J01: Satellite Remote Sensing for Earth Science Applications

Conveners: Alexander Braun[1], and Bernhard Rabus[2]

Co-chairs: Alexander Braun[1], and Bernhard Rabus[2]

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Session Description

Satellite remote sensing enables monitoring of the solid Earth, the hydrosphere, oceans and atmosphere. Modern satellite missions achieve spatial resolutions as low as 25 cm and temporal resolutions of one day. This allows for studying Earth system processes with unprecedented spatio-temporal resolution. Contemporary sensors achieve sensitivity levels which rival airborne surveys. In addition, contemporary satellite missions equipped with diverse sensors enable data fusion and more integrated analyses. We invite contributions, which employ satellite remote sensing observations from MICROWAVE SENSORS: scatterometry, altimetry, Synthetic Aperture Radar (SAR) including interferometric, polarimetric, or tomographic; OPTICAL SENSORS: LiDAR, multispectral, thermal, radiometric; as well as GEOPHYSICAL SENSORS: gravity, magnetic. The focus lies on the application of such observations towards an improved understanding of the targeted Earth system and its changes over time. The session is intended to bring together scientists from any of the CGU and CSAFM sections and create a truly interdisciplinary exchange. Contributions, which demonstrate how observations from comparable (constellations) or complementary sensors can be fused and applied to understand multi-scale Earth system processes, are of particular relevance. Those applications range from land cover and forestry, oceanography and hydrology, including sea ice and glaciers, through natural hazard and environmental assessment to natural resources and engineering problems.

Primary Affiliation: Joint CGU/CSAFM

NOTE: THIS DOCUMENT CONTAINS INFORMATION FOR ALL SESSION SUB-SECTIONS. PRESENTER ABSTRACTS ARE FOUND AT THE END OF THE DOCUMENT.

SCHEDULE MAY BE SUBJECT TO CHANGE.

ORAL SESSION J01a

Chairs: A. Braun & B. Rabus **Room: ESB 1012**

Monday, May 29th

TIME	AUTHORS	TITLE
14:00	Malek Singer, Stephan Gruber, Murray Richardson[2]	Digital surface modelling with Terrestrial Laser Scanning and UAV-based photogrammetry: a comparison of approaches under different terrain and vegetation conditions
14:15	K. Kornelsen, B. Davison, M. Cosh & P. Coulibaly	A Bias Correction Approach for Downscaling Passive Microwave and Soil Moisture Data for Modelling Applications
14:30	Jayson Eppler, Bernhard Rabus[1] and Manuele Pichierri	Multi-Sensor InSAR Constrained Modeling of the Fels Glacier Slide
14:45	K. Irwin, A. Braun & G. Fotopoulos	Comparing Quad-Pol RADARSAT-2 and Single-Pol TerraSAR-X Data for Surface Water Monitoring

POSTER SESSION J01

Chairs: B. Amiro & S. Nolan **Room: ESB Atrium**

Wednesday, May 31st

Poster No.	AUTHORS	TITLE
P01-J01	J. Murfitt, A. Robinson & L. Brown	Canadian Lake Depth Inventory using Landsat 8 OLI/TIRS

SUBMITTED ABSTRACTS

J01-01: Digital surface modelling with Terrestrial Laser Scanning and UAV-based photogrammetry: a comparison of approaches under different terrain and vegetation conditions

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Abstract
The rapid advancement of UAV-based photogrammetric surveying methods is revolutionizing the way topographic data are collected. Despite the growth of UAV photogrammetry, there is a critical need for a rigorous test of how these techniques perform compared to other conventional methods including RTK GPS and terrestrial laser scanning. This presentation will highlight recent research focused on mapping surface topography in heterogeneous northern environments using cutting-edge survey methods and software. In particular, results from surveys of tussock and peat covered sites, as well as active and abandoned highways will be discussed. The relative accuracies and characteristics of the different survey results (SfM photogrammetry vs terrestrial laser scanning) will be presented along with a discussion of the quality and distortion of the surface models due to vegetative cover. Finally, challenges associated with ground control point (GCP) distribution, surveying of linear areas, and validation against total station survey points will be discussed. The results are those from an applied research project inspecting ground surface deformities in Yellowknife, NWT.

Presentation type: Oral Presentation

J01-02: A Bias Correction Approach for Downscaling Passive Microwave and Soil Moisture Data for Modelling Applications

Kurt C. Kornelsen[1*], Bruce Davison[2], Michael H. Cosh[3], and Paulin Coulibaly[1, 4]

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Abstract
Soil moisture has been identified as a key geophysical state variable and its assimilation into models has been shown to enhance numerical weather prediction, streamflow forecasts, and agricultural and water resource management. The assimilation of data from passive microwave remote sensing can present a scaling challenge as hydrological processes occur at a scale that is finer than the >25km resolution of passive microwave sensors. Exploiting the temporal stability of soil moisture and brightness temperature (TB) will was demonstrated as a viable and computationally efficient approach for downscaling TB and soil moisture retrievals within the framework of a data assimilation application. The temporal stability of soil moisture has been well demonstrated in the literature and analysis of data from two USDA-ARS watersheds and the MESH hydrological land-surface scheme coupled to the Community Microwave Emissions Model (CMEM) demonstrates that vegetation has a generally positive influence on the temporal stability of TB. Temporal stability of soil moisture and TB allows the relationship between the high resolution soil moisture state and that of the radiometer scale state to be represented by a relatively simple relationship, where differences can be largely explained by the unconditional biases typically corrected prior to data assimilation. Application of a bias correction operator was found to reduce the difference between the large and small scale soil moisture to $0.03 m^3 m^{-3}$ and reduce TB differences by 36-75% in the two USDA-ARS watersheds. Applying a similar method to actual SMOS data in comparison to the MESH-CMEM model was found to produce grid scale (~800 m) soil moisture and TB that had comparable performance to SMOS data at radiometer resolution (~43 km). [268 words]

Presentation type: Oral Presentation

J01-03: Multi-Sensor InSAR Constrained Modeling of the Fels Glacier Slide

Jayson Eppler[1*], Bernhard Rabus[1] and Manuele Pichierri[1]

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Abstract
The Fels Glacier slide is a large deep-seated gravitational slope deformation located near the intersection of the Alaska pipeline corridor and the Denali fault. The M7.9 Denali earthquake in 2002 has raised questions about pre and post-quake dynamics, geo-physical and meteorological drivers, and the criticality of the identified instable slopes whose potential catastrophic failure would threaten pipeline integrity. We have obtained a large multi-sensor SAR imagery dataset (ERS, RADARSAT-1, RADARSAT-2 and TerraSAR-X) over the site spanning the period of 1991 to 2016 which allows for a comprehensive InSAR based analysis of historic and recent activity. The slope deformation is comprised spatially of several differentially moving nested lobes that produce large displacement gradients and discontinuities. This combined with seasonal effects leads to severe spatial aliasing and poor coherence even in the shortest temporal repeat interferograms, which in the past has prevented meaningful phase unwrapping and quantitative retrieval of the displacement information for the Fels Glacier Slide. We overcome these issues through a novel adaptive demodulation technique that uses recently acquired high resolution TerraSAR-X staring spotlight data to facilitate the unwrapping of previous lower resolution and longer time difference interferograms from ERS, and RADARSAT-1 and RADARSAT-2. The historical trends of measured motion field discontinuities are presented and correlated with potential slope deformation drivers.

Presentation type: Oral Presentation

J01-04: Comparing Quad-Pol RADARSAT-2 and Single-Pol TerraSAR-X Data for Surface Water Monitoring

Katherine Irwin[1*], Alexander Braun[1], and Georgia Fotopoulos[1]

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Abstract
The identification of surface water extent and changes are critical for understanding the potential for flooding hazards. Currently, infrequent helicopter and ground-based field investigations are used to monitor flooding and undermining hazards posed to nearby infrastructure. In this study, a space-based monitoring technique is developed and tested using Synthetic Aperture Radar (SAR). Previous studies demonstrate that single polarization SAR data is a viable technology for analysing surface water extent and its spatio-temporal change. However, due to the limitations of single-polarization SAR data, flooded vegetation and ice can lead to misclassification. Full-polarization SAR data assists in providing more information in order to discriminate between different backscattering mechanisms and thus different land cover types. The data for this study was collected from November 2016 to February 2017 over the Queen's University Biological Station (QUBS) located north of Kingston, Ontario. Five TerraSAR-X single polarization (HH) staring spotlight mode scenes were processed using grey-level thresholding to classify areas of water and non-water. Five RADARSAT-2 full polarization fine beam mode scenes, with similar acquisition dates, were also processed using polarimetric decomposition methods and classified, representing non-water, water, ice and flooded vegetation. A pixel-based analysis compares single-polarization and full-polarization surface water models over time. Finally, optical imagery was used to validate the changes in surface water extent seen in the aforementioned models. The results from this study aid in developing a SAR-based acquisition plan for monitoring surface water and flooding hazards. [233 words]

Presentation type: Oral Presentation

P01-J01: Canadian Lake Depth Inventory using Landsat 8 OLI/TIRS

Justin Murfitt[1], Alexis Robinson[1]*, Laura Brown[1]

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Abstract
Lakes are a dominant feature in the Canadian landscape, with over 2 million lakes estimated in Canada (over 31,000 are 3km^2 or larger). Determination of location, size, and depth of lakes is important for research in climate, lake ice, and hydrologic modelling, however, lake depth is largely unreported throughout Canada. Previous studies have either focused on a limited number of specific lakes using remote sensing techniques or used topography based methodologies; while global-scale lake inventories have been created by utilizing, numerical modelling, maps of geologic origin and high resolution satellite imagery / landcover maps. The extensive spatial coverage now available from Landsat 8 OLI/TIRS imagery provides an opportunity to assess the utility of lake depths derived from remote sensing data, with a particular focus on hydrologic applications (e.g. lake ice modelling where lake depth is currently a limiting unknown). Approximately 700 Landsat 8 OLI/TIRS images were collected between May to October for 2013 and 2016. A water mask was created using a near-infrared band to identify all bodies of water within Canada that can be resolved at 30m. To determine lake depth the SPEAR© relative water depth algorithm in ENVI © was used. SPEAR© uses a log ratio transform to determine water depth, followed by a 3x3 median filter in order to remove noise caused during creation of the product. An accuracy assessment of the derived depths was determined through limited in-situ measurements of lake level and bathymetry. The results provide a digital dataset of the approximate lake depths for all resolved lakes within Canada.
[255 words]

Presentation type: Poster