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>(\lambda) (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 VZ400</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>500</td>
<td>50</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 VZ400 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 VZ400)
- 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.