Review for "The added value and potential of long-term radio occultation data for climatological wind field monitoring" by Nimac et al.

The paper investigates wind fields derived from radio occultation (RO) data. Regions where geostrophic and gradient wind approximations are valid are identified by means of ERA5 data. RO derived wind fields are compared to ERA5 derived geostrophic and gradient winds and the full ERA5 wind fields.

The novelty of the study is that the analysis includes a comparison of geostrophic and gradient winds of ERA5 with the full winds in ERA5. Moreover, comparison of RO and ERA5 data are conducted on a higher resolved horizontal grid (2.5° x 2.5°) compared to earlier studies and lower latitudes close to the equator were also investigated. However, ERA5 analyses would be available on a 10 times higher resolved lat-lon grid (0.25° x 0.25°).

The paper is generally well structured, motivation and conclusion need to be strengthened, and some errors were found in the citations and references.

Major Comment (Motivation, Conclusion, L7, L24): The motivation and conclusion are in my view critical. The data product does provide no additional information to what is already available from ERA5. The accuracy was evaluated based on ERA5 which also has its limitations. But more importantly, ERA5 (and other reanalyses) are also available for long time periods that allow climate monitoring of wind fields up to mid-stratosphere. I think the important question is, can wind information determined from RO improve the wind fields in ERA5 reanalyses?

Aeolus did improve ECMWF IFS analyses and forecasts but as mentioned in the introduction, they were only available for a limited time period and therefore not feasible for reanalyses and climate time scales.
Additional independent evaluations with Aeolus winds and/or ECMWF IFS operational analyses (with Aeolus assimilated) (in addition to ERA5) would increase the robustness of the determined accuracy and the value of the additional data derived from RO but I agree that is probably beyond the scope of this paper. However, at probably a 2-months comparison of full resolution ECMWF IFS with Aeolus assimilated for one selected year could be added.

Additional comments:

Abstract:
L11: Please add here, that the focus is on synoptic scales (resolved by RO) because ERA5 native resolution is much higher.

L14/15: The third goal needs to be rephrased to be more specific: evaluate the potential of the RO wind fields for which purpose?

L17: Can you be more specific for what altitude range is meant by tropospheric? Presumably not in the surface boundary layer?

L19: For this latitude range and the exceptions that are given afterwards, I would not call it almost globally: …within 2 m/s accuracy for latitudes 5°-82.5°, with some…

L20/L21: Please tell at the beginning of the abstract which altitude levels are investigated. What is considered as lower altitudes? Lower troposphere? What is considered as higher altitudes? Mid-stratosphere?

L21: very good → good; partly 4 m/s

L22ff: temporal change: is this a temporal increase? Differences between RO and ERA5 increase in time because ERA5 was potentially improved in 2016?

L56: good → please be more specific

L61: What kind of wave activity? Rossby waves? Gravity waves?

L72, general: What is new to what was already published by Scherllin-Pirscher et al. 2014? They investigated different latitudinal and altitudinal regions. They had 5°x5° lat-lon bins and also found 2 m/s with respect to full wind in ECMWF IFS analysis.

L81: See major comment one. ECMWF IFS analyses are an additional data set.

L104: depends somewhat also → remove somewhat

L112ff: This statement is not appropriate and cannot be made in general. The focus on wind the manuscript is totally different from von Schuckmann et al. who dealt with the atmospheric heat content. This needs to be proven, e.g. by adding additional (re)analysis data. See also major comment 1. Please check your references and bibliography carefully for correctness! Von Schuckmann et al. is 2020, here it says 2023, in the bibliography 2022. Moreover, it is in Earth Syst. Sci. Data and no longer as Discussion paper.

L117: Please clarify and motivate why a 2.5°x2.5° grid is used, the native resolution of ERA5 is higher. The differences between the approximations and the original wind fields are likely different for ERA5 data on the 0.25° x 0.25° grid. Please comment on this or show, that your main findings (e.g. the regions were the approximations break down) are robust. Otherwise make clear, that your findings are may not hold for higher resolution ERA5 (or ECMWF IFS analysis) data.

L131/140: accurately; high accuracy: Accuracy of the RO geopotential height is missing?

L133: Is the 2.5° x 2.5° the best what can be achieved from the RO data? This then motivates why ERA5 data is used at such low grid resolution and should be stated above.

L140ff: The altitude range must be mentioned in the abstract and in the introduction (see earlier comments above). Not just the upper level (10 hPa) but also the lowest level. In L97 is says 1000 hPa but here you say RO data are accurate above 5 km which is mid troposphere? Please clarify.

L151: bias → ageostrophic contributions/components.

L155/156: I don't understand what is meant by the sentence "This way…". How does the comparison mention in the sentence before tell anything with respect to the original winds?

L158: higher → upper troposphere

L161: I don't see how this is an evaluation of an additional value of the RO data. Better: To assess the temporal homogeneity and long-term stability of the RO data, we analyse the temporal evolution of the differences in wind derived from RO and ERA5.

L168ff: This is not an f-plane because f is not set constant but depends on latitude. Must be Holton and Hakim, 2012 and bibliography is wrong (An Introduction to Dynamic Meteorology, 4th edition, Academic Press is 2004). Eq. 2: acos → a cos

L189: remove “on top”

Eq 5: ageo(strophic) is a more appropriate term than bias

L200: Is this old reference of 1986 still valid for data of 2007-2020 used here? E.g., Scherllin-Pirscher et al. 2014 do not state anything about smoothing their fields (however they used a 5°x 5° lat-lon grid)

L242: The terms advantages or disadvantages is not appropriate here.

L246: Bias is not the right term in this context (see previous comments).

L252, Fig2-Fig6/Fig10: Because you only have a 2.5° latitude grid, the -5°/+5° band is essentially represented by 2 grid points along latitude. In order to make this clearly visible, the maps and vertical sections should be plotted pixelwise rather than using a contour plot with linear interpolation between grid points.

L255: delete obstacles. Gravity waves/mountain waves should me mentioned here. Greenland, the Andes, and the Himalaya are hotspots of mountain waves propagating into the stratosphere. In addition, the pattern at 60 S in July is a region of high gravity wave activity, known as the gravity wave belt.

L283: Did you also avoid the mountain regions on purpose? If this is the case, this should be mentioned here.

L285: Its not directly above Antarctica but rather at 60°S. (cf. comment above).

L291, Fig2-Fig4: It would help to also show ERA_grad-ERA_orig.

L356: Can you be more specific what those changes were (reference to Discussion section)? For July, a break similar break is found at 2008, 2013 and 2019. Without additional investigations, this statement seems rather speculative and I think it should be left out in the manuscript and 2016 not to be highlighted at all.

L399: systematic differences: here you need to be more specific; to what exactly are you referring to in the previous section? How can this be understood? Additional comparison with ECMWF IFS winds would help; they are not identical to ERA5 (see comments above).
better wind speed estimations: better with respect to what?

L426: But not in the Boundary layer.

L428: there are more recent (review) references to (orographic) GWs.

L527: specify more active? More mountain/gravity wave activity?

L591: ERA5 data from Copernicus are on 0.25° x 0.25° lat-lon grid. How did you get to 2.5° x 2.5° from there? Are you aware that 0.25° x 0.25° interpolated or reduced to a 2.5° x 2.5° lat-lon grid is not necessarily the same as directly downloading ERA5 data on the 2.5° x 2.5° lat-lon grid which depends on the configuration of the MARS request at ECMWF.