Foreword

Most of the material that is presented in this book formed the core of a talk that was delivered to many branch audiences of the IEE or Institution of Electrical Engineers (now called the Institution of Engineering and Technology) under the title "A curious engineer's view of the history of meteorology". These were highly interactive events, where a personal perspective was presented. They started with an apologia for invading what might appear to be alien territory. The underlying strategy drew inspiration from James Burke whose TV series *Connections* changed the way we view history. In each episode (and in his *Scientific American* articles) he started with a medley of apparently unconnected facts which he then drew together in a fascinating web. The IEE/IET lectures started in much the same way. Apparently unconnected facts were considered with aspects of electrical communications acting as the cohesive factor. There is no claim that the presenter's skills matched those of Burke, but by the time that the audience had been through chronology, telegraphy, atmospheric physics, thermodynamics, two world wars as well as some sensitive issues concerning UK/Irish wartime relations, they were ready to go home feeling that they had had a good evening's entertainment. In late October 2008 the talk was presented to the IET South West Branch at Paignton in Devon. The organisers extended an invitation to the staff of the UK Met. Office which is now based at Exeter. The lecture was very well received by all including the guests from Exeter. There was a prolonged period of questions, and comments and discussions continued for sometime afterwards. This book is in response to the suggestion that the material needed to be written down and thus available to a wider audience,

Most authors have a problem in targeting their material at a particular audience and there is a similar consideration here: should this be an academic work or a popular book? The IEE/IET talks were aimed at a general audience. They contained some specialist material, but they tried to present things in such a way that non-specialist members of the audience might find something of interest to them. In all but the last chapter I endeavour to do the same, and in an attempt to convey the enthusiasm that was such a character of those meetings, the personal pronoun will be used where appropriate, in preference to the conventional scientific reporting style of academic papers and texts.

In summarising the content we could start with "in the beginning there was weather lore"
From the early 19th century onwards there were repeated attempts to apply science in a rigorous way. However, understanding weather so that hypotheses can be developed requires the synchronous collection of data and this was not possible before the advent of an all-weather communications system that could convey data quickly - the electric telegraph. It also needed a system of uniform time. Fortunately, by the 1850s both of these were already well established, thanks to the requirements of the rapidly expanding railway networks.

It is very rewarding in this year of Charles Darwin to acknowledge the contribution of Robert FitzRoy who, in setting up the UK Meteorological Service made significant use of telegraphs. There is much argument that he moved too far, too quickly, but I like to think that he was to meteorology what Mozart was to music. The basic fact is that science needed time to catch up in order to quantify the wonderful system of forecasting that FitzRoy had in his head.

The next two chapters review significant factors in the development of meteorology, namely aviation and warfare. Although the UK Met. office was brought under the Air Ministry in 1920, the major thrust did not start until the end of that decade. The experience of the 'Bremen' flight from Europe to North America was probably a key factor. Throughout the

1930s the objective of commercial trans-Atlantic flights led to the integration of wireless communication and meteorology. This dream was cut short by the second world war, but even here there are curious aspects that deserve special attention. The 'Weather War' in the Atlantic was every bit as important for the survival of Britain as the 'Battle of the Atlantic' or indeed, the Battle of Britain. The fact that the Irish Free State provided the Allies with exclusive access to meteorological data raises questions about the nature of its neutral stance in that conflict. Iceland refused to comply with a similar request and was promptly occupied by British forces following the Nazi invasion of Denmark. German attempts to counteract this denial of Atlantic weather data involved clandestine weather stations in Spitzbergen, Jan Mayan island and Greenland.

There is another fascinating story which has lots of twists and turns. The Norwegian Vilhelm Bjerknes, was appointed the founding director of a weather institute in Leipzig (where Zeppelin airships were manufactured). However in 1917 he and his research team returned home to establish the Geophysical Institute in Bergen. This move certainly ensured the continuation of funding from the Carnegie Institute even after the US entered the first world war. Several people from the Bergen School, as it was called, moved to the US between the wars and Carnegie support was centred there even after Norway was occupied by the Nazis. However, it is interesting to compare the involvement of Norwegian forecasters at the heart of UK and US wartime meteorology. I conjecture that they were kept away from key decisions in America, while at least one in Britain made a critical contribution to the D-Day forecast. There are many conflicting views on the D-Day forecast, and even though I am somewhat biased, a broad spectrum of evidence is presented.

The penultimate chapter sweeps up bits and pieces not covered elsewhere. Operation Outward in Britain represented an attempt to use prevailing weather to deliver aggression to the enemy. Fugo, its counterpart in Japan is interesting on several counts. The Japanese were already aware of the 'jet-stream' and used it to deliver payloads right across the Pacific. They had a rudimentary, but very effective control system that maintained a balloon at the correct altitude. Finally, I was amazed to discover that the Director of the Technology Agency that oversaw this operation was none other than Hidetsugu Yagi, the inventor of the modern terrestrial TV aerial.

Meteorologists will tell you that the 'tephigram' is one of their most important aids in the development of a synoptic chart. But when one attempts to find out how the information that is obtained from radio-sondes is converted into data on this multi-axis chart, then there seems to be a gap which this chapter hopes to fill.

The final chapter looks in depth at the science of meteorology and it is here that I will, without apology, jump into the mathematical theories behind weather models. Anyone who wishes to avoid this reverie will be excused for completing their reading of the book at the end of the previous chapter. It is nevertheless a very useful exercise which considers how computers have revolutionised forecasting and how novel mathematical approaches might improve the 'reliability' of predictions in this wonderful, multi-dimensional, multi-scale, non-linear dynamic problem. It really is the stuff of engineering!