Project: **755**

Project title: **Feedback of a limited-area model to the global scale**

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A two-way coupling between the spectral global model EMAC and the grid-point regional model COSMO/MESSy und between two COSMO/MESSy instances should be developed within the FLAGSHIP project. Unfortunately, the globally-regionally coupled simulations revealed very unphysical behaviour. Investigation of the reasons revealed that the interpolation between different (vertical) grids, systematically changes the physics in the global model. Due to the spectral nature of the model these changes trigger waves at the edges of the domain coupled back from the regional model. These waves in turn change the physics and especially the mass in the global model.

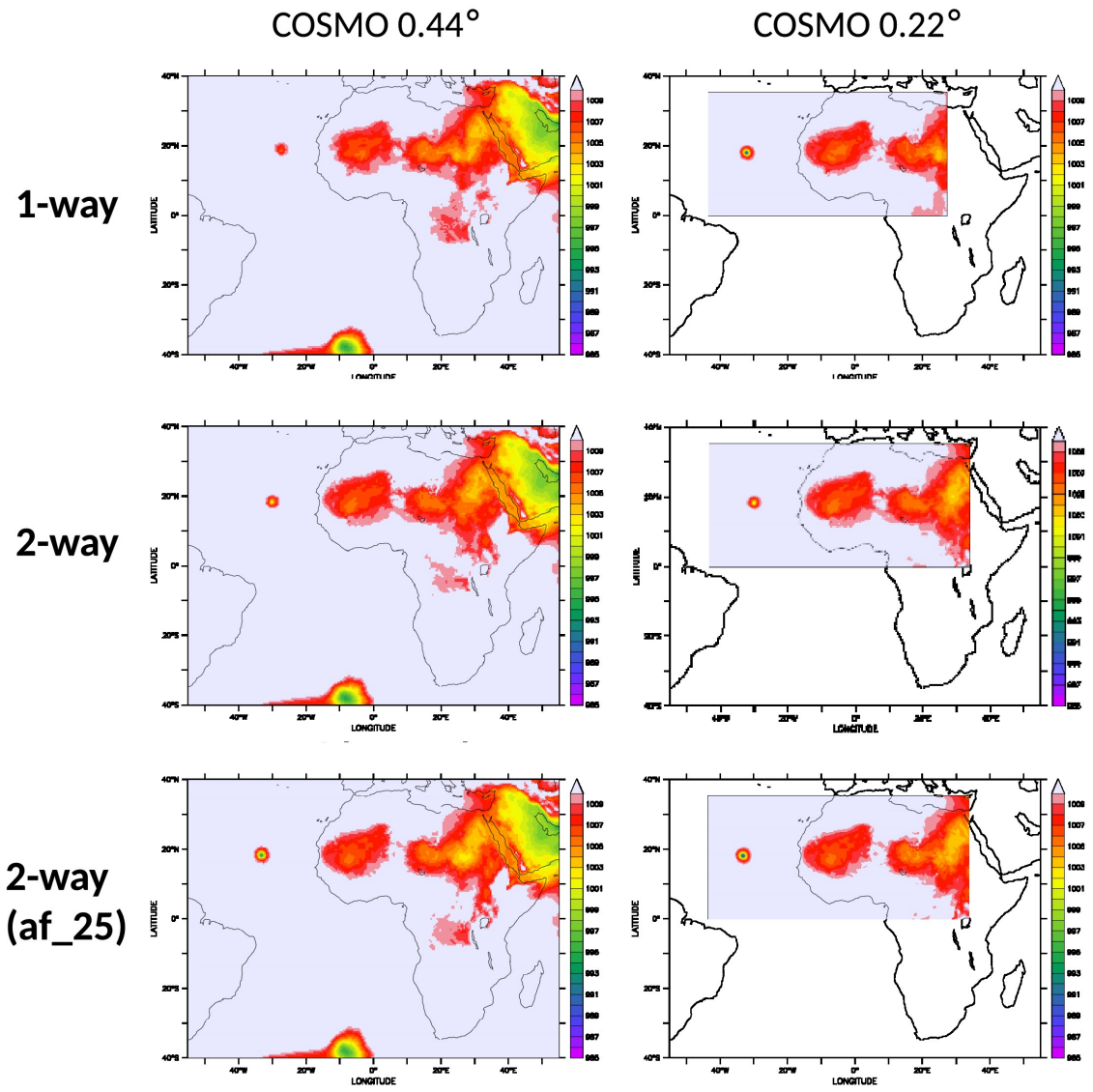

Figure 1: Genesis of hurricane Alberto in a coarser (0.44°, left) and a finer (0.22°, right) COSMO domain. Shown is the minimal sea level pressure [hPa] on 7 Aug. 2000 at 12 UTC.

Top: 1-way-coupled simulation, middle, bottom: 2-way-coupled simulation. For the coupling in the middle the inner domain of the finer resolved instance less the relaxation zone is fed back to the coarser domain. On the bottom, an additional frame (af) of 25 grid boxes was not fed back to the larger domain.

Therefore the investigation of the regional two-way coupled system became the scientific focus of the project. The newly implemented two-way-coupling between two COSMO/MESSy instances has exemplarily been tested for a case study of the hurricane Alberto. Its development starts with the genesis of a tropical cyclone over Africa at the beginning of August 2000.

Figure 1 shows the results from MECO(n) simulations, in which the coarser (0.44°, left panels) COSMO/MESSy instance is driven by a free running EMAC simulation. The finer (0.22°, right panels) COSMO/MESSy instance is nested into the coarser COSMO instance and coupled one-way (top), two-way (middle) and two-way with a reduced domain (bottom). In Figure 2, the corresponding temporal development of the minimal sea level pressure is compared to observational data.

Since smaller scale processes are only resolved in the finer model instance, the decrease of the sea level pressure in the one-way simulation is only captured in the finer resolved COSMO/MESSy instance (dashed, blue contour in Fig. 2). While the coarser instance produces only a low in this simulation (Fig. 1, top left, Fig. 2, solid blue line), the representation of the sea level pressure is improved, when the results from the finer instance are fed back to the coarser instance (Fig. 1, middle left, Fig. 2, solid, black line). Nevertheless, the hurricane realisation in the finer instance gets worse in that case (Fig. 1, middle right, Fig. 2, dashed, black line). Therefore, the sensitivity of the interaction of the different resolved COSMO/MESSy instances has been analysed depending on different parameters. The development of the hurricane in the better resolved instance can be considerable improved, if the size of the domain fed back to the coarser instance is smaller than the full inner domain. For the case study presented here, best results are achieved, if the inner domain of the finer resolved instance less an additional frame of 25 grid boxes is fed back to the coarser instance (Fig. 1, bottom panel, Fig. 2, red lines).

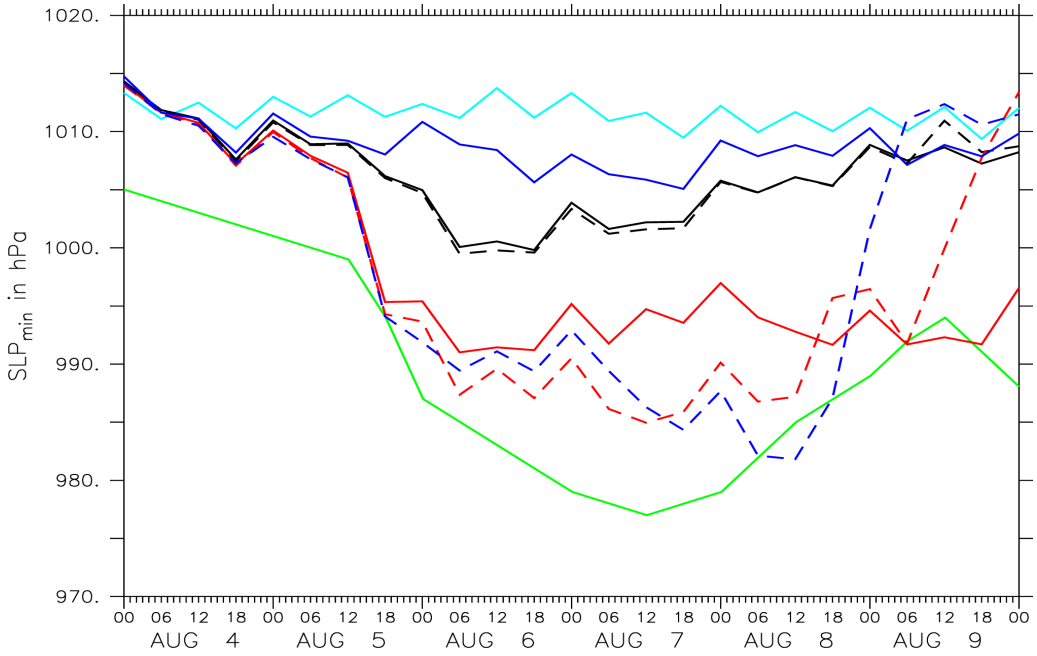

Figure 2: Development of the minimal sea level pressure [hPa] in the region 50°W - 25°W, 10°N – 30°N during the genesis of hurricane Alberto in EMAC (cyan) and COSMO/MESSy (solid: 0.44°, dashed: 0.22°) in a 1-way-coupled simulation (blue), 2-way-coupled-simulation (black) and a 2-way-coupled simulation with an reduced frame of 25 gridboxes (red). Observations (International Best Track Archive for Climate Stewardship (IBTraACS), http://www.ncdc.noaa.gov/ibtracs/) are shown in green.