Managing and Adapting to Climate Change at English Heritage Gardens

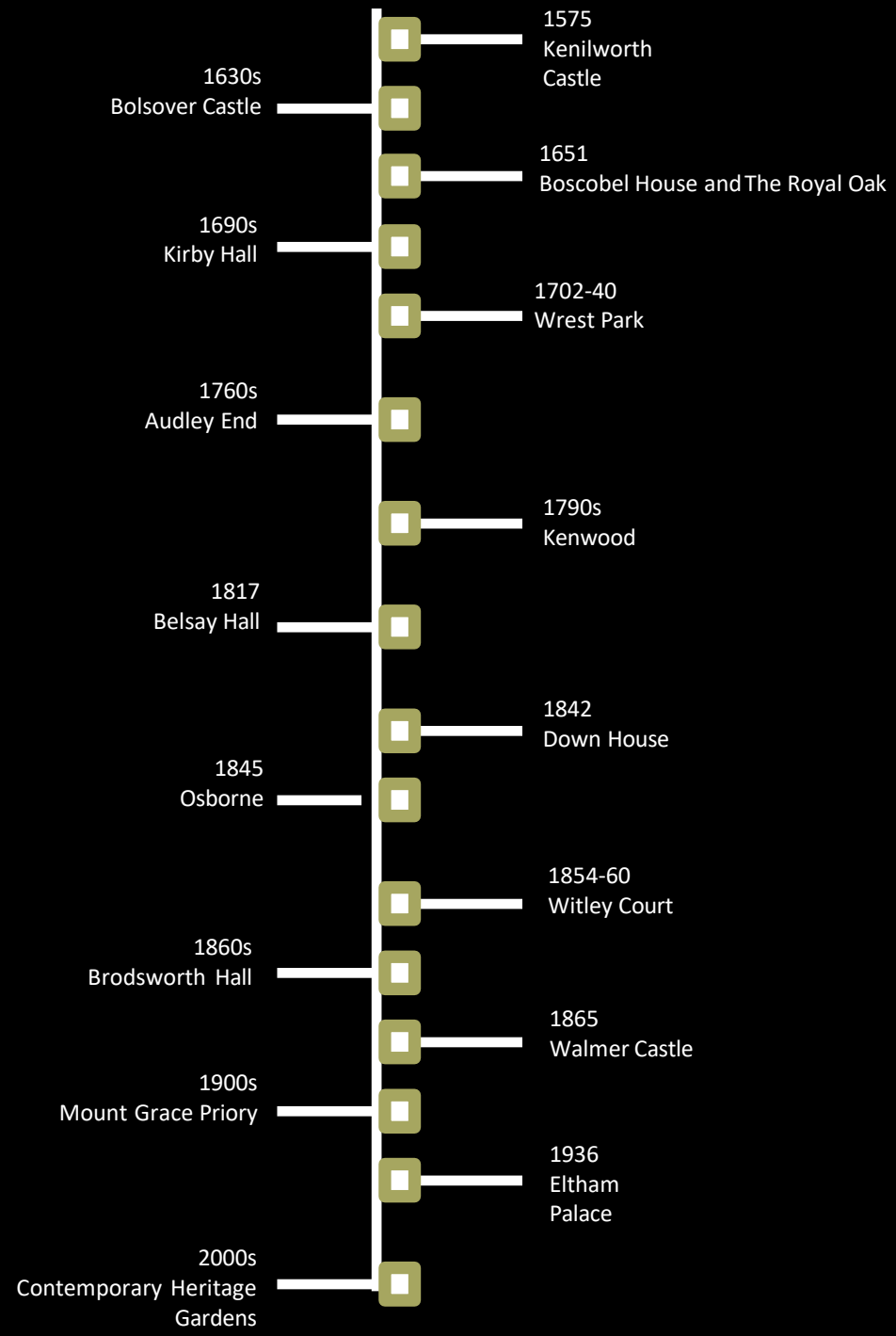
John Watkins
Head of Gardens and Landscape

ABOUT OUR GARDENS

The English Heritage Trust cares for over 400 historic monuments., our historic designed landscapes tell England's garden story.

From the formality of Wrest Park to the rolling parkland of Kenwood House; from Queen Victoria's garden at Osborne to the exotic Quarry Garden at Belsay Hall, English Heritage cares for gardens throughout England and from almost every century.

ENGLISH HERITAGE GARDENS TIMELINE



INFLUENCE OF GULF AND JET STREAMS

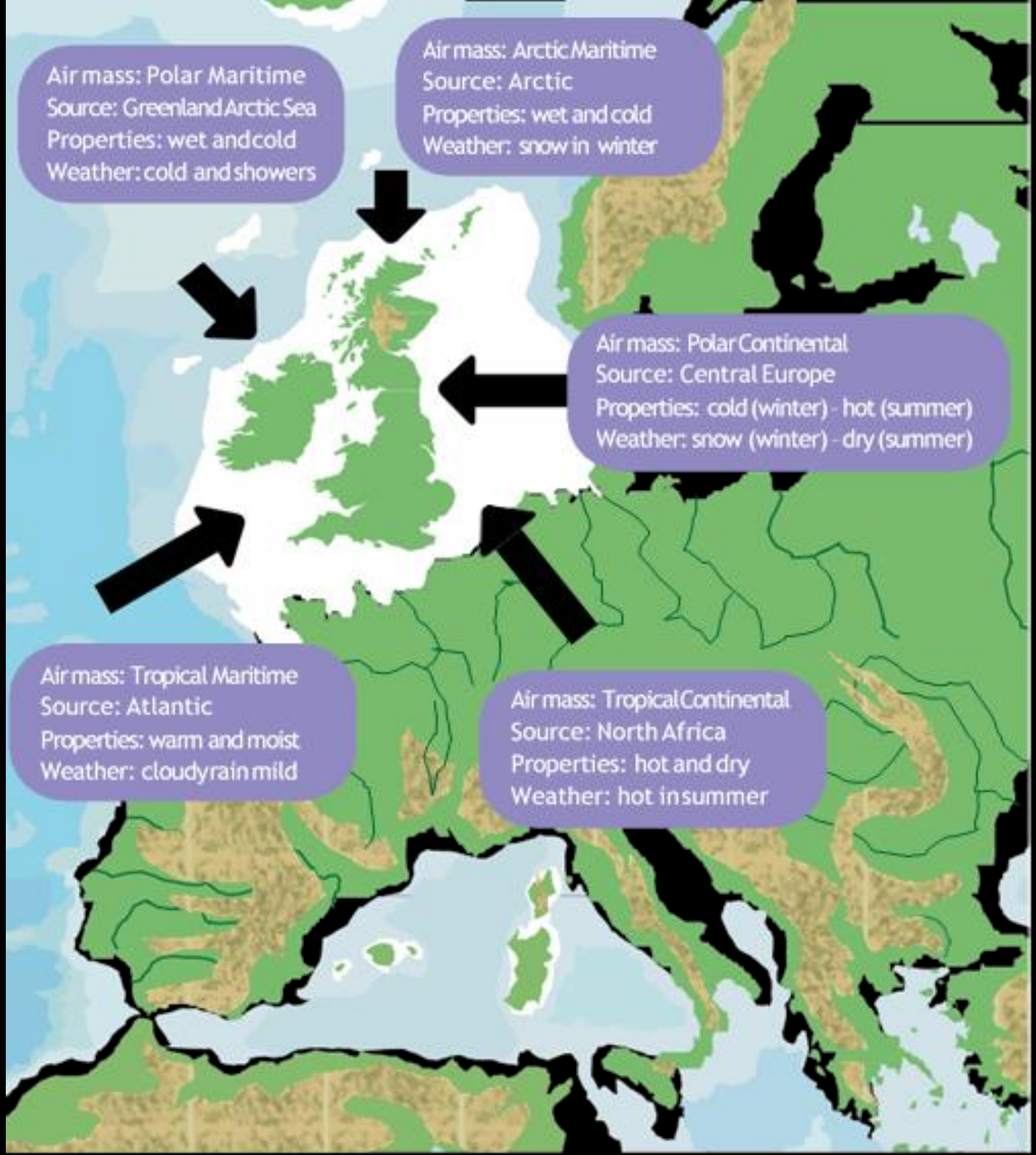
Schematic of the Gulf Stream and the Atlantic overturning circulation.

Warm water (red arrows) flows northwards and gives up its heat to the atmosphere. As the current moves further north it cools, sinks and then returns southwards at depth (blue arrows).

The Jet Stream

1.STRONG JET. Strong, westerly jet stream, storms regularly affecting the UK: weather unsettled, wet, cool and windy (especially in winter).

2.WEAK JET. Weak, meandering jet stream, storms take a path to the north or south of the UK: weather in summer dry and hot; weather in winter dry and cold.



The air masses that can affect the UK and the weather conditions they bring.

Potential Impact of Climate Projections on UK Gardens

Data from: Webster E, Cameron RWF and Culham A (2017) Gardening in a Changing Climate, Royal Horticultural Society, UK.

Average temperature is projected to increase in all seasons and across all regions of the UK.
It is theoretically possible that in the future, much of the UK could be frost free in some years.

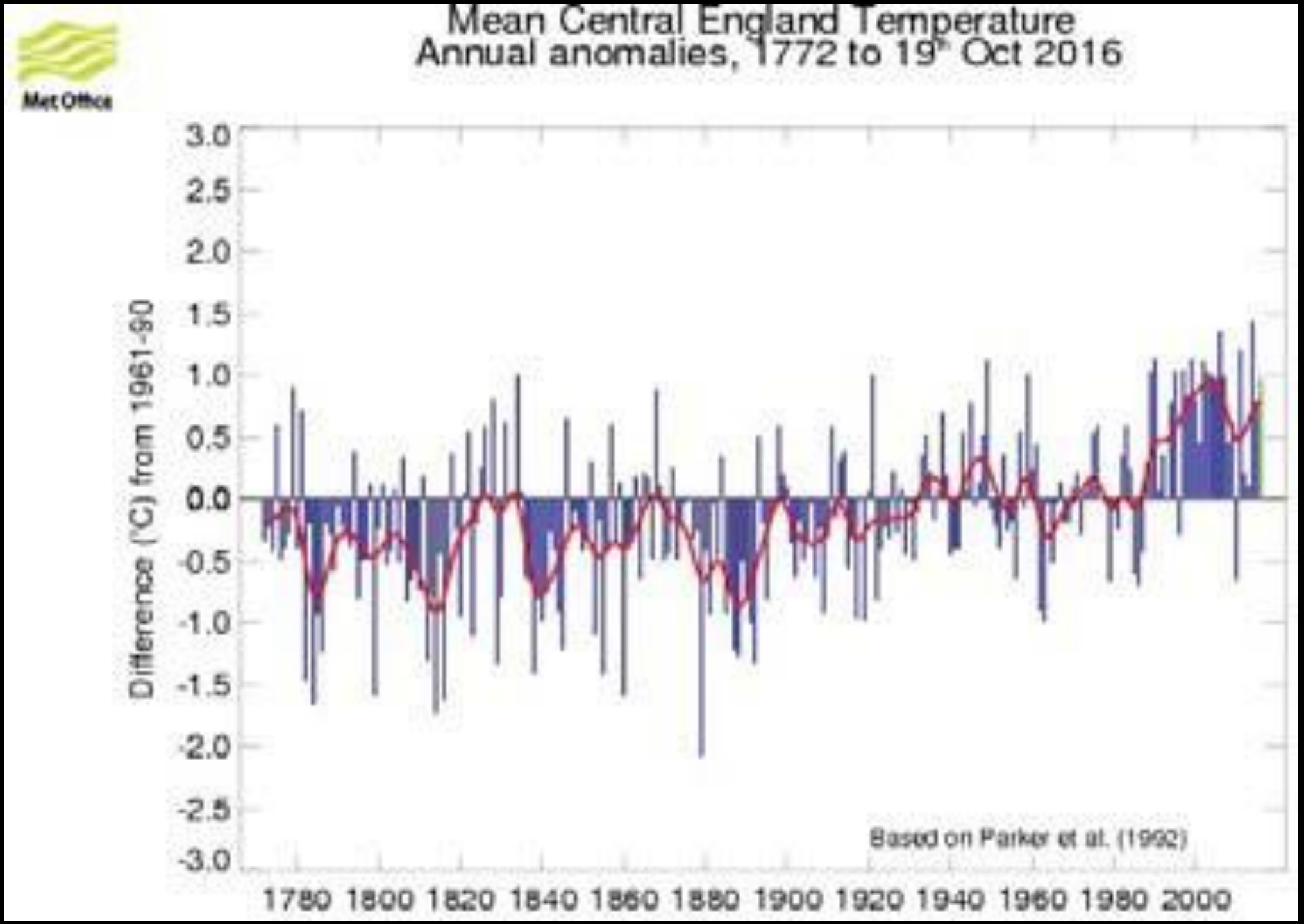
DROUGHT- There will continue to be high year on year variability in rainfall.

It is likely that there will be an increase in the number of dry spells, and this will be most pronounced in southern areas of the UK, and especially over the summer months.

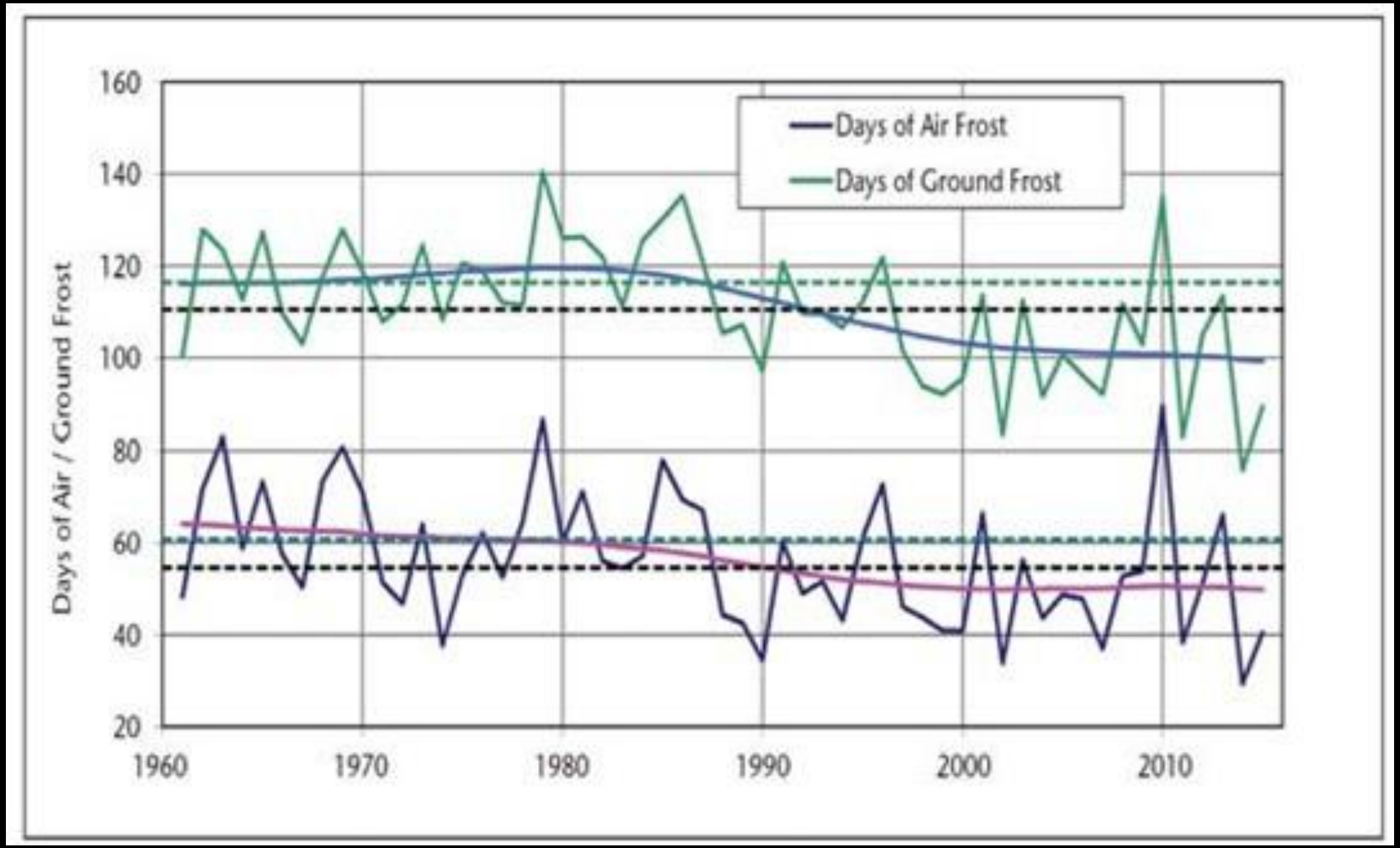
WET- The frequency of very wet days will increase over the winter, and this will be most pronounced in northern areas of the UK

Gardens close to the coast or located near estuaries may experience more flooding as a result of an increase in the frequency and severity of tidal surges, whereas gardens located upstream will experience an increase in flooding due to more frequent and intense fluvial flooding events.

TEMPERATURE 1

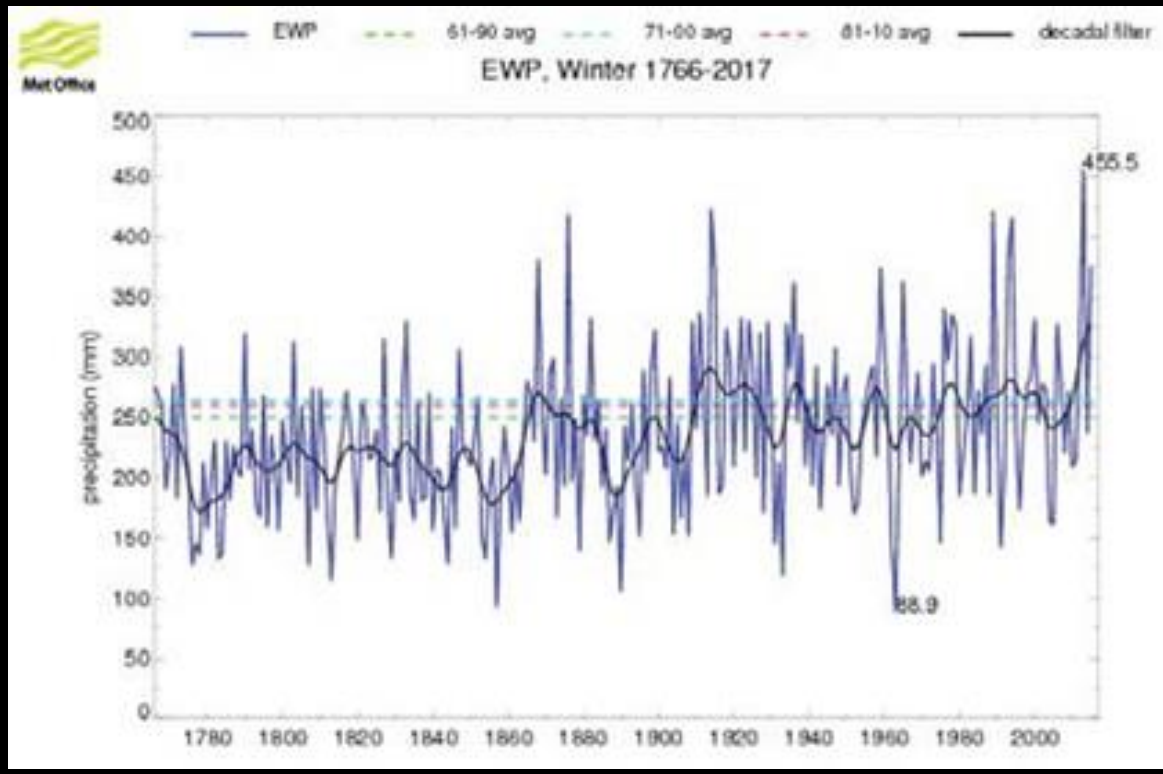


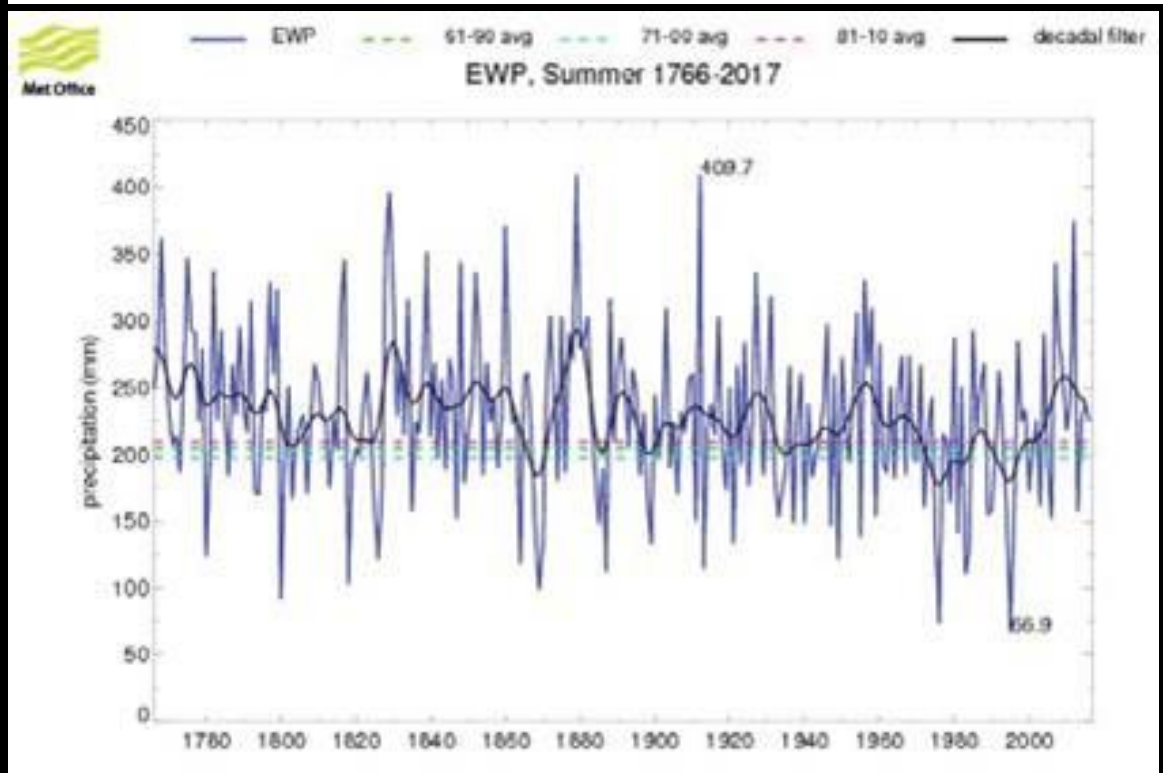
TEMPERATURE 2



Rainfall

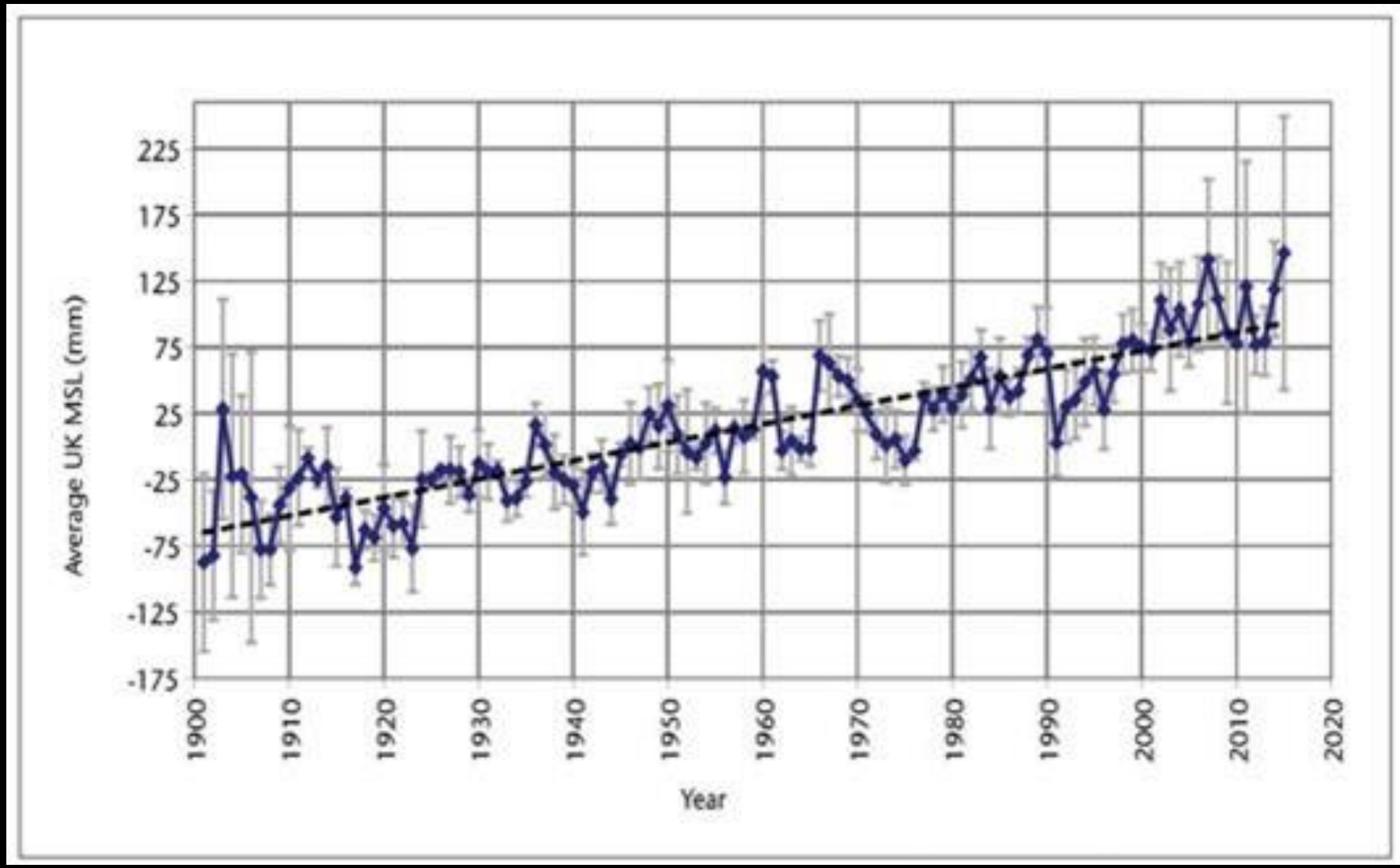
Precipitation (mm) in England and Wales during winter (December, January, February) (top) and summer (June, July, August) (bottom). The black line highlights decadal timescale variations from 1780 to 2017. The average England/ Wales precipitation for 1961 to 1990, 1971 to 2000 and 1981 to 2010 is shown by the green, blue and pink dashed lines respectively (Met Office 2016b)





UK sea level rise since 1901 computed from sea level data from five stations (Aberdeen, North Shields, Sheerness, Newlyn and Liverpool). The black– hashed line indicates the linear trend of 1.4 mm per year. Error bars represent the uncertainty for each individual year (Kendon et al. 2016).

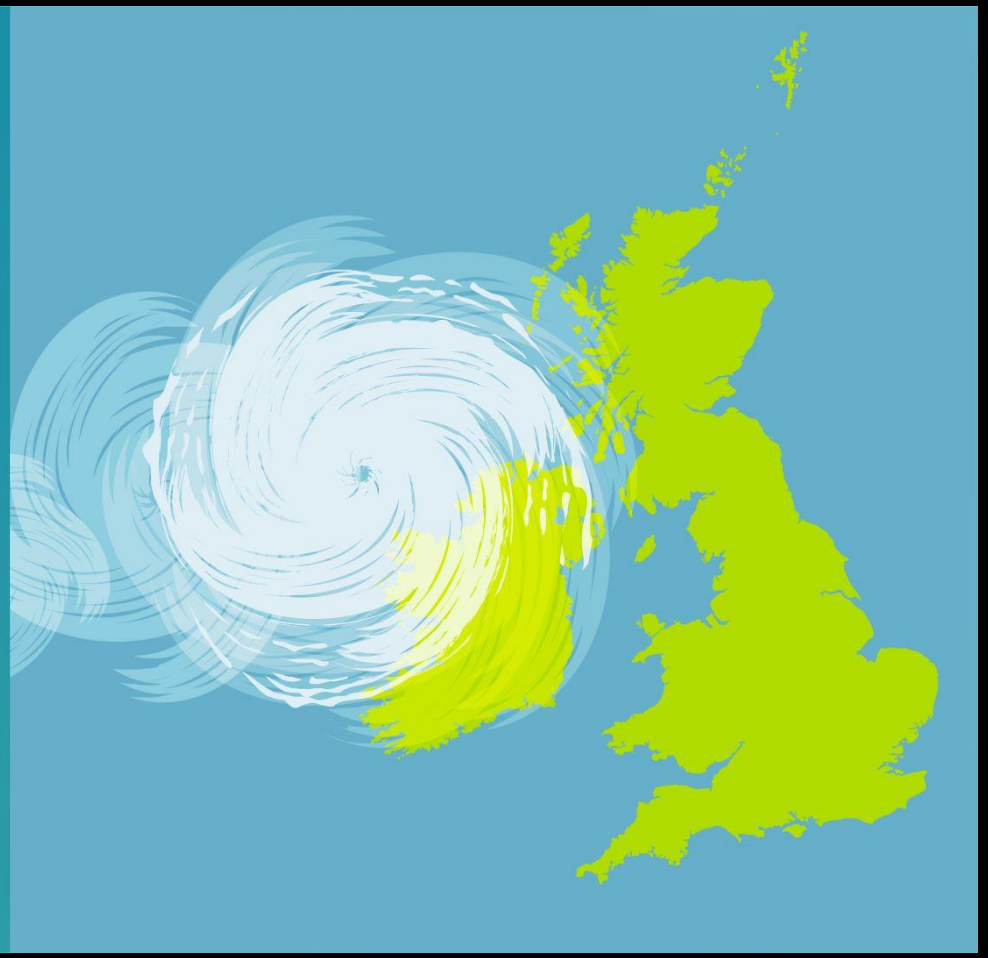
The continuing rise in sea levels around the coasts of the UK is increasing the risk of tidal/coastal flooding.



Met Office

UK wind storms

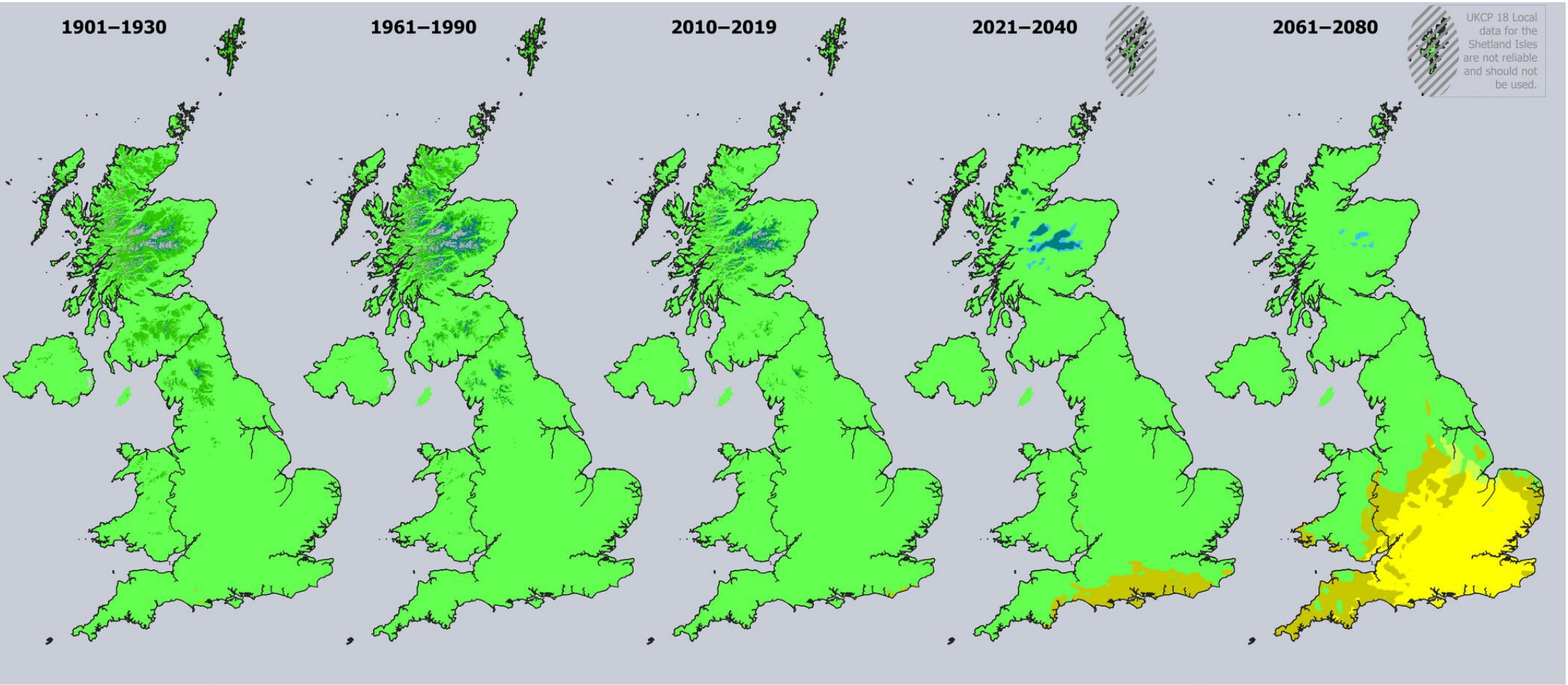
There is **little evidence** that climate change is affecting storms.



Some influences on storm activity that are likely to be affected by climate change are:

- Sea surface temperatures
- Extent of sea ice, mainly in regions close to the poles
- Position and strength of global jet streams, including the polar jet stream which influences UK weather
- Climate patterns, such as the El Nino Southern Oscillation or Indian Ocean Dipole

UK Köppen-Geiger climate classifications, Past, present and future



0 100 200 mi
0 100 200 300 km

- Temperate, no dry season, hot summer (Cfa)
- Temperate, no dry season, warm summer (Cfb)
- Temperate, no dry season, cold summer (Cfc)
- Temperate, dry summer, hot summer (Csa)
- Temperate, dry summer, warm summer (Csb)
- Temperate, dry summer, cold summer (Csc)
- Cold, no dry season, warm summer (Dfb)
- Cold, no dry season, cold summer (Dfc)
- Polar tundra (ET)

Instrumental data (1901–2019) from Met Office HadUK-Grid (1 km resolution). Future data (2021–2080) from Met Office UKCP18 Local (5 km resolution, interpolated to 1 km), mean of 12 ensemble runs for the RCP 8.5 climate change scenario. Köppen-Geiger classification follows Peel et al. (2007).

Climatic Data:

General increase of + 3C
- Warmest and coolest days

Increased rainfall of 30mm
- More weather events

Longer seasons
- Earlier flowering
- Later leaf fall, dormancy

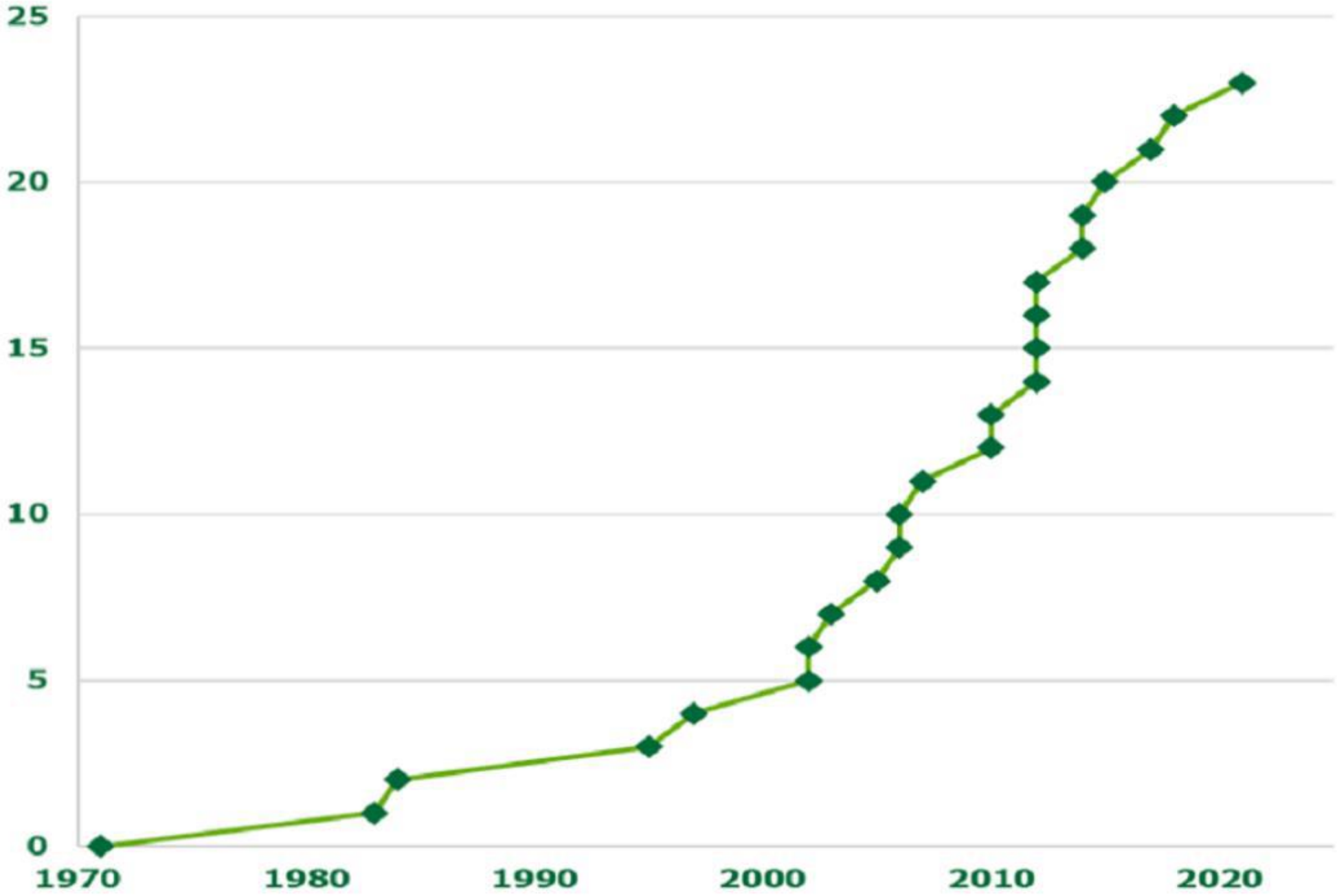
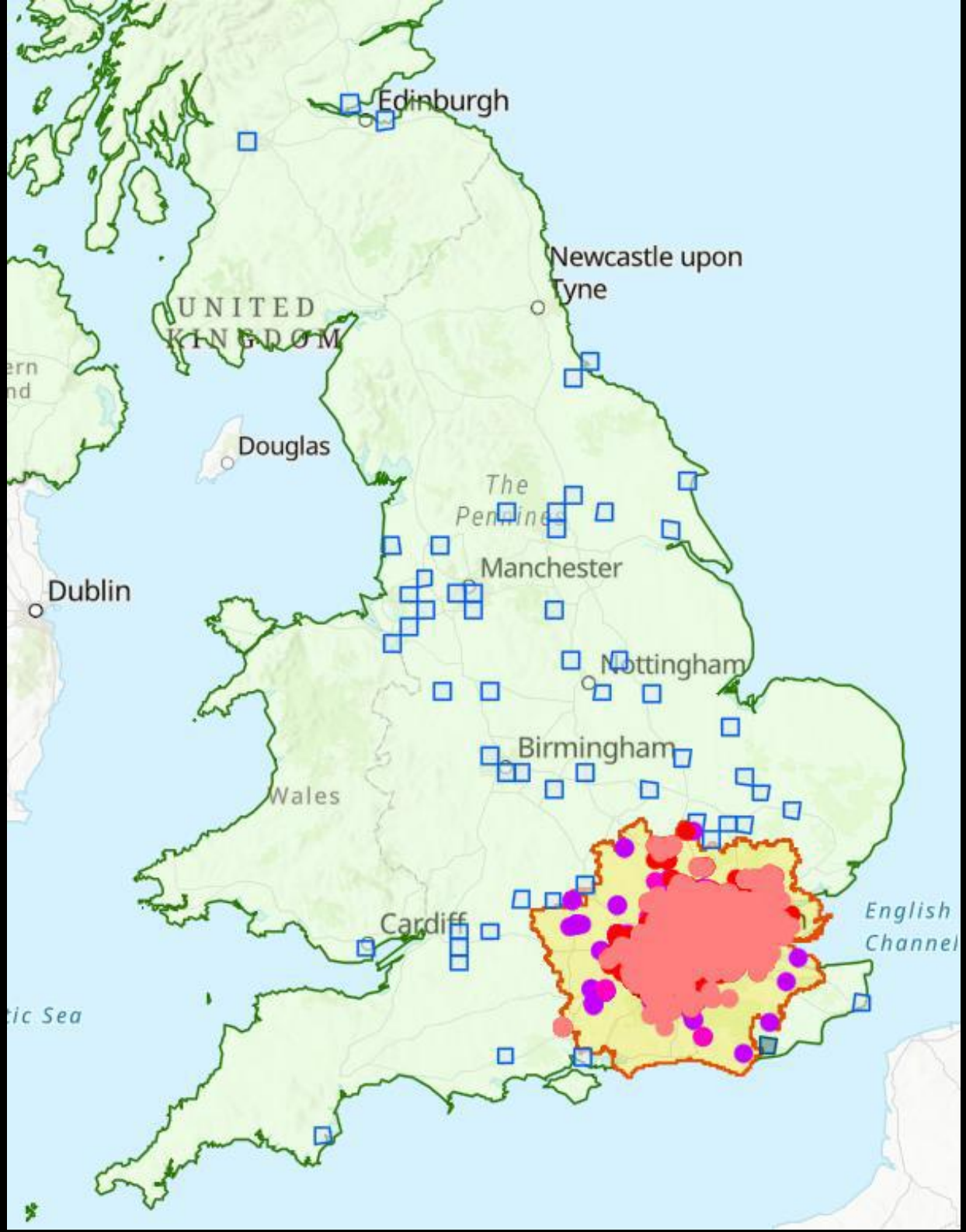


Figure 1: Graph showing a cumulative increase in the number of new pest and disease outbreaks (y axis) affecting trees since 1971 (x axis). The frequency of outbreaks has increased significantly since 2002 (Source: Forestry Commission)

Year (since 1971)	New pest and disease outbreak
1971	Dutch elm disease
1983	Great spruce bark beetle
1984	Phytophthora alni
1995	Gypsy moth
1997	Dothistroma needle blight
2002	Phytophthora ramorum
2002	Horse chestnut leaf miner
2003	Phytophthora kernoviae
2005	Bleeding canker of horse chestnut
2006	Oak processionary moth
2006	Phytophthora pseudosyringae
2007	Pine tree lappet moth
2010	Acute oak decline
2010	Phytophthora lateralis
2012	Ash dieback
2012	Asian longhorn beetle
2012	Sweet chestnut blight
2012	Phytophthora austrocedri
2014	Phytophthora sikiyouensis
2014	Sirococcus tsugae
2015	Oriental chestnut gall wasp
2017	Elm zigzag sawfly
2018	Eight toothed spruce bark beetle
2021	Phytophthora pluvialis

Map showing Spread of Oak Processionary Moth from its introduction in West London in 2006



Risks
& D

- OPM
- Emerald Ash Borer
- Xyella
- Phytophthora

Climatic

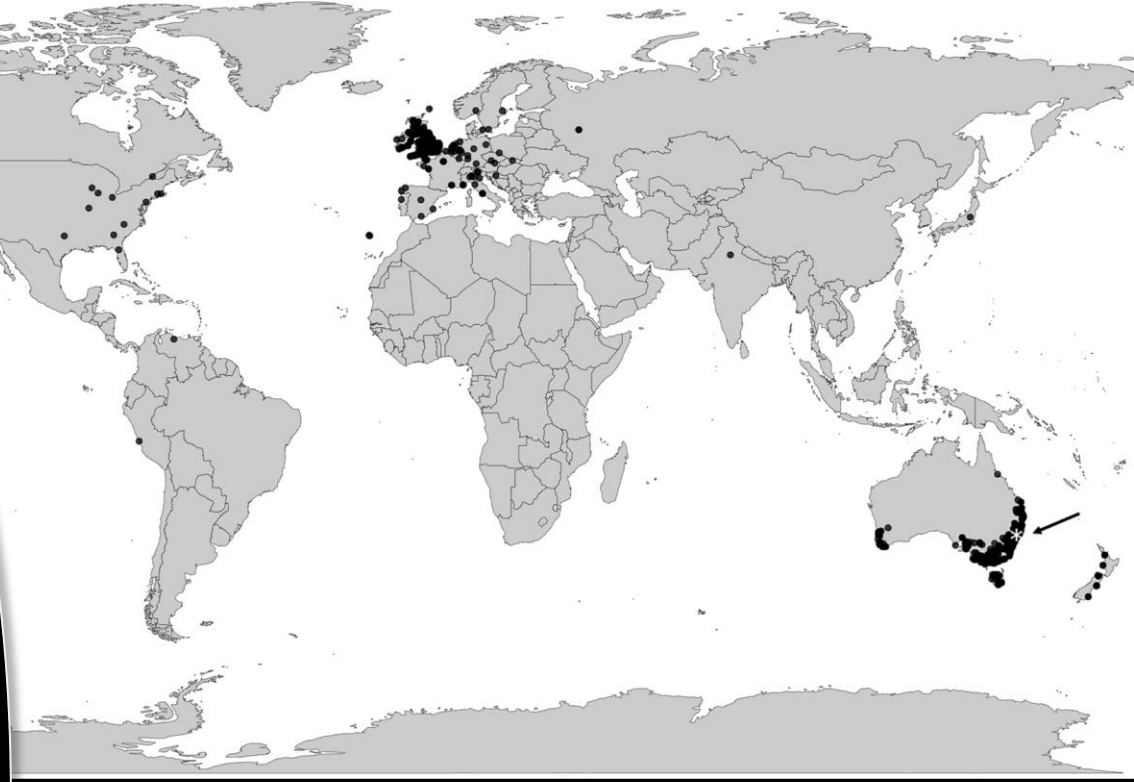
- Nutrient wash out (nitrogen)
- Winter chill (vernalisation)

Alien Plants

- Invasive potential

Climate Assessment Tool (BGCI)

Climate Change Alliance of Botanic Gardens. Climate Assessment Tool v1. Botanic Gardens Conservation International. Richmond, U.K. Available at: https://cat.bgci.org/

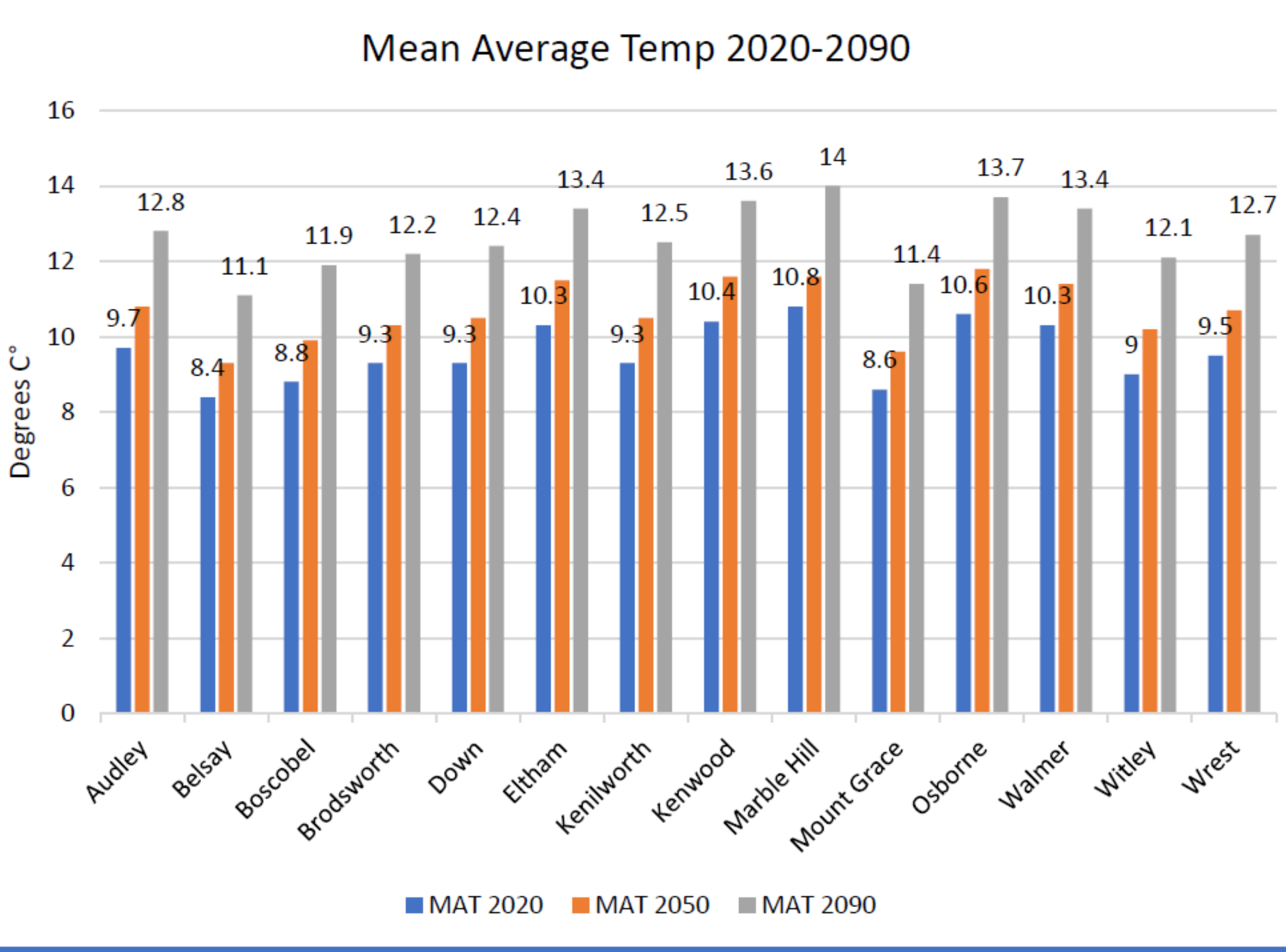


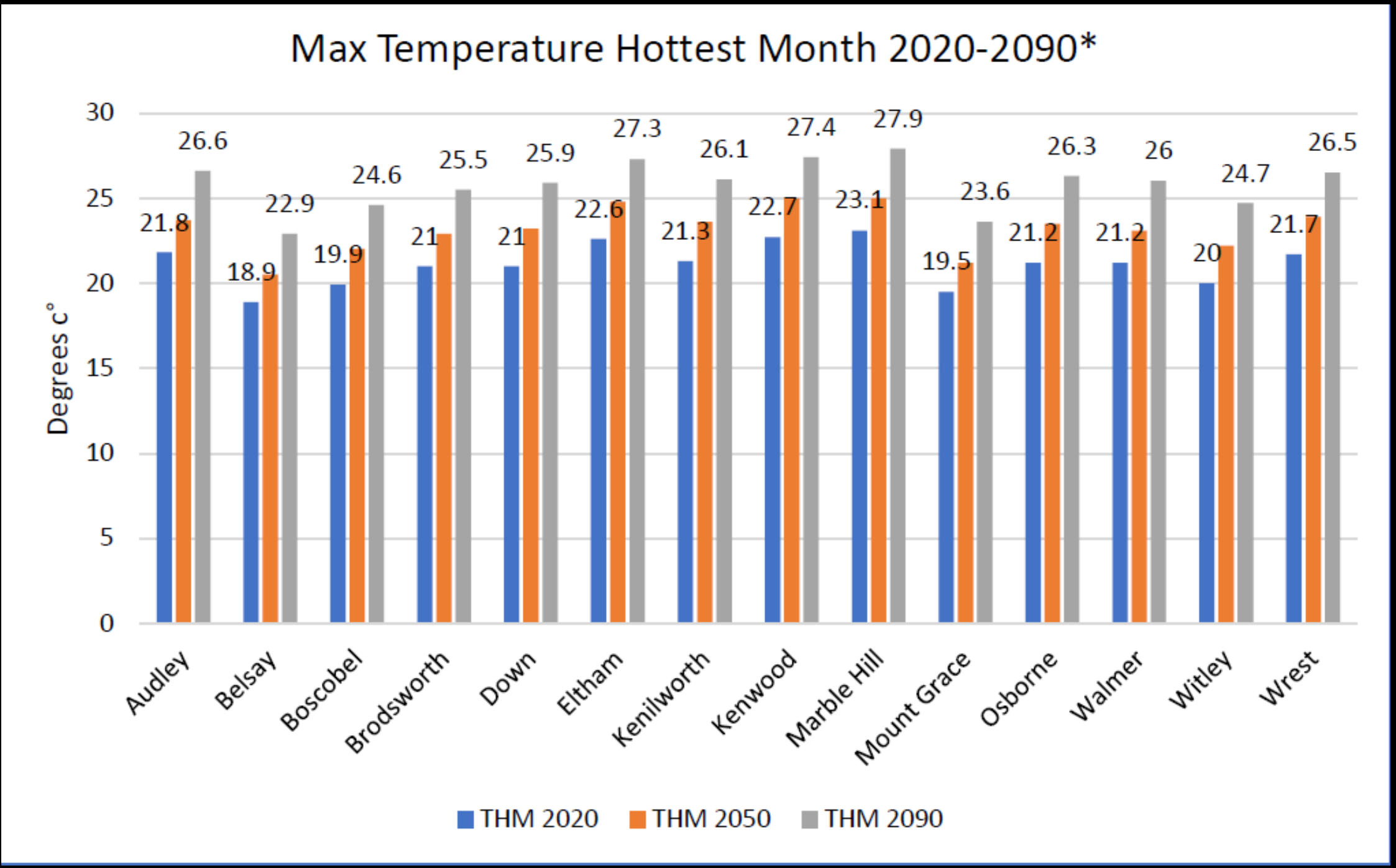
- Wollemi Pine
- Comparison by analysis of taxa
  - Climate
  - Ecology
  - Range – natural & botanic

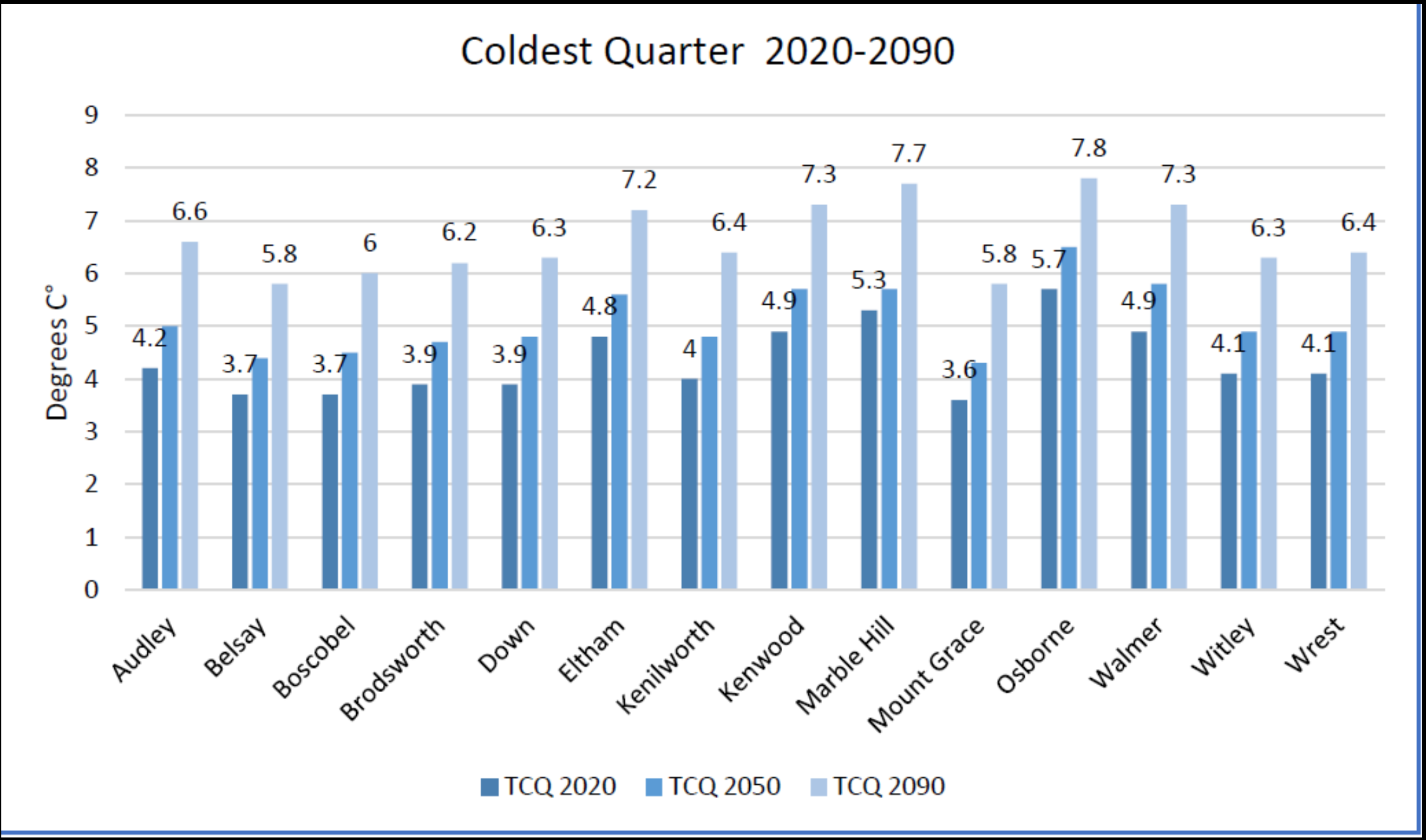
Limitations

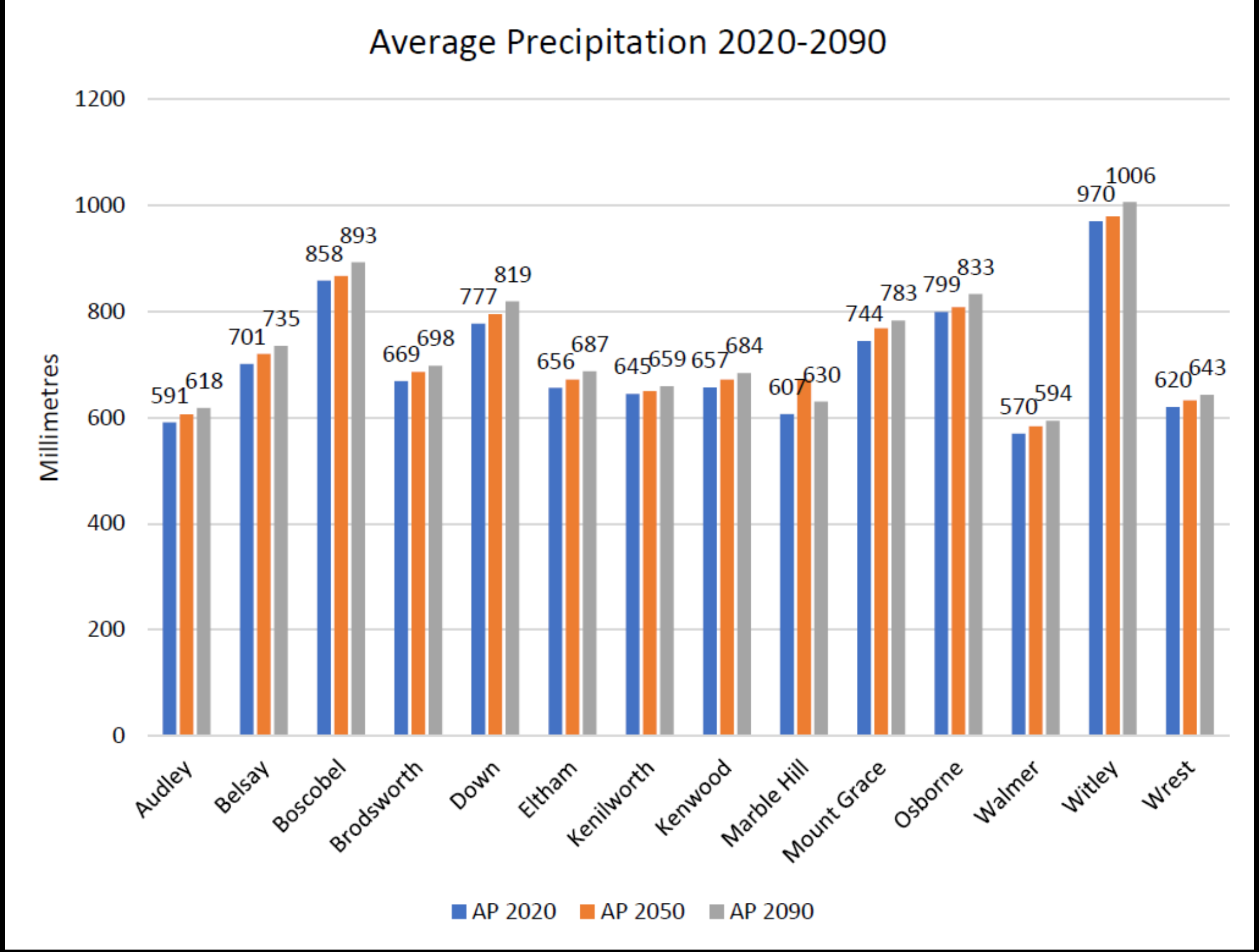
- Heavily favours northern hemisphere and cooler climates
- Only long-lived woody plants

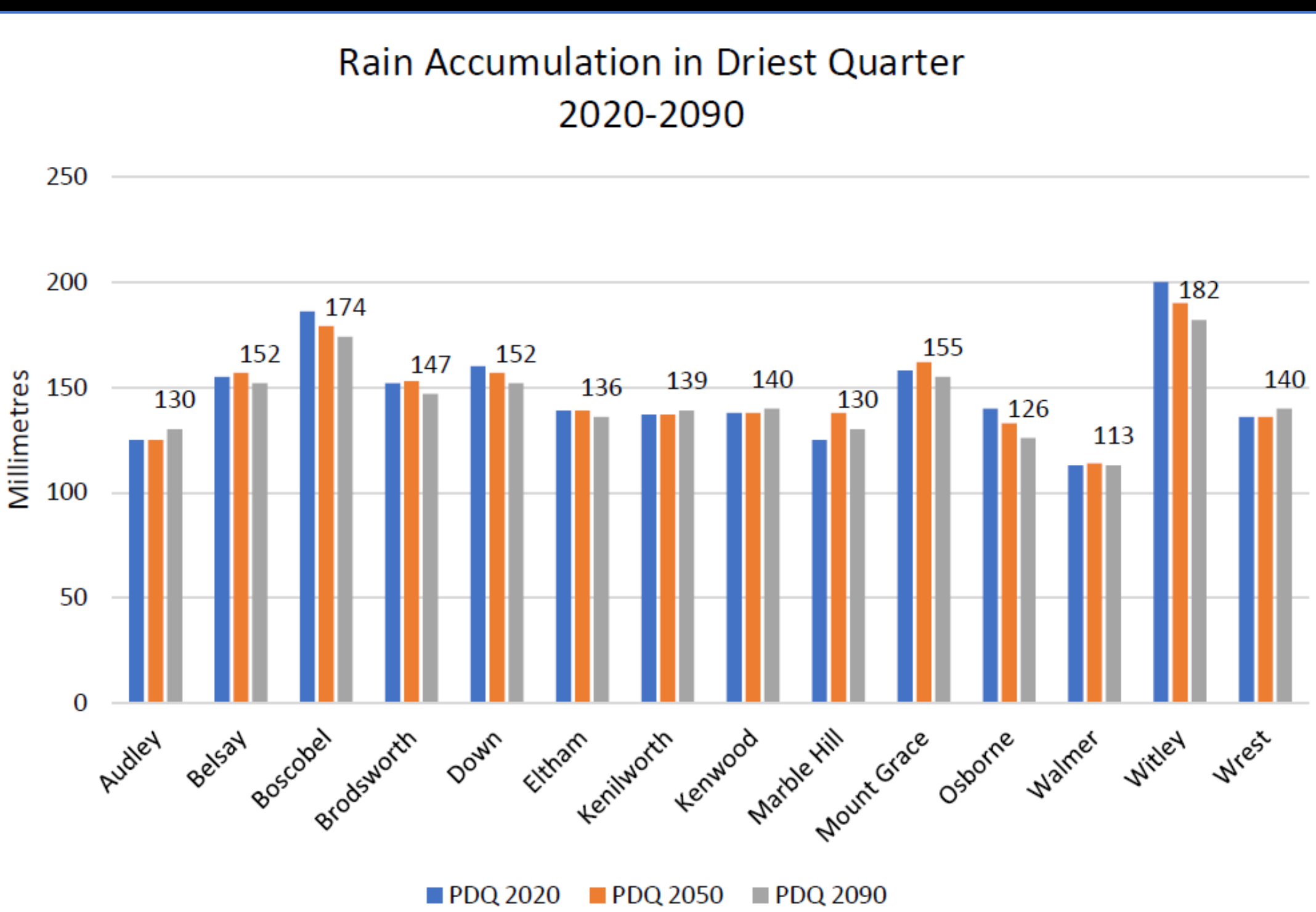
- Local knowledge/experience:
- Does a plant that tolerates heat also tolerate water scarcity?
- Can a plant tolerate prolonged heat if there is also low relative humidity?
- How will a plant react to heat waves or frost?
- How will it tolerate the annual climate patters at our garden sites?
- What soil type and profile is found at each garden?


Mean Average Temp 2020-2090
Degrees C°
16
14
12
10
8
6
4
2
0
9.7
12.8
8.4
11.1
8.8
11.9
9.3
12.2
9.3
12.4
10.3
13.4
9.3
12.5
10.4
13.6
10.8
14
8.6
11.4
10.6
13.7
10.3
13.4
9
12.1
9.5
12.7
Audley
Belsay
Boscobel
Brodsworth
Down
Eltham
Kenilworth
Kenwood
Marble Hill
Mount Grace
Osborne
Walmer
Witley
Wrest
MAT 2020
MAT 2050
MAT 2090


Max Temperature Hottest Month 2020-2090*
Degrees c°
30
25
20
15
10
5
0
21.8
26.6
18.9
22.9
19.9
24.6
21
25.5
21
25.9
22.6
27.3
21.3
26.1
22.7
27.4
23.1
27.9
19.5
23.6
21.2
26.3
21.2
26
20
24.7
21.7
26.5
Audley
Belsay
Boscobel
Brodsworth
Down
Eltham
Kenilworth
Kenwood
Marble Hill
Mount Grace
Osborne
Walmer
Witley
Wrest
THM 2020
THM 2050
THM 2090


Coldest Quarter 2020-2090
Degrees C°
0
1
2
3
4
5
6
7
8
9
4.2
6.6
3.7
5.8
3.7
6
3.9
6.2
3.9
6.3
4.8
7.2
4
6.4
4.9
7.3
5.3
7.7
3.6
5.8
5.7
7.8
4.9
7.3
4.1
6.3
4.1
6.4
Audley
Belsay
Boscobel
Brodsworth
Down
Eltham
Kenilworth
Kenwood
Marble Hill
Mount Grace
Osborne
Walmer
Witley
Wrest
TCQ 2020
TCQ 2050
TCQ 2090


Average Precipitation 2020-2090
Millimetres
1200
1000
800
600
400
200
0
591
618
701
735
858
893
669
698
777
819
656
687
645
659
657
684
607
630
744
783
799
833
570
594
970
1006
620
643
Audley
Belsay
Boscobel
Brodsworth
Down
Eltham
Kenilworth
Kenwood
Marble Hill
Mount Grace
Osborne
Walmer
Witley
Wrest
AP 2020
AP 2050
AP 2090


Rain Accumulation in Driest Quarter
2020-2090
Millimetres
250
200
150
100
50
0
130
152
174
147
152
136
139
140
130
155
126
113
182
140
Audley
Belsay
Boscobel
Brodsworth
Down
Eltham
Kenilworth
Kenwood
Marble Hill
Mount Grace
Osborne
Walmer
Witley
Wrest
PDQ 2020
PDQ 2050
PDQ 2090

Vulnerable taxa in 4 or more collections:

Taxa	Count
Betula pubescens	13
Pinus sylvestris	10
Ulmus glabra	9
Sequoiadendron giganteum	8
Crataegus monogyna	7
Fagus sylvatica	7
Malus sylvestris	7
Sorbus aucuparia	7
Acer pseudoplatanus	6
Aesculus hippocastanum	5
Betula pendula	5
Carpinus betulus	5
Castanea sativa	5
Fraxinus excelsior	5
Pinus nigra	5
Salix alba	5
Sorbus intermedia	5
Acer campestre	4
Acer platanoides	4
Alnus glutinosa	4
Juglans regia	4
Parrotia persica	4
Prunus avium	4
Quercus ilex	4
Salix caprea	4
Tilia cordata	4
Viburnum tinus	4

RATING SCORES (CAT/BGCI):

0	Not known and unlikely
1	Not known but possible
2	Not known, but likely
3	Near edge of BG range
4	Near edge of urban range
5	Near edge of natural range
6	Shoulder of BG range
7	Shoulder of urban range
8	Shoulder of natural range
9	Middle of BG range
10	Middle of urban range
11	Middle of natural range

The CAT data provides a rating on affected species ranging between 0 and 11 as shown in the table. Quite a number of taxa move from the edge of the range to middle ranges, such as *Blepharocalyx salicifolius* from south America and the palms *Areca catechu* and *Dypsis lutescens* from tropical Africa.

However, there are many commonly used forestry and ornamental species that will move into the edge or shoulder of the ranges, such as *Picea omorika*, *Sorbus aucuparia* and *Betula pendula*.

Belsay	2020	2050	2090
Acer davidii		8	
Acer griseum	6		
Aesculus indica	5	8	
Alnus cordata	6		
Betula pubescens			6
Calocedrus decurrens	8		
Castanea sativa	6		
Catalpa bignonioides	8		
Cornus mas	8		
Corylopsis pauciflora	5		
Crataegus monogyna	6		
Cryptomeria japonica	6	6	
Daphniphyllum macropodum	8	8	
Fagus sylvatica	8		
Ilex aquifolium	8		
Juglans regia	8		
Laburnum anagyroides	8		
Magnolia acuminata	8		
Magnolia stellata	8		
Magnolia wilsonii	6		
Osmanthus heterophyllus	5		
Parrotia persica	5	8	
Pinus nigra	6		
Prunus lusitanica	5		
Prunus serrulata	8		
Quercus ilex	6	6	
Quercus rubra	8		
Rhododendron			
Sequoia sempervirens	5	6	
Sequoiadendron giganteum	8		
Trachycarpus fortunei	3	6	
Yucca gloriosa	3	6	

0	Not known and unlikely
1	Not known but possible
2	Not known, but likely
3	Near edge of BG range
4	Near edge of urban range
5	Near edge of natural range
6	Shoulder of BG range
7	Shoulder of urban range
8	Shoulder of natural range
9	Middle of BG range
10	Middle of urban range
11	Middle of natural range

Walmer	2020	2050	2090
Acer campestre			6
Acer pseudoplatanus			6
Aralia bipinnata	5		
Betula pendula			6
Betula pubescens		6	3
Brahea edulis	6		
Castanea sativa			8
Crataegus monogyna			6
Euonymus europaeus			6
Fagus sylvatica			6
Fraxinus excelsior			6
Griselinia littoralis			6
Hoheria sexstylosa			8
Magnolia wilsonii			8
Magnolia yunnanensis	3		
Pinus nigra			6
Pinus sylvestris			6
Prunus avium			6
Sequoiadendron giganteum			5
Sorbus intermedia		6	3
Staphylea pinnata			6
Stewartia pseudocamellia			8
Tilia petiolaris			6
Ulmus glabra			6
Yucca gigantea	6		

0	Not known and unlikely
1	Not known but possible
2	Not known, but likely
3	Near edge of BG range
4	Near edge of urban range
5	Near edge of natural range
6	Shoulder of BG range
7	Shoulder of urban range
8	Shoulder of natural range
9	Middle of BG range
10	Middle of urban range
11	Middle of natural range

Train the next generation of gardens to do what gardeners have always done: Adapt to the changing growing environment

HBG
Training Programme

Practical garden placements:

- 12 month in a premier historic garden
- 300 trainees
- The host garden can be in any part of the UK
- 56 different host gardens
- HBGTP seminars & Master Classes
- Supervisor and Mentor Training