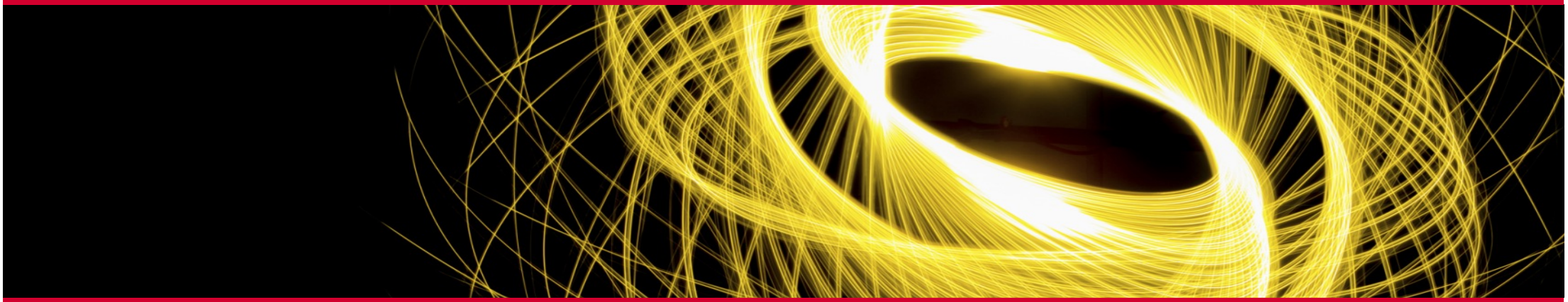
Department of Meteorology
School of Mathematical, Physical and Computational Sciences

University of Reading

NEXT GENERATION CHALLENGES IN ENERGY-CLIMATE MODELLING 2021

CLIMATE & ENERGY SYSTEMS: FORESIGHT DAYS TO DECADES AHEAD



Online workshop 16th and 17th September 2021

NB: The first plenary session will be recorded and may be released after the event

Organizing committee: Hannah Bloomfield (Reading), David Brayshaw (Reading), Jethro Browell (Glasgow), Matteo de Felice (EU Commission JRC), Paula Gonzalez (Reading), Katharina Gruber (BOKU), Alex Kies (Frankfurt), Julie Lundquist (UColorado), Laurens Stoop (Utrecht), Hazel Thornton (UK Met Office), Jan Wohland (ETHZ), & Marianne Zeyringer (Oslo)

Programme

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Day 1 – Thursday 16th September

UK		Denver	Sydney	Venue
1300	Welcome	0600	2200	Zoom
1310	Keynote talks	0610	2210	"
1440	Break	0740	2340	
1500	Research presentations (themed parallel sessions)	0800	0000	Gather
1645	Wrap up discussion	0945	0145	"
1700	Official end (Gather remains open for informal networking)	1000	0200	"
1800	Gather town closes	1100	0300	"

Day 2 – Friday 17th September

UK		Denver	Sydney	Venue
1300	Welcome	0600	2200	Zoom
1315	Themed breakout groups	0615	2215	"
1445	Break	0745	2345	"
1500	Themed breakout groups continue	0800	0000	"
1600	Plenary reporting from breakout groups	0900	0100	"
1630	Discussion	0930	0130	"
1700	Official end (Zoom remains open for social discussion)	1000	0200	"
1800	End	1100	0300	"

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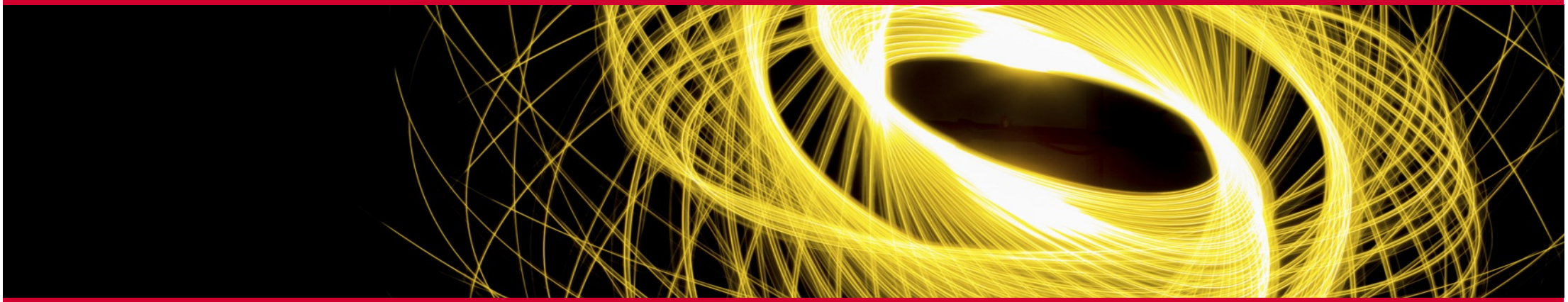

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Welcome

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- Thank you to everyone for coming!
  - Exceptional interest in the workshop
  - 255 registrations from around the globe (almost doubled from last year)

- Special thanks:
  - Organizing committee
  - Session convenors – Jethro Browell, Alex Kies, Jan Wohland, Hannah Bloomfield, Paula Gonzalez and Matteo De Felice
  - Invited guest speakers – Jose Manuel Gutierrez, Michael Craig, Christian Grams and Marta Victoria

- Technology/format is experimental – we'd welcome feedback!

- This introduction:
  - Motivation and goals of the workshop
  - Programme / rules of engagement
  - Recording

Motivation - a partial and personal viewpoint

- Energy sector has long been exposed to weather but:
  - Rapidly changing climate ➔ decarbonization (e.g., renewables)
  - Decarbonization ➔ increasing and changing the exposure of energy system to climate

- Relatively weak connections between energy- and climate- research. Timely to build bridges in order to:
  - anticipate effects of future climate on energy (e.g., changes in wind, solar, temperature; frequency/severity of stress events)
  - ensure future energy system "solutions" are robust to climate uncertainty (e.g., design, practice & policy)
  - support cross-fertilization in use of latest science & technology (e.g., extended range forecasting)

Energy-climate science in 2000's → 2010's → 2020's and beyond

Humber Bridge, near Hull in Yorkshire (UK). Formerly the longest single-span suspension bridge in the world, started construction 1973, opened 1981.
Images www.ioshmagazine.com/humber-bridge-open-all-hours; driventowrite.com/2019/10/06/bridge-across-the-humber/#jp-carousel-55246; historicengland.org.uk/listing/the-list/list-entry/1447321

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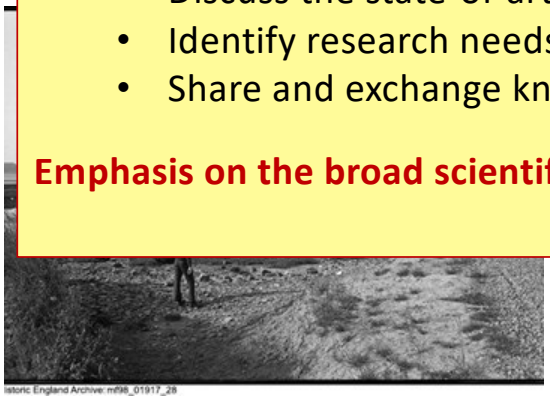
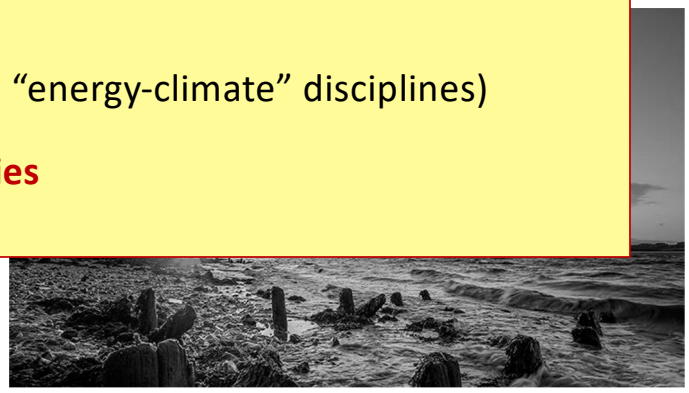
Focus: *Climate & Energy Systems: Foresight days to decades ahead*

Goals:

- Discuss the state-of-art (what doing now),
- Identify research needs (where do we need to go next),
- Share and exchange knowledge (supporting interactions across the "energy-climate" disciplines)

Emphasis on the broad scientific and technical challenges and opportunities





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Use of ”reanalysis” in energy-climate research

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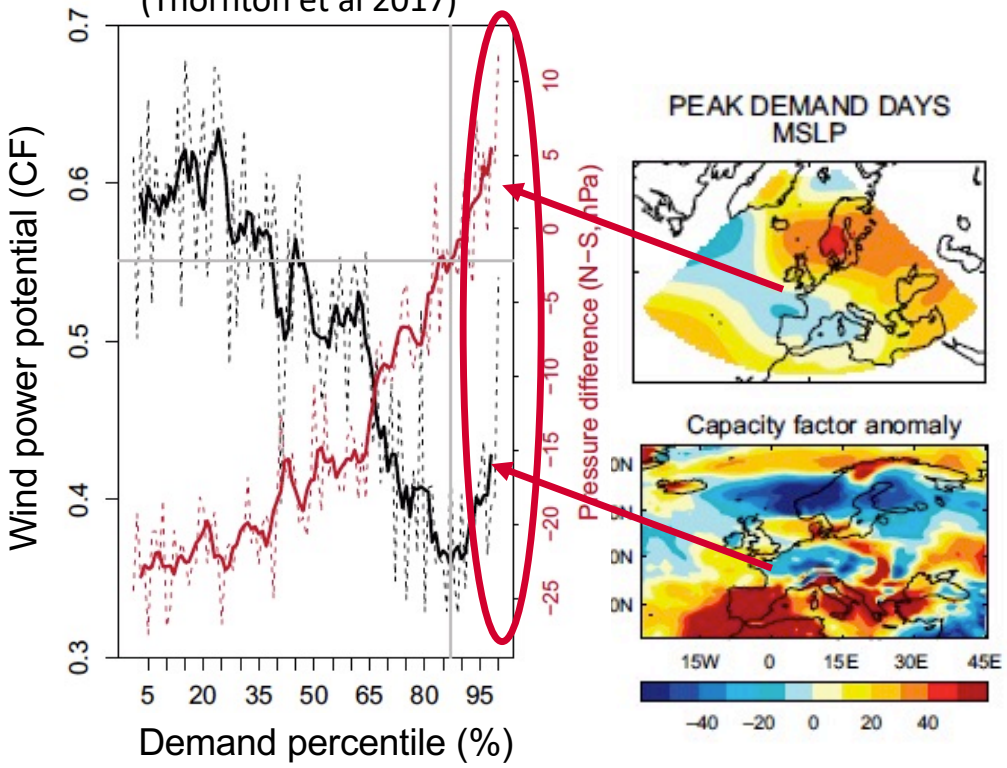
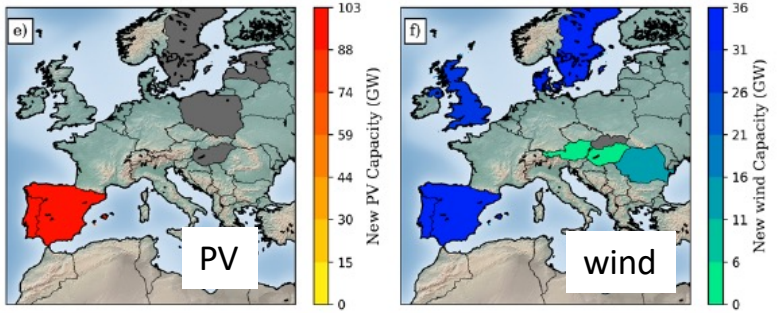
- Meteorological reanalyses: high quality historical weather reconstructions spanning 40-100+ years
- Underpin recent ”energy reanalyses” (ECEM, URead, EMHIRES, Ninja, …)
- Increasing use in extreme event characterization, power system planning, …

UK wind-during-peak-load
(Thornton et al 2017)

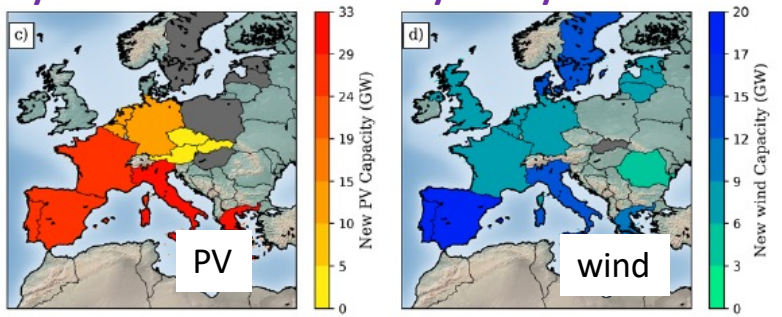


Optimizing EU renewables
(Santos-Alamilos et al 2017)

Capacity additions to maximize long-term average output



Capacity additions to minimize day-to-day variation in output



Beyond reanalysis

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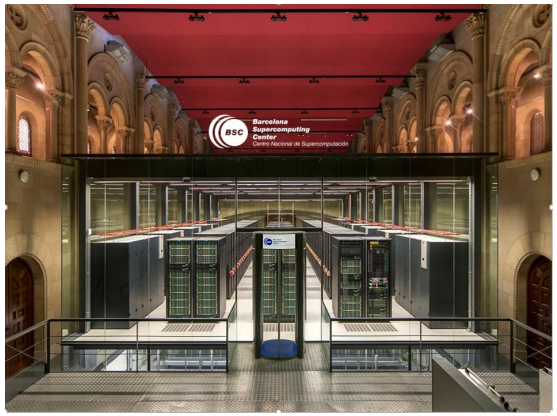
Climate information is more than just historical data:

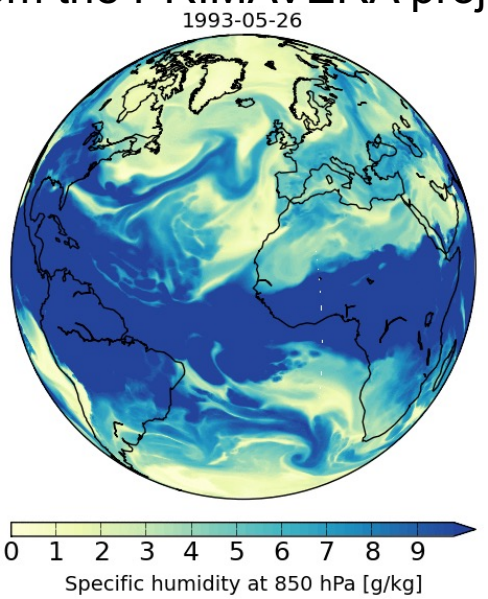
- Climate simulations of increasing fidelity (e.g., CORDEX, CMIP6, PRIMAVERA)
- Huge international efforts with carefully designed protocols, curated data archives, and standardized data formats
- Growth in climate services for energy



Mare Nostrum and ECMWF's Cray (two of several leading HPC systems used for PRIMAVERA simulations)

https://www.bsc.es/news/bsc-news/the-bsc's-bid-host-one-the-largest-supercomputers-the-eu-strengthened-the-support-three-additional, https://www.ecmwf.int/en/computing/our-facilities/supercomputer

EC Earth, hi-res simulation (from the PRIMAVERA project)



Foresight days to decades ahead

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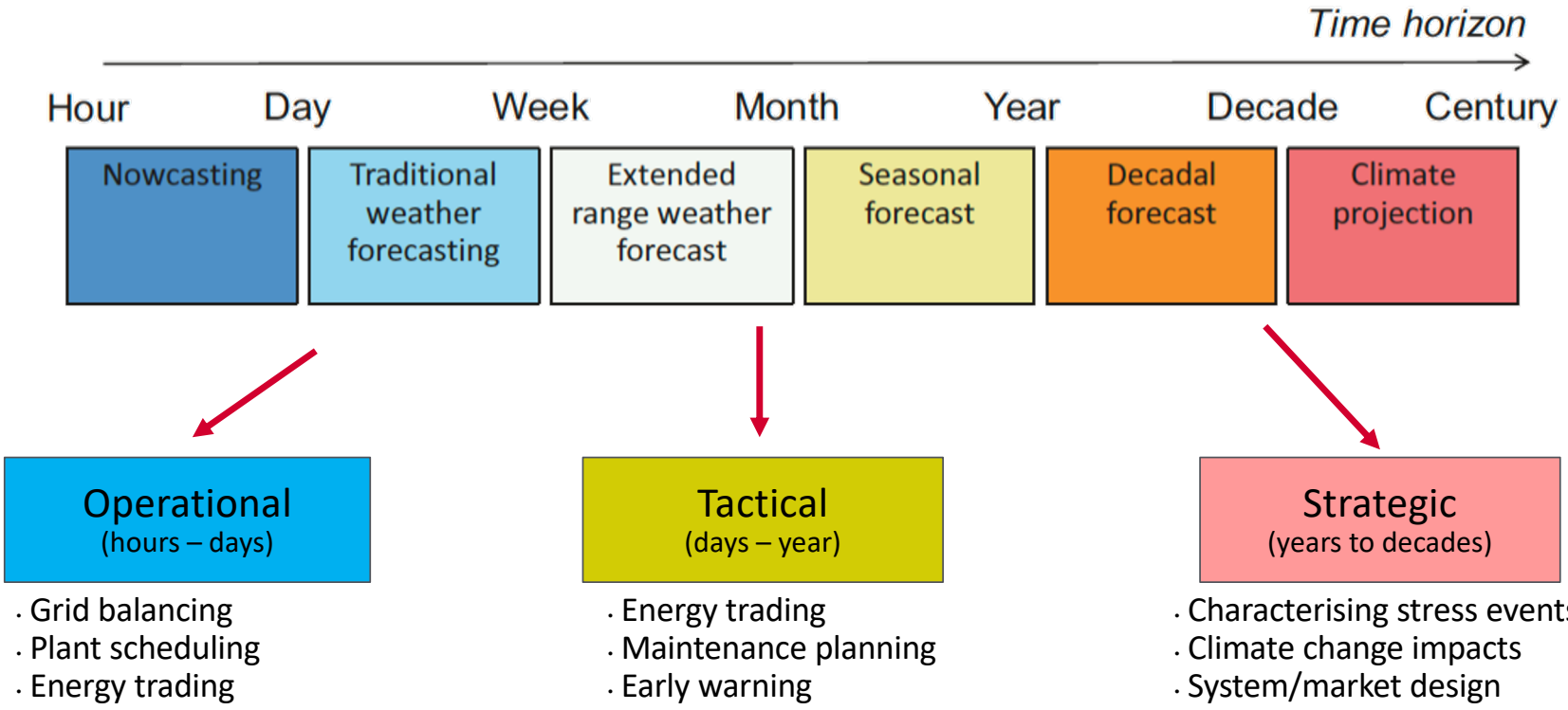
- A massive meteorological toolkit - much of which openly available for research
- Relevant to wide range of energy-applications



- Grid balancing
- Plant scheduling
- Energy trading

- Energy trading
- Maintenance planning
- Early warning

- Characterising stress events/extremes
- Climate change impacts
- System/market design

Some challenges

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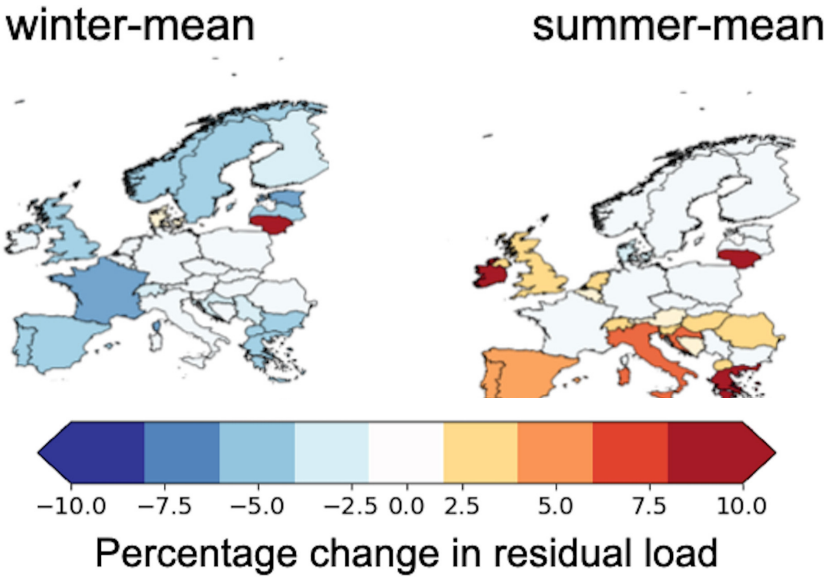
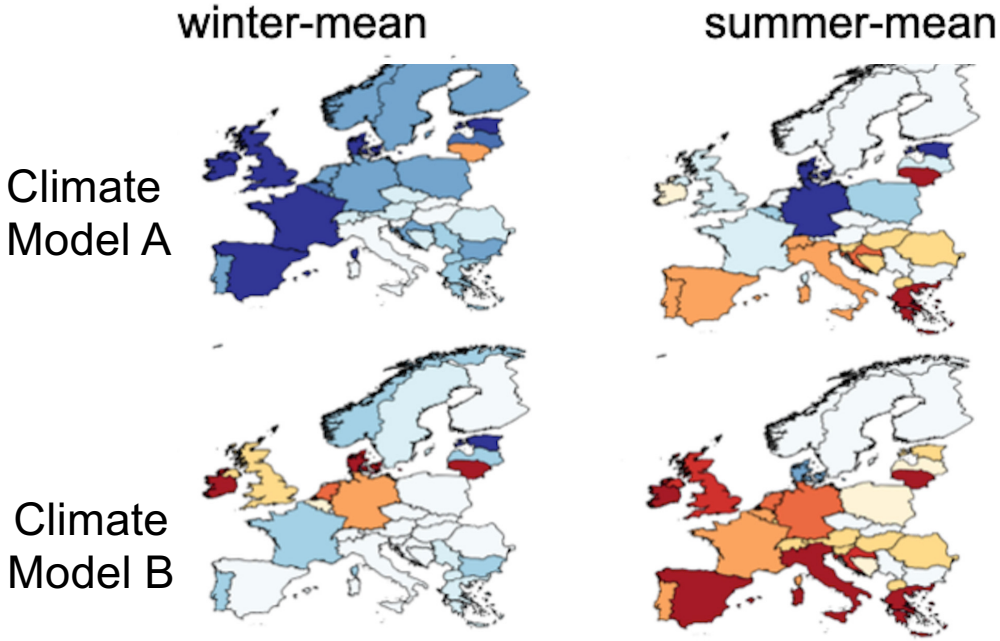
- Understanding/quantifying climate variability and climate change
- Differences between reanalysis products and climate models
- Climate model resolution, biases, process representation
- Imperfect short-term foresight in long-term planning

Some challenges

- Understanding/quantifying climate variability and climate change
- Differences between reanalysis products **and climate models**
- Climate model resolution, biases, process representation
- Imperfect short-term foresight in long-term planning
- **The challenge of using very large climate datasets in computationally-expensive power system models**

Multi-climate-model average response to climate change





EUROCORDEX models, converted into estimates of national residual load (demand net RE) in the ECEM project
Figure from Bloomfield et al (2021)

Climate uncertainty in power system expansion planning

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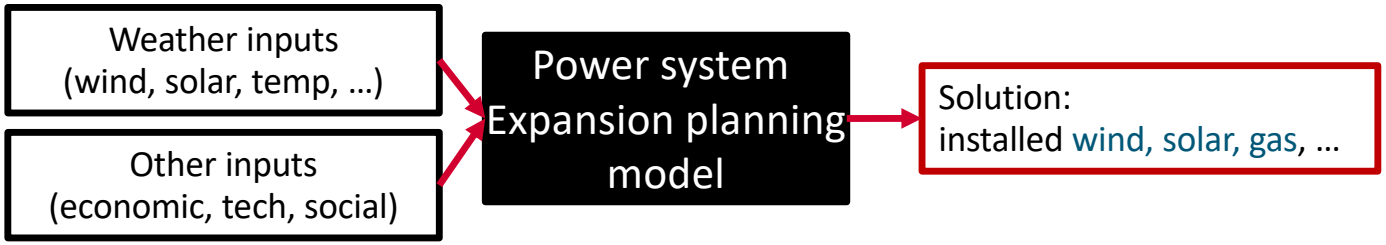
- "Power system expansion planning":

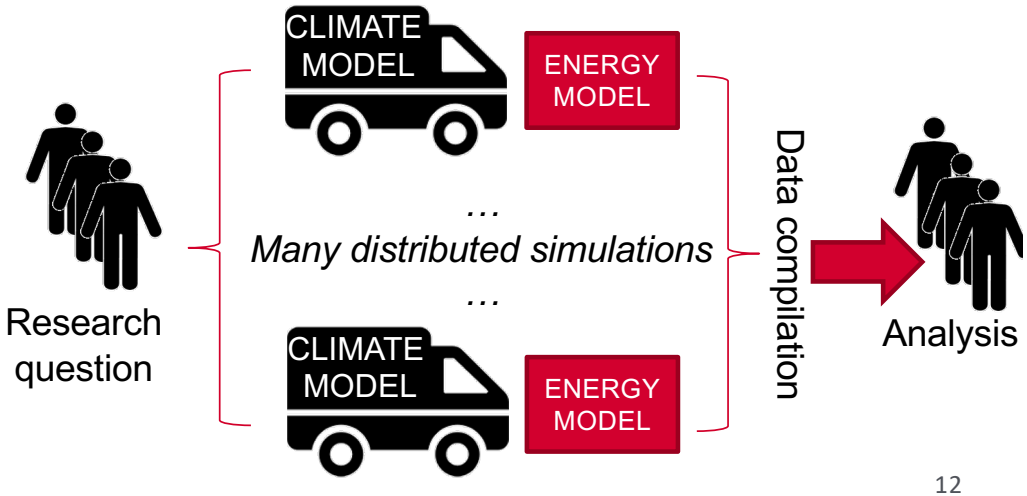


Standard practice: ~few years of historic climate data as input

- ***Strong evidence this is NOT robust***: different climate samples lead to very different power system "solutions" (Hilbers et al 2019)
- ***Problem magnified many times when using climate model data rather than reanalysis***
- → **Currently little understanding of whether power system planning "solutions" are robust to climate uncertainty**

Proposed community project:

- ClimatePrediction.net massive distributed computing framework
- Couple "climate model" to "energy system planning model"
- Systematic, robust exploration of uncertainty in both models
- Community resource for exploratory research
- **Please join us at 1600 in breakout room on Gather.Town**



Format

- Day 1 programme

UK	
1300	Welcome
1310	Jose Manuel Gutierrez, Cantabria University *Global and regional ensemble projections for risk assessment: The IPCC Interactive Atlas*
1330	Michael Craig, Michigan University *Power system planning under a changing climate: recent advances and future directions*
1350	Christian Grams, Karlsruhe Institute of Technology *Using Weather Regimes in Energy Meteorology*
1410	Marta Victoria, Aarhus University *Multi-timescale challenges in sector-coupled energy systems*
1440	Break
1500	Research presentations (themed parallel sessions) 1. Making the most of limited meteorological predictability 2. Climate uncertainty and power system planning 3. Weather stress events for energy 4. Added value of subseasonal-to-seasonal (S2S) forecasting 5. Renewable energy and developing markets
1645	Wrap up discussion
1700	Official end (Gather remains open for informal networking)
1800	Gather town closes

- **Remind rules of engagement**
  - Reminder – recording this plenary session in Zoom
  - Please mute microphones and turn off video in plenary – use the chat if wish to ask a question