

From microbiological to ecosystemic scale evaluation of carbon-based (CO₂, CH₄) greenhouse gas sources, production, and transfers in temperate peatlands: a pluridisciplinary week at the playground for Critical Zonists in Frasne, Jura Mountains

Alexandre Lhosmot^{*1}, Adrien Jacotot², Camille Bouchez³, Eliot Chatton³, Sarah Coffinet⁴, Philippe Binet¹, Robin Calisti⁵, Edward A. D. Mitchell⁵, Daniel Gilbert¹, Marie-Laure Toussaint¹, Marc Steinmann⁶, Travis Meador⁷, Christophe Loup⁶, Delphine Combaz⁸, Lilian Joly⁸, Florian Parent⁸, Nicolas Dumelie⁸, Grégory Albora⁸, Jean-Louis Bonne⁸, Charbel Abdallah⁸, Thomas Lauvaux⁸, Jérémie Burgalat⁸, Ngoc-Minh Hoang⁸, Laurent Longuevergne³, Olivier Mathieu⁹, Philippe Amiotte-Suchet⁹, Véronique Lavastre¹⁰, Marie-Noëlle Pons¹¹, Arnaud Elger¹², Romain Walcker¹², Valentin Essert⁶, Laurent Millet⁶, Hélène Masclaux⁶, Valérie Verneaux⁶, Anne Boetsch¹³, Joshua Ducasse⁶, Christina Hazard¹⁴, Huaiyu Wang¹⁴, Vincent Jassey¹², Laure Gandois¹², Jean Sébastien Moquet¹⁵, Sebastien Gogo⁴, Guillaume Bertrand^{1,16}, and Vincent Milesi¹⁷

¹Laboratoire Chrono-environnement, 25200 Montbéliard – CNRS : UMR6249, Université de Franche Comté – France

²Sol, Agro et hydrosystèmes, Spatialisation (SAS), Institut Agro, 35700 Rennes – CNRS : UMR1069, INRAE – France

³Géosciences Rennes, 35700 Rennes – CNRS : UMR6118, Université de Rennes I – France

⁴Ecosystèmes, Biodiversité, Evolution (Ecobio), 35700 Rennes – UMR 6553 CNRS, Université de Rennes I – France

⁵Laboratoire de Biodiversité du Sol, Université de Neuchâtel, 2000 Neuchâtel – Suisse

⁶Laboratoire Chrono-environnement, 25000 Besançon – CNRS : UMR6249, Université de Franche Comté – France

⁷Biology Center Czech Academy of Sciences, Soil Water Research Infrastructure, Ceske Budejovice, CZ-37005 – République tchèque

⁸GSMA, 51687 Reims – CNRS : UMR7331, Université de Reims - Champagne Ardenne – France

⁹Biogéosciences, Université de Bourgogne, 21000 Dijon – CNRS : UMR6282 – France

¹⁰LGL-TP, 42023 Saint-Etienne – Université Jean Monnet - Saint-Etienne, CNRS : UMR5276 – France

¹¹LRGP, 54000 Nancy – Université de Lorraine, Centre National de la Recherche Scientifique – France

¹²Laboratoire Ecologie Fonctionnelle et Environnement (LEFE), 31326 Castanet – CNRS : UMR5245, Université de Toulouse Paul Sabatier – France

¹³OSU-THETA, 25000 Besançon – Université de Franche-Comté, CNRS : UMR6249 – France

¹⁴École Centrale de Lyon, Université de Lyon, 69134 Ecully – CNRS : UMR5005 – France

¹⁵Institut des Sciences de la Terre d'Orléans (ISTO), 45100 Orléans – Observatoire des Sciences de l'Univers en région Centre, Université d'Orléans, CNRS : UMR7327 – France

¹⁶Water Resources and Environmental Engineering Laboratory, Federal University of Paraíba, 58051-900 Joao Pessoa – Brésil

¹⁷Institut des Sciences de la Terre d'Orléans - UMR7327 – Bureau de Recherches Géologiques et Minières (BRGM), Observatoire des Sciences de l'Univers en région Centre, Institut National des Sciences de l'Univers, Université d'Orléans, Centre National de la Recherche Scientifique – France

Résumé

Despite covering only 3% of the global land surface, peatlands are an active part of the Critical Zone (CZ) exchanging large water and greenhouse gas (GHG) fluxes with the surrounding aquifers, surface waters, and the atmosphere. While ecosystem services of peatlands (carbon and water storage, buffering of local climate) are essential to address 21st century challenges regarding climate, biodiversity, and water resources, they are directly threatened by human activities at global (climate change) and local (drainage for agriculture, forestry and peat harvesting) scales. Understanding the hydrological, biogeochemical, and ecological mechanisms of peatlands functioning at different spatiotemporal scales is therefore fundamental to mitigate these impacts.

In order to characterize the mechanisms and factors controlling GHG sources, production and transfers in peatlands, we organized an interdisciplinary field campaign at the Frasné peatland. The site (7 ha, 46.826 N, 6.1754E, 840 m a.s.l) is a long-term observatory since 2008 and one of the four French peatland observatories (SNO Tourbières) of the French CZ research infrastructure (OZCAR). The peatland is also an observatory of the Zone Atelier of Arc Jurassien dedicated to exploring the interrelationships between human and nature. This campaign is supported by the TERRA FORMA project, aiming at designing and testing in-situ smart, connected, low-cost, low-impact and socially appropriated environmental sensors to capture the trajectory of the CZ in the Anthropocene.

This field campaign will combine microbiological characterization (membrane lipid analysis to trace the involved microbial metabolisms) with hydrogeochemical analyses of peat pore water (major elements, DOC (quantity and quality), CO₂, CH₄, $\delta^{18}\text{O}_{\text{H}_2\text{O}}$ - $\delta^2\text{H}_{\text{H}_2\text{O}}$, $\delta^{13}\text{C}_{\text{DIC}}$, $\delta^{13}\text{C}_{\text{DOC}}$, $\delta^{13}\text{C}_{\text{CH}_4}$, $\delta^2\text{H}_{\text{CH}_4}$, $\delta^{13}\text{C}_{\text{CO}_2}$) along upstream-downstream and surface-depth gradients. In parallel, GHG fluxes will be measured from the plot to the ecosystem scale, by combining dissolved gas profiles, chamber measurements, eddy-covariance and unmanned aerial vehicle characterization.

This multiscale campaign will have the potential to address various challenges faced by Critical Zonists and environmental managers: (1) assessing 3D carbon fluxes (lateral and vertical) at the peatland scale; (2) characterizing biological processes and in particular how they favor or limit GHG production; (3) and transfers and developing affordable and user-friendly tools to face the above-mentioned topics.

Mots-Clés: Drone, Eddycovariance, Methanogenesis, Methanotrophy, GHG, SocioEcosystems, Critical Zone, Peatland

*Intervenant