Carbon Exchange over Five Years for a 90-year old Managed Deciduous Forest near Long Point, Ontario

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Introduction

• The Carolinian forest biome is characterized by the presence of mixed broadleaf species and is home to a variety of species not found anywhere else in Canada[1].

• Much of the region was converted to agricultural land, effectively removing ~95% of above-ground carbon. Many of these agricultural lands have been abandoned, with forests containing trees younger than a century[2].

• These forests average 2–20 times higher productivities than desert, grassland, or shrubland vegetation[3].

• Deciduous forests are characterized by phenological stages (leaf emergence/senescence), varying the timing and duration between forest/atmosphere exchange[4].

• Additionally, interannual climate variability may enhance or reduce water and carbon dioxide exchange[5].

• This study aims to undertake long-term atmospheric monitoring to better understand how Carolinian forests in Southern Ontario respond to variable climate events in terms of its carbon cycling.

Turkey Point Flux Station

• CA-TPD is a 90+ year old deciduous (Carolinian Species) forest, the only non-conifer forest of the four TPFs sites.

• Predominantly hardwood species (Quercus alba, Acer saccharum, Acer rubrum) with a few scattered conifers (Pinus strobus, Pinus resinosa).

• Unique geographical location between the boreal and broadleaf deciduous forest transition zone. The site is located 5 km SW of Walsingham, Ontario.

Table 1: TPD Site Characteristics and Delhi, ON Climatic Data

<table>
<thead>
<tr>
<th>Location</th>
<th>Average DBH (cm)</th>
<th>Average Tree Height (m)</th>
<th>Stem Density (stems/ha⁻¹)</th>
<th>Mean Tree Basal Area (m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>42 38.12 N 80 33.45 W</td>
<td>22.29 ± 14.02 cm</td>
<td>25.7 ± 4.77 m</td>
<td>504 ± 18</td>
<td>0.0578 ± 0.013</td>
</tr>
</tbody>
</table>

Delhi weather station Climate Normals (1981-2010)

<table>
<thead>
<tr>
<th>Average Temperature</th>
<th>Rainfall</th>
<th>Snowfall</th>
<th>Precipitation</th>
<th>Average Frost-Free Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.0 °C</td>
<td>906.4 mm</td>
<td>129.5 mm</td>
<td>1035.8 mm</td>
<td>145 Days</td>
</tr>
</tbody>
</table>

Methods

• Tower-based Closed Path Eddy Covariance (CPEC) system continuously measures half-hourly energy, CO₂, and H₂O fluxes between the forest and atmosphere.

• Eddy Covariance (EC) setup comprised of LI-7200 infrared gas analyzer and CSAT3 3D sonic anemometer.

• Additional instruments record site-specific meteorology.

Results

• High spring temperatures and summer VPD in 2012.

• Late season warming, low precipitation in 2016.

• 2012 and 2016 highest GDD, 1817 and 1699 respectively.

Results (Continued)

• Peak GCC occurs soon after leaf emergence, decreasing throughout the summer, lining-up well with GEP.

• Appears wetter years, less stressed, don’t follow trend.

• 61% correlation between GEP and GCC (R² = 0.61).

Conclusions

• 5-year mean annual GEP was 205 ± 92 g C m⁻² year⁻¹.

• Comparable annual GEP to other eastern North American deciduous forests (167 – 220 g C m⁻² year⁻¹[3]).

• Summer temperatures of 20 – 25 °C and VPD > 1 kPa were optimal conditions for maximum NEP.

• While GEP start and end matched up with growing season length, the GCC during some years appeared to lag, likely due to interannual climatic variability - Air temperature, photoperiod etc.

References


• Acknowledgements