

CURRICULUM VITAE: LAURENCE C. SMITH

<https://northernchange.brown.edu>

Laurence C. Smith is the John Atwater and Diana Nelson University Professor of Environmental Studies in the Institute at Brown for Environment & Society (IBES) and the Department of Earth, Environmental and Planetary Sciences (DEEPS) at Brown University. Previously, he was Professor and Chair of Geography at the University of California, Los Angeles (UCLA), where he also held a joint appointment in the Department of Earth, Planetary, and Space Sciences. His research interests include the Arctic, water resources, and satellite remote sensing technologies. He has published over 150 peer-reviewed articles, essays and books including in the journals *Science*, *Nature*, and *PNAS*, and won more than \$18M in research funding from NASA and the National Science Foundation. He is a Guggenheim Fellow of the John S. Guggenheim Foundation and an elected Fellow of the American Geophysical Union (AGU). His work has appeared prominently in Assessment Reports of the United Nations' Intergovernmental Panel on Climate Change (IPCC). He has assisted the World Economic Forum (WEF) with issues surrounding Arctic development and on three occasions was an invited speaker at their annual conference in Davos. He is currently assisting NASA with a new satellite mission (Surface Water and Ocean Topography – SWOT) to monitor global freshwater resources.

His general-audience book *THE WORLD IN 2050: Four Forces Shaping Civilization's Northern Future* (Plume: New York, 2011; U.K. edition titled *THE NEW NORTH*, Profile: London, 2011 with translations in 14 languages) examining cross-cutting trends in natural resource demand, demographics, globalization, and climate change with emphasis on northern countries was winner of the Walter P. Kistler Book Award and a *NATURE* Editor's Pick of 2012. His second book *RIVERS OF POWER*, about rivers and society (Hachette Group USA/Canada; Penguin Press U.K; plus overseas translation editions), was a *GEOGRAPHICAL* Best Book of 2020. His research has received coverage in *The New York Times*, *The Wall Street Journal*, *The Economist*, *The Los Angeles Times*, *The Washington Post*, *The Globe and Mail*, *The Financial Times*, *Discover Magazine*, *NPR*, *CBC Radio*, *BBC* and others.

EDUCATION

Ph.D. Cornell University (1996)	<i>Department of Earth and Atmospheric Sciences, Ithaca, New York</i>
M.S. Indiana University (1991)	<i>Department of Geological Sciences, Bloomington, Indiana</i>
B.S. University of Illinois (1989)	<i>Department of Geology, Urbana-Champaign, Illinois</i>

PROFESSIONAL HISTORY

John Atwater and Diana Nelson**University Professor***2019-present***Chair, Dept. of Geography***2013-2017***Professor***2006 – 2019***Associate Professor***2002 – 2006***Assistant Professor***1996 – 2002***Hydrologist***1991 – 1992*

- Brown University
Institute at Brown for Environment & Society (IBES) and
Dept. of Earth, Environmental and Planetary Sciences (DEEPS)
- Chair of the UCLA Department of Geography
- UCLA Department of Geography, with additional 0 FTE joint
appointment in the Department of Earth & Space Sciences
- UCLA Department of Geography, with additional 0 FTE joint
appointment in the Department of Earth & Space Sciences
- UCLA Department of Geography
- U.S. Geological Survey, Water Resources Division,
Indianapolis, Indiana

HONORS

*Phi Beta Kappa Visiting Scholar***Phi Beta Kappa Society**

(2021-22) The Phi Beta Kappa Society's Visiting Scholar Program affords undergraduates attending different institutions the opportunity to meet "some of America's most distinguished scholars," see <https://www.pbk.org/Press/VS-2021-2022>

*AGU Fellow***American Geophysical Union**

(2015) For "individual AGU members who have made exceptional scientific contributions and attained acknowledged eminence in the fields of Earth and space sciences" and bestowed "on only 0.1 percent of the membership in any given year" see <http://news.agu.org/press-release/american-geophysical-union-announces-2015-fellows/>

*PNAS Top 10 Story of 2013***Proceedings of the National Academy of Sciences**

(2013) paper "New Trans-Arctic shipping routes navigable by midcentury" was selected by PNAS as one of its top ten of the year, see <http://www.pnas.org/site/media/topten2013.xhtml>

*Best Analytic Presentation (First Place)***Esri User Conference**

(2013) Map competition winner for "New Trans-Arctic shipping routes navigable by midcentury" See <http://www.esri.com/events/user-conference/participate/map-gallery-results>

*AAAS John Wesley Powell Lecturer***American Association for the Advancement of Science**

(2012) Honorary annual lecture in memory of John Wesley Powell, AAAS Southwestern and Rocky Mountain Division

*Walter P. Kistler Book Award***Foundation for the Future**

(2012) Annual award to "recognize authors of science-based books that significantly increase the knowledge and understanding of the public regarding the future of our species"

<i>Woo Lecturer</i>	CMOS-CGU Joint Congress (2010) Honorary named lecture to the 3 rd Joint Congress of the Canadian Meteorological and Oceanographic Society and the Canadian Geophysical Union.
<i>Bellagio Residency</i>	The Rockefeller Foundation (2007) One-month residency for scholars who “demonstrate a history of significant achievement in their respective fields.” See http://www.rockefellerfoundation.org/bellagio-center/residency-program
<i>Guggenheim Fellow</i>	John S. Guggenheim Foundation, New York (2006-07) Annual award for “distinguished achievement in the past and exceptional promise for future accomplishment” For more information see http://www.gf.org/
<i>Discover Magazine Top 100</i>	Discover Magazine (January 2006) Annual award for “the Top 100 Science Stories of the Year” (2005). For more information see http://discovermagazine.com/2006/jan/environment/
<i>AGU Frontier Lecturer</i>	American Geophysical Union (2005) Honorary keynote “ <i>Arctic Change and the New Global Hydrology</i> ,” AGU Fall Meeting, San Francisco
<i>NASA New Investigator</i>	National Aeronautics and Space Administration (2000) Career development award for tenure-track faculty
<i>UCLA Career Development Award</i>	University of California, Los Angeles (2000) Career development award for promising junior faculty
<i>Outstanding Student Paper</i>	American Geophysical Union (1995) For description, see <i>Eos, Trans. AGU</i> 76(36), 1995.
<i>Graduate Student Researchers Program Fellow</i>	National Aeronautics and Space Administration (1994) Three years of Ph.D. tuition/stipend support
<i>Robert K. Fahnestock Memorial Award</i>	Geological Society of America (1994) Annual award to the ‘most outstanding student research proposal in Geomorphology.’ See <i>GSA TODAY</i> 4(9), 1994.
<i>Most Outstanding Graduate Student</i>	(1993) Cornell University Annual award in the Dept. of Earth and Atmospheric Sciences.

PEER-REVIEWED JOURNAL PUBLICATIONS

(*mentored paper)

140. Kurek, M. R., Garcia-Tigeros, F., Wickland, K. P., Frey, K. E., Dornblaser, M. M., Striegl, R. G., et al. (2023). Hydrologic and landscape controls on dissolved organic matter composition across western North American Arctic lakes. *Global Biogeochemical Cycles*, 37, e2022GB007495.
<https://doi.org/10.1029/2022GB007495>

139. HUANG, C., **SMITH, L.C.**, KYZIVAT, E.D., FAYNE, J.V., MING, Y., SPENCE, C. (2022) Tracking transient boreal wetland inundation with Sentinel-1 SAR: Peace-Athabasca Delta, Alberta and Yukon Flats, Alaska *GIScience & Remote Sensing* 59:1, 1767-1792, DOI: 10.1080/15481603.2022.2134620
138. *WANG, B., **SMITH, L.C.**, YANG, X., PAVELSKY, T.M., ALTENAU, E.H., GLEASON, C.J., PIETRONIRO, A., RODRIGUEZ, E., BATES, P.D. (2022) Remote sensing of broad-scale controls on large river anabranching. *Remote Sensing of Environment* 281, 113243, <https://doi.org/10.1016/j.rse.2022.113243>
137. *RYAN, J.C., **SMITH, L.C.**, COOLEY, S.W., PEARSON, B., WEVER, N., KEENAN, E., LENAERTS, J.T.M. (2022) Decreasing surface albedo signifies a growing importance of clouds for Greenland Ice Sheet meltwater production. *Nature Communications* 13, 4205. <https://doi.org/10.1038/s41467-022-31434-w>
136. MUTHYALA, R., RENNERMALM, A.K., LEIDMAN, S.Z., COOPER, M.G., COOLEY, S.W., **SMITH, L.C.**, VAN AS, D. (2022) Supraglacial Streamflow and Meteorological Drivers from Southwest Greenland. *The Cryosphere*, 16, 2245–2263, <https://doi.org/10.5194/tc-16-2245-2022>
135. *KYZIVAT, E.D., **SMITH, L.C.**, GARCIA-TIGREROS, F., HUANG, C., WANG, C., LANGHORST, T., FAYNE, J.V., HARLAN, M.E., ISHITSUKA, Y., FENG, D., DOLAN, W., PITCHER, L.H., WICKLAND, K.P., DORNBLASER, M.M., STRIEGL, R.G., PAVELSKY, T.M., BUTMAN, D.E., GLEASON, C.J. (2022) The importance of lake emergent aquatic vegetation for estimating Arctic-boreal methane emissions. *Journal of Geophysical Research: Biogeosciences*, 127, e2021JG006635. <https://doi.org/10.1029/2021JG006635>
134. YANG, K., **SMITH, L.C.**, ANDREWS, L.C., FETTWEIS, X., LI, M. (2022). Supraglacial drainage efficiency of the Greenland Ice Sheet estimated from remote sensing and climate models. *Journal of Geophysical Research: Earth Surface*, 127, e2021JF006269. <https://doi.org/10.1029/2021JF006269>
133. **SMITH, L.C.** The Powers of Rivers (2022) *GeoHumanities*, 19 pp. <https://doi.org/10.1080/2373566X.2021.2011765>
132. TSAI, V.C. **SMITH, L.C.**, GARDNER, A.S., SEROUSSI, H. (2022) A Unified Model for Transient Subglacial Water Pressure and Basal Sliding. *J. Glaciology* 68(268), 390–400. <https://doi.org/10.1017/jog.2021.103>
131. LI, Y., YANG, K., GAO, S., **SMITH, L.C.**, FETTWEIS, X., LI, M. (2022) Surface meltwater runoff routing through a coupled supraglacial-proglacial drainage system, Inglefield Land, northwest Greenland. *International Journal of Applied Earth Observation and Geoinformation* 106, 102647, <https://doi.org/10.1016/j.jag.2021.102647>
130. BOGHOSIAN, A. PITCHER, L.H. **SMITH, L.C.**, KOSH, E., ALEXANDER, P.M., TEDESCO, M., BELL, R.E. (2021). Development of ice-shelf estuaries promotes fractures and calving. *Nature Geoscience* 14, 899–905 <https://doi.org/10.1038/s41561-021-00837-7>
129. YANG, K., **SMITH, L.C.**, COOPER, M.G., PITCHER, L.H., VAN AS, D., LU, Y., LI, M. Seasonal evolution of supraglacial lakes and rivers on the southwest Greenland Ice Sheet (2021). *J. Glaciology* 67(264), 592-602. <https://doi.org/10.1017/jog.2021.10>
128. *STEIRO, V.D., RYAN, J.C., COOLEY, S.W., **SMITH, L.C.**, DALE, B., LYNCH, A.H., VELAND, S. (2021) Changes in sea ice travel conditions in Ummannaq Fjord, Greenland (1985–2019) assessed through remote sensing and transportation accessibility modeling, *Polar Geography*, <https://doi.org/10.1080/1088937X.2021.1938271>
127. *LEZINE, E.M.D, KYZIVAT, E.D., **SMITH, L.C.** (2021) Super-Resolution Surface Water Mapping on the Canadian Shield Using Planet CubeSat Images and a Generative Adversarial Network, *Canadian Journal of Remote Sensing*, <https://doi.org/10.1080/07038992.2021.1924646>
126. GLEASON, C.J., YANG, K., FENG, D., **SMITH, L.C.**, LIU, K., PITCHER, L.H., CHU, V.W., COOPER, M.G., OVERSTREET, B.T., RENNERMALM, A.K., AND RYAN, J.C. (2021). Hourly surface meltwater routing for a Greenlandic supraglacial catchment across hillslopes and through a dense topological channel network, *The Cryosphere* 15, 2315–2331, <https://doi.org/10.5194/tc-15-2315-2021>.
125. *COOPER, M.G., **SMITH, L.C.**, RENNERMALM, A K., TEDESCO, M., MUTHYALA, R., LEIDMAN, S.Z., MOUSTAFA, S.E., FAYNE, J.V. (2021) Spectral attenuation coefficients from measurements of light transmission in bare ice on the Greenland Ice Sheet, *The Cryosphere* 15, 1931–1953, <https://doi.org/10.5194/tc-15-1931-2021>
124. **SMITH, L.C.**, ANDREWS, L.C., PITCHER, L.H, OVERSTREET, B.T., RENNERMALM, A.K., COOPER, M.G., COOLEY, S.W., RYAN, J.C., MIÈGE, C., KERSHNER, C., SIMPSON, C.E. (2021) Supraglacial

river forcing of subglacial water storage and diurnal ice sheet motion. *Geophysical Research Letters*, 48, e2020GL091418. <https://doi.org/10.1029/2020GL091418> [AGU highlight “Greenland ice sheet surges in daily melt cycles” <https://news.agu.org/press-release/greenland-ice-sheet-surges-in-daily-melt-cycles-video/>]

123. XU, Y.J., WANG, B., XU, W., TANG, M., TSAI, F.T.-C., **SMITH, L.C.** (2021) Four-decades of bed elevation changes in the heavily regulated upper Atchafalaya River, Louisiana, USA. *Geomorphology*, 386, 107748, <https://doi.org/10.1016/j.geomorph.2021.107748>
122. HARLAN, M.E., GLEASON, C.J., ALTENAU, E.H., BUTMAN, D., CARTER, T., CHU, V.W., COOLEY, S.W., DOLAN, W.D., DURAND, M.T., EIDAM, E., FAYNE, J.V., FENG, D., ISHITSUKA, Y., KUHN, C., KYZIVAT, E.D., LANGHORST, T., MINEAR J.T., PAVELSKY, T.M., PETERS, D.L., PIETRONIRO, A., PITCHER, L.H., **SMITH, L.C.** (2021) Discharge estimation from dense arrays of pressure transducers. *Water Resources Research*, 57, e2020WR028714. <https://doi.org/10.1029/2020WR028714>
121. SIMPSON, C.E., ARP, C.D., SHENG, Y., CARROLL, M.L., JONES, B.M., **SMITH, L.C.** (2021) Landsat derived bathymetry of lakes on the Arctic Coastal Plain of northern Alaska, *Earth Syst. Sci. Data*, 13, 1135–1150, <https://doi.org/10.5194/essd-13-1135-2021>
120. BARONAS, J.J., HAMMOND, D.E., BENNETT, M.M., ROUXEL, O., PITCHER, L.H. **SMITH, L.C.** (2021) Ge/Si and Ge Isotope Fractionation During Glacial and Non-glacial Weathering: Field and Experimental Data From West Greenland. *Front. Earth Sci.* 9:551900. doi: 10.3389/feart.2021.551900
119. *COOLEY, S.W., RYAN, J.C., **SMITH, L.C.** (2021) Human alteration of global surface water storage variability. *Nature* 591, 78–81 (2021). <https://doi.org/10.1038/s41586-021-03262-3>
118. YANG, K., SOMMERS, A., ANDREWS, L.C., **SMITH, L.C.**, LU, X., FETTWEIS, X., AND LI, M. (2020) Intercomparison of surface meltwater routing models for the Greenland ice sheet and influence on subglacial effective pressures, *The Cryosphere*, 14, 3349–3365, <https://doi.org/10.5194/tc-14-3349-2020>
117. LU, Y., YANG, K., LU, X., **SMITH, L.C.**, SOLE, A.J., LIVINGSTONE, S.J., FETTWEIS, X. LI, M. (2020) Diverse supraglacial drainage patterns on the Devon ice Cap, Arctic Canada, *Journal of Maps*, 16:2, 834-846, <https://doi.org/10.1080/17445647.2020.1838353>
- 116* PITCHER, L.H., **SMITH, L.C.**, COOLEY, S.W., ZAINO, A., CARLSON, R., PETTIT, J., GLEASON, C.J., MINEAR, T., FAYNE, J.V., HARLAN, M.E., LANGHORST, T., TOPP, S.N., DOLAN, W., KYZIVAT, E.D., PIETRONIRO, A., YANG, D., CARTER, T., ONCLIN, C., HOSSEINI, N., MOREIRA, D., BERGE-NGUYEN, M., CRETAUX, J.-F., PAVELSKY, T.M. (2020) Advancing field-based GNSS surveying for validation of remotely sensed water surface elevation products. *Frontiers in Earth Science* 8(278), <https://doi.org/10.3389/feart.2020.00278>
115. *FAYNE J.V., **SMITH L.C.**, PITCHER L.H, KYZIVAT E.D., COOLEY S.W., COOPER M.G., DENBINA M., CHEN A., CHEN C., PAVELSKY T.M. (2020) Airborne Observations of Arctic-Boreal Water Surface Elevation from AirSWOT Ka-Band InSAR and LVI LiDAR. *Environmental Research Letters* 15(105005), <https://doi.org/10.1088/1748-9326/abadcc>
- 114*RYAN, J.C., **SMITH, L.C.**, COOLEY, S.W., PITCHER, L. H, PAVELSKY, T.M. (2020) Global characterization of inland water reservoirs using ICESat-2 altimetry and climate reanalysis. *Geophysical Research Letters* 47(17), e2020GL088543, <https://doi.org/10.1029/2020GL088543>
- 113.* POPELKA, S.J., **SMITH, L.C.** (2020) Rivers as political borders: a new subnational geospatial dataset. *Water Policy* 22(3): 293–312, <https://doi.org/10.2166/wp.2020.041>
- 112.* PITCHER, L.H., **SMITH, L.C.**, GLEASON, C.J., MIEGE, C., RYAN, J.C., HAGEDORN, B., VAN AS, D., CHU, W., FORSTER, R.R. (2020) Direct observation of wintertime meltwater drainage from the Greenland Ice Sheet, *Geophysical Research Letters*, e2019GL086521, <https://doi.org/10.1029/2019GL086521>
- 111.*RYAN, J.R., **SMITH, L.C.**, WU, M., COOLEY, S.W., MIÈGE, C., MONTGOMERY, L.N., KOENIG, L.S., FETTWEIS, X., NOEL, B.P.Y., VAN DEN BROEKE, M.R. (2020) Evaluation of CloudSat's cloud-profiling radar for mapping snowfall rates across the Greenland Ice Sheet, *J. Geophysical Research, JGR–Atmospheres*, e2019JD031411, <https://doi.org/10.1029/2019JD031411>
110. *COOLEY, S.W., RYAN, J.C., **SMITH, L.C.**, HORVAT, C., PEARSON, B., LYNCH A.H. (2020) Coldest Canadian Arctic communities face greatest reductions in shorefast sea ice. *Nature Climate Change*, 10, 533–538, <https://doi.org/10.1038/s41558-020-0757-5>

109. LU, X., YANG, K., LU, Y., GLEASON, C.J., **SMITH, L.C.**, LI, M. (2020) Small Arctic rivers mapped from Sentinel-2 satellite imagery and ArcticDEM. *Journal of Hydrology* 584, <https://doi.org/10.1016/j.jhydrol.2020.124689>
108. *COOPER, M.G., **SMITH, L.C.** (2019) Satellite Remote Sensing of the Greenland Ice Sheet Ablation Zone: A Review. *Remote Sensing* 11, 2405. <https://doi.org/10.3390/rs11202405>
107. *KYZIVAT, E.D., **SMITH, L.C.**, PITCHER, L.H., FAYNE, J.V., COOLEY, S.W., COOPER, M.G., TOPP, S.N., LANGHORST, T., HARLAN, M., HORVAT, C., GLEASON, C.J., PAVELSKY, T.M. (2019) A high-resolution airborne color-infrared camera water mask for the NASA ABoVE campaign. *Remote Sensing* 11(18): 2163. <https://doi.org/10.3390/rs11182163>
106. YANG, K., **SMITH, L.C.**, FETTWEIS, X., GLEASON, C.J., LU, Y., LI, M. (2019) Surface meltwater runoff on the Greenland ice sheet estimated from remotely sensed supraglacial lake infilling rate (2019). *Remote Sensing of Environment* 234, 111459, <https://doi.org/10.1016/j.rse.2019.111459>
105. PIETRONIRO, A., PETERS, D.L., YANG, D., Fiset, J.-M., SAINT-JEAN, R., FORTIN, V., LECONTE, R., BERGERON, J., SILES, G.L., TRUDEL, M., GARNAUD, C., MATTE, P., **SMITH, L.C.**, GLEASON, C.J., PAVELSKY, T.M. (2019) Canada's Contributions to the SWOT Mission–Terrestrial Hydrology (SWOT-TH). *Canadian Journal of Remote Sensing*, <https://doi.org/10.1080/07038992.2019.1581056>
104. *PITCHER, L.H., AND **SMITH, L.C.** (2019) Supraglacial Streams and Rivers. *Annual Review of Earth and Planetary Sciences* 47:1, 421-452, <https://doi.org/10.1146/annurev-earth-053018-060212>
103. ALTENAU, E.H., PAVELSKY, T.M., MOLLER, D., PITCHER, L.H., BATES, P.D., DURAND, M.T. AND **SMITH, L.C.** (2019) Temporal variations in river water surface elevation and slope captured by AirSWOT. *Remote Sensing of Environment* 224, 304-316 <https://doi.org/10.1016/j.rse.2019.02.002>
102. *PITCHER, L.H, PAVELSKY, T.M., **SMITH, L.C.**, MOLLER, D.K., ALTENAU, E.H., ALLEN, G.H., LION, C., BUTMAN, D., COOLEY, S.W., FAYNE, J., BERTRAM, M. (2019) AirSWOT InSAR mapping of surface water elevations and hydraulic gradients across the Yukon Flats Basin, Alaska. *Water Resources Research*, 55, 937– 953. <https://doi.org/10.1029/2018WR023274>
101. *RYAN, J.C., **SMITH, L.C.**, VAN AS, D., COOLEY, S.W., COOPER, M.G., PITCHER, L.H, HUBBARD, A. (2019) Greenland Ice Sheet surface melt amplified by snowline migration and bare ice exposure *Science Advances* 5(3), eaav3738, DOI: 10.1126/sciadv.aav3738
- This article featured as a *Nature* Research Highlight “Greenland’s snow cover will help to determine ice sheet’s fate”, <https://www.nature.com/articles/d41586-019-00785-8>
100. *COOLEY, S. W., SMITH, L. C., RYAN, J. C., PITCHER, L. H., & PAVELSKY, T. M. (2019). Arctic-Boreal lake dynamics revealed using CubeSat imagery. *Geophysical Research Letters*, 46. <https://doi.org/10.1029/2018GL081584>
99. YANG, K., **SMITH, L.C.**, SOLE, A., LIVINGSTONE, S.J., CHENG, X., CHEN, Z., MANCHUN, L. (2019) Supraglacial rivers on the northwest Greenland Ice Sheet, Devon Ice Cap, and Barnes Ice Cap mapped using Sentinel-2 imagery. *International Journal of Applied Earth Observation and Geoinformation*, 78, 1–13, <https://doi.org/10.1016/j.jag.2019.01.008>
98. *YANG, K., **SMITH, L.C.**, KARLSTROM, L., COOPER, M.G., TEDESCO, M., VAN AS, D., CHENG, X., CHEN, Z., LI, M. (2018), A new surface meltwater routing model for use on the Greenland Ice Sheet surface , *The Cryosphere* 12, 3791-3811, <https://doi.org/10.5194/tc-12-3791-2018>.
96. *COOPER, M.G, SCHAPEROW, J.R, COOLEY, S.W, ALAM, S., SMITH, L.C. LETTENMAIER, D.P. (2018) Climate Elasticity of Low Flows in the Maritime Western US Mountains, *Water Resources Research* 54, DOI:10.1029/2018WR022816
95. RYAN, J.C., HUBBARD, A., STIBAL, M., IRVINE-FYNN, T.D., COOK, J., **SMITH, L.C.**, CAMERON, K., BOX, J. (2018) Dark zone of the Greenland Ice Sheet controlled by distributed biologically-active impurities, *Nature Communications*, 1065, doi:10.1038/s41467-018-03353-2
97. *COOPER, M. G., **SMITH, L. C.**, RENNERMALM, A. K., MIEGE C., PITCHER, L. H, RYAN, J. C., YANG, K., AND COOLEY, S. (2018), Near surface meltwater storage in low-density bare ice of the Greenland ice sheet ablation zone, *The Cryosphere*, 12, 955-970, <https://doi.org/10.5194/tc-12-955-2018>
94. *COOLEY, S.W., **SMITH, L.C.**, STEPAN, L., MASCARO, J. (2017) Tracking Dynamic Northern Surface Water Changes with High-Frequency Planet CubeSat Imagery. *Remote Sensing* 9(12), 1306, doi:10.3390/rs9121306
93. **SMITH, L.C.**, YANG, K., PITCHER, L.H, OVERSTREET, B.T., CHU, V.W., RENNERMALM, Å.K., RYAN, J.C., COOPER, M.G., GLEASON, C.J., TEDESCO, M., JEYARATNAM, J., VAN AS, D. VAN DEN BROEKE, M.R., VAN DE BERG, W.J., NOËL, B., LANGEN, P.I, CULLATHER, R.I., ZHAO, B., WILLIS, M.J., HUBBARD, A., BOX, J.E., JENNER, B.A., BEHAR, A.E. (2017). Direct measurements of meltwater

- runoff on the Greenland Ice Sheet surface, *Proceedings of the National Academy of Sciences (PNAS)* 114 (50) E10622-E10631, <https://doi.org/10.1073/pnas.1707743114>
92. ALTENAU, E. H., T. M. PAVELSKY, D. MOLLER, C. LION, L. H. PITCHER, G. H. ALLEN, P. D. BATES, S. CALMANT, M. DURAND, AND **L. C. SMITH** (2017), AirSWOT measurements of river water surface elevation and slope: Tanana River, AK, *Geophysical Research Letters*, 44, 181–189, doi:10.1002/2016GL071577.
 91. RYAN J.C., HUBBARD A., BOX J.E., BROUGH S., CAMERON K., COOK J.M., COOPER M., DOYLE S.H., EDWARDS A., HOLT T., IRVINE-FYNN T., JONES C., PITCHER L.H, RENNERMARM A.K., **SMITH L.C.**, STIBAL M. AND SNOOKE N. (2017) Derivation of High Spatial Resolution Albedo from UAV Digital Imagery: Application over the Greenland Ice Sheet. *Front. Earth Sci.* 5:40. doi: 10.3389/feart.2017.00040
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FUNDED GRANTS WITH SMITH AS THE PRINCIPAL INVESTIGATOR (TOTAL: \$8,608,362)

- (PI) NASA JET PROPULSION LABORATORY (12/16/21-8/31/23) \$199,433**
SWOT Inland Hydrology Calibration and Validation (subcontract #1672951, PI L. Smith). This 20-month subcontract to NASA JPL will acquire field calibration/validation datasets in support of the NASA/CNES/CSA SWOT satellite mission (1.0 mo.)
- (PI) INSTITUTE AT BROWN FOR ENVIRONMENT AND SOCIETY (IBES) (2021-2022) \$13,060**
IBES seed grant to establish environmental DNA sampling capacity for a NASA Terrestrial Ecology Program proposal. This one year seed grant enabled collection of environmental DNA (eDNA) samples of *Ondrata zibethicus* (muskrat) from Rhode Island streams and wetlands, in collaboration with RI DEM and the USDA/USFS National Genomics Center for Wildlife and Fish Conservation (0 mo./yr)
- (PI) NASA SURFACE WATER AND OCEAN TOPOGRAPHY SCIENCE TEAM (9/1/20-8/31/24) \$792,695**
Advancing northern high-latitude hydrological science through SWOT water surface elevation mapping (grant #80NSSC20K1144, PI L. Smith, Co-I A. Pietroniro). This four-year appointment to the SWOT Science Team, facilitates scientific research on northern hydrological science using radar data from the NASA/CNES/CSA SWOT satellite mission (0.5 - 1.0 mo./yr)
- (PI) NASA CRYOSPHERIC SCIENCES PROGRAM (7/1/19-6/30/22) \$867,494**
Representing surface meltwater runoff in Greenland ice sheet models (grant #80NSSC19K0942) PI Smith, Co-I's Lauren Andrews, Adam LeWinter, Asa Rennermalm (Brown portion \$677,839) This three-year study uses remote sensing and remote river gauging in northern Greenland to improve climate model predictions of ice sheet runoff contributions to sliding velocity and global sea level rise (0.5 – 1.25 mo./yr)
- (PI) NASA TERRESTRIAL HYDROLOGY PROGRAM (12/18/19-12/17/22) \$484,444**
Dynamic northern rivers assessed with high-frequency CubeSat imagery (grant #80NSSC20K0429, PI Smith) This three-year study assesses surface water dynamics in Alaskan and Canadian rivers using high resolution, high-frequency remote sensing (0.5 – 1.0 mo./yr)
- (PI) NASA TERRESTRIAL ECOLOGY PROGRAM (1/1/17-12/31/2019) \$933,800**
Sensitivity of Arctic-Boreal surface water to permafrost state (grant NNX17AC60A, PI L. Smith, Co-I

Tamlin Pavelsky). This flight project will fly the NASA AirSWOT Ka-band radar interferometer over Canada and Alaska as part of the NASA ABoVE campaign (<https://above.nasa.gov/>) to conduct experimental remote sensing mapping of lakes and rivers (1.0 mo./yr)

(PI) NASA ROSES - SWOT Science Definition Team (4/4/2016-4/3/2020) \$744,348
U.S.-Canada collaboration to build SWOT calibration/validation and science capacity in northern rivers and wetlands (grant NNX16AH83G, PI L. Smith, Co-I A. Pietroniro, C. Gleason). This is a four-year appointment to the SWOT Science Definition Team, to aid prelaunch planning for the NASA/CNES/CSA SWOT satellite mission (0.5 - 1.0 mo./yr)

(PI) NASA CRYOSPHERE PROGRAM (9/1/2014-8/31/2017) \$777,738
Drainage efficiency of the Greenland supraglacial river network (grant NNX14AH93G, PI Smith, Co-I Rennermalm) This three-year study used high-resolution WorldView-1/2/imagery, field measurements, and hydrologic modeling of the hydraulic drainage efficiency of large supraglacial river networks to advance scientific understanding of meltwater transport from the Greenland ice sheet to the global ocean (0.25 – 1.25 mo./yr)

(PI) NASA Surface Water and Ocean Topography (SWOT) mission (2013-2016) \$169,069
Hydrology expertise for the Surface Water and Ocean Topography (SWOT) Science Definition Team [grant NNX13AD88G] (PI Smith, 1/08/2013-1/07/2016). This proposal supports a 3-year appointment to the SWOT Science Definition Team to aid prelaunch planning for this satellite mission (1 mo./yr)

(PI) NASA REMOTE SENSING THEORY PROGRAM (2011 – 2014) \$348,414
“Towards Remote Sensing of River Discharge from Space” [grant NNX12AB41G] (PI Smith) This three-year study will develop theoretical approaches for remotely-sensed estimates of river discharge (1 mo./yr)

(PI) NASA CRYOSPHERIC SCIENCES PROGRAM (2011 – 2014) \$658,014
“Towards hydrologic understanding of the Greenland Ice Sheet” [grant NNX11AQ38G] (PI L. Smith, Co-I’s A. Rennermalm, Y. Sheng) This three-year study will examine supraglacial meltwater hydrologic processes on the Greenland ice sheet, including ephemeral drainage networks, lake drainages, and hydrologic outflows to terrestrial rivers, using geophysical remote sensing and in situ field campaigns (1 mo./yr)

(PI) NASA TERRESTRIAL HYDROLOGY PROGRAM (2010) \$37,034
“Salton Sea Instrument cluster for in situ validation of MODIS water-quality products” [grant NNX10AB01G] (PI L. Smith). This one-year study installed in-situ water-quality monitoring equipment in California’s largest inland lake, the Salton Sea, for the purpose of obtaining a benchmark calibration dataset for assessment of remotely-sensed water quality parameters (0 mo./yr)

(PI) NASA CRYOSPHERIC SCIENCES PROGRAM (2005 – 2008) \$300,987
“Understanding ice-sheet elevation change: How much goes to the ocean?” [grant NNG05GN89G] (PI L. Smith, Co-I’s R. Forster, N. Reeh) This three-year study studied hydrologic processes on the Greenland ice sheet, including the influence of offshore sea-ice on surface melting, mapping of hydrologic “potentiometric drainage basins” within the ice sheet, and tracking of meltwater river outflows via remote sensing of turbid sediment plumes in estuaries. (1 mo./yr)

(PI) NASA TERRESTRIAL HYDROLOGY PROGRAM (2005 – 2008) \$387,297
“Area-stage relationships in rivers and wetlands: Tracking the high-latitude water cycle and provision of core knowledge requirements for a Surface Water satellite mission” [grant NNG06GE05G] (PI L. Smith) This three-year study examined storages and fluxes of surface water around the northern hemisphere and in low-relief environments, using *in situ* and remotely sensed data. Study sites included the Peace-Athabasca Delta, Canada, and the Lena Rivers, Russia. (1 mo./yr)

(PI) NATIONAL SCIENCE FOUNDATION, OFFICE OF POLAR PROGRAMS (3/01/03-3/01/06) \$592,114
“River discharge from the Russian Federation: An understanding of contemporary trends and their placement in a Holocene context” (L. Smith, G. MacDonald (UCLA), Lammers (UNH)). This three year “data rescue” project created a new digital database of daily Russian river discharge, based on compilation

and digitizing of extensive historical records currently archived in Russia. These data were then used to assess the source and timing of a recently discovered increase in Eurasian terrestrial runoff, with dendrochronology used to place these 20th century discharge increase in a longer Holocene context.

(PI) NASA NEW INVESTIGATOR PROGRAM (7/01/01-7/01/04) **\$211,520**
“Detection and modeling of mechanical ice break-up in large polar rivers with SAR interferometry”
 (L. Smith) This three-year developed new radar remote sensing methods (SAR interferometry, radar scatterometer, and MODIS) to study river-ice conditions on the major polar rivers of Russia and Canada.

(PI) NATIONAL SCIENCE FOUNDATION, OFFICE OF POLAR PROGRAMS (6/01/99-6/01/02) **\$752,261**
“Sensitivity of the West Siberian Lowland to Past and Present Climate” (L. Smith, G. MacDonald, A. Velichko) This three-year field study involved data collection from hundreds of sites across extensive peatlands, streams and rivers of Russia’s West Siberian Lowland. Radiocarbon dating of peat cores and remotely sensed imagery were used to relate Holocene evolution of these peatlands to atmospheric levels of methane as measured in ice cores. Stream geochemistry samples were used to show how climate warming and associated permafrost thaw will trigger increases in biogeochemical fluxes of carbon, nutrients and dissolved minerals from the land surface to the Arctic Ocean. New data products include polar scatterometer data and a detailed GIS inventory of the physical properties of ~10,000 peatlands (freely available from the National Snow and Ice Data Center).

(PI) NASA LAND SURFACE HYDROLOGY PROGRAM (9/01/98-9/01/01) **\$343,914**
“Real-time forecasting and rapid post-event assessment of erosional and depositional flood damage”
 (L. Smith, L. Mertes, B. Gomez, F. Magilligan) This three-year study used field campaigns, airborne laser altimetry and SAR interferometry to quantify 3-D volumes of sediment erosion and deposition resulting from a catastrophic 1996 glacial outburst flood in Iceland.

(PI) NATIONAL SCIENCE FOUNDATION, OFFICE OF POLAR PROGRAMS (8/01/97-7/31/99) **\$176,162**
“Temporal Remote Sensing of Seasonal Inundation and Ice Breakup on Arctic Russian Rivers: Controls on Water, Sediment, and Nutrient Delivery to the Arctic Ocean”
 (L. Smith) This two-year study used remotely sensed imagery to determine ranges of natural hydrologic variability in rivers and near-shore environments of Arctic Russia.

(PI) NASA OFFICE OF EARTH SCIENCE (\$193,000) and UCLA IoE/OID (\$51,000) **\$244,000**
“A Campus-Wide Initiative for Interdisciplinary Study of the Environment with Remote Sensing” (10/1/97)
 (L. Smith) This one-time equipment grant was awarded to create the Environmental Remote Sensing Research Laboratory at UCLA. The facility now aids faculty and graduate research emphasize image-processing and GIS analysis of satellite imagery for environmental study of the Earth.

(PI) CALIFORNIA SPACE INSTITUTE (7/1/97-6/30/99). **\$23,919**
“Study of Mackenzie River Delta Inundation Patterns with Interferometric Synthetic Aperture Radar”
 (L. Smith) This pilot study explored the use of SAR interferometry, particularly phase decorrelation, to study trends in the seasonal inundation on the Mackenzie River Delta.

FUNDED PROPOSALS WITH SMITH AS CO-INVESTIGATOR (TOTAL: \$10,172,411)

(Co-I) NASA TERRESTRIAL ECOLOGY PROGRAM (9/1/22-8/31/25) **\$613,486**
Do changing terrestrial-aquatic interfaces in Arctic-boreal landscapes control the form, processing, and fluxes of carbon? (grant #80NSSC22K1237) PI David Butman (U. Washington), Co-I’s R. Spencer (Florida State U.), L. Smith (Brown portion **\$197,826**). This two-year subaward is performing data synthesis of airborne and satellite remote sensing imagery for the NASA Arctic-Boreal Vulnerability Experiment (ABoVE) (0.75 mo. total)

(Co-I) NASA CRYOSPHERIC SCIENCES PROGRAM (2/1/23-1/31/25) **\$627,491**
Ice-Shelf Hydrological Evolution and Impacts on Ice-Shelf Stability (grant #80NSSC22K0382) PI Alex Boghosian (LDEO), Co-I’s Laurence Smith (Brown portion \$87,342, total award \$627,491, Brown portion \$87,342), Robin Bell (LDEO), Adam LeWinter (CRREL), Lincoln Pitcher (NGA). This two-year subaward is using remote sensing to document an ice-shelf estuary developing on Petermann Glacier, NW Greenland (0.75 mo. total)

- (Co-I) NASA CRYOSPHERIC SCIENCES PROGRAM (2/1/22-1/31/25) \$627,490**
Ice-Shelf Hydrological Evolution and Impacts on Ice-Shelf Stability (grant #80NSSC22K0382) PI A. Boghosian (LDEO), Co-I's R. Bell (LDEO), A. LeWinter (CRREL), A. Banwell (CU), L. Pitcher (CU), L. Smith (Brown portion \$87,342) This three-year study (with 2-year Brown subaward, 2/1/23-1/31/25) uses remote sensing and modeling to study the evolution of an ice-shelf estuary at Petermann Glacier, Greenland (0.0 – 0.5 mo./yr)
- (Co-I) NSF NAVIGATING THE NEW ARCTIC PROGRAM (9/01/20-8/31/25) \$2,999,698**
Collaborative Research: Navigating Convergent Pressures on Arctic Development (NSF grant #2022599, PI Amanda Lynch, Co-I Laurence Smith (Brown University) and others (RAND, GWU, UNC, Babson, UAF, NCAR; Brown portion \$1,163,987). This five year project combines survey methods, satellite data, maps, and models to identify potential future locations of economic development in the Arctic. Through multi-disciplinary analysis and synthesis, the project identifies long-term development scenarios and associated impacts on the Arctic environment and peoples (0.5 mo./yr)
- (Co-I) NASA ICESAT-2 SCIENCE TEAM (9/01/20-8/31/23) \$363,554**
Towards global characterization of inland water reservoir use from space (grant #80NSSC20K0963). PI Jonathan Ryan, Co-I L. Smith (Brown University), This three year project uses IceSat-2 satellite laser altimetry to evaluate freshwater management operations in reservoir dams worldwide (0.5 mo./yr)
- (Co-I) NASA TERRESTRIAL ECOLOGY PROGRAM (3/26/19-3/25/22) \$914,579**
Crossing the divide: Inundation drives hotspots of carbon flux (grant 80NSSC19M0104, PI David Butman, UW, Co-I's Laurence Smith (Brown portion \$280,075), Tamlin Pavelsky (UNC-Chapel Hill). This three year Arctic-Boreal Vulnerability Experiment (ABoVE) project uses remote sensing and field campaigns to assess methane fluxes from intermittently flooded wetlands across the ABoVE domain (0.5 mo./yr)
- (Co-PI) NSF OPP NAVIGATING THE NEW ARCTIC PROGRAM (8/15/18-7/31/21) \$479,377**
Co-production of shorefast ice knowledge in Uummannaq Bay, Greenland (NSF grant #1836473) PI Jonathan Ryan, Co-I's Laurence Smith, Amanda Lynch (Brown University). This three year project studies how shorefast ice, a platform for human subsistence food production and transport in the Arctic, has responded to atmospheric warming and how these changes affect community livelihoods in the Uummannaq region of West Greenland. (0.25 mo./yr)
- (Co-I) NASA Terrestrial Hydrology Program (UCLA portion) (12/24/2014-12/6/2017) \$96,990**
Airborne imaging of water level and inundation extent in high-latitude hydrologic systems to address SWOT mission science and validation goals (Grant 5100754, PI Tamlin Pavelsky, UNC-Chapel Hill) This three-year project validated AirSWOT water surface elevations, widths, and slopes over the Tanana River and Yukon River, Alaska (.5 mo./yr)
- (Co-I) U.S. Department of Interior/ U.S. Geological Survey (10/5/2012-10/4/2017) \$973,328**
"Developing decadal high-resolution global lake products from Landsat archival data and future missions" (grant G12PC00071, PI Y. Sheng, Co-I L. Smith) This 5-year project developed a global GIS database of lake locations and shorelines using archived and ongoing Landsat Thematic Mapper imagery (0.5 mo./yr)
- (Co-I) NASA PHYSICAL OCEANOGRAPHY PROGRAM (2010-2013) \$402,951**
Assessing and retiring risk in SWOT discharge products: Two methods for characterizing river depth (PI M. Durand, Co-I's Smith, Andreadis; UCLA portion \$132,599) This three-year study assessed the danger of river depth uncertainty for confounding discharge retrievals from the proposed SWOT satellite mission concept (1 mo./yr)
- (Co-I) NASA TERRESTRIAL HYDROLOGY PROGRAM (2007 – 2010) \$458,599**
"Growing or Going? A Pan-Arctic Assessment of Recent Terrestrial Water Storage Change in High-Latitude Lakes and Wetlands," [grant NNX08AE51G] (PI Y. Sheng, Co-I L. Smith) This three-year study developed a northern hemisphere database on lake distribution using archived satellite data (1 mo./yr)
- (Co-I) NSF ARCTIC SYSTEM SCIENCES PROGRAM (2007 – 2010) q \$242,684**

Collaborative Research: Changes in Lake Dynamics on the Arctic Coastal Plain of North America Over the Past Half-Century [ARC-0713903] (PI Y. Sheng, Co-I L. Smith) This three-year study used field work and remote sensing to examine thaw-lake evolution around Barrow, Alaska. (0.75 mo/yr)

(Co-I) NASA LAND SURFACE HYDROLOGY PROGRAM (01/03 – 12/04) **\$91,707**
 “NASA Working Group on Hydrologic Processes of Rivers and Wetlands” (P.I. D. Alsdorf, UCLA)
 Administrative funding for the working group formerly known as HYDRA-SAT, which is exploring technologies and science drivers for a possible space-based mission dedicated to the study of surface water.

(Co-I) NASA SOLID EARTH/NATURAL HAZARDS PROGRAM (9/09/00-9/01/03) **\$370,254**
 “Globally Consistent Topographic Characterization of Large River Floodplains Based on the SRTM DEM” (P.I. Leal Mertes, University of California, Santa Barbara) This project built accurate fine-scale watershed models of 50 reference sites from 24 of the world’s major rivers, to investigate flood hazards and their inundation potential.

(Co-I) INTEL CORPORATION (9/01/98-9/01/01) **\$703,485**
 “Proposal to Establish and Intel-based Regional Environmental Assessment Laboratory and Regional Environmental Geographic Information System (REAL/GIS)” (P.I. Richard Turco, Atmospheric Sciences, UCLA) This project provided advanced Intel workstations and networking hardware for computational research facilities housed in the UCLA Math Sciences and Geography Departments, as well as a new computer teaching facility in Geography.

(Co-I) NASA POLAR PROGRAMS (1/1/98-12/31/00). **\$206,738**
 “The Spatial and Temporal Characteristics of High Latitude Seasonal Snow Melt as Detected by Passive and Active Microwave Sensors” (P.I. Richard Forster, Department of Geography, University of Utah) This three-year study explored the use of SAR scatterometry and passive microwave radiometry to establish seasonal and temporal patterns in the timing of thaw onset in the Arctic.

TEACHING EXPERIENCE

undergraduate

Earth’s Physical Environment (Geography 1): This General Education course provides a fundamental understanding of the Earth’s atmosphere, energy balance, oceanic circulation, hydrology, weather, internal structure, geomorphology, natural hazards and ecology in an introductory synthesis emphasizing a systems approach to geoscience. Hands-on experience is also provided through weekly laboratory exercises.

People and Earth’s Ecosystems (Geography 5): This popular General Education course provides an introduction to the Earth’s physical and biological systems and their interface with human society. A systems approach is used to present climate change, tropical deforestation, biodiversity loss, environmental pollution, genetic engineering of foods, and other issues facing human society through a balanced format presenting both sides of controversial environmental issues. Additional exercises and group debates are provided in weekly laboratories.

Biophysical and Social Transformations in Northern Regions (Geography 119): This senior-level class examines ongoing transformation of the world’s northern high latitudes due to key 21st century trends of climate change, natural resource development, economic globalization, and population demographics. Eight northern countries (including U.S.) face array of challenges and opportunities ranging from species extinctions to increased viability of shipping lanes. The course blends principles of human and biophysical geography to gain new understanding of northern quarter of planet and its broader importance to the world.

Glacier Environments of California’s High Sierra (Geography 162): This summer field course takes place in the highly glaciated eastern Sierras, where students carry out individual research projects and learn basic mechanics of glacial flow, sediment transport, and geomorphology. Student research projects to date include mass balance studies of the Conness Glacier, snowline fluctuations, interpretation of Quaternary glacial advances from moraine mapping, aquatic geochemistry, invertebrate diversity, temperature lapse rates, and human impacts on a pristine wilderness area.

Introduction to Geographic Information Systems (Geography 168): This upper-level course introduces students to the fast-growing discipline of Geographic Information Systems, an information technology that is irrevocably changing the way we store, query, and analyze spatial data. Lectures are technical in nature and designed to provide students with an understanding of how data are created, stored and manipulated. Laboratory exercises and an independent project provide hands-on exposure to GIS software.

Introduction to satellite remote sensing and Imaging GIS (Geography 169): This upper-level course introduces concepts of remote sensing and raster GIS manipulation of satellite-derived images of the Earth's surface. Past, current and planned sensors operating in the visible, infrared, and microwave range of the electromagnetic spectrum are introduced. Global Positioning System (GPS), topographic imaging, and radar technologies are also discussed. Physical concepts and applications to land surface change, environmental monitoring, oceanography, and meteorology are stressed. Digital image processing methods are also provided in lecture and through weekly computer-based laboratory exercises.

Water in Our World (Earth, Environmental, and Planetary Sciences 0830): The coming century will see substantial pressure on global water resources owing to increasing human demand, alteration of river systems, and climate change. This intro-level undergraduate course provides an overview of natural and societal dimensions of the hydrologic cycle. The first half of the course introduces fundamental concepts in physical hydrology, progressing through different components of the water cycle (e.g. global hydrologic cycle, precipitation and evaporation, groundwater, snow and ice, rivers). The second half of the course explores human interactions and dependencies on freshwater resources and environmental problems associated with a perturbed water cycle (e.g. dams, pollution, governance, conflict, inequity, and technology).

TEACHING

graduate

Graduate courses and seminars include **Advanced Projects in Geographic Information Systems, Physical Environment of the Arctic, Satellite Synthetic Aperture Radar Remote Sensing and Interferometry; Geomorphology of Mars and other Planets, Advanced Regions, Emerging Controversies in Earth System Science, and Scientific Writing and Research Design.**

GRADUATE STUDENTS SUPERVISED

Cynthia Hall-Atkinson (M.A., now at JPL), Karen E. Frey (M.A., Ph.D., now Professor, Clark University Department of Geography), Tamlin M. Pavelsky (M.A., Ph.D., now Professor, UNC-Chapel Hill Department Geological Sciences), Gina Hendricks (M.A.), Scott R. Stephenson (M.A. 2010, PhD 2014, now at RAND), Matthew K. Mersel (M.A., 2012, now at CRREL, U.S. Army Cold Regions and Research Laboratory), Vena W. Chu (M.A. 2009, PhD 2015, now Assistant Professor, UC Santa Barbara Department of Geography), Colin J. Gleason (Ph.D. 2016, now Associate Professor, UMass Amherst Department of Civil and Environmental Engineering); Kang Yang (visiting Ph.D. student, 2012-13; now Associate Professor, Nanjing University), Mia Bennett (Ph.D. 2017, now Assistant Professor, University of Washington), Lincoln Pitcher (M.A. 2015, Ph.D. 2019, now at NGA), Sarah W. Cooley (Ph.D. 2020, now Assistant Professor, U. Oregon), Matthew G. Cooper (Ph.D. 2020, now at Pacific Northwest National Laboratory), Jessica Fayne (Ph.D. 2022, now Assistant Professor, U. Michigan), Ekaterina Lezine (M.S., now in tech sector); Ethan Kyzivat (now earning Ph.D.), Sarah Esenther (now earning Ph.D.), Nimisha Wagle (now earning Ph.D.)

POST-DOCTORAL SCIENTISTS SUPERVISED

Dr. Yongwei Sheng (Ph.D., UC Berkeley, now Professor, UCLA Department of Geography)
 Dr. Asa Rennermalm (Ph.D., Princeton, now Associate Professor, University of Rutgers, Department of Geography), Dr. Kang Yang (now Associate Professor, Nanjing University), Dr. Jonathan C. Ryan (now Assistant Professor, U. Oregon, Department of Geography), Dr. Bo Wang (current postdoctoral scholar, Brown University)

INDEPENDENT UNDERGRADUATE RESEARCH SUPERVISED

(since 2006)

Estey Theriault (2006), Kevin Sampson, Sarah Lewis (2005), Richard Carlos (2007), John Freedman, Nora Hakkakzadeh (2008), Kaitlin Kelley-Reif, Reni Pernova, Ryan Chen, Alana Ayasse, Laura McNerney,

Jinny Lee (2013), Robert Abraham (2014), Oliwia Baney (2014), Maya Bruguera (2014), Yingying Xiao (2015), Kelly Young (2015), Yuxi Suo (2015), Lin Lu (2016), Ariana Nickmeyer (2016), Claire Simpson (2016-17), Wing Yi Yeung (2016-17), Zhaoxin Ban (2016-17), Sarah Popelka (2017-18), Steiro Vida (2019-20), Michela Savignano (2020-22), Raquenel Abreu (2021); Seth Goldstein (2021-22); Carolyn Lober (2021-22); Lucas Fromm (2021-present); Duncan Jurayj (2022-present); Rebecca Bowers (2022-present)

MY OWN GRADUATE ADVISORS

M.S. (Indiana University): Gregory A. Olyphant, Gordon S. Fraser, Lawrence J. Onesti

Ph.D. (Cornell University): Bryan L. Isacks, Arthur L. Bloom., Wilfried H. Brutsaert, Donald L. Turcotte

PROFESSIONAL ACTIVITIES

Lifetime Member, *The American Geophysical Union (AGU)* and *American Association of Geographers (AAG)*; Member, *American Association for the Advancement of Science (AAAS)*, *American Geographical Society (AGS)*, and *the American Meteorological Society (AMS)*. Manuscript reviewer for *Arctic and Alpine Research*, *Catena*, *J. Climate*, *Environmental Geology*, *Eos*, *J. Geophysical Research*, *Geophysical Research Letters*, *J. Glaciology*, *Global and Biogeochemical Cycles*, *Hydrological Processes*, *J. Hydrometeorology*, *IEEE Trans. Geoscience and Remote Sensing*, *Intl. J. Remote Sensing*, *Intl. Assoc. Hydrological Sciences (IAHS)*, *Nature*, *Nature Climate Change*; *Permafrost and Periglacial Processes*, *Photogrammetric Engineering and Remote Sensing*, *Physical Geography*, *Proceedings of the National Academy of Sciences (PNAS)*, *Quaternary International*, *Remote Sensing of Environment*, and *Water Resources Research*, as well as the *IPCC Assessment Report on Climate Change*, and proposals to NERC, NASA and the National Science Foundation.

NASA Coordinating Subject Matter Expert, SWOT Level 2 KaRIn High Rate River Average Vector Product (2021-present)

NASA Science Team, SWOT Surface Water and Ocean Topography Mission, (2016-present)

Advisory Board, Arctic Circle (2014-2019)

Guest Editor, Proceedings National Academy of Sciences (PNAS) (2016)

External Reviewer, Department of Geography, UC Santa Barbara (Feb 3-4, 2016)

NASA Mission Concept Review panelist, SWOT Surface Water and Ocean Topography Mission (2012)

Proposal review panel, NASA Cryospheric Sciences Program (2012)

Associate Editor, *Annals of the Association of American Geographers*, 2010 - 2016

External Reviewer, Dartmouth College Department of Geography, 14-16 March 2010.

Board of Directors, AAG Cryosphere Specialty Group, 2008 – 2010.

JPL Visiting Committee (external review committee), 2007

Capitol Hill briefing, Thawing of Arctic Permafrost: Extent, Causation and Implications, Russell Senate Building, Washington D.C. (February 21, 2006)

NASA Earth Science Senior Review, Washington D.C. (April 26-29, 2005)

Special Session Organizer for annual meetings of the AGU (2002, 2004) and AAG (2005, 2007)

(2004 – 2006) Co-chair, Hydrology Section Remote Sensing Technical Committee, American Geophysical

Union

(January 2004 - 2007) Invited member, Science Advisory Committee, World Climate Research Program, United States CLiC (Climate and the Cryosphere program)

(2003-2007) member, Hydrology Section Remote Sensing Technical Committee, American Geophysical Union

(2003 – 2006) Co-director, NASA Working Group on Hydrologic Processes of Rivers and Wetlands (formerly HYDRA-SAT Working Group)

(2002 – 2004) UCLA representative to the CUAHSI (Consortium of Universities for the Advancement of Hydrologic Science) Board of Directors.

(2000 – 2003) member, HYDRA-SAT / NASA Working Group on Hydrologic Processes of Rivers and Wetlands

(1998- 2004) Review Committee Ta Liang Memorial Award, granted annually by the *American Society for Photogrammetry and Remote Sensing*

(2001- 2003) Invited Member, Alaska SAR Facility User's Working Group, Fairbanks, Alaska

(2000- 2003) Invited Member, Steering Committee for the National Science Foundation *Russian-American Initiative on Shelf-Land Environments in the Arctic (RAISE)*, Arctic System Science program, Office of Polar Programs.

(2001) Organizing Committee, *WSPCC 2001, International Field Symposium and Excursion: West Siberian Peatlands and Carbon Cycle--Past and Present*, 18-22 August 2001, Noyabrsk, Russia.

(2001) Organizer, Special Session H18, Remote Observation of Rivers and Wetlands, Fall Meeting, American Geophysical Union, 10-14 December 2001, San Francisco.

(2001) Science Instrument Panel, NASA '07 Mars Reconnaissance Orbiter

COLLABORATORS

Douglas Alsdorf (*Ohio State University*), Rick Forster (*University of Utah*), Dorothy Hall (*NASA/Goddard Space Flight Center*), Adam LeWinter (*CRREL*), Glen MacDonald (*UCLA*), Frank Magilligan (*Dartmouth*), Andrei Velichko (*Russian Academy of Sciences*), Yongwei Sheng (*UCLA*), Aleksey Sidorchuk (*Moscow State University*), Richard Lammers (*University of New Hampshire*), Alexander Shiklomanov (*University of New Hampshire*), Jason Box (*The Ohio State University*), Asa Rennermalm (*Rutgers University*); Carl Legleiter (*University of Wyoming*); Marco Tedesco (*City College of New York*), Michael Durand (*The Ohio State University*), Kostas Andreadis (*NASA JPL*), Ernesto Rodriguez (*NASA JPL*); Tamlin Pavelsky (*UNC-Chapel Hill*); David Butman (*U. Washington*); Colin Gleason (*UMass-Amherst*)

OUTREACH ACTIVITIES

Invited or sponsored lectures: *Caltech* (Division of Geological and Planetary Sciences), *Stanford University* (Department of Geological and Environmental Sciences), *UC Santa Cruz* (Department of Earth Sciences), *University of Nebraska* (Department of Geosciences); *UCLA* (Department of Earth and Space Sciences, 10/13/05), *UCLA* (Department of Civil and Environmental Engineering 2/14/06), *Caltech* (Division of Engineering and Applied Science), *University of Nebraska* (Department of Geosciences), *University of California, Santa Barbara* (Department of Geography, 2/26/04), *University of California, Irvine* (Earth Systems Science), *The Ohio State University* (School of Earth Sciences and Dept. Geography, 11/17/05), *Colorado University* (Department of Geography, 4/7/06), *Lamont-Doherty Earth Observatory* (11/06), *UC Berkeley* (Department of Geography, 11/15/06), *NASA Goddard Institute for Space Studies* (GISS, 10/11/06), *University of South Carolina* (Dept. Geological Sciences, 4/12/07), *Lamont-Doherty*

Earth Observatory (LDEO, 1/19/07), *UCLA IGPP* (10/16/07), *CGU/CMOS* (Keynote, 2010); *Texas A&M University* (Dept. Geography, 10/8/2010), *University of Kansas* (C-CHANGE Colloquium Series, 10/11/2010), *UCLA* (Dept. Geography, 10/15/2010), *Port 2050* (Vancouver, 10/27/10), *University of Arizona*, (Dept. Geography, 11/5/10), *UC Irvine open public lecture* (Irvine, 11/17/10), *California Capitol Summit* (Los Angeles, 11/19/10), *Skeptics Society Distinguished Lecture Series* (Caltech, Pasadena, 11/21/10), *Physicians for Social Responsibility-Los Angeles* (Global Security Seminar, Los Angeles, 12/7/10), *Northern Alberta Development Council* (Grande Prairie, 1/21/10), *University of Washington* (Dept. Civil and Environmental Engineering (1/27/11); *UCLA Friends of Geography* (3/6/2011); *UCLA School of Law* (Faculty Monday Colloquium, 3/7/11); The Royal Society of Arts, Manufactures and Commerce (RSA) (London, 3/23/11); *UNC-Chapel Hill* (Dept. Geological Sciences, 4/1/2011); *Pasadena Senior's Center* (4/21/2011); *UC Office of the President* (UCOP, 4/29/2011); *Los Angeles Times Festival of Books* (4/30/2011); *Amerika Haus München* (Munich, 6/14/2011); *Deutsch-Amerikanisches Institut* (Heidelberg, 6/15/2011); *Deutsch-Amerikanisches Zentrum* (Stuttgart, 6/16/2011); *Goethe-Universität/US-Generalkonsulat* (Frankfurt, 6/17/11); *Long Beach Aquarium of the Pacific* (6/23/11); *RAND Corporation* (Santa Monica, 6/29/11); *American Planning Association* (Nashville, 9/29/11); *Foundation for the Future* (Seattle, 10/27/11); *UCLA Marschak Colloquium* (Los Angeles, 10/28/11); *World Economic Forum* (Davos, 1/27/12); *Arctic Business Forum* (Rovaniemi, Finland 2/21/12); *DHL* (Cologne, Germany 3/14/2012), *Shell* (Houston, 3/28/12), *AAAS John Wesley Powell Memorial Lecture* (Tulsa, 4/1/2012), *University of Alaska Anchorage* (4/12/2012); *National Academy of Sciences Distinctive Voices series* (Irvine, CA 9/5/2012); *University of Michigan* (Dept. Geological Sciences, 9/21/2012), *International Women's Forum* (San Francisco, 10/26/2012); *Western Transportation Advisory Council* (Vancouver, 11/21/2012); *ION Geo* (New Orleans, 11/27/2012); *Finnish Meteorological Institute* (Helsinki, 1/15/2013); *Santa Monica College Global Connections lecture series* (Los Angeles, 3/5/2013); *Federation of Icelandic Industries* (Reykjavík, 3/14/13); *University of Nordland* (Bodø, Norway 3/20/13); *The Ohio State University Robinson Lecture* (Columbus, 4/5/2013); *Luleå University of Technology* (Luleå, Sweden, 9/11/2013); *Nordic Energy Research* (Stockholm, Sweden, 9/12/2013); *Loomis Chaffee School Hubbard Speaker Series* (Windsor, CT, 9/24/2013) *Simpson College McBride Lecture* (Indianola, IA, 10/2/2013), *California Science Teachers Association* (Palm Springs, 10/27/2013); *Saginaw Valley State University Dow Visiting Scholar Lecture* (Saginaw, MI, 11/5/2013); *World Economic Forum* (Davos, 1/23/14); *Energy Policy Foundation of Norway* (Oslo, Norway 2/14/2014); *University of Nordland* (Norway, 3/19/14); *Friends Central Science Lecture Series* (Philadelphia, PA, 4/9/2014); *Arctic Business Council keynote* (Norway, 10/9/14); *Duke University* (The Nicholas School, 10/16/14), *Arctic Circle Plenary Speaker* (Reykjavik, 10/31/2014), *MTU America keynote* (Miami, 1/29/2015); *University of Georgia* (Department of Geography, 1/30/15), *Arctic Economic Council* (Ottawa, 4/23/15); *World Economic Forum* (Davos, 1/21/16), *Brown University* (Department Earth, Environmental, and Planetary Sciences 1/28/16); *Yukon Land Use Planning keynote* (Whitehorse, Yukon Territory, 2/16/16), *Castilleja School keynote* (Palo Alto, CA, 4/5/2016); *University of Delaware Mather Lecture* (Department of Geography, 10/3/16), *University of Illinois* (Urbana-Champaign, 10/4/16); *University of Alberta Sustainability Speaker Series*, (Edmonton 11/22/2016); *University of Northern British Columbia* (Prince George, 2/2/17), *Stanford University Geophysics Department Seminar* (5/4/2018); *World Forum for Foreign Direct Investment*, Shanghai (5/24/17); *Safety Codes Council Annual Conference*, Banff Alberta (6/1/17); *Charity Dinner for the Toronto General Hospital* (Toronto, 10/28/17); *Canola Council of Canada Annual Convention* (Palm Springs, 3/07/18); *Barry Commoner Lecture*, Marymount Manhattan College (New York City, 3/13/18); *Grain Farmers of Ontario 2018 March Classic*, (London, 3/20/18); *Texas A&M University-Texarkana* (Program for Learning and Community Engagement, 4/3/18); *Korea Carbon Forum 2018* (Pyongyang, South Korea, 10/11/18); *Husky Energy Annual Fall Meeting* (Calgary, 10/16/18); *New Brunswick Potato Conference & Trade Show* (Woodstock, N.B., 7 February 2019); *Virginia & J. Edward Holtry Distinguished Lecture in Geographic Information Science*, *South Dakota State University*, (Geography Department and Geospatial Science, Brookings, SD, 18 March 2019); *Crichton Club Lecture*, (Columbus, OH, 12 November 2019); *Science Leadership School* (Surgut, West Siberia, Russia, 10 February, 2020); *Clark University* (11 November 2020); *Geology and Geography/GIS Colloquium*, (University of Illinois at Urbana-Champaign, 25 March 2021); *Geography Colloquium* (Pennsylvania State University, 6 April 2021); *E. Willard Miller Endowed Lecture* (Department of Geography and the Institutes of Energy and the Environment, Pennsylvania State University, 9 April 2021); *Osher Lifelong Learning Institute* (University of Michigan, 20 January 2022); *Visiting Lecture* (American University, 7 February 2022); *Phi Beta Kappa Visiting Scholar Lecture* (American University, 9 February 2022) *Phi Beta Kappa Visiting Scholar Lecture* (Centre College, 14 March 2022); *Phi Beta Kappa Visiting Scholar Lecture*

(Howard University, 3 May 2022); *Clark University School of Geography* (21 April 2022); *Phi Beta Kappa Visiting Scholar Lecture* (Middlebury College, AA25 April 2022); *Department of Earth & Environmental Sciences, Tulane University* (New Orleans, 21 October 2022)

Press Releases:

What a Glacial River Reveals About the Greenland Ice Sheet (NASA, 5 April 2021)--

Scientists supported by NASA are shedding more light into the complex processes under the Greenland Ice Sheet that control how fast its glaciers slide toward the ocean and contribute to sea level rise

<https://www.nasa.gov/feature/goddard/2021/what-a-glacial-river-reveals-about-the-greenland-ice-sheet>



Greenland ice sheet surges in daily melt cycles (American Geophysical Union, 5 April 2021)—

New study takes the pulse of a Greenland glacier at midsummer, finding a daily cycle of warming, surface melting, below glacier water storage, water runoff and ice motion.

<https://news.agu.org/press-release/greenland-ice-sheet-surges-in-daily-melt-cycles-video/>

<iframe width="500" height="281" src="https://www.youtube.com/embed/LrccMAEr9fI" title="YouTube video player" frameborder="0" allow="accelerometer; autoplay; clipboard-write; encrypted-media; gyroscope; picture-in-picture" allowfullscreen></iframe>

Arctic 'shorefast' sea ice threatened by climate change, study finds (Brown University, May 4, 2020)--

A new study shows that coastal sea ice used by Arctic residents for hunting and fishing will be reduced as the planet warms. <https://www.brown.edu/news/2020-05-04/shorefast>



Greenland Ice Sheet Meltwater Can Flow in Winter, Too (University of Colorado, April 9, 2020)-- Findings underscore need for year-round investigations of Arctic hydrology. <https://cires.colorado.edu/news/greenland-ice-sheet-meltwater-can-flow-winter-too>



Tiny satellites reveal water dynamics in thousands of northern lakes (Brown University, February 14, 2019)--In a finding that has implications for how scientists calculate natural greenhouse gas emissions, a new study finds that water levels in small lakes across northern Canada and Alaska vary during the summer much more than was assumed. <https://www.brown.edu/news/2019-02-14/cubesat>

Migrating snowline plays outsized role in setting pace of Greenland ice melt (Brown University, March 6, 2019) -- Meltwater from Greenland's ice sheet is a leading contributor to global sea level rise, and a Brown University study shows that an underappreciated factor — the position of the snowline on the ice sheet — plays a key role in setting the pace of melting. <https://www.brown.edu/news/2019-03-06/snowline>

Extreme fieldwork, drones, climate modeling yield new insights about Greenland's melting ice sheet (UCLA, December 5, 2017) -- A new UCLA-led study reinforces the importance of collaboration in assessing the effects of climate change. <https://newsroom.ucla.edu/releases/extreme-fieldwork-drones-climate-modeling-lead-new-insights-about-greenlands-melting-ice-sheet>

UCLA-led study shows how rivers of meltwater on Greenland's ice sheet contribute to rising sea levels (UCLA, January 12, 2015) -- Research will help improve understanding of global warming's impact.

<https://newsroom.ucla.edu/releases/ucla-study-shows-rivers-meltwater-on-greenlands-ice-sheet-contribute-rising-sea-levels>

UCLA geographers create 'easy button' to calculate river flows from space (UCLA, March 17, 2014)-- The frustrated attempts of a UCLA graduate student to quantify the amount of water draining from Greenland's melting ice sheet led him to devise a new way to measure river flows using satellite images. <https://newsroom.ucla.edu/releases/ucla-geographers-reveal-new-method-271604>

Global warming will open unexpected new shipping routes in Arctic, UCLA researchers find (UCLA, March 4, 2013) -- By mid-century, even ordinary vessels will be able to navigate previously blocked parts of the Arctic Ocean, a potential boon for economic development but a threat to the environment. <https://newsroom.ucla.edu/releases/new-unexpected-shipping-route-243485>

BOOK REVIEWS OF "THE WORLD IN 2050" / "THE NEW NORTH"

MOTHER JONES "Books: Fall Reading List" (September/October issue 2010)
<https://www.motherjones.com/media/2010/08/book-reviews/>

CHICAGO SUN-TIMES "Fall Preview: Books" (book picks) (Sept. 12, 2010)
<http://www.suntimes.com/entertainment/books/2695388,fall-preview-books-091210.article>

THE GLOBE AND MAIL "10 books you have to read this fall" (Sept 17, 2010)
<https://www.theglobeandmail.com/arts/books-and-media/10-books-you-have-to-read-this-fall/article4326332/>

NEW SCIENTIST "Triumph of the north or technological salvation?" (by Chris Mooney) (Sept. 22, 2010)
<https://www.newscientist.com/article/mg20727796-500-triumph-of-the-north-or-technological-salvation/?ignored=irrelevant>

WALL STREET JOURNAL "Go North, Young Man" (BOOK REVIEW) (Sept. 25, 2010)
<https://www.wsj.com/articles/SB10001424052748703989304575504110335459830>

WORLD POLITICS REVIEW "The New Rules: Global warming shifts focus to the Friendly North" (BOOK REVIEW, by Thomas P.M. Barnett, Sept. 27, 2010)
<https://www.worldpoliticsreview.com/articles/6516/the-new-rules-global-warming-shifts-focus-to-the-friendly-north>

NATURE "Books in Brief" (Sept. 29, 2010), Nature 467, p. 527, doi:10.1038/467527a
<https://www.nature.com/articles/467527a>

CBC BOOKS "Climate expert Laurence Smith paints an alarming picture of the future in his new book" (Oct 5, 2010) <http://www.cbc.ca/books/2010/10/climate-expert-laurence-smith-paints-an-alarming-picture-of-the-future-in-his-new-book.html>

NUTASIAQ ONLINE "Nunavut in 2050 may look like Nevada" (BOOK REVIEW, Oct. 19, 2010)
https://nunatsiaq.com/stories/article/19887_nunavut_in_2050_may_look_like_nevada/

SEED MAGAZINE "The New North" (BOOK REVIEW by Fred Pearce, Oct. 22, 2010)
https://www.seedmagazine.com/content/article/the_new_north/

ONEARTH MAGAZINE "Winners and Losers" (BOOK REVIEW by Tim Folger, Nov. 24, 2010)
<http://www.onearth.org/article/winners-and-losers>

SEATTLE TIMES "'The World in 2050': What countries of the north will look like 40 years hence" (Nov. 27, 2010) (BOOK REVIEW, by Curt Schleier)

https://old.seattletimes.com/html/books/2013516463_br28world.html

BIGTHINK.COM "Adapt to What? Laurence Smith's World in 2050" (Dec. 4, 2010) (BOOK REVIEW, by Parag and Ayesha Khanna) <https://bigthink.com/hybrid-reality/adapt-to-what-laurence-smiths-world-in-2050>

LIBRARY JOURNAL "Science and Technology Reviews" (BOOK REVIEW by Robin Dillow, Dec. 15, 2010) <https://www.libraryjournal.com/?reviewDetail=the-world-in-2050-four-forces-shaping-civilizations-northern-future>

LIBRARY JOURNAL "Best Sci-Tech Books 2010" (by Gregg Sapp, Dec. 16, 2010) http://www.libraryjournal.com/lj/collectiondevelopmentbestbooks/888365-476/lj_best_sci-tech_books_2010.html.csp

FRUMFORUM.COM "Our Favorite Books of 2010" (by Kenneth Silber, Dec. 24, 2010) <http://www.frumforum.com/our-favorite-books-of-2010>

EDMONTON JOURNAL "Review: The Silver Lining of Climate Change" (BOOK REVIEW by Richard Sherbaniuk, Jan. 2, 2011)

<http://www.edmontonjournal.com/business/Review+silver+lining+climate+change/4049557/story.html>

THE HIPPO "Future Reads: The View from 20 and 40 years out" (Jan 20-16, 2011)

<http://www.hippopress.com/read-article/future-reads->

THE FUTURIST Magazine "Human Civilization Migrates Northward" (Jan/Feb issue, 2011) (BOOK REVIEW, by Rick Docksai) <http://www.wfs.org/content/human-civilization-migrates-northward>

THE ECONOMIST "'The de-icing age: Tomorrow at the top of the world" [BOOK REVIEW] (Feb. 3, 2011) <https://www.economist.com/books-and-arts/2011/02/03/the-de-icing-age>

THE GLOBE AND MAIL (Toronto) "Laurier was wrong. It's the 21st century that's ours" (Feb. 21, 2011) [BOOK REVIEW, by Simon Dalby]

<https://www.theglobeandmail.com/arts/books-and-media/the-world-in-2050-by-laurence-c-smith/article627962/>

LONDON EVENING STANDARD <https://www.standard.co.uk/lifestyle/books/the-new-north-describes-a-not-to-distant-future-6578672.html>

ROYAL GEOGRAPHICAL SOCIETY "Book of the month: The rising of the North" (BOOK REVIEW, by Jonathan Wright, *Geographical Reviews*, March 2011)

NEW STATESMAN "The New North: the World in 2050" (March 31, 2011) [BOOK REVIEW, by John Gray] <https://www.newstatesman.com/books/2011/03/natural-resources-world-global>

THE ECOLOGIST "The New North: The World in 2050 by Laurence Smith" (March 31, 2011) [BOOK REVIEW, by Jeff Holman]

<https://theecologist.org/2011/mar/31/new-north-world-2050-laurence-smith>

TIMES HIGHER EDUCATION "The New North: The World in 2050" [BOOK REVIEW, by Steve Yearley] (April 13, 2011)

<https://www.timeshighereducation.com/books/the-new-north-the-world-in-2050/415787.article?sectioncode=26&storycode=415787&c=1>

FINANCIAL TIMES "The New North" (book review by Crispin Tickell) (April 22, 2011)

<https://www.ft.com/content/77dd0b4e-6b9f-11e0-93f8-00144feab49a?ftcamp=rss#axzz1Ka5l4XCy>

JOURNAL OF REGIONAL SCIENCE “The World in 2050: Four Forces Shaping Civilization’s Northern Future” (BOOK REVIEW, by Timothy Heleniak) JOURNAL OF REGIONAL SCIENCE, VOL. 51, NO. 4, 2011.

https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1467-9787.2011.00740_11.x

Schwab, James C. (2011) "Review of The World in 2050: Four Forces Shaping Civilization’s Northern Future," Journal of Homeland Security and Emergency Management: 8:1, Article 18. DOI: 10.2202/1547-7355.1844

<http://www.bepress.com/jhsem/vol8/iss1/18>

SURVIVAL: GLOBAL POLITICS AND STRATEGY BOOK REVIEWS “The New North: The World in 2050” by Ray Takeyh, H. R. McMaster & Gilles Andréani (2012): Book Reviews, Survival: Global Politics and Strategy, 54:2, 179-198

<https://www.tandfonline.com/doi/full/10.1080/00396338.2012.672809>

WORLD FUTURES REVIEW “Book Review: *The New North: The World in 2050*” by Elif Cepni (2014): World Futures Review, 7:1, 93-96. <https://doi.org/10.1177/1946756714555310>

BOOK REVIEWS OF “RIVERS OF POWER”

KIRKUS “A valuable, well-observed work of history and geography” (BOOK REVIEW by Kirkus, February 1, 2020) <https://www.kirkusreviews.com/book-reviews/laurence-c-smith/rivers-of-power/>

LIBRARY JOURNAL “Rivers of Power: How a Natural Force Raised Kingdoms, Destroyed Civilizations, and Shapes Our World” (BOOK REVIEW by Cynthia Lee Knight, April 1, 2020)

<https://www.libraryjournal.com/?reviewDetail=rivers-of-power-how-a-natural-force-raised-kingdoms-destroyed-civilizations-and-shapes-our-world>

GEOGRAPHY REALM “Review – Rivers of Power” (BOOK REVIEW by G.T. Dempsey, April 2, 2020)

<https://www.geographyrealm.com/review-rivers-of-power/>

THE SPECTATOR “Our rivers, as much as our oceans, are in urgent need of protection” (BOOK REVIEW by Derek Turner, 16 April 2020) <https://spectator.us/rivers-oceans-urgent-need-protection/>

THE GLOBE AND MAIL “Spring books preview: 38 of the best new reads in fiction, non-fiction, poetry and gardening (by Becky Toyne, 17 April 2020)

<https://www.theglobeandmail.com/arts/books/article-spring-books-preview-38-of-the-best-new-reads-in-fiction-non-fiction/>

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