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Extreme Weather in Northern Europe

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31st Nordic Meteorological Meeting
Reykjavík, 18-20 June 2018

Environment ▸ Climate change Wildlife Ene

Natural disasters and extreme weather

Climat far mor

Without actio temperatures

Beast causi

Snow chac hospitals

Red alerts ar

Blizzards, disruption combined experienc

The Met O temperatu Forecaster week.

Damian Carrington
Environment editor
@dpcarrington

Wed 27 Sep 2017 05.01 BST

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This article is over 9 months old

Storm-tossed

Natural disasters made 2017 a year of record insurance losses

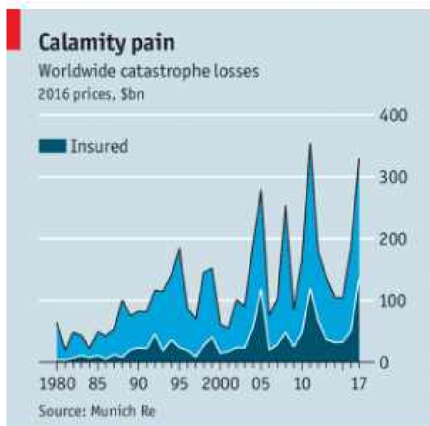
Highest losses (89%) from weather catastrophes ever (Munich-Re)

But the reinsurance industry emerged in good shape

Print edition | Finance and economics ›

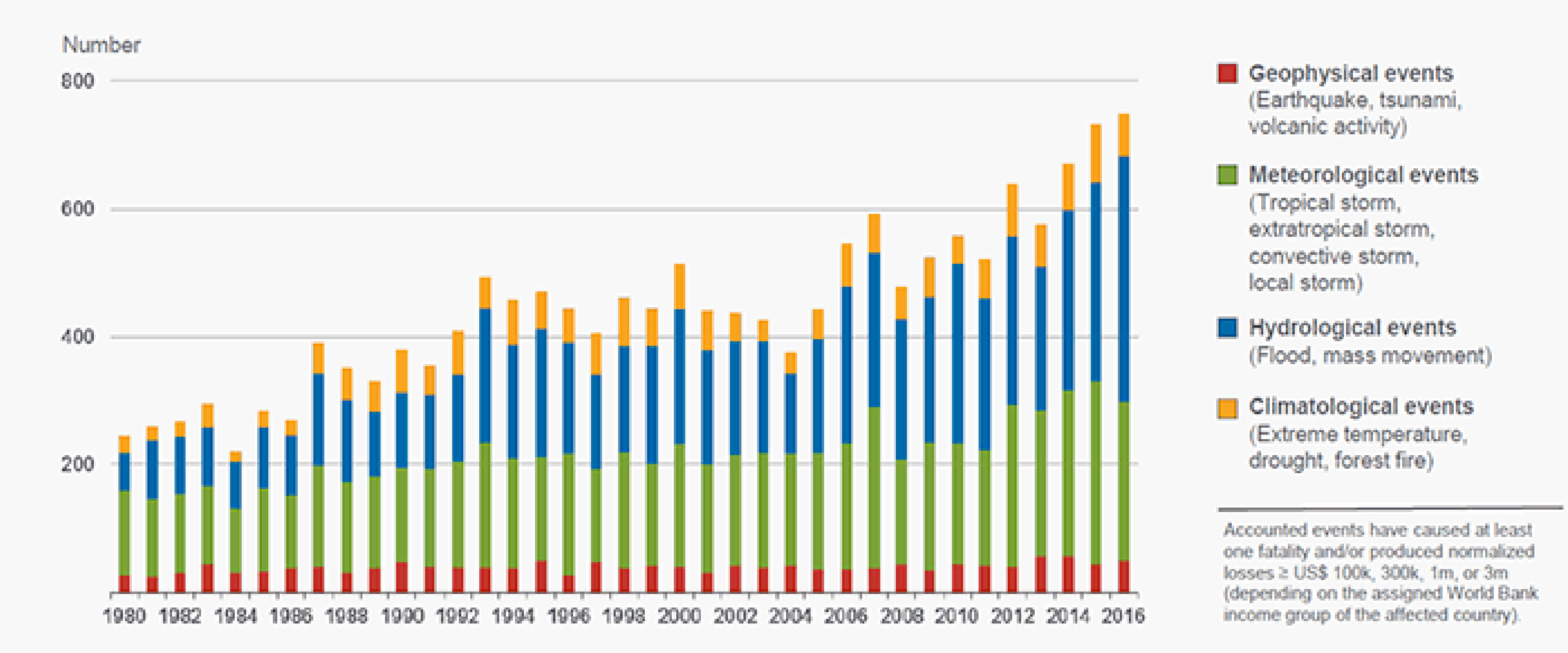
Jan 11th 2018

THAT 2017 suffered from more than its fair share of natural catastrophes was known at the time. In the wake of Hurricane Harvey, the streets of Houston, Texas, were submerged under brown floodwater; Hurricane Irma razed buildings to the ground on some Caribbean islands. That the destruction was great enough for insurance losses to reach record levels has only just been confirmed. According to figures released on January 4th by Munich Re, a reinsurer, global, inflation-adjusted insured catastrophe losses reached an all-time high of $135bn in 2017 (see chart). Total losses (including uninsured ones) reached $330bn, second only to losses of $354bn in 2011.



A large portion of the losses in 2011 was caused by one catastrophe: the earthquake and tsunami in Japan. Losses in 2017 were largely traceable to extreme weather. Fully 97% were weather-related, well above the average since 1980 of 85%. If climate change brings more frequent extreme weather, as Munich Re and others expect, last

Economic damage caused by weather and climate-related extreme events

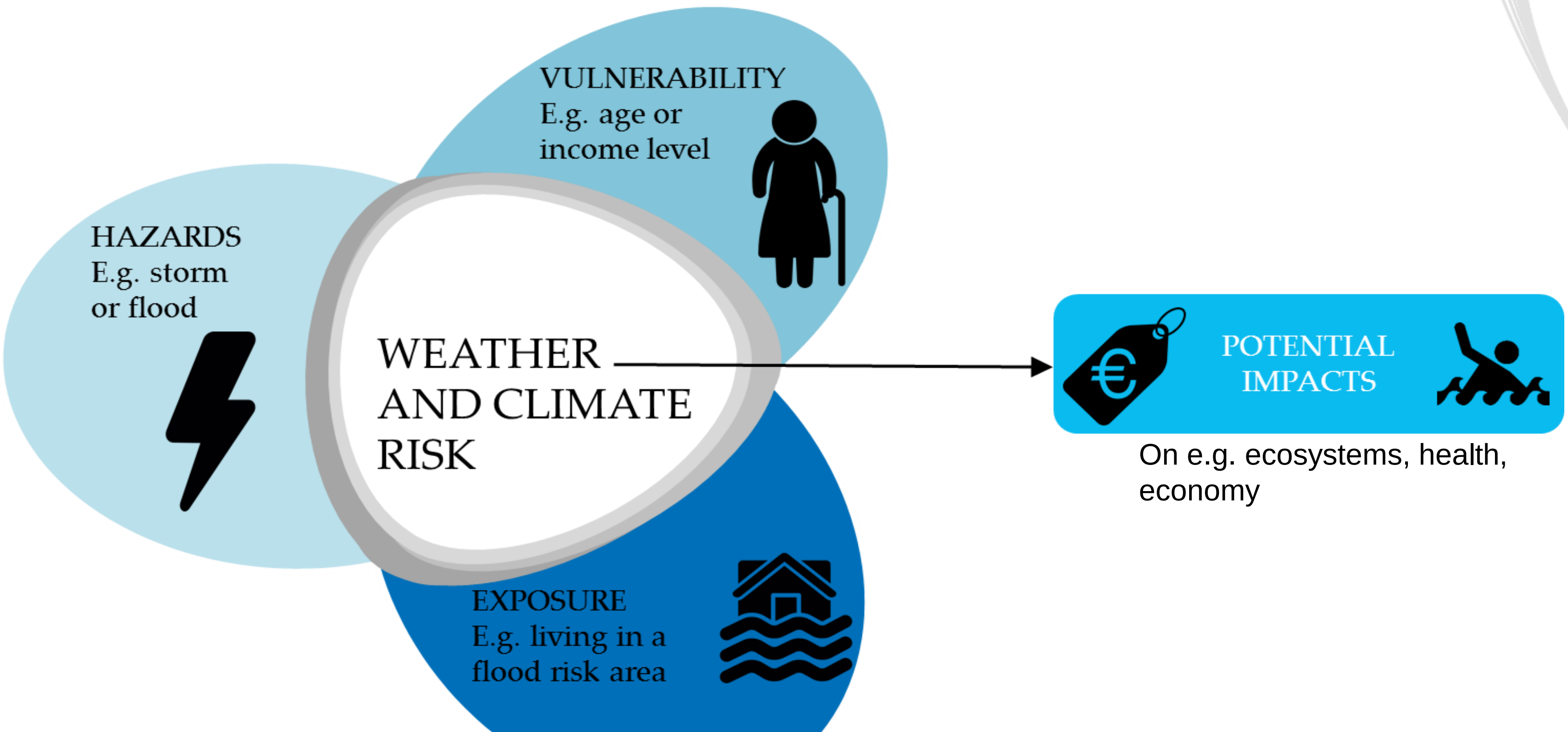


From: Munich Re

Between 1980 and 2016, natural disasters caused by weather and climate-related extremes accounted for some 83 % of the monetary losses in the EU Member States

Weather and climate risk: key concepts

The character and severity of impacts from climate extremes depend not only on the extremes themselves but also on exposure and vulnerability.



Based on IPCC 2012 & 2014
Graphics: Pilli-Sihvola K., Luhtala S. & Haavisto R.
Ikonit: Freepik/Flaticon.com & Pixabay.com.

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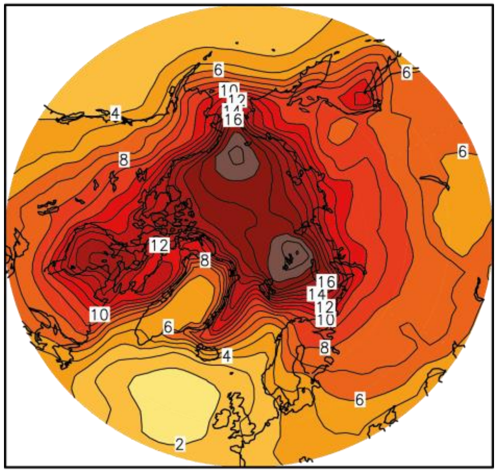
Future climatic changes in Europe by 2100: different trends in the north and in the south

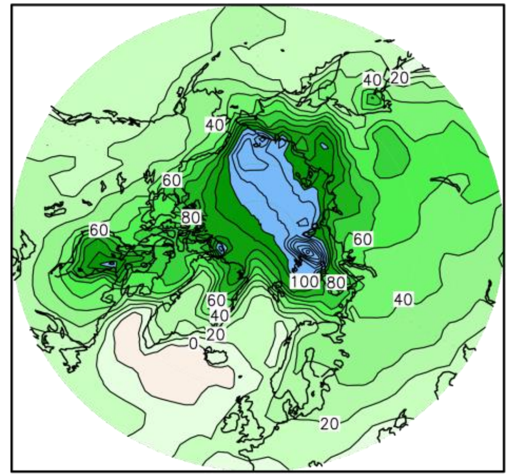
Temperature (°C)

Tmean, Dec-Feb, RCP8.5, 2070-2099



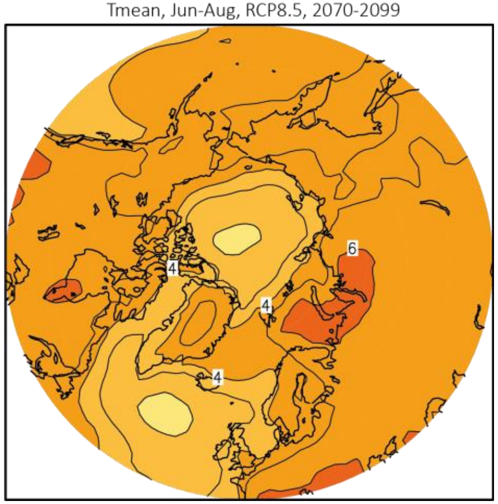
Precipitation (%)

Prec, Dec-Feb, RCP8.5, 2070-2099

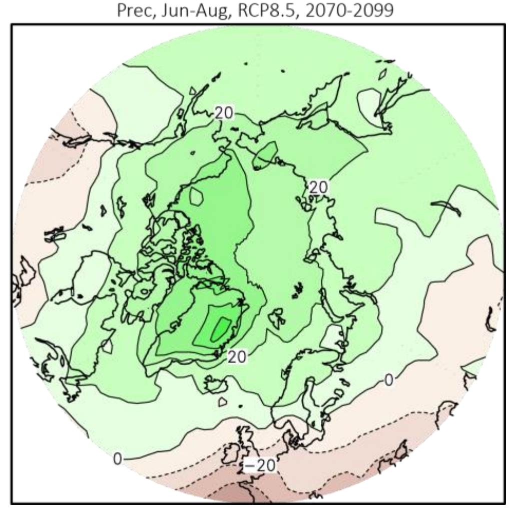


Winter mean

Tmean, Jun-Aug, RCP8.5, 2070-2099



Prec, Jun-Aug, RCP8.5, 2070-2099



Summer mean

From 1971-2000 to 2070-2099, RCP8.5, multi-model means (28 GCMs)

Source: K. Ruosteenoja

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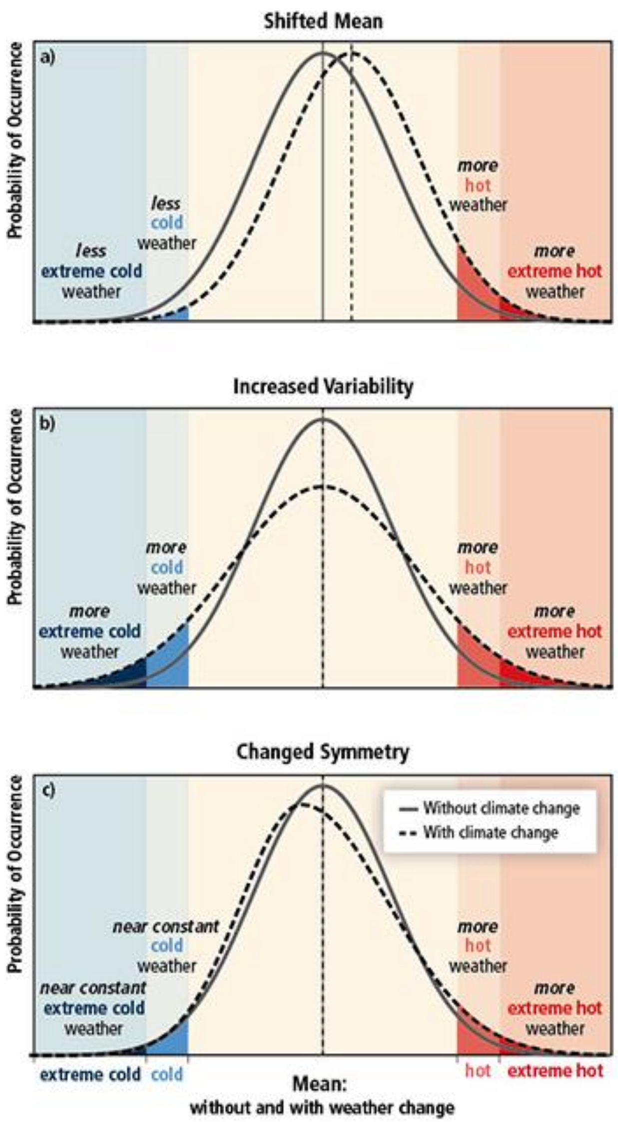
Changes in the mean → changes in frequency, intensity, spatial extent and duration of extremes



(IPCC 2012)

Adaptation measures alongside **mitigation** is needed by users to reduce adverse impacts

Sustainable development

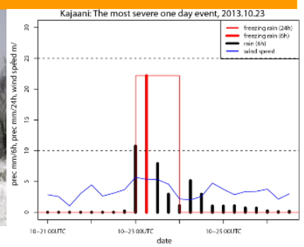
Most wished climate services in Finland:
Based on an online user need survey conducted in 2010 among state and municipal **authorities and enterprises:**

(1) probabilities of occurrence of extreme weather and climate events and
(2) climate risk assessment

Multi-sectoral assessments of weather and climate extremes

Forestry and agriculture
Storm damage
Snow load damage
Forest fire danger

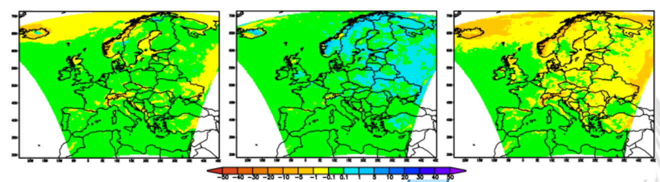
Energy, infrastructure and health
Extreme weather, e.g. storms, snow storms, snow load, freezing rain, sea level rise ↔ infrastructure safety
Temperature-related mortality



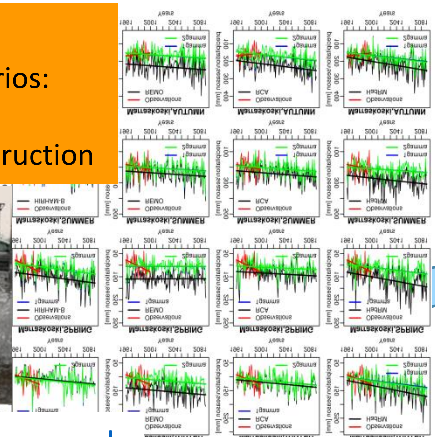
Observations, re-analysis, climate projections

Transportation
Extreme weather, e.g. freezing rain, snow events, sea-effect snowfall
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

http://en.ilmatieteenlaitos.fi/weather-and-climate-change-impact-research

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The most impacting severe phenomena according to the stakeholders

Europe-wide survey on Severe Weather Impact and Past Cases

- 28 critical infrastructure stakeholders
- Representatives from road management, railways, power transmission, telecommunication and rescue services

1. Windstorms
2. Heavy rainfall
3. River floods
4. Snowfall & snowstorms
5. Freezing rain

Groenemeijer et al.: Past Cases of Extreme Weather Impact on Critical Infrastructure in Europe (2015)

RAIN PROJECT

Survey / Workshop on Weather and Climate Risk Management in Finland

- 24 sectors of public and private actors, 118 replies
- Representatives from agriculture and food production, health care, and rescue services

1. Windstorms
2. Heavy rainfall
3. Floods
4. Drought
5. Heavy snow load

Haavisto et al. (2016)

VALTIONEUVOSTON SELVITYS- JA TUTKIMUSTOIMINTA

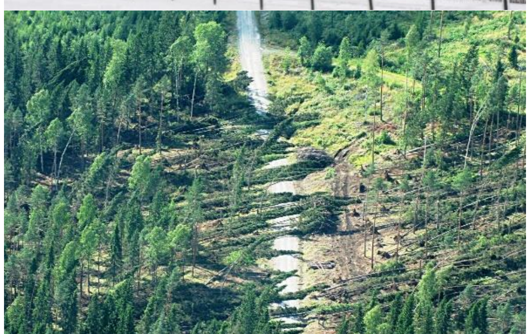
ELASTINEN project

Heavy snowfall
Sea-effect snowfall
Blizzard
Snow load

→ Slippery roads, poor visibility, blocked roads, snow accumulation on trees, power lines & structures, power cuts, forestry damage

Freezing rain

→ Slippery roads, ice accumulation on trees, power lines & structures, power cuts, forestry damage



Storms

→ Property damage, fallen trees, damaged power lines, power cuts, blocked roads, railways

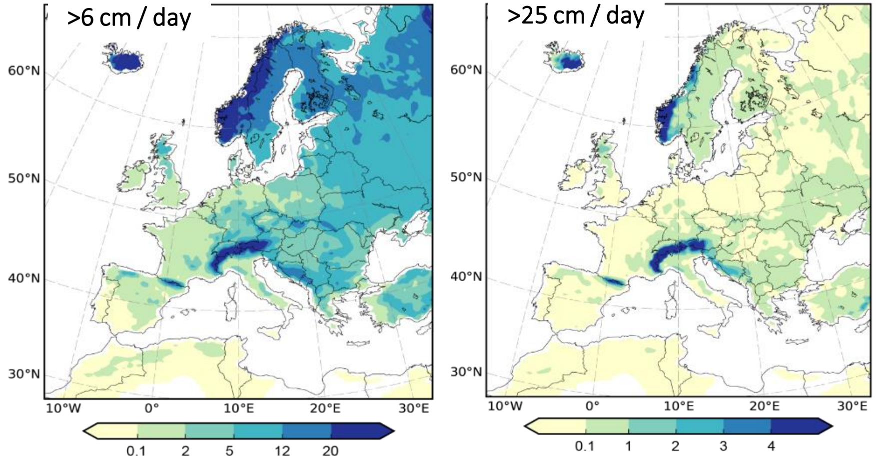
Heavy rainfall

→ Flood damage: streets, properties

Snowfall is expected to decrease, extreme snowfalls might become more frequent

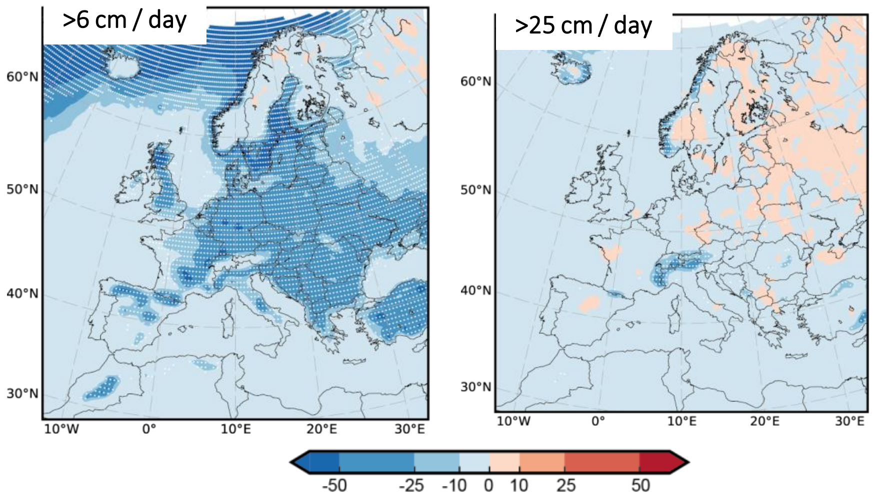
Mean annual number of days, 1981-2010

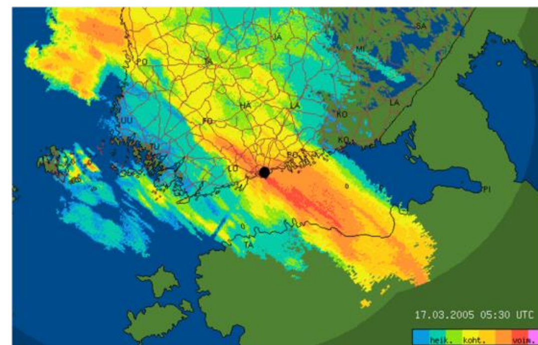
E-OBS observational data



Change in annual probability by 2071-2100

Multi-model mean compared to 1971–2000, RCP8.5





Helsinki, 17.3.2005

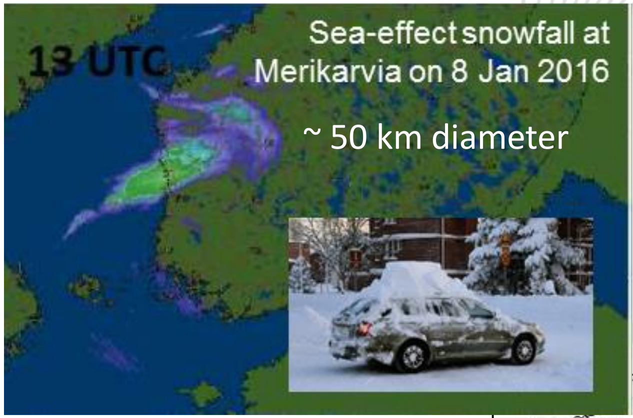
Photo: Board of Inquiry for Traffic Accidents

Heavy snowfall during the morning rush:
≈ only 5 cm snow accumulated, reduced visibility and road grip
→ 300 vehicles crashed, 3 fatalities, 60 injured, severe car pile-ups, high economical costs

Juga et al. (2012)

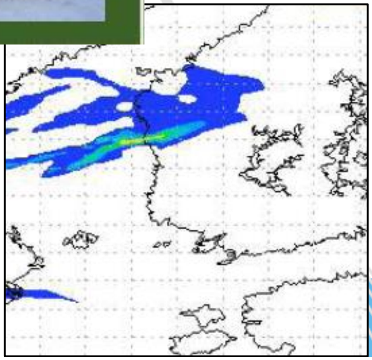
Examples of intense sea-effect snowfall

Snow cover increased by 73 cm in less than a day in Merikarvia (Finland), on the coast of the Sea of Bothnia on 8 Jan 2016 → new national daily snowfall record → the impacts remained reduced



Favourable conditions for wintertime convection to form:

- Exceptionally warm autumn and early winter in 2015
- Almost no ice; sea-surface temperatures above the average
- A flow of very cold and dry air masses

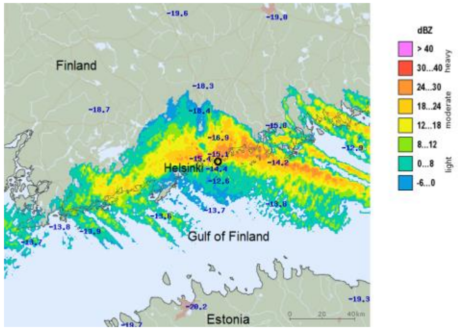


Olsson et al. (2017); https://doi.org/10.5194/asr-14-231-2017

HARMONIE simulations

Sea-effect snowfall in Helsinki on 3 Feb 2012

Photo: V. Oja/HS



Low temperature, intense snowfall (5-10 cm)
Rapidly worsening driving conditions → severe pile-ups, 690 vehicles crashed and 43 injured persons

Juga et al. (2014)

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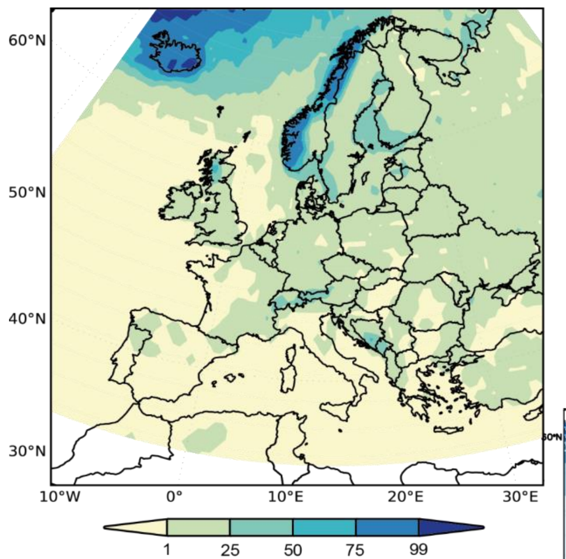
Blizzards and crown snow loads will impact more often Northern Europe

Blizzard, ≥ 10 cm/24 h, ≤ 0 °C, ≥ 17 m/s

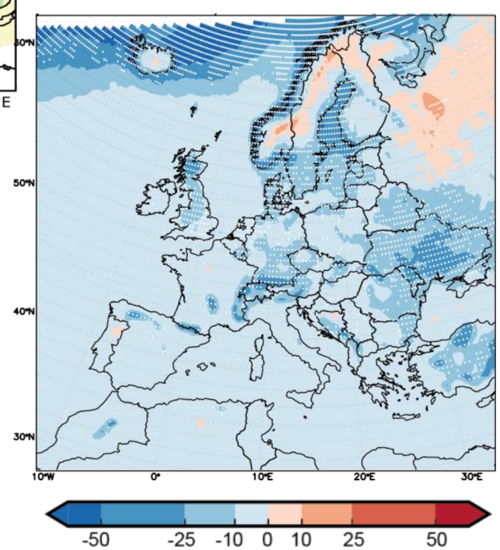


Annual probability (%), 1981-2010

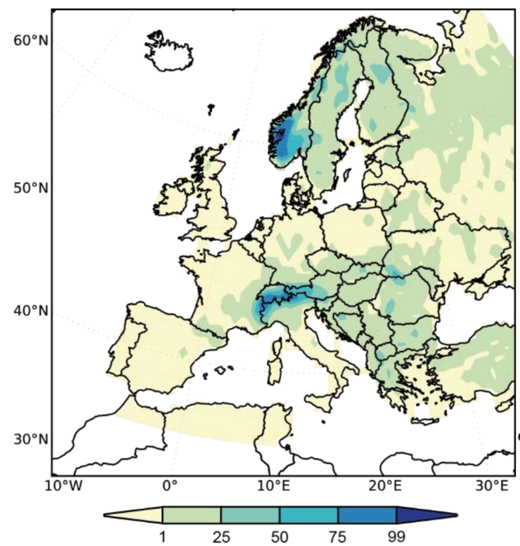
ERA-Interim reanalysis data

Change in annual probability by 2071-2100

Multi-model mean, RCP8.5 scenario compared to 1971–2000



Crown snow loads, >20 kg/m²

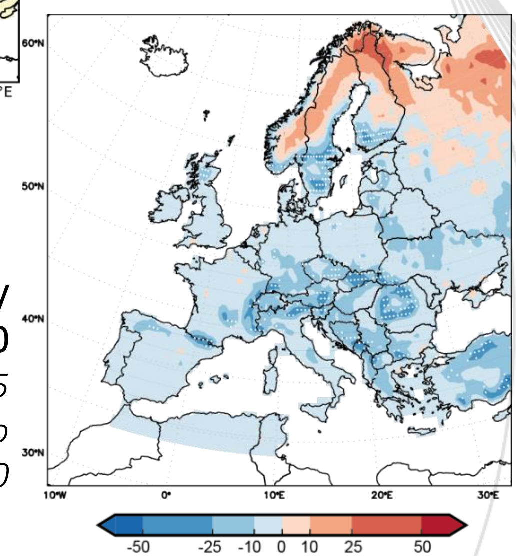


Annual probability (%), 1981-2010

ERA-Interim reanalysis data, FMI crown snow load model

Change in annual probability by 2071-2100

Multi-model mean, RCP8.5 scenario compared to 1971–2000



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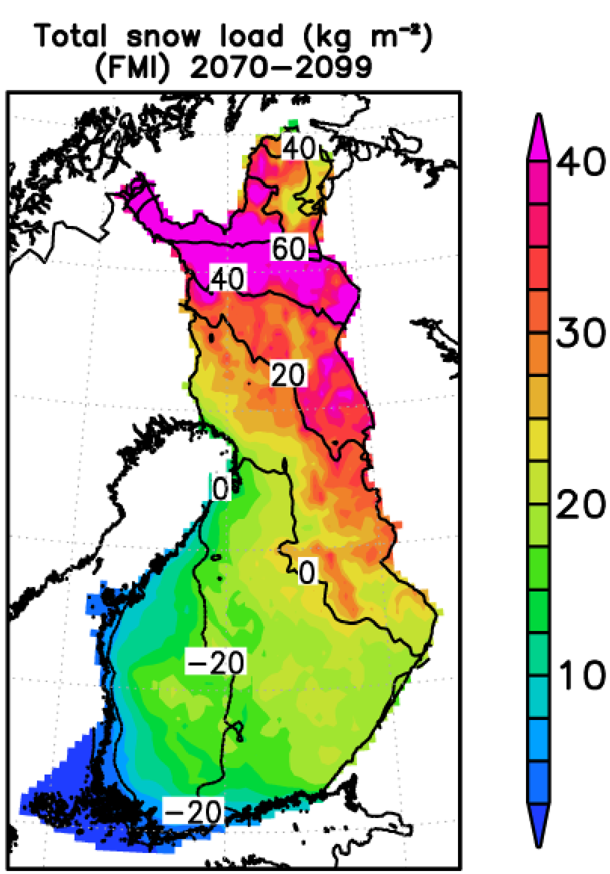
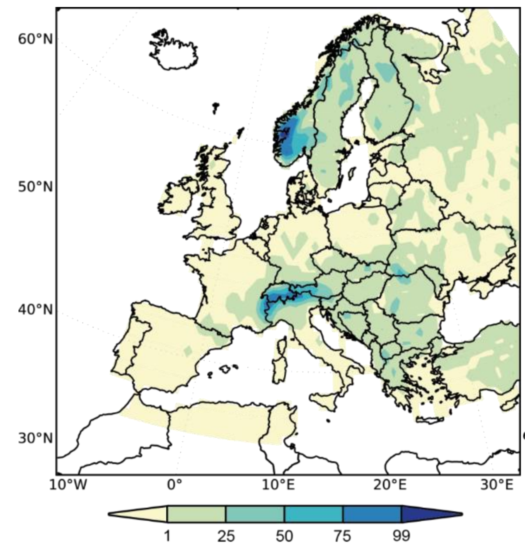


Multi-model mean (CMIP5), RCP8.5, contours show the change compared to 1980-2009

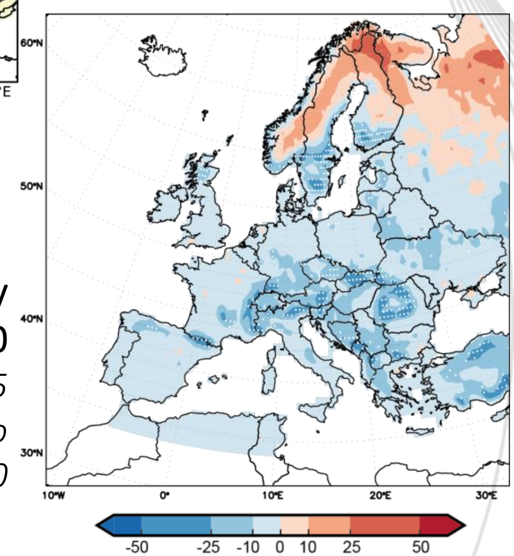
Lehtonen et al. (2016)

Crown snow loads, >20 kg/m^2



Annual probability (%), 1981-2010

ERA-Interim reanalysis data, FMI crown snow load model



Change in annual probability by 2071-2100

Multi-model mean, RCP8.5 scenario compared to 1971–2000

http://en.ilmatieteenlaitos.fi/adapt-project

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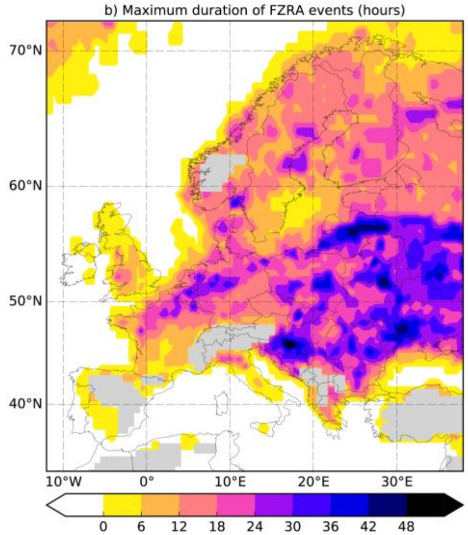
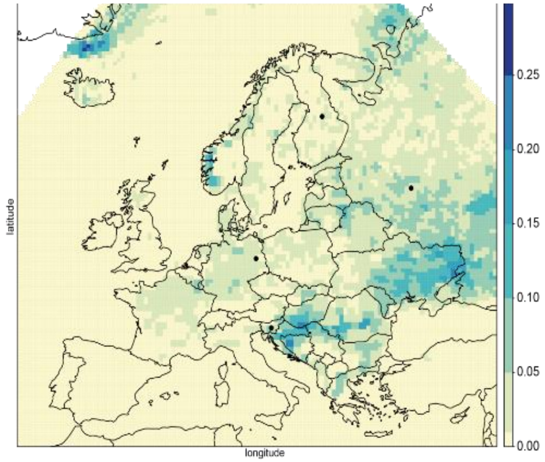
Copernicus Europe's eyes on Earth | Climate Change Service

CLIM4ENERGY - A service providing climate change indicators tailored for the energy sector

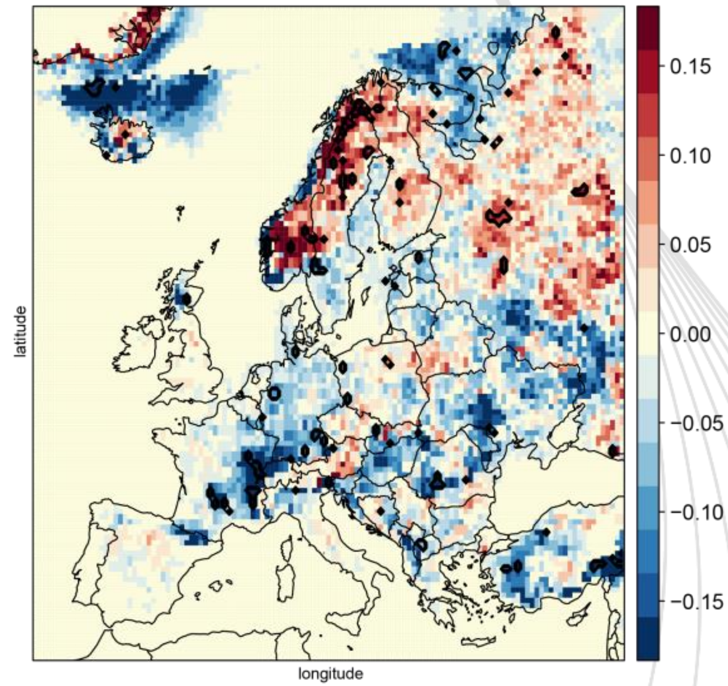
Freezing rain occurs most often in Central and Eastern Europe but becomes more frequent in Scandinavia



Daily probability of FZRA>10 mm/24 h
1971-2000, ERA-I



Changes in annual mean of FZRA>10 mm/24 h
by 2021-2050, multi-model mean, RCP8.5



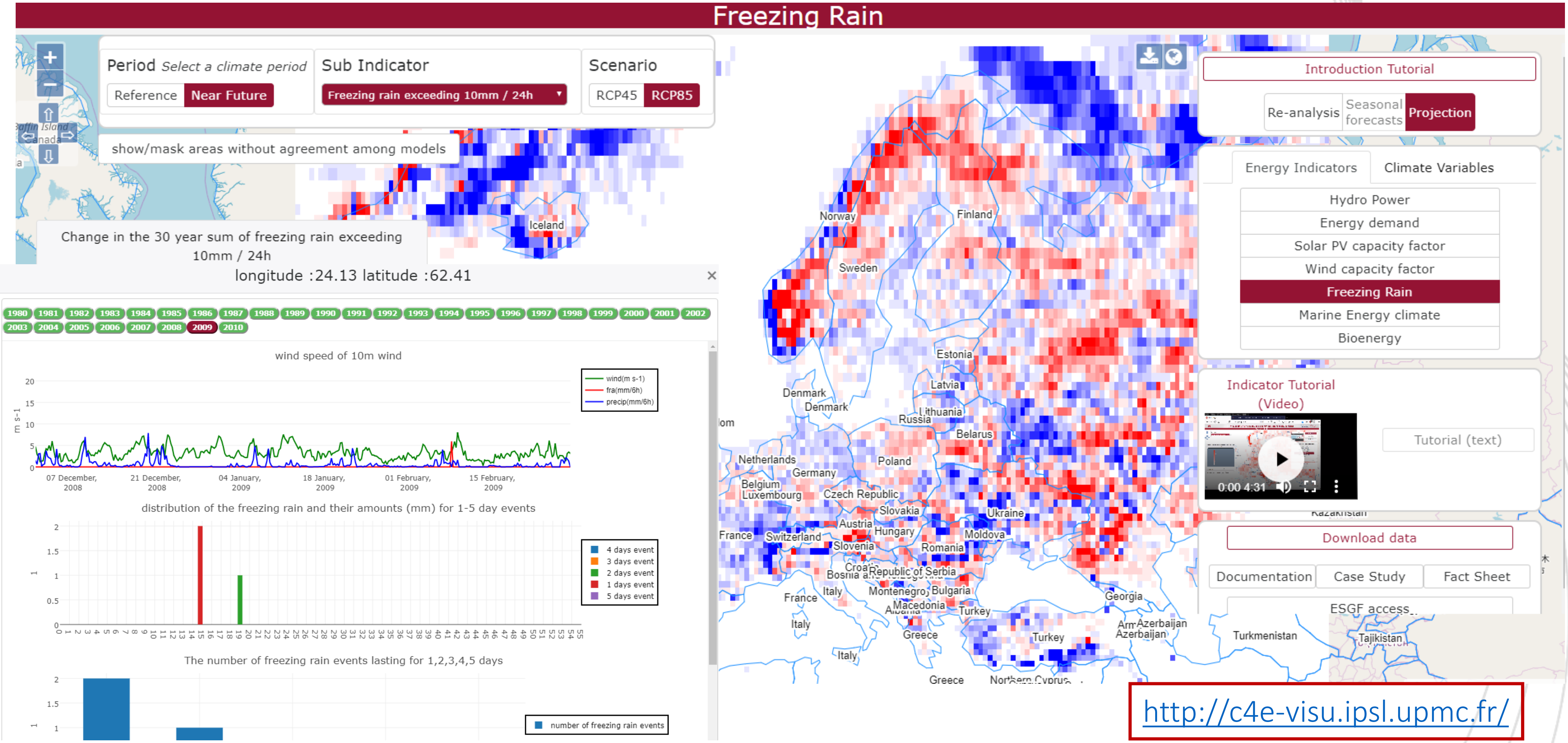
✓ Identification algorithm for freezing precipitation developed and implemented in FMI applied to ERA-I

Kämäräinen et al. (2017),
doi:10.5194/nhess-17-243-2017

Northward shift in the occurrence of severe freezing rain: slight decrease in probability in central Europe, intensification in Fennoscandia and Northern Russia

Portfolio of products developed for the energy sector

Risk of freezing rain damage for energy infrastructure → development of adequate prevention strategies, resilience improvement



http://c4e-visu.ipsl.upmc.fr/

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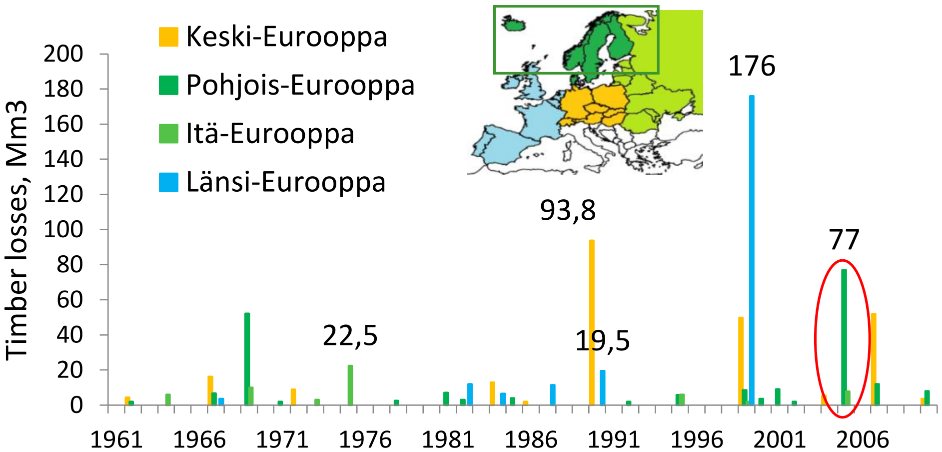
Storm induced damage in European forests has increased and is projected to increase in the storm track region

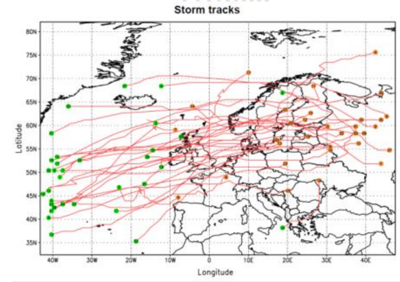
Damages increased 3-4 times during 1981-2010 compared to the earlier decades

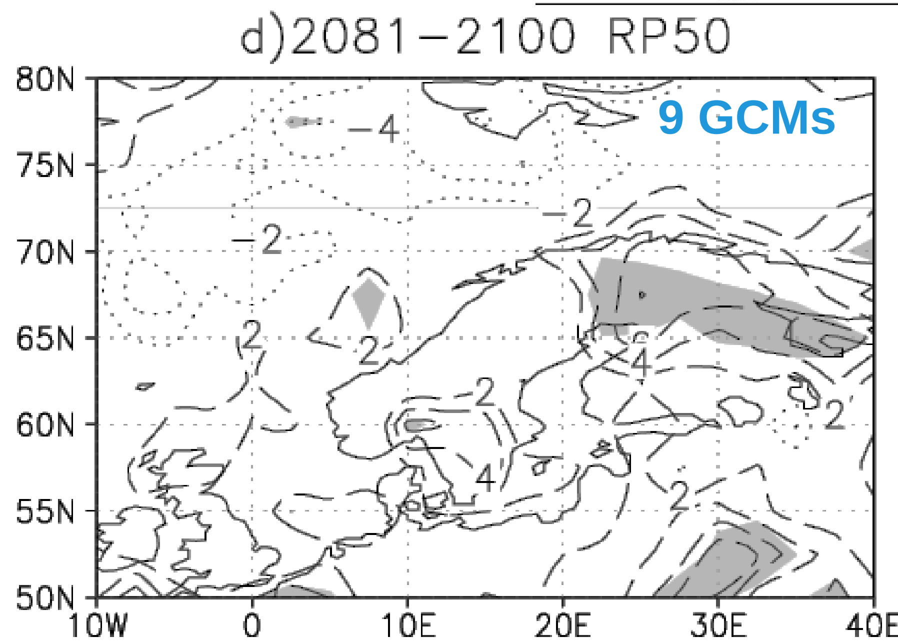


Source: Gregow, 2013; Gregow et al. 2017

Rare (once in 10 years) to very rare wind speeds (once in 50 years) increase in northern Europe by 2-6 % by 2100 (9 GCMs) and three SRES scenarios A1B, A2, B1)

Storm tracks
ERA-Interim 1979-2012

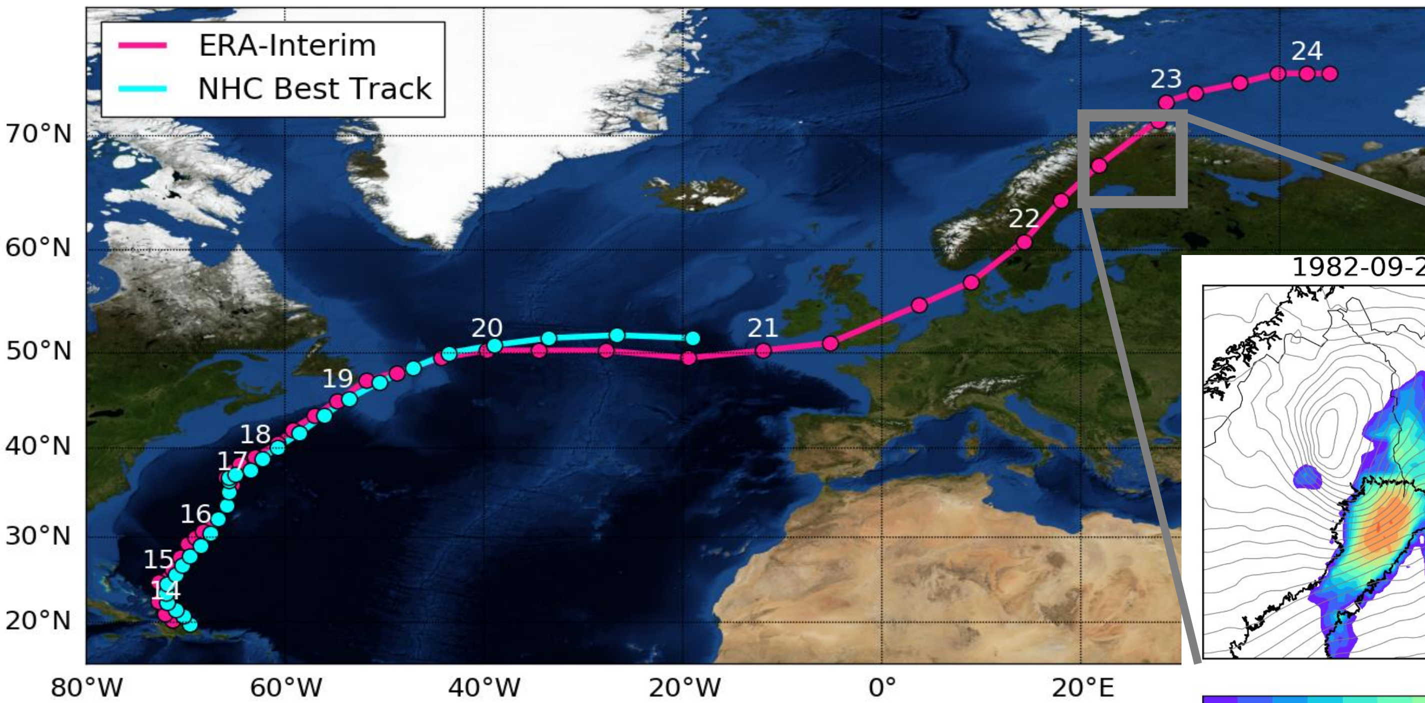




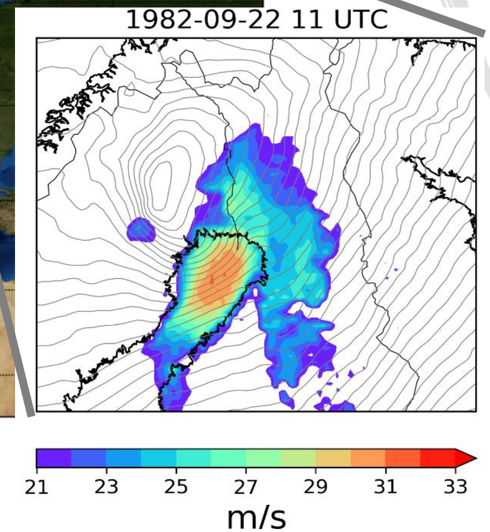
Gregow et al. (2012) Changes in the mean and extreme geostrophic wind speeds in Northern Europe until 2100 based on nine global climate models.

Extra-tropical transition of Hurricane Debby (1982) into a high-impact storm over Northern Europe

On-going work



Source: T. Laurila et al.



Maximum gust on 22 Sept 1982, 11 UTC

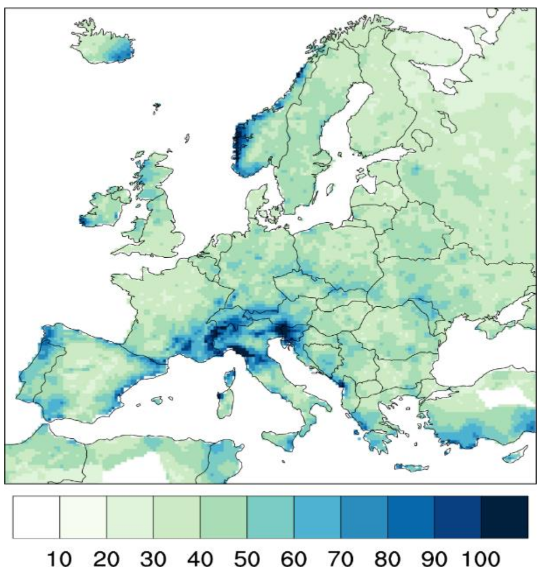
- Category 4 hurricane Debby
- Transitioned to an extra-tropical cyclone
- Travelled to Northern Europe
- One of the most intense storms in Finland (Mauri storm) → 2 fatalities, 3 Mm^3 of forest damage
- Only known hurricane-originated storm in Finland

Fallen trees in Lapland in Sep 1982

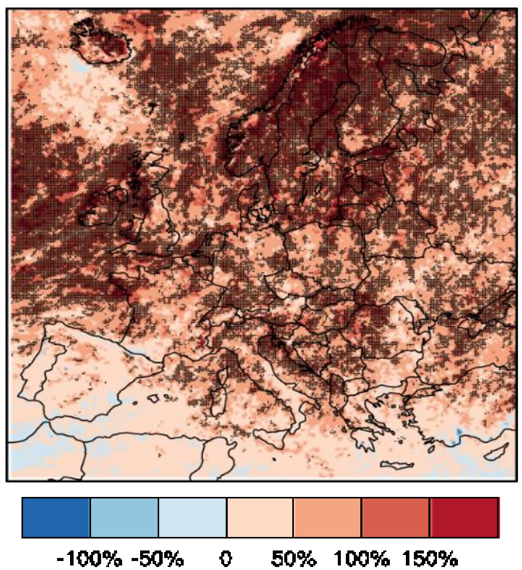
Significant increase in heavy rainfall over Northern Europe

Damaging long-lasting rainfall events will occur once every 4-5 years in Northern Scandinavia by 2100. 3-hourly events may occur once every 2-3 years in Northern Scandinavia by 2100.

10 year return level of daily precipitation



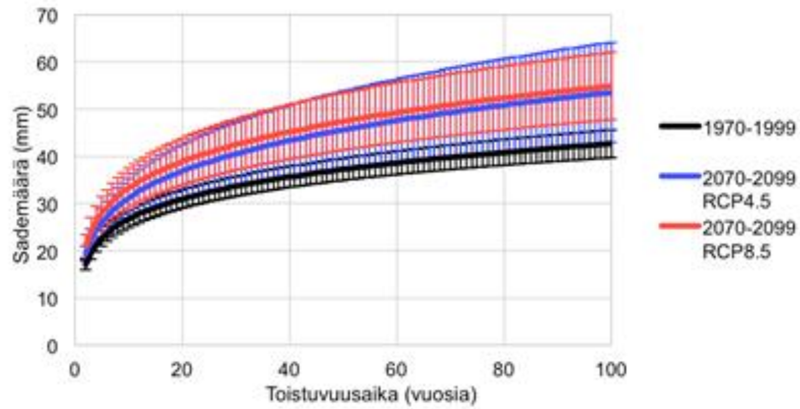
1981-2010, E-OBS obs



Relative change in probability, by 2071-2100, RCP8.5

Source: K. Nissen (FU-Berlin)

Recurrence interval of short duration (3-hourly) rainfall in Helsinki



3-hourly heavy rainfall event with recurrence 1/100 will increase to ~1/30 by 2100 in Helsinki

Mäkelä et al., 2016

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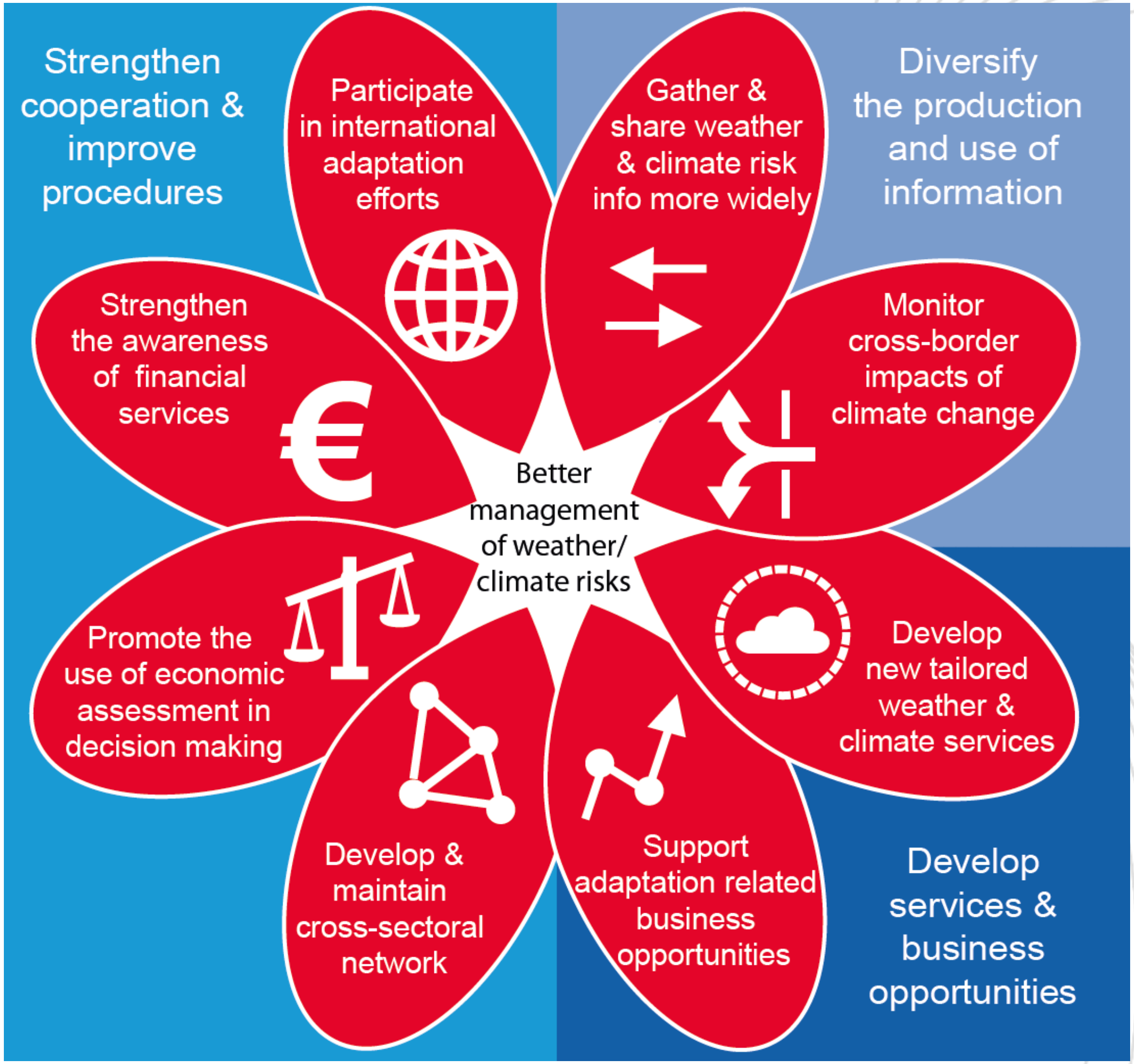
Policy recommendations and measures to improve the management of weather and climate risks and support adaptation to climate change



ELASTINEN (2015-2016)
http://en.ilmatieteenlaitos.fi/elastinen

Warnings implementation → Impact-based concept

History impact data

- Rescue service data
- Electricity failures
- Insurance
- Forest data
- ....

station data

Forecast data

- Wind gusts
- Wind directions
- Ensembles
- Uncertainties
- ....

Datafusion

of the forecasted weather

Data delivery to

Consultancy

Effectivity expressed with ”traffic lights”

A joint effort is needed to more widely collect and distribute info on weather and climate impacts

Source: I. Láng (FMI)

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Key messages

- Some of severe winter events are expected to strengthen or become more likely to occur, e.g. snow-storms, crown snow load, freezing rain and storms; a significant increase is expected for heavy rainfall events

- Confidence level of future trends varies among extremes, temporal and spatial scale of events and geographical location

- Improvements in weather risk management can reduce economical losses, e.g. implemented warning services

- New methods of data collection, distribution and production are needed to support management of weather risks

- Information about climate, impacts of climate change and adaptation is available on ClimateGuide.fi portal in three languages (FI, SE, EN)

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