ICECREAMDB 1.0.34

Technical description

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Introduction

The eutrophication of the Baltic Sea has received great focus recently, and especially the role of phosphorus. Since diffuse losses of phosphorus from arable land are one of the main sources, and since it is difficult to measure, the need for improved quantification tools has evolved. Since the phosphorus losses are affected by a number of factors, a comprehensive dynamic model would most likely improve the quantification and resolution of phosphorus losses from arable land. With a dynamic model including crop management operations, more elaborated scenarios for reduction of P losses could also be evaluated. Another reason for using a more comprehensive, dynamic model is that it takes a system analysis approach in describing the processes involved in phosphorus losses. To increase our understanding related to the quantitative importance of different factors influencing phosphorus losses, a system analysis approach is almost certainly necessary.

ICECREAMDB

We will here describe the ICECREAMDB-model for quantification of P losses from arable land for large areas. It is built on the dynamic, partly physically based, management oriented phosphorus loss model ICECREAM. With ICECREAMDB, calculations of P-leaching are facilitated compared to the ICECREAM model. ICECREAM is a field scale model for calculation phosphorus losses from agricultural land. The result is daily values of solute phosphorus (PO4) and particle bound phosphorus (PP) concentration in surface runoff and percolation through the soil profile via micropore and macropore flow. ICECREAM is controlled via text files and takes no additional inter active user input. ICECREAMDB is a user friendly graphical front-end for ICECREAM. All the data needed to run ICECREAM is read from Access databases and automatically converted to the text files needed by ICECREAM (Figure 1). ICECREAMDB makes it possible to run several hundred simulations in sequence without the need for user manipulation of text files between each simulation. ICECREAMDB also incorporates routines for generating leaching coefficients for each crop, slope, soil phosphorus level and fertilization type from the daily output values from ICECREAM.

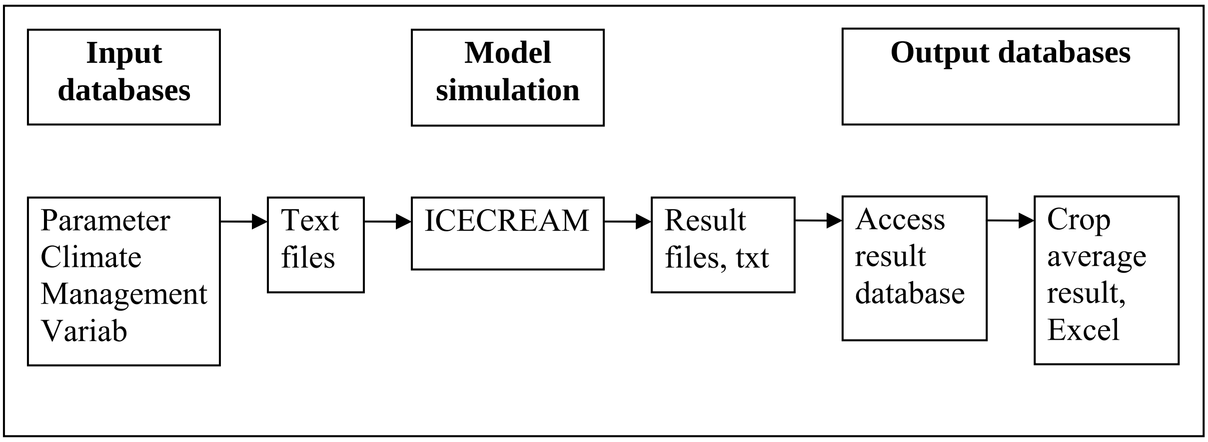


Figure 1. Illustration of the structure of ICECREAMDB.

The simulation model ICECREAM

ICECREAM is a management model for quantification of field-scale runoff, erosion, and losses of P (Rekolainen and Posch, 1993; Tattari et al., 2001) based on the CREAMS model (Knisel, 1980) and partly on GLEAMS (Leonard et al., 1987; Knisel, 1993), and WEPP (Lane and Nearing, 1989). The ICECREAM model runs on a daily time-step with standard meteorological data as input (i.e. daily temperature, precipitation, and solar radiation or cloudiness). The model contains a description of a full water balance including precipitation, evaporation, transpiration, surface runoff, and percolation out of the root zone (Knisel, 1980). A modification of the Soil Conservation Service curve number method is used to partition net rainfall between surface runoff and infiltration (USDA-SCS, 1972; Smith and Williams, 1980). Evapotranspiration is calculated according to the Ritchie (1972) model. Downward water flow between soil layers and percolation from the micropore region q_{mi} (mm d-1) is calculated with a 'storage-routing' concept (i.e. a capacity-type approach), and takes place if the water storage in a layer θ exceeds the field capacity θ_f minus the wilting point θ_w:

$$q_{mi} = \frac{\theta - (\theta_f - \theta_w)z}{\frac{\theta_s z}{\alpha} + 0.5} \tag{1}$$

where z is the thickness of the soil layer, α is an empirical conductivity parameter (mm d^{-1}) and θ_s is the saturated water content. If the water content in a layer exceeds θ_s, the excess water is directly transferred to the layer below or percolates out of the soil profile.

Soil temperature is calculated according to Williams et al. (1990) using mean air temperature, with corrections for snow cover, soil moisture, and biomass. The calculation of freezing and thawing, which influences infiltration at the soil surface, is independent of the selected thickness of the surface soil layer since a fixed 3-cm computational layer is employed. A new description to calculate the duration of periods with soil frost was included in ICECREAM by Persson (2001), where the freezing and thawing is coupled to the soil temperature on a daily basis. This implies that several freezing and thawing events can take place within one winter season if the temperature fluctuates around the freezing point. Threshold temperature values are used to determine a linear decrease of the amount of precipitation that falls in the form of rain T_l or snow T_s, respectively. Snowmelt starts at a threshold temperature T_0 and is calculated by a simple degree-day function governed by a snow melt factor f_0 and the air temperature (Vehviläinen, 1986; Rekolainen and Posch, 1993).

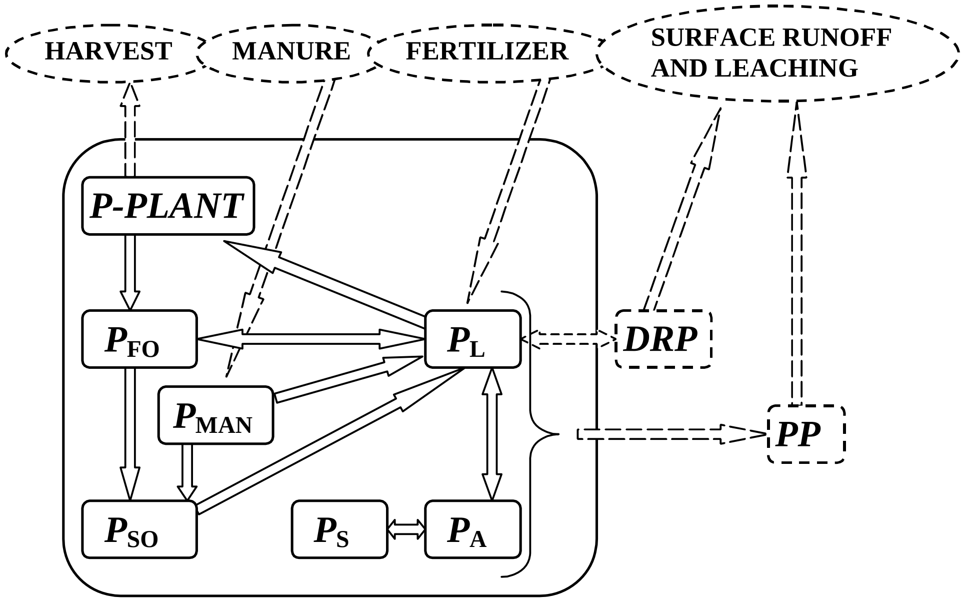


Figure 2. Pools and flows that are calculated by ICECREAM.

In ICECREAM, soil P is divided into six pools (kg m^{-2}), three of which are inorganic, in the form of stable P_S, active P_A and labile P_L phosphorus, and three are organic: a litter pool consisting of fresh organic material such as decomposing roots and straw P_{FO} a humus pool comprising more stable organic matter P_{SO} and a faeces pool containing added manure P_{MAN} (Figure 2). The phosphorus bound to suspended particles, is assumed to originate from all solid P pools.

The distribution of P between adsorbed and solution phases in the labile pool is described by a linear sorption isotherm assuming instantaneous equilibrium:

$$C_{DRP} = \frac{P_L}{z(k_{dw}\,\gamma + \theta)} \tag{2}$$

where C_{DRP} is the concentration of DRP, γ is the dry bulk density, and k_{dw} is the sorption distribution coefficient (L kg^{-1}) given by (Knisel et al., 1993):

$$k_{dw} = 100 + 250\,cc \tag{3}$$

where *cc* is the fraction of clay. During surface runoff and infiltration in the micropores, the distribution between P_L and DRP in the surface soil layer is also controlled by the infiltration rate, soil water content, porosity and soil solids specific gravity according to Knisel et al. (1993).

Four different options are available to calculate sorption distribution coefficients k_{dl} for partitioning between P_L and P_A, and between P_A and P_S, corresponding to different soil types *i.*) calcareous *ii.*) slightly weathered *iii.*) highly weathered (Sharpley and Williams, 1990), and *iv.*) a modified combination of *ii.*) and *iii.*) derived from 18 long-term field experiments on Finnish soils (Siimes et al., 1998). We use the last option, where the sorption distribution coefficient, k_{dl}, is given as a function of pH, percent base saturation, and the clay content.

Flows of P between pools include plant uptake of P_L, decomposition and humification of litter and faeces, immobilization of P_L to P_{FO} and mineralization of humus. Phosphorus in fertilizer is directly added to the labile P pool, P_L. Transport of DRP between layers in the micropore region and leaching from the micropores is calculated by convective mass transfer.

The original ICECREAM model only simulates seepage from the bottom soil layer. To simulate tile drain outflow, we introduced a groundwater reservoir separated into two compartments receiving water and P from the micropores and macropores, respectively. Water flow from the groundwater reservoir to tile drains starts when the storage capacities, defined by threshold values for the two compartments g_{mi} and g_{ma} are exceeded. Additionally, horizontal flows of groundwater are defined by separate rate coefficients for the micropores and macropores, respectively.

To simulate preferential flow and transport through macropores we have applied a simple functional approach. A short-circuit water flow and transport pathway, corresponding to a macropore domain, was linked to the original ICECREAM flow and transport description which now represents only the micropore region. Water, suspended particles and P entering the macropores are channelled directly to a groundwater reservoir without interaction with the water and solutes in the micropore region in accordance with the TAM-MO-DEL model (Steenhuis et al., 1997). Infiltration into macropores is only assumed to take place if the water content in the two upper soil layers exceeds a given soil moisture content expressed as a 'fraction of the field capacity' f_{fc}. Infiltrating water I_n is routed into the macropores when the infiltration capacity of the micropores I_{mi} is exceeded. Water flow through the macropores q_{ma} (mm d^{-1}) is therefore calculated as:

$$q_{ma} = R_f (I_n - I_{mi}) \tag{4}$$

where R_f is the fraction of the excess rainfall routed into macropores, which will depend on the saturated hydraulic conductivity of the micropores. The concentration of DRP in water routed into the macropores is calculated by assuming instantaneous local equilibrium and complete mixing of incoming net rainfall with the water stored in a shallow surface soil layer or mixing depth x_d set to *1* mm (Steenhuis and Walter, 1980):

$$C_{DRP_{ma}} = \frac{\frac{x_d}{z} P_{L_d}}{R + \left(\frac{x_d}{z} \left(\theta_1 + \gamma_1 k_{dw} \right) \right)} \tag{5}$$

where P_{L_d} is the amount of labile P stored in the mixing depth, R is net daily precipitation, and the subscript *1* refers to the top soil layer.

In addition to the existing routine used to calculate detachment of particles for erosion, a separate particle generation and detachment routine based on the model described by Jarvis et al. (1999) was introduced to simulate losses of PP to tile-drains. With this approach, the detachment of particles (g m^{-2} d^{-1}) is estimated as:

$$D = k_d \; EI \; M_s \; CROP \tag{6}$$

where k_d is the soil detachability coefficient (g J^{-1} mm^{-1}), EI is the erosivity factor (J mm m^{-2} d^{-1}) adapted for Finnish rainfall data by Rekolainen and Posch (1993) and M_s is the amount of readily available dispersible particles (g g^{-1}) within the mixing depth, x_d. *CROP* is the empirical crop management factor used in USLE to account for reduction of particle detachment when a crop covers the soil, here used as described by Laflen et al. (1985). The pool of readily available particles M_s dynamically changes between rainfall events due to removal of particles and particle replenishment R_p, such that the particle storage approaches a maximum value M_{max}:

$$R_p = k_r \left(1 - \frac{M_s}{M_{\max}} \right) \tag{7}$$

where k_r is a specific replenishment rate coefficient. The maximum size of the pool of readily available particles M_{max} is given as a function of the clay content (model 1 in Brubaker et al., 1992). The particle replenishment R_p is assumed to result from processes rearranging the soil such as soil tillage, freezing and thawing, wetting and drying, activities of earthworms. After soil tillage, M_s is increased to 50 % of M_{max} if it is not already above this value. The concentration of suspended particles routed into the macropores $C_{SS_{ma}}$ is calculated using the same mixing depth approach as for the extraction of DRP (equation 5):

$$C_{SS_{ma}} = \frac{D}{R + \frac{x_d}{z}\theta_1} \tag{8}$$

Due to 'filtering' (e.g. mechanical entrapment and sedimentation in the macropores) the flux of suspended particles reaching the depth of the tile-drains M_d is reduced compared to the amount entering the macropores:

$$M_d = q_{ma}\, C_{SS_{ma}}\, e^{(-f z_d)} \tag{9}$$

where f is a filter coefficient (m^{-1}) and z_d is the depth to the tile-drains. Since we employ a groundwater reservoir to reflect fluctuations in groundwater level, the SP reaching this reservoir is stored as an inert pool, and the flow of SP to the tile-drains is simply calculated as the product of the concentration in this pool and the water flow to the tile-drains. The particulate transport of phosphorus M_{PP} is calculated by summing a fraction f_{M_d} of each P pool according to Knisel et al. (1993):

$$M_{PP} = f_{M_d} (P_L + P_A + P_S + P_{FO} + P_{SO} + P_{MAN}) \tag{10}$$

where f_{M_d} is calculated as:

$$f_{M_d} = \frac{M_d}{\gamma_1 x_d} \tag{11}$$

Erosion is calculated for a field with a given slope and length, were the transport of particles is given at the field border by a modified USLE equation (Foster *et al.* 1977). The calculation separates sheet erosion and rill erosion. The detachment of particles (D_i) from sheet erosion is calulated as:

$$D_i = a_1\, EI\, (s+a_2)\, K_{soil}\, C\, P\, q_p/q_{surf} \tag{12}$$

a_1 and a_2 is regression constants, EI is the erosivity of presipitation, s (m m^{-1}) is the slope, K_{soil} is a soil specific erosion factor, C is a crop factor, P is a soilmanagement factor, q_p (mm d^{-1}) describes the flow intensity at high flows and q_{surf} (mm d^{-1}) is the runoff.
The detachment of particles (D_i) from till erosion is calulated as:

$$D_r = 5.9\, m\, P_2\, q_p^{4/3}\, P_3\, (x/72.6)^{m-1}\, s^2\, K_{soil}\, C\, P \qquad (13)$$

m is slope length, P_2 and P_3 is regression constants and x (m) is the field length.

The detachment of particles according to the equations 12 and 13 gives a potential particle transport which is used for the calculation of the actual particle transport. The actual particle transport is dependent of the transport capacity (W_s) and is calculated with the Yalin-equation (Foster *et al.* 1980). The erosion factor K_{soil}, the slope s and the field length x, is parameters that is set in the parameter files, while the regression coefficients a_1, a_2, P_2 and P_3 has fixed values. remaining parameters in the equations is calculated internally in the model.

Particle bound phosphorus loss related to erosion (PP) is calculated by a multiplication of sediment transport with a fraction of all P-pools in the soil and P in manure (Tattari m.fl 2001).

Input databases to ICECREAMDB

The input to ICECREAMDB is divided in three databases: parameters, climate and crop management. The parameter database contains all parameters that are constant for the whole country, the climate database contains time series of climate and the cropping database contains the cropping system and auxiliary data that are relevant on a regional scale.

The parameter database

This is a short description of the tables in the parameter database in alphabetical order. Most of the tables are cropped to better fit, to view the whole tables look in the actual database, which comes with the ICECREAMDB program.

The *CN2 & Mn* table (Table 1) contains the SCS Curve number (CN2) and the Manning's n (MN) for the *harvest*, *plant* and *remove* operations. Plant is sowing of the crop and remove is the partial removal of residues after the harvest of the crop. The values in this table is combined with the cropping data from the cropping database to generate the cropping.dat file containing all parameters connected to cultivation and crop management needed by ICECREAM. The soils can be divided into two infiltration classes, with different CN2 and MN values depending on infiltration characteristics.

Table 1. CN2 & Mn for different crops, soils and management

Infiltration class	Action	Crop	CN2	MN
1	Harvest	Barley	70	0.15
1	Harvest	Brfallow	70	0.15
1	Harvest	Grass	46	0.15
1	Harvest	Winter_wheat	70	0.15
1	plant	Barley	63	0.3
1	plant	Brfallow	63	0.3
1	plant	Grass	46	0.05
1	plant	Winter_rape	63	0.15
1	plant	Winter_wheat	63	0.3
1	remove	Barley	68	0.15
1	remove	Brfallow	68	0.15
1	remove	Grass	68	0.15
1	remove	Winter_wheat	68	0.15

The *CN2 & Mn implement* table (Table 2) contains the Curve number CN2 and the Manning's n MN for the *implement* action. The implement action is the use of a plow or harrow or any other user defined soil cultivator. The reason this table is split from the *CN2 & Mn* tables is to make it easy to add new implements and still keep a clear overview of the table. These values is combined with the cropping data from the cropping database to create the cropping.dat file that contains all the data about the management and the crop sequence that is needed by ICECREAM. The soils can be divided into two infiltration classes with different CN2 and MN values depending on their infiltration characteristics.

Table 2. CN2 & Mn for different soil tillage events and crops

Infiltration class	Implement	Crop	CN2	MN
1	harrow	barley	70	0.15
1	harrow	brfallow	63	0.15
1	harrow	grass	46	0.15
1	harrow	winter_wheat	70	0.15
1	plow	barley	63	0.3
1	plow	brfallow	63	0.15
1	plow	grass	46	0.05
1	plow	winter_wheat	63	0.3

The *Crop* table (Table 3) contains the information required to generate the cropdb.dat file for ICECREAM and holds all crop related data needed for calculation of crop growth and uptake of phosphorus, except for *Yield* and *Maximum root depth* that are replaced with data from other tables. Yield is considered a regional parameter and is taken from the table *Yield* in the crop database. The "Maximum root depth" is dependent of the current soil and is taken from the table *Rootdepth* in the parameter database were different values for each soil is stored.

Table 3. Parameters related to different crops

Crop	barley	brfallow	grass	winter_wheat
CropType	1	2	2	1
Yield*	0	0	0	0
Water content	0.15	0.8	0.8	0.15
Base temperature	5	5	5	5
GDD maturity	1050	1500	1500	1200
Growth parameter	2	1	1	2
Residues:Yield	1	0.1	0.2	1
GDD emergence	70	30	30	70
Fraction LAI decline	0.5	0.95	0.95	0.5
Max LAI	5	0.1	6	5
Canopy cover constant	6	10	15	6
Maximum canopy width	0.26	0.2	0.2	0.26
Maximum canopy height	1.1	0.2	0.9	1.1
Canopy height constant	3	20	20	3
Maximum root depth*	0	0	0	0
Root distribution	1	1	1	1
Root:shoot ratio	0.2	1	1	0.2
max root mass for grass	0	0.005	0.5	0
C:N Yield	34	17	17	30
N:P yield	4.09	8	2.5	5.07
C:N Above ground biomass	56	51	56	56
N:P Above ground biomass	5	5.6	5.6	5.7
C:N Below ground biomass	30	71	30	30
N:P Below ground biomass	5	5.6	5.6	5.7
Row width	0.125	0.1	0.05	0.125

*Are replaced with data taken from other tables.

The *ICECREAM Parameters* table (Table 4) contains a version number of the parameter database. This value is checked when the tables are read to memory and ensures that the table is a parameter database of the correct version as the format of the database could change between versions of ICECREAMDB. This arrangement is used for all databases read by ICECREAMDB.

Table 4. ICECREAM Parameters table

Version
1.0.2

The *MacroP* table (Table 5) contains parameters for the new macropore function in ICECREAM and is the basis for generation of the file macrop.par. Here follows explanations for the parameter names used in table 5:

Soilname is the name of the soil, in accordance with other tables where soils are used
tresh_watin (m) is the threshold value for rain, above which macropore flow is initiated
frac is the fraction of the rain above the threshold that is routed to the macropores.
fcfrac is the fraction of the field capacity in the uppermost layer that must be reached before macropore flows can occur
Drain depth (m) is the depth to the drainage system
Filter is a filter coefficient that affects calculation of particle retention in the macropores
KDPart is currently not in use
W_tresh_mic is a threshold value for the outflow from the invented groundwater pool in the micropore region

W_tresh_mac is a threshold value for outflow from the invented groundwater pool in the macropore region

K1 is a specific flow coefficient for flow of water from the micropore region of the invented groundwater pool to drainage

K2 is a specific flow coefficient for flow of water from the micropore region of the invented groundwater pool that by-pass the drainage

K1 is a flow coefficient for flow of water from the macropore region of the invented groundwater pool to drainage

K2 is a flow coefficient for flow of water from the macropore region of the invented groundwater pool that by-pass the drainage

Ini_mic_P (g/m^2) is the initial value of P in the micropore pool

Ini_mac_P (g/m^2) is the initial value of P in the macropore pool

Replenishment (g/m^2*h) is a specific soil particle replenishment coefficient governing generation of particles for macropore flow

Detachability (g/J*mm) is a specific soil detachability coefficient governing detachment of available particles for macropore flow

Particle extraction depth is the thickness of the layer from which particles are generated

Solute P extraction depth is the thickness of layer solute P, that enters macropores, is extracted from

Table 5. Macropore flow parameters for generation of the MacroP file

Soilname	S1F-Sand	S2F-LoamySand	S3F-SandyLoam	S4F-Loam
tresh_watin	0.036	0.0235	0.0188	0.0098
Frac	0.001	0.001	0.1	0.8
Fcfrac	0.9	0.91	0.91	0.91
Drain depth	0.9	0.9	0.9	0.9
Filter	0.0001	0.0001	0.0001	0.0001
KDpart	10	10	10	10
W_tresh_mic	0	0	0	0
W_tresh_mac	0.01	0.01	0.01	0.01
K1	1	1	1	1
K2	0	0	0	0
K3	1	1	1	1
K4	0	0	0	0
Ini_mic_P	0.001	0.001	0.001	0.001
Ini_mac_P	0.001	0.001	0.001	0.001
Replenishment	0.1	0.1	0.1	0.1
Detachability	0.2	0.2	0.2	0.2
Particle extraction depth	1	1	1	1
Soulte P extraction depth	1	1	1	1

The *Other* table (Table 6) contains nitrogen deposition and parameters governing volatilization and denitrification of nitrogen, and are used to create parts of the file icecream.par. Nitrogen is also a component of ICECREAM, but not simulated on purpose here. However, the parameters for N flows are still used, but should not be altered.

Table 6. Other table

parwi	parcec	parwat1	parwat2	Ndep NO3-N wet	Ndep NO3-N dry	Ndep NH4-N wet	Ndep NH4-N dry
0.05	0.038	1	0	0	0	0	0

The *Rootdepth* table (Table 7) contains the maximum root depth for all crops and soils. These values are used in generating the cropdb.dat file together with the values in the crop table. This is a separate table because crops have different root development on different soils.

Table 7. Rootdepth table

Crop	Soil name	Maximum root depth
barley	S10F-Clay	1000
brfallow	S10F-Clay	800
grass	S10F-Clay	1400
winter_wheat	S10F-Clay	1200
barley	S1F-Sand	500
brfallow	S1F-Sand	500
grass	S1F-Sand	900
winter_wheat	S1F-Sand	700

The *soil* table (Table 8) contains the non-layered information for generating the file soildb.dat containing all soil related information used by ICECREAM. The layered parameters values are located in the table named *soil_layer*.

The P-sorption equation can have values from 1 to 4, where 1 is calcareous soil, 2 is a slightly weathered soil, 3 is a highly weathered soil and 4 is derived from Finnish soils

Table 8. Parameters for generation of part of the Soildb file

Soilname	S1F-Sand	S2F-LoamySand	S6F-SandyClayLoam	S7F-ClayLoam	S8F-SiltyClayLoam
Infiltration class	1	1	2	2	2
P-sorption equation	4	4	4	4	4
ksoil	0.097	0.133	0.329	0.297	0.316
Max water input	10	10	10	10	10
soil loss calibration parameters 1	0.991	0.991	0.991	0.991	0.991
soil loss calibration parameters 2	0.8	0.8	0.8	0.8	0.8
soil loss calibration parameters 3	0.8	0.8	0.8	0.8	0.8
soil loss calibration parameters 4	15	15	15	15	15
soil loss calibration parameters 5	430	430	430	430	430

The *Soil_layer* table (Table 9) contains all soil parameters that are given for different soil layers. 4 layers are supported in ICECREAMDB. The thickness of soil layers is given in mm. *Sspg* (t/m^3) is the specific density of the soil. *Clay* is the proportion of clay, *sand* is the proportion of sand and *organic matter* is the proportion of organic matter in the soil. *Saturated conductivity* (mm/h) is the micropore hydraulic conductivity. Field capacity, soil porosity and wilting point are all in m^3/m^3. CaCO3 is the amount of calcium carbonate in the soil (µg/g), and base saturation is the level of cations in the soil in percentage of maximum possible. The initial values of nitrogen and phosphorus for the specific pools are given (g/kg). *FOP* is the fresh organic phosphorus such as harvest residues and roots, *Plab* is the amount of relatively easily availably phosphorus and *SorgP* represents stable organic phosphorus. The SoilP pool is split in ICECREAM to two pools of stable and very stable inorganic phosphorus minerals.

Table 9. Parameters for generation of the part of the Soildb file where different soil layers are separated

Layer_no	1	2	3	4
Soilname	S1F-Sand	S1F-Sand	S1F-Sand	S1F-Sand
Thickness	10	290	350	350
Sspg	2.6	2.6	2.75	2.75
Clay	0.02	0.02	0.02	0.02
Sand	0.91	0.91	0.91	0.91
Organic matter	0.043	0.043	0.01	0.01
Saturated conductivity	153.908	153.908	153.908	153.908
Field capacity	0.091	0.091	0.091	0.091
Soil porosity	0.437	0.437	0.437	0.437
Wilting point	0.033	0.033	0.033	0.033
pH	6.5	6.5	6.5	6.5
CaCO3	4000	4000	4000	4000
Base saturation	97	97	97	97
NO3-N	0.000333	0.009667	0.01125	0.00875
Org-N	0.000267	0.007733	0.008125	0.000875
FOP	0.00032	0.00034	0.00012	0.0001
Plab	0.0688	0.0688	0.0038	0.0038
SorgP	0.4286	0.4286	0.0116	0.0116
SoilP	1.5	1.5	0.08	0.08

In order to assign leaching coefficients to crops that are not simulated, due to their small area in a region, averages calculated from the simulated crops are used. In the summary table (Table 10) any number of crop averages can be defined. Each average is given a unique name in the summary column and up to 15 crops can be given. These averages are used by the Compleeter program when generating complete and formatted databases of the leaching coefficients.

Table 10. The summary table

Summary	All	Spr	Fall	X	Fallow
crop1	oats	oats	w_rye	oats	fallow_gr
crop2	potato	s_barley	w_wheat	potato	fallow_st
crop3	s_barley	s_wheat		s_barley	
crop4	s_rape			s_rape	
crop5	s_wheat			s_wheat	
crop6	su_beet			su_beet	
crop7	w_rape			w_rape	
crop8	w_rye			w_rye	
crop9	w_wheat			w_wheat	
crop10	fallow_st				
crop11	fallow_gr				
crop12	ley				
crop13					
crop14					
crop15					

The *tilldb* table (Table 11) contains information about soil cultivation practices necessary to generate the tilldb.dat file used by ICECREAM. *Depth* is the depth in mm affected by the use of the chosen soil tillage device. *Incorpefficeny* is the proportion of the crop residues that will be mixed into the soil and *Mixingefficency* describes the mixing efficiency between different soil layers. The *CN2 & Mn implement* table needs to be updated if new implements are added to this table and used in the cropping system.

Table 11. Tilldb table

Implement	Depth	Incorpefficency	Mixingefficency
Harrow	120	0.6	0.7
Plow	219.9	0.95	0.05
Prepmachine	120	0.6	0.7
Stubble	90	0.4	0.4

The *Variabn2* table (Table 12) contains all output variables that can be saved from an ICECREAM simulation. A maximum 100 variables can be saved each simulation. The variables to save are given in the *variab* database. The Variabn2 table should not be changed unless new output variables are added to ICECREAM.

Table 12. Variabn2 table

ID	Variable name	Unit
1	temp	oC
2	precipitation	mm
3	solrad	MJ/m2/d
4	Snow	mm
5	dayrun	mm
6	watin	mm
7	soilw	mm
8	sw_1	mm
9	sw_2	mm
10	sw_3	mm
11	sw_4	mm
12	sw_5	mm
13	sw_6	mm
14	sw_7	mm
15	perc_klayer	mm
16	ep0	mm
17	eplant	mm
18	es0	mm
19	esoil	mm
20	albedo	
21	rlai	LAI
22	Bybmpot_is0	kg/m2
23	Bybm_is0	kg/m2
24	Babm_is0	kg/m2
25	Bbbm_is0	kg/m2
26	sato_is0	kg/m2
27	resato_is0	kg/m2
28	cfact_is0	
29	rmann_is0	
30	cn2_is0	
31	soloss	kg/ha
32	enrich	
33	soil_fresh_org	kg/m2
34	humus_org	kg/m2
35	rolp	kg/ha
36	sedp	kg/ha
37	percP_klayer	kg/ha
38	upP	kg/ha
39	P_in_harv_biom	kg/ha
40	Plab_1	kg/m2
41	Plab_2	kg/m2
42	Plab_3	kg/m2
43	Plab_4	kg/m2
44	Plab_5	kg/m2
45	Plab_6	kg/m2
46	Plab_7	kg/m2
47	pminp_1	kg/m2
48	pminp_2	kg/m2
49	pminp_3	kg/m2
50	pminp_4	kg/m2
51	pminp_5	kg/m2
52	pminp_6	kg/m2
53	pminp_7	kg/m2
54	soilp_1	kg/m2
55	soilp_2	kg/m2
56	soilp_3	kg/m2
57	soilp_4	kg/m2
58	soilp_5	kg/m2
59	soilp_6	kg/m2
60	soilp_7	kg/m2
61	fop_1	kg/m2
62	fop_2	kg/m2
63	fop_3	kg/m2
64	fop_4	kg/m2
65	fop_5	kg/m2
66	fop_6	kg/m2
67	fop_7	kg/m2

68	sorgp_1	kg/m2
69	sorgp_2	kg/m2
70	sorgp_3	kg/m2
71	sorgp_4	kg/m2
72	sorgp_5	kg/m2
73	sorgp_6	kg/m2
74	sorgp_7	kg/m2
75	totp_1	kg/m2
76	totp_2	kg/m2
77	totp_3	kg/m2
78	totp_4	kg/m2
79	totp_5	kg/m2
80	totp_6	kg/m2
81	totp_7	kg/m2
82	orgpw_1	kg/m2
83	orgpw_2	kg/m2
84	orgpw_3	kg/m2
85	orgpw_4	kg/m2
86	orgpw_5	kg/m2
87	orgpw_6	kg/m2
88	orgpw_7	kg/m2
89	cplabw_1	g/l
90	cplabw_2	g/l
91	cplabw_3	g/l
92	cplabw_4	g/l
93	cplabw_5	g/l
94	cplabw_6	g/l
95	cplabw_7	g/l
96	totpfrac_1	g/kg
97	totpfrac_2	g/kg
98	totpfrac_3	g/kg
99	totpfrac_4	g/kg
100	totpfrac_5	g/kg
101	totpfrac_6	g/kg
102	totpfrac_7	g/kg
103	plab_1-7	kg/ha
104	pminp_1-7	kg/ha
105	soilp_1-7	kg/ha
106	fop_1-7	kg/ha
107	sorgp_1-7	kg/ha
108	totp_1-7	kg/ha
109	orgpw_1-7	kg/ha
110	rmp_1	kg/m2
111	rmp_2	kg/m2
112	rmp_3	kg/m2
113	rmp_4	kg/m2
114	rmp_5	kg/m2
115	rmp_6	kg/m2
116	rmp_7	kg/m2

117	pmn_1	kg/m2
118	pmn_2	kg/m2
119	pmn_3	kg/m2
120	pmn_4	kg/m2
121	pmn_5	kg/m2
122	pmn_6	kg/m2
123	pmn_7	kg/m2
124	flow_1	kg/m2
125	flow_2	kg/m2
126	flow_3	kg/m2
127	flow_4	kg/m2
128	flow_5	kg/m2
129	flow_6	kg/m2
130	flow_7	kg/m2
131	aspr_1	kg/m2
132	aspr_2	kg/m2
133	aspr_3	kg/m2
134	aspr_4	kg/m2
135	aspr_5	kg/m2
136	aspr_6	kg/m2
137	aspr_7	kg/m2
138	wimp_1	kg/m2
139	wimp_2	kg/m2
140	wimp_3	kg/m2
141	wimp_4	kg/m2
142	wimp_5	kg/m2
143	wimp_6	kg/m2
144	wimp_7	kg/m2
145	rmp_1-7	kg/ha
146	pmn_1-7	kg/ha
147	flow_1-7	kg/ha
148	aspr_1-7	kg/ha
149	wimp_1-7	kg/ha
150	rolNO	kg/ha
151	rolNH	kg/ha
152	sedN	kg/ha
153	percNO_klayer	kg/ha
154	percNH_klayer	kg/ha
155	upN	kg/ha
156	volNH4	kg/ha
157	dN2	kg/ha
158	sNH4_1	kg/m2
159	sNH4_2	kg/m2
160	sNH4_3	kg/m2
161	sNH4_4	kg/m2
162	sNH4_5	kg/m2
163	sNH4_6	kg/m2
164	sNH4_7	kg/m2
165	sNO3_1	kg/m2

166	sNO3_2	kg/m2
167	sNO3_3	kg/m2
168	sNO3_4	kg/m2
169	sNO3_5	kg/m2
170	sNO3_6	kg/m2
171	sNO3_7	kg/m2
172	fon_1	kg/m2
173	fon_2	kg/m2
174	fon_3	kg/m2
175	fon_4	kg/m2
176	fon_5	kg/m2
177	fon_6	kg/m2
178	fon_7	kg/m2
179	potmn_1	kg/m2
180	potmn_2	kg/m2
181	potmn_3	kg/m2
182	potmn_4	kg/m2
183	potmn_5	kg/m2
184	potmn_6	kg/m2
185	potmn_7	kg/m2
186	soiln_1	kg/m2
187	soiln_2	kg/m2
188	soiln_3	kg/m2
189	soiln_4	kg/m2
190	soiln_5	kg/m2
191	soiln_6	kg/m2
192	soiln_7	kg/m2
193	totn_1	kg/m2
194	totn_2	kg/m2
195	totn_3	kg/m2
196	totn_4	kg/m2
197	totn_5	kg/m2
198	totn_6	kg/m2
199	totn_7	kg/m2
200	orgnw_1	kg/m2
201	orgnw_2	kg/m2
202	orgnw_3	kg/m2
203	orgnw_4	kg/m2
204	orgnw_5	kg/m2
205	orgnw_6	kg/m2
206	orgnw_7	kg/m2
207	totnfrac_1	g/kg
208	totnfrac_2	g/kg
209	totnfrac_3	g/kg
210	totnfrac_4	g/kg
211	totnfrac_5	g/kg
212	totnfrac_6	g/kg
213	totnfrac_7	g/kg
214	sNH4_1-7	kg/ha
215	sNO3_1-7	kg/ha
216	fon_1-7	kg/ha
217	potmn_1-7	kg/ha
218	soiln_1-7	kg/ha
219	totn_1-7	kg/ha
220	orgnw_1-7	kg/ha
221	rmn_1	kg/m2
222	rmn_2	kg/m2
223	rmn_3	kg/m2
224	rmn_4	kg/m2
225	rmn_5	kg/m2
226	rmn_6	kg/m2
227	rmn_7	kg/m2
228	nmn_1	kg/m2
229	nmn_2	kg/m2
230	nmn_3	kg/m2
231	nmn_4	kg/m2
232	nmn_5	kg/m2
233	nmn_6	kg/m2
234	nmn_7	kg/m2
235	ron_1	kg/m2
236	ron_2	kg/m2
237	ron_3	kg/m2
238	ron_4	kg/m2
239	ron_5	kg/m2
240	ron_6	kg/m2
241	ron_7	kg/m2
242	rnit_1	kg/m2
243	rnit_2	kg/m2
244	rnit_3	kg/m2
245	rnit_4	kg/m2
246	rnit_5	kg/m2
247	rnit_6	kg/m2
248	rnit_7	kg/m2
249	wimn_1	kg/m2
250	wimn_2	kg/m2
251	wimn_3	kg/m2
252	wimn_4	kg/m2
253	wimn_5	kg/m2
254	wimn_6	kg/m2
255	wimn_7	kg/m2
256	rmn_1-7	kg/ha
257	nmn_1-7	kg/ha
258	ron_1-7	kg/ha
259	rnit_1-7	kg/ha
260	wimn_1-7	kg/ha
261	cum_dayrun	mm
262	cum_perc	mm
263	cum_eplant	mm

264	cum_esoil	mm
265	cum_soloss	kg/ha
266	cum_rolP	kg/ha
267	cum_sedP	kg/ha
268	cum_percP	kg/ha
269	cum_upP	kg/ha
270	cum_rolNO	kg/ha
271	cum_rolNH	kg/ha
272	cum_sedN	kg/ha
273	cum_percNO	kg/ha
274	cum_percNH	kg/ha
275	cum_upN	kg/ha
276	cum_volNH4	kg/ha
277	cum_dN2	kg/ha
278	tsc_1	oC
279	tsc_2	oC
280	tsc_3	oC
281	tsc_4	oC
282	Perc_1	mm
283	Perc_2	mm
284	Perc_3	mm
285	Perc_4	mm
286	Cum_biomass_P	kg/m2
287	transp_1	mm
288	transp_2	mm
289	transp_3	mm
290	transp_4	mm
291	c_part_mix	g/m3
292	c_part	g/m3
293	demP	kg/ha
294	N_harvesd_biom	kg/ha
295	Pleach	kg/ha
296	DrainPP	kg/ha
297	Totleach	kg/ha
298	P_drain_mac	kg/ha
299	P_drain_mic	kg/ha
300	P_lateral_mic	kg/ha
301	P_lateral_mac	kg/ha
302	drainmic	mm/d
303	drainmac	mm/d
304	lateral_mic	mm/d
305	lateral_mac	mm/d
306	micP	g/m3
307	macP	g/m3
308	PartPconc	g/m3
309	Pconc_drain	g/m3
310	PPconc_drain	g/m3
311	Drainpart	kg/ha
312	drainpartconc	g/m3

313	partflow	kg/ha
314	PartPpool	g/m2
315	Pstore_mac	g/m2
316	Pstore_mic	g/m2
317	c_part_p	kg/ha
318	Detachment	g/m2/h
319	Read_desp_part	g/g_soil
320	EI	J*mm/m2*h
321	Qmac	mm
322	w_mic	m
323	w_mac	m
324	Tot_drainWater	mm
325	H20*08+ytH20	mm
326	SP*08+ytSP	kg/ha
327	cmix	mg/l
328	PercP_1	kg/m2
329	PercP_2	kg/m2
330	PercP_3	kg/m2
331	PercP_4	kg/m2
332	pmnawsorgP_1	kg/m2
333	pmnawsorgP_2	kg/m2
334	pmnawsorgP_3	kg/m2
335	pmnawsorgP_4	kg/m2
336	pmnawPlab_1	kg/m2
337	pmnawPlab_2	kg/m2
338	pmnawPlab_3	kg/m2
339	pmnawPlab_4	kg/m2
340	UptP_1	kg/m2
341	UptP_2	kg/m2
342	UptP_3	kg/m2
343	UptP_4	kg/m2
344	PO4SurfaceP	mg/l
345	PartSurfaceP	mg/l
346	TotSoluteP	mg/l
347	TotPartP	mg/l
348	TotSoluteP	kg/ha
349	TotPartP	kg/ha
350	Allwater	l/ha
351	TotSolutePRed	kg/ha
352	TotPartPRed	kg/ha
353	TotWaterRed	l/ha
354	cPLabwRunoff	g/l
355	qs_mac	g/m2
356	fo	kg/ha
357	fn	kg/ha
358	fa	kg/ha
359	fp	kg/ha
360	fdep	mm
361	indf	f/m

362	TotSolutePRed	mg/l
363	TotPartPRed	mg/l
364	Surfpartpool	lbs/ft?
365	partpool	g/m3
366	All_water	mm
367	TotP_Red	mg/l
368	TotP_red_YearKonc	mg/l
369	SRP_red_YearKonc	mg/l
370	PP_red_YearKonc	mg/l

The years to skip table (Table 13) contains the number of years, from the start of the simulation period, which is not included in the result. The reason for skipping the first year(s) is that it takes time before the model has reached a stable condition, where artifacts due to the initial conditions have disappeared.

Table 13. YearsToSkip.

YearsToSkip
2

The climate database

The *climate* database contains a metadata table that holds information about different climates in the database. Different climate data are placed in separate tables, with descriptive names. The climate database can also contain the table coupling that has the same purpose as the Metadata table but is used by the SOILNDB model.

The *climate* table (Table 14) contains daily values for *temperature*, *Humidity* (not used by Icecream), *wind speed* (optional), *precipitation* and *cloudiness* or *solar radiation*. The date format is “YYYY-MM-DD” or “ YYYYMMDD”, notice the preceding space. The latter format is used by SOILNDB 1 & 2, ICECREAMDB can read this format as this will facilitate the use of the same climate databases with both SOILNDB and ICECREAMDB. Cloudiness could be given as values in the range 0-8 or 0-1. It is also possible to use solar radiation in MJ/m2. This is defined in the table Metadata.

Table 14. Climate data

datum	Temperature	Humidity	Windspeed	Precipitation	Cloudiness
19700101	-6.7	86.5	6.5	3.1	1
19700102	-4	88.5	8	1	0.6875
19700103	-7.7	87.4	6.1	0.1	0.485
19700104	-9.4	89.1	4.1	0.3	0.53125
19700105	-17.1	83.8	0.6	0.2	0.46875
19700106	-12.7	89.3	2.4	0.2	0.735
19700107	-14.7	91.9	1.5	0	0.46875
19700108	-8.9	90.4	0.8	0	0.61
19700109	-9.5	92.9	2.3	0.1	0.90625
19700110	-3.8	90.3	5.5	0	0.70375
19700111	-3.6	91.4	2.4	0.5	0.86
19700112	-0.9	94.1	2.8	0.4	1
19700113	-1.3	95.4	5.4	6.4	1
19700114	-4.2	92.4	4.9	2.7	1
19700115	-12	87.4	5.9	0.5	0.485
19700116	-13.2	90.9	6.1	0	0.1875
19700117	-7.7	92.6	5.5	0.6	0.96875

The Metadata table (Table 15) contains information about the climate series defined in their separate tables. The *Climate name* field must contain exactly the same name as given to the climate table. The *start* and *end date* is the start and end dates for the climate series. *Vegetation start* and *end* are the dates crops starts to grow in the spring and stops to grow in the autumn. This information is not used by ICECREAMDB but by the Crop Sequence and Management Generator program.

Latitude, *Longitude* and *Altitude* is used to calculate solar radiation from cloudiness. *Rain and snow correction factors* are used to correct rain and snow measurements for systematic errors and to adjust the simulated discharge to match measured values.

Cloudiness / Solar radiation is a trinary switch where 0 stands for solar radiation data, 1 is cloudiness between 0 and 8 and 2 is cloudiness between 0 and 1. *CN2Switch* is a binary switch where 1 uses higher values of CN2 under frozen soil conditions while 0 do not. Setting this switch to 1 leads to higher surface runoff during winter. *Temp snow* is a temperature threshold and below this, precipitation takes place as snow only and *temp rain* is the temperature threshold for rain. *Temp snow melt* is the temperature where snow starts to melt. *Melting factor* (mm/°C/day) is a day degree constant governing the snow melt rate. *Retention factor*, is the capacity of the snow to absorb the melt water. *Albedo snow* is the albedo for snow, *albedo soil* is the albedo for uncovered soil and *albedo vegetation* is the albedo for vegetation. *EI 1-12* and *BEI 1-12* are the monthly EI and BEI values for the modified RUSLE equation that calculates surface erosion.

Table 15. Metadata.table including climate related parameters and information

Climate name	08 - Östsvenska dalbygden	09 - Västsvenska dalbygden	10 - Södra bergslagen
Start date	01-Jan-70	01-Jan-70	01-Jan-70
End date	31-Mar-06	31-Mar-06	31-Mar-06
Vegetation start	apr-10	apr-03	apr-14
Vegetation end	nov-06	nov-10	okt-27
Latitude	57.8	57.8	58.8
Longitude	16.6	11.9	15.1
Altitude	35	20	215
Cloudiness / Solar radiation	2	2	2
CN2Switch	0	0	0
Rain correction factor	1.031	1.279	1.021
Snow correction factor	1.098	1.363	1.088
Temp snow	0.612	0.612	0.612
Temp rain	2.61	2.61	2.61
Temp snow melt	-1	-1	-1
Melting factor	2	2	2
Retention factor	0.2	0.2	0.2
Albedo snow	0.73	0.73	0.73
Albedo soil	0.17	0.17	0.17
Albedo vegetation	0.23	0.23	0.23
EI 1	1.61	1.61	1.61
EI 2	1.61	1.61	1.61
EI 3	1.61	1.61	1.61
EI 4	1.61	1.61	1.61
EI 5	1.85	1.85	1.85
EI 6	1.86	1.86	1.86
EI 7	1.78	1.78	1.78
EI 8	1.86	1.86	1.86
EI 9	1.67	1.67	1.67
EI 10	1.71	1.71	1.71
EI 11	1.7	1.7	1.7
EI 12	1.7	1.7	1.7
BEI 1	0.83	0.83	0.83
BEI 2	0.83	0.83	0.83
BEI 3	0.83	0.83	0.83
BEI 4	0.83	0.83	0.83
BEI 5	2.62	2.62	2.62
BEI 6	3.36	3.36	3.36
BEI 7	3.93	3.93	3.93
BEI 8	4.06	4.06	4.06
BEI 9	2.02	2.02	2.02
BEI 10	1.55	1.55	1.55
BEI 11	1.08	1.08	1.08
BEI 12	1.08	1.08	1.08

The *ICECREAM Climate* table (Table 16) contains a version number of the climate database. This value is checked by ICECREAMDB when the table is loaded. This ensures that the table is a climate database of the correct version as the format of the database could change between versions of ICECREAMDB.

Table 16. ICECREAM version number for the climate database

Version
1.0.1

The coupling table is only used by SOILNDB, if this table is present it is possible to use of the same climate database for both models.

The variab database

The *variab* database defines what output variables that will be produced by ICECREAM. It is possible to store several different sets of selected output variables in one database, where the different sets are saved in different tables.

The *ICECREAM Variab* table (Table 17) is a table that contains a version number of the variab database. This value is checked by ICECREAMDB when the table is loaded. This ensures that the table is a variab database of the correct version as the format of the database could change between versions of ICECREAMDB.

Table 17. ICECREAM version number for the variab database

Version
1.0.1

The *Metadata* table (Table 18) contains a list of the names of all the tables containing selected output variables. This table is used in the ICECREAMDB interface to present the user with a selectable list of all predefined variable sets.

Table 18. Metadata

Name
Phosphorus
Water
P-pools

The *selected output variables* tables (Table 19) must have the names defined in the Metadata table. They contain a list of selected output variables and the summary period (year or agro-hydrological year, July 1 to June 30) and an option to choose if an average for the period or a yearly sum should be calculated. The *Order* field governs the sequence of the result variables from ICECREAM. The maximum number of variables per table is 100.

Table 19. Selected output variables

Order	Variable nr	SummaryType
1	1	Year sum
2	2	Aghyd sum
3	3	Year avg
4	4	Year sum
5	5	Aghyd avg
6	6	Year sum
7	7	Year sum

The cropping system database

The *cropping system* database contains the necessary crop management data, slopes, soil phosphorus content and the names of the soil used in the simulation. Each crop system can be simulated for 3 different slope classes and 3 different soil phosphorus (soilP) classes, and as many soils that are defined in the parameter database.

The *cropping system* table contains the dates for planting (sowing), harvest, soil cultivation, manure and fertilizer application and for removal of residues (Table 20). The add command includes several parameters that are stored in the columns:
Organic matter (kg/ha) is the organic matter in fertilizer/manure
NO3-N (kg/ha) is the amount of NO3-N in fertilizer/manure
NH4-N (kg/ha) is the amount of NH4-N fertilizer/manure
P (kg/ha) is the amount of P in fertilizer/manure
Depth (mm) is the depth of fertilizer application
Fertiliser manure is a switch that decides if the applied nutrients are in the form of mineral fertilizer, FERT or manure, MANURE.

Several datasets can be saved in the same table. The first column, Dataset ID, is used to extract the different datasets from the table during the simulation. The datasets must be numbered in sequence with no gaps.

Table 20. Cropping

Dataset ID	Date	Action	Remove residues	Organic matter	NO$_3$-N	NH$_4$-N	P	Depth	Type of P applied
1	1970-09-16	plant rye;	0	0	0	0	0	0	
1	1971-08-18	harvest rye;	0	0	0	0	0	0	
1	1971-08-19	remove;	0.16	0	0	0	0	0	
1	1971-09-08	add;	0	0	99	49	20	7	MANURE
1	1971-09-09	use plow;	0	0	0	0	0	0	
1	1971-09-16	plant winter_wheat;	0	0	0	0	0	0	
1	1971-10-09	add;	0	0	99	49	14	7	FERT
1	1972-09-04	harvest winter_wheat;	0	0	0	0	0	0	
1	1972-09-05	remove;	0.63	0	0	0	0	0	
1	1972-09-08	add;	0	0	99	49	14	7	FERT
1	1972-09-09	use plow;	0	0	0	0	0	0	
1	1972-09-16	plant winter_wheat;	0	0	0	0	0	0	
1	1973-09-04	harvest winter_wheat;	0	0	0	0	0	0	
1	1973-09-05	remove;	0.63	0	0	0	0	0	
1	1973-09-08	add;	0	0	99	49	14	7	FERT
1	1973-09-09	use plow;	0	0	0	0	0	0	
1	1973-09-16	plant winter_wheat;	0	0	0	0	0	0	
1	1974-09-04	harvest winter_wheat;	0	0	0	0	0	0	
1	1974-09-05	remove;	0.63	0	0	0	0	0	
1	1974-10-10	use plow;	0	0	0	0	0	0	
2	1970-10-01	plant grfallow;	0	0	0	0	0	0	
2	1971-08-15	harvest grfallow;	0	0	0	0	0	0	
2	1971-09-08	add;	0	0	99	49	14	7	FERT
2	1971-09-09	use plow;	0	0	0	0	0	0	
2	1971-09-16	plant winter_wheat;	0	0	0	0	0	0	
2	1972-09-04	harvest winter_wheat;	0	0	0	0	0	0	
2	1972-09-05	remove;	0.63	0	0	0	0	0	
2	1972-09-09	use plow;	0	0	0	0	0	0	
2	1972-10-01	plant grfallow;	0	0	0	0	0	0	
2	1973-08-15	harvest grfallow;	0	0	0	0	0	0	
2	1973-09-09	use plow;	0	0	0	0	0	0	
2	1973-10-01	plant grfallow;	0	0	0	0	0	0	
2	1974-08-15	harvest grfallow;	0	0	0	0	0	0	
2	1974-09-08	add;	0	0	99	49	14	7	FERT
2	1974-09-09	use plow;	0	0	0	0	0	0	
2	1974-09-16	plant winter_wheat;	0	0	0	0	0	0	
3	1971-04-09	add;	0	0	99	49	14	7	FERT

The *ICECREAM cropping* system table (Table 21) is a table that contains a version number of the cropping system database. This value is checked by ICECREAMDB when the table is loaded. This ensures that the table is a cropping system database of the correct version as the format of the database could change between versions of ICECREAMDB.

Table 21. ICECREAM version number for the cropping system database

Version
1.0.4

The *Ferttype* table (Table 22) contains information about the type of fertilization or manure that is applied each year. This is used by ICECREAMDB when calculation crop averages separated by fertilization type. *Dataset* is the same dataset number used in the cropping table and *nr* is just an ordinal so each crop gets the correct fertilization type. *FertType* is the type of fertilization, *FERT* is chemical fertilization and *MANURE* is manure.

Table 22. The ferttype table.

Dataset ID	nr	FertType
1	0	FERT
1	1	FERT
1	2	MANURE
1	3	FERT
1	4	FERT
1	5	FERT
1	6	MANURE
1	7	FERT

The *Metadata* table contains the *Dataset ID* to crosslink it to the cropping system table. The *dataset name* is a name that will occur in the result database. *Soil* is the default soil for the dataset, *width* is the field width (m) and *StripNr* is the strip for which P calculations will be carrried out. ICECREAMDB currently supports only one strip, while ICECREAM supports several strips. *Climate* is the table in the climate database that will be used during the simulation. *Slope* is the default slope value and *SoilP* is the default SoilP value. Slopes and soilP values are defined in separate tables in the cropping system database. *FertManure* is only a reminder for which system that was selected in the Crop Sequence and Managament Generator. The fertilized and the manured systems can be simulated separately if it is considered that the manured system has higher P levels in the soil. It is possible to have different default values for each dataset but it is not recommended as it will confuse the average calculations on the results.

Table 23. Metadata including parameters for field size and slope, soilP and P application class

Dataset ID	Dataset name	Soil	Width	StripNr	Climate	Slope	SoilP	FertManure
1	po4 00001	S10F-Clay	100	1	4 Östgötaslätten	Medium	Medium	Fert
2	po4 00002	S10F-Clay	100	1	4 Östgötaslätten	Medium	Medium	Fert

The table of N:P ratios (Table 24) contains values for N:P ratio for each crop. This is information is included in the cropdb.dat file. The crop name *Not defined* indicates a crop that is present in the CSMG databases but is not defined in the ICECREAMDB databases.

Table 24. N:P ratios

Crop	NPRatio
s_barley	3.53
w_wheat	4
Ley	2.52
su_beet	8.74
w_rape	1.92
fallow_gr	2.52
oats	4.13
s_wheat	4.28
w_rye	3.43
w_barley	0
s_rape	1.92
potato	1.06
Not defined	0
Not defined	0
peas	0
Not defined	0
Not defined	0
Not defined	0
Not defined	0
fallow_st	2.52
catchcrop	2.52

The *reduction* table (Table 25) contains reduction values for P and water. It is possible to reduce the output for surface runoff soluble P (*Rolp*), surface runoff particle bound P (*SedP*), soluble P through drainage system (*Pleach*) and particle bound P through drainage system (*DrainPP*) if for some reason not all of the simulated P flows really leaves the field and enters the water ways. The same is possible for the surface water runoff (*dayrun*) and the drainage water runoff (*DrainWater*). In ICECREAM the flows are multiplied with (1 - value in the table).

Table 25. Reduction parameters

Rolp	Sedp	Pleach	DrainPP	dayrun	DrainWater
0.67	0.67	0.2	0.2	0	0

The *SlopeClasses* table (Table 26) contains the *length* of the field and the *slope* for three classes; low, medium and steep slopes.

Table 26. SlopeClass parameters

SlopeClasses	Segment nr	Length	Slope
Low	1	50	0.004
Medium	1	50	0.015
Steep	1	50	0.043

The *SoilPClasses* table (Table 27) contains soilP values for 3 classes and 4 soil layers. The SoilP classes are the same for all soils.

Table 27. Content of P for the different SoilPClasses

SoilPClasses	Layer1	Layer2	Layer3	Layer4
Low	0.81	0.81	0.0435	0.0435
Medium	1.185	1.185	0.063	0.063
High	1.92	1.92	0.102	0.102

The *Soils* table (Table 28) contains the soils that are present in the region.

Table 28. Soils texture classes

Soil
S03F-SandyLoam
S04F-Loam
S06F-SandyClayLoam
S07F-ClayLoam
S08F-SiltyClayLoam
S10F-Clay

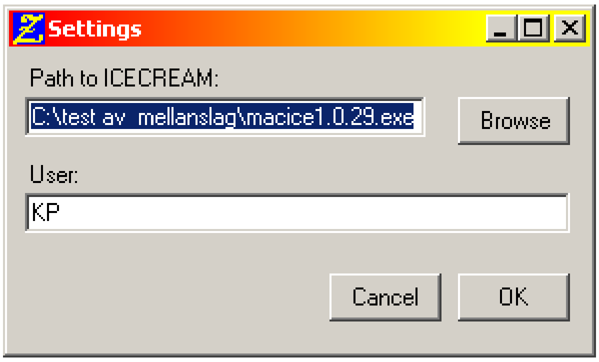
The *Yields* table (Table 29) contains the yields (kg/m2), for different crops this is written to the cropdb.dat file the rest of the data in the file is taken from the *cropdb* table in the parameter database. The yield varies between different regions.

Table 29. Crop yields

Crop	Yield
barley	0.5809
grass	0.9987
oats	0.7999
potato	4.738
rye	0.5561
spring_rape	0.2256
spring_wheat	0.6917
sugarbeet	4.3
winter_rape	0.3399
winter_wheat	0.7752

Description of the user interface

The first time ICECREAMDB is started a settings dialog is shown (Figure 3), it can later be opened under the file menu, the information is also present in the main window. In the dialog the path to the ICECREAM executable is given and a user name that will saved in each result database. All parameter files needed by ICECREAM for the simulations will be written to the same directory as the ICECREAM.exe is located in, it is therefore useful to create a separate directory for the calculations and locate a copy of ICECREAM there.



Path to ICECREAM: C:\test av mellanslag\macice1.0.29.exe

User: KP

Figure 3. Settings dialog.

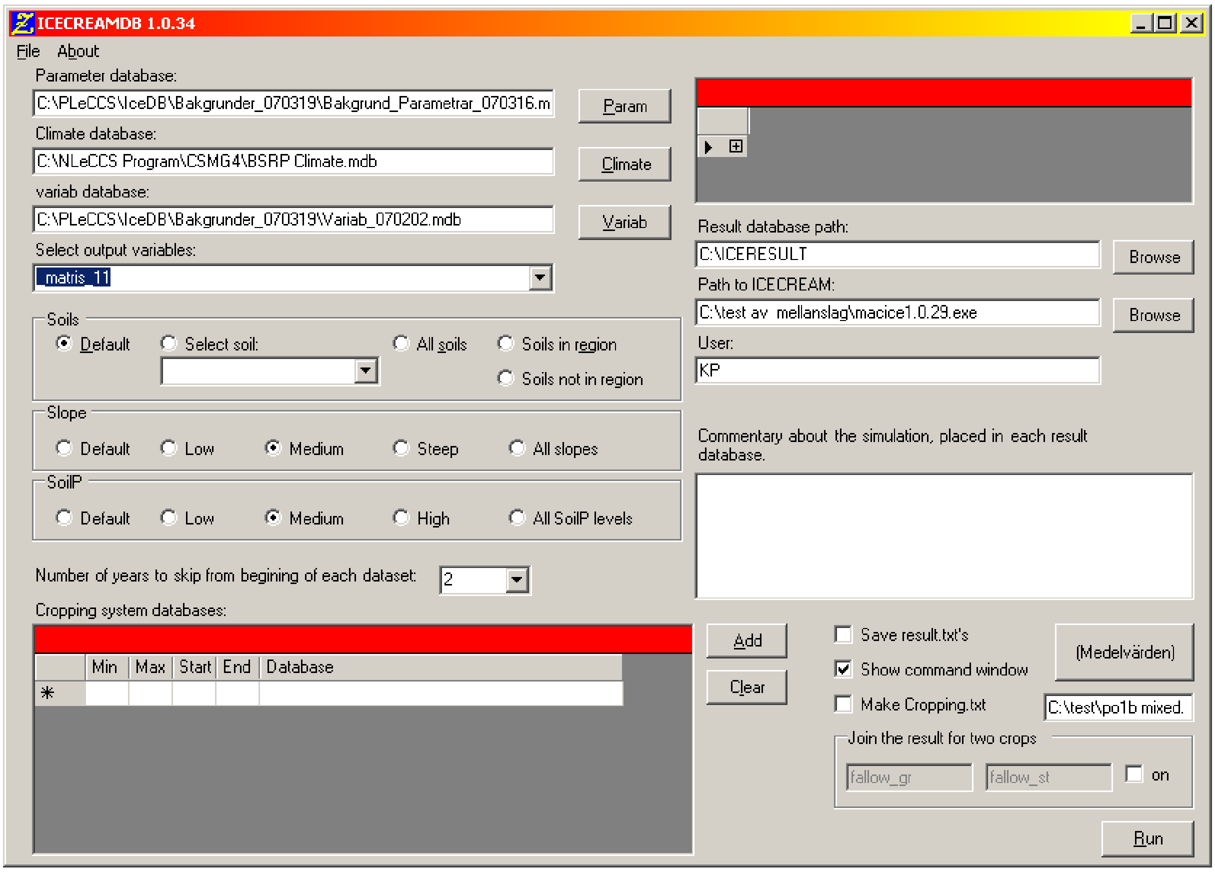
The main window is shown in Figure 4. To start a simulation, first load the parameter, climate and variable databases by clicking the buttons Param, Climate, Variab and select the respective databases. Then select output variables to be saved from the simulation in the drop down menu.

After that, soil texture class/classes are selected. By marking *Default,* the soil specified in the metadata table for each dataset of the cropping database is selected. By marking *Select soil* it is possible to manually select one soil to be simulated. If *All soils* is marked, simulations with all soils defined in the parameter database will be performed, and if *Soils in region* is selected a simulation with all soils present in the soils table in the cropping database will be used which is a subset to the soils defined in the parameter database. And finally if *Soils not in region* is checked all soils that are defined in the parameter database but is not present in the cropping database will be simulated.

Next, slope classes should be selected. By using *Default,* the slope in the metadata table of the cropping database for each dataset is selected. *Low*, *medium* and *steep* represents the slopes in the slope classes table in the cropping system database. If *All slopes* is indicated, all slope classes in the cropping system database will be simulated.

Subsequently, the soilP classes that the cropping system is to be simulated with are selected. The *Default* class corresponds to the soilP in the metadata table for each dataset of the cropping database. By marking *Low*, *medium* or *high,* the corresponding value from the soilp classes table in the cropping system database will be selected, and if *All soilP levels* is marked, all soilP classes in the cropping system database will be simulated.

Number of years to skip is the number of years from the start of the simulation to exclude from the results. This is useful if the model starts in an unbalanced state and 1 or 2 years simulation time is needed to reach stable values. This value is read from the parameter database but it is possibly to change it here.



Parameter database: C:\PLeCCS\IceDB\Bakgrunder_070319\Bakgrund_Parametrar_070316.m
Climate database: C:\NLeCCS Program\CSMG4\BSRP Climate.mdb
variab database: C:\PLeCCS\IceDB\Bakgrunder_070319\Variab_070202.mdb
Select output variables: matris_11
Soils: ● Default ○ Select soil: ○ All soils ○ Soils in region ○ Soils not in region
Slope: ○ Default ○ Low ● Medium ○ Steep ○ All slopes
SoilP: ○ Default ○ Low ● Medium ○ High ○ All SoilP levels
Number of years to skip from begining of each dataset: 2
Cropping system databases:
Result database path: C:\ICERESULT
Path to ICECREAM: C:\test av mellanslag\macice1.0.29.exe
User: KP
Commentary about the simulation, placed in each result database.
☐ Save result.txt's
☑ Show command window
☐ Make Cropping.txt C:\test\po1b mixed.
Join the result for two crops: fallow_gr fallow_st ☐ on

Figure 4. Main program window of ICECREAMDB.

Several databases, each containing several datasets, can be added and run in sequence, just click the *add* button and select the databases. The *min* and *max* dataset number is shown together with the *start* and *end* dataset to simulate and the *database name*. The start and end dataset can be adjusted. It is important to move the cursor to another line to make the change active. The datasets within each database must be numbered in sequence with no gaps. To remove all cropping databases click the *clear* button.

The small window on the upper right is only used for debugging purposes.

The result databases are saved in a directory that the user specifies. To change the directory click the *browse* button along side the *result database path* textbox and browse to the desired directory.

It is also possibly to enter the path to the ICECREAM executable, this is the same information as in the settings dialog.
The user name can also be set here as well as in the settings dialog.

Notes about the simulation can be saved in each result database and is entered in the commentary textbox. A maximum of 255 characters is allowed.

By checking *Save result.txt's* the result.txt containing daily results of all selected output variables from ICECREAM can be saved so that the simulation results can be viewed in detail after the simulation is completed. The result.txt file is normally overwritten during the next simulation.

If the *show command window* is checked, a window that shows the output from ICECREAM will be shown during the simulations.

If *Make cropping.txt* is checked a text file is produced with daily values for all events in the cropping system. This file is used for finding errors in the cropping system.

The button *medelvärden* and the textbox under it is a feature under development that probably will be moved to a separate program.

Join the result for two crops is a feature to make averages for two crops as if they were one crop. This has been replaced with a table in the parameter database. That allows more than two crops and several combinations to be calculated at the same time.

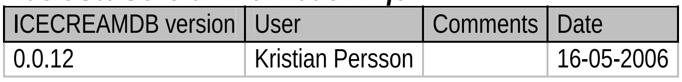
To start the simulation, click the *run* button. During the simulation an empty file with the name of the current dataset is created in the simulation directory. This is useful when simulating large databases with many datasets to get an idea of how much more time is needed until all datasets is simulated. Each dataset in a database is simulated with all soils, slopes and soilP levels as selected above before next dataset is simulated. The last moment is the calculation of crop averages. These are saved in an Excel file with the same name as the input database.

Result databases

Access result databases

The results from the simulations are saved in separate databases for every soil, slope and soilp combination. The names of the databases are set according to the input database name + soil + slope + soilp classes + number of dataset's simulated out of total number in the cropping system. A complete file name could be: po01a_Soil_S03F-SandyLoam_slope_Low_soilp_High_DS_500_of_500.mdb. This creates databases with unique names, easy to identify. The result database contains five tables, one with information and four with the actual results. The information table *Info* (Table 30) contains the version of ICECREAMDB used for simulation, the name of the person carrying out the simulation, a comment/note on the simulation and the date for the simulation.

Table 30. General information *Info*



ICECREAMDB version	User	Comments	Date
0.0.12	Kristian Persson		16-05-2006

The result tables are *Yearly sums*, *Agrohydrological sums*, *Yearly averages* and *Agrohydrological averages*. The contain output variables from ICECREAM, summarized on yearly or agro hydrological (July 1 to June 30) basis and yearly or agro hydrological averages. The tables (Table 31) contains the *dataset ID*, the *year* or *agro hydrological year*, the *crop* , the *fertilization type* and all output variables selected for that summary type.

Table 31. Simulation results

Dataset_ID	Year	Crop	FertType	Allwater (l/ha)	SRP_red_YC (mg/l)	PP_red_YC (mg/l)	TotP_red_YC (mg/l)
po01a 00002	1991	w_wheat	FERT	2191220.652	0.0333444	0.0353302	0.0686746
po01a 00002	1992	w_wheat	FERT	4182300.859	0.0297439	0.0000048	0.0297488
po01a 00002	1993	w_wheat	MANURE	2430533.439	0.0319672	0.0034672	0.0354344
po01a 00002	1994	w_wheat	FERT	4281527.418	0.035105	0.005786	0.040891
po01a 00002	1995	s_wheat	FERT	3693805.534	0.0333775	0.0191807	0.0525582
po01a 00002	1996	w_wheat	FERT	610857.1119	0.034023	0.0232084	0.0572314
po01a 00002	1997	su_beet	FERT	2001386.146	0.032306	0.0009617	0.0332677
po01a 00002	1998	su_beet	FERT	5743869.136	0.0364124	0.0907467	0.1271591
po01a 00002	1999	s_barley	MANURE	4501858.813	0.0360426	0.1277586	0.1638012
po01a 00002	2000	s_wheat	FERT	2900283.003	0.0300417	0.0003318	0.0303736
po01a 00002	2001	w_wheat	FERT	2262373.141	0.0367323	0.059455	0.0961873
po01a 00002	2002	su_beet	FERT	3439714.431	0.0381533	0.1242205	0.1623738

The crop average result file

The simulation results are aggregated and saved in an Excel file. The Excel file has the same name as the input database. The crop averages are calculated for the same 4 groups as described above (Yearly sums, Yearly averages, Agrohydrological sums and Agrohydrological averages), each presented in new tab. Empty tabs is not written, so if no variables with “Yearly sums” is selected the corresponding tab will not be written to the Excel file. The averages are calculated for different soils, soil phosphorus class, slope class, fertilization type and crops (Table 32).

A version of each table where the averages is calculated for different soils, soil phosphorus class, slope class and crops with the suffix _crop is also produced (Table 33).

Table 32. Yearly sums.

Soil	SoilP	Slope	Fert/manure	crop	FertType	Allwater (l/ha)	SRP_red_YC (mg/l)
S03F-SandyLoam	Low	Low	Mixed	fallow_gr	NONFERT	3059489	0.021274
S03F-SandyLoam	Low	Low	Mixed	fallow_st	NONFERT	3635446	0.021565
S03F-SandyLoam	Low	Low	Mixed	Ley	FERT	2763377	0.021406
S03F-SandyLoam	Low	Low	Mixed	Ley	MANURE	2916744	0.021414
S03F-SandyLoam	Low	Low	Mixed	oats	FERT	3291165	0.022182
S03F-SandyLoam	Low	Low	Mixed	oats	MANURE	3350655	0.021878
S03F-SandyLoam	Low	Low	Mixed	potato	FERT	3438460	0.022216
S03F-SandyLoam	Low	Low	Mixed	potato	MANURE	3197429	0.022845
S03F-SandyLoam	Low	Low	Mixed	s_barley	FERT	3209253	0.021887
S03F-SandyLoam	Low	Low	Mixed	s_barley	MANURE	3263399	0.021943

Table 33. Yearly sums_crop.

Soil	SoilP	Slope	crop	Allwater (l/ha)	SRP_red_YC (mg/l)
S03F-SandyLoam	Low	Low	fallow_gr	3059489	0.021274
S03F-SandyLoam	Low	Low	fallow_st	3635446	0.021565
S03F-SandyLoam	Low	Low	Ley	2869340	0.021411
S03F-SandyLoam	Low	Low	oats	3324405	0.022012
S03F-SandyLoam	Low	Low	potato	3363774	0.022411
S03F-SandyLoam	Low	Low	s_barley	3226280	0.021905
S03F-SandyLoam	Low	Low	s_wheat	3086772	0.022472
S03F-SandyLoam	Low	Low	su_beet	3257326	0.022451
S03F-SandyLoam	Low	Low	w_rape	3015642	0.021811
S03F-SandyLoam	Low	Low	w_rye	2995118	0.022061

The same tables are created for the averages of several crops with the suffix _AVG. Here the name of the crops are substituted with the name given in the table “Summary” in the parameter database.

All these tables also have corresponding tables with confidence values, with the suffix _Konf (Table 34). The confidence is calculated as

$$\frac{\left(\frac{1.96*\sigma}{\sqrt{n}}\right)}{\mu} \tag{13}$$

Where σ is the standard deviation and μ is the mean value.

Table 34. Yearly sums_AVG_Konf.

Soil	SoilP	Slope	Fert/manure	Crop	FertType	Allwater (l/ha)	SRP_red_YC (mg/l)
S03F-SandyLoam	Low	Low	Mixed	All	FERT	0.009844	0.00293
S03F-SandyLoam	Low	Low	Mixed	All	MANURE	0.013746	0.004079
S03F-SandyLoam	Low	Low	Mixed	All	NONFERT	0.02762	0.007168
S03F-SandyLoam	Low	Low	Mixed	Fall	FERT	0.016922	0.004402
S03F-SandyLoam	Low	Low	Mixed	Fall	MANURE	0.032844	0.009
S03F-SandyLoam	Low	Low	Mixed	Fallow	NONFERT	0.02762	0.007168
S03F-SandyLoam	Low	Low	Mixed	Spr	FERT	0.015965	0.004727
S03F-SandyLoam	Low	Low	Mixed	Spr	MANURE	0.021565	0.006342
S03F-SandyLoam	Low	Low	Mixed	X	FERT	0.010112	0.003044
S03F-SandyLoam	Low	Low	Mixed	X	MANURE	0.016194	0.004924

Two more tables is produced with the total number of each crop occurrence with (Table 35) and with out fertilization types (Table 36).

Table 35. Count

crop	FertType	Count
fallow_gr	NONFERT	612
fallow_st	NONFERT	90
Ley	FERT	408
Ley	MANURE	912
oats	FERT	184
oats	MANURE	233
potato	FERT	147
potato	MANURE	66
s_barley	FERT	1404
s_barley	MANURE	644
s_wheat	FERT	247
s_wheat	MANURE	95
su_beet	FERT	839
su_beet	MANURE	198
w_rape	FERT	270
w_rape	MANURE	116
w_rye	FERT	216
w_rye	MANURE	94
w_wheat	FERT	1832
w_wheat	MANURE	393

Table 36. Count_Crop

crop	Count
fallow_gr	612
fallow_st	90
Ley	1320
oats	417
potato	213
s_barley	2048
s_wheat	342
su_beet	1037
w_rape	386
w_rye	310
w_wheat	2225

System requirements

The ICECREAMDB program is written in Visual Basic .NET, Visual Studio 2003.
ICECREAM is written in Compaq Visual Fortran 6.

Requirements:

- MS .NET framework 1.1 or higher.
- At least 512 Mb RAM.
- Windows XP is recommended. Not tested on Windows Vista.
- A display capable of at least 1024*768 pixels.
- MS Access and MS Excel, MS Office XP or 2003 recommended. Not tested with MS Office 2007 and may not work with this version.

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