

**USING RESULTS OF MODELLED YIELD  
DEVIATION AND INDICES OF WEATHER  
EXTREMES TOWARDS A BETTER YIELD  
ASSESSMENT –  
CURRENT STATE OF RESEARCH**

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## TASK DEFINITION

- USING RESULTS OF CROP MODELS AND INDICES OF WEATHER EXTREMES TOWARDS A BETTER YIELD ASSESSMENT - MODEL UNCERTAINTIES

### THE MAIN GOAL OF THIS STUDY IS:

- TO IDENTIFY DIFFERENCES BETWEEN MODELLED AND OBSERVED CROP YIELD WHICH ARE RESULT OF EXTREME WEATHER IMPACT
- TO QUANTIFY THIS IMPACT USING AGM INDICES RELATED TO EXTREME WEATHER EVENTS
- TO COMPLETE THE INFORMATIONS WHICH ARE COMING FROM CROP MODELS BY VARIOUS INDICES WHICH CAN GIVE ADDITIONAL OR BETTER INFORMATION OF FUTURE REGIONAL CROP RISKS TO SPECIFIC EXTREMES



## DATA USED

- **CULTIVARS: WINTER WHEAT AND MAIZE**
- **COUNTRIES: AUSTRIA, BULGARIA, CROATIA, SERBIA, SLOVAKIA, SLOVENIA, SWEDEN, TURKIE**
- **RESTRICTIONS: DUE TO A PROBLEMS WITH INPUT METEOROLOGICAL DATA OR YIELD DATA SERIES, SOME LOCATIONS ARE OMMITED.**



## DATA USED

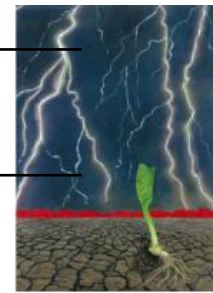
- **EXTREME WEATHER INDICATORS: NUMBER OF DAYS WITH EXTREME TEMPERATURES AND NUMBER OF DRY DAYS DURING VEGETATION PERIOD**
- **YIELD INDICATORS: YIELD, ABSOLUTE AND RELATIVE CHANGE OF YIELD**
- **INDICATORS: i) YIELD vs. AGM INDICES, ii) ABSOLUTE YIELD DEVIATIONS vs. AGM INDICES, iii) RELATIVE YIELD DEVIATIONS vs. AGM INDICES.**



## YIELD INDICATORS: YIELD, ABSOLUTE AND RELATIVE CHANGE OF YIELD

Country	location	soil type	Relative change of maize yield
Croatia	Dubrovca	Soil 1	266.01
		Soil 2	199.38
		Soil 3	31.61
		Soil 4	65.06
Serbia	Novi Sad-a	Soil 1	73.86
		Soil 2	70.82
		Soil 3	41.94
		Soil 4	45.20
Serbia	Novi Sad-b	Soil 1	73.86
		Soil 2	70.82
		Soil 3	41.94
		Soil 4	45.20
Serbia	Novi Sad-c	Soil 1	71.89
		Soil 2	68.00
		Soil 3	38.96
		Soil 4	39.97
Slovakia	Ziharec	Soil 1	78.08
		Soil 2	69.78
		Soil 3	63.14
		Soil 4	65.88
Slovakia	Podhajska	Soil 1	75.78
		Soil 2	60.59
		Soil 3	49.74
		Soil 4	59.96

Country	location	soil type	Relative change of winter wheat yield
Austria	Gross-Enzersdorf		40.97
Serbia	Novi Sad-a	Soil 1	40.05
		Soil 2	72.57
		Soil 3	121.73
		Soil 4	136.00
Serbia	Novi Sad-b	Soil 1	37.45
		Soil 2	59.19
		Soil 3	103.98
		Soil 4	118.23
Serbia	Novi Sad-c	Soil 1	40.13
		Soil 2	24.13
		Soil 3	44.27
		Soil 4	51.96
Serbia	Novi Sad-d	Soil 1	43.05
		Soil 2	19.75
		Soil 3	35.76
		Soil 4	41.93
Serbia	Novi Sad-e	Soil 1	44.91
		Soil 2	18.99
		Soil 3	30.30
		Soil 4	35.69
Slovakia	Ziharec	Soil 1	53.56
		Soil 2	51.40
		Soil 3	61.49
		Soil 4	60.53
Slovakia	Podhajska	Soil 1	51.25
		Soil 2	34.22
		Soil 3	40.99
		Soil 4	44.48
Slovakia	Belusa	Soil 1	66.30
		Soil 2	44.99
		Soil 3	22.74
		Soil 4	28.86
Sweedeen	Lund	Soil 1	48.14
		Soil 2	30.62
		Soil 3	20.60
		Soil 4	21.28
Sweedeen	Upsala	Soil 1	57.50
		Soil 2	47.61
		Soil 3	62.31
		Soil 4	53.67



## INDICATORS: OBSERVED YIELD vs. AGM INDICES MAIZE

		March	April	April	May	May	June	June	July	July	August	August	September
location	data type	FrostD	SumD	FrostD	TropD	SumD	TropD	SumD	TropD	SumD	TropD	SumD	SumD
Dubrovca	Obs.	0.00	0.03	-0.43	-0.31	-0.34	-0.07	-0.37	0.15	-0.05	-0.64	-0.42	-0.06
Novi Sad-a	Obs.	0.12	-0.44	0.31	-0.41	-0.21	-0.56	-0.51	-0.50	-0.49	-0.85	-0.34	0.09
Novi Sad-b	Obs.	0.09	-0.53	0.30	-0.41	-0.41	-0.66	-0.60	-0.86	-0.71	-0.76	-0.39	-0.03
Novi Sad-c	Obs.	-0.09	-0.03	0.24	-0.28	0.02	-0.53	-0.58	-0.59	-0.36	-0.59	-0.22	0.31
Ziharec	Obs.	0.55	0.09	0.24	0.51	0.38	-0.01	-0.01	-0.58	-0.72	-0.25	-0.25	0.11
Podhajska	Obs.	0.25	-0.47	0.08	0.00	-0.20	-0.19	-0.11	0.08	0.06	-0.56	-0.56	-0.12
<b>MAXIMUM</b>		<b>0.55</b>	<b>0.09</b>	<b>0.31</b>	<b>0.51</b>	<b>0.38</b>	<b>-0.01</b>	<b>-0.01</b>	<b>0.15</b>	<b>0.06</b>	<b>-0.25</b>	<b>-0.22</b>	<b>0.31</b>
<b>MINIMUM</b>		<b>-0.09</b>	<b>-0.53</b>	<b>-0.43</b>	<b>-0.41</b>	<b>-0.41</b>	<b>-0.66</b>	<b>-0.60</b>	<b>-0.86</b>	<b>-0.72</b>	<b>-0.85</b>	<b>-0.56</b>	<b>-0.12</b>

GREEN COLOUR INDICATES CORRELATIONS ABOVE 0.40



## INDICATORS: OBSERVED YIELD vs. AGM INDICES WINTER WHEAT

		January	January	January	February	February	March	April	May	June	June
location	data type	FrostD	FreezD	ArcticD	FrostD	FreezD	FrostD	FrostD	SumD	TropD	SumD
Gross-Enzersdorf	Observed	-0.14	-0.14		-0.43	-0.43	-0.27	0.14	-0.32	0.04	-0.24
Novi Sad-a	Observed	-0.01	0.15		-0.03	-0.07	-0.36	-0.05	-0.24	-0.30	-0.23
Novi Sad-b	Observed	-0.15	-0.04		-0.21	-0.14	-0.33	-0.02	-0.22	-0.27	-0.25
Novi Sad-c	Observed	-0.37	-0.19		-0.31	-0.31	-0.34	-0.15	-0.27	-0.39	-0.37
Novi Sad-d	Observed	-0.24	-0.19		-0.41	-0.37	-0.28	-0.02	-0.18	-0.44	-0.46
Novi Sad-e	Observed	-0.31	-0.16		-0.43	-0.40	-0.20	-0.06	-0.31	-0.54	-0.44
Ziharec	Observed	-0.37	-0.44		-0.12	-0.34	-0.33	-0.06	-0.22	-0.33	0.07
Podhajska	Observed	-0.23	-0.32		-0.15	0.08	-0.02	-0.23	-0.64	-0.58	-0.29
Belusa	Observed	0.11	-0.23		-0.30	-0.28	-0.21	-0.03	-0.20	-0.32	-0.17
Lund	Observed	-0.40	-0.44	-0.74	-0.24	-0.31	-0.15	0.10	0.21		0.29
Upsala	Observed	-0.26	-0.36	-0.50	0.45	0.66	0.33	0.12	0.38		-0.15
MAXIMUM		0.11	0.15	-0.50	0.45	0.66	0.33	0.14	0.38	0.04	0.29
MINIMUM		-0.40	-0.44	-0.74	-0.43	-0.43	-0.36	-0.23	-0.64	-0.58	-0.46



## INDICATORS: ABSOLUTE YIELD DEVIATIONS vs. AGM INDICES MAIZE

location	soil type	April	April	May	May	June	June	July	July	August	August	September
		SumD	FrostD	TropD	SumD	TropD	SumD	TropD	SumD	TropD	SumD	SumD
Dubrovca	Soil 3	0.19	-0.01	-0.48	-0.20	0.21	-0.02	0.19	0.05	-0.46	-0.65	0.13
Novi Sad-a	Soil 3	0.02	0.52	0.07	0.29	-0.16	-0.11	-0.28	-0.25	-0.44	0.09	0.07
Novi Sad-b	Soil 3	-0.13	0.60	0.07	0.05	-0.34	-0.26	-0.85	-0.61	-0.42	0.02	-0.09
Novi Sad-c	Soil 3	0.53	0.37	0.23	0.53	0.01	-0.09	-0.24	-0.08	0.00	0.22	0.20
Ziharec	Soil 3	-0.44	0.19	0.07	0.11	-0.34	-0.15	-0.44	-0.22	-0.03	-0.03	0.20
Podhajska	Soil 3	-0.19	0.13	0.18	0.27	0.03	-0.09	-0.15	-0.38	-0.13	-0.13	
<b>MAXIMUM</b>		0.53	0.60	0.52	0.53	0.27	0.10	0.56	0.20	0.00	0.44	0.30
<b>MINIMUM</b>		-0.44	-0.16	-0.48	-0.23	-0.60	-0.56	-0.86	-0.70	-0.70	-0.65	-0.57





## INDICATORS: ABSOLUTE YIELD DEVIATIONS vs. AGM INDICES WINTER WHEAT

Country	location	soil type	January FrostD	January FreezD	January ArcticD	February FrostD	February FreezD	March FrostD	May SumD	June TropD	June SumD
Austria	Gross-Enzersdorf	Soil 3	0.01	0.06		0.07	0.07	0.16	-0.06	-0.02	0.03
Serbia	Novi Sad-a	Soil 1	0.07	0.28		0.12	-0.07	-0.20	0.23	-0.13	0.02
Serbia	Novi Sad-b	Soil 1	-0.01	0.01		0.03	-0.05	-0.07	0.29	0.01	0.03
Serbia	Novi Sad-c	Soil 2	0.10	0.08		-0.33	-0.43	-0.03	0.26	-0.09	-0.13
Serbia	Novi Sad-d	Soil 2	-0.12	-0.01		-0.30	-0.53	0.00	0.27	0.01	0.03
Serbia	Novi Sad-e	Soil 2	-0.22	-0.06		-0.27	-0.51	0.07	0.25	0.16	0.08
Slovakia	Ziharec	Soil 2	-0.24	-0.24		-0.09	0.12	0.22	0.34	0.04	0.00
Slovakia	Podhajska	Soil 2	0.06	-0.04		0.17	0.17	0.41	-0.07	-0.17	0.19
Slovakia	Belusa	Soil 3	0.32	0.24		0.04	-0.34	-0.11	-0.06	-0.15	0.12
Sweeden	Lund	Soil 3	0.42	0.39	-0.09	0.52	0.75	0.20	-0.47	-0.04	-0.25
Sweeden	Upsala	Soil 2	0.05	0.18	0.16	-0.22	-0.02	-0.39	-0.15		0.06
<b>MAXIMUM</b>			0.42	0.39	0.20	0.55	0.75	0.62	0.57	0.52	0.66
<b>MINIMUM</b>			-0.39	-0.49	-0.21	-0.34	-0.53	-0.39	-0.47	-0.55	-0.53



## INDICATORS: RELATIVE YIELD DEVIATION vs. AGM INDICES MAIZE

Country	location	soil type	April	April	May	May	June	June	July	July	August	August	September
			SumD	FrostD	TropD	SumD	TropD	SumD	TropD	SumD	TropD	SumD	SumD
Croatia	DubrovcaK	Soil 3	0.23	0.08	-0.44	-0.14	0.24	0.03	0.27	0.13	-0.40	-0.68	0.04
Serbia	Novi Sad-a	Soil 3	0.43	0.49	0.49	0.63	0.25	0.30	0.04	0.09	0.11	0.47	0.03
Serbia	Novi Sad-b	Soil 3	0.43	0.49	0.49	0.63	0.25	0.30	0.04	0.09	0.11	0.47	0.03
Serbia	Novi Sad-c												
Serbia	Novi Sad-c	Soil 3	0.68	0.40	0.56	0.75	0.33	0.28	-0.03	0.17	0.37	0.49	0.14
Slovakia	Ziharec	Soil 3	-0.37	0.26	-0.16	0.06	-0.42	-0.28	-0.29	0.12	0.11	0.11	0.15
Slovakia	Podhajska	Soil 3	0.21	-0.11	0.24	0.46	0.35	0.01	-0.21	-0.63	-0.05	-0.05	
MAXIMUM			0.68	0.57	0.56	0.75	0.45	0.53	0.71	0.54	0.45	0.85	0.36
MINIMUM			-0.37	-0.11	-0.44	-0.21	-0.47	-0.41	-0.37	-0.63	-0.47	-0.77	-0.54



## INDICATORS: RELATIVE YIELD DEVIATION vs. AGM INDICES WINTER WHEAT

Country	location	soil type	January	January	January	February	February	March	April	May	June	June
			FrostD	FreezD	ArcticD	FrostD	FreezD	FrostD	FrostD	SumD	TropD	SumD
Austria	Gross-Enzersdorf	Soil 3	0.10	0.10		0.23	0.23	0.21	-0.24	0.03	-0.03	0.11
Serbia	Novi Sad-a	Soil 1	0.09	0.12		0.14	-0.02	-0.13	0.15	0.39	0.00	0.12
Serbia	Novi Sad-b	Soil 1	0.04	0.00		0.17	0.04	-0.01	0.18	0.43	0.14	0.19
Serbia	Novi Sad-c	Soil 2	0.19	0.09		-0.17	-0.31	0.06	-0.06	0.25	-0.07	-0.05
Serbia	Novi Sad-d	Soil 2	-0.10	-0.01		-0.21	-0.50	0.02	-0.09	0.22	-0.02	0.05
Serbia	Novi Sad-e	Soil 2	-0.14	-0.03		-0.22	-0.48	0.08	-0.06	0.28	0.21	0.11
Slovakia	Ziharec	Soil 2	-0.06	0.05		-0.04	0.31	0.33	0.16	0.32	0.21	-0.06
Slovakia	Podhajska	Soil 2	0.11	0.06		0.05	0.03	0.32	0.19	0.04	0.02	0.20
Slovakia	Belusa	Soil 3	0.31	0.26		0.11	-0.33	-0.08	-0.04	0.07	-0.07	0.22
Sweeden	Lund	Soil 3	0.47	0.45	0.07	0.55	0.79	0.16	0.34	-0.47		-0.30
Sweeden	Upsala	Soil 2	0.11	0.29	0.25	-0.15	0.10	-0.17	-0.27	-0.27		0.16
<b>MAXIMUM</b>												
<b>MINIMUM</b>			-0.17	-0.32	0.03	-0.34	-0.50	-0.24	-0.49	-0.47	-0.51	-0.46



## INDICATORS: RELATIVE YIELD DEVIATION vs. AGM INDICES MAIZE



## CONCLUSIONS:

- **MAIZE:** HIGH POSITIVE CORRELATIONS WITH NUMBER OF DAYS WITH EXTREME TEMPERATURES IN APRIL, MAY, JUNE AND JULY INDICATES FAILURE OF MODEL TO CORRECTLY PREDICT YIELD
- **WINTER WHEAT** - LESS PRONAUNCED CORRELATIONS BETWEEN YIELD AND EXTREME TEMPERATURE APPERANCE IN FEBRUARY, MAY AND JUNE



## CONCLUSION I

**RESULTS OBTAINED INDICATE SIGNIFICANT CROP AND REGIONAL VARIABILITY**

**FOR MAIZE, OBTAINED RESULTS ARE MUCH COHERENT THEN FOR WINTER WHEAT**

**INCREASED NUMBER AND INTENSITY OF EXTREME WETHER EVENTS REDUCES LEVEL OF CORRELATION INCREASING MODELING UNCERTAINTIES**



## **BUT HOW IT CAN HELP US TO DEAL WITH EXTREME WEATHER EVENTS?**

- 1. FOR CROP MODEL USERS – IT CAN BE HELPFUL FOR DEFINING CAUSE OF DIFFERENCES BETWEEN OBSERVED AND MODELED YIELD**
- 2. FOR CROP MODEL DEVELOPERS – IT CAN BE HELPFUL FOR DEFINING PROCESSES WHICH SHOULD MORE CAREFULLY PARAMETERISED**

