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The Fate of Greenland— Lessons from Abrupt Climate Change

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Review

The Fate of Greenland— Lessons from Abrupt Climate Change

Phillip Conkling, Richard Alley, Wallace Brooker, and George Denton. Cambridge, MA: MIT Press, 2011. 232 pp.

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In times of chronic lack of resources for academic research and ever increasing competition for grants it was every scientists dream coming true: a billionaire patron comes along and hands you unlimited resources to pursue the research that lies closest to your heart. In this case, the late Gary Comer (1927–2006), who had in 2001 taken his yacht through the notorious Northwest Passage then free of sea ice, engaged a team of outstanding climate scientists to lead a search for causal links controlling abrupt global climate change: Wallace (Wally) S. Broecker of Columbia University, George H. Denton of the University of Maine, and Richard B. Allen of Pennsylvania State University. Broecker is an oceanographer/geochemist, who is probably best known for developing the idea of a global "conveyor belt" linking the circulation of the global oceans and controlling large scale climate oscillations in the past; Denton is a geologist, long concerned with the (bi-polar) geological history of the large Quaternary ice sheets; and Alley is a glaciologist who is perhaps best known for his contributions on the relationships between Earth's cryosphere and global climate change. All three have developed ideas and concepts on rapid ocean-atmosphere-cryosphere reorganizations

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over past glacial cycles. Philip Conkling, a prominent Maine naturalist who participated in many of Comer's expeditions, played a vital role in putting the team together.

And off they went searching for clues that could highlight the how's, when's and why's of abrupt climate changes in the past. The underlying belief of the team was that understanding Earth's past climate dynamics is one key to predicting the future. Using Comer's 152-foot vessel (*Turmoil*) as a platform (but also with airplanes and helicopters in the toolbox), they organized a series of research expeditions during the Arctic summers of 2002, 2003, 2005 and 2006, specially targeting the Scoresby Sund area, north-eastern Greenland for fieldwork (having myself spent a rainy and cold summer in 1990 working out of a tent camp on Jameson Land, Scoresby Sund, I can appreciate the difference first class logistics make for fieldwork output). The field efforts were paralleled by a multiyear funding by Cromer for a network of senior scientists focusing on global dynamics of abrupt climate changes.

The volume, *The Fate of Greenland—Lessons from Abrupt Climate Change*, tells the story of this undertaking and puts palaeoclimatological finds into a global climate change perspective. It aims at capturing the excitement of palaeoenvironmental research over the past couple of decades that has highlighted how large-scale climate changes occur and spread through the global natural systems. Underway, the authors explain the types of proxy data that shed light on Late Quaternary environmental changes, and familiarize the reader with Milankovitch cycles, as well as Dansgaard-Oeschger (D-O) and Heinrich (H) events. The Serbian mathematician Milutin Milankovitch (1879–1958) calculated variations over time in solar radiation at the top of the atmosphere at different latitudes and suggested that periodic changes in energy received from the sun could cause ice ages. The D-O cycles are manifested in ice core oxygen isotope records as rapid climate fluctuations that occurred about twenty-five times during the last glacial period, whereas the H events are identified in deep sea sediment cores and signify ice-sheet collapses or rapid destruction of ice shelves and the consequent release of a prodigious volume of icebergs to the North Atlantic. It is an exciting research history, narrated with numerous examples and metaphors for clarity, and discussing causes and effects recognized through Earth's glacial and climate history. It is not always an easy task to present this to the layman without lapsing into scientific jargon, but the authors do this well. There are numerous large and small feedback effects

operating whenever changes occur in the natural systems (be it hydrosphere, lithosphere, cryosphere or atmosphere) and causal links are often obscure and difficult to detect. Climate events can be the result of some (minor) chaotic disturbances, where the future behavior and development of the system is highly sensitive to the initial (and often obscure) conditions. Although the book conveys this understanding in a broad sense, it highlights the quest to understand the sudden Younger Dryas (YD) climate reversal. At about 12,900 years ago, when the large Northern Hemisphere ice sheets had been melting away for few millennia and the Earth was slowly warming up, there was a sudden reversal to near full-glacial conditions that lasted for about 1200 years. There is a wealth of data from numerous palaeoclimate archives (e.g., ice cores, terminal moraines, sediment cores, and tree rings) that document the abrupt YD cooling as well as its sudden termination. It has been studied extensively because it is probably the best known manifestation that large-scale climate reversals can occur very rapidly. The book describes the hunt for data that can identify a triggering event for the abrupt YD cooling and its sudden termination. It makes for a great reading, but despite all efforts the cause of the cooling is still puzzling. Most scientists believe that the observed environmental changes are best explained by a shutdown of deep water formation in the North Atlantic Ocean combined with very extensive sea ice. The question remains, however, what triggered this?

The Little Ice Age (LIA) is another focus of the book. In addition to geological archives, the LIA is also well documented by historical and archaeological archives. The demise of the Norse settlements in Greenland, after 500 years of occupation, has been ascribed to the LIA cooling. There is no generally acknowledged definition of the LIA, and it is not well constrained in time. As with many glacial and climate events it appears to have been transgressive in time, that is lasting longer (and being more severe) at high northern latitudes (like Iceland, Greenland, and Svalbard) than in the Alps or elsewhere at lower latitudes. Although the LIA climate reversal was much less severe than the YD event, many scientists entertain the idea that the underlying causes might be similar, and that instead of conveyer belt shutdown during LIA the conveyer belt experienced wobbles/disturbances that affected sea ice situation and ocean currents. Thus, the when's and where's are well known for both YD and LIA events, whereas the why's are still enigmatic. The lesson from both these climate change events is, however, clear: mode

shifts do occur in the climate system, resulting in large, unexpected and rapid environmental changes.

The other aspect of the book is its engagement in the global change discussion. "Global warming is physics, not a hoax," the authors counsel (195), and take a thoughtful stand where observations and facts are highlighted while doomsday predictions and dramatizations are avoided. They correctly state that as no one really lives in Earth's average climate no one cares about it, but point out the many facets of global warming that include shifting distributions and intensity of draughts, floods and storms, as well as rising global sea level. What people should be concerned with is the fact that "we have built our cities, societies and economies for the climate that we have, and our ecosystems are adapted to our present day climate" (192). There is a take-home message to the book: The geological archives as well as archaeological and historical sources tell us that climate changes have occurred rapidly in the past and can occur rapidly in the future. This is worrisome because fast and unexpected changes are difficult to deal with.

This is an excellent book that has a strong message. It is not so much about results of the research funded by Cromer, but more about how their results highlight ideas, concepts and challenges in contemporary research on global changes, past and present. The eloquent prose makes for easy reading and the beautiful and illuminating photographs (most shot by Cromer, who was an accomplished photographer) complement and enrich the text. The authors have achieved what they set out to accomplish: to communicate the excitement, challenges and importance of climate history research in today's changing world. The book is dedicated to the memory of Cromer, who died in 2006, and it is a worthy and fine testimony. There are a few inconsistencies/errors that can bother the more initiated reader, like the dating of the Younger Dryas event (said to have occurred about 11,500 years ago (21) and 12,900–11,700 years ago (79), and the Swedish name Kungsleden (meaning the *Kings trail*) is misspelled (81) as Kungsladan (meaning the *Kings barn*), but these are minor blunders in an overall articulate, well composed, balanced and informative text.