

PROCEEDINGS OF SPIE

Lidar Remote Sensing for Environmental Monitoring IX

Upendra N. Singh
Kazuhiro Asai
Achuthan Jayaraman
Editors

18–20 November 2008
Noumea, New Caledonia

Cosponsored by

Gouvernement de la Nouvelle-Calédonie (New Caledonia) • IRD—Institut de Recherche pour le Développement (France) • SPC—Secretariat of the Pacific Community • ISRO—Indian Space Research Organization (India) • NASA—National Aeronautics and Space Administration (United States) • Scripps Institution of Oceanography, University of California, San Diego (United States) • Secretariat Permanent pour le Pacifique, République Française (France) • JAXA—Japan Aerospace Exploration Agency (Japan) • NiCT—National Institute of Information and Communications Technology (Japan) • NOAA—National Oceanic and Atmospheric Administration (United States)

Cooperating Organizations

CCG—International Ocean Colour Coordinating Group • IFREMER—Institut Français de Recherche pour l'Exploitation de la Mer (France) • Université de la Nouvelle-Calédonie (New Caledonia) • SOPAC—Pacific Islands Applied Geoscience Commission

Published by
SPIE

Volume 7153

Proceedings of SPIE, 0277-786X, v. 7153

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

The papers included 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. The papers published in these proceedings 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 this book:

Author(s), "Title of Paper," in *Lidar Remote Sensing for Environmental Monitoring IX*, edited by Upendra N. Singh, Kazuhiro Asai, Achuthan Jayaraman, Proceedings of SPIE Vol. 7153 (SPIE, Bellingham, WA, 2008) Article CID Number.

ISSN 0277-786X
ISBN 9780819473950

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 © 2008, 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/08/\$18.00.

Printed in the United States of America.

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

The logo for SPIE Digital Library features the word "SPIE" in a bold, sans-serif font above the words "Digital Library" in a smaller, lighter font. To the right of the text is a stylized graphic consisting of three vertical bars of increasing height, resembling a bar chart or a signal waveform.

SPIDigitalLibrary.org

Paper Numbering: Proceedings of SPIE follow an e-First publication model, with papers published first online and then in print and on CD-ROM. Papers are published as they are submitted and meet publication criteria. A unique, consistent, permanent citation identifier (CID) number is assigned to each article at the time of the first publication. Utilization of CIDs allows articles to be fully citable as soon they are published online, and connects the same identifier to all online, print, and electronic versions of the publication. SPIE uses a six-digit CID article numbering system in which:

- 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. The complete citation is used on the first page, and an abbreviated version on subsequent pages. Numbers in the index correspond to the last two digits of the six-digit CID number.

Contents

- vii *Conference Committee*
ix *Symposium Committees*

LASER TECHNOLOGIES AND APPLICATIONS

- 7153 07 **Remote Raman spectroscopy of minerals at elevated temperature relevant to Venus exploration (Invited Paper)** [7153-07]
S. K. Sharma, A. K. Misra, Univ. of Hawaii (United States); U. N. Singh, NASA Langley Research Ctr. (United States)
- 7153 08 **Engineered laser materials for remote sensing applications** [7153-08]
B. M. Walsh, N. P. Barnes, U. N. Singh, NASA Langley Research Ctr. (United States)
- 7153 09 **The selection of Q-switch for a 350mJ air-borne 2µm wind lidar** [7153-09]
M. Petros, Science and Technology Corp. (United States); J. Yu, B. Trieu, NASA Langley Research Ctr. (United States); Y. Bai, Science Applications International Corp. (United States); P. Petzar, National Institute of Aerospace (United States); U. N. Singh, NASA Langley Research Ctr. (United States)

LIDAR OBSERVATIONS AND INTERCOMPARISONS I

- 7153 0A **Lidar network observations of tropospheric aerosols (Invited Paper)** [7153-10]
N. Sugimoto, I. Matsui, A. Shimizu, T. Nishizawa, Y. Hara, C. Xie, National Institute for Environmental Studies (Japan); I. Uno, K. Yumimoto, Kyushu Univ. (Japan); Z. Wang, Institute of Atmospheric Physics (China); S.-C. Yoon, Seoul National Univ. (Korea, Republic of)
- 7153 0B **Fundamental measurement by in-line typed high-precision polarization lidar** [7153-11]
T. Shiina, M. Miyamoto, Chiba Univ. (Japan); D. Umaki, K. Noguchi, Chiba Institute of Technology (Japan); T. Fukuchi, Central Research Institute of Electric Power Industry (Japan)
- 7153 0C **Toward low-cost water-vapour differential absorption lidar** [7153-12]
M. Hamilton, The Univ. of Adelaide (Australia); R. Atkinson, Bureau of Meteorology (Australia); A. Dinovitsner, E. Peters, R. A. Vincent, The Univ. of Adelaide (Australia)

DIAL CONCEPTS FOR CO₂ OBSERVATIONS

- 7153 0J **Conductive-cooled 2micron laser for CO₂ and wind observations (Invited Paper)** [7153-19]
K. Mizutani, T. Itabe, S. Ishii, T. Aoki, National Institute of Information and Communications Technology (Japan); K. Asai, A. Sato, Tohoku Institute of Technology (Japan); H. Fukuoka, Hamamatsu Photonics K.K. (Japan); T. Ishikawa, Nippon Aleph Co. (Japan)

- 7153 0L **Development of 1.6 micron CW modulation ground-based DIAL system for CO₂ monitoring** [7153-21]
S. Kameyama, M. Imaki, Y. Hirano, S. Ueno, Mitsubishi Electric Corp. (Japan); S. Kawakami, M. Nakajima, Japan Aerospace Exploration Agency (Japan)

SPACE-BASED LIDAR FOR GLOBAL OBSERVATIONS

- 7153 0O **CALIPSO observations of volcanic aerosol in the stratosphere** [7153-24]
L. W. Thomason, M. C. Pitts, NASA Langley Research Ctr. (United States)

GROUND-BASED AEROSOLS AND CLOUDS MEASUREMENTS

- 7153 0V **Design and development of micro pulse lidar for cloud and aerosol studies** [7153-31]
P. K. Dubey, B. C. Arya, Y. N. Ahammed, A. Kumar, P. S. Kulkarni, S. L. Jain, National Physical Lab. (India)
- 7153 0W **On deriving the accurate aerosol extinction profiles in the troposphere and lower stratosphere using the range dependent scattering ratio** [7153-32]
M. Satyanarayana, Kerala Univ. (India) and Vikram Sarabhai Space Ctr. (India); S. R. Radhakrishnan, V. P. Mahadevanpillai, V. Krishnakumar, Kerala Univ. (India)
- 7153 0X **Monitoring low-level cloud activity using boundary layer lidar, AWS, and radiosonde data over Chennai** [7153-33]
V. S. Murty, M. Bhattacharjee, Indian Institute of Technology Madras (India)
- 7153 0Y **Microphysical parameters of cirrus clouds using lidar at a tropical station, Gadanki, Tirupati (13.5° N, 79.2° E), India** [7153-34]
M. Satyanarayana, Univ. of Kerala (India) and Vikram Sarabhai Space Ctr. (India); S. Radhakrishnan, V. Krishnakumar, V. P. Mahadevan Pillai, Univ. of Kerala (India); K. Raghunath, National Atmospheric Research Lab. (India)

INTERACTIVE POSTER SESSION

- 7153 0Z **Design of a back-illuminated, crystallographically etched, silicon-on-sapphire avalanche photodiode with monolithically integrated microlens, for dual-mode passive & active imaging arrays** [7153-35]
A. G. Stern, D. C. Cole, Boston Univ. (United States)
- 7153 10 **Automatic gain control for Raman lidar signals** [7153-36]
A. Lay-Ekuakille, G. Vendramin, Univ. of Salento (Italy); A. Trotta, Polytechnic of Bari (Italy)
- 7153 12 **Statistic study of effect of the sea surface temperature caused by typhoon based on remote sensing** [7153-38]
D. Fu, South China Sea Institute of Oceanology (China), Guangdong Ocean Univ. (China), and State Oceanic Administration (China); D. Pan, Y. Ding, H. Huang, State Oceanic Administration (China)

- 7153 14 **Influence of inland aerosol loading on the monsoon over Indian subcontinent** [7153-41]
M. Satyanarayana, V. Krishnakumar, V. P. Mahadevan Pillai, S. R. Radhakrishnan, Univ. of Kerala (India); K. Raghunath, National Atmospheric Research Lab. (India)
- 7153 15 **Q-switch operation of thulium and holmium-doped YAG ceramic laser at room temperature** [7153-42]
Y. Urata, Megaopto Co., Ltd. (Japan); M. Yumoto, Tokyo Univ. of Science (Japan) and RIKEN (Japan); O. Louchev, Megaopto Co., Ltd. (Japan); S. Wada, Tokyo Univ. of Science (Japan) and RIKEN (Japan)
- 7153 16 **Development of a high-energy, quasi-three-level Nd:YVO₄ laser at 914 nm for deep-blue light generation** [7153-43]
A. Sato, Y. Nitsuma, T. Terasaki, K. Asai, Tohoku Institute of Technology (Japan); S. Ishii, K. Mizutani, T. Itabe, National Institute of Information and Communications Technology (Japan)

Author Index

Conference Committee

Conference Chairs

Upendra N. Singh, NASA Langley Research Center (United States)
Kazuhiro Asai, Tohoku Institute of Technology (Japan)
Achuthan Jayaraman, National Atmospheric Research Laboratory
(India)

Program Committee

Robert L. Byer, Stanford University (United States)
Timothy J. Carrig, Lockheed Martin Coherent Technologies
(United States)
Pierre H. Flamant, Ecole Polytechnique (France)
Takashi Fujii, Central Research Institute of Electric Power Industry
(Japan)
Tetsuo Fukuchi, Central Research Institute of Electric Power Industry
(Japan)
Yoshihito Hirano, Mitsubishi Electric Corporation (Japan)
Yongxiang Hu, NASA Langley Research Center (United States)
Syed Ismail, NASA Langley Research Center (United States)
Toshikazu Itabe, National Institute of Information and Communications
Technology (Japan)
Sohan L. Jain, National Physical Laboratory (India)
Philippe L. Keckhut, Service d'aeronomie (France)
Takao Kobayashi, University of Fukui (Japan)
Hiroaki Kuze, Chiba University (Japan)
Shyam Lal, Physical Research Laboratory (India)
M. Patrick McCormick, Hampton University (United States)
Thomas J. McGee, NASA Goddard Space Flight Center (United States)
Kohei Mizutani, National Institute of Information and Communications
Technology (Japan)
Toshiyuki Murayama, Consultant (Japan)
Tomohiro Nagai, Meteorological Research Institute (Japan)
Chikao Nagasawa, Tokyo Metropolitan University (Japan)
Masakatsu Nakajima, Japan Aerospace Exploration Agency (Japan)
Takuji Nakamura, Kyoto University (Japan)
Yasunori Saito, Shinshu University (Japan)
Shiv K. Sharma, University of Hawai'i at Manoa (United States)
Takashi Shibata, Nagoya University (Japan)
Tatsuo Shiina, Chiba University (Japan)
Randhir K. Sinha, L. S. College (India)
Nobuo Sugimoto, National Institute for Environmental Studies (Japan)

Thomas D. Wilkerson, Space Dynamics Laboratory (United States)

Session Chairs

- 1 Keynote Session
Kazuhiro Asai, Tohoku Institute of Technology (Japan)
Robert L. Byer, Stanford University (United States)
- 2 Coherent Wind Lidar Technology Advancement
Kazuhiro Asai, Tohoku Institute of Technology (Japan)
Robert L. Byer, Stanford University (United States)
- 3 Laser Technologies and Applications
Upendra N. Singh, NASA Langley Research Center (United States)
Pierre H. Flamant, Ecole Polytechnique (France)
- 4 Lidar Observations and Intercomparisons I
Philippe L. Keckhut, Center National de la Recherche Scientifique (France)
- 5 Lidar Observations and Intercomparisons II
Kohei Mizutani, National Institute of Information and Communications Technology (Japan)
Toshikazu Itabe, National Institute of Information and Communications Technology (Japan)
- 6 DIAL Concepts for CO₂ Observations
George J. Komar, NASA Goddard Space Flight Center (United States)
Thomas J. McGee, NASA Goddard Space Flight Center (United States)
- 7 Space-based Lidar for Global Observations
Nobuo Sugimoto, National Institute for Environmental Studies (Japan)
- 8 Ground-based Aerosols and Clouds Measurements
Nobuo Sugimoto, National Institute for Environmental Studies (Japan)
Upendra N. Singh, NASA Langley Research Center (United States)

Symposium Committees

Symposium General Chairs

Upendra N. Singh, NASA Langley Research Center (United States)
Robert J. Frouin, Scripps Institution of Oceanography, University of California, San Diego (United States)
Frederic Guillard, Government of New Caledonia (New Caledonia)

Symposium General Cochairs

Hiroshi Kumagai, National Institute of Information and Communications Technology (Japan)
A. S. Kiran Kumar, Indian Space Research Organisation (India)
Delu Pan, State Oceanic Administration (China)

Symposium Honorary Chairs

Michael Freilich, NASA Headquarters (United States)
Mary Ellen Kicza, NOAA—National Oceanic and Atmospheric Administration (United States)
Fabrice Colin, Institut de Recherche pour le Développement (New Caledonia)
Yasushi Horikawa, Japan Aerospace Exploration Agency (Japan)
G. Madhavan Nair, Indian Space Research Organisation (India)
Shuguang Wang, Chinese Society of Oceanography (China)

Symposium Honorary Cochairs

Jimmie Rodgers, Secretariat of the Pacific Communities
Lionel Loubersac, Institut Français de Recherche pour L'Exploitation de la Mer (New Caledonia)
Jean-Claude Angue, French Ministry of Research and Technology (New Caledonia)

Symposium Technical Program Chairs

William L. Smith, Hampton University (United States)
Morgan Mangeas, Université de la Nouvelle-Calédonie (New Caledonia)
Kohei Mizutani, National Institute of Information and Communications Technology (Japan)
Vaddadi Jayaraman, Indian Space Research Organisation (India)
Chuqun Chen, South China Sea Institute of Oceanology (China)

Symposium Steering Committee

Chair: **Upendra Singh**, NASA Langley Research Center (United States)
Cochair: **George J. Komar**, NASA Goddard Space Flight Center (United States)

Kazuhiro Asai, Tohoku Institute of Technology (Japan)
Robert Frouin, Scripps Institution of Oceanography, University of California,
San Diego (United States)
Frederic Guillard, Government of New Caledonia (New Caledonia)
Toshikazu Itabe, National Institute of Information and Communications
Technology (Japan)
Achuthan Jayaraman, Physical Research Laboratory (India)
Jack A. Kaye, NASA Headquarters (United States)
A. S. Kiran Kumar, Indian Space Research Organisation (India)
Stephen A. Mango, NOAA National Polar-orbiting Operational
Environmental Satellite System (United States)
Takashi Moriyama, Japan Aerospace Exploration Agency (Japan)
Delu Pan, State Oceanic Administration (China)
Stephen P. Sandford, NASA Langley Research Center (United States)
Jinxue Wang, Raytheon Company (United States)

Symposium International Organizing Committee

Yu-Hwan Ahn, Korea Ocean Research and Development Institute
(Republic of Korea)
Jinyu Cheng, Chinese Society of Oceanography (China)
Adarsh Deepak, Science and Technology Corporation (United States)
Franco Einaudi, NASA Goddard Space Flight Center (United States)
Wolf Forstreuter, Pacific Islands Applied Geoscience Commission
Ramesh Kakar, NASA Headquarters (United States)
Yves Lafoy, Regional Cooperation Department of New Caledonia (New
Caledonia)
Mervyn J. Lynch, Curtin University of Technology (Australia)
Shailesh R. Nayak, Indian Space Research Organisation (India)
Haruhisa Shimoda, Japan Aerospace Exploration Agency (Japan)
Lelia B. Vann, NASA Langley Research Center (United States)
Yoshifumi Yasuoka, The University of Tokyo (Japan)
James R. Yoder, Woods Hole Oceanographic Institution (United States)

Local Organizing Committee

Yann-Eric Boyeau, Government of New Caledonia (New Caledonia)
Damien Buisson, Government of New Caledonia (New Caledonia)
Marc Despinoy, Institut de Recherche pour le Développement (New
Caledonia)
Morgan Mangeas, Université de la Nouvelle-Calédonie (New Caledonia)