Complexity in Colombian precipitation extremes from a non-extensive approach

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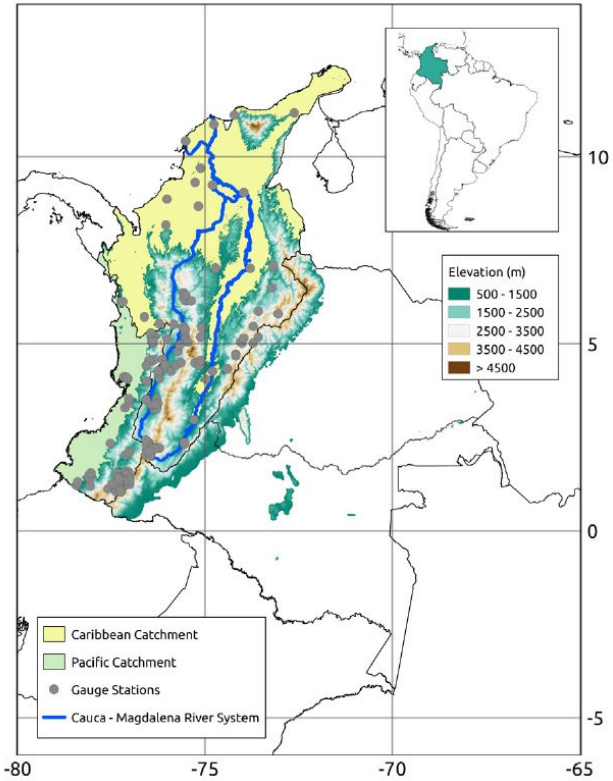
3rd Workshop on Cloud Organisation and Precipitation Extremes - WCO3

Outline

1. Colombian climate complexity
2. Complexity and extremes
3. Nonextensive entropy and universality
4. Results
5. Concluding remarks

1. Colombian climate complexity



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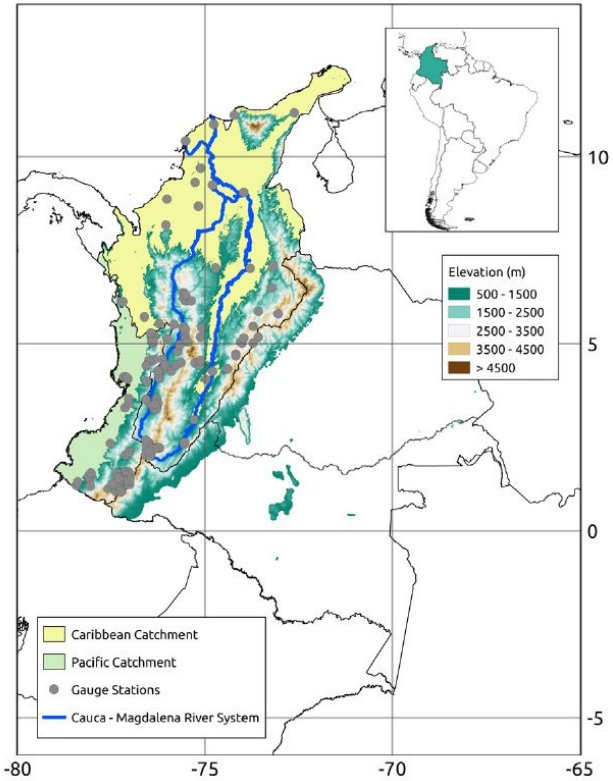

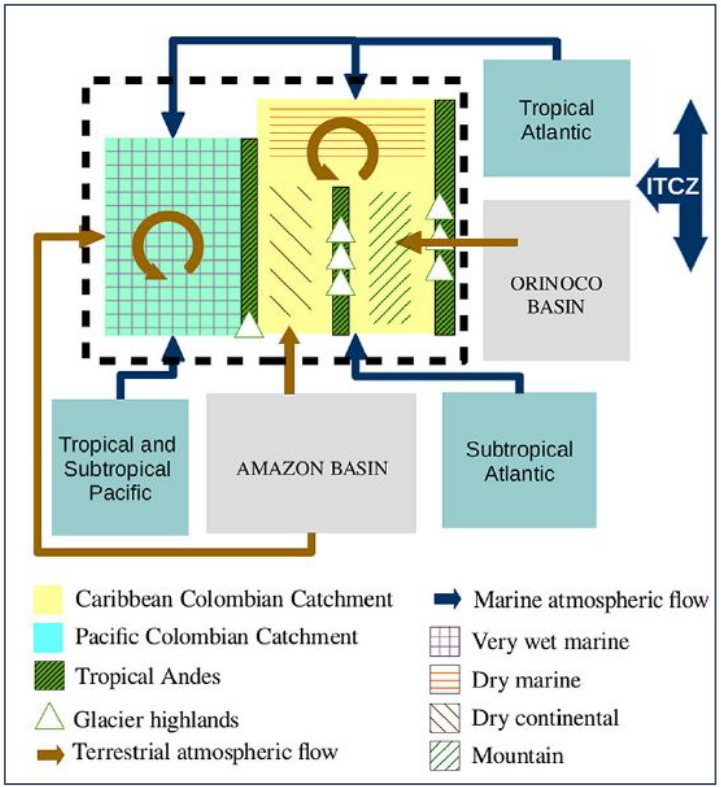

Hoyos and Rodríguez (2020). Physica A 548, 123673.

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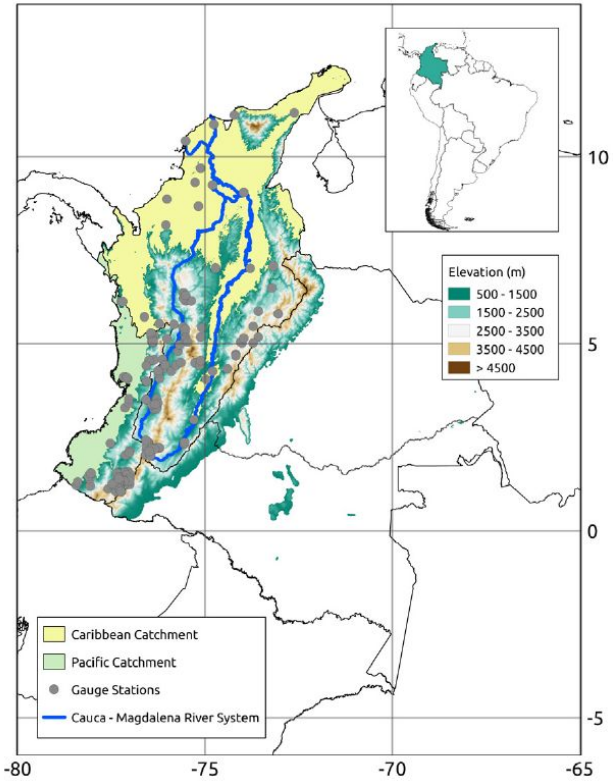

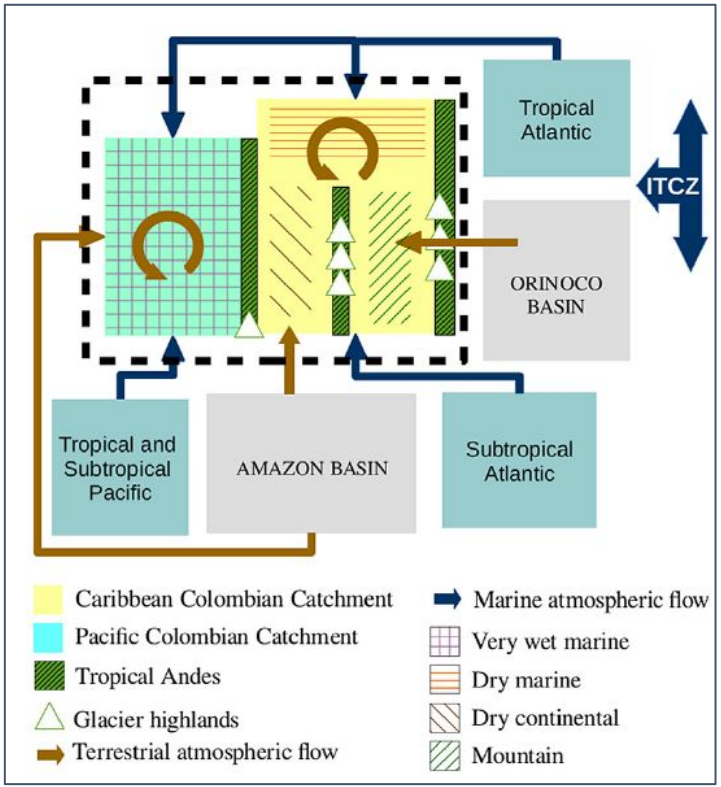

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Escobar et al. (2022). Hydrol. processes 36(6), e14595.

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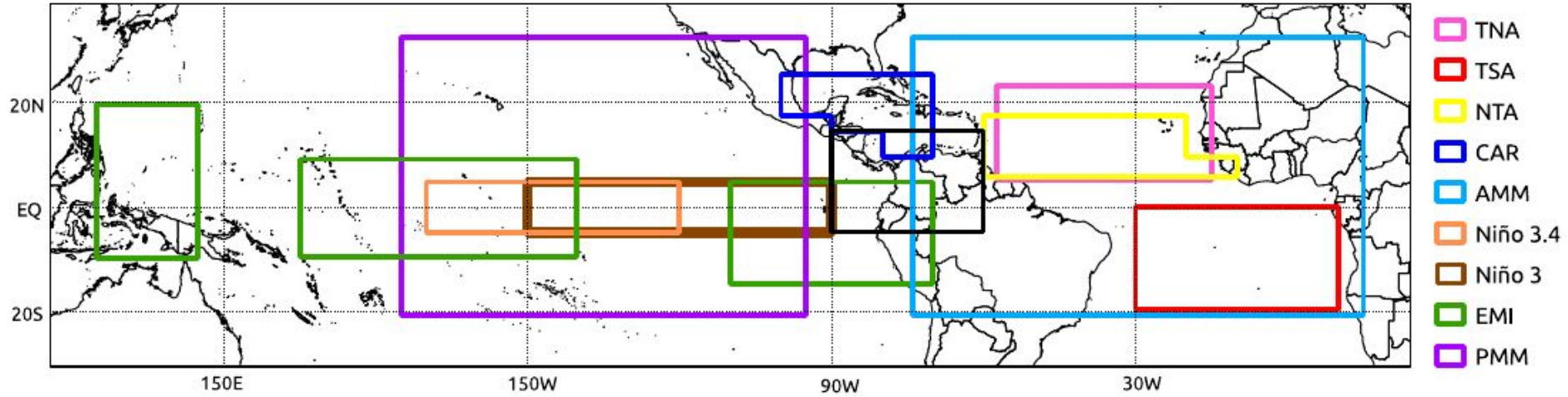
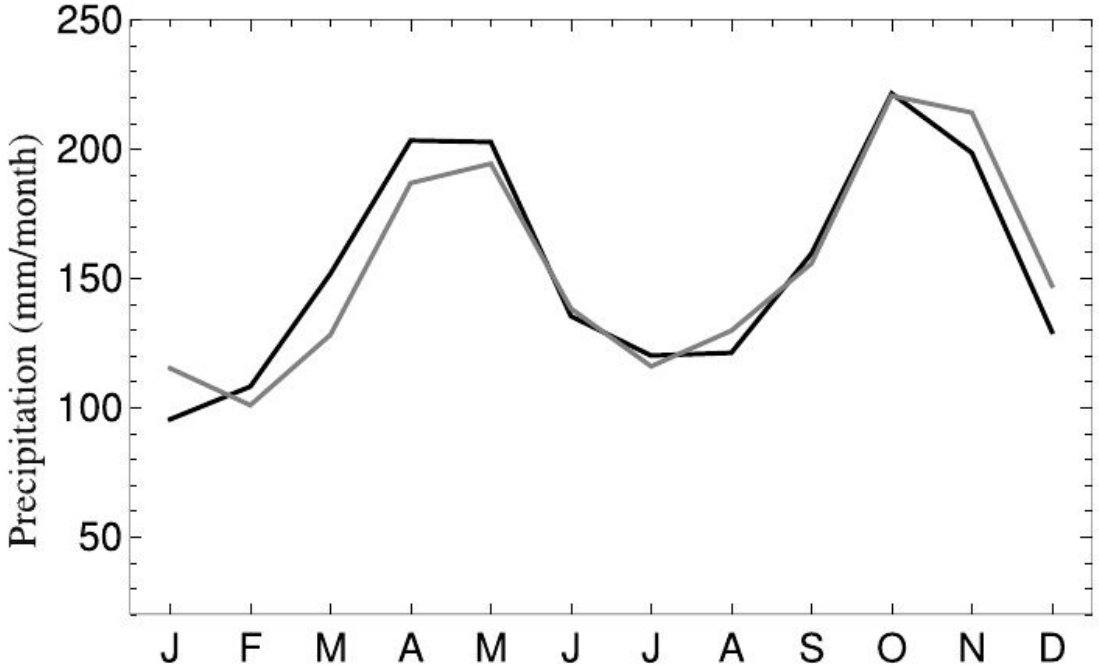
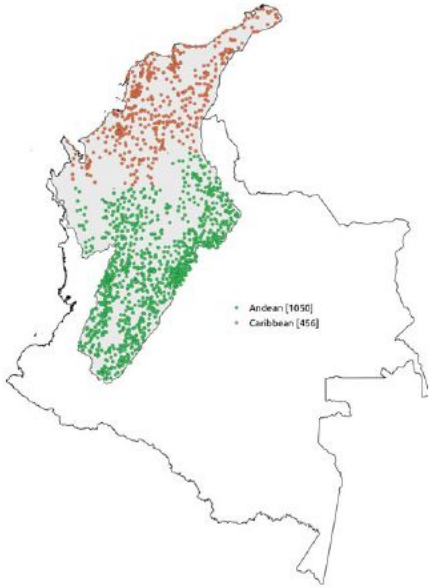


Hoyos et al. (2019). Clim Dyn. 52, 893–911





Escobar et al. (2022). Hydrol. processes 36(6), e14595.

Bogotá 18/1/2015

Medellín 29/10/2014

www.elcolombiano.com
Dec 1, 2021

Medellín. Aug 1, 2022

Tragedia en Medellín: fuertes aguaceros dejaron dos muertos en un carro

Las fuertes lluvias que azotaron a la ciudad por más de cuatro horas dejaron bajo el agua un Audi, en el deprimido de Conquistadores. Las víctimas son dos adultos. Además, se cayó una estructura de los alumbrados del río y dejó 10 heridos.

January 15, 2023

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10 heridos.

January 15, 2023

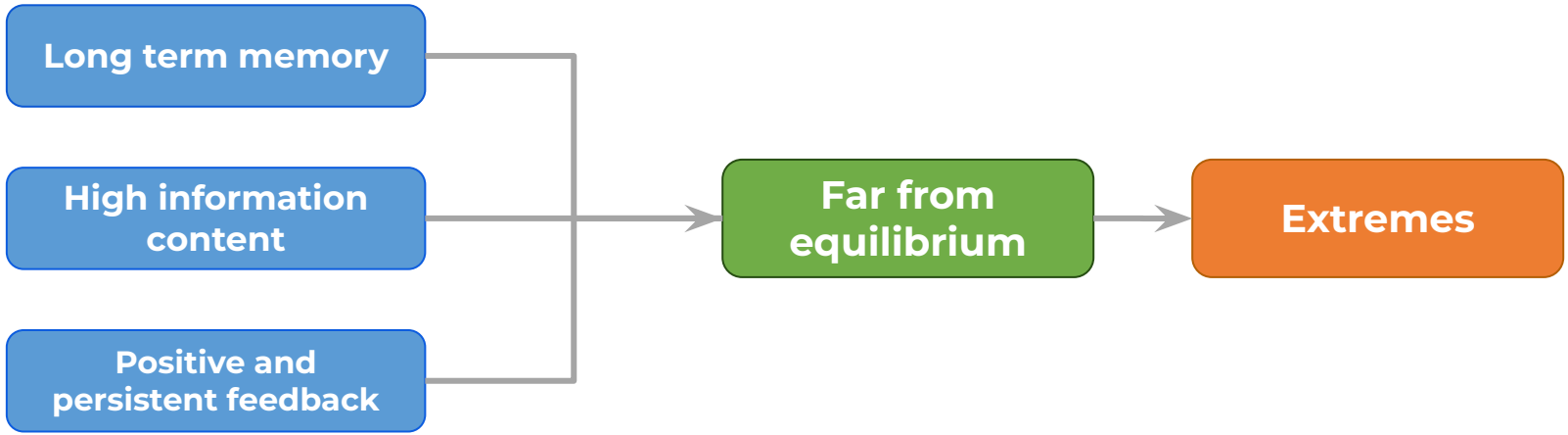
Casi 400 rayos, 9 horas de lluvia continua y otras asustadoras cifras que dejó el aguacero del martes en el Valle de Aburrá

El informe, centrado en nueve horas de lluvia continua, lo compartió el Siata.

January 18, 2023

2. Complexity and Extremes

Climate extremes are complex phenomena that emerge from interactions that occur on multiple spatiotemporal scales.



3. Nonextensive entropy and universality

Ergodicity (and equilibrium statistics, as its manifestation) is understood as one of the possibilities of microscopic mixing in complex systems and not necessarily as generalized behavior.

Tsallis C. (1998). Possible generalization of Boltzmann-Gibbs statistics . Journal of Statistical Physics 52, 479-487.

3. Nonextensive entropy and universality

$$S_q = k_B \frac{1}{q-1}\left[1 - \int_{\Omega} [f(x)]^q dx\right]; \quad q \in \mathbb{R}$$

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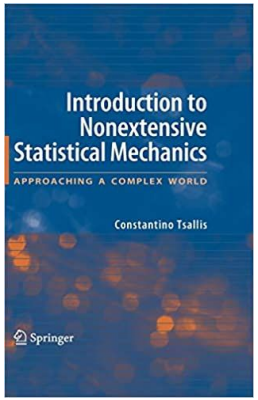
- How far is S_q from S_{BG}.
- Identification of universality
- Long term interactions
- Multifractal structure (scaling laws)



$$S_q = k_B \frac{1}{q-1}\left[1 - \int_{\Omega} [f(x)]^q dx\right]; \quad q \in \mathbb{R}$$

$$f_{q,\beta}(x) = \frac{1}{Z_{q,\beta}} e_q(-\beta x)$$

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$$1/(\beta(2-q))$$

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$$Z = X(t) - u_{ym} \mid X > u_{ym}, \text{ where } u_{ym} = L_{ym} + \epsilon$$

focus on the excess over 90th percentile

3. Nonextensive entropy and universality

q parameter:	If $q < 1$	→	Bounded distribution
	$1 < q < 2$	→	Unbounded distribution
	$q = 1$	→	Recovers S_{BG}

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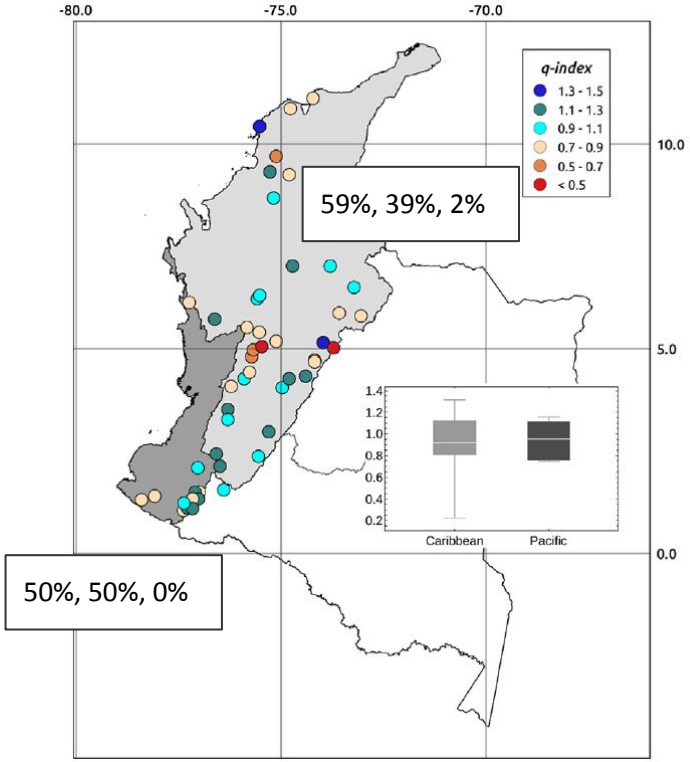
Universality: there is a common feature in the underlying microscopic dynamics of different systems or phenomena that causes this characteristic number to appear.

4. Spatial structure of q-index



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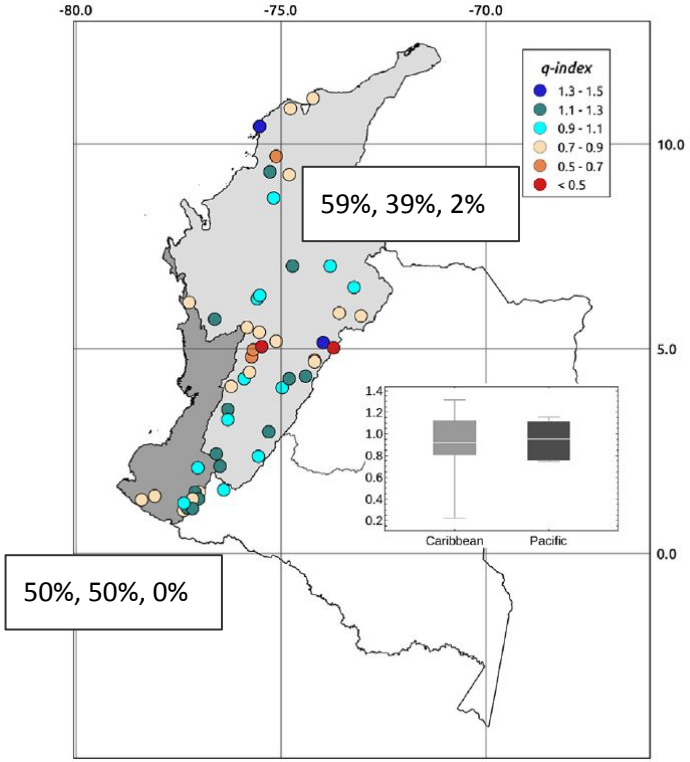

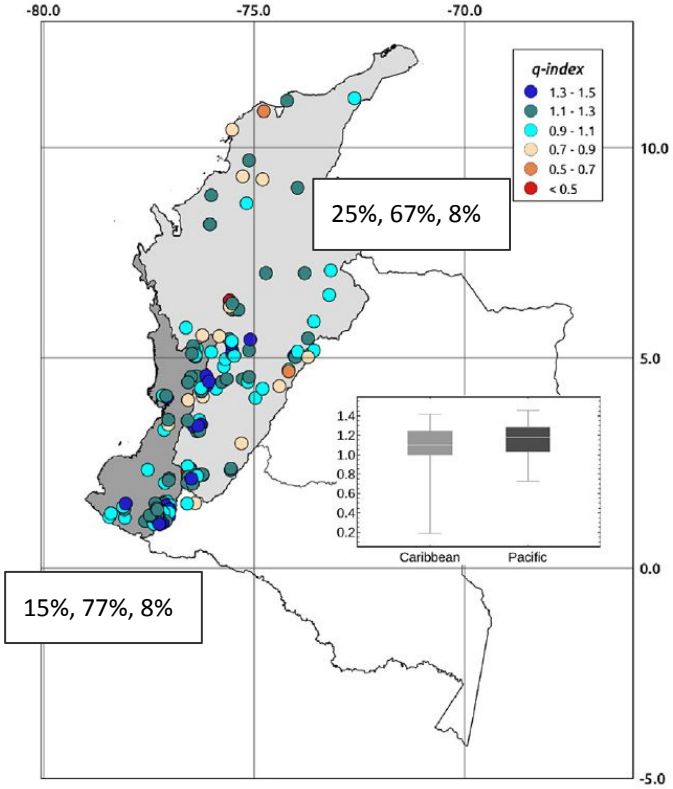

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4. Summary

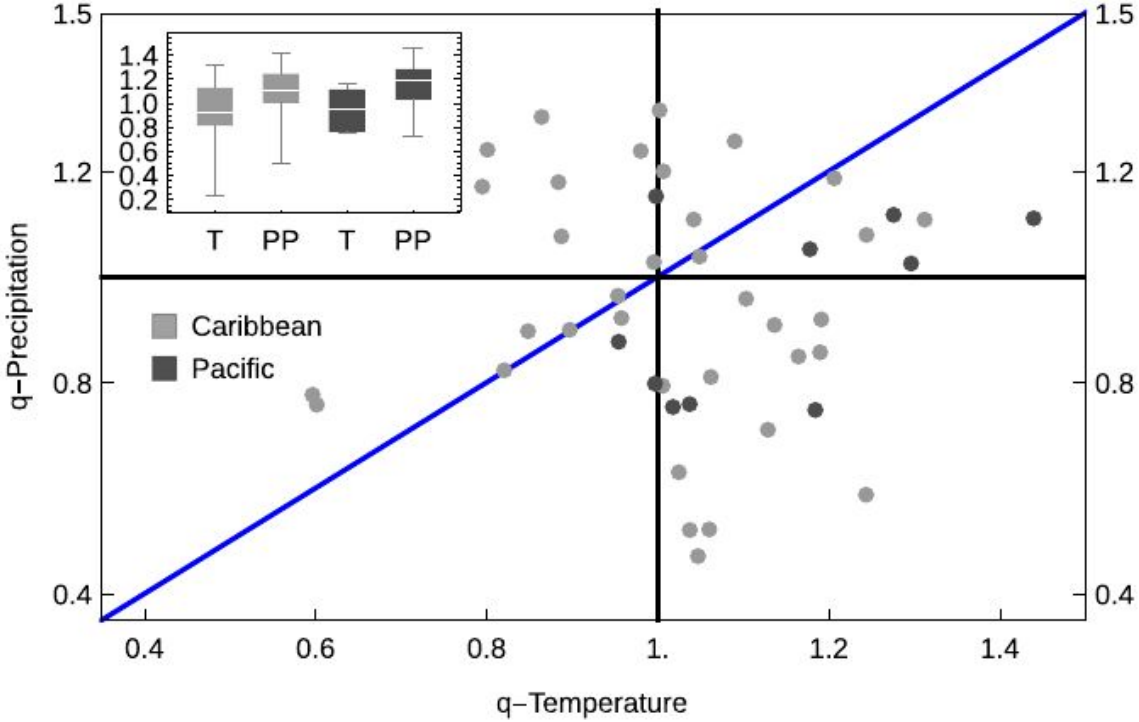

Fig. 5. q summary for stations with common temperature and precipitation data: 34 for Colombian Caribbean catchment; 10 for Pacific Colombian catchment.

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4. Universality

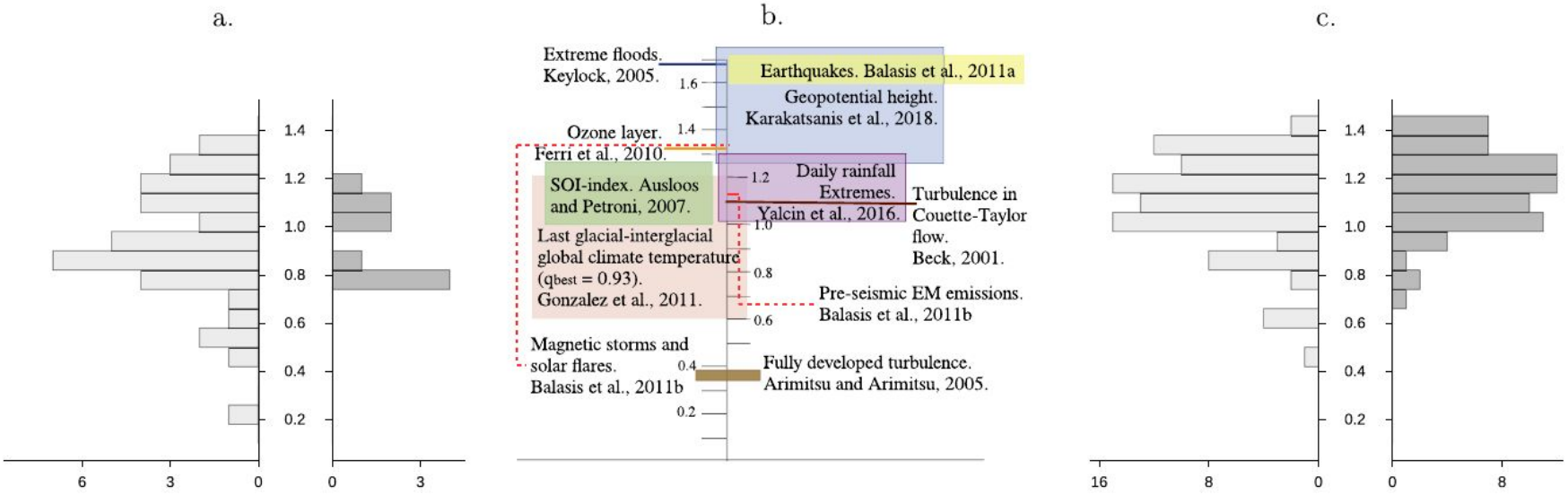

Fig. 4. Regional extreme q-index in the context of dynamic universality classes. (**a**) q-index histogram for temperature. (**b**) q-index summary for typical climate-related systems. (**c**) q-index histogram for precipitation. In (**a**) and (**c**) light (dark) gray for Caribbean (Pacific) Colombian basin.

Hoyos and Rodríguez (2020). Physica A 548, 123673.

5. Concluding remarks

The extremes in Colombian climate are essentially nonextensive.

Temperature and precipitation extremes do not share the same universality features.

The dynamic universality classes pave the way to a mechanistic insight into the spatial structure on the q-index.

q-index is a useful tool to test numerical model or even try new models.

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Thanks !!