Elements

Volume 25, Number 2 July 2007

THE NEWSLETTER OF THE CANADIAN GEOPHYSICAL UNION

IN THIS ISSUE

LE BULLETIN DE L'UNION GÉOPHYSIQUE CANADIENNE

President's Column

It is with great excitement and anticipation that I write you as the new President of the Canadian Geophysical Union, as these are auspicious times for the Union. First, I would like to thank Gary Jarvis for his dedication and leadership as President of the CGU for the past two years. Gary will be a tough act to follow! He presided over two very successful CGU annual meetings with skill and grace. The first, our joint meeting with the Canadian Society for Soil Science in Banff, 2006 and the second, the multifaceted meeting with the Canadian Meteorological and Oceanographic Society (CMOS), American Meteorological Society (AMS) and the Eastern Snow Conference (ESC) in St. John's this year. While both meetings may be gauged great successes due to his energy, vision and commitment, this second meeting in particular advanced the dream of the unified Canadian geophysical sciences meeting in one location and providing a critical mass of strong science. Gary arranged that we will hold our next annual meeting jointly with the Canadian Geomorphology Research Group in Banff, in the new and classy venue of the Banff Park Lodge. This should give us greater flexibility than we have had recently at the Banff Centre and with superb meeting rooms adjacent to each other should provide for an efficient and effective meeting. Gary has also driven four important initiatives for CGU that are important for the next few years:

i) CGU sponsorship of the Canadian National Committee for the International Union of Geodesy and Geophysics (CNC-IUGG) by providing funds to support representative travel to a CNC-IUGG meeting in Canada,

ii) arranging the support of the National Research Council for the invitation of the International Association of Meteorology and Atmospheric Science, the International Association of the Physical Sciences of the Ocean and the IUGG Commission on Cryospheric Sciences to Canada to hold their joint scientific assembly in Montreal in 2009,

iii) arranging a joint meeting of the CGU, American Geophysical Union, Geological Association of Canada and Mineralogical Association of Canada in Toronto in 2009, and

iv) a joint meeting of the CGU and CMOS executives resulting in the proposal for the Canadian Societies for the Geophysical Sciences (CSGS) under the auspices of CNC-IUGG.

The CGU will continue to benefit from Gary's wisdom and energy as he continues as Past President on the CGU executive.

There is further rotation on the CGU executive in which we lose skilled and valued hands and gain new expertise. Jim Craven and Lawrence Martz have completed their terms as CGU Treasurer, and Hydrology Section President respectively. Their valuable inputs to the CGU will be missed and their efforts are sincerely thanked. We welcome Spiros Pagiatakis as Vice President, Kathy Young as Treasurer, Jim Buttle as Hydrology Section President. We also very warmly thank Masaki Hayashi (Secretary), Marcelo Santos (President, Geodesy Section), Philip McCausland (Chair, GAC Geophysics Division), Hugh Geiger (Chair of Student Awards and Activities and the Awards Committees), Rod Blais (Scientific Meetings Coordinator) and Ed Krebes (Newsletter Editor) for agreeing to continue their valued contribution to the CGU. The continued success of the CGU depends on the talents, time and efforts of such volunteers.

We just had a superb and wide-ranging meeting in St. John's with CMOS, AMS and ESC and I wish to thank the many people who worked so hard to make this meeting a success. Special recognition goes to CGU representatives on the Local Arrangements and Scientific Program Committees, Rod Blais (co-chair of SPC), Colin Farquharson, Jim Buttle, Kim Welford, Ken Snelgrove. We also have much to thank to Margaret-Anne Stroh who works so hard to keep our meetings organized and running smoothly. I think we are all grateful to our gracious Newfoundland hosts whether in the hotel, taxi or pub trade who dealt with the needs of a very energetic conference with great aplomb. It was particularly encouraging to see the numbers and quality of student presentations this year, which bodes well for the future of the Geophysical Sciences.

We have some upcoming developments in CGU that I alluded to above and can describe in greater detail here. The first is the proposal with CMOS for the *Canadian Societies for the Geophysical Sciences, CSGS*. The CSGS is a mechanism to link and coordinate the relevant Canadian geophysical societies in their representations to the International Union of Geodesy and Geophysics and to funding agencies, governments and Canadian society on critical Earth Science issues. This is a long held goal of many in CGU, CMOS and other societies and will help us to represent our sciences better to ourselves, to funding agencies such as NSERC and to Canadian society. In this sense, the CSGS is also a mechanism to promote the public interest and support of the Geophysical Sciences through making decision makers and the public aware of the tremendous societal benefits that accrue from a vibrant and diverse geophysical science research community in Canada. The goals of CSGS are to facilitate collaboration, and exchange amongst Canadian geophysical societies whose activities are aligned with the international associations comprising the IUGG, and to coordinate and promote a vision for the development of the Geophysical Sciences in Canada. The geophysical sciences are defined as those branches of the Earth Sciences in which the principles and practices of physics are used to study the Earth. Prominent amongst these sciences are the Atmospheric and Ocean Sciences, Hydrological Sciences, Solid Earth Sciences and Near-Earth Space Sciences. The scope of study for the Geophysical Sciences includes the lithosphere, deep Earth, cryosphere, hydrosphere, atmosphere, biosphere and near-Earth space environment, and the interactions amongst these components of the Earth. CSGS will achieve its goals by proposing joint meetings of member societies, encouraging secondary and post-secondary educational programs in the Geophysical Sciences, promoting the benefits of discoveries made in the Geophysical Sciences to the public, industry and government, *articulating a vision for the advancement of the Geophysical Sciences in Canada*, identifying and recommending the level of research support required to support geophysical science research in Canada, and making periodic recommendations to member societies through their national Executives. The first members of the CSGS are expected to be the CGU and CMOS, but other societies are welcome. To further cement this relationship CGU and CMOS have decided to meet together again, soon, in 2010, tentatively in Ottawa. We are working with CMOS to approve the terms of reference of CSGS and have discussed the initiative with the President of NSERC as a vision for revitalization of the earth science funding sector.

CGU is also updating itself, with internal developments such as formal CGU Science, Scientific Program and Local Organizing Committees for all meetings and the promotion of new areas of scientific focus. Two areas of new scientific strength were particularly evident by their sets of strong sessions at our recent annual meeting: Biogeosciences and Cryospheric Sciences. Having strength in these areas adds multidimensionality and resilience to CGU and so suggestions for greater visibility and activity within CGU by these groups of scientists are strongly encouraged.

Finally, a charge to our membership. The CGU is yours, and the Executive asks your input on how you would like the Union to develop and progress. You have an Executive that will work for your interests and is trying to adapt the CGU to the broadening base of expectations and needs of our science, and we are in turn interested in your views as to how to proceed. Do not hesitate to contact any member of the Executive with ideas, initiatives, and suggestions for how the CGU can be improved.

Yours truly,

John Pomeroy

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J. Tuzo Wilson Medal – Call for Nominations

The Executive of the CGU solicits nominations for the J. Tuzo Wilson Medal – 2008. The Union makes this award annually to recognize outstanding contributions to Canadian geophysics. Factors taken into account in the selection process include excellence in scientific and/or technological research, instrument development, industrial applications and/or teaching.

If you would like to nominate a candidate, please contact Dr. Hugh Geiger, Chair of the CGU Awards Committee, Talisman Energy, Calgary AB (Email: HGEIGER@talisman-energy.com). At a minimum, the nomination should be supported by letters of recommendation from colleagues, a brief biographical sketch and a Curriculum Vitae. Nominations should be submitted by February 28, 2008. Additional details concerning the nomination process can be obtained from the Chair of the CGU Awards Committee.

L'exécutif de l'UGC vous invite à suggérer des candidats pour la médaille J. Tuzo Wilson – 2008. L'Union décerne la médaille chaque année "en reconnaissance d'une contribution remarquable à la géophysique canadienne". En choisissant parmi les candidats, on considére les accomplissements en recherches scientifique ou technologiques, aux développements d'instruments, aux applications industrielles et/ou à l'enseignement.

Si vous désirez suggérer un candidat pour cette médaille, s.v.p. contacter Dr. Hugh Geiger, Président du Comité des Prix d'Excellence, Talisman Energy (Email: HGEIGER@talisman-energy.com). Les nominations doivent être supportées de lettres de recommandation de colléques, d'un bref sommaire biographique et d'un Curriculum Vitae. Les nominations doivent être soumises avant le 28 février, 2008. Des détails additionnels concernant le processus de nomination peuvent être obtenus en communiquant avec le Président du Comité des Prix d'Excellence de l'UGC.

Past Wilson Medallists

1978	J. Tuzo Wilson
1979	Roy O. Lindseth
1980	Larry W. Morley
1981	George D. Garland
1982	Jack A. Jacobs
1983	D. Ian Gough
1984	Ted Irving
1985	Harold O. Seigel
1986	Michael Rochester
1987	David Strangway
1988	Ernie Kanasewich
1989	Leonard S. Collett
1990	Gordon F. West
1991	Thomas Krogh
1992	R. Don Russell
1993	Alan E. Beck
1994	Michael J. Berry
1995	Charlotte Keen
1996	Petr Vaníček
1997	Chris Beaumont
1998	Ron M. Clowes
1999	David Dunlop
2000	Don Gray
2001	Roy Hyndman
2002	Doug Smylie
2003	Garry K.C. Clarke
2004	W.R. (Dick) Peltier
2005	Ted Evans
2006	Alan Jones
2007	Herb Dragert

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CGU Young Scientist Award – Call for Nominations

The Executive of the CGU solicits nominations for the CGU Young Scientist Award – 2008. The CGU Young Scientist Awards recognize outstanding research contributions by young scientists who are members of the CGU. Both the quality and impact of research are considered. To be eligible for the award, the recipient must be within 10 years of obtaining their first Ph.D. or equivalent degree. The awards are made by the CGU Executive on the recommendations of a special committee struck for this purpose. The selection committee seeks formal written nominations from the membership, plus letters of support and a current curriculum vitae. Nominations for the CGU Young Scientist Awards may be submitted by CGU members at any time.

If you would like to nominate a candidate, please contact Dr. Hugh Geiger, Chair of the CGU Awards Committee, Talisman Energy, Calgary AB (Email: HGEIGER@talisman-energy.com). The nomination should be supported by three letters of recommendation from colleagues. Nominations should be submitted by February 28, 2008. Additional details concerning the nomination process can be obtained from the Chair of the CGU Awards Committee.

L'exécutif de l'UGC vous invite à suggérer des candidats pour le prix pour Jeune Scientifique de l'UGC –

2008. Les Prix pour Jeunes Scientifiques de l'UGC reconnaissent les contributions exceptionnelles de jeunes scientifiques qui sont membres de l'UGC. La qualité et l'impact de la recherche sont considérés. Pour être éligible pour le prix, le scientifique doit avoir obtenu son premier Ph.D. ou degré équivalent au cours des dix dernières années. Les prix sont accordés par l'Exécutif de l'UGC sur recommendations d'un comité spécial à cette fin. Le comité de sélection sollicite des nominations formelles par écrit des membres de l'UGC, accompagnées de lettres d'appui et d'un curriculum vitae à jour. Des nominations pour les Prix pour Jeunes Scientifiques de l'UGC peuvent être soumis en tout temps par les membres de l'UGC.

Si vous désirez suggérer un candidat pour cette médaille, s.v.p. contacter Dr. Hugh Geiger, Président du Comité des Prix d'Excellence, Talisman Energy, Calgary AB (Email: HGEIGER@talisman-energy.com). Les nominations doivent être supportées de trois lettres de recommandation de colléques. Les nominations doivent être soumises avant le 28 février, 2008. Des détails additionnels concernant le processus de nomination peuvent être obtenus en communiquant avec le Président du Comité des Prix d'Excellence de l'UGC.

Past Winners

2005 Shawn J. Marshall, J. Michael Waddington
2006 No winner
2007 No winner

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CGU Meritorious Service Award – Call for Nominations

The Executive of the CGU solicits nominations for the CGU Meritorious Service Award – 2008. The CGU Meritorious Service Award recognizes extraordinary and unselfish contributions to the operation and management of the Canadian Geophysical Union by a member of the CGU. All members of the CGU are eligible for this award, although the award is not normally given to someone who has received another major award (e.g. the J. Tuzo Wilson Medal). Nominations for the CGU Meritorious Service Award may be submitted by CGU members at any time. The award is made by the CGU Executive based on recommendations from the CGU Awards Committee, and is based on lifetime contributions to CGU activities.

If you would like to nominate a candidate, please contact Dr. Hugh Geiger, Chair of the CGU Awards Committee, Talisman Energy, Calgary AB (Email: HGEIGER@talisman-energy.com). The nomination should be supported by three letters of recommendation from colleagues. Nominations should be submitted by February 28, 2008. Additional details concerning the nomination process can be obtained from the Chair of the CGU Awards Committee.

L'exécutif de l'UGC vous invite à suggérer des candidats pour le Prix pour Service Méritoire de l'UGC – 2008. Le Prix pour Service Méritoire de l'UGC reconnait les contributions extraordinaires et désintéressées à l'opération et à l'administration de l'Union Géophysique Canadienne par un membre de l'UGC. Tous les membres de l'UGC sont éligibles pour ce prix, sauf que normalement, ce prix n'est pas donné à quelqu'un qui a recu un autre prix important tel que la Médaille Tuzo Wilson. Des nominations pour le Prix pour Service Méritoire de l'UGC peuvent être soumises en tout temps par les membres de l'UGC. Le Prix est accordé par l'Exécutif de l'UGC sur recommendations du Comité des Prix de l'UGC, pour l'ensemble des contributions d'un membre aux activités de l'UGC.

Si vous désirez suggérer un candidat pour cette médaille, s.v.p. contacter Dr. Hugh Geiger, Président du Comité des Prix d'Excellence, Talisman Energy, Calgary AB (Email: HGEIGER@talisman-energy.com). Les nominations doivent être supportées de trois lettres de recommandation de colléques. Les nominations doivent être soumises avant le 28 février, 2008. Des détails additionnels concernant le processus de nomination peuvent être obtenus en communiquant avec le Président du Comité des Prix d'Excellence de l'UGC.

Past Winners

2004 Ron Kurtz
2005 Ted Glenn
2006 J.A. Rod Blais
2007 Ed Krebes

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CMOS-CGU-AMS Congress 2007

Rod Blais, CGU Co-Chair

Under the theme "**Air, Ocean, Earth and Ice on the Rock**", the Canadian Meteorological and Oceanographical Society (CMOS), the Canadian Geophysical Union (CGU) and the American Meteorological Society (AMS) had a joint Congress on May 28 to June 1, 2007, in St John's Newfoundland. In addition, the Eastern Snow Conference (ESC) and the Canadian Society of Agricultural and Forest Meteorology (CSAFM) joined us for the Congress. Participation was excellent with registration of over 648 regular and 266 student participants, including 117 and 70 CGU members respectively, and some 232 and 94 nonmembers. ESC had 71 participants and CSAFM had 25. The science program was very comprehensive and second to none in recent years, as can be seen from the following list of plenary talks and the wide spectrum of technical sessions in Interdisciplinary, Atmosphere, Climate, Geophysics, Hydrology, Ocean and Snow. More details on these sessions will be included on the 2007 CGU Archival CD.

The science program included eight internationally recognized Invited Plenary Speakers:

- L. Thompson: Abrupt Climate Change: Past, Present and Future
- L. Fortier: The Melting Arctic Sea-Ice: Death and Rebirth of an Ecosystem
- B. Hoskins: Weather Systems and Climate Processes
- J.P. Bruce: Extreme Events in a Changing Climate
- C.K. Shum: Role of Space Geodesy in the Quantification of 20th Century Sea Level Rise
- S. Allen: Physical Controls on Phytoplankton Biomass and Composition in the Strait of Georgia: Results from a 1-D Model
- G. Clarke: The Lake Agassiz Megaflood and 8200 BP Cold Event: Was there a Causal Link?
- M. Holland: A Seasonnally Ice Free Arctic?

Fourteen sessions were held under Interdisciplinary (I):
I01: Atmospheric and Oceanographic General Contributions
I02: A Year in the Life of the Arctic Ocean Shelf: the Canadian Arctic Shelf Exchange Study
I03: Atmosphere-Cryosphere-Solid Earth Interactions
I04: New Developments in Numerical Modelling of the Oceans and Atmosphere
I05: Coupled Environmental Prediction Systems
I07: Monitoring Earth Systems Dynamics from Space
I08: The Influence of Sea Ice Variability on the Atmosphere and Ocean
I09: Exploring the Synergy between Geodesy and Meteorology
I10: Modeling Polar Oceans and Sea Ice
I11: Hydrometeorological Prediction in Cold Regions and Seasons
I12: Drought over Canada
I13: International Polar Year Coordination
I14: Soils and Climate Change
I15: Biogeoscience

Atmosphere (A) had seven sessions:
A01: Health Issues of Weather and Climate
A02: Atmospheric Community Modelling
A03: Canadian Society of Agricultural and Forest Meteorology Technical Session
A04: Operational Meteorology
A05: Open Access to Meteorological Data
A06: Polar Clouds and Aerosols: Properties, Processes, and Climatic Significance
A07: Intensive Arctic Atmospheric Observatories

Climate (C) had four sessions:
C01: Climate Change Projection, Detection and Attribution
C02: Polar Climate Stability
C04: Climate Change and Variability in the Polar Regions
C05: High Resolution Climate Modelling

Geophysics (G) had nine sessions:
G03: Multi-scale Deformation Monitoring for Earth Science and Engineering
G04: Geomagnetism, Paleomagnetism and Rock Magnetism
G05: The North Atlantic Rifted Margin: Geophysical Processes and Constraints
G06: Understanding the Relationships between Terrestrial and Oceanographic Datums
G07: Structure and Dynamics of the Continental Mantle Lithosphere
G08: Advances in Geophysical Techniques: Theory and Applications
G09: Near-surface Geophysical Applications
G10: Seismically Unravelling the Mysteries of the Crust
G11: Geophysics for Petroleum Exploration and Production in Atlantic Canada

Hydrology (H) had six sessions:
H01: Hydrology
H02: Isotope Tracing of Water Balance and Climate Processes
H03: Watershed Experiments in BC
H04: Prediction in Ungauged Basins
H05: Ecological Flow Needs: Understanding Stream Processes and the Effects of Altered Flow Regimes on Aquatic Ecosystems
H06: Glaciers and Ice Sheets – Processes and Modelling

Ocean (O) had three sessions:
O01: Oceanography of the Northwest Atlantic
O02: Operational Oceanography
O03: Coastal Oceanography and Inland Waters

Snow (S) had five sessions:
S01: General Eastern Snow Conference Contributions
S02: Remote Sensing of Snow Cover
S03: Snowfall and Snow Cover Measurement
S04: Snow Processes: Measurements and Modelling
S05: Snow Cover and Climate

The CGU Hydrology Section was especially active with a number of Interdisciplinary and Hydrology Sessions and the sponsorship of the Eastern Snow Conference, which are reported on separately. The Geodesy Section had a few Interdisciplinary Sessions and other Sessions under Geophysics, also reported on separately. It is also worth mentioning that all these sessions were proposed by individuals in response to the Call for Session Proposals one year ago. Their cooperation with the Science Program Committee (SPC), which included Guoqi Han (CMOS), Taneil Uttal (AMS) and myself for CGU, was greatly appreciated. The CGU Reps Jim Buttle, Colin Farquharson and Ken Snelgrove are to be thanked for their numerous contributions. The Local Arrangements Committee (LAC) under the leadership of Fraser Davidson and Catherine Hogan deserves much credit for all the coordination and hard work that brought about this most successful CMOS-CGU-AMS 2007 Congress. Sincere thanks and congratulations to all!

The 2007 CGU J. Tuzo Wilson Medallist: Herb Dragert

Citation, by Joe Henton

It is my great honour to introduce the 2007 J. Tuzo Wilson medalist, Dr. Herb Dragert. Herb, through careful, meticulous, and sometimes painstaking work, has made significant contributions to the field of crustal geodynamics. Herb is recognized as Canada's leading authority on the application of geodetic techniques in the study of crustal deformation and its application to seismic hazard. Through dedication and determination he has established a comprehensive program of co-operative, multi-disciplinary, regional crustal deformation studies which has gained both national and international recognition.

Herb's work has included all aspects of crustal deformation studies: from instrument design, hardware selection and evaluation, survey design, data collection, and through to data processing and analysis, data interpretation through modelling, and research publication. Furthermore his work has also involved research in multiple techniques, including: mean-sea-level studies, tiltmeter studies, precise levelling, precise gravimetry, magneto-tellurics, laser-ranging, and ultimately GPS.

I would first like to quickly share a little bit of Herb's background. Herb Dragert was born in Veldes, Yugoslavia near the end of World War II. Investigating opportunities following the war, Herb's parents looked to immigrate from Germany where they had been relocated, to Australia, the U.S., or Canada. Canada was ultimately the first country to accept them, and thus Herb's father immigrated to Toronto. There Herb's father managed to find quickly employment with a German bakery where he saved enough money, after one just year, for the fares needed to relocate the remainder of his family. (This bakery experience helps put in perspective a common, but slightly mixed-up phrase that Herb often uses to tell me, and others, that some activity or process should be easy, that is: "piece of kuchen").

Herb was 9 years old when he arrived in Toronto following a cross-Atlantic transit on a freighter with his mother and his two brothers. Herb continued to live in the Greater Toronto area, and he eventually attended the University of Toronto, and graduated in 1968 with an Honours B.Sc. degree in Mathematics and Physics. At the U of T he received the S.H. Janes Silver Medal for top graduating student in Terrestrial Physics. I think it also is worth mentioning that Herb must have no doubt been influenced by the lectures of J. Tuzo Wilson at U of T – but I'll let Herb touch on that.

Herb then attended the University of British Columbia where his post-graduate research in Department of Geophysics & Astronomy focused on geomagnetic induction. During his studies at UBC, Herb met his future wife Linda, and they were married in 1972. He completed his M.Sc in 1970 and Ph.D in 1973. Dr. Dragert was then awarded one of two national NRC-NATO post-doctoral fellowships, and he (and Linda) moved to Göttingen Germany, where he carried out research at the Institut für Geophysik. Following his post-doc Herb returned to UBC in 1974 as a visiting Assistant Professor in the Department of Geophysics & Astronomy. In 1976 he took a position with NRCan as a research scientist located in Ottawa. He was transferred to the Pacific Geoscience Centre near Victoria, BC in the fall of 1978, where he continues to work today.

Since joining the Earth Physics Branch in 1976, Herb has been involved in crustal deformation studies on the west coast of Canada. His earliest research involved precise relative gravity measurements and levelling surveys across Vancouver Island to determine cross-margin tilting. During the 1980's, he led the work which established regional strain networks first with laser trilateration measurements and subsequently with GPS campaign measurements.

It is important to note that prior to these efforts, experts were divided on whether or not the Cascadia subduction zone was seismogenic. This was not an academic argument when one considers the relevance to nearby population centres such as Vancouver, Seattle, Portland, and Victoria. However, work by quaternary geologists such as Brian Atwater was beginning to show that the Cascadia subduction zone had indeed ruptured in the past. Meanwhile Herb's pioneering work provided the first clear demonstration that the subduction fault surface was locked with strain accumulating towards a next great earthquake. Subsequently, precise strain data were increasingly used to constrain the portion of the locked thrust-surface that would rupture in a future great earthquake.

In 1989 with the cooperation of the Geodetic Survey Division, Herb was involved with the first Canadian test of a continuous GPS tracker which was set up at the Pacific Geoscience Centre. This pioneering work led to his proposal for the establishment of the Western Canada Deformation Array (or WCDA), the first Canadian regional continuous GPS network for the study of crustal deformation, and one of the first permanent networks of its kind in the world. Dr. Dragert has since been the driving force for the expansion and improvement of the Western Canada Deformation Array which continues to be known world-wide for its high-quality data and crustal deformation monitoring capabilities.

Through this technological achievement and through continuous leading-edge refinements, he has established a revolutionary tool for investigating the geodetic signature of processes on the northern Cascadia subduction zone margin. His discovery of a totally unsuspected dynamic behaviour of the Cascadia Subduction zone is widely considered to be the most important geodetic contribution of the decade. This exciting discovery and Herb's follow-up research with colleagues has now become the focus of international research on episodic tremor and slip at convergent margins – of which many of you are no doubt now very well aware.

Now it should be noted that the first audience to glimpse a geodetic transient related to episodic tremor and slip was at a CGU meeting. However, it was in the very early days of the WCDA and GPS analyses – that is well before these very small transients could be reliably defined or mapped…

In closing, as a colleague, friend, and former graduate student of Herb, I truly feel privileged to have such a role-model and mentor. Without question, Herb is one of the leading researchers integrating geodesy and geophysics. But before the medal is presented I wish to acknowledge those that have that have offered support to Herb's nomination including Norm Beck, Yehuda Bock, Mike Craymer, Jeff Freymueller, Roy Hyndman, Calvin Klatt, Kristine Larson, Mike Lisowski, Will Prescott, Garry Rogers, Takeshi Sagiya, and Mike Schmidt. Also, I would like to thank Linda Dragert for her help – as Linda supplied much of the information on Herb's earlier years. Finally, I must acknowledge the hard work and dedication of the CGU awards committee including Hugh Geiger, Chair, and Ted Glenn, past Chair. Again, it is a truly great honour to introduce this year's J. Tuzo Wilson medalist, Dr. Herb Dragert.

Acceptance, by Herb Dragert

Mr. President, colleagues, conference attendees, and guests:

First, I must thank Joe for his extremely generous description of what I have always considered "journeyman" research, and for spending the time and effort to submit and shepherd my nomination through the CGU Awards Committee. It is no small task to garner letters of support and ensure their timely submission. I would also like to thank my colleagues who took time to submit their obviously generous appraisals that I'm sure have been mellowed and aggrandized by the passage of time.

Looking over the list of previous Wilson medalists, I am truly humbled and still somewhat confounded to be placed in the company of such outstanding Canadian Earth scientists, many of whom I've known personally, and some of whom I have had the good fortune to work with.

Of course, "In the beginning, there was Tuzo...".

As an undergraduate enrolled in the Mathematics, Physics and Chemistry program at the University of Toronto, I had only a vague concept of what my career should be. A dismal encounter with n-dimensional topology and a bland reaction to the intricacies of quantum physics rendered me fertile ground for Tuzo's lectures in global geology and his evolving ideas in crustal tectonics. "Lectures" is a misnomer - Our undergraduate sessions with Tuzo consisted of 4 or 5 students gathered in his office on St. George St. where Tuzo would enthusiastically expound on his global travels and his examination of geological evidence in far-flung locations that attested to the movement of continents. Make no mistake, the course text we were using, the first edition of Jacobs, Russell, & Wilson's "Physics and Geology", was firmly entrenched in a "fixist" framework. But Tuzo had the capacity not to be encumbered by his own previous misconceptions - he kept an open mind and revised his world view, and soon had us replicating origami transform faults and reading Thomas Kuhn's treatise on the Structure of Scientific Revolutions. Tuzo's excitement in formulating and championing this new paradigm of "Plate Tectonics" was contagious and clearly set me on the road to geophysical studies.

While still an undergraduate at the University of Toronto, I also had the good fortune to be taught by two other Wilson medal winners: George Garland and Gordon West. Armed with knowledge of potential field and electromagnetic field theory from these two remarkable teachers led me directly to repeated summer jobs in applied geophysics in the employ of Harry Seigel, another Wilson medalist. Although I did not fully appreciate it at the time, Harry demonstrated amazing confidence in sending green undergraduate geophysics students into the field as crew chiefs of survey parties. This assignment of responsibility and the expectation of success I found to be a great builder of self-confidence, and the work itself quickly turned theoretical knowledge into practical knowledge necessary for mineral exploration in remote areas. I learned to carry out induced polarization surveys in Pine Point, NWT, and how to traverse undulating blankets of muskeg with snowshoes. The following summer I carried out ground radiometric surveys at Lac de Mouches in Quebec, and discovered that the rapid shutting of a field book could visit revenge on as many as 17 black flies in a single snap. The next summer I spent in the backwoods outside of Ducktown Tennessee carrying out E-M surveys searching for extensions of copper deposits and finding yellow jackets, copperhead snakes, and working stills. Nonetheless, these field experiences convinced me that geophysics was indeed the correct career choice for me.

My next move was across the country, joining the Department of Geophysics and Astronomy at the University of British Columbia, at the time headed by Don Russell, another Wilson medalist, and home to a young and vibrant faculty which included Garry Clarke and Doug Smylie, two more Wilson award winners. Garry became my supervisor for both my MSc and PhD research and although my research topics in magnetic variation studies were developed and pursued in close cooperation with Bernard Caner of the Dominion Observatory in Victoria, I will always be grateful to Garry for the independence that he encouraged and the unceasing, up-beat support he provided throughout my post-graduate studies. Although at the completion of my MSc thesis I was tempted with the offer of a job with Harry Seigel's new subsidiary office in Australia, it was the daily engaging interactions with faculty and fellow graduate students at UBC, whether over a game of darts in the coffee room or on the slopes of Whistler, that sealed my choice and inspired me to pursue research in geophysics.

As I indicated at the outset, I have always considered myself "a jack-of-all trades, master of none" in my research. To me, the successes that I have achieved have been primarily due to fortuitous timing, technological change, and most of all, the generous help and contributions from numerous colleagues. My graduate work on geomagnetic depth sounding across the Rocky Mountain Trench led directly to my post-doctoral studies with Professor Ulrych Schmucker and his colleagues at the Institut für Geophysik in Göttingen. Curiously enough, it was my rather limited knowledge of autoregressive spectral analysis which I had absorbed from Tad Ulrych at UBC that was of great interest to this group and I was welcomed as a prophet of maximum entropy - this was a harbinger of future diversification. The opportunity to fill in for Bob Ellis while he was on sabbatical leave brought me back to UBC in September 1974 as a visiting assistant professor. Among the tasks I was given was the management of a project contracted with B.C. Hydro which monitored induced seismicity at the Mica Dam in British Columbia. Besides forcing me to understand seismic "beach ball" diagrams and forcing me to confront regression with errors in both the dependent and independent variable, this project marked my first research excursion from crustal structure into crustal dynamics, admittedly on a small scale.

This rather minor excursion turned out to be, if not pivotal, at least prophetic, for the next step in my research career. Tony Lambert, then working for the Department of Energy, Mines, and Resources in Ottawa, came to interview me for a research scientist position within the Gravity and Geodynamics Division of the Earth Physics Branch. Whether it was the fact that we had both worked with Bernard Caner, or he recognized my desperation for permanent employment - I was now almost 32 years old and had never held a permanent job - Tony recommended my hiring and I joined him in Ottawa in July 1976 to begin my career in geodynamics. Tony and I, along with Jacques Liard, soon became known as Jim Tanner's "boy scouts" as we enthusiastically developed the microgravimetry survey technique, which, using the newly introduced LaCoste & Romberg D-meter, ultimately enabled observations of relative gravity values with a routine precision of 1 or 2 microgals, a precision which made this technique useful for the study of crustal dynamics.

My next career move came in November 1978. This move was geographical and it was perhaps the most critical in that it moved me to the Pacific Geoscience Centre (PGC) on Vancouver Island, directly into the region that had become the focus of my crustal dynamics studies. More significantly, it allowed me to interact on a daily basis with an extraordinary group of individuals who offered their technical and scientific insights and their support. The scientific success I was able to achieve once at PGC benefited tremendously from collaboration with not only in-house colleagues but also colleagues at other institutions, as well as from the rapidly evolving technology that allowed increasingly accurate monitoring of the motion and the deformation of the earth’s crust.

In the early 1980's, Mike Lisowsky, on study-leave from the U.S. Geological Survey to obtain a Masters degree at UBC, introduced long-distance, precise laser ranging surveying to Canada. With Mike and a field crew from the Geodetic Survey Division (GSD) manning instruments on mountain tops, me riding shotgun on a helicopter as “MetMan” to monitor temperature, pressure, and humidity along the laser beam, and George Houston from GSD directing progress via radio from poolside at the Gold River Chalet, we managed to complete the first regional crustal strain measurements on Canada’s west coast that yielded an estimate of on-going strain rates. The mid-1980's saw the introduction of the Global Positioning System which revolutionized the way we establish positions on the surface of the Earth. To this day I still don’t know how Joe Popelar convinced management to spend $300K on two TI-4100 GPS receivers, but that acquisition marked our entry into the new world of GPS geodesy. By 1989, the vision and ingenuity of Joe Popelar and Jan Kouba manifested itself in the development of the Canadian Active Control System and the establishment of a continuous GPS tracking station at PGC.

The impact of GPS on geodynamic studies in general, and the study of west-coast contemporary tectonics in particular, cannot be overstated. In 1991, with the arrival of Mike Schmidt, the number of people in the Geodynamics Section at PGC mushroomed to two, but with Mike's expertise in surveying and his unflagging energy and dedication, and my unrelenting pestering for support funding, we managed to initiate the Western Canada Deformation Array, an automated network of continuous GPS stations whose express purpose was to monitor crustal deformation in the seismically active region of southwestern British Columbia. As it expanded over the years, this network provided fundamental data that were the underpinnings of most of my research and enabled a number of important findings, the most significant of which, and may I add, the most sleep-depriving delight, was the discovery of Episodic Tremor and Slip on the Cascadia Subduction Zone.

Measurements and data, no matter how novel, deliver information, not knowledge and understanding. These, in my case, were developed through discussions with and contributions from research colleagues at PGC. To name them all individually and give proper credit would take far too long. However, I would like to acknowledge in particular Roy Hyndman, Tony Lambert, Garry Rogers, and Kelin Wang for offering their ideas, their encouragement, and their friendship throughout the years.

Michael Ovenden, a UBC faculty member at the time of my graduate studies and a crusty astronomer with wry British wit, credited me with "an uncanny grasp of the obvious" after the defence of my thesis. Looking back over my research activities, I now find that this summary judgement may have been far too generous since I have always been, and still am, puzzled by the obvious. I am humbled by the fact that my simple pursuits have gained this remarkable recognition from the Canadian Geophysical Union. I take great joy in the people that I have worked with in the past whose unselfishness and support has led to this award, and I take great pride in the fact that I have been able to influence their work in turn. I am sincerely grateful to the Earth Physics Branch and the Geological Survey of Canada for providing the opportunities that enabled my research and shaped my career. In closing, special thanks go to my wife Linda who has endured my workaholic lifestyle and given me a loving family and all the support anyone could ever hope for. Thank you all.

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The 2007 CGU Meritorious Service Award Winner: Ed Krebes

Citation, by Masaki Hayashi

It is my great pleasure to announce the recipient of 2007 CGU Meritorious Service Award, Dr. Edward S. Krebes. Dr. Krebes, or Ed, has been a member of the CGU since 1980 and contributed greatly to the CGU in many different ways over the years. Before describing his contribution to the CGU, however, I would first like to present his brief biography. Ed was born and grew up in Edmonton, and received a B.Sc. (Hons.) in physics from the University of Alberta in 1973. He went to the University of British Columbia to earn his M.Sc. in theoretical physics, in particular general relativity and cosmology in 1974. He started his Ph.D. in astrophysics at the UBC, but later switched his program to the University of Alberta and completed his Ph.D. in theoretical geophysics, on seismic body waves in anelastic media under the supervision of Franta Hron in 1979. After a short stint as an exploration geophysicist at AMOCO Canada Petroleum Company, Ed started his academic career in Calgary as an assistant professor in 1980. He is currently a professor in the Department of Geoscience (formerly the Department of Geology and Geophysics), and also an Associate Dean of Science at the University of Calgary. Ed is internationally recognized for his theoretical and computational studies of seismic wave propagation, and of electromagnetic geophysical prospecting methods. He was an Associate Editor for the leading journal Geophysics from 1999 to 2006.

I have been fortunate to be Ed's departmental colleague over the past ten years, during which I have seen Ed as one of the most generous and unselfish contributors to the academic and scientific communities. He has been co-organizing most of the CGU Annual Meetings with Rod Blais and Patrick Wu since 1996. In particular he has been editing the CGU abstract volumes essentially all by himself, which requires a great amount of time and effort, as one can easily imagine. Since 2003, he has been serving as a member of the CGU Executive and the Editor of the CGU Newsletter, ELEMENTS. All of this volunteer work puts tremendous pressure on his already busy schedule as a professor and Associate Dean, but he always seems to put his time gladly into serving the CGU. I cannot think of any more deserving person for the CGU Meritorious Service Award, and am very happy to see Ed receive the Award.

Acceptance, by Ed Krebes

I would like to express my sincere thanks to the CGU for this award. It is truly an honour to be selected for this award, and I appreciate it greatly. I have enjoyed working with Gary Jarvis, Rod Blais, Masaki Hayashi, Hugh Geiger, Phil Marsh, and all the other members of the CGU Executive. I also want to express my thanks to Kate Bentley at the University of Calgary for all the work she does in helping to get the CGU Newsletter, Elements, published. I have also benefited greatly from the assistance of the other members of the Banff CGU Meeting Organizing Committee, namely, Rod Blais, Patrick Wu, Margaret-Anne Stroh, and all others who have contributed to the success of the Banff meetings. I am not able to be at this year's CGU meeting because of administrative committments. But I plan to be at the Banff meeting next year, and I hope to see you all there. Thank you again.

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HYDROLOGY SECTION NEWS

CGU-Hydrology Section report on the CMOS-CGU-AMS Congress held in St. John's, NL, May 28 – June 1, 2007 (prepared by Jim Buttle)

The CMOS-CGU-AMS Congress was a highly successful meeting for members of CGU-HS, who engaged in a wide range of scientific sessions, both within CGU-HS and joint-sessions with other participating societies. In addition to the main hydrology session (17 oral papers, 18 poster papers), CGU-HS sponsored five special special hydrology sessions:

1. Isotope tracing of water balance and climate processes. This session included an invited talk from Kristof Sturm (Bjerknes Centre for Climate Research University of Bergen, Norway), along with 6 oral papers.
2. Watershed experiments in BC (7 oral papers)
3. Prediction in ungauged basins. This session included an invited talk from Marc Stieglitz (School of Earth and Atmospheric Sciences, Georgia Institute of Technology, Atlanta, GA), along with 6 oral papers
4. Ecological flow needs: understanding stream processes and the effects of altered flow regimes on aquatic ecosystems (8 oral papers, 2 poster papers).
5. Glaciers and ice sheets – processes and modelling. This session included an invited talk from Cornelis van der Veen (Department of Geological Sciences, Ohio State University, Columbus, OH), along with 14 oral papers and 4 poster papers.

CGU-HS members also participated in four hydrology-related interdisciplinary sessions:

1. Atmosphere-cryosphere-solid earth interactions (8 oral papers).
2. Hydrometeorological prediction in cold regions and seasons (16 oral papers, 2 poster papers).
3. Drought over Canada (8 oral papers, 4 poster papers).
4. Biogeoscience (13 oral papers, 2 poster papers).

Eastern Snow Conference also held its annual meeting in conjunction with CGU-HS at the Congress. Five snow-related scientific sessions were held that were of mutual interest to ESC and CGU-HS members:

1. General Eastern Snow Conference contributions (8 oral papers, 2 poster papers).

2. Remote sensing of snow cover (15 oral papers, 7 poster papers).
3. Snowfall and snow cover measurement (15 oral papers, 2 poster papers).
4. Snow processes: measurements and modelling (16 oral papers, 3 poster papers).
5. Snow cover and climate (15 oral papers, 4 poster papers).

Canadian Geophysical Union Hydrology Section 2006-2007 Committee Report

Glaciers and Environment Committee

Chair: Prof. D. Scott Munro, Department of Geography, University of Toronto at Mississauga, Mississauga, ON, L5L 1C6 CANADA, smunro@eratos.erin.utoronto.ca.

Vice-Chair: Michael N. Demuth, P. Eng., Geological Survey of Canada;

Advisory Members: Prof. Sarah Boon, University of Northern British Columbia; Prof. Gwenn E. Flowers, Simon Fraser University; Dr. Roy Koerner, Geological Survey of Canada; Prof. Shawn Marshall, University of Calgary; Prof. Brian Menounos, Univ. of Northern British Columbia; Prof. John W. Pomeroy, University of Saskatchewan; Jeffrey Schmok, P. Geo., Golder Associates Ltd.; Prof. Martin J. Sharp, University of Alberta.

Mandate and Objectives

a. Assist the CGU and its executive in promoting glaciological research that is relevant to hydrological and environmental problems.
b. Provide CGU members with information about glaciological research activity, as well as identify opportunities for collaboration among individuals and groups.
c. Provide CGU members with information about the scope and extent of glaciological data, and promote efforts to improve accessibility to such data.
d. Influence research development by establishing lines of communication with other working groups in snow and ice, such as the Cryospheric System (CRYSYS) to monitor global change in Canada and identify personnel training opportunities.
e. Identify and promote opportunities for educating other members of the scientific community and the general public about glaciers and their role in the environment.

Meetings and Activities

a. Michael Demuth and Roy Koerner continue with the National Glaciology Program (NGP) in the Geological Survey of Canada (GSC), supported by Natural Resources Canada, Environment Canada and University partners, consolidating research in Arctic and Western Canada.
b. Michael Demuth, continues as Canadian Correspondent to the International Glaciological Society, and Canadian Representative to the Union Commission on Cryospheric Sciences (UCCS).
c. Michael Demuth, Roy Koerner and Shawn Marshall have appeared in Canadian Broadcasting Corporation features that deal with global warming and ice cover loss in Arctic and Western Canada.
d. Sarah Boon and Gwenn Flowers are the conveners of the 2007 CGU-HS session on glaciers and ice sheets.
e. Scott Munro is representing the UCCS on the National Organizing Committee for the joint assembly of the International Association for Meteorology and Atmospheric Sciences (IAMAS), the International Association for Physical Sciences of the Oceans (IAPSO) and the UCCS, Montreal 2009.

Progress on Issues and Objectives

The NGP work, in linkage with the Cryospheric System (CRYSYS) program of Environment Canada, has been central to the objectives of this committee, where training in partnership with universities occurred through continued development of hydrometeorological research at NGP glacier mass balance sites in Western Canada, as well as through work in the Canadian Arctic. Despite the conclusion of the CRYSYS program, prospects for NGP-university linkages look brighter than ever, now that two new cryosphere research initiatives are underway: *Improved Processes and Parameterization for Prediction in Cold Regions* (IP3; J.W. Pomeroy, P.I.) and *Western Canadian Cryospheric Network* (WC2N; R. Menounos, P.I.). This signifies expanded opportunities for interaction among cryospheric scientists in Canada. We believe that this will raise the international profile of Canadian cryospheric research and do much to train new researchers to investigate the rapidly changing cryosphere.

Future Meetings and Activities

Progress toward a collaborative Canadian glacier network, a need identified in the GSC Workshop (Ottawa, 2000) and promoted through previous CRYSYS meetings, is expected to take on new life with the advent of IP3 and WC2N. Continued participation of the Canadian glacier research community in the CGU Annual Meeting is vital in this regard, so the Committee will look forward to continued organization of CGU-HS sessions on glaciological research, as well as to being influential at other meetings that provide opportunities to communicate the research efforts of our community. The forthcoming IAMAS/IAPSO/UCCS joint assembly, the theme of which is *Our Warming Planet*, will provide an excellent opportunity to display Canadian cryospheric research findings just as the efforts of IP3 and WC2N are bearing fruit.

Other Business

The glacier inventory and the degree of change within what is still a large reservoir of land ice is a continuing matter of concern, particularly as it relates to water resource changes in Western Canada. As noted at the final CRYSYS meeting, there is an urgent need to deal with issues related to archiving and sharing of data resources, a matter that could involve the Committee at some future date but which, for now, can be explored within IP3, WC2N and the NGP.

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GEODESY SECTION NEWS

prepared by Marcelo Santos

The is a report on the activities of the Geodesy Section of the Canadian Geophysical Union during the CMOS-CGU-AMS 2007 Joint Meeting, held at the Delta Hotel and the St. John's Congress Centre, Newfoundland and Labrador, May 28th through June 1st : Meeting of the Executive, Annual General Meeting, hosting of meeting sessions, and Student Paper Competition.

A total of 5 Geodesy- related sessions were held during the CMOS-CGU-AMS 2007 Joint Meeting. They were:

I07: Monitoring Earth Systems Dynamics from Space
Convener: Alexander Braun
I09: Exploring the Synergy between Geodesy and Meteorology
Conveners: Marcelo Santos and, Susan Skone
G03: Multi-scale Deformation Monitoring for Earth Science and Engineering
Convener: Georgia Fotopoulos
G06: Understanding the Relationships between Terrestrial and Oceanographic Datums
Conveners: Jiangliang Huang, Daniel R. Roman
G08: Advances in geophysical techniques: theory and applications
Conveners: Rod Blais and John Bancroft

Two guest speakers participated in the sessions: Dr. Seth Gutmann, from NOAA, and Dr. Remko Scharroo, from Delft University.

This year’s winner of the Student Paper Award was Mr. by Mohammed Dabboor, a graduate student from the University of Calgary. His paper was entitled “Digital elevations from SRTM and ICESat: Effects of Terrain Slope and Dynamic Terrain”. The $500 prize award is sponsored by the Geodetic Survey Division of NRCan.

Other geodetic papers were recognized during the CGU Annual Meeting. Mr. Wouter van der Wal won the CGU best student paper award and Mr. Mahmoud Abd El-Gelil won the Chevron Canada Outstanding Student Paper in Seismology (Oral Presentation).

On a very important note, Dr. Herb Dragert, from PCG/GSC, and former Geodesy Section Executive, was this year’s recipient of the Tuzo Wilson Award.

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CGU 2007 Best Student Paper Award Winners

A number of awards were presented in recognition of outstanding performance in scientific research and presentation by students. Each of the awards comes with a $500 monetary prize, except for the Campbell Scientific Award, which was $1000. The awards were announced and presented at the Awards Banquet at the recent CMOS-CGU-AMS Congress in St. John’s, Newfoundland. To be considered for an award the student must be the first author and presenter of the paper. The winners are listed below, and their abstracts or extended abstracts are printed below.

The CGU component of the Organizing Committee of the Congress and the CGU Executive Committee would like to sincerely thank all the judges of the student papers for their careful evaluations of the student presentations.

CGU Best Student Paper Award (all fields of geophysics – oral presentation)

Winner: Wouter van der Wal (University of Calgary)
Secular geoid rate in North America from GRACE: methodology, accuracy and interpretation.

Runner-up: Kristen Harrison (McMaster University)
Storage and episodic release of gas in pear: effects of temperature & atmospheric pressure.

Runner-up: Julie Turgeon (McGill University)
Partitioning decomposition in Canadian forest floors into dissolved organic carbon and carbon dioxide: relevance of vegetation type and degree of decomposition.

Chevron Canada Outstanding Student Paper in Seismology (oral presentation)

Winner: Mahmoud Abd El-Gelil (York University)
On the potential of least-squares self-coherency spectrum to recover low frequency seismic normal modes: detection and splitting

Runner-up: Elizabeth L'Heureux (University of Toronto)
Influence of scattering on the seismic detection of mineral deposits in hardrock environments

Runner-up: Julie Smith (Memorial University)
Processing and interpretation of ERABLE seismic reflection data from the southeast Newfoundland rifted continental margin.

Shell Canada Outstanding Student Poster Paper

Winner: Ursule Boyer-Villemaire (Université du Québec à Rimouski)
High resolution Holocene chronostratigraphy using paleomagnetic records in the Sept-Iles area, Gulf of St. Lawrence, Eastern Canada.

Runner-up: Nicholas Kinar (University of Saskatchewan)
An automated gauge for acoustically determining snow water equivalent.

Runner-up: Mohammed Dabboor (University of Calgary)
Object-oriented classification of polarimetric E-SAR data.

D.M. Gray Award for Best Student Paper in Hydrology (oral presentation)

Winner: Kristen Harrison (McMaster University)
Storage and episodic release of gas in peat: Effects of temperature and atmospheric pressure. (Co-authors: J.M. Waddington, A.J. Baird, and E. Kellner)

Campbell Scientific Award for Best Student Poster in Hydrology

Winner: Dan Thompson (McMaster University)
Hydrologic and vascular plant controls on *Sphagnum* production in a cutover peatland . (Co-author: J.M. Waddington)

Geodesy Award for Best Student Paper in Geodetic Research & Education (oral presentation)

Winner: Mohammed Dabboor (University of Calgary)
Digital elevations from SRTM and ICESat: Effects of Terrain Slope and Dynamic Terrain.

Runner-up: Robert Kingdon (University of New Brunswick)
A forward-modeling approach to estimating effects of three-dimensional topodensity distributions on height.

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Secular geoid rate in North America from GRACE: methodology, accuracy and interpretation

W. van der Wal, E. Rangelova, M.G. Sideris, P. Wu

The improving accuracy of the geoid in Canada makes it relevant to estimate its temporal variations and assess their contribution to the future vertical datum. While terrestrial gravimetry and GPS measurements can be combined to estimate the geoid rate, here we present the results obtained solely from GRACE data. The geoid rate pattern follows the familiar shape of postglacial rebound, however, interannual and long-term variations in continental hydrology can also contribute to the estimated geoid trend. From the point of view of modernization of the vertical datum, we wish to correct for the hydrology signal as only secular changes in geoid from postglacial rebound are of interest. From the point of view of postglacial rebound studies, secular mass changes from other processes (ice melting, hydrology, tectonics) are to be removed as well.

GRACE estimates of mass changes require filtering and spatial smoothing since errors increase with decreasing wavelength. We investigate the dependence of the geoid rate on the level of smoothing and show that the rate decreases significantly with increased spatial smoothing. We also investigate the leakage signal from melting of Alaska glaciers and the Greenland ice sheet. Correcting for the hydrology long-term mass changes reduces the geoid rate peak by a few tenths of mm/yr and alters the geoid rate pattern west and southeast of Hudson Bay. In addition, we compare two techniques to estimate the secular geoid changes from GRACE, namely least squares and principal component analysis.

We conclude that GRACE gives a reliable estimate of the geoid rate in Canada after filtering and smoothing up to a wavelength of 400 km. Physical processes contribute significantly to the uncertainty of the estimated geoid rate, therefore, care must be taken in the interpretation of the pattern and error bars.

On the potential of least-squares self-coherency spectrum to recover low-frequency seismic normal modes: Detection and Splitting

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Seismic data analysis has been providing very useful information on the Earth's internal structure, particularly when combined with magnetic and gravity data. Superconducting gravimeters (SG) contribute additional knowledge on the Earth's interior through careful spectral analyses of gravity records particularly after a strong earthquake. Recent research shows that the best SGs are less noisy than seismometers for frequencies less than 1.5 mHz. The latest strong earthquakes in Peru (June 2001) and Sumatra (December 2004) with moment magnitudes Mw = 8.4 and 9.3, respectively, were sources of good quality SG data for the investigation of the gravest seismic normal modes. Detecting and measuring these mode frequencies and their damping factor can provide additional constraint to the Earth models. In addition, precise estimation of their singlets improves the Earth density profile.

In this contribution, we use SG data recorded after the Sumatra earthquake at eight Global Geodynamics Project (GGP) stations to investigate the long-period seismic modes. First, the solid Earth tide is subtracted from the data, followed by an atmospheric pressure correction based on a frequency-, and location-dependent admittance estimated by the Least-Squares response method. Subsequently, after "cleaning" all SG data records, the least-squares spectrum is used to search for seismic normal modes in the frequency band 0.278-1.500 mHz. The analysis of the data is performed in two stages: The first stage involves the analysis of each individual station record using the least-squares self-coherency analysis approach (Pagiatakis et al., 2007). In the second stage, we construct the product spectrum of all stations from the self-coherency spectra of the individual stations with the aim to identify the singlets associated with the rotational/ellipsoidal splitting of each mode. The results show clearly the excitation of the 0S2, 0S3, 0S4, 0S5 and 0S0 modes both in the self-coherency spectra (single station data) and in the product self-coherency spectrum representing all stations. The singlets of 2S1, which are very difficult to detect, are also visible in the product self-coherency spectrum.

Pagiatakis, S.D., Yin, H. and Abd El-Gelil, M. (2007). Least-squares self-coherency analysis of superconducting gravimeter records in search for the Slichter triplet. Physics of the Earth and Planetary Interiors Vol. 160, Issue 2 , Pages 108-123.

High resolution Holocene chronostratigraphy using paleomagnetic records in the Sept-Îles area, Gulf of St. Lawrence, Eastern Canada

Ursule Boyer-Villemaire[1], *Guillaume St-Onge*[2], *Patrick Lajeunesse*[3], *Jacques Locat*[4], *Gabrielle Labbé*[3], *Christelle Not*[5], *Bassam Ghaleb*[5], *Claude Hillaire-Marcel*[5]
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Recent multibeam and seismic surveys uncovered a 30-40 m-thick sedimentary sequence embedded in a 4.5 km–wide circular submarine structure in the Sept-Îles area, Gulf of St. Lawrence. The first working hypothesis is that the sedimentary sequence would have escaped glacial erosion due to its particular morphology, possibly allowing the preservation of several glacial/interglacial sequences. The second hypothesis is that sedimentation within and outside the circular structure is significantly different. In order to test these two hypotheses, box, gravity and piston cores were collected within and outside the circular structure during cruises COR0503 and COR0602 onboard the RV Coriolis II. Laboratory methods included core description, initial physical and magnetic property measurements (Multi Sensor Core Logger, CAT-Scan, color reflectance), grain size and high resolution numerical imagery. ^{210}Pb measurements in the sandy surface layer of box cores sampled inside and outside the submarine structure indicate the presence of recently deposited sediments with similar sedimentation rates. In addition, four AMS ^{14}C dates from a piston core (COR0602-047PC) taken in the thinner sequence of seismic reflectors within the submarine structure indicate that the base of the core is about 13 000 cal BP. This suggests that several glacial/interglacial sequences were not preserved in the submarine structure. These results are nonetheless valuable to infirm the second hypothesis. Indeed, based on the correlation of physical properties, sedimentation within and outside the structure appears to be alike and are composed of three main lithostratigraphic units: 1) a proximal glaciomarine unit, 2) a distal glaciomarine unit and 3) a thin modern sandy top unit. Paleomagnetic analyses are presently being performed and will allow the establishment of a precise chronostratigraphy for the area.

Storage and episodic release of gas in peat: effects of temperature & atmospheric pressure

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Recent research suggests that entrapped gas in peatlands may act as a significant storage mechanism for CH_4; however, the episodic release of these gases via ebullition has also been identified as a major pathway for CH_4 transfer to the atmosphere. We developed simple models to examine ebullition and fluctuations in entrapped gas content (*VGC*). The ebullition model initiates V_g fluctuations through production and variations in pressure and temperature; gas fluctuations that exceed an applied gas storage threshold are released via ebullition. The *VGC* model similarly uses production, temperature and pressure to generate fluctuations in V_g, however uses measured ebullition events to focus on the influence of pressure and temperature on V_g. Peat cores were incubated for 190 days in the laboratory and volumetric gas content, ebullition, temperature and atmospheric pressure were measured. Laboratory results agreed with the application of a threshold value for modelling ebullition, and given the simplicity of the model, good agreement was found between measured and *modelled* values with an r^2 of 0.66 in the final 120 days. More realistic production and bubble retention values would improve model fit. The *VGC* model also generated good agreement with measured data with an average r^2 value of 0.56 with a maximum r^2 of 0.97. Results from these models indicate that peat temperature and atmospheric pressure are dominant controls on V_g fluctuation and that there is a strong relationship between V_g fluctuation and the episodic release of gas from peat.

1. Introduction

Recent research suggests that entrapped gas in peatlands may act as a significant storage mechanism for CH_4; however, the episodic release of these gases via ebullition (bubbling) has also been identified as a major pathway for CH_4 transfer to the atmosphere (Glaser et al., 2004; Baird et al., 2004; Tokida et al., 2005). While some CH_4 models have attempted to account for biogenic gas bubble formation and movement (e.g., Granberg et al., 2001), the treatment of bubble formation, build-up, and release are likely treated too simply (Baird et al., 2004; Tokida et al., 2005). Further work is needed on the physical factors affecting bubble dynamics. Thus the aim of this work was to consider how *VGC* (volumetric gas content) and ebullition are affected by two physical factors: atmospheric pressure and temperature.

Ebullition occurs when the buoyant forces of the gas exceed the forces keeping them in place (Fechner-Levy and Hemond, 1996; Strack et al., 2005). The point at which these forces are in balance can then be called the threshold, above which ebullition will occur, and below which bubbles will remain entrapped. Observations from both field (e.g. Fechner-Levy and Hemond, 1996; Glaser et al., 2004; Strack et al., 2005) and laboratory (e.g. Reynolds et al., 1992; Tokida et al., 2005) experiments have linked periods of decreasing atmospheric pressure to ebullition events. Tokida et al. (2005) recently showed that the volume of measured ebullition during a single decline in atmospheric pressure was proportional to the increase in entrapped gas volume (V_g) due to the pressure change within a laboratory peat sample (using equation (1)). Tokida et al. (2005) however, did not explicitly model ebullition, nor did they account for volume changes due to changes in temperature or the effects of gas production within their systems. The ebullition model presented here builds off the work by Tokida et al. (2005) by explicitly examining ebullition as a temporal process (i.e. as a time series of events) and considers the effect of a threshold V_g, temperature and pressure on the release of CH_4-containing bubbles.

Relatively few studies have estimated entrapped gas volumes (e.g. Fechner-Levy and Hemond, 1996; Glaser et al., 2004) and fewer have measured *VGC* continuously (e.g. Baird et al., 2004), and then measured at relatively coarse temporal resolutions and with limited detail on the factors that affect entrapped gas dynamics. As such, the influence of temperature and atmospheric pressure on V_g at a relatively fine temporal resolution is examined with the use of a simple model. While we were not in a position to incorporate a detailed production term, its effects are considered as a steady process for the ebullition model, and as a semi-variable process in the entrapped gas model.

2. Methodology

A change in either atmospheric pressure or temperature will influence the volume of entrapped gas by (i) expansion and contraction of the gas according to the ideal gas law (IGL), and (ii) the movement of gas between the gaseous and dissolved states according to Henry's law (HL). When dealing with a single gas species, the change of V_g with pressure is given by combining the HL and IGL and differentiating with respect to pressure to obtain:

$$\frac{\partial V_g}{\partial P} = -\frac{V_g}{P} - \frac{V_w RT}{PH_d} \qquad (1)$$

where V_g is the volume of gas (m^3), V_w is the volume of water within the peat containing V_g (m^3), P is the pressure (Pa) (atmospheric pressure + pore-water pressure), R is the universal ideal gas constant (J mol^{-1} K^{-1}), T is temperature (K), and H_d is the constant of Henry's law (J mol^{-1}). Similarly, the change in V_g with temperature is obtained by combining the IGL and HL and then differentiating with respect to T (see Fechner-Levy and Hemond, 1996):

$$\frac{\partial V_g}{\partial T} = \frac{V_g}{T} + \frac{V_w RT}{H_d^2} \times \frac{\partial H_d}{\partial T} \qquad (2)$$

Temperature also affects CH_4 production, which increases with increasing temperature (Dunfield et al., 1993). Equations (1) and (2) cannot be used in their existing form to calculate changes in V_g for a mixture of gases. Solubility ($H_{d,i}$, where i is the gas species) and variations in solubility with temperature ($H_{d,i}(T)$) varies with gas species so that the proportions of the gases between the dissolved and free phases change as T or P change. To accommodate this, HL and the IGL were used separately in an iterative scheme to give changes in V_g. A linear relationship of the form $H_{d,i} = k_i T + m_i$ where k_i and m_i are parameters, is assumed.

Only CH_4 was determined from the escaped ebullition bubbles. However, for a similar type of peat, Tokida et al. (2005) found gas contents of 12% CO_2 for a 43% N_2. For the purposes of our models, we assumed 10% CO_2 and 30% N_2. These gas proportions were used at the beginning of each model time step, prior to changes generated by the iterative calculations.

We did not attempt to describe the spatio-temporal variability of gas production, but rather included basic production values to account for the addition of gas to the system. Gas production was dealt with differently for each model and is discussed in the following sections.

2.1. Ebullition Model

A constant production value based on laboratory measurements of *VGC* was added at each time step. The total calculated change in V_g (equations (1), (2) and production) for all gas constituents and compared with a threshold V_g, any volume of gas beyond the threshold was assumed lost via ebullition. The time and volume of ebullition events is compared against measured ebullition events from a laboratory experiment (see below).

2.2. Entrapped Gas Model

Unlike the ebullition model, production is allowed limited variability based on changes in temperature and to some degree, model fit. Model calculated V_g was then compared against measured values of V_g. Measured ebullition events from the laboratory experiment (see below) were applied at the appropriate time step to focus on the influence of temperature and atmospheric pressure on controlling changes in VGC.

2.3. Laboratory Experiment

Six peat cores (*c.* 10.6-L) were removed from the upper 30 cm of a Sphagnum lawn in a poor fen located near St. Charles-de-Bellechasse, QC, and incubated in the laboratory in PVC cylinders (23.5 cm depth and 24.0 cm diameter) for 190 days. Two cores (C1 and C2) were incubated at ~20°C, three cores (C3, C4 and C5) at ~11°C, and one (C6) at ~4°C. All cylinders but C2 were fitted with gas traps. C2 was left open to test the influence of the gas traps on internal gas dynamics. Porosity of the cores was between 0.80 and 0.94 and bulk density values ranged between 0.051 and 0.078 g cm^{-3}.

Each core was instrumented with two time-domain reflectometry (TDR) probes and two pore-water samplers in the upper (U) and lower (L) portions of each core. Bubble volume collected in the gas traps was measured daily or more frequently with samples taken when a sufficient volume had collected, and pore-water samples taken approximately twice weekly. Samples were analysed for CH_4 using a gas chromatograph (GC). Hourly atmospheric pressure readings were obtained from Environment Canada for a station 10 km from the laboratory. Air temperatures were measured using thermocouples, connected to a data logger.

3. Results

3.1. Laboratory Experiment

Wetting resulted in initial VGC between 2 and 9 % followed by a small decrease in VGC due to the dissolution of entrapped air, then steadily increased. The climate chamber housing C3, C4 and C5 overheated on day 78 of the experiment causing the temperature of the cores to rise to 41°C (~12 hours). The cores were cooled to ~20°C at which they were maintained for the remainder of the experiment. The result of this can be seen in the pattern of C3 in Figure 2.

Smaller fluctuations occur within the larger patterns of VGC. Average fluctuation size was similar for all cores ranging from 0.1 to 0.4 %. Maximum fluctuations were largest in C1 (20°C) with a maximum increase and decrease in VGC of 4.0 and 3.0 % respectively; maximum fluctuations were relatively similar between the 11°C and 4°C cores with values of 1.1 and 1.3 % in the increasing and decreasing directions.

Ebullition only occurred in cores incubated at 20°C (no ebullition in C6 at ~4°C). Ebullition began on day 15 for C1, with ebullition volumes based on a 10-day running mean reaching their maximum in phase with the levelling out of VGC seen in C1 (~ day 70). Ebullition began on day 79 for C3, and day 110 for C4 and C5. These cylinders did not appear to reach stable VGCs or ebullition rates during the experiment.

3.2. Modelled Ebullition

Although ebullition occurred prior to the stabilization of VGC, most ebullition occurred after stabilisation, which is consistent with the suggestion that a large proportion of ebullition occurs after having reached a threshold gas volume. The ebullition model was run only where VGC and ebullition rates had levelled out. As such, the ebullition model was only run for C1 after ~ day 70. For C1, the average gas flux rate after day 70 was 32.4 ml day^{-1} and the average CH_4 content was 57% (±16% std dev), yielding a calculated CH_4 flux of *c.* 12.3 mg day^{-1} (*c.* 270 mg CH_4 m^{-2} day^{-1}). Pore-water CH_4 concentrations for C1 increased until levelling out at approximately day 50, then varied around 12-14 mg CH_4 l^{-1}, corresponding to 50-60% CH_4 saturation; i.e. partial pressures representing 50-60 % by volume of CH_4 in bubbles (corresponding to our data).

Two threshold values of V_g were considered – 0.12 and 0.15, representing the time-average value of VGC measured in C1 after day 70. Some error is introduced by using this average as the TDR probes represent only 6% of the total core volume, and short-term variations around the time-averaged mean VGC are not accounted for by employing an average threshold. These fluctuations and the occurrence of ebullition prior to reaching the applied threshold suggest that the gas threshold for ebullition occurrence should not be considered as a single value, but rather a fuzzy threshold.

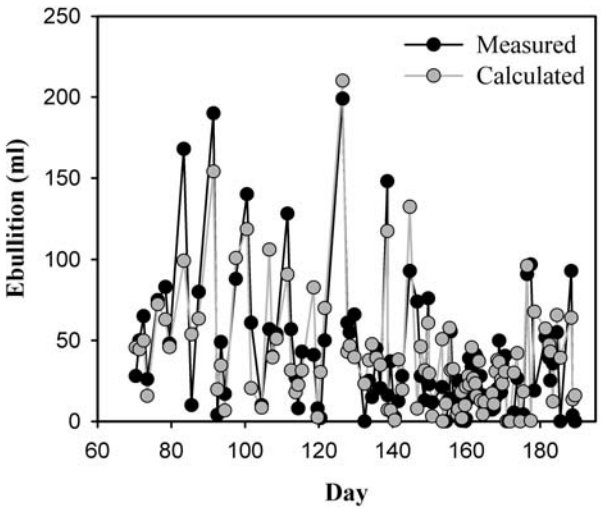

Figure 1: Measured and calculated ebullition (ml) for C1.

Some sensitivity analysis was carried out to determine the impact of various elements on the model output. When all elements were included (temperature, pressure, production) the model produced the best fit to measured ebullition data with an r^2 of 0.66 (Figure 1) for both threshold values. The exclusion of production from the model yielded r^2 of 0.35 and 0.37 for VGC = 0.15 and 0.12 respectively. The slightly better relationship for a threshold of 0.12 suggests that the effective VGC within the core was closer to 0.12 than 0.15.

3.3. Modelled Entrapped Gas

The V_g model was run for all capped cylinders (C1, C3, C4, C5 and C6) following the initial drop in VGC at experiment onset. The model was run for two scenarios: (i) pressure and temperature (PT) and (ii) pressure, temperature, production and ebullition (PTPE). The highest CH_4 production values were applied in C1 at ~17 ug g^{-1} d^{-1}, C3, C4, and C5 at 20°C had values of ~1.6 ug g^{-1} d^{-1} and ~0.4 ug g^{-1} d^{-1} at 11°C. CH_4 production values could not be calculated for C6, as no bulk density information was available for this core, but a total gas addition of 0.5 ml d^{-1} was applied based the increase in *VGC* over the experiment.

Model results from the PT run show patterns that correspond with the measured VGC values (r^2 of 0.34; max r^2 of 0.74). However, with the exception of C1U, the PTPE run improved model fit with an average r^2 of 0.56 (max r^2 of 0.97). Generally, model fit was strongest from the beginning to the middle of the period investigated, with a general over-estimation of V_g by the model towards the end of the model run. This trend was least pronounced in C3, and most evident in C4 and C5. Ebullition was most active in C1, and the effect of the sporadic nature of these events is evident in the relationship between measured and calculated values of VGC for this core (Figure 2).

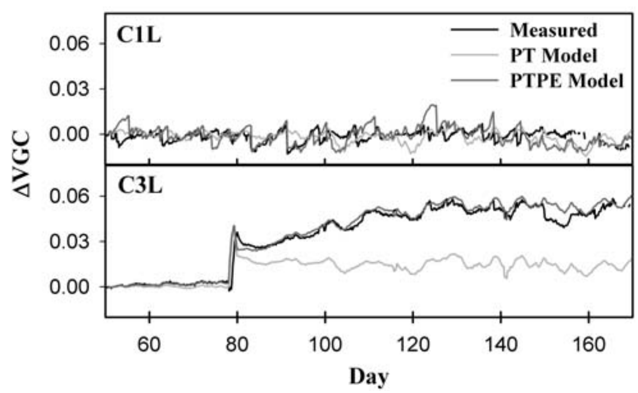

Figure 2: Measured and calculated ΔVGC for the lower (L) TDR probe locations of C1 and C3.

The model yielded the best fit for C3, followed by C5, C4, C1 and C6, in descending order of fit. Some outliers exist that could not be accounted for by the model, and in instances where VGC was below 0.1, the model was unable to predict reasonably changes in entrapped gas volumes (C4U, C5L, C6L and C6U), consistently over-predicting variability. In the case of C6, calculated values were an order of magnitude different from measured values for the entire model run.

4. Discussion & Conclusions

4.1. Ebullition Model

The relatively stable time-averaged VGC observed during the laboratory experiment supports the existence of a threshold for ebullition. This observation is further supported by the general success of the model. From the model results however, it is also evident that use of a single threshold value does not accurately represent these processes and in future CH_4 ebullition models, a fuzzy threshold should be employed to represent the transition from storage to release where, possibly in part due to differences in pore size distribution and bubble retention on small scales within the cores, creates variations in thresholds. Further improvement to the model could be accomplished through an improved production term, and the ability to account for ebullition during the period of increasing V_g prior to establishing stability. The model also does not explicitly deal with losses via diffusion, assuming that ebullition is the only sink for CH_4.

Overall, the main concept of a threshold for ebullition appears valid, as does the existence of the relationship between ebullition and changes in entrapped gas volume. The ebullition model extends the work presented by Tokida et al. (2005) supporting the concept of atmospheric pressure as a trigger for ebullition, but also illustrates the need to account for production and temperature processes.

4.2. Entrapped Gas Model

Results from the entrapped gas model suggest that pressure and temperature are dominant variables in generating the temporally frequent fluctuations observed in measured VGC. Improved model fit with the inclusion of production and ebullition suggests they are also important elements in generating V_g fluctuations. The model was also able to reasonably represent the spike in VGC generated when the climate chamber failed (C3, C4 and C5), supporting the influence of temperature on VGC in these cores and could support similar processes in natural systems.

Potential delays between manual ebullition measurements and TDR-measured changes or should several ebullition events occur between manual measurements, they would be offset or added as a single event, influencing the magnitude of the response in the model, or delay its response. Moreover, measuring VGC at more depths or by employing other geophysical techniques to gather further information about internal gas distribution may improve our understanding of entrapped gas processes.

Although general trends in V_g show a good fit between modelled and measured values, the treatment of production, ebullition, and conditions where *VGC* is <10%, needs to be further addressed. By increasing the measurement frequency of ebullition and improved methods of estimating production, model results could be improved.

As a first approximation, these models successfully illustrates the importance of temperature and atmospheric pressure in generating fluctuations in entrapped gas content and ebullition within peat, and may be important for understanding their effect on peatland processes.

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Hydrologic and vascular plant controls on *Sphagnum* production in a cutover peatland

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Introduction

Peatlands store approximately 455 Pg of carbon globally (Gorham, 1991). In Canada, non-permafrost peatlands cover 714 x 10^3 km^2 (Bridgham et al., 2006); peat extraction has increased recently in Canada, with more than 124 km^2 of peatlands harvested for peat (Cleary et al., 2005). Peat harvesting for thermal power generation may also contribute to the area of altered peatlands in the future. After harvesting, peatlands are left with extensive ditch-drainage systems and an absence of porous, young peat (Girard et al., 2002). Limited growth of *Sphagnum* moss hummocks in this stressed environment may mimic potential climate change impacts of increased temperature and decreased water surplus.

For plants with no active water transport mechanisms, such as *Sphagnum* mosses, soil matric tension (ψ) provides a useful measurement paradigm that measures water availability as a pressure constrained by capillarity law. Using capillary law, the hyaline cells of Sphagnum have been predicted to drain at pressures of c. 100-200 cm H_2O (Hayward and Clymo, 1982). Drainage of hyaline cells and subsequent desiccation damages photosynthetic pigments, leading to a reduction in carbon fixation in the short and long term (Gerdol et al., 1996). Similar observations using pressure transducers within hyaline cells (Lewis, 1988) and long term hummock establishment at the plot scale (Price and Whitehead, 2001) show a similar hydrologic constraint on photosynthesis. In this study, we examine controls on primary productivity in a *Sphagnum* and ericaceous shrub hummock in a harvested and abandoned peatland using intensive hydrologic and static climate controlled chamber carbon-exchange measurements.

Study Site

Fieldwork was undertaken in 2005 and 2006 at the Cacouna Bog, located 15 km NE of Riviere-du-Loup, Quebec. The bog was harvested with a block-cut method, leaving a series of trenches and raised baulk areas. Three rectangular collars were inserted 25 m apart in *Sphagnum* hummocks along a topographic gradient in a trench abandoned in 1970. The hummocks species *Sphagnum rubellum* dominates the uppermost and middle collar; *S. magellanicum* dominates in the lowermost collar. Vascular plants include *Ledum groenlandicum* (labrador tea), *Kalmia angustifolium* (sheep laurel), and *Vaccinium angustifolium* (low sweet blueberry).

Methods

At each collar, ceramic cup tensiometers at 5 and 15 cm below the cutover peat horizon were measured manually once daily. A meteorological station adjacent to the middle collar recorded photosynthetically active radiation (PAR, umol m^{-2} s^{-1}) every 20 minutes. Vascular green area (VGA, cm^2) was estimated in each collar by counting leaf number and area of eight species every two weeks in five 15 x 15 cm subplots. Gross ecosystem production (GEP) was measured as a linear change in CO_2 concentration in a plexiglass chamber over three minutes using an infrared gas analyzer. At least 130 measurements were made at each collar. Instantaneous GEP, scaled to g C m^{-2} d^{-1} for ease of understanding, was computed using a combination hyperbolic model (equation 1). The PAR term in the model is based on a light response curve (Frolking et al., 1998), while the VGA term is based on the self-shading VGA model of Wilson et al. (2007). These data were used to parameterize a model of GEP using least squares regression. Hydrometeorlogical data was integrated with the GEP model at 20-minute intervals to yield a cumulative GEP flux from Julian days 147-228 in 2005 and 2006.

$$GEP = \left(\frac{PAR \cdot GEP_{\max} \cdot k_{par}}{PAR \cdot GEP_{\max} + k_{par}} \right) \left(\frac{VGA}{VGA + k_{vga}} \right) \quad (1)$$

Results and Discussion

A large P-E deficit, particularly in July and August 2005, yielded lower average tensions across all six tensiometers. Despite the large P-E deficit in 2005, soil tensions did not exceed the –100 cm H_2O threshold of hyaline cell drainage, except for a brief interval in August 2005 at the –5 cm middle collar tensiometer.

Table 1. GEP model results and hydrologic conditions at the three collar sites. GEP is given in g C m^{-2}; ψ is a pressure in cm H_2O; P-E is the vertical water balance in mm between JD 147-228.

		ΣGEP	R^2	Mean ψ	Max ψ	LAI_{max}	P-E
2005	Lower	439	0.93	-24	-68	0.19	
	Middle	451	0.90	-53	-120	0.32	-95
	Upper	517	0.87	-31	-80	0.31	
2006	Lower	558	0.93	-9	-27	0.22	
	Middle	802	0.91	-16	-32	0.46	-62
	Upper	837	0.93	-10	-24	0.31	

The empirical photosynthesis model was implemented separately for each year at every collar, creating six models in total. While the light response term of the model was responsible for most of the model fit, the VGA term VGA explained up to 32% of the variance in the middle collar in 2005.

A high coefficient of determination in all six models leaves little explanatory room for soil tension and moisture availability as predictors of *Sphagnum* production within each model. Differences in cumulative GEP between modelled years in the same hummock, while algebraically a result of model parameters, do imply an altered photosynthetic response to light and leaf area between years. Ephemeral surface drying events during days of high evaporation, not captured at –5cm tensiometers, may be responsible for a drying stress at the hummock surface. After complete desiccation, hummock species of *Sphagnum* can take at least 18-20 days to recover to their pre-drying GEP rates (McNeil and Waddington, 2003; Gerdol et al., 1996). A larger frequency of even minor surface desiccation events in 2005 may have caused a systematic decrease in GEP under optimal conditions, and lower GEP output in the model.

Overall, this photosynthetic model absent of a hydrologic component reveals the robust nature of the *Sphagnum* hummocks. Unlike new (< 5 years) *Sphagnum* hummocks without shrubs that show a strong GEP response to fluctuations in water table (Tuittila et al., 2004), the hummocks studied here have accumulated dead *Sphagnum* for 35 years. The growth of ericaceous shrubs provides a shading effect that reduces dessication stress through evporation while transmitting sufficient PAR for near-maximum GEP rates (McNeil and Waddington, 2003). This thick, porous cushion of mosses appears to act as a buffer to drastic changes in tension, allowing minimal moisture limitation to *Sphagnum* mosses even in the relatively harsh hydrologic environment of an abandoned cutover bog.

Conclusions

Sphagnum mosses in hummocks overlying cutover peat are able to photosynthesize at low and fluctuating soil tensions near the range of hyaline cell drainage and potential desiccation. Low-magnitude drying stress events may cause a prolonged decline in photosynthetic capacity, not visible during discrete GEP measurements. Hummock formation after 30 years and underlying porous peat produces a sufficient "buffer" to large changes in water availability that mute impacts of dry periods of photosynthesis compared to younger, thinner, and less robust hummocks.

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Digital elevations from ICESat: Effects of dynamic terrain

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1. INTRODUCTION

Substantial problems arise from the sand movement in civilian and industrial cities in arid and semiarid countries. Problems are caused by the encroachment of sand on roads and railway tracks, farm-lands, towns and villages, industrial installations, airports, etc. Sand movement is highly affected by geomorphology such as vegetation, shapes and heights of terrains, and grain sizes of the sand [1]. However, wind direction and speed are the most important factors that affect sand movement. A minimum wind speed of 6 – 8 m/s is needed for sand to transport. With increasing wind speed there is an exponential increase in potential sand movement [2]. One of the most active areas regarding sand and dunes movement is the area of Arabian Peninsula. Approximately one-third of the Arabian Peninsula is covered by sand dune areas (Fig. 1). Different wind regimes that cause sand dune movements occur in the deserts of the Arabian Peninsula. Winds capable of moving sand have a northerly component 75 percent of the time and a southerly component 17.4 percent of the time; the remainder is from the east or the west [3]. The frequency of northerly winds is highest in April, May, and June and lowest in February and March. The frequency of southerly winds is relatively high in February and March but extremely low during May and June [3]. Thus, the amount of sand blown from north to south is highest in spring and summer and lowest in winter. In contrast, the amount of sand blown from south to north is highest in winter and lowest in spring and summer.

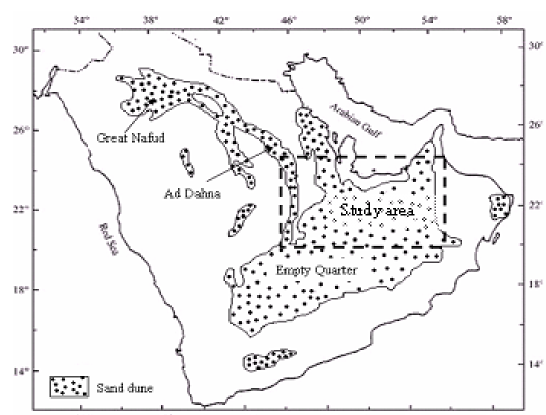

Fig. 1. Sand dune areas in the Arabian Peninsula.

The purpose of this study is to evaluate the elevations differences caused because of the sand dunes movement and to estimate the movement vector by computing the movement distance and direction. The selected study area is located in the eastern part of the Arabian Peninsula and extends between 20 to 25 degrees in latitude and 45 to 55 degrees in longitude (Fig. 1). The altimetry satellite data used are ICESat land surface altimetry data level 2. These data are good enough for this study since ICESat samples every 175 m along-track with a footprint size of only 65 m in diameter.

2. DATA PREPARATION

The available ICESat observations, were found for our specific study area, are in the years 2003, 2004, 2005, and 2006. ICESat tracks were plotted together in order to extract those closed to each other. As the footprint size is approximately 65 meters on the earth's surface, a limit of maximum 50 meters in between is considered in order two tracks to be covering the same dunes. Thus, two ICESat track sets are used in this study, the first set as well as the second contains two tracks the first one acquired in November 2005 and the second in March 2006 (five months in between).

3. ELEVATION DIFFERENCES CALCULATION

Elevation differences caused by sand movement can be calculated. In the first set as well as in the second one, the footprints of the first track (Nov. 2005) are projected in the second track (Mar. 2006). Thus, there elevations in Mar. 2006 can be interpolated using the available elevations of the footprints in the Mar. 2006 track. Each footprint in the first track will have two elevations, one measured elevation in Nov. 2005 and another interpolated one in Mar. 2006. Now, the elevations of Nov. 2005 are subtracted from the elevations of Mar. 2006 to calculate the change in elevations between these two time periods because of sand movement. The maximum and the minimum difference in elevations are 24.57 m and -18 m for the first set and 24.44 m and -43.58 m for the second set, respectively. The mean difference and the standard deviation for the first set are -0.07 m and 3.06 m while for the second set are -0.03 m and 4.58 m, respectively.

4. MOVEMENT VECTORS ESTIMATION

In order to calculate movement vectors, dune shifts in latitude and longitude are computed by correlating the different elevation profiles (Nov. 2005 and Mar. 2006) for each set. Having the two elevation profiles (Nov. 2005 and Mar. 2006) of the footprints, elevations are interpolated along the track latitude on the track points with 1 m distance. The elevation of each new point in Nov. 2005 and Mar. 2006 is calculated using the two elevation profiles of the footprints. In addition, the longitude of each point is interpolated using the longitude of the footprints. The same process is repeated by interpolating the elevations along the track longitude on points on the track with 1 m distance. The latitude of the new points is interpolated using the footprints latitude. Thus, new elevation profiles for each set are produced, in which elevations are known not only in footprints but also in points with 1 m distance in between along the track latitude/longitude. These profiles are used in calculating the distance and the direction of the moved dunes.

In order to find both, the distance and the direction of the moved dunes, the highest correlation coefficient between the two new elevation profiles (Nov. 2005 and Mar. 2006) should be evaluated. A moving window by fixed shift distance is defined. In each window step, the elevation curves inside the window are correlated. Analytically, one curve moves over the other with steps of one meter. The movement is performed to the right and to the left where the correlation coefficient is calculated for each step. Since dunes are moved by the wind with a certain distance, highest correlation is expected at this specific distance. For the highest correlation coefficient, the corresponding movement distance of the curve is calculated and the direction in which the curve moved (right or left) is determined. Thus, the resulted distance corresponds to the shift in latitude of the sand dunes inside the window. Moreover, the related direction of the movement (right or left) corresponds to the direction of the sand movement. The output of each window step is the maximum calculated correlation, the corresponding shift distance in latitude, the shift direction in latitude, and the latitude and longitude of the window center point. The same steps are repeated for longitude. Having the shift distance and direction in latitude and longitude, the length of the movement vector as well as its azimuth angle for each window center point can be calculated.

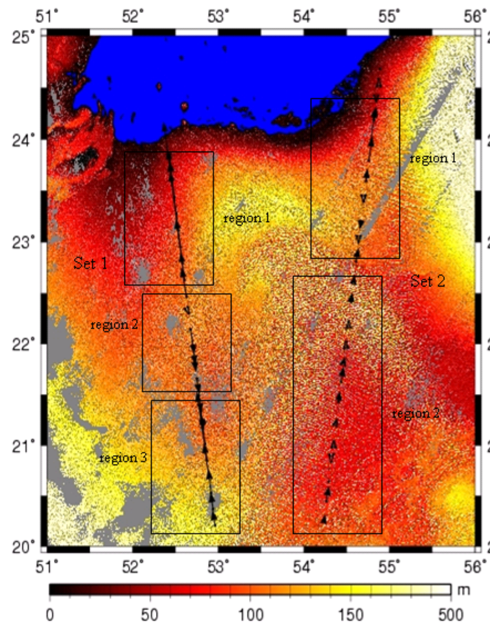

Fig. 2. Movement vectors plotted on SRTM DEM of the study area.

Fig. 2 shows the movement vectors of the two data sets plotted on SRTM Digital Elevation Model (DEM) of the study area. The length and the direction of the each vector are proportional to the dunes movement distance and direction. Four dune types can be discriminated in the areas of interest where the tracks of the two sets pass. In the first set, the area where the track passes can be divided into three regions. The first and the third regions contain complex linear dunes while the second region contains star dunes. The main movement direction in the first and third regions is from the south to the north. This direction agrees with the main wind direction in winter. On the other hand, the main movement direction in the second region is from the north to the south. This opposite direction should be related to winds in this region that had direction from the north to the south. The mean movement distance of the dunes is 22.87 m. In the second set, the area where the track passes can be divided into two regions. The first region contains longitudinal dunes while the second region contains complex crescentic dunes. The main movement direction in the two regions along the track is from the south to the north which agrees with the main winds direction in winter. The mean movement distance of the dunes is 6.40 m.

5. CONCLUSIONS

Elevation profiles from ICESat data can be used in a correlation analysis to find direction and distance of movement. The direction of the movement depends on the main direction of the winds. In the period between November and March the movement has main direction from the south to the north. This is because the main direction of the winds in this period is from the south to the north. However, some northern winds exist in this period and cause a movement of sand in some areas towards the south.

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Statement of Cash Receipts and Disbursements (2006)

Receipts	**2006**	**2005**	**2004**	**2003**
Memberships				
Canadian Association of Physicists	-	195	210	135
Geological Association of Canada	1,215	1,299	1,299	1,377
Memberships Direct	2,934	3,420	3,242	3,513
Annual Meeting	-	9,551	16,163	-
Annual Meeting (previous year)	-	702	10,640	-
CGU Conference Support	1,160	-	-	-
Bank Interest	1,025	350	1,288	423
GSC Grant (Student Support)	4,000	4,000	4,000	4,000
Miscellaneous	100	1,509	231	-
TOTAL RECEIPTS	**10,434**	**21,026**	**37,073**	**9,448**
Disbursements				
Newsletter	2,081	5,622	810	5,244
Prize for Best Student Papers/Poster	2,000	2,000	2,000	2,000
Student travel	-	5,375	4,225	5,700
Annual meeting (Translation, Travel)	8,864	6,690	1,709	5,906
CGU Executive Meetings	1,483	219	43	359
CGU-HS Student Conferences	-	-	572	244
Miscellaneous	30	348	453	30
Membership in Can. Geoscience Council	-	-	-	400
Bank charges	-	10	32	-
J. Tuzo Wilson Medal	-	-	-	4344
Seismix 2004 Student Support	-		3,000	-
PAGSE Membership	600	-	300	300
GAC Geophysics Division Award	-	-	300	-
Accountant, Lawyer Fees	-	6,484	-	-
Secretariat	2,500	5,893	3,400	200
TOTAL DISBURSEMENTS	**17,558**	**32,642**	**16,844**	**24,727**
Income less expenses	-7124	-11,615	20,229	-15,280

STATEMENT OF ASSETS	**31 Dec-06**	**31 Dec-05**	**31 Dec-04**
Savings account	29,511	76,885	76,446
Chequing account	22,109	3,992	16,552
Guaranteed income certificate	70,635	48,500	48,190
Credit with Canadian Ass'n of Physicists	241	241	46
Cash on hand	-23	-23	-23
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ABSTRACTS / RESUMES: 15 February/Février 2008

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