Reply to reviewer #1's comments

We appreciate valuable and constructive comments provided by this reviewer, we are also grateful for careful reading of the manuscript. Our response for each comments are shown below.

Main items

1. Regardless of the noise issue which is appropriately addressed in Section 5, one cannot ignore that GW are not omnipresent and permanent, as outlined e.g. by M.J. Alexander and C. Barnett (2007) in their Section 2a. Therefore statistical calculations cannot be straightforwardly applied to a large number of GPS RO, but some criterium must be established to separate cases including or not GW. Otherwise the statistical outcomes just reflect an average state of all the atmospheric structures detected by the observational window of the measurement technique.

GPS RO basically provides a snap-shot profile of temperature. It is very difficult to confirm the existence or absence of gravity waves in individual GPS RO data. However, it is now commonly accepted that the gravity wave activity is nearly continuous regardless of season, location and altitude, although considerable variations exist depending on wave generation mechanisms, wave-mean flow interactions, and so on.

GPS RO profiles normally appear as a projection of many gravity waves with different frequency, vertical and horizontal wavenumbers. Statistical characteristics of such perturbations can be described well by analyzing a vertical wavenumber spectrum. It is noteworthy, however, that the horizontal resolution of GPS RO is about 300 km, being common to a limb scanning method. Because of this observational filter effect [Alexander, 1998], a part of horizontal wavenumber spectrum is removed. Assuming a horizontal wavenumber spectrum with a logarithmic slope of -5/3 extending from 1 km to 5,000 km in wavelengths, Tsuda et al. [2000] estimated a reduction of the estimated wave energy to be less than 15%. GPS RO can resolve most of the vertical wave number spectrum with wavelengths ranging from a few hundred meters to about 10 km, which is very unique compared to other satellite instruments.

Some of above statements are included in Introduction.

2. P 2079, l 6: what is being stated here is that uncertainty in average may approach 0.5 K (2 K in individual profiles if one considers standard deviation intervals), i.e. a

typical GW amplitude, which is what the authors are trying to measure.

Figure 4 compares the magnitude of temperature bias between GO and FSI retrievals, which indicates that FSI is not inferior to GO in the entire height range in terms of the temperature bias.

Standard deviation of the temperature difference actually indicates the magnitude of the gravity wave effects. Profiles with radiosondes and GPS RO are obtained with certain time difference and spatial separation, i.e., 30 minutes and 400 km maximum in our analysis. Then, temperature perturbations caused by gravity waves may naturally have phase differences, which results in as the standard deviation of temperature differences. The standard deviation mostly reflects natural variability rather than error.

This discussion is included near the end of Section 3.

3. P 2083, l 23: here the estimated error is 1 K, same argument as above.

We do not understand clearly key point of this comment. In any case, as the r.m.s. value is about 2 K, the amplitude of GW can be estimated as about 3 K, though in a statistical sense. Therefore, FSI profile with 1 K error is useful to detect GW.

Minor points

4. Page 2072, line 25 and P 2084, l 14: the ionosphere is part of the atmosphere, I guess that neutral atmosphere and ionosphere is meant.
   "and ionosphere" is removed.
5. P 2073, l 17: data points per day.
   Revised as suggested.
6. P 2076, l 6-7: this is to optimistic, please see later references, e.g. G.A. Hajj et al. (2004). ,
   This statement is revised considering the comment.
   "Kursinski et al. (1997) estimated accuracy in the temperature inversion as 0.2–0.4 K at 5-30 km. Comparing nearby GPS RO profiles with CHAMP and SAC-C, Hajj et al. (2004) evaluated the discrepancy to be less than 0.86 K in the interval between 5 and 15 km."
7. P2076, Il 27: I guess L1 is missing.
   Revised
8. P 2078, l 10: a horizontal distance of 400 km is marginally acceptable from my point of view, so it should be at least specified if the distance is being measured between the balloon launch site and the RO average position in the neutral atmosphere or to

the RO closest position or : : :

This statement is revised considering the comment.

"These RO events occurred within about one hour from the balloon launch at 11:39 UTC from Kuching, Malaysia, and the distance between the launch site and the RO tangent position at around 4 km altitude (square symbols in Fig. 2) was about 250 km."

9. P 2081, l 5: show.

   Revised

10. P 2082, l 4: While, : : :, moreover: : : the sentence must be written in another way. ,

    This statement is revised considering the comment.

    "System noise may not depend on altitude, but ionospheric effects increase at higher altitudes."

11. P2082, l 15: Can you guess what other noise ?

    Revised as "system noise and ionospheric effects".

12. P 2083, l 24: What standard atmospheric model ? Can you give a reference ?

    We refered to MSISE.

13. Figure 4: Number of pairs. There are no references for each curve.

    Caption to Fig. 4 is revised.

    "Figure 4. Comparisons between COSMIC GPS RO profiles and high-resolution routine radiosonde data in November 2006 in North America. Blue lines show the temperature differences and standard deviations (bottom scale), where the GO and FSI methods are adopted for GPS RO retrieval in left and right panels, respectively. Red lines indicate the number of comparisons (top scale)."

14. Figures 5,6 and 7: where do the N2 values come from ? As far as I know spectral density should be in m2/cycle. In Figure 6 it should be "is shown" and "in parentheses".

    The mean value of N^2 is estimated by using GPS RO temperature profiles. We are sorry to correct that the unit of N is (rad/s). The variance of the normalized temperature perturbations does not have dimension, so, its spectral density has a unit of 1/(cycle/m).