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Supplementary Information

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Direct evidence of secondary reconnection inside filamentary

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currents of magnetic flux ropes during magnetic reconnection

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Events	Time	L (GSE)	M (GSE)	N (GSE)	Crossing
E1	09:01:05.0~09:01:06.0	(0.88,-0.47,-0.01)	(0.25,0.50,-0.83)	(0.39,0.73,0.56)	X-line
E2	09:01:15.9~09:01:16.2	(0.69,0.71,0.13)	(-0.61,0.67,-0.43)	(-0.40,0.22,0.89)	X-line
E3	09:01:18.57~09:01:18.89	(-0.92,0.05,0.39)	(-0.18,0.82,-0.55)	(-0.35,-0.57,-0.74)	X-line
E4	09:01:19.2~09:01:20.1	(-0.70,0.69,0.16)	(0.38,0.56,-0.73)	(-0.60,-0.45,-0.66)	X-line
E5	09:01:02.1~09:01:02.7	(-0.29,0.74,0.61)	(-0.34,-0.67,0.66)	(0.89,-0.02,0.45)	exhaust
E6	09:01:03.43~09:01:03.68	(0.96,-0.16,0.23)	(0.26,0.81,-0.53)	(-0.10,0.57,0.82)	exhaust
E7	09:01:04.5~09:01:04.7	(-0.87,-0.44,-0.22)	(-0.26,0.79,-0.56)	(0.42,-0.43,-0.80)	exhaust
E8	09:01:17.2~09:01:17.9	(0.99,0.07,0.08)	(-0.04,0.96,-0.28)	(-0.10,0.27,0.96)	exhaust
E9	09:01:21.6~09:01:22.5	(-0.19,-0.89,0.41)	(-0.67,0.42,0.61)	(-0.72,-0.16,-0.68)	exhaust

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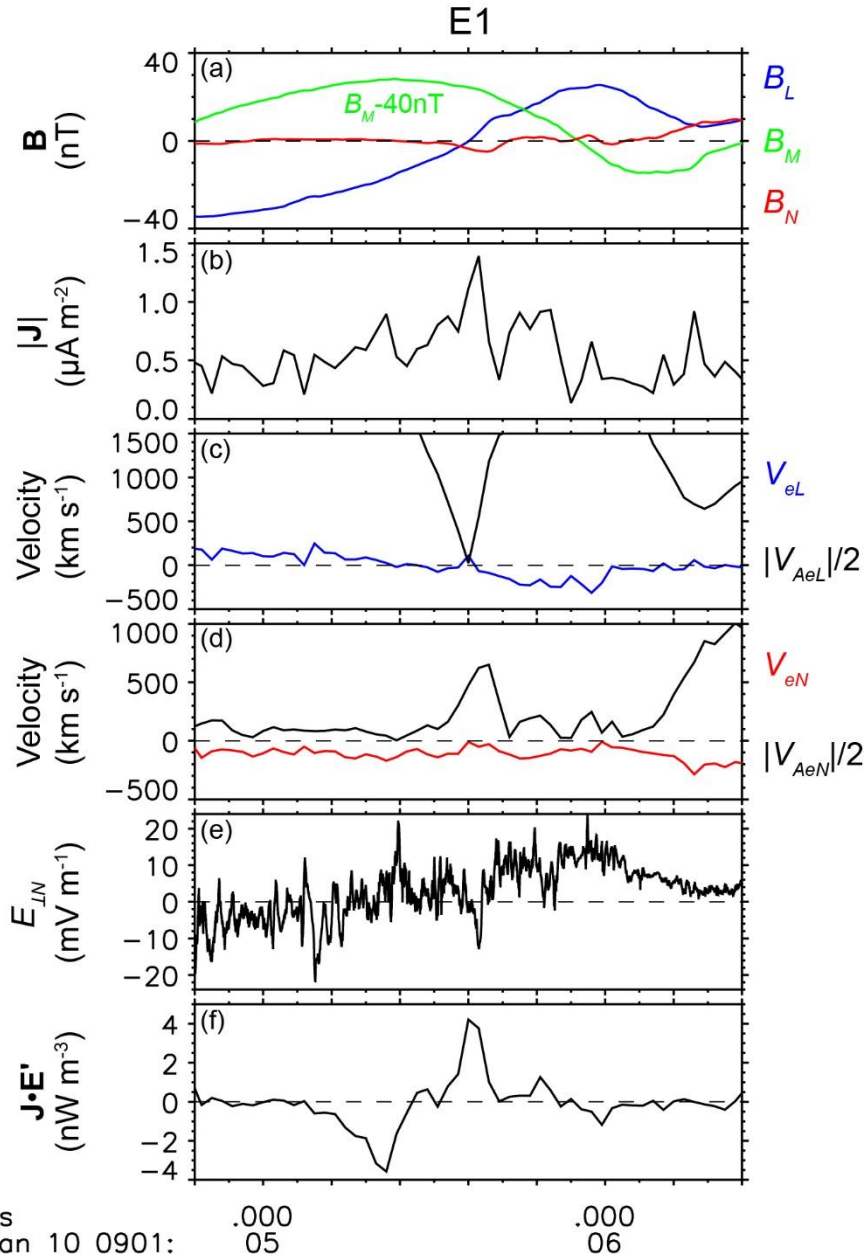
6 **Supplementary Table 1. The time intervals and local current coordinate systems**
7 **for all of the identified reconnection events.**

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Events	Time	Velocity (km/s)	Duration (s)	half-thickness (d_i)
E1	09:01:05.0~09:01:06.0	130.8*(0.062,0.004,-0.998) _{LMN}	1.0	1.4
E2	09:01:15.9~09:01:16.2	82.3*(-0.083,-0.145,-0.986) _{LMN}	0.3	0.3
E3	09:01:18.57~09:01:18.89	106.3*(-0.286,0.013,0.958) _{LMN}	0.32	0.4
E4	09:01:19.2~09:01:20.1	129.0*(-0.020,-0.483,-0.876) _{LMN}	0.9	1.3
E5	09:01:02.1~09:01:02.7	114.2*(0.155,-0.203,0.967) _{LMN}	0.6	0.8
E6	09:01:03.43~09:01:03.68	124.4*(0.149,-0.307,-0.940) _{LMN}	0.25	0.3
E7	09:01:04.5~09:01:04.7	111.7*(-0.159,-0.039,0.987) _{LMN}	0.2	0.2
E8	09:01:17.2~09:01:17.9	139.1*(-0.125,-0.273,-0.954) _{LMN}	0.7	1.1
E9	09:01:21.6~09:01:22.5	97.1*(-0.140,0.006,-0.990) _{LMN}	0.9	1.0

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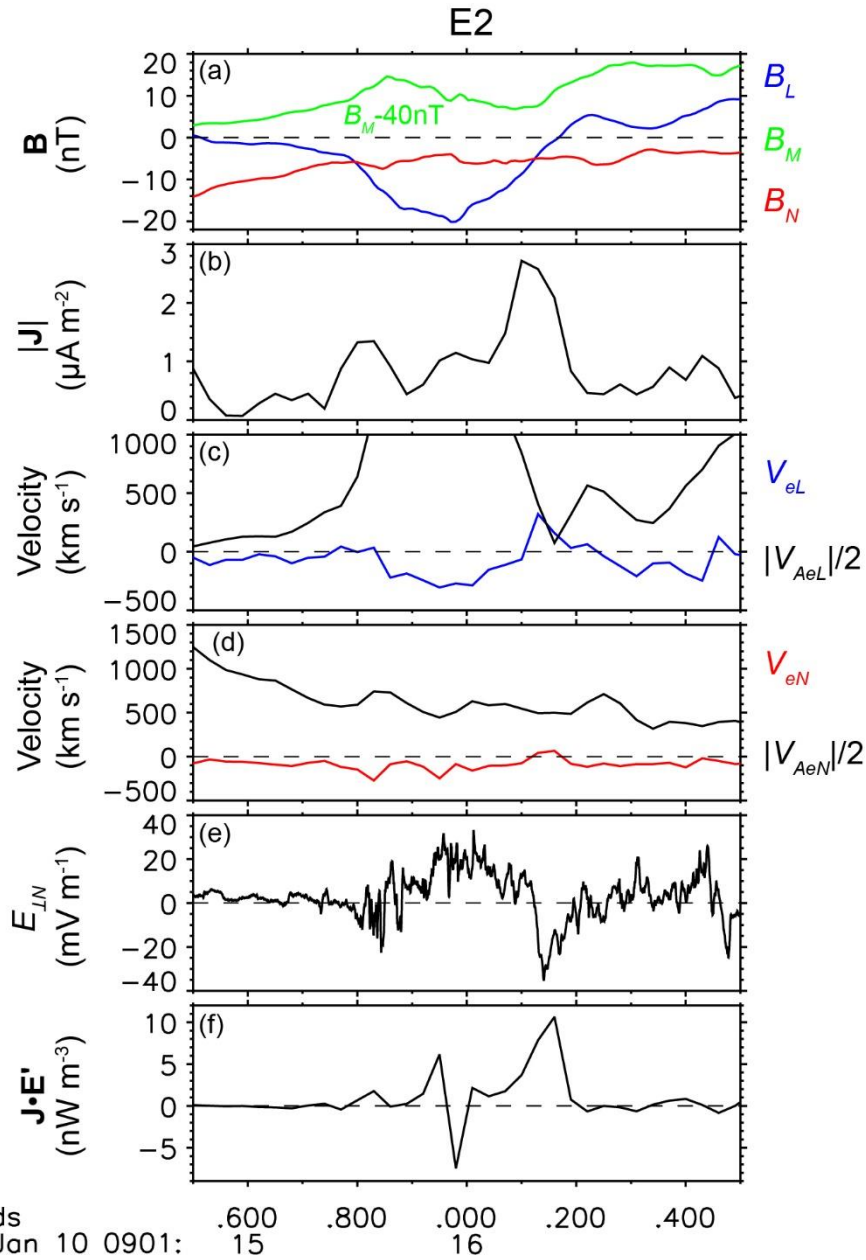
10 **Supplementary Table 2. The velocities and durations for all of the identified**
11 **reconnection events.**



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13 **Supplementary Figure 1 | Observations of the secondary reconnection sites E1. (a),**
 14 magnetic field B_{LMN} . **(b),** the total current density intensity. **(c),** electron bulk velocity
 15 and the half local electron Alfvén speed along the **L** direction. **(d),** electron bulk
 16 velocity and the half local electron Alfvén speed along the **N** direction. **(e),**
 17 perpendicular electric field in the **N** direction. **(f),** $\mathbf{J} \cdot \mathbf{E}' = \mathbf{J} \cdot (\mathbf{E} + \mathbf{V}_e \times \mathbf{B})$.

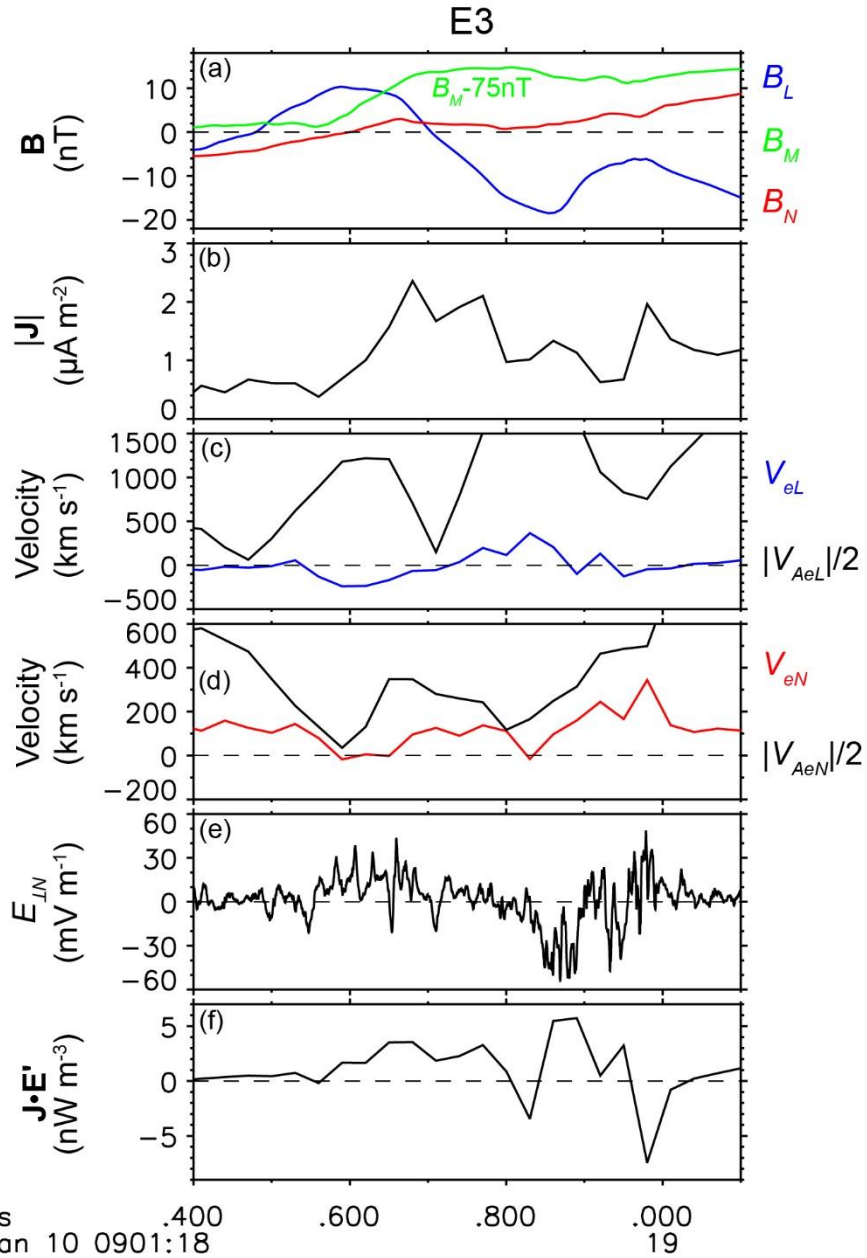
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20 **Supplementary Figure 2 | Observations of the secondary reconnection sites E2. (a)-**

21 **(f)**, the data are shown in the same format as in Supplementary Figure 1.

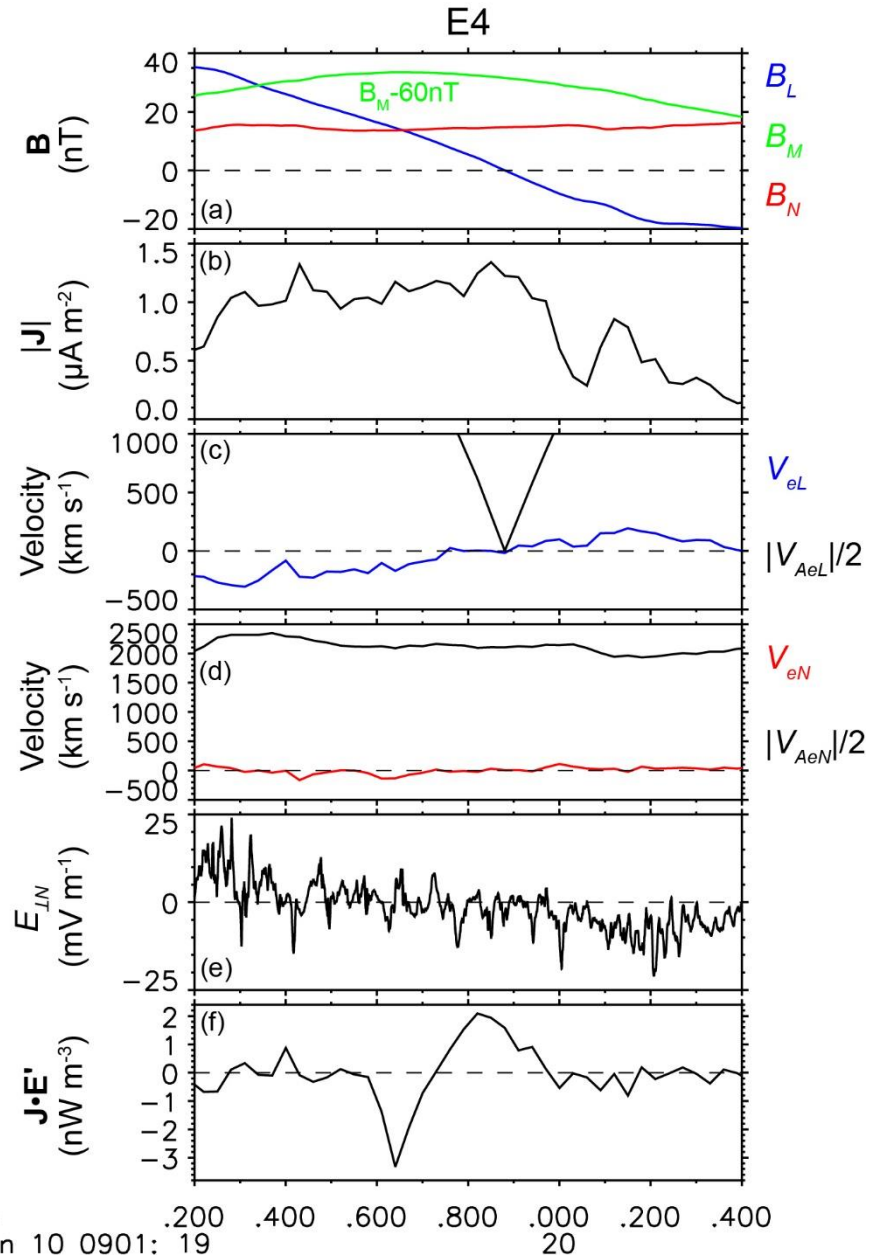


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23 **Supplementary Figure 3| Observations of the secondary reconnection sites E3. (a)-**

24 **(f)**, the data are shown in the same format as in Supplementary Figure 1.

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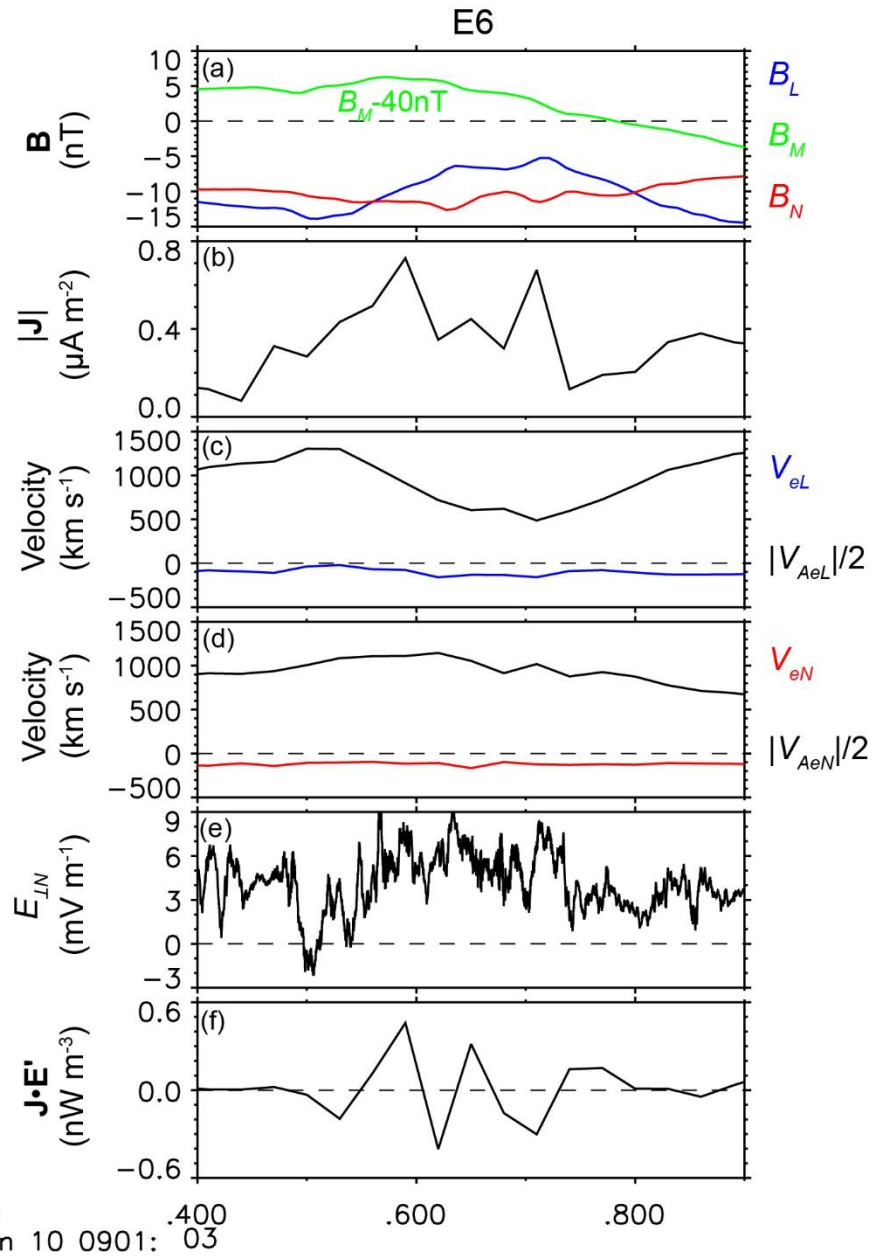


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27 **Supplementary Figure 4| Observations of the secondary reconnection sites E4. (a)-**

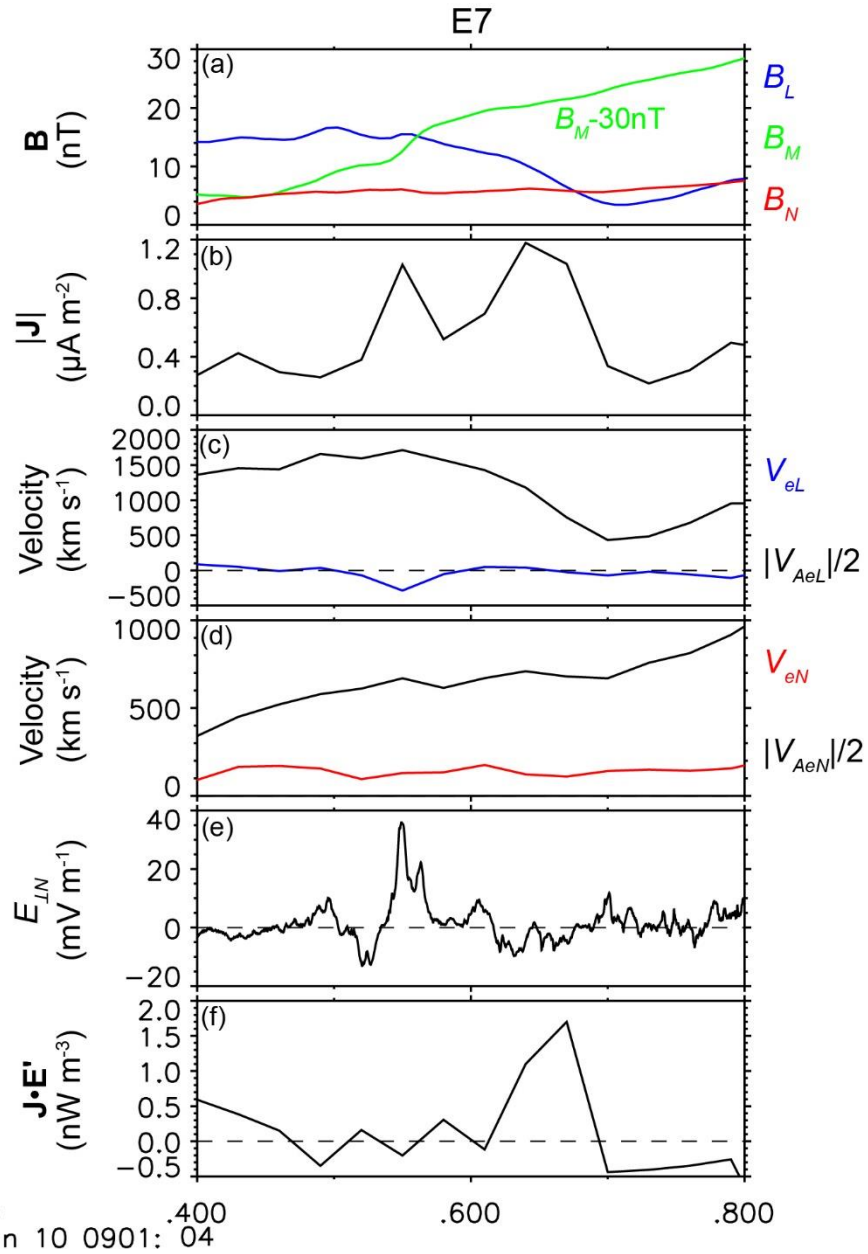
28 **(f)**, the data are shown in the same format as in Supplementary Figure 1.

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34 **Supplementary Figure 6 | Observations of the secondary reconnection exhaust E6.**

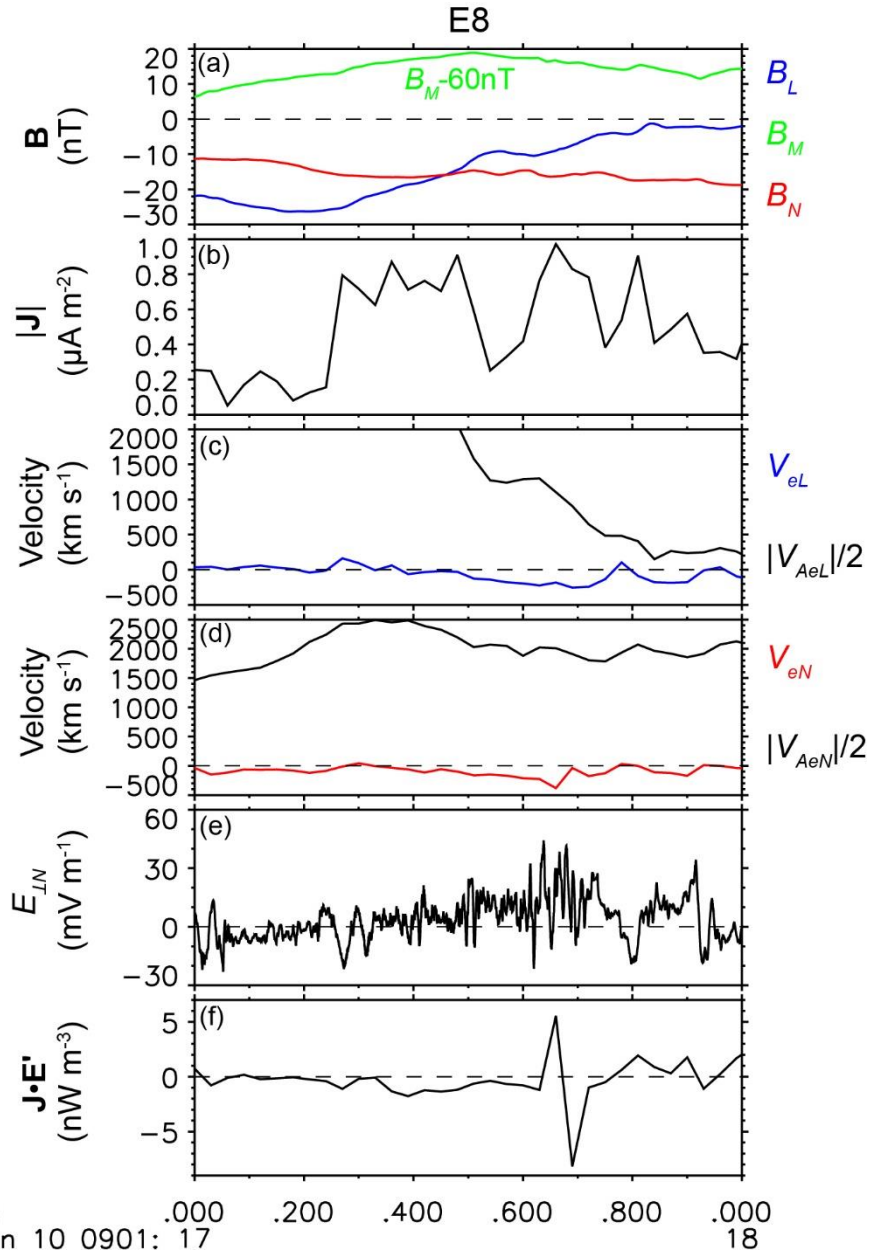
35 **(a)-(f)**, the data are shown in the same format as in Supplementary Figure 1.



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37 **Supplementary Figure 7 | Observations of the secondary reconnection exhaust E7.**

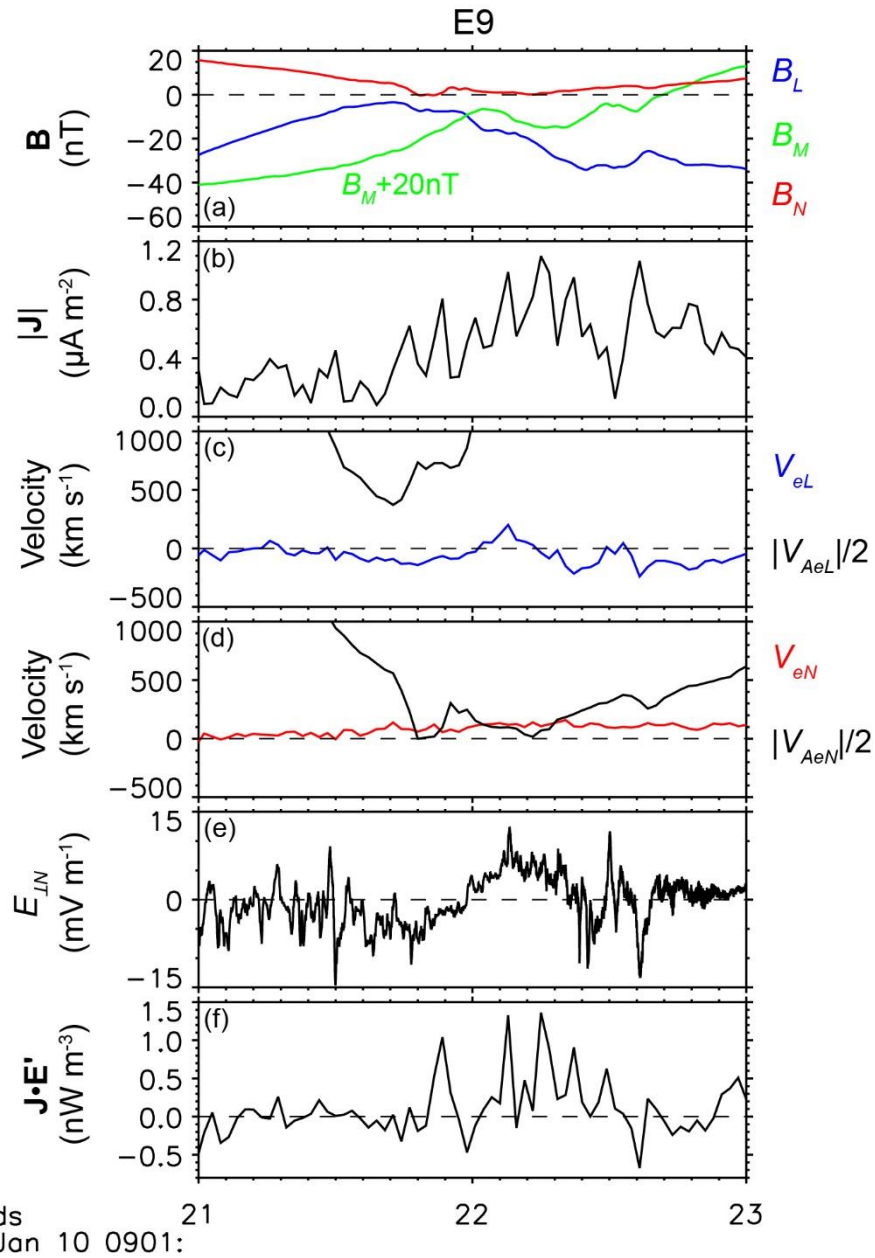
38 (a)-(f), the data are shown in the same format as in Supplementary Figure 1.



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40 **Supplementary Figure 8 | Observations of the secondary reconnection exhaust E8.**

41 **(a)-(f)**, the data are shown in the same format as in Supplementary Figure 1.



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43 **Supplementary Figure 9 | Observations of the secondary reconnection exhaust E9.**

44 **(a)-(f)**, the data are shown in the same format as in Supplementary Figure 1.