FONA Decadal Climate Prediction BMBF | MiKlip | Climate Limited-area Modelling Community

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

Is there potential added value in COSMO-CLM with increasing grid resolution?

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INTRODUCTION:

Within the BMBF funded programme MiKlip one focus is on the downscaling of coarse grid global decadal climate predictions to model grids with much higher spatial resolution. One aspect of research is the estimation of the added value achieved by the dynamical downscaling from the global to the regional scale.
*Besides many attempts to show the added value of climate simulations performed on high resolution numerical grids compared to coarser grid simulations (e.g. Feser, 2006; Feser et al., 2011; Prein et al., 2013; Paeth & Mannig, 2013) the concept of the so-called **potential added value (PAV)** by Di Luca et al. (2012, 2013) enables the user to show a theoretical added value by using only one regional climate model with respect to a virtual larger scale driving (global) model. The advantage of this method is the avoidance of a comparison with real coarser grid models with different physical properties and parameterizations as well as with gridded observational data including problems due to the representativeness of the measurements and the interpolation of the point measurements to the area-averaged gridded data.*

Runs performed:
- Driving data:
  ERA 40 (1959 – 1978),
  ERA Interim (1979 – 2010)
- RCM: COSMO-CLM
- Grid resolution:
  0.44° (1959 – 2010),
  0.22° (1959 – 2010)
  0.11° (1979 – 2010),
  initialization of soil in 1979 by interpolation from 0.22° run
- Model domain: CORDEX Europe

Variance decomposition analysis and PAV quantities (Di Luca et al., 2013):

Assumption:
Statistics of a (driving) coarse grid model can be approximated by aggregating the high-resolution field simulated by a regional climate model into a coarser grid mesh with an horizontal spacing similar to that used by the driving model.

➔ differences between the regional climate model and its corresponding virtual global model can be expressed using the Reynolds decomposition:

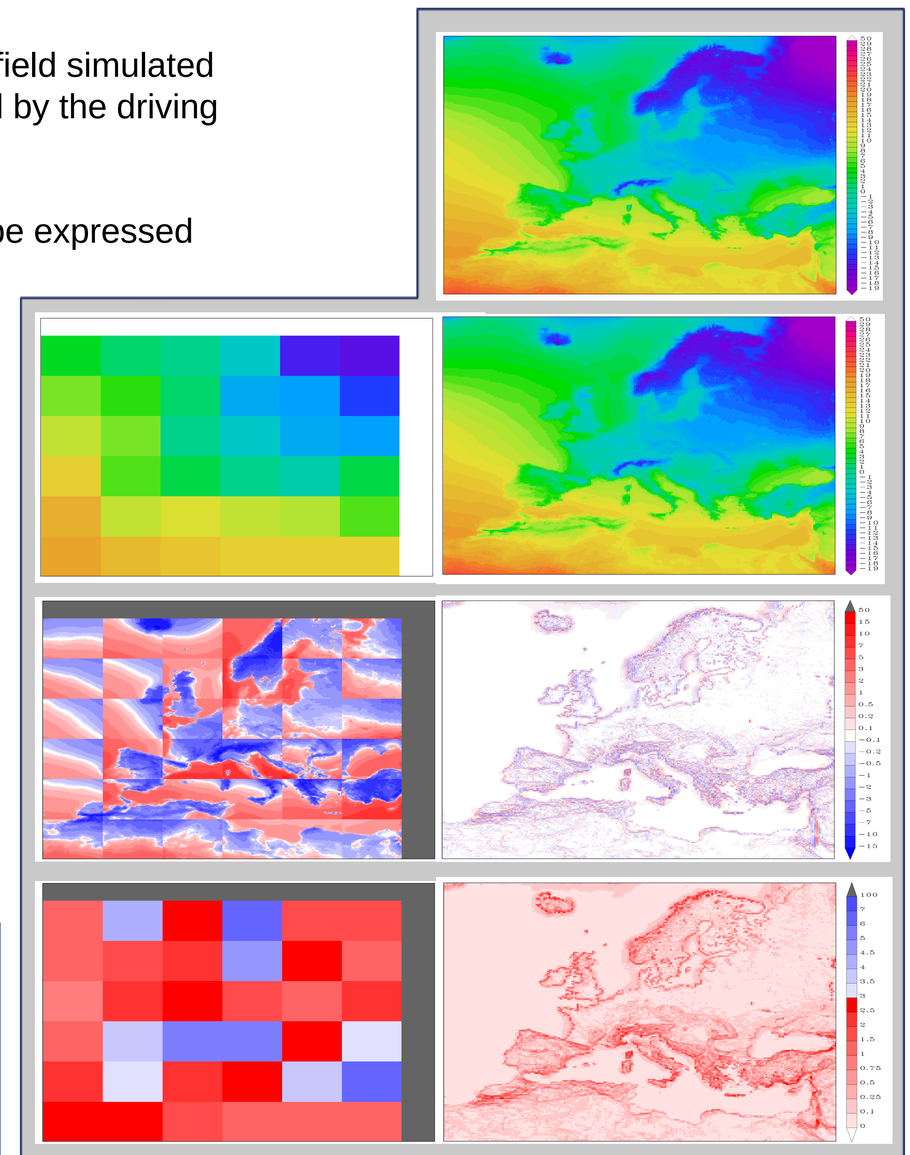
$$T_{i,k} = \overline{T_{i,k}}^{i} + \widehat{T_{i,k}} = VGCM_k + RCM_{i,k}$$

with

$T_{i,k}$: arbitrary 2-dimensional field of the regional model
i, k : indices representing space and time
$\overline{T_n}^{n}$: arithmetic mean of field T over n

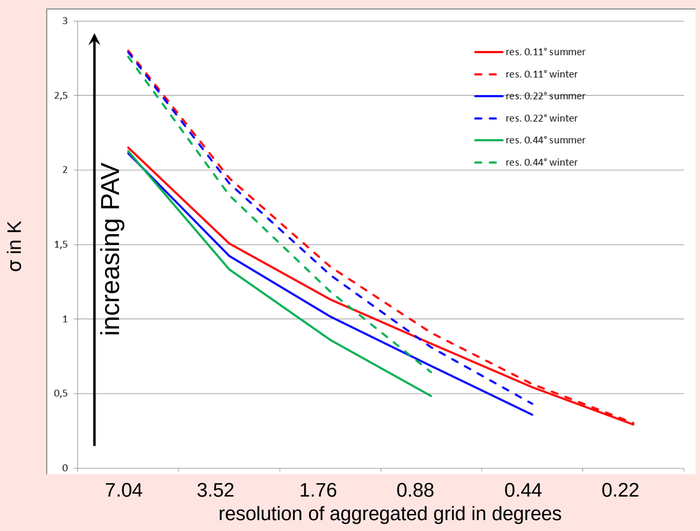
$\overline{T_{i,k}}^{i} = VGCM_k$: virtual global model result (time series of the spatial mean)
$\widehat{T_{i,k}} = RCM_{i,k}$: residual regional part of model results representing the time series of the spatial deviations

Potential added value: $PAV = {\sigma_{RCM_{i,k}}}^2$

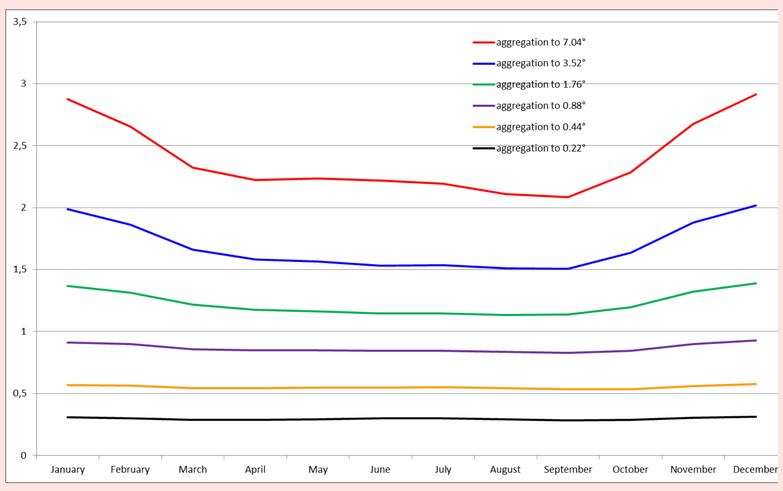


All figures: 2 m temperature, January 1979
Top: monthly mean on 0.11° COSMO-CLM grid in °C
2nd row: virtual global model part VGCM in °C, aggregated on 7.04° (left) and 0.22° (right)
3rd row: residual regional part RCM in K after aggregation on 7.04° (left) and 0.22° (right)
Bottom row: potential added value PAV regarding the aggregation on 7.04° (left) and 0.22° (right)

2 m temperature of COSMO-CLM run 0.11° resolution grid has been aggregated to model grids with resolutions of 0.22°, 0.44°, 0.88°, 1.76°, 3.52°, and 7.04°, the runs on 0.22° and 0.44° onto the coarser grids as well. These data have been subject to the variance decomposition analysis.



standard deviation of the residual regional part of the 2 m temperature model results aggregated on model grids with coarser resolution for summer and winter season



yearly cycle of standard deviation of the 2 m temperature residual regional part of the model results aggregated from 0.11° to model grids with different coarser resolution

Outlook:
- Extension of the PAV analysis to precipitation, wind velocity, and humidity
- Consideration of shorter periods than seasons and months, especially with respect to precipitation extremes
- Comparison of results with gridded observational data (e.g. E-OBS, HYRAS, DecReg data)

Conclusions:
- Model results show potential added value with respect to 2 m temperature
- PAV increases with increasing grid resolution of the regional climate model
- The gain of PAV by further refinement of the RCM grid decreases with increasing grid resolution (e.g. the gain of PAV between 0.11° and 0.22° is less than between 0.22° and 0.44° grid resolution)
- But PAV remains highest if the aggregation has been performed from a RCM grid with hoghest resolution
- PAV is dependent on the season

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