The authors are proposing that the solar wind (in particular high speed streams and coronal interaction regions) may trigger atmospheric instabilities via aurorally-driven atmospheric gravity-waves and this may lead to an intensification of tropospheric storms (hurricanes and medicanes).

The proposed link is based on an older paper of the authors and sounds reasonable. It has already been applied to different tropospheric weather phonomena as intensively noted in the introduction. Regarding the solar wind forcing of hurricanes some multi-epoch analysis of the presented paper show an interesting coincidence (e.g. the increased CIR numbers preceeding the strom intensification in Fig. 6) as well as an increasing solar wind velocity for the intensification in all presented multi-epoch analysis - which was impressive for me.

However there are major significant points of criticism that need to be solved before considering publication. Applying the proposed method the authors are presenting that 42% of the hurricanes are following CIRs. To me this seems similar than for a random distribution with the same data processing. Also the temporal dimension of the forcing link is very vague. The proposed three day time window is too large to draw direct conclusions. And finally I am not happy with showing single events for an effect that should appear on a statistical basis only.

The authors want to link all tropospheric weather phenomena with space weather by temporal coincidence, which is difficult due to the 3 day time window. My suggestion would be to investigate the energy density of aurorally driven waves in the troposphere in contrast to other disturbances. While any disturbance may trigger an instability, the probability of this triggering should increase with the energy of the disturbance. In case of Fig. 4 where the authors link all hurricane intensifications to solar forcing even though there already is a lot of mass in motion, horizontally as well as vertically - this clear link to solar forcing is only reasonable if AGW energy density is dominant.

Major:

1.) is the probability increased?

24% of the hurricanes with a strong wind speed increase happen after a HSS/CIR with solar wind speed >500km/s (line 125)

18% happen after HSS/CIR in the range of 300-500km/s (line 140).

I hope I got that right, so in total we have a probability of 42% that a hurricane happens after a (>300km/s) HSS/CIR.

Is that special? Let's use Fig.4 and count the CIRs. There are 16 CIRs in 3 months. That makes 4 CIRs per month, roughly of course. According to Figures 2/3 you are counting a hurricane as "belonging" to a CIR if it intensifies during the next three days. That on average makes about 12 days a month when a storm intensification would be counted as belonging to a CIR - regardless of any causal reason. With 12 days a month, even a completely random distribution of storm intensifications should show a co-incidence of about 40%. Well, give a take a few percent for my very poor statistic on CIRs but if this correlation does show anything than that it is ramdom.

belongs also to:

-l. 144 "often"

-l. 215 in case that these results were derived with the same method I would be careful with this statement as well

Reply 1: *It is important to note the first result. Fig 1 shows persistent pattern of the mean V increase from minimum to maximum with peaks in n_p, B and σ_{Bz} near or before the key time. As already demonstrated in the paper by Prikryl et al. (2019), these SPE analysis results by themselves "indicate a tendency of RI of hurricanes to occur following HSS/CIRs or ICMEs." If they occurred randomly relative to HSS/CIRs or ICMEs, the results would be different. They would either show flat curves, or the phase of the patterns would be random, depending on the number n of cases superposed.*

Figs. 2 and 3 are showing why Figs. 1a-c show the described pattern, by defining the key times for the SPE analysis as the actual arrival times of HSS/CIRs and ICMEs that were associated with intensifying hurricanes. Again, the reviewer only considered Fig. 2 and 3a. Out of all 363 hurricanes with RI ≥ 30 kt/24h in the SPE analysis shown in Fig. 1, Fig 2c shows that 87 (24%) of them followed arrivals of major HSSs from coronal holes within 3 days. Fig. 3a shows that 64 (18%) of them followed minor to moderate HSSs within 3 days, and Fig. 3b shows that 57 (16%) of them followed impacts of ICMEs within 3 days. Therefore, 87+64+57 events represent 57% of 363 events. In other words, more than a half of these hurricane RI events occurred within 3 days from HSS or ICMEs. Please, note that the number of hurricanes is not the same as number n, because some HSS/CIRs or ICMEs were followed by more than one hurricane.

Of course, there are many, many more HSS/CIRs and ICMEs without a hurricane RI. We are NOT saying that such solar-wind disturbances are often followed by a hurricane RI. In Section 3 we conclude that "RIs of hurricanes often occur following arrivals of HSSs from coronal holes or impacts of ICMEs". This statement is supported by Figs. 2 and 3, and for typhoons by Figs. S2 and S3 in the supplement.

The key times (HSS/CIRs or ICMEs) are only a proxy times for sources of AGWs. The point to be made is that the AGWs that originate at auroral latitudes are most intensely generated following HSS/CIRs arrivals and ICME impacts. But AGWs can be generated by geomagnetic activity outside of the 3 days time window that we used.

The reviewer suggestion "to investigate the energy density of aurorally driven waves in the troposphere in contrast to other disturbances" is difficult or impossible to accomplish, because generation and propagation of AGWs is a very complex subject. At any rate, the "AGW energy density" must be highest following arrivals of HSSs and ICMEs. However, we cannot estimate the "AGW energy density", let alone to directly observe AGWs. Yes, in some cases they drive traveling ionospheric disturbances (TIDs), which can be observed at times. All we can do is to show examples to demonstrate the possibility of aurorally generated AGWs to reach the troposphere, and in the presence of instabilities to suggest they can play a role in their release. We do not have access to sophisticated tools to study gravity waves and their propagation in detail.

It is true that, as the reviewer stated, "While any disturbance may trigger an instability, the probability of this triggering should increase with the energy of the disturbance." However, the conditionally symmetric instability is sensitive to even very small lift of a moist parcel of air to be released and slantwise convection initiated/triggered. The aurorally generated AGWs, if reaching the troposphere can do that, and a chance of that happen is more likely when the AGWs are generated most intensely – with arrival of HSS/CIRs or impact of ICMEs.

2.) Temporal dimension of the depencency:

How long does it take from a CIR forcing until we may expect the highest wind velocity increase? According to the paper it reaches from almost immediatelly until 3 days later. That is a very long time span if you want to see a direct impact on an instability that also might be the result of other disturbances. In Fig. 1 solar forcing and highest wind velocity increase seem to happen simultaneous. In that case we would not need a trigger. The forcing should happen before the strong wind increase takes place - and during that time (e.g. day -1) the solar wind forcing is very low (minimum in solar wind velocity in all plots of Fig. 1).

However, there seems to be a maximum in solar wind density at day -1. This even with the low solar wind speed this has an impact on the solar wind dynamic pressure and might be connected with increased substorm activity. Comparing that with AL or SML index might tell more.

belongs also to:

-l. 109 "following"

Reply 2: *It is the impact of HSS/CIR or ICME causing geomagnetic activity for several days that matters, because it is a source of AGWs, not how fast the solar wind velocity rises. There is no direct link between solar wind parameters, which represent much rarefied solar wind medium, and the troposphere. The solar wind forcing of the upper atmosphere, not only on the night side causing substorms and such, but also on the dayside driving convection/currents, generates AGWs. Thus, we propose that the AGWs mediate a link between solar wind and the troposphere and play a role in releasing/triggering instabilities that are already present in the troposphere (Sections 6 and 7).*

3.) Single storm studies:

The paper shows a couple of single storms (e.g. Section 4) that may be driven by solar wind forcing. We probably agree that triggering an instability is a statistical effect and might have different reasons. Without having any information on the disturbance that may (or may not) trigger this (may be existing) instability I do not see a benefit in single event studies.

Reply 3**:** *Fig. 4 shows cases as examples and because some of them are discussed in Sections 5 and 6. In fact, in response to another reviewer we will swap Sections 3 and 4 to show the cases before statistical results. This is often preferred by readers, although we initially started with statistical results as in the previous paper (Prikryl et al, 2019).*

4.) Fig.4 shows the problem of high rate of solar wind forcing in combination with the wide atmospheric response-time window.

Yes, you may attribute many of the storm intensifications with solar drivers. However, the same way you may also temporally connect almost any ending of the hurricanes with a CIR. The arbitrary response time window is too long to draw conclusions out of single storms.

And it should be very unlikely if every storm intensification in Fig. 4 (3 times three consecutive ones) would be linked to solar wind forcing (energy density argument, see above).

Reply 4: *See, the replies 1 and 2. Also, we do not think that one "may also temporally connect almost any ending of the hurricanes with a CIR" or ICME, statistically. Also, the response time window choice of 3 days is reasonable, not too long, because intense AGWs can be generated for several days following the key times.*

5.) introduction in general: I believe that the authors are convinced by the space weather forcing on tropospheric instabilities but an introduction should give an overview to the field and that also needs to include critical aspects, as the limited energy of an AGW compared to other waves, ongoing debate on the validity. I am sure the authors have these citations at hand.

Reply 5: *Introduction is now expanded to give more overview of the field including other possible physical mechanisms to address the observed link between solar wind and troposphere.*

minor:

-The title is very long.

Reply: *It could be shortened to "Contribution of solar wind to rapid intensification of tropical cyclones and transition of Mediterranean subtropical cyclones to tropical-like cyclones" but this would omit the coupling process that is needed.*

-l. 22 The first two sentences if the introduction contain 11 self-citations in a row without mentioning other work. Does that mean the authors are working alone on this field or they do not want to present a comprehensive overview as desired in an introduction?

Reply: *The expanded Introduction will include other citations, although the reviewer is right, regarding the proposed role of AGWs in troposphere, as far as we know, we are so far lone wolves, so to speak. Unfortunately, researchers who may have more expertise on AGWs generation and propagation have been so far either reluctant to consider this possibility or simply dismiss it. However, we have cited Hagiwara, M. and Tanaka, H. L.: A theoretical analysis of the atmospheric gravity wave that connects the thermosphere and the troposphere, Tsukuba Geoenvironmental Sciences, 16, 1–14, 2020.*

-l. 29 "Low-level winds...are favorable conditions for over-reflection..." this statement needs to be explained or cited.

Reply: *The statement will be explained with citations added.*

-l. 38 "Because of Joule heating and Lorentz forcing ... a key component of... coupling... is the generation of... waves..." Please rephrase this sentence. And what is meant by Lorentz forces in this context? Do you mean Joule heating by Pedersen currents?

Reply: *Yes. Sentence is rephrased and cited, as we are working on the revision.*

-l. 55 (all) links need to be referenced with the last access date

Reply: *Sure. Will be done when manuscript accepted, as it is usually the case*.

-l. 55 "best tracks" what is the criteria for a best track?

Reply: *This is the term used by database websites providing the data after being thoroughly checked. We do not have access to their criteria.*

-l. 60 What does this 24h limitation mean? The 6h timesteps are averaged? running average? The 6h values are used to calculate the maximum intensity but that's not very accurate?

Reply: *We have not done any smoothing. This is citing Landsea and Franklin (2013).*

-l. 71 The list is a black box at the moment. Please provide it (maybe as supplement) and note if all existing data has been used or any selection has been made. Please also include the derived intensification time. As such everyone may check the data and verify the findings.

Reply: *The list of these medicanes will be provided in Table S2 in the Supplement. These are not tropical cyclones, so no RI is provided, only the start date of the storm.*

-l. 85 "updated" what has been updated and by whom?

Reply: *Ian Richardson regularly updates this website once data for new ICMEs are processed* http://www.srl.caltech.edu/ACE/ASC/DATA/level3/icmetable2.htm

-Fig. 1: All lines should use the available y-axis space.

Reply: *All plots of solar wind parameters have the y-axis scale range for each parameter on the vertical axis - minimum and maximum with units and line type indicated. Having all parameters normalized to the full y-axis would not be helpful and would be too busy with overlapping lines.*

-Fig. 1: (l. 223) SLP is not explained in the text. Is it Mean Storm Low as indicated in the Figure or Sea Level Pressure?
Reply: *Yes. The acronym is now explained.*

-l. 117: "that were associated with intensifying hurricanes" please clarify what is meant by this criterium
Reply: *See, Section 2. This brief description can be expanded: Solar wind plasma parameters are used to identify co-rotating interaction regions (CIRs) at the leading edge of high-speed streams (HSSs). As CIRs pass by a spacecraft, the solar wind density increases to a maximum and then decreases within a narrow*

stream interface while the magnetic field magnitude peaks. This interface between the fast and slow solar wind defines arrivals of HSSs. But CIRs can be wider spanning the interface. CIRs that coincided with, or were followed by a hurricane RI, are used in the SPE analysis.

-Fig. 2: The discussion of the upper panel is missing. In case that this panel adds information to the paper, please discuss it, otherwise it should be removed.
Reply: *The top panels are now explained and discussed in the text.*

-Fig. 2 How many of the 87 and 363 storms have a slantwise instability that is the precondition for a triggered release?
Reply: *We don't know. We wish we could find out. It is beyond the scope of this work to analyze in detail each RI case and, unfortunately, beyond our capability and computer time/space limitation. It would take months to process so much data. We can present only some examples. The focus is to demonstrate a tendency of RI occurrence relative to HSS/CIRs and ICMEs.*

-the paper mentions geomagnetic storm several times even though the DST threshold for a strom is not met. The smallest geomagnetic strom ("moderate") starts at -50nT (e.g. l. 193)

Reply: *In Section 2 we added this sentence: Gonzalez et al. (1994) classified the storm intensity by suggesting thresholds −30, −50, and −100nT to be more negative for small, moderate and intense storms, respectively.*

-l. 156 Oho intensified already before the CIR

Reply: *As stated in Section 4.1, "Hurricane Oho reached the maximum RI ≥ 25 kt/24 h which coincided with a major HSS/CIR that triggered a moderate geomagnetic storm on October 7 as indicated by Dst index." Yes, it started to intensify (RI < 20 kt/24h) during a weaker geomagnetic storm triggered by a moderate HSS/CIR on October 1.*

-Fig. 4 is hard to read: tiny text, faint colors, and the legend "*20 nT" should be "*20/nT" as the y-axis is dimensionless. Maybe "*20 in nT" or even a second axis would be better.

Reply: Sorry, there is not much space for bigger fonts. This is how we always presented the solar wind data. Reader can always expand the figures for viewing, particularly with higher quality figures when published.

-Fig. 5 needs a colorbar and a more detailed description

Reply: *Color bar showing the cloud-top temperature is added. CBs are characterized by low cloud-top temperature.*

-l. 189 I do not see any intensification after the CIR on 14-15th of Sept.

Reply: *This sentence is modified with more detail added: Tropical storm Fiona formed and first intensified (20 kt/24h) following the impact of a strong CIR on September 14-15 at the leading edge of an initially relatively weak HSS. With the arrival of a broad CIR at the leading edge of a much faster and structured HSS on September 18 Fiona rapidly intensified (30 kt/24h) into a hurricane that continued to intensify.*

-l. 195 not sure if there even is a CIR

Reply: *Yes, it was weak, but HSS followed.*

-l. 240 This statement seems to be wrong. Fig. 8 shows 1, 6 and 5 CIRs on the days preceeding the WAA events. That is not outstanding to the other days.

Reply: *There is a smaller number of cases superposed. The statement is modified: Even with much smaller number of cases, this result shows a characteristic pattern indicating that the WAA cases of TCs tend to intensify following HSS/CIRs, which is similar to cases of TCs with CBs (Fig. 6).*

-Fig.7b: colorbar is missing. And it did not find any discussion of that figure.

Reply: *Unfortunately, the IR images https://www.ncdc.noaa.gov/gibbs/ do not include color bar for the cloud-top temperature, but it is likely similar to the one added in Figure 6. The image is briefly referenced in the text. We added to the sentence "…the IR images showed cold cloud tops (Fig. 7b)"*

-l. 268 "that were associated with medicane storms" (same in caption of Fig. 14) that needs to be clearly defined

Reply: *Yes. -l. 368. In Section 8 we now added: "The list of these medicanes can be viewed in the Supplement (Table S2)." Referenced also in the caption of Fig. 14.*

-l. 373 "mostly because of data gaps" makes this a vulnerable point of the multi-epoch analysis. Please provide more information.

Reply: *Information added: "Before 1995, there are not always continuous solar wind data available. If there are data gaps CIRs or ICMEs cannot be identified. Of course, medicanes can also occur when solar wind does not show any identifiable HSS/CIR or ICME."*

-Fig. 15: colorbar, and again, I do not see any use in showing single storm examples. They all show that a couple of days defore a CIR happened, which statistically is the case every 7.5 days - so what should this tell us?

Reply: *For the color bar, see reply to Fig. 7b. Not sure what is the concern the reviewer has about Figs. 15a-c that show cases/examples of medicanes discussed later in Fig. 16. Samir, Cornelia and Lucia clearly occurred following strong HSS/CIRs. In the case of Qendresa that intensified from 7 to 9 November 2014 the first HSS/CIRs triggered a geomagnetic storm that continued as the second CIR of this structured HSS arrived on November 7.*

Maybe there is some misunderstanding here. Where is "7.5 days" coming from? The two HSSs in Fig. 15a are about 7 days apart. This is about ¼ of solar synodic rotation. Indeed, both HSSs are recurrent streams from recurrent coronal holes. They returned after ~27 days. The corresponding HSS/CIRs were also observed on September 4 and 10, 1996. The HSS in Figure 15c recurred 3 times: April 11, May 8 and June 4, 2012.

-l. 411 Is Prikryl (2024) the correct citation for ERA5 reanalysis? Shouldn't that be Hersbach?

Reply: *Thanks. Hersbach et al. (2020) was missing in the references.*

typo/grammar/style:

Reply: *All done/corrected. Thank you very much for detail comments/corrections/suggestions.*

-l. 16 "development of weather" systems/patterns?

-l. 32/39 no need to introduce the acronym MIA as it is just only once again - together with the full form

-l. 70 The link is probably too long (remove #...)

-l. 74 ...indices...are diagnosed... . Please rephrase.

-l. 90 Ångström (first letter)

-l. 95 SPE in space weather is strongly connected to "solar proton event". Please use another abbreviation, maybe SPEP.

-Fig. 15 caption: if MSLP is minimum sea level pressure, what might be a minimim MSLP?

-l. 125 "underwent" -> with? (as precondition for the selection) followed arrivals

-l. 202 TC not introduced

-l. 224 (and Figures) RI=20+ typically is written $RI \ge 20$ and is the unit correct? kt or kt/24h?

-l. 393 this indeed is a moderate geomagnetic storm

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