SIXTH ASSESSMENT REPORT
Working Group 1 - The Physical Science Basis

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INTERGOVERNMENTAL PANEL ON climate change
WMO UNEP

Presentation to the Warsaw International Mechanism Excom 14

Richard Jones, Coordinating Lead Author, Atlas

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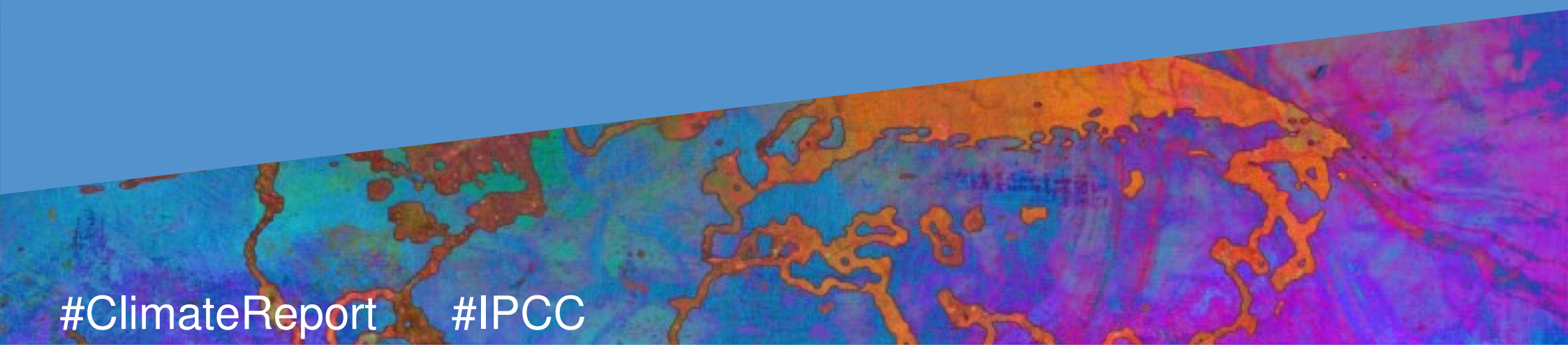

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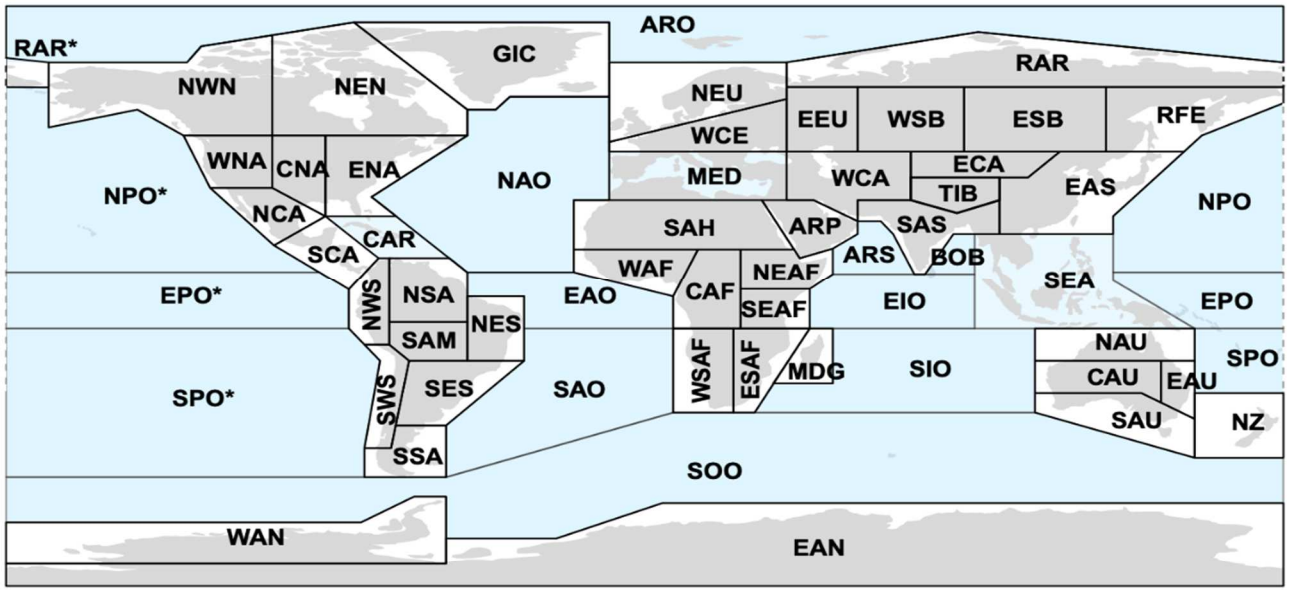
Outline

- New AR6 WGI reference regions
  - to better represent regional climate
- Observed and future changes in extremes in all regions
- Climatic Impact-Drivers (CIDs)
  - Physical climate information relevant to impact and risk assessment
- Multiple and diverse CID changes in all regions
- The Interactive Atlas
  - supporting the exploration of evidence and findings

New WGI AR6 reference regions



1	GIC	Greenland/Iceland
2	NWN	N.W.North-America
3	NEN	N.E.North-America
4	WNA	W.North-America
5	CNA	C.North-America
6	ENA	E.North-America
7	NCA	N.Central-America
8	SCA	S.Central-America
9-10	CAR	Caribbean
11	NWS	N.W.South-America
12	NSA	N.South-America
13	NES	N.E.South-America
14	SAM	South-American-Monsoon
15	SWS	S.W.South-America
16	SES	S.E.South-America
17	SSA	S.South-America
18	NEU	N.Europe
19	WCE	Western&Central-Europe
20	EEU	E.Europe
21-22	MED	Mediterranean

23	SAH	Sahara
24	WAF	Western-Africa
25	CAF	Central-Africa
26	NEAF	N.Eastern-Africa
27	SEAF	S.Eastern-Africa
28	WSAF	W.Southern-Africa
29	ESAF	E.Southern-Africa
30	MDG	Madagascar
31	RAR	Russian-Arctic
32	WSB	W.Siberia
33	ESB	E.Siberia
34	RFE	Russian-Far-East
35	WCA	W.C.Asia
36	ECA	E.C.Asia
37	TIB	Tibetan-Plateau
38	EAS	E.Asia
39	ARP	Arabian-Peninsula
40	SAS	S.Asia
41-42	SEA	S.E.Asia

43	NAU	N.Australia
44	CAU	C.Australia
45	EAU	E.Australia
46	SAU	S.Australia
47	NZ	New-Zealand
48	EAN	E.Antarctica
49	WAN	W.Antarctica
50	ARO	Arctic-Ocean
51	NPO	N.Pacific-Ocean
52	EPO	Equatorial.Pacific-Ocean
53	SPO	S.Pacific-Ocean
54	NAO	N.Atlantic-Ocean
55	EAO	Equatorial.Atlantic-Ocean
56	SAO	S.Atlantic-Ocean
57	ARS	Arabian-Sea
58	BOB	Bay-of-Bengal
59	EIO	Equatorial.Indic-Ocean
60	SIO	S.Indic-Ocean
61	SOO	Southern-Ocean

WGI AR6 Land and Ocean reference regions used in the report

46 Land regions
15 Ocean regions

Improved regional climate consistency

Better representation of regional climate features

Regional statistics more representative of new higher resolution models

Refinement of earlier reference regions via broad consultation and peer review

{Figure 1.18, Figure Atlas.2}

[Credit: Yoda Adaman | Unsplash]

"It is indisputable that human activities are causing climate change, making extreme climate events, including heat waves, heavy rainfall, and droughts, more frequent and severe.

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Climate change is already affecting every inhabited region across the globe with human influence contributing to many observed changes in weather and climate extremes

Figure SPM.3

- Changes in hot extremes observed and attributed to human influence almost everywhere
- Many regions also experiencing increases in heavy precipitation and droughts

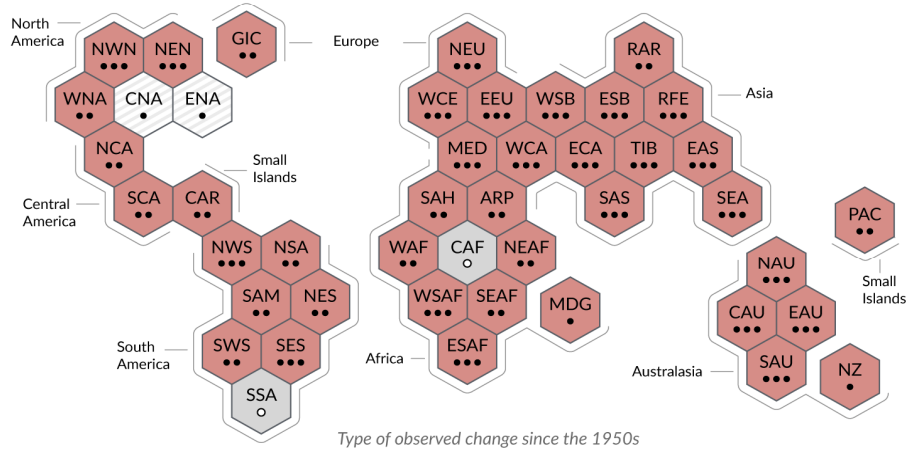
a) Synthesis of assessment of observed change in **hot extremes** and confidence in human contribution to the observed changes in the world's regions

Type of observed change
in hot extremes

- Increase (41)
- Decrease (0)
- Low agreement in the type of change (2)
- Limited data and/or literature (2)

Confidence in human contribution
to the observed change

- ●●● High
- ●● Medium
- ● Low due to limited agreement
- ○ Low due to limited evidence



Type of observed change since the 1950s

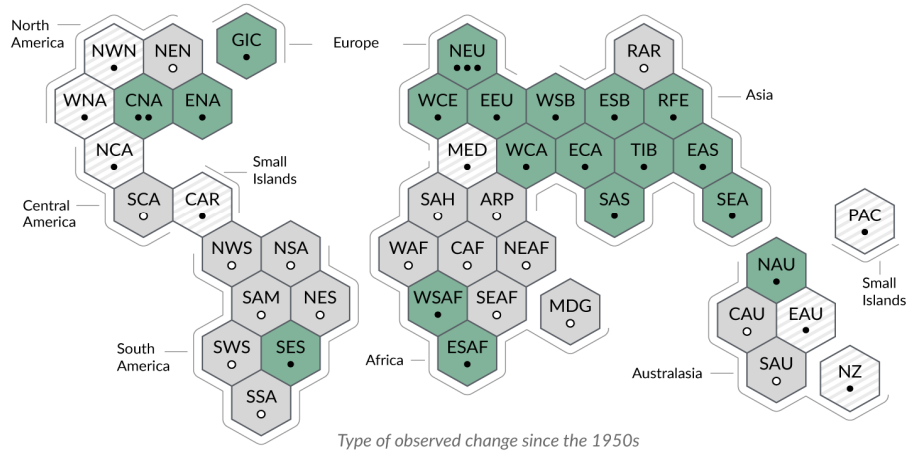
b) Synthesis of assessment of observed change in **heavy precipitation** and confidence in human contribution to the observed changes in the world's regions

Type of observed change
in heavy precipitation

- Increase (19)
- Decrease (0)
- Low agreement in the type of change (8)
- Limited data and/or literature (18)

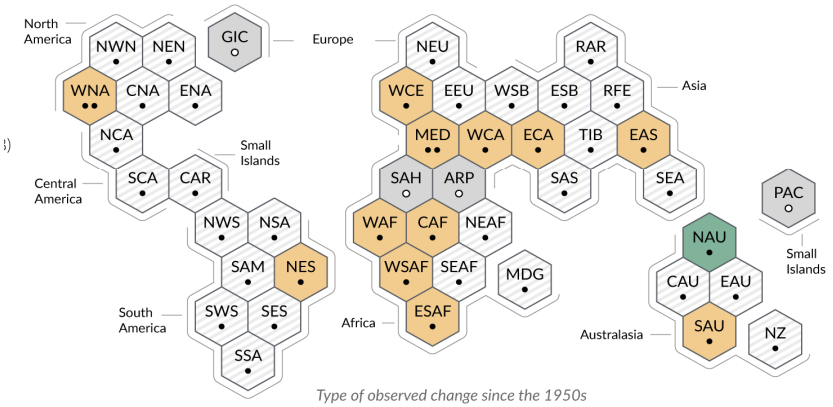
Confidence in human contribution
to the observed change

- ●●● High
- ●● Medium
- ● Low due to limited agreement
- ○ Low due to limited evidence



Type of observed change since the 1950s

c) Synthesis of assessment of observed change in **agricultural and ecological drought** and confidence in human contribution to the observed changes in the world's regions



Type of observed change since the 1950s

Changes in other extremes

It is *likely* that the global proportion of major (Category 3–5) **tropical cyclone** occurrence has increased over the last four decades. These changes cannot be explained by internal variability alone (*medium confidence*)

Human influence has *likely* increased the chance of **compound extreme events** since the 1950s:

- Increases in the frequency of **concurrent heatwaves and droughts** on the global scale (*high confidence*)
- Increase in **fire weather** in some regions of all inhabited continents (*medium confidence*)
- Increase in **compound flooding** in some locations (*medium confidence*

Projected changes in extremes are larger in frequency and intensity with every additional increment of global warming

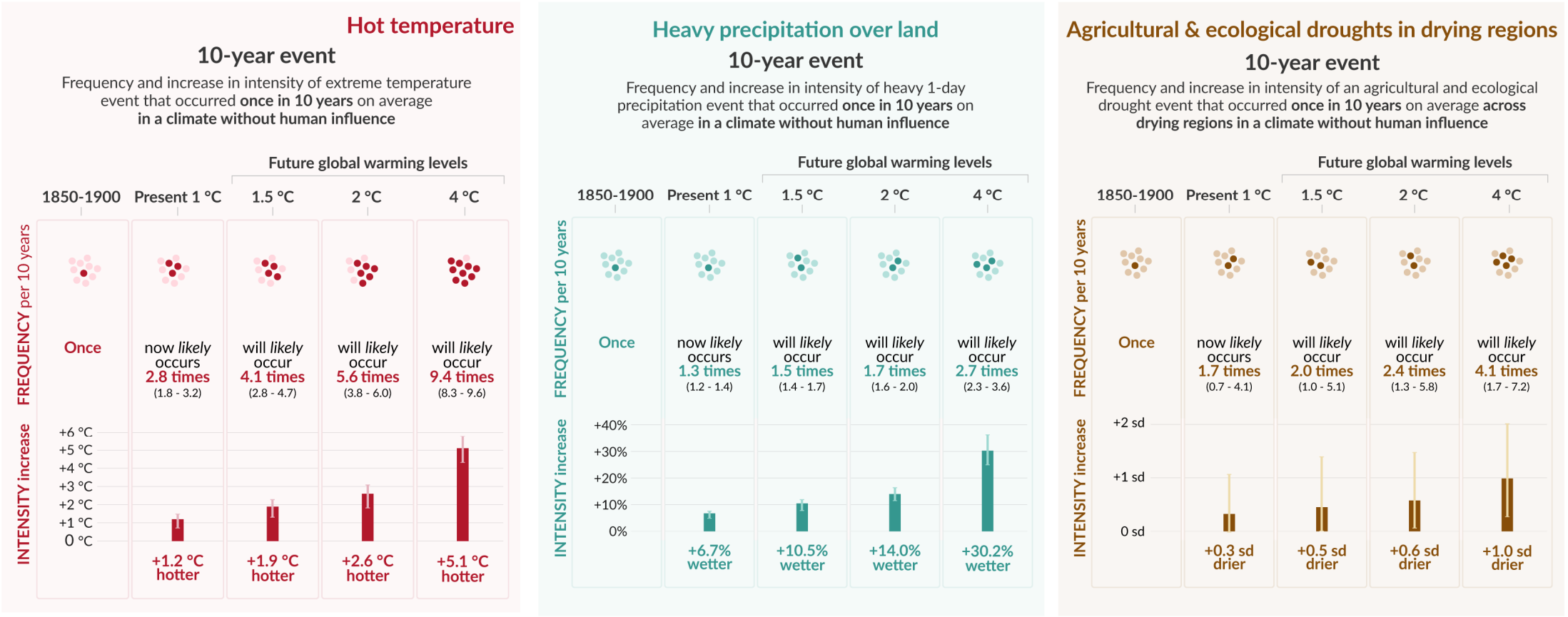
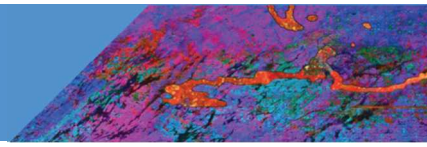


Figure SPM.6: Demonstrates extremes are already more likely and more intense due to current warming and these trends will continue with each additional fraction of warming.

Ocean, ice and sea-level changes



Human influence has *very likely* warmed the global upper ocean since the 1970s and is *virtually certain* the main driver of current open ocean surface acidification.

Human influence is *very likely* the main driver of the global retreat of glaciers since the 1990s and mountain and polar glaciers are committed to continue melting for decades or centuries (*very high confidence*).

Continued ice loss over the 21st century is *virtually certain* for the Greenland Ice Sheet and *likely* for the Antarctic Ice Sheet.

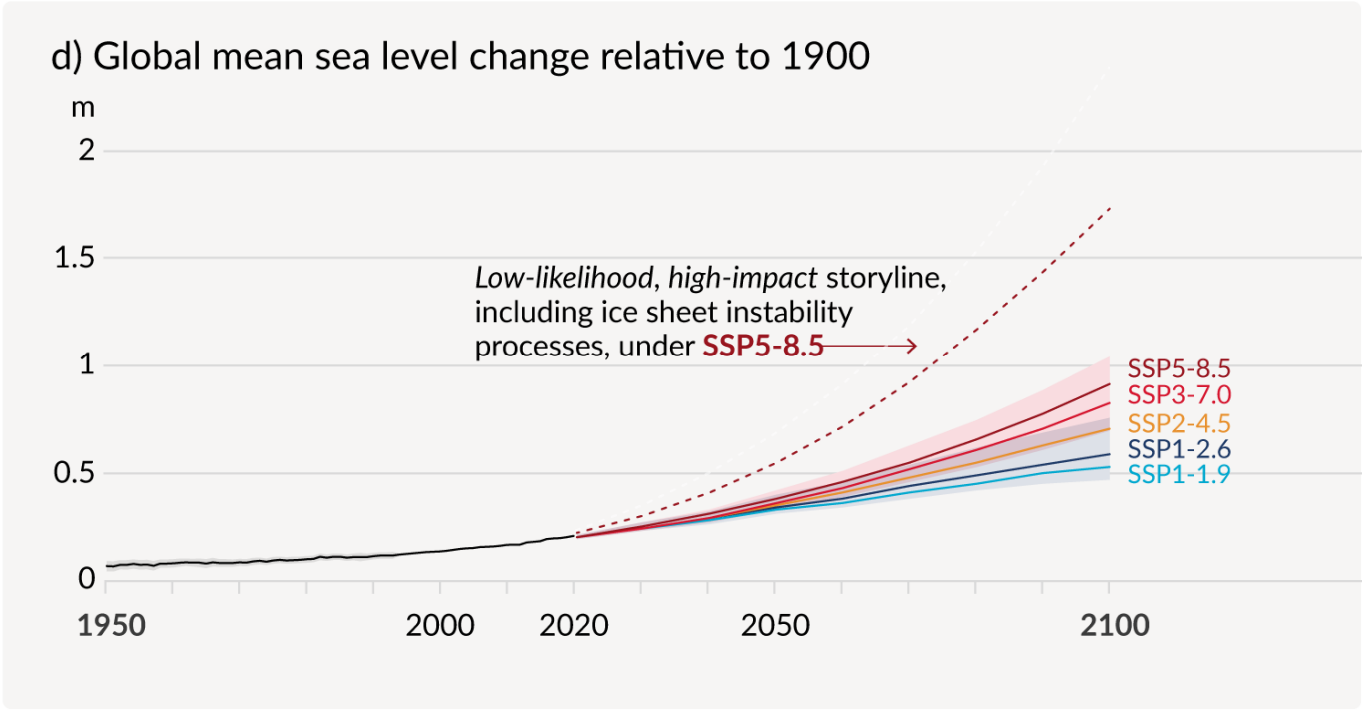
Human influence was *very likely* the main driver of increases in global mean sea level since at least 1971.

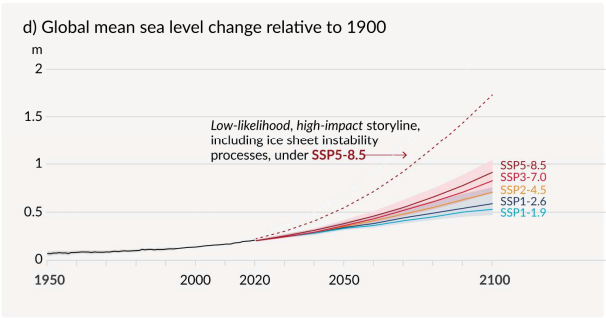
Due to relative sea level rise, extreme sea level events that occurred once per century in the recent past are projected to occur at least annually at more than half of all tide gauge locations by 2100 (*high confidence*).

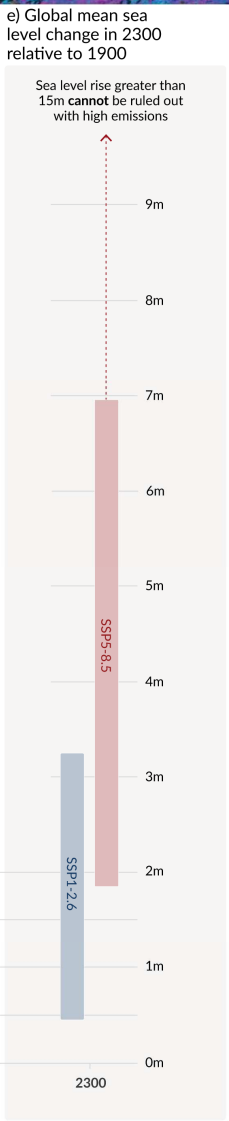
Sea-level rise projections

Figure SPM.8, panels d) and e):

- Sea levels will continue to rise this century even under the lowest emissions
- Increases between 0.5 and 1m are likely under the range of emissions considered
- Considering additional poorly understood but plausible processes (such as ice-sheet instability), much higher increases could occur
- Sea levels will continue to increase for centuries, even if warming stabilises







[Credit: Hong Nguyen | Unsplash]

"Climate change is already affecting every region on Earth, in multiple ways.

The changes we experience will increase with further warming.

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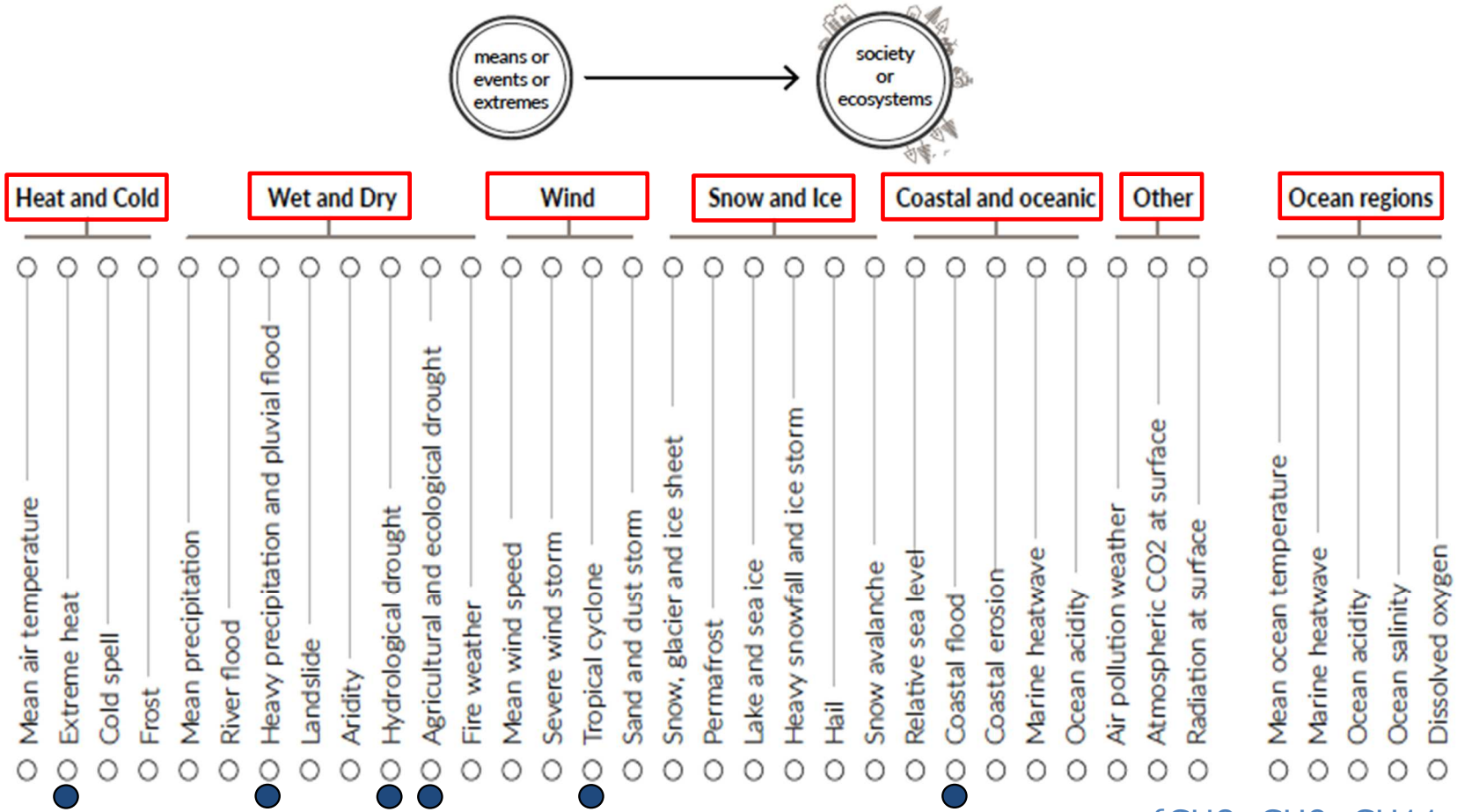
Climatic Impact-Drivers (CIDs)

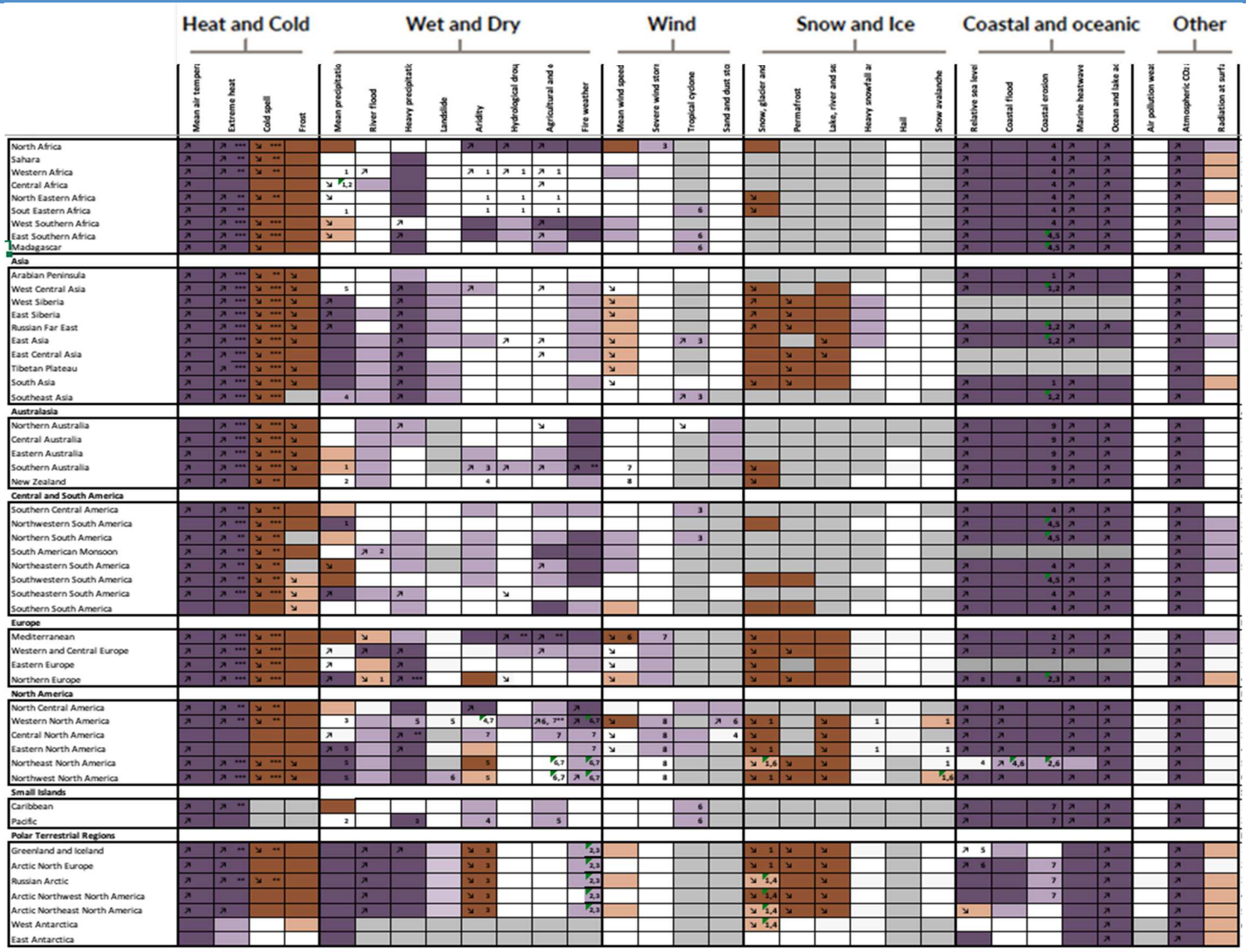
Climatic Impact-Drivers (CIDs) are physical climate system conditions (e.g., means, events, extremes) that affect an element of society or an ecosystem. CIDs assessed were selected as relevant to impacts and risks.



CIDs include also extremes (examples shown assessed in Ch 11**)**

{CH8, CH9, CH11, CH12, Atlas}

Summary CIDs assessment table for AR6 WGI reference regions

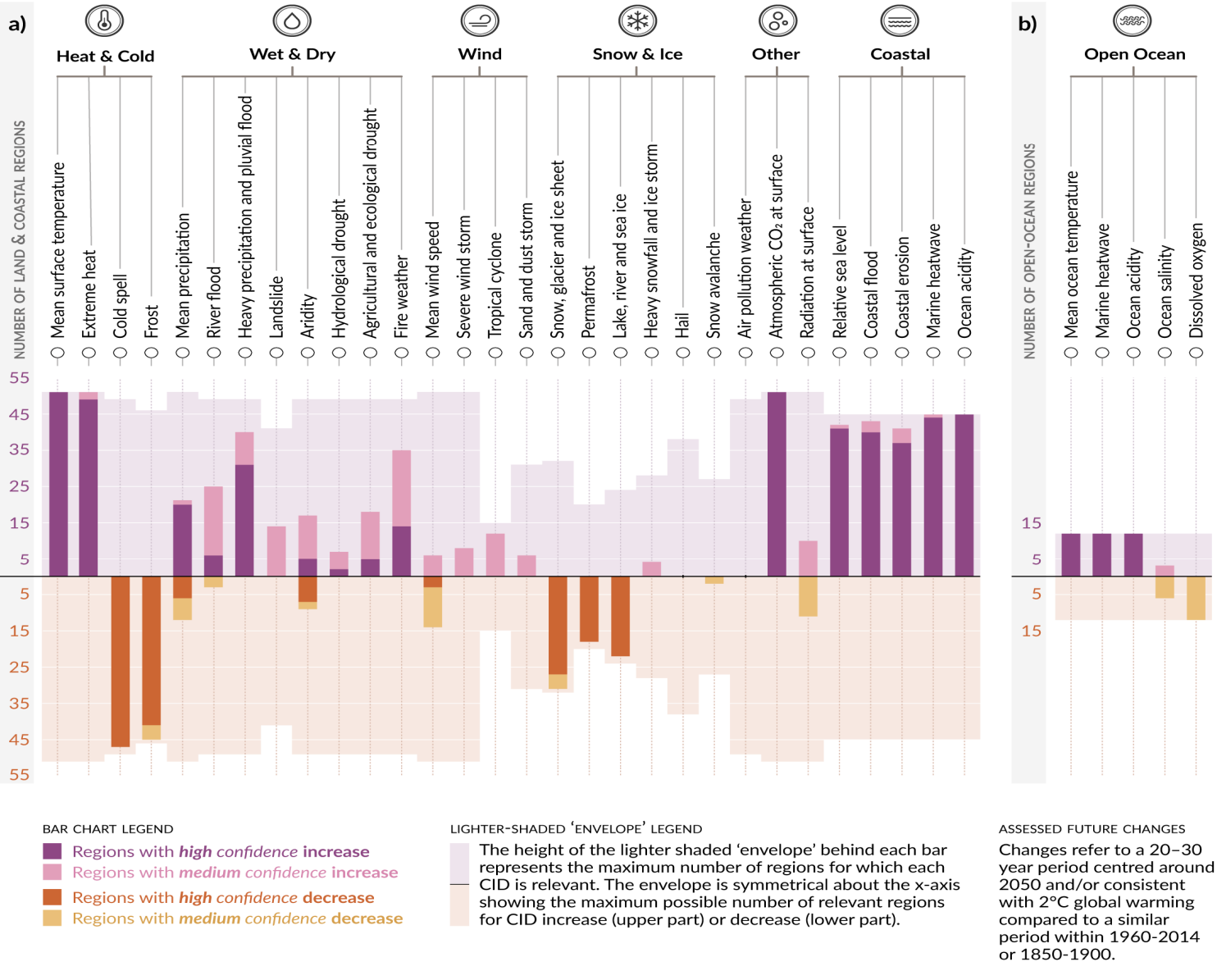


Ocean regions

Oceans	Mean ocean temperature	Marine heatwave	Ocean acidity	Ocean salinity	Dissolved oxygen	Sea ice
	Climatic Impact-Driver					
Arctic Ocean	↗		↗			↘ ***
South Pacific Ocean	↗	↗	↗			
Equatorial Pacific Ocean	↗	↗	↗			
North Pacific Ocean	↗	↗	↗			
South Atlantic Ocean	↗	↗	↗			
Equatorial Atlantic Ocean	↗	↗	↗			
North Atlantic Ocean	↗	↗	↗			
Equatorial Indian Ocean	↗	↗	↗			
South Indian Ocean	↗	↗	↗			
Arabian Sea	↗	↗	↗			
Bay of Bengal	↗	↗	↗			
Southern Ocean						

Table TS.5

Number of land & coastal regions (a) and **open-ocean regions** (b) where each **climatic impact-driver** (CID) is projected to increase or decrease with ***high*** *confidence* (dark shade) or ***medium*** *confidence* (light shade)



BAR CHART LEGEND

- Regions with ***high*** *confidence* **increase**
- Regions with ***medium*** *confidence* **increase**
- Regions with ***high*** *confidence* **decrease**
- Regions with ***medium*** *confidence* **decrease**

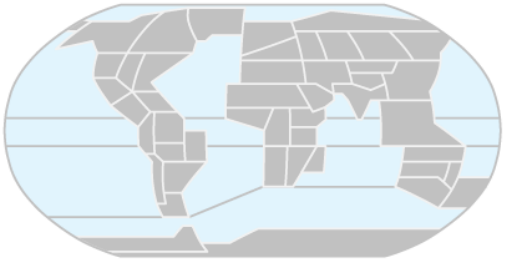
LIGHTER-SHADED 'ENVELOPE' LEGEND

The height of the lighter shaded 'envelope' behind each bar represents the maximum number of regions for which each CID is relevant. The envelope is symmetrical about the x-axis showing the maximum possible number of relevant regions for CID increase (upper part) or decrease (lower part).

ASSESSED FUTURE CHANGES

Changes refer to a 20–30 year period centred around 2050 and/or consistent with 2°C global warming compared to a similar period within 1960-2014 or 1850-1900.

Multiple climatic impact-drivers are projected to change in all regions of the world

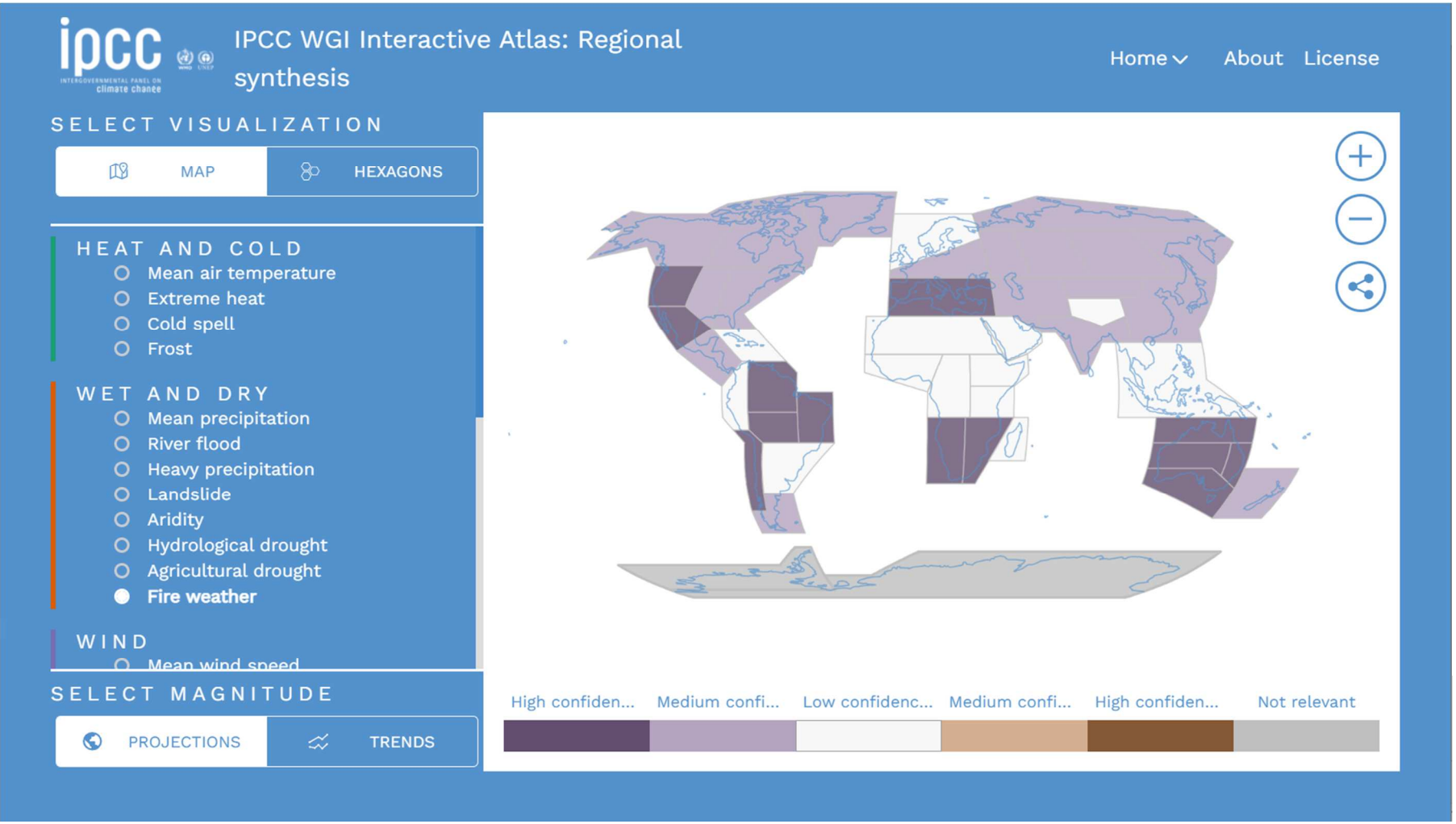


interactive-atlas.ipcc.ch

Figure SPM.9

- Demonstrates that at least 10 CIDs will change in almost all regions (96%), and at least 15 CIDs in half of the regions
- Each region will experience a specific set of CID changes
- Each bar represents a geographical set of changes that can be explored in the Interactive Atlas

Interactive Atlas – Regional synthesis of changes in CIDs

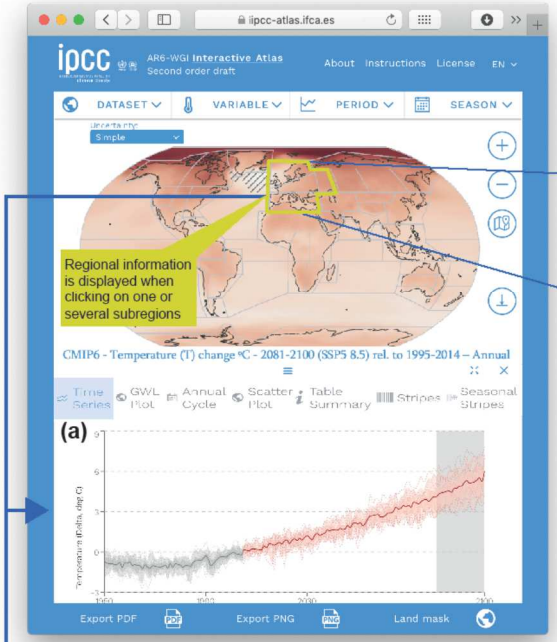


Example view showing those regions where fire weather will change with high or medium confidence

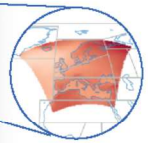
Dark and light purple showing regions with increases;

Changes are low confidence in white areas;

CID is not broadly relevant in grey areas.



The **Interactive Atlas** allows for **flexible spatial and temporal analyses** of essential climate variables, extreme indices and climatic impact-drivers including multiple lines of evidence to support the assessment of regional climate change:

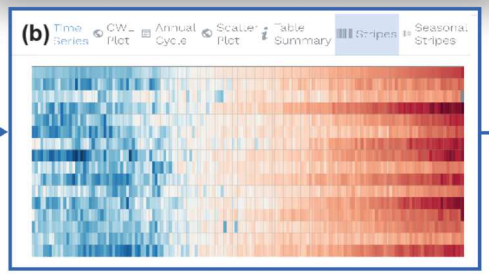


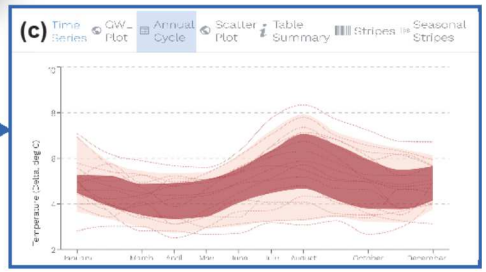
- **Observations**
- **CMIP5**
- **CMIP6**
- **CORDEX**, available for 12 continent-wide domains.

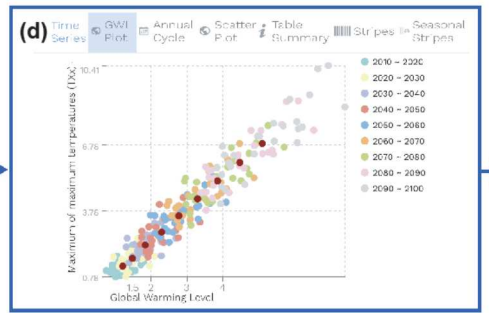
Regional (aggregated) information for reference and typological regions:

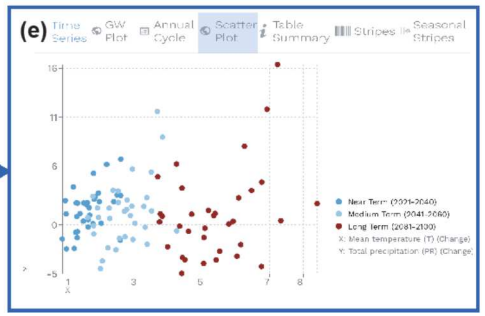
(a) Time series
(b) Stripes
(c) Annual cycle plots
(d) Global warming level (GWL) plots
(e) Scatter plots (e.g. precip. vs temp.)
( ) Summary tabular information

Dimensions of analysis include time periods for scenarios and global warming levels (1°C, 2°C, 3°C and 4°C).









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Interactive Atlas – Regional information on changes in CIDs

Interactive Atlas regional information example views
(a) Main interface includes a global map and controls to define the specific dataset, variable, period (reference and baseline) and season (example is for annual temperature change from CMIP6 for SSP3-7.0, 2081–2100 relative to 1995–2104).

Regions can be selected on the map to bring up options for summary visuals or tables of regionally averaged information. Examples show:
(b) evolution of temperature change using stripes;
(c) Change in annual cycle
(d) Change in selected CID at a range of global warming levels
(e) Scatter plots of changes in two variables (e.g. temperature and precipitation shown here)

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Thank you.

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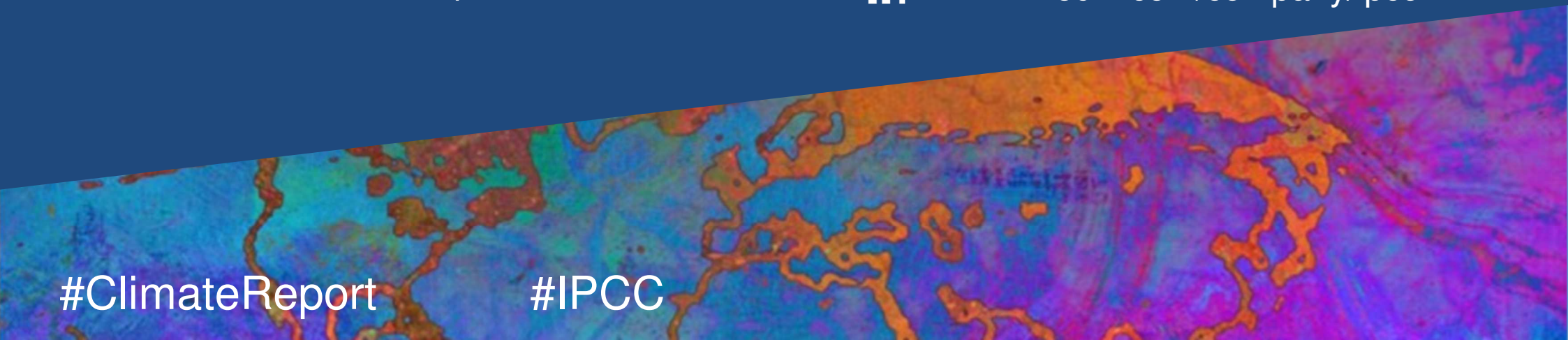

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