Chapter XVIII

Toward a “Virtual Laboratory” to Support Forest Fire Behaviour Modelling and Metrology

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INTRODUCTION

In forest fire research, it is now accepted that computational simulation and databases have become essential components of the scientific process, in order to combine theory and experiments. Although computers and software tools play a crucial role in the conduct of forest fire science today, scientists lack adequate software engineering tools to ease the construction, maintenance and reusability of modelling and database software.

Usually, scientific models are implemented using a general-purpose programming language, such as Fortran C or C++. But since this type of general-purpose language is not specifically customised for scientific modelling problems, the scientist is forced to translate scientific constructs into general-purpose programming constructs in order to implement the model. This “manual’’ translation process can be very complicated, labor-intensive and error-prone. Furthermore, the translation process obfuscates the original scientific intent behind the model, and buries important assumptions in the program code that should remain explicit. The resulting code is often complex and difficult to understand for anyone but the original developers.

In the same way, databases founded on fire behaviour terrain experiments have been developed through the world. However, because the measurement protocols used during these experiments are different, a lot of data cannot be used by other research units. And, unfortunately, it’s seldom that researchers exchange databases

in order to improve or validate models developed. This lack of exchanges prevents the transfer of models from their development environment (specified by the data experiments) to another domain of application. Often fire behaviour models are developed and tested with the same experiment data, reducing the possibility to employ the models for another kind of vegetation or other ranges of climatic parameters.

The aim is to design and build a software environment, which is called Problem Solving Environment (PSE) in computer science, that makes it easier for scientists to design, modify and share scientific models of forest fire behaviour. This original tool, related to the Decision Support System approach, tends to satisfy three main objectives:

- Its first purpose is to improve the factual basis for the modelling approach and to structure the modelling process to make it more consistent. This is obtained by providing easy access and efficient use of modelling methods and experimental data management which are normally restricted to a small group of technical experts.
- A second objective is to design and build an effective support modelling system based on the principles of the cooperative software environments, in order to help the user in his day-to-day modelling job.
- A third goal consists in improving research on wildfire dynamics by extending the knowledge: to design and test new models that are not yet validated on the field, to estimate the sensitivity of output data to small changes in initial conditions, parameter values and fitting functions.

FOREST FIRE MODELLING AND METROLOGY: AN OVERVIEW

A forest fire is a complex environmental phenomenon. Because of its spatial and temporal variability, it constitutes a system, where a multitude of parameters are in interrelation. An analysis of the parameters intervening during the various processes of the phenomenon can be carried out by the use of experiments. It is significant to proceed to a quantification of these parameters intervening in the phenomenon. The experiment intervenes before the analysis of the system components. It will make it possible to collect information according to the processes having to be modelled.

Thus, one objective in forest fire research is fire behaviour modelling in order to understand them better and to predict their spread. The majority of these studies are founded on data collection, carried out in laboratories (test benches), or in the natural field (experimental plots or during real wildland fires), during experiments. The measurement protocol used here, is in adequacy with the studied topics: propagation, intensity and gas emissions.

Experiments for forest fire modelling

The majority of the studies of fire propagation were carried out in laboratories and sheltered from external climatic variations during the propagation of which the duration is always restricted (Dupuy, 1997; Ventura et al., 1997). The climatic component thus is taken little into account in these analyses. However, the wind speed