WIND DROUGHTS AND WINTER COLD THREATEN EUROPE'S FUTURE ENERGY SECURITY
ENERGY TRANSITION – AMBITION

- Limit CO₂ emissions to mitigate further global climate change
- Transition from carbon-intensive fossil fuels to renewable energy sources
ENERGY TRANSITION - CONSEQUENCES

- Carbon-intensive fossil fuels
  - Production can be planned

- Low-carbon renewable energy
  - Production will depend on the weather
ENERGY TRANSITION - CHALLENGE

- Matching variable energy demand with variable energy production
MATCHING VARIABLE ENERGY DEMAND WITH VARIABLE ENERGY PRODUCTION

ENERGY TRANSITION - CHALLENGE

- Overcapacity
- Energy shortfall
- Variable renewable energy production
- Energy demand
RESEARCH OBJECTIVE

Investigate the meteorological conditions that lead to high risk for European energy safety in a highly renewable power system.
LARGE ENSEMBLE MODELLING METHOD

1. Simulate 2000 years of present-day weather
2. Calculate 2000 years of energy variables
3. Select 1-in-10 year extreme events
4. Investigate meteorological conditions
15 western European countries

Energy production
Wind turbines, solar panels
INTERMEZZO – ENERGY MODEL

- 15 western European countries
- Energy production
  Wind turbines, solar panels
- Energy demand
  Winter heating, summer cooling
ANNUAL CYCLE OF ENERGY VARIABLES

1-in-10 year high shortfall events
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METEOROLOGICAL CONDITIONS FOR HIGH ENERGY SHORTFALL

10 m wind speed
Solar radiation
2 m temperature

-6 -5 -4 -3 -2 -1 0 1 2 m/s
-20 -16 -12 -8 -4 0 4 8 12 16 20 W/m²
-6 -5 -4 -3 -2 -1 0 1 2 3 °C
LONG LASTING HIGH ENERGY SHORTFALL
SUMMARY

Ambition  European energy transition to mitigate climate change
Challenge  Match variable energy demand with variable energy production

Extreme high energy shortfall due to wintertime high pressure systems
  Low wind speeds  →  low production  →  high shortfall
  Low temperatures  →  high demand

Implication  Design our future energy system with these events in mind
Next for me  Investigate predictability of these events
Van der Wiel et al. (2019): Meteorological conditions leading to extreme low variable renewable energy production and extreme high energy shortfall, in review for Renewable & Sustainable Energy Reviews.
EXTRA SLIDES
WIND DROUGHTS AND WINTER COLD THREATEN EUROPE’S FUTURE ENERGY SECURITY

ANNUAL CYCLE OF ENERGY VARIABLES

1-in-10 year low production events
Meteoerological conditions for low energy production
Observed shortfall events fall in the distributions of modelled shortfall events.
CLIMATE CHANGE EFFECTS - LOW PRODUCTION

- Interannual variability exceeds changes due to further global climate change
- No significant change in risk of low production
CLIMATE CHANGE EFFECTS - HIGH SHORTFALL

- Further global climate change decreases winter energy demand
- Reduced risk of high shortfall

CAUTION Energy demand model based on the temperature-demand relationship as in 2006-2015, this is expected to change