Traditionally, soil science, atmospheric science, hydrology, plant science and agriculture have been studied largely as separate subjects. These systems are clearly interlinked, however, and in recent years a great deal of interdisciplinary research has been undertaken to understand the interactions better. This textbook was developed from a course that the authors have been teaching for many years on atmosphere-vegetation-soil interactions at one of the leading international research institutes in environmental science and agriculture.

Small-scale processes at the interface of soil and vegetation and in the lower atmosphere may have a profound impact on large-scale processes in the atmosphere and subsurface water. Furthermore, the interaction among soil, vegetation and atmosphere is important for the assessment and monitoring of water resources. This book describes the atmosphere-vegetation-soil continuum from the perspective of several interrelated disciplines, integrated into one textbook. The book begins with the treatment of individual terms in the energy and water balance of Earth’s surface, including the role of plants and solutes. A number of these aspects are then combined in the treatment of practical methods to estimate evapotranspiration. This leads to the presentation of a number of integrated applications, showing how the theory of the preceding chapters leads to new insights. The book concludes by presenting integrated hydrological and meteorological models in which the theory of transport processes is applied. The book assumes readers have some familiarity with basic radiation laws, thermodynamics and soil science. However, much of this prerequisite knowledge is also covered briefly in appendices. The text is interspersed with many student exercises and problems, with solutions included.

This textbook is ideal for intermediate to advanced students in meteorology, hydrology, soil science, environmental sciences and biology who are studying the atmosphere-vegetation-soil continuum, as well as researchers and professionals interested in the observation and modelling of atmosphere-vegetation-soil interactions.

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TRANSPORT IN THE ATMOSPHERE-VEGETATION-SOIL CONTINUUM

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Preface

This book has its roots in courses on Micrometeorology by Henk de Bruin and courses on Soil Physics and Agrohydrology by Reinder Feddes and colleagues at Wageningen University and Research Centre. Most universities teach these subjects in separate courses. In 2007, during a BSc-education reprogramming round at Wageningen University, micrometeorology, soil physics and agrohydrology were brought together in the current course ‘Atmosphere-Vegetation-Soil Interactions’. As teachers we had our reservations, but it turned out to work very well.

The interface between atmosphere and land is the location where both domains exchange energy, water and carbon. On the one hand, processes in soil and vegetation influence the development in the atmosphere (e.g., cloud formation). On the other hand, the atmospheric conditions determine to a large extent what happens below the soil surface (e.g., through the extraction of water for transpiration). Many environmental challenges, whether they concern climate change in drought-prone areas, salinization of coastal regions, development and spread of plant pathogens, natural vegetation impoverishment due to deep drainage or low water use efficiency in irrigated agriculture, have their origin in close interactions between atmosphere and land. To understand these processes and solve practical problems, students and professionals should have operational knowledge of transport processes in both domains and be able to understand how the atmosphere affects the land and vice versa.

This book intends to provide a consistent overview of the processes that occur in the continuum that extends from a few metres below the soil surface to roughly a hundred metres above it. It has been a challenge to connect the various disciplines that are active within this continuum: soil physics, ecohydrology, plant physiology and micrometeorology. The result is a unique text that covers all these disciplines on a scientific level that gives students a good preparation for continued education and thesis research. The ample use of up-to-date references to literature provides the student with starting points for further study. Questions and problems are interspersed with the text and answers to all questions are provided.
Preface

We gratefully acknowledge the contributions (direct or through inspiration) made by Henk de Bruin, Reinder Feddes and colleagues to the original lecture notes. Furthermore, we thank all the people who were involved in the collection of data that are used as illustrations in the text. Finally, we are grateful to Joel Schröter, Miranda Braam, Bert Holtslag and Reinder Ronda for their numerous comments on the text.