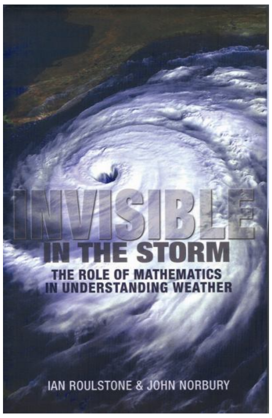


Invisible in the Storm: The Role of Mathematics in Understanding Weather. Ian Roulstone and John Norbury. Princeton University Press, 41 William Street, Princeton, New Jersey 08540, USA. 2013. ix + 325 pp. Price not mentioned.

This book is about using mathematics to understand weather. It is always a wonder to most people that we can predict movement of faraway planets and send rockets to them with a high degree of accuracy and yet we are unable to say much about weather, a fortnight hence.

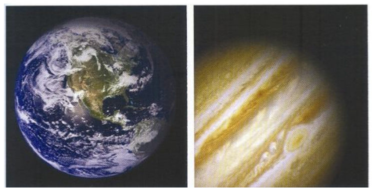
The authors trace the usage of mathematical techniques in understanding weather. In a simple yet elegant fashion they bring forth complex phenomena such as nonlinearity (‘wind blows wind’) and show how it complicates the analysis and prediction of weather. In a book about mathematics they use very little of it; yet the mathematical concepts are always close to the surface. They make excellent use of tech boxes to bring forth complex mathematical ideas which do not hinder regular flow of the book. This is a highly readable book which should appeal to both the scientist and a general reader interested in understanding the complexity of weather.

The book begins with an overview of weather and its prediction; tracing the history of prediction from the times of ancient Greece. The attempts of Archimedes and Aristotle to move weather prediction from an art to a more exact science governed by laws is brought out well. They further trace this history through the medieval period, highlighting the works of Descartes, Galileo, Torricelli and others and the importance of invention of such simple instruments as the thermometer and barometer to understand weather. The work of Halley and Hadley in understanding the movement of air around the planet is also explained well. The work of Ferrel who approached meteorology in the same fashion as mechanics and astronomy and explained the importance of rotation of the Earth in general circulation of the atmosphere is also brought out well.

The authors then trace the work of Richardson and his numerical experiments which failed spectacularly. They also highlight the lessons learnt by Bjerkness from his failure and the subsequent use of graphical techniques by his group in predicting weather in the chapter titled ‘Advances and adversity’. The realization that upper air movement could play an important role in modulating weather, which was first pointed out by the pioneering work of Messinger (‘played the French horn in the 134th Infantry’) is discussed in a simple yet elegant fashion. The tragic end of Messinger and his colleague who died when their balloon was struck by lightening is written in a poignant fashion bringing forth the risks which some early meteorologists took (and still take when chasing tornadoes) to collect data.

Perhaps the centrepiece of the book is the work of Rossby and his use of mathematics in weather prediction. The simplification of equations with the authors’ analogies to tidal equations is very readable. The concept of angular momentum and its importance is explained through examples from astronomy on the macro-scale, to the dance of an ice-skater on the smaller scale. However, even while meandering into these seemingly disjointed subjects, the underlying thread of application of mathematics to weather prediction is never lost.

The pioneering work of Charney and von Neumann in applying computers to weather prediction is described in a chapter aptly titled as ‘Metamorphosis of meteorology’. It makes one realize that Richardson was ahead of his time with his numerical techniques. The lack of adequate knowledge of computational fluid dynamics and the lack of high-speed computers were major handicaps which led to his failure. It makes one wonder how much faster weather prediction would have progressed if computers were available in Richadson’s lifetime. However, all this is not described in a dour fashion. The illustration about Charney (‘... and since hypergeometric differential equation with logarthmic singularities’) brings a smile.


The atmospheres of Earth and Jupiter are conspicuously different, but they are governed by the same basic physical laws.

The improvement in mathematical models is discussed in chapter entitled ‘Math gets the picture’. Lorenz’s path-breaking work on chaos and his dire prediction that long-range weather forecasting might be forever beyond our capabilities is brought out well. The butterfly effect and description of geometric thinking in understanding chaos is an interesting way of looking at this complex phenomenon. Their statement on the use of sympletic geometry instead of a ‘delicate thread’ alluded to by Bjerknes to describe the circulation theorem in the detailed calculation of modern-day forecasts, is a new view on this subject.

The ending is boldly titled as ‘Predicting the presence of chaos’. The importance of probabalistic forecasts in improving weather prediction and related method of ensemble forecasts are described. They end the chapter with a brief discussion of climate prediction. The certainty and uncertainty of climate forecasts is brought out to good effect. The certainty of increasing temperatures but the uncertainty related to the extent of this warming is well discussed.

This book is highly readable and gives a bird’s eye view of development of meteorology. However, I am disappointed that problems about forecasting weather in the tropics are not treated in any great detail. Important features of weather such as clouds and moist convection (which again is important in the tropics) are hardly discussed. Also, the importance of satellite data and their contribution to improving forecasts could have been discussed in a more detailed fashion. These shortcomings in no way reduce the readability of the book. It is strongly recommended to practitioners of meteorology and those interested in understanding this complex subject.

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