The Global-to-Regional ICON Digital Twin

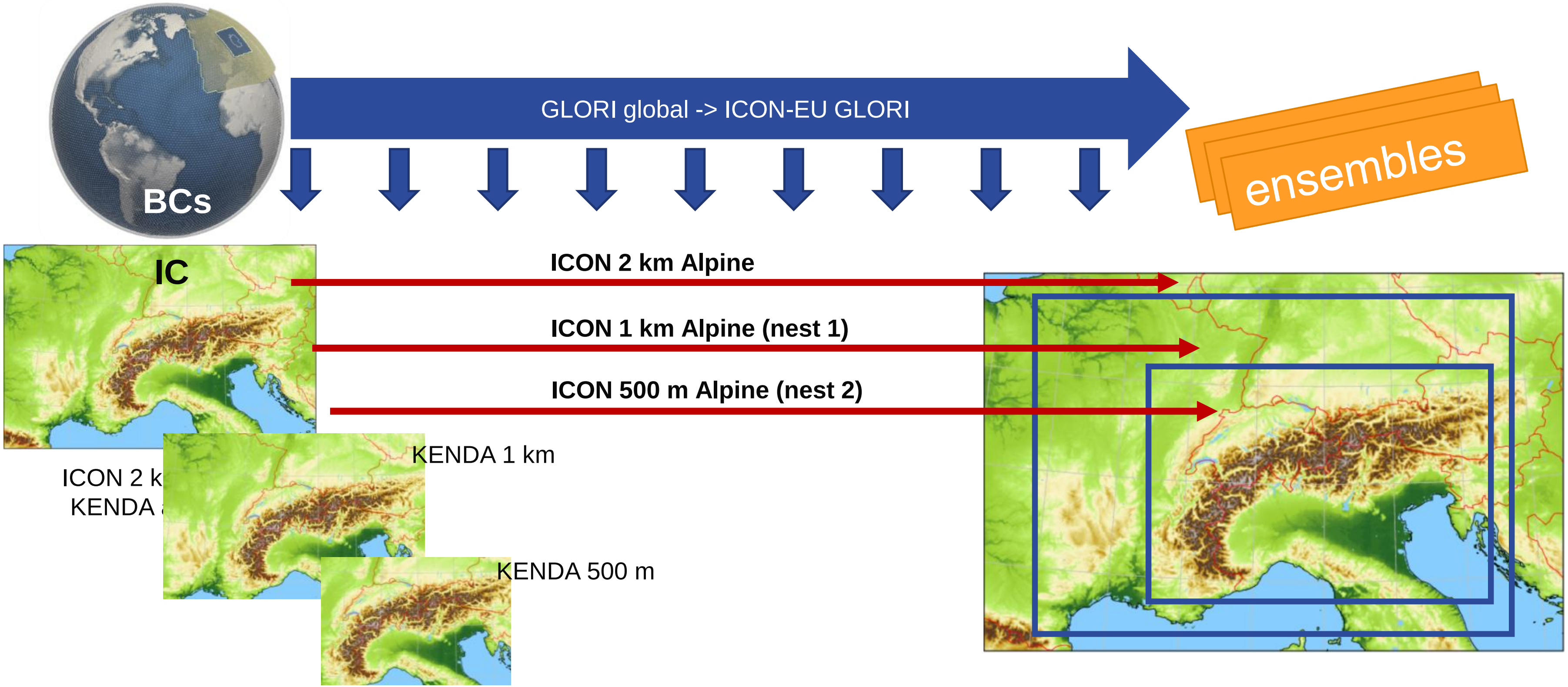
GLORI

High-resolution ensemble forecasts

100m PHY-EPS Workshop | 5-7 February 2024

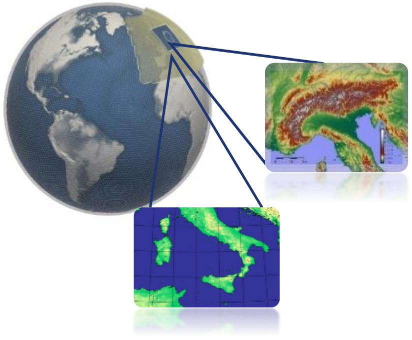
Zahra Parsakhoo, Chiara Marsigli, Christoph Gebhardt

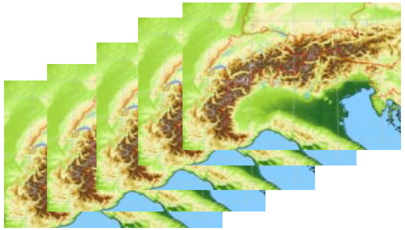
Alpine Twin Setup



Outline of the talk

- The goal of the GLORI Digital Twin is to provide weather forecast for applications like floods, energy and health. It is based on the ICON model and the DACE data assimilation
- Both data assimilation and forecasts are based on **ensembles**
- This work focuses on the development on ensembles for the regional domains, at a resolution on 1 km -> 500m
- We would like to adapt and further develop **model perturbation** for this scale





Overview of the experiments

Convection permitting ensemble experiments with 1-moment /2-moment microphysics scheme, with

- only shallow convection parameterization,
- also deep convection parameterisation, but only gray zone tuning: Tiedtke-Bechtold convection scheme in ‘grayzone deep convection’ mode

➢ 1-moment microphysics scheme

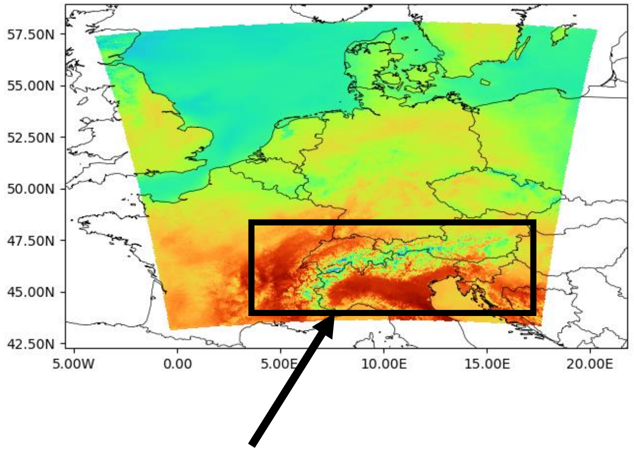
➢ 2-moment microphysics scheme

Seifert and Beheng (2006): A two-moment microphysical parameterization for mixed-phase clouds was developed to improve the explicit representation of clouds and precipitation in mesoscale atmospheric models. The scheme predicts the evolution of mass as well as number densities of the five hydrometeor types cloud droplets, raindrops, cloud ice, snow and graupel.

EXPERIMENTs SETUP

Two-way nesting	
Horizontal grid resolution	2km (ICON-D2), 1km (TeamX)
Upper boundary	22km
Vertical levels	90
LAT-BC	Forecasts (ICON-EU)
Perturbed initial conditions	KENDA (ICON-D2-EPS)
Forecast duration	24h starting on 2022062100
Forecast restart	6h
Ensemble members	20
Microphysics	1mom or 2mom
Turbulence	TURBDIFF
Land	TERRA
Standard operational model perturbations	

Parent domain: ICON-D2



Nest domain: 1km horizontal resolution

Configuration of the experiments

- ✓ 2mom microphysics scheme
- ✓ Latent Heat Nudging (LHN)

Experiments: A2 and B2

exp ID	Convection parameterization	Shallow convection parametrised		Deep convection partly parametrised (grayTuning)	
	2km & 1km	2km	1km	2km	1km
A2	ON	✓	✓	X	X
B2	ON	X	✓	✓	X

Configuration of the experiments

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

✓ 2mom microphysics scheme
✓ Latent Heat Nudging (LHN)

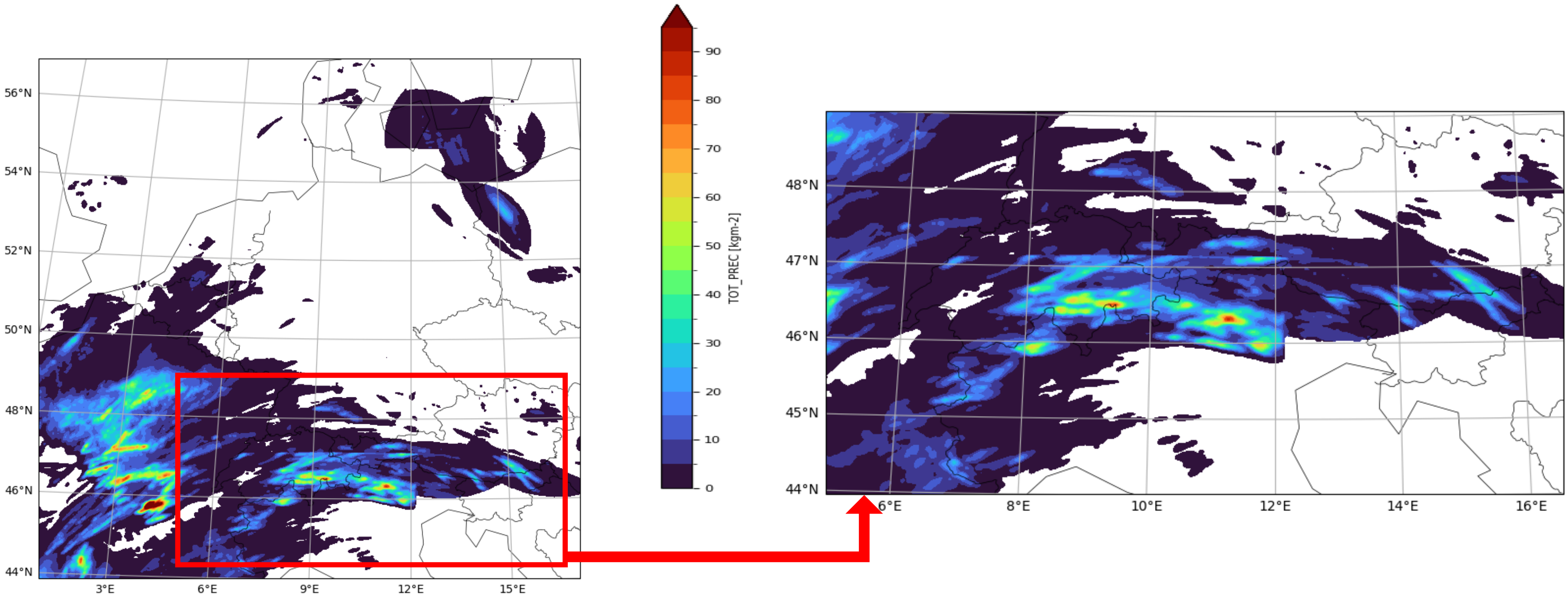
Experiments: A2 and B2

✓1mom microphysics scheme
X Latent Heat Nudging (LHN)

Experiments: A1 and B1

exp ID	Convection parameterization	Shallow convection parametrised		Deep convection partly parametrised (grayTuning)	
	2km & 1km	2km	1km	2km	1km
A2 , A1	ON	✓	✓	X	X
B2 , B1	ON	X	✓	✓	X

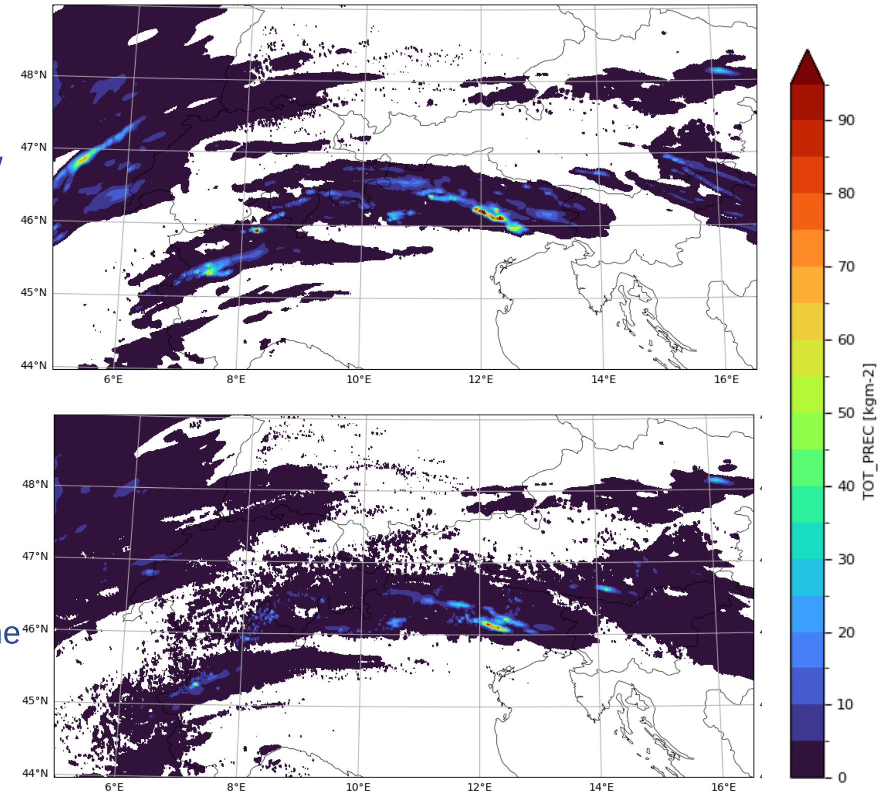
Radar data (total precipitation accumulated 00-18UTC)



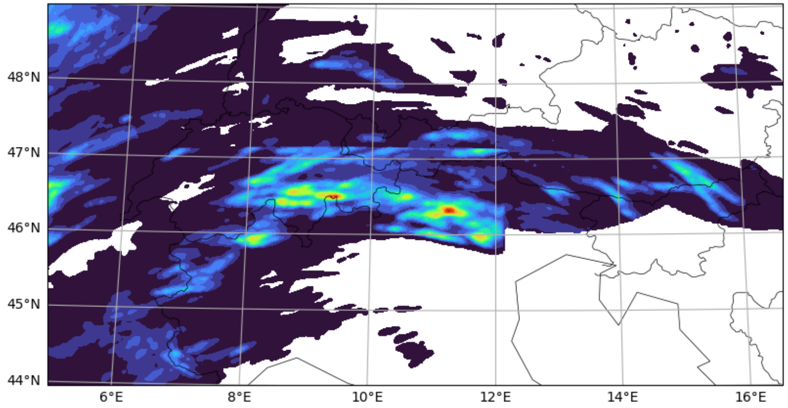
Det. / 2mom @ 18 fc lead time

A2
Shallow Conv. only

B2
Conv.+ Gray-zone tuning



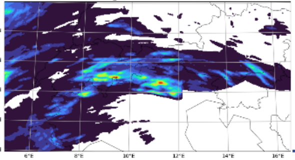
Radar data

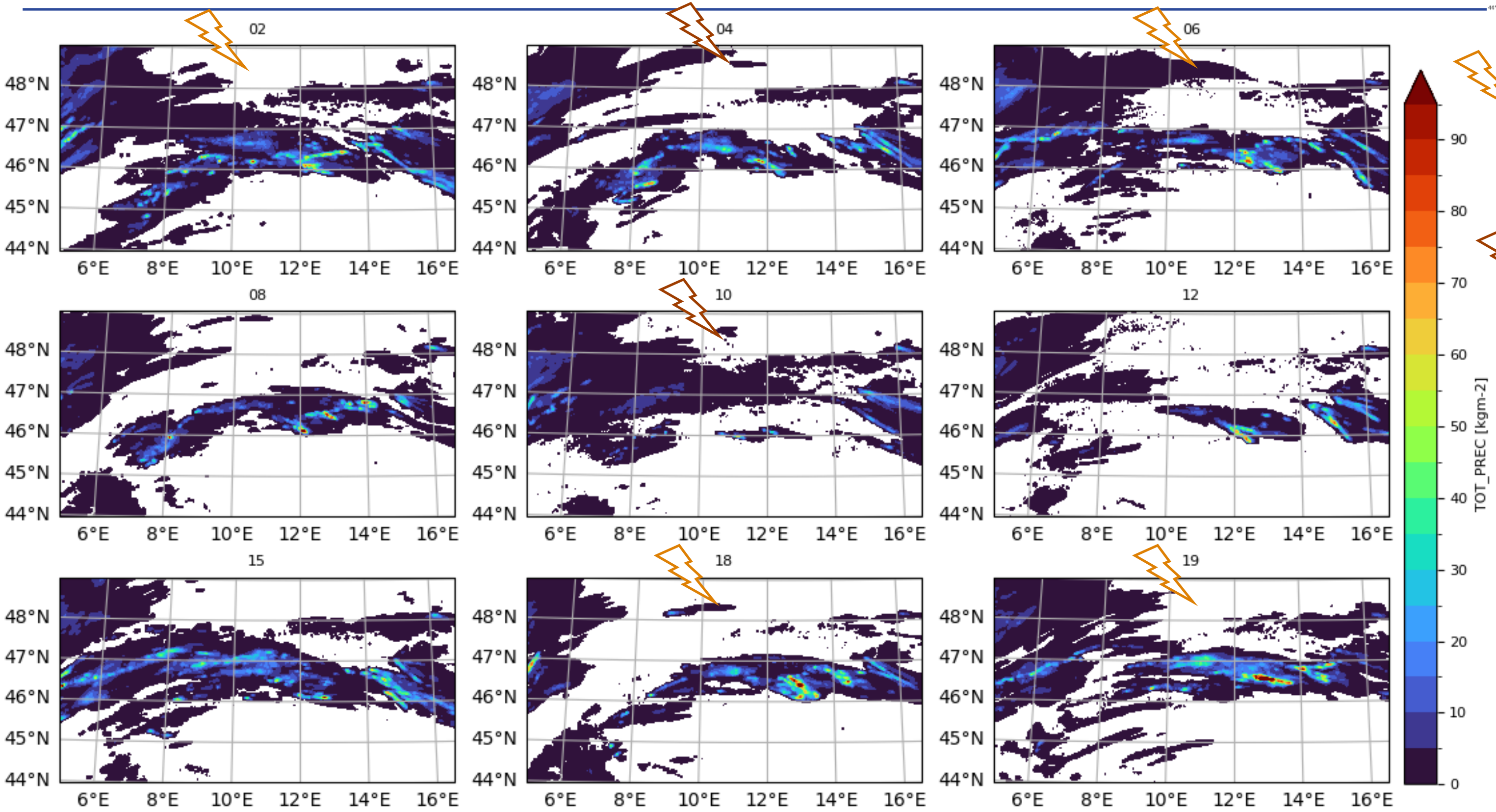


- Both experiments forecast less rain than observation.
- Shallow-conv-only (exp A2) forecasts relatively more rain than grayTuning (exp B2)
- Max. rain location forecast is shifted w.r.t. obs.

Exp. A2 (only-shallow-conv.) @ 18 fc lead time

Radar



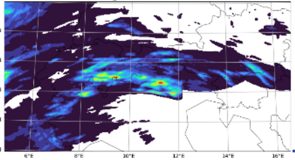


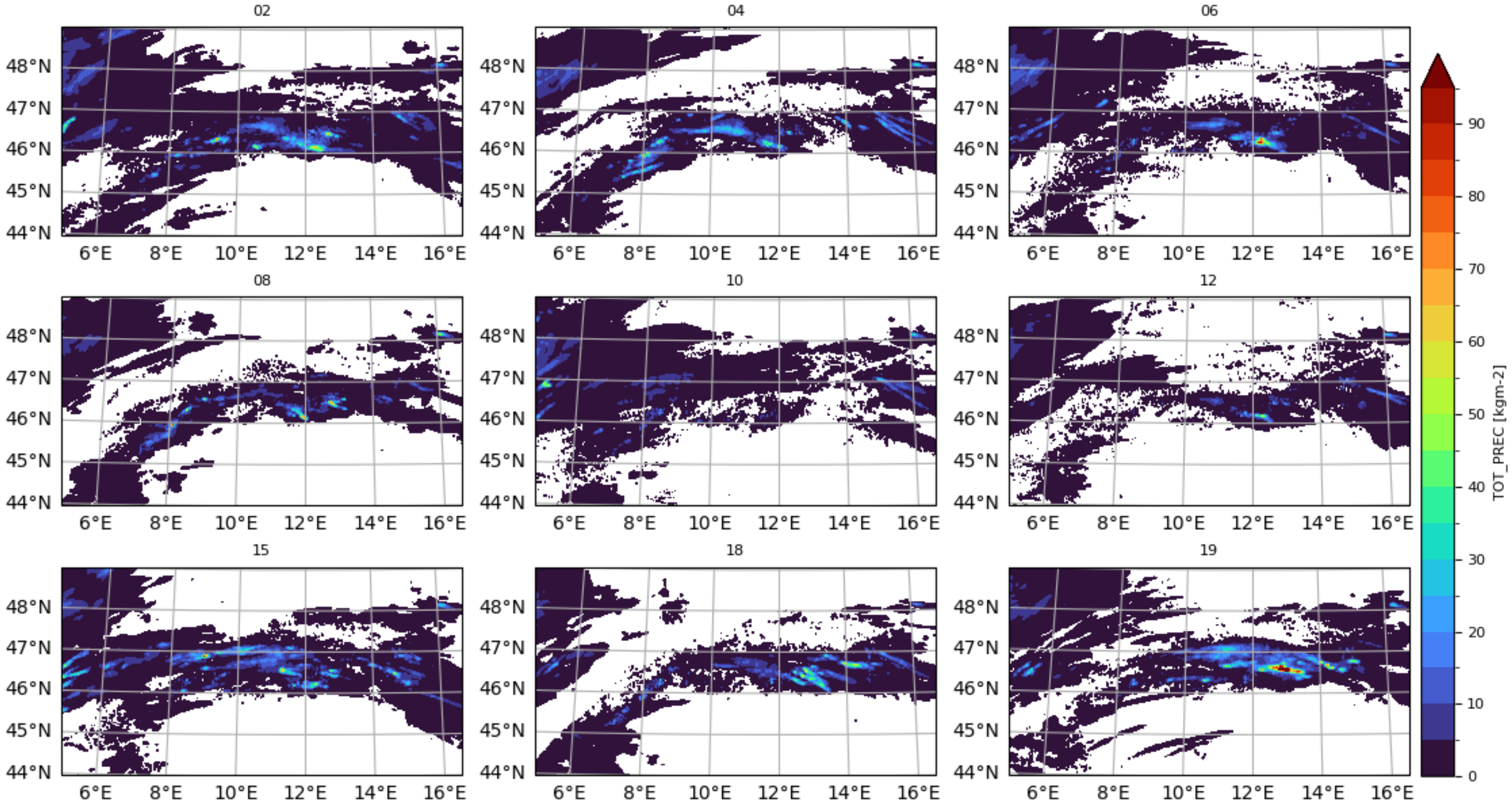
Some members with misplaced rain

Some members with too little rain

Exp. B2 (conv.+grayTuning) @ 18 fc lead time

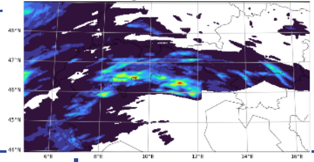
Radar





Ens. Mean & Spread @ 18 fc lead time

Radar

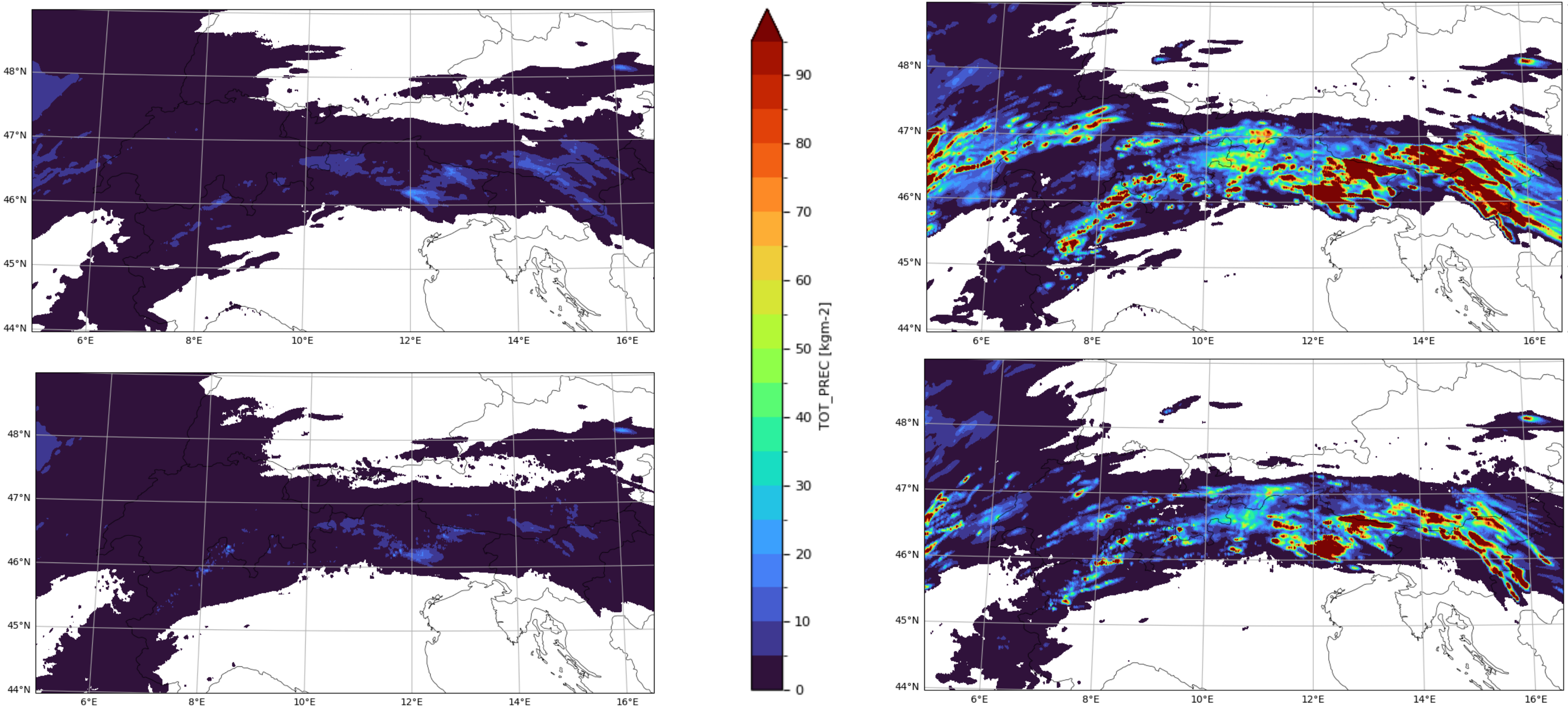


Ensemble Mean

Ensemble Spread

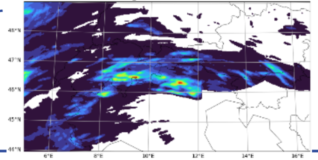
A2
Shallow Conv. only

B2
Conv.+ Gray-zone tunning



Det. @ 18 fc lead time
Comparing 1mom & 2mom microphysics schemes

Radar



2mom

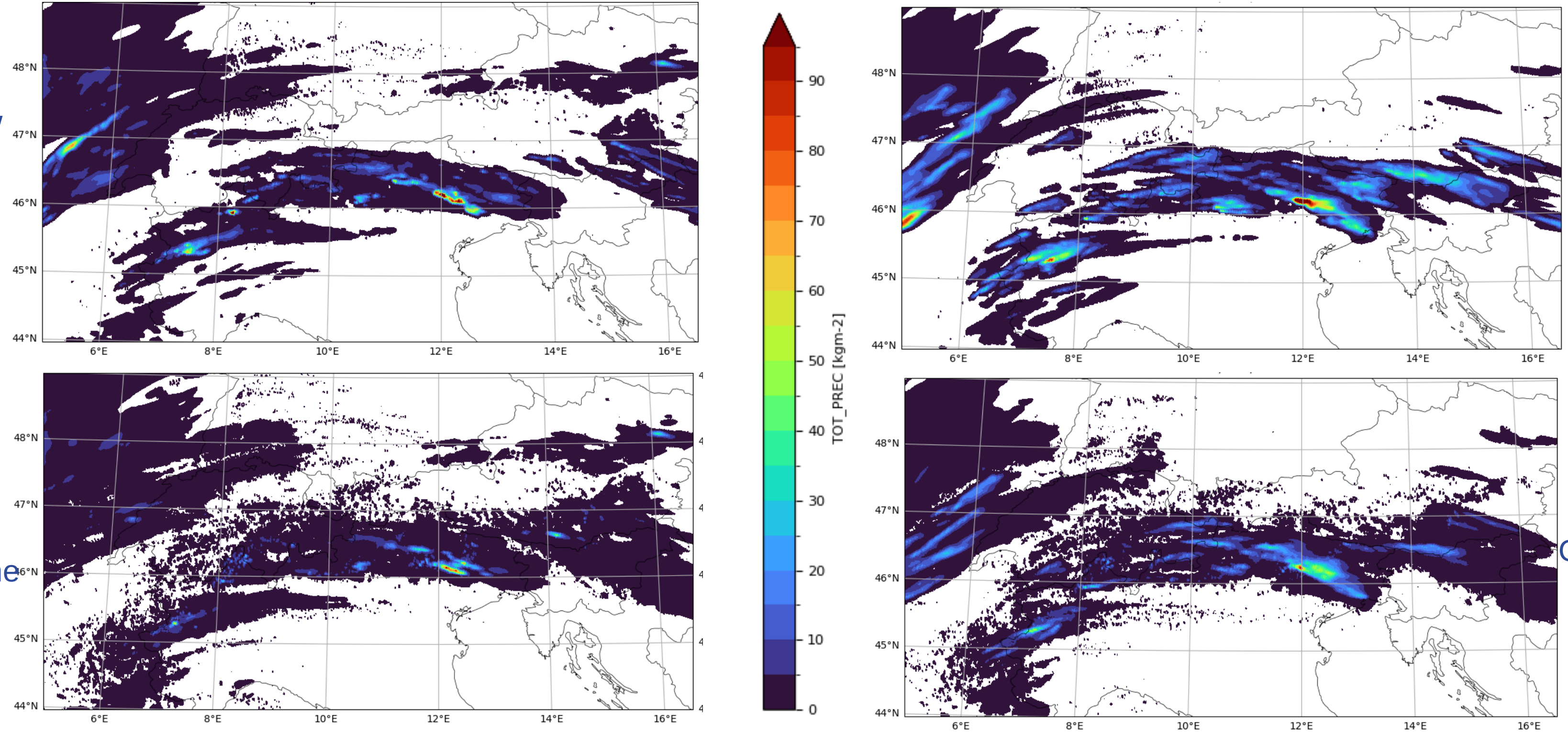
1mom

A2
Shallow Conv. only

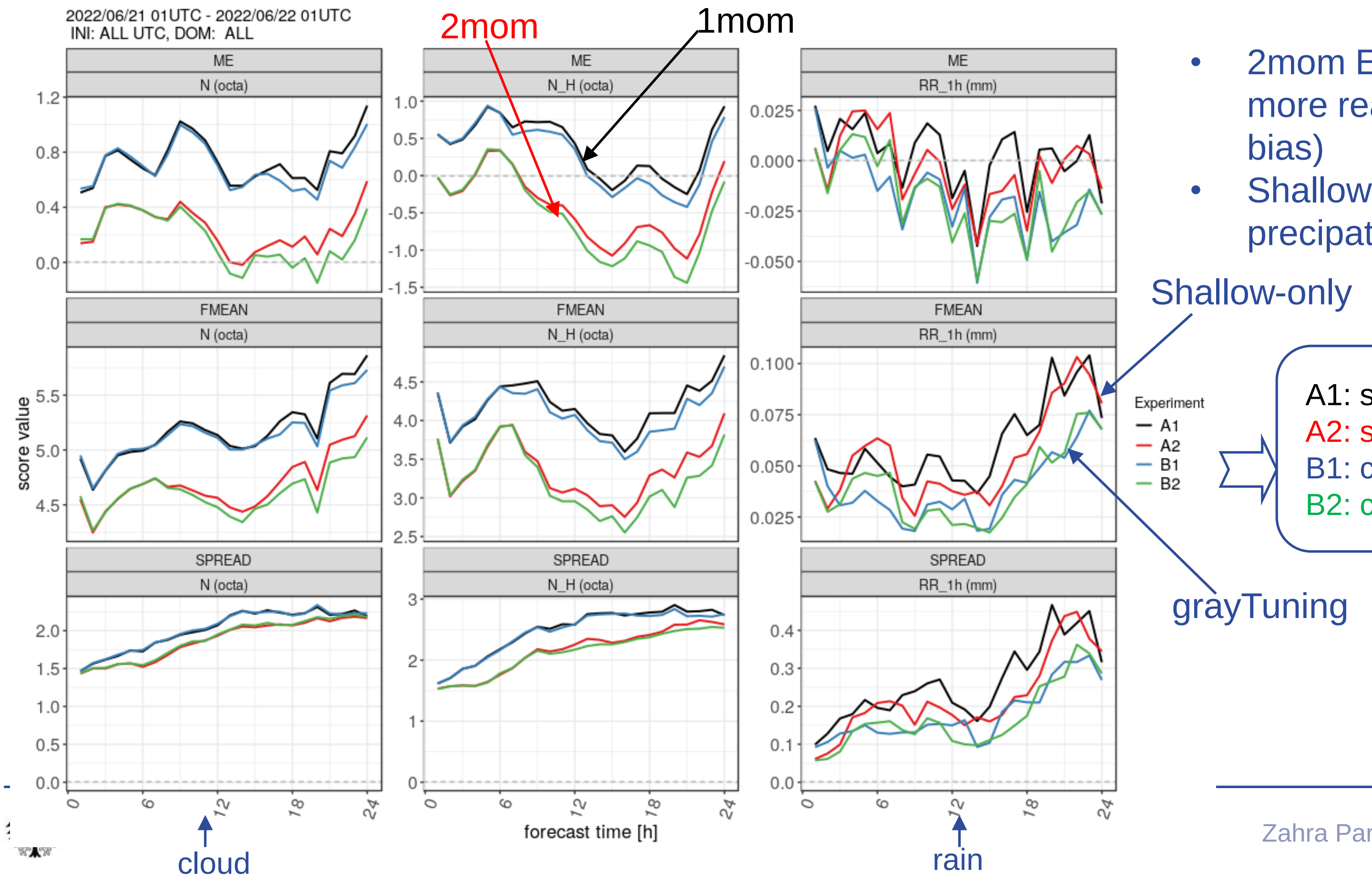
A1
Shallow Conv. only

B2
Conv.+ Gray-zone tunning

B1
Conv.+ Gray-zone tunning



Verification against Synoptic data

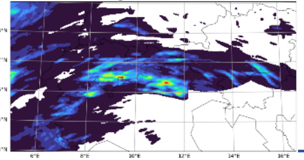


- 2mom Experiments produce more realistic clouds (smaller bias)
- Shallow-conv-only forecasts precipitation slightly better

A1: shallow-only with 1mom
A2: shallow-only with 2mom
B1: conv.+grayTuning with 1mom
B2: conv.+grayTuning with 2mom

Det. / 2mom @ 18 fc lead time
Comparing 2km vs. 1km

Radar

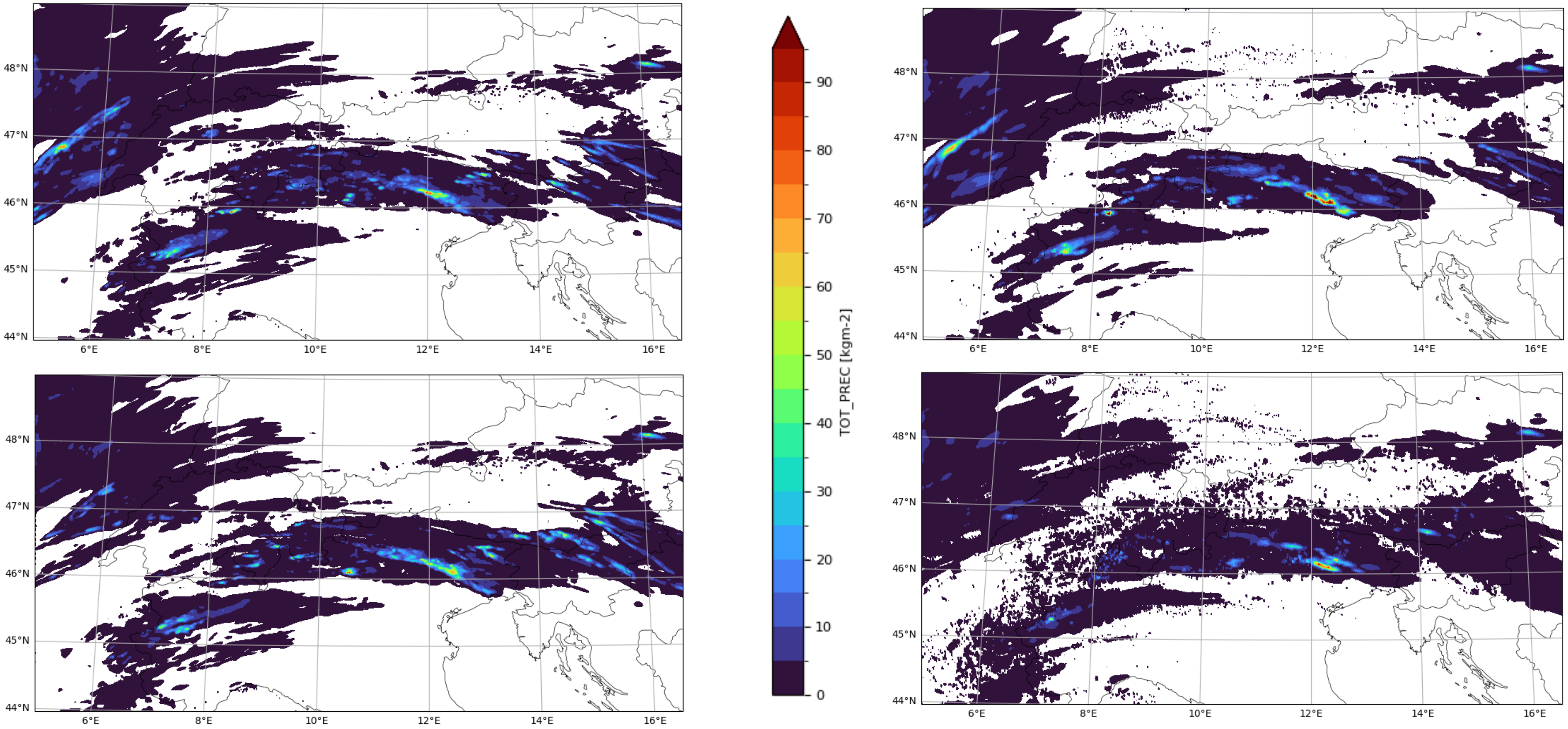


1km

2km

A2
Shallow Conv. only

B2
Conv.+ Gray-zone tunning



Further analyses need to be done to investigate the performance of the model at 1km res. locally

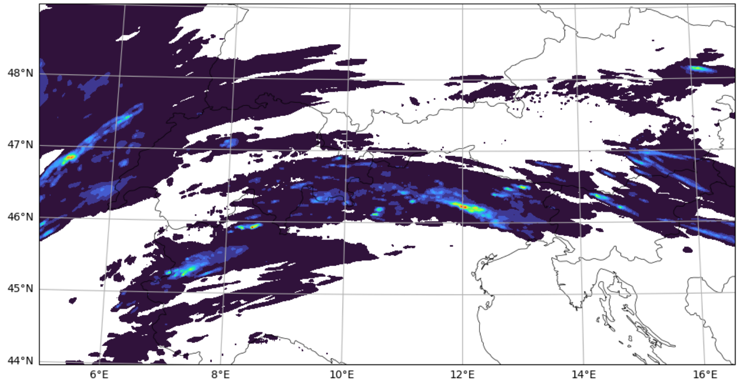
Summary

- Shallow-conv-only experiment (A2, A1) forecast is slightly better in generating rain,
- Experiments with 2mom microphysics produce more realistic clouds than 1mom,
- However, 2mom and 1mom are not significantly different in generating rain,
- In this case, there is no significant difference in precipitation between 1km and 2km in the south of Germany

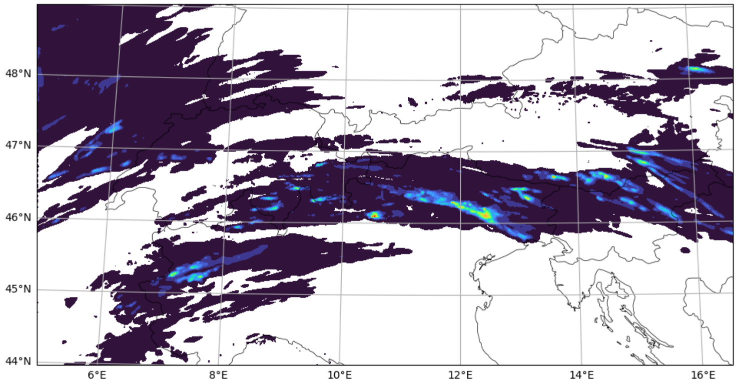
Det. / 2mom @ 18 fc lead time | 1km

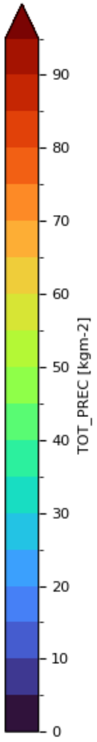
Deutscher Wetterdienst
Wetter und Klima aus einer Hand

A2
Shallow Conv. only

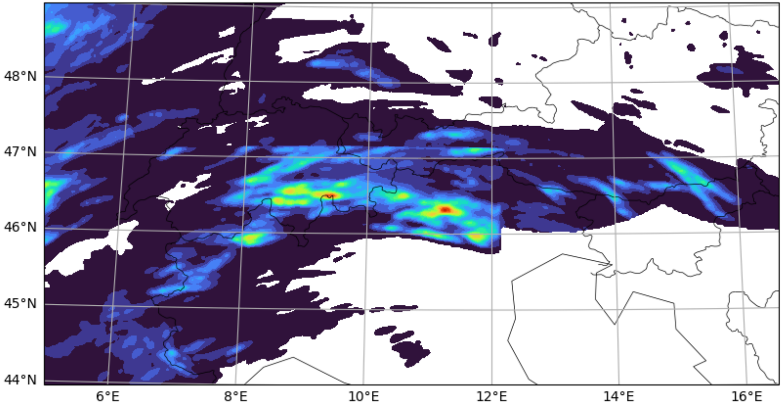


B2
Conv.+ Gray-zone tunning





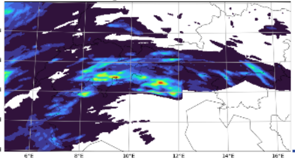
Radar data

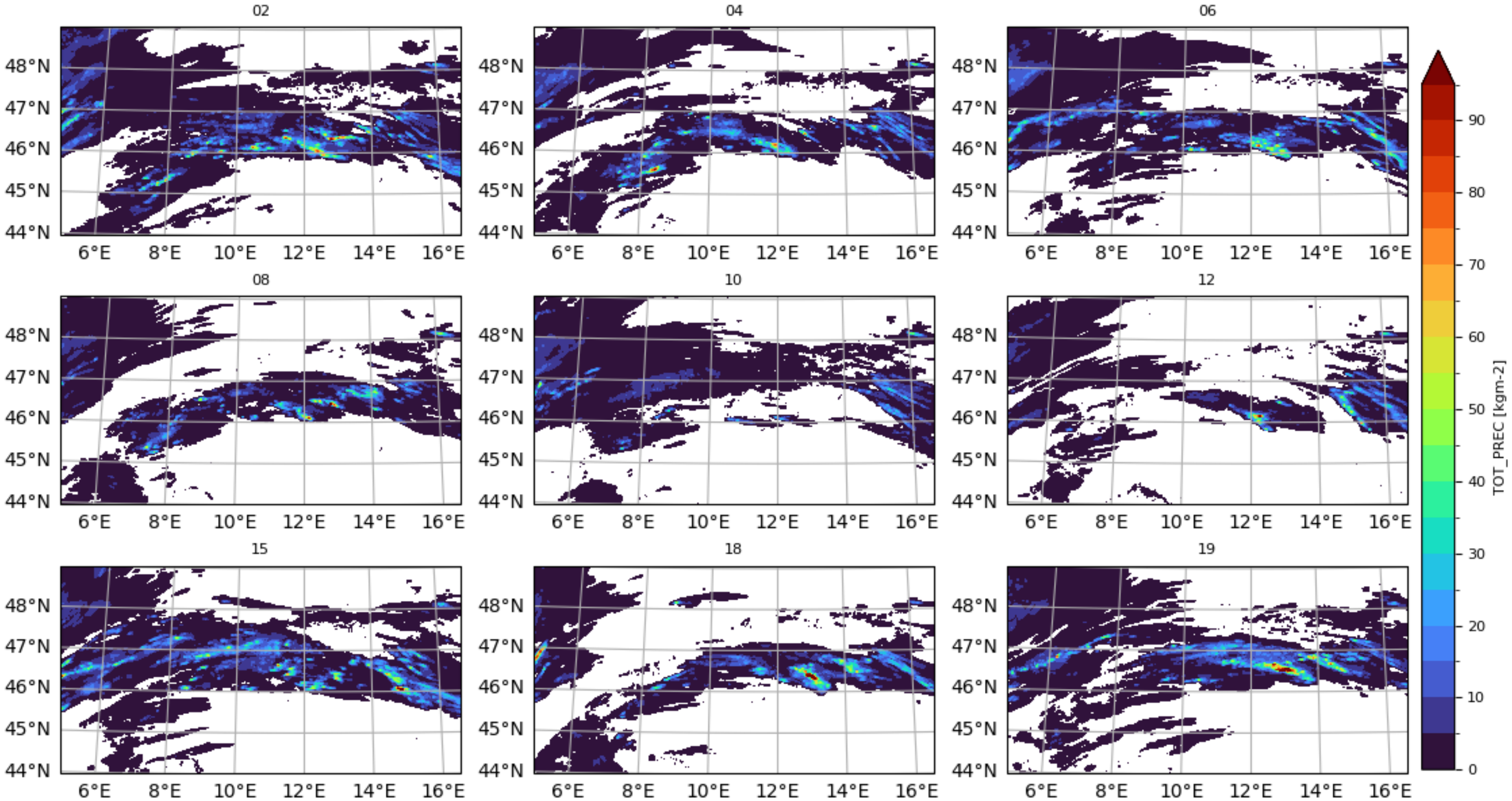


- Both experiments forecast less rain than observation.
- Only-shallow-Conv.-Par. (exp A2) forecast relatively more rain than conv.-par+grayTuning (exp B2).

Exp. A2 (only shallow conv.) @ 18 fc lead time | 1km

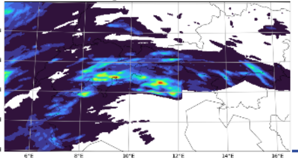
Radar

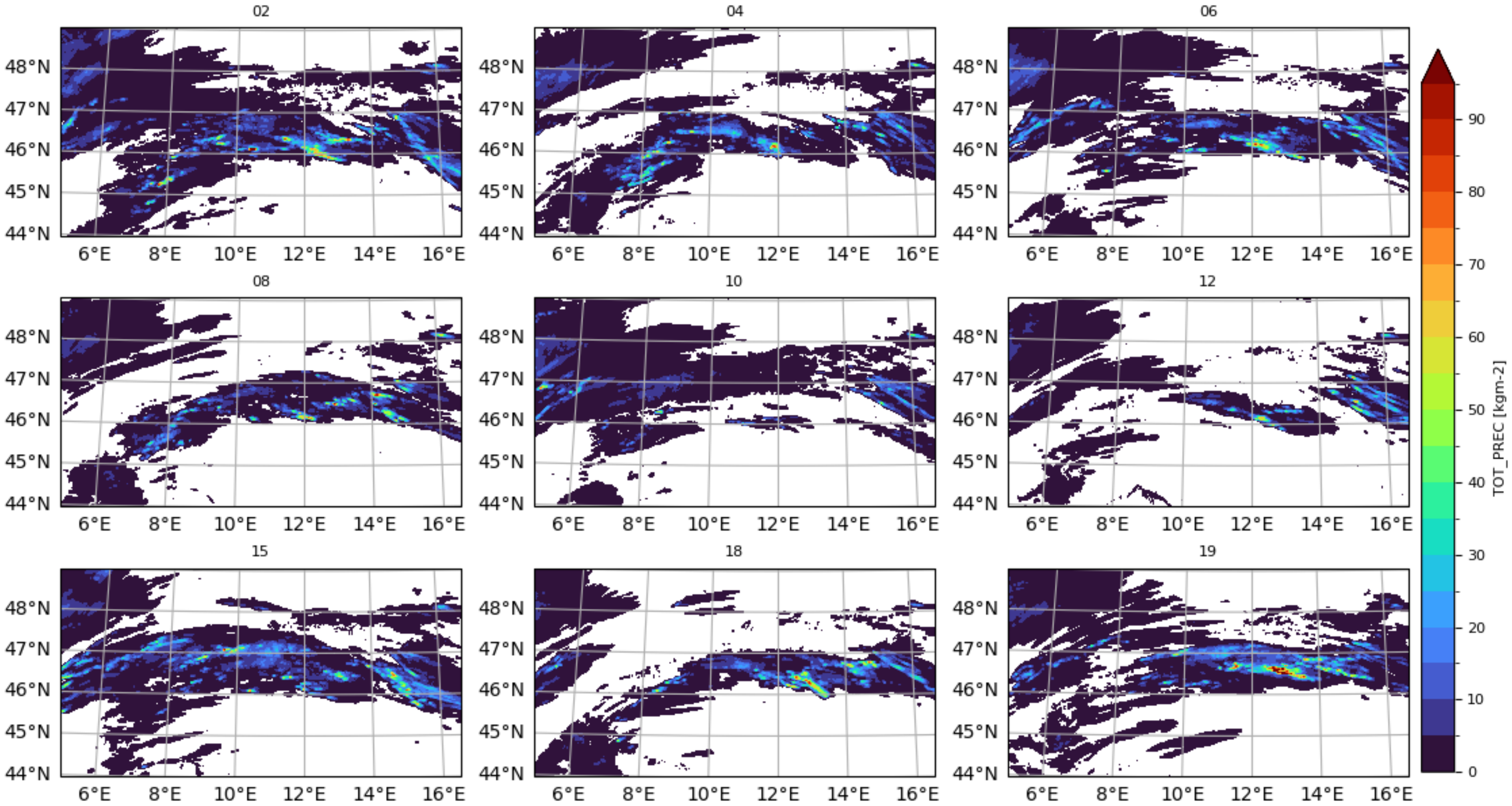




Exp. B2 (conv.+grayTuning) @ 18 fc lead time | 1km

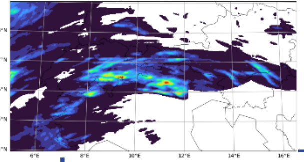
Radar





Ens. Mean & Spread @ 18 fc lead time | 1km

Radar



Ensemble Mean

Ensemble Spread

A2
Shallow Conv. only

B2
Conv.+ Gray-zone tunning