# Review of paper "Calibration and Validation of the Polarimetric Radio Occultation and Heavy Precipitation experiment Aboard the PAZ Satellite" by Ramon Padullés, Chi O. Ao, F. Joseph Turk, Manuel de la Torre Juárez, Byron Iijima, Kuo Nung Wang, and Estel Cardellach

## General Remarks

The paper presents impressive results on the calibration and validation of polarimetric radio occultation observation acquired by PAZ satellite. The authors thoroughly analyze the factors that can have an influence upon the observable phase differences characterizing the precipitation. Still, there are some concerns, especially regarding the phase ambiguity removal. Although I believe that this should significantly worsen the results, still the authors should address these concerns.

## Specific Comments

Page 2, lines 5–6: *The fact that in the PAZ satellite the incoming electromagnetic field is acquired at two linear and orthogonal polarizations allow us…*
The fact … allows …

Page 4, lines 19–21: *Even though the initial processing of the raw data corrects for cycle slips (i.e. changes in $\phi$ of more than one cycle in 20 consecutive measurements), after computing $\Delta\Phi(t)$ some jumps in the observable are detected. These jumps are associated to cycle slips that remained uncorrected before, or appeared after computing the difference between the two $\phi(t)$ (h and v).*
This is not clear. Why should any cycle slips remain uncorrected? Should not there be any physical cause for this effect? It should be better to present some examples.

Page 4, lines 22–26: *Therefore, the $\Delta\Phi(t)$ is also corrected for cycle slips in the following way:*

$$\Delta\Phi(t) = \arctan\left(\tan\left(\Delta\Phi(t)\right)\right) \quad (2)$$

*This approach should correct the cycle slips remaining in the data. However, this approach can still introduce a $2\pi$ jump in the phase if this is too close to $\pm\pi/2$, although this is an infrequent situation. Since the $\Delta\Phi(t)$ tends to follow a rather smooth variation in the presence of precipitation, events inducing such large $\Delta\Phi(t)$ values can be easily identified and treated accordingly.*
This paragraph raises some concerns. First, because arctan function varies from $-\pi/2$ to $\pi/2$, maximum what it can introduce is a jump by $\pi$. Second, why using formula (2), which does not distinguish between $\Delta\Phi$ values that differ by $\pi$? Referring to the fact that this is an "infrequent situation" does not really help, because the expense of implementing the standard procedure of the evaluation of the accumulated phase is low.
Page 4, lines 27–29: *For each port, data are processed to obtain $N(h)$. To assign a height to each time measurement (e.g. excess phase or SNR) is complicated, specially when atmospheric multipath is present. To do so we rely on the inverse Abel transform and we assign a tangent height (the height of the tangent point of each ray) to each phase and SNR measurement $\Delta\Phi(h_t)$, and $SNR(h_t)$.*
Provide more detail on your procedure of the evaluation of $h_t$. What about multipath propagation? How should you treat the multi-valued dependence $h_t(t)$ in this case?
Replace "specially" with "especially".

Page 7, Figure 3, caption: ... *more portion of the rays happen to be below the set altitude thresholds …*

Re-write this, e.g. as follows: … longer ray segments reach below the altitude thresholds…

Page 8, lines 10–15: *To account for the relative orientation, we use the quaternions, provided along with the orbits data. ... To account for the satellite orientation and maneuvers we use the quaternions, that precisely define the orientation of the satellite with respect to the center of the Earth Centered reference frame at any given time.*
Quaternions are briefly mentioned here and never more arise in the paper. Quaternions provide one of different representations of the spatial orientation, and they are hardly a unique means for solving the problem in question. They are, therefore, either unnecessary to mention or deserve a deeper explanation.

Page 9, line 4: *The positive values of $\phi_A$ are defined such as the angle increases towards the positive $Y$.*
Clarify the sentence, e.g. like this: *Angle $\phi_A$ has the same sign as $Y$.*

Page 17, line 9–11: *Therefore, instead of a simple average, here we perform a 1 second weighted average where the weight is represented by the SNR value, so that values of $\Delta\Phi$ associated to higher SNR contribute more than those associated to lower SNR.*
Because SNR and $\Delta\Phi$ are correlated random processes, should not this result in a systematic error?