Scenarios of climate change and potential for ambrosia invasion in Europe

Mikhail Semenov, Pierre Stratonovitch & Jonathan Storkey

Rothasmted Research

atopica®

ROTHAMSTED RESEARCH

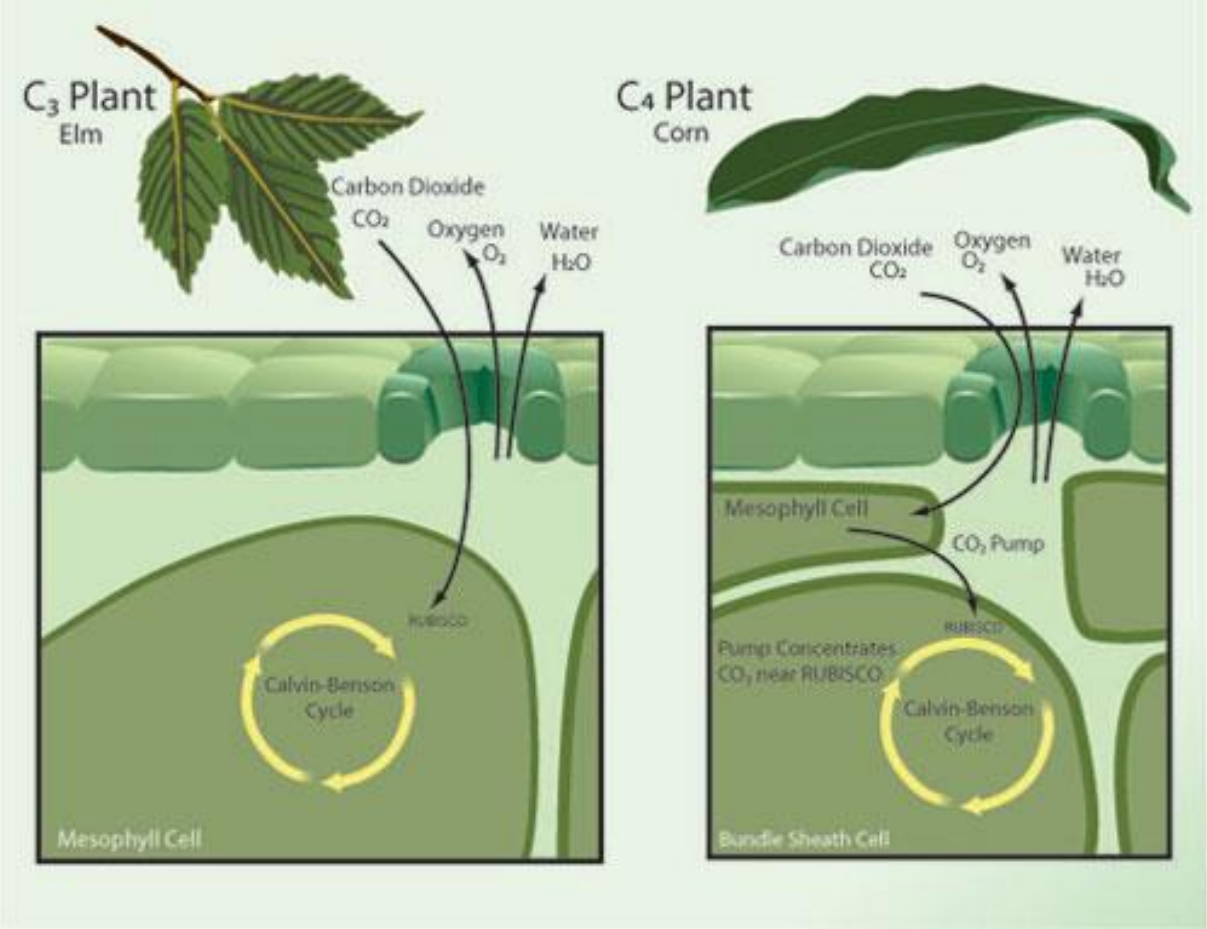
SEVENTH FRAMEWORK PROGRAMME

Ambrosia artemisiifolia - common ragweed

- Ambrosia is an invasive weed in Europe with highly allergenic pollen
- Originated in North America
- Populations are currently well established in the French Rhone valley, Austria, Hungary and Croatia causing significant health problems
- Once established, control measures are labour intensive and expensive
- Pollen season: August – October
- **C3-plant**

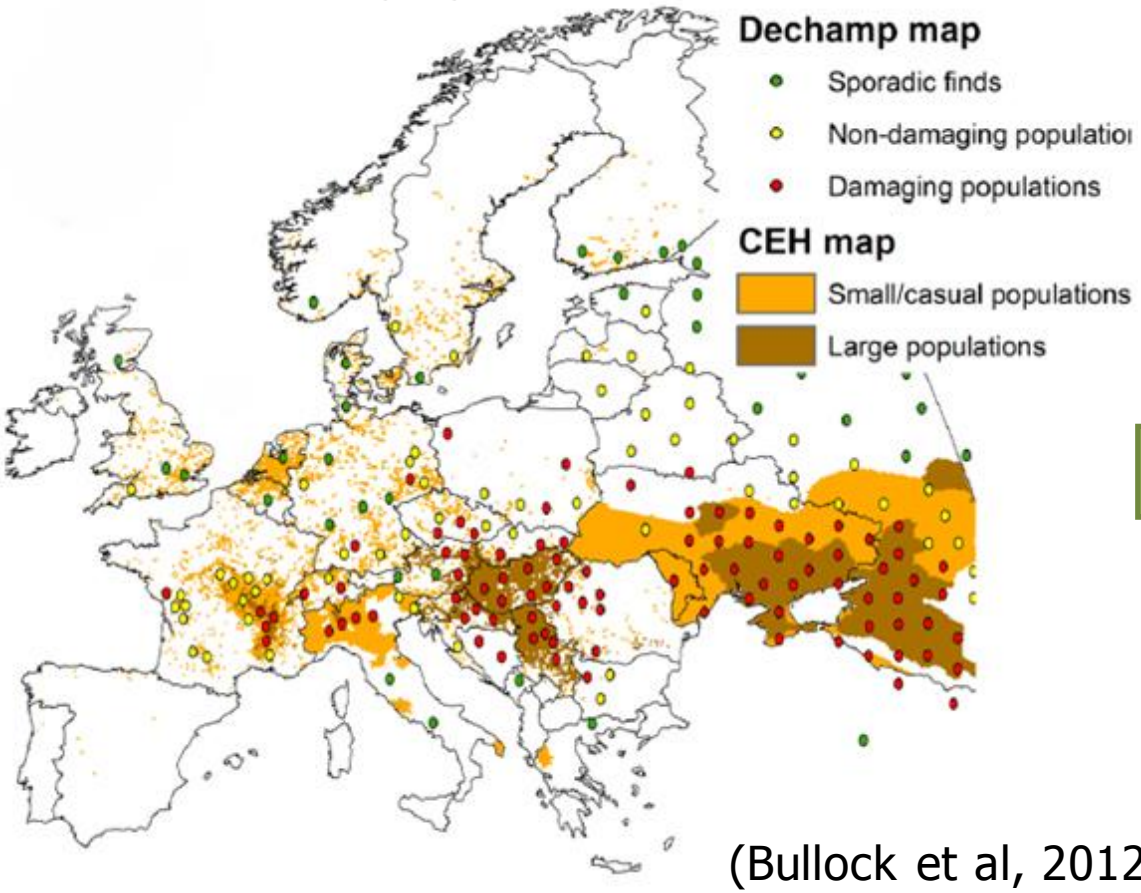
Each plant of ambrosia is able to produce about a billion grains of pollen over a season. It is highly allergenic, generally considered the greatest allergen of all pollens.

C3 vs C4 plants



Ambrosia distribution in Europe

2015



(Bullock et al, 2012)

2065

Future ?

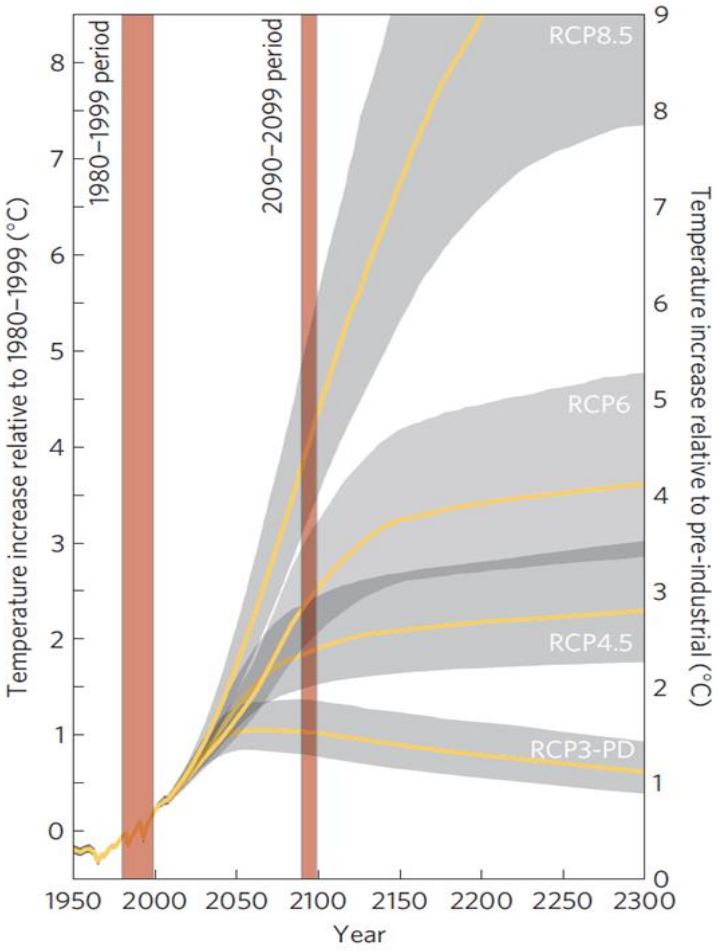
Modelling

Ambrosia climate suitability index and pollen production

- **Model of ambrosia:** Sirius, a process-based model of weed growth, competition and population dynamics in response to variations in climate and environment

- **Future weather:** local-scale climate scenarios based on LARS-WG, a stochastic weather generator, and climate projections from the CMIP5 ensemble of Global Climate Models (GCMs)

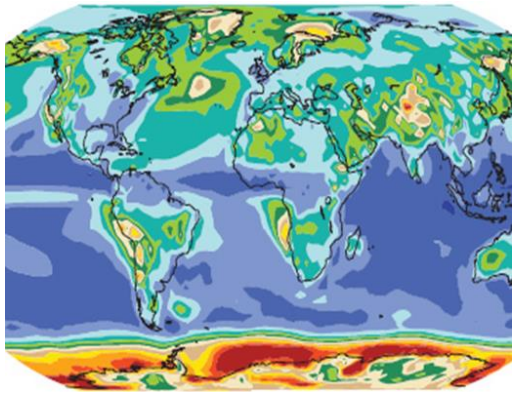
CMIP5 ensemble: projections of future climate



(IPCC AR5 WG1)

LARS-WG: downscaling with a weather generator

CMIP5 ensemble
of Global Climate Models



LARS-WG

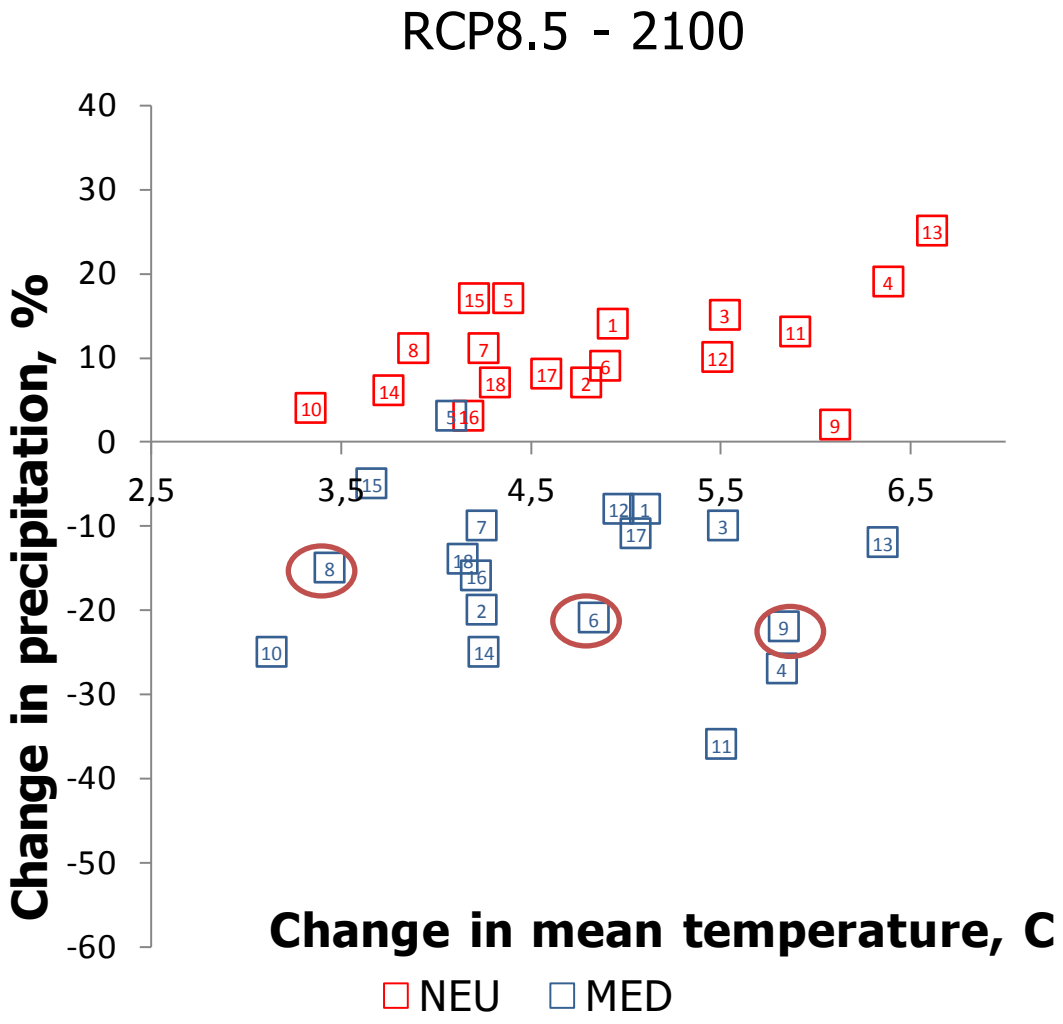
Local-scale parameters
derived from observed
weather

Local-scale climate scenarios

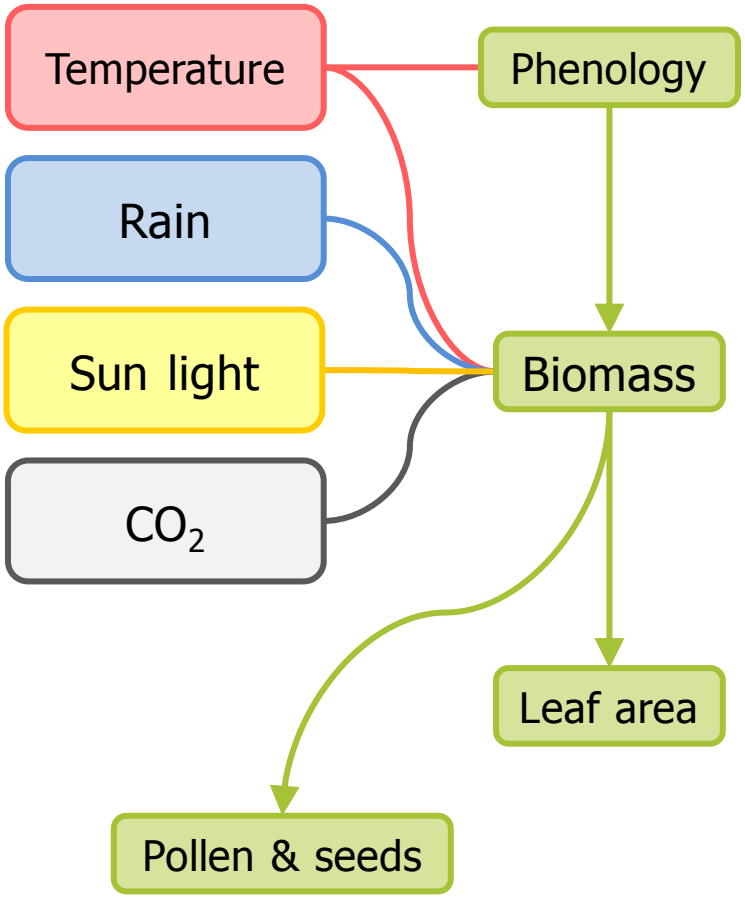
for impact assessments

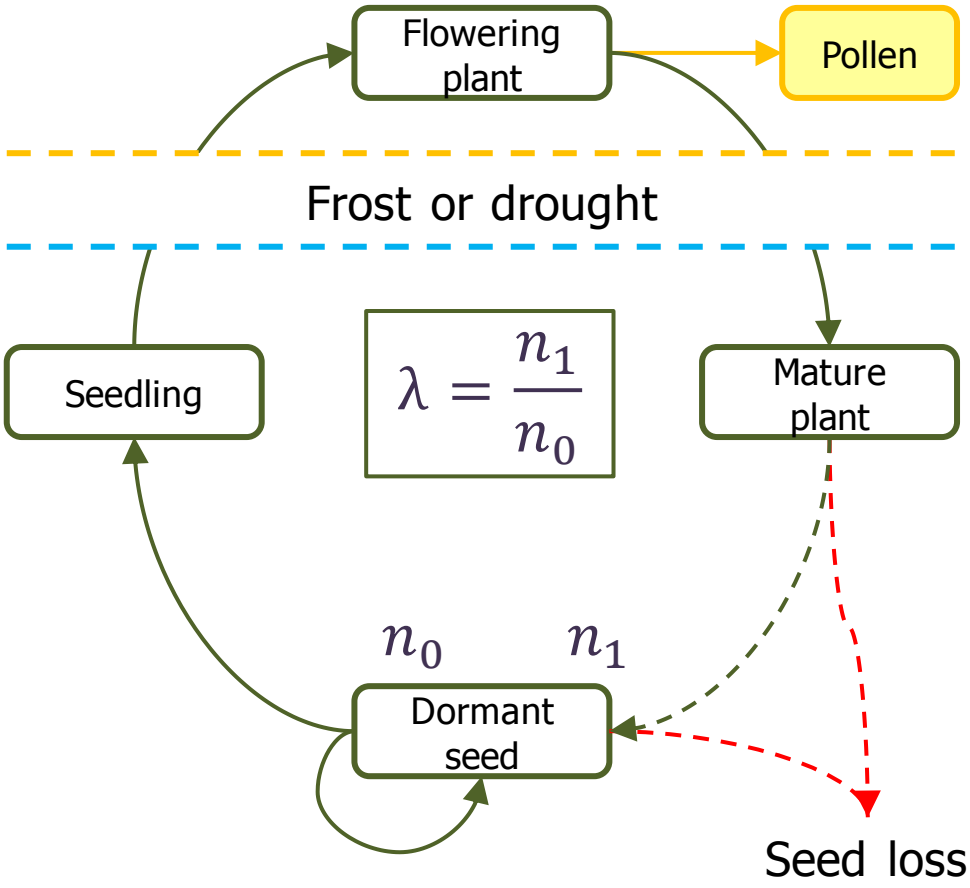
(Semenov et al, 2010)

CMIP5: climatic sensitivity



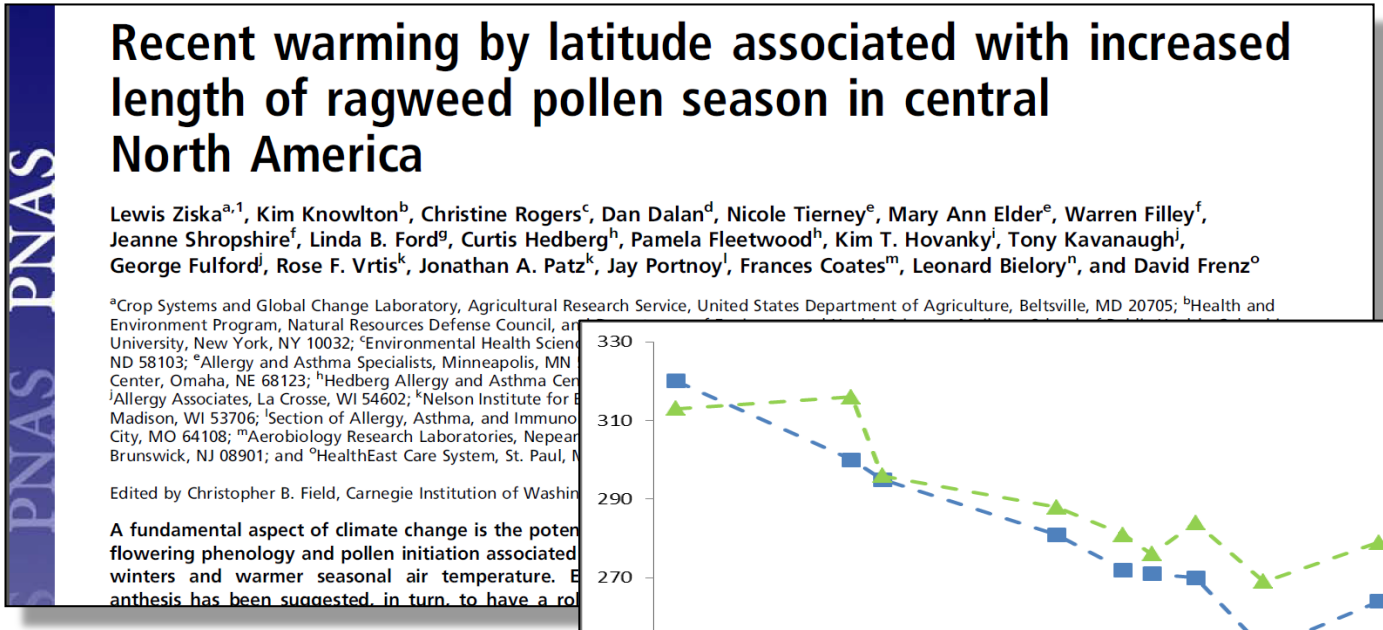
Sirius: a process-based model for ambrosia





Increase in pollen season in North America

Observed gradient of flowering time with latitude



PNAS PNAS

Recent warming by latitude associated with increased length of ragweed pollen season in central North America

Lewis Ziska[a,1], Kim Knowlton[b], Christine Rogers[c], Dan Dalan[d], Nicole Tierney[e], Mary Ann Elder[e], Warren Filley[f], Jeanne Shropshire[f], Linda B. Ford[g], Curtis Hedberg[h], Pamela Fleetwood[h], Kim T. Hovanky[i], Tony Kavanaugh[j], George Fulford[j], Rose F. Vrtis[k], Jonathan A. Patz[k], Jay Portnoy[l], Frances Coates[m], Leonard Bielory[n], and David Frenz[o]

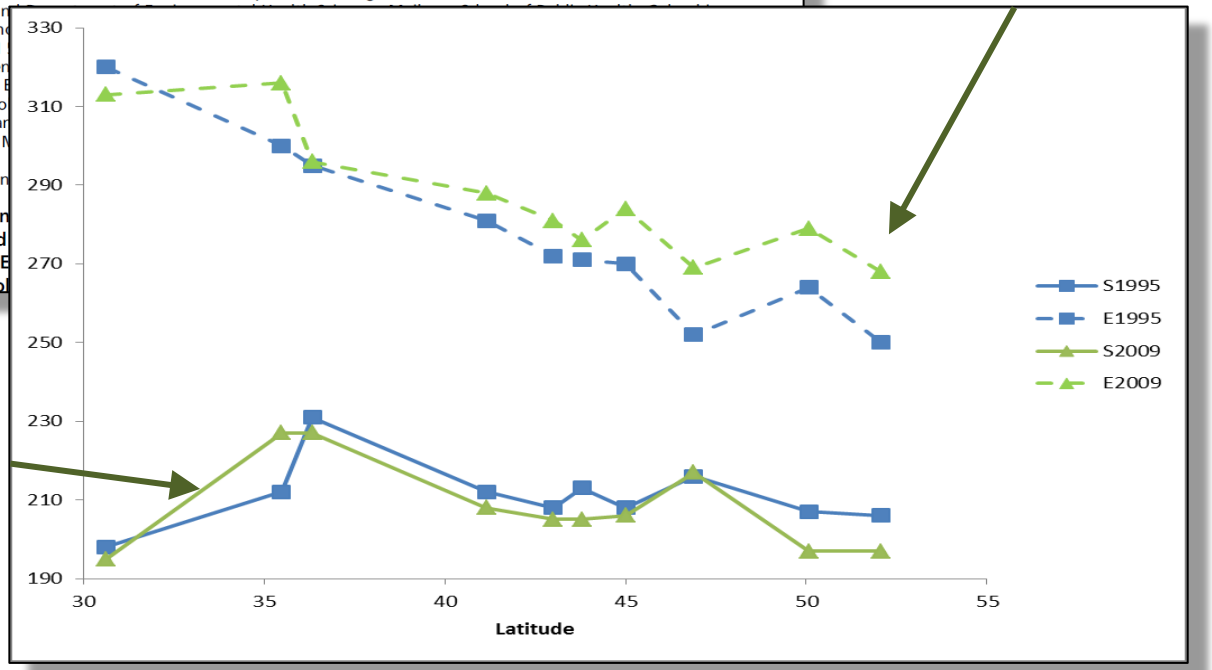
[a]Crop Systems and Global Change Laboratory, Agricultural Research Service, United States Department of Agriculture, Beltsville, MD 20705; [b]Health and Environment Program, Natural Resources Defense Council, ar
University, New York, NY 10032; [c]Environmental Health Scienc
ND 58103; [e]Allergy and Asthma Specialists, Minneapolis, MN
Center, Omaha, NE 68123; [h]Hedberg Allergy and Asthma Cen
[j]Allergy Associates, La Crosse, WI 54602; [k]Nelson Institute for E
Madison, WI 53706; [l]Section of Allergy, Asthma, and Immuno
City, MO 64108; [m]Aerobiology Research Laboratories, Nepear
Brunswick, NJ 08901; and [o]HealthEast Care System, St. Paul, M

Edited by Christopher B. Field, Carnegie Institution of Washin

**A fundamental aspect of climate change is the poten
flowering phenology and pollen initiation associated
winters and warmer seasonal air temperature. E
anthesis has been suggested, in turn, to have a ro**

End of flowering

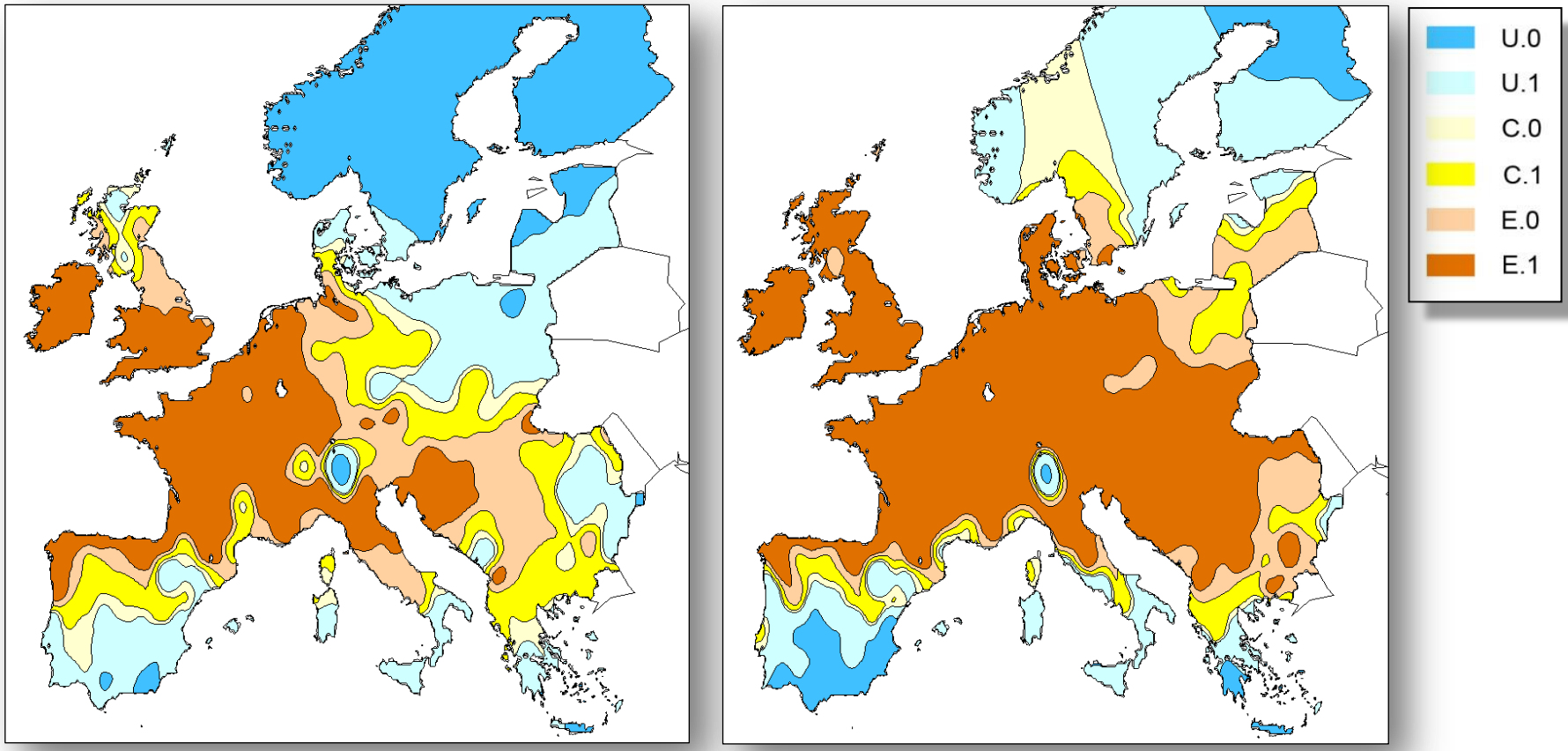
Start of flowering



Modelling predicts a northward shift for ambrosia suitability

Baseline (1980-2010)

HadGEM2 2050 RCP8.5



atopica®

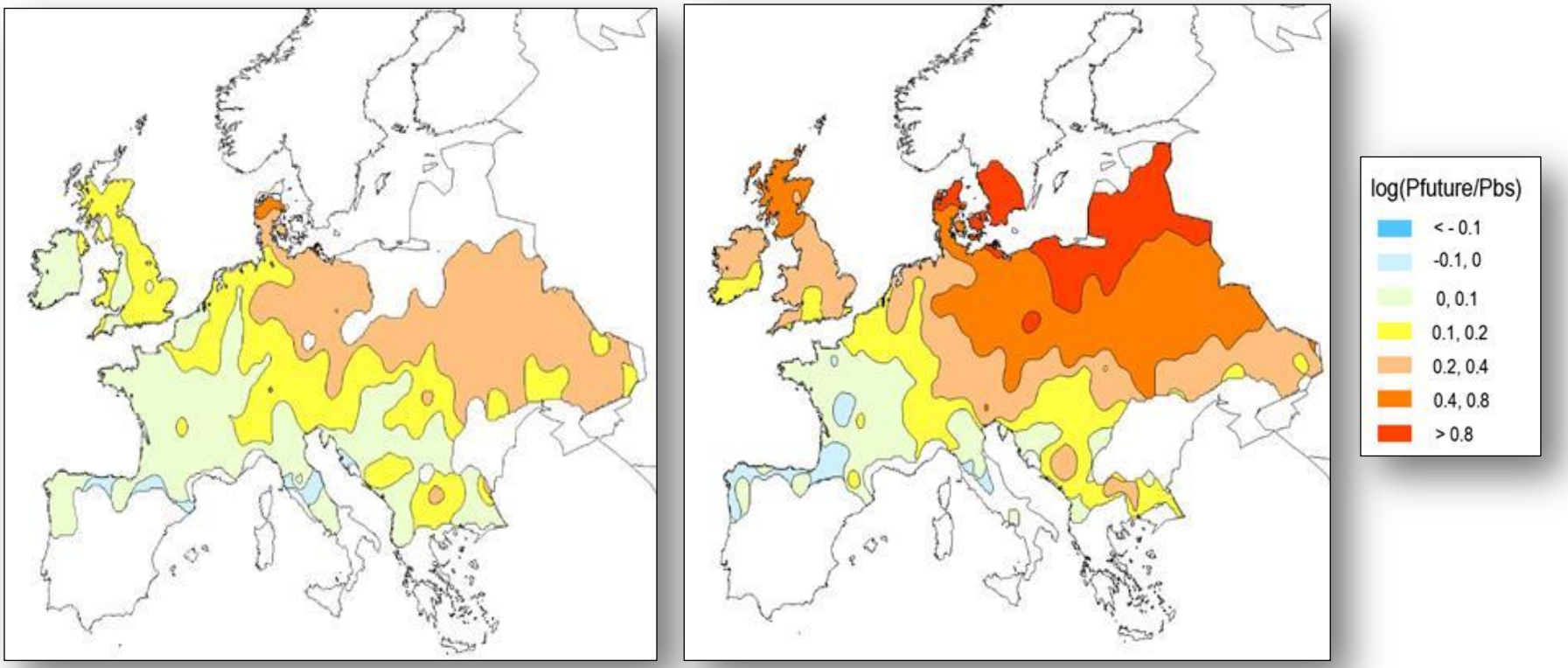
ROTHAMSTED RESEARCH

Increase in pollen production predicted

Positive effect of increased CO2 concentration on biomass and pollen

HadCM3(A1B), 2020

HadCM3(A1B), 2060

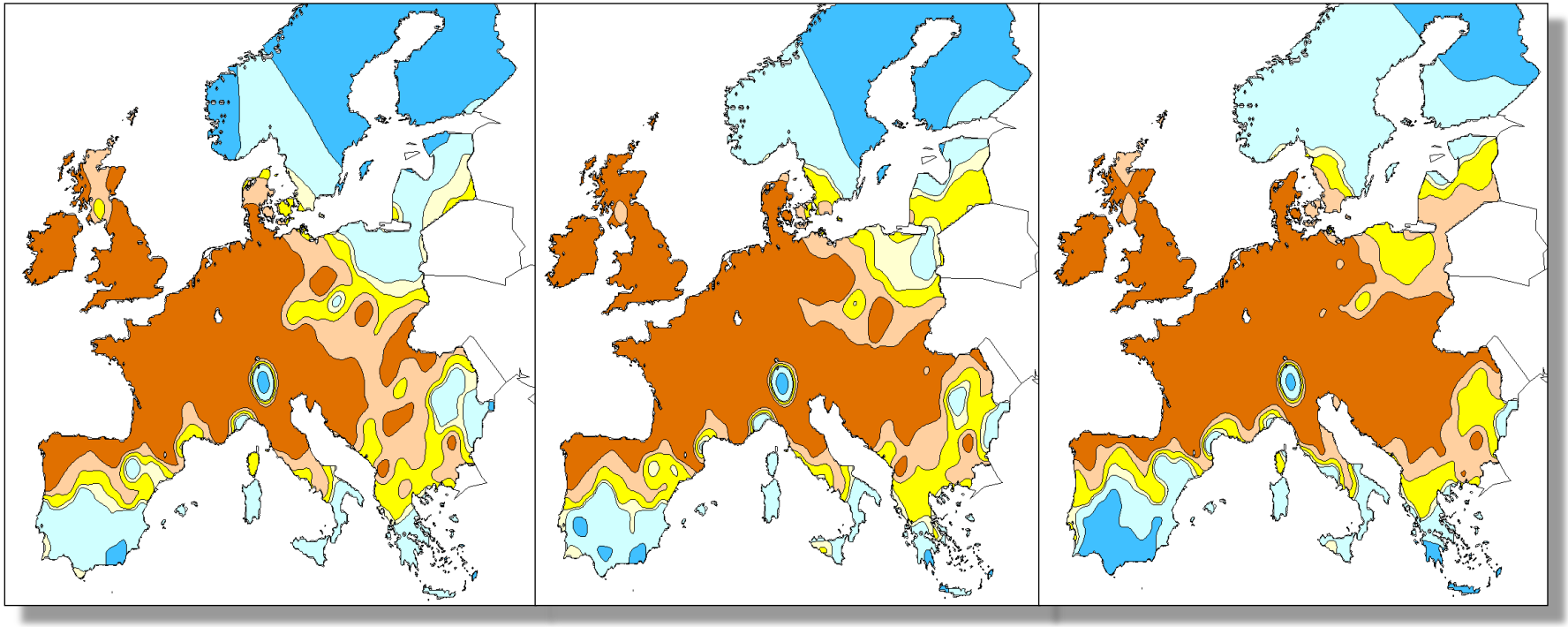


(Storkey et al. 2014)

Uncertainty in predictions from GCMs

2050 RCP4.5

GISS | EC-EARTH | HadGEM2



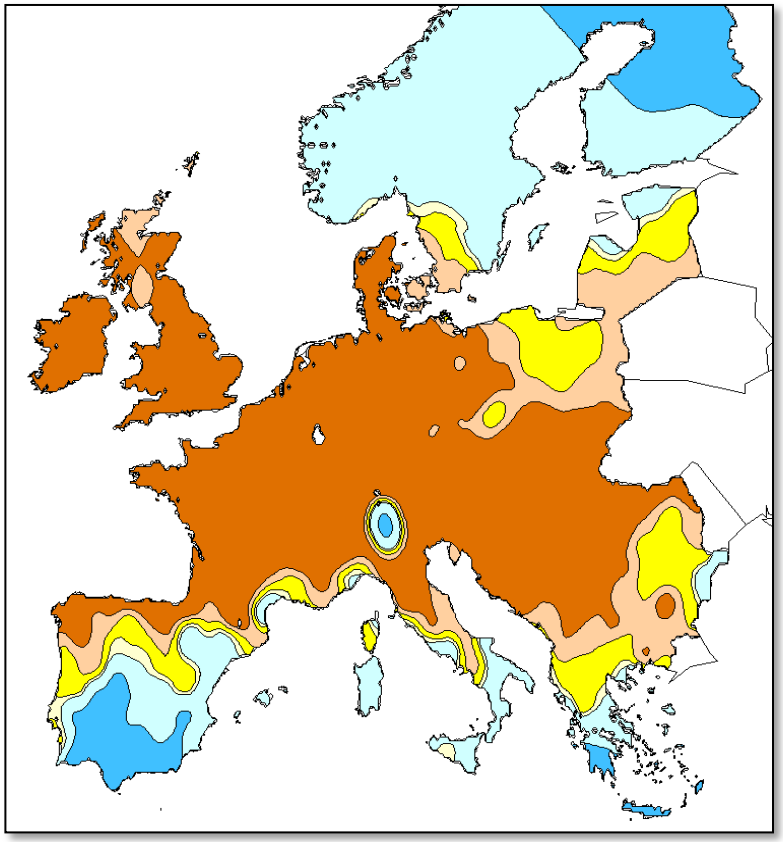
Low | Medium | High

Climate sensitivity

ROTHAMSTED RESEARCH

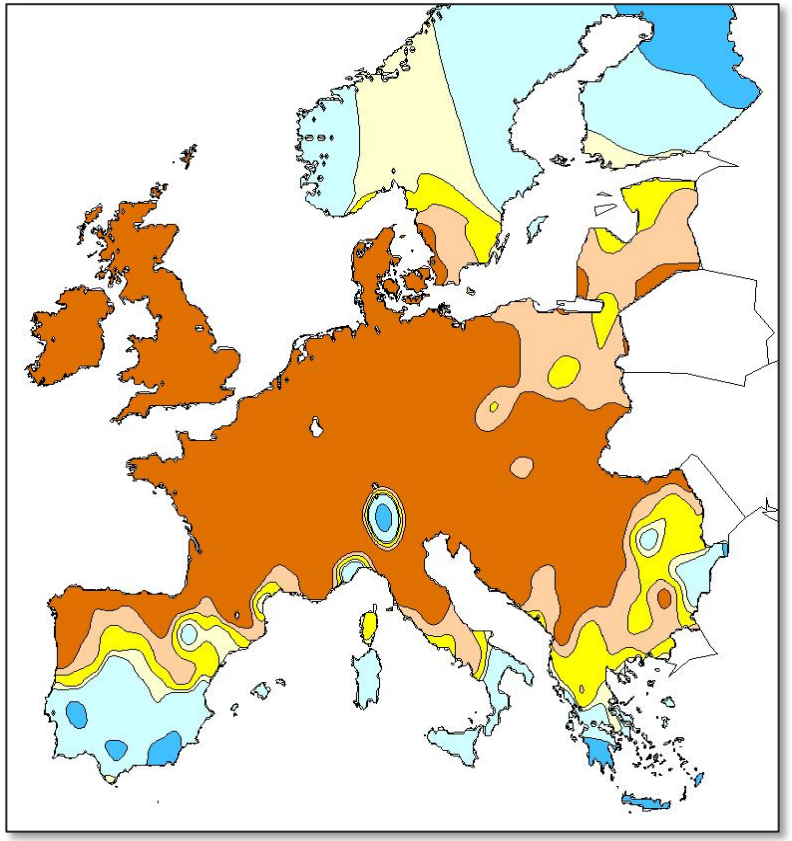
Uncertainty: RCPs vs GCMs

HadGEM2 2050 RCP4.5



high climate sensitivity : low RCP

GISS 2050 RCP8.5



low climate sensitivity : high RCP

Key messages

- Modelling predicts a northward shift in the available climatic niche for ambrosia populations to establish and persist due to changes in climate
- Increase in pollen production is predicted due to increase in productivity in response to higher CO_2
- Pollen season will increase due to later frosts in response to global warming

Acknowledgements

Daniel Chapman, CEH, UK
Francesco Vidotto, Uni Turin, Italy
Franz Essl, Uni Rennweg, Austria

Atopica partners: