

## Curriculum Vitae Oliver H. Wigmore

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### EDUCATION

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#### **PhD 2016, *The Ohio State University, Department of Geography, Columbus OH, USA***

Dissertation Title: *Assessing Spatiotemporal Variability in Glacial Watershed Hydrology: Integrating Unmanned Aerial Vehicles and Field Hydrology, Cordillera Blanca, Peru.*

Advisor: Bryan Mark, PhD.

Committee: Michael Durand, PhD; Desheng Liu, PhD; Darla Munroe, PhD.

#### **B.Sc. Hons. (First Class) 2010, *The University of Auckland, New Zealand***

School of Environment

Major: Geography (Geographic Information Science, Spatial Analysis and Remote Sensing)

Honours Dissertation: *Loss of an Andean Páramo Ecosystem: A Remote Sensing Change Detection Study, Pambamarca, Ecuador*

Advisor: Jay Gao, PhD.

#### **B.Sc. 2006, *The University of Auckland, Auckland, New Zealand***

School of Geography and Department of Marine Science.

Major 1: Geography (Physical Geography and Geographic Information Science)

Major 2: Marine Science

#### **B.A. 2006. *The University of Auckland, Auckland, New Zealand***

Department of Anthropology

Majoring in Anthropology (specialising in Archaeology)

#### ***Non Degree Programmes***

#### **2012 International School on Mountain Ecology and Global Change, *University of Innsbruck, Austria***

Institute of Ecology

#### **2005 Archaeology Fieldschool, *University of California Los Angeles, Los Angeles CA, USA***

Department of Anthropology, Study Abroad Program

### POSITIONS

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#### **Academic Positions**

2019 - Present **Royal Society of New Zealand Rutherford Foundation Postdoctoral Fellow, Victoria University of Wellington**, Antarctic Research Centre. Mentor – Huw Horgan & Brian Anderson, Antarctic Research Centre.

2016 - 2018 **Postdoctoral Research Associate, University of Colorado Boulder**, Earth Lab and the Institute of Arctic and Alpine Research (INSTAAR). Mentor – Noah Molotch, Geography, INSTAAR/CWEST.

2015 - 2016 **Presidential Fellow, The Ohio State University**, Graduate School, Department of Geography, Byrd Polar and Climate Research Center (BPCRC).

2014 - 2015 **Graduate Teaching Assistant, The Ohio State University**, Department of Geography,

Byrd Polar Research Center (BPRC).

2011 - 2014 **Graduate Research Assistant, The Ohio State University**, Department of Geography, Byrd Polar Research Center (BPRC).

2007 - 2008 **Field Director**, Three Rivers Archaeology Project (TRAP) **Santa Monica College, University of Texas at Austin**, Programme for Belize, Orange Walk, Belize.

2006 - 2008 **Project Archaeologist**, Pambamarca Archaeology Project (PAP) **University of California Los Angeles and Foothill College**, Northern Ecuadorian Highlands.

### Professional Positions

2010 - 2011 **GIS Operator, Klohn Crippen Berger**, Brisbane, Australia. Mining and environmental consultancy.

2010 **GIS Specialist and Field Archaeologist, International Archaeological Research Institute Inc.**, Honolulu, Hawaii. Cultural resources management consultancy.

2008 - 2009 **Archaeological Field Technician, CFG Heritage**, Auckland, New Zealand. Cultural resources management consultancy.

### RESEARCH INTERESTS

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My research interests centre on the themes of global change within mountain environments, ecohydrology, remote sensing and geospatial analysis. Specifically, I am interested in the following topics 1) glacier environmental change, 2) mountain hydrology and water resources, 3) mountain ecosystems and land use land cover change 4) spatial scaling of ecohydrologic pattern and process, 5) remote sensing/photogrammetry, in particular the development and deployment of unmanned aerial systems (UAS). My primary geographic focus has been the Tropical Andes, however I am interested in these processes throughout the world's mountain regions, conducting postdoctoral research in the Colorado Rockies, and have recently returned to New Zealand where I am working in the Southern Alps.

### PUBLICATIONS

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#### Peer-Reviewed Journal Articles

- 2019 Webb R.W., **Wigmore, O.**, Jennings, K., Fend, M., Molotch, N.P., Hydrologic connectivity at the hillslope scale through intra-snowpack flow paths during snowmelt, *Hydrological Processes*. DOI: 10.1002/hyp.13686
- 2019 Li, D., **Wigmore, O.**, Durand, M., Vander Jagt, B., Margulis, S., Molotch, N., and Bales, R., Potential of balloon photogrammetry for spatially continuous snow depth measurements, *IEEE Geoscience and Remote Sensing Letters*, DOI: 10.1109/LGRS.2019.2953481
- 2019 **Wigmore, O.**, Mark, B.G., McKenzie, J., Baraer, M., Lautz, L., Sub-metre mapping of surface soil moisture in proglacial valleys of the tropical Andes using a multispectral unmanned aerial vehicle. *Remote Sensing of Environment*, 222, 104-118, DOI: <https://doi.org/10.1016/j.rse.2018.12.024>
- 2018 **Wigmore, O.**, and Mark, B.G., High altitude kite mapping: Evaluation of kite aerial photography (KAP) and structure from motion digital elevation models in the Peruvian Andes, *International Journal of Remote Sensing*, 39, 4995-5015, DOI: 10.1080/01431161.2017.1387312
- 2017 Guittard, A., Baraer M., McKenzie J.M., Mark B. G., **Wigmore O.**, Fernandez A., Rapre A.C., Walsh E., Bury J., Carey M., French A. and Young K.R. Trace metal contamination in the glacierized Rio Santa Watershed, Peru. *Environmental Monitoring and Assessment*, 189:649 DOI: <https://doi.org/10.1007/s10661-017-6353-0>.
- 2017 Mark, B.G., French, A., Baraer, M., Carey, M., Bury, J., Young, K., Polk, M.H., **Wigmore, O.**, Lagos, P., Crumley, R., McKenzie, J.M., Lautz, L., Glacier loss and hydro-social risks in the

- Peruvian Andes, *Global and Planetary Change*, 159, 61-76, DOI: <https://doi.org/10.1016/j.gloplacha.2017.10.003>
- 2017 **Wigmore, O.**, Mark, B., Monitoring tropical debris covered glacier dynamics from high resolution unmanned aerial vehicle photogrammetry, Cordillera Blanca, Peru, *The Cryosphere*, 11, 2463-2480, DOI:<https://doi.org/10.5194/tc-11-2463-2017>
- 2016 Somers, L., Gordon, R., McKenzie, J., Lautz, L., **Wigmore, O.**, Glose, A., Glas, R., Mark, B., Baraer, M., Quantifying groundwater-surface water interactions using a stream energy balance model and dye tracing in a proglacial valley of the Cordillera Blanca, Peru, *Hydrological Processes*, DOI: 10.1002/hyp.10912
- 2015 Aubry-Wake, C., Baraer, M., McKenzie, J., Mark, B., **Wigmore, O.**, Hellstrom, R., Lautz, L., Measuring glacier surface temperatures with ground-based thermal infrared imaging, *Geophysical Research Letters*, 42(20), DOI: 10.1002/2015GL065321
- 2014 **Wigmore, O.**, and Gao, J., Spatiotemporal dynamics of a páramo ecosystem in the Northern Ecuadorian Andes 1988-2007, *Journal of Mountain Science*, 11(3), DOI: 10.1007/s11629-013-2365-6.

#### *Manuscripts in Review*

Sinclair, C., Mark B.G., Baraer M., **Wigmore O.**, McKenzie J. Glacial and groundwater contribution to dry-season discharge and bofedales in Tuni, Cordillera Real (Bolivia), and Pastoruri, Cordillera Blanca (Peru). Submitted to: *Journal of Mountain Science*.

#### *Manuscripts in Preparation*

**Wigmore, O.**, Molotch, N., Mapping spatiotemporal variability in alpine ecohydrology and examining limits on vegetation productivity with multispectral and thermal unmanned aerial systems, Target journal: *Remote Sensing of Environment*. Manuscript on request.

**Wigmore, O.**, Mark, B.G., McKenzie, J., Baraer, M., Hellstrom, R., and Lautz, L., Temporal variability and discharge buffering potential of soil moisture storage within Andean meadows and wetlands, Cordillera Blanca, Peru, Target journal: *Journal of Hydrology*. Manuscript on request.

**Wigmore, O.**, Mark, B., Somers, L., Lagos, P., McKenzie J.M., Crumley, R., Integrating unmanned aerial vehicles and terrestrial structure from motion photogrammetry for assessing high mountain glacier change, Huaytapallana, Peru, Target journal, *ISPRS Journal of Photogrammetry and Remote Sensing*.

**Wigmore, O.**, Molotch, N., Spatiotemporal controls on snow depth and snow melt variability detected with an unmanned aerial system, Niwot Ridge, Colorado Target journal: *The Cryosphere*

**Wigmore, O.**, Molotch, N., Refining the TVDI method for high resolution estimation of surface soil moisture, Target journal: *Remote Sensing of Environment*.

#### **Conference Proceedings**

- 2016 **Wigmore, O., Mark, B.**, UAV Mapping of debris covered glacier change, Llaca glacier, Cordillera Blanca, Peru, *Proceedings of the 73rd Annual Meeting of the Eastern Snow Conference*, Byrd Polar and Climate Research Center, Columbus, Ohio, 14-16 June 2016.
- 2014 Mark, B.G., Baraer M., Huh K.I., Carey M., French A., Bury J., Young K., McKenzie J., Eddy A., Fernandez A., and **Wigmore O.** From glaciers to the desert: Assessing hydrologic change and social vulnerability across a tropical Andean waterscape. *Proceedings from the 71st Eastern Snow Conference*, Boone, NC, 3-5 June, 2014.

#### **Technical Reports**

- 2008 **Wigmore, O.**, (Ed. Gonzalez A.L., et al.) Resumen del Mapeo y el Exploración del Campo, *Informe Preliminar del Proyecto Arqueológico Pambamarca 2006 & 2007*, pp. 101-117. Manuscript on file, Instituto Nacional de Patrimonio Cultural. Quito, Ecuador.
- 2008 Lewis, B.S. Dodge, R. and **Wigmore, O.**, (Ed. Valdez Jr., F.) Preliminary discussion of courtyard

149 at La Milpa, Belize: data generated from the 2007 field season. *Programme for Belize Archaeological Project, Summary Report of 2007 Investigations*, The University of Texas at Austin.

- 2005 **Wigmore, O.**, (Ed. Gonzalez A.L., et al.) Situación espacial y análisis característico de las Bolas y Boleadoras en el interior de la fortaleza incaica de montaña de Quitoloma, Pambamarca, Andes Ecuatorianos, *Proyecto Arqueológico Pambamarca: Informe Preliminar de la Temporada 2005*, pp. 26-41. Manuscript on file, Instituto Nacional de Patrimonio Cultural. Quito, Ecuador.

### Popular Publications

- 2010 **Wigmore, O.**, (Ed. Butler, S.), In focus: tramping New Zealand, *Fodor's New Zealand 15<sup>th</sup> Edition*, Fodor's - Random House Inc., New York.  
Reprinted in *Fodor's New Zealand 15<sup>th</sup> Edition*
- 2008 **Wigmore, O.**, (Ed. McIlvain, J.), In focus: big mountains of the Cordillera Blanca, *Fodor's Peru 3<sup>rd</sup> Edition*, Fodor's - Random House Inc., New York.  
Reprinted in *Fodor's Peru 4<sup>th</sup> and 5<sup>th</sup> Edition*.  
Reprinted in *Fodor's South America 8<sup>th</sup> Edition*, 2009 (Ed. Kidder, L. & Kealy, K.)  
Fodor's - Random House Inc., New York.
- 2008 **Wigmore, O.**, (Ed. McIlvain, J.), Close up: Cordillera Huayhuash, *Fodor's Peru 3<sup>rd</sup> Edition*, Fodor's - Random House Inc., New York.
- 2008 **Wigmore, O.**, (Ed. McIlvain, J.), Close up: life in the Andes, *Fodor's Peru 3<sup>rd</sup> Edition*, Fodor's - Random House Inc., New York.

### AWARDS AND HONOURS

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USD unless otherwise noted

- 2018 **Royal Society of New Zealand Rutherford Foundation Trust Postdoctoral Fellowship**, *Improving understanding of debris-covered glacier dynamics, Haupapa/Tasman Glacier, New Zealand*, NZ\$170,000 over two years.
- 2016 Eastern Snow Conference, **David Hewitt Miller Best Student Poster**, \$100.
- 2016 The Ohio State University, Department of Geography, **E. Willard and Ruby S. Miller Fellowship**, “the highest recognition the department can bestow on a graduate student given in recognition of potential to make a major contribution to geography particularly through scholarship and scholarly writing”, \$4,000.
- 2015 The Ohio State University, Council of Graduate Students, **Ray Travel Award for Service and Scholarship**: Funds to attend *Association of American Geographers Annual Meeting 2016 - San Francisco*, \$750.
- 2014 The Ohio State University, **Graduate School Presidential Fellowship**, “the most prestigious award given by the Graduate School. Recipients of this award embody the highest standards of scholarship in the full range of Ohio State's graduate programs” \$26,000 (12 month) stipend for final (5th) year of PhD + tuition waiver and healthcare.
- 2014 The Ohio State University, Department of Geography, **Lakshmanan Chatterjee Fellowship**, for outstanding PhD students from or doing research on the Global South, \$1,000.

### RESEARCH FUNDING

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\* denotes status as Co-Investigator

USD unless otherwise noted

- \*2018 **National Science Foundation**: EAR #1824152 Hydrological Sciences: *Extending the vadose zone: characterizing the role of snow for liquid water storage and transmission in streamflow generation*, PI: Webb, R., CoPI's: Wigmore, O., Musselman, K., Molotch, N., \$289,218.

- \*2018 Niwot Ridge Long Term Ecological Research program 2018 Request for Proposals. *Integrating patch-to catchment-scales in the alpine using a spatial polygonal statistical analysis*, PI: Hermes, A., CoPI's: Wigmore, O., Hinckley, E., \$4,327.
- 2017 Niwot Ridge Long Term Ecological Research program, **Travel Grant**, to attend 2017 AGU Fall Meeting 2017, \$850.
- 2017 **Planet Education and Research Partnership: Changing Andean Glacier Waterscapes: A multi-scale investigation of land-cover / land-use change and hydro-social implications, Access to Planet Cube-sat and RapidEye data archives.**
- 2015 **Geological Society of America Graduate Research Grant: Assessing Variability in Pro-glacial Soil Moisture: Integrating UAV's, Satellites and Field Hydrology in the Peruvian Andes, \$1,200**
- 2015 **The Explorers Club Exploration Fund Grant: Assessing Variability in Pro-glacial Soil Moisture: Linking Processes and Scale, Cordillera Blanca, Peru, \$1,500.**
- 2015 **The Foundation Mamont - Explorers Club World Exploration Challenge: Above, Below and Beyond: Mapping the Glacial Frontier, Cordillera Blanca, Peru**, Finalist.
- 2014 **The American Philosophical Society Lewis and Clark Fund: Assessing Variability in Pro-glacial Soil Moisture: Linking Processes and Scale, Cordillera Blanca, Peru**, \$5,000.
- 2014 **National Science Foundation: Doctoral Dissertation Research Improvement Award BCS #1434248: Doctoral Dissertation Research Assessing Variability in Pro-glacial Soil Moisture: Integrating UAV's, Satellites and Field Hydrology in the Peruvian Andes**, PI: Mark, B. (adviser), CoPI: Wigmore, O., \$15,999.
- 2014 The Ohio State University, Council of Graduate Students, Global Gateway Graduate Student Research Abroad Grant: \$1,500.
- 2014 **The Ohio State University, International Affairs Grant: Assessing Variability in Pro-glacial Soil Moisture: Linking Processes and Scale, Cordillera Blanca, Peru**, \$3,500 (including \$500 departmental match).
- 2014 **American Geographical Society Council Fellowship: Assessing Variability in Pro-glacial Soil Moisture: Linking Processes and Scale, Cordillera Blanca, Peru**, \$1,000.
- 2014 **Sigma Xi (Ohio State University Chapter) Student Research Grant: Assessing Variability in Pro-glacial Soil Moisture: Linking Processes and Scale, Cordillera Blanca, Peru**. Honourable mention.
- 2013 **The Tinker Foundation, Tinker Field Research Grant: Water, Land and Glaciers. Implications of Land Use and Land Cover Change on Hydrologic Resources in the Face of Glacier Recession, and Climate Change, Cordillera Blanca, Peru**, \$2,200.
- 2013 **The Ohio State University Department of Geography Rayner Graduate Research Scholarship: Water, Land and Glaciers. Implications of Land Use and Land Cover Change on Hydrologic Resources in the Face of Glacier Recession, and Climate Change, Cordillera Blanca, Peru**, \$1,000.
- 2012 The Ohio State University Department of Geography **Fenburr Graduate Travel Scholarship**, to attend: *University of Innsbruck International School on Mountain Ecology and Global Change*, \$600.

## **FIELD RESEARCH EXPERIENCE**

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- 2019 **Tasman Glacier, New Zealand**. Planning and management of fieldwork and instrument deployment to monitor glacier dynamics and melt processes over the debris covered tongue of Haupapa/Tasman Glacier, New Zealand.
- 2016 – 2018 **Postdoctoral Field Research**. Planning, management and deployment of weekly repeat multispectral UAV surveys of Niwot Ridge, CO LTER Saddle Catchment to quantify ecohydrologic variables – e.g. snow depth, vegetation productivity, surface soil moisture, etc.
- 2017 **NASA SnowEx**. Participant in Grand Mesa, CO, field campaign to support NASA SnowEx

- mission.
- 2015 **Graduate Researcher, The Ohio State University BPCRC, Sequoia National Park**, Balloon based aerial photogrammetric mapping of snow pack depth and snow pit measurements.
- 2013 - 2016 **Doctoral Dissertation Research, Cordillera Blanca Peru**. Conducting multispectral UAV surveys of glacier and pro-glacier systems. Installing, downloading and maintaining field instrumentation for hydrology, soil moisture and climate data collection. PPK and DGPS Survey.
- 2012 **Graduate Research Assistant, The Ohio State University, BPRC, Volcan Chimborazo, Ecuador**. Terrestrial LiDAR scanning of debris covered glaciers.
- 2011 - 2012 **Graduate Research Assistant, The Ohio State University, BPRC, NASA, Bolivia**. Installing weather and river discharge monitoring stations, and hydrochemistry (mixing model) sampling in the Cordillera Real and Sajama National Park.
- 2011 - 2016 **Graduate Research Assistant, The Ohio State University, BPRC, Cordillera Blanca, Peru**. Hydrochemical sampling for trace metals and mixing models; measuring river discharge (ADCP, wading rod, salt dilution); installing downloading and maintaining weather stations, groundwater wells and discharge gauges; glacier energy balance studies.
- 2007 **Field Surveyor and Cartographer: Instituto Nacional de Cultura (INC) – Chachapoyas, Peru**. Assisting project archaeologists in field survey and production of preliminary maps and GIS databases of recently discovered archaeological sites in the Chachapoyas highlands of Northern Peru. GPS survey and GIS.
- 2007 - 2008 **Field Director: Three Rivers Archaeology Project (TRAP) – Programme for Belize, University of Texas Austin, Santa Monica College, Orange Walk, Belize**. Supervising archaeological field activities associated with the excavation and mapping of Maya residential structures within the La Milpa archaeological complex. Identifying excavation locations; managing artefact collection; site, artifact and data interpretation; report writing and presentation/publication of findings.
- 2006 - 2008 **Project Archaeologist: Pambamarca Archaeology Project (PAP), University of California Los Angeles, Foothill College, Pambamarca, Ecuador**. Supervised the excavation and mapping of Inka and Pre-Inka fortresses. Included site, artifact and data interpretation, report writing and lab work associated with the cataloguing and storage of excavated artifacts. Leading field explorations and mapping of new sites within the Pambamarca region. Developing mapping methodology, formulating GIS protocol and the development, maintenance and updating of GIS databases. Under Samuel Connell, PhD and Chad Gifford, PhD.

## CONFERENCES AND PRESENTATIONS

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### Research Papers and Posters Presented at Professional Meetings

- 2019 Mark, B., McKenzie, J., Baraer, M., Hellstrom, R., Fernandez, A., Somers, L., Huh, K., La Frenierre, J., **Wigmore, O.**, Schoessow, F., Lautz, L., Tracing cryo-hydro-social transformations in the tropical Andes, *Presented at International Mountain Conference 2019*, Innsbruck, Austria, 8-12 September.
- 2018 **Wigmore, O.**, Molotch, N., Assessing spatiotemporal variability in mountain ecosystem productivity with multispectral unmanned aerial systems, Paper H13C-01, *Presented at 2018 Fall Meeting, American Geophysical Union (AGU)*, Washington DC, 10-14 December.
- 2018 Webb, R., Fend, M., Jennings, K.S., **Wigmore, O.**, Erickson, T., Finsterle, S., Williams M.W., Molotch, N.P., New approaches to address scaling issues of water flow through snow, Paper C41B-04, *Presented at 2018 Fall Meeting, American Geophysical Union (AGU)*, Washington DC, 10-14 December.
- 2018 Jacquemart, M., **Wigmore, O.**, Cassotto, R., Stopka, C., Hodge, B.E., Corsa, B.D., Bilham, R.G., Tiampo, K.F., Building a decision-making framework for operational landslide monitoring: Evaluating radar, lidar and UAV methods to monitor slope stability (Invited), Paper U12B-18,

- Presented at 2018 Fall Meeting, American Geophysical Union (AGU), Washington DC, 10-14 December.*
- 2018 **Wigmore, O.**, Molotch, N., Improving understanding of high resolution spatiotemporal variability in snow depth and vegetation productivity with multispectral UAS, Presented at *LTERR All Scientists' Meeting 2018*, Asilomar, California, 1-4 October.
- 2018 Hinckley, E., Hermes, A., **Wigmore, O.**, Chen, Y., Livneh, B., Determining changes to landscape connectivity with “too much summer” at Niwot Ridge LTER, Presented at *Ecological Society of America Annual Meeting*, New Orleans, Louisiana, 5-10 August.
- 2018 **Wigmore, O.**, Molotch, N., Mapping snow depth variability and ecosystem response with a multispectral unmanned aerial system (UAS), Presented at *86th Annual Western Snow Conference*, Albuquerque, New Mexico, 16-19 April.
- 2018 Manos J., Mark B., DeGrand, J., **Wigmore, O.**, Annual surface elevation change of the Lehman rock glacier in Great Basin National Park, Nevada, USA, Presented at *Association of American Geographers (AAG) Annual Meeting*, New Orleans, Louisiana, 10-14 April.
- 2017 **Wigmore, O.**, Molotch, N., Improving understanding of spatial heterogeneity in mountain ecohydrology with multispectral unmanned aerial systems (UAS), Paper H41D-1470, Presented at *2017 Fall Meeting, American Geophysical Union (AGU)* New Orleans, Louisiana, 11-15 December.
- 2017 La Frenierre, J., Decker, C.R., Jordan, E., **Wigmore, O.**, Hodge, B., Niederriter, C., Michels, A., Geodetic mass balance measurements on debris and clean-ice tropical glaciers in Ecuador, Paper C33D-1236, Presented at *2017 Fall Meeting, American Geophysical Union (AGU)* New Orleans, Louisiana, 11-15 December.
- 2017 **Wigmore, O.**, Monitoring tropical Andean glacier change with structure from motion photogrammetry, Presented at *Global Land Ice Measurements from Space (GLIMS) Workshop*, Boulder, Colorado, 11-13 August.
- 2017 Lagos, P., Mark, B.G., McKenzie, J., Baraer, M., **Wigmore, O.**, Somers, L., Casani, Y., Investigating climate forcing of Huaytapallana glacier recession, central Peruvian Andes, Presented at *Association of American Geographers (AAG) Annual Meeting*, Boston, Massachusetts, 5-9 April.
- 2017 Mark, B., McKenzie, J., Baraer, M., Lautz, L., Somers, L., **Wigmore, O.**, Hellstrom, R., Lagos, P., Glacier-water fluxes, feedbacks and groundwater connections in the Peruvian Andes, Presented at *Association of American Geographers (AAG) Annual Meeting*, Boston, Massachusetts, 5-9 April.
- 2016 **Wigmore, O.**, Mark, B., Lagos, P., Somers, L., McKenzie, J., Huh, K.I., Hopkinson, C., Baraer, M., Crumley, R., Integrating unmanned aerial vehicles and terrestrial structure from motion photogrammetry for assessing high mountain glacier change, Huaytapallana, Peru, Paper C34C-06, Presented at *2016 Fall Meeting, American Geophysical Union (AGU)* San Francisco, California, 12-16 December.
- 2016 Li, D., **Wigmore, O.**, Vanderjagt, B.J., Durand, M.T., Molotch, N.P., Bales, R.C., Catchment-scale snow depth monitoring with balloon photogrammetry, Paper C51C-0669, Presented at *2016 Fall Meeting, American Geophysical Union (AGU)* San Francisco, California, 12-16 December.
- 2016 Lagos, P., Mark, B., McKenzie, J., Baraer, M., **Wigmore, O.**, Somers, L., Casani, Y., Climate in the glaciated central Peruvian Andes observed since 1921: Trends in maximum, minimum, mean and DTR surface air temperature, Paper GC54C-03, Presented at *2016 Fall Meeting, American Geophysical Union (AGU)* San Francisco, California, 12-16 December.
- 2016 McKenzie, J., Glas, R., Lautz, L., Mark, B., **Wigmore, O.**, Baraer, M., Baker, E., Hydrologic transformation of the glacierized watersheds in Peruvian Andes: from glaciers to groundwater, Paper H13L-1588, Presented at *2016 Fall Meeting, American Geophysical Union (AGU)* San Francisco, California, 12-16 December.

- 2016 Glas, R., Lautz, L., McKenzie, J., Baker, E., Somers, L., Aubry-Wake, C., **Wigmore, O.**, Mark, B., Moucha, R., Integrating multiple geophysical methods to quantify alpine groundwater-surface water interactions: Cordillera Blanca, Peru, Paper NS43C-1937, Presented at *2016 Fall Meeting, American Geophysical Union (AGU)* San Francisco, California, 12-16 December.
- 2016 Glas, R., Lautz, L., McKenzie, J.M., Aubry-wake, C., Baker, E.A., Somers, L., Mark, B.G., **Wigmore, O.**, Using multiple, integrated hydrogeophysical methods to understand groundwater/surface water interactions in glaciated, tropical catchments of the Cordillera Blanca, Peru, Paper 157-14, Presented at *2016 Geological Society of America Annual Meeting*, Denver, Colorado, 25-28 September.
- 2016 **Wigmore, O.**, Mark, B., UAV mapping of debris covered glacier change, Llaca glacier, Cordillera Blanca, Peru, Poster presented at *Eastern Snow Conference 73<sup>rd</sup> Annual Meeting*, Columbus, Ohio, 14-16 June.
- 2016 **Wigmore, O.**, Mark, B., McKenzie, J., Baraer, M., Gordon, R., Lautz, L., High resolution thermal UAV mapping of proglacial streams and wetlands in the Cordillera Blanca, Peru, Presented at *Association of American Geographers (AAG) Annual Meeting*, San Francisco, California, 29 March-2 April.
- 2016 Baker, E., Lautz, L., McKenzie, J., Aubry-Wake, C., Somers, L., **Wigmore, O.**, Glose, A., Glas R., and B.G. Mark. Infrared imaging and modelling of proglacial stream temperature in the Cordillera Blanca, Peru. Paper No. 16-4 presented at the *Northeast Section Geological Society of America Annual Meeting*, Albany, NY, 21-23 March, GSA Abstracts with Programs Vol. 48, No. 2.
- 2015 Glas, R., Lautz, L., McKenzie, J., Mark, B., Baker, E., Aubry-Wake, C., Somers, L., **Wigmore, O.**, Constraining subsurface structure and composition using seismic refraction surveys of proglacial valleys in the Cordillera Blanca, Peru, Paper H13E-1601, Presented at *2015 Fall Meeting, American Geophysical Union (AGU)* San Francisco, California, 14-18 December.
- 2015 **Wigmore, O.**, Mark, B., Mapping glacier dynamics and proglacial wetlands with a multispectral UAV at 5000m in the Cordillera Blanca, Peru, Paper C41D-0719, Presented at *2015 Fall Meeting, American Geophysical Union (AGU)* San Francisco, California, 14-18 December.
- 2015 Mark, B., McKenzie, J., Baraer, M., Lagos, P., Lautz, L., Carey, M., Bury, J., Crumley, R., **Wigmore, O.**, Somers, L., Glacier loss and emerging hydrologic vulnerabilities in the Peruvian Andes, Paper U42A-01, Presented at *2015 Fall Meeting, American Geophysical Union (AGU)* San Francisco, California, 14-18 December. INVITED.
- 2015 McKenzie, J., **Wigmore, O.**, Aubry-Wake, C., Mark, B., Hellstrom, R., Lautz, L., Time-lapse and UAV thermal imaging of glacial and periglacial environments in the Peruvian Andes (Cordillera Blanca, Peru), (Invited) Paper NS21A-1916, Presented at *2015 Fall Meeting, American Geophysical Union (AGU)* San Francisco, California, 14-18 December. INVITED.
- 2015 Baker, E., Lautz, L., McKenzie, J., Aubry-Wake, C., Somers, L., **Wigmore, O.**, Glose, A., Glas, R., Mark, B., Infrared imaging and modeling of proglacial stream temperature in the Cordillera Blanca, Peru, Paper H23H-1670, Presented at *2015 Fall Meeting, American Geophysical Union (AGU)* San Francisco, California, 14-18 December.
- 2015 Somers, L., Gordon, R., McKenzie, J., Lautz, L., **Wigmore, O.**, Baraer, M., Mark, B., Quantifying groundwater-surface water interactions using a stream energy balance model and dye tracing in a proglacial valley of the Cordillera Blanca, Peru, Paper H31K-07, Presented at *2015 Fall Meeting, American Geophysical Union (AGU)* San Francisco, California, 14-18 December.
- 2015 **Wigmore, O.**, Mark, B., Crumley R., Despliegue de vehículos aéreos no tripulados (UAV) para mapeo de alta resolución de cuencas glaciales, Cordillera Blanca, Perú, *Taller de Intercambio Científico*, Huaraz, Peru, 17 July.
- 2015 Somers, L., McKenzie, J., Lautz, L., Gordon, R., **Wigmore, O.**, Mark, B., Quantifying groundwater-surface water interactions with a stream energy balance, Cordillera Blanca, Peru, Abs H12B-05, *Joint Assembly AGU-GAC-MAC-CGU*, Montreal, Canada, 3-7 May.



- 2015 Aubry-Wake, C., McKenzie, J., Baraer, M., Mark, B., **Wigmore, O.**, Hellstrom, R., Melt processes at glacier margins: high-resolution ground-based IR imagery in the Cordillera Blanca, Peru, Abs H32A-03, *Joint Assembly AGU-GAC-MAC-CGU*, Montreal, Canada, 3-7 May.
- 2015 Baraer, M., Mark, B., McKenzie, J., Huh, K., **Wigmore, O.**, Fernandez, A., Post peak water in the Cordillera Blanca, Peru: toward a redistribution of water resources, Abs H32A-04, *Joint Assembly AGU-GAC-MAC-CGU*, Montreal, Canada, 3-7 May.
- 2015 Baraer, M., McKenzie, J., Mark, B., **Wigmore, O.**, Fernandez, A., Guittard, A., Spatiotemporal variability of heavy metals contamination of surface water: a case study in the Cordillera Blanca, Peru, Abs H42A-04, *Joint Assembly AGU-GAC-MAC-CGU*, Montreal, Canada, 3-7 May.
- 2015 **Wigmore, O.**, Mark, B., Crumley, R., Development and deployment of a multispectral mapping UAV at 5000m in the Cordillera Blanca, Peru, *Association of American Geographers (AAG) Annual Meeting*, Chicago, Illinois, 21-25 April.
- 2014 McKenzie, J., Gordon, R., Baraer, M., Lautz, L., Mark, B., **Wigmore, O.**, Chavez, D., Aubry-Wake, C., Water resources and groundwater in a glaciated Andean watershed (Cordillera Blanca, Peru), (Invited) Paper GC11G-07, presented at *2014 Fall Meeting, American Geophysical Union (AGU)* San Francisco, California, 15-19 December. INVITED.
- 2014 Aubry-Wake, C., Baraer, M., McKenzie, J., Mark, B., **Wigmore, O.**, Hellstrom, R., Investigating glacier surface conditions using high-definition ground based infrared imagery: Insight from the Cordillera Blanca, Peru, Paper C33B-06, presented at *2014 Fall Meeting, American Geophysical Union (AGU)* San Francisco California, 15-19 December.
- 2014 Mark, B.G., Baraer, M., Huh, K.I., Carey, M., French, A., Bury, J., Young, K., McKenzie, J., Eddy, A., Fernandez A., **Wigmore, O.**, From glaciers to the desert: Assessing hydrologic change and social vulnerability across a tropical Andean waterscape. Extended Abstract, Proceedings from the *71st Eastern Snow Conference, Boone, NC*, 3-5 June.
- 2014 Baraer, M., Mark, B.G., Huh, K.I., McKenzie, J., **Wigmore, O.**, Fernandez, A., Glacial retreat and hydrological response across the Rio Santa watershed, Peru, Poster EGU2014-4395 presented at *2014 General Assembly, European Geosciences Union (EGU)*, Vienna, Austria, 27 April - 2 May 2014.
- 2014 **Wigmore, O.**, Mark, B.G. High resolution aerial photogrammetry and DEM generation in the Peruvian Andes: evaluation of a kite based platform, Illustrated Paper 2224 - R.S. Tarr Student Illustrated Paper Competition (Sponsored by Cryosphere Specialty Group, Polar Geography Specialty Group), *Association of American Geographers (AAG) Annual Meeting*, Tampa, Florida, 8-12 April.
- 2013 Mark, B.G., Eddy, A., Baraer, M., McKenzie, J.M., Walsh, E., Fernandez-Rivera, A., **Wigmore, O.**, Battista, R., Guittard, A., Characterizing changing stream water quality in a glacierized tropical watershed, Paper GC23D-0981, presented at *2013 Fall Meeting, American Geophysical Union (AGU)*, San Francisco, California, 9-13 December.
- 2013 Baraer, M., Mark, B., Huh, K.I., **Wigmore, O.**, Fernandez, A., McKenzie J., Walsh, E., Glacial retreat and hydrological consequences across the Rio Santa watershed. *International Glacier Forum*: <http://foroglaciares.pe/>, Huaraz, Peru, 1-4 July.
- 2013 Mark, B.G. Baraer, M., McKenzie, J. Walsh, E. Fernandez-Rivera, A. **Wigmore, O.** Tracking stream flow and water quality below melting Andean glaciers: survey along the Santa River Peru, Paper presented at session 5223, *2013 Association of American Geographers (AAG) Annual Meeting*, Los Angeles, California, 7-13 April
- 2012 Baraer, M. Mark, B.G. **Wigmore, O.** Fernandez-Rivera, A. McKenzie, J. Walsh, E. From the Cordillera Blanca to the Pacific Ocean: hydrological changes and consequences across the Rio Santa watershed, Paper GC52B-07, presented at *2012 Fall Meeting, American Geophysical Union (AGU)*, San Francisco, California, 3-7 December.

- 2012 Slayback, D.A. Yager, K. Baraer, M. Mohr, K. Argollo, J. **Wigmore, O.** Meneses, R. and Mark, B.G., Changing hydrology in glacier-fed high altitude Andean peatbogs, Poster GC21A-0858 presented at *2012 Fall Meeting, American Geophysical Union (AGU)*, San Francisco, California, 3-7 December.
- 2008 Dodge, R. and **Wigmore, O.**, Excavations of a mid-level elite residential compound at the site of La Milpa, Belize, Abstract 297 presented at *73rd Annual Meeting, Society for American Archaeology (SAA)*, Vancouver, BC, Canada, 26-30 March.

### Invited Presentations

- 2019 *Deploying Drones to Study Mountain Glaciers and Ecohydrology*, Victoria University of Wellington, GED Seminar Series, 1<sup>st</sup> August, Wellington, New Zealand.
- 2018 *Using Drones to Study Mountain Ecohydrology*, National Ecological Observatory Network (NEON), 9<sup>th</sup> October 2018, Boulder, CO.
- 2018 *Using Drones to Study Mountain Snow and Ice*, National Snow and Ice Data Center (NSIDC) Special Seminar, 18<sup>th</sup> July 2018, Boulder, CO.
- 2018 *Using Drones to Study Mountain Snow, Ice and Water*, University of Colorado Boulder, Institute of Arctic and Alpine Research Open House, 20<sup>th</sup> April 2018.
- 2016 *Deploying Unmanned Aerial Vehicles for High Resolution Glacial Watershed Mapping, Cordillera Blanca, Peru*, Department of the Interior (DOI) UAS User Call - Webinar, 2 October 2016.
- 2016 *Deploying Unmanned Aerial Vehicles for High Resolution Glacial Watershed Mapping, Cordillera Blanca, Peru*, University of Colorado Boulder, CWEST - INSTAAR, 3 June 2016.
- 2016 *Deploying Unmanned Aerial Vehicles for High Resolution Glacial Watershed Mapping, Cordillera Blanca, Peru*, UCLA CA, Civil and Environmental Engineering Hydrology and Water Resources Margulis Research Group, 5th February 2016.
- 2015 *Drones for Science? Using Unmanned Aerial Vehicles for Glacial Watershed Mapping in the Peruvian Andes*, Gustavus Adolphus College MN, Invited Geography and Environmental Studies Department Colloquia and UAV demonstration, 12 May 2015.
- 2015 *Deploying Unmanned Aerial Vehicles for High Resolution Pro-glacial Watershed Mapping*, Ohio State University, Byrd Polar and Climate Research Center, Latin America Night, 31st March 2015.
- 2015 *Development and Deployment of a Multispectral Mapping UAV at 5000m in the Cordillera Blanca, Peru*, The Ohio State University, Byrd Polar and Climate Research Center, Ice Core Research Group, 9th March 2015.
- 2014 *Integrating Multispectral UAV's and Field Hydrology in the Cordillera Blanca, Peru*, The Ohio State University, School of Earth Sciences, Water Ice and Snow Research Group, 20th November 2014.
- 2014 *Development and Deployment of a Multispectral Mapping UAV at 5000m in the Cordillera Blanca, Peru*, The Ohio State University, Byrd Polar and Climate Research Center, Byrd Bites, 4<sup>th</sup> November 2014.
- 2013 *Water, Land and Glaciers, Rio Santa Peru*, The Ohio State University, Center for Latin American Studies, Tinker Talks, 14th October 2013.

### TEACHING EXPERIENCE

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#### Courses Taught

(Victoria University of Wellington = VUW; The Ohio State University = OSU) (GTA\*)

GIS 424 (VUW) – Introduction to Remote Sensing (T2 2019) – Course development, Lecturer and Course Coordinator

\*Geography 3900 (OSU) - Global Climate Change: Causes and Consequences (AU 2014, SP

2015)

\*Geography 2960 (OSU) - Introduction to Physical Geography (AU 2014)

### **Guest Lectures**

- 2017 *Unmanned Aerial Vehicles in Mountain Hydrology*, University of Colorado Boulder, Geography 4321 Snow Hydrology, 20<sup>th</sup> February 2017.
- 2015 *Introduction to Research within the Glacier Environmental Change Group*, The Ohio State University, Byrd Polar and Climate Research Center, Geography 3900 Class Tour, 3rd & 5th February 2015.
- 2014 *Introduction to Research within the Glacier Environmental Change Group*, The Ohio State University, Byrd Polar Research Center, Geography 3900 Class Tour, 13th October 2014.
- 2013 *Glacier Environmental Change, Cordillera Blanca, Peru*, The Ohio State University, Byrd Polar Research Center STEM Lecture, 15th May 2013.
- 2012 *Australia and New Zealand*, The Ohio State University, Department of Geography, World Regional Geography, 28th November 2012.

### **Workshops:**

- 2013 Instructor: USAID High Mountain Adaptation Partnership (HiMAP) Managing climate change in high mountain glacial watersheds: promoting social, scientific, and institutional collaboration. Co-led field course: Hydrology and water quality of Quilcay watershed, end-point water sampling and calculations

### **Additional Experience:**

- 2018 Field instructor and mentor for University of Colorado Boulder INSTAAR snow intern program
- 2017 Instructor for University of Colorado Boulder snow hydrology fieldwork exercises
- 2007 – 2008 Three Rivers Archaeology Project (TRAP) (Santa Monica College, University of Texas at Austin), Programme for Belize, Orange Walk, Belize. Supervising and educating a group of thirty field-school students in archaeological field research, excavation techniques and archaeological method and theory within the Santa Monica College Summer Archaeology Field-School Programme.
- 2006 – 2008 Pambamarca Archaeology Project (PAP) (University of California Los Angeles, Foothill College), Northern Ecuadorian Highlands. Teaching archaeological field, excavation, and mapping techniques to students enrolled in the Summer Archaeology Field-School Programme through UCLA and Foothill College. Assisting with student archaeological and ecological research projects within the programme.

### **Student Mentoring:**

\*Denotes undergraduate students mentored

Anna Hermes – PhD Student University of Colorado Boulder

Using spatial polygonal statistics to investigate spatiotemporal dynamics and integrate patch to catchment scale ecohydrologic process in the Colorado Rockies.

Will Wicherski – MA Student University of Colorado Boulder

Applying structure from motion photogrammetry to historical aerial imagery to investigate river changes in the Pacific North West.

\*John-Morgan Manos – The Ohio State University

Using repeat balloon aerial photogrammetry to quantify changes in the Lehman rock glacier, Great Basin National Park, Nevada, USA.

## SERVICE

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**Judge** for The Ohio State University Council of Graduate Students Career Development Grant. (2015 SP)

**Judge** for The Ohio State University Council of Graduate Students Global Gateway Student Research Abroad Grant. (2015 SP)

**PhD Student Representative** - Department of Geography Graduate Studies Committee, The Ohio State University. (2013-2014)

**Personnel Committee Representative** - The Geography Graduate Organisation, The Ohio State University. (2012-2013).

**Manuscript Reviewer:**

Annals of Glaciology (2018)

Climatic Change (2018)

The Cryosphere (2019)

Earth System Science Data (2019)

ISPRS Journal of Photogrammetry and Remote Sensing (2017, 2018)

Journal of Land Use Science (2015, 2016)

Water Resources Research (2017, 2019)

## PROFESSIONAL SERVICE

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*Professional Memberships*

- Association of American Geographers (AAG)
- American Geophysical Union (AGU)

*Service to Professional Societies*

2020	Snow and Ice Research Group Annual Workshop – organising committee member
2019	Co-convener Geosciences NZ session: Technological and Computational Innovations in the Geosciences
2018	Co-convener and Chaired AGU Annual Meeting Session: Remote Sensing of Snow
2017	Co-convener AGU Annual Meeting Session
2016	Convener and Chair (2) Sessions at AAG Annual Meeting
2016	Served as Discussant for (2) Sessions at AAG Annual Meeting
2015-16	Served on Board of Directors for Cryosphere Specialty Group, AAG

## OUTREACH AND ENGAGEMENT

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2017-18	Involvement in Niwot Ridge LTER/Univ. Colorado Boulder Science Discovery High School Program
2014	French Connection Films - <i>Pérou planète extrême : le secret des glaciers andins</i> . Interview for documentary on climate change in Peru.
2012	Interfacing Science and Art CCAD BPRC collaborative infographic development.
2011	Big 10 Network – <i>Impact the World</i> . Interview to describe ongoing research at BPRC.

## MEDIA COVERAGE (Partial)

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Glacier Hub (Arley Titzler) “Drones in the Service of Sustainability: Tracking Soil Moisture in the Peruvian Andes” (12 February 2019) <http://glacierhub.org/2019/02/12/drones-in-the-service-of-sustainability-tracking-soil-moisture-in-the-peruvian-andes/>

Glacier Hub (Natalie Belew) “Glacier Retreat and Trace-Metal Contamination in Peru” (20 December 2017) <http://glacierhub.org/2017/12/20/glacier-retreat-trace-metal-contamination-peru/>

Discover Magazine – Drone 360 (Laura Sigfusson) “Researchers Use Drones to Track Glacier Change in Peru” (30 November 2017) <http://blogs.discovermagazine.com/drone360/2017/11/30/drone-glacier->

[change-peru/#.WiwT6EqnGM9](#)

Science Magazine (David Malakoff) "Glacier-mapping drone soars to nearly 5000 meters, setting a record" (10 November 2017) <https://www.sciencemag.org/news/2017/11/glacier-mapping-drone-soars-nearly-5000-meters-setting-record>

Glacier Hub (Andrew Angle) "Water Access and Glacial Recession in Peru" (7 November, 2017) <http://glacierhub.org/2017/11/07/water-access-glacial-recession-peru/>

Glacier Hub (Sarah Kai Zhen Toh) "Using Drones to Study Glaciers" (2 May, 2017) <http://glacierhub.org/2017/05/02/using-drones-to-study-glaciers/>

Unmanned Systems (AUVSI) (Chloe Svolos) "Unmanned Unplugged: Oliver Wigmore, Ohio State University (12 May, 2016) <http://increasinghumanpotential.org/unmanned-unplugged-oliver-wigmore-ohio-state-university/>

NASA TechBriefs (Billy Hurley) "Customized drone maps glaciers" (1 May, 2016) <http://www.techbriefs.com/component/content/article/ntb/features/application-briefs/24691>

UNDARK (Aleszu Bajak) "Homemade drones, Peruvian glaciers" (7 March, 2016) <http://undark.org/2016/03/07/counting-peruvian-glaciers-homemade-drones/>

UAS Magazine (Patrick Miller) "UAS used to study climate change impacts on Andes glaciers" (17 December, 2015) <http://www.uasmagazine.com/articles/1364/uas-used-to-study-climate-change-impacts-on-andes-glaciers>

The Hindu "Drones to map high-altitude glaciers" (17 December, 2015) <http://www.thehindu.com/todays-paper/tp-national/drones-to-map-highaltitude-glaciers/article7997847.ece>

Phys.org "Three miles high: Using drones to study high-altitude glaciers" (15 December, 2015) <http://phys.org/news/2015-12-miles-high-drones-high-altitude-glaciers.html>

Eureka Alert "Three miles high: Using drones to study high-altitude glaciers" (15 December, 2015) [http://www.eurekaalert.org/pub\\_releases/2015-12/osu-tmh121415.php](http://www.eurekaalert.org/pub_releases/2015-12/osu-tmh121415.php)

OSU.edu "Innovation in the Andes" (14 December, 2015) <https://www.osu.edu/features/2015/innovation-in-the-andes.html>

OSU News (Pam Gorder) "Three miles high: Using drones to study high-altitude glaciers" (15 December, 2015) <https://news.osu.edu/news/2015/12/15/thermodrone/>

## **ADDITIONAL SKILLS**

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### **Languages**

- English – Native
- Spanish – Conversational

## REFERENCES

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**Bryan Mark (PhD)** (PhD Advisor)  
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