Project Summary:

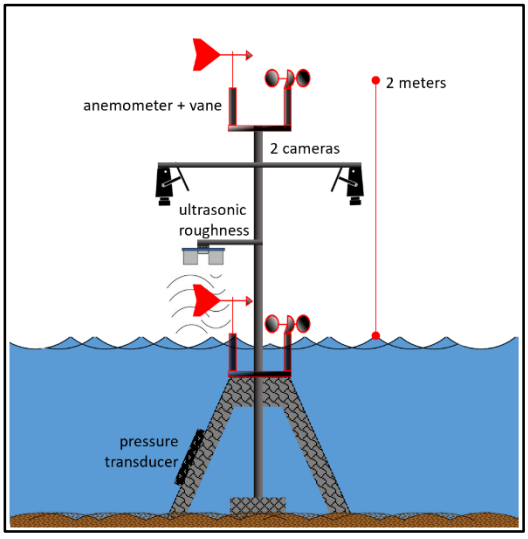
Name of project:
Building an operational network to validate novel inland water swath altimetry

Project lead and contact details:
Jessica Fayne
Department of Geography
1255 Bunche Hall
University of Los Angeles, California
571-265-9249
Project partners and contact details:
Laurence Smith, PhD
Department of Earth Environmental and Planetary Sciences
Institute at Brown for Environment & Society
Brown University

Proposed start and end date:
Start: July 2018
End September: January 2018
Budget Requested:
$5,000 for equipment and materials.
Budget Summary:

The budget covers the costs of building two field stations for measuring wind speed, surface roughness, and water color. Building two stations as an initial prototype will help us quantify errors in our measurements and to identify optimal placement for these water quality stations.

1) HOBO Anemometer + Vane x4 (~$2,500)
2) Time Lapse Camera x4 (~$ 1,000)
3) Tripod/Crane instrument mount (~$500)
4) Ultrasound roughness sensors x4 (~$ 1,000)



Project Outline:

Project description:

As a part of the Surface Water Ocean Topography (SWOT) calibration effort, it is proposed that a network of ground stations would be set up to measure water surface roughness, wind speed and water color to compare with optical data from satellites, airborne sensors and unmanned aerial vehicles (UAVs). Building empirical relationships between the measured physical parameters of wind speed, water color, and turbidity with optical remotely sensed datasets is critical to our ability to accurately measure surface water elevation from satellite swath interferometry which will be tested for the first time in 2021 when SWOT is launched into orbit. Because SWOT measures radar backscatter alone, it is problematic to identify contributors to varying backscatter measurements within and around water bodies without a reference dataset. Building the connection between ground measurements, optical data, and radar backscatter will help to quantify sources of errors in the elevation product that stem from the backscatter measurements. To this end, this project seeks to build and test ground stations. Future iterations of the proposed instrument suite may be utilized in multiple SWOT calibration deployments, with the goal of increasing the quality and quantity of data we can collect with each field mission. With subsequent missions, we will be able to further refine our ground instrument stations by designing and using customized sensors, which may save costs and increase the number of permanent and temporary ground stations we can construct.

Project objectives, significance and impact:
Optical imagery from the airborne SWOT mission (AirSWOT) has been acquired coincident with AirSWOT Ka-band radar measurements, lacking structural measurements of emergent vegetation that are useful for assessing Ka-band radar penetration of the vegetation to image the water below. *The proposal seeks to construct permanent and temporary water quality stations specifically for calibrating swath water altimetry, assessing water movement and surrounding vegetation to validate Ka-band backscatter measurements.* More specifically, the research asks: 1) can water surface roughness can be measured via a proxy of wave reflectance 2) what is the relationship between water color and turbulence 3) to what extent does wetland vegetation impact water turbulence and radar backscatter? Measuring ground and vegetation elevation in regions surrounding water bodies helps to assess possible layover effects and signal scattering from specular or turbulent water.

To achieve these goals, we will construct two semi-permanent installations in Piute Ponds, California to collect continuous data to be compared with optical data from UAVs and more coarse resolution satellite imagery from Landsat 8 and Sentinel-2, where the resolution is more similar to the resolution that will be on the SWOT satellite. The UAV will collect high resolution (2cm) imagery of the water surface (turbulence and color) and surrounding land (channel width, depositional areas, and undercuts). The ground station will collect a vertical profile of wind speed and direction, measuring just above the water surface, and two meters from the surface. An ultrasonic sensor will be employed to measure the water surface roughness. Time lapse imagery will be used to measure water color and correlate the ultrasonic roughness measurements with the surface texture measurements from the optical imagery. In addition to the ground station data that will be made publically available for use, four products will be created: 1) digital surface model of water heights, emergent vegetation, and surrounding land, 2) water/vegetation fraction, 3) water color, and 4) water surface texture/roughness.

Description of key project steps and timeline:
During the summer and fall of 2018, researchers and students at the University of California, Los Angeles, and Brown University will work to design and build two ground station prototypes to demonstrate as a proof of concept to build similar structures to be used in the SWOT calibration effort.

July-September will be used to design and erect the two stations in Piute Ponds, California. While July-January will be used to analyze the data from the stations and to acquire and analyze the imagery RGB imagery from the UAV. At the end of the 6 month period, we expect to have preliminary results detailing how to set up calibration stations for water swath altimetry measurements to increase the efficiency in our fieldwork when used alongside UAV measurements and optical satellite data when visits to the field are not feasible. We will build the station, acquire ancillary optical data, and classify the optical data based on the station measurements. This work will ultimately reduce the number of total stations necessary to build a global calibration network as we may be able to estimate the surface water physical parameters though available optical imagery.

Outreach:

What groups/audiences will be engaged in the project?
Remote sensing students are commonly expected to simply use the data that has been provided to them, either from an online data portal or through a colleague who has been working with the data. Rarely do students have the opportunity to build their own sensor stations and collect data. In this project, students are responsible for the entire project lifecycle, from designing, building, and troubleshooting the individual sensors, saving the measurements in real time to a data logger, analyzing the data, and presenting the findings to groups at scientific conferences and publishing papers on the results of the data.

How will you judge that project has had impact?
The project will have initial impact by being able to erect the sensor stations and begin to collect data in real time. Because data like this has not been collected in the past, or is not made publically available, this initial step would be a boon for the scientific community. In addition, we seek to derive empirical relationships between the physical parameters measured from the station, and those estimated from the optical data. This too, will be a significant development towards understanding surface water characteristics. Finally, the results of the project will be shared with the SWOT science team at the SWOT science team meeting in 2019 as well as during the American Geophysical Union Meeting (AGU) in December 2018, and ESIP Winter Meeting 2018. If the presentations are received favorably by the scientific community, specifically the SWOT science team, the project may be more likely to receive funding for future station developments.

How will you share the knowledge generated by the project?
In addition to posting the project report on the ESIP GITHUB as per the project requirements, this project will be presented at several conferences including ESIP, AGU, SWOT Science Team Meeting, and ASPRS. The project outcomes will be published in two papers: Measuring Surface Texture from Optical Imaging, and Quantifying Radar Backscatter Coefficients from Optical Imaging.

Project Partners (as applicable):

Description of project partners (individuals and/or organizations) and their involvement:
Laurence Smith, of Brown University will be overseeing the project and providing mentorship.

How will this project engage members of the ESIP community?
As this project will be presented at ESIP meeting, it is hoped that fellow students and researchers in remote sensing, and sensor development will be able to contribute to the methodology to make more robust sensor networks at a reduced cost and more rapid deployment in the field. It is hoped that students who do not have experience building sensor networks learn how feasible it is to develop sensor networks for their research and to be able to make substantial contributions to the