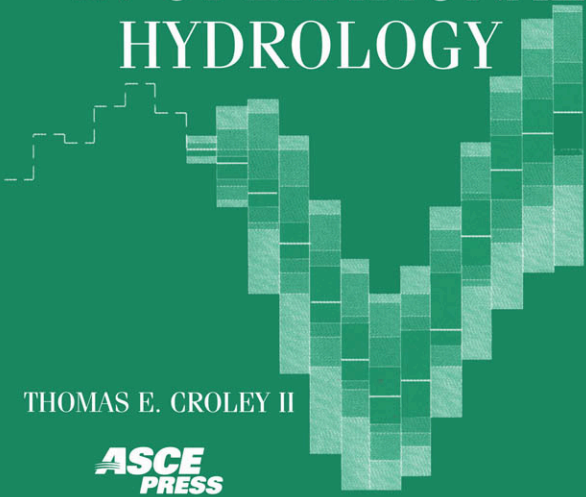
USING METEOROLOGY PROBABILITY FORECASTS IN OPERATIONAL HYDROLOGY



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Abstract: This book presents theory, procedures, and examples for using short-term, seasonal, and interannual forecasts of meteorology probabilities, available every day from the National Oceanic and Atmospheric Administration, Environment Canada, other agencies, and the user. The heuristic approach simultaneously uses forecasts over different time scales, time periods, spatial domains, probability statements, and meteorology variables. The book describes the generation of consequent hydrology (or other) probability forecasts, via operational hydrology methods, for assessing decision risks associated with uncertain meteorology. Any hydrology (or other) model may be used, as illustrated herein. Freely available graphical user interface software is documented to use intuitively and easily the multitude of probabilistic meteorology outlooks available.

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PREFACE

This book describes how to use the numerous forecasts of meteorology probabilities that are now available to the geophysical scientist or engineer. It defines an approach to generating consequent hydrology (or other) probabilities for a designer or manager in assessing decision risks related to *meteorology uncertainty*. This is a heuristic approach that is suitable for simultaneously using a wide variety of disparate probabilistic meteorology forecasts over a variety of time scales, time periods, spatial domains, probability statements, and meteorology variables. The book includes application examples largely from the US Laurentian Great Lakes, but the methodology is not particular to the Great Lakes; readers may use any hydrology (or other *derivative*) model of their own, as the book illustrates. (In fact, readers *must* supply their own models for their applications.) The examples not only include different (hydrology) models, but also illustrate the use of six currently available agency meteorology forecasts in the United States and Canada as well as user-defined meteorology probabilities. The latter include El Niño and La Niña conditional probabilities as well as examples of their derivation and sufficient information for the reader's own applications.

Forecasts of meteorology probabilities are generally available as spatial maps over the United States, Canada, and other countries. This book presents methods to use these forecasts at any specific site on such a map, with the reader's relevant models for that site, to make forecasts of *derivative* probabilities at that site. It is not a treatise on making spatial maps of hydrology probability forecasts throughout the United States or Canada, like the parent meteorology forecast maps. Furthermore, this book neither endorses the available weather forecasts nor expresses more confidence in some than in others. Readers must make their own judgments of the importance and priority of multiple meteorology probability forecasts, though the book provides some guidance. The book then helps readers use meteorology forecasts of their own selection to make derivative forecasts. Finally, while the examples in this book deal with long-range meteorology forecasts over a week, a month, or a 3-month period, set anywhere over the next 12 months, the methodology applies equally well to, and can immediately be used for, short-term forecasts.

Material of this type will be useful to water resource engineers, forecasters, and decision makers *only* if concepts are simply presented yet accompanied by sufficient depth in theory and applied principles. The writer has found that any new methodology must be clear and straightforward to be useful, yet engineers will not use it unless they also are comfortable with its underpinnings. Most recently, the writer has been working on these issues in small workshops for his laboratory's *Advanced Hydrologic Prediction System*, which utilizes these methods. He has also wrestled with these issues over the last 3 decades in both the university classroom and numerous university short courses for engineers. He has found that the two objectives of clear presentation of methodology and complete detail of theory and application can be difficult to achieve simultaneously. Very often, the mathematics and application details that are necessary for understanding a new methodology can obscure the explanation of it and of its use. It is often advantageous to separate the methodology presentation from the theory and application details.

This book is an expansion of ideas found in the writer's recently published works, in his lecture and tutorial notes for the workshops, and in his current work. In keeping with the philosophy of separate (but equal) presentations of methodology and sufficient theoretical underpinnings, the writer has organized the book in several ways. First, the book is divided into two parts. Part I presents the practical use and basic understanding of the forecasting techniques developed therein. Part I should enable practitioners to use the techniques, embodied in the free software described in the appendix, to make forecasts of their own based on available forecasts of meteorology probabilities. Part II of the book presents extensions of the methodology, much of the theoretical development, and real-world examples. It should enable the curious to understand why the methodology works, to appreciate its limitations, and to establish familiarity with some of the tradeoffs involved. It also illustrates applications for all who would use the methodology.

The second way the writer has organized the material is to place selected material in "sidebars" or boxed sections, which can be skipped at first reading. Such material comprises additional details, supporting mathematics, or discussions of some extensions, which can aid understanding but are not strictly essential for learning and understanding the methodology. These materials are placed where they are most relevant but are organized for omission without impeding the flow of the concepts presented in this book. Readers may, at their discretion, elect to include the material on first exposure or return to it later, if interested, after gleaning a basic understanding.

The methodology entails duties that are easily handled by companion software, which is freely available. Otherwise, these duties are cumbersome in detail and could impede obtaining experience with the numerous examples presented in this book. The methodology requires readers to prepare historical data files for their applications and to tediously input forecast meteorology probabilities each time they make their own forecasts. It also requires readers to extract reference quantile estimates from the historical data and to prioritize the meteorology forecasts (and the resulting probability equations) in order of importance to them. Furthermore, it requires them to choose or define an objective for selecting a solution, and to solve the system of equations simultaneously (often iteratively while eliminating lowest-priority equations). The free computer software is in the form of a graphical user interface and enables the reader to easily perform these duties in an understandable and intuitive manner. Appendix 2 describes the acquisition and use of this software, contains illustrative examples for using it, and provides detailed instruction for duplicating all of the application examples in this book. The writer suggests that the reader study Part I and then acquire the software and become familiar with it by perusing the section "Usage" in Appendix 2. The reader can then revisit Chapters 4 and 5 while working the first four exercises, which are found in the "Usage" section in Appendix 2 but are frequently cross-referenced in Chapters 4 and 5. Then the reader should continue with Part II, referring as needed to the "Exercises" section in Appendix 2 when encountering each application example.

PART I

PRACTICAL USAGE