Reviewer #1

We thank Reviewer #1 for the helpful comments. Based on the suggestions in the general comments part of Reviewer #1, we would like to reorganize parts of the paper. We will add more details regarding the course background, design, requirements and goals in the introduction. Additionally, we used a survey to ask the participants of the first course to recap what they have learned. These results will be added to the conclusion part. To stay within the recommended page range, we will shorten the part about the students' contributions and write it in a more concise way.

Please note that we formatted the reviewer comments in bold and cursive text settings, and the authors' answers in blue.

Comments of Reviewer #1 (abbreviated as RC1): *General comments:*

RC1: 1. The motivation/introduction would be improved with additional information. For example, example, where in the curriculum does this course fit in? Are these undergraduate students or graduate students? Is there any other course that covers this material? Additional background about this and why the course was developed would be useful to include. Are there pre-existing courses elsewhere that this course was modeled after? The degree of innovation of this course would be clearer with both more specific context of the institution as well as broader community context (i.e., how novel is this course).

Answers and Comments of the Authors (abbreviated as AC): The course was intended for graduate students at the master level and for advanced undergraduate students of meteorology or atmospheric sciences of semester 5 and upward. Basic programming experience with at least one programming language (such as Fortran, Python, or similar) is expected at this level of education. Additionally, the basic knowledge of the fluid dynamical equations and of what climate and weather models do is expected. The course is mandatory for students with an interest in cloud processes, thunderstorms and visualization of meteorological data. No other course at the University of Bonn covers the specific topics offered in the course. To our knowledge there are courses in Germany that teach the use of climate and numerical weather models, however we have seen no course specifically on the topic of (severe) convection. At first, numerical weather prediction and climate models may seem mysterious to students, akin to black boxes generating data. Through this block course, our goal is to demystify their operation, using CM1 as an example. Students will navigate from initialization to visualization, empowering them to customize code and methods for their own research. This leads to a deeper understanding of numerical weather modeling, while also equipping students to confidently conduct simulations on high-performance computing systems. The advantage of a course based on CM1 is that students can experiment freely with the code and idealized set-ups. This allows a deeper understanding of how a model behaves dependent on the chosen set-up like boundary layer conditions, resolution, and parameterization schemes. Of course, the model sometimes does not work as expected and it might be challenging to find the reasons and workarounds. Hence, this course offers a safe environment to explore failures as well and find solutions.

The course was developed partially because of personal interests of the main instructor. The author has a strong interest in (severe) convection herself and was fascinated by 3d animations/visualizations of supercells such as those done by Leigh Orf (https://orf.media/ , last access: 3-Feb-2024). One motivation for the students is that they will be capable of producing high-quality 3d images from thunderstorms. On the other hand, many students express a strong interest in thunderstorms and cloud processes and give this as a reason for studying meteorology. To meet these interests the course was developed. To our knowledge there is no specific course on convection-resolving models offered at German Universities. However, the topics learned are also general such as the usage of an HPC and slurm, using namelists to start simulations, or 3d visualizations. We think that this course offers learning topics beyond the specific model that can be useful in other areas of meteorology and beyond, too.

Additionally, the project topics chosen in the field of convective storms cover this field in detail that is beyond the general learning curriculum. It includes the forecast of convection initiation as a new framework that supports the conceptual understanding of how the atmosphere works and how numerical models deal with the representation of the associated processes.

RC1: 2. With regards to course design/requirements, I have several questions. What was the title of the course? What were the course learning objectives? Did students self-select into this course? How many hours per day and days per week did the course meet? How did the authors decide the topics to cover? How were students evaluated? What was submitted with the project? What were the course requirements? Was the class conducted using in-person instruction? What was the method of content delivery (e.g., lecture vs. active learning activities vs. group work, etc)? How many students were enrolled? This section in particular needed a lot more information in it to give readers a good sense of what the course was like.

AC: Thanks for the questions. I will answer them in the following:

Course Title and Schedule: The course is entitled “2-weeks block course: Cloud Model 1 (CM1)”. We met for 10 days (2 weeks, Monday to Friday) between 10 am and 4 pm partially in person, partially online (partially due to train strikes in Germany).

Learning objectives: The overall learning objectives are the following:

- **Understand model initialization:** Students will comprehend the process of initializing complex models, including the selection of namelist variables, to gain insight into how models are set up and prepared for simulations.
- **Demystify model operation:** Students will learn to navigate and manipulate model code, transitioning from perceiving models as black boxes to understanding them as accessible tools for conducting simulations.

- **Model modification:** Students will gain the ability to modify model code according to their research questions and preferences, fostering adaptability and creativity in utilizing modeling tools.
- **Visualization:** Students will learn 3D visualization techniques to interpret model output, enabling them to effectively communicate their findings and insights.
- **Confidence in model usage:** Students will build confidence in utilizing models independently, beyond the confines of the course, by understanding their inner workings and operation on high-performance computing systems.
- **Improve understanding of numerical weather modeling:** Students will develop a foundational understanding of numerical weather modeling, including the processes involved and the significance of model customization in research.

The learning intended to show various possibilities to use CM1. It started by simple application of pre-configured cases and ended by (simple) changes implemented in the code. Topics always started from “easy” to “advanced”: (1) Set-up and run of CM1 on a high-performance computing (HPC) cluster; (2) Simulate pre-configured test cases of CM1; (3) Adapt simulations by using modified namelists; (4) Implement changes to the source code; (5) Implement terrain. Participants learned not only the basics of how to work with a numerical model, but also how to get started and consecutively evolve the abilities.

Course completion requirements: For the successful completion of the course, students had to attend and participate actively for at least 80% of the course time and had to hand in a report of about 20 pages 3 weeks after the course. A guideline for writing the report was given in the course material (course material, Chapter Day 08-10, Schielicke, 2023, http://dx.doi.org/10.13140/RG.2.2.30017.12642). The research topics were chosen by the students themselves. Some had prior knowledge of severe weather topics and already had ideas on what to study. They presented their ideas in the course and were guided through the development process. Others were directed to the extensive selection of test cases available in CM1 and were encouraged to reproduce one or more of the cases and document the process. The reports had the main goal that students documented how to run experiments with CM1 on a high-performance computing (HPC) cluster and how to visualize the data. An extensive research on the literature background of the topics was not required, however, the students were asked to – at least – read the cited literature that is provided in the specific test case folders or in the source code. The reports were evaluated according to the guideline given in the course material. The final grade was given on the basis of the reports and the active participation during the course (see below).

Number of participants: Five students were enrolled at first, but one of them became ill and couldn’t complete the course.

Instructional format and content delivery: The content was mainly delivered as active learning activities, the amount of frontal lectures given by the instructor was at a minimum. Students worked individually and in their own time on the course material (see reference above). Each student had the course material as a google document and were encouraged to write down tasks and comments directly in their document. The instructor had access to the google documents, and hence could judge the active participation. In case of problems, the instructor gave guidance on how to solve them. At some times, the students helped each other to complete tasks, for example for visualization solutions. They also helped each other in finding a balance regarding the extent of simulations done for the research topic.

RC1: 3. Highlighting the student projects is interesting, though given the limited time spent on them (thus preventing a more detailed analysis), I would be more curious about student feedback about the course and the skills that they were supposed to acquire. If the authors continue to include these projects, a bit more information about them would be helpful (e.g., how these were assessed). Alternatively, simply including them in the supplemental material would be sufficient.

AC: We appreciate this comment that improves the manuscript! We will ask the students for additional feedback to include this in the text. It is true that the research projects fit in the supplementary material.

RC1: 4. Was there any kind of pre- and post-assessment given to students? Being able to demonstrate that this course was impactful on student understanding of convection (in a quantified way) as well as specific skills would be very useful, particularly given the short timeline.

AC: Thanks. We indeed did a survey at the beginning of the course. However, due to technical problems, it was only available after the first day, when we already covered a lot of topics regarding HPC and slurm. We will ask the students to recap the course and give feedback. This may also give some more insights about the longer term benefit of the course. Students can again consider which skills they developed during the course that they are using since. Moreover, the course will be given this year again and a survey will be done before the course starts and at the end of the course.

RC1: Specific comments:

RC1: 1. Line 28: By "realistic models," do you mean operational models? The phase "realistic" implies that the results from CM1 are unrealistic, which is not correct.

AC: Thanks. Yes we meant operational models. We will change the term.

RC1: 2. Line 35: Since the authors are specific in their choice of model, what software was used to visualize model results? This is mentioned later, but would be helpful to describe here as well.

AC: We will add the choice of visualization models here.

RC1: 3. Line 42: Is visualization instruction rare at your institution, or more broadly? If so, please provide a citation or other reference.

AC: Generally visualization is taught during the programming introductions. However, 3D visualization, as intended in this course, is not covered in much detail.

RC1: 4. Line 134: I don't think there is enough information given about what is active learning or what sorts of learning activities occurred in the course on a day-to-day basis for the authors to be able to describe the course as using an active learning approach. It may be an appropriate label, but there simply isn't enough information provided to the reader.

AC: Thanks, we will elaborate.

RC1: 5. Line 156: I'm unfamiliar with the term "fazit"

AC: We will change it to feedback.

RC1: Technical corrections:

RC1: 1. Line 16: The phrase "…often essential for a further career in meteorology" sounds a bit off. Further, not every single scientist who earns a degree in meteorology needs these skills. Thus, I suggest rephrasing to something like "…often essential for many career paths in meteorology"

AC: Thanks, we will change the sentence according to your suggestion.

RC1: 2. Line 84: "A follow-up course is in planning" should be "A follow-up course is currently being planned."

AC: Thanks!