

Introduction

As with other dynamic systems, proper analysis in agricultural systems modelling requires gathering of knowledge from different disciplines, and collecting suitable data. Appropriate software development technology for implementing the often quite complex models is critical. A well-recognized method for reaching that goal involves structuring the model as a set of distinct modules, thus facilitating more systematic model development, documentation, maintenance, and sharing. The concept of modularity gained strong momentum with the wide spread adoption of the object-oriented approach in software development. Routines for crop, soil, cropping systems calculations have been implemented in several crop growth and hydrologic models by applying the traditional procedural approach, with minor investment on code transparency. The consequence is the re-implementation of the approaches every time an estimate is needed for specific applications. Therefore, we chose to develop sharable **dynamic link libraries (DLL)**, that incorporate relevant aspects of crop model computations and evaluation, which can be plugged into existing application software running on a Microsoft Windows-based operating system.

ET_CSDLL

ET_CSDLL contains routines to estimate reference crop evapotranspiration following the guidelines of the FAO Irrigation and Drainage Paper No. 56 for implementing the Penman-Monteith equation. In addition, the Priestley-Taylor equation (implementation by Steiner et al.) is also included for calculating reference crop evapotranspiration for conditions where meteorological data are insufficient to apply the Penman-Monteith equation.

PAR_CSDLL

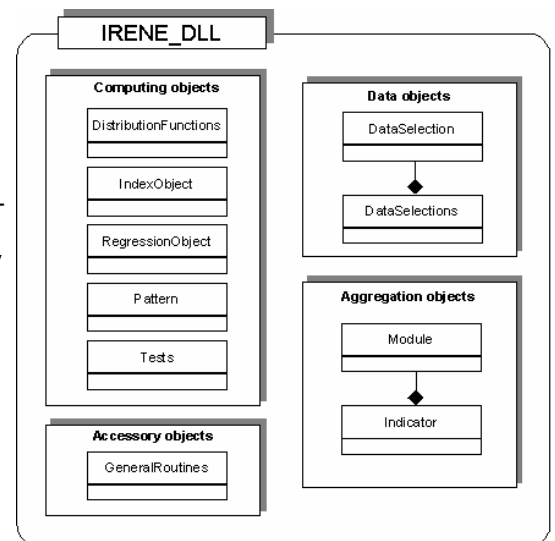
PAR_CSDLL consists of routines to load files containing information about driving variables (weather) and input parameters of cropping systems simulation models. It allows loading crop, soil, location/meteorology, management, rotation, and simulation files. The file format is the one used in the model CropSyst. This DLL allows model developers to use CropSyst parameter and meteorology files when developing their own applications.

CropPheno_CSDLL

CropPheno_CSDLL contains routines to estimate variables related to crop phenology according to the approach used in the cropping systems simulation model CropSyst, based on thermal time requirements. Correction factors for vernalization, photoperiod and water stress can also be computed.

IRENE_DLL

IRENE_DLL contains routines to provide easy access to model evaluation techniques. An integrated evaluation of model performance is allowed, based on the difference between estimates and measurements, the correlation-regression between estimates and measurements, probability distributions, pattern analysis, and fuzzy-based aggregation statistics. Statistical tests are applied when replicates of estimates, measurements or both are available. Options are included for investigating the uncertainty about possible displacements (delay or acceleration) registered in the time series.



Availability

The DLLs mentioned above have been tested on MS Windows 98, 2000 and XP operating systems. The libraries are available for downloading from the website <http://www.isci.it/tools>, as part of a larger software production in the field of agrometeorology and agricultural modelling, distributed by the Agronomy Section of the Research Institute for Industrial Crops (ISCI-TC). The installation packages (including the manuals and sample files) are available free of charge for non profit users. Each DLL is provided with a documented help file that includes examples of how use the DLL within MS Excel spreadsheet. Sample applications of the DLLs within the visual modelling environment MODCOM (web page at: <http://biosys.bre.orst.edu/modcom>) are under development.

Remarks

The DLLs illustrated here are part of a joint effort towards a commonly-agreed architecture for agronomic/agrometeorological modelling. They serve as convenient means to support collaborative model development among a large, distributed network of scientists involved in creating object-oriented models in the agronomy and agrometeorology fields. They can be used as submodels or utilities of any model, written in any language. The documentation provided significantly increases transparency of the underlying science.