Monsoon Planet: Bimodal rainfall distribution due to barrier-structure in pressure field

Anja Katzenberger[1,2], Anders Levermann[1,2,3], Georg Feulner[1,2], and Stefan Petri[1]

[1]Potsdam Institute of Climate Impact Research, Potsdam, Germany
[2]Institute of Physics and Astronomy, Potsdam University, Potsdam, Germany
[3]Lamont-Doherty Earth Observatory, Columbia University, New York, USA

Monsoon systems are transporting water vapour and energy across the globe, making them a central component of the global circulation system. Changes in different forcing parameters have the potential to fundamentally change the monsoon characteristics as indicated in various paleoclimatic records. Here, we use the Atmosphere Model version 2 developed at the Geophysical Fluid Dynamics Laboratory (GFDL-AM2) and couple it with a slab ocean to analyse the monsoon's sensitivity to changes in different forcing parameters on a planet with idealized topography. This Monsoon Planet concept of an Aquaplanet with a broad zonal land stripe allows to reduce the influence of topography and to access the relevant meridional monsoon dynamics. In the simulations that enable monsoon dynamics, a bimodal rainfall distribution develops during the monsoon months with one maximum over the tropical ocean and the other one over land. The intensity and expansion of the land monsoon depends on the relative height of a local maximum in the surface pressure field that is acting as a barrier and determines the landward moisture transport. This dynamic is emerging during the course of one year, but also occurs when varying different parameters in a sensitivity analysis (slab ocean depth, sulfate aerosols, carbon dioxide, solar constant, land albedo). This structure of a bimodal rainfall distribution and a pressure-barrier located between the two maxima is also present in the Westafrican monsoon.