Modeling acclimatization by hybrid systems: Condition changes alter biological system behavior models

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In order to describe the dynamic behavior of a complex biological system, it is useful to combine models integrating processes at different levels and with temporal dependencies. Such combinations are necessary for modeling acclimatization, a phenomenon where changes in environmental conditions can induce drastic changes in the behavior of a biological system. In this article we formalize the use of hybrid systems as a tool to model this kind of biological behavior. A modeling scheme called strong switches is proposed. It allows one to take into account both minor adjustments to the coefficients of a continuous model, and, more interestingly, large-scale changes to the structure of the model. We illustrate the proposed methodology with two applications: acclimatization in wine fermentation kinetics, and acclimatization of osteo-adipo differentiation system linking stimulus signals to bone mass. © 2014 Elsevier Ireland Ltd.