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FINNISH METEOROLOGICAL INSTITUTE

Future climate scenarios for Finland

Finnish Meteorological Institute

Expert Seminar “Climate change scenarios for Latvia”
20 May 2016

Contents

- **Methods, projects, achievements**
- **Simulation process, data, scenarios, ensembles, accessibility**
- **Climate scenario usage etc**
- **Challenges and suggestions**

Methods, projects etc

- Climate Service Centre of FMI has long history of using GCMs, CMIP and CORDEX data
- Joint research also with other national research institutes and universities
- Both scenario data and adaptation services
- Joint projects & publications dealing with the expected climate change impacts for the Finnish society

FMI's examples

- **Use of GCM data to develop global climate projections:**
  - Ruosteenoja, K., Carter, T.R., Jylhä, K. and Tuomenvirta, H. 2003. Future climate in world regions: an intercomparison of model-based projections for the new IPCC emissions scenarios. The Finnish Environment 644, Finnish Environment Institute, Helsinki, 83 pp.
  - This report, related to the work of IPCC-TGCIA, has been widely referred to in IPCC Assessment Reports, see e.g
  - http://www.ipcc-data.org/syn/tar_scatter/index.html
  - http://unfccc.int/resource/cd_roms/na1/v_and_a/Resource_materials/Climate/FEI_FutureClimate.pdf

Examples

- **Use of GCM data to develop European-scale climate projections:**
  - Ruosteenoja, K., Tuomenvirta, H. and, Jylhä K., 2007: GCM-based regional temperature and precipitation change estimates for Europe under four SRES scenarios applying a super-ensemble pattern-scaling method. Clim. Change, 81, Supplement 1, 193-208.
  - Jylhä, K., Tuomenvirta, H., Ruosteenoja, K., Niemi-Hugaerts, H., Keisu, K. and Karhu, J.A., 2010. Observed and projected future shifts of climatic zones in Europe, and their use to visualize climate change information. Weather, Climate, and Society, 2:2, 148-167.
  - Lehtonen I., Ruosteenoja K., Jylhä K. 2014. Projected changes in European extreme precipitation indices on the basis of global and regional climate model ensembles. International Journal of Climatology, 34, 1208-1222, doi:10.1002/joc.3758
  - Ruosteenoja, K. and P. Räisänen, 2013. Seasonal changes in solar radiation and relative humidity in Europe in response to global warming. J. Climate, 26, 2467–2481, doi:10.1175/JCLI-D-12-00007.1.
  - Ruosteenoja K., Räisänen J., Venäläinen A., Kämäräinen M., 2015: Projections for the duration and degree days of the thermal growing season in Europe derived from CMIP5 model output. Int. J. Climatol., http://dx.doi.org/10.1002/joc.4535

Examples

- **Use of GCM data to develop Scandinavian or national-scale climate projections:**
  - Jylhä K., H. Tuomenvirta and K. Ruosteenoja 2004: Climate change projections for Finland during the 21st century. Boreal Env. Res., 9, 127–152.
  - Gregow, H., Ruosteenoja, K., Pimenoff, N. and Jylhä, K., 2012: Changes in the mean and extreme geostrophic wind speeds in Northern Europe until 2100 based on nine global climate models. International Journal of Climatology. 32: 1834–1846.
  - Luomaranta, A., Ruosteenoja, K., Jylhä, K., Gregow H., Haapala J., & Laaksonen A. 2014: Multimodel estimates of the changes in the Baltic Sea ice cover during the present century. Tellus A, 66, 22617.
  - Ruosteenoja K., Jylhä K.T., Kämäräinen M.: Climate projections for Finland under the RCP forcing scenarios. Geophysica (in print)

Examples

- **Use of GCM data for climate change impacts assessments:**
  - Lehtonen, I., K. Ruosteenoja, A. Venäläinen and H. Gregow, 2014. The projected 21st century forest-fire risk in Finland under different greenhouse gas scenarios. Boreal Environment Research, 19, 127–139.

Examples

- **Scenario data usage investigations:**
  - Pilli-Sihvola, K., van Oort, B., Hanssen-Bauer, I., Ollikainen, M., Rummukainen, M., Tuomenvirta, H., 2014. Communication and use of climate scenarios for climate change adaptation in Finland, Sweden and Norway. Local Environment 1–15. doi:10.1080/13549839.2014.967757

Examples

- **FMI's own simulations by a GCM:**
  - Räisänen P., Järvenoja S., Järvinen H., Giorgetta M., Roeckner E, Jylhä K, Ruosteenoja K, 2007: Tests of Monte Carlo Independent Column Approximation in the ECHAM5 atmospheric GCM. J. Climate, 19, 4995-5011.
  - Räisänen, P., Luomaranta, A., Järvinen, H., Takala, M., Jylhä, K., Bulygina, O. N., Riihelä, A., Laaksonen, A., Koskinen, J., and Pulliainen, J. 2014: Evaluation of North Eurasian snow-off dates in the ECHAM5.4 atmospheric GCM, Geosci. Model Dev., 7, 3037–3057, doi:10.5194/gmd-7-3037-2014
  - Vajda A., Venäläinen A., Tuomenvirta H. and Jylhä K. 2004. An estimate about the influence of climate change on heating energy demand in Hungary, Romania and Finland. Idojárás, 108, 123-140.
  - Venäläinen, A., Tammelin, B., Tuomenvirta, H., Jylhä, K., Koskela, J., Turunen, M.A., Vehviläinen, B., Forsius, J. and Järvinen, P., 2004: The influence of climate change on energy production & heating energy demand in Finland. Energy & Environment, 15, 93-109.
  - Ylhäisi, J. S., Tietäväinen, H., Peltonen-Sainio, P., Venäläinen, A., Eklund, J., Räisänen, J., and Jylhä, K., 2010: Growing season precipitation in Finland under recent and projected climate, Nat. Hazards Earth Syst. Sci., 10, 1563-1574, doi:10.5194/nhess-10-1563-2010.
  - Laapas, M., Jylhä K., and Tuomenvirta, H.: 2012: Climate change and future overwintering conditions of woody, horticultural plants in Finland. Boreal Env. Res. 17, 31-45.

Examples

- **Www-pages of some of the research projects where GCM data have been used:**
  - http://en.ilmatieteenlaitos.fi/acclim-project-2006-2010
  - http://en.ilmatieteenlaitos.fi/setuklim
  - http://en.ilmatieteenlaitos.fi/plumes
  - http://www.finessi.info/finsken/
  - http://www.syke.fi/projects/finadapt

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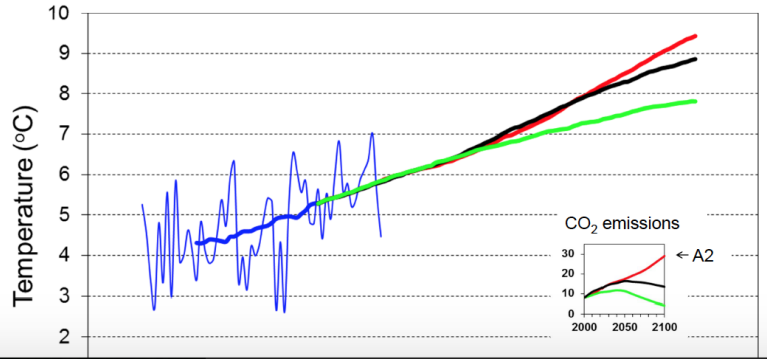
1 FINNISH METEOROLOGICAL INSTITUTE
2 Aalto University School of Engineering
3 1918 TALLINNA TEHNIKAÜLIKOOL TALLINN UNIVERSITY OF TECHNOLOGY
4 TAMPERE UNIVERSITY OF TECHNOLOGY

Climate change impacts on energy demand for heating and cooling of buildings in Finland

Kirsti Jylhä[1], Juha Jokisalo[2], Karoliina Pilli-Sihvola[1], Kimmo Ruosteenoja[1], Targo Kalamees[3], Hanna Mäkelä[1], Juha Vinha[4]

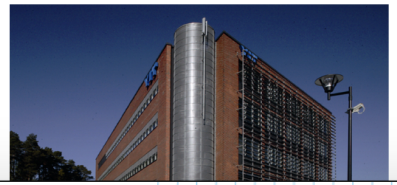
BACKGROUND

- In the building sector, both climate change adaptation and mitigation are needed.
- In 2007, heating and electricity use in buildings accounted for 38% of the final energy use and 32% of the CO_2-eq. emissions in Finland. [1]
- The most crucial climatic variable for building energy demand in Finland, i.e., air temperature [2], is projected to increase by 2-6°C by the end of this century [3]. (Fig. 1)



MATERIALS & METHODS

- Current climate: the new Finnish test reference year for building energy demand, separately for southern, central and northern Finland. ⇦ past months having typical weather conditions. [2, 4]
- Future climate: Estimates for typical weather conditions around the years 2030, 2050 and 2100 ⇦ Climate model projections for the SRES A2 scenario and special tailored methods to produce future hourly data [4].
- Simulations of energy consumption for a detached house and an office building (Fig. 2) using the IDA Indoor Climate and Energy algorithm [5].
- The current value of future savings due to climate-induced changes in energy demand ⇦ the average price in 2011 for electricity and district heating, together with three alternative discount rates. [6]



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RAPORTTEJA
RAPPORTER
REPORTS
2013:4

MAAILMANLAAJUISIIN CMIP3-MALLEIHIN PERUSTUVIA ARVIOITA SUOMEN TULEVASTA ILMASTOSTA

KIMMO RUOSTEENOJA
JOUNI RÄISÄNEN
KIRSTI JYLHÄ
HANNA MÄKELÄ
ILARI LEHTONEN
HENRIIKKA SIMOLA
ANNA LUOMARANTA
STEFAN WEIHER

FINNISH METEOROLOGICAL INSTITUTE

Series title, number and report code of publication
Finnish Meteorological Institute Reports 2013:4

Published by	Finnish Meteorological Institute, (Erik Palménin aukio 1) P.O. Box 503, FIN-00101 Helsinki, Finland	Date 2013
Author(s)	Kimmo Ruosteenoja, Jouni Räisänen, Kirsti Jylhä, Hanna Mäkelä, Ilari Lehtonen, Henriikka Simola, Anna Luomaranta, Stefan Weiher	Name of project ACCLIM II, SETUKLIM
Title	Climate change estimates for Finland on the basis of global CMIP3 climate models	

Abstract

Meteorological measurements indicate that the annual mean temperature in Finland has increased by nearly one degree during the past one hundred years. Global and regional climate model simulations prepared for the 4th Assessment Report of the IPCC reveal that warming will continue in the future. It is likely that during the ongoing decade (2011-2020) the mean temperature is already higher (with a probability of more than 90 %) and precipitation more abundant (with a probability of about 75 %) than in the reference period 1971-2000. Along with increasing temperatures, Finnish winters are becoming moister, darker and less snowy. In the last three decades of the present century, solar radiation in winter is estimated to decrease by 10-15 %, relative humidity to increase by 2-3 percentage points, and in southern Finland the snow water equivalent will probably be reduced by 70-80 %. There will be less frost in the ground, and the ice cover in the Baltic Sea will decrease. By the end of the century, the southern parts of Finland will transfer from the boreal D climate zone to the temperate C zone.

The number of hot summer days with a mean temperature above 20°C may increase fourfold before the end of the century. Even in the next few decades, most monthly mean temperatures are expected to exceed the prevailing standard climate normals. Despite regular updating, in a warming climate these standard normals will always represent the observed past rather than the present climate. The probability of the occurrence of record-high temperatures will increase with time. Heavy precipitation and strong winds may occur somewhat more frequently than hitherto, and in autumn and winter winds will blow ever more often from the west and south.

mmm.fi

Miten väistämättömään ilmaston-muutokseen voidaan varautua?

Yhteenveto suomalaisesta sopeutumis-tutkimuksesta eri toimialoilla

"How to prepare against the inevitable climate change?"

Summary of the Finnish adaptation research in various sectors (agriculture, forestry, fisheries, biodiversity, urban, …)

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RAPORTTEJA
RAPPORTER
REPORTS
2009:4

Arvioita Suomen muuttuvasta ilmastosta sopeutumistutkimuksia varten

ACCLIM-hankkeen raportti 2009

KIRSTI JYLHÄ
KIMMO RUOSTEENOJA
JOUNI RÄISÄNEN
ARI VENÄLÄINEN
HEIKKI TUOMENVIRTA
LEENA RUOKOLAINEN
SEPPO SAKU
TEIJA SEITOLA

The changing climate in Finland: estimates for adaptation studies.

Signs of climate change

Examine eight signs showing the changes in the global climate.

Open ▶▶

Flood risk increases

Climate change increases flooding but damages can be reduced by managing the risks.

Open ▶▶

Video of the week

Forests are significant carbon sinks in Finland. Interviewee: Pekka Vanhala, SYKE. Video is in Finnish.

Go to the video page ▶▶

News

The climate challenge requires significant new innovations for Finnish wood use

A recent study shows that the emission reductions gained through replacing non-renewable raw materials with wood were not enough to compensate for the lost carbon sequestration capacity and emissions from felling and production processes. In order for wood use to produce significant reductions, new way of thinking and innovations are required.

Read more ▶▶

Research - 28.4.2016 - SYKE, University of Helsinki

An accurate inventory of ship traffic emissions for the European sea areas

New inventory includes also the geographical distribution of emissions. For example the shipping in the Mediterranean Sea accounts for 40 % of the CO2 and 49% of the SOx emissions. Results can be used to evaluate the impacts of shipping emissions on human health and climate as well as in greenhouse gas inventories.

Read more ▶▶

Be the first of your friends to like this

Ilmasto-opas.fi
Yesterday at 3:49am

Laivaliikenteen päästöjen

New mapping tool shows how cross-country skiing in Finland is vulnerable to climate change

The Finnish Environment Institute and the Natural Resources Institute Finland have released a new interactive mapping tool about climate change effects on cross-country skiing in Climateguide.fi web portal. Cross-country skiing is one of the most popular recreational activities in Finland, but it is now becoming clear that it will be severely affected by a warming climate.

Read more ▸▸

Climateguide - 18.2.2016 - SYKE, Natural Resources Institute Finland

Climate change deteriorates water quality in the Himalayas

A study shows that global warming affects geochemical processes such as glacier melting, soil erosion and sediments release on the Tibetan Plateau. This deteriorates water quality of rivers and lakes, thus significantly impacting the lives of 40 percent of the world's population living in the area.

Read more ▸▸

Research - 15.2.2016 - Lappeenranta University of Technology

More news in the news archive! **Open ▸▸**

Find out about climate change

- C Climate change as a phenomenon
- I Impacts
- A Adaptation
- H How hot in your lifetime? test
- C Community response wizard
- F Finland's changing climate
- M Mitigation
- V Videos and visualizations
- I IPCC infographics
- M Maps, graphs and data

ClimateGuide.fi provides practical information for climate change impacts in Finland and abroad

Climate-Proof City – The Planner's Workbook

The planner's workbook for climate-proof city provides a collection of tools, best practices and reports about the impacts of climate change and how to implement the adaptation activities.

This workbook is designated for urban planners and city officials who have to deal with the consequences of climate change. It also provides vital information for land owners, city residents and companies operating in fields of construction and green building. Watch an introduction video of the workbook.

The workbook includes:

- Best adaptation practices from Finland and abroad
- Studies and reports about the impacts of climate change and adaptation
- Tools and techniques for planning and implementing adaptation activities

Best practices, reports and tools have been divided under four main themes, each of them having its own theme colour. The themes are adaptation implementation, storm water management, green infrastructure, and urban heat islands.

ILKKA-project was coordinated by the City of Helsinki and other members of the consortium were Cities of Lahti, Turku and Vantaa, Helsinki Region Environmental Services Authority, Finnish Meteorological

Examples of best practices and reports

- Developing a green factor tool for City of Helsinki
- Helsinki Flood Guide advises estates to be prepared for floods
- Storm Water Management Strategy implemented in Kuninkaantammi
- Peer Review as a development tool for the climate change work
- Developing a Green Factor Tool for City of Helsinki (pdf)
- Helsinki Metropolitan Area Climate Change Adaptation Strategy (pdf)
- Finland's National Strategy for Adaptation to Climate Change (pdf)

Changing climate in the capital Finland – background investigations for adaptation strategies

Contents

- Methods, projects, achievements
- **Simulation process, data, scenarios, ensembles, accessibility**
- Climate scenario usage etc
- Challenges and suggestions

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Example of CMIP5 data retrieval and handling at FMI

CMIP5
- > 30 models
- History runs up to 2005
- RCP runs (4 scen.) from 2006
- Parallel runs (for some models)
- Separate files for each parameter (T, p, …)

Download
- Monthly means:
  - For 1 parameter, takes ~few days
- Daily means (30 larger files):
  - For 1 parameter takes several weeks
- Time consuming (all the model data cannot be download at the same time)

Data handling
- Files differ:
  - Some contain the whole period (2006-2100)
  - Some e.g. 5-y sequences
  - For some the period is Dec-Noc
- Time consuming manual handling

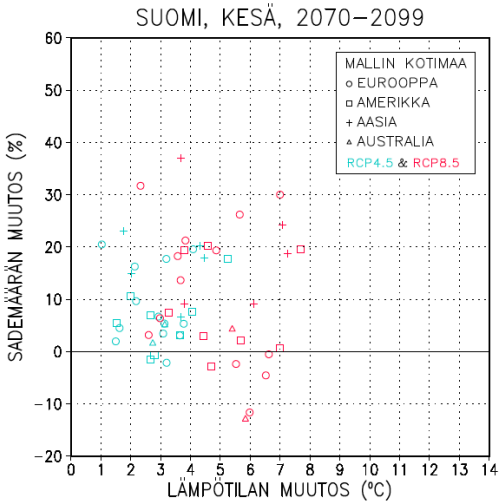
Interpolation to grid
- Models use different grids (~1…3° resolutions)
- When comparing the models statistics, all must be interpolated into a common grid

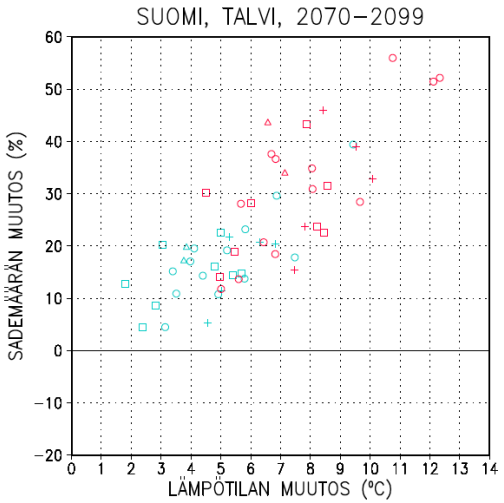
Regional averages
- Regional future changes for different parameters (e.g. for Finland)

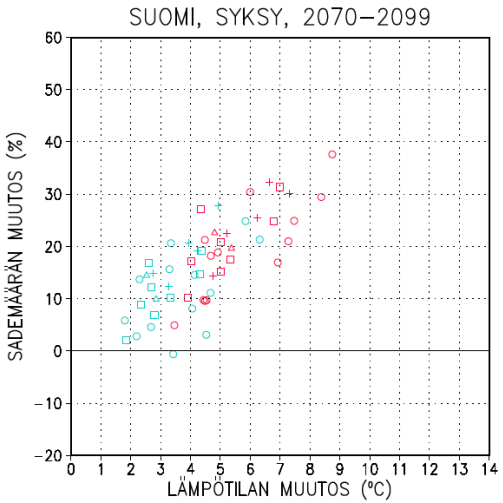
Information/ data to end users

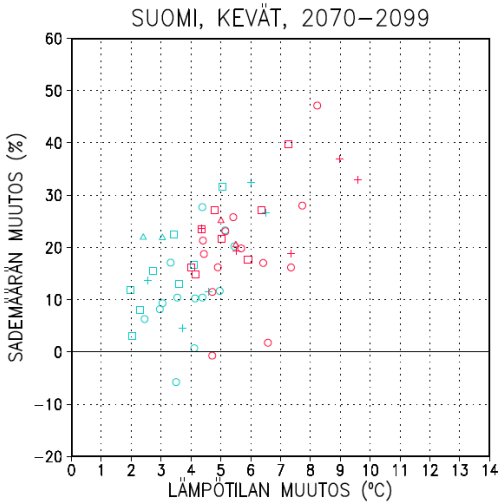
Intercomparison of models runs

- Some models do not fit well with the **observed climate** → wise to reject









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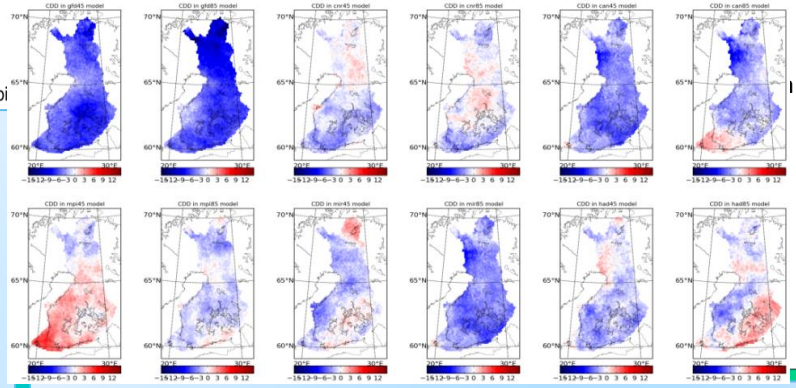
Climate projections used in FMI

Millennium simulations of the past climate

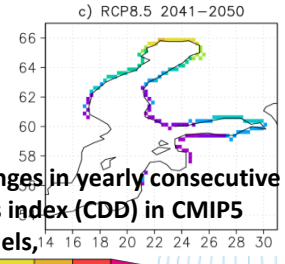
- MPI-ESM model with ECHAM5
- Spatial resolution: T31/L19
- 4824 years of a simulated past climate
- Temporal resolution: 6 hours
- FMI application: 800 AD to 2005 AD

Global Climate Models - CMIP3, CMIP5

- 35 models
- Historical and scenario simulations
- RCP2.6,RCP4.5,RCP6.0 & RCP8.5
- Monthly and daily data
- 8 variables
- Spatial resolution: 2.5°x2.5°



ice thickness (cm), 28 GCMs



Changes in yearly consecutive dry days index (CDD) in CMIP5 models, 1981-2010→2071-2100

Regional Climate Models

PRUDENCE, ENSEMBLE, CORDEX

- EUR-domain
- 21 RCM-GCM pairs
- A1B emission scenario
- 9 variables
- Spatial resolution: 0.22°x0.22°
- EUR-domain
- 13 RCM-GCM pairs
- 5 variables
- RCP4.5 & RCP8.5
- Spatial resolution: 0.44°x0.44°
- Several pressure levels

Finnish high resolution data-set derived from CMIP5 models

- 6 CMIP5 models
- RCP4.5 & RCP8.5
- Temporal coverage: 1980–2099
- 7 variables
- Spatial resolution: 0.1°x0.2°
- Bias correction/downscaling procedure using quantile mapping

Bias correction: using ERA-Interim & E-OBS data, different methods, e.g. DBS method, delta change

Storage and usage

- At FMI, the scenario data storage is not “complete”:
  - Only a limited set of basic variables
  - Not from all pressure levels
- Why:
  - Takes a lot of space!
  - At the moment, Climate Service Centre has storage of about 30TB for our scenario data (at the moment this is used)
  - Easy to acquire more space, but needs money

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Usage

- Plenty of investigations, projects, reports, publications by the research institutes
- What about the end users, do they use this information?
- This is not at all clear!

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CLIMATE CHANGE ADAPTATION IN NORWAY, SWEDEN, AND FINLAND – DO RESEARCH, POLICY AND PRACTICE MEET? - CARePol

- *Finnish Meteorological Institute:* Heikki Tuomenvirta, Karoliina Pilli-Sihvola, Reija Ruuhela
- *Helsinki University, Department of Economics and Management:* Jenni Heikkinen, Markku Ollikainen
- *Swedish Meteorological and Hydrological Institute:* Markku Rummukainen, Elin Löwendahl
- *Linköping University, Center for Climate Science and Policy Research:* Louise Simonsson, Björn-Ola Linnér, Karin André
- *Norwegian Meteorological Institute:* Inger Hanssen-Bauer, Eirik Førland
- *Center for International Climate and Environmental Research, Oslo*: Bob van Oort, Grete Hovelsrud

CARePol findings

- There is a need to facilitate easy access to climate data and information
    - Web-portals and -tools may provide a solution
- Scientific community need to put more effort in communicating research results to decision makers
    - Scientific articles vs. info material
- Decision making process should have enough resources (time and expertise) to absorb the complex information on climate change
- The “gap” in information flow is between researchers and policy-makers

Conclusions

Adaptation is often a local "issue", therefore,

- **knowledge building at regional and community level is necessary**

Climate change information services are being set up, therefore,

- **both scientific community (information provider) and regional/local administration (user community) should participate into the development work**

Usage

- Some end users we know:
  - Some cities in Finland:
    - green roofs, urban flooding protection
  - Energy sector:
    - air transmission lines put under ground
    - nuclear power plants (protection against very unlikely phenomena)
    - also analysis of the benefits of climate change
  - Forestry & agriculture
  - Insurance
  - Decision makers

Usage

- Some end users we know:
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  - Energy sector:
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    - also analysis of the benefits of climate change
  - Forestry & agriculture
  - Insurance
  - Decision makers → a bit unclear how this works?

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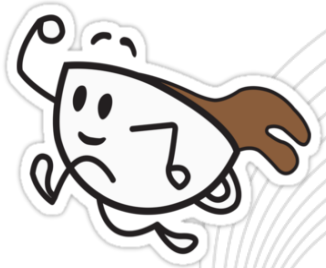
Suggestions

- Well-organized and coordinated data storage
  - On national, Nordic, European etc levels
- Better interactions with the end-users
- Share of information with the neighbouring countries and areas
  - What, why and how we do?
  - Especially the research regarding the extremes in Scandinavia and Baltics

Climateguide.fi: Information in many forms

- **Available in three languages:**
- **Background articles**
- **Sector-specific mitigation and adaptation articles**
- **Tools**
- **Visualizations, researcher video interviews, bite-size videos, infographics, quiz**
- **Learning assignments for upper secondary schools**
- **News section + Facebook**

What else is needed?



1. Media plays a key role in disseminating information
2. We noticed that ”Same language” was needed to help the daily work of both the journalists and climatologists
3. Goal: well written articles about climate change and its impacts, risks and possibilities

=> Education for journalists

Education for journalists - contents

Day 1: physical science basis with updates

- Present climate and climate variability
- Scientific basis for climate change
- Projected future climate, especially in Finlar

Day 2: varying topics

Technologies

Carbon trade

IPCC

Impacts

Politics

Training session on **Climateguide.fi**

- **Lecturers from FMI, the Ministry of the Environment, the Finnish Environment Institute (SYKE) and other institutes**
- **Usually about 10 – 15 lectures (30 minutes to 1,5 hours)**

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