Changes in climate extremes and their impacts on the natural physical environment

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• Complexities: observations/attribution/projections, variety of extremes ➔ First time that literature on extremes was synthesized by a single team

• Applied new IPCC uncertainty guidance throughout

• Provided regional assessments of observed and projected changes in extremes of temperature, heavy precipitation and drought for 26 regions

• >5’000 comments on chapter 3 material; ~4’600 CLA-CLA emails…
• **More literature** (~1100 references in Chapter 3; >70% of these published since AR4)

• **Many AR4 assessments were found to be robust** (e.g. observed and projected changes in *temperature extremes*)

• **Some needed to be revised based on new evidence and literature** (e.g. *droughts* and *tropical cyclones*)

• **New assessments are provided at the *regional scale* & based on revised region definition**
Step 1

Assess confidence level

Low confidence

Medium confidence

High confidence

Direction of change only

Step 2

Likelihood assessment

Virtually certain (99-100%)

Very likely (90-100%)

Likely (66-100%)

More likely than not (50-100%)

About as likely as not (33-66%)
Key messages – Observed changes

• **Very likely** increase in warm days and nights & **decrease in cold days and nights** on global scale

• ** Likely** that **more regions have experienced increases** than decreases in **heavy precipitation events**

• ** Likely** that there has been an **increase in extreme coastal high water** related to increases in mean sea level

• ** Low confidence** in any observed long-term (i.e., 40 years or more) increases in **tropical cyclone activity**

• ** Medium confidence** that some regions of the world have experienced more intense and longer **droughts**, but in some regions droughts have become less frequent, less intense, or shorter
SREX: Regional projections

C. Europe - 12

Projected return period (of hot day with late 20th century return period of 20 years)

Decide in return period implies more frequent extreme temperature events
Temperature: A (late 20th-century) 1-in-20 year hottest day is likely to become a 1-in-2 year (B1: 1-in-5 year) event by the end of the 21st century in most regions, except in the high latitudes of the Northern Hemisphere, where it is likely to become a 1-in-5 year (B1: 1-in-10 year) event.

Precipitation: A (late 20th-century) 1-in-20 year annual maximum daily precipitation amount is likely to become a 1-in-5 to 1-in-15 year event by the end of the 21st century in many regions.
Gray shading: less than 66% model agreement on sign of change
Coloured shading: ≥ 66% model agreement on sign of change
Stippling: ≥ 90% model agreement on sign of change
Consistent projections of increased dryness for these (and other) indices in the Mediterranean region, central Europe, central North America, Central America and Mexico, northeast Brazil, and southern Africa.
Limited number of regions with agreement, but including important agricultural regions ➔ global implications

Consistent projections of increased dryness for these (and other) indices in the Mediterranean region, central Europe, central North America, Central America and Mexico, northeast Brazil, and southern Africa
Key messages – Projected changes

- **Virtually certain** that increases in the frequency and magnitude of *warm daily temperature extremes* and decreases in *cold extremes* will occur.

- **Likely** that the frequency of *heavy precipitation* or the proportion of total rainfall from heavy falls will increase over many areas.

- **Medium confidence** that *droughts* will intensify in some seasons and areas.

- **Very likely** that mean sea level rise will contribute to upward trends in extreme *coastal high water levels*.

- Average *tropical cyclone* maximum wind speed is *likely* to increase, although increases may not occur in all ocean basins. It is *likely* that the global frequency of tropical cyclones will either decrease or remain essentially unchanged.
SREX: Significantly expanded information compared to AR4 in particular on regional scale
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Level of certainty in projections strongly depends on the considered extreme, region and season
Summary and conclusions

SREX: Significantly expanded information compared to AR4 in particular on regional scale

Level of certainty in projections strongly depends on the considered extreme, region and season

Both adaptation and mitigation are required to reduce impacts: Need to be considered jointly
Limited number of regions with agreement, but including important agricultural regions \(\rightarrow\) global implications

(IPCC 2012)

(West et al. 2010, PNAS)
nature and severity of event
vulnerability
exposure
1: Climate change: new dimensions in disaster risk, exposure, vulnerability, and resilience

2: Determinants of risks: exposure and vulnerability

3: Changes in climate extremes and their impacts on the natural physical environment

4: Changes in impacts of climate extremes: human systems and ecosystems

5: Managing the risks from climate extremes at the local level

6: National systems for managing the risk from climate extremes

7: Managing the risks: international level and integration across scales

8: Towards a resilient and sustainable future

9: Case studies
• More literature
  
  ~ 1100 references in Chapter 3
  
  >70% of these published since AR4

• More observations & further study of quality of observations (tropical cyclones, drought measures)

• New attribution studies (heat waves; heavy rainfall; runoff)

• Quantitative assessments regarding magnitude of projected changes in temperature and precipitation extremes (chapter figures)

• Direct collaboration with a user community: Needed to balance requirements for detailed regional information vs scientific robustness of assessments