

PROCEEDINGS OF SPIE

Lidar Technologies, Techniques, and Measurements for Atmospheric Remote Sensing XI

Upendra N. Singh
Doina Nicoleta Nicolae
Editors

21–22 September 2015
Toulouse, France

Sponsored by
SPIE

Cooperating Organisations
European Association of Remote Sensing Companies (Belgium)
European Optical Society
CENSIS—Innovation Centre for Sensor & Imaging Systems (United Kingdom)
EARSeL—European Association of Remote Sensing Laboratories
Optitec (France)
Route des Lasers (France)

Published by
SPIE

Volume 9645

Proceedings of SPIE 0277-786X, V. 9645

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 XI,
edited by Upendra N. Singh, Doina Nicoleta Nicolae, Proc. of SPIE Vol. 9645, 964501
© 2015 SPIE · CCC code: 0277-786X/15/\$18 · doi: 10.1117/12.2228152

Proc. of SPIE Vol. 9645 964501-1

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 SPIEDigitalLibrary.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 XI*, edited by Upendra N. Singh, Doina Nicoleta Nicolae, Proceedings of SPIE Vol. 9645 (SPIE, Bellingham, WA, 2015) Six-digit Article CID Number.

ISSN: 0277-786X

ISSN: 1996-756X (electronic)

ISBN: 9781628418552

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

Copyright © 2015, 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. 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/15/\$18.00.

Printed in the United States of America.

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



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 six-digit CID article numbering system structured as follows:

- The first four 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	Authors
vii	Conference Committee

SESSION 1 NEW DEVELOPMENTS IN LIDAR TECHNOLOGY I

- 9645 02 **Double-pulsed 2- μ m lidar validation for atmospheric CO₂ measurements (Invited Paper)** [9645-1]
- 9645 03 **Atmospheric CO₂ remote sensing system based on high brightness semiconductor lasers and single photon counting detection** [9645-2]
- 9645 04 **Advanced intensity-modulation continuous-wave lidar techniques for ASCENDS CO₂ column measurements** [9645-3]

SESSION 2 NEW DEVELOPMENTS IN LIDAR TECHNOLOGY II

- 9645 07 **Multispecies transmitter for DIAL sensing of atmospheric water vapour, methane and carbon dioxide in the 2 μ m region** [9645-6]
- 9645 08 **Langley Mobile Ozone Lidar (LMOL) results from the Denver, CO DISCOVER-AQ campaign** [9645-8]

SESSION 3 NEW DEVELOPMENTS IN LIDAR TECHNOLOGY III

- 9645 0B **Long range wind lidars based on novel high spectral brilliance all-fibered sources** [9645-12]
- 9645 0C **CW Lidar for wind sensing featuring numerical range scanning and strong inherent suppression of disturbing reflections** [9645-13]
- 9645 0E **ALART: a novel lidar system for vegetation height retrieval from space** [9645-15]

SESSION 4 LIDAR APPLICATIONS TO REGIONAL AND GLOBAL ISSUES I

- 9645 0F **Detecting the planetary boundary layer height from low-level jet with Doppler lidar measurements (Best Student Paper Award)** [9645-17]
- 9645 0G **Use of lidar water vapor retrieval for assessment of model capability to simulate water vapor profiles** [9645-18]
- 9645 0H **A comparison and evaluation between ICESat/GLAS altimetry and mean sea level in Thailand** [9645-19]

SESSION 5 LIDAR APPLICATIONS TO REGIONAL AND GLOBAL ISSUES II

- 9645 0K **Spatial mapping of greenhouse gases using laser absorption spectrometers at local scales of interest** [9645-22]
- 9645 0L **Aerosol classification study by lidar** [9645-23]
- 9645 0M **One-year monitoring of the atmosphere over Penang Island using a ground-based lidar** [9645-24]

POSTER SESSION

- 9645 0N **Aerosol cloud interaction: a multiplatform-scenario-based methodology** [9645-16]
- 9645 0Q **DIAL measurements of the vertical ozone distribution at the Siberian lidar station** [9645-27]
- 9645 0R **A portable imaging lidar for lower boundary layer atmospheric measurement** [9645-29]
- 9645 0U **A robust optical parametric oscillator and receiver telescope for differential absorption lidar of greenhouse gases** [9645-7]

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.

- | | |
|---------------------------------|-----------------------------|
| Adamiec, Paweł, 03 | Landulfo, Eduardo, 0F, 0N |
| Ai, Xiao, 03 | Lefebvre, Michel, 07 |
| Alados-Arboledas, Lucas, 0N | Le Gouët, J., 0B |
| Augère, B., 0B | Lim, Hwee San, 0M |
| Baldasano, J. M., 0G | Lin, Bing, 04 |
| Banks, R. F., 0G | Liu, Xiaoqin, 0R |
| Barbero, Juan, 03 | Lolli, Simone, 0M |
| Besson, C., 0B | Lombard, L., 0B |
| Binietoglou, I., 0G | Lopes, Fabio J.S., 0N |
| Blume, Nathan, 0K | Lussana, R., 0E |
| Botos, Chris, 0K | Mammmez, Dominique, 07 |
| Bourdon, P., 0B | Marques, T. A. M., 0F |
| Braun, Michael, 0K | Matjafri, Mohd Zubir, 0M |
| Brinkmeyer, Ernst, 0C | Meadows, Byron, 04 |
| Burlakov, V. D., 0Q | Melkonian, Jean-Michel, 07 |
| Cadiou, Erwan, 07 | Moncrieff, John B., 0U |
| Campbell, Joel F., 04 | Moreira, A. C. de C. A., 0F |
| Canat, G., 0B | Nakaema, W., 0F |
| Cao, Nianwen, 0L | Naksen, Didsaphan, 0H |
| Carrión, William, 08 | Nehrir, Amin R., 04 |
| Conticello, S., 0E | Nevzorov, A. A., 0Q |
| de A. Moreira, G., 0F | Nevzorov, A. V., 0Q |
| De Young, Russell, 08 | Obland, Michael D., 04 |
| Dherbecourt, Jean-Baptiste, 07 | Papayannis, A., 0G |
| Dobler, Jeremy, 0K | Pelon, Jacques, 07 |
| Dolfi-Bouteyre, A., 0B | Pérez-Serrano, Antonio, 03 |
| Dolgii, S. I., 0Q | Pernini, Timothy G., 0K |
| Durécu, A., 0B | Petros, Mulugeta, 02 |
| Ehret, Gerhard, 03 | Pfeiffer, N., 0E |
| Entner, T., 0E | Planchat, C., 0B |
| Esposito, M., 0E | Pliutau, Denis, 08 |
| Esquivias, Ignacio, 03 | Qin, Laiyan, 0R |
| Faugeron, Mickael, 03 | Quatrevallet, Mathieu, 03 |
| Foglia Manzillo, P., 0E | Rae, Cameron F., 0U |
| Ganoe, Rene, 08 | Rarity, John G., 03 |
| Godard, Antoine, 07 | Raybaut, Myriam, 07 |
| Gorju, Guillaume, 07 | Refaat, Tamer F., 02 |
| Goular, D., 0B | Remus, Ruben G., 02 |
| Guerrero-Rascado, Juan Luis, 0N | Renard, W., 0B |
| Harrison, F. Wallace, 04 | Robinson, Iain, 0U |
| Hee, Wan Shen, 0M | Romanovskii, O. A., 0Q |
| Hou, Zaihong, 0R | Roncat, A., 0E |
| Jack, James W., 0U | Singh, Upendra N., 02 |
| Kharchenko, O. V., 0Q | Tamborini, D., 0E |
| Khor, Wei Ying, 0M | Tosi, A., 0E |
| Kochem, Gerd, 03 | Traub, Martin, 03 |
| Krakowski, Michel, 03 | Valla, M., 0B |
| Labzovskii, Lev, 0G | van Dijk, C. N., 0E |
| Lampridis, D., 0E | van Dijk, Frédéric, 03 |

Vilera, Maria Fernanda, 03
Villa, F., 0E
Weng, Ningquan, 0R
Yang, Dongkai, 0H
Yu, Jirong, 02
Zaccheo, T. Scott, 0K
Zappa, F., 0E

Conference Committee

Symposium Chair

Charles R. Bostater, Florida Institute of Technology, Marine-Environmental Optics Laboratory and Remote Sensing Center
(United States)

Symposium Co-chair

Klaus Schäfer, Karlsruher Institut für Technologie, Institute of Meteorology and Climate Research (Germany)

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. Papayannnis, 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. Tseremes, European Space Agency (Netherlands)
Ulla Wandinger, Leibniz Institut für Troposphärenforschung (Germany)
Jirong Yu, NASA Langley Research Center (United States)

Session Chairs

- 1 New Developments in Lidar Technology I
Upendra N. Singh, NASA Langley Research Center (United States)
- 2 New Developments in Lidar Technology II
Upendra N. Singh, NASA Langley Research Center (United States)
- 3 New Developments in Lidar Technology III
Upendra N. Singh, NASA Langley Research Center (United States)
- 4 Lidar Applications to Regional and Global Issues I
Doina Nicoleta Nicolae, National Institute of Research and Development for Optoelectronics (Romania)
- 5 Lidar Applications to Regional and Global Issues II
Doina Nicoleta Nicolae, National Institute of Research and Development for Optoelectronics (Romania)