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Impact of different and time-varying land cover data sets in a regional climate model on regional and local climate over Europe

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According to IPCC, Land use and Land Cover (LC) changes have a key role to adapt and mitigate future climate change aiming to stabilize temperature rise up to 2°C. Land surface change at regional scale is associated to global climate change, such as global warming. It influences the earth's water and energy cycles via influences on the heat, moisture and momentum transfer, and on the chemical composition of the atmosphere. These effects show variations due to different LC types, and due to their spatial and temporal resolutions. Thus, we incorporate a new time-varying land cover data set based on ESACCI into the regional climate model COSMO-CLM(v5.0). Further, the impact on the regional and local climate is compared to the standard operational LC data of GLC2000 and GlobCover 2009. Convection-permitting simulations with the three land cover data sets are performed at 0.0275° horizontal resolution over Europe for the time period from 1992 to 2015.

Overall, the simulation results show comparable agreement to observations. However, the simulation results based on GLC2000 and GlobCover 2009 (with 23 LC types) LC data sets show a fluctuation of 0.5K in temperature and 5% of precipitation. Even though the LC is classified into the same types, the difference in LC distribution and fraction leads to variations in climate simulation results. Using all of the 37 LC types of the ESACCI-LC data set show noticeable differences in distribution of temperature and precipitation compared to the simulations with GLC2000 and GlobCover 2009. Especially in forest areas, slight differences of the plant cover type (e.g. Evergreen or Deciduous) could result in up to 10% differences (increase or decrease) in temperature and precipitation over the simulation domain. Our results demonstrate how LC changes as well as different land cover type effect regional climate. There is need for proper and time-varying land cover data sets for regional climate model studies. The approach of including ESACCI-LC data set into regional climate model simulations also improved the external data generation system.

We anticipate this research to be a starting point for involving time-varying LC data sets into regional climate models. Furthermore, it will give us a possibility to quantify the effect of time-varying LC data on regional climate accurately.

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