Review of the study "Closing the gap in the tropics: the added value of radio-occultation data for wind field monitoring across the equator" by Danzer et al.

The authors have made substantial improvements to the manuscript and have properly addressed most of my comments. The purpose of this study is now nicely communicated, and the way if fills the scientific gap is described as well. Furthermore, the authors have performed extra analyses, which further confirm the robustness of their results. My suggestion would be to address better a single major point that has to be revised prior to acceptance. I think nothing is wrong with the analysis, but in the conclusions, the authors are overestimating the usefulness of GPSRO and equatorial wind balance to assess the meridional wind component. When this is revised, I would suggest accepting the paper.

Major comments:
It is clear from Figure 2 in in the manuscript that the equatorial wind balance is not applicable for the meridional wind in the tropical troposphere. The equatorial-balance bias is evidently above the threshold in many longitude bands below 100 hPa (Fig. 2c,f). This is more pronounced for the meridional wind, which can be seen by comparing Fig. 2d and Fig. 2e. Below, I attach some of my computations for ERA5, April 2010, 2.5x2.5 grid, for 10, 70, 200 and 500 hPa (see Figures 1-4). These plots confirm my suspicions that the equatorial wind balance is inappropriate for the estimation of meridional wind component, while the approximation works out nicely for the zonal wind component (the full fields and not only for the zonal-mean zonal wind as suggested in previous studies, which should be better communicated in this study).

In my opinion, it would be important to see not only the absolute error of the reconstruction (as in Fig 2f) but also the relative error, which often exceeds 100% (see attached Figures 5 and 6 below).

I do not fully understand, why Fig.3 compares u_{eb} to V_o. In my opinion, u_{eb} should be compared to u_o, v_{eb} should be compared to v_o and V_{eb} should be compared to V_o, as in Figure 2. What is the aim of that?

The WMO threshold should not be followed blindly. The accurate description of climate trends of tropospheric meridional winds is extremely important as they describe the upper and lower branches of the Hadley circulation, which governs the precipitation distribution in the Tropics and Subtropics. The annual-mean magnitude of meridional wind in the upper branch of HC is around 1.5 m/s (Figure 0). In this respect, the WMO threshold is much too high.

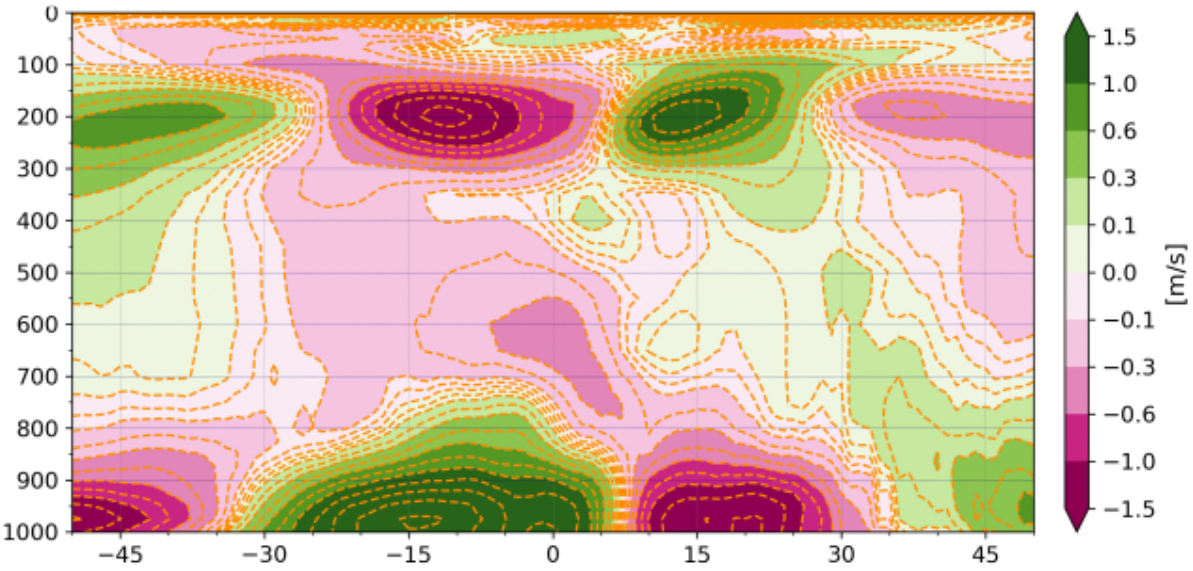

Figure 0. Annual-mean meridional wind as a function of latitude and pressure in ERA5, 1979-2018.

Lines 8-10 and line 16 in the Abstract should therefore be revised – I am not convinced about the added value of meridional wind component for the reasons state above. I think the ability to reconstruct zonal winds (and not only the zonal-mean zonal winds) is still a nice result, but it has to be accurately communicated precisely both in the Abstract as well as in the Conclusions, as well as in the main text (e.g. discussion in lines 238-240).

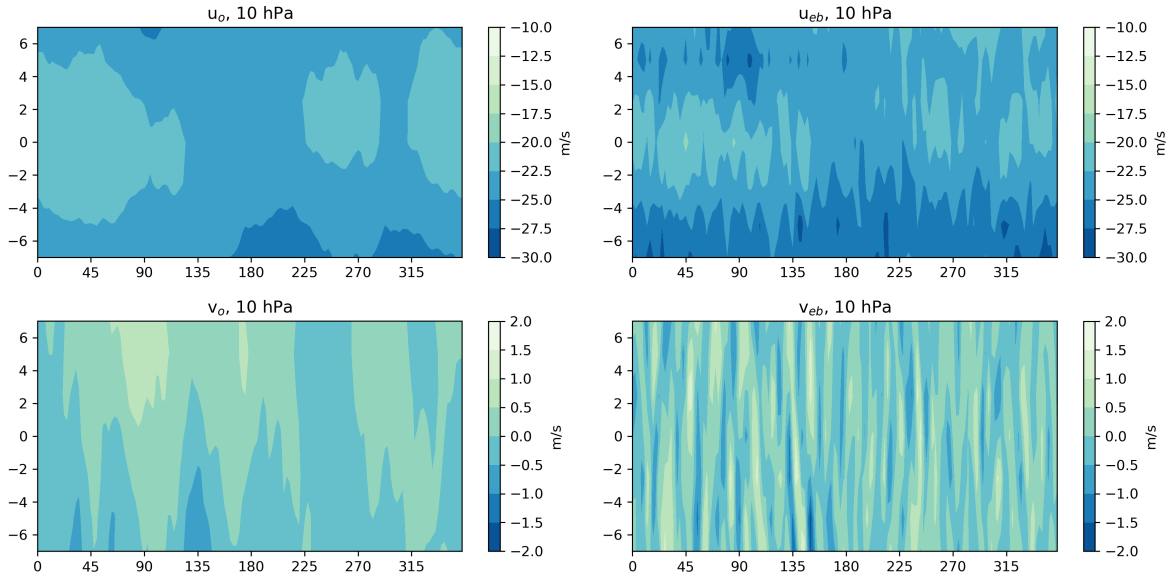

Figure 1. ERA5 original wind [left] and equatorial wind balance reconstruction [right] for zonal wind [top] and meridional wind [bottom]. ERA5, April 2010, 10 hPa pressure level.

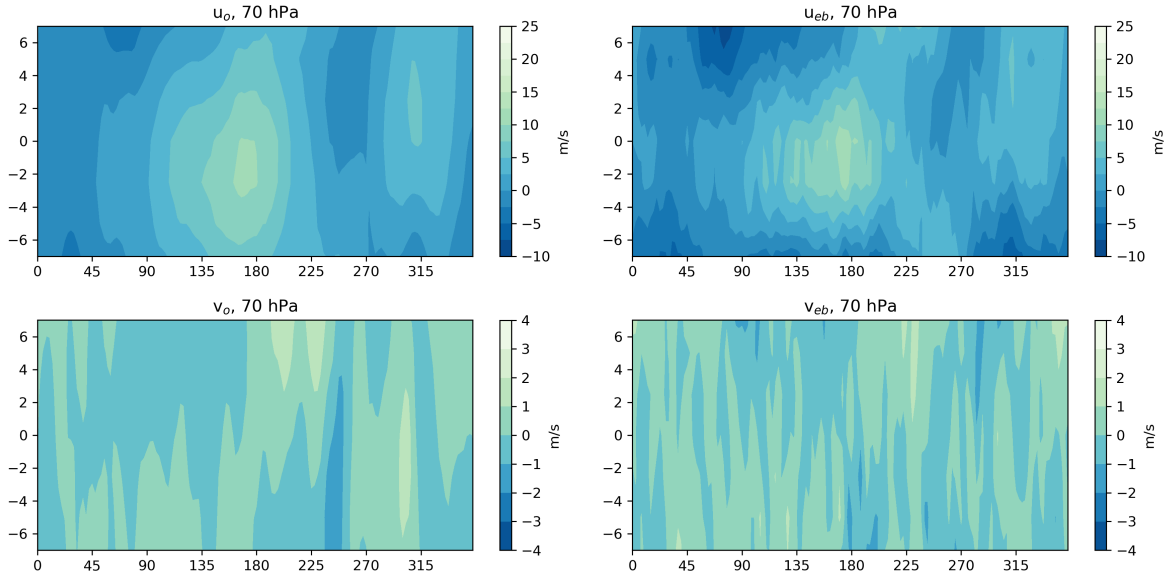

Figure 2. ERA5 original wind [left] and equatorial wind balanced reconstruction [right] for zonal wind [top] and meridional wind [bottom]. ERA5, April 2010, 70 hPa pressure level.

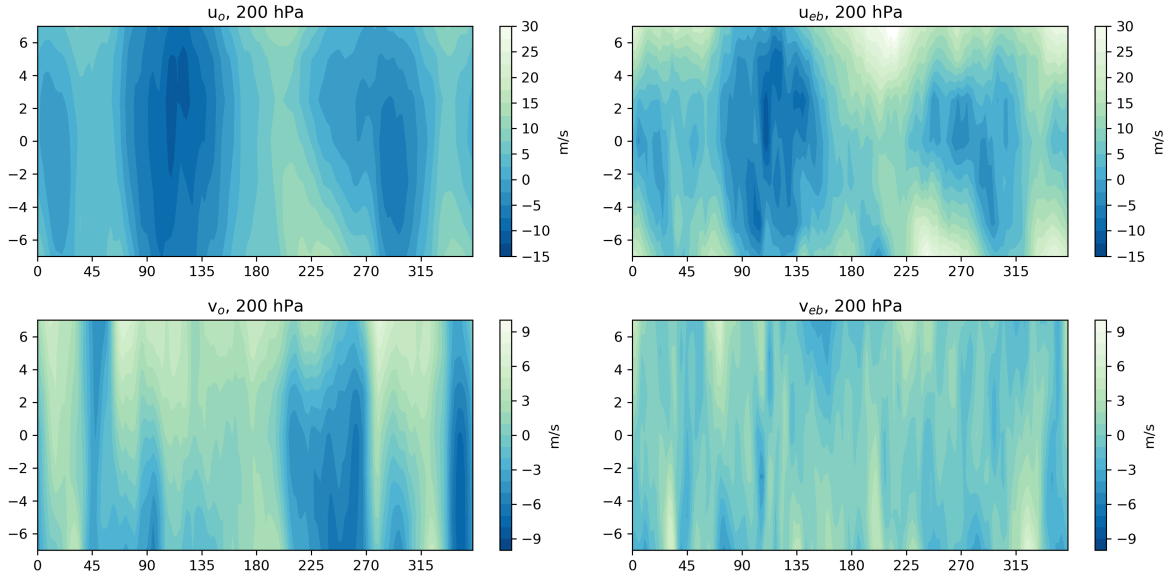

Figure 3. ERA5 original wind [left] and equatorial wind balanced reconstruction [right] for zonal wind [top] and meridional wind [bottom]. ERA5, April 2010, 200 hPa pressure level.

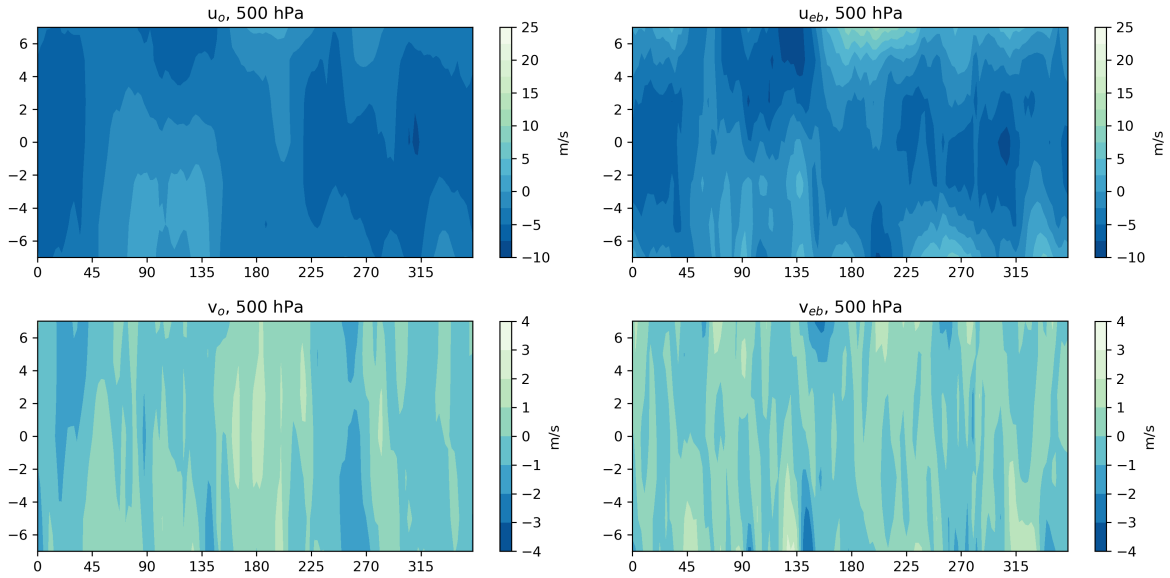

Figure 4. ERA5 original wind [left] and equatorial wind balanced reconstruction [right] for zonal wind [top] and meridional wind [bottom]. ERA5, April 2010, 500 hPa pressure level.

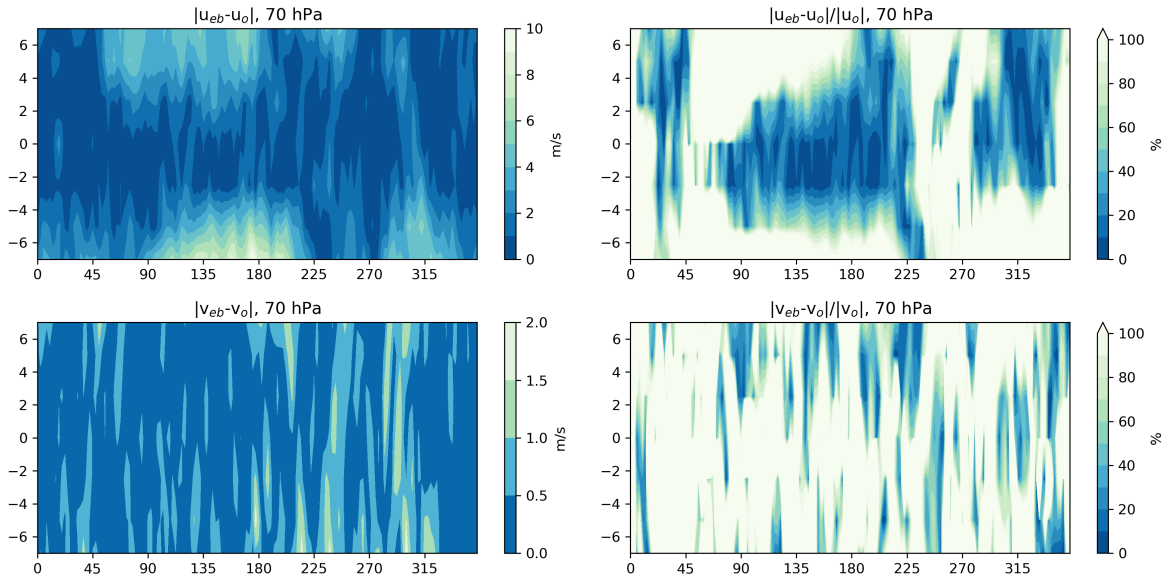

Figure 5. Absolute errors [left] and relative errors [right] of equatorial wind balance reconstruction for zonal wind [top] and meridional wind [bottom]. ERA5, April 2010, 70 hPa pressure level.

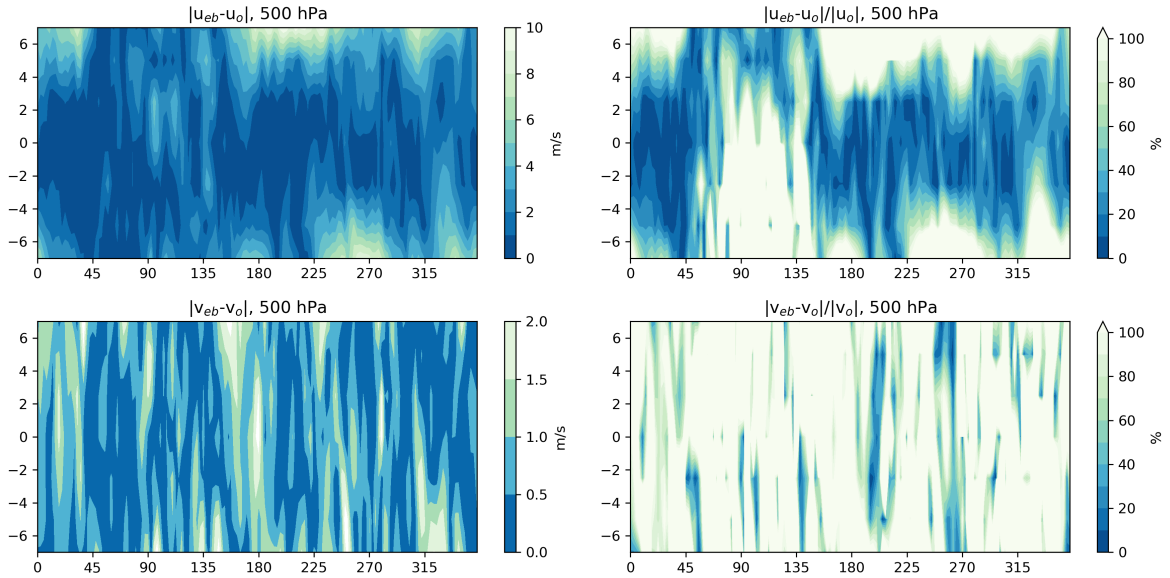

Figure 6. Absolute errors [left] and relative errors [right] of equatorial wind balance reconstruction for zonal wind [top] and meridional wind [bottom]. ERA5, April 2010, 500 hPa pressure level.

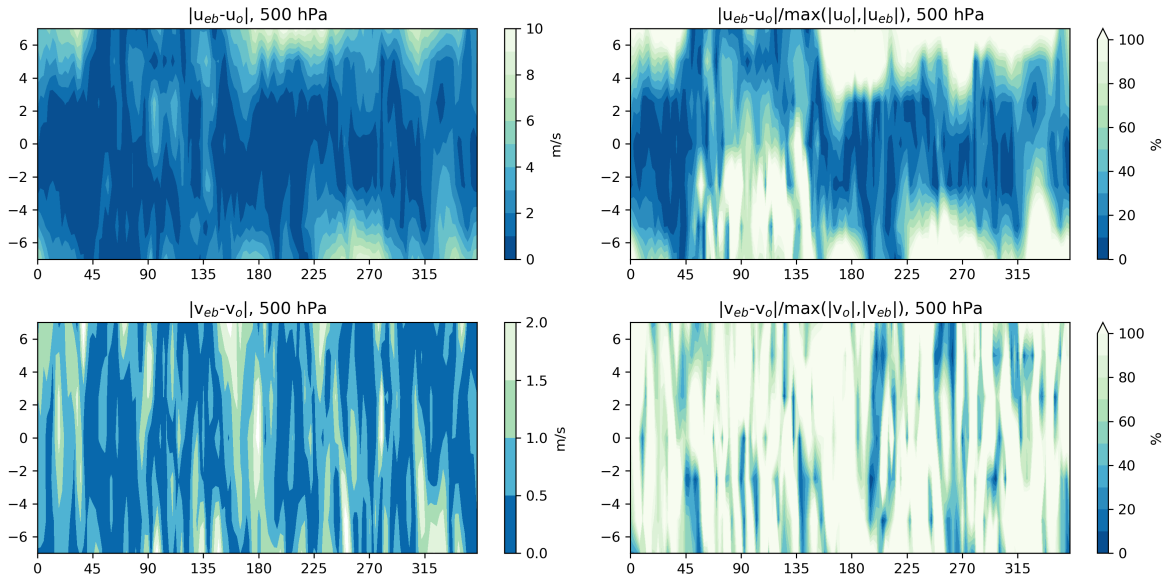

Figure 7. Absolute errors [left] and relative errors [right] of equatorial wind balance reconstruction for zonal wind [top] and meridional wind [bottom]. ERA5, April 2010, 500 hPa pressure level. Note that the relative errors were now computed differently than in Figure 6, see figure caption.

Minor comments:

I currently do not see the potential of assimilating GPSRO derived winds for NWP/reanalyses applications, opposed to the author's response to reviewers. While the equatorial wind balance applies well particularly in the monthly mean fields in the stratosphere (Fig. 2), it is somewhat less applicable for the upper troposphere and below, and even less applicable for instantaneous fields. Another issue would be the observation correlation between the already assimilated bending angles and the GPSRO winds. On the other hand, I agree there is certainly great potential in the climate scope – both for monitoring as well as climate model verification, as it is also outlined in the paper. While the authors mention that they "do not focus on analysing or describing at the same time atmospheric dynamical processes as such; this is not within the scope of this study", they should note that the atmospheric dynamics are essential to the [potential of the] GPSRO wind retrieval.

Lines 5,6: Considering the previous comment, the equatorial balance approximation becomes important in the temporal mean, while the geostrophic balance mostly applies well for the fields at any time instance too. At any time instance, we do not have a predominant balance between winds and geopotential in the tropical upper-troposphere, the fields are only multivariately coupled through the equatorial modes (e.g. Matsuno, 1966).

25: vertical resolution of wind information (in the current form it might be misread as the vertical wind component)

34-37: reformulate the tenses. ADM Aeolus is down now. It also depends on the hydrometeor Mie scattering.

77: what observing system change do you refer to? Please, be more specific.

83: stratospheric zonal-mean wind field

102: The geostrophic balance breaks down in the tropics, due to the…

107: accuracy

109-110: Try to avoid "strong" and be more specific about the averaging, e.g. as reformulate as: "Since our focus are monthly-averaged mesoscale (might even be synoptic-scale already) winds relevant for the description of climate, …
120: remove new paragraph indent

125: great! Very convincing!

138: equatorial balance approximation takes over. [not the winds themselves]

133 and Table 1: you now use the same subscript for globe and geostrophic. At this point, it seems somewhat puzzling.

Figure 1: is this based on the fields at single time instance or whole 2009, as suggested in line 149.

167: convincing!

174: consider “timeframe” → temporal averaging

175: reformulate

200: “results”: which results, be more specific? Was the systematic data bias reduced?

220: Figure 2: do these statistics apply for time-mean data (year 2009) or for some specific time instance? It should be explained somewhere.

Figure 3: (a,b) and (c,d) have the same captions, despite first two representing absolute error and the second two the relative error.

238-239 I do not agree with the statement: “The difference fluctuates within he ±2 m s−1 threshold, also in the tropical troposphere.” Also, such threshold is irrelevant given the small magnitude of the meridional wind.

242-244: Again, I do not agree with the reasoning here. The sole reason, why “it was possible to derive the wind fields close to the original wind speed” is because the zonal wind contributes the most to the wind speed and that component is well reconstructed by the equatorial wind balance.

252-257: I am not sure this improvement comes from the right source. The meridional winds could have wrong sign here and the wind speed would still improve. Any meridional wind addition would improve the total wind, i.e. if v<<u, adding v would bring the reconstructed total wind closer to the true total wind.

Fig 5f: the reconstruction error in f) is unacceptably large to capture the upper branch of the southern Hadley cell, the main feature of the tropospheric tropical circulation, despite fulfilling WMO requirements.