

Parma Summer School 2018

«Emerging Risks for Food Safety
and Public Perception»



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Climate changes and food safety implications: the example of **Mycotoxins**

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- **Increase in health risks** expected/confirmed in climate change scenarios
- **Mycotoxins** play a pivotal role



Rating health risks from food

Acute

Microbiological

Phycotoxins

Some phytotoxins

Mycotoxins

Antropogenic contaminants

Pesticide residues

Food additives

Chronic

Mycotoxins

Antropogenic contaminants

Some phytotoxins

Unbalanced diet

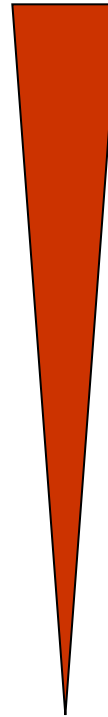
Phycotoxins

Food additives

Pesticide residues

Microbiological

High

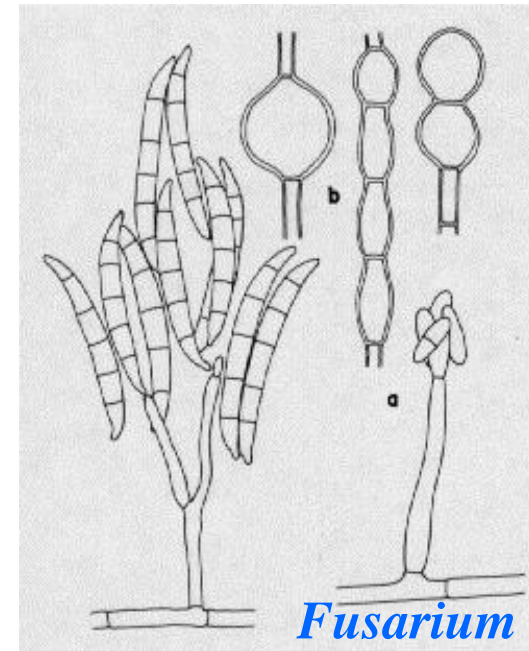
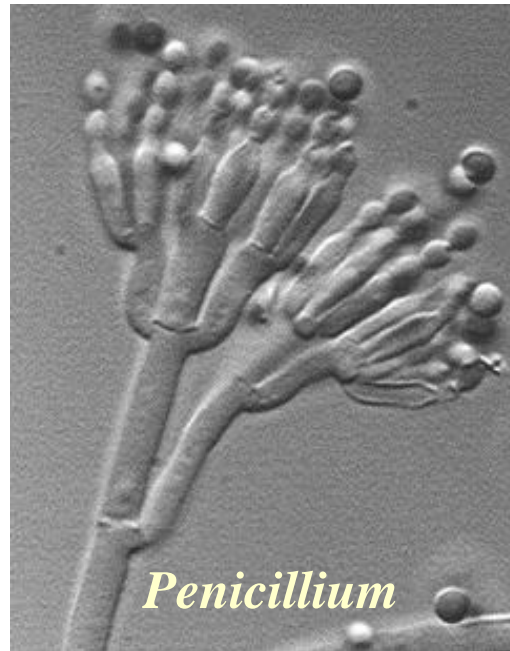
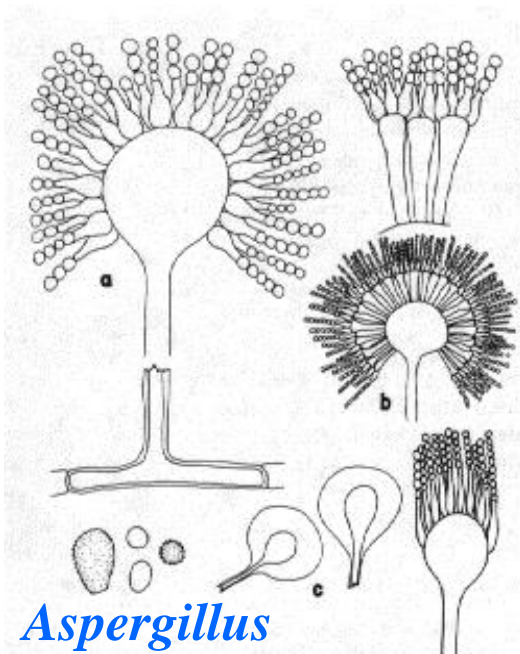


Low



Mycotoxins

Produced by fungi, secondary metabolites



different ecological needs



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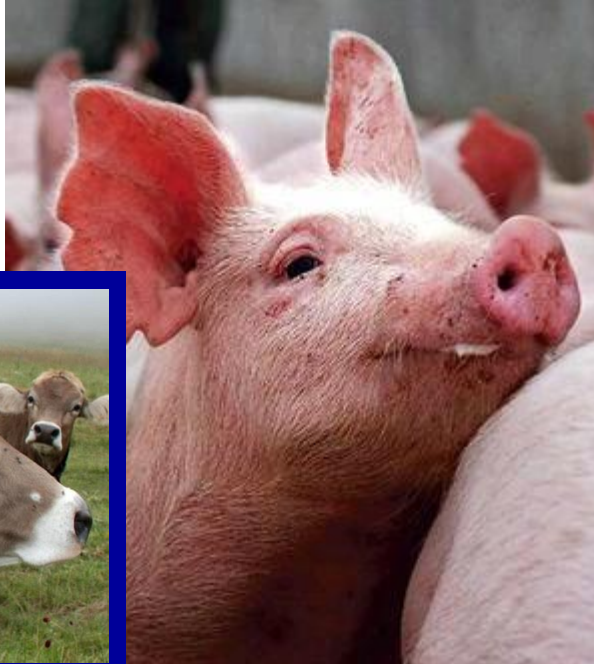
Crops & Food





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Feed & food





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Mycotoxins around the world

Climate

key factor for mycotoxin production

Maize

Fumonisin (subtropical, tropical)

Maize, wheat, grapes, cocoa, coffee

Ochratoxin (moderate, subtropical)

Maize, wheat

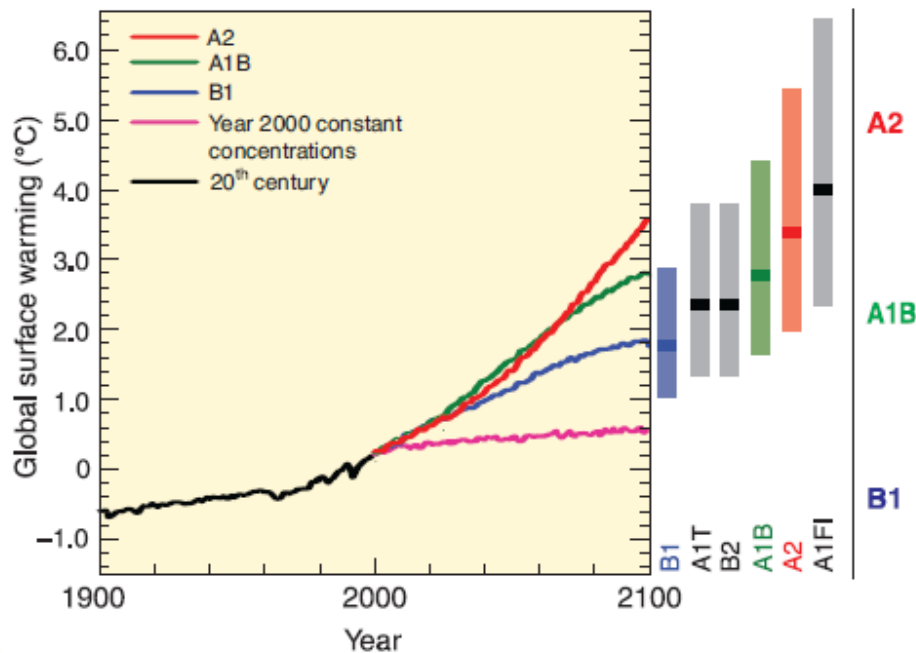
Trichothecenes, Zearalenone (worldwide)



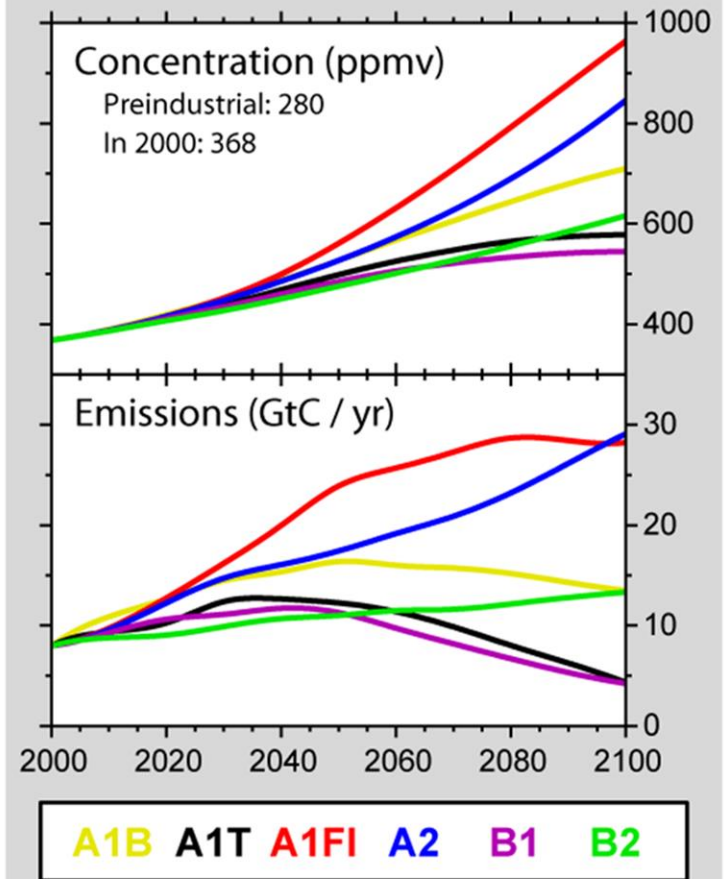
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Climate change scenarios - *CERTANTIES*

- Increase in air **temperature** and **CO₂**,
- different **rain** distribution and intensity



IPCC Emissions Scenarios: Carbon Dioxide

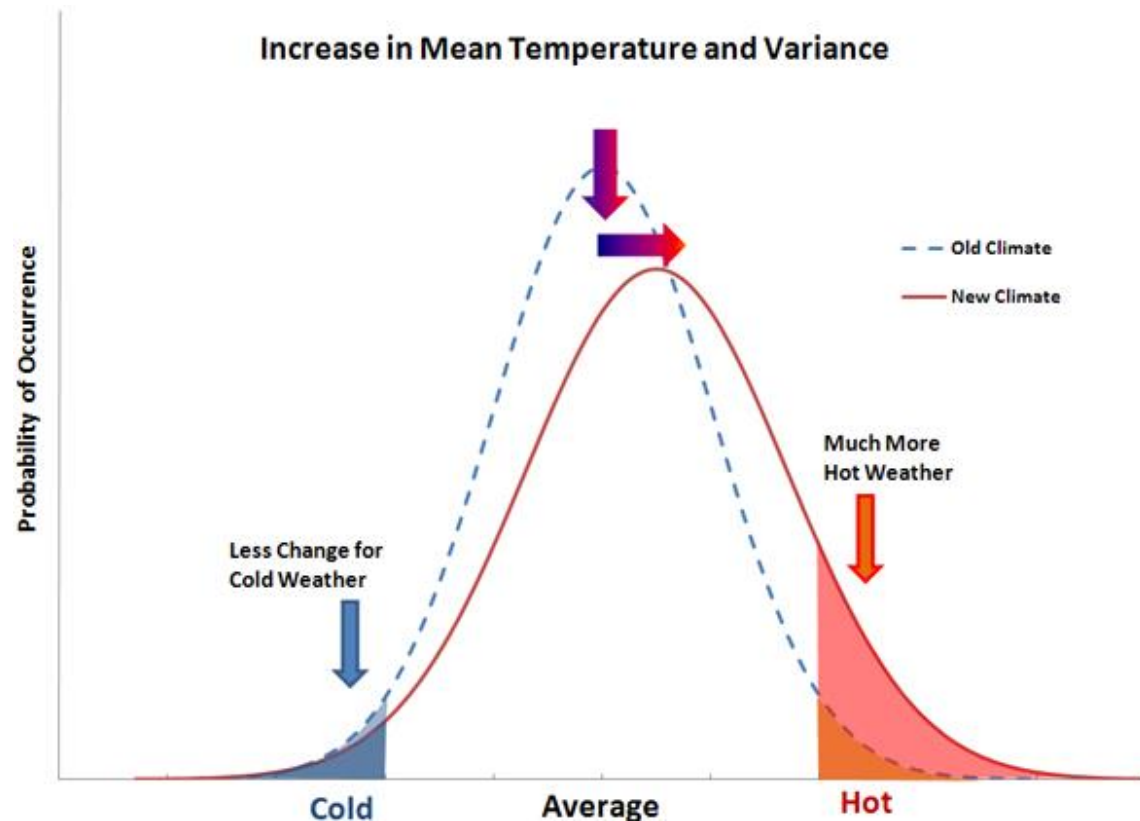


<http://www.globalwarmingart.com/>



Climate change variability - **UNCERTANTIES**

- Very high temperature
- Exceptional amount of rain



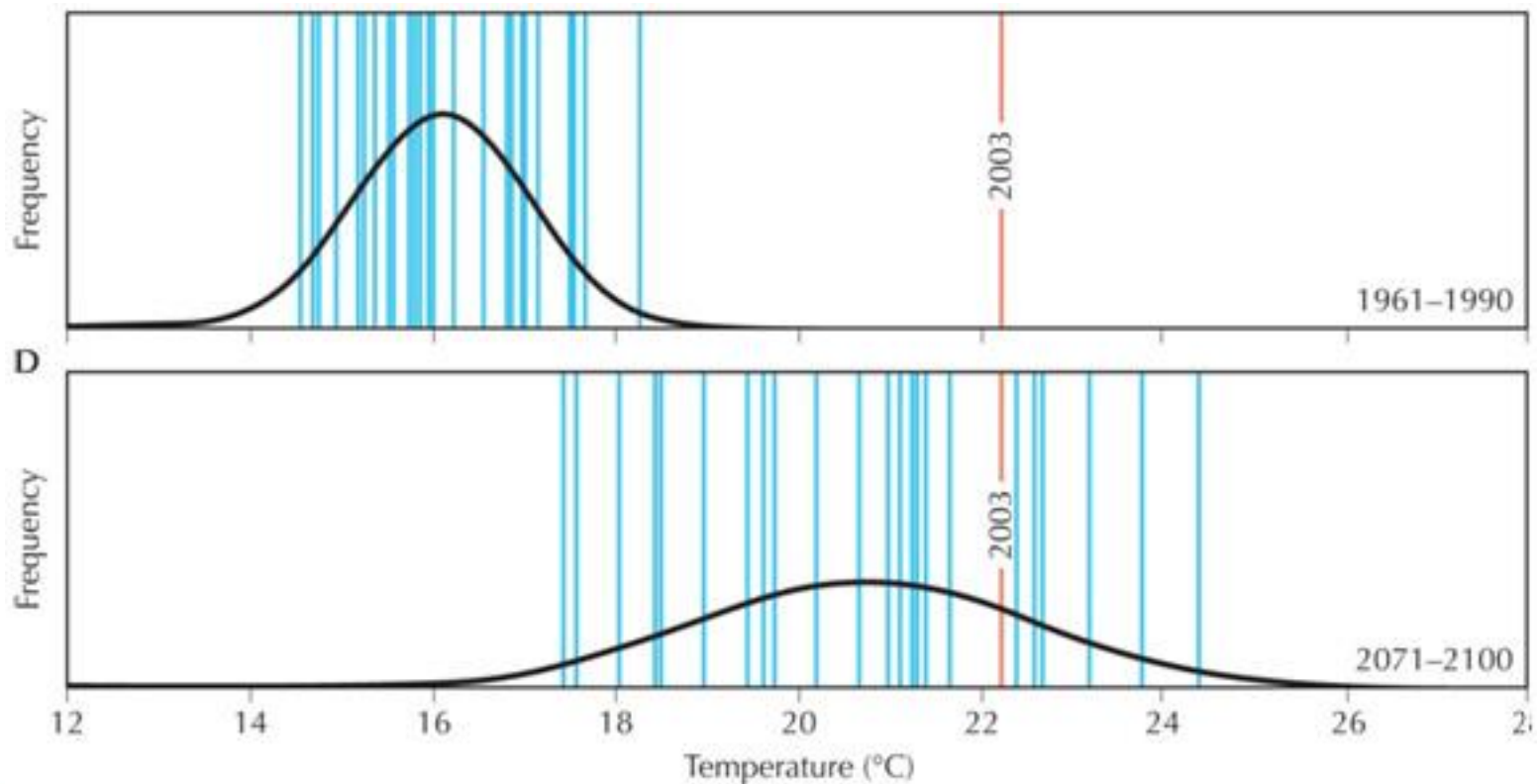
Extreme events: change in their frequency
Change in climate variability



Effect of CC: aflatoxin in maize

Aflatoxin outbreak in Italy in 2003, first alert in Europe

*Emerging issues in Southern Europe: aflatoxins in Italy
(Piva et al. 2006, The Mycotoxin Factbook)*





Aflatoxin in Europe

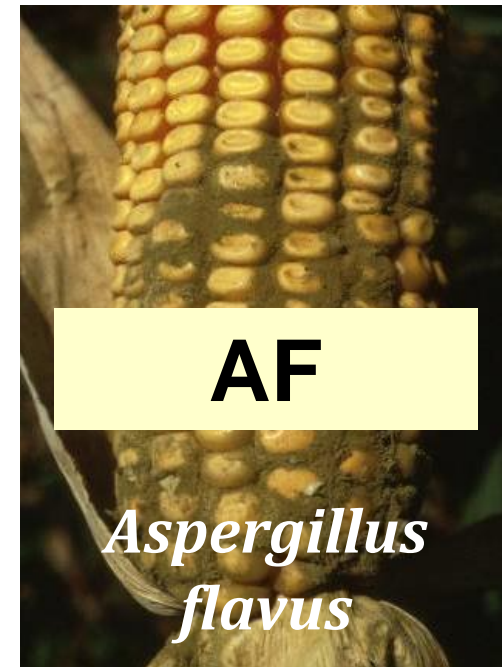
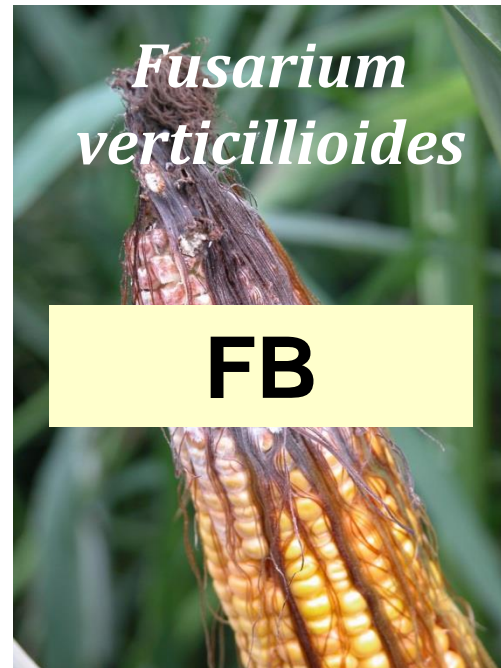
- **2003** outbreak of AFs contamination in Italy (Battilani *et al.*, 2008a; Piva *et al.*, 2006)
- **2012** severe alerts launched in several European countries (Dobolyi *et al.*, 2013; Levic *et al.*, 2013)
- **10 notifications** reported in the EC RASFF (Rapid Alert System for Food and Feed) from **autumn 2012 to March 2013** versus **9 cases 2001- 2011**
- **2015** high incidence of contaminated samples
- **2016** milk contaminated above the legal limit, related problems in cheese (several articles in newspapers)

The **increased risk** of aflatoxin contamination for maize in recent years is **associated with modified meteorological conditions**, with persistent dry conditions and increases in ambient temperature (Blaney *et al.*, 2008)



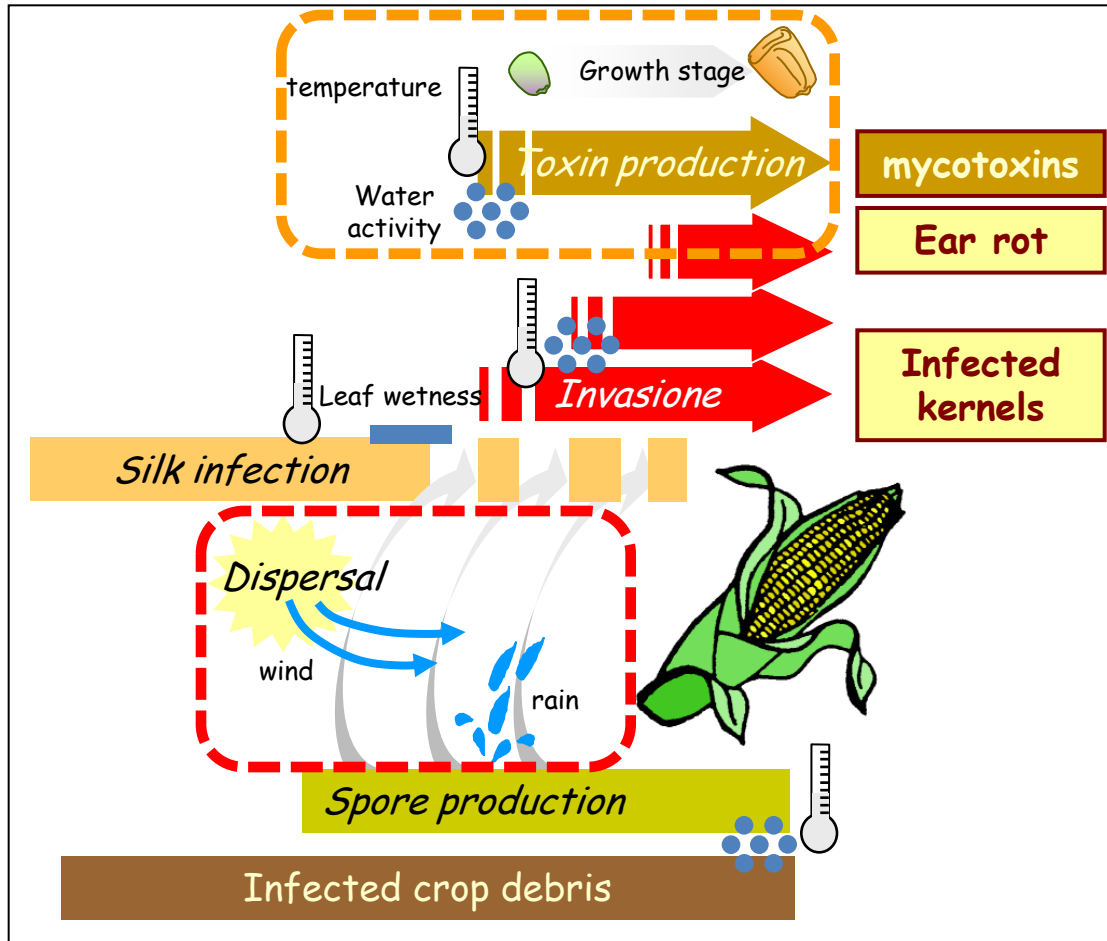
Mycotoxin producing fungi - maize

- Maize is frequently mentioned as host crop for different mycotoxin producing fungi

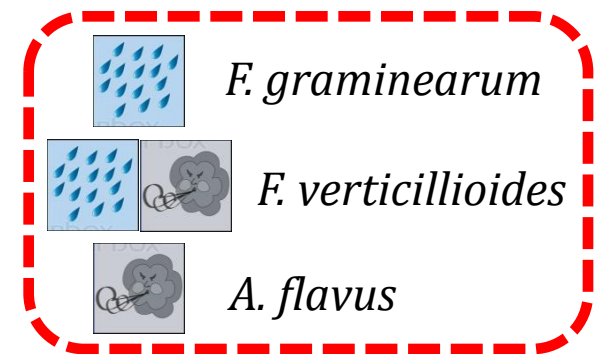




Mycotoxin producing fungi - maize



	Topt	RH/a _w min
DON	26°	0.93
ZEA	28°	0.90
FBs	30°	0.91
AFs	30°	0.78





Effect of CC: differences between years



Findings of aflatoxins in maize in 2012-2013

* Several RASFF notifications on high levels of aflatoxin in maize intended for feed originating mainly from South (- East) Europe

* High levels of aflatoxins in maize due to extreme weather conditions in maize growing season 2012 in certain part of Europe.

Hot Topic of the month



Fusarium toxins challenge corn (maize) harvest 2014

Table 1: Occurrence of ZEN and DON in European corn samples, 2014 harvest

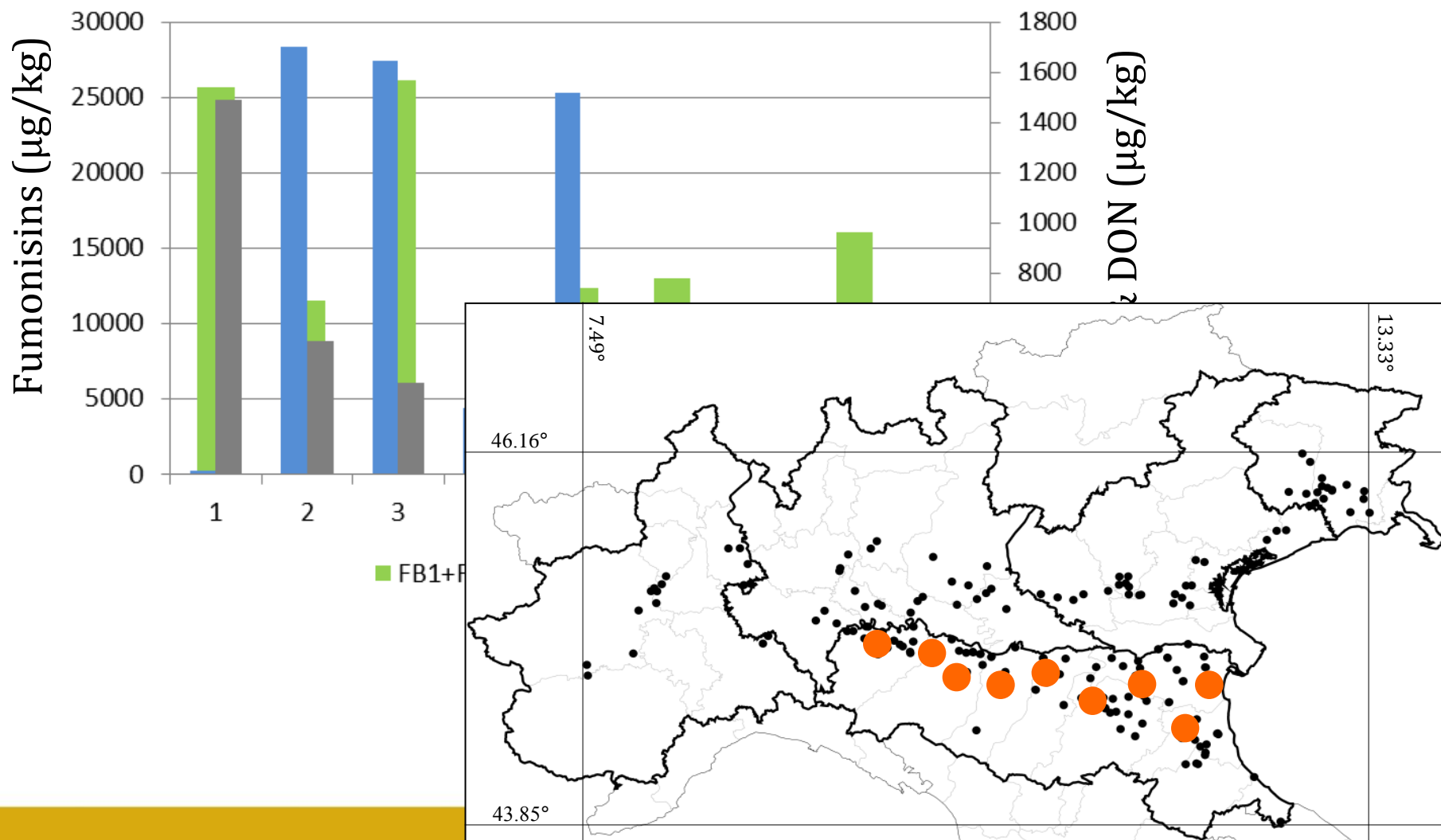
	ZEN	DON
Number of samples tested	132	223
Positive (%)	80	92
Average of positive (µg/kg)	497	3,221
Maximum (µg/kg)	2,064	11,320



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Effect of CC: differences during years

2014





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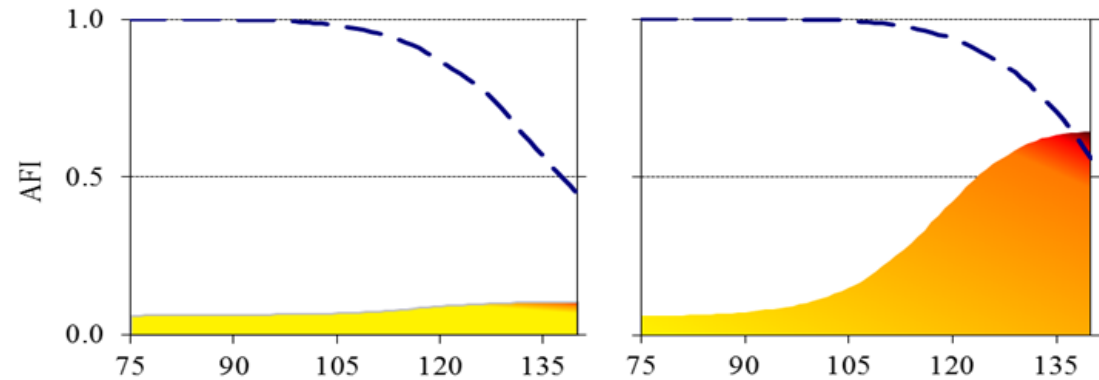
Predictive modelling – AFLAmaize

Weather data

Sporulation
Dispersal
Germination
Infection
Fungal growth
Toxin production

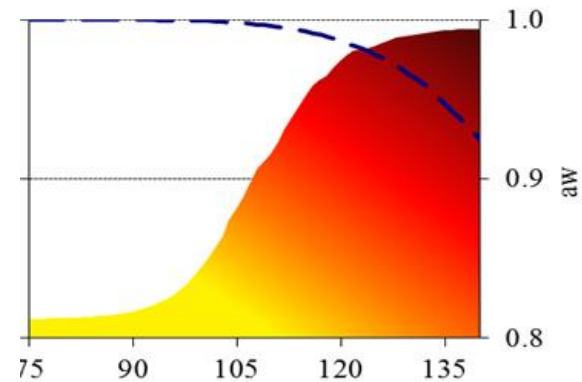
Fungi
infection
cycle

PREDICTIONS



Low risk

Medium risk



High risk



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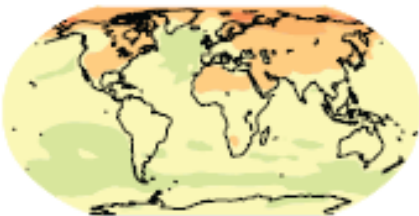


European Food Safety Authority

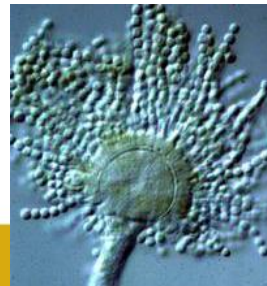
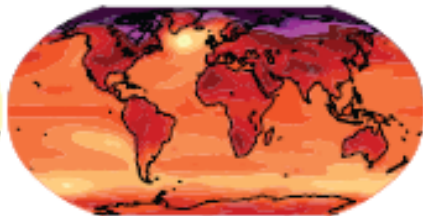
Modelling, predicting and **m**apping the (re)emergence of **a**flatoxins in cereals in the EU due to climate change

MODMAP- AFLA

2020 - 2029



2090 - 2099





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Predicted meteorological data

- **Europe** as geographic base
- Scale: 50x50 km (**2248** points)



- Data on: **temperature, relative humidity, rain, solar radiation**

- **100 years** data generated, 3 scenarios:

➤ **actual**

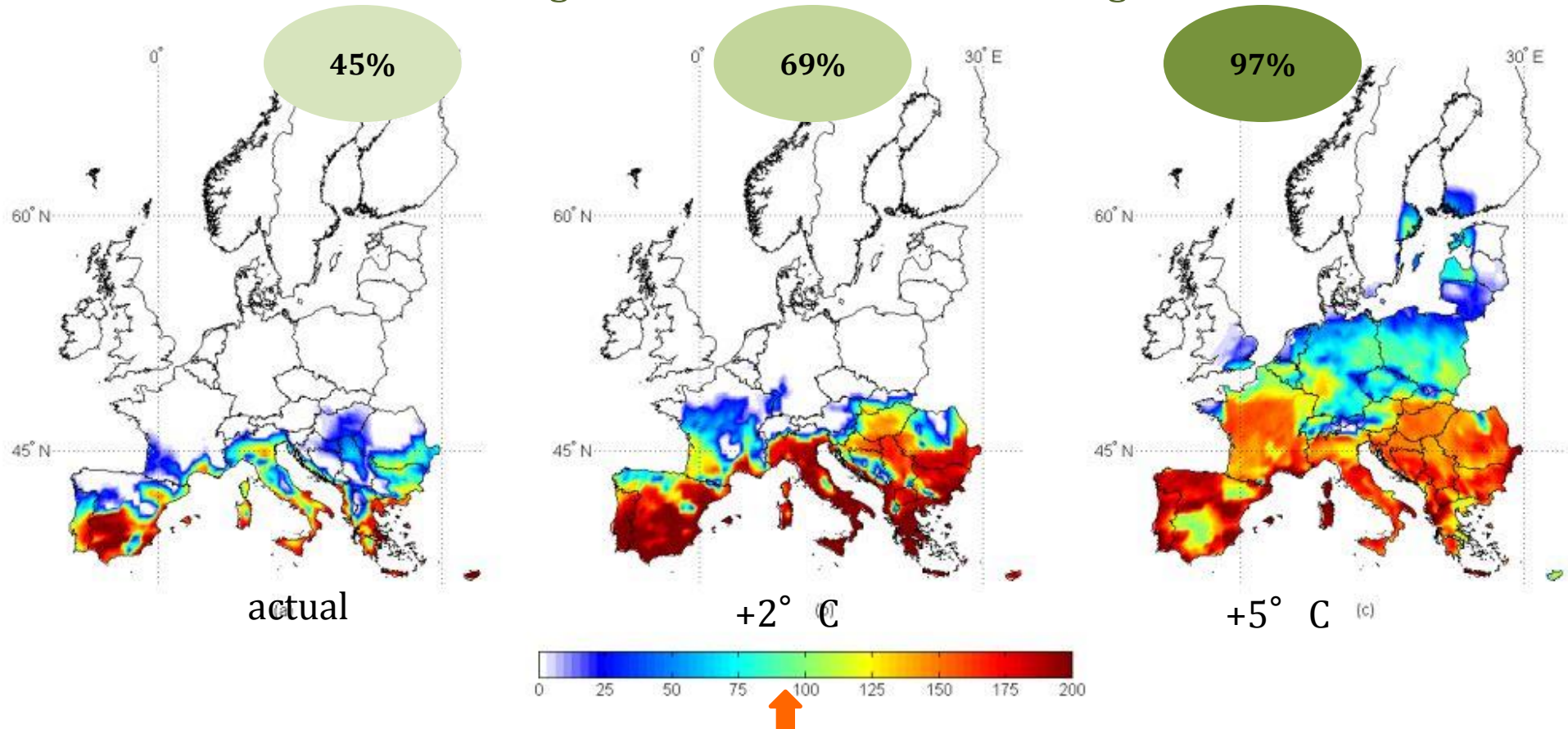
➤ **+2° C (B1)**

➤ **+5° C (A2)**



AF in maize, future scenario – risk maps

Increasing suitable condition for maize growth

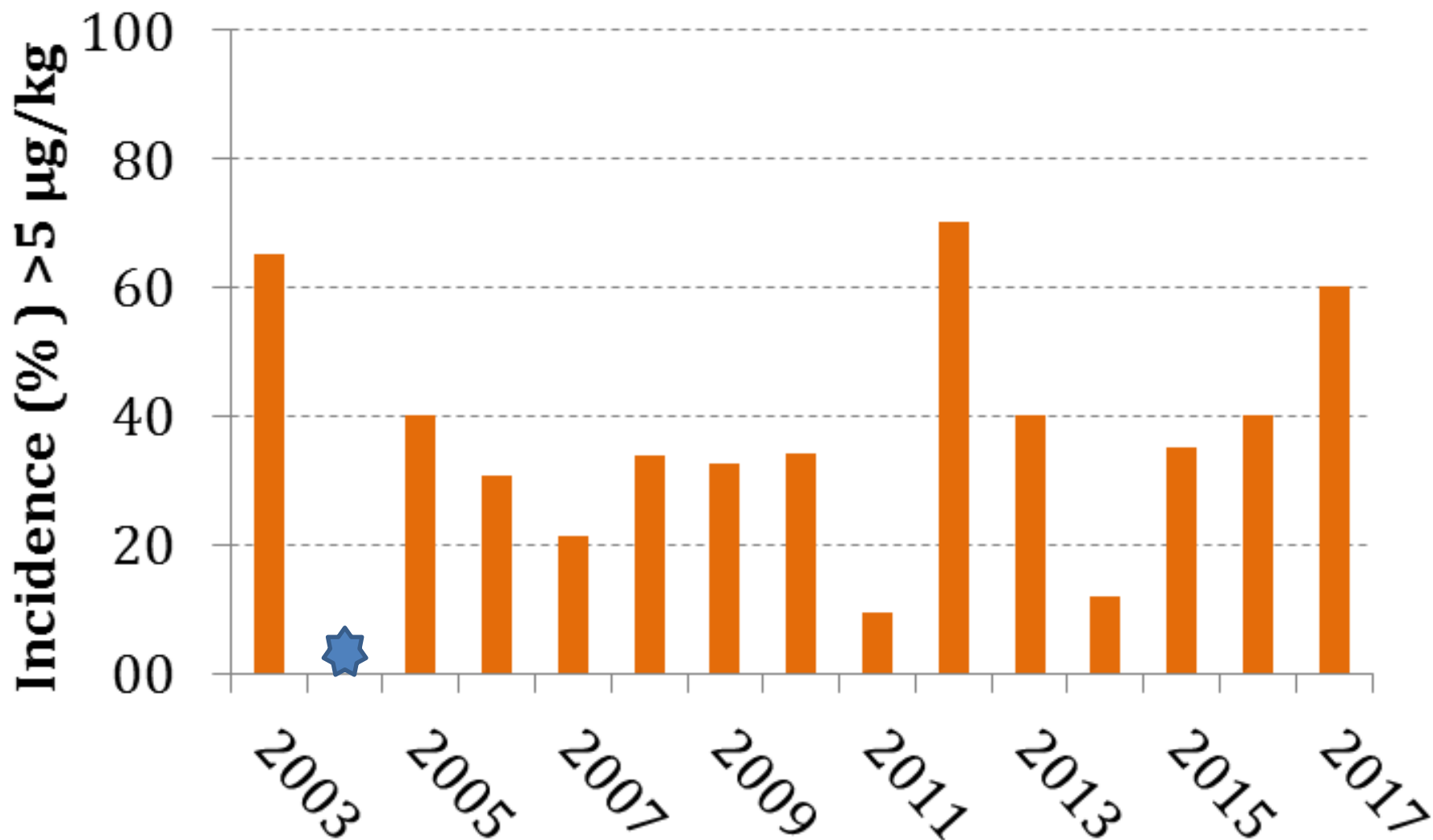


➤ the risk of ABs contamination increases significantly, mainly in +2° C scenario



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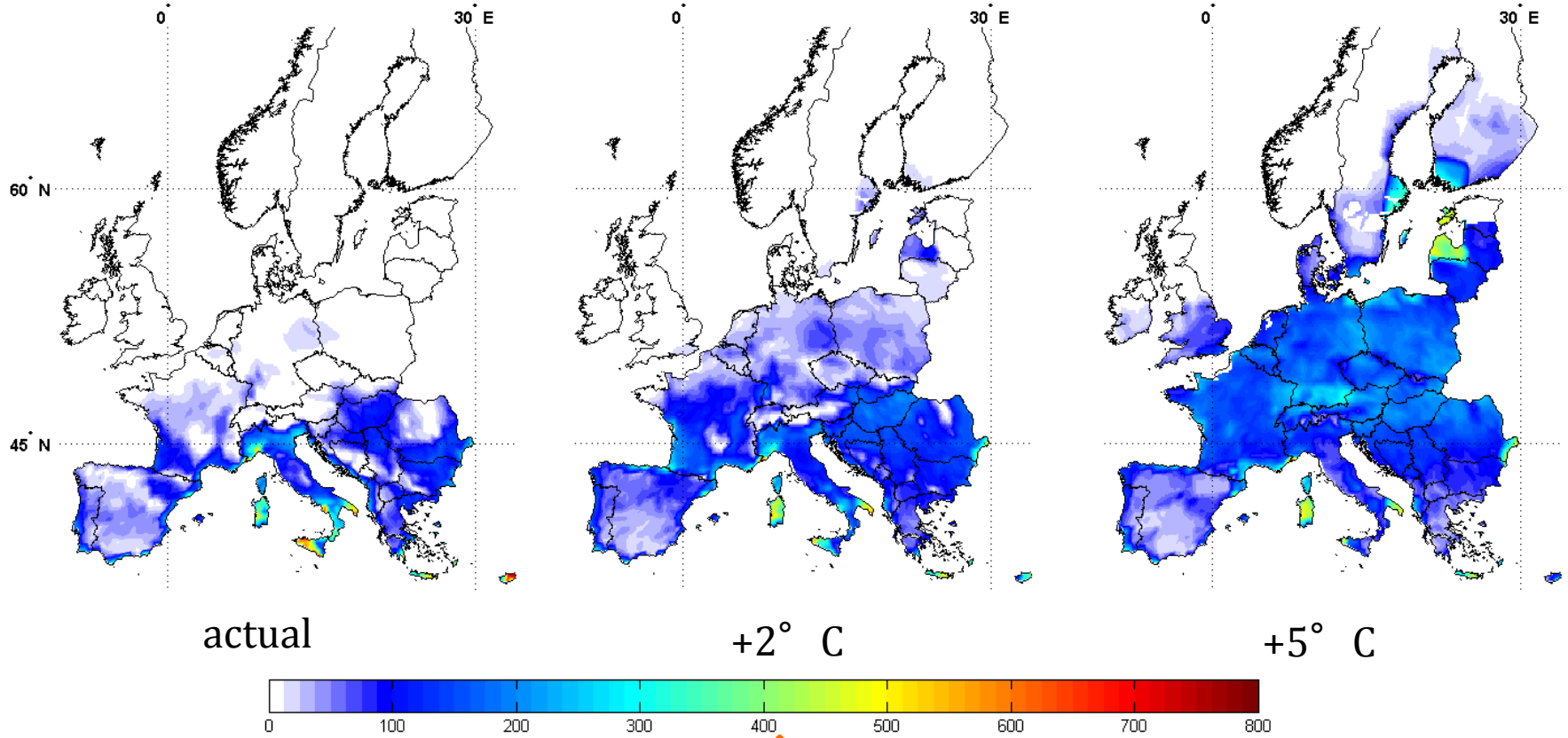
Aflatoxin in maize in Italy (ER) from 2003



 No data



FB in maize, future scenario – risk maps



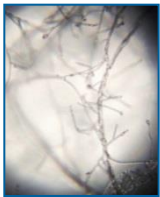
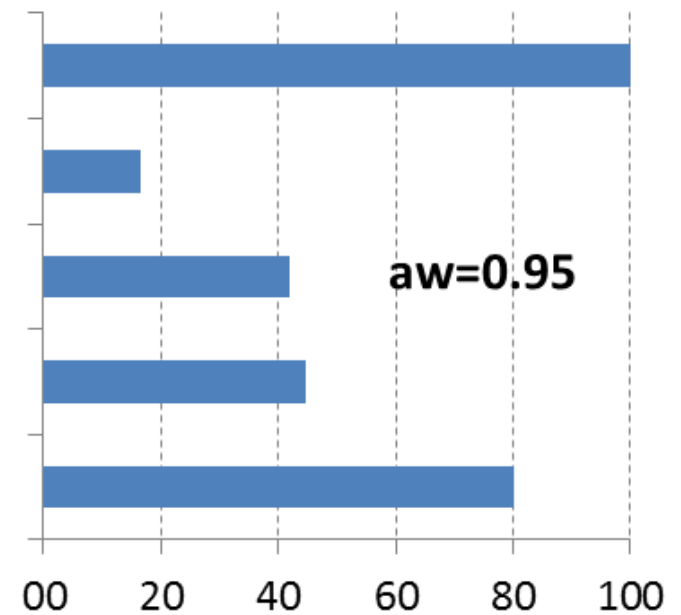
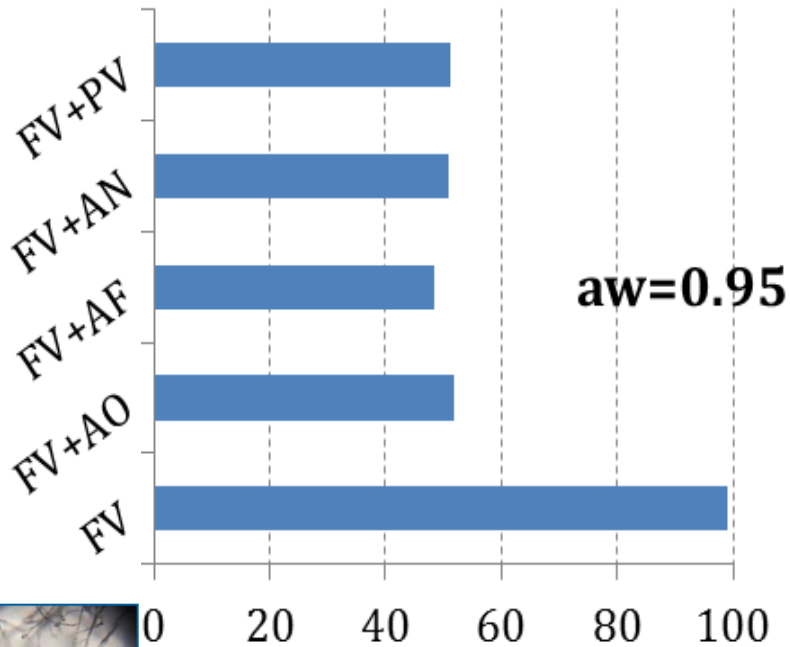
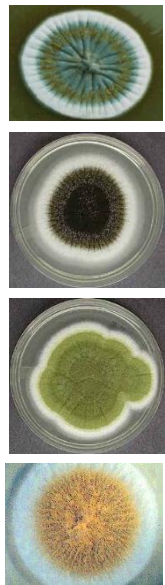
➤ the risk of FBs contamination is very similar in different CC scenarios



Fungal co-occurrence

Growth rate

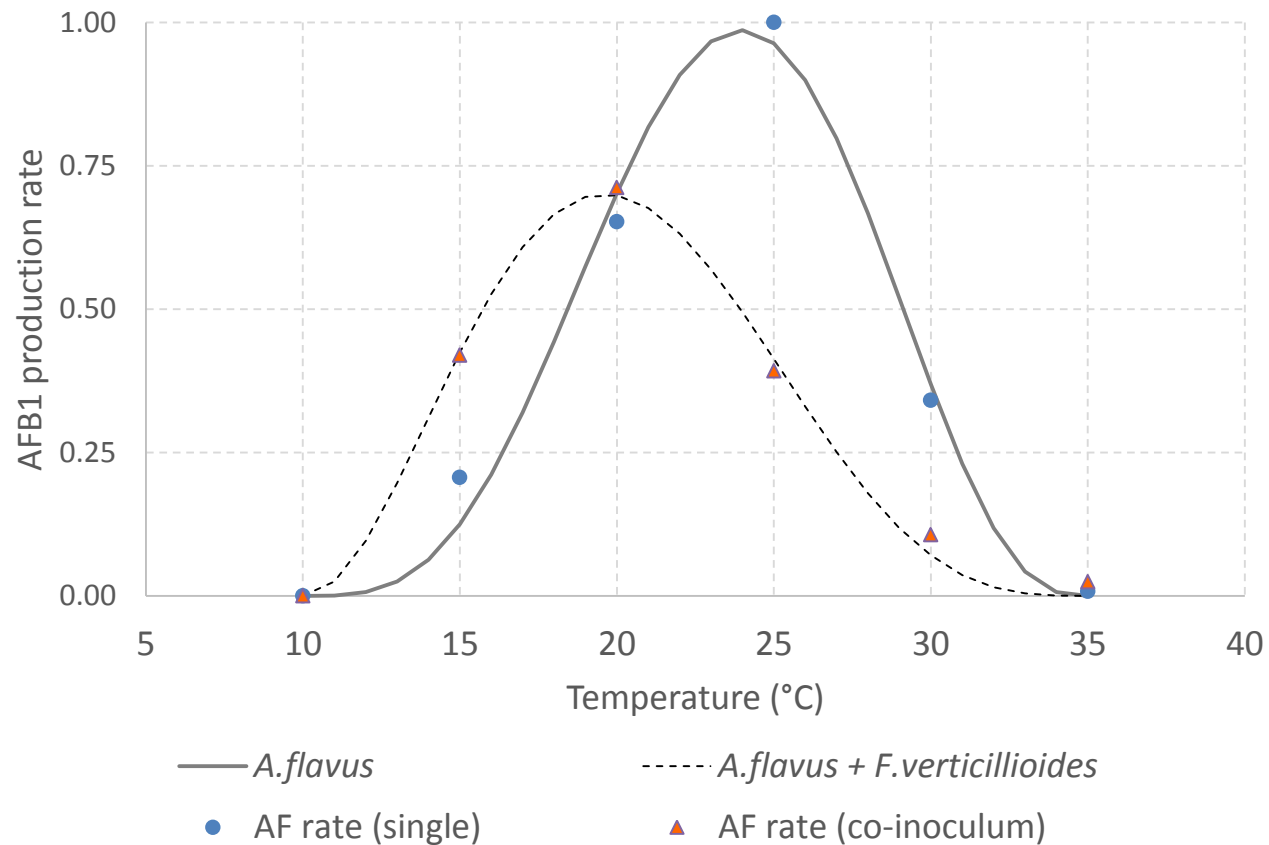
Fumonisin rate



Mycotoxins co-occurrence

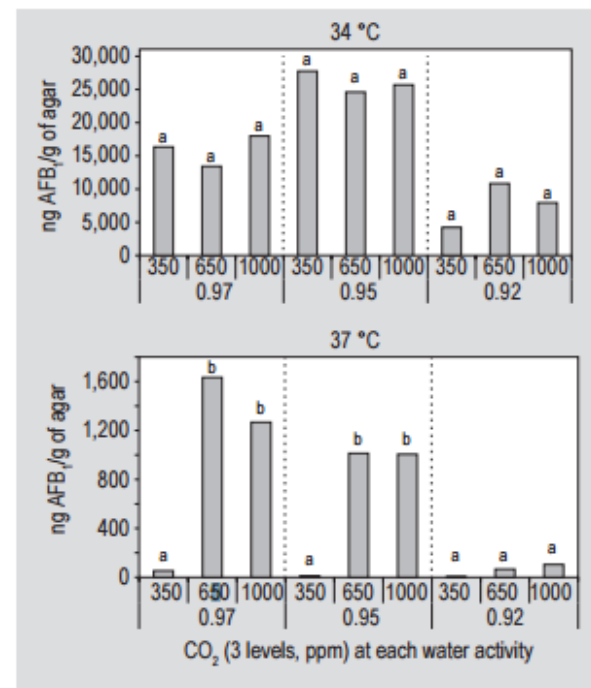
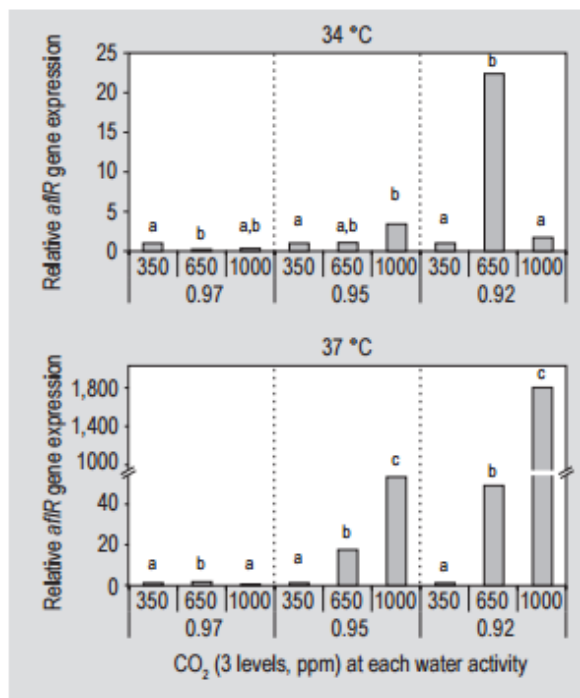
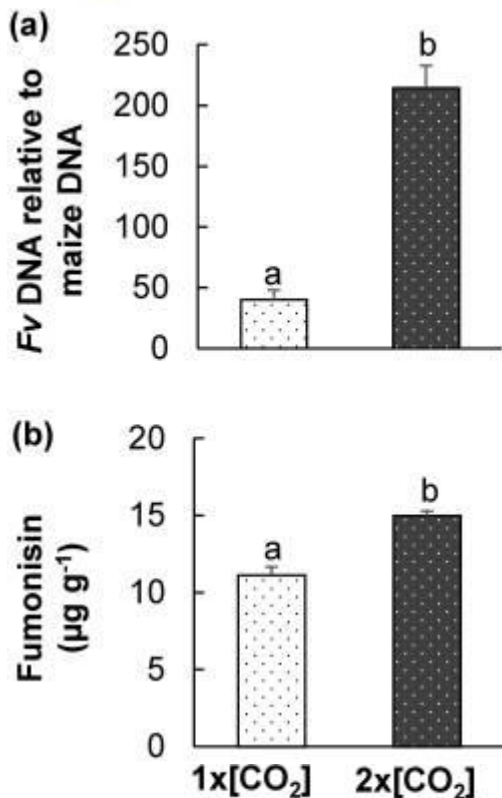


Aflatoxin production - Fungal co-occurrence





Role of CO₂ Gene expression



High [CO₂] and drought
enhanced **maize**
susceptibility to
F. verticillioides

High [CO₂] and high T influenced *A. flavus* gene expression and aflatoxin production



Take home messages

- **Mycotoxins** cause main **concern for food safety**
- **Climate change** is crucial for mycotoxin prevalence, **the effect is uncertain**
Most relevant mycotoxin, co-occurrence???
- **Resilience** and **value chain approach** requested to mitigate CC impact on food safety



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Thanks for your attention



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