Geophysical Research Abstracts
Vol. 16, EGU2014-527-1, 2014
EGU General Assembly 2014

Comparison of soil CO_2 emission in poorly and well-drained mineral soil at a small agricultural hillside scale

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The increase of greenhouse gases (GHG) in the atmosphere and the climate change which results from it, will have major effects in the 21th century. In agricultural landscapes and others ecosystems, soil CO_2 emissions are controlled by thermal and hydrological regimes, but their relative importance seems to be dependant of soil drainage conditions. The purpose of this study was to measure and model soil CO_2 emissions at the scale of a hillslope presenting a gradient of soil drainage conditions.

The studied hillslope is located in the Kervidy-Naizin headwater catchment (Brittany, France, 48°00'N 2°50W) and corresponds to an agricultural field cropped in a maize / winter wheat rotation. Soil CO_2 emissions were measured once per week from February 2013 to March 2014, in two locations contrasting by soil drainage condition: (1) well-drained mineral (WDM) soil classified as Cambisol in upslope position, (2) poorly-drained mineral (PDM) soil classified as Haplic Albeluvisol and which undergoes continuous or periodic saturation and reduction conditions in downslope position. The measurement sites of 9m2 were equipped for continuous measurement of soil water content (TDR probes) and soil temperature. Soil CO_2 emissions were measured with the infrared gas analyzer (IRGA) Li-8100A (Li-Cor, Lincoln, USA) until now.

Results showed that PDM soils were waterlogged in winter and autumn inducing a low CO_2 emission (average of 1.1±0.2μmol.m-2.s-1) which was two times lower than CO_2 emissions in WDM soil. A shift of soil moisture to field capacity leading to an availability of oxygen in soil in the spring and summer induced an increase of soil CO_2 emissions in PDM soil with a maximum of 5.03±0.5μmol.m-2.s-1 at the end of July. In WDM soil, CO_2 emissions were high at the end of spring (average of 7μmol.m-2.s-1) and decreased of 65% at the end of summer because of the drought conditions. The modeling of temporal variability of soil CO_2 emission by temperature and moisture empirical functions showed that the combined effect of soil temperature and soil moisture explained 77% (61% by T° and 39% by SWC) of soil CO_2 emission variability in PDM soil, against 63% (53% by T° and 47% by SWC) in WDM soil. Others factors such as C input, and oxygen availability due to soil management may also controlled soil CO_2 emission and mostly in WDM soil. The integration of these factors in model could help to well understand the difference in soil CO_2 emission in Poorly-drained mineral soil compared with well-drained soil at agricultural hillside scale.