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Climate change and Citrus Pests

Darren KRITICOS & Anna SZYNISZEWSKA

IOBC Nafplion, Greece, 6 April 2022

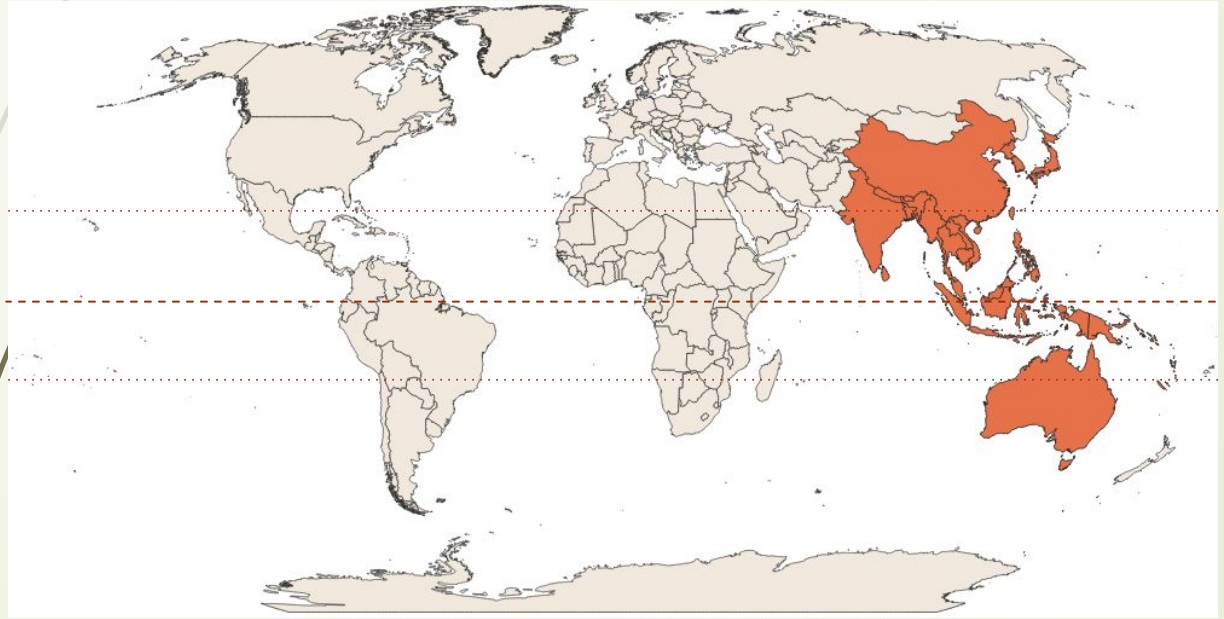
Outline

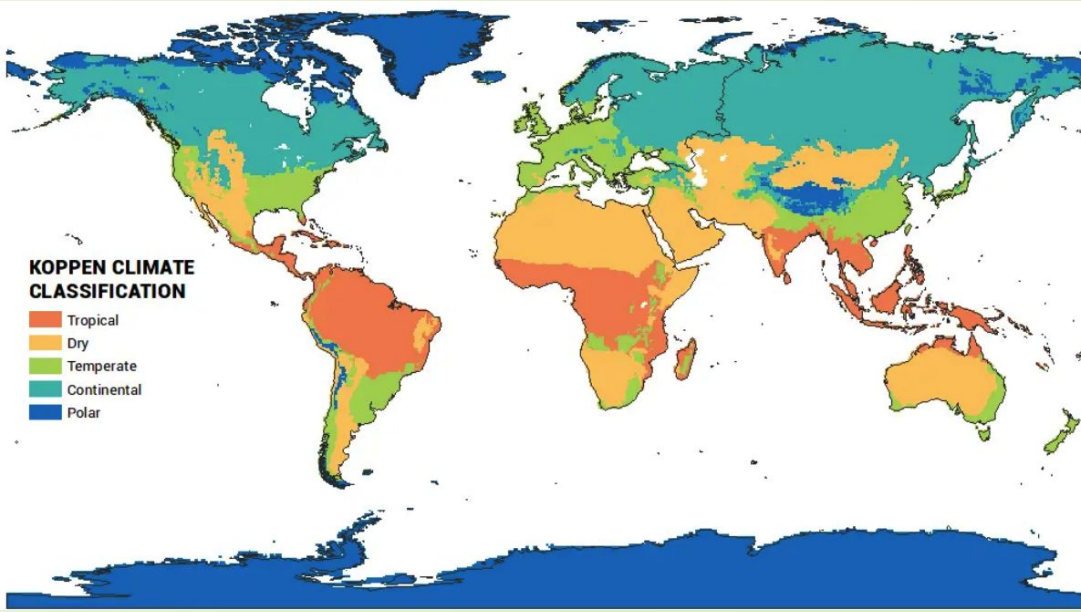
- Citrus climates
- Species responses to climate
- Historical impacts
- Projected climate changes
- Projected climate change impacts
- Biological control
- Adapting under uncertainty

Citrus climates

Citrus

- Native to South Asia, East Asia, Southeast Asia, Melanesia, and Australia.

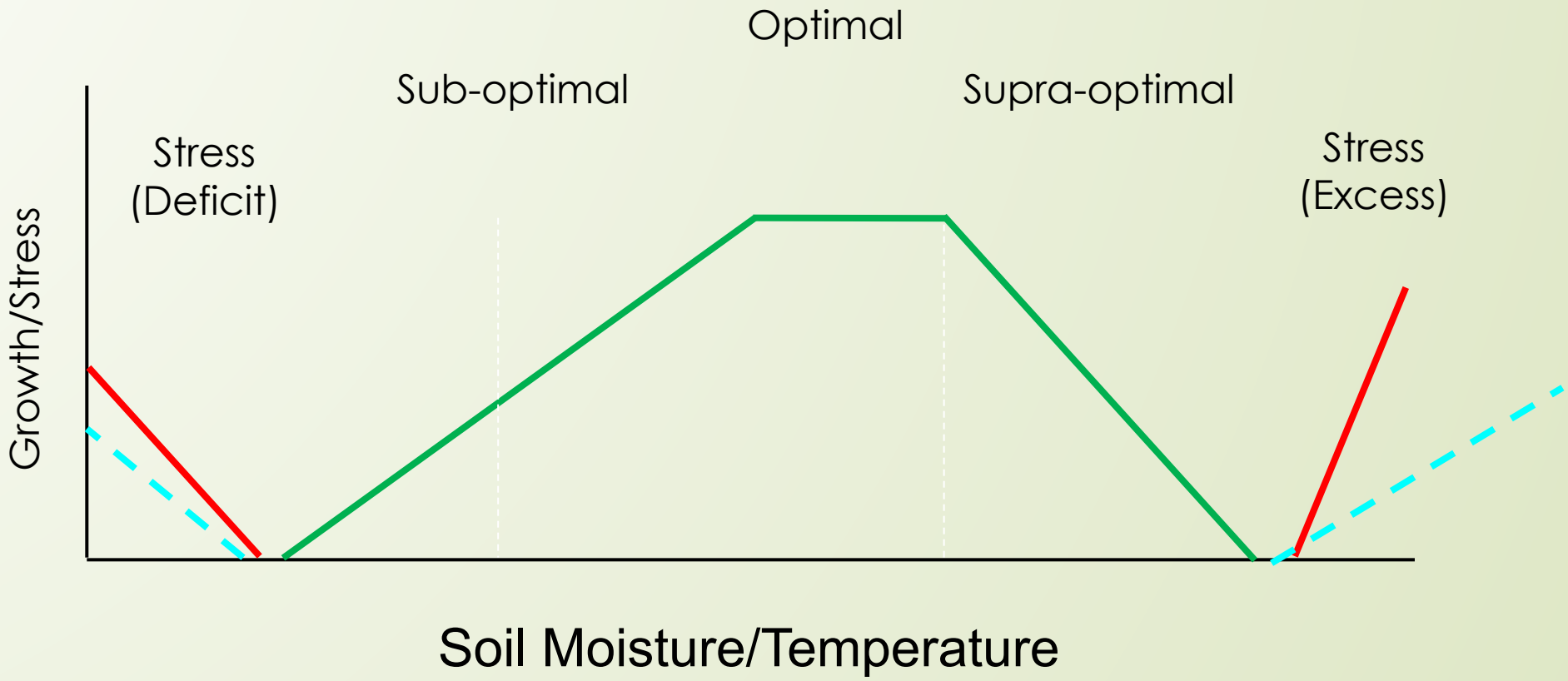




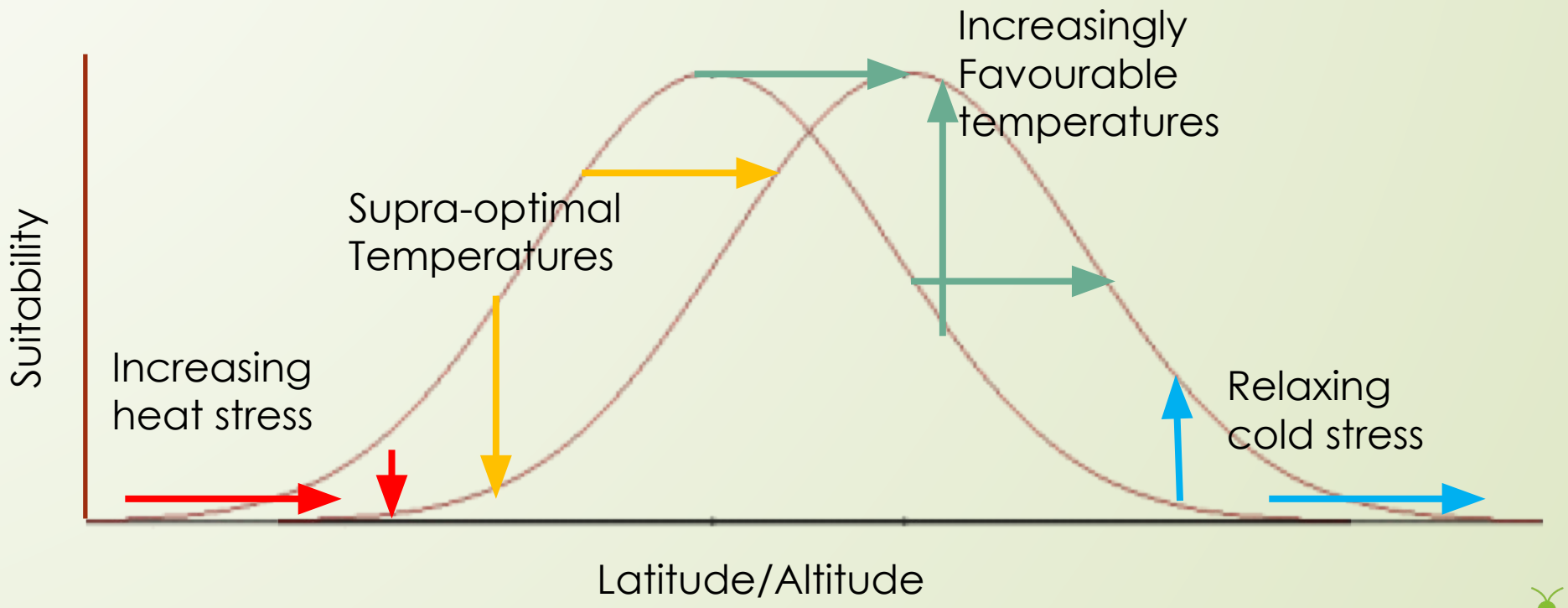
https://earthhow.com

Species responses to climate

Species abundance and climate



Changes in climate suitability



Historical Impacts of climate on citrus pests

Ceratitis capitata

Photo: Alvesgaspar

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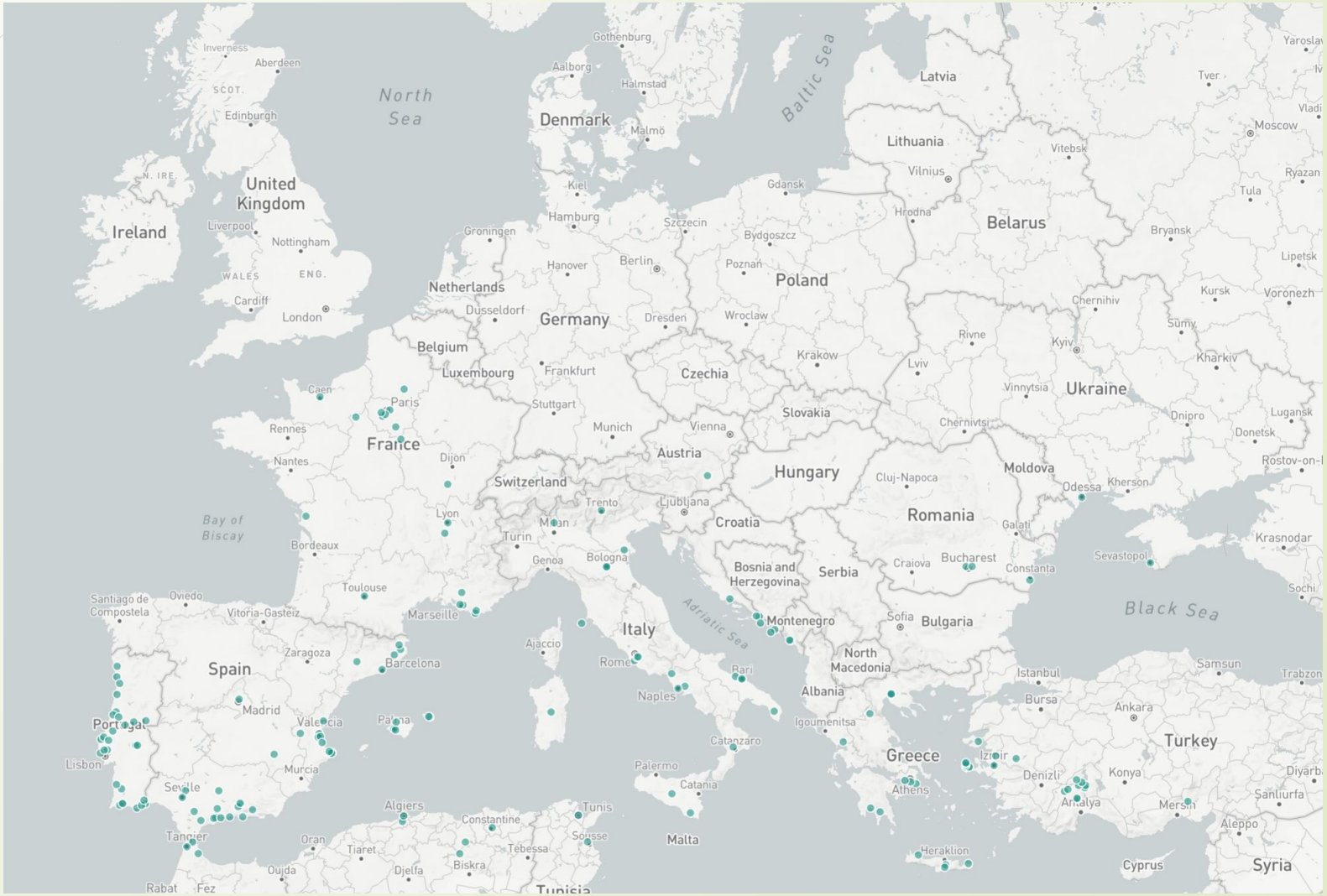
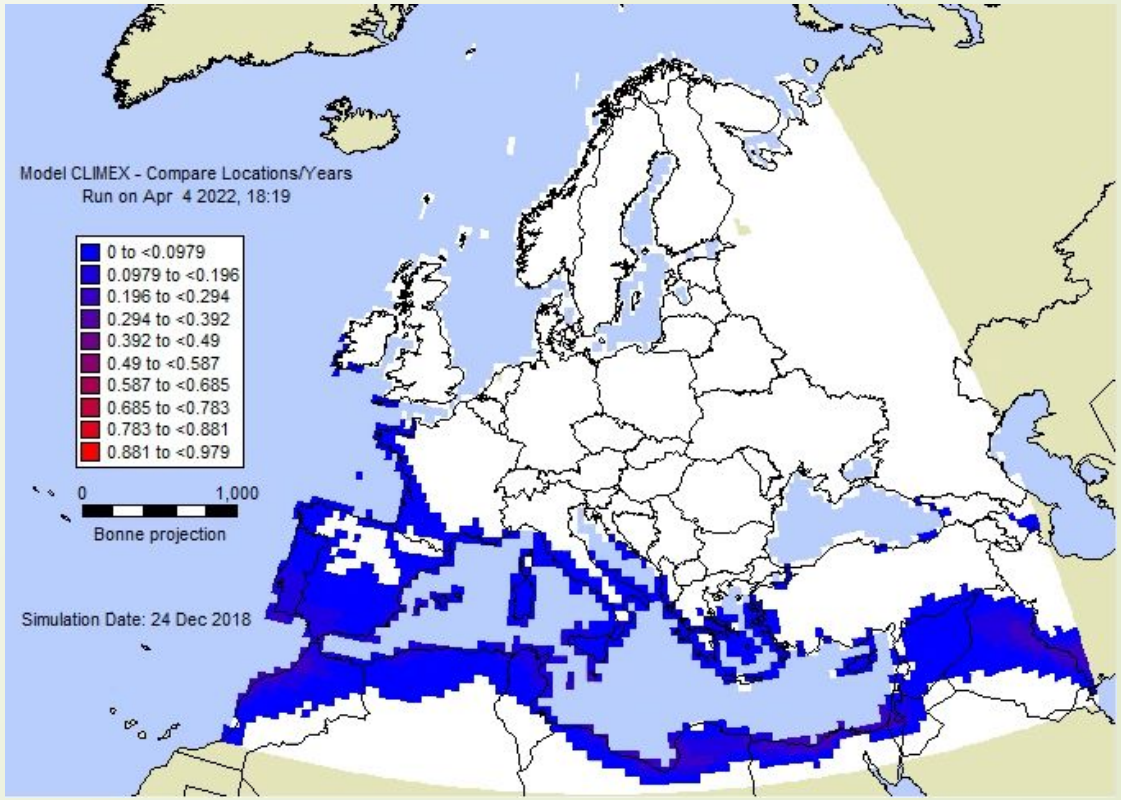
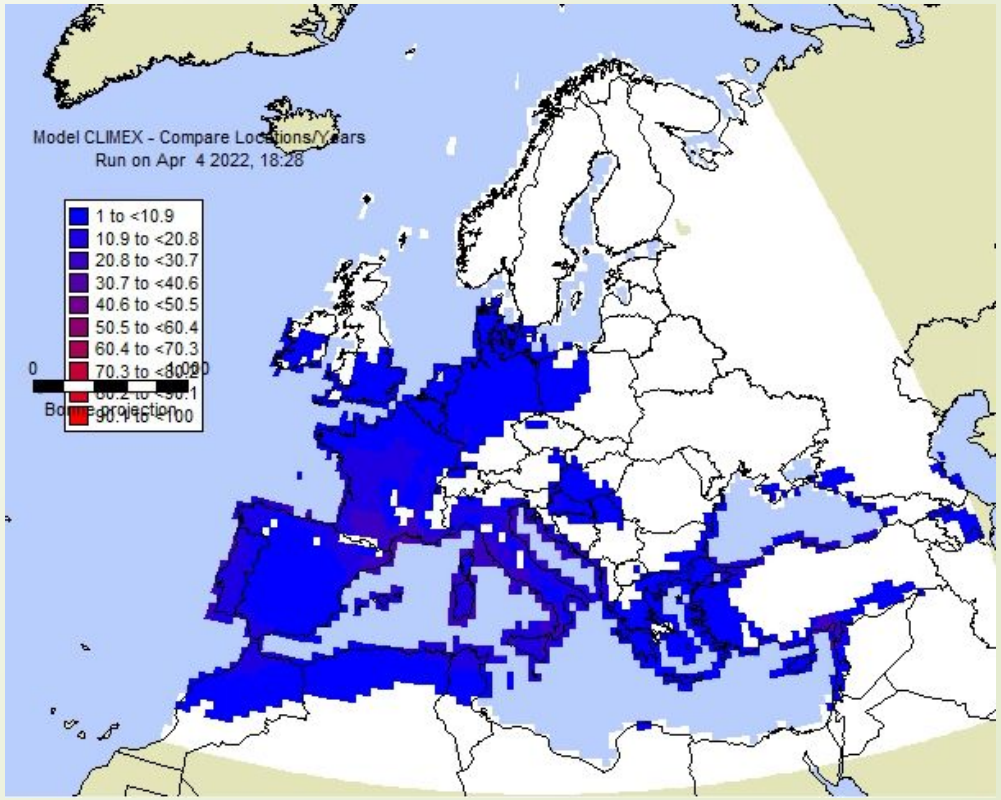
Medfly occurrence data



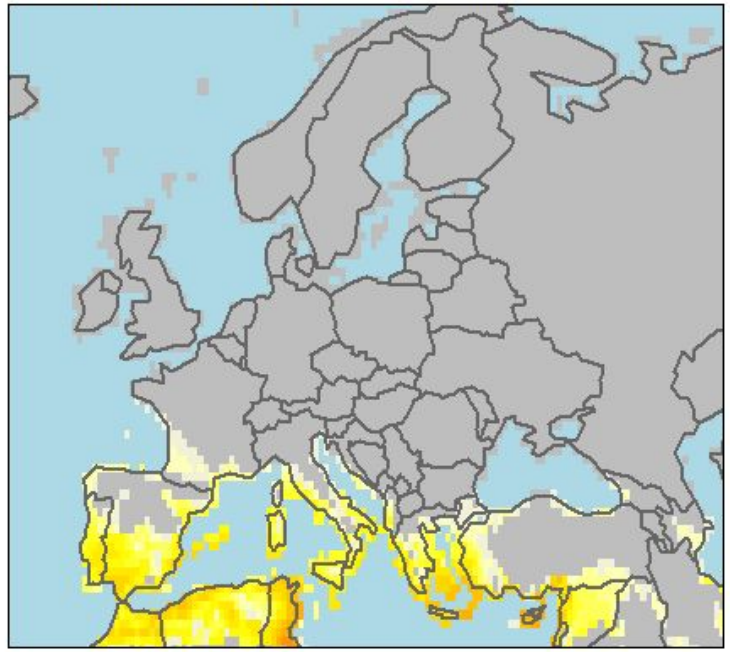
Seasonal patterns of suitability



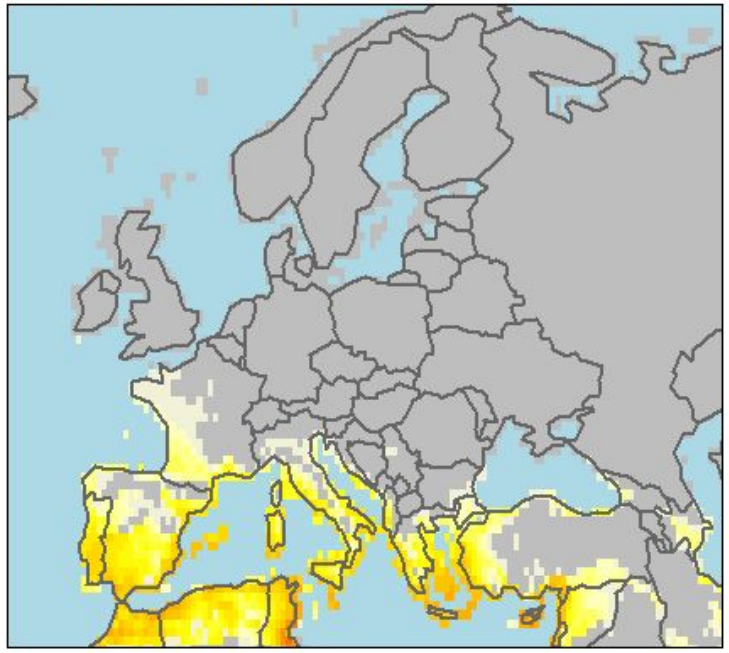
Interannual variation in suitability for persistence

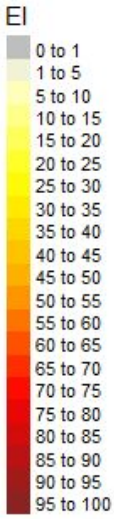


EI - mean values - 1970-1979

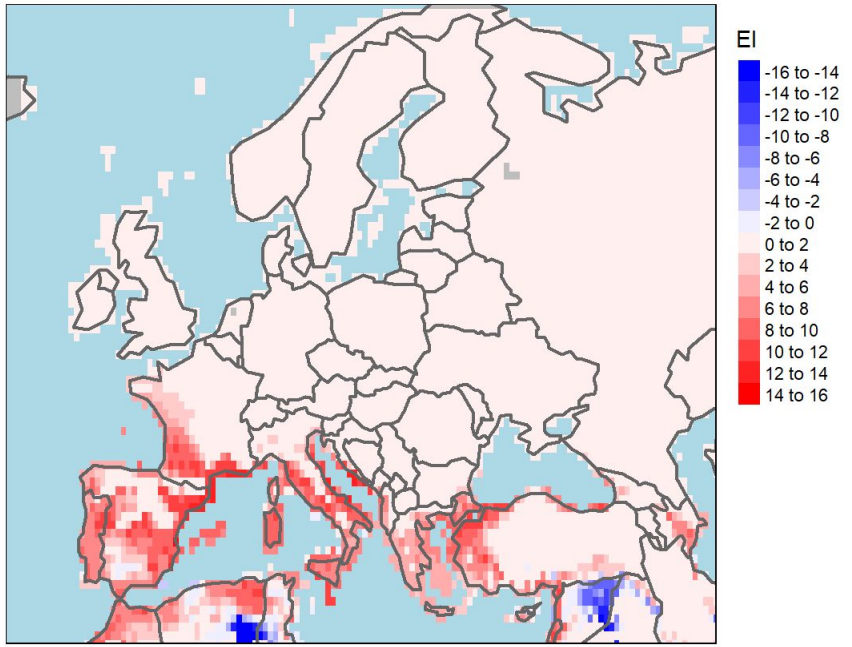


EI - mean values - 2010-2019

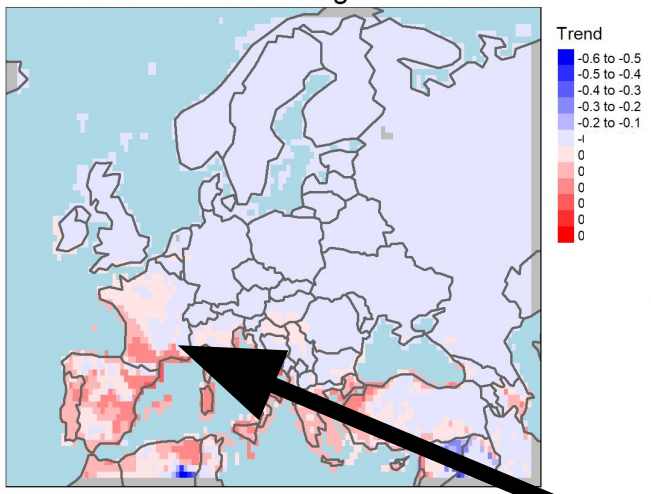




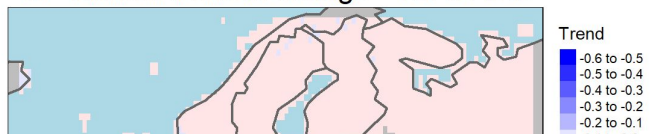
EI - diff: first and last decade - 1970-2019



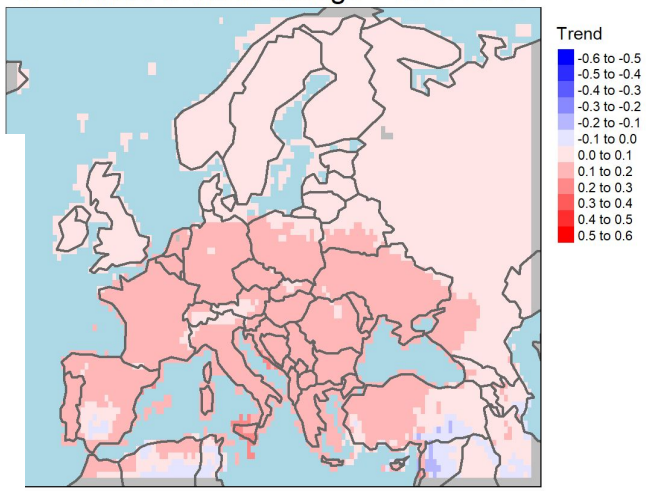
EI - Annual trend in change - 1970-2019



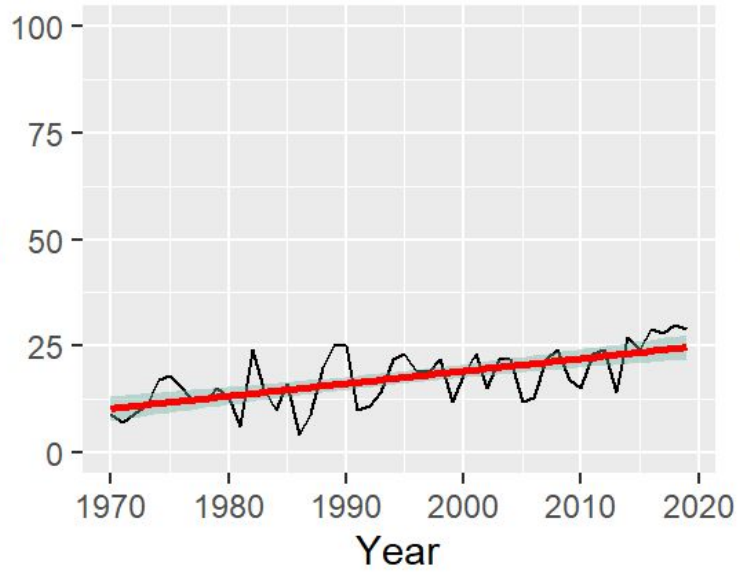
GI - Annual trend in change - 1970-2019



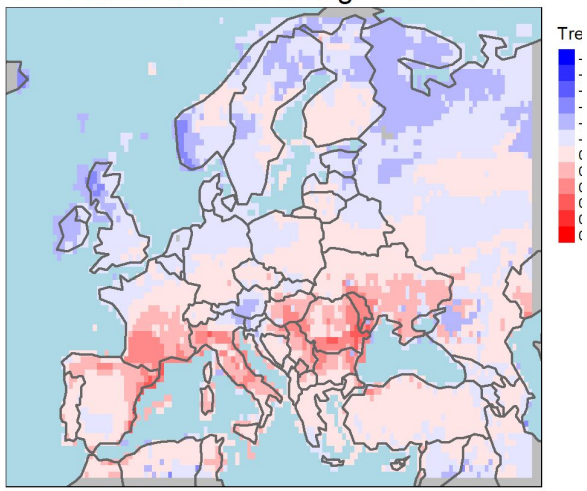
TI - Annual trend in change - 1970-2019

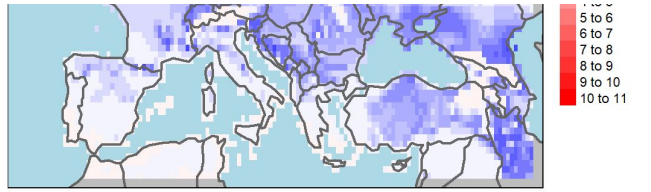


EI - Marseille, FR
Slope: 0.294, p: 0

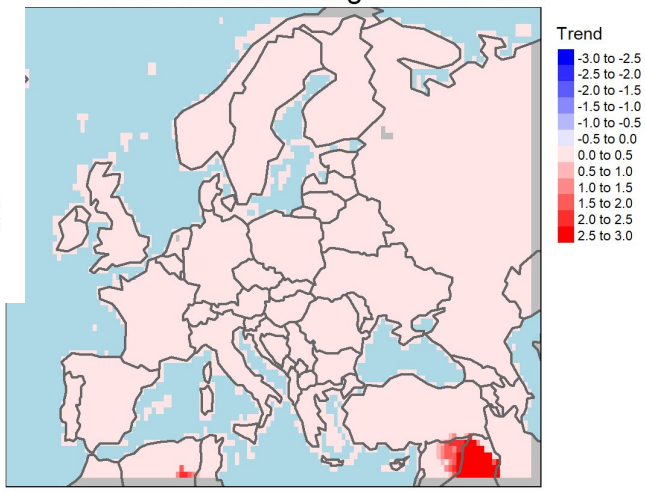


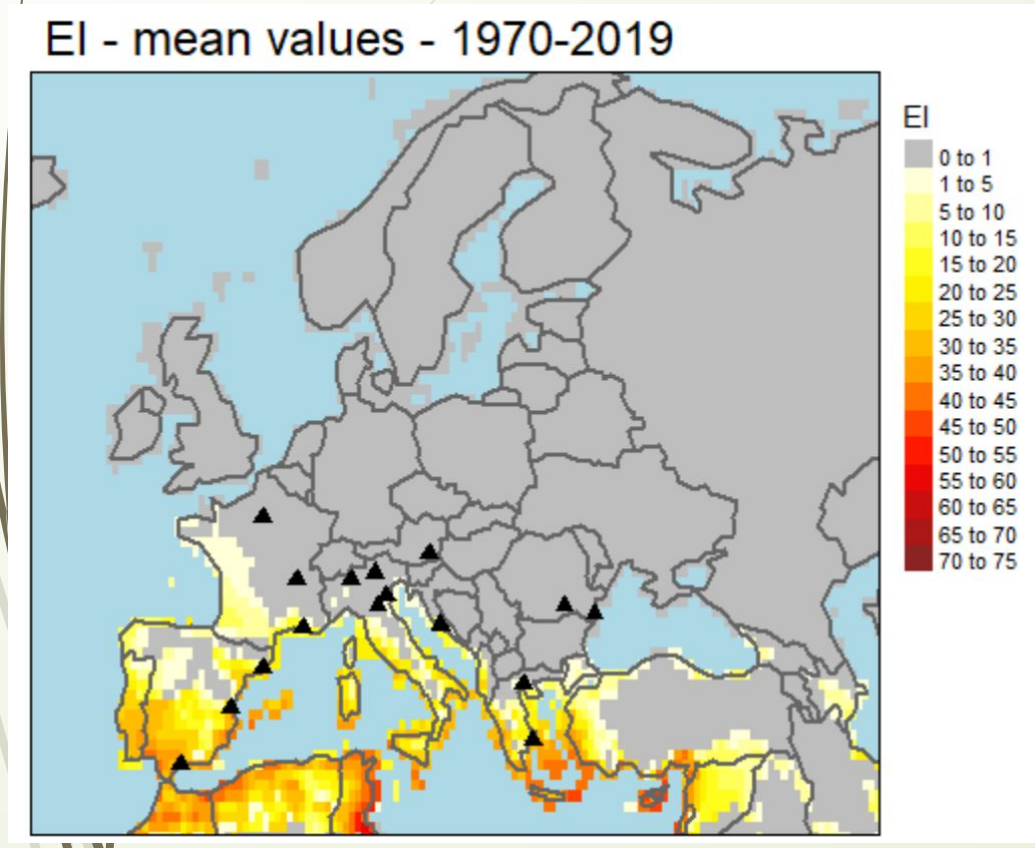
MI - Annual trend in change - 1970-2019

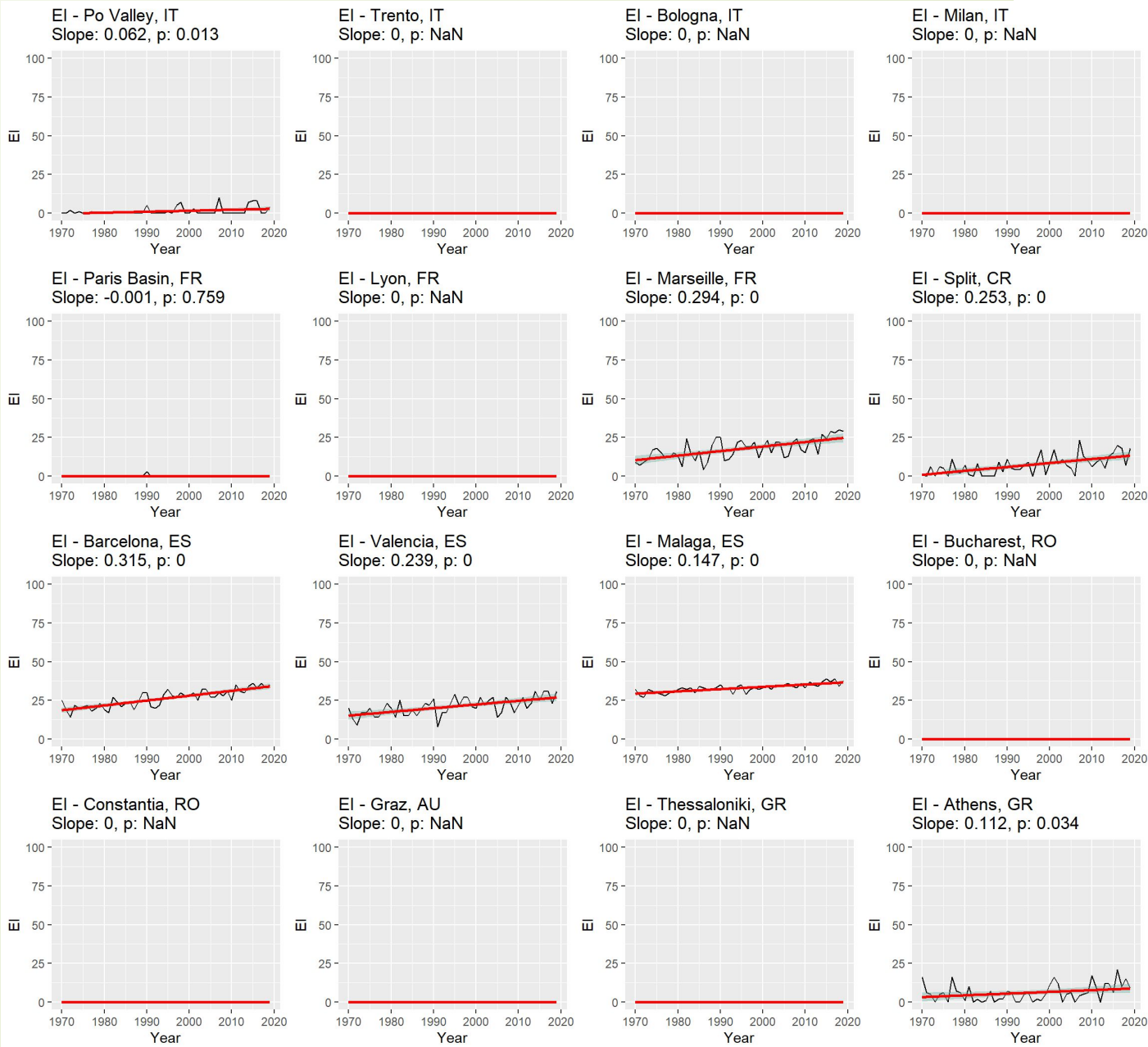




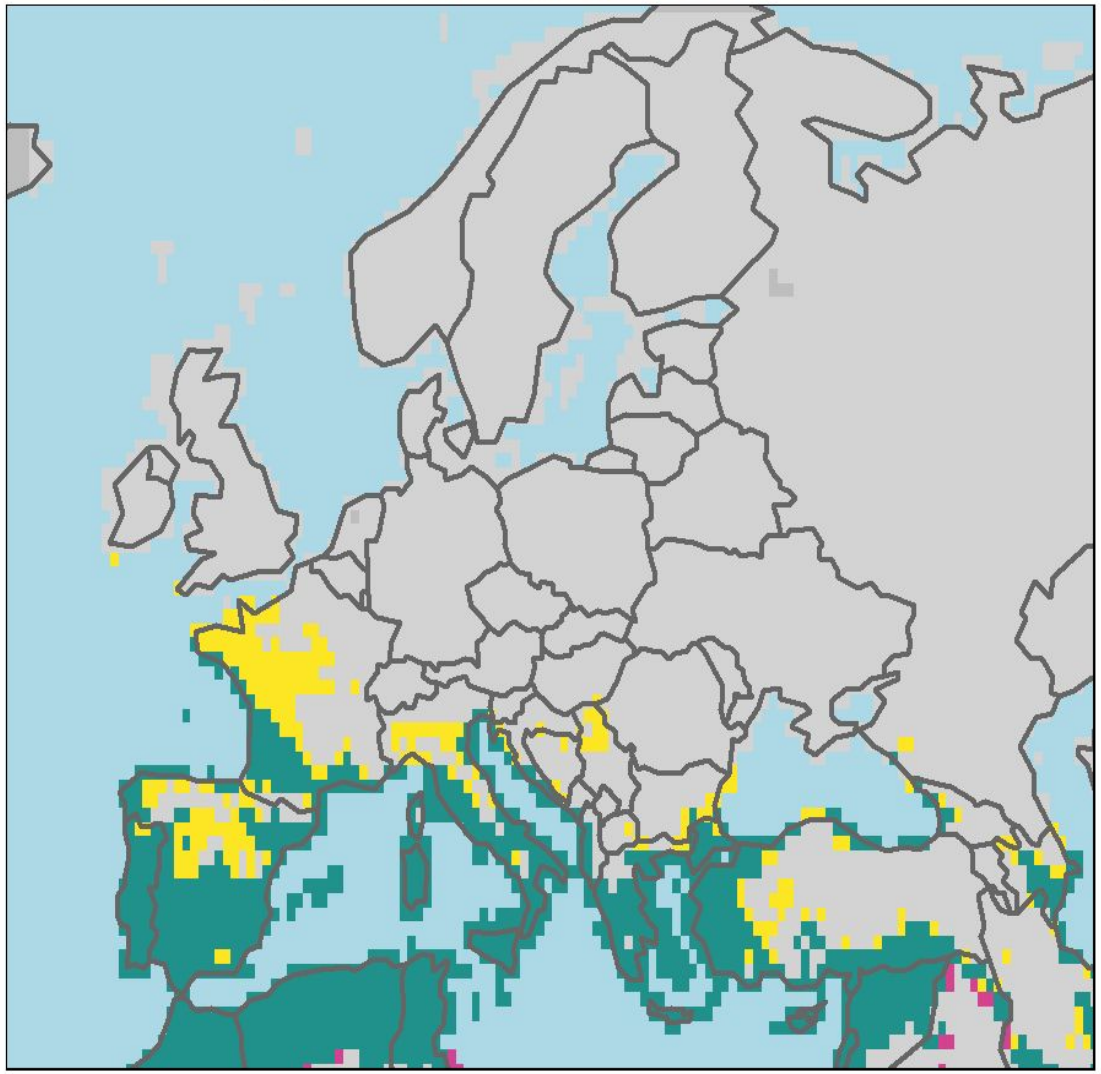
HS - Annual trend in change - 1970-2019




EI - mean values - 1970-2019
EI
0 to 1
1 to 5
5 to 10
10 to 15
15 to 20
20 to 25
25 to 30
30 to 35
35 to 40
40 to 45
45 to 50
50 to 55
55 to 60
60 to 65
65 to 70
70 to 75


EI - Po Valley, IT
Slope: 0.062, p: 0.013
EI - Trento, IT
Slope: 0, p: NaN
EI - Bologna, IT
Slope: 0, p: NaN
EI - Milan, IT
Slope: 0, p: NaN
EI - Paris Basin, FR
Slope: -0.001, p: 0.759
EI - Lyon, FR
Slope: 0, p: NaN
EI - Marseille, FR
Slope: 0.294, p: 0
EI - Split, CR
Slope: 0.253, p: 0
EI - Barcelona, ES
Slope: 0.315, p: 0
EI - Valencia, ES
Slope: 0.239, p: 0
EI - Malaga, ES
Slope: 0.147, p: 0
EI - Bucharest, RO
Slope: 0, p: NaN
EI - Constantia, RO
Slope: 0, p: NaN
EI - Graz, AU
Slope: 0, p: NaN
EI - Thessaloniki, GR
Slope: 0, p: NaN
EI - Athens, GR
Slope: 0.112, p: 0.034
EI
Year

EI - change between first and last decade



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Future Climate Changes

IPCC 6th Assessment Report

- Global warming of 1.5 °C above pre-industrial levels is now almost certain by 2050.
- The current and future impacts of 1.5 °C (the scenario with the least warming) include:
  - More frequent and intense heatwaves
  - Heavy precipitation and associated flooding, become more intense and frequent
  - More frequent compound events – e.g., concurrent heatwaves, droughts, floods and/or fire weather – in many regions
  - Generally milder winters

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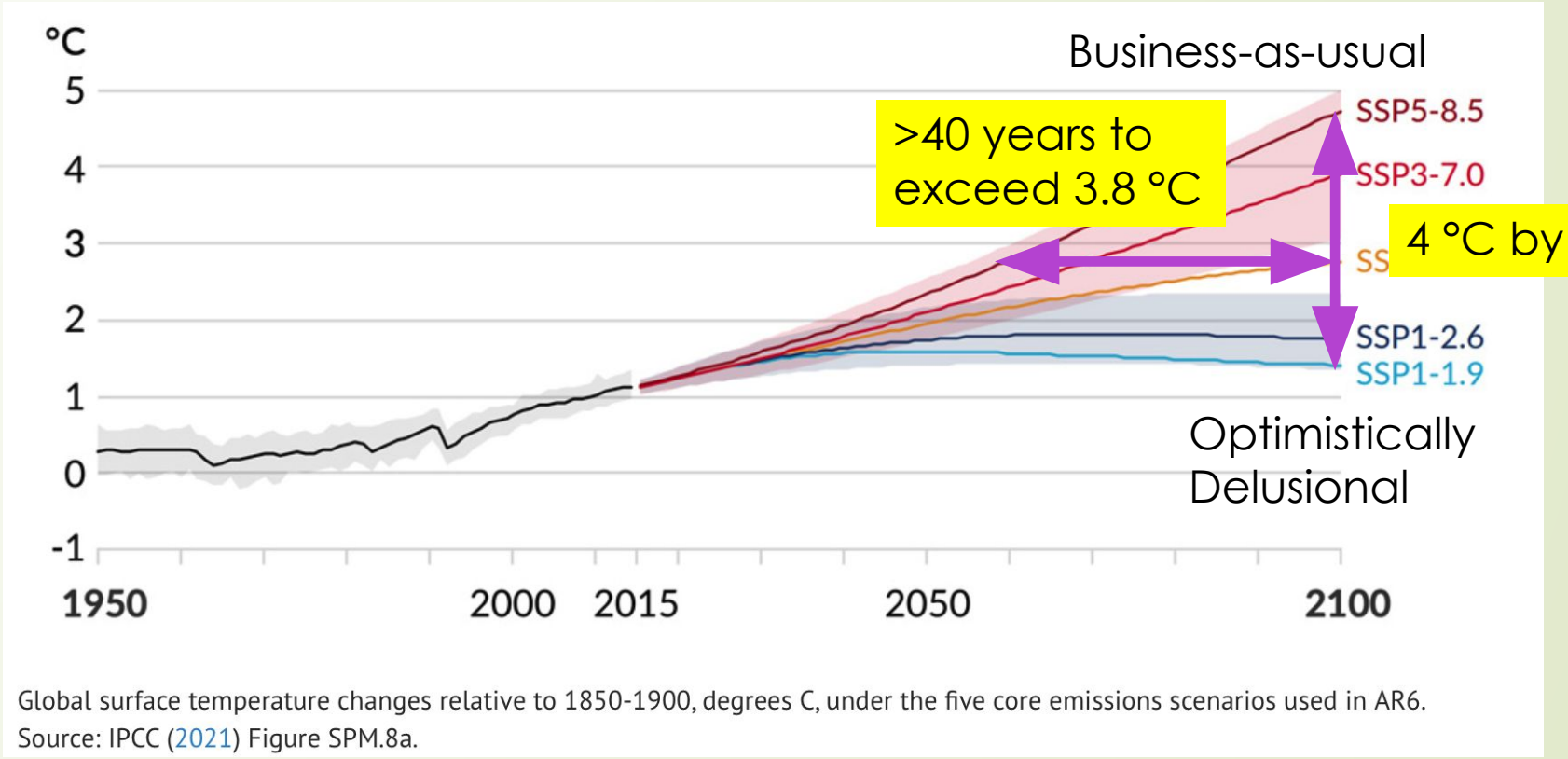
Climate change is real

Strong science… and *substanial irreducible uncertainties*

Changes in invasive pests attributable to climatic changes

Silver-leaf whitefly and Cassava Mosaic Virus in East Africa, and Medfly



Global surface temperature changes relative to 1850-1900, degrees C, under the five core emissions scenarios used in AR6.
Source: IPCC (2021) Figure SPM.8a.

Greenhouse Gas Emission ***Scenarios***

IPCC emissions scenarios

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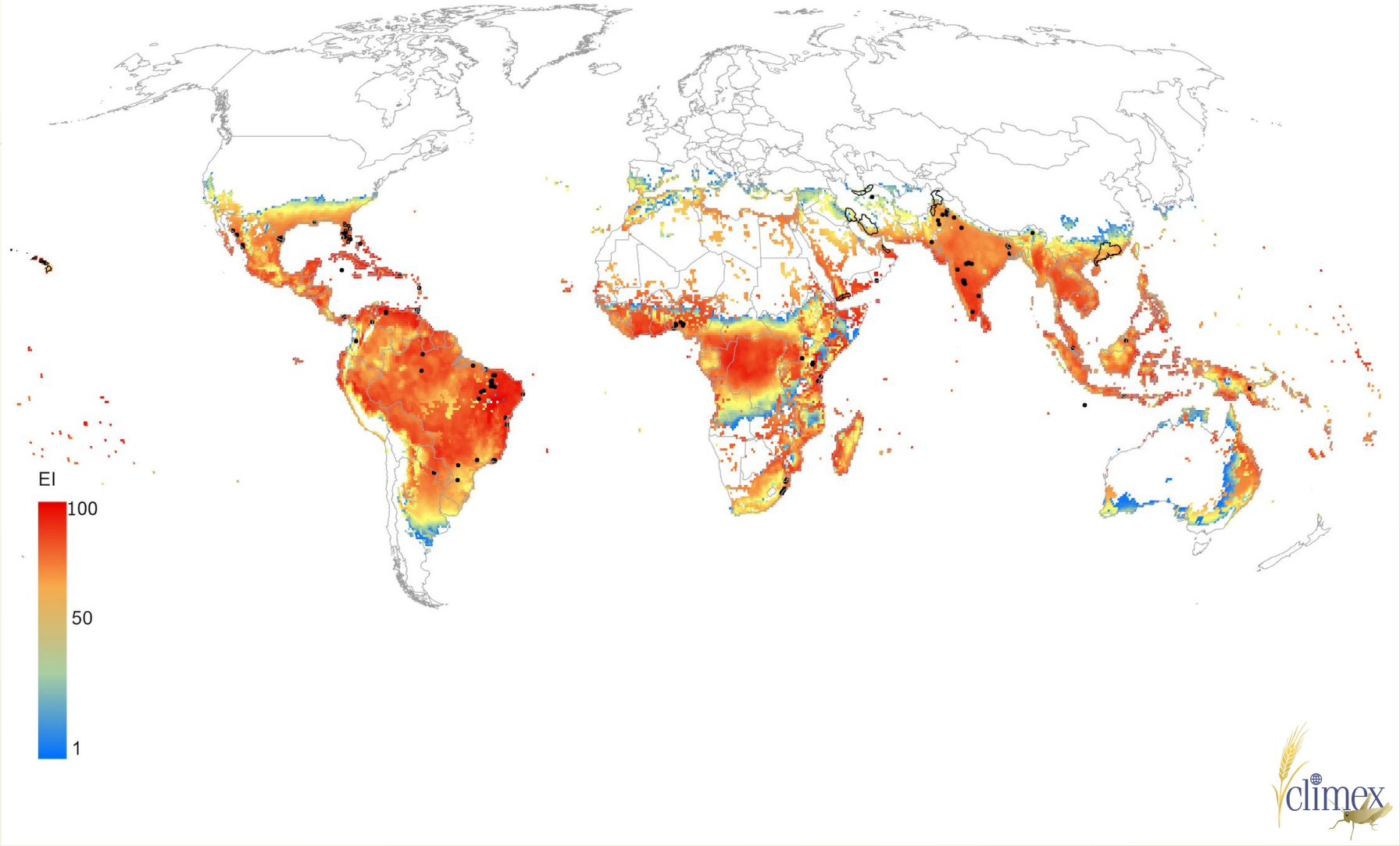
Projected Impacts on Citrus Pests

Aleurocanthus woglumi

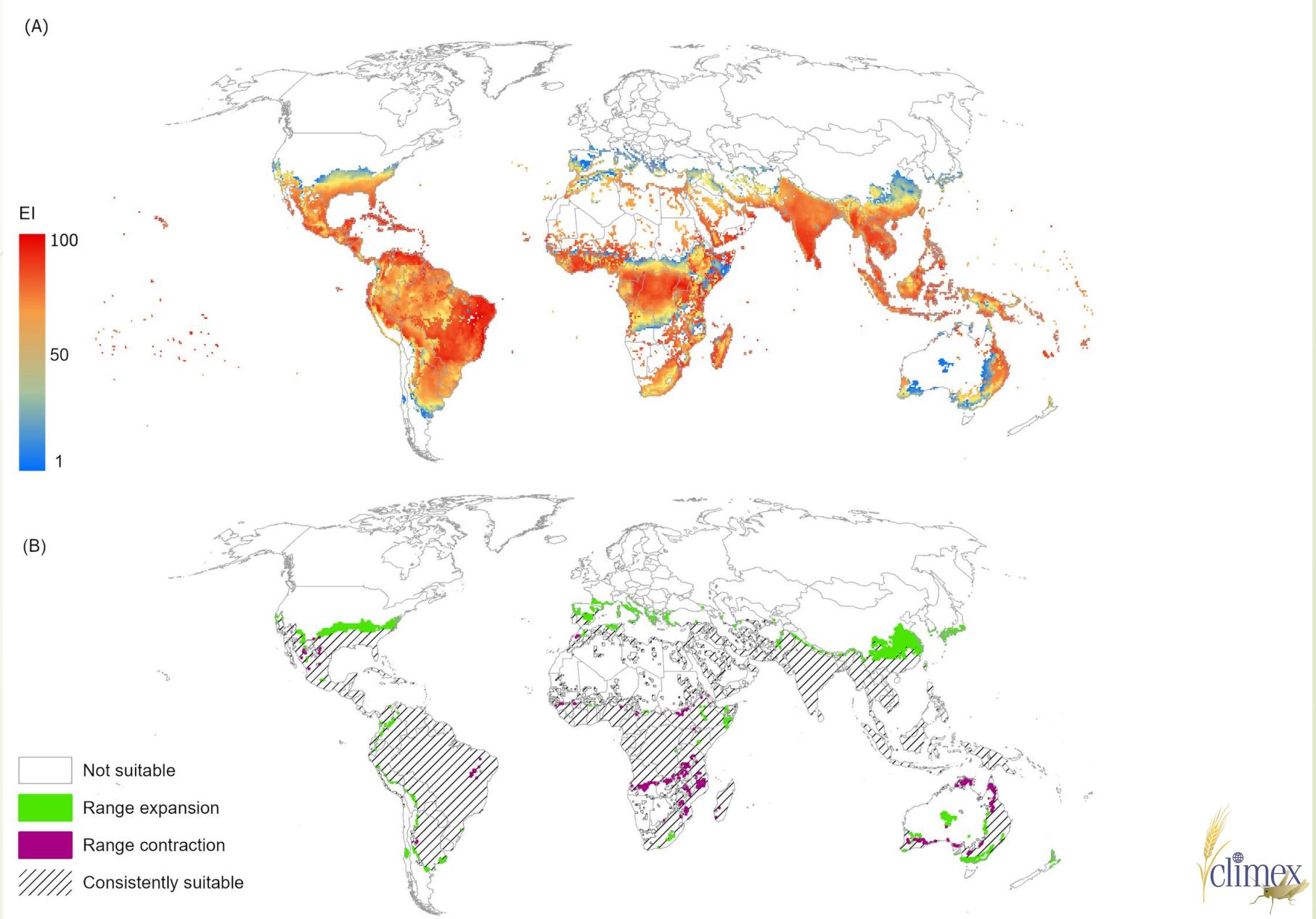
Florida Department of Agriculture and Consumer Services

Aleurocanthus woglumi

- Citrus Blackfly
- Polyphagous, favours citrus
- Continuous sucking of leaf sap causes direct damage
- Promotes sooty mold (*Capnodium* sp.)
- Yield losses up to 80%
- Native to India and other parts of Asia
- CLIMEX model developed by Akrivou *et al.* (2021).

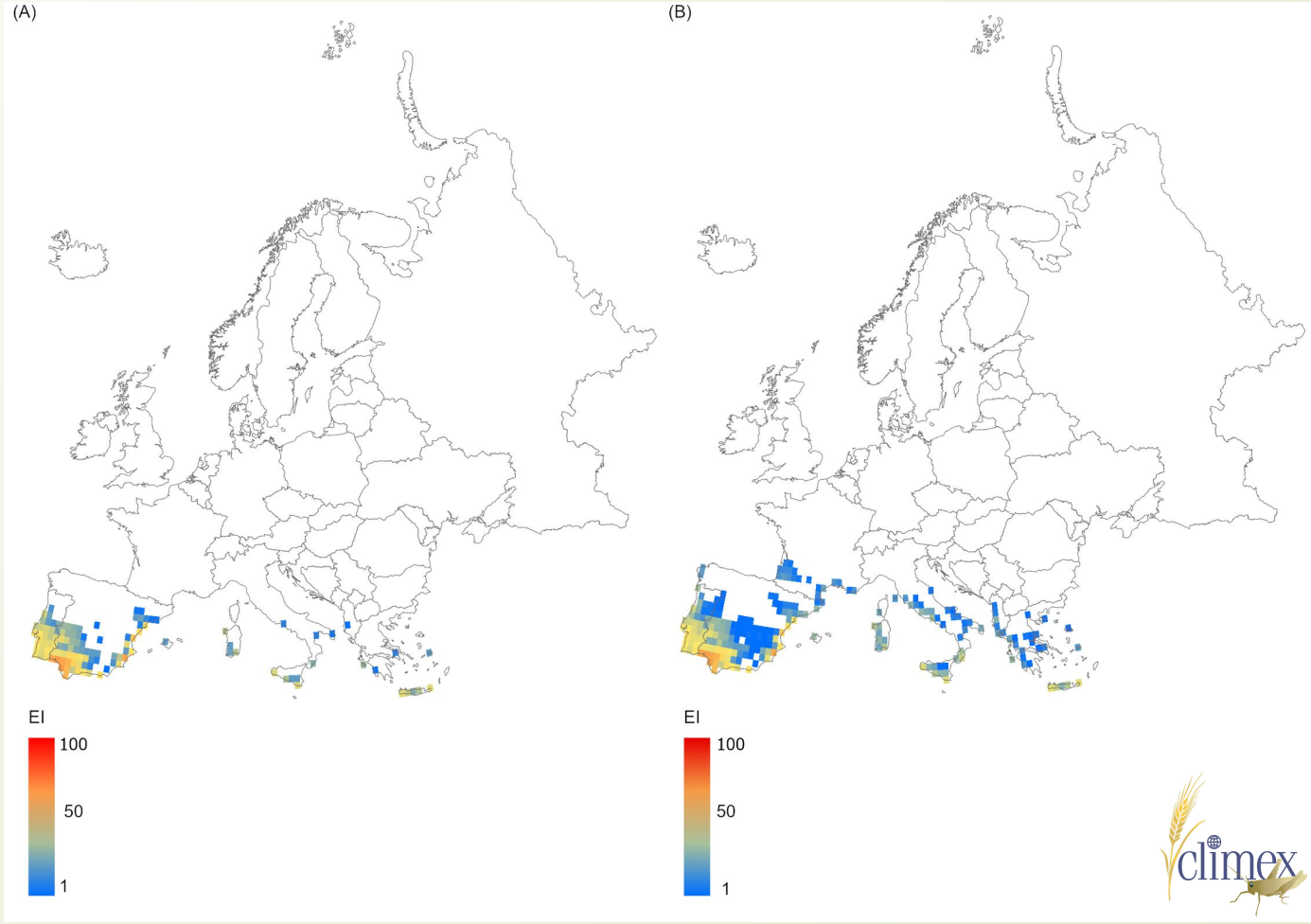


Aleurocanthus woglumi composite climate suitability (1995H)

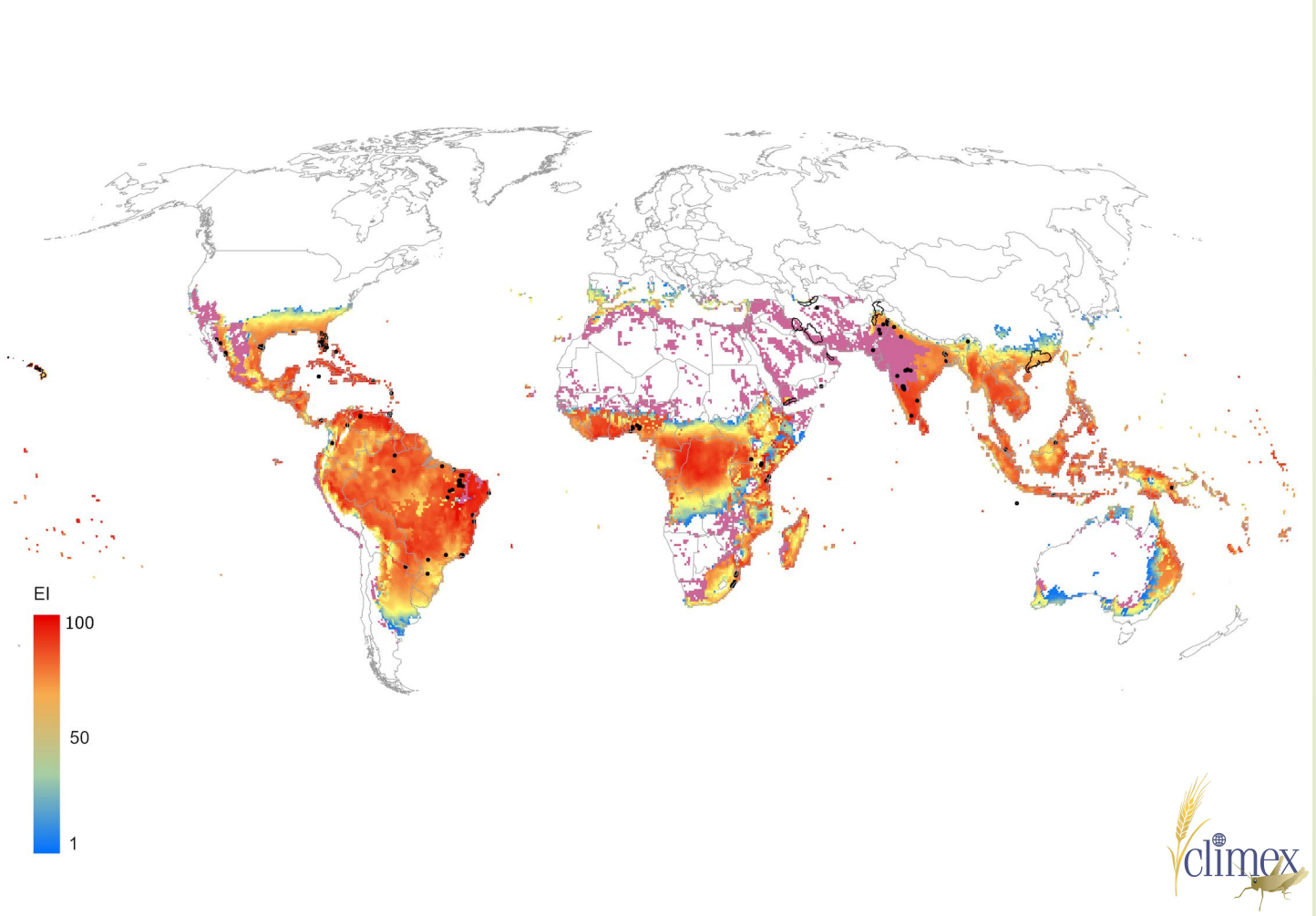


Aleurocanthus woglumi composite climate suitability (2050)

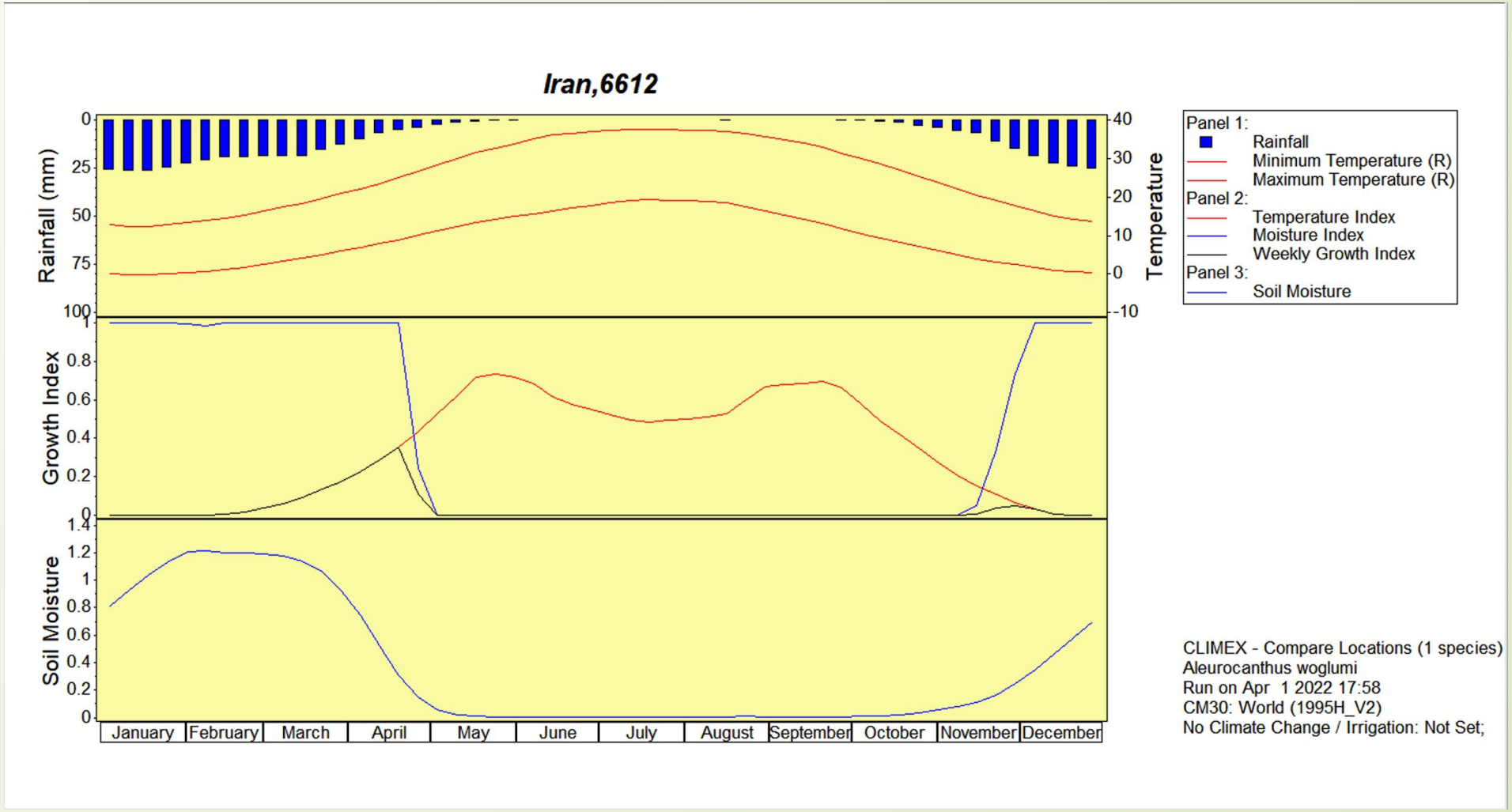
European perspective



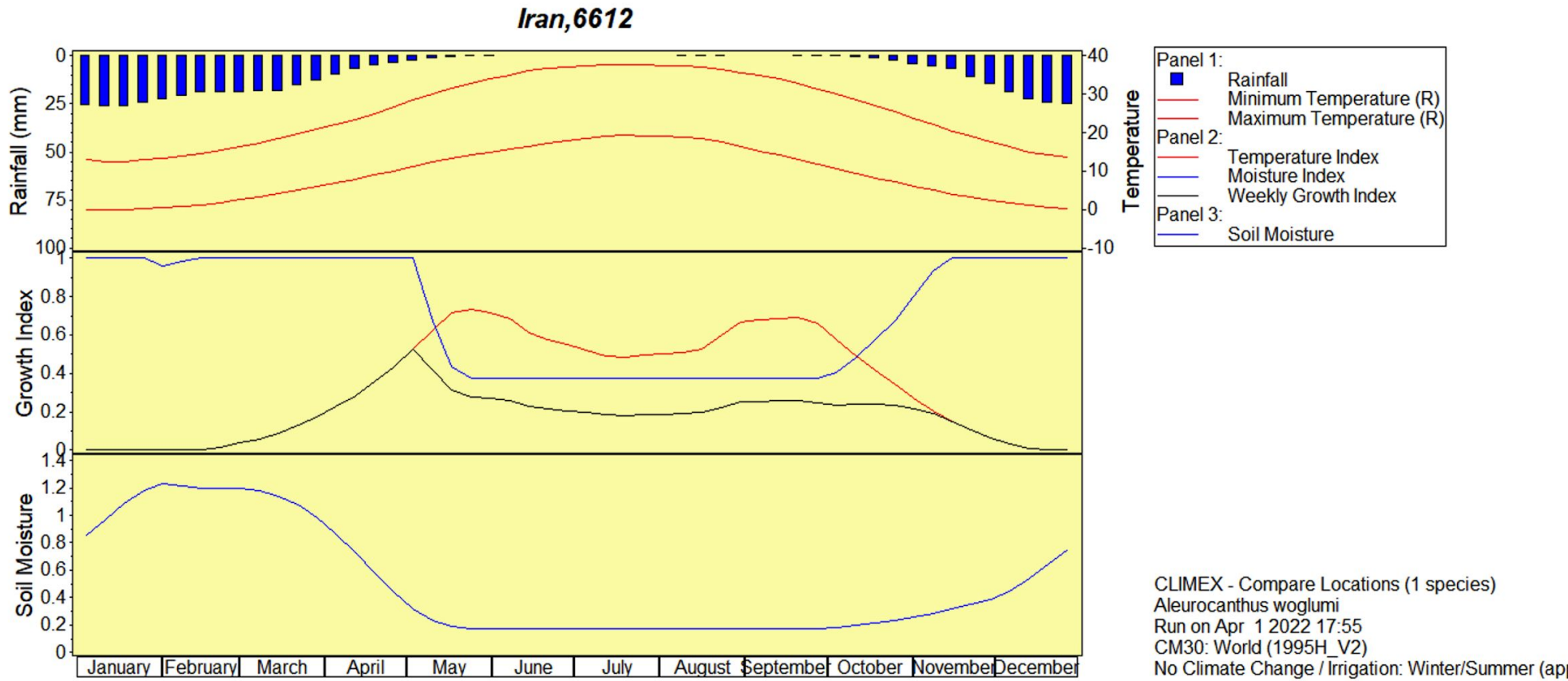
Critical role of irrigation



Fars, Iran – Natural rainfall



Fars, Iran – Top-up irrigation



Aleurocanthus woglumi - summary

- Poleward shift in distribution
  - (Northern hemisphere)
- Increased suitability and more generations in main production areas

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Biological Control

Auto-adaptive capacity of biological control systems

- Natural enemies are *mostly* adapted to similar climate conditions to their hosts
- Doesn't mean they are perfectly aligned in their climate response functions
- **In broad terms**, climate conditions that favour the pest (host) ***tend*** to favour the natural enemy
- Exceptions
  - Polyphagous, climate generalists
  - Climate-specialists

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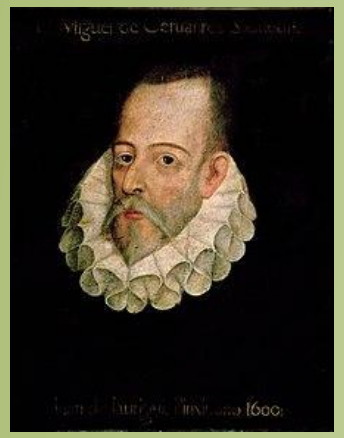
Adapting under uncertainty



"forewarned, forearmed; to be prepared is half the victory"
Miguel de Cervantes Saavedra

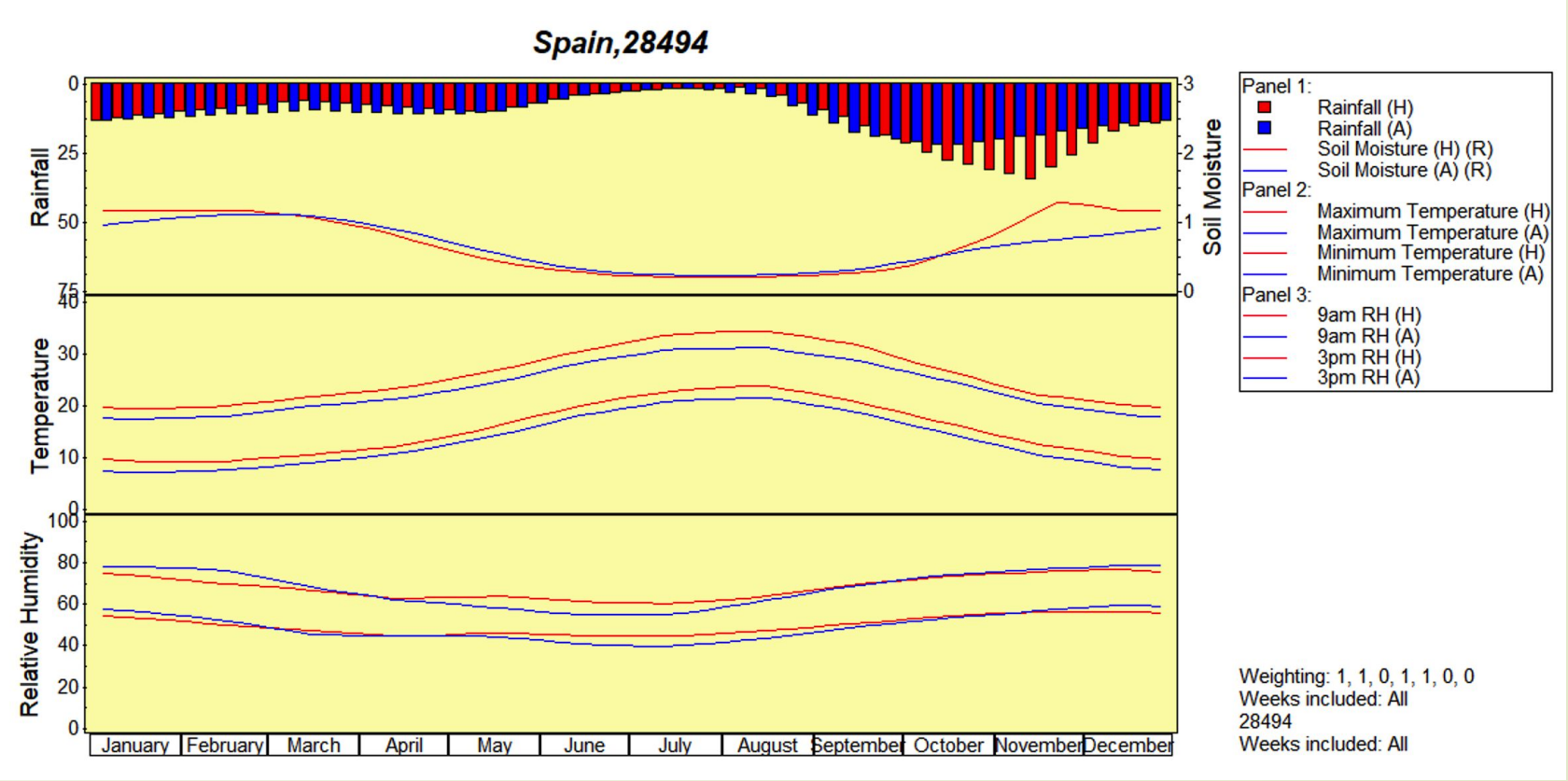
Promising Strategies

- Foresight and Planning
  - Use extreme/business-as-usual scenarios to identify sensitivities
  - Contingency planning
  - Analogue climates
    - Identify emerging threats and adaptation options
  - Micro-adaptations and adaptive management
- Monitor
  - Intelligence network
  - Crowd source information
  - IOBC seems like a good platform for intelligence sharing

Analogue Climates

- Identify where your future climates may be located presently
- Study the pests and production systems in those climates
- Assess what adaptations might be necessary or desirable to cope with those conditions if they were realised in your area
- The analogues may not exist in present climatology, or may not be used to grow citrus

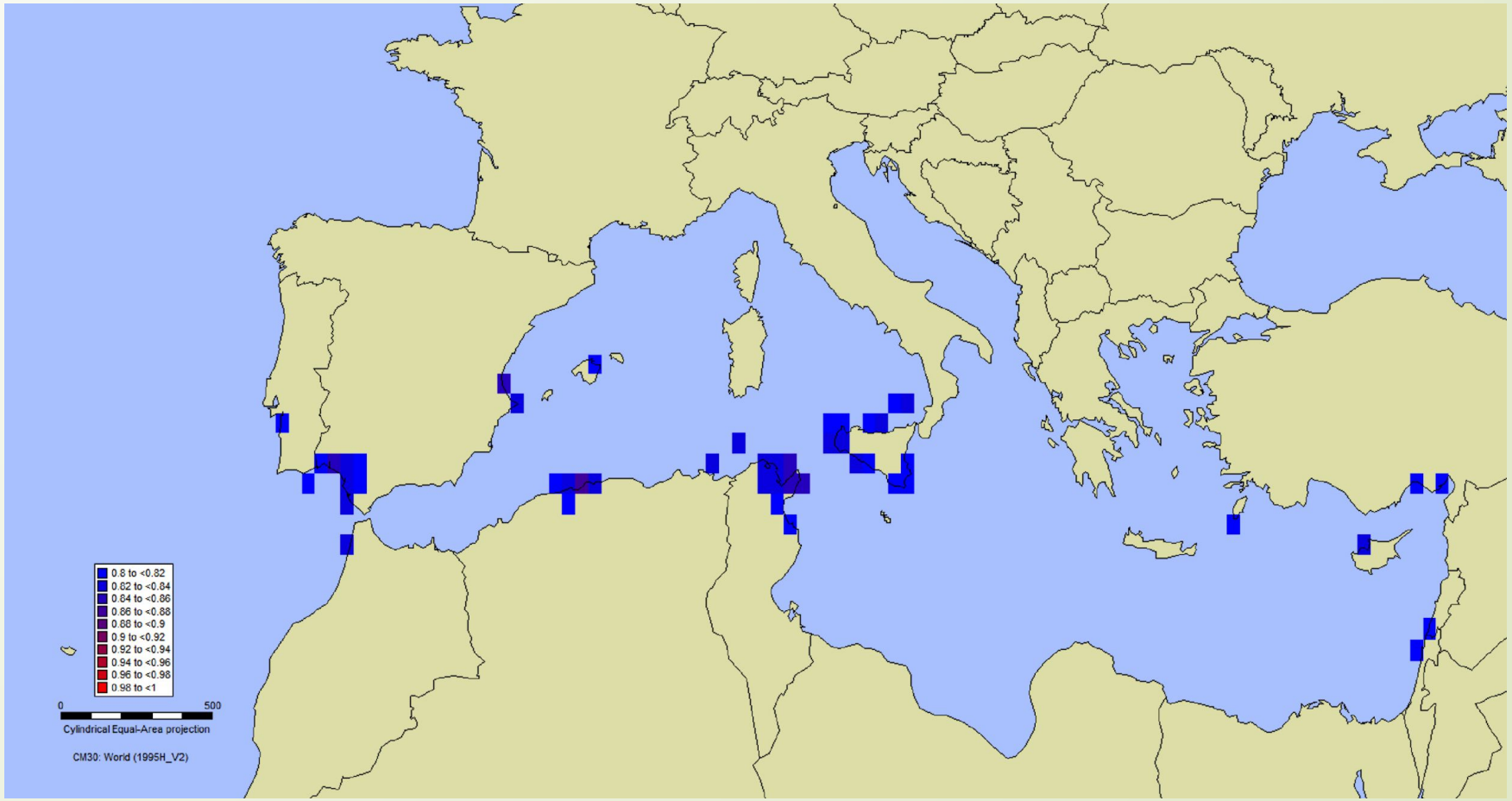
Valencia 1995 vs 2050 Access



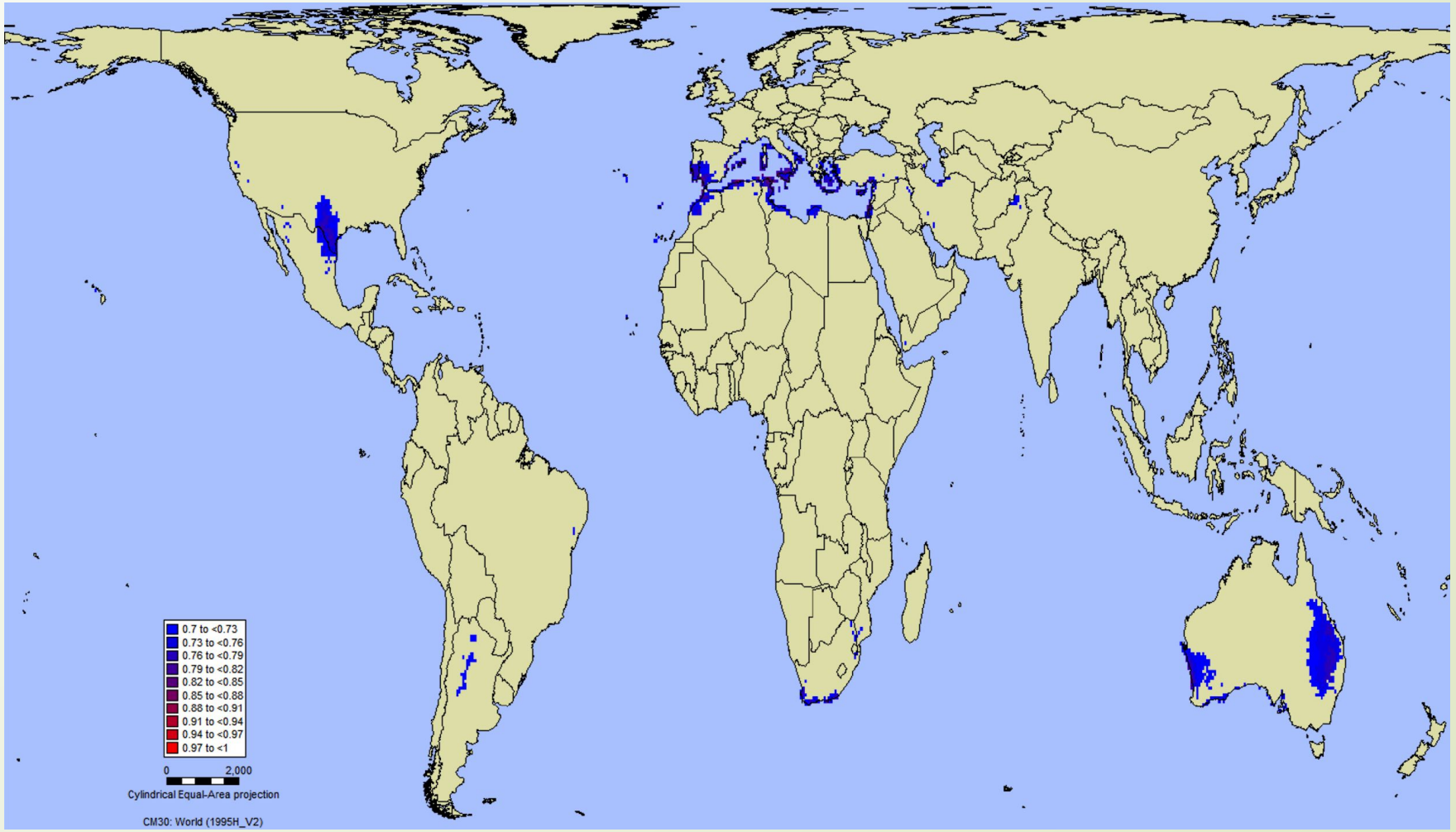
Analogue climates

- Match climates
- Match Valencia 2050 with World 1995 to find Valencia's future climate match today

Closest matches



Identifying new pest management threats and their management…



Climate trends are noisy

- Difficult to see trends
- Need to **actively monitor** variables of interest and **analyse** them through time
  - Range shifts of pests
  - Number of generations
  - Synchronicity of agents and hosts and crops
- Use models to understand the context for expected changes

Conclusions

- Future climate simulations are based on highly uncertain inputs of GHG's
  - Future climate simulations are highly uncertain
  - Don't speak of *predictions*,
  - Prefer *scenarios* or *projections*
- Prefer multi-faceted, micro-adaptations
- Citrus industries need a pro-active multi-faceted strategy for dealing with climate change impacts of pests
- Use climate scenarios to understand how current pest problems are likely to change
- Use analogue climates to study and understand emerging pest issues and how to manage them
- Irrigation plays a critical role in increasing production and pest risk
  - Including stepping-stone invasions
- Information *collection*, *analysis* and *sharing* are vitally important

Acknowledgements

ΜΠΕΝΑΚΕΙΟ ΦΥΤΟΠΑΘΟΛΟΓΙΚΟ ΙΝΣΤΙΤΟΥΤΟ

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Efxaristo

- Darren Kriticos
- E: darren@cervantesagritech.com