A few links between the notion of Entropy and Extreme Value Theory in the context of analyzing climate extremes [1]

Philippe Naveau
Laboratoire des Sciences du Climat et l'Environnement (LSCE) CNRS, France,
naveau@lsce.ipsl.fr

Théo Rietsch
LSCE and Université de Strasbourg

Armelle Guillou
Université de Strasbourg

James Merleau
IREQ Canada

Abstract:
Climate change could have an important impact on the distribution of future extreme events. To assess such changes, it is essential to develop statistical tools based on Extreme Value Theory. In this talk, we make and study some connections between the notion of entropy (divergence) and Extreme Value Theory. We apply these links to detect changes in extremes.

Keywords: Extreme Value Theory, entropy, climate

Materials and Methods

The Kullback-Leibler information (Kullback, 1968) is defined as

$$I(f;g) = E_f \left\{ \log \left(\frac{f(\mathbf{Z})}{g(\mathbf{Z})} \right) \right\}, \tag{1}$$

and it measures the entropy distance (Robert, 2001) between the probability densities f and g for a random variable $\mathbf{Z}$. Kullback (1968) also refers to this quantity as the directed divergence to distinguish it from the divergence given by

$$J(f;g) = I(f;g) + I(g;f), \tag{2}$$

[1] Part of this work has been supported by the EU-FP7 ACQWA Project (www.acqwa.ch) under Contract Nr 212250, by the PEPER-GIS project, by the ANR-MOPERA project, by the ANR-McSim project and by the MIRACCLE-GICC project.

which is a symmetrical measure relative to f and g. This notion has been exhaustively used and studied in many research fields. Here we explore this concept within the framework of climatology and Extreme Value Theory (EVT). While the divergence (2) is expressed in function of densities, it is more convenient to work the tail distribution when analyzing large excesses. In this talk, we propose an approximation to bypass the need of computing densities. This allows us to derive and study new estimators of the entropy. We apply this approach to the important problem of detecting changes in our warming climate.

References

[Kullback, 1968] Kullbcak, S. (1968). *Information Theory and Statistics*, 2nd ed. New York: Dover.

[Resnick, 2007] Resnick, S. (2007). *Heavy-Tail Phenomena: Probabilistic and Statistical Modeling*. Operations Research and Financial Engineering, Springer, New York.

[Robert, 2001] Robert, C. P. (2001). *The Bayesian Choice*. New York: Springer-Verlag.