

## Review on „Assessing the uncertainty of soil-moisture impact on convective precipitation by an ensemble approach“ by O. Henneberg, F. Ament, and V. Grützun

In this article, the authors evaluate the impact of different soil-moisture initializations on the simulation of convective precipitation with the COSMO model, using a set of ensemble simulations for one case study. These consist of 8 uncertainty ensembles based on one soil-moisture ensemble. The uncertainty ensembles consist of 11 simulations with a shifted model domain and in one case, on 6 additional simulations with a modified start time.

The underlying idea is that the uncertainty ensemble is a method to estimate model uncertainty, which is then used to assess the significance of different soil-moisture initializations. It is found that „only drastic soil moisture changes“ can overcome the model uncertainties.

The idea to compare model uncertainty with soil-moisture induced uncertainty seems to be somehow neglected in recent literature and therefore the article is recommended for publication, even if it is not entirely clear if domain shifting can be regarded as a reliable measure to account for model uncertainty.

### Major / general comments:

Before the article can be published, there is a strong need to clarify its structure. Moreover, the model setup is not well explained or even completely missing (the experiments can not be repeated at all with the given information) and a comprehensive overview of all performed and evaluated simulations is missing. Pieces of information can be gathered from different sections, but this makes it very hard to read.

It would be much more comfortable for the reader to have a section #2 called „Model setup“ and a section #3 (or 2.2) called „Performed model simulations“ to get a better overview at a first glance.

Following that, the case study should be described in its own Section. More work should be done on that – it is not sufficient just to say that it is a case of „convectively induced precipitation“ (beginning of Section 2). The soil-moisture precipitation feedback can depend strongly on the strength of the synoptic-scale forcing. Thus it is essential for the reader to have some idea about the general synoptic conditions of this case.

Related to this: It would be good to include a discussion on the question whether the domain shifting does generate / include new physical processes or not. In Figure 3, for example, LOC 10 00 is shown but not LOC 30 00. In LOC 30 00 and LOC 00 30, the domain is shifted by 30 km, which is not negligible. If a larger part of the ocean / coast is included in the shifted simulation for example, this could very well modify the simulation also in a physical way.

It is strongly recommended to separate the aims and the argumentation for the chosen comparisons from the description of applied methods. The SAL method should be described in a separate section (or subsection) with a clear description of which simulations / precipitation fields (15-min precipitation sums? which evaluation area?) are compared to which reference. Don't mix the argumentation for your method of generating uncertainty estimations into this Section.

In contrast, a discussion of this point is missing in the introduction. Can you give some references / examples of other studies which use domain shifting to estimate model uncertainty?

Finally, the English language needs to be revised carefully as there are a large number of

inaccuracies. Examples are given below.

## Specific comments

### 1 Introduction

p. 1, l. 23-24: „Soil moisture affects the partitioning of turbulent heat fluxes ..., which once affects the surface temperature“; soil moisture rather directly affects the surface temperature

p. 2, l. 1-2: „in the lower troposphere“ → in the boundary layer?

p. 2, l. 2: „surface temperatures can ... initiate convection“ → can influence the initiation of convection

p. 2., l. 7: „that following the process chain“ → that follow the...

p. 2, l. 34-35: „convective precipitation suffers strongly from model uncertainty such (as!) caused by initial and boundary data“ → uncertainties caused by initial and boundary data are not really model uncertainties, even if this is stated in Richard et al. (2007) – is it?

p. 3., l. 1: „many simulations“ → a large number of simulations

p. 3, l. 3: „the effect ... can be ranged“ → can be assessed and quantified?

### 2 Soil moisture perturbation and its influence on precipitation

The Section could be called „Model / experiment setup and overview of performed simulations“

Please give a comprehensive description of the model setup: How many vertical levels did you use? Are the chosen settings for the physics parametrizations similar to the operational ones? For example the parametrization of bare soil evaporation could be decisive for processes in the considered case of convection initiation. Model start time, length of the simulations?

p. 3, Figure 1: It would be great if you could show a larger domain with additional rectangles for used model domains (e.g. black solid line for ctrl domain, black dashed for LOC 00 30 and LOC 30 00).

p. 3, l. 6: „convective introduced precipitation“ → convectively induced precipitation

p. 3, l. 8: „A 1 km resolution ... provide(s!) a much more accurate simulation of convective precipitation“ → more accurate than what?

p. 3, l. 11: „coarse-grid COSMO operational analysis“ → 2.8 km is not really coarse; omit „coarse-grid“

p. 3., l. 15: „enhancement [of soil moisture] of 50 %“ → did you apply this enhancement taking into

account the underlying soil-type distribution?

p. 3, l. 15: „red framed domain“ → insert here „(hereafter, referred to as area „red““

p. 3, l. 15 ff: „Those changes are **first** applied over whole model domain (DRY\_a and MOI\_a, Table 1) and second ...**Another** artificial modification is **the** redistribution ... (BAND...)“ → also give references to names in Table 1 in the following sentences

Figure 2: Is there a reason that you show only 6 out of 8 members of the soil-moisture ensemble?

p. 4, l. 2-3: „high uncertainty of convective precipitation on the initial and boundary data is accounted **for** by...“ → **sensitivity** of conv. precip on?

same sentence: better discuss the reasoning behind the method before – either in a separate (sub-)section „Aims and estimation of model uncertainties“ or (better) directly at the end of the introduction

p. 4, l. 4: „Those simulations“

p. 4, l. 5: „the simulation with **a domain shifted** by“

p. 4, l. 4 ff (starting with „Here we will focus on...“): This part should be moved into its own (sub-)section (see also general comments); but before, show Table 2 and give the corresponding explanations.

The new (sub)section could be called something like „Overview of convective precipitation event and influence of different soil moisture perturbations“.

First, give a more general overview of the case study (Synoptic conditions? When did convection initiation occur? Which processes did contribute? Can you assume in the first place that soil moisture patterns had an influence at all? How much precipitation was observed over which period?).

Only afterwards, sensitivity experiments can be described.

p. 5, l. 1: „differences are predicated to“ → presumably caused by? attributed to?

p. 5., l. 1: „brutal changes“ → extreme changes?

p. 5., l. 2: „more obvious changes“ → modifications / differences?

p. 5, l. 8: „similar order of magnitude **as** soil-moisture modifications“

Table 1, title: „**which** represents the shifting...“

Table 1, last column: The nomenclature „DRY\_a *ii jj*“ here is not really used in the text; could you give just „LOC *ii jj*“ in this columns and refer to „CTRL-LOC *ii jj*“ or „DRY\_a-LOC *ii jj*“ at places where it is explicitly referenced.

Figure 3, title: „Precipitation rate at 14:45“ → this is misleading; I assume that this is the 15-min precipitation sum, recalculated to mm/h (assuming that you have output time steps of 15 min)?

Figure 3: Is there a good reason to use a logarithmic colour scale?

It would be great if you could include the blue rectangle as this evaluation area is used later.

### 3 Estimation of model uncertainties

Section title could be „Determination of objective criteria for the given model uncertainty“

Which precipitation threshold did you use for the SAL (necessary to determine the precipitation objects, called „cells“ in this article)?

p. 5, l.12: „provide representative results by using the SAL score“ → can you reformulate this sentence?

p. 5, l.13: „for every single time step“ → you mean **output time step**? you also have to give it (15 min)?

p. 5, l.13: „The SAL-score **gives**“

p. 7, l. 25 to p. 8, l. 4: as said in the general comments, leave this passage out at this place (parts have to be included when you describe the aims, parts in the Section „Overview of performed model simulations“).

The definition of the „uncertainty ensemble“ would be clearer if it would be distinguished between the „CTRL-uncertainty ensemble“ (shown in Table 2) and the other uncertainty ensembles for the simulations with perturbed soil moisture, e.g. the „DRY\_a-uncertainty ensemble“.

p. 8., l. 4 ff: Related to the previous comment, it is not easy to understand which simulation is compared to which reference (don't use „CTRL“ in l. 8, p. 8 - that ambiguous here; additionally, in the given description of the SAL components, it is called „comp“). How do you count 122 simulations?

Table 1: Columns headings: „lower-left corner“ or „LL corner“ with abbrev. given in title

Figure 4: Which evaluation area – red or blue? Markers can be hardly distinguished – could you make two sub-plots?

p. 9, l.1-2: „Hence, a reduction in **precipitation** amplitude is **related with** too small **and / or** peaked precipitation objects ... larger and / **or shallower** precipitation objects. ... This **agrees** with...“.

p. 9, l. 6: dependent ... „Conclusively, no **systematic behaviour can be detected** for locally perturbed simulations, but for time-shifted simulations, which is caused by the differing precipitation onset.“

p. 9., l. 9: „**According** to this definition“

### 4 Significant effects of soil moisture modification on precipitation

p. 9, l. 14 to p. 10, l.2: leave the passage out; as said above, overview of all simulations should be given in Section 2.2 / 3

p. 10, l. 3: „Each uncertainty ensemble will be compared to the CTRL-uncertainty ensemble, only comparing ensemble members with the same domain shifting. That **yields** again a ...“  
Again for all output time steps?

p. 10, l. 6: „The percentage of the **values exceeding the uncertainty range** is ...“

p. 10, l. 11: „in only 5 % **of all cases**“

p. 10, l. 14: „soil moisture reduction in the whole domain (**DRY\_a**) affects ...“

p. 10., l. 17: „soil moisture enhancement in a sub-domain only (**MOI\_p**) ...“

p. 10, l. 19: „the redistribution of soil moisture **as in BAND** does not...“

p. 10, l. 19-20: „The redistribution of soil moisture increases the large-area heterogeneity, but decreases the small-area heterogeneity“ → do you mean that the heterogeneity on the length scale of the chosen band is increased by the perturbation itself while smaller-scale secondary circulations become less important?

Figure 6: Which time steps are analysed? The shading in the rectangles is not necessary and blurs the images. Just give the frames. What are the dashed lines?

## 5 Systematics

p. 12, l. 7: „in MOIST\_p, significant but random changes occur“ → are they really random or could the sign of A also be caused by the location of the patch relative to the shifted domain?

p. 13, l. 7: „**According to the z-test** [is it a z-test?], only two simulations [ensembles?] with overall modified soil moisture have a systematic effect...“ → only two of this kind exist; do you mean „only two simulations have a systematic effect: DRY\_a and MOI\_a, i.e. the two simulations with overall...“

p. 13., l. 11 ff: I would be careful to call it „feedback“ if it is not symmetric. Could the differences of the results found by Barthlott and Kalthoff (2011) compared to the results of others be caused by the influence of orography in their investigation?