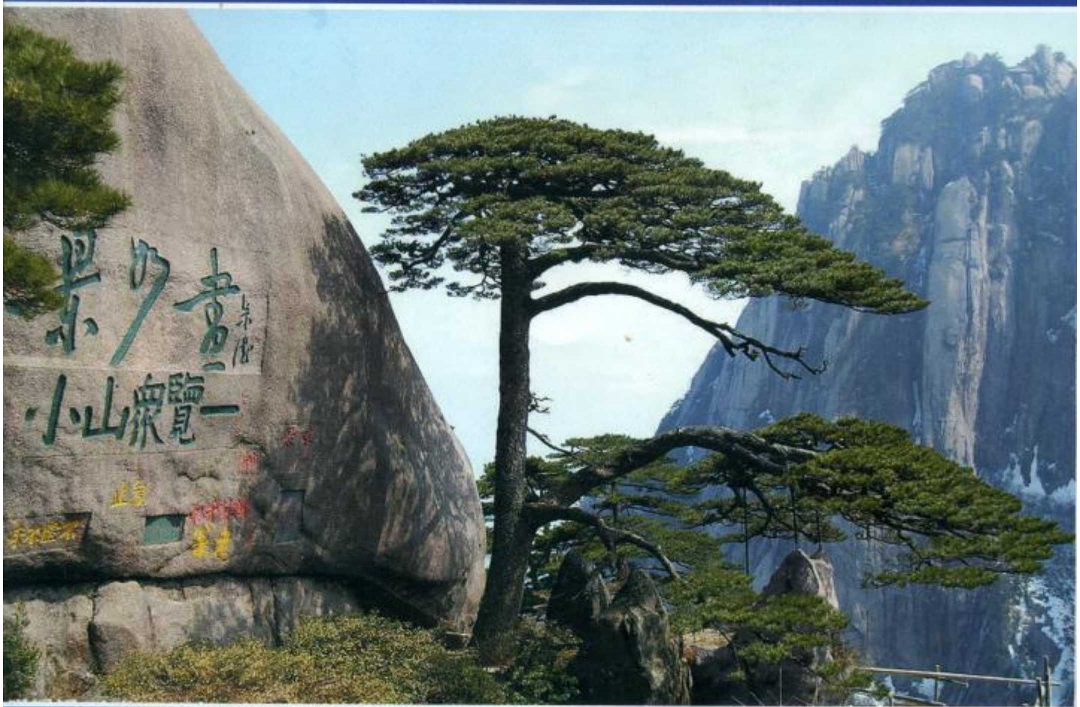
欧盟第七框架计划
7th Framework Programme

“发展中国家基于电子农业工具的农作物监测”项目座谈会

International Workshop on Crop Monitoring as an E-agriculture Tool in Developing Countries

会 议 手 册

CONFERENCE MANUAL



2011年11月2日-4日
中国 • 合肥

November 2 - 4 2011
Hefei · China

E-AGRI
E-Agriculture

Partners:

ANHUI INSTITUTION FOR ECONOMIC RESEARCH

ALTERRA WAGENINGEN UR

JRC EUROPEAN COMMISSION

vito vision on technology

MARS

PROGRAMME

1. Thanks

Many thanks to the Prof. Hu Zaisheng, Director of the Anhui Institution For Economic Research, for the invitation and the support and the hospitability. Thanks to Dr. Dong QINGHAN and Dr. Yang QING for the excellent organization of this workshop. Many thanks also to Dr. Allard de Wit and ir. Raymond van der Wijngaart for their presentations and their technical contribution to the E-Agri Project.

2. List of participants and their representatives

- Political leaders and experts:

Wu Jingsong: Vice Chairman, Anhui Development and Reform Commission

Frank Greco: First Counsellor, Head of Information Society and Media Section, EU Delegation

Jiang Yan: Assistant to First Counsellor, EU Delegation

Yang Bo: Ph.D, Director, Information Office, The General Office of the People's Government of Anhui Province

Yang Xiaoyang: Director, International Cooperation Office, Science and Technology Department of Anhui Province

Chen Youping: Deputy Director, Anhui Provincial Science & Technology Exchange Center with Foreign Countries

Prof. Dong Qinghan: VITO, Belgium

Prof. Allard de Wit: ALTERRA, Netherlands

Prof. Raymond van der Wijngaart: ALTERRA, Netherlands

Prof. Charles Situma: Ministry of Environment and Mineral Resources, Kenya

Prof. Hicham Marzouki: National Meteorological Direction, Morocco

Prof. Wei Guo: School of Information Science and Technology, University of Science and Technology of China

Teng Fei: Ph.D, Chinese Academy of Agricultural Sciences

- Members from Anhui province:

Prof. Hu Zaisheng: Director, Anhui Institution for Economic Research

Prof. Ma Zhongmo: Deputy Director, Anhui Institution for Economic Research

Jiang Xudong: Associate Prof., Assistant Director, Head of Institute of Geographical Information, Anhui Institution for Economic Research

Wang Xueping: Senior Economist, Head of Institute of Training Department, Anhui Institution for Economic Research

Xu Zhenyu: Associate Prof., Head of Institute of Regional Development and Environment Resource, Anhui Institution for Economic Research

3. Introduction

- E-Agri Project:: small description + liste of partenar institutions (JRC, DMN, INRA, DSS, European Commission,).
- The first workshop in Rabat: satellite images and yield estimation
- The objective of this workshop

4. Agenda of the workshop

Tuesday, November 1st

Registration

Wednesday, November 2nd

Time: 08:30-18:30

Place: Gui Yuan, No. 1 Meeting Room

Chair: Prof. Ma Zhongmo

Time Slot	Agenda	Speaker
8:30-8:40	Welcome Address	Hu Zaisheng
8:40-9:00	Speech	Wu Jingsong
9:00-9:30	Collaboration in the ICT sector between EU and China; some flagship projects	Frank Greco
9:30-9:50	Presentation of the information development in Anhui	Yang Bo
9:50-10:10	Introduction of ICT project	Wei Guo
10:10-10:30	**Coffee Break(Take a group photo)**	
10:30-11:00	Introduction of E-AGRI project	Dong Qinghan
11:00-11:30	Crop monitoring using agro-meteorological models in Europe	Allard de Wit
11:30-12:00	Crop monitoring in Anhui province	Xu Zhenyu
12:00-14:30	**Dinner(Gui Yuan, Bai Lu Hall)**	Wu Jingsong
14:30-18:30	Social activity (city –tour)	
18:30	**Supper(Liangyuan Revolving Restaurant)**	

Thursday, November 3rd

Time: 08:30-17:50
Place: Gui Yuan, No. 2 Meeting Room
Chair: Prof. Dong Qinghan

Time Slot	Agenda	Speaker
8:30-10:00	Introduction to the WOFOST model: principles, processes, parameters Exercises with the WOFOST Control Centre	Allard de Wit Raymond van der Wijngaart
10:00-10:20	**Coffee Break**	
10:20-11:50	Introduction to the WOFOST model: principles, processes, parameters Exercises with the WOFOST Control Centre	Allard de Wit Raymond van der Wijngaart
12:00-14:30	**Lunch(Daoxianglou Hotel, East Building Restaurant)**	
14:30-16:00	Introduction to the Crop Growth Monitoring System (CGMS) and its database	Allard de Wit Raymond van der Wijngaart
16:00-16:20	**Coffee Break**	
16:20-17:50	Introduction to the Crop Growth Monitoring System (CGMS) and its database	Allard de Wit Raymond van der Wijngaart
18:00	**Dinner(Yintong Hotel)**	

Friday, November 4th

Time: 08:30-17:50

Place: Gui Yuan, No. 2 Meeting Room

Chair: Prof. Dong Qinghan

Time Slot	Agenda	Speaker
8:30-10:00	CGMS operations and maintenance, understanding and visualizing CGMS output	Allard de Wit Raymond van der Wijngaart
10:00-10:20	**Coffee Break**	
10:20-11:50	CGMS operations and maintenance, understanding and visualizing CGMS output	Allard de Wit Raymond van der Wijngaart
12:00-14:30	**Lunch(Daoxianglou Hotel, East Building Restaurant)**	
14:30-16:00	Introduction to and exercises with the statistical toolbox for crop yield forecasting	Allard de Wit Raymond van der Wijngaart
16:00-16:20	**Coffee Break**	
16:20-17:50	Introduction to and exercises with the statistical toolbox for crop yield forecasting	Allard de Wit Raymond van der Wijngaart
18:00	**Dinner（Huadu Hotel）**	

Saturday, November 5th

Airport See Off

5. Daily reports

5.1. Day 1: Wednesday, November 2nd

5.2. Day 2: Thursday, November 3nd

5.2.1. PART1: The WOFOST.

The main objectives of this day are to learn the principals of the WOFOST model, how it can be implemented, how to configure different parameters and to practice some examples of use.

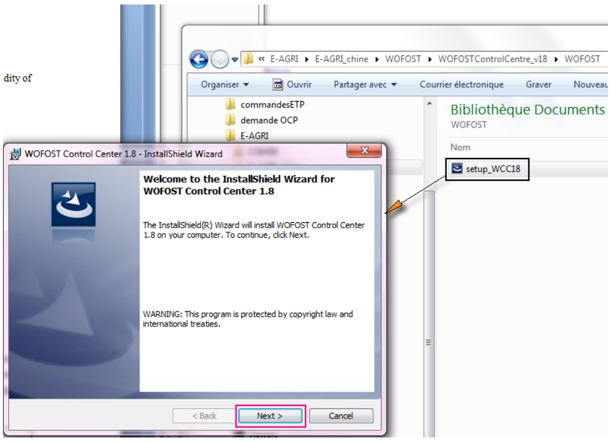
There is an inter-annual of yield variability of crops over regions and countries of the world. That's because the field is depending on multiple parameters: weather, meteorological data's, simulated yield data. All this parameters are used as predictors for the regional crop yield model (CGMS).

a) Installation of WOFOST

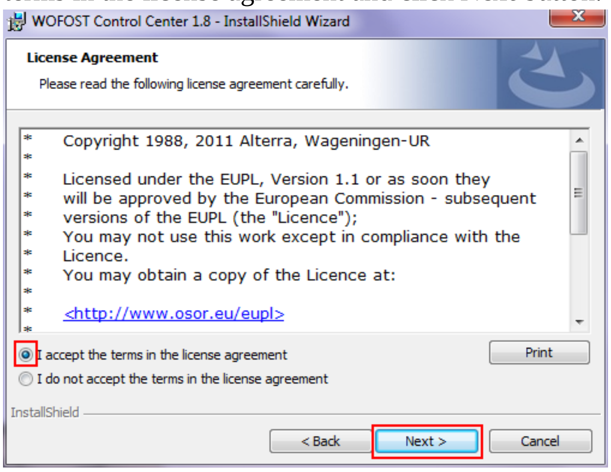
First, the WOFOST software should be downloaded from the web site: www.wofost.wur.nl . In this dedicated web site, we can also find the manuals and different slide presentations to learn more about how to implement WOFOST correctly. There is also a wiki page for this software: http://wofost.wikispaces.com , where we can find FAQ pages, the FORTRAN source codes, the hard ware requirements and much other useful information.

How to install it?

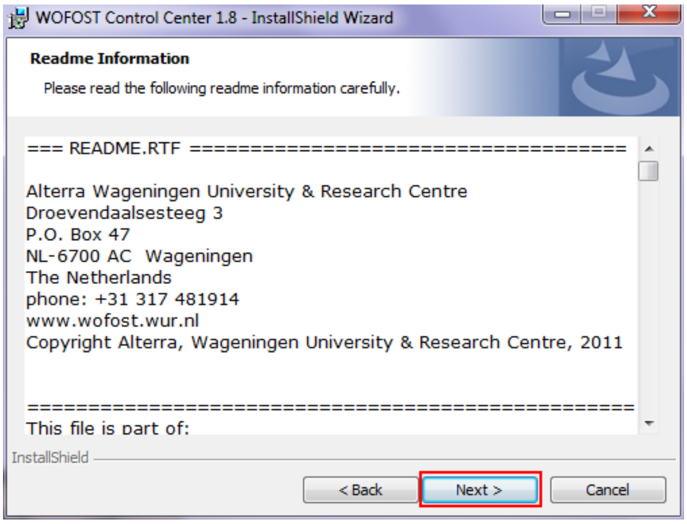
- **1:** to start the installation, we just lunch the **setup8WCC18.exe**, and click on **Next** button.



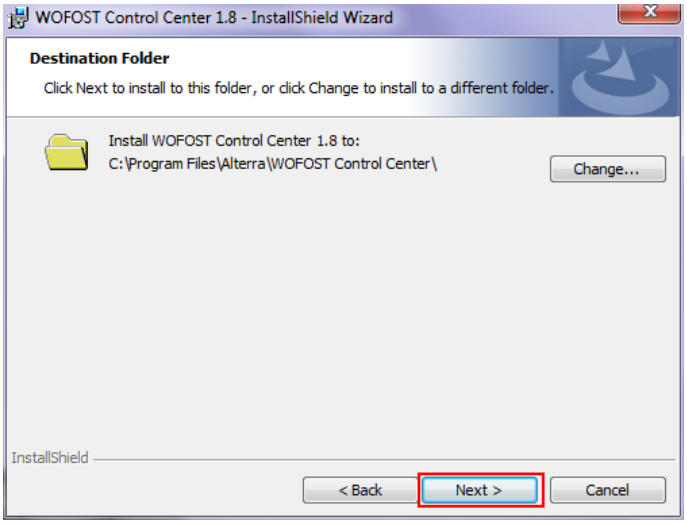
- **2:** Accept the terms in the license agreement and click **Next** button.



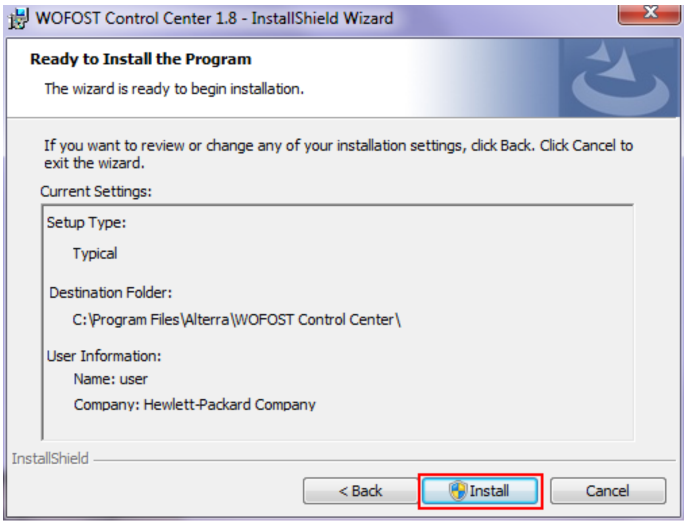
- **3:** After reading the readme information's, click on **Next** button.



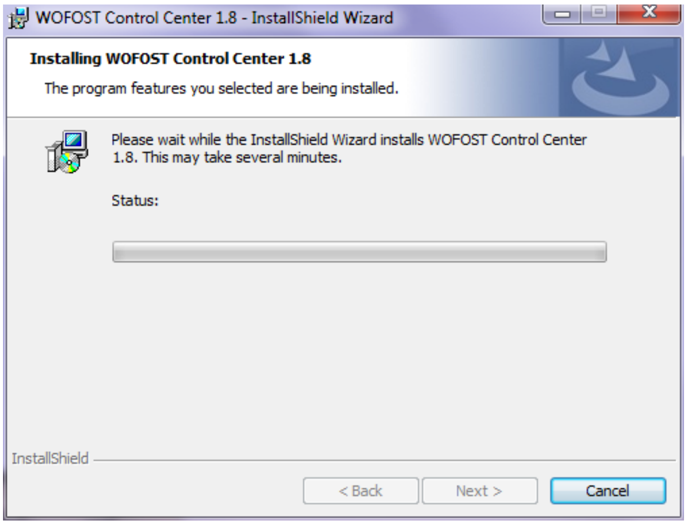
- **4:** Specify the destination folder, and click on **Next** button.



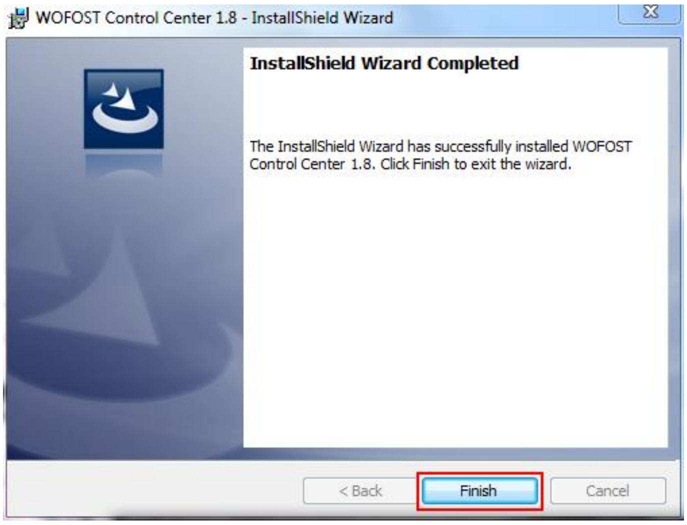
- **5:** click on **Install** button.



- **6:** Just wait the installation of the WOFOST Control Center (WCC) v1.8.

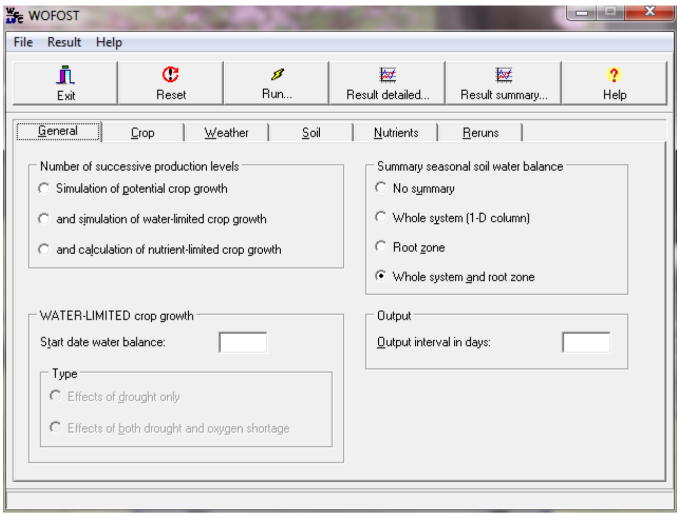


- **7:** Click on **Finish** button, to exit the wizard.

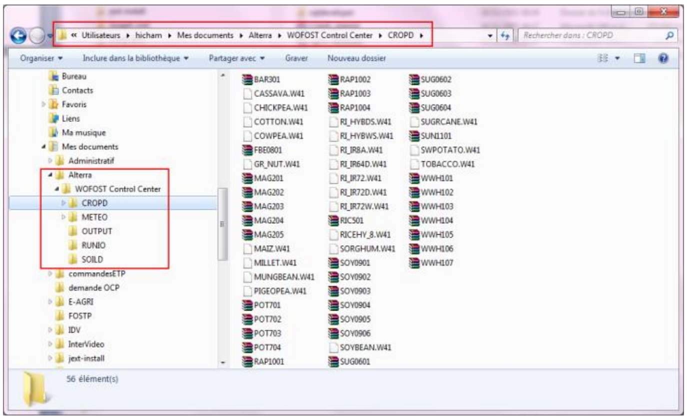


- **8:** A quick launch of WCC should be on Desktop.

- **9:** This is the main page of WCC.



- **10:** This is the personnel directories installed for the WCC:

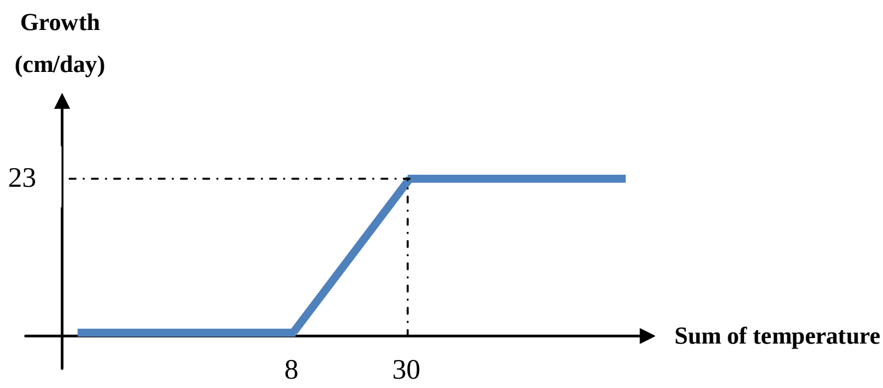


b) What is WOFOST?

WOFOST is a semi-deterministic crop simulation model. It can be run's in daily time steps. We can use single value parameters types for a specified point or tabular one's for regional scale. To manage the crop phonology evolution, WOFOST use the DVS parameter: the value zero is for the emergence step, the other values (1, 2, and 3) are used for others (maturity…etc).

c) The growth

The following graph shows the growth evolution (cm/j) per day depending of the sum of temperature of crops:



d) Light interception

The light interaction depends on three parameters: the first one is the solar radiation (Direct/diffuse...), the second is the LAI parameter (Leaf Area Index). The last one is the CO2 assimilation. WOFOST can manage the Leaf Area Dynamics, by using two parameters:

- The senescence which depend on the heat sum (SPAN), the PERDL or water stress, and KDIFTB (LAI>LAIcritic, LAIcritic=3.2/KDLF~5.5).
- LSUM, which is the $\sum_{class=1}^{n}$ biomass $*$ SLA

e) Transpiration

The crop's transpiration depends on the reference evapo-transpiration, the LAI and the humidity of soils.

f) Soil fertility

The soil fertility is not yet implemented in CGMS model.

g) CGMS limitations

The limitations of CGMS are:

- It's inherent to simulation techniques
- The chosen generalization
- The chosen system boundaries
- The limited knowledge of crop response relations.
- The observation data's are needed for a quick configuration of CGMS-WOFOST.

h) Trainings

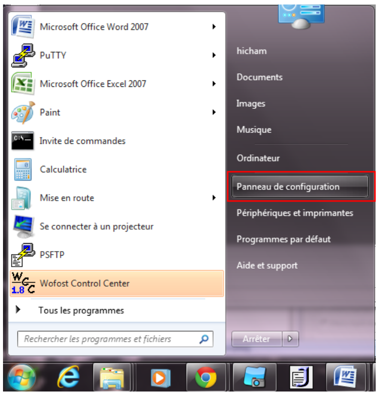
All the trainings are described in the file named "WOFOST_Training_Anhui.pdf"

i) The first simulation

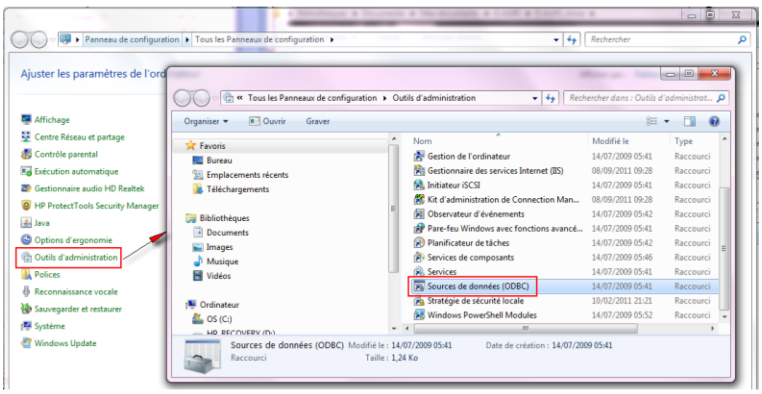
The WOFOST software can be installed just by executing the file already downloaded from the web site: www.wofost.wur.nl . Then we can launch the WCC (WOFOST Control Center) by double clicking on the quick link named "wcc" in the desktop. Then, the control center appears.

But before we can start our first simulation, we should make an ODBC connection to the mdb database used by the WCC, by following these few steps:

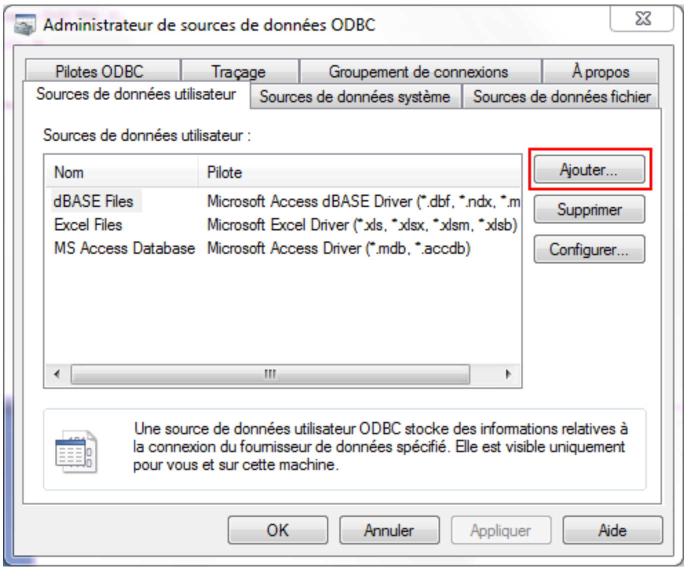
- First go to the **Control Panel**:



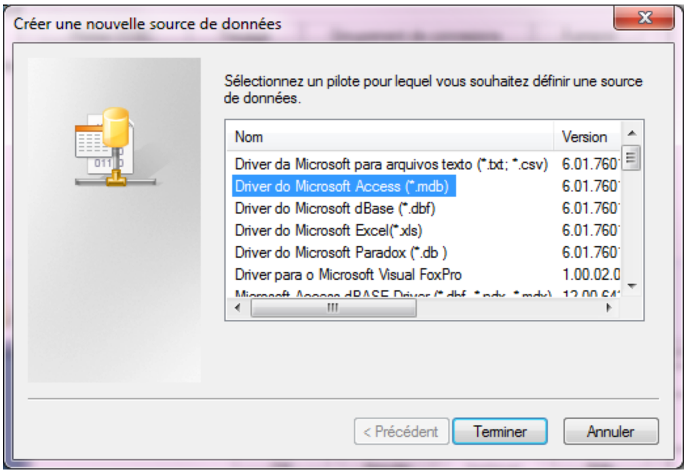
- Then go to **Administration tools**, then to **ODBC Data Sources**:



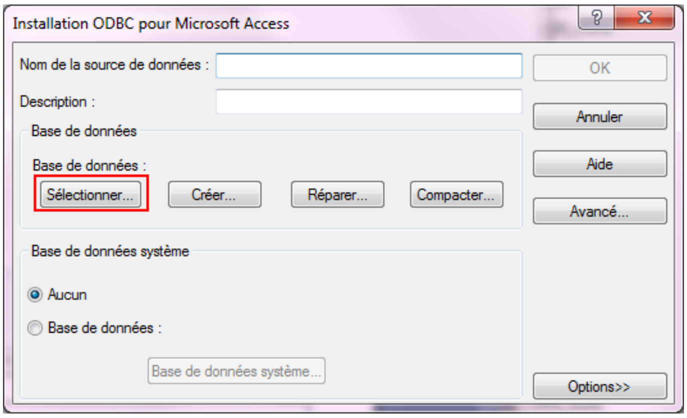
- Click on Add button:



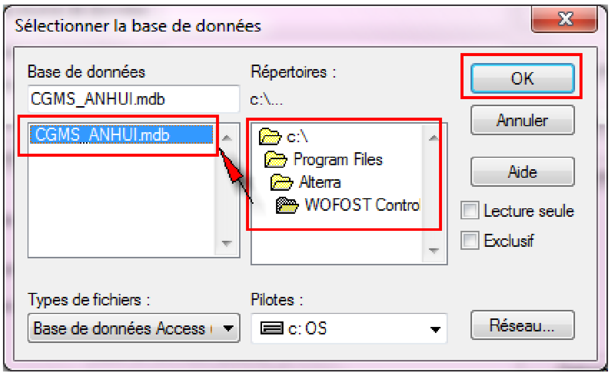
- Select **Driver do Microsoft Access (*.mdb)**, then click on **Finish** button:



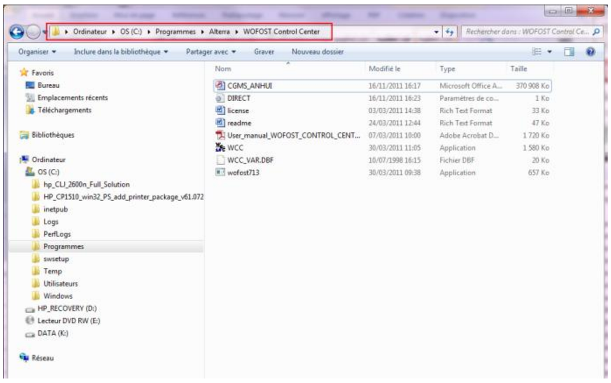
- Then **Select** button, to choice the mdb database for WCC:



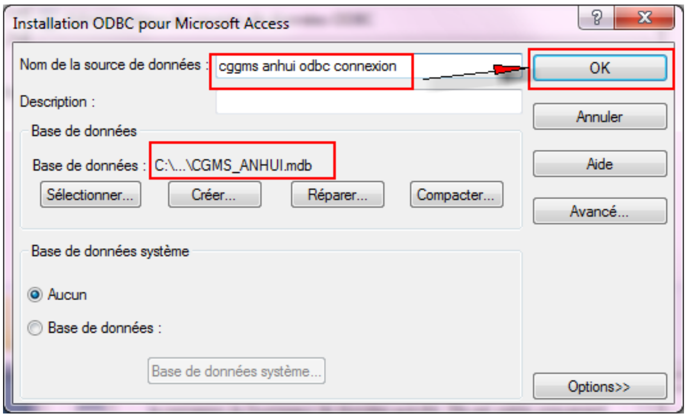
- Now select where this mdb database is located:



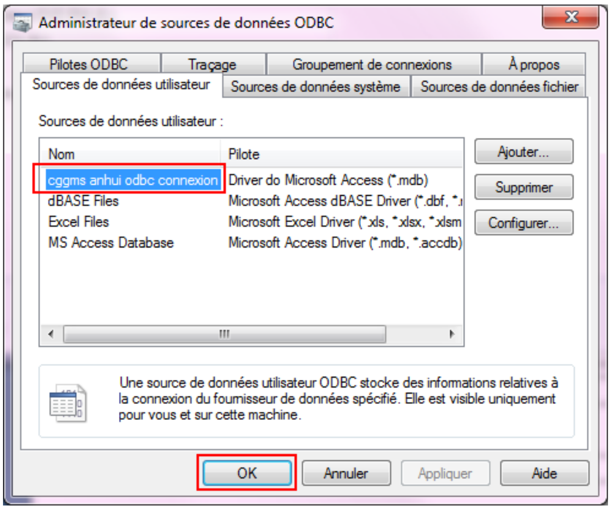
In our case:



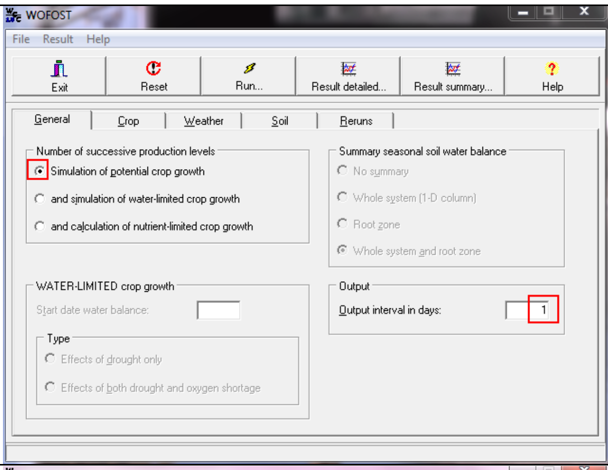
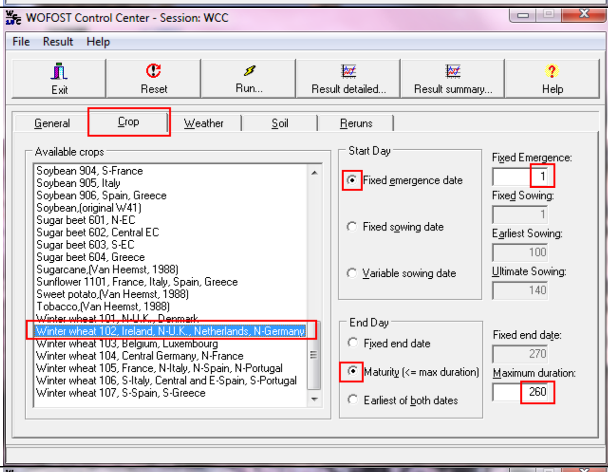
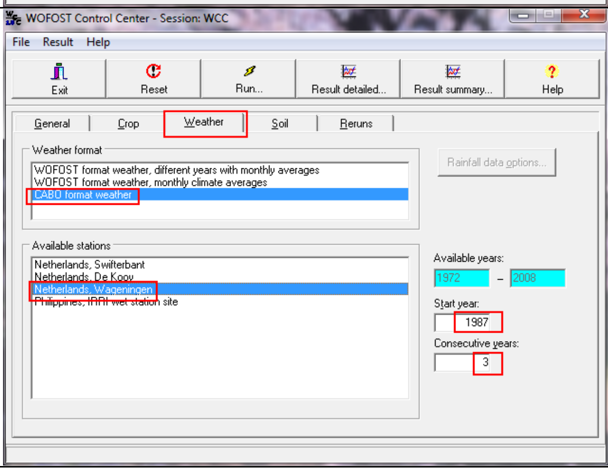
- Then tape a name for this ODBC connection:

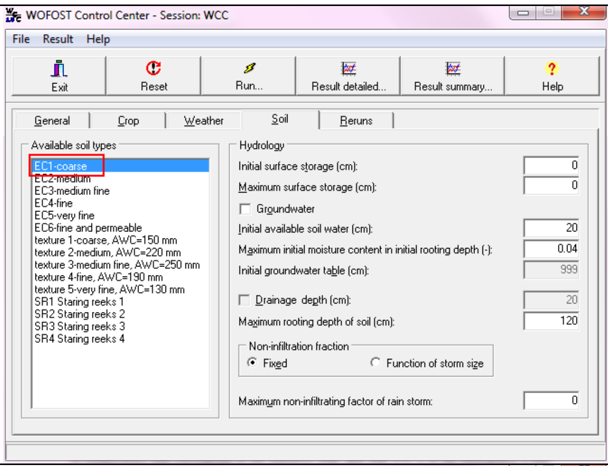
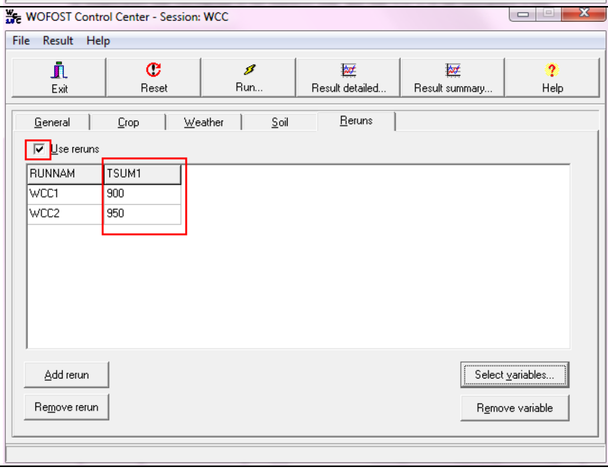
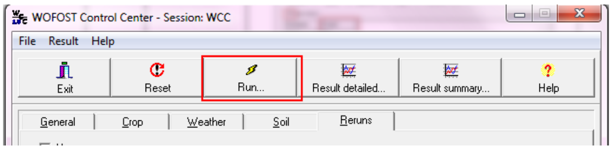
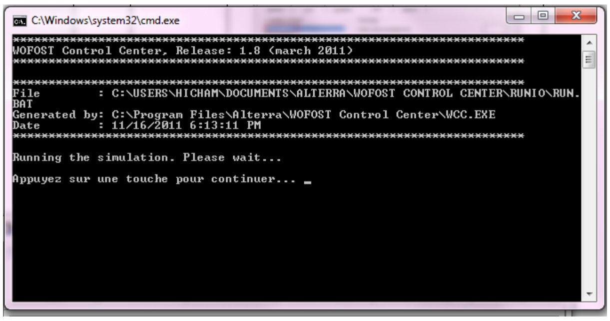
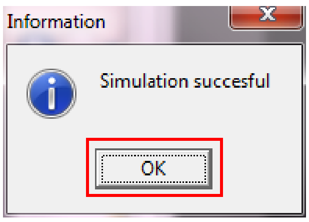
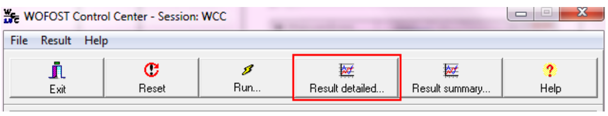


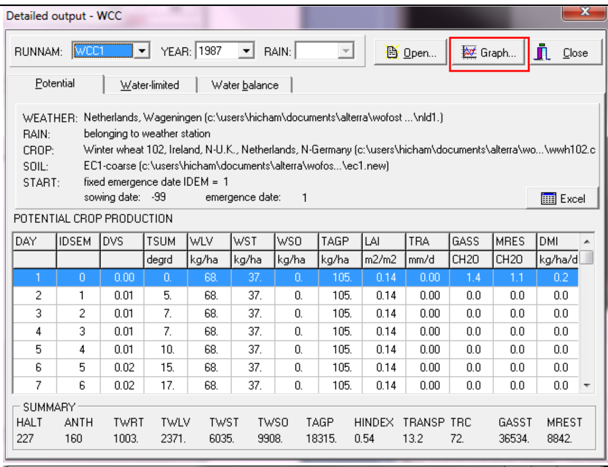
- Finally, click on **OK** button, to finish this installation:

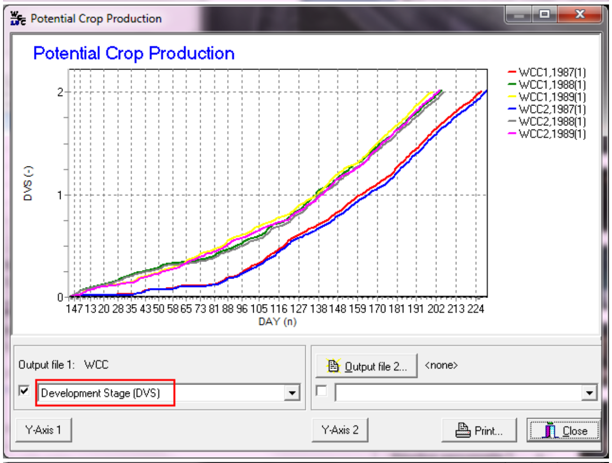


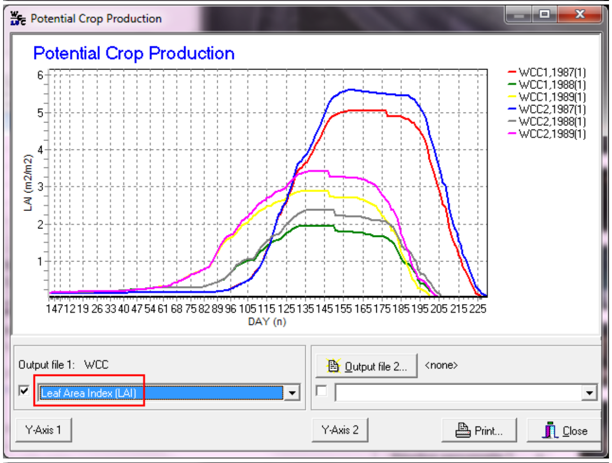
Following is first simulation that we tested:

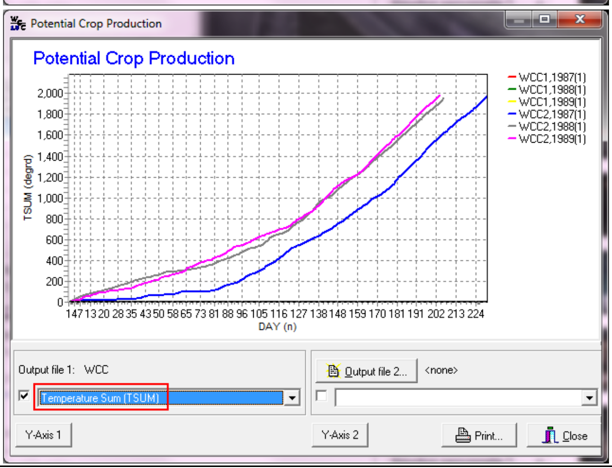
steps	Menu	To do
1	General	
2	Crop: winter wheat	
3	Weather	

4	Soil parameterization	
5	Reruns	
6	Running WOFOST CC	
7	Result detailed	


Detailed output - WCC
RUNNAM: WCC1 YEAR: 1987 RAIN:
Open... Graph... Close
Potential Water-limited Water balance
WEATHER: Netherlands, Wageningen (c:\users\hicham\documents\alterra\wofost ...\nld1.)
RAIN: belonging to weather station
CROP: Winter wheat 102, Ireland, N-U.K., Netherlands, N-Germany (c:\users\hicham\documents\alterra\wo...\wwh102.c
SOIL: EC1-coarse (c:\users\hicham\documents\alterra\wofos...\ec1.new)
START: fixed emergence date IDEM = 1
sowing date: -99 emergence date: 1
Excel
POTENTIAL CROP PRODUCTION
DAY IDSEM DVS TSUM WLV WST WSO TAGP LAI TRA GASS MRES DMI
degrd kg/ha kg/ha kg/ha kg/ha m2/m2 mm/d CH2O CH2O kg/ha/d
1 0 0.00 0. 68. 37. 0. 105. 0.14 0.00 1.4 1.1 0.2
2 1 0.01 5. 68. 37. 0. 105. 0.14 0.00 0.0 0.0 0.0
3 2 0.01 7. 68. 37. 0. 105. 0.14 0.00 0.0 0.0 0.0
4 3 0.01 7. 68. 37. 0. 105. 0.14 0.00 0.0 0.0 0.0
5 4 0.01 10. 68. 37. 0. 105. 0.14 0.00 0.0 0.0 0.0
6 5 0.02 15. 68. 37. 0. 105. 0.14 0.00 0.0 0.0 0.0
7 6 0.02 17. 68. 37. 0. 105. 0.14 0.00 0.0 0.0 0.0
SUMMARY
HALT ANTH TWRT TWLV TWST TWSO TAGP HINDEX TRANSP TRC GASST MREST
227 160 1003. 2371. 6035. 9908. 18315. 0.54 13.2 72. 36534. 8842.


Potential Crop Production
Potential Crop Production
DVS (-)
DAY (n)
WCC1,1987(1)
WCC1,1988(1)
WCC1,1989(1)
WCC2,1987(1)
WCC2,1988(1)
WCC2,1989(1)
Output file 1: WCC
Development Stage (DVS)
Output file 2... <none>
Y-Axis 1 Y-Axis 2 Print... Close

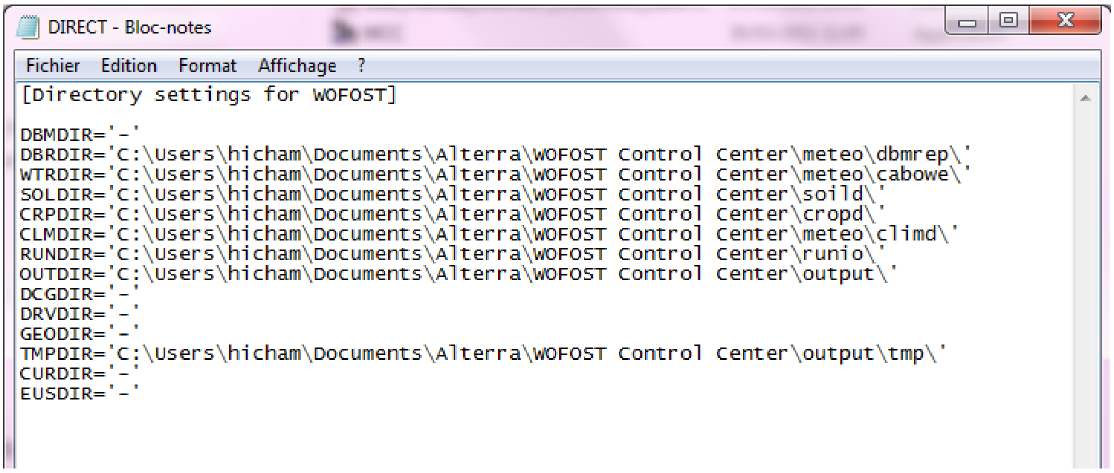

Potential Crop Production
Potential Crop Production
LAI (m2/m2)
DAY (n)
WCC1,1987(1)
WCC1,1988(1)
WCC1,1989(1)
WCC2,1987(1)
WCC2,1988(1)
WCC2,1989(1)
Output file 1: WCC
Leaf Area Index (LAI)
Output file 2... <none>
Y-Axis 1 Y-Axis 2 Print... Close


Potential Crop Production
Potential Crop Production
TSUM (degrd)
DAY (n)
WCC1,1987(1)
WCC1,1988(1)
WCC1,1989(1)
WCC2,1987(1)
WCC2,1988(1)
WCC2,1989(1)
Output file 1: WCC
Temperature Sum (TSUM)
Output file 2... <none>
Y-Axis 1 Y-Axis 2 Print... Close

The reruns can be used to calculate the sum of temperature that a crop needs to arrive in certain phonology step. For example, if we use the reruns (900, 950, 1000, 1050…) and run the WOFOST, then we can use the graph menu to select the DVS one. Then if we know the exact date (Julian day) corresponding to those phonological steps, then we can visually determines that 900°C is the sum of temperature that correspond to the maturity step, and that 950°C is the emergency's one.

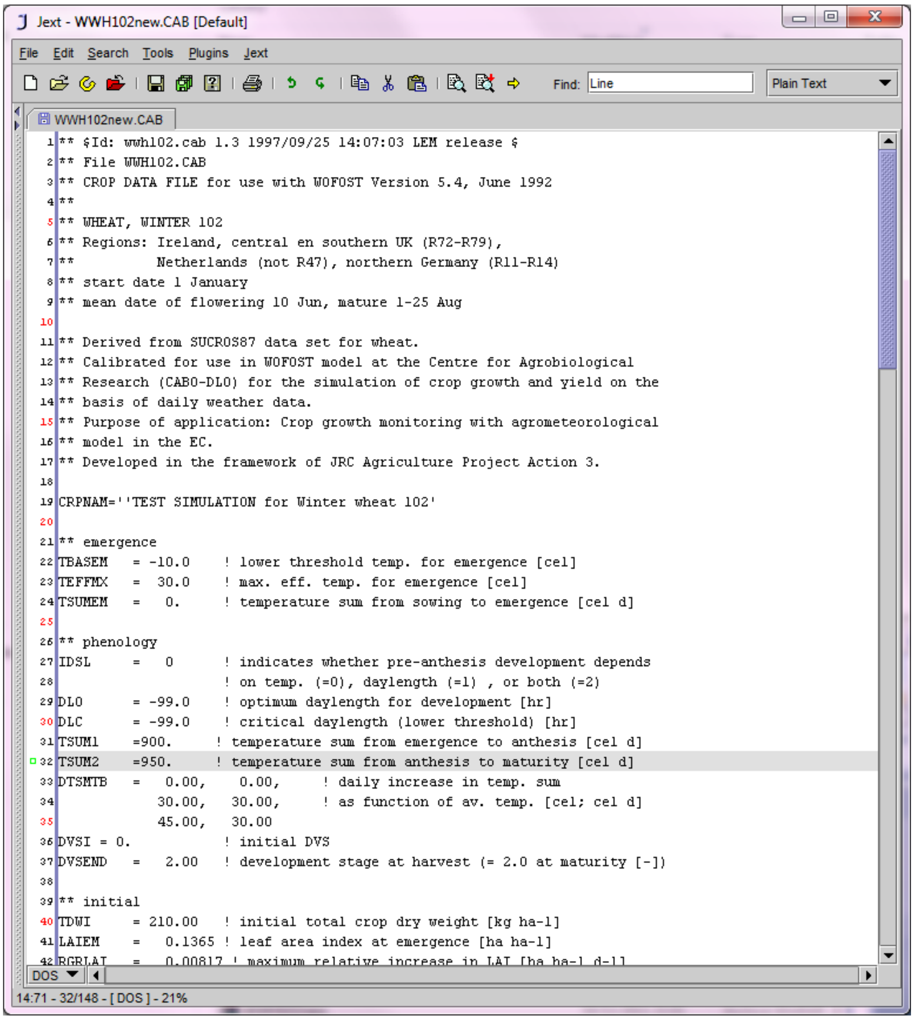
j) Configuration files

To configure the WOFOST, we just edit the file DIRECT located in: "C:\Programme Files\Alterra\WOFOST Control Centres\".



Then, we can copy the file: "C:\Documents\Alterra\WCC\WWH.102N.CAB" in "C:\ Programme Files\Alterra\WOFOST Control Centres\CROPD\". Then we can modify this file by using a text editor:

- The line started by "CRPNAM=" (line n° 19) can be changed into to "CRPNAM='TEST SIMULATION for Winter wheat 102' ". This is the name of this test simulation that will appear on the WOFOST application.
- The lines defining "∑T" (line n° 31 and 32) can also be changed to specify the SUM1 and SUM2 constants. For our example, TSUM1=900 and TSUM2=950.



- To run WOFOST with the new parameters, first we should delete all the RERUNS, and then, we can select the CROP “test Sim”. In the end, we can launch the WOFOST application by clicking on the RUN button.

5.2.2. PART2: The CGMS.

CGMS is the implementation of WOFOST for a hall region. First, we started this presentation by looking at the development (growth) for a crop, by using the fint formula:

$$D = 1 - e^{(-0.6*LAI)}$$

CGMS manage three levels:

a) **Weather mapping:** for all climatologically parameters (Tmax, Tmin…etc).
b) **Crop simulation:** for crop, soil and the land use. All this parameters can be visualized in maps.
c) **Yield forecasting:** for official harvested yields and other statistical tools. The result can also be visualized in maps.
d) **CGMS mdb Database:**

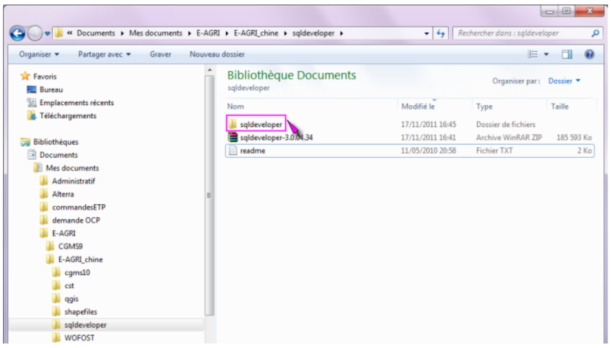
In CGMS, we transform the point model (WOFOST) into a regional one. The files are changed into tables in the CGMS database. It's a relational database containing:

- Base and derived tables and views.
- Different domains to control and manage extreme values for example.
- All table constraints.
- Other database specifications: Primary keys, procedures, indices for faster access to data.

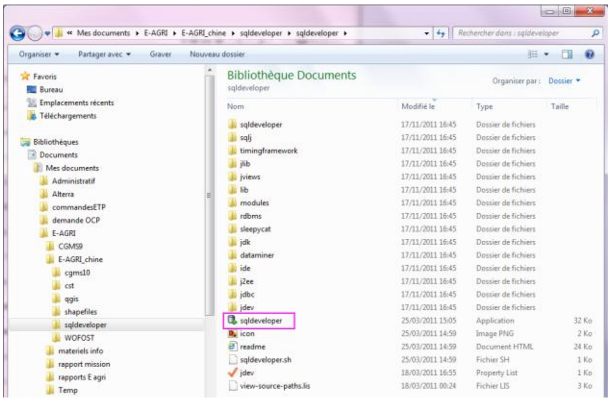
5.2.2.1. SQL Developer 3.0.04

CGMS can use also an oracle database. Sql Developer can also be used to access to the oracle DB data's:

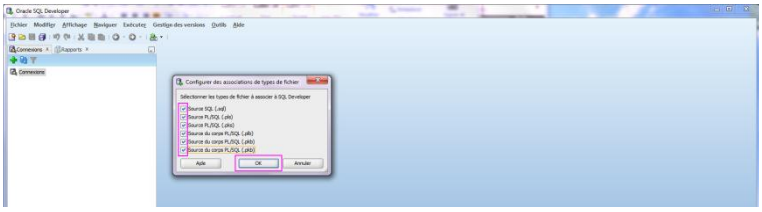
- First, we should unzip the file: **sqldeveloper-3.0.04.34.zip** in, for example, *C:\Users\hicham\Documents\E-AGRI\E-AGRI_chine\sqldeveloper*



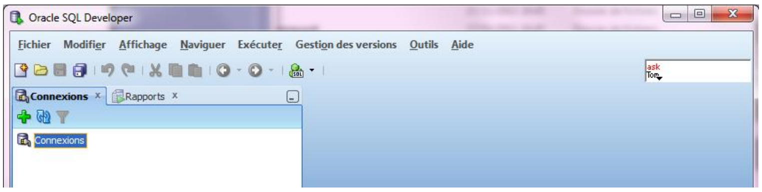
- Then just start the program: **sqldeveloper.exe**



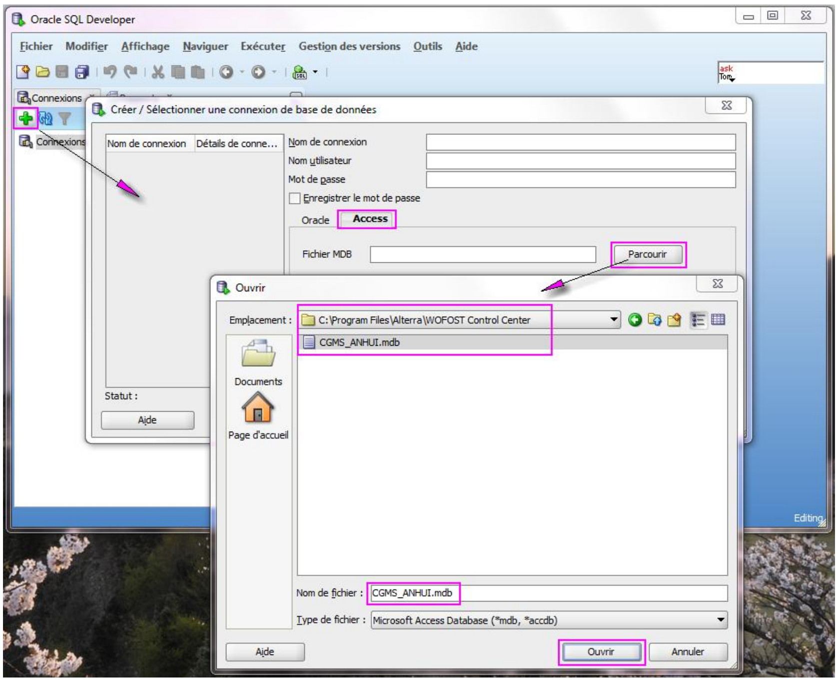
- Then, select all file types to associate to SQL Developer, and click on **OK** button.



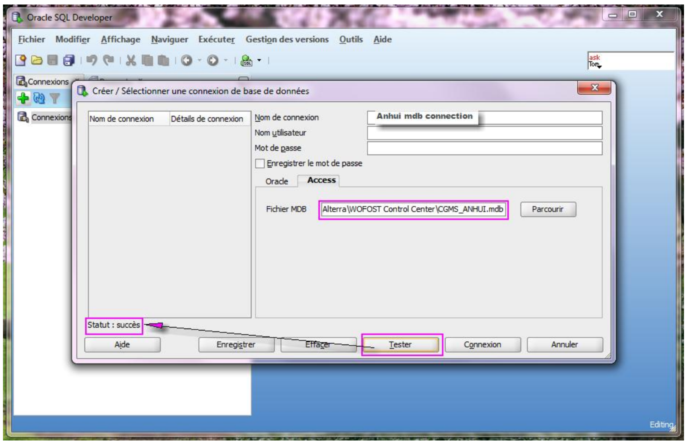
- This is the first interface of the Oracle SQL Developer:



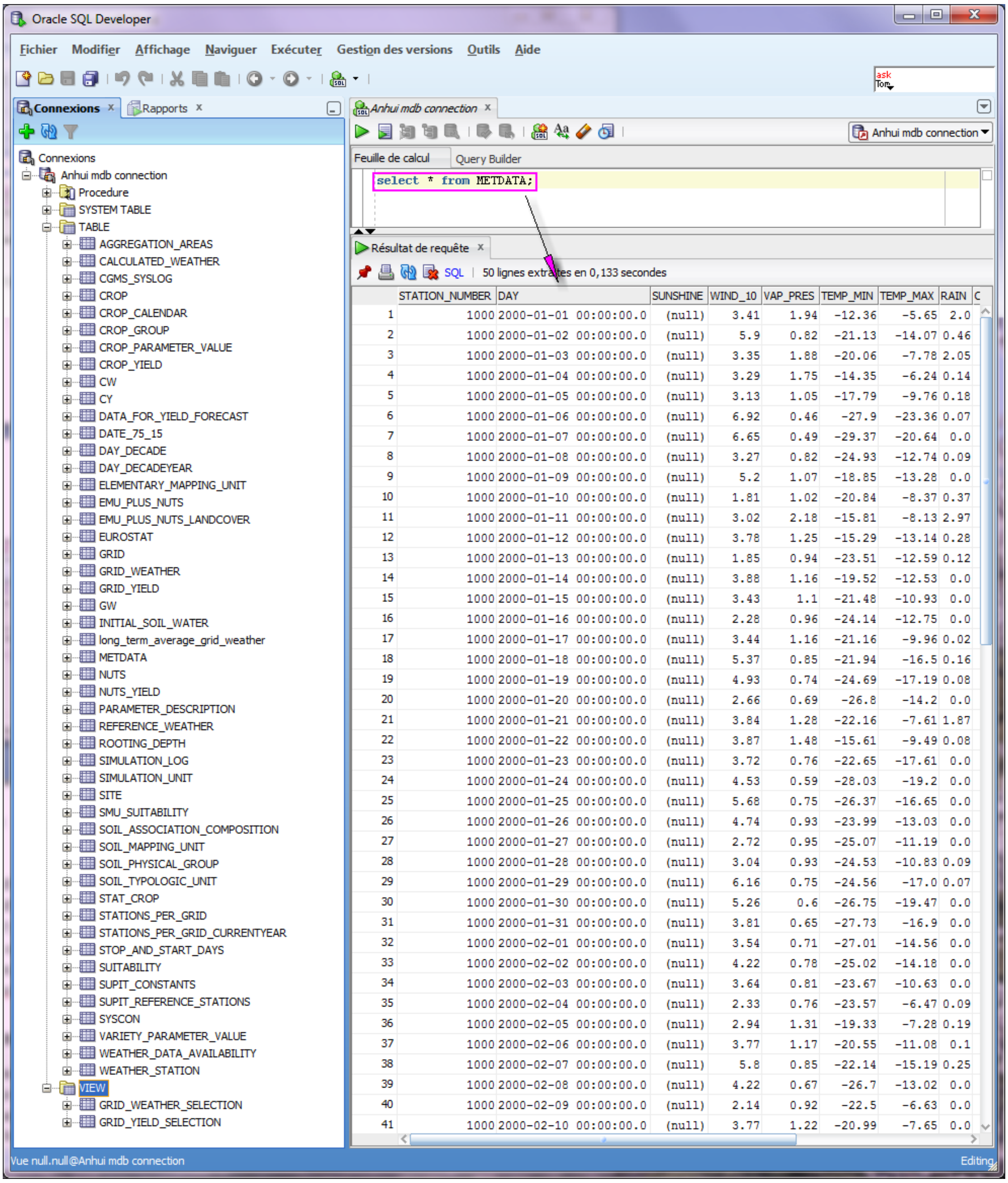
- Now, we can establish a connection to our mdb database:



- We can test this connection, by clicking on **Test** button: if it works, we should have the status **success**:

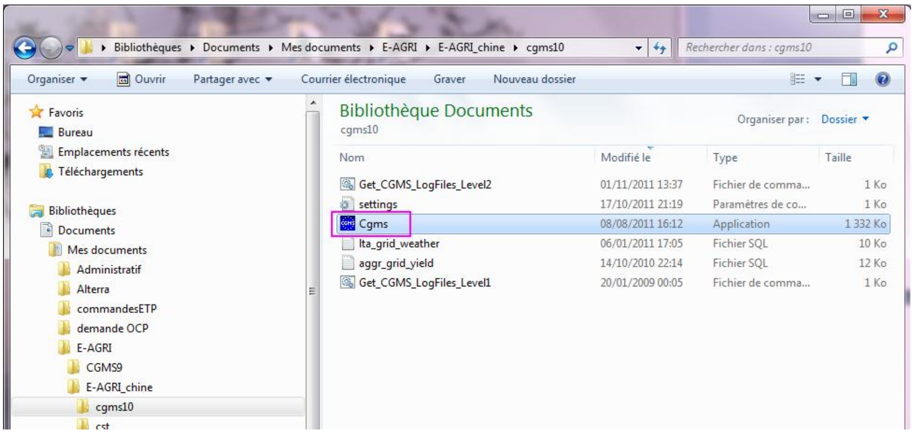


- Now, we can connect to that database, and make a simple SQL query on it:

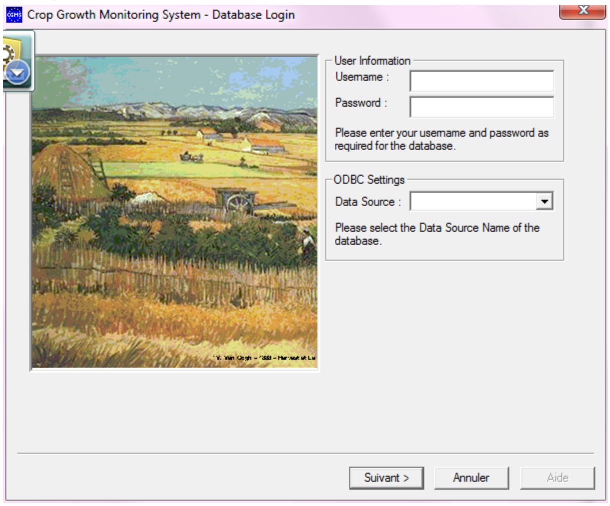


5.2.2.2. Cgms.exe v10

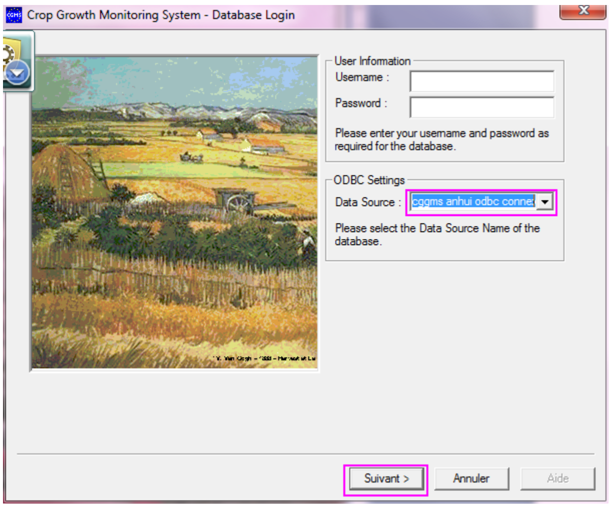
Cgms.exe is a quick launch for CGMS. It can be used just by double clicking on it:



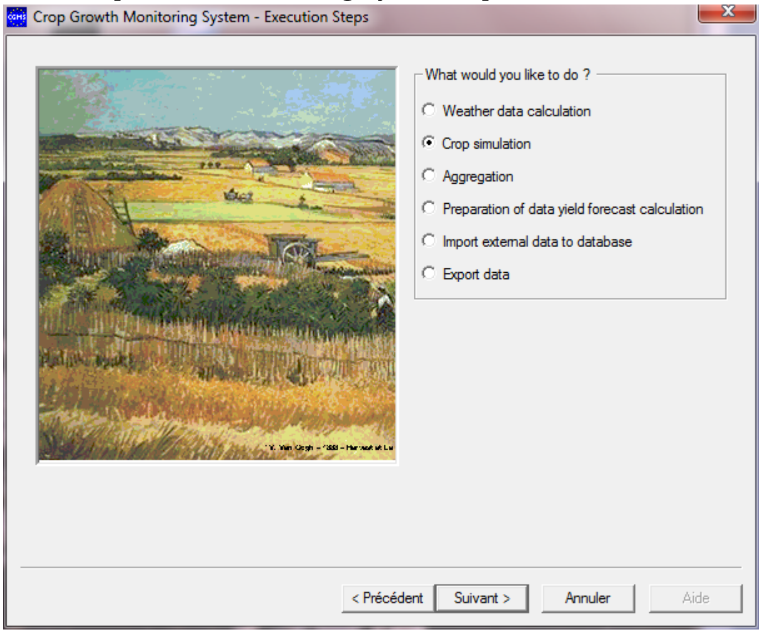
- This is the first page of CGMS:



- Let's make a connection to our database:



- This the first Crop Growth Monitoring System step:



Many other tools were developed for the CGMS:

- Supiconstant.exe to make forecast of yield crops.
- CgmsStatTool.exe to make statistics on yields estimation.
- Scripts, procedures and packages…etc

To visualize the CGMS outputs, we can use ArcGis/FME/OGIS or Custom Build Viewer.

5.2.2.3. Weather monitoring

The first level of CGMS is to monitor climatologically weather data's. We can also evaluate abnormal or alarming situations climatologically. Other useful thing in CGMS is to manage drought, extreme temperatures, and extreme rainfall during flooding or harvest.

This weather data will serve later as input for the crop simulations, after a quality testing and checking of course before any later use. Other important functionality of CGMS is the generation of a complete spatial and temporal coverage for a hall region. It's also possible to make interpolation of the climatologically data's to the grid, and also, to make downscaling easily.

a) Observed weather data:

To run CGMS, we need this daily data's: Precipitation, Temperature (maximal and minimal), Radiation or sunshine, cloud cover, Vapor pressure or humidity (maximal and minimal), Wind speed and Snows.

For this observed data's, CGMS will calculate new weather data's such as:

- The radiation at the surface of the ground, by using one of the three formulas (Angstrom, Supit, or Hargreaves). The Supit method uses sunshine, Tmax, Tmin, Longitude and Latitude.
- The evaporation of water at the surface (EO) and the evaporation of wet bare soil (ESO);
- The evapo-transpiration by using Penman Montith methode for the daily ETO, or other one if the data are not complete.

b) **Weather monitoring:**

Initially, we use ECMWF forecasts and analyses data's that we downscaled to generate climate data's in the CGMS grid. Then, we can use GIS tools for visualization of this new data's.

The ms access database contains 25x25 km grid, with administrative regions and pseudo stations. The tables that are used for managing the observed data's are:

- GRID: CGMS uses Albert projection for gridded observed data's.
- WEATHER_STATION
- METDATA

These last three tables are important to run CGMS.

- SYSCON
- SUPIT_REFERENCE_STATIONS
- CROP
- CROP_GROUP
- STAT_GROUP
- STAT_CROP
- NUTS

c) **Similarity score:**

There are three groups of similarities: RAIN, TEMP and REST. To calculate scores, CGMS use's the average functionality by calculating for each grid point:

- The distance is calculated using weighting average with only four nearest observations.
- The distance to the coast.
- If there is any difference or same uniform region (EMU).
- Distance between grid and center of gravity of stations.

d) **Output tables of CGMS:**

- GRID_WEATHER
- STATIONS_PER_GRID
- STATIONS_PER_GRID_CURRENTYEAR
- LONG_TERM_AVERAGE_GRID_WEATHER
- SUPIT_REFERENCE_STATIONS

All these last five tables are very important, and contain constants that should be specified for Morocco.

- CGMS_SYSLOG
- SUPIT_CONSTANTS: contains all constants used, not only by SUPIT method, but by the entire system.
- CALCULATED_WEATHER: to calculate even statistical means or the 360 records per station.
- REFERENCE_WEATHER
- WEATHER_DATA_AVAILABILITY

5.3. Day 3: Friday, November 4nd

5.3.1. PART1: CGMS system for crop simulations

The GRID_WEATHER table is the most important table that contains observation data's from the table METDATA, and also the weather calculated from observations (radiation, ETO…etc) available in CALCULATED_WEATHER.

a) Input data:

The weather data observation's are of course important, and should be available at the database. Then, we need crop parameter files to be correctly modified and upgraded. The third input data is the soil map files that should also be carefully implemented in the different tables of the CGMS database. We need also to configure administrative regions and special schematization.

b) Crop parameters:

These parameters are described in different CGMS database tables:

- CROP_PARAMETER_VALUE: where the different crops are described and where to go if we would like to add a new variety of crops.
- PARAMETER_DESCRIPTION: to describe the crop growth.
- VARIETY_PARAMETER_VALUE: here we can specify crop varieties. For example, the parameters TSUM1 and TSUM3 are specified in this table for the winter wheat.
- CROP_CALENDAR: this table is dedicated to specify the crop calendars. Also, we can identify, in this table, which crop is growing in which cell zone.
- CROP_GROUP: here we can specify the suitability of soil and spatial/temporal variations.

c) Soil map:

Soil characteristics	Spatial distribution or STU's
• SOIL_TYPOLOGIE_UNIT (STU): where we can define soil parameterizations. • ROOTING_DEPTH • SOIL_PHYSICAL_GROUP • SUITABILITY: to define the suitable STU per CROP_GROUP. • SITE: this table is dedicated to define infiltration of soil.	• SOIL_MAPPING_UNIT (SMU): to define the geographic regions mapping. • SOIL_ASSOCIATION_COMPOSITION: to determine which STU is included in which SMU.

d) Administrative regions:

In CGMS, regions are hierarchically structured, by using Nuts and different levels (country, city, province…). This is important for the aggregation of crop yields in AGGREGATION_AREA table.

e) Spatial schematization:

WOFOST combine spatially the weather, the soil and the crop by using a unique intersection between SMU (grid table, soil map) and EMU.

For example, for the grid number (GRID_NO) 69163, we can see in SIMULATION_UNIT table that this number exist in the field GRID, and correspond to 5 values in the field STU_NO, which means that WOFOST has been running 5 times for that grid. Now, in the table ELEMENTARY_MAPPING_UNIT, we can find these SMU_NO values. The soil map table SOIL_ASSOCIATION_COMPOSITION contains also these SMU_NO's and STU_NO's. That's simply how we can associate spatially weather, soil and crop.

f) Output table:

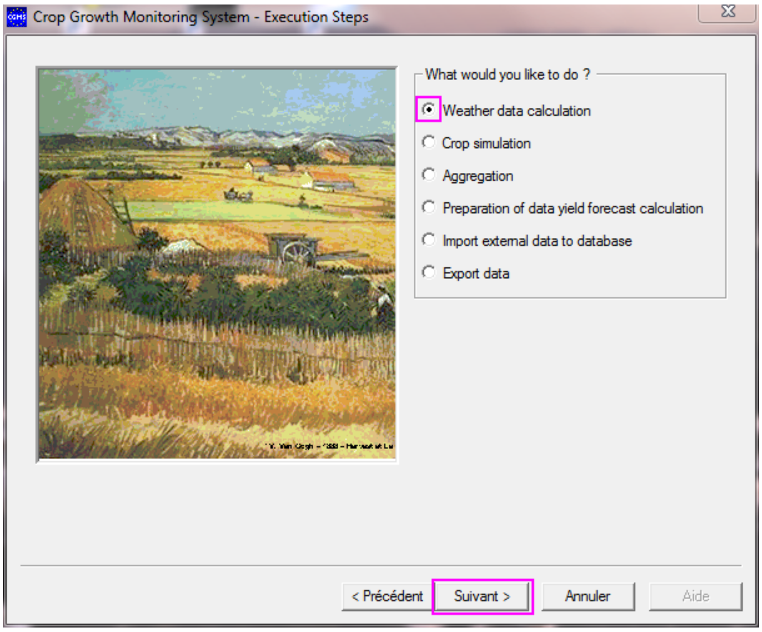
The output tables for CGMS are:

- INITIAL_SOIL_WATER
- CROP_YIELD
- GRID_YIELD
- NUTS_YIELD: for level 1(region), 2 and 3(country).

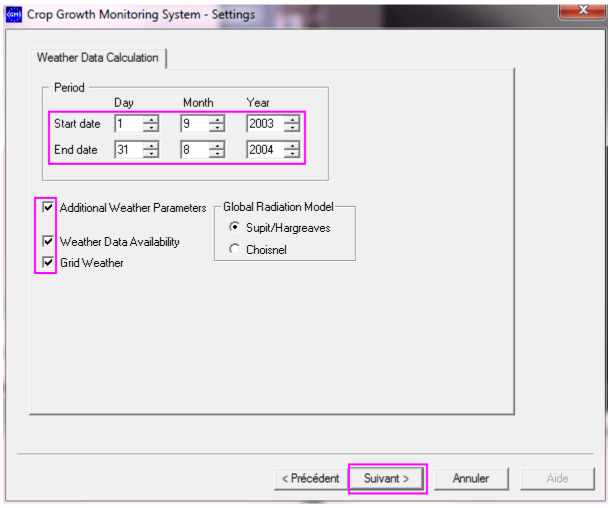
5.3.1.1. Crop simulation

5.3.1.1.1. Weather data calculation

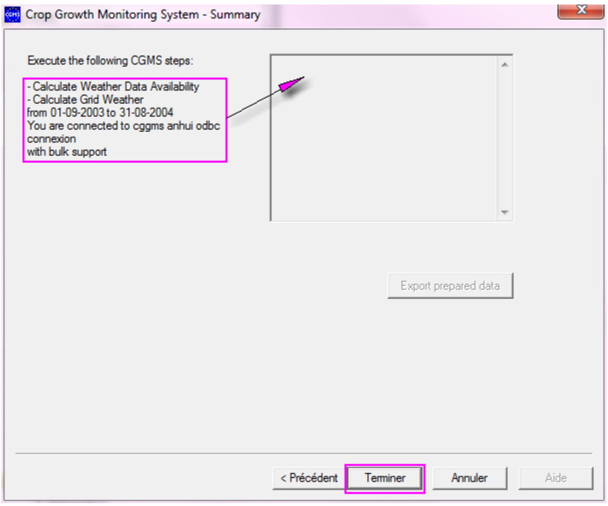
- Start by double clicking on **Cgms.exe,** then select **Weather data calculation,** and then on **Next** button.



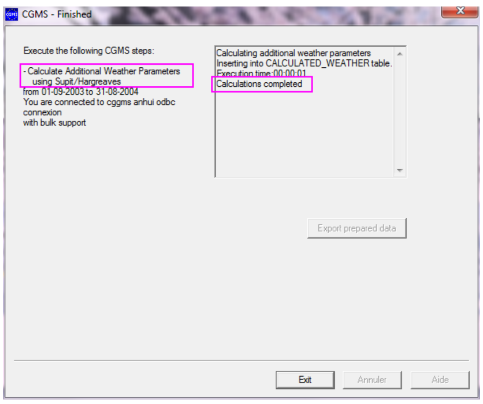
- Weather Data Calculation: Select the period from **1/9/2003** to **31/8/2004**

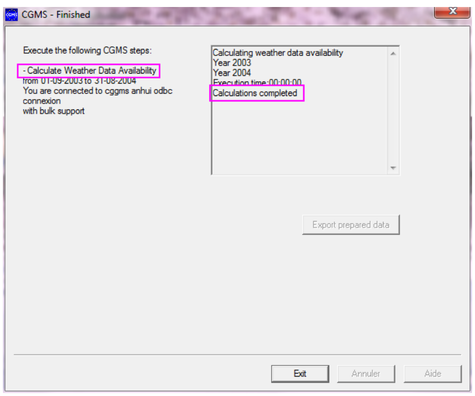


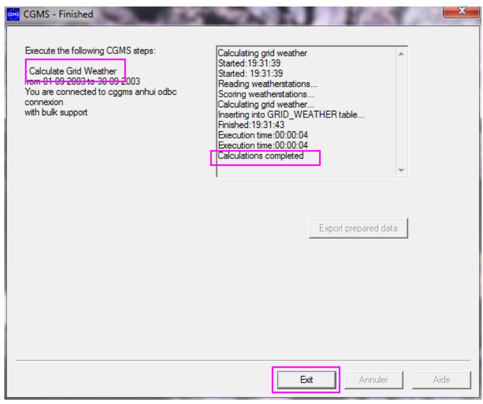
- Now, CGMS will calculate the weather data and the grid weather for that period. That takes few minutes. Don't forget to click on **Finish** to start running CGMS:



- If CGMS finish running this simulation, we should have this:

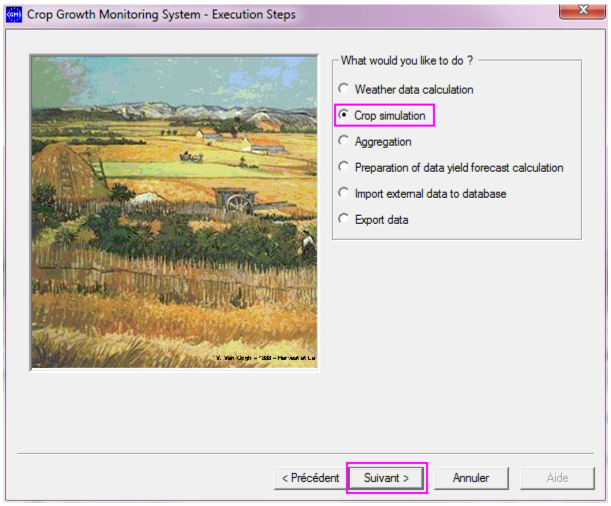




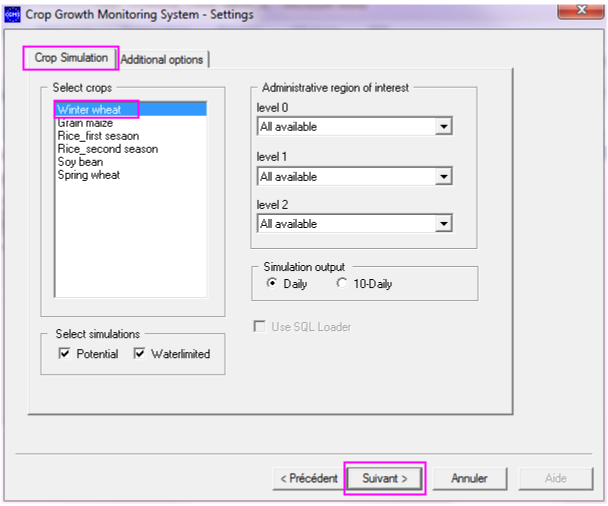


5.3.1.1.2. Crop simulation

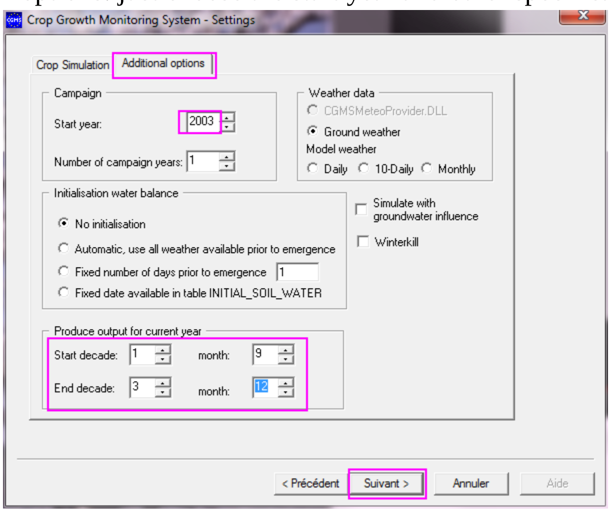
- Start by double clicking on **Cgms.exe,** then select **Weather data calculation,** and then click on **Next** button.



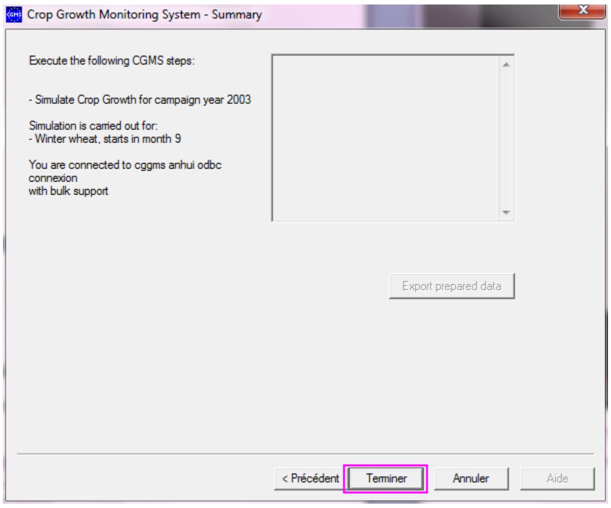
- Crop Simulation: Choose Winter Wheat:



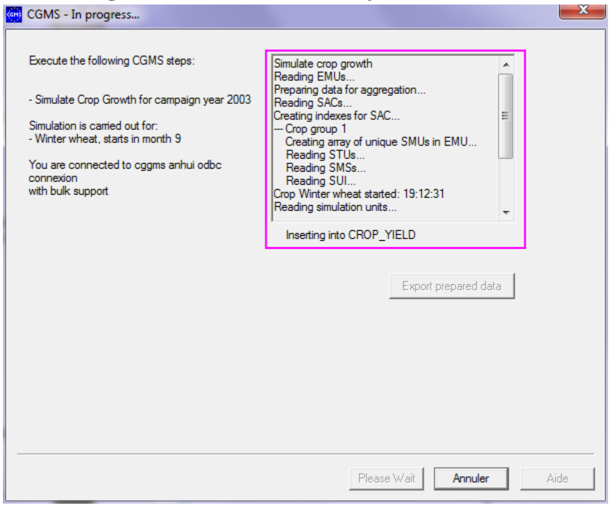
- Additional options: just choose the start year and other specifications as below:



- Now, CGMS will start a winter wheat simulation for that period. That takes few minutes. Don't forget to click on **Finish** to start running CGMS:

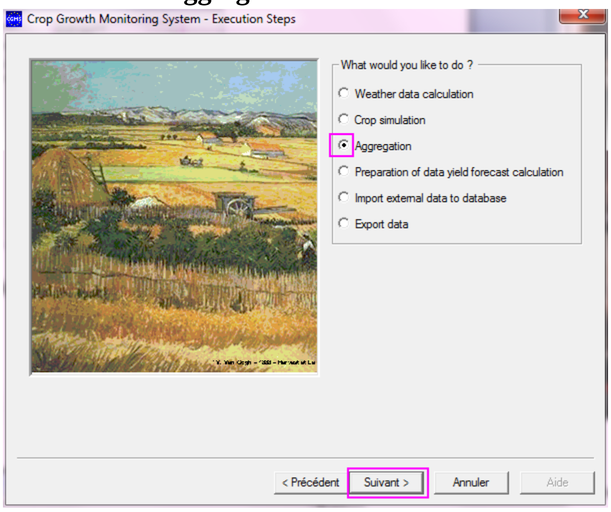


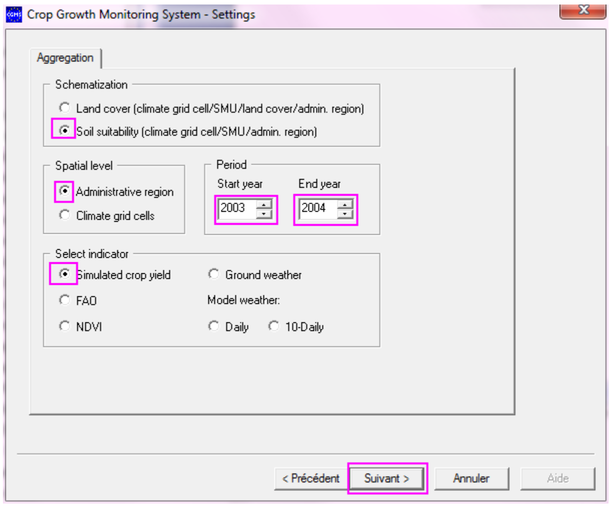
- If CGMS is running, we should have this, just wait until it finished:

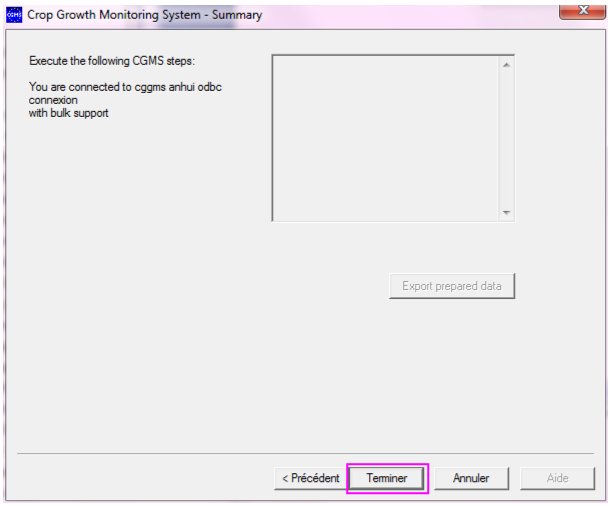


5.3.1.1.3. Aggregation

- Start **CGMS** and select **Aggregation. T**hen click on **Next** button.

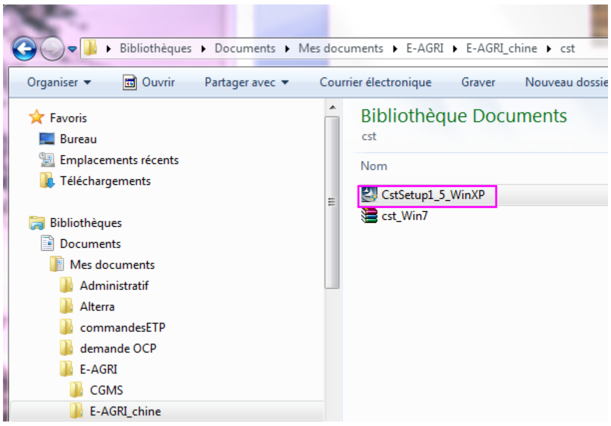




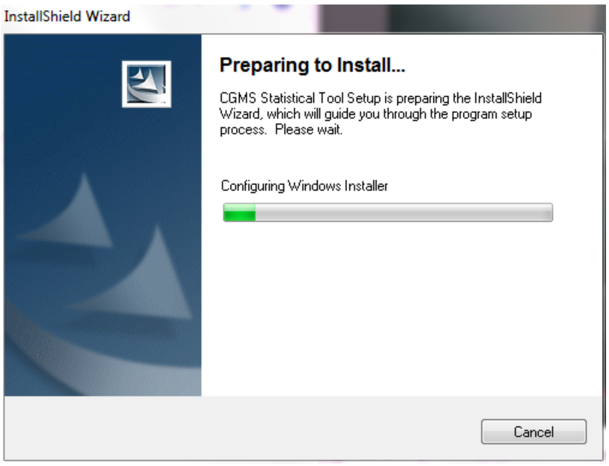


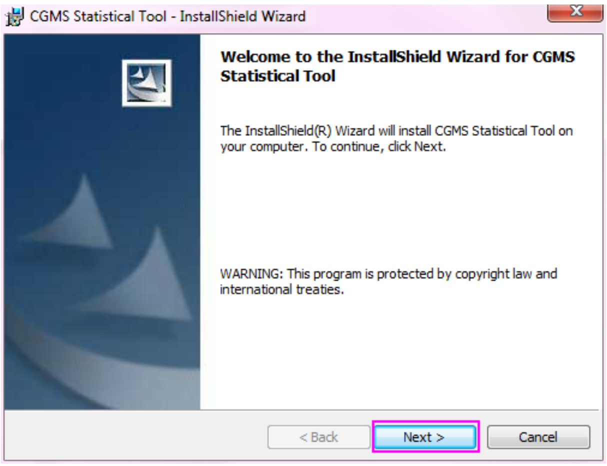
5.3.1.1.4. The CGMS Statistical Tool CST

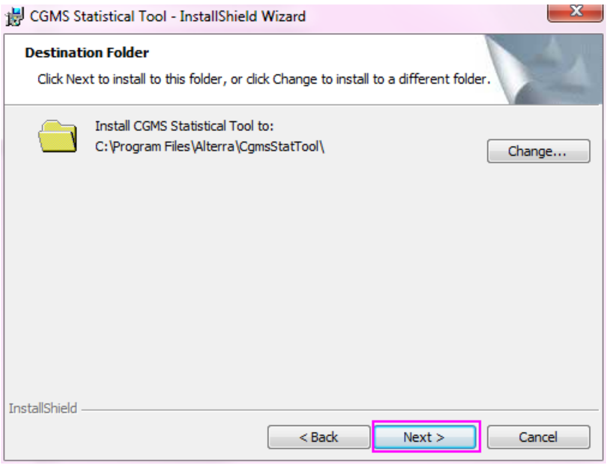
- First, we have to install the CST, by just double clicking on **CstSetup1_5_WinXP.exe:**

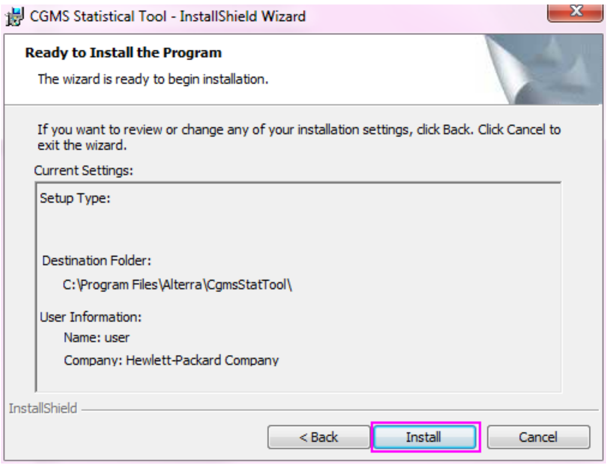


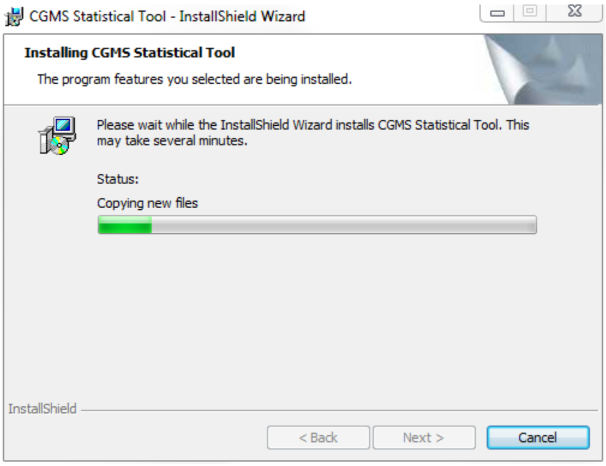
- Then, follow these few steps:





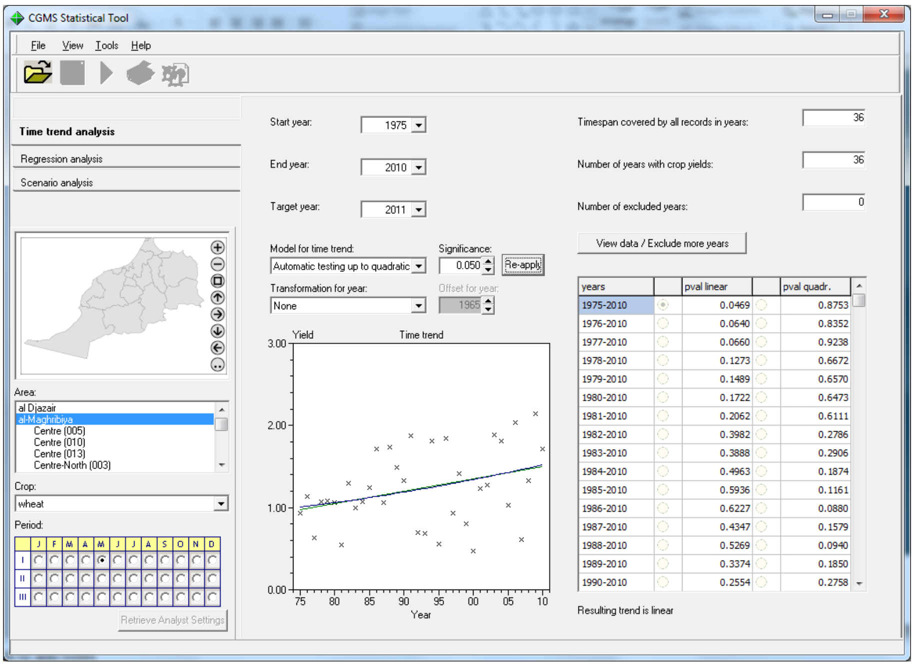




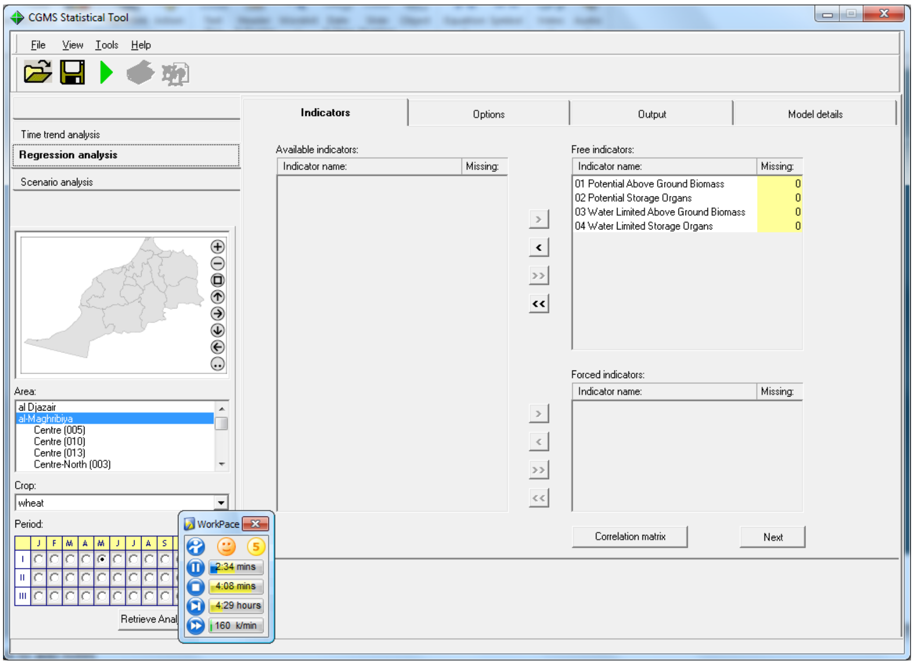


Remark: the next steps of CST are inspired from the presentation: The CGMS crop yield forecasting system. By: Steven Hoek & Allard de Wit.

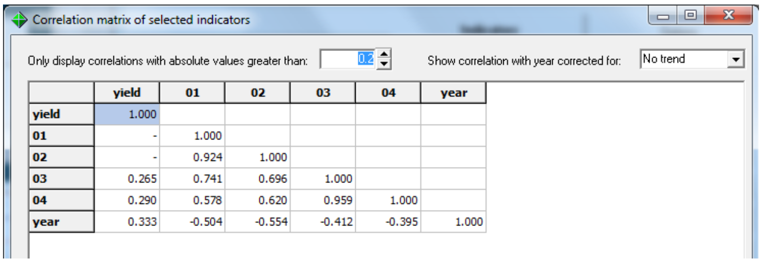
- Then, we can start it, by doing a simple trend analysis:



- Then, we can choose indicators:

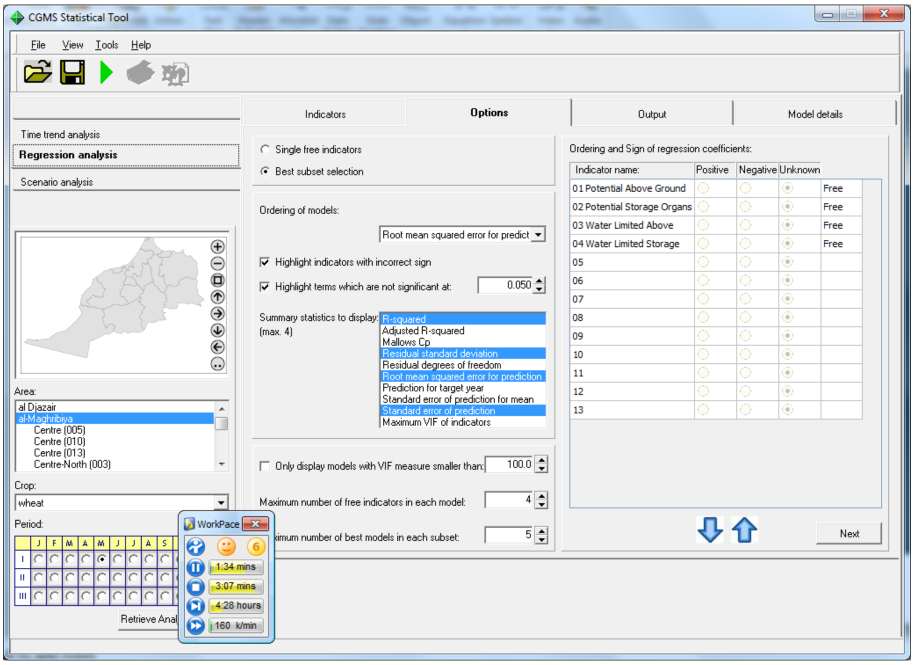


- Correlation with indicators:

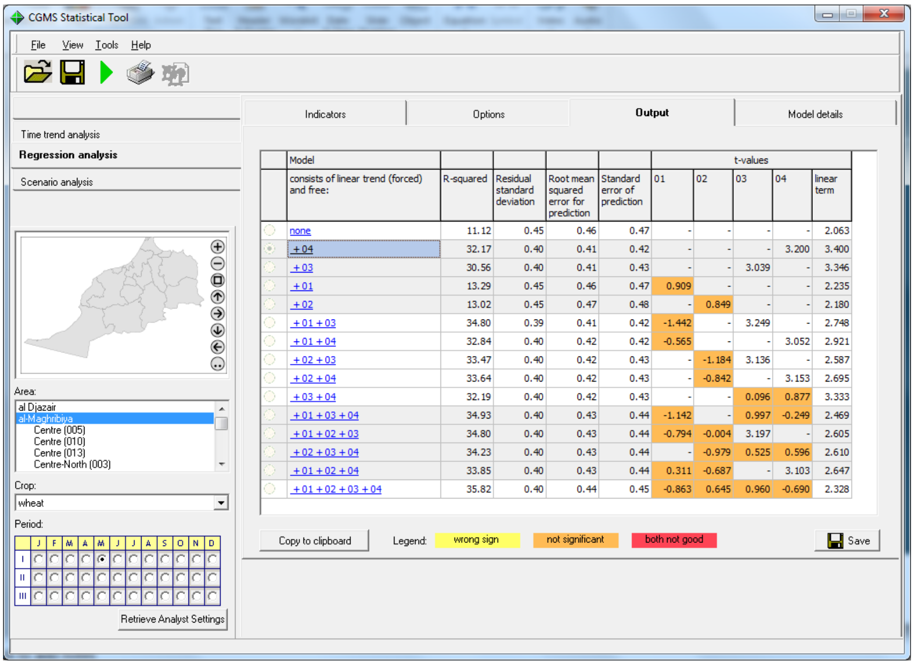


	yield	01	02	03	04	year
yield	1.000					
01	-	1.000				
02	-	0.924	1.000			
03	0.265	0.741	0.696	1.000		
04	0.290	0.578	0.620	0.959	1.000	
year	0.333	-0.504	-0.554	-0.412	-0.395	1.000

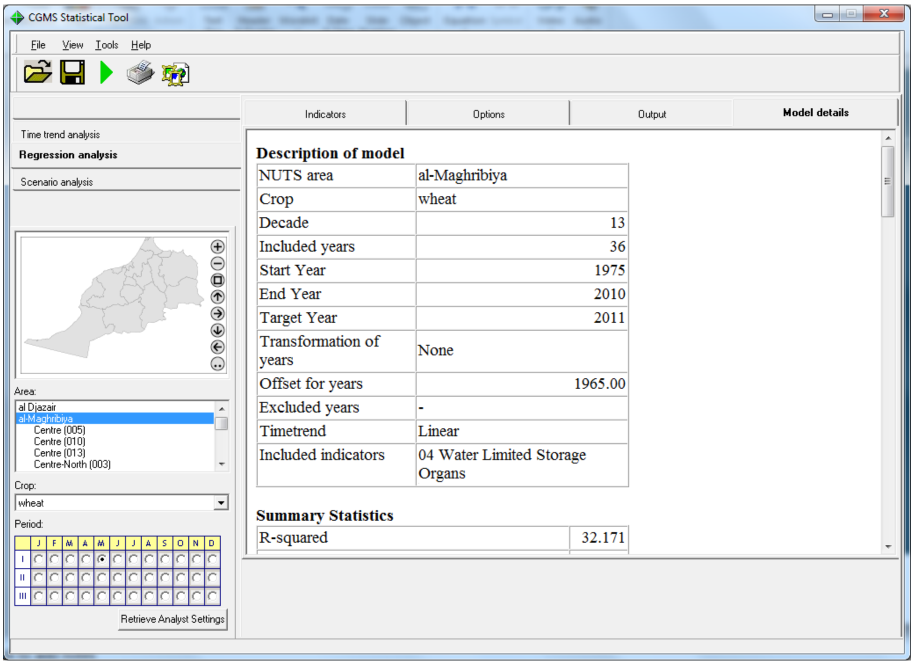
- Choose options for regression analysis:



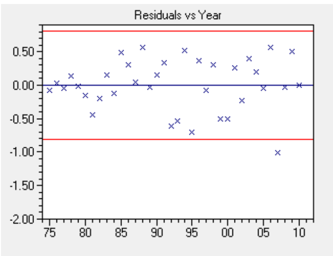
- Select the best model:

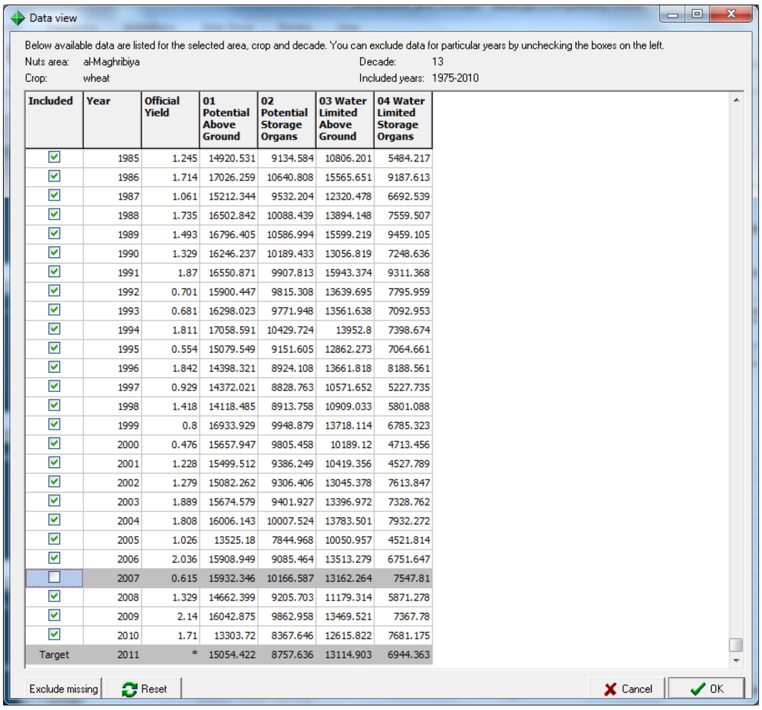


- Analyze the model details:

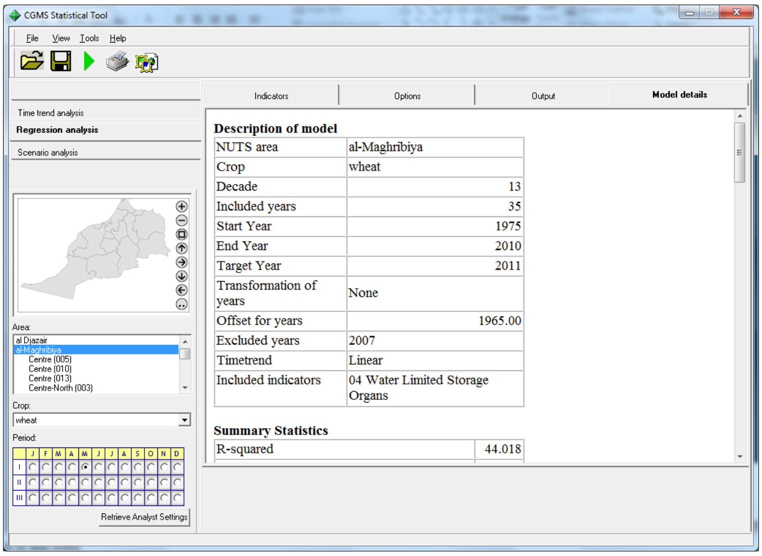


- Analysis of residuals, Correct model by excluding one/more year(s), Build and Evaluate the final model:





Included	Year	Official Yield	01 Potential Above Ground	02 Potential Storage Organs	03 Water Limited Above Ground	04 Water Limited Storage Organs
☑	1985	1.245	14920.531	9134.584	10806.201	5484.217
☑	1986	1.714	17026.259	10640.808	15565.651	9187.613
☑	1987	1.061	15212.344	9532.204	12320.478	6692.539
☑	1988	1.735	16502.842	10088.439	13894.148	7559.507
☑	1989	1.493	16796.405	10586.994	15599.219	9459.105
☑	1990	1.329	16246.237	10189.433	13056.819	7248.636
☑	1991	1.87	16550.871	9907.813	15943.374	9311.368
☑	1992	0.701	15900.447	9815.308	13639.695	7795.959
☑	1993	0.681	16298.023	9771.948	13561.638	7092.953
☑	1994	1.811	17058.591	10429.724	13952.8	7398.674
☑	1995	0.554	15079.549	9151.605	12862.273	7064.661
☑	1996	1.842	14398.321	8924.108	13661.818	8188.561
☑	1997	0.929	14372.021	8828.763	10571.652	5227.735
☑	1998	1.418	14118.485	8913.758	10909.033	5801.088
☑	1999	0.8	16933.929	9948.879	13718.114	6785.323
☑	2000	0.476	15657.947	9805.458	10189.12	4713.456
☑	2001	1.228	15499.512	9386.249	10419.356	4527.789
☑	2002	1.279	15082.262	9306.406	13045.378	7613.847
☑	2003	1.889	15674.579	9401.927	13396.972	7328.762
☑	2004	1.808	16006.143	10007.524	13783.501	7932.272
☑	2005	1.026	13525.18	7844.968	10050.957	4521.814
☑	2006	2.036	15908.949	9085.464	13513.279	6751.647
☐	2007	0.615	15932.346	10166.587	13162.264	7547.81
☑	2008	1.329	14662.399	9205.703	11179.314	5871.278
☑	2009	2.14	16042.875	9862.958	13469.521	7367.78
☑	2010	1.71	13303.72	8367.646	12615.822	7681.175
Target	2011	*	15054.422	8757.636	13114.903	6944.363

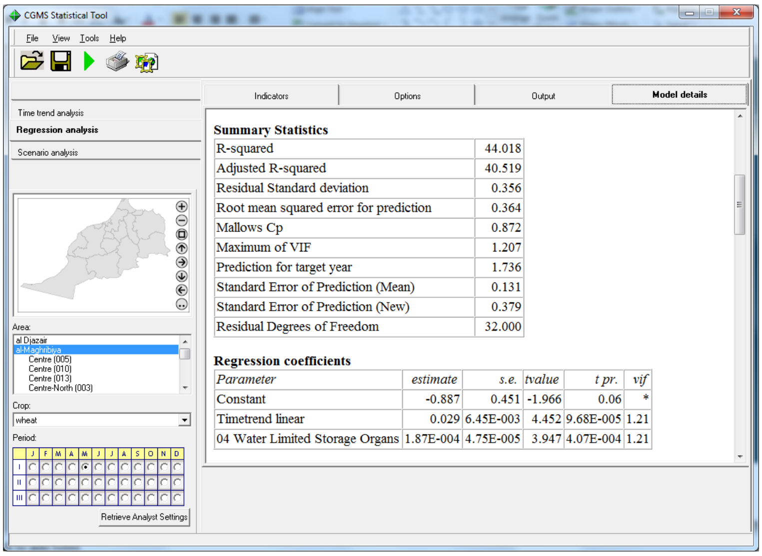


Description of model

NUTS area	al-Maghribiya
Crop	wheat
Decade	13
Included years	35
Start Year	1975
End Year	2010
Target Year	2011
Transformation of years	None
Offset for years	1965.00
Excluded years	2007
Timetrend	Linear
Included indicators	04 Water Limited Storage Organs

Summary Statistics

R-squared	44.018



Summary Statistics

R-squared	44.018
Adjusted R-squared	40.519
Residual Standard deviation	0.356
Root mean squared error for prediction	0.364
Mallows Cp	0.872
Maximum of VIF	1.207
Prediction for target year	1.736
Standard Error of Prediction (Mean)	0.131
Standard Error of Prediction (New)	0.379
Residual Degrees of Freedom	32.000

Regression coefficients

Parameter	*estimate*	*s.e.*	*tvalue*	*t pr.*	*vif*
Constant	-0.887	0.451	-1.966	0.06	*
Timetrend linear	0.029	6.45E-003	4.452	9.68E-005	1.21
04 Water Limited Storage Organs	1.87E-004	4.75E-005	3.947	4.07E-004	1.21

5.3.2. PART 2: Inventory of usability of CGMS for Morocco

5.3.2.1. Inventory of available data sources and their suitability for applying CGMS

5.3.2.1.1. Meteorological available data's

- Locations of meteo stations and attributes:
    - Data from 42 stations of all the Moroccan Meteorological Agency can deliver daily data.
- List of available meteo variables:
    - TMAX
    - TMIN
    - RAIN
    - WIND (**to precise which one: Daily Mean or Maxi or Mini**)
    - Humidity Maxi and Mini
    - SUNSHINE
- Archive of daily meteo data for the period 1990-2010:
    - Archive data can be retrieved from the Oracle meteorological database of the MMA (Moroccan Meteorological Agency).
    - MMA will grant the use of interpolated observation data's product for Moroccan grid cells (resolution: 25x25 km).
- Regular updates of the meteo data : 10-daily may be possible (to be confirmed later):
    - It's possible that daily data will become available in MMA during the project. At least with a 1 month delay.
- Classical interpolation approach OR AURELHY approach (only 10-daily temp, rain):
    - Classical CMGS interpolation immediately.
    - AURELHY method will be used in a second level to compare with.

5.3.2.1.2. Setup a database system

- ORACLE (well-tested but expensive & complicated):
    - Oracle 8i is available. We have a good experience with Oracle 9i and 10g, but not installed yet.
    - OS: Microsoft Windows Server 2008 Service Pack 2, Standard
    - HW: IBM Server, Raid5.

5.3.2.1.3. Inventory of factors explaining

regional yield variability in Morocco: irrigation, fertilizer, disease, heat damage

- To be done by INRA

5.3.2.1.4. Inventory of technical constraints

- MMA: no technical constraints.

5.4. Conclusion and perspectives