

Hyltemossa and Norunda are research stations hosting the two infrastructures ICOS (Integrated Carbon Observation System) and ACTRIS (Research Infrastructure for the observation of Aerosol, Clouds and Trace Gases). Both stations are operated by Lund University and set in a spruce forest ecosystem. In summer 2019, I did an internship of about eight weeks in Hyltemossa and of one in Norunda, gaining insight into the ICOS research stations. In total there were six interns of Lund University in the research station this summer. Hyltemossa and Norunda are stations that focus on ecosystem-atmosphere exchange and both are pan European infrastructures that monitor gas fluxes of among others CO₂, CO and CH₄ and of energy and water. The data is made available for the research community via the ICOS RI Carbon Portal. Furthermore, they host several different short-term projects.

During the internship I had the possibility to conduct a variety of measurements in a variety of different research fields connected to carbon fluxes as described in the following.

To obtain data about the average litter fall in the ecosystem, we emptied the twenty litter traps that are located in four representative areas (CPs) for the spruce forest ecosystem every second week. After that they needed to be sorted into different components like twigs, flowers and fruits and dried for 48 hours on 70°C. Once they were dry, we weighed them. Since all ICOS stations conduct the method standardized, the values for all ICOS stations collecting litter data can be used to compare the litter fall in different ecosystems and thus also roughly the different carbon "losses".

Furthermore, the Hyltemossa ICOS station uses a fish-eye camera that takes pictures of the tree tops. This will then be used to estimate the GAI (Green Area Index), an important part of the carbon cycle. Since the method is highly sensitive to sunlight, it can only be conducted when the sky is cloud covered. We, the interns, therefore tried to make an alternative method, using a ceptometer to estimate the LAI (Leaf Area Index), utilizable. The ceptometer measures the PAR (Photosynthetically active radiation) under the trees and compares it with the value of another sensor in the same moment. To obtain a value for that second sensor that was unaffected by shading objects or reflections, it was attached to the measurement tower and sent up. The conditions for the measurements had to be either a cloud covered or a cloud less sky. When comparing the data of the ceptometer to previous GAI measurements they seemed reasonable. Getting to work with the instruments on our own was an interesting challenge that helped me to gain a deeper understanding of the instrument itself and the method used.

In the late weeks of July we started to sample soil probes. They would be processed and send to a central lab for all soil samples of ICOS stations to examine the soil carbon content. Before starting, the randomly chosen points needed to be examined and marked. We were then supported by a professional during the first days who explained what to pay attention to and how best to dig. Firstly, the organic soil was carefully divided into its different layers depending on the progress of decay and mineralization in it. The soil pits were dug up to 50 cm and their different layers, the colour, texture and depth of those, as well as root and stone content were recorded. We then sampled a certain volume of soil from each layer and took all fresh weights. In the lab

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only the organic soils were processed while I was still doing the internship. We picked out any tissue that was alive, like active roots and then let them dry.

Additionally, we helped Erica Jaakkola (PhD, Lund University) conducting stem BVOC measurements that aim to understand how spruce trees react to stresses like drought and bark beetles. The measurements were taken in June, July and August at three sites. Each tree site consisted of four trees and was chosen so that each was subject to a different stress. At one site the stress was artificially induced by putting a bark beetle trap on a tree. Especially in August it was impressive to see the rapid die off of two spruces due to bark beetle attacks and likely other previous stresses like drought.

In Norunda and Hyltemossa, we were helping with determining the ground biomass. In each CP were five randomly chosen areas of 25 x 25 cm located, in which everything but mosses, shrubs and saplings was harvested dried and weight. Saplings and shrubs furthermore needed to be measured in length and diameter. While there were only few saplings and shrubs in Hyltemossa, Norunda had an abundance of blueberry bushes that were harvested and weighed after measuring. Since trees have different speeds of growth in different locations, each station needs to collect samples of trees in different size categories to set up an allometric function for a certain species. The Hyltemossa station had done that in 2018 but we helped with collecting and processing birch trees for that purpose in Norunda.

The Norunda research station is moreover responsible to check the measurement station of the IVL (Swedish Environmental Research Institute) which is close to the research site and measures air and water particles. We helped with the weekly check and also learned about several other long-time projects at the same site.

In the course of this internship I gained deeper understanding of the ecosystem forest and its interactions with the lithosphere and the atmosphere. Since the internship was organised by ICOS, most of the tasks we helped with were related to carbon fluxes, carbon uptake, storage losses, etc. While a lot of the methods produced samples that were sent into a central lab, some methods like litter collection or LAI showed directly visible results which was particularly impressive.

During the course of two and a half months, changes in the litter fall became visible. I imagine that a comparison of this year's not so dry summer and last year's very dry summer must be very fascinating in that aspect. Additionally, the method might provide some insight about changing times of seasons over a longer time period.

Working with the ceptometer to conduct LAI measurements was very memorable for me because it challenged me to work with an until then unknown measurement instrument myself. It also took many tries and changes to get the measurements to work the way we wanted and was a great learning experience.

When we started soil sampling, it was fascinating to see how heterogenous the ground was, large differences were visible within a small area. Working on the soil was a very varying work that included determining soil colour, texture, rock and root ratio etc. The processing of the organic soils in the lab was very tedious afterwards but it was interesting to get to know about the method.

The BVOC measurements were taken with self-built instruments and it was very interesting to

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get the different parts and their purpose explained. Although, I was not able to see the results of the measurements, the changes at the trees that were under bark beetle attack were very fascinating to observe.

The chance to also spend some time in Norunda gave me furthermore the opportunity to see how different ICOS stations work and how the ecosystems differed in terms of the age of the forest and different environmental factors leading to a notably different ground vegetation. Additionally, I was able to get to know more about other research projects, methods and instruments.

All in all, the internship at the atmosphere-ecosystem station Hyltemossa gave me the opportunity to look into many different study areas that are part of physical geography like geology, atmospheric science, biology, ecology and many more. Additionally, I got to gain a lot of field experience and learned about several different methods and instruments. It made me think about the possibility of pursuing further academic studies after a master and in the nearer future provided me with a lot of stimulus for a Bachelor thesis in my third year. Furthermore, it gave me the opportunity to get in contact with many researchers or non-researchers of different backgrounds working with subjects related to the ecosystem forest.