University of Innsbruck
Institute of Ecology

MUW 13
MOUNTAINS UNDER WATCH 2013
Observing climate change effects in the Alps

As simple as possible, but not simpler than that

An efficient soil water content model for broad ecological applications

Albin Hammerle, Perluigi Calanca, Matthias Themessl, Andreas Gobiet & Georg Wohlfahrt

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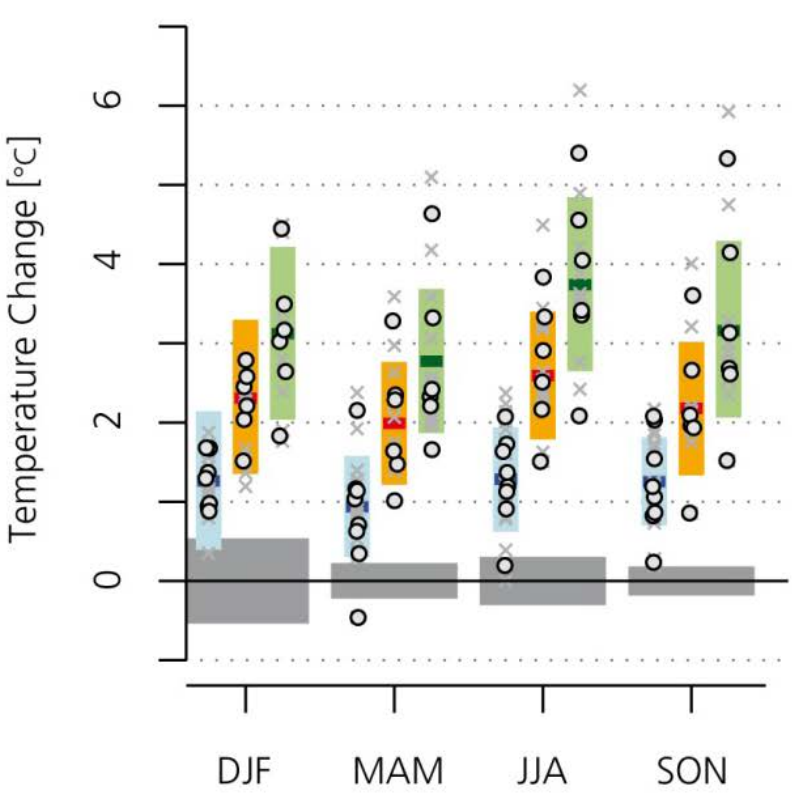
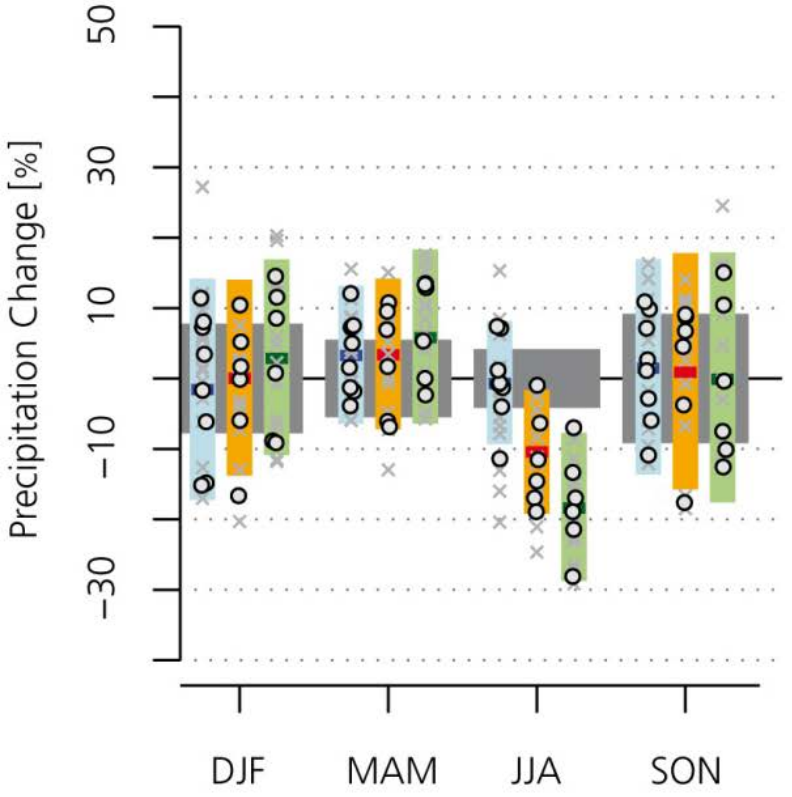
Future Climate in the Alps

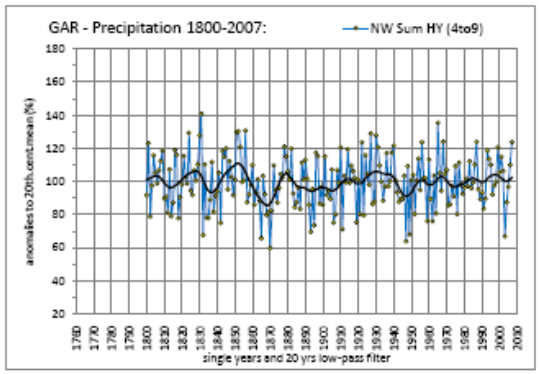


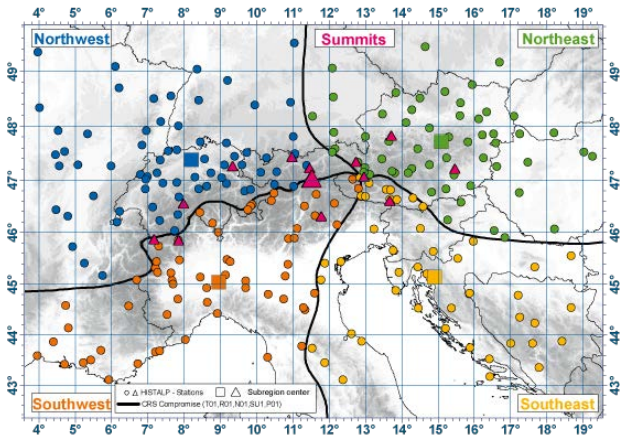


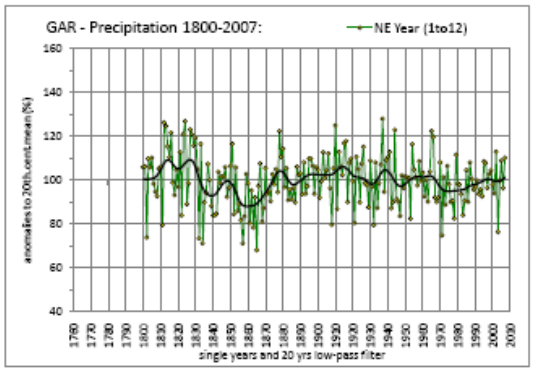
Reference period: 1980 – 2009 vs. 2020–2049, 2045–2074 and 2070–2099

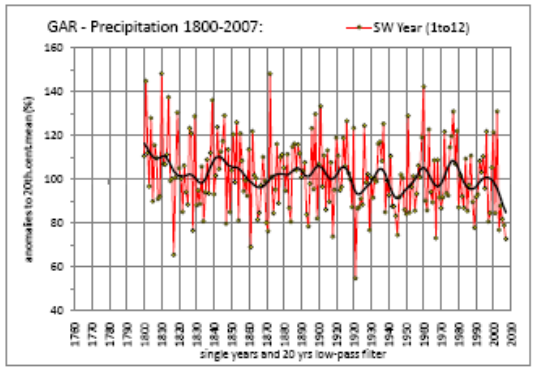
CH2011 (2011), Swiss Climate Change Scenarios CH2011, published by C2SM, MeteoSwiss, ETH, NCCR Climate, and OcCC, Zurich, Switzerland, 88 pp. ISBN: 978-3-033-03065-7

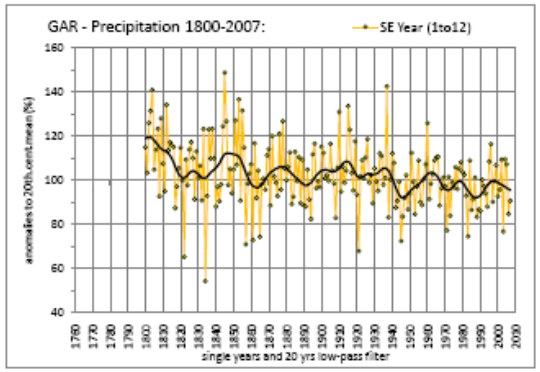
Recent Trends





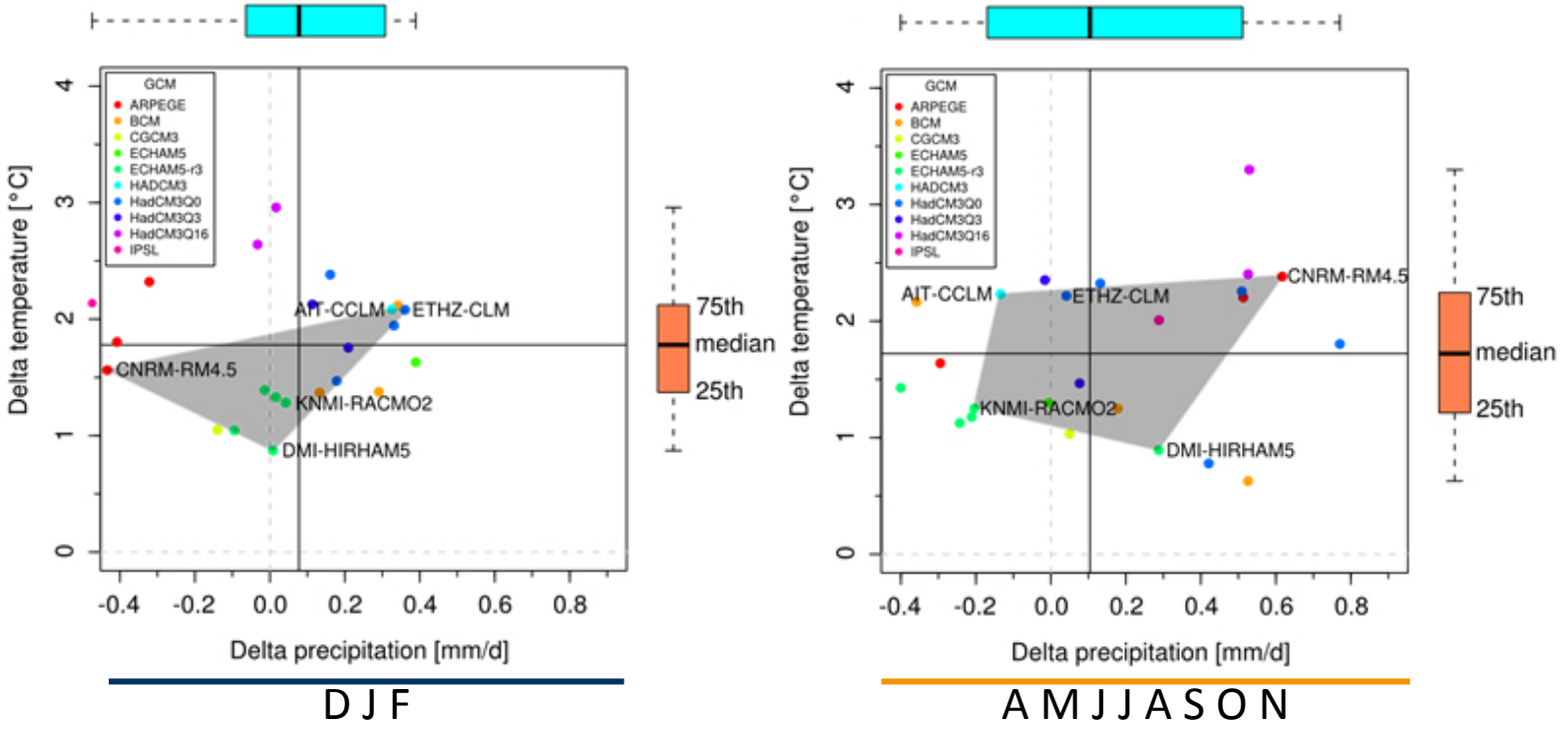




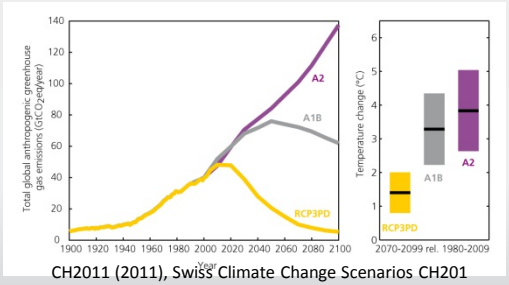


http://www.zamg.ac.at/histalp/

Regional Climate Models

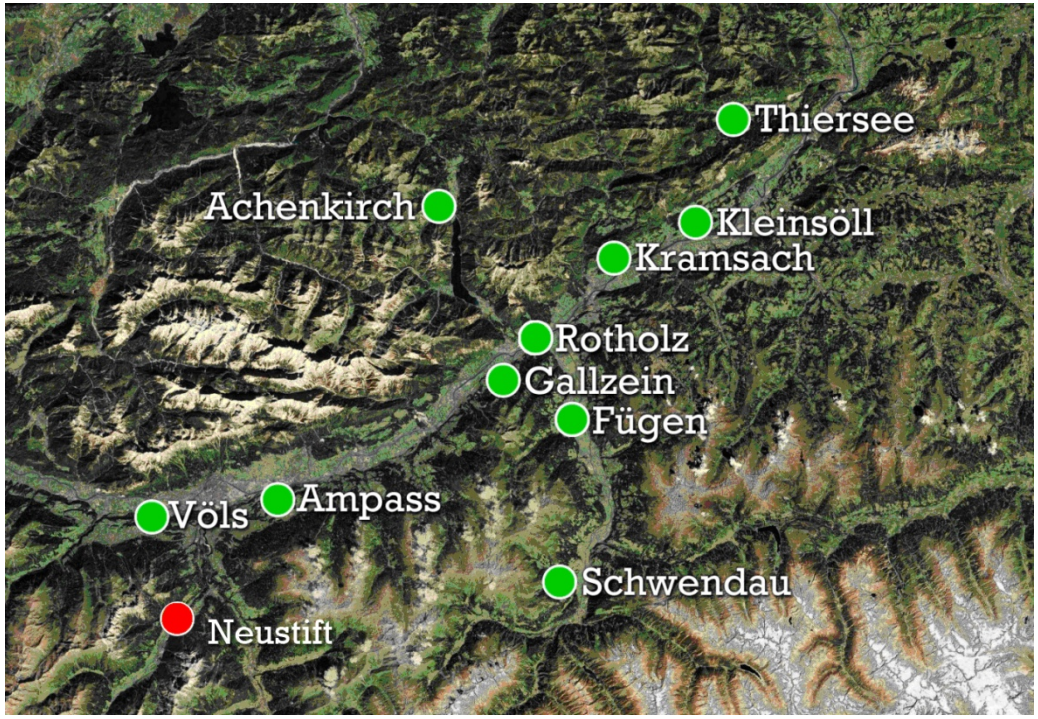


Spatial domain: Tyrol
1961-1990 *vs*. 2021-2050
A1B scenario



CH2011 (2011), Swiss Climate Change Scenarios CH201

Investigated Sites



Spatial domain: Tyrol
1961-1990 *vs*. 2021-2050
A1B scenario

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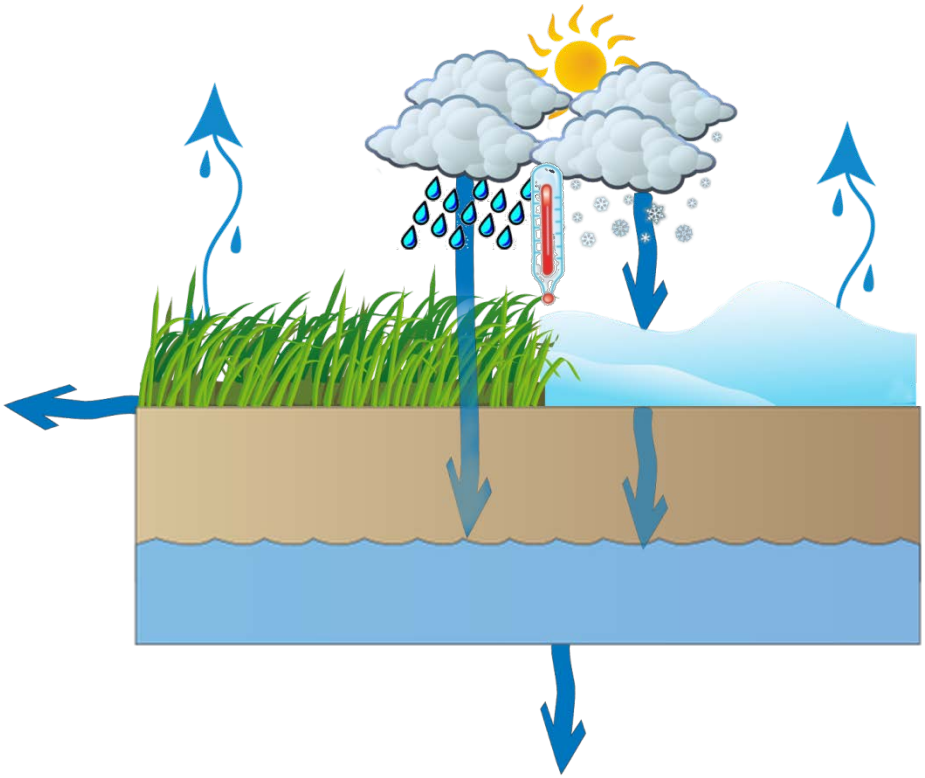
“Soil Bucket” Model

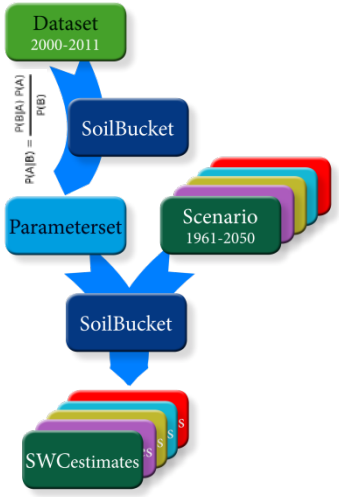
by Pierluigi Calanca

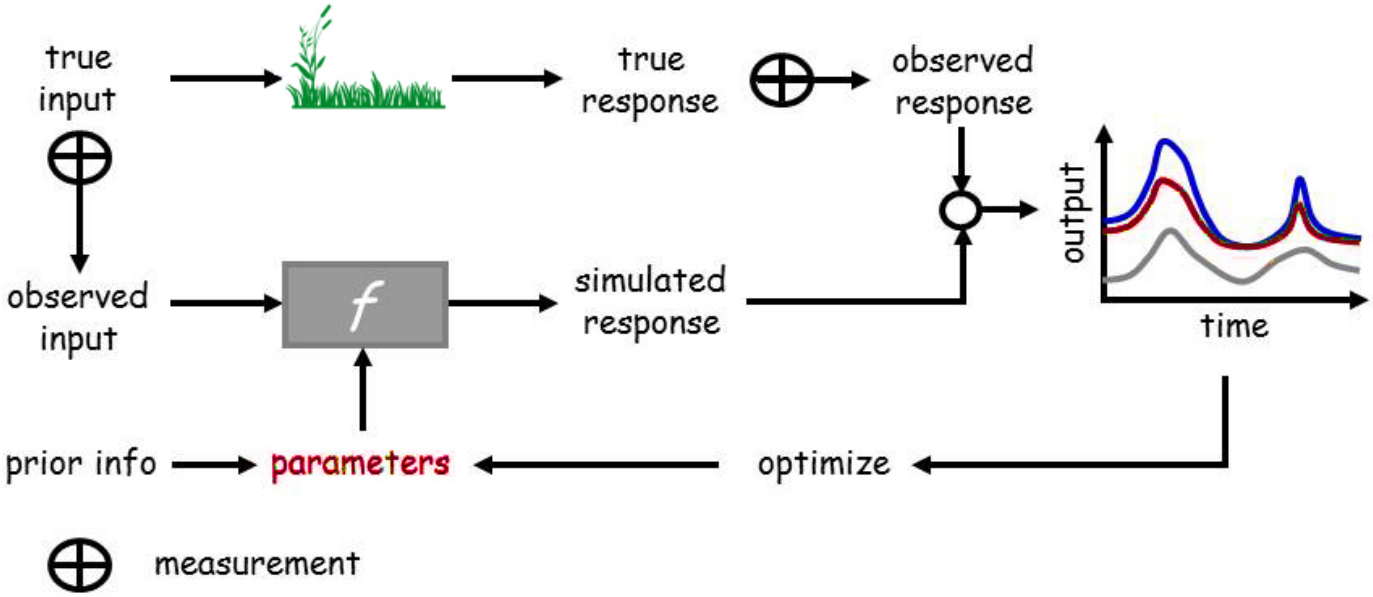


$$Z_r \frac{\partial \theta}{\partial t} = I - ET - K$$

Developed by Pierluigi Calanca, Forschungsanstalt Agroscope Reckenholz-Tänikon ART, Zürich (CH)

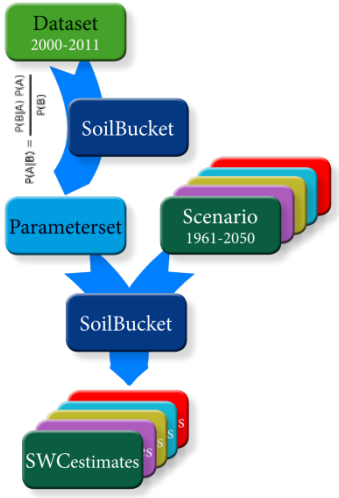
Calibration "Problem"

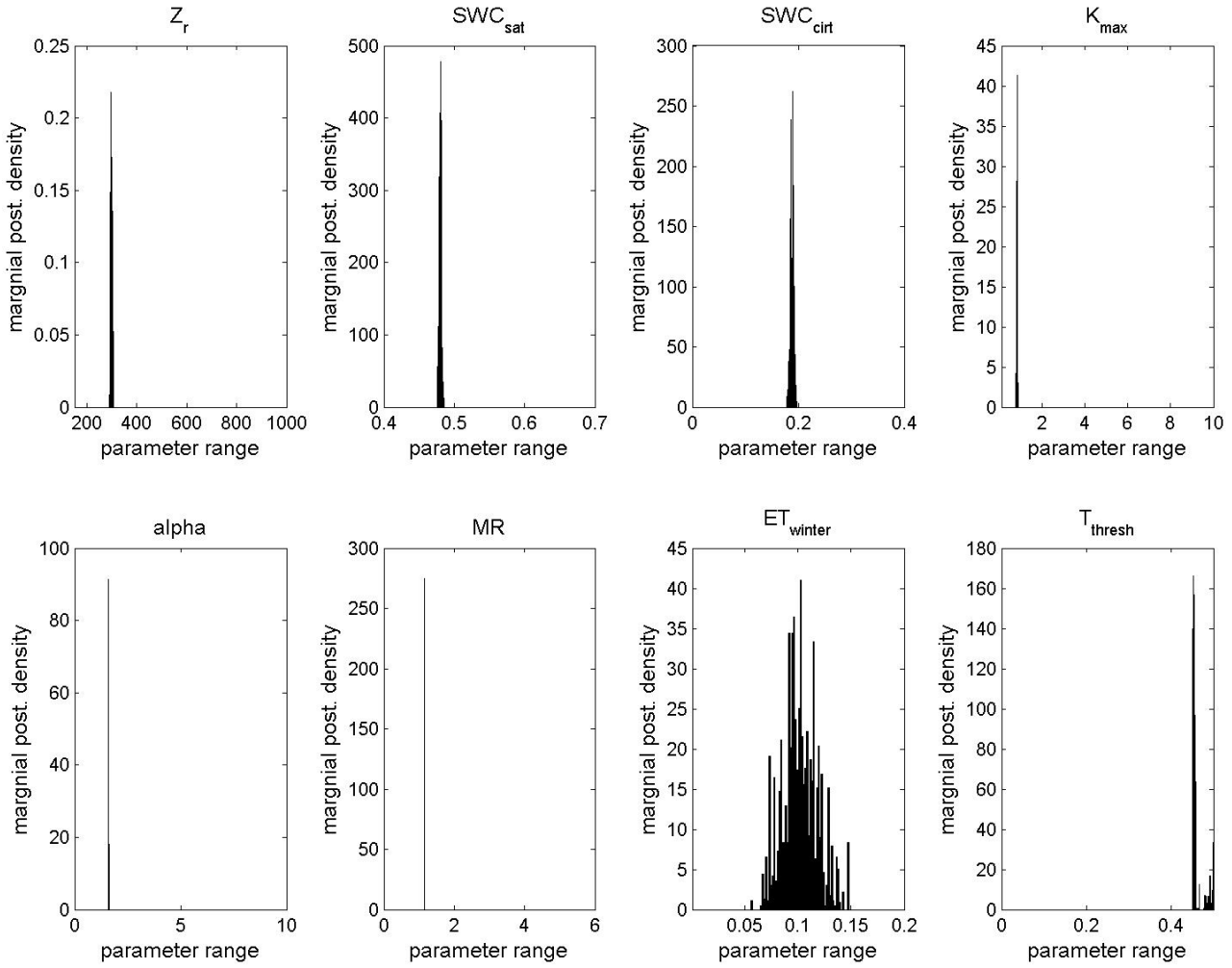




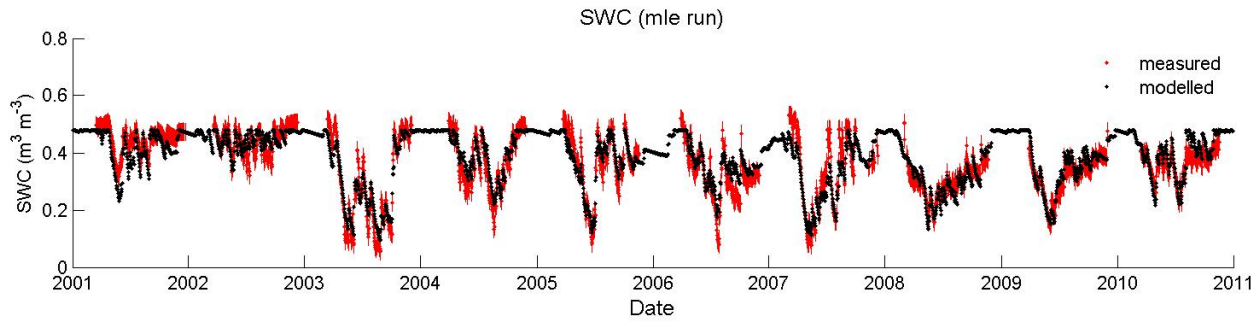
Vrugt, J. A., ter Braak, C. J. F., Clark, M. P., Hyman, J. M. & Robinson, B. A. Treatment of input uncertainty in hydrologic modeling: Doing hydrology backward with Markov chain Monte Carlo simulation. *Water Resour Res* **44** (2008) (modified)

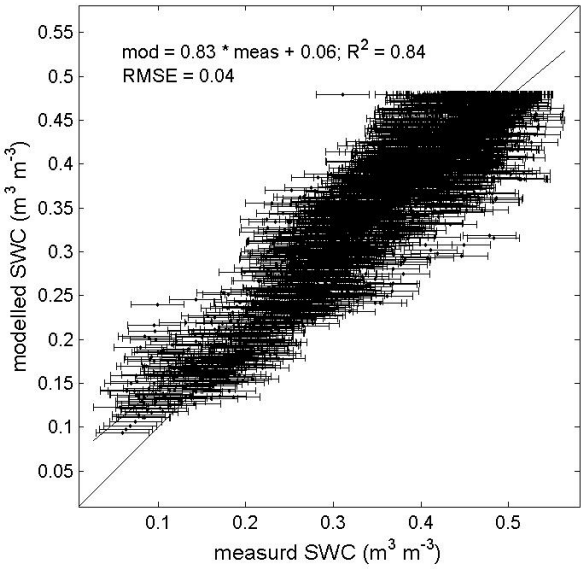
Parameter estimation

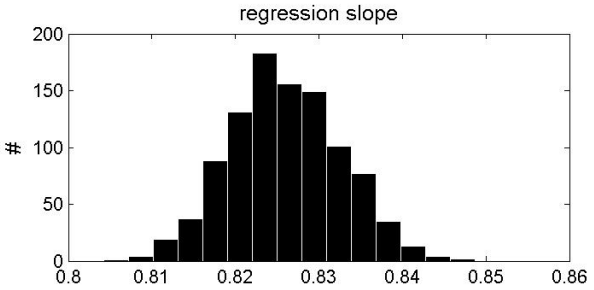


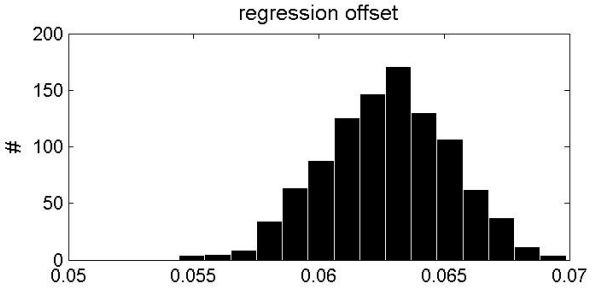


Maximum Likelihood Run









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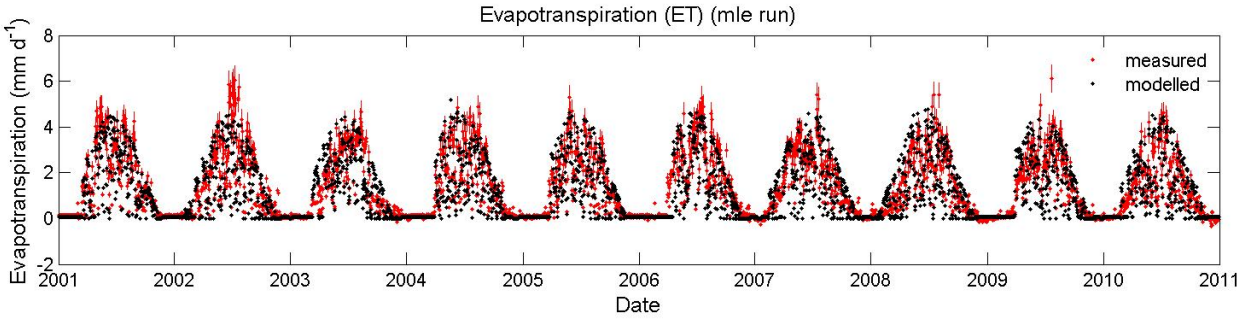
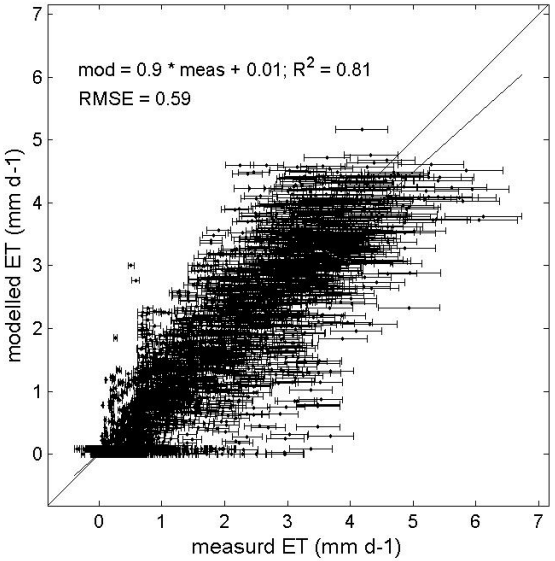
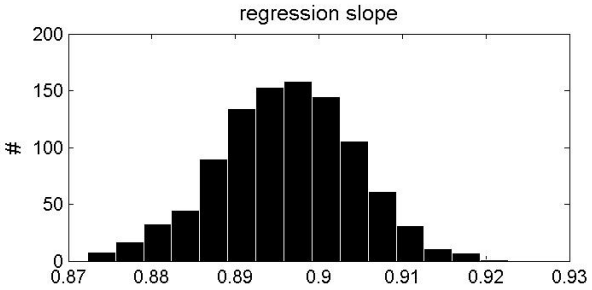
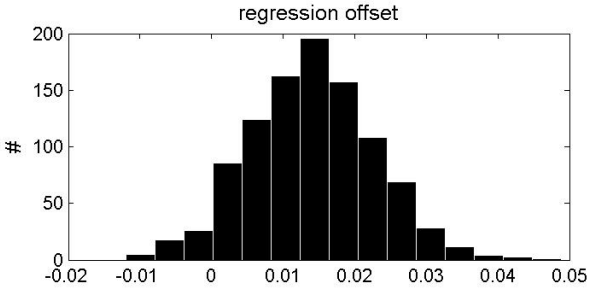
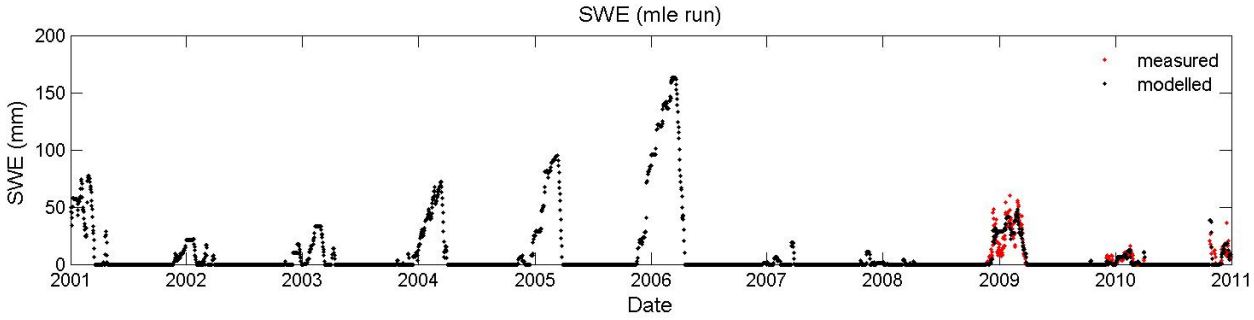


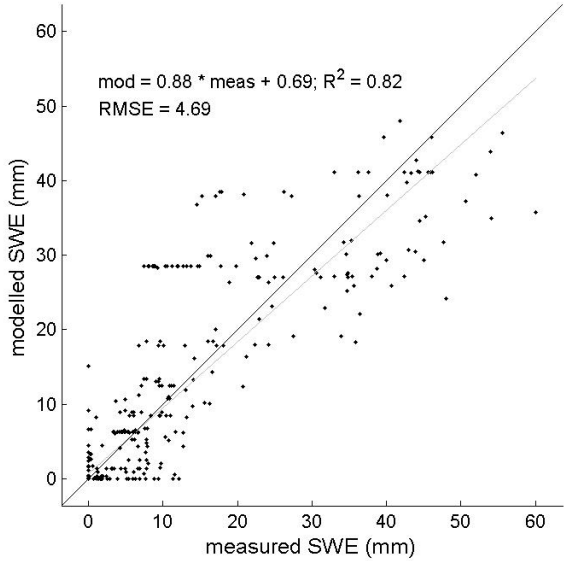


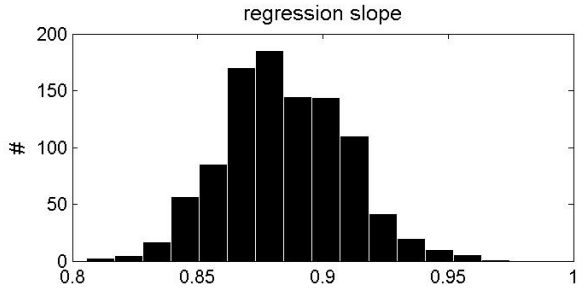


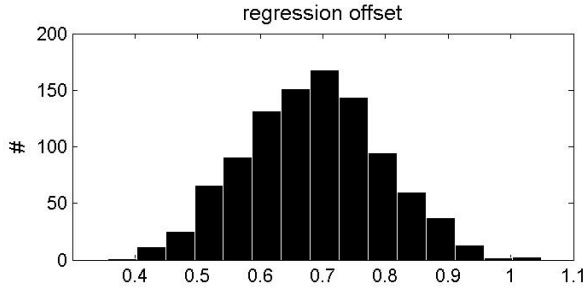


Maximum Likelihood Run

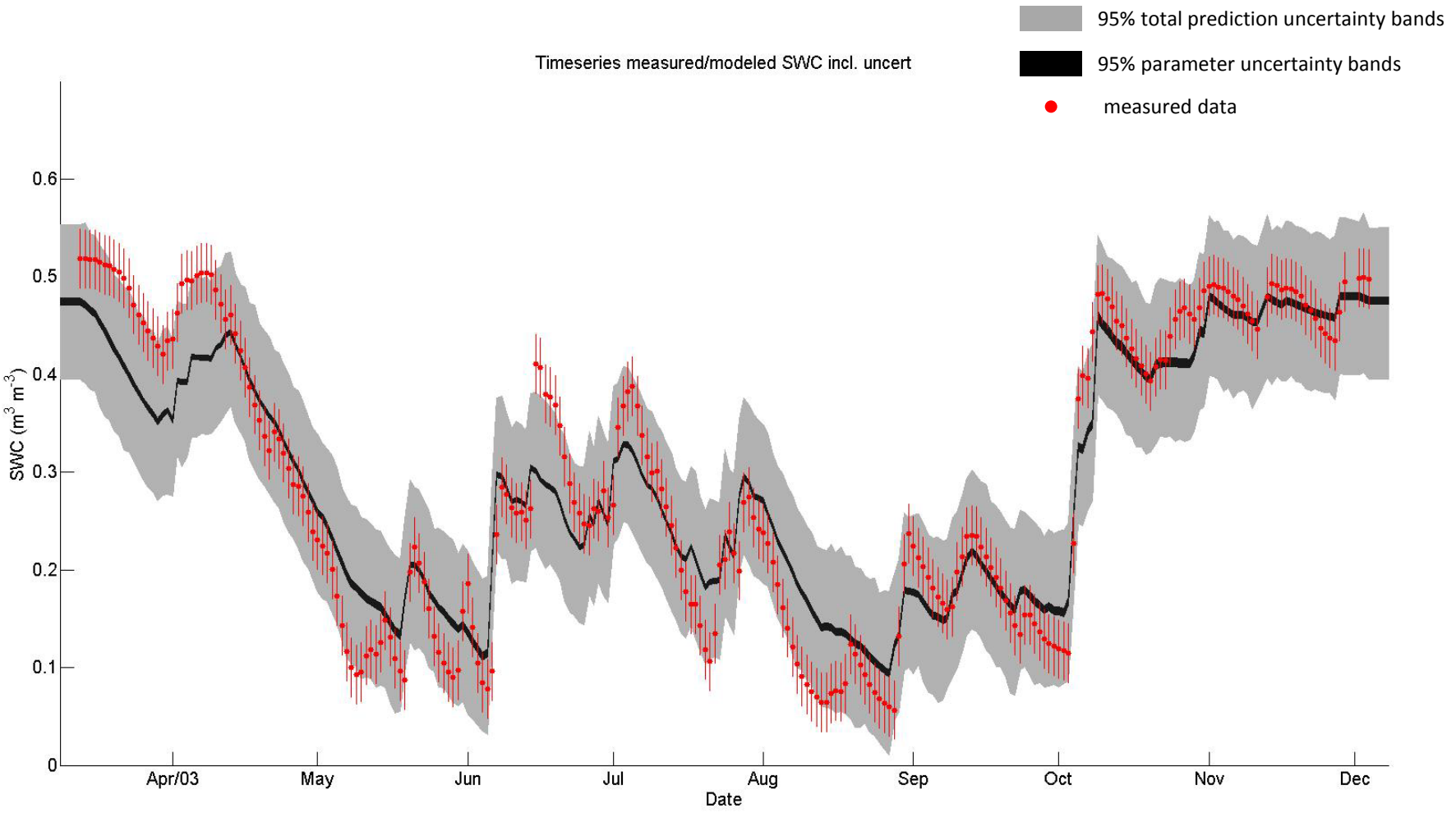




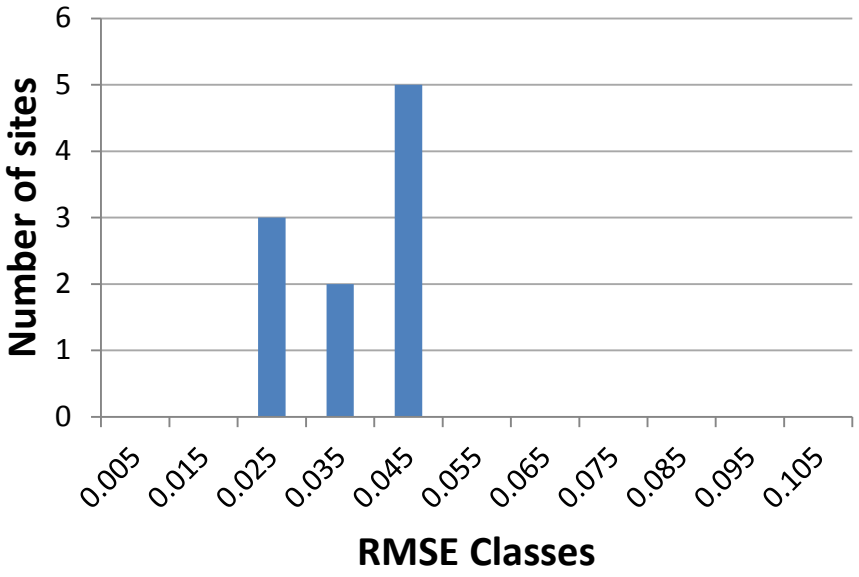


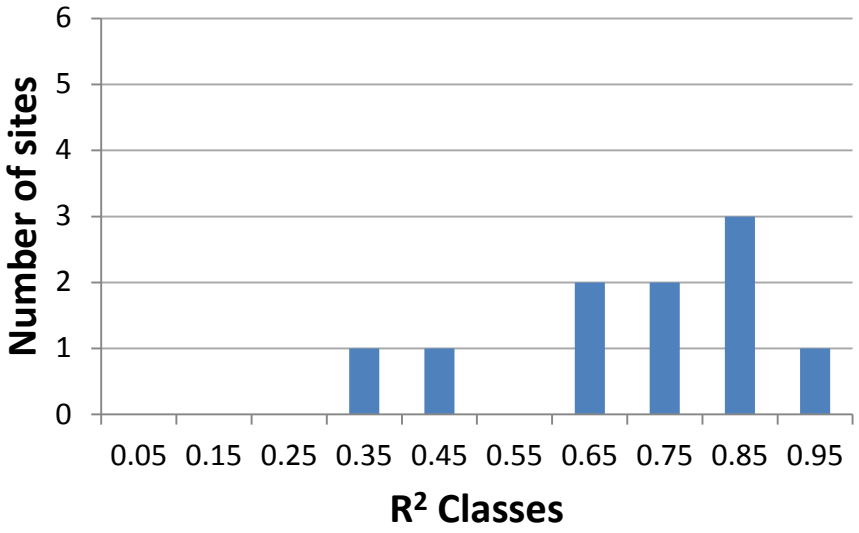


Uncertainties

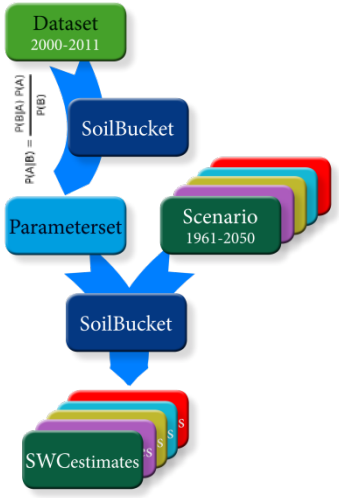


Model Performances



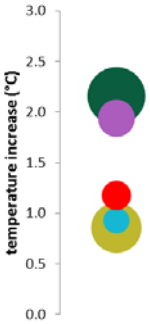


Climate Scenarios



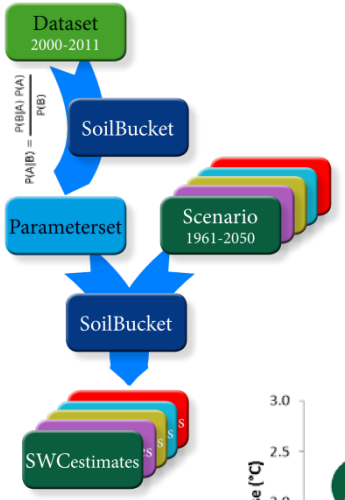
	Difference (2021-2050) - (1961-1990)											
	mean air temperature veg. per. (K)						mean precipitation sum veg. per. (mm)					
Site	Mod1	Mod2	Mod3	Mod4	Mod5	MEAN	Mod1	Mod2	Mod3	Mod4	Mod5	MEAN
Achenkirch	2.2	2.0	1.1	0.8	2.1	1.6	127.2	-14.6	21.3	46.0	39.9	44
Ampass	2.1	2.1	1.2	0.9	1.8	1.6	89.6	24.0	16.7	71.0	50.2	50
Fuegen	2.1	1.9	1.1	0.8	1.9	1.6	106.7	27.0	27.3	77.7	28.6	53
Gallzein	2.3	2.1	1.2	0.9	2.0	1.7	105.6	18.7	25.9	82.0	34.7	53
Kleinsöll	2.1	2.0	1.1	0.7	2.0	1.6	121.4	-6.1	30.0	75.8	14.3	47
Kramsach	2.2	2.0	1.1	0.8	2.0	1.6	123.8	9.5	28.3	75.3	21.5	52
Neustift	2.2	2.0	1.3	1.0	1.9	1.7	74.8	19.8	24.3	88.0	76.4	57
Rotholz	2.1	2.0	1.1	0.8	1.9	1.6	105.4	25.9	27.2	76.8	32.0	53
Schwendau	2.2	2.0	1.2	1.0	2.0	1.7	88.2	49.0	36.7	86.2	43.6	61
Thiersee	2.2	2.0	1.2	1.0	2.0	1.7	88.2	49.0	36.7	86.2	43.6	61
Völs	2.1	2.0	1.2	0.8	1.7	1.6	87.9	24.6	15.9	91.2	77.8	59
MEAN	2.2	2.0	1.2	0.9	1.9	1.6	101.7	20.6	26.4	77.8	42.0	54

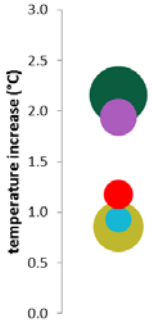
Mod1 … CNRMRM4.5; **Mod2** … AITCCLM; **Mod3** … KNMIRACMO; **Mod4** … DMIHIRHAM; **Mod5** … ETHZCLM

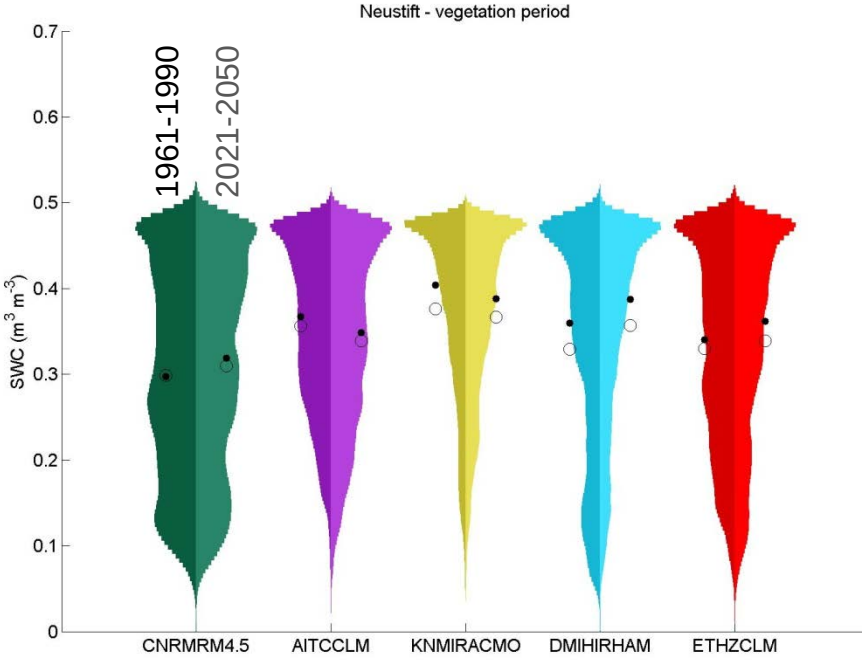


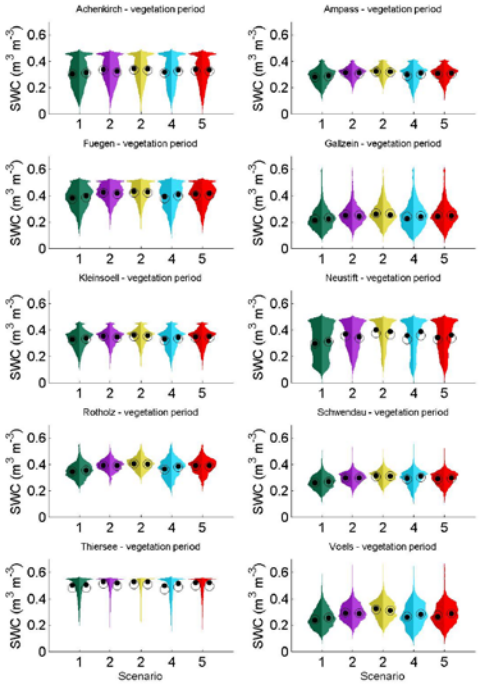
… precipitation increase

SWC projection



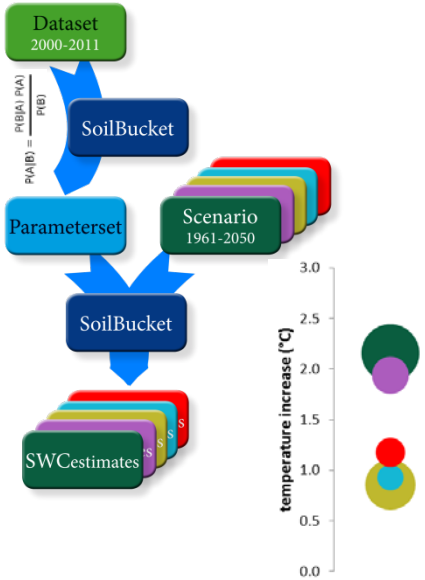




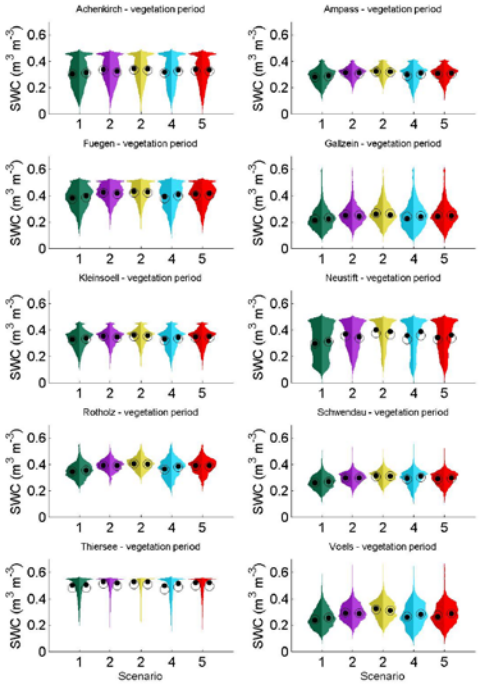




SWC projection

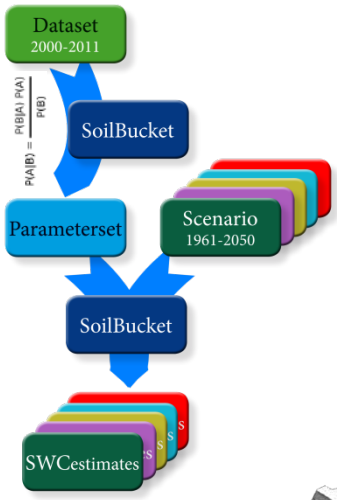


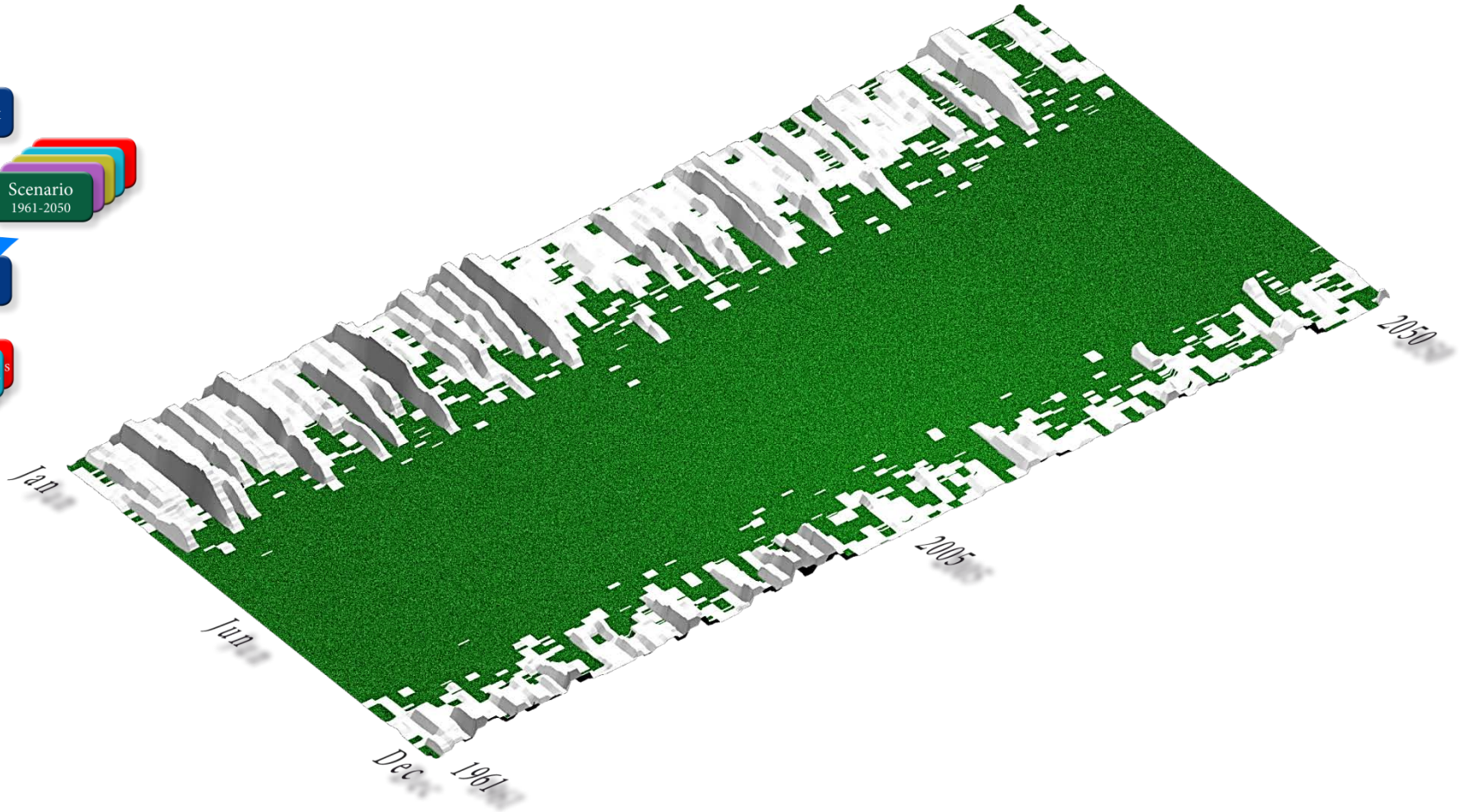
Model	Dry Days per veg. per.		Duration of dry periods	
	1961-1990	2021-2050	1961-1990	2021-2050
CNRMRM4.5			8.7	10.1
AITCCLM	10.7	19.7	8.7	10.4
KNMIRACMO				
DMIHIRHAM	10.7	4.0	12.5	8.2
ETHZCLM	10.7	13.7	9.6	11.2

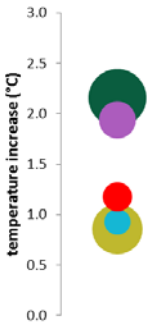




Snow cover projection

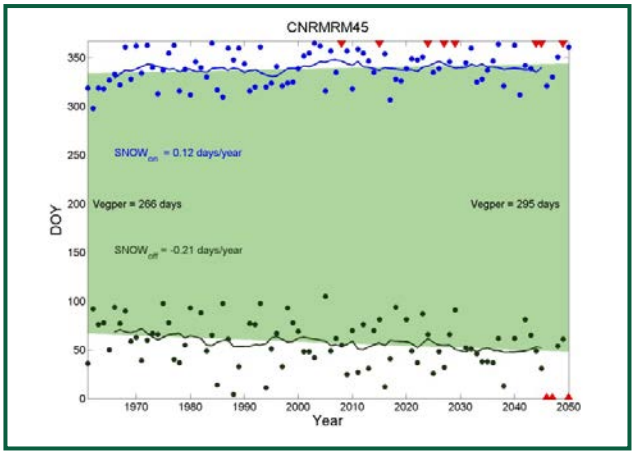


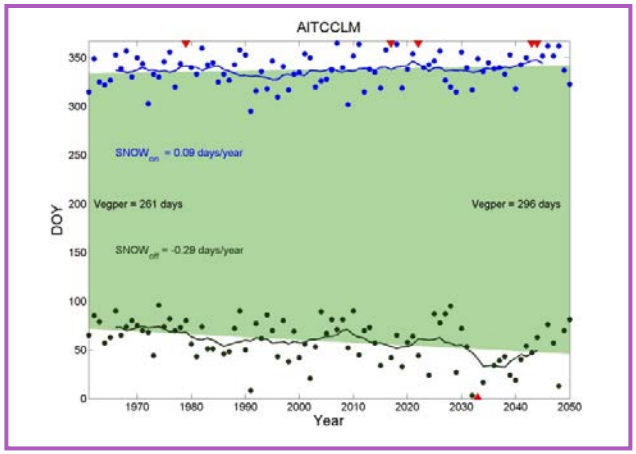


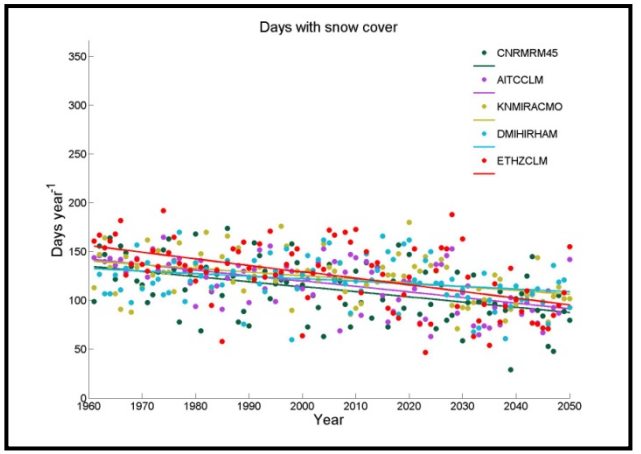


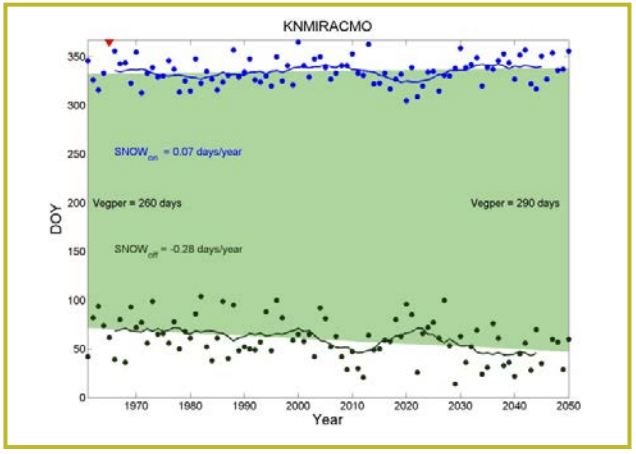


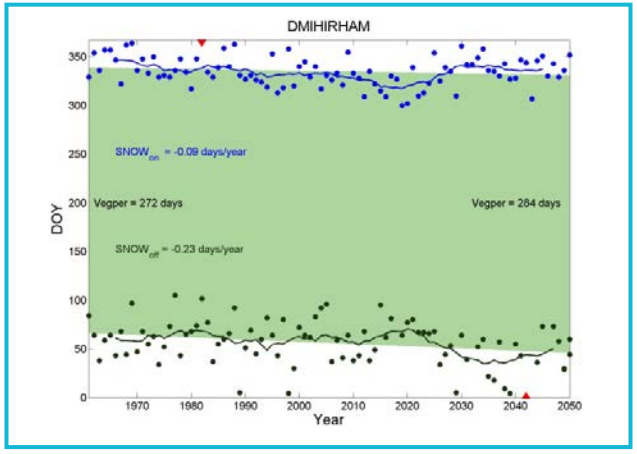
Snow cover projection

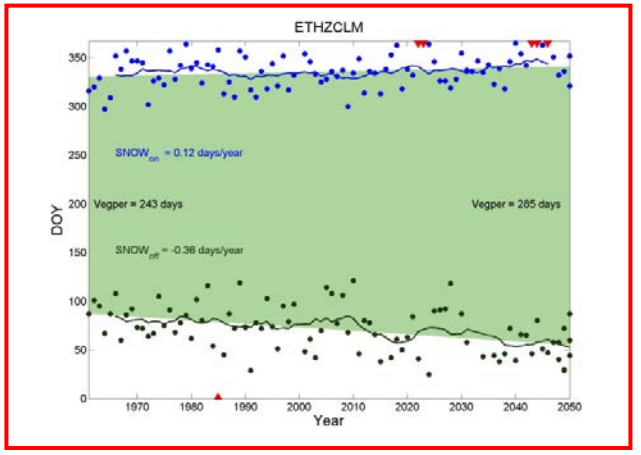










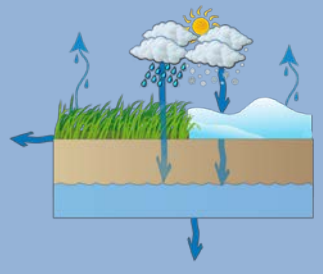




Conclusions

„SoilBucket“

(i) Efficient
(ii) Good performance
(iii) Broad range of application

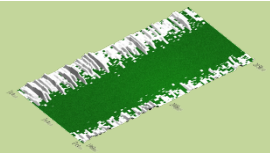


SWC-trends until 2050

(i) no clear trend among the different scenarios concerning average SWC
(ii) majority of scenarios leads to wetter conditions on average
(iii) increase in dry days more likely than not
(iv) length of dry periods is likely to increase

Snow cover

(i) less days with snow cover



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