Session: C39 Poster: TH155B

Need for caution in interpreting extreme weather statistics

Prashant Sardeshmukh[†]; Gilbert Compo; Cecile Penland
[†] University of Colorado, USA
Leading author: Prashant.D.Sardeshmukh@noaa.gov

Given the reality of anthropogenic global warming, there is great interest in how this is affecting the statistics of extreme weather events. Indeed, any observed event of magnitude "4 sigma" or larger immediately comes under close scrutiny as possibly being attributable to human influences, since the likelihood of such an event occurring from natural causes "within living memory" or "since records began" (that is, about 100 years) is negligible if the associated PDFs are Gaussian. Extreme events, however, are usually associated with the extremes of daily weather, and the PDFs of daily atmospheric anomalies are definitely not Gaussian. They are generally skewed and heavy tailed, with characteristic relationships between the skewness and higher statistical moments and with one tail already heavier than the other (and also the tail of the corresponding Gaussian PDF) for anomaly magnitudes of greater than 1.73 standard deviations. These features have important implications for the statistics of extreme anomalies; for instance a "4-sigma" event is far more common than in the corresponding Gaussian case. They also have implications for establishing the significance of changes in extreme statistics using 50- or even 200-yr records. We are developing a new approach to this important problem using the first four statistical moments (mean, standard deviation, skewness, and kurtosis) to approximate the PDFs of daily atmospheric anomalies as generic Stochastically Generated Skewed (SGS) PDFs, based on the theory of Sardeshmukh and Sura (2009). In this presentation we will provide further evidence of the high relevance of SGS distributions in representing the non-Gaussian features of observed daily atmospheric variability around the globe. A virtue of our approach to extremes is that it uses a physically based model to derive the entire PDF and not just its tails, and makes use of all the values in a data sample to estimate the parameters of that PDF. This makes it distinct from approaches based on GEV theory that attempt to fit a GEV distribution to just the extreme values in a data sample. All of our model's parameters can be estimated from knowledge of the first four moments of the variable under consideration and its temporal correlation scale. The model can then be run forward in time to generate Monte Carlo statistics of the extremes and their sampling error bars, and also to estimate more complicated statistics such as the durations of extreme events that are challenging to estimate using GEV theory. Our approach is particularly well suited for investigating the statistics of extreme precipitation events. Extensive Monte Carlo statistics generated using representative sample values of observed skew and kurtosis estimated from 25- and 100-yr daily records demonstrate that the SGS-theory based estimation of extreme value distributions is much less prone to sampling uncertainty than other methods. As such, it provides a sharper tool for establishing the statistical significance or otherwise of changes in observed extreme statistics over the 20th century, and of projected changes over the 21st century.