Session: B5 Oral presentation

## Detection of historical summertime monsoon precipitation variations and trends over the southwestern United States

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Detection, e.g. the process of demonstrating that an observed change in climate is unusual, first requires some means of estimating the range of internal variability absent any external drivers. Ideally, the internal variability would be derived from the observations themselves, however generally the observed variability is a confluence of both internal variability and variability in response to external drivers. Further, numerical climate models - the standard tool for detection studies - have their own estimates of intrinsic variability, which may differ substantially from that found in the observed system as well as other model systems. These problems are further compounded for weather and climate extremes, which as singular events are particularly ill-suited for detection studies because of their infrequent occurrence, limited spatial range, and underestimation within global and even regional numerical models. Here we will show how stochastic daily-precipitation models - models in which the simulated interannual-to-multidecadal precipitation variance is purely the result of the random evolution of daily precipitation events within a given time period - can be used to address many of these issues simultaneously. Through the novel application of these well-established models, we evaluate the significance of interannual to multi-decadal variations in seasonal-mean summertime precipitation and precipitation characteristics over the southwestern United States during the North American Monsoon (NAM). As part of this work we find that over the last 70 years there has been a significant overall increase in summertime monsoon precipitation - as well as an increase in number of rainfall events and coverage of rainfall events - in peripheral regions north of the "core" monsoon area of Arizona and western New Mexico. In addition, there is an increasing trend in intense storm activity and a decreasing trend in extreme dry-spell lengths. Further analysis indicates that there has been a systematic expansion of the near-surface dynamic pressure field associated with the monsoon-induced thermal low corresponding to enhanced global-mean temperatures. While our results do not unequivocally attribute the northward expansion of the NAM precipitation to increasing global-mean temperatures, they are in agreement with the northward expansion of the summertime North American monsoon into Colorado and Utah during periods of relatively warm temperatures such as the climatic optimum of A.D. 900-1300 as well as the mid-Holocene.