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FINNISH METEOROLOGICAL INSTITUTE

Climate Change in Finland

Finnish Meteorological Institute

Expert Seminar “Climate change scenarios for Latvia”
19-20 May 2016

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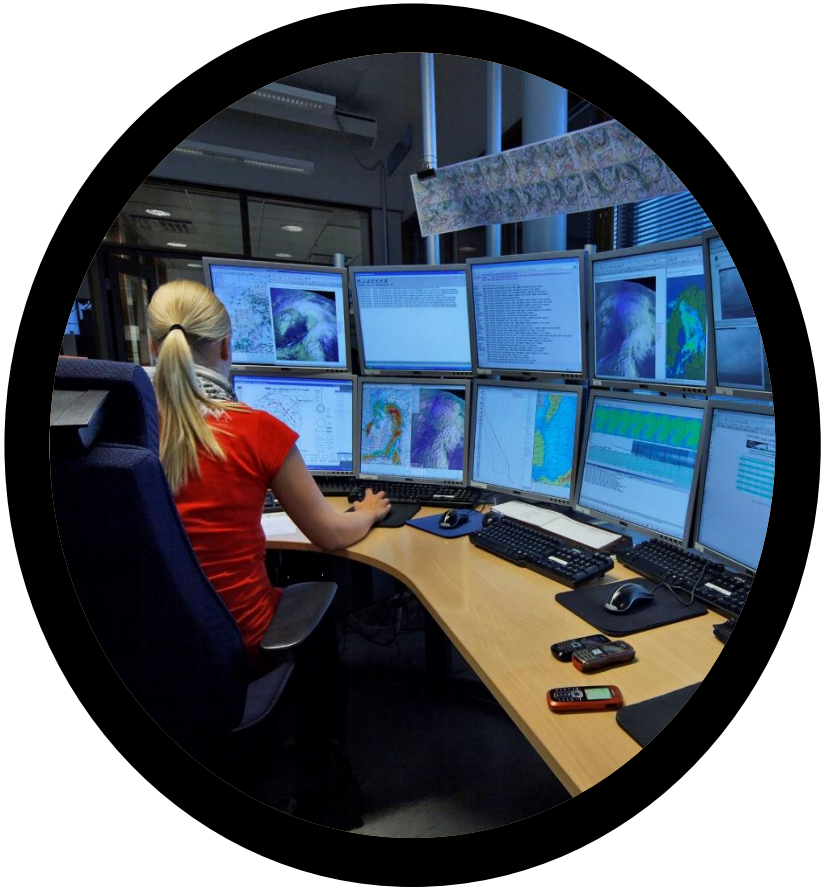
Contents

- **Background of FMI**
- **Data accessibility, challenges, quality, methods, interpolation etc**
- **How climate will change in Finland?**

Expertise

- Finnish Meteorological Institute produces weather, marine and climate services that are of importance to public safety and business.
- High standard observations and high level research are the basis for efficient services for the benefit of Finnish society.

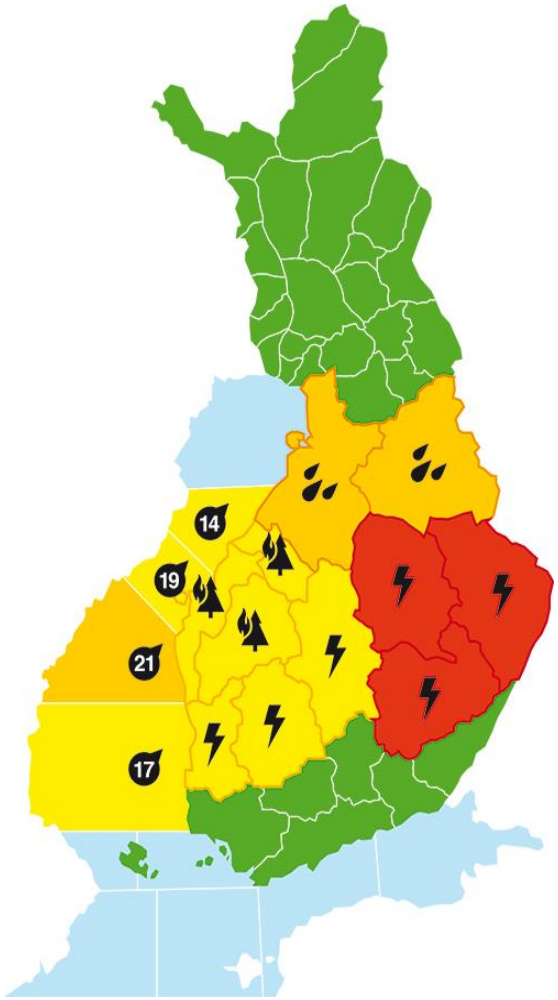


Information on the weather and atmosphere

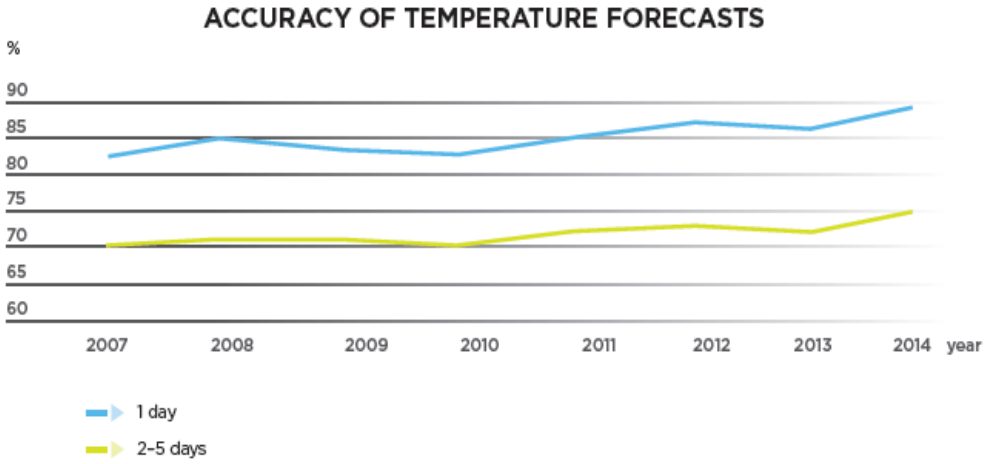
- Finnish Meteorological Institute produces specialist atmosphere and weather related services required by Finnish society and functions under the **Ministry of Transport and Communications.**
- The University of Helsinki Magnetic and Meteorological Observatory was established in 1838.

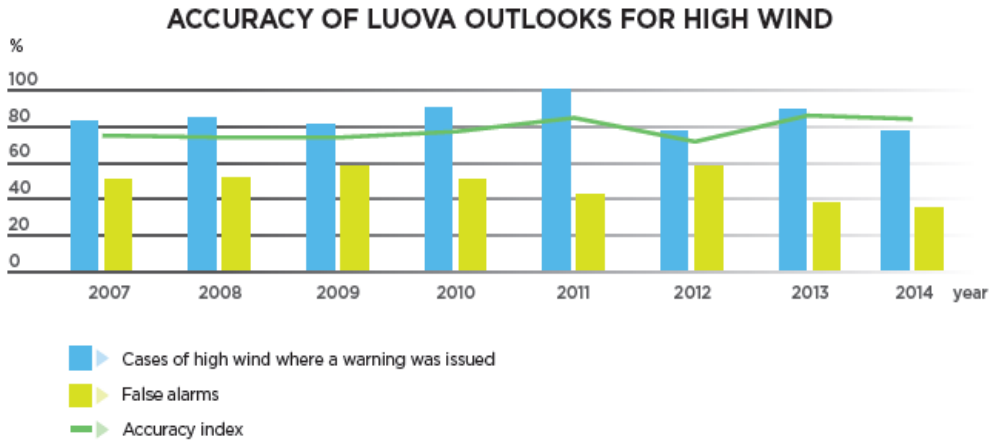
Weather and Safety

- FMI's Weather and Safety Centre produces weather services that are of importance to public safety.
- Key services include nationwide 1-10 day forecasts and weather-related warnings.
- FMI is constantly prepared to react real-time to disruptions and emergencies.



Accuracy of forecasts





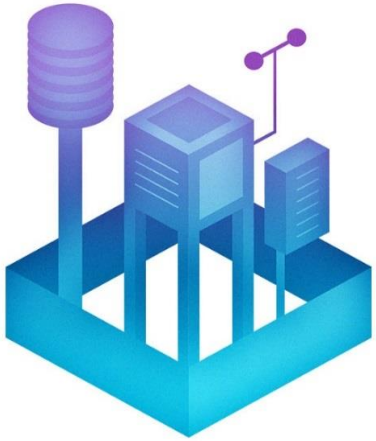
Warnings


severe thunderstorm warning
wind warning for land areas
heavy rain warning
traffic weather warning
pedestrian weather warning
forest fire warning
grass fire warning
heat wave warning
cold warning
UV
UV advisory


32
wind warning for sea areas
thunderstorm wind gusts for sea areas
warning for high sea level
warning for low sea level
wave height warning
ice accretion warning
+
many warnings in effect
no particular weather awareness is needed
potentially dangerous
dangerous
very dangerous

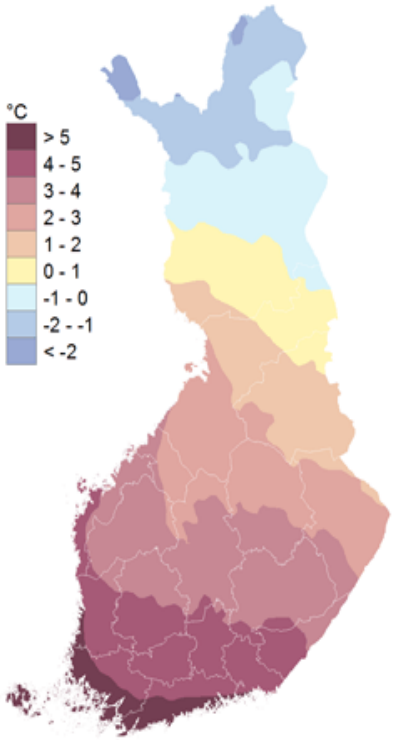
Observation Services

Approx. 400 operative posts	
Radio sounding stations	3
Weather radars	9
Lightning location sensors	8
Background air quality stations	18
Weather stations	179
Precipitation stations	95



Climate Service Centre

- Provides services for climate data users, such as the transport, agriculture and forestry and energy sectors.
- Develops methods and services for the management of seasonal fluctuation and change of climate, and carries **out field related research** natural science and social science.
- Uses weather observations, as well as seasonal and climate models to study current characteristics of regional climate, as well as changes in the climate changes that have taken place or are expected to take place.
- Studies the economic and social impacts of weather and climate change and assesses the methods for preventing and adapting to climate change.



Average annual amount of lightning

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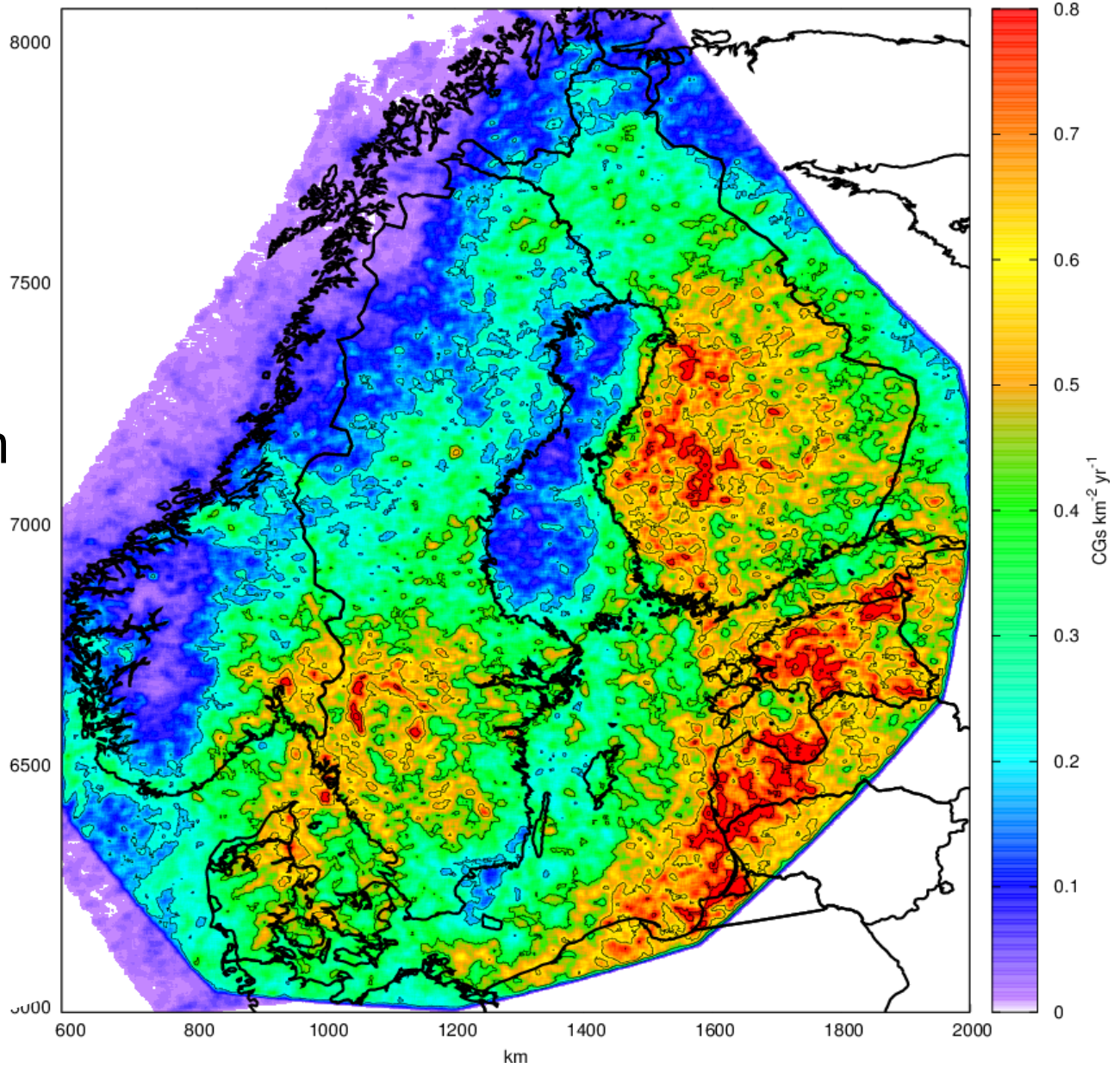
Severe weather research

- On average, most lightning occurs in the Baltic countries, Western Finland and Southern Sweden
- In Norway, the hotspot is Oslo!
- Impact of climate change??



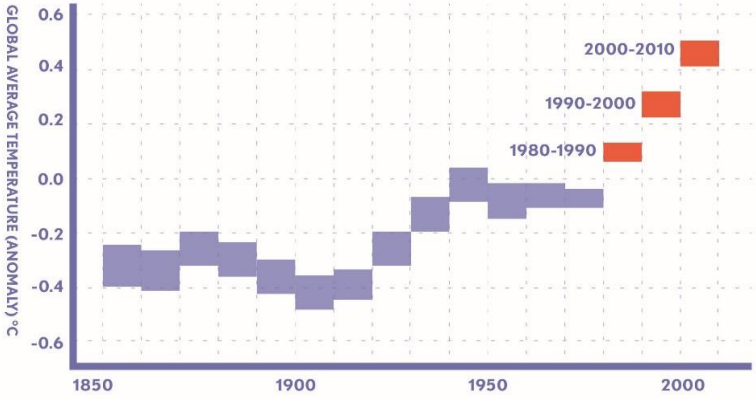
Climate change challenges - research

- In addition to weather and safety, climate change and adaptation to climate change is one of the greatest challenges of the 2000s and one of FMI's focal areas.
- FMI's measurement and computational data is used to study the impacts of climate change and possible adaptation measures.
- The objective is to produce and provide data for society on climate change and its consequences.

IPCC Assesment Report

OBSERVED CHANGES: WARMING

EACH OF THE LAST 3 DECADES HAS BEEN WARMER THAN ALL PRECEDING DECADES SINCE 1850.



AVERAGE COMBINED LAND AND OCEAN TEMPERATURE

+0,85 °C

1880-2012

Based on IPCC Assessment Report 5, Working Group 1.

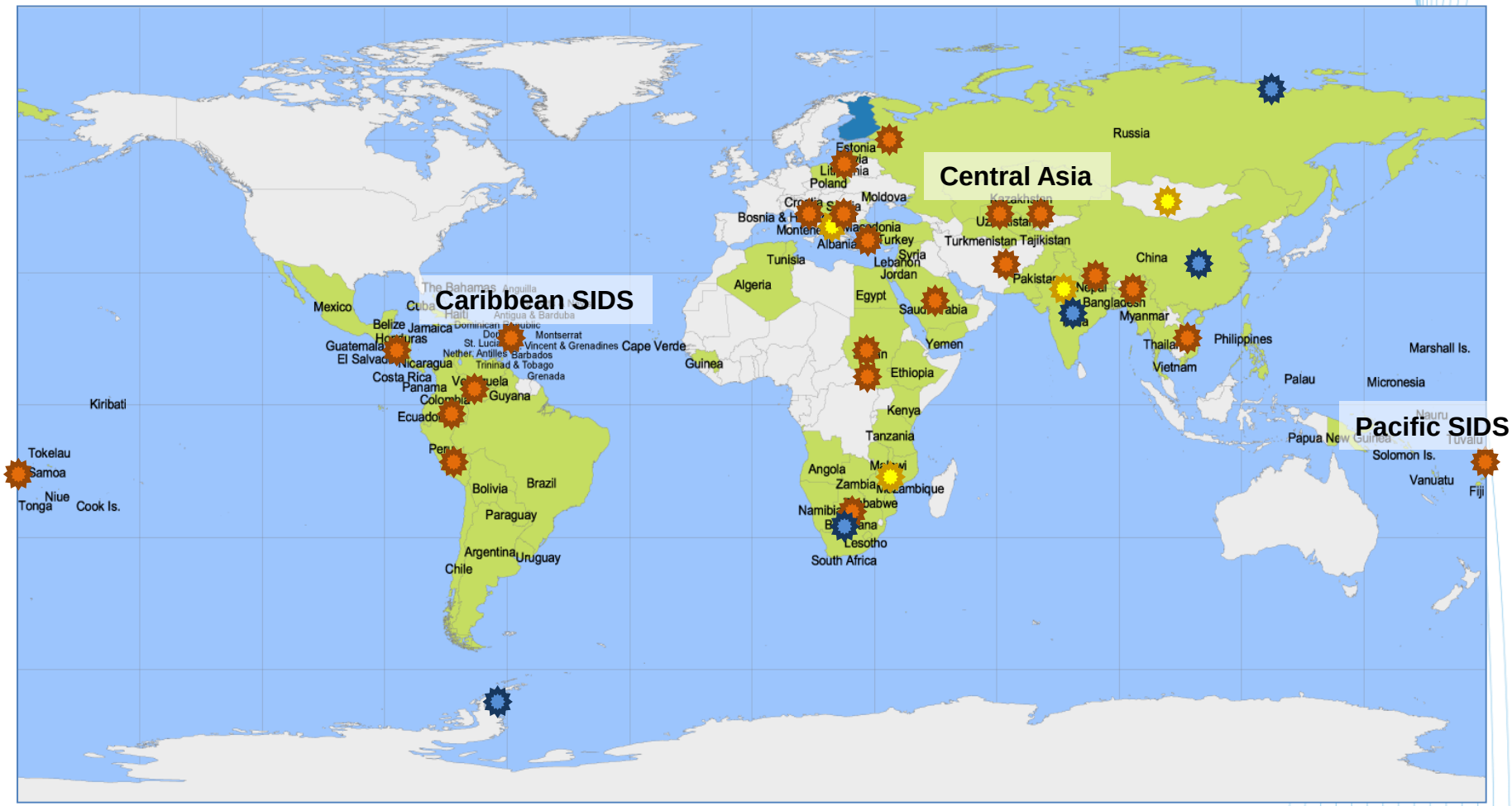
Arctic research

- The most important area of research is climate change in the northern hemisphere.
- Due to its northern location, the Arctic Research Centre plays an important role as an observation point for cold temperatures and **their** research in Finland.
- The utilisation of satellite data in observation of the Arctic and northern areas is one of the key functions of the FMI-coordinated national satellite service centre in Sodankylä.

Pallas-Sodankylä station

- The percentage of particulates and greenhouse gases in the atmosphere is measured at the FMI-maintained Pallas-Sodankylä weather station. This work is helping to establish a strong foundation for **monitoring and forecasting of climate change in northern regions.**
- Modelling of the climate system has been compiled into a broad-scoped project carried out by an international group of scientists.

Development projects in different parts of the world



On-going In preparation Scientific research

Finalised cooperation and consultation project

Organization

Fmi.fi
and social media

- Weather forecasts for over 17 000 locations in Finland
- An abundance of thematic data on different topics of research
- One of Finland's most valued internet brands
- Record number of visitors: nearly 650,000 visitors in 24 hours
- FMI is also present in social media Twitter: @meteorologit and @IlmaTiede, Facebook: FMI Beta, YouTube, Flickr, LinkedIn

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- **Data accessibility, challenges, quality, methods, interpolation etc**
- How climate will change in Finland?

Data accessibility etc

- FMI's OpenData Catalog services provide various meteorological data freely for anyone
  - Real time observations since 2010
  - Climate data
  - Sea level and wave observations
  - Weather radar and lightning location information
  - Aviation weather
  - Air quality
  - HIRLAM model forecasts (1/hour, 2 days ahead)
  - **Climate change scenarios** (avg. 30-y periods based on 19 climate model simulations)

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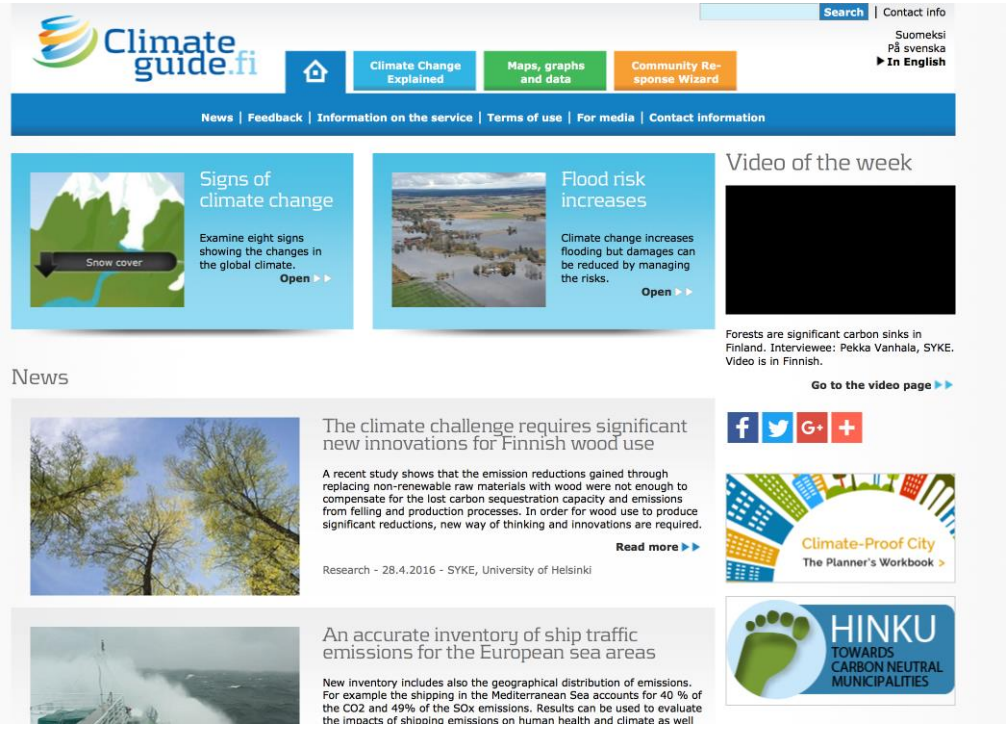
Data accessibility etc – ClimateGuide.fi

- FMI together with the Finnish Environmental Institute (SYKE) are hosting www-portal focused for climate and climate change: **Climateguide.fi**
- Information regarding climate change on various levels for citizens, decision makers, etc



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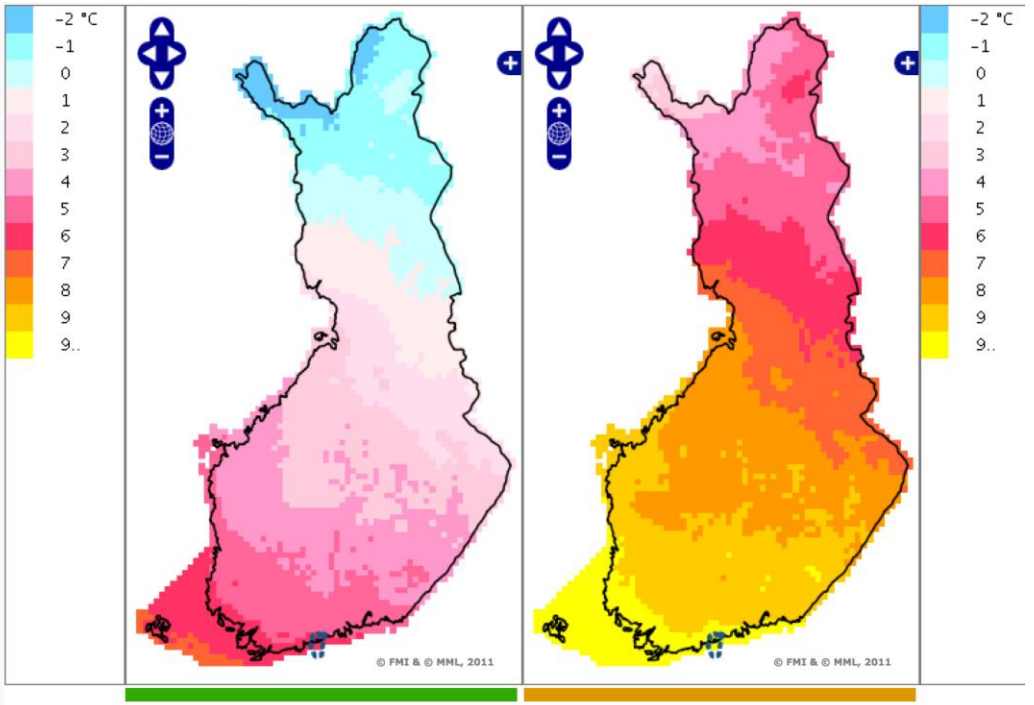
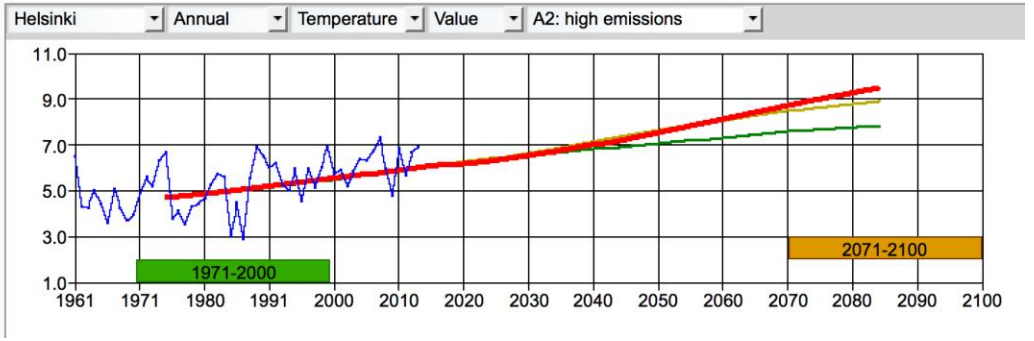
Data accessibility etc – ClimateGuide.fi

- Maps, graphs on climate change in Finland
  - All communities
  - Under updating for RCP-scenarios and downloadable data (ready 2016)





Climate and impacts

Water resources

- (•) Snow duration (days)
- ( ) Maximum snow amount (kg/m²)
- ( ) Soil moisture deficit (mm)
- ( ) Annual evapotranspiration (mm)
- ( ) Maximum runoff (mm)
- ( ) Total runoff (mm)
- ( ) Timing of maximum runoff (percent of years)

Potential energy demand

- ( ) Cooling demand (°Cd or degree-days)
- ( ) Heating demand (°Cd or degree-days)

Natural ecosystems

- ( ) Rate of litter decomposition (relative units)

Time period

- ( ) Baseline
- ( ) 2010 - 2039
- ( ) 2040 - 2069
- (•) 2070 - 2099

Map option

- (•) value
- ( ) change

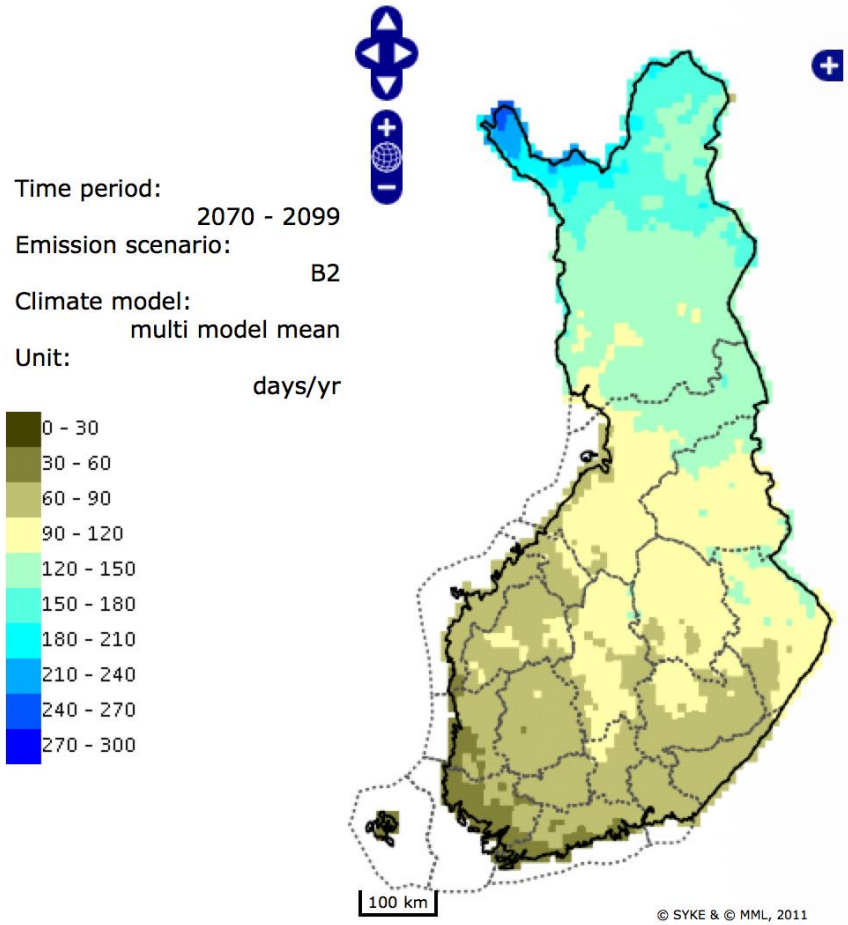
Climate scenario

view scenarios

- ( ) Low change scenario
  7% wetter, +3.1°C warmer
- (•) Average change scenario
  12% wetter, +3.5°C warmer
- ( ) High change scenario
  30% wetter, +6.2°C warmer

Snow duration (days)

Select county: Suomi



Explanation

Map

Maps show estimates of the impacts of climate change in different parts of Finland, either on a regular network of grid boxes (10km squares), or by region.

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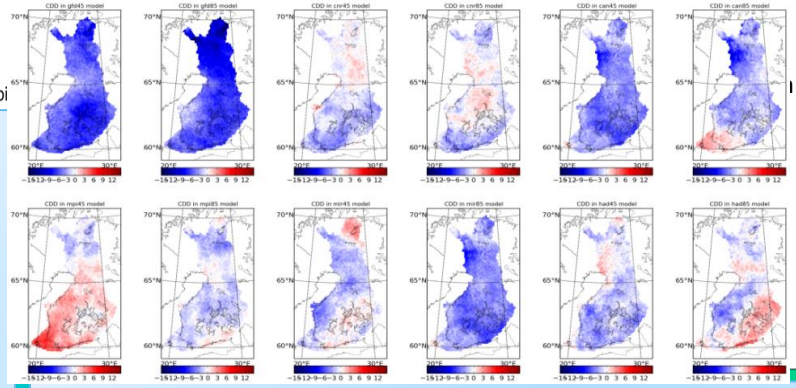
Climate projections used in FMI

Millennium simulations of the past climate

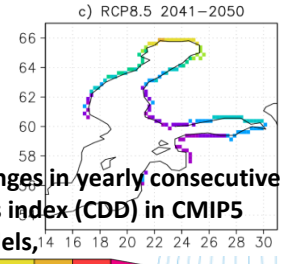
- MPI-ESM model with ECHAM5
- Spatial resolution: T31/L19
- 4824 years of a simulated past climate
- Temporal resolution: 6 hours
- FMI application: 800 AD to 2005 AD

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

Data accessibility etc

- FMI provides (and has provided) tailored climate change assessments (reports, scenario data provision etc) for many sectors and end users as well as for the Finnish decision makers
- Special studies for the private sector (e.g. Nuclear power and other energy providers/companies, forestry, shipping, cities etc)
  - Calculation of various indexes for fixed locations
  - Return periods taking climate change into account for
- Monthly climate bulleting nowadays (only) in the www
- http://www.ilmastokatsaus.fi/

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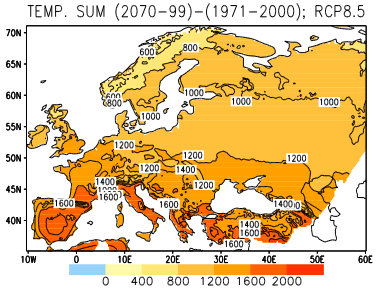
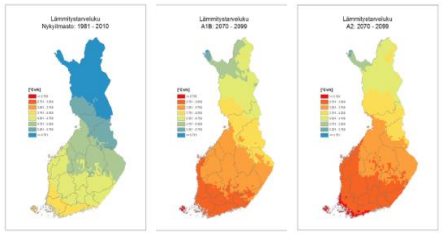
Multi-sectoral assessments

Forestry
Storm damage
Snow load damage
Forest fire danger
Growing season



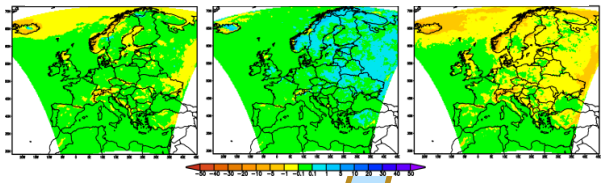
Energy and infrastructure
Heating and cooling demand
Extreme weather ↔ energy production
Extreme weather ↔ infrastructure safety
Sea level rise ↔ infrastructure safety



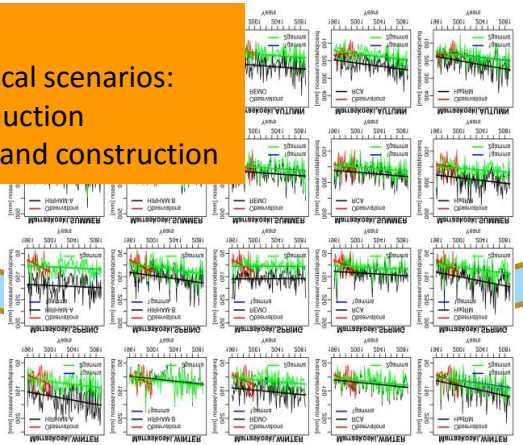
Climate projections

Transportation
Extreme weather ↔ transportation
Baltic sea ice conditions

Blizzard days (2041-2070)-(1971-2000)



Hydrology
Input for hydrological scenarios:
- hydropower production
- flood prevention and construction



Socio-economic applications
Risk assessment
Adaptation measures
Cost and benefit assessment

Decision support tools

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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

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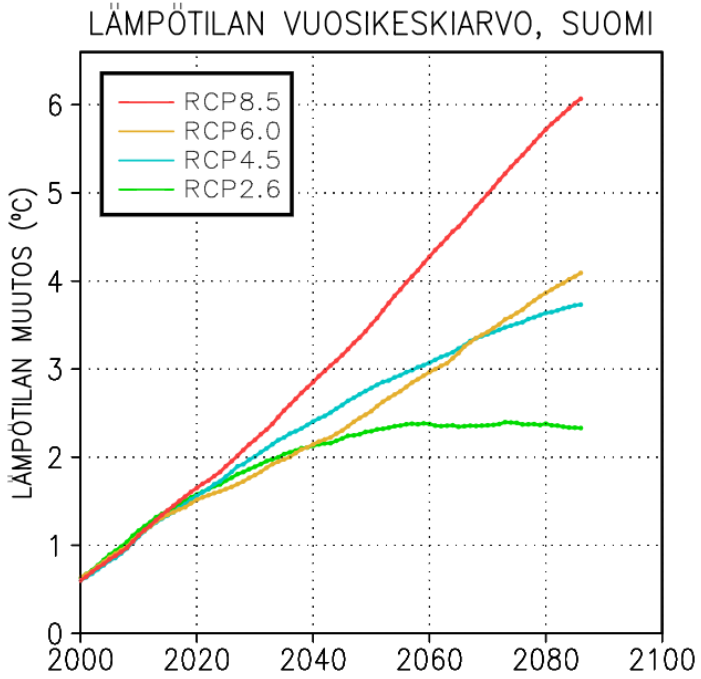
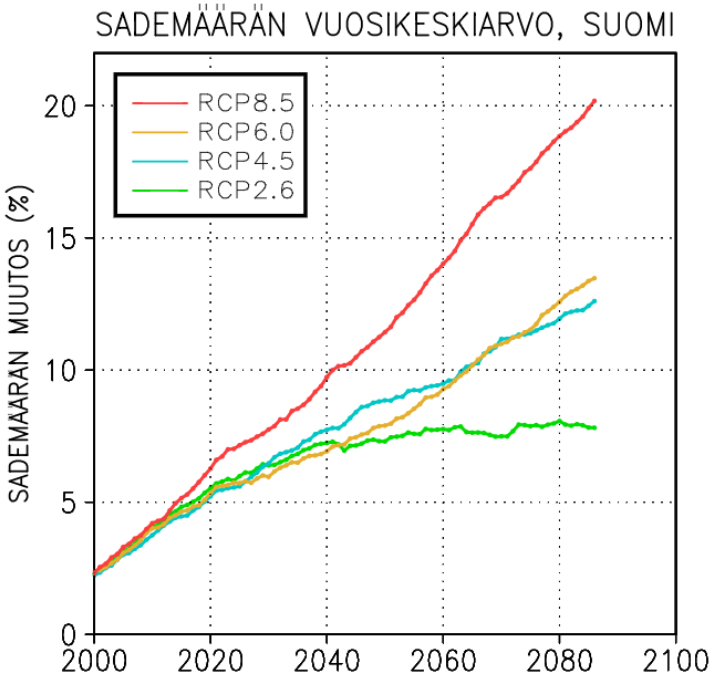
Finland

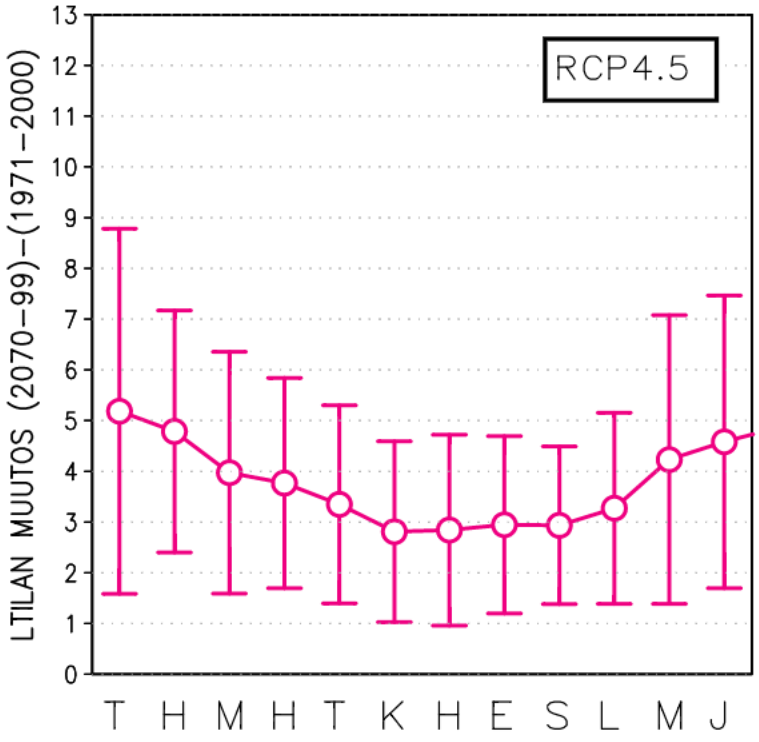
- Climate has and will change in Finland!
- Temperature (left) and precipitation (right) compared to 1971-2000
- Based on 28 models (CMIP5)

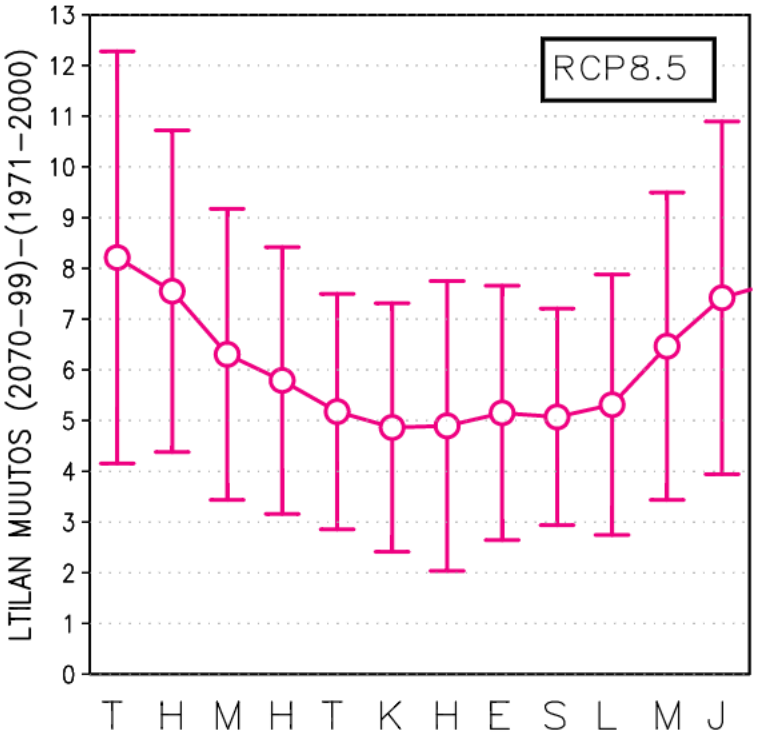




Finland

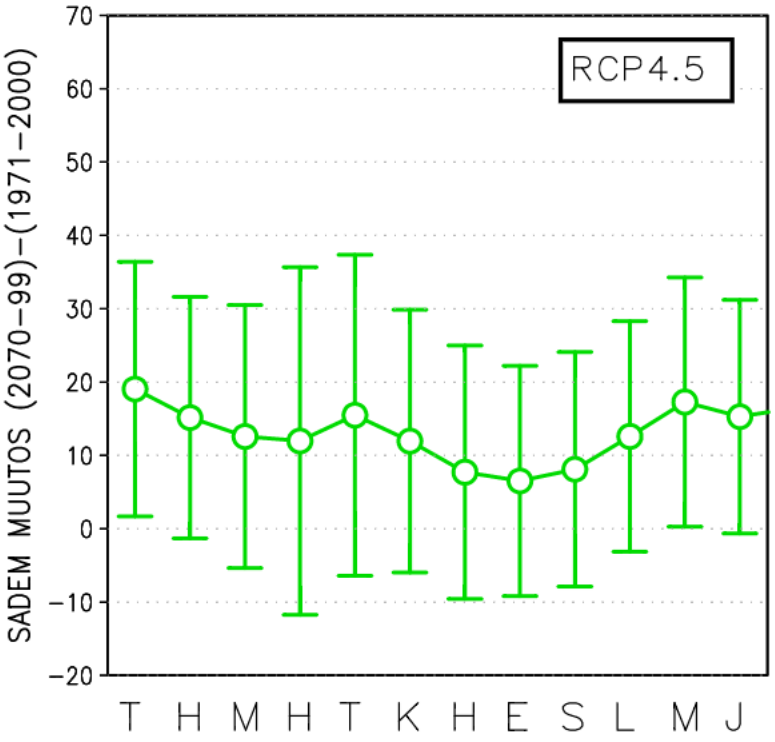
- Monthly temperature (with 90% probability marked)
- For RCP4.5 (left) and RCP 8.5 (right)

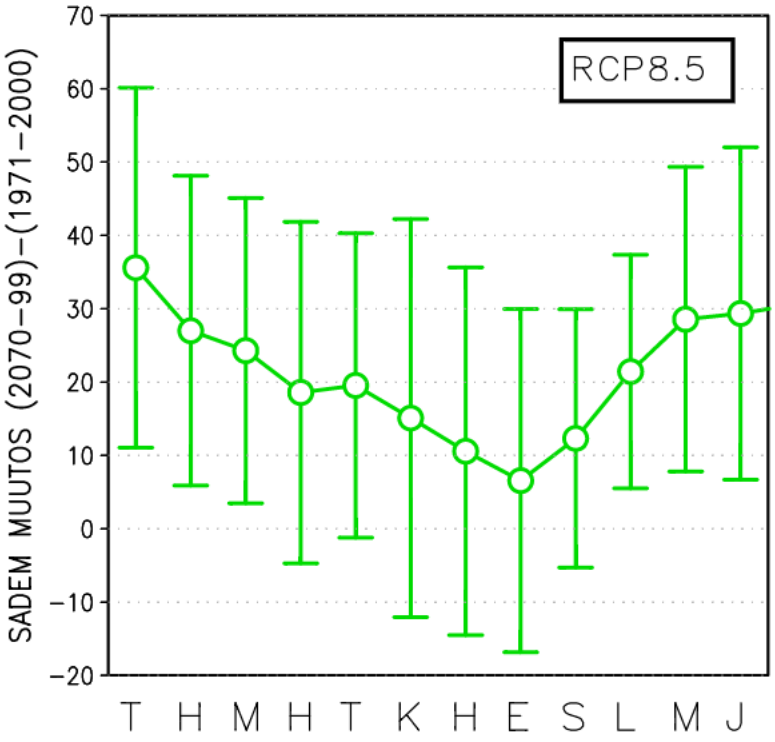




Finland

- Monthly precipitation change (%, with 90% probability)
- For RCP4.5 (left) and RCP 8.5 (right)





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