Predictive Modelling of Mycotoxins in Cereals

21st Nov 2016, Cheng Liu

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Mycotoxin contamination of cereal grains

- Fungal infection → mycotoxin production
- Weather and agronomical conditions
- Contamination can be limited, but not avoided
- Mycotoxin is chemically stable contaminant
- Affect human and animal health

Application of predictive models

- Farmers
  - To decide on fungicides use
- Food safety authorities
  - To identify high risk areas for inspection
- Wheat supply chain actors
  - To identify batches with low/high DON levels
- Impact assessment of climate change

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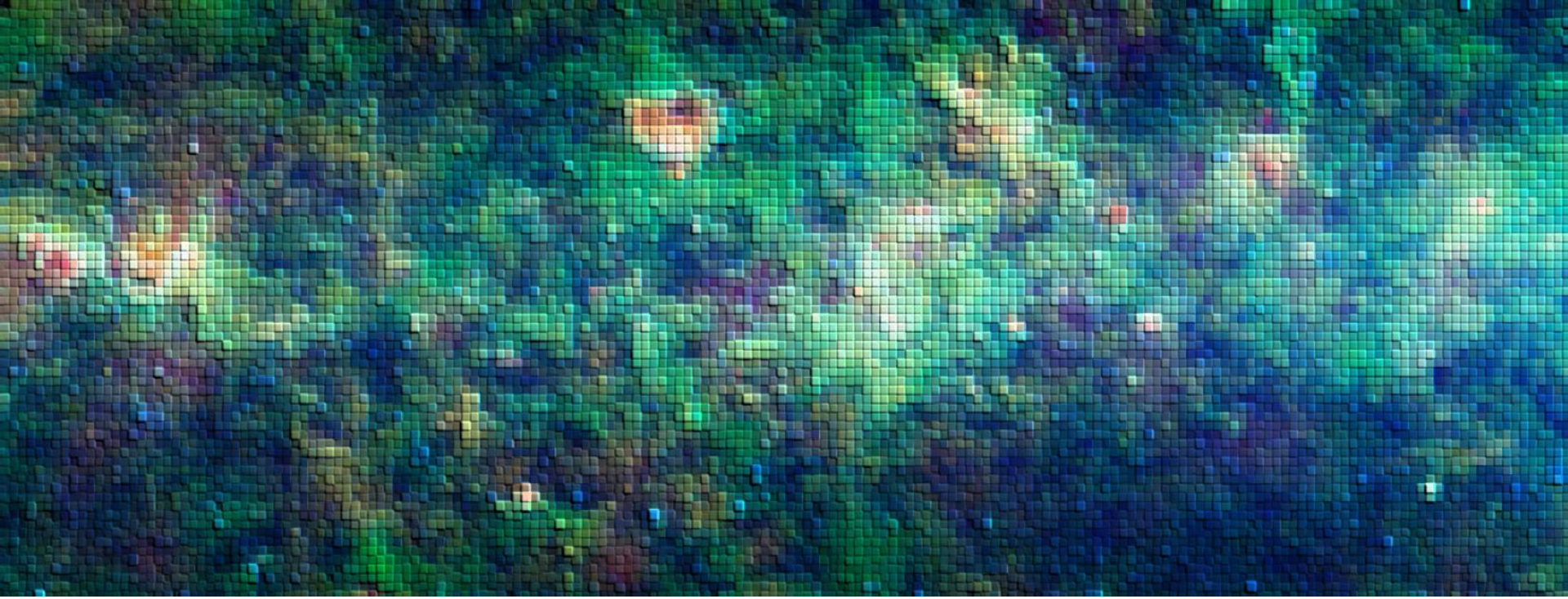
Predictive models mycotoxins

- **Three modelling approaches to predict** DON levels in wheat in the Netherlands

- **Climate change study: Predicting and mapping** Aflatoxin in maize in Europe

  EFSA project: MODMAP-AFLA



Predictive modelling of DON levels in wheat in the Netherlands

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Aim

To predict the DON levels in wheat at the moment of harvest for farmers and buyers in the NL

->To plan optimal harvest date and fungicide use

->To identify batches with low/high DON levels

Data input

- Monitoring data since 2001:
  - DON levels in wheat (sample analysis)
  - Weather data (KNMI)
  - Agronomic data (questionnaire)

Three modelling approaches

- Empirical model
- Bayesian network model
- Mechanistic model

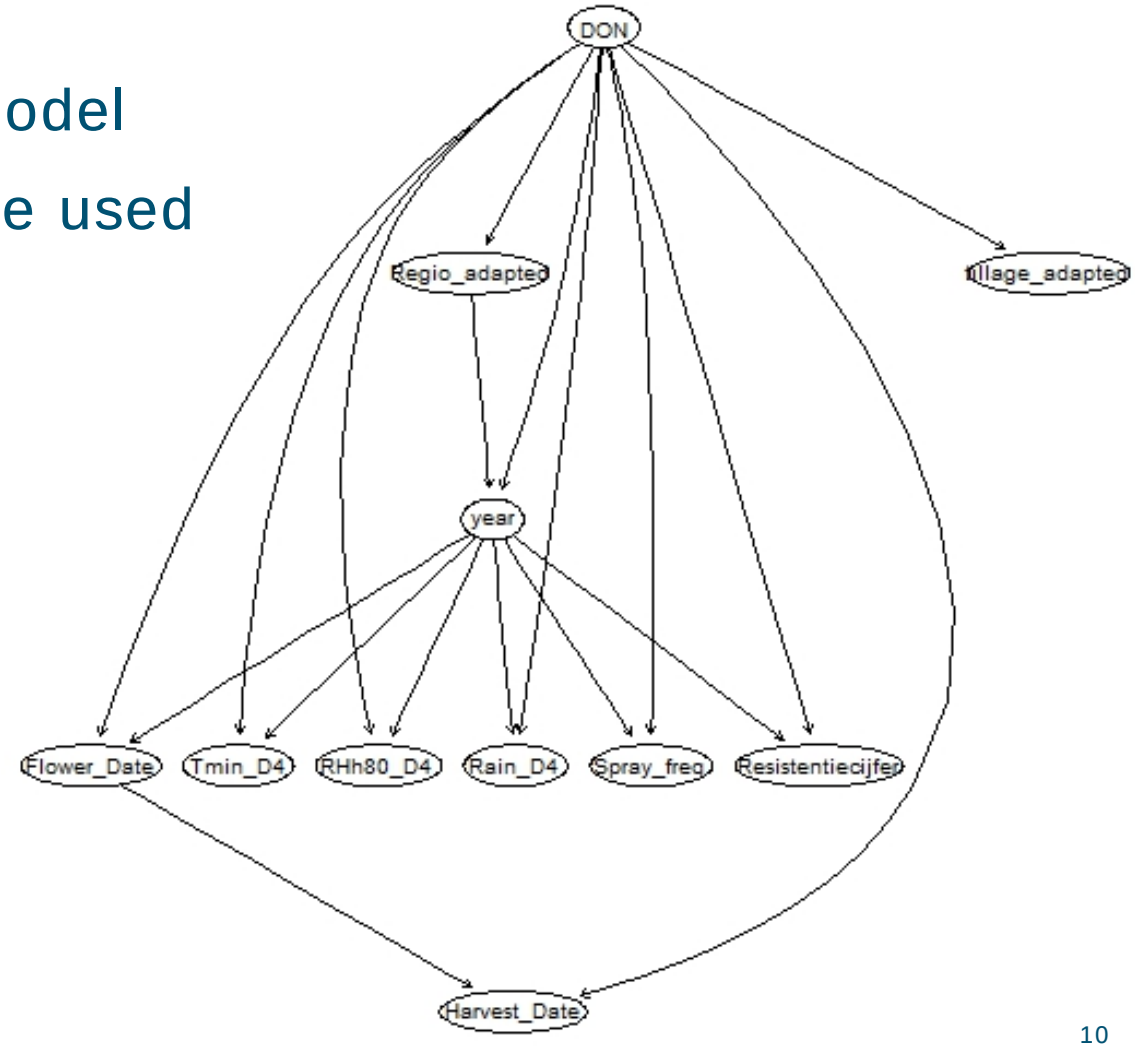
Empirical model - method

- Based on existing model by van der Fels-Klerx et al., 2010
  - Multiple linear regression model
  - Prediction of ‘exact’ DON level

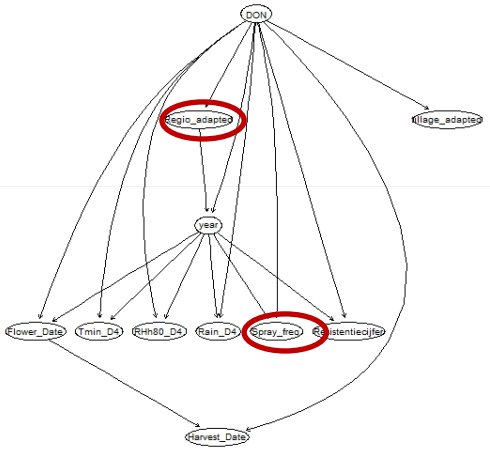
- Main changes:
  - Added more data from 2010-2013
  - Year as a random effect
  - Binary prediction
    - Chances of >100 ppb
    - Chances of >500 ppb
    - Chances of >1000 ppb

Bayesian network model - method

- Directed graphical model
- 80% of the data were used for model learning



Bayesian network model – Prediction and validation



IF

- Region = North
- Resistance level = 5.5

	<=500 ppb	500-1000 ppb	>1000 ppb
Resistance level = 5.5	0.58	0.32	0.10

Bayesian network model – Prediction and validation

IF

- Region = North
- Resistance level = 5.5
- Tmin = 8 ºC

- 2 predictors

Correct prediction = 79%

- 3 predictors

Correct prediction = 83%

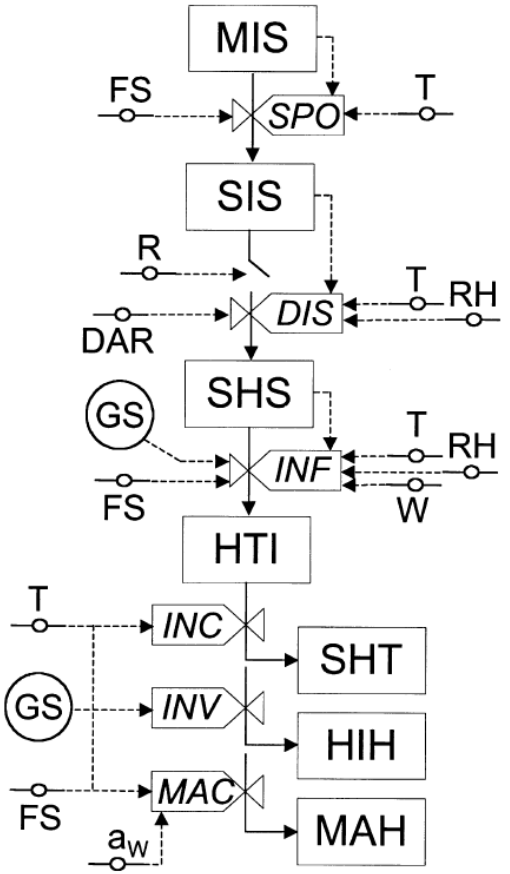
Mechanistic model - method

- Based on existing mechanistic model by Rossi et al., 2003 (Italy)

  - simulate contamination process, e.g. sporulation, dispersal and infection

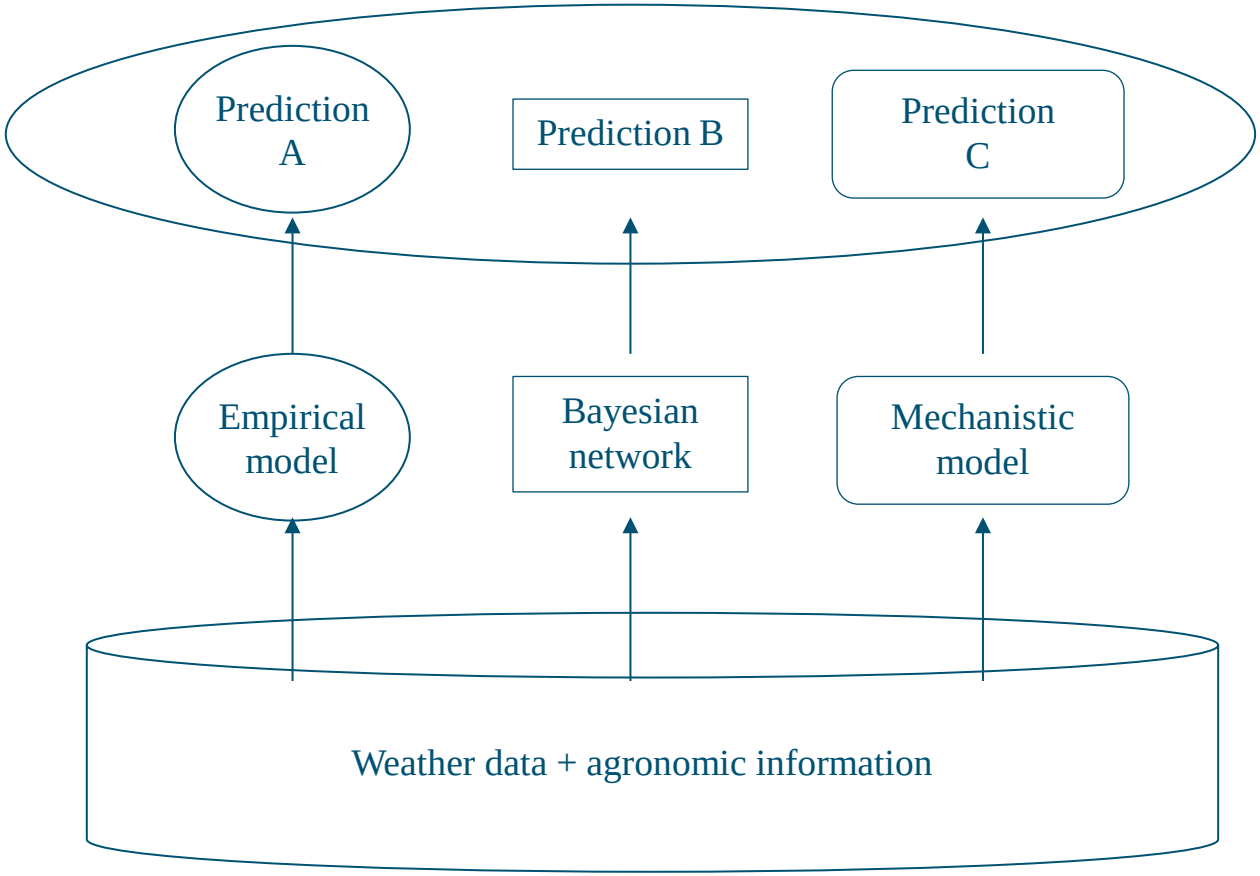
- Working progress:

  - Adapt the model to Dutch environment



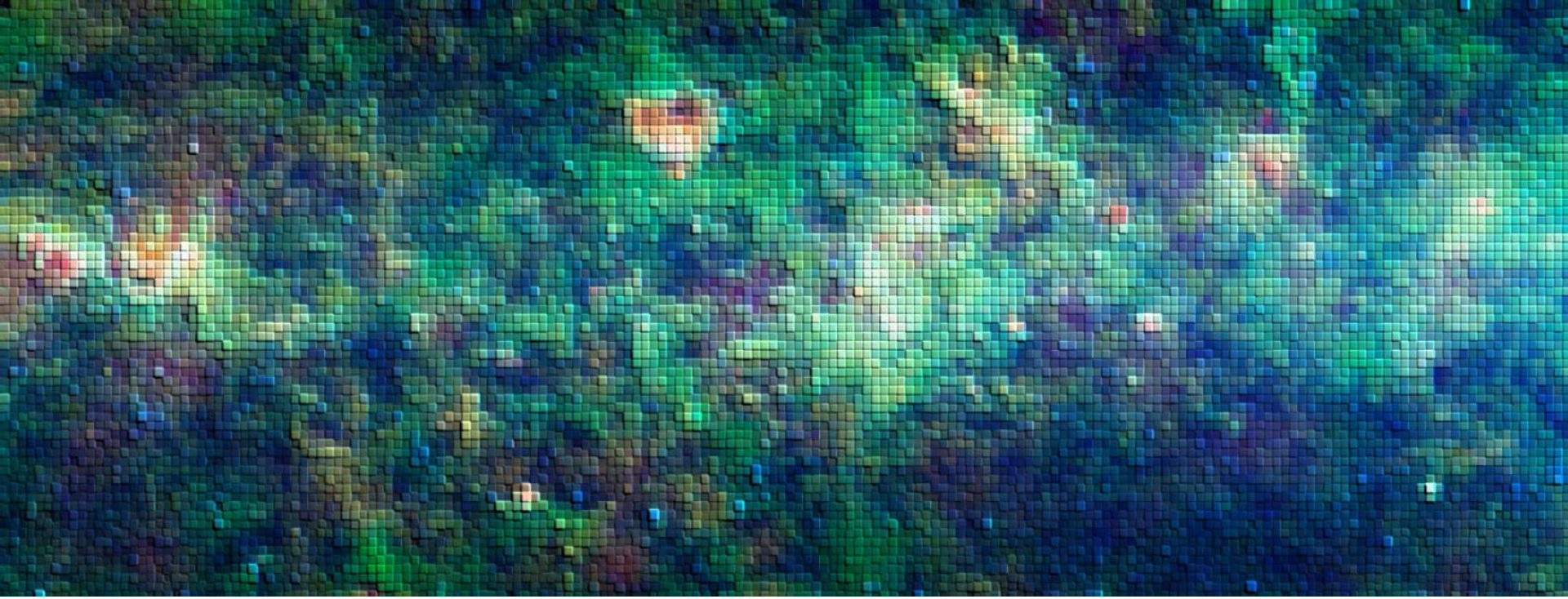
Rossi et al., 2003

Three modelling approaches – Model envelope



Prediction uncertainties

Model input (climate data)



Climate change study:

Empirical model for DON concentrations in wheat in north west Europe

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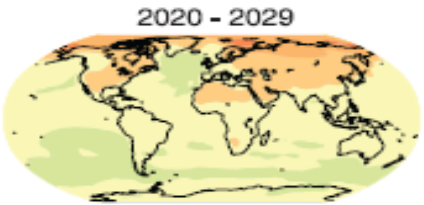
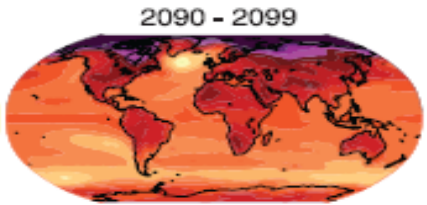
Climate Change study: aims

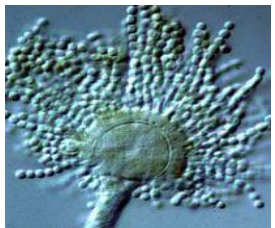
Estimate the impact of climate change effects on mycotoxins in cereal grains.

Afla-maize in Europe

The results were reported in maps for some selected years.

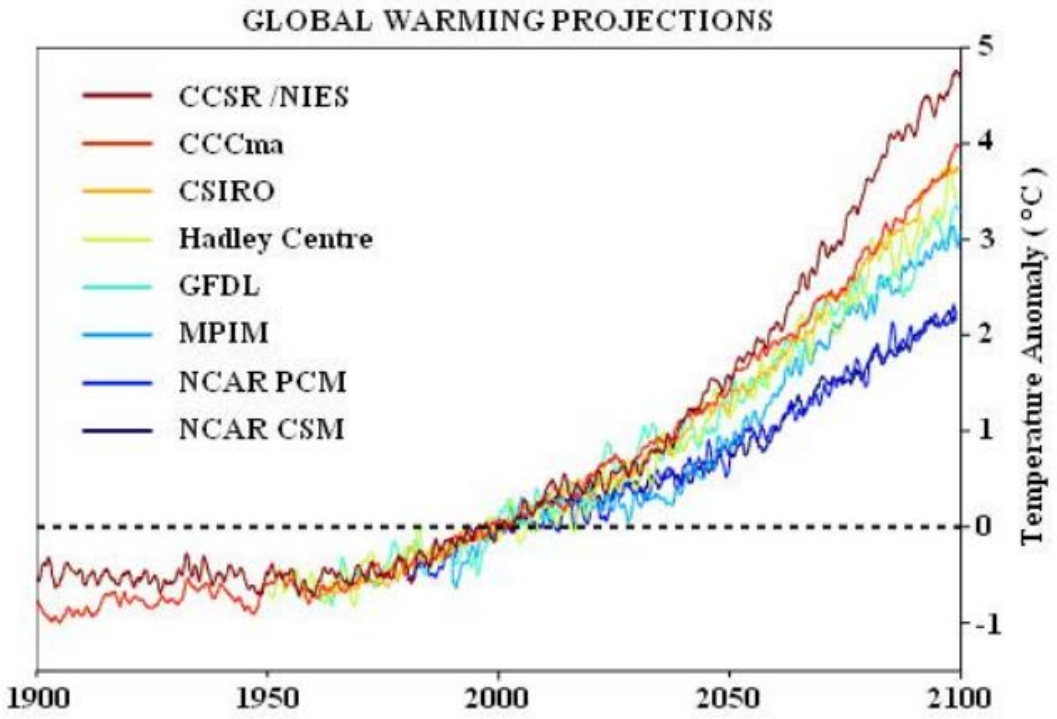






Climate change scenarios

- IPCC scenario +2°C and + 5°C
- Climate for 2011-2100
- Baseline 1975-1994
- Two GCM x RCM combinations
- ENSEMBLES database
- LARS-WG for daily T, P and solar radiation



(GNU online)

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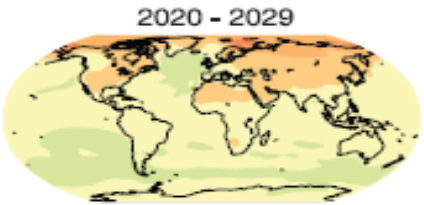
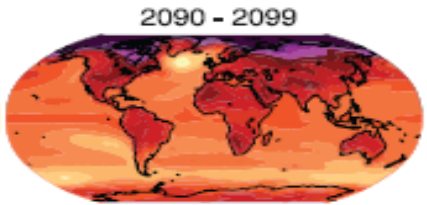
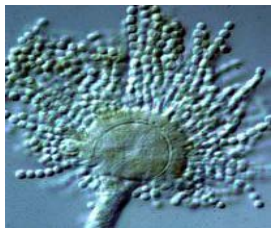
AF index

4 different levels of risk could be identified:

- AF index between **140** and **180** associated with a high aflatoxin risk (from red to dark red in the map);
- AF index between **100** and **140** associated with medium aflatoxin risk (yellow to orange in the map);
- AF index between **40** and **100** (green to pale blue in the map) associated with a low aflatoxins risk;
- AF index below **40** (Blue to violet in the map) not associated with a true risk



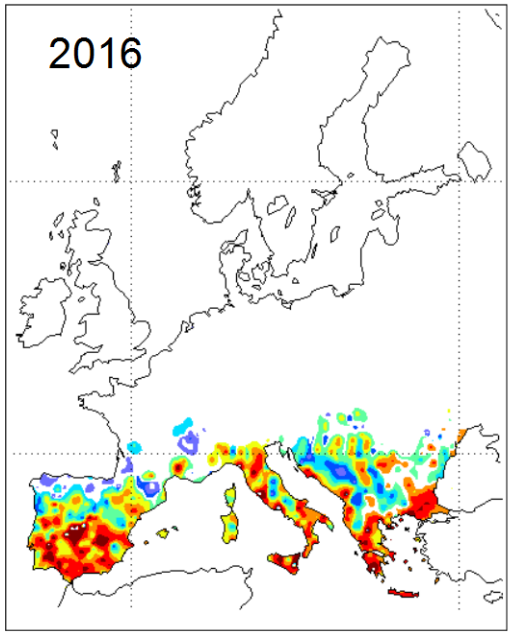


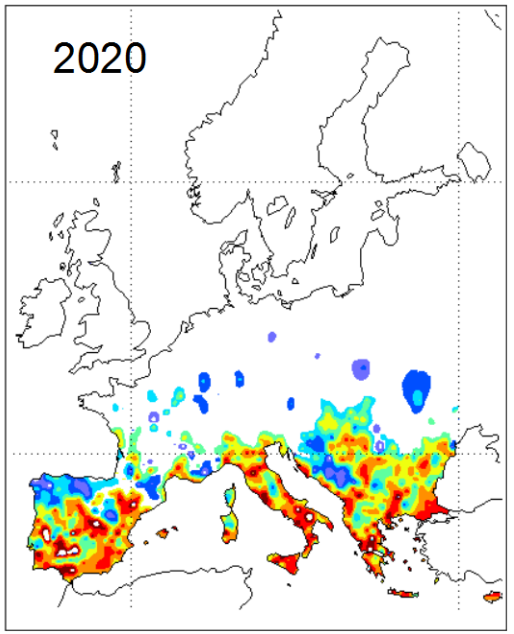


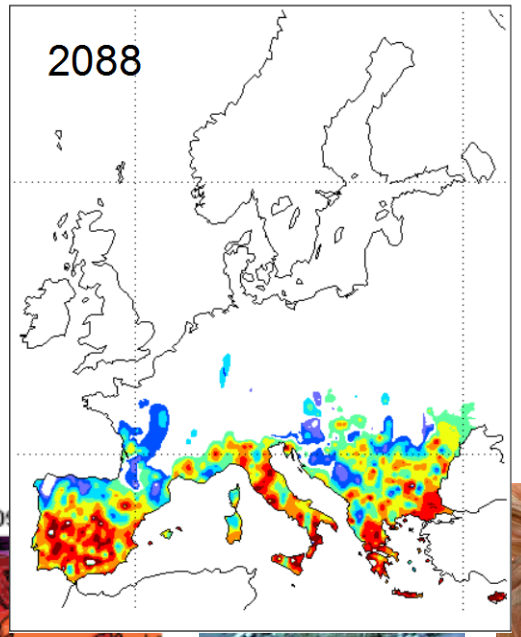
AF risk

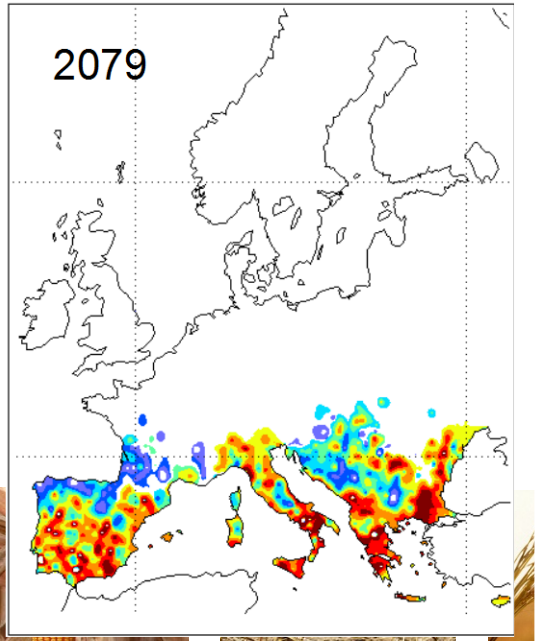
Maize

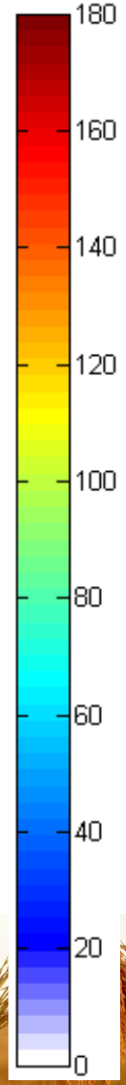
+2 scenario

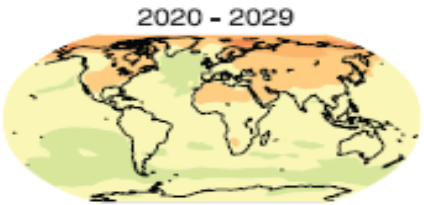


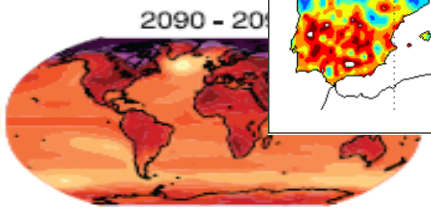


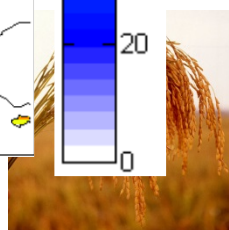






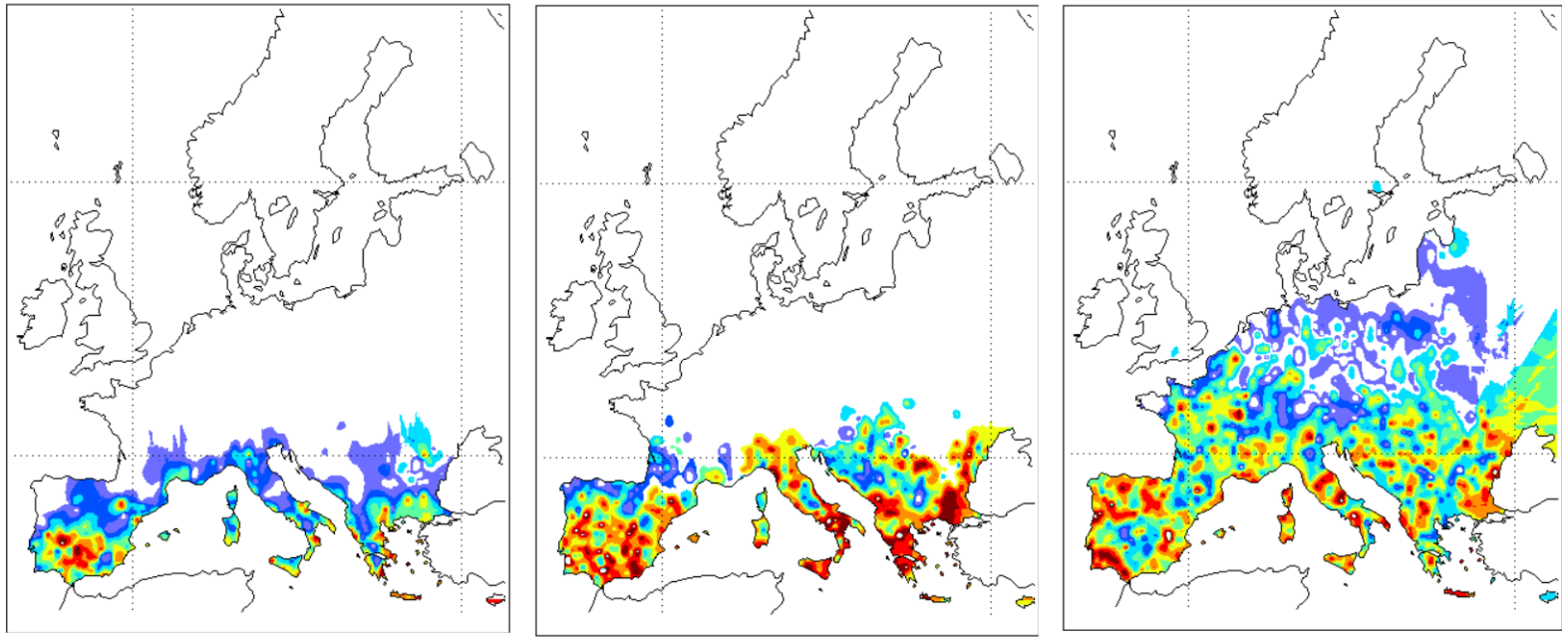




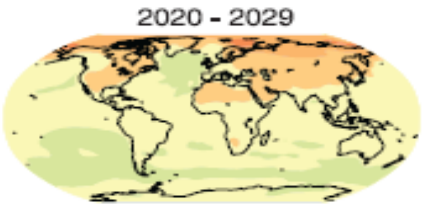


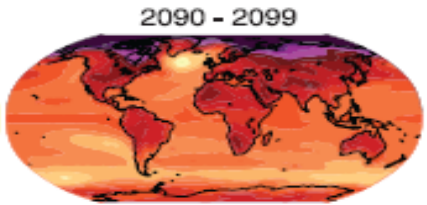
AF risk

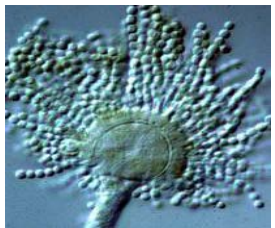
2079 - Maize



Actual +2 +5



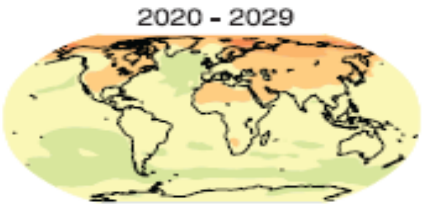


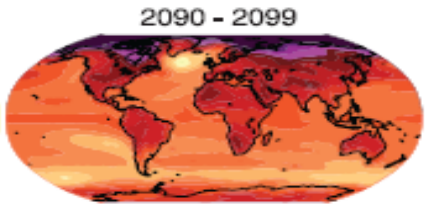


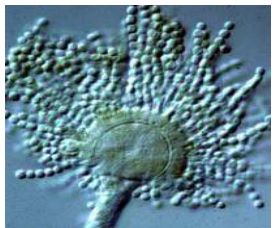
AF risk scenarios

✓The risk for AFs contamination is expected to increase in maize, both in the +2° C and +5° C scenario

✓Very low risk levels are predicted in wheat and no risk in rice; therefore, attention must be focused on maize







Thanks for your attention

Questions?

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