

## Book review

**Human Impacts on Weather and Climate, Geophysical Science Series Vol. 2** by W.R. Cotton and R.A. Pielke (Aster Press 1992) ISBN 0 9625986 1 5. 288 pp. US\$39.95.

I found this to be a fascinating, thought provoking, and most readable book. It is divided into three sections:

- I The rise and fall of the science of weather modification by cloud seeding;
- II Human impacts on regional weather and climate; and
- III Human impacts on global climate.

There is also a brief 'Epilogue' (really a section IV) which sets out the authors' ideas on certain 'common themes', which to my mind are the most contentious, but which certainly do summarise some of the lessons or problems arising from the more technical subject matter.

A sceptical tone is set in the first section, and is continued throughout, with one or two odd exceptions. Clearly, the authors' perceptions are somewhat coloured by their participation in cloud-seeding experiments in Florida in the 1970s (p. 220), where Bill Cotton felt that participation in an operational program during a drought jeopardised the credibility of the participants as 'objective scientists'. The authors make the leap from cloud seeding to greenhouse, fearing that advocacy of action to limit greenhouse gas emissions now may cause a loss of credibility and 'destroy the prospects of obtaining solid scientific evidence that human activity is affecting weather and climate'.

Such contentious remarks aside, the bulk of the book is a brief and fairly reliable summary of many complex areas of atmospheric science. For example, I found the exposition of the various theoretical 'modes' of cloud seeding, including their weaknesses, clear and useful for a relative outsider. Their account of Langmuir and Schaefer's Project Cirrus, 1949–51, accords with my reading of the official reports and the subsequent controversy. However, I feel that the authors go over the top in referring to the impact of the project on the field as 'similar to the effects of the launching of Sputnik on the United States aerospace industry' (p. 8). This is hardly consistent with their note on p. 56 that even at its peak,

funding for weather modification research was only six per cent of the total federal spending in atmospheric research.

The authors justifiably regard useful cloud seeding as not yet proven scientifically, and characterise current operational programs as either 'pork barrel' funding or otherwise unjustified. This fails to recognise the merit in the argument that a hypothesis which is not established at the 95 per cent confidence level might still be worth acting upon, after a cost-benefit analysis, even if the chance of it being correct is much less than 95 per cent. This is the difference between a pure science 'Type I' error and an applied science/engineering 'Type II' error (see Pittcock (1983) for a full exposition of this argument). The same issue arises in their later discussion of action to reduce greenhouse gas emissions (pp. 221–222). If decisions are going to be made, whether by commission or omission, they should be made on the best available scientific advice, while fully recognising the uncertainties.

The authors correctly point to natural variability as the Achilles' heel of cloud-seeding science (p. 59), and rightly carry this over to the question of proof that the enhanced greenhouse effect is occurring (p. 196). What gets lost is the question of whether society should act in advance of observational proof, if the theory is strong enough.

A short chapter on anthropogenic emissions of aerosols and gases canvasses the idea that emissions of cloud condensation nuclei might increase rainfall or change cloud properties. They seem to accept the first on the basis of the 1970 paper by Hobbs et al. on the effect of emissions from paper mills in Washington State (a paper which I believe was discredited by Pittcock (1977)). However, their scepticism comes out when they cite the work of Porch et al. (1990) as undermining the CCN-cloud albedo hypothesis in regard to ship track trails (p. 141).

Their treatment of urban-induced changes in precipitation focusses on the METROMEX experiment at St Louis, Missouri. Here again, their scepticism is evident when they point out that St Louis, like many cities, is situated in a valley (p. 81) and may experience complex effects of local topography (which I pointed out in my 1977 paper above). They suggest that modern limited area models should be used to simulate these effects.

In the chapter on land use changes they accept the view that the leaf area index is the single most useful structural variable for quantifying the effects of terrestrial ecosystems. This neglects the important difference between trees and grasses due to the different depths of the roots, which tap into moisture in different soil layers.

They also draw parallels between sea-breezes and local circulations generated by anthropogenic vegetation boundaries (p. 90). They suggest that these can lead to rainfall differences due to convective storms. However, they go too far in accepting the argument (p. 100) that this can explain the observed decline of winter rainfall in the vicinity of the 'Bunny Fence' near Esperance in Western Australia (Lyons et al. 1993). Rainfall in this region has declined over a much wider region (Allan and Haylock 1993), and is dominated by frontal passages, not by locally generated convective storms.

Section III deals with climate models, the climatic effects of anthropogenic aerosols, nuclear winter, the 'greenhouse gas theory', and a brief chapter on 'biospheric forcing of climatic variability'.

In regard to climate change 'scenarios', they fail to recognise such cautious terminology, choosing instead to take a highly sceptical stand against climate change 'forecasts'. They make sceptical references to Houghton et al. (1990), without acknowledging this as the work of the Intergovernmental Panel on Climate Change, and without giving due weight to its considered judgements. They dismiss coupled ocean-atmosphere models as in their infancy, the results of which should not be taken 'too seriously quantitatively or even qualitatively' (p. 186), while also stating that it is 'quite unrealistic to examine regional scale impacts of greenhouse gases in anything but a transient, coupled atmospheric/ocean model' (p. 191).

There are many more points which deserve detailed comment, but readers will have to find them for themselves. The editing and layout is a bit uneven, with one very cramped figure on p. 156 which is almost unreadable, yet many pages of unnecessarily large diagrams on pp. 106-109 and 224-231. The last group of graphs could well have been summarised in a single and more useful table. My copy also has two sets of pp. 249-256 (reference pages), which was a bit confusing.

Arguably the strongest policy recommendation made in the book is that, for various reasons, 'getting the earth's population under control (i.e., zero population growth)' (p. 169) is fundamental. In their penultimate paragraph the authors assert that 'One does not need strong scientific evidence that human activity is causing global warming to recognize a reduction in the population on earth will have long-term benefits; common sense is all that is needed!' (p. 222).

Given that the authors fail to discuss any other means of reducing greenhouse gas emissions, this comes across as pure developed-country prejudice. In a world in which each US citizen generates more carbon dioxide emissions than 5 to 10 Indians or Chinese, surely the issue of per capita consumption must also be raised. If so much weight is to be given to population control as a 'no regrets' policy (i.e., a policy beneficial for other reasons than greenhouse) then other no regrets policies should have been discussed, such as energy efficiency, research into renewable energy technologies, and reforestation. The authors' one-sided opinions would go down like a lead balloon in much of the developing world.

In conclusion, I found this book interesting and stimulating. It is pitched at the educated scientific reader, not the specialist, but needs critical thought if the authors' subjective opinions are not to unduly sway the reader.

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