Triggering Change and climate change visualisation

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Triggering Change Project Workshop 12th September 2025

The James Hutton Institute

Outline

- Intro: using climate change projection data to visualise the future
- Why visualise the future?
  - Types of visualisation.
- About the data – where it comes from
- What the visualisations show – what does the future look like
- Global context

Intro

- To help adapt to climate change, it is useful to understand better what change looks like in terms of the weather and what this means for things like the amount of water available for crops and nature, or how many extreme events there may be.
- Visualisations help stimulate discussion.
- Visualising the future helps to answer questions like, “what does a 2°C temperature rise really look like, and what are the impacts?”
- The aim is to help you to better understand how much the climate has already changed and how much more it may do in the future.

Why visualise the future?

- To help plan and build resilience
- Identify risks and points of vulnerability in:
  - A business or land use system
  - Natural Capital
- Identify a trigger point
- Envisage opportunities and inform decision making
- Comparisons across time:
  - We use the 1960-1989 period as a baseline
  - Observed change: Baseline compared to 1990-2019 period
  - Future projections: Baseline compared with 2020-2049 and 250-2079 periods
- Types of visualisation:
  - Maps – static and time series videos
  - Graphs
  - Tables

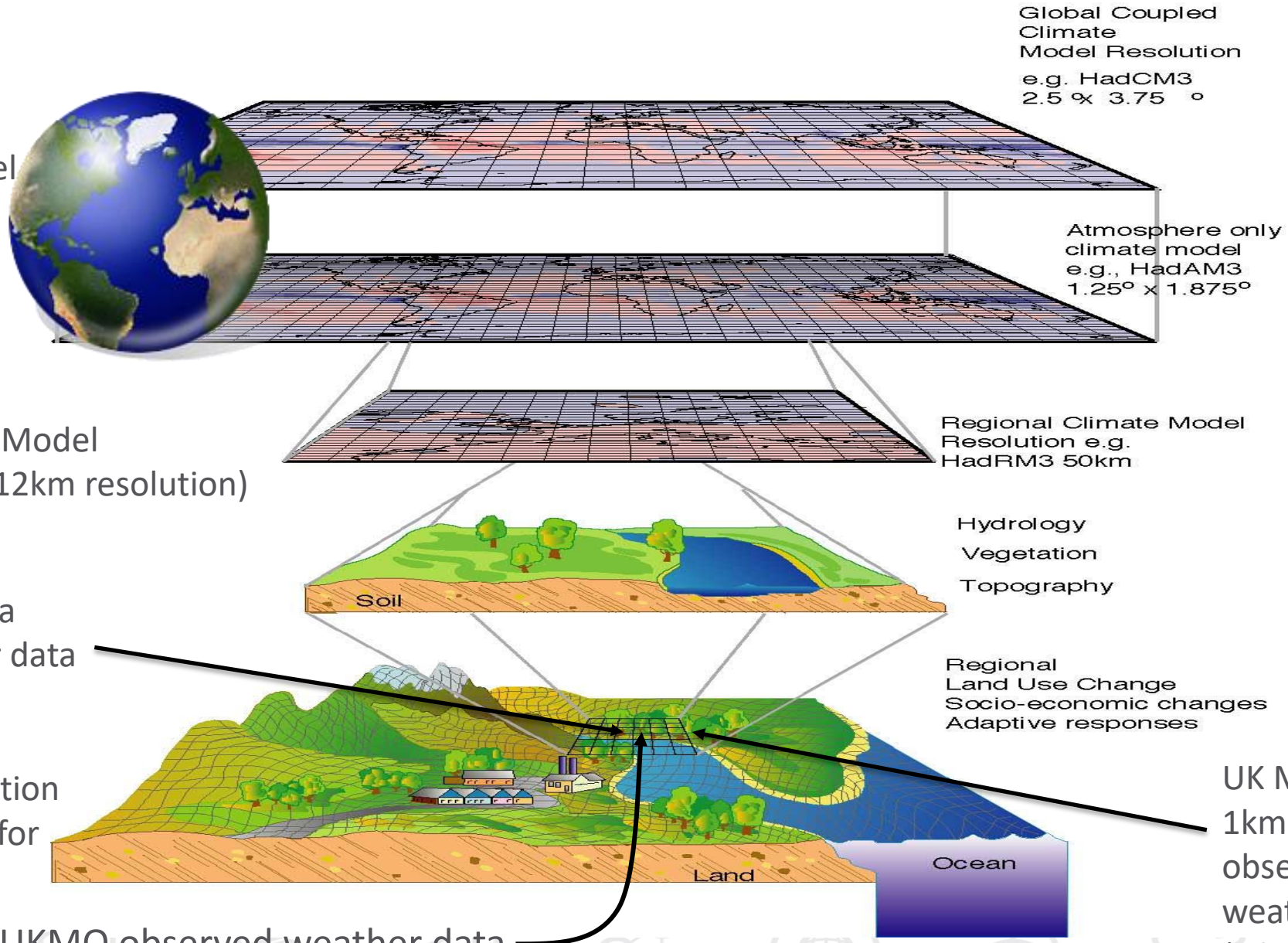
Where does the climate projection data come from? UKCP18

HadGEM3
global Model

HadRM3
Regional Climate Model
(x 12 parameterisations at 12km resolution)

Additional Steps:

1. Compare modelled data with observed weather data to identify errors.
2. Apply bias correction factors to future projection data to increase utility for future condition representation.

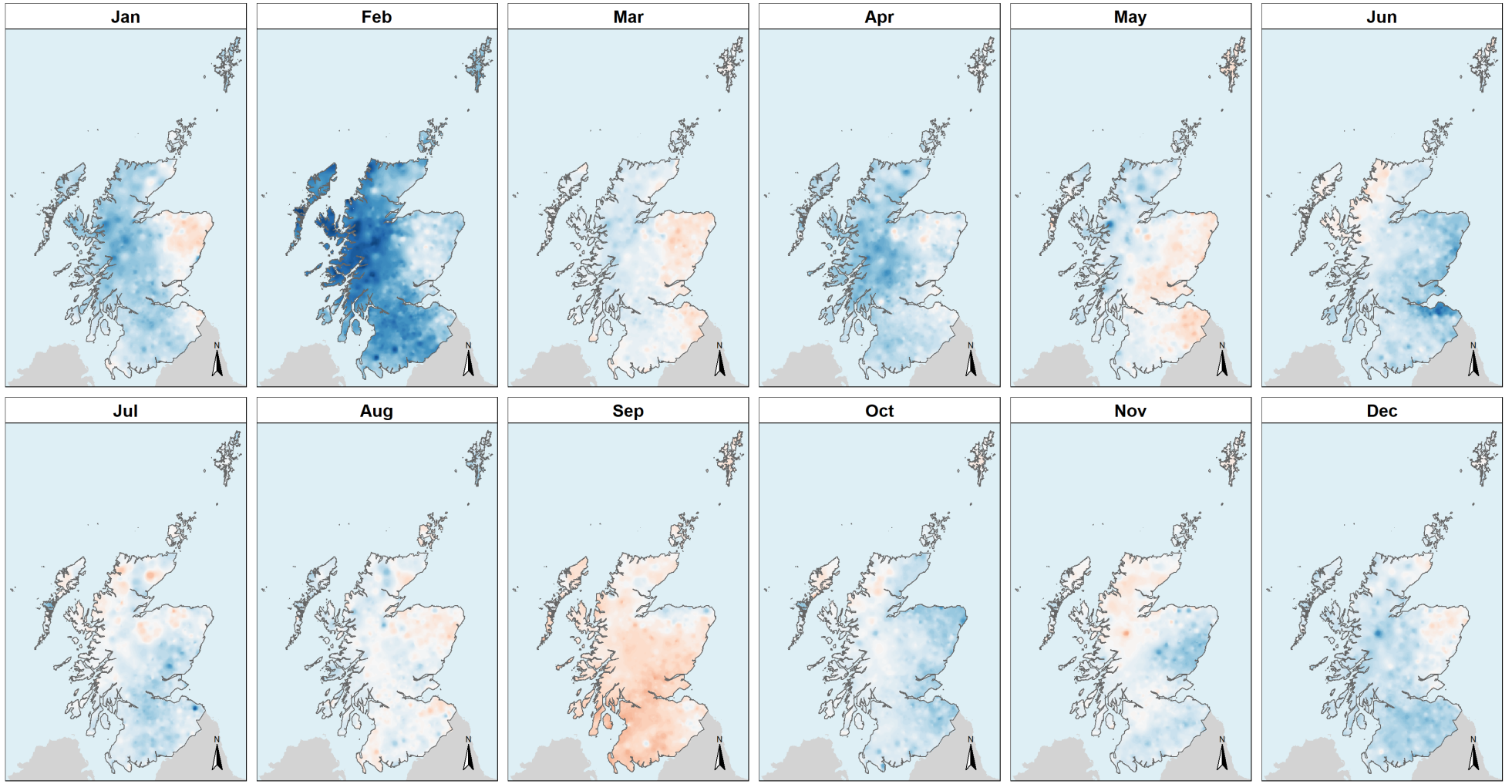


UKMO observed weather data

UK Met Office 1km interpolated observed weather data (whole UK)

Observed changes: Precipitation

Mean monthly precipitation change over the historical period 1990-2019 as compared to the baseline period 1960-1989

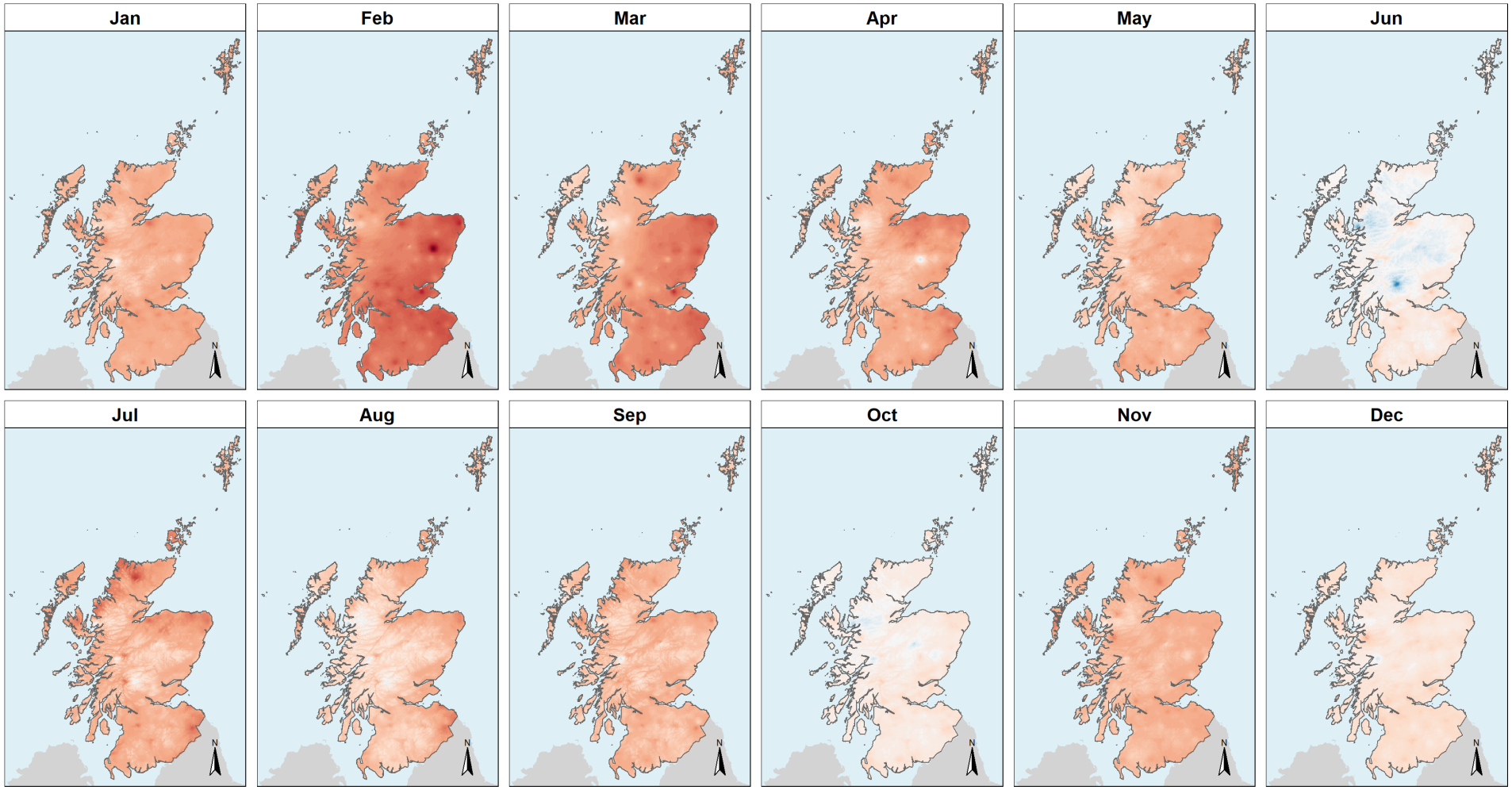


Darker blue areas indicate larger increases in precipitation change from the 1960-1989 period, e.g. February has seen up to 60% increase.

Orange areas indicate a decrease in precipitation.

Observed changes: Maximum Temperature

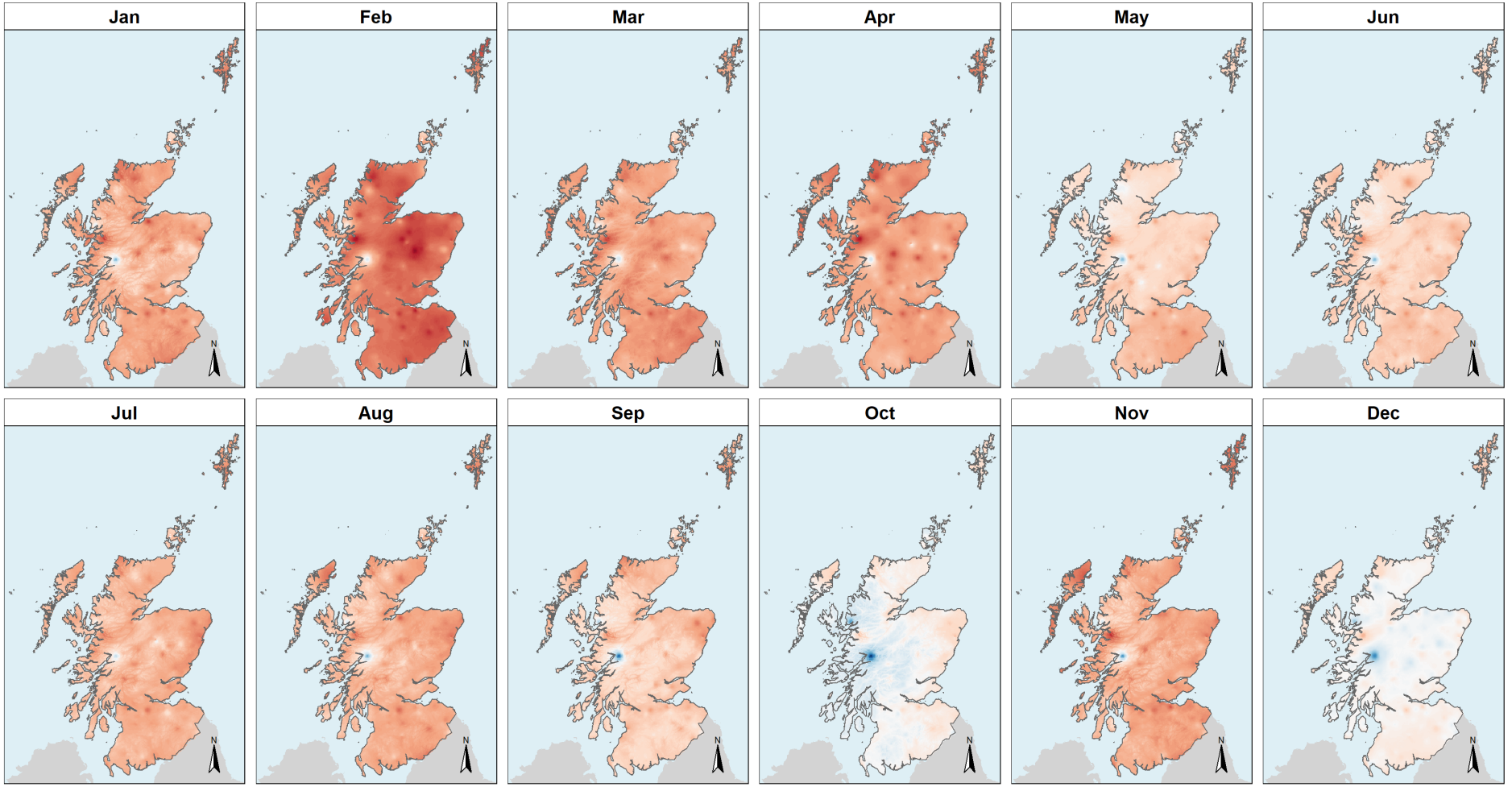
Mean monthly maximum temperature change over the historical period 1990-2019 as compared to the baseline period 1960-1989



All months have experienced an overall increase in mean monthly maximum temperature since 1960, though June and October have seen some areas where it has become cooler.

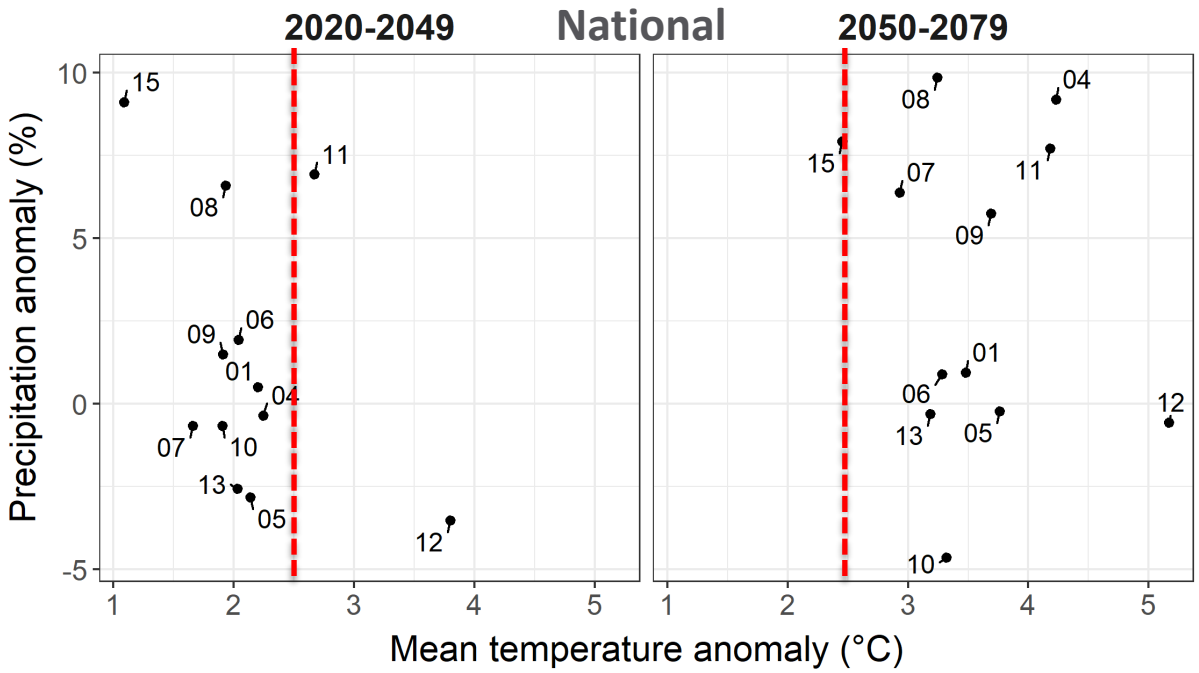
Observed changes: Minimum Temperature

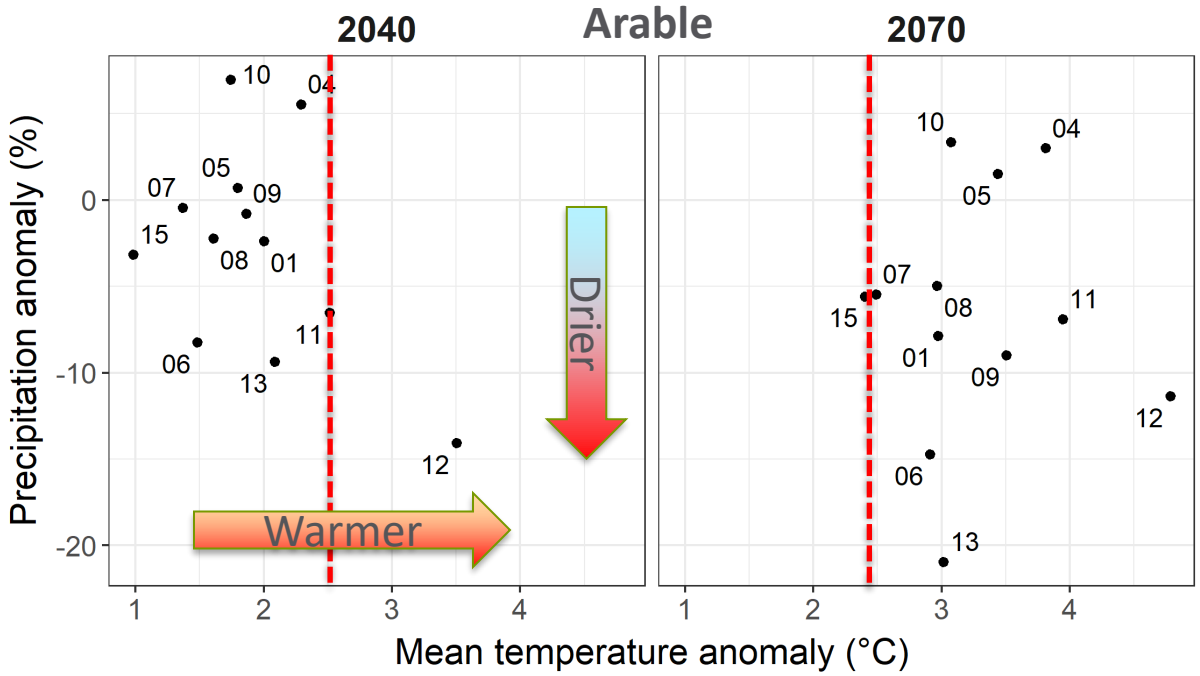
Mean monthly minimum temperature change over the historical period 1990-2019 as compared to the baseline period 1960-1989



All months have experienced an overall increase in mean monthly minimum temperature since 1960, though October and December have seen some areas where it has become cooler.

Future Projections





Climate change signal for the 12 projections used to generate the future maps (UKCP18 RCP 8.5).

Top: Annual **National** precipitation and temperature anomaly under RCP8.5 for 2030-2049 (‘2040’) and 2060-2079 (‘2070’) with respect to a 1994-2015 baseline.
Bottom: Comparison of the Scotland **arable area-wide** mean climate change signal in the growing season only (March to September).

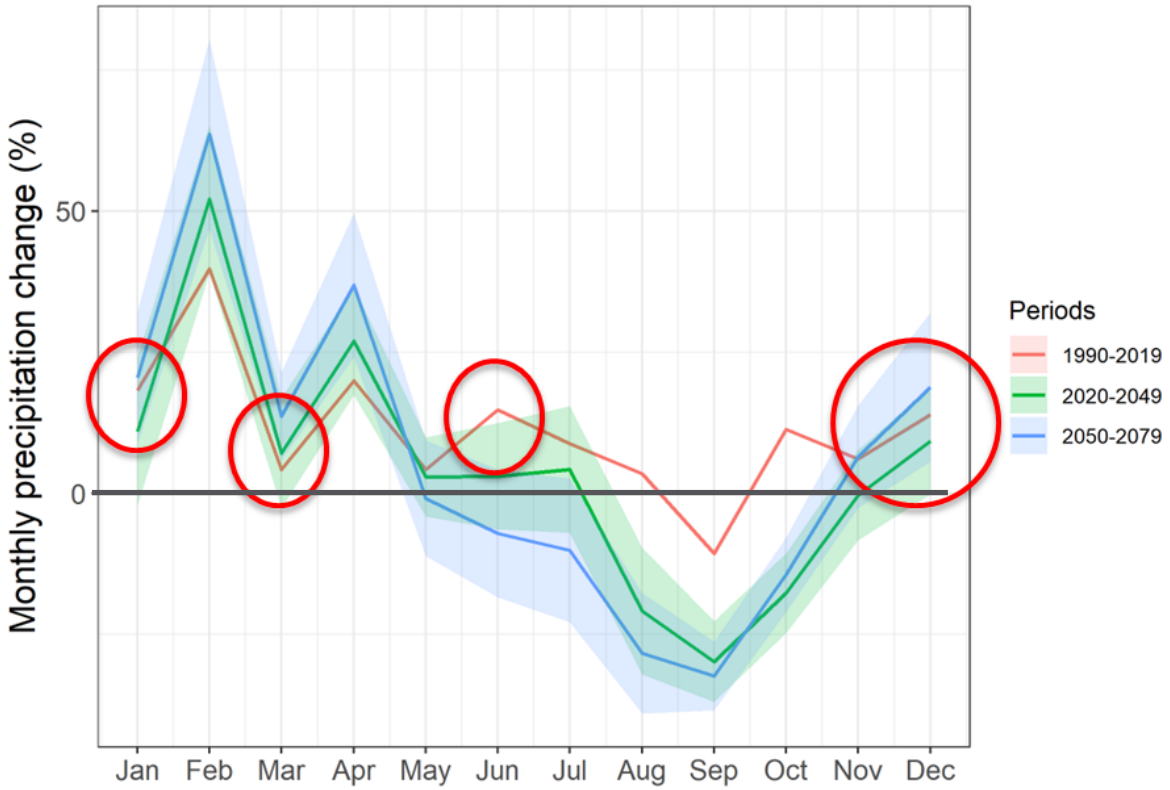
So… although emissions scenario is ‘High end’ RCP8.5, the 12 projections contain precipitation and temperature changes that also represent lower emissions as well (e.g. 15, 07, 06).

approx. temperature increase based on current global mitigation commitments to 2050

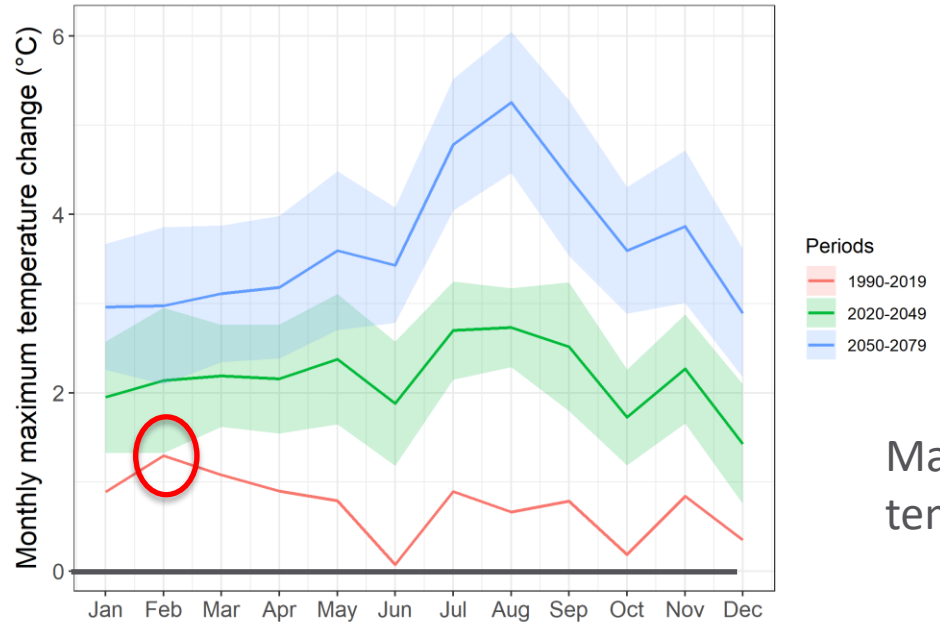
Future projections

Scotland summary

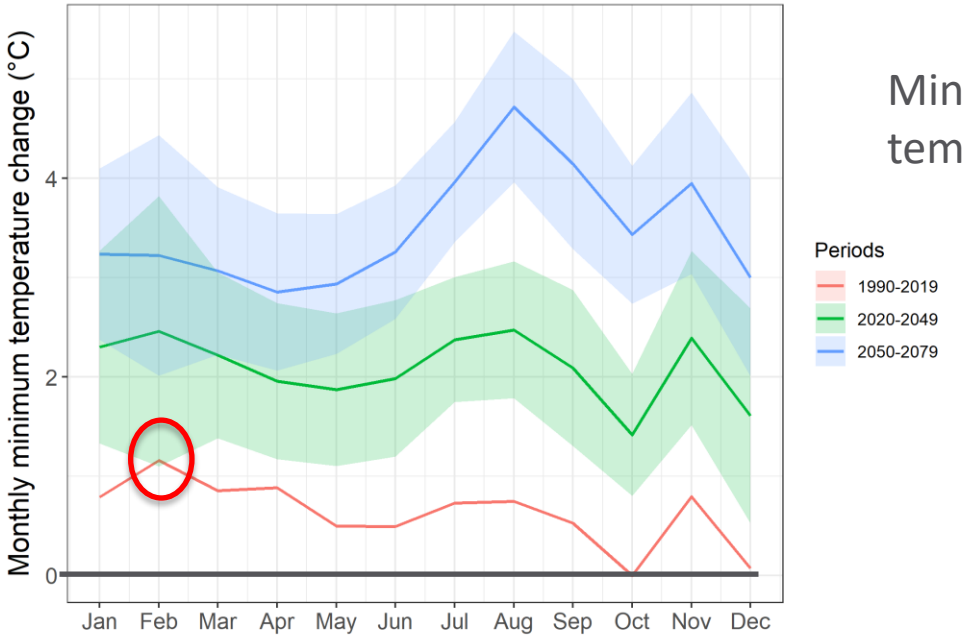
Precipitation



Black line represents the 1960 – 1989 baseline



Maximum temperature



Minimum temperature

Break to agrometeorological indicators videos

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Future projections: more extremes and increasing spatial and temporal variability

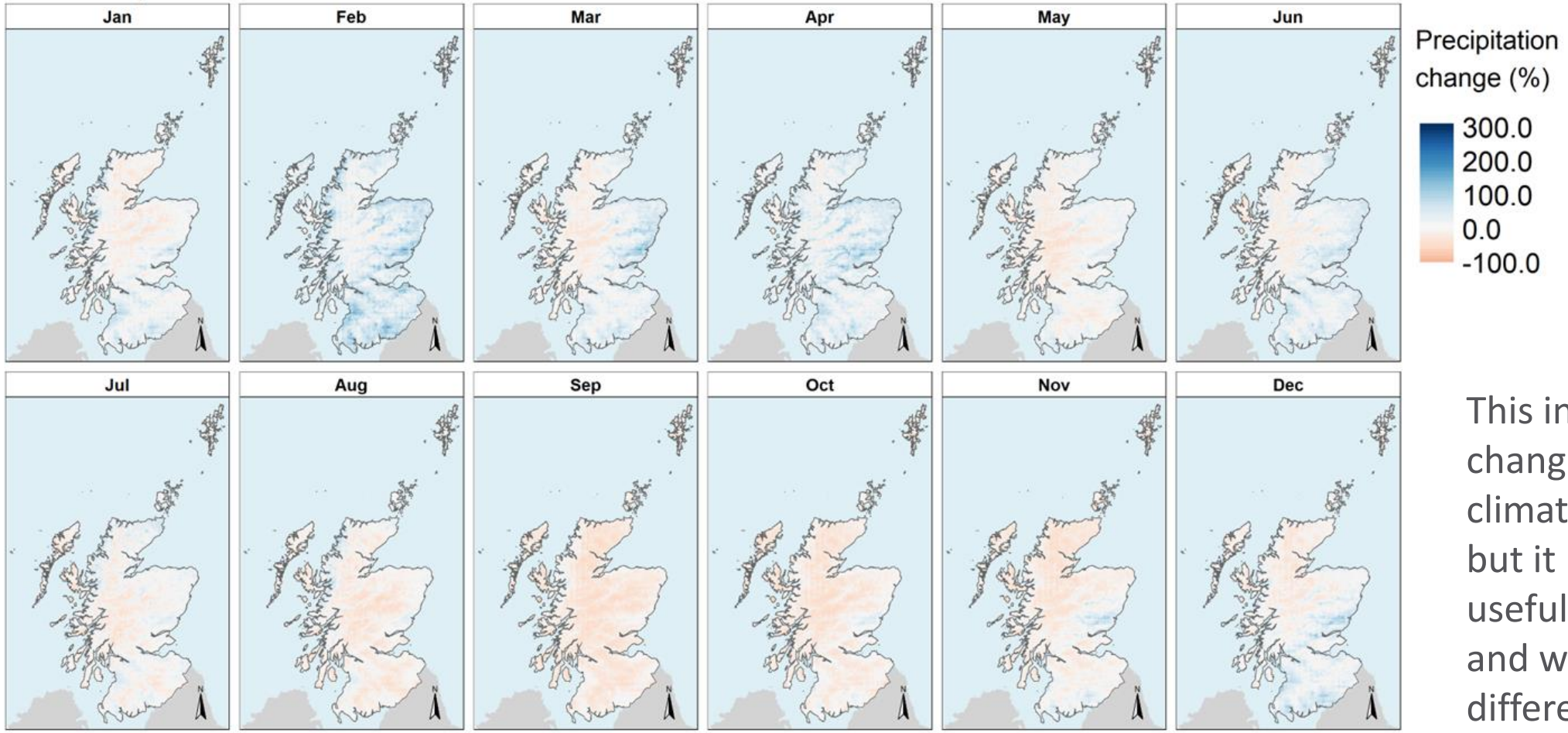
Precipitation:

- 2020 to 2049: Scotland's climate to be wetter in December, January (both c.10%), February (45 – 55%) and April (25%) but less so in March (c. 5%). August, September and October are projected to become drier.
  - Projected changes align with the observed changes already seen.
- Patterns continue into 2050 – 2079 with increases in the magnitude of change.
- High level of agreement between projections that February and April precipitation will increase, whilst August, September and October will decrease.
- Large spatial variation in changes to the monthly mean precipitation between projections: eastern areas may become wetter in some months (February, April, May, November and December); upland areas are likely to decrease in May, August, September and October, and November in the north.

Temperature:

- Observed trends in maximum and minimum temperature projected to continue.
  - High agreement between all 12 projections on there being continued warming, with all exceeding 2°C by the 2070s.
- More warming between May and November (up to 4°C per month between 2020 – 2049), but also with substantial warming in the winter (variable by projection, approximately 2-3°C).
- The spatial distribution of change is relatively uniform across Scotland, e.g. does not reflect topographical differences.

Changes in mean monthly precipitation over the period 2020-2049 as compared to the historical baseline period 1960-1989 for the ensemble member 01

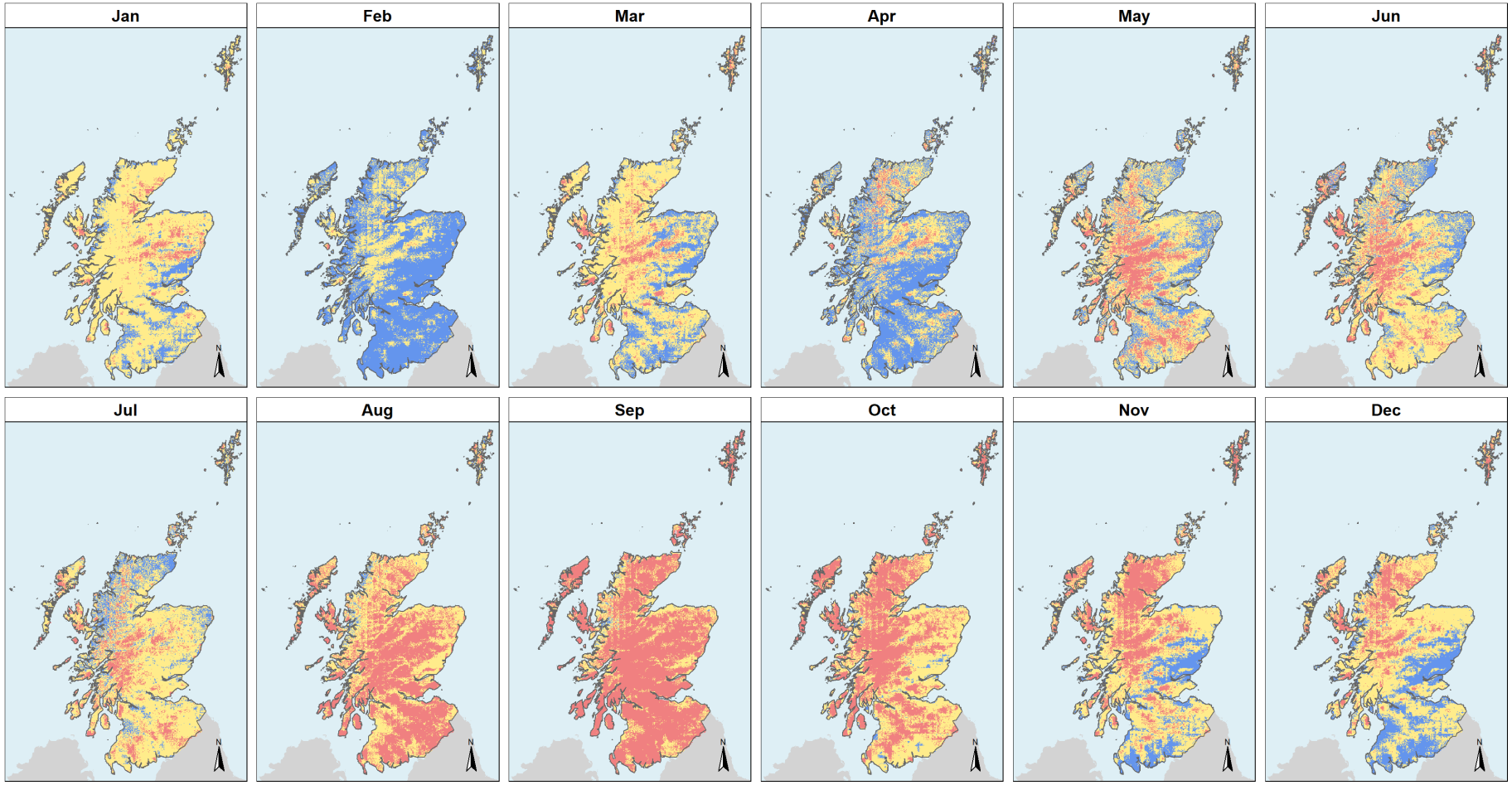


This informs us of changes for one climate projection, but it may be more useful to see how and where the different projections agree on the direction of change

Future projections

Agreement maps - precipitation

Change direction agreement for mean monthly precipitation over the period 2020-2049 for at least 12 ensemble members

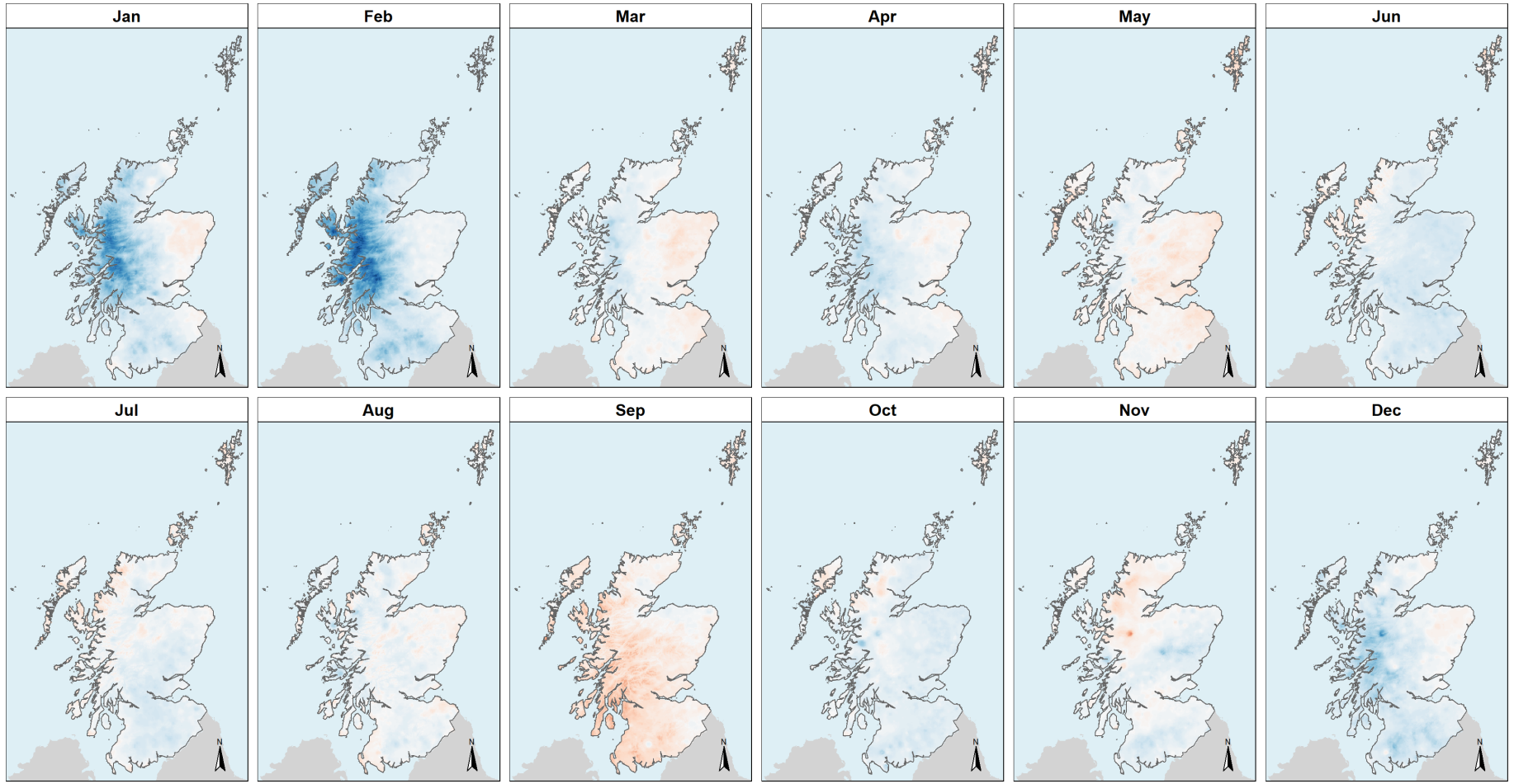


Red (decrease) or Blue (increase) indicates where all 12 projections agree the direction of change. Yellow means not all 12 agree, but it may be that most projections do agree.

Observed changes in Climatic Water Balance

(Precipitation – Evapotranspiration)

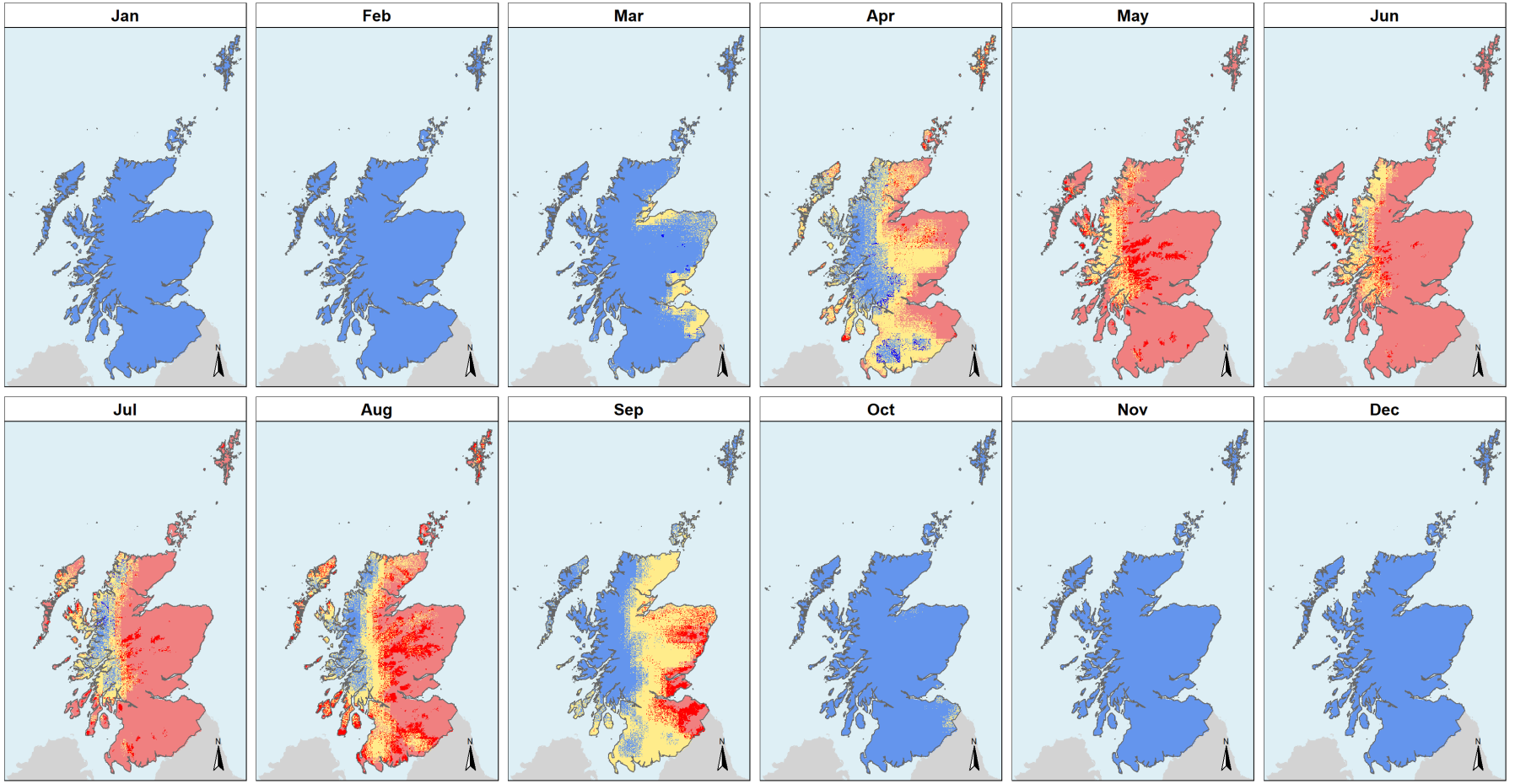
Change in mean monthly climatic water balance over the historical period 1990-2019 as compared to the baseline period 1960-1989



Blue indicates areas where there has been more water available, orange shows where there has been less water.

Future Climatic Water Balance agreement map

Change direction agreement for mean monthly climatic water balance over the period 2020-2049 for at least 12 ensemble members



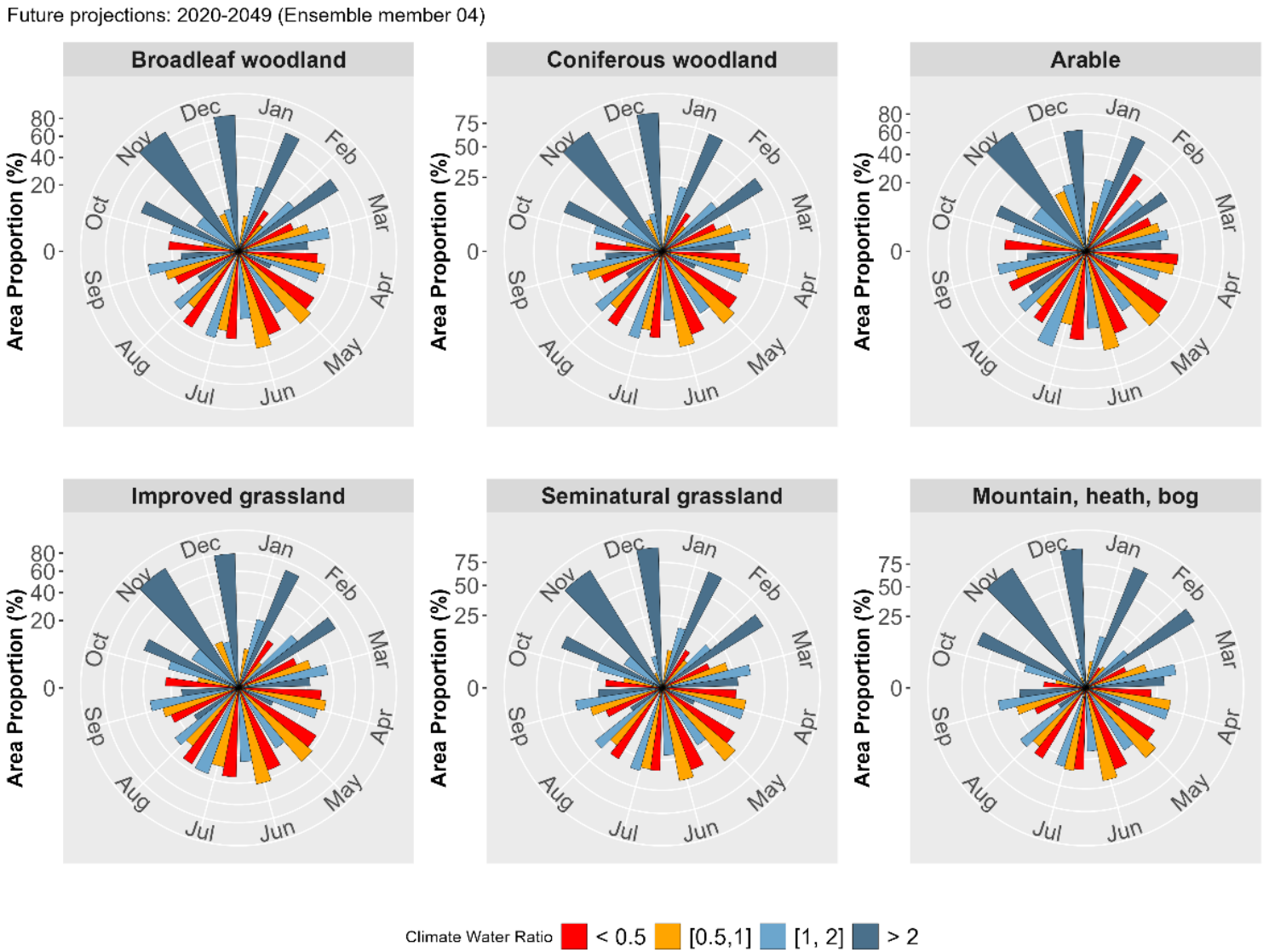
Habitats that exist in the areas that are projected to experience a shift from water surplus to deficit (dark red) are likely to experience higher levels of water stress.

Unknowns: role of occult precipitation (i.e. dew), ground water, hydrological flows

Climatic Water Balance Ratio and Habitats

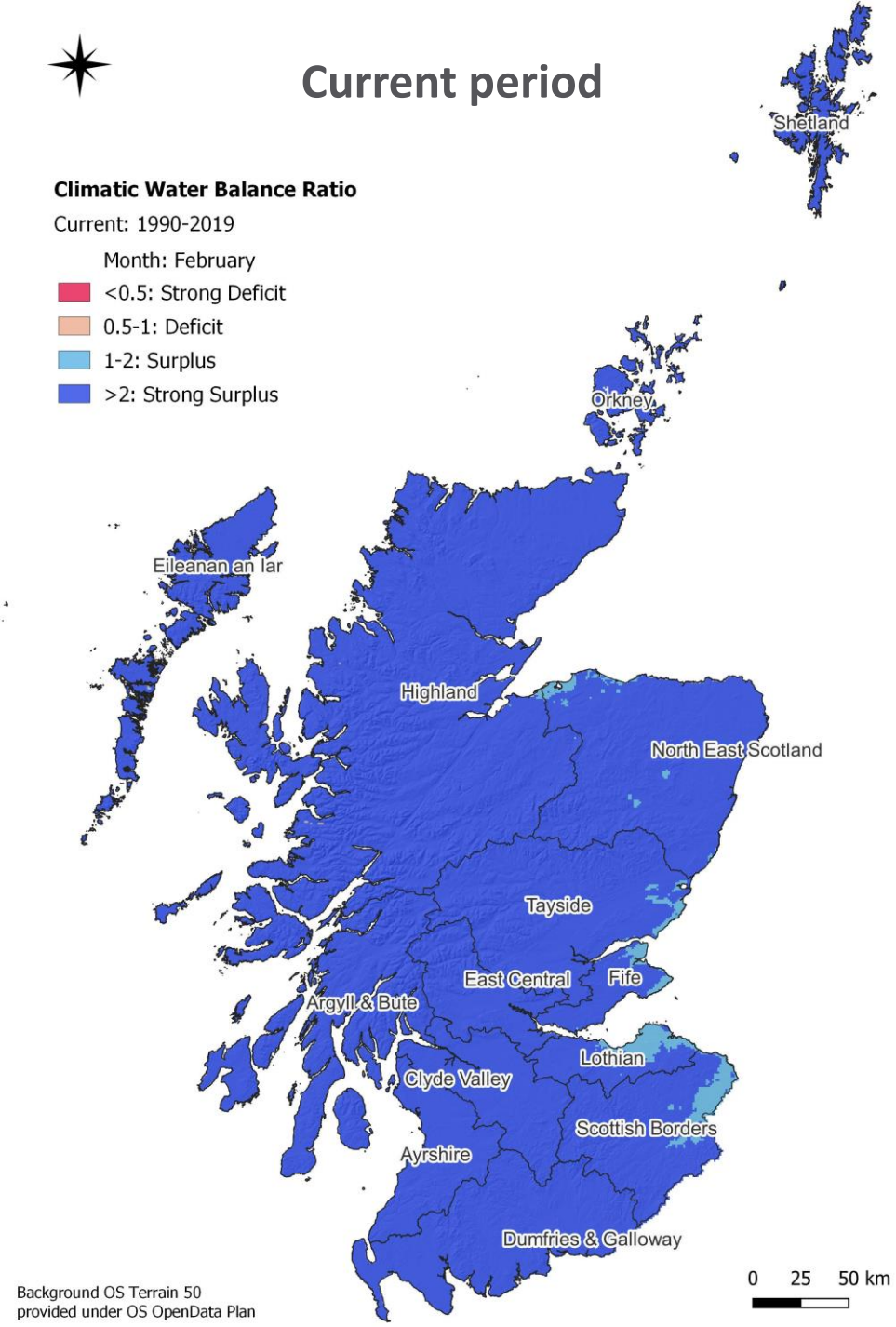
- Climatic Water Balance ratios (CWBR) defined as the ratio of Precipitation (P) to Reference Evapotranspiration (ET_0) ($CWB\ ratio = \frac{P}{ET_0}$).
- Four classes of CWBR levels:
  - CWR < 0.5: Severe climatic water stress, precipitation covers 50% of the evapotranspiration demand);
  - CWR between 0.5 and 1 (moderate climatic water stress);
  - CWR between 1 and 2 (moderate climate water surplus);
  - CWR > 2 ('extreme' climatic water surplus').
- Used to assess and highlight proportions of habitat type areas in climatic water surplus, or in deficit

Spey catchment example



Current period

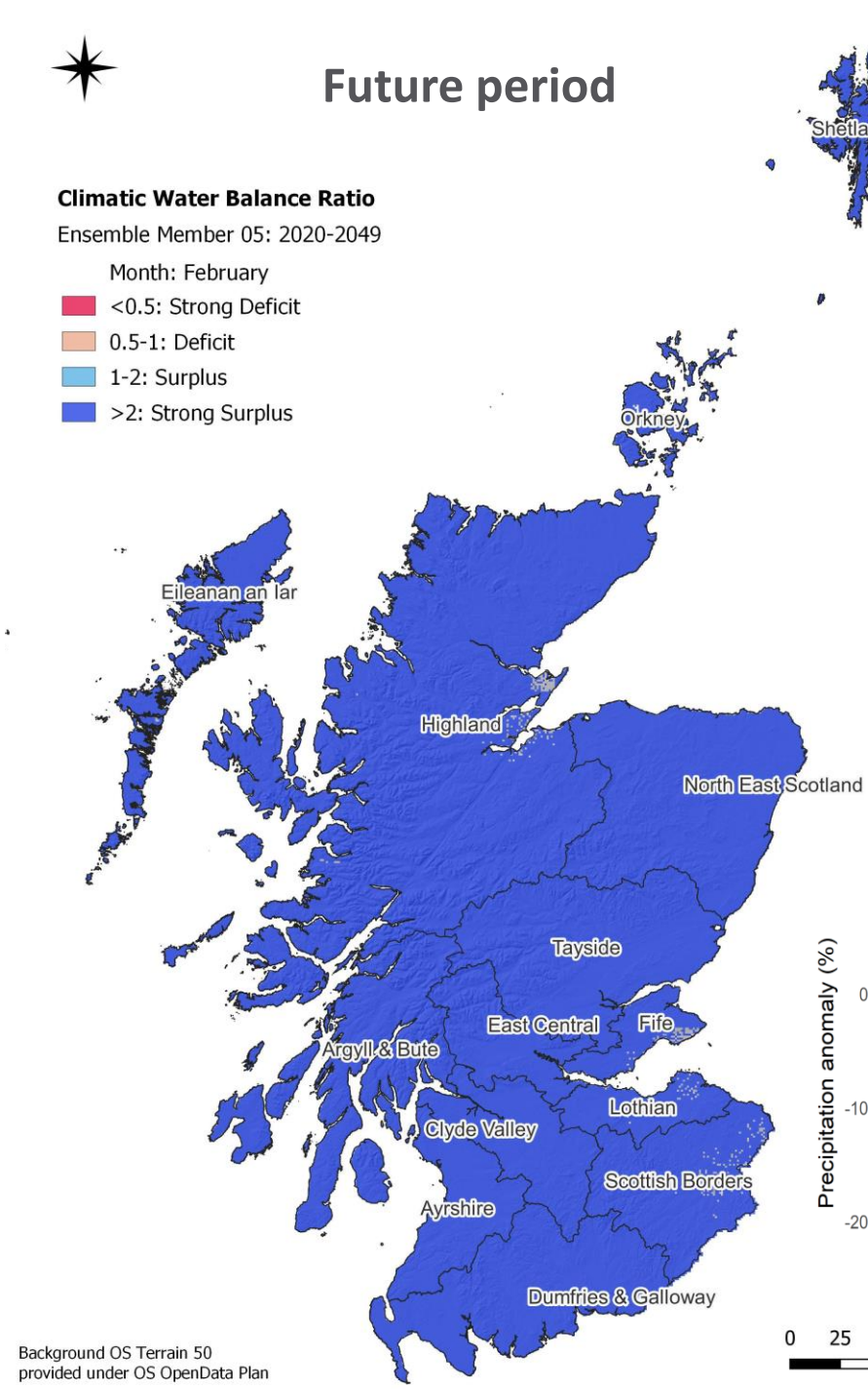
Climatic Water Balance Ratio
Current: 1990-2019
Month: February
<0.5: Strong Deficit
0.5-1: Deficit
1-2: Surplus
>2: Strong Surplus



Background OS Terrain 50
provided under OS OpenData Plan

Future period

Climatic Water Balance Ratio
Ensemble Member 05: 2020-2049
Month: February
<0.5: Strong Deficit
0.5-1: Deficit
1-2: Surplus
>2: Strong Surplus



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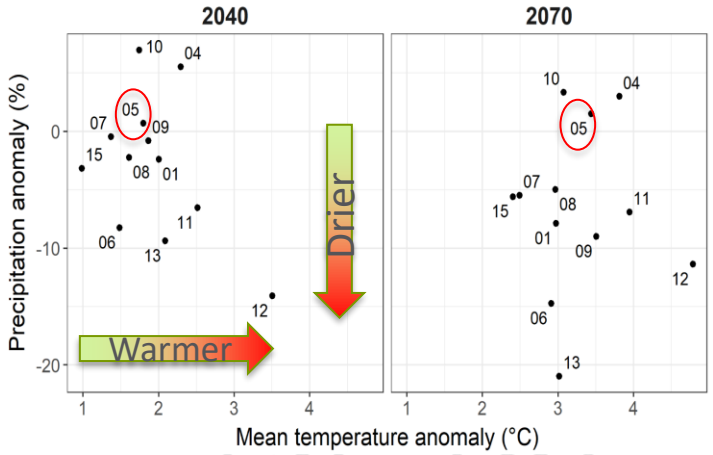
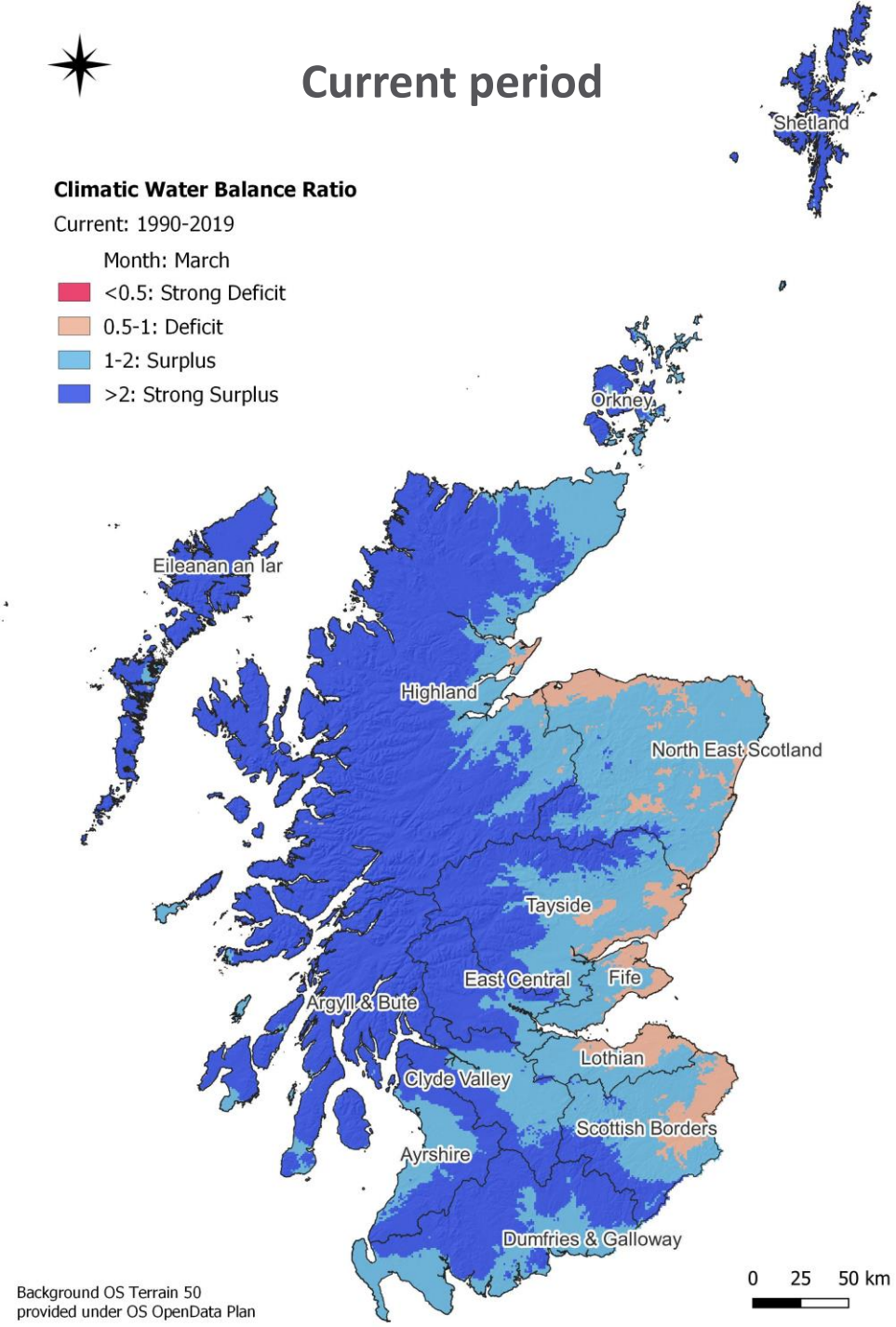
Climatic Water Balance Ratio: February

EM05: 1.8°C warmer, 2% wetter



Current period

Climatic Water Balance Ratio
Current: 1990-2019
Month: March
<0.5: Strong Deficit
0.5-1: Deficit
1-2: Surplus
>2: Strong Surplus



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provided under OS OpenData Plan

Future period

Climatic Water Balance Ratio
Ensemble Member 05: 2020-2049
Month: March
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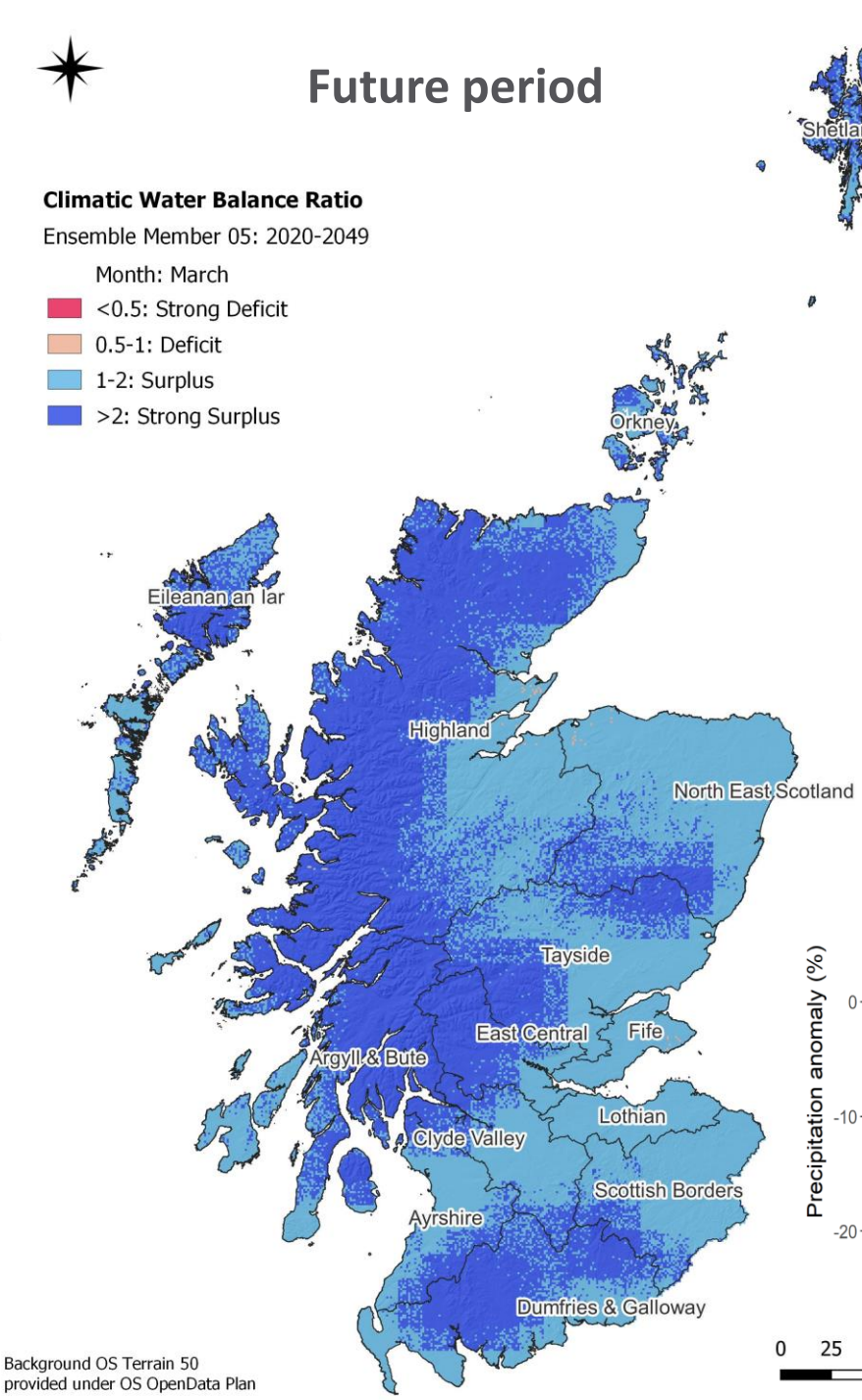

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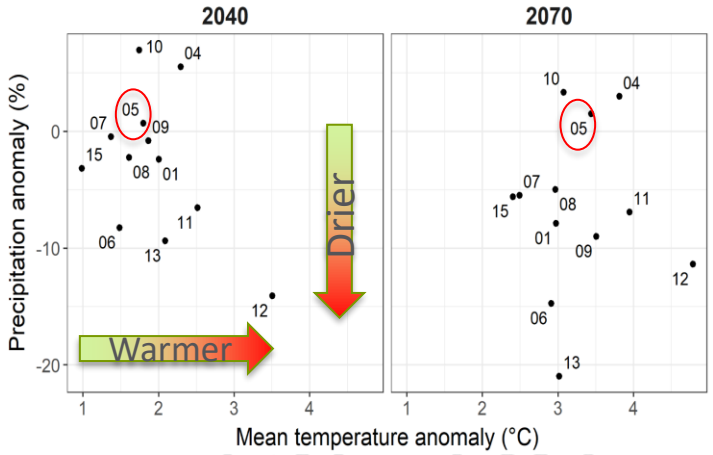
Climatic Water Balance Ratio: March

EM05: 1.8°C warmer, 2% wetter



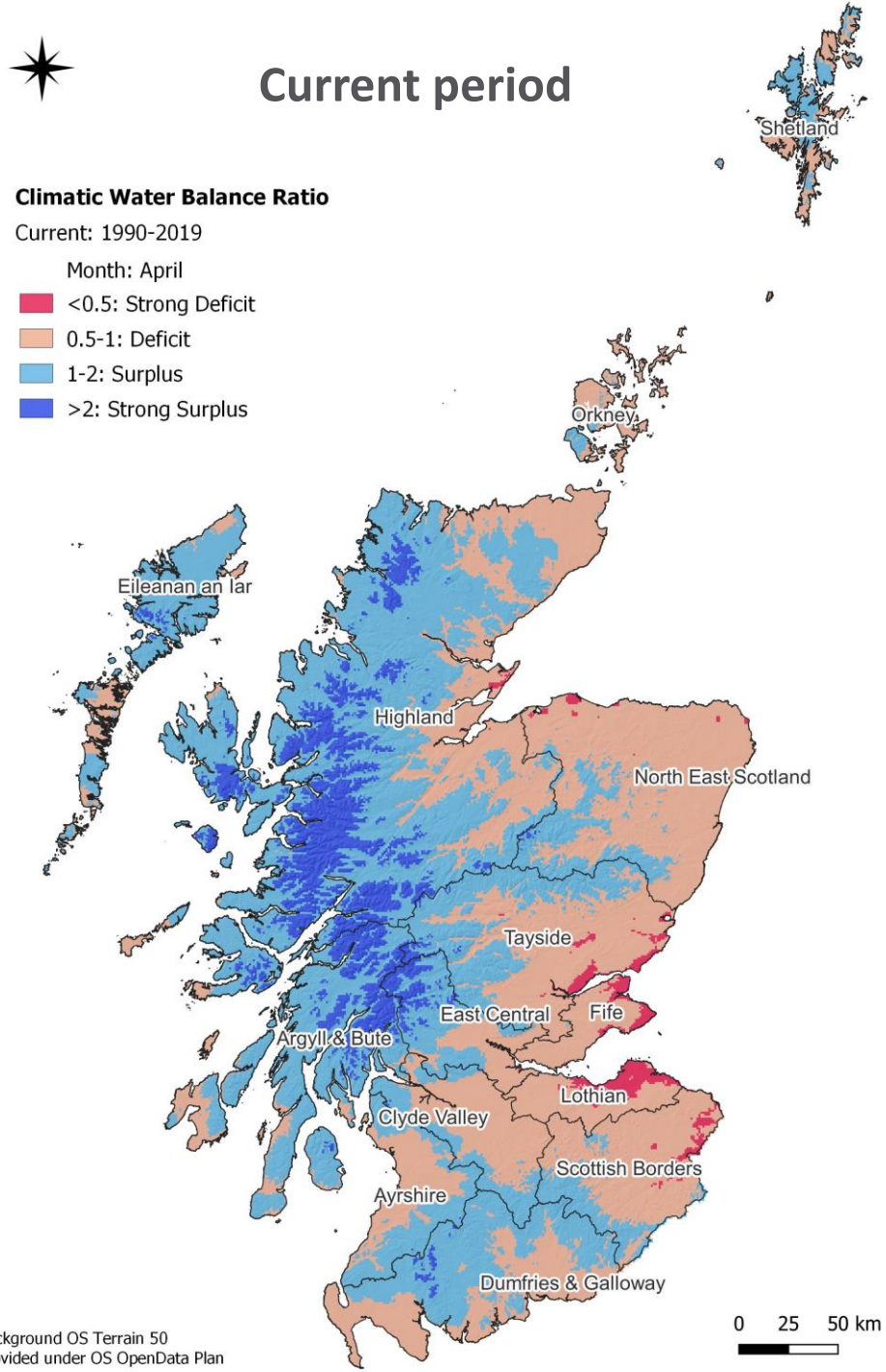
Current period

Climatic Water Balance Ratio

Current: 1990-2019

Month: April

- <0.5: Strong Deficit
- 0.5-1: Deficit
- 1-2: Surplus
- >2: Strong Surplus



Background OS Terrain 50
provided under OS OpenData Plan

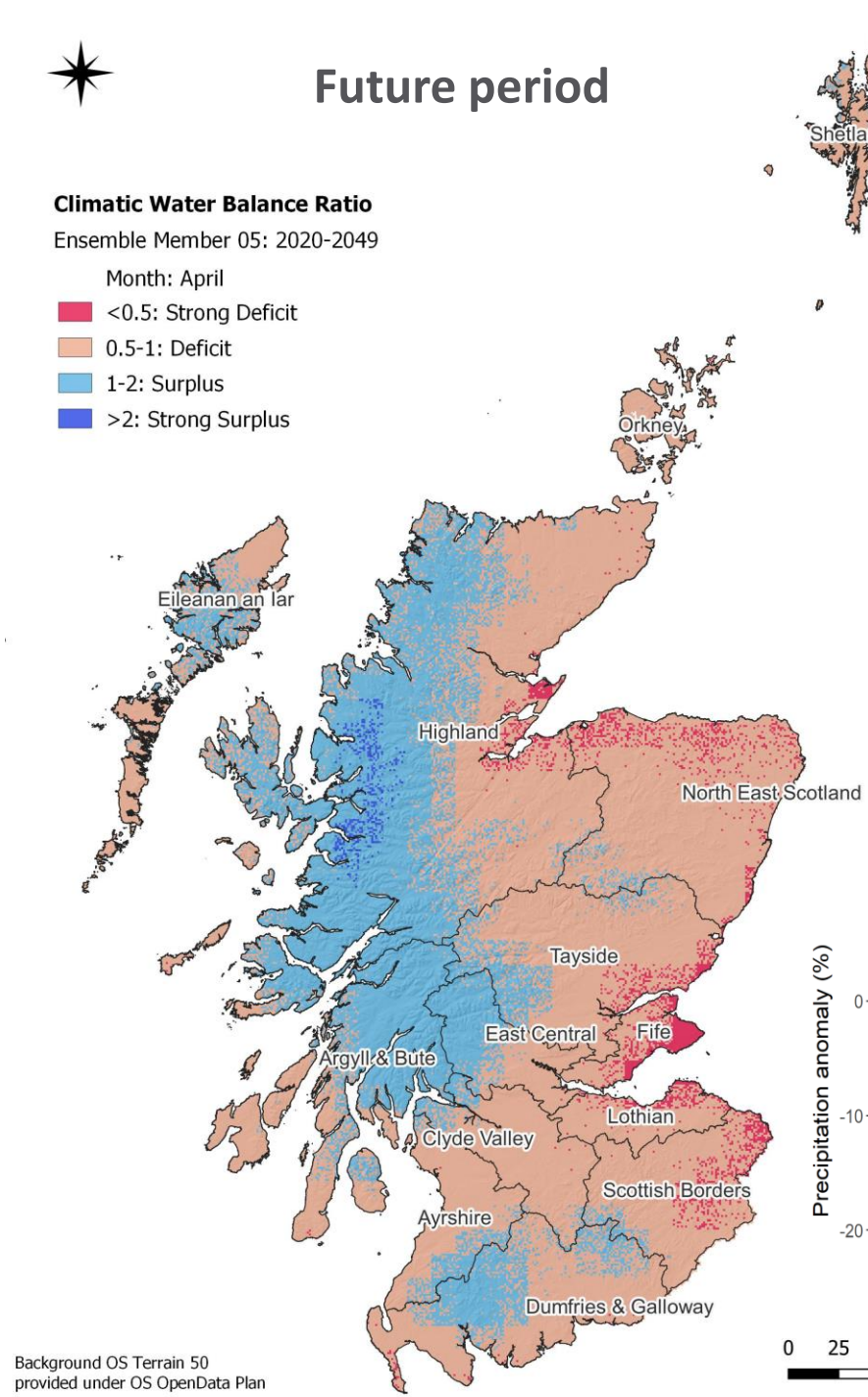
Future period

Climatic Water Balance Ratio

Ensemble Member 05: 2020-2049

Month: April

- <0.5: Strong Deficit
- 0.5-1: Deficit
- 1-2: Surplus
- >2: Strong Surplus



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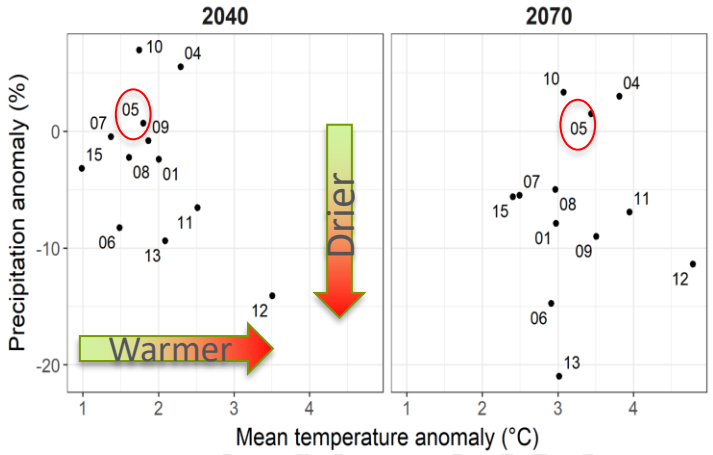
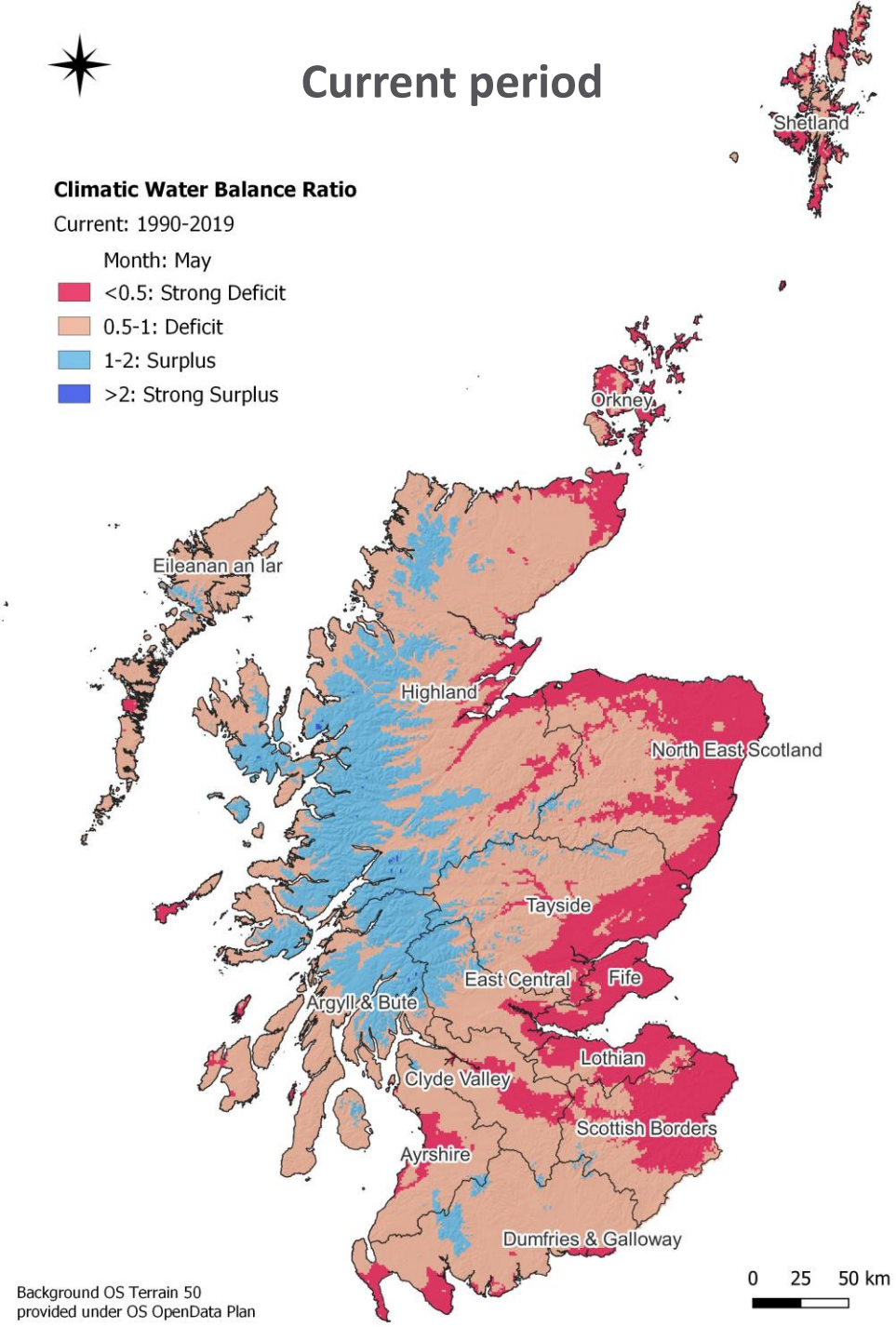
Climatic Water Balance Ratio: April

EM05: 1.8°C warmer, 2% wetter



Current period

Climatic Water Balance Ratio
Current: 1990-2019
Month: May
<0.5: Strong Deficit
0.5-1: Deficit
1-2: Surplus
>2: Strong Surplus



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Future period

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Ensemble Member 05: 2020-2049
Month: May
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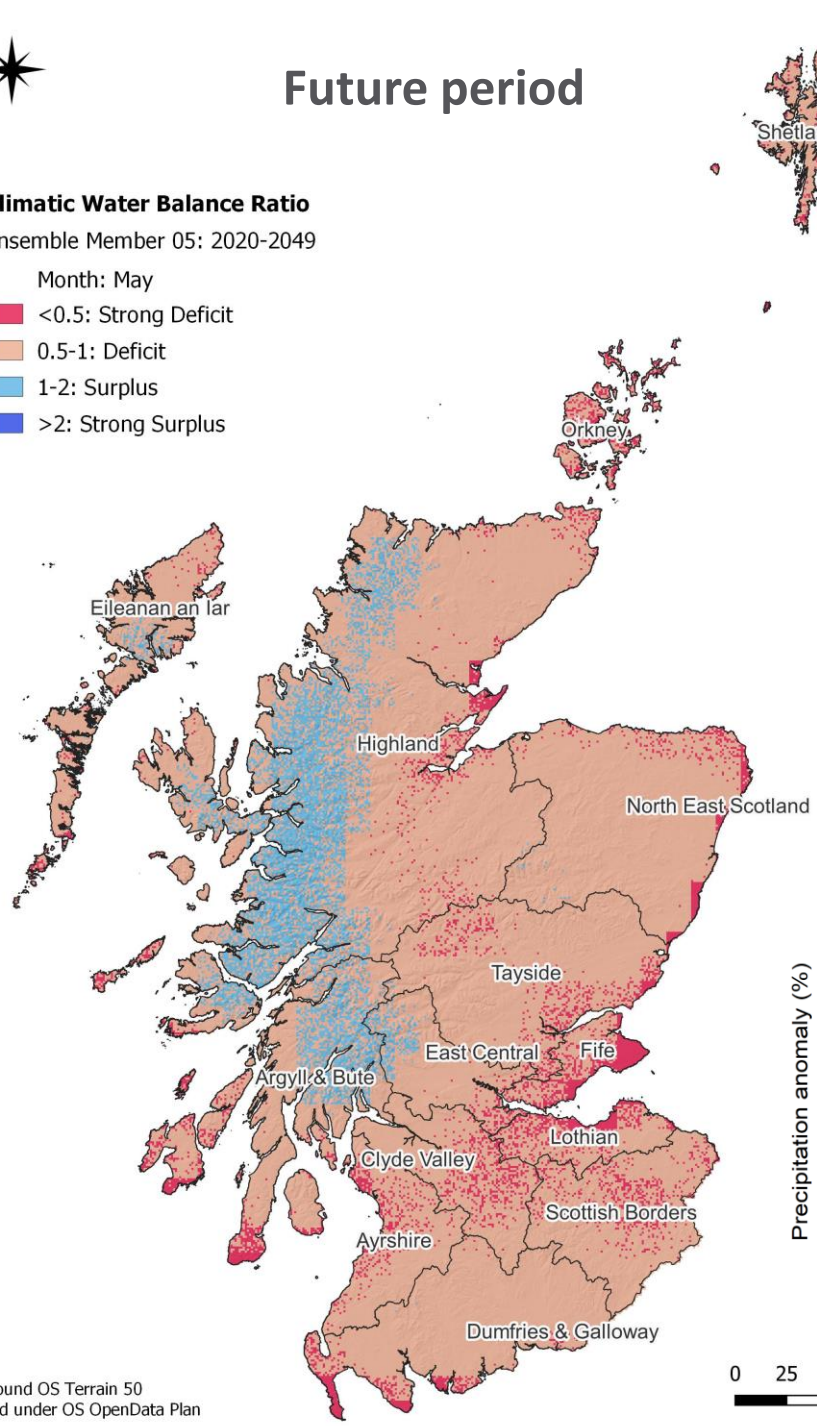

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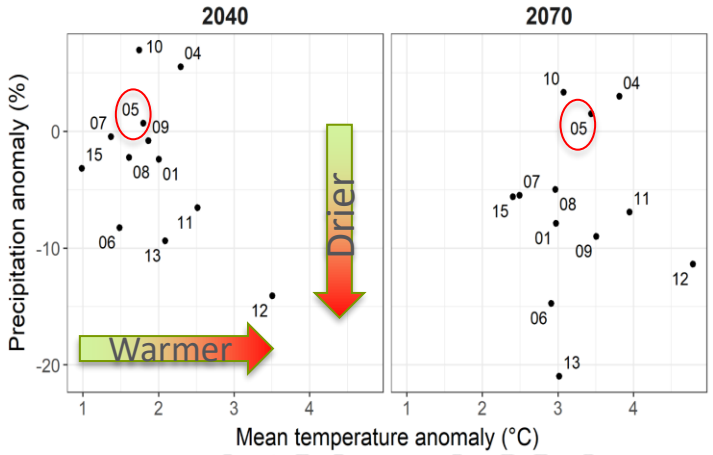
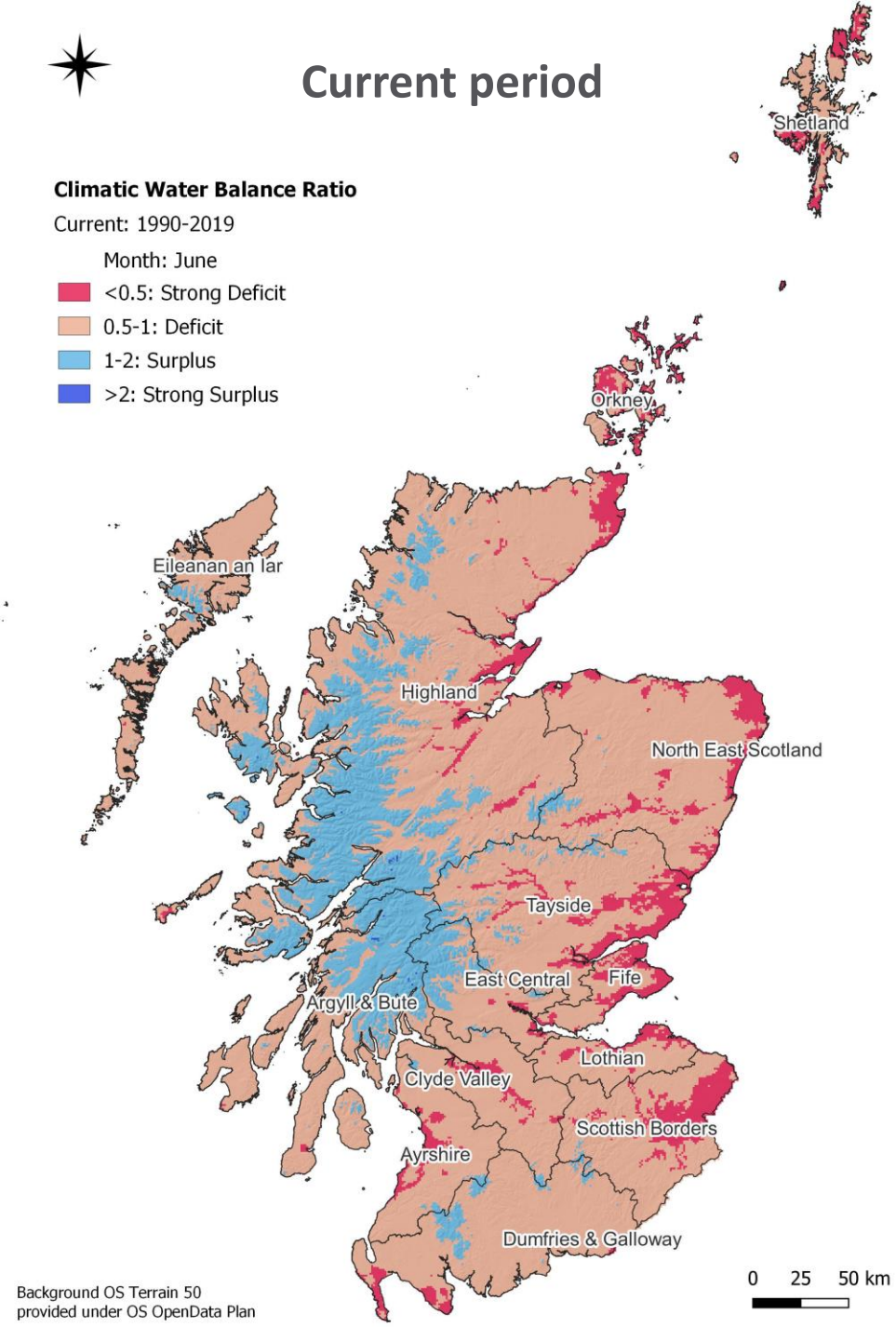
Climatic Water Balance Ratio: May

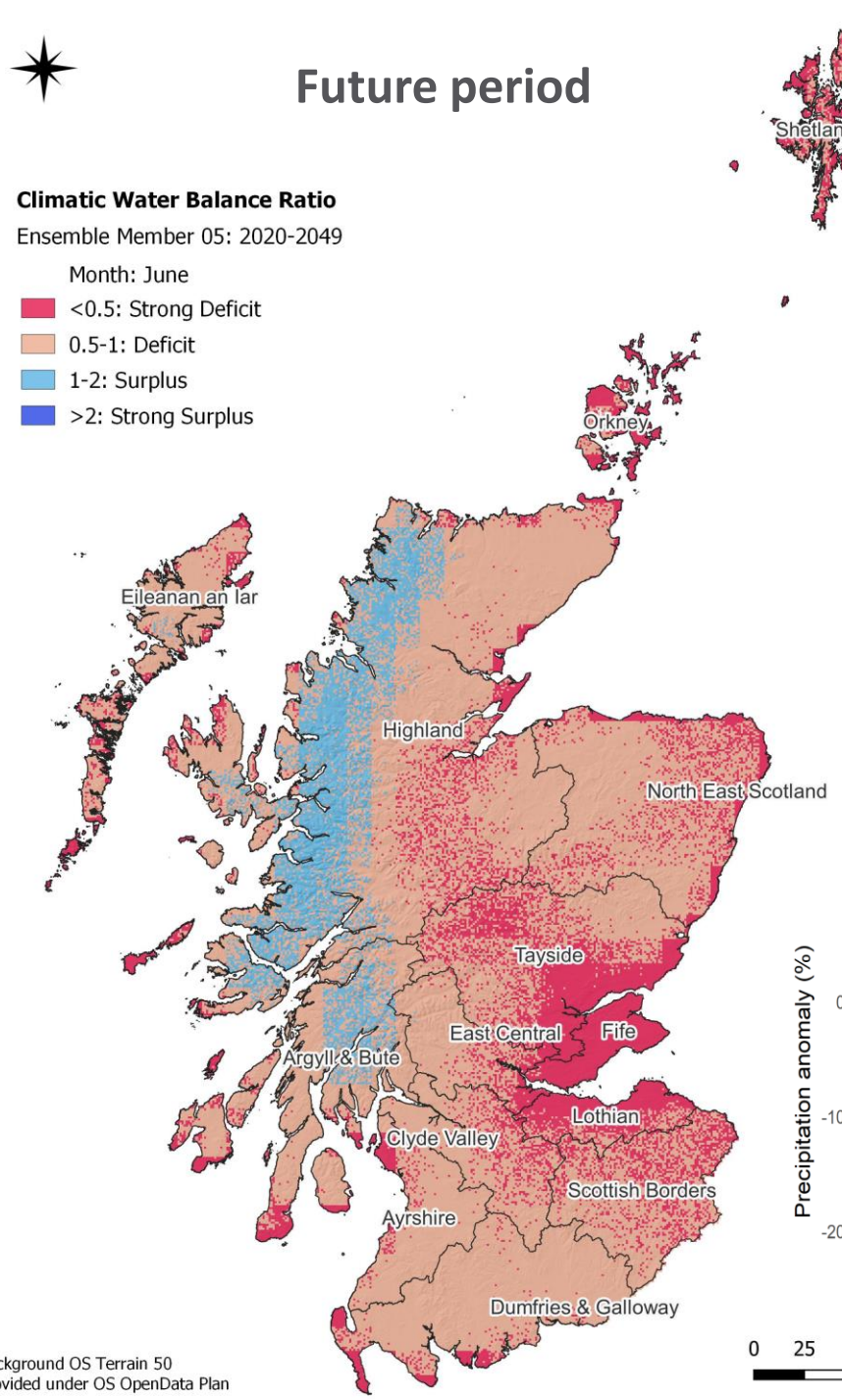
EM05: 1.8°C warmer, 2% wetter



Current period



Future period



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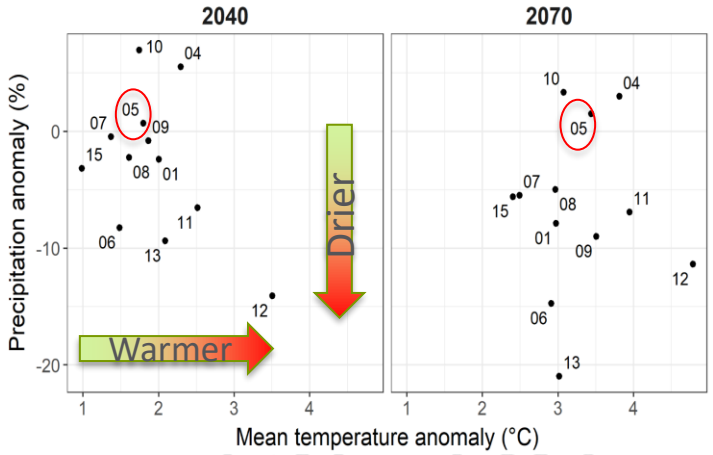
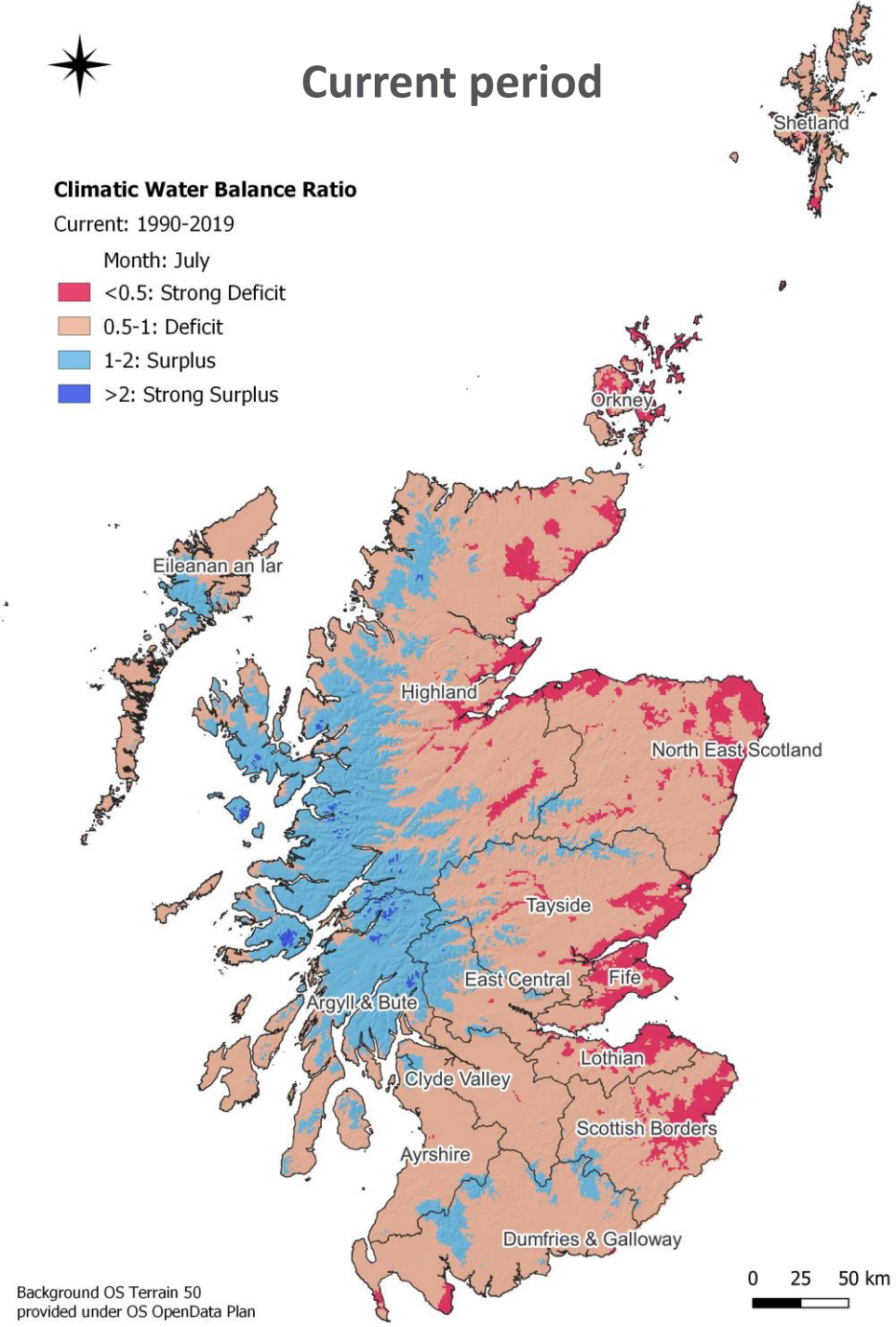
Climatic Water Balance Ratio: June

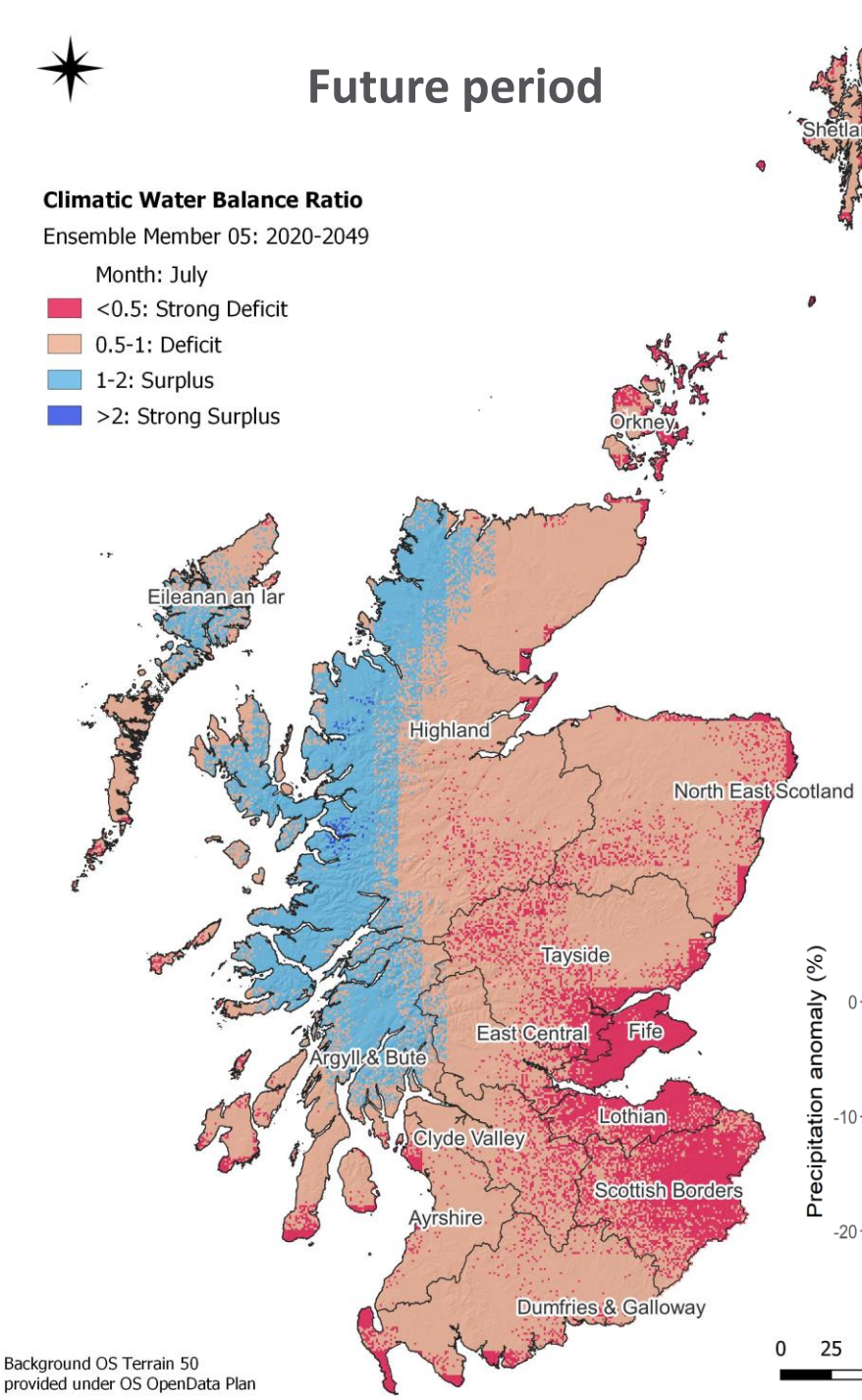
EM05: 1.8°C warmer, 2% wetter



Current period



Future period



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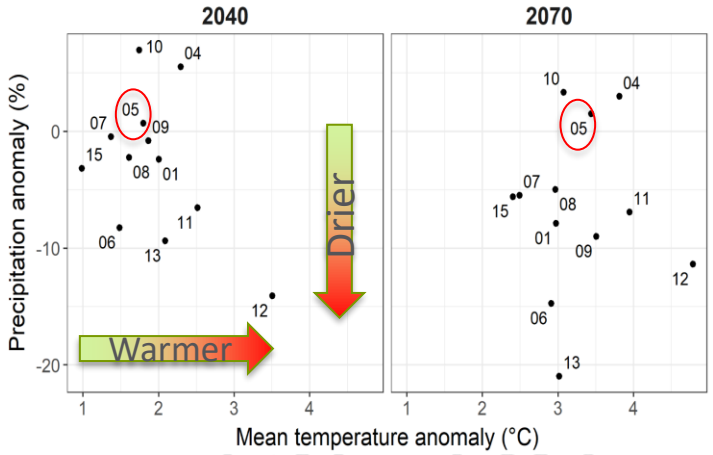
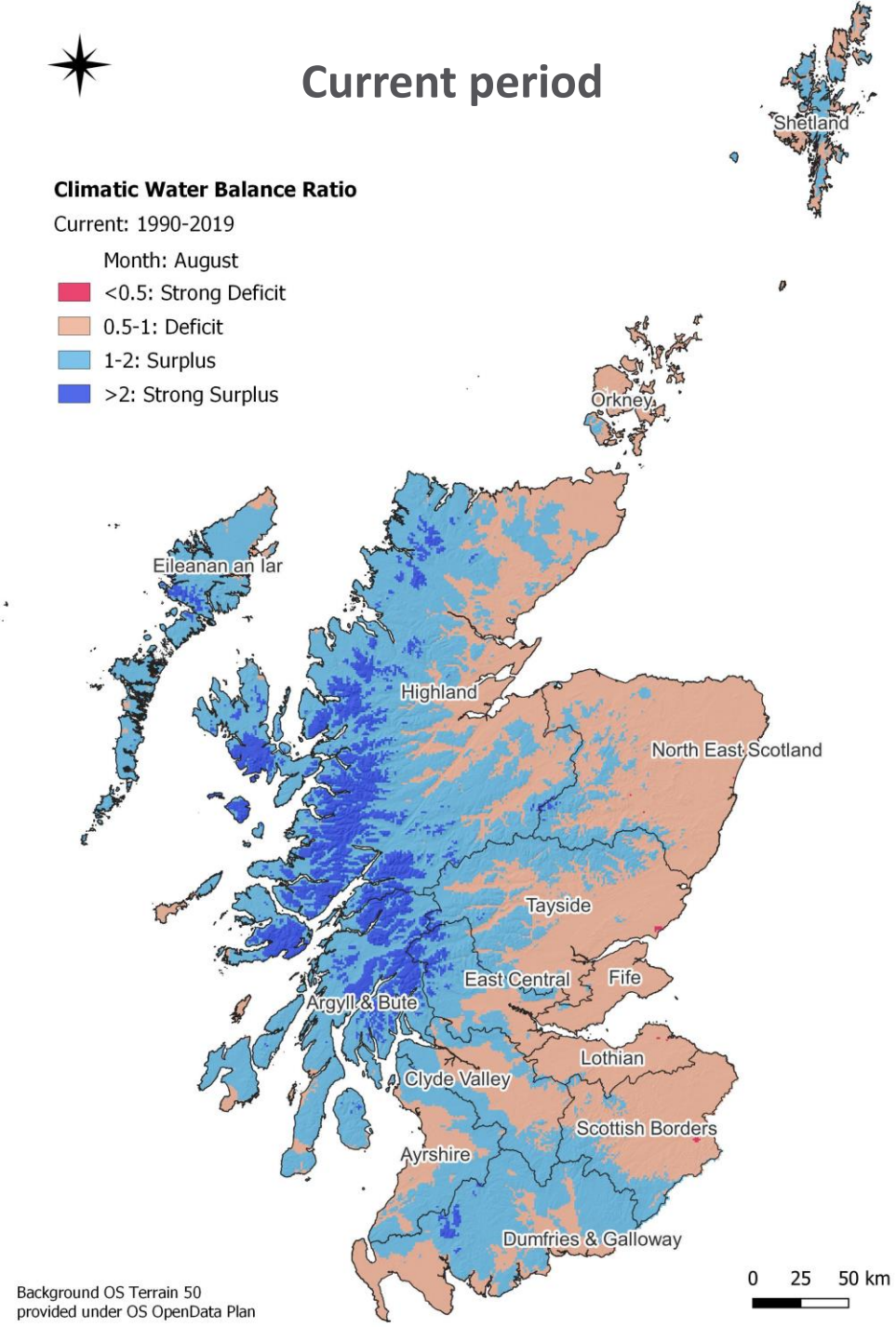
Climatic Water Balance Ratio: July

EM05: 1.8°C warmer, 2% wetter



Current period

Climatic Water Balance Ratio
Current: 1990-2019
Month: August
<0.5: Strong Deficit
0.5-1: Deficit
1-2: Surplus
>2: Strong Surplus



Background OS Terrain 50
provided under OS OpenData Plan

Future period

Climatic Water Balance Ratio
Ensemble Member 05: 2020-2049
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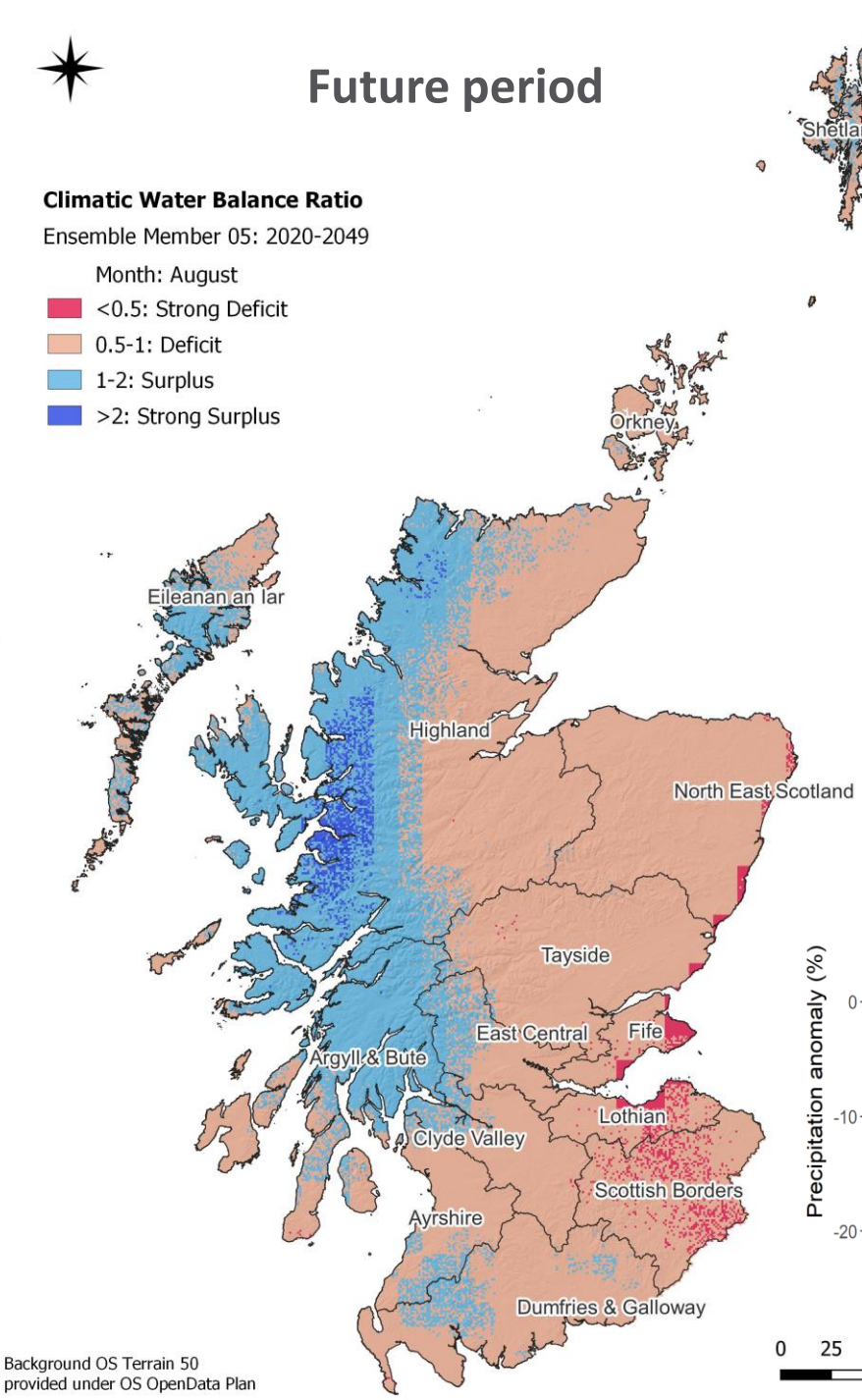

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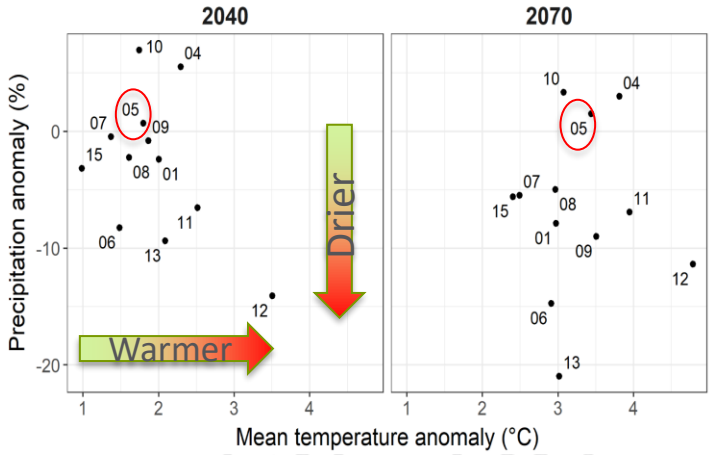
Climatic Water Balance Ratio: August

EM05: 1.8°C warmer, 2% wetter



Current period

Climatic Water Balance Ratio

Current: 1990-2019

Month: September

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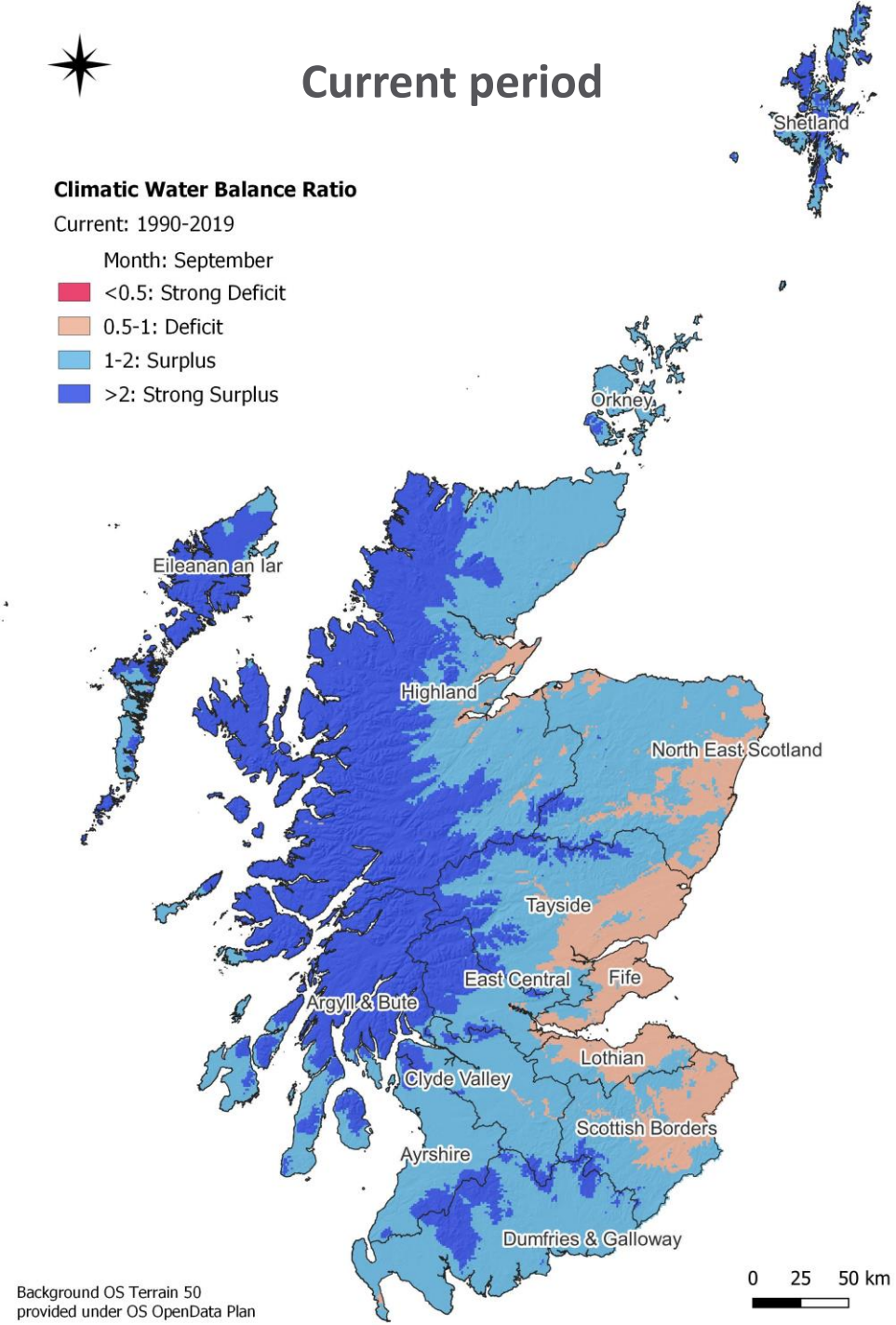

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Future period

Climatic Water Balance Ratio

Ensemble Member 05: 2020-2049

Month: September

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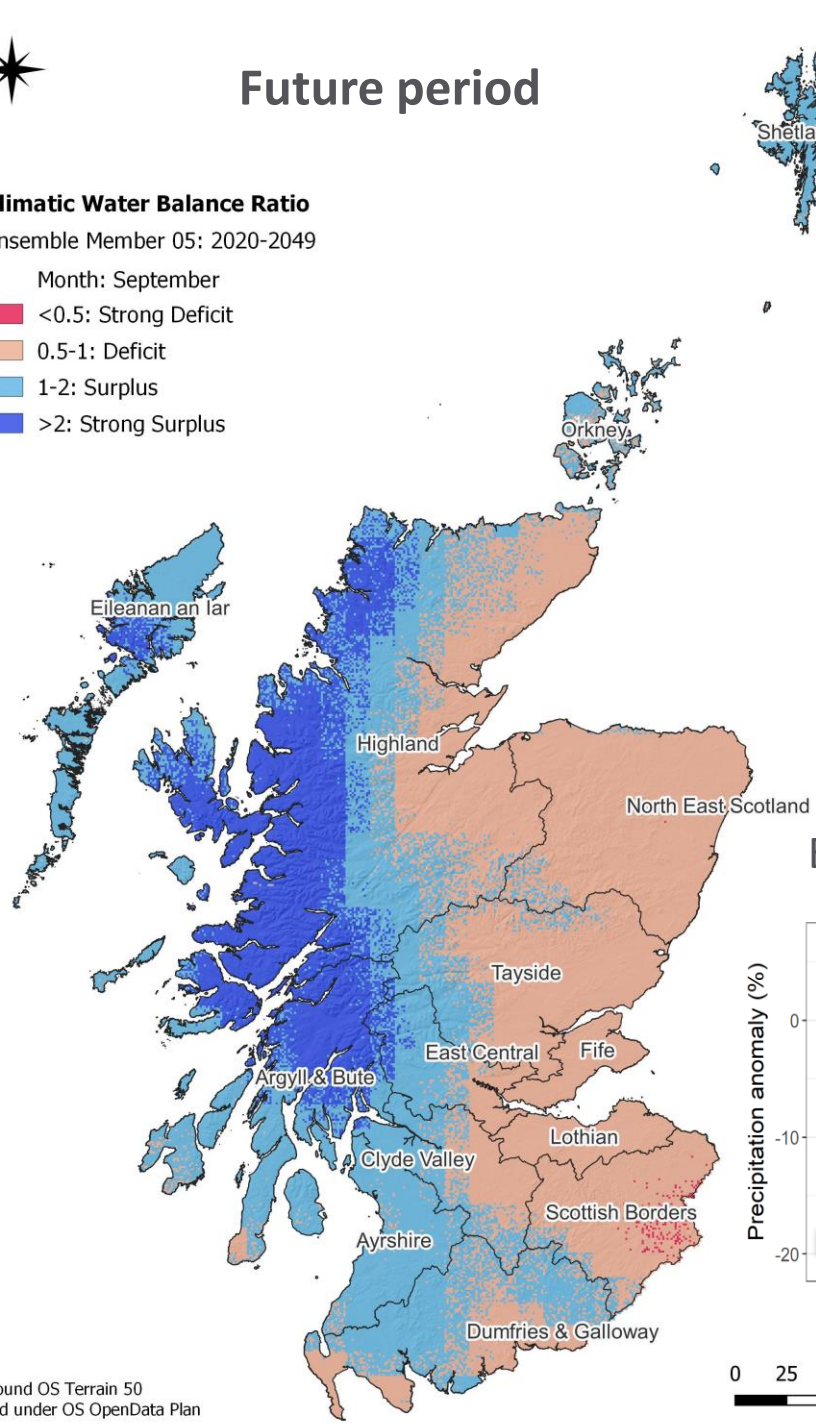

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Climatic Water Balance Ratio: September

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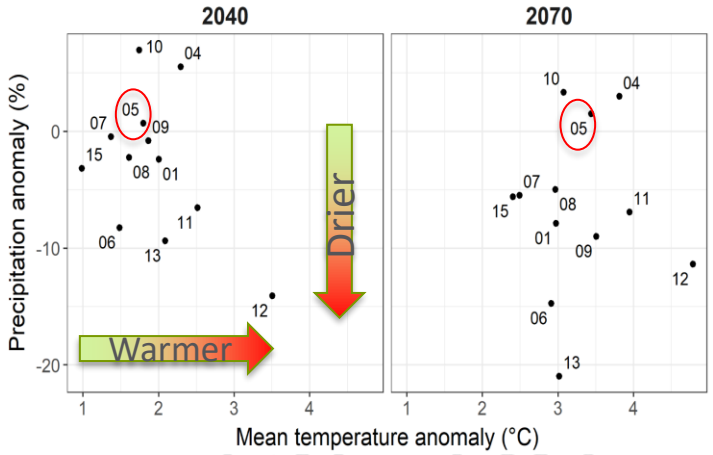
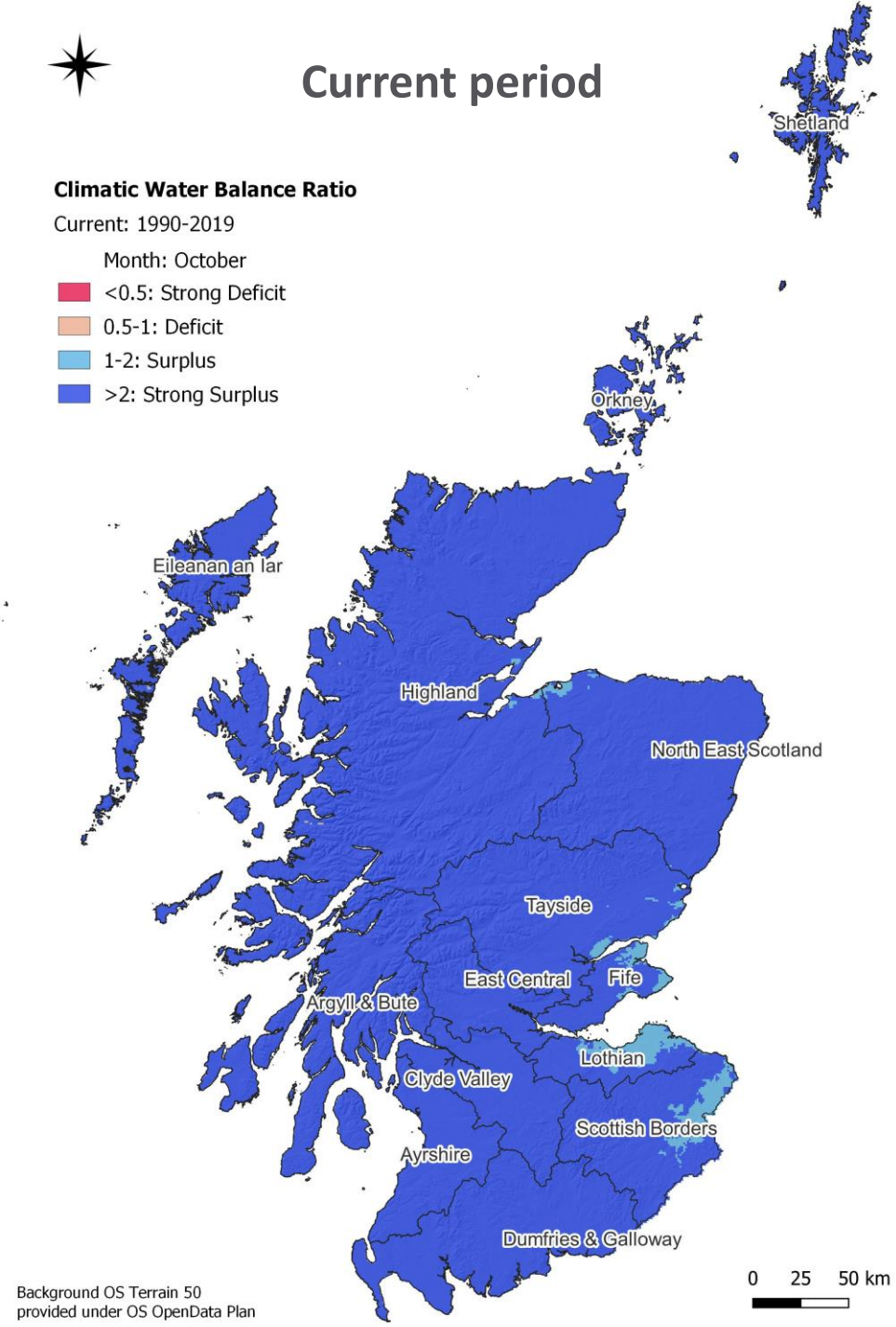
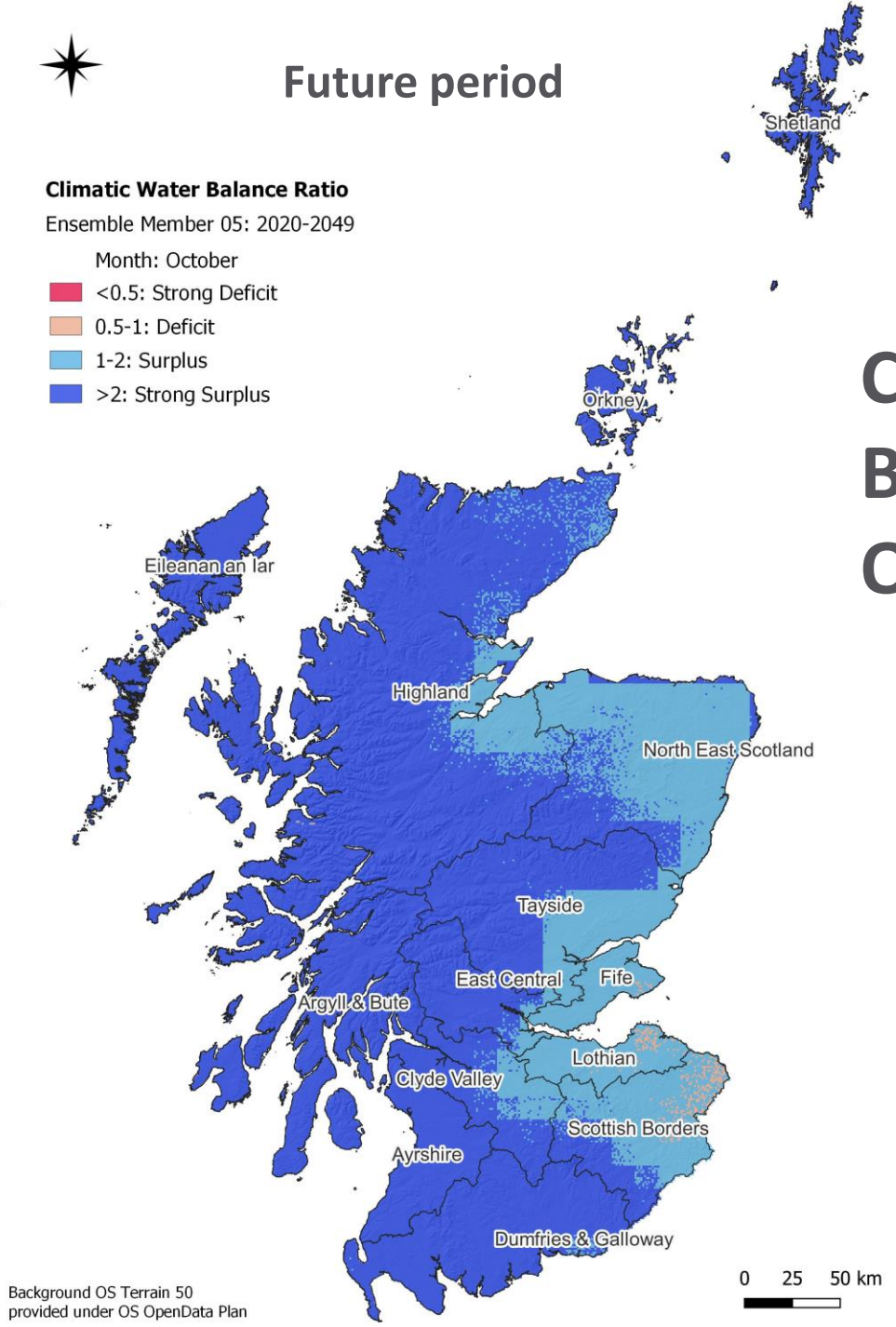


Current period



Future period



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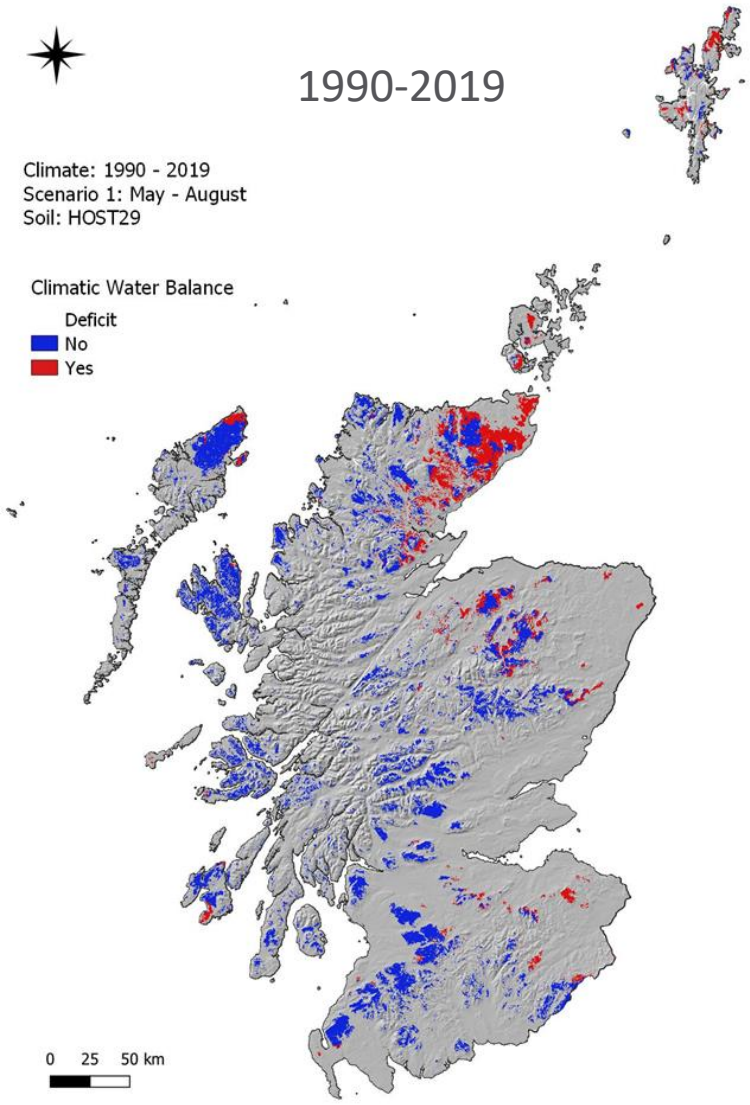
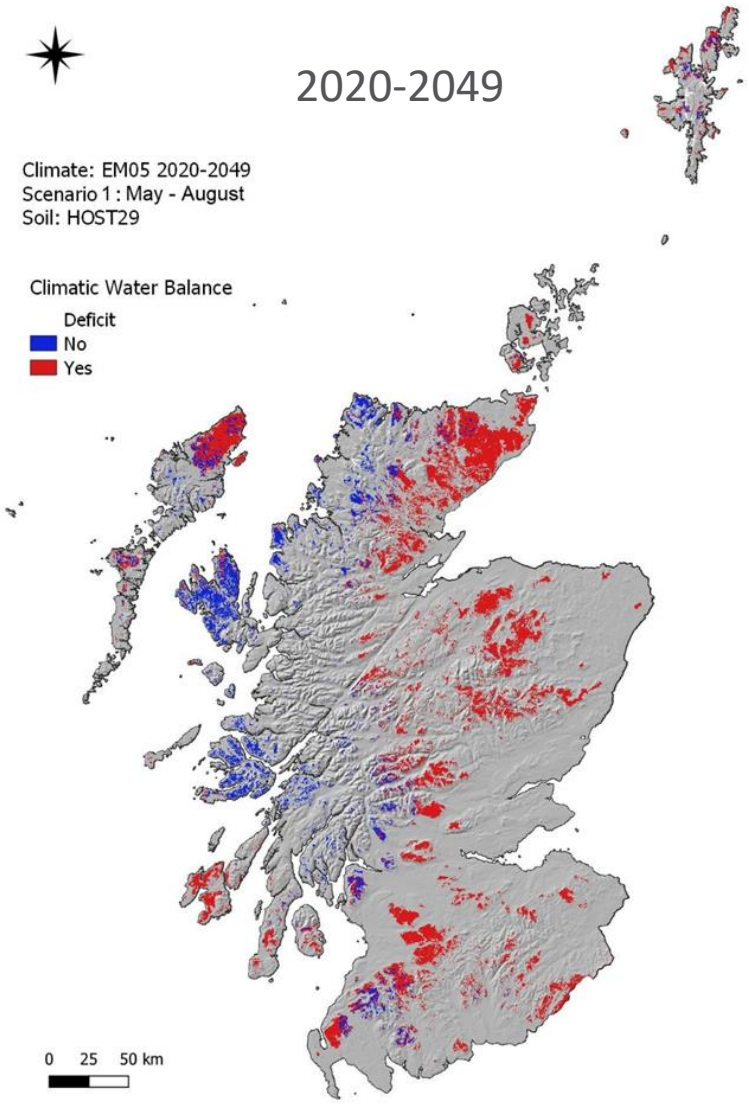
Climatic Water Balance Ratio: October

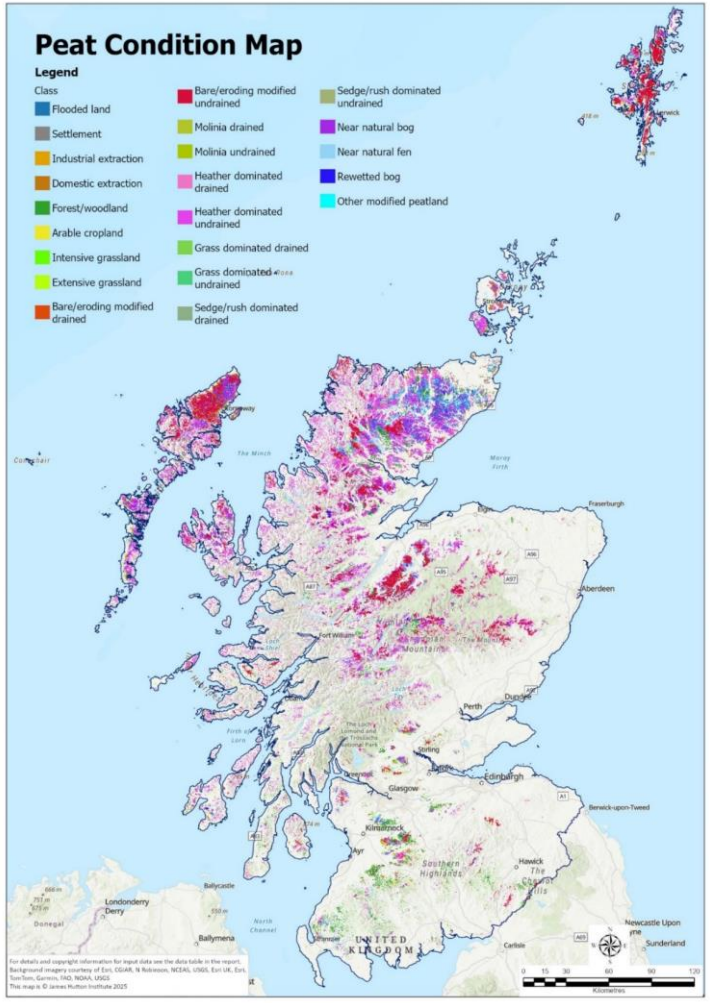
Water deficit and Hydrological Soil Types (HOST)

1990-2019



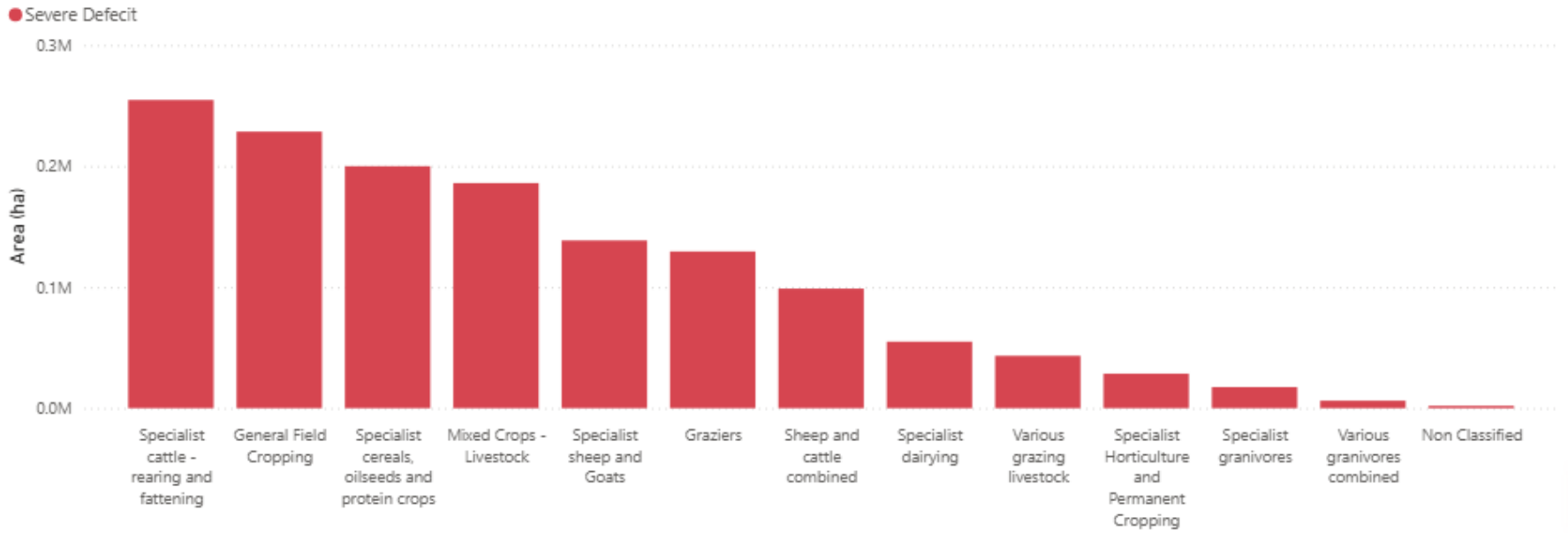
2020-2049





Maps of Upland Blanket Peat (HOST class 29) based on a scenario of continuous climatic water deficit from May to August, for the observed (1990 – 2020) period and future (2020 – 2049) period for Ensemble Member (EM) 05.

Climatic Water Balance (severe deficit) and farm types



CWR

- Large Surplus
- Surplus
- Defecit
- Severe Defecit

Graphical Representation click Here

Graphical Representation

Farm Type	Argyll & Bute	Ayrshire	Clyde Valley	Dumfries & Galloway	East Central	Eileanan an Iar	Fife	Highland	Lothian	NE Scotland	Orkney	Scottish Borders	Shetland	Tayside	Grand Total
Specialist cattle - rearing and fattening	7.14K	7.71K	12.23K	17.25K	1.92K	1.59K	5.52K	40.41K	8.29K	67.39K	35.20K	36.52K	4.37K	9.12K	254.68K
General Field Cropping	0.24K	0.85K	0.30K	0.21K	0.35K	0.00K	29.10K	14.58K	15.74K	46.07K	0.04K	22.30K	0.76K	97.97K	228.51K
Specialist cereals, oilseeds and protein crops		1.20K	1.73K	1.91K	4.55K	0.25K	16.70K	13.54K	29.22K	79.07K	0.35K	35.24K		16.23K	199.98K
Mixed Crops - Livestock		1.82K	1.90K	4.30K	2.97K	1.17K	16.52K	16.37K	11.46K	73.41K	0.63K	31.59K	2.36K	21.52K	186.02K
Specialist sheep and Goats	3.09K	0.98K	3.52K	1.21K	1.45K	2.02K	1.29K	18.07K	4.42K	11.82K	4.27K	33.36K	48.23K	4.86K	138.60K
Graziers	2.43K	5.72K	6.26K	6.17K	2.27K	2.02K	4.56K	18.84K	4.14K	33.99K	5.82K	11.29K	17.44K	8.55K	129.50K
Sheep and cattle combined	4.81K	1.02K	3.34K	0.97K	0.29K	1.18K	0.26K	16.51K	5.03K	8.46K	4.77K	30.36K	18.05K	3.76K	98.81K
Specialist dairying	1.03K	11.21K	6.78K	16.99K	0.88K	0.91K	2.64K	1.29K	1.87K	3.77K	2.09K	3.13K	1.50K	0.87K	54.96K
Various grazing livestock	0.60K	1.07K	1.45K	1.20K	0.21K	1.28K	1.56K	7.03K	2.06K	5.17K	1.10K	6.09K	11.51K	2.97K	43.30K
Specialist Horticulture and Permanent Cropping	0.00K	0.11K	0.02K	0.12K			5.85K	0.32K	0.52K	6.20K	0.05K	0.29K	0.91K	14.15K	28.54K
Specialist granivores		0.22K	0.20K	0.08K	0.08K	0.90K	0.45K	1.20K	0.43K	7.16K	0.03K	5.28K	0.01K	1.39K	17.43K
Various granivores combined		0.04K	0.46K	0.01K			0.16K	0.18K	0.42K	2.81K	0.02K	0.31K	1.58K	0.24K	6.22K
Non Classified		0.00K	0.08K	0.05K	0.06K		0.10K	0.93K	0.02K	0.45K	0.06K	0.03K	0.08K	0.07K	1.93K
Grand Total	19.34K	31.95K	38.27K	50.45K	15.04K	11.31K	84.73K	149.28K	83.63K	345.78K	54.44K	215.78K	106.79K	181.70K	1388.49K

1.39M

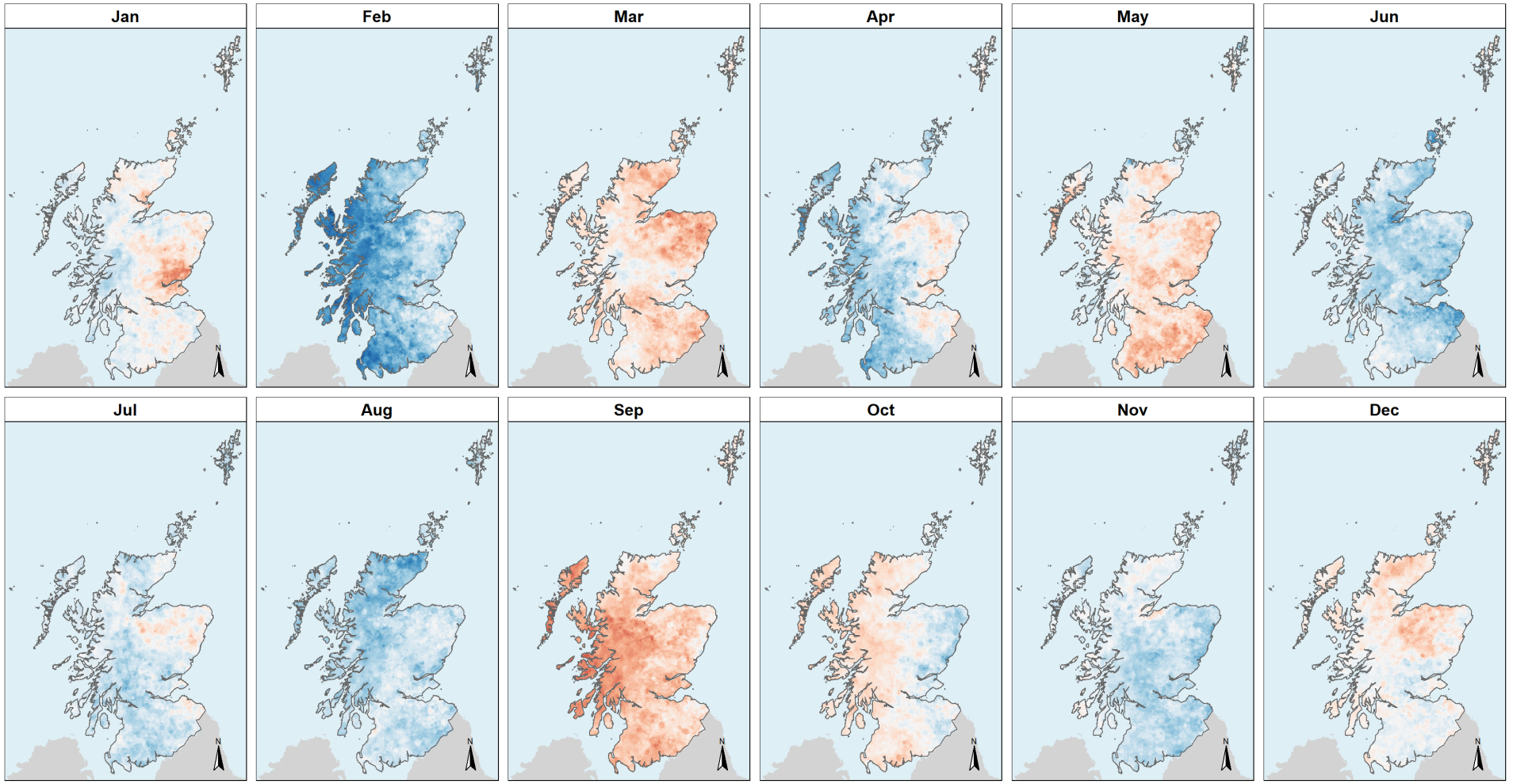
Total Area

https://storymaps.arcgis.com/collections/ca878400fdf14337855cd66e2b5b0bd5?item=6

Extremes Indicators: Consecutive Dry Days (CDD) (maximum length of a dry spell in any one month, when precipitation is less than 1mm per day)

The James Hutton Institute

Changes in mean monthly consecutive dry days over the historical period 1990-2019 relative to the baseline period 1960-1989



Blue: fewer CDD e.g. February

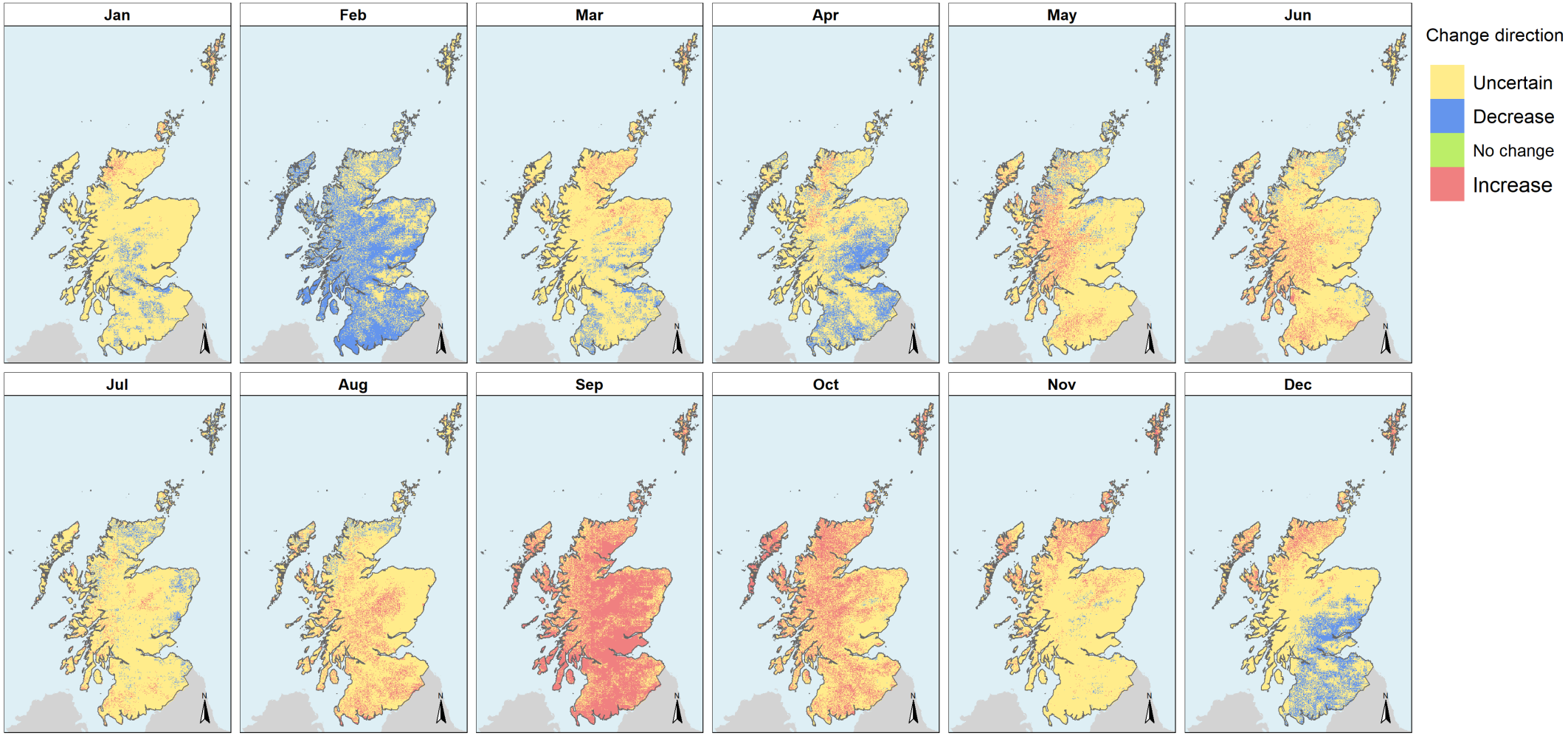
Red: more CDD e.g. September

This reflects the 'wetter winters and drier summers' headline message

Extremes Indicators: Consecutive Dry Days (CDD) (maximum length of a dry spell in any one month, when precipitation is less than 1mm per day)

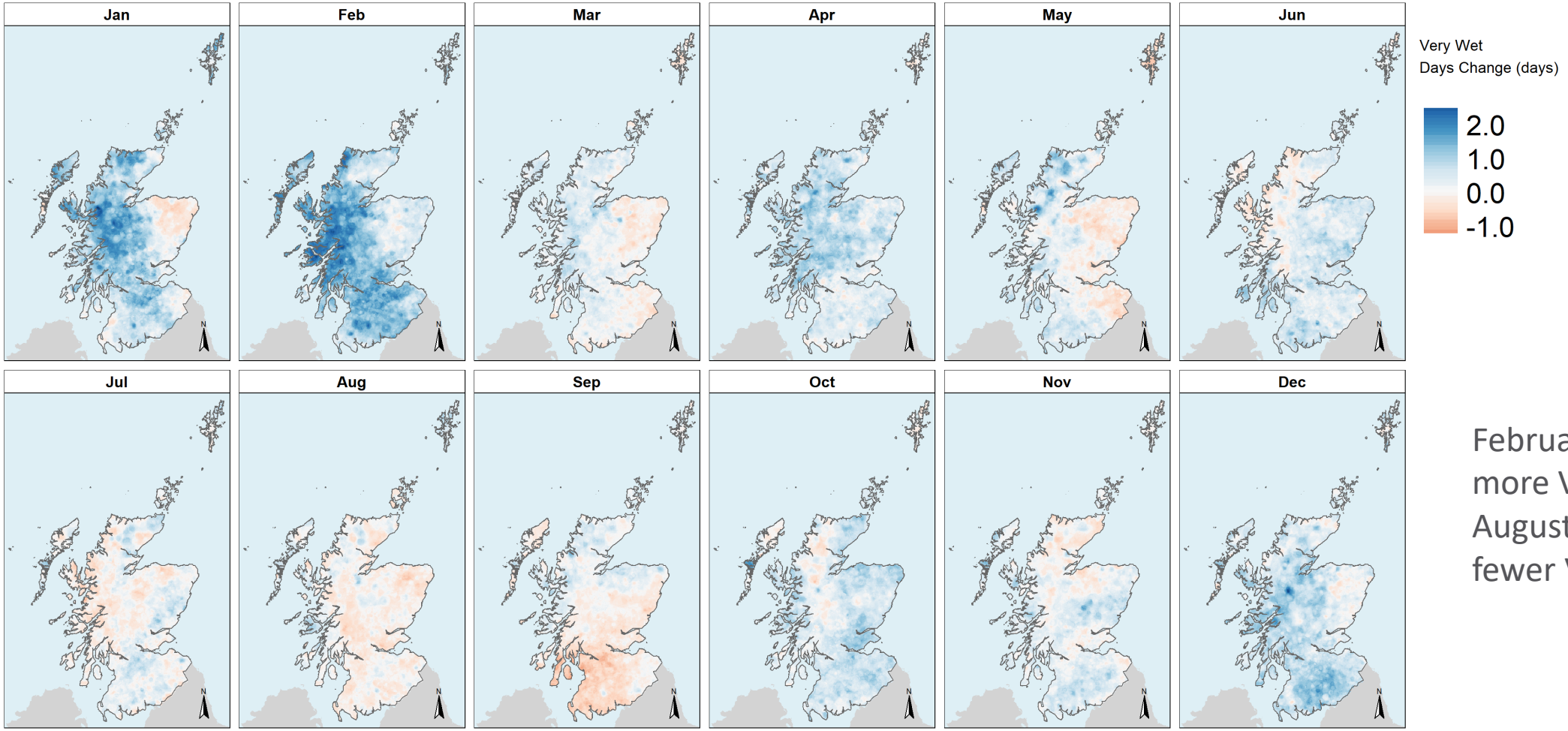
The James Hutton Institute

Change direction agreement for mean monthly consecutive dry days over the period 2020-2049 for at least 12 ensemble members



Very Wet Days (VWD) (precipitation amount that is greater or equal to the 95th Percentile of the observed baseline)

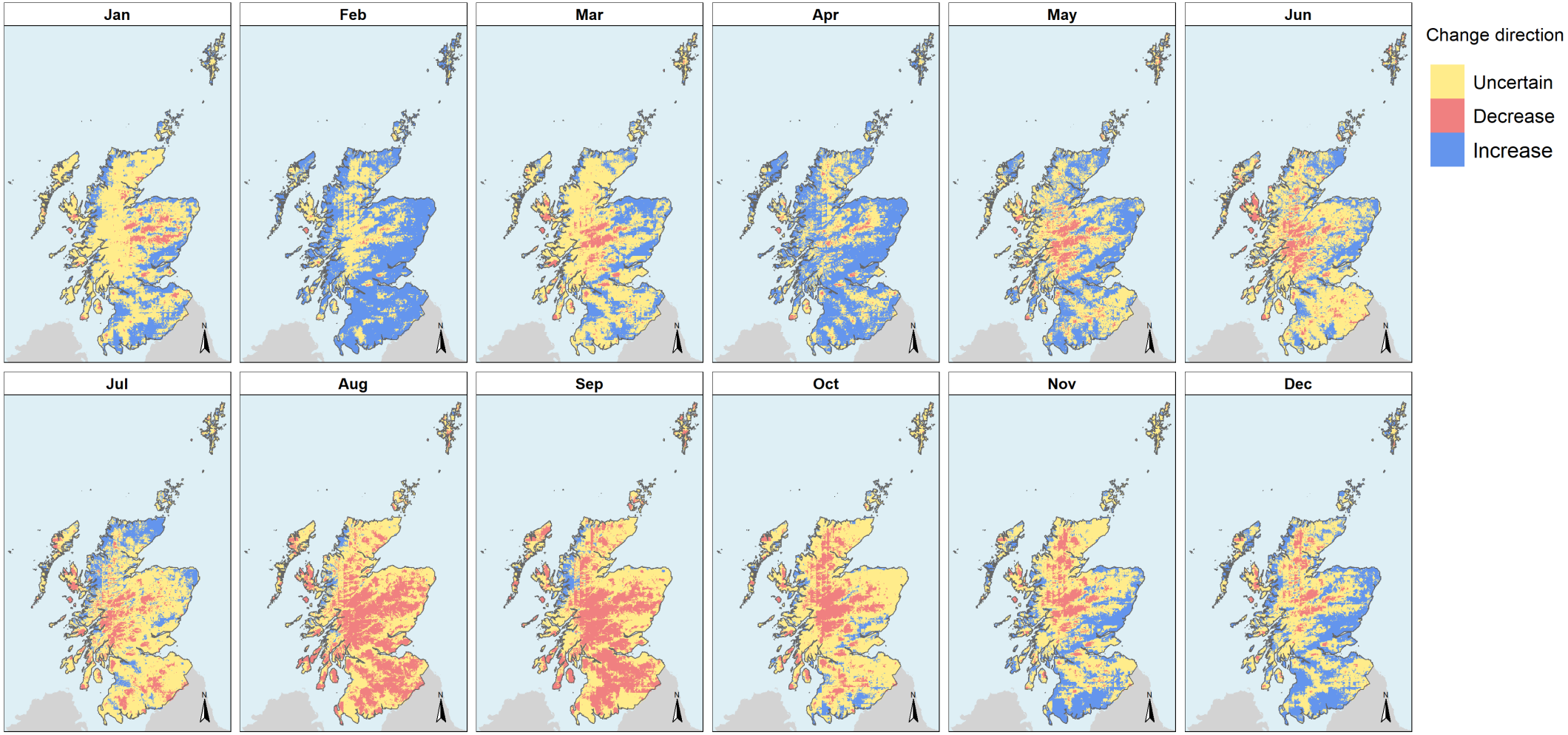
Changes in mean monthly number of very wet days over the historical period 1990-2019 relative to the baseline period 1960-1989



February: more VWD
August: fewer VWD

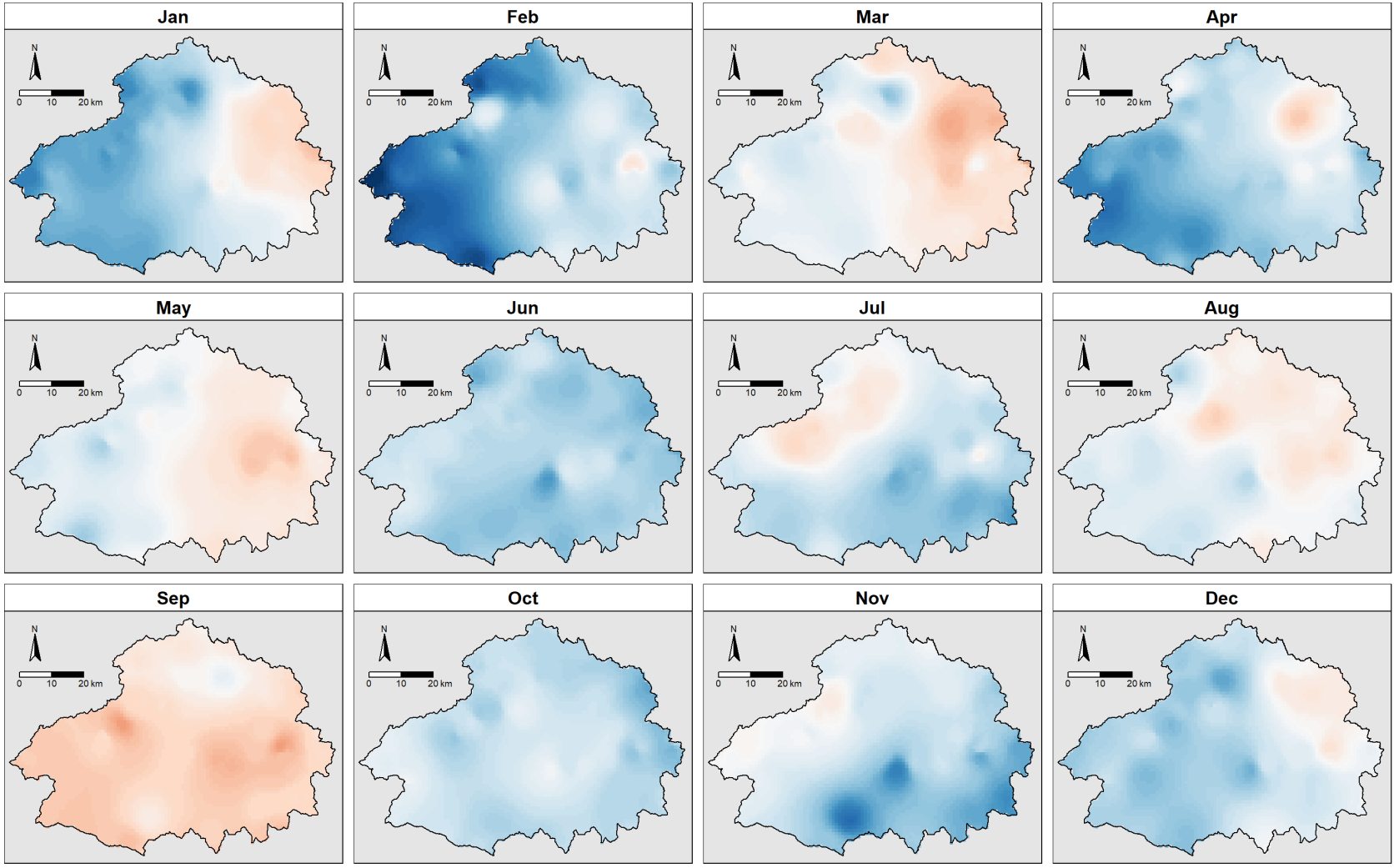
Very Wet Days (VWD) (precipitation amount that is greater or equal to the 95th Percentile of the observed baseline)

Change direction agreement for mean monthly number of very wet days over the period 2020-2049 for at least 12 ensemble members



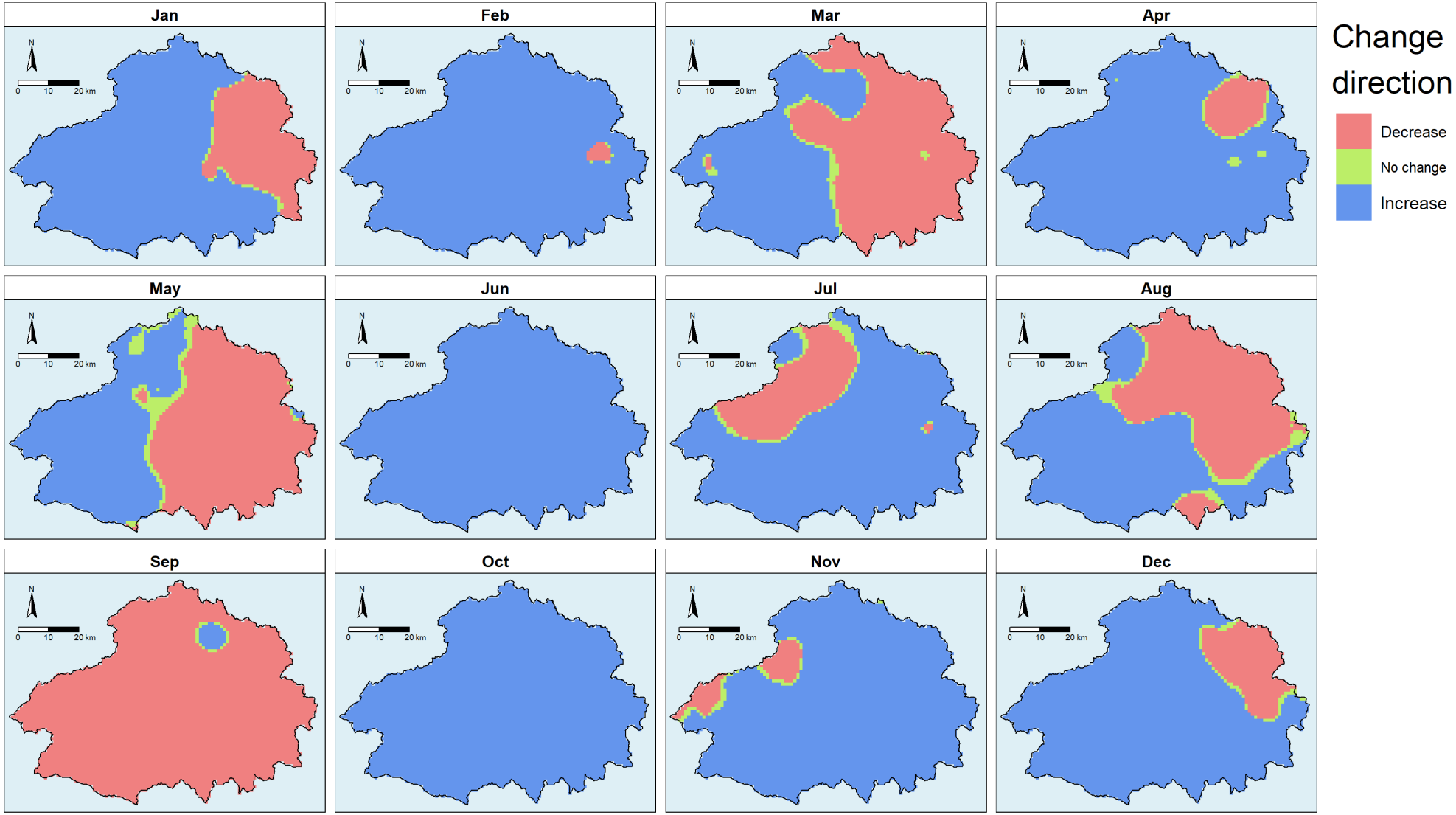
Cairngorms National Park: observed changes

Mean monthly precipitation change over the period 1990-2019 as compared to the baseline period 1960-1989



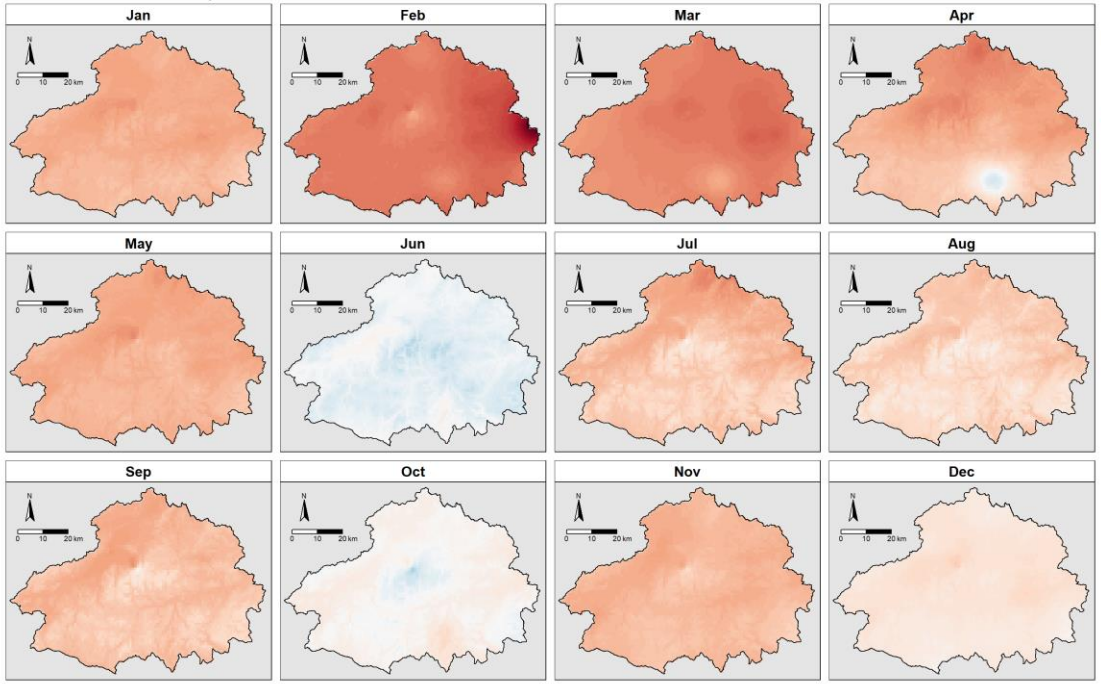
Cairngorms National Park: observed changes

Mean monthly precipitation change direction over the historical period 1990-2019

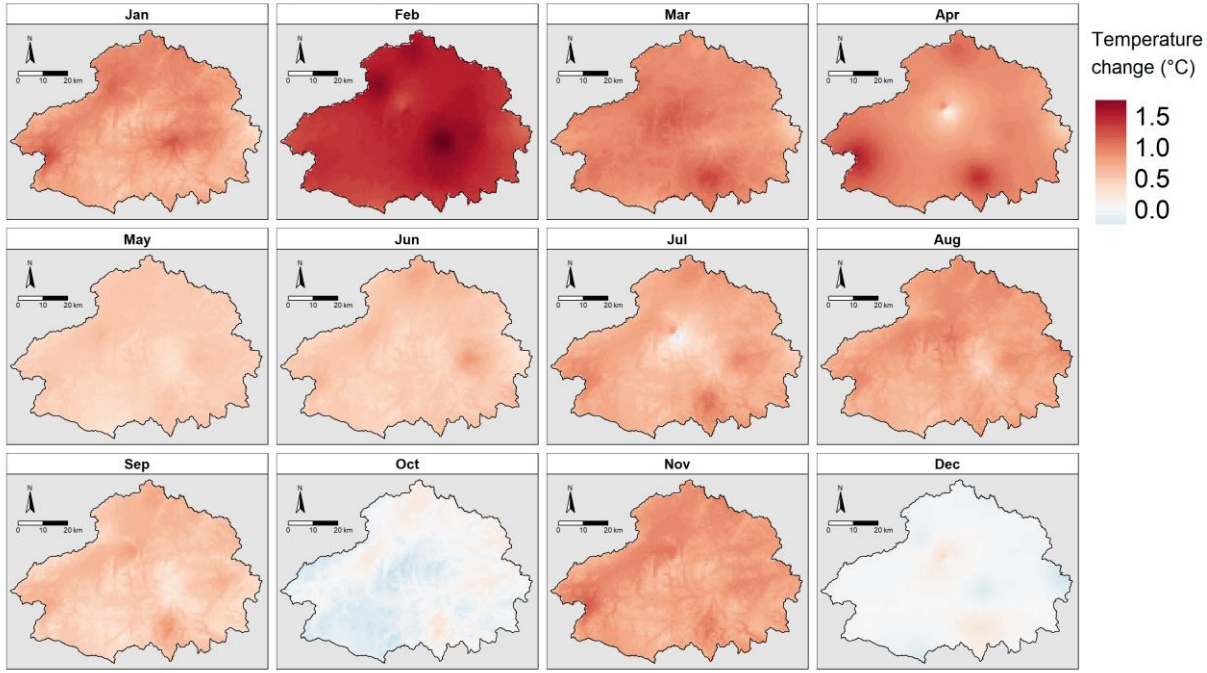


Cairngorms National Park: observed changes

Mean monthly maximum temperature change over the period 1990-2019 as compared to the baseline period 1960-1989

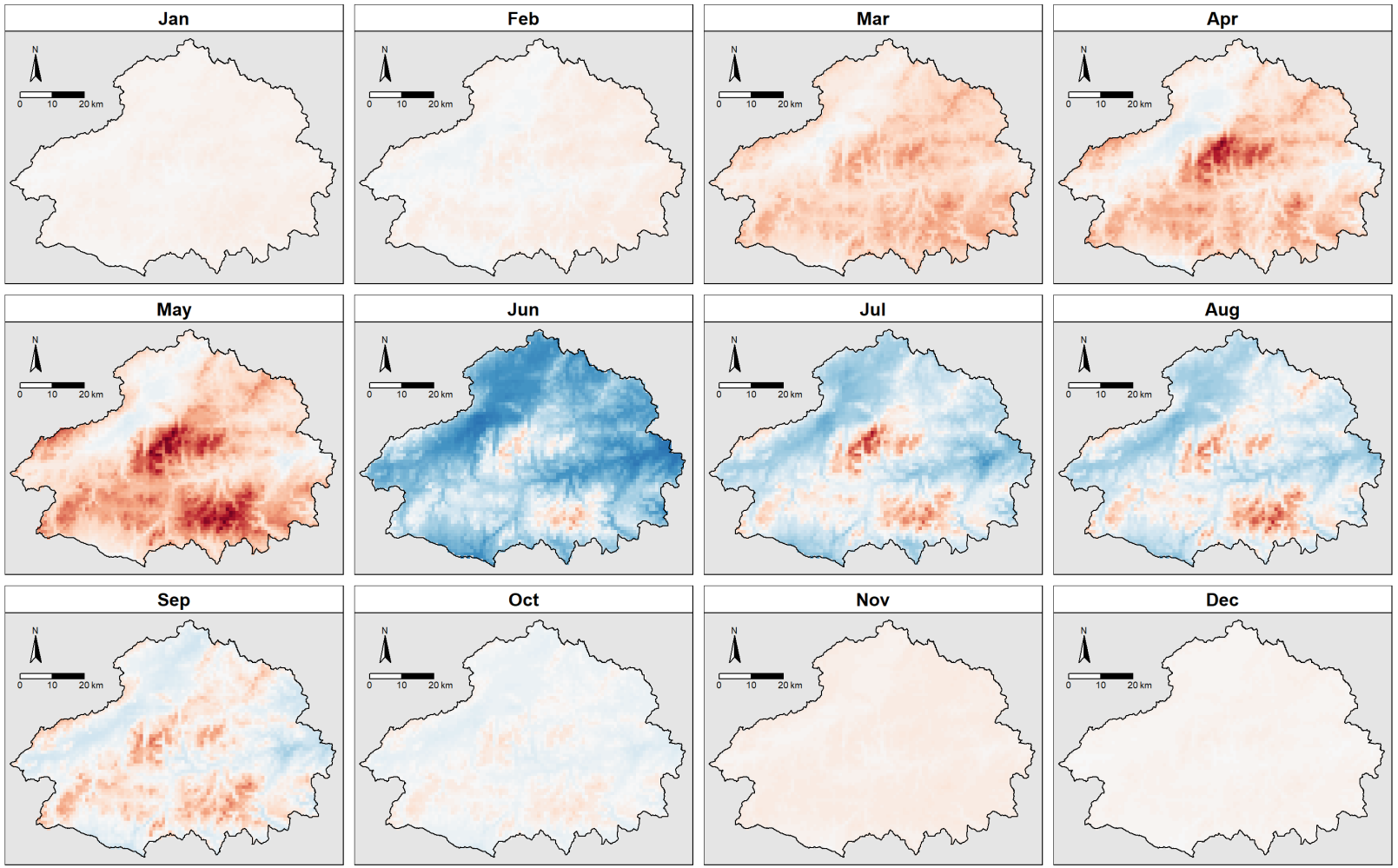


Mean monthly minimum temperature change over the period 1990-2019 as compared to the baseline period 1960-1989



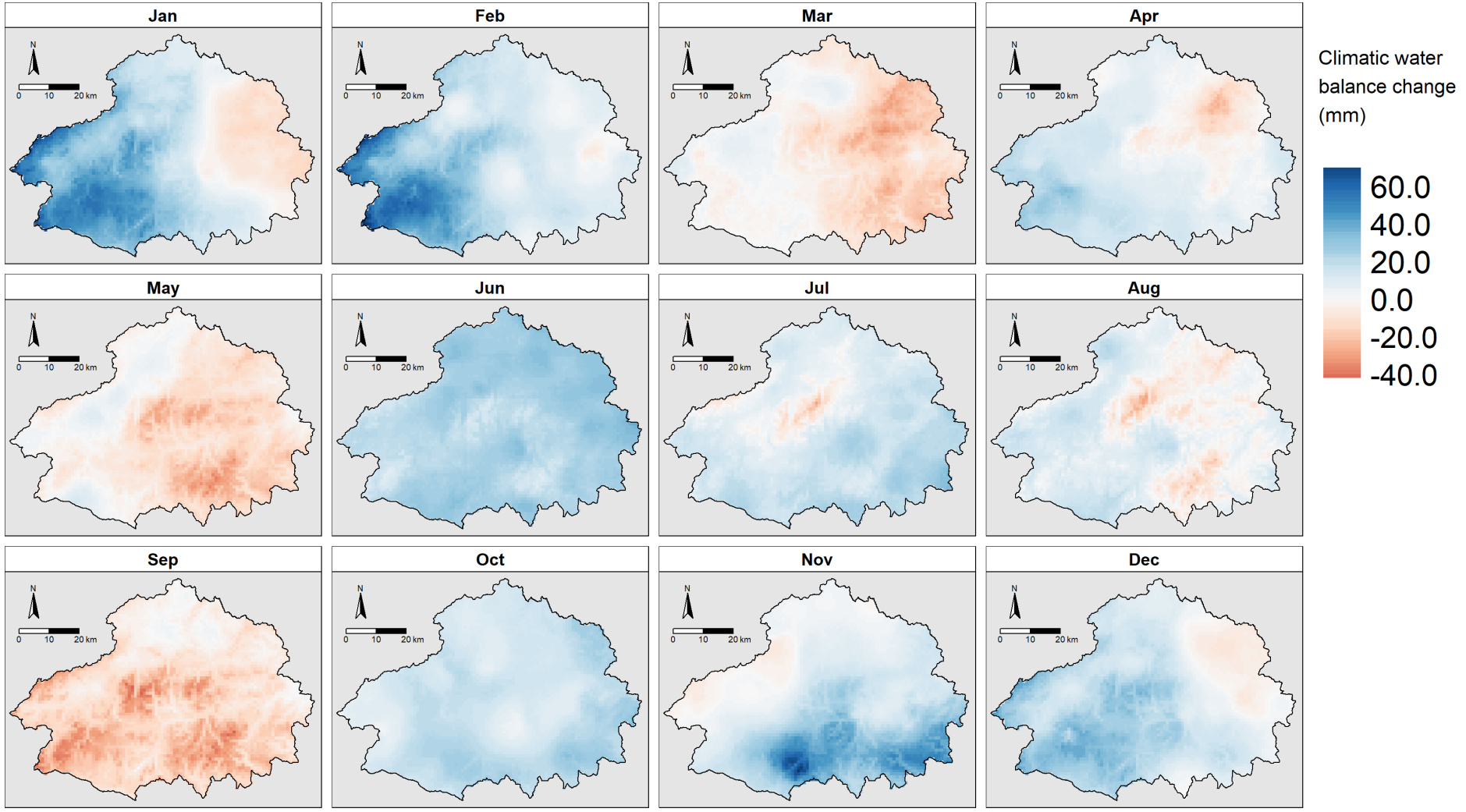
Cairngorms National Park: observed changes

Changes in mean monthly evapotranspiration over the period 1990-2019 as compared to the baseline period 1960-1989



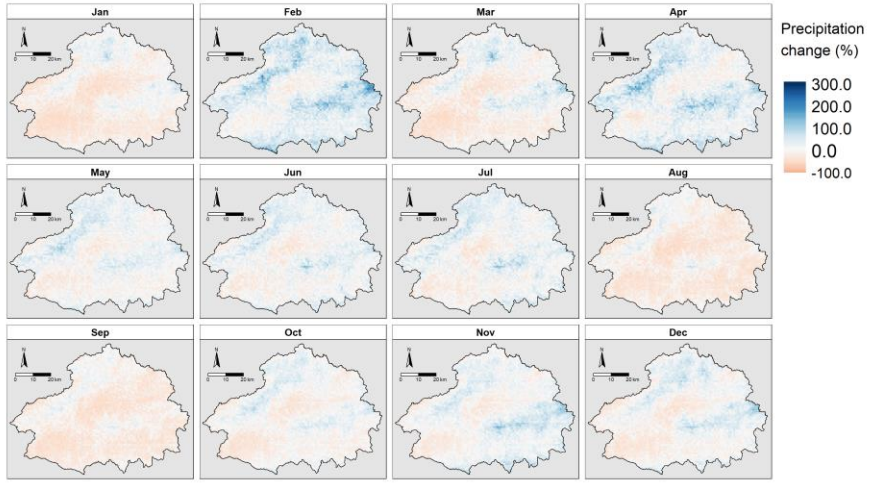
Cairngorms National Park: observed changes

Changes in mean monthly climatic water balance over the period 1990-2019 as compared to the baseline period 1960-1989

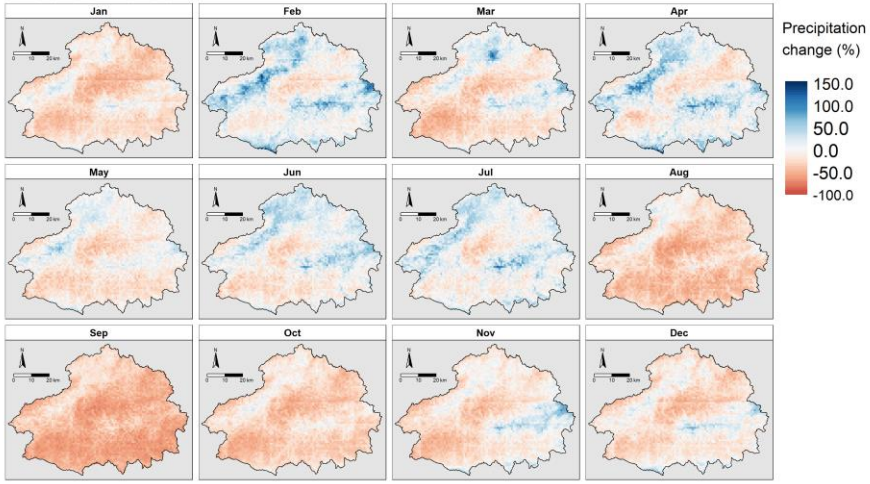


Cairngorms National Park: Projections - Precipitation

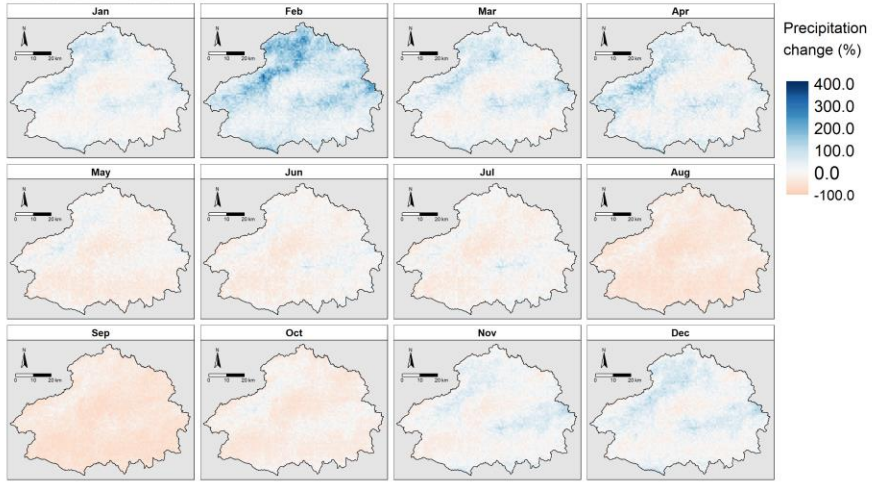
Changes in mean monthly precipitation over the period 2020-2049
Ensemble member 04



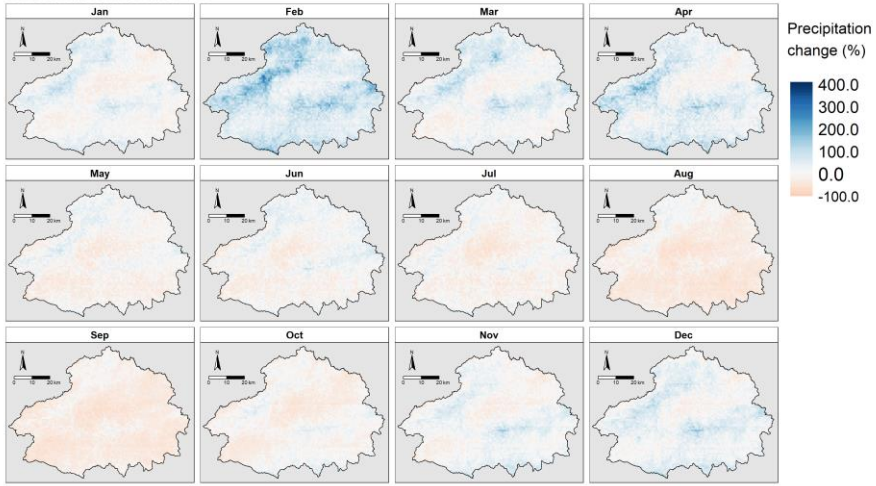
Changes in mean monthly precipitation over the period 2020-2049
Ensemble member 10



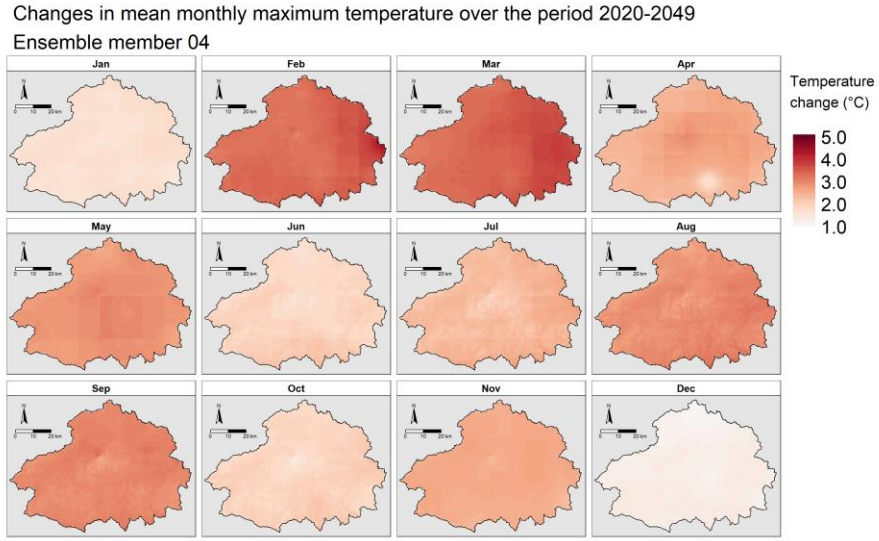
Changes in mean monthly precipitation over the period 2020-2049
Ensemble member 12

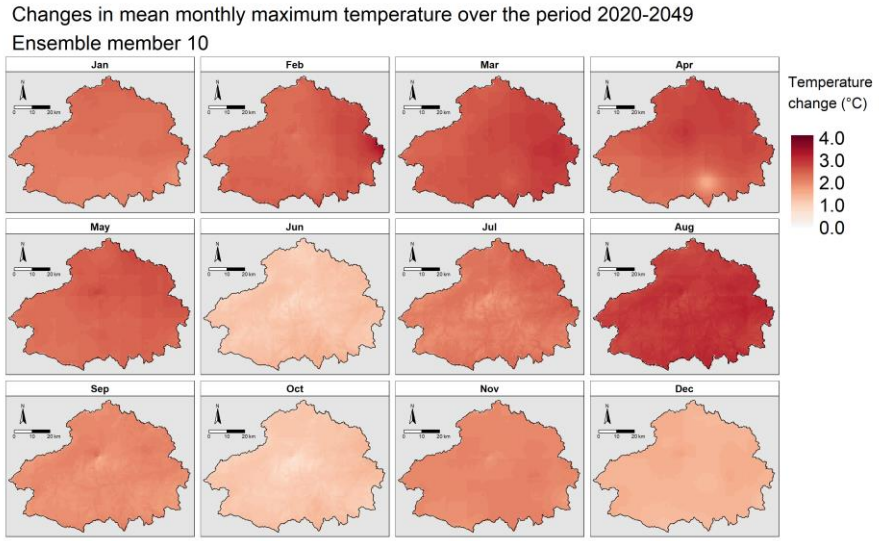


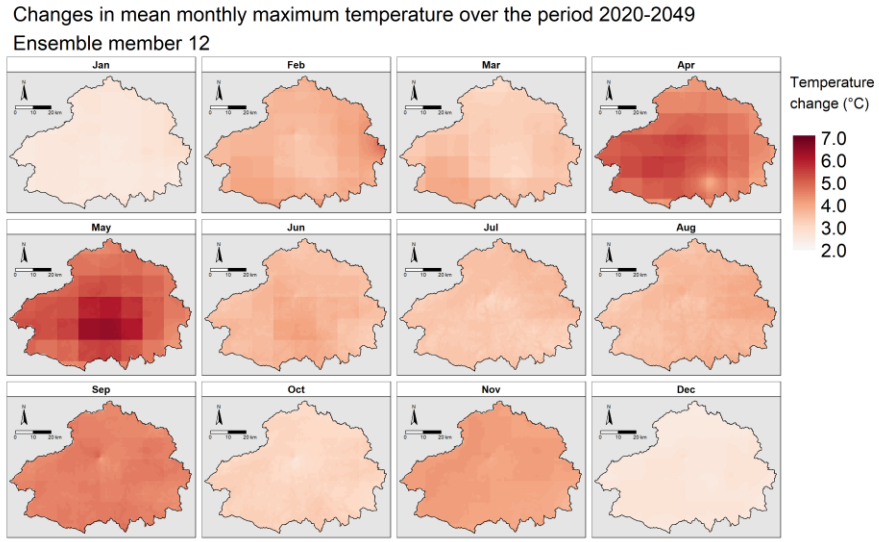
Changes in mean monthly precipitation over the period 2020-2049
Ensemble member 15

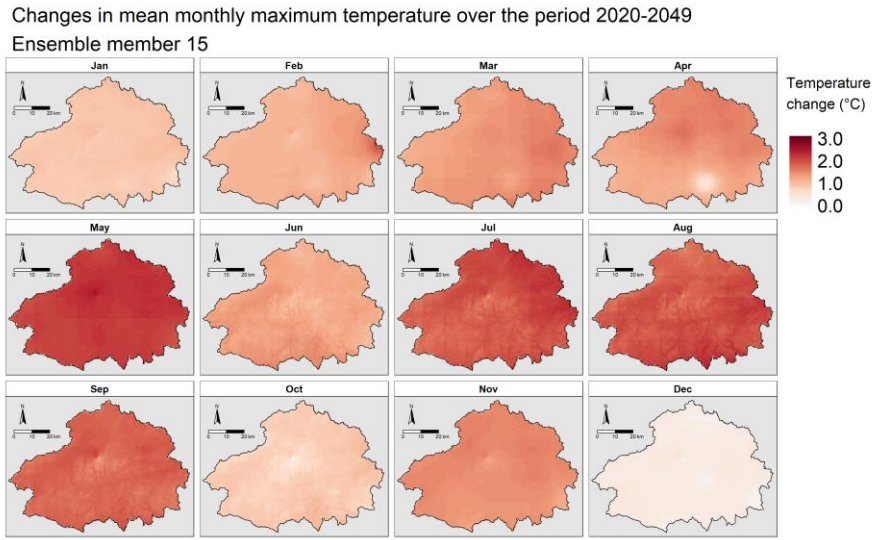


Cairngorms National Park: Projections – maximum temperature







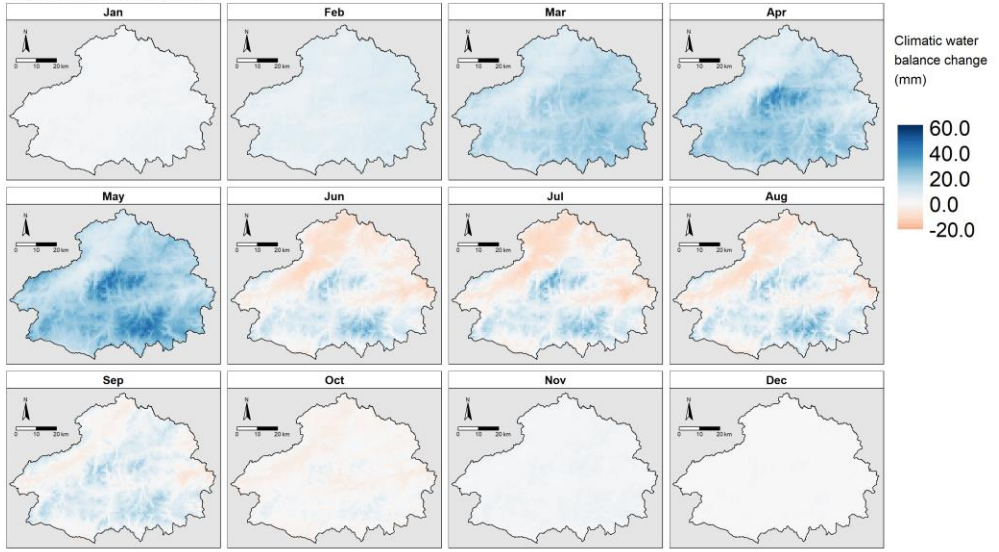


Changes in projected mean monthly maximum temperature for the period 2020-2049. **Note differences in scales means it is not possible to directly compare between projections.**

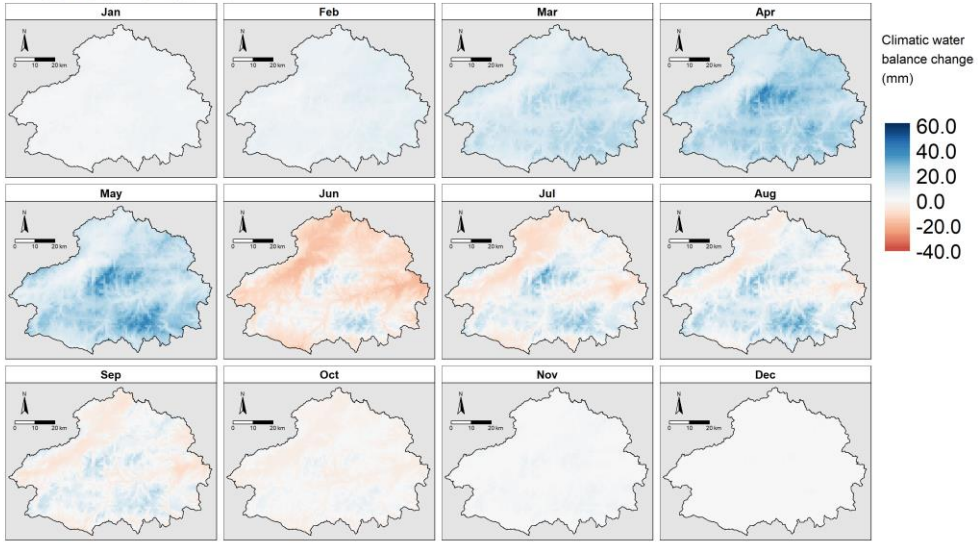
Cairngorms National Park: Projections – Climatic Water Balance

The James Hutton Institute

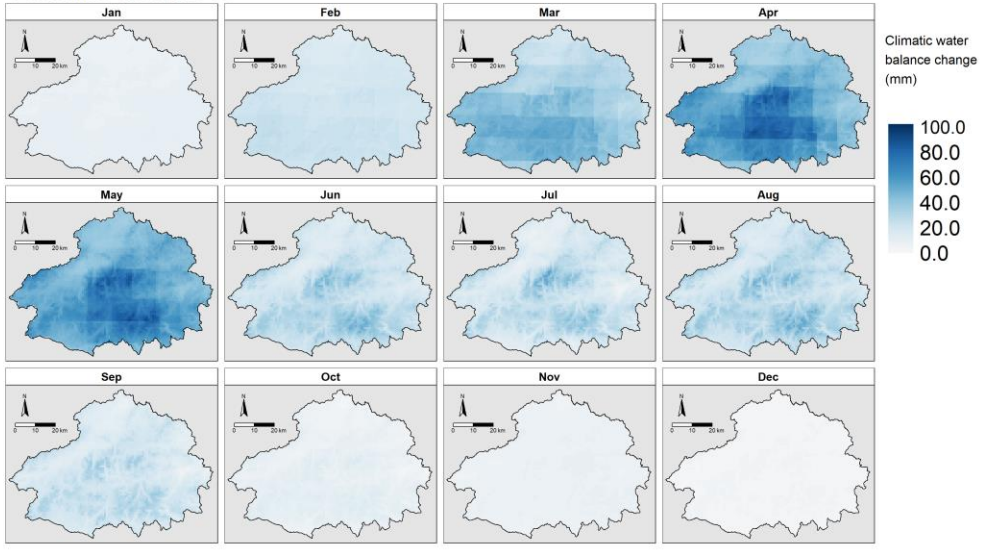
Changes in mean monthly climatic water balance over the period 2020-2049
Ensemble member 04



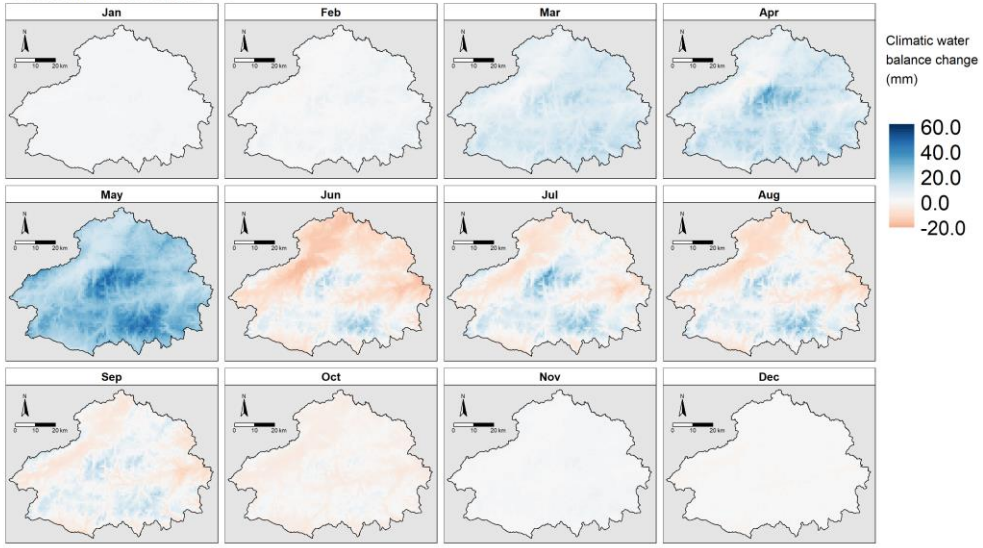
Changes in mean monthly climatic water balance over the period 2020-2049
Ensemble member 10



Changes in mean monthly climatic water balance over the period 2020-2049
Ensemble member 12



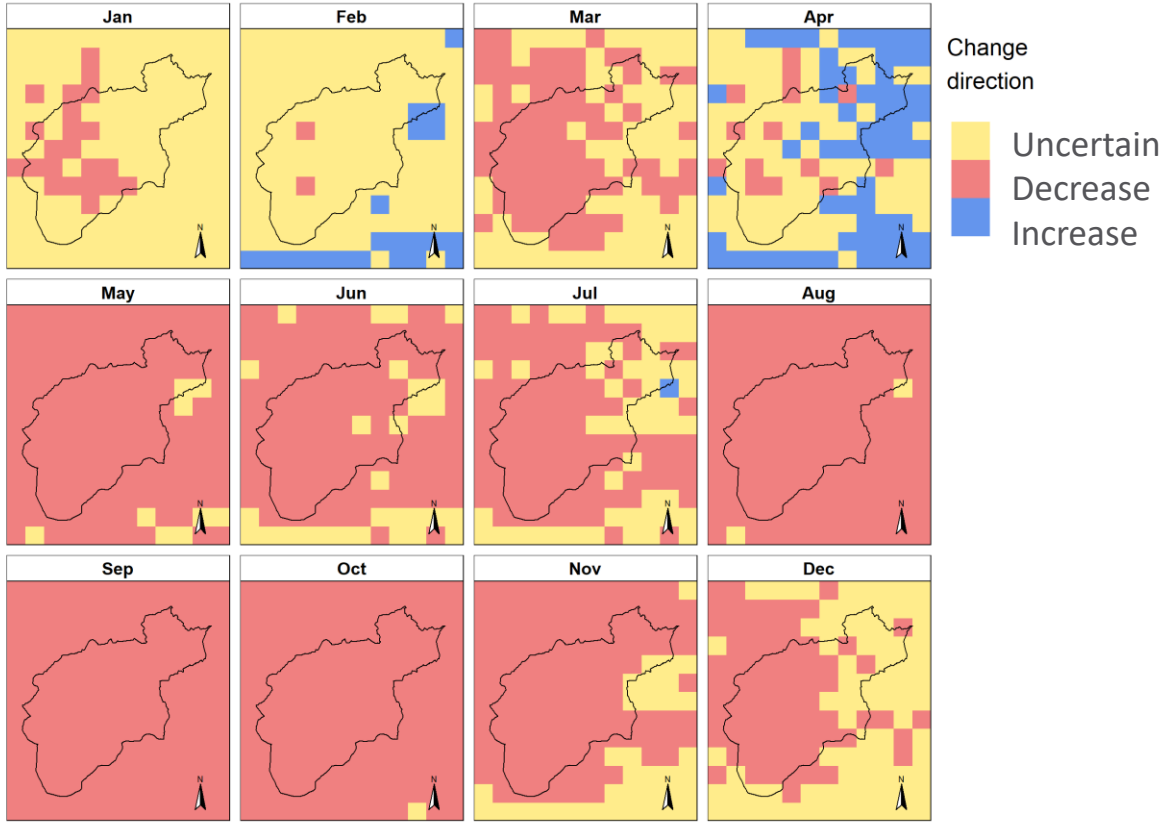
Changes in mean monthly climatic water balance over the period 2020-2049
Ensemble member 15



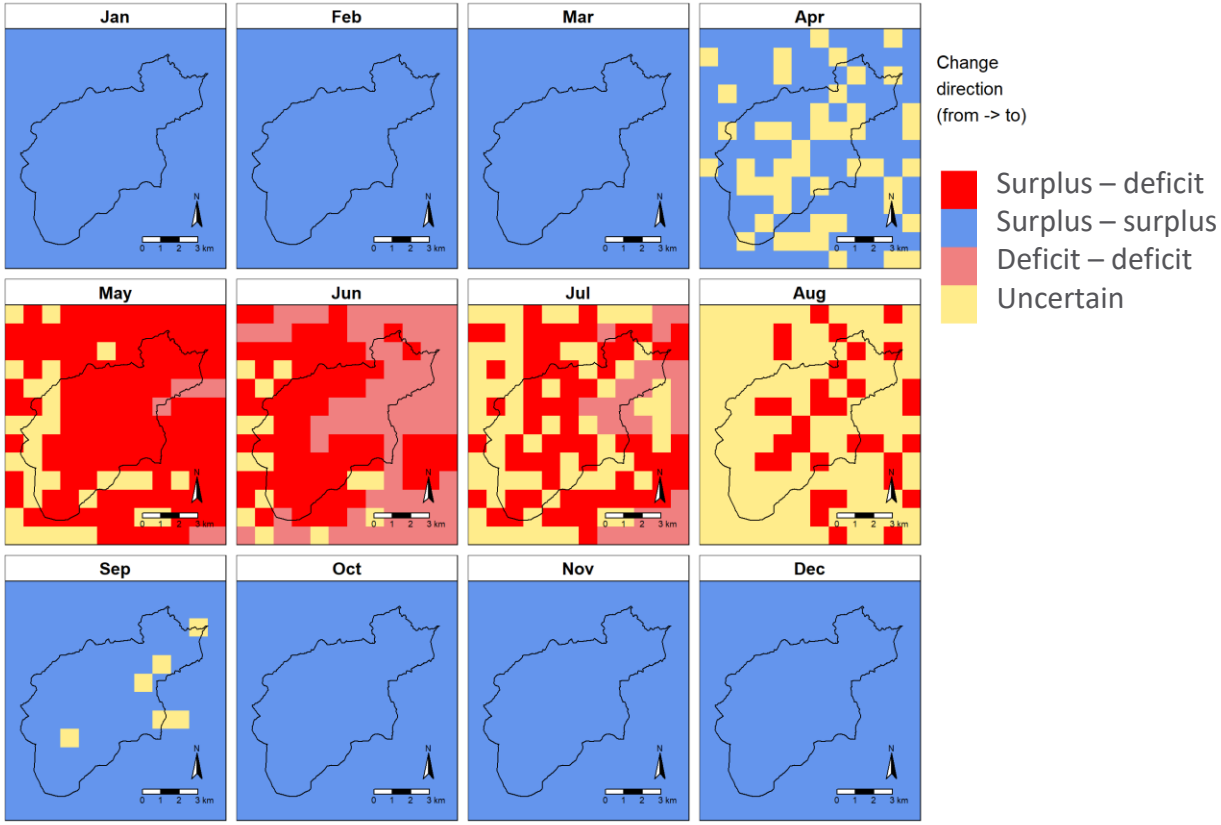
Changes in projected mean monthly Climatic Water Balance for the period 2020-2049.
Note differences in scales means it is not possible to directly compare between projections.

Estate level: change in precipitation and Climatic Water Balance

Change direction agreement for mean monthly precipitation over the period 2020-2049 for at least 12 ensemble members



Change direction agreement for mean monthly climatic water balance over 2020-2049 for at least 12 ensemble members

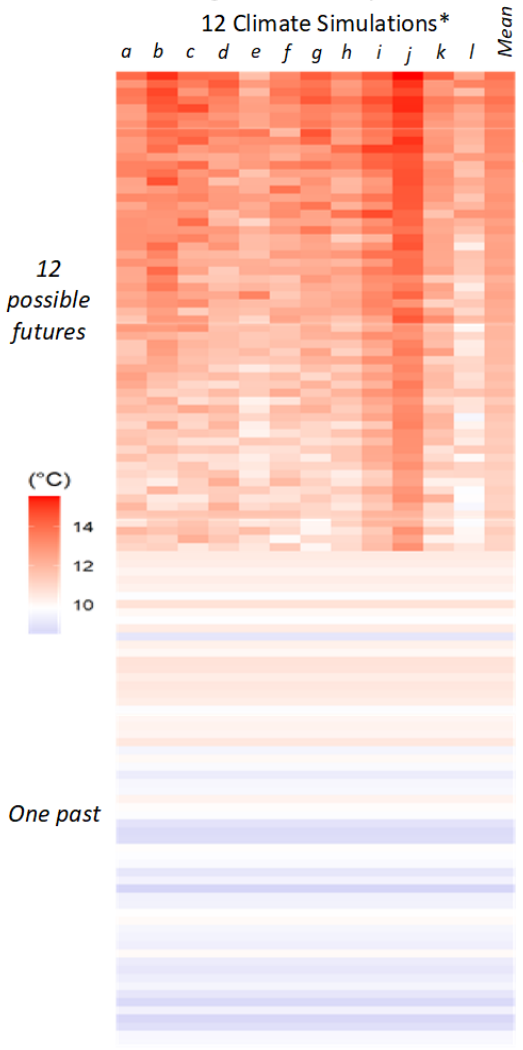


Putting projected changes in a global perspective

- Scotland may be ‘relatively’ less impacted directly by climate change and ecosystem degradation (initially) than other countries.
- BUT – we need to take a global perspective to understand local and Scotland-scale impacts and adaptation needs.

CoP26: Putting Glasgow’s changing climate in a global context

Glasgow’s temperature



* UKCP18 Climate Projections, RCP8.5
Mid-point for scale: average temperature 1980-2010

Plausible Global Impacts

2080 4.4°C (3.3 – 5.7°C)† Unprecedented droughts, heatwaves, floods. Severely reduced agricultural production.

2070 Loss of climate regulation ecosystem services: only 38% of emissions captured by Nature. Ocean acidification increases. Mass species extinction.

2060 Amazon rainforest collapse. Sea level rise of 0.5m means many Island States disappear.

2050 2.4°C (1.9 – 3.0°C)† Paris Agreement 2°C limit exceeded. 300m people displaced by sea level rise. Arctic Sea practically ice-free (September).

2040 1.6°C (1.3 – 1.9°C)† global average temperature rise exceeds 1.5°C. More frequent droughts, intense storms and flooding, increased rate of species extinction, loss of coral reefs. Arctic releasing more carbon. Food Security threats.

2030 50 million climate refugees.

2021 Atmospheric CO_2 is 412 ppm. Emissions from energy increasing by 4.8%. Nature increasingly a source of carbon, not a sink. 25 million climate refugees.

2003 European heatwave with 20,000 heat related deaths.

1960 Atmospheric CO_2 is 318 parts per million.

† Increase above pre-industrial levels, IPCC AR6 WG1 2021

The James Hutton Institute

For further details please contact:
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mike.rivington@hutton.ac.uk

Reports available here:
Trends and future projections:
https://www.hutton.ac.uk/sites/default/files/files/D2_1a%20Climate%20trends%20summary%20report%20FINAL%206-12-22.pdf
Extremes:
https://www.hutton.ac.uk/sites/default/files/files/D2_1b%20Climate%20extremes%20report%205-3-23%20FINAL%20submitted.pdf