COST734 International Conference on current Knowledge of Climate Change Impacts on Agriculture and Forestry in Europe

Topolcianky, Slovakia, 3-6 May, 2011

Use of ASCAT Data for Crop Model Application A Case Study from Austria

Gerhard Kubu, Josef Eitzinger, Sabina Thaler

Institute of Meteorology
University of Natural Resources and Applied Life Sciences (BOKU)

Peter Jordanstr. 82
1190 Vienna, AUSTRIA

www.boku.ac.at / gerhard.kubu@boku.ac.at / josef.eitzinger@boku.ac.at

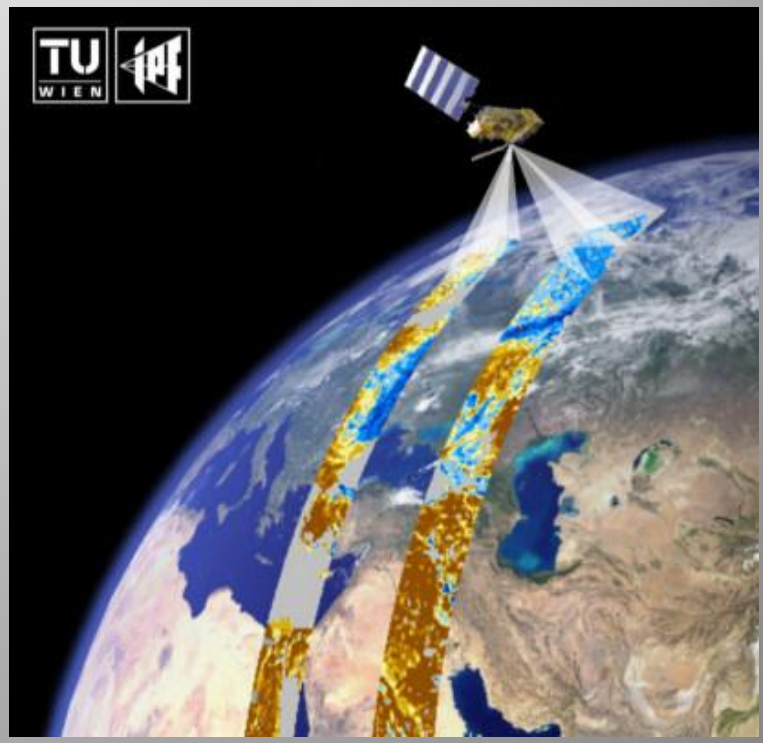
Global Monitoring of Soil Moisture for Water Hazards Assessment (GMSM)

Overall Project Goals:

- Advance the use of METOP ASCAT soil moisture services in water hazards applications
  - EUMETSAT declared the ASCAT SM service operational in December 2008

Our Goal:

- Use ASCAT soil moisture data for crop modeling



GMSM Partners

- Vienna University of Technology (TU Wien)
  - Institute of Photogrammetry and Remote Sensing (I.P.F.)
  - Institute for Hydraulic and Water Resources Engineering (I.W.I.)
- Central Institute for Meteorology and Geodynamics (ZAMG)
  - Department of Remote Sensing Meteorology
  - Numerical Weather Prediction Department
- University of Natural Resources and Applied Life Sciences (BOKU)
  - Institute of Meteorology
- University of Veterinary Medicine Vienna (VUW)
  - Biometeorology and Mathematical Epidemiology Group
- Austrian Research Centres (ARC)
  - Division of Systems Research
- GeoVille
- Paris Lodron University Salzburg (PLUS)
  - Centre for Geoinformatics (Z_GIS)

Data

- ASCAT – advanced scatterometer data
  - Backscatter signal of active microwave
  - intensity is correlated with water content of top soil layer (~ 1 cm)
- EUMETSAT Global product SM-OBS-1
  - generated and distributed in Near-Real-Time, 25 km
- ZAMG Regional product SM-OBS-2
  - generated from Global product, 1 km
  - Downscaling using ENVISAT ASAR information, European database available (provided by TUWien)

Get in touch with data
Part I of II

Case study from Austria – Seewinkel Region

SM-OBS-2 Data (1 km): Comparison with Digital Soil Map

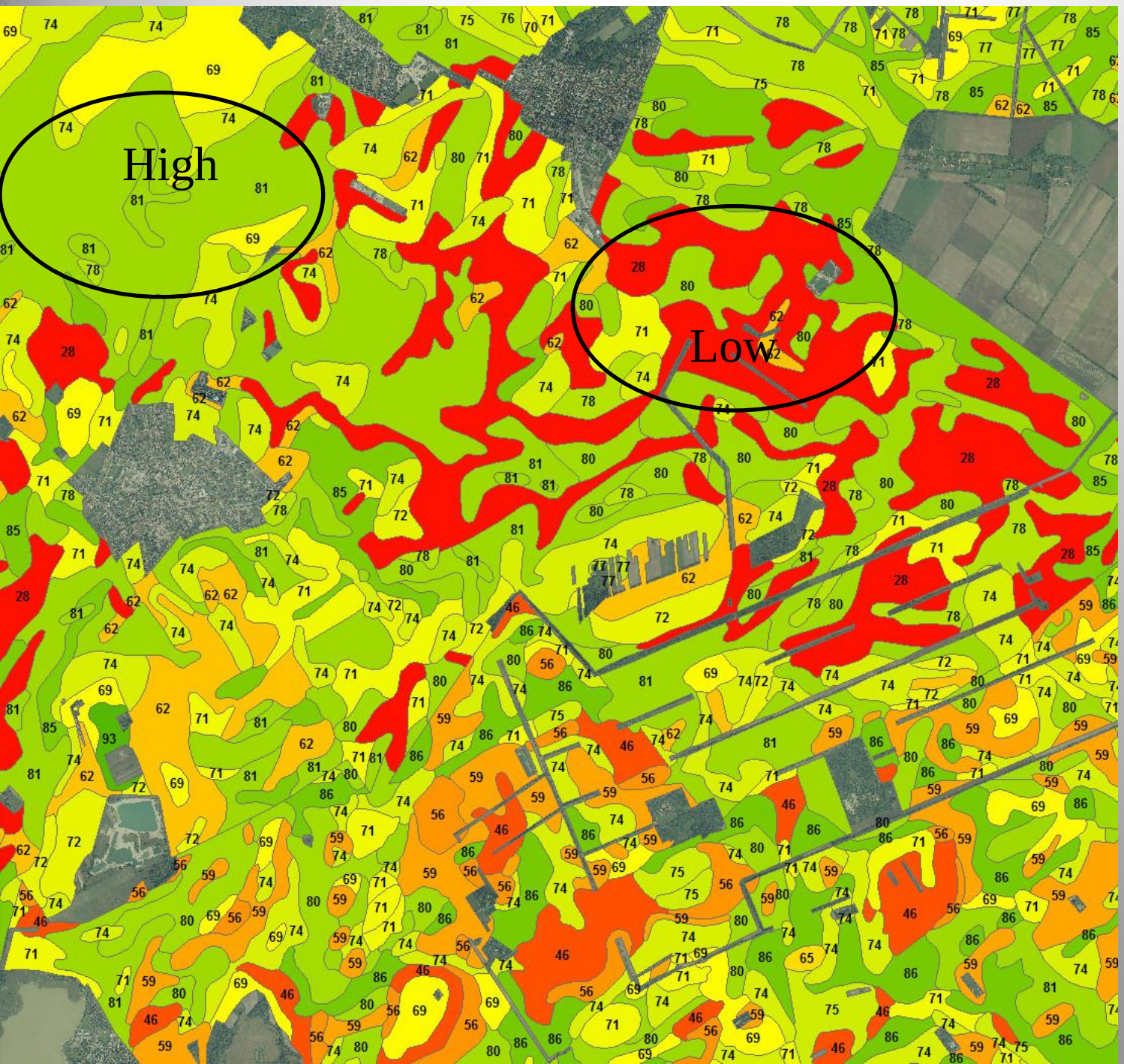


Fig: Subregion-analysis Frauenkirchen

Soil map with available soil water capacity of 40cm topsoil layer

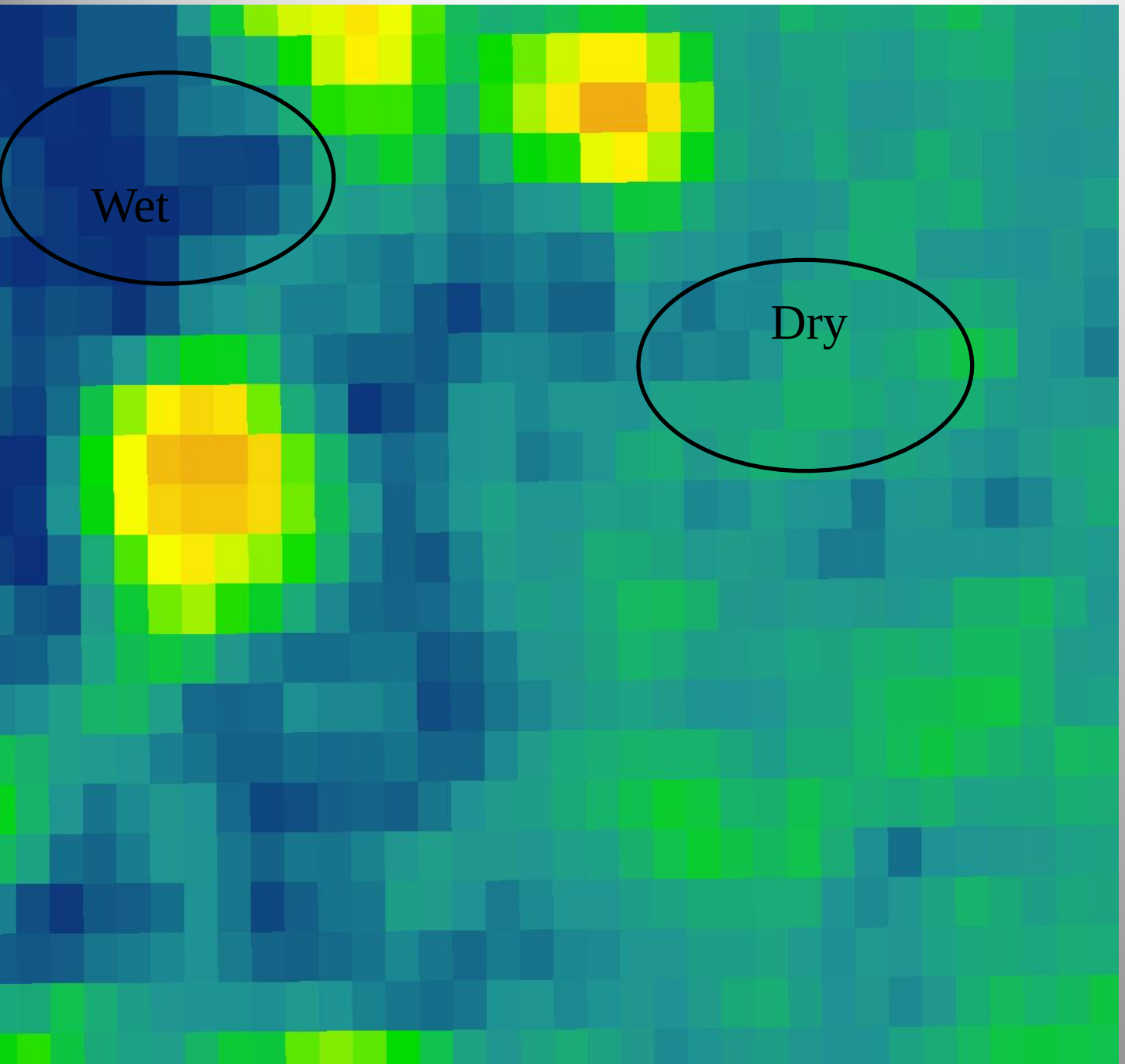
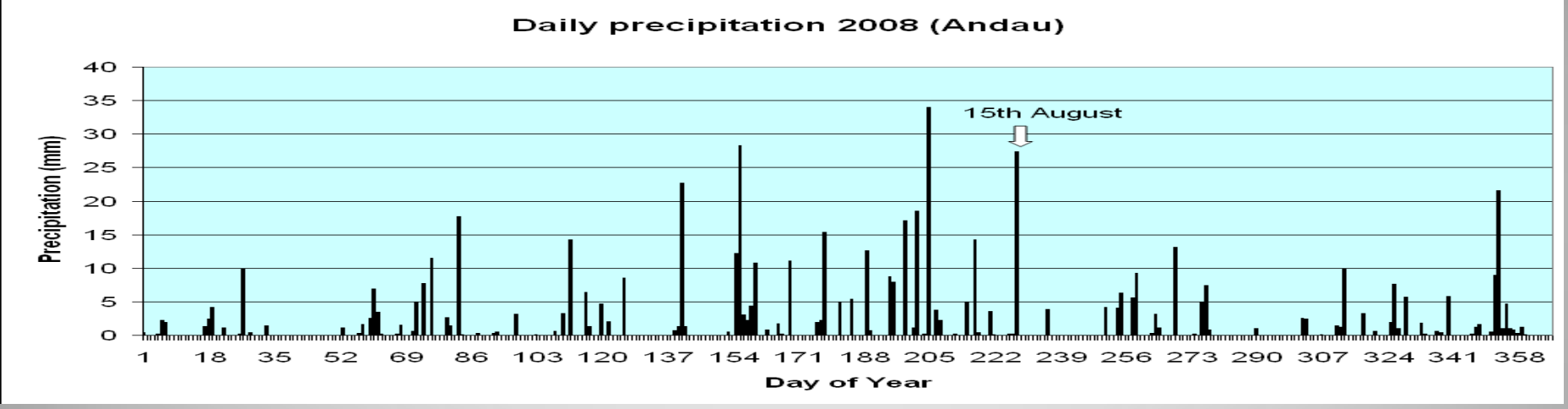
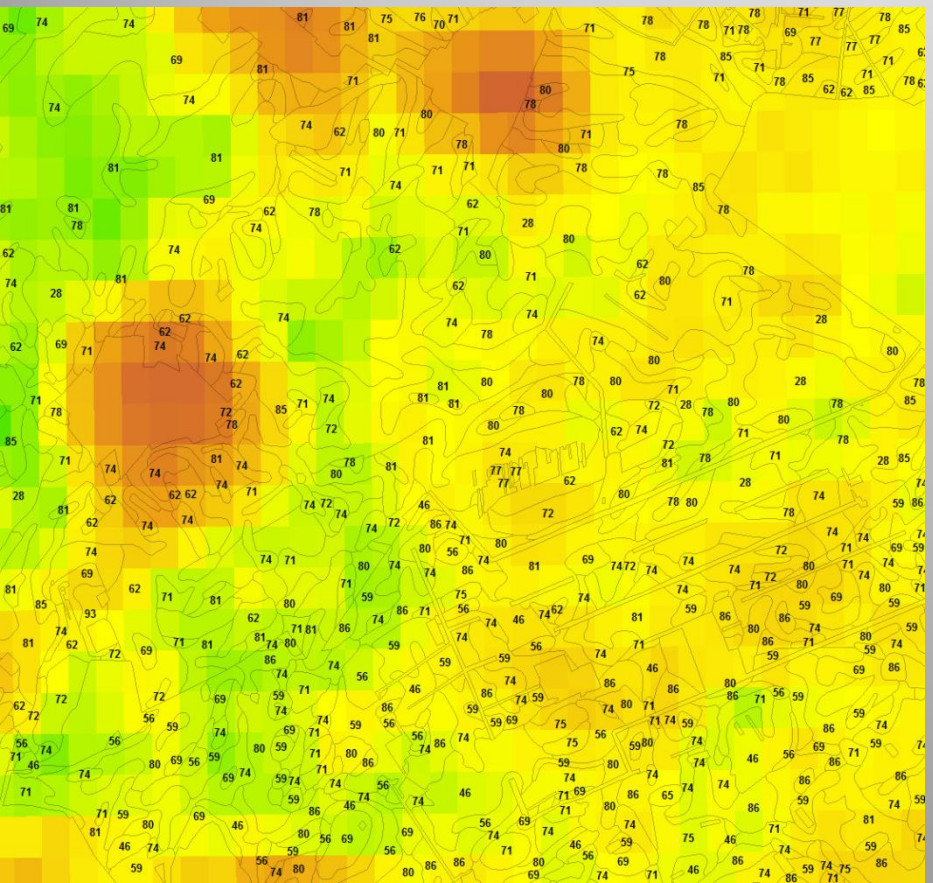


Fig: Subregion-analysis Frauenkirchen

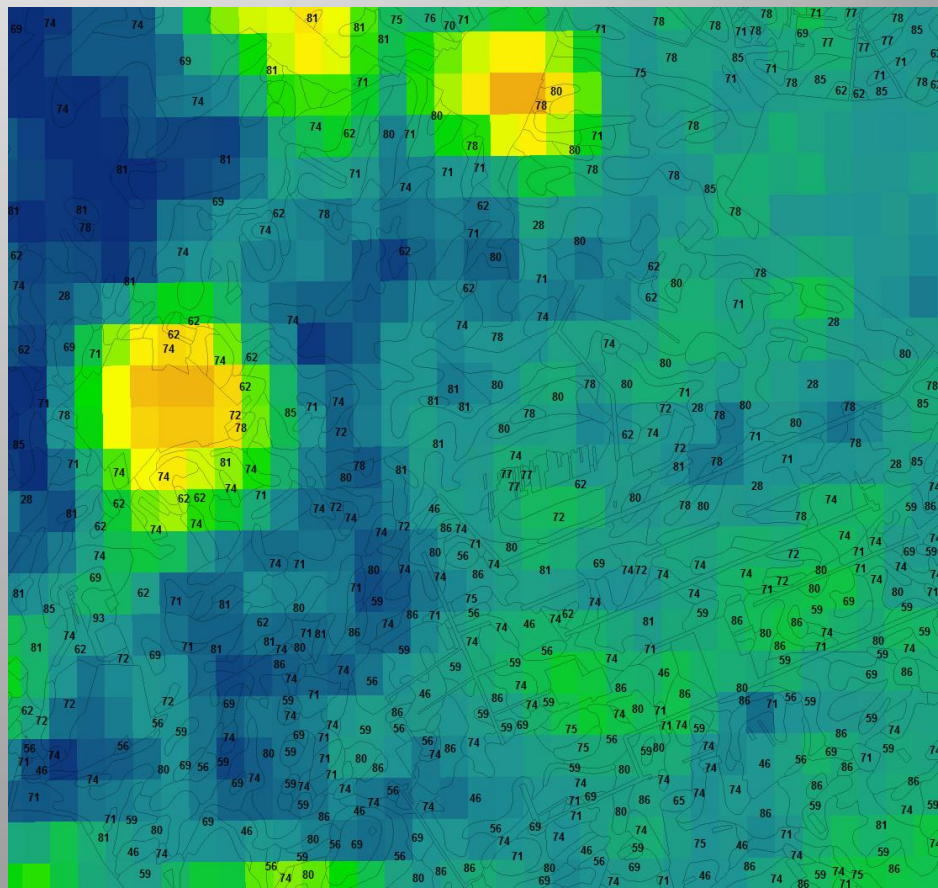
Scatterometer shot from 16th August 2008



13th August 2008 (before rain)



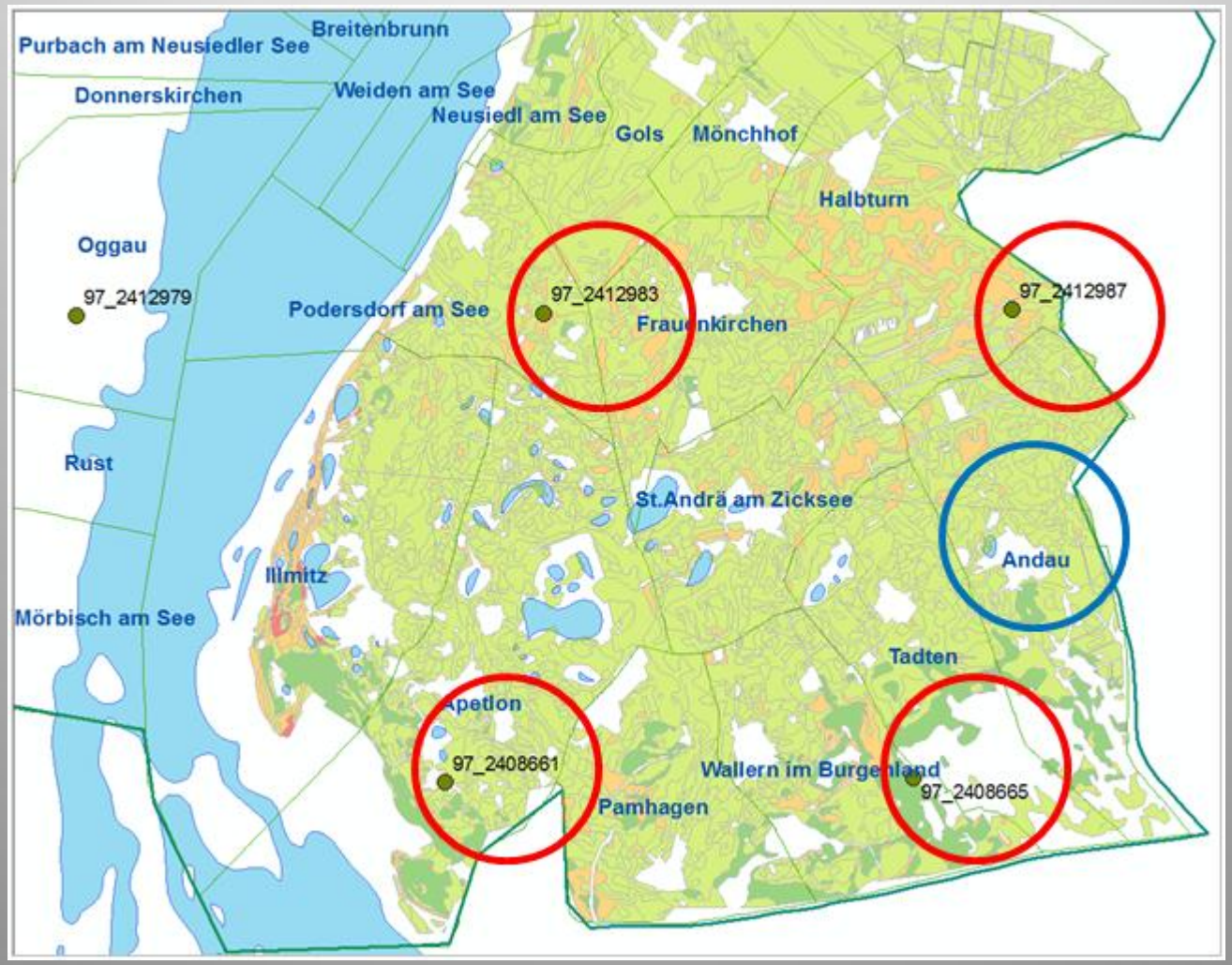
16th August 2008 (after 25mm rain)



Get in touch with data
Part II of II

Comparison of SM-OBS-1 data, 25 km, with data from crop model simulation for the Austrian Seewinkel Region

Data grid centers and location of the ZAMG weather station ANDAU



Crop modeling

- DSSAT was used to simulate crop yield and related soil water balance (spring barley)
- weather data from the ZAMG station Andau
- prevailing regional physical soil parameters

The DSSAT model calculates a detailed water balance and for different soil layers, so the soil water content of the top soil layer 0-5 cm is available on a daily basis …

0	25	14	44	16	0.191	0.269	0.328	0.349	0.356	0.352	0.344
0					0.189	0.267	0.326	0.348	0.355	0.352	0.344
0					0.187	0.265	0.325	0.347	0.355	0.351	0.343
1	53	49	73	51	0.196	0.263	0.323	0.346	0.355	0.351	0.343
0					0.192	0.260	0.321	0.346	0.354	0.351	0.343
3	26	19	39	15	0.221	0.257	0.319	0.345	0.354	0.350	0.343
0					0.208	0.255	0.316	0.344	0.353	0.350	0.343
14					0.355	0.297	0.312	0.342	0.352	0.350	0.343
0	99	72	100	79	0.271	0.309	0.312	0.341	0.352	0.349	0.343
0	44				0.253	0.302	0.314	0.340	0.351	0.349	0.343
0	50	15	73	16	0.224	0.290	0.312	0.339	0.351	0.349	0.342
6		34			0.308	0.294	0.310	0.338	0.350	0.348	0.342
2	57	28	85	36	0.268	0.298	0.308	0.336	0.349	0.348	0.342
0	51	18	86	30	0.243	0.287	0.305	0.334	0.349	0.347	0.342
0	18	12	42	10	0.211	0.273	0.300	0.331	0.348	0.347	0.342
4	50	25	75	30	0.283	0.262	0.295	0.329	0.347	0.347	0.342
0	6	0	33	0	0.253	0.259	0.292	0.327	0.346	0.346	0.341
2	49	31	73	44	0.269	0.252	0.288	0.325	0.345	0.346	0.341
0	15	2	55	13	0.235	0.245	0.282	0.321	0.344	0.345	0.341
0	13	9	38	8	0.208	0.235	0.276	0.318	0.343	0.345	0.341
0	17	1	35	0	0.187	0.225	0.271	0.315	0.342	0.345	0.340
9	44	40	56	39	0.320	0.231	0.266	0.313	0.341	0.344	0.340
0	40	13	65	17	0.271	0.233	0.261	0.310	0.340	0.343	0.340
0	1	0	25	0	0.234	0.226	0.256	0.306	0.339	0.343	0.339
0	6	3	31	4	0.201	0.215	0.250	0.303	0.337	0.342	0.339
0	18	0	41	0	0.181	0.205	0.244	0.300	0.336	0.342	0.339
0	0	0	16	0	0.161	0.196	0.236	0.295	0.334	0.341	0.339
0	27	7	46	7	0.140	0.191	0.225	0.289	0.333	0.341	0.338
0					0.119	0.188	0.215	0.283	0.331	0.340	0.338
0	0	0	21	0	0.102	0.184	0.207	0.275	0.328	0.339	0.338
0	15	1	26	0	0.102	0.181	0.202	0.265	0.325	0.339	0.337
0	0	0	11	0	0.102	0.177	0.197	0.251	0.321	0.338	0.337
0	5	0	26	0	0.101	0.175	0.194	0.238	0.318	0.337	0.336
0		0			0.101	0.173	0.192	0.224	0.313	0.336	0.336
0	0	0	7	0	0.113	0.172	0.190	0.217	0.310	0.335	0.335
1		0		0	0.127	0.170	0.189	0.212	0.307	0.334	0.335
23	49	55	50	48	0.399	0.256	0.188	0.212	0.305	0.333	0.335
1	42	52	44	47	0.330	0.285	0.189	0.212	0.304	0.332	0.334
0	34	32	51	29	0.270	0.283	0.191	0.212	0.302	0.331	0.334
0	6	6	22	1	0.227	0.267	0.192	0.212	0.300	0.330	0.333
0		6			0.193	0.250	0.193	0.211	0.298	0.329	0.332
0	0	4	14	0	0.169	0.231	0.192	0.210	0.296	0.328	0.332
0	15	18	28	10	0.144	0.209	0.192	0.209	0.293	0.327	0.331
0	0	2	10	0	0.108	0.184	0.191	0.207	0.289	0.325	0.331
0	13	20	28	12	0.102	0.178	0.188	0.202	0.280	0.323	0.330
0	0	0	3	0	0.101	0.174	0.185	0.199	0.270	0.321	0.330
0					0.101	0.170	0.182	0.195	0.257	0.318	0.329
0	25	27	37	16	0.101	0.167	0.180	0.193	0.245	0.314	0.328
1	18	24	25	12	0.111	0.165	0.179	0.191	0.232	0.310	0.327
0		27	21	15	0.101	0.164	0.177	0.189	0.220	0.306	0.327
12	78	63	82	61	0.321	0.173	0.176	0.187	0.211	0.300	0.326
28	58	52	71	64	0.351	0.366	0.196	0.186	0.211	0.298	0.325
3	71	68	74	65	0.330	0.349	0.220	0.187	0.212	0.297	0.324
2	44	44	54	40	0.294	0.334	0.231	0.187	0.213	0.296	0.323
5	78	76	87	79	0.317	0.329	0.239	0.187	0.214	0.296	0.322
10	68	62	70	59	0.372	0.348	0.258	0.188	0.215	0.295	0.321
0	75	73	78	73	0.283	0.322	0.273	0.189	0.215	0.294	0.320
0					0.230	0.303	0.268	0.190	0.215	0.293	0.319
1	36	45	47	40	0.214	0.285	0.263	0.191	0.216	0.292	0.318
0	41	39	52	37	0.180	0.270	0.258	0.192	0.216	0.291	0.317
0					0.165	0.258	0.254	0.193	0.216	0.290	0.316
2	18	25	31	22	0.171	0.243	0.247	0.193	0.216	0.289	0.315
0					0.157	0.231	0.240	0.194	0.216	0.288	0.314
0	18	19	24	12	0.122	0.217	0.233	0.194	0.216	0.287	0.313
11	63	52	75	60	0.304	0.218	0.227	0.194	0.216	0.286	0.313
0	40	47	47	41	0.236	0.215	0.220	0.194	0.216	0.285	0.312
0	47	54	62	55	0.179	0.206	0.214	0.194	0.216	0.284	0.311
0	59	66	66	63	0.129	0.193	0.206	0.194	0.215	0.282	0.310
0	16	23	29	17	0.102	0.184	0.199	0.193	0.212	0.279	0.309
0		45		48	0.102	0.178	0.193	0.191	0.209	0.274	0.308

Comparison

- Precipitation
- ASCAT SM data
- Crop modeling SM data

Columns:

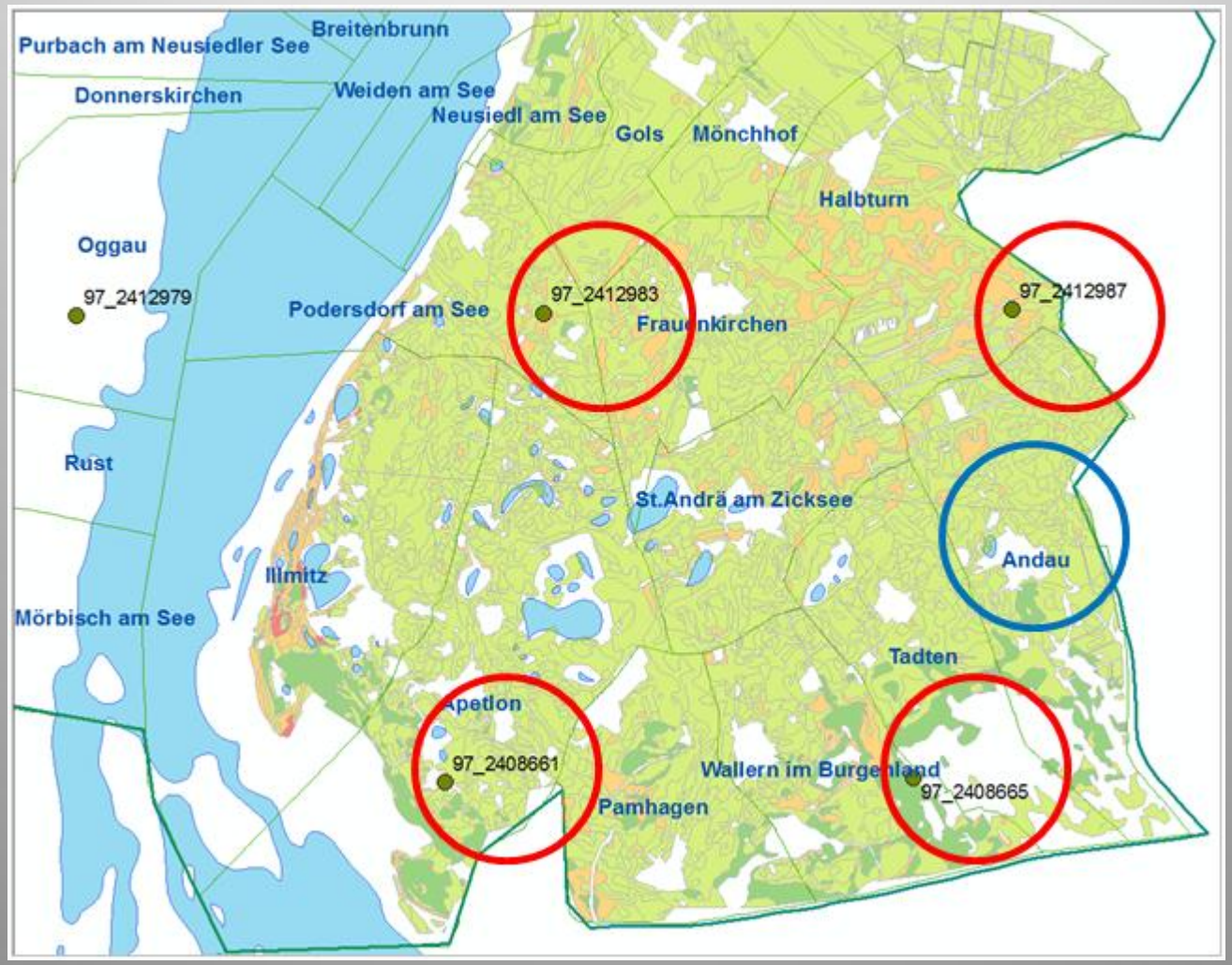
1: Daily precipitation (mm)
2-5: ASCAT surface soil moisture of 4 grid points

6-12: simulated soil water content (cm^3/cm^3) under spring barley in different depths (from left to right: 0-5 cm, 5-15 cm, 15-30 cm, 30-45 cm, 45-60 cm, 60-90 cm, 90-120 cm)

Discussion

- days with precipitation are clearly represented in the ASCAT surface soil moisture values
- simulated soil water contents show
  - the wetting and drying of the vertical soil profile
  - the progressive drying of the top soil layer
- however simulation data represents only the weather station site
- a spatial variation is visible in the ASCAT data
  - this variation is realistic and can be verified by INCA data

Data grid centers and location of the ZAMG weather station ANDAU



Conclusion

- The result of the study point directly to one of the most significant advantages of ASCAT soil moisture data which should be used for improving spatial crop yield modeling:
  - The use of information on spatial variability of top soil moisture as crop model input could improve the spatial crop yield simulations as compared to the use of the point information of a single weather station, even with spatial interpolation between weather stations.
- The comparison of the 4 ASCAT grid point data with the DSSAT simulation results shows the highest correlation with the closest grid points (columns 2 and 4) while greater distance to the weather stations indicates different soil moisture conditions.
- That means also, that only one meteorological station, even in a flat region as in our case, is not sufficient for accurate spatial crop yield monitoring within the entire Seewinkel region due to the high spatial variability of precipitation.

www.boku.ac.at gerhard.kubu@boku.ac.at josef.eitzinger@boku.ac.at