An Introduction to Clouds

Clouds, in their various forms, are a vital part of our lives. The second edition of this comprehensive textbook includes new tables, color figures, and updates taking into account recent research. It discusses cloud types and their effects on climate, including the Earth's energy budget and the hydrological cycle. These depend on processes on the cloud microphysical scale, encompassing the formation of cloud droplets, ice crystals and precipitation, as well as on the stability and dynamics of the large-scale environment and availability of aerosol particles. Chapters cover fundamentals of atmospheric thermodynamics, radiation, midlatitude and tropical storms, and climate intervention. Supplementary problem sets and multiple-choice questions for each chapter are available online. Combining mathematical formulations with qualitative explanations of the underlying concepts, this book requires relatively little previous knowledge, making it ideal for advanced undergraduate and graduate students in atmospheric science and related disciplines. This title is also available as Open Access on Cambridge Core.

Ulrike Lohmann is Professor in the Institute for Atmospheric and Climate Science at ETH Zurich. Her research focuses on the role of clouds and aerosol particles in atmospheric and climate science, with an emphasis on clouds containing ice. Ulrike has published more than 300 peer-reviewed articles and several book chapters and was a lead author of the Fourth and Fifth Assessment Reports from the Intergovernmental Panel on Climate Change. She has received many awards, including the Canada Research Chair in 2002, the Henry G. Houghton Award from the American Meteorological Society in 2007, and the Bjerknes Medal from the European Geophysical Union in 2025. She is Fellow of the American Geophysical Union and the German Academy of Sciences Leopoldina. She was awarded an honorary doctoral degree from the University of Stockholm in 2018. Ulrike has been teaching classes on atmospheric physics, cloud microphysics and cloud dynamics for more than 25 years, at both the undergraduate and graduate levels.

Fabian Mahrt is Assistant Professor in the Chemistry Department at Aarhus University, where he leads a research group at the Center for Chemistry of Clouds (C3). His research is mostly experimental, measuring physical and chemical properties of aerosol particles, their ability to form clouds and impact their microphysics, in order to understand aerosol–cloud interactions, in both the laboratory and in the field. He teaches courses in atmospheric physics and chemistry for undergraduate and graduate students. Fabian has won several prizes, including the Prix Schläfli in Geosciences in 2021, awarded by the Swiss Academy of Sciences, and received a Villum Young Investigator award in 2024.

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"This textbook on clouds is authoritative yet approachable, appropriate for upper level undergraduate or graduate students who have no prior background in atmospheric science. After introducing fundamental concepts in radiation, dynamics, and thermodynamics, it then describes the microphysics of both warm and cold clouds and the roles of clouds in precipitation and storm systems. The second edition is particularly impressive for its state-of-the-art description of our evolving understanding of the relationships between aerosol particles and clouds, the role of clouds in the climate system, and the importance of clouds to potential climate intervention strategies."

Jon Abbatt, University of Toronto

"Lohmann and Mahrt have delivered a definitive modern reference for cloud science. Masterfully bridging the space from detailed microphysics to the role of clouds in global climate change, it is my primary resource whether teaching the basics of contrail science to undergraduates or refining a cirrus cloud model for research purposes. In particular, the text's integration of clear and comprehensive diagrams with research-relevant equations and real-world photographic examples allows it to be both accessible and authoritative."

Sebastian Eastham, Imperial College London

"This book stands out for its ability to present both a comprehensive overview of cloud microphysical processes and a larger-scale perspective on clouds and their role in the climate system. It is an excellent introduction to clouds for university students, combining clear, pedagogical illustrations with an accessible writing style, without compromising scientific rigor."

Annica Ekman, Stockholm University

"The second edition of An Introduction to Clouds: From the Microscale to Climate should be a part of any collection of books on clouds and their impact on our environment. I have used the first edition as the required textbook for an upper level undergraduate and graduate course on cloud microphysics and will now replace it with the second edition. The level of the book is perfect for this usage; students often comment that it is both approachable for the non-expert and yet contains the advanced concepts required for a full understanding of the topic."

Daniel Cziczo, The University of Chicago

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From the Microscale to Climate

SECOND EDITION

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