

---

## ***Academic CV, Shawn J. Marshall***

---

Shawn Marshall

b. December 5, 1967

Department of Geography, University of Calgary

Earth Sciences 404, 2500 University Dr NW, Calgary, Alberta, T2N 1N4

Telephone: (403) 220-4884; FAX: (403) 282-6561

shawn.marshall@ucalgary.ca

### *Education*

B.A.Sc. (Honours), Engineering Science (Physics), University of Toronto, 1991

Ph.D., Geophysics, University of British Columbia, 1996

### *Academic Appointments*

Professor, Department of Geography, University of Calgary, 2009-present

Associate Professor, Department of Geography, University of Calgary, 2003-2009

Assistant Professor, Department of Geography, University of Calgary, 2000-2003

Canada Research Chair in Climate Change (Tier II), University of Calgary, 2007-2017

Fellow, Institute for Sustainable Energy, Environment and Economy, Univ. Calgary, 2007-2012

Departmental Science Advisor, Environment and Climate Change Canada, 2019-present

Adjunct Research Professor, Carleton University, Ottawa, 2018-present

Fellow, Canadian Institute for Advanced Research Earth System Evolution Program, 2001-2015

Visiting Scientist, Institut des Sciences de l'Environnement, Université de Genève, 2013-2014

Visiting Scientist, Department of Earth and Atmospheric Sciences, UQAM, 2006-2007

Postdoctoral Research Associate, Department of Earth and Ocean Sciences, UBC, 1997-1999

### *Honours*

2004,2014 University of Calgary distinguished research award

2011 University of Calgary Undergraduate Student Society teaching award

2009 Fellow, Royal Canadian Geographical Society

2006-2008 W. Garfield Weston Foundation Fellow, Canadian Institute for Advanced Research

2005 Young Scientist Award of the Canadian Geophysical Union

2004 Invited Delegate, "Leaders of Tomorrow" Symposium of the Partnership Group for Science and Engineering Research in Canada (PAGSE), November 2, 2004, Ottawa

2001-2015 Scholar (2001-2005), Associate (2005-2010), and Fellow (2010-2015), Canadian Institute for Advanced Research (CIFAR) Earth System Evolution Program

1999 U.S. National Oceanic and Atmospheric Administration (NOAA) Postdoctoral Fellowship, NOAA Global Climate Change Program, 1999

1998-1999 NSERC Postdoctoral Fellowship, Earth and Ocean Sciences, UBC

1997 NSERC national doctoral thesis prize

1997 Governor General's Gold Medal for highest standing among UBC doctoral graduates

1989-1991 University of Toronto Varsity award, combined athletic and academic performance

## Leadership Experience

### *External Governance Boards*

- Chair, Board of Governors, The Rockies Institute (rockiesinstitute.com), Canmore, AB, 2015-2019.  
Oversee strategic planning and provide scientific guidance to non-profit organization working with community-based climate change impact and adaptation initiatives.
- Science Steering Committee, U.S. National Center for Atmospheric Research (NCAR) Community Earth System Model, Boulder CO, 2014-2018. Provide input on strategic directions and priorities for the global climate model development at NCAR.
- Board of Directors, Arctic Institute of North America (AINA), Calgary AB, 2008-2016.  
Provide guidance to AINA Executive Director on strategic directions, budget, and management. AINA is an Institute within the University of Calgary, but also exists as a federally established non-profit organization, with an independent governance board.
- Interim Executive Director, Arctic Institute of North America, 2011, 2013.

### *University of Calgary*

- Associate Director, Arctic Institute of North America (AINA), 2016-2018.  
Assist the Executive Director with AINA governance and research initiatives, including a specific mandate to assist with the management and research profile of AINA's Kluane Lake Research Station, Yukon, and academic partnerships between U.Calgary and Yukon College.
- Member, Interdisciplinary 'SUPPORT' Committee on research chairs and strategic priorities, University of Calgary, 2013-2018. Committee Chair in 2016.
- Graduate Program Director, Geography, University of Calgary, 2008-2010.  
Oversaw admission, management, and success of ca. 80 graduate students in the program.

### *International Scientific Community*

- Canadian representative, International Arctic Science Committee (IASC) Cryosphere Working Group, 2016-2021.
- Committee member, U.S. National Academy of Sciences Panel on Advancing Climate Modeling, Washington, D.C., 2011-2012.
- Invited contributor, Intergovernmental Panel on Climate Change (IPCC) Workshop on Ice Sheet Contributions to Sea Level Rise, Kuala Lumpur, Malaysia, 2010.
- Lead author, Arctic Council Assessment Report, *The Greenland Ice Sheet in a Changing Climate*, Copenhagen, Denmark, 2007-2009.
- Committee member and contributing author, U.S. Climate Change Science Program Assessment Report on Abrupt Climate Change, Washington D.C., 2007-2008.
- Council Member, International Glaciological Society, 2003-2005.
- Executive Committee, American Geophysical Union (AGU) Cryosphere Section, 2002-2004.
- Chair, American Geophysical Union Snow, Ice, and Permafrost Committee, 2000-2002.
- Member, American Geophysical Union Snow, Ice, and Permafrost Committee, 1998-2000.
- Organizing Committee, AGU Fall Scientific Meeting, San Francisco CA, 2001-2002.

### *Editorial Appointments*

Editor, *Journal of Climate*, 2019-present

Associate Editor, *Canadian Water Resources Journal*, 2012-2019.

Editor, Earth Systems and Environmental Science Reference, Elsevier Press, 2012-2018.

Associate Editor, *The Cryosphere*, 2008-2012.

Associate Editor, *Geophysical Research Letters*, 2004-2006.

Guest Editor, *Annals of Glaciology* special volume on Fast Glacier Flow, 2002.

Guest Editor, *Quaternary International* special volume on Ice Age Inception, 2001.

### *Review Panels*

Review Panel, Earth Sciences, Compute Canada Resource Allocation Committee, 2013-2019.

Committee Member, NSERC Discovery Grant Evaluation Group, Earth Sciences, 2014-2017.

Interdisciplinary Adjudication Committee (IAC), Canada Research Chairs Program, 2013-2017.

Served as IAC Chair, 2017.

Panel Member, NASA Cryosphere Program Review Committee, 2016.

Committee Member, NSERC PGS/PDF Earth Sciences and Ecology Group, 2011-2013.

Grant Reviews for NERC (UK) and the U.S., Austrian, Swiss, and Netherlands National Science Foundations, 2012-2017.

Science Steering Committee, Canadian Polar Continental Shelf Project (PCSP), 2003-2007.

### **Research Summary**

My research group studies glaciers, ice sheets, and ice-climate interactions. How are glaciers and ice sheets responding to climate change, and how quickly will global sea level rise in the coming decades? What are the implications of glacier retreat for regional water resources? How did glaciers interact with the global climate system to give periods of large-scale glaciation in Earth history (i.e. Ice Ages), and what can this tell us about climate system sensitivity and feedbacks? Can we understand these processes and include them in climate models? I examine these questions through field and modelling studies in western Canada, Iceland, the Canadian Arctic, and Greenland. Fieldwork is focused on meteorological conditions and glacier-climate processes and in alpine and polar environments, to inform models of glacier energy and mass balance. This is basic environmental research on climate and Earth system dynamics. The research is relevant to water resource management, climate change impact studies, and to inform mitigation and adaptation strategies in response to climate change and global sea level rise.

### **Significant Contributions to Research**

*Modelling Ice Sheet Dynamics.* Doctoral and postdoctoral research at UBC centred on the development of a three-dimensional numerical model of ice sheet dynamics. The model is a tool for study of continental ice sheets and ice-climate interactions, which has been used by climate research groups at several institutions (e.g., the University of Victoria, Alberta, McGill, UQAM). This work has facilitated numerous international collaborations, including NSF subcontracts with

Oregon State University and the University of California-Berkeley and collaborations with the University of Iceland and the U.S. National Center for Atmospheric Research.

*Ice Age Climate Dynamics.* I study several aspects of ice age climate dynamics, including the climatic and glaciological patterns of ice sheet nucleation and deglaciation, reconstruction of the Last Glacial Maximum ice sheets in North America, and the role of ice sheets in millennial climate variability. These studies contribute to understanding of the role of ice sheets in the climate system. These papers present a model of ice sheet dynamics and continental surface hydrology during the last glacial cycle. Freshwater runoff impacts ocean stratification and North Atlantic thermohaline circulation, which was erratic during the glaciation. The modelled runoff patterns provide insight into the nature of millennial-scale climate instability, ice sheet-climate interactions and Earth's natural climate variability.

*Sea Level Change.* Sea level rise is well-documented in recent years, and the amount of sea level rise being caused by glacier melt is a pressing question in for climate science and society. The Greenland Ice Sheet harbours a volume of water equivalent to 7 m of global sea level, enough to wreak havoc on coastal regions should the ice melt back over the next several centuries. To investigate Greenland's sensitivity to increased warmth, Kurt Cuffey (UC-Berkeley) and I examined ice sheet retreat in Greenland during the last interglacial period. Our predictions that the Greenland Ice Sheet caused up to 5 m of sea-level rise during the last interglacial period received global attention, spurring ongoing follow-up work and triggering my involvement in international climate change assessments for the U.S. Climate Change Assessment Program, the Arctic Council, and the IPCC (AR5). I have also served as a consultant on sea level rise with the U.S. Navy and the Government of Singapore.

*Glacier-Climate Processes.* My main current research objective is the development of improved models of regional-scale icefield dynamics and their sensitivity to climate change. This requires statistical methodologies for terrain characterization and downscaling of climate fields in mountain and polar regions, where weather observations are scarce and the topography is poorly represented in most climate models. This guides my group's field studies of glacier mass balance processes and mesoscale climate variability in western Canada and the Arctic. Our fieldwork is designed to improve climate downscaling strategies. As an example, work on Ellesmere Island has elucidated the seasonal and synoptic variability of surface temperature lapse rates in the Canadian high Arctic, with important implications for modelling of snow/ice melt.

**Peer-Reviewed Publications** (students and postdoctoral researchers underlined).

Google Scholar Citations: 6037; H-index 36; i10 index 65 [July 9, 2019]

*Submitted*

Marshall, S.J. and R. Nath, in revision. Enhanced flowband modelling of fluctuations of Athabasca Glacier, Canadian Rocky Mountains, over the last millennium. *Journal of Glaciology*.

Foroutan, M., S.J. Marshall and B. Menounos, accepted. Automatic mapping and geometry extraction techniques for glacier crevasses. *Journal of Glaciology*.

- [1] Pelto, B.M., B. Menounos and S.J. Marshall, 2019. Multi-year evaluation of airborne geodetic surveys to estimate seasonal mass balance, Columbia and Rocky Mountains, Canada. *The Cryosphere*, 13, 1709-1727, <https://doi.org/10.5194/tc-13-1709-2019>.
- [2] Laskin, D.N., G.J. McDermid, S.E. Nielsen, S.J. Marshall, D.R. Roberts and A. Montaghi, 2019. Advances in phenology are conserved across scale in present and future climates, *Nature Climate Change*, 9, 419-425, doi:10.1038.s41558-019-0454-4.
- [3] Marshall, S.J., 2019. Sea Ice; Glaciers and Ice Sheets; Palaeoclimate; Sea Level. Entries in *30-Second Climate* (J.D. Haigh, Ed.), Ivy Press, Brighton, U.K., pp. 62-65, 106-107, 122-123.
- [4] Perroud, M., M. Fasel and S.J. Marshall, 2019. Development and testing of a subgrid glacier mass balance model for nesting in the Canadian Regional Climate Model. *Climate Dynamics*, 52, 24 pp, <https://doi.org/10.1007/s00382-019-04676-6>.
- [5] Roberts, D.R., W.H. Wood and S.J. Marshall, 2019. Assessments of downscaled climate data with a high-resolution weather station network reveal consistent but predictable bias. *International Journal of Climatology*, 39 (6), 3091-3103, doi: 10.1002/joc.6005.
- [6] Wood, W.H., S.J. Marshall, and S.E. Fargey, 2019. Daily measurements of near-surface humidity from a mesonet in the foothills of the Canadian Rocky Mountains, 2005-2010. *Earth System Science Data*, 11, 23-34, <https://doi.org/10.5194/essd-11-23-2019>.
- [7] Holden, W. and S.J. Marshall, 2018. Climate Change and Typhoons in the Philippines: Extreme Weather Events in the Anthropocene. In Samui, P., Kim, D., Ghosh, C., (Eds.), *Integrating Disaster Science and Management: Global Case Studies in Mitigation and Recovery*, pp. 407–421), Elsevier Press, Amsterdam.
- [8] Wood, W.H., S.J. Marshall, S.E. Fargey and T.L. Whitehead, 2018. Near-surface atmospheric humidity data from a mesoscale meteorological network in the foothills of the Canadian Rocky Mountains, 2005-2010. *PANGAEA*, <https://doi.pangaea.de/10.1594/PANGAEA.889435>.
- [9] Wood, W.H., S.J. Marshall, T.L. Whitehead and S.E. Fargey, 2018. Temperature records from a mesoscale observational network in the Canadian Rocky Mountains, 2005-2010. *Earth System Science Data*, 10(1), 595-607, <https://doi.org/10.5194/essd-10-595-2018>.
- [10] Samimi, S. and S.J. Marshall, 2017. Diurnal cycles of meltwater percolation, refreezing, and drainage in the supraglacial snowpack of Haig Glacier, Canadian Rocky Mountains. *Frontiers in Earth Science*, 5 (6), 1-15, doi: 10.3389/feart.2017.00006.
- [11] Wood, W.H., S.J. Marshall, S.E. Fargey and T.L. Whitehead, 2017. Daily temperature data from the Foothills Climate Array Mesonet, Canadian Rocky Mountains, 2005-2010. *PANGAEA*, <https://doi.org/10.1594/PANGAEA.880611>.
- [12] Criscitiello, A.S., S.J. Marshall, M. Evans, C. Kinnard, A.-L. Norman and M.J. Sharp, 2016. Marine aerosol source regions to Prince of Wales Icefield, Ellesmere Island, and influence from the tropical Pacific, 1979-2001. *Journal of Geophysical Research – Atmospheres*, 121 (16), 9492-9507, doi: 10.1002/2015JD024457.
- [13] Ebrahimi, S. and S.J. Marshall, 2016. Surface energy balance sensitivity to meteorological variability on Haig Glacier, Canadian Rocky Mountains. *The Cryosphere*, 10, 2799-2819, doi:10.5194/tc-2016-6.

- [14] Durage, S., S.C. Wirasinghe, J. Ruwanpura, L. Kattan and S.J. Marshall, 2015. Canadian prairie tornadoes – preplanning for warning issuance and initiation of protective measures. *International Journal of Disaster Risk Reduction*, 14(4), 556-563.
- [15] Ebrahimi, S. and S.J. Marshall, 2015. Parameterization of incoming longwave radiation at glacier sites in the Canadian Rocky Mountains. *Journal of Geophysical Research – Atmospheres*, 120 (24), 12,536-12,556, doi:10.1029/2015JGD023324.
- [16] Wake, L.M. and S.J. Marshall, 2015. Assessment of current methods of Positive Degree Day calculation using in-situ observations from glaciated regions. *Journal of Glaciology*, 55, 138-152.
- [17] Zuliani, A., A. Massolo, T. Lysyk, G. Johnson, S. Marshall, K. Berger and S.C. Cork, 2015. Modelling the northward expansion of *Culicoides sonorensis* (Diptera Ceratopogonidea) under future climate scenarios. *PLoS ONE*, 10(8): e0130294, doi:10.1371/journal.pone.0130294.
- [18] Bash, E.A.R. and S.J. Marshall, 2014. Estimation of glacial melt contributions to the Bow River, Alberta, Canada, using a radiation-temperature melt model. *Annals of Glaciology*, 55, 138-152.
- [19] Marshall, S.J., 2014. Glacier retreat crosses a line. *Science*, 345 (6199), 872.
- [20] Marshall, S.J., 2014. Meltwater runoff from Haig Glacier, Canadian Rocky Mountains, 2002-2013. *Hydrology and Earth Systems Science*, 18, 5181-5200, doi: 10.5194/hess-18-5181-2014.
- [21] Marshall, S.J., 2014. The Water Cycle. In *Earth System and Environmental Sciences* (S. Elias, Ed.), Elsevier Press, Amsterdam, The Netherlands, doi:10.1016/B978-0-12-409548-9.05927-3.
- [22] Rajewicz, J. and S.J. Marshall, 2014. Variability and trends in anticyclonic circulation over the Greenland Ice Sheet, 1948-2013. *Geophysical Research Letters*, 2842-2850.
- [23] Adhikari, S. and S.J. Marshall, 2013. Influence of high-order mechanics on simulation of glacier response to climate change: Insights from Haig Glacier, Canadian Rocky Mountains. *The Cryosphere*, 7, 1527-1541.
- [24] Bamber, J.L., M. Siegert, J. Griggs, S.J. Marshall and G. Spada, 2013. Paleofluvial mega-canyon beneath the central Greenland Ice Sheet. *Science*, 341(6149), 997-999.
- [25] Bitz, C.M. and S.J. Marshall, 2013. Modeling of the cryosphere. *Encyclopedia of Sustainability Science and Technology* (R.A. Meyers, Ed.), Springer, New York, NY.
- [26] Hirose, J.M.R. and S.J. Marshall, 2013. Glacier contributions to streamflow and glacio-meteorological regime in the Illecillewaet River Basin, British Columbia, Canada. *Atmosphere-Ocean*, 51 (4), 416-435, doi:10.1080/07055900.2013.791614p.
- [27] Hurrell, J., M.M. Holland, S. Ghan and 16 others, 2013. The Community Earth System Model: A Framework for Collaborative Research. *Bulletin of the American Meteorological Society*. 94, 1339-1360, doi. 10.1175/BAMS-D-12-00121. I am a co-author on this through my work with the NCAR CESM Science Steering Committee.
- [28] Marshall, S.J., 2013. Solution proposed for Ice Age mystery. *Nature (News and Views)*, 500, 159-160, doi:10.1038/500159a.
- [29] Marshall, S.J., 2013. From white to blue: Climate change in the Arctic. In *Energy Security and Geopolitics in the Arctic: Challenges and Opportunities in the 21<sup>st</sup> Century* (H. Peimani, Ed.), World Scientific Press, New York, pp. 25-58.
- [30] Marshall, S.J., 2013. Surface Water. In *Earth System and Environmental Sciences* (S. Elias, Ed.), Elsevier Press, Amsterdam, The Netherlands, doi:10.1016/B978-0-12-409548-9.05924-8.

- [31] Adhikari, S. and S.J. Marshall, 2012. Parameterization of lateral drag in flowline models of glacier dynamics. *Journal of Glaciology*, 58 (212), 1119-1132.
- [32] Adhikari, S. and S.J. Marshall, 2012. Glacier volume-area relation for high-order mechanics and transient glacier states. *Geophysical Research Letters*, 39 (16), doi:10.1029/2012GL052712.
- [33] Adhikari, S. and S.J. Marshall, 2012. Modelling dynamics of valley glaciers, Miidla, P. (Ed.), *Numerical Modelling*, InTech Publications, pp. 115-142, doi:10.5772/35474.
- [34] Marshall, S.J., 2012. Evidence of environmental change from the cryosphere. In *The SAGE Handbook of Environmental Change, Vol I* (J.A. Matthews, Ed.), Sage Press, London, pp. 211-238.
- [35] Marshall, S.J., 2012. *The Cryosphere*. In *Princeton Primers in Climate Science*, Princeton University Press, Princeton, NJ, 288 pp.
- [36] National Academy of Sciences, 2012. *A National Strategy for Advancing Climate Modeling*. The National Academies Press, Washington D.C., ISBN 978-0-309-25977-4, 300 pp. *I was one of 17 climate scientists co-authoring the report, as Chapter Lead for Chapter 4: Scientific Frontiers*.
- [37] Adhikari, S. and S.J. Marshall, 2011. Improvements to shear-deformational models of glacier dynamics through a longitudinal stress factor. *Journal of Glaciology*, 57 (206), 1003-1016.
- [38] Adhikari, S., S.J. Marshall and P. Huybrechts, 2011. On characteristic timescales of glacier AX010 in the Nepalese Himalaya. *Bulletin of Glaciological Research*, 29, 19-28.
- [39] Cullen, R.M. and S. J. Marshall, 2011. Mesoscale temperature patterns in the Rocky Mountains and foothills region of southern Alberta. *Atmosphere-Ocean*, 49 (3), 189-205.
- [40] Gillett, N.P., V. Arora, K. Zickfeld, S.J. Marshall and W.J. Merryfield, 2011. Ongoing climate change following complete cessation of carbon dioxide emissions. *Nature Geoscience*, 4, 83-87.
- [41] Marshall, S.J. and M. Losic, 2011. Temperature lapse rates in glacierized catchments. In *Encyclopedia of Snow, Ice and Glaciers*, (V.P. Singh, P. Singh and U.K. Haritashya, Eds.), Springer, Dordrecht, The Netherlands, pp. 1145-1150.
- [42] Marshall, S.J., E.C. White, M.N. Demuth, T. Bolch, R. Wheate, B. Menounos, M. Beedle and J.M. Shea, 2011. Glacier water resources on the eastern slopes of the Canadian Rocky Mountains. *Canadian Water Resources Journal*, 36 (2), 109-134.
- [43] Moran, T.A., S.J. Marshall and M.J. Sharp, 2011. Isotope thermometry in melt-affected ice cores. *Journal of Geophysical Research*, 116 (F02010), doi:10.1029/2010JF001738.
- [44] Sinclair, K.E., S.J. Marshall and T.A. Moran, 2011. A Lagrangian approach to modelling stable isotopes in precipitation over mountainous terrain. *Hydrological Processes*, 25 (16), 2481-2491.
- [45] Alley, R.B., J.T. Andrews, J. Brigham-Grette, G.K.C. Clarke, K.M. Cuffey, J.J. Fitzpatrick, S. Funder, S.J. Marshall, G.H. Miller, J.X. Mitrovica, D.R. Muhs, B.L. Otto-Bliesner, L. Polyak, and J.W.C. White, 2010. History of the Greenland Ice Sheet: Paleoclimatic insights. *Quaternary Science Reviews*, 29(15-16), 1728-1756.
- [46] Alley, R.B., J.T. Andrews, G.K.C. Clarke, K.M. Cuffey, S. Funder, S. J. Marshall, J.X. Mitrovica, D.R. Muhs, and B. Otto-Bliesner, 2009. History of the Greenland Ice Sheet. In U.S. Climate Change Science Program Synthesis and Assessment Product 1.2, *Past Climate Variability and Change in the Arctic and at High Latitudes*, U.S. Geological Survey, Washington D.C., pp. 303-415.
- [47] Gardner, A.S.<sup>‡</sup>, M.J. Sharp, R.M. Koerner, C. Labine, S. Boon, S.J. Marshall, D.O. Burgess<sup>‡</sup>, and D. Lewis<sup>‡</sup>, 2009. Near-surface temperature lapse rates over Arctic glaciers and their implications for temperature downscaling. *Journal of Climate*, 22, 4281-4298.

- [48] Mair, D., D. Burgess, M.J. Sharp, J. Dowdeswell, T. Benham, S.J. Marshall, and F. Cawkwell, 2009. Mass balance of the Prince of Wales Icefield, Ellesmere Island, Nunavut, Canada. *Journal of Geophysical Research*, 114, F02011.
- [49] Marshall, S.J., 2009. Future climate and ice sheet scenarios: Response of the Greenland Ice Sheet to a warmer climate. In *The Greenland Ice Sheet in a Changing Climate*. Arctic Monitoring and Assessment Programme (AMAP) report, Oslo, pp. 54-61.
- [50] Marshall, S.J. and M.J. Sharp, 2009. Temperature and melt modelling on the Prince of Wales Icefield, Canadian High Arctic. *Journal of Climate*, 22 (6), 1454-1468.
- [51] Marshall, S.J. and C.J. van der Veen, 2009. Modelling Greenland Ice Sheet dynamics. In *The Greenland Ice Sheet in a Changing Climate*. Arctic Monitoring and Assessment Programme report, Oslo, pp. 45-54.
- [52] Moran, T.A. and S.J. Marshall, 2009. Effects of meltwater percolation on stable isotope stratigraphy in a high Arctic snowpack. *Journal of Glaciology*, 55 (194), 1012-1024.
- [53] Sinclair, K.E. and S.J. Marshall, 2009a. Engaging students in atmospheric science: A university-high school collaboration in British Columbia, Canada. *Journal of Geoscience Education*, 57 (2), 128-136.
- [54] Sinclair, K.E. and S.J. Marshall, 2009b. The impact of vapour trajectory on the isotope signal of Canadian Rocky Mountain snowpacks. *Journal of Glaciology* 55 (191), 485-498.
- [55] Marshall, S.J., 2008. Quaternary Glaciations, In *Encyclopedia of Paleoclimatology and Ancient Environments* (Gornitz, V., Ed.), Encyclopedia of Earth Science Series, Kluwer Academic Publishers, Dordrecht, The Netherlands.
- [56] Pritchard, M.S.<sup>†</sup>, A.B.G. Bush and S.J. Marshall, 2008. Interannual atmospheric variability affects continental ice sheet simulations on millennial timescales. *Journal of Climate* 21 (22), 5976–5992.
- [57] Pritchard, M.S.<sup>†</sup>, A.B.G. Bush and S.J. Marshall, 2008. Neglecting ice-atmosphere interactions underestimates ice sheet melt in millennial-scale deglaciation simulations. *Geophysical Research Letters*, 35, L01503, doi:10.1029/2007GL031738.
- [58] Sinclair, K.E. and S.J. Marshall, 2008. Postdepositional modification of stable isotopes in winter snowpacks in the Canadian Rocky Mountains. *Annals of Glaciology* 49, 96-106.
- [59] Steffen, K., P.U. Clark, G. Cogley, D. Holland, S.J. Marshall, E. Rignot, and R.H. Thomas, 2008. Rapid changes in glaciers and ice sheets and their impacts on sea level. In U.S. Climate Change Science Program Synthesis and Assessment Product 3.4, *Abrupt Climate Change*, (P.U. Clark et al., Eds.), U.S. Geological Survey, Washington D.C., pp. 60-142.
- [60] Moran, T.A., S.J. Marshall, E.C. Evans and K.E. Sinclair, 2007. Altitudinal gradients of stable isotopes in lee-slope precipitation in the Canadian Rocky Mountains. *Arctic, Antarctic and Alpine Research*, 39 (3), 455-467.
- [61] Marshall, S.J., M.J. Sharp, D.O. Burgess<sup>‡</sup> and F.S. Anslow, 2007. Near-surface temperature lapse rate variability on the Prince of Wales Icefield, Ellesmere Island, Nunavut: Implications for regional-scale temperature downscaling. *International Journal of Climatology*, 27 (3), 385-398.
- [62] Shea, J.M. and S.J. Marshall, 2007. Synoptic controls on regional precipitation and glacier mass balance in the Canadian Rockies. *International Journal of Climatology*, 27 (2), 233-247.



- [63] Valeo, C., W. van der Wal, and S.J. Marshall, 2007. Validating gravimetry measurements in Canada with a continental-scale hydrological database. *International Association of Hydrological Sciences Publ.*, 316, 169-177.
- [64] Wasiuta, V.L., A.-L. Norman and S.J. Marshall, 2006. Spatial patterns and seasonal variation of snowpack sulphate isotopes of the Prince of Wales Icefield, Ellesmere Island. *Annals of Glaciology*, 43, 390-396.
- [65] CAPE Last Interglacial Project Members, 2006. Last interglacial Arctic warmth confirms polar amplification of climate change. *Quaternary Science Reviews* 25, 1383-1400.
- [66] Marshall, S.J., 2006. Modelling glacier response to climate change, in *Glaciers Science and Environmental Change* (P.G. Knight, Ed.), Blackwell Publishing, Oxford, U.K, pp 272-295.
- [67] Marshall, S.J. and M.R. Koutnik, 2006. Ice sheet action vs. reaction: Distinguishing between Heinrich events and Dansgaard-Oeschger cycles in the North Atlantic. *Paleoceanography* 21 (2), PA2021, doi: 10.1029/2005PA001247, 13 pp.
- [68] Otto-Bliesner, B., S.J. Marshall, J.T. Overpeck, G.H. Miller, G. Hu and CAPE Last Interglacial Project members, 2006. Simulating Arctic climate warmth and ice sheet retreat in the last interglaciation. *Science* 311, 1751-1753.
- [69] Bauder, A., D.M. Mickelson and S.J. Marshall, 2005. Numerical modelling investigations of the subglacial conditions of the southern Laurentide Ice Sheet. *Ann. Glaciology*, 40, 204-209.
- [70] Clarke, G.K.C., D.W. Leverington, J.T. Teller, A.S. Dyke, and S.J. Marshall, 2005. Fresh arguments against the Shaw megaflood hypothesis. *Quat. Science Reviews*, 24, 1533–1541.
- [71] Clarke, G.K.C., L'homme, N.<sup>\*</sup>, and S.J. Marshall, 2005. Tracer transport in the Greenland Ice Sheet: three-dimensional isotopic stratigraphy. *Quaternary Science Reviews*, 24, 155-171.
- [72] Flowers, G.E., S.J. Marshall, H. Björnsson and G.K.C. Clarke, 2005. Sensitivity of Vatnajökull ice cap hydrology and dynamics to climate warming over the next two centuries. *Journal of Geophysical Research* 110, F02011, doi:10.1029/2004JF000200.
- [73] L'homme, N.<sup>\*</sup>, G.K.C. Clarke, and S.J. Marshall, 2005. Tracer transport in the Greenland Ice Sheet: constraints on ice cores and glacial history. *Quaternary Sci. Rev.* 24 (1-2), 173-194.
- [74] Marshall, S.J., 2005. Recent advances in understanding ice sheet dynamics. *Earth and Planetary Science Letters*, 240 (2), 191-204.
- [75] Marshall, S.J., H. Björnsson, G.E. Flowers, G.K.C. Clarke, 2005. Modeling Vatnajökull Ice Cap dynamics. *Journal of Geophysical Research*, 110, F03009, doi: 10.1029/2004JF000262.
- [76] Shea, J. M., F.S. Anslow, and S. J. Marshall, 2005. Hydrometeorological relationships on Haig Glacier, Alberta, Canada. *Annals of Glaciology*, 40, 52-60.
- [77] Wang, L.<sup>‡</sup>, M.J. Sharp, B. Rivard, S.J. Marshall and D.O. Burgess<sup>‡</sup>, 2005. Melt season duration on Canadian Arctic ice caps, 2000-2004. *Geophysical Research Letters*, 32 (19), L19502.
- [78] Hildes, D.H.D.<sup>\*</sup>, G.K.C. Clarke, G.E. Flowers and S.J. Marshall, 2004. Subglacial erosion and englacial sediment transport modelled for North American ice sheets. *Quaternary Science Reviews* 23 (3), 409-430.
- [79] Shea, J. M., S. J. Marshall, J. L. Livingston, 2004. Climate controls on glacier distribution in the Canadian Rockies. *Arctic, Antarctic and Alpine Research*, 36 (2), 272-280.
- [80] Marshall, S. J., D. Pollard, P. U. Clark, and S. H. Hostetler, 2003. Coupling ice sheet and climate models for simulation of former ice sheets. *Developments in Quaternary Science, Vol. 1: The*

- Quaternary Period in the United States*, Gillespie, A., S.C. Porter, and B.F. Atwater (Eds.), Elsevier Press, 105-129.
- [81] Marshall, S. J. and P. U. Clark, 2002. Basal temperature evolution of the North American Ice Sheets and implications for the 100-kyr glacial cycle. *Geophysical Research Letters*, 29 (18).
- [82] Marshall, S.J., 2002. Modelled nucleation centres of the Pleistocene ice sheets from an ice sheet model with subgrid topographic and glaciologic parameterizations, *Quaternary International*, 95, 125-137.
- [83] Stroeven, A. P., D. Fabel and S. J. Marshall, 2002. Inceptions: mechanisms, patterns and timing of ice sheet inception, *Quaternary International*, 95, 1-4.
- [84] Clarke, G. K. C. and S. J. Marshall, 2002. Isotopic balance of the Greenland Ice Sheet: Modelled concentrations of water isotopes from 30,000 BP to present. *Quaternary Science Reviews*, 21, 419-430.
- [85] Marshall, S. J., T. S. James, and G. K. C. Clarke, 2002. North American Ice Sheet reconstructions at the Last Glacial Maximum. *Quaternary Science Reviews*, 21, 175-192.
- [86] Clark, P. U., S. J. Marshall, G. K. C. Clarke, S. Hostetler, J. M. Licciardi, J. T. Teller, 2001. Freshwater forcing of abrupt climate change during the last glaciation. *Science*, 293, 283-287.
- [87] Yoshimori, M., A.J. Weaver, S.J. Marshall, and G.K.C. Clarke, 2001. Glacial termination: Sensitivity to orbital and CO<sub>2</sub> forcing in a coupled climate system model. *Climate Dynamics*, 17, 571-588.
- [88] Cuffey, K.M. and S.J. Marshall, 2000. Sea level rise from Greenland Ice Sheet retreat in the last interglacial period. *Nature*, 404, 591-594.
- [89] Marshall, S.J. and K.M. Cuffey, 2000. Peregrinations of the Greenland Ice Sheet divide through the last glacial cycle and implications for disturbance of central Greenland ice cores. *Earth and Planetary Science Letters*, 179, 73-90.
- [90] Marshall, S.J., L. Tarasov, G.K.C. Clarke and W.R. Peltier, 2000. Glaciological reconstruction of the Laurentide Ice Sheet: Physical processes and modelling challenges. *Canadian Journal of Earth Sciences*, 37, 769-793.
- [91] Payne, A.J., P. Huybrechts, A. Abe-Ouchi, R. Calov, J.L. Fastook, R. Greve, S.J. Marshall, I. Marsiat, C. Ritz, L. Tarasov, M.P.A. Thomassen, 2000. Results from the EISMINT model intercomparison: the effects of thermomechanical coupling. *J. Glaciology*, 46, 227-238.
- [92] Clarke, G.K.C., S.J. Marshall, C. Hillaire-Marcel, G. Bilodeau, and C. Veiga-Pires, 1999. A glaciological perspective on Heinrich events. In *Mechanisms of Global Climate Change at Millennial Time Scales*, P. U. Clark, R. S. Webb, and L. D. Keigwin (Eds.), AGU Geophysical Monograph 112, Washington D.C., pp. 243-262.
- [93] Marshall, S.J. and G.K.C. Clarke, 1999a. Ice sheet nucleation: Subgrid hypsometric parameterization of mass balance in an ice sheet model. *Climate Dynamics*, 15, 533-550.
- [94] Marshall, S.J. and G.K.C. Clarke, 1999b. Modeling North American freshwater runoff through the last glacial cycle. *Quaternary Research* 52, 300-315.
- [95] Marshall, S. J., 1998. Dynamics of the Pleistocene Ice Sheets, In *Dynamics of the Ice Age Earth: A Modern Perspective*, P. P. Wu (Ed.). GeoResearch Forum Series, Trans Tech, Zurich, pp. 217-248.

- [96] Marshall, S. J. and G. K. C. Clarke, 1997a. A continuum mixture model of ice stream thermomechanics in the Laurentide Ice Sheet, 1. Theory. *Journal of Geophysical Research* **102** (B9), 20,599-20,614.
- [97] Marshall, S. J. and G. K. C. Clarke, 1997b. A continuum mixture model of ice stream thermomechanics in the Laurentide Ice Sheet, 2. Application to the Hudson Strait Ice Stream. *Journal of Geophysical Research* **102** (B9), 20,615-20,638.
- [98] Marshall, S. J., G. K. C. Clarke, A. S. Dyke, and D. A. Fisher, 1996. Geologic and topographic controls on fast flow in the Laurentide and Cordilleran Ice Sheets. *Journal of Geophysical Research* **101** (B8), 17,827-17,839.
- [99] Marshall, S. J. and G. K. C. Clarke, 1996. Sensitivity tests of coupled ice-sheet/ice-stream dynamics in the EISMINT experimental ice block. *Annals of Glaciology* **23**, 336-347.
- [100] Peltier, W. R. and S. J. Marshall, 1995. Coupled energy-balance/ice-sheet model simulations of the glacial cycle: A possible connection between terminations and terrigenous dust. *Journal of Geophysical Research* **100** (D7), 14,269-14,289.

<sup>†</sup> Student of A.B.G. Bush, University of Alberta; <sup>‡</sup> Student of M.J. Sharp, University of Alberta

\* Student of G.K.C. Clarke, University of British Columbia

#### *Selected Edited Contributions*

- [101] Marshall, S.J. and E.C. White, 2010. Alberta glacier inventory and ice volume estimation. Report for the Alberta Water Research Institute, 55 pp.
- [102] Whitehead, T. and S.J. Marshall, 2008. Rainfall patterns in southwestern Alberta, 2004-2007. Alberta Financial Services Corporation, Lacombe, AB, 43 pp.
- [103] Sinclair, K.E., N. Schaffer and S.J. Marshall, 2007. *Protocols for monitoring and reporting on Snowpack in Parks Canada's Montane Cordillera Bioregion*. Commissioned report, Parks Canada Ecological Integrity Monitoring Program, Glacier National Park, Revelstoke B.C., 64 pp.
- [104] Little, C.M., M. Oppenheimer, R.B. Alley and 17 others, 2007. Toward a new generation of ice sheet models, *EOS Transactions of the American Geophysical Union*, 88 (52), 577-578.
- [105] Marshall, S.J., 2003. Glacier retreat in alpine areas, In *Ecological and Earth Sciences in Mountain Areas* (Taylor, L., K. Martin, D. Hik and A. Ryall, Eds.), Banff Centre Conference Proceedings, Banff AB, pp. 120-123.

#### **Selected Invited Talks**

Seminars (2007-2018): University of Geneva, Cambridge, U.Toronto, U.Michigan, Harvard, Princeton, Cal Tech, UBC, UNBC, U.Victoria, U.Calgary, Carleton University, Bremen University, University of Oslo, UNIS-Svalbard, Northumbria University.

Invited speaker, El cerebro científico, International Symposium on Science, Technology, Arts and Mathematics, 2018, Bogotá, Columbia, <https://www.elcerebrocientifico.com/>.

Keynote speaker, European Space Agency CryoSat Meeting, March 20-24, 2017, Banff AB.

Invited speaker, IUGG General Assembly, June 22-July 2, 2015, Prague, Czech Republic.

Invited speaker, Symposium on Northern Hemisphere glacier response to climate change, January 11-13, 2013, Reykjavik, Iceland.

- Invited speaker, 'How Climate Works' Symposium, October 12, 2012, Princeton Environmental Institute, Princeton NJ.
- Invited speaker, Symposium on The Arctic: Geopolitics, International Relations and Energy Security, April 13-14, 2011, National University of Singapore.
- Invited speaker, IPCC Workshop on Ice Sheet Instabilities and Sea Level Rise, June 21-24, 2010, Kuala Lumpur, Malaysia.
- Keynote Lecture. UN University for Peace Conference on 'Climate Change: Disaster or Opportunity'. San José, Costa Rica, April 17-18, 2010.
- Invited talk on Arctic climate change. 'After Copenhagen' conference. University of Texas, Austin TX, April 6-9, 2010.
- Invited session chair, Sea Level Rise session. Japanese-American Kavli Frontiers of Science Symposium, U.S. National Academy of Sciences, Irvine CA, December 5-7, 2008.
- Invited speaker, Canadian Embassy International Science and Technology Speaker Series, Washington D.C., October 27, 2008.
- Keynote speaker, Second International Conference on Arctic Palaeoclimate and its Extremes (APEX), Durham University, UK, April 1-4, 2008.
- Invited speaker, European Science Foundation Conference on The Role of the Arctic in the Global Climate System, Nynashamn, Sweden, October 13-17, 2007.
- Invited speaker, Rosenberg International Forum on Water Policy, Banff AB, Sept 6-9, 2006.
- Keynote speaker, GSC workshop on North Pacific Climate Variability, Sidney B.C., March 1-3, 2006.
- Plenary speaker, Earth System Processes II Meeting, Geological Society of America, Calgary AB, August 8-11, 2005.
- Invited lecturer, Grand Combin Summer School on Fundamental Problems in Geophysical and Environmental Fluid Dynamics, Course XI: Paleoclimate Observations and Dynamics, Aosta, Italy, June 16-25, 2003.
- Keynote speaker, International Marine Global Changes (IMAGES) Workshop on Ice Sheet-Ocean Interactions, Boulder Colorado. December 2-4, 2002.
- Invited speaker, International Geosphere-Biosphere Program Past Global Changes (IGBP-PAGES) Workshop on the Last Interglacial Period in the Arctic, Portland, Maine. October 11-13, 2002.
- Plenary address, International Conference on Ecological and Earth Sciences in Mountain Areas, Banff, AB, September 6-10, 2002.
- Invited speaker, International School of Geophysics Symposium on Antarctic Ice Sheet Evolution, Erice, Italy. September 7-13, 2001.
- Keynote speaker, Swedish Research Council/International Quaternary Association Workshop on Ice Age Inception, Idre Fjäll, Sweden. June 17-21, 2001.
- Invited speaker, International Marine Global Changes (IMAGES) Workshop on the Last Glacial Maximum, Mt. Hood, Oregon. October 1-5, 2000.
- Invited speaker, European Ice Sheet Modelling Initiative Workshop on the Vatnajökull Ice Cap, Skaftafell, Iceland. June 18-23, 1998.
- Invited speaker, European Ice Sheet Modelling Initiative Workshop on Coupling Climate and Ice Sheet Models, Aussois, France. March 12-15, 1998.
- Invited speaker, Model Intercomparison Workshop of the European Ice Sheet Modelling Initiative, Grindewald, Switzerland. September 24-27, 1997.

Invited speaker, European Ice Sheet Modelling Initiative Workshop on Former Ice Sheets, Edinburgh, Scotland. March 16-18, 1995.

Invited speaker, European Ice Sheet Modelling Initiative Workshop on Subglacial Processes, Reykjavik, Iceland. August 2-8, 1993.

Invited participant, NATO Advanced Study Institute on Paleoclimate Data and Modelling, Siena, Italy: September 26-October 10, 1992.

### **Graduate Student Supervision**

Ochwat, N., 2019. Characterization of the firn in the accumulation area of Kaskawulsh Glacier, Yukon Territory, Canada. M.Sc., University of Calgary, 162 pp.

Miller, K., 2018, Meltwater chemistry of Haig Glacier, Canadian Rocky Mountains. M.Sc., University of Calgary, 102 pp.

Nath, R., 2018. Flowline modelling of glacier dynamics and Little Ice Age glacier reconstructions in the Canadian Rockies. M.Sc., University of Calgary, 114 pp.

Wood, W.H., 2017. Weather system controls of temperature variability in the Alberta foothills. Ph.D., University of Calgary, 194 pp.

Ebrahimi, S., 2016. Modelling glacier energy balance sensitivity to meteorological variability. Ph.D., University of Calgary, 243 pp.

Foroutan, M., 2016. Transverse aeolian bedforms on Mars and in the Lut desert of Iran. M.Sc., University of Calgary, 144 pp.

Rozek, A., 2016. Climate downscaling for modelling of glacier mass balance. M.Sc., University of Calgary, 144 pp.

Adhikari, S., 2012. Advances in modelling of valley glaciers. Ph.D., University of Calgary, 243 pp.

Hirose, J.M.R., 2012. Glacier contributions to streamflow in Illecillewaet River, Glacier National Park, B.C. M.Sc., University of Calgary, 144 pp.

Bash, E.A.R., 2011. Glacier contributions to streamflow and glacier change forecasts in the Bow River Basin, Alberta. M.Sc., University of Calgary, 196 pp.

Moran, T.A., 2011. Isotopic processes in high Arctic snowpacks and implications for isotope thermometry in melt-affected ice cores. Ph.D., University of Calgary, 156 pp.

Schaffer, N., 2010. A statistical model of air temperatures in the glacier boundary layer. M.Sc. Thesis, University of Calgary, 212 pp.

Losic, M., 2009. On the turbulent heat flux contributions to energy balance at Opabin Glacier, Yoho National Park, Canada. M.Sc., University of Calgary, 152 pp.

Mattie, R., 2009. Surface temperature as a function of terrain variables in the Rocky Mountain and Foothills Region of Southern Alberta. M.Sc., University of Calgary, 102 pp.

Sinclair, K.E., 2009. Stable isotope-vapour trajectory relationships in Rocky Mountain snowpacks. Ph.D., University of Calgary, 176 pp.

Lane, K.E., 2008. Evaluation of climate events that influence the ground transportation industry along the TransCanada corridor: Historical trends and GCM projections. M.Sc., University of Calgary, 258 pp.

- Fargey, S.E., 2007. Spatial evaluation of rain events and growing season rainfall patterns in southwestern Alberta, 2005-2006. M.Sc., University of Calgary, 225 pp.
- Horton, B., 2006. Multivariate classification of Calgary weather systems: exploring trends, variability and synoptic relationships, 1953-2004. M.Sc., University of Calgary, 173 pp.
- Wasiuta, V. 2006. Seasonal patterns and spatial variations of snowpack sulphate isotopes of the Prince of Wales Icefield, Ellesmere Island. M.Sc., University of Calgary, 206 pp.
- Anslow, F.S., 2004. Development and testing of a temperature and radiation based melt model for glaciers in the Canadian Rockies. M.Sc., University of Calgary, 181 pp.
- Shea, J.M., 2004. Synoptic circulation and glacier mass balance in the Canadian Rockies. M.Sc., University of Calgary, 176 pp.

#### *Current Graduate Students*

- Samimi, S. (BSc, Univ. of Lahijan, Iran 2011), PhD student (2015-present), Meltwater refreezing and retention in glaciers and implications for glacier runoff and water resources.
- Rahimian, P. (BSc, Univ. of Calgary, 2016), MSc student (2017-present), Modelling ice sheet isotope and ice core evolution in the NCAR Community Earth System Model.
- Ochwat, N. (BSc, University of Colorado, 2016), MSc student (2017-present), Accumulation area processes based on ice core reconstructions on the upper Kaskawulsh Glacier, Yukon.

#### *Masters of Geographic Information Science (MGIS) Students Supervised*

- Wood, W.H. (2008), Modelling mean monthly temperature in Southwestern Alberta using multiple regression with a focus on the contribution of potential solar radiation.
- Law, T. (2006), Flood hazard modelling for the Rainy River, Fort Frances, Ontario.
- LoVechhio, J. (2004) (co-supervised with D. Draper), The use of Geographical Information Systems (GIS) as a Decision Support System (DSS) for assessing the feasibility of wind energy at the Sunshine Village Ski Resort in Banff National Park, Alberta.
- Geldsetzer, T. (2003), Modelling snow distribution for slab avalanche hazards.
- Aeschlimann, U. (2002), Glacier terrain characteristics in the Canadian Rocky Mountains.

#### *Postdoctoral Research Associates*

- David Roberts, 2017-2019. Cryosphere-climate studies at Kluane Lake Research Station, Yukon.
- Kambiz Teimour Najad, 2016-2017. Glacial isostatic modelling in the Community Ice Sheet model.
- Marjorie Perroud, 2014-2016. Current position: Research scientist, University of Geneva.
- Alison Criscitiello, 2014- 2016. Current position: Research associate, University of Alberta.
- Gabrielle Gascon, 2014. Current position: Research scientist, Environment Canada, Edmonton AB.
- Leanne Wake, 2010-2012. Current position: Lecturer, Northumbria University, Newcastle, U.K.
- Amanda Adams, 2006-2009. Current position: Science officer, U.S. National Science Foundation.
- Damon Mathews, 2005-2007. Current position: Associate Professor, Concordia University.
- Hester Jiskoot, 2001-2002. Current position: Associate Professor, University of Lethbridge.

I have also been fortunate to work with over 40 talented undergraduate research assistants over the past 18 years, through Honours Thesis projects and as summer employees. Approximately two thirds of these students have gone on to graduate studies (including several in my own

research group). It has been rewarding to expose these young students to environmental and climate-change research and to see many of the students find their academic passion and career direction. Environmental and climate concerns are only going to grow in the years ahead, and it is a privilege to contribute to the training of future leaders in this field.

*Projects and Operating Funds, 2000-2018. My portion of collaborative project funds is noted.*

- NSERC Discovery Grant, *Glacier and ice sheet response to climate change*, 2018-2023: \$55,000/yr.
- NSERC Operations and Maintenance Support for Research Infrastructure, *Kluane Lake Research Station*, 2017-2019. Marshall, S. (PI) and 8 others, \$148,500/yr.
- Polar Knowledge Canada, *Cryosphere-Climate Monitoring at Kluane Lake Research Station, Yukon*, 2017-2019. Marshall, S. (PI) and 4 others, \$124,795/yr.
- NSERC Equipment Grant (RTI), *Ice-coring instrumentation for firn studies in western and Arctic Canada*, 2016. Marshall, S. (PI) and B. Menounos, \$149,700.
- U.S. Department of Energy Scientific Discovery Through Advanced Computing (SciDAC) program, Longterm evolution of the Greenland Ice Sheet and sea level rise (B. Otto-Bliesner, U.S. National Center for Atmospheric Research, PI), 2014-2018. \$34,000/yr.
- NSERC Climate Change and Atmospheric Research network, Canadian Regional Climate Modelling (L. Sushama, UQAM, PI), 2013-2018: \$45,000/yr.
- NSERC Climate Change and Atmospheric Research network, Canadian Cold Regions Network (H. Wheeler, U.Sask., PI), 2013-2018: \$24,000/yr.
- NSERC Create Grant, ArcTrain: Processes of Climate Variability and Change in the North Atlantic and Arctic (A. de Vernal, UQAM, PI), 2013-2018: \$15,000/yr.
- Alberta Innovates – Energy and Environment Solutions Grant, Predicting Alberta’s Water Future (G. Goss, U. Alberta, PI), 2014-2016: \$20,000/yr.
- NSERC Discovery Grant, *Glacier and ice sheet response to climate change*, 2009-2018 (four-year extension while serving on the NSERC Discovery Grant committee, 2014-2017): \$64,000/yr.
- NSERC Discovery Accelerator Grant, *Glacier and ice sheet response to climate change*, 2009-2012.
- NSERC Equipment Grant (RTI), *Ice-penetrating radar system for studies of glacier dynamics in western Canada*, 2008. Marshall, S. (PI) and three others at UBC, UNBC and SFU.
- Canada Research Chair (Tier II) in Climate Change, 2007-2017, \$100,000/yr.
- Canadian Foundation for Climate and Atmospheric Sciences (CFCAS), *Western Canadian Cryosphere Network* (B. Menounos, UNBC, PI), 2006-2010, \$28,000/yr.
- Alberta Ingenuity Centre for Water Resources, *Flowing to the Future* (S. Rood, UL, PI), 2006-2009.
- Alberta Ingenuity Centre for Water Resources, *Hydrological Processes in an Alpine Catchment, Lake O’Hara Basin, Yoho National Park, B.C.* (M. Hayashi, Calgary, PI), 2006-2009.
- Canadian Foundation for Climate and Atmospheric Sciences (CFCAS), *Polar Climate Stability Network* (W.R. Peltier, University of Toronto, PI), 2005-2010.
- Climate Change Action Fund (CCAF), *Impact of climate change on freight transport in the TransCanada highway corridor* (C.W. Woudsma, University of Waterloo, PI), 2005-2007.
- NSERC Discovery Grant, *Field and modelling studies of glacier-climate processes*, 2004-2009.
- Canadian Foundation for Climate and Atmospheric Sciences (CFCAS), *A high-resolution ice core for study of sea ice and climate variability over the last millennium in the Canadian Arctic* (Martin Sharp, University of Alberta, PI), 2004-2006.

- CFI New Opportunities/Alberta Innovation Fund (ASRIP), *Foothills Climate Array: Mesoscale Meteorological Processes Studies and Parameterization of Surface-Atmosphere Interactions for Climate Modelling*. CFI awarded, October 2001; ASRIP awarded, June 2002.
- Polar Continental Shelf Project (PCSP), Natural Resources Canada, logistical support for glacier-climate field studies on the Prince of Wales Icefield, Ellesmere Island, 2002-2005, 2007, 2011-2013.
- Natural Sciences and Engineering Research Council of Canada (NSERC) Discovery Grant, *Dynamics and Environmental Controls of Glaciers and Ice Sheets*, 2000-2004.
- NSERC Research Network, Climate System History and Dynamics (CSHD; W.R. Peltier, PI); PI of CSHD subproject *Ice sheet-climate interactions*, 2000-2003.
- NSF Earth System History Program, *Modeling ice sheet evolution on orbital and millennial time scales* (Peter Clark, Oregon State University, PI), 1999-2003.
- NSF Office of Polar Programs, *A new collaborative model of Greenland Ice Sheet dynamics* (Kurt Cuffey, University of California-Berkeley, co-PI), 2000-2002.

### *Teaching at the University of Calgary, 2000-2019*

GEOG 305: Weather and Climate (11)  
GEOG 315: Global Water Resources (1)  
GEOG 391: Geography Field School (6)  
GEOG 415: Physical Hydrology (1)  
GEOG 439: Analytical Methods II (Multivariate and Spatial Statistics) (1)  
GEOG 503: Climate Change (16)  
GEOG 685: Arctic Climate System (5)  
GEOG 695: Geographic Research Methods (1)  
GEOG 799.04: Numerical Analysis of Environmental Systems (1)  
GEOG 799.08: Atmospheric Thermodynamics (2)  
GEOG 599.03: Glaciology (6)  
GEOG 599.12: Snow Hydrology (1)  
GEOG 599.22 : Topics in Oceanography (2)  
ENVSCI 502/504: Directed Studies in Atmospheric Sciences & Climatology (5)