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High resolution atmospheric modelling on the Tibetan Plateau: How to understand a system with sparse observations?

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My research focuses on the Nam Co Lake basin on the Tibetan Plateau, which is a large lake surrounded by mountain chains. I use a high-resolution atmospheric model (ATHAM) in order to investigate atmospheric processes and the interaction of the land and lake surfaces with complex topography in the development of convection: It is frequently observed that, over the course of a day, fair weather cumulus clouds develop into the thunderstorms. These developments create feedbacks through precipitation and the surface energy-balance. Convection is dependent on the state of the atmosphere (stability and moisture contents), surface fluxes and soil moisture, wind speed and direction as well as thermal circulations developing between lake, land surface and mountains.
There is a high spatial variability of the surface and atmospheric conditions in mountainous areas. Additionally, observations are sparse and lack representativeness as stations locations are biased to more easily accessible locations.
My work tries to integrate field observations from standard atmospheric measurements and radio-soundings that where gathered during two field campaigns at Nam Co Lake in 2009 and 2012 into the high-resolution model in order to gain a better understanding of the system's dynamics. Our focus is on idealized sensitivity studies that show the influence of the different factors such as atmospheric profiles or wind direction.
The Tibetan Plateau acts as an elevated heat source and modifies the monsoon system and has thus very likely a great influence on the water cycle and water resources in the region. Up to this point there is a very limited understanding of atmospheric processes and surface-atmosphere interactions on the plateau, yet these processes determine both the surface energy-balance and the generation of precipitation. Increasing our understanding of these processes is hence vital for our understanding of water resources and environmental processes in a changing climate.

Uncertainty is of central importance to all modelling work, as small changes in input parameters have potentially large effects on modelled outcomes. Input parameters such as atmospheric temperature and moisture profiles and the state of the surface are relatively difficult to measure in a coherent manner. This is especially true for the Tibetan Plateau, where mountains and complex surfaces lead to large variability of surface conditions. There are few weather stations, which additionally do not adequately reflect true conditions: For instance, no permanent weather stations on the Tibetan Plateau are located above 4800 m, while the mean elevation of the plateau is more than 4500 m. An important source of atmospheric data both for modelling purposes and in order to assess the impact of climate change are reanalysis data sets and satellite measurements. These however have been mainly developed and tested for regions that are less remote and complex in topography, so that uncertainties and biases are large.
As a consequence, we try to integrate data from different sources and try to estimate sensitivities of the atmosphere-surface system by running idealized simulations spanning a wide range of conditions, which is obviously limited by computational resources.