Measurement report: Regional characteristics of seasonal and longterm variations in greenhouse gases at Nainital, India and Comilla, Bangladesh, by S. Nomura, M. Naja, M. K. Ahmed, H. Mukai, Y. Terao, T. Machida, M. Sasakawa, and P. K. Patra

Response to Reviewers

We would like to thank the reviewers for providing comments and suggestions in our manuscript. We revised the manuscript based on the comments. Comments and questions from reviewers are reproduced here in black. Responses to reviewers are written in red.

Anonymous Referee #1

This manuscript presents important observation data for major GHGs from the northern Indian region. The weekly flask samples taken at a northern Indian station (Nainital, NTL) and a Bangladesh station (Comilla, CLA) for 2006-2012 were analyzed for the atmospheric concentrations of CO2 (and d13C-CO2, d18O-CO2), CH4, CO, H2, N2O and SF6. Authors discussed their seasonal variabilities considering regional climate conditions and contributions of regional sources and sinks. This study expanded the GHGs datasets for the Indian subcontinent, which is one of the most important regions in terms of the GHGs global budget, and thus provides new information about the regional characteristic features of major GHGs. This paper contains significant material and merits publication in Atmospheric Chemistry and Physics. The following comments will be considered for minor revision.

>Thank you very much for reading the manuscript. We appreciate your constructive comments and suggestions.

Specific comments:

Authors use 10-day average values to calculate a long-term trend and a smooth fit. And the seasonal variabilities were based on the deviation of a 10-day mean from the long-term trend curve. Were those 10-day means determined from a 10-day “moving” average? Can you explain why the 10-day means were used? Actually weekly raw data used for 10 day averaging are only one or two, and thus original data features might be misled due to this averaging of inconsistent number of data.

>The date intervals of the original data must be qual interval in order for our script for calculating only the “long-term trend” and “smooth fitting curve” (based on FFT). Basically, the date interval of the flask sampling is every 7 days. But irregularly, the date intervals are 6 days, 8 days or 14 days. The reason for setting 10-day means is to reduce missing data in intervals smoothing the original data and

to run our script. Also, we calculated the long-term trend and a smooth fitting curve from the data set as the date intervals of 7-days mean (The mean is put the dummy data during the missing periods), 20-days mean and 30-days mean and checked those values. For other evaluations such as scatter diagram and seasonal variation, we used individual data itself.

For Fig. 4, the atmospheric CO2 concentrations at NTL and CLA were compared with those from two background stations, and seasonal high values in August-October were explained by influence of air masses passing over the Indo-Gangetic plain. In addition, other noticeable features for CLA are ca. 20 ppm higher CO2 concentrations peaks shown above the smooth fit, and the corresponding lowest d13C-CO2 values, which periodically appeared at the beginning of each year. Air mass trajectory analysis for those data points and appropriate explanations for those distinctive values need to be added.

>We added the sentence of explanation for the distinctive values in L280-282. It is "small episodic peaks of the atmospheric CO2 mole fraction and isotopic ratio of d13C-CO2 of CLA at the beginning of each year was influenced by the biomass burning for heating in the close region, which is considered to be inland area from the site according to the air trajectory analysis".

For the CO2 growth rates in Fig. 5, the observations at the Cape Rama (CRI) station on the western coast of India can be compared with those for NTL and CLA because CRI represents the SH regional background site.

>The periods of the data set of NTL and CLA are from 2006 and 2012. But, the periods of CRI data set are in Feb 1993- Oct 2002 and Jul 2009- Jan 2013 (We got CRI data set from the WDCGG web site). The records in CRI data set from 2006 that we would like to compare were too short to calculate the growth rate. So, we didn't add the data of CO2 growth rate of CRI in Fig. 5.

Line 378-379: the long term trend of d18O-CO2 at CLA (Fig. 8b) seems to decrease, and authors suggested the amount effect of precipitation increase. But d18O-CO2 of CLA in Fig. 8f doesn't seem correlated well with precipitation amount.

>We added the monthly mean data of the precipitation at CLA until Jul 2021. The precipitation at CLA in trends to increase. Relationship between the monthly mean of δ18O-CO2 and the monthly mean of precipitation of CLA appears weaker than that of NTL. However, if the monthly mean δ18-CO_2 at CLA adds one or two months of time lag to the monthly mean of the precipitation, the correlation coefficient (R^2) between the monthly mean $\delta^{18}O$-CO_2 at CLA and the monthly mean of precipitation is 0.4 to 0.5. This sentence added in L396-398 in the paper. We think that the monthly mean of $\delta^{18}O$-

CO_2 at CLA related with the monthly mean of precipitation, although the direct relationship between the $\delta^{18}O$-CO_2 and precipitation in CLA seems weak.

Fig. 9a showed that the pollution signals of CH4 concentrations at CLA increased after 2018. The increases are more noticeable in 2019-2020. If there is any possibility of recent changes in rice field area, could the observed change in CH4 pollution concentrations be related with the increased rice cultivation in this region?

>There is no change in the rice field area and rice cultivation in Bangladesh. The amount of fertilizer application in the rice field area increased slightly. The increase of CH4 mole fraction at CLA in 2019-2020 might be influenced by the regional climate condition (e.g., increase of precipitation) and the enhancement of the global CH4 emission in 2020.

Line 137: move “by MT-252” (Air d13C-CO2 and d18O-CO2 were measured by MT-252 using….)

>We moved “by MT-252” as suggested.