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# Identifying causal gateways and mediators in complex spatio-temporal systems

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Identifying regions important for spreading and mediating perturbations is crucial to assess the susceptibilities of spatio-temporal complex systems such as the Earth's climate to volcanic eruptions, extreme events or geoengineering. Here a data-driven approach is introduced based on a dimension reduction, causal reconstruction, and novel network measures based on causal effect theory that go beyond standard complex network tools by distinguishing direct from indirect pathways. Applied to a data set of atmospheric dynamics, the method identifies several strongly uplifting regions acting as major gateways of perturbations spreading in the atmosphere. Additionally, the method provides a stricter statistical approach to pathways of atmospheric teleconnections, yielding insights into the Pacific–Indian Ocean interaction relevant for monsoonal dynamics. The novel causal interaction perspective provides a complementary approach to simulations or experiments for understanding the functioning of complex spatio-temporal systems with potential applications in increasing their resilience to shocks or extreme events.

Reference:
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