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ERRATUM | OPEN ACCESS

The Interplanetary and Magnetospheric causes of Geomagnetically Induced Currents (GICs) > 10 A in the Mäntsälä Finland Pipeline: 1999 through 2019 – Erratum

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Abstract – In this erratum we rectify the parts of the paper that were not corrected before the publication of the paper. The conclusions of the paper are unchanged.

Keywords: GIC / Supersubstorm / Plasma Parcel / Shock / ICME / Superstorm / Errata / Addenda

In Section 3, last sentence of the penultimate paragraph on page 4, the onset "shock/SSS" should be replaced by "PP/SSS", thus reading:

> Figure 3 shows the second Halloween magnetic storm on days 303–304 of year 2003. A sheath Bs upstream of an ICME causes a superstorm of intensity *SYM-H* = −432 nT. A solar wind density spike (PP) at ~1949UT (2249 LT) caused a SI^+ of 61 nT and triggered a short duration *SSS* of *SML* = −3872 nT. A GIC of 49 A occurred at the time of the **PP**/SSS onset.

On the next paragraph, a sentence is missing:

> A second short duration SML = −2724 nT SSS occurred in the storm main phase. It is associated with a double GIC event with peaks of 33 A and 27 A. There are two clusters of GICs with > 10 A intensities in the storm recovery phase. They are associated with substorm intervals of peak *SML* intensities of −1821 nT and −797 nT, respectively. In the first cluster there is a GIC of 30 A at 0213 UT on day 304. **A PP occurred nearly time-coincident with the GIC**. In the second cluster there is a 27 A GIC at 0536 UT on day 304. There is another GIC cluster, well after storm recovery, with 16 A at 1119 UT, 19 A at 1152 UT, 14 A at 1227 UT and 16 A at 1246 UT on day 304.

In Section 3.2, second paragraph of the section, page 8, a miss numbering has not been rectified:

> Figure 10 and Table 1 give the detailed information of all Mäntsälä GICs with > 30 A intensities. There are only 21 > 30 A GIC events in the 21-year study period. Thus, these events are quite rare. One of these > 30 A events was related to a shock and **five** were related to ram pressure increases caused by PPs. Figure 10 gives the information in a graphic format and Table 1 in a tabular form. The plot format in Figure 10 is the same as for Figure 9 but here all > 30 A GICs are shown independent of whether they were shock-related or not.

This correction should have also been added in the first paragraph of Sect. 4.2, page 10:

> From Table 1, it is noted that **5** out of the 21 Mäntsälä > 30 A GICs were due to PPs. PPs being time-coincident with Mäntsälä GICs is a new discovery. PPs are the second most geoeffective interplanetary cause (after substorms) for > 30 A GICs. Why were these PPs more geoeffective than shocks? The plasma density increase across a shock is a maximum of ~4 (Kennel et al., 1985), but statistically only a factor of 1–3 (Tsurutani & Lin, 1985). Several of the geoeffective PPs were noted to have considerably higher density increases than ~4.
> In Table 1, in first row (for 197/2000) corresponding to Shock/PP column, **PP** should be replaced by **No**.

Page 13, the reference Tsurutani et al. (2015), the title of the article should be changed to:

> Tsurutani BT, Hajra R, Echer E, Gjerloev JW. 2015. Extremely intense (SML $\leq$ −**2500** nT) substorms:

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Table 1. Details of the GIC > 30 A events under study.

Day/year	LT	GIC peak (A)	SYM-H peak (nT)	SML peak (nT)	Nsw (cm^{-3})	Shock/No	Sheath	MC
197/2000	2302	30	−347	−3077	20.6	No	No	Yes
310/2001	0453	32	−320	−2301		Shock	Yes	No
328/2001	1014	32	−233	−3839	65.0	No	No	No
302/2003	0946	33	−390	−3548		No	Yes	No
302/2003	0957	57	−390	−3548		No	Yes	No
302/2003	1003	51	−390	−3548		No	Yes	No
302/2003	1027	51	−390	−3548		No	Yes	No
303/2003	0130	30	−390	−2729		No	No	Yes
303/2003	0410	36	−390	−2340		No	No	Yes
303/2003	2309	49	−432	−3872	3.0	PP	Yes	No
304/2003	0019	33	−432	−2724	3.0	PP	Yes	No
304/2003	0513	30	−432	−807	3.0	PP	No	Yes
312/2004	0231	35	−392	−2071		No	No	Yes
314/2004	2251	43	−282	−2324		No	No	Yes
314/2004	2253	31	−282	−2324		No	No	Yes
314/2004	2322	42	−282	−2324		No	No	Yes
314/2004	2325	31	−282	−2324		No	No	Yes
075/2012	2001	38	−79	−1753	12.0	PP	Yes	No
075/2012	2003	39	−79	−1753	12.0	PP	Yes	No
076/2013	2105	32	−131	−990		No	Yes	No
251/2017	2055	30	−115	−1223		No	No	Yes

isolated events that are externally triggered? *Ann Geophys* 22: 519–524. https://doi.org/10.5194/angeocom-33-519-2015.

In the Appendix, page 19, in the *Days 303–304* paragraph, a sentence is missing:

Days 303–304 (30–31 October), 2003 (Fig. A27). This event was previously discussed in Results section (Fig. 3). The second "Halloween" superstorm. A sheath Bs upstream of an ICME causes the second October Halloween storm of intensity *SYM-H* = −432 nT. A solar wind density spike (PP) at ~1949 UT (2249 LT) (denoted by the SI+ of ~61 nT) created a GIC of 49 A and a short-duration SSS of amplitude *SML* = −3872 nT. Mäntsälä was in the midnight sector at the time. **Another PP at 0213 UT day 204 caused a 30 A GIC.** A second short-duration *SML* = −2724 nT SSS occurred in the storm main phase. It is associated with a double GIC of 33 and 27 A. There are two clusters of GICs with > 10 A intensities in the storm recovery phase. They are associated with substorm intervals of peak intensities of *SML* = −1821 and −797 nT, respectively. In the first cluster there is a GIC of 30 A at 0213 UT on day 304. In the second cluster there is a 27 A GIC at 0536 UT day 304. There is a fourth GIC cluster with 16 A at 1119 UT, 19 A at 1152 UT, 16 A at 1119 UT, 14 A at 1227 UT and 16 A at 1246 UT. There were 90 GICs > 10 A and 3 GICs > 30 A.

References

Tsurutani BT, Hajra R, Echer E, Gjerloev JW. 2015. Extremely intense (SML ≤ −2500 nT) substorms: isolated events that are externally triggered? *Ann Geophys* **22**: 519–524. https://doi.org/10.5194/angeocom-33-519-2015.

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