High-resolution sensitivity studies with the regional climate model COSMO-CLM

CATHÉRINE MEISSNER\textsuperscript{1,*}, GERD SCHÄDLER\textsuperscript{2}, HANS-JÜRGEN PANITZ\textsuperscript{2}, HENDRIK FELDMANN\textsuperscript{2} and CHRISTOPH KOTTMEIER\textsuperscript{2}

\textsuperscript{1}Sande, Norway
\textsuperscript{2}Institut für Meteorologie und Klimaforschung, Universität Karlsruhe/Forschungszentrum Karlsruhe, Karlsruhe, Germany

(Manuscript received October 31, 2007; in revised form July 19, 2009; accepted July 19, 2009)

Abstract
This paper presents sensitivity studies with the regional climate model COSMO-CLM for southwest Germany and the period from 1991 to 2000. The influence of horizontal resolution (7 km and 14 km) and driving data (ERA-40 and NCEP reanalysis data) on simulation results are assessed and a suitable simulation setup for high-resolution simulations is derived by using varying domain sizes, soil moisture initialization, physical parameterizations and numerical schemes. The use of ERA-40 reanalyses as driving data yields better overall results for temperature and precipitation than the use of NCEP reanalysis data. Increase in the horizontal resolution leads to better simulation results compared to observations. The choice of driving data has a larger impact on simulation results than changing resolutions, physical parameterizations, numerical schemes or initial soil water contents for simulations of this area.

Zusammenfassung

1 Introduction

Due to global warming, changes in the near-surface temperature and water cycle can be expected on the regional scale (ALLEY et al., 2007; CHRISTENSEN and CHRISTENSEN, 2002; EASTERLING et al., 2000). In order to assess these changes and to conceive adaptation measures in complex topography like southwest Germany, a high horizontal resolution is necessary to obtain reliable results with climate models. Due to their coarse resolution, the results of global models cannot be used directly for regional climate analyses. Therefore, the non-hydrostatic regional climate model COSMO-CLM was chosen for dynamic downscaling of scenarios from global models to the regional scale with a resolution better than 15 km. In order to gain confidence in statements about future changes, it is necessary to assess how well and with what uncertainties the past and present climate, and particularly components of the regional water cycle like precipitation and evapotranspiration, can be modelled in such orographically structured regions. Another prerequisite is the definition of a suitable simulation setup, since this has a strong influence on the model results and changing the parameter settings may affect the quality of the results considerably. The importance of a specific parameter generally depends on the meteorological variables considered, so that no single set of parameters will give optimal overall results. In this study a parameter set is proposed, which gives best results for the simulation of past episodes for the area of southwest Germany as regards precipitation and near-surface temperature. The uncertainties in such simulations are assessed and the influence of domain size, horizontal resolution, driving data, and model setup is investigated in this article.

The main focus lies on the horizontal resolution, since it has a very high impact on CPU costs which is an important factor in climate research. Especially in complex terrain, a higher resolution is expected to yield better overall results. This assumption will be checked in the present paper.

The outcome of studies like this one is clearly tied to the simulation area, the model in use, and the model ver-