Response to Anonymous Referee #2

Author's have used COSMIC -2 RO data to show the effect of the Taal volcanic eruption on the atmospheric temperature and humidity. The report is interesting to see the effect due to eruption, however, its quantification is generally complicated processes due to other dominated atmospheric process especially in the tropopause region. Authors reported a typical formation of the multiple tropopauses due to warming (at 15.5 km and 16.5 km) from a volcanic eruption. However, such temperature inversions can also be due to cirrus clouds occurrence or due to planetary wave propagation. Thus, to ascertain that such effects are only due to Taal eruption, authors need to rule out other possibilities for the formation of an inversion occurring just below the tropopause. Authors have claimed the tropospheric warming and drying following the eruption that needs a proper justification. They have provided possible reason is due to the formation of the sulphate aerosols in the troposphere. However, I doubt that sulphate aerosol can persist for about one month in the troposphere as it has small residence time. Further, authors found that cold point tropopause has been warmed by 1K after the eruption, but it appears within the standard deviation and hence cannot be significant warming. My detailed comments are listed below.

Reply: We thank the reviewer for the thorough review of our paper and for the constructive comments. We agree with the reviewer that the temperature inversion near tropopause either due to the volcanic eruption or cirrus cloud near the location. However, the present case, the atmosphere is strongly affected by the volcanic eruption on 12-15 Jan 2020. The observed SO2 data during 12-15 Jan 2020 is significant enough to modify the background temperature structure.

In the revised manuscript, we did our analysis with respect to the background climatology. For this we utilized 13 years of COSMIC-1 RO data from 2007 to 2019. The results in the revised manuscript also focused on one week before and one week after the eruption. Based on climatology, we found that 4.5 K magnitude of significant warming in the lower troposphere on 12 Jan 2020 and this warming persist up to 15 Jan 2020. This warming in the lower stratosphere is not found before the eruption in the same altitude region. This clearly shows the eruption signals in the temperature anomalies from our study.

40: Earth's lower atmosphere→ troposphere or surface will be more appropriate here

Reply: Modified in the revised manuscript as suggested by the reviewer.

50: is it tropospheric warming or cooling?

Reply: Its tropospheric cooling. We have corrected it in the revised manuscript.

71-74: Why only altitude and latitude dependent but not longitude?

Reply: This is clearly stated in the very recent publication reported by Stocker et al., 2019. They investigated several volcanic eruptions and concluded that the impact of volcanic eruptions are altitude and latitude dependent. It might be true that, in any of the volcanic eruptions happened in the tropics (irrespective of longitude), it will inject the SO2 into the tropical stratosphere. Then the SO2 will be transported to the mid-latitudes through the Brewer-Dobson circulation.

113 Estimate→ Estimates

Reply: Corrected in the revised manuscript.

132 SO2 column?

Reply: Its middle tropospheric column (TRM) SO2. We have changed it in the revised manuscript.

135: exists

Reply: Corrected in the revised manuscript.

160: has→ had played

Reply: Modified in the revised manuscript.

165: active→remained active throughout 13 January

Reply: Corrected in the revised manuscript.

169: varied→ will vary

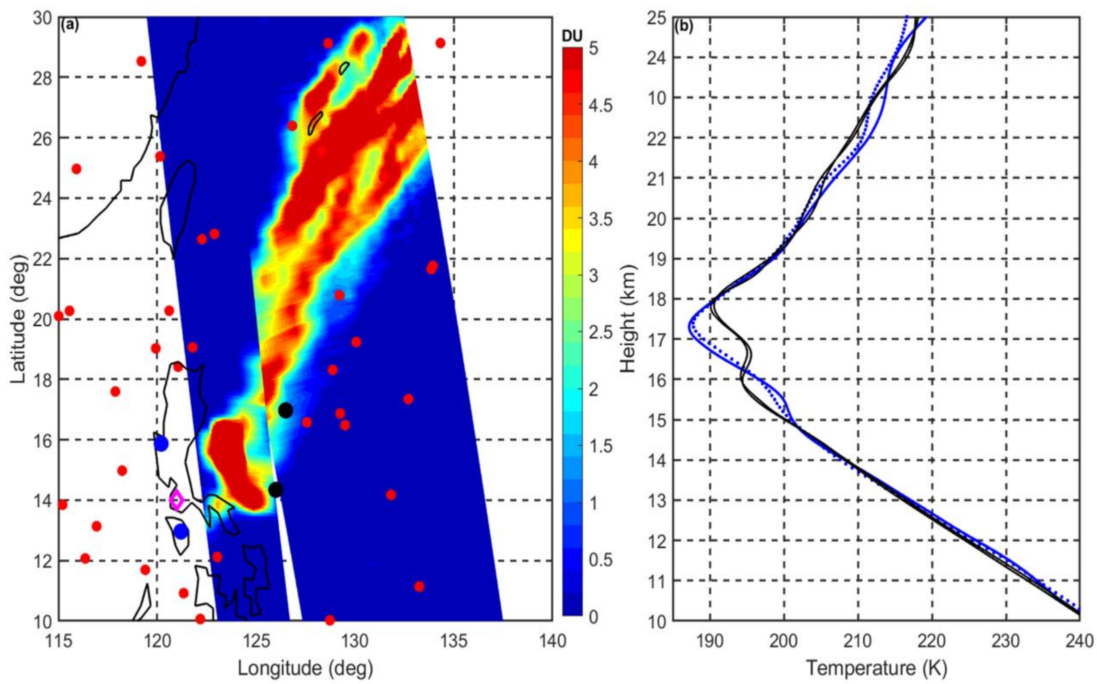
Reply: Corrected in the revised manuscript.

171-172→ To see temperature structure on 13 Jan. . ..COSMIC-2 RO data is used.

Reply: Modified in the revised manuscript as suggested.

196: Why the temperature profiles far away from the eruption site is warmer than the temperature profile closer to the site?

Reply: The temperature is not warmer in the profiles that are observed away from the volcano. If you carefully see the below figure, the warmer temperatures are clearly evident at 15 km altitude region in the profiles near the volcano. In case of the temperature profiles that are located away from the volcano, the warmer temperatures are noticed at 16-17 km altitude region.



201 is mention of "radius" here and elsewhere necessary? I think within ±5 latitude and longitude itself make sense.

Reply: Corrected in the revised manuscript.

225 The word "noticed" has been used several times throughout the manuscript, authors may consider using some different words such as observed, found, detected etc. Figure 3a: are these red dots represents occultation points?

Reply: The authors thank the reviewer for nice suggestion. They have used different words as suggested in the revised manuscript.

250: How to be sure that the bending anomalies detecting cloud top are volcanic cloud top, not the convective cloud top. Since occultations lie mostly away from volcanic plume (Figure 3a).

Reply: The authors agree with the reviewer comments. It is reported that the discrimination between volcanic ash clouds and convective (water) clouds from RO is not possible, since the cloud top cooling is common to all convective processes (Biondi et al., 2012, 2013, 2015). As our main purpose of the study is to see the atmospheric temperature and relative humidity changes on a diurnal scale during a volcanic eruption, the cloud top detection somewhat deviates our study foci. To avoid deviating from the main purpose, we totally removed this section from the revised manuscript.

251: cloud

Reply: Corrected in the revised manuscript.

279: I do not see ~ 1K significant warming in the CPT temperature. The temperature change by ~ 0.5 K (upper limit 201.1K-201.7K and lower limit 185.9K-186.3K) before and after the eruption and are within the standard deviation.

Reply: Corrected in the revised manuscript.

Fig6: It would be clearer if the data presented are shown for one week before and after the eruption. Mark a vertical line on the day of eruption and show the anomalies for the 6 Jan-19 Jan taking 13 Jan as eruption date.

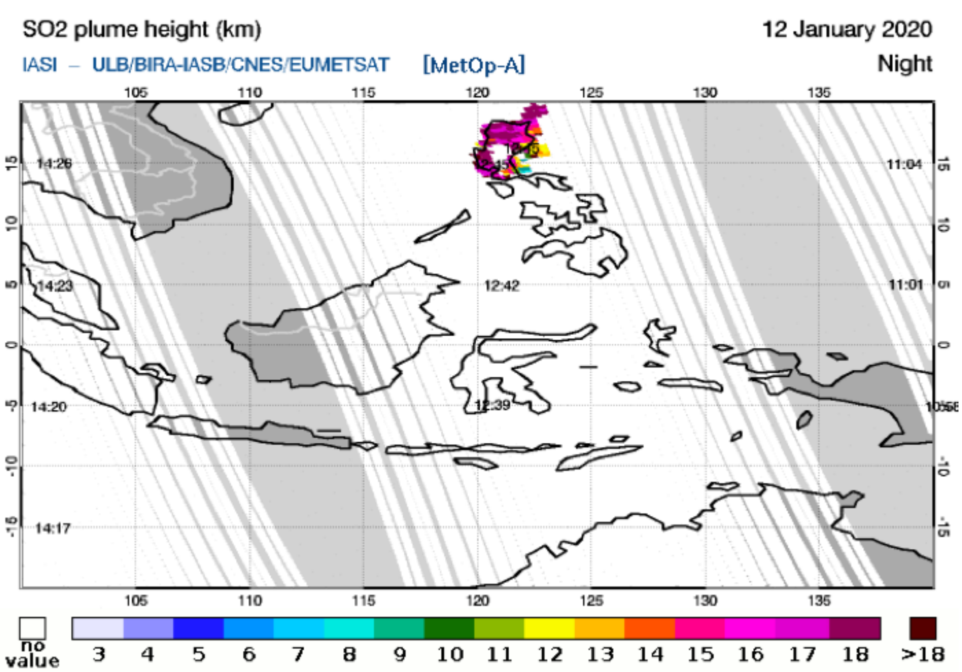
Reply: In the revised manuscript, we have performed the analysis based on 13 years of COSMIC-1 RO data. We carried out our analysis for the period of 05-20 January, 2020 as suggested by the reviewer. As the eruption happened on 12 January, we considered that day as an eruption day and 05-11 Jan as one week before and 13-20 Jan as one week after in the revised manuscript. We obtained the temperature anomalies by subtracting the background climatology from daily mean temperature profiles. Finally, the obtained anomalies are discussed with respect to one week before and one week after the eruption.

Fig6a: As plumes become very week after 13 Jan, why positive temperature anomalies (at 16-17 km) are present throughout the month with maximum warming on 19-24 Jan? I would have expected higher positive temperature anomalies on 14-16 Jan too. Do you not think that positive temperature anomalies are the part of the stronger anomalies seen on 12 Jan or before?

Reply: In the revised manuscript, we did our analysis with respect to the background climatology. For this we utilized 13 years of COSMIC-1 RO data from 2007 to 2019. The results in the revised manuscript also focused on one week before and one week after the eruption. Based on climatology, we found that 4.5 K magnitude of significant warming in the lower troposphere on 12 Jan 2020 and this warming persist up to 15 Jan 2020. This warming in the lower stratosphere is not found before the eruption in the same altitude region. This clearly shows the eruption signal in the temperature anomalies.

310 Then again, 315: What about warming seen on 12 Jan?

Reply: Corrected in the revised manuscript. The Taal volcano began to erupt in the afternoon on 12 January 2020, sending a volcanic plume that is composed of ash and sulfur dioxide (SO2) 15 km up into the atmosphere. This was captured on satellite imagery as seen in the map below. Based on climatology, we found that 4.5 K magnitude of significant warming in the lower troposphere on 12 Jan 2020 and this warming persists up to 15 Jan 2020. This warming in the lower stratosphere is not found before the eruption in the same altitude region.



Map showing the height (km) of the SO2 plume on 12 January 2020 (Source: IASI/ULB/BIRA-IASB/CNES/EUMETSAT)

316-17: It is not true. 19-24 Jan is the warmest when compared to remaining days.

Reply: Corrected in the revised manuscript. In the revised manuscript, we did our analysis with respect to the background climatology. For this we utilized 13 years of COSMIC-1 RO data from 2007 to 2019. We obtained the temperature anomalies by subtracting the background climatology from daily mean temperature profiles. Finally, the obtained anomalies are discussed with respect to one week before and one week after the eruption.

320-24: which figure do you refer here (Fig 6).

Reply: Corrected in the revised manuscript.

325-328: One should expect cooling in the troposphere, not warming. If the warming in the troposphere is due to upper tropospheric anticyclone, then it must not be linked to warming due to volcanic ash. How do you claim that warming between 5-20 km is significant?

Reply: Yes, we agree with the reviewer. In the revised manuscript, we mainly focus on the temperature variations within the altitude 10-20 km over two locations. We found significant warming in the lower stratosphere over both locations with some delay over the Pacific region. There is also a warming layer between 10 and 14 km over the Pacific region compared to the climatology. The warming in the lower stratosphere is mainly due to the presence of volcanic ash. However, the observed warming in the 10-14 km region might be due to the localized synoptic weather conditions. Note that Wang et al. (2009) reported that the temperature changes in the troposphere might be influenced by synoptic scale weather conditions and then volcanic eruptions might not always exert the same influence. We also found prominent anti-cyclonic circulation over the Pacific region just after the eruption.

333: Which both locations authors refer here? Both locations: Do you mean west and east Pacific region?

Reply: Sorry for the confusion. Both locations mean that the Taal volcano region and the Pacific region. Corrected in the revised manuscript.

Fig 7. Why a large decrease in RH is noticed between 10-15 km? How RH profiles appear before and after the eruption? This could an interesting part to examine why troposphere has been dried after the eruption. I suggest to authors to show the plots before and after the eruption.

Reply: We agree with the reviewer. However, the RH above 10 km is very likely completely coming from the model. So in the revised manuscript we only focused on the RH data below 10 km and compared the data with background climatology. Further, we did analysis with respect to one week before and one week after the eruption in the revised manuscript as suggested by the reviewer.

355-360: Authors explained that the formation of the sulphate would have decreased the RH. They further claimed a decrease in temperature also accounted due to formation of the sulphate. My understanding is that sulphate aerosol residence time is very less in the troposphere and it will quickly get deposited to the surface. But authors show that they remain persistent for about a month (Fig 6a) which have significantly dried the troposphere.

Reply: Yes, we agree with the reviewer that sulphate aerosol residence time is very less in the troposphere. In the revised manuscript, we considered the 05-20 Jan 2020 period for the analysis and the data is compared with the background climatology.

435 small-scale

Reply: Corrected in the revised manuscript.

We once again thank the reviewers for going through the manuscript carefully and offering potential solutions which made us to improve the manuscript content further.

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