Supplementary material

Different regional climatic drivers of Holocene large wildfires in boreal forests of northeastern America

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**Appendix 1.** Main characteristics of lakes. Sedimentary sequences for lakes in the Eastern, Central and Western regions have been published by Remy *et al* (2016), El Guellab *et al* (2015) and Oris *et al* (2014), respectively.

| Region | Lake | Coordinates | Elevation (m a.s.l.) | Current local vegetation | Lake surface (ha) | Water depth (m) | Length of organic core (cm) | Mean sediment accumulation rate (cm year\(^{-1}\)) | Median time-resolution (year per sample) |
|--------|------|-------------|----------------------|--------------------------|------------------|-----------------|--------------------------|---------------------------------|---------------------------------|
| **Eastern** | Ayla | 52°53'39.3" N 67°02'27.3" W | 582 | *Picea mariana*, *Picea glauca*, *Abies balsamea* | 10.8 | 10.2 | 408 | 0.0499 | 10 |
| | Steeve | 51°56'23.9" N 68°09'19.2" W | 548 | *Picea mariana* | 3.4 | 3.5 | 327 | 0.0349 | 17 |
| | Innu | 50°04'10.9" N 68°48'40.7" W | 399 | *Picea mariana*, *Abies balsamea* | 1.4 | 7.7 | 370 | 0.0415 | 13 |
| **Central** | Twin | 50°56'68.9" N 74°33'91.2" W | 376 | *Picea mariana*, *Pinus banksiana* | 2.9 | 5.7 | 189 | 0.0317 | 21 |
| Location   | Coordinates       | Species Details                          | Diameter | Height | Age     | DBH   |
|------------|-------------------|------------------------------------------|----------|--------|---------|-------|
| Richard    | 50°36'69.9" N 74°40'69.9" W | Picea mariana, Pinus banksiana | 4.0      | 5.3    | 160     | 0.0234 |
| Aurelie    | 50°25'06.6" N 74°13'67.6" W | Picea mariana, Pinus banksiana | 0.18     | 5.7    | 355     | 0.0731 |
| Nans       | 50°22'07.1" N 74°18'21.3" W | Picea mariana                           | 5.0      | 213    | 0.0494  |
| Western Loup | 53°03'18.1" N 77°24'01.9" W | Picea mariana, Pinus banksiana         | 1.6      | 3.0    | 106     | 0.0145 |
| Nano       | 53°01'25.5" N 77°21'51.3" W | Picea mariana, Pinus banksiana         | 0.4      | 3.2    | 140     | 0.0185 |
| Marie-Eve  | 52°01'47.4" N 75°31'14.6" W | Picea mariana, Pinus banksiana         | 16.5     | 8.7    | 290     | 0.0416 |
| Trèfle     | 51°57'54.7" N 76°04'52.0" W | Picea mariana, Pinus banksiana         | 6.8      | 5.4    | 150     | 0.0208 |
| Location | Latitude   | Longitude  | Species  | Diameter | Height | DBH  | Density | Area    | Notes  |
|----------|------------|------------|----------|----------|--------|------|---------|---------|--------|
| Garot    | 51°05'58.7" N 77°33'12.9" W | 291 | *Picea mariana*, *Pinus banksiana* | 2.8 | 7.0 | 133 | 0.0181 | 26 |
| Schön    | 50°35'41.7" N 77°34'06.1" W | 248 | *Picea mariana*, *Pinus banksiana* | 5.1 | 6.9 | 100 | 0.0133 | 37 |
Appendix 2. Analysis of CHAR series using CharAnalysis

To remove the bias induced by differences in sedimentation rates, CHAR series were interpolated (CHAR_{interpolated}) using a constant time-resolution of 20 years per sample, corresponding approximately to the mean of the median time-resolution of all records. CHAR_{interpolated} series were decomposed into a low-frequency component (CHAR_{background}) and a high-frequency component (CHAR_{peak}; appendix 4B). CHAR_{background} results from long-distance burning and/or redeposition processes of charcoal particles that are unrelated to local fire occurrences. CHAR_{background} was estimated by applying the LOWESS-smoother robust technique to outliers and removing CHAR_{interpolated} to isolate the CHAR_{peak} component. CHAR_{peak} was decomposed into two subpopulations: CHAR_{noise}, representing variability in sediment mixing and sampling as well as analytical and naturally occurring noise, and CHAR_{fire}, representing significant charcoal peaks considered to originate from local fire events (Gavin et al. 2006, Higuera et al. 2010). For each peak, we used a Gaussian mixture model to identify the CHAR_{noise} distribution according to a locally-defined threshold. Signal-to-noise index (Kelly et al. 2011) and goodness-of-fit (Brossier et al. 2014) were used to evaluate the effectiveness of the discrimination between CHAR_{fire} and CHAR_{noise} and to assess peak detection accuracy by comparing the empirical and fitted noise distributions, respectively. Each CHAR_{peak} that exceeded the 99th percentile threshold was assumed to originate from a local fire event, but could actually have originated from more than one fire (Gavin et al. 2006).
Appendix 3. Additional Pearson’s correlation coefficients between reconstructed RegFF and RegBB history and main climatic variables

|                       | West RegBB | West RegFF | Centre RegBB | Centre RegFF | East RegBB | East RegFF |
|-----------------------|------------|------------|--------------|--------------|------------|------------|
| **Temperature**       |            |            |              |              |            |            |
| spring                | 0.003      | -0.440***  | -0.267***    | -0.437***    | -0.081     | -0.335***  |
| summer                | 0.481***   | 0.027      | 0.418***     | 0.215***     | 0.634***   | 0.607***   |
| spring + summer       | 0.375***   | -0.431***  | 0.052        | -0.234***    | 0.346***   | 0.101      |
| **Precipitation**     |            |            |              |              |            |            |
| spring                | 0.124**    | -0.411***  | 0.002        | -0.054       | 0.380***   | 0.230***   |
| summer                | -0.094**   | -0.647***  | 0.340***     | 0.343***     | 0.888***   | -0.232***  |
| spring + summer       | -0.024     | -0.645***  | 0.288***     | 0.249**      | 0.846***   | -0.096*    |
| **Fire season length**|            |            |              |              |            |            |
| spring                | -0.321***  | -0.460***  | 0.105        | -0.037       | -0.214***  | -0.149**   |
| summer                | -0.003     | 0.114      | -0.227***    | -0.322***    | -0.563***  | 0.167***   |
| spring + summer       | -0.164***  | -0.128**   | -0.191***    | -0.440***    | -0.569***  | 0.103**    |

Fire season is split into two periods: “spring” from April to June and “summer” from July to October. Significant correlation coefficients are marked in boldface type and asterisks indicate \( P \) values (* \( P < 0.1 \), ** \( P < 0.05 \), *** \( P < 0.01 \)) determined by permutation tests (sample size: \( n = 8 \) millennia).
Appendix 4. Sedimentation rates and CHAR series for each lake
(A) Sedimentation rates from sediment sequences of lakes. The black lines indicate the average sedimentation rate in lakes located in the corresponding regions. The grey areas indicate 90% bootstrap confidence intervals. (B) Charcoal area series from sediment sequences of lakes.
Appendix 5. Reconstructions of monthly means of daily Drought Code (DC) during the Holocene from UGAMP simulations. Numbers in parentheses are monthly means of DC at present-day.
Appendix 6. Simulated seasonal precipitation (left) and temperature (right) with standard errors, obtained from the HadCM3 model (anomalies relative to 0 cal. years BP) for the three regions of the study area (East, Centre and West) during the fire season (spring from April to June and summer from July to October). The temperature and precipitation at present-day are indicated for each of the three regions.
Appendix 7. Reconstructions of water table depth from reported values for three peatlands in the western region of the study area (van Bellen et al 2011) and four in the eastern region (Magnan et al 2014). Water table depths are negatively linked to atmospheric humidity.
References

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