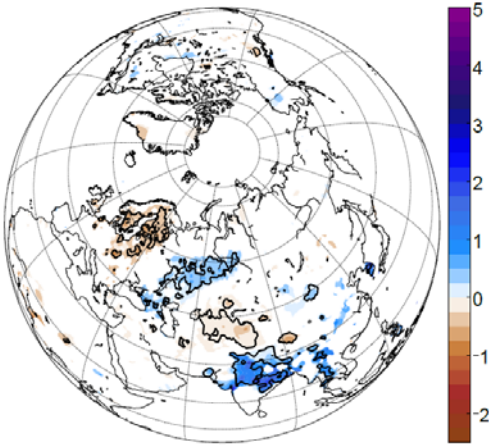
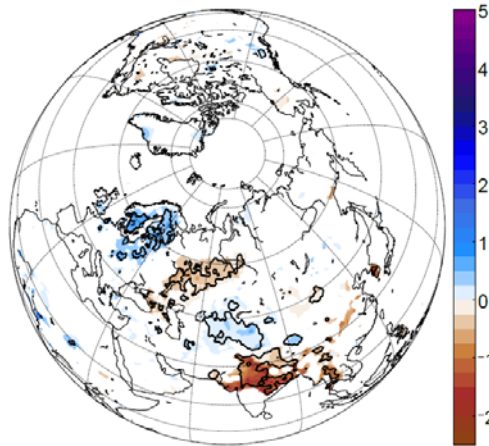


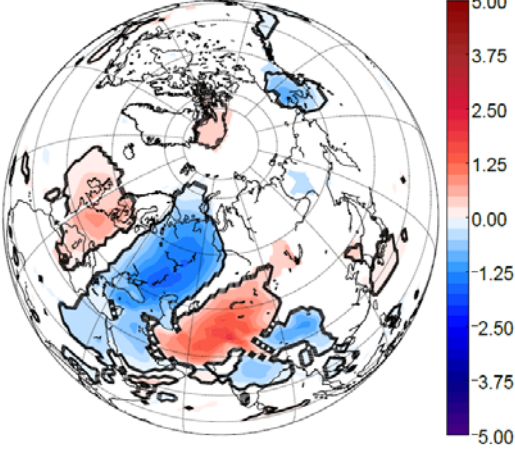
(a) P anomalies for with + 1 $CGTI_{s,d}$ ($mm\ day^{-1}$)



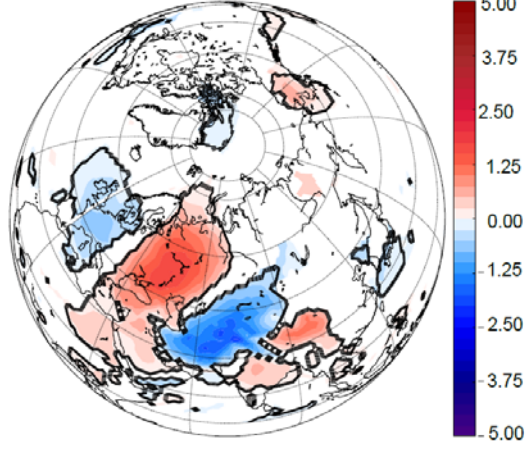
(b) P anomalies for with - 1 $CGTI_{s,d}$ ($mm\ day^{-1}$)



(c) T anomalies for with + 1 $CGTI_{s,d}$ (K)

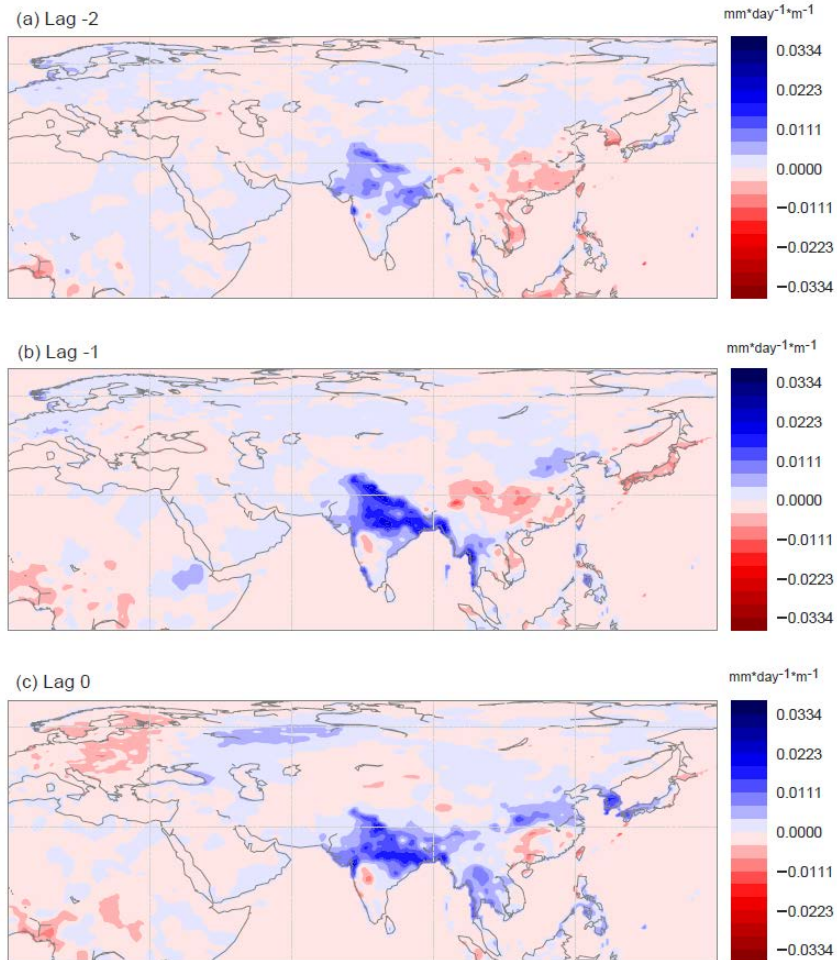


(d) T anomalies for with - 1 $CGTI_{s,d}$ (K)



130 **Figure S4. Temperature and precipitation anomalies related to high and low CGTI states.** Panels (a) and (b) show mean precipitation anomalies over the Northern Hemisphere during weeks with $CGTI > 1\ CGTI_{s,d}$ and weeks with $CGTI < -1\ CGTI_{s,d}$ respectively from NCEP CPC data and for the period 1979-2017. Panel (c) and (d) as for panel (a) and (b) but for temperature anomalies (from ERA-Interim reanalysis).

Lin. Regr. of CPC rainfall on CGTI, slope



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Figure S5. Linear regression of the MT rainfall on the CGTI index. Precipitation from CPC/NCEP for the period 1979-2917 linearly regressed on the CGTI index. Panel (a) show the regression coefficient ($\text{mm} \cdot \text{day}^{-1} \cdot \text{m}^{-1}$) for lag -2 (i.e. the CGTI leads the precipitation by 2 weeks). Panel (b) and panel (c) as for panel (a) but for lags -1 and lag 0 respectively.

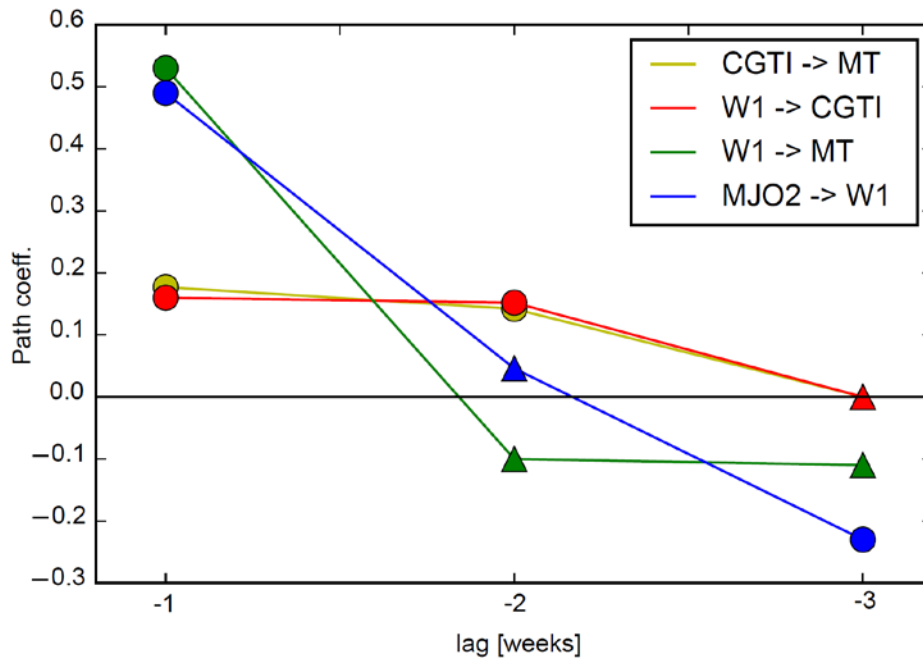
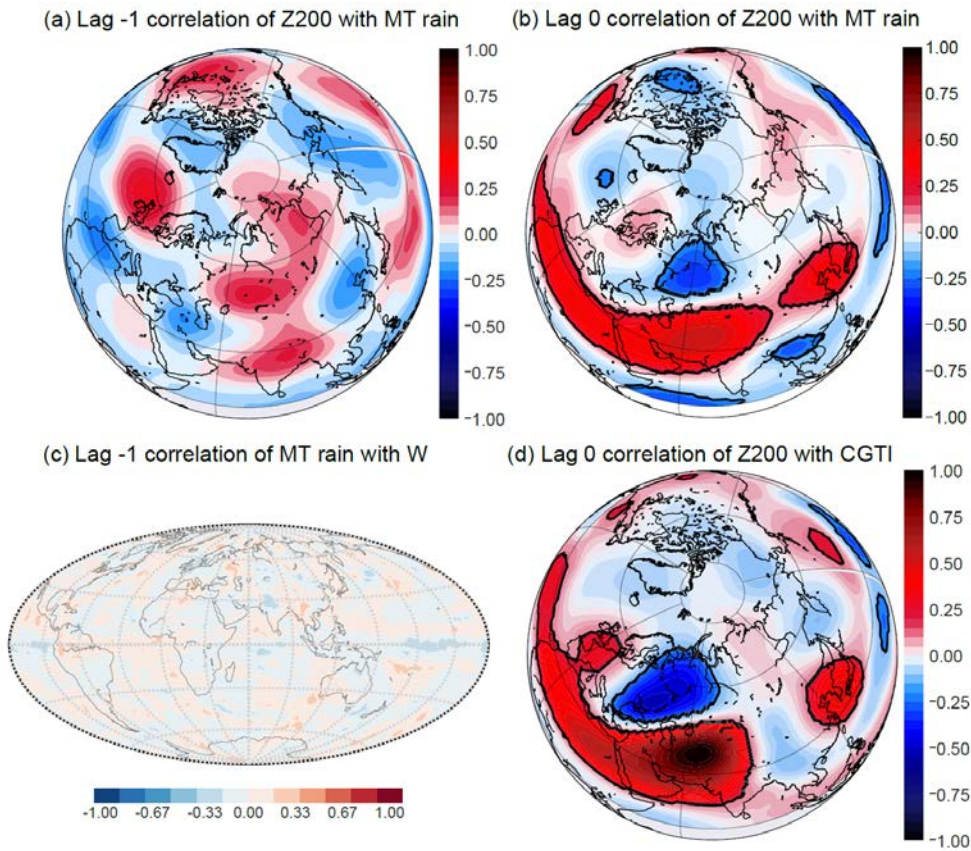


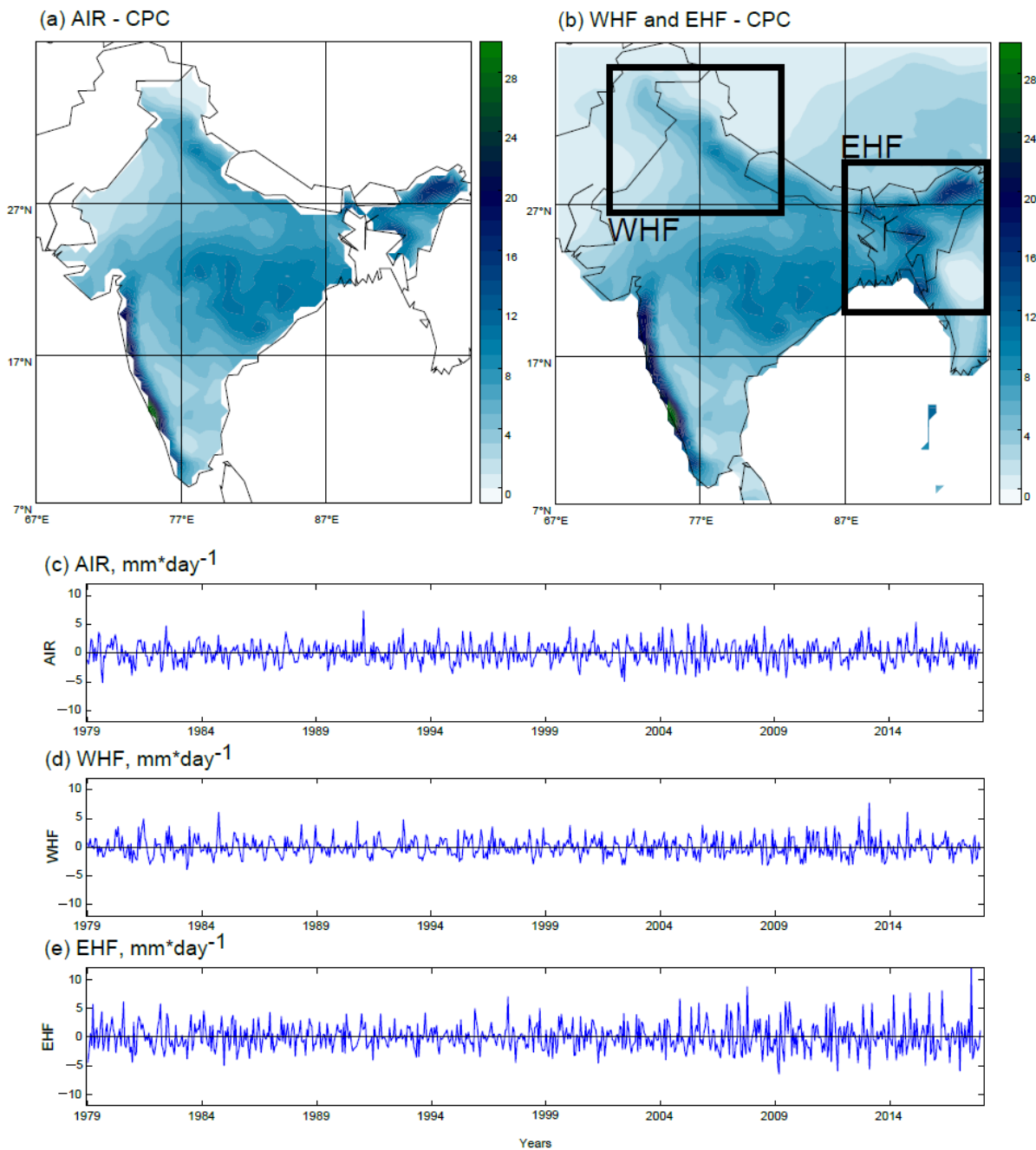
Figure S11. Time evolution of path coefficients for a CEN built with CGTI, W1, MJO2 and MT (over the period 1979-2017) from lag -1 up to lag -3 weeks. Circles denote significant values at $pval < 0.5$, while nonsignificant values are plotted with triangles.



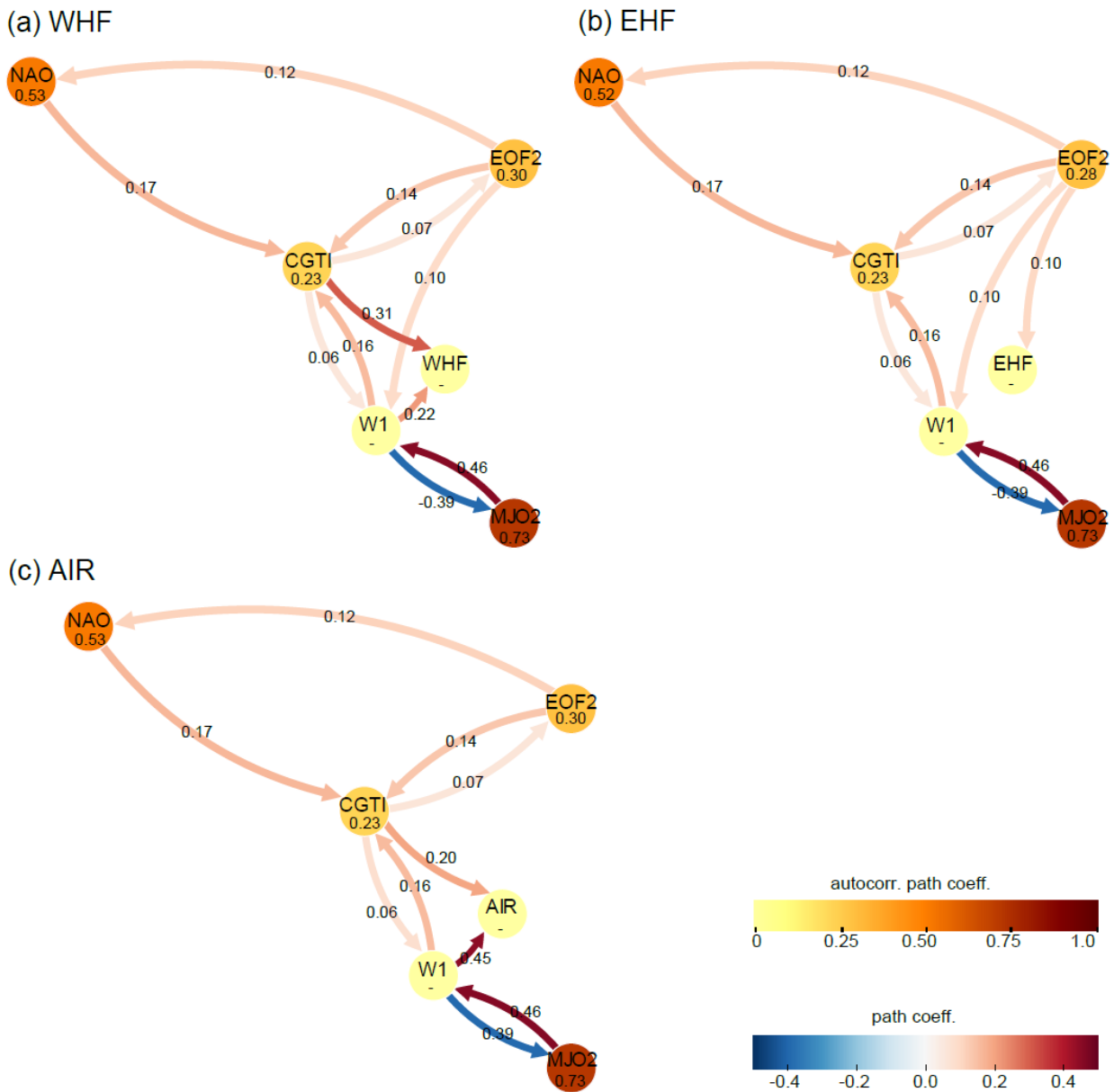
175

Figure S12. CGTI and MT rainfall at monthly time scale. Panel (a): correlation between monthly MT rainfall (lag = 0) and Z200 (lag = -1 month). Panel (b): as panel (a) but with monthly MT rainfall (lag = 0) and Z200 (lag = 0). Panel (c) as panel (a) but for MT rainfall and W. Panel (d): correlation between CGTI and Z200 (both at lag = 0), which forms the circumglobal teleconnection pattern. In panels (c) and (d), correlation coefficients and anomalies with a p -value of $p < 0.05$ (accounting for the effect of serial correlations) are shown by black contours.

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225 **Figure S20. AIR, WHF and EHF rainfall.** Panel (a) shows all-India rainfall (AIR) for CPC-NCEP data. Panel (b) shows western Himalayan foothills (WHF, defined over 26°-35°N and 70°-83°E) and eastern Himalayan foothills (EHF, defined over 20°-30°N and 87°-97°E) contoured by a black box. Panel (c) shows the time series for AIR averaged over the whole country for the period 1979-2017. Panel (d) and (e) as panel (c) but for WHF and EHF rainfall respectively. See main text for the description of the results.



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Figure S21. CEN for AIR, WHF and EHF rainfall. Panel (a) shows a CEN as for Fig. 7 in the main text but for western Himalayan foothills (WHF) rainfall from CPC-NCEP data. Panel (b) and (c) as panel (a) but for eastern Himalayan foothills (EHF) rainfall and all-India rainfall (AIR) respectively. See main text for the description of the results.

Link	Link strength (CE)	Simple correlation
$\beta_{W1 \rightarrow MT}$	0.54	0.55
$\beta_{MJO2 \rightarrow W1}$	0.49	0.45
$\beta_{CGTI \rightarrow MT}$	0.18	0.26
$\beta_{W1 \rightarrow MJO2}$	-0.39	0.17
$\beta_{EOF2 \rightarrow NAO}$	0.12	-0.01
$\beta_{NAO \rightarrow CGTI}$	0.17	0.12
$\beta_{W1 \rightarrow CGTI}$	0.16	0.2
$\beta_{EOF2 \rightarrow CGTI}$	0.14	0.16
$\beta_{CGTI \rightarrow EOF2}$	0.07	0.15
$\beta_{CGTI \rightarrow W1}$	0.09	0.15
$\beta_{MJO2 \rightarrow W1} * \beta_{W1 \rightarrow MT}$	$0.49 * 0.54 = 0.26$	0.38
$\beta_{CGTI \rightarrow W1} * \beta_{W1 \rightarrow MT}$	$0.09 * 0.54 = 0.05$	0.26
$\beta_{NAO \rightarrow CGTI} (\beta_{CGTI \rightarrow MT} + \beta_{CGTI \rightarrow W1} * \beta_{W1 \rightarrow MT})$	$0.17 * (0.18 + 0.05) = 0.04$	0.04

240 **Table S1. Causal effect (CE) values.** CE values for links presented in Fig. 7 in the main text.

	MT rainfall	NAO	CGTI	EOF2	W1	MJO2
ACE	0.0	0.033	0.066	0.051	0.217	0.098
ACS	0.143	0.023	0.093	0.013	0.116	0.077

Table S2. Average causal effect (ACE) and average casual susceptibility (ACS). ACE and ACS for actors presented in Fig. 7 in the main text.