Project: **802**
Project title: **COSMO-CLM simulations with 2-way nesting**
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Report period: **1.1.2015 - 31.12.2015**

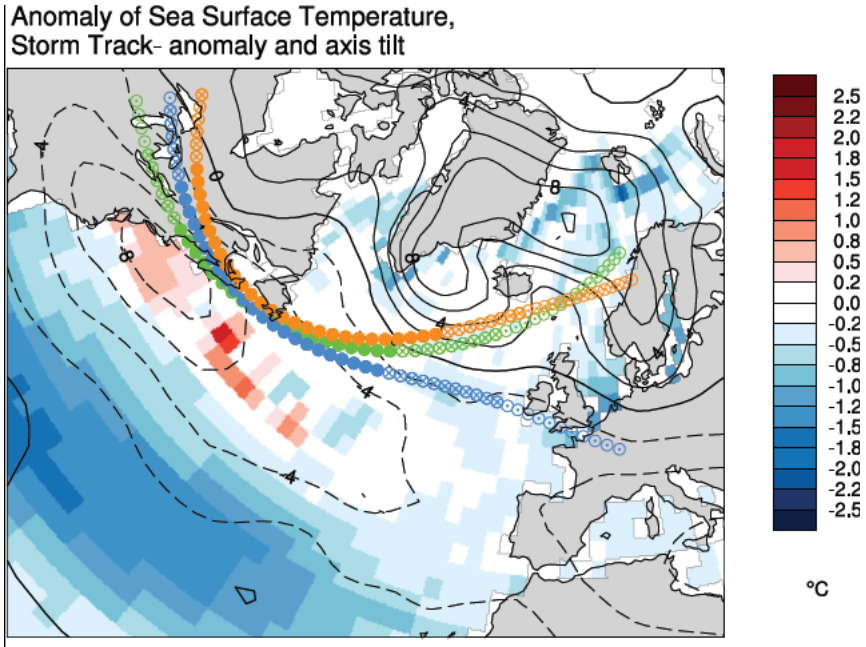
The current status of the project

One major project aim was to configure and to evaluate COSMO-CLM in the Central America to North Atlantic (CANA) region. Hereto the results of COSMO-CLM simulations with different configurations and ERA-Interim initial and boundary conditions were analyzed (report period 2013/2014). A significant improvement in comparison with the reference results could be achieved. In particular the model artifacts at the domain boundaries and the 2m temperature bias could be significantly reduced. Nevertheless, the annual mean 2m temperature bias is still exceeding 1K in some regions and the spatial distribution of precipitation exhibits substantial deviations from the CRU reference data.

A major project milestone was the development of an efficient 2-way coupling between COSMO-CLM and ECHAM6. The task was to interpolate all 3D atmospheric variables between the grids and to exchange them between the models at every ECHAM6 time step (10 min.) within the COSMO-CLM domain. Instead of the OASIS4 coupler the OASIS3-MCT coupler is used, which has the capability of horizontal interpolation and parallel data exchange. The performance tests exhibit an additional computing time of approx. 5 % of the total computing time of COSMO-CLM and ECHAM6. Due to the physically consistent sequential coupling strategy a total waiting time of 50% occurs, because either ECHAM6 or COSMO-CLM has to wait for the results of the other model (report period 2013). The second aim was the development of the physical coupling between ECHAM6 and COSMO-CLM and the implementation of a substantial part of it. A strategy of coupling in the physical grid space was developed. This strategy avoids additional spectral transformations and requires two major developments: first, the vertical interpolation of the model variables between the grids with different orographies and second, the calculation of spatial derivatives of the velocity components, needed for the grid-scale scalar transport in ECHAM6. Both shall be calculated in COSMO-CLM. The physical coupling was developed at report period 2014/2015. The vertical interpolation from ECHAM6 to COSMO-CLM grid is already implemented and shows a temperature deviation of up to 0.1 K for the monthly mean in comparison with the reference interpolation of 1-way nesting. A similar accuracy can be expected for the aggregation from the COSMO-CLM to the ECHAM6 grid. It has the same order of magnitude as the accuracy of the horizontal interpolation.

From July on we define the first fully coupled model and concentrate on performing an ensemble simulation similar to the MiKlip one. To be consistent with the MiKlip Baseline 1 reference in this study we focused on the decades of 1960 to 2010. Due to computing limitations the first realization was chosen and we decided to simulate only two years for each decade.

Regarding the scientific objective we are currently investigating the cyclone statistic, storm track activity, blocking index and climatology of the simulations. The cyclone tracks show an increased density in the North Atlantic compared to Baseline 1 (see report 2014). Comparing the storm tracks of both simulations it is obvious that the US coast and Mediterranean area are characterised by less variability in the Two-Way coupled simulations. The storm track tilt is better represented in the Two-Way coupled runs, less zonality (see fig. 1). Looking at the instantaneous blocking it is apparent that especially in the coupling source region, the blocking is quite better represented than in the Baseline 1 simulation (see fig. 2).



DJF	x_{max}	σ	α_1	α_2	α_3	n
ERA	68.81	8.47	14.28	14.89	16.22	32
BL	66.98	9.40	7.23	6.84	4.64	51
TWC	61.60	7.16	11.43	11.30	13.07	51

Figure 1: Anomaly of Sea Surface Temperature, Storm Track- anomaly and axis tilt; ERA-Interim (green), MPIESM B1 ensemble (blue) and TWC B1 (orange).

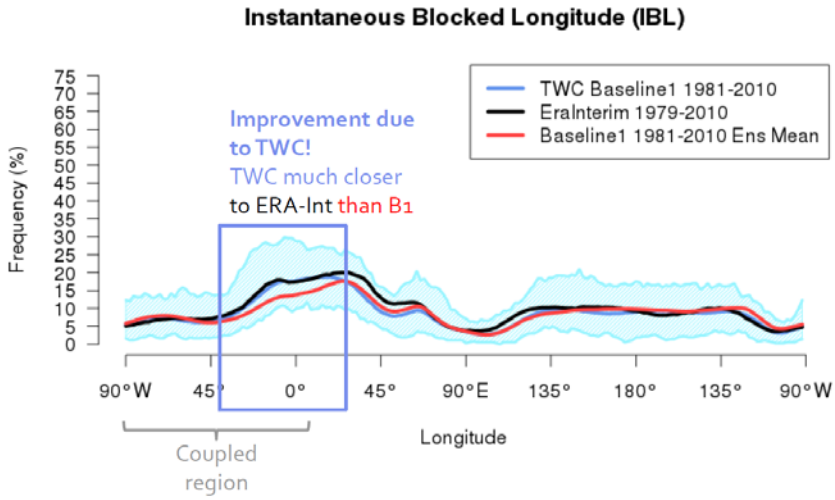


Figure 2: Instantaneous Blocking in ERA-Interim (black), MPIESM B1 ensemble (red) and TWC B1, realization 1 (blue).

From the incoming year on we plan to extend the coupling to the ocean model (MPI-OM). Concerning the COSMO-CLM, the sea surface temperatures can directly relate to the MPI-OM and therefore the higher resolution of the ocean model can be used. Other parameters should also be obtained directly, such as sea ice and sea ice thickness.