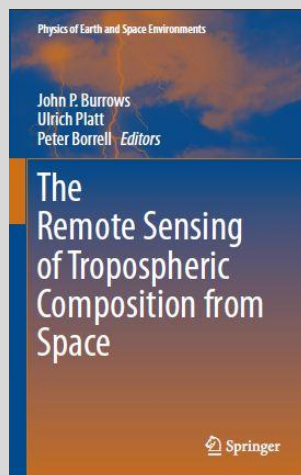


The Remote Sensing of Tropospheric Composition from Space

Editors:

John P. Burrows
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The Remote Sensing of Tropospheric Composition from Space

With 158 Figures and 23 Tables

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Preface

The impact of anthropogenic activities on our atmospheric environment is of much public concern, and the economic and technical solutions needed to provide a sustainable environment require reliable observations, coupled with a proper scientific understanding. Satellite-based techniques now provide an essential component of observational strategies on regional and global scales.

It is now some 15 years since the launch of GOME, the first satellite instrument designed specifically to retrieve the composition of trace gases and pollutants in the troposphere. Since then the number of satellite instruments has increased steadily, and the availability of satellite data is providing the capability of monitoring the state of the global atmosphere. It is also radically changing the field of atmospheric chemistry.

The purpose of this book is to summarise the state of the art in the field; to describe the technology and techniques used; and to demonstrate the key findings and results. The book has its origins in TROPOSAT, a project initiated within the EUROTRAC framework, to encourage the use and usability of satellite data for tropospheric research; the project was continued within the EU air quality project, ACCENT. Two of the book's editors were proposers of SCIAMACHY and the smaller scale GOME, which initiated European-based remote sensing of tropospheric trace gases from space. The third has coordinated the various TROPOSAT activities, having previously been the Executive Scientific Secretary of the EUROTRAC project. All the contributing authors to this volume are senior scientists actively involved in the field – in satellite data retrievals, in the validation of tropospheric data, in the interpretation of the global and regional results and in the modelling, which relies on the data; most are part of the TROPOSAT community.

The book opens with an historical perspective of the field together with the basic principles of remote sensing from space. Three chapters follow on the techniques and on the solutions to the problems associated with the various spectral regions in which observations are made.

The particular challenges posed by aerosols and clouds are covered in the next two chapters. Of special importance is the accuracy and reliability of remote sensing data and these issues are covered in a chapter on validation.

The final section of the book is concerned with exploitation of the data for scientific and operational applications. These include investigations using individual data products and synergistic studies using a variety of data products. Comparison of global and regional observations with chemical transport and climate models are discussed and the potential added value from the synergetic interaction of model and measurements identified.

The book concludes with scientific needs and likely future developments in the field, and the necessary actions to be taken if we are to have the global observation system that the Earth needs in its present, deteriorating state.

The appendices provide a comprehensive list of satellite instruments, global representations of some ancillary data such as fire counts and light pollution, a list of abbreviations and acronyms, and a set of colourful timelines indicating the satellite coverage of tropospheric composition in the foreseeable future.

The recent impact of volcanic ash on European air transport (Chapter 10) has provided a forceful reminder of the utility of satellite observations in monitoring and understanding the tropospheric constituents in the atmosphere. Thus the book provides a timely account of the developments in a new area of much utility to sustaining a healthy atmosphere.

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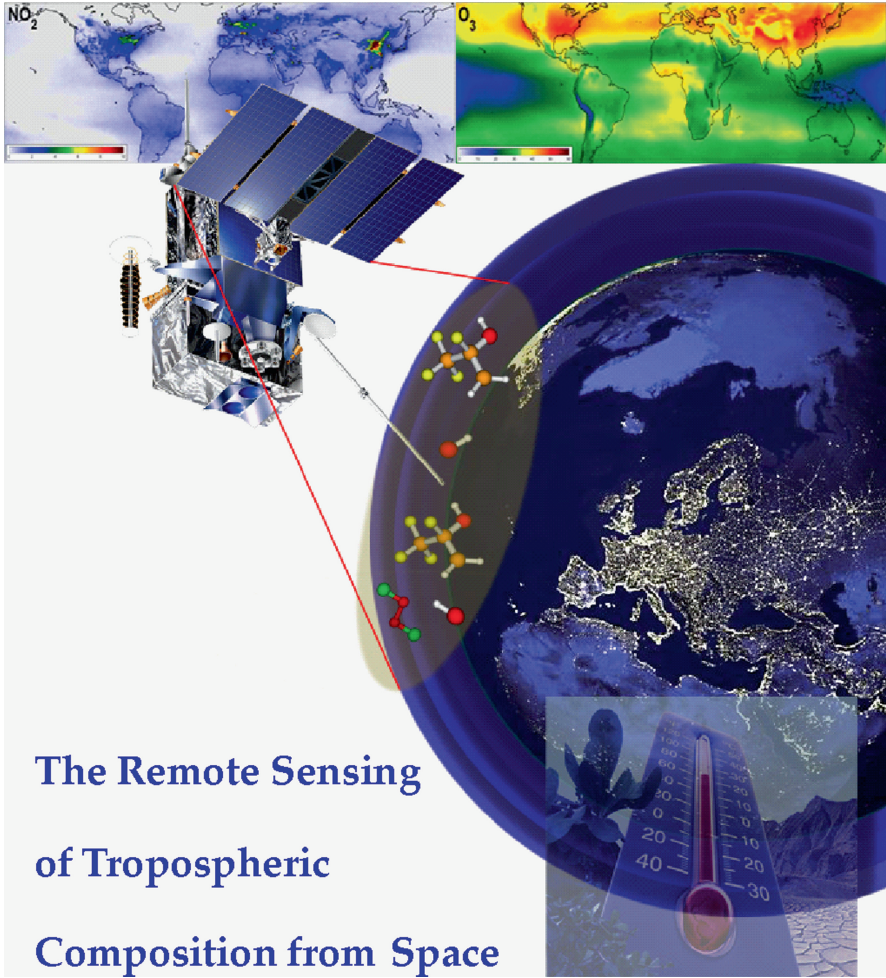
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Picture created by Maria Kanakidou and Vassilis Papadimitriou

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Chemical Names and Molecular Formulae

Oxygen and hydrogen containing molecules and radicals

Oxygen	O ₂
Oxygen atom	O
Oxygen atom (ground state)	O(³ P)
Oxygen atom (first excited state)	O(¹ D)
Ozone	O ₃
Water	H ₂ O
(Ice, liquid, vapour)	
Water	
(Partially deuterated)	HDO
Hydrogen peroxide	H ₂ O ₂
Hydroxyl radical	OH
Hydroperoxy radical	HO ₂

Nitrogen compounds

Nitrogen	N ₂
Nitric oxide	NO
Nitrogen dioxide	NO ₂
Nitrous oxide	N ₂ O
Nitrate radical	NO ₃
Nitric acid	HNO ₃
Dinitrogen pentoxide (nitric acid anhydride)	N ₂ O ₅
Peroxynitric acid	HNO ₄
Ammonia	NH ₃
Hydrogen cyanide	HCN

Oxidised carbon

Carbon monoxide	CO
Carbon dioxide	CO ₂

(continued)

Organic compounds

Methane	CH ₄
Ethyne (acetylene)	C ₂ H ₂
Ethane	C ₂ H ₆
Ethene (ethylene)	C ₂ H ₄
Methanol	CH ₃ OH
Formaldehyde	HCHO
Formic acid	HCOOH
Glyoxal	CHOCHO
Acetone	CH ₃ COCH ₃
Peroxyacetyl nitrate (PAN)	CH ₃ COO ₂ NO ₂

Halogen compounds

Chlorine nitrate	ClONO ₂
Hypobromous acid	HOBr
Hypochlorous acid	HOCl
Bromine nitrate	BrONO ₂
Hydrogen fluoride	HF
Hydrogen chloride	HCl
Methyl chloride	CH ₃ Cl

Halogen radicals

Chlorine monoxide	ClO
Bromine monoxide	BrO
Iodine monoxide	IO

CFCs

CFC-11	CFCl ₃
CFC-12	CF ₂ Cl ₂
CFC-113	Cl ₂ FC ₂ CF ₂

(continued)

<i>HCFCs</i>	
HCFC-142b	CF ₂ CCH ₃
HCFC-22	CHClF ₂
<i>Sulfur compounds</i>	
Sulfur dioxide	SO ₂

(continued)

Hydrogen Sulfide	H ₂ S
Dimethyl Sulfide DMS	CH ₃ SCH ₃
Carbon disulfide	CS ₂
Sulfuric acid	H ₂ SO ₄
Carbonyl sulfide	OCS
Sulfur hexafluoride	SF ₆

A Full list of Abbreviations and Acronyms is given in Appendix C.