

# **Use of climate projections for EEA climate change assessments**

**Blaz Kurnik**

**Climate change impacts and adaptations  
European Environment Agency (EEA)**

# European Environment Agency networking with member countries (Eionet)



## EEA coverage

 Member countries

 Cooperating countries

\*Kosovo under UNSCR 1244/99

- 33 member and six collaborating countries (ministries and environment agencies)
- Main target audience: policymakers at European and national levels
- Supporting and informing policy development and implementation by data, indicators and assessments (e.g. on climate change impacts, vulnerability and adaptation)
- Networking: annual Eionet workshop, expert meetings, user/contributor meetings Climate-ADAPT, other conferences like ECCA2015
- Supported by a European Topic Centre, see: <http://cca.eionet.europa.eu/>

# THE EUROPEAN ENVIRONMENT

## STATE AND OUTLOOK 2015



European Environment Agency



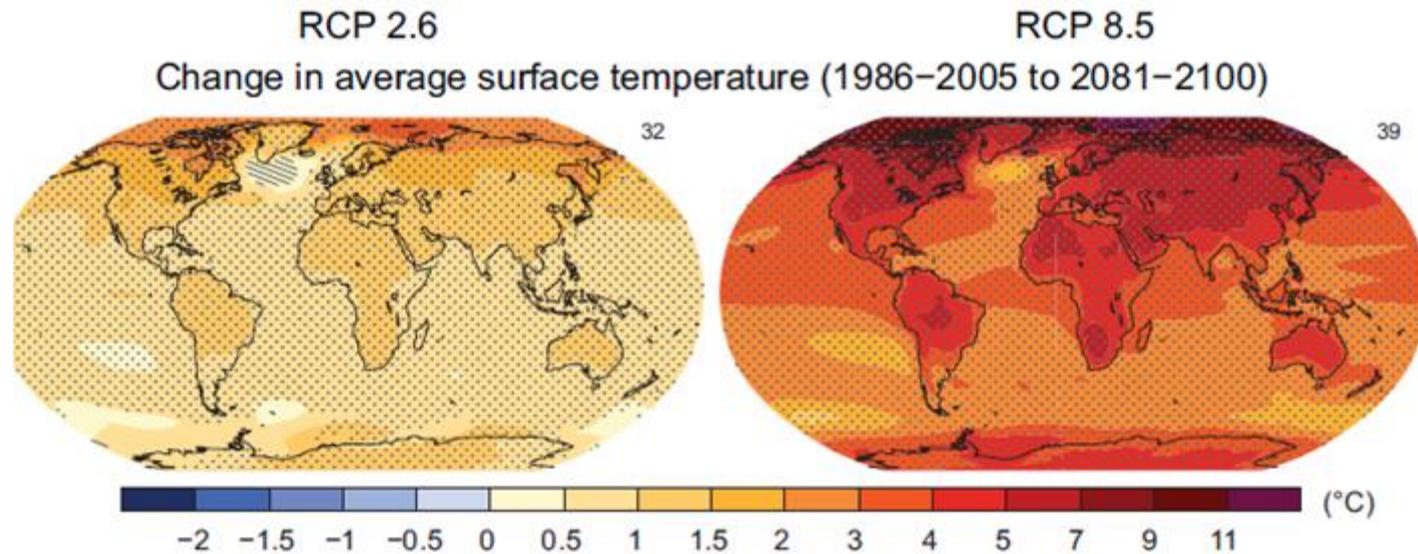
# Global megatrends

- Diverging global population trends (GMT 1)
- Towards a more urban world (GMT 2)
- Changing disease burdens and risks of pandemics (GMT 3)
- Accelerating technological change (GMT 4)
- Continued economic growth? (GMT 5)
- An increasingly multipolar world (GMT 6)
- Intensified global competition for resources (GMT 7)
- Growing pressures on ecosystems (GMT 8)
- **Increasingly severe consequences of climate change (GMT 9)**
- Increasing environmental pollution (GMT 10)
- Diversifying approaches to governance (GMT 11)

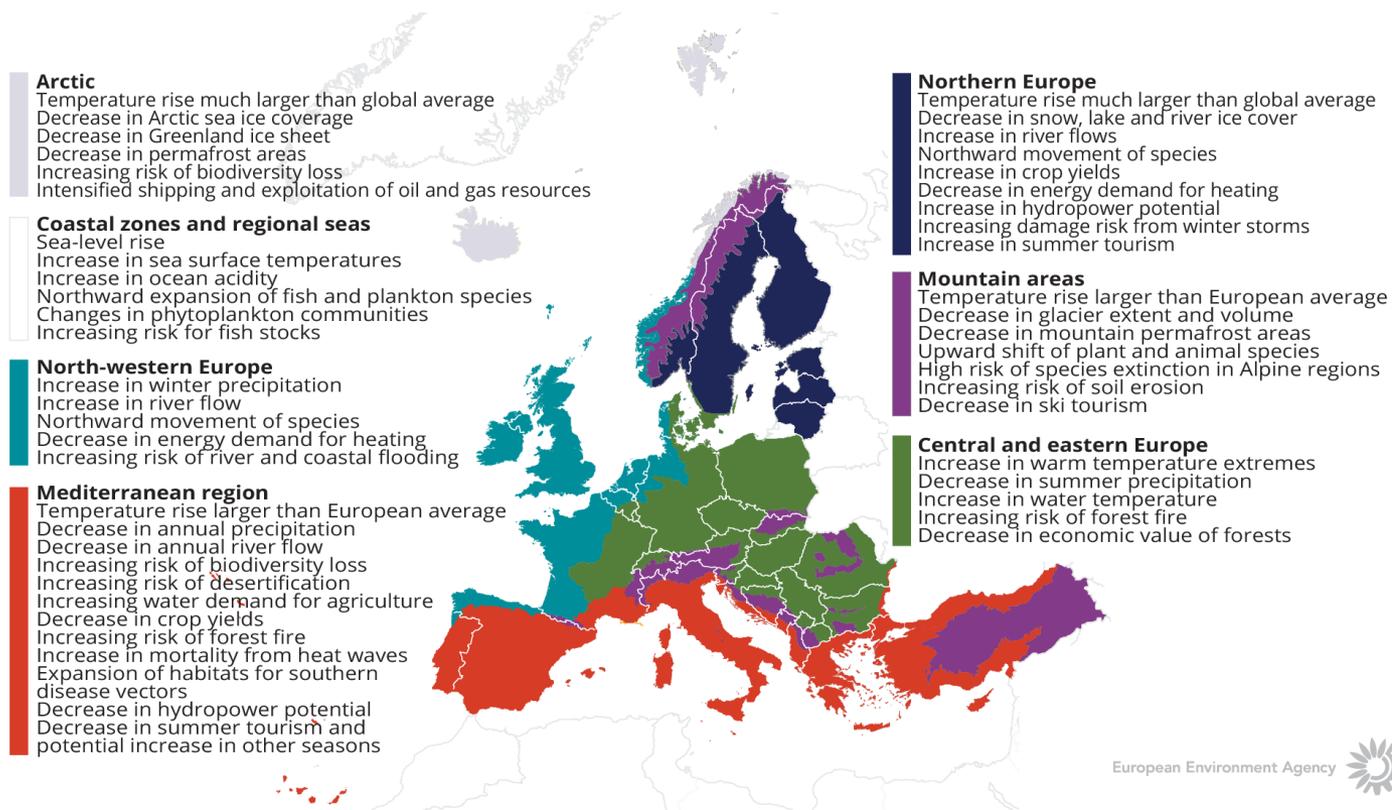


## Increasingly severe consequences of climate change

Climate change is expected increasingly to threaten natural ecosystems and biodiversity, slow economic growth, erode global food security, harm human health and increase inequality



# Key observed and projected impacts from climate change for the main regions in Europe



Climate change impacts on ecosystems	Water use and water stress	Urban systems and grey infrastructure	Climate change & related envi. health risks
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Source: EEA (2012), Climate change, impacts and vulnerability in Europe 2012. An indicator-based report, EEA Report No 12/2012, European Environment Agency, Copenhagen, Denmark.

Related content



# The EU CC adaptation strategy (2013)

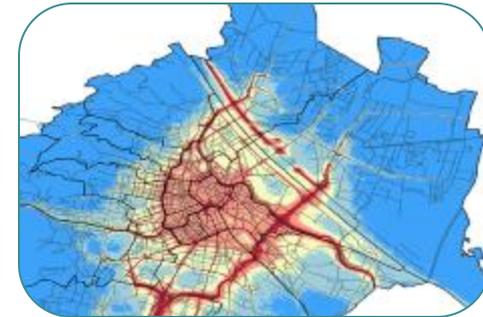
## Priority 1: Promoting action by Member States

- Action 1. Encourage MS to adopt Adaptation Strategies and action plans
- Action 2. LIFE funding, including adaptation priority areas
- Action 3. Promoting adaptation action by cities along the Covenant of Mayors initiative



## Priority 2: Better informed decision-making

- Action 4. Knowledge-gap strategy
- Action 5. Climate-ADAPT



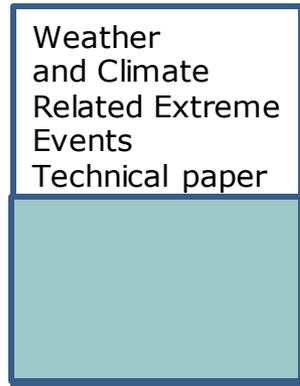
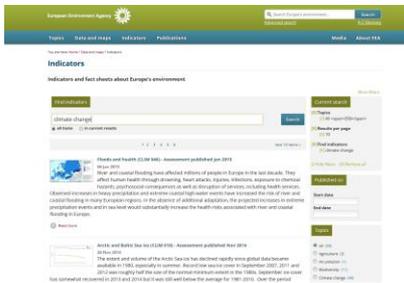
## Priority 3: Key vulnerable sectors

- Action 6. Climate proofing the Common Agricultural Policy, Cohesion Policy, and the Common Fisheries Policy
- Action 7. Making infrastructure more resilient
- Action 8. Promote products & services by insurance and finance markets



# Thematic climate change assessments in 2015/2016

- Technical paper on Weather and Climate Related Extreme Events (new 2015)
- Climate change impacts indicators (CLIM) (updated every 1-3 years)
- Climate change impacts report (update in 2016)
- Climate-ADAPT (regularly updated)



# Climate and weather related extreme events: Workshop and report

## Outline of the paper based on the EEA workshop

- a. Motivation
- b. Extremes
  - i. Past
  - ii. Future
- c. Details on Indices, interrelations
- d. Data Issues
  - i. Gaps, homogeneity, time series
  - ii. Different types (e.g. synops, radar, satellite)
  - iii. Gridding (upscaling, downscaling, sampling, interpolating)
- e. Scenarios
  - i. Emissions scenarios
  - ii. Socio-economic scenarios
  - iii. Climate Modelling

## Extremes

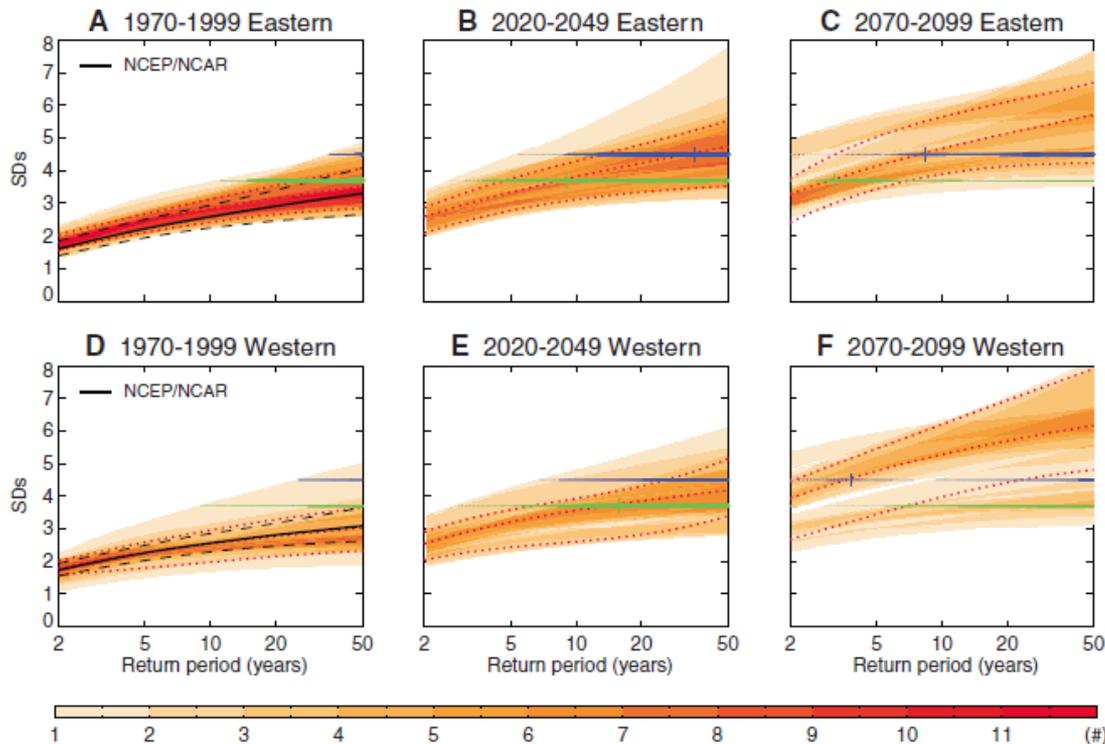
- a. Extreme Temperature
- b. Heavy Precipitation
- c. Hail
- d. Droughts
  - Meteorological Drought
  - Hydrological Drought (low flows, groundwater)
  - Soil Moisture Drought

## Case Studies

Heat wave in Russia (2010)  
German Hail event  
Drought 2003/2012



Return periods decrease by a factor of 5-10 until 2050  
The extreme may become the norm



2010 temperature anomaly  
2003 temperature anomaly

11 RCMs  
forced by A1B

# Droughts in Europe

J. Vogt (JRC),  
S. Seneviratne (ETH),  
EEA workshop on Extreme events (18-19  
March 2015)

Limited number of regions with agreement  
in soil moisture decreases;  
Mediterranean region is one of them

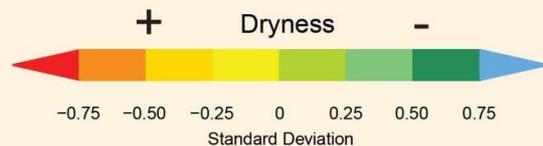
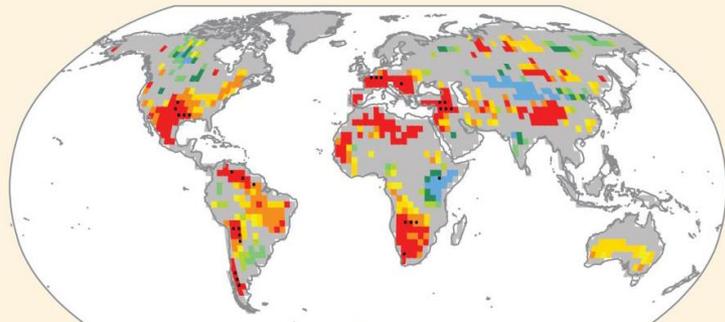
NORTH-EASTERN EUROPE: DROUGHT projected to  
decrease caused by increases in rainfall

CENTRAL EUROPE/BALKANS/TURKEY: DROUGHT  
projected to increase caused by PET (T) INCREASE

MEDITERRANEAN/SOUTHERN EUROPE: DROUGHT  
projected to increase caused by RAINFALL DECREASE and  
PET (T) INCREASE

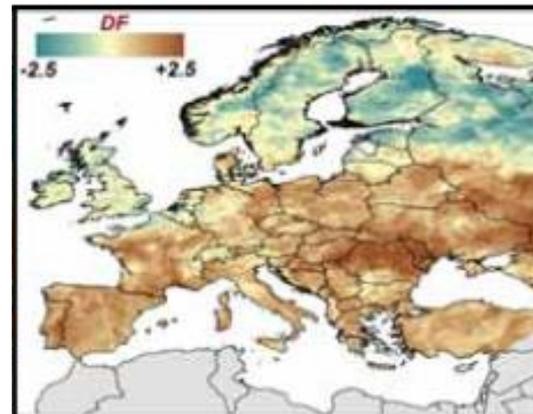
## Soil moisture anomalies (SMA)

2081–2100



IPCC SREX 2012 based on  
Orlowsky and Seneviratne 2012

## SPEI-12



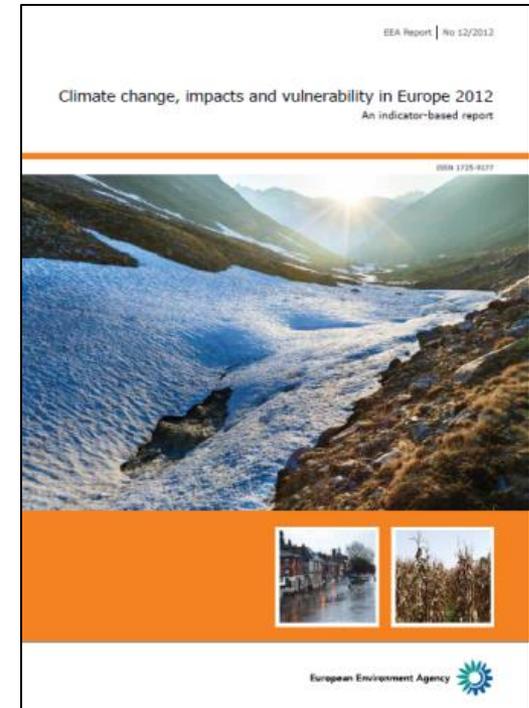
Changes in drought frequency  
(drought events/10 years)

2071-2100 wrt 1981-2010  
Scenario A1B  
Racmo2

Spinoni et al. (2015)  
*Advances in Science and  
Research*

# 2012 EEA indicator report on climate change, impacts and vulnerability

- **Coordination** by EEA
- **Authors and contributors (total 90):**
  - EEA and 3 European Topic Centres (CCA, ICM, BD)
  - Joint Research Centre (European Commission)
  - World Health Organisation (Regional Office for Europe)
  - European Centre for Disease Prevention and Control
  - Other organisations
- **External Advisory Group:**  
EC, EEA SC, WHO, ECMWF, IPCC, AMAP/SWIPA, etc.
- **Content:**  
Focus on indicators, but including additional information that is not suitable as EEA indicator
- **Data sources:**  
International databases, European and other research projects, academic publications
- **Extent:**  
300 pages, 42 indicators, >120 maps and figures

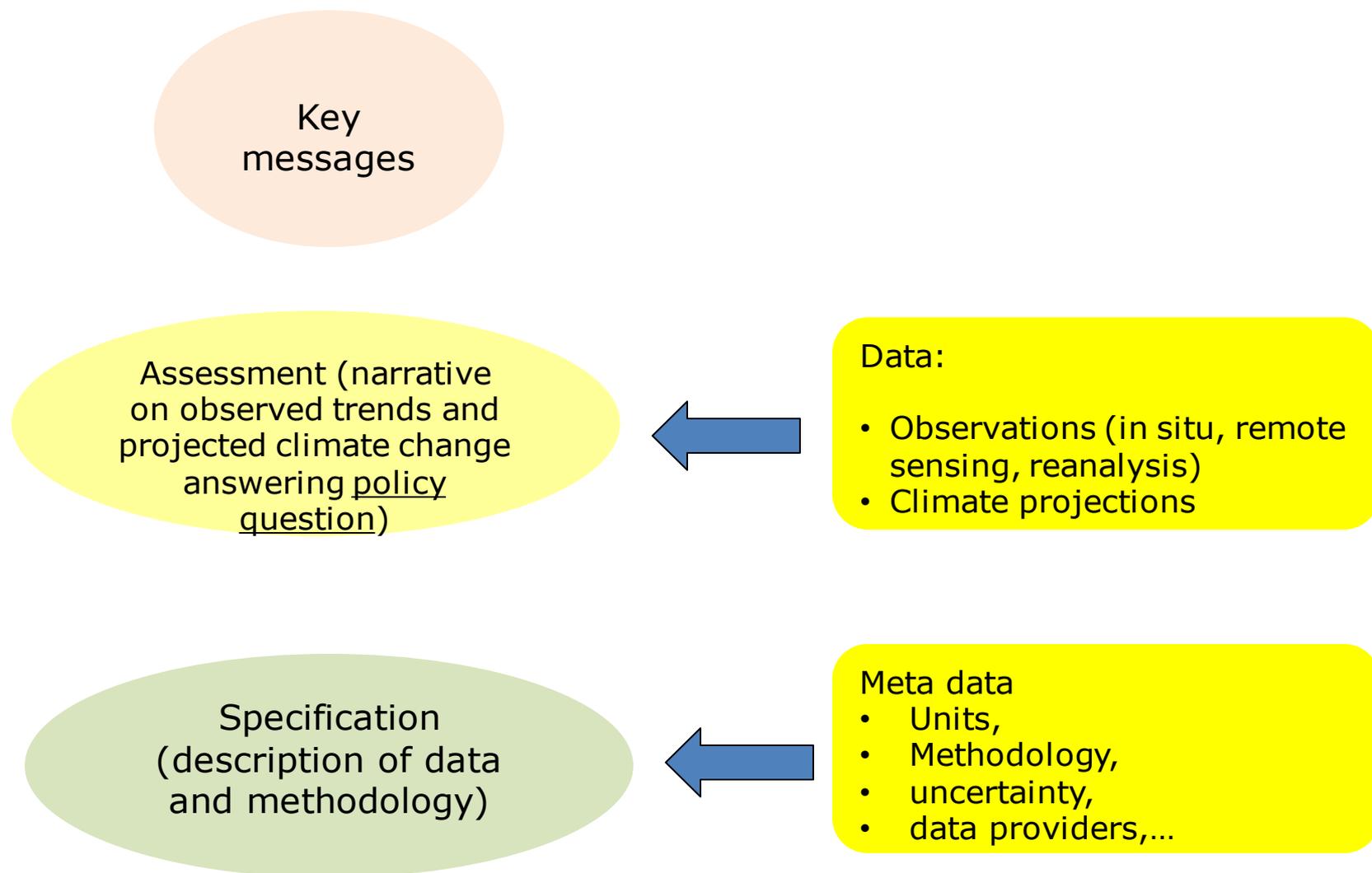


*New report in 2016*

# Organisation of 2016 CCIV report

- Lead: EEA climate change impact, vulnerability and adaptation group
- Various other EEA programmes involved
- External contributors:
  - European Topic Centres (ETC-CCA, ETC-ICM, ETC-BD)
  - JRC, WHO, ECDC, several EU projects
- External Advisory Group:
  - Commission (ENV, CLIMA, RTD, JRC)
  - EEA Scientific Committee
  - ECMWF
  - WHO Europe
  - UNEP (Carpathian convention)
  - Alpine Convention,
  - AMAP
  - Countries' experts (DE, ES, SE, UK)
  - EPA network
  - several EU projects
- Review: Advisory Group, EEA member countries, Commission, further experts

# Structure of a climate change impacts indicator



# Presenting climate change with indicators

Past trends  
>30 years

Future projections  
21<sup>st</sup> century

Describing climate system  
with climate variables

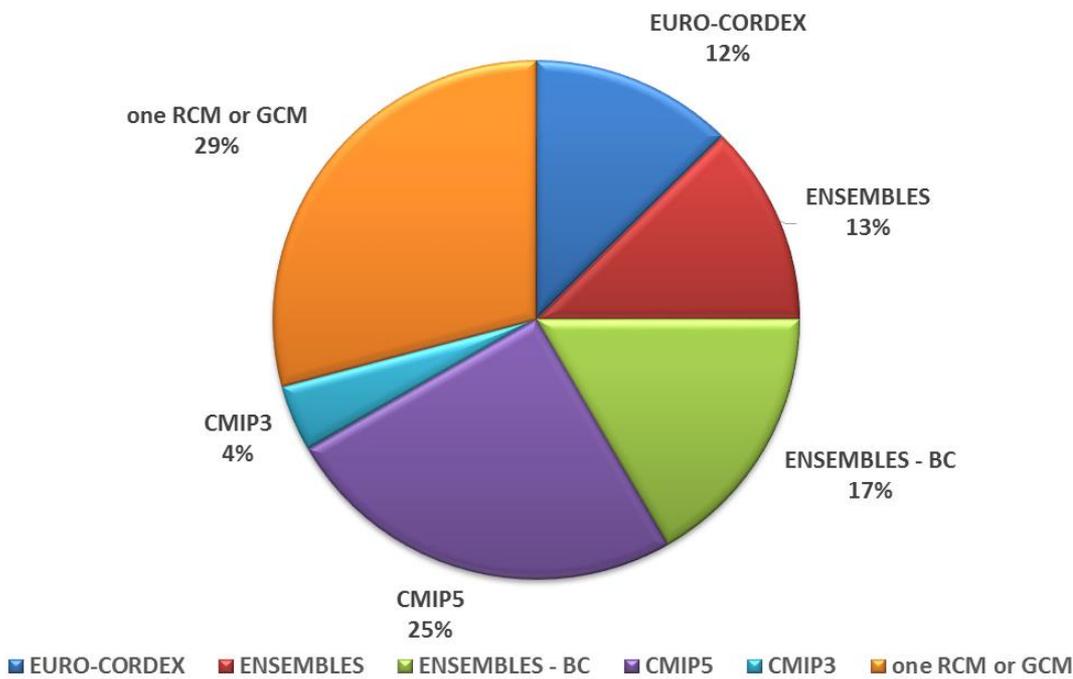
Describing climate change  
impacts on environmental  
systems

Describing climate change  
impacts on socio-economic  
systems and health

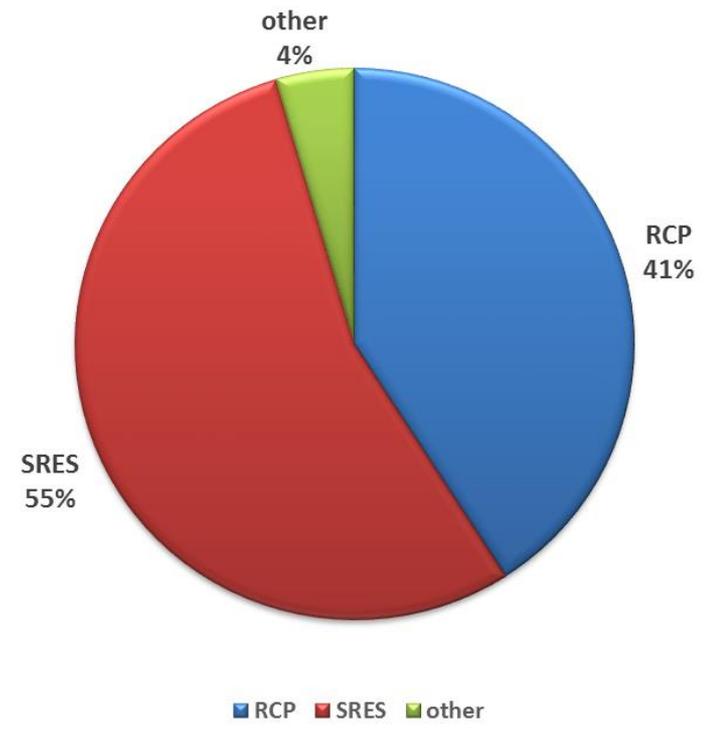
Set of 45 climate  
change impacts  
indicators

# Use of climate models and scenarios in climate change indicators

## Climate models



## Emission Scenarios

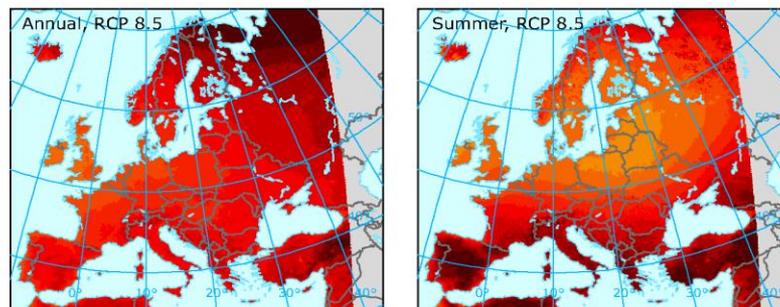


# Example: Temperature and precipitation projections

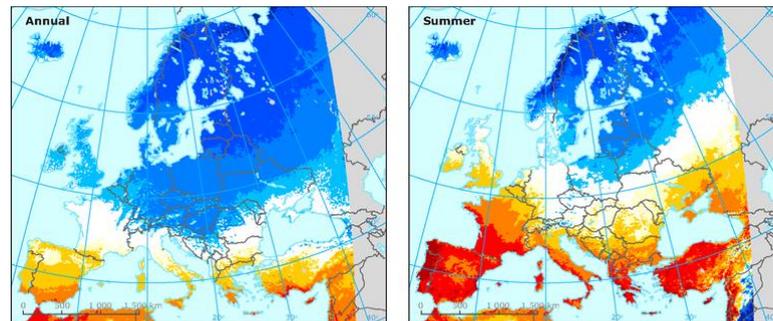
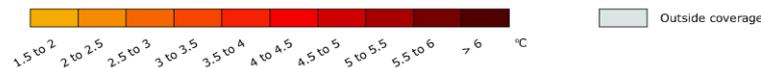
Policy Question: What are the projected changes in temperature and precipitation in Europe?

To answer the PQ we need:

- Reliable multi-model projections by RCMs from EURO-CORDEX
- High spatial resolution datasets to assess regional differences
- RCMs driven by boundary conditions from different GCMs to assess ranges
- Different RCPs
- Projections for the whole 21<sup>st</sup> century
- Annual or seasonally aggregated data
- Bias corrected data in case of projections from impact models



Projected change in annual, summer and winter temperature for the forcing scenarios RCP 4.5 and RCP 8.5



Projected change in annual and summer precipitation (%)



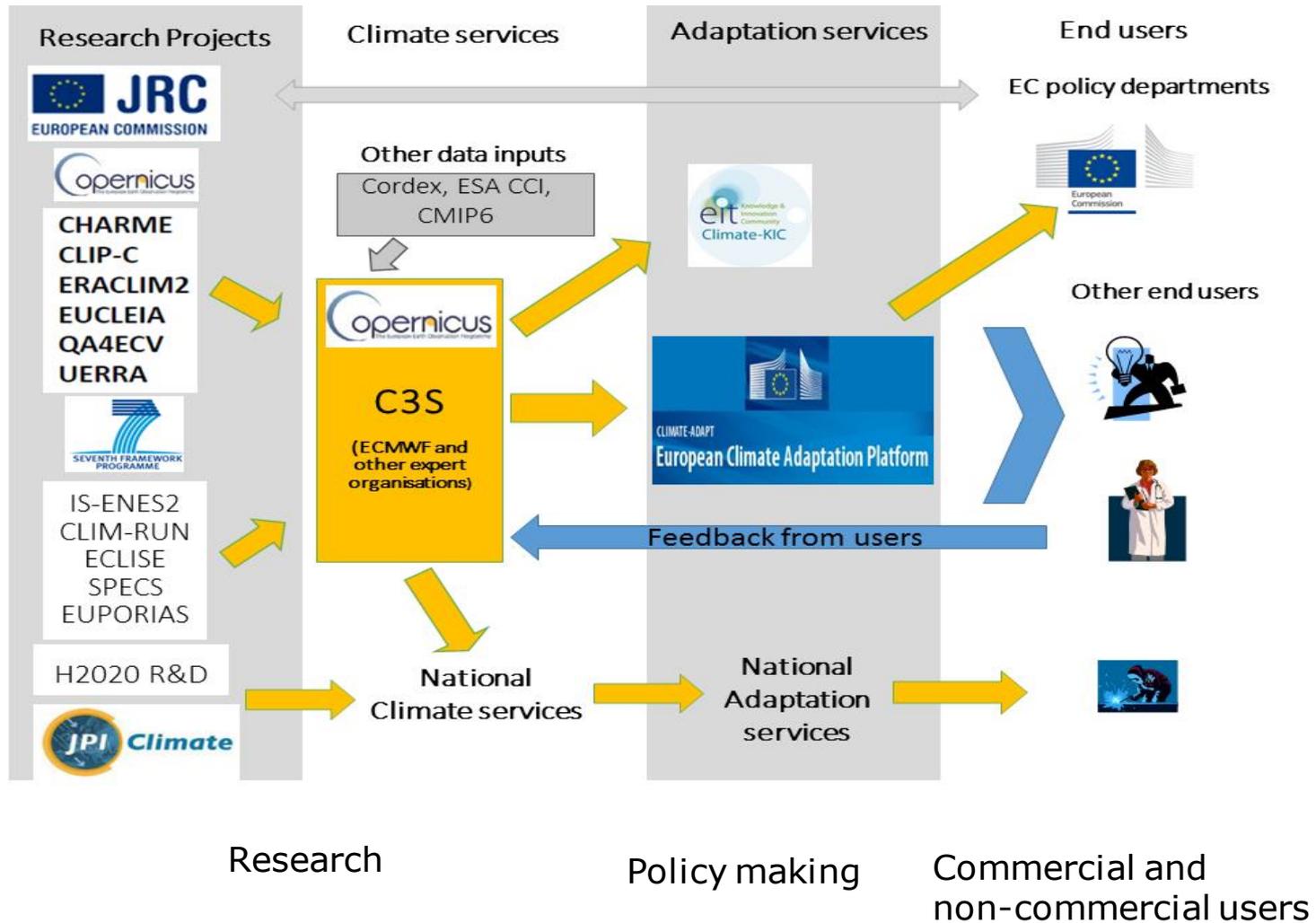
# The European Climate Adaptation Platform (Climate-ADAPT)...

...aims to support Europe in adapting to climate change. It is an initiative of the European Commission and helps users to access and share information on:

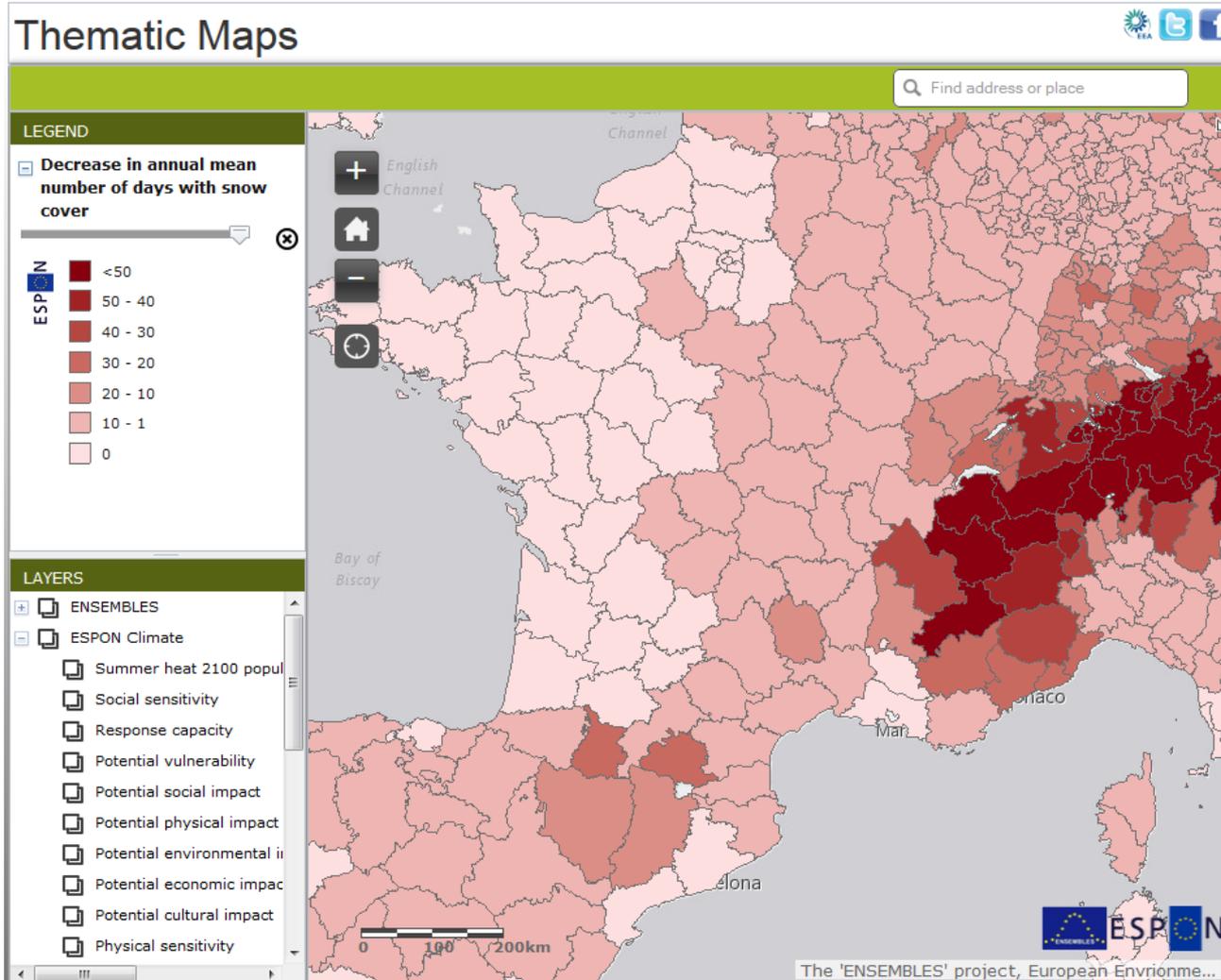
- Expected climate change in Europe
- Current and future vulnerability of regions and sectors
- National and transnational adaptation strategies
- Adaptation case studies and potential adaptation options
- Tools that support adaptation planning



# Climate-ADAPT and climate information in Europe



# Presenting thematic maps through the Climate-ADAPT mapviewer



- 70 layers on climate change impacts and vulnerabilities and risks
- 5 data providers
- to support adaptations at various levels

# Conclusions

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- **EEA supports and informs policy development and implementation** (data, indicators and assessments on climate change impacts, vulnerability and adaptation),
- EEA **main audience are policymakers** and EEA **collaborates with member countries** (environment agencies) and with many other organisations,
- **EEA manages** (in collaboration with the European Commission) and **updates the European Climate Adaptation platform Climate-ADAPT** for sharing information and connecting adaptation communities,
- Climate-ADAPT tools like **mapviewer** and **time series tool** could in future include also outputs (like aggregated maps, timeseries of different indices, ...) from C3S,
- EEA climate change impacts **indicators** present both **past trends** and **future projections**,
- **C3S information can contribute**
  - to EEA climate change and impact indicators;
  - to maps on observed and projected climate change in the map viewer of Climate-ADAPT;
  - to searchable database items.

# Thank you

See for more information:

<http://www.eea.europa.eu/themes/climate>

<http://climate-adapt.eea.europa.eu/>

<http://www.eea.europa.eu/soer>



Extra, discard this

# EEA Climate change impact indicators

## An EEA climate change impact indicator:

- is a measure that can be used to illustrate and communicate complex climate change phenomena in a simple way
- comprises specification and assessment(s) including key messages
- uses quantitative data on observed changes and projections
- includes information on uncertainties
- has policy defined purposes
- uses well defined criteria
- is published on EEA web pages (IMS) and in Climate-ADAPT
- supports development of adaptation policies

The screenshot displays the EEA Indicators web interface. At the top, there is a search bar with the text "Search Europe's environment..." and a "Search" button. Below the search bar, there are navigation tabs for "Topics", "Data and maps", "Indicators", and "Publications". The main content area is titled "Indicators and fact sheets about Europe's environment". A search box contains the text "climate change" and a "Search" button. Below the search box, there are two search results. The first result is titled "Floods and health (CLIM 046) - Assessment published Jan 2015" and includes a small map of Europe. The second result is titled "Arctic and Baltic Sea ice (CLIM 010) - Assessment published Nov 2014" and includes a line graph showing ice cover over time. On the right side of the page, there are several filter panels: "Current search" with options for "Topics", "Results per page", and "Find indicators"; "Published on" with "Start date" and "End date" input fields; and "Topics" with a list of categories including "All (29)", "Agriculture (3)", "Air pollution (1)", "Biodiversity (11)", and "Climate change (49)".

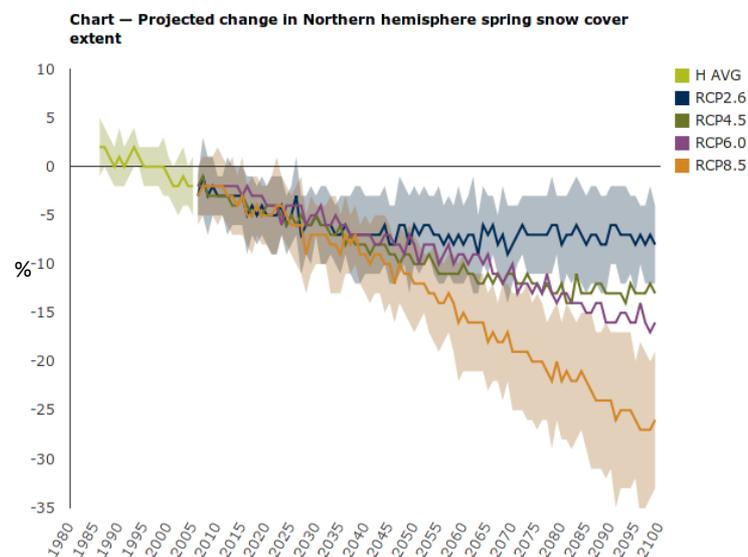
[www.eea.europa.eu/data-and-maps/indicators/](http://www.eea.europa.eu/data-and-maps/indicators/)

# Example: Snow cover

Policy Question: What are the trends and projections in snow cover extent and snow mass in Europe?

To answer the PQ we need:

- Different indices; snow cover extent and snow mass from different sources (GlobSnow project, Global Snow Lab, Laboratoire de Glaciologie et Géophysique de l'Environnement (LGGE))
- Observations are based on in-situ and satellite observations show
- Projections based on GCMs and different RCPs



# Selections of the indicators

## Type:

**Climate variables** (daily min, max, mean air temperature, total precipitation amount, ...)

**Climate indices** (e.g. drought index, cold spell index, soil moisture index, ...)

**in-situ** and/or **modelled** datasets (e.g. animal phenology data, distribution of species)

## Sources:

**Research projects** and programmes (EURO4M, UERRA, EURO-CORDEX, ENSEMBLES...)

**Met** offices and **Climate** Services (ECMWF, UK MO, KNMI, ...)

**Global** and **European** organisations (WHO, ECDC, CRED, JRC, ...)

**Scientific** literature, through scientific databases

## Criteria:

Thematic and policy **relevance**

Scientific **soundness**

Geographical **coverage**

**Appropriate** geographical characterization

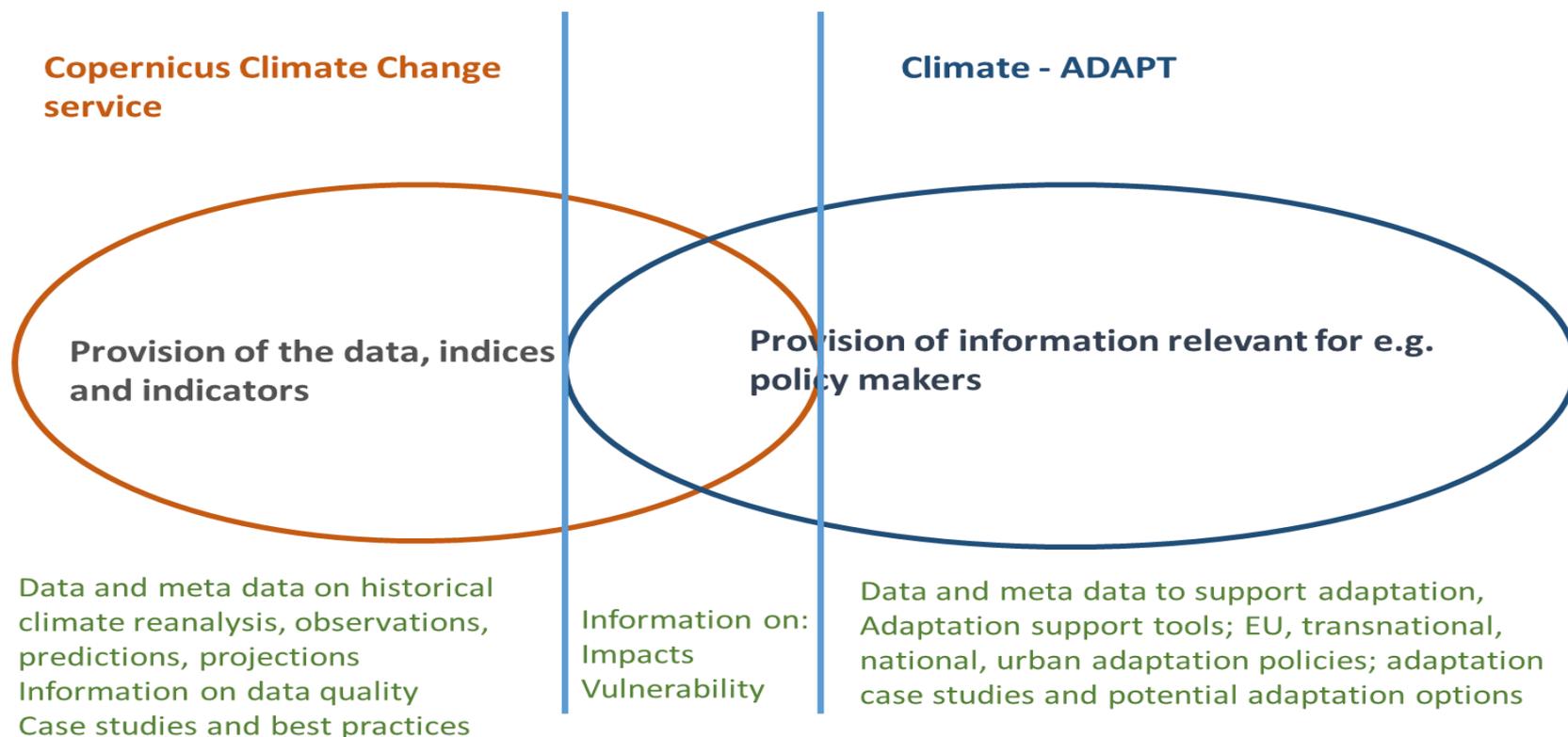
**Long** time series

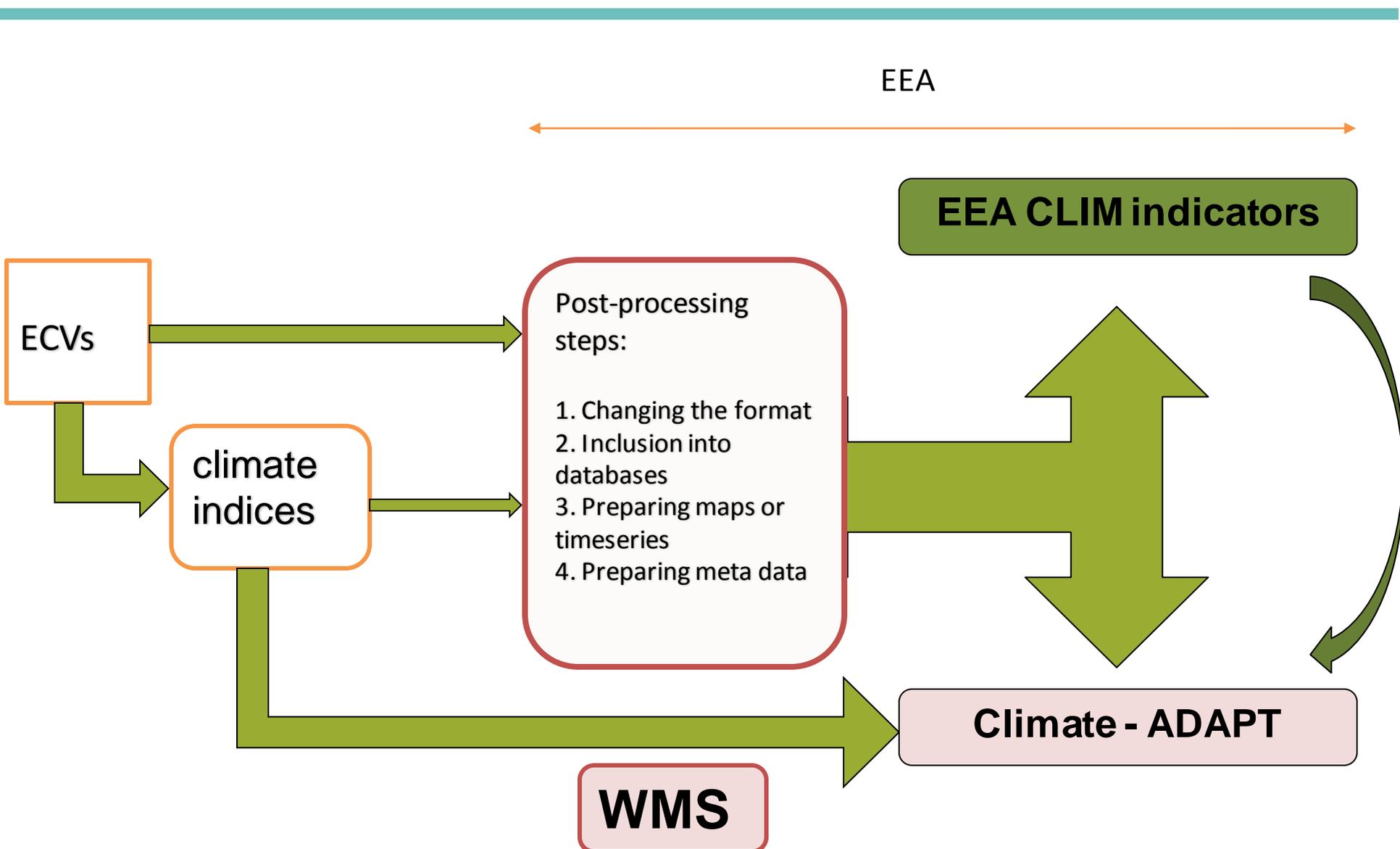
**Reliable** data supply

**Clear** methodology



# Potential linkages between C3S and Climate-ADAPT





EEA

**EEA CLIM indicators**

**climate indices**

**ECVs**

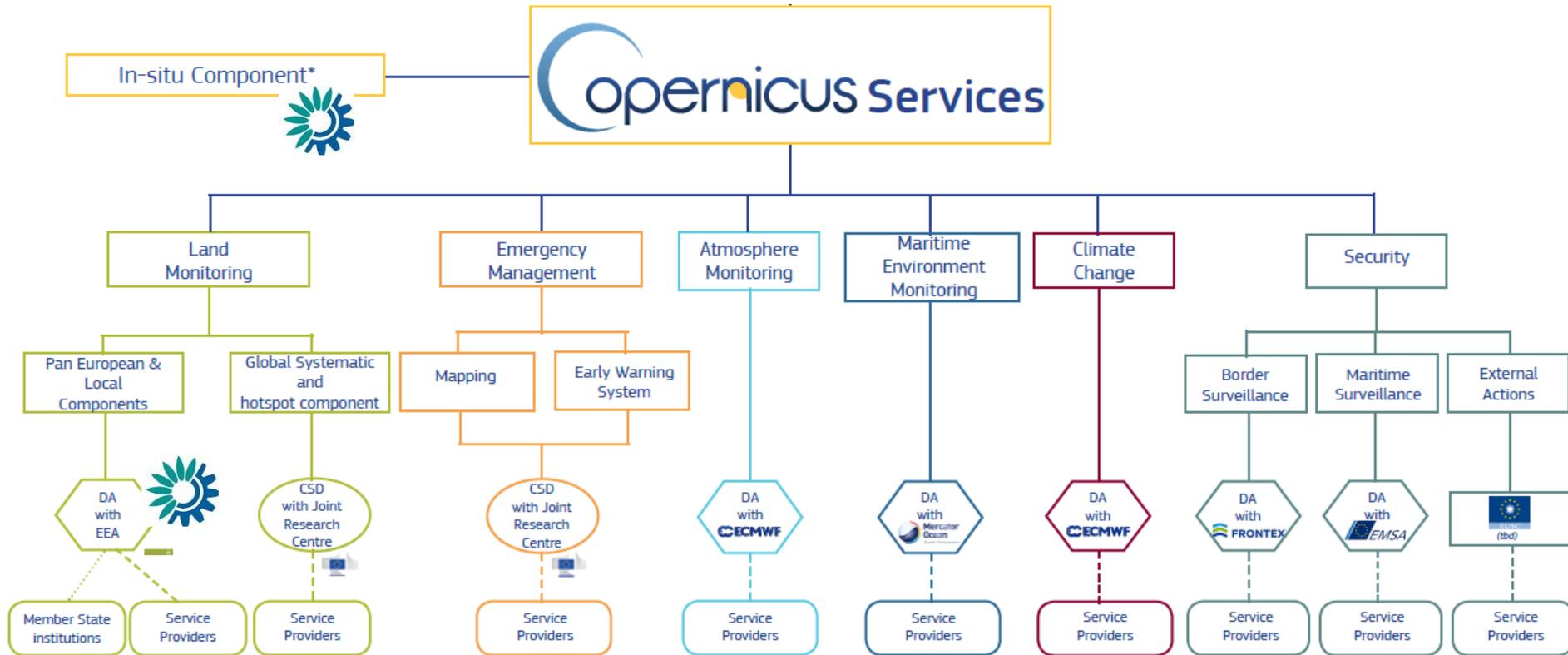
Post-processing steps:

- 1. Changing the format
- 2. Inclusion into databases
- 3. Preparing maps or timeseries
- 4. Preparing meta data

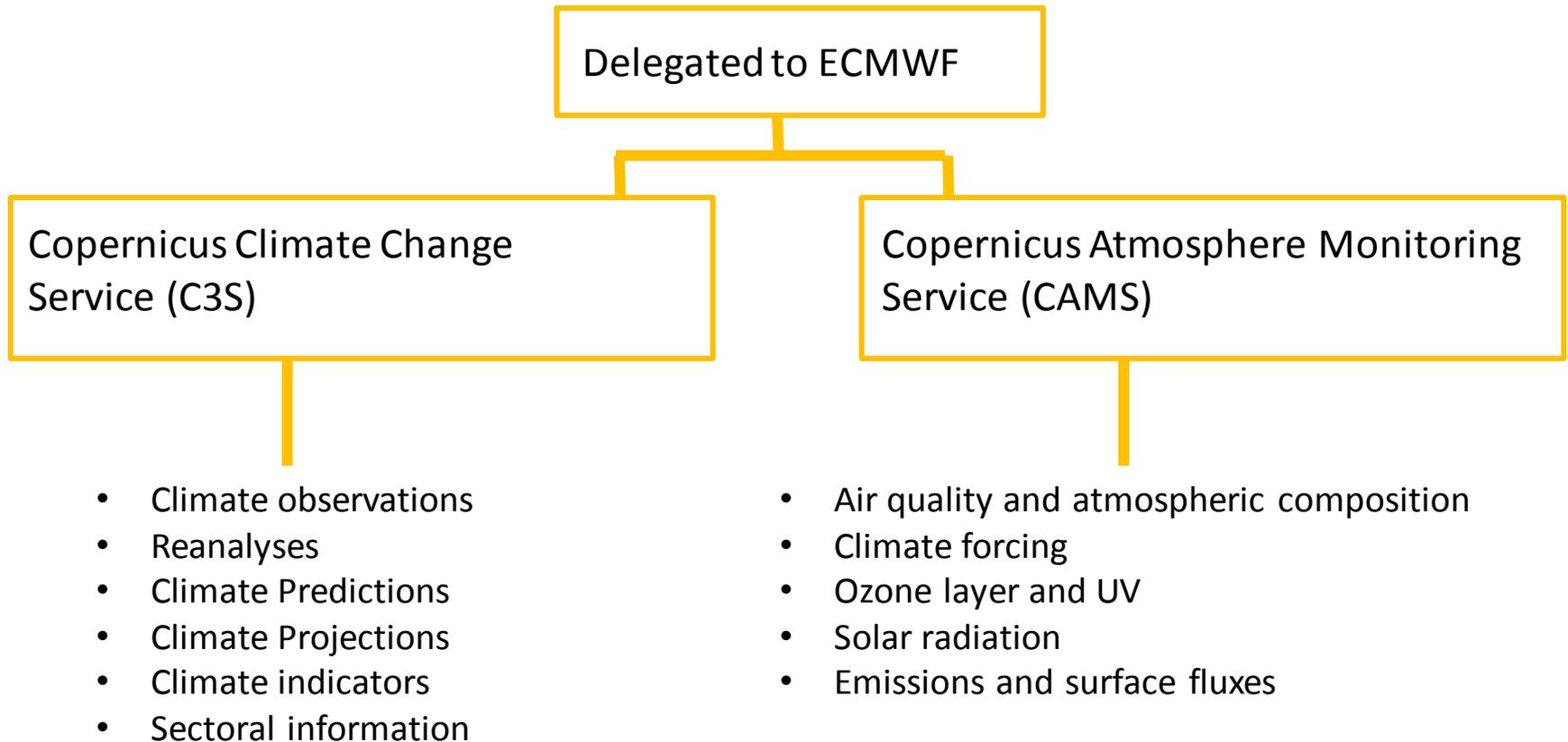
**Climate - ADAPT**

**WMS**

# Copernicus services



# C3S and CAMS



2015-2020

60-70 new staff members

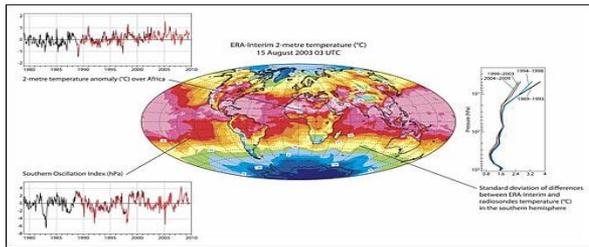
approx. 250 Meuro

approx. 70 % outsourced

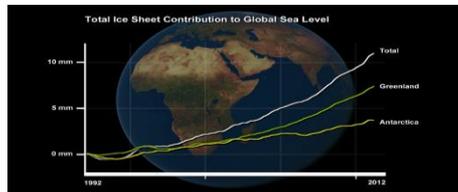
# C3S Service elements

## Series of ECV datasets and climate indicators

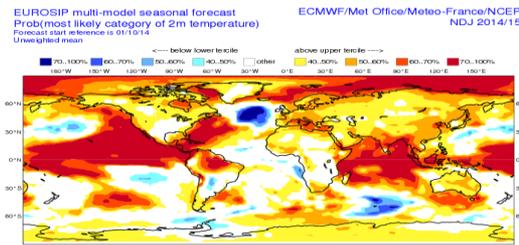
- Observed, reanalysed and simulated
- Relevant to support adaptation/mitigation policies at European level and wider



Reanalyses



Other ECV datasets



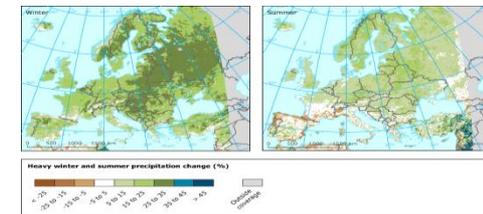
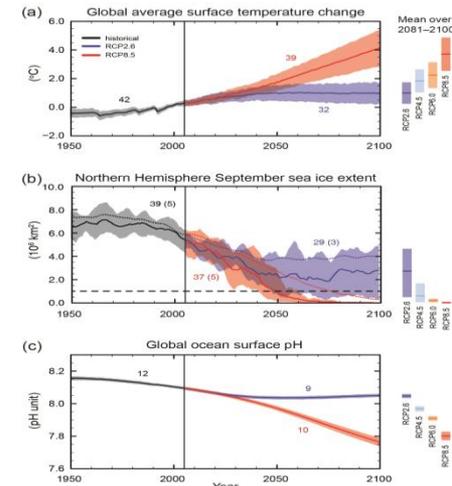
Multi model seasonal forecast products



Data reprocessing



Data collection and data rescue



Climate projections

# Copernicus Climate Change Service: C3S Vision

To be an authoritative source of climate information for Europe

To build upon national investments and complement national climate service providers

To support the market for climate services in Europe

How is the climate changing?

- Observations
- Reanalyses

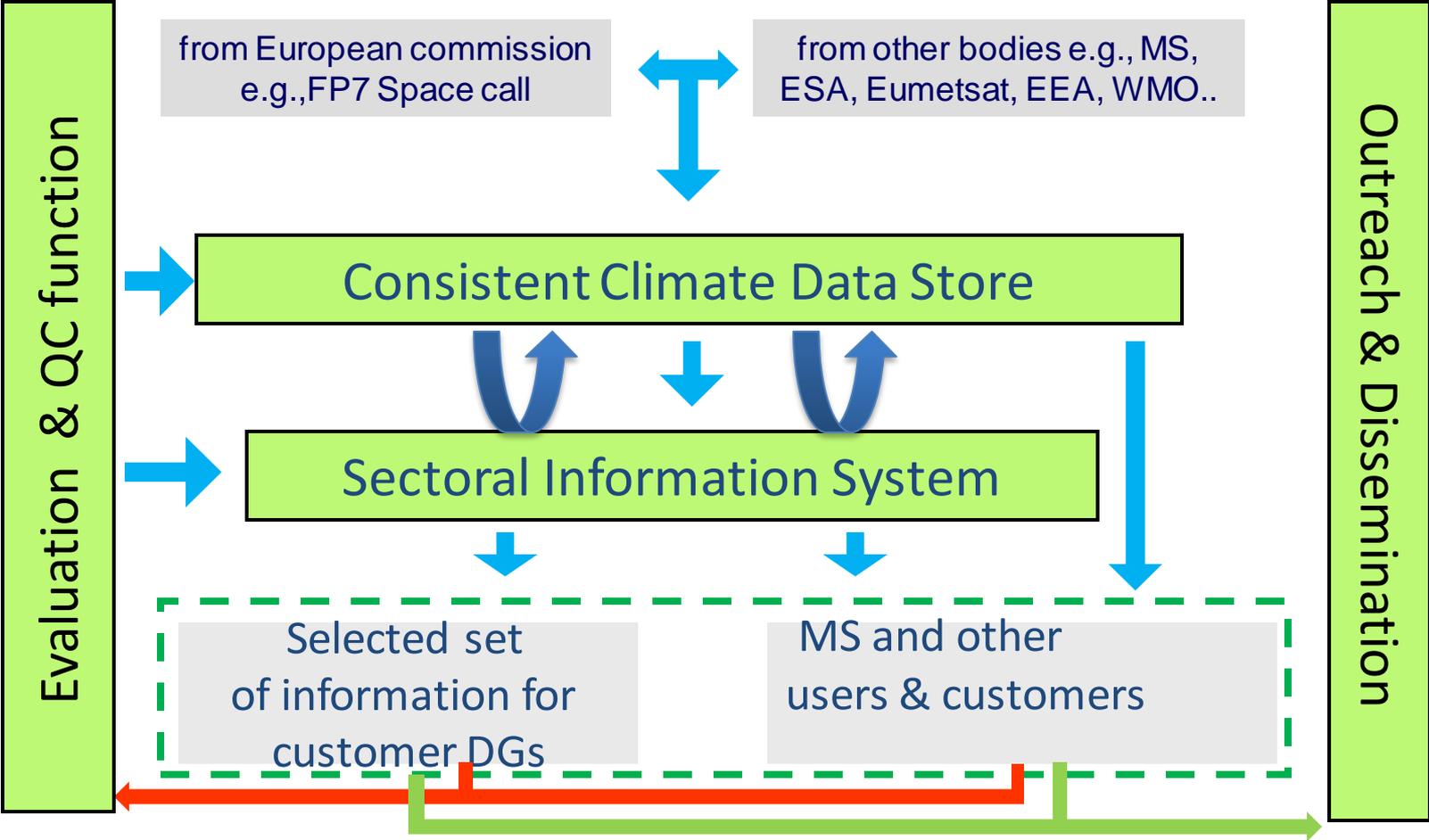
Will climate change continue, accelerate?

- Predictions
- Projections

What are the societal impacts?

- Climate indicators
- Sectoral information

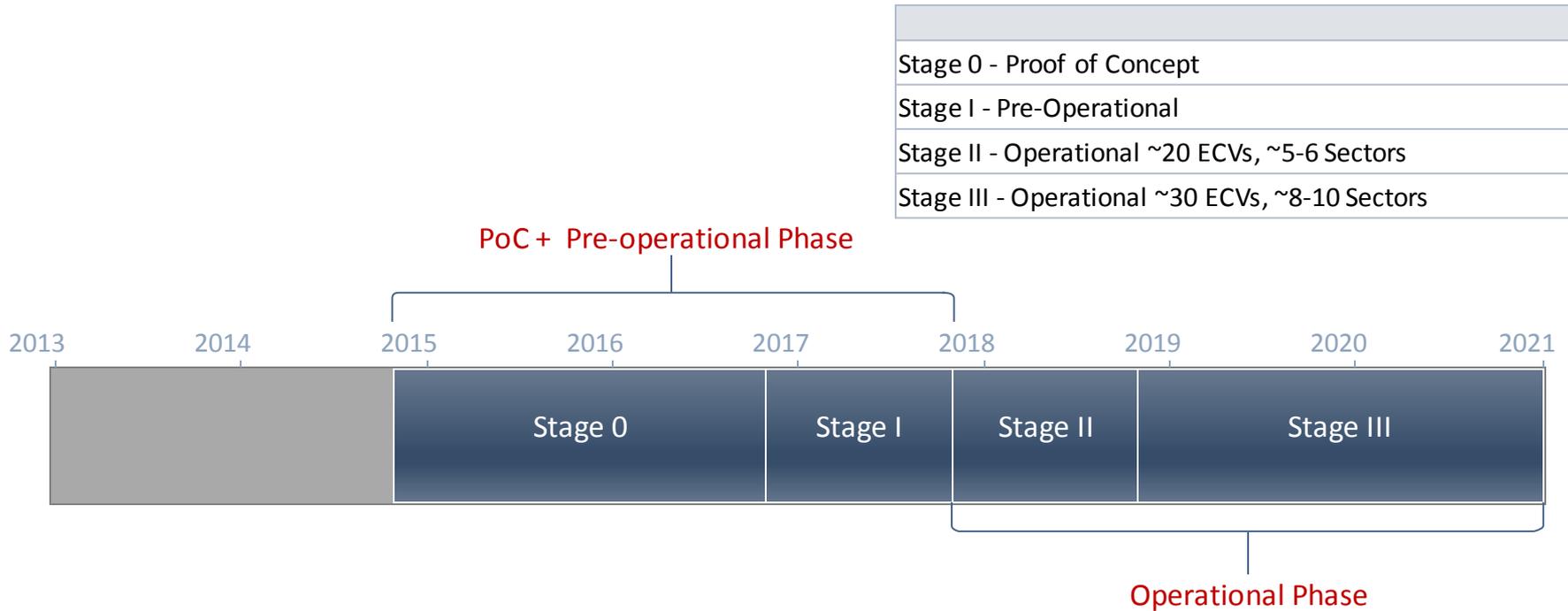
# C3S Architecture



Monitoring, QC of the service and feedbacks to production or R&D

Education, general public and authorities, reports, media, bulletin

# Provisional timing



Consistent Climate Data Store - ~ 30 ECVs & ~ 10 indicators –  
Based on observed, reanalysed and/or model simulated datasets

# Proposed ECVs and Sectoral Information

## Stages I and II

Code	Climate variable
<b>T2m</b>	Surface Air Temperature
<b>Pcp</b>	Surface Precipitation
<b>H2m</b>	Water Vapour (Surface Humidity)
<b>SRB</b>	Surface Radiation Budget
<b>ERB</b>	Earth Radiation Budget
<b>GHG</b>	Carbon Dioxide & Methane
<b>O3A</b>	Ozone & Aerosol
<b>Cld</b>	Cloud Properties
<b>FF&amp;D</b>	Wind speed and direction
<b>D</b>	
<b>OC</b>	Ocean Colour
<b>SIC</b>	Sea Ice
<b>SL</b>	Sea level
<b>SST</b>	Sea Surface Temperature
<b>OHC</b>	Global Ocean Heat Content
<b>Snow</b>	Snow Cover
<b>Gla</b>	Glaciers and Ice Caps
<b>Alb</b>	Albedo
<b>FPR</b>	Fraction of Absorbed Photosynthetically Active Radiation (FAPAR)
<b>FID</b>	Fire Disturbance
<b>IcS</b>	Ice Sheets

## Stages III

Code	Climate variable
<b>UaT</b>	Upper Air Temperature
<b>LLGG</b>	Other Long-Lived Greenhouse Gases
<b>ppCO2</b>	Carbon Dioxide Partial Pressure
<b>OA</b>	Ocean Acidity
<b>OC</b>	Ocean Currents
<b>OS</b>	Ocean Salinity
<b>La</b>	Lakes
<b>PsFg</b>	Permafrost and seasonally frozen ground
<b>LC</b>	Land Cover (including Vegetation Type)
<b>LAI</b>	Leaf Area Index (LAI)
<b>SM</b>	Soil Moisture

Sectors
Water managements
Energy
Agriculture and forestry
Coastal areas
Health
Marine & Fisheries
Biodiversity
.....

Stage II

Stage III

Each sector will be addressed by several indicators (indices)

# EEA needs for Copernicus climate change service

- **Climate-ADAPT:**

- provision of climate indices and ECVs on observations
- C3S products needed: **maps and time series of climate indices**

- **EEA climate change impacts indicator and assessments:**

- ECVs underpin various climate change impact indicators
- C3S products needed: **Long time series of observed changes** in mean and extremes; **multi-model projections** of climate indices (mean + extreme values). Relatively low spatial resolution, but long time series in daily time steps (in order to assess extreme values).
- Possibly in **future collaboration on 'state and impacts of climate change reports'**

- **EEA ecosystems assessments, including environmental accounts:**

- C3S products needed: observed data in **high spatial resolution; short annually/seasonally** aggregated time series

# EEA indicators and ECVs

<i>Indicator name</i>	<i>ECV or climate index</i>
Global and European Temperature	T2m
Temperature extremes	T2m
Mean precipitation	Pcp
Precipitation extremes	Pcp
Storms	FF&DD
Snow cover	Snow
Greenland ice sheet	IcS
Glaciers	Gla
Permafrost	Permafrost and seasonally frozen ground(stage III)
Arctic and Baltic sea ice	SIC
Ocean acidification	Ocean Acidity (stage III)
Ocean heat content	OHC
Sea surface temperature	SST
Phenology of marine species	SST
Distribution of marine species	SST
Global and European sea level rise	SL

<i>Indicator name</i>	<i>ECV or climate index</i>
Storm surges	SL, FF&DD
Soil organic carbon	LAI, FPR
Soil erosion	Pcp, LAI
Soil moisture	Soil moisture (stage III)
Growing season for agricultural crops	LAI, FPR
Agrophenology	LAI, FPR
Water-limited crop productivity	Crop moisture index (stage II), Soil moisture (stage III)
Irrigation water requirement	Crop moisture index (stage II), Soil moisture (stage III)
Forest fires	Fid
Extreme temperatures and health	Heat stress index (stage II)
Air pollution by ozone and health	O3A
Heating degree days	Residential Energy Demand Temperature index (stage II)



# Climate change, impact and vulnerability indicators on EEA web site (many updated 2013/2014)

Category	Indicators	Category	Indicators
<b>Key climate variables</b>	<ul style="list-style-type: none"> <li>• Global and European Temperature</li> <li>• Temperature extremes</li> <li>• Mean precipitation and Precipitation extremes</li> <li>• Storms</li> </ul>	<b>Soil</b>	<ul style="list-style-type: none"> <li>• Soil organic carbon</li> <li>• Soil erosion</li> <li>• Soil moisture</li> </ul>
<b>Cryosphere</b>	<ul style="list-style-type: none"> <li>• Snow cover</li> <li>• Greenland ice sheet</li> <li>• Glaciers</li> <li>• Permafrost</li> <li>• Arctic and Baltic sea ice</li> </ul>	<b>Agriculture</b>	<ul style="list-style-type: none"> <li>• Growing season for agricultural crops</li> <li>• Agropenology</li> <li>• Water-limited crop productivity</li> <li>• Irrigation water requirement</li> </ul>
<b>Oceans, marine environment, coastal areas</b>	<ul style="list-style-type: none"> <li>• Ocean acidification</li> <li>• Ocean heat content</li> <li>• Sea surface temperature</li> <li>• Phenology of marine species</li> <li>• Distribution of marine species</li> <li>• Global and European sea level rise</li> </ul>	<b>Forests and forestry</b>	<ul style="list-style-type: none"> <li>• Forest growth</li> <li>• Forest fires</li> </ul>
<b>Freshwater quantity and quality</b>	<ul style="list-style-type: none"> <li>• River flow</li> <li>• River floods</li> <li>• River flow drought</li> <li>• Water temperature</li> <li>• Lake and river ice cover</li> </ul>	<b>Human health</b>	<ul style="list-style-type: none"> <li>• Floods and health</li> <li>• Extreme temperatures and health</li> <li>• Air pollution by ozone and health</li> <li>• Vector-borne diseases</li> </ul>
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		<b>Vulnerability/risks</b>	<ul style="list-style-type: none"> <li>• Damages from weather and climate events</li> </ul>

# Next steps/open questions

- Joint (working) paper on links between C3S and EEA activities
- Call for experts to evaluate tenders (EEA involvement?)
- Climate-ADAPT mentioned in various C3S documents?
  - Prior Information Notice on Proof-of-concept of the Sectoral Information System.
- Working with ECMWF to and with various C3S contractors in initial stages
  - shaping C3S outputs to fit EEA needs before becoming final deliverables
- Collaboration in practice?
  - Jean-Noel Thepaut (director of C3S) is the contact point
  - Attendance to various meetings and workshops
  - possibly exchange of staff?
  
  - involvement of DG Clima
  - possibly also involving pre-operational projects
  - is a new exchange forum required?
  
  - involvement of EIONET: presentation by Jean-Noel Thepaut at the EIONET meeting in June



# Links between C3S and EEA

EEA Climate-ADAPT is one of the prime user of C3S

- Authoritative datasets (observed and projected)
- From CDS and also from SIS

Climate-ADAPT could be a vehicle to reach out with the EU DGs (DG Climate Action and others). JRC can also play a significant role.

Climate-ADAPT could provide access to socio-economic datasets required by the SIS?

C3S boundaries: European level - Climate-ADAPT boundaries: covers national and local?

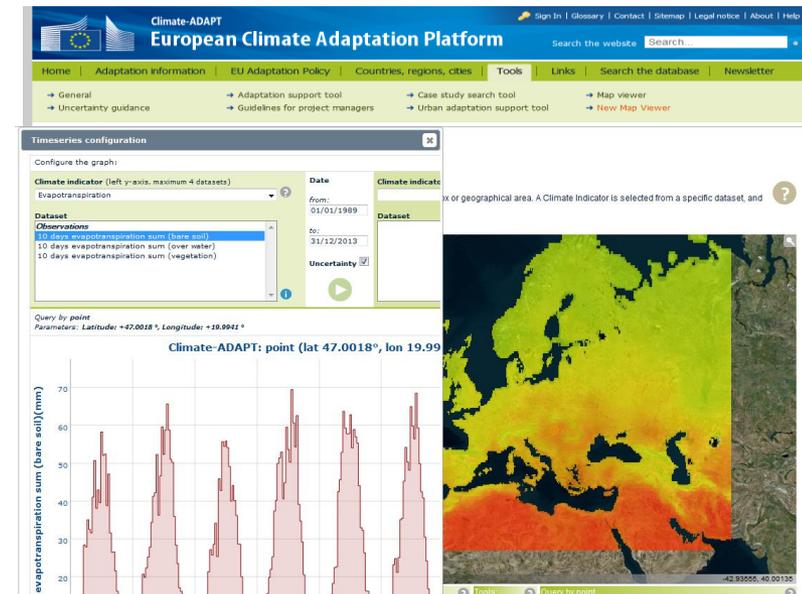
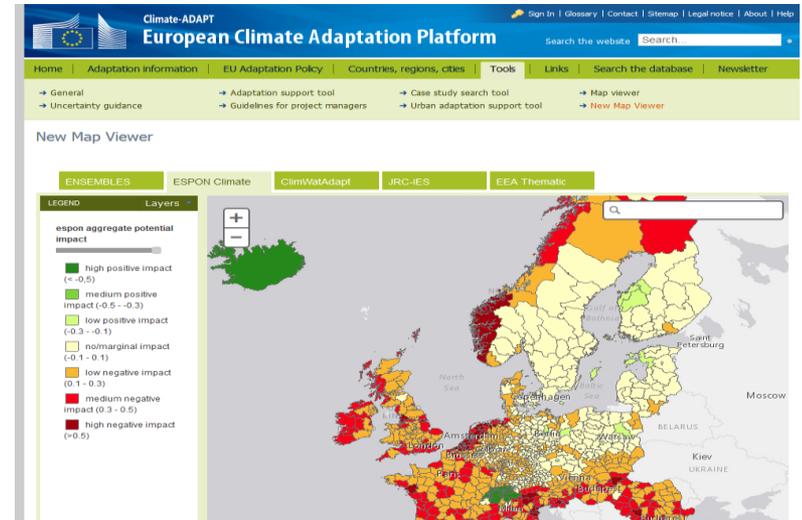
What needs to be further discussed:

- The grey zone (Information on impacts)
- The role of each Web portals
- The respective users (incl. downstream services and market at large) and associated outreach activities

# Climate observations and projections in Climate-ADAPT

- Map viewer and time series tool
- Spatial information on different ECVs and indices including time series
- Raster and vector maps with climate indices
- Various types of data providers
- Data stored at the source
- Combining different datasets in one map
- Next steps/future developments:
  - EEA to decide on some IT/GIS improvements
  - Discuss with C3S how to link to C3S, evaluate options and how to collaborate in practice
  - Over longer term EEA to decide how much to develop further or to rely primarily on C3S

See: <http://climate-adapt.eea.europa.eu/tools/general>



# Climate change, impact and vulnerability indicators on EEA web site (many updated 2013/2014)

Category	Indicators	Category	Indicators
<b>Key climate variables</b>	<ul style="list-style-type: none"> <li>• Global and European Temperature</li> <li>• Temperature extremes</li> <li>• Mean precipitation and Precipitation extremes</li> <li>• Storms</li> </ul>	<b>Soil</b>	<ul style="list-style-type: none"> <li>• Soil organic carbon</li> <li>• Soil erosion</li> <li>• Soil moisture</li> </ul>
<b>Cryosphere</b>	<ul style="list-style-type: none"> <li>• Snow cover</li> <li>• Greenland ice sheet</li> <li>• Glaciers</li> <li>• Permafrost</li> <li>• Arctic and Baltic sea ice</li> </ul>	<b>Agriculture</b>	<ul style="list-style-type: none"> <li>• Growing season for agricultural crops</li> <li>• Agrophenology</li> <li>• Water-limited crop productivity</li> <li>• Irrigation water requirement</li> </ul>
<b>Oceans, marine environment, coastal areas</b>	<ul style="list-style-type: none"> <li>• Ocean acidification</li> <li>• Ocean heat content</li> <li>• Sea surface temperature</li> <li>• Phenology of marine species</li> <li>• Distribution of marine species</li> <li>• Global and European sea level rise</li> </ul>	<b>Forests and forestry</b>	<ul style="list-style-type: none"> <li>• Forest growth</li> <li>• Forest fires</li> </ul>
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## Open questions

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