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# Facing with CC challenges by using seasonal weather forecast in agricultural production

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# Facing with CC challenges by using long range weather forecast in agricultural production

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CC – chalange of our generation





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## LONG RANGE WEATHER FORECAST



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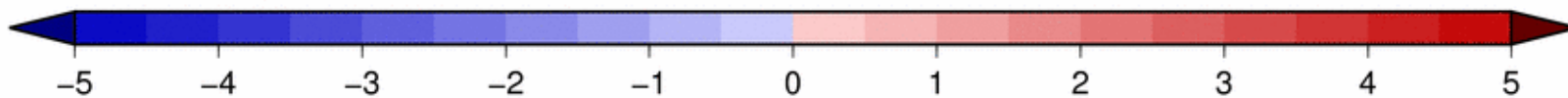
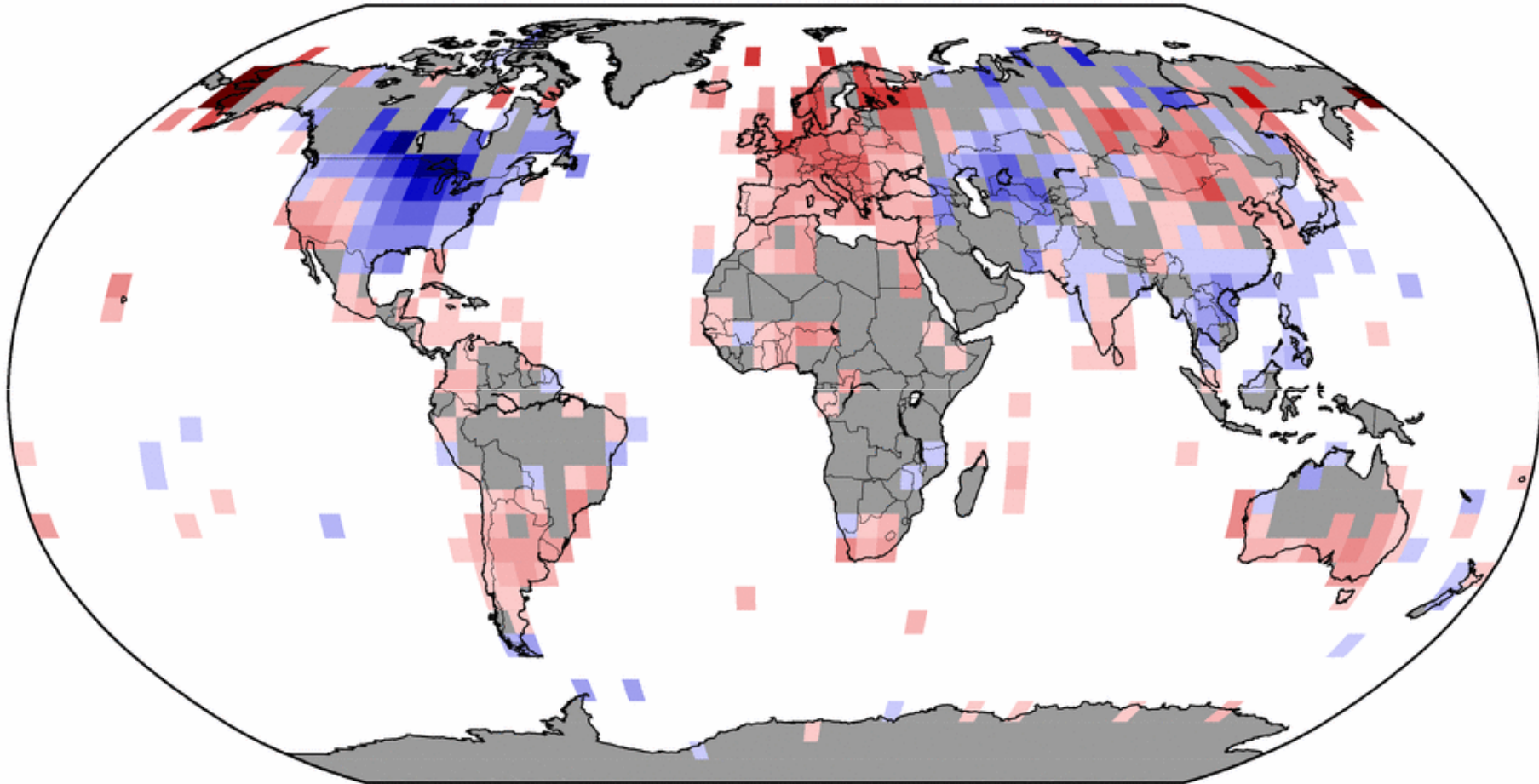
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CC – time to change paradigm

**What happens on smaller time and spatial scale?**

# Land-Only Temperature Anomalies Dec 2013–Feb 2014 (with respect to a 1981–2010 base period)

Data Source: GHCN-M version 3.2.2



Degrees Celsius

Please Note: Gray areas represent missing data  
Map Projection: Robinson



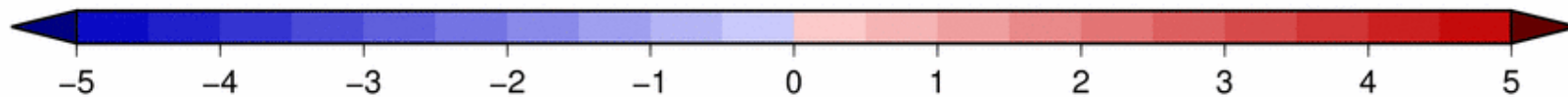
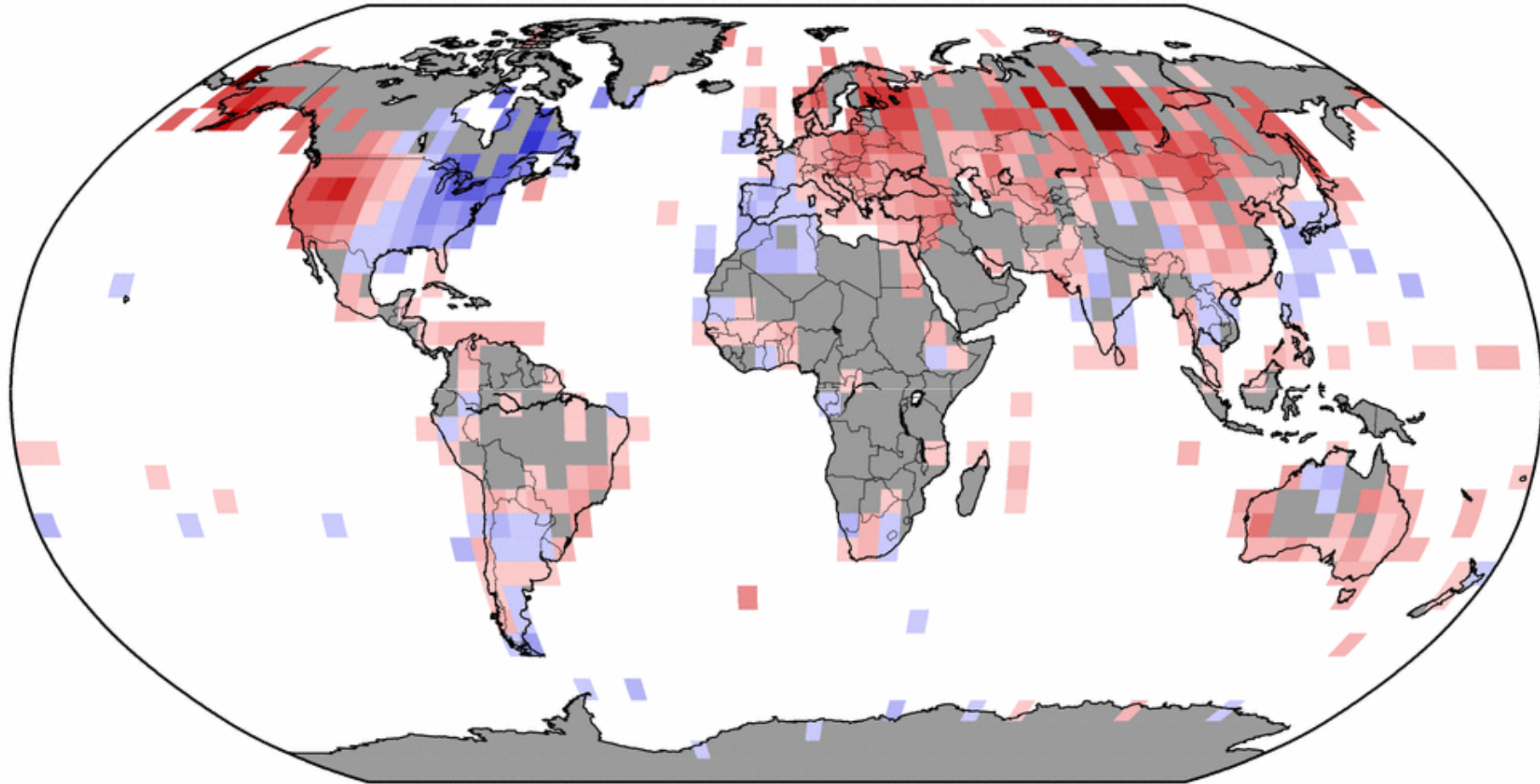
NOAA's National Climatic Data Center

Fri Mar 14 07:41:05 EDT 2014

23.-24. May 2016 7th CASEE Conference, Temisoara (Romania)

# Land-Only Temperature Departure from Average Dec 2014–Feb 2015 (with respect to a 1981–2010 base period)

Data Source: GHCN-M version 3.2.2



Degrees Celsius

Please Note: Gray areas represent missing data  
Map Projection: Robinson



NOAA's National Climatic Data Center

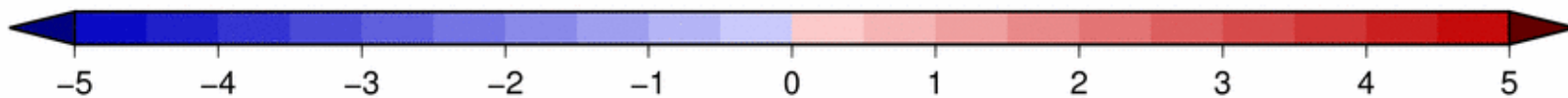
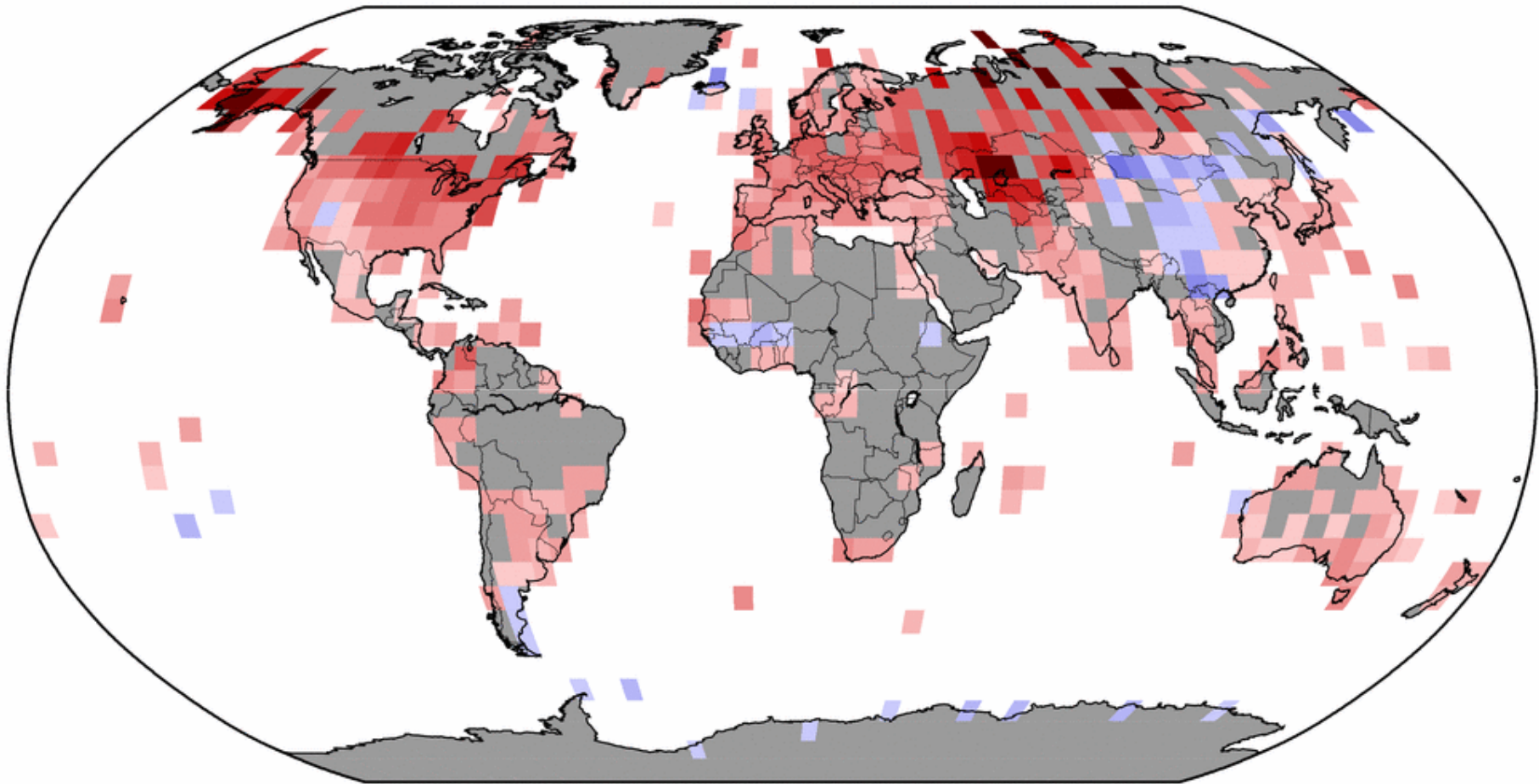
Sun Mar 15 19:10:34 EDT 2015

23.-24. May 2016 7th CASEE Conference, Temisoara (Romania)



# Land-Only Temperature Departure from Average Dec 2015–Feb 2016 (with respect to a 1981–2010 base period)

Data Source: GHCNM v3.3.0



Degrees Celsius

Please Note: Gray areas represent missing data  
Map Projection: Robinson



National Centers for Environmental Information

23.-24. May 2016 7th CASEE Conference, Temisoara (Romania)

Mon Mar 14 06:20:13 EDT 2016



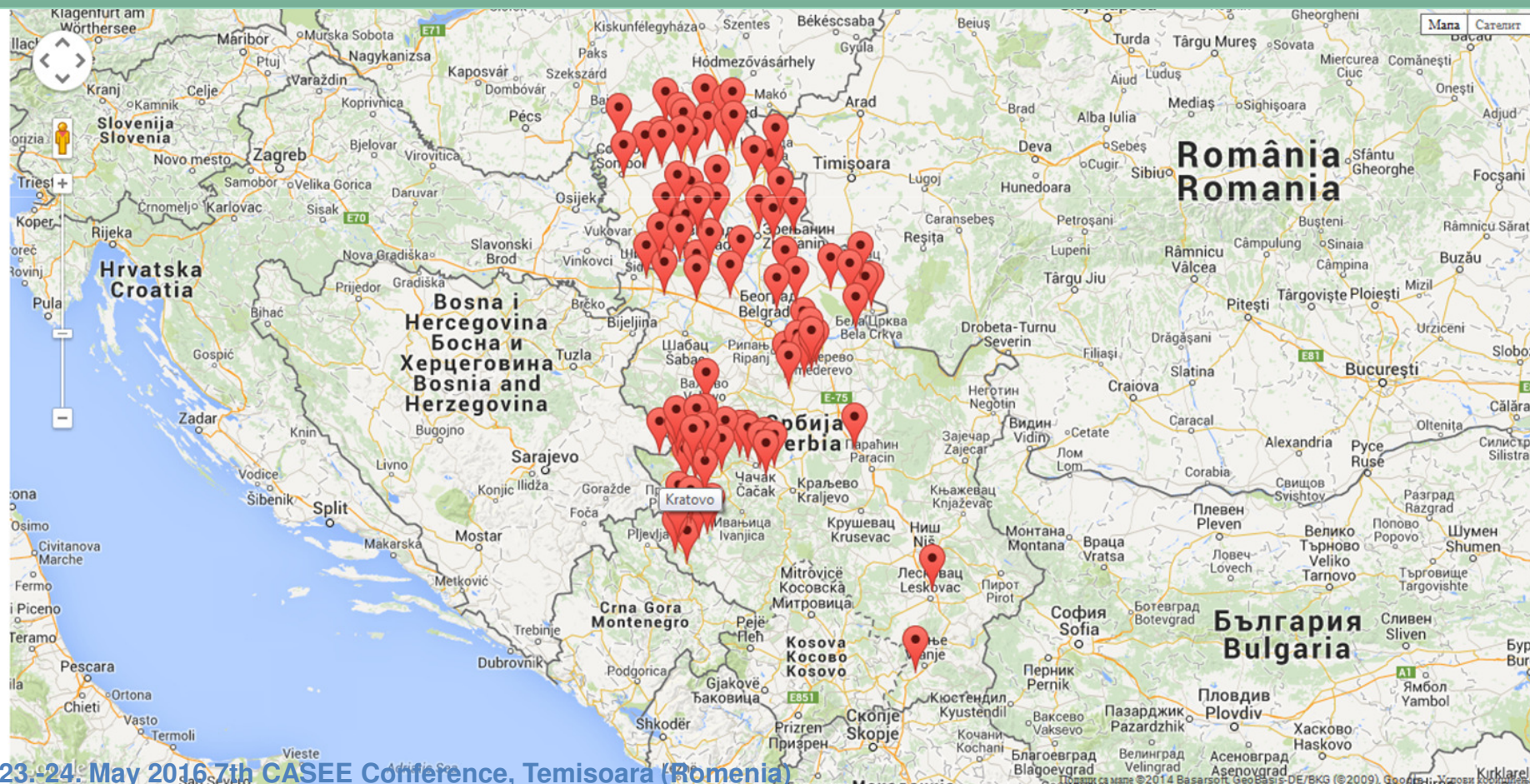
# Forecasting and Warning Service of Serbia in plant protection



Authors: Republic and Regional Centres, Forecast and Warning Service in Plant Protection, Republic of Serbia

[WWW.PISSRBIJA.COM](http://WWW.PISSRBIJA.COM) • [WWW.PISVOJVODINA.COM](http://WWW.PISVOJVODINA.COM)

## The AWS Network



23-24. May 2016 7th CASEE Conference, Timisoara (Romania)



## OBSERVED CHANGES IN PHENOLOGY DYNAMICS

Region	Dates	Change (days)
Novi Sad	13.03.2015.	- 58
	14.01.2016.	
Bačka Topola	19.03.2015.	- 58
	20.01.2016.	
Pančevo	12.03.2015.	- 26
	15.02.2016.	
Ruma	22.02.2015.	- 53
	31.12.2015.*	
Sombor	03.03.2015.	- 73
	21.12.2016. *	

### **GROWING PROBLEM**

Shift in appearance of "four tillers detectable" - growing stage of winter wheat in Serbia (Source: PIS Serbia).



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**CC – time to change paradigm**

**Adapt to climate change = Face with weather**

**Meet it ... Do not wait for it!**



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## BEST STRATEGY - TO BE A PART OF SOLUTION

### Application of advanced meteorological products

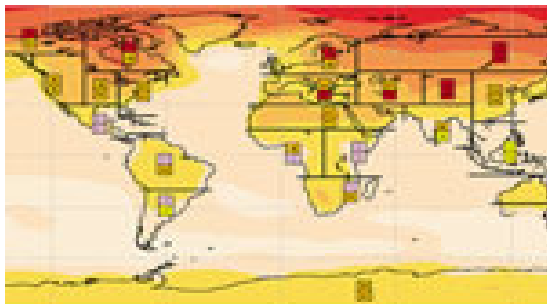
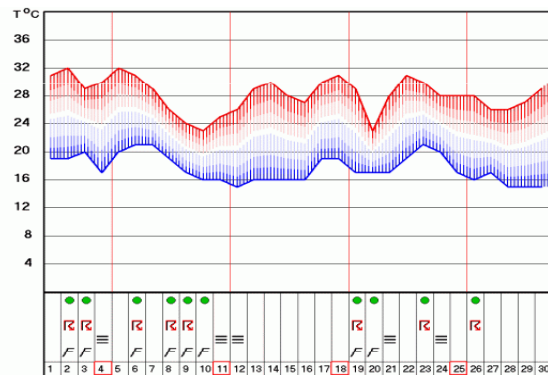
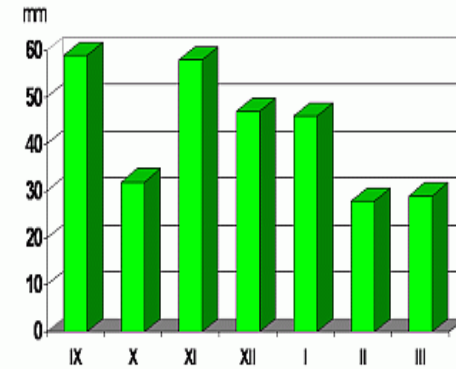
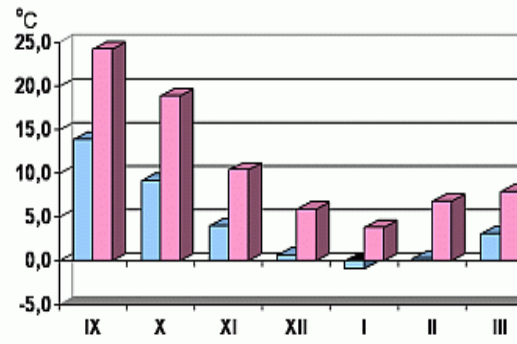
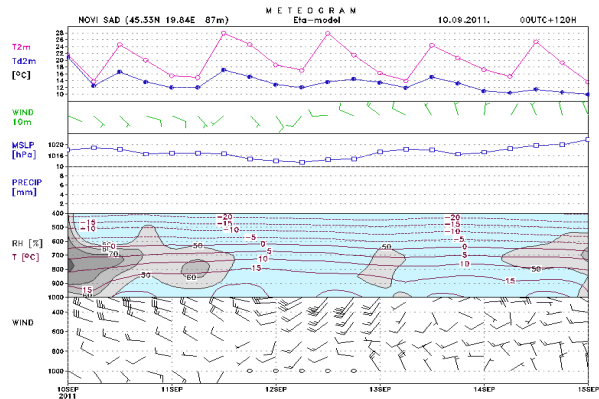
- Numerical weather prediction of different scales: short range, monthly and seasonal forecast

### Application through

- Plant & harmful organism phenology models
- Crop models



## Forecasting weather ...



## NWP products of interest in agrometeorology (AgM), crop modelling (CM) & plant protection (PP)

- Short-range weather forecast (out to 5 days)
- Monthly forecast (out to 30 days)
- Seasonal forecast (out to 7 months)
- Climate model simulations (30 years or more)



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OBJECTIVE

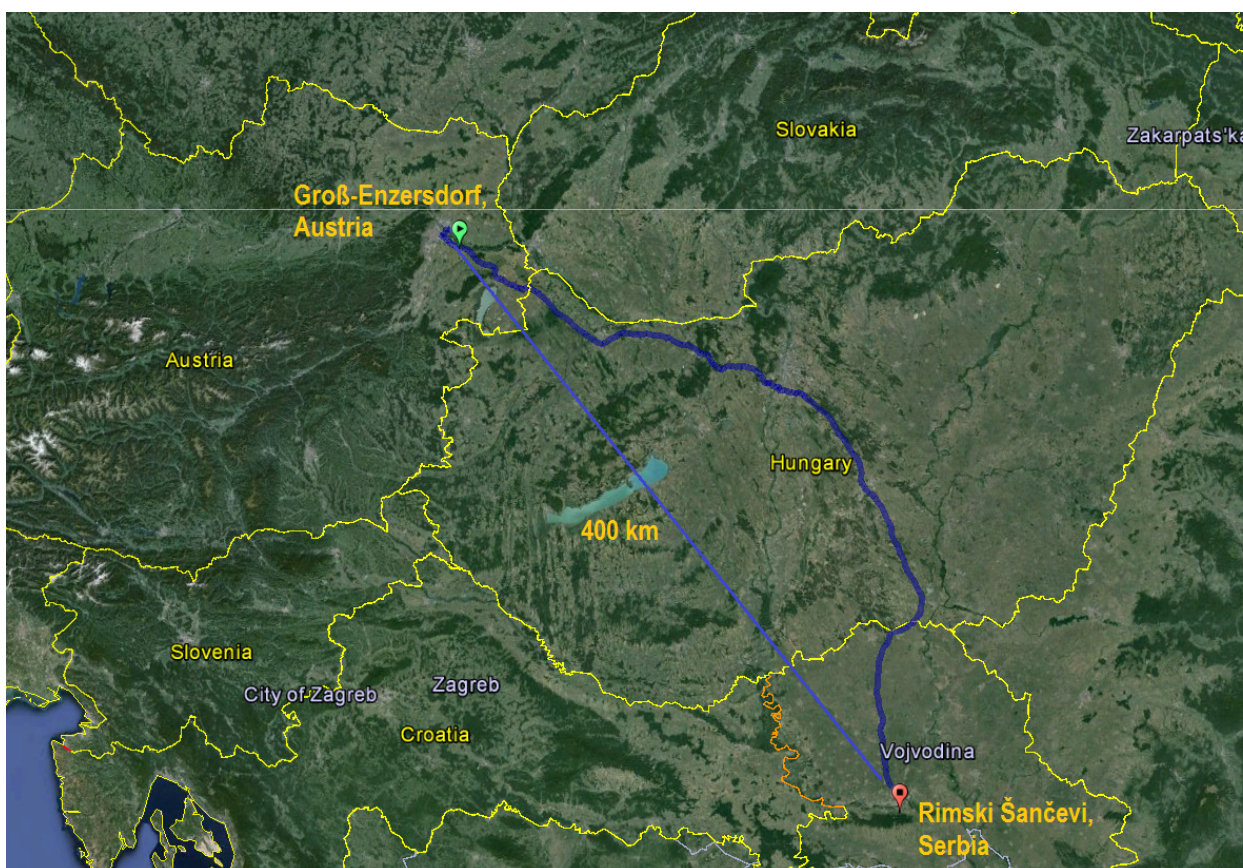
**Provide background for more efficient use of  
different NWP products for tactical and/or  
strategical decision making in agriculture  
/crop production and plant protection/**



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## EXAMPLE OF SOLUTIONS - LOCATIONS



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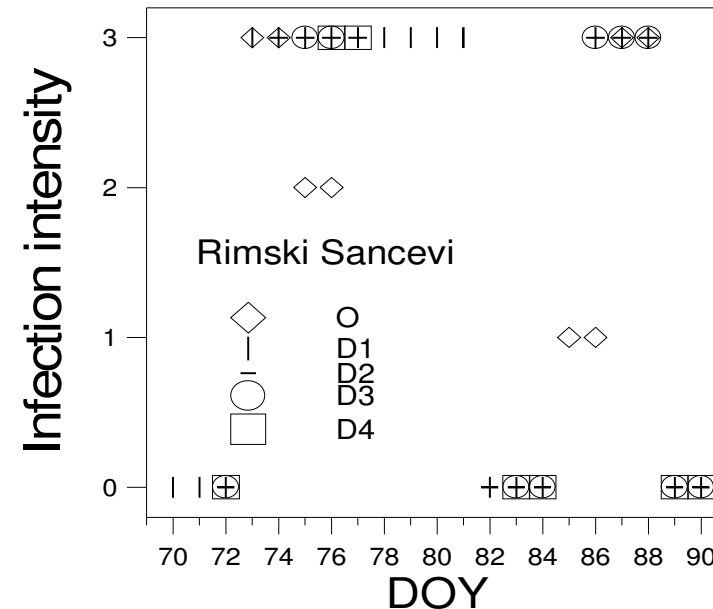
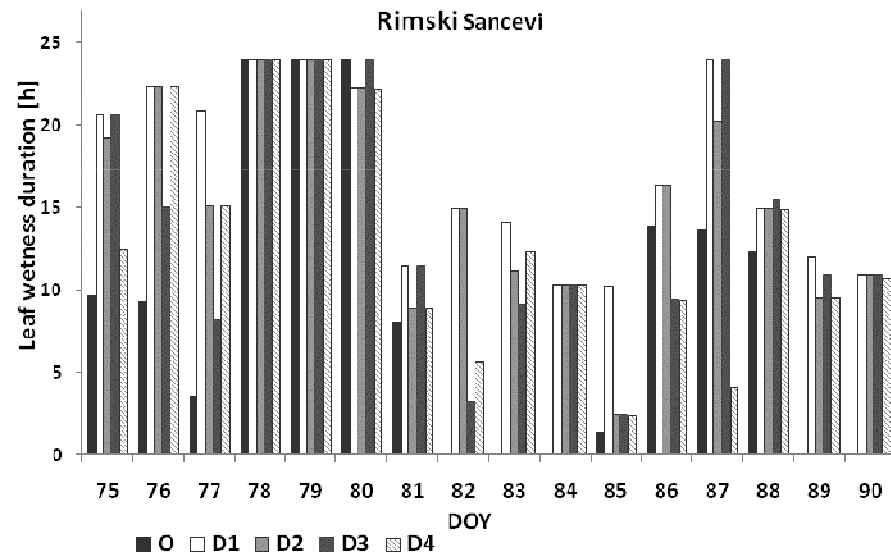
## ACTIVITY 1

### Application of **short range** weather forecast in agrometeorology and plant protection

- ◆ AgM - forecasting : ♣ leaf wetness and temperature ♣ canopy air temperature and humidity ♣ soil temperature and moisture ♣ precipitation ...
- ◆ AgM - forecasting application : ♣ fruit vegetation dynamic (in progress)
- ♣ meteorological conditions for plant disease appearance (done)

Forecasting apple scab infection intensity: **TEMPERATURE & LEAF WETNESS DURATION**

- Observations: BOKU-MET (Austria) and Pest Management Service of Vojvodina (Serbia) [www.pisvojvodina.com](http://www.pisvojvodina.com)
- Simulations: Work Eta NWP model, Faculty of Agriculture, Novi Sad



Lalic, B. Francia, M., Eitzinger, J., Podrascanin, Z., Arsenic, I., 2015: Effectiveness of Short-term Numerical Weather Prediction in Predicting Growing Degree Days and Meteorological Conditions for Apple Scab Appearance, *Meteorological Applications*, DOI: 10.1002/met.1521.



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## ACTIVITY 2

### Application of **Monthly&Seasonal** weather forecast in agrometeorology and crop modeling

- ◆ AgM - ensembl forecasting : ♣ air temperature and humidity ♣ precipitation ...
- ◆ AgM ensembl forecasting application : ♣ fruit vegetation dynamic (in progress) ♣ AgM conditions ♣ meteorological conditions for plant disease appereance (done)



♣ Forecasting AgM conditions: **EXTREME TEMPERATURES**

- ♣ **Observations:** BOKU-MET (Austria) and Pest Management Service of Vojvodina (Serbia)  
[www.pisvojvodina.com](http://www.pisvojvodina.com) ♣ **Simulations:** Hydrometeorological Service of Serbia from ECMWF MARS  
Archive and Faculty of Agriculture, Novi Sad (Serbia)

		March		April		May			Jun		
		FrostD	FreezD	FrostD	FreezD	TropicalD	SummerD	Tropica N	TropicalD	SummerD	TropicalN
GS	Obs	13	5	4	0	3	10	0	2	19	0
	Mon	23	6	4	0	1	4	0	6	17	1
	Ses	25	9	6	0	0	1	0	0	6	0
NS	Obs	15	2	1	0	4	12	0	3	18	0
	Mon	17	0	4	0	2	8	2	11	21	3
	Ses	24	3	4	0	0	3	0	1	10	0



♣ Forecasting AgM conditions: **EXTREME DRY DAYS**

- ♣ **Observations:** BOKU-MET (Austria) and Pest Management Service of Vojvodina (Serbia)  
[www.pisvojvodina.com](http://www.pisvojvodina.com) ♣ **Simulations:** Hydrometeorological Service of Serbia from ECMWF MARS  
Archive and Faculty of Agriculture, Novi Sad (Serbia)

		Dry Intensive		Dry extreme		Dry very extreme		Dry rate	Harvest
		AMJ	MAM	AMJ	MAM	AMJ	MAM	AMJ	Jun
GS	Obs	34	33	18	25	9	17	0.51	22
	Mon	45	28	32	22	13	13	0.42	25
	Ses	30	41	23	23	15	15	0.61	12
NS	Obs	24	29	13	21	5	13	0.58	22
	Mon	54	26	41	21	26	15	0.35	25
	Ses	26	27	20	21	9	10	0.61	12



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## ACTIVITY 2

### Application of **Monthly&Seasonal** weather forecast in agrometeorology and crop modeling

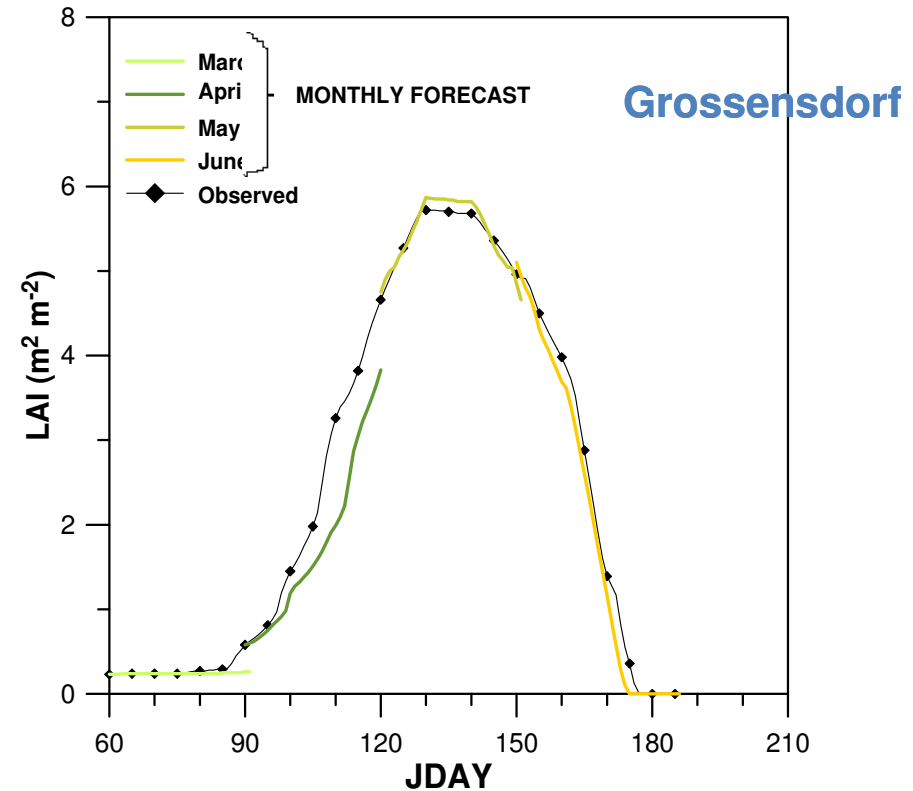
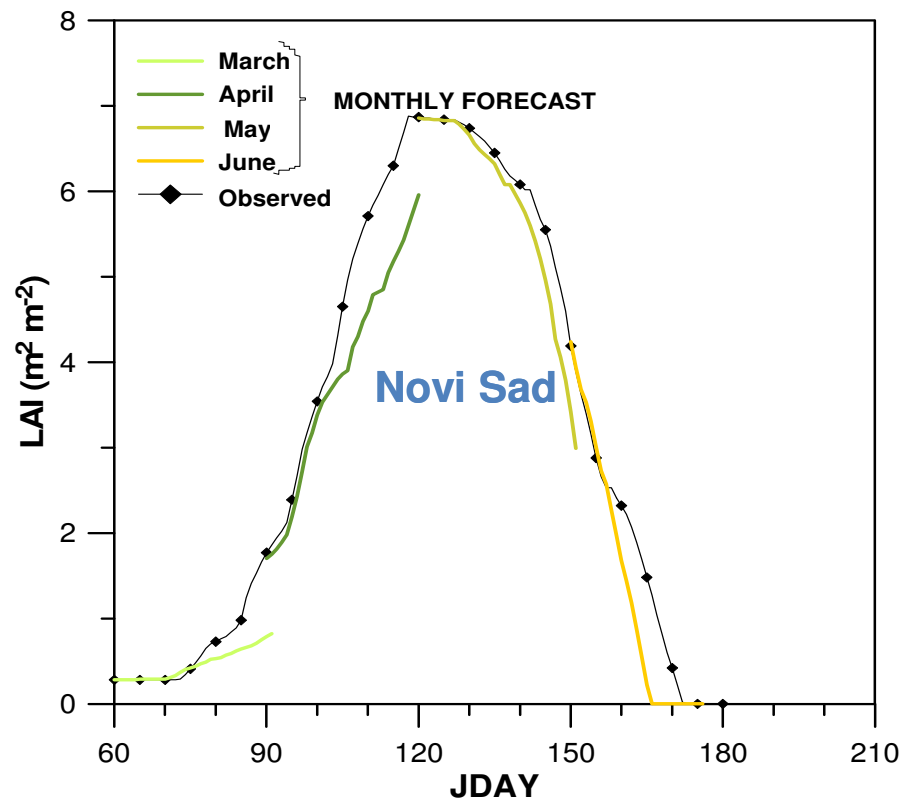
- ◆ CM - ensembl forecasting : ♣ crop dynamic ♣ soil moisture deficit ♣ evapotranspiration ♣ LAI development
- ◆ CM ensembl forecasting application : ♣ yield and biomass formation ♣ N uptake ♣ scheduling of farm operations according to weather and crop conditions on monthly scale ♣ optimization of irrigation, fertilization and plant protection application-spraying



♣ CM - ensembl forecasting : LAI DEVELOPMENT

SIRIUS: WINTER WHEAT

♣ **Observations:** BOKU-MET (Austria) and Pest Management Service of Vojvodina (Serbia) [www.pisvojvodina.com](http://www.pisvojvodina.com) ♣ **Simulations:** Hydrometeorological Service of Serbia from ECMWF MARS Archive and Faculty of Agriculture, Novi Sad (Serbia)

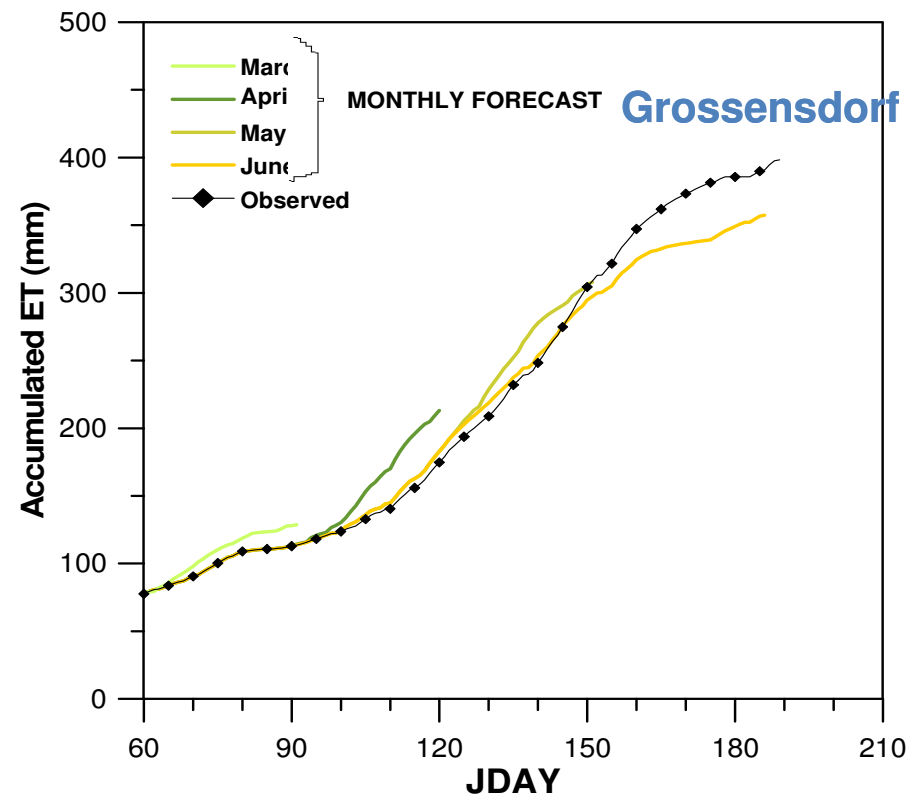
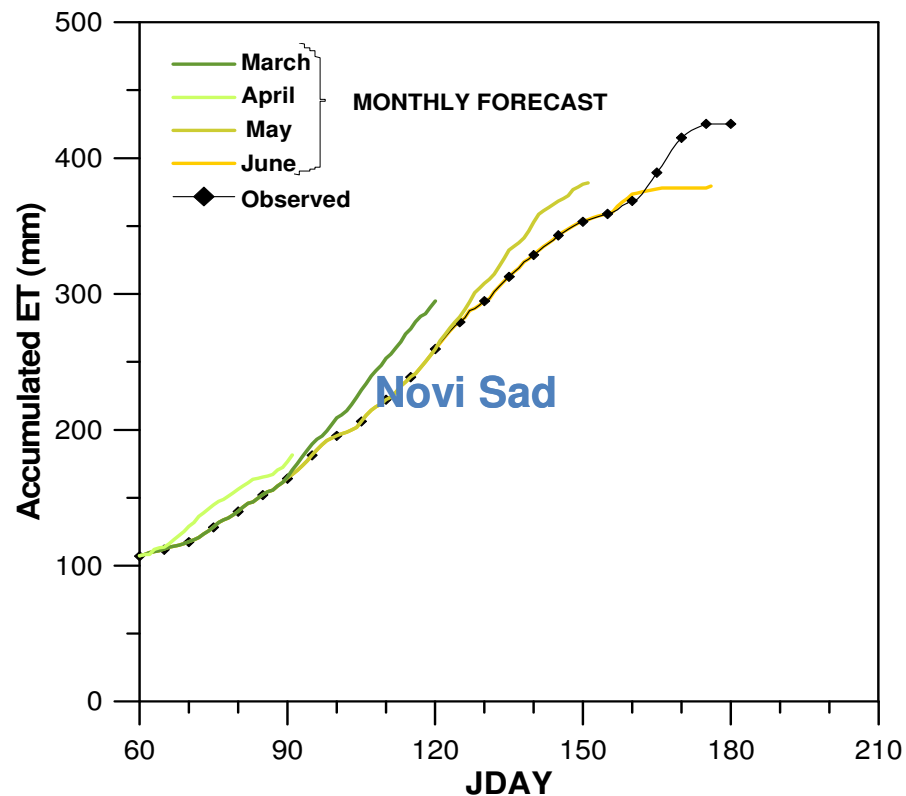




♣ CM - ensembl forecasting : **ACCUMULATED ET**

**SIRIUS: WINTER WHEAT**

- ♣ **Observations:** BOKU-MET (Austria) and Pest Management Service of Vojvodina (Serbia) [www.pisvojvodina.com](http://www.pisvojvodina.com)
- ♣ **Simulations:** Hydrometeorological Service of Serbia from ECMWF MARS Archive and Faculty of Agriculture, Novi Sad (Serbia)



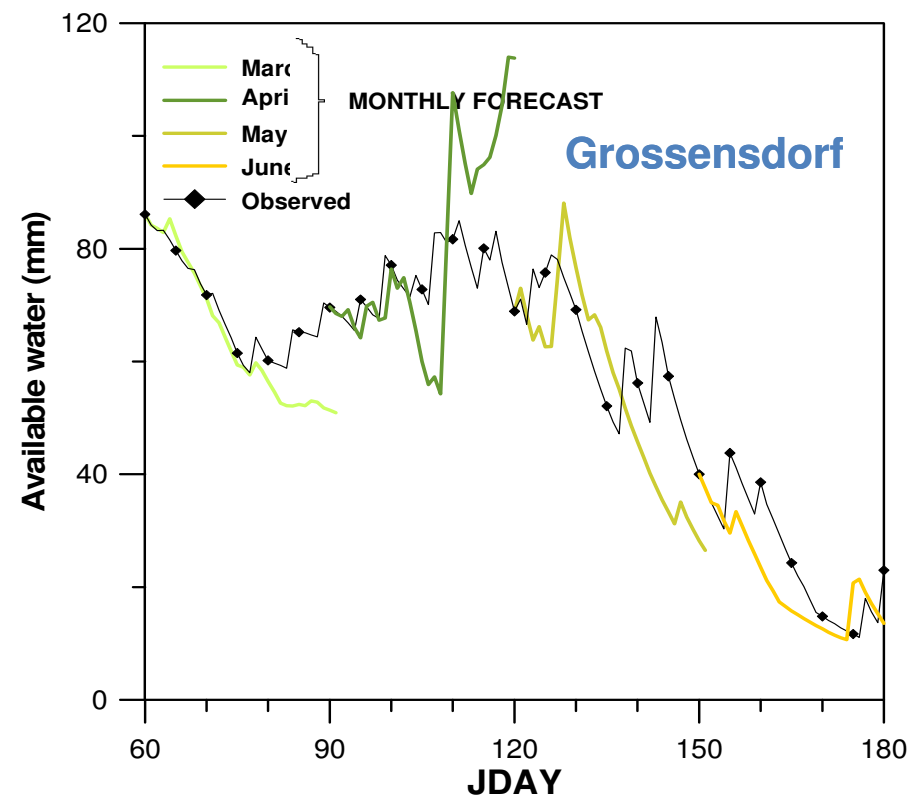
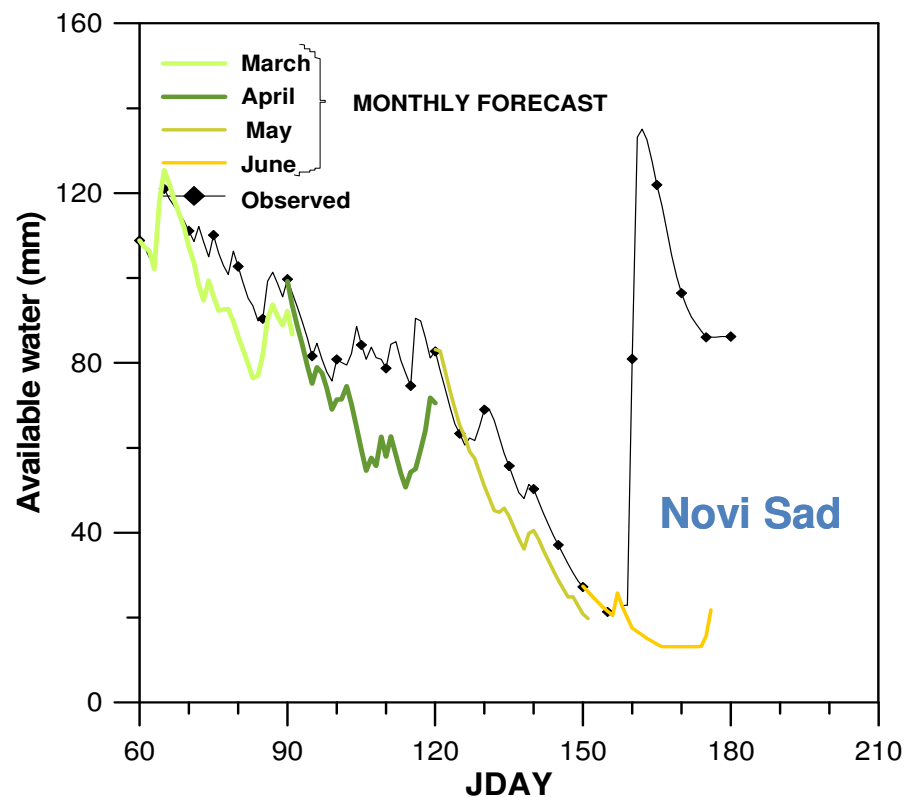




♣ CM - ensembl forecasting : **AVAILABLE WATER**

**SIRIUS: WINTER WHEAT**

- ♣ **Observations:** BOKU-MET (Austria) and Pest Management Service of Vojvodina (Serbia) [www.pisvojvodina.com](http://www.pisvojvodina.com)
- ♣ **Simulations:** Hydrometeorological Service of Serbia from ECMWF MARS Archive and Faculty of Agriculture, Novi Sad (Serbia)





♣ CM - ensembl forecasting: **MARCH-JUNE observed vs. Monthly&Seasonal** **SIRIUS: WINTER WHEAT**

♣ **Observations:** BOKU-MET (Austria) and Pest Management Service of Vojvodina (Serbia) [www.pisvojvodina.com](http://www.pisvojvodina.com) ♣ **Simulations:** Hydrometeorological Service of Serbia from ECMWF MARS Archive and Faculty of Agriculture, Novi Sad (Serbia)

		ET (mm)	Max. def. (mm)	AnthesisD	MaturityD	Biomass (kg/ha)	Yield (kg)
GS	Obs	408	175	149	192	15592	7057
	Mon	503	119	160	202	16537	7080
	Ses	443	65	161	203	14633	6275
NS	Obs	425	136	139	181	14473	6006
	Mon	472	125	144	184	15564	6830
	Ses	451	82	150	191	15674	6761

Lalic, Dekic, Eitzinger, Firanj Sremac (Manuscript in preparation)



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# OVERVIEW

	AgM	Pest and disease appearance	Crop yield
Short – term weather forecast	✓	✓	to be done ...
Monthly forecast	✓	✓	✓
Seasonal forecast	✓	✓	✓

✓ → case studies made, further work in progress ...



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RESULTS

## MONTHLY WEATHER FORECAST

Source: Monthly EPS products of ECMWF (European Centre for Medium range Weather Forecast)

Forecast: March 1, 2005 - June 30, 2005;  
51-member ensemble  
(boundary conditions for WRF NMM model)



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RESULTS

## PHENOLOGY MODEL

Model: **PIS\_PHEN**

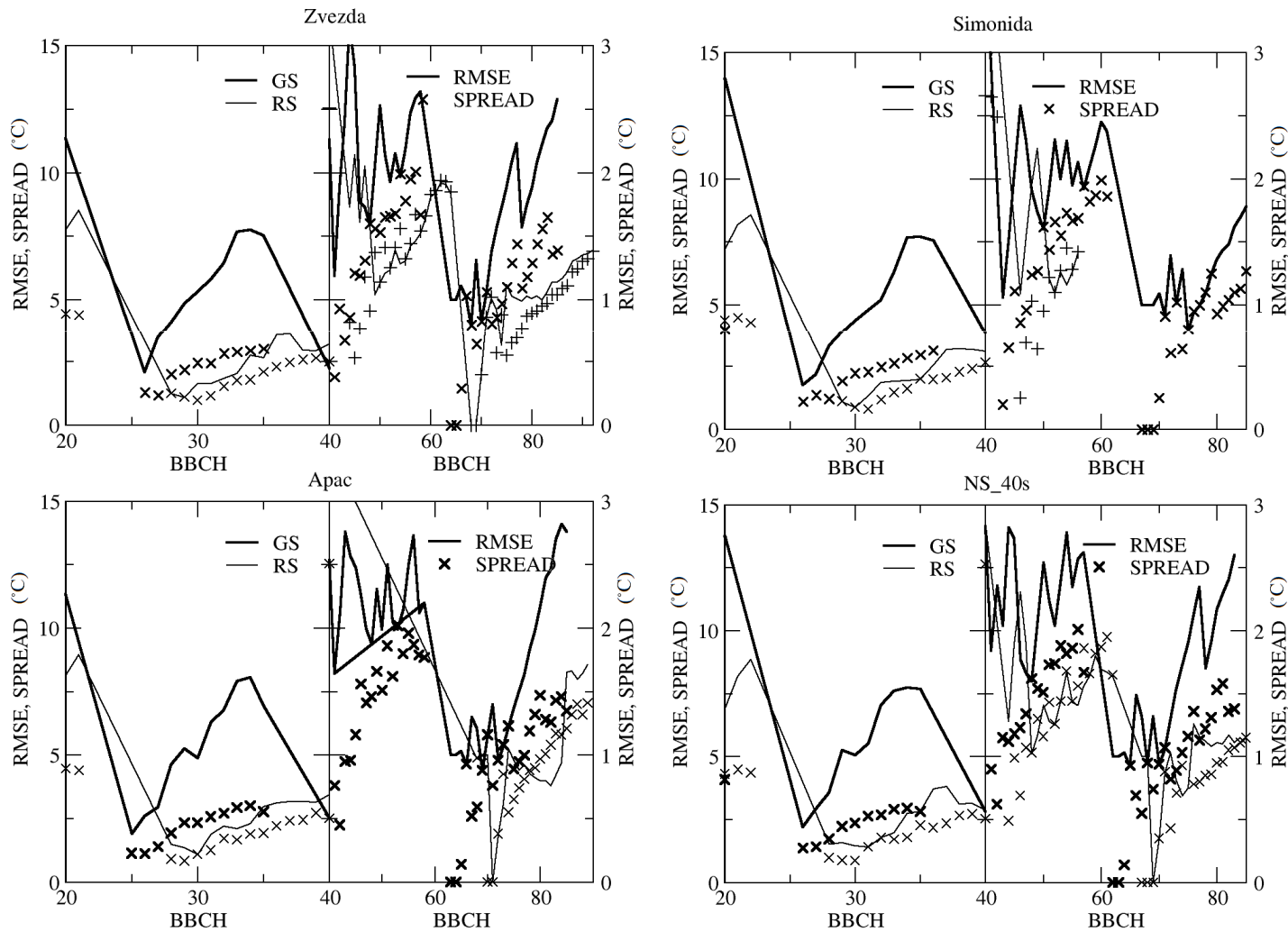
Source: Forecasting and Warning Service of Serbia in plant protection

Methodology: Continuous observation of plant growing stages according to BBCH scale

Cultivar: Winter wheat



## RESULTS - CALCULATED PHENOLOGY DYNAMIC



0 °C lower  
threshold

OBSERVED  
WEATHER  
VS.  
MONTHLY  
WEATHER  
FORECAST



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## RESULT 2.2

### ♣ Forecasting met. conditions for plant disease appearance: **BLIGHT OF GRAPEVINE**

- ♣ **Observations:** BOKU-MET (Austria) and Pest Management Service of Vojvodina (Serbia) [www.pisvojvodina.com](http://www.pisvojvodina.com) ♣ **Simulations:** Hydrometeorological Service of Serbia from ECMWF MARS Archive and Faculty of Agriculture, Novi Sad (Serbia)

**Grossensdorf (Austria)** - no conditions for occurrence of infection

#### **Novi Sad (Serbia)**

	Observed	Control run			
<b>Start of IP</b>	<b>117</b>	<b>135</b>	<b>140</b>	<b>142</b>	<b>177</b>
<b>End of IP</b>	<b>124</b>	<b>140</b>	<b>145</b>	<b>146</b>	<b>179</b>
<b>Duration</b>	<b>7</b>	<b>5</b>	<b>5</b>	<b>4</b>	<b>2</b>
<b>No. IP</b>	<b>1</b>	<b>4</b>			