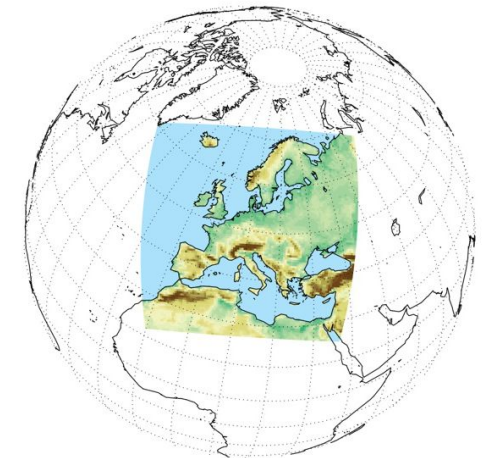


EURO-CORDEX Input

CORDEX International Workshop on Coordinated Regional Projection Research and Synthesis



2026-05-11, Trieste



■ Outline

- Who is the EURO-CORDEX community?
- Present activities with EURO-CORDEX participation
 - CORDEX-FPSs
 - Contribution to CORDEX-15-years papers
 - EURO-CORDEX joint evaluation
- Possible future activities



EURO-CORDEX GA 2026

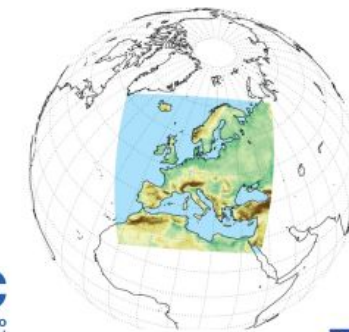
in Hamburg,
Germany

89 participants

56 on-site
33 on-line



EURO-CORDEX



An institution of Helmholtz-Zentrum Hereon



CHARLES UNIVERSITY



Danish Meteorological Institute

Deutscher Wetterdienst
Wetter und Klima aus einer Hand



METEO FRANCE



GHENT UNIVERSITY

MeteoSwiss



ARISTOTLE UNIVERSITY OF THESSALONIKI



DHMZ



JÜLICH FORSCHUNGSZENTRUM



KIT
Karlsruher Institut für Technologie



UNIVERSIDAD DE MURCIA



Met Office Hadley Centre



RMI



The Abdus Salam International Centre for Theoretical Physics



INERIS



Meteorologisches Institut
Universität Bonn



Sciences de l'environnement

Institut Pierre Simon Laplace



INSTITUTO DOM LUIZ



hereon



HungaroMet
Hungarian Meteorological Service



Royal Netherlands Meteorological Institute
Ministry of Infrastructure and the Environment

SMHI

NUI MAYNOOTH
Ollscoil na hÉireann Má Nuad



UNIVERSITY OF HOHENHEIM



UNIVERSITÉ DE VERSAILLES
SAINT-QUENTIN-EN-YVELINES



Wegener Center



NORCE





WCRP CORDEX

Strategic partnerships

- Vulnerability Impacts Adaptation and Climate Services communities (VIACS)
- GCM community
- Data centers

EURO-CORDEX

POC:
Daniela Jacob, Stefan Sobolowski, Eleni Katragkou



Secretariat

Dynamical Downscaling

POC
*Eleni Katragkou
Stefan Sobolowski*

- RCM development
- Dynamical simulations
- Evaluation / historical simulations and projections
- 0.44°, 011° and convection permitting resolutions
- Evaluation studies
- Climate dynamics analysis

Climate Information Distillation

POC
*Douglas Maraun
Jésus Fernandez
Sven Kotlarski*

- Process-based model evaluation
- Understand sources of uncertainty
- Interdisciplinary collaboration
- Develop guidelines

Empirical Statistical Downscaling

POC
*Douglas Maraun
José M. Gutierrez
Rasmus Benestad*

- Development of statistical methods
- Evaluation and intercomparison studies
- Historical simulations and projections
- Convection permitting emulators

Flagship Pilot Studies: Convective Phenomena, Land Use Change

EURO-CORDEX available simulations

EUR-12 balanced matrix experiment [^]

The EURO-CORDEX balanced matrix experiment comprises simulations filling a GCM-RCM-SSP combination matrix with a fractional factorial design.

Colour legend for status: (**planned** **running** **completed** **published**) // source_type: (*unregistered* **ARCM** **AORCM** **ESD**)

	Institution(s)	CNRM-MF	HCLIMcom-SMHI	CLMcom-DWD, CLMcom-FZJ, CLMcom-WEGC, CLMcom-Hereon, CLMcom-KIT	KNMI	GERICS	CNR-ISAC, CUNI, ICTP	AUTH, BCCR- UCAN, IDL-FCUL, TASK-IMWM
	RCM	CNRM- ALADIN64E1	HCLIM43-ALADIN	ICON- CLM-202407-1-1	RACMO23E	REMO2020-2-2	RegCM5-0	WRF451Q
driving_source_id	driving_variant_label							
ERA5		evaluation	evaluation	evaluation	evaluation	evaluation	evaluation	evaluation
CMCC-CM2-SR5	r1i1p1f1	hist ssp126 ssp370		hist ssp126 ssp370				hist ssp126 ssp370
CNRM-ESM2-1	r1i1p1f2	hist ssp126 ssp370	hist ssp126 ssp370		hist ssp126 ssp370		hist ssp126 ssp370	
EC-Earth3-Veg	r1i1p1f1		hist ssp126 ssp370	hist ssp126 ssp370	hist ssp126 ssp370	hist ssp126 ssp370	hist ssp126 ssp370	
MIROC6	r1i1p1f1		hist ssp126 ssp370	hist ssp126 ssp370		hist ssp126 ssp370		
MPI-ESM1-2-HR	r1i1p1f1			hist ssp126 ssp370		hist ssp126 ssp370	hist ssp126 ssp370	hist ssp126 ssp370
NorESM2-MM	r1i1p1f1	hist ssp126 ssp370			hist ssp126 ssp370		hist ssp126 ssp370	hist ssp126 ssp370

Overarching criteria:

- Past climate or baseline performance
- Future climate spread

(avoid an ensemble of opportunity)

Source: https://wcrp-cordex.github.io/simulation-status/CORDEX_CMIP6_status_by_experiment.html#EUR-12
 Paper on GCM selection: GCM Selection and Ensemble Design: Best Practices and Recommendations from the EURO-CORDEX Community, Sobolowski et al., <https://doi.org/10.1175/BAMS-D-23-0189.1>

EURO-CORDEX participation in CORDEX-FPSs

finished FPSs

- CORDEX convection
 - Europe + Mediterranean: Convective phenomena at high resolution over Europe and the Mediterranean. *PI: Erika Coppola and Stefan Sobolowski*
- CORDEX-FPS LUCAS
 - Europe: Impact of land use changes on climate in Europe across spatial and temporal scales. *PI: Diana Rechid*

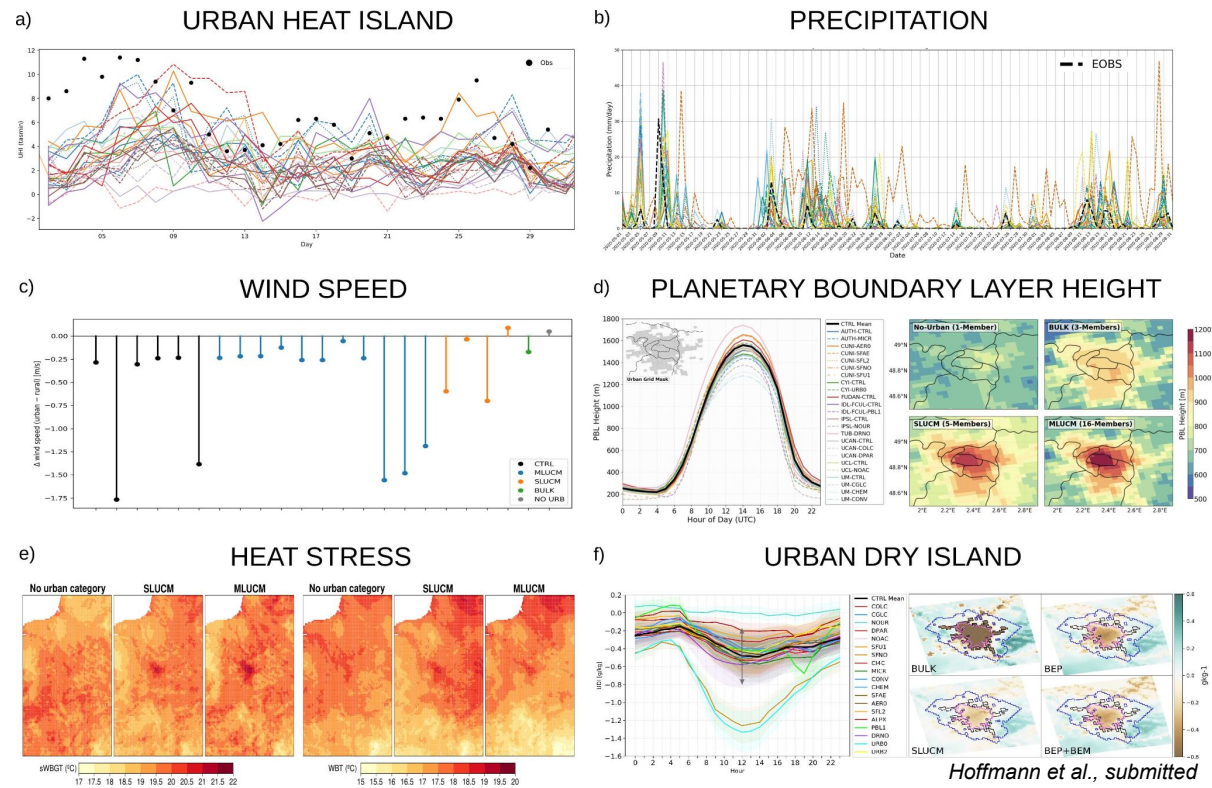
ongoing FPSs

- CORDEX-URB-RCC
 - Europe: URBan environments and Regional Climate Change (URB-RCC). *PI: Tomas Halenka, Gaby Langendijk, Peter Hoffmann*

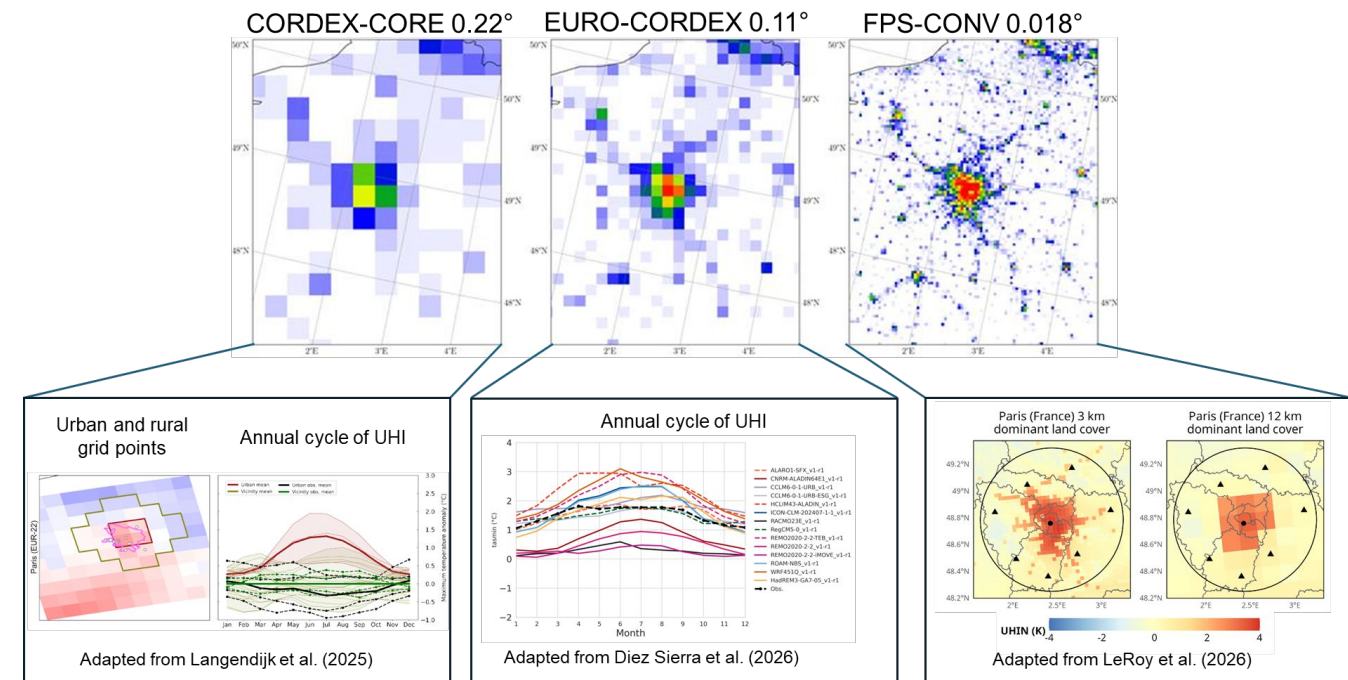
Main goal: to understand the two-way interactions between urban areas and regional climate change, with the help of coordinated experiments with urbanized RCMs.

- 30 partners worldwide
- Bridging RCM and urban climate community
- CORE-city: Paris
- Global Satellite Cities (incl. Johannesburg, Sao Paulo, Buenos Aires, Montreal, Shanghai).

Analysis of short-term evaluation ensemble (STAGE-0) for Paris



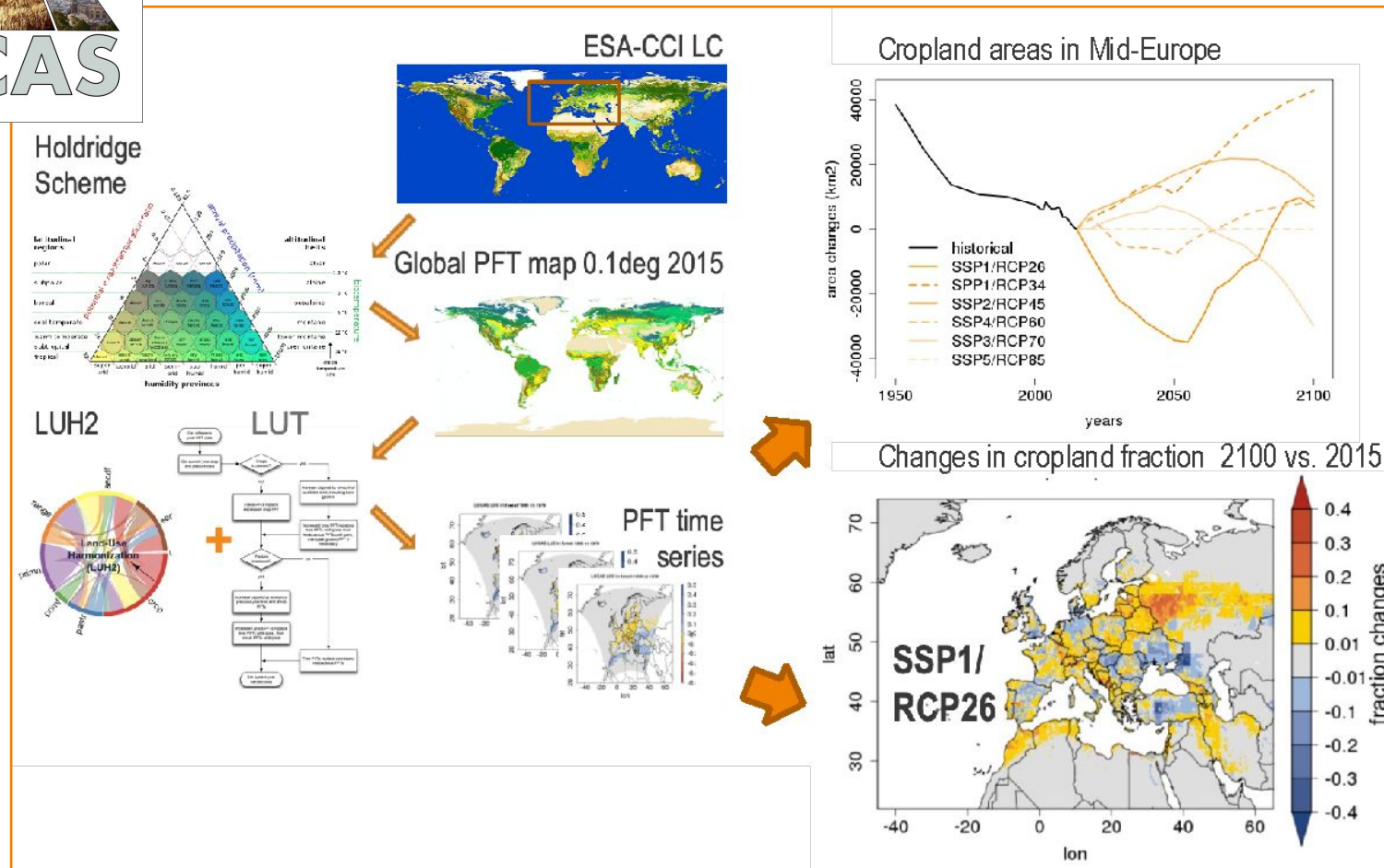
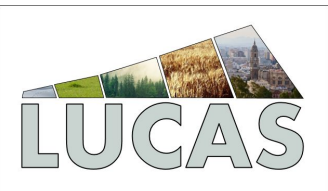
Analysis of existing CORDEX/RCM datasets



Hoffmann et al., submitted

Overview paper of the activity: Langendijk et al., 2024 <https://doi.org/10.1016/j.uclim.2024.102165>

Overview paper on first outcomes: Hoffmann et al., submitted to PLOS Climate



LANDMATE PFT + urban areas for Europe 2015 V1.1 (Reinhart et al., 2022, WDCC/DKRZ)

- PFT map 2015 on **0.1 deg** and **0.018 deg** for EURO-CORDEX domain

LUCAS LUC historical and future land use land cover change for Europe V1.1 (Hoffmann et al., 2022)

- Annual PFT maps on 0.1 deg for EURO-CORDEX domain for the past 1950-2015, and for **multiple SSPs 2016-2100** following LUMIP/CMIP6, based on LUH2

The method was extended to **CORDEX-NA** (Hoffmann et al. 2024, WDCC/DKRZ)

⇒ **Gobal LANDMATE and LUCAS LUC datasets on 0.1 deg in prepration for use in all CORDEX regions**

Hoffmann, P., Reinhart, V., Rechid, D., de Noblet-Ducoudré, N., Davin, E. L., Asmus, C., Bechtel, B., Böhner, J., Katragkou, E., and Luyssaert, S.: High-resolution land use and land cover dataset for regional climate modelling: historical and future changes in Europe, *Earth Syst. Sci. Data*, 15, 3819–3852, <https://doi.org/10.5194/essd-15-3819-2023>, 2023.

Contribution to CORDEX-15-years papers

- EURO-CORDEX from science to practice: Lessons learnt and future perspectives

CORDEX-FPSs

- Challenges of *urbanization* in CORDEX - lessons learnt from FPS URB-RCC
- Lessons learnt from the first coordinated regional climate modelling experiments accounting for *land use changes*: impacts and opportunities for modellers and society
- Perspectives on convection permitting modelling from CORDEX

CORDEX-TFs

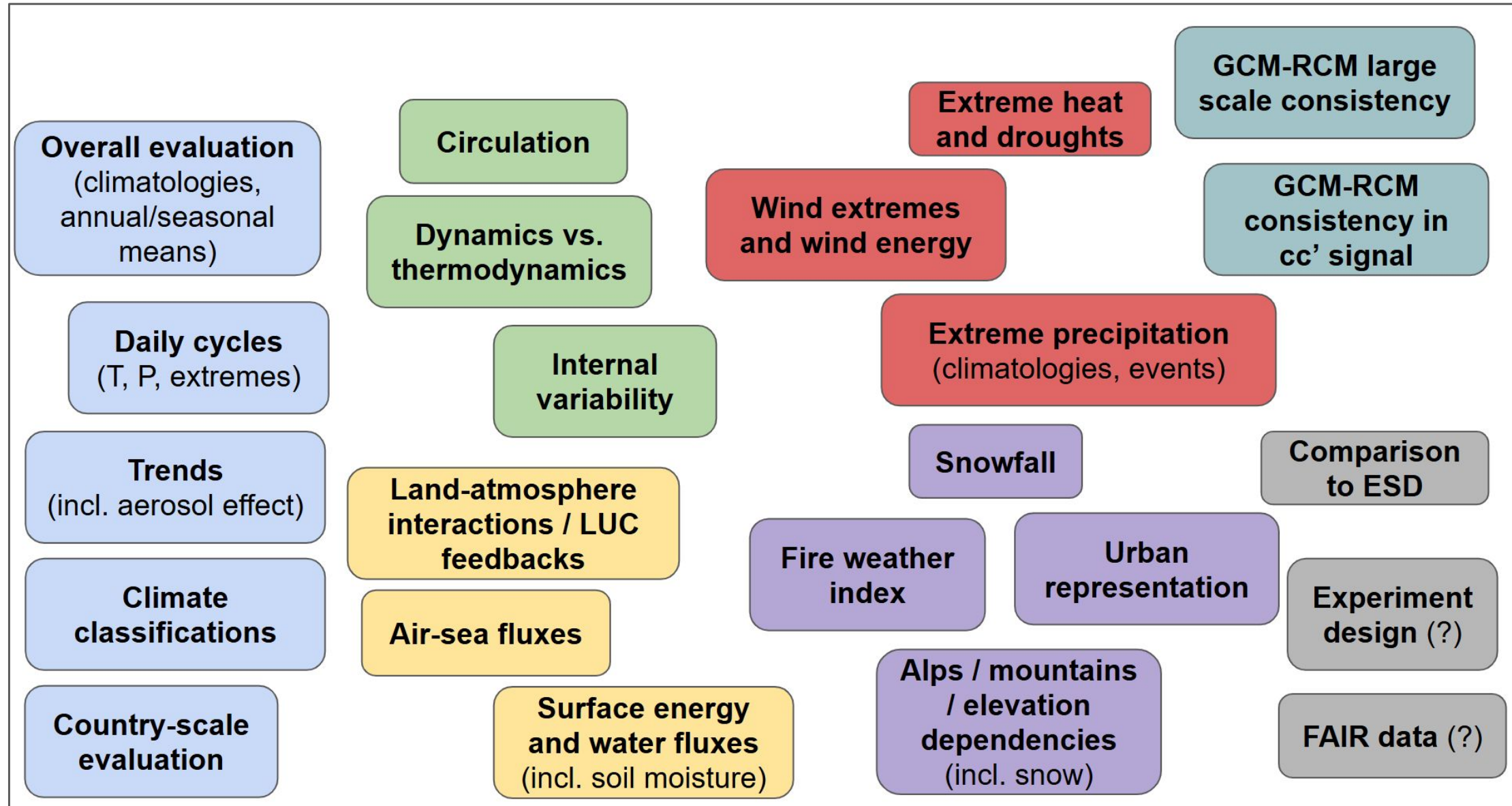
- CORDEX-CORE EXP-II -- New Coordinated Output for Regional Evaluations
- Advancing Climate Downscaling with *Machine Learning Methods*: The CORDEX Task Force on ML
- Towards global standardization of climate downscaling: CORDEX experimental and technical setup (t.b.c.)

Joint Evaluation activity

Objectives and Scope

- Jointly evaluate the CMIP6-based EURO-CORDEX ensemble.
- Focus on ERA5-driven runs first.
- Cover different aspects of model performance in individual “topics”
See <https://docs.google.com/spreadsheets/d/1YNLeY9sLmR5ZdCtjfuZUT7AGodkgLtycP7iyDGB6e9g/edit?gid=0#gid=0>
- If possible: Compare to CMIP5-based ensemble
- Publish results ideally **before or shortly after** public release of data.
- **Open exercise:** Participation open to entire EURO-CORDEX community. Coordination/overview by Claas and Sven. Co-authorship offered to all modelling groups that provide data.
- **Temporary data storage** at Julich Supercomputing Centre (JSC). Currently ~14 evaluation runs. **Thanks to Klaus and Lars!**
- **Topic leads request required variables** via Github. Modeling groups upload data if possible. **Data to be used for joint evaluation exclusively.**

Scoping Meeting September 2024: Suggested Topics



Actual topics and leads

Overview evaluation (Fernandez)

Trends (Nabat / Somot)

Water budgets (Goergen)

Extreme heat and droughts (Spinoni)

Extreme precipitation (Evin / Caillaud / Feldmann / Hundhausen)

Urban representation (Diez-Sierra / Zazulie / Langendijk)

Heat stress (Casanueva)

Extreme precipitation trends (Adinolfi / Vichot Llano)

GCM-RCM consistency (Boé / Corre)

Atmospheric rivers (Ramos)

Air-sea-fluxes (Hagemann)

Wind (Sanchez)

Fire weather (Bedia / Ramos)

Mountains (Matiu / Schellander-Gorgas / Kotlarski)

Snow (Steger / Kotlarski)

GCM-RCM large scale consistency (Buonomo)

Multi-feature analysis of mean and extreme precipitation (Prein)

Climate classifications (Belda)

Circulation (X)

Country-scale evaluation (X)

Diurnal cycles (X)

Dynamics vs. Thermodynamics (X)

Land-atmosphere interactions (X)

(mostly) **open to further ideas and contributors**
(contact topic leads or volunteer as topic lead)



Paper draft available (soon)
Analysis advanced but no paper draft yet
Analysis in (very) early stage
No topic lead yet

Summary: Joint evaluation

- Jointly evaluation exercise **on its way**. Thanks to all topic leads, contributors and JSC/Klaus/Lars!
- Several **paper submissions** planned by summer 2026
- **Extension to GCM-driven ensemble** planned for many topics

Possible future activities

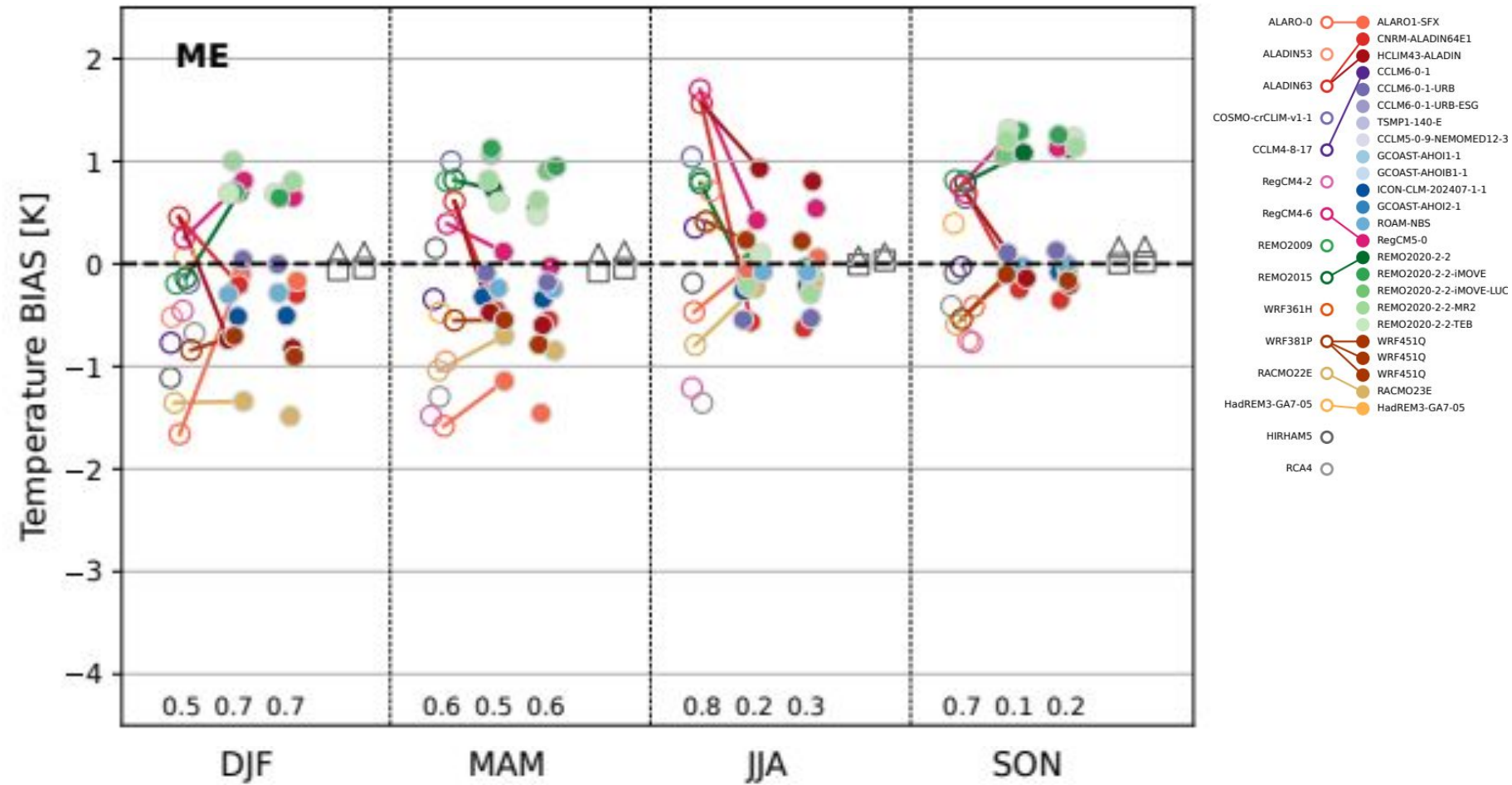
Possible future activities

- Fire danger (Joaquín Bedia)
 - Follow-on study after EURO-CORDEX joint evaluation of ERA5-driven FWI simulations
- Heat stress (Ana Casanueva)
 - Follow-on study after evaluation paper
- Urban (Natalia Zazulie, Javier Diez-Sierra)
 - Continue the evaluation analysis for EUR-12 and extend it to projections, examining the climate change signal in urban environments as well as the urban–rural contrast across different climate indices.
- Large multi-model ensembles (Rasmus Benestad)
 - Ensemble mean, standard deviations plus 3 quality measures gridded with 5 arc-minute resolution
- Wind (Enrique Sánchez Sánchez)
- (EURO-)CORDEX comparison with high-resolution GCMs (Claas Teichmann)
 - mean climate change, daily cycles, extremes

■ Thank you for your attention!

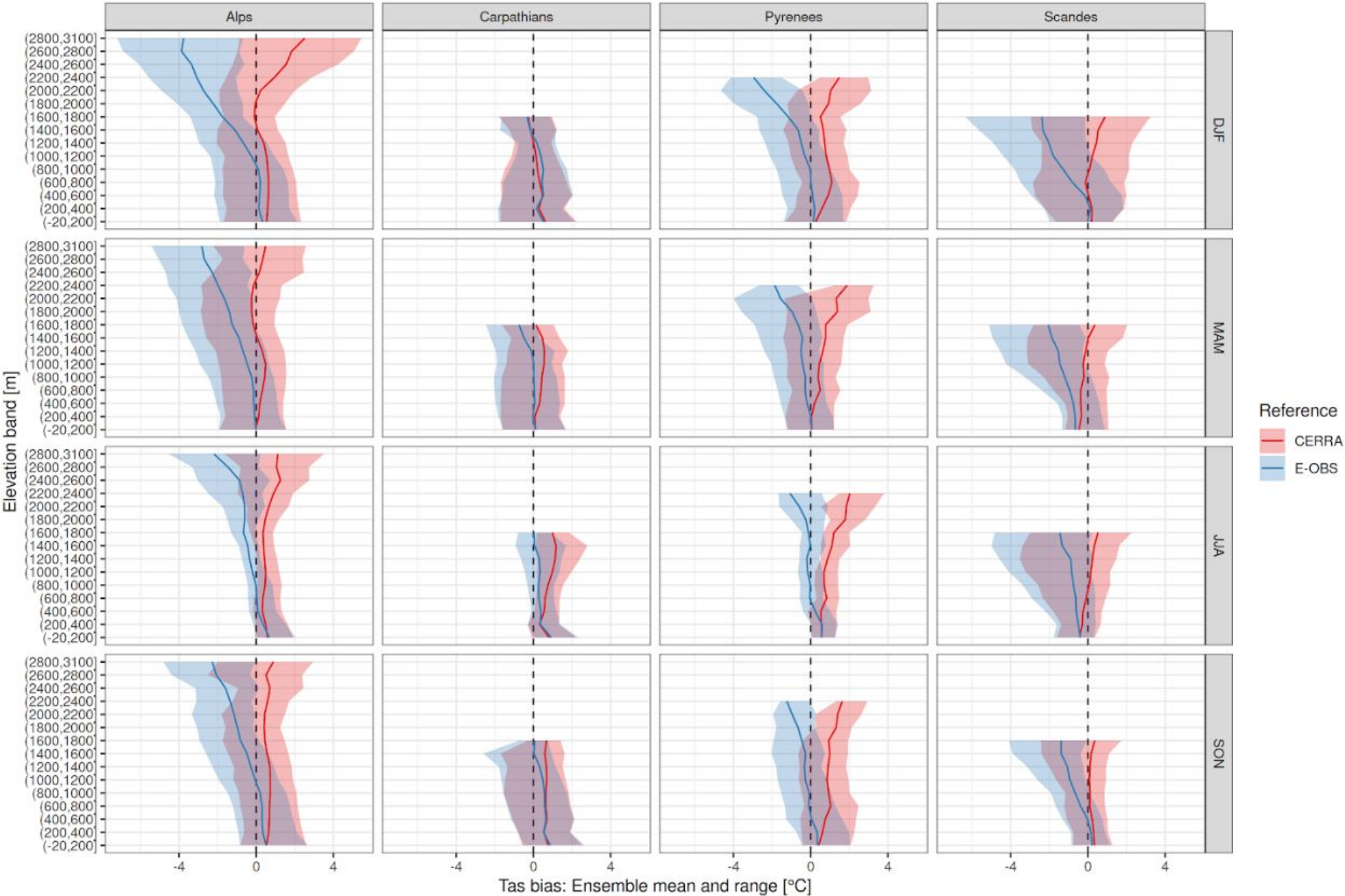
Overview evaluation

Mean JJA temperature bias wrt. EOBS



Source: Jesus Fernandez, Javier Diez Sierra

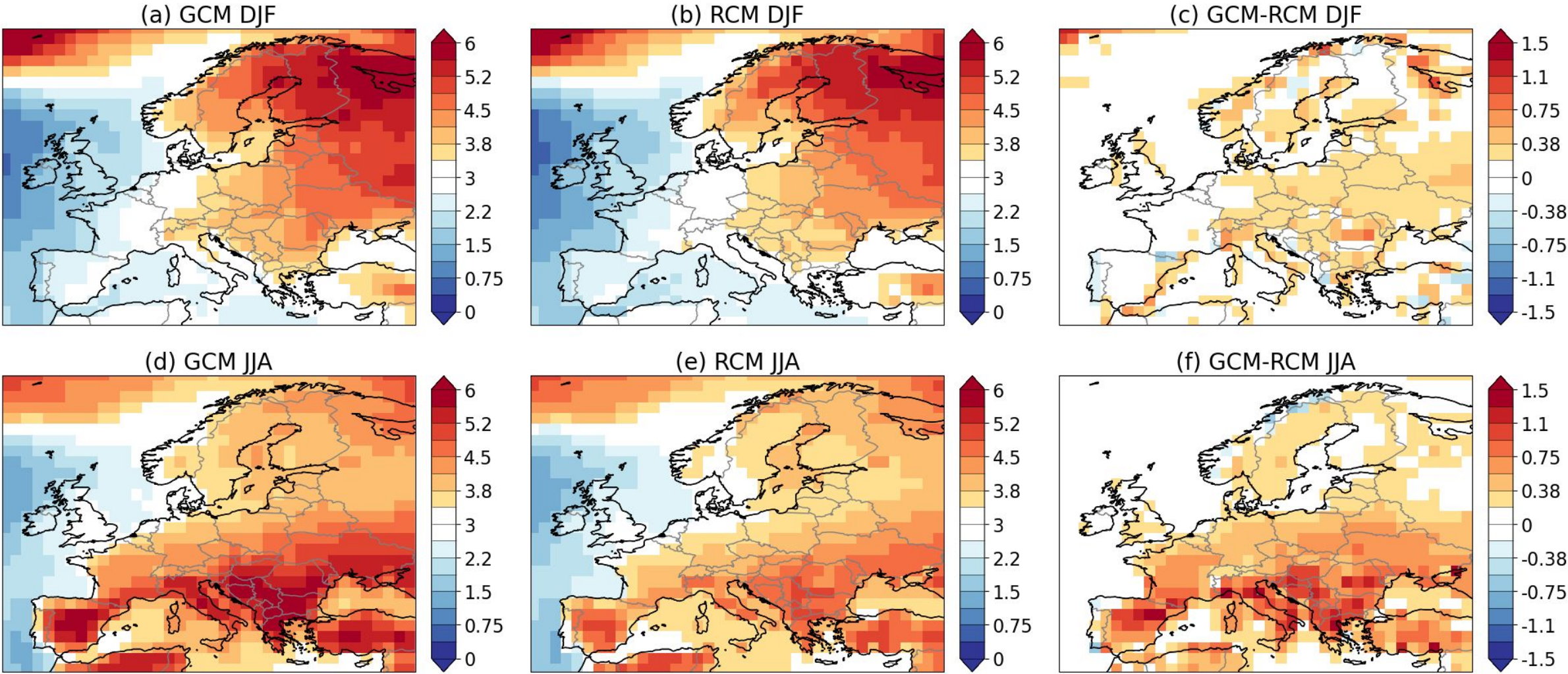
Example: Mountains



Source: Michael Matiu

Example: GCM-RCM consistency

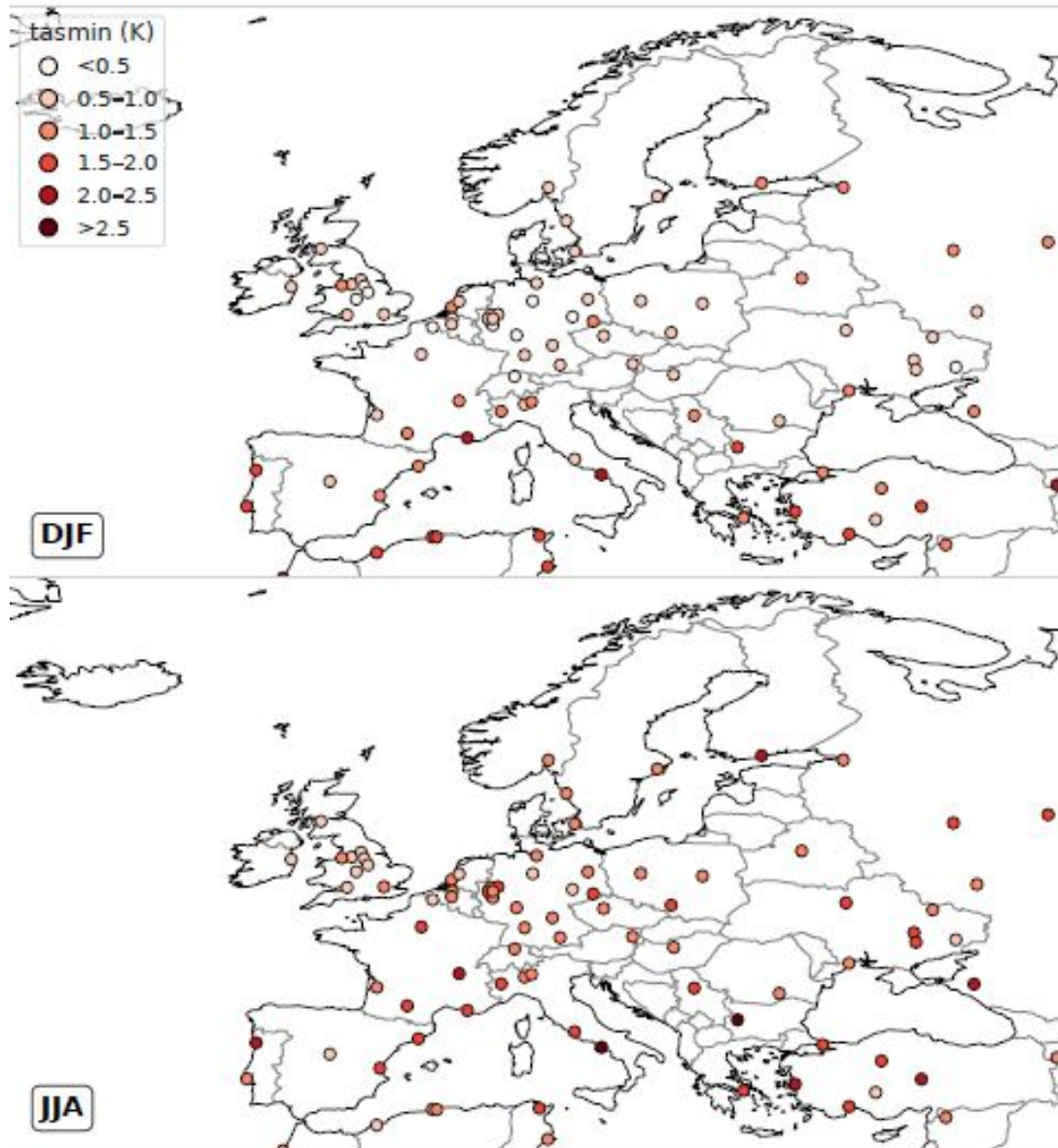
Temperature change 1985-2014 until 2070-2099, ssp3-7.0



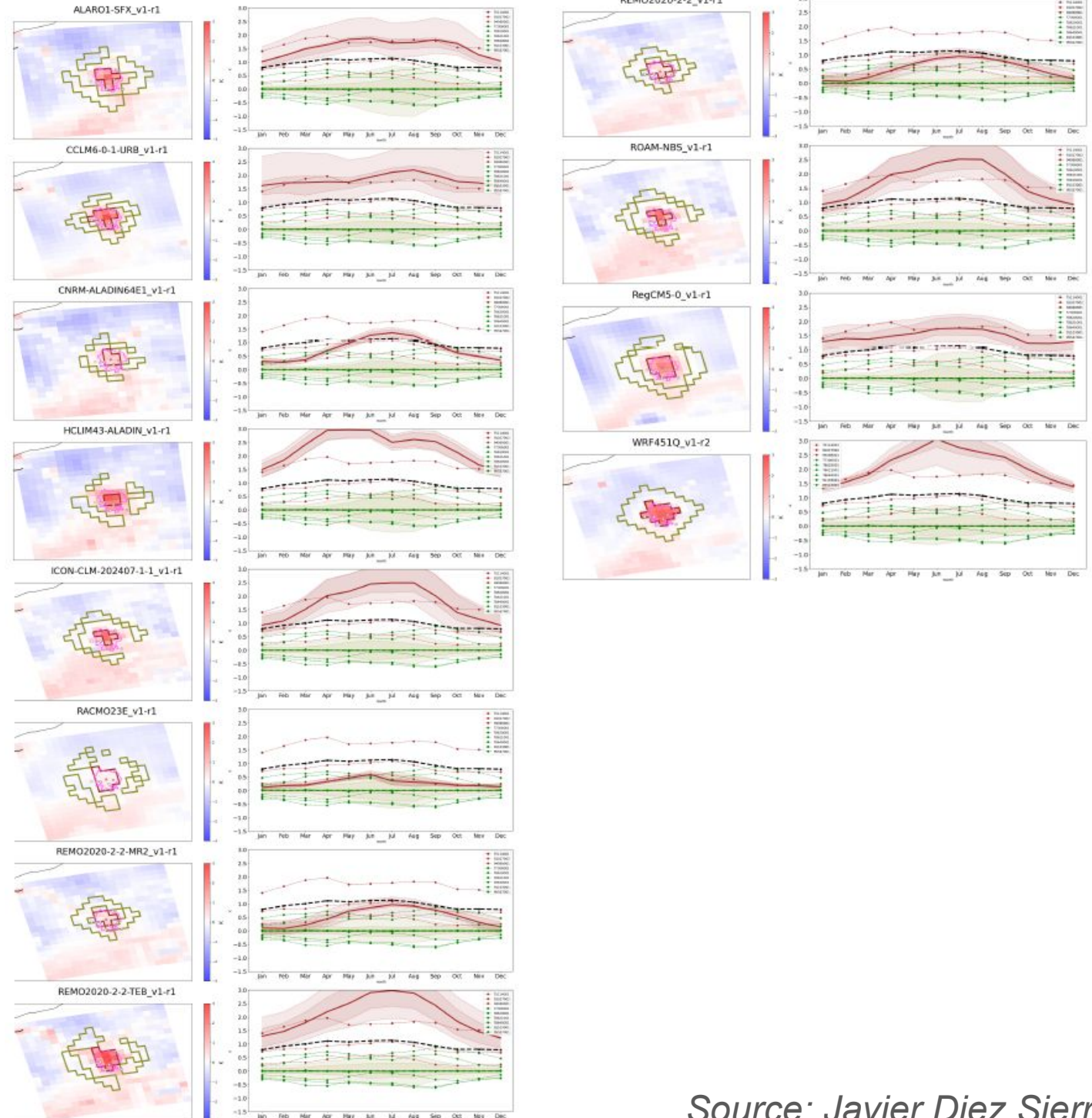
Source: Julien Boé

Example: Urban

Nocturnal urban heat island (ensemble mean, 87 cities)



UHI (Paris)



Example: FWI

Reference Data

- ERA5-Land hourly variables (tas, pr, hurs, wss) + FWI available on Jülich HPC.
- Most **FWI calculations completed for 11 RCMs** (additional simulations in progress)

Evaluation Framework

- Shared repository: <https://github.com/euro-cordex/fwi-evaluation>
- Reproducible workflow combining R scripts (FWI computation utilities) + notebooks (end-to-end examples).

Next Steps (towards manuscript)

- Decide on EUR subregions for regionalized evaluation
- Compute full FWI validation metric suite (MAE FWIm, MAE FWI95, FWI95 freq bias, spell length bias, ACF7, AUC FWI95).
- Produce publication-ready figures (maps, boxplots, regional summaries) → **June 2026?**

Further collaborators welcome!

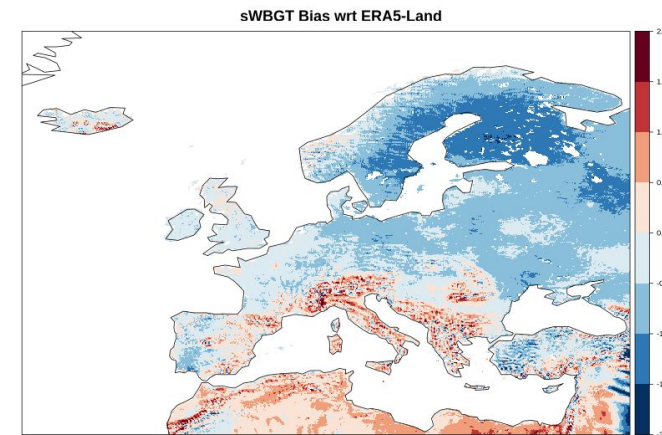
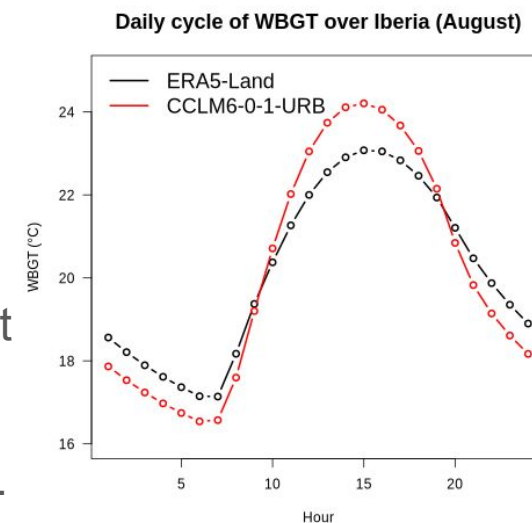
Example: Heat stress

- ~20 contributors, first analyses in progress.
- Use of hourly data: **13 simulations** available with hourly tas, hurs and sfcWind.
- **ERA5-Land** will be used as reference.
- Consider a **set of multivariate heat stress** indices with different characteristics/sensitivities.

- Evaluation metrics:

- Biases in daily min/max heat stress and compared to daily min/max temperatures.
- Daily cycle and biases in the timing of daily min/max heat stress.
- Intervariable relationships between tas and hurs (or dew point temperature), associated with high heat stress (e.g. above p95).
- Possibility to examine city vs. vicinity for exemplary, big cities.

Example for 1 simulation: sWBGT in August



- GitHub repository:

<https://github.com/euro-cordex/heat-stress-evaluation>



Source: Ana Casanueva

Joint evaluation CMIP6-EURO-CORDEX: precipitation extremes

Research questions

- Is there a fair reproduction of the characteristics of extreme precipitation events in CMIP6-EUROCORDEX in terms of intensity-duration-frequency, and spatial extent?
- What is the **effective resolution** of regional simulations?

Statistics

- For all seasons and time scales (1h, 3h, ..., 24h)
- 99.0 and 99.9 percentiles from different observational datasets and for the simulations
- Maxima at the different duration and spatial scales (2x2, 4x4, ... , 32x32)
- Return levels estimated from GEV distributions
- Simple scaling parameters (e.g. Innocenti et al., 2017)