

Reviews

JOUZEL J, LORIOUS C and REYNAUD D (2013) *The white planet: the evolution and future of our frozen world*. (English translation, adapted and revised) Princeton University Press, Princeton, NJ. 306pp. ISBN-10: 0-691144-99-0, ISBN-13: 978-0-691-14499-3, hardback, \$US29.95

Two scientific breakthroughs in the latter part of the 20th century changed forever our understanding of and attitude to our global environment. Curiously and coincidentally, both of these were made in the polar regions: first, the discovery in the early 1980s of the springtime depletion in stratospheric ozone over Antarctica; and, second, the revealing of the detailed history of our planet's climate over several glacial cycles from ice cores retrieved in both polar regions. *The white planet* documents, in a highly accessible style, the story and principal results of the latter.

The authors, Jean Jouzel (2012 Veltlesen co-prizewinner), Claude Lorius and Dominique Reynaud, are glaciologists who are well known for their fundamental work on ice-core chemistry and related climate research. Their first-hand experience of masterminding campaigns of deep core drilling, especially in Antarctica, and their practical and expert knowledge of the environmental significance of ice-core data give this book a vivid and scholarly quality. The text, nevertheless, is aimed at a general and non-specialist readership, and by and large they succeed admirably in guiding the reader through the details of atmospheric chemistry, climate variations, driving mechanisms and contentious interpretations. Reader beware! The authors pull no punches in their belief that during the last several hundred years human beings and their actions are responsible for the changes in atmospheric chemistry and the consequential planetary warming.

The book is divided into four sections. The first introduces 'the world of ice' and provides a succinct overview of the cryosphere with a focus on the Arctic and Antarctic regions. There is a little history of scientific exploration, description of the main features of the ice cover and importantly a summary of observations of changes in ice extent, flow and mass balance. A brief recounting of past glaciations, and astronomical theories that have been invoked to explain their occurrence, ends the section.

The heart of the book is section 2, comprising almost 100 pages and a third of the text. In it the authors set out with remarkable clarity the story of extracting the extraordinarily rich record of climate from ice cores; the focus is on the science, not the technology. The section begins with a little essay on isotope chemistry and moves swiftly into chronicling the numerous challenging and enormously exciting deep-drilling campaigns, first in 1966 at Camp Century, Greenland, and thereafter at Byrd Station, Antarctica (it is a pity the pioneering work of Lyle Hansen is not mentioned), and the early results reported by Chester Langway, Willi Dansgaard and Hans Oeschger. The saga moves on relentlessly to the Greenland Ice Core Project (GRIP), Greenland Ice Sheet Project (GISP), Dome C and, above all, Vostok, where Jouzel, Lorius and Reynaud elaborate the critical results of the 420 ka record (published in *Nature* in 1987) which exposed the strong sensitivity of climate (temperature) to CO₂ and CH₄ (they carefully decouple sensitivity from driving mechanisms), also discussing the

many feedbacks involved (sea ice/albedo, water vapour, clouds, etc.). The 800 ka record established from Dome C is reviewed before shifting back to Greenland to describe rapid climate variations (Dansgaard–Oeschger events) and their links to massive North Atlantic Ocean episodes. The authors are very even-handed in admitting their early misinterpretation of putative rapid events in the Eemian (due to ice mixing close to the bedrock at GRIP). At the end of this long section they reflect on the stability of the Holocene and presage discussion in section 3 of the role of humans in adding to the greenhouse gas loading of the atmosphere and its climate impacts.

The penultimate section takes us temporarily out of the realm of ice and to the work of the Intergovernmental Panel on Climate Change (IPCC). In answer to the question whether humans have already changed the climate, the authors make their position clear: 'We must face the facts. For two hundred years our various activities have rapidly and greatly modified the composition of our atmosphere.' They go on to embrace the IPCC conclusions and argue that humans have already changed the climate. In so doing they also deal with the issues raised by climate change sceptics, in particular the timing and correlation of the rise in CO₂ and temperature using the ice-core data. Although they report the various challenges to the IPCC findings, there is no mention of the vociferous anti-climate-change lobby in the USA where strong political dimensions have been observed and shockingly revealed in the personal account by Raymond Bradley (2011).

The polar regions and the cryosphere, the authors argue, are at the centre of the Earth systems considered vulnerable to extant and future warming, with shrinking of snow-covered regions, diminishing Arctic sea ice, increased and more extensive ice loss from the Greenland ice sheet, rapid retreat of many mountain glaciers, and the melting of Arctic permafrost (and the concomitant release of CH₄). Some of the well-recognized consequences are highlighted, such as rising sea levels and a slowing of the Gulf Stream. The authors also digress briefly into some of the economic, social and political impacts.

The final chapter of section 3 (chapter 15) challenges the reader in respect of the actions needed to both mitigate and adapt to the rise in greenhouse gas emissions, and draws heavily on the range of intergovernmental negotiations from Kyoto through Bali, Copenhagen, Cancún and Durban. Despite all the setbacks encountered to date, the authors are, perhaps surprisingly, positive about the long-term outcomes.

The last section of this engrossing book is an eclectic menu of topics focused on the critical role played in the climate system by polar regions, and emphasizes the need for continued research. There is a brief overview of the value of the various Polar Years and the requirements for future ice-core drilling; a brief foray into the subglacial and aquatic world of Vostok lake; the role of international stations in Antarctica such as Concordia; and the measurement from ice samples of other forms of global pollution such as heavy metals.

There are obvious comparisons to be made between this book and earlier texts such as Richard Alley's *The two-mile time machine* (2000) and the more autobiographical account of ice-core research in Greenland by Willi Dansgaard,

Frozen annals (2005). Jouzel, Lorius and Reynaud have produced a complementary and equally compelling and well-written book, a book with a Eurocentric, indeed Gallic perspective; they report the very latest findings and confront the reader with the consequences of their important discoveries. The translation into English of the original (2008) French publication does result in a few curious phrases and terminological puzzles but these are minor and rapidly deciphered. Although it is pitched at a general scientific readership, the serious glaciologist will find this a most useful reminder of the power and value of the science that has emerged from the analysis of hard-won ice-core samples from the polar regions. Have it on your shelves!

REFERENCES

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