Project: 1115
Projecttitle: Frontier Simulations for the Monsoon Region
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Report Period: 2023-07-01 to 2024-06-30

1 Project Progress

We present our progress within this project on Frontier Simulations for the Monsoon Region by summarizing some of our work and results. This project is a data project, no model simulations were performed. Since the last request for computing resources in 2023, we further retrieved selected files via slk containing the artificial tracer mixing ratios (depending on different emission regions within the area of the Asian Monsoon) and files including the positions of ATTILA trajectories from our frontier simulations. Our climate simulations (already performed before 2023 within the HGF-ESM project) comprise

- simulations with EMAC with and without convective transport of tracer,
- two Lagrangian simulations with ATTILA (Lagrangian Model coupled to EMAC) also with and without Lagrangian convection of tracer and
- one simulation with the Lagrangian model CLaMS (also coupled to EMAC).

All simulations used the same model set up and therefore EMAC, ATTILA and CLaMS are driven by exactly the same model climate. The overall project goal is to quantify the amount of boundary layer air from certain emission regions in Asia, that reach the Asian monsoon anticyclone (AMA) as simulated with EMAC, ATTILA and CLaMS.

We **defined the boundary of the AMA** by calculating the strength of the AMA in terms of geopotential height anomaly following Nützel et. al, 2022. This was necessary as the strength (threshold value to determine the boundary) of the AMA strongly depends on the type of simulation (e.g. nudged, free-running, resolution,...). A value from observations is not necessarily applicable for our simulations.

We **employed two methods of quantifying the boundary layer air within the AMA**:

- (i) We analyse **trajectories** (from ATTILA only) starting in the AMA at 150 hPa by following them backwards in time to their boundary layer origin similar as described in Nützel et al. (2022). We will use these results for a thorough intercomparison with the results presented in Nützel et al. 2022 (not finished).
- (ii) We use **tracer** contributions to quantify the boundary layer sources to the air masses within the AMA.

A further step will be to intercompare the results of the 2 different methods (i and ii). This will allow us to estimate the robustness of the respective quantifications of the boundary layer air masses within the AMA.

We **intercompared the results of EMAC, ATTILA and CLaMS** with respect to the distribution of boundary layer air at 150 hPa in the Monsoon region, dependent on the different emission regions (using a life time of 5 days). CLaMS shows qualitative similar results compared to ATTILA and EMAC simulations without tracer convection. This is no surprise as the CLaMS version employed here has no convection parametrisation. Mostly, CLaMS is used as a stand-alone model and forced by input data (e.g. ERA5 or ERA-interim) with a higher resolution (convection resolving) than in the coupled EMAC-ATTILA-CLaMS simulation (T42L47) evaluated here. Therefore, CLaMS mainly shows a lower value of boundary layer air within the AMA for most of the emission regions if compared with EMAC or ATTILA (including tracer convection).

Unfortunately, our analysis stays behind what we have originally planned, partly because we still could not allure an appropriate master/bachelor student. Nonetheless, we do not loose track of our goal to analyse and publish the result of the frontier simulations.

References

Nützel, M., Brinkop, S., Dameris, M., Garny, H., Jöckel, P., Pan, L. L., and Park, M.: Climatology and variability of air mass transport from the boundary layer to the Asian monsoon anticyclone, Atmos. Chem. Phys., 22, 15659–15683, https://doi.org/10.5194/acp-22-15659-2022, 2022.