COST Action 718 Meteorological Applications for Agriculture

WG2
Crop, pest-and-disease and irrigation models

Evaluation of PLASMO model for grapevine downy mildew

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Objectives

- Application of PLASMO model using climatic data from different countries.

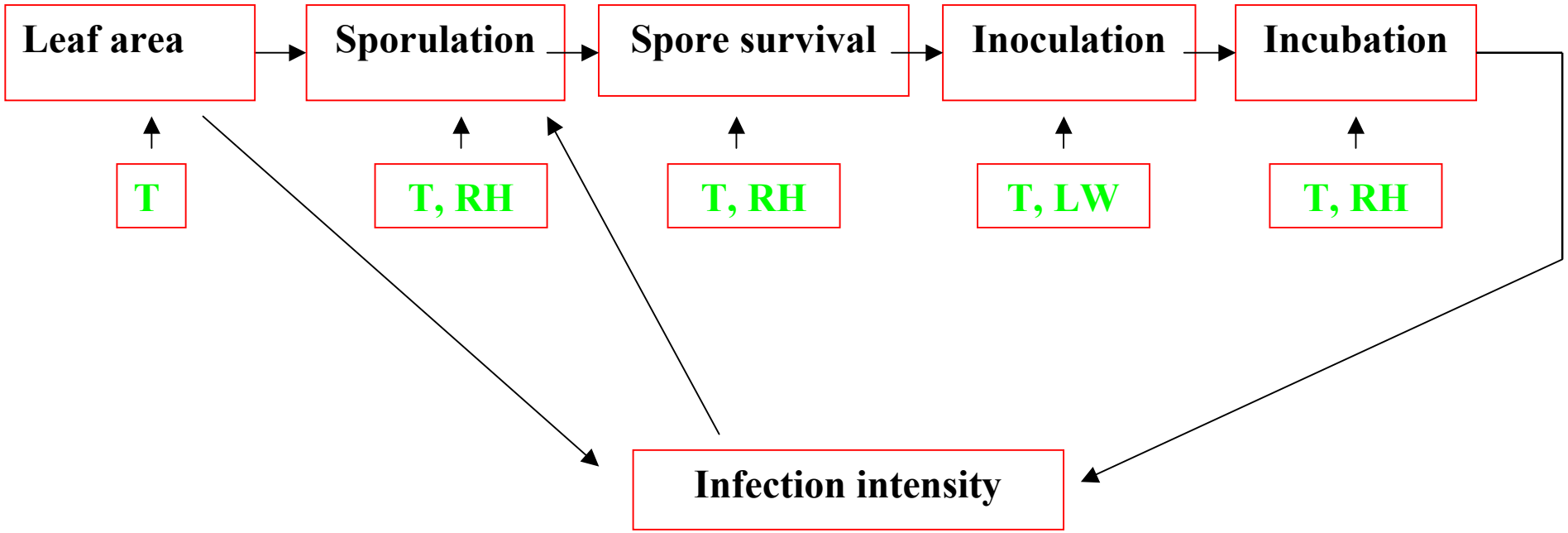
- Analysis of the results and discussion of model performances, also considering the meteorological conditions of studied environments.

Considered data

		C	P	E	G
Greece	1997	X	X		
	2000	X	X	X	X
Italy	1995-98	X	X	X	X
	2001	X	X	X	X
Slovenia	2000	X	X	X	

Data from Germany and other countries in 2001 will be analysed in the following months

Flow diagram of PLASMO



PLASMO validation in Italy

Goodness-of-fit

$$MBE = \frac{\sum_{0}^{n} (v_o - v_s)}{n} \qquad MB\%E = \frac{\sum_{0}^{n} \left(\frac{v_o - v_s}{v_o} \right)}{n}$$

$$MAE = \frac{\sum_{0}^{n} (| v_o - v_s |)}{n} \qquad MA\%E = \frac{\sum_{0}^{n} \left(\frac{| v_o - v_s |}{v_o} \right)}{n}$$

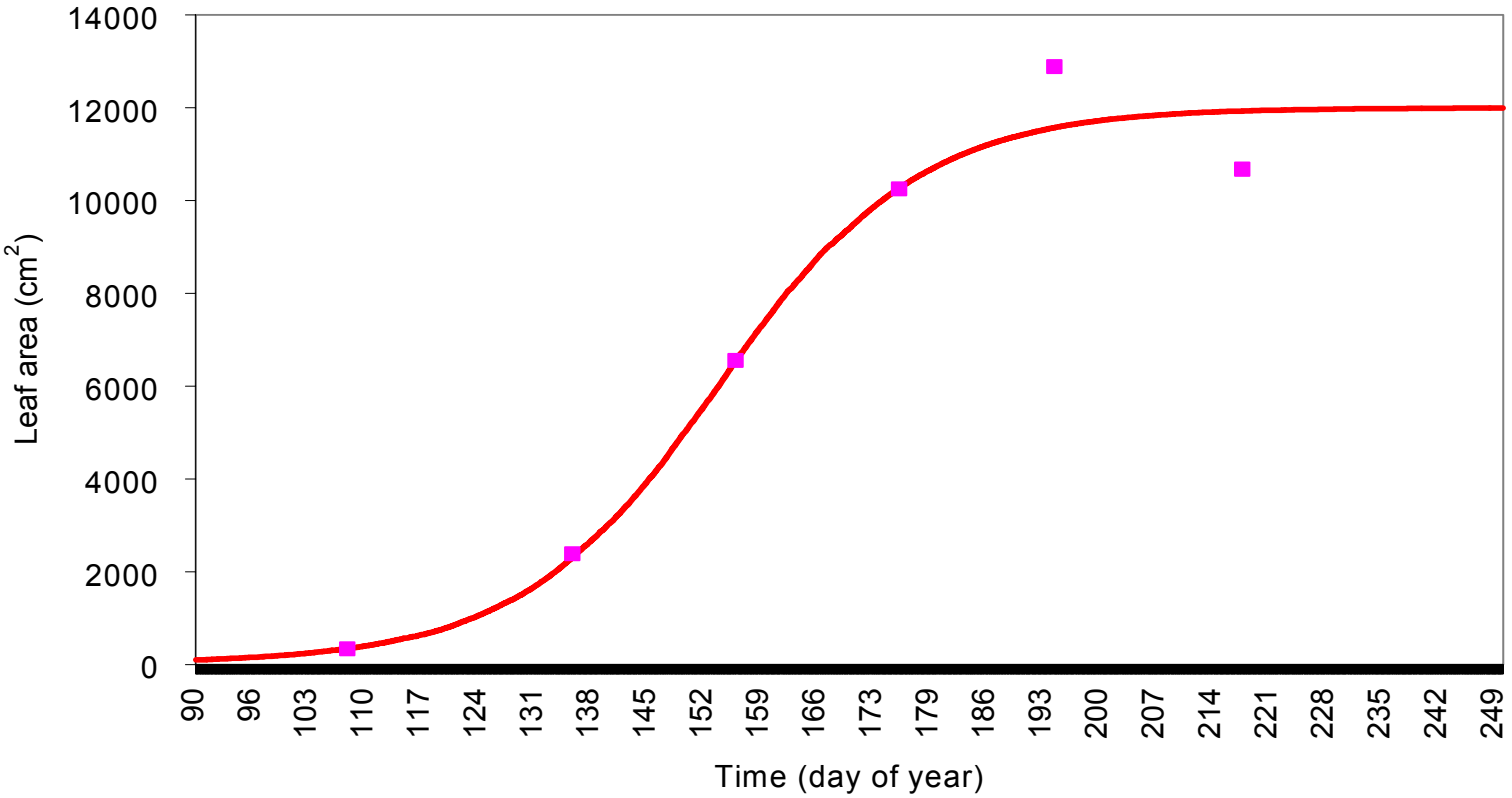
Modelling efficiency $$EF = \sum_{0}^{n} (v_s - v_o)^2 - \sum_{0}^{n} (v_s - AVGv_o)^2$$

Linear regression analysis

Sensitivity analysis

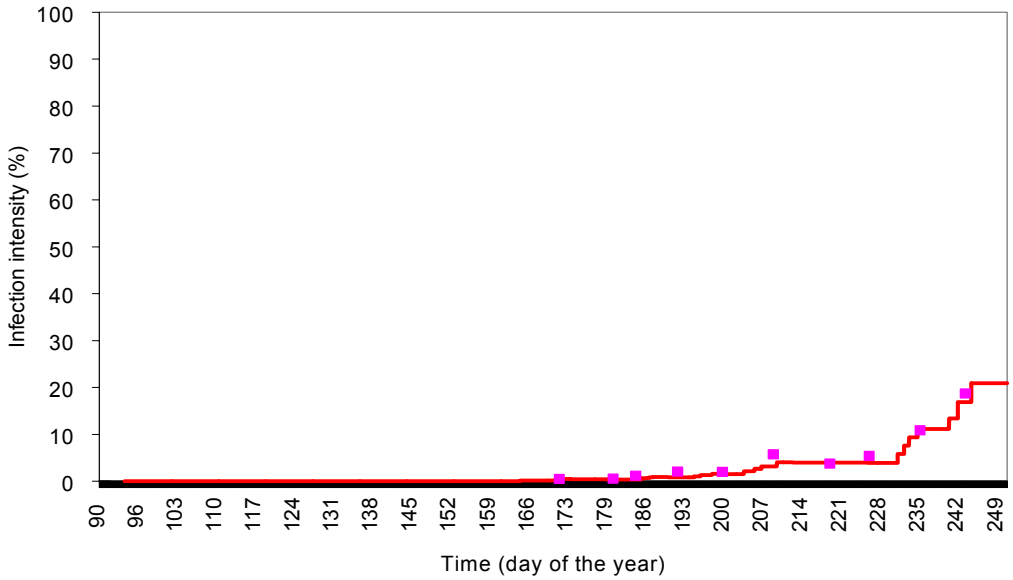
- This analysis was performed comparing the deviations of model output variables to modification of the main driving variables: temperature for leaf area model; temperature and relative humidity for downy mildew model. Throughout each season from 1995 to 1998, input variable values were changed by -10, -5, +5 or +10%. Disease intensity at the end of August was chosen to test the sensitivity of epidemiological model, while for leaf area model the values measured at the end of growing period (about the 15 July).

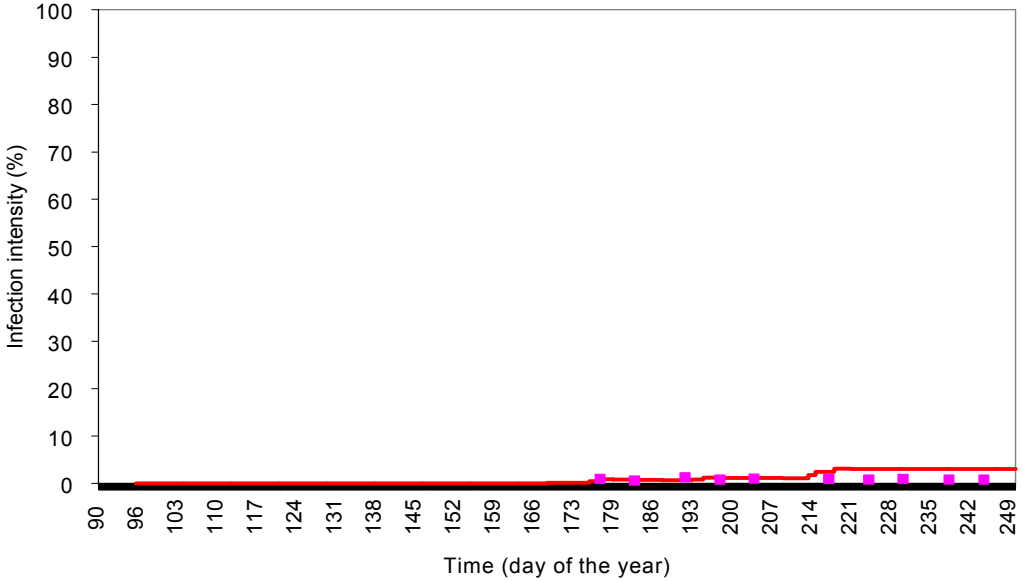
Leaf area 1995



Downy mildew

1995 - high





1997 - low

Statistical analysis

	MRE	MR%E	MAE	MA%E	Slope	Intercept	R^2	EF
DM	-0.22	-33.03	1.20	92.39	0.85^{ns}	0.15^{ns}	0.97**	0.92
LA	166.14	2.21	456.49	5.26	1.00^{ns}	125^{ns}	0.99**	0.97

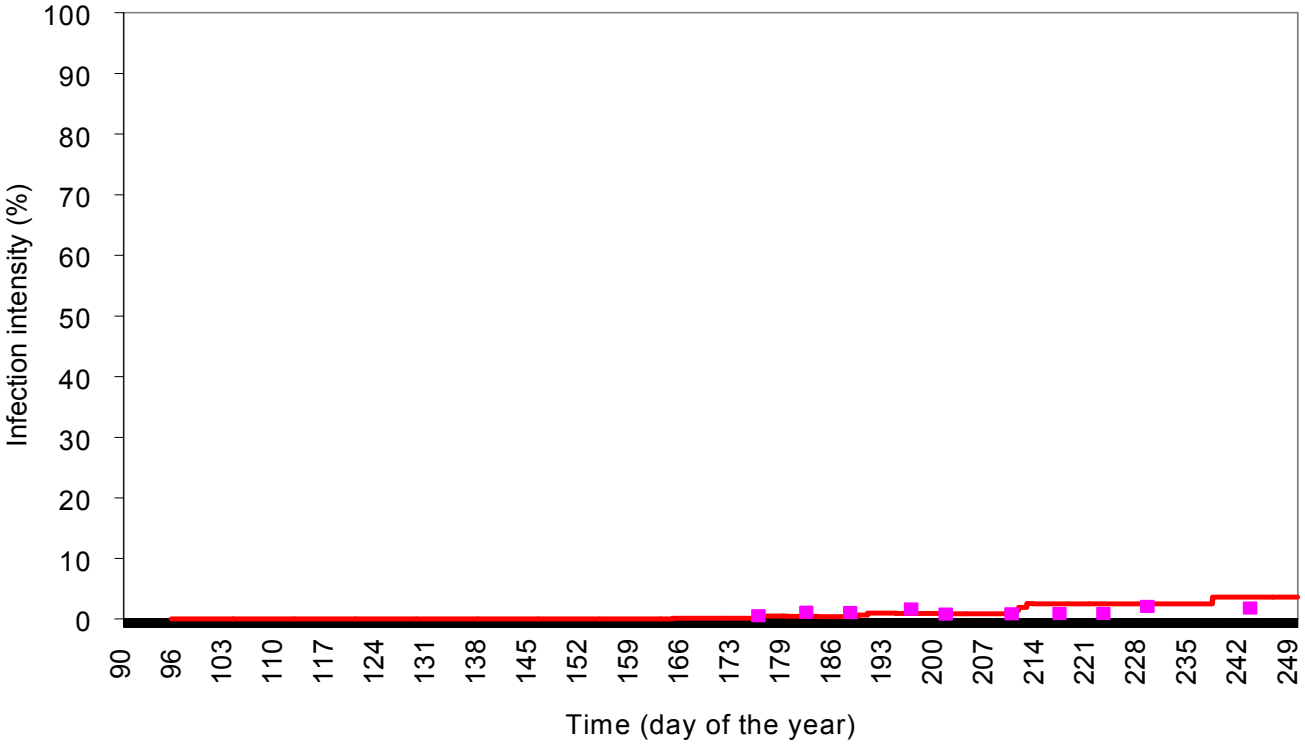
Sensitivity analysis for downy mildew

	Changes (%)										
Year	Temperature						Relative humidity				
	-10	-5	0	5	10		-10	-5	0	5	10
1995	9.29	12.10	16.85	21.46	13.54		1.61	6.79	16.85	37.04	73.87
1996	1.06	2.36	2.26	2.40	4.66		0.36	0.68	2.26	12.22	56.91
1997	4.47	5.50	3.04	3.40	4.59		0.57	2.64	3.04	7.99	16.51
1998	4.18	5.10	3.60	4.94	5.13		0.34	1.40	3.60	22.09	36.87

Sensitivity analysis for leaf area

	Changes (%)				
Year	Temperature				
	-10	-5	0	5	10
1995	9494	9789	10000	10144	10231
1996	9168	9640	10000	10273	10475

Downy mildew 2001

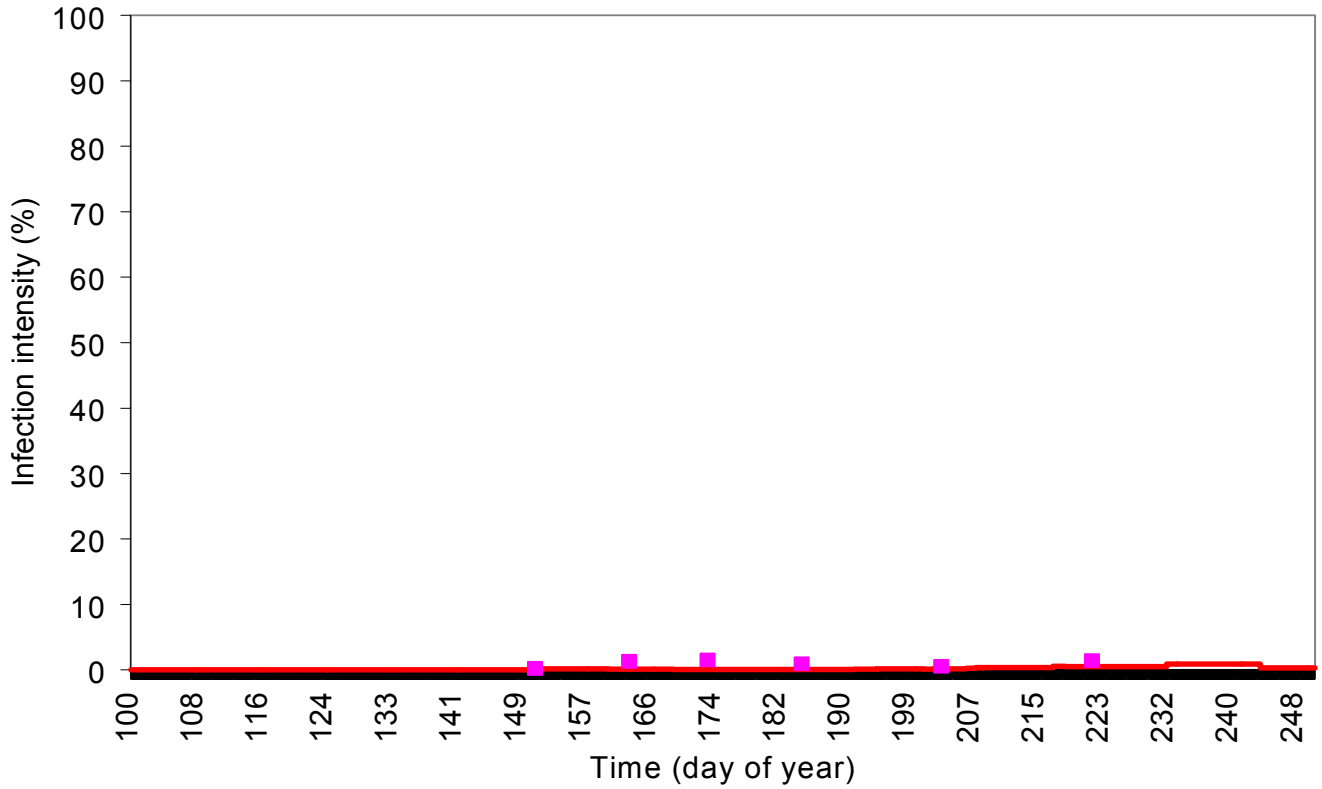


Considerations - Italy

- The model provided a satisfactory simulation of grapevine-disease system. It accurately calculated the dynamic of infections, precisely simulating the changing in infection intensity during the season.
- Furthermore the model resulted sensible to the inter-annual variation in infection level as determined by weather conditions.
- Sensitivity analysis pointed out a different responses of models to changing in weather variables, according to their specific biological role. Accordingly, the structure of the model will be revised to reduce the possible problems caused by a high sensitivity to input parameters.

PLASMO validation in the other European environments

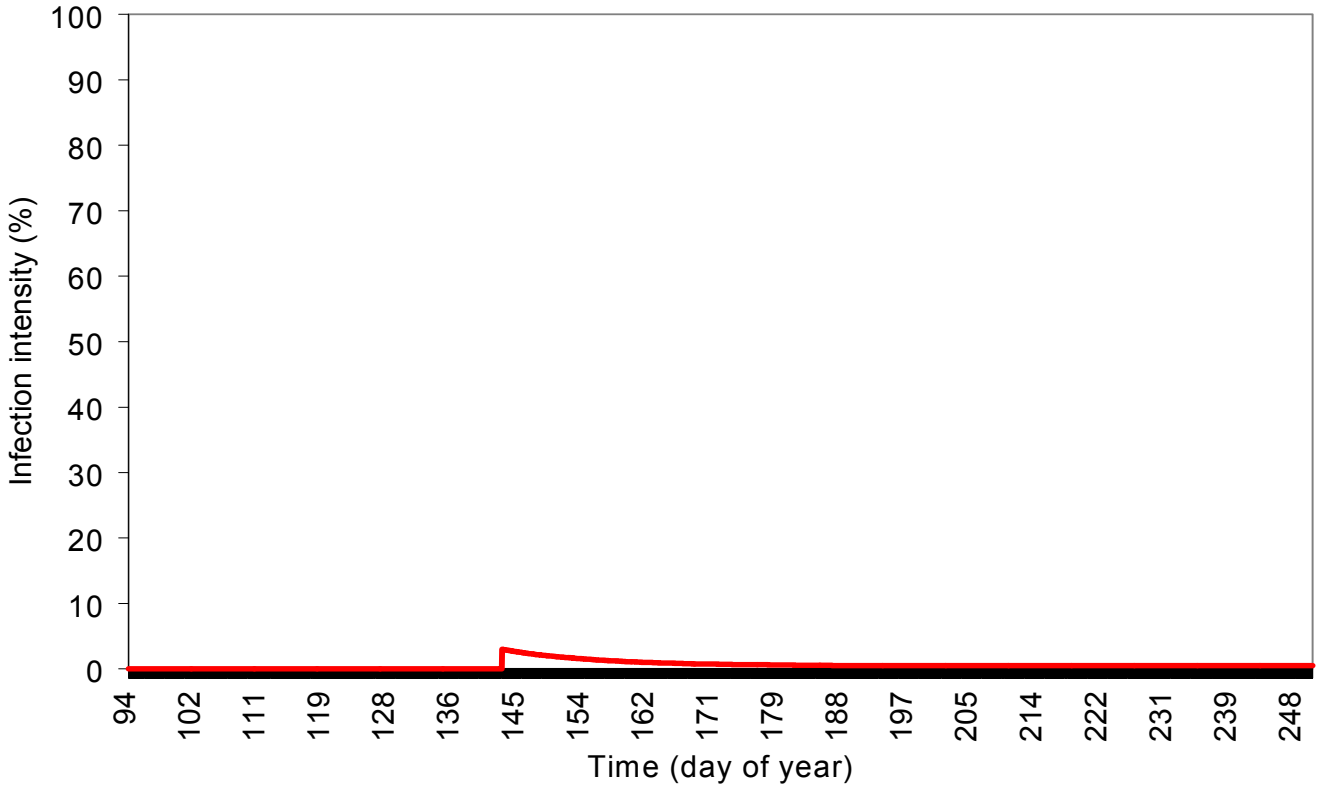
Slovenia 2000



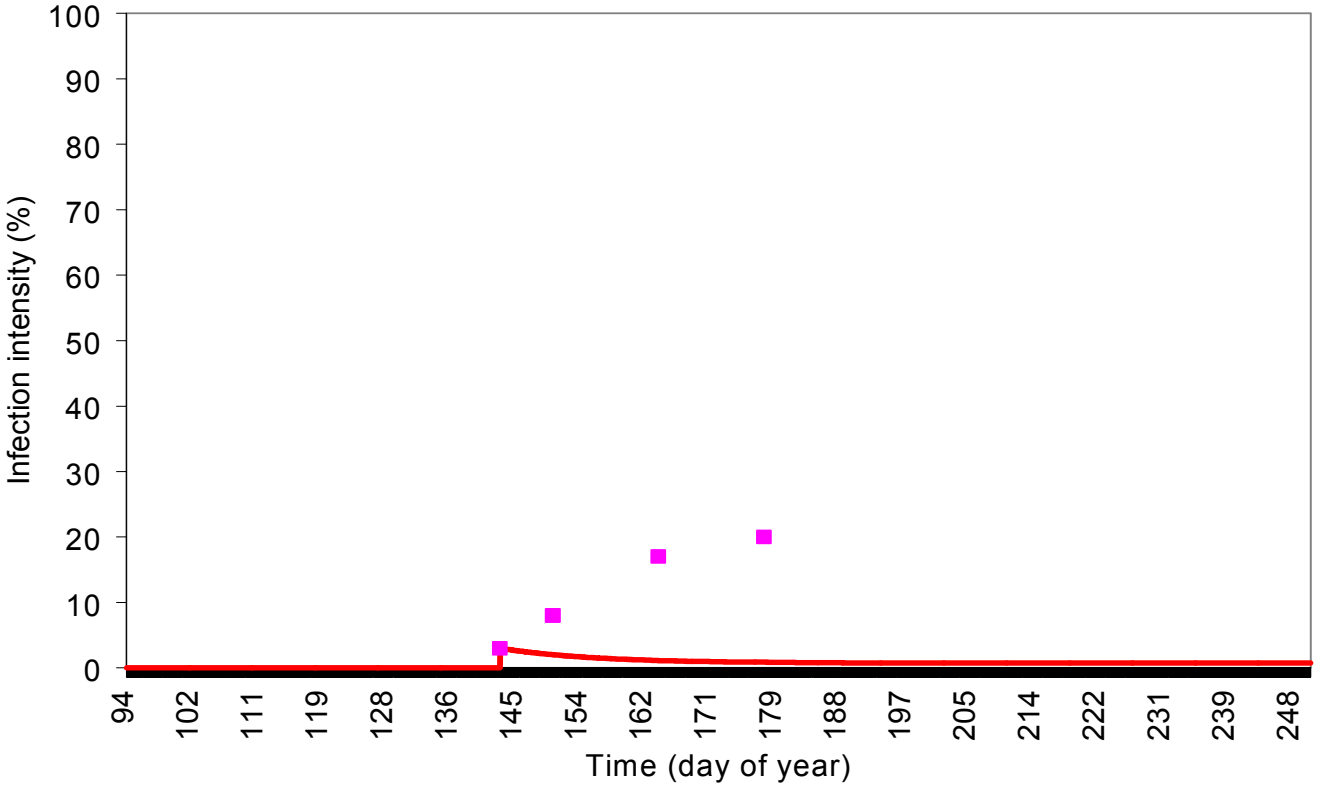
Considerations - Slovenia

- Disease intensity was well simulated by the model. However it is necessary to compare these results with those obtained during a year with high intensity of pathogen attacks.
- The level of relative humidity was lower then in Italy (see next tables), and this could be a crucial point for the model performance.

Greece 1997


100
90
80
70
60
50
40
30
20
10
0
Infection intensity (%)
94
102
111
119
128
136
145
154
162
171
179
188
197
205
214
222
231
239
248
Time (day of year)

Greece 2000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Considerations - Greece

- Observed disease intensity was not available during 1997.
- The model simulates disease intensity values very low (1%) in comparison to the real level of infection (20%) during 2000.
- These results can be due to the very low level of relative humidity and leaf wetness duration (see next tables) measured in Greece.
- Moreover the periods of leaf wetness and high relative humidity are not coincident.

Climatic summary (1 April to 31 August)

Location	T (°C)	RH (%)	R (mm)	LW (hour)	O_DI (%)	S_DI (%)
Greece 2000	23.97	48.89	285.6	35	20	0.85
Greece 1997	22.53	50.05	125	354	NA	0.58
Slovenia 2000	21.52	66.88	391	559	1.4	0.54
Italy 1997	20.32	76.83	219.4	550	0.77	2.37
Italy 1995	19.62	78.77	276.2	783	18.64	16.51

Number and intensity of simulated infections

Location	Number of infections (n)	Global intensity of infections (cm^2)
Greece 2000	0	0
Greece 1997	2	36.20
Slovenia 2000	11	106.5457
Italy 1997	6	319.33
Italy 1995	29	3012.18

Conclusions

- Differences in meteorological conditions can affect model performances in the studied environments. This is particularly true for the relative humidity and leaf wetness patterns in downy mildew model.

- Further data sets will be collected to calibrate the model in a wider range of conditions, so obtaining a better estimation of model accuracy.
- Model structure will be analysed to find the possible improvements to increase model performances.
- PERO model will be also considered.

Greece 2000 after model calibration