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Improving Learning Processes in Meteorology with Computational Modelling

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Advanced computational knowledge and technologies play a fundamental role in the development of modern research in meteorology. In depth learning of such computational skills is a difficult cognitive process that requires a strong background in physics, mathematics and computer programming. However, the analysis of meteorological phenomena is an important curricular aspect for a wide range of courses taken by students who do not have this kind of advanced scientific background. The corresponding learning environments and pedagogic methodologies should then involve sets of computational modelling activities with computer software systems which allow students the possibility to overcome their lack of advanced mathematical or programming knowledge and focus on the learning of meteorological concepts and processes taking advantage of basic scientific computation methods and tools.

This expectation is supported by the results of many research efforts (see, e.g., Blum, Galbraith, Henn & Niss, 2007; Handelsman et al., 2005; McDermott & Redish, 1999; Slooten, van den Berg & Ellermeijer, 2006), which have shown that the learning processes in various areas of science, technology, engineering and mathematics can be effectively enhanced when students are embedded in atmospheres with activities that approximately recreate the cognitive involvement of scientists in modelling research experiences. Fundamental to the implementation of these modelling cycle pedagogies is an early integration of activities with computational knowledge and technologies, a goal that in particular should be achieved in introductory meteorology courses.

To reduce the level of cognitive opacity associated with mathematical or programming knowledge, several computer modelling systems have already been developed (Neves & Teodoro, 2010; Teodoro & Neves, 2011). Among such systems, Modellus is particularly well suited to achieve this goal because it is a domain general environment for explorative and expressive modelling with the following main advantages: 1) an easy and intuitive creation of mathematical models using just standard mathematical notation; 2) the simultaneous exploration of images, tables, graphs and object animations; 3) the attribution of mathematical properties expressed in the models to animated objects; and finally 4) the computation and display of mathematical quantities obtained from the analysis of images and graphs.

In this work, we describe a set of computational modelling activities on introductory meteorology developed with Modellus a course gathering students from several undergraduate university degrees: environmental engineering, marine sciences and biology. We report on the student's receptivity to the integration of this computational modelling approach and discuss its effect on the learning process.

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