We thank the referee for his/her valuable comments and suggestions, which will improve the paper. The responses to your comments are marked in blue.

Review on „Assessing the uncertaintiy 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.
We restructured the article as following:

- 2 Modelling approach
  - 2.1 Numerical Setup
  - 2.2 Soil moisture experiments
  - 2.3 Ensemble approach
- 3 Case description
- 4 Results
- 4.1 Estimate of model uncertainty ...

and extended the description of the synoptic situation
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.

We agree, that a larger fraction of sea surface in the model domain includes physical processes due to different surface fluxes that affect precipitation formation. However we do not see any trend that a stronger shifting changes precipitation in one or the other direction and therefore consider the shifting to be suitable to generate changes. We included a discussion paragraph on that.

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.

We tried to make clearer that SAL is applied on every model output step of the precipitation rate. However, we tested the analysis for the 15min accumulated precipitation for the REAL ensembles and found the results are more sensitive to the chosen analysis area than the chosen output variable.

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?

We are not aware of any studies using this approach

Finally, the English language needs to be revised carefully as there are a large number of inaccuracies. Examples are given below.

We included the following comments either as suggested or as stated in blue:

Specific comments

1 Introduction

p. 1, l. 23-24: „Soil moisture affects the partitioning of turbulent heat fluxes …, which once affects

included

the surface temperature“; soil moisture rather directly affects the surface temperature

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

included

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

included

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

included

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?

Reformulated

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

included

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

Included

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).

We extenden the figure for simulation CTRL to a slighly larger domain, to show both analysis areas within this plot

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

included

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

Than simulations for which a convection pramatrization is required

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

included

p. 3., l. 15: „enhancement [of soil moisture] of 50 %“ → did you apply this enhancement taking into account the underlying soil-type distribution?

No. Are there essential reasons to do so?

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

included

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

included

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

We included a rectangle for the locally changed soil moisture. That differs from the allover changes by its local restriction.

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?

reformulated

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

We included in the introduction that we used this estimate on model uncertainty to compare this to comparable strong soil moisture changes as soil moisture perturbations are also used in ensemble prediction.

p. 4, l. 4: „Those simulations“

included

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

included

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.

We included a section on the synoptic description and show the occurrence of precipitation in the radar

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

included

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

included

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

included

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

included

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

included

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.

ii and jj is a replacement for all simulations in table to as described in the heading.

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)?

It’s the precipitation rate and results are very different chosing one or the other variable

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

We decided to use a logarythmic scale to show precipitation detailes, which cant be seen with a linear scale (which is anyhow rather unusal for precipitation). And a logarythmic scale is still more intuitive than a irregular scale.

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

Included

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)?

The treshold for every object is calculated by the 5%-percentile of all precipitating grid points with rates higher than 1e-4 kg m-2 s-1

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

Changed

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

changed

p. 5, l.13: „The SAL-score gives“

provides

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“.

We renamed into reference simulation for ensemble and ensemble generating changes.

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?

We changed the subscrips in SAL to ctrl and diff. There are 122 combinations to compare the different simulations. We corrected that.

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

included

Figure 4: Which evaluation area – red or blue?

Red, we included it in the text now

Markers can be hardly distinguished – could you make two sub-plots?

included

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...“.

included

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.“

included

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

included

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

deleted

p. 10, l. 3: „Each uncertainy 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?

Yes included

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...“

all included

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?

Changed to: The redistribution of soil moisture changes the heterogeneity of the soil moisture by reducing small-scale structures, but induce stronger variations on the large scale.

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?

Shading was deleted, the dashes lines represent average values

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?

You mean accorind to the location of the modification (patch) relative to the domain boundaries? The location of the patch stays the same.

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...“

This had been formulated missleading. We reformulated this.

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?

What is menat by symmetric? There are mainly two feedback mechanism, one positive one negative resulting dependent on the conditions in either an overall positive or negative feedback. As in all reffered manuscripts this is called feedback we will stick to the term as well. The results from Barthlott are influenced from the orography.