



## **Temperatures from Energy Balance Models: the effective heat capacity matters**

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Energy balance models (EBM) are highly simplified systems of the climate system. The global temperature is calculated by the radiation budget through the incoming energy from the Sun and the outgoing energy from the Earth. The argument that the temperature can be calculated by the simple radiation budget is revisited. The underlying assumption for a realistic temperature distribution is explored: One has to assume a moderate diurnal cycle due to the large heat capacity and the fast rotation of the Earth. Interestingly, the global mean in the revised EBM is very close to the originally proposed value. The time dependent-EBM predicts a flat meridional temperature gradient for large heat capacities which can be related to very effective vertical diffusion. Motivated by this finding, sensitivity experiments with a complex model are performed where the vertical diffusion in the ocean has been increased. The resulting climate shows a flat meridional temperature gradient and a deeper thermocline. The common pattern of surface temperature anomalies and climate reconstructions suggests a possible mechanism for past climate changes prior to 3 million years ago.