Date: December 11, 2018

Manuscript #: amt-2018-271
Manuscript title: ***Processing and quality control of FY-3C/GNOS data used in numerical weather prediction applications***

Brief Summary of the Manuscript
This manuscript presents an approach to correct for L2 signal degradation of the GNOS receiver, as well as it introduces quality control (QC) checks to evaluate this new approach in bending angle profiles. Finally, the manuscript presents comparison statistics between the GNOS L2-corrected profiles with ECMWF. Despite the authors' efforts, there are serious concerns regarding the physical-mathematical interpretation of the new approach and in extent of the results presented in this manuscript. Based on the comments below, I recommend rejection of this manuscript.

Major Comments:

1) ***Introduction.*** The manuscript lacks motivation. Since the authors present a new methodology to correct the L2 signal bending, the "old" ROPP L2 signal correction approach should be described. Additionally, the differences between the "old" and the "new" approaches should be emphasized and discussed in detail. Currently, the reader cannot understand why the current ROPP approach does not work for the GNOS retrievals and all relevant references are missing.

2) ***Introduction: P. 3; Line 30.*** "These biases are not seen with other RO missions." Yes, the L2 signal is weaker than the L1 signal. However, other RO missions do not lose L2 signal tracking that much high up in the neutral atmosphere. The authors should explain why GNOS loses L2 signal tracking in the stratosphere at ~ 20 km, unlike all other RO missions. The authors state that the most prominent quality issue was the large departures biases, in the vertical range of 5 – 30 km. This altitude covers the middle troposphere up to the middle stratosphere. Then, within this context, if GNOS loses 30% of the profiles below 20 km (see P. 5; Line 11), then the authors should explain how does GNOS contribute to Numerical Weather Prediction (NWP) and specify the most effective altitude range of the GNOS RO profiles.

3) **New L2 extrapolation**: Equation (3.4) states that the bending angle in L2 frequency equals the bending angle in L1 frequency plus a correction factor, which is proportional to the ionospheric TEC. The problem in Equation (3.3) is that it is derived using Equation (3.2), which is valid only for ionospheric bending and not for neutral atmosphere bending, as specifically mentioned in *Culverwell and Healy* (2015). Within the neutral atmosphere the ionospheric bending becomes negligible and the signal bending at tropospheric and stratospheric altitudes has an exponential dependency on the impact parameter – different than Equation (3.2). Therefore, how could the authors apply Equation (3.2) to correct for the L2 bending angle within the neutral atmosphere using bending angle approximations derived for ionospheric bending only – particularly when applying this method from the lowest altitude the L2 signal is lost and 20 km up with a maximum upper limit of 70 km that is around the bottomside of the ionospheric D layer?

4) **Equation (4.1):** The X_{so} is estimated from the least squares fit between the observed L1 and L2 bending angles. Then again, the new *noise_estimate* the authors introduce defines a new statistical metric based on how close the X_{so} is to the observed L1 and L2 bending angle difference. But, the X_{so} was estimated in Equation (3.4) to fit the minimum bending angle difference in L1 and L2. This *noise_estimate* appears to be misleading, without physical underpinning and with an over-fitting nature that beats down the scatter. Additionally, P. 9; Line 8: "The physical meaning of *noise_estimate* is easy to understand." Is not easy to understand and the authors should explain the rationale of defining it, because the X_{so} has already been estimated well via Equation (3.4). Also, how do the authors decide on the 20 microradiances as the threshold value?

5) **Section 4.2:** The authours do not explain why is it necessary to monitor the performance of GNOS mean L1 and L2 phase delays in the height interval of 60 to 80 km. Also, why the mean phase and not the phase variation with altitude within this height range? What GNOS product is assimilated in NWP models and how does monitoring the 60-80 km phase delays help us to QC the profile below?

6) **P. 10; Line 21:** "*...these have been tested with one day of data*..." The statistical sampling used in the determination of the statistical performance of the QC methods is low and does not represent the statistical performance of the GNOS profiles around the globe and under different seasons.

7) **Section 5:** The authours explanation of the 15% disagreement between the GNOS and GRAS profiles below 10 km is inadequate. Ideally, collocated profiles between GNOS and GRAS should be used to quantify the degree of agreement or disagreement. However, if there are not enough collocated profiles between July 6 and August 2, 2018, perhaps the authours could use the entire time period GNOS provides RO profiles and if there are still not enough collocated profiles the authours could bin their profiles either into latitude sectors or seasons and then compare with GRAS to create an ensemble study to greatly increase the statistical sampling. ***The results represent a limited statistical sampling to support the authours' claims.***

Minor Comments:

a) **P. 2; Line 16:** "...velocity and anti-velocity antennas..." Do you mean fore and aft antennas?
b) **P. 2; Line 19:** What is the GNOS inclination in Table 1?
c) **P. 2; Line 17:** Is BDS global or region constellation. Mention geographic restrictions of RO.
d) **P. 3; Line 22:** "...departure statistics..." From what?
e) **P. 3; Line 25:** Why more than 20% levels of the profile? How was this threshold selected? Explain.
f) **P. 4; Line 10:** What is the most effective altitude range that GNOS provides the best RO profiles and explain how this information is used in NWP and how does it improve NWP. Include references to support claims.
g) **P. 4; Line 14:** "...may..." replace with "...could be..."
h) **P. 5; Line 11:** Is this L2 signal loss at 20 km normal? Usually L2 signal is lost in the middle troposphere which is about 5 km. Explain.
i) **P. 5; Line 27:** "...consistency..." replace with "...agreement..."
j) **P. 6; Line 5:** Define "obvious errors".
k) **P. 6; Line 9:** Define "other profiles".
l) **P. 6; Line 11:** This definition of the ionosphere is crude, general, and unrealistic. Usually, the ionosphere is represented with multiple Chapman profiles with different scale heights. Mathematically, the Dirac function obtains a value of 0 at altitudes outside a very small neighbourhood of the peak height.
m) **P. 6; Line 27:** Why the peak height is 300 km? What led to this selection? The rule of thumbs says that per 100 km different in ionospheric shell height leads to 1 TECU error in the ionospheric total electron content. How sensitive is the estimation of X_{so} to the ionospheric TEC?
n) **P. 7; Equation (3.4):** This equation describes the ionospheric bending angle and not the neutral atmosphere. How can the authors apply this equation to correct for the L2 bending in the neutral atmosphere?