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Spatial and temporal (co-)variability in renewable energy

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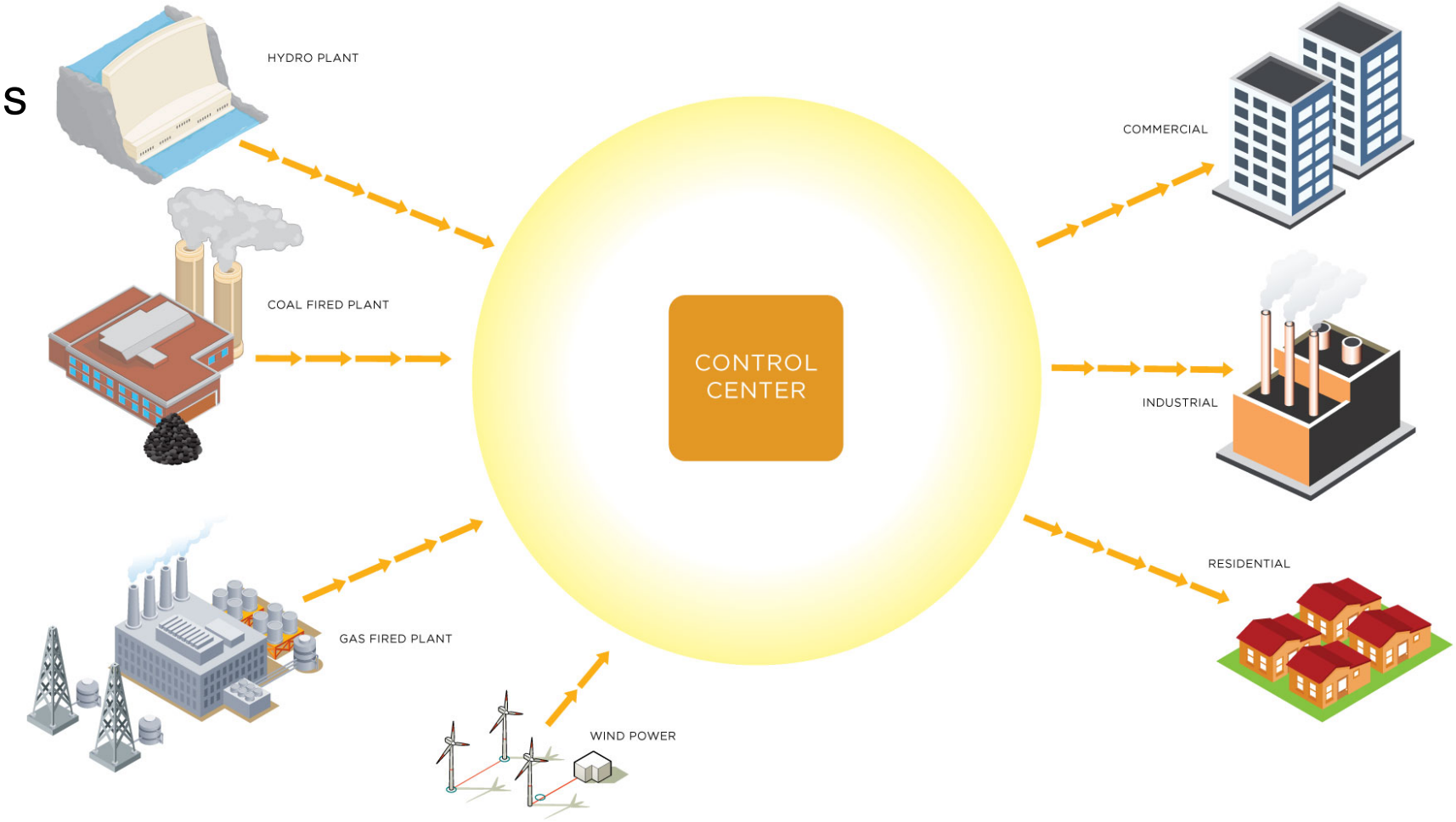
Traditional electricity grid

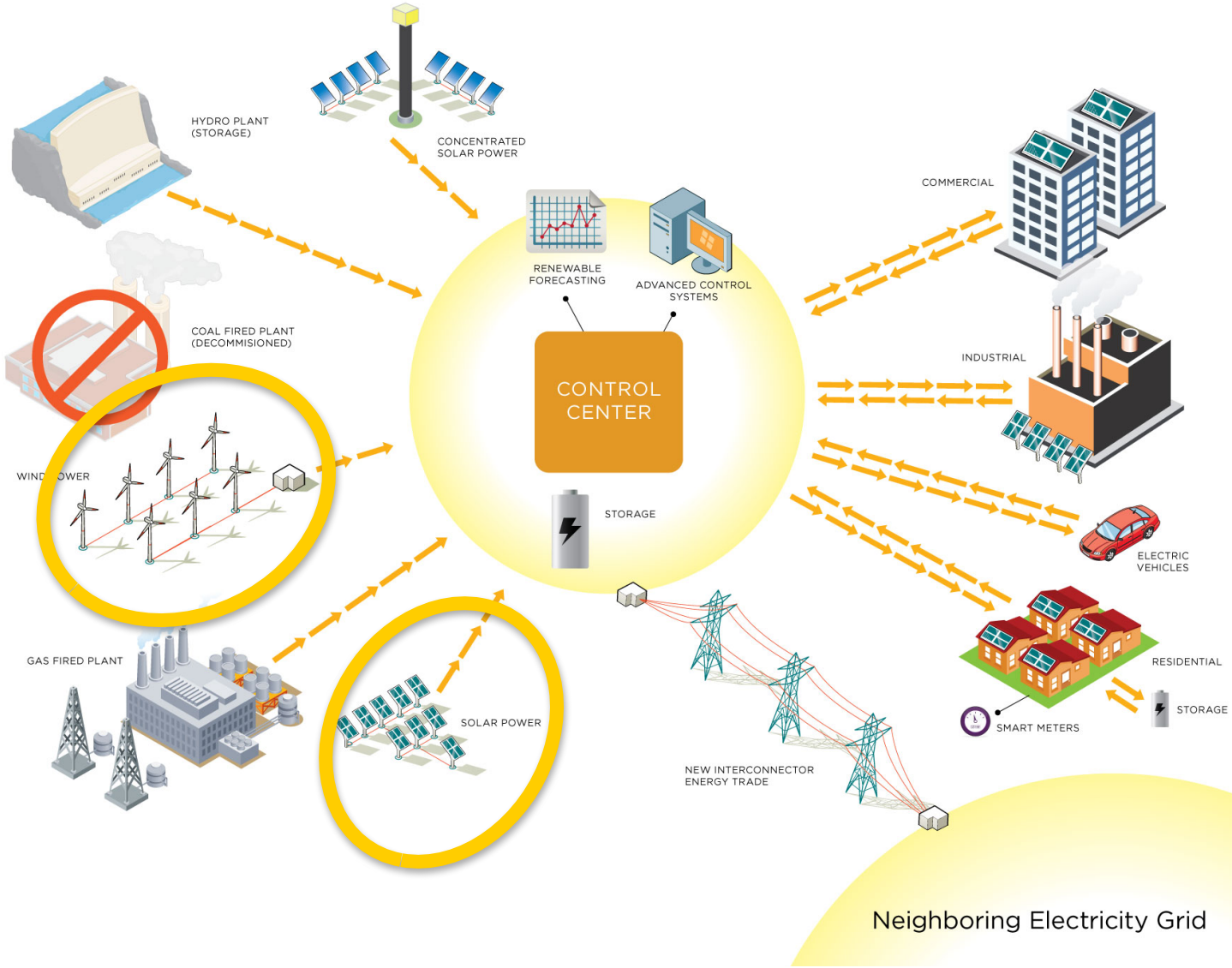
- Carbon-intensive fossil fuels
- Production can be planned



Infographic by World Bank Group

Post-transition electricity grid

- Low-carbon renewable energy
- Production dependent on weather



Infographic by World Bank Group

Research objective

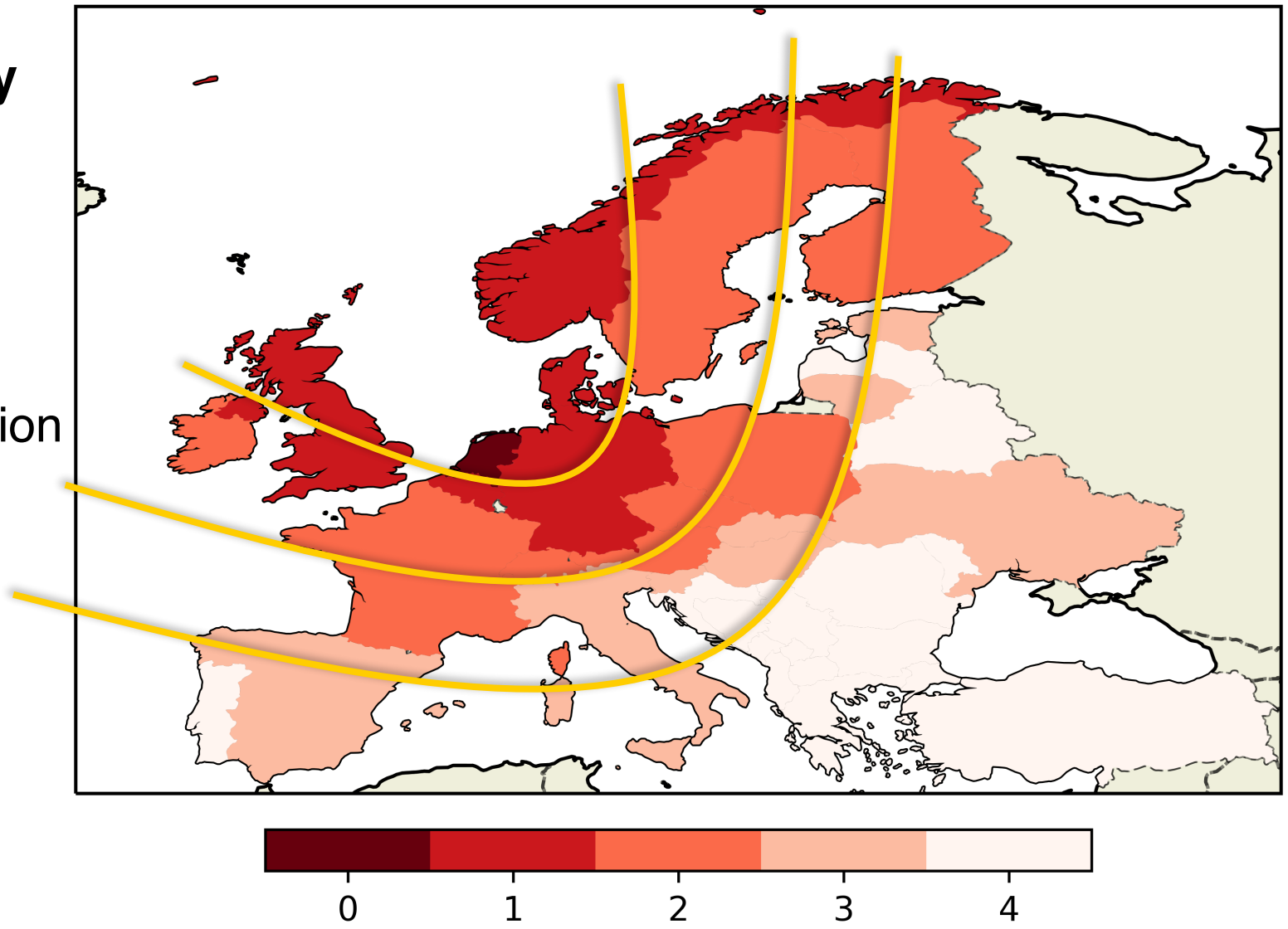
Investigate how the spatial and temporal (co-)variability of renewable energy resource in Europe can be characterised in both mean and extreme conditions

Large ensemble modeling method

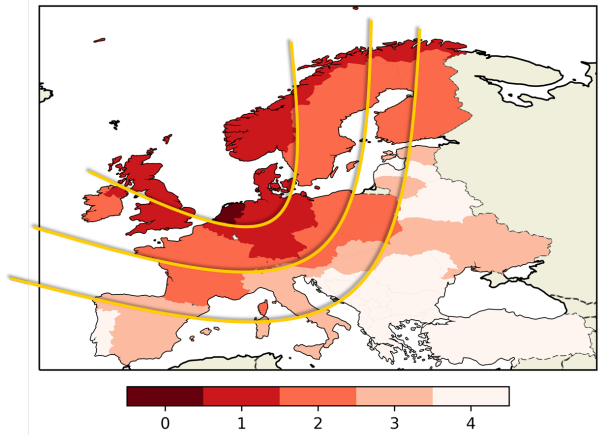
- Simulate 2000 years of present day weather
  - Calculate 2000 years of daily capacity factors
    - Combine solar and wind (25 % -- 75 %)
      - Aggregate CF to national levels
        - Calculate (co-)variability for selected nations

Influence of interconnectivity

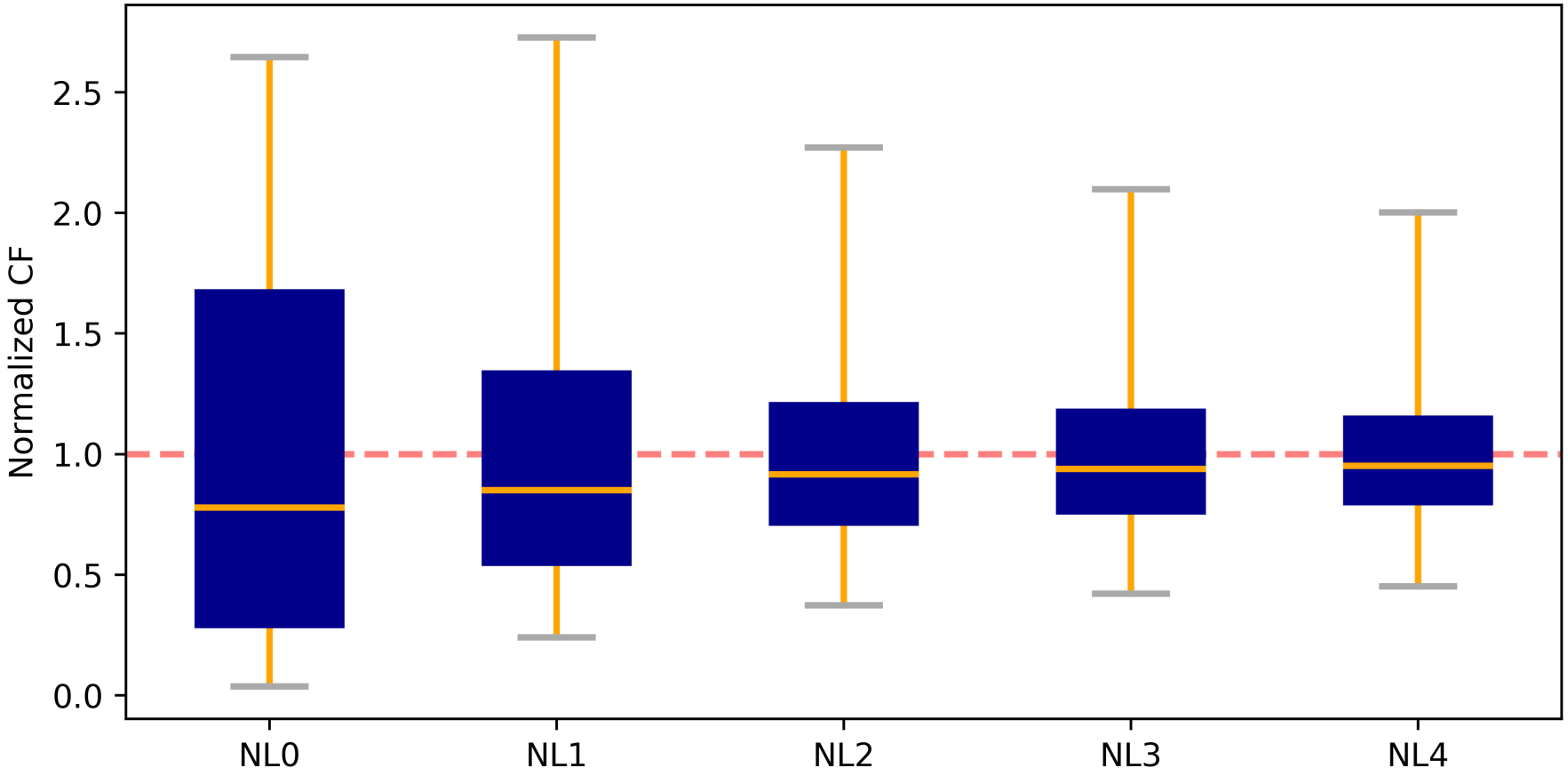
- Label countries based on interconnection steps
- Based on current interconnection



Influence of interconnectivity

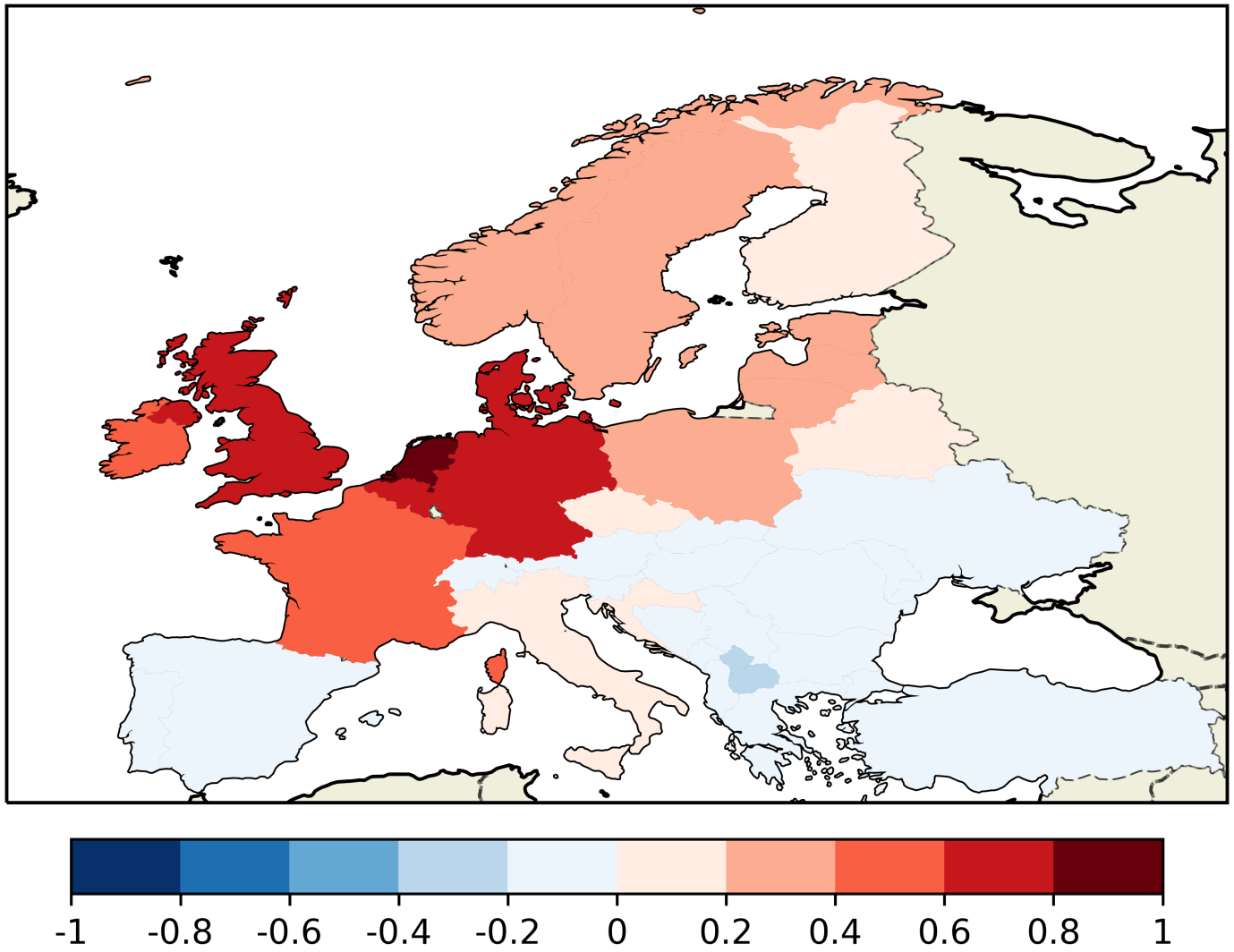


- CF normalised for each considered region
- Median goes to mean for larger regions
- Variance goes down



Covariability between nations

- Covariability is the correlation in normalised capacity factor
- Closer nations show larger covariability
- Large distance ≠ low covariability
- Non-linear correlation decay



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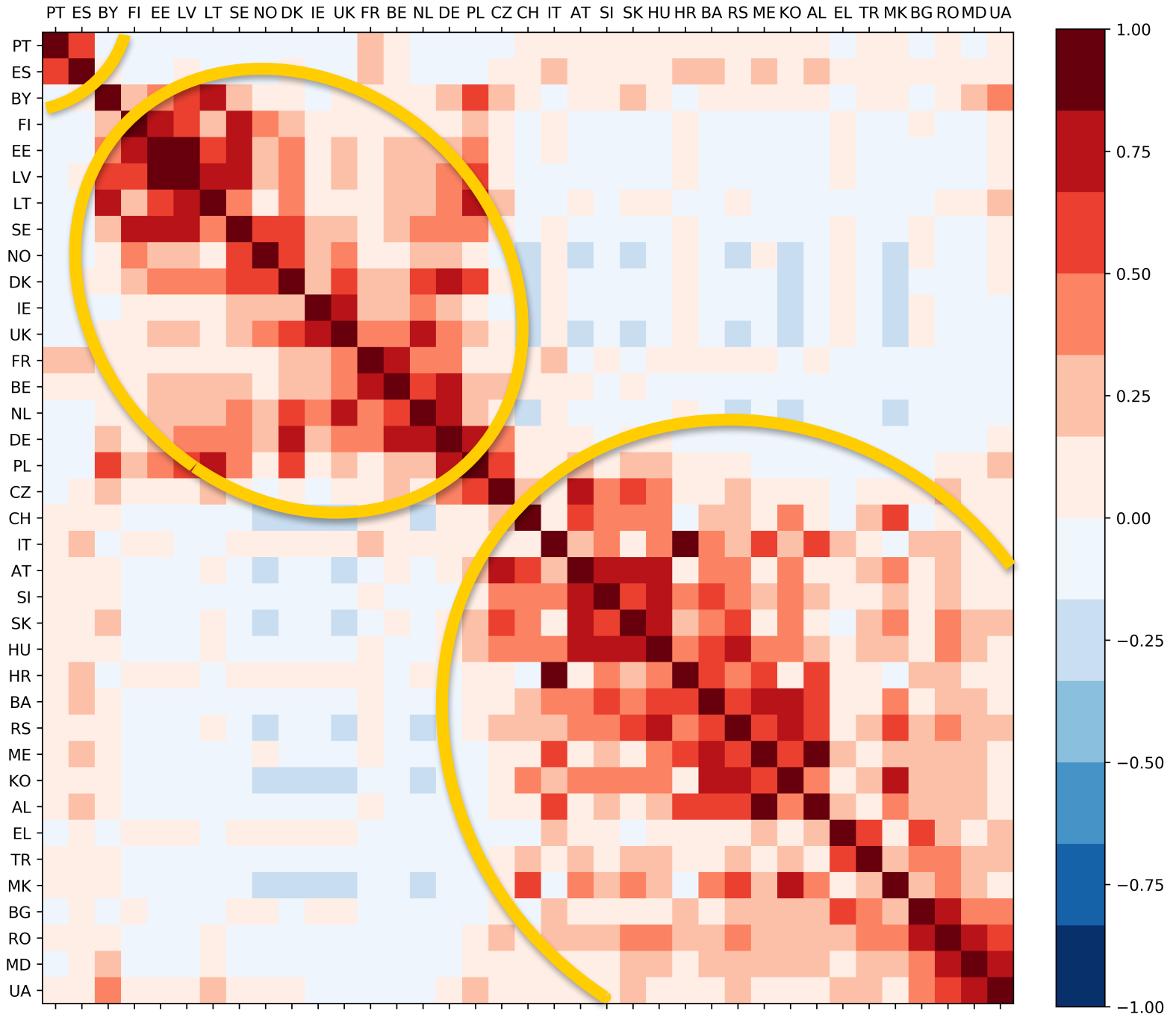
Covariability between nations

- Covariability shown by correlation matrix
- Three clusters can be distinguished

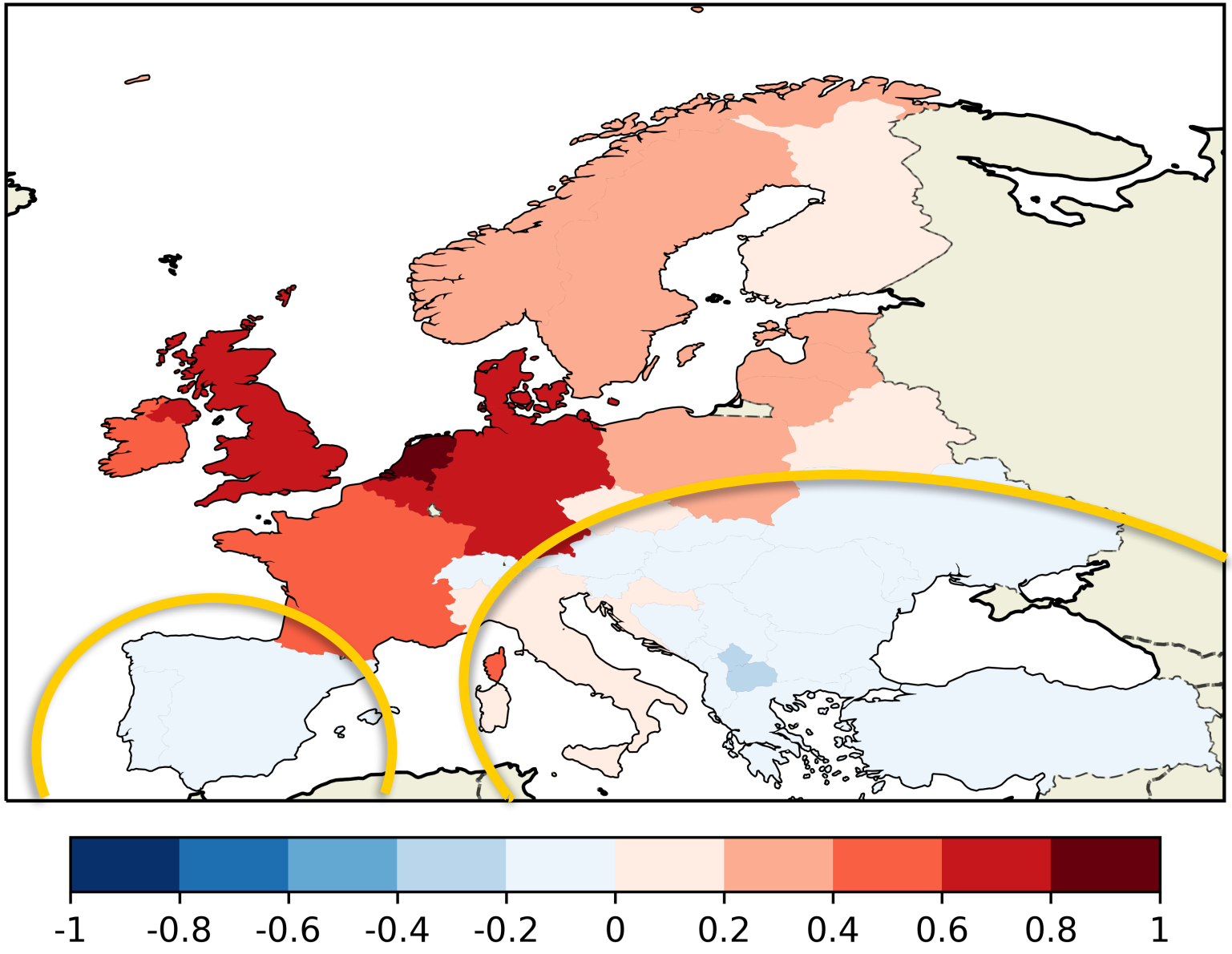


Covariability between nations

Reason for clustering still unresolved

- ? Effect of orography
- ? Related to weather regimes

Further ideas to look at?



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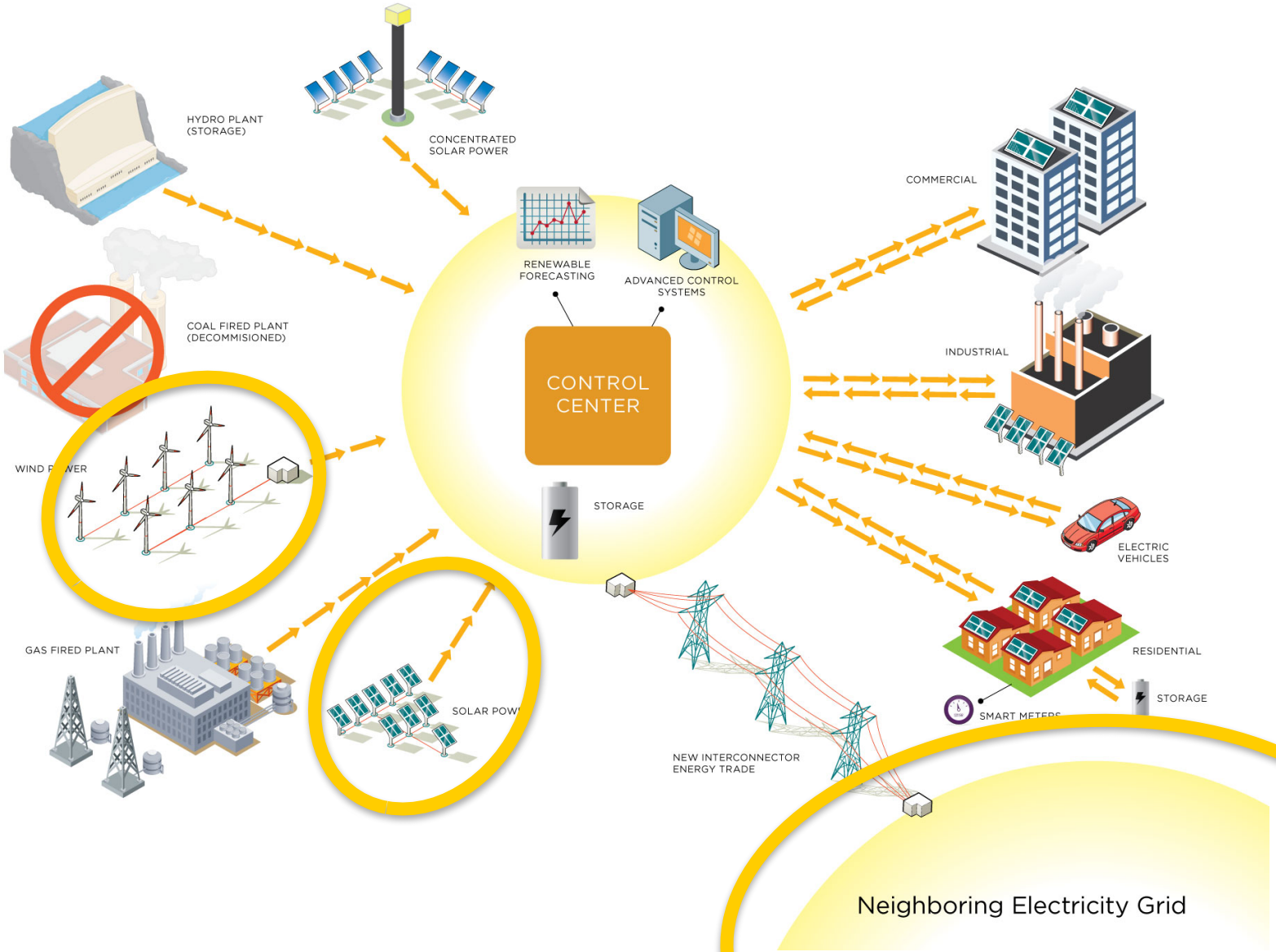
Mean vs Extreme

Variability in extremes

- *'In extreme cases we'll import the energy from other countries'*
- Can the neighbouring electricity grid supply local demand in extreme conditions?



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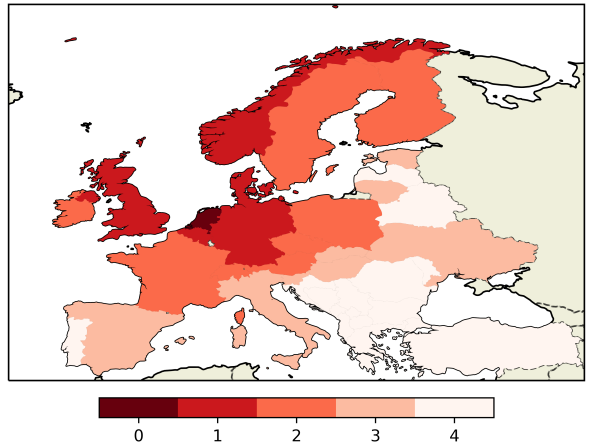
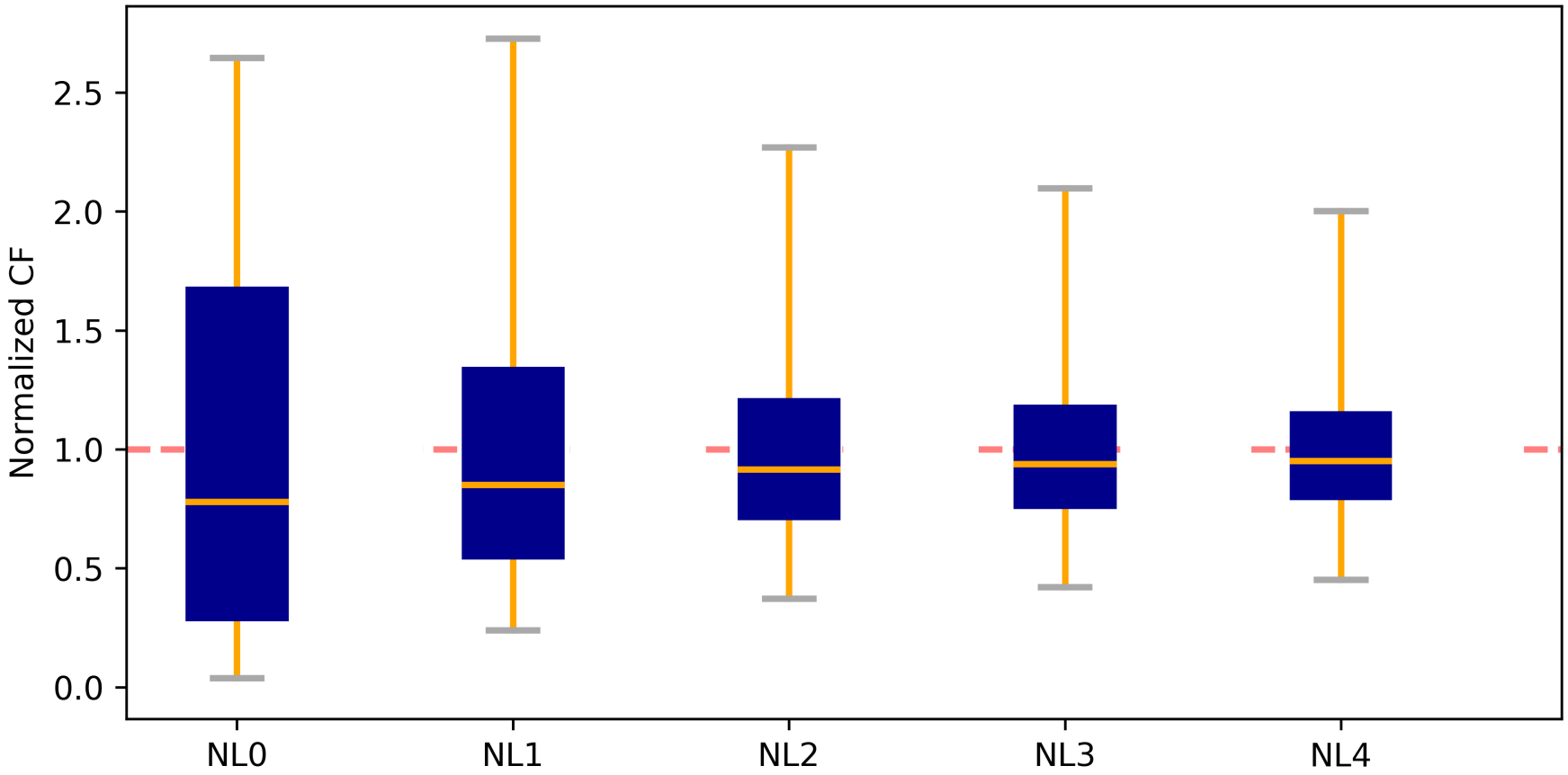
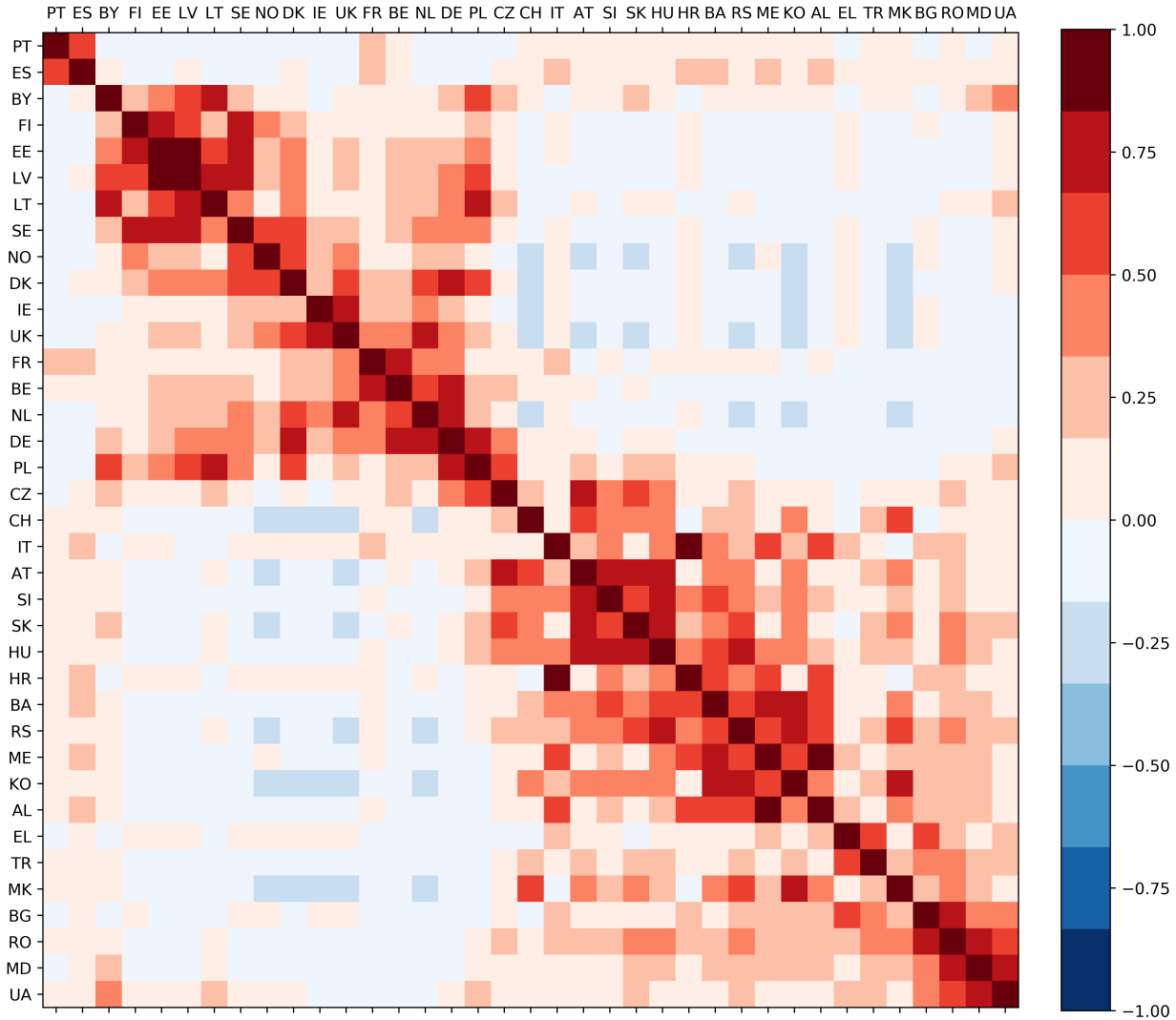


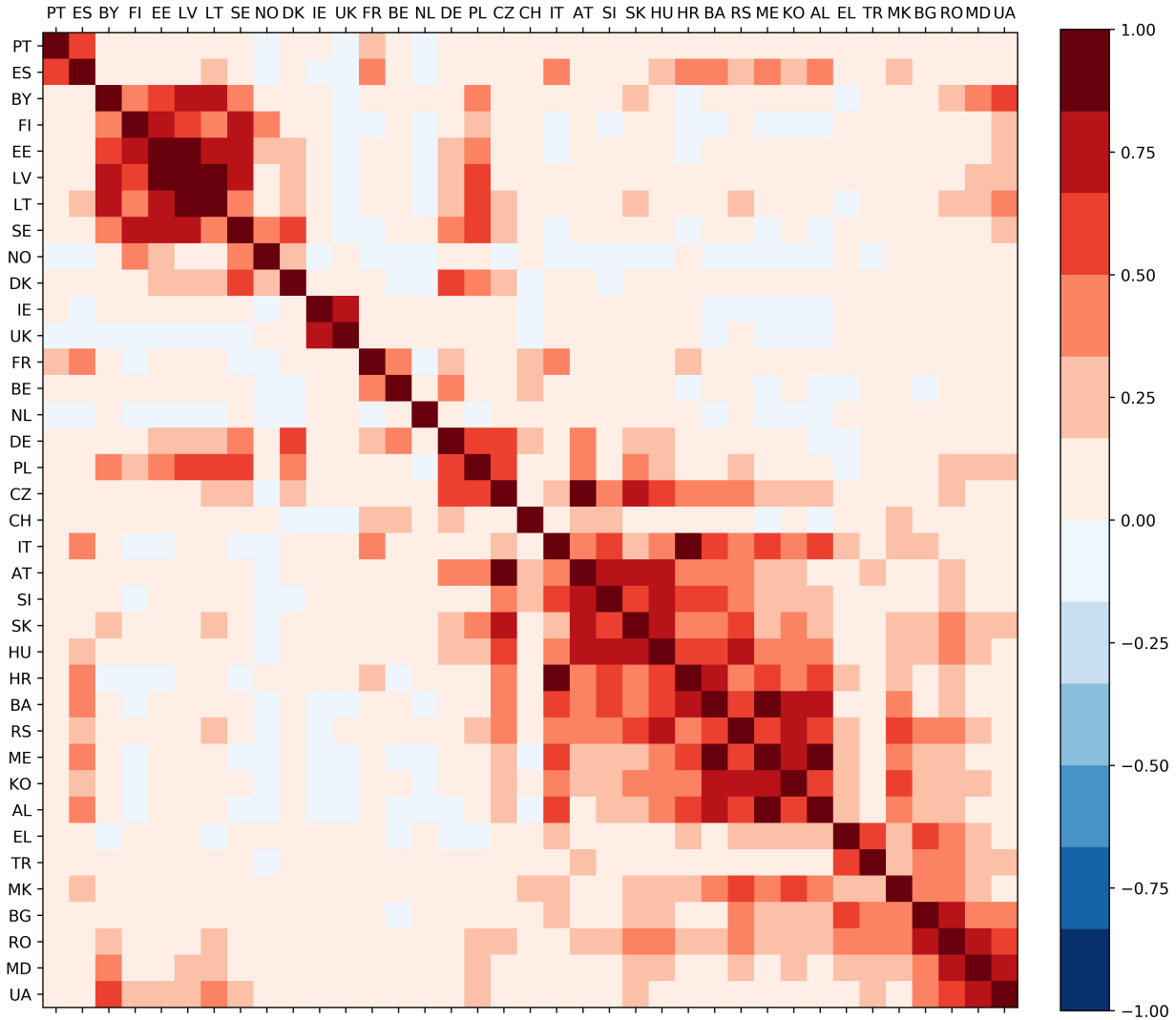
Interconnectivity in extremes

- CF normalised for each considered region
- Median goes to mean for larger regions
- Mean production always below normal
- Variance grows for larger regions



Covariability in extreme condition

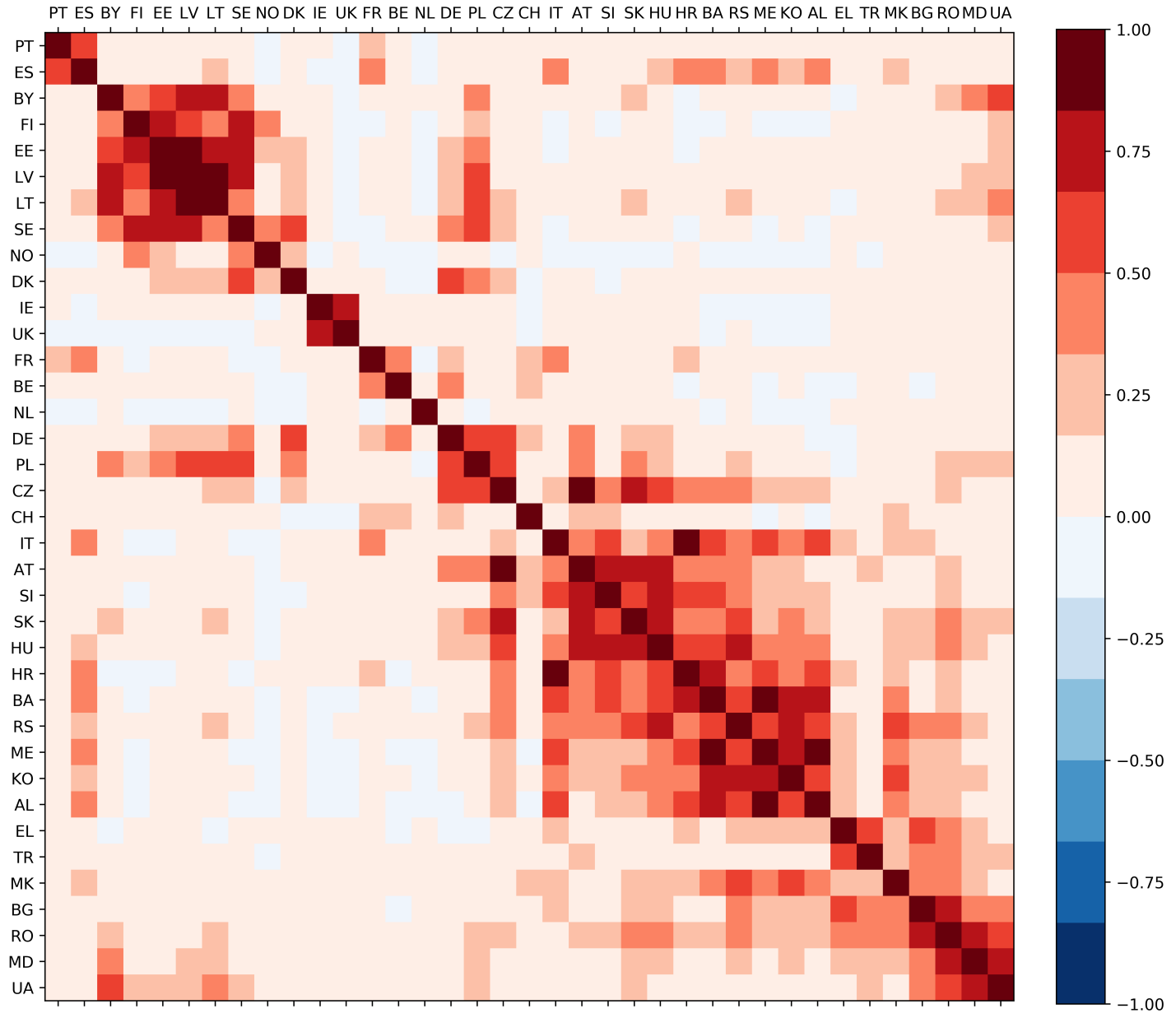




Covariability in extreme conditions

- Three clusters can no longer be distinguished as clearly
- Subclusters appear

More questions arise then answers



Summary

- Interconnectivity helps reduce variability in normal conditions
- Covariability shows clustering in nations, non-linear with distance
- Extreme conditions are extreme for the whole region considered
- Temporal variability not yet considered

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