Karlsruhe Institute of Technology



Climate Limited-area Modelling Community

Regional Decadal Climate Simulations for Europe Using ICON-XPP

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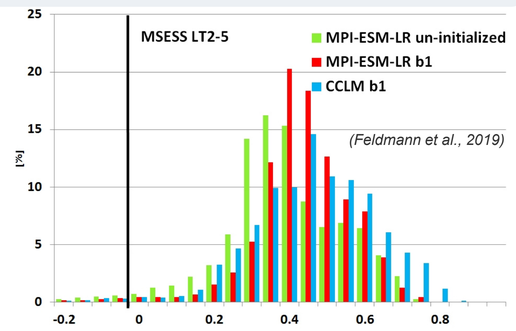
Project Motivation & Background

Coming Decade Project: Optimizing dynamical nesting within ICON for European decadal predictions.

Global-to-Regional Challenge: Coarse GCM resolution and biases limit regional utility of decadal predictions.

Proven added value (MiKlip): Refining global predictions enhances regional accuracy and reliability (Feldmann et al., 2019; Moemken et al., 2020; Marotzke et al., 2016).

Dynamical Downscaling Implemented: ICON-NWP coupled with JSBACH land surface model.

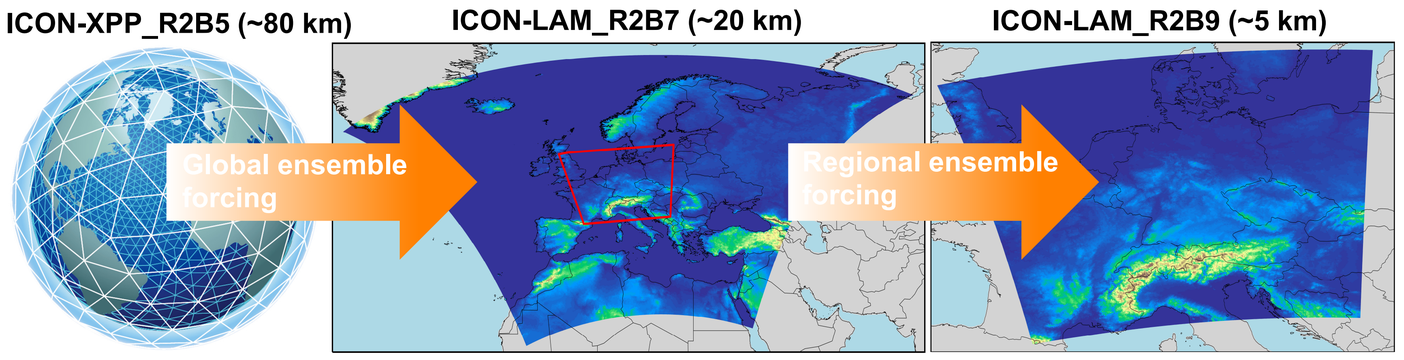


Downscaling Framework

ICON-XPP: ICON-based Earth System Model for Climate Predictions and Projections (Müller et al., 2025).

ICON-LAM (Limited-area Mode): ICON based regional configuration coupled with JSBACH land surface model.

Set of Hindcasts (initialized on 1st Nov., 1960–2023):
- **Global (R2B5) :** 3+3 ensemble members
- **Regional (R2B7):** 3 ensemble members
- **Regional (R2B9):** 1 ensemble member

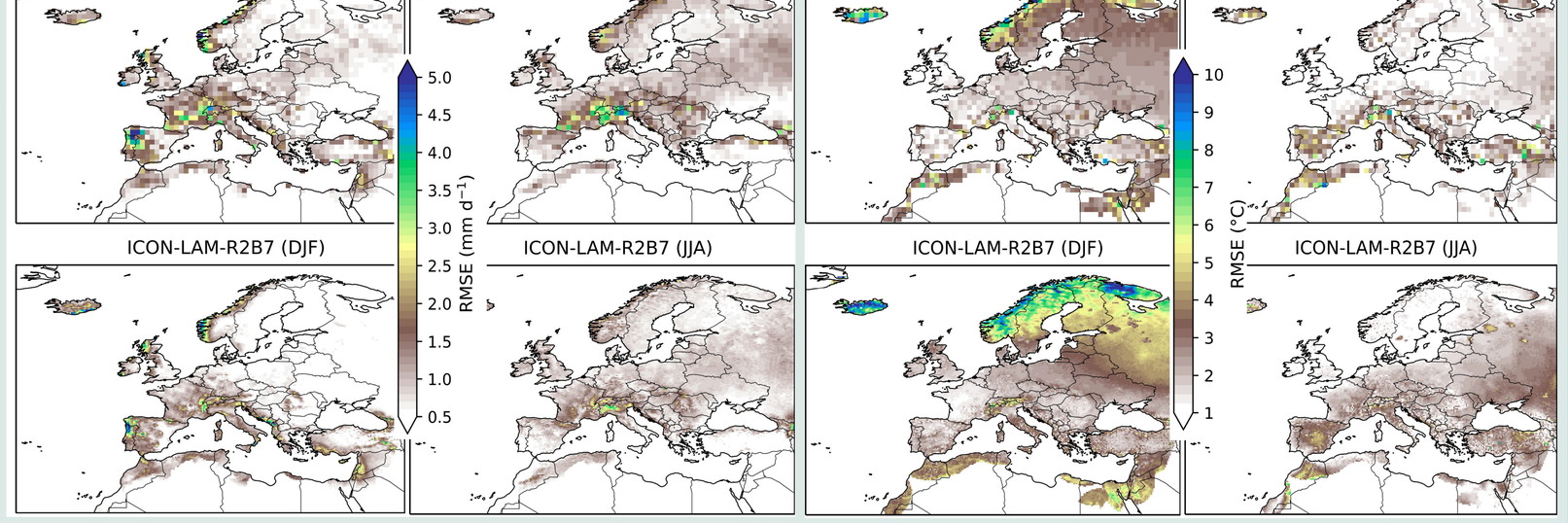


Initial Simulations and Tuning

Regional to Global Consistency

First set of ICON R2B7 simulations with default JSBACH/VDIFF settings

Regional configuration is highly sensitive to the JSBACH vertical diffusion (VDIFF) parameterization



VDIFF Parameter Tuning

To Improve consistency of temperature representation with global forcing data in the regional Version 2 configuration.

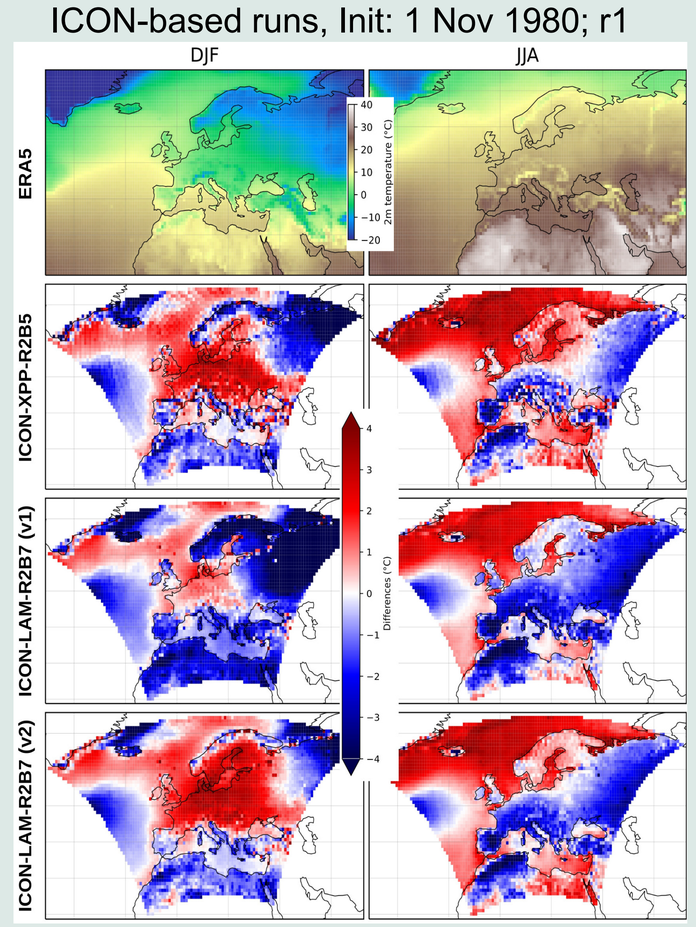
Tuning-changes for 2nd setup

Parameters	v1	v2
fsl	0.4	0.8
pr0	1	0.85
f_theta_limit_fraction	0	0.15
ek_ep_ratio_stable	3	2.33
ek_ep_ratio_unstable	2	1

v1 vs. v2

2-m air temperature and differences relative to ERA5 for 1981–1985

ICON-based runs, Init: 1 Nov 1980; r1



Consistency Global/Regional for JSBACH and TERRA Simulations

Summary

- *First set of regional hindcasts completed (~1000 sim. years)*
- *Default VDIFF settings caused cold bias over land.*
- *Tuning of VDIFF could improve the consistency with the forcing data*
- *ICON driven simulations comparable to TERRA, but larger differences for ERA5 driven experiments (not shown)*
- *Further tuning and testing required to exploit the earth system components provided by JSBACH.*

Gefördert durch:

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FONA Forschung für Nachhaltigkeit

DKRZ Deutsches Klimarechenzentrum

COMING DECADE

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