Victoria Scholl

**Useful sites:**

* <http://www.qgistutorials.com/en/index.html>
* Manual LiDAR editing. But I couldn’t get all the functionality working when using lastools with wine on mac ☹ <https://rapidlasso.com/2014/03/02/tutorial-manual-lidar-editing/>
* LASmoons (“lunar licenses for poor academics”) are complimentary licenses given to underfunded researchers for a certain number of moon cycles - <https://rapidlasso.com/lasmoons/> <https://rapidlasso.com/category/lasmoons/>
* Non-commercial software for viewing 3d things: <http://vterrain.org/Packages/NonCom/>
* University of California, Santa Barbara Dept. of Geography LAS reader and viewer code: <http://www.tpingel.org/code/lasread/lasread.html>
* Remote sensing regulations come under congressional scrutiny – laws that govern remotely sensed imagery. With the recent drone boom, the regulations are being reconsidered as they are outdated.
* LAS data classification codes: <http://desktop.arcgis.com/en/arcmap/10.3/manage-data/las-dataset/lidar-point-classification.htm>
* Swiss grid (CH1903) coordinate system is chosen so that all points in the country have positive coordinates, expressed in meters, and that easting is always greater than northing. It uses a fundamental point in Bern as the center of the projection, located at x = 600’000 E, y = 200’000 N. Reference frame is LV03 (Landesvermessung 1903) . <http://www.giangrandi.ch/soft/swissgrid/swissgrid.shtml>
* RSL Outing Excursion panning for gold albums: <https://photos.google.com/share/AF1QipOcaRucgdjCfOQ7wpEMGE7opciOrNUPAbr7yGp_xuHO99oDrMqVcdiQPiyYwmXHZg?key=cG1mQmZzWXlBRjY0NFlPdV8tS2l0bWIxSHpvU0x3>
* <https://photos.google.com/share/AF1QipP8sQPfneqiPY4e8oaR5XvTG33wiu5QRnxKUQHCl3jDqZQ3VlsXig7aULLrHMoV1g?key=WmhsNzhlbEJiSnlxUVAyR2Y1Q3h4cmRGaHhMdUNn>
* To turn off the screen but keep the computer awake: SHIFT + CTRL + POWER
* SwissPhoto - <http://www.bsf-swissphoto.com/>
* Gillian keeps a wiki page for notes and information. PhD coffee meeting notes: <http://gmilani-tux.client.geo.uzh.ch/mediawiki/index.php/Spectrolab_PhD_Coffee>
* Matthew Parkan’s useful LiDAR code: <http://mparkan.github.io/Digital-Forestry-Toolbox/>
* Map with aerial imagery for visual assessment of regions: map.geo.admin.ch
* RSL website calendar for conference info: <http://www.geo.uzh.ch/en/units/rsl/services/conference-calendar/>
* Geography Association at UZH: <http://www.geoteam.uzh.ch/>
* The Carnegie Airborne Observatory <https://cao.carnegiescience.edu/>
* FunDivEUROPE <http://www.fundiveurope.eu/>

**Data**

* LiDARLabNAS 🡪 lidarlab (lidarlab, multispectral) 🡪 data

Laegern

Masoala Hall

Kanton Argau

Within each site, data varies but typically includes

* + LAS, DTM, MAT files for leaf on/off conditions.
  + RGBI Mosaic 16-bit tif
  + ORT directory.
  + CHM data product
  + Forest\_type map (immergrün/ evergreen / conifers, sommergrün / deciduous)
* Code:

sftp://vscholl@sftp.geo.uzh.ch

/group/lidarlab/asltools/

Unix Permissions notes

* 3 ownership relations: owner, group, all
* 3 access permissions: read (r), write (w), execute (x)
* A set bit has a letter, a clear bit has a dash ( - )
* chmod used to set or modify a file’s permissions
* *u* = user, *g* = group, *o* = others (not *u* or *g*), *a* = all
* *r* = 4, *w* = 2, *x* = 1. Sum of permissions used with chmod

Study Sites

* Main study site is Laegern
* Masoala Rainforest in the Zürich Zoo. It’s an indoor rainforest environment opened in 2993 for studying and practicing measurement techniques. More than 500 plant species grow there. <http://www.zoo.ch/en/visiting-zoo/areas/masoala-rainforest>
* Borneo – field campaign location during which a 1 hectare plot was imaged using terrestrial laser scanning. Reflective targets were placed along a center transect of the region, and a set of targets were moved along the path at each segment during scanning. These targets were used to register scans.

**Info / Meeting Notes**

09/19 Felix

We agree that it makes sense to move forward in the direction of applying tree detection methods to data across Switzerland, as described in the research proposal. One issue is that this data is rather heterogeneous, and methods have all only been applied to small, homogenous regions. Some areas have multiple time steps/series/dates of data collection while others have a single collect. We also do not have all of the data here to access at the moment.

There is data for the Laegern and Aargau cantons readily available - both LAS point cloud and DTM derived from it. Both leaf-on and leaf-off data is present for Aargau. However, the existing field data or ground truth is not exhaustive (it does not contain data for every single tree, so we can not assess the overall number of trees identified in this way). Fabian just manually created a morphological traits / tree crown map for Laegern, so that will be treated as ground truth for the ALS processing for that site.

There are two main ITD methods to use here; one that is successful for coniferous trees (Morsdorf et al. 2004, hybrid method that finds local minima as seed points) and the other for deciduous (Geodetic Voting by Parkan & Tuia 2015, graph based segmentation algorithm for leaf-off conditions). We want to use both methods and combine the results, since they have been validated in each respective forest type.

My first task is to classify coniferous from deciduous trees, so the proper tree detection technique may be applied to each tree type region (and then to possibly do some morphological processing to grow the region of interest for each tree type). For the Kanton Argau, Felix suggests utilizing leaf-off data since the conifers keep their leaves while deciduous trees lose them during this time. These results will be validated using multispectral imagery, and/or species mapping done manually (such as Fabian’s recent creation of a Laegern 2010 morphological traits table).

After the ALS data is read into MATLAB, its structure contains a variety of fields. The Return Number (also referred to as Echo) field is of interest. The numbers range from 11, 21, 22, 31, 32, 33, … 76, 77. The pattern is as follows: the first number indicates the total number of returns for that pulse. The second number indicates which of the returns the specific point is. For instance: 11 means a single return. 21 means the first of two returns. 2 means the second of two returns.

I must find all of the first returns in the point cloud based on the second of these two numbers. Felix suggested using the unique MATLAB function. Subtract the DTM from them, create a raster (raw2ras) and play with the resolution parameter. Is there a threshold we can use to identify coniferous from deciduous regions? Coniferous regions should have high values in the raster while deciduous should be low or noisy. Incorporation of intensity information may also be helpful.

9/22 Felix

Felix has reached out to Christian Ginzler at the WSL, and he says our plan is “Tip Top”! In German, that means it sounds good. He is on board with the plan to initially identify coniferous vs. deciduous areas of trees, then apply the appropriate processing to them. One day, we will hopefully organize a meeting with him and the others at WSL.

Canton Aargau has some products including forest type (sommergrün vs. immergrün). This was created by Reik based on phenology from multiple seasons, the difference between the leaf on/off data. The resulting map will be useful for me as truth (coniferous vs. deciduous), but this type of map is not available for many of the cantons (many only have one collection time of the year). There is also the MATLAB species data that Fabian created, which can be used to validate some tree classification results in the Laegern Canton. After the Aargau and Laegern cantons have been processed, others may be too. Then, individual tree detection can be applied. WSL will be able to then provide ground truth for individual trees within the cantons.

To view rasters in 2D, imagesc is often used. For a DTM, or other products that are generally smooth, surf may be used to view a 3D continuous surface. 3D surfaces are not generally constructed for looking at canopies due to pits and other variations (it will look noisy).

The masters students took a trip to SwissPhoto to learn about LiDAR work (apparently, a partner of the GIUZ).

9/26

We will be meeting with Christian Ginzler of the WSL on October 6.

Eidg. Forschungsanstalt für Wald, Schnee und Landschaft WSL

9/28

Spoke with Reik today during the coffee break to try to understand the data I’ve been looking at. (This includes LAS tiles for Kanton Aargau leaf on / leaf off, polygon data with the percentage of conifers and percentage of forest per polygon, raster statistics Matlab files containing canopy cover values). Some new information:

* The leaf on data was acquired in August, leaf off in March/April (so it’s not actually completely leaf off). In particular, beech trees maintain their leaves for most of the season, and only lose them once new leaves start to grow in. So the period of time where they do not have leaves is very small.
* The Aargau polygon data was created using inventory data, and it may not be very accurate. There exists ground truth with higher accuracy for Laegeren, although the forest type within that small study site is not necessarily representative of other forest types throughout all of the cantons.
* The canopy cover calculations involve relative differences between canopy cover of two seasons. This involves summing the number of points above a certain height threshold (for instance, 3m) and taking the ratio to the total number of points. However, this is sensitive to point density. The flight line overlap during collection varies between seasons, which results in different point density.
* The forest type map used a canopy cover difference threshold of > 0.35 to differentiate broadleaf from needle leaf types.
* He believes that crown delineation for broadleaf vegetation is truly impossible to do in a robust and accurate fashion. This is due to how the crowns grow and form together in dense forests. During leaf off periods, the stem-based detection methods may work well. But, during leaf-on periods, this is a problem.
* He suggests using the ORT imagery for visual inspection to find regions that are clearly broadleaf vs. needle leaf. Apparently, ORT imagery was collected simultaneously with the ALS data.
* Need to ask Felix what the goals are of the tree detection. Is it primarily stem location? Crown delineation? Neither, both?

Overall, Reik helped increase my awareness of the complexity and difficulty of using airborne laser scanning to measure vegetation structure. Many limitations exist, and the existing products / results should be approached with a critical mind. He encourages skepticism.

Gillian organized a PhD scientific coffee break, where current research topics, conference/journal dates and information, as well as computing resources were all discussed. Diego pointed me to ALS processing tools on Matthew Parkan’s github, which may come in handy. Many of the functions process the point cloud directly, although his watershed method processes the raster.

10/6 Meeting with Christian Ginzler and Felix at WSL Brimensdorf

Felix and I met with Christian at WSL (which stands for Eidg. Forschungsanstalt für Wald, Schnee und Landschaft) to discuss data availability and access. Our collaboration will be within the framework of the Swiss NFI (National Forest Inventory) / LFI (Schweizerischen Landesfortinventar), which has ground truth data available for validation of our methods. The maintain long-term plots and areas of study. Inventory data typically includes tree height, stem location, and species information. Uncertainties in these measurements varies.

ALS data exists for all Swiss cantons except for one (Lucerne. Apparently a large cost of 40-50 thousand CHF is being demanded, so who knows if/when that data will be acquired). Most of the data features leaf-off conditions. In addition, DTMs are available, and the data is already normalized. The cantons of Zürich and Zug (leaf on) data has a very high point density.

Other processing tools that exist to do individual tree detection include the [FINT](https://www.conftool.net/EARSeL-WS-Forest-2016-Krakow/index.php?page=browseSessions&print=head&form_session=39&metadata=show) (Find Individual Trees), which uses a raster-based (Normalized Surface Model) local maximum approach to identify dominant trees. Photogrammetry methods using passive imaging may be used to build up point clouds effectively.

The future of ALS forestry work includes using FPAs to detect LiDAR signals. Additionally, using UAS technology to save money and time (a 9 hectare area may be imaged in about 1 hour as opposed to an entire week using TLS). However, the systems are expensive (CHF 6000) and there are restrictions regarding altitude of flight and area of coverage.

We plan to meet regularly with Christian at the WSL or UZH every 5-6 weeks. In the beginning of next year (possibly January), I will plan to present my work and initial findings at WSL.

The first thing is seriously to differentiate between broad/needle leaf tree regions. Felix says that his Finnish colleagues believe strongly in using rasters of first-return data during the leaf-off season. We can test these methods using Aargau and also the Laegern site within it.

Christian gave me a forest type map of Aargau to be used as ground truth. (in TIF form, to be opened by qGIS).

17.10.16

Professor [David Coomes](http://www.plantsci.cam.ac.uk/directory/coomes-david), the head of the Forest Ecology and Conservation Group at the University of Cambridge spoke at a seminar at UZH today (part of the UZH URPP Global Change and Biodiversity Seminar Series). In his talk, *Ecology from 2000 metres up: what can airborne remote sensing tell us about life on earth*, he discussed some of the past and current motivations and methodologies for imaging vegetation with remote sensing technologies.

General science background: ALS allows for widespread, large-scale estimation of vegetation structure. Ecologists are concerned with monitoring species and changes in forests over time. A current global goal is more accurate estimation of carbon dioxide emission into the atmosphere due to deforestation, as well as carbon sequestration. Biomass can be estimated using metrics including TCH (top of the canopy height), BA (basal area), and wood density (WD, as a function of species). The transition from ABA (area-based approaches) to ITD (individual tree detection) methods and availability of high resolution LiDAR data has immensely increased the possible metrics, and accuracy, of remotely sensing vegetation.

[Greg Asner](http://globalecology.stanford.edu/labs/asnerlab/) (of [Stanford](https://cao.carnegiescience.edu/), famous within the ALS forestry community) is known for his LiDAR work in the Amazon. Asner argues that TCH is all that is needed for carbon estimates.

Coomes described the methods used by his group to estimate biomass, to identify individual coniferous trees. This is successful for the larger, bigger trees, and it has been shown that accurately measuring them is a decent proxy for biomass estimates. It has been shown that these trees are the predominant cnotributors of above ground biomass. But it yields a systematic underestimation of biomass. But it is hopeless for small, suppressed trees. Coomes claims that the next essential work in this field involves individual tree detection for suppressed trees in the lower strata of forests. This will lead to a more accurate assessment of basal area (which is apparently has the strongest relation to biomass, compared to other tree structure measurements).

The [SAFE](https://www.safeproject.net/) project is one of the largest ecological experiments in the world, studying the impact of humans on biodiversity and ecosystem function. The [FunDivEUROPE](http://www.fundiveurope.eu/) (fundamental diversity) project aims to promote understanding of tree species diversity.

Met [Florian Zellweger](http://www.wsl.ch/info/mitarbeitende/zellweger/index_EN), working at WSL, recently finished his PhD at ETH in collaboration with UZH. He recommends I also contact / look into the work being done by [Lars Waser](http://www.wsl.ch/info/mitarbeitende/waser/index_EN).