

Supplementary Material

for “Common solar wind drivers behind magnetic storm–magnetospheric substorm dependency”

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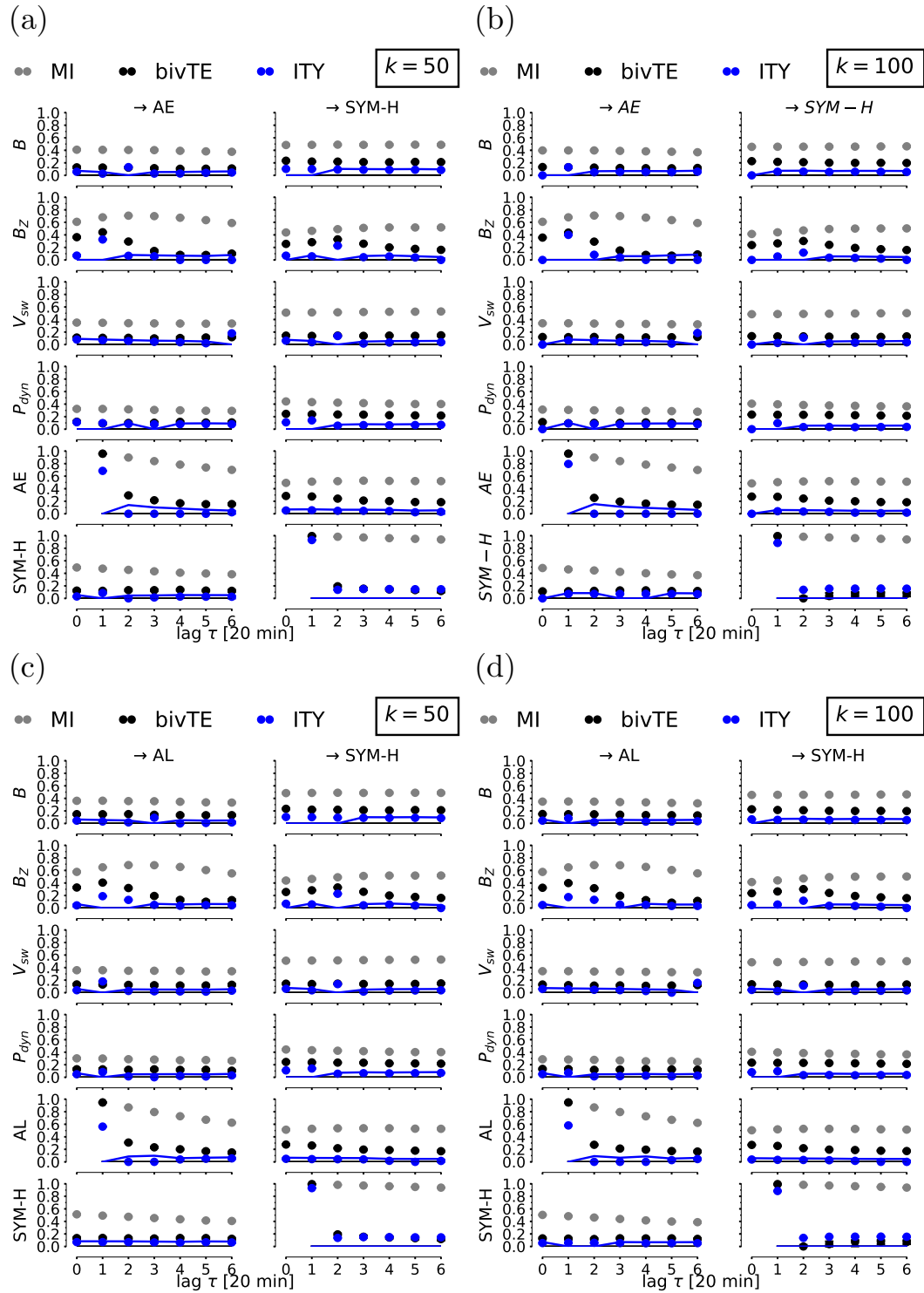


Figure S1. Lag functions as in Fig. 3, but for additional parameters: nearest-neighbor CMI estimation parameter $k = 50$ (a,c) and $k = 100$ (b,d) resulting in a stronger smoothing of the densities; substorm index AE (a,b) and AL (c,d).

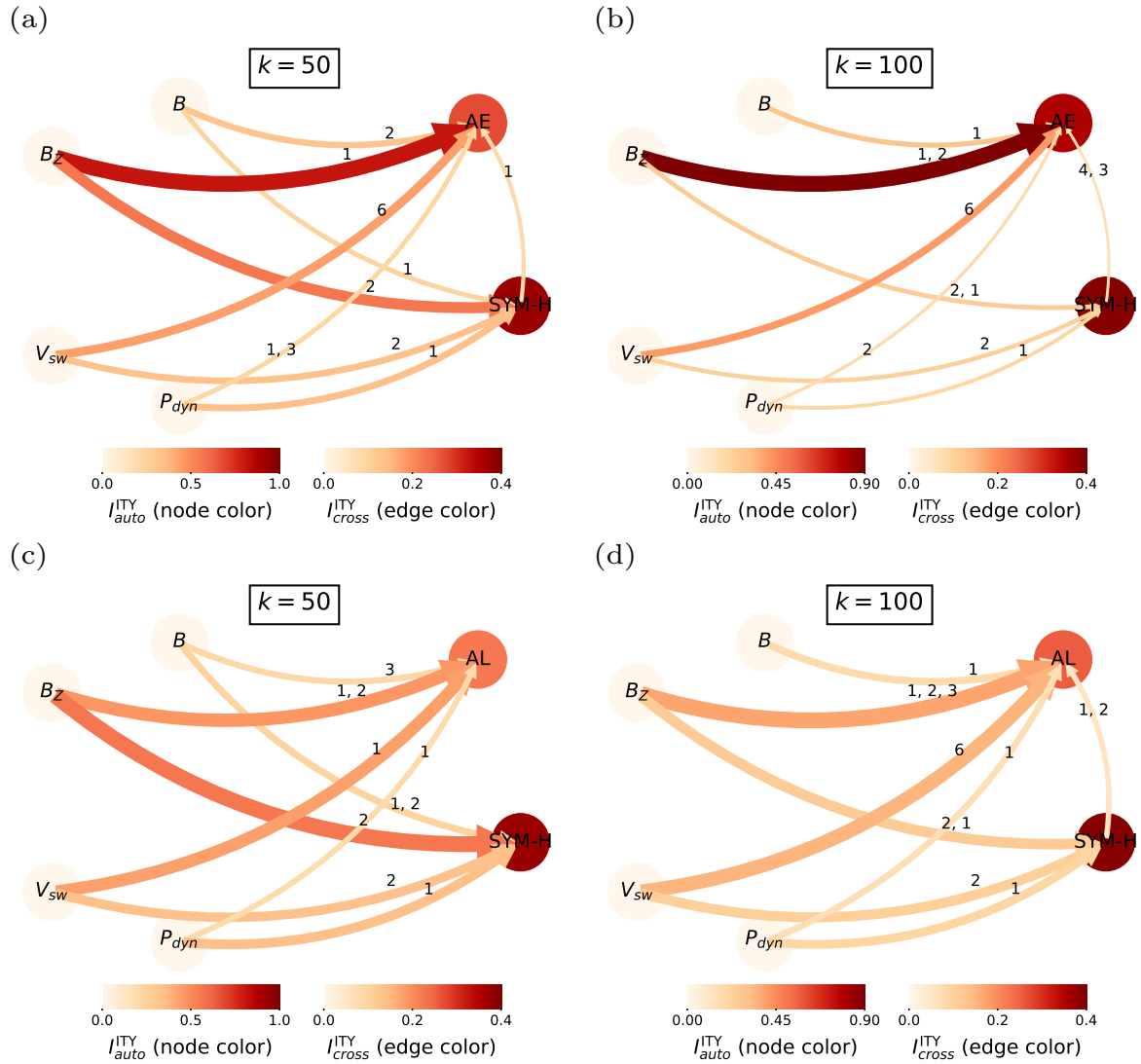


Figure S2. As in Fig. 4, but for additional parameters: nearest-neighbor CMI estimation parameter $k = 50$ (a,c) and $k = 100$ (b,d) resulting in a stronger smoothing of the densities; substorm index AE (a,b) and AL (c,d).

Moderate			Intense			Super-storm		
Date	Time	Dst (nT)	Date	Time	Dst (nT)	Date	Time	Dst (nT)
2001/01/24	07:00:00 PM	-61	2001/03/19	11:00:00 PM	-105	2001/03/31	09:00:00 AM	-387
2001/02/13	10:00:00 PM	-50	2001/03/20	01:00:00 PM	-149	2001/04/11	12:00:00 AM	-271
2001/03/05	05:00:00 AM	-73	2001/04/18	07:00:00 AM	-114	2001/11/06	07:00:00 AM	-292
2001/03/23	05:00:00 PM	-75	2001/04/22	04:00:00 PM	-102	2001/11/24	05:00:00 PM	-221
2001/03/28	04:00:00 PM	-87	2001/08/17	10:00:00 PM	-105			
2001/04/09	07:00:00 AM	-63	2001/09/26	02:00:00 AM	-102			
2001/04/13	04:00:00 PM	-77	2001/10/01	09:00:00 AM	-148			
2001/05/10	02:00:00 AM	-76	2001/10/03	03:00:00 PM	-166			
2001/06/18	09:00:00 AM	-61	2001/10/21	10:00:00 PM	-187			
2001/09/13	08:00:00 AM	-57	2001/10/28	12:00:00 PM	-157			
2001/09/23	07:00:00 PM	-73	2001/11/01	11:00:00 AM	-106			
2001/10/09	04:00:00 PM	-64						
2001/10/11	08:00:00 PM	-70						
2001/10/12	01:00:00 PM	-71						
2001/10/19	10:00:00 PM	-57						
2001/12/21	11:00:00 PM	-67						
2001/12/24	11:00:00 AM	-55						
2001/12/30	06:00:00 AM	-58						

Table S1. Storm classifications for 2001 as a year of strong solar activity. We distinguish moderate ($-50 \text{ nT} > \text{minimum of Dst} > -100 \text{ nT}$), intense ($-100 \text{ nT} > \text{minimum Dst} > -250 \text{ nT}$), and super-storm (minimum of $\text{Dst} < -250 \text{ nT}$) events.

Parents of SYM-H ($k = 100$)			
Parent (τ [20 min.])	$I_{\text{Par} \rightarrow \text{SYM-H}}$ [nats]	$I_{\text{AL} \rightarrow \text{SYM-H}}$ [nats]	p -value
No conds.		0.1569	$< 10^{-2}$
SYM-H (-1)	2.2162	0.0336	$< 10^{-2}$
+ B_Z (-2)	0.0479	0.0069	$< 10^{-2}$
+ P_{dyn} (-1)	0.0126	0.0018	$< 10^{-2}$
+ V_{sw} (-2)	0.0077	0.0010	0.145
+ B_Z (-1)	0.0016		
Parents of AL ($k = 100$)			
Parent (τ [20 min.])	$I_{\text{Par} \rightarrow \text{AL}}$ [nats]	$I_{\text{SYM-H} \rightarrow \text{AL}}$ [nats]	p -value
No conds.		0.1330	$< 10^{-2}$
AL (-1)	1.1489	0.0079	$< 10^{-2}$
+ B_Z (-1)	0.0865	0.0052	$< 10^{-2}$
+ AL (-4)	0.0125	0.0051	$< 10^{-2}$
+ V_{sw} (-6)	0.0136	0.0025	0.035
+ B_Z (-2)	0.0078	0.0018	0.060
+ B (-1)	0.0045		
+ P_{dyn} (-1)	0.0026		

Table S2. As in Tab. 1, but for a nearest-neighbor CMI estimation parameter $k = 100$, i.e., with a stronger smoothing of the densities.

Parents of SYM-H ($k = 50$)			
Parent (τ [20 min.])	$I_{\text{Par} \rightarrow \text{SYM-H}}$	$I_{\text{AE} \rightarrow \text{SYM-H}}$	p -value
No conds.		0.1527	$< 10^{-2}$
SYM-H (-1)	2.2092	0.0395	$< 10^{-2}$
+ B_Z (-2)	0.0571	0.0100	$< 10^{-2}$
+ P_{dyn} (-1)	0.0164	0.0032	$< 10^{-2}$
+ V_{sw} (-2)	0.0094	0.0016	0.405
Parents of AE ($k = 50$)			
Parent (τ [20 min.])	$I_{\text{Par} \rightarrow \text{AE}}$	$I_{\text{SYM-H} \rightarrow \text{AE}}$	p -value
No conds.		0.1281	$< 10^{-2}$
AE (-1)	1.2574	0.0074	$< 10^{-2}$
+ B_Z (-1)	0.1088	0.0074	$< 10^{-2}$
+ B_Z (-3)	0.0093	0.0050	$< 10^{-2}$
+ B (-2)	0.0085	0.0045	0.015
+ V_{sw} (-6)	0.0177	0.0036	0.030
+ SYM-H (-1)	0.0036		

Table S3. As in Tab. 1, but for another substorm index (AE) and $k = 50$.

Parents of SYM-H ($k = 100$)			
Parent (τ [20 min.])	$I_{\text{Par} \rightarrow \text{SYM-H}}$	$I_{\text{AE} \rightarrow \text{SYM-H}}$	p -value
No conds.		0.1469	$< 10^{-2}$
SYM-H (-1)	2.2162	0.0382	$< 10^{-2}$
+ B_Z (-2)	0.0479	0.0079	$< 10^{-2}$
+ P_{dyn} (-1)	0.0125	0.0024	$< 10^{-2}$
+ V_{sw} (-2)	0.0077	0.0012	0.125
+ B_Z (-1)	0.0016		
Parents of AE ($k = 100$)			
Parent (τ [20 min.])	$I_{\text{Par} \rightarrow \text{AE}}$	$I_{\text{SYM-H} \rightarrow \text{AE}}$	p -value
No conds.		0.1205	$< 10^{-2}$
AE (-1)	1.2673	0.0067	$< 10^{-2}$
+ B_Z (-1)	0.1056	0.0060	$< 10^{-2}$
+ B (-1)	0.0102	0.0045	$< 10^{-2}$
+ V_{sw} (-6)	0.0174	0.0026	0.080

Table S4. As in Tab. 1, but for another substorm index (AE) and $k = 100$.