

## Noah P. Molotch, Ph.D.

Associate Professor of Geography  
Fellow, Institute of Arctic and Alpine Research  
Director, Center for Water, Earth Science & Technology  
University of Colorado at Boulder  
&  
Research Scientist  
Jet Propulsion Laboratory, California Institute of Technology

### EDUCATION

- Ph.D.** Department of Hydrology and Water Resources, College of Engineering,  
University of Arizona, Tucson, 2004  
**Minor:** Remote Sensing and Spatial Analysis
- M.E.S.M.** Donald Bren School of Environmental Science and Management, University of  
California, Santa Barbara, 2000
- B.A.** Environmental Studies, University of Colorado, Boulder, 1997

### RESEARCH INTERESTS

Surface Water Hydrology, Snow Hydrology, Ecohydrology, Remote Sensing

### PROFESSIONAL EXPERIENCE

- 2015 – Present **Associate Professor** of Geography and Fellow, Institute of Arctic and  
Alpine Research, University of Colorado at Boulder.
- 2015 – Present **Director**, Center for Water, Earth Science and Technology (CWEST),  
University of Colorado at Boulder.
- 2009 – 2015 **Assistant Professor** of Geography and Fellow, Institute of Arctic and  
Alpine Research, University of Colorado at Boulder.
- 2008 – Present **Research Scientist**, Surface Hydrology Group, Jet Propulsion Laboratory,  
California Institute of Technology.
- 2006 – 2009 **Assistant Research Scientist and Lecturer**, Department of Civil and  
Environmental Engineering, University of California, Los Angeles.
- 2004 – 2006 **Post-Doctoral Fellow**, Cooperative Institute for Research in  
Environmental Sciences, University of Colorado at Boulder.

### HONORS AND AWARDS

- 2010 Excellence in scientific review nomination, *Journal of Hydrology*
- 2008 Director's Fellowship, NASA Jet Propulsion Laboratory.
- 2004-2006 Cooperative Institute for Research in Environmental Sciences (CIRES)  
Visiting Fellowship.
- 2003-2004 Graduate College Fellow Award: Research Excellence, U. Arizona.

- 2003-2004 Arizona Floodplain Management Association Scholarship.  
 2003 *Best Paper*, Western Snow Conference.  
 2003 *The Montgomery Prize: Best Oral Presentation*, El Dia del Agua, Dept. of Hydrology and Water Resources, University of Arizona.  
 2002-2004 Dept. of Hydrology and Water Resources, *Graduate Student Scholarship*, University of Arizona.  
 2001 *Dr. James E. Church Memorial Award, Best Student Paper*, Western Snow Conference.  
 2000-2002 NSF STC, Sustainability of semi-Arid Hydrology and Riparian Areas, *Graduate Research Fellowship*, University of Arizona.

### MEMBERSHIP IN PROFESSIONAL ORGANIZATIONS

- 2008 – Present European Geosciences Union  
 2001 – Present American Geophysical Union

### RESEARCH ACTIVITIES

**Publications** (ISI: 79 Published; 2200+ citations; h-index = 27)

\*Graduate Student Advisee \*\*Post-Doctoral Advisee #Undergraduate Advisee

*In Review*

- (86) \*Barnhart, T.B., C.L. Tague, and **N.P. Molotch**, The Influence of snowmelt rate and timing on runoff generation, *Water Resources Research*, in review.  
 (85) \*Schneider, D., **N.P. Molotch**, J.S. Deems, T.H. Painter, Analysis of topographic controls on depletion curves derived from airborne Lidar snow depth data. *Hydrology Research*, in review.  
 (84) Huerta, M.L., J.P. McPhee and **N.P. Molotch**, Inter-annual variability of snowfall interception in a deciduous Nothofagus forest and implications for spatial snowpack distribution. *Hydrological Processes*, in review.  
 (83) \*Schneider, D., **N.P. Molotch**, J. Deems, Estimating relationships between snow water equivalent, snow covered area, and topography to extend the Airborne Snow Observatory dataset, *The Cryosphere*, in review.  
 (82) \*\*Barnard, D.; J.K. Knowles; H. Barnard; M. Goulden; J. Hu; M. Litvak; **N.P. Molotch**, Reevaluating growing season length controls on net ecosystem production, *Nature Scientific Reports*, in review.

*In Press*

- (81) Bueno de Mesquita, C.P., L.S. Tillmann, C.D. Bernard, K.C. Rosemond, **N.P. Molotch**, and K.N. Suding, Topographic heterogeneity mediates vegetation response to climate change in the Rocky Mountains, USA, *Arctic, Antarctic, and Alpine Research*, in press.

*Published*

**2018**

- (80) Driscoll, J.M., T. Meixner, **N.P. Molotch**, T.P.A. Ferré, M.W. Williams, J.O. Sickman, Event-response ellipses: a method to quantify and compare the role of dynamic storage at the

- catchment scale in snowmelt-dominated systems, *Water*, 10 (12), Pgs 1824-1841, doi: 10.3390/w10121824, 2018.
- (79) \*\*Webb, R.W., M. Fend, and **N.P. Molotch**. Combining ground penetrating radar with terrestrial LiDAR scanning to observe the spatial distribution of liquid water content in seasonal snowpacks. *Water Resources Research*, 54, doi: 10.1029/2018WR022680, 2018
- (78) Evans, S.G., S. Ge, C.L. Voss, and **N.P. Molotch**, The role of frozen soil in groundwater discharge predictions for warming alpine watersheds, *Water Resources Research*, 54 (3), Pgs 1599-1615, doi: 10.1002/2017WR022098, 2018.
- (77) Zheng, Z., **N.P. Molotch**, C.A. Oroza, M. Conklin, R.C. Bales, Spatial snow estimation for mountainous areas using wireless-sensor networks and remote-sensing products, *Remote Sensing of Environment*, 215, Pgs 44–56, doi: 10.1016/j.rse.2018.05.029, 2018.
- (76) \*\*Jepsen, S.A., T.C Harmon; D.L Ficklin, **N.P. Molotch**, \*\*B. Guan, Evapotranspiration sensitivity to air temperature across a snow-influenced watershed: space-for-time substitution versus integrated watershed modeling, *Journal of Hydrology*, 556, Pgs 645-659, <https://doi.org/10.1016/j.jhydrol.2017.11.042>, 2018.
- (75) \*\*Knowles, J.K., **N.P. Molotch**, \*\*E. Trujillo, M. Litvak, Snowmelt-driven trade-offs between early and late season productivity negatively impact forest carbon uptake during drought, *Geophysical Research Letters*, 45(7), Pgs 3087-3096, [doi.org/10.1002/2017GL076504](https://doi.org/10.1002/2017GL076504), 2018.
- (74) \*Jennings, K.S., T.G.F. Kittel, **N.P. Molotch** Observations and simulations of the seasonal evolution of snowpack cold content and its relation to snowmelt and the snowpack energy budget. *The Cryosphere*, 12, 1595-1614, doi:10.5194/tc-12-1595-2018, 2018.
- (73) \*Jennings K.S., \*T.S. Winchell, B. Livneh, **N.P. Molotch**, Spatial variation of the rain-snow temperature threshold across the Northern Hemisphere, *Nature Communications*, 9, Article number: 1148, doi:10.1038/s41467-018-03629-7, 2018.
- 2017**
- (72) \*Musselman, K.N., **N.P. Molotch**, S.A. Margulis, Snowmelt response to simulated warming across a large elevation gradient, southern Sierra Nevada, California, *The Cryosphere*, 11, 2847-2866, [doi.org/10.5194/tc-11-2847-2017](https://doi.org/10.5194/tc-11-2847-2017), 2017.
- (71) Stibal, M., J.E. Box, K.A. Cameron, P.L. Langen, M.L. Yallop, R.H. Mottram, A.L. Khan, **N.P. Molotch**, N.A. M. Christmas, F.C. Quaglia, D. Remias, C. J. P. Smeets, M.R. van den Broeke, M. Tranter, D. van As, A.P. Ahlstrøm, Surface ice algae are more important than dust for albedo-driven Greenland ice sheet melting, *Geophysical Research Letters*, 44, [doi.org/10.1002/2017GL075958](https://doi.org/10.1002/2017GL075958), 2017.
- (70) Hart, S.J., T.T. Veblen, \*D. Schneider, **N.P. Molotch**, Summer and winter drought drive the initiation and spread of spruce beetle infestation in the Southern Rocky Mountains, *Ecology*, 98: 2698–2707. doi:10.1002/ecy.1963.
- (69) Thomas B.F., J.S. Famiglietti, F.W. Landerer, D.N. Wiese, **N.P. Molotch**, D.F. Argus, California groundwater drought characterization using GRACE, *Remote Sensing of Environment*, Volume 198, pgs. 384-392, doi:10.1016/j.rse.2017.06.026, 2017.
- (68) López-Moreno, I., S. Gascoin, J. Herrero, E. A. Sproles, M. Pons, E. Alonso-González, L. Hanich, A. Boudhar, \*K.N. Musselman, **N.P. Molotch**, J. Sickman, J. Pomeroy, Different sensitivities of snowpack to warming in Mediterranean climate mountain areas,

- Environmental Research Letters*, Vol. 12, article: 074006, doi:10.1088/1748-9326/aa70cb, 2017.
- (67) \*\*Knowles, J.K., L. Lestak, **N.P. Molotch**, On the use of a snow aridity index to predict remotely sensed forest productivity in the presence of bark beetle disturbance, *Water Resources Research*, 53, doi:10.1002/2016WR019887.
- (66) \*\*Barnard, D.R., H.R. Barnard, **N.P. Molotch**, Microclimate effects on growing season length and montane conifer growth in complex terrain, *Environmental Research Letters*, Vol. 12, article: 064003, doi:10.1088/1748-9326/aa6da8, 2017.
- (65) \*\*Cowie, R.M., J.F. Knowles, K.R. Dailey, M.W. Williams, J.T. Mills, **N.P. Molotch**, Sources of streamflow along a headwater catchment elevational gradient, *Journal of Hydrology*, Vol. 549, doi:10.1016/j.jhydrol.2017.03.044, 2017.
- (64) Fyfe, J.C., C. Derksen, L. Mudryk, N.C. Swart, **N.P. Molotch**, G.M. Flato, X. Zhang, H. Wan, V.K. Arora, J. Scinocca, Y. Jiao, Large near-term projected snowpack loss over the western United States, *Nature Communications*, Vol. 8, article: 14996, doi:10.1038/ncomms14996, 2017.
- (63) Hallar, A.G., **N.P. Molotch**, J. Hand, L.R. Lestak, I.B. McCubbin, B. Livneh, R. Petersen, J. Michalsky, D. Lowenthal, Impacts of increasing aridity and wildfires on aerosol loading in the intermountain western U.S., *Environmental Research Letters*, 12(1): article 014006. doi: 10.1088/1748-9326/aa510a, 2017.
- (62) \*Baker, E, T. H. Painter, D. Schneider, A. Meddens, J.A. Hicke, **N.P. Molotch**, Quantifying insect-related forest mortality with the remote sensing of snow, *Remote Sensing of Environment*, 188: 26-36. doi: 10.1016/j.rse.2016.11.001, 2017.
- 2016**
- (61) \*Schneider, D., **N.P. Molotch**, Real-time estimation of snow water equivalent in the Upper Colorado River Basin using MODIS-based SWE reconstructions and SNOTEL data, *Water Resources Research*, 52, doi:10.1002/2016WR019067, 2016.
- (60) **Molotch, N.P.**, \*\*D.M. Barnard, S.P. Burns, and T.H. Painter, Measuring spatio-temporal variation in snowpack microstructure under a subalpine forest canopy using contact spectroscopy, *Water Resources Research*, 52, doi:10.1002/2016WR018954, 2016.
- (59) \*Barnhart, T.B., **N.P. Molotch**, B. Livneh, \*\*A.A. Harpold, \*\*J.F. Knowles, and \*D. Schneider, Snowmelt rate dictates streamflow, *Geophysical Research Letters*, 43, 8006–8016, doi:10.1002/2016GL069690, 2016.
- (58) \*Winchell, T.S., \*\*D.M. Barnard, R.K. Monson, S.P. Burns, and **N.P. Molotch**. Early snowmelt reduces atmospheric carbon uptake in mid-latitude subalpine forests, *Geophysical Research Letters*, 43, 8160–8168, doi:10.1002/2016GL069769, 2016.
- (57) Seidel, F.C, K. Rittger, S.M. Skiles, **N.P. Molotch** and T.H. Painter, Case study of spatial and temporal variability of snow cover, grain size, albedo and radiative forcing in the Sierra Nevada and Rocky Mountain snowpack derived from imaging spectroscopy, *The Cryosphere*, 10, 1–16, doi:10.5194/tc-10-1-2016, 2016.
- (56) Foster, L., L. Bearup, **N.P. Molotch**, P. Brooks, R. Maxwell, Energy budget changes impact arid mountain hydrology more than snow-rain transitions, *Environmental Research Letters*, 11(40), doi:10.1088/1748-9326/11/4/044015, 2016.
- (55) Cornwell, E.N., J. McPhee, and **N.P. Molotch**, Spatio-temporal variability of snow water equivalent in the extra-tropical Andes cordillera from distributed energy balance

modeling and remotely sensed snow cover data, *Hydrology & Earth System Science*, 20, 411-430, doi:10.5194/hess-20-411-2016, 2016.

## 2015

- (54) Williams, M.W., E. Hood, **N.P. Molotch**, N. Caine, \*\*R. Cowie, F. Liu, The "Teflon basin" myth: hydrology and hydrochemistry of a seasonally snow-covered catchment, *Plant Ecology and Diversity*, Volume 8, Issue 5-6, November 2015, pages 639-661.
- (53) \*\*Harpold, A. A., and **N. P. Molotch**, Sensitivity of soil water availability to changing snowmelt timing in the western U.S., *Geophysical Research Letters*, 42, 8011–8020, doi:10.1002/2015GL065855, 2015.
- (52) Broxton, P.D., A. A. Harpold, J. A. Biederman, P. A. Troch, **N. P. Molotch**, and P. D. Brooks, Quantifying the effects of vegetation structure on snow accumulation and ablation in mixed-conifer forests, *Ecohydrology*, Volume 8(6): 1073–1094, DOI: 10.1002/eco.1565, 2015.
- (51) \*\*Harpold, A.A., J.A. Marshall, S.W. Lyon, T.B. Barnhart, B. Fisher, M. Donovan, K.M. Brubaker, C.J. Crosby, N.F. Glenn, C.L. Glennie, P.B. Kirchner, N. Lam, K.D. Mankoff, J.L. McCreight, **N.P. Molotch**, K.N. Musselman, J. Pelletier, T. Russo, H. Sangireddy, Y. Sjöberg, T. Swetnam, N. West, Laser vision: Lidar as a transformative tool to advance critical zone science, *Hydrology and Earth System Science*, 19, DOI: 10.5194/hess-19-2881-2015, 2015.
- (50) \*\*Harpold, A.A., **N.P. Molotch**, K.N. Musselman, R.C. Bales, P.B. Kirchner, M. Litvak, and P.D. Brooks, Soil Moisture Response to Snowmelt Timing in Mixed-Conifer Subalpine Forests, *Hydrological Processes*, Volume: 29(12), DOI: 10.1002/hyp.10400, 2015.
- (49) Livneh B., J.S. Deems, B. Buma, J.J. Barsugli, D. Schneider, **N.P. Molotch**, K. Wolter, and C.A. Wessman, Catchment Response to Bark Beetle Outbreak in the Upper Colorado River Basin, *Journal of Hydrology*, Vol. 523, DOI: 10.1016/j.jhydrol.2015.01.039, 2015.
- (48) \*Meromy, L., **N.P. Molotch**, M.W. Williams, K.N. Musselman, L.M. Kueppers, Snowpack-climate manipulation using infrared heaters in subalpine forests of the Southern Rocky Mountains, USA, *Journal of Agricultural and Forest Meteorology*, Vol. 203, doi:10.1016/j.agrformet.2014.12.015, 2015.
- (47) Vander Jagt, B., M.T. Durand, S.A Margulis, E.J Kim, **N.P. Molotch**, On the characterization of vegetation transmissivity using LAI for application in passive microwave remote sensing of snowpack, *Remote Sensing of Environment*, Vol. 156, doi:10.1016/j.rse.2014.09.001, 2015.
- (46) **Molotch, N.P.**, M.T. Durand, B. Guan, S.A. Margulis, R.E. Davis, Snow cover depletion curves and snow water equivalent reconstruction: six decades of hydrologic remote sensing applications, *AGU Monograph on Remote Sensing of the Terrestrial Water Cycle*, ISBN: 978-1-118-87203-1, 576 pages, 2015.

## 2014

- (45) Livneh B., J.S. Deems., D. Schneider, J. Barsugli, and **N.P. Molotch** (2014), Filling in the gaps: inferring spatially distributed precipitation from gauge observations over complex terrain. *Water Resources Research*, DOI: 10.1002/2014WR015442, 2014.
- (44) \*Perrot D., **N.P. Molotch**, M.W. Williams, J.O. Sickman, Relationships between stream nitrate concentration and spatially distributed snowmelt in high elevation catchments of the western United States, *Water Resources Research*, 10.1002/2013WR015243, 2014.

- (43) Kirchner, P.B., R.C. Bales, **N.P. Molotch**, J. Flanagan, Q. Guo, LiDAR measurement of seasonal snow accumulation along an elevation gradient in the southern Sierra Nevada, California, *Hydrology and Earth System Science*, 8, 4261-4275, doi:10.5194/hess-18-4261-2014, 2014.
- (42) \*\*Trujillo, E., **N.P. Molotch**, Snowpack Regimes of the Western United States, *Water Resources Research*, 50(7): 5611-5623. doi: 10.1002/2013WR014753, 2014.
- (41) **Molotch, N.P.**, \*L. Meromy, Physiographic and climatic controls on snow cover persistence in the Sierra Nevada Mountains, *Hydrological Processes*, 28(16), 4573-4586, doi: 10.1002/hyp.10254, 2014.
- (40) Ralph, F.M., M. Dettinger, A. White, D. Reynolds, D. Cayan, T. Schneider, R. Cifelli, K. Redmond, M. Anderson, F. Gherke, J. Jones, K. Mahoney, L. Johnson, S. Gutman, V. Chandrasekar, J. Lundquist, **N. Molotch**, L. Brekke, R. Pulwarty, J. Horel, L. Schick, A. Edman, P. Mote, J. Abatzoglou, R. Pierce, G. Wick, A vision for future observations for Western U.S. extreme precipitation and flooding, *Journal of Contemporary Water Research & Education*, 153, 16-32, 2014.
- (39) \*\*Harpold, A.A., Q. Guo, **N.P. Molotch**, P. Brooks, R. Bales, J.C. Fernandez, P. Kirchner, M. Meadows, R. Lucas, J. Flannagan, \*K. Musselman, and T. Swetnam, LiDAR-derived snowpack datasets from mixed conifer forests across the Western U.S., *Water Resources Research*, 50, 2749–2755, doi:10.1002/2013WR013935, 2014.
- (38) #Perrot, D., **N.P. Molotch**, \*K.N. Musselman, E. Pugh, Modeling the effects of the Mountain Pine Beetle on snowmelt in a subalpine forest, *Ecohydrology*, 7(2), 226 – 241, doi: 10.1002/eco.1329, 2014.
- (37) Burns, S.P., **N.P. Molotch**, M.W. Williams, J.K. Knowles, B. Seok, R.K. Monson, A.A. Turnipseed, P.D. Blanken, Snow temperature changes within a seasonal snowpack and their relationship to turbulent fluxes of sensible and latent heat. *Journal of Hydrometeorology*, 15, 117-142, doi:10.1175/JHM-D-13-026.1, 2014.
- 2013**
- (36) \*\*Guan, B., **N.P. Molotch**, D.E. Waliser, E.J. Fetzer, and P.J. Neiman, The 2010/11 snow season in California’s Sierra Nevada: role of atmospheric rivers and modes of large-scale variability, *Water Resources Research*, 49, 6731–6743, doi:10.1002/wrcr.20537, 2013.
- (35) \*\*Guan, B., **N.P. Molotch**, D.E. Waliser, \*\*S. Jepsen, T.H. Painter, J. Dozier, Snow water equivalent in the Sierra Nevada: blending snow sensor observations with snowmelt model simulations, *Water Resources Research*, VOL. 49, 1–18, doi:10.1002/wrcr.20387, 2013.
- (34) #Meromy, L., **N.P. Molotch**, T.E. Link, S.R. Fassnacht, R. Rice, Subgrid variability of snow water equivalent at operational snow stations in the western USA, *Hydrological Processes*, VOL 27(17), DOI: 10.1002/hyp.9355, 2013.
- (33) Vander Jagt, B., M.T. Durand, S.A. Margulis, **N.P. Molotch**, E.J. Kim, The effect of spatial variability on the sensitivity of passive microwave measurements to snow water equivalent, *Remote Sensing of Environment*, Vol. 136, Pgs 163 – 179, DOI: 10.1016/j.rse.2013.05.002, 2013.
- (32) \*Musselman, K.N., S.A. Margulis, **N.P. Molotch**, Estimation of solar direct beam transmittance of conifer canopies from airborne LiDAR, *Remote Sensing of Environment*, Vol. 136, Pgs 402–415, DOI: 10.1016/j.rse.2013.05.021, 2013.

- (31) Mahat, V., D.G. Tarboton, **N.P. Molotch**, Testing above- and below-canopy representations of turbulent fluxes in an energy balance snowmelt model, *Water Resources Research*, Vol. 49, 2, Pgs: 1107–1122, DOI: 10.1002/wrcr.20073, 2013.
- (30) Berisford, D.F., **N.P. Molotch**, M.T. Durand, T.H. Painter, Portable spectral profiler probe for rapid snow grain size stratigraphy, *Cold Regions Science and Technology*, 85, 183–190, doi:10.1016/j.coldregions.2012.09.007, 2013.

## 2012

- (29) \*Musselman, K.N., **N.P. Molotch**, S.A. Margulis, M. Lehning, D. Gustafson, Improved snowmelt simulations with a canopy model forced with photo-derived direct beam canopy transmissivity, *Water Resources Research*, 48, 10, doi:10.1029/2012WR012285, 2012.
- (28) \*\*Trujillo, E., **N.P. Molotch**, M. Goulden, A. Kelly, R. C. Bales, Elevation-dependent influence of snow accumulation on forest greening, *Nature Geoscience*, doi:10.1038/ngeo1571, 2012.
- (27) \*Musselman, K.N., **N.P. Molotch**, S.A. Margulis, P.B. Kirchner, R.C. Bales, Influence of canopy structure and direct beam solar irradiance on snowmelt rates in a mixed conifer forest, *Agricultural and Forest Meteorology*, VOL. 161, Pgs. 46-56, DOI: 10.1016/j.agrformet.2012.03.011, 2012.
- (26) \*\*Jepsen, S.M., **N. P. Molotch**, M.W. Williams, K.E. Rittger, J.O. Sickman, Interannual variability of snowmelt in the Sierra Nevada and Rocky Mountains, United States: Examples from two alpine watersheds, *Water Resources Research*, VOL. 48, W02529, DOI: 10.1029/2011WR011006, 2012.
- (25) \*\*Guan, B., **N. P. Molotch**, D. E. Waliser, E. J. Fetzer, and P. J. Neiman, Does the Madden-Julian Oscillation Influence Wintertime Atmospheric Rivers and Snowpack in the Sierra Nevada?, *Monthly Weather Review*, Vol.,140, 325–342. DOI: 10.1175/MWR-D-11-00087.1, 2012.

## 2011

- (24) Durand, M., E.J. Kim, S.A. Margulis, **N.P. Molotch**, A first-order characterization of errors from neglecting stratigraphy in forward and inverse passive microwave modeling of snow, *IEEE Transactions of Geoscience and Remote Sensing*, Vol. 8 (4), DOI: 10.1109/LGRS.2011.2105243, 2011.
- (23) \*\*Guan, B., **N. P. Molotch**, D. E. Waliser, E. J. Fetzer, and P. J. Neiman, Extreme snowfall events linked to atmospheric rivers and surface air temperature via satellite measurements, *Geophysical Research Letters*, 37, L20401, doi:10.1029/2010GL044696, 2011.

## 2010

- (22) Gustafson, J. R., P. D. Brooks, **N. P. Molotch**, and W. C. Veatch, Estimating snow sublimation using natural chemical and isotopic tracers across a gradient of solar radiation, *Water Resources Research*, 46, 2010.
- (21) Njoku, E. G., M. Moghaddam, D. Moller, and **N. Molotch**, Microwave remote sensing for land hydrology research and applications: introduction to the special issue, *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing*, 3(1), 3-5, 2010.
- (20) **Molotch, N. P.**, S. A. Margulis, and S. M. Jepsen, Response to comment by AG Slater, MP Clark, and AP Barrett on 'Estimating the distribution of snow water equivalent using

- remotely sensed snow cover data and a spatially distributed snowmelt model: A multi-resolution, multi-sensor comparison', *Advances in Water Resources*, 33(2), 231-239, 2010.
- 2009**
- (19) **Molotch, N.P.**, P.D. Brooks, S.P. Burns, M. Litvak, J.R. McConnell, R.K. Monson, and \*K. Musselman, Ecohydrological controls on snowmelt partitioning in mixed-conifer sub-alpine forests, *Ecohydrology*, Vol. 2, doi: 10.1002/eco.48, 2009.
- (18) Veatch, W, P.D. Brooks, J. Gustafson, **N. P. Molotch**, Quantifying the effects of forest canopy cover on net snow accumulation at a continental, mid-latitude site, Valles Caldera National Preserve, NM, USA, *Ecohydrology*, Vol. 2, doi: 10.1002/eco.45, 2009.
- (17) **Molotch, N.P.**, Reconstructing snow water equivalent in the Rio Grande headwaters using remotely sensed snow cover data and a spatially distributed snowmelt model, *Hydrological Processes*, Vol. 23, doi: 10.1002/hyp.7206, 2009.
- 2008**
- (16) **Molotch, N.P.**, T. Meixner, and M.W. Williams, Estimating stream chemistry during the snowmelt pulse using a spatially distributed, coupled snowmelt and hydrochemical modeling approach, *Water Resources Research*, Vol. 44, doi:10.1029/2007WR006587, 2008.
- (15) Driscoll, J. M., T. Meixner, W. Williams, and **N. Molotch** , Evolution of flowpaths in an alpine watershed of the Colorado Front Range, USA, *Geochimica Et Cosmochimica Acta*, 72(12), A227-A227, 2008.
- (14) Durand, M., **N.P. Molotch**, and S. Margulis, A bayesian approach to snow water equivalent reconstruction, *Journal of Geophysical Research*, 113, doi:10.1029/2008JD009894, 2008.
- (13) **Molotch, N.P.**, and S.A. Margulis, Estimating the distribution of snow water equivalent using remotely sensed snow cover data and a spatially distributed snowmelt model: a multi-resolution, multi-sensor comparison, *Advances in Water Resources*, 31, 2008.
- (12) Lyon, S.W., P.A. Troch, P.D. Broxton, **N.P. Molotch**, P.D. Brooks, Monitoring the timing of snowmelt and the initiation of streamflow using a distributed network of temperature/light sensors, *Ecohydrology*, 1, 2008.
- (11) \*Musselman, K., **N.P. Molotch**, and P.D. Brooks, Effects of vegetation on snow accumulation and ablation in a mid-latitude sub-alpine forest, *Hydrological Processes*, Vol 22, 2008.
- (10) Durand, M., **N.P. Molotch**, and S. Margulis, Merging complementary remote sensing datasets in the context of snow water equivalent reconstruction, *Remote Sensing of Environment*, Vol. 112, doi:10.1016/j.rse.2007.08.010, 2008.
- 2007**
- (9) **Molotch, N.P.**, P.D. Blanken, M.W. Williams, A.A. Turnipseed, R.K. Monson, and S.A. Margulis, Estimating sublimation of intercepted and sub-canopy snow using eddy covariance systems, *Hydrological Processes*, 21, doi: 10.1002/hyp.6719, 2007.
- (8) Painter, T.H., **N.P. Molotch**, and M. Cassidy, Contact spectroscopy for determination of stratigraphy of snow grain size, *Journal of Glaciology*, 53(180), 2007.
- 2006**



- (7) Bales, R.C., **N.P. Molotch**, T.H. Painter, M. Dettinger, R. Rice, and J. Dozier, Mountain hydrology of the Western United States, *Water Resources Research*, **42**, W08432, doi:10.1029/2005WR004387, 2006.
- (6) **Molotch, N.P.**, and R.C. Bales, Comparison of ground-based and airborne snow-surface albedo parameterizations in an alpine watershed: impact on snowpack mass balance, *Water Resources Research*, VOL. **42**, doi:10.1029/2005WR004522, 2006.
- (5) **Molotch, N.P.**, and R.C. Bales, SNOTEL representativeness in the Rio Grande headwaters on the basis of physiographics and remotely sensed snow cover persistence, *Hydrological Processes*, VOL. **20**, doi: 10.1002/hyp.6128, 2006.

#### 2005

- (4) **Molotch, N.P.**, and R.C. Bales, Scaling snow observations from the point to the grid-element: implications for observation network design, *Water Resources Research*, VOL. **41**, doi: 10.1029/2005WR004229, 2005.
- (3) **Molotch, N.P.**, M.T. Colee, R.C. Bales, and J. Dozier, Estimating the spatial distribution of snow water equivalent in an alpine basin using binary regression tree models: the impact of digital elevation data and independent variable selection, *Hydrological Processes*, VOL. **19**, doi: 10.1002/hyp.5586, 2005.

#### 2004

- (2) **Molotch, N.P.**, T.H. Painter, R.C. Bales, and J. Dozier, Incorporating remotely sensed snow albedo into a spatially distributed snowmelt model, *Geophysical Research Letters*, VOL. **31**, doi:10.1029/2003GL019063, 2004.
- (1) **Molotch, N.P.**, S.R. Fassnacht, R.C. Bales, and S. R. Helfrich, Estimating the distribution of snow water equivalent and snow extent beneath cloud-cover in the Salt-Verde River basin, Arizona, *Hydrological Processes*, VOL **18**, doi:10.1002/hyp.1408, 2004.

#### Peer Review Book Chapters

- Molotch, N.P.**, Link, T.E., Blanken, P.D. Snow: Hydrological and Ecological Feedbacks in Forests. In: Levia, D.F., Carlyle-Moses, D.E. and Tanaka, T. (Eds.), *Forest hydrology and biogeochemistry: synthesis of past research and future directions*. Ecological Studies Series, Vol. 216, Springer-Verlag, <>Heidelberg, Germany. First Edition., XXII, 740 p., doi: 10.1007/978-94-007-1363-5, 2011.
- Fenn, M.E., Sickman, J.O., Bytnerowicz, A., Clow, D.W., **Molotch, N.P.**, Pleim, J.E., Tonnesen, G.S., Weathers, K.C., Padgett, P.E., and Campbell., D.H. Methods for measuring atmospheric nitrogen deposition inputs in arid and montane ecosystems of western North America. pp. 179-228 In A.H. Legge (ed.), *Developments in Environmental Science*, Vol. 9: Relating Atmospheric Source Apportionment to Vegetation Effects: Establishing Cause Effect Relationships. Elsevier, Amsterdam, 2009.

#### Non-Peer Review Conference Proceedings

- Molotch, N.P.**, P.D. Blanken, M.W. Williams, A.A. Turnipseed, R.K. Monson, and S.A. Margulis, Estimating sublimation of intercepted and sub-canopy snow using eddy covariance systems, *Proc. of the 63<sup>rd</sup> Eastern Snow Conference*, Newark, Delaware, 2006.

**Molotch, N.P.**, and R.C. Bales, SNOTEL representativeness in the Rio Grande headwaters on the basis of physiographics and remotely sensed snow cover persistence, *Proc. of the 73<sup>rd</sup> Western Snow Conference*, Great Falls, Montana, 2005.

**Molotch, N. P.**, T.H. Painter, R. C. Bales, and J. Dozier, Optimization of binary regression tree models for estimating the spatial distribution of snow water equivalent in an alpine basin, *Proc. of the 71<sup>st</sup> Western Snow Conference*, Scottsdale, Arizona, 2003

**Molotch, N.P.**, S.R. Fassnacht, S.R. Helfrich, and R.C. Bales, Estimating the distribution of snow water equivalent and snow extent beneath cloud-cover in the Salt-Verde River Basin, Arizona, *Proc. of the 59<sup>th</sup> Eastern Snow Conference*, Stowe, Vermont, 2002.

**Molotch, N. P.**, T. H. Painter, M. T. Colee, C. W. Rosenthal, J. Dozier, and R. C. Bales, Analysis of the spatial variability of snow cover depletion in an alpine watershed, Tokopah Basin, Sierra Nevada, California, USA, *Proc. of the 69<sup>th</sup> Western Snow Conference*, Sun Valley, Idaho, USA (*Best Student Paper Award*), 2001.

*Abstracts/Presentations (list does not include over 100 co-authored abstracts since 2006).*

#### 2018

**Molotch, N.P.**, Informing drought response using remotely sensed and modeled snowpack data, NASA Applied Sciences Team Workshop, Boulder, CO, 27 June.

#### 2017

**Molotch, N.P.**, Analysis of agricultural water supply-demand imbalance during the California drought, NASA Applied Sciences Team Workshop, Pasadena, CA, 19 July.

**Molotch, N.P.**, Mega-snowstorms follow epic drought in the Sierra Nevada. Western Snow Conference, Boise, ID, 19 April.

#### 2016

**Molotch, N.P.**, T. Barnhart, A. Harpold, E. Trujillo, Hydrologic response to changes in the timing and rate of snowmelt: implications for water resource management in the Western U.S. presented at 2016 Fall Meeting, AGU, San Francisco, Calif., 12-16 Dec. (*Invited*)

**Molotch, N.P.**, D. Schneider, Development of universal relationships between snow depth, snow covered area and terrain roughness from NASA Airborne Snow Observatory data, presented at the Eastern Snow Conference, Columbus, Ohio, 15-16 June. (*Invited*)

**Molotch, N.P.**, Measuring and monitoring our snow water resource, Colorado Water Resources Association annual meeting, Golden, Colorado, 22 April. (*Invited*)

#### 2015

**Molotch, N.P.**, D. Schneider, Establishing Transferable Sub-Pixel Relationships between Snow Depth, Snow Covered Area and Terrain Roughness, International Union of Geodesy and Geophysics General Assembly, Prague, Czech Republic, 24 June.

**Molotch, N.P.**, D. Schneider, Combining ground-based observations, distributed models, and remotely sensed data for real-time SWE estimates, International Union of Geodesy and Geophysics General Assembly, Prague, Czech Republic, 24 June.

**Molotch, N.P.**, B. Guan, L. Lestak, T. Painter, J. Dozier, Real-time analysis of snow-related drought in the Sierra Nevada using MODIS-BASED SWE reconstructions and in situ measurements, AGU Chapman Conference on the California Drought, Irvine, Calif., 3 June.

**Molotch, N.P.**, Spatial analysis of snow-related drought in the Sierra Nevada using MODIS-based SWE reconstructions, Western Snow Conference, Grass Valley, Calif., 20 April.

#### 2014

**Molotch, N.P.**, Impacts of insect-related forest mortality on hydrologic partitioning and forest productivity in the Southern Rocky Mountains, USA, presented at 2014 Fall Meeting, AGU, San Francisco, Calif., 15-19 Dec. (*Invited*)

**Molotch, N.P.**, Forest response to snow-related drought in the Southwestern U.S., World Meteorological Organization, International Symposium on Weather and Climate Extremes, Food Security and Biodiversity, Fairfax, Virginia, 21 Oct.

**Molotch, N.P.**, Real time Satellite Estimation and Mapping of Snow Water Equivalent across the Sierra Nevada, Workshop on remote sensing applications for water resources management and drought, Sacramento, CA, 25 Feb. (*Invited*)

**Molotch, N.P.**, E. Trujillo, Anomalous forest stress in the Rocky Mountains caused by snow-aridity, consistent with expected future conditions, presented at the 2014 European Geosciences Union General Assembly, Vienna, Austria, 28 April – 2 May.

#### 2013

**Molotch, N.P.**, E. Trujillo, L. Lestak, Record-setting forest stress in the Rocky Mountains caused by low snowfall and high potential evapotranspiration, consistent with expected future conditions, presented at 2013 Fall Meeting, AGU, San Francisco, Calif., 3-7 Dec. (*Invited*)

**Molotch, N.P.**, A. Harpold, Forest-snow interactions at Critical Zone Observatories of the Western U.S., presented at 2013 Fall Meeting, AGU, San Francisco, Calif., 3-7 Dec. (*Invited*)

**Molotch, N.P.**, E. Trujillo, L. Lestak, Satellite observations of snowpack-ecosystem feedbacks in the Western U.S., presented at the Eastern Snow Conference, Huntsville, Ontario, Canada, 4 – 6 June.

**Molotch, N.P.**, L. Meromy, M.W. Williams, and L. Kueppers, Estimating future snowpack conditions using thermal infrared heaters and a physically based snowmelt model: results from Niwot Ridge, Colorado, USA, presented at the 2013 European Geosciences Union General Assembly, Vienna, Austria, 7 – 12 April.

**Molotch, N.P.**, E. Trujillo, L. Lestak, Multi-scale observations of snowpack-ecosystem feedbacks: identifying tipping points in forest response to climate change in the Western U.S., presented at the International Union of Geodesy and Geophysics, Atmosphere and Cryosphere Assembly, Davos, Switzerland, 8 – 12 July. (*Invited*).

#### 2012

**Molotch, N.P.**, S. Jepsen, Geological filters modulating streamflow response to snowmelt and climate change, presented at the 2012 annual meeting of the American Association of Geographers, New York, NY., 24 – 28 Feb.

**Molotch, N.P.**, B. Guan, M. Durand, J. Dozier, Remote sensing of the mountain snowpack: Integration of observations and models to support water resource management and ecosystem science, presented at 2012 AGU Chapman Conference: Remote Sensing of the Terrestrial Water Cycle, Kona, Hawai'i, 19-22 Feb.

- Molotch, N.P.**, Improved snow observations from remote sensing, presented at the Western States Water Council Extreme Events Meeting, San Diego, CA, 31 July. (*Invited*)
- Molotch, N.P.**, B. Guan, E. Trujillo, Elevation-dependent controls on snowmelt partitioning and vegetation response inferred from satellite observations, presented at 2012 Fall Meeting, AGU, San Francisco, Calif., 3-7 Dec. (*Invited*)
- Molotch, N.P.**, K.N. Musselman, P.B. Kirchner; R.C. Bales, P.D. Brooks, Effects of forest structure on snow accumulation and melt derived from ecohydrological instrument clusters across the Western US, presented at 2012 Fall Meeting, AGU, San Francisco, Calif., 3-7 Dec. (*Invited*)

## 2011

- Molotch, N.P.**, Monitoring Rocky Mountain Snow Water Equivalent, presented at the Water Education Foundation, Border Area Remote Sensing Water Management Workshop, San Diego, CA, 8-9 June. (*invited*)
- Molotch, N.P.**; Jepsen, S.M.; Williams, M.W.; Trujillo, E.; Sickman, J.O.; Rittger, K.E., Snowmelt and the geological and ecological filters modulating climate variability and streamflow response, presented at 2011 Fall Meeting, AGU, San Francisco, Calif., 5-9 Dec.
- Molotch, N.P.**; E. Trujillo; K.N. Musselman, Sub-alpine forest response to spatio-temporal variability in snowmelt, presented at the 2011 European Geosciences Union General Assembly, Vienna, Austria.
- Molotch, N.P.**; E. Trujillo; K.N. Musselman, Vegetation-snowpack feedbacks from plot to regional scales, presented at the 2011 annual meeting of the American Association of Geographers, Seattle, WA.

## 2010

- Molotch, N.P.**, K.N. Musselman, E. Trujillo, P.D. Brooks, J.R. McConnell, M.W. Williams, Ecohydrological response to snowmelt dynamics from plot to regional scales, Abstract C14B-02, presented at 2010 Fall Meeting, AGU, San Francisco, Calif., 13-17 Dec.
- Molotch, N.P.**, Reconstructing snow water equivalent in mountainous regions using remotely sensed data and distributed snowmelt models, Abstract HS4.14, presented at the European Geosciences Union General Assembly, Vienna, Austria, 02 - 07 May.
- Molotch, N.P.**, Topographic and Climatic Controls on Snow Cover Duration and Snow Water Equivalent in the Sierra Nevada, presented at the 78th Western Snow Conference, Logan, UT, 19 - 22 April.

## 2009

- Molotch, N.P.**, Meromy, L., Topographic and climatic controls on snow cover duration in the Sierra Nevada, 2009 Fall AGU Meeting, San Francisco, CA.

## 2008

- Molotch, N.P.**, T. Link, S.R. Fassnacht, E. Herchmer, L. Meromy, S. Roberts, R. Rice, Determining subgrid variability in snow water equivalent surrounding operational snow stations of the Western U.S., *2008 Fall AGU Meeting, San Francisco, CA.*
- Molotch, N.P.**, S.A. Margulis, J. Dozier, T.H. Painter, D. Shen, A. Kwok, Inter-annual variability in snow cover depletion and snow water equivalent in the Sierra Nevada inferred from MODIS data, *2008 Fall AGU Meeting, San Francisco, CA.*

**2007**

**Molotch, N.P.**, J.R. McConnell, M. Litvak, and P.D. Brooks, Ecohydrological controls on snowmelt partitioning in a mixed-conifer sub-alpine forest, Valles Caldera, New Mexico, *2007 Fall AGU Meeting, San Francisco, CA.*

**Molotch, N.P.**, Reconstructing snow water equivalent in the Rio Grande headwaters using remotely sensed snow cover data and a spatially distributed snowmelt model, *21<sup>st</sup> Conference on Hydrology, American Meteorological Society, San Antonio, TX.*

**2006**

**Molotch, N.P.**, T.H. Painter, and M. Cassidy, Snow / vegetation interactions inferred from contact spectroscopy, *2006 Fall AGU Meeting, San Francisco, CA.*

**Molotch, N.P.**, Reconstructing snow water equivalent in the Rio Grande headwaters using remotely sensed snow cover data and a spatially distributed snowmelt model. *2006 AGU Hydrology Days, Fort Collins, CO.*

**2005**

**Molotch, N.P.**, and R.C. Bales, Local-scale controls on snow distribution in the Rio Grande headwaters: implications for evaluating spatially distributed snowpack estimates, *2005 Fall AGU Meeting, San Francisco, CA.*

**Molotch, N.P.**, and R.C. Bales, Scaling snow observations from the point to the grid-element: implications for observation network design. *2005 AGU Hydrology Days, Fort Collins, CO.*

**2004**

**Molotch, N.P.**, and R.C. Bales, Evaluation of the representativeness of automated snow water equivalent sensors in the Rio Grande headwaters using intensive field observations, remotely sensed snow cover data, and distributed snowmelt models. *2004 Fall AGU Meeting, San Francisco, CA.*

**Molotch, N. P.**, T.H. Painter, and R.C. Bales, Simulating snow / atmosphere energy exchange using semi-physical models and remotely sensed snow albedo data. *2004 AGU Western Pacific Geophysics Meeting, Honolulu, HI.*

**2003**

**Molotch, N. P.**, T.H. Painter, R. C. Bales, and J. Dozier, Incorporation of remotely-sensed snow grain size into a spatially distributed physical snowmelt model, *12<sup>th</sup> JPL Airborne Earth Science Workshop, Jet Propulsion Laboratory, Pasadena, CA.*

**Molotch, N. P.**, T.H. Painter, R. C. Bales, and J. Dozier, Accuracy assessment of a net radiation and temperature index snowmelt model using ground observations of snow water equivalent in an alpine basin, *2003 Spring AGU Meeting, Nice, France.*

**Molotch, N.P.**, T.H. Painter, R.C. Bales, and J. Dozier, Assimilation of remotely sensed snow cover properties into operational snowmelt modeling, *13<sup>th</sup> Annual El Dia del Agua, Dept. of Hydrology and Water Resources, University of Arizona.*

**2002**

**Molotch, N.P.**, T.H. Painter, M.T. Colee, R.C. Bales, and J. Dozier, Incorporating remotely sensed snow surface grain size into spatially distributed snowmelt modeling, *2002 Fall AGU Meeting, San Francisco, CA (Invited Presentation).*

**Molotch, N.P.**, S.R. Fassnacht, T. Bardsley and R.C. Bales, A comparison of spatial statistical techniques for the development of a validation data set for mesoscale modeling of snow water equivalence, *SAHRA 2<sup>nd</sup> Annual Meeting.*

**2001**

**Molotch, N.P.**, S.R. Fassnacht, M.T. Colee, T. Bardsley and R.C. Bales, A comparison of spatial statistical techniques for the development of a validation data set for mesoscale modeling of snow water equivalence, *2001 Fall AGU Meeting*, San Francisco, CA.

<b>External Grants</b>	<i>(\$5.66M as PI; \$17.82M as Co-PI w/ \$1.86M Molotch portion)</i>
<i>Current</i>	
NASA - \$510,000	<b>PI-Molotch:</b> Characterization of the spatio-temporal variability of snow properties to support active and passive microwave remote sensing of snow (2017 – 2022).
NASA - \$515,000	<b>Co-PI</b> (M. Durand PI): Characterizing accuracy of an advanced snow water equivalent retrieval algorithm applied to airborne microwave remote sensing measurements (Molotch portion ~\$50,000; 2017 – 2022).
NASA - \$1.5M	<b>PI-Molotch:</b> Analysis of agricultural water supply-demand imbalance during the unprecedented California drought using NASA satellite data (2017 – 2020).
CWI - \$50,000	<b>Co-PI</b> (J. Knowles PI): Colorado Water Institute. Bark beetle impacts on remotely sensed evapotranspiration in the Colorado Rocky Mountains (2017-2018).
NASA - \$90,000	<b>PI-Molotch:</b> Assessing the climate sensitivity of mountain snowpacks using the Airborne Snow Observatory and a distributed snowpack model (2016 – 2019).
NSF - \$6.8M	<b>Co-PI</b> (K. Suding PI): NWT LTER VII: Long-term research on the dynamics of high-elevation ecosystems – a framework for understanding ecological responsiveness to climate change (Molotch portion ~\$500,000; 2016 – 2021).
NSF - \$151,000	<b>PI-Molotch</b> (w/ S. Anderson): Hydrologic partitioning across the CZO network: transforming knowledge of water and energy fluxes through Earth’s living skin (supplement to Boulder Cr. CZO; 2016 – 2017).
NOAA - \$3.5M	<b>Co-PI</b> (L. Dilling PI): Western Water Assessment: Building Climate Resilience By Design (2015 – 2020); ~\$300,000 Molotch portion.
NSF EAR - \$5M	<b>Co-PI</b> (S. Anderson PI): Boulder Creek CZO II: Evolution, Form, Function, and Future of the Critical Zone, (2013 – 2018); ~\$325,000 Molotch portion.
<i>Past</i>	
NASA - \$90,000	<b>PI-Molotch:</b> Combining a MODIS-based snow water equivalent product and statistical interpolation methods to estimate snowpack conditions in the Colorado headwaters (2014 – 2017); Fellowship for D. Schneider.
CU - \$44,000	<b>PI-Molotch:</b> Multi-Scale Modeling and Measurement of Ecosystem Sensitivity to Water and Energy Availability (2016 – 2017).
USDA/NSF - \$1.4M	<b>PI-Molotch:</b> Snowpack and Ecosystem Dynamics: The Sustainability of Inter-basin Water Transfers under a Changing Climate (2012 – 2017).
State of WY - \$70,000	<b>PI-Molotch:</b> A 13-year analysis of snow water equivalent in the North Platte and Tongue River basins, Wyoming (2016-2017).

NASA - \$96,000 NSF DEB - \$5.9M	<b>PI-Molotch:</b> Field work planning for NASA SnowEx Campaign (2015-2016) <b>Co-I</b> (K. Suding PI): Niwot Ridge Long Term Ecological Research (2011 - 2016); \$70,000 / yr Molotch Portion.
NASA - \$1.4M	<b>Co-PI</b> (J. Dozier PI): Error analysis of MODIS fraction snow-covered area and snow albedo in mountainous regions (2011 – 2016); \$385,386 Molotch portion.
NSF EAR - \$256,625	<b>PI-Molotch:</b> Climatic controls on snow-vegetation interactions across an elevational gradient (2012 – 2016).
NASA - \$580,000	<b>Co-PI</b> (M. Durand PI): Relating in situ snow cover properties to multi-scale, multi-frequency remote sensing data utilizing CLPX datasets. (2009 – 2014); \$176,872 Molotch portion.
NSF - \$1M	<b>Co-PI</b> (S. Anderson PI): Boulder Creek CZO renewal: Weathered profile development in a rocky environment and its influence on watershed hydrology and biogeochemistry; \$10,000 Molotch Portion.
NASA - \$349,898	<b>PI-Molotch:</b> Assimilation of MODIS snow cover products into operational hydrologic forecast models. (2007 – 2012).
NSF - \$300,000	<b>PI-Molotch:</b> Quantifying controls on snow distribution in the Sierra Nevada using ground-based and remotely sensed observations within an ensemble Kalman smoother. (2007 – 2012).
NSF - \$352,723	<b>PI-Molotch:</b> Collaborative Research: Snowpack energy and mass balance: implications for biogeochemical feedbacks in alpine watersheds. (2008 – 2012).
NSF - \$38,831	<b>PI-Molotch:</b> RAPID: Snow Sensor Maintenance in Boulder Creek and Jemez River Basin CZOs (2011-2012).
NSF - \$33,150	<b>Co-PI</b> (S. Anderson PI): RAPID: Collecting Field Data in Support of LiDAR Acquisition During Maximum Snow Conditions and Maximum Leaf Out in the Boulder Creek Critical Zone Observatory (2010-2011).
NASA - \$45,186	<b>PI-Molotch:</b> Bridging Research to Operations in Support of Water Resources Decision Support Using NASA Snow Data Products (2010).
USGS - \$63,116	<b>PI-Molotch:</b> A Bayesian approach to snow water equivalent reconstruction (2008-2011).
NASA/JPL - \$47,269	<b>Co-PI</b> (S. Margulis PI): Characterizing snowpack accumulation and melt and the resulting spring streamflow in Sierra basins using a novel data assimilation and modeling approach (2007 – 2010).
NOAA - \$365,495	<b>PI-Molotch:</b> Scaling snow observations from the point to the grid element: supporting NOHRSC's National Snow Analysis system (2007 – 2010).
NSF – \$97,653	<b>Co-PI</b> (G. Okin PI): Acquisition of an ASD FieldSpec3: field spectroscopy in support of aeolian geomorphology, snow hydrology, and teaching at UCLA (2008-2009).
NSF - \$307,678	<b>Co-PI</b> (R. Bales PI): Observatory design in the mountain west: scaling measurements and modeling in the San Joaquin Valley and Sierra Nevada (2006 – 2008).

NOAA - \$14,077

**PI-Molotch:** Realization of snow / vegetation interactions using field spectroscopy (2005 – 2006).

CUAHSI - \$5,000

**Co-PI** (R. Rice PI): Consortium of Universities for the Advancement of Hydrologic Science Inc., Vision paper grant: Mountain hydrology of the semi-arid western U.S. (2005).**Invited Presentations**

- 2017 Remote sensing of the Sierra Nevada snowpack under extreme drought: transformative information at the nexus of science and stakeholders, UC Santa Barbara, Environmental Science and Management, 28 Feb.
- 2016 Hydrologic Response to Changes in the Timing and Rate of Snowmelt: Implications for Water Resource Management in the Western U.S. presented at 2016 Fall Meeting, AGU, San Francisco, Calif., 12-16 Dec.
- 2016 Slower snowmelt in a warmer world: exploring the hydrological and ecological implications of earlier snowmelt in the Western U.S., University of Bristol, Civil & Environmental Engineering, 5 Oct.
- 2016 Remote sensing and modeling of the mountain snowpack: transforming our understanding of the mountain water cycle under a changing climate, UC Berkeley, Civil & Environmental Engineering, 30 Sept.
- 2016 Establishing transferable sub-pixel relationships between snow depth, snow covered area and terrain roughness using NASA Airborne Snow Observatory data, Eastern Snow Conference, 10 June.
- 2016 Measuring and monitoring our snow water resource, Colorado Water Resources Association annual meeting, 22 April.
- 2016 For the love of snow: snow science at the Storm Peak Laboratory, Steamboat Springs, CO, Ski Country USA annual meeting, 8 April.
- 2015 Remote sensing and modeling of the mountain snowpack: tools for understanding the mountain water cycle under a changing climate, Portland State University, 2 June.
- 2015 Observing the mountain water cycle under a changing climate: new challenges and opportunities, Oregon State University, 3 June.
- 2015 Merging satellite data, ground measurements and modeling to understand the mountain water cycle, University of Utah, 10 March.
- 2014 Impacts of insect-related forest mortality on hydrologic partitioning and forest productivity in the Southern Rocky Mountains, USA, presented at 2014 Fall Meeting, AGU, San Francisco, Calif., 15-19 Dec.
- 2014 Snowmelt as a Driver of Ecohydrological Processes in Semi-Arid Mountainous Regions, Colorado School of Mines, 16 Oct.
- 2014 Real time Satellite Estimation and Mapping of Snow Water Equivalent across the Sierra Nevada, Workshop on remote sensing applications for water resources management and drought, Sacramento, CA, 25 – 26 Feb.
- 2013 Record-setting forest stress in the Rocky Mountains caused by low snowfall and high potential evapotranspiration, consistent with expected



- future conditions, presented at 2013 Fall Meeting, AGU, San Francisco, Calif., 3-7 Dec.
- 2013 Forest-snow interactions at Critical Zone Observatories of the Western U.S., presented at 2013 Fall Meeting, AGU, San Francisco, Calif., 3-7 Dec.
- 2013 Multi-scale observations of snowpack-ecosystem feedbacks: identifying tipping points in forest response to climate change in the Western U.S., International Union of Geodesy and Geophysics, Atmosphere and Cryosphere Assembly, Davos, Switzerland, 8 – 12 July.
- 2012 Effects of forest structure on snow accumulation and melt derived from ecohydrological instrument clusters across the Western US, 2012 Fall Meeting, AGU, San Francisco, Calif., 3-7 Dec.
- 2012 Elevation-dependent controls on snowmelt partitioning and vegetation response inferred from satellite observations, 2012 Fall Meeting, AGU, San Francisco, Calif., 3-7 Dec.
- 2012 Integrated hydrologic measurements of the Sierra Nevada: Implications for feedbacks with ecological processes, UC Davis, 12 Nov.
- 2012 Snowmelt as a driver of ecohydrological processes: low-hanging fruit for cross-CZO research, Invited Cyberseminar, Consortium of Universities for the Advancement of Hydrological Sciences Inc. (CUAHSI), 6 April.
- 2012 Improved snow observations from remote sensing, Western States Water Council, Extreme Events Meeting, San Diego, CA, 31 July.
- 2011 Remote sensing of the Rocky Mountain snowpack, California Department of Water Resources / NASA JPL, Border Area Remote Sensing Water Management Workshop, San Diego, CA, 9 June.
- 2010 Observations and models for quantifying of the mountain water cycle. Invited seminar, USGS, Lakewood, CO, 8 Feb.
- 2010 Estimating the spatial distribution of mountain snow from remote sensing and modeling, Invited seminar NOAA Physical Sciences Division, Boulder CO, 1 Dec.
- 2010 Remote sensing of the mountain snowpack: mitigating climate change impacts on water resources, Invited Seminar, Denver Water, 21 Oct.
- 2009 Merging satellite data, ground measurements, and modeling to understand the mountain water cycle, Swiss Federal Institute for Forest, Snow, and Landscape Research, Switzerland, March 3.
- 2009 Integrated measurement and modeling approaches for mapping snow over complex topography, Ecole Polytechnique Federale de Lausanne, Switzerland, March 13.
- 2008 State-of-the-art snow measurement and modeling of the American Cordillera, Department of Civil Engineering, University of Chile, Oct. 6.
- 2008 Merging satellite data, ground measurements, and modeling to understand the mountain water cycle, Department of Civil & Environmental Engineering, UC Berkeley, March 3.

- 2008 Snowmelt Modeling in the Rio Grande Headwaters: Merging Field Studies with Satellite Observations, Department of Earth & Planetary Sciences, University of New Mexico, February 28.
- 2006 Snowmelt modeling in mountainous watersheds: merging field studies with satellite observations, Department of Environmental Science, UC, Riverside, April 3.
- 2005 Up-scaling point observations of snow water equivalent in the Rio Grande headwaters: implications for observation network design, Department of Hydrology and Water Resources, University of Arizona, February 2.
- 2004 Incorporating remotely sensed data into distributed snowmelt modeling in a mountainous watershed, *Forest Watershed Science Special Seminar*, Department of Environmental Science, Policy and Management, UC Berkeley, February 26.
- 2003 Snow measurement, melt & runoff research at the University of Arizona, *El Niño, Drought, and Fire-Related Forecasts and Research Initiatives: A Phoenix Press Briefing*, Arizona Department of Water Resources, March 20.
- 2002 Incorporating remotely sensed snow surface grain size into spatially distributed snowmelt modeling, *Fall AGU Meeting*, San Francisco, CA., December 8.

## TEACHING ACTIVITIES

### Courses Taught

#### *University of Colorado*

- Geography 1001: Climate & Vegetation (S2010, S2011, F2014, S2017)  
 Geography / Environmental Studies 4201: Biometeorology (F2011, F2012)  
 Geography / Geology 4093 / 5093: Remote Sensing of Environment (S2011, S2012, F2012)  
 Geography 5241: Topics in Physical Geography: Advanced Methods in Snow Measurement (S2011, S2013, S2015, S2018)  
 Geography 4321/5321: Snow Hydrology (S2014, S2015, S2017, F2017)  
 Geography 5100: LiDAR Remote Sensing of the Critical Zone (SU2014)

#### *University of California, Los Angeles*

- Environmental Science 180A: Practicum in Environmental Sciences (F2007, F2008)  
 Civil & Environmental Engineering 251C: Remote Sensing with Hydrologic Applications (S2007, S2008)

## Thesis Committees

### *Chaired*

Keith Jennings, Ph.D., 2018, Evaluating the climatic and energy balance controls on snow accumulation and melt processes in mountain snowpacks, University of Colorado at Boulder.

Current Position: Post-Doctoral Researcher, University of Nevada.

- Qinghuan Zhang, Ph.D., 2018, University of Colorado at Boulder, Modeling the hydrology and hydrochemistry of the Boulder Creek watershed.
- Theodore Barnhart, Ph.D., 2018, University of Colorado at Boulder, The response of streamflow and evapotranspiration to changes in snowmelt across the Western United States.  
Current Position: US Geological Survey, Wyoming-Montana Water Science Center.
- Alana Wilson, Ph.D., 2017, University of Colorado at Boulder, Glaciers of High Asia: Water Resources, Water Security, and Scientific Capacity Building  
Current Position: Campus Transportation Master Plan Coordinator, University of Colorado Boulder.
- Alice Hill, Ph.D., 2017, University of Colorado at Boulder, Rapid assessment of hydrologic controls on mountain water resources.  
Current Position: Post-Doctoral Researcher, University of Colorado.
- Dominik Schneider, Ph.D., 2017, University of Colorado at Boulder. Understanding the distribution of snow using remotely sensed snow covered area data.
- Keith Musselman, Ph.D., 2012, University of California, Los Angeles (in residence at INSTAAR); Estimating the spatial and temporal distribution of snow in mountainous terrain (co-chaired committee with Prof. Steven Margulis). Current Position: Research Faculty, University of Colorado.
- Taylor Winchell, M.S., 2016, Civil Engineering, University of Colorado at Boulder, Early Snowmelt Reduces Atmospheric Carbon Uptake in Coniferous Forests & Global Rain-Snow Temperature Thresholds.  
Current Position: International Center for Environmental Management.
- Emily Baker, M.A., 2015, University of Colorado, Quantifying forest mortality with the remote sensing of snow.  
Current Position: US Geological Survey, Alaska Science Center.
- Leah Meromy, M.A. 2012, University of Colorado, Subalpine snowpack-climate manipulation and modeling experiment at Niwot Ridge, CO and Valles Caldera National Preserve, NM.  
Current Position: Environmental Consultant, Boulder, Colorado.
- Danielle Perrot, M.A. 2012, University of Colorado, Nitrate export response to spatially distributed snowmelt in alpine catchments.  
Current Position: Hydrologist, Riverside Technology Inc., Colorado.
- Kehan Yang, Ph.D., ongoing, University of Colorado at Boulder.
- Katherine Hale, M.A., ongoing, University of Colorado at Boulder.

*Committees, University of Colorado*

- Shirley Kurc, Ph.D., 2006; Ben Hudson, Ph.D. 2014; Sarah Evans, Ph.D. 2017; Sean Burns, Ph.D. 2018; Joshua Aikens, Ph.D. 2018.
- Evan Pugh, Ph.D. 2012; Rory Cowie, Ph.D. 2014; Katya Hafich, M.A., 2014; Bunyamin Yilmaz, M.A., 2016; Jennifer Petrzalka, M.A., 2011; Glen Grant, M.A., 2012

*Committees, Other Institutions*

- Jessica Driscoll, Ph.D., 2014, University of Arizona; Michael Durand, Ph.D., 2008, University of California, Los Angeles; Will Veatch, M.S., 2008, University of Arizona; Keith Musselman, M.S., 2006, University of Arizona.

**Post-Doctoral Advising***University of Colorado*

Dr. Adam Wlostowski, Co-evolution of critical zone structure and function, 2017 – present.

Dr. Oliver Wigmore, Remote sensing of alpine snow using UAV's, 2016 – present.

Dr. Ryan Webb, Hydrologic controls on meltwater flow through snow, 2016 – 2018.

Current Position: Assistant Research Professor, University of New Mexico.

Dr. John Knowles, Forest response to drought and disturbance, 2015 – 2018.

Current Position: Post-Doctoral Researcher, University of Arizona.

Dr. David Barnard, Forest transpiration variability across elevational gradients, 2014 – 2016.

Current Position: Ecologist, U.S. Geological Survey, Boise, ID.

Dr. Rory Cowie, 2015, Snowmelt-groundwater interactions in alpine catchments.

Current Position: Lecturer, Colorado College.

Dr. Adrian Harpold, 2012 – 2014, Snowpack-vegetation interactions across the Western U.S.

Current Position: Assistant Professor, University of Nevada, Reno.

Dr. Ernesto Trujillo, 2009 - 2012, Elevation-dependent controls of snowpack on forest greening.

Current Position: Research Scientist, University of California, Merced.

*University of California, Los Angeles*

Dr. Dayong Shen, 2007-2008, Quantifying controls on snow distribution in the Sierra Nevada Mountains.

Current Position: Research Software Developer, University of Mississippi

*Jet Propulsion Laboratory, California Institute of Technology*

Dr. Bin Guan, 2009 – 2012, Hydrologic impacts of Atmospheric Rivers in the Sierra Nevada, California.

Current Position: Research Scientist, University of California, Los Angeles.

Dr. Steven Jepsen, 2008 - 2009; Spatio-temporal variability of snowmelt and streamflow in the Sierra Nevada and Rocky Mountains.

Current Position: Research Scientist, University of Nevada, Reno.

**Undergraduate Advising***Undergraduate Research Opportunities Program (UROP)*

Nickolas Braun, Feb 2017 – May 2018, Meteorological controls on avalanches in Colorado.

Danielle Beaty, Oct 2014 – May 2015, Estimating bark-beetle mortality impacts on satellite viewable gap fractions using MODIS data and hemispherical photography.

Roger Carter, Oct 2014 – May 2015, Estimating bark-beetle mortality impacts on satellite viewable gap fractions using MODIS data and hemispherical photography.

Ken Peterson, Nov 2011-May 2012, Impacts of dust deposition and insect-related litter deposition on snowmelt in the Rocky Mountains.

Andrew Steger, Aug 2011-May 2012, Impacts of dust deposition and insect-related litter deposition on snowmelt in the Rocky Mountains.

*Undergraduate Research Assistants*

Brooke Stamper, 2013, Sensitivity of mountain soil moisture to the spatial distribution of snowmelt.

Kyle Baker , 2012, Impacts of dust deposition and insect-related litter deposition on snowmelt in the Rocky Mountains.

Aaron Rice, 2011, Impacts of dust deposition and insect-related litter deposition on snowmelt in the Rocky Mountains.

Jeff Lipton, 2012, Impacts of dust deposition and insect-related litter deposition on snowmelt in the Rocky Mountains.

*Undergraduate Honors Theses*

Michal Fagrelus, 2012-2013, *Cum Laude*, Measuring the spatial distribution of snow properties using Snow Penetrating Radar. (Chair)

Danielle Cluckey, 2012-2013, *Cum Laude*, Impacts of forest disturbance on snow distribution, snowmelt, and soil temperature. (Member)

*Undergraduate Advising, Other Institutions*

Jordan Anderson, 2010, Relationships between snowmelt and soil moisture in the Southern Sierra Nevada, Jet Propulsion Laboratory, California Institute of Technology, STEM Teacher and Researcher STAR Program.

Danielle Perrot, 2008 – 2010, Impacts of Mountain Pine Beetle infestation on snowmelt in sub-alpine forests, University of California, Los Angeles. Now published in *Ecohydrology*.

Leah Meromy, 2008 – 2010, Spatial variability of snow depth surrounding operational snow stations in the Western U.S., University of California, Los Angeles. Now published in *Hydrological Processes*.

Angel Kwok, 2007-2008, Inter-annual variability in snow cover persistence in the Sierra Nevada as observed from satellite, University of California, Los Angeles.

**Student Awards**

2017	CUAHSI Pathfinder Fellowship, Keith Jennings
2016	AGU Outstanding Student Presentation Award, Keith Jennings
2016	U. Colorado, Geography Dept., Gilbert F. White Fellowship, Theo Barnhart
2016	NASA Earth and Space Science Fellowship, Keith Jennings
2016	U. Colorado, Geography Dept., James A. and Jeanne B. DeSana Graduate Research Scholarship, Theo Barnhart
2016	American Water Resources Association Colorado Chapter Richard Herbert Scholarship, Keith Jennings
2015	CUAHSI Pathfinder Fellowship, Theo Barnhart
2015	U. Colorado, Geography Dept., DeSana Graduate Research Scholarship, Dominik Schneider
2015	U. Colorado, Geography Dept., Mabel Duncan Scholarship, Dominik Schneider
2014	NSF Graduate Research Fellowship, Taylor Winchell
2014	U. Colorado, CEAE Dept. Academic Excellence Fellowship, Taylor Winchell

- 2014 NASA Earth and Space Science Fellowship, Dominik Schneider  
 2014 NSF Pathfinder Fellowship, Dominik Schneider  
 2011 Eastern Snow Conference Best Poster Award, Keith Musselman  
 2011 U. Colorado, Hydrologic Sciences Symposium Outstanding Student Poster Award, Danielle Perrot  
 2011 United Government of Graduate Students Travel Grant, Leah Meromy  
 2010 UCLA Dean's Prize for Outstanding Undergraduate Research, Danielle Perrot; now published in *Ecohydrology*.  
 2009 NASA Earth and Space Science Fellowship, Keith Musselman

### Teaching Improvement Workshops Attended

- 2011 Learning Goals Workshop, University of Colorado Faculty Teaching Excellence Program (FTEP) (October 2011; November 2011)  
 2012 Presentation Skills Workshop, University of Colorado Faculty Teaching Excellence Program (FTEP) (February 2012; 2 sessions)

### SERVICE ACTIVITIES

#### University of Colorado

##### *System-Wide*

Excellence in Leadership Program, 2016-2017

##### *College of Arts and Sciences*

Boulder Faculty Assembly, 2018-2020

##### *Department of Geography*

Hiring Committee, Soil Biogeochemistry, 2018-2019

Hiring Committee, Surface Processes, 2017-2018

Personnel Committee, 2016-2018

Newsletter Committee Chair, 2017

Undergraduate Committee, 2015-2016.

Graduate Committee, 2014-2015.

Newsletter Committee, 2012 – 2013.

Colloquium Committee, 2011 – 2013.

Computer Committee, 2009 – 2011.

#### INSTAAR

Director, Center for Water, Earth Science, and Technology (2015 – Present).

Research Committee (Chair), Center for Water, Earth Science and Technology, 2014-2015.

Search Committee for INSTAAR / LTER PI Faculty Member, 2013.

Noon Seminar Coordinator, 2012 – 2013.

Web Page Committee, 2009 – 2013.

Information and Technology Committee, 2009 – 2013.

Teaching & Research Faculty Equity Assessment Committee, 2009 – 2011.

*Other*

Co-Chair National Snow and Ice Data Center, Ice Bridge Science User Working Group, 2009 – 2013.

National Snow and Ice Data Center, DAAC User Working Group, 2009 – 2013.

Associate Director, NOAA RISA, Western Water Assessment, 2013 - 2014.

**External Service Activities***Editorial Service*

Associate Editor, *Water Resources Research*, 2012 – 2017.

Associate Editor: *Arctic, Antarctic, and Alpine Research*, 2009 – 2013.

Guest Editor, *IEEE, Journal of Selected Topics in Earth Observations and Remote Sensing*, 2009-2010.

*Journal Reviews*

*Proceedings of the National Academy of Sciences; Global Change Biology; Climate Dynamics; Journal of Hydrometeorology; Journal of Geophysical Research; Water Resources Research; Talanta; Hydrological Processes; Monthly Weather Review; Hydrological Sciences Journal; Advances in Water Resources; Journal of Hydrology; Cold Regions Science and Technology; Arctic, Antarctic, & Alpine Research; Geophysical Research Letters*

*Proposal Reviews*

NASA-Cryospheric Sciences (Panelist)

NASA-Suomi NPP Science Team (Panelist)

NASA-Earth and Space Science Student Fellowship (Panelist)

NASA-Terrestrial Hydrology (Panelist)

NASA Applied Sciences, Water Resources Applications (Panelist)

NSF-Hydrological Sciences

NSF- Arctic Natural Sciences

NSF-Instrumentation and Facilities

Inter-American Institute for Global Change Research

*Sessions Organized*

2014 Fall AGU, Modeling of the Cryosphere

2014 Mountain Research Initiative (MRI); Mountain observatories - a global fair and workshop on socio-ecological systems.

2014 European Geosciences Union, Mountain Hydrology: Monitoring and modeling of snow

2013 Fall AGU, Modeling of the Cryosphere

2013 Fall AGU, Large Scale Experimentation in Hydrologic Science

2012 Fall AGU, Town Hall on Snow Remote Sensing

2012 Fall AGU, Modeling of the Cryosphere

2011 Fall AGU, Modeling of the Cryosphere  
 2009 Spring AGU, Remote Sensing and Modeling of Snow and Glacial Processes  
 2009 Fall AGU, Remote Sensing and Modeling of Snow and Glacial Processes  
 2007 Spring AGU, Hydrologic Uncertainty and Water Resource Management in the American Cordillera

*Other*

2010 Fall AGU Outstanding Student Presentation Award coordinator for Cryosphere focus group

*Scientific Committees and Working Groups*

2016 – Present Department of Energy, Scientific Advisory Board for the Watershed Function Scientific Focus Area.  
 2014 – Present Western Snow Conference Executive Committee & South Continental Area Chair.  
 2012 – 2013 NSF Physical Dynamical Meteorology / Hydrological Sciences joint program steering committee.  
 2012 - Present NASA Snow Remote Sensing Working Group Executive Committee  
 2012 – Present AGU Hydrology Section: Large-Scale Experimentation Committee  
 2009 – Present AGU Cryosphere Executive Committee  
 2008 – 2013 NASA JPL's Global Climate and Energy Initiative  
 2001 – 2005 NASA Cold Lands Processes Working Group