LIFE Project Number

ENV/FIN/000133

1st In-situ Data Document

Reporting Date

30/11/2009

Action

Action 5 – In situ data collection and processing by SYKE

LIFE+ PROJECT NAME or Acronym

SNOWCARBO

Author


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List of key-words and abbreviations

| | |
|---|---|
| ASD | Analytical Spectral Devices (company) |
| CAL-VAL | Calibration - Validation site |
| FMI | Finnish Meteorological Institute |
| Field Spec Pro | Field Spectrometer Professional (model of a measurement device) |
| E-code | A code from FMI weather station network describing the snow conditions in the surroundings. |
| GIS | Geographic information system |
| METLA | Finnish Forest Research Institute |
| SCA | Snow covered area |
| SCAmod | Snow covered area model |
| SNOWCARBO | Alias for the project "Monitoring and assessment of carbon balance related phenomena in Finland and Northern Eurasia" |
| SWE | Snow water equivalent |
| SYKE | Finnish Environment Institute |
| TDR | Time domain reflectometry |
| WMO | World Meteorological Organization |

# 1 Summary

Finnish Environment Institute (SYKE) conducts several observations and measurements of environmental parameters operationally, while monitoring the Finnish environment. Some datasets expand several decades, whereas automated observations stations have been set up more recently, and the datasets from these station span only for few years. The monitoring covers a number of processes from the hydrological cycle and environmental quality indicators from snow covered are and evaporation to water quality etc. Some of these datasets are particularly useful in the context of SNOWCARBO project, namely the development of seasonal snow cover and data from soil moisture measurement network. Additionally to the data available at SYKE, Finnish Meteorological Institute maintains a dense weather station network. Automated weather stations provide all the basic weather parameters, but over some time span observer based supplementary information is available about the snow conditions from the locations of the weather stations.

In-situ data is a vital part of satellite observations. The satellite driven estimates of environmental parameters need to be validated against ground truth data in order to rely on the larger areal coverage they provide. If the satellite products are sufficiently validated it allows the application of satellite images to frequently monitor large areas and areas otherwise difficult to access.

In SNOWCARBO the following datasets are utilized to aid in the development of satellite data retrieval algorithms and as an input to the climate-vegetation models, when applicable:

- SYKE snow courses, giving detailed information on the seasonal snow cover.
- SYKE spectral library, help in the error estimation of satellite driven environmental data.
- Finnish Forest Research Institute (METLA) phenological dataset, provide the only available in-situ data for seasonal cycle in vegetation.
- E-code from Finnish Meteorological Institute (FMI) weather stations, describe the snow covered area around the weather stations, additionally to the basic weather data.
- Other supplementary in-situ observations include the information on soil moisture and temperature and in-situ data gathered at the Sodankylä Arctic Research Centre.

The datasets existing at SYKE have some known gaps and new datasets, such as the phenological data from METLA, are analyzed for the need of complementary data. These data gaps are filled by four dedicated field campaigns during the project, of which two are conducted in spring and two in the autumn conditions, during years 2009 and 2010.

# 2 Datasets included

Following sections describe each in-situ dataset in detail and give a brief description about the field campaigns conducted during 2009. The analysis of all datasets is ongoing in order to make full use of them in the framework of SNOWCARBO- project. Here the datasets are described and some examples are given.

## 2.1 SYKE snow courses

SYKE snow course network is an important validation data source for all snow related satellite data products in SNOWCARBO- project (1st EO-Data document from Action 2 and 3 for more details on the satellite products).

SYKE snow course network covers the entire Finland with 108 active locations of observations (in 2009). The time span for some of the locations can be several decades. Some changes occur in the network within few years time. The active snow course network (based on data currently at SYKE databsase from 2009) is displayed in Figure 1 and the locations are listed in Annex 1. Snow courses are few kilometres (2-8 km) long traverses over a representative site of the local landscape. Their path should cover as many of the 7 land cover types given in Table 1, within two kilometre distance, as possible (National Board of Waters, 1984):

Table 1 Land cover types for snow courses.

| Land cover |
|---|
| 1. open land |
| 2. openings in forests |
| 3. pine dominated forests |
| 4. spruce dominated forests |
| 5. birch dominated forests |
| 6. mixed forests |
| 7. bogs and mires |

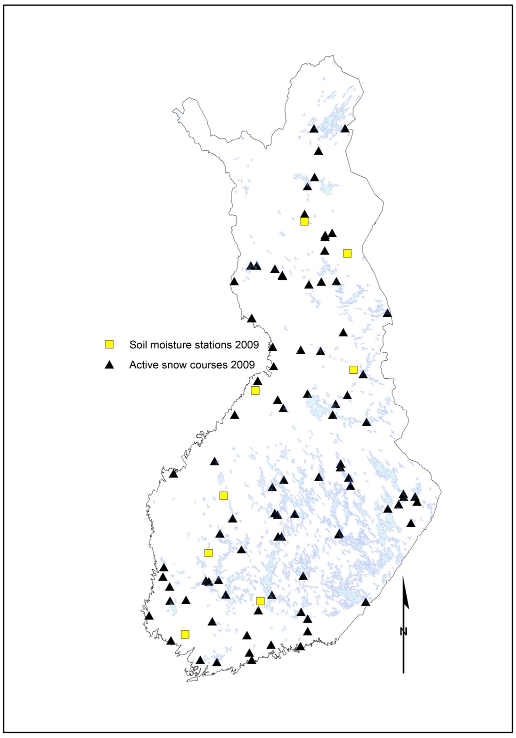


Figure 1 Active SYKE snow course network and soil moisture stations in 2009.

Snow courses are measured once every two weeks. Depending on the length of the snow course, snow depth and patchiness are measured and estimated at 50 or 80 locations for 2 km or 8 km course, respectively. Over the shorter snow courses, more emphasis is then given for snow water equivalent (SWE) measurements. SWE is measured at 10 locations for the shorter courses and at 8 locations for the longer courses. Table 2 summarizes the basic measurements from each snow course, although additional information can accompany the basic data.

Table 2 Measurements performed at each snow course.

| Parameter | Description | # meas./site | Unit |
|---|---|---|---|
| Snow depth | - at least 10 for each land cover type | 50 or 80 | Cm |
| Snow patchiness | - the % terrain covered by snow<br>- at least 10 for each land cover type | 50 or 80 | % |
| Snow water equivalent | - the water content/$m^2$ if the snow pack would be melted<br>- at least 1 for each land cover type | 10 or 8 | [mm] w.e. |
| Snow density | - at least 1 for each land cover type | 10 or 8 | $kg/m^3$ |

## 2.2 SYKE spectral reflectance library

By measuring the reflectivity spectrum accurately at ground level from different targets observed by the satellite instruments, the errors in the estimation of the snow covered area can be calculated and given together with the final product (Salminen et al. 2009). To satisfy requirements for statistical treatment of errors, the spectrum database has to be extensive and cover a variety of targets and lighting conditions.

The spectral library, which has been built up in collaboration with the Finnish Meteorological Institute (FMI), currently covers around 290 measurement events of reflectivity spectrum from snow covered and snow-free land targets under direct sunlight and diffuse lighting conditions. At each measurement spot the reflectivity spectrum of the target is sampled 30 times, which builds the library to cover 8700 individual spectrums. Measurements are made with ASD Field Spec Pro JR (Analytical Spectral Devices – Field Spectrometer Professional Junior), which covers a spectral range of 350-2500 nm, with 1.4-2 nm spectral sampling interval. An image of the measurement setup in the field is shown in Image 1. Table 3 lists target classes for spectral measurements and classes for different lighting conditions.

Table 3 Classes of targets and lighting conditions for measurements of reflectivity spectrum.

| Classes of targets for spectral measurements |
|---|
| Dry snow |
| Wet snow |
| Bare ground/ ground vegetation |
| The main ground vegetation species in Boreal forest: |
| - Lichen, heather, moss, lingonberry |
| Natural depressions (dark targets) |

| Covered light conditions include |
|---|
| Direct sunlight |
| Diffuse light (during total cloud cover conditions) |
| Shadow of tree trunks |
| Shadow of tree branches |


Image 1 Photograph showing the measurement set up for reflectivity measurements.

During the spectrum measurements detailed observations on the snow properties are also conducted. These measurements are described in Table 4.

Table 4 Other measurements made during measurements of reflectivity spectrums.

| Snow property | Description | Unit |
|---|---|---|
| cloud cover | Measured in octas. | e.g. [1/8] |
| snow depth | | [cm] |
| snow temperature | Measured from two depths, i.e. surface and at 1/2 of the depth. | [°C] |
| Soil surface temperature | Measured at the snow and soil interface. | [°C] |
| air temperature | Measured at free air under shadow. | [°C] |
| snow grain size | Median of measurements | [mm] |
| snow grain type | 6 classes:<br>1. fine separated crystals<br>2. metamorphosed separated crystals<br>3. clustered crystals<br>4. almost slush<br>5. slush<br>6. ice layer | |
| snow quality | 5 classes:<br>1. dry<br>2. moist<br>3. wet<br>4. very wet<br>5. slush | |
| snow patchiness | The percentage of open ground | [%] |
| Impurities in snow | 2 classes:<br>1. clean<br>2. dirty | |

*Preliminary analysis of the Spectral database*

Preliminary analysis of the spectrum database shows that vast quantity of measurements have been conducted under direct sun light, both on dry and wet snow cover. These measurements cover wide range of snow properties and there offers sound bases for statistical analysis. As the satellite instruments observe also large areas of shadowed terrain cover the altered reflectivity spectrum due to shadows also needs to be known.

Figure 2 shows the distribution of measurement events in the existing database for different targets, snow conditions under direct sunlight or under shadows. The current database consists of less than 20 measurements from tree trunk shadows and branch shadows. Therefore additional measurements on shadowed snow cover are needed. The measurements of shadowed terrain should be carried out under both dry and wet snow conditions. Measurements under diffuse light conditions allow the discrimination between variability due to terrain conditions and variability caused by seasonal variation in sun illumination angle (Salminen et al. 2009). If weather conditions prohibit the measurements of shadowed snow cover, the diffuse measurements should be taken. This gap in the dataset will be addressed in the SNOWCARBO field campaigns.

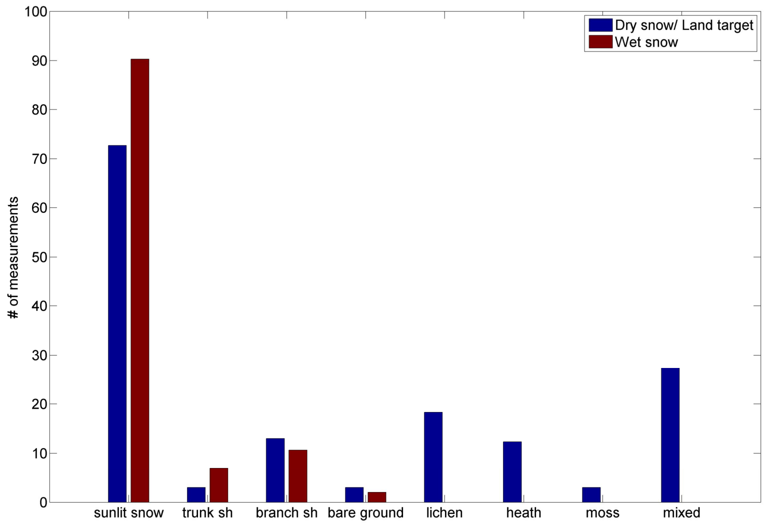


Figure 2 Distribution of targets and for snow cover the discrimination between wet and dry snow in the present spectrum database.

## 2.3 METLA phenological dataset

Phenology describes the cycles of natural phenomena. The interest of climate researchers towards these data series has increased due to their long time span. From the perspective of carbon balance estimation the phenological events describe important phases in the annual cycle of photosynthesis of vegetation. The beginning of the growing season, namely the bud burst of leaves for deciduous species and the beginning of growth of new shoots for ever green species. The end of growing season is observed as yellowing of leaves or end of the annual shoot growth. The phenomena are not directly correlated with photosynthetic activity, which up takes the atmospheric $CO_2$ and especially so for coniferous forests, which can have photosynthetic activity even during the winter, but the phenological cycle give some boundaries for the full photosynthetic potential of the forests and ground vegetation.

*Phenological observation network*

Finnish Forest Research Institute (METLA) is currently continuing the work for gathering the information for the timing of certain phenological events of selected vegetation species. The network (Figure 3) covers around 30 observations stations spread across four vegetation zone: 1) Hemiboreal, 2) Southboreal, 3) Midboreal and 4) Northboreal zones (Figure 3). The observation sites and individual trees are carefully selected using the following criteria:

Selection criteria for observation sites (Kubin et al. 2007)

- The site should be relatively dry heath.
- The tree stand should represent a developed cultivated forest.
- The site should representative of the average environmental conditions of the region.

Selection criteria for three specimens (Kubin et al. 2007)

- Healthy and normally grown trees.
- Preferably naturally developed over.

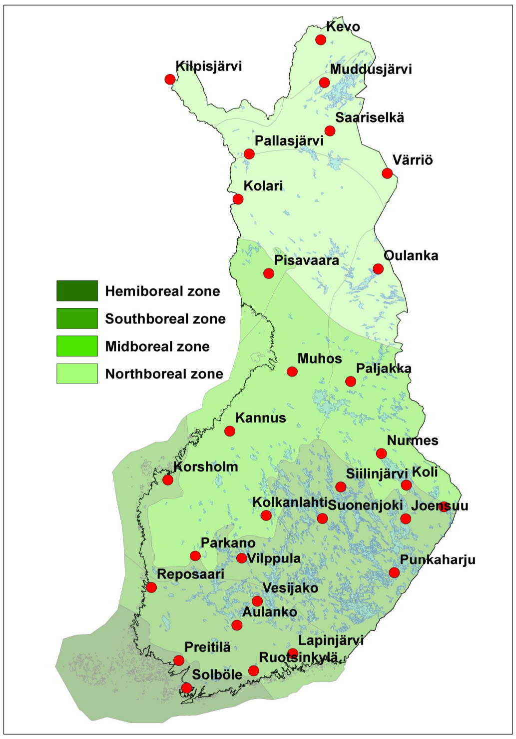


Figure 3 Phenological observation network of METLA in 2007.

The phenological observations are done twice a week from the beginning of the growing season until the late autumn when leaves fall off from deciduous trees. Observations are made on easily visible phenomena, which describe different stages in the annual cycle of vegetation. The data consists of the first days of the observed phenomena with pre-given criteria. If the event falls between the observation days the day, the true day is used only if it's accurately known, e.g. from other field work in the area.

For SNOWCARBO a dataset was purchased from METLA and data was received in late spring 2009. The observed species and related phenomenon in the SNOWCARBO- phenological dataset are listed in Table 5, together with the criteria of the observations.

Table 5 The observed vegetation species, the related phenological phenomenon and criteria for the observer.

| Species | Latin | Phenomenon | Criteria |
|---|---|---|---|
| Downy birch | *Betula pubescens* | Bud burst | - Leaves are still very small.<br>- The leaf is not fully open yet.<br>- The venation is not yet visible.<br>- At least 50% of the leaves of the tree have bursted in all 5 observation trees.<br>- For aid: the tree looks green from distance for the first time |
| | | Fully grown leaves | - Leaves are dark green and thick<br>- Can be checked by measuring the length and width of some leaves |
| | | Colouring of leaves | - At least 50% of the leaves from all 5 observation trees are yellow. |
| | | Falling of leaves | - At least 50% of the leaves have fallen off from all 5 observation trees. |
| Scott's pine | *Pinus sylvestris* | Beginning of height growth | - The tip of the shoot swells and the scales at the tip puff up.<br>- To aid: the tip of the shoot gets a lighter color. |
| | | End of height growth | - The growth of the shoot is measured until it stops growing.<br>- Note: The tip of the shoot develops a new bud in the end. During some warm autumns the shoots can grow again later on, but this is not considered in the annual growth. |
| Bilberry | *Vaccinium myrtilus* | Opening of flowers | - At least 50% of the flowers in the twigs have opened in all observation areas (5). |
| | | Ripening of berries | - At least 50% of the berries in the observation areas are ripe. |

*Preliminary analysis*

The fist analysis is based mainly on visual inspection of the data. Figure 4 illustrates two examples from the dataset. Generally the data shows strong variation between years, but relatively constant differences between sites (see Figure 4, May shoot for pine, *left*), but the data also exhibits some significant differences in the observations in some years for the same phenomenon occurring after significant delay in another location relatively close to the first one, even though during earlier years the occurrence of the phenomena did not show such large differences (see Figure 4, Bud burst for Downy birch, *right*).

Some possible explanations for large discrepancies can be:

- Local climatic conditions have varied significantly.
- The vegetation has suffered from external stress, e.g. insect pest.
- Error in the observations, due to observer.
- Errors in the observations, due to qualitative nature of the method.

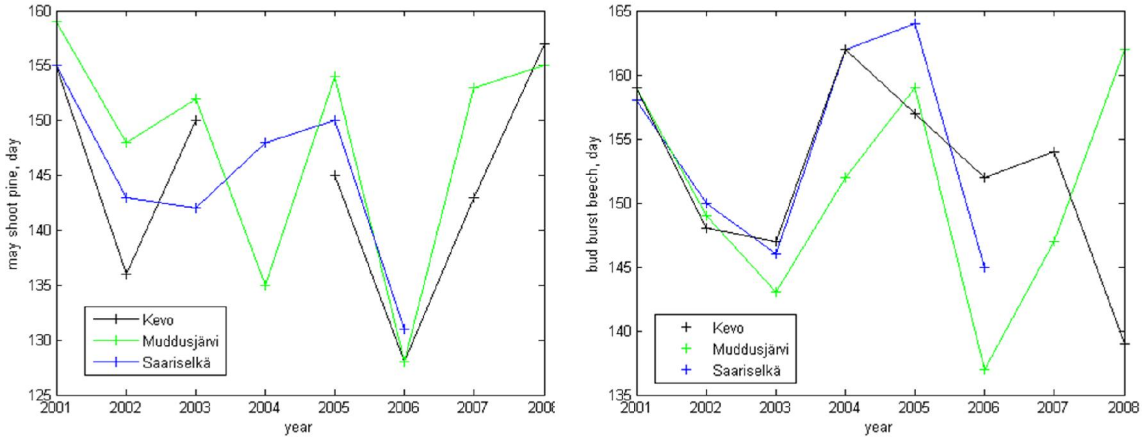


Figure 4 Day of year marking May shoot growth for Scotts pine (*left*) and bud burst for Downy birch (*right*) from 2001-2008.

Further work is needed to evaluate the possible error sources and the data needs to be compared with climatic information to find possible explanations.

## 2.4 FMI weather stations and e-code

Weather data is important background information for understanding the seasonal evolution in snow cover and vegetation. Finnish Meteorological Institute (FMI) has an extensive weather station network in Finland (Figure 5). Additionally to regular automated weather observations the FMI weather station network have provided observer based estimations of the fractional snow cover over some of the weather stations. These observations were ceased in February 2008, but still cover most of the years (2001-2008) of the period of interest in this project and are a good supplement to the snow course data, due to denser network. E-code describes the fractional snow cover in the vicinity of the weather station. The descriptions for E-code are given in Table 6.

Table 6 Description of E-codes.

| E-code | Description |
|---|---|
| 0 | Dry snow free terrain, vegetation can be covered by moisture from dew or fog. |
| 1 | Wet snow free terrain. |
| 2 | Snow free terrain with water ponds. |
| 3 | Terrain frosted or covered with surface ice. |
| 4 | Open terrain snow free, some snow in forested areas. |
| 5 | Snow covering over 0%, but less than 50% of the terrain. |
| 6 | Wet or re-frozen snow covering over 50% but less than 100% of the terrain. |
| 7 | Wet or re-frozen snow covering 100% of the terrain. |
| 8 | Dry, loose snow covering over 50%, but less than 100% of the terrain. |
| 9 | Dry, loose snow covering 100% of the terrain. |

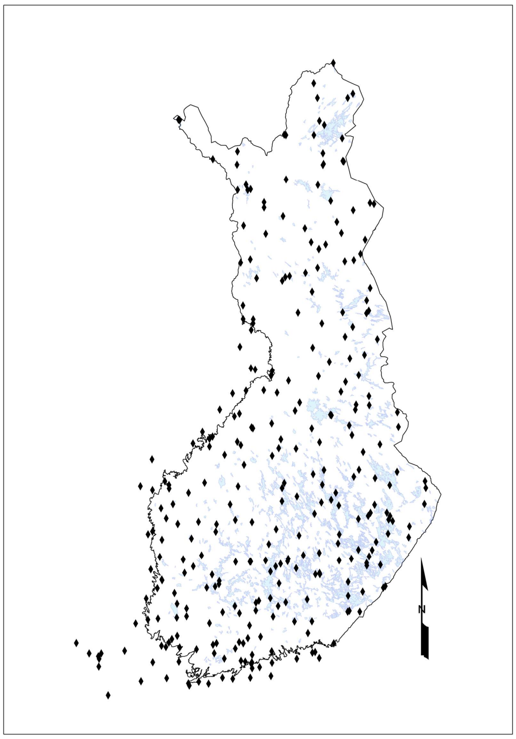

Figure 5 FMI weather station network.

The e-code can be used as supplementary information to the patchiness of snow cover observed at the snow courses in order to validate the fractional snow cover derived from satellite images. This has previously been done in the development of the algorithm used for retrieval of snow covered area, i.e. SCAmod (Snow Covered Area MODel, Metsämäki et al. 2005), which is also applied in SNOWCARBO. Metsämäki et al. (2005) have validated fractional snow cover estimates separately against the snow course information and E-code data. From selected weather stations also the snow depth information is available. This information can be used as a supplementary information source, while evaluating the performance of the SCA- algorithm.

## 2.5 Other in-situ observations

Other data sources are also available with direct relevance to the SNOWCARBO project and these will be used to supplement the datasets described above when the need arises. From these two data sources are worth mentioning.

*Soil moisture measurement network in SYKE*

SYKE has a network of nine active automated soil moisture measurement stations (Figure 1), which have been active since 2007. Locations of the stations are given in Annex 2. The stations measure the soil moisture at four depths, i.e. 10, 30 50 and 70 cm from the surface. The measurement is so called TDR (Time-Domain-Reflectometry) measurement, which gives the dielectric permittivity of the soil, which is further related to the soil moisture. Additionally to the soil moisture, the stations have a temperature sensor at around 20 cm depth. The soil moisture and temperature information can be used in monitoring the ground freezing.

*Sodankylä - Arctic Research Centre*

Sodankylä Arctic Research Center holds vast capacity for development of remote sensing methodology for ground targets and especially the snow cover. The following list gives the primary additional information sources that can be applied in the SNOWCARBO project framework to aid the development of satellite algorithms used at SYKE. The list is not exhaustive, but gives the most important parameters:

- Synoptic weather observations (part of the FMI weather station network) and additional manual observations.
- Solar radiation and albedo measurements.
- Meteorological mast for measurements of flux measurements of atmospheric components, including $CO_2$.
- CAL-VAL (Calibration-Validation) mast for remote sensing observations, accompanied with spectral reflectance monitoring, measurements of soil parameters (temperature and soil moisture) and observations of snow characteristics.

Finally additionally to all the data described above other governmental institutions hold data sources and constantly develop new datasets, which can become useful in the course of the development of methods for carbon balance mapping. For example a new soil dataset, covering Finland, will be released by the end of 2009. The current distinction of different soils in present land cover datasets could benefit from the new data.

# 3 In-situ field campaigns in 2009

Altogether four field campaigns are included in the project plan. Two of them are conducted in spring time with focus on the seasonal snow cover and especially in the later stages during the melting period. Two field campaigns are focused to the autumn in order to give additional information on soil parameters and vegetation. The spectral data from the spring campaign has been added to the database and the analysis is ongoing in preparations for the spring 2010 field campaign.

## 3.1 Spring 2009 campaign

The spring campaign included measurements from both dry snow cover, as well as measurements from the later stages of the melting period, when the snow cover becomes thin and is wetted through out. The main objective was to complement the existing spectral library. Following measurements were conducted:

- Spectral reflectivity from dry snow cover, under direct sun light over lake ice.
- Spectral reflectivity from wet snow cover, under diffuse lighting conditions.
- Spectral reflectivity from new snow, under diffuse lighting conditions.
- Snow properties and surface characteristics at measurement site of the spectrum.

### 3.2 Autumn 2009 campaign

The autumn campaign was conducted in October. The measurement campaign included observations under two climatic conditions, first above 0°C conditions and later after a snow fall event in freezing conditions.

- Soil temperature
- Soil moisture
- Characterization of vegetation cover Additionally

## References

Kubin, E. E. Kotilainen, J. Poikolainen, T. Hokkanen, S. Nevalainen, A. Pouttu, J. Karhu and J. Pasanen. 2007. Fenologisen havaintoverkon seurantaohje (trans. Manual for phenological observations). *Publication of the Forest Research Institute*. 2007.

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Salminen, M., J. Pulliainen, S. Metsämäki, A. Kontu and H. Suokanerva. 2009. The behaviour of snow and snow-free surface reflectance in boreal forests: Implications to the performance of snow covered area monitoring. *Remote Sensing of Environment*, Vol. 113, p. 907-918.

# Annexes

Annex 1 Locations of Active SYKE snow courses in 2009.

| ID | Location | Lat | Lon |
|---|---|---|---|
| 1802 | Jänisjoki,Ruskeakoski | 62.2536 | 30.2643 |
| 4026 | Sorsavesi-Sorsakoski | 62.1702 | 27.5338 |
| 4164 | Korpijärvi-Luusua | 63.2221 | 27.5932 |
| 4166 | Tiilikanjoki | 63.4339 | 27.9965 |
| 4411 | Saimaa lähialueineen | 61.0959 | 28.4637 |
| 4462 | Juankoski-Lastukoski | 63.0403 | 28.2038 |
| 4727 | Kallavesi-Konnus+Karvio | 62.1813 | 27.5451 |
| 4791 | Koitajoki,Siikakoski,Pamilo | 62.5133 | 30.1358 |
| 4811 | Saimaa-Imatra | 61.0959 | 28.4637 |
| 4834 | Pielisjoki,Jakokoski | 62.4427 | 30.0225 |
| 4841 | Pielinen | 62.5426 | 30.1350 |
| 4851 | Onkivesi-Viannonkoski | 63.1313 | 27.1225 |
| 4862 | Vuotjärvi-Juankoski | 63.0403 | 28.2038 |
| 4863 | Syväri-Lastukoski | 63.1212 | 28.1654 |
| 4882 | Höytiäinen-Puntarikoski | 62.4044 | 29.3915 |
| 4892 | Koitajoki,Lylykoski | 62.4605 | 30.4207 |
| 4894 | Koitere-Hiiskoski | 62.5109 | 30.3824 |
| 14129 | Jyväsjoki | 62.1439 | 25.4603 |
| 14235 | Saarij+Viitasaar+Rautalammin r. | 62.3553 | 25.4417 |
| 14311 | Pernoo-Kalkkinen | 60.4156 | 26.4905 |
| 14321 | Päijänne lähialueineen | 61.1701 | 25.3554 |
| 14718 | Paaskoski,Jyräänkoski | 60.5408 | 26.4855 |
| 14811 | Pernoon haarapaikka | 60.2722 | 26.3438 |
| 14821 | Päijänne-Kalkkinen | 61.1701 | 25.3554 |
| 14831 | Leppävesi-Haapakoski | 62.1439 | 25.5326 |
| 14841 | Keitele-Äänekoski+Mämminkoski | 62.3553 | 25.4417 |
| 14844 | Vuosjärvi-Huopanankoski | 63.0250 | 25.3158 |
| 14847 | Kolimajärvi-Kellankoski | 63.1005 | 25.5624 |
| 14861 | Kiimasjärvi-Kiimaskoski | 62.3732 | 25.3823 |
| 14871 | Konnevesi-Siikakoski | 62.3706 | 26.2048 |
| 14891 | Puolakka+Jaala | 61.0044 | 26.3530 |
| 14892 | Vahvajärvi-Ripatinkoski | 61.3611 | 26.3936 |
| 18802 | Porvoonjoki,Vakkola | 60.2820 | 25.3631 |
| 21103 | Kytäjoki | 60.3653 | 24.4751 |
| 21108 | Tuusulanjärvi | 60.2000 | 24.5351 |
| 21801 | Oulunkylä | 60.1258 | 24.5902 |
| 23802 | Peltokoski | 60.0936 | 23.5036 |
| 24701 | Kiskonjoki,Koski | 60.1049 | 23.1738 |
| 28800 | Halistenkoski | 60.2756 | 22.1724 |
| 32100 | Puttakoski | 60.5032 | 21.3021 |
| 34803 | Kauttuankoski | 61.0635 | 22.0952 |
| 35014 | Leineperinkoski | 61.2926 | 21.5151 |
| 35083 | Pääjärvi,Jokelankoski | 61.0138 | 25.0913 |
| 35242 | Ähtäri+Pihlajavesi+Keuruun r. | 62.1543 | 23.4359 |
| 35312 | Nokialta Harjavaltaan | 61.2019 | 22.0659 |
| 35743 | Hankaveden Luusua | 62.3100 | 24.0913 |
| 35791 | Maurialankoski | 61.0826 | 22.4158 |
| 35812 | Harjavalta | 61.2019 | 22.0659 |
| 35821 | Pyhäjärvi-Nokia | 61.2747 | 23.2625 |
| 35822 | Vanajavesi-Kuokkalankoski | 61.2747 | 23.2625 |
| 35831 | Näsijärvi-Tammerkoski | 61.2946 | 23.4602 |
| 35851 | Ikaalisten reitti, Siuronkoski | 61.2831 | 23.2007 |


SYKE
ILMATIETEEN LAITOS
METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE
Life

| | | | |
|---|---|---|---|
| 35861 | Vilppula | 62.0051 | 24.3029 |
| 35871 | Valkeakoski | 61.1553 | 24.0206 |
| 35893 | Pyhäjärvi-Kuhalankoski | 60.4858 | 23.3723 |
| 36701 | Karv.j suuhaarat Et.+Po.+La. | 61.3849 | 21.5215 |
| 42701 | Kyrönjoki,Skatila | 63.1114 | 21.5657 |
| 47802 | Evijärvi-Luusua | 63.2556 | 23.2409 |
| 53802 | Kalajoki,Hihnalankoski | 64.1208 | 24.0333 |
| 57502 | Uljua | 64.2009 | 25.5231 |
| 57702 | Siikajoki,Heikkilänkoski | 64.2809 | 25.3932 |
| 57801 | Siikajoki,Länkelä | 64.4600 | 24.5251 |
| 59311 | Oulujoki, Jokivarsi | 65.0055 | 25.2826 |
| 59331 | Oulujärvi | 64.3419 | 26.4709 |
| 59381 | Sotkamon r.,Nuas-Ontojärvi | 64.1346 | 27.4402 |
| 59541 | Emäjoki | 64.2411 | 27.5056 |
| 59811 | Merikoski | 65.0055 | 25.2826 |
| 59831 | Oulujärvi-Vaala | 64.3419 | 26.4709 |
| 59841 | Leppikoski,Kiehimä | 64.2411 | 27.5056 |
| 59848 | Pyhäntä | 64.3242 | 28.1740 |
| 59851 | Kiantajärvi-Pysty | 64.5246 | 28.5510 |
| 59881 | Rehjänselkä-Kajaani | 64.1346 | 27.4402 |
| 59891 | Ontojärvi-Luusua | 64.0555 | 28.5923 |
| 61731 | Jokijärvi,Niskakoski | 65.3436 | 28.1119 |
| 61761 | Koitijärvi | 65.3437 | 28.1113 |
| 61771 | Jaurakkajärvi-Luusua | 65.1627 | 27.1720 |
| 61811 | Raasakka | 65.2003 | 25.2455 |
| 61813 | Kipinä | 65.1742 | 26.3058 |
| 65051 | Sinettäjärvi-Luusua | 66.3626 | 25.2538 |
| 65211 | Raudanjoki ym + suuosa | 65.4734 | 24.3303 |
| 65239 | Jumiskonjoki.Jumisko | 66.2440 | 27.5651 |
| 65311 | Jokivarsi,suuosa | 65.4722 | 24.3352 |
| 65321 | Raudanjoki+lisäalueet | 66.2944 | 25.4431 |
| 65331 | Kemijärvi | 66.2418 | 27.2000 |
| 65551 | Ounasjoen Alapuoli | 66.3030 | 25.4420 |
| 65713 | Kemijoki,Valajaskoski | 66.2944 | 25.4431 |
| 65733 | Kemijoki,Pelkosenniemi | 66.5439 | 27.2847 |
| 65741 | Kemihaara,Kummaniva | 67.1157 | 27.4737 |
| 65811 | Kemijoki,Isohaara | 65.4734 | 24.3303 |
| 65821 | Kemijoki ennen Ounasjokea | 66.2944 | 25.4431 |
| 65831 | Seitakorva | 66.2418 | 27.2000 |
| 65851 | Ounasjoki | 66.3030 | 25.4420 |
| 65861 | Ounasjoen Yläpuoli | 67.3032 | 26.3807 |
| 65881 | Kitinen | 67.0800 | 27.2952 |
| 65883 | Kitinen,Porttipahta | 67.5743 | 26.4505 |
| 65891 | Luiro | 67.0948 | 27.3011 |
| 65893 | Luirojoki,Lokka | 68.0701 | 27.0334 |
| 65922 | Kaihua | 66.2134 | 26.4928 |
| 65983 | Lokka+Porttipahta | 67.5743 | 26.4505 |
| 67096 | Raanujärvi | 66.3856 | 24.4045 |
| 67496 | Vietosen oma alue | 66.3850 | 24.2553 |
| 67891 | Tengeljoki,Portimojärvi | 66.2251 | 23.4714 |
| 67896 | Vietonen | 66.3850 | 24.2553 |
| 71411 | Inarin lähialueet | 68.5411 | 28.2619 |
| 71721 | Juutuanjoki,Saukkoniva | 68.5429 | 27.0202 |
| 71811 | Inari-Luusua | 68.5411 | 28.2619 |
| 71842 | Ivalojoki,Pajakoski | 68.3247 | 27.1418 |
| 74802 | Muojärvi,Piiksijoki | 65.5218 | 29.5737 |

Annex 2 Locations for soil moisture and soil temperature measuremets and start of the automated observation period.

| Station | Location | Latitude | Longitude | Beginning of obs. |
|---|---|---|---|---|
| METSÄHOVI (Kylmälä) | Kirkkonummi | 60.2183 | 24.3950 | 2006-06-15 |
| TULLINKANGAS | Lammi | 61.1775 | 25.2189 | 2006-06-02 |
| TAIPALE (Lehtimäki) | Alavus | 62.8753 | 23.7979 | 2006-10-08 |
| TARVASJOKI | Tarvasjoki | 60.5804 | 22.7464 | 2007-08-10 |
| TURTAKANGAS | Ruukki | 64.6075 | 24.7999 | 2007-08-24 |
| MÄNTYNIEMI | Pesiö | 64.9557 | 28.5519 | 2008-09-14 |
| SODANKYLÄ | Sodankylä | 67.3848 | 26.6246 | 2007-10-05 |
| VALLOVAARA | Salla | 66.8579 | 28.4186 | 2007-09-24 |
| SEITSEMINEN | Ikaalinen | 61.9303 | 23.3755 | 2008-12-11 |