# Project Summary

Relatively little is known about the North American monsoon despite the fact that this seasonal climate phenomenon controls the distribution of rainfall, streamflow and vegetation in the southwestern United States and northwestern Mexico. As the summer monsoon can account for up to 70% of the annual rainfall in the region, there is a pressing need for binational studies that properly characterize the spatial and temporal variability in hydrologic variables such as precipitation, soil moisture, and streamflow. Furthermore, the monsoon impacts areas that are typically composed of complex mountain ranges where orographic processes are poorly understood. Our current lack of understanding is due to various factors, including a paucity of ground observations, the high spatiotemporal variability of hydrologic processes, and limitations in remotely-sensing and modeling these landscapes. We argue that significant advances can be made with focused efforts that synthesize in-situ and remote sensing data with hydrologic models in these environments. Moreover, we believe that monsoon studies require joint binational efforts as the climate phenomenon equally affects semi-arid, mountainous regions in the American Southwest and northwestern Mexico. In this proposal, we present an International Research Experience for Students program that promotes binational research for early career scientists, stimulates learning of hydrologic field methods, and will result in an improved understanding of the spatiotemporal variability of hydrologic processes during the North American monsoon.

**Intellectual Merit:** We seek to address an identified gap in our current understanding of monsoon hydrology by integrating ground observations, remote sensing and hydrologic modeling in a semiarid, mountainous watershed of northern Sonora, México. Our major objectives are to: (1) Quantify the spatiotemporal variability of hydrologic variables through field and remotely-sensed data, and characterize it in terms of functional relations between scaling behavior and dynamic landscape indices; (2) Estimate the uncertainty of remotely-sensed hydrologic variables such as rainfall and soil moisture through field validation; and (3) Synthesize these observations and their uncertainty with a hydrologic model to understand interactions between the monsoon and the complex land surface properties and to assess the value and utility of remote sensing data in hydrologic models. In order to do so, we propose to use a distributed sensor network, spatial field campaigns, and the application of a distributed hydrologic model in a basin in northern Sonora, México. One unique contribution of this work is that it focuses on quantifying hydrologic variability in its true sense (full distribution function), and not only at the mean level, as it is common practice. The proposed network can form the basis for long-term measurements used to advance our understanding of the monsoon and validate remote sensing observations of precipitation, soil moisture and other variables in a complex, semiarid monsoon setting.

**Broader Impacts:** Our work will utilize the international setting as an educational tool to teach students of varying levels about binational hydrologic research. Through hands-on field experience with the distributed sensor network and field campaigns, we anticipate to inspire inquiry-based learning and promote development of global scientists enabled to study monsoon phenomena. We will encourage women and underrepresented minorities to participate in the international research experience with a contingent of students and researchers from México. Our program includes various components: (a) a field program in México for instrument deployment and data collection, (b) research training for undergraduate students prior to and after the field study, and (c) mentoring activities to promote hands-on, team-based learning in a field setting. Educational activities will expand collaborations between the Universidad de Sonora and New Mexico Tech to enhance the long-term impacts of the project. Dissemination of results through public presentations, web-based materials and research publications will be used to attract future funding for sustained, long-term activities in this monsoon-driven, semiarid mountain setting.