VACCIA

Vulnerability Assessment of ecosystem services for Climate Change Impacts and Adaptation (VACCIA)

ACTION 3: Derivation of climate scenarios

Deliverable 1: First database on climate change scenarios for assessment work in Actions 5-13

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1. Introduction

The VACCIA project (Vulnerability assessment of ecosystem services for climate change impacts and adaptation), to be run for three years (2009-2011), will provide both detailed descriptions about the methodology and tools for making climate impacts and adaptation assessments, as well as an inventory of realistic adaptation measures for key ecosystem goods and services. This methodology and information can be used by stakeholders at local, regional, national and international scales. The project, funded by the LIFE+ financial instrument of the European Community, will also contribute directly to the development of existing/planned national and international policies and networks in this field.

The Finnish Meteorological Institute (FMI) is a research and service agency under the Ministry of Transport and Communications. The main objective of the FMI is to provide the Finnish nation with the best possible information about the atmosphere above and around Finland. FMI produces high-quality observational data and research knowledge about the atmosphere, combining its know-how into services to benefit of mankind and environment.

In Action 3 of the VACCIA project, FMI derives climate change scenarios for impacts and adaptation studies of the ecosystem goods and services at nine LT(S)ER (Long-Term Socio-Ecological Research network) areas in Finland. This report documents the first database on climate change scenarios for assessment work in other actions of the project. An updated database, as well as a report on climate change scenarios, will be created by the end of October 2010.

In the kickoff meeting of the VACCIA project in January 2009, it was decided that the climate scenarios to be constructed and applied in the project should, as far as possible, be consistent with those developed for the Finland's Research Programme on Adaptation to Climate Change (ISTO) (www.mmm.fi/ISTO). These scenarios are documented by Jylhä et al. (2009).

2. Methods employed

Climate change scenarios for Finnish LT(S)ER areas (Fig. 1) are constructed with respect to the baseline period 1971-2000. Scenarios for the mean temperature and precipitation are based on output from nineteen global climate models (GCMs) (Table 1); for other climatic variables, a bit smaller ensemble of the models is utilized. The projections were composed for three different greenhouse gas emission scenarios: SRES A1B, A2 and B1 (Fig. 2).

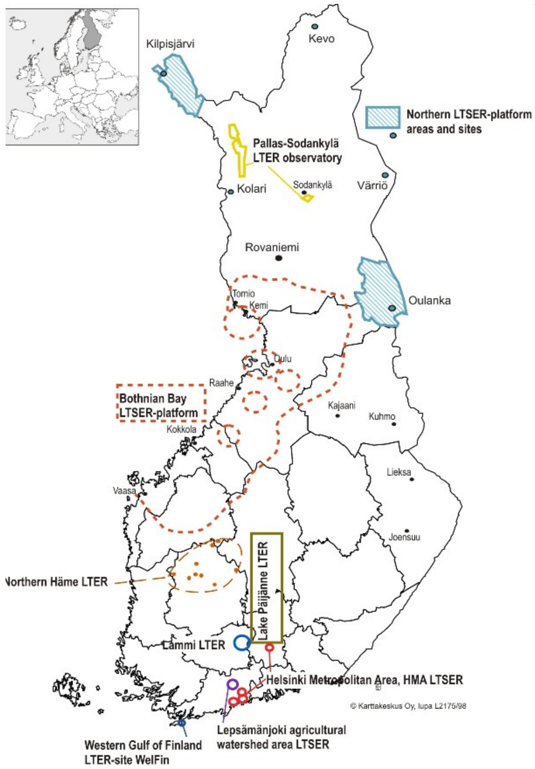

Fig. 1 The sitemap of the Finnish LTSER network (source: FinLTSER web pages).

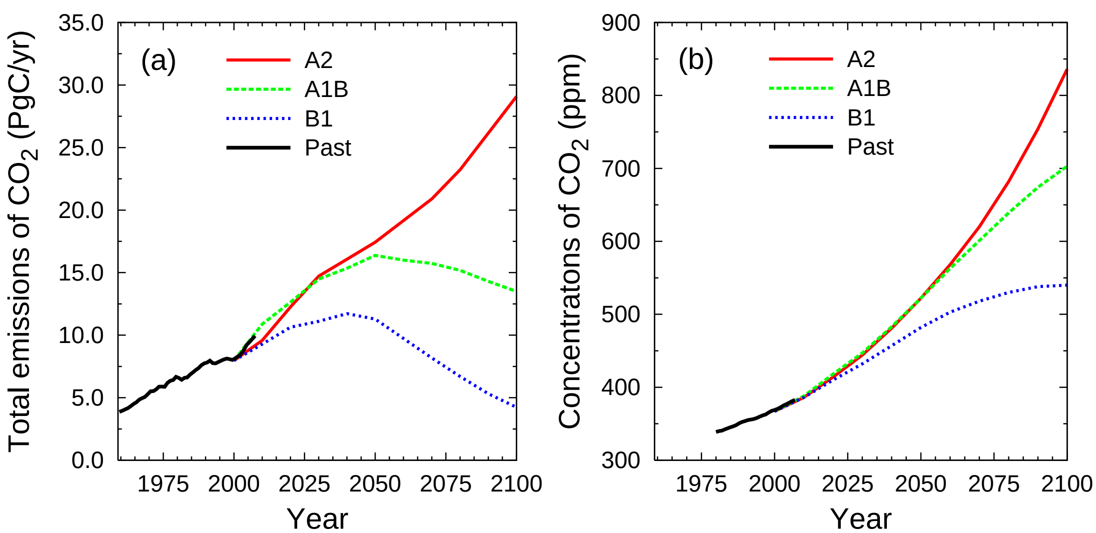

Fig. 2 Estimated temporal evolution of the emissions (a) and atmospheric concentration (b) of carbon dioxide under three SRES greenhouse gas scenarios. Observed emissions and concentrations for years 2000-2007 are depicted as well. Figures for the SRES scenarios are based on IPCC (2001) and the observational data on the Internet pages of the University of East Anglia and NOOA/ESRL.

Table 1. The global climate model experiments considered here, with the model acronym and country of origin. For model documentations, see Randall et al. (2007).

Model	Country
BCCR_BCM2	Norway
CGCM3.1(T47)	Canada
CGCM3.1(T63)	Canada
CNRM-CM3	France
CSIRO-Mk3.5	Japan
GFDL-CM2.0	USA
GFDL-CM2.1	USA
GISS-ER	USA
INM-CM3.0	Russia
IPSL-CM4	France
MIROC3.2(hires)	Japan
MIROC3.2(medres)	Japan
ECHO-G	Germany/Korea
ECHAM5/MPI-OM	Germany
MRI_CGCM2.3.2	Japan
NCAR_CCSM3	USA
NCAR_PCM1	USA
UKMO_HADCM3	UK
UKMO_HADGEM	UK

The climate change scenarios were primarily developed at 0.5° x 0.5° spatial resolution over the whole country for the period 2001-2099. For mean temperature and precipitation, the grid resolution is 0.25° x 0.25°. Best estimates of the climatic changes, constructed separately for each greenhouse gas scenario, are simply ensemble-means of the 19 GCMs. The 90% probability intervals of the changes were constructed by fitting a normal distribution to the set of projections calculated by the various GCMs and then defined as mean±1.645×standard deviation of the GCM simulations (Ruosteenoja and Jylhä, 2007; Jylhä et al., 2009).

The period 1971-2000 has been selected to represent a baseline climatology on which to compose future projections; this climatology can be modified on the grounds of climate model projections. In the so-called delta-change method the projected increases of monthly mean temperatures are added to the observed baseline period climatological monthly means. For precipitation, the observed baseline period climatological means are multiplied by the projected relative changes. When projected future climate at single weather stations are of relevance (instead of maps or area averages), the closest point in the 0.5° x 0.5° (or 0.25° x 0.25°) grid is considered.

In some applications of the VACCIA project, monthly resolution of future climate information is not sufficient but daily data are needed. The approach applied here for developing regional climate scenarios at the sub-monthly scale follows the method used in the EU-FP6 funded project ALARM (Assessing LArge scale Risks for biodiversity with tested Methods). In that project scenario information was also primarily provided from GCMs, at a monthly time step. In order to get daily time series, climate change scenarios for monthly mean variables were combined with the inter-annual and inter-decadal variability observed during the 20th century using procedures described by Mitchell et al. (2004). The scenario time series thus incorporated future changes in mean climate but with observed inter-annual and decadal variability unchanged. This allows for a direct comparison between the baseline period and future periods (such as 2020-2049 or 2040-2069) for which only the mean climate has changed. However, it should be stressed that this approach does not account for likely changes in climatic variability with a changing climate.

In the ALARM project, scenarios based on regional climate model (RCM) simulations were also offered, including daily data, in order to offer more detailed information on possible changes in climate variability and extremes. In the current project, RCM data produced in the EU-FP5 project PRUDENCE for the period 2071-2100 may be exploited (Table 2). It has been found out that for changes in snow cover in Finland, projections based on RCM data seem to be more useful than those directly based on GCM data. Consequently, some climate scenarios in VACCIA are based on RCM simulations, although the primary source of information consists of GCM simulations.

Table 2. The regional climate model experiments considered here, with the following characteristics defined: the model acronym; country of origin; acronym of the driving GCM (see the footnotes) and the SRES scenarios employed, together with the number of ensemble simulations (in parentheses).

Model	Country	Driving GCM – SRES scenario (# of runs)
CHRM	Switzerland	H-A2
CLM	Germany	H-A2
HadRM3H	UK	H-A2
HadRM3P	UK	HP-A2(3), HP-B2
HIRHAM (dk)	Denmark	H-A2(3), E'-A2(3), E'-B2
HIRHAM (no)	Norway	H-A2, H-B2
RACMO2[1]	Netherlands	H-A2
RCA3	Sweden	E-A2, E-B2
RCAO	Sweden	H-A2, H-B2, E-A2, E-B2
REMO[2]	Germany	H-A2

[1] indicates not available for the entire domain; [2] denotes not used for summer and autumn. Acronyms in col. 2: H stands for the HadAM3H AGCM, HP for the HadAM3P AGCM, and E and E' for two parallel runs by the ECHAM4/OPYC3 AOGCM.

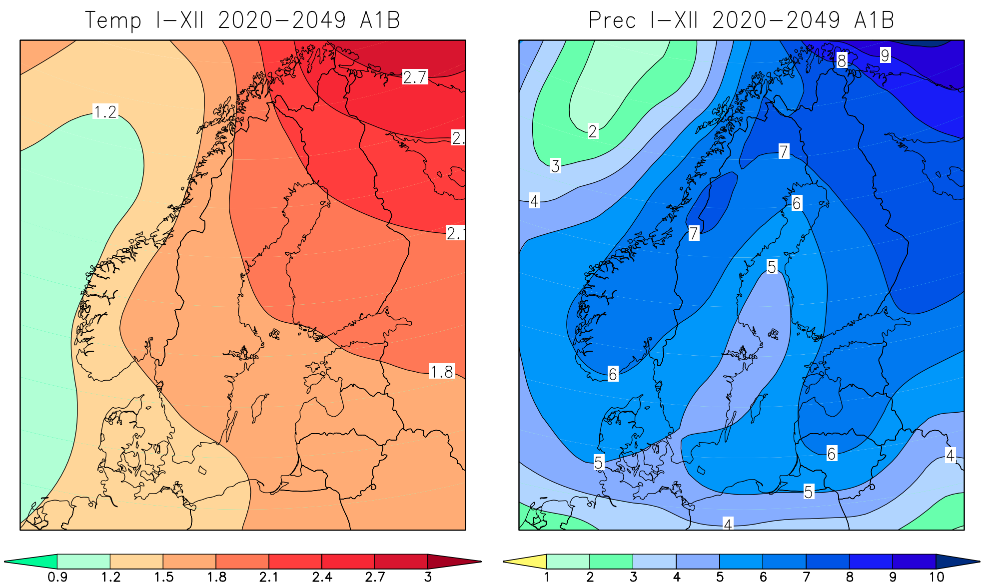

Fig. 3 Spatial distribution of projected changes in annual mean temperature (left panel, unit ºC) and precipitation (right panel, unit %) for the A1B scenario, computed as the multi-model mean difference between 2020-2049 and 1971-2000.

3. Products

The data including observations during the period 1971-2000 and climate scenarios for the 21st century are stored at the FMI. To give a few visualized examples of the data, Figures 3-5 are presented. The first one shows the best estimate of changes in annual mean temperature and precipitation across Finland and its surroundings from 1971-2000 to 2020-2049. The second figure indicates seasonal changes in mean temperature and precipitation as area averages for the whole country. The last figure represents spatial distribution of projected changes in seasonal mean snow water equivalent in winter and spring by the end of this century.

Tailored climate scenarios for the LT(S)ER areas are founded on the common data base discussed above. Climate information delivered so far for VACCIA Actions 12 and 10 are documented in Appendices 1 and 2. To meet the needs of these two actions, observed past/current and projected future climate at the following weather stations have been considered: Kuusamo, Kajaani, Jokioinen, Lahti/Asikkala, Jämsä and Jyväskylä. The variables under consideration somewhat varied among the Actions. As an example of information produced, Fig. 6 shows observed and projected future development of annual mean temperature in Kajaani under the three emission scenarios. Information available via the internet of FMI already prior to the VACCIA project was also disseminated, such as Fig. 7.

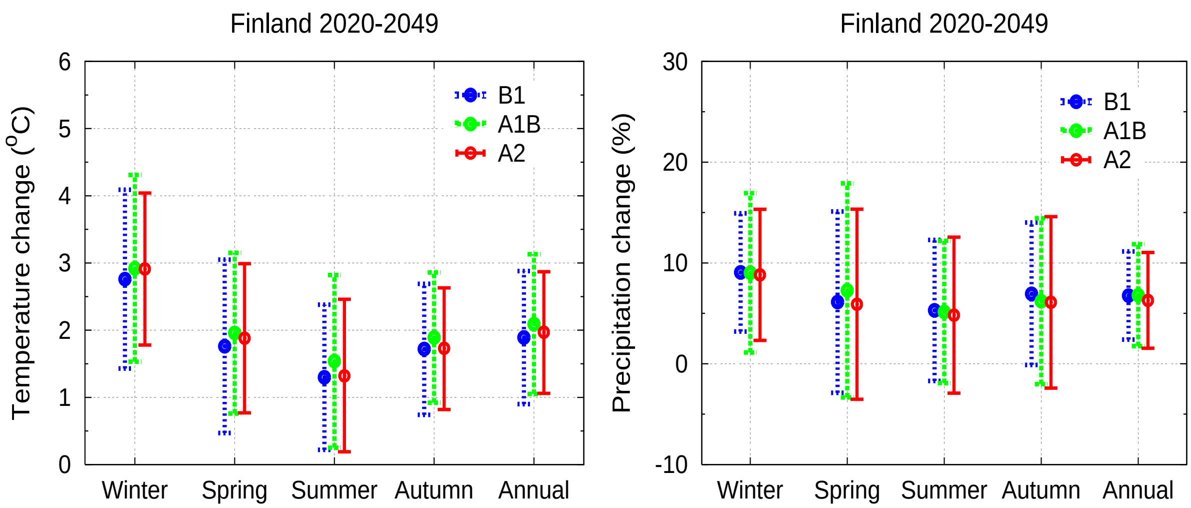

Fig. 4 Seasonal and annual mean temperature (in °C, left panel) and precipitation (in %, right panel) responses in Finland to the SRES A1B, B1 and A2 forcing. Means of the responses simulated by the 19 GCMs are denoted by open circles, 90% probability intervals (mean ±1.645× the standard deviation of the simulations) of the change by vertical bars. All changes are given for the period 2020-2049, relative to the baseline period 1971-2000.

References

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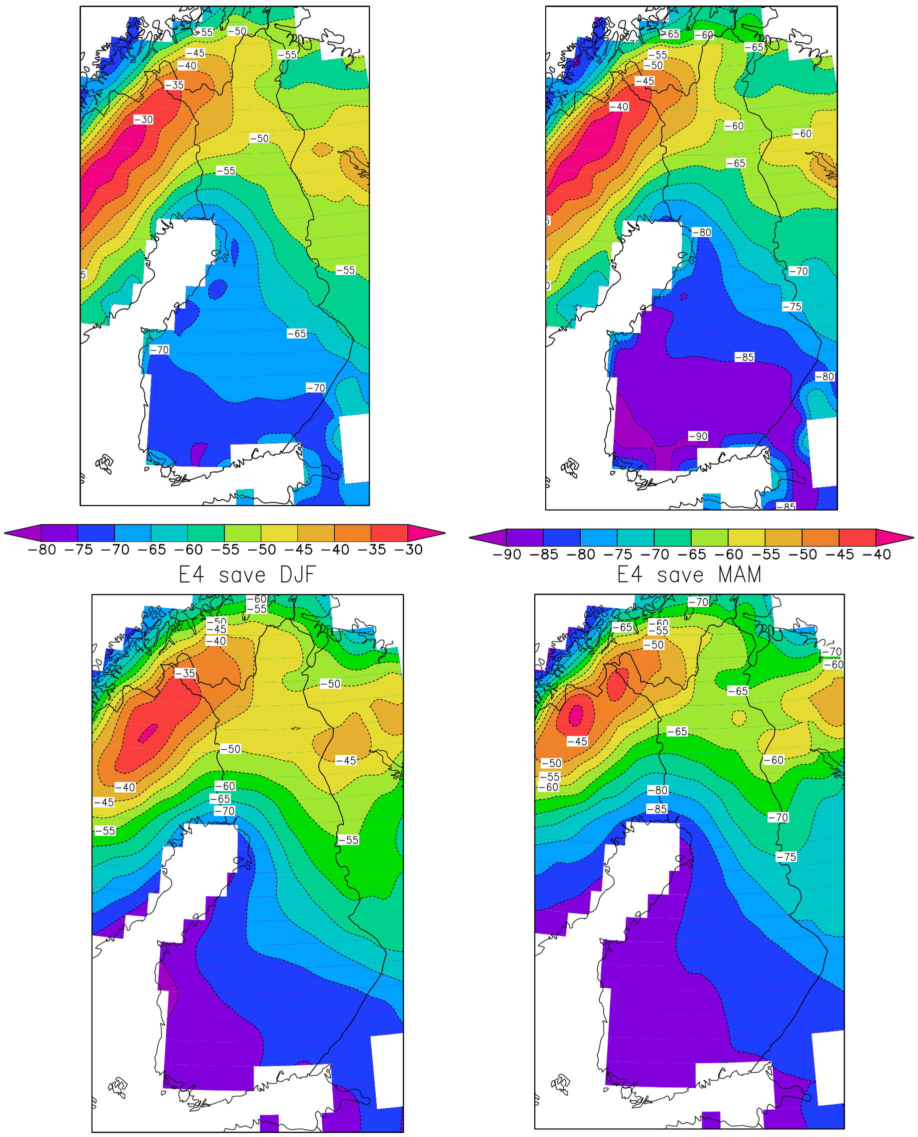

Fig. 5 Spatial distribution of projected changes in seasonal mean snow water equivalent in December-February (left panel) and March-April (right panel) for the A2 scenario, computed as the multi-model mean difference between 2071-2100 and 1961-1990. The first row: based on simulations performed with six RCMs under the lateral boundary forcing from the HadAM3 global climate model. The second row: based on simulations performed with three RCMs under the lateral boundary forcing from the ECHAM5/MPI-OM global climate model. (unit %)

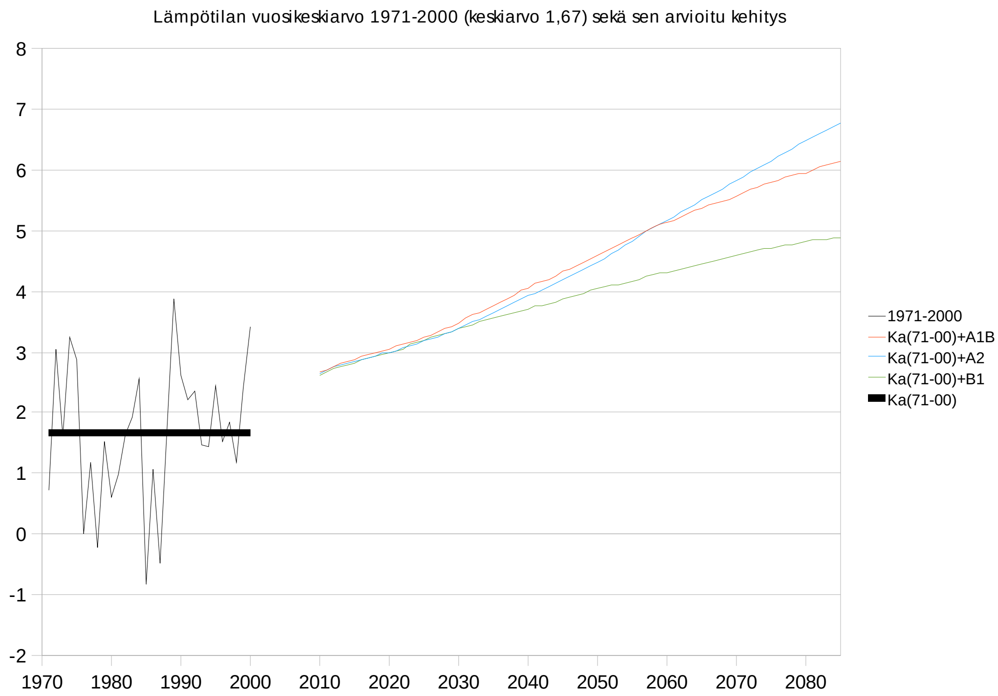

Fig. 6. Observed time series of annual mean temperature in Kajaani (black curve) during period 1971-2000 and three future projections (2010-2085) for SRES-emission scenarios B1 (green), A1B (red) and A2 (blue).

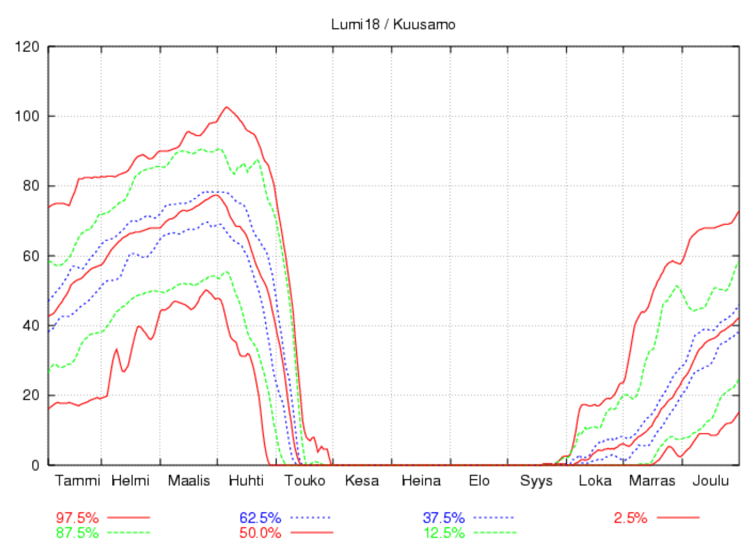

Fig. 7 Observed frequency distribution of snow depth (in cm) during calender days of the year (from January 1 to December 31) in Kuusamo based on observations in 1961-2000. The curves from the bottom to the top give percentiles of 2.5%, 12.5%, 37.5%, 50% (median), 62.5%, 87.5% and 97.5%. Source: Finnish Meteorological Institute.

Appendix 1: Delivered data for VACCIA Action 12

Data is stored to \\kori\jakelu\IlmaPalvelu

Observational data in areas of Kainuu and Kuusamo (northern Finland)

Daily observations at the weather stations of Kuusamo (65° 59' N, 29° 13' E) and Kajaani (64° 16' N, 27° 40' E) (the latter is close to Sotkamo):

- Daily temperature observations of period 1971-2008, including minimum, maximum and mean values.
- Daily precipitation and snow depth observations of period 1971-2000.
- Variables derived from observations for period 1971-2000.
  - Monthly and annual mean temperatures and precipitation sums.
  - Annual amount of days with snow depth over 5 cm and 20 cm.
  - Annual amount of hot days (daily maximum temperature above 25 °C) days with intense frost (daily minimum temperature below -20 °C).
  - Annual amount of thaw days (daily minimum temperature above zero) during mid winter (December-February) and period from November to March.

Climate scenarios for areas of Kainuu and Kuusamo (northern Finland)

Future scenarios of changes in monthly, seasonal and annual temperatures and precipitations for three SRES greenhouse gas emission scenarios (B1, A1B and A2), covering period 2010-2085, based on mean results of 19 global climate models:

- Absolute (temperature) and relative (precipitation) changes compared to the 1971-2000 baseline period at the grid points (0.25° x 0.25° grid) closest to Kuusamo and Kajaani.
- Time series of projected development of annual (Kajaani as an example in Fig.6), April, July and December mean temperature and precipitation sum in B1-, A1B- and A2-scenarios.

Additional climate information in central and southern Finland

Data at more southern weather stations of Lahti (60° 57' N, 25° 38' E) and Jämsä (61° 51' N, 24° 47' E) were delivered to act as a comparison.

- Annual, April, July and December mean temperature and precipitation sum observations for period 1971-2000.
- Time series of projected development of annual, April, July and December mean temperature and precipitation sum in B1-, A1B- and A2-scenarios.

Appendix 2: Delivered data for VACCIA Action 10

Observational data in Päijänne area

Daily observations at the weather stations of Jyväskylä (62° 24` N, 25° 40` E), Lahti (60° 57` N, 25° 38` E) and Jokioinen (60° 48` N, 23° 30` E), covering period 1971-2000.

- Daily mean temperature, precipitation, snow depth, mean relative humidity, mean amount of cloud cover, mean sea level air pressure and mean wind speed for all three stations.
- Daily amount of global radiation for Jyväskylä, Jokioinen and Asikkala (close to Lahti)

Climate scenarios for Päijänne area

Daily future scenarios of mean temperature and precipitation in Lahti and Jyväskylä.

- Daily scenarios are produced from monthly climate change data by using so-called delta change method, which means that simulated monthly climate change signal is added to daily observations of 1971-2000.
- Climate change signal is based on mean results of 19 global climate models using SRES-A1B greenhouse gas emission scenario.
- Three 30-year data sets, covering periods 2010-2039, 2040-2069 and 2070-2099.