, 8 July 2003; "M03"), noting first two points of apparent agreement with our work [*Soon and Baliunas*, 2003; *Soon et al.*, 2003; "SB03"]:

(1) Studies of climatic and environmental changes (including temperature) on hemispheric or global scales over time periods of millennia based on paleoclimate proxies must contend with significant uncertainties.

(2) Knowledge of past climatic changes does not have a direct bearing on the climatic effects of anthropogenic carbon dioxide added to the air during the 20th century and beyond.

M03 relies mainly on a northern hemisphere reconstruction of average annual temperature by *Mann et al.* [1999]. Their reconstruction calibrates environmental proxies going back many centuries, using the thermometer record that extends back only to the 1860s. Their northern hemisphere reconstruction prior to 1400 C.E. depends sensitively on tree growth from one region; namely, trees growing at high elevations in western North America.

For some tree species, annual growth rings can be measured to yield a proxy for warm-season temperature. The tree growth indices, based on the width of an annual growth ring, and the growth-ring density formed in late summer, yield a positive correlation with warm-season temperature where thermometry is available. The value of tree growth records is that some extend back many centuries, well beyond the period for which instrumental temperature measurements exist. However, the 20th century—the instrumental calibration period for the tree growth indices—shows declining patterns of tree growth, despite rising temperatures, especially at high northern latitude sites.

Several causes have been offered for the divergence of recent tree growth and summer temperature; for example, land use or soil property changes, changes in the length of the growing season, or even changes in the efficiencies of water and nutrient utilization through perhaps physiological adaptation [*Graybill and Idso*, 1993; *Jacoby and D'Arrigo*, 1995; *Briffa et al.*, 1998; *Feng*, 1999; *Barber et al.*, 2000; *Jacoby et al.*, 2000; *Knapp et al.*, 2001], but none have been convincingly established.

The resultant uncertainty in the calibration of tree growth to temperatures, combined with the general difficulties with the subtraction of biological growth trends [*Briffa et al.*, 1998], may explain the different results derived independently; for example, from measurements of

several thousand boreholes drilled through rock and ice. Results for boreholes show that *Mann et al.* [1999] have significantly underestimated variations of the northern hemisphere annual mean temperature on time scales of several decades to centuries [*Huang et al.*, 2000], and that the 20th century may not be as warm as it was roughly 1000 years ago [*Huang et al*., 1997].

Additional discussions were given on pp. 258–264 (see especially footnote 18 on pp. 261–262) of *Soon et al.* [2003].

Each proxy for a climate variable has sampling deficiencies related to its spatial and temporal resolution. Added to these difficulties is the problem of calibrating proxies to temperature based on surface thermometer records which can have potentially large biases related to historical land use changes, the growth of cities ("urban heat island effect"), uneven spatial sampling, and instrumental or technique changes [*Christy et al.*, 2001; *DeGaetano and Allen*, 2002; *Pielke et al.*, 2002; *Arnfield*, 2003; *Chase et al.*, 2003; *Kalnay and Cai*, 2003].

These are some of the reasons for the significant uncertainties that arise in reconstructing temperature on large spatial scales from proxy data that provide information at particular locations, and which may be influenced by variables other than temperature, or in addition to temperature. SB03 attempted to overcome some of those uncertainties by carrying out an extensive survey of many different proxy studies. Results for each proxy were primarily based on the opinions of the researchers who constructed the proxies. Those results provide clear and widespread (not just Northern European) evidence for climate and environmental anomalies related to two periods previously defined by proxy researchers; namely, the Medieval Warm Period (~800–1300; "MWP") and the Little Ice Age (~1300–1900, "LIA"). Here, "anomalies" are roughly viewed as 50-year or longer intervals of sustained warmth during the MWP, and sustained cold during the LIA, together with concurrent water, ice, chemical, and biological evidence during such intervals.

Taken together, the results from available climate and environmental proxies suggest that neither higher temperatures (where a proxy has been related to temperature), nor more extreme climate variability (where a proxy relates to other climate or environmental variables) occurred in the 20th century than during the MWP.

For the proxy data alone, the temperature reconstruction within the uncertainties of M03 (Figure 1 of M03) and even the updated results in *Mann and Jones* [2003] are in general agreement with our assessment of climate proxies. For example, Figure 2 of *Mann and Jones* [2003] clearly shows temperatures in the MWP that are as high as those in the 20th century.

Finally, we comment on several assertions made by M03.

M03 state that the "SB03 approach... defines a global 'warm anomaly'..." SB03 wrote: "A global association for the Little Ice Age or Medieval Warm Period is premature because proxy data are geographically sparse and either or both phenomena could be multi-phased events acting under distinct local and regional constraints and modes." [*Soon and Baliunas*, 2003; p. 91]

M03 caution against making "the patently invalid assumption that hydrological influences can literally be equated with temperature influences in assessing past climate." SB03 agree and noted that the MWP and LIA should be based on the temperature field, but cautioned that thermal anomalies cannot be easily dissociated from hydrological, cryospheric, chemical, and biological influences, and historical accounts [*Soon et al.*, 2003; pp. 235–239 and 243].

M03 also caution that "any analysis (SB03) that considers simply '20th century' mean conditions...can provide only very limited insight into whether or not recent warming is anomalous in a long-term and large-scale context." SB03 distinguished between early and late-20th-century climate anomalies, when the end points and the resolution of the proxies allowed such consideration. Observed early 20th-century and late 20th-century patterns of climate change were specifically noted [see pp. 236, 243 and Figure 3 *of Soon et al.*, 2003]. The SB03 study recognizes various man-made factors of climate change throughout history, and briefly discusses the topic of climatic forcing by anthropogenic carbon dioxide [see *Soon et al.*, 2003; pp. 269–271].

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Response

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Soon and his colleagues ('S03') fail to address any of the three specific issues we raised in our *Eos* criticism ('M03') of their previous work ('SB03'). These were the need for critical evaluation of proxy data to be used; consistent assimilation of widespread, well-dated, and resolved records; and the objective, quantitative calibration of these records [see also *Bradley et al.*, 2003]. S03, instead, start with the implausible claim that we agree with their assertion, "knowledge of past climatic changes does not have a direct bearing on the climatic effects of anthropogenic carbon dioxide...." Reconstructions of past temperature histories do, indeed, have such a bearing. They provide one of several independent lines of evidence supporting the consensus scientific conclusion, expressed in the 2001 report of the Intergovernmental Panel on Climate Change (IPCC), that anomalous, hemispheric, late-20th-century warmth cannot be explained by natural factors. S03 follow with an equally puzzling assertion that "M03 relies mainly on a northern hemisphere reconstruction of average annual temperature by *Mann et al.* [1999]." Our article, quite to the contrary, demonstrated that nearly a dozen

different published estimates based on proxy data and model simulations give the same picture—anomalous, late-20th-century warmth that is unprecedented in a millennial or longer context.

These "straw man" arguments set the tone for an ensuing list of myths and unsubstantiated claims. Ironically, many of the criticisms raised might better be applied to the ill-conceived, largely subjective approach taken by SB03. While the claims made by S03 are too numerous to address in detail, several are so at variance with the accepted science that they deserve special attention:

(1) The contention that the conclusions expressed by M03 for the period prior to AD 1400 rely mainly "on tree growth from one region" belies the fact that several of the proxy estimates shown were based on composites of estimates from regions across the northern hemisphere, some based primarily on non-tree ring proxy information. The claims of S03 regarding non-climatic impacts on tree growth, even if valid, would thus be irrelevant. However, the claims are not valid. Their assertion that "[20th-century] tree growth indices...show declining patterns of tree growth, despite rising temperatures" is misleading. Declines in the response of tree growth to temperature are found in certain high-latitude regions only. In such cases, relatively recent (i.e., post 1950) data are not used in calibrating temperature reconstructions. In many other (even high-latitude) areas, density or ring width records display no such recent bias.

(2) The statement by S03 that the *Mann and Jones* [2003] reconstruction "clearly shows temperatures in the MWP that are as high as those in the 20th century" is misleading, if not false. M03 emphasize that it is the late, and not the early- or mid-20th-century warmth, that is outside the range of past variability. Mann and Jones emphasize conclusions for the northern hemisphere, noting that those for the southern hemisphere (and globe) are indeterminate, due to a paucity of southern hemisphere data. Consistent with M03, they conclude that late-20th-century northern hemisphere mean temperatures are anomalous in a long-term (nearly two millennium) context.

(3) SO3 argue that borehole data provide a conflicting view of past temperature histories. To the contrary, the borehole estimates for recent centuries shown in M03 are potentially consistent with other estimates, provided consideration is given to statistical uncertainties, spatial sampling, and possible influences on the ground surface [e.g., snow cover changes; *Beltrami and Kellman*, 2003]. For times more than 500 years ago, uncertainties in the borehole reconstructions preclude any useful quantitative comparison [*Pollack et al.*, 1998].

(4) S03 promote the myth that "urban heat island" effects lead to significant biases in the instrumental record of surface temperature used to calibrate proxy data. A recent case study of modern urban thermometer measurements in the U.S. [*Peterson*, 2003] supports previous findings that the influence of urban heat bias on estimates of global surface temperature change is minimal [*Hansen et al.*, 1999].

(5) In contrast to their claims, land use changes are believed to have led to an overall cooling—not a warming—of global surface temperatures during the 19th and 20th century [*Govindasamy et al.*, 2001].

Articles in *Scientific American* and the *Chronicle of Higher Education* have quoted numerous other leading climate scientists as indicating that SB03 misinterpreted the paleoclimatological literature. The controversy over the publication of SB03 has now led, since the publication of M03, to the resignation of the editor-in-chief and five other editors at the journal *Climate Research*. It is clear that we are not alone in finding the work of SB03 seriously flawed.

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