Dear Reviewer,

Thank you very much for your reviewing and so many valuable comments. I am very glad to answer your questions one by one.

Chapter 2.2:

1. First paragraph: sound analysis means frequency analysis? Did you do this? I only see time dependent or elevation dependent plots.

A: I'm sorry, this is a small misunderstanding, here "sound" means "solid", not the spectral analysis. I have changed it, used "solid" instead of "sound".

2. Second paragraph: 1/sqrt(sin) you should mention where this dependence is coming from and what could be the cause why it is not fulfilled after fixing the RINEX converter. I would not even state that it fits well before the fixing. Please discuss in more detail what a deviation from 1/sqrt(sin) means.

A: We added a sentence on typical observation weighting in GNSS processing; $1/\sqrt{\sin(Elev)}$ is one of the models often used to assess weak elevation dependence compared to $1/\sin(Elev)$.

This weaker dependence is due to a software issue in the RINEX converter and reported in the ESA website, but there is no detailed information about the reason and effects of this issue. (https://earth.esa.int/web/guest/missions/esa-operational-eo-missions/swarm/news/-/asset_publisher/K3vp2LwLXSrF/content/swarm-software-issue-in-rinex-converter-fixed?redirect=https%3A%2F%2Fearth.esa.int%2Fweb%2Fguest%2Fmissions%2Fesa-operational-eo-missions%2Fswarm%2Fnews%3Fp_p_id%3D101_INSTANCE_K3vp2LwLXSrF%26p_p_lifecycle%3D0%26p_p_state%3Dnormal%26p_p_mode%3Dview%26p_p_col_id%3Dcolumn-1%26p_p_col_pos%3D1%26p_p_col_count%3D2%26_101_INSTANCE_K3vp2LwLXSrF_cur%3D12%26_101_INSTANCE_K3vp2LwLXSrF_keywords%3D%26_101_INSTANCE_K3vp2LwLXSrF_advancedSearch%3Dfalse%26_101_INSTANCE_K3vp2LwLXSrF_delta%3D10%26_101_INSTANCE_K3vp2LwLXSrF_andOperator%3Dtrue).

The elevation dependence of the noise in GNSS is under nominal reception conditions- covered by the antenna gain pattern. For the spacecraft an exponentially elevation dependent pattern could fit even better the residual time series. A deviation from the curve shows that the precision of the observations at that specific elevation is either overestimated or underestimated.

3.Third paragraph: second difference is not a good expression for the difference of differences, please explain in more detail.

A: Thanks for this comment. .We changed "second differences" to "second-order differences" , which is often used in the time series analysis and added a formula $\Delta_2 L(t)=L(t+1)-2L(t)+L(t-1)$ for a better understanding.

4.With the construction of these differences of the differences a problem is accompanied, namely in giving this quantity an unit. You chose m (as it is a difference of two meter values) but this value is in some parts dependent on the sampling rate so m/s2? but this is also not really correct as we do not talk about accelerations. You can stick to meter, but you should be aware that is this somehow an arbitrary unit and it is only useful in comparing the same data set. What you mention in the text. You should make this clear and I would even prefer to indicate the fact in the plots by using "arbitrary units". In this sense also your paragraph 6 where you discuss the 8 and 9mm noise level of this quantity is not adequate. You should just compare xx times higher in the regions of the poles and equator.

A: With the added definition of “second differences” and the formula, it is more clear that the unit is meter.

The noise for L1 and L2 are computed from Δ_2L1 and Δ_2L2 again, according to the error propagation law, $\sigma_{L1} = \sigma_{\Delta_2 L1}/\sqrt{6}$, same for L2.

5. You should also stick to standard deviation 1sigma or 3sigmas but do not mix it.

A: Sorry for the confusing with 1/3 sigma. We have changed them to 1 sigma.

6. Paragraph 4 is wrong: difference of differences of L3 can have strong influence left from the ionospheric fluctuations. Two frequencies do not take exactly the same path through the ionosphere and therefore depending on the size of the fluctuations can have a totally different instantaneous effect on L1 and L2 what you extract by building the differences. So this is probably no issue of the receiver.

A: We agree that it is difficult to assess the actual reason of the noise, thus, we changed the sentence.

We delete the sentence “This indicates that the fluctuations are observation noise caused by the GPS receiver and not the variations of ionospheric delays.”

Actually, at least some of these errors are caused by the GPS receivers, which are sensitive to differential dynamic, e.g. due to ionosphere (private communication with Franz Zangerl). After the update of carrier loop bandwidth (L1: from 10 Hz to 15 Hz, L2: from 0.25 Hz to 0.5Hz), these systematic errors are significantly reduced.

Section 2.3

1. Equation 3 b1 and b2 have no unit (but in the equation meters are needed)

A: Yes, b1 and b2 have no unit, the unit is contained in 0.4844 and 0.3775. We added formula instead of these values, so, the unit problem can be avoided.

2. Line 14 page10: what does n stand for? Which value does it have?

A: n is the number between two epochs used in the computation of ΔL_3, that means $\Delta L_3(t) = L_3(t+n) - L_3(t)$. Considering the noise level, we propose n=100 for Swarm satellites.

Minor points:

1. Page 2 line 26 An approach . . .

A: corrected

2. Page3 paragraph 2 and 3 belong together

A: I think, it is too long to put paragraph 2 and 3 together.

3. Page 3 line 23: Another reason for tracking less than . . .

A: corrected

4. Page 5 line 8: errors

A: corrected

5.Page 6 line 5 degrades A: corrected