HURRICANES AS WEATHERQUAKES AND THEIR RESPONSE TO CLIMATE CHANGE

ÁLVARO CORRAL

In a recent article, M. E. Walter introduces the interesting concept of "weatherquake", in analogy with earthquakes (1). Tornados and hurricanes are mentioned as examples of such meteorological events. Then, Walter enunciates the *weatherquake hypothesis*, summarized by the statement that there is no preferred scale for the size of weatherquakes, which implies that their size has to be power-law distributed. For simplicity, size is labeled as intensity, although I find it more clear to talk about energy (nevertheless, the distinction is not relevant for the purposes here). So, the probability density of the size z verifies $N_z(z) = \tau z^{-(1+\tau)}$ for $1 < z < \infty$ (in arbitrary units). Defining a magnitude x as $x = \alpha \ln z$ it turns out to be that x is exponentially distributed, $N_x(x) = \beta e^{-\beta x}$, with $\beta = \tau/\alpha$.

In Ref. (2) we have found that the weatherquake hypothesis is in some sense verified by tropical cyclones (from which hurricanes constitute a subset), that is, there is a range $1 < z < b < \infty$ for which the power law holds, although a better description is given for the whole range by $N_z(z) = Az^{-(1+\tau)}e^{-z/w}$ (3). The extra exponential term arises as a boundary effect, and does not reflect an intrinsic characteristic of tropical-cyclone evolution, in contrast to the power-law exponent.

Combining the weatherquake hypothesis with *Gallet's conjecture*, which associates an increase in the proportion of extreme weather events with atmospheric warming, Walter proposes as plausible that the characteristic constant β in $N_x(x)$, and therefore the power-law exponent $1+\tau$, decreases in a warmer environment.

What we have found for tropical cyclones is that τ (and then β) is nearly independent on sea surface temperature (SST), but the characteristic energy cutoff w increases with SST, both in the North Atlantic and in the Northeastern Pacific ocean basins. Our result is in agreement on the one hand with Gallet's conjecture but also with common knowledge in thermodynamics of phase transitions, where critical exponents such as τ are extremely robust under perturbations.

Another example of weatherquake arises in rainfall, for which similar features hold (4).

Let me thank information flow from my campus neighbor P. Puig.

REFERENCES

[1] M. E. Walter. Earthquakes and weatherquakes: mathematics and climate change. *Notices of the American Mathematical Society*, 57:1278–1284, 2010.

CRM Preprint Series number 1070

[2] A. Corral, A. Ossó, and J. E. Llebot. Scaling of tropical-cyclone dissipation. *Nature Phys.*, 6:693–696, 2010.
[3] A. Corral. Variability of North Atlantic hurricanes: seasonal versus individual-event features. *preprint*, 2011.
[4] O. Peters, A. Deluca, A. Corral, J. D. Neelin, and C. E. Holloway. Universality of rain event size distributions. *J. Stat. Mech.*, P11030, 2010.

CENTRE DE RECERCA MATEMÀTICA
EDIFICI CC
CAMPUS BELLATERRA
E-08193 BARCELONA, SPAIN
E-mail address: ACorral atcrm.cat

CRM Preprint Series number 1070