Assessing Changes in Climate Extremes over the 20th and 21st Centuries

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Climate change is associated with more than a shift of the mean. By itself, a mean increase of surface temperatures over the 21st century will increase the risk of extreme warm and reduce the risk of extreme cold temperatures almost everywhere. The reality, however, could well be different if there is also a significant change in the shape of the temperature probability distributions, especially in regions of large natural variability associated with the NAO, the PNA, the NAM, the SAM, and the Walker Circulation. Such changes could also affect the risk of extreme storminess and precipitation. In this talk, we will assess the changes in various indices of these circulation modes over the last 140 years using the 20th Century Reanalysis (20CR) data set spanning 1871 to the present, and to what extent they are captured by climate models. Our emphasis will not only be on changes in the mean but also the variance, skew, and kurtosis of these indices in moving 25-yr windows through the 140-yr record. We will estimate the impact of any significant changes in these statistical moments on the probability of extreme index values by fitting "stochastically generated skewed" distributions (SGS distributions) to the observational data and model output, derived from a new physically based theory of non-Gaussian atmospheric probability distributions being developed by us. We will argue that such an approach provides more robust estimates of altered extreme climate risks than standard approaches based on extreme value theory.

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