Revision of the SVAT model TERRA in the COSMO model based on the validation of TERRA standalone

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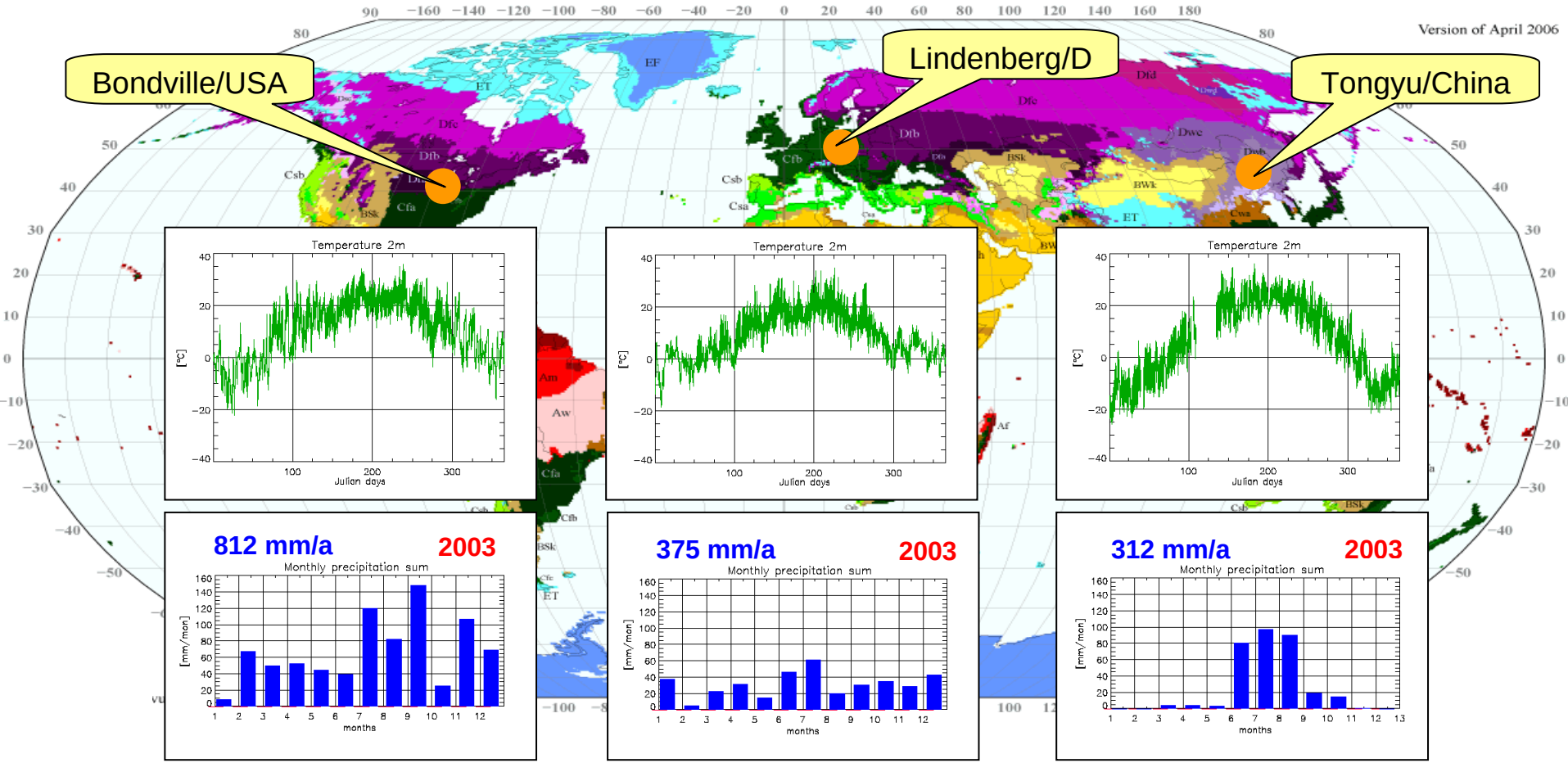

snow, fully humid, hot summer (**Dfa**)

warm temperate, fully humid, warm summer (**Cfb**)

snow, winter dry, hot summer (**Dwa**)

CEOP sites

List of grassland/cropland sites with complete data sets

network	location	latitude	longitude	altitude	climate classification	vegetation	availability
CEOP	**Lindenberg/D**	52.27N	14.12E	73m asl	**warm temp, fully hmd, warm su**	grassland	2003-2006
CEOP	**Bondville/USA**	40.00N	88.30W	216m asl	**snow, fully humid, hot summer**	cropland	2003,2004
CEOP	**Tongyu/China**	44.40N	122.90E	184m asl	**snow, winter dry, hot summer**	grassland	2003,2004
CEOP	**Tongyu/China**	44.40N	122.90E	184m asl	**snow, winter dry, hot summer**	cropland	2004
FLUXNET	**Mitra IV (P)**	38.48N	8.02W	190m asl	**warm temp, hot and dry summer**	grassland	2005
FLUXNET	**Amplero (I)**	41.90N	13.61E	884m asl	**warm temp, hot and dry summer**	grassland	2003
FLUXNET	**Tadham Moor (UK)**	51.21N	2.83W	3m asl	**warm temp, fully humid, warm su**	grassland	2001
FLUXNET	**Oensingen (CH)**	47.29N	7.73E	450 asl	**warm temp, fully humid, warm su**	grassland	2002-2006
FLUXNET	**Lille Valby (DK)**	55.68N	12.08E	10m asl	**warm temp, fully humid, warm su**	grassland	2004,2005
FLUXNET	**Malga Arpaco (I)**	46.12N	11.70E	1730m asl	**warm temp, fully humid, warm su**	grassland	2003
FLUXNET	**East Saltoun (UK)**	55.90N	2.50W	97m asl	**warm temp, fully humid, warm su**	cropland	2004,2005
FLUXNET	**Lonzee (B)**	50.55N	4.74E	165m asl	**warm temp, fully humid, warm su**	cropland	2005
FLUXNET	**Mehrstedt (D)**	51.58N	10.66E	286m asl	**warm temp, fully humid, warm su**	cropland	2004-2005
FLUXNET	**Grignon (F)**	48.84N	1.95E	125m asl	**warm temp, fully humid, warm su**	cropland	2004-2005

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CEOP	**Tongyu/China**	44.4					2004
CEOP	**Tongyu/China**	44.4					04
FLUXNET	**Mitra IV (P)**	38.4					05
FLUXNET	**Amplero (I)**	41.9					03
FLUXNET	**Tadham Moor (UK)**	51.2					01
FLUXNET	**Oensingen (CH)**	47.2					2006
FLUXNET	**Lille Valby (DK)**	55.6					2005
FLUXNET	**Malga Arpaco (I)**	46.1					03
FLUXNET	**East Saltoun (UK)**	55.90N	2.50W	97m asl	**warm temp, fully humid, warm su**	cropland	2004,2005
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Since January, soil and surface measurements from SP Capofiume (Italy) are continuously used to validate the operational predictions of 2m temperature, 2m dewpoint temperature, 10m wind speed, soil moisture, soil temperature and of radiation balance available from COSMO-EU, GME and COSMO-I7 forecasts. The work has been done for the Work Package of PBL monitoring.

Tested options and assumptions

… and various combinations of them

- **Reference conditions for different soil types (sand, silty sand, loamy sand, sandy loam and loam)**
- **Impermeable lower hydrological boundary (“rigid lid”)**
- **Depletion of root density with depth**
- **Bare soil evaporation according to *Noilhan & Planton (1989)***
- **Reduction of root depth (0.2m)**
- **Revised parameterization of infiltration allowing higher infiltration rates**
- **Moisture drainage and diffusion parameterization according to *Brooks & Coorey* (DWD soil types)**
- **Soil heat conductivity does not depend on soil moisture**
- **Satellite derived LAI and plant cover (climatological annual cycle)**
- **Variation of surface roughness**
- **Variation of stomatal resistance and wilting point**

CEOP Lindenberg 2003

	SM06 [vol%]	SM18 [vol%]	SM54 [vol%]	SHFL [W/m2]	LHFL [W/m2]	CONDITIONS/OPTIONS LINDE 2003
1	4,71	3,44	6,53	74,34	42,30	**Reference (DWD-sand)**
2	3,45	2,13	5,12	62,49	64,07	**Rigid lid**
3	3,32	2,13	5,71	70,29	54,65	**Bare soil evaporation Noilhan & Planton**
4	4,71	3,44	6,53	74,34	42,30	**Enlarged infiltration**
5	5,40	5,29	8,58	94,68	38,86	**Water transfer Brooks & Coorey (DWD soil type sand)**
6	4,33	3,11	3,78	76,86	41,86	**Root depletion with depth**
7	4,37	3,25	3,35	83,09	45,33	**Root depth = 0.2m**
8	4,25	3,57	3,29	85,58	51,23	**Root depletion + root depth = 0.2m**
9	3,66	2,61	6,25	44,47	41,60	**DWD-sand z0=0.003m**
10	5,63	4,22	6,86	102,12	44,07	**DWD-sand z0=0.3m**
11	4,76	3,62	6,15	76,66	38,10	**Squeezed range of mn/mx-stomatal resistence**
12	4,66	3,44	6,94	73,55	43,27	**Wilting point DWD-sand = 0.36**
13	5,15	4,07	6,95	75,70	47,25	**satellite based LAI (reference conditions,DWDsnd)**
14	4,32	3,20	6,48	74,77	43,10	**satellite based plant cover (reference cond,DWDsand)**
15	4,92	3,98	6,95	77,29	50,20	**satbased LAI+plcov (reference conditions,DWDsnd)**
16	4,36	3,24	6,91	75,56	49,83	**Mod. sand (reference conditions)**
17	4,53	2,51	6,60	76,22	50,83	**Silty sand (reference conditions)**
18	5,43	2,40	5,49	80,58	43,14	**Loamy sand (reference conditions)**
19	8,89	4,55	2,81	77,33	42,70	**Sandy loam (reference conditions)**
20	9,68	7,94	2,32	77,42	44,16	**Loam (reference conditions)**
21	2,93	2,56	1,60	64,53	56,80	**Rigidlid+rtdpl+bsevapNP+rtdepth=0.6,modsnd z0=0.03m**
22	2,73	3,07	2,47	67,98	48,36	**Rigidlid+rtdpl+bsevapNP+rtdepth=0.6,silty sand**
23	3,52	3,36	4,40	75,55	42,84	**Rigidlid+rtdpl+bsevapNP+rtdepth=0.6,loamy sand**
24	4,10	3,86	2,43	34,30	67,44	**Rigidlid+rtdpl+bsevapNP+rtdepth=0.6,sand, z0=0.003m**
25	3,40	3,10	2,02	80,52	69,12	**Rigidlid+rtdpl+bsevapNP+rtdepth=0.6,sand, z0=0.3m**
26	4,10	3,86	2,43	34,30	67,44	**Rgdlid+rtdpl+bsevapNP+rtdepth=0.6,DWDsnd,z0=0.003m**
27	3,40	3,10	2,02	80,52	69,12	**Rgdlid+rtdpl+bsevapNP+rtdepth=0.6,DWDsnd,z0=0.3m**
28	3,67	3,40	2,20	54,61	66,42	**Rigidlid+rtdpl+bsevapNP+rtdepth=0.6,DWDsnd z0=0.03m**
29	2,38	1,82	1,82	55,22	72,88	**Rglid+rtdpl+bsNP+rtd0.6,DWDsnd z0=0.03m,satb LAI+plc**

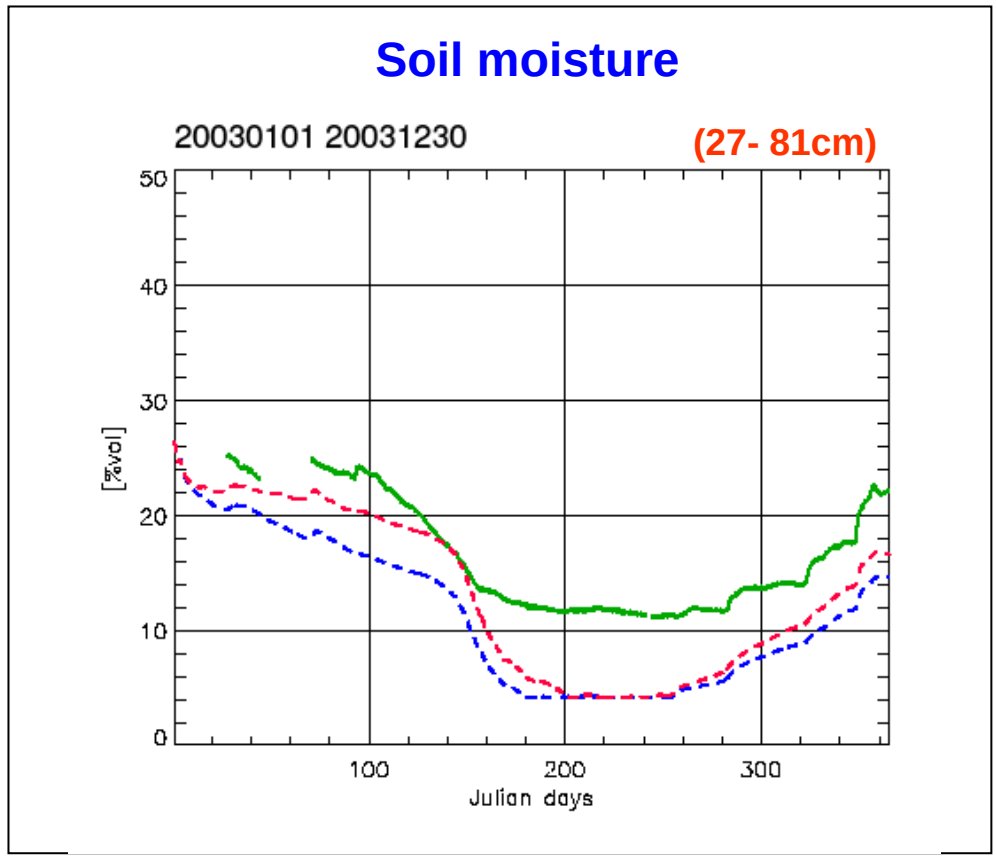
„Rigid lid“

CEOP Lindenberg (Falkenberg) 2003

measurement

reference run (v4.0)

experimental run



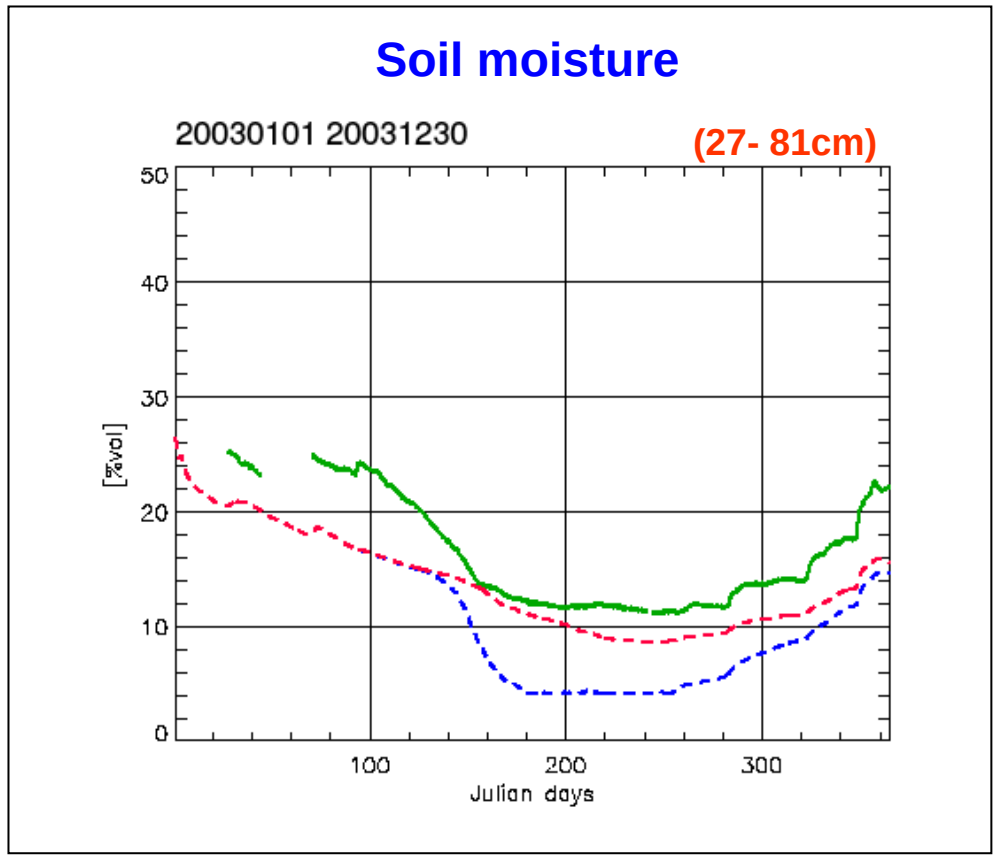
„Root depletion with depth“

CEOP Lindenberg (Falkenberg) 2003

measurement

reference run (v4.0)

experimental run



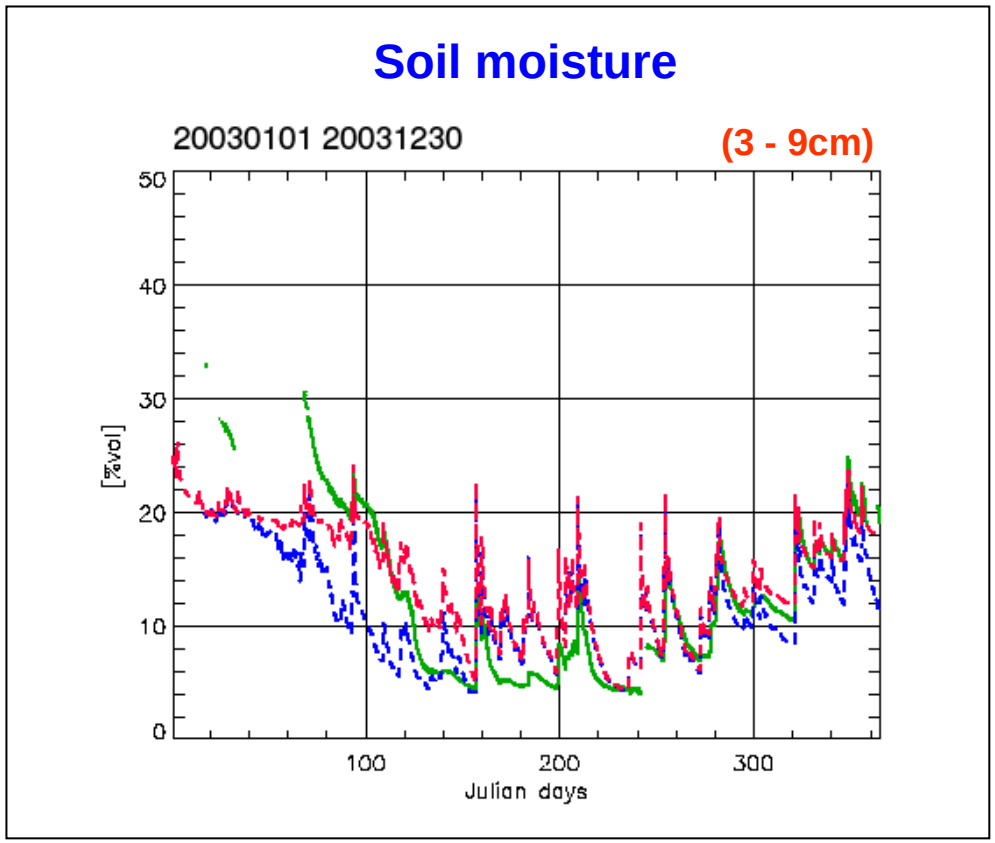
„Bare soil evaporation according to Noilhan & Planton (1989)“

CEOP Lindenberg (Falkenberg) 2003

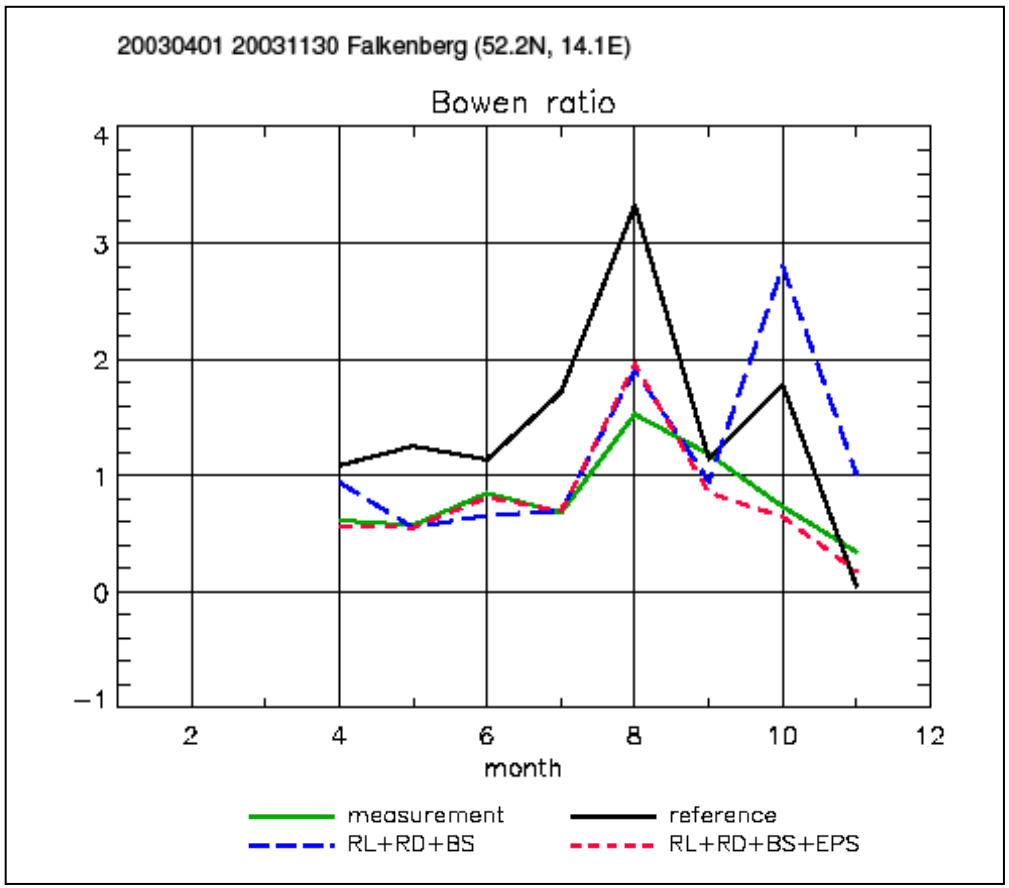
measurement

reference run (v4.0)

experimental run



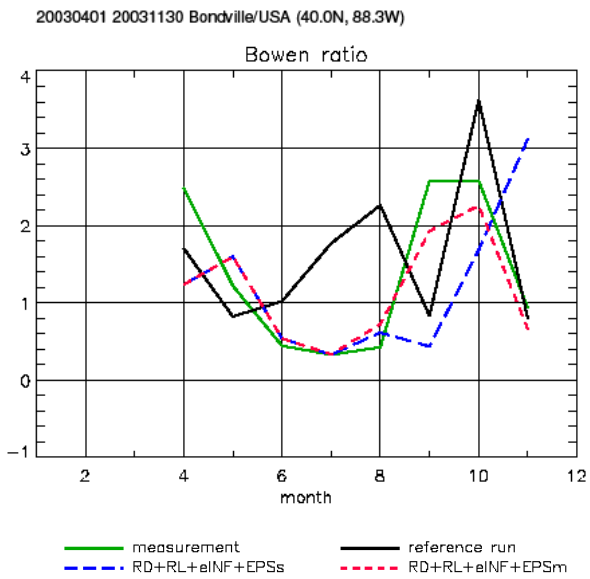
CEOP Lindenberg (Falkenberg) 2003



Similar improvement also achieved in 2004 – 2006 !

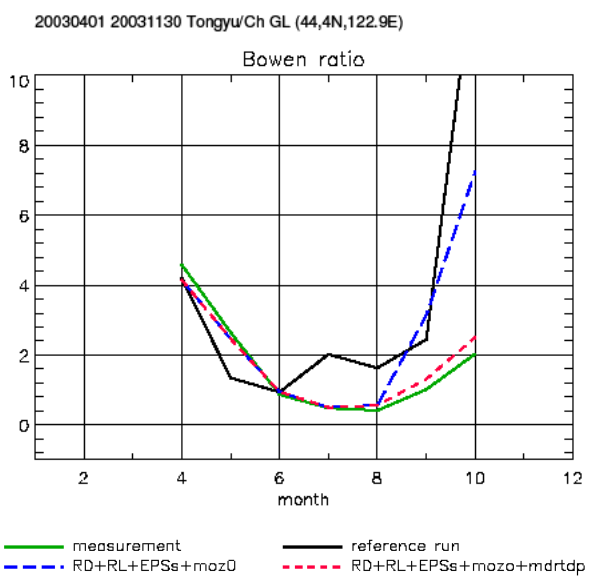
Cropland site (corn)

Bondville (USA) 2003



Grassland site

Tongyu (China) 2003



Conclusions from TERRA standalone

- The Bowen ration can be reasonably simulated if the options **RL, RD, BSEV and satellite-derived plant cover values** are used. In order to consolidate the findings the stand-alone runs should be extended to further sites and years.

- In autumn, the model performance depends essentially on vegetation pro- perties. Their typical temporal variations should be considered more than before in the simulations.

- Systematic sensitivity studies should be made to find out under which con- ditions the soil moisture clearly impacts on cloudiness, convection or preci-pitation. For such studies a preceding comparison between the operational assimilations of COSMO-DE- and COSMO-6.6 would be helpful to detect suitable cases.

COSMO-Experiments - Outlook

- Adaptions of TERRA standalone 4.0 to COSMO 4.7
- Incorporation of enhanced external parameters (min. stom. resistance, emissivity, NDVI climatology, clim. soil temperature)
- Adaptions of look-up tables (ensure backward compatibility)
- Impact of adaptions in TERRA on soil moisture analysis (SMA) in COSMO-EU (DWD) has to be considered

COSMO-Experiments - Outlook

- Adaptions of TERRA standalone 4.0 to COSMO 4.7
  - Bare soil evaporation after Noilhan and Platon, 1989 (BS) - former Dickinson, 1984
  - Non-uniform root distribution (RD)
  - Soil moisture dependent heat conductivity

- Experiments COSMO-EU (SMA!), COSMO-DE: Start at March 2009
- Monitoring at Falkenberg
- Verification after weeks/months