3D-FOREST

Novel in-situ 3D forest structure and biomass estimates to validate air/spaceborne products

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Global distribution of terrestrial carbon is highly uncertain

➔ BUT these estimates are important for:
  - Effective forest management
  - Climate mitigation actions

Disagreement of two tropical biomass maps
➔ need for better ground validation:

Source: Mitchard et al., 2013 (CBM)
Research topic & project relevance

Ideally ➔ Direct measurements
Research topic & project relevance

In practice ➔ use allometry:

- Size to mass relationships
- Find relationships between volume (diameter D, height H) & mass

BUT: allometry relies on VERY limited measurements of trees we have actually cut down and weighed
Research topic & project relevance

Can we do better? ➞ weighing trees with lasers:

Rapid and robust ground reference data of full 3D structure
Research topic & project relevance

Can we do better? ➔ weighing trees with lasers:

Example of Terrestrial LiDAR (TLS) point cloud:
Concepts and methods

Tree extraction

Tree reconstruction
Objectives of 3D-FOREST

Objective 1:
Improving estimates of plot-level AGB using terrestrial LiDAR

<table>
<thead>
<tr>
<th>Ecosystems</th>
<th>Location</th>
<th>TLS acquisition &amp; processing</th>
<th>Forest available</th>
<th>inventory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural tropical forests</td>
<td>Pan-tropical</td>
<td>Completed (by WUR, UCL, UGent)</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Semi-managed temperate forests</td>
<td>Wytham Woods, UK</td>
<td>Completed (by K. Calders UCL)</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Managed poplar plantation</td>
<td>Belgium, Lochristi</td>
<td>Completed (by UGent)</td>
<td>Yes (incl. destructive harvesting)</td>
<td></td>
</tr>
</tbody>
</table>
OBJECTIVE 2:
Upscaling LiDAR derived AGB and forest structure to larger areas

Objectives of 3D-FOREST

OBJECTIVE 2:
Upscaling LiDAR derived AGB and forest structure to larger areas

<table>
<thead>
<tr>
<th>Various ecosystems (TERN network)</th>
<th>Australia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Semi-managed temperate forest</td>
<td>Belgium, Zoniën</td>
</tr>
<tr>
<td>(SONIA, BELAIR site)</td>
<td></td>
</tr>
</tbody>
</table>

- Contrasting sites and ecosystems: woodland to rainforest
- Good site set-up and infrastructure for UAV take-off/landing
- Forest inventory and other data available

... And lots of paperwork..
OBJECTIVE 3:
Improving estimates of forests growth function dynamics using LiDAR derived AGB and structure

- How do we link 3D LiDAR data to ecosystem models?
WORKPLAN

WP 1: Improving estimates of plot-level AGB using terrestrial LiDAR

Task 1.1 Development of a quality-assessment framework for AGB estimates from TLS

Task 1.2 Development of new allometric equations using unbiased TLS calibration data

WP 2: upscaling

Task 2.1 UAV – TLS fusion

Task 2.2 upscaling method

WP 3: modelling forest dynamics

Task 3.1 TLS data integration

Task 3.2 TLS driven ecosystem models
Innovation

1. Novel quality assessment framework for 3D volume estimates
2. New allometric equations using unbiased calibration data
3. New insights into upscaling and spatial distribution of AGB and structure
4. Unique co-incident TLS – UAV LiDAR dataset covering a range of ecosystems
5. Proof-of-concept of improved forest growth modelling

- AGB is a new focus area in the CEOS land product validation group

- 3 upcoming spaceborne missions focusing on AGB:
  - GEDI (2019, NASA)
  - BIOMASS (2020, ESA)
  - NISAR (2020, NASA-ISRO)

  ➤ Success of these missions ~ quality of the ground data (cal/val)
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