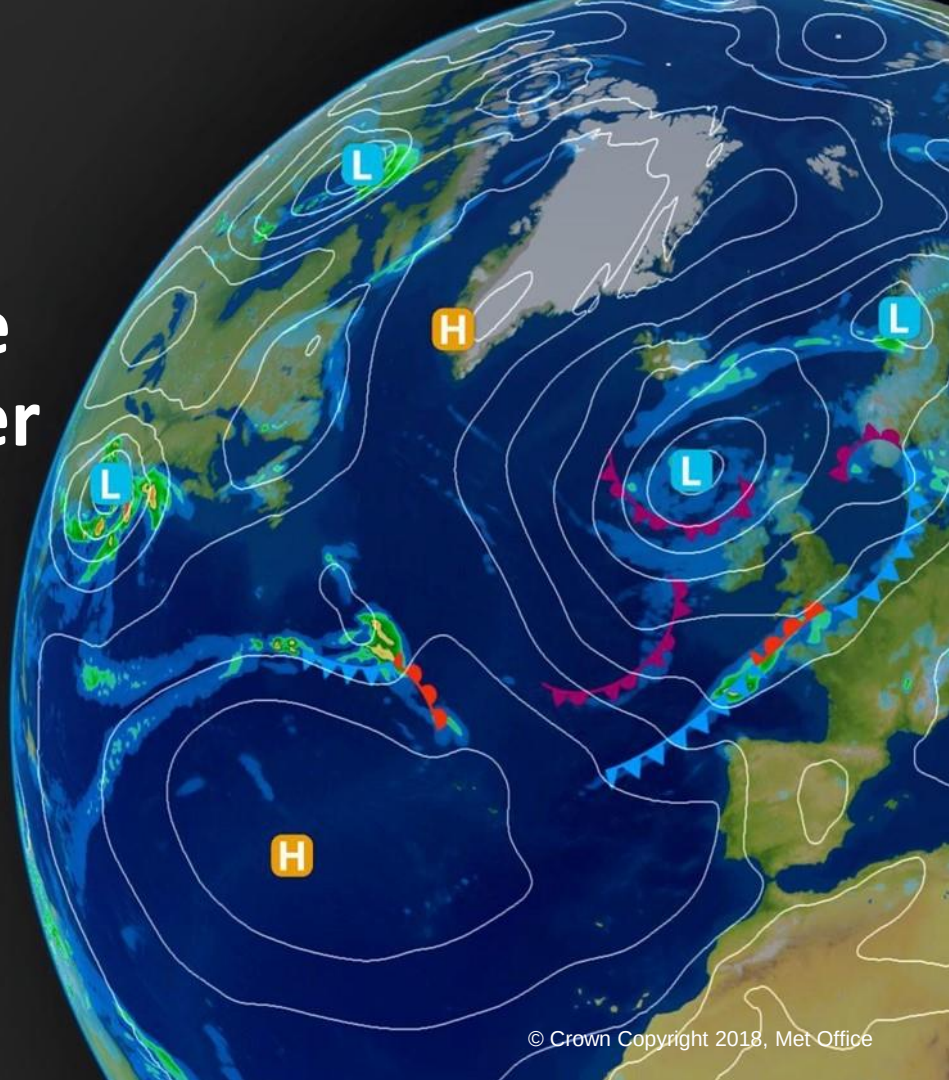
Investigation of Future Climate Change Over the British Isles using Weather Patterns

James O. Pope, Kate Brown, Fai Fung, Helen M. Hanlon, Rob Neal, Erika J. Palin, & Anne Reid

james.pope@metoffice.gov.uk

james-pope-10



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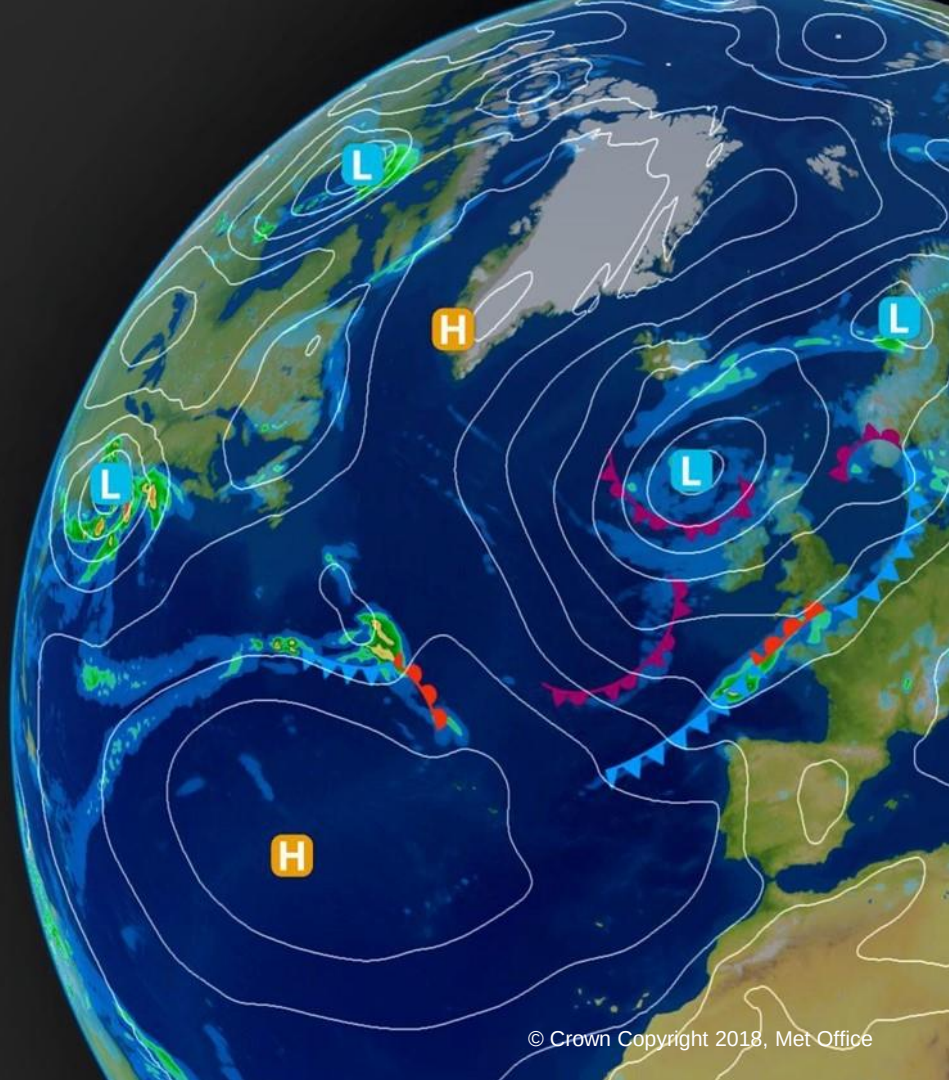
Met Office

Quick Introductions!

UKCP
&
Met Office 30 Static Weather Patterns



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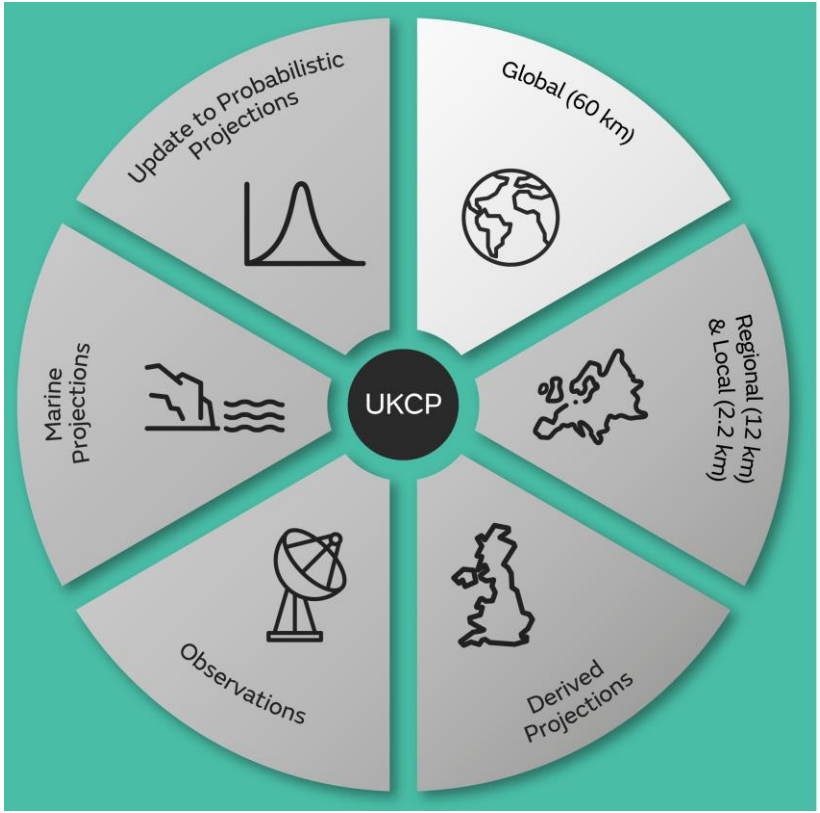
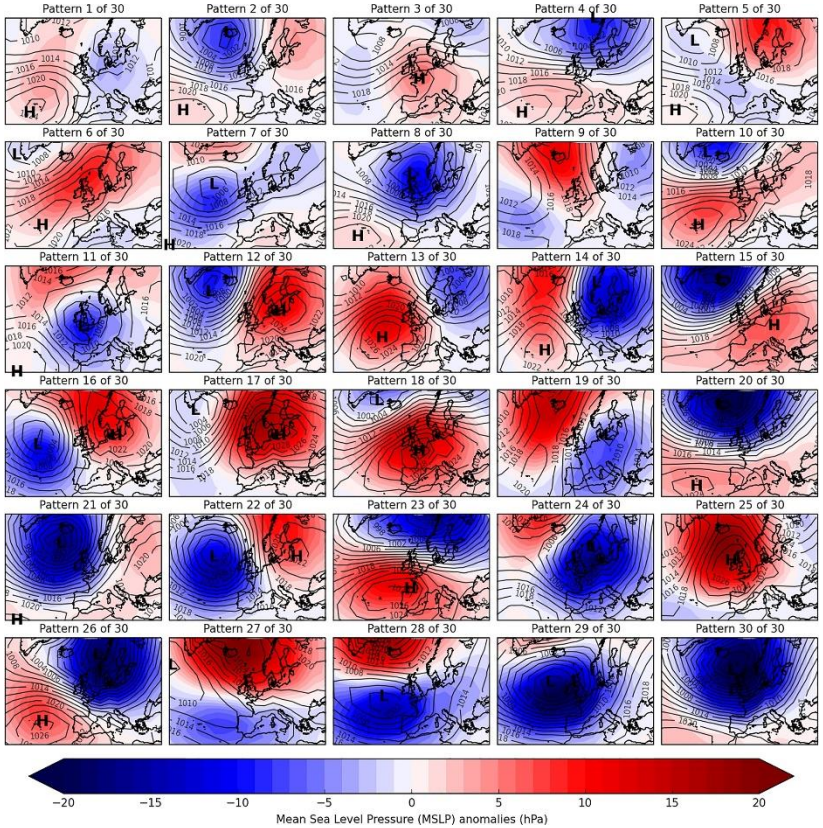
UK Climate Projections (UKCP)



- A range of products from climate models to sea level rise, observations to statistical projections.
- All the gory details can be found on our Met Office webpages here:
  - https://www.metoffice.gov.uk/research/approach/collaboration/ukcp
- Used by everyone from UK Government to individual members of the public.
  - Available in full on the CEDA Archive
  - UK data also available on our dedicated UKCP User Interface

Met Office 30 Weather Patterns



- 30 static weather patterns for use in medium- to long-range forecasting.
- Representing a broad range of the circulation types we see over the British Isles.
- Each weather pattern has an associated climatology and frequency on annual and seasonal timescales.

UKCP & Weather Patterns?

	Wed 31 Aug	Thu 1 Sep	Fri 2 Sep	Sat 3 Sep	Sun 4 Sep	Mon 5 Sep	Tue 6 Sep	Wed 7 Sep	Thu 8 Sep	Fri 9 Sep	Sat 10 Sep	Sun 11 Sep	Mon 12 Sep	Tue 13 Sep	Wed 14 Sep
Regime 1									2	6	4	6	4	2	
Regime 2													4	2	4
Regime 3												6	6	4	
Regime 4														2	2
Regime 5				2	2	45	39	2	4		8	6	8	6	2
Regime 6		96										4	2		4
Regime 7							4	16	8	6	4	12	12	4	12
Regime 8									2				4	10	6
Regime 9						2	12	4	10	25	35	27	25	18	2
Regime 10															
Regime 11					6	6	27	63	49	27	10	4	6	10	8
Regime 12													4	4	4
Regime 13												4			
Regime 14									2	4	8		2	6	4
Regime 15														2	2
Regime 16					33	33	16			6	8	4	8	10	10
Regime 17	100	4									4	4			2
Regime 18															
Regime 19									6	12	8	8	6	4	4
Regime 20															
Regime 21															6
Regime 22												2	4	8	6
Regime 23															
Regime 24										2				4	14
Regime 25												2	2		
Regime 26															
Regime 27			100	98	59	14				2	2	4			
Regime 28							2	16	18	10	10	6	2		2
Regime 29												2	2	4	4
Regime 30														2	4
Total Members	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51

- Here we have a typical output from the weather patterns for our operational meteorologists.
- Different ensemble members assigned to different weather patterns.
- Greater spread as you look further into the future.

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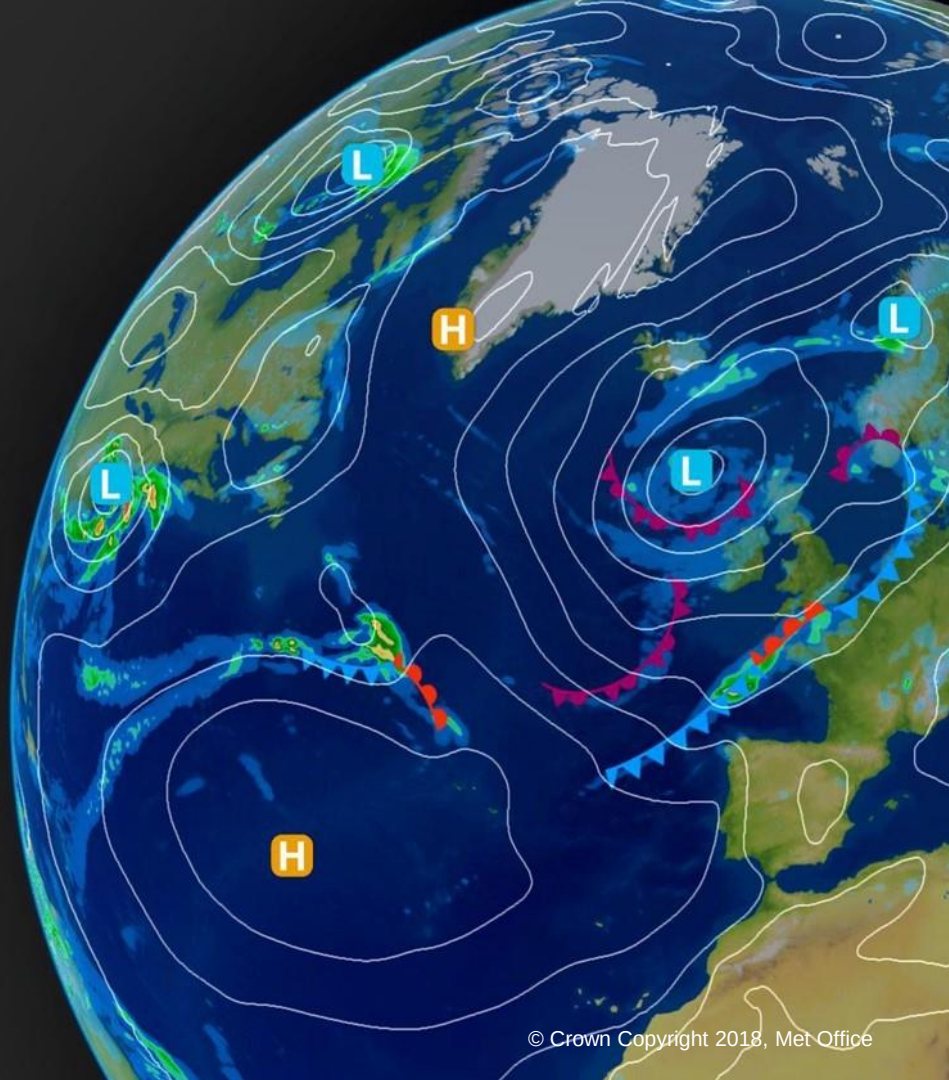
Using the 28 members of the UKCP Global ensemble covering 1900-2100 we did just that!

Why Weather Patterns?



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But Why?

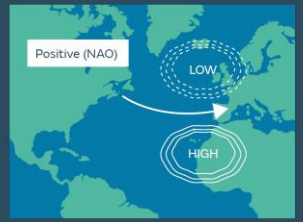
- The weather patterns provide a methodology to translate climate scale information into meteorological scale information.

Downscaling

UKCP Global (60km)

Temperature Changes

Influence of North Atlantic Oscillation



Large scale hydrological changes

Influence of North Atlantic Storm Track

UKCP Local (2.2km)

Summertime rainfall intensity and duration

Severe convective wind gusts

Short duration rainfall extremes and flash flooding

Urban changes

Downscaling

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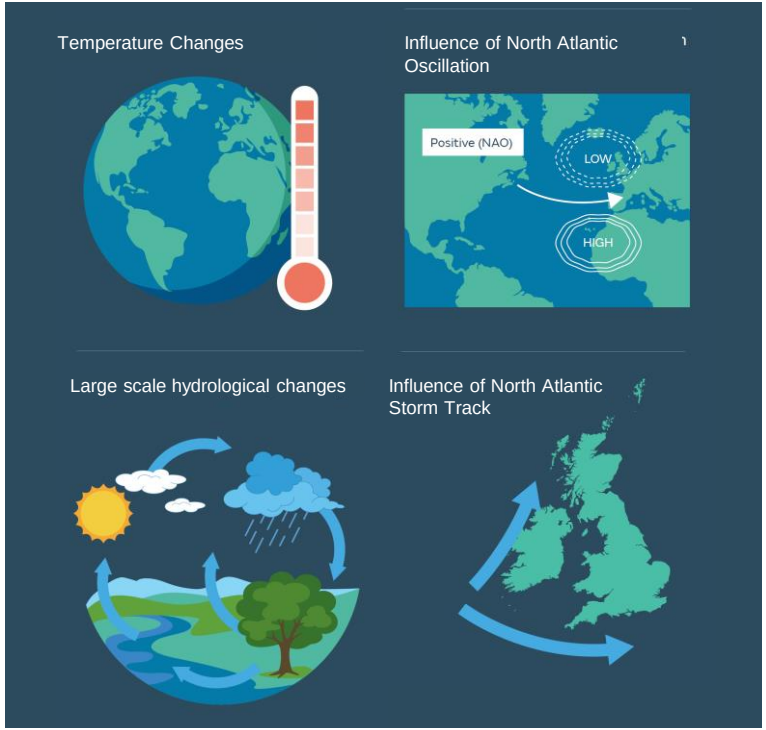
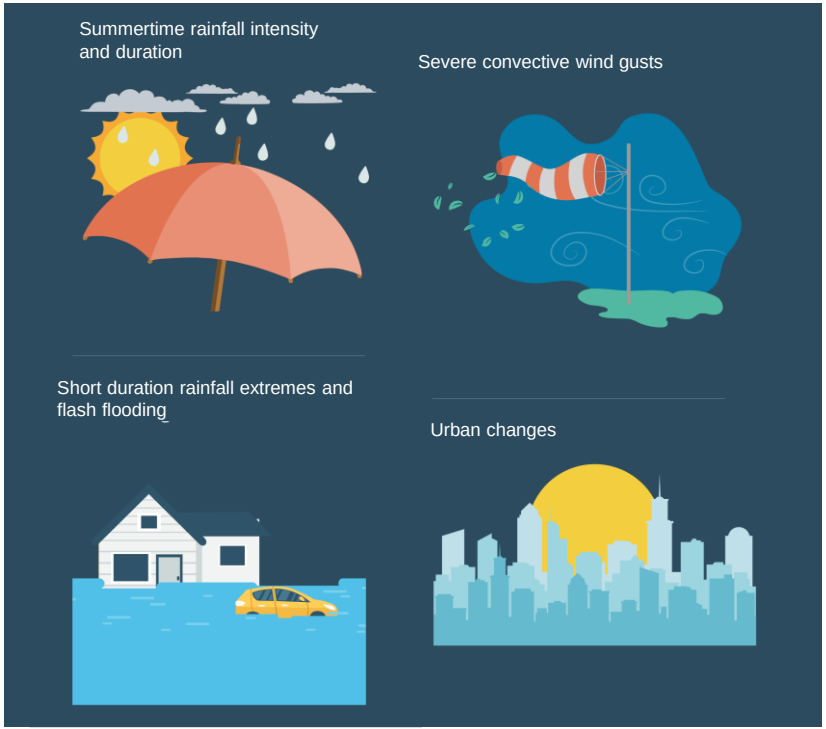


Computationally expensive

UKCP Local (2.2km)



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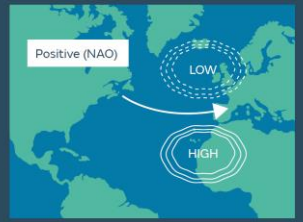

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Hard work

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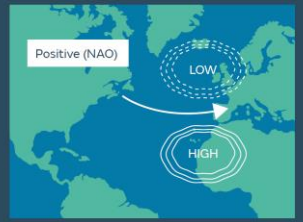

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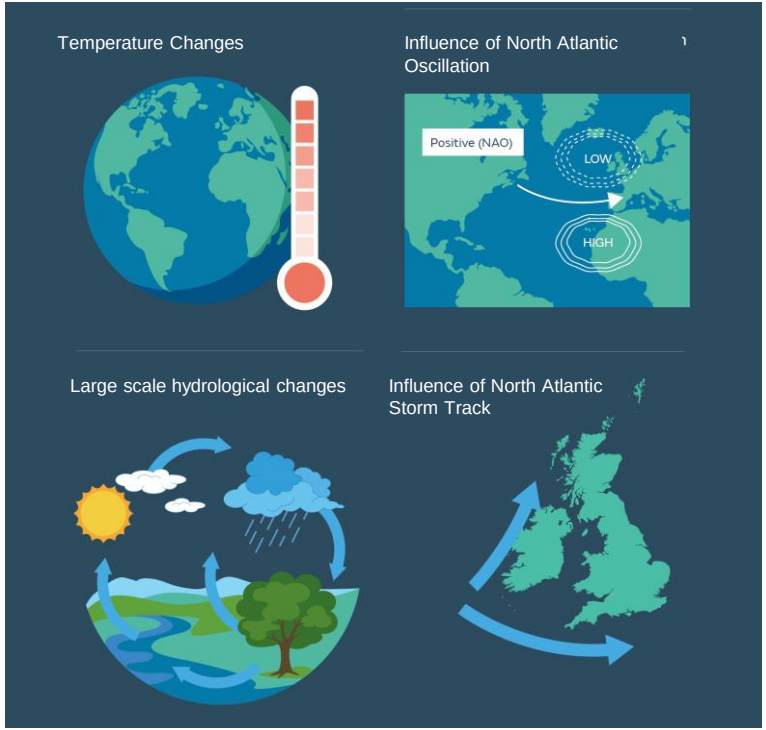

Computationally expensive

Hard work

Time intensive

Immense storage cost (136 GB vs 23 TB)

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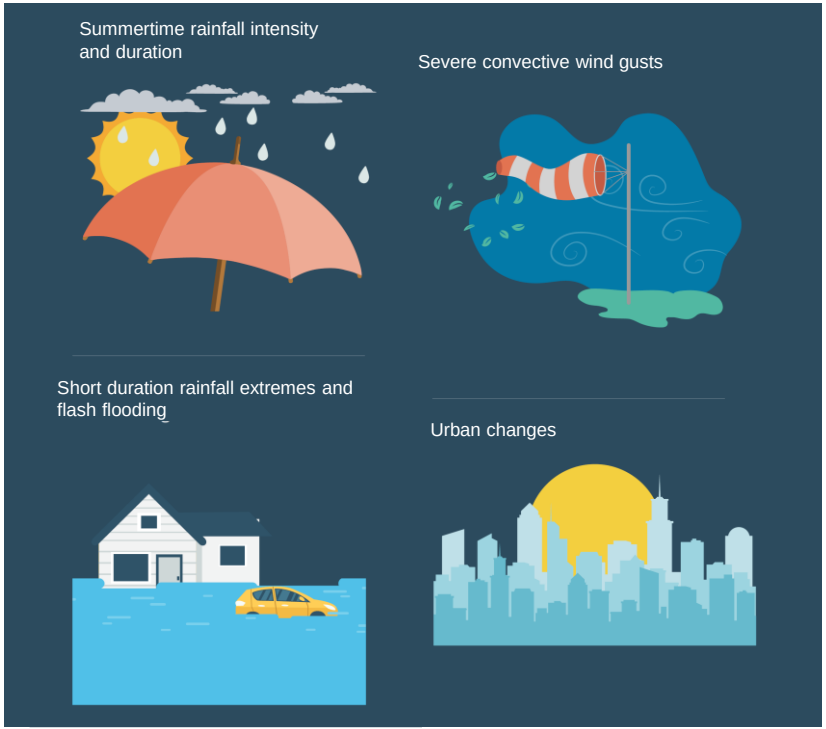
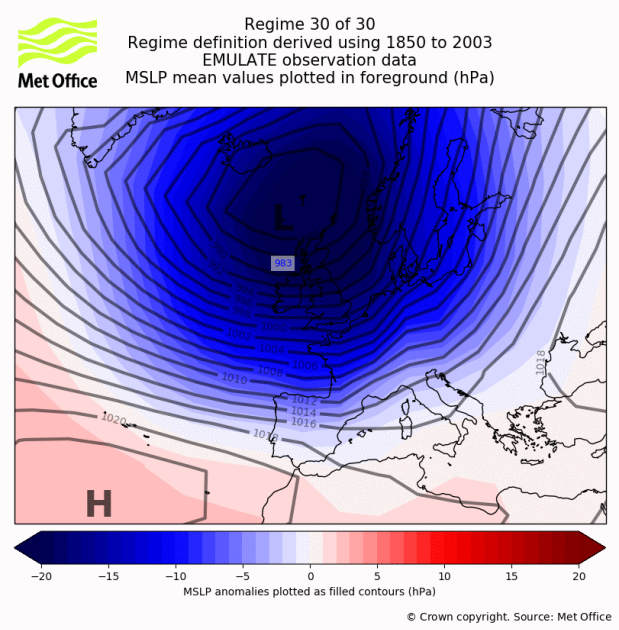
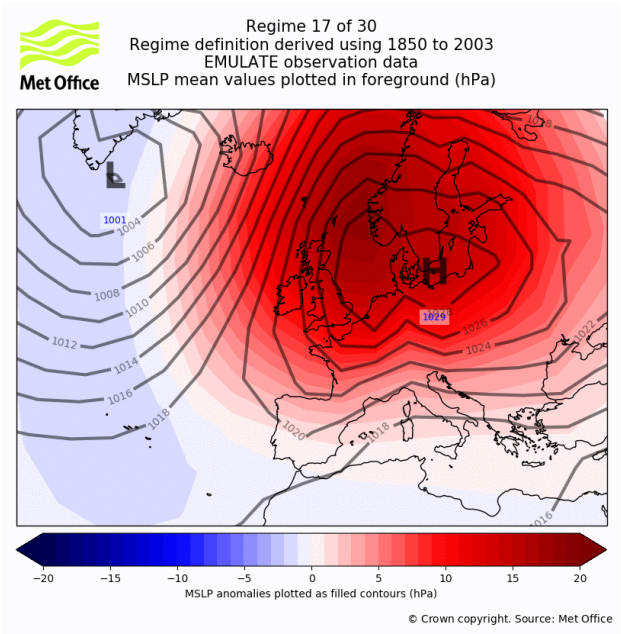


Large Scale Drivers…



Winter (DJF)



Pattern 30 – A dominant low-pressure system, could easily be part of a sequence with a named storm.

Pattern 17 – High pressure with some continental flow. A dry, cold winters day

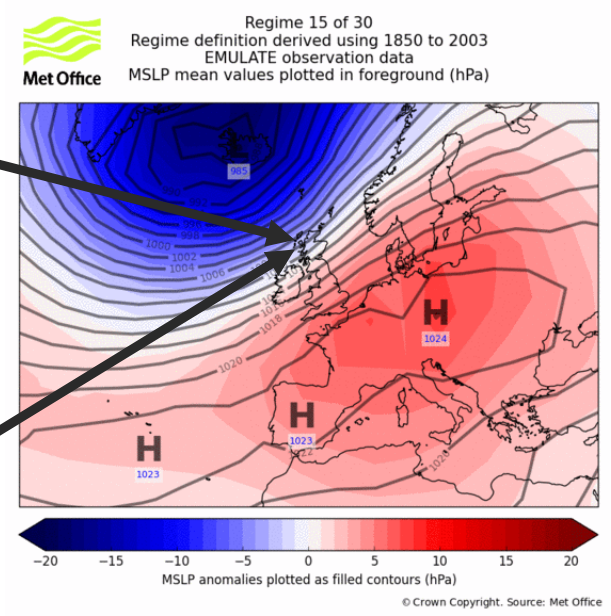
…Local Scale Details

Stornoway Airport

Winter Mean: 4.2%

South Uist Range

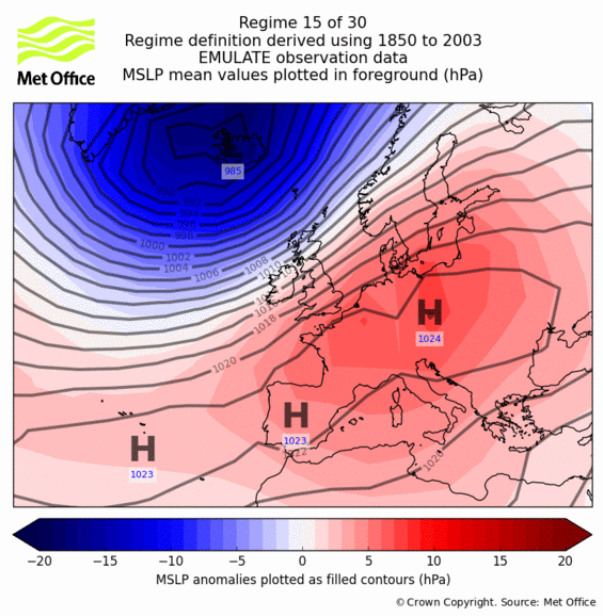
Winter Mean: 4.2%



…Local Scale Details

Stornoway Airport
Frequency of >20 mm Precip: 9.8%
Winter Mean: 4.2%

South Uist Range
Frequency of >20 mm Precip: 19.2%
Winter Mean: 4.2%



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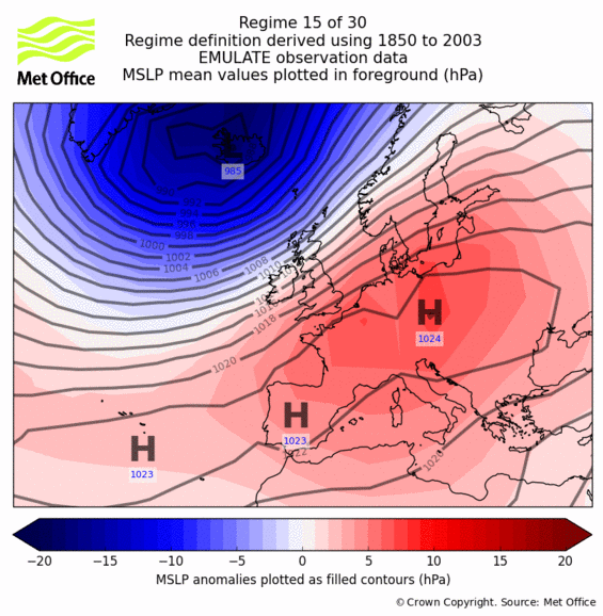

The weather pattern represents the whole North Atlantic-European domain, but climatologically days with this weather pattern show different responses between two areas only 160 km apart. Giving useful detail at a local area from a large-scale pattern!

But Why?

- The weather patterns provide a methodology to translate climate scale information into meteorological scale information.
  - Without engaging in computationally expensive dynamical downscaling.
- Provides a categorisation of the conditions, and from this associated climatological conditions.
  - Also enables some analogue-based comparisons between events in the past and those projected within the climate model.

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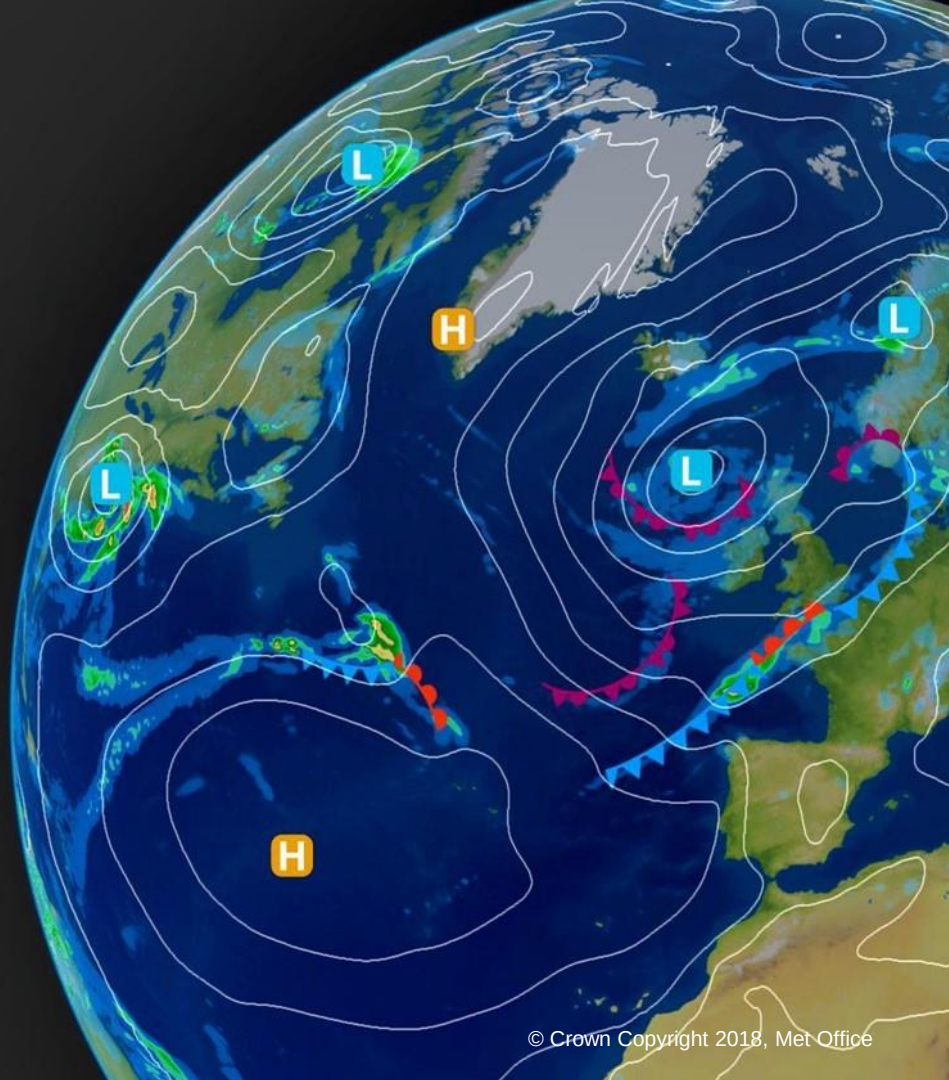
It looked like, was and is a fun, novel and interesting piece of science.

Key Results!



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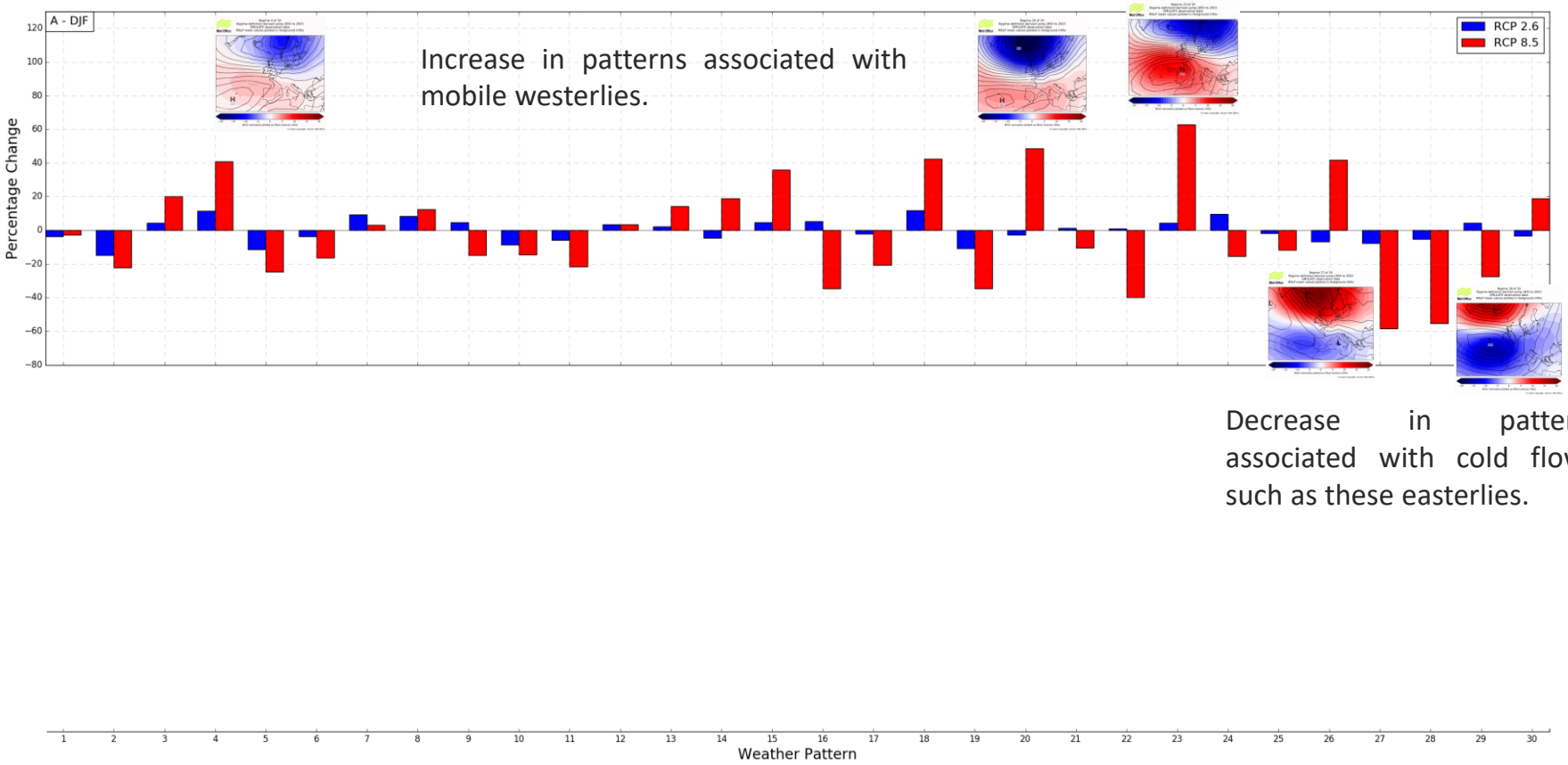
Winter Frequency Changes



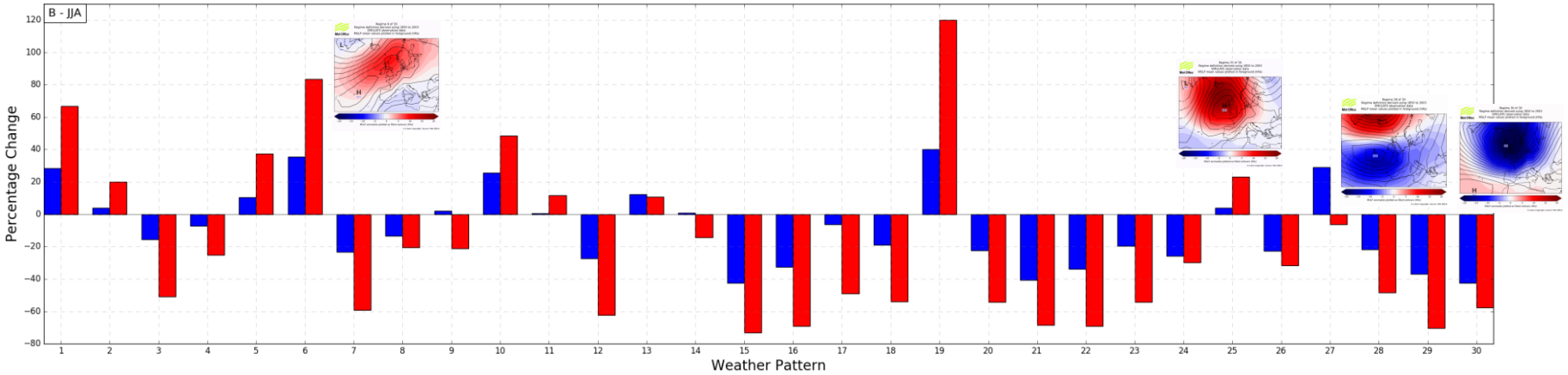
Increase in patterns associated with mobile westerlies.

Decrease in patterns associated with cold flows, such as these easterlies.

Summer Frequency Changes

Increase in patterns that anti-cyclonic conditions.

Decrease in conditions associated with storm conditions.



What Does This All Mean?

Winter

- Increased frequency, decreased persistence of mobile westerly cyclonic patterns.
  - More, but shorter duration storm events (such set ups currently associated with more impactful conditions).

Summer

- Increased frequency & persistence of anti-cyclonic patterns.
  - More and longer prolonged spells of warmer settled weather.

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- Decreased frequency & persistence of anti-cyclonic patterns and those associated with easterly flow.
  - Fewer and shorter durations of stable but colder weather.

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- Increased frequency & persistence of anti-cyclonic patterns.
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- Decreased frequency & persistence of cyclonic patterns.
  - Fewer and shorter duration summer storms and a decrease in frontal precipitation events.

What Does This All Mean?

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- Increased frequency & decreased persistence of more westerly cyclonic patterns
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WINTERS

HOTTER

What Does This All Mean?

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WINTERS

HOTTER

DRIER

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WARMER WETTER WINTERS HOTTER DRIER SUMMERS

A useful nod towards the UKCP Headline Findings

So Much More!

Longer summers?

Work by Daniel Cotterill with a blog here and the paper here. Used the weather patterns to identify a change in UK seasons in the future.

Outer Hebrides Storyline

I presented a poster yesterday, on this research published in Climate Services combining weather patterns, climate model output and an artist to drive community engagement in future adaptation needs.

Flow from Iceland!

A summer student and I looked at the weather patterns that could bring volcanic ash into the airspace around the British Isles. The paper can be read here.

Wind/Flood Events!

Hannah Bloomfield used these weather patterns in an analysis of the synoptic conditions related to compound events and their future change in likelihood, read the paper here.

UK Power Outages!

Laiz Souto used the weather patterns to compare to recent failures across the UK power network. That research is here and we are continuing to develop this concept further.

If you are interested in collaborating in this space using these weather patterns

please e-mail me – james.pope@metoffice.gov.uk