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Emulation of the MBM-MEDUSA model: exploring the sea level and the basin-to-shelf transfer influence on the system dynamics

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Complex climate models require high computational burden. However, computational limitations may be avoided by using emulators. In this work we present several approaches for dynamical emulation (also called metamodelling) of the Multi-Box Model (MBM) coupled to the Model of Early Diagenesis in the Upper Sediment A (MEDUSA) that simulates the carbon cycle of the ocean and atmosphere [1]. We consider two experiments performed on the MBM-MEDUSA that explore the Basin-to-Shelf Transfer (BST) dynamics. In both experiments the sea level is varied according to a paleo sea level reconstruction. Such experiments are interesting because the BST is an important cause of the CO_2 variation and the dynamics is potentially nonlinear. The output that we are interested in is the variation of the carbon dioxide partial pressure in the atmosphere over the Pleistocene. The first experiment considers that the BST is fixed constant during the simulation. In the second experiment the BST is interactively adjusted according to the sea level, since the sea level is the primary control of the growth and decay of coral reefs and other shelf carbon reservoirs. The main aim of the present contribution is to create a metamodel of the MBM-MEDUSA using the Dynamic Emulation Modelling methodology [2] and compare the results obtained using linear and non-linear methods. The first step in the emulation methodology used in this work is to identify the structure of the metamodel. In order to select an optimal approach for emulation we compare the results of identification obtained by the simple linear and more complex nonlinear models. In order to identify the metamodel in the first experiment the simple linear regression and the least-squares method is sufficient to obtain a 99,9% fit between the temporal outputs of the model and the metamodel. For the second experiment the MBM's output is highly nonlinear. In this case we apply nonlinear models, such as, NARX, Hammerstein model, and an 'ad-hoc' switching model. After the identification we perform the parameter mapping using spline interpolation and validate the emulator on a new set of parameters.

References:

[1] G. Munhoven, "Glacial-interglacial rain ratio changes: Implications for atmospheric CO_2 and ocean-sediment interaction," Deep-Sea Res Pt II, vol. 54, pp. 722–746, 2007.

[2] A. Castelletti et al., "A general framework for Dynamic Emulation Modelling in environmental problems," Environ Modell Softw, vol. 34, pp. 5–18, 2012.