

## **Curriculum Vitae for Dr. Joel Brown, Ph.D.**

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### **Education:**

**Ph.D., Geophysics, Boise State University 2012;** Dissertation: “Non-destructively mapping the in-situ hydrologic properties of snow, firn, and glacial ice with georadar.”

**M.S., Geology, University of Montana, 2006;** Thesis: “Spatiotemporal variations of englacial scattering of radar within Bench Glacier, a temperate glacier in coastal Alaska.”

**B.A., Physics/Astronomy, University of Montana, 2003**

### **Professional Development:**

**Faculty Affiliate, Adjunct Professor, and Research Assistant, 2019, January – present, *University of Montana.*** Developing user interface for command line Hydrologic/Economic model, porting the model from python 2 to python 3, teaching introductory geoscience course, assisting graduate students with instrumental and coding problems, and assisting with debugging command line model. This position is an extension of my consulting business, with the positions required in order to work under the original grant.

**Owner and principal research scientist, 2015 – present, *Aesir Consulting LLC.*** Collecting and analyzing data in the fields of glaciology, geophysics, economics, and accounting. Writing, running, and/or assessing models of complex systems such as impacts of reduced power generation on end-user electrical rates, national energy economy, and the interaction of Ground Penetrating Radar with snow and ice. Creating tables, GIS maps, and graphs to facilitate the understanding of large and complex data relationships. Writing and editing peer-reviewed as well as white papers, with a focus on data interpretation and context of data in systems in the fields of glaciology and economics. Developing scripts for accessing, downloading, and statistically interpreting large data from multiple API sources; developing full-stack web apps for local businesses; and creating and managing websites for local businesses.

**Research Scientist, 2014, August-October, *University of Montana.*** Conducting a model inter-comparison of three different ice flow models. This is a NASA funded project aimed at kick-starting a larger-scale model inter-comparison project.

**Faculty Affiliate, 2014-2015, *University of Montana.*** This position allowed me to work closely with other cryosphere scientists, write grant proposals, and continue research on ice sheets.

**Postdoctoral Research Scientist**, 2012-September 2014, *Norwegian Polar Institute*. working on the Ice Rise project to determine ice flow field, mass balance, and changes in strain field over the past few millennia in the Fimbul Ice Shelf, Antarctica.

**Postdoctoral Research Scientist**, 2012, Feb-October, *University of Montana*. Working on a project to determine the subglacial hydrology of Isunngua Sermia, Greenland Ice Sheet.

**Research Staff**, 2008-2011, *University of Montana*. Determining densification rates of firn in the percolation zone of Greenland.

**Research Assistant**, 2008-2009, *University of Montana*. Modeling glacial development of Sperry Glacier, Glacier National Park, Montana.

**Research Assistant**, 2005-2006, *University of Montana*. Magnetic mapping of an archeological site in southwestern Montana.

**Research Assistant**, 2005, *University of Montana*. Radio echo sounding determination of the depth to the bed of Sperry Glacier, Glacier National Park, Montana.

### **Field Experience:**

**Greenland Ice Sheet**, May 2018-June 2018. Conducted 200 MHz common-offset georadar profiles, 100 MHz common-source-point multi-offset studies, collected 30 m firn cores, and helped drill 100 m instrumentation boreholes in the firn with a hot water drill. We occupied this remote field location for 21 days, living out of tents for the duration of the field season.

**Fimbul Ice Shelf, Antarctica**, Jan 2014-Feb 2014. Studied Ice Rises within the Fimbul ice sheet. Conducted 400 MHz and multi-band stepped frequency radar surveys, drilled multiple shallow firn cores to determine spatial variability of surface density over the scale of ice rises, field processed radar and GPS data to determine quality of data. I was also in charge of conducting continuous 400 MHz GPR measurements during traverses between ice rises and over grounding lines to detect hidden crevasses for safe travel. Traversed from SANAE station to Troll station over 30 days, driving TL6s and snow mobiles; we lived out of 2 sledge based modules when traversing and set up base camps with personal tents while on ice rises.

**Fimbul Ice Shelf, Antarctica**, Dec 2012-Feb 2013. Studied Ice Rises within the Fimbul ice sheet. Conducted kinematic GPS surveys, conducted 400 MHz and multi-band stepped frequency radar surveys, drilled multiple shallow firn cores to determine spatial variability of surface density over the scale of ice rises, field processed radar and GPS data to determine quality of data. I was also in charge of conducting continuous 400 MHz GPR measurements during traverses between ice rises and over grounding lines to detect hidden crevasses for safe travel. Traversed from Troll station to SANAE

station over 30 days, driving TL6s and snow mobiles; we lived out of 2 sledge based modules when traversing and set up base camps with personal tents while on ice rises.

**Greenland Ice Sheet**, June 2012. Conducted various georadar surveys with low frequency radar system built by myself in terrain that consisted of large hummocks and melt streams, lived out of a tent on the margin for 5 days and on ice in the ablation zone for 15 days.

**Greenland Ice Sheet**, May-June 2008. Conducted multiple georadar surveys and drilled multiple ice cores, lived out of a tent on the Ice Sheet for 20 days.

**Greenland Ice Sheet**, June-July 2007. Conducted multiple georadar surveys, drilled multiple ice cores, and helped with surface water infiltration experiments, lived out of a tent on the Ice Sheet for 28 days.

**Bench Glacier, AK**, Late August 2006. Conducted multiple georadar surveys, lived out of a tent for 5 days.

**Bench Glacier, AK**, July-August 2005. Conducted multiple georadar surveys and helped with dye experiments, lived out of a tent for 14 days.

**Sperry Glacier, MT**, June and August 2005. Conducted multiple georadar surveys and helped drill 2 m depth holes for GPS and ablation stake placement.

**Tree Frog Spring, MT**, Summer 2005. Mapped the magnetic field of a 118-acre archeological site in Southwest Montana with 0.5 m – 1 m spaced transects, this work involved 6 separate trips to the field site, walking for 10-14 hours a day for 2-4 days at a time.

## **Awards and Services:**

### **Journal review:**

Nature Geoscience

The Cryosphere

Journal of Glaciology

Annals of Glaciology

Arctic, Antarctic, and Alpine Research

### **Past Students:**

Secondary Advisor to **Vikram Goel**, PhD candidate at the University of Oslo and the Norwegian Polar Institute 2014-2016

Secondary Advisor to **César Deschamps-Berger**, undergraduate research intern at the Norwegian Polar Institute 2014

## **Awards:**

Boise State University Geosciences Departmental Fellowship, 2008-2009

Inland Northwest Research Alliance Fellowship, 2006-2008

Student Representative at Annual INRA Course Meeting, 2007

## **Invited talks and lectures:**

### **Institutional Seminars:**

**2012: University of Oslo, Norway** – “Using georadar to elucidate hydrologic properties of firn and ice in the percolation and ablation zones of the Greenland Ice Sheet”

**2012: Norwegian Polar Institute, Tromsø, Norway** - “Using georadar to elucidate hydrologic properties of firn and ice in the percolation and ablation zones of the Greenland Ice Sheet”

**2012: University of Montana** – “A model based approach to estimating the effects of a changing climate on small mountain glaciers: A case study of Sperry Glacier, Glacier National Park, Montana”

### **Conference talks:**

**2013: Antarctic Ice Rises Workshop, Tromsø, Norway** – “Measuring the trees to see the forest: bridging the gaps through synthesis of core and radar data”

**2013: Radio Echo Sounding Layer Tracing Workshop, Copenhagen, Denmark** – “Large spatial variations in firn density – a surprising effect on radar derived accumulation pattern”

**2009: Lessons from Continuity and Change in the Fourth International Polar Year, Fairbanks, AK** – “Firn densification rates in the percolation zone of Western Greenland”

**2006: Environmental and Subsurface Science Symposium, Moscow, ID** – “Time variability of radar reflections from englacial and subglacial waters, AK”

**2006: Graduate Student and Faculty Research Conference, Missoula, MT** – “Time variability of radar reflections from englacial and subglacial waters, AK”

### **Professional workshops:**

**2018: USGS Northern Rocky Mountain Science Center, Montana** – “Georadar in snow and ice – basic theory and processing techniques.”

## **Computational expertise:**

**Data mining and analytics:** Writing scripts in Python, Ruby, and BASH to parse large amounts of data from public sources including the US Patent and Trademark Office, the US Department of Labor, the Bureau of Labor and Statistics, the Bureau of Economic Analysis, the US Energy Information Administration, and the Mine Safety and Health Administration. Writing models and analytical analysis programs in Excel, MatLab, and Python to compile and analyze data for economic and scientific publications.

**Seismic and ground penetrating radar (GPR) processing:** Developed scripts for filtering, visually processing, and displaying both airborne and ground-based GPR data using MatLab, Python, and R. Using SeisUNIX and ProMax for seismic processing and processing GPR multi-offset data.

**High precision GPS processing:** Kinematic survey processing using TRACK (GAMIT/GLOBK); static site precise point position (PPP) processing with Trimble Business Center, TRACK, auto GYPSY, and CSRS; static site relative positioning with TRACK.

**Glacial flow modeling:** Thermo-mechanically coupled full Stokes finite element modeling of 2D ice flow over ice divides using Elmer/Ice; thermo-mechanically coupled full Stokes finite element modeling of 3D ice flow over the Greenland Ice Sheet using ISSM as well as VarGlaS; rule-based modeling of 3D glacier volume using a cellular automata model written in MatLab.

**Economic modeling:** Modeling the economic impact of increased carbon and methane emissions from proposed coal mining using Excel (the preferred platform for many economists); assessing the economic impact of reduced power generation at the Glen Canyon Dam on the western United States as well as the individual consumers of this electricity using Python and Excel; assessing the ability of different national energy economy models including the National Energy Modeling System (NEMS) and the Integrated Planning Model to model the increase in carbon associated with proposed coal mines.

**Internet resources:** Creating full-stack code for a web application with multiple database tables and logic that analyzes input data to determine personalized outputs for individuals using Ruby, HTML, JavaScript, and PostgreSQL. Developing docker container with python Flask application to run server and client side concurrently on local computer as a user interface for command line python model.

**Remote Sensing:** Processing radar reflectivity data collected by Operation IceBridge to create volumetric models of glacial ice and layering within the ice. Developing inversion techniques to measure vertical density profile of firn along bistatic radar transects. One technique uses a standard Lagrangian optimization algorithm to minimize an objective function which is based on empirically derived steady state firn densification models to solve for vertical density variations along a radar transect which intersects a dated firn/ice core. The other technique uses the measured source wavelet of the radar to deconvolve radar data into reflectivity profiles and, using a layer stripping technique, solve for the dielectric permittivity profile of firn and snow to determine the density profile.

## Professional society memberships:

Member, European Geophysical Union, 2013-2014

Member, American Geophysical Union, 2005-2012

Member, Society of Exploration Geophysicists, 2006-2011

Member, Geological Society of America, 2006-2010

## Publications:

### Peer reviewed publications:

Goel, V., **Brown, J.**, and Matsuoka, K., (2017) Glaciological settings and recent mass balance of Blåskimen Island in Dronning Maud Land, Antarctica, *The Cryosphere*, 11, 2883-2896, doi:10.5194/tc-11-2883-2017.

**Brown, J.**, Harper, J., and Humphrey, N., (2017) Liquid water content in ice estimated through a full-depth ground radar profile and borehole measurements in western Greenland, *The Cryosphere*, 11, 669-679, doi:10.5194/tc-11-669-2017.

Drews, R., **J. Brown**, K. Matsuoka, E. Witrant, M. Philippe, B. Hubbard, and F. Pattyn, (2016), Constraining variable density of ice shelves using wide-angle radar measurements, *The Cryosphere*, 10(2), 811-823, doi:10.5194/tc-10-811-2016.

Matsuoka, K., R. C. A. Hindmarsh, G. Moholdt, M. J. Bentley, H. D. Pritchard, **J. Brown**, H. Conway, R. Drews, G. Durand, D. Goldberg, T. Hattermann, J. Kingslake, J. T. M. Lenaerts, C. Martín, R. Mulvaney, K. Nicholls, F. Pattyn, N. Ross, T. Scambos, and P. L. Whitehouse (2015), Antarctic ice rises and rumples: their properties and significance for ice-sheet dynamics and evolution, *Earth-Science Reviews*, 150, 724-745, doi:10.1016/j.earscirev.2015.09.004.

Lenaerts, J. T. M., **J. Brown**, M. R. Van Den Broeke, K. Matsuoka, R. Drews, D. Callens, M. Philippe, I. V. Gorodetskaya, E. Van Meijgaard, C. H. Reijmer, F. Pattyn, and N. P. M. Van Lipzig, (2014), High variability of climate and surface mass balance induced by Antarctic ice rises, *Journal of Glaciology*, 60(224), 1101-1110.

Harper, J., N. Humphrey, W. T Pfeffer, **J. Brown**, and X. Fettweis (2012), Greenland ice-sheet contribution to sea-level rise buffered by meltwater storage in firn, *Nature*, 491(7423), doi:10.1038/nature11566

**Brown, J.**, J. Bradford, J. Harper, W. T. Pfeffer, N. Humphrey, and E. Mosley-Thompson (2012), Georadar-derived estimates of firn density in the percolation zone, western Greenland ice sheet, *Journal of Geophysical Research*, 117, F01011, doi:10.1029/2011JF002089.



**Brown, J.**, J. Harper, W.T. Pfeffer, N. Humphrey, and J. Bradford (2011), High resolution study of layering within the percolation and soaked facies of the Greenland ice sheet, *Annals of Glaciology*, 52(59).

**Brown, J.**, J. Harper, and N. Humphrey (2010), Cirque Glacier Sensitivity to 21st Century Warming: Sperry Glacier, Rocky Mountains, U.S.A., *Global planetary Change*, 74, 91-98, doi:10.1016/j.gloplacha.2010.09.001.

Bradford, J. H., J. T. Harper, and **J. Brown** (2009), Complex dielectric permittivity measurements from ground-penetrating radar data to estimate snow liquid water content in the pendular regime, *Water Resources Research.*, 45, W08403, doi:10.1029/2008WR007341.

**Brown, J.**, J.T. Harper, and J.H. Bradford (2009), A radar transparent layer in a temperate valley glacier: Bench Glacier, Alaska, *Earth Surface Processes and Landforms*, 34(11), 1497-1506.

**Brown, J.M.**, L. Steinbronn, J. Nichols, and J. Bradford (2009), Improved GPR interpretation through resolution of lateral velocity heterogeneity: Example from an archaeological site investigation, *Journal of Applied Geophysics*, 68(1), 3-8.

#### Official reports:

Power, T., D. Power, and **J. Brown** (2016) Comments on the Greenhouse Gas Impacts and the Modeling of Coal Flows in the Millennium Bulk Terminals Longview SEPA Draft Environmental Impact Statement, A Report Prepared for Sierra Club and Earthjustice.

Power, T., D. Power, and **J. Brown** (2016) The Economic Consequences of the Federal Coal Leasing Program: Improving the Quality of the Economic Analysis, A Report Prepared for Sierra Club and Earthjustice.

Power, T., D. Power, and **J. Brown** (2015) Misuse of Integrated Planning Model as an assessment tool in the Tongue River Railroad DEIS, A Report Prepared for the Northern Plains Resource Council.

Power, T., D. Power, and **J. Brown** (2015) The National Energy Modeling System's ability to model the impacts of the increase in coal production in the North Fork Valley, A Report Prepared for Sierra Club and Earthjustice.

Power, T., D. Power, and **J. Brown** (2015) Comments on the Rulemaking for the Colorado Roadless Areas Supplemental Draft Environmental Impact Statement, A Report Prepared for Sierra Club and Earthjustice.

Power, T., D. Power, and **J. Brown** (2015) The Impact of the Loss of Electric Generation at Glen Canyon Dam, Phase II: Financial Impacts on Existing Electric Consumers, A Report Prepared for the Glen Canyon Institute.

Power, T., D. Power, and **J. Brown** (2015) The Impact of the Loss of Electric Generation at Glen Canyon Dam, A Report Prepared for the Glen Canyon Institute.

**Brown, J.M.**, 2006, Report to accompany the magnetic map of the Tree Frog Spring archeological site near Monida, MT. Magnetic survey report, Regional BLM office, Dillon, MT

### Meeting abstracts:

**Brown, J.**, K. Matsuoka, E. Isaksson, and J. Kohler, Asymmetric mass balance patterns over three ice rises in the Fimbul Ice Shelf, East Antarctica, 2014, EGU spring meeting

Harper, J., N. Humphrey, W.T. Pfeffer, and **J. Brown**, Firn Stratigraphy and Temperature to 10 m Depth in the Percolation Zone of Western Greenland, 2007–2009. INSTAAR, Occasional Paper, 2011. ISSN 0069-6145(60).

**Brown, J.** and J. Harper, 2010, Georadar Imaging of Percolation Generated Ice Layers, Western Greenland, poster presentation, 2010, International Glaciological Society, 2010 Symposium on Disappearing Ice, Abstract 59A069.

Harper J.T., Humphrey N.F., Pfeffer, W.T., **Brown J.M.**, West, and J. H. Bradford, 2010, Field Measurement of Meltwater Retention on the Greenland Ice Sheet, International Glaciological Society, 2010 Symposium on Disappearing Ice, Abstract 59A07.

**Brown, J.M.**, 2009, Firn densification rates in the percolation zone of Western Greenland, Lessons from Continuity and Change in the Fourth International Polar Year, Fairbanks, AK, Abstracts with programs

Harper, J.T., Humphrey, N.F., Pfeffer, W.T., **Brown, J.M.**, West, D., Bradford, J.H., 2009, Firn densification and meltwater runoff in western Greenland, Eos Trans. AGU, 90(52), Fall Meet. Suppl., Abstract C34B-04.

**Brown, J.M.**, Bradford, J.H., Harper, J.T., Pfeffer, J.T., Humphrey, N.F., 2008, Change in Firn Densification Rates to 80 m Depth Across the Percolation Zone of Western Greenland: Eos Trans. AGU, 89(53), Fall Meet. Suppl., Abstract C31B-0490



- Brown, J.M.**, Bradford, J., Harper, J.T., Pfeffer, W.T., Humphrey, N.F., 2007, Ice penetrating radar surveys along the EGIG line in the percolation zone of Western Greenland: EosTrans. AGU, 88(52), Fall Meet. Suppl., Abstract NS11A-0161.
- Bradford, J.H., Clement, W., Nichols, J., **Brown, J.**, Mikesell, D., Harper, J., Humphrey, N., and Tshetter, T., 2007, Geophysical imaging of a temperate glacier's hydrologic system in 1, 2, and 3 dimensions: Eos Trans. AGU, 88(52), Fall Meet. Suppl., Abstract H23H-06.
- Brown, J.M.**, Harper, J.T., Bradford, J.H., and Humphrey, N.F., 2006, Temporal Variation of Depth of the Radar-Transparent Layer Within Bench Glacier, AK, Eos Trans. AGU, 87(52), Fall Meet. Suppl., Abstract C31A-1233.
- Brown, J.M.**, Harper, J.T., Bradford, J.H., and Humphrey, N.F., 2006, Time variability of radar reflections from englacial and subglacial waters, AK. Environmental and Subsurface Science Symposium, Moscow, ID, Abstracts with programs
- Brown, J.M.**, Harper, J.T., Bradford, J.H., and Humphrey, N.F., 2006, Time variability of radar reflections from englacial and subglacial waters, AK. Graduate Student and Faculty Research Conference, The University of Montana, Missoula, MT, Abstracts with programs
- Brown, J.M.**, Harper, J.T., Bradford, J.H., and Humphrey, N.F., 2005, Time variability of radar reflections from englacial and subglacial waters, Eos Trans. AGU, 86(52), Fall Mtg, Suppl., Abstract C13B-1076.