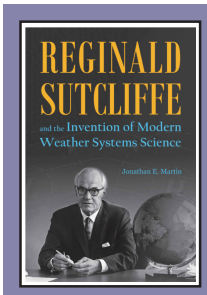

Reginald Sutcliffe and the Invention of Modern Weather Systems Science

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I welcome the publication of this book on Reggie Sutcliffe, one of the greats of British meteorology in the twentieth century. The blurb on the back of the book suggests that he has been 'understudied and underappreciated'. I think that this may be true in general, but most of us who started our meteorological careers in the United Kingdom some decades ago certainly start with a very high appreciation of him.

The author, Jonathan Martin, is a professor in the Department of Atmospheric and Oceanic Sciences at the University of Wisconsin. His research area is midlatitude weather systems and he is well known for his text books and recognised for his teaching. It is to be applauded that someone with this background has taken the time to find out all the details that he has and to write this book. It is primarily a biography of Sutcliffe, but as the subtitle suggests, it is written in the broader context of the huge development of weather system science during his career.

The introduction and the first two chapters give the background of the Sutcliffe family and recount the youth and education of Sutcliffe. The background material on nineteenth century industrial England, including for example working conditions and factory acts, may perhaps be helpful for the wider audience. Scholarships enabled Sutcliffe to get a good schooling and both undergraduate and PhD degrees in mathematics and statistics. The detail on the early part of Sutcliffe's life is evidence of the wide investigations that the author must have made.

Martin describes how the newly qualified PhD student found limited opportunities for a job, and wandered into one at the Met Office, an institution that was not sure it needed people with such training. At this time, the production of the weather forecast operation owed little to physical science, and research was viewed as an optional out-of-office-hours activity.

One of the fascinations for me is how Sutcliffe obtained the essential grounding in dynamics and the inspiration for his very individual and world-leading research on the development of weather systems. The book gives tantalising hints of this but does not strive to put them together. Sutcliffe clearly took to the weather forecasting problem – this is central to his whole career and outlook – and wanted it to become a proper science. Quite early on he was posted to Malta, where by chance he overlapped with Tor Bergeron for a period during which Sutcliffe must have been exposed to the perspective and expertise of the Norwegian school, and perhaps much more. Martin relates this, and also that his job was undemanding, to leaving him time to read German and French literature in synoptic meteorology.

In the 1930s Sutcliffe decided that dynamics must be central to understanding and forecasting surface pressure changes, and that the vertical structure of the atmosphere and horizontal temperature contrasts were crucial. The two great leaps forward by Sutcliffe, the subjects of his 1938 and 1947 papers, are described in some detail in the book in a manner intended to be understandable by most readers. Martin views the 1947 'development' paper as the climax of Sutcliffe's contribution, and there is little doubt that this is the case for practical synoptic meteorology. In it, Sutcliffe derived for the first time what can be viewed as an approximate form of the ω-equation, the equation for the vertical velocity in pressure coordinates which can be solved if the height field is known. The crucial aspect for him was that it gave an expression that could be evaluated from basic charts in a reasonable time, and that would provide the forecaster with quantitative information on where cyclonic and anticyclonic 'development' might be expected.

However, for dynamicists the 1938 paper may be even more significant. It was the first to use the quasi-geostrophic approximations. It also gave the basis for understanding the cross-front circulation in the deformation and shear frontogenesis cases. Sutcliffe may not have appreciated the power of what he had done, but it inspired others. For example, the theory was later extended by Sawyer and Eliassen in their celebrated work on cross-frontal circulation.

A long chapter is devoted to the 1939–1945 war, the period between the two great papers. It describes in some detail the progress of the war, and the roles Sutcliffe had. Being chief forecaster for bombing raids will no doubt have encouraged Sutcliffe in his quest to understand upper level winds. However, there is almost no information on what he was thinking or really doing, and I found this the least worthwhile portion of the book. An exception to this is the section on his very positive role in re-building the weather service in Germany at the end of the war.

Martin gives an interesting discussion of the differing approaches in the 1950s to the use of computers in weather forecasting. The most popular route, following the lead of Rossby and Charney, was to use a barotropic model. Eady wanted to compute the growth of small perturbations on a relevant zonal flow. Sutcliffe was sure that the thermal structure was crucial, and his 1947 paper provided the basis for the approach in the UK. In retrospect all the approaches were valuable. However, Sutcliffe's way forward was that of the weather forecaster. Until he left the Met Office in 1965, he was never convinced that the numerical product was superior to that of the experienced professional weather forecaster armed with his theory and extensions of it.

I was not aware of Sutcliffe's research after his major development papers, in particular on the hydrological cycle and insights into the general circulation and climate variability, all viewed from the perspective of a weather systems scientist. The discussion in the book certainly encouraged me to go back to the original papers.

Following his responsibilities at the end of the war, and the scientific reputation he had built, Sutcliffe took on leadership positions in the Met Office. For the Royal Meteorological Society, he was President and served two periods as Editor of its *Quarterly Journal*. He became a major figure on the world meteorological scene. Martin brings out the strong views of Sutcliffe on the crucial complementary roles of the meteorological services and the university sector and, consistent with this, he played leading roles in both World Meteorological Organization and International Union of Geodesy and Geophysics. Also, as discussed in one chapter, Sutcliffe did not want to serve under the new Director General of the Met Office and left to be the founding head of the new Meteorology Department at the University of Reading. The organisational and teaching challenge of this is well described!

The final two chapters of the book discuss the post retirement years of Reggie Sutcliffe, initially quite active but latterly focussing on family and garden.

Sutcliffe was not the sort of person that it is easy to write a biography of. He did not keep diaries or record his thoughts. I know from my few meetings with him and from the reactions of others who knew him better that he was a man who liked social interactions and often spoke with a twinkle in his eye. However, these aspects are unlikely to appear in any records available now and were difficult for the author to reflect.

I enjoyed reading this book and highly recommend it. It is successful in its mission of describing the life and influence of Reggie Sutcliffe, and, as was the case for me, is likely to drive some readers to delve into research papers by this pioneer in our subject. In addition to his two 'development' papers in 1938 and 1947, I particularly enjoyed his papers on a synoptic meteorologist perspective on the general circulation in 1949, his thoughts on weather forecasting in 1952, and on water balance and the general circulation in 1956 (all in the *Quarterly Journal*).

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