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**<sup>1</sup> The effect of diamagnetic drift on motion of the  
<sup>2</sup> dayside magnetopause reconnection line**

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3 Magnetic reconnection at the magnetopause occurs with a large density  
4 asymmetry and for a large range of magnetic shears. In these conditions, a  
5 motion of the X-line has been predicted in the direction of the electron dia-  
6 magnetic drift. When this motion is super-Alfvenic, reconnection should be  
7 suppressed. We analysed a large dataset of Double Star TC-1 dayside mag-  
8 netopause crossings, which includes reconnection and non-reconnection events.  
9 Moreover, it also includes several events during which TC-1 is near the X-  
10 line. With these close events we verified the diamagnetic suppression con-  
11 dition with local observations near the X-line. Moreover, with the same close  
12 events we also studied the motion of the X-line along the magnetopause. It  
13 is found that, when reconnection is not suppressed, the X-line moves north-  
14 ward or southward according to the orientation of the guide-field, which is  
15 related to the interplanetary magnetic field  $B_Y$  component, in agreement with  
16 the diamagnetic drift.

## 1. Introduction

17 Magnetic reconnection between the interplanetary magnetic field (IMF) and the geo-  
 18 magnetic field is the main process that allows the transfer of solar wind mass, energy,  
 19 and momentum into the Earth's magnetosphere. One of the most important controlling  
 20 factors for magnetic reconnection at the magnetopause is the orientation of the IMF; for  
 21 pure northward IMF antiparallel reconnection occurs at the high-latitude magnetopause  
 22 poleward of the cusps; when the IMF is southward and/or has a large  $B_Y$  component,  
 23 reconnection occurs at the dayside equatorial magnetopause. In this region several ob-  
 24 servations have shown that the orientation of the X-line is related to the sign of the  $B_Y$   
 25 component, as predicted by the component merging model [Sonnerup, 1974; Gonzales &  
 26 Mozer, 1974]. It is found that reconnection at the dayside magnetopause can occur also  
 27 when the local magnetic shear angle is quite low ( $90^\circ$  or less), i.e. in presence of a strong  
 28 guide field [Scurry & Russell, 1994; Phan & Paschmann, 1996; Trenchi et al., 2008].

29 In these low shear conditions, according to the simulations of Swisdak et al. [2003] the  
 30 X-line should experience a motion along the magnetopause due to the diamagnetic drift  
 31 of ions and electrons. If this X-line motion exceeds the local Alfvén speed, reconnection is  
 32 suppressed. Swisdak et al. [2010] proposed that reconnection is suppressed based on the  
 33 local conditions at the X-line, if:

$$\Delta\beta > 2\frac{L_p}{d_i}\tan\left(\frac{\theta}{2}\right) \quad (1)$$

34 Where  $\Delta\beta$  is the  $\beta$  difference across the current sheet,  $\theta$  the magnetic shear angle, and  
 35  $\frac{L_p}{d_i}$  is the pressure scale length in units of ion inertial length. At the dayside magnetopause,

36 near the magnetic equator where the X-line is expected to lie [Trattner et al., 2007],  $\frac{L_p}{d_i}$   
 37 should be approximately equal to unity [Berchem & Russell, 1982]. With this assumption,  
 38 equation 1 becomes  $\Delta\beta > 2 \tan\left(\frac{\theta}{2}\right)$ . When this equation is satisfied, reconnection should  
 39 be suppressed by diamagnetic drift.

40 This process can explain why reconnection events are more often observed when the  $\beta$   
 41 values in the adjacent magnetosheath are lower [Paschmann et al., 1986; Scurry & Russell,  
 42 1994; Phan & Paschmann, 1996; Trenchi et al., 2008]. Indeed, the magnetopause crossings  
 43 without reconnection signatures (non-reconnection events) recently examined by Phan et  
 44 al. [2013] generally satisfy the equation 1, while the opposite inequality usually held for  
 45 reconnection events. This process can also be important in the magnetopause of other  
 46 planets [Masters et al., 2012; DiBraccio et al., 2013].

47 In this paper, we analyzed a large dataset (207) of Double Star TC-1 magnetopause  
 48 crossings [Trenchi et al., 2008], which comprise both non-reconnection and reconnection  
 49 events. We verify the results of Phan et al. [2013], that the reconnection and non-  
 50 reconnection events are well-ordered by the Swisdak et al. [2010] relation. However, while  
 51 in previous studies the suppression condition was evaluated on the expectation that the  
 52 X-line was not too far away from the spacecraft, here we test the condition with the local  
 53 conditions at the X-line by separately considering a subset of events during which TC-1  
 54 observes a reversal in the jet direction, indicating that TC-1 was very close to the X-line.

55 Moreover, the main result of our paper is that by considering the latter subset, we are  
 56 able to demonstrate statistically that the motion of the X-line along the magnetopause  
 57 is controlled by the orientation of the guide-field. This verifies a second prediction made

58 by Swisdak et al. [2010]; in their simulation, when the local  $\Delta\beta$  and  $\theta$  are in the non-  
 59 suppressed regime, the X-line moves in the direction of the diamagnetic drift of electrons.  
 60 Since the pressure gradient at the dayside magnetopause is directed outward, this results  
 61 in the motion of the X-line being controlled by the orientation of the guide field, i.e. by  
 62 the  $B_Y$  GSM component of the IMF.

## 2. The Double Star TC-1 dataset

63 This Double Star TC-1 dataset, first examined to study the occurrence of reconnection  
 64 at the magnetopause, comprises all the dayside magnetopause crossings observed by TC-1  
 65 during the first year of the mission [Trenchi et al., 2008, 2009]. It is based on the plasma  
 66 moments computed onboard from the Hot Ion Analyzer (HIA) [Rème et al., 2005] and  
 67 magnetic field data measured by the Fluxgate Magnetometer (FGM) [Carr et al., 2005],  
 68 both with four second time resolution.

69 In order to identify the reconnection events, we used the Walén relation and, as an  
 70 example, we show an inbound magnetopause crossing in Figure 1. The first four panels  
 71 display the ion density, velocity and temperatures and the magnetic field vector. For  
 72 each data point in this time interval, we compared the observed velocity jump relative  
 73 to a reference value in the magnetosheath ( $V - V_{MSH}$ ) with the expected velocity jump  
 74 predicted by the Walén relation (Equation (1) of Trenchi et al. [2008]). The magnetosheath  
 75 reference period is indicated by yellow shading. Comparing these two vectors, we obtained  
 76 the two parameters used to evaluate the agreement of the Walén relation:  $R_W$  as the ratio  
 77 of their absolute values and  $\Theta_W$  as their relative angle, shown in the last two panels of  
 78 figure 1.

79 The Walén test is perfectly fulfilled when  $R_W$  equals unity and  $\Theta_W$  equals  $0^\circ$  or  $180^\circ$ ,  
 80 corresponding to the positive or negative signs of the Walén relation that at the dayside  
 81 magnetopause correspond to observations northward or southward of the X-line. In this  
 82 study we considered that the Walén relation is satisfied when  $R_W > 0.4$  and  $\Theta_W < 30^\circ$   
 83 or  $\Theta_W > 150^\circ$ , for at least three consecutive data points, with average ion density larger  
 84 than  $1\text{cm}^{-3}$  [Trenchi et al., 2008]. This test indicates the presence of reconnection jets at  
 85 the magnetopause or in the boundary layer. These criteria are meaningless when satisfied  
 86 during magnetosheath intervals; therefore magnetosheath periods are excluded.

87 In this example, TC-1 crosses the magnetopause several times between 6:50 and 07:12  
 88 UT, and later it has other encounters with the boundary layer. While in the first part of  
 89 the event TC-1 detects northward and dawnward jets ( $\Theta_W < 30^\circ$ , blue shadings), after  
 90 7:13 UT, it detects southward and duskward jets ( $\Theta_W > 150^\circ$ , pink shadings). This  
 91 magnetopause crossing is classified as two-sided reconnection event, since TC-1 passes  
 92 from northward to southward of the reconnection X-line, indicating it is very close to the  
 93 spacecraft.

94 On the contrary, during other magnetopause crossings, called one-sided reconnection  
 95 events, TC-1 detects reconnection jets that satisfy the Walén relation, but it remains on  
 96 the same side of the X-line. Finally, during the non-reconnection events, no reconnection  
 97 jet that satisfies the Walén relation is observed during the entire crossing. Overall, this  
 98 database consists of 110 one-sided reconnection events, 33 two-sided reconnection events  
 99 and 64 non-reconnection events, whose positions are shown in figure 2A, in the  $Y - Z_{GSM}$   
 100 plane.

### 3. Diamagnetic suppression of magnetic reconnection

101 For each of the TC-1 crossings, we identified a reference in the magnetosheath and  
 102 another in the magnetosphere, both adjacent to the magnetopause, where we evaluated  
 103 the average values of the ion pressure (as the trace of the pressure tensor measured by  
 104 HIA) and the average magnetic field vectors. The plasma  $\beta$  in the Swisdak equation is  
 105 the total  $\beta$  that includes both the ion and the electron pressures. However, the dayside  
 106 magnetosheath is characterized by a large ion-to-electron temperature ratio ( $\frac{T_i}{T_e}$ ), in the  
 107 range 6-12 [Paschmann et al., 1993; Phan et al., 1994]. The same large ( $\frac{T_i}{T_e}$ ) is also  
 108 expected in the boundary layer, since it is related to the one in the adjacent magnetosheath  
 109 [Lavraud et al., 2009]. Assuming quasi-neutrality, the ion and electron densities should be  
 110 very similar. Therefore, it is expected that the ion pressure dominates over the electron  
 111 pressure in these regions. For this reason, we evaluated the average total  $\beta$  from the ion  
 112 pressure, assuming that the electron pressures are one eighth of the proton pressures on  
 113 both sides of the magnetopause.

114 As expected, in the majority of cases (97%) the local  $\beta$  in the magnetosheath (MSH)  
 115 is larger than the local  $\beta$  in the adjacent magnetosphere (MSPH). The few events with  
 116  $\beta_{MSH} < \beta_{MSPH}$  (7/207), are characterized by a lower magnetic field magnitude in the  
 117 magnetosphere with respect to the one in the magnetosheath, while the plasma pressure  
 118 in the magnetosheath is always larger than the one in magnetosphere.

119 Figure 2B shows the scatter plot of the magnetic shear angle ( $\theta$ ) as a function of  
 120  $|\Delta\beta|$  for the three families of events, where  $\theta$  is the angle between the magnetosheath and  
 121 magnetospheric reference magnetic fields. The black lines report the theoretical prediction



122 given by equation 1, in the hypothesis that  $\frac{L_p}{d_i}$  is equal to 1 (continuous line) or 0.5  
123 or 2 (dashed lines). These curves define the two regions of the  $\theta - |\Delta\beta|$  plane where  
124 reconnection should be suppressed (on the right), or where reconnection is possible since  
125 it is not suppressed by the diamagnetic drift (on the left).

126 If we look at the non-reconnection events, they are spread across the suppressed and  
127 non-suppressed regions. On the other hand, the majority of the reconnection events lie  
128 in the region where reconnection is not suppressed, satisfying quite well the Swisdak  
129 prediction. Considering the continuous line (1 ion inertial length thickness), 99/110 of  
130 the one-sided reconnection events are in the non-suppressed region, i.e. 10% fall in the  
131 suppressed region. This is a similar proportion to that found by Phan et al. [2013].  
132 However, if we restrict our analysis to the two-sided reconnection events, for which we  
133 can be confident that the spacecraft is near the X-line and hence the observed conditions  
134 are more representative of the conditions at the X-line, all but one of the events (32/33)  
135 is in the non-suppressed region. Therefore, the fraction of reconnection events in the  
136 suppressed region is only 3% (1 event).

137 The presence of non-reconnection events in the region where reconnection should not  
138 be suppressed by diamagnetic drift could indicate that another mechanism, for example  
139 velocity shear [Cassak & Otto, 2011], turned off reconnection at the dayside magnetopause.  
140 Alternatively, pulsed reconnection may have been occurring [Trattner et al., 2015], causing  
141 the reconnection jet to be missed when TC-1 crossed the magnetopause.

142 On the other hand, the one-sided reconnection events in the suppressed region are  
143 not necessary at odds with the Swisdak predictions: these reconnection events could

144 be observed several Earth radii away from the X-line. Taking into account the magnetic  
 145 shear variations along the magnetopause caused by magnetic field draping, the local shear  
 146 obtained for these one-sided events could differ significantly from the shear at the X-line.  
 147 Moreover, according to the maximum shear model [Trattner et al., 2007], the X-line follows  
 148 the position of the local maximum of the shear angle at each local time. In this case, any  
 149 displacement from the X-line would result in the underestimation of shear angle at the  
 150 X-line, which could explain the local  $\theta - |\Delta\beta|$  values in the suppressed region.

151 Another feature that can be noted in figure 2B is that, while several one-sided recon-  
 152 nection events have very low  $|\Delta\beta|$ , the two-sided reconnection events have all  $|\Delta\beta| > 0.1$ ,  
 153 being more concentrated near the theoretical suppression condition of Swisdak. According  
 154 to the diamagnetic drift effect, the X-line velocity increases as the suppression condition  
 155 is approached, and, a larger X-line velocity could explain the passage of the spacecraft  
 156 from one to the other side of the X-line during these two-sided events. This suggests that  
 157 the diamagnetic drift has a role for the motion of the X-line when reconnection is not  
 158 suppressed. In the following section, we use a subset of two-sided reconnection events to  
 159 study the X-line motion along the magnetopause.

#### 4. The motion of the X-line along the dayside magnetopause

160 According to the Swisdak simulations, the X-line should move along the current sheet  
 161 in the direction of the diamagnetic drift of the electrons. The X-line velocity with respect  
 162 to the ion rest frame is given by the sum of the ion and electron diamagnetic drift:

$$V_{XLdrift} = c \frac{\nabla p_i \times \vec{B}_g}{|q_i| n_i B_g^2} + c \frac{\nabla p_e \times \vec{B}_g}{|q_e| n_e B_g^2} \quad (2)$$

163 where  $c$  is the speed of light,  $\vec{B}_g$  is the guide field at the center of the current sheet, while  
 164  $p_i$  and  $p_e$ ,  $q_i$  and  $q_e$ ,  $n_i$  and  $n_e$  are the pressures, charges and densities of ions and electrons,  
 165 respectively. At the dayside magnetopause, where the pressure gradient is outward along  
 166 the magnetopause normal, the direction of the X-line motion is related to the orientation  
 167 of the guide field, which is mainly determined by the  $B_Y$  component of the IMF. Therefore  
 168 the X-line is expected to move northward/southward for duskward/dawnward guide fields  
 169 respectively.

170 The guide field can be evaluated as the projection of the magnetosheath or magneto-  
 171 spheric field along the X-line. For the two-sided reconnection events, we evaluated the  
 172 orientation of the X-line predicted by the component merging model [Sonnerup, 1974;  
 173 Gonzales & Mozer, 1974] from the magnetosheath and magnetospheric fields, which are  
 174 likely to be similar to the fields at the reconnection site. Here we introduce a local refer-  
 175 ence frame, with  $\widehat{N}$  along the Fairfield magnetopause normal [Fairfield, 1971],  $\widehat{XL}$  along  
 176 the X-line orientation with a positive  $Y_{GSM}$  component and  $\widehat{RC}$  (representing the recon-  
 177 necting component), perpendicular to these vectors, with a positive  $Z_{GSM}$  component (see  
 178 figure 3). The X-line orientation is obtained as perpendicular to  $\vec{B}_{MSH} - \vec{B}_{MSPH}$ , where  
 179  $\vec{B}_{MSH}$  and  $\vec{B}_{MSPH}$  are the projections in the plane perpendicular to the Fairfield normal  
 180 of the magnetosheath and magnetospheric fields, respectively.

181 For several two-sided reconnection events, a single passage from northward to southward  
 182 jets, or vice versa, is observed during the entire crossing, such as in the example shown in  
 183 figure 1. In these single passage events we can make the simplifying assumption that the  
 184 X-line velocity does not change direction during the event. On the contrary, other two-

185 sided events are characterized by multiple passages between northward and southward  
 186 jets. This could be due to the presence of multiple X-lines, which could eventually move  
 187 in the same direction, or alternatively to a reversal of the X-line motion. In the former  
 188 case, the formation of FTEs between the multiple X-lines is expected [Lee & Fu, 1985;  
 189 Raeder, 2006; Trenchi et al., 2011; Fear et al., 2012a, b].

190 In figure 2B, the black bars over the cyan dots indicate the two-sided single passage  
 191 events. It is interesting to note that all the two-sided events with low magnetic shear  
 192 ( $\theta < 90^\circ$ ) are characterized by a single passage. In figure 4A we report the distribution of  
 193 the magnitude of  $\vec{B}_g$  for single passage and multiple passage events. In agreement with  
 194 their lower magnetic shear, the single passage events have a much stronger guide field  
 195 compared with the multiple passage events. The average values are  $|\vec{B}_g| = 26 \pm 15nT$   
 196 and  $|\vec{B}_g| = 6 \pm 5nT$  for the single passage and multiple passage events, respectively.  
 197 According to equation 2, a higher guide field would produce a larger X-line velocity,  
 198 which could be responsible for the clear constant motion of the X-line in one direction  
 199 during these single passage events.

200 The direction of the X-line motion can be easily inferred for the single passage events  
 201 from the order in which northward and southward reconnection jets are observed. When  
 202 first northward and then southward reconnection jets are detected, the X-line is moving  
 203 northward with respect to the spacecraft, while it is moving southward when the order of  
 204 the reconnection jets is the opposite. In figure 4B,  $B_g$  as a function of the order in which  
 205 the jets are detected for the single passage events is reported. The blue dots indicate

206 the northward-southward events (N-S), while the red dots are the southward-northward  
207 events (S-N).

208 Our observations show a good agreement with the diamagnetic motion of the X-line: all  
209 the S-N events have a negative  $B_g$ , and all but one of the N-S events have a positive  $B_g$ .  
210 The only N-S event with a negative guide field still has a  $B_g$  very close to zero ( $-0.4nT$ ).  
211 These observations suggest therefore that the diamagnetic drift has a role in the X-line  
212 motion along the magnetopause when the local conditions are not in the suppressed region,  
213 as predicted by the simulations of Swisdak et al. [2003]. We also verified that using other  
214 X-line models [Moore et al., 2002; Swisdak & Drake, 2007; Borovsky, 2013] the orientation  
215 of the guide field  $B_Y$  component do not change. Therefore, the choice of a different X-line  
216 model would not change our findings.

217 The other mechanism that could be responsible for the X-line motion is the convection  
218 from the adjacent magnetosheath. Indeed, a recent study found that during a reconnection  
219 event at high latitude characterized by super-Alfvénic magnetosheath velocity, the X-line  
220 was moving tailward convected by the magnetosheath velocity [Wilder et al., 2014]. We  
221 therefore evaluated the component of the magnetosheath velocity perpendicular to the  
222 X-line ( $V_{MSHRC}$ ), which is the component that could convect the X-line. If the X-line  
223 motion is related to the magnetosheath convection, since the RC axis has a positive  $Z_{GSM}$   
224 component, N-S events should be associated with positive  $V_{MSHRC}$  while S-N events with  
225 negative  $V_{MSHRC}$ . We also estimated the X-line diamagnetic drift velocity predicted by  
226 the Swisdak simulation with equation 2). As for the suppression condition, we assumed

227 that the electron pressures are one eighth of the proton pressures on both sides of the  
 228 magnetopause and  $\frac{L_p}{d_i}$  is equal to 1. The X-line velocity is therefore obtained as:

$$V_{XLdrift} = c \frac{9}{8} \frac{(p_{MSH} - p_{MSPH}) B_g}{d_i | q_i | n_i B_g^2} \hat{R}C \quad (3)$$

229 where  $p_{MSH}$  and  $p_{MSPH}$  are the average proton pressures in magnetosheath and magne-  
 230 tospheric reference, respectively. While these assumptions can certainly introduce errors  
 231 in the values of  $V_{XLdrift}$ , we believe that it can not change its sign, since outward pressure  
 232 gradient at the magnetopause implies that  $p_{MSH} > p_{MSPH}$ .

233 In figure 4C,  $V_{XLdrift}$  as a function of  $V_{MSHRC}$  is reported. Blue and red dots refer  
 234 to N-S and S-N events, for which the velocity of the X-line is northward and southward  
 235 respectively.  $V_{XLdrift}$  better separates the N-S from the S-N events. Indeed, all the S-N  
 236 events are associated with negative  $V_{XLdrift}$  and all but one of the N-S events are associated  
 237 with positive  $V_{XLdrift}$ . On the contrary, five of the N-S events are observed during negative  
 238  $V_{MSHRC}$ , contrary to expectation according to the magnetosheath convection. Therefore,  
 239 it seems that the velocity of the adjacent magnetosheath does not affect the motion of the  
 240 X-line at the dayside magnetopause. However it is interesting to note that the only event  
 241 not in agreement with the diamagnetic drift, the only N-S event with negative  $V_{XLdrift}$ ,  
 242 is the only event with  $V_{MSHRC}$  larger than Alfvén magnetosheath velocity. In this case,  
 243 the magnetosheath convection hypothesis is in agreement with the order of the jets.

## 5. Summary and Conclusions

244 During component reconnection, the diamagnetic drift of ions and electrons causes a  
 245 motion of the X-line along the dayside magnetopause, which is proportional to the local

246 pressure gradient and to the intensity of the guide field at the X-line [Swisdak et al., 2003].

247 If this X-line velocity exceeds the local Alfvén speed, reconnection is suppressed.

248 In order to investigate the effects of diamagnetic drift, we analysed a large dataset of  
249 Double Star TC-1 magnetopause crossings (207) which includes both reconnection events  
250 and magnetopause crossings without reconnection signatures. The reconnection events  
251 were divided into two categories, one where the distance of the spacecraft from the X-line  
252 is unknown (one-sided events, can be also several  $R_E$  from the X-line), the other one where  
253 TC-1 explores both sides of the X-line, being probably very close to the reconnection site  
254 (two-sided events). This latter category allows us to test the suppression condition with  
255 the local conditions at the X-line.

256 We found that most of the reconnection events were observed in the regime where recon-  
257 nection is not predicted to be suppressed by diamagnetic drift. Moreover, the agreement  
258 with the suppression condition further increased when the spacecraft was near the X-line  
259 (97%, or 32/33 of the two-sided events in the non-suppressed region) with respect to the  
260 one-sided events (90% in the non-suppressed region). The fact that the local conditions  
261 at the X-line show such a good agreement with the suppression condition, confirms that  
262 the diamagnetic drift is able to turn off reconnection at the dayside magnetopause.

263 For several two-sided events, we also determined the direction of the X-line motion with  
264 respect to the spacecraft, from the order in which northward and southward reconnection  
265 jets were detected. With these events, we tested if the X-line motion is related to the  
266 diamagnetic drift, which should move the X-line in the direction of the electron drift even  
267 when reconnection is not suppressed [Swisdak et al., 2003]. At the magnetopause, where

268 the pressure gradient is outward, the direction of the X-line motion should be related  
269 to the orientation of the guide field, which is principally determined by the IMF  $B_Y$   
270 component.

271 We found that the direction of the X-line motion is in agreement with the velocity  
272 predicted by the diamagnetic drift for all but one of these events (9/10), which are all  
273 characterized by a non-negligible guide field. The only event not in agreement with the  
274 diamagnetic drift prediction has instead a very small guide field, which results in a small  
275 X-line velocity. On the contrary, the convection hypothesis is not in agreement with the  
276 observations for half of these events. This suggests that, during component reconnection,  
277 the X-line has always a motion along the magnetopause under the effect of diamagnetic  
278 drift. This X-line motion, not considered by the present models that predict the X-line  
279 location, can cause a non-stationary reconnection even for stable solar wind conditions.

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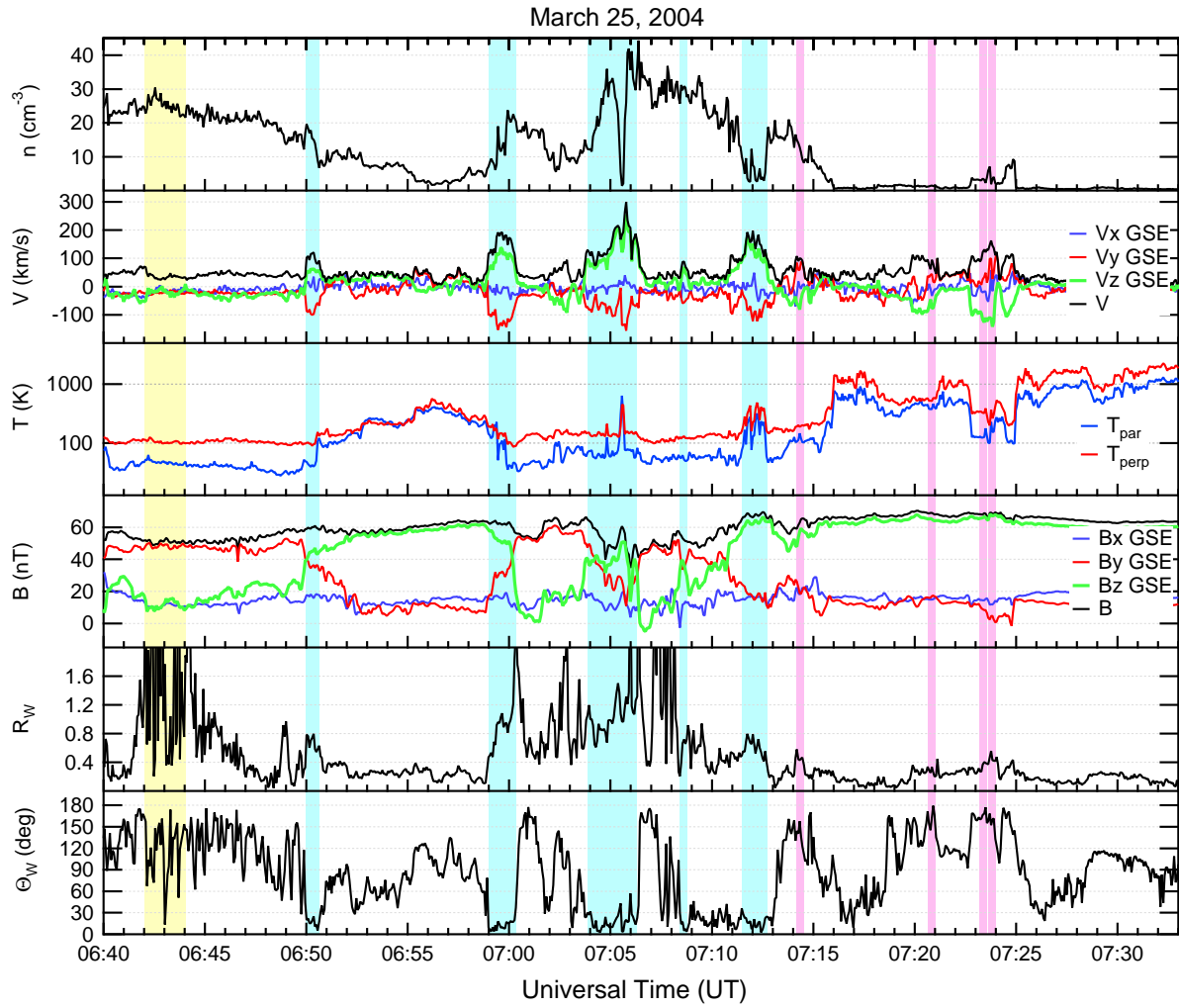
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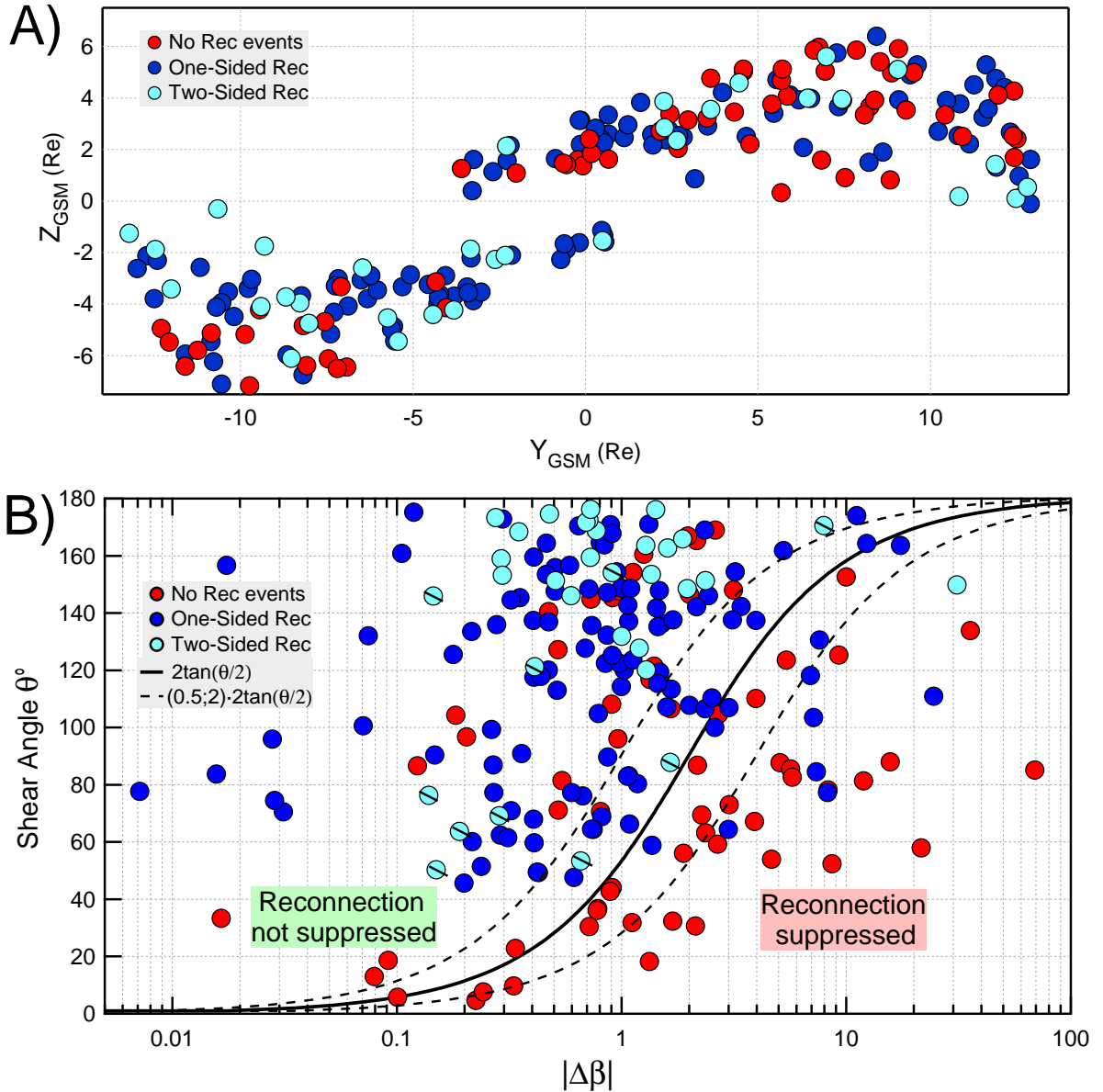
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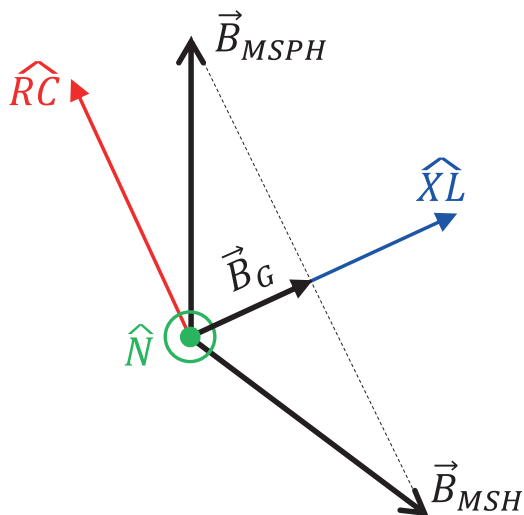


**Figure 1.** An example of magnetopause crossing with reconnection jets. In the top four panels the ion density, velocity, temperatures and the magnetic field vector. The last two panels show the parameters used to evaluate the agreement of the Walén test, that is perfectly fulfilled when  $R_W$  equals unity and  $\Theta_W$  equals  $0^\circ$  or  $180^\circ$ , corresponding to observations northward or southward of the X-line. In this event TC-1 explores both sides of the X-line, observing first northward and then southward reconnection jets, therefore it is classified as a two-sided event.

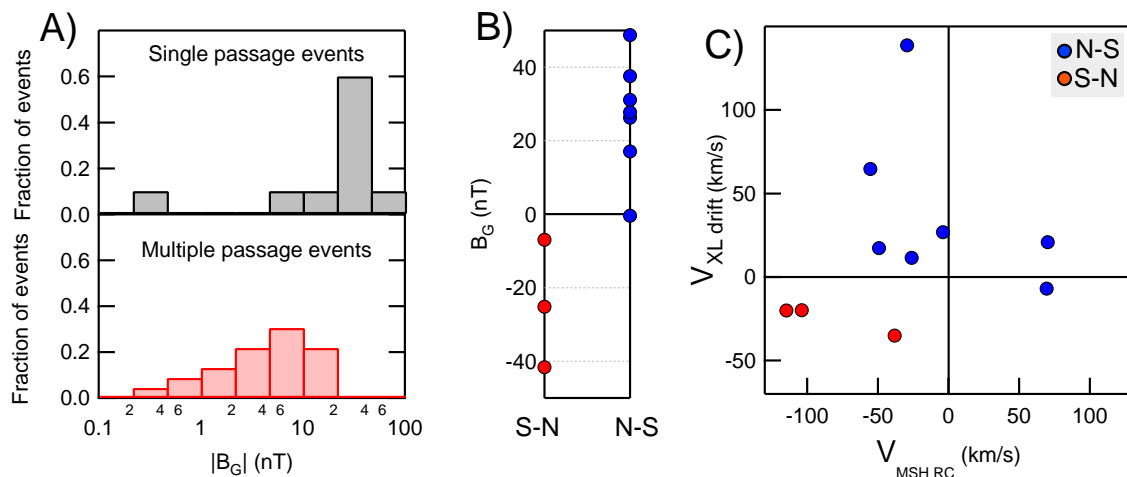


**Figure 2.** Panel A). The positions of the non-reconnection events (red dots), one-sided reconnection events (blue dots) and two-sided reconnection events (cyan dots) in the  $Y - Z_{GSM}$  plane.

Panel B). The magnetic shear angle ( $\theta$ ) as a function of  $|\Delta\beta|$  for the non-reconnection events (red dots), one-sided reconnection events (blue dots) and two-sided reconnection events (cyan dots). The black lines are the prediction for the diamagnetic suppression of reconnection (equation 1), when  $\frac{L_p}{d_i}$  is equal to 1 (continuous line) or 0.5 or 2 (dashed lines). On the right of these curves, reconnection should be suppressed by diamagnetic drift effect, while on the left it should not be suppressed.



**Figure 3.** A scheme of the local X-line reference used to evaluate the guide field component ( $\vec{B}_g$ ) for the two-sided reconnection events.



**Figure 4.** Panel A). The histograms of the magnitude of the guide field component for single passage and multiple passage events.

Panel B).  $B_g$  as a function of the order in which the jets are detected. Panel C). The diamagnetic drift velocity of the X-line as a function of the velocity of the adjacent magnetosheath perpendicular to the X-line. Blue and red dots indicate N-S and S-N events, for which the observed X-line velocity is northward and southward, respectively.