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地球卫星遥感

卷1：理论与仪器

Earth Science Satellite Remote Sensing

Science and Instruments

Volume 1

John J.Qu · Wei Gao · Menas Kafatos
Robert E. Murphy · Vincent V. Salomonson
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内 容 简 介

本书共有两卷。此为第1卷，包含20章，主要提供了有关中分辨率成像光谱仪(MODIS)产品的信息和科学应用，介绍了美国国家极轨环境卫星系统(NPOESS)和NPOESS预备计划(NPP)，还探讨了其他卫星遥感装备和应用。有关数据格式、数据处理、数据查询和订购等方面的内容在第2卷中给出。

本卷论及美国宇航局(NASA)用于监测和探测地球变化的主要卫星系统——地球观测系统(EOS)，EOS包括的卫星Terra、Aqua和Aura及其装载的MODIS、AIRS、AMSU、AMSR-E、OMI等遥感仪器，并讨论了NPP将携带的4个NPOESS系统重要部件：可见光红外成像辐射组件(VIIRS)，航线交叉红外探测器(CrIS)，先进技术微波探测器(ATMS)以及臭氧成图和廓线仪装置(OMPS)，可用于研究地球气候环境和天气变化。

本书作者均为相关领域具有权威性的专家与学者。图书内容既包括现代遥感技术的基础知识，又涉及卫星遥感的前沿领域，有广泛的实用性，可作为遥感、地学、环境、空间信息等地球科学领域的专业参考书。

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This book is dedicated to Dr. Vincent V. Salomonson

Few individuals have had such profound impact on the development of Earth remote sensing as Dr. Vincent V. Salomonson. We, his co-editors of this volume, have been chosen to dedicate it to him in recognition of his many contributions to our field. There is not a topic discussed in the book that has not been strongly influenced either by his personal research or his leadership.

After completing his undergraduate studies, he began his career as a weather officer in the US Air Force. He then returned to graduate school, earning a PhD in Atmospheric Science from Colorado State University in 1968. The bulk of his career was spent at the NASA Goddard Space Flight Center (1968 – 2005) where he conducted research and served as a branch head, laboratory chief, and, for 11 years, as the Director of Earth Sciences. He was deeply engaged in mission development, serving as the Project Scientist for Landsat-4 and -5 (1977 – 1989), and as the team leader for the Moderate Resolution Imaging Spectroradiometer (MODIS) from 1989 to the present. Under his leadership as a laboratory chief and as the Director of Earth Sciences, the men and women of the NASA Goddard Space Flight Center built the foundation for the study of global climate and environmental change using space-based systems and theoretical modeling.

He has served as the president of the American Society for Photogrammetry and Remote Sensing (ASPRS), and is a fellow of the ASPRS, as well as of the Institute for Electrical and Electronics Engineers (IEEE). He has served as an associate editor of several journals and has twice received the NASA Exceptional Scientific Achievement Medal. He has been recognized for career achievements twice, first with the William T Pecora award for his work on Landsat and the NASA Outstanding Leadership Medal for his role in establishing the Earth Sciences Directorate as an internationally recognized entity performing interdisciplinary Earth System Science.

Dr. Salomonson is now a Research Professor at the University of Utah, and the Director of Earth Sciences (Emeritus) at NASA Goddard Space Flight Center.

Foreword

From the late 1990's to the present there has been a truly spectacular series of missions brought to fruition by NASA in the context of the Earth Observing System (EOS). Beginning with the launch and operation in 1997 of the Orbview-2 and the SeaWiFS sensor followed soon by the Tropical Rainfall Monitoring Mission (TRMM) and in 1999, followed by the Quicksat mission and Landsat-7 missions, NASA embarked on a truly spectacular set of missions and sensors that have and are enabling very marked increases in understanding of Earth-atmosphere system processes and trends related to climate change potentially related to future habitability of the earth and the management of the earth's natural resources. The first "flagship" mission launched in very late 1999 of the EOS was the Terra mission devoted to providing a suite of observations that emphasized land processes, but also provided extensive observations of ocean and atmosphere features by utilizing a rich array of sensors with multi-band, multi-angle observations at several spatial resolutions ranging from 15 meters to several kilometers and observing extensive portions of the globe each day. The Terra mission was followed by its sister mission, Aqua, with another formidable array of sensors primarily devoted to observations of the atmosphere, but also key components of the hydrological cycle. On both the Terra and Aqua mission, a sensor often referred to as the "keystone" instrument, was the Moderate Resolution Imaging Spectroradiometer (MODIS). MODIS has provided global, daily observations in 26 spectral bands with spatial resolution ranging from 250 to 1,000 meters that observe many land, ocean, and atmospheric features (e.g. cloud microphysical properties) that serve to not only offer exciting new data for scientific studies, but also provide substantial context around and within which the other instruments on the Terra and Aqua missions are also providing very insightful and useful geophysical products for use by the science and applications communities.

Within the background and context provided in the previous paragraph, nearly the first half (Chapters 1 – 9) of this book offers the reader some in-depth

explanatory material describing the MODIS instruments, the background and information included in representative products from MODIS, and the data product development, processing and validation efforts that go into these products. The Chapters 10 – 15 that follow describe the succeeding operational, environmental missions called the National Polar-Orbiting Environmental Satellite Series (NPOESS) and the NPOESS Preparatory Project (NPP) and the attendant sensors including the Visible and Infrared Imaging Radiometer Suite (VIIRS) that is essentially a follow-on instrument to the MODIS with very similar capabilities. The NPP bridges the gap between the Terra and Aqua missions and the beginning of the NPOESS series that should occur early in the next decade; i.e. after 2010. Chapters 16 – 20 describe other various instruments and applications of remote sensing from satellites that give some indication of not only what other missions like the TRMM mission and its envisioned follow-on, the Global Precipitation Mission (GPM) are doing or will do with regard to precipitation, but also what some of the applications of spaceborne observations might be as well as the plans for meteorological satellite development and operation in China.

It is hoped by the authors of this volume that readers will benefit in terms of understanding how to utilize spaceborne observations of the Earth, its processes, and changes over time that affect everyone. Certainly improved information derived from these spaceborne observations of the Earth on a daily, synoptic, high observation basis is valuable and necessary if everyone is to work more closely and harmoniously together to sustain this Earth that is home to humankind.

Vincent V. Salomonson

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Preface

Earth science satellite remote sensing has seen rapid expansion during the last decade. NASA's Earth Observing System (EOS) program is providing data for in-depth scientific understanding of the functioning of the Earth as a system through a constellation of satellites that have been launched in recent years or will be launched in the near future. The National Polar-orbiting Operational Environmental Satellite System (NPOESS) Preparatory Project (NPP) mission is the latest in a series transitioning from research to operational satellite status. NPOESS will provide NASA with a continuation of global change observations following EOS Terra and Aqua. NPP will provide NPOESS with risk reduction demonstration and validation for the four critical NPOESS sensors, algorithms, and processing. The NPOESS mission will provide a national, operational, polar-orbiting remote-sensing capability by converging Department of Defense (DoD) and National Oceanic and Atmospheric Administration (NOAA) satellite programs while incorporating new technologies from NASA. Scientists and students have expressed great interest in these missions. However, there is currently no textbook for graduate students to learn about the EOS, NPP and NPOESS missions, or the current and potential applications of the resulting data.

The core of this book arose from the Workshop for Earth Science Satellite Remote Sensing held at George Mason University (GMU) from October 15 to 22, 2002. Updated information is included in this book. This book is designed to give readers having limited remote sensing background a thorough introduction to current and future NASA, NOAA and other Earth science remote sensing. It covers missions/sensors, such as Tropical Rainfall Measuring Mission (TRMM), Atmospheric Infrared Sounder (AIRS), and Advanced Microwave Sounding Unit (AMSU). It also discusses the NPOESS and NPP missions. Emphasis is placed on the recently launched Moderate Resolution Imaging Spectroradiometer (MODIS) on board both of the satellites Terra and Aqua. Key MODIS science team members were invited to contribute several chapters. The editors acknowledge

support by the Center of Earth Observing and Space Research (CEOSR) at GMU and NASA/GSFC MODIS and NPP projects.

The goals of this volume are to: (1) provide information on the MODIS products and data processing; (2) give an introduction to the NPOESS and NPP missions; and (3) explore other satellite remote sensing instruments and applications. Detailed information about data formats, data searching and ordering, remote sensing and GIS products, Web GIS applications and tools can be found in volume 2 of Earth Science Satellite Sensing.

There are many people who assisted with this book. First, the editorial team would like to thank all authors involved in contributing chapters for the Earth Science Satellite Remote Sensing. Each author has spent extra hours in addition to existing workloads and ongoing commitments. Second, we would like to thank over eighty anonymous reviewers for their constructive comments and suggestions. The most chapters in this book were originally presented at the Second Workshop of the Earth Science Satellite Remote Sensing at George Mason University (GMU). We would also like to thank many of the Moderate Resolution Imaging Spectroradiometer (MODIS) and the NPOESS Preparatory Project (NPP) science team members who contributed their MODIS and NPOESS/NPP chapters. Much appreciation also goes to the Center for Earth Observation and Space Research (CEOSR) at GMU for supporting the workshop and this book. Special thanks and appreciation go to Mr. Manny Smith for providing editing assistance and tracking chapter status with leading authors. We would like to acknowledge Ms. Lingli Wang, Ms. Bockhwa Kim and Ms. Wanting Wang of the School of Computational Sciences (SCS) at GMU spending tremendous effort working on templates, tables and figures for this book. The efforts of many individuals including Prof. George Taylor, Dr. William Sommers, Prof. Ruixin Yang, Dr. Xianjun Hao and Mr. Hank Wolf at GMU and Dr. Xiaoxiong Xiong at NASA/GSFC, who supported this book, are highly appreciated.

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