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SNOWCARBO

MONITORING AND ASSESSMENT OF CARBON BALANCE RELATED PHENOMENA IN FINLAND AND NORTHERN EURASIA

LIFE07 ENV/FIN/000133

EC Life+ project 2009–2012

Project participants
Finnish Meteorological Institute (FMI)
Finnish Environment Institute (SYKE)
Commissariat a l'energie atomique, Le Laboratoire des Sciences du Climat et l'Environnement (CEA-LSCE/IPSL)

Photo: Timo Lindholm

Overview

The main objective of the SnowCarbo project is to implement and demonstrate a new innovative approach for the net carbon balance mapping in Finland and Baltic EC countries. The method uses local in situ observations of snow evolution, phenology, land cover, CO_2 fluxes and concentrations and earth observation (satellite) data in larger scales together with climate-vegetation models. The final outcome of annual maps of carbon balance produced by SnowCarbo can be used to aid the definition of the European and national adaptation strategies to climate change impacts and to support the formulation of the environmental legislation and regulations.

Background

One of the key problems of the climate change prediction and monitoring is that the magnitudes of carbon sinks and sources of boreal forests are not accurately quantified. They are currently measured in higher precision only at individual observation sites and the monitoring over large regions is very coarse. The influence of seasonal snow cover on the carbon exchange is also poorly known. The lack of accurate carbon exchange estimates handicaps the performance of climate scenarios and the evaluation of anthropogenic influences on climate change.

Analysis of the spatial variability and long-term trends in snow cover distribution together with in-istu observation data and climate change prediction models show that the models project changes in the spatial and temporal distribution of snow in the boreal and in the arctic terrestrial regions. Thus, changes in seasonal snow cover evidently lead to changes in CO_2 balance, as snow cover directly effects the respiration (carbon sources) and increase of forest and other vegetation biomass (magnitude of carbon sinks). Snow also impacts the vegetation, the ecology, and the subnivean environment, which is a habitat for many plant and animal species. Changes in the timing of snowmelt in spring can affect the breeding of certain ground nesting species and the distribution of some plant communities.

The SnowCarbo project targets to development of new monitoring tools and methods to aid European and national adaptation strategies to climate change impacts, having relevance to the Green Paper of European Climate Change Programme II: 'Adaptation to climate change in Europe – options for EU action'.

Objectives

1. To provide accurate map information on net carbon balance in boreal forest zone in order to assess the real levels of carbon sinks and sources for future climate controlling treaties and policy making.
2. To provide and demonstrate methodologies to extract anthropogenic influence from natural background CO_2 sources in order to enable the development new legislative means for CO_2 regulation.
3. To provide information for the future needs of required in situ, model, Earth observation and land cover data needs of continental scale carbon balance mapping/monitoring (focusing on northern areas).

Methodology

In order to map the net carbon balance, the SnowCarbo project will implement an approach, which combines in-situ and satellite observations of snow evolution, phenology, land cover, CO_2 fluxes and CO_2 concentrations to feed mathematical CO_2 models. The CO_2 models are a combination of vegetation model, which determines the interaction of atmosphere and vegetation and provides the CO_2 fluxes, and a general circulation model (GCM), which gives the driving forcing for the vegetation component and distributes the CO_2 fluxes allowing estimating CO_2 concentrations in atmosphere (Figure 1).

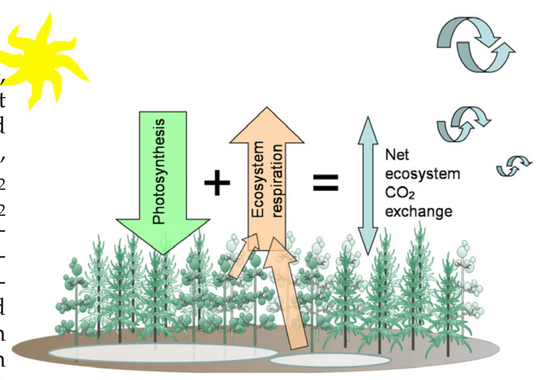

Figure 1. Land ecosystem CO_2 Balance is modeled by combining ecosystem processes to their climatic drivers and transport processes in the atmosphere.

SnowCarbo at Finnish Environment Institute (SYKE)

Earth observation data from both microwave and optical satellite instruments are utilized for monitoring the seasonal cycle of vegetation and snow cover. At SYKE the optical satellite data is processed and analyzed to be further used in connection with the CO_2-modeling. SYKE provides filtered and interpolated time-series of snow depletion and vegetation development based data from MODIS-satellite. These time-series will be used to extract carbon balance-related indicative features, such as (i) beginning of growth season, (ii) seasonal vegetation peak, and (iii) end of seasonal vegetation growth.

Land cover, land use and related change have strong effects on the terrestrial carbon exchange. During the project available land cover data sources are evaluated for their suitability for producing land cover information for CO_2-modeling.

Additionally a dense network of in-situ observations, covering four boreal vegetation zones, is used for validating EO-products and for reference to the final product of carbon balance estimates.

The modeling grid and the optical EO-products cover to a large extent the Baltic Sea drainage basin. The in-situ observations are mainly available from Finland (Figure 6).

Earth observations data products

- Time-series of snow covered area (SCA) from optical satellite data (MODIS) (2001–2008) for monitoring evolution of seasonal snow cover (Figure 2).
- Time-series of normalized difference vegetation index (NDVI) from optical satellite data (MODIS) for monitoring the annual cycle of vegetation (Figure 3). Extraction of phenological events (beginning, end and peak of the growing season) from the developed time-series.

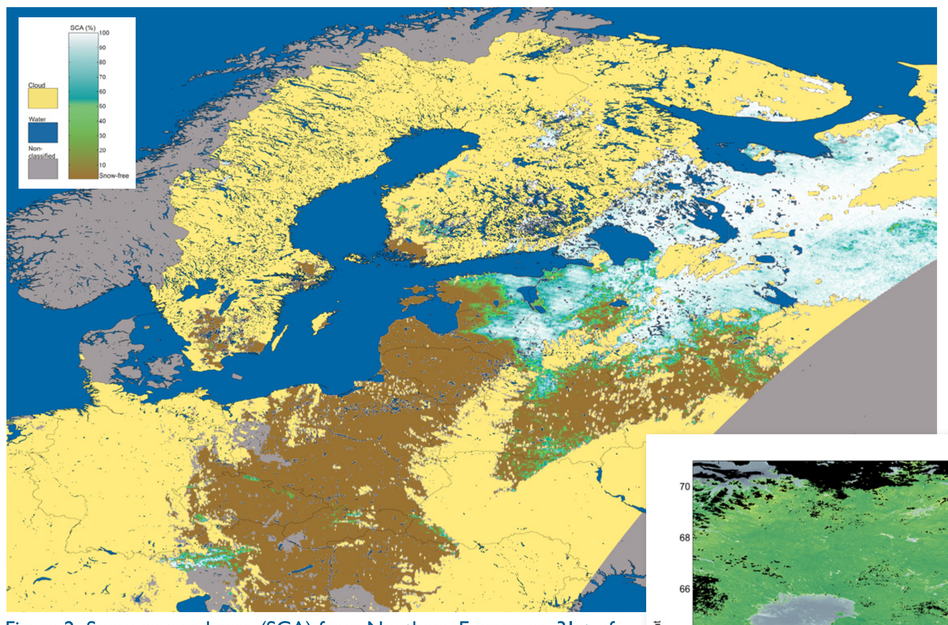

Figure 2. Snow covered area (SCA) from Northern Europe on 31st of March 2008. The product describes the fraction of snow covered area.

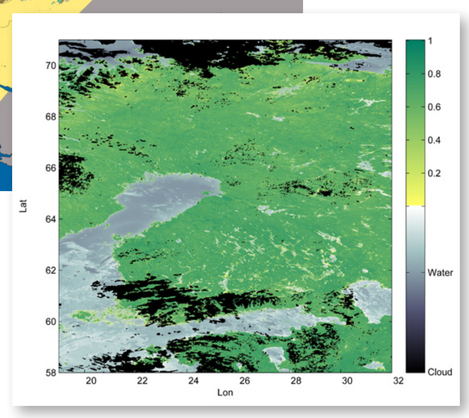

Figure 3. Normalized difference vegetation index (NDVI) a weekly composite from week 30 in July 2004. NDVI describes the phenological state of the vegetation. NDVI is reacting to the increase of foliage on deciduous trees and to a lesser extent on needles on coniferous trees.

Land cover datasets

- European CORINE, describing the land cover/land use in 25ha minimum mapping unit.
- Modified national CORINE, with higher resolution (25 m raster) and more extensive thematic content, especially in the boreal forests (Figure 4).
- GLOBCOVER – Global land cover dataset (based on 300m resolution EO-data.)

In situ datasets

The locations of in-situ data sites are shown in figure 5.

- Phenological observations from METLA to validate the phenological features extracted from satellite data.
- Observations from around 120 snow operational snow courses to validate the EO-snow products.
- A spectral data bank for further development of the retrieval of phenological and snow cover information from optical satellite images.
- CO_2 -flux station network operated by Finnish Meteorological Institute and University of Helsinki used as reference for the final carbon balance maps, but also the phenological features extracted from the EO-data.
- The weather station network from Finnish Meteorological Institute.

CORINE land cover 2000

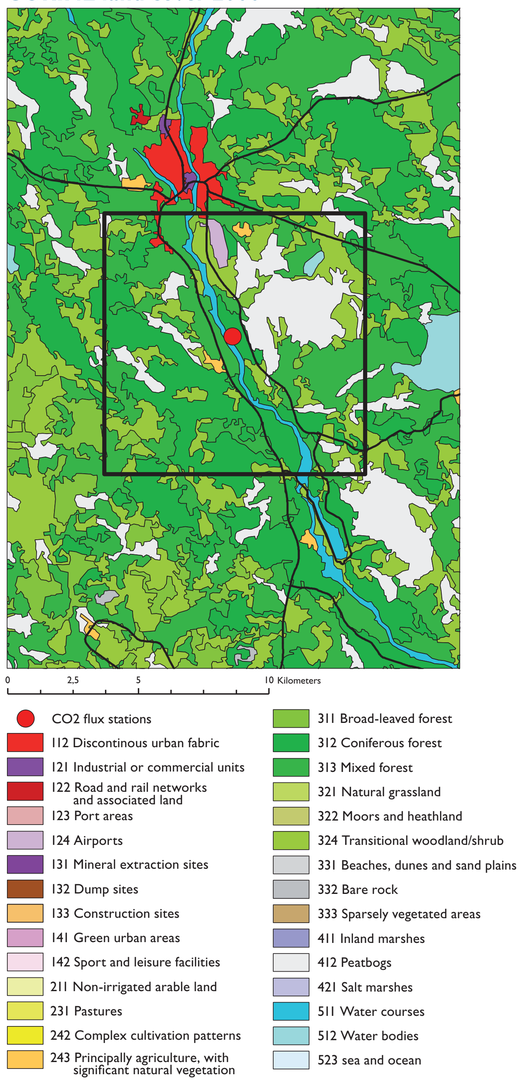

Figure 4. CORINE land cover 2000 data from around Sodankylä observatory, a site for high accuracy calibration and validation of the carbon balance modeling results.

SNOWCARBO in-situ network

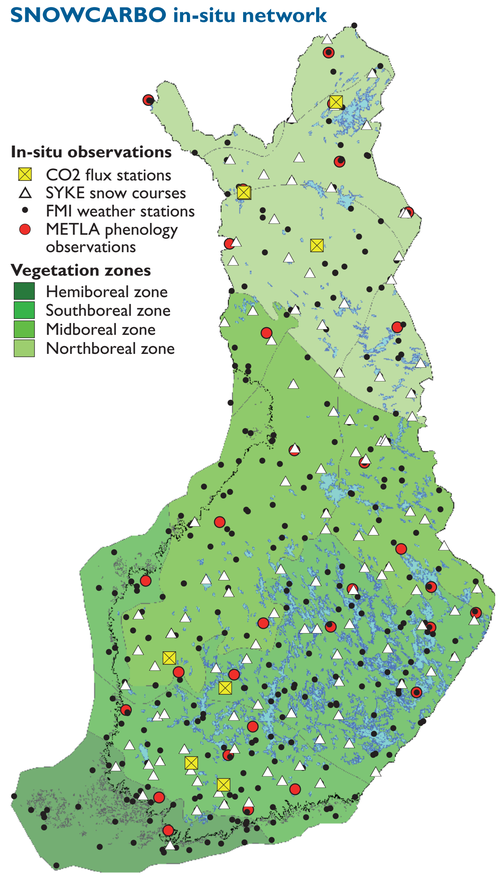

Figure 5. The dense in-situ measurement network used in SnowCarbo-project covers four different vegetation zones.

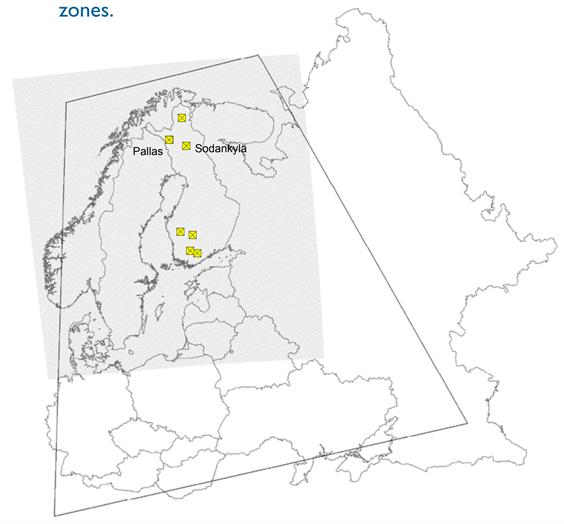

Figure 6. The geographical coverage of the SnowCarbo -project. The shaded area gives the extent of the grid for higher resolution carbon balance modeling. The yellow boxes mark the CO_2 measurement stations used for validation of the modeling results and the black polygon describes the area covered by the SCA and NDVI products.

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