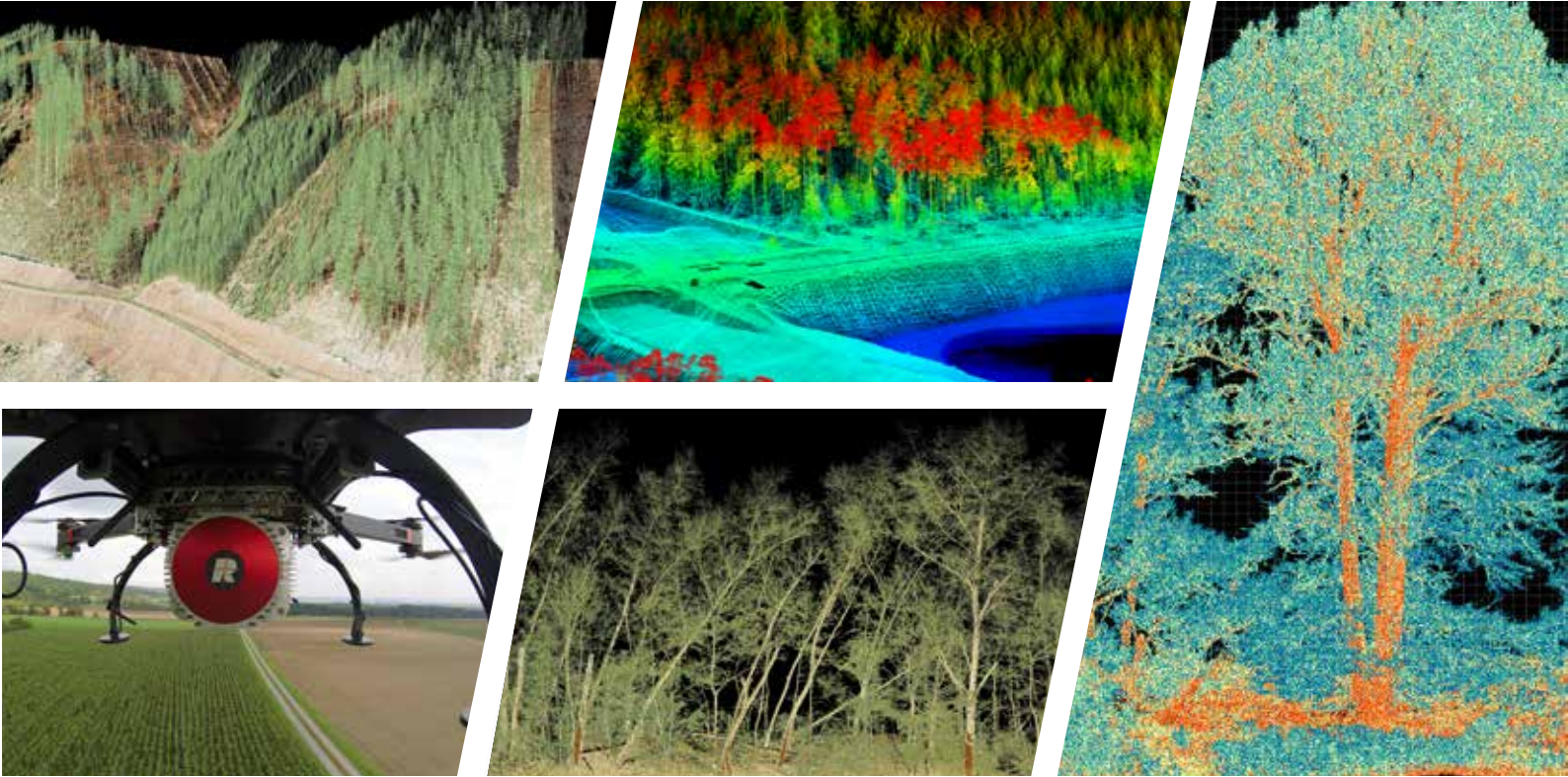# *RIEGL* LiDAR in Forestry & Precision Agriculture

ALS · ULS · TLS

## Various LiDAR Sensors & Systems for Most Challenging Projects



Based on most innovative and proprietary Waveform-LiDAR technology *RIEGL* laser scanners and systems provide an outstanding high-density point cloud ideally suited for applications in forestry and precision agriculture. Advanced processing algorithms account for a full exploitation of the information included in scan data. Multi-target capability enables excellent vegetation penetration and the computing of detailed terrain models. Point classification is the basis for growth monitoring, height modeling, or the detection of deadfall.

## WAVEFORM-LiDAR TECHNOLOGY

**RIEGL VQ-1560i-DW**
Dual Wavelength Waveform Processing Airborne LiDAR Scanning System for High-Point Density Mapping Applications

**RiCOPTER**
Remotely piloted, fully integrated UAV-based Airborne LiDAR System

**RIEGL VZ-400i**
High Performance 3D Terrestrial Laser Scanner

**RIEGL VQ-480 II / VQ-580 II**
Airborne Laser Scanning System for use in small aircrafts, helicopters, or large UAVs

**RIEGL UAS-based LiDAR Sensors**
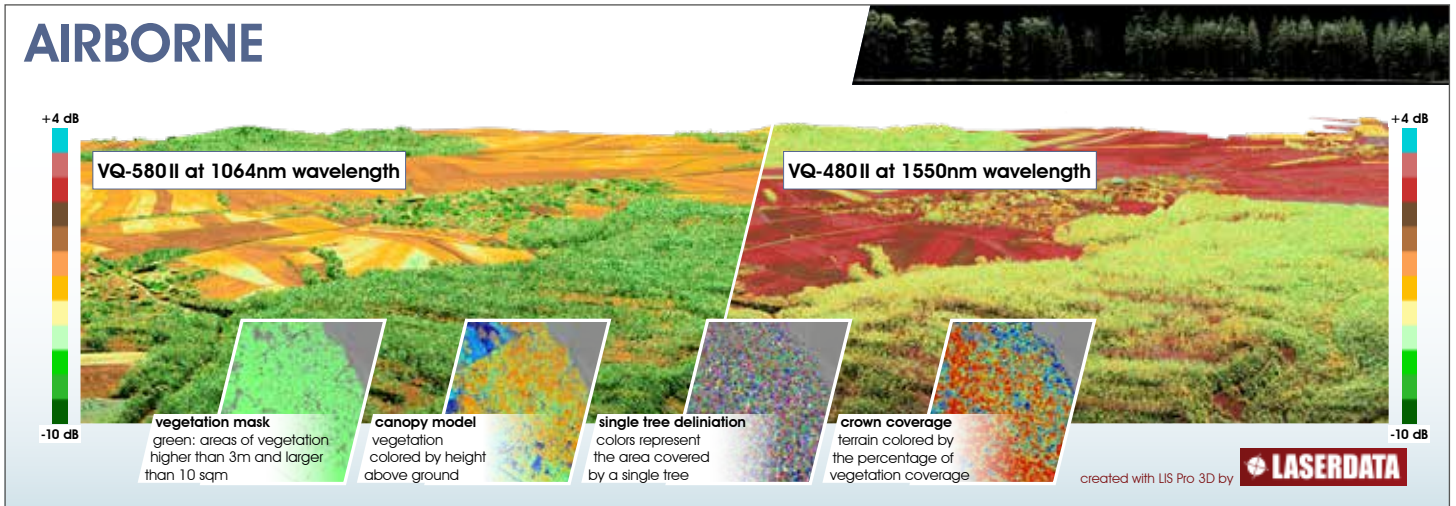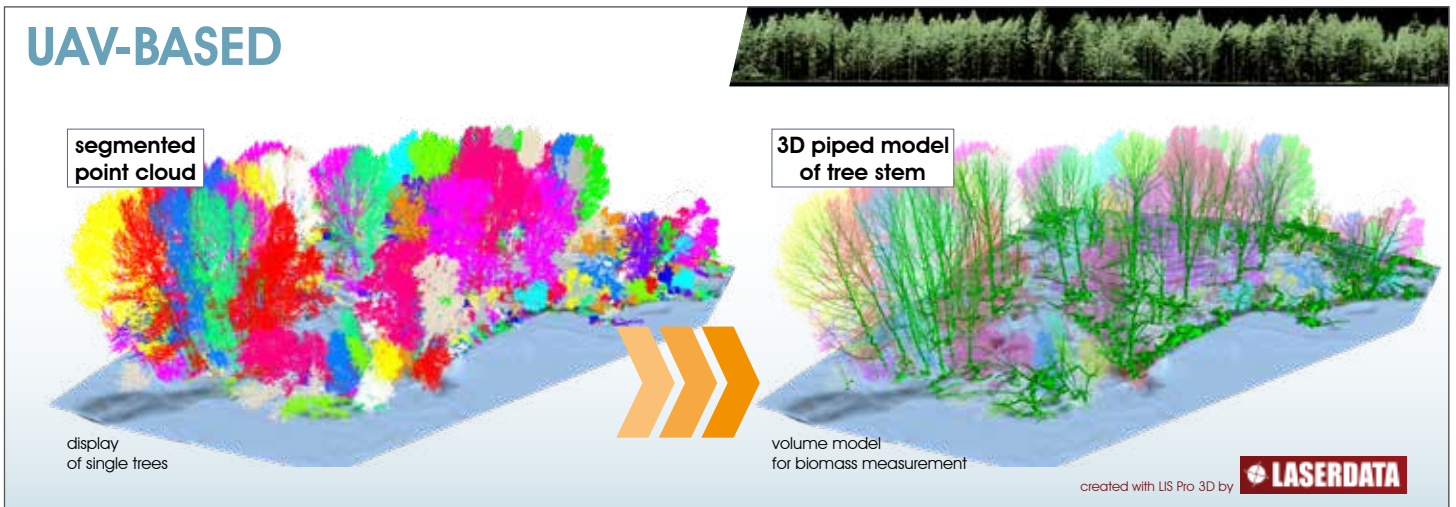for integration in the RiCOPTER and various types of renowned UAVs



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*RIEGL*®

# Forestry Applications

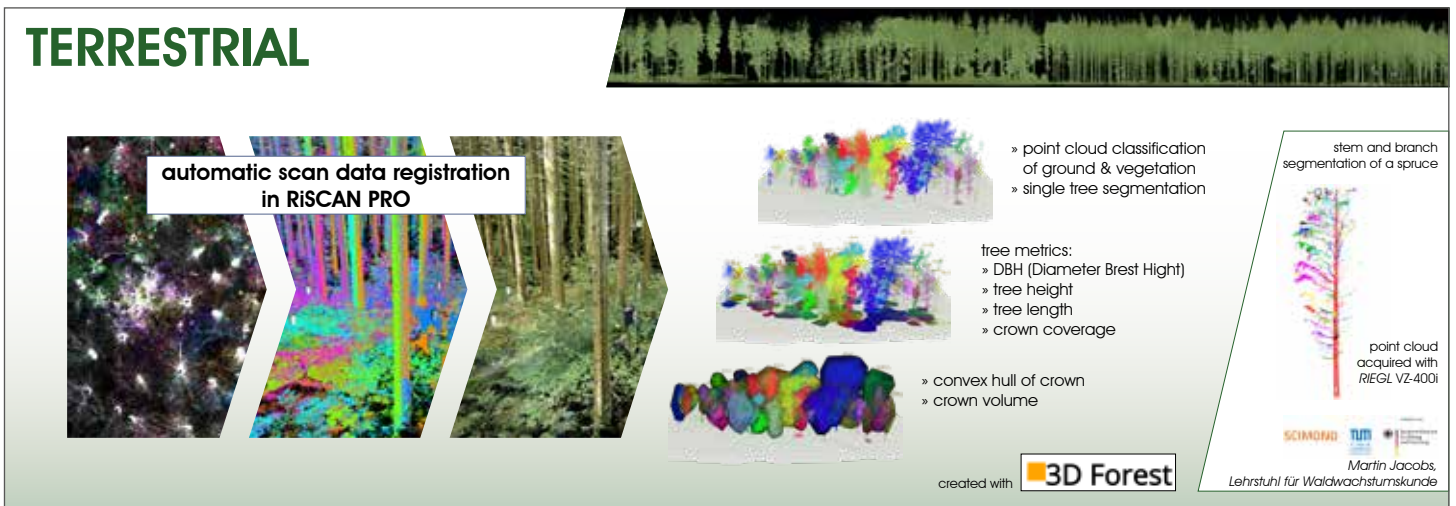Data Acquisition using Airborne, UAV-based, and Terrestrial Laser Scanning

## AIRBORNE



VQ-580 II at 1064nm wavelength

VQ-480 II at 1550nm wavelength

+4 dB
-10 dB

**vegetation mask**
green: areas of vegetation higher than 3m and larger than 10 sqm

**canopy model**
vegetation colored by height above ground

**single tree deliniation**
colors represent the area covered by a single tree

**crown coverage**
terrain colored by the percentage of vegetation coverage

created with LIS Pro 3D by **LASERDATA**

## UAV-BASED



**segmented point cloud**

display of single trees

**3D piped model of tree stem**

volume model for biomass measurement

created with LIS Pro 3D by **LASERDATA**

## TERRESTRIAL



**automatic scan data registration in RiSCAN PRO**

» point cloud classification of ground & vegetation
» single tree segmentation

tree metrics:
» DBH (Diameter Brest Hight)
» tree height
» tree length
» crown coverage

» convex hull of crown
» crown volume

created with **3D Forest**

stem and branch segmentation of a spruce

point cloud acquired with *RIEGL VZ-400i*
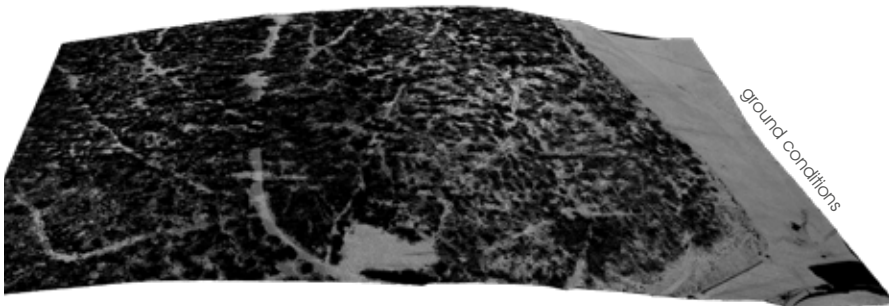
SCIMOND   TUM

*Martin Jacobs, Lehrstuhl für Waldwachstumskunde*

## VEGETATION

Due to the extremely high scanning rates the **VUX®-1UAV** provides an outstanding high-density pointcloud, which makes it ideal for forestry applications.

## GROUND CONDITIONS

The excellent vegetation penetration rate results in a high number of ground returns that can be used to generate very detailed terrain models. The sample to the left depicts points classified as ground coloured by reflectance.
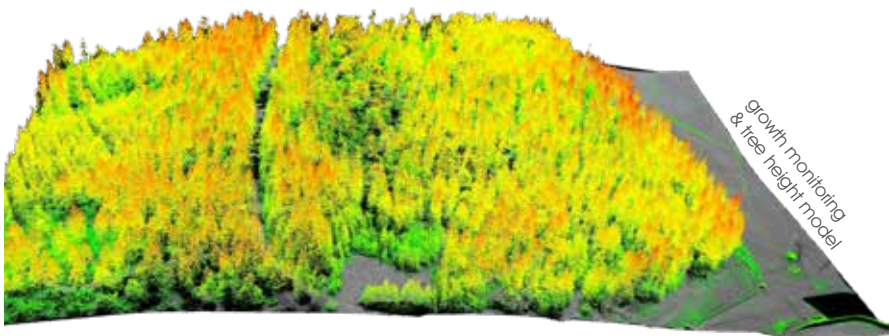
## GROWTH MONITORING & TREE HEIGHT MODEL

All points classified as vegetation can be coloured by relative height above ground. This results in a relative estimation model of the trees revealing regions of low and high vegetation stands. Growth rates can be documented by comparison of height models collected over a period of time.

## SHRUB LAYER & DEADFALL

The undergrowth of a forest consists of shrubby vegetation and seedling trees. It plays an important role in the forest eco system and is a habitat for wildlife and birds. The image to the left shows points classified as low vegetation (red) and clearly shows areas of dense natural cover. Furthermore deadwood can be detected in this data layer.

## BARE EARTH

With all vegetation data removed, the remaining points define a very detailed terrain model. This model clearly reveals roads and trenches as well as results of slope instability and erosion.

## Precision Agriculture Applications



- continuous crop monitoring during growth period
- observation of irregularities in plant growth
- detection of hail damage
- analysis of terrain changes
- yield estimation
- observation of nutrient over- or undersupply
- longterm regular observation of growth characteristics for geological evaluation and classification
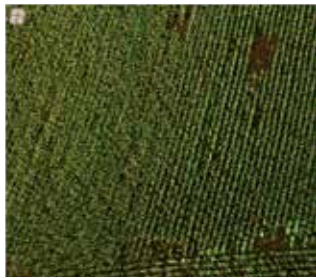


corn
colored pointcloud



sunflowers
colored pointcloud



illustration of
penetration capacity



crop stand variations

## ADVANTAGES OF LASER SCANNING IN VEGETATION MONITORING

By contrast to photogrammetry, which is limited to determining Digital Surface Models (DSM), the technique of laser scanning enables the user to capture data suitable for the generation of DSM and Digital Terrain Models (DTM).

Advanced processing algorithms account for a full exploitation of the information included in scan data. A typical target situation is measuring areas covered by vegetation. Several target echoes resulting from a single laser pulse emission are obtained by echo digitization and subsequently resolved by online waveform processing, resulting in measurement ranges, echo amplitudes, calibrated target reflectance and pulse shape information.
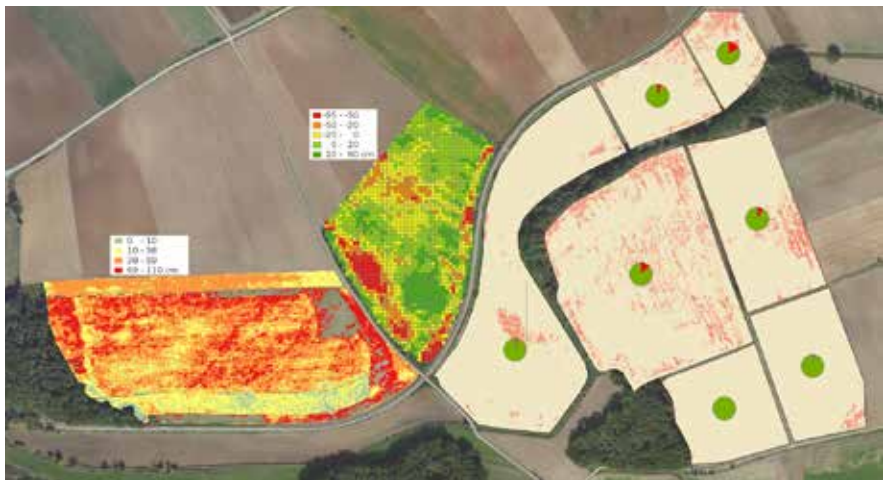
## CROP GROWTH

Crop growth and health is closely monitored in Precision Farming in order to minimize the use of fertilizers or irrigation. Airborne laser scanning data enable to observe plant growth – while at the same time displaying changes in ground surface – or to detect areas of irregularities.

## FIELD CHARACTERISTICS

While plant height cannot per se be interpreted as a direct factor for yield calculation, irregularities due to, e.g., different soil composure, variety of seed type or damage (e.g., weather-related, caused by storm, hail, or rainfall) can easily be discerned and taken as an indicator for further developments and estimation of yield at harvest.

## MONITORING

Constant monitoring of agricultural areas enables early yield estimation based upon differences in plant growth development.

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