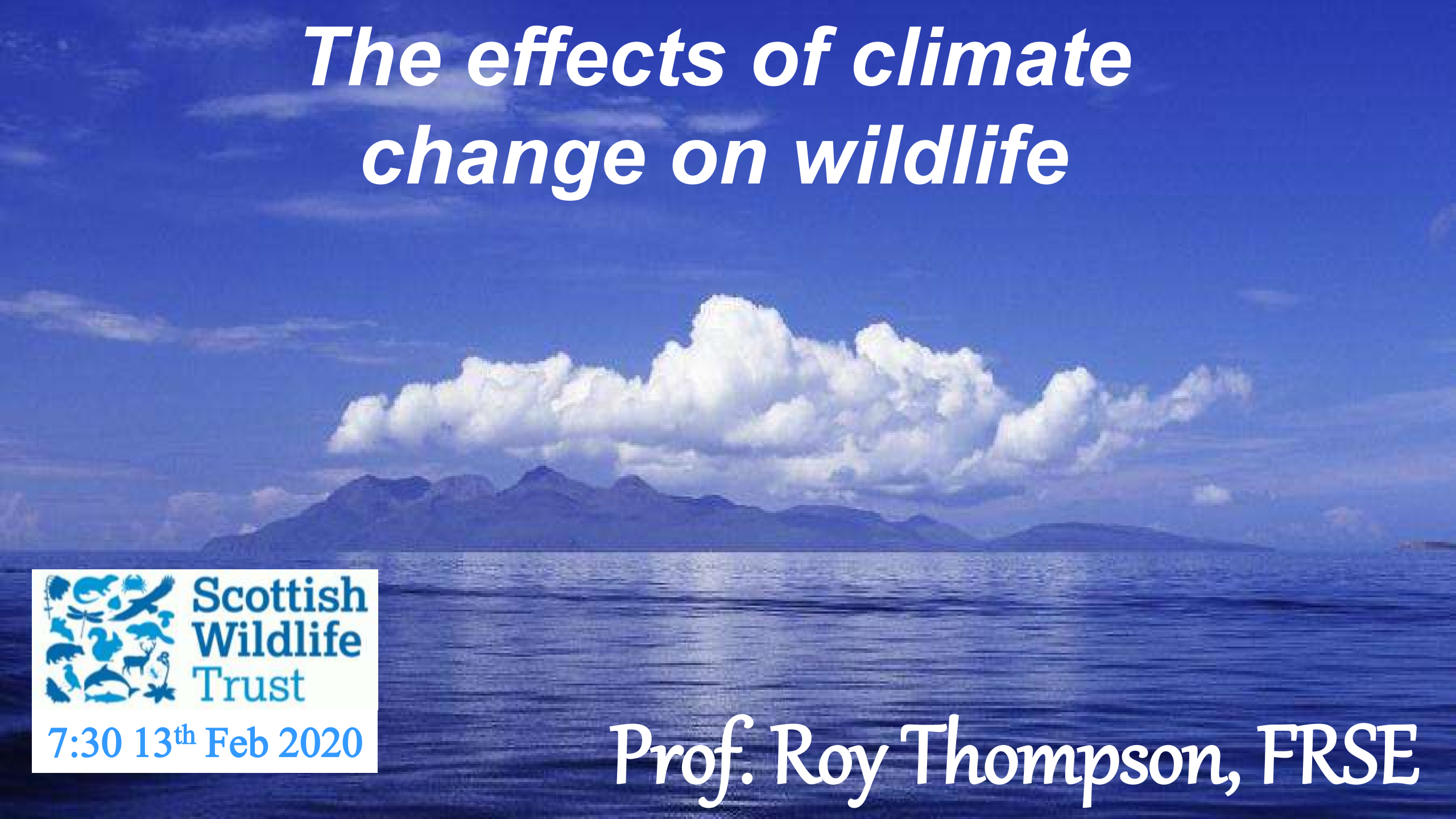
The effects of climate change on wildlife



Scottish Wildlife Trust

7:30 13th Feb 2020

Prof. Roy Thompson, FRSE

A. Is Scotland's climate really changing?

B. What impacts of climate change have already been observed on wildlife?

C. What does the future hold?

itv Live TV Shows Categories News

NEWS Top stories Your area Topics Sport Weather

ITV REPORT 3 January 2019 at 12:03am

Scotland's famous wildlife faces catastrophic damage from climate change: report

The repo
Photo: handout/PA

ercaillie and the
has warned.
Rising sea temperatures could mean cold water species, such as the white beaked dolphin, are

and Scottish Environment LINK, added.

Th
di
re

could be at risk from climate change

Rising temperature could mean

Salmon rivers may lose fish as temperatures rise

the impact climate change could have

INDEPENDENT

NEWS POLITICS VOICES SPORT

-0:00

Climate 'apocalypse' to leave Scotland with abandoned villages, doomed forests and no birdsong within decade

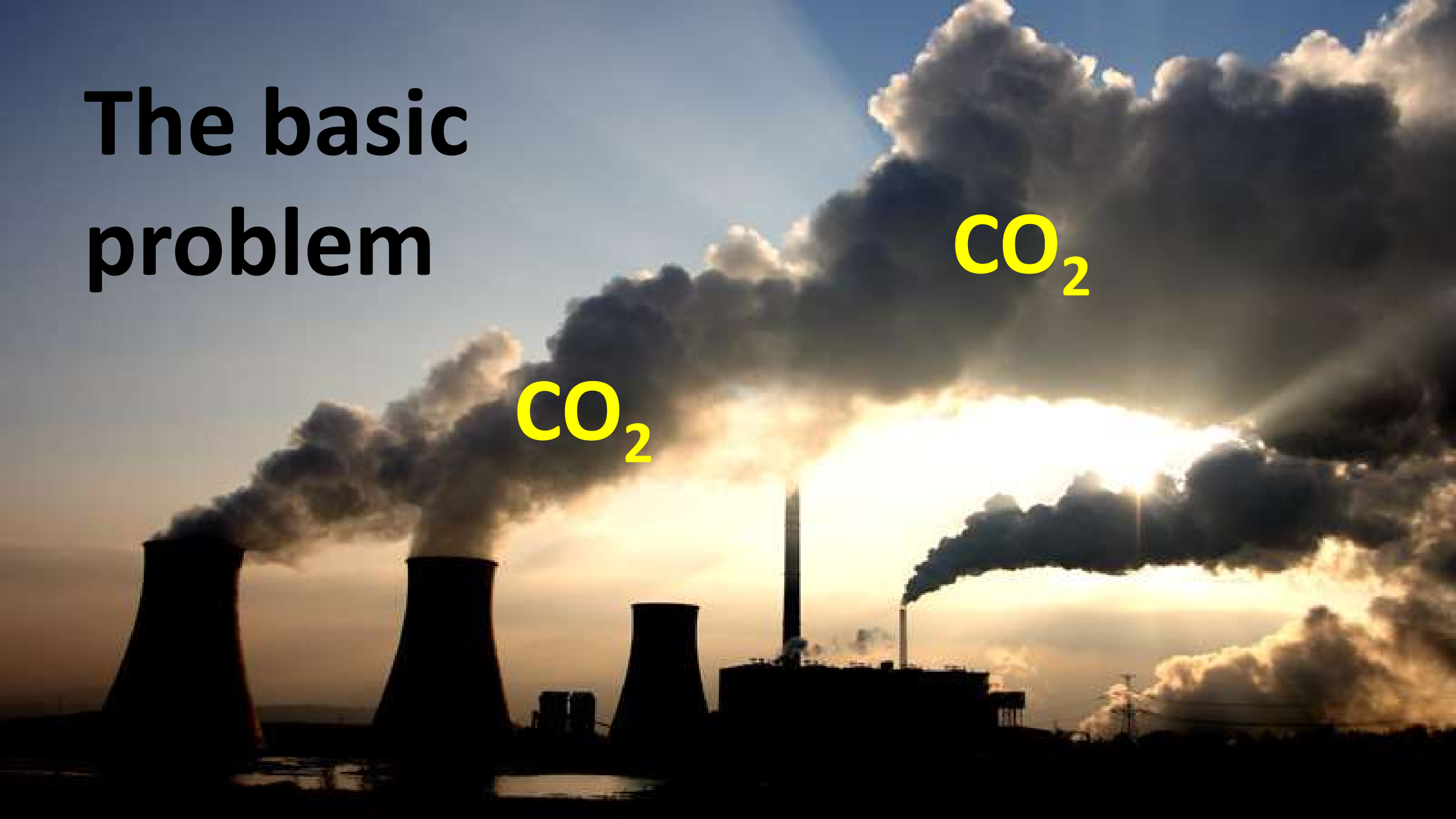
Warming world and commercial pressures putting country at risk of severe degradation, Scottish Natural Heritage warns

Thursday 30 May 2019 14:42 | 63 comments

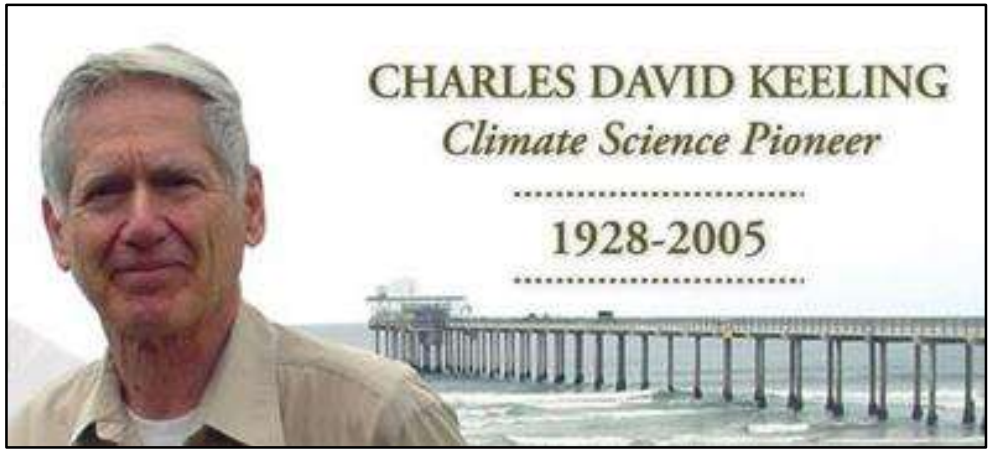
Scotland faces numerous catastrophic impacts from the climate crisis
which could leave the co
dying forests and few re
environment agency is t

the climate crisis which could ...

The basic problem



Atmospheric CO_2 at Mauna Loa Observatory



PARTS PER MILLION

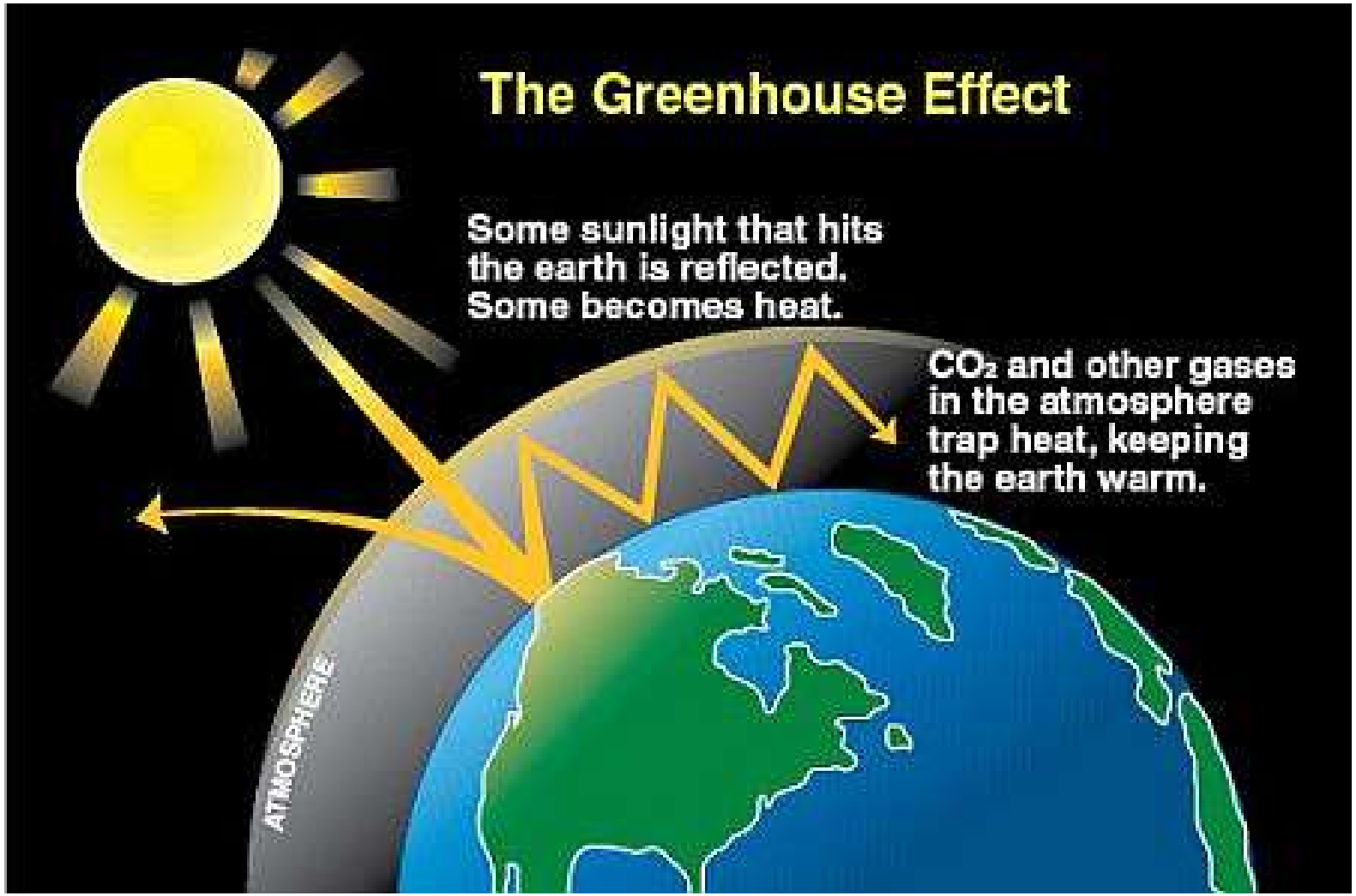
400
380
360
340
320

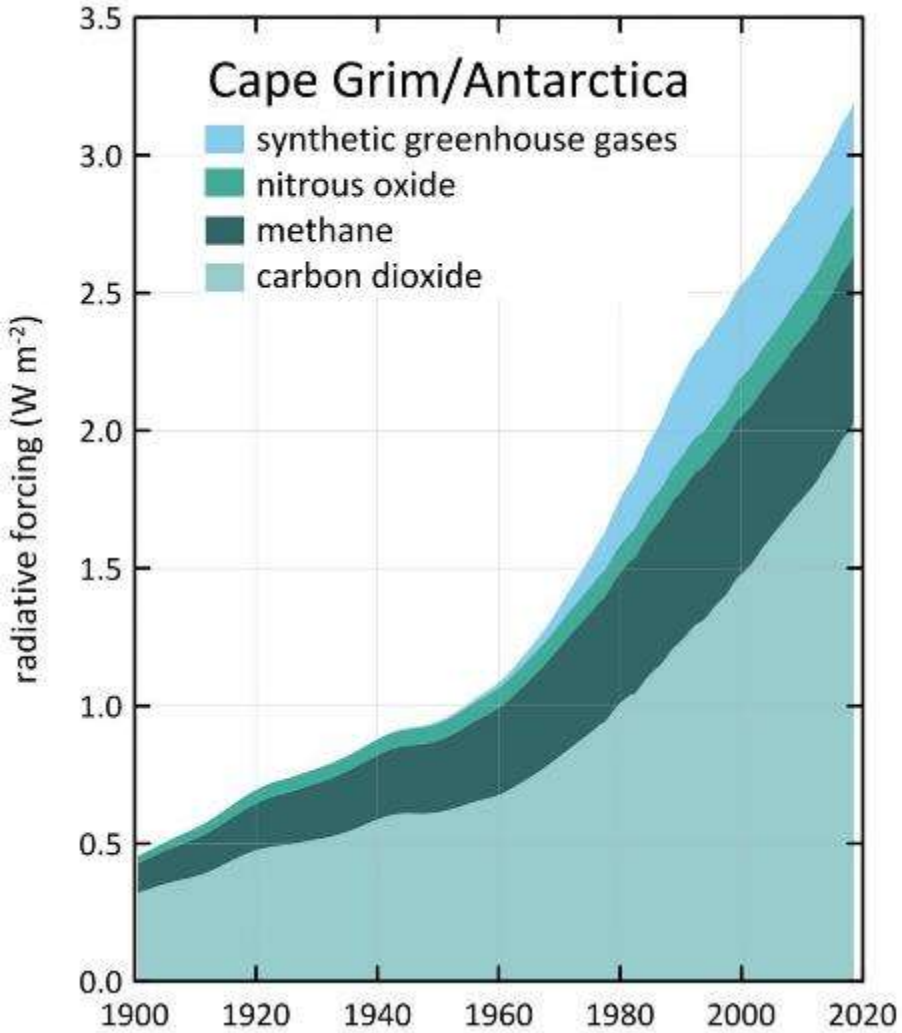
1960 1970 1980 1990 2000 2010 2020

YEAR

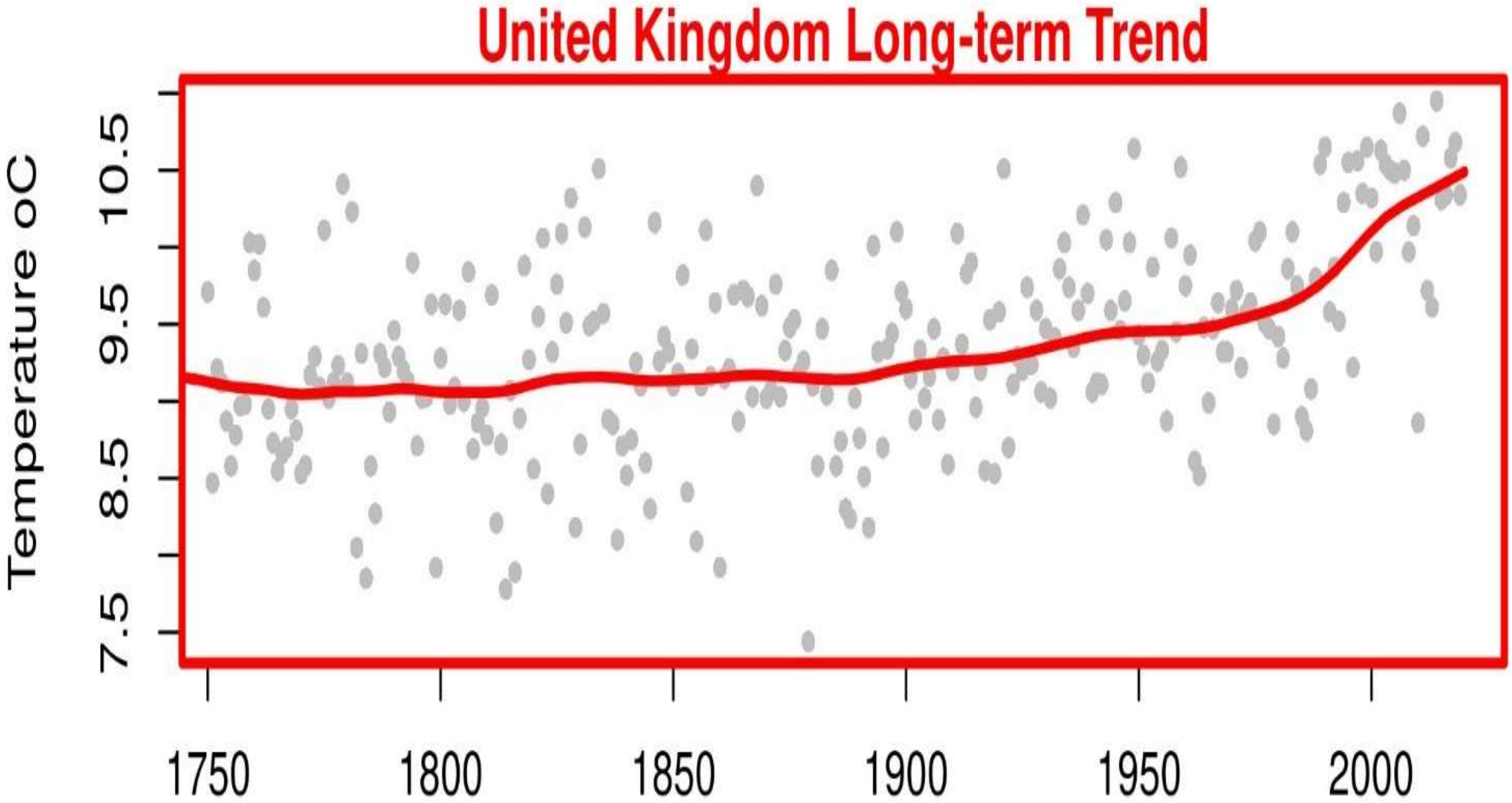
CO_2 still accelerating

February 2020

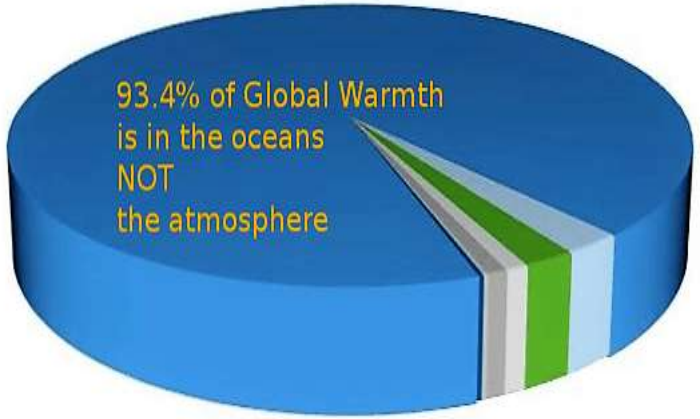


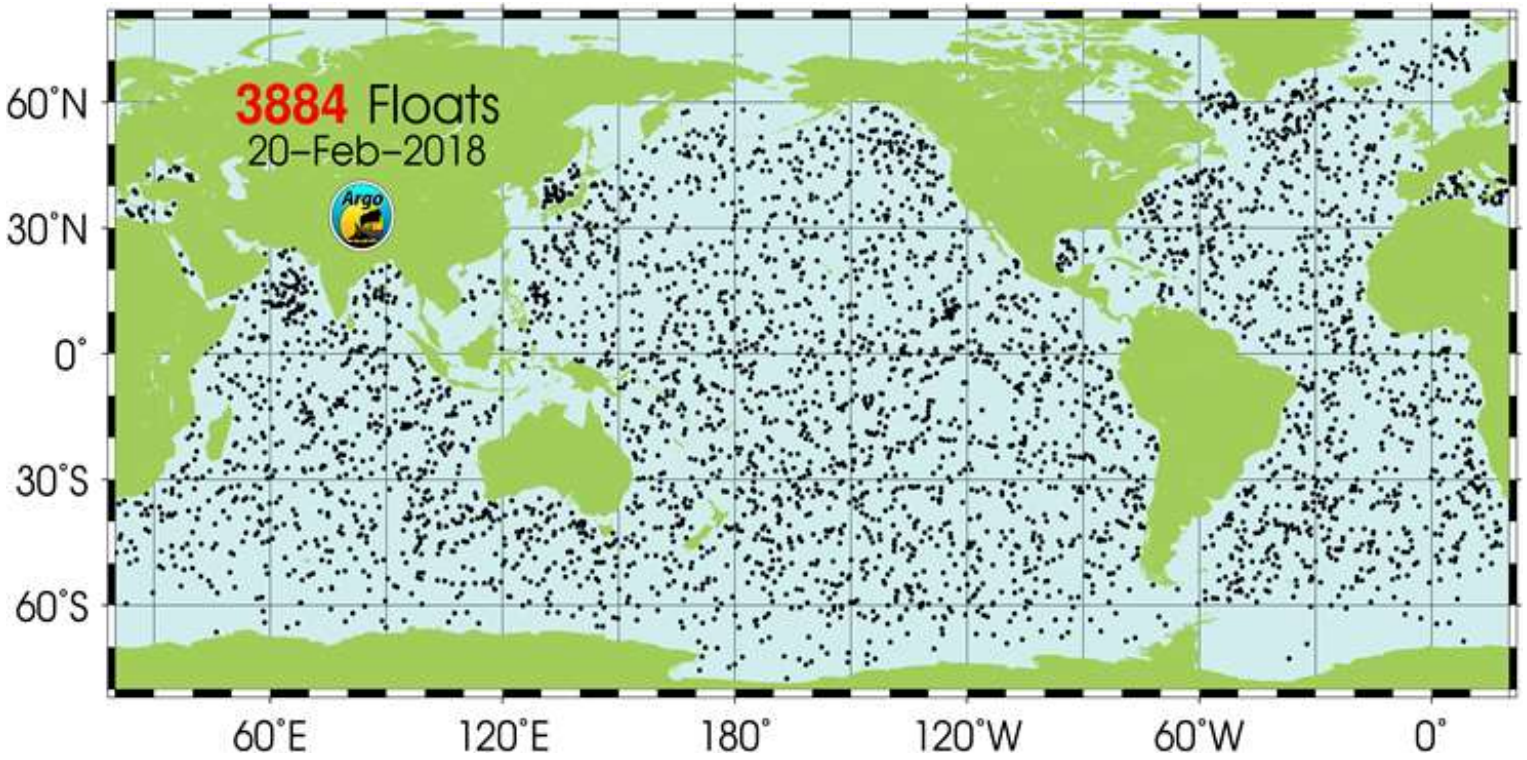


Over the past century human activities have increased atmospheric concentrations of greenhouse gases – CO_2 is the most important. It has caused about 65% of the warming.

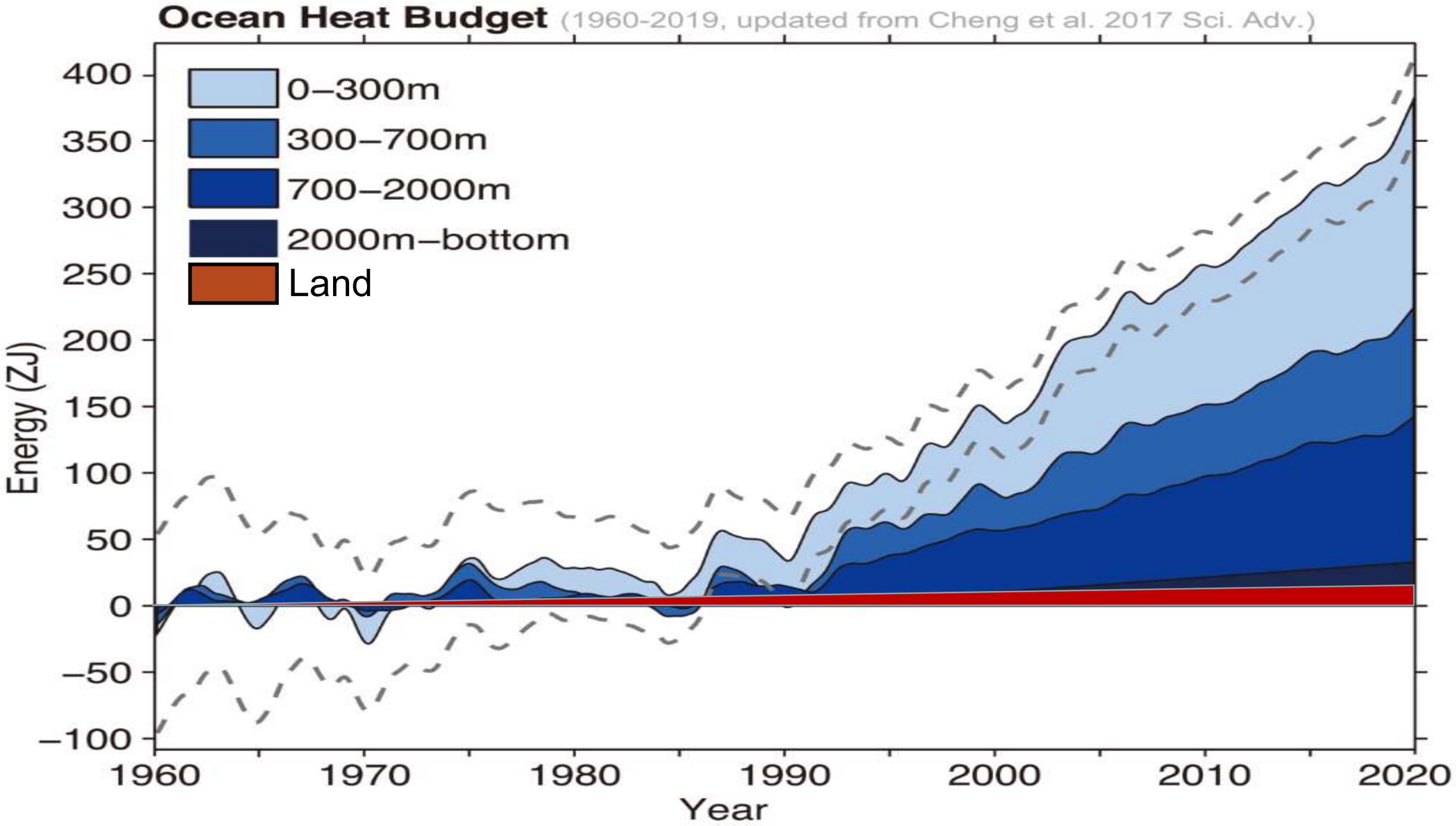

United Kingdom Long-term Trend
Temperature oC
7.5
8.5
9.5
10.5
1750
1800
1850
1900
1950
2000

Where is greenhouse warmth going?



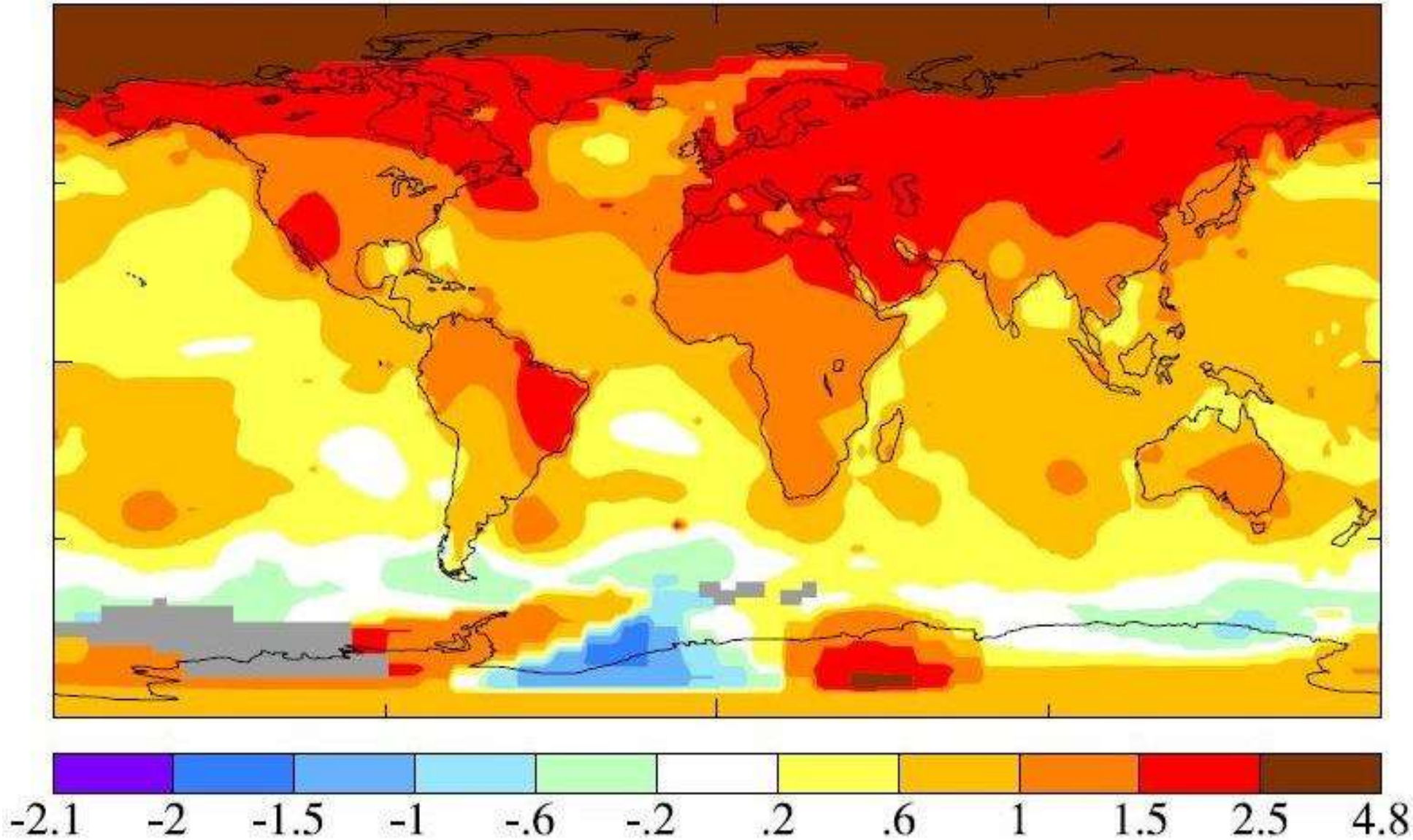


Boris Johnson holding an Argo float used for ocean temperature and salinity measurement.


Ocean Heat Budget (1960-2019, updated from Cheng et al. 2017 Sci. Adv.)
0–300m
300–700m
700–2000m
2000m–bottom
Land
Energy (ZJ)
400
350
300
250
200
150
100
50
0
−50
−100
1960
1970
1980
1990
2000
2010
2020
Year

Surface Temperature Change (°C)

Last 50 Years (1968-2018) 0.92 °C



Dragonflies

Emperor Dragonfly (*Anax imperator*)

The Big Trek Northwards:

Recent Changes in the European Dragonfly Fauna

JÜRGEN OTT, 2010

Dragonflies are one of the best groups to document the effects of climate change: they are mobile generalists, depend on aquatic habitats, their biology and ecology are well known, they are attractive animals and easy to identify, many are strong fliers, and finally their range expansion has been studied for a long time.

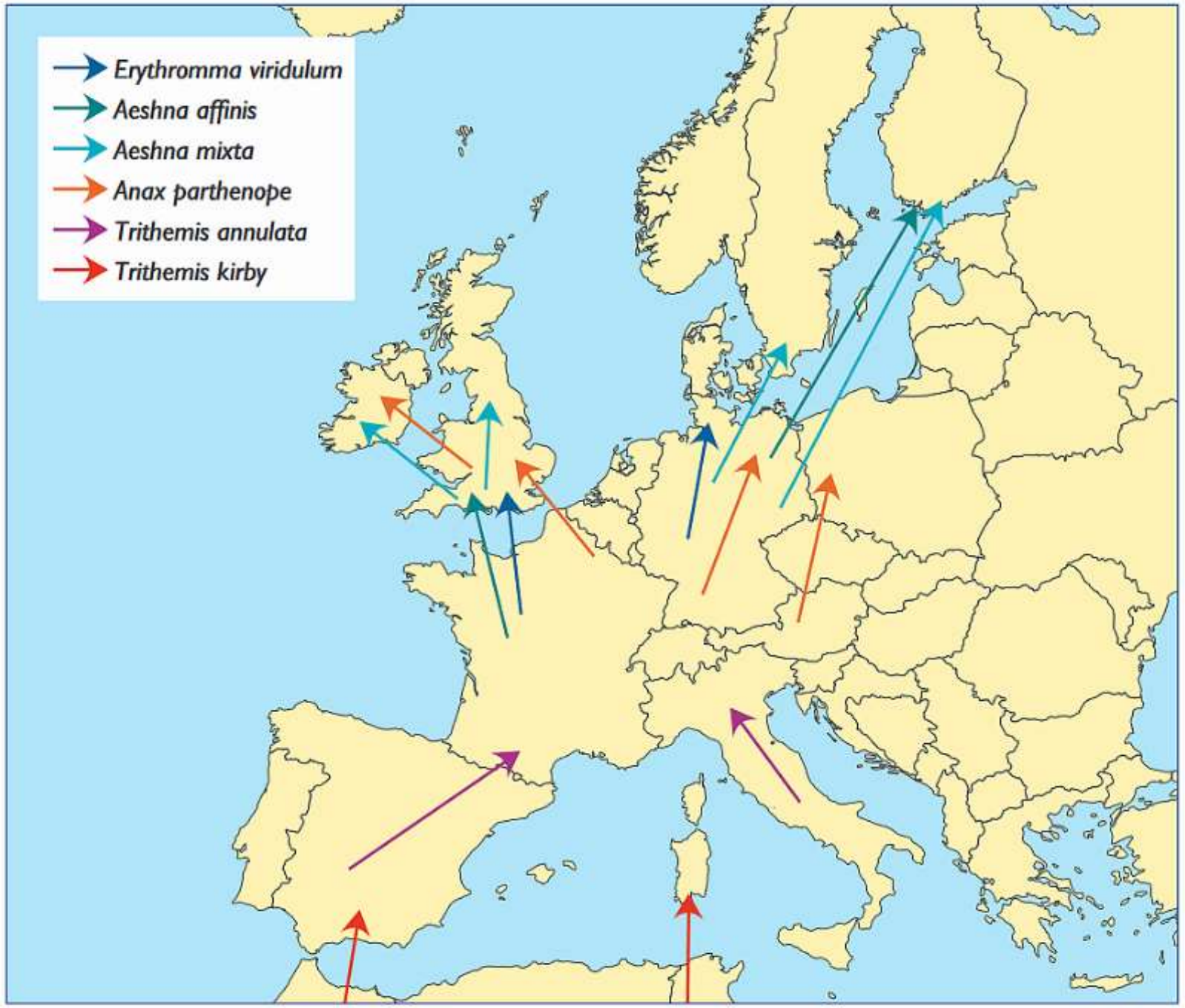
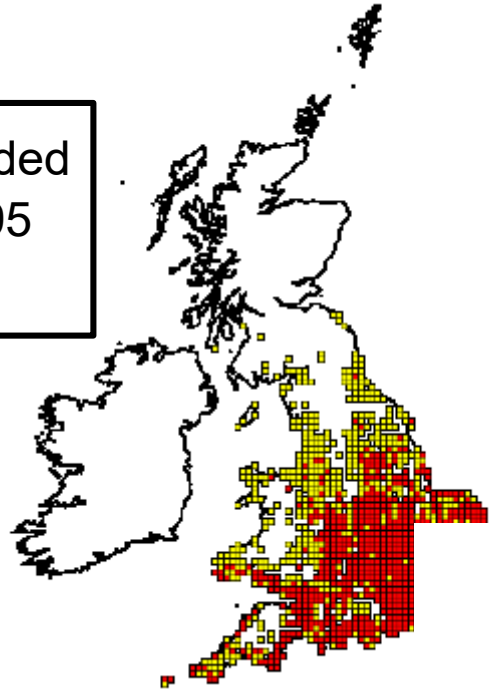


Figure 2. Range expansion of Mediterranean and African Odonata in Europe – some examples.

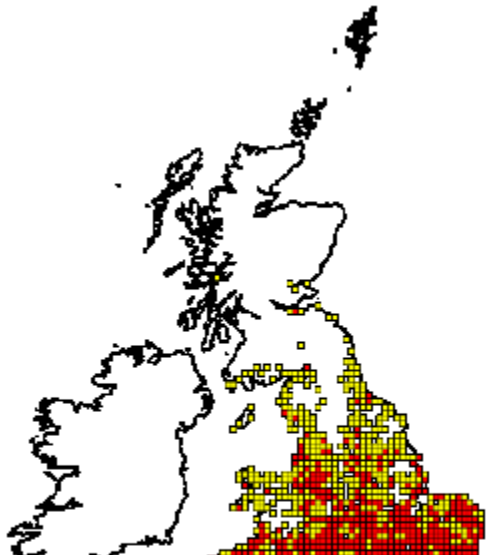
Four southern species of dragonfly shov
on into Scotland since 19

- First recorded before 1995
- After 1995

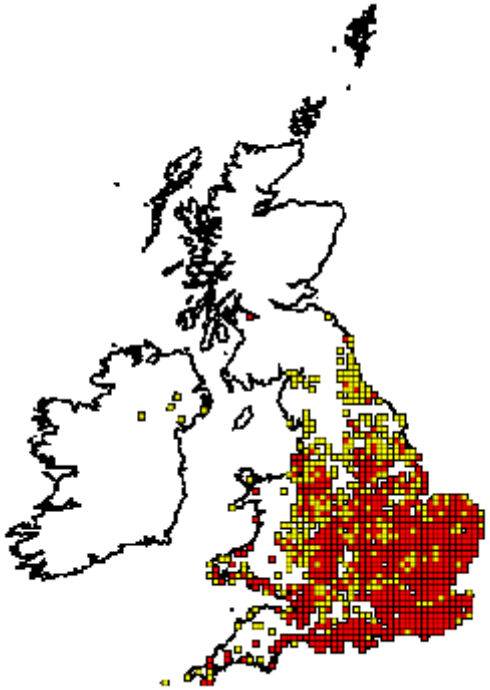


mixta

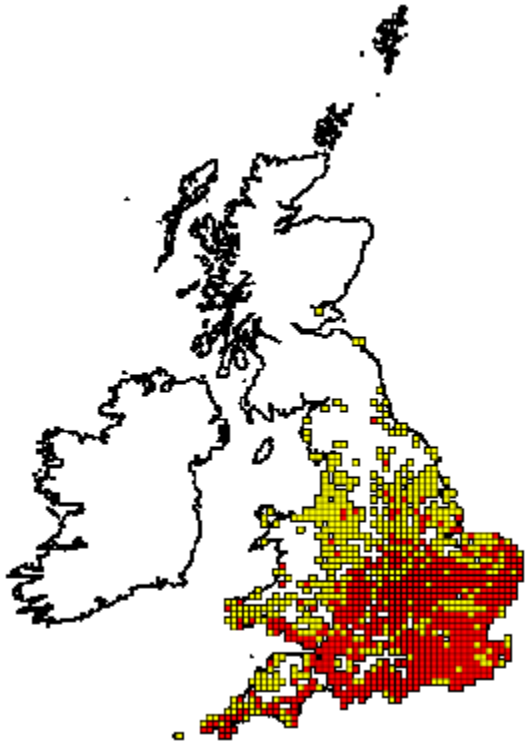
A. imperator

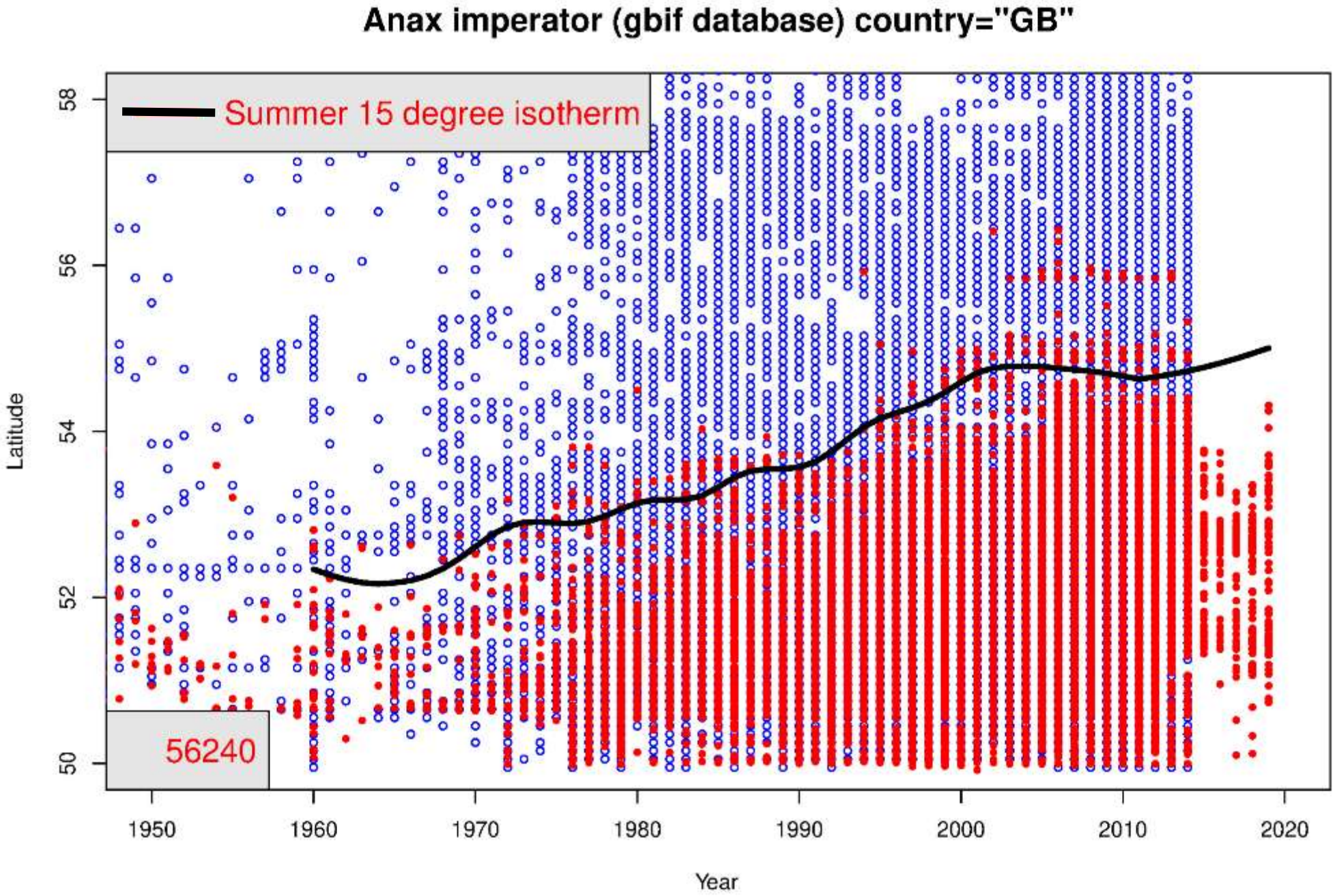


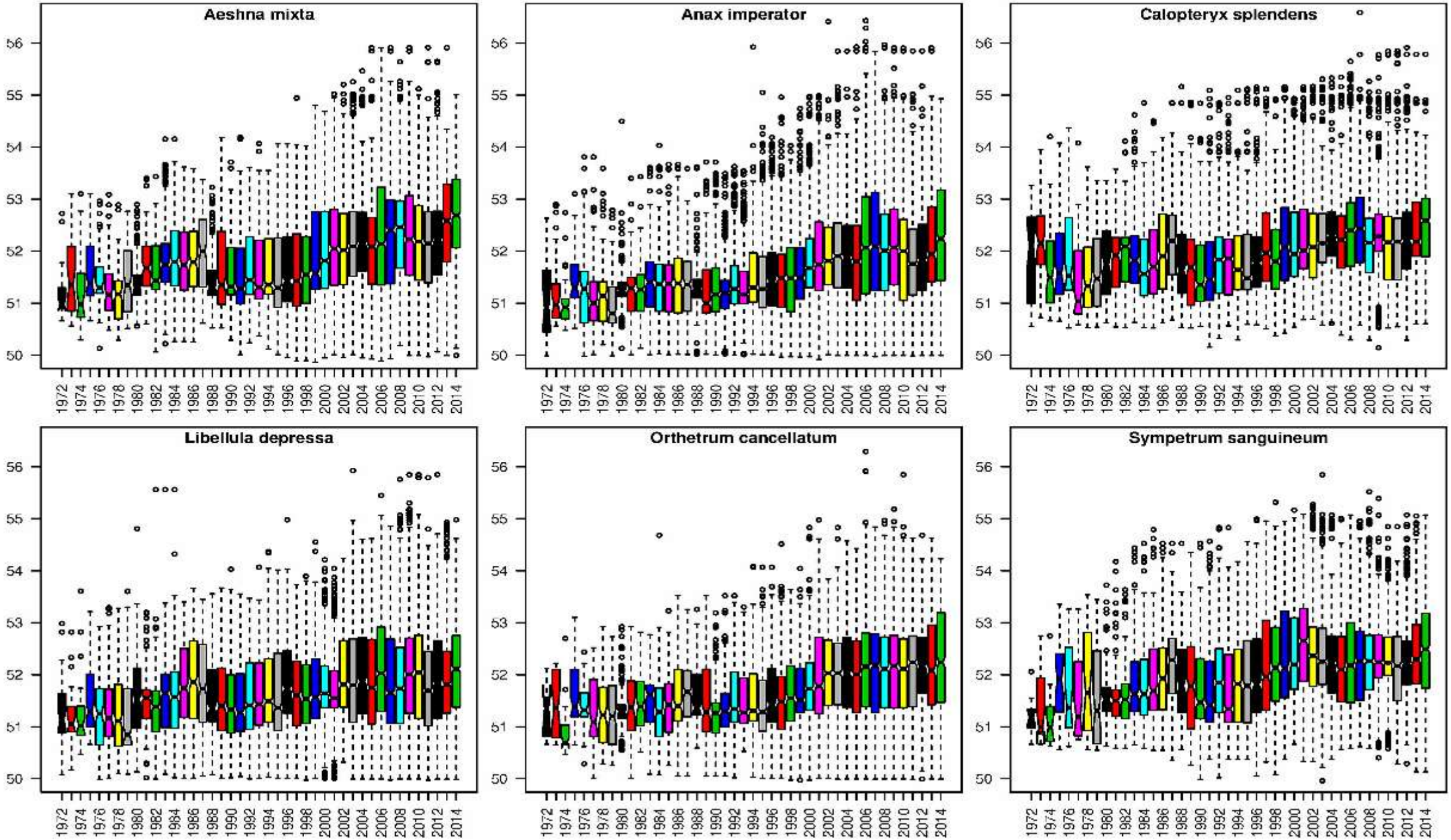
S. sanguineum



O. cancellat




Anax imperator (gbif database) country="GB"
Summer 15 degree isotherm
56240
Latitude
Year
50
52
54
56
58
1950
1960
1970
1980
1990
2000
2010
2020


Aeshna mixta
Anax imperator
Calopteryx splendens
Libellula depressa
Orthetrum cancellatum
Sympetrum sanguineum
50
51
52
53
54
55
56
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014

Treelines

Creag Fhiaclach,

Cairngorms - the UK's most famous natural treeline - a pine/juniper-scrub complex on a rocky, northwest-facing slope. It forms the best natural treeline in the whole of Britain.

Photo credit
J Grace

Pine regeneration on Meall a'Bhuachaille in the Cairngorms.

Climate change or reduced grazing pressure (red deer < 3.5/km^2)?

Effect of reducing red deer density on Scots pine seedlings in the Cairngorms.

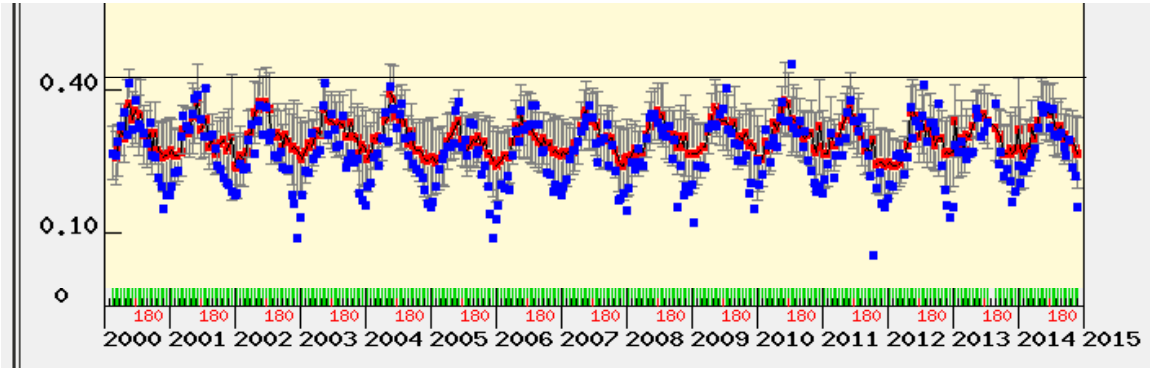
Seedling growth increased once red deer numbers were maintained below 3.5/km^2.

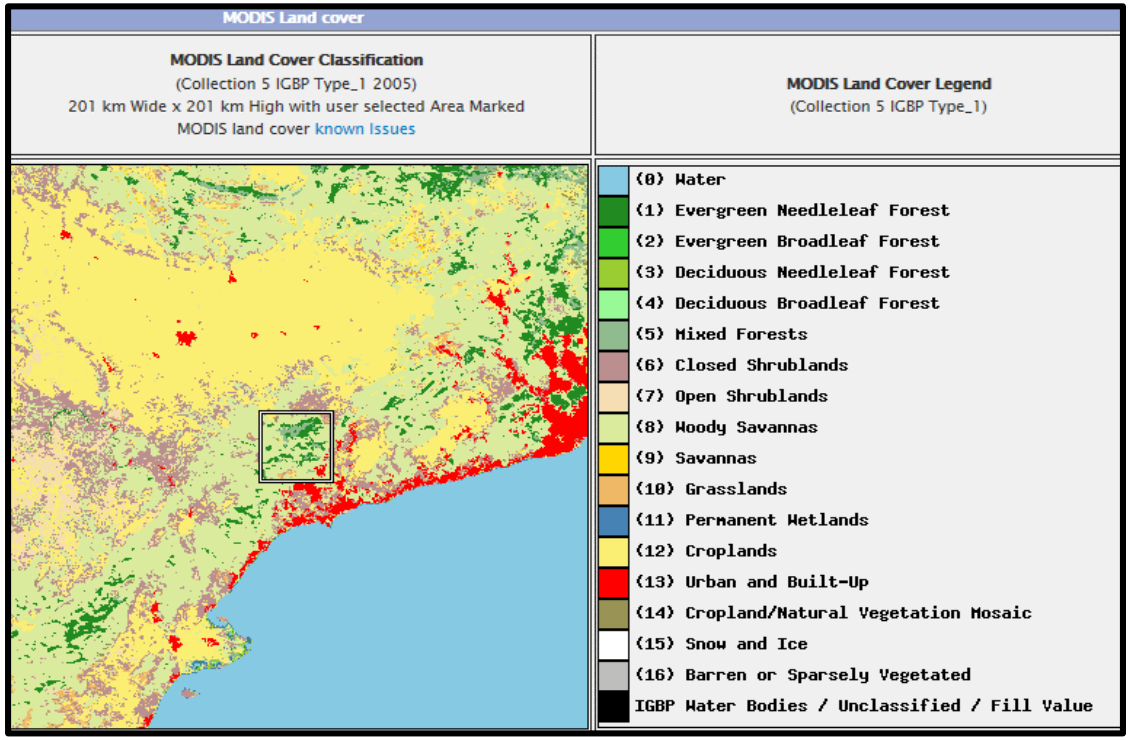
8. Photos illustrating the tree seedling growth within two quadrats between 2005 (left) and 2016 (right).

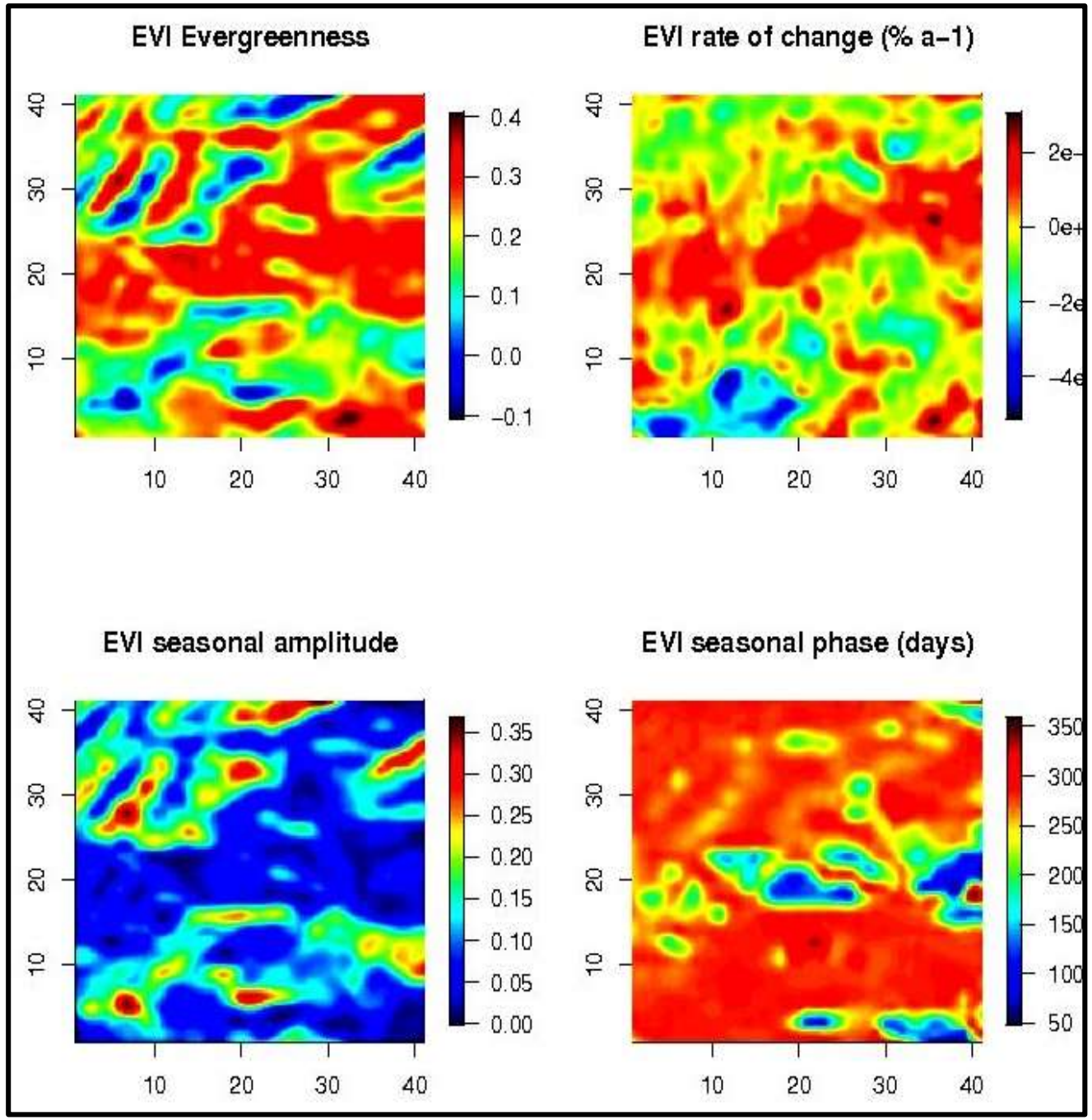
Living on the edge: Scots pine at the southern limits of its distribution in Europe

Pine and oak forest and limestone cliffs, Prades Mountains, Spain

Using the enhanced vegetation index (EVI) as obtained from satellite imagery to study productivity at 250m resolution.







Altitudinal gradients

are among the most powerful ‘natural experiments’ for testing ecological responses to geophysical influences, such as air temperature.

Typically 6.5 °C per 1000m

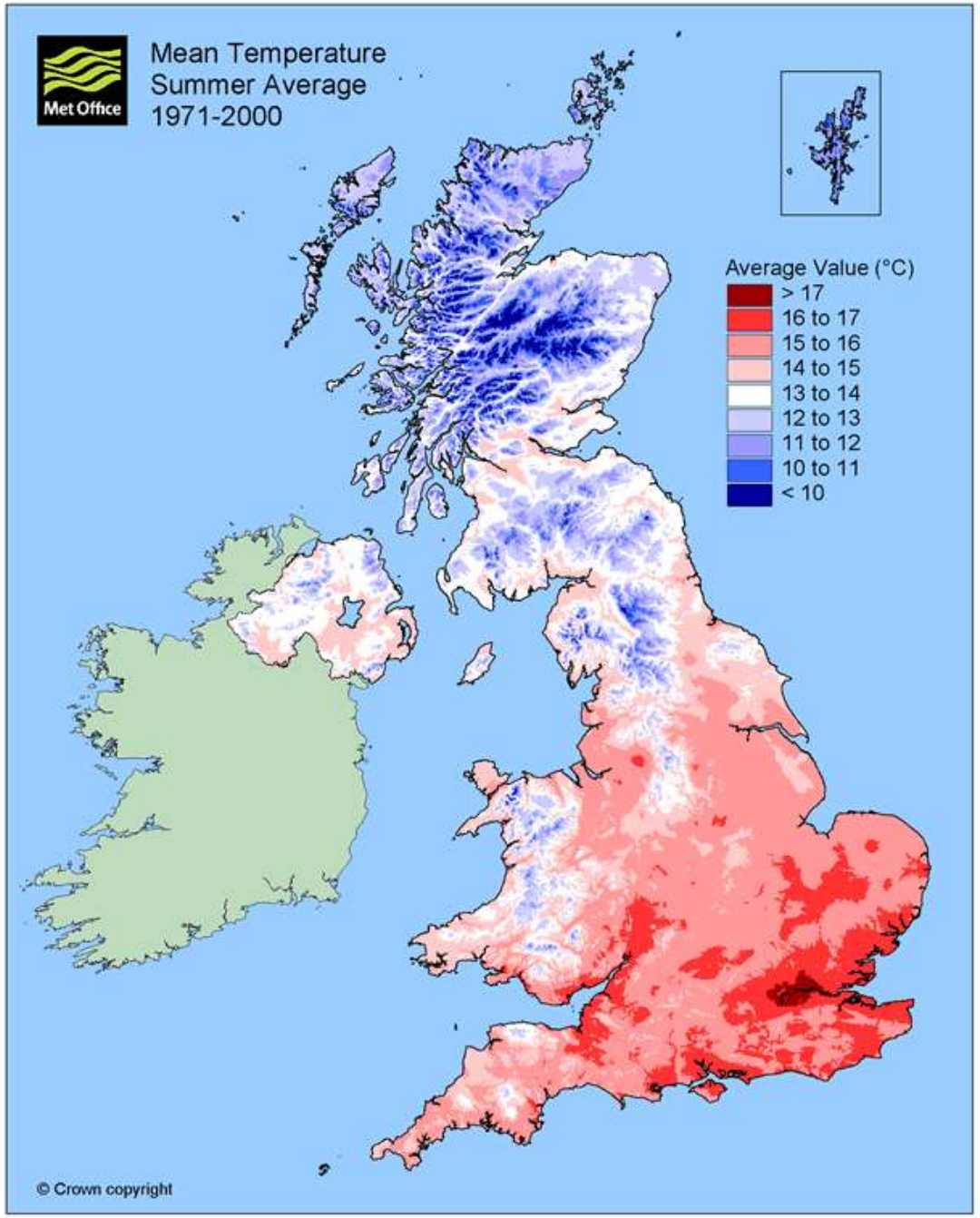
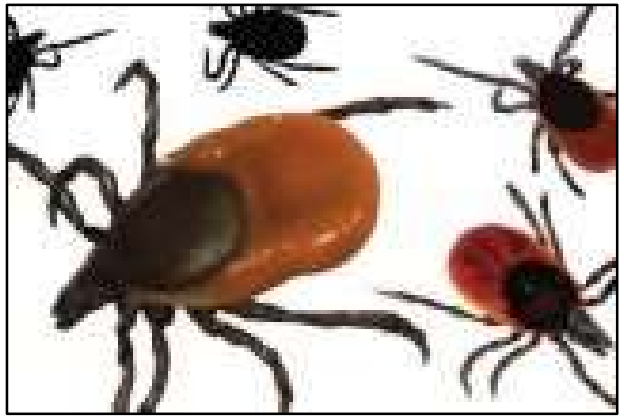
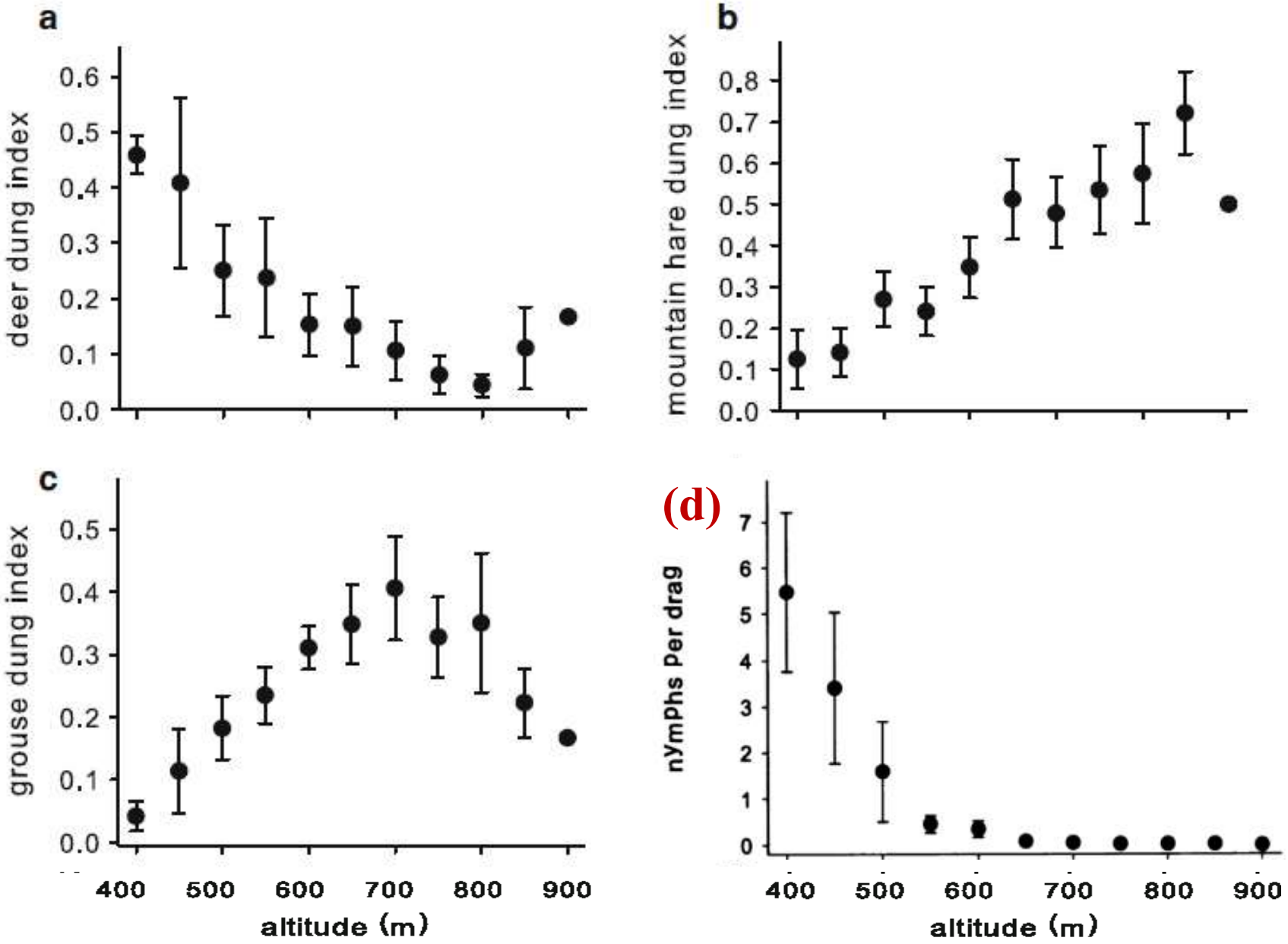


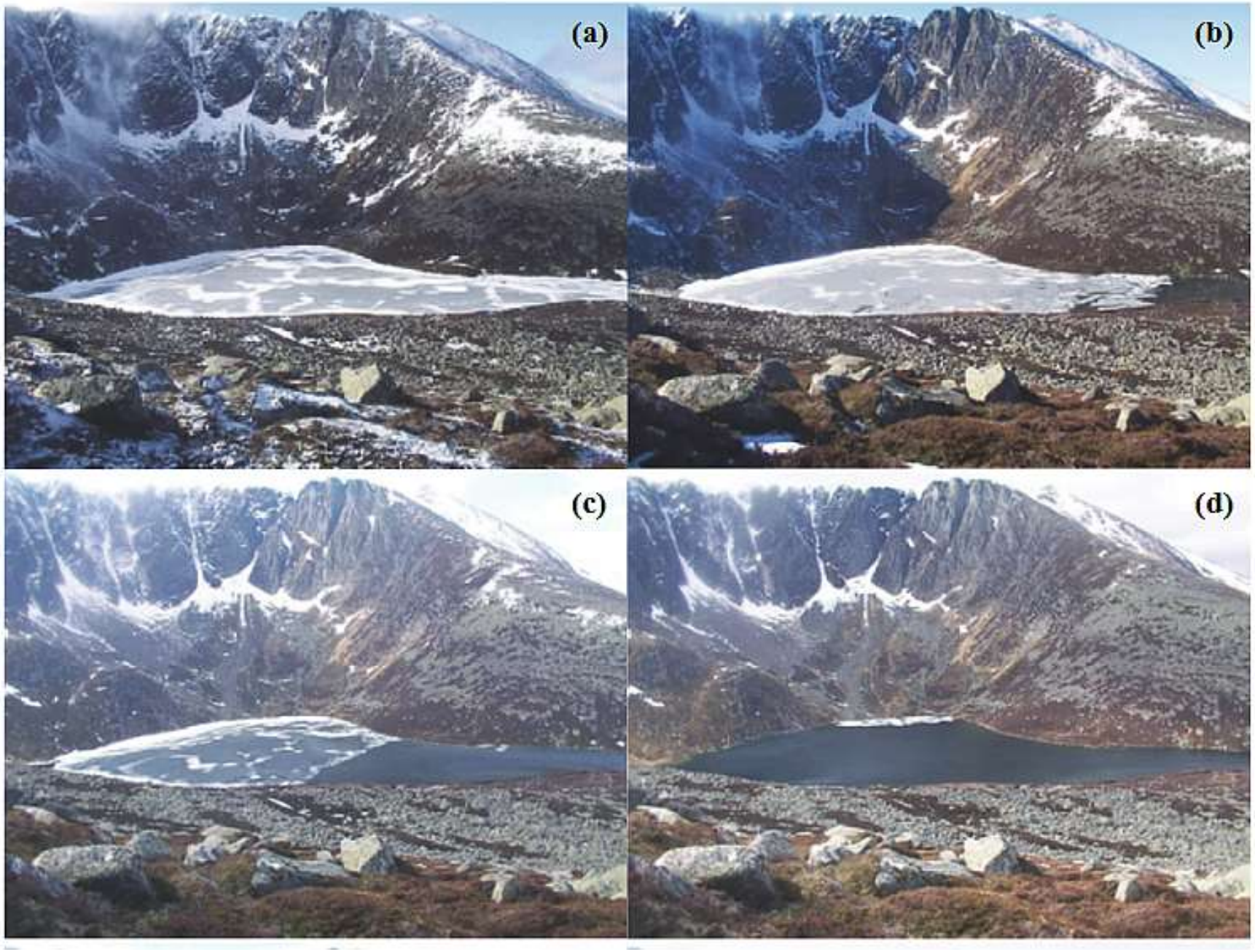
Fig. 1 The relationship between altitude and a deer abundance index, **b** mountain hare abundance index, **c** red grouse abundance index, **d Nymphs of *Ixodes ricinus* ticks per blanket drag**

Eastern Cairngorms altitudinal patterns of host abundance of tick-borne diseases.
Gilbert, 2010





LOCHNAGAR WATER-TEMPERATURES,CLIMATE AND WEATHER. Thompson et al. 2007



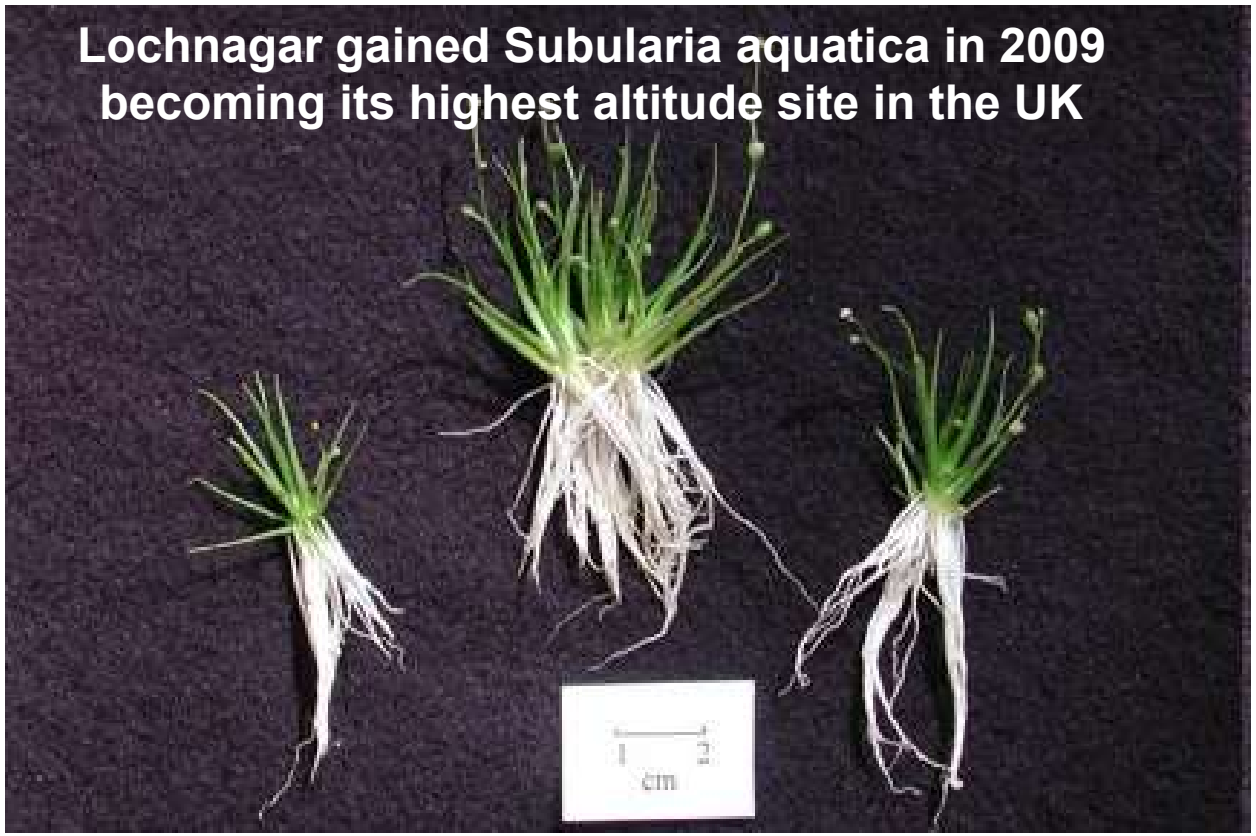
"Reconstructions of summer water-temperatures, open-season water-temps, & ice-free period all show increasing trends over recent decades."

Montage of four digicam photographs taken on 6th, 18th, 22nd & 29th March 2003 illustrate how snow cover in recent years has been rather ephemeral with rapid clearing of the catchment and rapid demise of ice-cover.

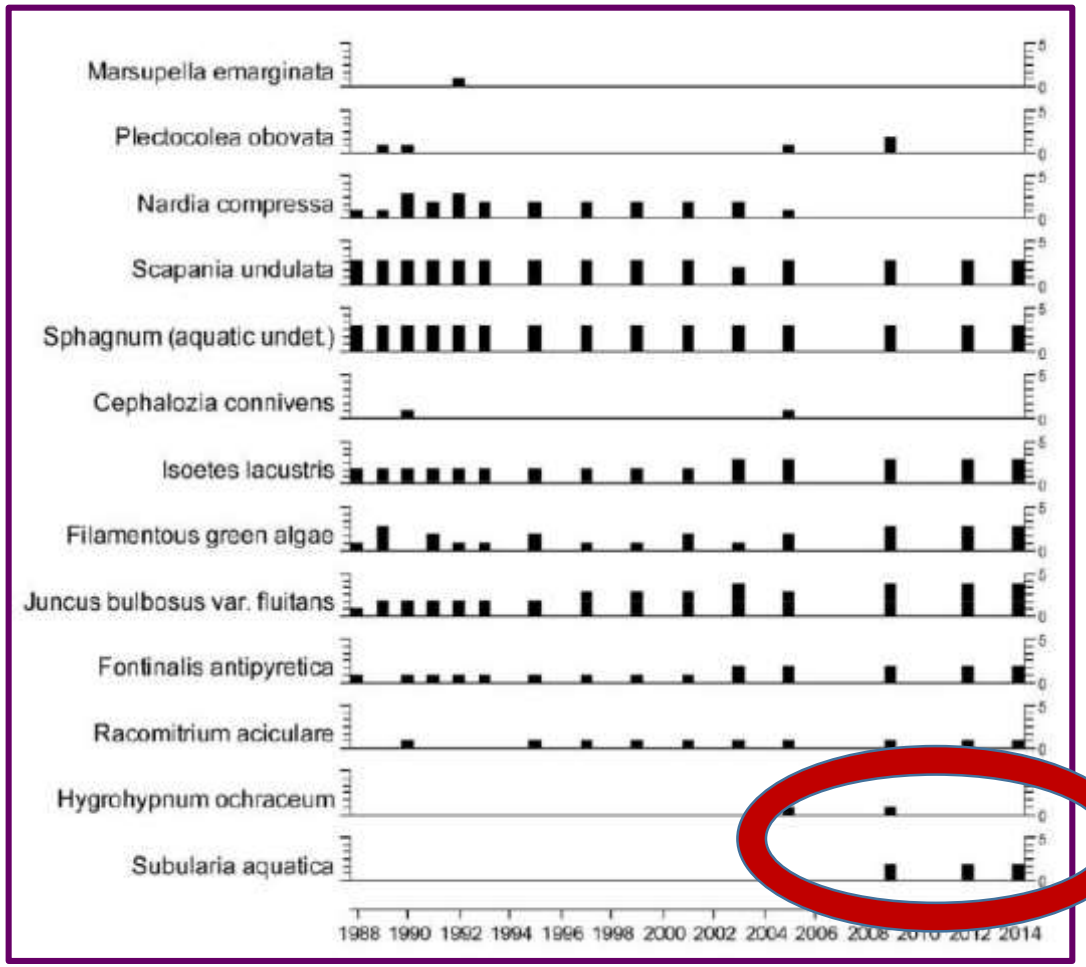
In N.L. Rose (ed.), Lochnagar: The Natural History of a Mountain Lake Developments in Paleoenvironmental Research, 63–91. © 2007 Springer.

Shift in species range – an example of a warmth-demanding species extending its altitudinal range?

30 years of aquatic macrophyte monitoring with the UK Upland Waters Monitoring Network (Ewan Shilland & Don Monteith)



Lochnagar



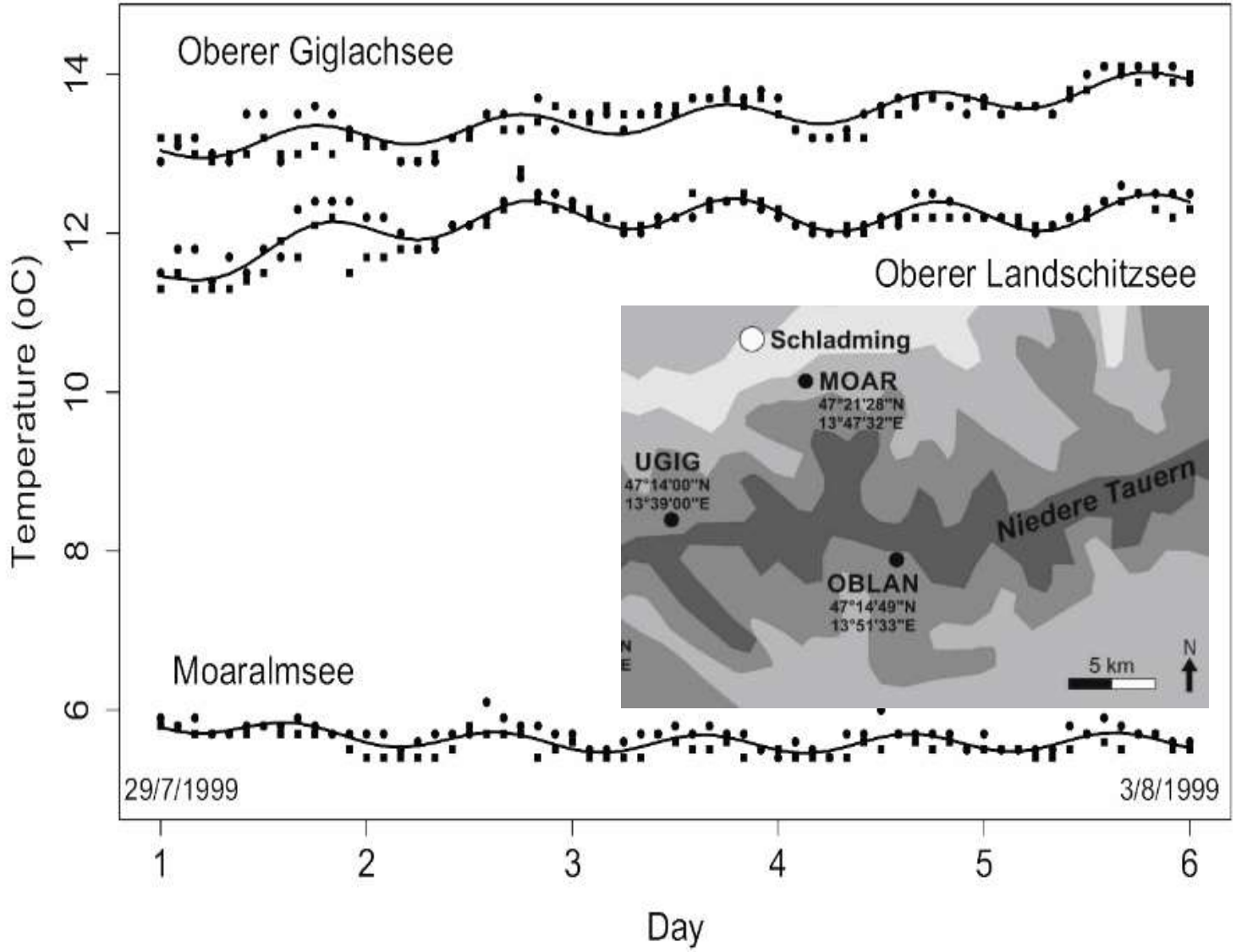
Thresholds

Moaralmsee 12°C summer warming this century?

North face of the Alps

Moaralmsee 12°C summer warming this century?

Thompson et al., 2005



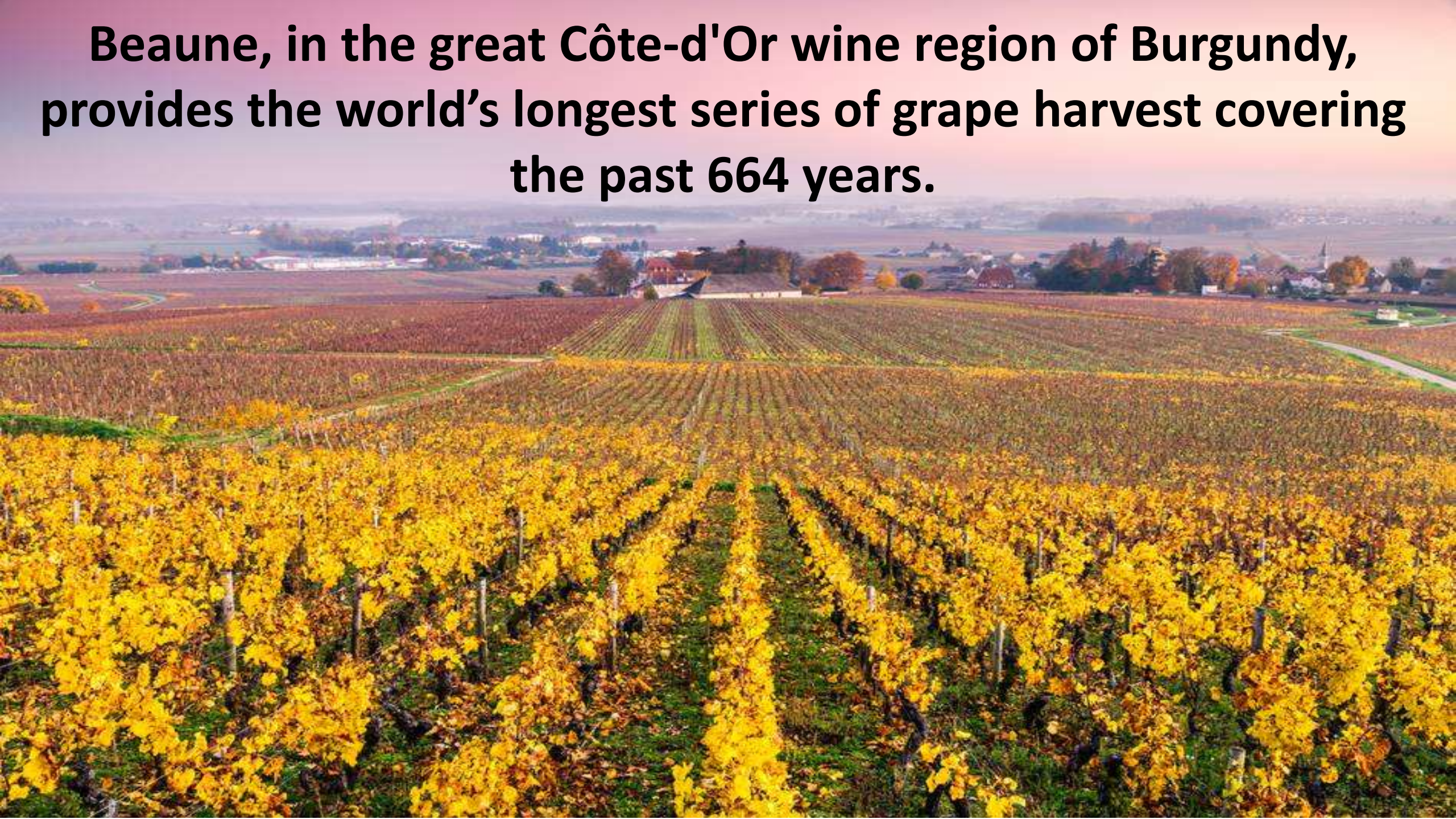
1922 m

2067 m

1825 m

Fig. 7. Diurnal variation of epilimnion water temperature at Moaralmsee, Oberer Giglachsee and Oberer Landschitzsee in early summer 1999. Thermistor 1, circles: thermistor 2, squares. The smooth curves emphasise the diurnal cycle. Although the three lakes are of similar size and altitude, Moaralmsee is much colder, is cooling rather than warming and has a suppressed, phase-shifted diurnal temperature cycle.

Beaune, in the great Côte-d'Or wine region of Burgundy, provides the world’s longest series of grape harvest covering the past 664 years.

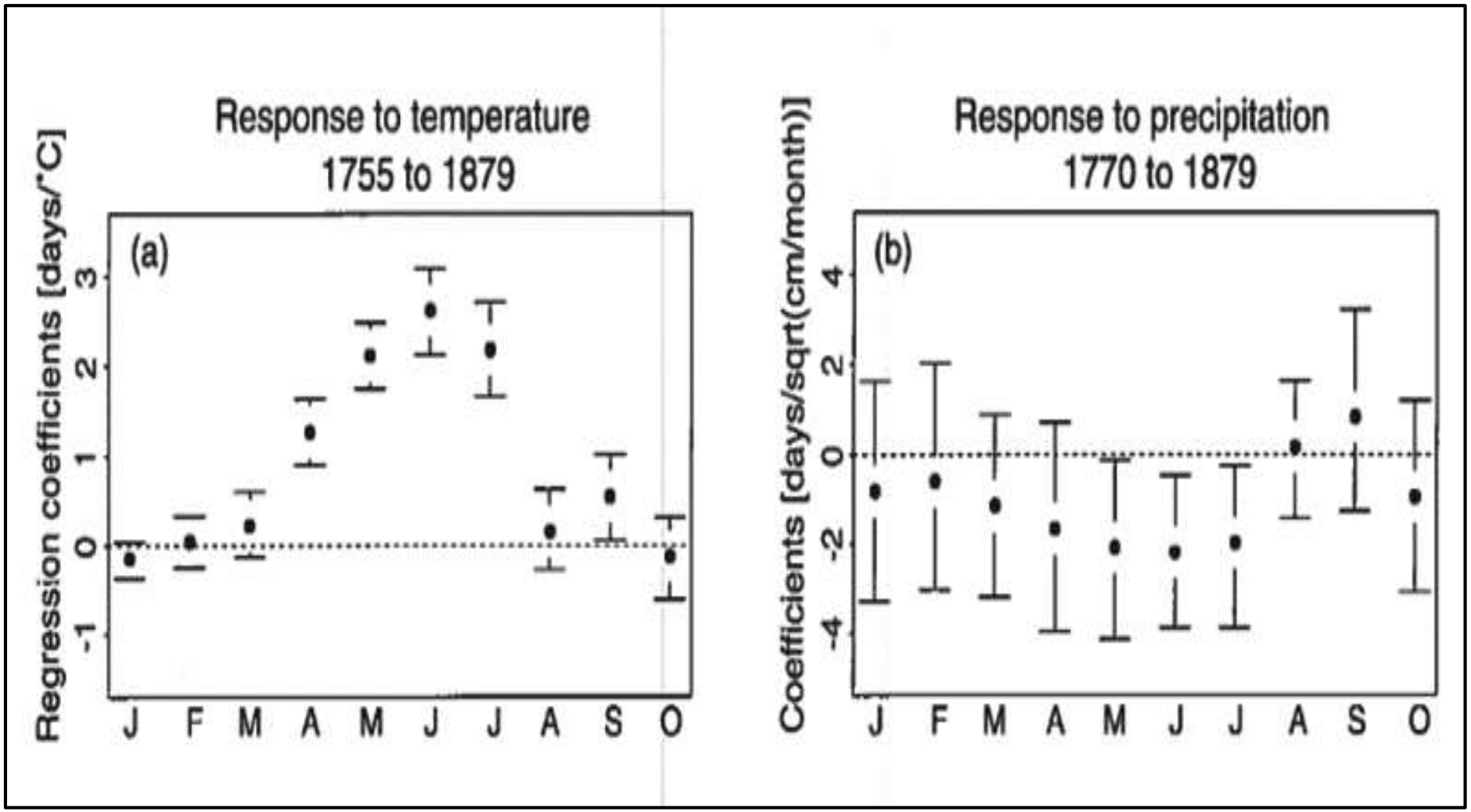


Past Climate Variability through Europe and Africa pp 7-29 | Cite as

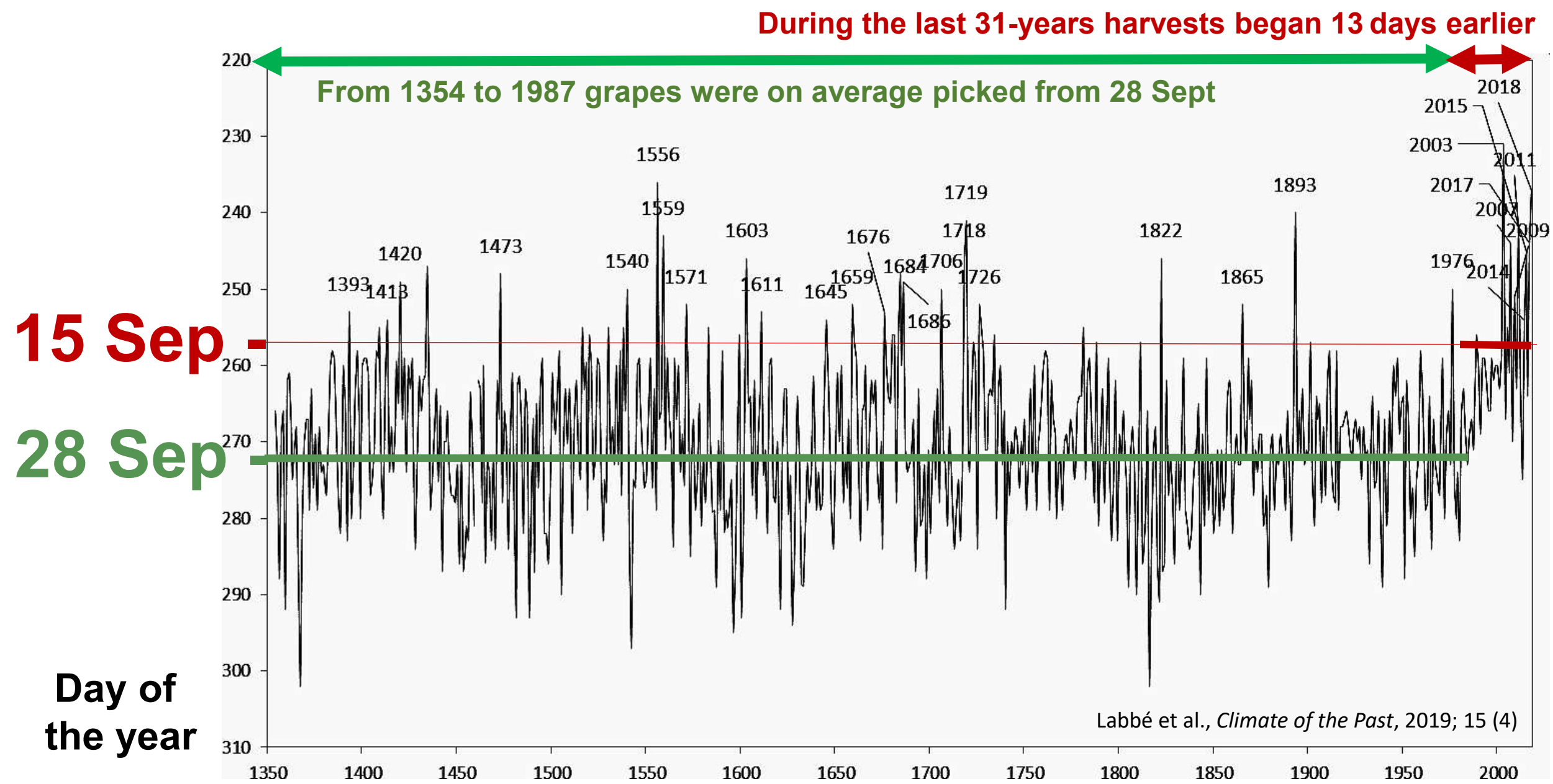
Archives and Proxies along the PEP III Transect

Authors Authors and affiliations

Frank Oldfield, Roy Thompson



The longest homogeneous series of grape harvest dates, Beaune 1354–2018

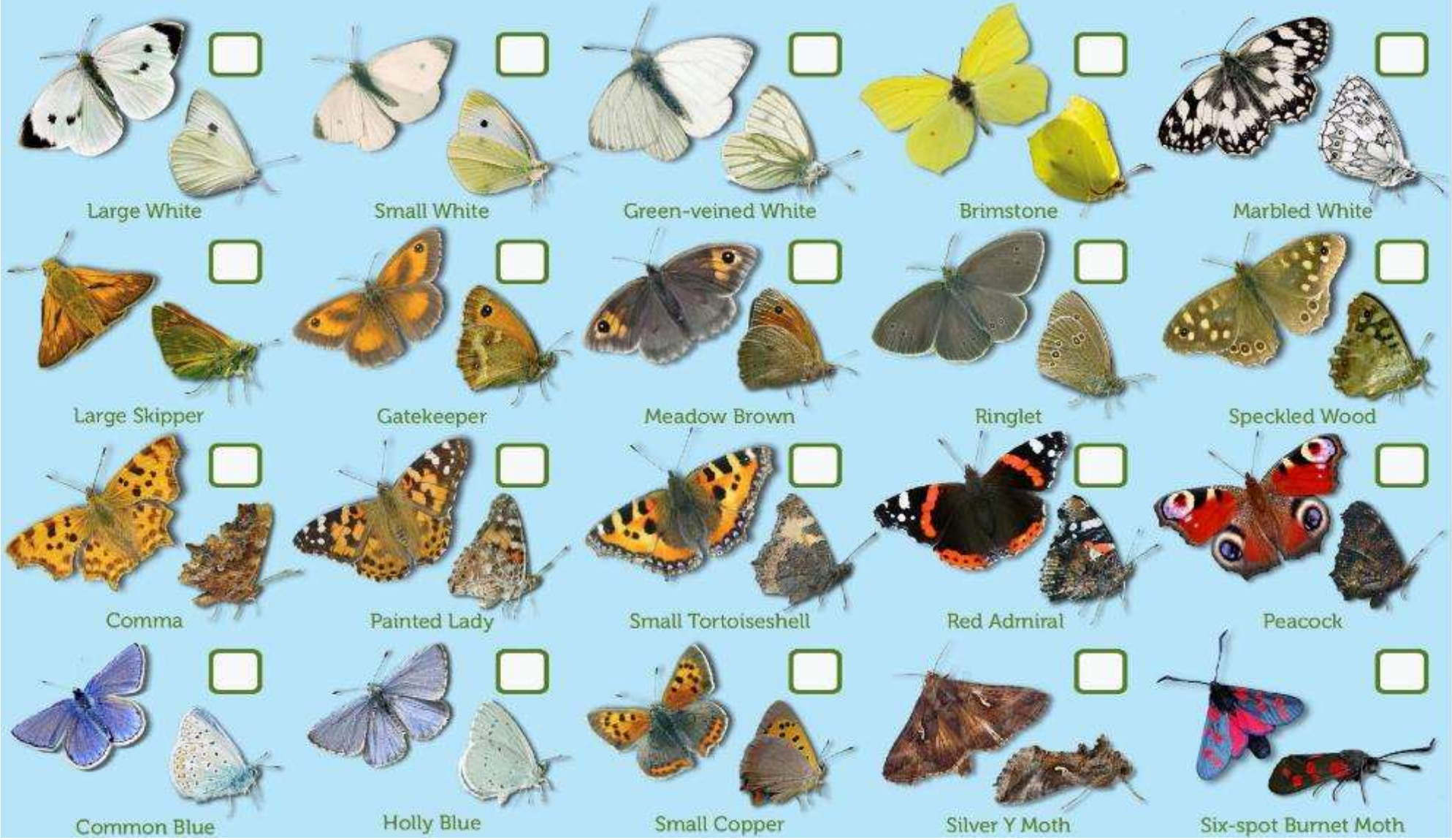


COMMUNITY AND CITIZEN SCIENCE

big butterfly count

Butterfly Conservation

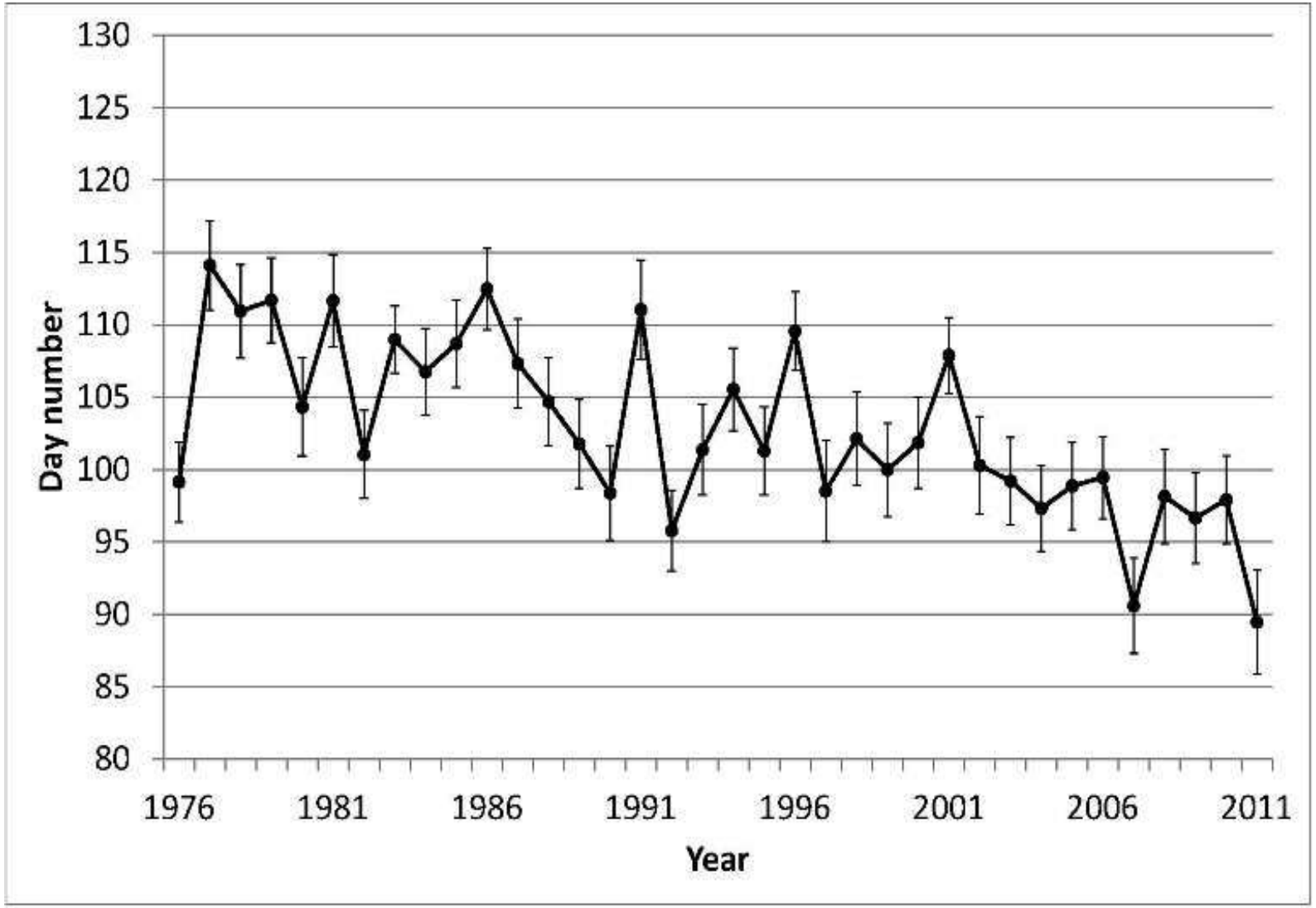
Spend 15 minutes in a sunny spot.
Use this chart to note how many of each species you see.
Then submit your sightings, date and location at **www.bigbutterflycount.org**




Mass digitisation of the Museum's 80 million natural history specimens.
NHS is currently digitising one specimen every 2.9 minutes

United Kingdom
Butterfly Monitoring Scheme

UKBMS



Trends towards earlier appearance averaged across all UK butterfly species.

Mean dates of almost 47,000 flight periods shows a significant trend of 5 days / decade for both spring and summer butterflies.

Contrast warm vs. cold years

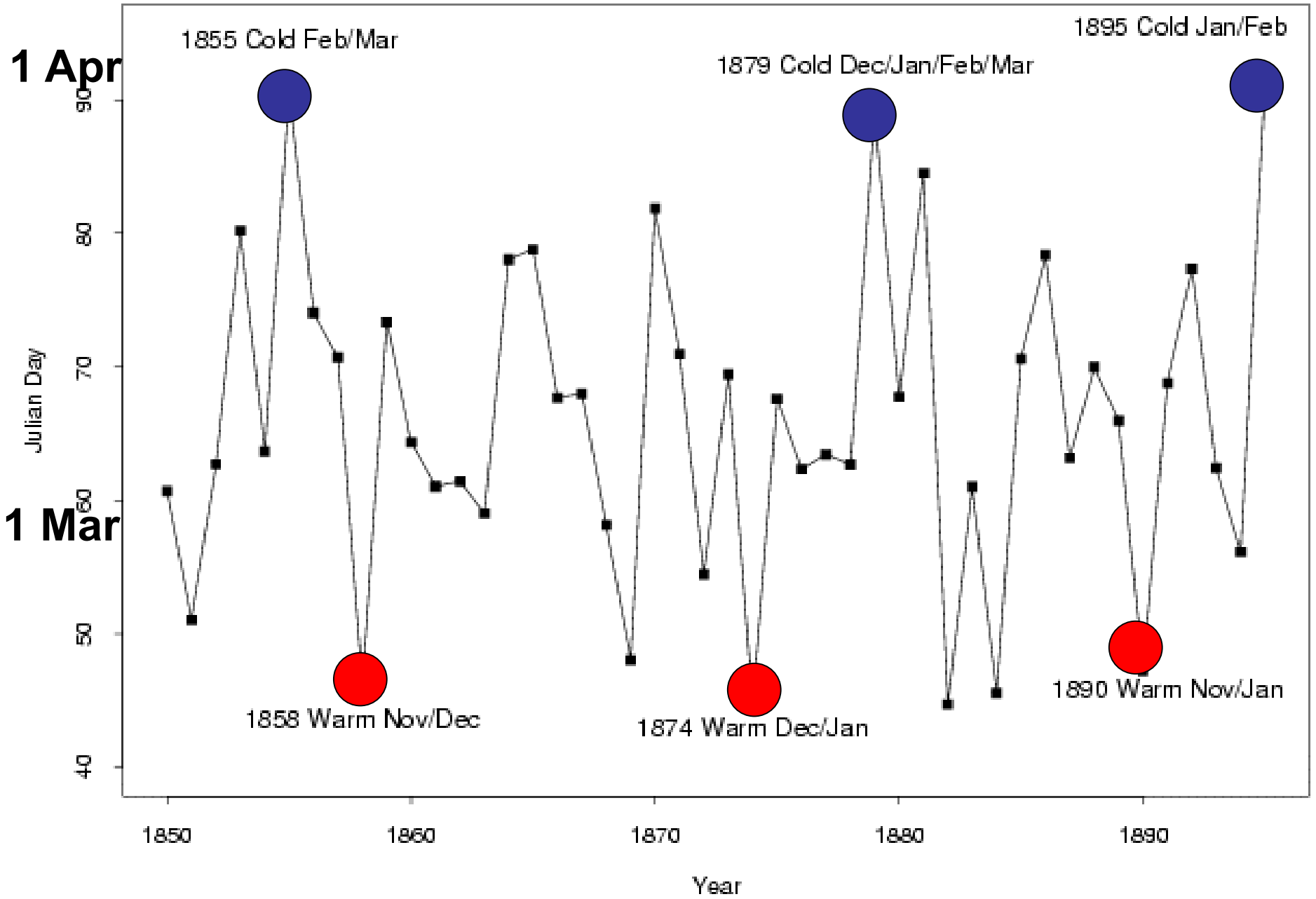
Environmental Geoscience students (Tom Jilbert and Libby Eva) record the number of flowers on individually tagged stems as part of their final year project.

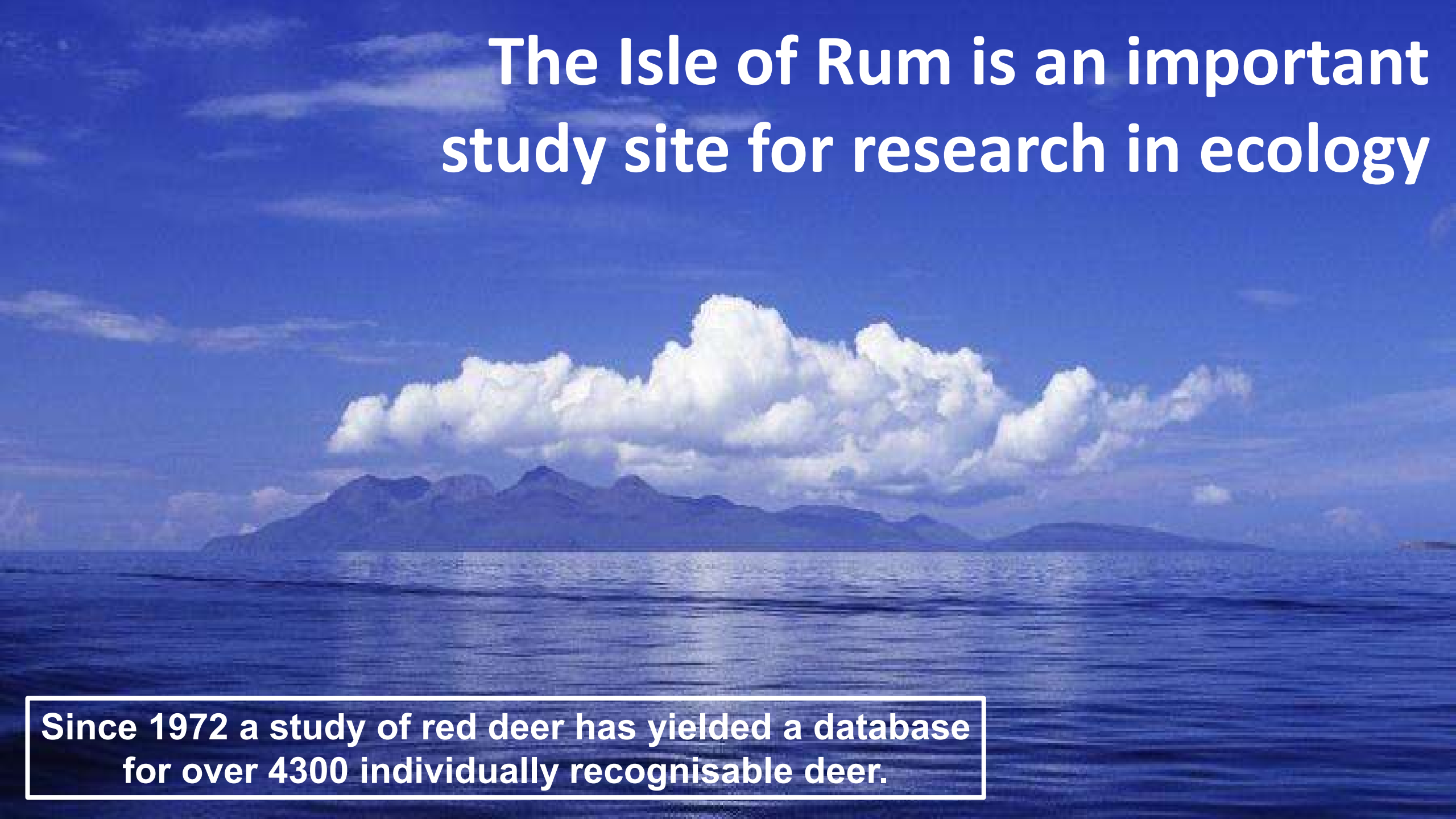
Their work used flowering records, first begun in 1850 by James McNab.

James McNab's first flowering dates 1850-1895

The three warmest years and three coldest years show extreme flowering dates for the 66 taxa monitored.

Thompson, 2004





The Isle of Rum is an important study site for research in ecology

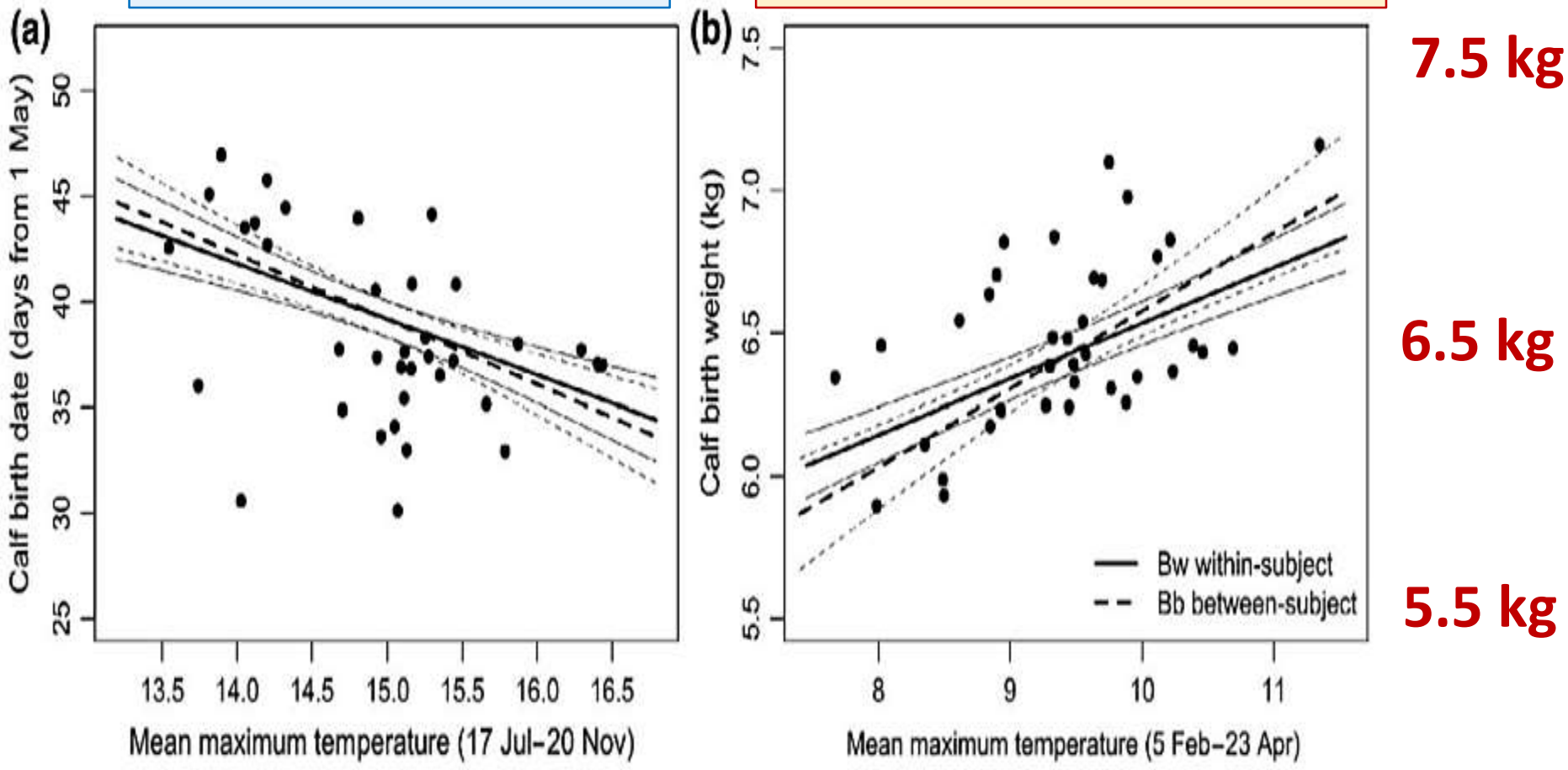
Since 1972 a study of red deer has yielded a database for over 4300 individually recognisable deer.

Calving date vs. Autumn Temp

Weight at birth vs. Spring Temp

1 July

1 June



7.5 kg

6.5 kg

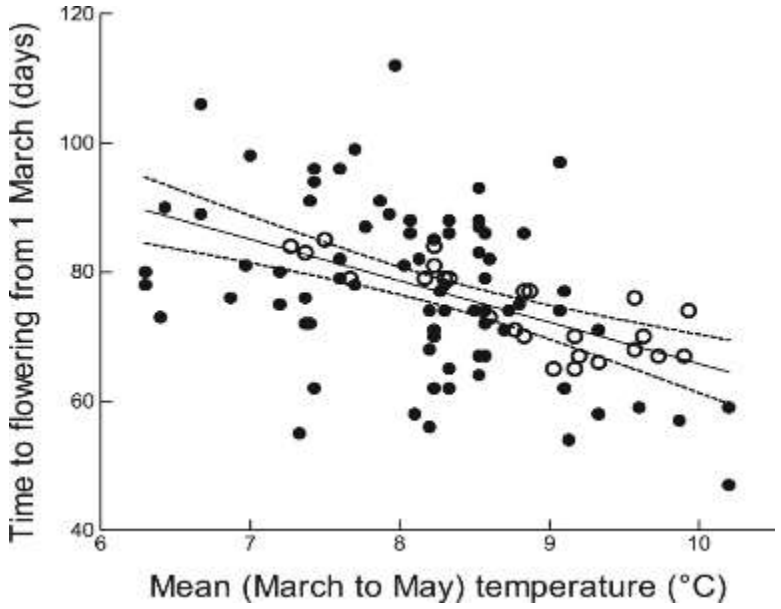
5.5 kg

FIGURE 3 The relationship between average maximum temperature in the critical window and a) annual average calving date and b) annual average calf birth weight. Points show averages of raw data for each year (1980–2015).

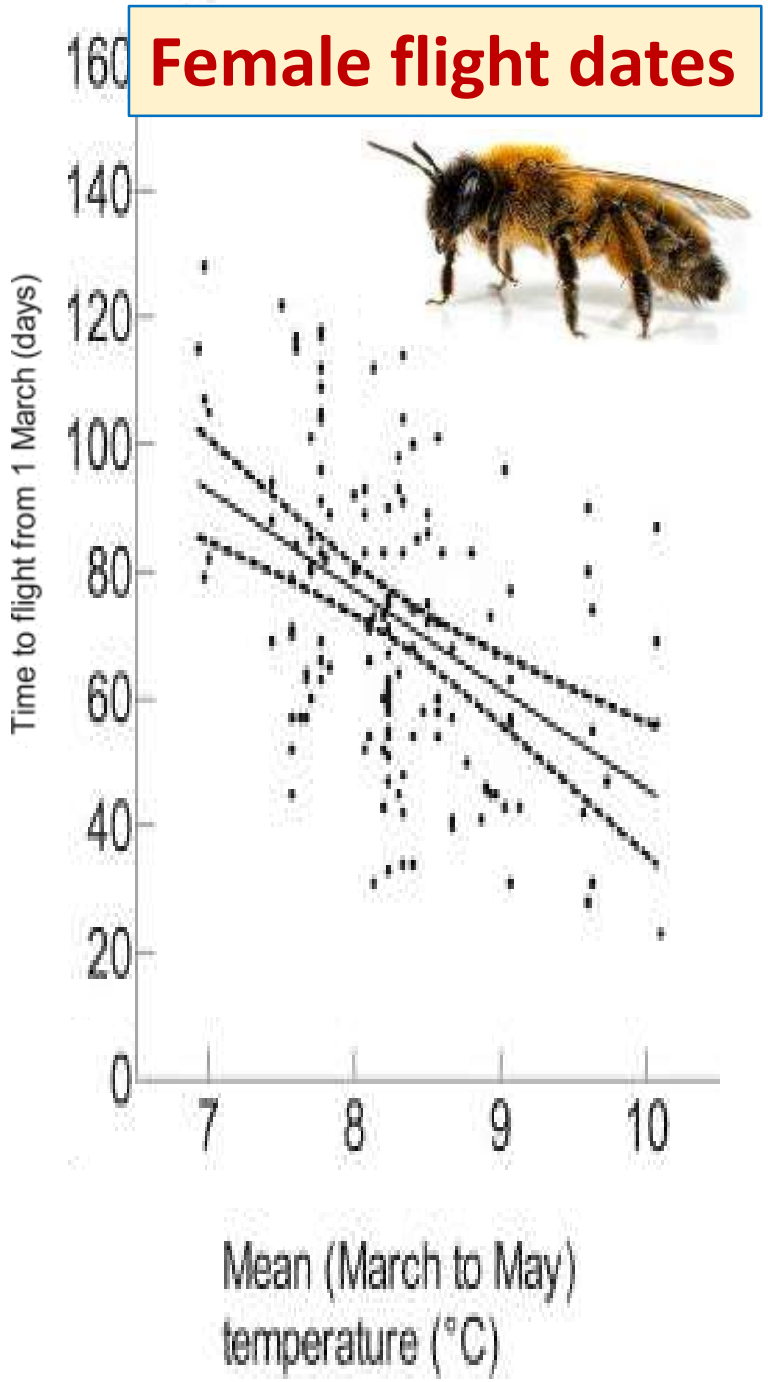
(Froy et al)

Flight Dates and Flowering Dates Respond Differently to Spring Warming

Peak flowering dates

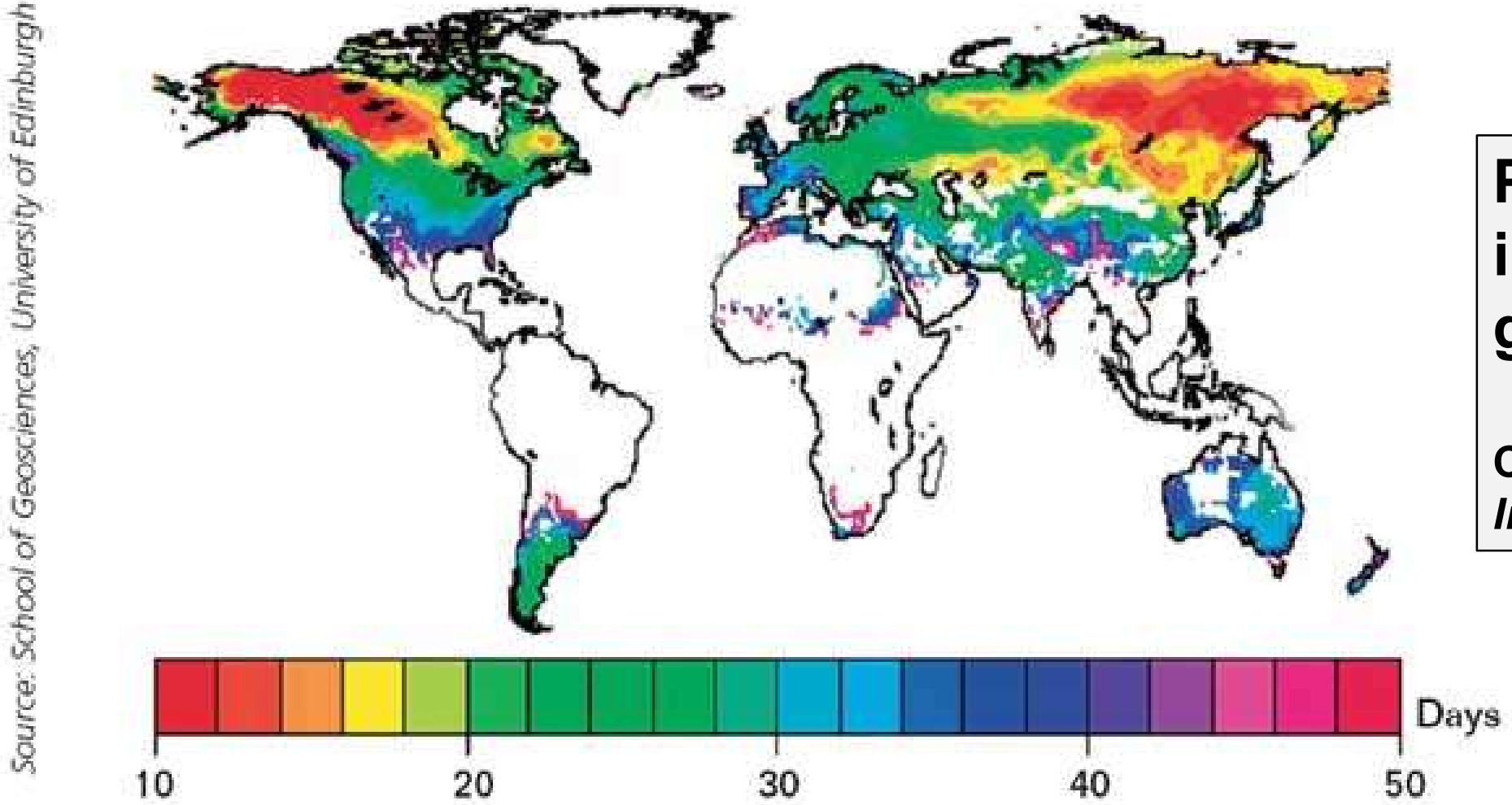


Female flight dates



Climate change exposes the vulnerability of the relationship of the sexually deceptive, early spider orchid with the solitary mining bee, its sole pollinator in the UK.

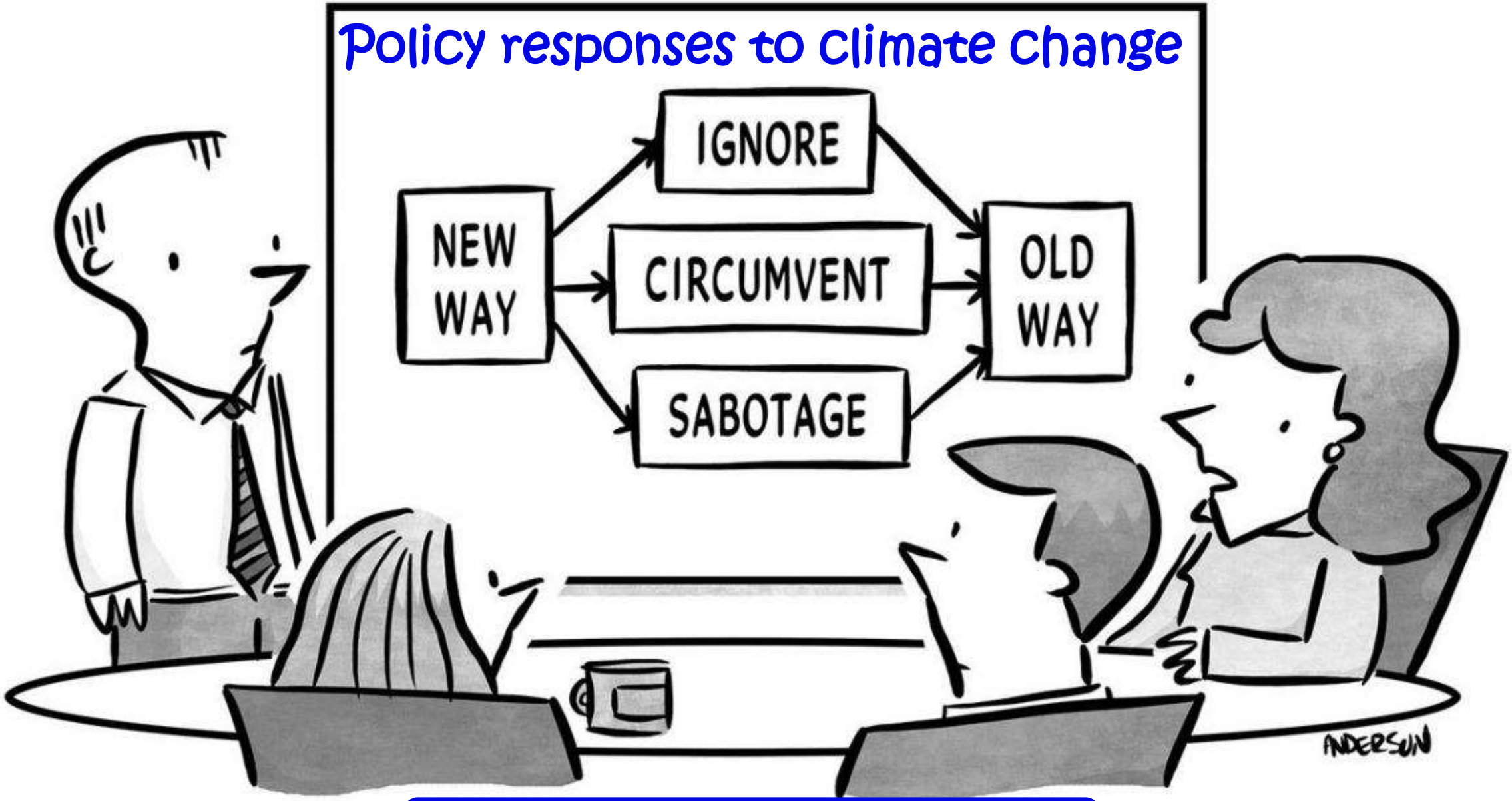
Desynchronisation



Colour-coded regions are where plant life will be affected by 2080. Figures reveal the number of days by which plants will flower earlier than expected

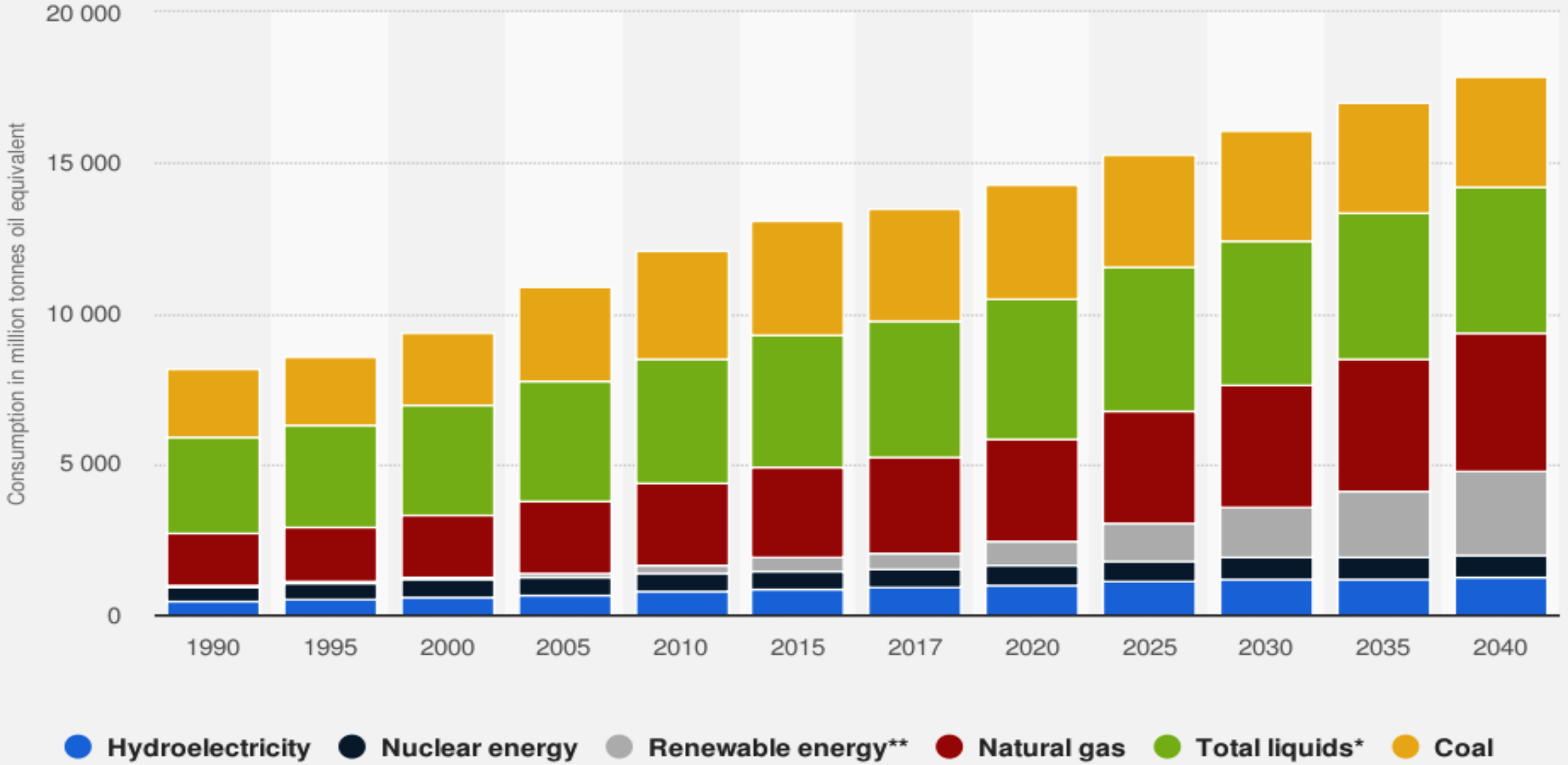
Predicting the impact of global warming

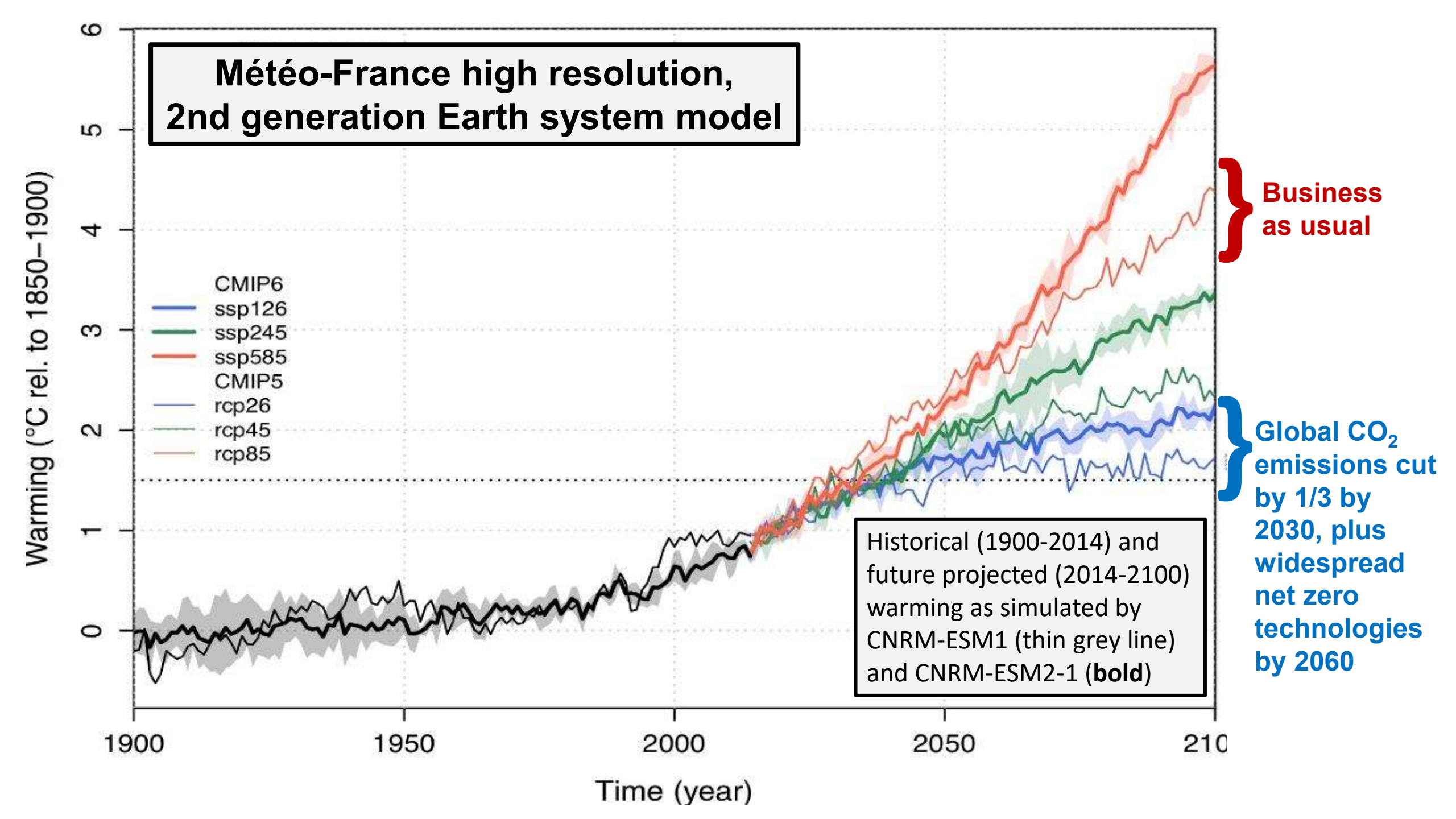
Clark and Thompson
Int. J. Climatol., 2010



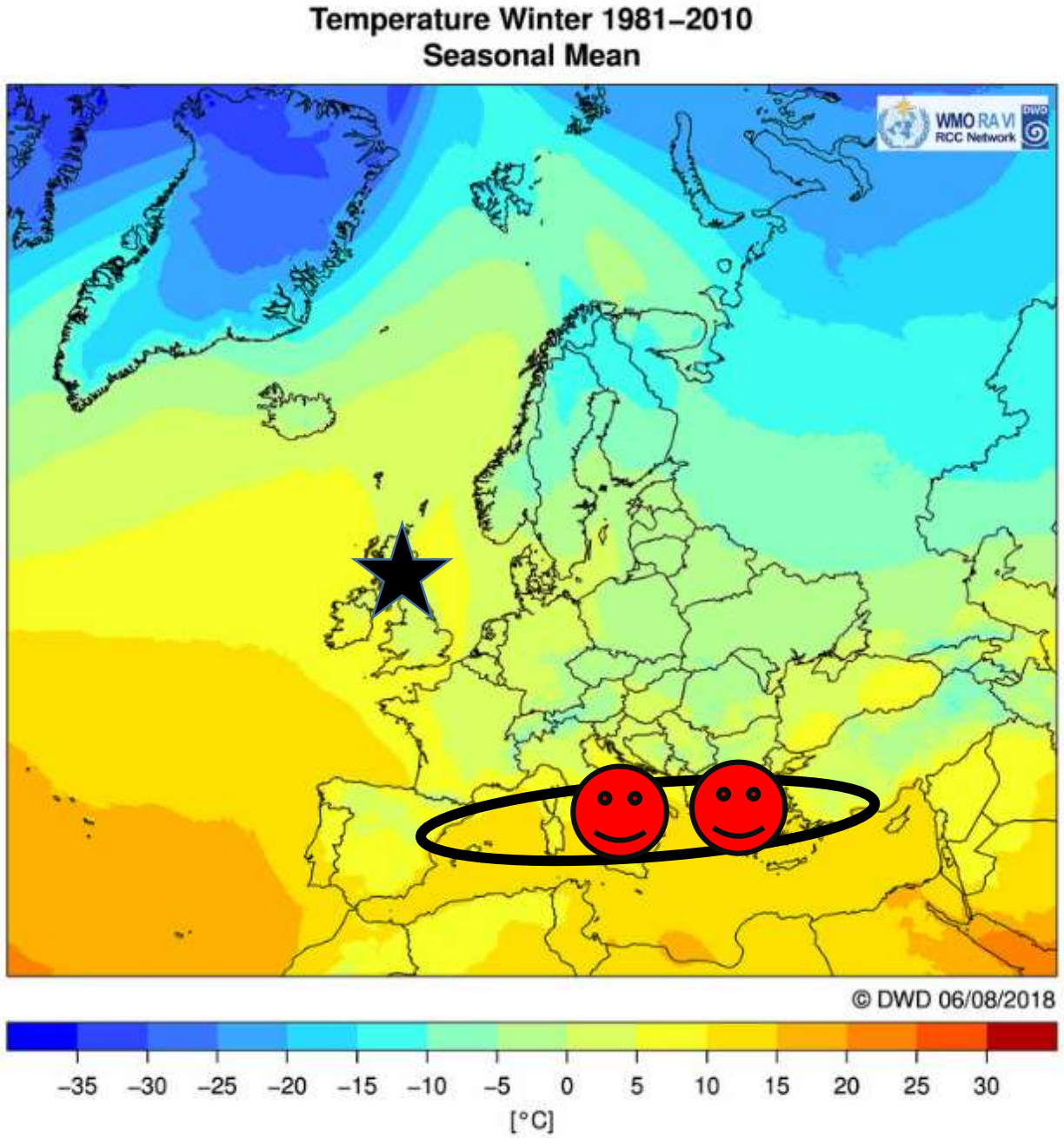
"So business as usual."

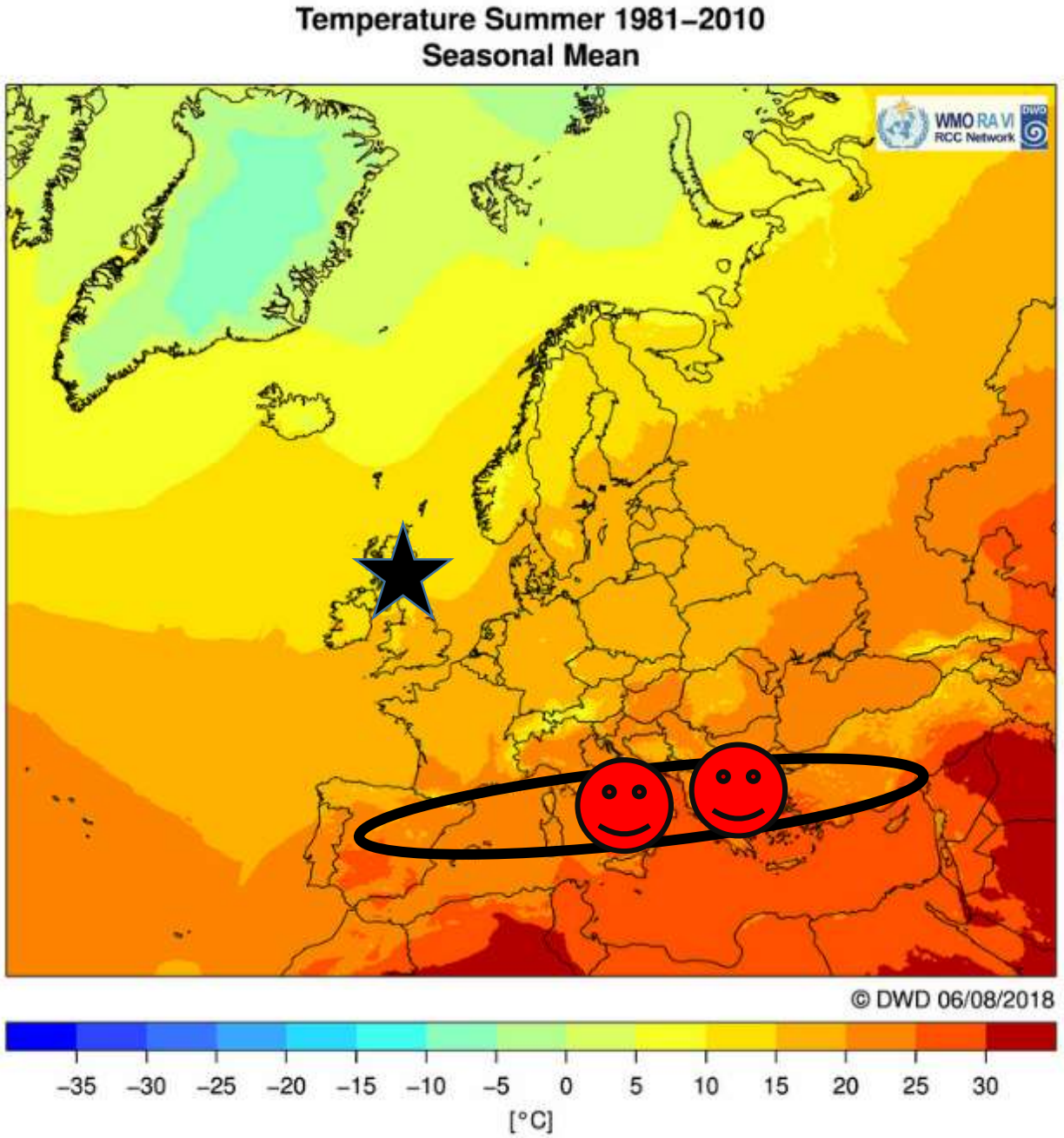
Projected global energy consumption from 1990 to 2040, by energy source (in million metric tons of oil equivalent)



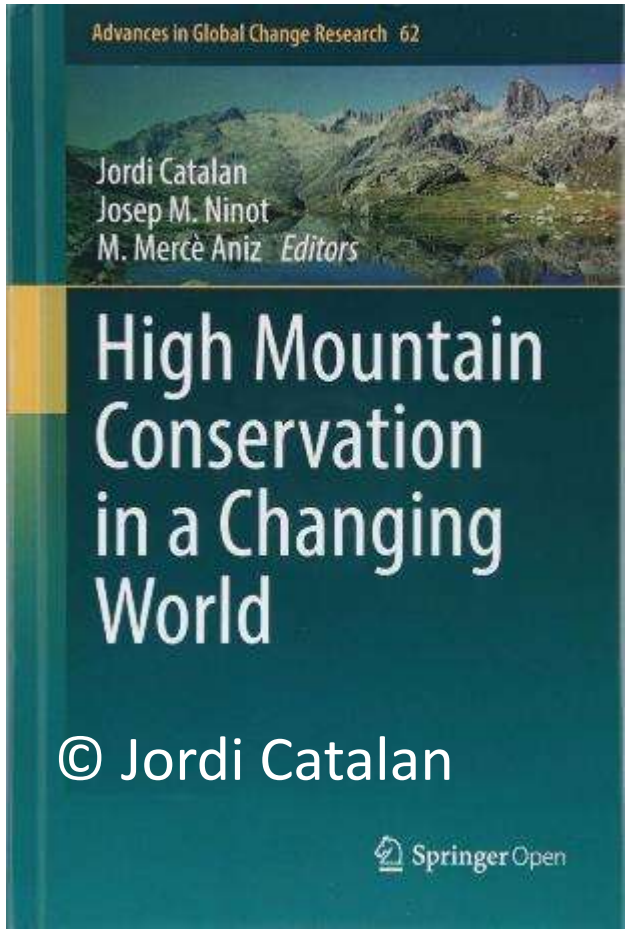

Météo-France high resolution,
2nd generation Earth system model
Warming (°C rel. to 1850–1900)
Time (year)
1900
1950
2000
2050
210
0
1
2
3
4
5
6
CMIP6
ssp126
ssp245
ssp585
CMIP5
rcp26
rcp45
rcp85
Historical (1900-2014) and future projected (2014-2100) warming as simulated by CNRM-ESM1 (thin grey line) and CNRM-ESM2-1 (bold)
Business as usual
Global CO_2 emissions cut by 1/3 by 2030, plus widespread net zero technologies by 2060

Future warming: Winter +7°C, Summer +7°C





Where are we going: Conservation and climate change?



Access this book for free

- ISBN 978-3-319-55982-7

- This book is an open access book,

- *"Nature reserves were often created with the general goal of preserving wildlife and natural landscapes, based on the assumption that things would not change significantly for many generations.*
- *"Thus the preserved lands would remain pristine, or recover to a state close to that unmodified by humans.*
- *"Now the situation has drastically changed. National Parks and other nature reserves will have to review their foundational goals.*
- *"Beyond managing their internal problems and pressures from their immediate surroundings, they will have to deal with atmospheric drivers that will shift their natural systems into previously unexpected situations.*
- *"The larger the expected problem, the sooner the reaction should begin."*

Summary

- Climate change continues to accelerate - despite Rio, Kyoto, Paris.
- Global land-temperatures have already risen 1.6^{o}C.

- The environment is changing faster than at any time in recorded history, due to a range of factors:- climate change, habitat loss, pollution and over-exploitation of resources.

- Mobile generalists (e.g. dragonflies) respond to warmth with minimal climate deficit.
- Other taxa (e.g. Scots pine) and biome boundaries (e.g. tree-lines) only react slowly.
- Climate change is already causing desynchronisation and disrupting wildlife behaviour.

- Higher temperatures are coming:- heatwaves, extreme highs, changed rainfall patterns.
- By 2100, over land, a 6 to 8^{o}C rise will not be unusual, locally +12^{o}C.

- Conservationists need to be preparing for a much, much warmer world.