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Comment on angeo-2020-94

Anonymous Referee #2

Referee comment on "Predictability of variable solar–terrestrial coupling" by Ioannis A. Daglis et al., Ann. Geophys. Discuss., <https://doi.org/10.5194/angeo-2020-94-RC2>, 2021

This review paper is well written, informative and timely in its content –especially as interest in space weather science and applications has grown, and on the approach to a new solar maximum.

This referee found the different sections of the review useful, as they were clearly written by experts in their fields. It was particularly good to see that for the most part they included efforts to paint the bigger picture of their areas- generally describing details in that context so a reader could understand why specific details are important. The one exception to this pattern was the discussion of solar energetic particles and shocks, which seemed to dive into details of still active research without having described present understanding and major open questions as a framework. For example, the locations/sources of the important energization processes (flares (reconnection? Waves?) vs. DSA at the interplanetary shocks are still not well sorted out. The importance of suprathermal seed particle populations from small flares, CIRs and previous solar events, of ion composition information, of whether a shock is even necessary for DSA (or is compression sufficient?). Laying the big issues out seems more appropriate in this review than particular authors' specific ideas on details. Then there are the issues associated with the interplanetary transport and the shocks themselves. There is a mix of scatter free and diffusive transport inferred from observations. How can the conditions for these be sorted out? What about coronal/near Sun SEP processes-do the sources map back to flare sites or shocks there? What do we know about the coronal shocks vs interplanetary shocks and what more could/should be learned? What do we know about the shock properties both at their onset and as they travel outward (e.g. their shape, shock normal, associated waves)? What do we still need to know and why does it matter? Finally the interest in GLE generation should be mentioned together with what makes a GLE happen in the first place.

As for discussions in the other sections-these additional questions/comments/suggestions came to mind while reading:

1-There are observational needs as well as knowledge needs. Should the former be

explicitly mentioned?

- The slow solar wind is increasingly found to have much structure-especially in the vicinity of the HCS and stream boundaries. What impacts does this have across the board of the space weather questions? For example Old thinking was that the magnetosphere is a low pass filter-responding mainly to larger scales- with the exception of shocks and HCS crossings. But waves/fluctuations couple into the system in various ways (certain pulsations, cusp entry, etc). What do models and modelers have to worry about including to achieve various goals?
- Regarding the climate connection. There did not seem to be much discussion about the cloud cover hypothesis of sun-climate coupling. While this mechanisms seems to be in disfavor, is it sufficiently interesting that the question should be kept open? Likewise for other aerosol effects like those from dust.
- I thought the occasional mention of the importance of 'memory'/preconditioning in the various areas was important. Should this be called out somewhere as an overarching question/challenge to include?
- Finally, while I like the idea of noting key points at the end- this brings up the question as to whether the sections also each need key points. In any case a more uniform treatment of key points in the sections might be helpful, and/or restricting the concluding key points to over-arching themes rather than specific areas. Putting the latter in a box/table to highlight may also help. In addition, rather than ending the paper on key points, a paragraph describing/summarizing the plan of action going forward would be good.