"Refractivity and temperature climate records from multiple radio occultation satellites consistent within 0.05%" by U. Foelsche et al.

Reply to Referee # 2

We would like to thank referee #2 for the thorough review of our paper and his/her constructive and useful comments. We have answered all comments below.

The referee's comments are included in *italic*.

This paper seeks to show consistency between climatologies of RO products assembled by individual RO satellites. It finds that the climatologies are consistent to < 0.05% in refractivity after ECMWF analyses have been used to correct for sampling error. From this the authors conclude that RO satellites are spectacularly consistent and that ECMWF analyses are very useful for correcting for sampling error. This is already an excellent paper and deserves publication. I only have the most minor of quibbles before publication.

Thank you for this appreciation of our work.

(1) Rather than "instationarity", consider the expression "temporal inhomogeneity" instead. (Line 16 on page 1594; line 5 on page 1604)

We followed your suggestion.

(2) One cannot resolve the semidiurnal cycle with four-times daily sampling, because the semidiurnal coefficients are at the Nyquist frequency for four-times daily sampling. (Lines 23-25 on page 1601)

Right, the formulation was not precise enough, we changed it to: ".. whose four time layers per day are sufficient to sample the diurnal cycle and subdiurnal variations up to the semidiurnal cycle."

(3) The folks who introduced double-differencing for RO calibration are Hardy, Hajj, and Kursinski, 1994: Int. J. Sat. Comm., 12, 463-473; not Hajj et al., 2002. (Line 14 of page 1595)

Thank you for this comment – we have included the reference.

That's all I have of substance. The following points are for consideration scientifically:

(1) What are the consequences for this analysis of that fact that ECMWF has assimilated much of the satellite data that is being inter-compared?

For the sampling error calculation this does not really matter, since the sampling error stems from regions (and times) where there are no radio occultation data. In our retrieval we use ECMWF data for the high altitude initialization, but we use forecasts and not analyses.

(2) Sampling error seems to be consequential only for high latitudes. Why is the sampling error so large there?

Sampling errors are largest, where atmospheric variability is high (most pronounced at mid to high latitudes in winter) and where strong latitudinal gradients exist (e. g, at the edges of the polar vortices). Due to its comparatively low inclination the Formosat-3/COSMIC constellation provides a modest sampling of the polar cap. This was most pronounced during the early stage of the mission, when the satellites were still at low orbit altitudes.

(3) Are there really no temporal biases in RO data due to sampling? Doesn't mutual precession of LEO and GPS satellites give rise to tropical biases?

So far we have not been able to find any false **trends** caused by sampling errors, but we are aware of this potential issue and will also carefully consider it in the future. There are certainly biases, e.g. due to uneven local time sampling (Pirscher et al. (2007, cited in the manuscript). For Formosat-3/COSMIC we found, e.g., a (very small) oscillatory local time component of the sampling error in monthly mean climatologies in the extratropics (hemispherically antisymmetric, with a half cycle pf ~60 days, and ± 0.03 K amplitude). But this error already disappears to < 0.01 K when building seasonal means (Foelsche et al., 2009, cited in the manuscript).