Replies to Reviewer 1

Authors thank the Reviewer for the constructive comments and suggestions. We believe that the revised paper is more clear and concise.

Please note that authors' replies are in blue.

The authors use data from the Formosat-3/COSMIC constellation to compare temperatures derived from GPS Radio Occultation with temperatures from other satellite measurements and different reanalyses.

The paper could become an interesting contribution the current literature but there are several open questions, which I would like to see answered before the manuscript can be recommended for final publication (see my general comments below). Page and line numbers refer to the document http://www.atmos-meas-tech-discuss.net/6/6187/2013/amtd-6-6187-2013.pdf

General comments:

(1) The paper deals with the validation of the "new "atmPrf" dataset" and the authors come to conclusions like "Earlier the COSMIC data was available only up to 40 km and was reliable only up to ~ 30 km. This new dataset extends further up to 60 km and is reliable up to ~50 km as the present validation study reveals." (page 6191, lines 10 - 12) - but there is a terrible lack of information about this data set.
Authors apologize for the confusion.

What are the "new" and the "old" data?
The 'new' dataset is the 'atmPrf' level 2 dataset and the old one is the 'wetPrf' level 2 dataset. We have dropped the words 'old' and 'new' in the revised manuscript.

If you used real-time data from CDAAC: Which data version(s) did you use?
We have used post-processed level 2 data and the product version is 2010.2640. We have modified the text appropriately in the abstract and section 2.1.

Why are the new data so much better?
By neglecting the water vapor information, the temperatures are retrievable up to 60 km and hence can be used to investigate the stratosphere.

If this should be indeed the case it must be due to differences in the retrieval. Please describe these differences and provide a proper reference. RO temperatures in the upper stratosphere are very sensitive to the high-altitude initialization scheme used. How is this done for the "new dataset"?

From the same GPS RO measurement 'atmrf' and 'wetPrf' are retrieved using different procedures.

'atmPrf': Initially, L1 and L2 bending angle profiles are computed and then are linearly combined at common impact parameters to produce an ionosphere free bending angle profile versus impact parameter. During the retrieval process, this observational bending angle profile is differenced with a climatological bending angle profile (i.e. RO bending minus climate bending) to obtain the optimized bending angle. The mean (SMEAN) and standard deviation (STDV) of these bending angle differences are computed between 60 and 80 km altitude (where neutral atmospheric bending is negligible) and are used to estimate errors (that are reasonably assumed to be valid at other heights) for quality control purposes. The optimized bending angle $\alpha_{opt}(a)$ is obtained in the height range defined by RO observations. If RO starts below 150 km, the optimized bending angle is extended up to 150 km height by setting $\alpha_{opt}(a) = \alpha_{guess}(a)$ by using exponential extrapolation of the $\alpha_{guess}(a)$ above the top height. Thus optimized and extended bending angle profile is subjected to Abel inversion (the large top height allows setting zero boundary condition at the top) to get the refractivity:

$$n(x) = \frac{1}{\pi}\int_{x}^{x_{top}} \frac{\alpha_{opt}(a)}{\sqrt{a^2 - x^2}}\, da$$

where $x = rn(r)$ and $N = 10^6(n-1)$ and $z = r - r_{curv} + \Delta z_{geoid}$, where r_{curv} is the local curvature radius at the occultation point (step 5) and Δz_{geoid} is geoid correction.

Under the assumption of dry air, the retrieved refractivity is directly proportional to density $N = c\rho$. Then pressure is retrieved by integration of the hydrostatic equation: $p(z) = c^{-1}\int_{z}^{z_{top}} g(z')\rho(z')dz'$ and temperature is derived from the equation of state: $T = mp/R\rho$.

Further details can be found at http://tacc.cwb.gov.tw/cdaac/doc/documents/roam05.doc and in Schreiner, etal (2010, GPS Solut.).

'wetPrf': This data product is obtained using the one-dimensional Variational Atmospheric Retrieval Scheme (1D-VARS) For neutral atmospheric condition, after the removal of ionospheric contribution, the atmospheric refractivity (N) can be expressed by

$$N = 10^6(n-1) = 77.6\frac{P}{T} + 3.73 * 10^5 \frac{e}{T^2}$$

where *n* is atmospheric refractive index, *P* is pressure in hPa, *T* is temperature in K, and *e* is water vapor pressure in hPa. Because of the local property of atmospheric refractivity (or refractive index), the computation of refractivity from temperature, pressure, and moisture is straightforward. In a spherically symmetric atmosphere, the bending angle of GPS signal (α) relates to refractive index via Abel integral transform. Further details can be found at http://cdaac-www.cosmic.ucar.edu/cdaac/doc/documents/1dvar.pdf .

What are the "old" data you are referring to, and why have they only been reliable up to ~30 km (+ reference)?
The 'wetPrf' data are the old data. The validation study by Kishore et al (2009) shows that the temperatures are reliable up to 30 km only.

(2) The comparisons with radiosondes are based on a minuscule ensemble of 34 profiles only, obtained at a single station in Taiwan. While being relevant for this particular station this study is totally insufficient for an assessment of global temperature data.
We agree with the reviewer and since in the current paper we are concentrating on the stratospheric temperatures, we have removed this section.

(3) The authors used reanalysis date from different centers, which have only been available at limited height levels. For long-term data-sets there might be good reasons to use reanalyses as reference, but for comparison over just a year it would have been a better idea to use analysis data with higher vertical resolution and an extended vertical domain – especially when focusing on the performance in the stratosphere and beyond. ERA-Interim data are available at 37 pressure levels up to 1 hPa, but ECMWF analyses for 2010/11 are available at 91 levels up to 0.01 hPa. Even worse – NCEP data have only been available up to 100 hPa, which is certainly not appropriate to study temperatures in the stratosphere.
We agree with the Reviewer. However, due to non-academic reasons, we could use only data that is freely available for the comparisons. And hence we are limited to certain altitudes with all the reanalysis outputs.

Specific comments:
(1) I am not entirely sure about AMT rules, but most journals (e.g. all AGU journals) require authors to use "data" as a plural word ("data are" instead of "data is" – on several locations).
Done

(2) Page 6188, line 8: "above the tropopause (> 100 hPa)": The height of the tropopause varies considerably with latitude. 100 hPa is fine in the Tropics, but certainly not at mid and high latitudes.
Done

(3) Page 6188, line 10: "during December 2010 to November 2011" --> from December …
Done

(4) Page 6189, line 5, 6, and 7: "for e.g.": "e.g." means already "for example", therefore you can discard "for".
Done

(5) Page 6191, line 2-4: ".. into six orbit planes at 800 km with a 30° separation for evenly distributed global coverage, which has been successfully achieved." This not entirely true: The orbit raising of FM-3 has been stopped at ~710 km due to problems with the solar panels. Furthermore, the main reason for the 30° separation was a good coverage in local time.
We thank the Reviewer for the clarification. The text is modified appropriately.

(6) Page 6191, line 25 – 26 and Fig. 1: "Number of observations is marginally higher …. Very uniformly distributed ..": In my interpretation a factor about two is not marginal. Also the longitudinal distribution is surprisingly non-uniform (especially at southern mid to high latitudes), given the geometry of the COSMIC constellation. Do you have an explanation for this?
The text is modified as depicted by the figure.

(7) Page 6193, line 17: ".. at 1.30 a.m. and 1.30 p.m. ..": In Fig. 1 the maxima appear to be right at 2:00 a.m and 2:00 p.m.
This is due to the common data analysis procedure for all satellites where data are gridded to the nearest hour. However, Aura takes measurements at 1:30 am and 1:30 pm.

(8) Page 6195: line 19: ".. -20° to 20° ..": In Fig. 2 you show separate results for -20° to 0° and 0° to 20 °.
Corrected

(9) Page 6195, line 21: "… medians and their standard deviations ..": Was there a particular reason to use medians and not mean (like many outliers or so)?
Yes, to remove the outliers we have used the median.

(10) Page 6213, Fig, 6, caption: "Right" and "left" are reversed.
Corrected

There are several minor issues (use of articles …), which can be solved in a later stage of the review process.

We have thoroughly checked the paper for grammatical and typographical mistakes and hope that the language has now improved.