Test cases Swap-Wofost

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Test cases Swap-Wofost

hydrology and crop growth with Swap-Wofost

Joop Kroes, Jos van Dam, Martin Mulder, Mirjam Hack-tenBroeke, Rob Hendriks, Iwan Supit, Joost Wolf

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Abstract

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Contents

1 Introduction

This document describes test-results of simulations with the SWAP model.

In the first chapter summaries are given in several tables.
Overall performance: i) was the simulation succesfull completed, ii) was the water balance sound, iii) what was the required cpu time;
The performance is given with different performance indicators (PI):
1. Yield (kg/ha/yr DM); mean of cumulative value per year
2. LAI (m2 leaf/m2 soil); mean pf daily values
3. ETact (mm/d); mean of daily values
4. Gwl (m-soil surface); mean of daily values
5. Volumic soil moisture content at 20 cm below the soil surface: theta20 (-); mean of daily values
6. Soil Pressure head at 20 cm below the soil surface: phead20 (cm); mean of daily values
7. Lateral drainage flux: qDrain (mm/d); mean of daily values
8. Water flux across the lower boundary of the model system: qBot (mm/d); mean of yearly values.

In the next chapters the following is reported of each case :
1. a table with a short characterisation;
2. a table with the numerical input settings;
3. a table with the results from Performance Indicators;
4. a series of figures with pictures corresponding to the Performance Indicators;
5. a yearly water balance of each simulated year; mass balance of water (and when relevant of solutes), if the nr of years is high then the table may be truncated.

2 Method and Materials

This report describes results achieved for field experiments where soil hydrological and crop growth observations were collected. The experiments are modelled using the SWAP model for hydrology with a module for crop growth that is based on the WOFOST model.
A summary of the simulation results is given in the following table for cpu-time (sec) and indicator for successful completion with a sound water balance.

Table 2.1
Summary of results

	case	completed	watbalok	cpu.sec
1	CropgrowthGrasslandM(Ruurlo16)	yes	yes	14.72
2	CropgrowthGrasslandM(Ruurlo48)	yes	yes	14.39
3	CropgrowthGrasslandM(Zegveld03)	yes	yes	194.90
4	CropgrowthMaizeD(Cranendonck16)	yes	yes	14.68
5	CropgrowthMaizeD(Dijkgraaf)	yes	yes	7.65
6	CropgrowthPotatoD(Borgerswold03)	yes	yes	4.70
7	CropgrowthPotatoD(Borgerswold13)	yes	yes	5.30
8	CropGrowthPotatoD(RusthoeveB7)	yes	yes	3.64
9	CropgrowthPotatoD(Vredepeel26)	yes	yes	4.26
10	total	9	9	264.24

Statistics for different Performance Indicators are calculated using an R-package hydroGOF from Mauricio Zambrano Bigiarini. This results is summarised using the following statistics:

Results are analysed using different statistics:

- SIM = simulated value for the indicator PIname with unit PIunit;
- OBS = observed values;
- ME = Mean Error is the mean difference between SIM and OBS;
- RMSE = Root Mean Square Error (RMSE) between sim and obs, in the same units of sim and obs, with treatment of missing values. RMSE gives the standard deviation of the model prediction error. A smaller value indicates better model performance;
- NSE = Nash-Sutcliffe efficiency between sim and obs, with treatment of missing values. NSE indicates how well the plot of observed versus simulated data fits the 1:1 line. Nash-Sutcliffe efficiencies range from -Inf to 1. Essentially, the closer to 1, the more accurate the model is;
  - NSE = 1, corresponds to a perfect match of modelled to the observed data.
  - NSE = 0, indicates that the model predictions are as accurate as the mean of the observed data,
  - -Inf < NSE < 0, indicates that the observed mean is better predictor than the model.
- IoA = Relative Index of Agreement (d) between sim and obs, with treatment of missing values. It varies between 0 and 1. A value of 1 indicates a perfect match, and 0 indicates no agreement at all.

Table 2.2
Performance Indices 1

	PIname	PIunit	SIM	OBS	ME	RMSE	NSE	IoA
1	Yield	kg/ha/yr DM	14375.40	14317.80	57.60	3037.23	-0.43	0.01
2	Yield	kg/ha/yr DM	14598.20	14508.40	89.80	3209.70	-0.57	0.00
3	Yield	kg/ha/yr DM	10306.67	12577.00	-2270.33	3018.82	-1.04	0.72
4	Yield	kg/ha/yr DM	14116.22	13787.78	328.44	3007.66	-1.89	0.60
5	Yield	kg/ha/yr DM	14249.00	16306.00	-2057.00			
6	Yield	kg/ha/yr DM	12298.50	9246.44	3052.06	3125.58	-175.06	0.16
7	Yield	kg/ha/yr DM	12303.00	10690.87	1612.13	1677.61	-0.36	0.73
8	Yield	kg/ha/yr DM	11234.00	8610.00	231.33			
9	Yield	kg/ha/yr DM	12548.00	11359.00	1189.00			

Table 2.3
Performance Indices 2

	PIname	PIunit	SIM	OBS	ME	RMSE	NSE	IoA
1	LAI	m2/m2	1.51					
2	LAI	m2/m2	1.53					
3	LAI	m2/m2	1.19					
4	LAI	m2/m2	1.76					
5	LAI	m2/m2	2.53	2.47	-0.61	0.83	0.52	0.85
6	LAI	m2/m2	2.41					
7	LAI	m2/m2	2.35					
8	LAI	m2/m2	2.38					
9	LAI	m2/m2	2.66					

Table 2.4
Performance Indices 3

	PIname	PIunit	SIM	OBS	ME	RMSE	NSE	IoA
1	ETact	mm/yr	1.63					
2	ETact	mm/yr	1.65					
3	ETact	mm/yr	1.43					
4	ETact	mm/yr	1.13					
5	ETact	mm/yr	1.44	1.93	-0.50	0.81	0.61	0.88
6	ETact	mm/yr	1.14					
7	ETact	mm/yr	1.19					
8	ETact	mm/yr	1.49					
9	ETact	mm/yr	1.19					

Table 2.5
Performance Indices 4

	PIname	PIunit	SIM	OBS	ME	RMSE	NSE	IoA
1	Gwl	m-soilsurface	-1.05	-1.05	0.00	0.02	1.00	1.00
2	Gwl	m-soilsurface	-0.93	-0.93	0.00	0.02	1.00	1.00
3	Gwl	m-soilsurface	-0.46	-0.43	-0.03	0.11	0.58	0.87
4	Gwl	m-soilsurface	-1.41	-1.36	-0.05	0.25	0.37	0.87
5	Gwl	m-soilsurface	-0.94					
6	Gwl	m-soilsurface	-1.10	-1.10	0.00	0.03	0.99	1.00
7	Gwl	m-soilsurface	-1.20	-1.20	0.00	0.03	0.99	1.00
8	Gwl	m-soilsurface	-1.07	-1.10	0.03	0.19	0.63	0.92
9	Gwl	m-soilsurface	-1.03	-1.07	0.04	0.12	0.80	0.94

Table 2.6
Performance Indices 5

	PIname	PIunit	SIM	OBS	ME	RMSE	NSE	IoA
1	Theta20cm	m3/m3	0.26					
2	Theta20cm	m3/m3	0.28					
3	Theta20cm	m3/m3	0.61					
4	Theta20cm	m3/m3	0.24					
5	Theta20cm	m3/m3	0.27	0.27	0.00	0.03	0.63	0.85
6	Theta20cm	m3/m3	0.24					
7	Theta20cm	m3/m3	0.28					
8	Theta20cm	m3/m3	0.39					
9	Theta20cm	m3/m3	0.16					

Table 2.7
Performance Indices 6

	PIname	PIunit	SIM	OBS	ME	RMSE	NSE	IoA
1	PresHead20cm	cm	-155.43					
2	PresHead20cm	cm	-115.97					
3	PresHead20cm	cm	-1033.64	-100.82	-932.82	2433.81	-249.45	0.16
4	PresHead20cm	cm	-481.04					
5	PresHead20cm	cm	-63.00					
6	PresHead20cm	cm	-105.39					
7	PresHead20cm	cm	-101.06					
8	PresHead20cm	cm	-112.71					
9	PresHead20cm	cm	-63.19					

Table 2.8
Performance Indices 7

	PIname	PIunit	SIM	OBS	ME	RMSE	NSE	IoA
1	qDrain	mm	0.03					
2	qDrain	mm	0.06					
3	qDrain	mm	0.47					
4	qDrain	mm	0.00					
5	qDrain	mm	0.00					
6	qDrain	mm	0.00					
7	qDrain	mm	0.00					
8	qDrain	mm	1.06	0.62	0.44	1.41	0.35	0.84
9	qDrain	mm	0.89					

Table 2.9
Performance Indices 8

	PIname	PIunit	SIM	OBS	ME	RMSE	NSE	IoA
1	qBot	mm	-122.65					
2	qBot	mm	-104.07					
3	qBot	mm	-39.43					
4	qBot	mm	-287.86					
5	qBot	mm	-416.10					
6	qBot	mm	-533.01					
7	qBot	mm	-511.04					
8	qBot	mm	68.41					
9	qBot	mm	0.00					

3 Grassland

3.1 Grassland mowing

3.1.1 CropgrowthGrasslandM(Ruurlo16)

Table 3.1
Description of case

	1
CaseNr	1
dirnam	CropgrowthGrasslandM(Ruurlo16)
Location	Ruurlo
SimulationPeriod	1980-1984
SoilType	sandy loam
CropType	grassland
drainage	basic
irrigation	none
bottomboundary	given gwl
reference	Kroes and Supit (2011)

Project: RuurloGrasfield16-600N-2K-80i
File name: RuurloGrasfield16-600N-2K-80i.swp
Model version: Swap 4.0.1

Simulation started at Mon Jun 12 11:49:42 2017
Simulation stopped at Mon Jun 12 11:49:56 2017
Simulation elapsed time 14.72 (sec)

Succesfull completion of simulation: yes
Succesfull closure of water balance: yes

Table 3.2
Iteration parameters

	variables	values	units
1	DTMIN	1e-06	(d)
2	DTMAX	0.2	(d)
3	GWLCONV	100	(cm)
4	CRITDEVMASBALABS	0.099	(d)
5	CRITDEVMASBALDT	NA	(d)
6	CRITDEVPONDDT	1e-04	(cm)
7	MAXIT	30	(-)
8	MAXBACKTR	3	(-)
9	SWkmean	1	(-)
10	SWkImpl	0	(-)

Table 3.3
Statistics of Performance Indices

	PIname	PIunit	SIMmean	OBSmean	ME	RMSE	NSE	d
1	Yield	kg/ha/yr DM	14375.40	14317.80	57.60	3037.23	-0.43	0.01
2	LAI	m2/m2	1.51					
3	ETact	mm/yr	1.63					
4	Gwl	m-soilsurface	-1.05	-1.05	0.00	0.02	1.00	1.00
5	Theta20cm	m3/m3	0.26					
6	PresHead20cm	cm	-155.43					
7	qDrain	mm	0.03					
8	qBot	mm	-122.65					
9	yieldN	kg/ha/yr N						
10	leachN	kg/ha/yr N						

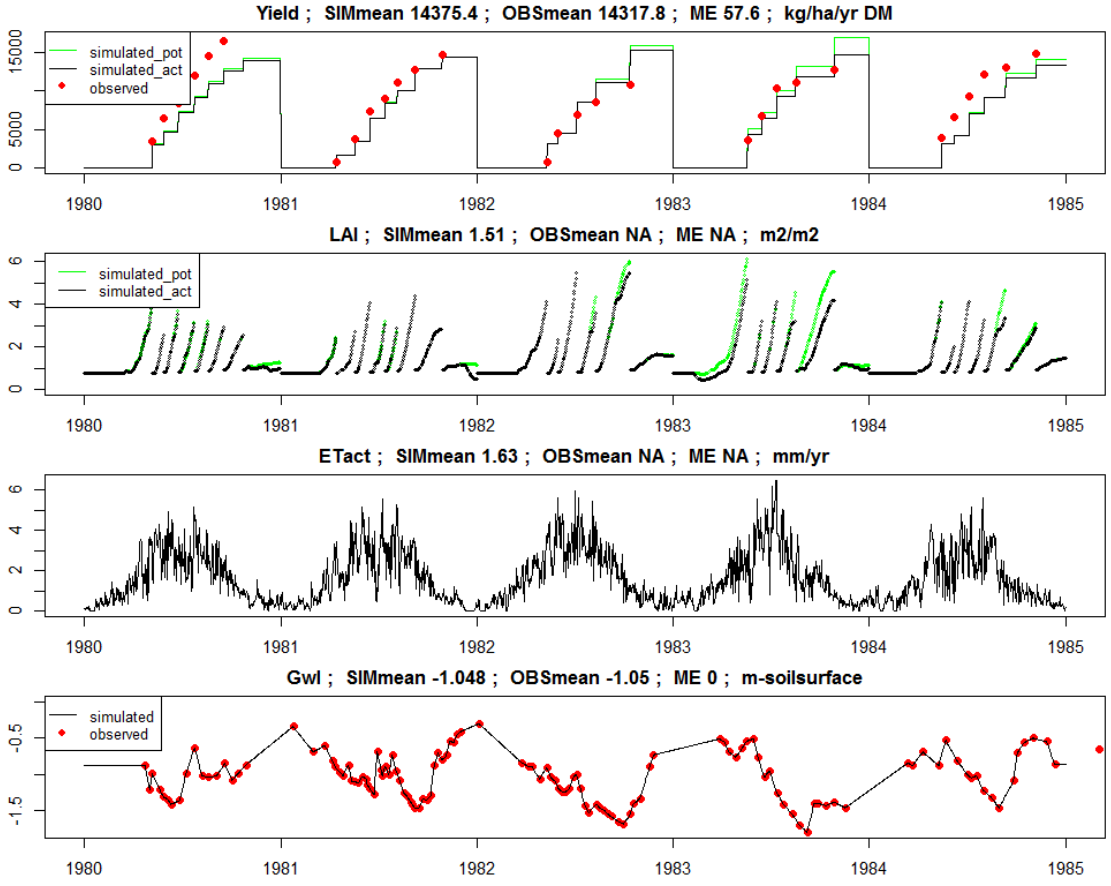

Figure 3.1
CropgrowthGrasslandM(Ruurlo16)

Table 3.4
Waterbalans

	1	2	3	4	5
ipl	1	1	1	1	1
yr	1980	1981	1982	1983	1984
Igrai	723	771	611	762	736
Igsnow	20	34	5	2	8
Igirr	0	0	0	0	0
RunOn	0	0	0	0	0
fldrin1	0	0	0	0	0
fldrin2	0	0	0	0	0
fldrin3	0	0	0	0	0
flindr4	0	0	0	0	0
fldrin5	0	0	0	0	0
flbtin	210	308	289	159	240
evicpr	-39	-37	-49	-30	-30
evicir	0	0	0	0	0
evso	-109	-104	-94	-103	-105
evsubl	0	-3	0	0	-1
evpn	0	0	0	0	0
flev	-442	-441	-510	-466	-420
runoff	0	-2	0	0	-11
fldrou1	-1	-16	-38	-1	-1
fldrou2	0	0	0	0	0
fldrou3	0	0	0	0	0
fldrou4	0	0	0	0	0
fldrou5	0	0	0	0	0
flbtou	-316	-495	-248	-381	-378
deltast	-46	-15	34	59	-37
deltapn	0	0	0	0	0
deltasnow	0	0	0	0	0
badev	0	0	0	0	0
evsoma	-147	-135	-149	-151	-140
evtrma	-449	-445	-527	-501	-436

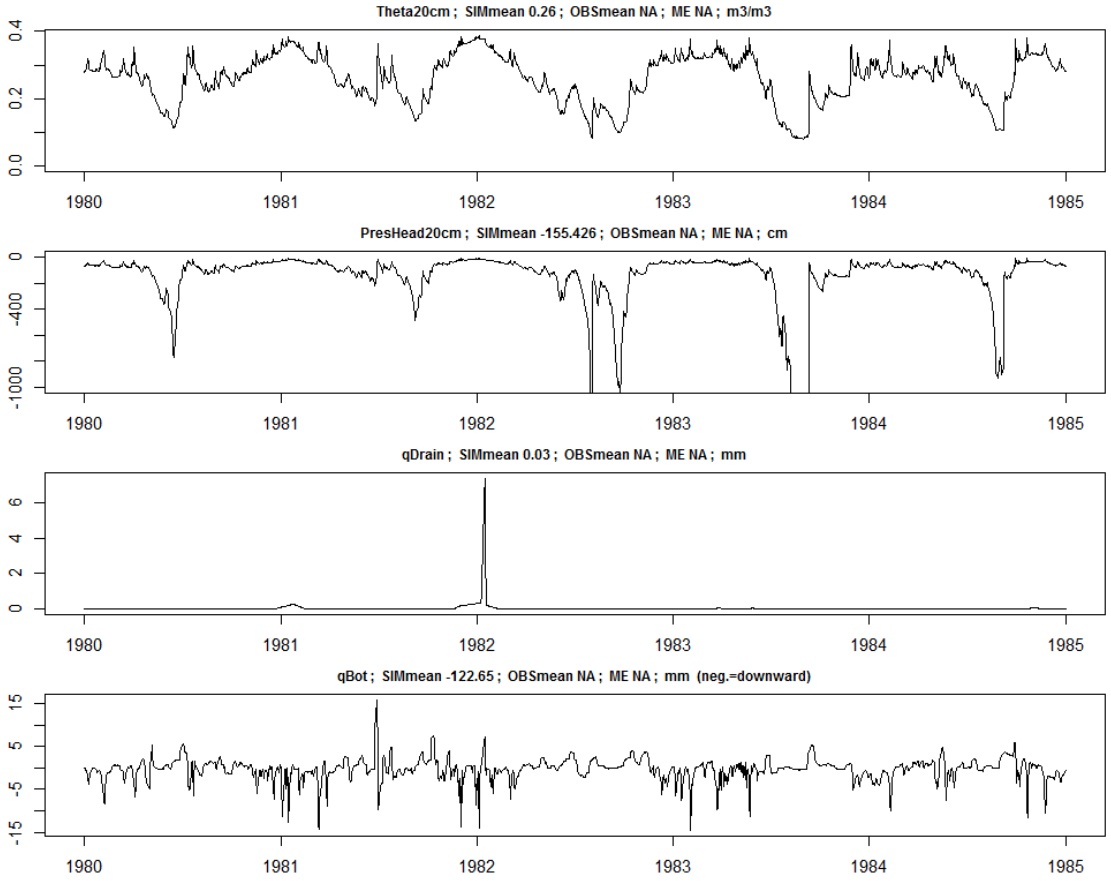

Figure 3.2
CropgrowthGrasslandM(Ruurlo16)

3.1.2 CropgrowthGrasslandM(Ruurlo48)

Table 3.5
Description of case

	2
CaseNr	2
dirnam	CropgrowthGrasslandM(Ruurlo48)
Location	Ruurlo
SimulationPeriod	1980-1984
SoilType	sandy loam
CropType	grassland
drainage	basic
irrigation	none
bottomboundary	given gwl
reference	Kroes and Supit (2011)

Project: RuurloGrasfield48-800N-3K-40b
File name: RuurloGrasfield48-800N-3K-40b.swp
Model version: Swap 4.0.1

Simulation started at Mon Jun 12 11:50:00 2017
Simulation stopped at Mon Jun 12 11:50:14 2017
Simulation elapsed time 14.39 (sec)

Succesfull completion of simulation: yes
Succesfull closure of water balance: yes

Table 3.6
Iteration parameters

	variables	values	units
1	DTMIN	1e-06	(d)
2	DTMAX	0.2	(d)
3	GWLCONV	100	(cm)
4	CRITDEVMASBALABS	0.099	(d)
5	CRITDEVMASBALDT	NA	(d)
6	CRITDEVPONDDT	1e-04	(cm)
7	MAXIT	30	(-)
8	MAXBACKTR	3	(-)
9	SWkmean	1	(-)
10	SWkImpl	0	(-)

Table 3.7
Statistics of Performance Indices

	PIname	PIunit	SIMmean	OBSmean	ME	RMSE	NSE	d
1	Yield	kg/ha/yr DM	14598.20	14508.40	89.80	3209.70	-0.57	0.00
2	LAI	m2/m2	1.53					
3	ETact	mm/yr	1.65					
4	Gwl	m-soilsurface	-0.93	-0.93	0.00	0.02	1.00	1.00
5	Theta20cm	m3/m3	0.28					
6	PresHead20cm	cm	-115.97					
7	qDrain	mm	0.06					
8	qBot	mm	-104.07					
9	yieldN	kg/ha/yr N						
10	leachN	kg/ha/yr N						

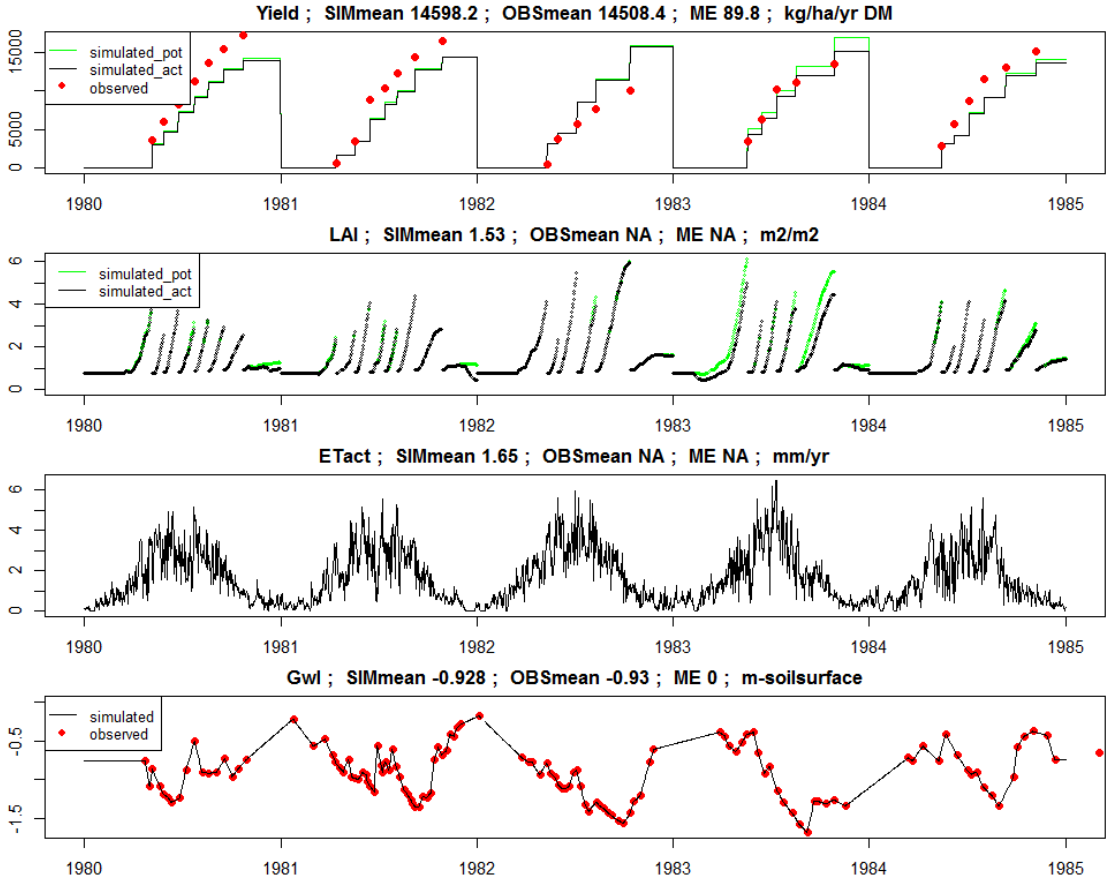

Figure 3.3
CropgrowthGrasslandM(Ruurlo48)

Table 3.8
Waterbalans

	1	2	3	4	5
ipl	1	1	1	1	1
yr	1980	1981	1982	1983	1984
Igrai	723	771	611	762	736
Igsnow	20	34	5	2	8
Igirr	0	0	0	0	0
RunOn	0	0	0	0	0
fldrin1	0	0	0	0	0
fldrin2	0	0	0	0	0
fldrin3	0	0	0	0	0
flindr4	0	0	0	0	0
fldrin5	0	0	0	0	0
flbtin	224	300	303	186	266
evicpr	-39	-37	-51	-31	-30
evicir	0	0	0	0	0
evso	-110	-104	-94	-106	-106
evsubl	0	-3	0	0	-1
evpn	0	0	0	0	0
flev	-444	-439	-518	-478	-427
runoff	0	-2	0	0	-11
fldrou1	-4	-34	-51	-16	-11
fldrou2	0	0	0	0	0
fldrou3	0	0	0	0	0
fldrou4	0	0	0	0	0
fldrou5	0	0	0	0	0
flbtou	-330	-477	-229	-377	-386
deltast	-40	-9	25	58	-37
deltapn	0	0	0	0	0
deltasnow	0	0	0	0	0
badev	0	0	0	0	0
evsoma	-147	-136	-148	-149	-139
evtrma	-450	-445	-528	-503	-436

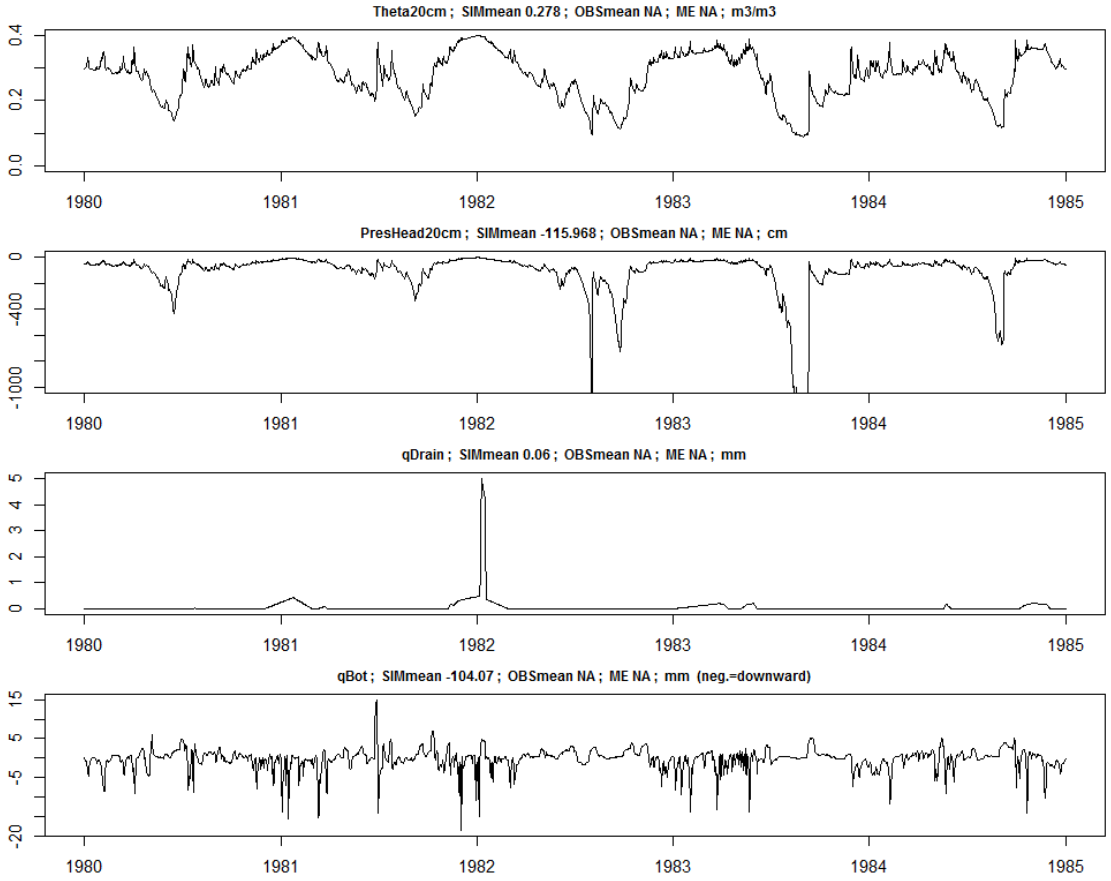

Figure 3.4
CropgrowthGrasslandM(Ruurlo48)

3.1.3 CropgrowthGrasslandM(Zegveld03)

Table 3.9
Description of case

	3
CaseNr	3
dirnam	CropgrowthGrasslandM(Zegveld03)
Location	Zegveld
SimulationPeriod	2003-2005
SoilType	peat
CropType	grassland
drainage	basic
irrigation	none
bottomboundary	given gwl
reference	Hendriks (20xx)

Project: Zeg03
File name: Zeg03.swp
Model version: Swap 4.0.1

Simulation started at Mon Jun 12 11:50:17 2017
Simulation stopped at Mon Jun 12 11:53:32 2017
Simulation elapsed time 194.9 (sec)

Succesfull completion of simulation: yes
Succesfull closure of water balance: yes

Table 3.10
Iteration parameters

	variables	values	units
1	DTMIN	1e-06	(d)
2	DTMAX	0.01	(d)
3	GWLCONV	100	(cm)
4	CRITDEVMASBALABS	0.099	(d)
5	CRITDEVMASBALDT	NA	(d)
6	CRITDEVPONDDT	1e-04	(cm)
7	MAXIT	30	(-)
8	MAXBACKTR	3	(-)
9	SWkmean	4	(-)
10	SWkImpl	0	(-)

Table 3.11
Statistics of Performance Indices

	PIname	PIunit	SIMmean	OBSmean	ME	RMSE	NSE	d
1	Yield	kg/ha/yr DM	10306.67	12577.00	-2270.33	3018.82	-1.04	0.72
2	LAI	m2/m2	1.19					
3	ETact	mm/yr	1.43					
4	Gwl	m-soilsurface	-0.46	-0.43	-0.03	0.11	0.58	0.87
5	Theta20cm	m3/m3	0.61					
6	PresHead20cm	cm	-1033.64	-100.82	-932.82	2433.81	-249.45	0.16
7	qDrain	mm	0.47					
8	qBot	mm	-39.43					
9	yieldN	kg/ha/yr N						
10	leachN	kg/ha/yr N						

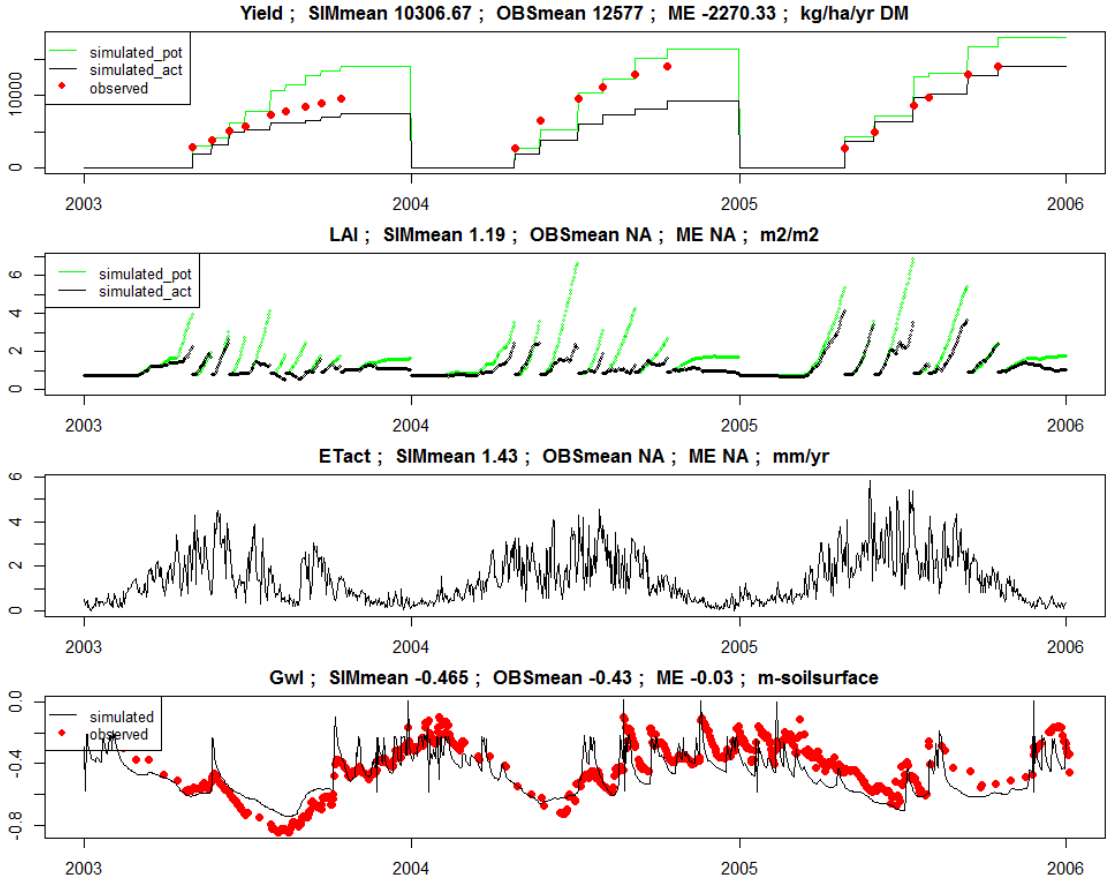

Figure 3.5
CropgrowthGrasslandM(Zegveld03)

Table 3.12
Waterbalans

	1	2	3
ipl	1	1	1
yr	2003	2004	2005
Igrai	608	881	830
Igsnow	8	7	21
Igirr	0	0	0
RunOn	0	0	0
fldrin1	114	55	54
fldrin2	0	0	0
fldrin3	0	0	0
flindr4	0	0	0
fldrin5	0	0	0
flbtin	2	1	2
evicpr	-25	-35	-42
evicir	0	0	0
evso	-80	-115	-105
evsubl	-2	0	0
evpn	0	0	0
flev	-362	-355	-444
runoff	-25	-61	-70
fldrou1	-72	-131	-108
fldrou2	-132	-194	-105
fldrou3	0	0	0
fldrou4	0	0	0
fldrou5	0	0	0
flbtou	-38	-54	-31
deltast	3	0	-2
deltapn	0	0	0
deltasnow	0	0	0
badev	0	0	0
evsoma	-220	-200	-168
evtrma	-531	-468	-503

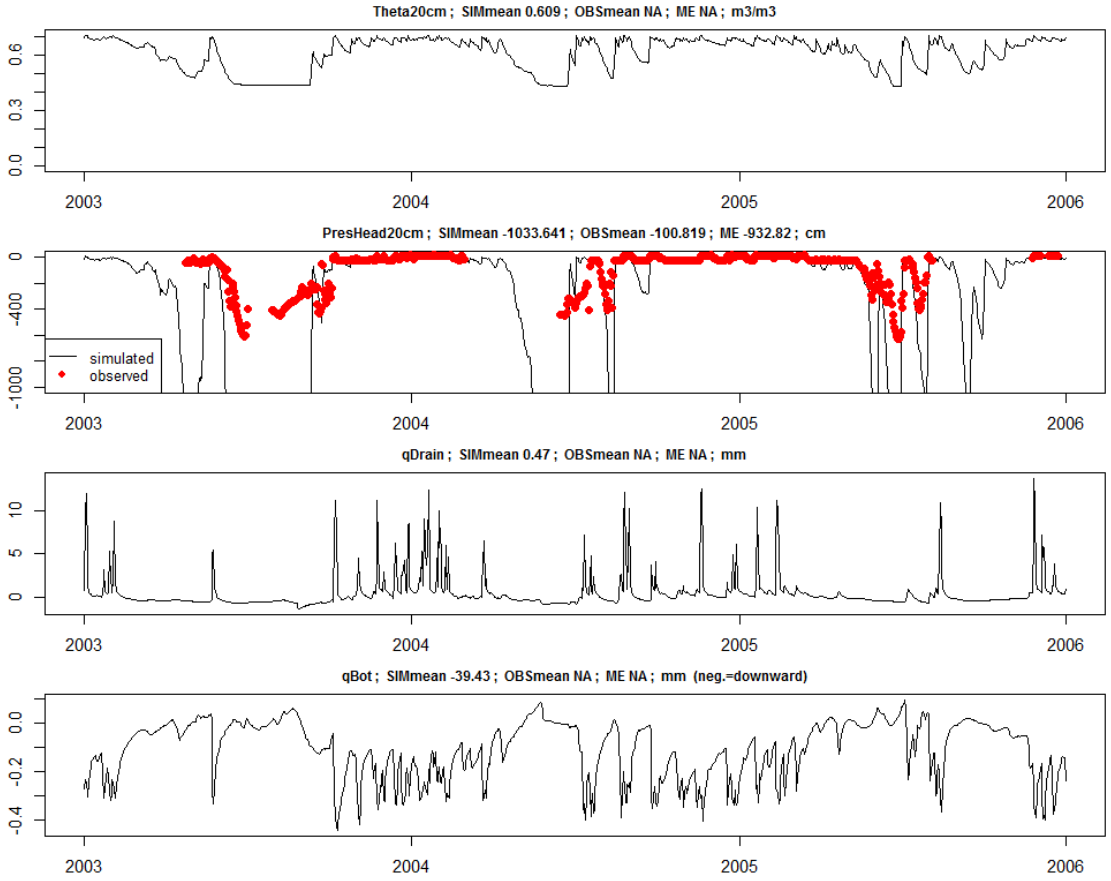

Figure 3.6
CropgrowthGrasslandM(Zegveld03)

4 Maize

4.1 CropgrowthMaizeD(Cranendonck16)

Table 4.1
Description of case

	4
CaseNr	4
dirnam	CropgrowthMaizeD(Cranendonck16)
Location	Cranendonck
SimulationPeriod	1974-1982
SoilType	
CropType	forage maize
drainage	
irrigation	
bottomboundary	
reference	

Project: Cranmais
File name: Cranmais.swp
Model version: Swap 4.0.1

Simulation started at Mon Jun 12 11:53:34 2017
Simulation stopped at Mon Jun 12 11:53:49 2017
Simulation elapsed time 14.68 (sec)

Succesfull completion of simulation: yes
Succesfull closure of water balance: yes

Table 4.2
Iteration parameters

	variables	values	units
1	DTMIN	1e-07	(d)
2	DTMAX	0.2	(d)
3	GWLCONV	100	(cm)
4	CRITDEVMASBALABS	0.099	(d)
5	CRITDEVMASBALDT	NA	(d)
6	CRITDEVPONDDT	1e-04	(cm)
7	MAXIT	30	(-)
8	MAXBACKTR	3	(-)
9	SWkmean	1	(-)
10	SWkImpl	0	(-)

Table 4.3
Statistics of Performance Indices

	PIname	PIunit	SIMmean	OBSmean	ME	RMSE	NSE	d
1	Yield	kg/ha/yr DM	14116.22	13787.78	328.44	3007.66	-1.89	0.60
2	LAI	m2/m2	1.76					
3	ETact	mm/yr	1.13					
4	Gwl	m-soilsurface	-1.41	-1.36	-0.05	0.25	0.37	0.87
5	Theta20cm	m3/m3	0.24					
6	PresHead20cm	cm	-481.04					
7	qDrain	mm	0.00					
8	qBot	mm	-287.86					
9	yieldN	kg/ha/yr N						
10	leachN	kg/ha/yr N						

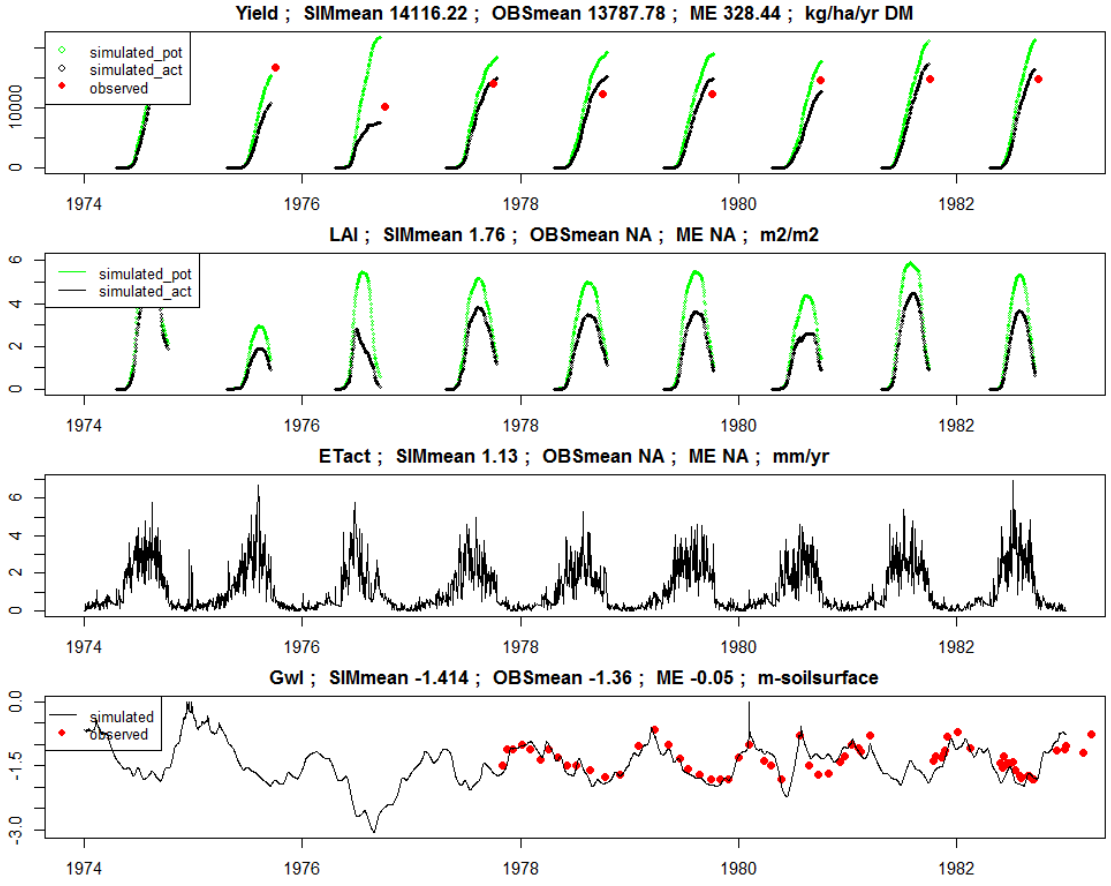

Figure 4.1
CropgrowthMaizeD(Cranendonck16)

Table 4.4
Waterbalans

	1	2	3	4	5	6	7	8	9
ipl	1	1	1	1	1	1	1	1	1
yr	1974	1975	1976	1977	1978	1979	1980	1981	1982
Igrai	823	600	483	807	614	729	792	808	645
Igsnow	0	0	0	0	0	0	0	0	0
Igirr	0	0	0	0	0	0	0	0	0
RunOn	0	0	0	0	0	0	0	0	0
fldrin1	0	0	0	0	0	0	0	0	0
fldrin2	0	0	0	0	0	0	0	0	0
fldrin3	0	0	0	0	0	0	0	0	0
flindr4	0	0	0	0	0	0	0	0	0
fldrin5	0	0	0	0	0	0	0	0	0
flbtin	205	142	399	206	183	133	278	246	334
evicpr	-38	-6	-7	-22	-20	-20	-19	-22	-18
evicir	0	0	0	0	0	0	0	0	0
evso	-140	-176	-139	-142	-132	-152	-151	-140	-147
evsubl	0	0	0	0	0	0	0	0	0
evpn	0	0	0	0	0	0	0	0	0
flev	-268	-244	-221	-244	-230	-264	-222	-260	-269
runoff	-17	0	0	0	0	0	-1	0	0
fldrou1	0	0	0	0	0	0	0	0	0
fldrou2	0	0	0	0	0	0	0	0	0
fldrou3	0	0	0	0	0	0	0	0	0
fldrou4	0	0	0	0	0	0	0	0	0
fldrou5	0	0	0	0	0	0	0	0	0
flbtou	-538	-520	-526	-464	-470	-417	-651	-629	-502
deltast	-28	205	10	-140	54	-11	-26	-3	-42
deltapn	0	0	0	0	0	0	0	0	0
deltasnow	0	0	0	0	0	0	0	0	0
badev	0	0	0	0	0	0	0	0	0
evsoma	-204	-260	-268	-205	-191	-204	-225	-199	-232
evtrma	-282	-258	-367	-253	-238	-279	-243	-272	-292

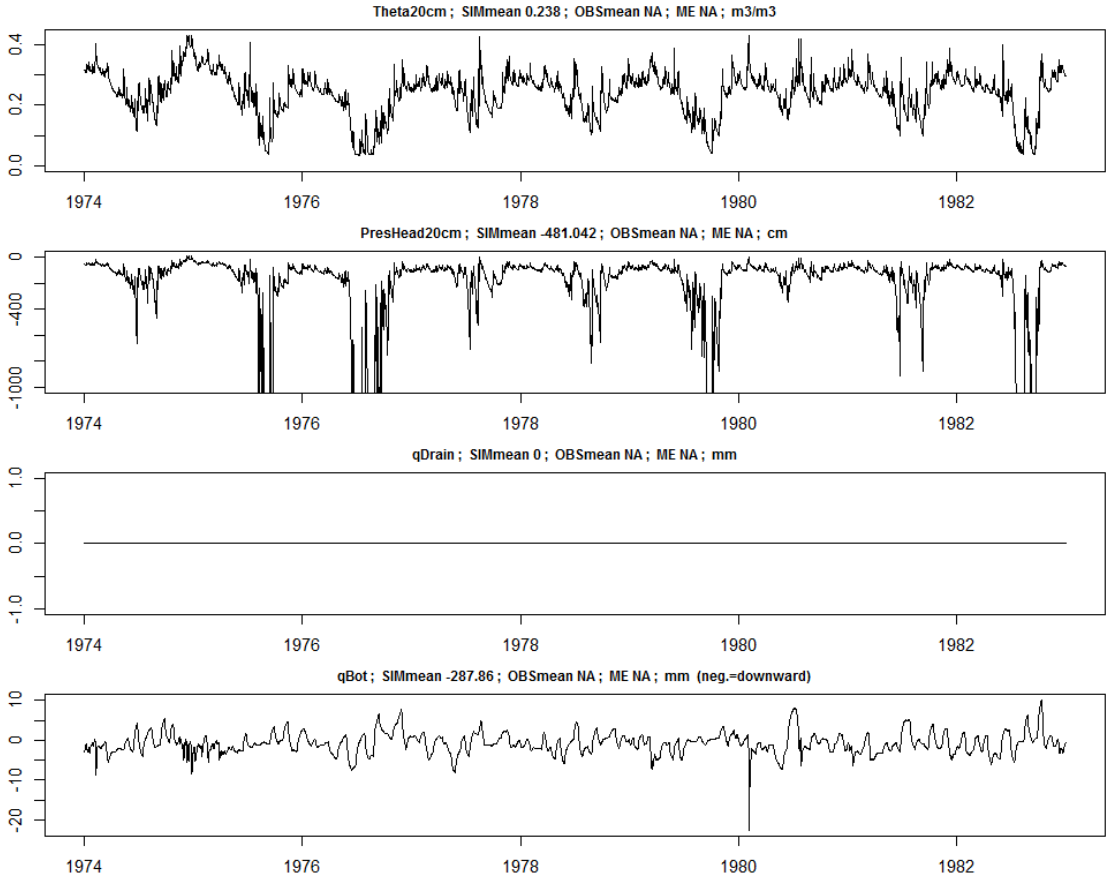

Figure 4.2
CropgrowthMaizeD(Cranendonck16)

4.2 CropgrowthMaizeD(Dijkgraaf)

Table 4.5
Description of case

	5
CaseNr	5
dirnam	CropgrowthMaizeD(Dijkgraaf)
Location	Wageningen
SimulationPeriod	2007-2008
SoilType	clay
CropType	forage maize
drainage	
irrigation	
bottomboundary	free drainage
reference	Elbers et al, 2012

Project: Dijkgraaf
File name: Dijkgraaf.swp
Model version: Swap 4.0.1

Simulation started at Mon Jun 12 11:53:51 2017
Simulation stopped at Mon Jun 12 11:53:59 2017
Simulation elapsed time 7.65 (sec)

Succesfull completion of simulation: yes
Succesfull closure of water balance: yes

Table 4.6
Iteration parameters

	variables	values	units
1	DTMIN	1e-06	(d)
2	DTMAX	0.2	(d)
3	GWLCONV	100	(cm)
4	CRITDEVMASBALABS	0.099	(d)
5	CRITDEVMASBALDT	NA	(d)
6	CRITDEVPONDDT	1e-04	(cm)
7	MAXIT	30	(-)
8	MAXBACKTR	3	(-)
9	SWkmean	1	(-)
10	SWkImpl	0	(-)

Table 4.7
Statistics of Performance Indices

	PIname	PIunit	SIMmean	OBSmean	ME	RMSE	NSE	d
1	Yield	kg/ha/yr DM	14249.00	16306.00	-2057.00			
2	LAI	m2/m2	2.53	2.47	-0.61	0.83	0.52	0.85
3	ETact	mm/yr	1.44	1.93	-0.50	0.81	0.61	0.88
4	Gwl	m-soilsurface	-0.94					
5	Theta20cm	m3/m3	0.27	0.27	0.00	0.03	0.63	0.85
6	PresHead20cm	cm	-63.00					
7	qDrain	mm	0.00					
8	qBot	mm	-416.10					
9	yieldN	kg/ha/yr N						
10	leachN	kg/ha/yr N						

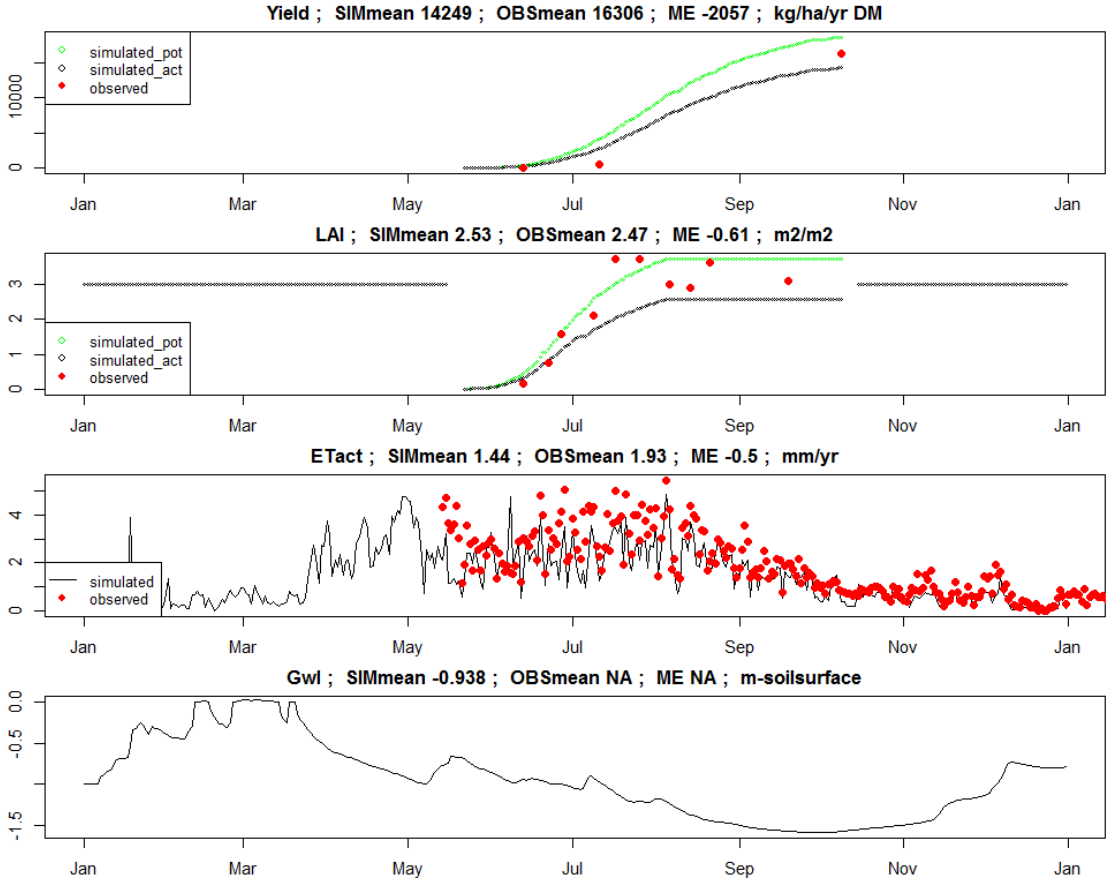

Figure 4.3
CropgrowthMaizeD(Dijkgraaf)

Table 4.8
Waterbalans

	x
ipl	1
yr	2007
Igrai	985
Igsnow	7
Igirr	0
RunOn	0
fldrin1	0
fldrin2	0
fldrin3	0
flindr4	0
fldrin5	0
flbtin	46
evicpr	-75
evicir	0
evso	-98
evsubl	0
evpn	0
flev	-344
runoff	-21
fldrou1	0
fldrou2	0
fldrou3	0
fldrou4	0
fldrou5	0
flbtou	-462
deltast	-38
deltapn	0
deltasnow	0
badev	0
evsoma	-133
evtrma	-376

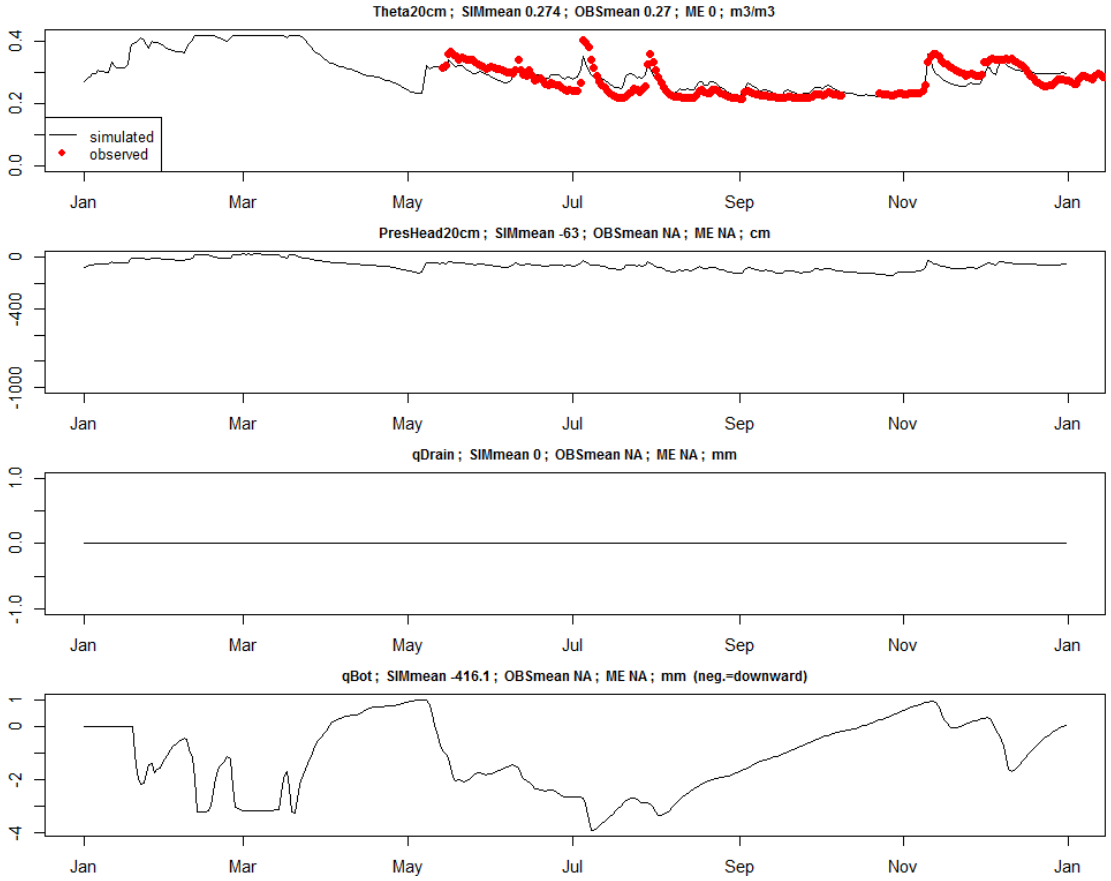

Figure 4.4
CropgrowthMaizeD(Dijkgraaf)

5 Potato

5.1 CropgrowthPotatoD(Borgerswold03)

Table 5.1
Description of case

	6
CaseNr	6
dirnam	CropgrowthPotatoD(Borgerswold03)
Location	Borgerswold
SimulationPeriod	1992-1994
SoilType	sand
CropType	potatoes
drainage	
irrigation	
bottomboundary	
reference	Dijkstra et al, 1996, SC-rapport 287.3

Project: Borgerswold03
File name: Borgerswold03.swp
Model version: Swap 4.0.1

Simulation started at Mon Jun 12 11:54:01 2017
Simulation stopped at Mon Jun 12 11:54:06 2017
Simulation elapsed time 4.7 (sec)

Succesfull completion of simulation: yes
Succesfull closure of water balance: yes

Table 5.2
Iteration parameters

	variables	values	units
1	DTMIN	1e-06	(d)
2	DTMAX	0.2	(d)
3	GWLCONV	100	(cm)
4	CRITDEVMASBALABS	0.099	(d)
5	CRITDEVMASBALDT	NA	(d)
6	CRITDEVPONDDT	1e-04	(cm)
7	MAXIT	30	(-)
8	MAXBACKTR	3	(-)
9	SWkmean	1	(-)
10	SWkImpl	0	(-)

Table 5.3
Statistics of Performance Indices

	PIname	PIunit	SIMmean	OBSmean	ME	RMSE	NSE	d
1	Yield	kg/ha/yr DM	12298.50	9246.44	3052.06	3125.58	-175.06	0.16
2	LAI	m2/m2	2.41					
3	ETact	mm/yr	1.14					
4	Gwl	m-soilsurface	-1.10	-1.10	0.00	0.03	0.99	1.00
5	Theta20cm	m3/m3	0.24					
6	PresHead20cm	cm	-105.39					
7	qDrain	mm	0.00					
8	qBot	mm	-533.01					
9	yieldN	kg/ha/yr N						
10	leachN	kg/ha/yr N						

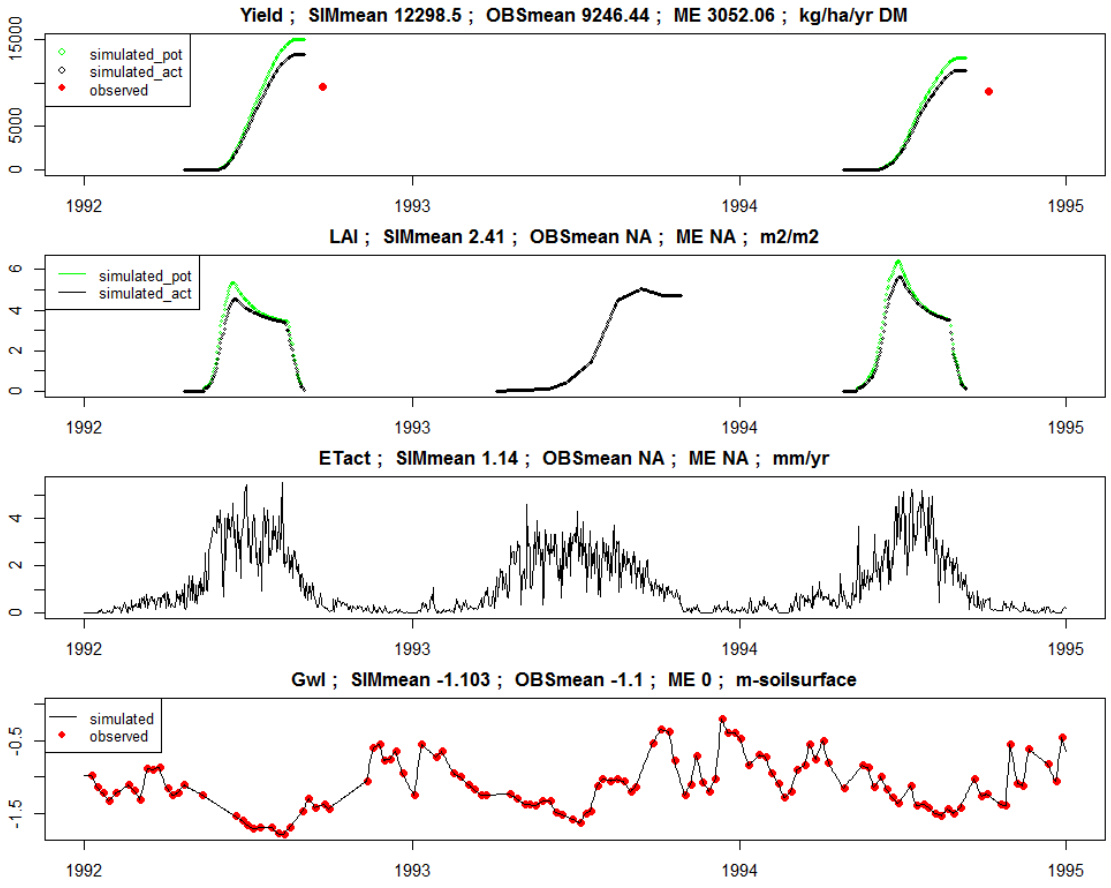

Figure 5.1
CropgrowthPotatoD(Borgerswold03)

Table 5.4
Waterbalans

	1	2	3
ipl	1	1	1
yr	1992	1993	1994
Igrai	747	972	943
Igsnow	0	20	13
Igirr	0	0	0
RunOn	0	0	0
fldrin1	0	0	0
fldrin2	0	0	0
fldrin3	0	0	0
flindr4	0	0	0
fldrin5	0	0	0
flbtin	314	419	444
evicpr	-15	-48	-21
evicir	0	0	0
evso	-107	-113	-110
evsubl	-2	0	0
evpn	0	0	0
flev	-293	-284	-264
runoff	0	0	-12
fldrou1	0	0	0
fldrou2	0	0	0
fldrou3	0	0	0
fldrou4	0	0	0
fldrou5	0	0	0
flbtou	-903	-863	-1009
deltast	38	-103	17
deltapn	0	0	0
deltasnow	220	0	0
badev	0	0	0
evsoma	-166	-193	-152
evtrma	-305	-287	-274

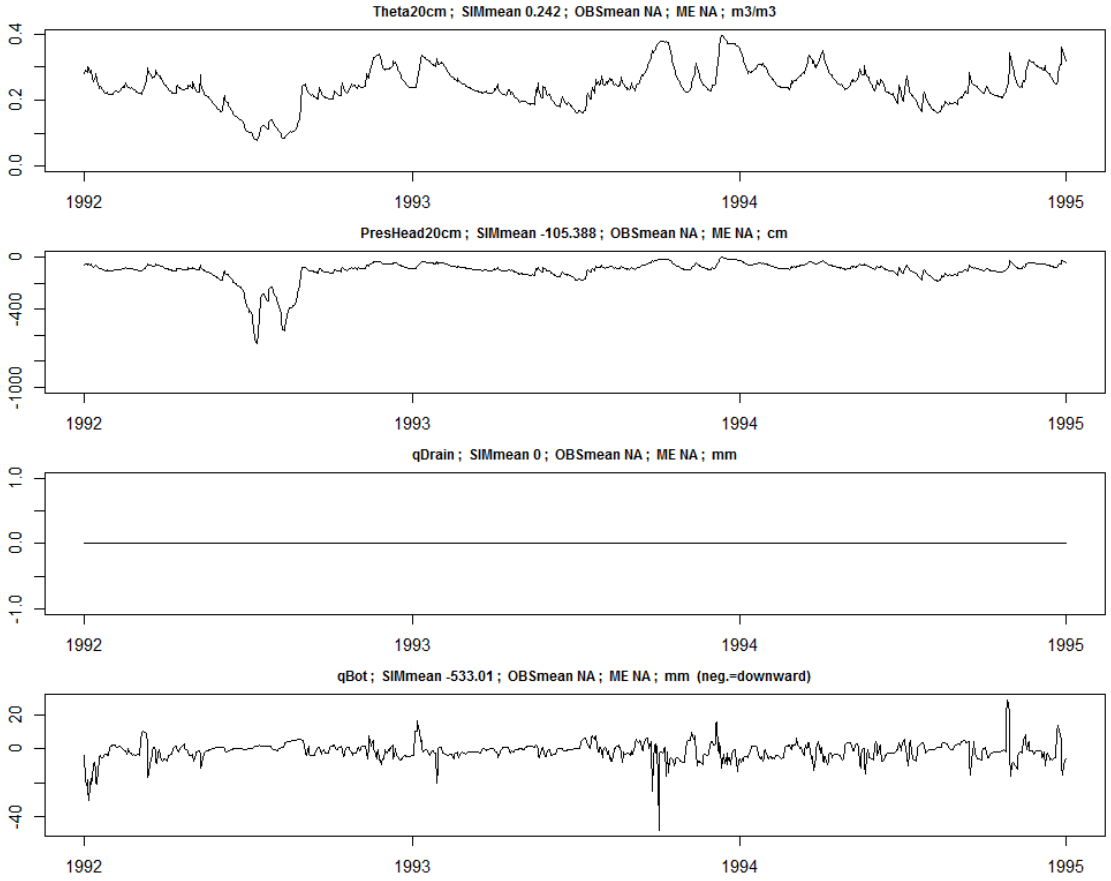

Figure 5.2
CropgrowthPotatoD(Borgerswold03)

5.2 CropgrowthPotatoD(Borgerswold13)

Table 5.5
Description of case

	7
CaseNr	7
dirnam	CropgrowthPotatoD(Borgerswold13)
Location	Borgerswold
SimulationPeriod	1992-1994
SoilType	sand
CropType	potatoes
drainage	
irrigation	
bottomboundary	
reference	Dijkstra et al, 1996, SC-rapport 287.3

Project: Borgerswold13
File name: Borgerswold13.swp
Model version: Swap 4.0.1

Simulation started at Mon Jun 12 11:54:08 2017
Simulation stopped at Mon Jun 12 11:54:14 2017
Simulation elapsed time 5.3 (sec)

Succesfull completion of simulation: yes
Succesfull closure of water balance: yes

Table 5.6
Iteration parameters

	variables	values	units
1	DTMIN	1e-06	(d)
2	DTMAX	0.2	(d)
3	GWLCONV	100	(cm)
4	CRITDEVMASBALABS	0.099	(d)
5	CRITDEVMASBALDT	NA	(d)
6	CRITDEVPONDDT	1e-04	(cm)
7	MAXIT	30	(-)
8	MAXBACKTR	3	(-)
9	SWkmean	1	(-)
10	SWkImpl	0	(-)

Table 5.7
Statistics of Performance Indices

	PIname	PIunit	SIMmean	OBSmean	ME	RMSE	NSE	d
1	Yield	kg/ha/yr DM	12303.00	10690.87	1612.13	1677.61	-0.36	0.73
2	LAI	m2/m2	2.35					
3	ETact	mm/yr	1.19					
4	Gwl	m-soilsurface	-1.20	-1.20	0.00	0.03	0.99	1.00
5	Theta20cm	m3/m3	0.28					
6	PresHead20cm	cm	-101.06					
7	qDrain	mm	0.00					
8	qBot	mm	-511.04					
9	yieldN	kg/ha/yr N						
10	leachN	kg/ha/yr N						

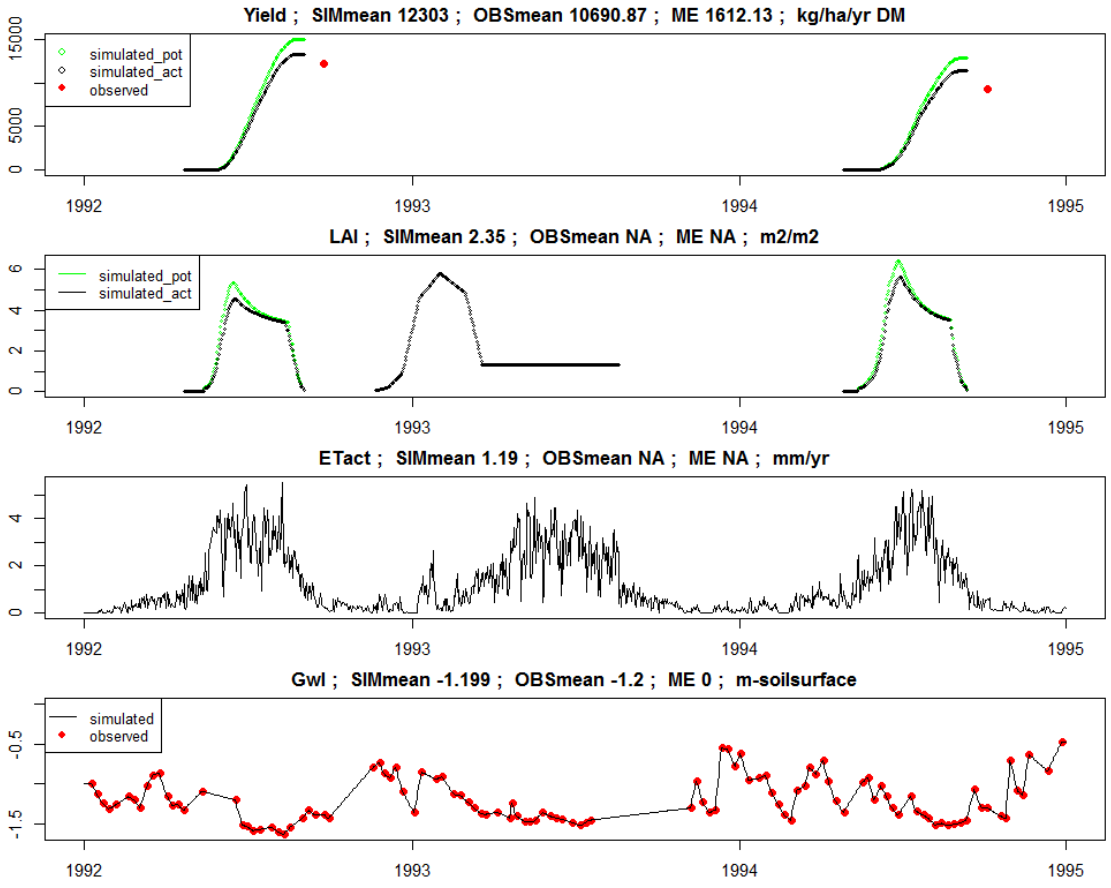

Figure 5.3
CropgrowthPotatoD(Borgerswold13)

Table 5.8
Waterbalans

	1	2	3
ipl	1	1	1
yr	1992	1993	1994
Igrai	747	972	943
Igsnow	0	20	13
Igirr	0	0	0
RunOn	0	0	0
fldrin1	0	0	0
fldrin2	0	0	0
fldrin3	0	0	0
flindr4	0	0	0
fldrin5	0	0	0
flbtin	307	347	387
evicpr	-16	-33	-21
evicir	0	0	0
evso	-108	-107	-111
evsubl	-2	0	0
evpn	0	0	0
flev	-299	-344	-261
runoff	0	0	-12
fldrou1	0	0	0
fldrou2	0	0	0
fldrou3	0	0	0
fldrou4	0	0	0
fldrou5	0	0	0
flbtou	-911	-744	-920
deltast	61	-112	-17
deltapn	0	0	0
deltasnow	220	0	0
badev	0	0	0
evsoma	-167	-143	-153
evtrma	-310	-346	-274

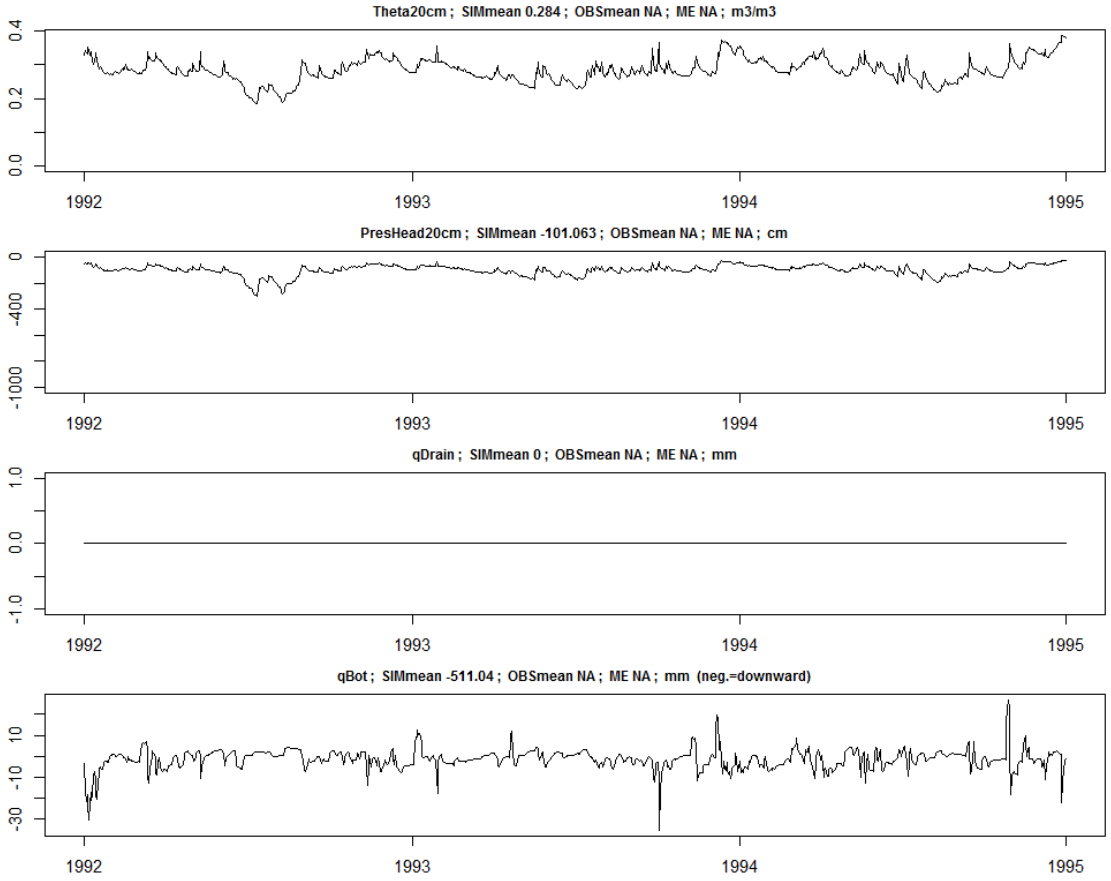

Figure 5.4
CropgrowthPotatoD(Borgerswold13)

5.3 CropgrowthPotatoD(RusthoeveB7)

Table 5.9
Description of case

	8
CaseNr	8
dirnam	CropGrowthPotatoD(RusthoeveB7)
Location	Rusthoeve
SimulationPeriod	2011-2013
SoilType	humic sandy
CropType	potatoes
drainage	
irrigation	
bottomboundary	
reference	

Project: blok7
File name: blok7.swp
Model version: Swap 4.0.1

Simulation started at Mon Jun 12 11:54:16 2017
Simulation stopped at Mon Jun 12 11:54:19 2017
Simulation elapsed time 3.64 (sec)

Succesfull completion of simulation: yes
Succesfull closure of water balance: yes

Table 5.10
Iteration parameters

	variables	values	units
1	DTMIN	1e-06	(d)
2	DTMAX	0.2	(d)
3	GWLCONV	100	(cm)
4	CRITDEVMASBALABS	NA	(d)
5	CRITDEVMASBALDT	NA	(d)
6	CRITDEVPONDDT	1e-04	(cm)
7	MAXIT	30	(-)
8	MAXBACKTR	3	(-)
9	SWkmean	1	(-)
10	SWkImpl	0	(-)

Table 5.11
Statistics of Performance Indices

	PIname	PIunit	SIMmean	OBSmean	ME	RMSE	NSE	d
1	Yield	kg/ha/yr DM	11234.00	8610.00	231.33			
2	LAI	m2/m2	2.38					
3	ETact	mm/yr	1.49					
4	Gwl	m-soilsurface	-1.07	-1.10	0.03	0.19	0.63	0.92
5	Theta20cm	m3/m3	0.39					
6	PresHead20cm	cm	-112.71					
7	qDrain	mm	1.06	0.62	0.44	1.41	0.35	0.84
8	qBot	mm	68.41					
9	yieldN	kg/ha/yr N						
10	leachN	kg/ha/yr N						

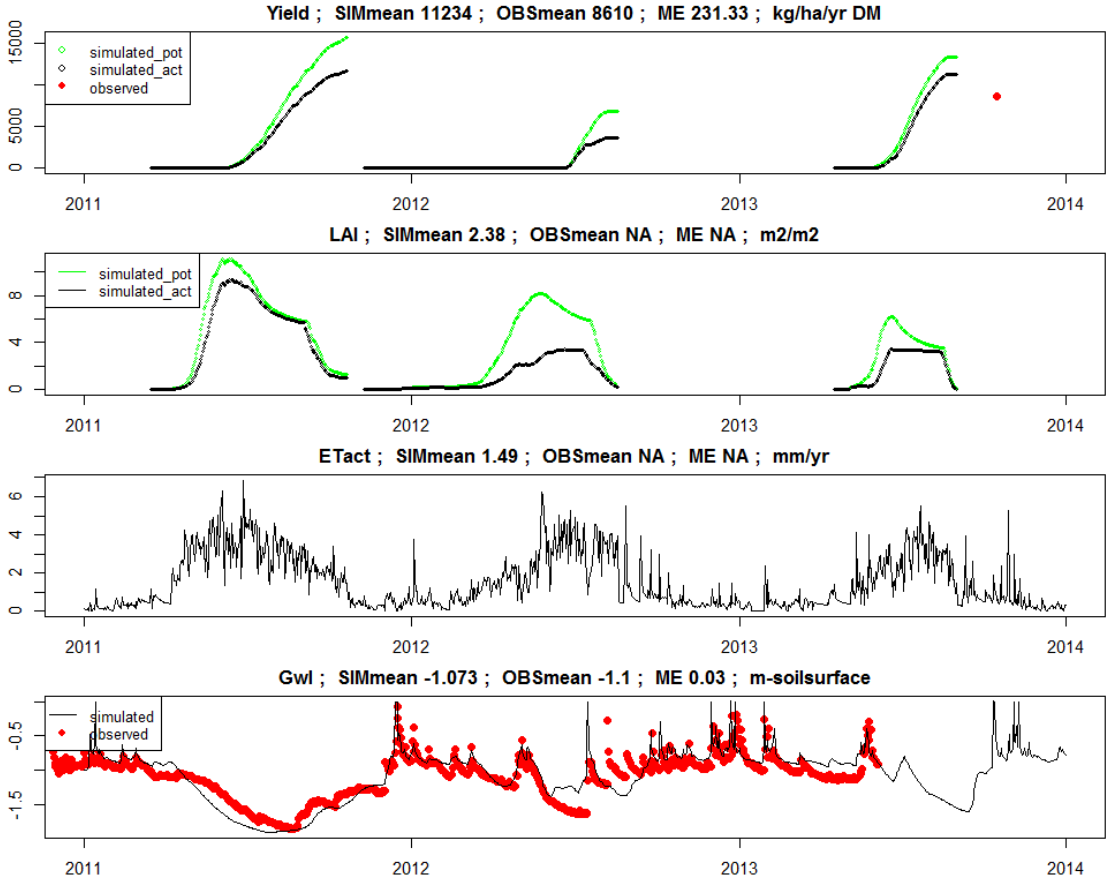

Figure 5.5
CropgrowthPotatoD(RusthoeveB7)

Table 5.12
Waterbalans

	1	2	3
ipl	1	1	1
yr	2011	2012	2013
Igrai	826	1027	884
Igsnow	0	6	22
Igirr	0	0	0
RunOn	0	0	0
fldrin1	0	0	0
fldrin2	0	0	0
fldrin3	0	0	0
flindr4	0	0	0
fldrin5	0	0	0
flbtin	116	50	49
evicpr	-73	-33	-14
evicir	0	0	0
evso	-108	-200	-178
evsubl	0	-2	-4
evpn	0	0	0
flev	-468	-336	-226
runoff	-39	-32	-60
fldrou1	-202	-419	-418
fldrou2	-28	-52	-56
fldrou3	0	0	0
fldrou4	0	0	0
fldrou5	0	0	0
flbtou	-2	-3	-4
deltast	-20	-7	5
deltapn	0	0	0
deltasnow	0	0	0
badev	0	0	0
evsoma	-152	-243	-248
evtrma	-471	-386	-243

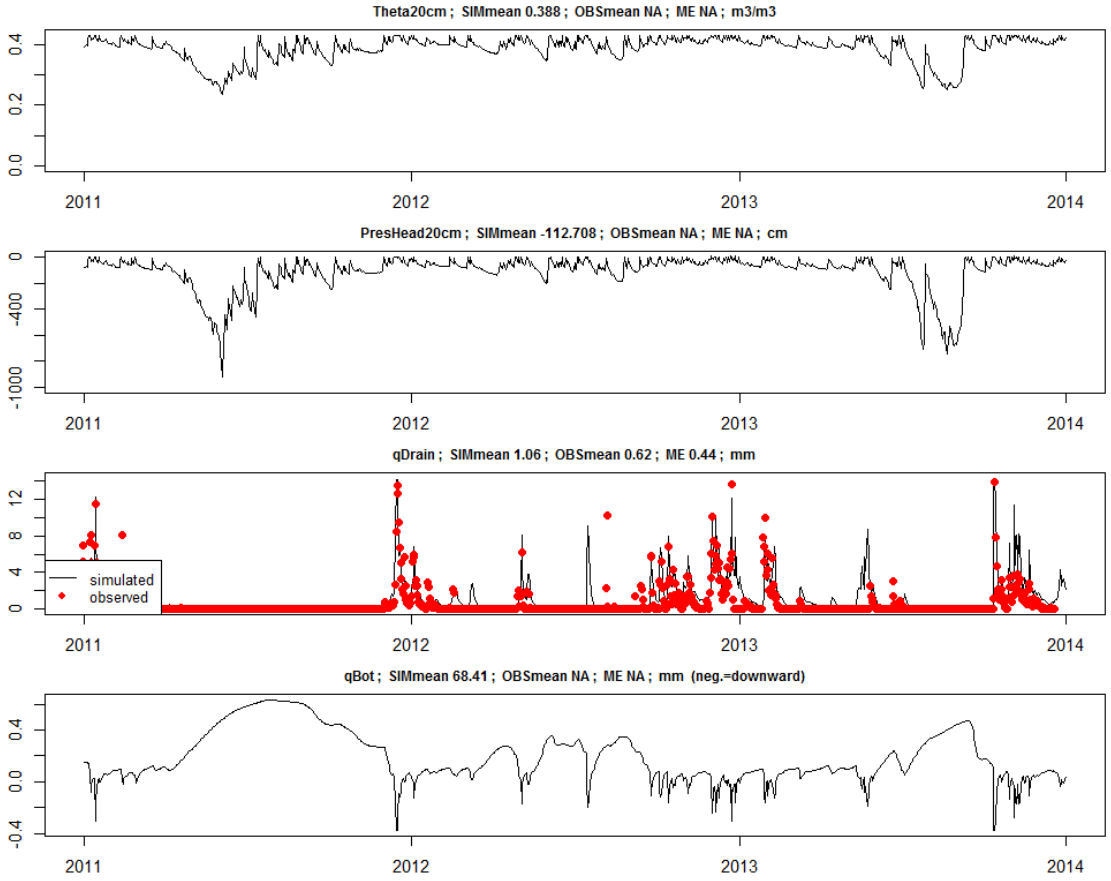

Figure 5.6
CropgrowthPotatoD(RusthoeveB7)

5.4 CropgrowthPotatoD(Vredepeel26)

Table 5.13
Description of case

	9
CaseNr	9
dirnam	CropgrowthPotatoD(Vredepeel26)
Location	Vredepeel
SimulationPeriod	2002-2002
SoilType	
CropType	potatoes
drainage	
irrigation	
bottomboundary	
reference	Stolk

Project: VredePotatofield26
File name: VredePotatofield26.swp
Model version: Swap 4.0.1

Simulation started at Mon Jun 12 11:54:22 2017
Simulation stopped at Mon Jun 12 11:54:26 2017
Simulation elapsed time 4.26 (sec)

Succesfull completion of simulation: yes
Succesfull closure of water balance: yes

Table 5.14
Iteration parameters

	variables	values	units
1	DTMIN	1e-06	(d)
2	DTMAX	0.2	(d)
3	GWLCONV	100	(cm)
4	CRITDEVMASBALABS	NA	(d)
5	CRITDEVMASBALDT	NA	(d)
6	CRITDEVPONDDT	1e-04	(cm)
7	MAXIT	30	(-)
8	MAXBACKTR	3	(-)
9	SWkmean	1	(-)
10	SWkImpl	0	(-)

Table 5.15
Statistics of Performance Indices

	PIname	PIunit	SIMmean	OBSmean	ME	RMSE	NSE	d
1	Yield	kg/ha/yr DM	12548.00	11359.00	1189.00			
2	LAI	m2/m2	2.66					
3	ETact	mm/yr	1.19					
4	Gwl	m-soilsurface	-1.03	-1.07	0.04	0.12	0.80	0.94
5	Theta20cm	m3/m3	0.16					
6	PresHead20cm	cm	-63.19					
7	qDrain	mm	0.89					
8	qBot	mm	0.00					
9	yieldN	kg/ha/yr N						
10	leachN	kg/ha/yr N						

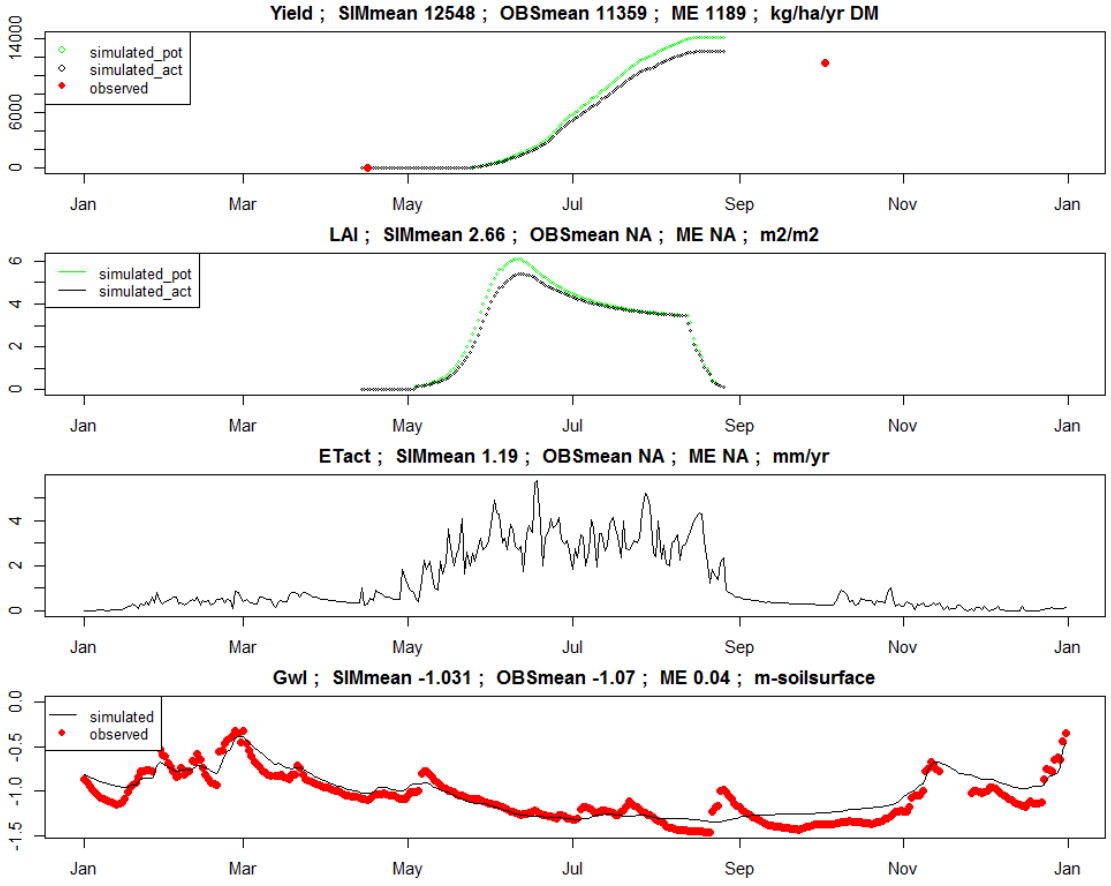

Figure 5.7
CropgrowthPotatoD(Vredepeel26)

Table 5.16
Waterbalans

	x
ipl	1
yr	2002
Igrai	802
Igsnow	0
Igirr	0
RunOn	0
fldrin1	167
fldrin2	0
fldrin3	0
flindr4	0
fldrin5	0
flbtin	0
evicpr	-27
evicir	0
evso	-119
evsubl	0
evpn	0
flev	-289
runoff	0
fldrou1	-135
fldrou2	-357
fldrou3	0
fldrou4	0
fldrou5	0
flbtou	0
deltast	-42
deltapn	0
deltasnow	0
badev	0
evsoma	-184
evtrma	-299

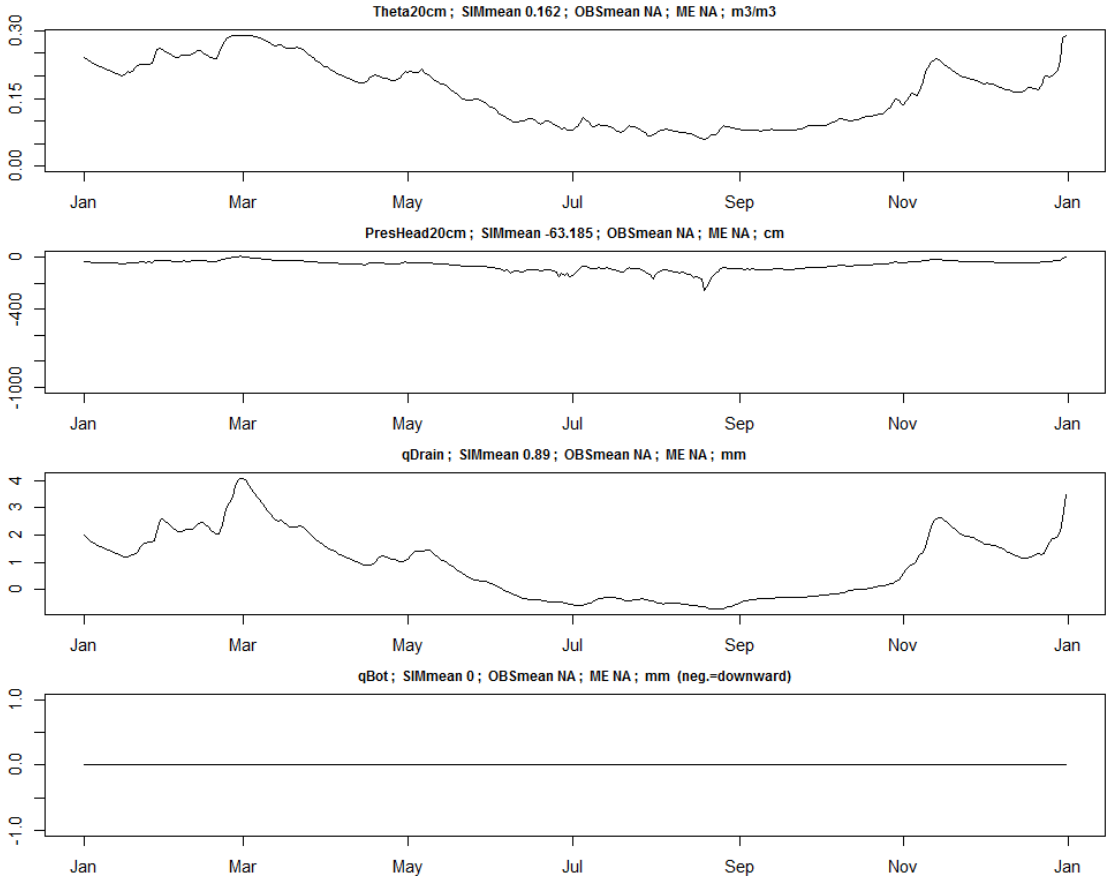

Figure 5.8
CropgrowthPotatoD(Vredepeel26)

Bibliography