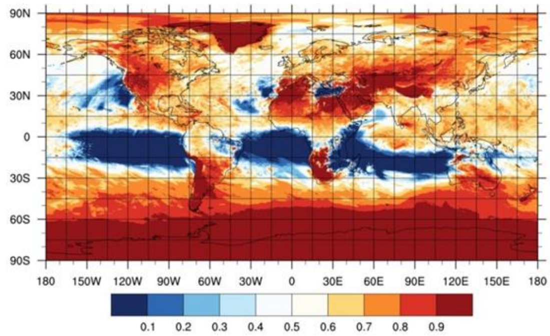
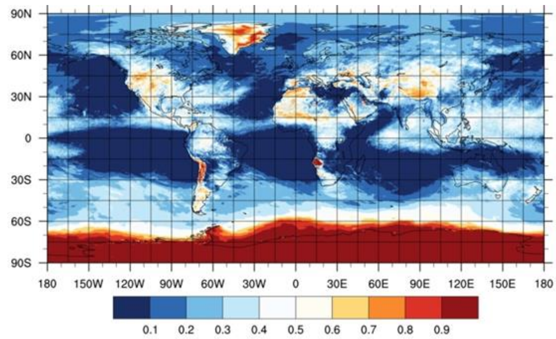
Project: 1154
Project title: Monsoon
Project leader: Dr. Ulrike Burkhardt
Report period: 2020.01.01. – 2020.12.31

1. Analyse und Evaluation hochauflösender Simulationen von Eiswolken (Burkhardt b309022, Corko b309188)

During the last year we have analyzed high resolution global simulations performed within the DYAMOND project. Within the DYAMOND project 9 models simulated the atmosphere for 40 days at up to 5km resolution globally (Stevens et al., 2020). The models are mostly run without a parameterization for convection and thought to describe the dynamics relevant for cloud formation well. Our initial aim is to study the representation of cirrus cloudiness in the different models and determine areas or regimes in which cirrus properties vary strongly. While the global pattern of frozen water path (cloud ice plus graupel plus snow) differs only moderately in the different simulations, the fraction of the frozen hydrometeors of the total water path varies strongly (Abb. 1). The fraction of frozen hydrometeors is very large in NICAM, in ICON most of the water is liquid in most areas. Given the low complexity of the model's cloud schemes the differences are surprising. A first possible explanation may be that the vertical distribution of the water is very different in the two models. A vertical cross section showing the fraction of the water content that is frozen (fig. 1c) reveals that close to 50% frozen hydrometeors fraction can be found at temperatures close to 0°C and nearly all of the water below about -10°C is frozen in NICAM. This does not change significantly if snow is not considered. The large fraction of frozen water at such high temperatures does not compare well with observations.





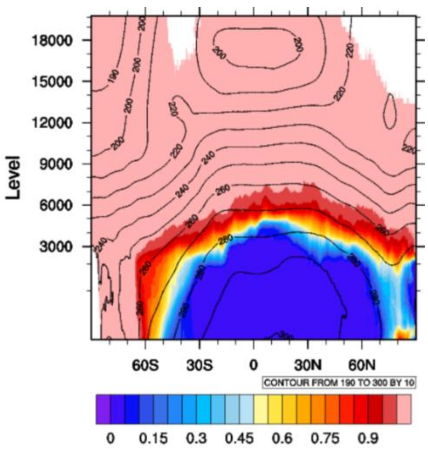


Figure 1: Fraction of frozen hydrometeor path from the frozen and liquid hydrometeor path (Water path of ice + graupel + snow divided by water path of ice + graupel + snow + liquid + rain) in NICAM (left top) and ICON (right top) and the vertical cut of the zonal mean fraction of frozen hydrometeors in NICAM.

Due to problems finding a PhD student and hiring the student during the corona virus pandemic the project is delayed by at least half a year. We are currently still working on developing software to handle all the different data formats of the DYAMOND model simulations while at the same time discussing the use of satellite data for model evaluation. We hope to continue with that work in the next year as well as analyzing ICON simulations from the project partners as they become available and performing some smaller ICON sensitivity studies ourselves.

2. Testläufe und Debugging

Verantwortlich: Luis Kornblueh (214089), Reiner Schnur und Chao Li, MPI-M

The work plan of our Monsoon project has been largely delayed by the ongoing Corona-Pandemic. In our original plan, preparation and development work on the proposed Monsoon simulation should have been on-going for almost 10 months. Unfortunately, the Postdoc positions are still under hiring processing. For most part of the year it has been nearly impossible to hire especially Chinese scientists, which would be of great advantage in this Chinese German project, due to the international travel ban caused by Corona-Pandemic. This situation makes some of the original project ideas to explore the performance, and an additional urban land class, and associated work nearly impossible. Dr. Martin Bergemann who was originally hired by MPI-M on the project has left for another position. MPI-M and DKRZ are still working hard on hiring two Postdocs for the project. Furthermore, the ongoing Corona-Pandemic makes the communication among our project partners more difficult. We planned to visit our collaborators in China this summer, to discuss our simulations strategy, and to help port ICON to their machines, but the planned meeting and personal exchanges had to be cancelled. For those reasons we have not managed to use most of the granted computing time of this year. Together with the funding agencies we have recently agreed on developing an updated, new project work plan and simulation strategies. We apply for computing time consistent with the new work plan.

The requested computing time and disk space for this funding period was intended to develop and test an urban land class, which is expected to play a major role in South-East Asia in the later part of this century. We evaluated the newly developed urban land class of the DWD land surface model TERRA on its usability in JSBACH to overcome the shortage in developers. The second part is the land class data sets. We found out that the European and Northern American and some other areas data sets are available in the nominal resolution of the data sets of 1 km, but not for most parts of South-East Asia, which are based on 3km resolution data sets. As this data would act as a kind of low-pass filter, we approached our Chinese partners and they could provide a higher resolution. However, this work is still ongoing as they suffer from even more restrictive Corona-Pandemic restriction.

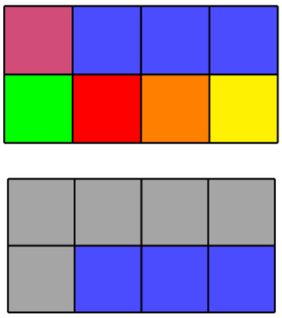


Figure 2: The figure on the top shows an arbitrary grid with different land use properties. Each of the different land uses has a different influence on the flow and e.g. the thermodynamic feedback to the PBL. One can imagine that the identical land use properties below (in gray) have no disturbing effect on the flow and the other atmospheric processes, which does mean that eventually the configuration has a smoothing effect contradicting in parts the use of high resolution. Of course, the shown configuration could be real, but if it is going back to coarse input parameter sets this is a problem.

So, we decided to build-up a replacement development strategy. We created out of some older coarse data sets low resolution model input and try to learn more on the model's feedback and technical issues. This is still ongoing work. We do not expect to use most of the remaining computing time allocated for this year. To be fair to the other users of DKRZ, we did not use the provided time more than absolutely necessary. In contrast to the original plan, we have been using only a marginal amount due to development capacity shortages. However, we would like to finish the development proposed for the last year in 2021. The advantage is that we can reduce the required computing time based on our technical developments of the first three quarters of this year.

References
Stevens, B. et al., 2020: DYAMOND: The DYnamics of the Atmospheric general circulation Modeled On Non-hydrostatic Domains. Progress in Earth and Planetary Science (2019) 6:61https://doi.org/10.1186/s40645-019-0304-z