Preface to the first edition

Half a century ago, Christian Junge, the founding "father" of atmospheric chemistry, summarized the existing knowledge in his field of research. In 1960, Junge counted only 75 research articles dealing with atmospheric chemistry and radioactivity (Junge 1958, 1963). At present, the publication rate and number of researchers in atmospheric chemistry are orders of magnitude greater. Many major advances have been made since then. For example, in the early 1970s, the role of OH radicals in oxidizing gases, leading to their removal from the atmosphere, was discovered. The necessary ingredients to produce OH are ozone, water vapor, and ultraviolet B (UV-B) solar radiation. The catalytic role of NO in producing ozone was also recognized in the early 1970s. Until that time it was generally believed that tropospheric ozone was produced in the stratosphere and transported downward into the troposphere. The feedstocks for the creation of ozone are CO, CH_4, and many biogenic gases. Both natural and anthropogenic processes are responsible for their emissions. Although the main photochemical chain reactions are reasonably well known, their quantification needs much further research. They all are parts of the biogeochemical cycles of carbon, nitrogen, and sulfur. They can also play a role in climate, as does particulate matter (PM), which, contrary to the greenhouse gases (CO_2, CH_4), tends to cool the Earth and atmosphere.

In his book, Detlev Möller gives a thorough overview of the main chemical processes that occur in the atmosphere, only a few of which were mentioned earlier. The novel title of this book, *Chemistry of the Climate System*, should direct the attention of the reader to the fact that understanding atmospheric chemistry is incomplete without considering interfacing neighboring reservoirs such as the hydrosphere, lithosphere, and biosphere.

An overview of the topics treated is provided in the introduction. It emphasizes that drawing strong borderlines between disciplines makes no sense; this is also valid for the various systems because they overlap and the most important processes can happen at their interfaces. Therefore, chemistry of the climate system combines atmospheric with water, soil, and biological chemistry. Another general approach of this book lies in the incorporation of historical facts: despite the orders of magnitude more publications each year at present than in the past, we should not forget that careful observations were made and serious conclusions drawn by many of our scientific ancestors.

The text has its roots in a book written in German, entitled *Luft* and published by De Gruyter in 2003. Although the text was entirely rewritten and many chapters were replaced, the main emphasis on regarding the atmosphere as a *multiphase system* is essentially unchanged. Moreover, by adding *interfacial chemistry*, the system is enlarged into a *multireservoir system*, encompassing the climate system. Ultimately, however, the central focus is chemistry. The author avoids using the term *environ-*

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mental chemistry, emphasizing that substances having specific physical and chemical properties can modify (chemical) systems in various directions depending on the mixture and initial conditions. Specialists in physics, chemistry, and biology, as well their many subdisciplines, need to understand what their disciplines can bring to the subject of climate system chemistry. This book is about fundamental aspects of (chemical) climate change, but it does not attempt to review all of the research on this topic. At many places in the book, a list of "Further Reading" is provided referring the reader to more specialized textbooks.

The book comprises three large fundamental chapters on chemical evolution, physicochemical fundamentals and substances, and chemical reactions. Following the introduction, the chapter "Chemical Evolution" gives a brief history from the Big Bang to the Anthropocene, the human-influenced Earth system. Möller describes the historical dimension in connecting the past with future developments. Changing chemical air composition is based on three pillars: land-use change, burning of fossil fuels, and agricultural fertilization, all caused by the rising global population. The resulting air chemical "episodes" (acid rain, ozone, PM) are fairly well understood, and end-of-pipe technologies to control air pollution were introduced. The remaining future challenge, limiting global warming through reduced emission of CO_2, however, can be achieved only by moving the anthroposphere into a solar era, as suggested in Chapter 2.8.4. Hence, Möller defines global sustainable chemistry as a coupling of biogeochemical cycles with anthropogenic matter cycles, proposing a global carbon dioxide cyling (CO_2 economy).

Chapter 4 provides a brief overview pf the physical and chemical principles of transporting and transforming substances in natural reservoirs, again with an emphasis on multiphase and interfacial processes. The texts on chemical reactions, multiphase processes, atmospheric removal, and characteristic timescales are well written and easy to read, even for nonchemists. The third main chapter treats "Substances and Chemical Reactions in the Climate System" according to the elements and their compounds, depending on the conditions of reactions and whether the given substance exists in the gaseous or condensed phase. The structure is adapted from "classical," substance-oriented textbooks in chemistry: hydrogen, oxygen, nitrogen, sulfur, phosphorus, carbon, and halogens. Many excellent figures summarize chemical pathways under different natural conditions and make it easy to understand complex chemical processes.

The various appendixes provide useful information on abbreviations, quantities, units, and the Earth's geological time scale. The respect brought to the history of science is reflected by the inclusion of nice biographical sketches, including of some not-so-well-known scientists.

In short, this well-written and useful book fills a gap in the attempt to provide books written from the perspective of a particular discipline (chemistry) on an interdisciplinary subject (the climate system) for readers and scientists from different disciplines to learn (or teach) some chemistry outside of the laboratory retort or industrial vessel.

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