Exploring Predictability of Extreme Climate Events via a Complex Network Approach

Juergen Kurths
Potsdam Institute for Climate Impact Research & Humboldt University, Berlin
E-mail: Juergen.Kurths@pik-potsdam.de

The Earth system is a very complex and dynamical system based on various feedbacks. This makes predictions and risk analysis even of very strong (sometime extreme) events as floods, landslides, heatwaves, earthquakes etc. a challenging task. Here I will introduce a recently developed approach via complex networks mainly to analyze strong climate events. This leads to an inverse problem: Is there a backbone-like structure underlying the climate system? For this we propose a method to reconstruct and analyze a complex network from data generated by a spatio-temporal dynamical system. This approach enables us to uncover relations to global and regional circulation patterns in oceans and atmosphere, which leads to construct substantially better predictions, in particular of strong rainfall in Bolivia, of the onset of the Indian Summer Monsoon and El Nino.

References

N. Boers, B. Bookhagen, H.M.J. Barbosa, N. Marwan, J. Kurths, and J.A. Marengo, Nature Communications 5, 5199 (2014)
N. Boers, R. Donner, B. Bookhagen, and J. Kurths, Climate Dynamics 45, 619 (2015)
J. Runge et al., Nature Communications 6, 8502 (2015)
V. Stolbova, E. Surovyatkina, B. Bookhagen, and J. Kurths, Geophys. Res. Lett. (2016)
D. Eroglu, F. McRobies, I. Ozken, T. Stemler, K. Wyrwoll, S. Breitenbach, N. Marwan, J. Kurths, Nature Communications 7, 12929 (2016)
B. Goswami, N. Boers, A. Rheinwalt, N. Marwan, J. Heitzig, S. Breitenbach, J. Kurths, Nature Communications 9, 48(2018)
N. Boers, B. Goswami, A. Rheinwalt, B. Bookhagen, B. Hoskins, J. Kurths, Nature 566, 373 (2019)
J. Meng, J. Fan, J. Ludescher, A. Agarwal, X. Chen, A. Bunde, J. Kurths, H. Schellnhuber, PNAS 117, 177 (2020)

Bio-sketch of Juergen Kurths

JÜRGEN KURTHS studied mathematics at the University of Rostock. He received the Ph.D.degree from the GDR Academy of Sciences, in 1983. He was a Full Professor with the University of Potsdam, from 1994 to 2008. He has been a Professor of nonlinear dynamics at the Humboldt University, Berlin, and the Chair of the Research Domain Complexity Science of the Potsdam Institute for Climate Impact Research, since 2008. He has published more than 600 articles that are cited more than 45,000 times (H-factor: 99). His primary research interests include synchronization, complex networks, and time series analysis and their applications in Earth Sciences, Physiology, infrastructure and others. He is a Fellow of the American Physical Society. He became a member of the Academia Europaea, in 2010. He received the Alexander von Humboldt Research Award in 2005, and the Richardson award from the European Geoscience Union in 2013. He got eight Honorary Doctorates and Honorary Professors.