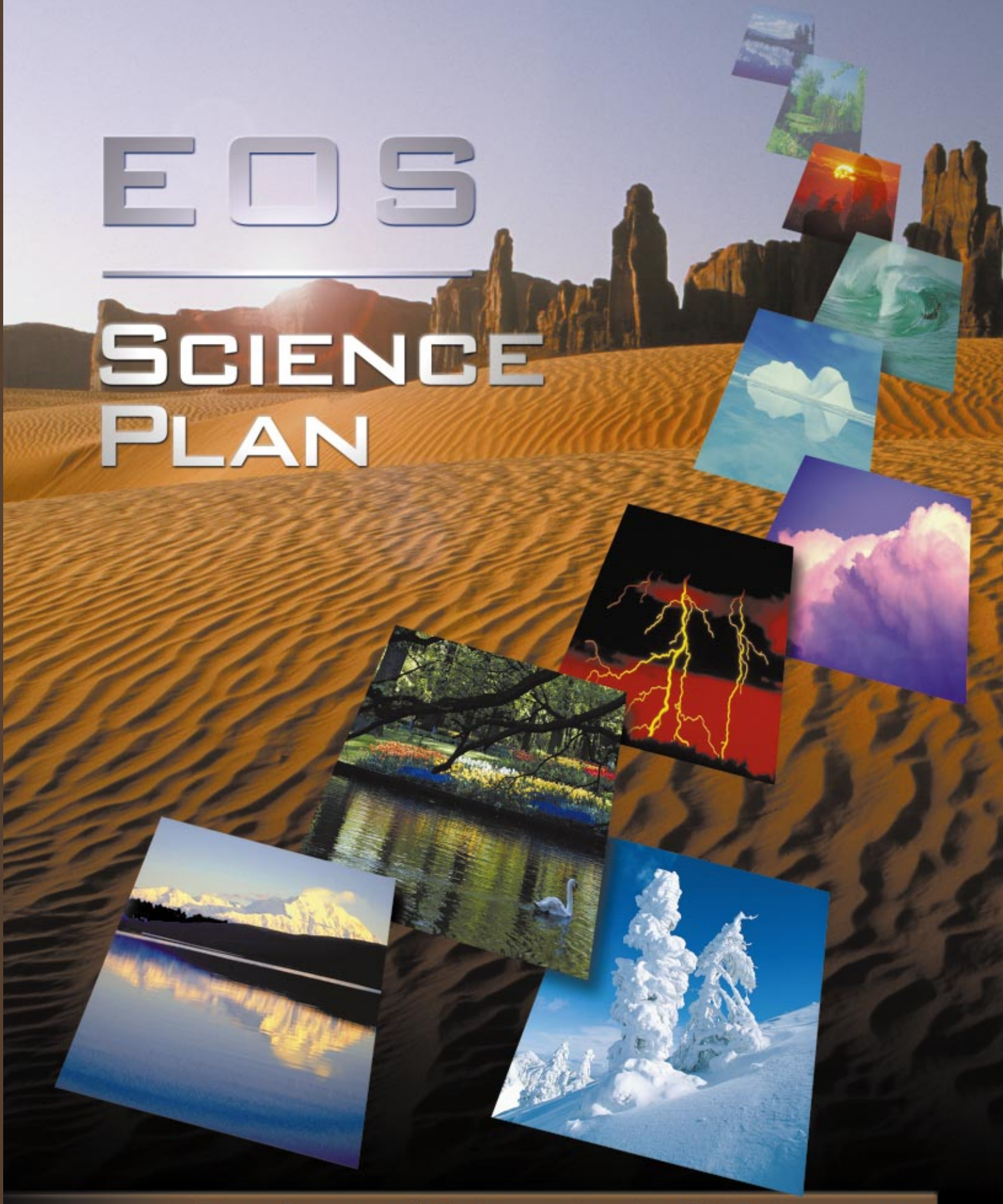
EOS

SCIENCE PLAN

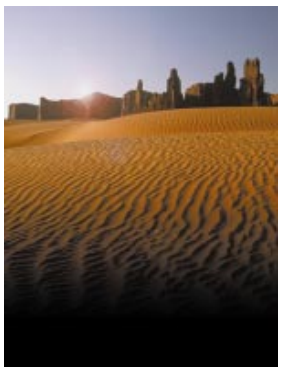


The State of Science in the EOS Program

EOS

SCIENCE PLAN

The State of Science in the EOS Program



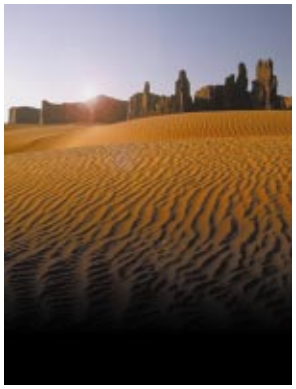
EDITOR
Michael D. King
NASA/Goddard Space Flight Center

TECHNICAL EDITORS
Reynold Greenstone
William Bandeen
Raytheon ITSS

DESIGN AND PRODUCTION
Sterling Spangler
Raytheon ITSS

EOS
SCIENCE PLAN

The State of Science in the EOS Program



EOS Senior Project Scientist

Dr. Michael D. King
NASA/Goddard Space Flight Center
Code 900
Greenbelt, Maryland 20771
Phone: 301-614-5636
Fax: 301-614-5620
E-Mail: king@climate.gsfc.nasa.gov

For Additional Copies

Ms. Lee McGrier
NASA/Goddard Space Flight Center
Code 900
Greenbelt, Maryland 20771
Phone: 301-441-4259
E-Mail: lmcgrier@pop900.gsfc.nasa.gov

EOS HomePage

http://eos.nasa.gov/

Table of Contents

Foreword

From the dawn of space exploration NASA has been in the forefront of providing the unique vantage point of space as an ideal setting for observing Earth as a whole system consisting of atmosphere, oceans, and continents capable of supporting life in our solar system. Today, NASA continues to sponsor research and development towards understanding the origins of life in the universe. The best proxy for this search and discover mission is life on Earth, and the NASA Earth Science Enterprise captures the spirit of exploration and focuses it back on our home planet. But this requires understanding Earth as an integrated system of atmosphere, land, oceans, and life, which has evolved in the past and will continue to evolve in the future. Building on our observations of the Earth since the earliest days of the space program—NASA built the first weather and land observing satellites—we are using orbiting spacecraft to bring congruency to multiple disciplines within Earth sciences through integrated observations, interdisciplinary scientific research and analysis, and modeling. This is the blueprint for the Earth Science Enterprise at NASA and its Earth Observing System (EOS) program.

The EOS program was established in 1991 as a U.S. Presidential initiative to provide in-depth scientific understanding about the functioning of Earth as a system. It was envisioned that such scientific knowledge would provide the foundation for understanding the natural and human-induced variations in Earth's climate system and also provide a sound basis for environmental policy decision making. Beyond scientific discovery and explorations, it was also envisioned that EOS would have practical societal benefits in the form of providing scientific knowledge toward the efficient production of food and fiber, management of fresh water resources, and improvement of air quality. Less than a decade later, EOS is now a reality and delivering on its promises. During the first phase of the EOS program NASA is funding the development and launch of 25 satellites, and a uniquely comprehensive Earth observations-related data and information system. Hundreds of Earth scientists and engineers are supported, and more than 350 students per year are pursuing graduate degrees in Earth science with NASA funding.

The EOS Science Plan is the product of several years of discussion and debate among the EOS investigators. The considerable time required to develop this document should be viewed as a major strength because of the deep-rooted commitments of the contributors to this document and their ability to deliver on their promise. The objective of this Plan is to convey how EOS investigators plan to utilize the space-based and in situ observations along with modeling and data analysis methods/techniques to address the EOS scientific and applications objectives. Therefore, the principal intended audience for this plan is the body of international Earth scientists and science program directors. Given the complexity of the task at hand and the level of details that had to be provided, the Pan became more than 350 pages long. A short version of the Plan has also been developed in the form of an Executive Summary. We believe that these two documents will be seen to be an effective means of communicating the scientific priorities of the EOS program and how NASA and EOS investigators plan to implement these priorities during the next 5-7 years.

As we move towards the next century the changing Earth's environment will be the focus of many agricultural, industrial, and societal concerns and policy decisions. NASA's Earth Science Enterprise is committed to timely provision of the scientific knowledge needed by world leaders to formulate sound and equitable environmental decisions.

Ghassem R. Asrar
Associate Administrator

Office of Earth Science
NASA Headquarters
Washington, D.C.

Preface

The EOS Science Plan was first proposed to the community of EOS investigators at a meeting of the EOS Investigators Working Group in the fall of 1994. As the concept of the Plan evolved, it was decided that the primary audience for the Plan would be the scientific community and not the general public. Thus, the audience not only includes members of the EOS scientific community, but also includes scientists in related fields who are not necessarily acquainted with the goals and philosophies of scientists in the EOS program.

Accordingly, readers will find a very thorough presentation of the state of the science being investigated by participants in the EOS program. They also will find discussions on how science investigations are being conducted both before and after launch of the EOS satellites. This review of the state of the science, along with its extensive documentation of scientific references, should be of value to both working scientists and to the graduate students who will take their place in the scientific endeavors of the next century.

Both the anticipated contributions of the EOS satellites to our knowledge of Earth science and the synergisms existing between the various instruments are discussed throughout the plan. Also described are the many theoretical studies [called Interdisciplinary Science (IDS) investigations] that draw upon the satellite observations, and the role of field investigations in both validating instrument observations and enhancing our understanding of Earth System processes.

The Plan consists of an overview chapter followed by seven topical science chapters that discuss, in considerable detail, all aspects of EOS science. The overview chapter was written by Eric Barron of The Pennsylvania State University and gives the background of concerns and recommendations that led to the formation of the EOS Program. Each of the topical science chapters has a lead author(s) who is an expert in the particular field and is a Principal Investigator on a related IDS team. Typically, lead authors were heading up EOS scientific working groups at the time they assumed responsibility for their respective chapters. Each lead author has drawn on a team of "contributing" authors who are named at the start of each chapter. The seven science topics addressed in the plan, with their corresponding chapter names and lead authors, are as follows:

2. Radiation, clouds, water vapor, precipitation, and atmospheric circulation
D. L. Hartmann – *University of Washington*

3. Ocean circulation, productivity, and exchange with the atmosphere
D. A. Rothrock – *University of Washington*

4. Atmospheric chemistry and greenhouse gases
D. Schimel – *National Center for Atmospheric Research*

5. Land ecosystems and hydrology
S. W. Running – *University of Montana*
G. J. Collatz – *Goddard Space Flight Center*
J. Washburne – *University of Arizona*
S. Sorooshian – *University of Arizona*

6. Cryospheric systems
B. E. Goodison – *Atmospheric Environment Service, Canada*
R. D. Brown – *Atmospheric Environment Service, Canada*
R. G. Crane – *Pennsylvania State University*

7. Ozone and stratospheric chemistry
M. R. Schoeberl – *Goddard Space Flight Center*

8. Volcanoes and climate effects of aerosol
D. L. Hartmann – *University of Washington*
P. Mouginis-Mark – *University of Hawaii.*

Readers wishing to know more details about the IDS investigations or the planned EOS spacecraft missions and the instruments they will carry are advised to consult the 1998 edition of the Earth Science Enterprise/EOS Reference Handbook. The handbook also provides the names of all IDS Principal Investigators and Co-Investigators as well as the names of the EOS instrument team leaders, team members, Principal Investigators, and Co-Investigators. An excellent way to keep current with EOS developments is to consult the EOS Project Science Office website at
http://eos.nasa.gov/.

It should be noted that EOS is a fluid program, with changes in long-term plans always a possibility due to new scientific developments or to budgetary considerations. Authors and editors have tried to keep abreast of changes in mission and instrument names, but some of the older terminology may not have been caught in every instance. For this we apologize.

Acknowledgments

Special thanks go to D. A. Rothrock, University of Washington, who provided the outline for all the topical science chapters, and thus, in a sense, gave the necessary impetus to the launching of this Plan. Much of the technical material in the Plan was provided not only by the listed lead authors and named contributors, but also by many other unnamed EOS scientists and engineers. R. Greenstone and W. R. Bandeen (both of Raytheon Corporation) provided technical editing throughout the lengthy process of assembling and refining in standard format the text and appendices of this Plan. Design and layout of the Plan were the work of Sterling Spangler (also of Raytheon Corporation).

Michael D. King
EOS Senior Project Scientist

January 1999