Sources of uncertainty over Central Europe based on the recent climate model experiments – PA-110

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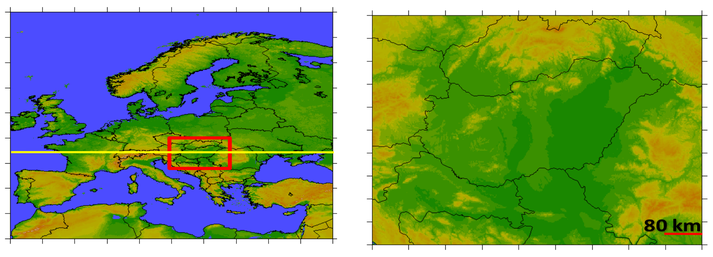
1. Introduction

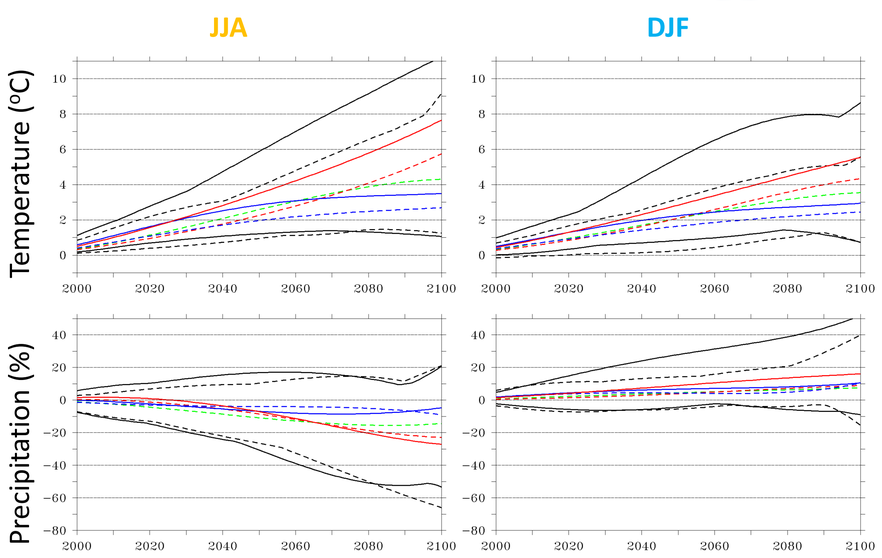
Uncertainties of climate projections are mainly originating from internal variability, model and scenario uncertainty. Shown here are the climate change signals for summer and winter temperature and precipitation results based on global climate models; internal variability as unavoidable part of the climate system; fractions of total uncertainty; signal-to-noise ratio and time of emergence. We seek the answer whether the CMIP5 results are leading to different conclusions than CMIP3 at regional level.



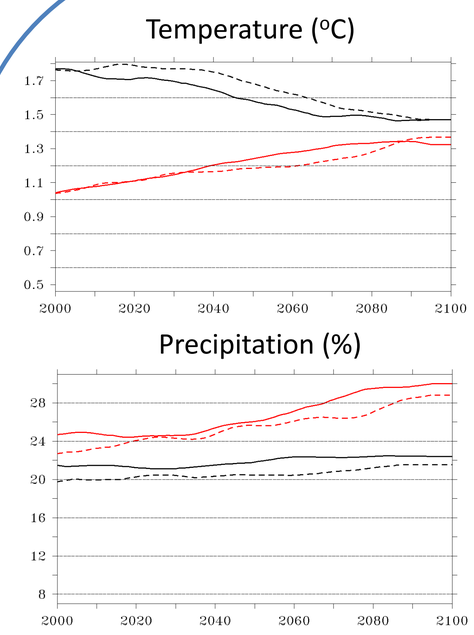
2. Data & method

- Outputs of 15/14 CMIP3 models with 3 SRES scenarios (B1, A1B and A2) and 15 CMIP5 models with 2 RCP scenarios (4.5 and 8.5) were selected for analysis for 1951–2100 (based on validation of CMIP5 ensemble). Gridpoints over the Carpathian Basin are 2-21 in the analysed CMIP3 models and 6-84 for CMIP5.
- Method of Hawkins & Sutton (2009, 2011) was applied with some modifications:
  - ✓ yearly re-calculated internal variability for the previous 30-year – it is not constant in observations over the Carpathian Basin;
  - ✓ yearly annual and seasonal means are applied instead of decadal ones – to capture real variability;
  - ✓ no model weighting – same weights are not ensured over different regions;
  - ✓ no significance test for signal-to-noise ratio – it would never be significant for regional precipitation results.
- Areas of interest: Northern Europe, Southern Europe (separation at 47°N following different precipitation signals in ENSEMBLES) and Carpathian Basin (Central Europe) – see figures left.

3. Climate change signal over the Carpathian Basin



- Climate change is captured through fourth-order polinomial fits to the raw data.
- Temperature signals are remarkably higher for CMIP5, resulting in higher model spread.
- Broadly same JJA precipitation results in both ensembles, while higher model spread for CMIP5 than CMIP3 in DJF.



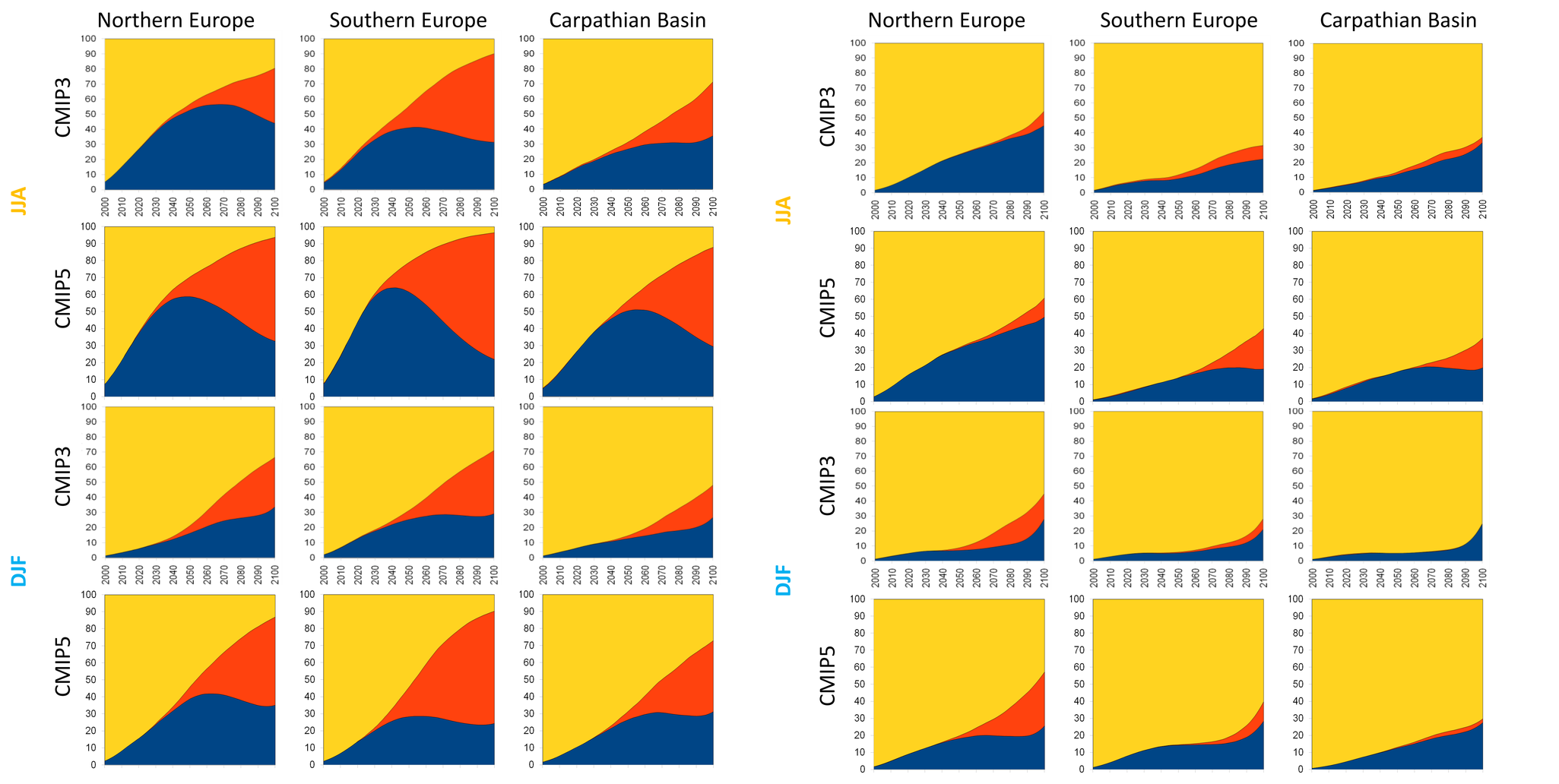
4. Internal variability over the Carpathian Basin

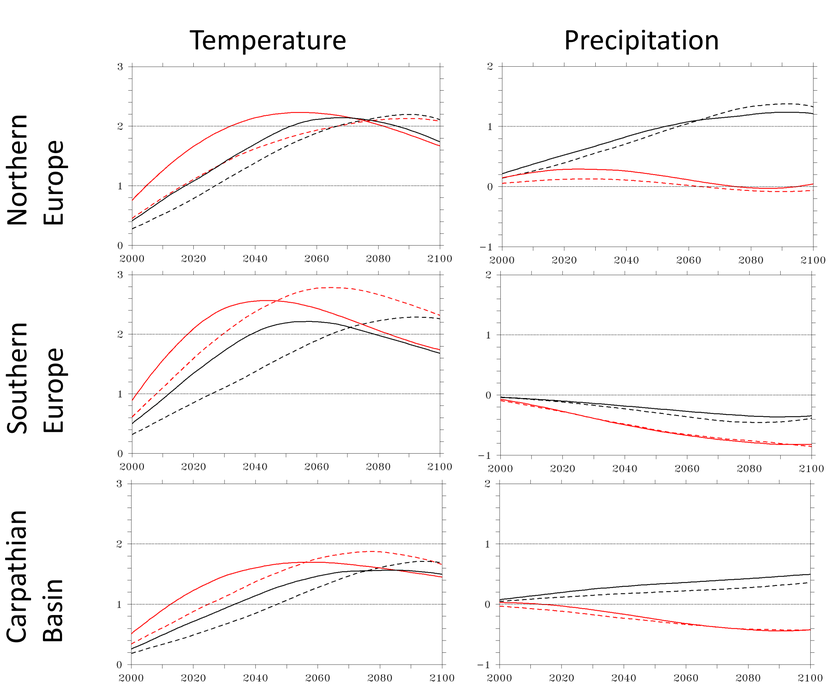
- Internal variability plays an important role of the climate system, but its magnitude depends on the region, the season and the variable.
- DJF temperature of CMIP5 shows less fluctuation than CMIP3.
- Increased internal variability of precipitation in CMIP5.

5. Fractions of uncertainty (in per cent of total uncertainty)

TOTAL = internal variability + model uncertainty + scenario uncertainty

- Internal variability is the leading uncertainty factor until 2050 for both CMIP5 and CMIP3, but slightly lower proportion within the total uncertainty for CMIP5.
- The choice of scenario has considerable impact on temperature change signal, while model selection is more important than scenario for precipitation projections.
- More momentous model and scenario uncertainty for CMIP5 than for CMIP3.

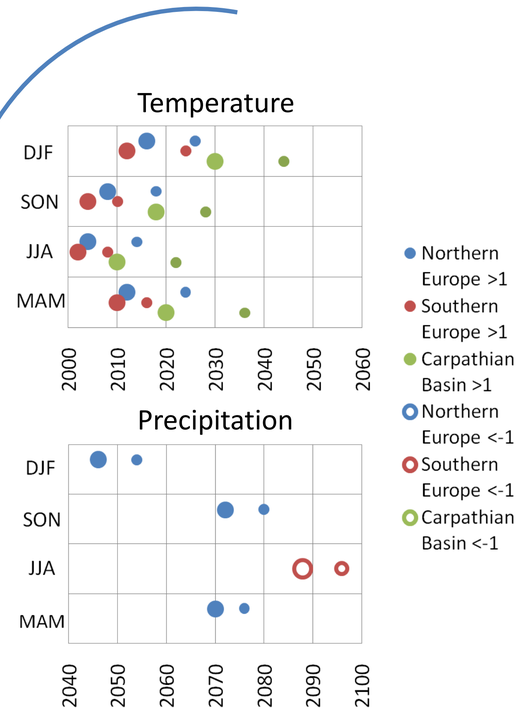




6. Signal-to-noise ratio

$$\text{STN} = \frac{\text{average signal}}{\text{total uncertainty}}$$

- Signal-to-noise ratio measures robustness of the projections.
- CMIP5 results reach the critical value of 1 earlier than CMIP3 for temperature.
- For precipitation, results only for DJF and Northern Europe are robust.



7. Time-of-emergence (for all seasons)

$$\text{TOE} = \text{t, when} \frac{\text{average signal}}{\text{internal variability}} \geq \text{threshold}$$

- When climate change signal is larger than internal variability, it draws the attention of policymakers and urges an act.
- For temperature it is already happening (before 2016), while for precipitation due to high natural variability, it occurs at the second half of the century (or beyond 2100?). Negative is precipitation decrease.
- CMIP5 outputs „shifted" this time 5-10 years earlier than CMIP3.

8. Summary, discussion and outlook

- CMIP5 results give higher temperature change and model spread than CMIP3, leading to higher signal-to-noise ratio and earlier time of emergence.
- CMIP5 results have bigger model and scenario uncertainty than CMIP3 → is model uncertainty bigger also in absolute sense? what does it mean? what if SRESA1B is omitted?
- Well known that GCMs are not independent → how could this influence the conclusions?
- The Carpathian Basin is an area with high internal variability and low predictability for precipitation.
- What is the added value of RCMs on model uncertainty, role of internal variability? → investigation of EURO-CORDEX ensemble (10 RCMs & 2 scenarios are selected)