Point-by-point replies to each comment are listed below.

Major comments:

1. **Comment:** *There may be an issue with the GBM discretisation and Brownian scaling. Please implement the standard GBM increment for time step Δt. The text describes sampling the Normal with standard deviation equal to dt (the time step). This should be $\sqrt{dt}$. If steps remain annual, state $\Delta t = 1$ year explicitly and correct the noise scaling.*

   Reply: We sincerely thank you for pointing out this potential error. This was a mistake in the description only and done correctly in the computations. We will correct the text accordingly and state the yearly time step more explicitly.

2. **Comment:** *Linear area-fraction scaling implies constant hazards per unit area and no explicit dependence on lake size, clustering, or covariates. A modest generalisation with state-dependent intensities $\lambda f(\cdot), \lambda d(\cdot)$ (e.g. log-link GLM or Cox hazards) would capture simple nonlinear feedbacks while remaining identifiable.*

   Reply: We agree that the linear area-fraction scaling is a simplification that implies constant hazards unrelated to lake size, clustering or covariates and thank the reviewer for their suggestion to generalize this. However, we believe that the influence of these factors on formation and drainage probability is difficult to measure. In light of that, we argue that the current linear scaling is a sufficient simplification and that a generalization with a log-link GLM or the Cox hazards method without these quantifications will not be insightful. We are going to give further thought to how these methods could be implemented without adding additional degrees of freedom to the model in our forthcoming research beyond this manuscript.

3. **Comment:** *Specify the boundary condition at zero area (absorbing vs. truncation) and whether very small areas are killed. This choice affects the conceptual split between gradual (GBM) and abrupt (Poisson) drainage under annual sampling.*

   Reply: We will add a clearer explanation of the treatment of gradually vs. abruptly drained lakes in the model:

   - Abruptly drained lakes are removed from the pool of active lakes and will therefore stay drained throughout the rest of the simulation. This means that abruptly drained lakes are effectively killed.
   - Gradually drained lakes are not removed from the pool of active lakes. Small areas as a result of gradual drainage are therefore not killed, but can be subject to expansion or further gradual drainage. However, if an area has reached a value of zero due to gradual drainage, it will effectively stay zero for the rest of the simulation due to the nature of the SDE (GBM) that is used to model lake area evolution.

4. **Comment:** *Beyond merging, lakes evolve independently. Introducing weak correlation (shared random environment / spatial frailties) or lightly correlated GBM shocks could capture hydrologic connectivity without materially increasing complexity.*

   Reply: While we agree that weak correlation in lake area evolution would not materially increase complexity in terms of computation, we do want to emphasize that it would add another degree of freedom to the model, i.e. another parameter that would need to be calibrated using observational data. Considering that we found parameterization / calibration of the model to be difficult with currently available remote sensing datasets, we argue that it could be more beneficial to keep this first model version simple and conceptual with as few parameters as possible. Following the argumentation by Victorov et al. 2019, we believe that independent lake evolution is a justified assumption for a first modelling approach. We are happy to give further thought to this, but do not consider it a priority at this point.

5. **Comment:** *The current merging rule can produce implausibly large single lakes and is computaionally heavy. A stochastic, geometry-consistent alternative (continuum percolation / Boolean union-of-sets with polydisperse footprints), optionally with post-merge fission, would improve realism and cluster statistics.*

   Reply: We strongly agree that a stochastic and geometry-consistent alternative for lake merging could significantly improve realism of model simulations as well as computational requirements. We sincerely thank you for your input on this issue. We will try to implement a Boolean union-of-sets approach based on clustering overlapping lakes rather than merging them. This way we could still keep track of the individual circles / disks and potentially allow them to separate again (post-merge fission). Such an approach can also lead to more realistic representation of the surface area of merged lakes and their shape. While we still need to get an overview on the details of such an approach and possibly useful functions or packages, we think that an implementation is feasible.

6. **Comment:**
   The birth–growth–death structure invites analysis:
   - *a size-structured Fokker–Planck (McKendrick–von Foerster + diffusion) for the area density p(a,t) with integral birth/death terms;*
   - *conditions for stationarity or self-similarity (lognormal-type tails) and closed-form moment dynamics;*
   - *expectation dynamics for the total water fraction under an A_{lim} ceiling.*

   Even partial moment equations would substantively strengthen the mathematical core.

   Reply: Thank you for your suggestions on additional analysis of the model dynamics. We think that a stronger focus on changes in the PDF of lake areas under different regimes and parameterizations makes sense for the paper, especially after improving the implementation of lake merging. We therefore agree that a Fokker-Planck equation that describes the time evolution of the PDF or partial moment equations of lake numbers, average lake area and area variance would be a useful addition to the analysis of the model output, and will include this. Depending on our available time, we will also consider analyzing under which conditions the PDF becomes stationary or self-similar and how A_{lim} influences expected behavior of total water fraction, but we do not see this as a priority at this point.

7. **Comment:** *With annual data and gaps, the drift μ is weakly identified relative to the volatility σ. Consider a composite-likelihood or state-space formulation with uncertainty bands; Bayesian pooling (across neighbouring cells) can stabilise μ and the hazards.*

   Reply: Thank you for your suggestions on how to improve identification of the drift parameter in observational data, which is otherwise difficult to detect due to high volatility and data gaps. We note that we already excluded data points (i.e. lake area for an individual lake in a specific year) from the calculation if they contained measurement gaps (i.e. an area within a lake polygon that was categorized as "no data" due to gaps in the satellite data). At this stage, we are not sure if the suggested methods would lead to an improvement, but will consider and potentially test this.

8. **Comment:** *Simple contemporaneous or one-year-lag correlations have low power and can miss nonlinearity. Try distributed-lag specifications, information-criteria-based lag selection, partial correlations (conditioning on antecedent water fraction), or spline thresholds before concluding there is no relationship.*

   Reply: Thank you for these suggestions. We understand that the current investigation of a correlation between climate and our lake dynamics parameters is too simplified and appreciate your input on this. We are happy to test the mentioned methods and are prepared to adjust our conclusions regarding a climate influence on lake dynamics according to the new results.

9. **Comment:** *State the units of λf ,λd (e.g. events per year per area) and specify how rates scale under aggregation/disaggregation so ESM tiles can ingest them consistently.*

   Reply: Thank you for pointing this out. We will make sure that the unit (event per year per m^2) for our parameters for formation and abrupt drainage is stated clearly everywhere in the paper. The rates should be multiplied by the time step and the relevant area (depending on model variant) within one or several ESM tiles. In the case of several tiles, the multiplication needs to be done with the sum of the relevant area across these tiles. The relevant areas are calculated according to eq. 9 or 10 depending on the model variant. In addition to these equations, we will also add equations for the scaling of the parameters directly.

10. **Comment:** *Abrupt drainage = (near) complete loss within a year via the Poisson process; gradual drainage = negative GBM drift. With annual sampling, large partial losses (e.g. 60–90%) can be ambiguous; a competing-risks view with size-dependent abrupt-drainage hazard would help.*

    Reply: We interpret this comment to refer to the analysis of / parameterization from observational data rather than model development or analysis of model results, since the model itself can keep track of whether a lake was abruptly or gradually drained. However, large partial losses of lake area in observational data can indeed be ambiguous, making it difficult to estimate an abrupt drainage rate. We therefore sincerely appreciate this suggestion. However, we think that determining such a size-dependent abrupt-drainage hazard accurately enough to significantly improve estimates of abrupt drainage rate from observational data, would go beyond the scope of this paper. Instead of incorporating this into our method, we will add this point to the "Discussion" as an outlook for improving parameterization approaches.

11. **Comment:** *Provide a short Δt sensitivity (e.g. semiannual with rescaled noise) to test robustness of annual stepping.*

    Reply: We see how a short time step sensitivity study can be beneficial to test robustness and will conduct one. We also want to note, however, that our model does not contain explicit seasonal dynamics and that we therefore do not recommend using it with a time step of less than a year.

12. **Comment:** *Complement the qualitative regimes with simple statistics (cluster count, Gini coefficient of lake areas, distribution quantiles) that distinguish regimes numerically.*

    Reply: Thank you for this suggestion. However, we are not yet sure how much additional information they can provide to the Fokker-Planck or partial moment equations. We will need to look more into the suggested measures.

Minor comments:

13. **Comment:** *Bring the Variant 1/2 definitions forward and summarise implications in a small table. Clarify whether A_{lim} is a hard cap (projection) or a soft ceiling (e.g. logistic drift modulation).*

    Reply: We agree that the definitions of Variant 1 and 2 should be put more into the foreground and made clearer, e.g. through a table - as suggested by the reviewer. Besides adding such a table, we will also add further equations that directly show the calculation of the formation and drainage probability (also see comment 9), which will aid in clarifying the differences in the two variants.
    The area fraction limit A_{lim} is a hard cap for lake expansion. When it is reached, no expansion of existing surface areas is allowed and lakes can therefore only shrink at that point, until the area fraction is below the limit again. Formation, however, is not explicitly inhibited. Instead, the formation probability will typically be zero at A_{lim} due to the implementation of the area-fraction scaling. We will make this clearer in the text.

14. **Comment:** *Clearly state the initial area assigned to newly formed lakes.*

    Reply: In the currently included simulations, the initial area of lakes was 1 km^2. We will make sure to state this more clearly. After upgrading parts of the model, we will redo the simulations and adjust the initial to 1 ha to be in line with the resolution of the observational data.

15. **Comment:** *Collect symbols/units in one table (including whether μ,σ are per-year) to aid reproducibility.*

    Reply: We thank the reviewer for suggesting this and agree that this would significantly increase clarity. We will include this in a revised version of the manuscript.