Conceptual Understanding of Climate Change with a Simple Climate Model

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The future climate change projections are essentially based on coupled general circulation model (CGCM) simulations, which give a distinct global warming pattern with arctic winter amplification, an equilibrium land-sea warming contrast and an inter-hemispheric warming gradient. While these simulations are the most important tool of the Intergovernmental Panel on Climate Change (IPCC) predictions, the conceptual understanding of these predicted structures of climate change and the causes of their uncertainties is very difficult to reach if only based on these highly complex CGCM simulations.

In the study presented here we will introduce a very simple, globally resolved energy balance (GREB) model, which is capable of simulating the main characteristics of global warming. The model shall give a bridge between the strongly simplified energy balance models and the fully coupled 4-dimensional complex CGCMs. It provides a fast tool for the conceptual understanding and development of hypotheses for climate change studies and teaching. It is based on the surface energy balance by very simple representations of solar and thermal radiation, the atmospheric hydrological cycle, sensible turbulent heat flux, the transport by the mean atmospheric circulation and heat exchange with the deeper ocean. It can be run on any PC computer and compute 200yrs climate scenarios within minutes.

The simple model's climate sensitivity and the spatial structure of the warming pattern are within the uncertainties of the IPCC models simulations. It is capable of simulating the arctic winter amplification, the equilibrium land-sea warming contrast and the inter-hemispheric warming gradient with good agreement to the IPCC models in amplitude and structure.