WISE N-CYCLE

DNDC Simulation of N_2O Fluxes under Mineral and Organic Nitrogen Management in Boreal Grasslands

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Introduction

- N_2O is a potent greenhouse gas (~273× CO_2)
- Emissions in boreal grasslands depend on:
  - ❖ Nitrogen management
  - ❖ Soil conditions
  - ❖ Climate

- DNDC models simulate emissions & mitigation
- Gap: Uncertainty under cold climates & organic fertilization

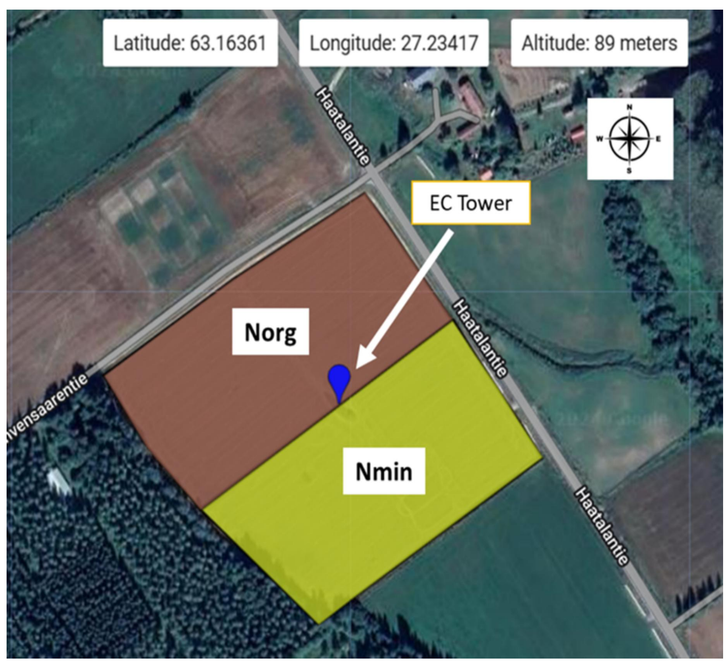
Objective: Evaluate HE-DNDC performance for N_2O fluxes under mineral (Nmin) and organic (Norg) nitrogen using eddy covariance data.

Materials & Methods

Location: Maaninka, Finland (63°09′49″ N, 27°14′3″ E; 89 m a.s.l.)
- Mean temp: 3.8°C
- Precipitation: 619 mm

Crop: Timothy–red clover ley with barley as cover crop in the establishment year.

Treatments:
Nmin: Mineral fertiliser (106 kg N ha^{-1} yr^{-1})
Norg: Digestate slurry (98 kg TN ha^{-1} yr^{-1})
Study period: 2017–2020 (3 rotations)



- HE-DNDC captured **seasonal trends and peak emissions**
- Good agreement for **mineral N treatment**
- Significant **underestimation under organic N**
- Largest errors during **re-establishment year (R3)**

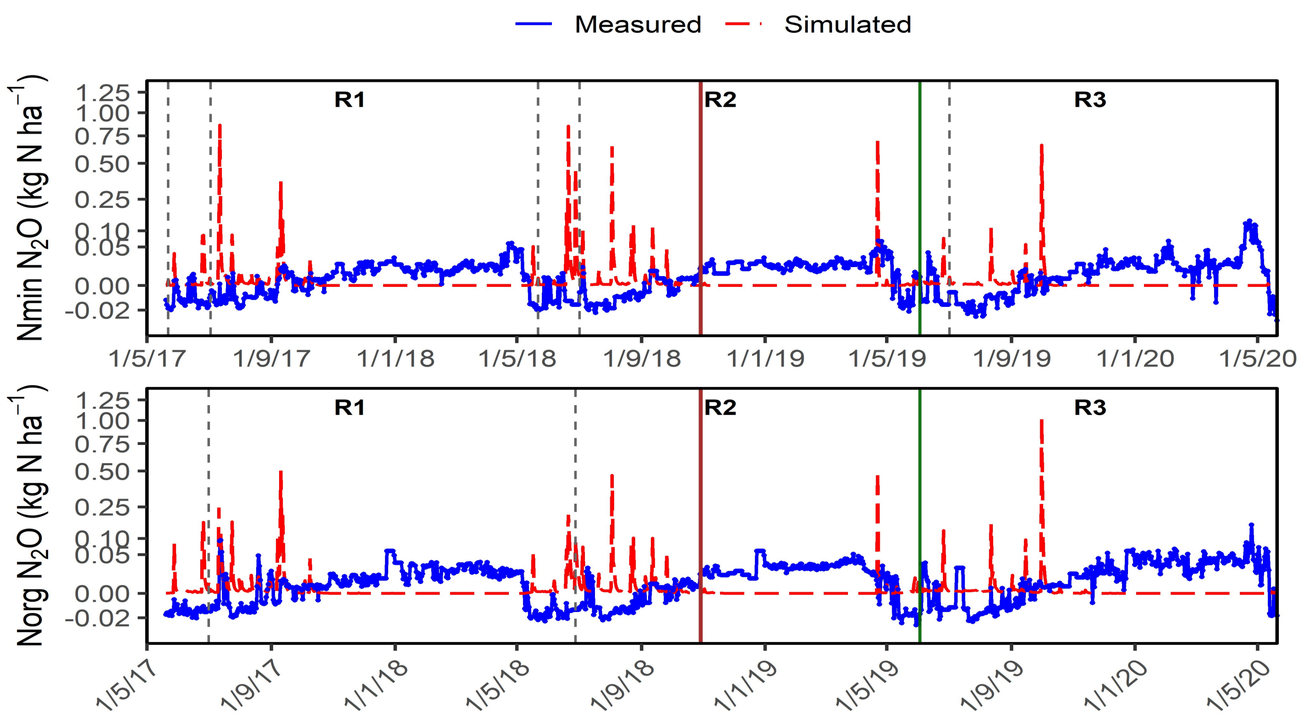


Fig 1: Measured and simulated N_2O fluxes under mineral (Nmin) and organic (Norg) treatments. Peaks correspond to fertilization (doted lines) and freeze–thaw events.

Study period	Nmin measured	Nmin simulated	Norg measured	Norg simulated
R1	1.9	2.1	2.6	3.5
R2	2.2	3.7	3.0	2.1
R3	3.4	1.1	5.4	1.7
Total	7.5	6.9	10.9	7.3

Table 1: Measured and simulated N_2O emissions (kg N ha^{-1}) during R1 (2017–2018), R2 (2018–2019), and R3 (2019–2020) for mineral (Nmin) and organic (Norg) treatments.

Results & Discussion

Underestimation linked to (Table & Fig 1):
- Poor representation of winter microbial activity
- Limited simulation of freeze–thaw dynamics
- Missing plant uptake processes

Organic treatment errors due to:
- Simplified handling of manure inputs
- Lack of legume N fixation

RepresentationRe-establishment phase (R3):
- High emissions due to soil disturbance and organic matter turnover

Conclusion

- HE-DNDC performs well for mineral fertilisation systems
- Underestimates emissions were observed under Organic inputs and winter conditions

Future improvements needed:

- Better winter process representation
- Inclusion of legume dynamics
- Improved organic matter modelling

Acknowledgements
Supported by:
Regional Council of Pohjois-Savo (N-Fiksu & NERO projects)

Co-funded by the European Union

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