*Use of **G**eographic **I**nformation **S**ystems in Crop Protection Warning Service in Germany*

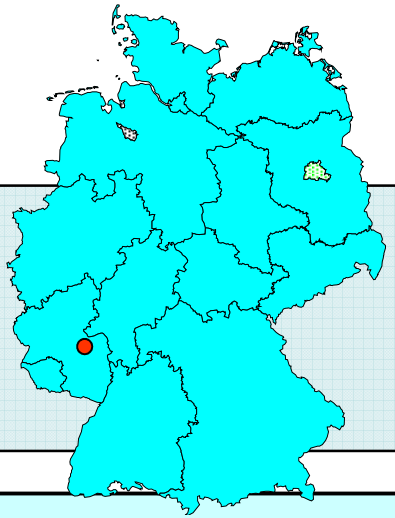
3rd Conference on PRECISION CROP PROTECTION
Bonn, September 19 - 21 2010

Zeuner & Kleinhenz

Content

- Introduction
- Spatial input data
  - Temperature and relative humidity
  - Precipitation
- Risk maps
- Summary & Conclusion

Structure of ZEPP



14 Crop Protection Services of the German Federal States

ZEPP

Central Institution for Decision Support Systems in Crop Protection

Modelbuilders

scient. Institutions
(Universities, Federal Research Centers for Agriculture and Forestry, etc.)
in Germany and Europe

other partners

German Met. Service,
Software Companies, etc.
in Germany and Europe

Aims in Crop Protection Warning Service by ZEPP

Improvement of Decision Support Systems (DSS)

- ➔ Forecasting the first appearance of plant diseases
- ➔ Identifying areas of maximum and minimum infection risk
- ➔ Giving best control for pests and diseases
- ➔ Optimising spraying strategy
- ➔ Reducing the fungicide intensity

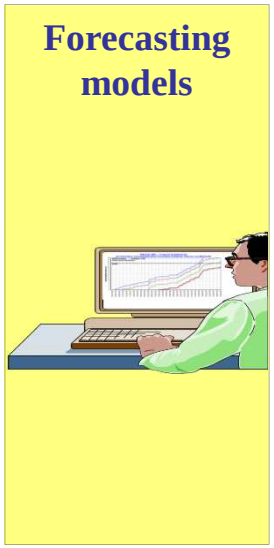
Models

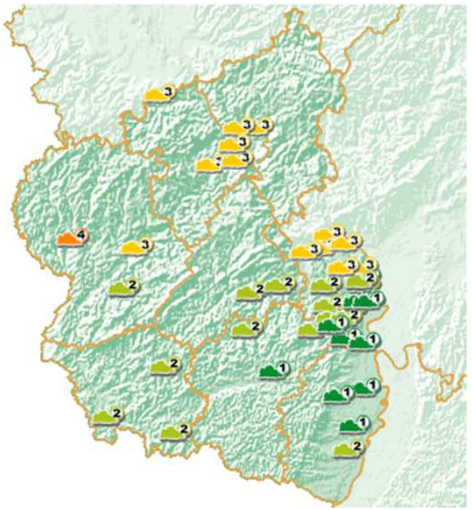
in practical use	22
under development	18
total models	40

Use of internet warning service

met. data
- temperature
- relative humidity
- precipitation

field data
- cultivar
- plant emergence
- crop rotation
- geographic data
- etc.





(www.isip.de)

Technical advance

GIS

ZEPP

geographic data

met. data + elevation + aspect + slope + geo data (???)

spatial met. data

temperature + precipitation + relative humidity + forecasting model

$$f(y) = \frac{f(MR) + \sum_{n\to\infty} x_n * f(entf_n)}{1 + \sum_{n\to\infty} f(entf_n)}$$

$$f(entf_n) = \left(\frac{1}{\vec{p} - \vec{w}_n}\right)^2$$

forecasting model run

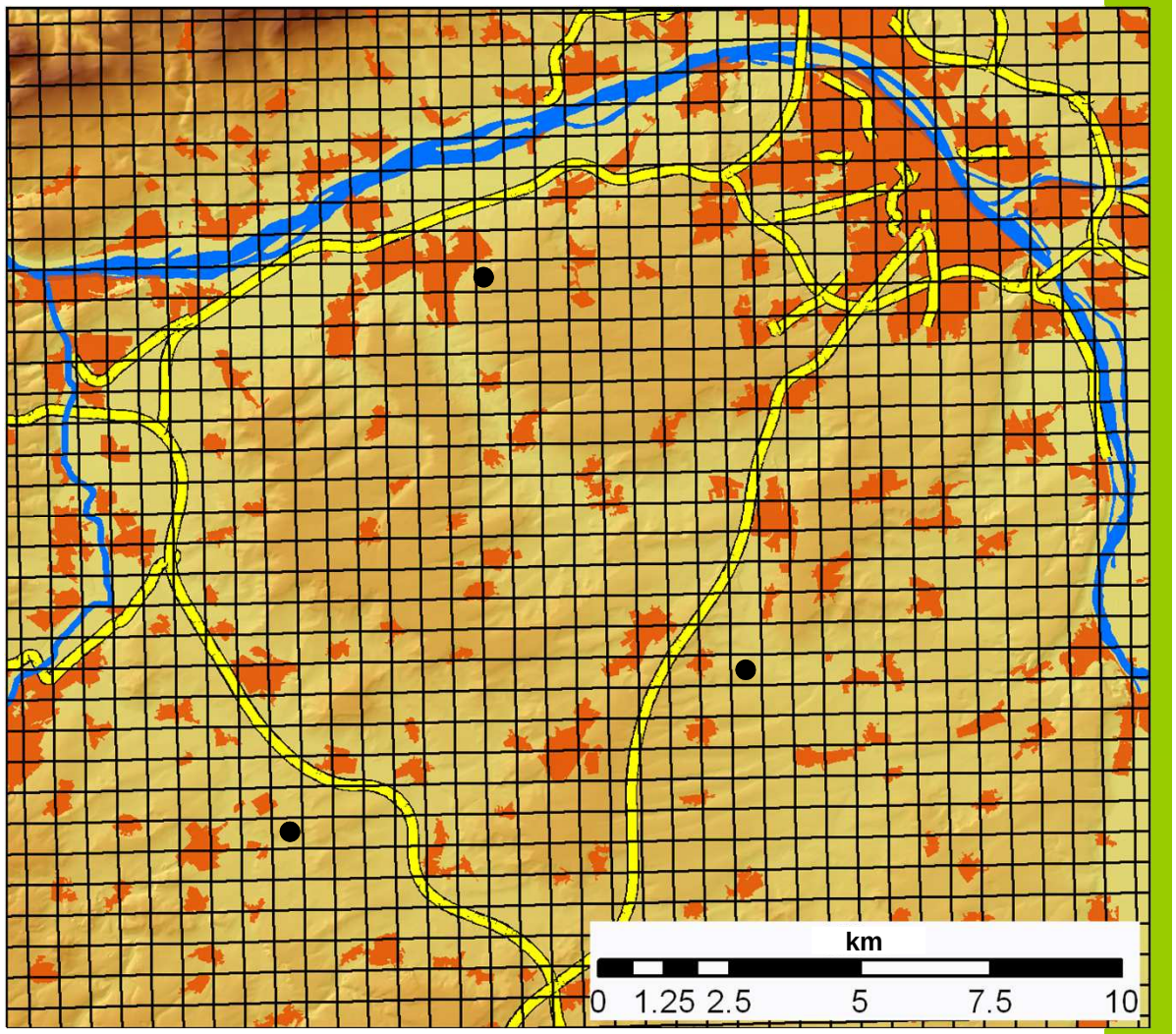
risk map

Content

- Introduction
- **Spatial input data**
  - Temperature and relative humidity
  - Precipitation
- Risk maps
- Summary & Conclusion

Storage of spatial met. data

- virtual weather database
- grid of 1 km^2
- virtual met. stations
- Germany: 357 050 km^2
- 360 000 virtual stations



3 met. stations against 1367 virtual stations on this map

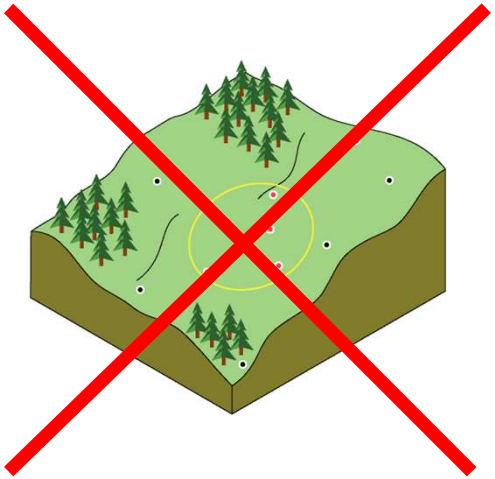
Content

- Introduction
- **Spatial input data**
  - **Temperature and relative humidity**
  - Precipitation
- Risk maps
- Summary & Conclusion

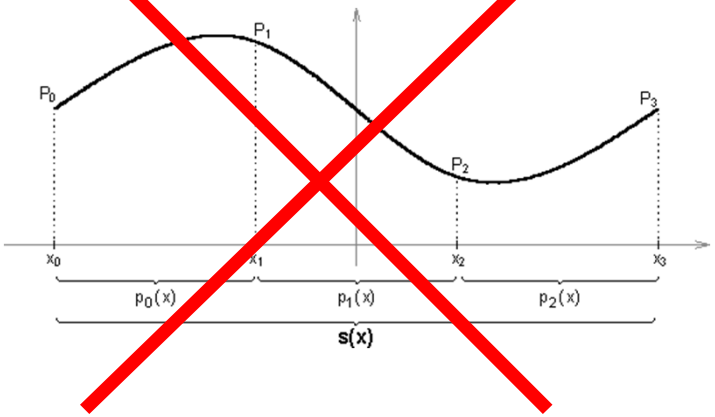
Interpolation of temperature and relative humidity

Deterministic interpolation methods

IDW next neighbor method

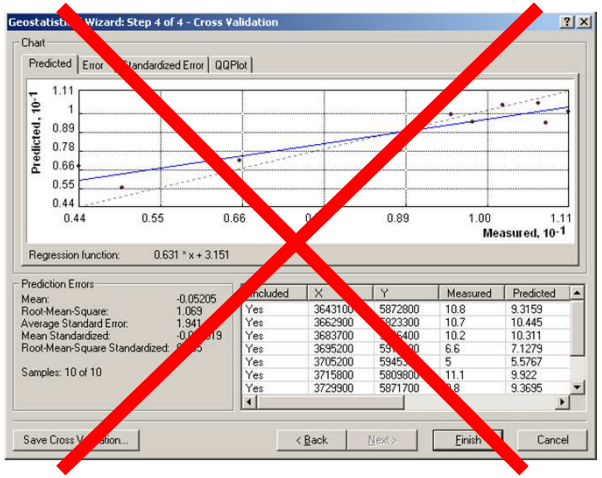


spline

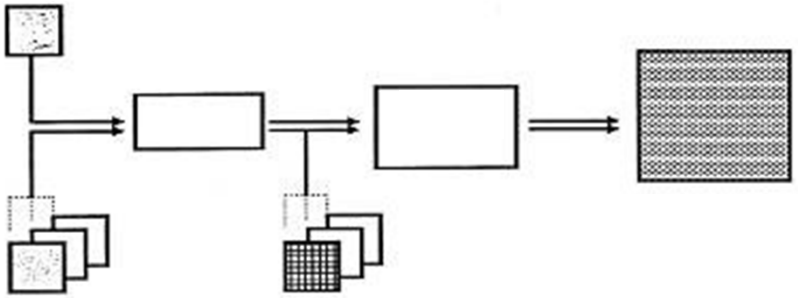


Geostatistic interpolations methods

kriging



multiple regression



Interpolation with multiple regression (MR)

met. data (measured)

- temperature
- relative humidity
- 570 met. stations over Germany

regression formula

spatial met. data map

MR

$$F(x)= const+H*x_1+N*x_2+E*x_3$$

geographic data (at met. station)

- dlm
- dem
- elevation
- slope
- aspect
- etc.

spatial geographic data

best correlations with altitude, longitude and elevation

Validation of model results

Validation of the method

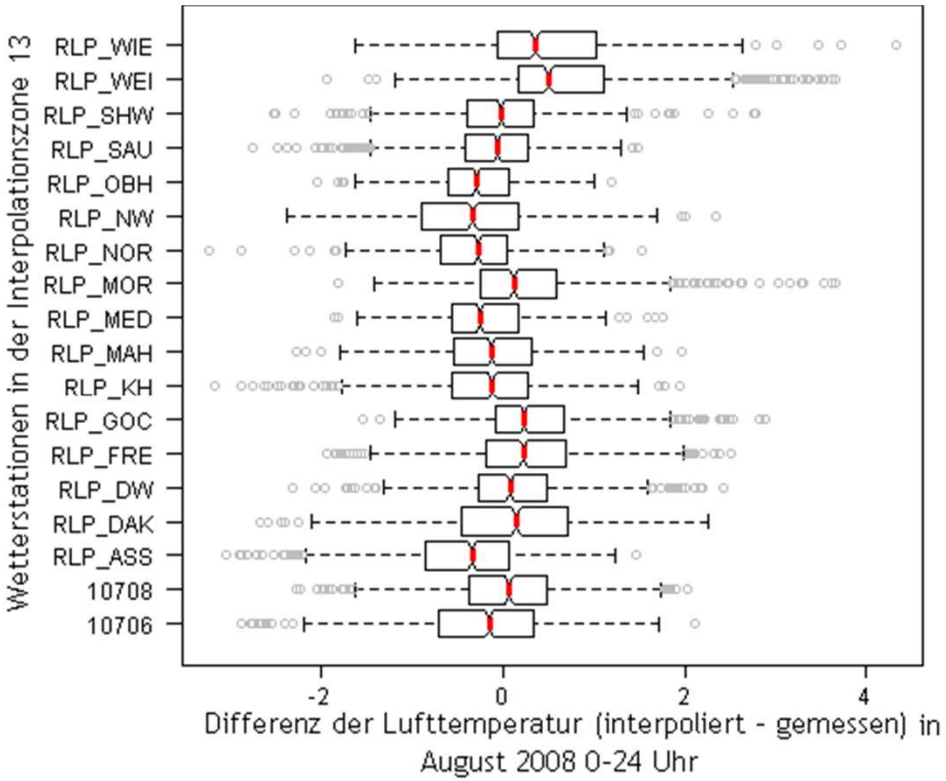
year	days/ Year	hours/ Day	stations	temperature	humidity	n
2004	366	24	676	x	x	11.875.968
2005	365	24	676	x	x	11.843.520
2006	365	24	676	x	x	11.843.520
2007	365	24	676	x	x	11.843.520
2008	366	24	676	x	x	11.875.968
alle						**59.282.496**

Number of Boxplots

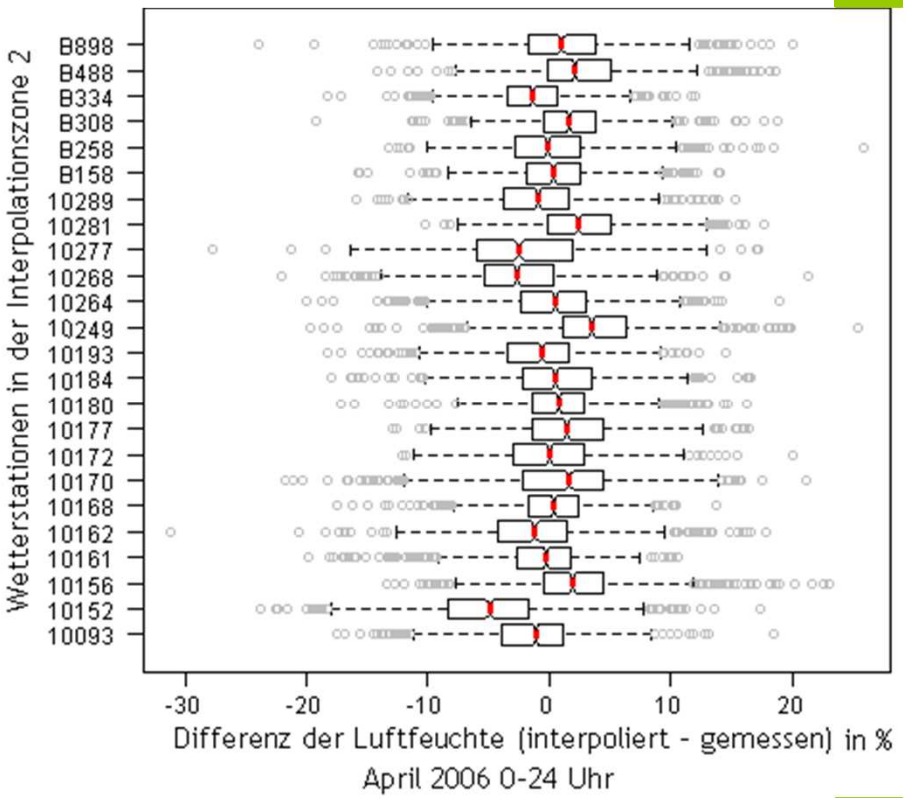
year	stations	parameter	whole year	spring/ summer	April	May	Juni	Juli	August	frequence	Boxplots
2004	676	2	x	x	x	x	x	x	x	3	28.392
2005	676	2	x	x	x	x	x	x	x	3	28.392
2006	676	2	x	x	x	x	x	x	x	3	28.392
2007	676	2	x	x	x	x	x	x	x	3	28.392
2008	676	2	x	x	x	x	x	x	x	3	28.392
alle											**141.960**

Validation of model results

Temperatur



relative Luftfeuchte

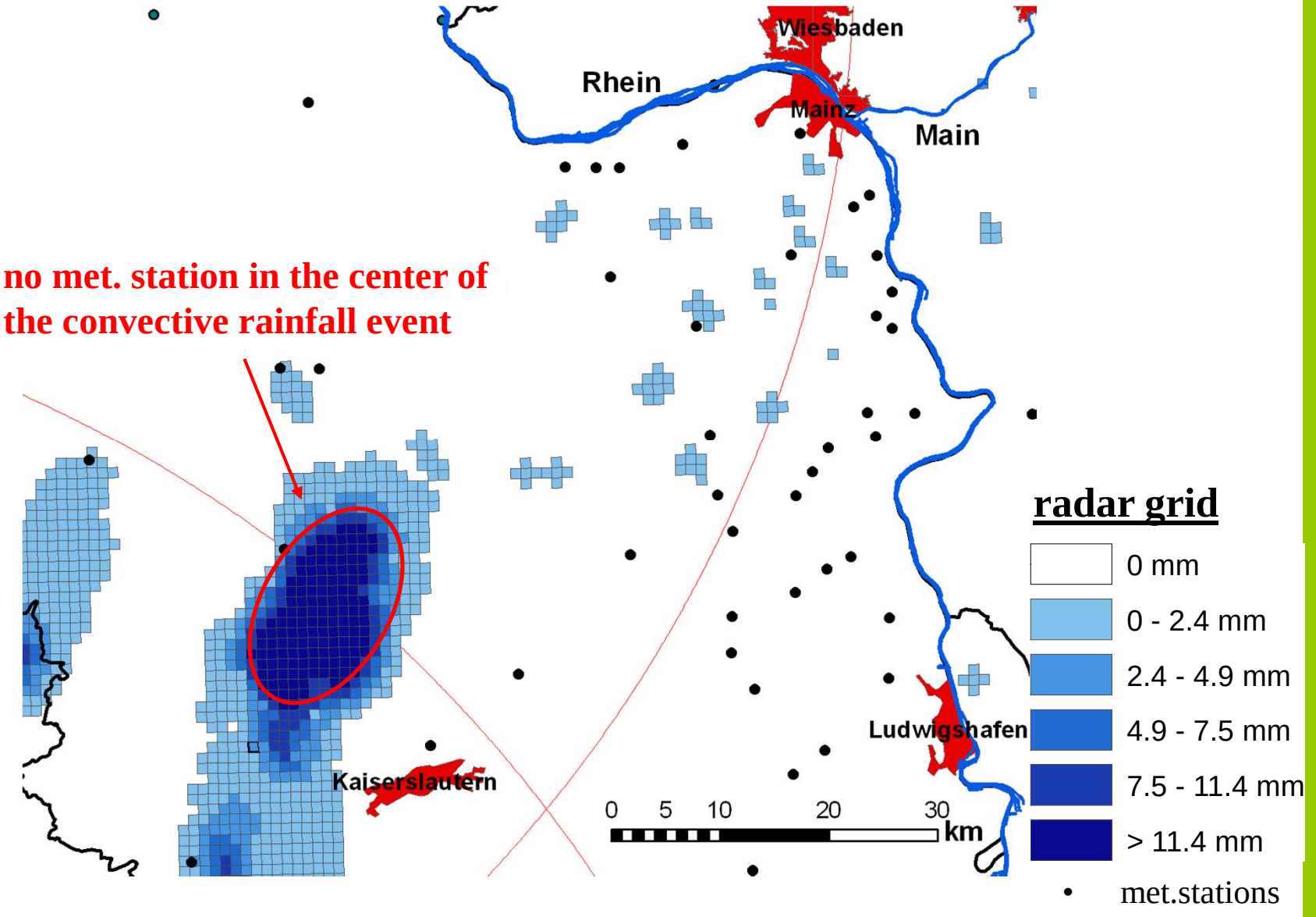


- **simular results for other Boxplots**
- **Statistic check (T-Test): not significant**
- **useful as input for forecasting models**

Content

- Introduction
- **Spatial input data**
  - Temperature and relative humidity
  - **Precipitation**
- Risk maps
- Summary & Conclusion

One hour with precipitation



Spatial precipitation with radar data

- Spatial measured precipitation data is collected by the German Met. Service
- 16 radar stations measure the data nationwide over Germany
- The radar data is calibrated by 1600 classic automatic precipitation stations (Ombrometer) which are located over the whole area of Germany
- The radar data is collected in a frequent of one hour and in a spatial resolution of 1km^2

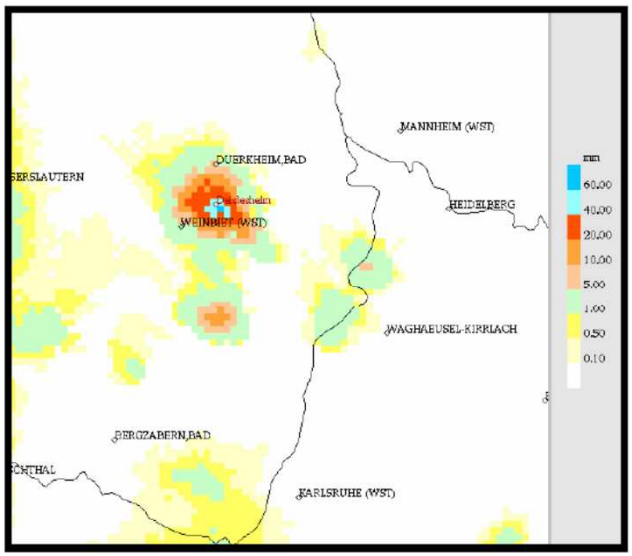
Ombrometer

+

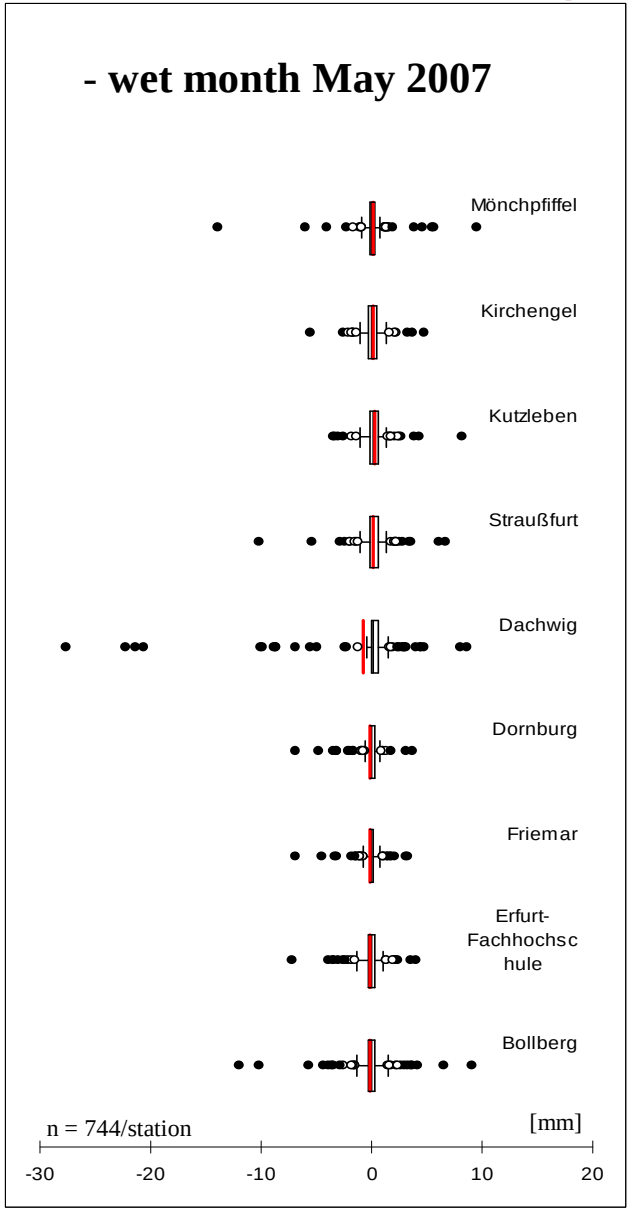
radar station

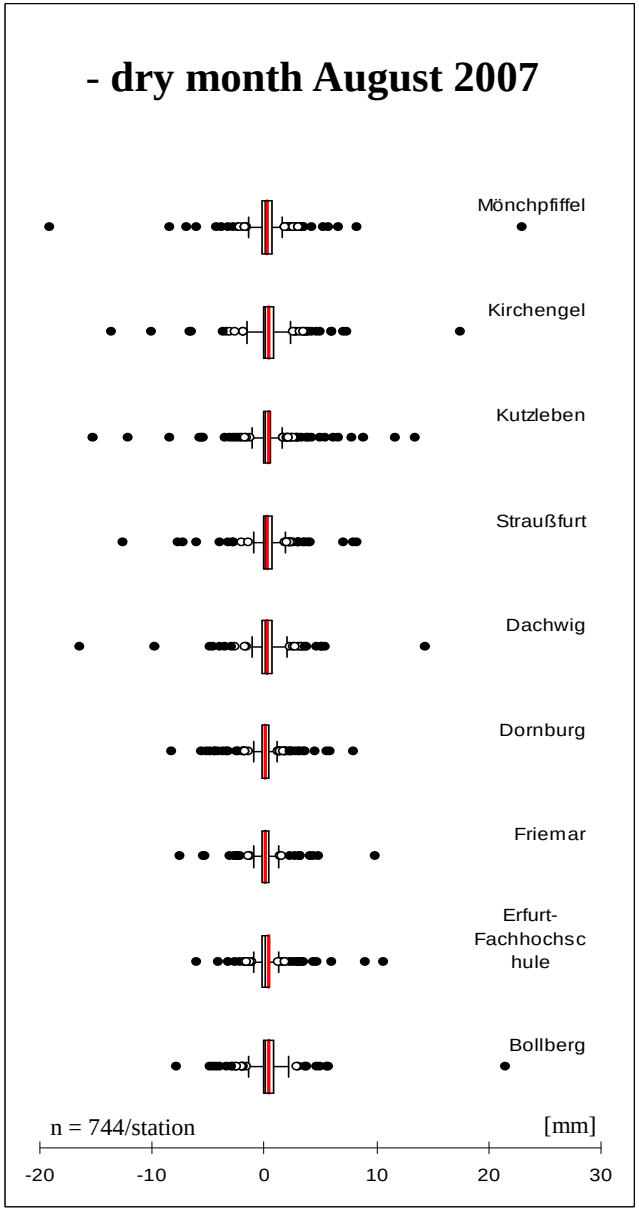
=

precipitation map



Comparison between radar data and independently classically collected precipitation data





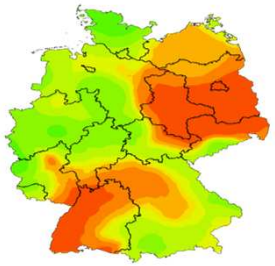
Content

- Introduction
- Spatial input data
  - Temperature and relative humidity
  - Precipitation
- **Risk maps**
- Summary & Conclusion

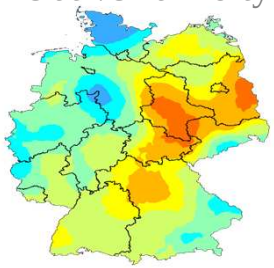
Risk maps

spatial input data

temperature



relative humidity



precipitation

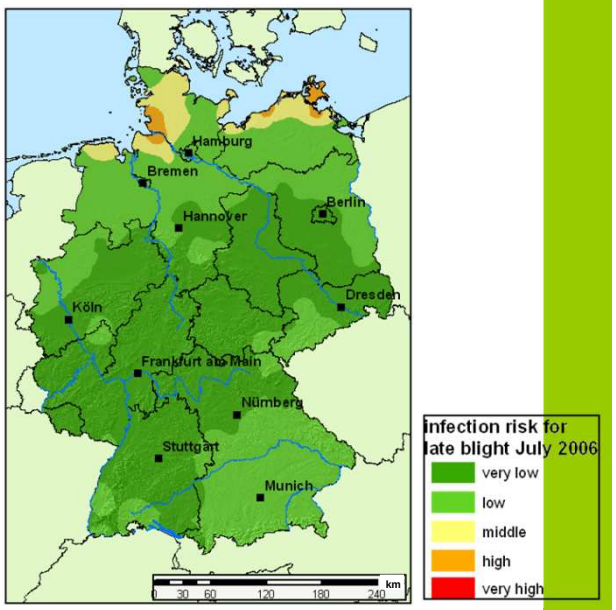
warning service

field specific input data
cultivar, plant emergence, crop rotation, etc.

forecasting models

spatial result presented as risk map

risk map presentation



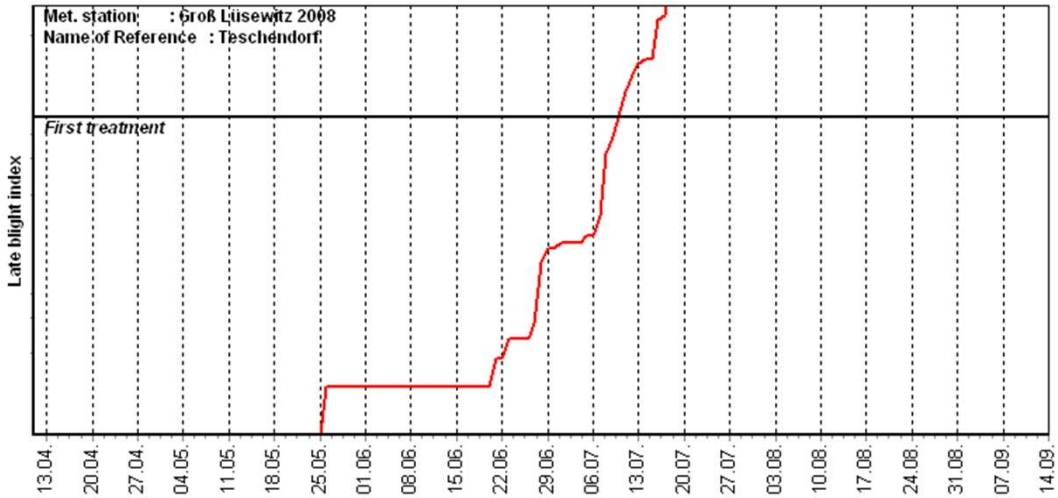
Forecasting model runs with spatial input data

Two type of models used by ZEPP

First Type

plant disease outbreak

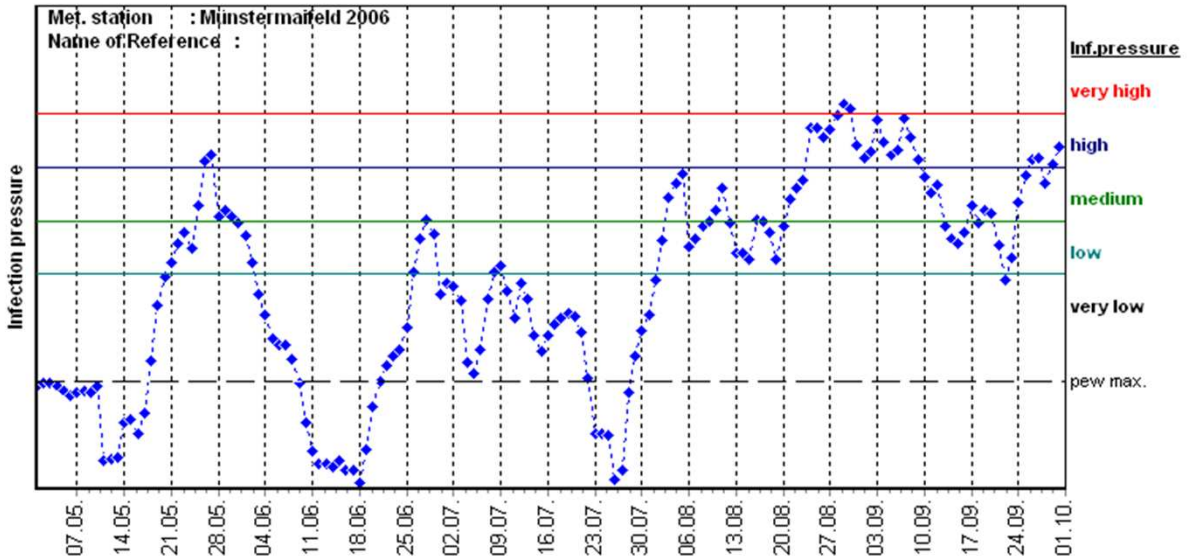
- **date of first monitoring**
- **date of first treatment**



Second Type

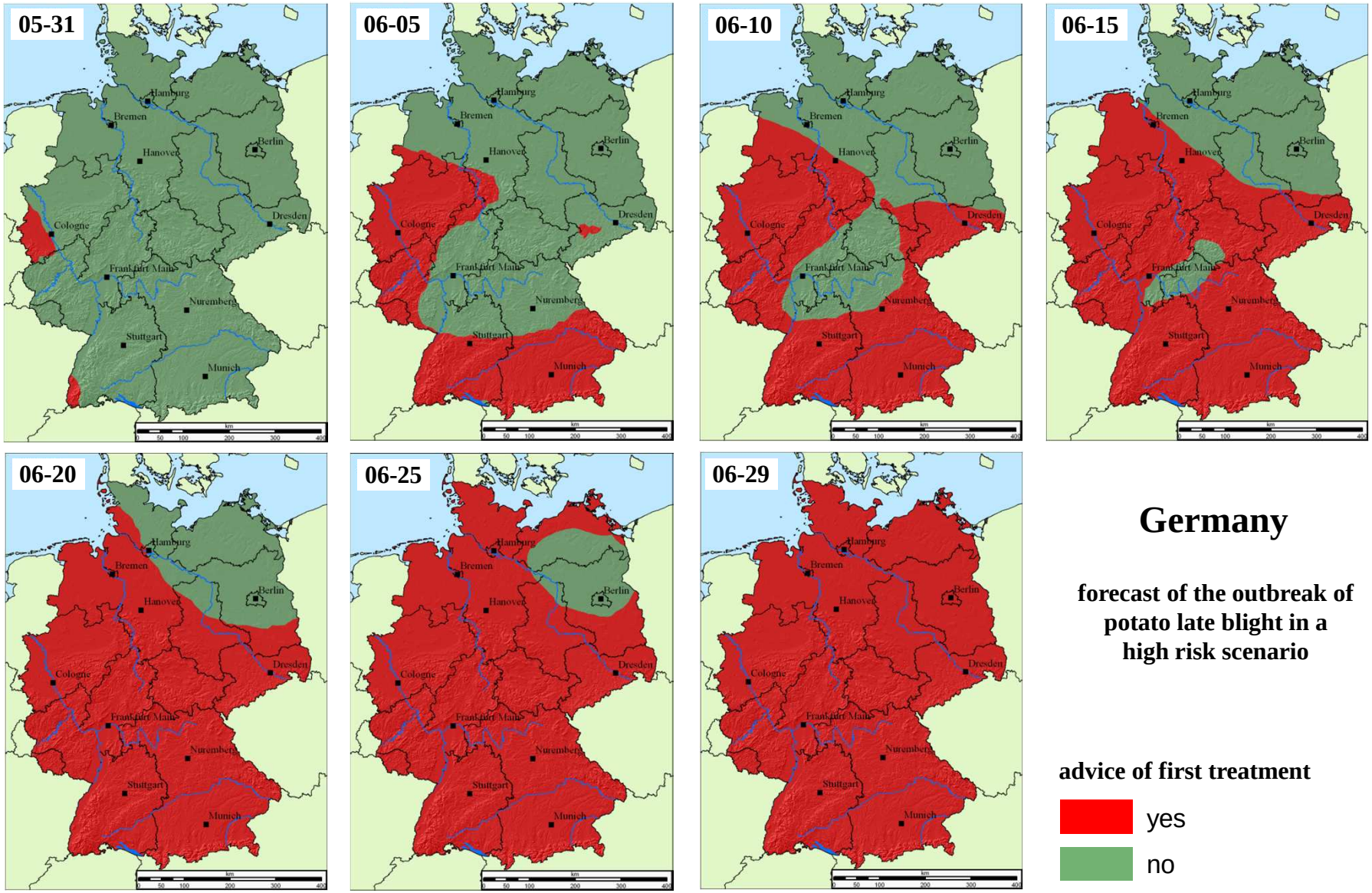
plant disease infection risk

- **high/low risk situations**
- **spraying strategy**



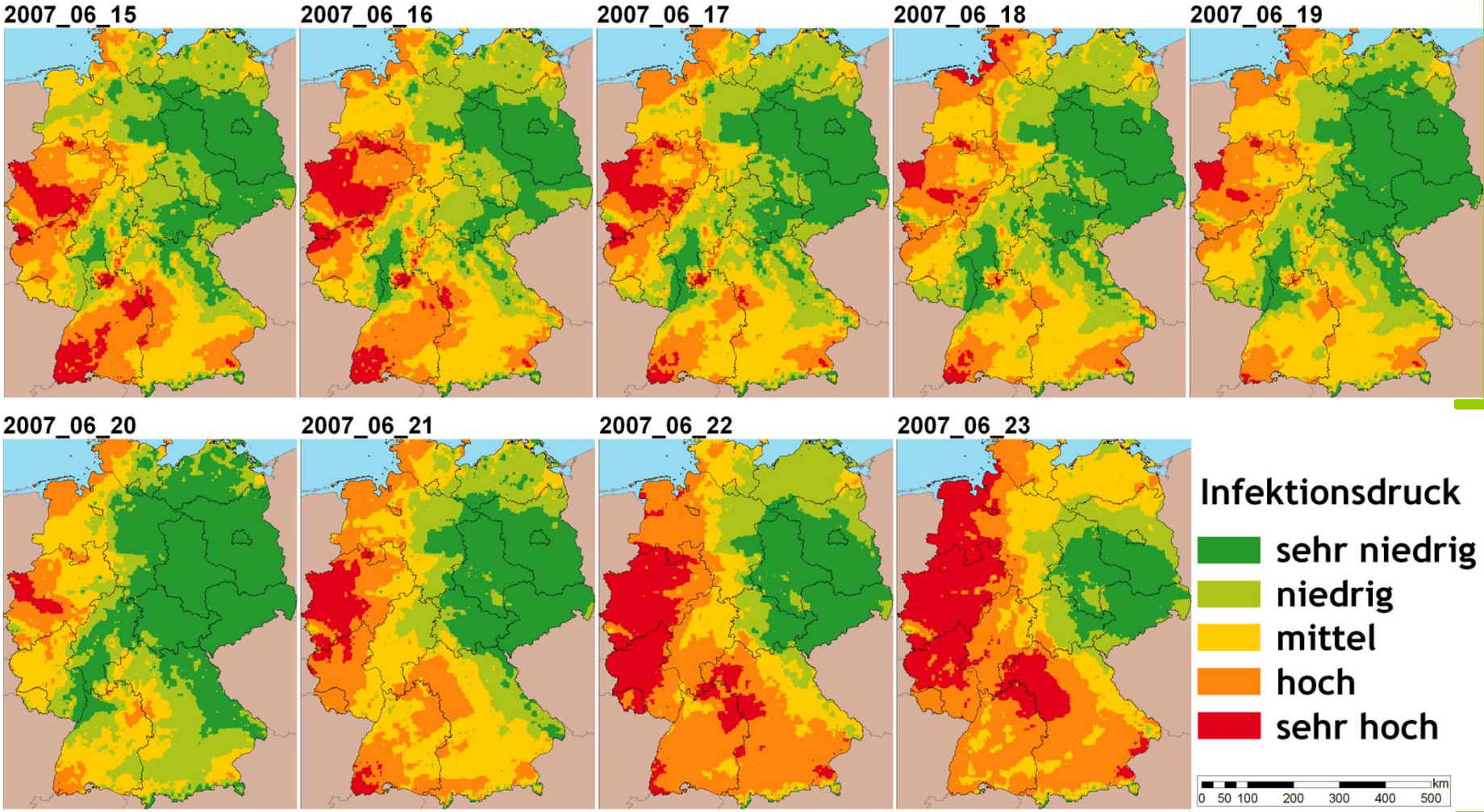
First type: Risk maps of late blight with SIMBLIGHT1

Forecast of the outbreak of potato late blight in Germany



Second type: Risk maps of infection pressure with SIMPHYT3

• The output of SIMPHYt3 is a daily met. data based infection pressure for late blight by checking at met. data of the last 14 days



Content

- Introduction
- Spatial input data
  - Temperature and relative humidity
  - Precipitation
- Risk maps
- **Summary & Conclusion**

Summary and Conclusion

- Virtual met. data were produced and tested on validity
  - interpolation method for temperature and relative humidity
  - radar data for precipitation
- Virtual met. data were used as input for forecasting models to produce risk maps
  - risk maps show hot spots of disease outbreak
  - risk maps show daily infection pressure for plant diseases
- Forecasting results as risk maps are easier to understand and to interpret
- GIS helps to obtain more detailed calculations and results with higher accuracy than before
- Risk maps are available under www.isip.de since April 2010

This leads to a reduced pesticide use and
an economical and environmental friendly crop protection strategy

Thanks for your attention

SIMPHYT3

2007