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Atmospheric Electrodynamics

With 120 Figures



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Preface

This book resulted from lectures which I gave at the Universities of Kyoto, Cologne, and Bonn. Its objective is to summarize in a unifying way two otherwise rather separately treated subjects of atmospheric electrodynamics: electric fields of atmospheric origin, in particular thunderstorm phenomena and related problems on the one hand, and magnetic fields, in particular those which are associated with electric currents of upper atmospheric origin, on the other. Geoelectricity and geomagnetism were not always considered as belonging to quite different fields of geophysics. On the contrary, they were recognized by the physicists of the 19th and the beginning of the 20th century as two manifestations of one and the same physical phenomenon, which we presently refer to as electromagnetic fields. This can still be visualized from the choice of names of scientific journals. For instance, there still exists the Japanese *Journal of Geomagnetism and Geoelectricity*, and the former name of the present American Journal of Geophysical Research was *Terrestrial Magnetism and Atmospheric Electricity*.

Whereas geomagnetism became the root of modern magnetospheric physics culminating in the space age exploration of the earth's environment, geoelectricity evolved as a step-child of meteorology. The reason for this is clear. The atmospheric electric field observed on the ground reflects merely the local weather with all its frustrating unpredictability. The variable part of the geomagnetic field, however, is a useful indicator of ionospheric and magnetospheric electric current systems.

Only in the last two decades have ionospheric and magnetospheric physicists rediscovered the importance of electric fields of upper atmospheric origin. With the development of new instruments and their carriers (balloons, rockets, satellites), electric and magnetic fields of lower and upper atmospheric origin are now measured within the whole atmosphere from the ground to the magnetosphere and beyond. This again closes the gap between geoelectricity and geomagnetism that existed for more than a half a century. It is appropriate to select a new name for this branch of research: Atmospheric Electrodynamics.

In order to deal with such a broad field within the limiting space of a monograph, severe restrictions were necessarily imposed on the selection of the topics. Naturally, this selection is somewhat biased toward the author's own work. The potential reader is expected to possess some basic knowledge in electrodynamics. In the quantitative treatments of the subjects, simple analyt-

ical solutions are generally preferred in order to provide the reader with a physical insight into the problem rather than a full sophisticated description of the phenomenon in detail.

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