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1 A fully coupled architecture for atmosphere-vegetation-hydrology legacy models applied to the West African Monsoon

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The aim of this work was to develop and use a modular structure of coupling, applied to climate topics, specially to the monsoon and to the water cycle over West Africa. These objective are included in the HYCYWAC (Hydrological Cycle over the West African Continent) project that is a part of the DEISA (Distributed European Infrastructure for Scientific Applications) program funded by the European Union.

One of the main objectives was to develop an architecture of flexible coupling (modular) able to be integrated into GRID computing environments while using legacy models. This project has already shown the possibilities of coupling legacies models of the atmospheric(with a Regional Climate Model), hydrologic scientific communities and the biospheric one trough vegetation models (SVAT: Surface Vegetation Atmosphere Transfer models).

HYCYWAC project includes two parts:

1. **a scientific part** aimed at the evaluation of the importance of the coupling between the water cycles from the atmosphere, the hydrological watersheds, the surface oceanic conditions (evolutive and prescribed from a weekly climatology) and the vegetation, into a thin scale approach. It also aimed at highlighting feedbacks that each system can result on the others, and to understand their reflected effects on the climate over West Africa.

2. **a technical part** designed to achieve the previous scientific objectives. To do that, it was necessary to develop a tool which permits **modularity** (independence of each legacies models), **inter-operability** (heterogeneous grid computing is thus possible) and **portability**.

The goal of this coupling is also to join many types of models resulting from several environmental scientific communities not being based on same methodologies and on different numerical and programming methods. The common point of these disciplines (and models) is the physical interface which represents boundary conditions that are usually treated either by forcing (boundary conditions are provided by climatologies) or by other no-inlined model outputs.Therefore, interfaces are the objects on which all the scientific and the technical works must be focused because technical interfaces are strongly linked with physical interfaces defined between each type of models.

Four climatic environments – and type of models - must be thus represented: (i) atmosphere (ii) continental hydrologic systems (iii) temporal evolution and sub-surface impact of the vegetation (iv) ocean surface conditions. The concept of heterogeneity is thus here very strong. The coupling from a technical point of view is thus the communication of several models via a distributed architecture based on CORBA (Common Object Request Broker Architecture) objects which allows the integration of applications distributed on heterogeneous computers with heterogeneous models.

This architecture has been used with the MAR model (atmospheric MCR), the SISVAT model and both the ABC hydrologic model (for the Sahelian areas) and TOPMODEL (for the Soudano-Guinea region). The results are, for a part, gathered in Messager et at. (2004); Messager et al. (2006a); Messager et al. (2006b).

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