**Review of “The Development of Atmospheric General Circulation Models” by Leo Donner, Wayne Schubert, and Richard Somerville**

Minghua Zhang

Donner et al’s book starts out with a depiction of the emergence of atmospheric general circulation models (AGCMs), and goes on with descriptions of their gradual evolution. Written by a group of major players in atmospheric sciences, this book contains a fascinating account of what happened at the very dawn of numerical weather prediction, most of which are rarely found in the literature, as well as discussions on the current course of AGCM development and prospects for the future.

This is a book suited for general readers who want to know how atmospheric general circulation models were first conceived and how their development was propelled by scientific advances on one hand and rigorous efforts of a few key people on the other. It is also a book for those who want a glimpse of the present status of AGCMs with an eye on their future development. When I opened the book, I could not help but read it from the beginning to the very end in a single go. By and large, this is a book on the history of sciences.

The chapters of the book connect some less-known but important links in the historical chain of events leading to the atmospheric model development: In 1945, Vladimir Zworykin of the electronic company RCA, inventor of television transmitting and receiving devices, imagined human intervention of weather and climate guided by computer calculations in his “Modern Computing Devices” and the flamboyant “Outline of Weather Proposal” (this was at the time of the nuclear bomb – the Manhattan Project); in the same year, John Mauchly of the University of Pennsylvania, inventor of computers, went to the Weather Bureau to seek examples of weather applications using the EDVAC computer; in January 1946, Francis Reichelderfer, chief of the Weather Bureau, convened a meeting of himself with Zworykin, von Newmann, and Wexeler among a few others to discuss the subject; Wexler’s Professor at MIT, Carl Rossby, started to interact with von Neumann in early 1946, and suggested the Institute of Advanced Study (IAS) to submit a proposal that he outlined on weather research to the Navy Office of Research and Invention (ORI); von Newmann submitted the proposal on May 7th, 1946 and ORI funded it on July 19th, 1946 (the content of the proposal, significantly influenced by Rossby with emphasis on science rather than premature applications, is still amazingly relevant to what is occurring at present: “to examine the foundations of meteorology, to solve the basic problems of the general circulation, and to improve our understanding of atmospheric processes”); at the end of 1947, von Neumann and Wexler worked with Rossby to recruit Jule Charney and a few other young people to the project because the project appeared to be losing steam. These events then led to the birth of atmospheric modeling: In 1950, Charney, Fjortoft and von Neumann successfully produced the first calculation of the 500 hPa geopotential height with 24 hour lead time, setting the landmark of numerical weather prediction, while in 1955 Norman Phillips demonstrated the simulation of the general circulation, posting the milestone for the development of atmospheric general circulation models.

The reader will also take notice from the book that Charney’s 1950 model used 19 by 16 horizontal grid points with a spatial resolution of 736 kilometers and a single layer, while Phillips’s model used 16 by 17 grid points with two layers for a beta-plane channel of the whole atmosphere. Both models used equations of balanced flows, after taking a lesson from Richardson’s bitter experience in trying to solve the primitive equations directly. Advances in the theoretical understanding of large-scale atmospheric circulations at that time had a profound impact on the successes of numerical models. Charney’s work prompted the establishment of the Joint Numerical Weather Prediction Unit of (JNWPU) of the weather bureau and the military Weather Services – which was the predecessor of the present National Center for Environmental Prediction (NCEP); Phillips’s work prompted the establishment of the General Circulation Research Section in Princeton, now the Geophysical Fluid Dynamics Laboratory (GFDL).

The account of history in the book is a record of imagination and pursuits, expectations and disappointments, reinvigoration and triumph. The process of how sciences are shaped by individual people and events is vividly described with great details. For people who wonder about the future direction of current research on anthropogenic climate change, this book should be a useful source of reflection and inspiration, just as Winston Churchill said: “The farther backward you can look, the farther forward you are likely to see.”

The book also contains a chapter on the co-evolution of climate models with the Intergovernmental Panel on Climate Change (IPCC). Like the giants in early history, it is the courage and foresight of a few key individuals that initiated the IPCC -- another era in atmospheric modeling. One of these giants was Bert Bolin, who served as chairman of IPCC between 1988 and 1997. Twenty days before his death, the Norwegian Nobel Committee awarded the 2007 Nobel Peace Prize to the IPCC.

Complementing the historical flavor of the initial chapters, the book includes some modern topics on the crossing paths of numerical weather prediction and climate modeling, the use of observational data to constrain models, and numerical techniques in the digital age. These chapters are good references for people engaged in active research and can be read separately as standalone materials. The book also highlights the development trajectory of the coupling of atmospheric models with the oceans, and coupling with the land surfaces, however, these chapters are relatively brief.

The book by Donner et al. is not a text book. The scope and depth of the chapters are uneven. While some chapters are easy to follow by any reader with a basic science background; others contain sophisticated materials with the intricacy of review articles in peer-reviewed journals. By necessity, the book cannot possibly cover all the topics on the development of atmospheric models. But in view of the current ongoing activities with Earth System Models, it would be nice and timely to see future editions of the book to include accounts of the development of atmospheric chemistry and aerosols models, and to expand on its current content on the coupling of atmospheric models with biogeophysical and biogeochemistry models.

All in all, this book is a delight to read and to own.