Geophysical Research Abstracts
Vol. 12, EGU2010-14335, 2010
EGU General Assembly 2010

The diurnal precipitation cycle over Sweden – comparing observations with simulations from a high-resolution Regional Climate Model (RCA3)

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It is known that climate models still have remarkable defficiencies in simulating precipitation characteristics observed on different temporal scales. This also applies for sub-daily scales, i.e. the diurnal precipitation cycle. Even if the large-scale circulation conditions are simluated fairly well and give the background conditions for regional rainfall characteristics, the mechanisms triggering timing and amount of rainfall are not understood completely. Precipitation characteristics show a relativey low spatial autocorrelation. Increasing the spatial resolution of climate models may be one way to improve the quality of climate simulations in terms of simulating local and regional precipitation climatology.

In this study we utilize a database with long term sub-daily precipitation observations over Sweden (13 years, 93 stations) in order to analyze characteristics of the diurnal precipitation cycle. From this high-resolution dataset characteristical spatial and seasonal patterns of both precipitation amount and frequency are derived for summer (JJA) and winter (DJF) season. The results from the observation dataset are compared with diurnal cycle characteristics simluated by a high resolution Regional Climate Model. The observed diurnal cycle in each station is compared with the 9 surrounding model grids in each simulation. The model chosen is RCA3, the third version of the Rossby Centre Atmospheric Model developed and run by the Swedish Meteorological and Hydrological Institute (SMHI). We utilize long term simulations of RCA3 driven by ERA-40 reanalysis with 50, 25, 12.5, and 6 km horizontal grid-resolution for the same period as covered by the observations, 1996 – 2008.

Different model resolutions give different results in terms of simulated precipitation amount and frequency. In general, peak timing of amount and frequency are simulated to be quite homogeneous throughout the research area. The typical afternoon peak identified in summer is uniformly simulated to be around noon. The observations reveal a much more heterogeneous timing of the summer afternoon peak, both in terms of phase (later afternoon) and spatial difference. Simulations run with higher spatial resolutions better simulate the heterogeneous pattern observed. Better topography in higher resolution simulations may contribute to this improvement. However, in some areas the precipitation frequency increased with the model resolution. In general the phenomenon of coastal early morning rainfall peaks in summer is captured by the model which can help to investigate and explain this distinct summer pattern.