A changing climate leads to changes in extreme weather and climate events – **the focus of Chapter 3**

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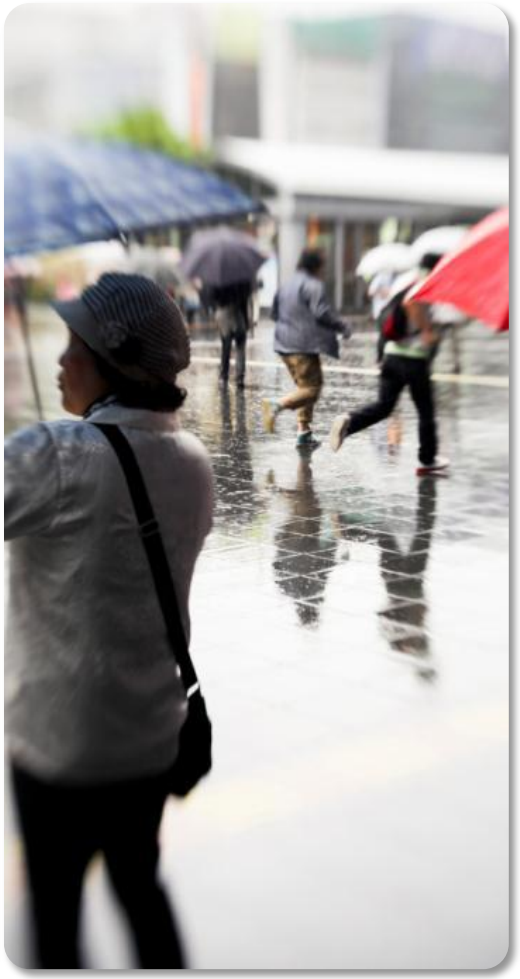

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INTERGOVERNMENTAL PANEL ON climate change

Chapter 3:**Changes in Climate Extremes & their Impacts on the Natural Physical Environment**

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Overview of SREX Chapter 3

- Complexities: variety of extremes, definitional issues, different measures, scale issues
- Applied new uncertainty guidance throughout (confidence and likelihood).
  - More than 50 assessments using uncertainty terms (e.g., “very likely”, “medium confidence”) in Chapter 3 Executive Summary
  - Most of these are consistent with AR4, but there are a few revisions; one-to-one comparison is not possible (change in uncertainty guidance, differences in aspects being assessed, …)
- Provided regional assessments of changes in extremes of temperature, heavy precipitation, drought in tables and figures
- Tried to balance needs of policymakers for regional projections, with the need for scientific credibility
- >5’000 comments on chapter 3 material; ~4’600 CLA-CLA emails…

SREX Chapter 3: Contents

Progress regarding extremes since AR4

- **More literature**

  ~ 900 references in Chapter 3

  ~ 75% of these published since AR4

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

- **New attribution studies**

  Floods; heat waves; heavy rainfall

- **Closer study of model projections**

- **Extensive study of droughts**

  More studies; definition issues

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**

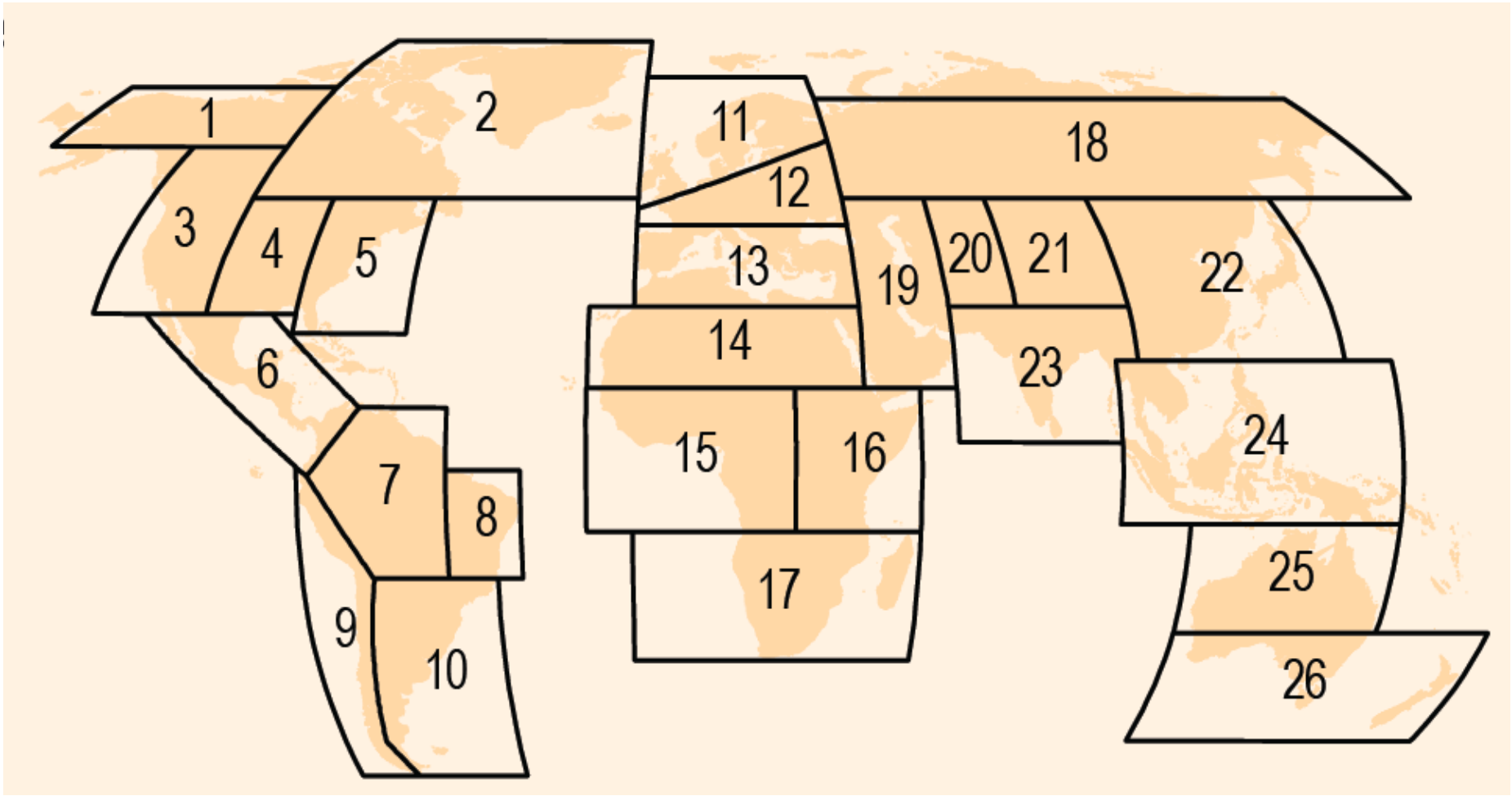
- ***Medium confidence*** that some regions of the world have experienced more intense and longer **droughts**, but in some regions droughts have become less frequent, less intense, or shorter

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: Regional Observed and Projected Changes

Large-scale, land only, regions used for temperature & precipitation extremes:



All Africa
Observed changes in Warm Days and Nights, and Cold Days and Nights since 1950

- ***Low confidence to Medium confidence:***
  - –Low confidence due to insufficient evidence for all Africa.
  - –Medium confidence in increase in frequency of WD and decrease in frequency of CD in southern part of continent and increase in frequency of WN in northern and southern part of continent.
  - –Medium confidence in decrease in frequency of CN in southern part of continent

All Africa

Observed changes in Heatwaves/Warm Spells since 1950

- ***Low confidence:***
  - insufficient evidence, some analyses in localized regions.

Observed Changes in Heavy Precipitation Since 1950

Low confidence:

- Partial lack of data and literature and inconsistent patterns in existing studies

All Africa
Observed changes in Dryness since 1950

- ***Medium confidence:*** Overall increase in dryness (SMA, PDSI); much regional variability,
  - –1970s prolonged Sahel drought dominates.
  - –No apparent continent-wide trends in change in rainfall over the 20th century.
  - –Wet season arrives 9–21 days later,
  - –large interannual variability of wet season start, local scale geographical variability

East Africa
Observed changes in Warm Days and Nights, and Cold Days and Nights since 1950

- ***Warm* Days, *Cold* Days: Low confidence:**
  - Lack of evidence due to lack of literature and spatially non-uniform trends.
  - Over time period 1939–1992 spatially non-uniform trends in daytime temperature, some areas with cooling.
  - In southern tip of domain increases in WD, decreases in CD

- ***Warm Nights, Cold Nights: Medium confidence***:
  - Over time period 1939-1992, spatially non-uniform trends, rise of nighttime temperature at several locations, but with many coastal areas and stations near large water bodies showing a significant decrease.
  - In southern tip of domain, decreases in CN, increases in WN.

East Africa
Observed changes in Heatwaves, Heavy Precipitation and Dryness since 1950

- Heatwave/Warm Spells: *Low confidence*:
  - Insufficient evidence (lack of literature) for most of region; increase in WSDI in southern tip of domain (New et al., 2006).

- Heavy Precipitation: *Low confidence*:
  - Insufficient evidence (lack of literature) to assess trends.

- Dryness: *Low confidence*:
  - Spatially varying trends in dryness (SMA, PDSI) (Sheffield and Wood, 2008a; Dai, 2011).

All Africa
Projected Changes in Warm Days and Nights, Cold Days and Nights

- Warm and Cold Days: ***High confidence***: WD ***likely*** to increase and CD ***likely*** to decrease in all regions

- Warm Days: ***Medium confidence***: Increase in WD largest in summer and fall.

- Warm and Cold Nights: ***High confidence***: WN ***likely*** to increase and CN ***likely*** to decrease.

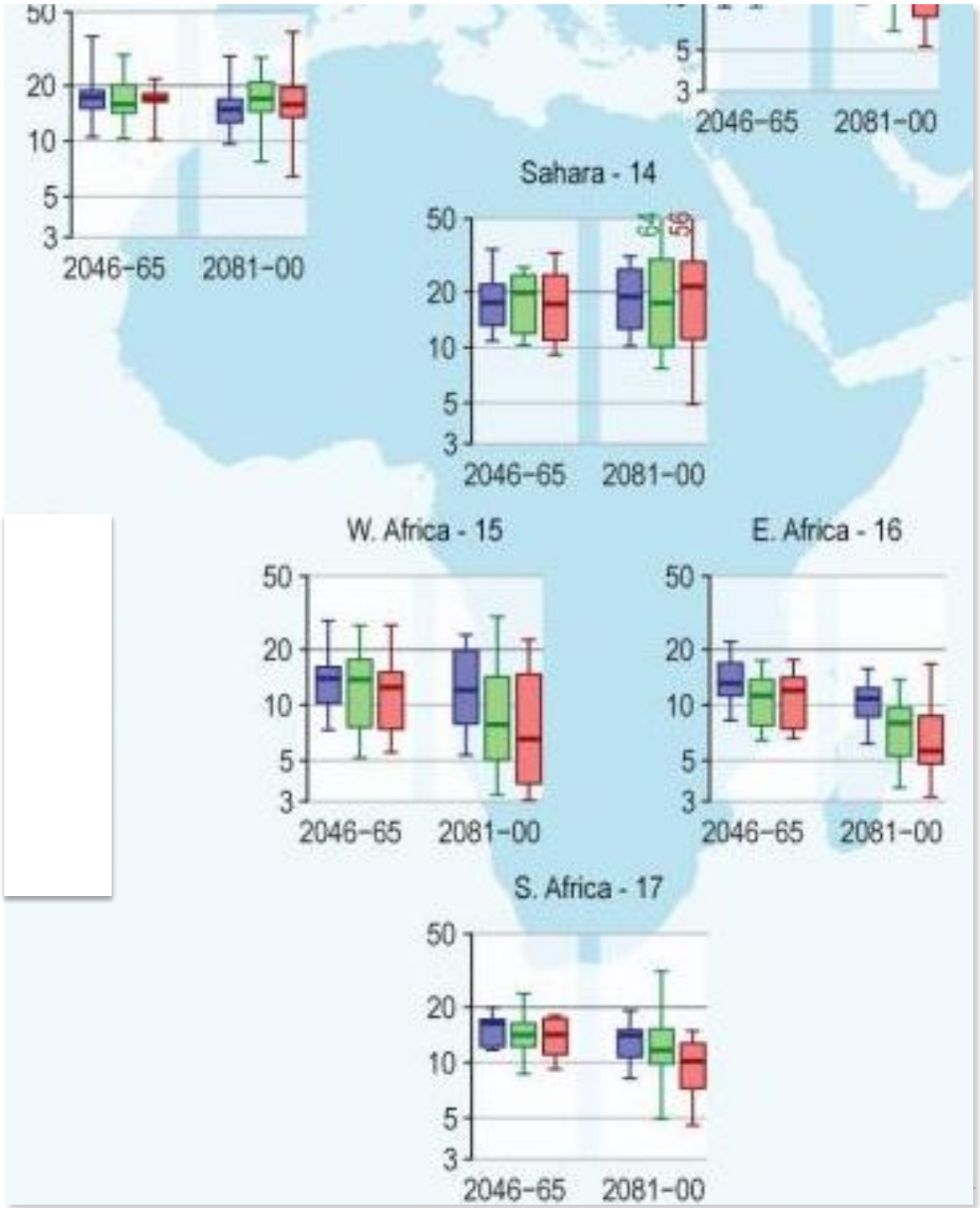
All Africa

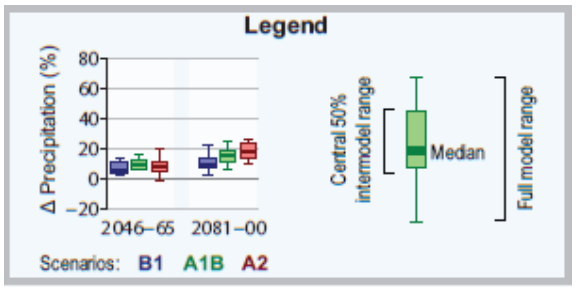
Projected Changes in Heat Waves, Heavy Precipitation, Dryness

- **Heat Waves**: High confidence: Likely more frequent and/or longer heat waves and warm spells
- **Heavy Precipitation** ***Low confidence to High confidence*** depending on region:
  - Inconsistent change or no signal in HP indicators across much of continent
  - Strongest and most consistent signal is ***likely*** increase in HP in E. Africa.
- **Dryness**: ***Low confidence to Medium confidence*** depending on region:
  - Low confidence in most regions,
  - Medium confidence of increase in dryness (CDD, SMA) in southern Africa except eastern part.

Projected return periods for a daily precipitation event that was exceeded in the late 20th century on average once during a 20-year period.

This event happens more like every 10 years (or even more frequently) by the end of the 21st century in all African regions except Sahara and N. Africa, depending on which emissions scenario is followed.





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Summary and conclusions

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

- **Level of certainty in projection strongly depends on the considered extreme, region and season**

- **Both adaptation and mitigation are required to reduce impacts: Need to be considered jointly**

Also assessed changes in phenomena related to weather & climate extremes, and impacts on physical environment:

Monsoons

- *Low confidence* in observed trends and their attribution due to insufficient evidence
- *Low confidence* in projected changes due to insufficient agreement between climate models

Tropical cyclones (typhoons)

- *Low confidence* that any observed long-term (i.e., 40 years or more) increases in tropical cyclone activity are robust, after accounting for past changes in observing capabilities
- *Low confidence* in attribution of any detectable changes to anthropogenic influences
- *Likely* decrease or no change in frequency of tropical cyclones (projections)
- *Likely* increase in mean maximum wind speed, but possibly not in all basins (projections)
- *Likely* increase in heavy rainfall associated with tropical cyclones (projections)

Extreme sea level and coastal impacts

- *Likely* increase in extreme coastal high water worldwide related to increases in mean sea level in the late 20th century
- *Likely* anthropogenic influence on observed changes via mean sea level contributions
- *Very likely* that mean sea level rise will contribute to upward trends in extreme coastal high water levels
- *High confidence* that locations currently experiencing coastal erosion and inundation will continue to do so due to increasing sea level, in the absence of changes in other contributing factors

See Table 3.1. *Very likely* = 90-100% probability.