

PROCEEDINGS OF SPIE

# ***Lidar Technologies, Techniques, and Measurements for Atmospheric Remote Sensing XII***

**Upendra N. Singh**  
**Doina N. Nicolae**  
*Editors*

**26–27 September 2016**  
**Edinburgh, United Kingdom**

*Sponsored by*  
SPIE

*Cooperating Organisations*

Innovation Centre for Sensor and Imaging Systems (United Kingdom)  
ADS Scotland (United Kingdom) · The Knowledge Transfer Network (United Kingdom)  
Visit Scotland (United Kingdom) · European Regional Development Fund (Belgium)  
Technology Scotland (United Kingdom) · European Association of Remote Sensing  
Companies (Belgium) · European Association of Remote Sensing Laboratories (Germany)  
The British Association of Remote Sensing Companies (United Kingdom) · Remote Sensing &  
Photogrammetry Society (United Kingdom)

*Published by*  
SPIE

**Volume 10006**

Proceedings of SPIE 0277-786X, V. 10006

SPIE is an international society advancing an interdisciplinary approach to the science and application of light.

Lidar Technologies, Techniques, and Measurements for Atmospheric Remote Sensing XII,  
edited by Upendra N. Singh, Doina Nicoleta Nicolae, Proc. of SPIE Vol. 10006, 1000601  
© 2016 SPIE · CCC code: 0277-786X/16/\$18 · doi: 10.1117/12.2264936

Proc. of SPIE Vol. 10006 1000601-1

The papers in this volume were part of the technical conference cited on the cover and title page. Papers were selected and subject to review by the editors and conference program committee. Some conference presentations may not be available for publication. Additional papers and presentation recordings may be available online in the SPIE Digital Library at [SPIDigitalLibrary.org](http://SPIDigitalLibrary.org).

The papers reflect the work and thoughts of the authors and are published herein as submitted. The publisher is not responsible for the validity of the information or for any outcomes resulting from reliance thereon.

Please use the following format to cite material from these proceedings:

Author(s), "Title of Paper," in *Lidar Technologies, Techniques, and Measurements for Atmospheric Remote Sensing XII*, edited by Upendra N. Singh, Doina N. Nicolae, Proceedings of SPIE Vol. 10006 (SPIE, Bellingham, WA, 2016) Seven-digit Article CID Number.

ISSN: 0277-786X  
ISSN: 1996-756X (electronic)

ISBN: 9781510604162  
ISBN: 9781510604179 (electronic)

Published by

**SPIE**

P.O. Box 10, Bellingham, Washington 98227-0010 USA  
Telephone +1 360 676 3290 (Pacific Time) · Fax +1 360 647 1445  
[SPIE.org](http://SPIE.org)

Copyright © 2016, Society of Photo-Optical Instrumentation Engineers.

Copying of material in this book for internal or personal use, or for the internal or personal use of specific clients, beyond the fair use provisions granted by the U.S. Copyright Law is authorized by SPIE subject to payment of copying fees. The Transactional Reporting Service base fee for this volume is \$18.00 per article (or portion thereof), which should be paid directly to the Copyright Clearance Center (CCC), 222 Rosewood Drive, Danvers, MA 01923. Payment may also be made electronically through CCC Online at [copyright.com](http://copyright.com). Other copying for republication, resale, advertising or promotion, or any form of systematic or multiple reproduction of any material in this book is prohibited except with permission in writing from the publisher. The CCC fee code is 0277-786X/16/\$18.00.

Printed in the United States of America.

Publication of record for individual papers is online in the SPIE Digital Library.

**SPIE. DIGITAL LIBRARY**  
[SPIDigitalLibrary.org](http://SPIDigitalLibrary.org)

---

**Paper Numbering:** *Proceedings of SPIE* follow an e-First publication model. A unique citation identifier (CID) number is assigned to each article at the time of publication. Utilization of CIDs allows articles to be fully citable as soon as they are published online, and connects the same identifier to all online and print versions of the publication. SPIE uses a seven-digit CID article numbering system structured as follows:

- The first five digits correspond to the SPIE volume number.
- The last two digits indicate publication order within the volume using a Base 36 numbering system employing both numerals and letters. These two-number sets start with 00, 01, 02, 03, 04, 05, 06, 07, 08, 09, 0A, 0B ... 0Z, followed by 10-1Z, 20-2Z, etc. The CID Number appears on each page of the manuscript.

# Contents

v	<i>Authors</i>
vii	<i>Conference Committee</i>

---

## GREENHOUSE GAS MEASUREMENTS

---

10006 02	<b>Airborne lidar for simultaneous measurement of column CO<sub>2</sub> and water vapor in the atmosphere (Invited Paper) [10006-1]</b>
10006 03	<b>Er:YAG laser technology for remote sensing applications [10006-2]</b>
10006 05	<b>Differential absorption lidar measurements of H<sub>2</sub>O and O<sub>2</sub> using a coherent white light continuum [10006-4]</b>

---

## AEROSOL/CLOUD MEASUREMENTS I

---

10006 07	<b>DUSTER lidar: transatlantic transport of aerosol particles from the Sahara and other sources: first results from the recently installed lidar and sunphotometer in Natal/Brazil [10006-7]</b>
10006 08	<b>Monitoring the environmental impact of aerosol loading and dispersion from distinct industrial sources in Cubatao, Brazil, using a scanning lidar [10006-8]</b>

---

## AEROSOL/CLOUD MEASUREMENTS II

---

10006 0C	<b>Performance of a compact elastic 355 nm airborne lidar in tropical and mid-latitude clouds [10006-11]</b>
10006 0D	<b>Analysis of the influence of system parameters on the measurement accuracy of a high spectral resolution lidar [10006-12]</b>

---

## COHERENT WIND LIDAR FOR SPACE

---

10006 0E	<b>Research on the space-borne coherent wind lidar technique and the prototype experiment [10006-14]</b>
----------	--

---

## LED/MICROCHIP LIDAR FOR SPACE

---

10006 0F	<b>LED minilidar for Mars rover (Invited Paper) [10006-15]</b>
10006 0G	<b>Dynamic analysis of sea wave data measured by LED lidar [10006-16]</b>

10006 OH **Development and validation of a microchip pulsed laser for ESA space altimeters**  
[10006-17]

---

**POSTER SESSION**

---

10006 OI **Laser polarization sensing of high-level clouds: problem of interpretation of experimental data** [10006-20]

10006 OJ **Effect of collisional lines broadening and calibration functions in the pure rotational Raman lidar technique** [10006-21]

10006 OM **A point cloud modeling method based on geometric constraints mixing the robust least squares method** [10006-24]

## Authors

Numbers in the index correspond to the last two digits of the six-digit citation identifier (CID) article numbering system used in Proceedings of SPIE. The first four digits reflect the volume number. Base 36 numbering is employed for the last two digits and indicates the order of articles within the volume. Numbers start with 00, 01, 02, 03, 04, 05, 06, 07, 08, 09, 0A, 0B...0Z, followed by 10-1Z, 20-2Z, etc.

Abreu, Hernâni, 0H  
Alados-Arboledas, Lucas, 07  
Amorim, António, 0H  
An, Chao, 0E  
Anfill, Charles W., 02  
Baibakov, Konstantin, 0C  
Baji, Hiroyuki, 0G  
Boselli, Antonella, 0D  
Bryukhanov, I. D., 0I  
Burns, Patrick M., 03  
Chen, Moran, 03  
Couto, Bruno, 0H  
da Costa, Renata F., 08  
Du, Guojun, 0E  
Fernandez, José H., 07  
Fujita, M., 05  
Gao, Long, 0E  
Gerasimov, Vladislav V., 0J  
Gordo, Paulo, 0H  
Guardani, Maria Lucia G., 08  
Guardani, Roberto, 08  
Guedes, Anderson G., 07  
Guerrero-Rascado, Juan L., 07  
Hashimoto, George, 0F  
Hoelzemann, Judith J., 07  
Huang, Nan, 0M  
Kawabata, Yasuhiro, 0F  
Konoshonkin, A. V., 0I  
Korolev, Alexei, 0C  
Kuze, H., 05  
Landulfo, Eduardo, 07, 08  
Litvinovitch, Viatcheslav, 03  
Liu, Bin, 0M  
Liu, Dapeng, 0M  
Lopes, Daniel Silveira, 08  
Lopes, Fábio J. S., 07  
Macedo, Fernanda de Mendonca, 08  
Manago, N., 05  
Marques, Marcia Talita Amorim, 08  
Montilla, Elena, 07  
Mori, Yasukuni, 0G  
Nasonov, S. V., 0I  
Nguyen, Cuong, 0C  
Otohe, Naohito, 0F  
Pan, Yi, 0M  
Petros, Mulugeta, 02  
Refaat, Tamer F., 02  
Remus, Ruben, 02  
Samokhvalov, I. V., 0I  
Sannino, Alessia, 0D  
Sawruk, Nicholas W., 03  
Senshu, Hiroki, 0F  
Shiina, Tatsuo, 0F, 0G  
Shimada, Shohei, 0G  
Singh, Upendra N., 02  
Somekawa, T., 05  
Song, Changbo, 0D  
Spinelli, Nicola, 0D  
Storm, Mark, 03  
Takemoto, Sae, 0G  
Tao, Yuliang, 0E  
Wang, Xuan, 0D  
Wang, Zhien, 0C  
Wechsler, Perry, 0C  
Wolde, Mengistu, 0C  
Yamada, Sonoko, 0F  
Yang, Jukui, 0E  
Yu, Jirong, 02  
Yue, Jianping, 0M  
Yue, Shun, 0M  
Zhao, Yiming, 0D  
Zheng, Yongchao, 0E  
Zuev, Vladimir V., 0J



# Conference Committee

## *Symposium Chair*

**Klaus Schäfer**, (Retired) Karlsruhe Institute of Technology, Institute of Meteorology and Climate Research (Germany)

## *Symposium Co-chairs*

**Christopher M. U. Neale**, University of Nebraska-Lincoln (United States), Daugherty Water for Food Institute (United States)  
**Iain H. Woodhouse**, The University of Edinburgh (United Kingdom), Geography and the Lived Environment Research Institute (United Kingdom)

## *Conference Chairs*

**Upendra N. Singh**, NASA Langley Research Center (United States)  
**Doina Nicoleta Nicolae**, National Institute of Research and Development for Optoelectronics (Romania)

## *Conference Program Committee*

**Arnoud Apituley**, Rijksinstituut voor Volksgezondheid en Milieu (Netherlands)  
**Lucas Alados-Arboledas**, Universidad de Granada (Spain)  
**Andreas Behrendt**, Universität Hohenheim (Germany)  
**Gerhard Ehret**, Deutsches Zentrum für Luft- und Raumfahrt e.V. (Germany)  
**Barry M. Gross**, NOAA-CREST (United States)  
**Philippe L. Keckhut**, LATMOS (France)  
**George J. Komar**, NASA Headquarters (United States)  
**Eduardo Landulfo**, Instituto de Pesquisas Energéticas e Nucleares (Brazil)  
**Kohei Mizutani**, National Institute of Information and Communications Technology (Japan)  
**Lucia Mona**, Istituto di Metodologie per l'Analisi Ambientale (Italy)  
**Alexandros D. Papayannis**, National Technical University of Athens (Greece)  
**Gelsomina Pappalardo**, Istituto di Metodologie per l'Analisi Ambientale (Italy)  
**Vincenzo Rizi**, Università degli Studi dell'Aquila (Italy)

**Laurent Sauvage**, Leosphere France (France)  
**Georgios D. Tzeremes**, European Space Agency (Netherlands)  
**Ulla Wandinger**, Leibniz Institut für Troposphärenforschung (Germany)  
**Jirong Yu**, NASA Langley Research Center (United States)

*Session Chairs*

- 1 Greenhouse Gas Measurements  
**Upendra N. Singh**, NASA Langley Research Center (United States)
- 2 Aerosol/Cloud Measurements I  
**Kevin B. Strawbridge**, Environment Canada (Canada)
- 3 Aerosol/Cloud Measurements II  
**Eduardo Landulfo**, Instituto de Pesquisas Energéticas e Nucleares  
(Brazil)
- 4 Coherent Wind Lidar for Space  
**Tatsuo Shiina**, Chiba University (Japan)
- 5 LED/Microchip Lidar for Space  
**Zhaoyan Liu**, NASA Langley Research Center (United States)