# Perspectives for causal inference in Earth system sciences

Jakob Runge

Institute of Data Science, German Aerospace Center, Jena, Germany (jakob.runge@dlr.de)

The heart of the scientific enterprise is a rational effort to understand the causes behind the phenomena we observe. In disciplines dealing with complex dynamical systems, such as the Earth system, replicated real experiments are rarely feasible. However, a rapidly increasing amount of observational and simulated data opens up the use of novel data-driven causal inference methods beyond the commonly adopted correlation techniques. The key idea shared by several approaches is that, while the truism "correlation does not imply causation" holds, causal relations among variables can be estimated from their joint probability distribution given some assumptions. Causal inference is indeed a rapidly growing field with enormous potential to help answer long-standing scientific questions. Unfortunately, many methods are still little known and therefore rarely adopted in Earth system sciences. In this talk I will give an overview over causal inference methods and identify key tasks and major challenges where causal methods have the potential to greatly advance the state-of-the-art. Several methods will be illustrated by 'success' examples where causal inference methods have already led to novel insights and I will close with an outlook of this relatively new and exiting field.