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*Supplement of*

# Sequestering carbon in the subsoil benefits crop transpiration at the onset of drought

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## S1. Climate projections

Table S 1 - Names of climate projection's models selected from CH2018 (https://www.nccs.admin.ch/nccs/de/home/materialien-und-daten/daten/ch2018---klimaszenarien-fuer-die-schweiz.html). Only sets that included all climatic variables required for SWAP (temperature, precipitation, wind speed, solar radiation and vapour pressure).

| Selected model chains | RCP |
|---|---|
| CLMCOM-CCLM5_ECEARTH_EUR44 | RCP85 |
| CLMCOM-CCLM4_HADGEM_EUR44 | |
| CLMCOM-CCLM5_MIROC_EUR44 | |
| CLMCOM-CCLM5_MPIESM_EUR44 | |
| CLMCOM-CCLM5_HADGEM_EUR44 | |
| DMI-HIRHAM_ECEARTH_EUR11 | |
| DMI-HIRHAM_ECEARTH_EUR44 | |
| KNMI-RACMO_ECEARTH_EUR44 | |
| KNMI-RACMO_HADGEM_EUR44 | |
| SMHI-RCA_ECEARTH_EUR11 | |
| SMHI-RCA_ECEARTH_EUR44 | |
| SMHI-RCA_IPSL_EUR11 | |
| SMHI-RCA_IPSL_EUR44 | |
| SMHI-RCA_HADGEM_EUR11 | |
| SMHI-RCA_HADGEM_EUR44 | |
| SMHI-RCA_MPIESM_EUR11 | |
| SMHI-RCA_MPIESM_EUR44 | |
| SMHI-RCA_CCCMA_EUR44 | |
| SMHI-RCA_CSIRO_EUR44 | |
| SMHI-RCA_MIROC_EUR44 | |
| SMHI-RCA_NORESM_EUR44 | |
| SMHI-RCA_GFDL_EUR44 | |

| | |
|---|---|
| KNMI-RACMO_ECEARTH_EUR44 | RCP45 |
| KNMI-RACMO_HADGEM_EUR44 | |
| DMI-HIRHAM_ECEARTH_EUR11 | |
| DMI-HIRHAM_ECEARTH_EUR44 | |
| SMHI-RCA_ECEARTH_EUR11 | |
| SMHI-RCA_ECEARTH_EUR44 | |
| SMHI-RCA_IPSL_EUR11 | |
| SMHI-RCA_IPSL_EUR44 | |
| SMHI-RCA_HADGEM_EUR11 | |
| SMHI-RCA_HADGEM_EUR44 | |
| SMHI-RCA_MPIESM_EUR11 | |
| SMHI-RCA_MPIESM_EUR44 | |
| SMHI-RCA_CCCMA_EUR44 | |
| SMHI-RCA_CSIRO_EUR44 | |
| SMHI-RCA_MIROC_EUR44 | |
| SMHI-RCA_NORESM_EUR44 | |
| SMHI-RCA_GFDL_EUR44 | |
| DMI-HIRHAM_ECEARTH_EUR11 | RCP26 |
| KNMI-RACMO_HADGEM_EUR44 | |
| SMHI-RCA_ECEARTH_EUR11 | |
| SMHI-RCA_ECEARTH_EUR44 | |
| SMHI-RCA_HADGEM_EUR44 | |
| SMHI-RCA_MPIESM_EUR44 | |
| SMHI-RCA_MIROC_EUR44 | |
| SMHI-RCA_NORESM_EUR44 | |

**S2. Summary of climatic variables at winter and summer for RCP2.6 and RCP4.5**

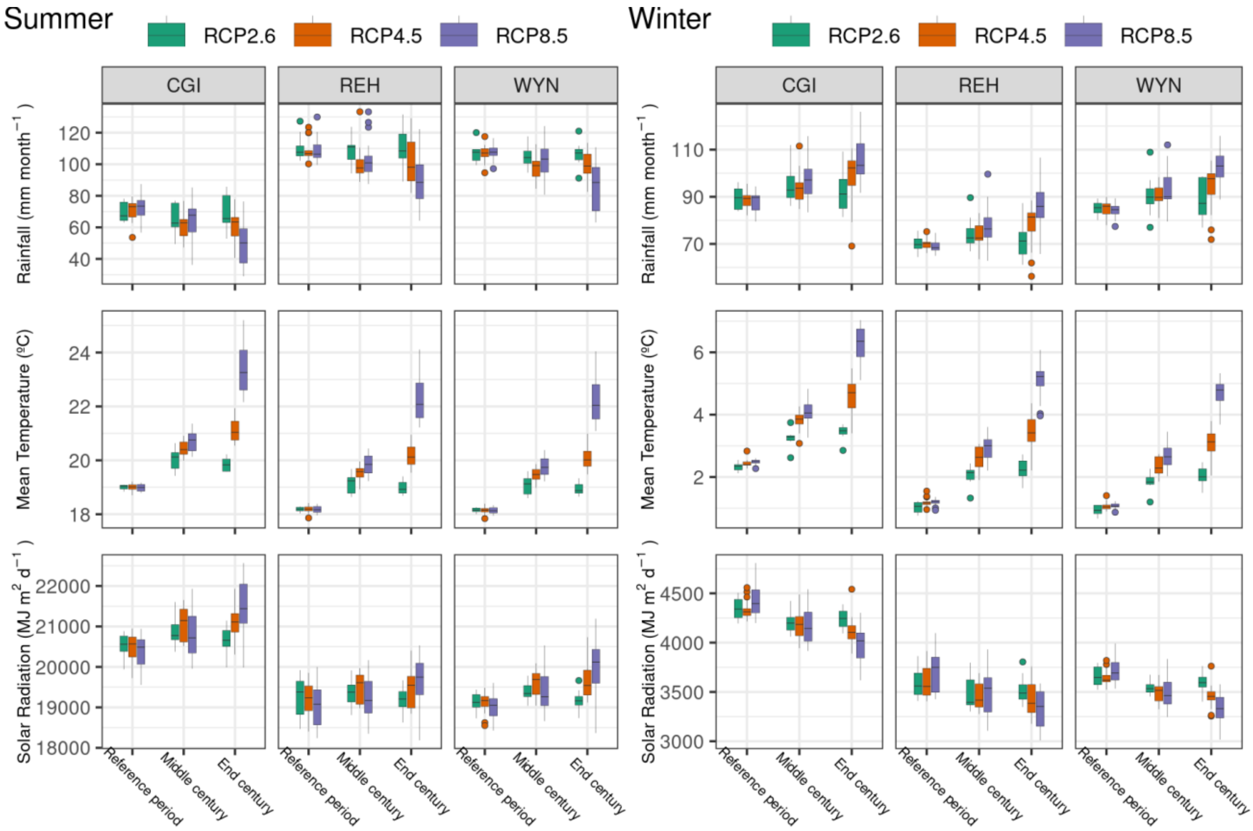


Figure S 1 - Summary of climatic variables considering monthly mean values at the stations Changins (CGI), Reckenholz (REH), and Wynau (WYN) for the projections RCP2.6, RCP4.5, and RCP8.5. Summer was considered as the months June, July and August, winter corresponds to December, January and February. Reference period: 1981-2020, mid-century: 2031-2060, end-of-century: 2071-2099. Rainfall corresponds to monthly sums, mean temperature is the mean between maximum and minimum temperature per day, averaged by month, solar radiation corresponds to daily values averaged by month.

## S3. SWAP Masterfile parametrization

```
****************************************************************
Filename: Swap.swp
* Contents: Main input data
***************************************************************
*   The main input file .swp contains the following sections:
*           - General section
*           - Meteorology section
*           - Crop section
*           - Soil water section
*           - Lateral drainage section
*           - Bottom boundary section
*           - Heat flow section
*           - Solute transport section
*** GENERAL SECTION ***
***************************************************************
* Part 1: Environment
  PROJECT   = 'reh_lysimeter'  ! Project description [A80]
  PATHWORK  = ' '       ! Path to work folder [A80]
  PATHATM   = '..\..\..\..\Data\projections\clim_CGI\CLMCOM-
CCLM4_HADGEM_EUR44_RCP85\'
  PATHCROP  = ' '       ! Path to folder with crop files [A80]
  PATHDRAIN = ' '       ! Path to folder with drainage files [A80]
  SWSCRE    = 0         ! Switch, display progression of simulation run to
screen:
                             !   0 = no display to screen
                             !   1 = display water balance components
                             !   2 = display daynumber
  SWERROR   = 1              ! Switch for printing errors to screen [Y=1,
N=0]
****************************************************************************
* Part 2: Simulation period
   TSTART      =01-jan-2081
   TEND        =31-dec-2099
```

```
***************************************************************************
* Part 3: Output dates
* Number of output times during a day
  NPRINTDAY = 1     ! Number of output times during a day [1..1000, I]

* If NPRINTDAY = 1, specify dates for output of state variables and fluxes
  SWMONTH = 0       ! Switch, output each month [Y=1, N=0]

* If SWMONTH = 0, choose output interval and/or specific dates
  PERIOD = 1        ! Fixed output interval, ignore = 0, [0..366, I]
  SWRES  = 0        ! Switch, reset output interval counter each year [Y=1, N=0]
  SWODAT = 0        ! Switch, extra output dates are given in table below [Y=1, N=0]

* If SWODAT = 1, list specific dates [dd-mmm-yyyy], maximum MAOUT dates:
  OUTDATINT =
  31-Jan-2002
  31-Dec-2004
* End of table

* Output times for overall water and solute balances in *.BAL and *.BLC file: choose output
* at a fixed date each year or at different dates:
  SWYRVAR = 0       ! 0 = each year output at the same date
                    ! 1 = output at different dates

* If SWYRVAR = 0 specify fixed date:
  DATEFIX = 31 12   ! Specify day and month for output of yearly balances [dd mm]

* If SWYRVAR = 1 specify all output dates [dd-mmm-yyyy], maximum MAOUT dates:
  OUTDAT =
  31-dec-2003
  31-dec-2004
* End of table
```

```
**********************************************************************
* Part 4: Output files
* General information
  OUTFIL   = 'Result' ! Generic file name of output files [A16]
  SWHEADER = 0        ! Print header at the start of each balance period
[Y=1, N=0]


* Optional files
  SWVAP  = 0        ! Switch, output soil profiles of moisture, solute and
temperature [Y=1, N=0]
  SWBLC  = 0        ! Switch, output file with detailed yearly water
balance [Y=1, N=0]
  SWATE  = 0        ! Switch, output file with soil temperature profiles
[Y=1, N=0]
  SWBMA  = 0        ! Switch, output file with water fluxes, only for
macropore flow [Y=1, N=0]
  SWDRF  = 0        ! Switch, output of drainage fluxes, only for extended
drainage [Y=1, N=0]
  SWSWB  = 0        ! Switch, output surface water reservoir, only for
extended drainage [Y=1, N=0]


* Optional detailed output files on hydrology, e.g. for water quality
models as PEARL and ANIMO
  SWAFO  = 0        ! Switch, output file with formatted hydrological data
                    ! 0 = no output
                    ! 1 = output to a file named *.AFO
                    ! 2 = output to a file named *.BFO


  SWAUN  = 0        ! Switch, output file with unformatted hydrological
data
                    ! 0 = no output
                    ! 1 = output to a file named *.AUN
                    ! 2 = output to a file named *.BUN


* Maximum deviation in water balance; in case of larger deviation, an error
file is created (*.DWB.CSV)
  CRITDEVMASBAL = 0.00001  ! Critical Deviation in water balance during
PERIOD [0.0..1.0 cm, R]
```

```
* If SWAFO = 1 or 2, or SWAUN = 1 or 2: fine vertical discretization can be
lumped to more coarse discretization

  SWDISCRVERT = 0   ! SWDISCRVERT = 0: no conversion

                    ! SWDISCRVERT = 1: convert vertical discretization,


* If SWDISCRVERT = 1 then specify:

  NUMNODNEW = 6    ! New number of nodes [1..macp, I, -]

* List thickness of each compartment, total thickness should correspond to
Soil Water Section, part 4

  DZNEW     = 10.0 10.0 10.0 20.0 30.0 50.0 ! thickness of compartments
[1.0d-6...5.0d2, cm, R]

**********************************************************************

*** METEOROLOGY SECTION ***

**********************************************************************

* General data

* File name

METFIL = 'CGI_clim'

                        ! Extension is equal to last 3 digits of year, e.g.
003 denotes year 2003


* Type of weather data for potential evapotranspiration

  SWETR  =  0           ! 0 = Use basic weather data and apply Penman-
Monteith equation

                        ! 1 = Use reference evapotranspiration data in
combination with crop factors


* If SWETR = 0, specify:

     LAT       =   46.400

     ALT       =   455.00

     ALTW      =     2.00

     ANGSTROMA =     0.25

     ANGSTROMB =     0.50

  SWDIVIDE  =     1    ! 0 = Distribution E and T based on crop and soil
factors

                        ! 1 = Distribution E and T based on direct
application of Penman-Monteith


* Time interval of evapotranspiration and rainfall weather data
```

SWMETDETAIL = 0 ! 0 = time interval is equal to one day

! 1 = time interval is less than one day

* In case of detailed meteorological weather records (SWMETDETAIL = 1), specify:

NMETDETAIL = 10 ! Number of weather data records each day [1..96 -, I]

* In case of daily meteorological weather records (SWMETDETAIL = 0):

SWETSINE = 0 ! Switch, distribute daily Tp and Ep according to sinus wave [Y=1, N=0]

SWRAIN = 0 ! Switch for use of actual rainfall intensity (only if SWMETDETAIL = 0):

! 0 = Use daily rainfall amounts

! 1 = Use daily rainfall amounts + mean intensity

! 2 = Use daily rainfall amounts + duration

! 3 = Use detailed rainfall records (dt < 1 day), as supplied in separate file

* If SWRAIN = 1, specify mean rainfall intensity RAINFLUX [0.d0..1000.d0 mm/d, R]

* as function of Julian time TIME [0..366 d, R], maximum 30 records

| TIME | RAINFLUX |
|---|---|
| 1.0 | 20.0 |
| 360.0 | 20.0 |

* End of table

* If SWRAIN = 3, specify file name of file with detailed rainfall data

RAINFIL = 'WagRain' ! File name of detailed rainfall data without extension .YYY, [A200]

! Extension is equal to last 3 digits of year, e.g. 003 denotes year 2003

**************************************************************************

*** CROP SECTION ***

**************************************************************************

* Part 1: Crop rotation scheme

```
* Switch for bare soil or cultivated soil
  SWCROP = 1 ! 0 = Bare soil
             ! 1 = Cultivated soil


* Specify for each crop (maximum MACROP):
* INITCRP    = type of initialisation of crop growth: emergence (default) =
1, sowing = 2 [-]
* CROPSTART  = date of crop emergence [dd-mmm-yyyy]
* CROPEND    = date of crop harvest [dd-mmm-yyyy]
* CROPNAME   = crop name [A40]
* CROPFIL    = name of file with crop input parameters without extension
.CRP, [A40]
* CROPTYPE   = growth module: 1 = simple; 2 = detailed, WOFOST general; 3 =
detailed, WOFOST grass
    INITCRP    CROPSTART      CROPEND       CROPNAME   CROPFIL     CROPTYPE
    2          6-may-2081      8-nov-2081       'maize'  'MaizeS'     1
    2          6-may-2082      8-nov-2082       'maize'  'MaizeS'     1
    2          6-may-2083      8-nov-2083       'maize'  'MaizeS'     1
    2          5-may-2084      7-nov-2084       'maize'  'MaizeS'     1
    2          6-may-2085      8-nov-2085       'maize'  'MaizeS'     1
    2          6-may-2086      8-nov-2086       'maize'  'MaizeS'     1
    2          6-may-2087      8-nov-2087       'maize'  'MaizeS'     1
    2          5-may-2088      7-nov-2088       'maize'  'MaizeS'     1
    2          6-may-2089      8-nov-2089       'maize'  'MaizeS'     1
    2          6-may-2090      8-nov-2090       'maize'  'MaizeS'     1
    2          6-may-2091      8-nov-2091       'maize'  'MaizeS'     1
    2          5-may-2092      7-nov-2092       'maize'  'MaizeS'     1
    2          6-may-2093      8-nov-2093       'maize'  'MaizeS'     1
    2          6-may-2094      8-nov-2094       'maize'  'MaizeS'     1
    2          6-may-2095      8-nov-2095       'maize'  'MaizeS'     1
    2          5-may-2096      7-nov-2096       'maize'  'MaizeS'     1
    2          6-may-2097      8-nov-2097       'maize'  'MaizeS'     1
    2          6-may-2098      8-nov-2098       'maize'  'MaizeS'     1
    2          6-may-2099      8-nov-2099       'maize'  'MaizeS'     1
* End of table
**************************************************************************
```

```
**********************************************************************
* Part 2: Fixed irrigation applications

* Switch for fixed irrigation applications
  SWIRFIX = 0    ! 0 = no irrigation applications are prescribed
                 ! 1 = irrigation applications are prescribed

* If SWIRFIX = 1, specify:

* Switch for separate file with irrigation data
  SWIRGFIL  = 0  ! 0 = irrigation data are specified below
                 ! 1 = irrigation data are specified in a separate file

* If SWIRGFIL  = 0 specify the follwing information of each fixed
irrigation event (max. MAIRG):
* IRDATE   = date of irrigation [dd-mmm-yyyy]
* IRDEPTH  = amount of water [0..1000 mm, R]
* IRCONC   = concentration of irrigation water [0..1000 mg/cm3, R]
* IRTYPE   = type of irrigation: sprinkling = 0, surface = 1

       IRDATE   IRDEPTH     IRCONC   IRTYPE
  05-jan-2002       5.0     1000.0        1
* end of table

* If SWIRGFIL  = 1, specify name of file with irrigation data:
  IRGFIL = 'testirri'      ! File name without extension .IRG [A32]d(temp)
**********************************************************************
*** SOIL WATER SECTION ***
**********************************************************************
* Part 1: Initial soil moisture condition

 SWINCO = 1 ! Switch, type of initial soil moisture condition:
            ! 1 = pressure head as function of soil depth
            ! 2 = pressure head of each compartment is in hydrostatic
equilibrium
            !     with initial groundwater level
```

```
          ! 3 = read final pressure heads from output file of previous
Swap simulation

* If SWINCO = 1, specify soil depth ZI [-1.d5..0 cm, R] and initial
* soil water pressure head H [-1.d10..1.d4 cm, R] (maximum MACP):

      ZI         H
    -0.5     -100.0
  -120.0     -100.0
* End of table

* If SWINCO = 2, specify initial groundwater level:
  GWLI   = -200.0  ! Initial groundwater level [-10000..1000 cm, R]

* If SWINCO = 3, specify output file with initial values for current run:
  INIFIL = 'result.end'   ! name of output file *.END which contains
initial values [A200]
***************************************************************************
***************************************************************************
* Part 2: Ponding, runoff and runon

* Ponding
* Switch for variation ponding threshold for runoff
  SWPONDMX = 0   ! 0 = Ponding threshold for runoff is constant
                 ! 1 = Ponding threshold for runoff varies in time

* If SWPONDMX = 0, specify
  PONDMX  = 0.2  ! In case of ponding, minimum thickness for runoff
[0..1000 cm, R]

* If SWPONDMX = 1, specify minimum thickness for runoff PONDMXTB [0..1000
cm, R] as function of time
      DATEPMX    PONDMXTB         ! (max. MAIRG records)
  01-jan-2002      0.2
  31-dec-2004      0.2
* End of table
```

```
* Runoff
  RSRO    =  0.5 ! Drainage resistance for surface runoff [0.001..1.0 d, R]
  RSROEXP =  1.0 ! Exponent in drainage equation of surface runoff
[0.01..10.0 -, R]

* Runon: specify whether runon data are provided in extra input file
  SWRUNON = 0  ! 0 = No input of runon data
               ! 1 = Runon data are provided in extra input file

* If SWRUNON = 1, specify name of file with runon input data
* This file may be an output file *.inc (with only 1 header line) of a
previous Swap-simulation
  RUFIL = 'runon.inc' ! File name with extension [A80]
***************************************************************************
* Part 3: Soil evaporation

  CFEVAPPOND = 1.25 ! When ETref is used, evaporation coefficient in case
of ponding  [0..3 -, R]

  SWCFBS = 0   ! Switch for use of soil factor CFBS to calculate Epot from
ETref
               ! 0 = soil factor is not used
               ! 1 = soil factor is used

* If SWCFBS = 1, specify soil factor CFBS:
  CFBS   = 0.5 ! Soil factor CFBC in Epot = CFBS * ETref [0..1.5 -, R]

* If SWDIVIDE = 1 (partitoning according to PMdirect) specify minimum soil
resistance
  RSOIL  =   30.0 ! Soil resistance of wet soil [0..1000.0 s/m, R]

  SWREDU = 1   ! Switch, method for reduction of potential soil
evaporation:
               ! 0 = reduction to maximum Darcy flux
               ! 1 = reduction to maximum Darcy flux and to maximum Black
(1969)
               ! 2 = reduction to maximum Darcy flux and to maximum
Boesten/Stroosnijder (1986)
```

```
 COFRED = 0.35 ! Soil evaporation coefficient of Black [0..1 cm/d1/2, R],
               ! or Boesten/Stroosnijder [0..1 cm1/2, R]

 RSIGNI =  0.5 ! Minimum rainfall to reset method of Black [0..1 cm/d, R]
***************************************************************************
* Part 4: Vertical discretization of soil profile

* Specify the following data (maximum MACP lines):
* ISUBLAY  = number of sub layer, start with 1 at soil surface [1..MACP, I]
* ISOILLAY = number of soil physical layer, start with 1 at soil surface
[1..MAHO, I]
* HSUBLAY  = height of sub layer [0..1.d4 cm, R]
* HCOMP    = height of compartments in the sub layer [0.0..1000.0 cm, R]
* NCOMP    = number of compartments in the sub layer (Mind NCOMP =
HSUBLAY/HCOMP) [1..MACP, I]

 ISUBLAY ISOILLAY  HSUBLAY    HCOMP    NCOMP
        1         1  5.0000  0.5000       10
        2         1 22.0000  1.0000       22
        3         2 33.0000  1.0000       33
        4         3 25.0000  5.0000        5
        5         4 25.0000  5.0000        5
        6         5 25.0000  5.0000        5

* end of table
***************************************************************************
* Part 5: Soil hydraulic functions

* Switch for analytical functions or tabular input:
  SWSOPHY = 0   ! 0 = Analytical functions with input of Mualem - van
Genuchten parameters
                ! 1 = Soil physical tables

* If SWSOPHY = 0, specify MvG parameters for each soil physical layer
(maximum MAHO):
```

* ISOILLAY1 = number of soil physical layer, as defined in part 4 [1..MAHO, I]

* ORES = Residual water content [0..1 cm3/cm3, R]

* OSAT = Saturated water content [0..1 cm3/cm3, R]

* ALFA = Parameter alfa of main drying curve [0.0001..100 /cm, R]

* NPAR = Parameter n [1.001..9 -, R]

* KSATFIT = Fitting parameter Ksat of hydraulic conductivity function [1.d-5..1d5 cm/d, R]

* LEXP = Exponent in hydraulic conductivity function [-25..25 -, R]

* ALFAW = Alfa parameter of main wetting curve in case of hysteresis [0.0001..100 /cm, R]

* H_ENPR = Air entry pressure head [-40.0..0.0 cm, R]

* KSATEXM = Measured hydraulic conductivity at saturated conditions [1.d-5..1d5 cm/d, R]

* BDENS = Dry soil bulk density [100..1d4 mg/cm3, R]

| ISOILLAY1 | ORES | OSAT | ALFA | NPAR | KSATFIT | LEXP | ALFAW | H_ENPR | KSATEXM | BDENS |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.0427 | 0.4422 | 0.1283 | 1.1556 | 57.76 | -3.0951 | 0.1283 | 0.0 | 57.76 | 1500.00 |
| 2 | 0.0409 | 0.3774 | 0.0521 | 1.1659 | 19.24 | -2.9550 | 0.0521 | 0.0 | 19.24 | 1530.00 |
| 3 | 0.0732 | 0.3872 | 0.0849 | 1.2123 | 26.69 | -3.7196 | 0.0849 | 0.0 | 26.69 | 1470.00 |
| 4 | 0.0748 | 0.3820 | 0.0214 | 1.3604 | 10.17 | -1.1543 | 0.0214 | 0.0 | 10.17 | 1470.00 |
| 5 | 0.0722 | 0.3905 | 0.0116 | 1.2607 | 5.02 | -0.9575 | 0.0116 | 0.0 | 5.02 | 1470.00 |

* --- end of table

* If SWSOPHY = 1, specify names of input files [A80] with soil hydraulic tables for each soil layer:

FILENAMESOPHY = 'topsoil_sand_B2.csv', 'subsoil_sand_O2.csv'

```
**********************************************************************************
```

* Part 6: Hysteresis of soil water retention function

* Switch for hysteresis:

```
  SWHYST = 0   ! 0 = no hysteresis
               ! 1 = hysteresis, initial condition wetting
               ! 2 = hysteresis, initial condition drying
```

* If SWHYST = 1 or 2, specify:

TAU = 0.2 ! Minimum pressure head difference to change from wetting to drying and vice versa, [0..1 cm, R]

```
**************************************************************************
* Part 7: Maximum rooting depth

  RDS  = 135.0   ! Maximum rooting depth allowed by the soil profile
[1..5000 cm, R]
**************************************************************************
* Part 8: Preferential flow due to macropores

  SWMACRO = 0     ! Switch for macropore flow [0..2, I]:
                  ! 0 = no macropore flow
                  ! 1 = macropore flow
**************************************************************************
* Part 9: Snow and frost

* Snow
  SWSNOW = 1           ! Switch, calculate snow accumulation and melt [Y=1,
N=0]

* If SWSNOW = 1, specify:
  SNOWINCO = 22.0      ! Initial snow water equivalent [0..1000 cm, R]
  TEPRRAIN = 2.0       ! Temperature above which all precipitation is rain
[ 0..10 °C, R]
  TEPRSNOW = -2.0      ! Temperature below which all precipitation is snow
[-10..0 °C, R]
  SNOWCOEF = 0.3       ! Snowmelt calibration factor [0.0...10.0 -, R]

* Frost
  SWFROST = 1  ! Switch, in case of frost reduce soil water flow [Y=1, N=0]

* If SWFROST = 1, specify soil temperature range in which soil water flow
is reduced
  TFROSTSTA = 0.0      ! Soil temperature (°C) at which reduction of water
fluxes starts [-10..5 °C, R]
  TFROSTEND = -1.0     ! Soil temperature (°C) at which reduction of water
fluxes ends [-10..5 °C, R]
**************************************************************************
* Part 10 Numerical solution of Richards' equation for soil water flow
```

DTMIN = 1.0d-6 ! Minimum timestep [1.d-7..0.1 d, R]

DTMAX = 0.2 ! Maximum timestep [dtmin..1 d, R]

GWLCONV = 100.0 ! Maximum difference of groundwater level between time steps [1.d-5..1000 cm, R]

CRITDEVH1CP = 1.0d-2 ! Maximum relative difference in pressure heads per compartment [1.0d-10..1.d3 -, R]

CRITDEVH2CP = 1.0d-1 ! Maximum absolute difference in pressure heads per compartment [1.0d-10..1.d3 cm, R]

CRITDEVPONDDT = 1.0d-4 ! Maximum water balance error of ponding layer [1.0d-6..0.1 cm, R]

MAXIT = 30 ! Maximum number of iteration cycles [5..100 -, I]

MAXBACKTR = 3 ! Maximum number of back track cycles within an iteration cycle [1..10 -,I]

* Switch for averaging method of hydraulic conductivity [1..4 -, I]:

SWKMEAN = 1 ! 1 = unweighted arithmic mean

! 2 = weighted arithmic mean

! 3 = unweighted geometric mean

! 4 = weighted geometric mean

* Switch for updating hydraulic conductivity during iteration [0..1 -, I]:

SWKIMPL = 0 ! 0 = no update

! 1 = update

**********************************************************************

*** LATERAL DRAINAGE SECTION ***

**********************************************************************

* Specify whether lateral drainage to surface water should be included

SWDRA = 0 ! Switch, simulation of lateral drainage:

! 0 = No simulation of drainage

! 1 = Simulation with basic drainage routine

! 2 = Simulation of drainage with surface water management

* If SWDRA = 1 or SWDRA = 2 specify name of file with drainage input data:

DRFIL = 'Hupsel' ! File name with drainage input data without extension .DRA [A16]

```
**********************************************************************
*** BOTTOM BOUNDARY SECTION ***
**********************************************************************
* Bottom boundary condition

  SWBBCFILE  = 0    ! Switch for file with bottom boundary data:
                    ! 0 = data are specified in current file
                    ! 1 = data are specified in a separate file

* If SWBBCFILE = 1 specify name of file with bottom boundary data:
  BBCFIL = ' '      ! File name without extension .BBC [A32]

* If SWBBCFILE = 0, select one of the following options [1..8 -,I]:
  SWBOTB = 7  ! 1  Prescribe groundwater level
              ! 2  Prescribe bottom flux
              ! 3  Calculate bottom flux from hydraulic head of deep
aquifer
              ! 4  Calculate bottom flux as function of groundwater level
              ! 5  Prescribe soil water pressure head of bottom compartment
              ! 6  Bottom flux equals zero
              ! 7  Free drainage of soil profile
              ! 8  Free outflow at soil-air interface

* Options 1-5 require additional bottom boundary data below
**********************************************************************
* SWBOTB = 1  Prescribe groundwater level

* specify date [dd-mmm-yyyy] and groundwater level GWLEVEL [cm, -
10000..1000, R]

        DATE1    GWLEVEL         ! (max. MABBC records)
  01-jan-2002     -95.0
  31-dec-2004     -95.0
* End of table
**********************************************************************
* SWBOTB = 2   Prescribe bottom flux
```

* Specify whether a sinus function or a table are used for the bottom flux [1..2,-,I]:

  SW2    = 2      ! 1 = sinus function

                  ! 2 = table

* In case of sinus function (SW2 = 1), specify:

  SINAVE =  0.1   ! Average value of bottom flux [-10..10 cm/d, R, + = upwards]

  SINAMP =  0.05  ! Amplitude of bottom flux sine function [-10..10 cm/d, R]

  SINMAX =  91.0  ! Time of the year with maximum bottom flux [0..366 d, R]

* In case of table (SW2 = 2), specify date [dd-mmm-yyyy] and bottom flux QBOT2 [-100..100 cm/d, R, positive = upwards]:

| DATE2 | QBOT2 | ! (maximum MABBC records) |
|---|---|---|
| 01-jan-2002 | 0.1 | |
| 30-jun-2002 | 0.2 | |
| 23-dec-2002 | 0.15 | |

* End of table

***************************************************************************

* SWBOTB = 3    Calculate bottom flux from hydraulic head in deep aquifer

* Switch for vertical hydraulic resistance between bottom boundary and groundwater level

  SWBOTB3RESVERT = 0 ! 0 = Include vertical hydraulic resistance

                     ! 1 = Suppress vertical hydraulic resistance

* Switch for numerical solution of bottom flux: 0 = explicit, 1 = implicit

  SWBOTB3IMPL = 0    ! 0 = explicit solution (choose always when SHAPE < 1.0)

                     ! 1 = implicit solution

* Specify:

  SHAPE  =   0.79  ! Shape factor to derive average groundwater level [0..1 -, R]

HDRAIN =  -110.0 ! Mean drain base to correct for average groundwater level [-1d4..0 cm, R]

RIMLAY =   500.0 ! Vertical resistance of aquitard [0..1d5 d, R]

* Specify whether a sinus function or a table are used for the hydraulic head in the deep aquifer [1..2 -,I]:

SW3    = 1      ! 1 = sinus function

! 2 = table

* In case of a sinus function (SW3  = 1), specify:

AQAVE  =  -140.0 ! Average hydraulic head in underlaying aquifer [-1d4..1000 cm, R]

AQAMP  =    20.0 ! Amplitude hydraulic head sinus wave [0..1000 cm, R]

AQTMAX =  120.0  ! First time of the year with maximum hydraulic head [0..366 d, R]

AQPER  =  365.0  ! Period hydraulic head sinus wave [0..366 d, R]

* In case of table (SW3  = 2), specify date [dd-mmm-yyyy] and average hydraulic head

* HAQUIF in underlaying aquifer [-1d4..1000 cm, R]:

| DATE3 | HAQUIF | ! (maximum MABBC records) |
|---|---|---|
| 01-jan-2002 | -95.0 | |
| 30-jun-2002 | -110.0 | |
| 23-dec-2002 | -70.0 | |

* End of table

* An extra groundwater flux can be specified which is added to above specified flux [0..1 -,I]

SW4    = 1      ! 0 = no extra flux

! 1 = include extra flux

* If SW4 = 1, specify date [dd-mmm-yyyy] and bottom flux QBOT4 [-100..100 cm/d, R, positive = upwards]:

| DATE4 | QBOT4 | ! (maximum MABBC records) |
|---|---|---|
| 01-jan-2002 | 1.0 | |
| 30-jun-2002 | -0.15 | |

```
  23-dec-2002       1.2
* End of table
***************************************************************************
* SWBOTB = 4     Calculate bottom flux as function of groundwater level

* Specify whether an exponential relation or a table is used [1..2 -,I]:
  SWQHBOT = 2       ! 1 = bottom flux is calculated with an exponential relation
                    ! 2 = bottom flux is derived from a table

* If SWQHBOT  = 1, specify coefficients for qbot = A * exp(B * |groundwater level|)
  COFQHA =  0.1  ! Coefficient A [-100..100 cm/d, R]
  COFQHB =  0.5  ! Coefficient B [-1..1 /cm, R]

* If SWQHBOT  = 1, an extra flux can be added to the exponential relation
  COFQHC =  0.05 ! Water flux (positive upward) in addition to flux from exponential relation [-10..10 cm/d, R]

* If SWQHBOT = 2, specify groundwaterlevel Htab [-1d4..0, cm, R] and bottom flux QTAB [-100..100 cm/d, R]
* Htab is negative below the soil surface, Qtab is positive when flux is upward

  HTAB   QTAB           ! (maximum MABBC records)
  -0.1   -0.35
  -70.0  -0.05
 -125.0  -0.01
* End of table
***************************************************************************
* SWBOTB = 5     Prescribe soil water pressure head of bottom compartment

* Specify DATE [dd-mmm-yyyy] and bottom compartment pressure head HBOT5 [-1.d10..1000 cm, R]:

        DATE5     HBOT5           ! (maximum MABBC records)
  01-jan-2002     -95.0
  30-jun-2002    -110.0
```

```
  23-dec-2002     -70.0
* End of table
***************************************************************************
*** HEAT FLOW SECTION ***
***************************************************************************
* Part 1: Specify whether simulation includes heat flow

  SWHEA  = 1     ! Switch for simulation of heat transport [Y=1, N=0]
***************************************************************************
* Part 2: Heat flow calculation method

* Switch for calculation method
  SWCALT = 2     ! 1 = analytical method
                 ! 2 = numerical method
***************************************************************************
* Part 3: Analytical method

* In case of the analytical method (SWCALT = 1) specify:
  TAMPLI = 10.0 ! Amplitude of annual temperature wave at soil surface
[0..50 °C, R]
  TMEAN  = 15.0 ! Mean annual temperature at soil surface [-10..30 °C, R]
  TIMREF = 90.0 ! Time at which the sinus temperature wave reaches it's top
[0..366.0 d, R]
  DDAMP  = 50.0 ! Damping depth of soil temperature wave [1..500 cm, R]
***************************************************************************
* Part 4: Numerical method

* In case of the numerical method (SWCALT = 2) specify:

* Specify for each physical soil layer the soil texture (g/g mineral parts)
* and the organic matter content (g/g dry soil):

  ISOILLAY5  PSAND    PSILT    PCLAY    ORGMAT     ! (maximum MAHO records)
        1  0.5400  0.2800  0.1800  0.0205
        2  0.4700  0.3100  0.2200  0.0068
        3  0.5600  0.1900  0.2600  0.0059
        4  0.5000  0.2300  0.2800  0.0044
```

```
         5  0.5500  0.2100  0.2500  0.0065
* End of table

* If SWINCO = 1 or 2, list initial temperature TSOIL [-50..50 °C, R] as function of
* soil depth ZH [-1.0d5..0 cm, R]:

      ZH    TSOIL   ! (maximum MACP records)
   -10.0     15.0
   -40.0     12.0
   -70.0     10.0
   -95.0      9.0
* End of table

* Define top boundary condition:
  SwTopbHea = 1     ! 1 = use air temperature of meteo input file as top boundary
                    ! 2 = use measured top soil temperature as top boundary

* If SwTopbHea = 2, specify name of input file with soil surface temperatures
  TSOILFILE = 'Haarweg' ! File name without extension .TSS, [A16]

* Define bottom boundary condition:
  SwBotbHea = 1     ! 1 = no heat flux; 2 = prescribe bottom temperature

* If SwBotbHea = 2, specify bottom boundary temperature TBOT [-50..50 °C, R] as function of date [dd-mm-yyyy]:
  DATET           TBOT   ! (maximum MABBC records)
  01-jan-2002    -15.0
  30-jun-2002    -20.0
  23-dec-2002    -10.0
* End of table
**********************************************************************
*** SOLUTE SECTION ***
**********************************************************************
* Part 1: Specify whether simulation includes solute transport
```

```
  SWSOLU = 0    ! Switch for simulation of solute transport, [Y=1, N=0]
**********************************************************************
* Part 2: Boundary and initial conditions


  CPRE = 0.0    ! Solute concentration in precipitation, [0..100 mg/cm3, R]

  CDRAIN = 0.1  ! Solute concentration in surface water [0..100 mg/cm3, R]


* If SWINCO = 1 or 2, list initial solute concentration CML [0..1000
mg/cm3, R]

* as function of soil depth ZC [-1d5..0 cm, R]:


      ZC       CML          ! (maximum MACP records)

   -10.0       0.0

   -95.0       0.0

* End of table
**********************************************************************
* Part 3: Miscellaneous parameters as function of soil depth


* Specify for each physical soil layer:

* ISOILLAY6 = number of physical soil layer, as defined in soil water
section (part 4) [1..MAHO, I]

* LDIS      = dispersion length [0..100 cm, R]

* KF        = Freundlich adsorption coefficient [0..1d4 cm3/mg, R]

* DECPOT    = potential decomposition rate [0..10 /d, R]


 ISOILLAY6     LDIS          KF  DECPOT    ! (maximum MAHO records)

     1         5.00   0.0001389     0.0

     2         5.00   0.0001378     0.0

     3         5.00   0.0001378     0.0

     4         5.00   0.0001378     0.0

     5         5.00   0.0001378     0.0

     6         5.00   0.0001378     0.0

     7         5.00   0.0001378     0.0

* --- end of Table
**********************************************************************
* Part 4: Diffusion constant and solute uptake by roots
```

```
  DDIF = 0.0    ! Molecular diffusion coefficient [0..10 cm2/day, R]

  TSCF = 0.0    ! Relative uptake of solutes by roots [0..10 -, R]
****************************************************************************
* Part 5: Adsorption


  SWSP = 0      ! Switch, consider solute adsorption [Y=1, N=0]


* In case of adsorption (SWSP = 1), specify:

  FREXP = 0.9   ! Freundlich exponent [0..10 -, R]

  CREF  = 1.0   ! Reference solute concentration for adsorption [0..1000
mg/cm3, R]
****************************************************************************

* Part 6: Decomposition


  SWDC = 0      ! Switch, consider solute decomposition [Y=1, N=0]


* In case of solute decomposition (SWDC = 1), specify:

  GAMPAR = 0.0  ! Factor reduction decomposition due to temperature [0..0.5
/°C, R]

  RTHETA = 0.3  ! Minimum water content for potential decomposition [0..0.4
cm3/cm3, R]

  BEXP   = 0.7  ! Exponent in reduction decomposition due to dryness [0..2
-, R]


* List the reduction of potential decomposition for each soil type [0..1 -,
R]:


  ISOILLAY7  FDEPTH           ! (maximum MAHO records)

       1       1.00

       2       0.65

* End of table
****************************************************************************

* Part 7: Solute residence time in the saturated zone

  SWBR = 0       ! Switch, consider mixed reservoir of saturated zone [Y=1,
N=0]


* Without mixed reservoir (SWBR = 0), specify:
```

```
* Switch for groundwater concentration in case of upward flow (seepage):
  SWBOTBC = 0    ! 0 = Equal to surface water concentration CDRAIN
                 ! 1 = Constant concentration CSEEP
                 ! 2 = Concentration as function of time

* In case of constant concentration (SWBOTBC = 1), specify:
  CSEEP = 0.1  ! Solute concentration in surface water [0..100 mg/cm3, R]

* In case of SWBOTBC = 2, specify groundwater conc. CSEEPARR [0..100
mg/cm3, R] as function of time
        DATEC     CSEEPARR   ! (maximum MABBC records)
  01-jan-2002         25.0
  30-jun-2002         40.0
  23-dec-2002         25.0
* End of table

* In case of mixed reservoir (SWBR = 1), specify:
  DAQUIF = 110.0 ! Thickness saturated part of aquifer [0..1d4 cm, R]
  POROS  = 0.4   ! Porosity of aquifer [0..0.6 -, R]
  KFSAT  = 0.2   ! Linear adsorption coefficient in aquifer [0..100 cm3/mg,
R]
  DECSAT = 1.0   ! Decomposition rate in aquifer [0..10 /d, R]
  CDRAINI = 0.2  ! Initial solute concentration in groundwater [0..100
mg/cm3, R]
**********************************************************************

* End of the main input file .SWP!
```

## S4 Crop parametrization

```
**********************************************************************
* Filename: MaizeS.CRP
* Contents: SWAP 4 - Crop data of simple model
**********************************************************************
*** PLANT GROWTH SECTION ***
**********************************************************************
* Part 1: Crop development


* Duration of crop growing period
  IDEV = 1 ! 1 = duration is fixed
           ! 2 = duration is variable


* If duration is fixed (IDEV = 1), specify:
  LCC  =   165 ! Duration of the crop growing period [1..366 days, I]


* If duration is variable (IDEV = 2), specify:
       TSUMEA =     1101.88
       TSUMAM =     1623.99
       TBASE  =        6.00
**********************************************************************
* Part 2: Light extinction


  KDIF   =     0.60 ! Extinction coefficient for diffuse visible light
[0..2 -, R]
  KDIR   =     0.75 ! Extinction coefficient for direct visible light
[0..2 -, R]
**********************************************************************
* Part 3: Leaf area index or soil cover fraction


  SWGC = 1 ! choice between leaf area index [=1] or soil cover fraction
[=2]


* If SWGC = 1, list leaf area index LAI [0..12 (m2 leaf)/(m2 soil), R],
as function of dev. stage [0..2 -, R]:
* If SWGC = 2, list soil cover fraction SCF [0..1 (m2 cover)/(m2 soil), R],
as function of dev. stage [0..2 -, R]:
```

```
*        DVS   LAI or SCF  ! ( maximum MAGRS records)
  GCTB =
        0.00   0.05
        0.30   0.14
        0.50   0.61
        0.70   4.10
        1.00   5.00
        1.40   5.80
        2.00   5.20
* End of table
***************************************************************************
* Part 4: Crop factor or crop height


* Choose between crop factor and crop height
* Choose crop factor if ETref is used, either from meteo input file (SWETR
= 1) or with Penman-Monteith
* Choose crop height if Penman-Monteith should be used with actual crop
height, albedo and canopy resistance
  SWCF = 2 ! 1 = crop factor
           ! 2 = crop height


* If SWCF = 1, list crop factor CF [0..2 -, R],   as function of dev. stage
DVS [0..2 -, R]:
* If SWCF = 2, list crop height CH [0..1.d4 cm, R], as function of dev.
stage DVS [0..2 -, R]:


    DVS       CH     CF   ! ( maximum MAGRS records)
    0.0       1.0    0.8
    0.3      15.0    0.8
    0.5      40.0    0.9
    0.7     140.0    1.0
    1.0     170.0    1.1
    1.4     180.0    1.2
    2.0     175.0    1.2
* End of table


* If SWCF = 2, in addition to crop height list crop specific values for:
```

```
  ALBEDO =   0.23 ! crop reflection coefficient [0..1.0 -, R]

  RSC    =   61.0 ! Minimum canopy resistance [0..1d6 s/m, R]

  RSW    =    0.0 ! Canopy resistance of intercepted water [0..1d6 s/m, R]
**********************************************************************
* Part 5: rooting depth


* List rooting depth RD [0..1000 cm, R], as a function of development stage
DVS [0..2 -, R]:


*        DVS   RD        ! (maximum MAGRS records)

  RDTB =

        0.00    5.00

        0.30   20.00

        0.50   50.00

        0.70   80.00

        1.00   90.00

        2.00  100.00

* End of table
**********************************************************************
* Part 6: yield response


* List yield response factor KY [0..5 -, R], as function of development
stage DVS [0..2 -, R]:


*        DVS   KY   (maximum MAGRS records)

  KYTB =

        0.00   1.00

        2.00   1.00

* End of table
**********************************************************************
* Part 7: Soil water extraction by plant roots


* -- Part 7a: Oxygen stress -----------------------

* Switch for oxygen stress:

  SwOxygen = 1      ! 0 = No oxygen stress

                    ! 1 = Oxygen stress according to Feddes et al. (1978)
```

```
                    ! 2 = Oxygen stress according to Bartholomeus et al.
(2008)


* If SwOxygen = 1, specify:

  HLIM1  =    -15.0    ! No water extraction at higher pressure heads [-
100..100 cm, R]

  HLIM2U =    -30.0    ! h below which optimum water extr. starts for top
layer [-1000..100 cm, R]

  HLIM2L =    -30.0    ! h below which optimum water extr. starts for sub
layer [-1000..100 cm, R]


* If SwOxygen = 2, specify:

  SwOxygenType = 1      ! Switch for physical processes or reproduction
functions to calculate oxygen stress:

                        ! 1 = Use physical processes

                        ! 2 = Use reproduction functions


* If SwOxygenType = 1, specify:

  Q10_microbial       = 2.8d0          ! Relative increase in microbial
respiration at temperature rise of 10 °C [1.0..4.0 -, R]

  Specific_resp_humus = 1.6d-3         ! Respiration rate of humus at 25 °C
[0.0..1.0 kg O2/kg °C/d, R]

  SRL                 = 151375.d0      ! Specific root length [0.d0..1d10
(m root)/(kg root), R]

  SwRootRadius        = 2              ! Switch for calculation of root
radius:

                                       ! 1 = Calculate root radius

                                       ! 2 = Root radius is given in input
file

* If SwRootRadius = 1, specify:

  Dry_mat_cont_roots      = 0.075d0    ! Dry matter content of roots [0..1
-, R]

  Air_filled_root_por     = 0.05d0     ! Air filled root porosity [0..1 -,
R]

  Spec_weight_root_tissue = 1.0d3      ! Specific weight of non-airfilled
root tissue [0..1d5 (kg root)/(m3 root), R]

  Var_a                   = 4.175d-10  ! Variance of root radius [0..1 -,
R]


* If SwRootRadius = 2, specify:
```

Root_radiusO2 = 0.00015d0 ! Root radius (mind: in meter!) for oxygen stress module [1d-6..0.1 m, R]

* If SwOxygenType = 2, specify:

SwTopSub = 2 ! Switch for topsoil or subsoil: 1 = topsoil, 2 = subsoil

NrStaring = 3 ! Number of soil type according to Staring series (Wosten et al., 2001), [1..18, I]

* -- Part 7b: Drought stress -----------------------

* Switch for drought stress:

SwDrought = 1 ! 1 = Drought stress according to Feddes et al. (1978)

! 2 = Drought stress according to De Jong van Lier et al. (2008)

* If SwDrought = 1, or in case of irrigation scheduling (SCHEDULE = 1), specify:

HLIM3H = -325.0 ! Pressure head below which water uptake reduction starts at high Tpot [-1d4..100 cm, R]

HLIM3L = -600.0 ! Pressure head below which water uptake reduction starts at low Tpot [-1d4..100 cm, R]

HLIM4 = -8000.0 ! No water extraction at lower soil water pressure heads [-2d4..100 cm, R]

ADCRH = 0.5 ! Level of high atmospheric demand, corresponding to HLIM3H [0..5 cm/d, R]

ADCRL = 0.1 ! Level of low atmospheric demand, corresponding to HLIM3L [0..5 cm/d, R]

ALPHACRIT = 1.0 ! Critical stress index (Jarvis, 1989) for compensation of root water uptake [0.2..1 -, R]

* If SwDrought = 2, specify:

WILTPOINT = -20000.0 ! Minimum pressure head in leaves [-1d8..-1d2 cm, R]

KSTEM = 1.03d-4 ! Hydraulic conductance between leaf and root xylem [1d-10..10 /d, R]

RXYLEM = 0.02 ! Xylem radius [1d-4..1 cm, R]

ROOTRADIUS = 0.05 ! Root radius [1d-4..1 cm, R]

KROOT = 3.5d-5 ! Radial hydraulic conductivity of root tissue [1d-10..1d10 cm/d, R]

ROOTCOEFA = 0.53 ! Defines relative distance between roots at which mean soil water content occurs [0..1 -, R]

SWHYDRLIFT =        0 ! Switch for possibility hydraulic lift in root system [N=0, Y=1]

ROOTEFF    =      1.0 ! Root system efficiency factor [0..1 -, R]

STEPHR   =        1.0 ! Step between values of hroot and hxylem in iteration cycle [0..10 cm, R]

CRITERHR =      0.001 ! Maximum difference of Hroot between iterations; convergence criterium [0...10 cm, R]

TACCUR =        0.001 ! Maximum absolute difference between simulated and calculated potential transpiration rate (1d-5..1d-2 cm/d, R)

***************************************************************************

* Part 8: salt stress

* Switch salinity stress

SWSALINITY = 0  ! 0 = No salinity stress

! 1 = Maas and Hoffman reduction function

! 2 = Use osmotic head

* If SWSALINITY = 1, specify threshold and slope of Maas and Hoffman

SALTMAX   =  3.0 ! Threshold salt concentration in soil water  [0..100 mg/cm3, R]

SALTSLOPE =  0.1 ! Decline of root water uptake above threshold [0..1.0 cm3/mg, R]

* If SWSALINITY = 2, specify:

SALTHEAD  =  624.0 ! Conversion salt concentration (mg/cm3) into osmotic head (cm) [0..1000.0 cm/(mg/cm3), R]

***************************************************************************

* Part 9: interception

* Switch for rainfall interception method:

SWINTER =  1  ! 0 = No interception

! 1 = Agricultural crops (Von Hoyningen-Hune and Braden)

! 2 = Closed forest canopies (Gash)

* In case of interception method for agricultural crops (SWINTER = 1), specify:

COFAB =  0.25 ! Interception coefficient Von Hoyningen-Hune and Braden [0..1 cm, R]

* In case of interception method for closed forest canopies (SWINTER = 2), specify as function of time T [0..366 d, R]:

* PFREE = Free throughfall coefficient [0..1 -, R]

* PSTEM = Stem flow coefficient [0..1 -, R]

* SCANOPY = Storage capacity of canopy [0..10 cm, R]

* AVPREC = Average rainfall intensity [0..100 cm/d, R]

* AVEVAP = Average evaporation intensity during rainfall from a wet canopy [0..10 cm/d, R]

| T | PFREE | PSTEM | SCANOPY | AVPREC | AVEVAP | ! (maximum MAGRS records) |
|---|---|---|---|---|---|---|
| 0.0 | 0.9 | 0.05 | 0.4 | 6.0 | 1.5 | |
| 365.0 | 0.9 | 0.05 | 0.4 | 6.0 | 1.5 | |

* End of table

**********************************************************************

* Part 10: Root density distribution and root growth

* List root density [0..100 cm/cm3, R] as function of relative rooting depth [0..1 -, R]:

* In case of drought stress according to Feddes et al. (1978) (SWDROUGHT = 1), relative root density (-) is sufficient

```
*    Rdepth Rdensity          ! (maximum 11 records)
  RDCTB =
0.0,1.000
0.1,0.741
0.2,0.549
0.3,0.407
0.4,0.301
0.5,0.223
0.6,0.165
0.7,0.122
0.8,0.091
0.9,0.067
1.0,0.050
```

* End of table

```
**********************************************************************************
*** IRRIGATION SCHEDULING SECTION ***
**********************************************************************************
* Part 1: General

  SCHEDULE = 0  ! Switch for application irrigation scheduling [Y=1, N=0]

* If SCHEDULE = 0, no more information is required in this input file!
* If SCHEDULE = 1, continue ....

  STARTIRR = 30 3 ! Specify day and month at which irrigation scheduling
starts [dd mm]
  ENDIRR  = 31 12 ! Specify day and month at which irrigation scheduling
stops [dd mm]
  CIRRS = 0.0     ! Solute concentration of irrigation water [0..100
mg/cm3, R]
  ISUAS = 1       ! Switch for type of irrigation method:
                  ! 0 = sprinkling irrigation
                  ! 1 = surface irrigation

* Specify pressure head at field capacity which will be used for irrigation
timing options
  phFieldCapacity = -100.0   ! Soil water pressure head at field capacity
[-1000..0 cm, R]
**********************************************************************************
* Part 2: Irrigation time criteria

*** Choose one of the following 5 timing options:
  TCS = 1  ! Switch for timing criterion [1..6 -, I]
           ! 1 = Ratio actual/potential transpiration
           ! 2 = Depletion of Readily Available Water
           ! 3 = Depletion of Totally Available Water
           ! 4 = Depletion of absolute Water Amount
           ! 5 = Pressure head or moisture content
           ! 6 = Fixed weekly irrigation, bring root zone back to field
capacity
```

```
* Ratio actual/potential transpiration (TCS = 1)

* If TCS = 1, specify mimimum of ratio actual/potential transpiration Trel
[0..1 -, R] as function of crop development stage

  DVS_tc1  Trel   ! (maximum 7 records)

      0.0  0.95

      2.0  0.95

* End of table


* Depletion of Readily Available Water (TCS = 2)

* If TCS = 2, specify minimum fraction of readily available water RAW [0..1
-, R] as function of crop development stage

  DVS_tc2   RAW   ! (maximum 7 records)

      0.0  0.95

      2.0  0.95

* End of table


* Depletion of Totally Available Water (TCS = 3)

* If TCS = 3, specify minimal fraction of totally available water TAW [0..1
-, R] as function of crop development stage

  DVS_tc3   TAW   ! (maximum 7 records)

      0.0  0.50

      2.0  0.50

* End of table


* Depletion of absolute Water Amount (TCS = 4)

* If TCS = 4, specify maximum amount of water depleted below field capacity
DWA [0..500 mm, R] as function of crop development stage

  DVS_tc4   DWA   ! (maximum 7 records)

      0.0  40.0

      2.0  40.0

* End of table


* Pressure head or Moisture content (TCS = 5), specify

  PHORMC = 0    ! Switch, use either pressure head (PHORMC = 0) or water
content (PHORMC = 1)

  DCRIT = -30.0 ! Depth of the sensor [-100..0 cm, R]

* Also specify critical pressure head [-1d6..-100 cm, R] or moisture
content [0..1 cm3/cm3, R] as function of crop development stage
```

```
  DVS_tc5  Value_tc5
      0.0    -1000.0
      2.0    -1000.0
* End of table


* In case TCS = 5, over-irrigation can be applied if the salinity concentration exceeds a threshold salinity
* Switch for over-irrigation:
  SWCIRRTHRES = 0    ! 0 = No over-irrigation
                     ! 1 = Apply over-irrigation
* If SWCIRRTHRES = 1, specify:
  CIRRTHRES = 8.0    ! Threshold salinity concentration above which over-irrigation occurs [0..100 mg/cm3, R]
  PERIRRSURP = 10.0  ! Over-irrigation as percentage of the usually scheduled irrigation depth [0..100 %, R]


* Fixed weekly irrigation, root zone back to field capacity (TCS = 6), specify
* Threshold value for weekly irrigation; only irrigate when soil water deficit in root zone is larger than threshold
  IRGTHRESHOLD = 1.0       ! threshold value  [0..20 mm, R]


* Switch for minimum time interval between irrigation applications
  TCSFIX = 0       ! 0 = no minimum time interval
                   ! 1 = define minimum time interval
* If TCSFIX = 1, specify:
  IRGDAYFIX = 7    ! Minimum number of days between irrigation applications [1..366 d, I]


**************************************************************************
* Part 3: Irrigation depth criteria


* Choose one of the following two options for irrigation depth:
  DCS = 1      ! 1 = Back to Field Capacity
               ! 2 = Fixed Irrigation Depth



* Back to Field Capacity (DCS = 1)
```

```
* If DCS = 1, specify amount of under (-) or over (+) irrigation dI [-100..100 mm, R],
* as function of crop development stage [0..2, R]
    DVS_dc1    dI        ! (maximum 7 records)
        0.0  10.0
        2.0  10.0
* End of table
  RAITHRESHOLD = 10.0 ! When rainfall exceeds RAITHRESHOLD, irrigation is reduced with rainfall [0..1000 cm, R]

* Fixed Irrigation Depth (DCS = 2)
* If DCS = 2, specify fixed irrigation depth FID [0..400 mm, R],
* as function of crop development stage [0..2, R]
    DVS_dc2   FID         ! (maximum 7 records)
        0.0  60.0
        2.0  60.0
* End of table

* Select minimum and maximum of irrigation depths:
  dcslim = 0         ! Switch, limit range irrigation depth  [Y=1, N=0]

* If dcslim = 1, specify:
  irgdepmin = 10.0    !  Minimum irrigation depth [0..100 mm, I]
  irgdepmax = 80.0    !  Maximum irrigation depth [irgdepmin..1d7 mm, I]

* End of .crp file !
```

**S5. Effect of Representative Concentration Pathways (RCP)**

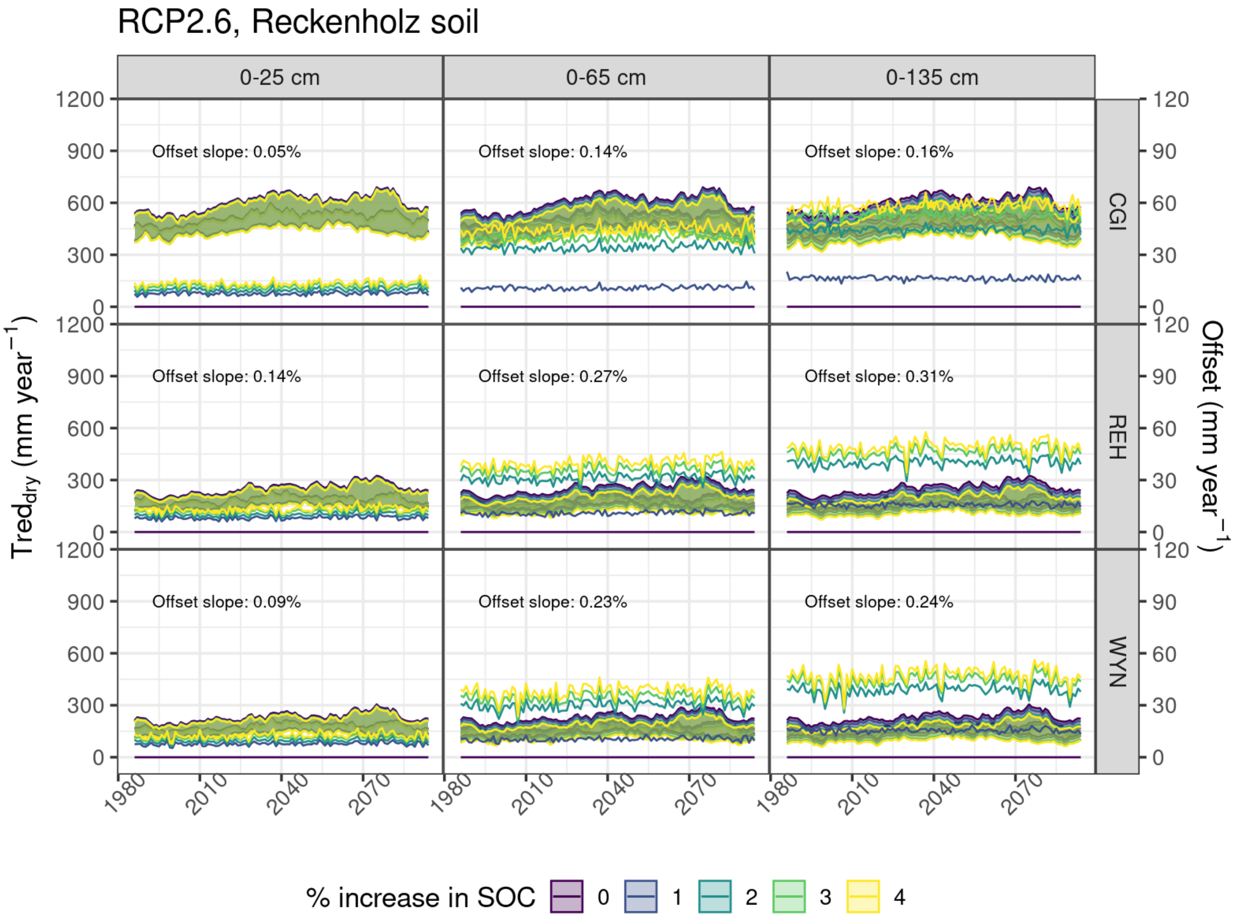


Figure S 2 - Transpiration reduction due to drought stress (Tred$_{dry}$) (left axis) for actual and future climate conditions considering different levels of SOC increase in the soil at different effective soil depths. Climate projections considering RCP2.6 and averaged for every 10 years. Shaded area refers to the values between quantiles $q_{0.05}$ and $q_{0.95}$ of the climate projections. The slope refers to the offset (right axis; interpretable as average seasonal gain in transpiration with SOC increase) between 0 and 4% addition of SOC. *Offset slope* refers to the slope of the offset line between 0 and 4% SOC addition.

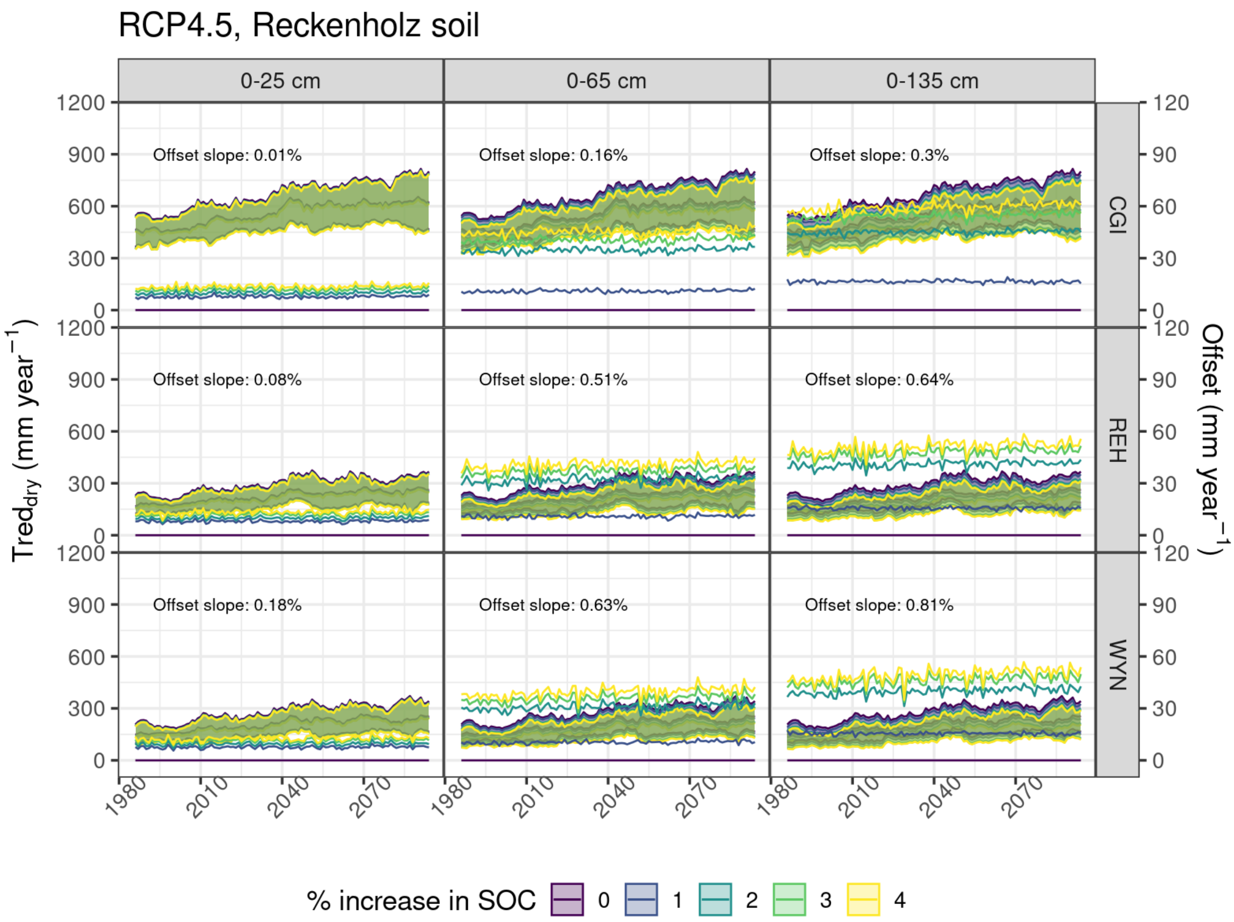


Figure S 3 - Transpiration reduction due to drought stress (Tred$_{dry}$) (left axis) for actual and future climate conditions considering different levels of SOC increase in the soil at different effective soil depths. Climate projections considering RCP4.5 and averaged for every 10 years. Shaded area refers to the values between quantiles $q_{0.05}$ and $q_{0.95}$ of the climate projections. The slope refers to the offset (right axis; interpretable as average seasonal gain in transpiration with SOC increase) between 0 and 4% addition of SOC. *Offset slope* refers to the slope of the offset line between 0 and 4% SOC addition.

## S6. Detailed profile soil water content at CGI and WYN

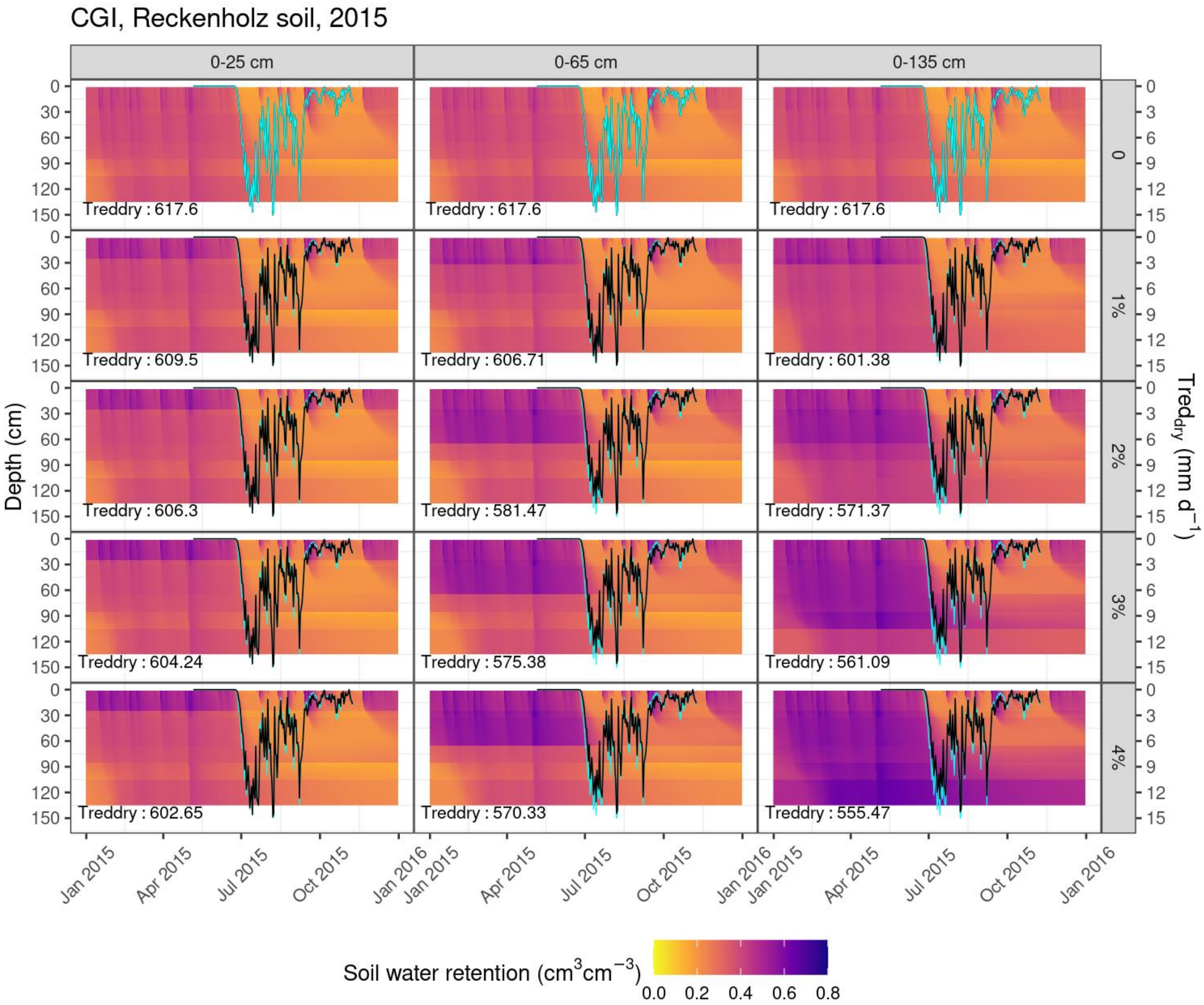


Figure S 4 - Detailed profile of soil water content (left axis) and Tred$_{dry}$ (right axis, black lines) according to the different added SOC levels at the Changins site (CGI) in the year of 2015. The blue line represents Tred$_{dry}$ for the original soil profile (0% SOC). When cumulated for the year, their difference yields the annual offset in crop transpiration deficit that is due to the addition of carbon to the soil.

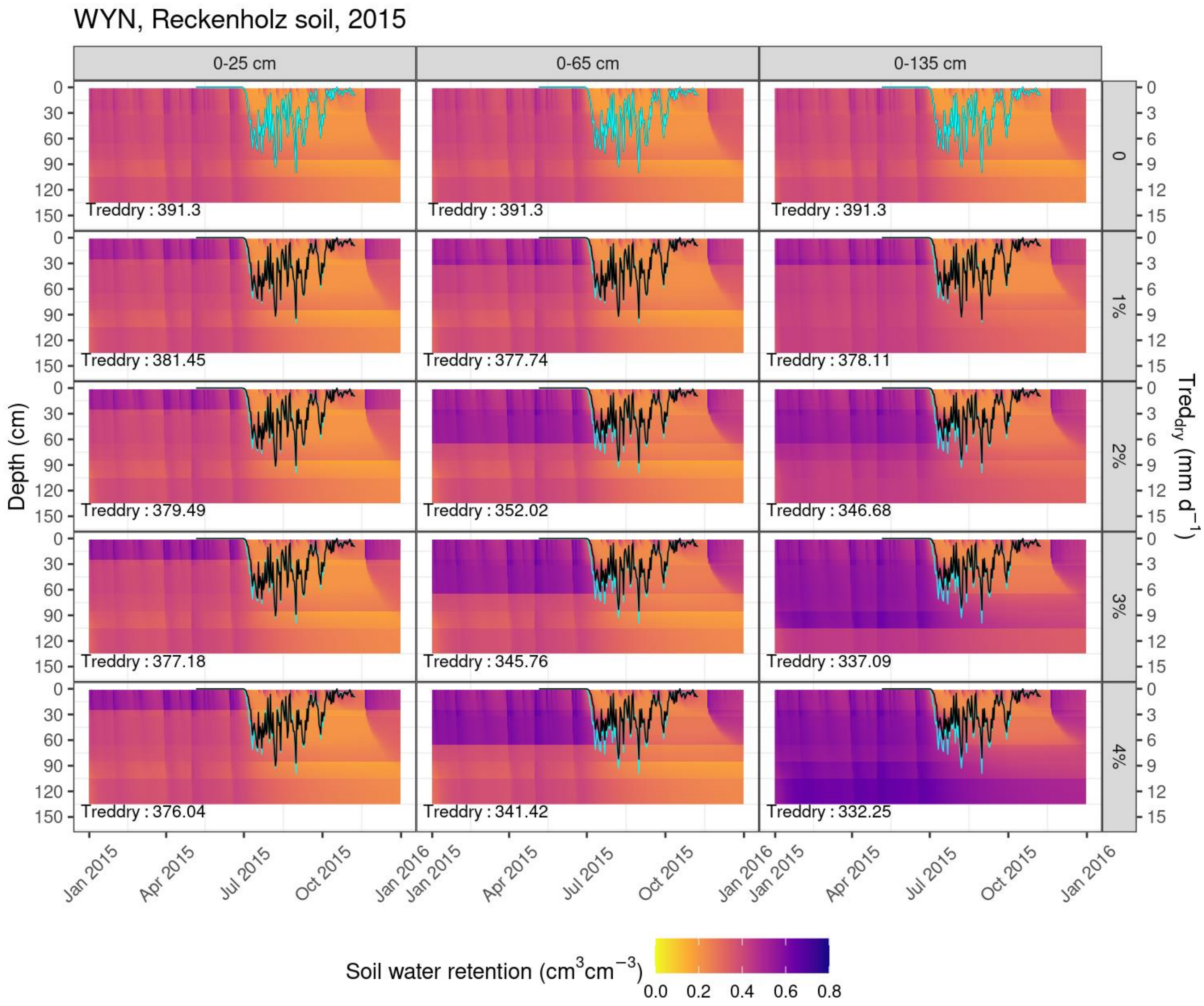


Figure S 5 - Detailed profile of soil water content (left axis) and Tred$_{dry}$ (right axis, black lines) according to the different added SOC levels at the Wynau site (WYN) in the year of 2015. The blue line represents Tred$_{dry}$ for the original soil profile (0% SOC). When cumulated for the year, their difference yields the annual offset in crop transpiration deficit that is due to the addition of carbon to the soil.