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Contribution of vegetation (trees and ground vegetation) on the methane budget of a temperate forest.

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Methane (CH4) is one the most important greenhouse gas and is responsible for approximatively 20% of the global warming (IPCC, 2013). Soils and mainly upland forest soils where aerobic environment prevails, are one of the main global sink of methane (IPCC 2013). At the soil-atmosphere interface, the net methane efflux consists in a net balance between the production of CH4 by methanogenic bacteria mainly in deep anaerobic soil layers and the consumption by methanotrophic bacteria in the aerobic soil horizons of the methane produced in the soil or diffusing from the atmosphere into the soil. In upland forest, some episodic temporary waterlogging may exist, especially in managed forest where trafficked work on silty or clayey soils compacts the soil and then, enhanced the waterlogging (Startsev and McNabb, 2000).
But the methane budget of ecosystem may be improved when considering not only soil but also plant compartments. Plants can impact the CH4 production and consumption by different pathways (enhance production, consumption, and/or gases transport). When the soil is submitted to compaction and then, to an increase of waterlogging, the ground vegetation is modified in favor of vegetation with aerenchymous tissues (Goutal-Pousse et al, 2012) and the soil can shift from a methane sink to an episodic methane source (Epron et al 2016).
In the present study, our objectives were to determine (i) if vegetation emits CH4, (ii) if abiotic factors drive the seasonal CH4 flux pattern by plants (ground vegetation and trees) and (iii) to quantify the impact of the emissions by vegetation (tree and ground vegetation) on the methane budget of a forest submitted to compaction. We hypothesized that in an upland forest, vegetation (ground vegetation and tree stems) by enhancing the CH4 emission or by producing CH4 may reduce the methane sink of the forest ecosystem.
This study was carried out in a 6-ha experimental site set up in 2007 in the state-owned forest of “les Hauts Bois” (north-eastern France) to assess the long-term impact of a loaded forwarder. To study this effect, the soil was compacted before afforestation. We recorded CH4 fluxes during 7 months at a 3-hour frequency using automated chambers on stem tree, bare soil and soil with vegetation, connected to a laser-based gas analyser in a forest site where the ground-vegetation consists mainly in two aerenchymous plants (glyceria striata and juncus sp) and trees in planted Quercus petraea.
In contradiction with our hypothesis and previous studies, in this studied site, the presence of ground vegetation increases the methane forest ecosystem uptake compared to the bare soil but with an impact varying during the season. In addition, the increase in the methane uptake depended on the species, from 80 % to 120%. Methane emission by tree stem were low compared to methane uptake by soil (-3.6 $\pm$ 0.4 kg ha-1 and 0.90 $\pm$ 0.31 g ha-1 respectively) but methane emission by stem was enhanced when methane was produced into the soil.