FRENCH REFINEMENT OF GROUNDWATER SCENARIOS (VERSION 3.3.3.3)

Description of FROGS database version 3

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1 Introduction

The FROGS database contains all parameters on soil, crops, scenarios, substances and application necessary to create PEARL input files (*.prl).

The database comprises 17 tables defining scenario combinations, agronomic units, soil, crop, substance properties, and substance application. Most of the entries are fixed and can not be changed via the FROGS-GUI. Only substance and application data can be modified through the GUI.

In the following a description is given of how the tables are linked and how the containing parameters are defined.

Further, guidance is given on how to add new Agronomic Units (AU), soils, or crops, and how to use other application types than the application to the soil surface (*AppSolSur*), and how to distribute runs to multiple computers or processors.

2 Descriptions of tables and interactions

2.1 Agronomic Units

The geographical building block of the scenarios, the agronomic unit, is defined in table "**tblAgriculturalUnit**" (Table 1).

2.2 Weather data and irrigation

The information of which weather file (*.met) is used for which scenario is stored in the table "**tblAUSoilCropMeteoCombination**" (Table 6). In each AU the same MARS-tile is used.

Information on irrigation per crop and AU is stored in table "**tblIrrigation**" (Table 14).

2.3 Soils

Soils are defined by two tables. "**tblSoils**" (Table 16) contains all parameters applicable to the entire profile, whereas "**tblHorizons**" (Table 13) stores horizon specific information. Vertical numerical discretization of the profile was adopted from FOCUS-Châteaudun scenario (2.5 cm layers for 0-50 cm, 5 cm for 50-100 cm, and 10 cm for below 100 cm). To be able to define the target depth as accurate as possible, an additional soil horizon was defined around the target depth (from about 5 cm above the target depth to 5 cm below the target depth) with a 1 cm resolution. The depth-dependent transformation factors were selected similar to those of the FOCUS scenarios (1 for 0-30 cm soil depth, 0.5 for 30-60 cm and 0.3 for 60-100 cm). For soils that are deeper than 100 cm the depth factor was set to 0.15 for deeper layers.

2.4 Crops

Information on crops is stored in several tables:

- "**tblCrops**" (Table 11): basic crop parameters
- "**tblCroppar**" (Table 9): crop parameters that change with development stage
- "**tblCropDates**" (Table 7): emergence and harvest dates for each crop in each AU

Additional information on crops is needed when defining applications:

- "**tblCropEvent**" (Table 8) fills the drop down list *Crop event* in the GUI for the relative applications.
- "**tblDVStoBBCH**" (Table 12) contains conversion information from development stage, e.g. the output of the phenology sub-model when BBCH-based application timing is selected, and BBCH growth stage code.

3 Basic FROGS scenario definition

A FROGS scenario is defined uniquely by geography (Agronomic Unit, hereafter named AU), soil, and a main crop (AU/soil/crop-combination). This information is stored in two tables:

- "**tblAU_soil_crop_area_ha**" (Table 5) contains cultivated surfaces per crop for each soil in the AU (ha) with an area larger than 1 kha
- Occurrence of a main crop in an AU is defined in "**tblCropRotation**" (Table 10).

Main crops occur in rotation with rotational crops. Rotations can differ from one AU to another. This information is stored in "**tblCropRotation**" (Table 10).

3.1 Substances

Substance properties are defined in table "**tblSubstances**" (Table 17). There is no difference made between parents and metabolites. The relationship between parent and metabolites are defined in the table "tblMetabolism", where both attributes "ParentID" and "MetaboliteID" refer to the attribute "SubID" in table "tblSubstances" (Table 17).

By entering new substances in the GUI these two tables are updated accordingly.

3.2 Application schemes and applications

Applications are organized in application schemes ("**tblApplicationScheme**" (Table 4)). Each application scheme is linked to a main crop. However, applications that belong to a particular scheme can be applied to the main crop and/or a crop that occurs in rotation with the main crop. Combined with the unique FROGS-scenarios (i.e. AU/soil/crop-combination) an application scheme defines a unique FROGS-scenario-run (i.e. AU/soil/crop/application scheme-combination).

Individual applications are stored in "**tblApplications**" (Table 3).

"**tblApp_type**" (Table 2) defines the different application types of PEARL. However, this option is not activated yet. In FROGS 3.3.3.3 application to soil surface is activated only, i.e. attribute "*App_type*" takes value "*AppSolSur*" (for workarounds see section "How to…").

Table 1: Parameters of database table "tblAgriculturalUnit"

Name	Description	Data Format	Range
AUID	Agronomic Unit ID	Integer	
Name	Name of Agronomic Unit	Text	
Lat	Latitude of meteo station	Float	-60 to 60

Table 2: Parameters of database table "tblApp_type"

Name	Description	Data Format	Range
ApplicationType	Type of application	Text	AppSolSur
Description	Short description of application type	Text	

Table 3: Parameters of database table "tblApplications"

Name	Description	Data Format	Range
APPID	Application ID	Integer	
APPSCHEMEID	Application Scheme ID	Integer	
CID	Crop ID	Integer	
App_type	Application type. In PEARL other types are possible, but not implemented in teh first version of FROGS	Text	AppSolSur
Dosage (kg/ha)	Dosage of application (kg/ha)	Float	
AppTimingType	Type of application timing	Text	absolute / relative / BBCH
App_date	Date of application (only for absolute applications)	Date / DD.MM.YYYY	
IsFirstYearApp	Only relevant for biennial crops like winter wheat and application timing = “absolute”: flag indicating if application occurs in first or second year (yes = first year; no = second year)	true/false	true/false

CropEvent	Crop event to which relative application should be performed (only if AppTimingType = relative)	text	Emergence/Harvest
RelativeDays	Number of days before (-) or after (+) the crop event the application takes place (only if AppTimingType = relative)	Integer	
BBCH	BBCH to which relative application should be performed (only if AppTimingType = BBCH)	Integer	
FallSpring	Identifies the application as Fall or Spring application [Fall ; Spring ; -] (only if AppTimingType = BBCH)	Text	Fall /Spring/-
RelativeDaysBBCH	Number of days before (-) or after (+) the BBCH the application takes place (only if AppTimingType = BBCH)	Integer	

Table 4: Parameters of database table "tblApplicationScheme"

Name	Description	Data Format	Range
APPSCHEMEID	ApplicationSchemeID	Integer	
CID_main	Main crop ID	Integer	
ApplicationScheme	Name of application scheme	Text	

Table 5: Parameters of database table "tblAU_soil_crop_area_ha"

Name	Description	Data Format	Range
AUID	Agronomic Unit ID	Integer	
SID	Soil ID	Integer	
CID	Crop ID	Integer	
Area (kha)	Area (kha)	Integer	

Table 6: Parameters of database table "tblAUSoilCropMeteoCombination"

Name	Description	Data Format	Range
AUID	Agronomic Unit ID	Integer	
SID	Soil ID	Integer	
CID	Main Crop ID	Integer	
MeteoStation	Meteofile (*.met) ID (file has to be existent in folder "met")	Text	

Table 7: Parameters of database table "tblCropDates"

Name	Description	Data Format	Range
CID	Crop ID	Integer	
AUID	Agronomic Unit	Integer	
Emergence	Date of Emergence	Date / DD-MM	
Harvest	Date of harvest	Date / DD-MM	
Comment_Emergence	Source of emergence date and info if changes were applied to meet restrictions of calendar format in PEARL (SWAP)	Text	
Comment_Harvest	Source of harvest date and info if changes were applied to meet restrictions of calendar format in PEARL (SWAP)	Text	

Table 8: Parameters of database table "tblCropEvent"

Name	Description	Data Format	Range
CropEvent	Selectable crop events for relative applications	Text	
Pos	Position in drop down menu	Integer	

Table 9: Parameters of database table "tblCroppar"

Name	Description	Data Format	Range
CPARID	Running Number (unique ID)	Integer	
CID	Crop ID	Integer	
DVD	Development stage: 0 = emergence; 1 = harvest (-) (in contrast to the parameter "DVS" in "tblDVStoBBCH" "DVD" is scaled from 0 to 1 for PEARL)	Float	0 to 1
LAI	Leaf Area Index (m2/m2)	Float	0 to 12
FacCrp	Crop factor (-)	Float	0 to 2
ZRoot	Rooting depth (m)	Float	0 to 10
HeightCrp	Crop height (m)	Float	0 to 10

Table 10: Parameters of database table "tblCropRotation"

Name	Description	Data Format	Range
AUID	Agronomic Unit ID	Integer	
CID_main	Main Crop ID	Integer	
CID_rot	Rotational Crop ID	Integer	
Pos	Position of rotational crop in rotation	Integer	

Table 11: Parameters of database table "tblCrops"

Name	Description	Data Format	Range
CID	Crop ID	Integer	
Crop_engl	Crop Name in English	Text	
Crop_french	Crop Name in French	Text	
PrlFileName	Short name occuring in PEARL input file	Text	
Comment	Comment on where parameterization origins from	Text	
HLim1	Anaerobiosis point (cm)	Float	-100 to 0
HLim2	Wet reduction point (cm)	Float	-1000 to 0
HLim3U	Dry reduction point (cm)	Float	-10000 to 0
HLim3L	Dry reduction point (cm)	Float	-10000 to 0
HLim4	Wilting point (cm)	Float	-16000 to 0

RstEvpCrp	Min. canopy resistance (s/m)	Float	0 to 1000
CofExtDif	Extinction coefficient for diffuse global radiation (-)	Float	
CofExtDir	Extinction coefficient for direct global radiation (-)	Float	
CofIntCrp	Constant in Braden eq for interception (cm)	Float	0 to 1
ZTensiometer	Depth of (virtual) tensiometer (m)	Float	
PreHeaIrrSta	Critical pressure head for irrigation (cm)	Float	
Tsum_1	Temperature sum from emergence to anthesis (degree days)	Float	0 to 10000
Tsum_2	Temperature sum from anthesis to maturity (degree days)	Float	0 to 10000
Tlb	Lowest temperature for development (°C)	Float	
Tub	Maximum temperature for optimal development (°C)	Float	
flagDaylength	Flag if daylength should be considered (0 = no; 1 = yes)	Integer	0;1
DLO	Minimum daylength for optimum crop development [Habekotté (1999) calls it Pb] (h) (= Parameter "Pb" in report)	Integer	0 to 24
DLC	Shortest daylength for any development [Habekotté (1999)calls it Psat] (h) (= Parameter "Psat" in report)	Integer	0 to 24
flagVernalization	Flag if vernalization should be considered (0 = no; 1 = yes)	Integer	0 to 1
Rv_max	Maximum rate of vernalization (1/(d °C))	Float	
Tv_max	Maximum temperature for vernalization (°C)	Float	
Tv_min	Minimum temperature for vernalization (°C)	Float	

Tv_op1	Lowest optimum temperature for vernalization (°C)	Float	
Tv_op2	Maximal optimum temperature for vernalization (°C)	Float	
a_0_1	Fitting factor for development stage (DVS) (= Parameter "at" in report)	Float	0 to 1
GSCONVID	ID of conversion table from DVS to BBCH --> tblDVStoBBCH	Integer	

Table 12: Parameters of database table "tblDVStoBBCH"

Name	Description	Data Format	Range
GSCONVID	ID of conversion table from DVS to BBCH	Integer	
DVS	Development stage (0 = Emergence; 2 = Harvest) (= Parameter “Ds” in Report)	Float	0 to 2
BBCH	BBA growth stage	Float	0 to 90

Table 13: Parameters of database table "tblHorizons"

Name	Description	Data Format	Range
AUID	Agronomic Unit ID	Integer	
SID	Soil ID	Integer	
HID	Horizon ID	Integer	
ThiHor	Thickness of horizon (m)	Float	
NumLay	Number of numerical layers	Integer	1 to 500
FraSand	Mass content of sand, expressed as a fraction of the mineral soil (kg/kg)	Float	0 to 1
FraSilt	Mass content of silt, expressed as a fraction of the mineral soil (kg/kg)	Float	0 to 1
FraClay	Mass content of clay, expressed as a fraction of the mineral soil (kg/kg)	Float	0 to 1
CntOm	Organic matter mass content (kg/kg)	Float	0 to 1
pH	pH measured in 0.01 M CaCl2 is preferred (-)	Float	1 to 13
ThetaSat	Saturated soil water content (m3/m3)	Float	0 to 0.95

ThetaRes	Residual soil water content (m3/m3)	Float	0 to 0.04
AlphaDry	Alpha from drying curve (1/cm)	Float	1E-3 to 1
AlphaWet	Alpha from wetting curve (1/cm)	Float	1E-3 to 1
n	Parameter n of van Genuchten equ. (-)	Float	1 to 5
KSat	saturated conductivity (m/d)	Float	1E-4 to 10
L	Parameter lambda of van Genuchten equ. (-)	Float	-25 to 25
Rho	Soil bulk density (kg/m3)	Float	100 to 2000
LenDisLiq	Dispersion length of solute in liquid phase (m)	Float	0.5Delz to 1; Delz= ThiHor/NumLay
FacZTra	Factor for the effect of depth on transformation (-)	Float	0 to 1; -99
FacZSor	Factor for the effect of depth on sorption (-)	Float	0 to 1; -99

Table 14: Parameters of database table "tblIrrigation"

Name	Description	Data Format	Range
CID	Main Crop ID	Integer	
AUID	Agronomic Uit ID	Integer	
First_Irri	Date of first irrigation	Date / DD.MM	
Interval	Interval between irrigation events (d)	Integer	
N_irri_events	Number of irrigation events	Integer	
mm_per_event	Irrigation amount per event (mm)	Float	
duration_event	Duration of each event (d)	Integer	

Table 15: Parameters of database table "tblMetabolism"

Name	Description	Data Format	Range
ParentID	Substance ID of the parent	Integer	
MetaboliteID	Substance ID of the metabolite	Integer	
FormationFraction	Formation Fraction	Float	0 to 1

Table 16: Parameters of database table "tblSoils"

Name	Description	Data Format	Range
SID	Soil ID	Integer	
Name	Name of soil type	Text	
Target_depth	Depth at which substance concentration will be extracted	float	
OptRho	Option to calculate Rho based on OC	Text	Calculate or Input
OptHysteresis	Option to include hysteresis	Text	No
PreHeatWetDryMin	Minimum pressure head to switch drying/wetting (cm)	Float	
ZPndMax	Maximum ponding depth (m)	Float	0 to 1
ThiAirBouLay	Boundary air layer thickness (m)	Float	1E-6 to 1
OptSolEvp	Option to select evaporation reduction method	Float	
FacEvpSol	"Crop factor" for bare soil (-)	Float	0.5 to 1.5
CofRedEvp	Soil evaporation coefficient(Parameter in Boesten equation) (cm^1/2)	Float	0 to 1
PrcMinEvp	Minimum rainfall to reset evaporationreduction (cm/d)	Float	
OptCofDifRel	Parameter values of the functions describing the relative diffusion coefficients	Text	MillingtonQuirk, Troeh or Currie
ExpDifLiqMilNom	Exponent in nominator of equation (-)	Float	0.1 to 5
ExpDifLiqMilDen	Exponent in denominator of equation (-)	Float	0.1 to 2
ExpDifGasMilNom	Exponent in nominator of equation (-)	Float	0.1 to 5
ExpDifGasMilDen	Exponent in denominator of equation (-)	Float	0.1 to 2
CofDifLiqTro	Coefficient in Troeh equation (-)	Float	0 to 1
ExpDifLiqTro	Exponent in Troeh equation (-)	Float	1 to 2
CofDifGasTro	Coefficient in Troeh equation (-)	Float	0 to 1
ExpDifGasTro	Exponent in Troeh equation (-)	Float	1 to 2

CofDifLiqCur	Coefficient in Currie equation (-)	Float	0 to ∞
ExpDifLiqCur	Exponent in Currie equation (-)	Float	1 to ∞
CofDifGasCur	Coefficient in Currie equation (-)	Float	0 to ∞
ExpDifGasCur	Exponent in Currie equation (-)	Float	1 to ∞

Table 17: Parameters of database table "tblSubstance"

Name	Description	Data Format	Range
SUBID	Substance ID	Integer	
Code	Substance Name as occuring in the PEARL input file	Float	
SubstanceName	Substance Name	Text	
MolMas_	Molar Mass (g/mol)	Float	
OptDT50_	Option to select for DT50 input	Text	Input or Calculate
DT50Ref_	Half-life time (d)	Float	1 to 1E6
TemRefTra_	Temperature at which DT50 is measured (°C)	Float	5 to 30
ExpLiqTra_	Exponent for the effect of liquid (-)	Float	0 to 5
OptCntLiqTraRef_	Option to use the moisture content during the incubation study	Text	OptimumConditions or NonOptimumConditions
CntLiqTraRef_	Liq. content at which DT50 is measured (kg/kg)	Float	0 to 1
MolEntTra_	Molar activation energy (kJ/mol)	Float	0 to 200
OptCofFre_	Option to choose between pH - dependent or pH -independent sorption	Text	pH-dependent, pH-independent, CofFre
ConLiqRef_	Reference conc. in liquid phase (mg/L)	Float	0.1 to ∞
ExpFre_	Freundlich sorption exponent (-)	Float	0.1 to 1.3
KomEql_	Coef. eql. sorption on org. matter (L/kg)	Float	0 to 1E9
KomEqlAcid_	Coef. for eql. sorption on om - acid	Float	0 to1E9

	(L/kg)		
KomEqlBase_	Coef. for eql. sorption on om - base (L/kg)	Float	0 to 1E9
pKa_	Coef. for influence of pH on sorption (-)	Float	0 to 14
pHCorrection	pH correction	Float	-2 to 1
KSorEql_	Coef. for equilibrium sorption (-)	Float	0 to 1E9
MolEntSor_	Molar enthalpy of sorption (kJ/mol)	Float	
TemRefSor_	Temperature of reference at which the sorption coefficient was measured (°C)	Float	
PreVapRef_	Saturated vapour pressure (Pa)	Float	0 to 2E5
TemRefVap_	.. measured at (°C)	Float	0 to 40
MolEntVap_	Molar enthalpy of vaporisation (kJ/mol)	Float	-200 to 200
SlbWatRef_	Solubility in water (mg/L)	Float	1E-9 to 1E6
TemRefSlb_	.. measured at (°C)	Float	0 to 40
MolEntSlb_	Molar enthalpy of dissolution (kJ/mol)	Float	-200 to 200
CofDesRat_	Desorption rate coefficient (1/d)	Float	0 to 0.5
FacSorNeqEql_	CofFreNeq/CofFreEql (-)	Float	0 to ∞
FacUpt_	Coefficient for uptake by plant (-)	Float	0 to 10
OptDspCrp_	Option to choose Lumped or Specified	Text	Lumped or Specified
DT50DspCrp_	If lumped: Half-life at crop surface (d)	Float	1 to 1E6
DT50PenCrp_	If specified: Half-life due to penetration (d)	Float	1 to 1E6
DT50VolCrp_	If specified: Half-life due to volatilization (d)	Float	1 to 1E6
DT50TraCrp_	If specified: Half-life due to transformation (d)	Float	1 to 1E6
FacWasCrp_	Wash-off factor (1/m)	Float	1E-6 to 0.1
CofDifWatRef_	Reference diff. coeff. in water (m2/d1)	Float	1E-5 to 3E-4
CofDifAirRef_	Reference diff. coeff. in air (m2/d)	Float	0.1 to 3
TemRefDif_	Diff. coeff measured at temperature (°C)	Float	10 to 30

4 How to …

… add an agronomic unit?

To add a new agronomicunit the following tables have to be updated:

1) tblAgriculturalUnit: Add ID, Name, and Latitude for the new AgronomicUnit
2) tblSoils_in_AU: Add new soil/AU combinations with areas
3) tblAUSoilCropMeteoCombination: Add one entry for each new unique scenario specifying the meteo file *.met
4) tblAU_soil_crop_area_ha: Add one entry for each new unique scenario specifying the area (ha); in standard FROGS only AU-soil-crop-combinations > 1000 ha is considered
5) tblCropRotation: Add crop rotations for the new AU
6) tblCropDates: Add harvest and emergence dates for all crops occurring in the crop rotations within the new AU (main crops and rotational crops)
7) Provide new .met file(s) in /met folder
8) Close database
9) Manually set the entry for variable “OptHyd” from “OffLine” to “Automatic” in the template.prl-file to enable simulation of the bfo hydrology file.
10) Start FROGS

… add a soil type?

To add a new soil type the following tables have to be updated:

1) tblSoils: Add soil ID, Name, and parameters for the new soil type
2) tblHorizons: Add horizon properties of all horizons of the new soil type for each AU
3) tblAU_soil_crop_area_ha: Add one entry for each new unique scenario

4) tblAUSoilCropMeteoCombination: Add one entry for each new unique scenario specifying the meteo file .met (using the same .met file as the other scenarios within the same AU).
5) Close database
6) Manually set the entry for variable “OptHyd” from “OffLine” to “Automatic” in the template.prl-file to enable simulation of the bfo hydrology file.
7) Start FROGS

… add a crop?

To add a crop the following tables have to be updated:

1) tblCrops: Add crop ID, Name, and parameters of the new crop
2) tblCroppar: Add crop parameter for every development stage
3) tblCropRotation: Add crop rotation for each new crop/AU combination
4) tblCropDates: Add emergence and harvest dates of the new crop in all AUs in which it occurred. Additionally check, whether new crop/AU combinations exist for other “old” crops, introduced in one AU by the newly defined rotations. If this is the case enter emergence and harvest dates for these combinations.
5) tblAUSoilCropMeteoCombination: Add one entry for each new unique scenario specifying the meteo file .met (using the same .met file as the other scenarios within the same AU. If the new run fails, try the splitted version of the meteo file xxxxx**_S**.met).
6) tblAU_soil_crop_area_ha: Add one entry for each new unique scenario
7) Close database
8) Manually set the entry for variable “OptHyd” from “OffLine” to “Automatic” in the template.prl-file to enable simulation of the bfo hydrology file.
9) Start FROGS

… use other application types than application to the soil surface?

In FROGS versions 1.1.1.1, 2.2.2.2 and 3.3.3.3. only one application type is implemented, which is the application to the soil surface (AppSolSur).

A typical application table in the PEARL input file *.prl looks as follows (in Section 6 of the *.prl file)

```
table Applications
01-Nov-1981 AppSolSur 0.06
01-Nov-1982 AppSolSur 0.06
end_table
```

with two applications of 0.06 kg/ha on 1st November in the years 1981 and 1982.

In PEARL other application types can be chosen. These are:

AppSolInj = Injection

AppSolTil = Incorporation

AppCrpUsr = Application to the canopy; fraction of substance intercepted user specified

AppCrpLAI = Application to the canopy; fraction of substance intercepted calculated on the basis of the soil coverage fraction

For some of them besides the application mass an additional number has to be provided in a fourth column behind the application mass (AppSolInj = Injection depth (m); AppSolTil = Incorporation depth (m); AppCrpUsr = Fraction intercepted (-)).

For the incorporation of the substance into 10 cm depths the application table has to look as following:

```
table Applications
01-Nov-1981 AppSolTil 0.06 0.1
01-Nov-1982 AppSolTil 0.06 0.1
end_table
```

Hence, only each string “AppSolSur 0.06” has to be substituted by the necessary string for the desired application type in the *.prl file.

No direct solution for this is offered in the current version of FROGS. However a workaround outside of FROGS can be used to implement the other application options. Either small routines doing this can be programmed individually or the following method is used (using the text editor "TextPad")

1) Generate *.prl runs as usual in the FROGS-GUI
2) Open the Windows Explorer and enter the FROGS folder, in which *.prl files were saved.
3) Select all *.prl files and open them with the program "TextPad"
4) Select old string (e.g. "AppSolSur 0.06") and press "F8"
5) A new window pops up: Enter new string (e.g. "AppSolTil 0.06 0.1") in the field "Replace with"
6) In "Scope" select "all documents"
7) Press "Replace all" (now all strings "AppSolSur 0.06" should have been replaced by the new string "AppSolTil 0.06 0.1" in all opened *.prl files)
8) Close and save all *.prl files
9) Start batch and evaluate runs as usual

… distribute runs on multiple computers or processors

The FROG runs are started by double clicking the batch file "run.bat". All runs are started successively. To start multiple runs simultaneously the following procedure can be followed.

As an example the simple case of distributing a FROGS-run (located under e.g. "…\FROGS\barley") for barley (162 single runs) on two computers (or processor) is described here. If more computers or processor are available the files can be splitted analogous to the procedure below.

1) create runs with FROGS as usual
2) copy "run.bat" into the same folder and rename the copy to e.g. "run1.bat"

3) open (by clicking with the right mouse button and selecting “edit”) “run.bat” and delete all lines (for cases without *.pfo files) or blocks (for cases including *.pfo files. One block consisting out of 3 lines; extracting the pfo file with 7za, renaming *.pfo file and starting PEARL run) which end with numbers >81 ; save and close “run.bat” (this batch will start all runs from 1-81.

4) open “run1.bat” and delete all lines which end with numbers <82; save and close “run1.bat” (this batch will start all runs from 82-162)

5)

   a. for multiple computers: copy the whole folder “…\FROGS\barley” from computer 1 to a local drive of computer 2

   b. for multi-processor computers: copy the whole folder “…\FROGS\barley” to e.g. “…\FROGS\barley1”. You can not start the two batches from one location, since they both may try to use the same input files (e.g. *.met) at the same time, which will abort the runs.

6)

   a. for multiple computers: start “run.bat” at computer 1 and “run1.bat” on computer 2.

   b. for multi-processor computers: start “run.bat” in “…\FROGS\barley”and “run1.bat” in “…\FROGS\barley1”.

   c. Wait until all runs are finished.

7) Copy all sum files from computer 2 (or from “…\FROGS\barley1”) into “…\FROGS\barley” on computer 1

8) Go back to FROGS and evaluate as usual

5 References

Habekotté, B. (1999). A model of the phenological development of winter oilseed rape (Brassica napus L.). Field Crops Research 54: 127-136.