

Climate Meets Complex Systems: from 2021 Physics Nobel Price Winners to Recent Directions

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The Earth system is a very complex and dynamical one basing 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. After introducing physical models for weather forecast already in 1922 by Richardson, a strong problem has been the understanding of basic physical mechanisms and exploring anthropogenic influences on climate. In 2021 Hasselmann and Manabe got the Physics Nobel Price for their pioneering works on this. I will shortly review their main contributions. Next, 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 observational and reanalysis data. 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 the onset of the Indian Summer Monsoon and El Niño.

References

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