An Investigation of North American Monsoon Variability using Instrumental and Tree-Ring Data

1. PROJECT SUMMARY

The North American Monsoon (NAM) is a critical source of moisture for northwestern Mexico and the U.S. Southwest. Monsoon research over the past several decades has investigated moisture source regions, spatial and temporal variability, timing and intensity of monsoon precipitation, and relationships to large-scale circulation. Although the NAM is now much more clearly understood through this body of research, questions still remain, particularly with regard to the long-term, low frequency behavior of the monsoon, and how it is related to both winter precipitation and natural variability of ocean-atmosphere circulation at decadal and longer time scales. Key questions about how the NAM may respond to global climate change also remain unanswered.

Instrumental records for the monsoon region are limited to the past century, at best, and are inadequate for investigating the long-term natural variability of the NAM, which will likely underlie future changes due to anthropogenic climate change. Proxy data can be used to reconstruct records of past climate variability, and great promise exists for using paleoclimatic data from sources such as tree rings and speleothems to document monsoon variability. Several key studies have indicated the potential for tree-ring based reconstructions of monsoon precipitation in Mexico and the Southwest, while other studies have pioneered new sampling and laboratory techniques to accentuate the summer moisture signal in trees. In this proposal, our goal is to design and apply these new techniques to the first tree-ring network, utilizing both existing and new collections, to specifically target long-term NAM variability in the US Southwest. We will use partial-width indices (earlywood and latewood) from this network, in combination with stable-carbon isotope measurements from tree rings, to reconstruct and examine the long-term variability of monsoon season precipitation, its relation with winter precipitation and widespread droughts in western North America, and to ocean/atmosphere circulation in the Pacific Ocean. The consistency of downscaled general circulation model (GCM) simulations with paleoclimatic evidence of NAM variability will also be examined.

Intellectual merit: This project will produce a tree-ring network explicitly tailored to reflect summer precipitation variability, a critical component of natural climate variability in the NAM region. The results of this work will provide the first reconstructions of both the spatial and temporal characteristics of the NAM in the southwestern U.S. over past centuries, providing a baseline for assessing both the instrumental records and the skill of downscaled GCMs in replicating natural variability. The proposed work will also significantly advance methods used in dendroclimatology to identify intra-annual climate signals in tree rings through testing of alternative field-sampling and laboratory protocols for developing latewood proxies for summer precipitation, making use of both new and existing tree-ring collections**.**

Broader impacts. The result of this work will be extremely useful to a range of stakeholders, including water managers, who have expressed the need for this work. Understanding patterns of variability and the relationship between monsoon behavior, winter precipitation, and large-scale circulation patterns such as ENSO, will greatly enhance the ability of water providers and resource managers to effectively and efficiently manage a limited resource. Partnerships between the PIs and water managers and with organizations such as the NOAA Regionally Integrated Science and Assessment CLIMAS and WWA programs already exist to facilitate the transfer of this information in ways that are useful and applicable to management questions. This work will support the goals of the North American Monsoon Experiment (NAME) project as well. The proposed project will provide undergraduate training in these new dendrochronological techniques, as well as support for several graduate student projects. Project results will be the topic of a UA Global Change Interdisciplinary Ph.D. student seminar, and will be presented at stakeholder meetings, and national and region scientific conferences, as well as through peer-reviewed publications.