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Fusion of UAV and terrestrial laser scanning data to assess tree- and stand-level leaf and wood properties

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Introduction

- The popularization of LiDAR technology, and notably the possibility to multiply acquisition viewpoints thanks to Unmanned aerial vehicles (UAVs) opens-up new opportunities in forest ecology research. High temporal frequency of LiDAR coverage allowed by UAV systems provides a way of monitoring phenology overtime at the individual crown scale. We can now envisage the calibration of architecture/growth models and carbon allocation models for numerous tropical species, while accounting for local biotic interactions and microclimatic variations.
- We introduce here preliminary results on the potential of ULS to describe vegetation profiles and compare them with other LiDAR technologies (TLS and ALS).

Material

- LiDAR data were acquired in French Guyana (Paracou) and Cameroon (Bouamir)
- A range of sensors and platforms were used

<table>
<thead>
<tr>
<th>Platform</th>
<th>Sensor</th>
<th>λ (nm)</th>
<th>Height (m)</th>
<th>Footprint at 100m (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>UAV (ULS)</td>
<td>Riegl Minivux</td>
<td>905</td>
<td>70 &amp; 90</td>
<td>80</td>
</tr>
<tr>
<td>Terrestrial (TLS)</td>
<td>Riegl V2400</td>
<td>1550</td>
<td>1.5</td>
<td>35</td>
</tr>
<tr>
<td>Terrestrial (TLS)</td>
<td>Leica C10</td>
<td>532</td>
<td>1.5</td>
<td>13</td>
</tr>
<tr>
<td>Plane (ALS)</td>
<td>Riegl LMS-Q560</td>
<td>1550</td>
<td>900</td>
<td>25</td>
</tr>
<tr>
<td>Plane (ALS)</td>
<td>Riegl LMS-Q780</td>
<td>1064</td>
<td>900</td>
<td>25</td>
</tr>
</tbody>
</table>

Methods

Amapvox: From point cloud to vegetation density

By tracing each lidar pulse emitted and all the returns triggered (and their back-scattered energy) AMAPvox generates a 3D map of vegetation transmittance from which Plant Area Density is computed.

Please visit www.amapvox.org

Preliminary results

- We present a first characterisation of mean sampling intensity offered by the different platforms/sensors
- TLS V2400 seems to have a lesser penetration in the canopy than TLS Leica C10
- ULS data offer a better sampling across the whole profile than reference ALS data.
- ULS data present little interest for describing branches and trunks, even for emerging trees

Conclusion – Perspectives

The interest of fusion between ULS and TLS is most obvious:
- For completing sampling of TLS scanners having a limited penetration (Riegl V2400)
- For characterizing leaf area and crown sizes over significant extents (1000 ha) or repetitively (phenology)

Accounting for variations in sampling densities (e.g. with AMAPVox) is fundamental to obtain a meaningful description of leaf/plant area across the vertical profile.