Geophysical Research Abstracts
Vol. 18, EGU2016-10324-1, 2016
EGU General Assembly 2016

Using scaling fluctuation analysis to quantify anthropogenic changes in regional and global precipitation, including extremes

Isabel de Lima (1,2) and Shaun Lovejoy (3)

(1) Department of Civil Engineering, University of Coimbra, Coimbra, Portugal (iplima@uc.pt), (2) MARE - Marine and Environmental Sciences Centre and IMAR - Institute of Marine Research, Portugal, (3) Physics Department, McGill University, Montreal, Canada (lovejoy@physics.mcgill.ca)

Anthropic precipitation changes affect the mean and the magnitude and frequency of extreme events, and therefore potentially have severe consequences in all aspects of human life. Unfortunately, - unlike the anthropic temperature changes - precipitation changes of anthropic origin have been proven difficult to establish with high statistical significance. For example, when changes have been established for individual precipitation products, the serious divergences found between products reflect our limited ability to estimate areal precipitation even at global scales. In addition to data issues, the usual approaches to assessing changes in precipitation also have methodological issues that hamper their identification.

Here we discuss how the situation can be clarified by the systematic application of scaling fluctuation analysis – for example, to determine the scales at which the anthropogenic signal exceeds the natural variability noise (we find that it is roughly 20 years). Following a recent approach for estimating anthropogenic temperature changes we directly determine the effective sensitivity of the precipitation rate to a doubling of CO_2. The novelty in this approach is that it takes CO_2 as a surrogate for all anthropogenic forcings and estimates the trend based on the forcing rather than time - the usual approach. This leads both to an improved signal to noise ratio and, when compared to the usual estimates of trends, it augments their statistical significance; we further improve the signal to noise ratio by considering precipitation over the ocean where anthropogenic increases are strongest, finding that there are statistically significant trends at the 3 to 4 standard deviation level. This approach also permits the first direct estimate of the increases in global precipitation with temperature: we find 1.71 ± 0.62 %/K which is close to that found by GCM's (2 - 3%/K) and is well below the value of ≈ 6 - 7%/K predicted on the basis of increases in humidity. In terms of global forcing, it is equal to 5.07 ± 1.92 W/m2/CO_2 doubling which is slightly larger than the canonical 3.7 W/m2 value for the radiative forcing due to a CO_2 doubling. This comparison confirms the GCM predictions that the anthropic increase in precipitation is radiation controlled.

Applying our approach regionally (at 5ºx5º spatial resolution), we quantify the anthropogenic effects regionally and make multidecadal projections of precipitation rates. As regions get wetter or dryer, the corresponding extremes get accentuated, so that the extremes of wetness or dryness will increase as quantified by the anthropogenic estimates of their changes.