Equations (8) and (9): These equations are used to reflect both isotopic fractionation and mixing. However, the mixing part is necessarily mass / isotope conserving. I.e., it is only a valid approximation if Ftop, Fbot, N2Onit, N2Oden and N2Ored are small compared to N2Oconc,0. The reason is as follows: Assume that in (7), N2Onit 4 times N2Oconc,0 and SP0 is 0. The shift in SP would be 4 *34.4 per mil = 137.6 per mil. This is outright impossible. Consequently, the formulation as it is doesn't ensure a physically sane mixing process as the highest possible shift would be limited to a shift that results in SP of 34.4 per mil for nitrification-derived N2O and 0 for denitrification. This means, the authors need to find criterions for the time step control or find a formulation that allows simultaneous fractionation and mixing calculations in a mathematically correct way.

We understand the reviewer's concern, but need to underline that our approach is not a simulation model. Clearly, some gross N_2O production rates in the absence of other processes would lead to unrealistic shifts in the isotope values of N_2O when simply plugging numbers into the equation. The point of solving the set of equation is to identify mathematically plausible values for gross N_2O production and consumption based on observed N_2O concentrations and isotope values. If the equations derived in this study were to be used in a simulation model, we agree that further constraints would be essential. In our approach, however, we believe that constraints would unnecessarily add potential bias and assumptions.

We do acknowledge that the assumption used in the last step in the model proof is likely only valid when the incoming N_2O is smaller than the initial N pool with each time step. To address the time-step issue, we will solve the model at different time-steps as part of the model testing and validation. This will be done with the original equation used on our study:

$$\frac{\Delta I}{\Delta t} = \frac{k_{in,1}\left(I_{in,1} - I_0\right) + k_{in,2}\left(I_{in,2} - I_0\right) - \eta_{out,1}k_{out,1} - \eta_{out,2}\,k_{out,2}}{C_0}$$

As well as the equation where the time step is not assumed to approach 0.

$$\frac{\Delta I}{\Delta t} = \frac{\left(I_{in,1}k_{in,1} + I_{in,2}k_{in,2} - \eta_{out,1}k_{out,1} - \eta_{out,2}\,k_{out,2} - I_0 k_{in,1} - I_0\,k_{in,2}\right)}{\left(C_0 + k_{in,1}\Delta t + k_{in,2}\Delta t\right)}$$

Final model results for the whole data set will be shown for the model and time step that rises as the best performing in our sensitivity analysis for the time-step optimization.