Our point-by-point responses are provided below. The *referees' comments are italicized*, our answers are in blue and the **texts from the manuscript is highlighted in bold** for the Editor's easy reference. Some key issue we want to address is underlined:

Song et al. developed a new version of the process-based TRIPLEX-GHG model to estimate N_2O emissions from croplands by coupling major agricultural activities. The authors state that they found that the coefficient of the NO_3^- consumption rate for denitrification was the most sensitive parameter based on their sensitive analysis result. I commend the authors for their effort to improve global N_2O emissions from croplands as it is essential but I have some major issues with the paper that I believe need to be addressed before it can be published.

RE: Thank you so much for your positive comments and feedback. We fully considered and addressed your suggestions and questions and made a point-by-point response below.

First, the authors simulate daily N_2O emissions and compare them to observational data. However, most of the measurements are often taken once a day, neglecting variations within a day, and so they are not representative for daily emission estimates. I am unsure how the authors have quantified daily estimates from existing literature. Also, there are different flux calculation schemes and for example, Venterea et al. (2020) illustrate a gold standard approach for calculating N_2O flux. I wonder how many of the studies cited follow this approach and how these uncertainties in the observational data are taken into account.

RE: Thanks for your question and suggestion about the measurement, method to estimate daily emission rate as well as the reliability of our model.

First, it is very true that most of the field measurements that we used for model testing took one gas sample a day as presented by the Table 2 column 'Method' which listed the ways to measure the N_2O flux. Knowledge of the diurnal fluctuations in N_2O flux has been used to choose a sampling time that maximizes the accuracy of N_2O flux estimates, thereby reducing the sampling frequency required, but results from previous studies are inconsistent (Francis Clar and Anex, 2020). A general agreement for most of the studies is that the "Preferred Measuring Times" (PMTs) are between 10:00 and 12:00 AM, which means measuring the N_2O fluxes at this time well represent the daily emission rate (Francis Clar and Anex, 2020; Reeves and Wang, 2015; Ferrari Machado et al., 2019). However, this measurement methods probably bring in some uncertainties during the emission hot moment (emission pulses after fertilization mostly) when high frequency of the measurement should be taken to ensure the reliability of reported flux data (Francis Clar and Anex, 2020).

In this study, we cited and utilized 107 observed sites for model calibration and validation and found that most of the chamber-based studies took the gas samples in the mid-morning which were in line with the recommended period (although some of them did not provide such information). In addition, consistent with the statement above, the variance of the measured emission data was larger during emission hot time (emission pulses) which means a larger uncertainty for this data. Fortunately, more frequent measurements were taken by most of the calibrated sites after fertilization and growing seasons (e.g., Fig. 4c, Fig. 4g and Fig. 6c). So, we believe those published papers provided relative reasonable reliability of the flux data, thus the reliability of the calibrated results of the model. The daily flux data we used from the literatures were captured and obtained with the software GetData Graph Digitizer. At least 40% of the calibrated sites did not include the variance of the daily fluxes in the figures (e.g., Mosier et al. 2006), it was extremely difficult to obtain all of the measured data to show whether or not the modeled daily flux was within the range of the standard deviation or confidence interval. To our knowledge, it is common practices for all existing process-based model assessments that reported the comparison of N_2O emission rate with daily time step to use the reported mean fluxes in order to evaluate the model performances (Senapati et al., 2016; He et al., 2020; Zhang et al., 2017).

As for the flux calculation schemes, we thank you for your information so that we can look into this problem. Most of the field observation did not pay great attention to the description of the flux calculation schemes by just saying that 'N_2O and CO2 fluxes were calculated from the slope of the linear temporal change in the concentrations of the chambers' atmosphere.' which is of majority (Pfab et al., 2012) or 'Fluxes were calculated from the linear or nonlinear increase in concentration (selected according to the emission pattern) in the chamber.' (Mosier et al., 2006). A small number of studies used nonlinear fitting only (Cui et al., 2012). Therefore, to sum up, for the sites included to test our model, only limited studies considered the 'gold' standard provided by Venterea et al. (2020) at least they did not claim so. This probably resulted in uncertainties of the measured flux data.

Anyway, we thank you for pointing out these questions which are very critical when judging the reliability of the model because of the potential uncertainties for the data we used to test the model. Therefore, we summarized, improved and restated the answers about the uncertainties associated with the measurement frequency and flux calculate schemes in the discussion section (please see page 22, lines 634-645).

"For example, daily N_2O flux data was used to calibrate the model while the lower sampling frequency of the fieldwork (e.g., once a day) probably failed to represent the daily N_2O emission since the strong fluctuation within a day as suggested by micrometeorological methods (Lammirato et al., 2018; Lognoul et al., 2019; Jones et al., 2011). This uncertainty became even more evident during high emission rates periods (e.g., short-lived N_2O emission pulses after base fertilizer application in the fallow season), casting shadow to the estimation of cumulative emissions (Francis Clar and Anex, 2020). In the meantime, the calculated daily N_2O flux data used for model testing should also be questioned because most of the field observations used linear regression which had large uncertainties compared with other flux calculation schemes (Venterea et al., 2020). Therefore, flux measurements with high temporal resolution as well as more frequent sampling were required to reduce the uncertainties of measure N_2O flux data to ensure a more reliable estimated cumulative emissions for models (Giltrap et al., 2020)."

Second, the authors write down equations in the paper without explaining the units and some of the assumptions are not well explained. For example, the authors state that COE_{NO3} was set to 4.0 according to the model test (L. 160) but it is unclear what kind of test was conducted.

RE: We are sorry for the missing units and descriptions of the assumptions. We added up the unit of associated variables in the revised manuscript and supplement materials (e.g., on page 7, line 154-156).

As for the parameter COE_{NO3} is less important parameter comparing with COE_{dNO3} which we used to calibrate the model so that the detailed procedure to decide of the value COE_{NO3} was not presented. We apologize for missing this information and the test was just simply comparing the estimated mean annual N_2O emission levels with site information (please see page 7, line 154-157 and Table S2).

We did not provide a detailed comparison of soil NO_3^- and NH_4^+ concentration between model output and reported data because the unit of simulated soil mineral N is kg N ha^{-1} of our model instead of mg N kg^{-1} dry soil which is mostly used and reported in the literatures. The unit transfer requires soil bulk density (g m^{-3}) and the depth of plow layer (m) but these information can not be provided by current model. You may ask why not use the published information (i.e., bulk density) to find a possible close answer? It can be explained with 3 reasons. First, although published papers provide the information of bulk density while there is still discrepancy between the soil dataset used by model and the reality. Next, the soil properties are varying with soil layers, so that we can not be sure of how many layers we are supposed to use for calculation. Finally, the plow layer depth was not reported although the commonly used size is 0.3m.

N_2O flux is the target and the most interested variables for current study. Previous large scale process-based model did not chose to report the simulated soil mineral N variation with multiple reasons (Thorburn et al., 2010; Tian et al., 2010; Ito et al., 2018; Zhang et al., 2017). One possible reason is that the excessively high atmospheric N deposition rates probably results in overestimation of soil NH_4^+ concentrations.

Zhang et al. (2017) showed a trend of slightly overestimation of the N_2O flux from natural grassland. This overestimation probably derived from the simulation of N plant uptake because TRIPLEX-GHG model v1.0 assumed that plant takes NH_4^+ first to satisfy the N demand and uses NO_3^- until the soil NH_4^+ is used up (Kucharik et al., 2000; Foley et al., 1996; Zhang et al., 2017). Such design is un-realistic in terms of mechanism and also leads to excessive soil NO_3^- concentration (Chalk and Smith, 2021; Daryanto et al., 2018). In general, NO_3^- is usually more available for plants, owing to its higher mobility which leads to more rapid diffusion to root and easier access to plant as mass flow and diffusion is main pathway for N uptake (Daryanto et al., 2018). Theoretically, the reduction of soil NO_3^- result in lower N_2O emission and we hope that by comparing the modelled and reported N_2O emissions, we can indirectly prove the effectiveness of current improved model design in terms of soil mineral N level. We also should highlight that due to the substantial external N input to cropland soil, the soil mineral N level exceed the crop N demands and result in large N_2O emission (Shcherbak et al., 2014). Therefore, the effect of the COE_{NO3} on cropland N_2O flux is minor compared with that of natural soil. We hope you can understand this and the data was added in the supplementary material to show the effectiveness of the value of COE_{NO3} (Table S2). We also changed the sentence in the manuscript as '**In cropland soil, NO_3^--N is more easily absorbed by roots due to higher concentration and mobility (Malhi et al., 1988; Kronzucker et al., 1997; Chalk and Smith, 2021; Daryanto et al., 2018)**' (please see line 148-149). In the future, we will keep improving the model with more precise results of the variation of soil mineral N concentrations.

Third, the authors state that the NO_3^- consumption rate for denitrification was the most sensitive parameter based on their sensitive analysis result but it is also written that the authors selected the coefficient of the NO_3^- consumption rate (COE_{dNO3}) as the fitting parameter to simplify the parameter fitting processes (L. 301). It is unclear to me how this variable was selected as the fitting *parameter and if it can really be considered as sensitivity analysis if all the other parameters were simply set to the original constant value.*

RE: Thanks for your question and we are sorry for the limited explanation of testing the sensitivity of the parameters.

First, we should clarify that it is supposed to be named 'sensitivity analysis of the model parameters' instead of 'sensitivity analysis' which is kind of misleading. We changed the subtitle 'sensitivity analysis' to '**3.1.2 sensitivity analysis of model parameters**' (please see line 254). We also added a sensitivity experiment for the new integrated processes (i.e., fertilizer application, irrigation etc.) of the model to highlight the model improvement (please see page 9-10, line227-251).

Next, we should highlight that it was **'The coefficient of the NO_3^- consumption rate for denitrification (COE_{dNO3}) was identified to be the most sensitive parameter based on sensitivity analysis of model parameters**' (see line 16-17 of the revised version). This statement was constant through this paper. One exception probably was in the Discussion section of the previous version of the manuscript that 'NO_3 consumption rate for denitrification was the most sensitive **processes**'. COE_{dNO3} was a parameter to constrain the process which is widely used technique for modelling (e.g., DNDC,DAYCENT etc.) (Li et al., 2000; Tian et al., 2018; Ito et al., 2018).

In our study, sensitivity analysis of the response of N_2O emissions to key model parameters are required to identify the most sensitive parameter or parameters before further model calibration and validation (as the fitting parameter). During the sensitivity analysis of model parameter, we changed the value of one parameter each time while keeping others as default value to compare the relative changes of the N_2O emissions by saying '**We changed one parameter at a time, while holding the others fixed at default value to evaluate the response rate of the model output (i.e., in this case N_2O emission) to the changed parameter**' (please see line 260-262). Because a previous study of TRIPLEX-GHG model v1.0 has conducted sensitivity analysis of parameters and only one variable, N_2O emission, were focused, a priori assumption can be made about the linearity, monotonicity, or additivity of the model response to parameter changes. Therefore, the common practice 'changing one parameter at a time' (as described in our study, line 264-266) is applicable (Pappas et al., 2013; Ogejo et al., 2010).

During the calibration, we changed the value of the selected, most sensitive parameter (after sensitivity analysis of parameters), to fit the modelled and measured daily N_2O flux data for each site. In the meantime, other parameters were set to original value (please see line 340-343), which is for calibration not for sensitivity analysis of model parameter. We further addressed this to prevent possible misunderstanding by saying '**For model calibration, we adjusted value of the most sensitive parameter of the N_2O emissions (obtained from sensitivity analysis of parameters) in order to fit the best model performance by comparing the output of daily N_2O flux data with the observed data obtained from published papers…**' in the method section (please see line 340-342).

To prevent possible misunderstanding, we also revised this sentence as "**Overall, to simplify the parameter fitting processes and to evaluate the model's performance, we selected the most sensitive parameter of the model, COE_{dNO3}, as the fitting parameter for model calibration, while we set the other parameters to their original constant values as the default during model calibration** (Table 1)." (please see line 394-396). Thanks for pointing out this.

I find that there is a value to the paper but without the above issues being addressed, it is hard for me to recommend publication in GMD. I think more explanation of the sensitivity analysis itself is also essential.

RE： Thank you again for your comments and suggestions. We revised the description of the integrated process and provided additional explanation of the sensitivity experiment to show the impact of the new incorporated agricultural practices on N_2O as section 4.1. We also revised the section of sensitivity analysis of parameter to prevent possible misunderstanding. Further comparison between the modeled and observed Emission Factors (EFs) were conducted to further confirm the relative reasonable mechanism of the model in response to external N inputs. Hopefully you can satisfy with revised version of this manuscript.

Minor comments:

1. *90 validate modeled the results --> validate the modeled results*
   RE： Thanks, we changed the sentence to '**test the modeled results**' as suggested. (please see line 95)
2. *314 I don't quite understand what the two D values are referring to (D = 0.65, D = 0.56)*
   RE： Sorry for my carelessness, we revised as "(D=0.65, D=0.56 for NA-1 and NA-2, respectively)". Please see line 408.
3. *485 pluses --> pulses*
   RE： Done as suggested.
4. *485 to captured --> to be captured*
   RE： Thank you for this. Revised as suggested (please see line 542).

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