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Testing empirical relationships between global sea-level and global temperature in long climate model simulations

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Estimations of future global sea-level rise brought about by increasing concentrations of atmospheric greenhouse gases of anthropogenic origin are based on simulations with coarse-resolution global climate models, which imposes some limitations on the skill of future projections because some of the processes that modulate the heat and fresh water flux into may not be adequately represented. To fill this gap, and until more complex climate models are available, some ad-hoc methods have been proposed that link the rise in global average temperature with the global mean sea-level rise. The statistical methods can be calibrated with observations and applied to the future global temperature rise simulated by climate models.
This methods can be tested in the virtual reality simulated by global atmosphere.ocean models. Thereby, deficiencies can be identified and improvement suggested. The output of 1000-year long climate model simulation with the coupled atmosphere-ocean model ECHO-G over the past millennium has been used to determine the skill of different predictors to describe the variations of the rate of sea-level change in the simulation. These predictor variables comprise the global mean near-surface temperature, its rate of change with time and the heat-flux into the ocean.
It is found that, in the framework of this climate simulation, global mean temperature is not a good predictor for the rate-of-change of sea-level. The correlation between both variables is not stable along the simulations and even its sign changes. A better predictor is the rate-of-change of temperature. Its correlation with the rate-of-change of sea-level is much more stable, it is always positive along the simulation, and there exists a lead-lag relationship between both that can be understood in simple physical terms. The best predictor among those tested is the heat-flux into the ocean. Its correlation is higher and there exists no time lag to the rate-of-change of sea-level, as expected on theoretical grounds.