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Dynamical-core of the new SDAM Aeolus

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Shifts in large-scale circulation patterns can strongly alter the frequency and/or intensity of extremes and can thus have severe humanitarian impacts. Climate change over the last century has already altered some large scale circulation patterns, but the uncertainties are large. Here we present the new statistical-dynamical atmosphere model (SDAM) Aeolus which we intend to use to study the stability of atmospheric circulation patterns and its relation to extreme weather events.

Aeolus is part of the Earth System Model of Intermediate Complexity (EMIC) Climber-4, which is developed and maintained at the Potsdam Institute for Climate Impact Research. The key novelty of Aeolus is its dynamical core, consisting of a new set of statistical- dynamical equations which accurately capture the wind dynamics of a range of different climates. The model explicitly solves the planetary scale circulation (Rossby waves, jet streams, Hadley cell) but parameterizes synoptic circulation. From the momentum fluxes from both the planetary waves and synoptic eddies, the zonal-mean meridional circulation is derived, determining the Hadley cells. We show that Aeolus produces accurate dynamical fields, including synoptic-scale second-order moments, for present day climate by comparing against reanalysis data. In addition, the model is able to reproduce GCM-generated dynamical fields for the last glacial maximum, and for a climate with twice the present-day CO_2 concentration.

Aeolus is computationally much faster than high-resolution atmosphere general circulation models, which allows us to do sensitivity analysis of large-scale atmospheric circulation patterns on internal atmosphere-dynamical processes and forcings arising from changes in boundary conditions. With such sensitivity analysis, we aim to provide fundamental insights into the stability of large scale circulation patterns and their influence on extreme weather events.