A framework for causality under data assimilation

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Time varying processes in nature are often complex with non-linear and non-gaussian components. Complexity of environments and processes make it hard to disentangle different causal mechanisms which drives the observed time-series. It also makes it harder to make forecasts. The standard ways of studying causal relation in the geosciences which includes information theoretic measures of causation as well as predictive framework have deficiencies when applied to non-linear dynamical systems. Here we focus on investigating building a predictive causal framework that allows us to make predictions in simpler systems in a consistent way. We use a Bayesian framework to embed causal measures akin to mutual information from information theory to quantify relations between different random processes in this system. We examine causal relations in toy models and simple systems with a view to eventually applying to the interocean exchange problem in the Indian, the South Atlantic and the Southern Ocean.