Module title	Climate Modelling: Part 1 (block course)
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Module assignment:	Module section 4 / Advanced Environmental Physics
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Abstract. High-profile scientific reports such as the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (AR5) attest to the exceptional societal interest in understanding and projecting future climate. IPCC AR5 concluded that the warming of the climate system is unequivocal and that the human influence on the climate system is clear. Observed increases of greenhouse gases, warming of the atmosphere and ocean, sea ice decline, and sea level rise, in combination with climate model projections of a likely temperature increase between 2.1 and 4.7°C for a doubling of atmospheric CO_2 concentration, make it an international priority to improve our understanding of the climate system. Coupled atmosphere-ocean General Circulation Models (GCMs) are common tools to understand and project climate change. The lecture gives an overview of the main components of global climate models and explains the underlying basics and the numerical formulation of the fundamental equations, including subgrid-scale parameterizations. Different types of climate models are introduced. In addition, topics such as the major modes of variability, climate feedbacks; climate change and climate warming, and climate model evaluation with observations are covered and an introduction to the Coupled Model Intercomparison Project (CMIP) is given. Selected areas of current research activities and results from GCMs are presented. The lecture includes computational exercises with the NCAR Command Language (NCL) and Python.

Topics to be addressed: Types of Climate Models; Components of atmosphere-ocean General Circulation Models (GCMs); Fundamentals and representation in GCMs: atmospheric component, ocean and sea ice component, and terrestrial component; Parametrizations of subgrid-scale processes; Modes of variability; Climate feedbacks; Introduction to the Coupled Model Intercomparison Project (CMIP); Climate change and climate warming; Climate model evaluation with observations; Results from GCMs; Frequently Asked Questions IPCC Assessment Reports; Computational exercises in NCL and Python.

Literature:

1. Brasseur & Jacob, Modeling of Atmospheric Chemistry, 2016
2. Gettelman & Rood, Demystifying Climate Models, 2016
3. Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report, 2013
4. Jacobson, Fundamentals of Atmospheric Modeling, 2005
5. McGuffie & Henderson-Sellers, A Climate Modelling Primer, 2013