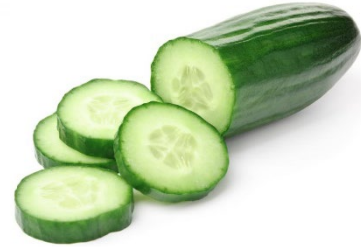


A case study of *Bemisia tabaci* in north-west Europe and assessment of potential future establishment in the United Kingdom under climate change

Catherine Bradshaw, Debbie Hemming
(Met Office)

Richard Baker, Matthew Everatt, Dominic Eyre & Anastasia Korycinska
(Defra Plant Health)



Feeds on hundreds of different plant species



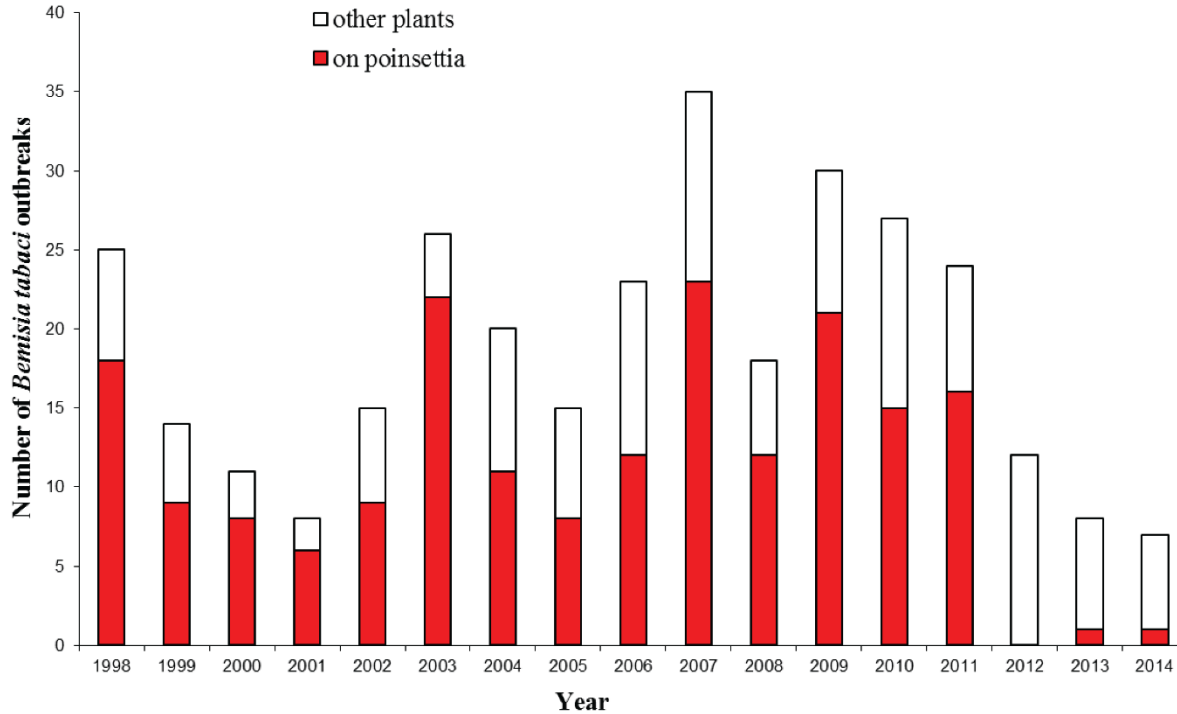
Leaf curl virus



Tomato irregular ripening disorder



Vector for hundreds of different plant viruses

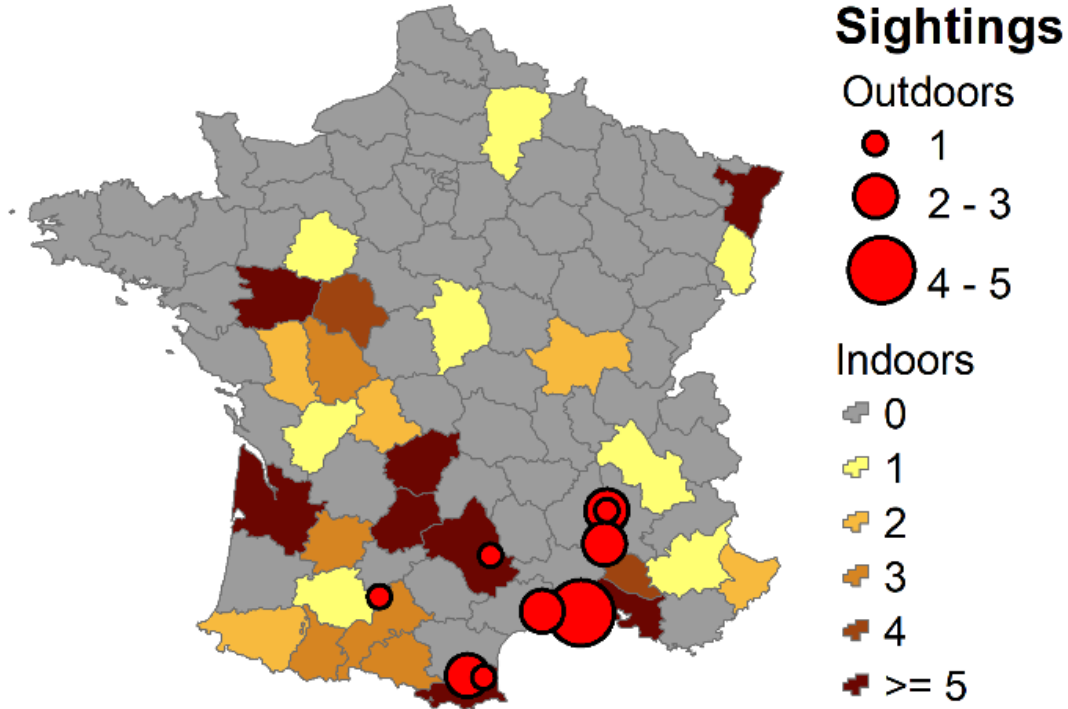


Cuthbertson and Vänninen, 2015

The number of *Bemisia tabaci* outbreaks in England and Wales (1998–2014)



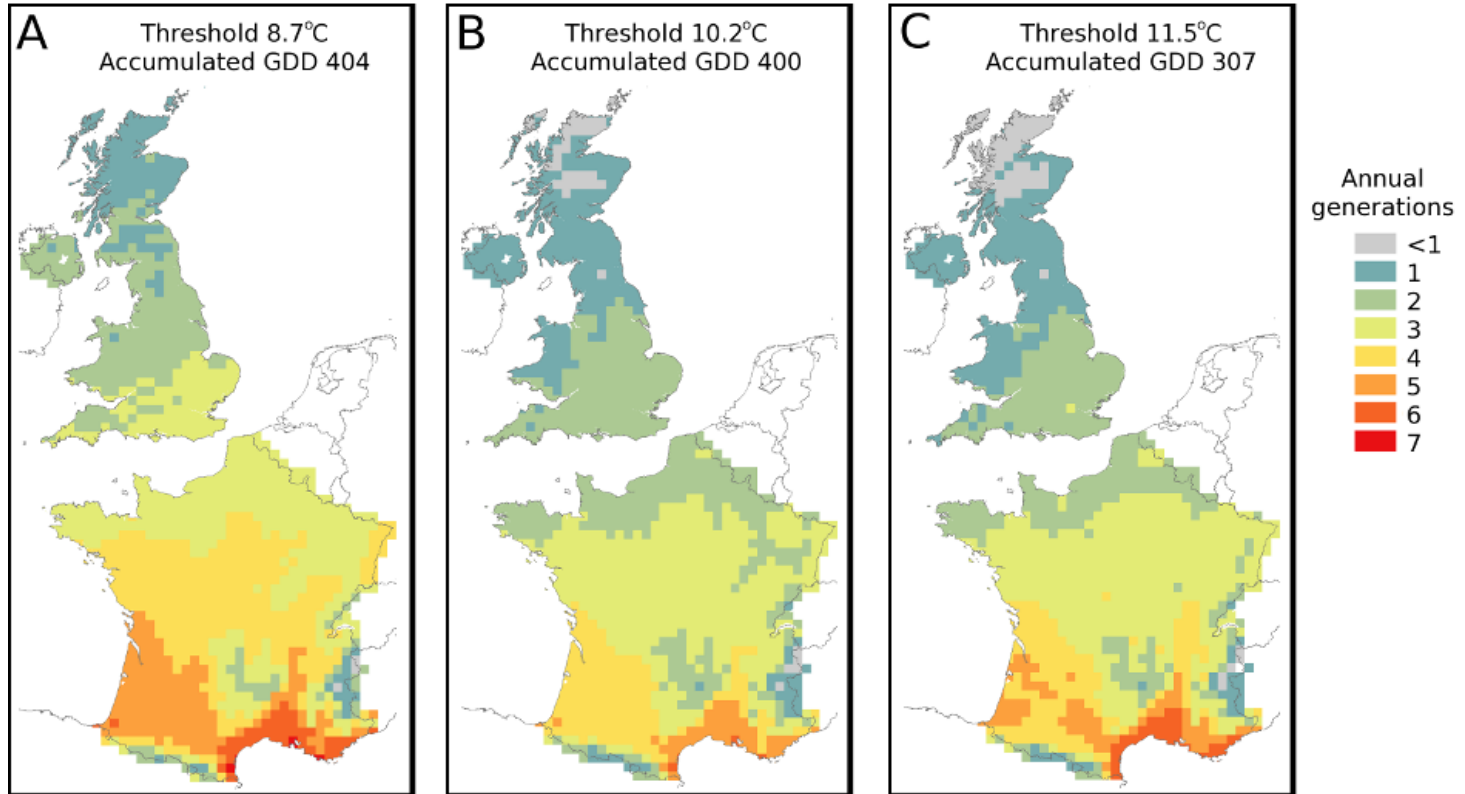
Cannot establish outdoors in the UK



The number of *Bemisia tabaci* outbreaks in France (1996–2016)

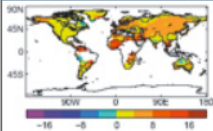



Typical British summer compared to typical French Mediterranean summer



http://etccdi.pacificclimate.org/list_27_indices.shtml

ETCCDI/CRD Climate Change Indices



Climate Change Indices

Definitions of the 27 core indices

Indices
Definition
Calculation
Homogeneity
Examples
Software
Data
Workshops
Home

1. **FD, Number of frost days:** Annual count of days when TN (daily minimum temperature) $< 0^{\circ}\text{C}$.

Let TN_{ij} be daily minimum temperature on day i in year j . Count the number of days where:

 $TN_{ij} < 0^{\circ}\text{C}$.
2. **SU, Number of summer days:** Annual count of days when TX (daily maximum temperature) $> 25^{\circ}\text{C}$.

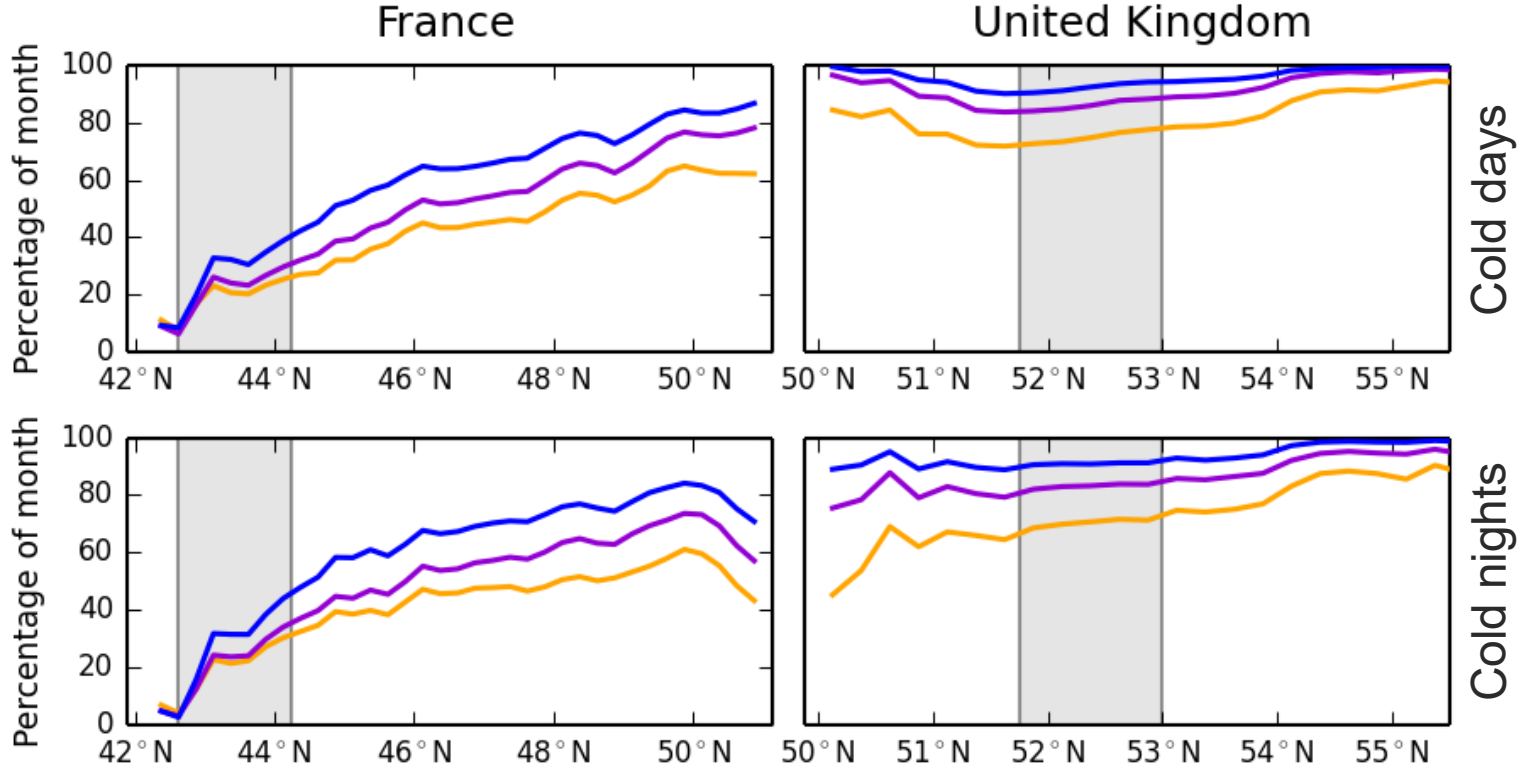
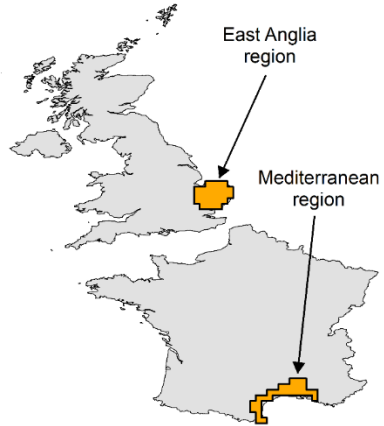
Let TX_{ij} be daily maximum temperature on day i in year j . Count the number of days where:

 $TX_{ij} > 25^{\circ}\text{C}$.
3. **ID, Number of icing days:** Annual count of days when TX (daily maximum temperature) $< 0^{\circ}\text{C}$.

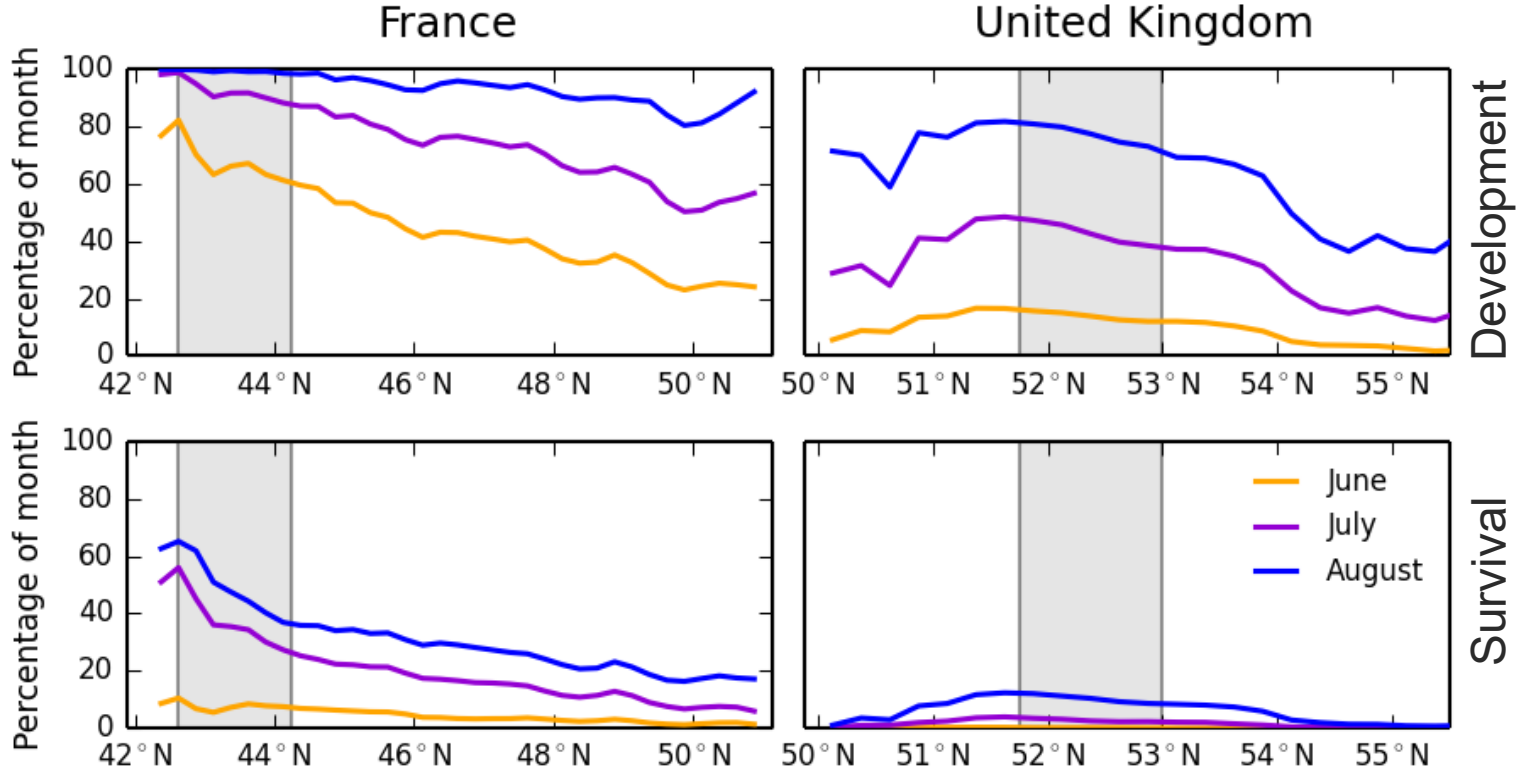
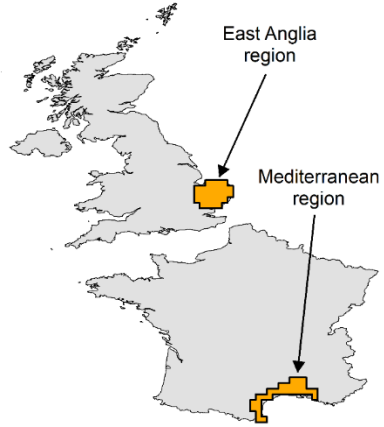
Climate indices to explore other aspects of climate that may be important

Biology-related indices for optimal development and optimal survival

Climate indices to explore other aspects of climate that may be important



Days/nights as cold as the 10th percentile cold days/nights in Mediterranean



Percentage of month with conditions optimal for development and survival

- Degree-day models suggest multiple generations possible outdoors in UK... but none found
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Department
for Environment
Food & Rural Affairs



Met Office
Hadley Centre

So what about climate change?

HadGEM3

CMIP-5

ACCESS1.0

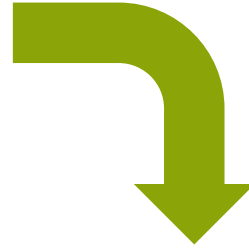
GFDL-ESM2M

HadGEM2-ES

IPSL-CM5A-LR

IPSL-CM5A-MR

MIROC-ESM-CHEM



HadGEM3

**Sea surface temperatures
and
Sea ice extents**

CMIP-5

ACCESS1.0

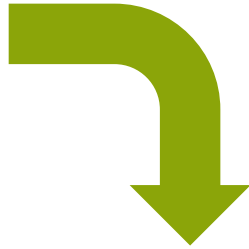
GFDL-ESM2M

HadGEM2-ES

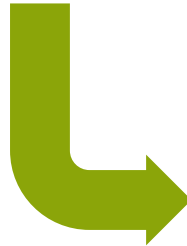
IPSL-CM5A-LR

IPSL-CM5A-MR

MIROC-ESM-CHEM



HadGEM3



HELIX

HadGEM3-ACCESS1.0

HadGEM3-GFDL-ESM2M

HadGEM3-HadGEM2-ES

HadGEM3-IPSL-CM5A-LR

HadGEM3-IPSL-CM5A-MR

HadGEM3-MIROC-ESM-CHEM

HELIX

HadGEM3-ACCESS1.0

HadGEM3-GFDL-ESM2M

HadGEM3-HadGEM2-ES

HadGEM3-IPSL-CM5A-LR

HadGEM3-IPSL-CM5A-MR

HadGEM3-MIROC-ESM-CHEM

Run in atmosphere-only mode

**Sea surface temperatures
and
Sea ice extents**

Atmospheric CO₂

Atmospheric CO₂ concentrations determined by scenarios developed by the International Panel on Climate Change

IPCC

IPPC

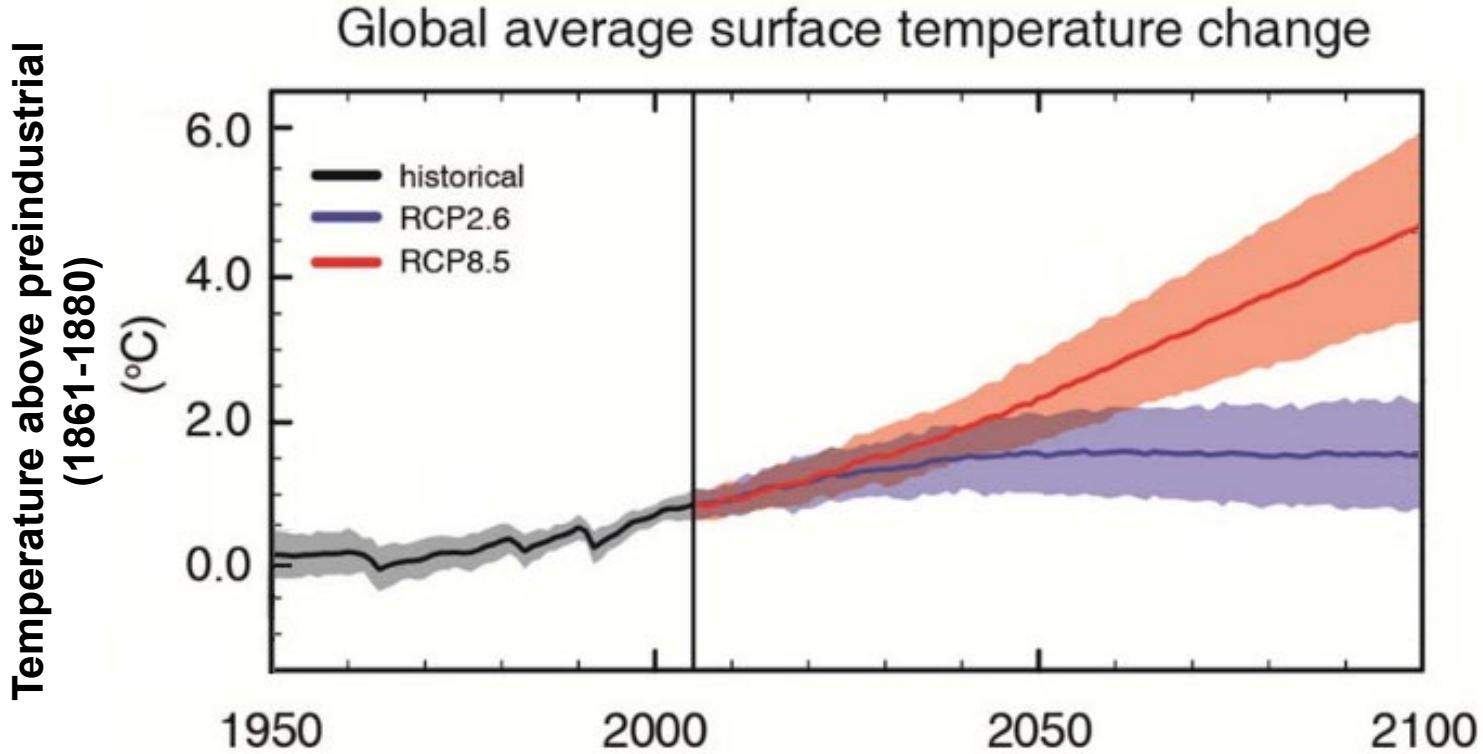


Figure
adapted from
IPCC (2013)

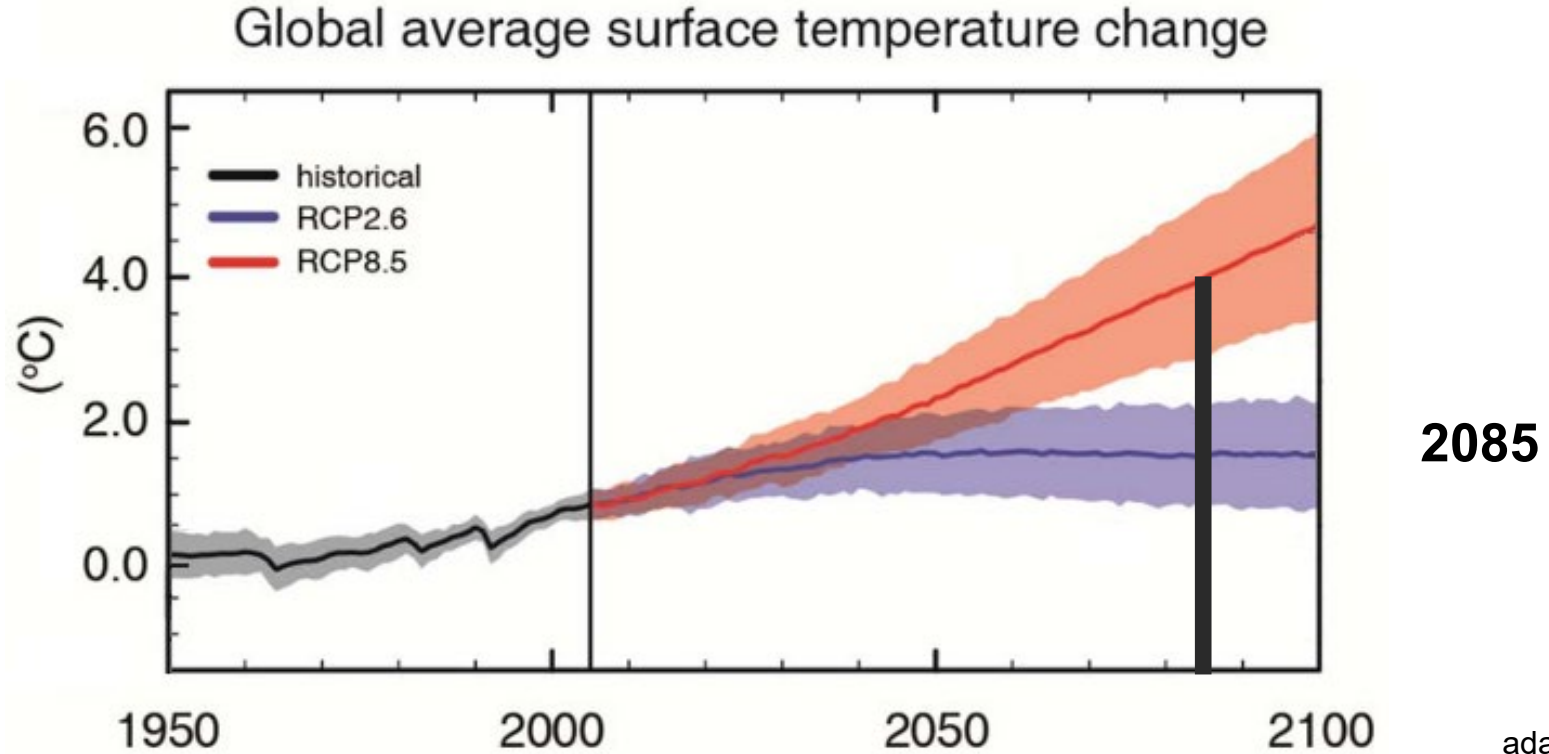


Figure
adapted from
IPCC (2013)

Global average surface temperature change

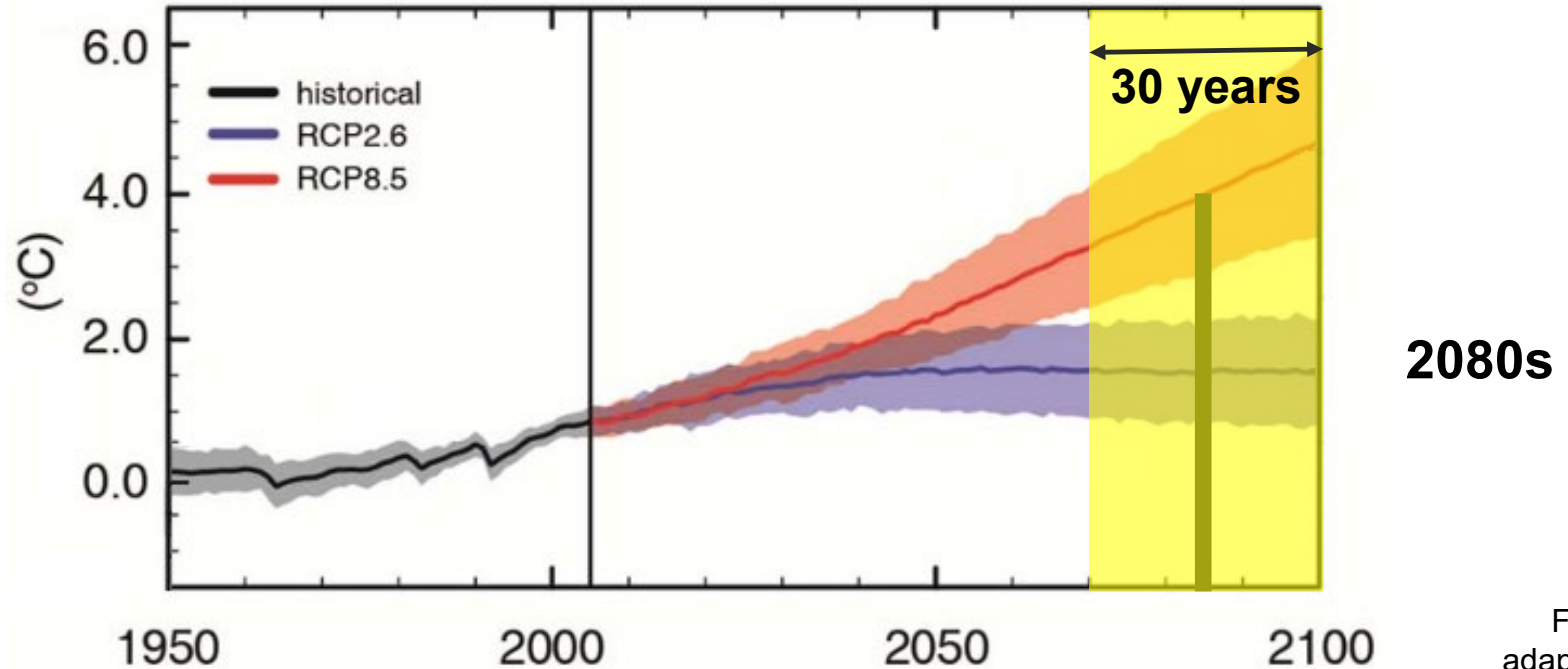


Figure
adapted from
IPCC (2013)

Global average surface temperature change

Temperature
uncertainty

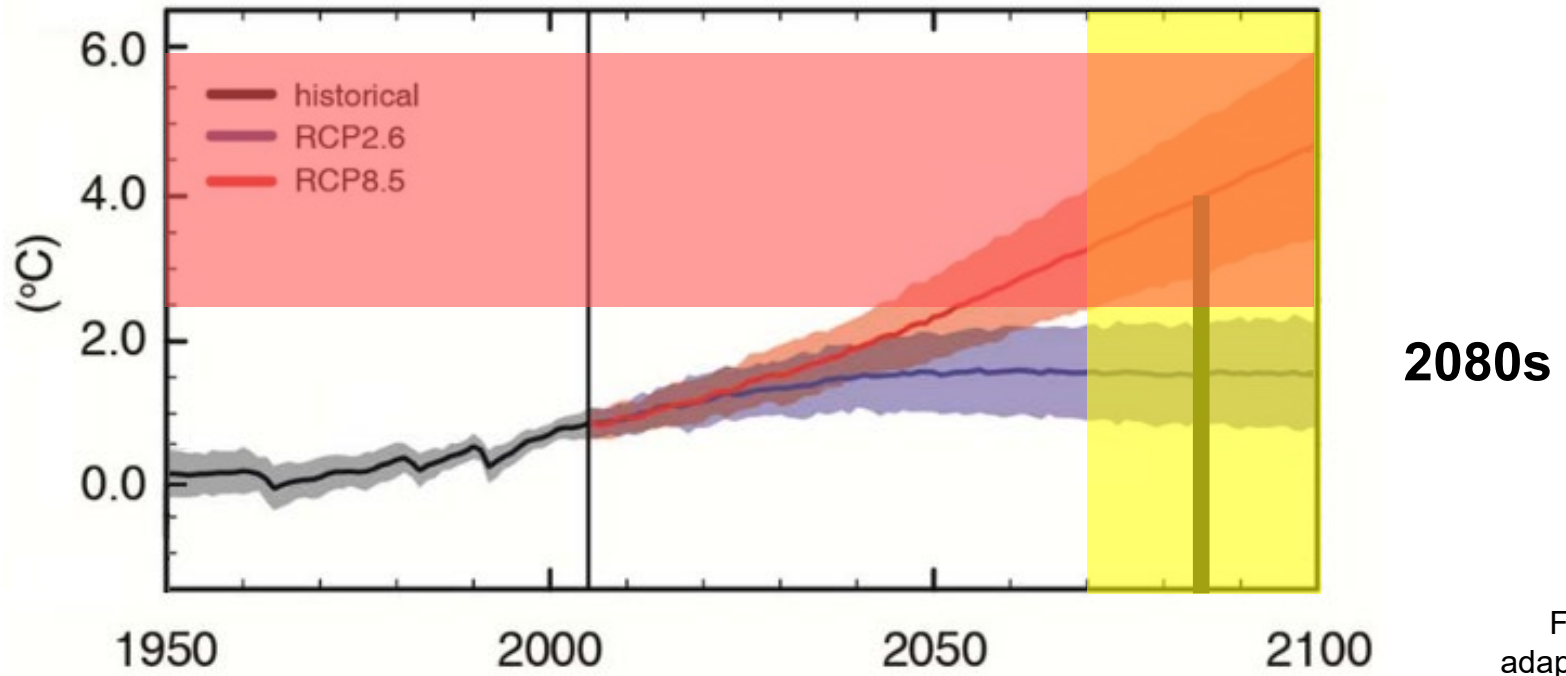


Figure
adapted from
IPCC (2013)

Global average surface temperature change

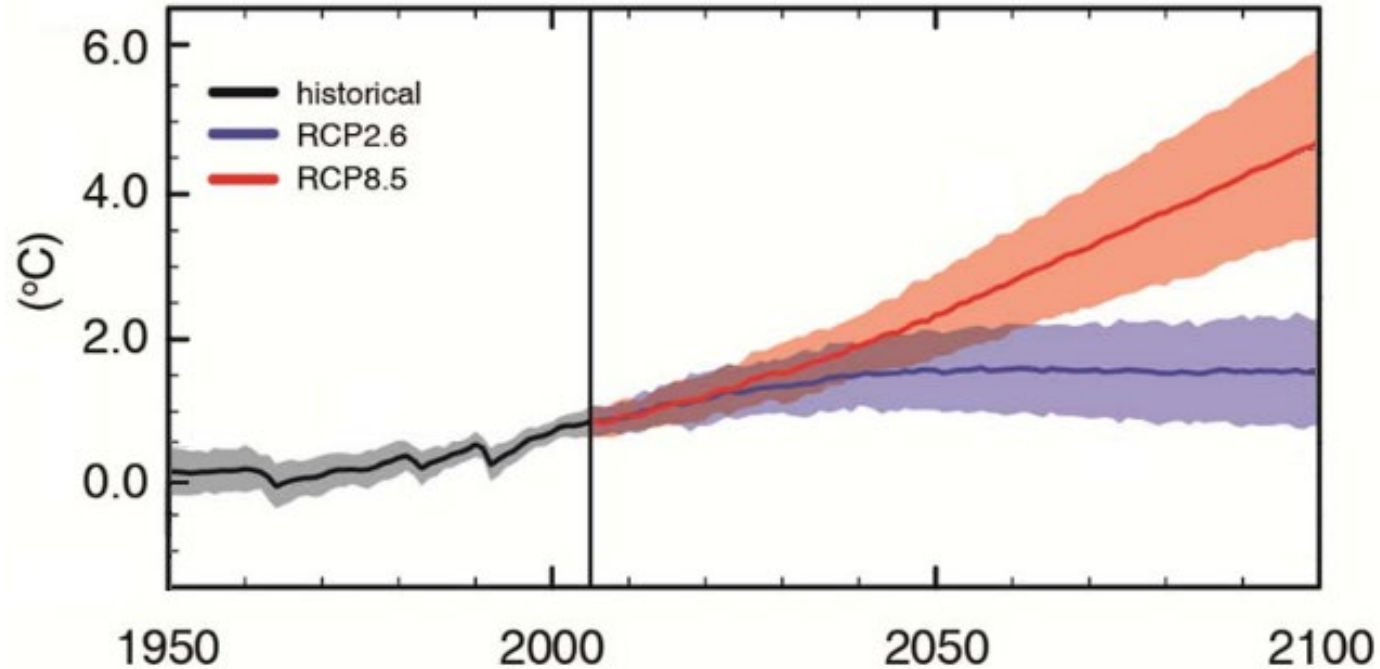


Figure
adapted from
IPCC (2013)

Global average surface temperature change

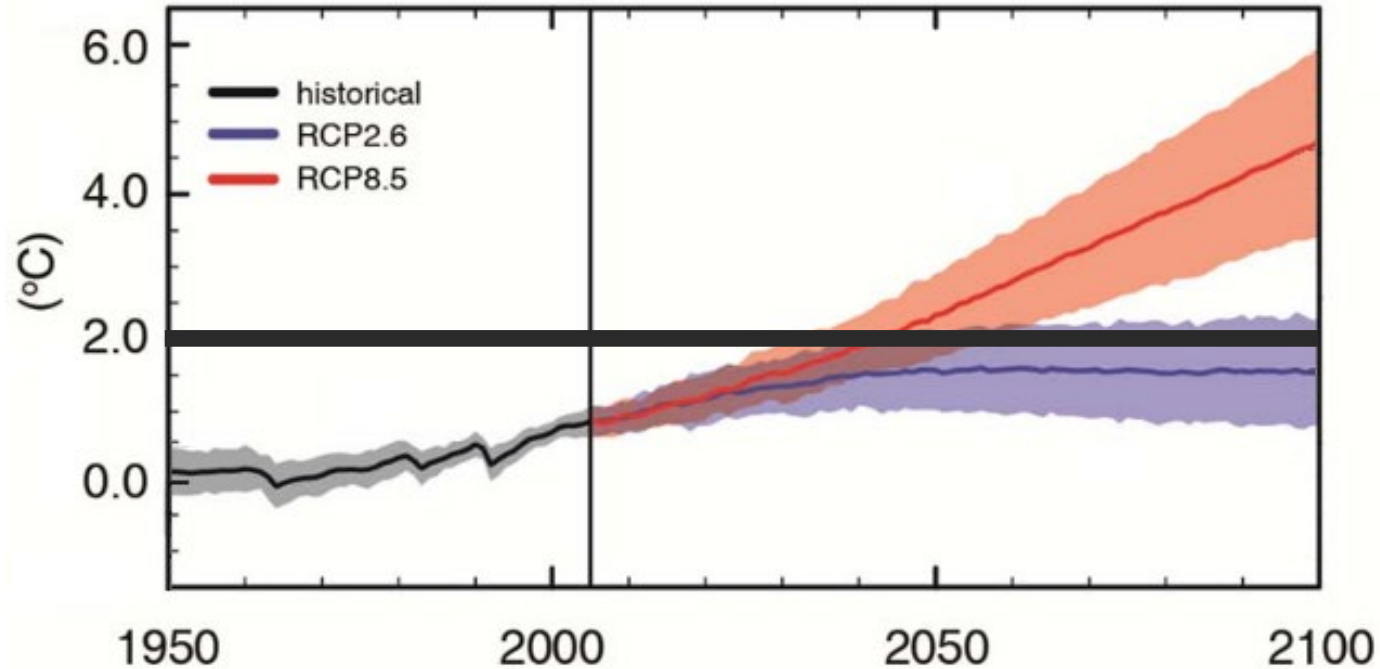


Figure
adapted from
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Global average surface temperature change

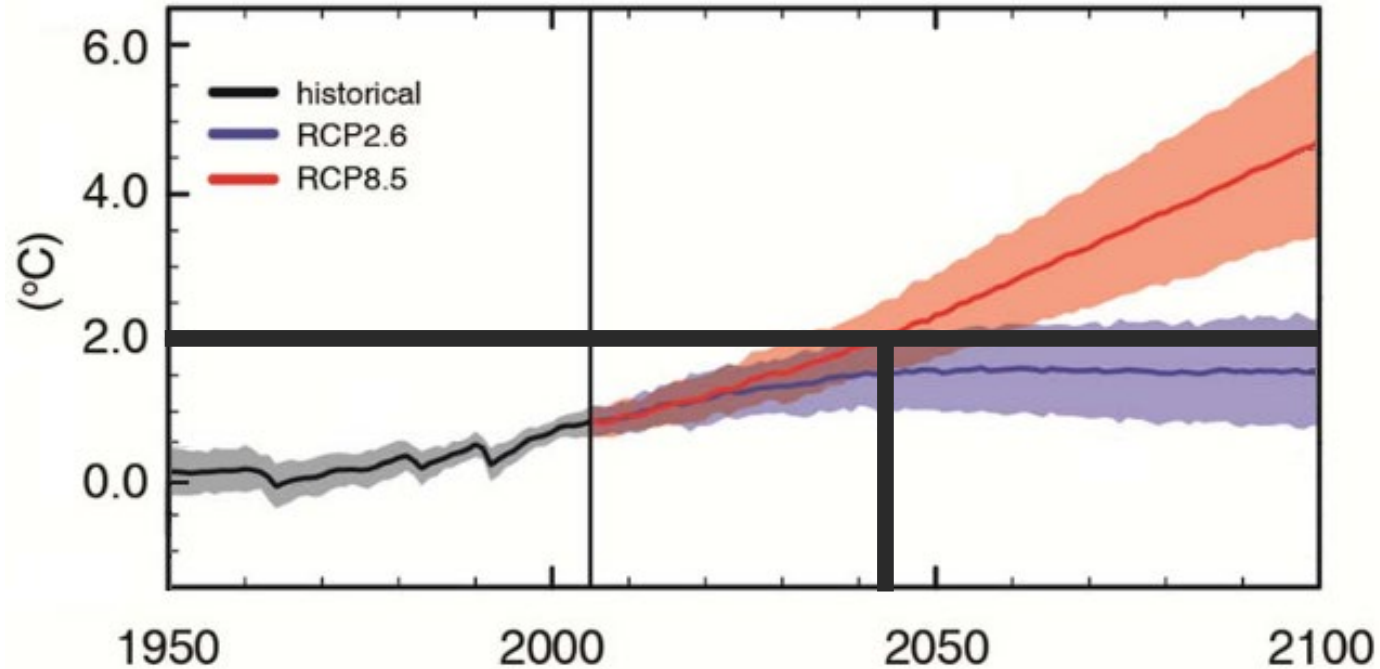


Figure
adapted from
IPCC (2013)

Global average surface temperature change

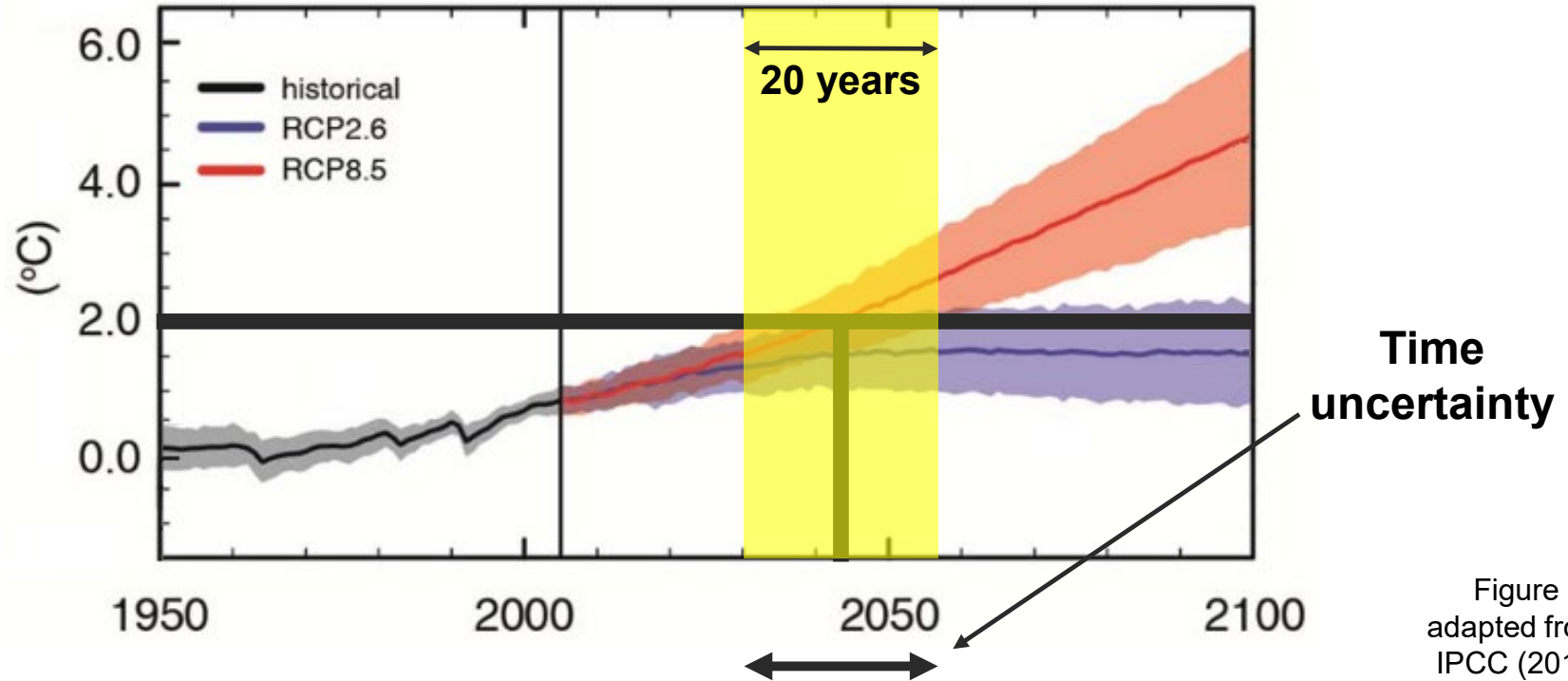
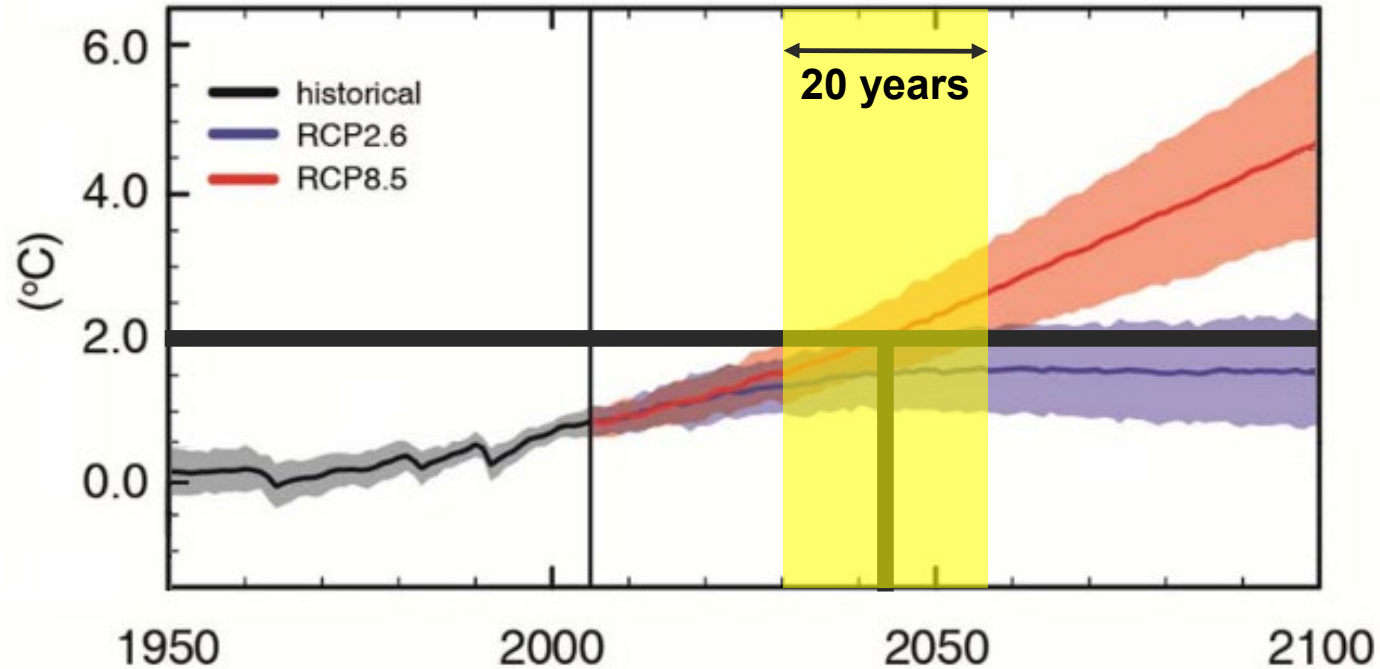


Figure
adapted from
IPCC (2013)

Representative Concentration Pathways

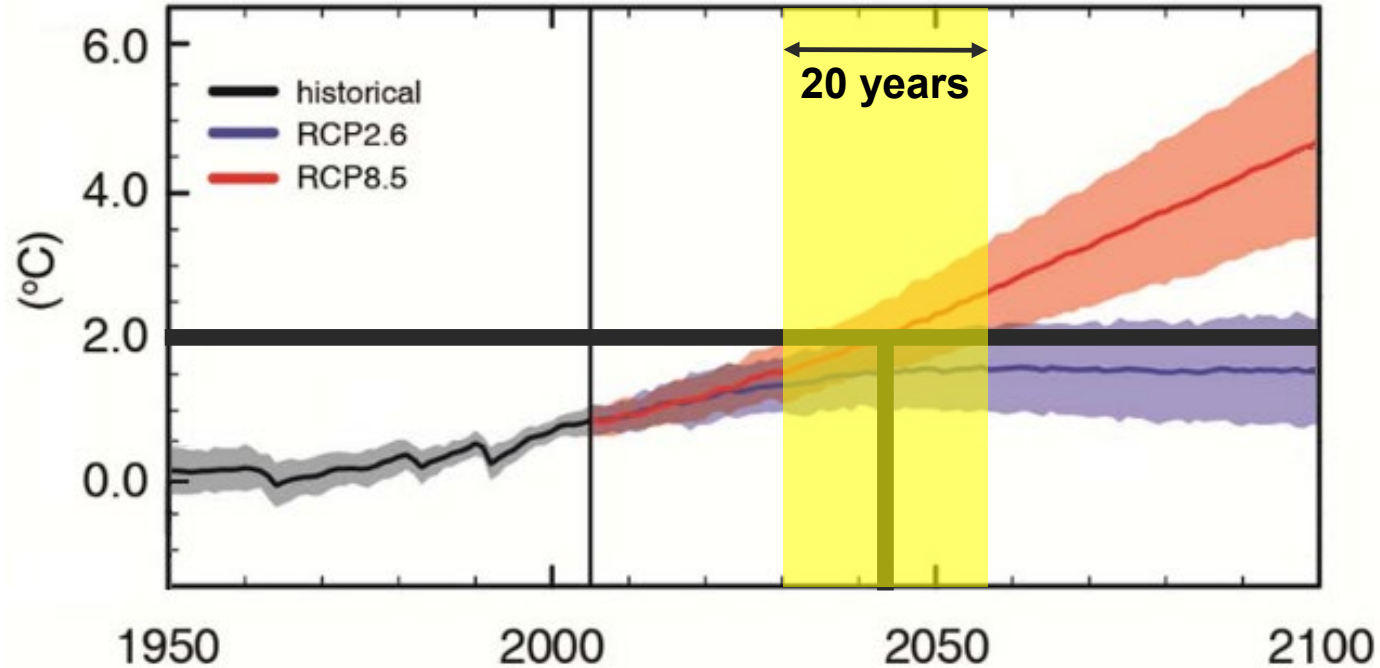
Global average surface temperature change



**Specific
Warming
Level 2
(SWL2)**

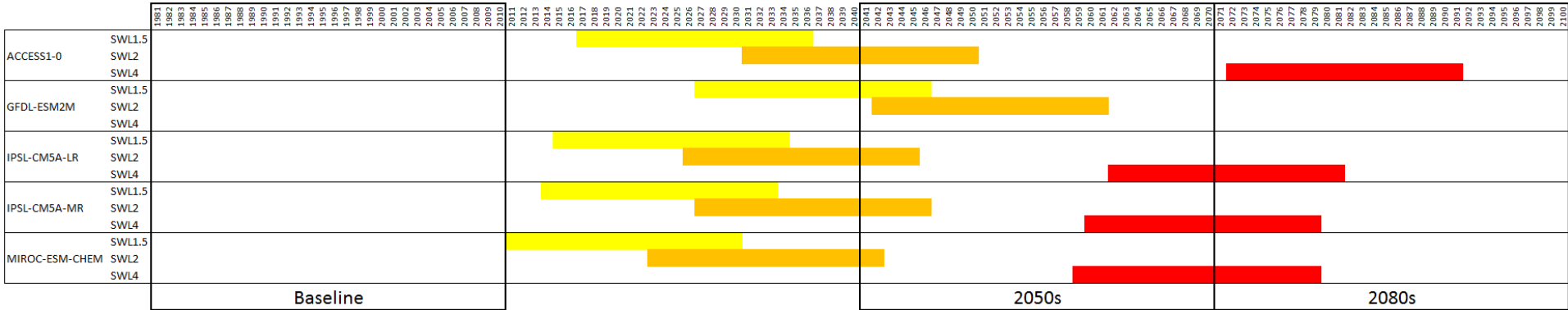
Figure
adapted from
IPCC (2013)

Global average surface temperature change



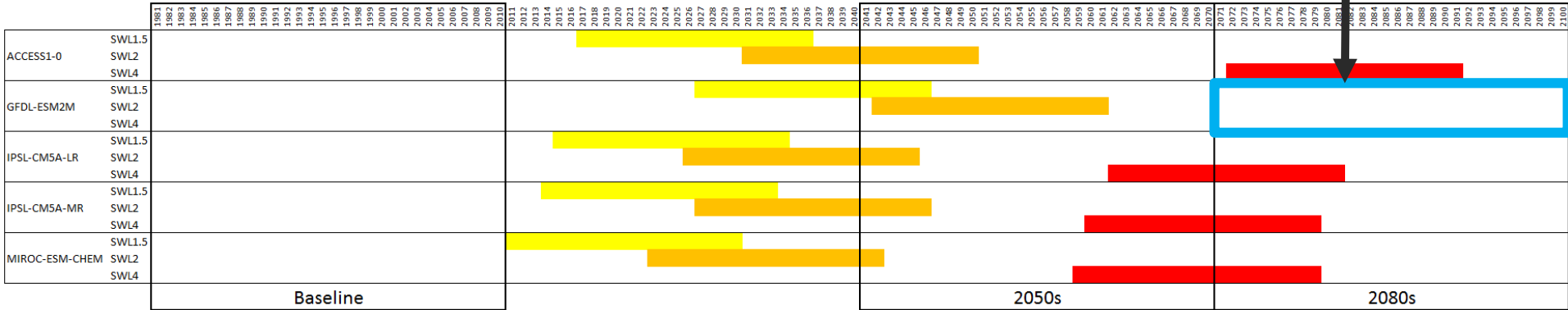
**Global
Warming
Level 2
(GWL2)**

Figure
adapted from
IPCC (2013)

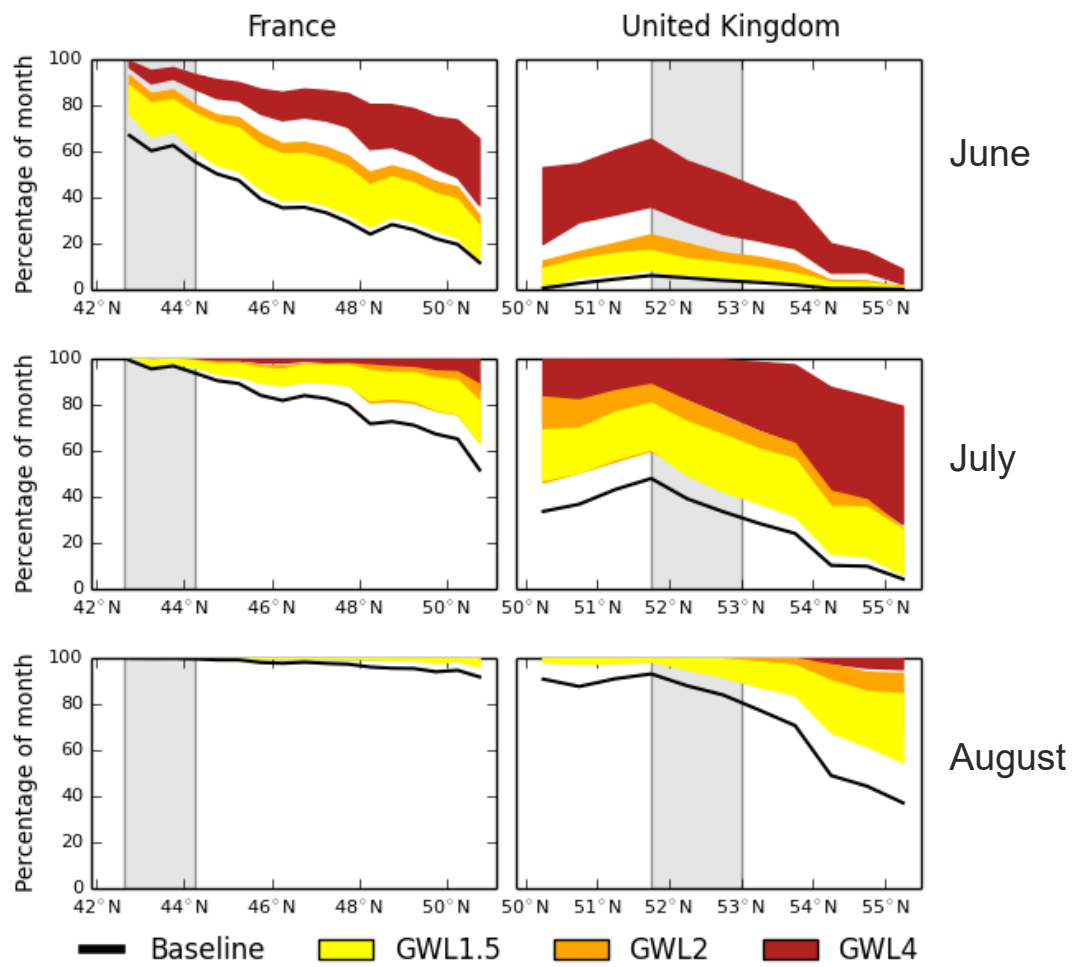
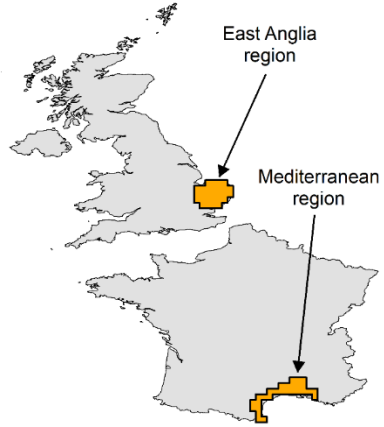


HELIX model GWLs (yellow=1.5°C, orange=2°C, red=4°C)

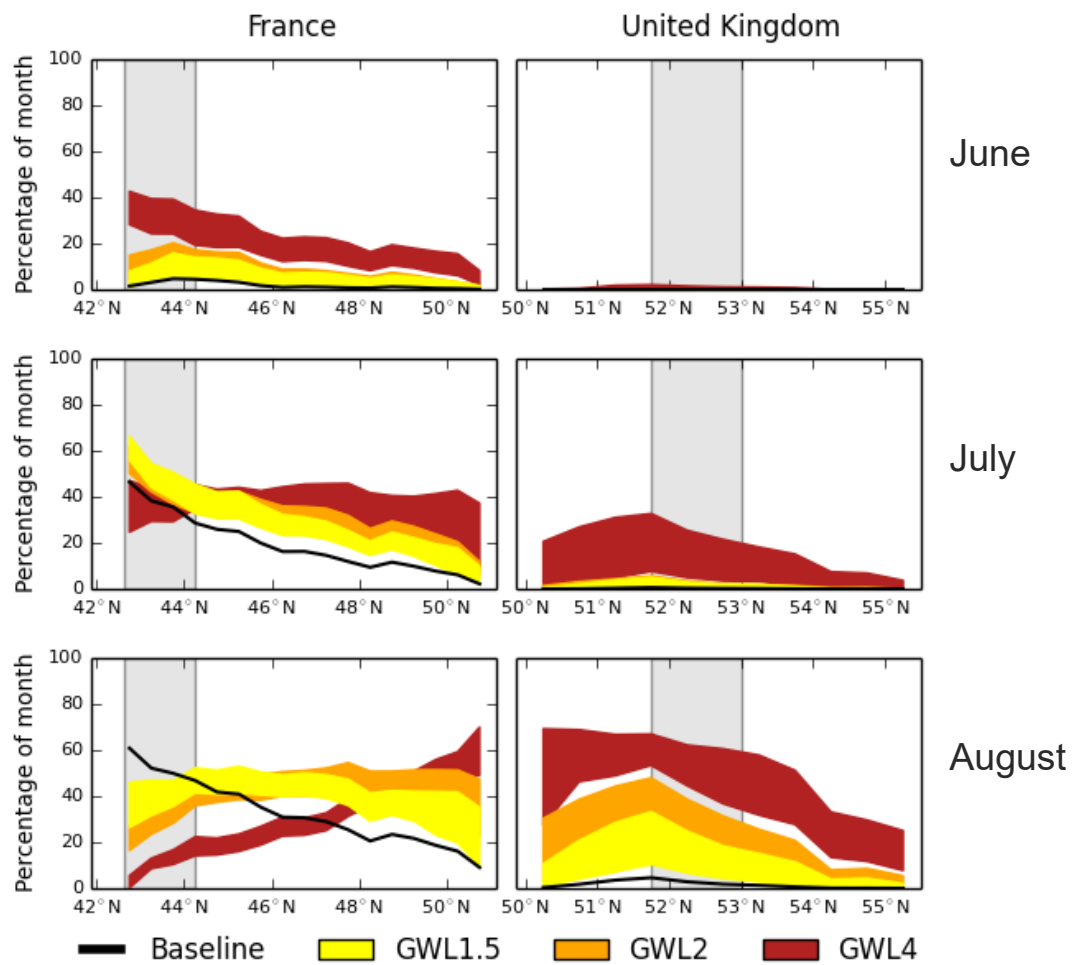
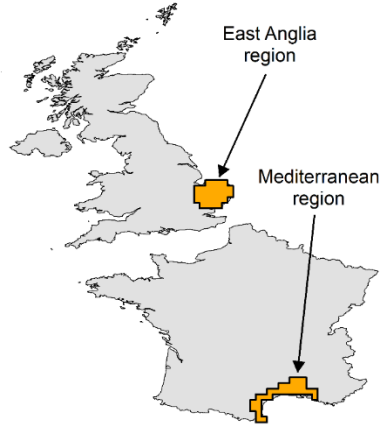
did not reach by 2100



HELIX model GWLs (yellow=1.5°C, orange=2°C, red=4°C)



Percentage of month with conditions optimal for development



Percentage of month with conditions optimal for survival

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- Future climate change **likely to** mean UK climate more amenable to whitefly
- Northward migration within France may indicate increase in risk to UK

Thank you!

