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Supplementary Information for

Network-based Forecasting of Climate Phenomena

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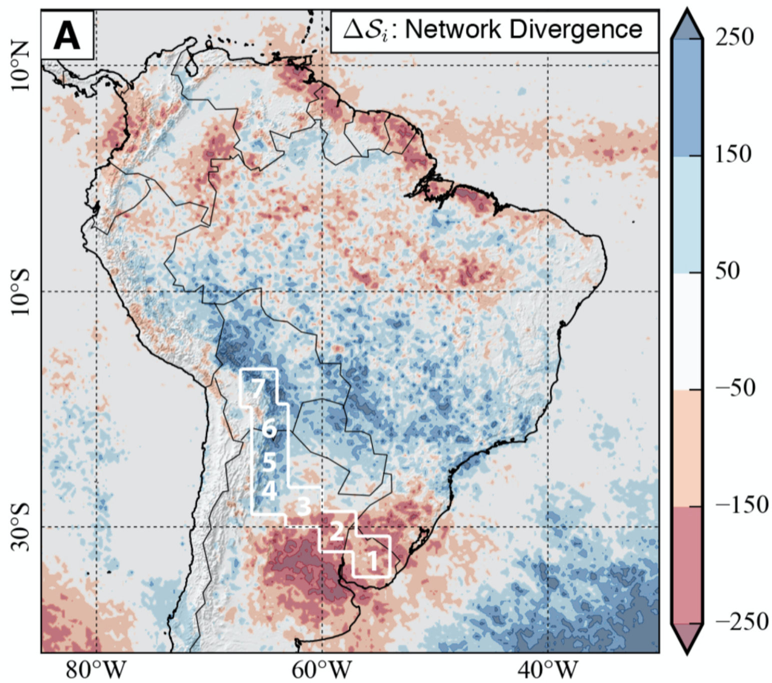

Fig. S1. Results of the network analysis and propagation of extreme rainfall from southeastern South America to the eastern Central Andes. The figure shows the network divergence of a directed and weighted network constructed from 3-hourly rainfall events above the 99th percentile. The network divergence is defined as the difference of in-strength and out-strength at each grid cell, $\Delta S_i = S_i^{in} - S_i^{out}$, where the in- and out-strengths at each node are themselves given by the sums of all network weights assigned to directed links leading into and out of that node. Positive values thus indicate sinks of the directed and weighted network, which are interpreted as locations where synchronized extreme rainfall occurs within 2 days after it occurred at several other locations. Negative values indicate sources, that is, locations where synchronized rainfall occurs within 2 days before it occurs at several other locations. The boxes labelled 1 to 7 track the path of the extreme events from southeastern South America toward the Central Andes. Figure adapted with permission from ref. (4), copyright 2014 Nature Publishing Group.

Table S1. Comparison between network-based forecasts and comparable or similar state-of-the-art operational forecasts, to the best of our knowledge.

Phenomenon	Network Forecast	Comparable state-of-the-art operational forecast	Similar state-of-the-art operational forecast
El Niño onset	73% of El Niño onsets and 89% of their absences were correctly hindcasted or forecasted in the calendar year before. Mean lead time before an El Niño onset is 12 months (1).	No comparable 12 months ahead forecast available.	Forecasts for Nov-Jan provide less than 10% explained variance when initiated in February and more than 80% when initiated in September of the same year (2).
Droughts in the Central Amazon	Six out of the seven most severe droughts in the last four decades were hindcasted at lead times of 12 to 18 months (3).	No prior attempt to forecast this specific climate phenomenon.	Same as left.
Extreme Rainfall in the eastern Central Andes	Up to 2 days lead time for correctly forecasting 60% (90% during El Niño conditions) of the extreme rainfall events (4).	No prior attempt to forecast this specific climate phenomenon.	Same as left.
Indian summer monsoon onset and withdrawal	73% (84%) correct onset (withdrawal) hindcasts for Central India for 1965-2015 (5). All forward-looking onset (withdrawal) forecasts with 40 (70) days lead time were correct for 2016-2020 (6).	No dedicated long-term forecast for Central India, standard weather forecast of about 5 days (7).	Two weeks in advance onset forecast for Kerala in South India, no dedicated withdrawal date forecast (7).
Extreme stratospheric polar vortex states	Predictive skill up to 45 days for extreme 15-day-mean events (8)	No prior attempt to forecast a 15-day-mean of the SPV.	Predictability up to 30 days for daily events, but strongly varying for individual events and usually much shorter (9).

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