The development and visualization of climate projections for C3S ECEM

Climate Change

C3S European Climatic Energy Mixes (ECEM)
Webinar Programme
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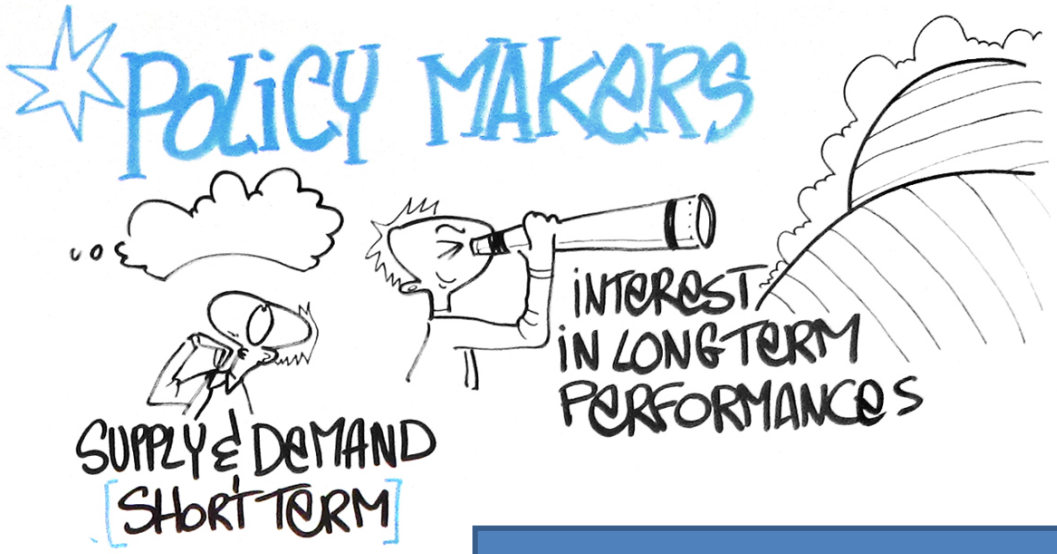
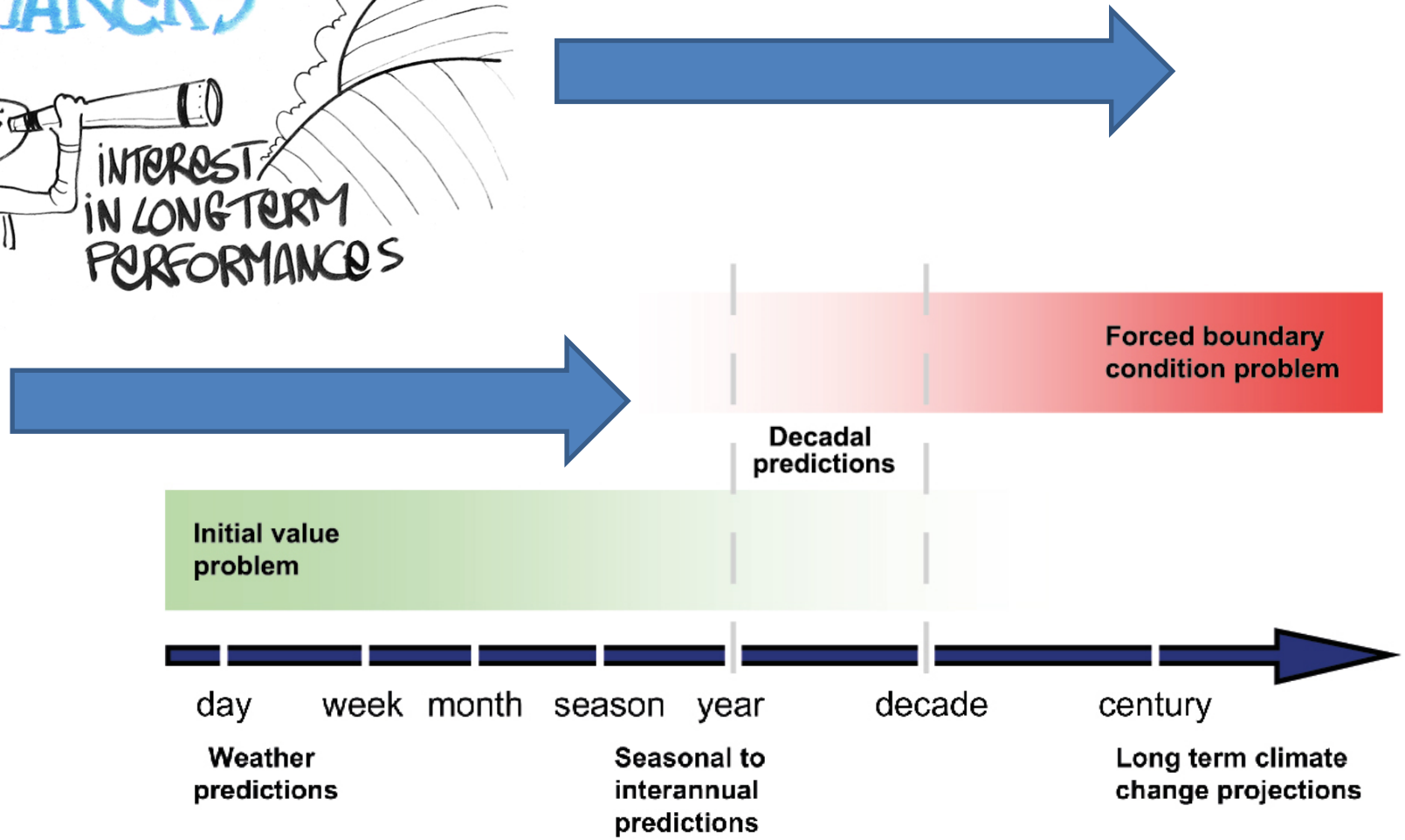
Forecasts, predictions or projections?





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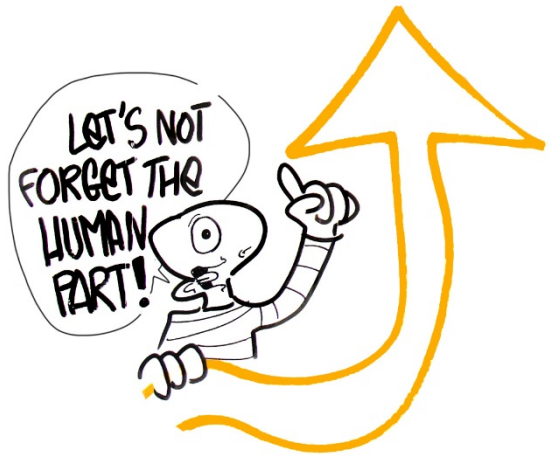
Climate scenarios and projections

Projection A projection is a potential future evolution of a quantity or set of quantities, often computed with the aid of a model. Unlike predictions, projections are conditional on assumptions concerning, for example, future socioeconomic and technological developments that may or may not be realized.



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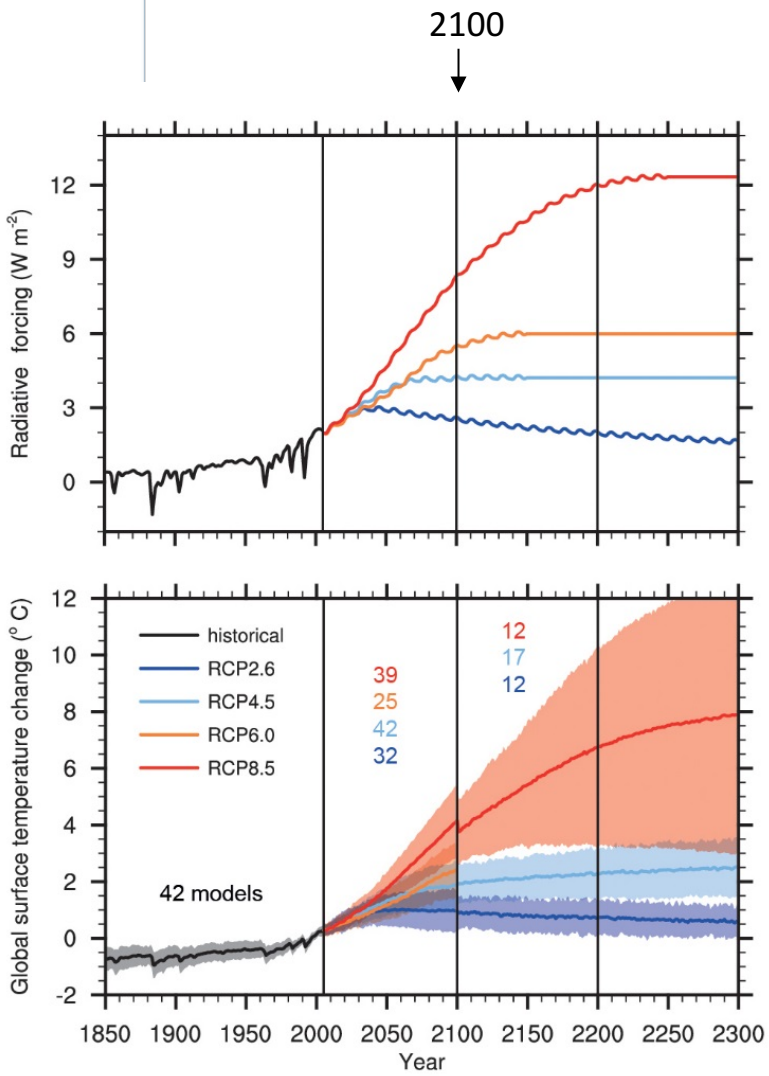
Representative Concentration Pathways (RCPs)



From IPCC Fifth Assessment Report

RCP8.5 High emissions: Business as usual

RCP4.5 Low to moderate emissions

RCP2.6 Low emissions: Consistent with Paris 2°C target

The shaded range for each RCP shows the importance of using a multi-model ensemble. In this case, the CMIP5 ensemble of global climate models.

Major sources of uncertainty:

- Emissions scenario (forcing)
- Model structure and response
- Natural variability

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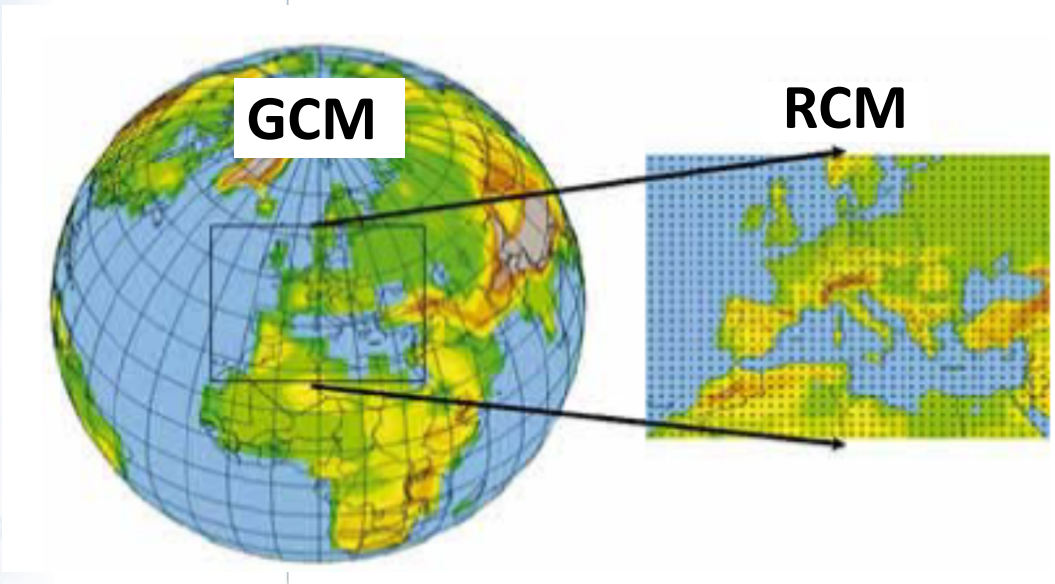
Dynamical downscaling with regional climate models



Downscaling is also a source of uncertainty – so CORDEX provides multi-model ensembles (i.e. different RCMs driven by different GCMs)

For Europe: 12 km grid box resolution
Forced by CMIP5 global models

Potential benefits of higher spatial resolution
But for now restricted to RCP8.5 and RCP4.5

http://euro-cordex.net/

WCRP CORDEX

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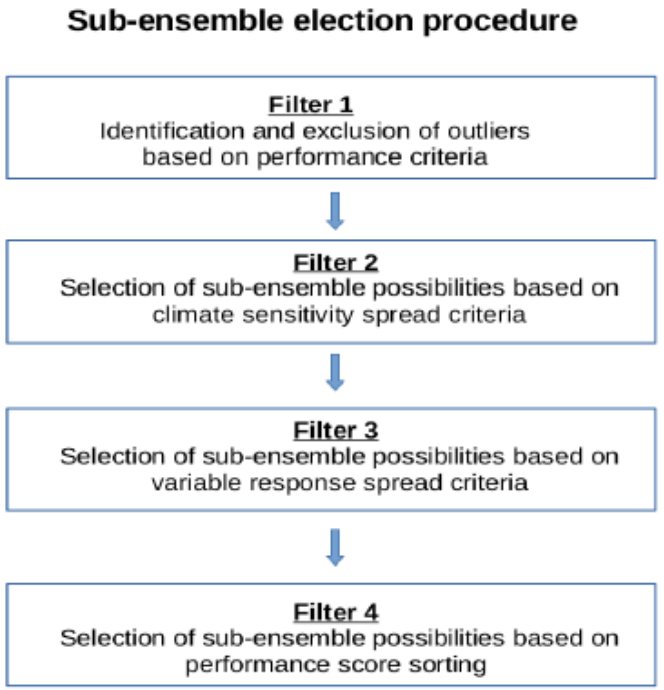
ECEM is using projection data from CLIM4ENERGY

- Objectively selected sub-ensembles of 3, 5 and **7** models best representing the ensemble for the energy-relevant variables



Temperature (03h instantaneous values, daily)
Precipitation (daily)
10m wind (03h instantaneous values)
Downwelling solar radiation (03h averages)
Mean sea level pressure (daily)
Snow depth (daily)

7-member ensemble used in ECEM is a combination of 6 RCMs and 5 driving GCMs

http://clim4energy.climate.copernicus.eu/report-climate-projection-dataset

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CLIM4ENERGY bias adjusted most variables (not MSLP/SD)

Using WFDEI and Cumulative Distribution Function transform (CDFt) to account for nonlinear changes in distributions from current to future climate, allowing a fair preservation of trends in the adjustment

Generally see improvement (lower biases), e.g. for winter precipitation:

Statistics	HR BC simulation	LR BC simulation	HR original simulation
Mean absolute bias	0.52	[illegible]	1.22
Q95 absolute bias	2.16	1.98	3.25
Q99 absolute bias	3.55	9.22	9.43
Fraction of stations with mean absolute bias>1mm	0.14	0.14	0.44
Fraction of stations with Q95 absolute bias>5mm	0.10	0.09	0.18
Fraction of stations with Q99 absolute bias>5mm	0.18	0.79	0.73

TABLE 4-2: Verification of bias correction performance vs. station data for daily precipitation (*pr*, in mm/day)

One of several caveats:
On climate change timescales need to remember that good reproduction of observations is only a "necessary but not sufficient" guide to the reliability of future projections

http://clim4energy.climate.copernicus.eu/report-climate-projection-dataset

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Climate projections in the C3S ECEM Demonstrator

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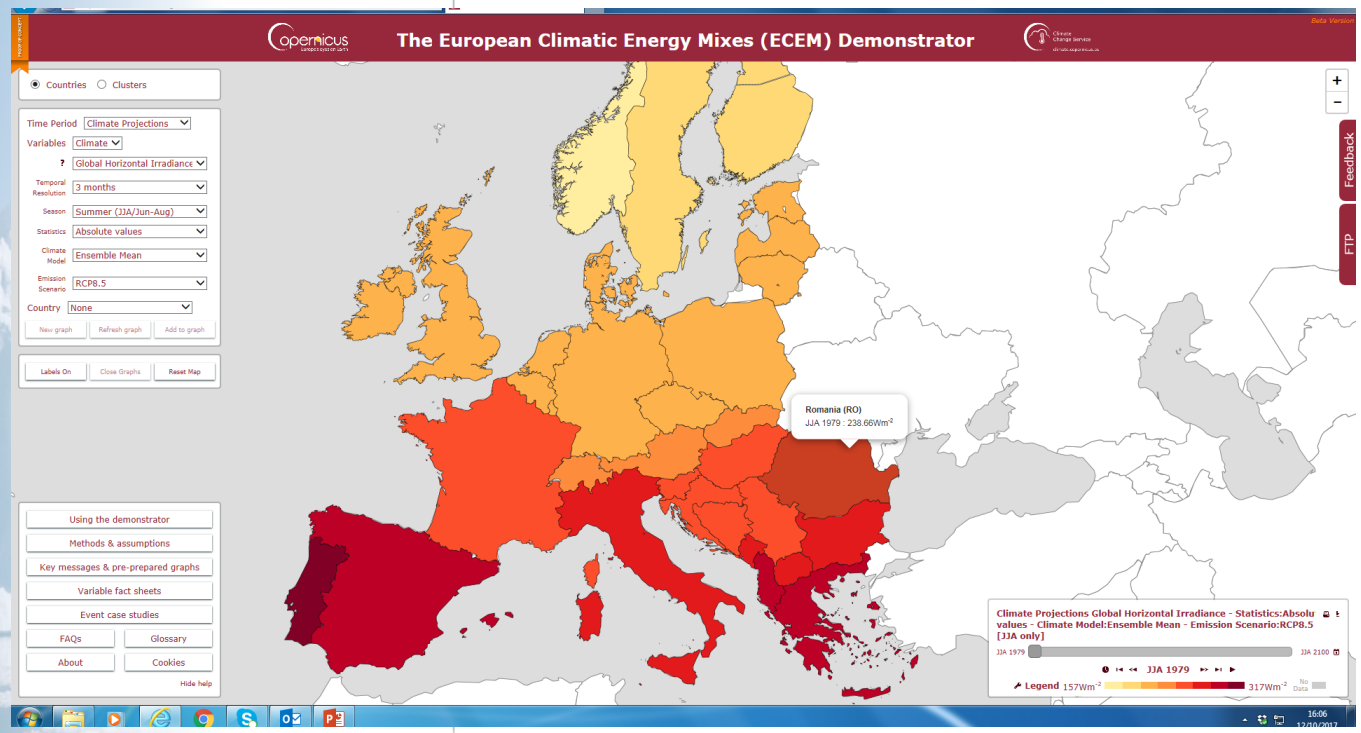

http://ecem.climate.copernicus.eu/demo

Data can be downloaded and visualised

- MSLP/PSL and RH are not bias adjusted
- RH is not from Clim4Energy but consistent
- SD is unadjusted and not provided in the Demonstrator (but is being used to produce hydropower generation projections)
- All of this and more is documented in Variable Fact Sheets and other guidance material

Table 1 – GCM/RCM configurations and data availability by ECV. Green colour means model/variable combination is available, orange is not.

RCM Full name	RCM Abbr.	TA	TP	WS	GHI	RH	PSL	SD
MOHC-Hadgem2-ES and SMHI-RCA4	RCMO							
ICHEC-EC-EARTH and RACMO22E	RAIC							
CNRM-CERFACS-CNRM-CM5 and CNRM-ARPEGE51	ARCN							
IPSL-CM5A-MR and IPSL-INERIS-WRF331F	WRIP							
MPI-M-MPI-ESM-LR and MPI-CSC-REMO2009	REMP							
ICHEC-EC-EARTH and DMI-HIRHAM5	HIIC							
ICHEC-EC-EARTH and SMHI-RCA4	RCIC							

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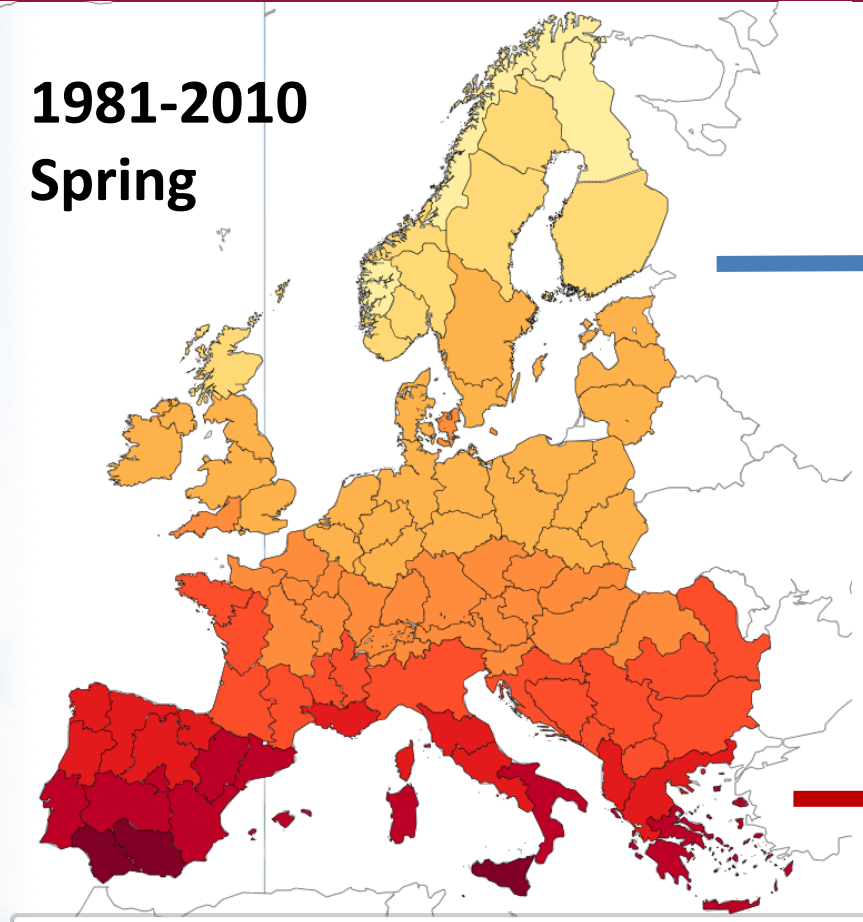
Mapping climate projections, e.g. GHI RCP8.5 ensemble mean

1981-2010
Spring



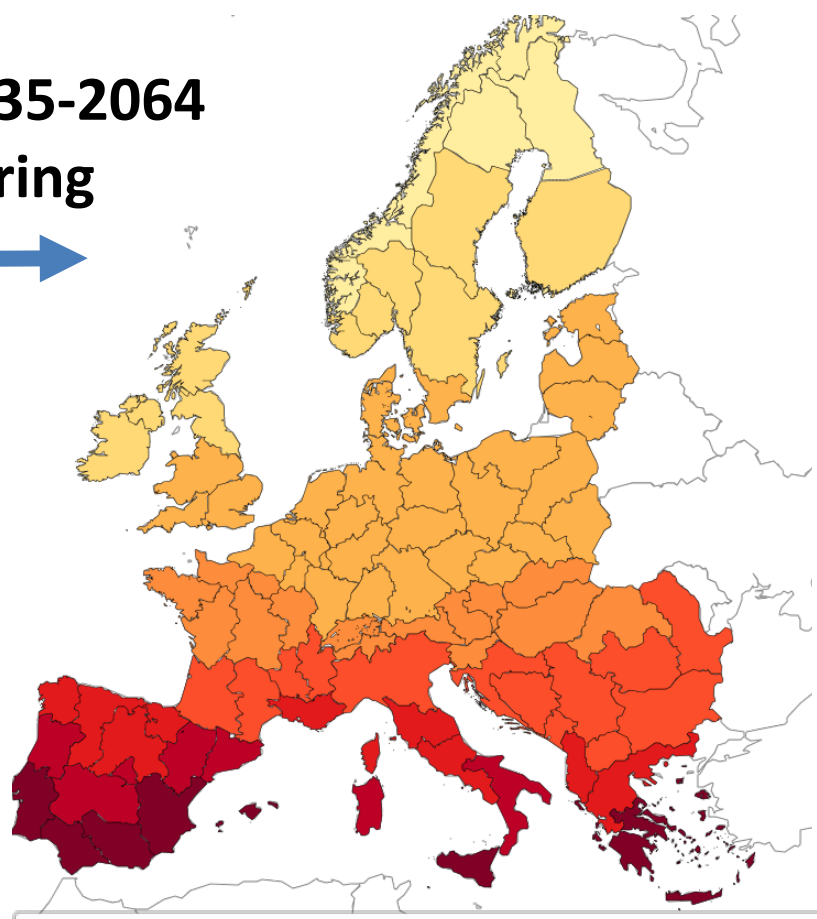
Climate Projections Global Horizontal Irradiance | Long term mean(s) | Ensemble Mean | RCP8.5 [MAM only]

MAM 1981-2010

Legend 118Wm-2 258Wm-2 No Data

Produced by the ECEM Demonstrator Vn2.2(http://ecem.climate.copernicus.eu/demo)

2035-2064
Spring



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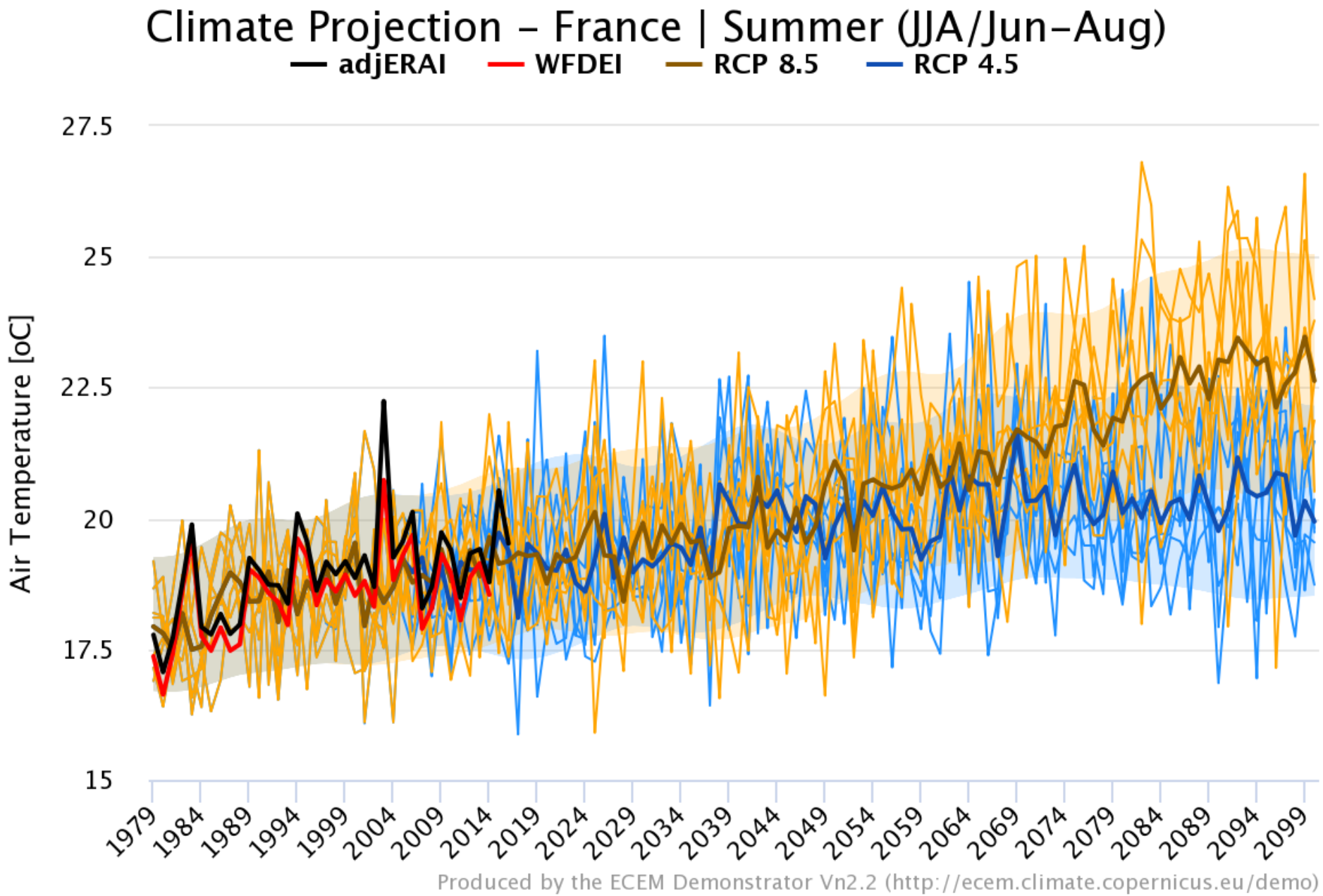
Representation of uncertainty in ‘full projection plots’



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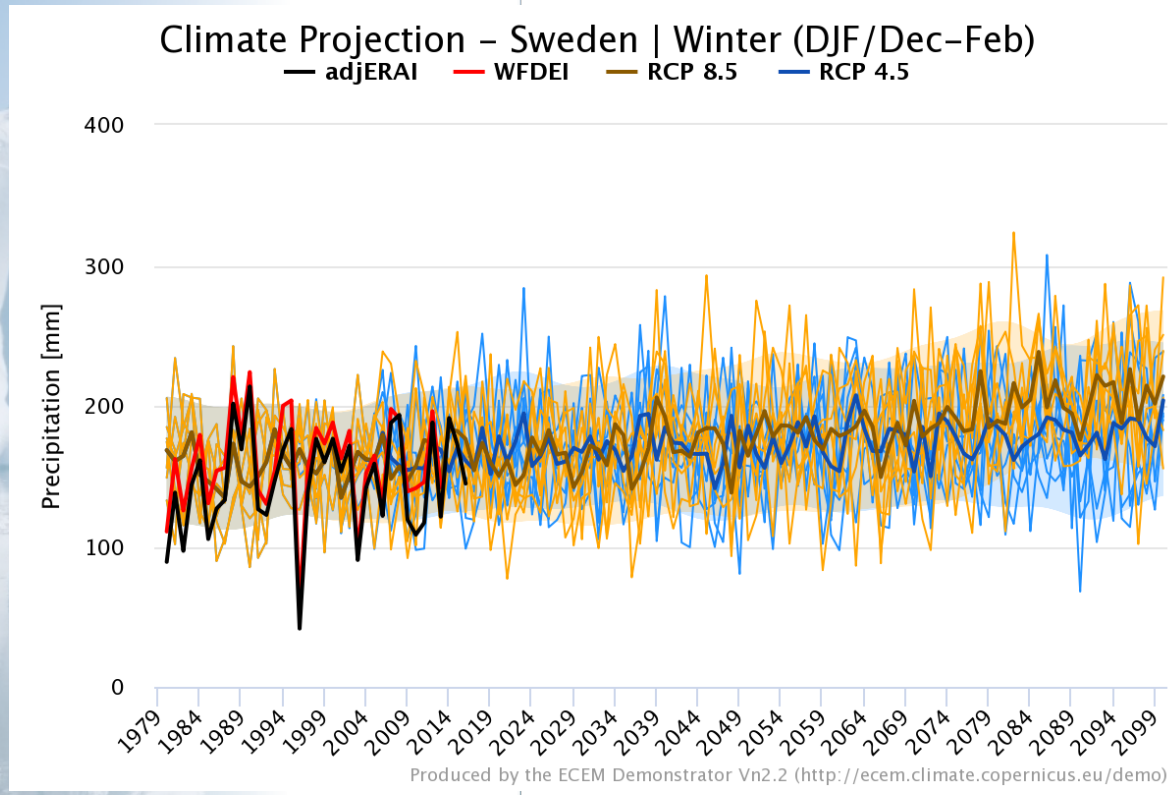
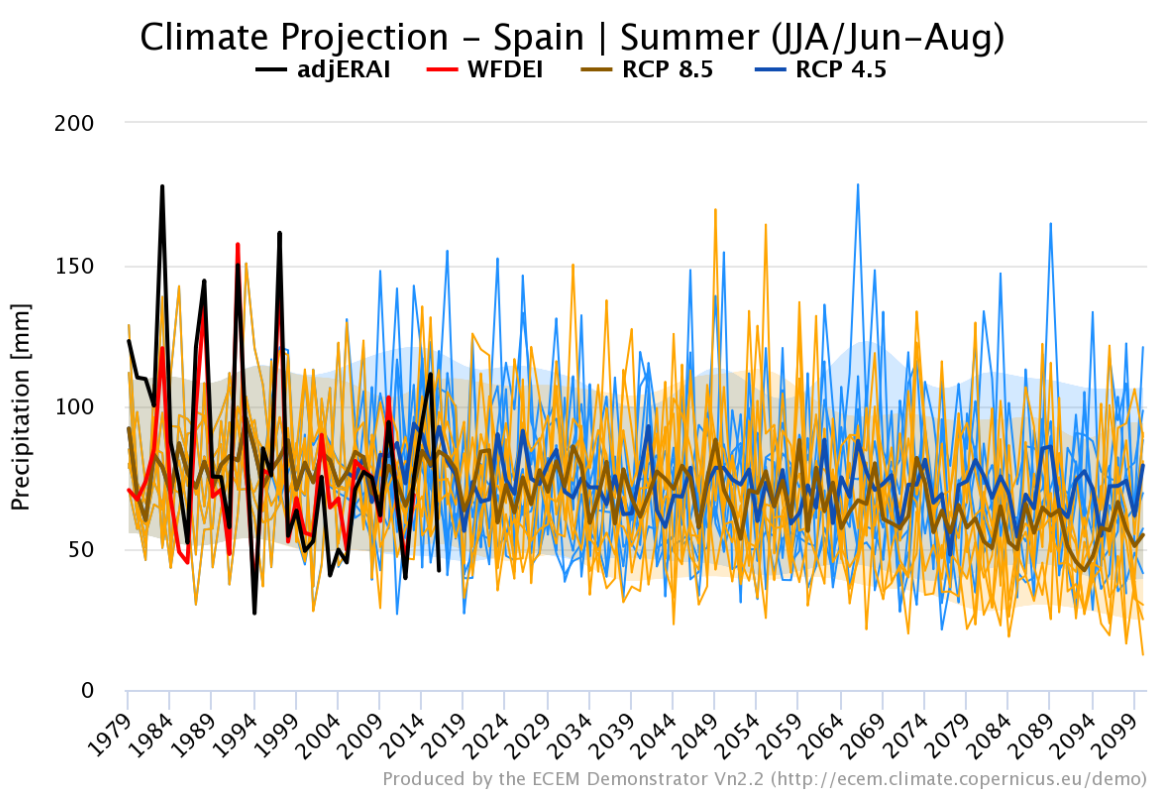
Contrasting seasonal/spatial changes in precipitation





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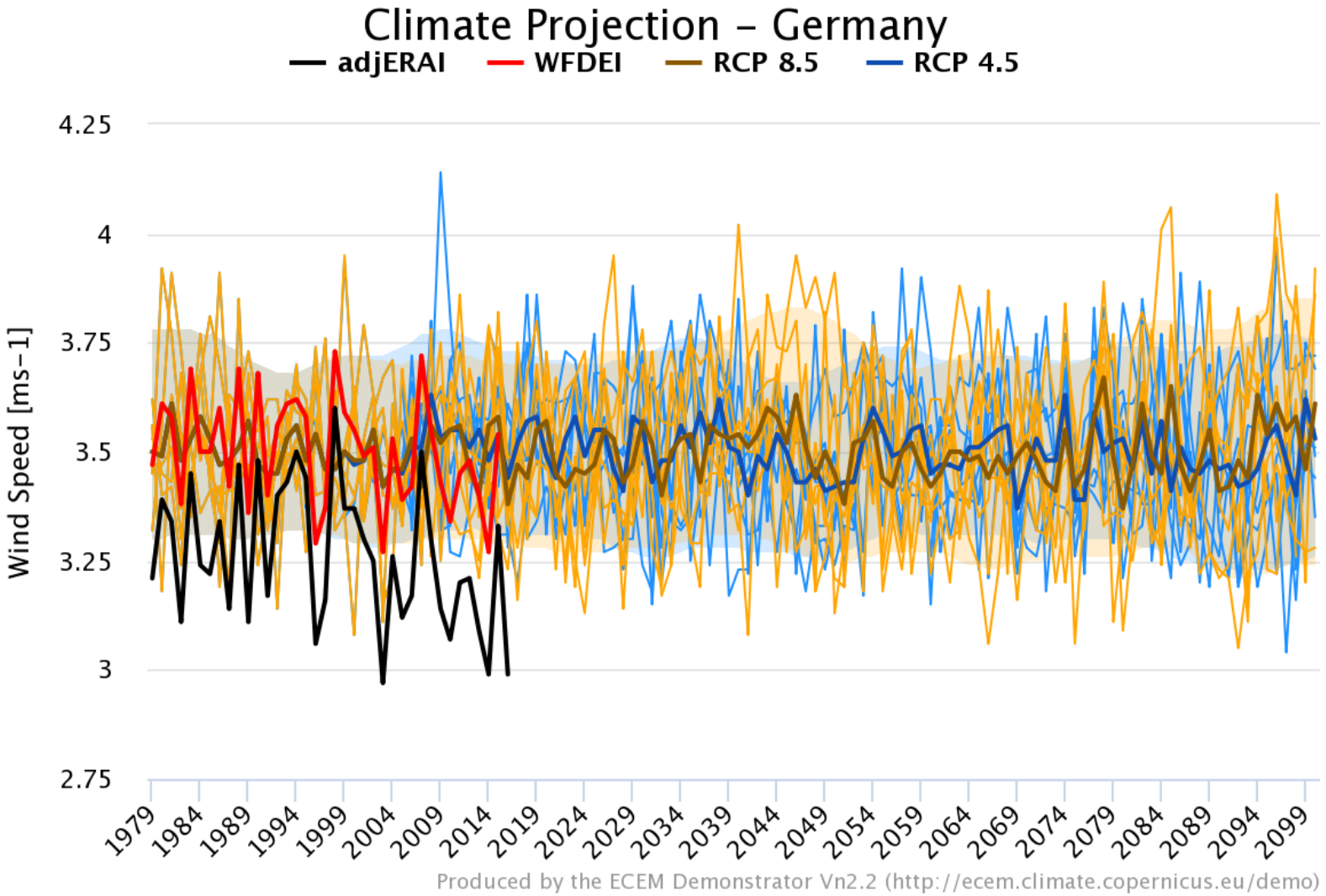
Less projected change in other variables e.g. wind speed



This example also highlights the issues associated with what we use for the observed baseline discussed by Phil Jones, i.e. the difference between WDFEI (used to bias adjust the climate models) and adjERAI (used to construct wind power generation in ECEM)

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Some issues associated with the ECEM climate projections

- Not all variables are bias adjusted
- Uncertainties and some inconsistencies associated with bias adjustment – including the observed data which is used
- Ensemble size is relatively small (so we show max/min rather than probabilistic ranges)
- Would be good to include RCP2.6 (low emissions)
- Can we improve the way we present the projection data (balancing an appropriate representation of uncertainty with clarity and ease of use)?

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Summary: climate projections in the ECEM Demonstrator

- Country/cluster spatial scale
- 1979-2100; historical forcing to 2005, then RCP4.5 and RCP8.5
- Based on 7-member 12-km resolution RCM ensemble
- Most variables are bias adjusted using gridded observations
- Energy-relevant variables: temperature, precipitation, GHI, wind speed at 10m and 100m, relative humidity, sea level pressure
- Daily, monthly, seasonal, annual time resolutions
- Absolute values, anomalies, long-term means
- Ensemble means and smoothed max/min range
- Visualisation: maps and time series, including 'full projection plots'
- Documentation and guidance

What are the implications of these projections for energy demand and supply?

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