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Separation of land-use change induced signals from noise by means of evaluating perturbed RCM ensembles: Assessing the potential impacts of urbanization and deforestation in Central Vietnam

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Regional climate models (RCMs) comprise both terrestrial and atmospheric compartments and thereby allowing to study land atmosphere feedbacks, and in particular the land-use and climate change impacts. In this study, a methodological framework is developed to separate the land use change induced signals in RCM simulations from noise caused by perturbed initial boundary conditions. The framework is applied for two different case studies in SE Asia, i.e. an urbanization and a deforestation scenario, which are implemented into the Weather Research and Forecasting (WRF) model. The urbanization scenario is produced for Da Nang, one of the fastest growing cities in Central Vietnam, by converting the land-use in a 20 km, 14 km, and 9 km radius around the Da Nang meteorological station systematically from cropland to urban. Likewise, three deforestation scenarios are derived for Nong Son (Central Vietnam). Based on WRF ensemble simulations with perturbed initial conditions for 2010, the signal to-noise ratio (SNR) is calculated to identify areas with pronounced signals induced by LULCC. While clear and significant signals are found for air temperature, latent and sensible heat flux in the urbanization scenario (SNR values up to 24), the signals are not pronounced for deforestation (SNR values < 1). Albeit statistically significant signals are found for precipitation, low SNR values hinder scientifically sound inferences for climate change adaptation options.
It is demonstrated that ensemble simulations with more than at least 5 ensemble members are required to derive robust LULCC adaptation strategies, particularly if precipitation is considered. This is rarely done in practice, thus potentially leading to erroneous estimates of the LULCC induced signals of water and energy fluxes, which are propagated through the regional climate – hydrological model modeling chains, and finally leading to unfavorable decision support.