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Qualitative Models of Global Warming Amplifiers[1]

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Abstract

We present a set of qualitative models in the field of environmental science, particularly in the domain of global warming. One motivation behind this effort is to enrich the model repository of the DynaLearn interactive learning environment (http://www.DynaLearn.eu). This learning environment gives learners automated feedback based on a comparison of their model to a set of (expert) models stored in a repository [2]. Therefore, a model repository is created that consists of a large set of models. The second motivation follows the interest of ecological experts to create qualitative models of phenomena for which numerical information is sparse or missing [1,5].

Society is concerned about global warming and the impact this is expected to have on people and the ecosystems on which they depend [4,6,7,8]. Factors that can amplify or reduce the effect of the causes of climate change are known as positive and negative feedbacks, respectively. In this contribution we will present qualitative models of key feedback mechanisms in this context. The models are implemented in Garp3 [3] and provide abstract explanations of these phenomena, tailored to secondary and early years of higher education.

Six models are described and discussed. We first model two of the so-called negative feedback factors (snow and ice albedo, and cooling aerosols). Next, two of the positive feedback factors are tackled (water vapour and warming aerosols). We then combine the two mechanisms in a larger model (low and high clouds), proving the possibility of extracting general mechanisms that can be reapplied to other systems sharing similar characteristics.

Two domain experts have evaluated the models. According to their reviews, the main goal of creating a set of simple models that faithfully represent the domain of global warming amplifiers has been accomplished. Moreover, the secondary goal of creating a set of reusable mechanisms has also been achieved. On the critical side the experts commented the choice of quantity spaces, and the names given to type definitions in the model. It appears that most of the evaluators' comments revolve around preferences regarding the level of explicitness.

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