Regional climate system modeling

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The primary tool for projections of climate change is the coupled ocean-atmosphere general circulation model (OAGCM). Due to the computational limitations, they are often run on coarse-to-moderate resolution. A typical OAGCM includes a representation of the atmosphere, of the land surface, of the ocean and of the sea ice. There is ongoing work to add yet additional components as interactive parts to OAGCMs. Consequently, the trend in model development is towards Climate System Models (CSM), or Earth System models (see e.g. www.enes.org).

Most coupled modeling and climate system modeling is done with global models addressing large-scale climate features. It is also relevant in regional climate modeling. Details of the local-to-regional physiography (coast lines, inland seas, lakes and lake systems, mountain ranges etc.) exert control to the climate of a region even when they are not important for the global climate. Regional and local features can also host mechanisms for climate change feedback on scales not resolved in global projections. An examples of such would be a change in lake ice cover, or a change in the circulation of a regional ocean, as a consequence of an overall warming or a change in wind or freshwater forcing. There are also indications that subgridscale features, and how they are treated, can affect the simulations. Such details presently fall below the scales easily addressed in global models. They can be addressed in regional models. Such details should indeed be addressed in regional climate models whenever the goal is to improve the representation of the regional climate system in modeling and in providing regional projections on climate change and its impacts.

In addition to making a research contribution for a particular region, regional climate system modeling contributes to the development of climate modeling in general. For example:

1. Development of climate system descriptions and coupling in the context of regional models can already today contribute to the dealing with details and mechanisms that future global models will address as their resolution is increased.
2. Adding climate system components for natural and managed systems in climate models, like lakes and river runoff, contributes to impact analysis. When impact studies are done in an interactive manner within a climate model, the problem of how to best transfer information from a climate simulation to an impact model is circumvented. The question of impacts has often a strong regional character and is an area where regional studies are applicable.
3. Coupling of different model components developed and previously applied in isolation offers a new way of checking their performance, and is a powerful tool to look for compensating errors in the different components.

At the Rossby Centre of the Swedish Meteorological and Hydrological Institute, a coupled atmosphere-land surface-lake system-lake-river runoff-ocean-sea ice regional model system now exists. The model system is called the RCAO. This presentation focuses on the regional climate system model RCAO. Selected examples of model development efforts and studies of regional climate and climate change impacts are given.