Biogeosciences Discuss., 10, C1881–C1886, 2013
www.biogeosciences-discuss.net/10/C1881/2013/

Interactive comment on "Three years of increased soil temperature and atmospheric N deposition have no effect on the N status and growth of a mature balsam fir forest" *by* L. D'Orangeville et al.

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Received and published: 15 May 2013

We thank the referee for the thorough review of our manuscript. Here we address each of the main concerns raised by the referee.

REFEREE. I believe that this study would make an interesting addition to the literature on the topic after considering the following comments. I'm not entirely convinced that the lack of effect is explained by what the authors refer (soil competition). The authors will have to persuade the readers that their experimental design and methods

used are not responsible for these results. I believe the authors should discuss more about the implications of 1) using heating cables vs. infrared warming, 2) heating only during the growing season (i.e. Apr to Oct) vs. year-round, 3) having two years of temperature/precipitation anomalies in their data set (2010-2011), 4) the heating system malfunction in August 2009, 5) not having sampled the mineral soil by soil horizons (the authors sampled the first 30cm of the mineral soil, not taking into account the variable depth of the Ae and B-hor, that could have bias their results). I would also like to see a graph of the evolution of soil temperature for the control, fertilized, heated and fertilized+heated plots during the monitoring period.

1. Implications of using heating cables

The burial of heat-resistance cables is a widely used method to warm soils in climate change studies (see Aronson & McNulty, 2009, Agr Forest Meteorol 149:1791-1799). In comparison to infra-red lamps (IR), heating cables provide a more homogeneous warming of the soil strata (Aronson & McNulty, 2009). Considering the thickness of the organic layer, we cannot assume with certainty that IR lamps would have much of an effect on the mineral soil temperature unless a much larger area than the sampled area had been equipped with IR lamps which would have made it prohibitive. Given that one of our major objectives was to quantify the effect of soil warming on N availability in both the organic and mineral soil, we believe that using heat-resistance cables was the most appropriate method. The main disadvantage of heat-resistance cables is the soil disturbance caused by the burial of cables (which necessitates the use of non-heating buried cables for control trees). We would like to emphasize that great care was taken during the installation of the cables to minimise disturbance. Large roots >5 mm were never cut: the cables were passed below or above. Most of the disturbance probably impacted fine-roots, which have a relatively rapid turnover of ca. one year (Yuan and Chen, 2010, Crit Rev Plant Sci 29:204-221). As the cables were buried in fall 2008 and the data discussed in the manuscript spans from April 2010 to October 2011, tree roots and soil chemistry had probably recovered by then. A study conducted in a temperate forest of North Eastern United States showed that following cable burial, disturbed soils were not significantly different from controls by the end of the first year following cable installation (McHale and Mitchell, 1996, Biol Fertility Soils 22:40-44). In another study also conducted in a northeastern deciduous forest (Massachusetts, USA), Peterjohn et al. (1994, Ecol Appl 4:617-625) detected a trend for higher extractable NH4 in organic and mineral horizons of disturbed plots three to six months after cable installation. Three negative control trees (no soil disturbance) were monitored during the experiment, although these results are not presented in the manuscript. We measured radial growth using wood microcores (same method as in the manuscript) as well as foliar nutrient content. There were no significant differences between negative control and treated trees in terms of growth or foliar nutrients (D'Orangeville et al. [accepted]. A three-year increase in soil temperature and atmospheric N deposition has minor effects on the xylogenesis of mature balsam fir. Trees - Structure and Function). From these data, we assume that our results were not confounded by the initial soil disturbance caused by the burial of heat-resistance cables.

The manuscript will be changed in order to justify the use of heat-resistance cables as well as to clarify the role of cable burial in explaining our results.

2. Implications of heating during the growing season only and not all year

With the current climatic models for 2050-2090, it is predicted that the soil will continue to be insulated by a thick snowpack and soil temperatures are expected to vary very little in winter in the future (Houle et al., 2012, cited in the manuscript). Soil warming in winter would therefore not be an appropriate way to duplicate future temperature regimes in winter. But warmer spring temperatures are expected to induce an earlier snowmelt. The soil warming treatment was therefore applied in order to reproduce as precisely as possible, future soil temperature projections.

3. Implications of temperature/precipitation anomalies in data set

The term "anomalies" does not really apply here. The 1975-2008 records indicate that

precipitations from May to September averaged 654 mm, with lower and upper confidence limits (95%) of 456 and 851 mm, respectively. In comparison, the 596 mm of precipitations received in 2010 during that period falls within the normal range of precipitation at the site. In fact, 10 out of the 34 monitored years (29%) received less rain than during the May to September 2010 period. As for the 2011 year, the 747mm received during that period are also within the normal range at the site. 18% of the monitored years from 1975 to 2008 received more rain than in 2011. Thus, although we highlighted in the manuscript climatic differences between the two monitored years, both remain representative of the normal climate at the site. So there was no "anomalies" that could have affected the results of our study. We will change the manuscript to clarify this point, according to your comment.

4. Implications of the heating system malfunction in 2009

The heating was ended prematurely in 2009 in mid-August due to a malfunction of the power supply. The plots were nonetheless heated from late April to mid-August, while tree growth was terminated on August 10. The heating treatment was applied without any problems in the two following years. Thus, there is no evidence that this interruption may have affected our results over a three-year experiment, particularly when only the data of the second and third year are discussed.

5. Implications of not having sampled by soil horizon:

It must be said that the Ae horizon at the site of treatments is discontinuous and very thin when present. Therefore, we did not sample the Ae (eluvial) horizon but rather the first 20 cm of the B horizon. The text will be changed to clarify this point.

6. I would also like to see a graph of the evolution of soil temperature for the control, fertilized, heated and fertilized+heated plots during the monitoring period.

We will add a figure (attached) displaying soil temperature per treatment for the two years discussed in the manuscript.

Interactive comment on Biogeosciences Discuss., 10, 1313, 2013.

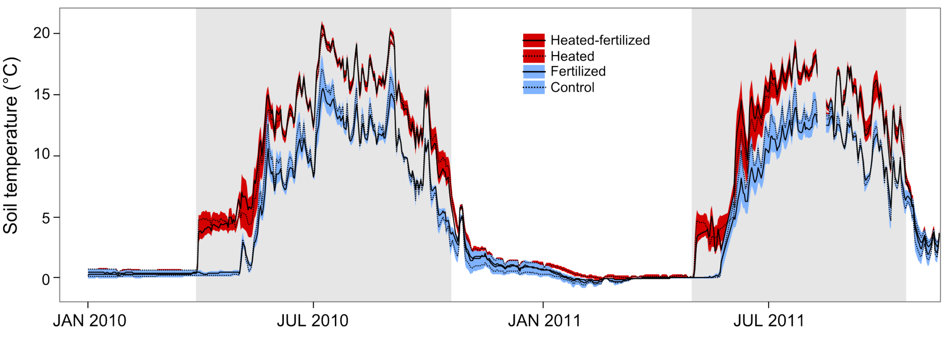

Fig. 1. Average soil temperature in control, fertilized, heated and heated-fertilized plots in 2010 and 2011. Coloured ribbons are standard error. The periods of soil warming are represented by the shaded are