



Climate Change

CRECP

C3S_34a Lot 3 – Copernicus Roadmap for European Climate Projections

Met Office – **Bernd Eggen**, Jane Strachan, Chris Hewitt

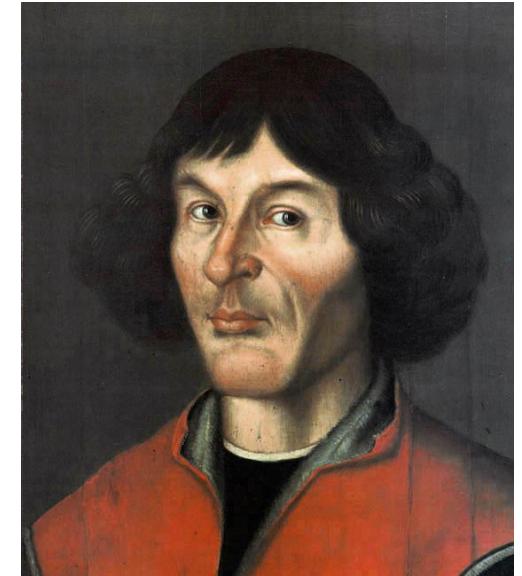
CNRS – Carley Iles, Robert Vautard, Sylvie Joussaume

1st Sept 2016 – 30th Nov 2018



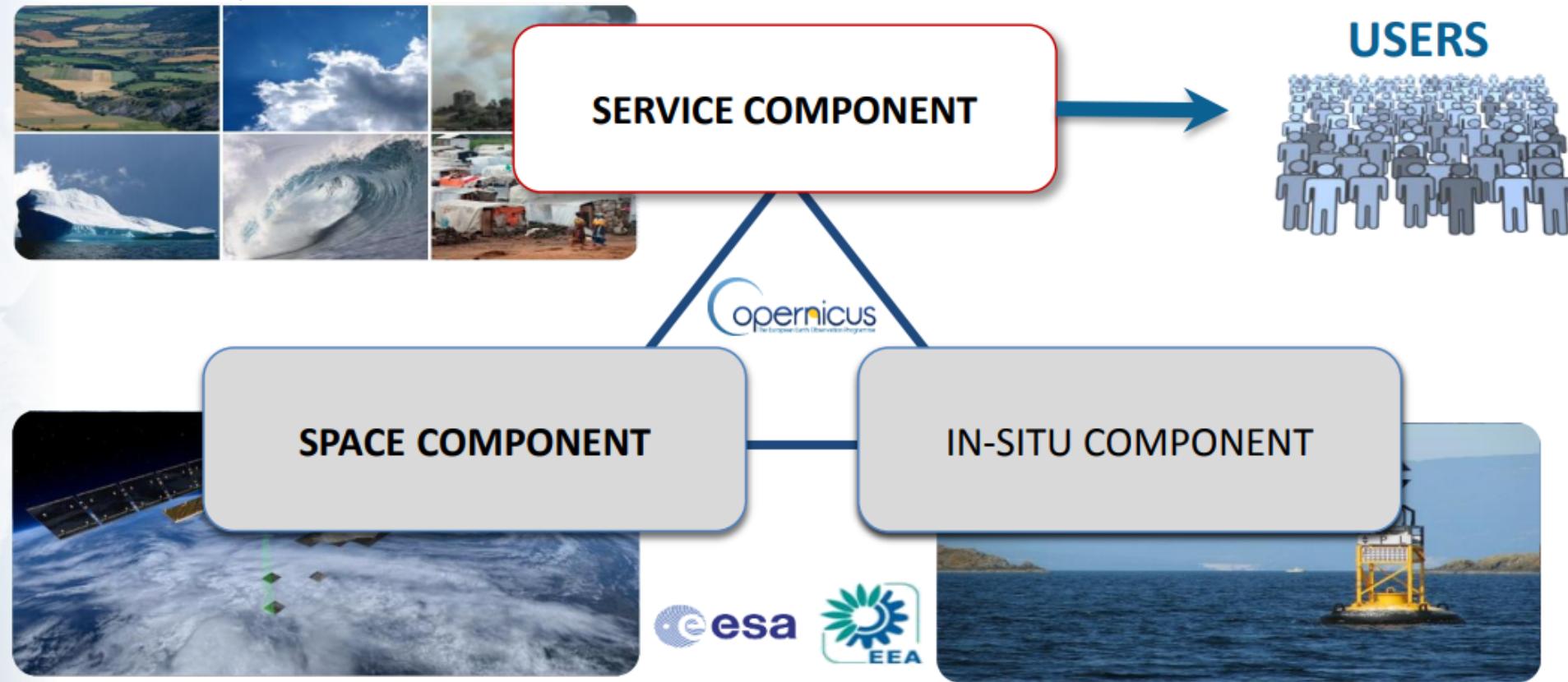


- Copernicus Roadmap for European Climate Projections (**CRECP**)
- WP1: Resolution vs Ensemble Design
- WP2: (Un)initialised near-term Predictions
- WP3: Expert Panel
- European Climate Prediction (**EUCP**) system





Copernicus previously known as GMES (Global Monitoring for Environment and Security), is the European Programme for the establishment of a European capacity for Earth Observation; it is globally the largest Earth Observation project.





Atmospheric Monitoring;



Marine Environment Monitoring;



Land Monitoring;



Climate Change;



Emergency Management;



Security;





Scientific basis:

- Essential Climate Variables as defined by GCOS
- GCOS Status Report and Implementation Plan
- IPCC, CMIP



Action engaged



In preparation
(PIN or ITT out)



Not started

Observations

Global estimates
of ECVs from
satellite and in-
situ observations

Reprocessed
CDRs, reference
observations

Support for data
rescue, climate
data collections

Climate reanalysis

Global atmosphere,
ocean, land

Regional
reanalysis for
Europe

Coupled climate
reanalysis for 100
years

Model output

Multi-model seasonal
forecast products

Access to CMIP
data and
products (global
and regional)

Reference set of
climate projections
for Europe

Climate Indicators



A central deliverable will be the Climate Data Store (CDS)

- not really a “store”, more a sophisticated “broker”
- will contain a “toolbox” which can process data

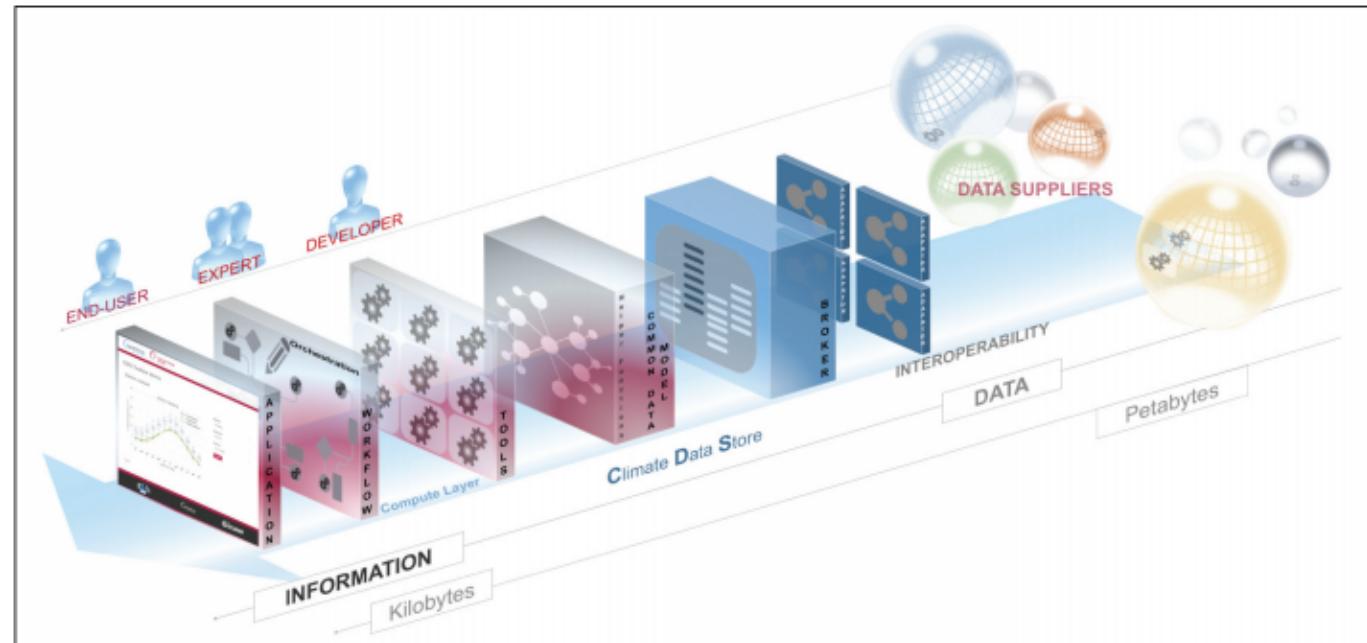


Figure 1 The CDS is designed to meet the needs of different users, including developers, expert users and a wide range of other users, who can interact with the CDS at different levels.



CDS Infrastructure

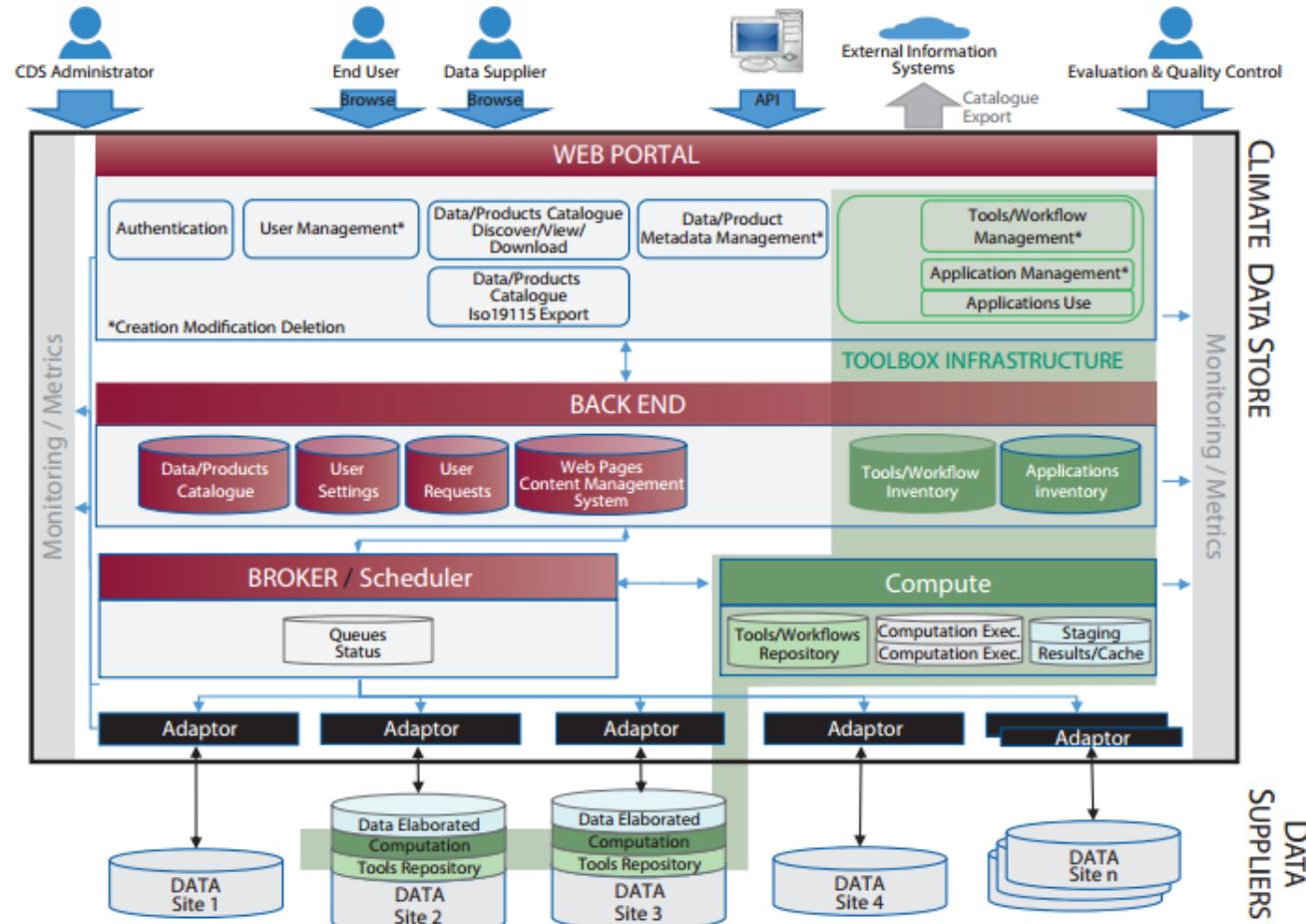
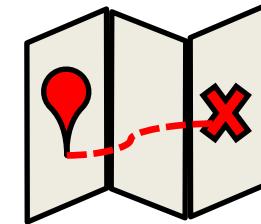


Figure 2 Overview of the CDS infrastructure. The role of each component is described in the text. ECMWF is one of many data sites supplying data to the CDS.



Project Requirements: Roadmap towards a reference set of climate projections for Europe



- *Assess the benefit of additional resources for front-line global simulations, in order to guide requirements for the operational phase of C3S.*
- *Areas of interest:*
 - (a) *comparative benefit of increased ensemble size versus resolution for global models, make explicit links to relevant FP7/H2020 projects and CMIP5/CMIP6 simulations*
 - (b) *the benefit of initialised projections for the first half of the 21st Century, with a focus on advantages and disadvantages of estimating multi-decadal signals in the presence of a drifting model climate.*
–Linking the results to consequences in terms of climate information to be used by sectoral applications and specific needs of different economic sectors.
- *Respond to sectoral (& associated ECV) requirements*
- *Propose a representative set of projections for how the European climate, including extreme events, may change over the next few decades, highlighting requirements for additional simulations*



CRECP approach

Impact of
model design
on climate
projections

Assess sectoral
requirements &
application of
projections

WP1
Review & analysis:
resolution vs
ensemble design

WP2
Review & analysis:
initialisation vs non-
initialisation

WP1&2 Case study development
End-to-end assessment of phenomena
simulation/projection relevant to sectoral
application

WP3
Advisory Board
Expert engagement

Roadmap: to advise on best use of
resource for global simulations
suitable for operational EUCP

Draw on existing/
upcoming climate
modelling
programmes/
projects (e.g.
CMIP5/6
FP7/H2020)

Consult climate-
sensitive sectors
via C3S/other
European projects

Draw from scientific
expertise from
across Europe



Work Package 1: Resolution vs Ensemble Design

Undertake research and analysis into the **comparative advantages/disadvantages** of increased **model resolution versus increased ensemble size** in the simulation of **climate scenarios**.

Project/
programme

Met Office
Teams

Resolution

CMIP5
CMIP6 HighResMIP
H2020 PRIMAVERA
PRACE-UPSCALE
NCAR CESM1
EURO-CORDEX

Ensemble Design

CMIP6 (MME)
CMIP5 (MME)
UKCP09/18
HadGEM3/QUMP (PPE)
NCAR CESM
EC-Earth
MPI large ensemble

Global High
Resolution
Modelling Team

Understanding
Climate Change

Monthly to
Decadal
Prediction Team

UKCP18 Team

Scenarios
Development

Quantifying
Uncertainty



Project/
programme

Met Office
Teams

Work Package 2: Initialised vs non-initialised

Undertake research and analysis into the **comparative advantages/disadvantages** of using **initialized vs. non-initialized scenario simulations for the period 2021-2050.**

Decadal Climate Prediction Project – CMIP6

Multi-Model Decadal Forecast Exchange

SPECS – FP7 (Seasonal to decadal climate prediction)

DePreSys (initialised decadal prediction system)

UKCP18 (non-initialised plus assessment of initialised)

GLOSEA (initialised)

Monthly to
Decadal
Prediction Team

UKCP18 Team

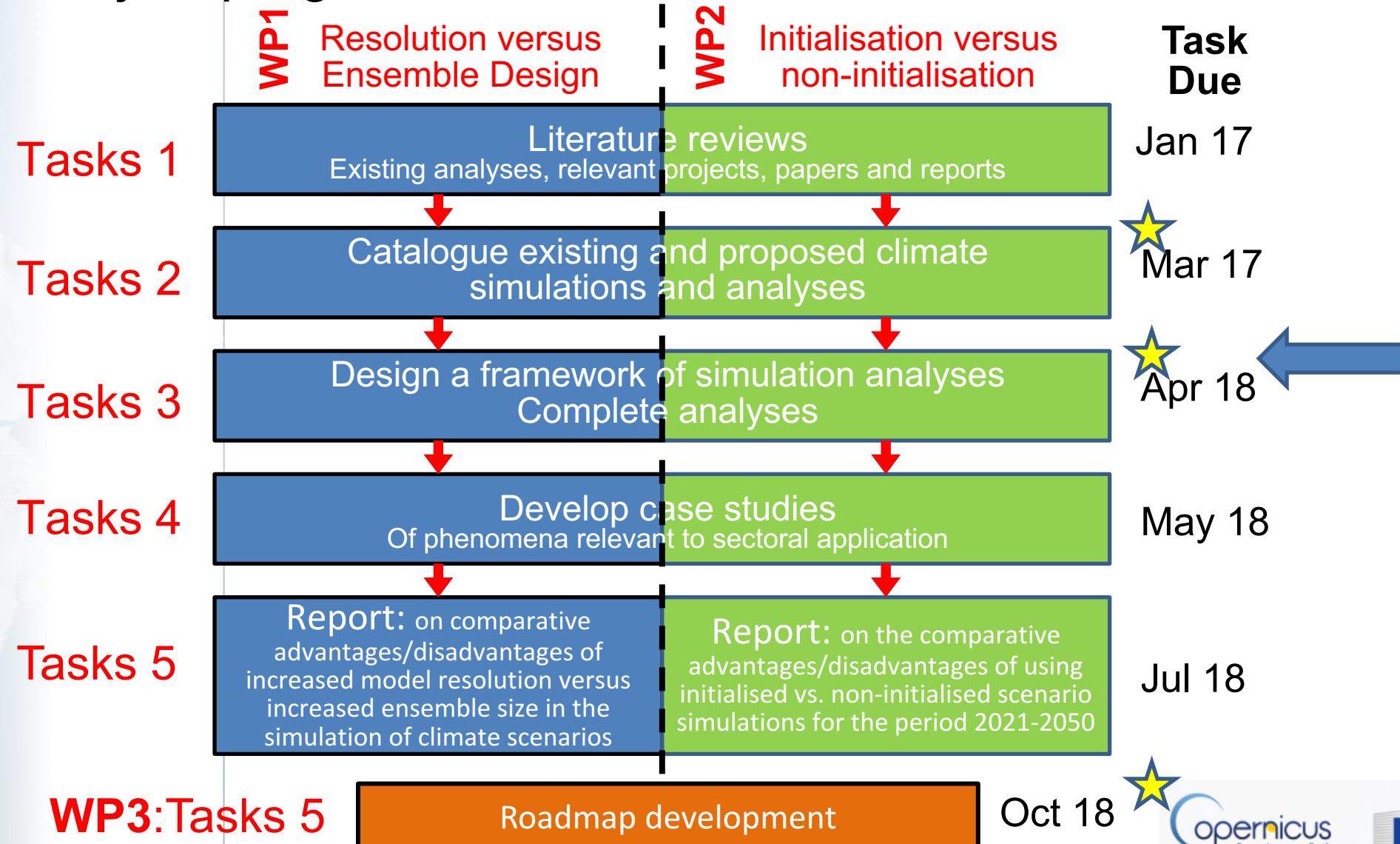
Understanding
Climate Change

DePreSys

Scenarios
Development



Project progress





Analysis Framework

- Focus on (but not limited to) three phenomena, selected due to their impact on European economic sectors:
 - **Intense precipitation**
 - **European windstorms**
 - **Summer heatwave and drought**
- Analysis will examine the results of previous studies, complemented by our own analysis across projects
- A consistent analysis approach will allow comparative assessment of what is gained in terms of simulation capability



Resolution vs Ensemble Size/Design

- Statistics of extremes
 - (return levels/periods, biases, timing etc)
- Processes (if time)
 - Atmospheric blocking, weather regimes, storm tracks, jet stream, land-surface feedbacks
- 3 experiments:
 - Global high vs low resolution
 - Regional high resolution vs driving models
 - Ensemble size/ design - subsampling of CMIP5/CESM large ensemble



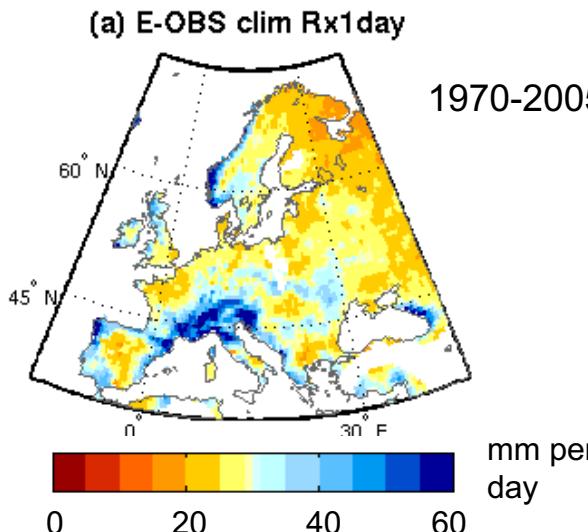
Climate
Change

Regional vs global high resolution

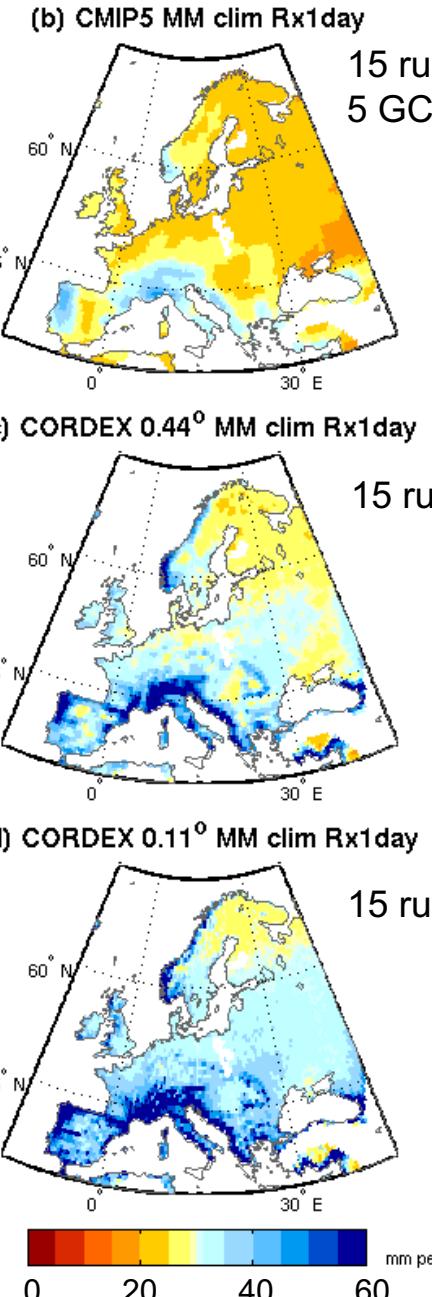
CORDEX 0.11° and 0.44° resolution vs driving CMIP5 GCMs

Precipitation extremes

Rx1day, Rx5day : annual maximum daily (or 5 day) precipitation

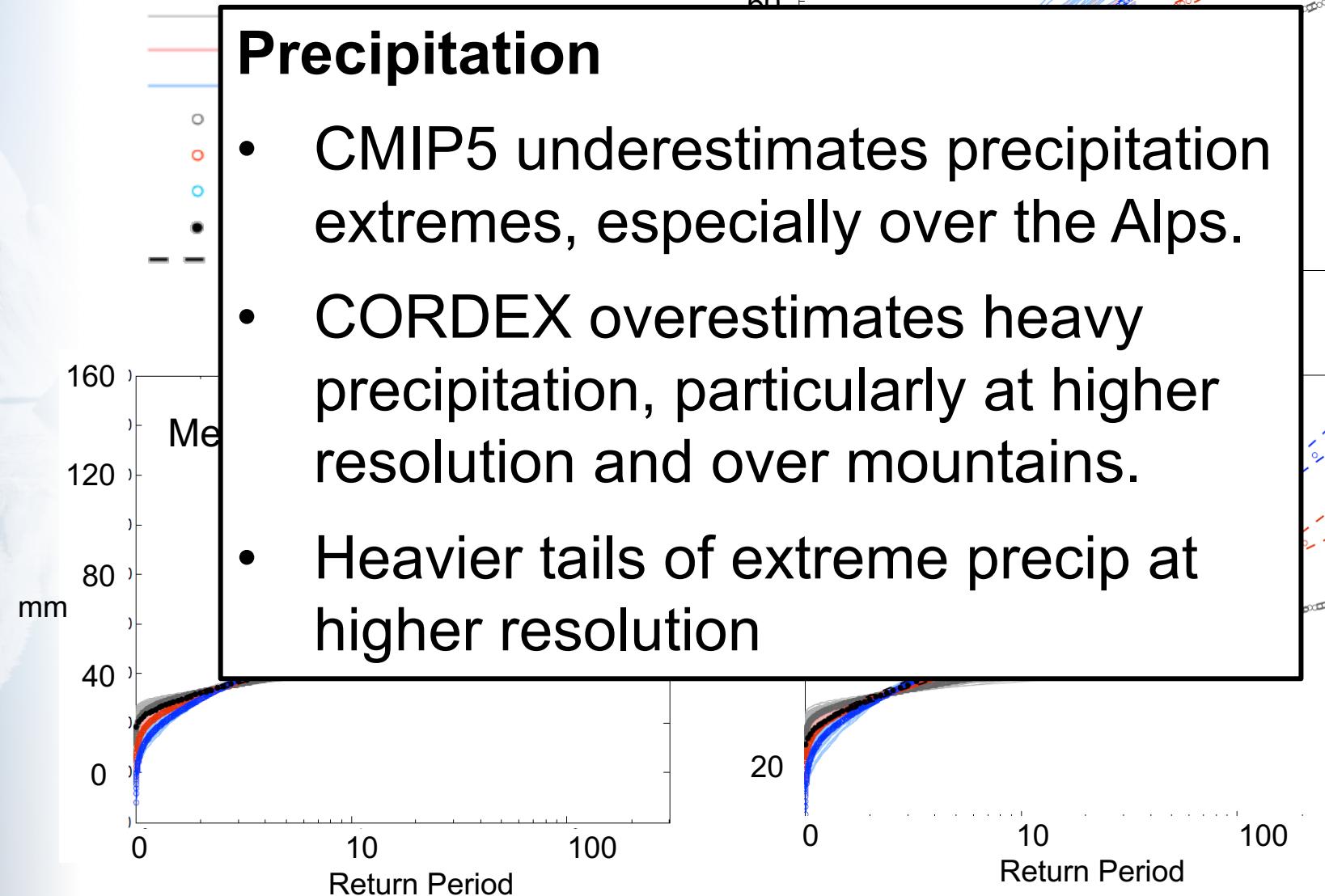


Climatology





Precipitation Extremes: Rx1day





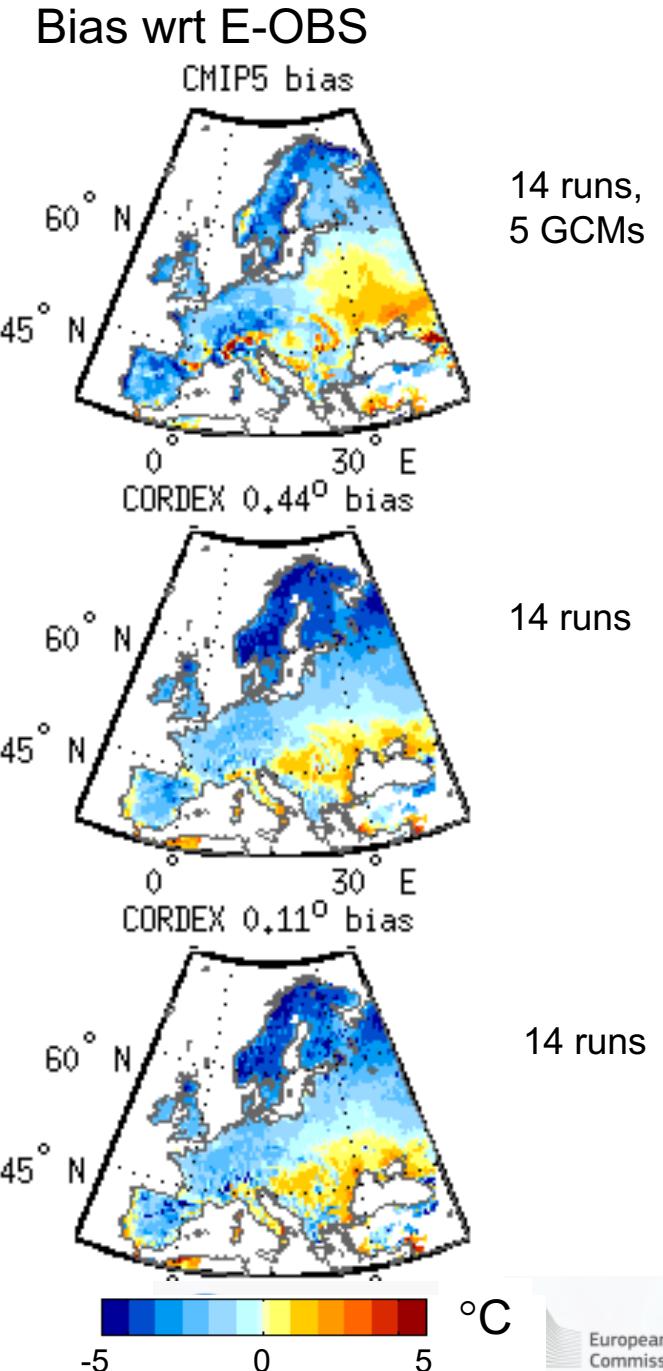
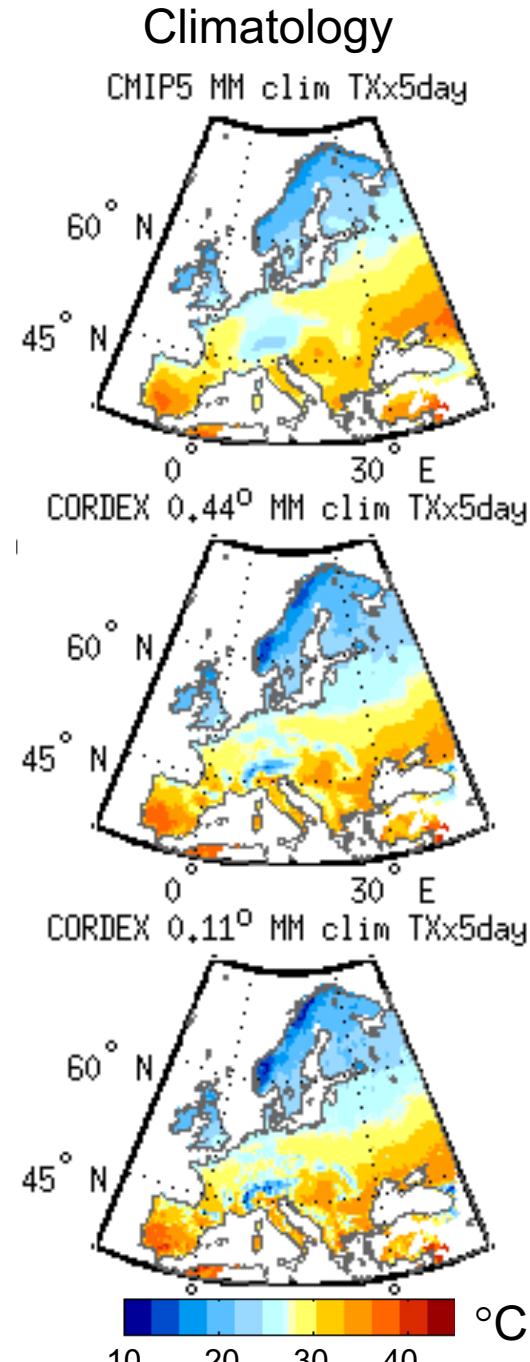
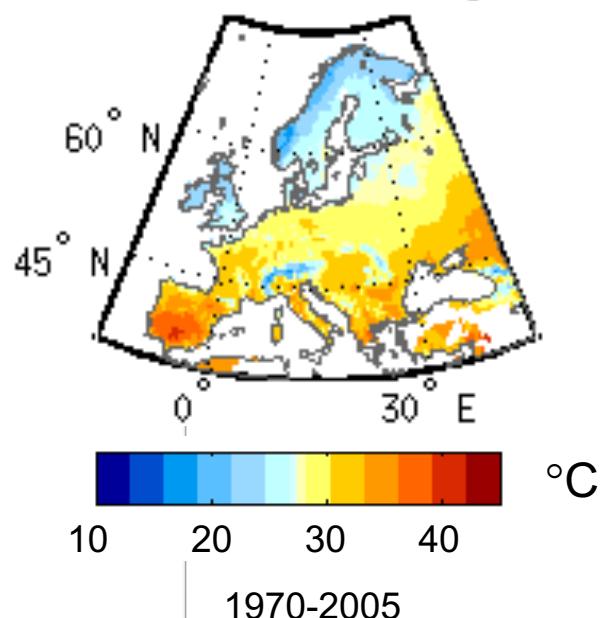
Climate
Change

Temperature extremes

- TXx and TXx5day

Annual maximum of daily
(or 5 day) max
temperature

- E-OBS clim TXx5day



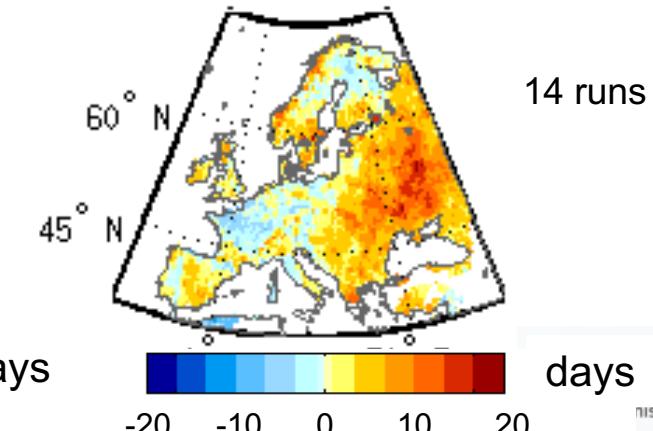
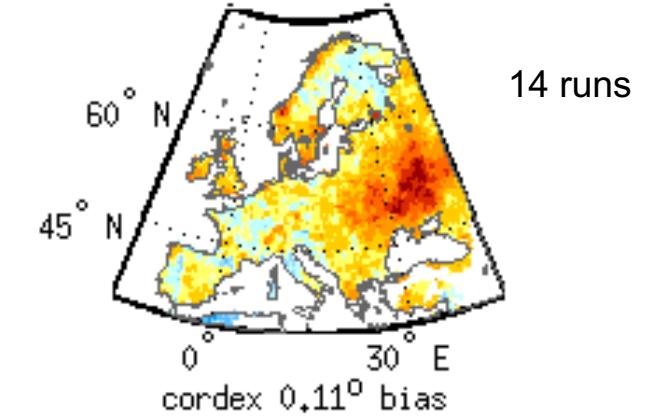
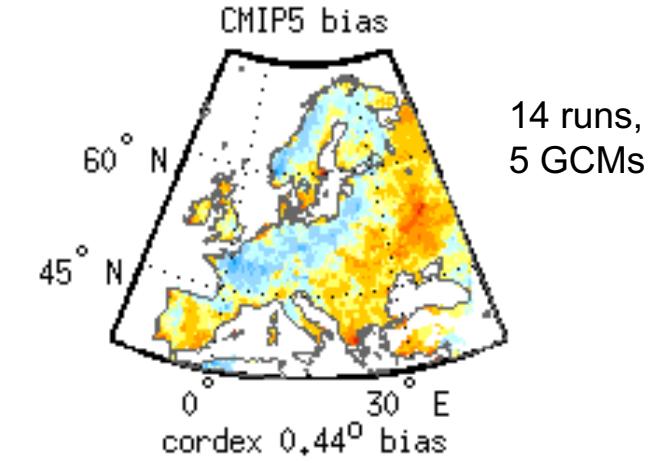
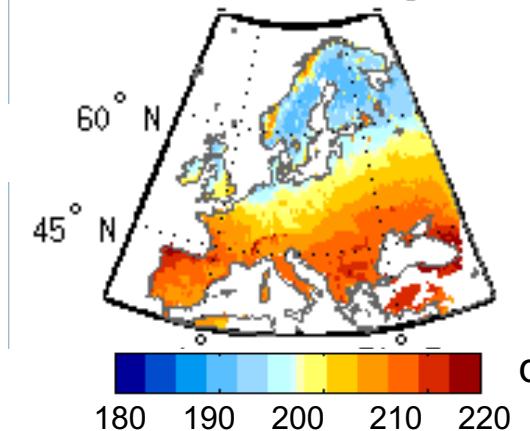
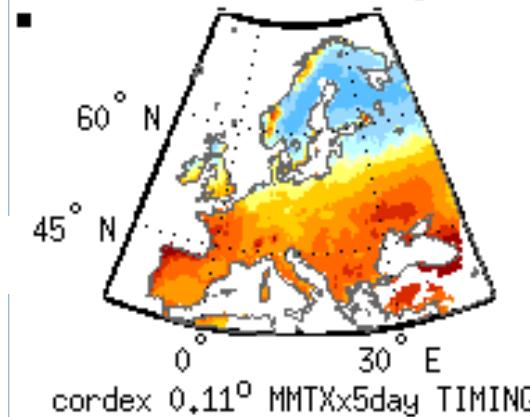
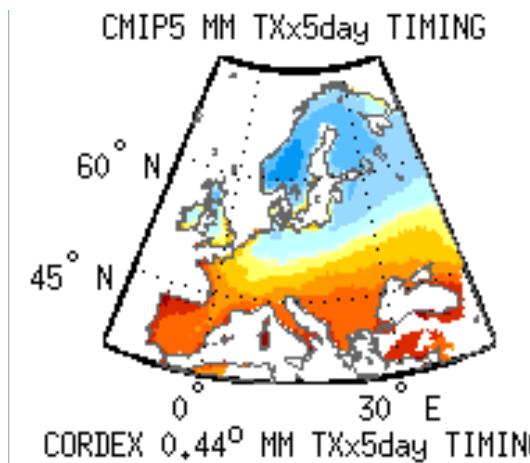
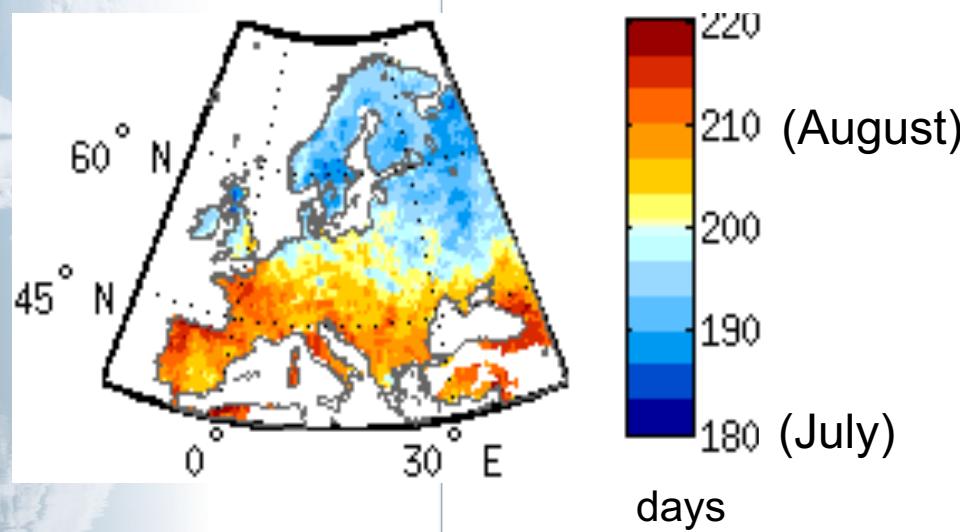


Climate
Change

Temperature extremes

- Timing of TXx5day

EOBS (1970-2005 mean timing)

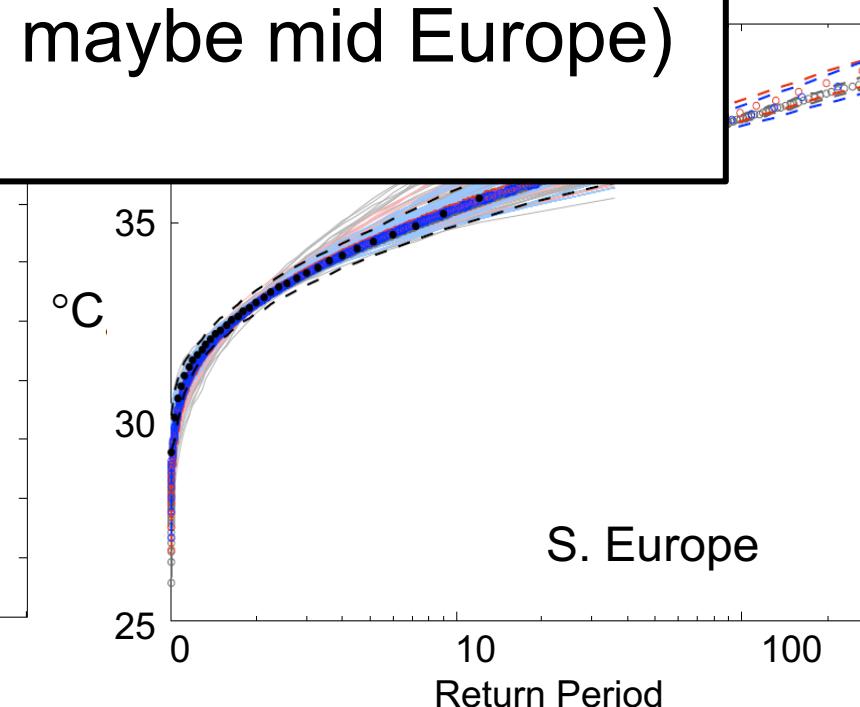
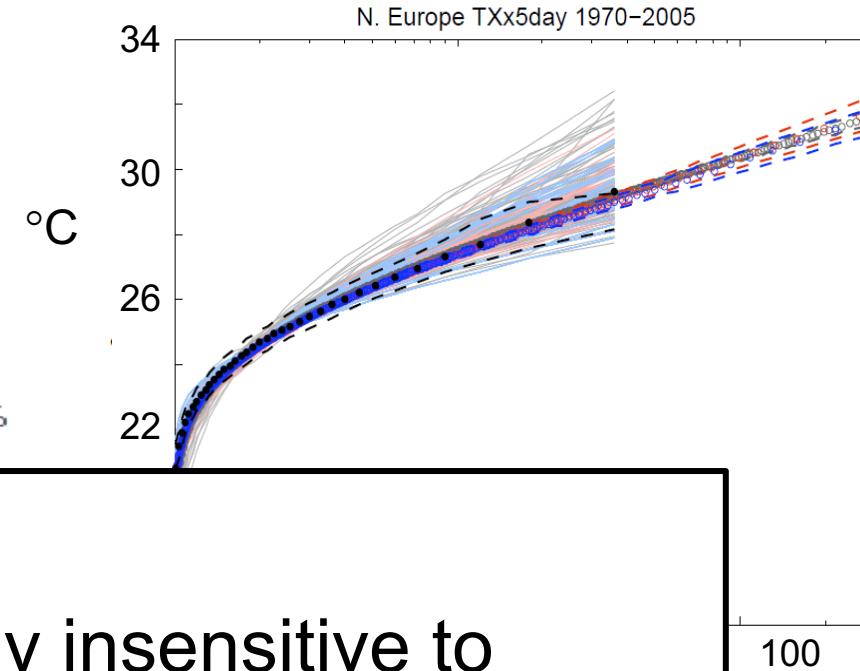
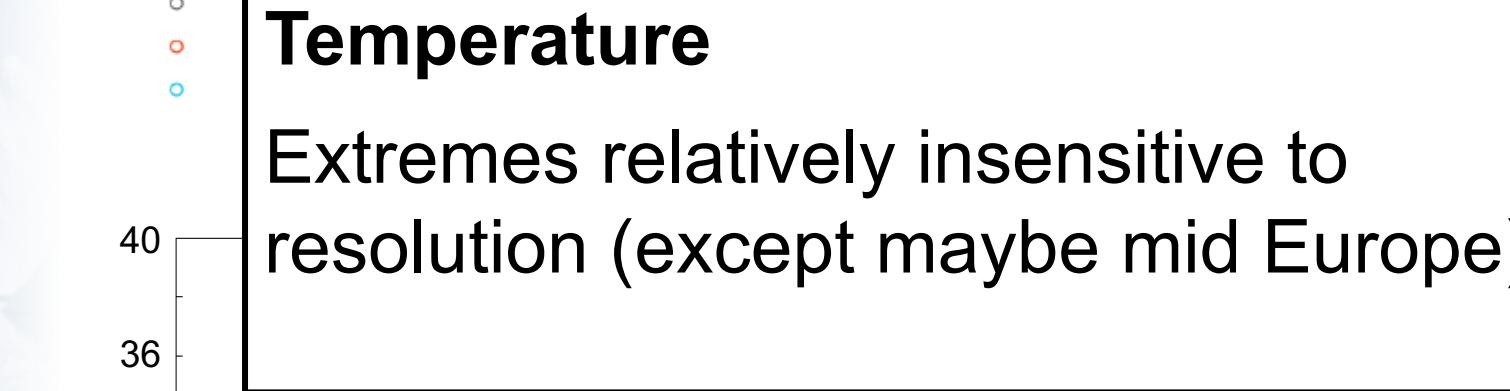




Temperature Extremes: TXx5day

CMIP5
CORDEX 0.44
CORDEX 0.11

• E-Obs
- - - E-OBS 5-95%





Climate
Change

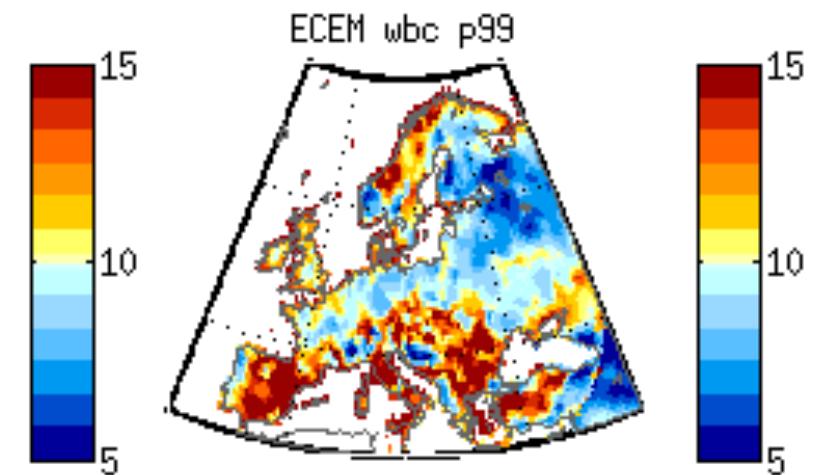
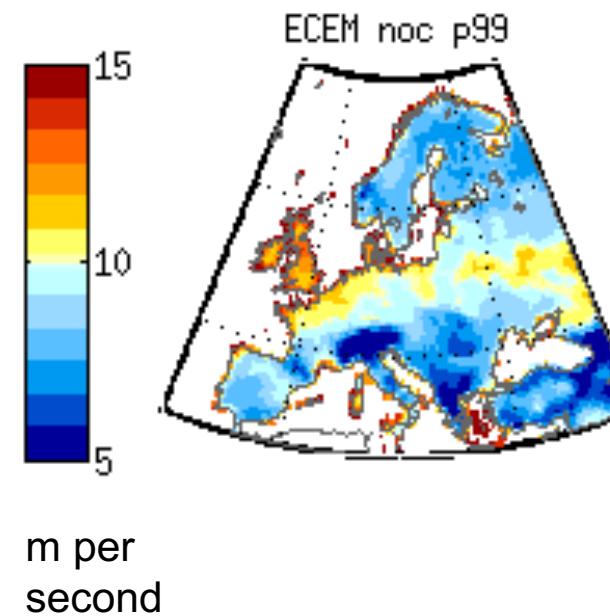
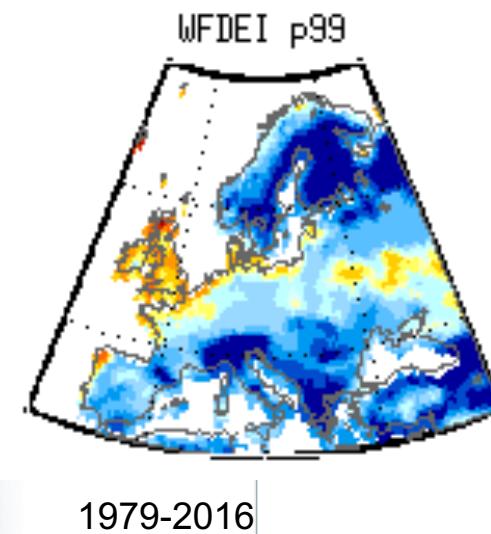


Next steps:

- Wind – e.g. annual or seasonal maxima of subdaily wind



Wind observations – 99th percentile



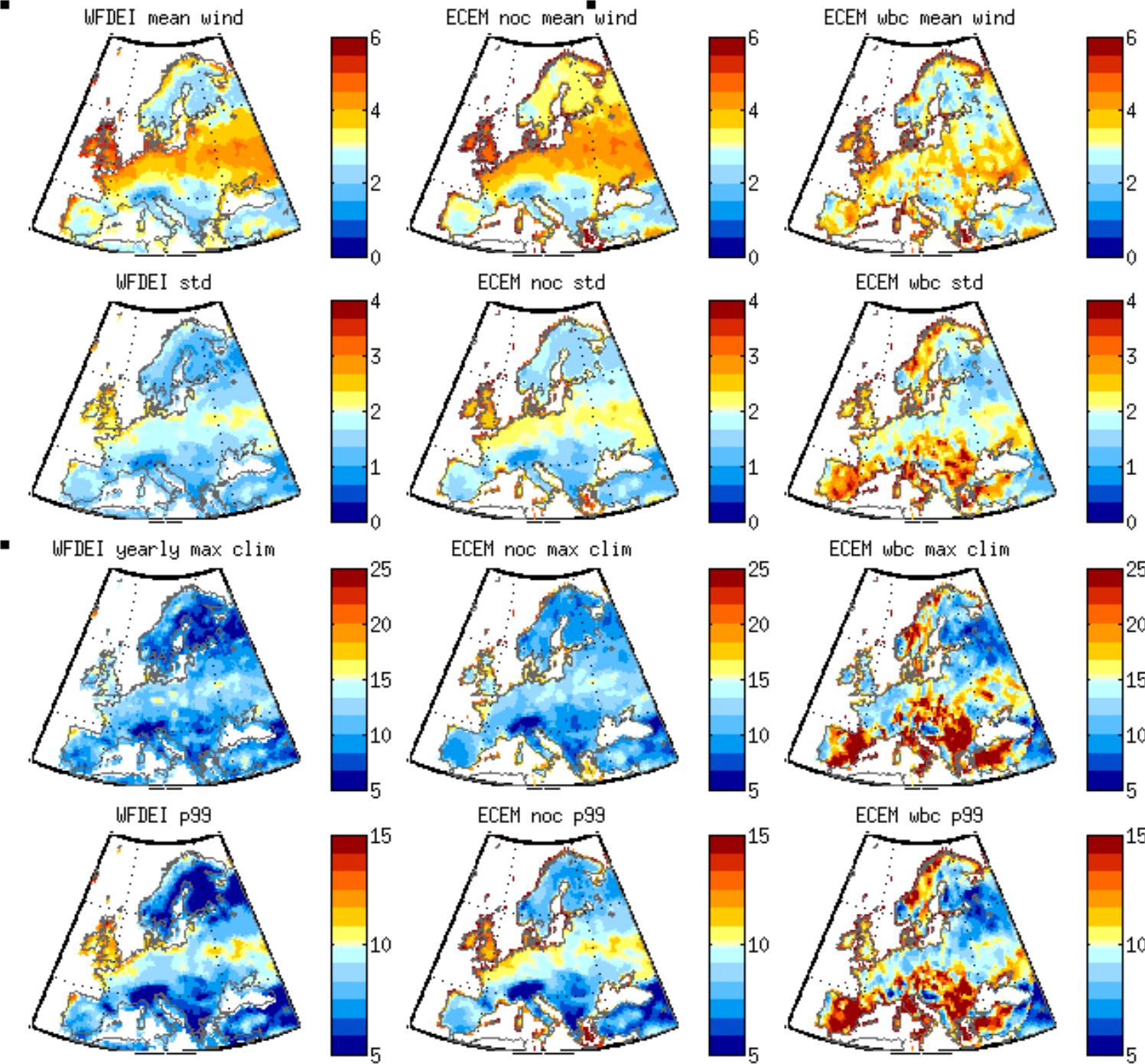


Next steps:

- Global high (~25km) vs low (~125km) resolution
 - Is circulation better?
 - UPSCALE simulations (HadGEM3-A at 130km, 60km and 25km resolutions, 3-5 ensemble members each)
 - PRIMAVERA simulations
- Ensemble size/ design
 - Subsampling of CMIP5/CESM large ensemble



Climate
Change



mean

standard
deviation

Climatology
of yearly
max

99th
percentile



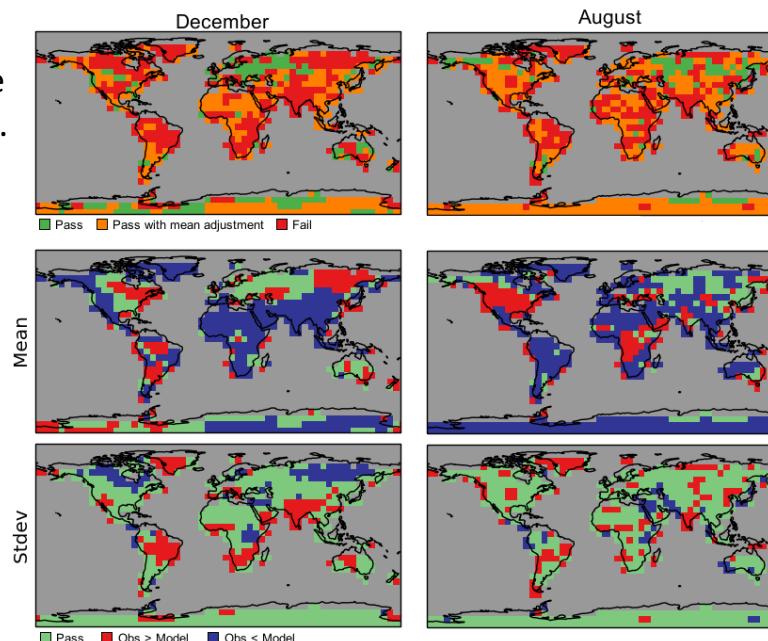
Analysis Framework

WP2: assess the benefits of initialised decadal predictions

- Identification of impact of initialisation requires assessment of large ensembles (30+ members)
- Examine how far into the future (up to 10 years) the benefits of initialisation last
- Focus on assessment of probability of conditions conducive to phenomena occurrence: e.g. frequency of weather regimes, phase of the NAO.

Plot showing the model fidelity for surface air temperature for December and August.

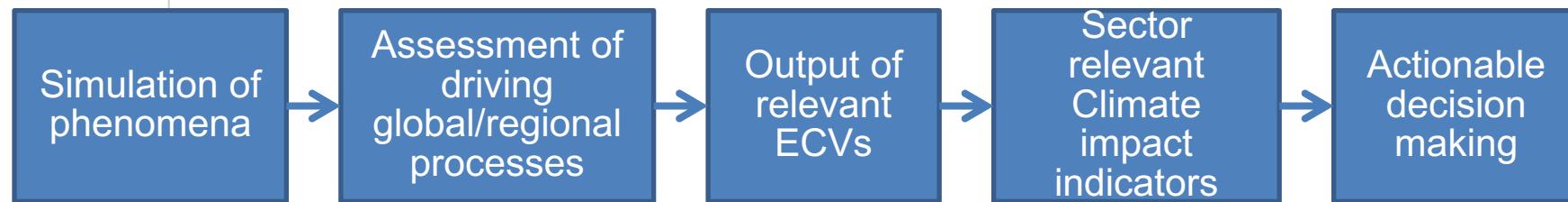
The upper plots show in which regions model is consistent with observations, using methods outlined in Thompson et al 2017 (Nature Comms). Only in the green regions can the **UNSEEN** method be used without applying any adjustments to model data. The lower plots show the nature of biases in the model mean and model standard deviation.





Case Studies for phenomena relevant to sectoral application

- Summary case studies based on phenomena relevant to sectoral application
- Drawing together previous case studies to produce an end-to-end assessment:



- Focus on impact of/ what is gained on the phenomena assessed from:
 - (a) Resolution versus ensemble design (WP1)
 - (b) Initialisation versus non-initialisation (WP2)
- Draw upon C3S SIS Proof-of-Concept (PoC) projects and other projects
- Assessing the ability of models to simulate fundamental processes allows rigorous testing models on capability;
- While assessing whether climate model simulations are sufficient for impacts assessment and for use by climate sensitive sectors.



Case Studies for phenomena relevant to sectoral application – examples considered

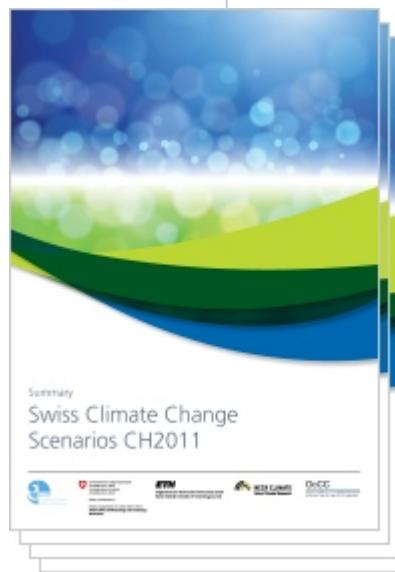
- A number of sectors more closely involved: health, insurance, water
- Eg case studies for water sector include:
 - UKWIR study on “*Rainfall Intensity for Sewerage Design*”, using km-scale RCM results;
 - EDgE – C3S “Proof of Concept” project, water sector;
 - SWICCA – C3S project on adaptation in water sector;
- For each sector we are aiming to synthesise best practice from a number of projects / studies



Climate
Change

Work Package 3

Expert engagement and Copernicus Roadmap for European Climate Projections



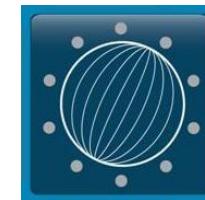


Advisory Board creation

Draw from team's involvement in numerous European Networks



*European Research Area
for Climate Services*





Scientific Expert Advisory Board

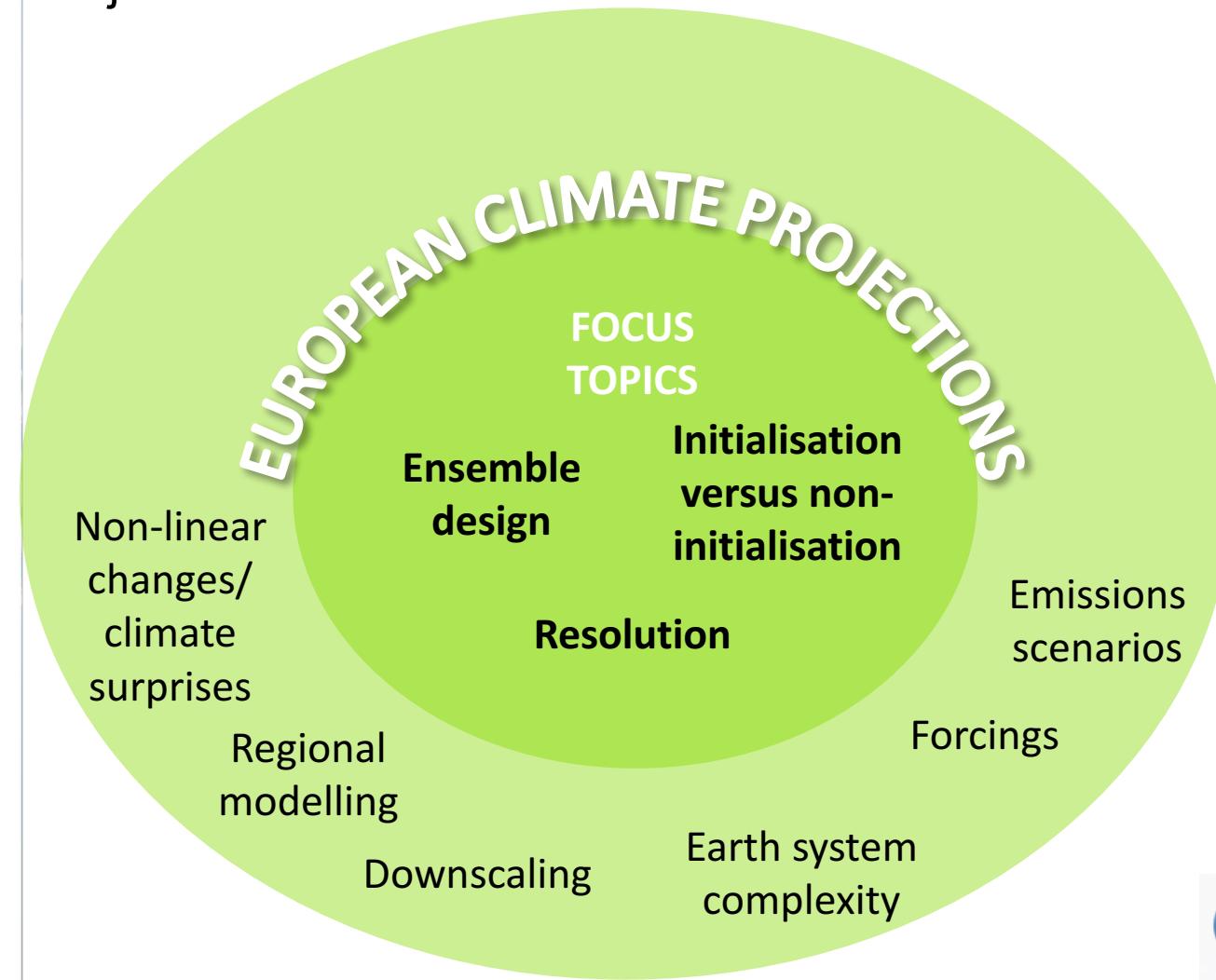
- Francisco Doblas-Reyes (BSC)
- Veronika Eyring (DLR)
- Jason Lowe (UKMO)
- Bart van den Hurk (KNMI)
- Antonio Navarra (CMCC)
- Jens Christensen (DMI)
- Christoph Schär (ETHZ)
- Pier Luigi Vidale (University of Reading)
- Daniela Jacob (GERICS)
- Jochem Marotzke (MPI)
- Gabriella Zsebeházi (Hungarian Met Service)

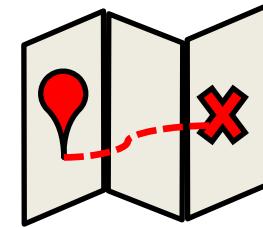
- Provide independent technical advice
- Expert scientists and user representatives from across European institutions
- Draw from team's involvement in European networks/programmes



Work Package 3

Expert engagement and Copernicus Roadmap for European Climate Projections





Roadmap Structure

A roadmap for predictions and projections in the operational phase of C3S, guided by output from WP1 and WP2.

Primary elements of discussion will include:

- (a) inclusion of initialised decadal predictions to complement non-initialised projections;
- (b) inclusion of multi-model and single model perturbed ensembles;
- (c) impact of horizontal and vertical resolution on simulation of European climate phenomena;
- (d) signposting ongoing and future activities;
- (e) further simulation issues/requirements including resource restrictions;
- (f) required observational datasets;
- (g) recommendations for European climate projections.

European Climate Prediction (EUCP) system

- Met Office led Horizon 2020 EUCP system
- An innovative European regional ensemble climate prediction system based on a new generation of high-resolution climate models, covering timescales from seasons to decades initialised with observations
- Met Office will be coordinating the project with a consortium of 16 organisations comprising the major European modelling centres, universities, and research institutes
- €13M EC funding for the project
- Four year project started December 2017, kick-off meeting end Jan 2018



European Climate Prediction (EUCP) system

Work Package Summary

WP1 Development of an interannual-to decadal climate forecast system

WP2 Producing uncertainty quantifications/PDFs and realisations of future climate on time-scales beyond 10 years

WP3 Demonstrator of high impact weather in a changing climate

WP4 End user driven characterisation of near term trends in regional climate impact and risks

WP5 Towards a seamless near-term European climate prediction system

WP6 Documentation, data exchange and integrating science with users

WP7 Project management and scientific coordination of EUCP

WP8 Ethics requirements





Climate
Change



Thank you !

Any questions ?

crecp@metoffice.gov.uk



Some useful links

- Copernicus
URL <http://www.copernicus.eu/main/overview>
- Copernicus (C3S)
URL <http://climate.copernicus.eu/>
- CRECP
URL <https://climate.copernicus.eu/copernicus-roadmap-european-climate-projections>
- SECTEUR
URL <http://www.the-iea.org/projects/secteur/>
- SIS (Sectoral Information System)
URL <http://climate.copernicus.eu/sectoral-information-system>