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.

P.1. L.1 : It is rather ambitious to state that Swarm can be a gap filler between GRACE and GRACE-FO. It can provide temporal gravity field information for the gap, but not with the same quality and spatial resolution.

A: We changed the sentence according to your suggestions.

P.1. L.14: Please specify for which purpose(s) the correlation needs to be taken into account.

A: I added " for example, for the recovery of gravity field from kinematic orbits" after "taken into account"

P.2. L.5:

A: the -> independent

P.2. L21: Please note that for the ESA orbit products use is made of the DLR/GSOC GHOST software. Thus this is not an ESA estimator. Please correct.

A: changed to "Bayesian weighted least-squares estimator, which is implemented in the GPS High-precision Orbit Determination Software Tools (GHOST) developed at the Deutsches Zentrum für Luft- und Raumfahrt in close cooperation with TU Delft and used for the ESA official orbits".

P.3 L.1 : It also relies on the quality of GPS ephemeris and clock solutions!

A: added "as well as on the introduced GPS orbit and clock products".

P.3. L.10

A: 10° -> 10° elevation

P3. L.28 and L.29: Do these numbers apply for daily period?

A: No, they are for monthly period, in September 2015, which can be seen in Fig.1b.

P.5. L.4: 21 cm is not slightly smaller than 31 cm?

A: we removed "slightly".

P.5 L.6: Exactly how is "second differences" defined? Is the difference between two consecutive observations at a time step of one second?

A: not exactly, the second differences is the difference of differences between two consecutive observations at a time step of one second. 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.

P.5 L.20: Are you sure, how about higher order ionospheric effects? Ionospheric scintillations? Am I missing the point here? Please explain.

A: The higher order ionospheric effects cannot reach decimeter level. According to the study of Jäggi (2015), the effects of higher order ionospheric effects can be neglected.

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.

P.6 L.5 & 6

A: degrade -> degrades; make -> makes

P.6 L.8: standard deviation is 1-sigma, not 3-sigma. Please be consistent with terminology and symbols. This is confusing ...

A: sorry for the confusion, I have changed all of them to 1 sigma, also for the code noise part. Because the 3-sigma are directly estimated from the figure and the 1-sigma is computed from the data, so, the computed 1-sigma is not exactly 1/3 of the 3-sigma value used in the original text.

P.8 L.1:

A: Detect-> Detection

P.10 eqa. (1): Please check if all symbols have been described (before).

A: Thank you for the remind, I added f1 f2 L1 L2.

P.10 L.17 & 19: m in Italics? Now, it suggests "meter". Also, what does "m" represent, is it number of observations?

A: sorry for the confusion. Here m should be in italics, m is the length of moving-average window, namely, the number of observations.

P.10 L.5: zero constant?

A: No, it is not a constant zero, but zero-mean, because of noise.

P.10 L.14 n?

A: sorry for it, here m should be n.

P.11 L.5 : This is only two times 10 cm. What is the confidence interval?

A: here 20 cm is just an empirical value, derived from the time series in the figure, there is no strict threshold for it. Theoretically, the confidence interval should be 95%.

P.12 L.6: Reference or copyright sign?

A: This is developed by ourselves.

P.14 L.2 :

A: satellite arc -> GPS satellite-to-satellite tracking pass.

P.14 L.2: What are the parameter settings for the Gauss-Markov process, e.g. correlation time, a priori and steady-state sigmas? Did I overlook?

A: These information are listed in Table 3. A batch lease-squares adjustment is used, so no noise processes are set up.

P.14.L.12: The large noise in the orbits can be eliminated using the Matérn covariance family (Kermarrec et al. , 2018). Did you use this? If yes, then please describe how, otherwise remove this remark.

A: We do not use this method to the results in this paper. We deleted it.

P.14. L.31: Can you explain the significant difference between these two values, i.e. 93.5 and 80.3 min?

A: We are not very sure about the reason for the 80.3 min for ESA. These PSD are derived from the computed orbits, so it is normal that there is a difference between the real and theoretic value. Some uncorrected systematic errors can also change the period of the time series, for example, undetected cycle slips.

P.15 Fig.10

A: added "RMS = r, mean =m".

P.15 L.3: Do you mean periods of 250 s and 100 s?

A: Yes.

P.16 Fig.11

A: added "with respect to ESA reduced-dynamic orbits".

P.16 L.1: ITRF2014 FES2004 Please include references for ITRF2014 and FES2004.

A: added Altamimi(2016) for ITRF2014 and Lyard et al. (2006) for FES2004

P.16 L.5: Did you also apply elevation and azimuth corrections for the Swarm SLR reflectors?

A: No, reflector-dependent range corrections were not applied. This information is added to the text.

P.18 L.1: the covariance of 1 s is computed epoch-wise, Please describe how?

A: We added "the covariance of 1~s is computed epoch-wise by sequential inversion of block submatrices", the formulas are listed below but not shown in the paper.

$$Q = (A^T PA)^{-1} = inv(\begin{bmatrix} N_{11} & N_{12_1} & \cdots & \cdots & N_{12_j} \\ N_{21_1} & N_{22_1} & 0 & \cdots & 0 \\ \vdots & 0 & N_{22_2} & \cdots & \vdots \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ N_{21_j} & 0 & \cdots & \cdots & N_{22_j} \end{bmatrix}) = \begin{bmatrix} Q_{11} & \cdots & \cdots & \cdots & \cdots \\ \vdots & Q_{22_{11}} & Q_{22_{12}} & \cdots & Q_{22_{1j}} \\ \vdots & Q_{22_{21}} & Q_{22_{22}} & \cdots & \vdots \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ \vdots & Q_{22_{j1}} & \cdots & \cdots & Q_{22_{jj}} \end{bmatrix}$$

$$Q_{22_{jj}} = N_{22j}{}^{-1} + N_{22j}{}^{-1} N_{12_j}{}^{T} Q_{11} N_{12_j} N_{22_j}{}^{-1}$$

$$Q_{22_{ij}} = N_{22_i}{}^{-1} N_{12_i}{}^{T} Q_{11} N_{12_j} N_{22_j}{}^{-1}$$

P.18 L.6: 24 hr is two times the GPS orbital period?

A: Yes.

P.20 L.5

A: inner -> internal

P.21 L.3:

A: clock->clocks

P22. L.36: No authors for this technical report?

A: No, this is an offical document from ESA. We do not find the authors' name.

P.25 Table2: How many cycle slips were not repaired for L1 and how many for L2? Do I overlook?

A: The number of unrepaired cycle slips is same for L1 and L2. The cycle slips on L1 and L2 are repaired together, which means, if we can repair L1, L2 can also be repaired, if we cannot repair L1, L2 cannot be repaired neither.

P.26 Table:

A: Orbits-> ephemeris