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Interactive comment on "Development of a formalism for computing in situ transits of Earth-directed CMEs. Towards a forecasting tool II" *by* Pedro Corona-Romero and Pete Riley

Anonymous Referee #1

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This paper provides an empirical set of relationships that can be used to predict the in situ profiles of interplanetary coronal mass ejections (CMEs) as they transit through 1 AU (or at the Earth), namely predicting their speed, density, temperature and magnetic field strength time profiles. The method requires input information from coronagraph images and information on the upstream ambient solar wind conditions that the CME is propagating into. The method is tested on a number of example CMEs from the LASCO catalog against corresponding in situ data from the NASA-OMNI data set.

A difficulty I had reading the paper is that the formalism introduced in Section 2 is quite hard to follow, particularly in keeping connected to the physical picture being described,

unless previous papers by the same first author have been read. For example, I found myself quite confused on the meaning of the constants a and c, described simply as related to the inertia of the CME, until I had found and read Appendix A of Corona-Romero et al. (2017) (see reference list in the paper). While some referencing back for the finer details is of course appropriate, I recommend that the authors review and adjust Section 2 from the point of view of a reader encountering this formalism for the first time.

However, the methodology having been established, I found that the remainder of the paper describing the test cases to be a sensible approach and much more straightforward to follow. The method requires fine tuning of four free parameters to optimise the match to the in situ observations and the final section (4.2) of the paper explores how these might be estimated in a forecasting scenario by carrying out a parametric analysis of their relationship to the input observables within the test data set. I found these relationships somewhat tentative as possibly do the authors through their use of phrases such as "is somehow related" and "seems to be related". Nonetheless it would be very interesting to see how these relationships would perform in a test where the in situ data was not already known. Further limitations, if I have understood correctly, are that the methodology only applies to fast CMEs associated with solar flares that produce halo CMEs as viewed from the Earth. Overall I consider that the methods described have the potential to be a useful tool in space weather prediction for appropriate events and I am happy to support publication of this paper subject to minor revisions.

Suggestions and corrections:

Note that many of these refer to English language adjustments – I included these where I noticed them but this was not an exhaustive proof read which should still be carried out by the authors.

Line 21 – would it be worth a mention here that high speed streams are another source

and stating the relative importance of CMEs?

Line 93 – While -> while, and terminate previous line with a comma

Line 100 – roughly -> rough

Line 102 – believe -> believed

Line 107 – make clear that r is the distance from the Sun of the CME centre

Line 126 – on first reading I did not realise straightaway that TT_r was a single variable name.

Line 140 – another -> other

Line 146 – I don't think that the significance of the section of data described by the dotted black lines is ever explained.

Line 153 – TT as marked on the figure is actually the arrival time rather than the travel time – this needs to be rephrased.

Line 157 – list -> lists

Figure 2 – the yellow and green markers may need more emphasis

Line 168 – at in situ -> in situ

Line 181 – there is a missing reference indicated as ?

Line 190 – e.j. -> e.g., also at lines 195 and 200

Line 201 – relation -> a relation

Line 204 – I think you should immediately define b in the text which directly follows Equation 15; at the moment the definition comes a whole paragraph later.

Line 207 – there is a missing word before "by Gulisano", perhaps "reported".

Line 226 – the "accumulative magnetic flux" is discussed in a number of places in the

paper and would benefit from being clearly defined the first time, rather than just relying on the reference.

Table 1 – there is a missing reference in footnote b indicated by ?

Line 257 – currents -> streams

Line 266 – You use the term "aging" quite frequently – please explicitly define what you mean the first time rather than just relying on the reference.

Line 290 – tendency -> dependency, or relationship?

Line 335 – The Figure 7 -> Figure 7

Line 343 – The angular separation described here is not well defined – is it measured back at the Sun? I found the comparison to the work of Jian et al (2006) at the end of the paragraph interesting.

Line 376 – The first sentence of this paragraph is poorly worded – I was not clear on what point it is trying to make.

Line 386 – There is a broken reference to Figure 7.

Line 392 – even with the extra explanation here I was still not clear on the definition of the accumulated magnetic flux.

Line 412 – There is a reference to Figure 8 here – should it still be Figure 7?

Line 417 – The sentence starting "Of course" is poorly worded – I was not clear what it is trying to say.

Line 430 – derived into -> resulted in

Line 438 – the Figure 8 -> Figure 8

Line 447 – CMEs -> the CMEs

Line 469 – There is a missing reference indicated by ?

Line 534 – For -> By

Line 546 – Linquist -> Lundquist (also at line 626); not longer -> no longer

Line 548 – among of others -> among others

Line 565 – it is an -> it is a

Line 577 – simpler -> simple

Line 581 – help in -> help to

Line 596 – We realized -> We note (also at line 633)

Line 617 – Regarding of -> Regarding the

Line 622 – rephrase to “an assumption that contrasts”

Line 643 – for construction -> by construction

Line 657 – of CMEs -> which require to be specified for each CME (?)

Line 660 – of CMEs -> of the CMEs

Line 667 – that relates -> relates

Line 722 – empiric -> empirical

Line 725 – our we -> we

Line 732 – occurred -> which occurred

Line 740 – a curved-like -> curved-like

Line 756 – redaction -> production

Figure 6(c) – In legend, theoric -> theoretical

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