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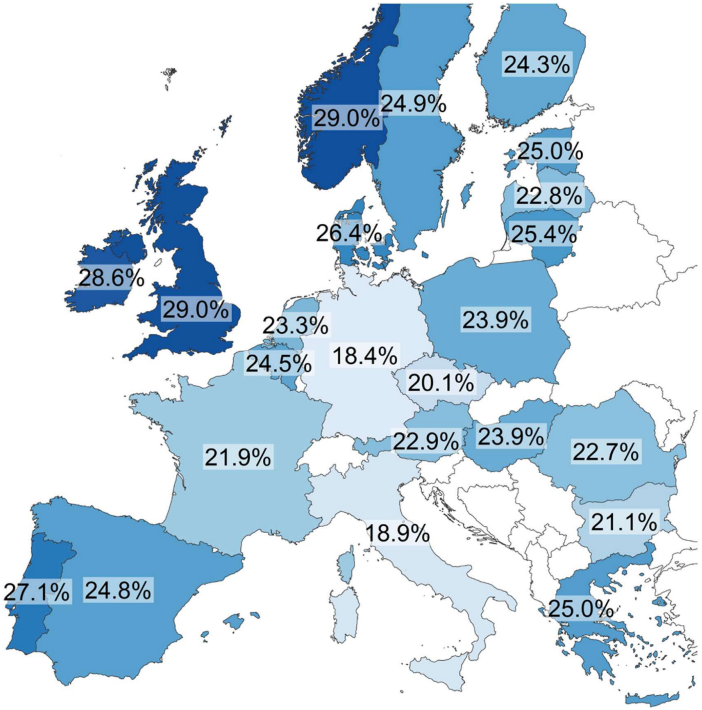
DAFS - Energy System Modelling Module

Tutorial 3 & Assignment



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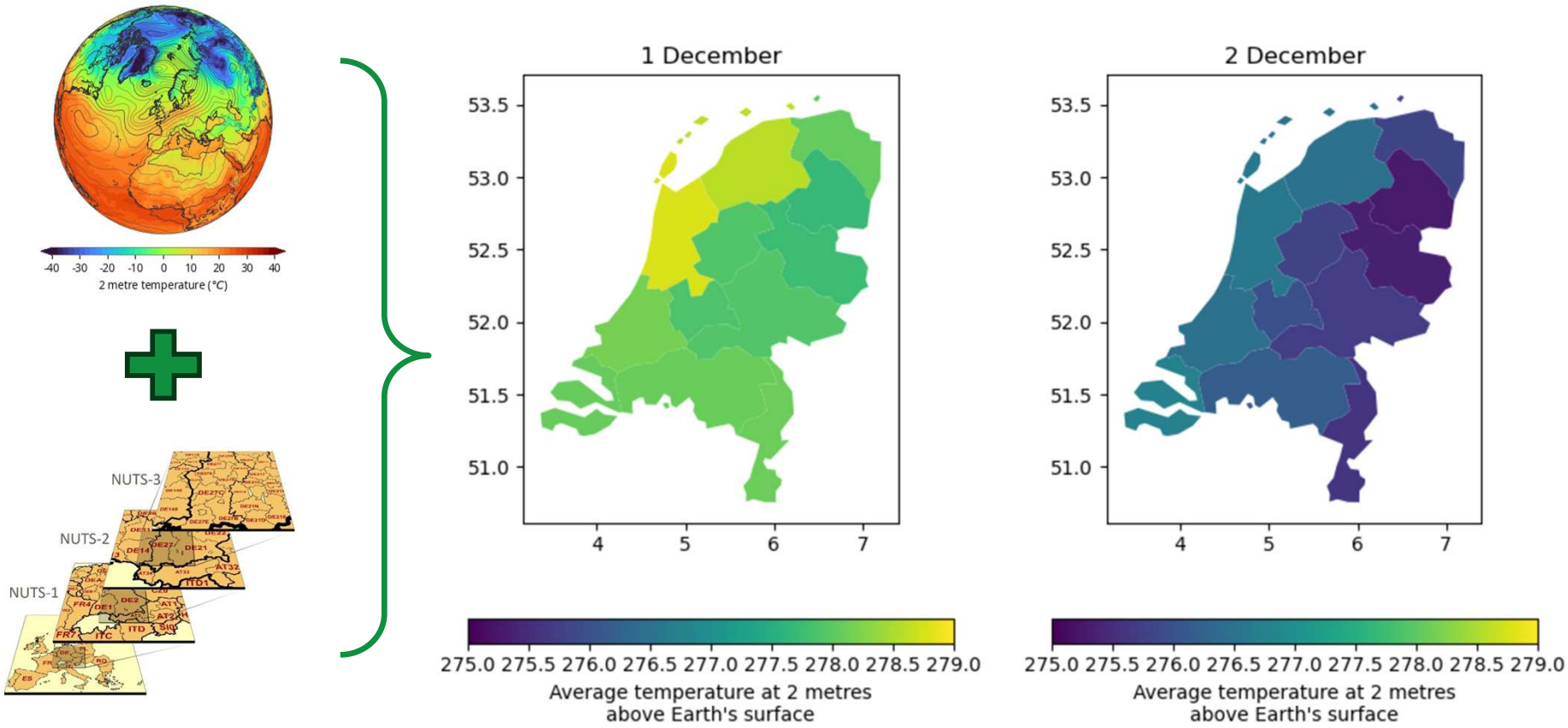
Tutorial 3: Goals

- Combine all we learnt in the previous 2 tutorials: how to manipulate aligned weather and spatial NUTS data
- Learn to calculate simple statistical indicators for the weather data in separate NUTS regions



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Assignment: Goals (1/2)

- Apply what we learnt regarding manipulation of spatio-temporal weather data to a *European RES Assessment* study
- Why? RES Assessment is the first step in modelling future decarbonized energy systems.
- Compute and visualize RES *capacity factors* and solar/wind profiles in the EU
- Deep dive into your favourite NUTS-1 region: understand the concept *of correlation* between RES (solar or wind) time series of different regions
- Understand the concept of *RES droughts* and apply this concept to identify periods of drought in your dataset
- Cluster NUTS-1 regions according to their RES drought pattern
- => Understand implications for the design of the *interconnected energy system* of Europe.

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Why an Interconnected European Energy System?

Three main reasons

- Energy security
- Energy affordability

- Ensure optimal integration of RES

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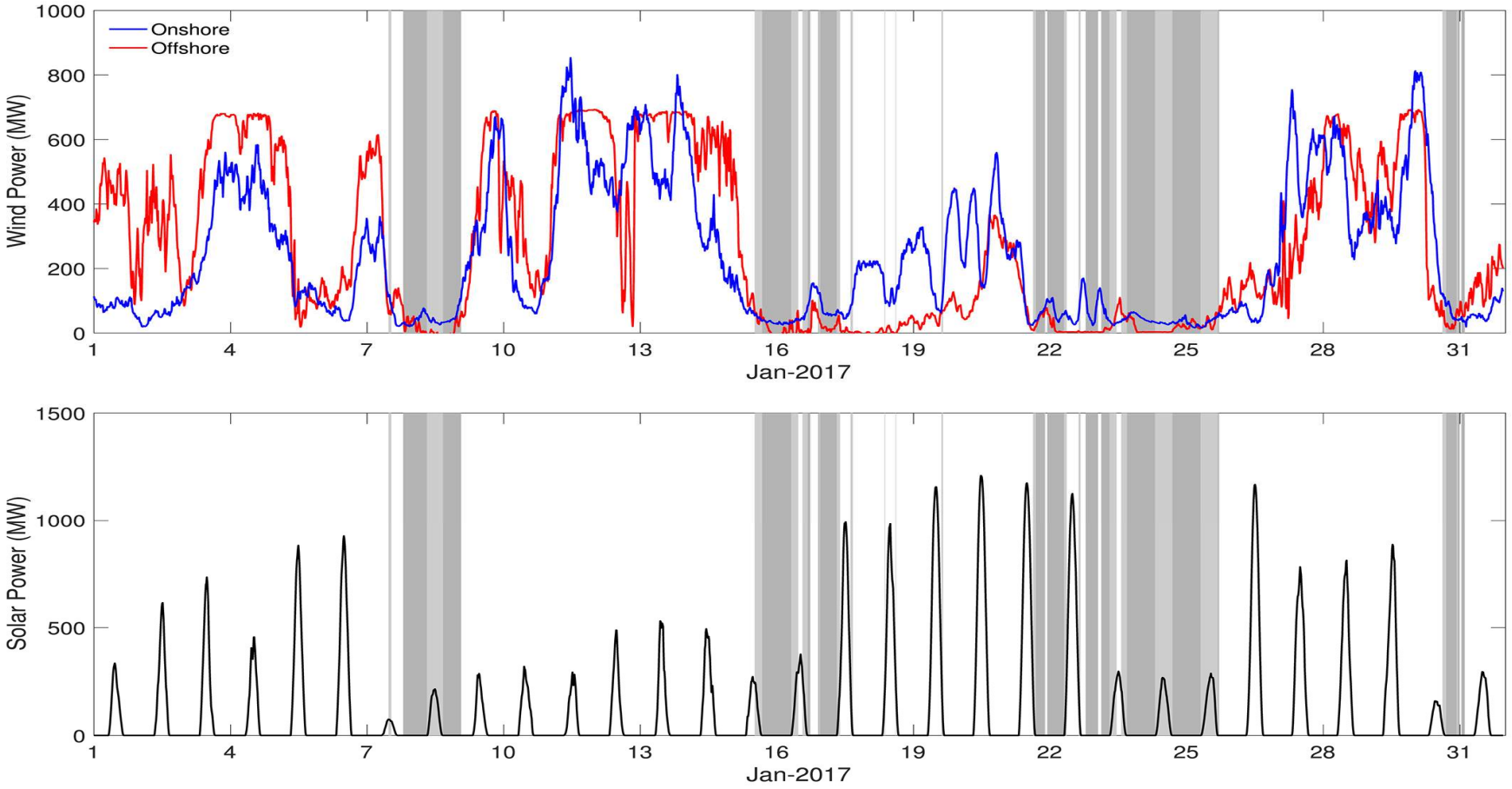
RES Droughts: Belgium example



Bowen Li,Sukanta Basu,Simon J. Watson,Herman W. J. Russchenberg
Mesoscale modeling of a “Dunkelflaute” event

Wind Energy, Volume: 24, Issue: 1, Pages: 5-23, First published: 10 August 2020, DOI: (10.1002/we.2554)

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Assignment: Goals (2/2)

- Sharpen your data analytical skills by posing and answering your own energy system related research question.
- **Examples from last year:**
  - How do day-ahead electricity market price signals correspond to renewable energy droughts in Countries X and Y?
  - How do wind and solar conditions correlate with imbalance prices in Country X?
  - What is the influence of “dunkelflaute” events on the carbon intensity of electricity production in Country Z?
  - How much flexible non-RES capacity is needed in Country X to negate intermittency, if the installed RES capacity is enough to supply all electricity demand?

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Way of working (1/2)

- Total workload: 12 + 60 = 72 hours per student
- Start this week already: Exercises 1-3 are pretty easy!
- Agree on data structures and functions
- Divide tasks per (sub)-question so you can work in parallel whenever possible
- Make sure you understand each other's code
- Keep in mind that having a code that works and produces correct results is a necessary (but not sufficient) condition to get a passing grade => reserve time for analyzing and validating your results
- Alternate between coding and analyzing/literature search, swap roles per (sub)-question to keep engaged
- Reserve regular time in the 3 weeks of 2026 to work on your independent RQ
- Check rubric on BrightSpace to see how you can score points.

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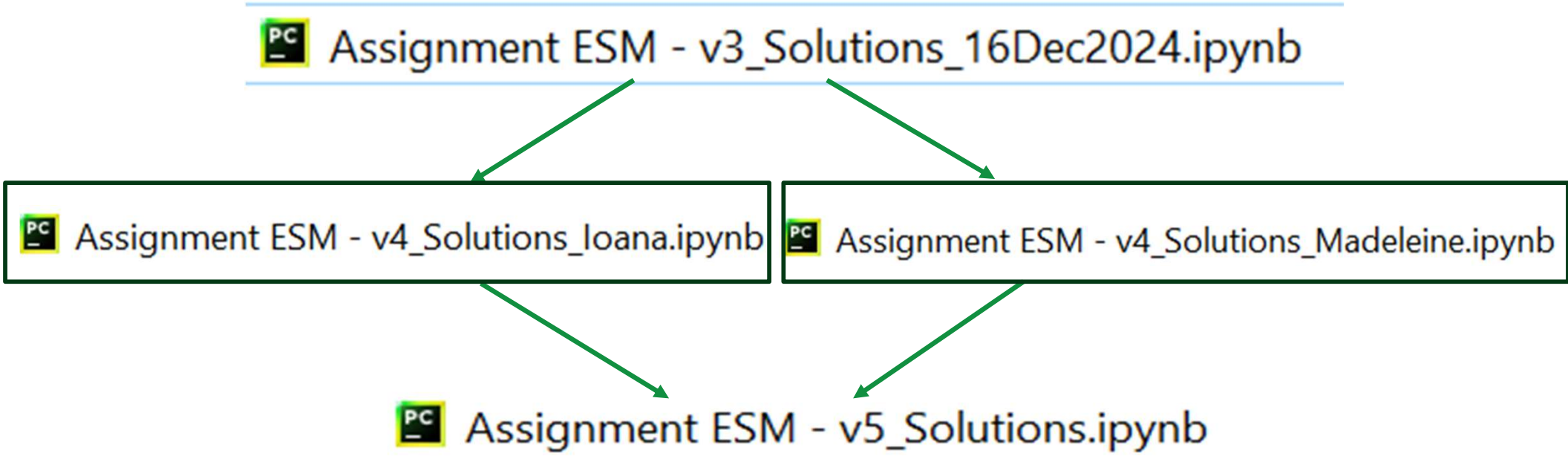
Way of working (2/2)

- Share Jupyter notebooks and data on OneDrive or your favourite cloud-based environment
- Do NOT work on the same notebook at the same time!
- Start with a joint version, fork to work individually and merge again at the end of the day by copy-pasting individual cells in a new version of the notebook
- Verify regularly that the code runs in both your environments!



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Last minute announcements & tips

- Assignment groups – finally – finalized: https://docs.google.com/spreadsheets/d/1J0In9Y9VOvEsj2hOpw0qEi9hpJasfmV_e9DXbiSxLuE/edit?usp=sharing
- Fill in NUTS-1 region and Open RQ by Jan. 5, 2026

- Tips for Q1, see: Xaray User Guide here:
  - use *xarray.merge* to combine datasets for t2m, u100 and v100 with dataset for ssrd for the *same* time slice.
  - use *xarray.concat* to combine the 6 month-long datasets into a final dataset of 1-year length: dataset_final = xarray.concat([datset_jan_jun, dataset_jun_jul], dim='valid_time')
  - Final dataset has the size: 2920(time) x 148(latitude) x 300 (longitude)

HAPPY HOLIDAYS!