PROCEEDINGS OF SPIE

High-Performance Computing in Remote Sensing

Bormin Huang
Antonio J. Plaza
Editors

19–20 September 2011
Prague, Czech Republic

Sponsored by
SPIE

Cooperating Organisations
EOS— European Optical Society
Remote Sensing and Photogrammetry Society (United Kingdom)

Published by
SPIE

Volume 8183

Proceedings of SPIE, 0277-786X, v. 8183

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 *High-Performance Computing in Remote Sensing*, edited by Bormin Huang, Antonio J. Plaza, Proceedings of SPIE Vol. 8183 (SPIE, Bellingham, WA, 2011) Article CID Number.

ISSN 0277-786X
ISBN 9780819488107

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

Printed in the United States of America.

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

SPIEDigitalLibrary.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 as 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

Conference Committee

Symposium Chair

Karin Stein, Fraunhofer-Institut für Optronik, Systemtechnik und Bildauswertung (Germany)

Symposium Cochair

Charles R. Bostater, Florida Institute of Technology (United States)

Conference Chairs

Bormin Huang, University of Wisconsin-Madison (United States)
Antonio J. Plaza, Universidad de Extremadura (Spain)

Programme Committee

Philip E. Ardanuy, Raytheon Intelligence & Information Systems (United States)
Chein-I Chang, University of Maryland, Baltimore County (United States)
Yang-Lang Chang, National Taipei University of Technology (Taiwan)
David J. Crain, ITT Communications Systems (United States)
Qian Du, Mississippi State University (United States)
Yong Fang, Northwest A&F University (China)
Samuel D. Gasster, The Aerospace Corporation (United States)
Mitchell D. Goldberg, National Environmental Satellite, Data, and Information Service (United States)
Mingyi He, Northwestern Polytechnical University (China)
Allen H.-L. Huang, University of Wisconsin-Madison (United States)
Roger L. King, Mississippi State University (United States)
Chulhee Lee, Yonsei University (Korea, Republic of)
Tsengdar J. Lee, NASA Headquarters (United States)
Yunsong Li, Xidian University (China)
Sebastián López Suárez, Universidad de Las Palmas de Gran Canaria (Spain)
Enrico Magli, Politecnico di Torino (Italy)
Jarno S. Mielikainen, University of Eastern Finland (Finland)
Abel Paz, Universidad de Extremadura (Spain)
John J. Pereira, National Environmental Satellite, Data, and Information Service (United States)
Jordi Portell de Mora, Institut d'Estudis Espacials de Catalunya (Spain)
Jeffery J. Puschell, Raytheon Space & Airborne Systems (United States)
Shen-En Qian, Canadian Space Agency (Canada)

Stefan A. Robila, Montclair State University (United States)
Roger W. Saunders, Met Office (United Kingdom)
Joan Serra-Sagrista, Universitat Autònoma de Barcelona (Spain)
Yuliya Tarabalka, University of Iceland (Iceland)
Carole Thiebaut, Centre National d'Études Spatiales (France)
Miguel Velez-Reyes, Universidad de Puerto Rico Mayagüez (United States)
Raffaele Vitulli, European Space Research and Technology Centre (Netherlands)
Shih-Chieh Wei, Tamkang University (Taiwan)
Jiaji Wu, Xidian University (China)

Session Chairs

1 HPC for Remote Sensing and Astronomical Data Processing
Antonio J. Plaza, Universidad de Extremadura (Spain)

2 HPC for Remote Sensing Data Compression
Bormin Huang, University of Wisconsin-Madison (United States)

3 HPC for Hyper- and Multispectral Remote Sensing I
Jarno S. Mielikainen, University of Eastern Finland (Finland)

4 HPC for Hyper- and Multispectral Remote Sensing II
Yang-Lang Chang, National Taipei University of Technology (Taiwan)

5 GPU Processing of Remote Sensing Data
Antonio J. Plaza, Universidad de Extremadura (Spain)

6 Applications of HPC in Remote Sensing
Bormin Huang, University of Wisconsin-Madison (United States)

The Evolution of Airborne Chemical and Radiological Remote Sensing For Emergency and Natural Disaster Response

Summary of the September 19, 2011 SPIE Remote Sensing Plenary Session Presentation by
Paul E. Lewis
National Geospatial-Intelligence Agency, United States of America

First responders, joint operations centers, and recovery and remediation personnel consider timely and affordable airborne chemical, radiological, imagery analysis, and related mapping products essential in the formulation of a complete understanding of an incident and its potential impact on adjacent communities, and for recovery and remediation. Airborne remote sensing provides the flexibility to produce incident specific products and conduct over-flights at the frequencies needed to provide timely and relevant information for recovery and remediation operations, optimization of resources during an event, and for the safety of emergency response personnel.

The utility of airborne chemical remote sensing became apparent to the EPA during a chemical plant explosion, which occurred in Sioux City, Iowa in December of 1994. The facility produced ammonium nitrate fertilizer, and also produced its own ammonia for use in the process. In late December an explosion occurred rupturing the main storage tank and spilling three million gallons of ammonia. This resulted in lethal vapor levels in and around the plant and created a plume of ammonia vapors estimated to be 35 miles long. Approximately 3,500 people were evacuated over a 50 square mile area. The EPA sent in vehicles with ground sampling crews dressed in Level A hazmat suits with 30 minute air packs to monitor the site. Due to heavy snow coverage on the ground and saturated soil conditions underneath the snow, all of the EPA vehicles became stuck. Ground sampling crews had to be rescued before air supplies ran out. Consequently, no monitoring of vapor levels was accomplished.

The lessons learned from responding to the chemical explosion in Sioux City, Iowa in 1994 prompted the EPA to begin evaluating the application of airborne remote sensing infrared and gamma ray spectroscopy for emergency responses involving chemical and radiological incidents. Concurrently, with the evaluation process to determine the performance and feasibility of implementing infrared and gamma ray spectroscopy in an airborne platform came the evolution of a set of core requirements for an airborne operational capability: Standoff chemical and gamma ray detection and identification with low false alarm rates; High resolution ortho-rectified day-night imagery; Airborne data collection under cloud ceilings; Rapid dispatch-wheels up in under one hour after activation; Automated data processing –real or near-real-time chemical data analysis; Direct integration of data and information to local incident commanders-local and federal joint operations centers; Data telemetry to and from the aircraft.

According to the EPA, in the United States there are approximately 123 facilities where a release of chemicals could threaten more than one million people. There are approximately 750 additional facilities where a chemical release could threaten more than a hundred thousand people.

In 2001, the EPA implemented the United States only civilian operational airborne chemical detection and identification capability called the **A**irborne **S**pectral **P**hotometric **E**nvironmental **C**ollection **T**echnology (**ASPECT**) Program. Subsequently in 2003, the EPA and NGA agreed to collaborate in a cooperative research and development program focused on evolving the capabilities of the ASPECT Program to produce near-real-time state of the art chemical, radiological and imagery mapping emergency response products.

Airborne Spectral Photometric Environmental Collection Technology (ASPECT) Program
The United States Only Airborne
24/7 Operational CIVIL Emergency Response Chemical, Radiological, & Imaging Mapping Capability

The ASPECT model of operation combines an airborne operational remote sensing suite with a research and development support team to insure that analysis and products are validated and verified scientifically and are reviewed and checked before release. The research and development support team collaboration between the EPA and NGA to evolve the capabilities of the ASPECT Program has resulted in the following significant accomplishments: Near-real-time automated onboard chemical detection and identification of 78 chemical compounds with low false alarm rates; Near-real-time information on plume direction and concentrations; Automated software producing day/night ortho-rectified imagery rapid response maps; Automated software producing gamma ray survey information maps onboard the aircraft; Data and information telemetry to and from the aircraft facilitating turn-around times and seamless integration of vital situational awareness information from the aircraft to first responders or joint operation centers in 5 to 15 minutes.

Since 2001 the ASPECT Program has provided essential information during 115 emergency, disaster, and homeland security related incidents ranging from chemical plant explosions and train derailments to fires, floods, hurricanes, and special events. The ASPECT Program played key roles in providing essential information to first responders and joint operations centers in response to the following historical events: The Shuttle Columbia break up during re-entry over Texas in February of 2003; Hurricane Katrina in August of 2005; The Deepwater Horizon Oil Spill disaster in the Gulf of Mexico from April-August 2010.

Over the past decade in over 115 responses, the ASPECT program has demonstrated the utility of having timely, cost-effective operational airborne chemical and radiological remote sensing information integrated seamlessly into to the local, state and federal emergency response and disaster recovery and remediation communities. What is needed next is the implementation of multiple aircraft strategically located throughout the United States so that ASPECT capabilities can be on the scene of a disaster or event in less than three hours.