General comments:

The paper seeks to investigate how PV is generated in Mediterranean tropical cyclones 'medicanes' by using a Lagrangian backward trajectories from a defined mature state over the previous 48 hours for the IFS model and ERA5. The paper describes the relative contributions of accumulated PV both from the environment of the cyclone, the cyclone itself and any initial PV anomaly. The paper then further tries to isolate the contributions of both environmental and cyclonic PV by breaking it down into diabatic components such as convection and microphysics. The authors also spend some time talking about PV generated from orography and its contribution to environmentally generated or destroyed PV. The authors do a good job of generalizing their work by including composite plots of their key results and relevant representative case studies.

Overall the paper presents a fairly compelling story that for most developing medicanes, the principle generation of PV is from diabatic generation inside the cyclone itself, and from the convection in particular. The authors are careful to note, that a significant minority of storms do generate much of their PV from the environment including orographic production of PV.

This study does provide useful novel results on the generation of PV in medicanes, which are understudied storms in general. I think the paper could be stronger, however, if the authors justified why the generation of PV is something we should care about so these new results can be contextualized.

I do have some concerns with the methodology notably with the "cyclone effective area" parameter being considerably larger than the eyewall radius of a typical medicane. As such I think there needs to be further discussion about how the grid spacing of the models could affect the results, and how some of the cyclonically generated PV likely comes from thunderstorms outside of the medicane core rather than the small ring of convection near the centre.

Another related issue I have is that the authors do not attempt to account for the changing structure of the storms throughout their development. Unlike a normal tropical cyclone which may have a deep warm core from cyclogenesis to landfall a medicane inevitably transitions from an extratropical deep cold core low, through to a large subtropical low with scattered thunderstorms, to finally a tiny, tightly bound tropical structure with a self-sustaining shallow warm core. It should not be assumed PV generation throughout these different life stages are the same, and I suspect they could be very different. A way to address this concern would be some stricter filtering that only contains storms that have a tropical phase (some will only ever be subtropical) and then identify the times at which this transition occurs. You should try to ensure that your definition of 'maturity' occurs after the storm has entered its tropical phase. There are some other concerns I have with this definition to which I have outlined in the detailed comments. Other than these concerns my only other substantive issue is that there is sometimes a lack of clarity in the specific PV related quantity being referred to. I'd suggest being more explicit about things like whether the PV has been averaged over all of the back trajectories, or that you are referring to diagnosed PV and so on.

I think this is an interesting paper with robust use of the back trajectory methodology applied to an underappreciated context. I would recommend this paper be accepted once the concerns have been

addressed.

Specific comments

- L57 has a 'mature' medicane been defined? I think this is important, everyone knows what a mature tropical cyclone is, but medicanes have a very long transition (relative to their lifetime) from extratropical to subtropical to tropical like. So I think 'mature' needs to be more clearly defined. You first mention maturity in L29 where you say *"Thereby, the typically (very) strong cyclonic circulation in the lower troposphere in the mature stage of extratropical and Mediterranean cyclones can be explained by the distinct vertical alignment of the diabatically produced positive PV anomaly at low levels with the upper-level PV streamer or cutoff, forming a so-called PV tower"* so you have referred to a characteristic of 'mature' medicanes, but the word 'mature' is not explicitly defined prior. You did define it later at L90 however it feels like it is a bit late.

- L77. Medicanes are very small (in their tropical phase), 0.4 degrees would have the entire inner core on possibly a single grid point. This may be a major limitation of the study, since everything might be the 'environment'.

- L94. You don't mention a means of filtering out purely extratropical cyclones from medicanes. I suspect there are some extratropical cyclones in your study (or ones that are pre tropical or post tropical when 'mature') as there are rather a large number of red dots over land. Medicanes decay very quickly over land (even faster than a normal TC), though they may then intensify as post tropical cyclones with frontal systems so I doubt the red dots over Tunisia still have tropical characteristics by the time they have moved so far inland and, as a fundamentally different type of storm, their dynamical processes will also be different. You may also get an issue where the storm is strongest (and 'mature' by your definition) in its pre-tropical phase. I wouldn't be surprised if a medicane precursor over the Linguarian sea has an initially much stronger relative vorticity as a 970mb extratropical frontal cyclone than 48 hours later as a 995mb tropical like medicane. You may be able to filter these cases out manually but I think it needs checking and mentioning in your methodology from your figure 2b I'd be the most wary of any storms that are below 990mb which is strong for a medicane.

- L101. A quick note bene which you may already have considered. A medicane can actually increase its MSLP but still be intensifying because the 'upper trough envelope' is decaying faster than the medicane is intensifying, so the pressure gradient near the medicane centre can go up and the absolute value of the MSLP can also go up. This is an intricacy that might mean your T+0h is actually before many of your medicanes are at their strongest. I don't think there is anything wrong with how you define T+0h (apart from my previous comment) but the reader should be aware that it doesn't necessarily correspond to when the medicane is at its strongest.

- L119. One way you could extend this work (in, perhaps, a future paper) is to use MetUM simulations of chosen medicanes which have built in PV lagrangian tracers in addition to a higher spatial resolution.

- L140. Since you are initiating your backward trajectories using your prior T+0 definition, some further consideration of my comment for L101 might be useful since your results might be stronger if T+0 did, indeed, correspond to the medicane at its strongest. You could, include wind speed or tangential wind speed in your definition of maturity for example or use a radial gradient of SLP rather than the MSLP.

- L151. You do now do this (previous comment), I think it would be easier for the reader if this came slightly earlier. These first couple of sentences do indeed help my understanding of what you are doing a lot.

- L172. I think you have a reasonable justification for your "cyclone effective area" parameter here, but I am still a little nervous about how large it is. 400km might be reasonable in a normal Atlantic or Pacific TC (although even then it feels on the large side) but medicanes are very small, which is why Hart phase space diagrams struggle to denote them as tropical with the usual calculation domain size. The two papers you reference in the justification both also use fairly low resolution spatial data (1.125 degrees). In model simulations and observations the 'eyewall' and RMW is much smaller than this (most likely much less than 0.5 degrees) so will the radius of any PV modification from the diabatic processes associated with this convection be. I think, as a result, of how these convective processes are parameterized in this lower resolution data, you would expect the effective core size to appear larger than it is in a real medicane. Nevertheless, I feel like this needs to be explicitly acknowledged here and in a limitations section, particularly since a future (higher resolution) modelling or observational study might find very different and considerably smaller 'cyclone effective area' sizes if an analogous method, based on this work, is chosen to be adopted by another researcher.

- Have you checked diurnal variation in Radiative PV changes (particularly cyclonic), we know medicanes are much stronger at night, so I wonder if this is also visible in the dark blue line (which we cannot see because it is cropped). I feel like it is possible there may be a very interesting result hidden here. Even if you don't spot a diurnal cycle since this has been observed before it is definitely worth a sentence on.

Technical corrections:

- L150. Could be clearer about how many of these backward trajectories are going to be initialized in your study. In your example you initialize 3 but I'm assuming this number is not special, I think it would be clearer to more explicitly say that Fig 3 uses three backward trajectories so it doesn't feel like the number 3 is integral to the method.

- L162. Could be really nitpicking here, but would it read better if you swapped the order of (i) and (ii) since (ii) is this backward trajectory method that you have just spent the last section and the first part of this section explaining in detail whilst (i) is ancillary and doesn't need any explanation. Also since you haven't talked about (iii) yet the grammar seems slightly weird. 'For (iii)' makes it seem like you are referring to something hitherto mentioned. Perhaps 'In addition we also pragmatically define (iii), a "cyclone effective area"' reads better.

- L178. you are defining 'apve' and 'apvc' now but they also appear in your Figure 3 when they are not defined. I would expand your Figure 3 caption to deal with this. Additionally, I'd be more clear about the coloured lines being the *diagnosed* PV and the other lines being cumulative components integrated over time. Another issue with Figure 3 is the scale goes off the bottom in (c).

- L187: how do you know the cyclone both 'produces' and 'destroys' PV resulting in the net negative cyclonic PV? The cyclone could entirely destroy PV (albeit intuitively unlikely – is this what you mean) and still cause the same result to be seen, is there unseen work that led you to this conclusion?

- L194 the word 'remaining' makes me think of budget residuals, while I believe the intention is to refer to the positive environmental PV left over after the large peak at around T-45h (so 'remaining' here refers to a change in time of one component rather than some difference involving multiple components). I'd possibly think of a way of rephrasing to make it clearer. It is rather unfortunate that the difference between the top black line and the solid grey line is also coincidentally around 0.5PVU, be aware a reader might, incorrectly, think this is what you are referring to.

- L196 *"It is 0.5 PVU of orographic PV and not 1.5 PVU, because the environmental PV at t = −38 h, which is completely orographic (dotted and grey lines), is reduced by the environment between t = −38 h and t = −22 h in absence of orography."*. I understand what you are trying to say but am not sure its semantically true. The orographic PV surely *is* 1.5PVU but also combines with a -1 non orographic PV (which you say in L198) to give the overall 0.5 environmental PVU at T+0h. It is true that this positive 0.5PVU remnant is entirely orographically generated as you have shown, but calling it the 'orographic PV' feels misleading. I wonder if the overall points might be clearer if, instead, of partitioning your components into 'orographic', 'environmental' and 'cyclonic' you have 'environmental orgographic', 'environmental non orographic' and 'cyclonic'. That way the components intuitively add up to give the diagnosed PV and the figures are easier to read and understand on the first reading. I suspect your explanation will also be shorter and clearer.

- L205 this is the first time you mention the 'core' of the medicane. Is this the same as your 'cyclone effective area' for T=0h? Also do you initialize a back trajectory at every gridpoint in this region? If you do, it isn't clear.

- Fig 5b could be clearer, I don't think, for example, you explicitly refer to your solid grey PV line (I think it needs to be explicitly said that this is an average of (a) the **diagnosed** PV over (b) **the trajectories**).

- L295: "*After the trajectories enter the cyclone effective radius (vertical grey line)"*. I assume this vertical grey line is the **average** time the trajectories enter the cyclone effective radius (as they will presumably happen at slightly different times).

- L300: Your 2nd case study involves a cyclone reaching maturity in the Black sea. I have no problem with this, the tropical-like storms that occasionally form in the black sea are structurally similar to medicanes however you don't mention the black sea in your introduction. It might be worth including a sentence so the reader is not surprised by the location of this case study.

- L330: The yellow line goes off the scale so I can't see that it produces 2PVU as stated. Also, to be picky, the line looks more yellow than orange. The blue line also goes off the scale. I understand, as a result, we get a zoomed in version of the other lines, but I'm not sure it can justify cropping out this data.

- L346. A little unclear about the difference between small case apv and APVtot. I'm assuming apv is simply the difference between the diagnosed PV at T+0h and T-48h?