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Understanding climate sensitivity to greenhouse gas concentrations and orbital forcing in the cGenie Earth System Model of Intermediate Complexity

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To better understand the Earth's climate system reaction to internal climate perturbations (i.e. changes in continental configuration or greenhouse gas concentrations) and external orbital forcing, it is crucial to determine the climate sensitivity of the system to various ranges of environmental boundary conditions. We examine the climate variability in response to orbital parameters and CO_2 concentration in the atmosphere, using an Earth System Model of Intermediate Complexity (cGenie). Our low-resolution experiment model design uses a simple one-continent symmetry, includes a biogeochemical cycle, an ocean circulation and a simplified atmosphere. First we run fast models with constant values for precession, eccentricity and obliquity, thus creating strongly opposing insolation conditions, that identify variations of surface air temperature across continent and ocean. We test the sensitivity of the model to orbital variations with the initiation of a marine carbon cycle and the generation of more complex continental topologies. By changing the complexity of the carbon cycle, we quantify the effect of marine carbon cycling on the surface air temperature in a simplified world. In sensitivity experiments that run with the same model setup, we observe variations in the imprint of the orbital parameters on seasonal temperature when changing the atmospheric CO_2 content. At predefined latitudes, weighted averages of mean surface air temperature across the continent and the ocean are calculated and used to estimate the impact of the orbital parameters.