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Building dams for ESMs

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Several studies based on global hydrology models demonstrate the importance of including water reservoirs and water management policies in impact studies. Not only are the evaporation flux and river discharge effected by such practices, but more importantly, the reservoirs provide a water storage, e.g. for irrigation, which impacts the productivity of crops as well as other sectors. Also for Earth System Models (ESMs) the representation of reservoirs is beneficial as most land surface models do consider crops in their land surface parametrization. Furthermore, the freshwater flux into the ocean can be altered which affects ocean circulation. Nonetheless, reservoir schemes are not yet very common in ESMs.

Here, we present a simple implementation of a reservoir scheme for a river routing model used in an ESM. While there are databases available that contain information about the location, size and purpose of existing reservoirs, we chose a dynamical approach instead, in order to enable future projections where dams can adapt to changes in climatic conditions. For every grid cell, the scheme diagnoses a potential reservoir size based on the water volume of the peak flow months. An actual reservoir is created if a given threshold is passed indicating that a reservoir is beneficial at the given location. Additionally, the impact of every reservoir on its downstream grid cells is estimated and the reservoir is adapted to sustain a given minimum discharge. In this way, reservoirs are iteratively generated along the river flow paths where the capacity of the best performing reservoirs is kept or increased while others are reduced in size.

For the development and testing of the scheme, we implemented three rather general water management policies:

- maximizing the reservoir content,
- stabilizing the river discharge throughout the year, and
- guaranteeing environmental discharge.

We present results of the scheme based on these different management policies and compare their impacts for different climate scenarios.