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

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INTERGOVERNMENTAL PANEL ON climate change

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*

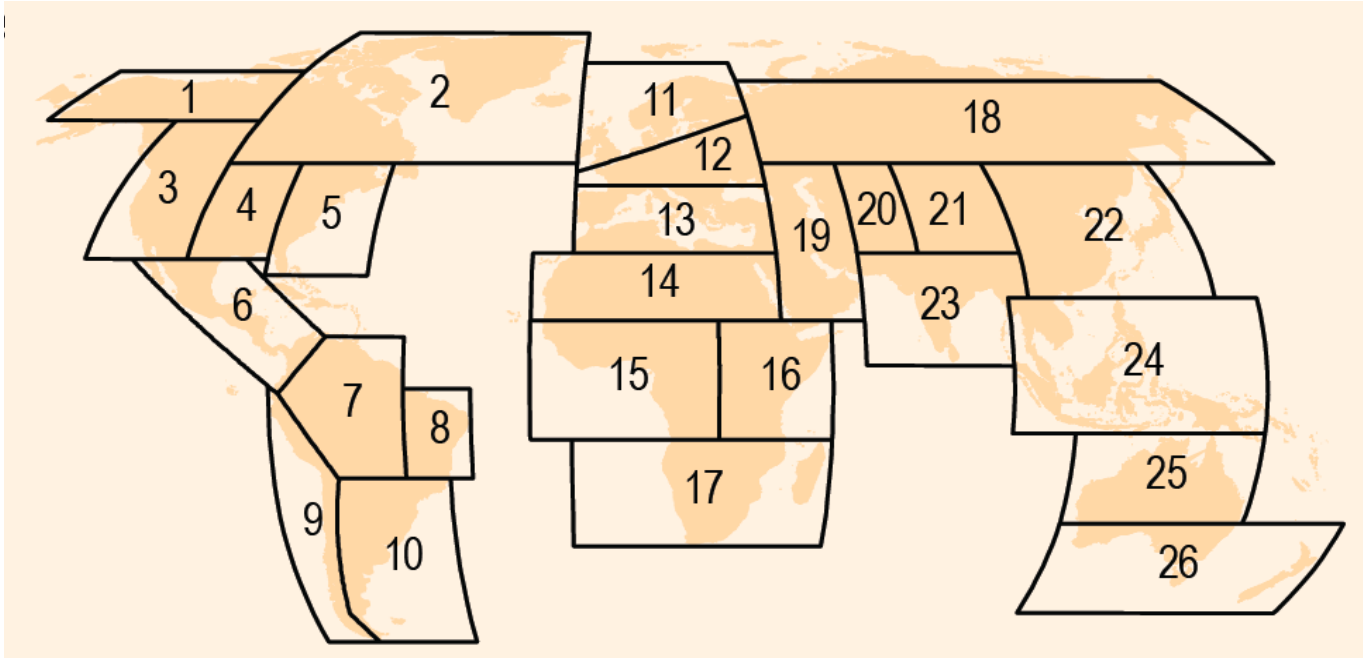
- Applied new IPCC uncertainty guidance throughout

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

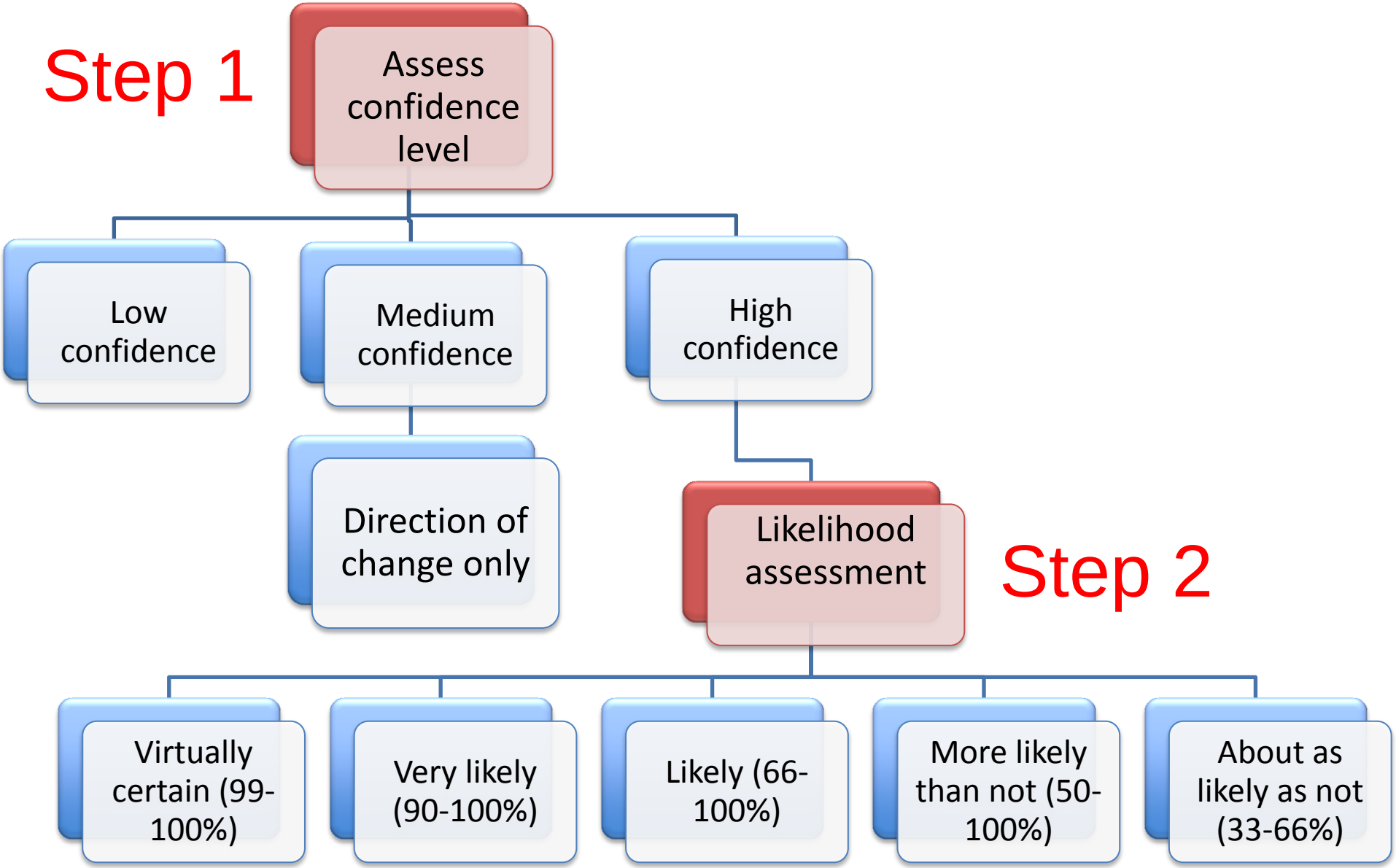
- >5’000 comments on chapter 3 material; ~4’600 CLA-CLA emails…

SREX vs AR4

- **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



SREX: 2-step assessment of uncertainty



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Key messages – Observed changes

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

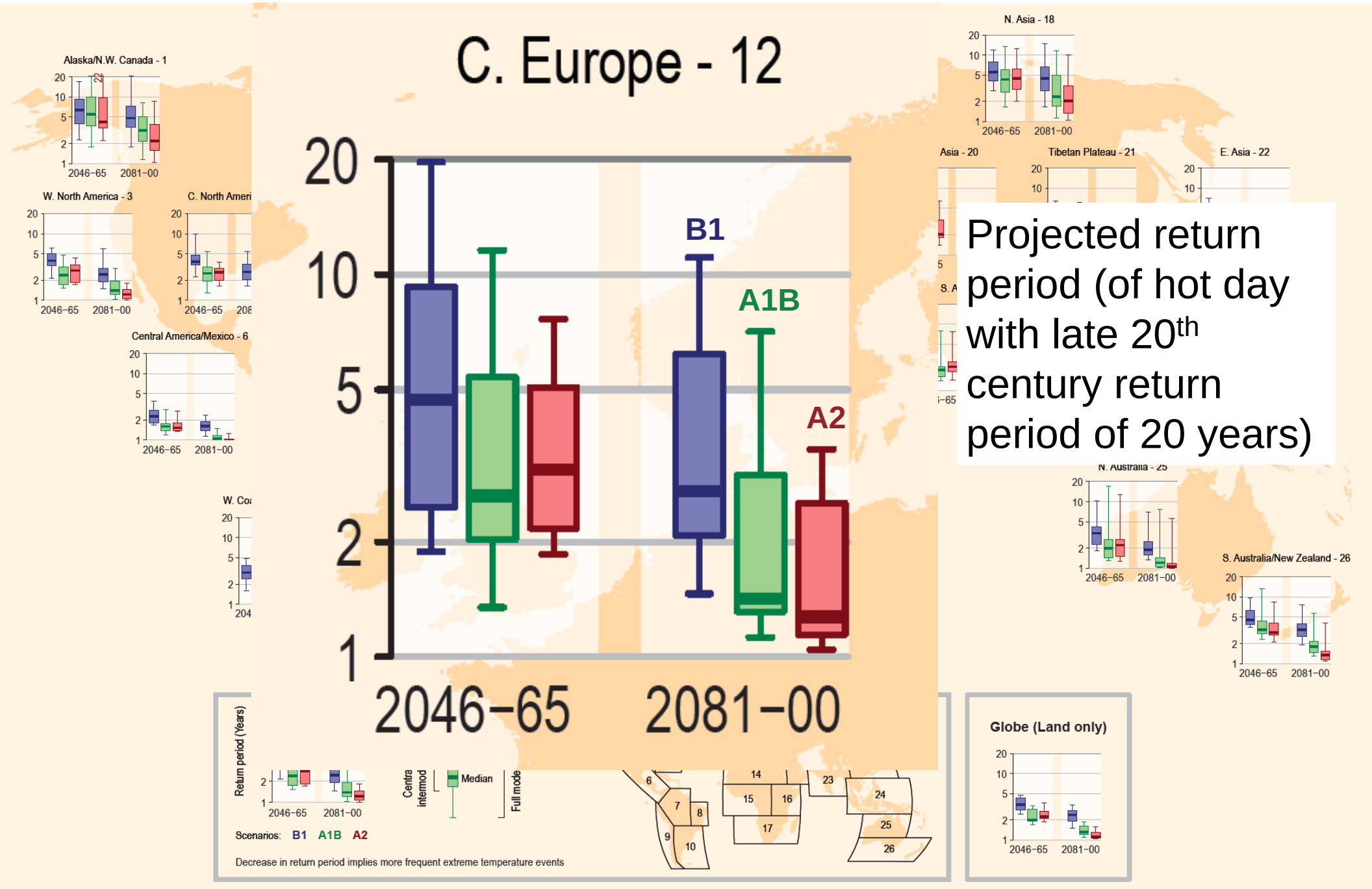
- ***Likely*** that **more regions have experienced increases** than decreases in **heavy precipitation events**

- ***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



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

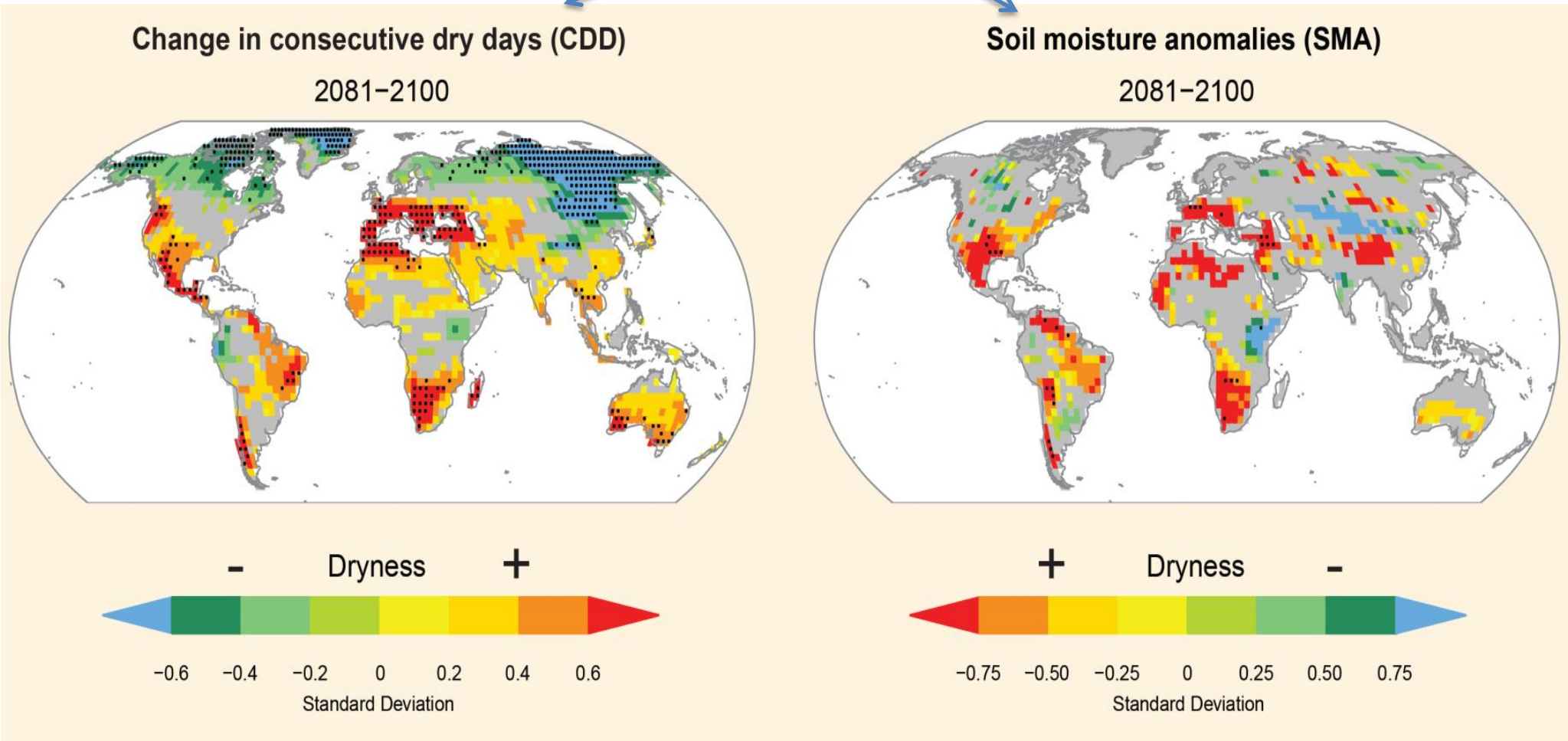
SREX projections: Temperature & Precipitation

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

SREX Projections: Dryness assessments

Two dryness indices



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

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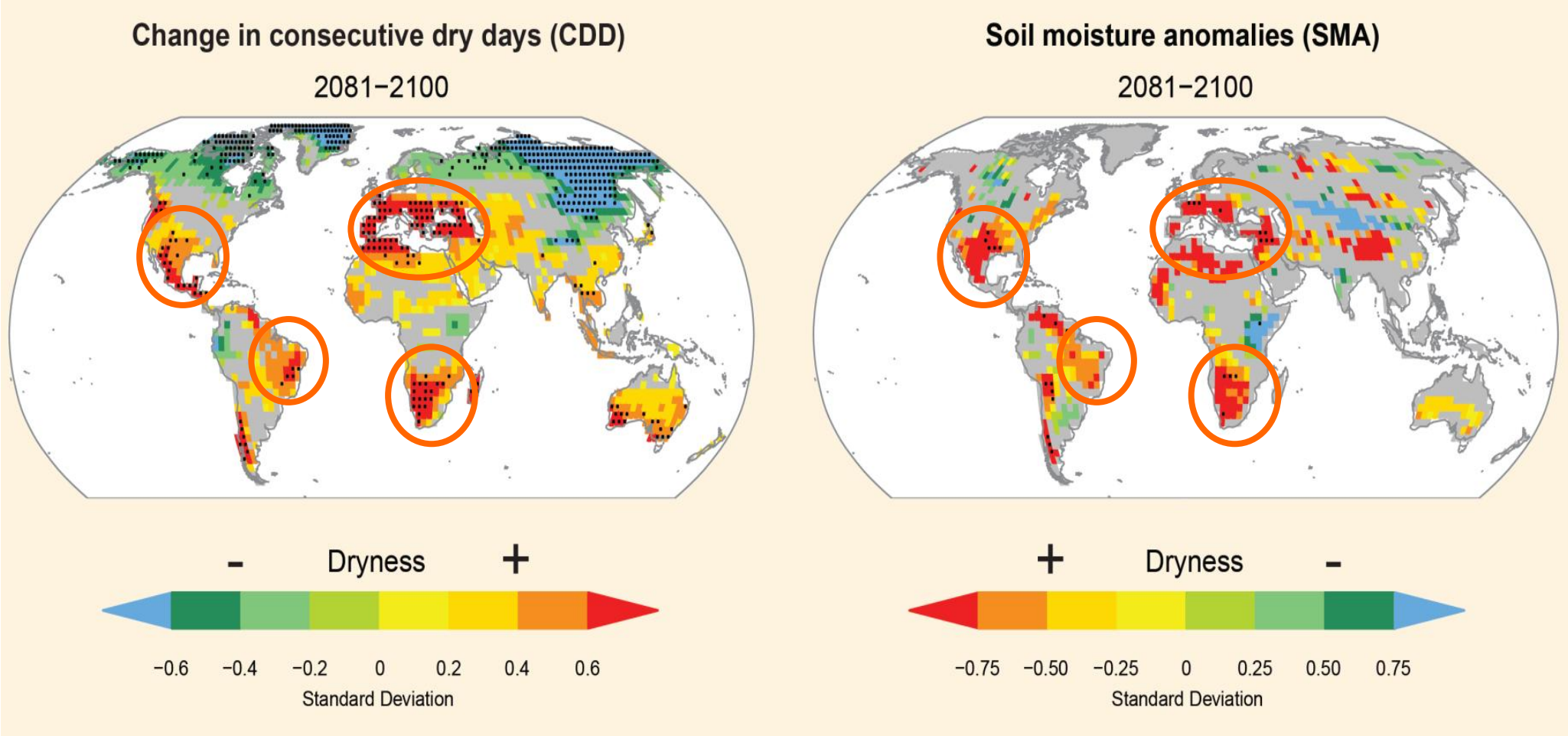
SREX Projections: Dryness assessments

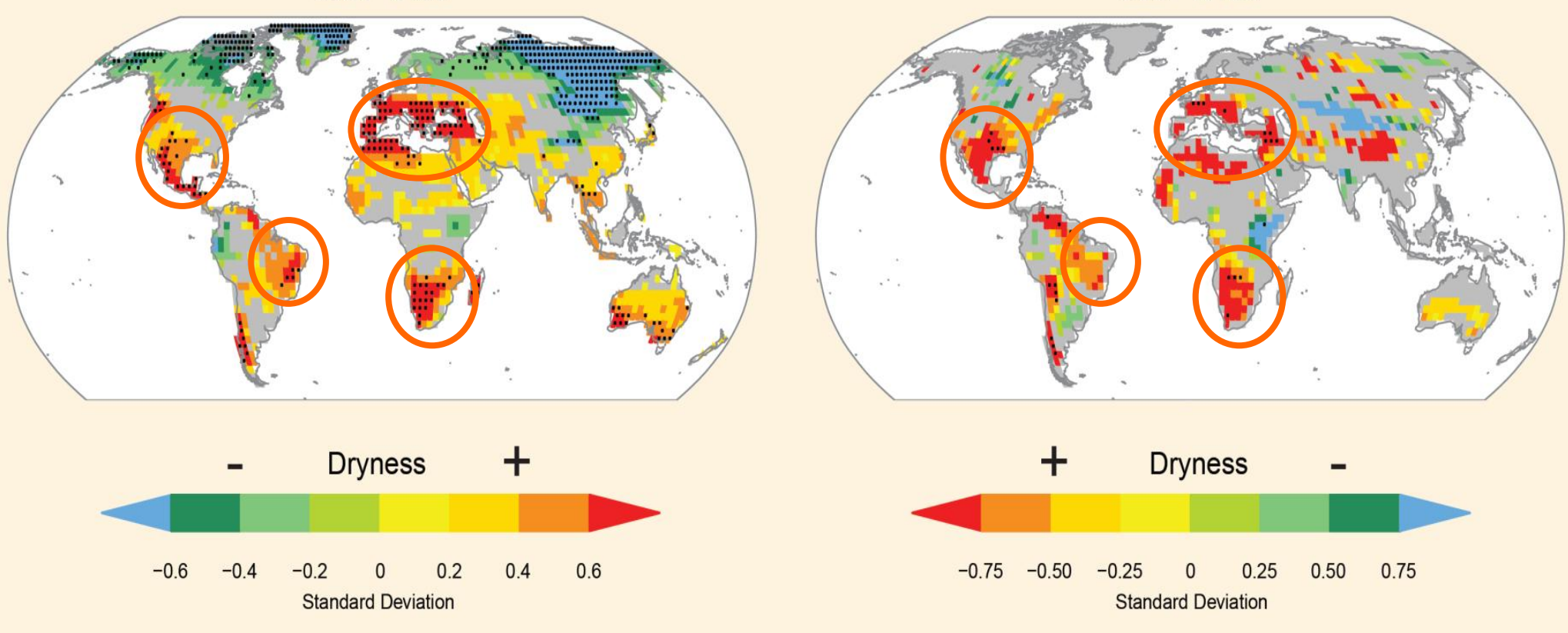
Consistency between indices



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

SREX Projections: Dryness assessments

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

Summary and conclusions

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

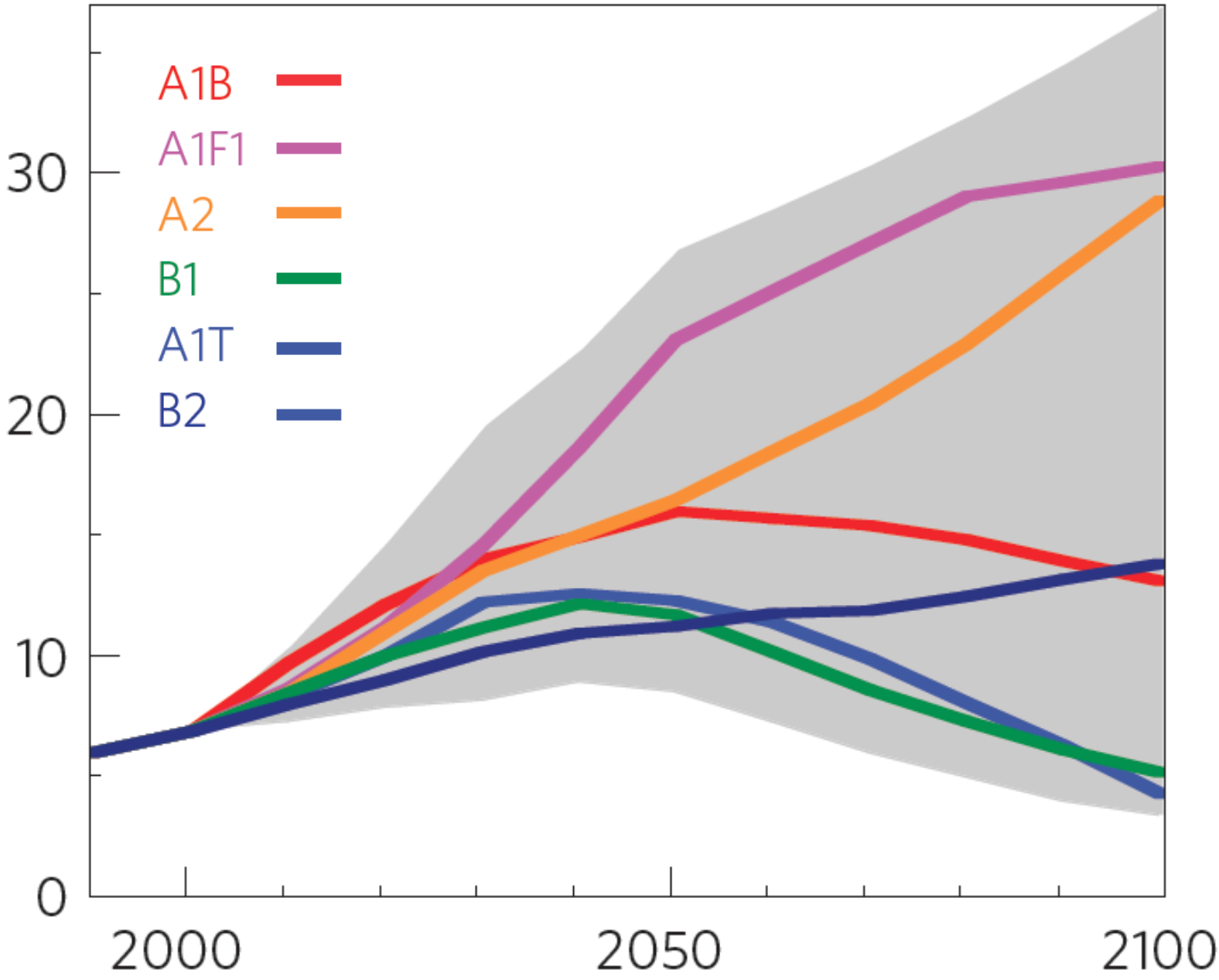
Summary and conclusions

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

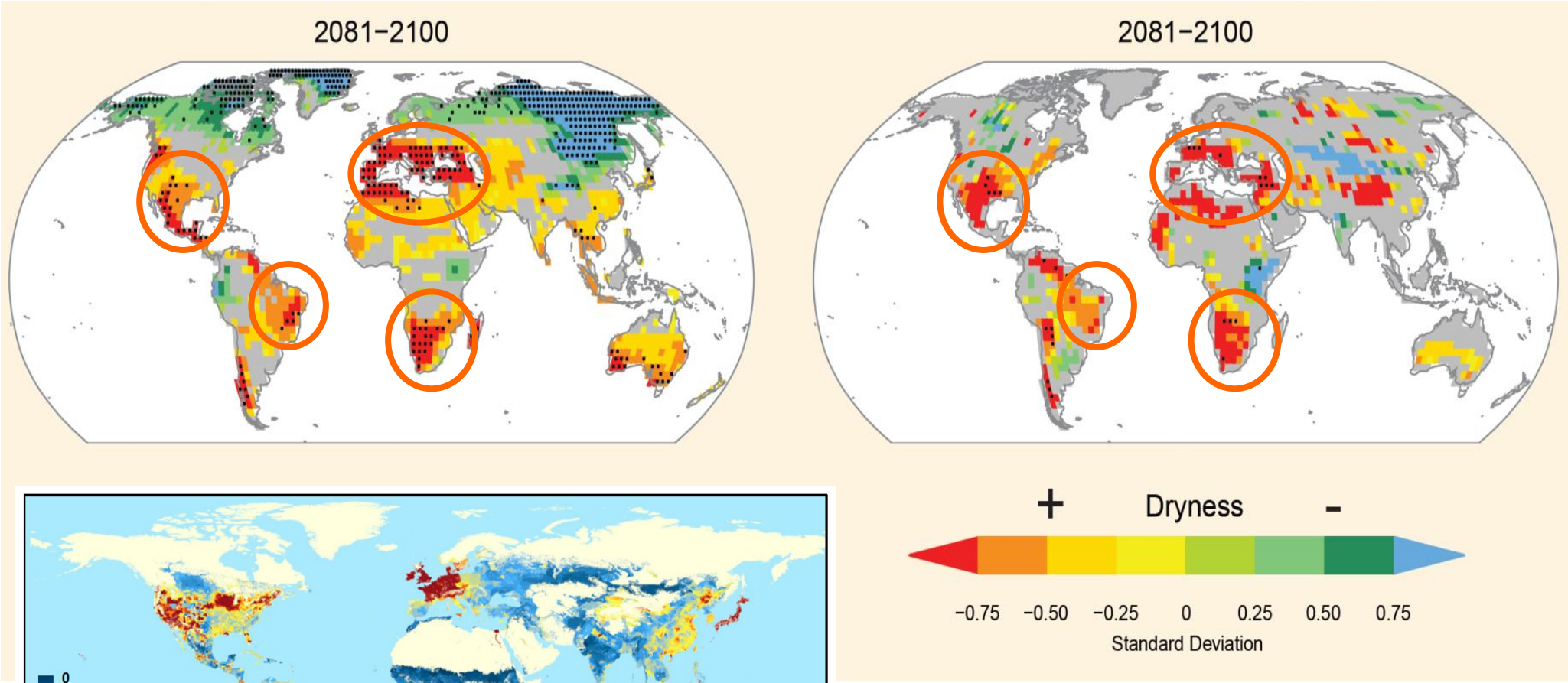
Level of certainty in projections strongly depends on the considered extreme, region and season

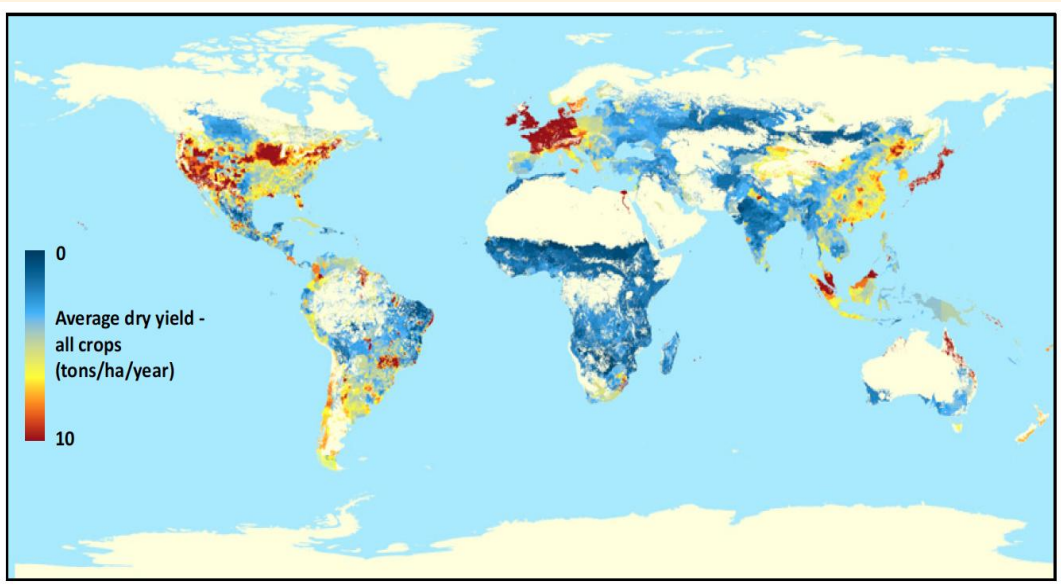
Both adaptation and mitigation are required to reduce impacts: Need to be considered jointly

IPCC SRES Scenarios



Limited number of regions with agreement, but including important agricultural regions ➔ global implications





(West et al. 2010, PNAS)

(IPCC 2012)

SREX IPCC Working Group 1 Contribution: Chapter 3

nature and severity of event

vulnerability

exposure

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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

Progress regarding extremes since AR4 (1/2)

- **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