

## Book review

**Storm World: Hurricanes, Politics and the Battle Over Global Warming** by Chris Mooney (Harcourt Inc.). ISBN 9780151013043. Hardcover, US\$26. 400 pp.

This book is an account of very public battles that took place in newspapers and on television, over the three years from 2004 through 2006, between two groups of scientists. The battles were over the issue of whether or not tropical cyclones have been affected by anthropogenic global warming. The author is a science journalist, and a very good one. Thus the story unfolds in an easy-to-read style that reminds me of a feature article in the Sunday Magazine section of a major newspaper. I would recommend the book to readers of the *Australian Meteorological Magazine*, as the story it tells is important in the history of our science.

The author synthesises the tale in his prologue when he refers to it as 'the story of how a largely unsuspecting group of scientists had been drawn by politics, the media, the weather and the history of meteorology itself into a situation of tense conflict more typical of political operatives and opposition researchers'.

Chris Mooney structures the tale by focussing the account on the roles played by two of the leading tropical cyclone scientists of our time (or using the United States terminology of the book *Hurricane scientists*). The two are Kerry Emanuel from Massachusetts Institute of Technology and William Gray from Colorado State University. Other leading players are Chris Landsea and Tom Knutson from the National Oceanic & Atmospheric Administration (NOAA), Peter Webster and Judy Curry from Georgia Tech School of Earth and Atmosphere Sciences, and Greg Holland (formerly of the Australian Bureau of Meteorology) from the US National Center for Atmospheric Research (NCAR).

These are all people I know well. I studied under William Gray for my PhD degree, and, like the protagonists in the book, I was sent off to Miami in the 1970s to fly on a research flight into a hurricane. When I am in the US, I occasionally stay in Gray's guestroom in his house in Fort Collins. When Kerry Emanuel was in Australia several years ago for the BMRC Modelling Workshop, I had him up to my place in North Melbourne for dinner on several evenings. I have known Greg Holland and Peter

Webster very well all my working life, and have worked with Chris Landsea and Tom Knutson on various WMO Committees. I also know well the story unfolded by Chris Mooney. During the years of the tale, I was Chair of a WMO Committee on Climate Change Impacts on Tropical Cyclones. In this role I coordinated large groups of scientists, including many of those featured in the book, to assemble two Expert Statements on the topic, as advice to the Permanent Heads of the world's National Hydrometeorological Services through the WMO Commission for Atmospheric Science. Both statements were primarily in response to the events recounted in the book. The first statement was presented to the 14th Assembly of the Commission for Atmospheric Science in February 2006. The second statement is what is known as the WMO/IWTC Statement and was published in December 2006 following a major International Workshop on Tropical Cyclones (IWTC) held in Costa Rica. The WMO/IWTC Statement was accompanied by a one-page summary set of Consensus Statements; and these are reproduced in an Appendix of Mooney's book.

Given this familiarity with the people and the events, I have to say Chris Mooney does an excellent job of portraying both. He describes the science in a manner that should be understandable to laymen, and he captures the major points of scientific disagreement and discussion. He treats well all the scientists involved, with journalistic descriptions of their appearance, personality and the way they go about their science. During the stress and tension of the years discussed, there was a certain level of name-calling and public criticism that did a discredit to our science. Chris has described this well, but has still maintained a respectful treatment of all scientists involved. In fact, he probably did too good a job of this. Having known the lead players for many years, I am well aware of their tendency to let off steam when professionally challenged. In Chris's book these fiery and temperamental friends of mine come across as the most logical and reasonable people on earth.

The book is about hurricane science and interactions with the media in the USA, rather than globally. This is appropriate as, during the period discussed, the main stage was on the US scientific conference circuit and in the US media.

The book begins with a Prologue and an Introduction. The Prologue gives the motivation, beginning with the author's account of visiting his

mother's home in New Orleans in the aftermath of hurricane *Katrina*. Descriptions include street after street of uninhabited houses, collapsed floors, stinking refrigerators and everything being covered with mud and grime. The Introduction is an account of the Fall Meeting of the American Geophysical Union in December 2005, where Kerry Emanuel presented his results that according to his analysis there had been a major increase in recent decades in the power dissipation of tropical cyclones in the North West Pacific and the North Atlantic, an increase which, according to his analysis, can be attributed to anthropogenic global warming. In the same address Emanuel caused a sensation among the audience when he contrasted these results with what he referred to as the NOAA party line that increases in Northern Atlantic hurricane activity (affecting the highly populated east coast of the United States) have been caused by natural fluctuations and have not been affected by global warming. The title of the Introduction is 'The Party Line'.

The bulk of the book consists of three parts. Part I titled 'Warming and Storming' consists of five chapters and is a historic account. It gives an introduction to tropical cyclone science through accounts of the early researchers. These include William Redfield in early 19th century USA. Redfield built up a body of work on the properties of rotating storms based on observations from shipping and from the orientation of fallen trees after cyclones had made landfall. Redfield is contrasted with James Espy, a theoretical scientist of the time whose views on cyclones were based on physical principles of the effect of convection and the release of latent heat. Thus Mooney sets up a picture of observational scientists being in opposition to theoretical scientists. This continues through his account of the developments of the 1950s and the 1960s with the work of Herbert Riehl and Joanne Malkus based on data obtained from instrumented aircraft flights into tropical cyclones being superseded by the numerical modelling and theoretical models of Jule Charney. Part I finishes with two chapters dedicated to the scientific descendants of Riehl and Charney, they being William Gray and Kerry Emanuel. Chapter four is an entertaining but respectful account of William Gray's distrust of numerical models and of global warming. It also describes Gray's achievements. These include his 1968 paper which set out the now-accepted large-scale climatological conditions that account for the presence and frequency of tropical cyclones and they include the development of seasonal forecasting of tropical cyclones that was pioneered (in the US at least) by Bill Gray. Chapter 5 gives a similar background on Kerry Emanuel describing his high profile appearance in tropical meteorology research in the 1980s with his

dismantling of Charney's CISK theory and with his development of Maximum Potential Intensity theory for tropical cyclones.

Part II, 'Boiling Over' is the core of the book. Chapter 6 'The luck of Florida' describes the events of 2004. Category 5 tropical cyclone *Gafilo* makes landfall in Madagascar. *Catarina*, a system with the satellite image of a major hurricane, makes landfall on the coast of Brazil, a region that climatologically has no tropical cyclone activity. Ten tropical cyclones make landfall in the islands of Japan. In the US four major hurricanes make landfall, including three across the State of Florida, with a combined damages cost in Florida of \$45 billion dollars.

Chapter 7, also drawing on the events of 2004, discusses the contributions of two scientists from NOAA. Tom Knutson in NOAA's GFDL laboratories in Princeton was lead author of a *Journal of Climate* paper giving the results of numerical modelling experiments indicating an increase in tropical cyclone intensity in response to anthropogenic global warming. Chris Landsea from NOAA's Hurricane Research Division found himself at the centre of controversy when he had a public dispute with Kevin Trenberth of NCAR over Trenberth's claims at public meetings that the Atlantic Hurricane Season of 2004 may well be a harbinger of the future. Landsea believed there was no scientific research at that stage (2004) linking the increases in cyclone activity to global warming. At the time, Chris Landsea was contributing to a section of the IPCC fourth assessment report with Trenberth as lead author. Due to this dispute, Landsea resigned from the IPCC process emailing a denunciation of Trenberth's statements on climate change and tropical cyclones to forty-five colleagues, an email that eventually found its way to wide distribution on the Internet.

Chapter 8, 'Meet the Press' describes the publication in 2005 of Kerry Emanuel's paper in *Nature* on the link between tropical cyclones and the observed global increases in sea-surface temperatures. As described by Mooney the online appearance of Kerry's paper was like a thunderclap. Up to that point Emanuel had considered hurricane intensification due to global warming as something predicted by theory but had remained unconvinced that such intensification was yet manifest in the observations. Yet, as Mooney discusses: 'Here was perhaps the world's leading hurricane theorist undergoing a very public conversion'. Less than a month later, hurricane *Katrina* made landfall in New Orleans. *Katrina* was the most damaging hurricane in US history, with estimated costs of over \$80 billion and more than 1500 deaths. As described in Chapter 9, 'the #\$\$^& Hit the Fan' there was more to come in 2005. Two weeks after *Katrina* a paper appeared in *Science* authored by

Peter Webster, Greg Holland, Judy Curry and H.-R. Chang, with the title 'Changes in Tropical Cyclone Number, Duration and Intensity in a Warming Environment'. This paper examined tropical cyclone tracks globally and presented evidence for a very large increase in the proportion of high intensity cyclones (Category 4 and 5), this increase having occurred while global sea-surface temperatures have increased. The scientific response to the Emanuel paper and the Webster et al. paper could be described as a furore, with a large number of scientists including Gray and Landsea arguing that the continuous improvements in our ability to monitor tropical cyclones, including the developments in satellite technology, are such that the trends reported by Emanuel and by Webster and colleagues were entirely artificial, and were the result of changes in observation procedure. And so, as described in Chapter 9, the year 2005 continued. More and more major hurricanes hit the east coast of the US, and while this went on the media fed the controversies between scientists with radio and television showdowns (Curry versus Landsea on 'The News Hour', Curry versus Gray on 'The Diane Rehm Show', Webster versus Patrick Michaels on CNN, and so on). Chapter 10 'Resistance' describes Bill Gray's rebuttal of the Webster et al. paper, and then Gray's appearance before a committee of US Congress where he gave a theatrical performance denouncing those who linked tropical cyclones to global warming.

Chapter 11 is titled 'Consensus'. It is a fascinating chapter as it tells the tale of internal politics in NOAA. At press conferences, at testimonies before the US Senate and in articles on the official NOAA website, statements were made that 'there is consensus among NOAA hurricane researchers and forecasters that recent increases in hurricane activity are primarily the result of natural fluctuations in the tropical climate system known as the tropical multi-decadal signal'. As Mooney points out, nowhere did the NOAA Press release mention the work of Tom Knutson, a NOAA scientist suggesting that global warming may increase the risk of category 5 cyclones in coming decades. While this was going on NOAA was enforcing its internal policy whereby its scientists had to gain approval before speaking to the press on the issue of tropical cyclones and climate change. Such policies of prior clearance on controversial issues are common in Government agencies (for example they exist here in the Bureau of Meteorology). However, as documented by Mooney, they effectively were used in late 2005 to make it difficult for NOAA scientists whose work went against the party line to talk to the press (such as Tom Knutson) whereas other NOAA scientists whose work tended to support the NOAA party line (such as

Chris Landsea) effectively had free and open access to the press. All this was without the scientists involved being aware of the unequal treatment – as Landsea is quoted in the book: 'I feel like I've been used as a kind of pawn in this.... I didn't know what was going on'.

The final part is titled 'Storm World'. It contains three chapters documenting the events of 2006, followed by a chapter titled 'Conclusions'. It doesn't come out very well in the book, but 2006 was an unpleasant year for those of us involved in tropical cyclone science. The controversies, the name-calling and the air of aggression at meetings and on the science discussion lists were simply stressful and unpleasant. As described in the book, the year began with a major Panel Discussion on tropical cyclones and climate change conducted at the American Meteorological Society annual meeting in January. In the subsequent months, behind the scenes activity went on to organise a high profile debate on the topic at the AMS specialist meeting on hurricanes and tropical meteorology to be held in April 2006. At that meeting William Gray, who had been a prominent speaker at these specialist meetings for decades, was banned from participating in the panel discussion, basically because Peter Webster and Kerry Emanuel refused to sit on the panel with Gray. Later in the year, Mooney describes events whereby fifty to one hundred demonstrators protested outside NOAA's Offices in Maryland due to NOAA's 'suppression of information on the link between hurricanes and global warming'. It describes how the high profile press articles continued to play up the controversy and how the scientists' fame increased such that they met the politicians, with President Bush calling in on Landsea's office in NOAA, and Webster and Curry having an audience in Tallahassee with then-governor Jeb Bush. It also describes some events that served to calm the waters. These include the appearance of the paper by Jim Kossin and collaborators and the development of the WMO/IWTC consensus statement. Kossin and collaborators constructed a homogeneous global database of tropical cyclone satellite images from 1983 through December 2005, and examined it for trends in intensity according to the standard algorithms. As described by Mooney, Kossin's paper did not settle the debate. It had something for everyone, in that it substantiated the observed increase in intensity in recent decades in the Atlantic; but it found no increase in intensity anywhere else on the globe.

The last chapter of the book, titled 'Conclusions' philosophises about the lessons to be learned from the hurricane-media wars. It states that the tropical cyclone scientists of the world were unprepared for the media scrutiny and the pressure on them, but that they handled themselves well. He points out that the scientists helped fan the flames by publicly attacking

each other, but that our biggest mistake lay in allowing the hurricane-climate change issue be framed around scientific uncertainty and contentious debate, rather than around common ground and solutions.

The book concludes with a list of interviews conducted, a bibliography and recommended reading list, and 75 pages of detailed notes on sources for the various statements throughout the book. Given that he is a journalist, not trained in the topic of tropical cyclones, Chris Mooney has done an excellent job on explaining

the science and the controversies, and being a journalist rather than a scientist, he has described it in a manner that is readable and enjoyable.

**John McBride**

*John McBride is a Principal Research Scientist at the Centre for Australian Weather and Climate Research – a partnership between the Australian Bureau of Meteorology and CSIRO.*