LIFE Project Number
ENV/FIN/000133

2nd Data document

Reporting Date
31/12/2010

Action
Action 4 – *In situ* data collection and processing by FMI

LIFE+ PROJECT NAME or Acronym
SNOWCARBO

Author

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List of abbreviations

COSMOS   Community Earth System Models (network for earth system modelling)

EC   Eddy Covariance (micrometeorological technique)

FMI   Finnish Meteorological Institute

MPI-M   Max Planck Institute on Meteorology, Hamburg

JSBACH   Jena Scheme for Biosphere-Atmosphere (model describing biosphere-atmosphere interaction)

ECHAM5   European Centre Hamburg Model (global circulation model, atmosphere)

REMO   Regional climate model

1 Summary

This report describes the data used for running and evaluating the climate models. Two different data sets are prepared for these purposes. The input data, i.e. the gridded data set, are collected from various global data sources and they are synthesised to global grids. The validation data (i.e. the *in situ* data set) such as, CO_2 fluxes and concentrations, have routinely been measured at stations maintained by FMI for several years. The former is used as boundary and initial conditions for model runs, whereas the latter will be facilitated in assessing the reliability of the model predictions.

The models facilitated in SNOWCARBO project are regional climate model (REMO2008), global circulation model (ECHAM5) and the ecosystem model (JSBACH) describing the CO_2 circulation within various ecosystems and soils and its exchange between the surface and the atmosphere. All these models belong to COSMOS model family which is developed by Max Planck Institute, Hamburg. While the project aims at estimating the terrestrial ecosystem CO_2 source and sink strengths with detailed process models, for reliable balance of CO_2, its exchange by oceans and fossil fuel sources have to be prescribed with appropriate emission data bases. Furthermore, both models need to be initialised and the regional model continuously forced from the domain boundaries with observed weather data. Additionally, in order to keep the weather similar to the actual one the models can be nudged with gridded meteorological data.

In order to estimate the performance of the models, CO_2 fluxes and concentrations they predict will be compared to point measurements at certain sites located at Boreal ecosystems. Data characteristics of the measurement sites maintained by FMI together with data availability and general data quality will be given in this report.

2 Data

2.1 Gridded data

The input data set needed for weather and tracer transport simulations consists of initial and boundary forcing data. This input data for the models (REMO2008, ECHAM5 and JSBACH) are given in the form of meteorological fields and as maps of surface properties. In addition to the standard meteorological fields such as air temperature, liquid water content and 3D velocity fields we also need the initial atmospheric CO_2 concentration fields, fire information, anthropogenic sources and sea ecosystem CO_2 exchange for estimating the CO_2 balance. Various possibilities for the initial and boundary forcing data fields have been explored. The selected data sources are presented in Table 1.

Table 1. Datasources of the initial and boundary forcing data for the models (REMO2008, ECHAM5 and JSBACH)

Name of the dataset	Included data types	Limitations/ Drawbacks	Spatial/Time resolution	Time coverage
ECMWF analysis data	Detailed meteorology derived from observations	-	0.167° Six-hourly	2001-2008
TM3	3D concentration fields due to all the relevant surface fluxes	-	1.875° Six-hourly	2001-2007
EDGAR4.0	Surface fluxes due to fires and anthropogenic sources	Limited time coverage	0.1° Annual	2001-2005
Takahashi database	Oceanic CO2 fluxes	-	4° × 5°	Present (2000)
Optional				
ECHAM5	3D concentration fields and meteorology	No real years. No anthr. or oceanic sources.	Approx. 2° Six-hourly	2001-2006
CarbonTracker Europe	3D concentration fields due to all the relevant surface fluxes	Limited time coverage	1° Three-hourly	2007
CarbonTracker	3D concentration fields due to all the relevant surface fluxes	Coarse resolution for Europe	4°-6° Three-hourly	2001-2007
ECMWF ERA-INTERIM	Snow depth	-	1° Daily	2001-2009

ECMWF (The European Centre for Medium-Range Weather Forecasts) operational data will be used for boundaries and initial fields of meteorology. There may be some problems with the snow depth information of ECMWF operational data and substitutive data sources will be considered (e.g., ERA-INTERIM data). TM3 model results from The Atmospheric Tracer Transport Model Intercomparison Project (TransCom) will be used as CO_2 concentration boundaries. EDGAR 4.0 will be used as fossil fuel emission data source in this project. The Emissions Database for Global Atmospheric Research (EDGAR) provides gridded global past and present day anthropogenic emissions of greenhouse gases and air pollutants. Ocean fluxes from so called Takahashi database will be used to prescribe oceanic CO_2 emissions.

The ECHAM5 is an optional source for boundaries and initial fields of meteorological data. ECHAM5 coupled with its ecosystem scheme JSBACH would provide the regional model with most complete and internally consistent set of boundary and initial data as it contains both CO_2 concentration fields and complete meteorology. CarbonTracker is an optional source for initial and boundary CO_2 fields in SNOWCARBO. CarbonTracker data may also serve as a comparison data set for the CO_2 balance predictions in the later stages of the project.

2.2 Validation data

The validation data set is based on the CO_2 flux and concentrations measurements from various flux and concentration measurement stations of Finnish Meteorological Institute. The flux measurements are conducted by the eddy covariance (EC) technique which provides a direct measurement of the net exchange of CO_2, water vapour and sensible heat between the biosphere and the atmosphere. The measurements at Finnish flux sites Kaamanen wetland, Sodankylä Scots pine forest, Kenttärova Spruce forest and Lomplojänkkä wetland have continued in a standard way in 2010. The background CO_2 concentration measurements were continued at Pallas-Sodankylä GAW station on top of Sammaltunturi hill (67°58'24"N, 24°06'58"E, 565m above sea level), about 100m above the treeline. In addition to the actual CO_2 exchange data the flux stations provide additional meteorological data which may be used for evaluating the representativeness of gridded meteorological data products at each flux measurement site. The most important parameters (air and soil temperature together with different radiation components) are available at all sites. The measurement sites, measurement methods and the measured parameters are presented in more detail in 1ˢᵗ Data report.

2.3 Mast-based field spectrometer measurements

Mast-based field spectrometer measurements for the operational validation of applied optical satellite data products are conducted at Sodankylä (Sukuvaara et al. 2007). In 2006, an ASD field spectroradiometer was installed in a 30-m tower close to the CO_2 flux measurement tower. The spectroradiometer has a 5 m long fiber optic cable allowing measurements from the end of a 4.5-m horizontal pole. This rotating pole enables measurements of two separate land covers: a sparse Scots pine forest and a deforested area covered by lichen and heather. There is also a web camera installed in the tower taking pictures of the measurement area to allow detection of trees, shadows, snow etc. from the field of view.

In nominal operating mode the spectroradiometer performs scheduled measurements automatically once per hour. Due to problems with the measurement and control software, the measurements have been performed mainly manually during sunny weather conditions.

Parameter	Value
Manufacturer	Analytical Spectral Devices Inc.
Model	FieldSpec Pro Jr.
Spectral range	350-2500 nm
Sampling interval	1.4 nm (350-1050 nm) 2 nm (1000-2500 nm)
Wavelength accuracy	+/- 1 nm
Field of view	25º

Due to technical issues with the mechanical structures of the tower installation, the pole was fixed over the forest area in May 2009. In September 2009 the spectroradiometer was returned to the manufacturer for maintenance and calibration. The tower measurements were continued in February 2010 and were operating until October 2011.

References

Sukuvaara, S., Pulliainen, J., Kyrö, E., Suokanerva, S., Heikkinen, P., and Suomalainen, J., "Reflectance spectroradiometer measurement system in 30 meter mast for validating satellite images", IEEE International Geoscience and Remote Sensing Symposium, 23-28 July 2007, Barcelona, Spain, pp. 2885-2889, 2007.