Institut für Meteorologie und Klimaforschung – Bereich Troposphäre (IMK-TRO)

Decadal Prediction of African Rainfall and Atlantic Hurricane Activity (DEPARTURE), Subproject 5

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Project overview

Simulations using the RCM COSMO-CLM (CCLM) contribute to a multi RCM ensemble that will be created within DEPARURE, a joint project within the frame of the research program MiKlip. Within DEPARTURE it is intended to assess the decadal climate predictability in the West African monsoon region and the Atlantic region of tropical cyclogenesis. The decadal forecast skill will be assessed for decadal hindcast periods by downscaling decadal MPI-ESM-LR (ECHAM6/MPIOM) simulations and the comparison of the results with appropriate observations. Further initial and boundary conditions, whose impact will be studied, are anthropogenic land-cover changes (LCCs), greenhouse-gas (GHG) and aerosol (AER) emissions. In addition, a series of sensitivity studies with different Surface-Vegetation-Atmosphere-Transfer (SVAT) models coupled to CCLM will assess the effect of interactive soil and vegetation processes on decadal climate predictability in Africa.

Sensitivity study with respect to soil initial, SST boundary conditions, and Aerosol Optical Depth (AOD)

- Decade 2000, Period 2001 until 2010, start-time: 01.01.2001, 00:00 UTC
- Forcing : decadal MPI-ESM-LR data, baseline 0 , Realization r1i1p1
- characteristics of study see Table 1
- altogether 6 decadal runs for decade 2000
- size of model domain (see Fig. 1, left): 275*207*35
- horizontal resolution: 0.44°
- results are evaluated in 15 African sub-regions (see Fig. 1, right) and compared with climatological data according to Willmott-Matsuura (http://climate.geog.udel.edu/~climate/)
- only land-points have been considered

Table 1: Characteristics of CCLM sensitivity experiments related to initial and boundary conditions.
W_SO: soil moisture, T_SO: soil temperature, T_SNOW: snow temperature, W_SNOW: water equivalent of snow, W_I: canopy water amount, SST: Sea Surface Temperature

DS1R1E1	DS1R1E2	DS1R1E3	DS1R1E4	DS1R1E5	DS1R1E7
Reference run: all initial and boundary conditions from MPI-ESM-LR; Tanre AOD, which is standard for CCLM (Fig. 2)	exchanged initial condition: **W_SO,** taken from ERA-Interim driven CCLM run; Tanre AOD (Fig. 2)	exchanged initial condition: **W_SO, T_SO, T_SNOW, W_SNOW,** taken from ERA-Interim driven CCLM run; Tanre AOD (Fig. 2)	exchanged initial condition: **W_SO, T_SO, T_SNOW, W_SNOW, W_I,** taken from ERA-Interim driven CCLM run; Tanre AOD (Fig. 2)	initial conditions like DS1R1E4, but **exchanged AOD**: time dependent AeroCom climatology instead of temporal constant Tanre AOD (Fig. 3)	initial conditions like DS1R1E4, but **exchanged SST**: SST taken from ERA-Interim instead from MPI-ESM-LR (Fig. 4)

Results

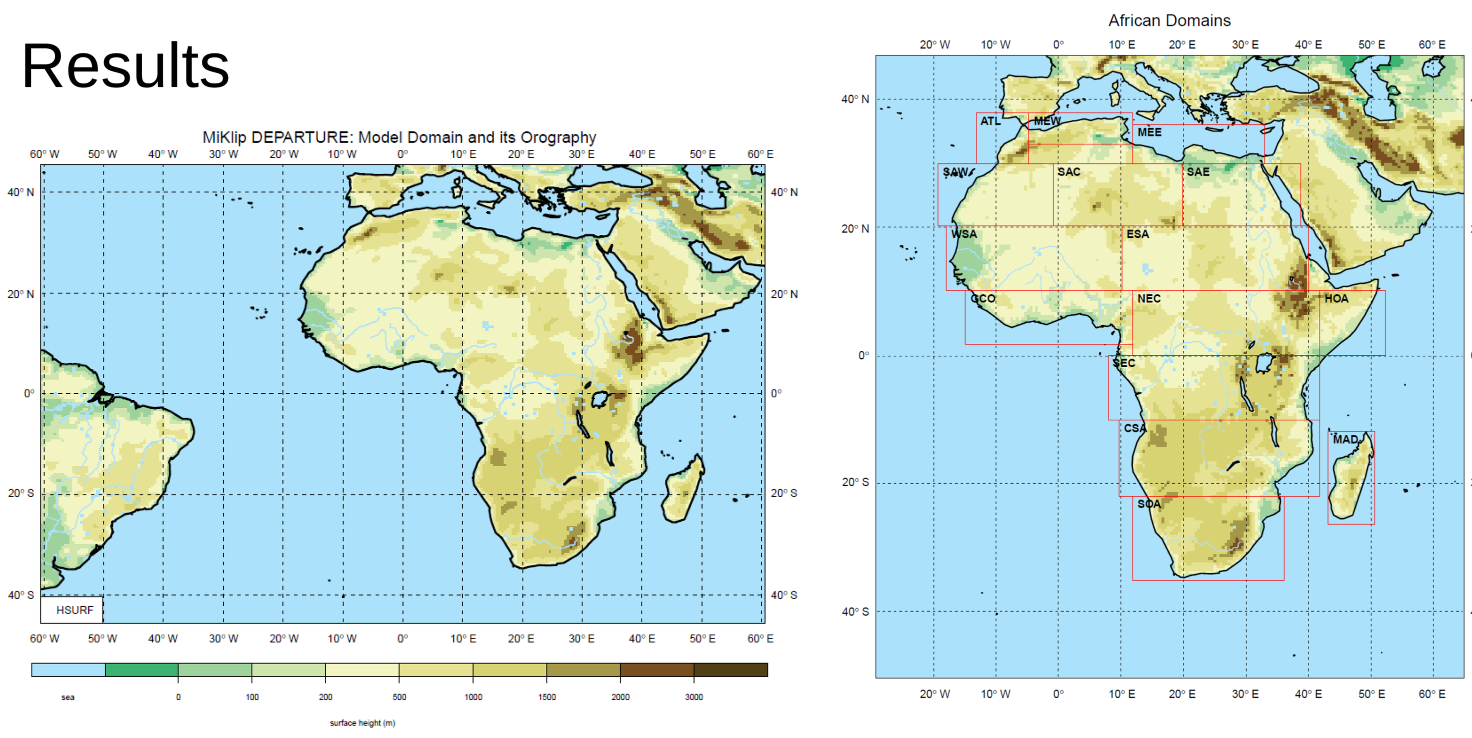


Fig. 1: DEPARTURE model domain (left) and location of African sub-regions (right)

Figure 2:

- Comparison of different CCLM runs in terms of time-series of monthly sums of total precipitation (mm, left) and monthly means of 2 m temperature (K, right) averaged over all land-points of the indicated area (WSA = Western Sahelian, see Fig. 1)
- The RMSE (lower panels) is with respect to Willmott-Matsuura data; the RMSE is on a annual basis
- the impact of different soil initializtion on precipitation is not very striking
- compared to the reference run (DS1R1E1, green curve) the balanced soil initialization improves the temperature results for the first one to three years (lower RMSE)

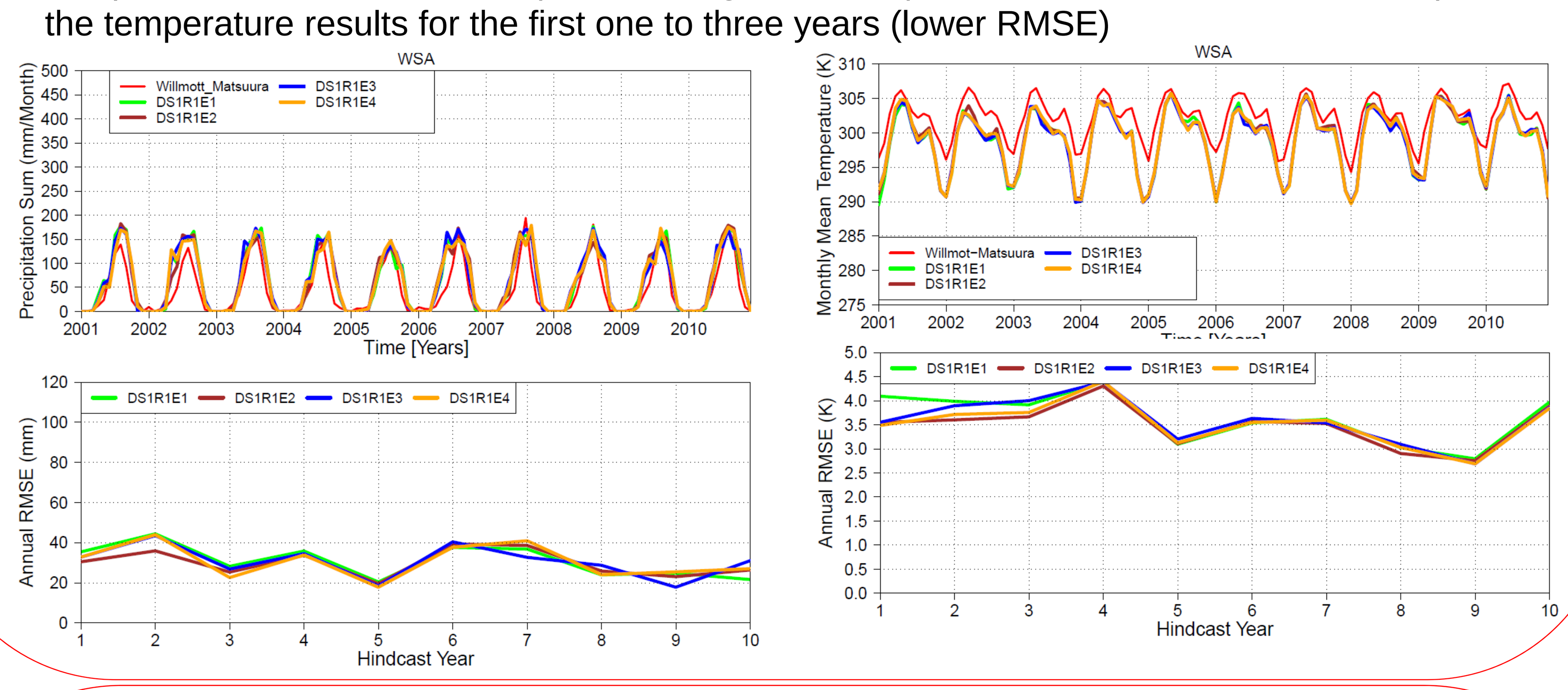


Figure 3:

- left:**Sensitivity** of 2 m temperature **to AOD** for region ESA (see Fig. 1)
  - Reference (green curve): Use of Tanre AOD which varies spatially but does not vary in time
  - Alternative (blue curve): AeroCOM AOD, which varies spatially and from month to month; no interannual variation
  - also comparison with Willmott-Matsuura observations (in red)
  - slight but systematic improvement of CCLM results when using the AeroCOM AOD; this is valid for all African regions but with varying „intensity“ of improvement
- right: the results for monthly sum of total precipitation and sub-region GCO showing no striking difference between the CCLM results

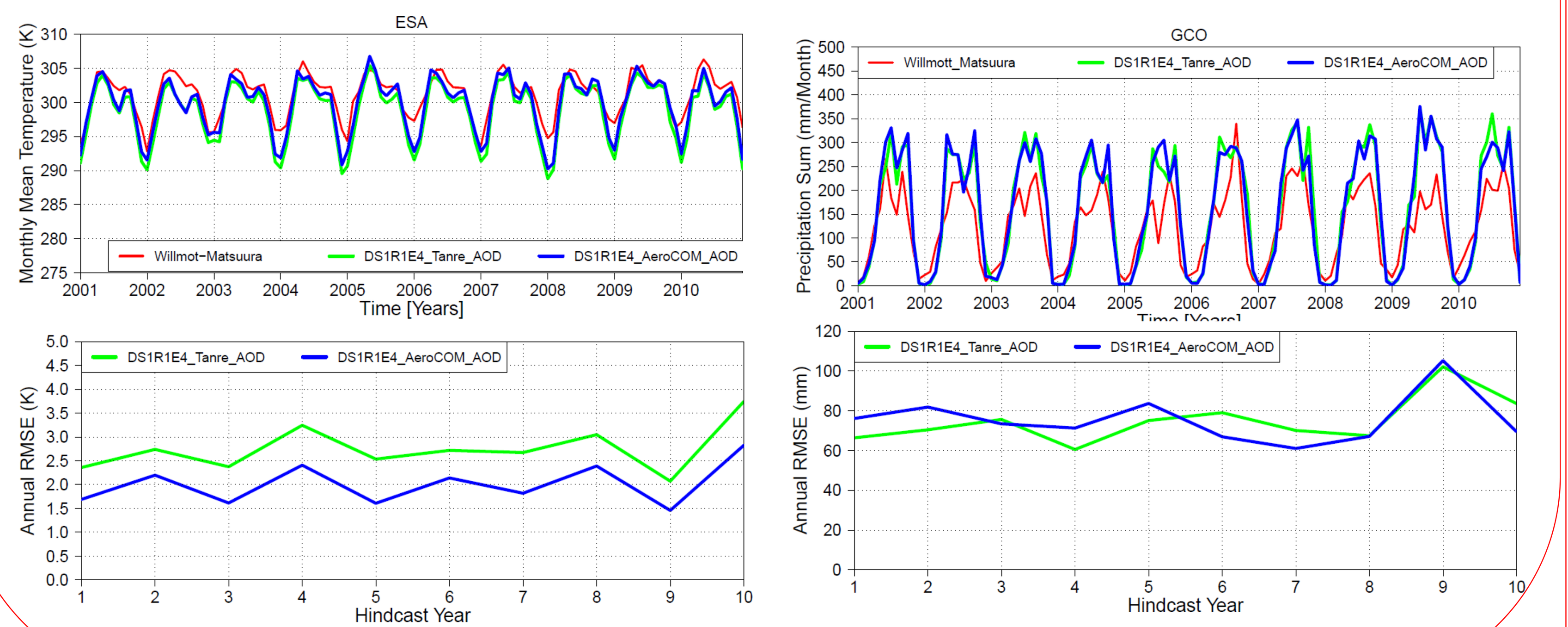
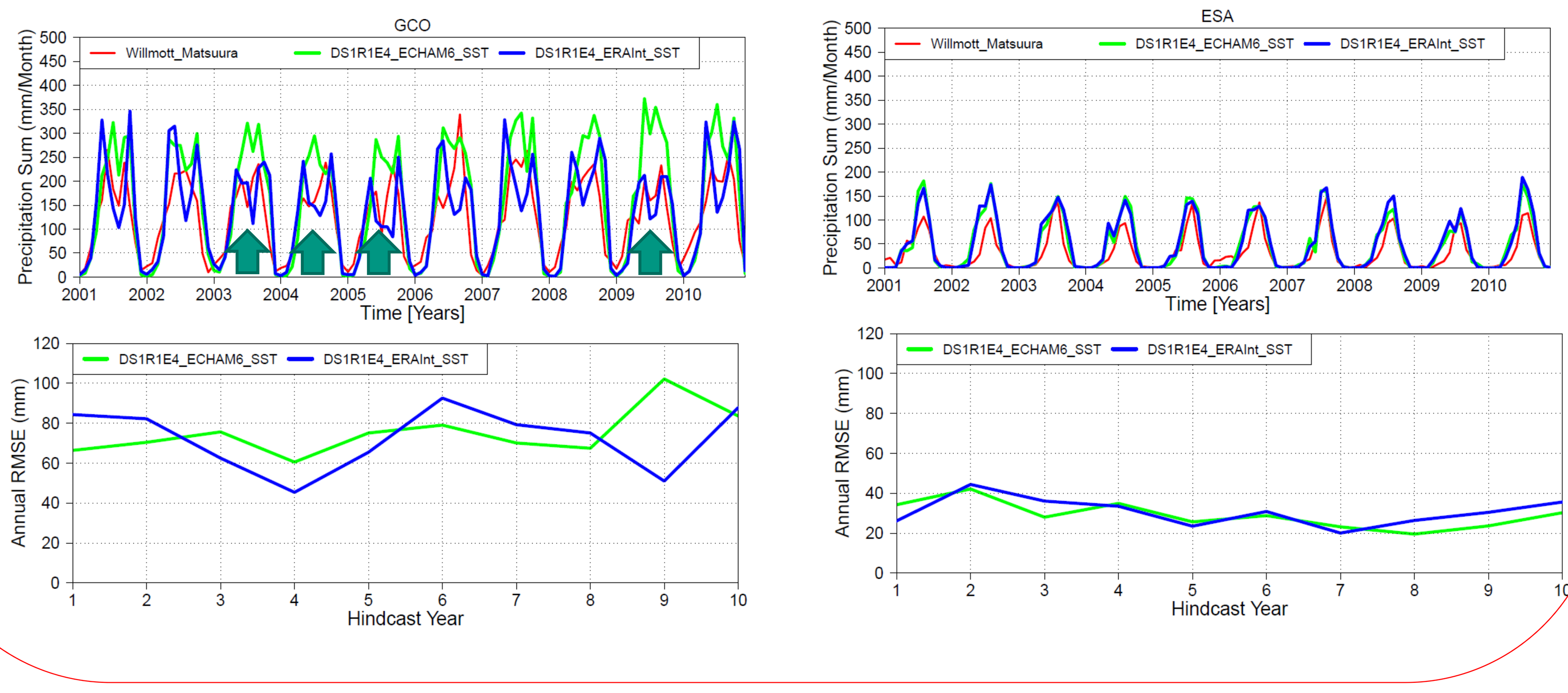


Figure 4:

- left: **Sensitivity** of total precipitation **to SST** for region GCO (see Fig. 1)
  - Reference (green curve): Use of MPI-ESM-LR SST
  - Alternative (blue curve): Use of ERA-Interim SST
  - also comparison with Willmott-Matsuura observations (in red)
  - along coastal regions CCLM results become better, not on all years, but in some (indicated by green arrows)
- right:Sensitivity of total precipitation for region ESA (see Fig. 1)
  - the SST impact on precipitation nearly vanishes



Technical Aspects using BLIZZARD

Nodes used	Tasks per Node	No. of Tasks	Computing time per year (Node-h)	CPU-time per decade (CPU-h)	Storage capacity per Decade (Tbyte)
4	64	256	25	8000	2