

List of changes (major revision):

Line 26–35 (Abstract): Added clarification that relationships are based on linear mixed models and explicitly linked variables (NH_4^+ , DOC, depth) to the same model for N_2O .

Line ~70–90 (Methods 2.1): Expanded soil data description; now includes multiple depth intervals (0–200 cm) instead of only 30–60 cm and clarified data sources.

Line ~90–110 (Methods 2.2): Improved description of vegetation cover assessment by specifying standardized method (same observer, fixed reach length).

Line ~100–120 (Methods 2.2): Added methodological detail for velocity measurements ($0.4 \times \text{depth}$ positioning).

Line ~110–140 (Methods 2.2): Added CO_2 sampling alongside N_2O in gas sampling protocol.

Line ~140–190 (Methods 2.4): Substantially expanded dissolved gas analysis: added detector types (ECD, TCD), ideal gas law calculation, correction for ambient air, uncertainty treatment, and analytical precision for N_2O and CO_2 .

Line ~190 (Methods): Removed/streamlined sediment appendix content and integrated only relevant elements.

Line ~200 (Methods 2.6): Minor technical edits: clarified 'stream identity' → 'stream number' in random structure.

Line ~230–260 (Results 3.1): Minor wording changes for clarity (e.g., 'all sampling sites' → 'distinct stream systems').

Table 1 caption: Improved definition and added sample size and CO_2 clarification.

Line ~300–340 (Results 3.3): Added new analysis of CO_2 interaction with pH and N_2O (separate LMM results).

Line ~320–350 (Results 3.3): Added interpretation of $\text{CO}_2 \times \text{pH}$ interaction and stratified analysis for pH <6 vs >6 affecting N_2O .

Figure A5: Added panel including CO_2 relationships with N_2O .

Line ~370–420 (Discussion 4.3): Substantially expanded discussion on indirect pH effects, including carbonate chemistry, CO_2 – N_2O coupling, and mechanistic interpretation.

Discussion section: Added new literature and interpretation regarding CO_2 – N_2O interactions and ecosystem metabolism.

Throughout manuscript: Minor language edits for clarity, grammar, and consistency.

Figures: Improved captions (e.g., added sampling date/number details).