

EGU23-4849, updated on 04 Mar 2024

<https://doi.org/10.5194/egusphere-egu23-4849>

EGU General Assembly 2023

© Author(s) 2024. This work is distributed under the Creative Commons Attribution 4.0 License.



Importance of in-situ measurements of both N₂O and N₂ emissions to calibration of biogeochemical models to simulate N budgets

Naoya Takeda¹, Johannes Friedl¹, David Rowlings¹, Clemens Scheer^{1,2}, Edwin Haas², David Kraus², and Peter Grace¹

¹Queensland University of Technology, Centre for Agriculture and the Bioeconomy, Sustainable Agroecosystems, Australia (n3.takeda@qut.edu.au)

²IMK-IFU, Karlsruhe Institute of Technology, Garmisch-Partenkirchen, Germany

Denitrification is a key process in the global nitrogen (N) cycle, causing nitrous oxide (N₂O) and dinitrogen (N₂) emissions. Even though denitrification is assumed to be a major N loss pathway from agroecosystems, field-scale estimates of both N₂O and N₂ are scarce, reflecting methodological difficulties in measuring and upscaling N₂ emissions. Mechanistic biogeochemical models allow estimates of seasonal denitrification losses at the field scale, extrapolating important yet often limited experimental results. However, such predictions rely mostly on N₂O data, meaning that the lack of N₂ data hinders the validation of overall denitrification rates, which remain a major uncertainty for N budgets.

This study investigated denitrification losses and N budgets in two subtropical sugarcane systems using Agricultural Production Systems sIMulator (APSIM) with unique datasets of both N₂O and N₂ emissions measured in the field with the ¹⁵N gas flux method and upscaled over the growing season. Five key soil N parameters in APSIM were identified as influential on N₂O and N₂ emissions via global sensitivity analysis, followed by generalised likelihood uncertainty estimation to determine their posterior distributions using (i) both N₂O and N₂ data and (ii) N₂O data only.

For both approaches, the calibration of APSIM led to larger denitrification (N₂O+N₂) losses and a shift towards N₂ compared to the use of default parameters. Simulated N₂O emissions did not differ between the different calibration approaches. However, simulated N₂ emissions were larger and agreed better with the observed values when calibrated with both N₂O and N₂ consistently across sites. This approach also improved the simulation of fertiliser N losses via denitrification, leaching and runoff, compared to the observed fertiliser ¹⁵N loss at harvest.

These findings indicate that biogeochemical models commonly used with default soil N parameters or calibration limited to N₂O data are likely to underestimate denitrification losses, producing a bias in simulations of N budgets. Our findings also highlight the importance to integrate in-situ measurements of N₂O and N₂ in simulation exercises, and demonstrate how innovative isotope methods can be used to inform biogeochemical models, ensuring more accurate N budget estimates across scales.

