Academic History

My interest in geosciences began with a field geology course in California during the fall of my first year of undergrad at the University of North Carolina at Chapel Hill. I have always had an interest in science, math and physics, but while surveying glaciers in Yosemite National Park, I discovered that I could combine my love for science with my passion for the natural environment. With the support of a Morehead-Cain scholarship, I explored different aspects of geoscience that interested me during my geophysics degree, including studying glacier hydrology on the Juneau Icefield, visiting the Greenland Ice Sheet, and conducting my senior honors thesis research on river ice breakup in Northern Canada and Siberia. Through these experiences, I discovered a passion for the Arctic and remote sensing. At the end of my senior year of undergrad, I received a Gates Cambridge Scholarship to purse my masters at the University of Cambridge. While in Cambridge, I used satellite imagery to study rapid lake drainage events on the Greenland Ice Sheet and embraced the interdisciplinary nature of the Scott Polar Research Institute. I then moved to Brown University where I am currently pursuing a PhD in Earth, Environmental and Planetary Sciences with Professor Laurence Smith funded by an NSF Graduate Research Fellowship. During my PhD, I have continued to research Arctic climate change but have also developed a passion for conducting research relevant to local Arctic peoples.

Research Interests and Experience

My research seeks to use novel satellite remote sensing and big data analysis techniques combined with field observations and climate model outputs to better understand rapid environmental change in the Arctic. I have substantial experience working with high-resolution satellite imagery and using GIS/spatial data analysis, machine learning and cloud computing to efficiently perform image and time series analyses on large data volumes. While I am primarily a remote sensing scientist, I believe fieldwork can be highly valuable for contextualizing findings, providing ground-truth, and inspiring new research directions, and have conducted fieldwork in Alaska, Northern Canada and Greenland. Broadly, my work seeks to answer two primary questions:

Research Question #1: How can we leverage new satellite technologies to better understand surface water dynamics?

My core research has sought to improve our understanding of how surface water moves across the Arctic landscape using newly available CubeSat imagery. Through operation in a constellation of hundreds of tiny satellites, CubeSats operated by companies such as Planet Labs now provide daily imagery of the entire land surface at 3 m resolution, representing a significant step-change in our ability to observe dynamic processes over space and time. As one of Planet Labs' first research ambassadors, I tested the value of CubeSat imagery for surface water mapping in the Yukon Flats, Alaska (Cooley et al., *Remote Sensing,* 2017). This research produced one of the first scientific publications using CubeSat imagery and demonstrated that it can accurately map water area. I then applied this lake classification and tracking method over a much larger area through incorporating machine learning, cloud computing and object-based classification approaches. Through analysis of >75,000 images and >25 TB of data, I tracked near-daily changes in surface area for 85,000 lakes covering diverse climatic and hydrologic terrains in Northern Canada and Alaska (Cooley et al., *Geophysical Research Letters,* 2019). This work revealed a surprisingly hydrologically dynamic landscape and a near-ubiquitous decline in lake area between May and October. These results have implications for the estimation of freshwater carbon emissions, which are often higher along seasonally fluctuating lake margins. As a Stanford Science Fellow, my goal is to up-scale this method across the entire Arctic to constrain methane emissions. I additionally plan to combine these results with new satellite technologies from NASA's ICESat-2 and upcoming Surface Water Ocean Topography (SWOT) missions to better understand the Arctic hydrological cycle.

Research Question #2: How are dynamic hydrologic processes changing in a warming climate?

For local Arctic residents, perhaps the most impactful result of climate warming is changes to river and shorefast ice. Most Arctic communities are located along the coast or along rivers, meaning changes to the timing and progression of shorefast and river ice breakup can critically affect transportation, subsistence activities and ecology of the Arctic region. To investigate spatial patterns in river ice breakup, I mapped trends in the timing of river ice breakup along the entire length of the four largest pan-Arctic rivers over 2000-2014 using daily MODIS satellite imagery (Cooley and Pavelsky, *Remote Sensing of Environment,* 2016). Interestingly, we found that trends in breakup timing were only present along some river subsections, indicating that standard point-based trends do not represent overall river patterns. Using a similar approach, I more recently mapped changes in the timing of shorefast ice breakup around 28 Arctic communities over 2000-2018. We found that breakup timing is strongly correlated with springtime air temperature, but its sensitivity varies substantially between communities. By combining these air temperature sensitivities with future climate scenarios, we found that the coldest Arctic communities are projected to experience the most dramatic reductions in springtime ice duration. This research, which is currently in revision in *Nature Climate Change*, emphasizes the highly localized nature of climatic changes, even within a region frequently seen as monolithic in its response to warming. In the future, I plan to continue and improve upon this research by incorporating local perspectives on these changes through collaborating with social scientists and conducting additional fieldwork in these communities.

Future Goals

My aim is to become a professor at a large research university where I could teach, mentor students and build my own hydrologic remote sensing research group. Considering the rapid development in high resolution remote sensing, there are numerous opportunities to improve our understanding of surface water dynamics using CubeSats and other satellite technologies. I aim to continue working at the forefront of remote sensing and hydrology research and to harness the power of new sensors to address human-relevant questions. Particularly given Stanford's new data agreement with Planet Labs, as a Stanford Science Fellow, I would be excited to develop new methods for cloud-based processing of CubeSat and to work with Stanford Libraries, the AI for Climate Initiative and the Data Science Initiative to make working with CubeSat imagery more accessible. I also hope to become more involved with NASA satellite missions, such as the recently launched ICESat-2 and upcoming Surface Water Ocean Topography (SWOT) satellites, and to someday serve on their science teams.

A key goal of mine is to improve diversity within Earth Science and particularly within hydrologic remote sensing, which remains overwhelmingly male. The lack of female role models has been challenging but has made me especially passionate about improving diversity within remote sensing to build a stronger community of women and underrepresented minorities (URM) in this exciting, growing field. Through volunteering in science outreach events, mentoring female undergraduate researchers and tutoring URM students, I have endeavored to serve as a role model for future environmental scientists. I hope to continue this work at Stanford by mentoring undergraduate researchers and in the future by building a diverse hydrologic remote sensing research group. Finally, I feel strongly that principles of diversity and inclusion not only apply to classroom or fieldwork settings but also apply to our interactions outside of academia. As an Arctic scientist, I think it is extremely important to learn how to engage positively with local Arctic residents, particularly considering the colonialist and problematic history of research in the Arctic. Throughout my PhD, I have consistently sought out opportunities to engage with Indigenous Arctic residents and learn from their experiences, whether through presenting at workshops in the Northwest Territories and Nunavut or including locals in our fieldwork in Greenland. These experiences have shaped my research and teaching trajectory, and I plan to continue engaging with Indigenous communities as part of my research in years to come.