# Alexander L. Handwerger

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## Professional Appointments

**Assistant Researcher**, Joint Institute for Regional Earth System Science and Engineering, University of California, Los Angeles and Jet Propulsion Laboratory, California Institute of Technology, 2020-

**Visiting Assistant Researcher**, Joint Institute for Regional Earth System Science and Engineering, University of California, Los Angeles and Jet Propulsion Laboratory, California Institute of Technology, 2019

**NASA Postdoctoral Program Fellow**, Jet Propulsion Laboratory, California Institute of Technology, 2016-2019

**Visiting Scientist**, University of Edinburgh, 2015-2016

**Postdoctoral Research Associate**, University of Oregon, 2015

**Graduate Student Researcher**, University of Oregon, 2009-2015

**Undergraduate Research Assistant**, Boston University, 2007-2008

## Education

**Ph.D. Geological Sciences, University of Oregon, 2015**
Advised by Dr. Joshua Roering, Dr. David Schmidt, and Dr. Alan Rempel
Area of Study: Landslides, InSAR, Gas Hydrates
Dissertation: *Controls on the Kinematics of Slow-moving Landslides from Satellite Radar Interferometry and Mechanical Modeling*

**B.A. Earth Sciences *cum laude*, Boston University, 2008**
Advised by Dr. Sergio Fagherazzi
Directed study: *Morphology of distributary channels in tidal deltas*

**Geology Field School in Ireland, James Madison University, 2008**

**Study Abroad Program, University of Auckland, New Zealand, 2007**

## Research Interests

Landslide mechanics, radar interferometry, remote sensing, quantitative geomorphology, landscape evolution, fault and glacier mechanics, groundwater hydrology, gas hydrates and submarine landslides.

# Awards

NASA Postdoctoral Program Fellowship, 2016-2019

Johnston Scholarship Travel Grant, University of Oregon Department of Geological Sciences, 2011, 2013, 2014

# Grants

## *Funded Proposals*

"Water from Stone – Investigating the Hydrologic Role of Rock Glaciers", **NSF: Hydrologic Sciences**, 2020-2023, $337,649. Co-PI with PI Jeffrey Munroe (Middlebury College).

"Evaluating Landslide State with Combination of S- and L-band SAR for Soil Moisture Measurements", **NASA: Utilization of Airborne L- and S- Band Synthetic Aperture Radar Imagery over North America - Joint NASA and ISRO Airborne Campaign**, 2020-2021, $100,001. Co-I with PI Eric Fielding (Jet Propulsion Laboratory) and Co-I Seung-Bum Kim (Jet Propulsion Laboratory).

"Defining precursors of ground failure: a multiscale framework for early landslide prediction through geomechanics and remote sensing", **NSF: Prediction of and Resilience against Extreme Events (PREEVENTS)**, 2019-2023, $1,400,000. Co-PI with PI Giuseppe Buscarnera (Northwestern University), Co-PI Daniel Horton (Northwestern University), and Co-PI Karen Daniels (North Carolina State University).

"Landslide Kinematics in Response to Ongoing Climate Shifts", **NASA: Earth Surface and Interior**, 2019-2021, $681,211. Science PI with PI Eric Fielding (Jet Propulsion Laboratory).

"Environmental Controls on Landslide Motion Revealed by InSAR and Pixel Offset Tracking", **NASA: Earth Surface and Interior**, 2016-2019, $878,430. Co-I with PI Eric Fielding (Jet Propulsion Laboratory), Co-I Roland Bürgmann (University of California Berkeley), Co-I Jeffery Coe (US Geological Survey).

# Publications

## *Peer-Reviewed*

Lacroix, P., **Handwerger, A. L.**, and Bièvre, G. (2020). Life and death of slow-moving landslides. *Nature Reviews Earth & Environment*, 1-16. `https://doi.org/10.1038/s43017-020-0072-8`.

Bekaert, D., **Handwerger, A. L.**, Agram, P., and Kirschbaum, D. B. (2020). InSAR-based detection method for mapping and monitoring slow- moving landslides in remote regions with steep and mountainous terrain: An application to Nepal. *Remote Sensing of Environment*, 249, 111983. `https://doi.org/10.1016/j.rse.2020.111983`.

**Handwerger, A. L.**, Fielding, E. J., Huang, M., Bennett, G. L., Liang, C., and Schulz, W. H. (2019). Widespread initiation, reactivation, and acceleration of landslides in the northern California Coast Ranges due to extreme rainfall. *Journal of Geophysical Research: Earth Surface*. 124(7), 1782-1797. `https://doi.org/10.1029/2019JF005035`.

**Handwerger, A. L.**, Huang, M., Fielding, E. J., Booth, A., and Bürgmann, R. (2019). A shift from drought to extreme rainfall drives a stable landslide to catastrophic failure. *Scientific Reports*, 9(1), 1569. `https://doi.org/10.1038/s41598-018-38300-0`.

Hu, X., Bürgmann, R., Lu, Z., **Handwerger, A. L.**, Wang, T., and Miao, R. (2019). Mobility, thickness, and hydraulic diffusivity of the slow-moving Monroe landslide in California revealed by L-band satellite radar interferometry. *Journal of Geophysical Research: Solid Earth*. 124(7), 7504-7518. https://doi.org/10.1029/2019JB017560.

Finnegan, N. J., Broudy, K. N., Nereson, A. L., Roering, J.J., **Handwerger, A. L.**, and Bennett, G. (2019), River Channel Width Controls Blocking by Slow-moving Landslides in California's Franciscan Melange. *Earth Surface Dynamics*. 7, 879-894. https://doi.org/10.5194/esurf-7-879-2019.

**Handwerger, A. L.**, Rempel, A. W., and Skarbek, R. M. (2017). Submarine landslides triggered by destabilization of high-saturation hydrate anomalies. *Geochemistry, Geophysics, Geosystems*, 18, 2429-2445. https://doi.org/10.1002/2016GC006706.

**Handwerger, A. L.**, Rempel, A. W., Skarbek, R. M., Roering, J. J., and Hilley, G. E. (2016). Rate-weakening friction characterizes both slow sliding and catastrophic failure of landslides. *Proceedings of the National Academy of Sciences*, 113(37), 10281-10286. https://doi.org/10.1073/pnas.1607009113.

Bennett, G. L., Roering, J. J., Mackey, B. H., **Handwerger, A. L.**, Schmidt, D. A., and Guillod, B. P. (2016). Historic drought puts the brakes on earthflows in Northern California. *Geophysical Research Letters*. 43(11), 5725-5731. https://doi.org/10.1002/2016GL068378.

**Handwerger, A. L.**, Roering, J. J., Schmidt, D. A., and Rempel, A. W. (2015). Kinematics of Earthflows in the Northern California Coast Ranges using Satellite Interferometry. *Geomorphology*. 246, 321-333. https://doi.org/10.1016/j.geomorph.2015.06.003.

Roering, J. J., Mackey, B. H., **Handwerger, A. L.**, Booth, A. M., Schmidt, D. A., Bennett, G. L., and Cerovski-Darriau, C. (2015). Beyond the angle of repose: A review and synthesis of landslide processes in response to rapid uplift, Eel River, Northern California. *Geomorphology*, 236, 109-131. https://doi.org/10.1016/j.geomorph.2015.02.013.

**Handwerger, A. L.**, Roering, J. J., and Schmidt, D. A. (2013). Controls on the seasonal deformation of slow-moving landslides. *Earth and Planetary Science Letters*, 377, 239-247. https://doi.org/10.1016/j.epsl.2013.06.047.

Roering, J. J., Mackey, B. H., Marshall, J. A., Sweeney, K. E., Deligne, N. I., Booth, A. M., **Handwerger, A. L.**, and Cerovski-Darriau, C. (2013). 'You are HERE': Connecting the dots with airborne lidar for geomorphic fieldwork. *Geomorphology*, 200, 172-183. https://doi.org/10.1016/j.geomorph.2013.04.009.

## Invited Talks

Dartmouth College, USA, 2020

Northwestern University, USA, 2019

McGill University, Canada, 2019

University of California, Santa Cruz, USA, 2018

University of Strasbourg, France, 2018

California State University, Long Beach, USA, 2018

Portland State University, USA, 2017

Northern Arizona University, USA, 2017

Middlebury College, USA, 2017

University of Bologna, Italy, 2016

University of Edinburgh, UK, 2015

## Conference Presentations

Dille, A., Dewitte, O., **Handwerger, A. L.**, Derauw, D., d'Oreye, N., Monsieurs, E., Smets, B., Kervyn, M., Kervyn, F. (2020, May). Urban growth changing the pulse of a large deep-seated landslide. In EGU General Assembly Conference Abstracts.

Brencher, G., **Handwerger, A. L.**, Munroe, J., (2020, May). Using InSAR to asses rock glacier movement in the Uinta Mountains, Utah. In EGU General Assembly Conference Abstracts.

**Handwerger, A. L.**, Fielding, E. J., Booth, A. M., and Huang, M. H. (2019, December). Inferring the thickness of non-catastrophic deep-seated landslides from airborne synthetic aperture radar interferometry. In AGU Fall Meeting Abstracts.

**Handwerger, A. L.**, Fielding E. J., and Huang. M., (2019, November). Landslide kinematics in response to ongoing climate shifts. NASA Solid Earth Team Meeting.

**Handwerger, A. L.**, Huang. M., Fielding E. J., Booth, A. M., Bürgmann, R., and Bekaert, D., (2019, April). Slow and fast motion of landslides along California Highway 1 from satellite and airborne InSAR. NISAR Landslide Applications Workshop.

**Handwerger, A. L.**, Fielding E. J., Huang. M., Bennett G., and Liang. C., (2019, April). Rapid response of slow-moving landslides to extreme rainfall following historic drought in California. In EGU General Assembly Conference Abstracts.

Provost, F., **Handwerger, A. L.**, Malet, J. P., Hibert. C., (2019, April). Combining Sentinel (S1/S2) and Ground-based SAR acquisitions to retrieve landslide 3D displacement: application to Pas-de-l'Ours landslide, France. In EGU General Assembly Conference Abstracts.

**Handwerger, A. L.**., Fielding, E. J., and Huang, M. H. (2018, December). Widespread increase and acceleration of slow-moving landslides in response to extreme rainfall. In AGU Fall Meeting Abstracts.

Provost, F., **Handwerger, A. L.**, Malet, J. P., Point, J., and Hibert, C. (2018, December). Combining Sentinel-1 and Ground-based SAR to retrieve landslide 3D displacement: application to Pas de l'Ours landslide, France. In AGU Fall Meeting Abstracts.

Finnegan, N. J., Broudy, K. N., Nereson, A. L., Roering, J. J., **Handwerger, A. L.**, and Bennett, G. L. (2018, December). Fluvial boulder transport, jamming and valley blocking by earthflows. In AGU Fall Meeting Abstracts.

Hu, X., Bürgmann, R., Lu, Z., **Handwerger, A. L.**, Wang, T., and Miao, R. (2018, December). Characterization of slow-moving, deep-seated landslides using geodetic InSAR observations. In AGU Fall Meeting Abstracts.

Roering, J. J., Bennett, G. L., Booth, A. M., Cerovski-Darriau, C., **Handwerger, A. L.**, Mackey, B., McKean, J. A., and Struble, W. (2018, December). A multi-method exploration of landslides and their contribution to landscape evolution. In AGU Fall Meeting Abstracts.

**Handwerger, A. L.**, Huang, M., Fielding, E. J., Booth, A. M., and Bürgmann, R. (2018, April). A Shift from Drought to Extreme Rainfall Drives a Stable Landslide to Catastrophic Failure. Gordon Research Conference: Rock Deformation.

**Handwerger, A. L.**, Huang, M., Fielding, E. J., Booth, A. M., and Bürgmann, R. (2018, April). Extreme rainfall drives a slow-moving landslide to catastrophic failure (invited). In EGU General Assembly Conference Abstracts (Vol. 20, p. 9805).

**Handwerger, A. L.**, Huang, M., Booth, A. M., and Fielding, E. J. (2017, December). Using UAVSAR Interferometry to Quantify the Geometry and Sediment Flux of Slow-moving Landslides in the Eel River Catchment, Northern California. In 2017 AGU Fall Meeting.

Fielding, E. J., **Handwerger, A. L.**, Bürgmann, R., and Liu, Z. (2017, December). Slow, fast, and post-collapse displacements of the Mud Creek landslide in California from UAVSAR and satellite SAR analysis. In 2017 AGU Fall Meeting.

**Handwerger, A. L.**, and Fielding, E. J. (2017, April). Controls on slow-moving landslides revealed by satellite and airborne InSAR. In EGU General Assembly Conference Abstracts (Vol. 19, p. 5289).

Bennett, G., Roering, J., Mackey, B., **Handwerger, A.**, Guillod, B., and Schmidt, D. (2016, April). Geomorphic response to historic drought in northern California. In EGU General Assembly Conference Abstracts (Vol. 18, p. 10247).

**Handwerger, A. L.**, Rempel, A. W., and Skarbek, R. (2015, December). Submarine Landslides and Gas Hydrates: Using a Rate and State Friction Model to Describe Incipient Motion Triggered by the Dissociation of High Saturation Hydrate Anomalies. In 2015 AGU Fall Meeting.

Rempel, A. W., Irizarry, J. T., VanderBeek, B. P, and **Handwerger, A. L.** (2015, December). How Hydrate Saturation Anomalies are Diffusively Constructed and Advectively Smoothed. In 2015 AGU Fall Meeting.

**Handwerger, A. L.**, Rempel, A. W., Roering, J. J., Hilley, G. E., and Skarbek, R. M. (2014, December). A rate-and state-dependent friction model to describe the seasonal motion of slow-moving earthflows and quantify their potential for catastrophic failure. In AGU Fall Meeting Abstracts (Vol. 1, p. 04).

**Handwerger, A. L.**, and Rempel, A. W. (2014, July), Environmental change, hydrate dissociation, and submarine slope failure along continental margins: the role of saturation anomalies in landslide triggering. ICGH, Beijing, China, 28 July - 1 August.

**Handwerger, A. L.**, and Rempel, A. W. (2014, March), Submarine landslides induced by environmental changes and hydrate dissociation along the continental shelf. Gordon Research Conference: Natural Gas Hydrate Systems.

**Handwerger, A. L.**, Roering, J. J., and Schmidt, D. A. (2013, December). Landslides that never go catastrophic: dynamics of self-regulating earthflows along the Eel River, CA. In AGU Fall Meeting Abstracts (Vol. 1, p. 05).

**Handwerger, A. L.**, Roering, J. J., and Schmidt, D. A. (2012, December). Using airborne lidar and multi-temporal InSAR to explore the role of landslide geometry in controlling their response to seasonal precipitation. In AGU Fall Meeting Abstracts (Vol. 1, p. 0807).

Roering, J. J., Mackey, B. H., Schmidt, D. A., **Handwerger, A. L.**, Booth, A. M., and Cerovski-Darriau, C. (2012, December). Tracking landslides and landscape evolution using airborne lidar, InSAR, historical air photos, cosmogenic radionuclides, and numerical models. In AGU Fall Meeting Abstracts (Vol. 1, p. 04).

**Handwerger, A. L.**, Roering, J. J., and Schmidt, D. A. (2011, December). Using Insar to Quantify Seasonal Fluctuations in Landslide Velocity, Eel River, Northern California. In AGU Fall Meeting Abstracts (Vol. 1, p. 0704).

**Handwerger, A. L.**, and Rempel, A. W. (2011, July), Hydrate dissociation and slope stability on the continental shelf. Paper 636 presented at 2011 ICGH, Edinburgh, Scotland, 17-21 July.

**Handwerger, A. L.**, Schmidt, D. A., and Roering, J. J. (2010, December). Regional reconnaissance of seasonal landslide activity in the Eel River catchment, northern California, using InSAR and airborne LiDAR. In AGU Fall Meeting Abstracts (Vol. 1, p. 1422).

## Teaching Experience

**Graduate Teaching Fellow, University of Oregon (2009–2015)**
Taught labs and gave lectures for Tectonic Geomorphology and Landscape Evolution (Geol 410/510), Surveying (Geol 410/510), Oregon and Pacific Northwest Geology (Geol 308), Geology of National Parks (Geol 213), Evolving Earth (Geol 103), Earth's Dynamic Interior (Geol 101).

## Professional Activities

Publications reviewed for: *Journal of Geophysical Research – Earth Surface*, *Geophysical Research Letters*, *Scientific Reports*, *Geomorphology*, *Remote Sensing of Environment*, *Remote Sensing*, *Geophysical Journal International*, *Natural Hazards and Earth System Sciences*, *Hydrology and Earth System Sciences*.

Guest Editor (with Estelle Chaussard, Pietro Milillo, and Hélène Le Mével) for a Special Issue of *Remote Sensing* entitled "SAR for Natural Hazards".

Member of the Committee on Earth Observation Satellites (CEOS) Landslide Pilot, American Geophysical Union (AGU), and European Geosciences Union (EGU).

## Skills

Computational:

Extensive experience programming and numerical modeling in MATLAB. InSAR processing with ISCE and ROI PAC (NASA/JPL) and time series processing with GIAnT (NASA/JPL). Experience with Python, UNIX, Perl. Mapping and analysis with QGIS, ArcGIS, and MATLAB. Advanced ability with productivity software including LaTeX, Microsoft Office, Adobe Creative Suite.

Field experience:

Identified active landslides for instrumentation. Assisted with installation of piezometers, extensometers, pressure gauges, and a weather station in a slow-moving landslide in Northern California (2013).

Trained to use GAMMA's ground-based radar interferometer (GBRI) and able to run surveying equipment (total station and level).

Produced geologic maps in Western Ireland as part of James Madison University's field school (2008)