Growing up alongside Alabama's dense forests and vast lakes, I saw nature as a serene and unchanging backdrop to daily life. It wasn't until I moved to Los Angeles for my studies at Caltech that I realized this wasn't the case. Southern California's destructive wildfires, volatile tectonic events, and intense atmospheric rivers revealed nature as a dynamic force reshaping environments and communities. This realization led me to study sediment transport processes at Caltech, where I investigated how landscapes evolve across scales, from the development of meandering rivers to particle interactions in riverbeds. Now, this fascination with Earth's surface processes drives my pursuit of a PhD in Earth and Planetary Sciences at Harvard, where I aim to develop computational models that bridge the gap between surface dynamics and subsurface processes.

As a freshman at Caltech, I joined Dr. Michael Lamb's Surface Processes Group to investigate how meandering rivers evolve and reshape landscapes over time. While probabilistic models effectively forecast flood hazards, predicting future river channel evolution remains a challenge due to its dynamic and nonlinear nature. My work addressed this gap by focusing on the Ucayali River, one of the most active meandering rivers in the Amazon Basin. By processing 30 years of Landsat imagery and implementing Markov Chain Monte Carlo (MCMC) simulations, I developed a stochastic model that enabled us to predict future river paths and quantify uncertainty in these forecasts. This research on river migration forecasting culminated in my first-author publication in *Earth Surface Dynamics* and presentations at the 2022 and 2024 AGU Annual Meetings. To build upon this work, I took advantage of the ThinkSwiss Summer School Travel Grant awarded to me in 2024 to study at the Swiss Federal Institute of Aquatic Science and Technology. There, I expanded my use of probabilistic modeling to alpine watershed systems, applying similar Bayesian approaches to characterize hydrological variability while gaining valuable international perspectives on managing diverse river landscapes.

My current work with the Caltech Surface Processes Group investigates sediment transport at the microscale by examining freshwater floc formations. Since mud constitutes most river sediments in the Mississippi River, understanding how organic matter influences mud floc formation and settling behavior is crucial for predicting fluvial landscape evolution and addressing Louisiana's coastal land loss due to relative sea-level rise. Using a flume tank and high-speed imaging, I developed a Python algorithm to track flocs and calculate their characteristics. The project presented two technical challenges in accurately measuring sediment behavior. Firstly, excessive particle scatter in the flume caused blurred images, hindering accurate floc characterization. To address this, I implemented a 3 mm slit at the camera's focal point to constrain particle movement and improve image clarity. Secondly, background turbulence affected our settling velocity measurements. I adapted Particle Image Velocimetry techniques by introducing neutrally buoyant tracer particles. By tracking both flocs and tracer particles simultaneously, I accounted for the background flow field and accurately measured gravitational settling velocities. These solutions improved measurement precision, allowing us to build a comprehensive dataset linking organic matter content to floc dynamics and sediment settling.

Building on this work, I am developing a machine learning approach to measure the fractal dimensions of flocs, a key parameter for understanding their aggregation. Traditional methods, which rely on perimeter-based relationships, are highly sensitive to image resolution and often yield inconsistent results. To address this limitation, I am generating simulated fractal aggregates with known values, systematically blurring these images, and training a convolutional neural network (CNN) to analyze them. This approach enables a robust and reliable measurement technique that remains accurate even when image clarity is reduced.

The research and observational experiences I have gained at Caltech shaped my passion for addressing critical needs in combining surface processes with broader Earth system dynamics. My current research examines relationships between fluvial geomorphology and climate drivers, particularly how sediment flocculation shapes coastal landscape evolution in regions facing rapid relative sea-level rise. Building on this foundation, I look forward to working with Dr. Brendan Meade to integrate surface processes with tectonics, examining how the surface boundary fundamentally controls topographic evolution through crustal deformation and earthquakes.

At Harvard, I aim to quantify the poorly understood coupling among climate, erosion, and deformation through computational approaches. Thanks to recent technological advancements, we have significantly expanded the volume and resolution of available data. While this offers the exciting potential to generate a wealth of new knowledge, my experiences have revealed two principal challenges that must be overcome by mechanistic models. Firstly, balancing a model's generalizability with its ability to capture unique, detailed phenomena is crucial. In my research on forecasting river channel dynamics, I found that using larger spatial datasets often reduced predictive accuracy by overlooking fine-scale phenomena. This experience highlighted the importance of applying informed spatial constraints to retain localized features. Secondly, the continuous influx of new data can render computational methods obsolete more quickly. I encountered this issue when the existing particle tracking algorithm proved incompatible with our floc experiment, as the original code was designed for a highly specific setup and outdated libraries. To address this limitation, I developed a more versatile tracking algorithm that utilizes optimized libraries such as TensorFlow, which I used to train a convolutional neural network (CNN) to establish a stable method for measuring the fractal dimensions of flocs.

With mentorship from Dr. Brendan Meade and access to Harvard's extensive resources such as the Harvard Data Science Initiative (HDSI), I am confident in my ability to advance our understanding of the interactions between surface and subsurface processes while developing scalable models that balance physical principles with data-driven methods.