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# Book review

## Spatial objective analysis: with applications in atmospheric science. H. J. Thiébaux and M. J. Pedder (Academic Press, Florida, 1987) ISBN 012 686 9308. 299pp. $US63.00.

Before this book, to my knowledge the only other textbook devoted primarily to objective analysis was written by Gandin in 1963. Gandin's book was ahead of its time. A decade or more passed before the theoretical concepts of statistical (optimum) interpolation, so convincingly developed and set out in that book, were matched by the computing power necessary for their effective application. Gandin's book still has much to offer today, but the need for another more up to date text has long been recognised.

In the preface to the present book, the authors state their objective, 'to make a rigorous and clear exposition of the types of techniques which are applied to the analysis of atmospheric data (in geographic coordinates and spatial dimensions) as they have been developed to the time of writing'. In the following chapters they achieve that objective more than adequately. The book does not purport to cover in detail the wider subject of four-dimensional data assimilation. However, considerations of mass-wind coupling in multivariate analysis and the concepts of optimally combining predicted and observed data, both receive due emphasis.

The book has an appropriately strong statistical flavour. For the benefit of readers with a limited statistical background, there are several appendixes, comprising some 20 per cent of the text, that address a variety of basic statistical concepts and techniques. An aptitude for matrix algebra, and a familiarity with concepts of linear filtering and spectral analysis, would also be necessary to get the most from the book. But the mathematically faint-hearted should not be deterred; it is unnecessary to follow every equation in order to comprehend the essential messages.

The book is organised as follows. In a brief introductory chapter, basic definitions are set out, and important analysis concepts introduced. The latter include, concepts of signal and noise, the least squares criterion, and analysis as a linear process. Throughout the book, the term 'linear' denotes that a grid-point estimate can be written as a linear combination of observed values; it carries no implication about the way the analysis varies in physical space.

Chapter 2 considers a wide range of surface fitting methods, ranging from the early simple polynomial methods, to the more recent generalised spline applications. The ideas are logically developed, with similarities and differences being explicitly noted. Particular topics covered include effects of observing errors, effects of model misspecification, constrained and unconstrained fitting, orthogonal polynomials, spherical harmonic models, and global and piecewise local approaches.

Chapter 3, entitled 'Empirical linear interpolation', deals with a variety of linear methods not explicitly based upon surface fitting, and not explicitly based upon statistical covariance structure. This chapter addresses, *inter alia*, the well-known successive correction methods, both univariate and multivariate (geopotential and wind) approaches, and stream function/velocity potential methods for wind analysis. There are instructive discussions of frequency domain responses, and of expected signal to noise ratios.

Chapter 4 addresses 'statistical objective analysis', more commonly known in the literature as statistical (or optimum) interpolation. As in earlier chapters, the subject is developed with the help of simple examples designed to give a feel for the method. There is a particularly thorough treatment of models for covariance structure, a subject to which Thiébaux has made substantial contributions. Other aspects covered include covariance functions for multivariate analysis, the covariance – spectral density dichotomy, and the use of statistical interpolation theory for network design.

The stated purpose of the book is very largely achieved in Chapters 1 to 4, and it is these chapters and the relevant appendixes which would be the most useful to readers seeking an introduction to objective analysis. Chapters 5 and 6 are more for the specialists. They relate to spatial stochastic models and their time-series analogues, and provide instructive background to the design of covariance functions.

It is easy and a bit unfair to suggest additional topics that could have been covered. So it probably reflects my own prejudices that I would like to have seen a more extensive discussion of those methods for coupling geopotential and wind analyses pioneered by Sasaki (1970) and based upon the calculus of variations. Perhaps such methods were considered beyond the scope of the book, because they are applied to grid-point fields, and do not contain any element of interpolation.

In summary, the book is a welcome addition to the objective analysis literature. It would be suitable for teaching or self-teaching, to those with the prerequisite mathematical expertise. Workers in objective analysis and data assimilation will find it a valuable consolidated reference. It would also be of interest to workers in related fields such as dynamical modelling and remote sensing. The price may deter some, but the book should be a mandatory acquisition for atmospheric sciences libraries.

The technical production is of a high standard. I noted only a few inconsequential errors, mainly in the spelling of authors' names.

Although the book is dated 1987, the reference list suggests a delay of two or three years between writing and publication. Undoubtedly a similar book written in 1988 would reflect, amongst other recent developments, the emergent awareness of the similarities and in certain instances the equivalence of some of the methods in Chapters 2 to 4. This final comment is offered, not as a criticism of the present book, but in the hope that we don't have to wait another 24 years for the next one!

## References

Gandin, L. S. 1963. *Objective Analysis of Meteorological Fields.* Translated by the Israeli Program for Scientific Translations (1965), 242 pp.

Sasaki, Y. 1970. Some basic formalisms in numerical variational analysis. *Mon. Weath. Rev., 98, 875-83.*

**R. S. Seaman**

*Bob Seaman is a research scientist with the Bureau of Meteorology Research Centre, and is a specialist in objective analysis.*