

Large-scale Weather and Climate Fore-casting 1,2

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Local long-term weather and climate prediction relies on modelling both the movement of heat and moisture from the earth's surface to the atmosphere above, and the large-scale movement of the atmosphere as it transports such heat (and moisture) on average towards the poles. These two processes naturally lead to inner[physics based]and outer[dynamics based] loops in a time-stepping computer algorithm that forms the core of global circulation models GCMs. The first talk will outline for a general audience the key steps involved in mathematically modelling the stable dynamics of these outer loops in GCMs. The usual meteorological ideas[layered, hydrostatic behaviour in the vertical, thermal wind laws for the horizontal flow]will be introduced for middle latitude weather. These ideas need to be modified for flow in the tropics, and some results from the last decade will be mentioned. Some highlights of a book for the general reader 'Invisible in the storm' by Roulstone and Norbury, Princeton U Press, jan 2013 will be included to illustrate the ideas and their historical development. The second talk will describe a model of a column of atmosphere, whose purpose is to move heat and moisture from the ground/sea surface up into the air above. The upwards movement is essentially unstable dynamically, and the longer time, larger scale prediction algorithm is unable to resolve these rapid motions, and so needs the inner loop to re-stabilise the flow. The second talk focusses on a very simple column model with an exact mathematical solution to illustrate the ideas. The solutions are useful for (a) testing the mathematical formulation, (b) testing the accuracy and stability of numerical algorithms, and (c) giving understanding for the more elaborate models that better describe reality. As well as showing mathematical modelling in practice, this column model and its solutions allow us to see how physics-based sub-grid scale modelling may be interpreted more mathematically. This underlines the message of the book, that mathematics is, in several senses, an essential part of modelling and computation in the modern world. As well as providing a language to describe and to compute with, mathematics is a key part of designing better algorithms—and it helps us to understand and to interpret the (overwhelming) amounts of data that now float around the modern world.

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