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Modelling paleoclimate with a simple box model

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In an effort to gain further understanding of the variation of climate during the last ice ages, we have been building a conceptually simple model from the bottom up, adding constituent processes as necessary in order to satisfy the constraints of proxy data. In particular, the form of our model has evolved under the constraint that (a) Milanković variations affect, but are not the primary cause, of ice age timing, and (b) CO_2 varies roughly in line with proxy temperature, and to a degree which is greater than can be explained by the ocean solubility pump. These constraints lead us to build a model which includes ocean carbon, calcium, biomass and phosphorus, silicate and carbonate weathering, ice sheet volume and proglacial lake volume. We provide numerical results which show that self-sustained sawtooth oscillations of ice sheet volume can occur, and that, when modulated by Milanković variations, these take on the characteristic irregularity of the ice age proxy data.