Hydro-climatic effects of future land-cover/land-use change in montane mainland southeast Asia

Climatic Change

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Description:
Explaination of the effect of large domain size on the model performance
Southeast Asia is a complex region with some remarkable contrasting features in topography, landscape and land-sea boundary. It is also a region that is under the influence of three different air currents in summer (the Indian monsoonal westerlies, cross-equatorial airflow and tropical western Pacific easterlies), which cause monsoon processes (Ding 1994). Convective activity usually takes place in combination with orographic lifting and frontal activity in Southeast Asia, resulting in high levels of precipitation (Wang et al. 2003). For these and other reasons, the region presents a challenging environment for the climate modeling, and therefore it is not uncommon for model simulations to generate large biases in the estimated climate parameters for that region (e.g., Werth and Avissar 2005; Chow et al. 2006; Chen et al. 2011; Chotamonsak et al. 2011). Modeling studies that focus on China also report biases in the estimated precipitation (e.g., Gao et al. 2007; Zhang et al. 2008; Gao et al. 2008; Gao et al. 2011; Gao et al. 2012). It is recognized that the primary reason behind such biases is related to the deficiencies in the convective schemes (Chow et al. 2006). The "large domain size" could be another factor causing the biases in the precipitation simulations. Such issues are discussed in detail in a paper by Wang et al. (2004). They state that "the use of a large domain could degrade the skill of the RCM in reproducing the large-scale circulation due to model deficiencies". And, a degradation in large-scale circulation could result in biases in climate parameters. Another point is that the RCMs receive the large-scale information at their boundaries from the hosting GCM or Reanalyses data whose resolution is low. Boundary conditions are provided using interpolation from low resolution grids of GCM/Reanalyses to high resolution grids of RCM over a boundary relaxation zone. No matter what nudging method is used for this transition, it introduces some error to boundary conditions taken by the RCM. Such error may have higher potential to affect the large-scale fields, hence the climate parameters, simulated by the RCM in case the domain is larger. In other words, the error could have more space to amplify in larger domains. Wang et al. (2004) state that "With "one-way nesting" the RCM circulation could differ from that of the host GCM. This is possible especially when large domains are used".

As further discussed by Wang et al. (2004), there are advantages as well as disadvantages of using a large domain in a sensitivity study. There are a few reasons why we preferred a large domain over a small one in the Southeast Asia in the present paper. The first one, as stated in the paper, is that we desired to include both the Indochina Peninsula and China to be able to detect possible downwind effects of LCLU change in MMSEA (Montane Mainland Souteast Asia). We know from Sen et al. (2004) that LCLU changes in the Indochina Peninsula could have far reaching effects in the downwind side under the influence of summer monsoon circulation. The other reason is that we wanted to give the RCM enough space to establish its own dynamics so that the land-atmosphere interactions are not affected much from the boundary conditions. In small domains, large-scale fields that are affected more by the host model/reanalysis could suppress the changes at the surface. This is not desired for a sensitivity simulation. Wang et al. (2004) state that "The use of a relatively large model domain, with good model physics parameterizations, should be encouraged in future assessment to thoroughly
understand the complex land atmosphere interactions”. The third reason is related with the topography of the region. We did not want to place the western boundary on complex topography, so close to the perturbation area, which may introduce more error to the large scale fields along the western boundary.


