Spanning Scale and Platform to Track Spring and Autumn Phenology

Mark D. Schwartz
Department of Geography
UW-Milwaukee
Multiple Measures of Spring and Autumn Phenology

- Satellite sensor-derived reflectance (MODIS)
- Near-surface reflectance (Phenocam)
- Eddy-covariance flux tower carbon measurements
- Under-canopy light sensors
- Visual ground-based observations
WLEF/Park Falls Phenology Study Areas

Spatially: 3/7 cyclic sampling; 25m unit size; 625m $\times$ 625m areas
Park Falls Spring Phenology

Red Maple

Aspen

UW-Milwaukee Geography
Park Falls Spring Phenology Comparisons

WLEF Flux Tower NEE
Pearson's $r$ correlation = 0.948

Red Maple Full Leaf (10%+)

Under Canopy Light Sensor (Q10)
Pearson's $r$ correlation = 0.968

Year
2006 2007 2008 2009 2010 2011 2012 2013 2014
End of Spring Day of Year
124 128 132 136 140 144 148 152 156 160 164 168 172 176 180 184 188 192 196 200 204 208
Park Falls Autumn Leaf Color Phenology

Red Maple

Aspen
Park Falls Autumn Leaf Fall Phenology

Red Maple

Aspen

UW-Milwaukee Geography
Park Falls Autumn Phenology Comparisons

Under Canopy Light Sensor (Q10)
Pearson's r correlation = 0.821

Sugar Maple Full Leaf Fall (90%+)
Pearson's r correlation = 0.998

WLEF Flux Tower NEE

End of Autumn Day of Year

Year

2008 2009 2010 2011 2012 2013 2014
Downer Woods Spring Phenology

Basswood

White Ash

UW-Milwaukee Geography
Downer Woods Phenocam: May 22, 2014

Temperature: 45.0 °C internal
Exposure: 84
Downer Woods Spring Phenology Comparisons

- **DW Under Canopy Light Sensor SOS (51)**
  - Pearson's r correlation = 0.969

- **DW Phenocam EOS**
  - Pearson's r corr. = 0.954

**Day of Year**

<table>
<thead>
<tr>
<th>Year</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **DW Basswood 500 leaf unfolding level**
Downer Woods Autumn Leaf Color Phenology

White Ash

Basswood

UW-Milwaukee Geography
Downer Woods Autumn Leaf Fall Phenology

White Ash

Basswood
Downer Woods Phenocam: Oct. 12, 2014

Temperature: 40.0 °C internal
Exposure: 110
Downer Woods Autumn Phenology Comparisons

- DW Under Canopy Light Sensor MOF (51)
  Pearson’s r correlation = 0.652

- Basswood 950 leaf fall level
- DW Phenocam MOF
  Pearson’s r correlation = 0.988
Conclusions

- Satellite-derived measures have been effectively compared to ground-based visual observations in both Spring and Autumn in the northern mixed forest (Liang et al. 2011, Liu et al. 2015)

- Compared to Spring, Autumn changes are more abrupt, the events themselves are more abrupt, and the environmental drivers are more subtle.

- Spring and Autumn visual phenological observations can be effectively compared to canopy light interception levels and NEE levels, but species variations need further study.

- Near-surface remote sensing (Phenocam) can be effectively compared to both visual phenological observations and canopy light interception levels.
Future Research

- Additional years of data gathering
- Additional strategic deployment of Phenocams
- Development of Spring and Autumn species models, through linkage to environmental variables
- Comparison between Park Falls and Downer Woods data
- Evaluation of phenological differences between species
Thanks for your attention!