Reply to Anonymous Referee #2

(https://doi.org/10.5194/angeo-2019-140-RC2, 2019)

Authors thank the Reviewer for her/his positive comments and suggestions. Please note that point by point replies are given below in blue. We sincerely hope that the revised manuscript is now clear and concise.

General comments

Temperature data from the FORMOSA Satellite Series No. 3/Constellation ObservingSystem for Meteorology, Ionosphere and Climate (FORMOSAT-3/COSMIC) observationsobtained during 2009 to 2010 have been used to analyze migrating (DW1) andnon-migrating (DS0 and DW2) diurnal tides in the middle atmosphere from 10 to 50 kmover equator and 65_N. For this, the authors have separated two overlapping groupswith data from 4 satellites each besides to consider data from 6 satellites group. Theanalysis of each group was performed considering 21 days data centred over each 11days. The topic of the manuscript is interesting for understand the source of generationof non-migrating tides in the high latitude during winter, as well as to identify aliasingeffects in satellite data analysis. The manuscript presentation is clear and the scientificcontribution is appropriate for this journal. However, there are some moderated issuesthat need to be addressed.

Specific comments

Some important works that deal with short-term variability of the tides were not contemplated.For example: using NAVGEM-HA reanalysis and meteor radars McCormack etal. (2017) have observed day-to-day variability of the winds and tides. Recently, Baumgartenand Stober (2019) have estimated the tidal variability from 10-day continuouslidar observation.

Ans: Authors thank the Reviewer for providing these important references. They are now discussed in the revised manuscript in Section 6.

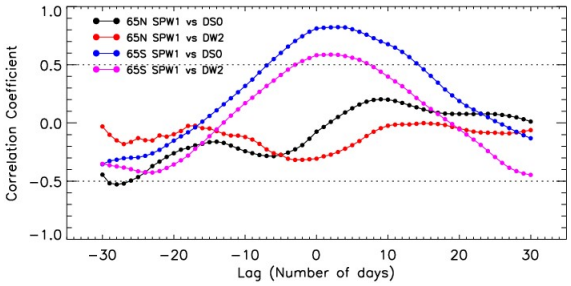
"Baumgarten and Stober (2019) derived short term tidal variability in the altitude range from 30 to 70 km using temperature derived from lidar observations at Kühlungsborn (54°N, 12°E), a mid latitude station. The diurnal tide (consisting of all wavenumbers) in temperature and winds was extracted from lidar data and compared with DW1 component of temperature and winds from Modern-Era Retrospective analysis for Research and Applications, Version 2 (MERRA-2). It was shown that the local tidal fields are dominated by the migrating diurnal and migrating semidiurnal tides and that other components are negligible. This indicates that the non-migrating components may have very little contribution and thus supports the current study that the observed non migrating tides could be possibly due to aliasing."

"McCormack et al (2017) investigted the short term tidal variability during the SSWs of January 2010 and January 2013 using high latitude Navy Global Environmental Model (NAVGEM) data in the mesosphere and lower thermosphere region. NAVGEM is a result of assimilation of middle atmospheric data from nine meteor radar stations and other satellite measurements, including those from SABER on board TIMED satellite. Their results show a reduction in semi-diurnal amplitude before the onset of SSW and increases after the event, peaking 10-14 days later."

Information about the COSMIC mission and its temperature profiles was not sufficientlyaddressed. Could the authors include a brief summary containing minimal informationabout the COSMIC mission as well as the temperature derivation process?
Ans: The phase delay of L1 and L2 in signals received is due to change in refractivity which is converted to electron density in the ionosphere and temperature and other parameters in the lower atmosphere and are described in detail in literature (Kuo et al., 2004; Kursinski et al., 1997). Briefly, the Earth's refractive index at microwave wavelengths is affected by the dry neutral atmosphere, water vapour and free electrons in the ionosphere and thus by deriving refractivity of the atmosphere, the above mentioned parameters can be retrieved. This is now included in the revised manuscript.

What is the COSMIC post-processed level of data used in the study? The authorscould also add information about the spatial distribution of the COSMIC observations(vertical and horizontal resolutions) of the data used in the study.
Ans: COSMIC level2 dry temperature 'atmPrf' profiles for lower atmosphere are used in the present study. Data is considered at 1 km intervals from 15 to 50 km. It is known that the vertical resolution of RO derived temperature profiles is 0.5 km in the troposphere and 2 km in the stratosphere (Kursinski et al., 1997, Scherllin-Pirscher et al., 2017). This is now added in the revised manuscript.

Based on correlation analysis between tides and SPW1 amplitudes, the authors claimthat the contribution of nonlinear interaction to non-migrating tides generation is not important.To provide convincing support for this finding, an effort should be undertakento include additional analysis (for example, cross-correlation and phase coherence).
Ans: Figure 7 shows that there is no significant correlation between non migrating tides and SPW1 and thus, no reasonable statistical relation can be established between occurrence of these waves. To investigate this further, the numerical experiments have been performed as described in Table 1 and shown in Figure 9. These numerical experiments show significant aliasing between SPW1 and DS0 & DW2. Based in this latter figure, we are concluding that non-linear interactions may not be as important a source as is believed.
In continuation, and as suggested by the Reviewer we performed a cross correlation study between SPW1 and DS0 & DW2 as a function of lag of ±30 days and is shown below.



This Figure does not add any new information to existing understanding and hence is not included in the revised manuscript.

The discussion needs to be improved considering some studies on tidal variability inboth stratosphere and mesosphere. For example: nonmigrating diurnal tides generatedby tide-planetary wave interactions have been studied by Lieberman et al. (2015), andNiu et al. (2018) have discussed this issue and their relationship to SSW.
Ans: Authors thank the Reviewer for providing these important references. They are now discussed in the revised manuscript in Section 6.

"There are also studies that have shown that time evoltion of DW2 over equatorial mesopause region follows SPW1 variation over high latitude stratosphere (Lieberman et al., 2015; Niu et al., 2018). It is proposed that mid to high latitude stratospheric SPWs are ducted upward and equatorward that interact with equatorial DW1 over mesopause and thereby generate DW2 over the equatorial mesoapuse region. DS0 is not quite discussed by Lieberman et al (2015). Niu et al (2018) invetigated this SPW1-DW1 interaction during SSWs using extended Canadian Middle Atmosphere Model (eCMAM) data and found good but varying correlations during 20 out of 31 SSW events with both DW2 nd DS0 which indicated that the strength of non-linear interactions also varied from year to year. As the correlations are not observed during all SSW events the proposed mechanism of non-linear interactions is still questionable."

Minor/Technical comments:
Throughout the manuscript, many acronyms were used without proper designation.

Please provide compound term on first appearance.
Ans: Abbreviations are provided for all acronyms.

Lines 28-29: "TIMED satellite" Line 45: "satellite observations of TIDI and SABERinstruments onboard TIMED" Line 46: "UARS"
Ans: Abbreviations are provided for all acronyms.

Line 105: change "As mentioned earlier 10 days data from all six COSMIC" to "Asmentioned earlier +-10 days data from all six COSMIC"
Ans: It is correctly stated in this line that 10 days of data are in principle sufficient when data from all six COSMIC satellites is considered. If three satellites are considered, 20 days data is required and if only one satellite is considered then 60 days of data is required. In the analysis of the paper ±10 days data is considered for groups G0 (six satellites), G1 (C001, C002, C003, and C004) and G2 (C004, C005, C006 and C001)to maintain uniformity and to avoid data gaps. The text in this paragraph is modified appropriately to clarify this aspect.

References:

1. McCormack et al. Comparison of mesospheric winds from a high-altitude meteorologicalanalysis system and meteor radar observations during the boreal winters of2009-2010 and 2012-2013, J. Atmos. Solar-Terr. Phys., 154, 132-166. 2017.
2. Baumgarten, K. and Stober, G. On the evaluation of the phase relation between temperatureand wind tides based on ground-based measurements and reanalysis data in the middle atmosphere, Ann. Geophys., 37, 581–602. 2019.
3. Lieberman, R.S.; Riggin, D.M.; Ortland, D.A.; Oberheide, J.; Siskind, D.E. Globalobservations and modeling of nonmigrating diurnal tides generated by tide-planetarywave interactions. J. Geophys. Res. Atmos., 120, 11419–11437. 2015.
4. Niu, X. Du, J., Zhu, X. Statistics on Nonmigrating Diurnal Tides Generated by Tide-Planetary Wave Interaction and Their Relationship to Sudden Stratospheric Warming.Atmosphere, 9, 416. 2018.

Authors thank the Reviewer for providing the above references. They are all now discussed in the revised manuscript.