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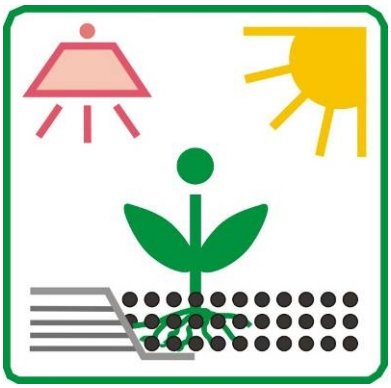
Санкт-Петербург, 21–23 сентября 2016 г.



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A MULTI-SCALE AND MULTI-MODEL GRIDDED FRAMEWORK FOR RUNNING ENSEMBLE OF CROP MODELS

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1. Introduction

As world's climate changes, resulting in increasing temperatures, changes in rainfall amounts and patterns, desertification and other weather extremes our agricultural practices will have to change too. The crop models help in decision making for sustainable agriculture and there has been a lot of progress in their use in the search for strategies for more efficient crop production, improved risk management, more sustainable crop production systems, and study of climate change impact on agricultural systems. The most widely used crop models are the DSSAT (Hoogenboom et al., 2015), APSIM (Keating et al., 2003), WOFOST (Boogaard et al., 2014), MONICA(Nendel et al., 2011) and AgroTOOL (Poluektov et al., 2006) that simulate crop growth, development and yield along with management strategies that involve irrigation, fertilizer application, crop rotations and a variety of other management options.

In the light of changing climatic conditions and increasing food demand in the world, improved climate risk management and agricultural decision support systems are needed to aid with appropriate selection of practices and strategies so that the current and future climate risks are taken care of. Keeping in mind the above stated background and a demand for flexible and easy to use gridded modelling frameworks that can integrate different crop models the CCAFS Regional Agricultural Forecasting Toolbox (CRAFT) was developed. The main purpose of this framework is to provide a platform through which risk analysis and forecasting systems can be constructed, and that allows flexibility in the integration of new models and data.

2. The software architecture and development

The CRAFT application is based on the Microsoft .Net Windows platform and includes: a) a user-friendly client application – C# program which provides the interface to the crop models and database, b) a MySQL database implementation as a

central Relational Data Base Management System that contains all input and output data of the crop models, including crop management, soil, weather, and climate data, as well as crop model related information and c) an integrated map component – MapWinGIS ActiveX GIS control (www.mapwindow.org), which is used for the visualization of gridded simulation results using the matic maps by region. It is integrated with external crop model engine and CPT (Climate Predictability Tool) engine for modeling purpose.

The CRAFT application architecture follows an Object Oriented Programming (OOP) model using software design patterns (Gamma et al., 1995) and is designed as a multi-tiered system to allow for modularity and scalability. The various tiers of the system are Presentation, Business, and Data Tiers. The Presentation tier contains the components that implement and display the intuitive user interface and manages user interaction. The Business tier implements the business rules for the system functionality, treats data as objects and does not consider how the data is stored or displayed. In the Data Tier the data access layer is designed in such a way that it will abstract the logic necessary to access the database. Due to its object oriented design, the framework is very flexible and easily extensible. The integrated and modular design and structure of the CRAFT allows easy adaptation of the system in other spatial domains as well as crop models.

The CRAFT toolbox works on a gridded scale with each grid cell representing an area along with its attributes. It is designed to use gridded data schemes for spatial variability through the use of two predefined reference grids of 5 arc minute and 30 arc minute resolutions. Users will need to develop all data inputs in reference grid formats adhering to the data structure of the grid and consistent with the grid resolution. The gridded input data required for the CRAFT include weather conditions and soil, cultivar and other management levels and are necessary to run crop models. Using schematization, three spatial scales are considered at a country, state/province, and district levels. The input data must be prepared as shape files and masked datasets using ArcGIS and uploaded into the database using the schema upload option of the application or using templates provided in CRAFT for different

data types. Once uploaded, all data is stored within the MySQL database. This contains both configuration data, including location specific information (e.g. coordinates and properties of grid cells, etc.), and dynamic time series data.

The CRAFT toolbox is integrated with two engines for linking to external modules. One engine is for crop modeling and spatial crop simulations and the other is for seasonal climate forecasting using the CPT. These engines further provide the required inputs to Crop Model / CPT to process the data and to return their outputs or external supporting files to the CRAFT.

3. The craft application user interface overview

CRAFT application provides .Net base Windows forms for various user input/outputs. A summary of main features of the CRAFT user interface is described in Table. The main components of the User Interface (UI) (Fig.) are: Home window, Data, Project, Simulation, Results and Configuration.

Table. **User Interface Features of the CRAFT**

Data	Crop management data	Project & run setup	Run project	Results
Import default data sets – ADMIN ONLY Import gridded user data sets Export default data sets Export gridded user data sets Load cultivars Load soils	Define Cultivar Define Planting Dates Define Irrigation Applications Define Fertilizer Applications Define Field History	Create a project Search and Select Project & Run Create Run(s) Identify data sources Apply UI based inputs	Run crop model Run Calibration module Run Seasonal Forecast module Run hind cast module	Single Project Run Select project Select outputs to view View/Export Results Compare Projects Run Select two projects Select outputs to compare View/Export Results

A project is defined by its spatial domain, the spatial resolution, crop type and model, run type, and data span. This enables the user to navigate to data source screen to configure Data Source for the active run of selected active project and apply input for the same. After creating the project, values for Crop, Engine, Model and Description can be selected for creating Run Project level.

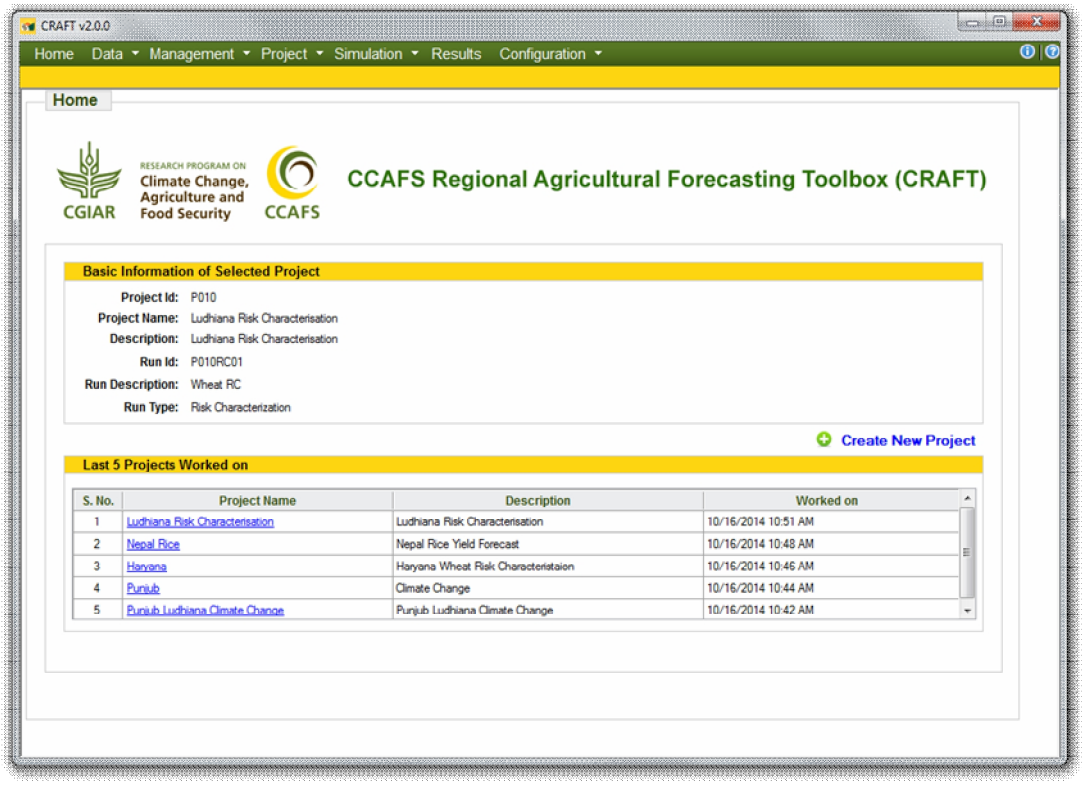

Fig. 2. The CRAFT Application Main window

The output module of the CRAFT is designed to optimize the display, analysis, and retrieval of the result data sets. It generates informative interactive maps of simulation results with colour representing different scales, as well as numeric results, with their summary statistics (mean, standard deviation, median, etc.) and comparing summaries.

4. Conclusions

CRAFT toolbox provides support for spatial input data through the use of grids of 5m and 30 m arc resolutions. Spatial crop simulations are based on the DSSAT and APSIM. The toolbox integrates seasonal climate forecasts based on the CPT engine. It provides spatial aggregation and probabilistic analysis of the forecast uncertainty. The toolbox also provides calibration of the model predictions from historic agricultural statistics, analysis and visualization of the simulation results.

The software can support the efforts of governments, policy makers and researchers to better prepare for the impacts of climate variations on crops and rangeland production for the different regional level in support of agricultural management and food security decisions.

References

1. Gamma, E., Helm, R., Johnson, R., Vlissides, J., 1995. Design Patterns: Elements of Reusable Object-Oriented Software. Addison-Wesley, Boston.

2. Hoogenboom, G., J. W. Jones, P. W. Wilkens, C. H. Porter, K. J. Boote, L. A. Hunt, U. Singh, J. I. Lizaso, J. W. White, O. Uryasev, R. Ogoshi, J. Koo, V. Shelia, and G. Y Tsuji,2015. Decision Support System for Agrotechnology Transfer (DSSAT) Version 4.6 (www.DSSAT.net). DSSAT Foundation, Prosser, Washington.

3. Keating, B. A., Carberry, P. S., Hammer, G. L., Probert, M. E., Robertson, M. J., Holzworth, D., Huth, N. I., Hargreaves, J. N. G., Meinke, H., Hochman, Z., McLean, G., Verburg, K., Snow, V., Dimes, J. P., Silburn, M., Wang, E., Brown, S., Bristow, K. L., Asseng, S., Chapman, S., McCown, R. L., Freebairn, D. M., Smith, C. J., 2003. An overview of APSIM, a model designed for farming systems simulation. European Journal of Agronomy 18, 267–288.

4. Boogaard H. L., De Wit A. J. W., te Roller J. A., Van Diepen C. A., 2014.WOFOST CONTROL CENTRE 2.1; User's guide for the WOFOST CONTROL CENTRE 2.1 and the crop growth simulation model WOFOST 7.1.7. Wageningen (Netherlands), Alterra, Wageningen University & Research Centre.

5. Nendel C., Berg M., Kersebaum K. C., Mirschel W., Specka X., Wegehenkel M., Wenkel K. O., Wieland R., 2011. The MONICA model: Testing predictability for crop growth, soil moisture and nitrogen dynamics. Ecological Modelling, Volume 222, Issue 9, Pages 1614–1625.

6. Полуэктов Р. А., Смоляр Э. И., Терлеев В. В., Топаж А. Г. Модели продукционного процесса сельскохозяйственных культур. СПб.: Изд-во С.-Петерб. ун-та, 2006. 396 с.

ФУРАЖИРОВАНИЕ: ДИНАМИКА И РАВНОВЕСИЕ

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В настоящей работе предлагается динамическая модель, сочетающая описание взаимодействия в пределах ареала (система Лотки – Вольтерры) и миграции популяций хищника и жертвы. Решается задача определения долей участвующих в миграции взаимодействующих популяций. Построенная модель относится к теории фуражирования, в которой рассматриваются проблемы выбора ареала популяцией, условия ее ухода из ареала и распределения по ареалам. Следует отметить, что один из основных результатов теории фуражирования, полученный в работе (Charnov, 1976), касается статической модели без учета динамики. В исследовании (Кириллов, 1999) предложен подход к моделированию динамики ухода хищника из ареала и возвращения в

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