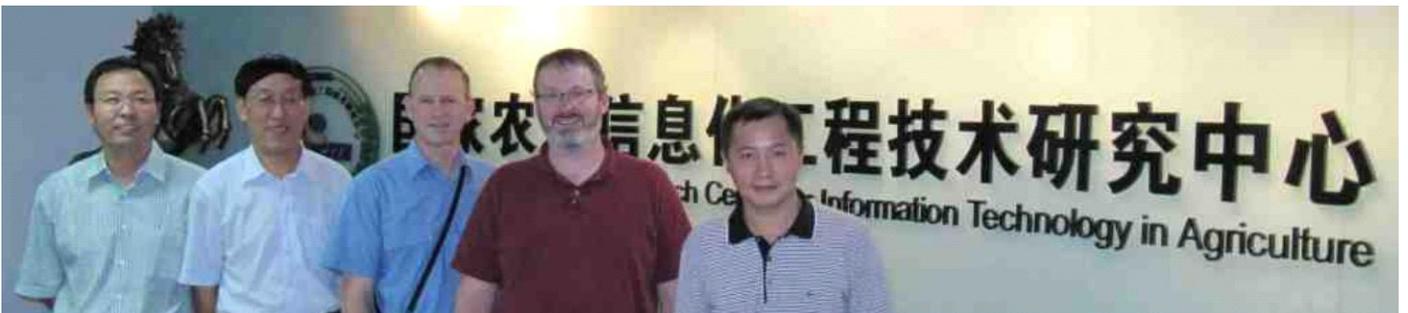
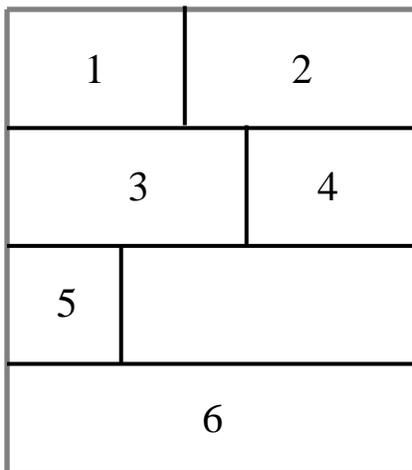


# 2010 Annual R&D Report

## Remote Sensing Group





1. The far-infrared beam-line at the Canadian Light Source, Saskatoon, Saskatchewan.
2. Participants at the 20<sup>th</sup> International Conference on Spectral Line Shapes, St. John's, Newfoundland.
3. BRDF field work over barley in Fairfield, Alberta using the unique University of Lethbridge goniometer system.
4. The University of Lethbridge goniometer system at work near an irrigation system in Fairfield, Alberta.
5. Dr. Karl Staenz, recipient of the 2010 Gold Medal award from the Canadian Remote Sensing Society.
6. International cooperation at the National Engineering Research Centre for Information Technology in Agriculture (NERCITA), Beijing, China. Left to right: Dr. Zhijie Wang (University of Lethbridge), Dr. Jihua Wang (NERCITA), Dr. Phil Teillet (University of Lethbridge), Dr. Craig Coburn (University of Lethbridge), and Dr. Wenjiang Huang (NERCITA).

### ***Report Editor***

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## Remote Sensing Group

### *Faculty*

Craig Coburn, Department of Geography  
Derek Peddle, Department of Geography  
Adriana Predoi-Cross, Department of Physics and Astronomy  
Karl Staenz, Department of Geography  
Phil Teillet, Department of Physics and Astronomy

### *Adjunct Professors*

Department of Physics and Astronomy:  
Brant Billinghamurst, Canadian Light Source, Saskatoon, Saskatchewan  
Dionisio Bermejo, Instituto de Estructura de la Materia, Madrid, Spain  
Per Jensen, University of Wuppertal, Wuppertal, Germany  
Nadia Rochdi, Alberta Terrestrial Imaging Corporation, Lethbridge, Alberta  
Department of Geography:  
Ron Hall, Canadian Forest Service, Edmonton, Alberta  
Anne Smith, Agriculture and Agri-Food Canada, Lethbridge, Alberta

### *Post-Doctoral Fellows*

Zhijie Wang, Department of Physics and Astronomy

### *Research Assistants*

Xiaomeng Ren, Department of Physics and Astronomy

### *Graduate Students*

Ashley Bracken, Department of Geography, AMETHYST Award Student  
Subir Chowdhury, Department of Geography  
Cathy Kloppenburg, Department of Geography  
Amr Ibrahim, Department of Physics and Astronomy  
Deep Mazumdar, Department of Geography  
Aaron Mullin, Department of Geography  
Steve Myshak, Department of Geography, AMETHYST Award Student  
Kean O'Shea, Department of Geography  
Ilia Parshakov, Department of Geography, AMETHYST Award Student  
Chad Povey, Department of Physics and Astronomy, AMETHYST Award Student  
Logan Pryor, Department of Geography, AMETHYST Award Student  
Gairik Roy, Department of Physics and Astronomy  
Hoimonti Rozario, Department of Physics and Astronomy, AMETHYST Award Student  
Shiyong Xu, Department of Geography, AMETHYST Award Student

### *Undergraduate Research Assistants*

Josh Sorell, Department of Physics and Astronomy  
Jonathan Vos, Department of Physics and Astronomy

### *Administrative Support*

Trevor Armstrong, AMETHYST Program Coordinator, University of Lethbridge  
Dana Andrei, Alberta Water and Environmental Science Building, University of Lethbridge  
Margaret Cook and Charlene Sawatsky, Department of Geography, University of Lethbridge  
Sheila Matson and Laurie Scott, Department of Physics and Astronomy, University of Lethbridge

## Overview

### *Introduction*

The Remote Sensing Group (RSG) at the University of Lethbridge (UL) is composed primarily of faculty, students and other researchers from the Department of Geography and the Department of Physics and Astronomy, Faculty of Arts and Science. The RSG also collaborates with imaging scientists at the UL in the fields of neuro-imaging, image processing/computer science, kinesiology, and astronomy.

### *Primary Research Areas*

- Analysis of atmospheric trace gases
- Atmospheric correction of satellite image data
- Autonomous systems in support of post-launch satellite sensor calibration
- Bidirectional reflectance properties of Earth surfaces
- Development of remote sensing applications in agriculture, rangeland, forestry, mountainous terrain, oil sands, water resources, etc
- Hyperspectral imaging / imaging spectroscopy
- Image classification, texture analysis, and spectral mixture analysis
- Image processing and analysis methodologies
- Investigations of molecular structures
- Remote sensing laboratory and field analyses
- Remote sensing instrumentation (field/airborne/atmospheric sensors)
- Sensor radiometric calibration
- Vegetation canopy reflectance modeling and inversion

### *NSERC CREATE AMETHYST Program*

The University of Lethbridge received a prestigious NSERC Collaborative Research and Training Experience (CREATE) grant for an Advanced Methods, Education and Training in Hyperspectral Science and Technology (AMETHYST) Program. The AMETHYST Program will provide excellent support for research training over a six year period (2011-2016). It is designed to expose students to the broader context of imaging science and technology, with research foci in remote sensing methodologies, resource and environmental monitoring, greenhouse gas studies, and neuro-imaging. Student internships are offered at the undergraduate and graduate levels, including research placements in academic laboratories, government agencies and industry settings. In addition to periodic and ongoing research and training events, AMETHYST features two types of workshops. The annual multi-day Workshop on Hyperspectral Imaging Science and Technology (summer) provides an intensive interdisciplinary research training experience. The annual single-day Workshop on Career Development and Workforce Preparation (winter) offers trainees a unique and diverse training experience, allowing them to acquire a full scope of individual and team-oriented professional skills that are highly valued and optimized for today's job market. Both workshops are open to participants from across Canada and internationally. More information is available on the AMETHYST web site: <http://www.uleth.ca/fas/amethyst/>.



### ***Remote Sensing Gold Medal Award***

Dr. Karl Staenz, University of Lethbridge Professor of Geography and Remote Sensing Group Member, was awarded the prestigious Gold Medal from the Canadian Remote Sensing Society (CRSS) in 2010. This award recognizes a significant long-term contribution to the field of remote sensing in Canada and is the highest award in the country granted by the CRSS for Excellence in Remote Sensing. Staenz' research has long been focused on spectral sensing, including the process of image data preprocessing, information extraction for various applications, and building intelligent image processing and monitoring systems. He worked at the Canada Centre for Remote Sensing, a branch of Natural Resources Canada, in Ottawa for over 20 years before joining the University of Lethbridge in 2006. The Gold Medal was awarded to Staenz in June 2010 at the 31st Canadian Symposium on Remote Sensing – the Prairie Summit – in Regina, Saskatchewan.

### ***Multi-Disciplinary Major in Remote Sensing***

The University of Lethbridge has initiated a new Multi-Disciplinary Major in Remote Sensing, combining the strengths of the university's Department of Geography and Department of Physics and Astronomy. The program is designed to prepare B.Sc. graduates for a broad spectrum of job opportunities as well as graduate education and research.

### ***Major R&D Funding Sources***

Agriculture and Food Council of Alberta  
Alberta Ingenuity New Faculty Award  
Canadian Foundation for Innovation Infrastructure Operating  
Natural Sciences and Engineering Research Council of Canada Grants: Discovery, Strategic, CREATE  
University of Lethbridge Faculty of Arts and Science

### ***Laboratories***

The ***Remote Sensing Laboratory*** in the Alberta Water and Environmental Sciences Building (AWESB) consolidates various elements of UL remote sensing research. It is the home base for the UL goniometer systems, a variety of laboratory and field-deployable sensors and experimental target systems, 3-D structural measurement devices, and other specialised field equipment.

The ***Remote Sensing Calibration Spectrometry Laboratory*** is a highly specialized yet critical facility unique to Canada. The laboratory carries out spectroradiometric calibration of instrumentation used to support a variety of Earth and environmental science studies.

The ***Atmospheric Spectroscopy Laboratory*** in University Hall undertakes laboratory spectroscopy of terrestrial and planetary atmospheric molecules. The main instrument is a three-channel home-made laser spectrometer, tuneable from 1.48 to 3.8 micrometers. A variable-temperature single-pass absorption gas cell was designed and built in-house for the spectroscopic study of gases. This setup enables highly sensitive line shape studies and fundamental spectroscopic studies of molecular interactions. Tuneable diode laser absorption spectroscopy has also been used to develop an instrument capable of high-accuracy measurements of greenhouse gases such as N<sub>2</sub>O, CO<sub>2</sub>, and CH<sub>4</sub>. The field-portable instrument can be deployed in remote locations and used to measure greenhouse gas concentrations in real time.

### ***Instrumentation***

- AERONET/AEROCAN node Cimel CE-318 autonomous Sun-tracking photometer
- Airborne Multispectral Camera System
- ASD spectrometers (3): ASD FieldSpec 3, ASD FieldSpec 3 Hi-Res, and ASD FieldSpec Pro
- ASD mercury argon calibration source assembly ALZSOLO
- ASD RTS-3ZC Reflectance/Transmittance Integrating Sphere
- HEMI digital hemispherical photography system
- LAI-2000 plant canopy analyzer system
- Pulnix AccuPiXEL cameras (6)
- Science mode Cimel CE-318 autonomous Sun-tracking photometer
- SVC HR-1024 field spectrometer
- SWIR imaging spectrometer: Specim VN25E / MCT camera / Specim mirror scanner
- TRAC (Tracing Radiation and Architecture of Canopies) system
- Trimble TSCL and ProXRS DGPS receivers
- VNIR imaging spectrometers (2): Specim V10E / Hamamatsu C8484 / Specim mirror scanner
- Yankee Environmental Systems SPUV sun photometer

### ***Field Goniometer System***

The UL Goniometer System version 2 (ULGS-2) apparatus has a unique design that incorporates a number of advancements over other goniometers for measuring bi-directional reflectance data that are used to support remote sensing analyses. It is the most advanced field goniometer system in the world. The ULGS 2 uses a quarter circle positioning arc with a 2-m radius and no part of the apparatus touches the ground in the target area. This new design reduces the weight of the apparatus, increases portability, allows positioning over a wider variety of surfaces, and facilitates significantly faster data acquisition. ULGS-2 incorporates a computer-controlled motor-driven instrument payload that rapidly samples target bidirectional reflectance distribution functions.

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### **Edited Volumes**

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### **Conference Proceedings Publications**

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Povey, C., A. Predoi-Cross, J. Sorell, and A. Chatelet. 2010. Line shape study of R-branch transitions in the  $\nu_1+\nu_2+\nu_4+\nu_5$  band of acetylene over a range of temperatures. *Proceedings of the 20th International Conference on Spectral Line Shapes*, St. John's, Newfoundland, American Institute of Physics, 1290: 189-194.

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Wang, Z., C.A. Coburn, X. Ren, D.D. Mazumdar, S. Myshak, A. Mullin, and P.M. Teillet. 2010. Assessment of soil surface BRDF using an imaging spectrometer. *Proceedings of SPIE Remote Sensing Conference on Sensors, Systems, and Next-Generation Satellites*, Toulouse, France, pp?

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### **External Reports**

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Moruzzi, G., R.J. Murphy, R.M. Lees, A. Predoi-Cross, and B. Billingham. 2010. High-Resolution FIR Spectra of the O-17 Isotopologue of Methanol for Astrophysical Applications, *2009 CLS Activity Report*, pp. 76-77.

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## 2010 Professional Activities, University of Lethbridge Remote Sensing Group

### *Conferences, Workshops and Specialist Meetings*

- 2010 IEEE International Geoscience and Remote Sensing Symposium, Honolulu, Hawaii, USA
- 2010 National Forest Pest Management Forum, Ottawa, Ontario
- 20th International Conference on Spectral Line Shapes, St. John's, Newfoundland
- 22nd Colloquium on High-Resolution Molecular Spectroscopy, Poznan, Poland
- 31<sup>st</sup> Canadian Symposium on Remote Sensing, Regina, Saskatchewan
- 4<sup>th</sup> Annual University of Lethbridge GSA Conference, Lethbridge, Alberta
- Annual Users Meeting, Canadian Light Source, Saskatoon, Alberta
- Prairies Universities Seminar Series, Saskatoon and Regina, Saskatchewan
- Workshop on Infrared Visible Optical Sensors (IVOS), Working Group on Calibration and Validation (WGCV), Committee on Earth Observation Satellites (CEOS), European Commission Joint Research Centre, Ispra, Italy

### *Service Activities and Memberships*

- Alberta Geomatics Group
- American Society of Agronomy
- American Society of Photogrammetry and Remote Sensing
- Canadian Association of Geographers
- Canadian Association of Physicists
- Canadian Institute of Forestry, Rocky Mountain Section Council member, Program and Membership Committees
- Canadian Remote Sensing Society
- Canadian Society of Agronomy
- Co-chair, IEEE International Spaceborne Imaging Spectroscopy (ISIS) Working Group
- Co-Editor, *Proceedings of the 20th International Conference on Spectral Line Shapes*, American Institute of Physics
- College of Alberta Professional Foresters
- Director of Communications, Regional Councilor for Alberta, Nunavut and Northwest Territories provinces and Co-Chair of the Committee to Encourage Women in Physics, Canadian Association of Physicists
- Editorial Board, *Canadian Journal of Forest Research*
- Editorial Board, *Canadian Journal of Remote Sensing*
- Editorial Board, *Remote Sensing of Environment*
- Editorial Board, *The Forestry Chronicle*
- Editors, *Proceedings of the 30th Canadian Symposium on Remote Sensing*, Canadian Remote Sensing Society
- Environmental Mapping and Analysis Program Scientific Advisory Committee (EnSAG) for a spaceborne hyperspectral mission, German Aerospace Centre, Germany
- Guest Editor, Special Issue: Terrestrial Reference Standard Test Sites for Post-Launch Calibration, *Canadian Journal of Remote Sensing*
- Guest Editors, Special Issue: 30th Canadian Symposium on Remote Sensing, *Canadian Journal of Remote Sensing*

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- IEEE Geoscience and Remote Sensing Society
- Past-Chair, Canadian Remote Sensing Society
- Remote Sensing Science Review Panel, Belgian Remote Sensing Program, Brussels, Belgium.
- Scientific Advisory Committee (SAC), Tecterra, Canadian Networks of Centres of Excellence (NCE) and Alberta Innovates – Technology Futures
- Society of Range Management.
- Subgroup on Infrared-Visible Optical Sensors (IVOS), Committee on Earth Observation Satellites (CEOS) Working Group on Calibration and Validation
- Technical Program Committee, 2010 Congress of the Canadian Association of Physicists (CAP), Toronto, Ontario
- Technical Program Committee, 20th International Conference on Spectral Line Shapes, St. John's, Newfoundland
- Technical Program Reviewer, 2010 IEEE International Geoscience and Remote Sensing Symposium, Honolulu, Hawai'i, USA
- Vice-Chair, Canadian Remote Sensing Society

### *Courses Taught*

- Introduction to Geography, Geography 1000
- Introduction to Geographical Information Science, Geography 2735
- Cartography, Geography 3700
- Remote Sensing, Geography 3720
- Advanced Remote Sensing, Geography 4725/5725
- Spatial Modelling, Geography 4751
- Seminar in Remote Sensing, Geography 4753/5753
- Advanced Spatial Modelling and Geography, Geography 5751
- Research Methods in Geography, Geography 5850

