



HAL
open science

Modelling interannual variability of methane emissions from a temperate degraded peatland

Line Jourdain, Elodie Salmon, Christophe Guimbaud, Chunjin Qiu, Sébastien Gogo, Bertrand Guenet, Fabrice Jégou, Fatima Laggoun-Défarge, Philippe Ciais

► To cite this version:

Line Jourdain, Elodie Salmon, Christophe Guimbaud, Chunjin Qiu, Sébastien Gogo, et al.. Modelling interannual variability of methane emissions from a temperate degraded peatland. EGU Assembly General 2023, Apr 2023, Vienne (AUT), Austria. 2023, 10.5194/egusphere-egu23-12374. insu-04148990

HAL Id: insu-04148990

<https://insu.hal.science/insu-04148990>

Submitted on 3 Jul 2023

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Modelling interannual variability of methane emissions from a temperate degraded peatland

L. Jourdain (1), Elodie Salmon (2), C. Guimbaud (1), C. Qiu (2)
 Sébastien Gogo (3), B. Guenet (2), F. Jégou (1), Fatima Laggoun-Déferge (4), Philippe Ciais(2)

(1)LPC2E, CNRS-University of Orleans, France, (2) LSCE, CEA-CNRS-UVSQ, France, (3) Université de Rennes1, (4) ISTO, CNRS-University of Orleans, France.

line.jourdain@cnrs-orleans.fr

La Guette peatland is a temperate ombrotrophic fen located in the Sologne region (France), dominated by Sphagnum. The site is instrumented for long term monitoring of hydrological variables, GHG emissions and biodiversity. An analysis of La Guette peatland methane emissions is presented where CH₄ fluxes measured by the dynamic close chamber method in the field are compared with CH₄ fluxes simulated by the ORCHIDEE model. Our study focuses on the 2014-2019 period after an hydrological restoration was undertaken to raise the water table level and promote the rewetting of the peat.

Site Description

- La Guette peatland : temperate ombrotrophic fen peat dominated by *Sphagnum*, located in Sologne region
- Perturbation of the peat due to urbanisation :
 - Water table level decrease
 - Vascular plants (*Molinia caerulea*, *Erica Tetralix*) invasion
- Hydrological restoration and vegetation experiments :
 - Dam built at the outlet of the downstream sub-watershed in 2014
 - Control (C) plots with intact vegetation
 - Bare (B) plots = bare peat
 - Sphagnum (S) plot = bare peat seeded with Sphagnum

Dam built in feb. 2014

Model Description and Set-up

- ORCHIDEE land surface model adapted for peatland (Largergeron et al., 2018; Qiu et al., 2018)
- Set-up from Qiu et al. (2018) :
 - Spin-up to accumulate soil carbon (with preindustrial CO₂ concentrations)
 - Transient simulations from 1860 to now driven by meteorological data from La Guette and CRUNCEP data as well as CO₂ time series concentrations.
 - Photosynthetic parameter (Vcmax) tuned to match GPP derived from La Guette (D'Angelo et al., 2016) .
- Implementation of a methane module (Salmon et al., 2021)

The diagram shows the ORCHIDEE model (Terrestrial Biosphere) and the Methane module. The ORCHIDEE model includes Energy and Water Balances, Photosynthesis, Vegetation and Soil Carbon Cycle, and Vegetation distribution. The Methane module includes Methanogenesis, Methanotrophy, and Soil carbon. Processes like Root oxidation, Diffusion, and Ebullition connect the two modules.

RESULTS

A) Comparison between observations and simulations

- Water table depth:** Comparison of observed (aval, amont) and modeled water table levels from 2014 to 2020. The model captures the seasonal fluctuations and the overall decreasing trend.
- Humidity content:** Heatmap showing humidity content (water vol./soil vol.) over depth and time. The model (moadel) closely follows the measured data (mmeasured).
- Ground temperature:** Time series of ground temperature at different depths (20 cm, 40 cm, 80 cm). The model correctly reproduces the seasonal variation.
- Methane Flux:** Methane emissions from La Guette peatland. The model (Model) is compared with observed data (Obs aval, Obs amont) from 2014 to 2020. The model captures the seasonal peaks but overestimates the flux in summer.

- Higher water table level for downstream station than upstream station and magnitude of water table fluctuations smaller for downstream than for upstream station
- Hydrological restoration has worked
- Decreasing trend of water table position between 2014 and 2019
- Water table variations correctly captured by the model.
- Seasonal variation correctly reproduced
- Variation with depth indicates an overestimation of thermal conductivity

Consistent with WTD

- Higher emission for downstream station than upstream station
- Decreasing trend of CH₄ flux with time between 2014 and 2019
- Modelled flux :
 - Seasonality well reproduced,
 - Decreasing trend of CH₄ flux not reproduced, peat too dry in summer
 - overestimation of methane diffusion

RESULTS

B) Simulations Analysis

Modelled methane production, oxygen and carbon soil profiles :

- Methanogenesis:** Heatmap showing modeled methane production (gCH₄/day/m³soil) over depth and time.
- O₂ profile:** Heatmap showing modeled oxygen concentration (gO₂/day/m³soil) over depth and time.
- Soil carbone:** Line graph showing modeled and measured soil carbon (kg/m³) over depth and time.

- CH₄ production and O₂ profile concentrations compare well with previous work

Relative contribution of different processes :

- Contribution to the total methane Flux :
 - Plant-mediated transport 70%
 - Ebullition flux 14%
 - Diffusion flux 16%

Further work

- Better representation of peat humidity.
- Investigate the decrease of methane flux between 2014-2019

- Factors controlling Methanogenesis (MG) and methanotrophy (MT):
 - MG (blue) correlates with ground temp. (red)
 - Decrease of water table level too small to affect methanogenesis
 - MT (blue) correlates with plant biomass (via root oxidation) and not water table level (red) variation that is too weak.