北京师范大学
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地表过程与资源生态国家重点实验室
State Key Laboratory of Earth Surface Processes and Resource Ecology
ESPRE

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Risks and responses to future climate change
未来气候变化风险及应对

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Sixth Assessment Report

Synthesis Report

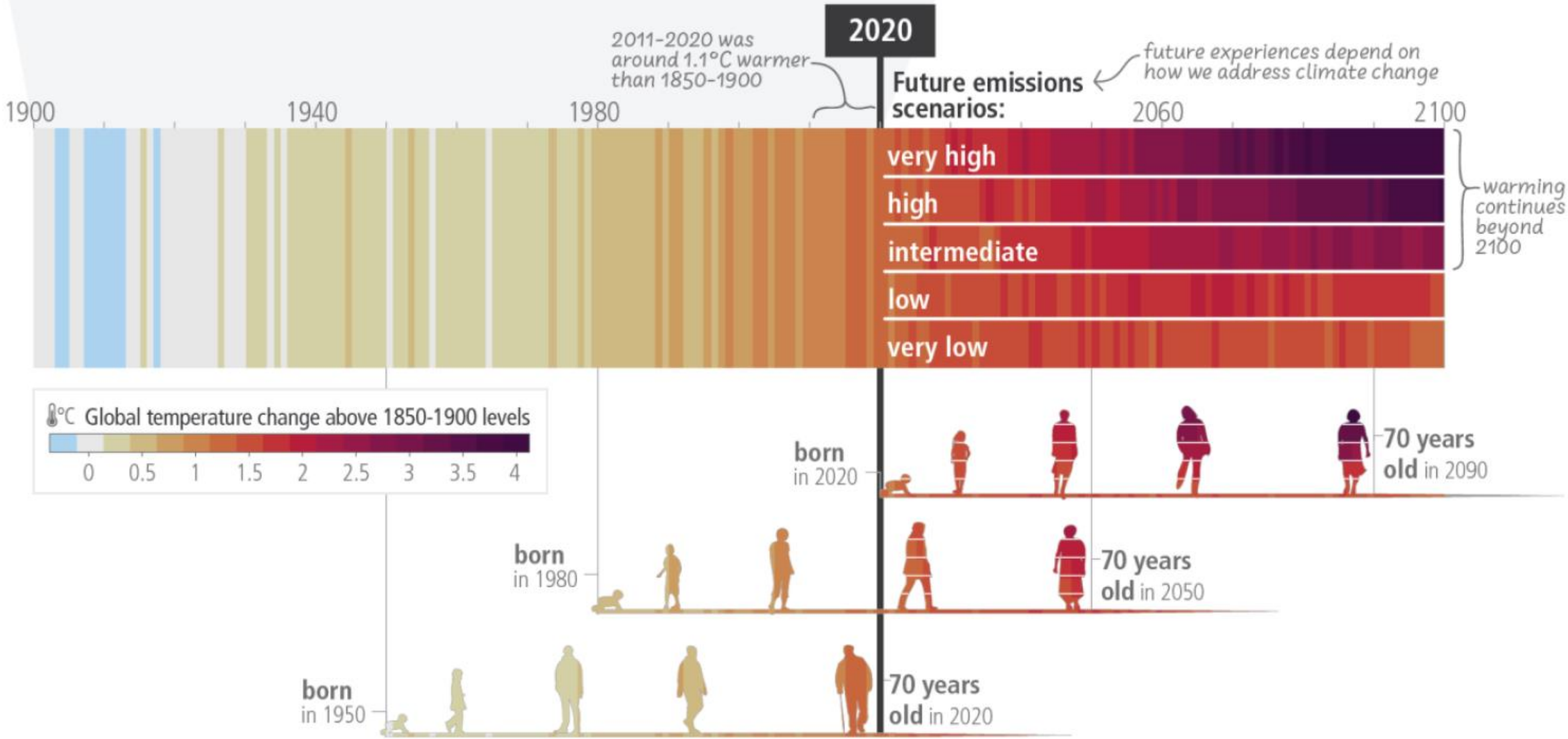
20 March 2023

ipcc

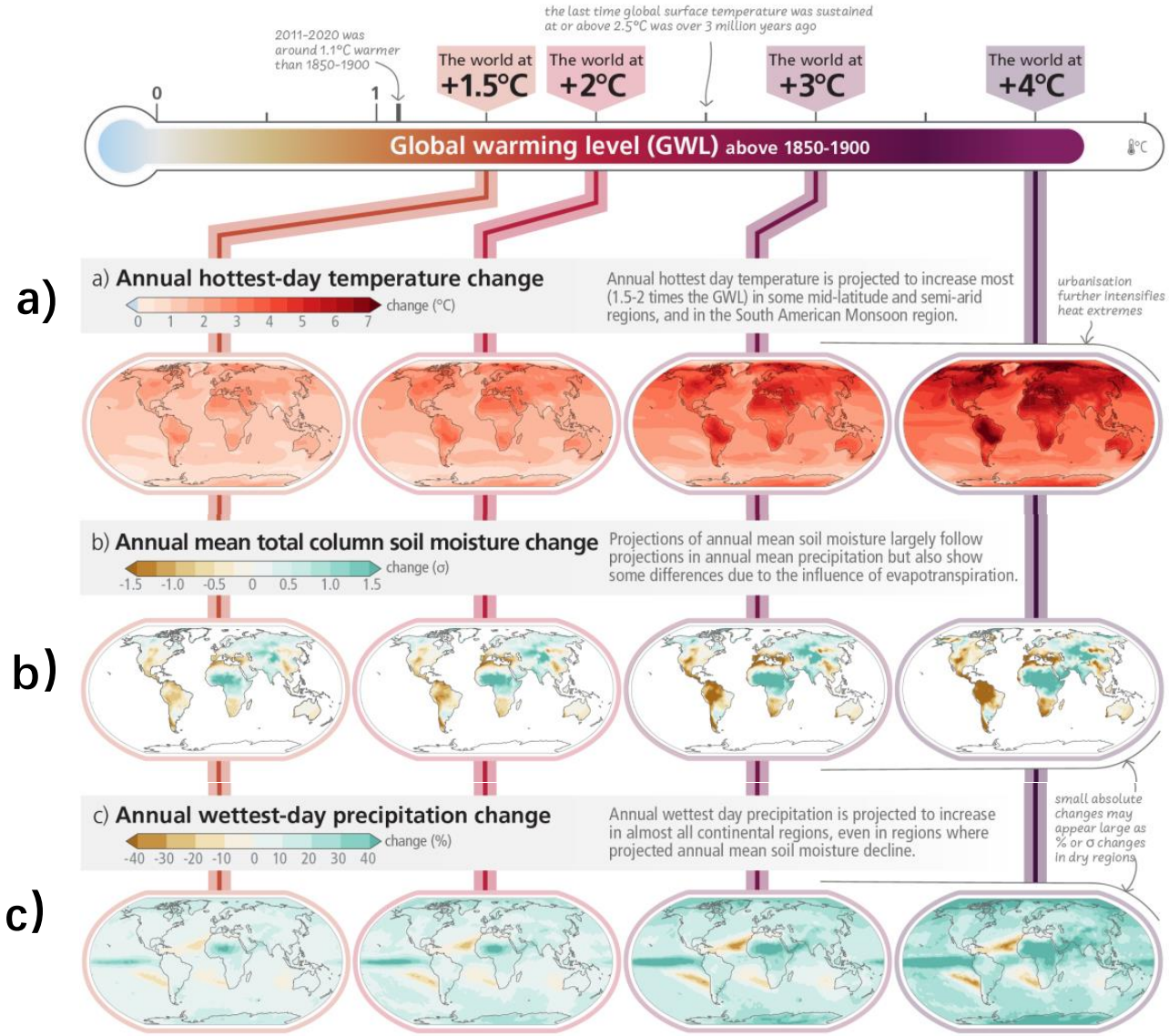
Outlines

- Long-term risks (6 key messages)
- Interactions between Adaptation, Mitigation and SDGs(3 main points)

c) The extent to which current and future generations will experience a hotter and different world depends on choices now and in the near-term



key mesage-1

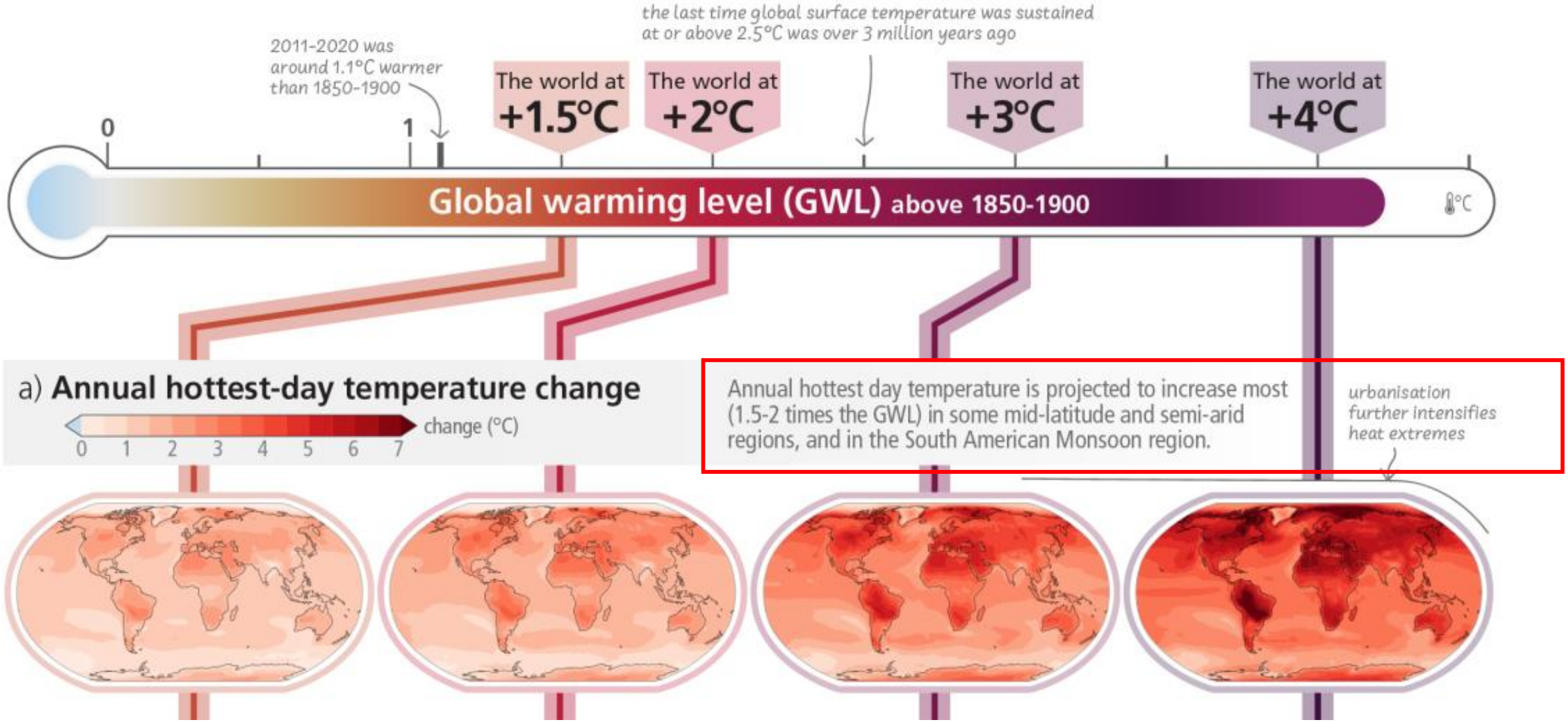


With every increment of global warming, regional changes in mean climate and extremes become more widespread and pronounced.

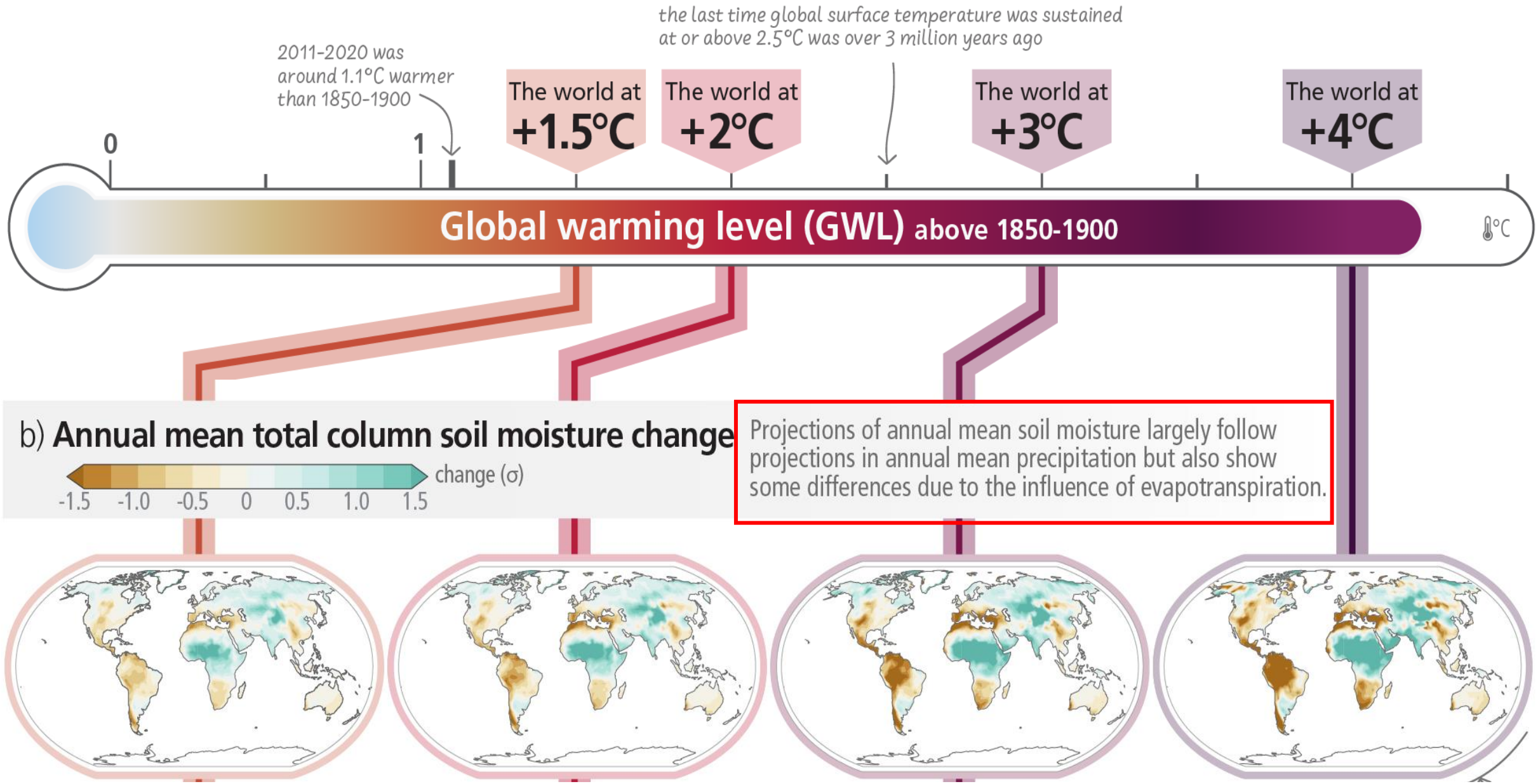
全球气候的每一点点变暖，都将导致广泛而显著的区域平均气候变化和极端气候事件

Figure SPM.2*: Projected changes of annual maximum daily maximum temperature, annual mean total column soil moisture and annual maximum 1-day precipitation at global warming levels of 1.5°C, 2°C, 3°C, and 4°C relative to 1850–1900.*

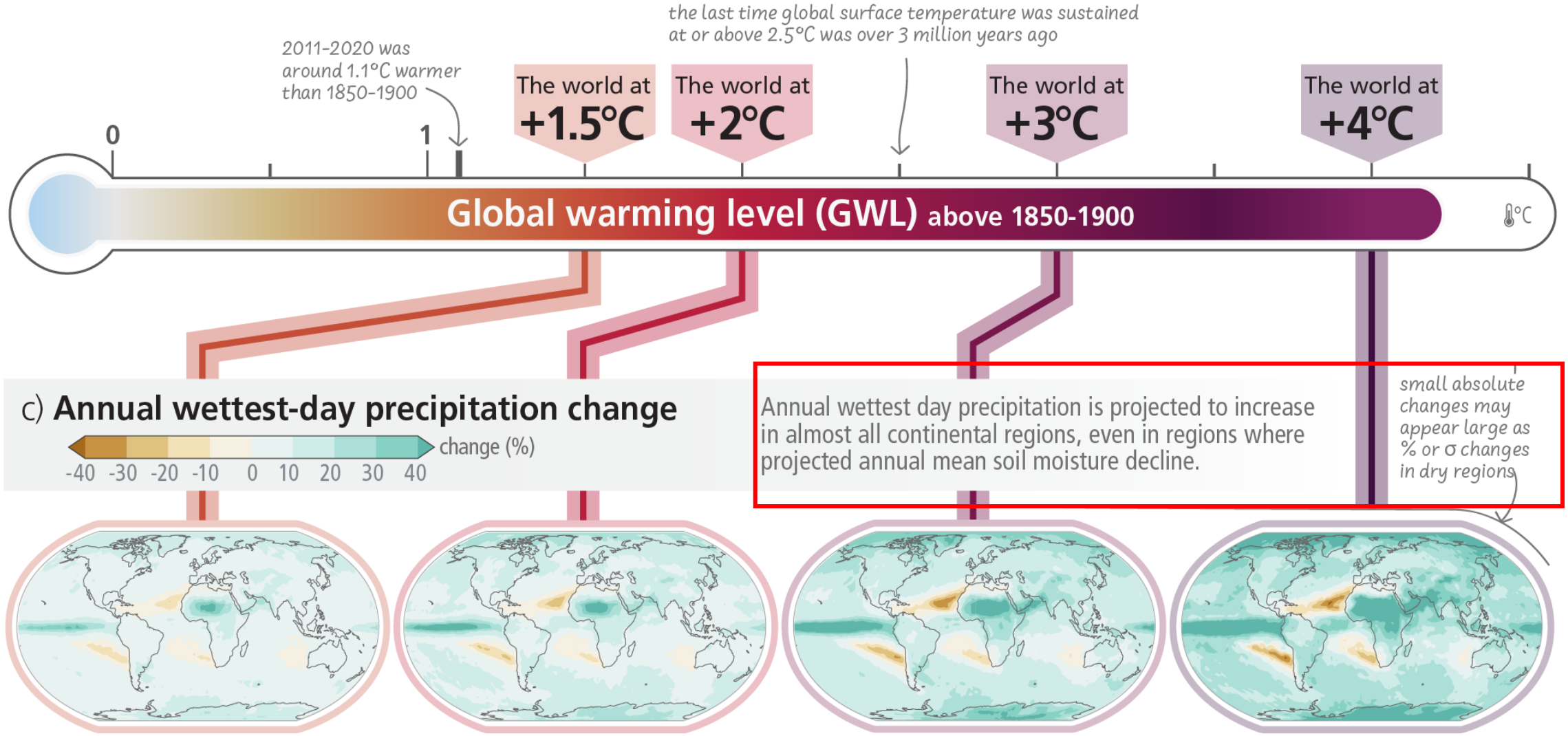
图 SPM.2*: 全球温升水平1.5 ℃, 2 ℃, 3 ℃和 4 ℃ （相对于 1850–1900年平均）情景下，预估的年最高温度（a)、年均土壤湿度(b)、年最大日降水量(c)的全球分布结果。*



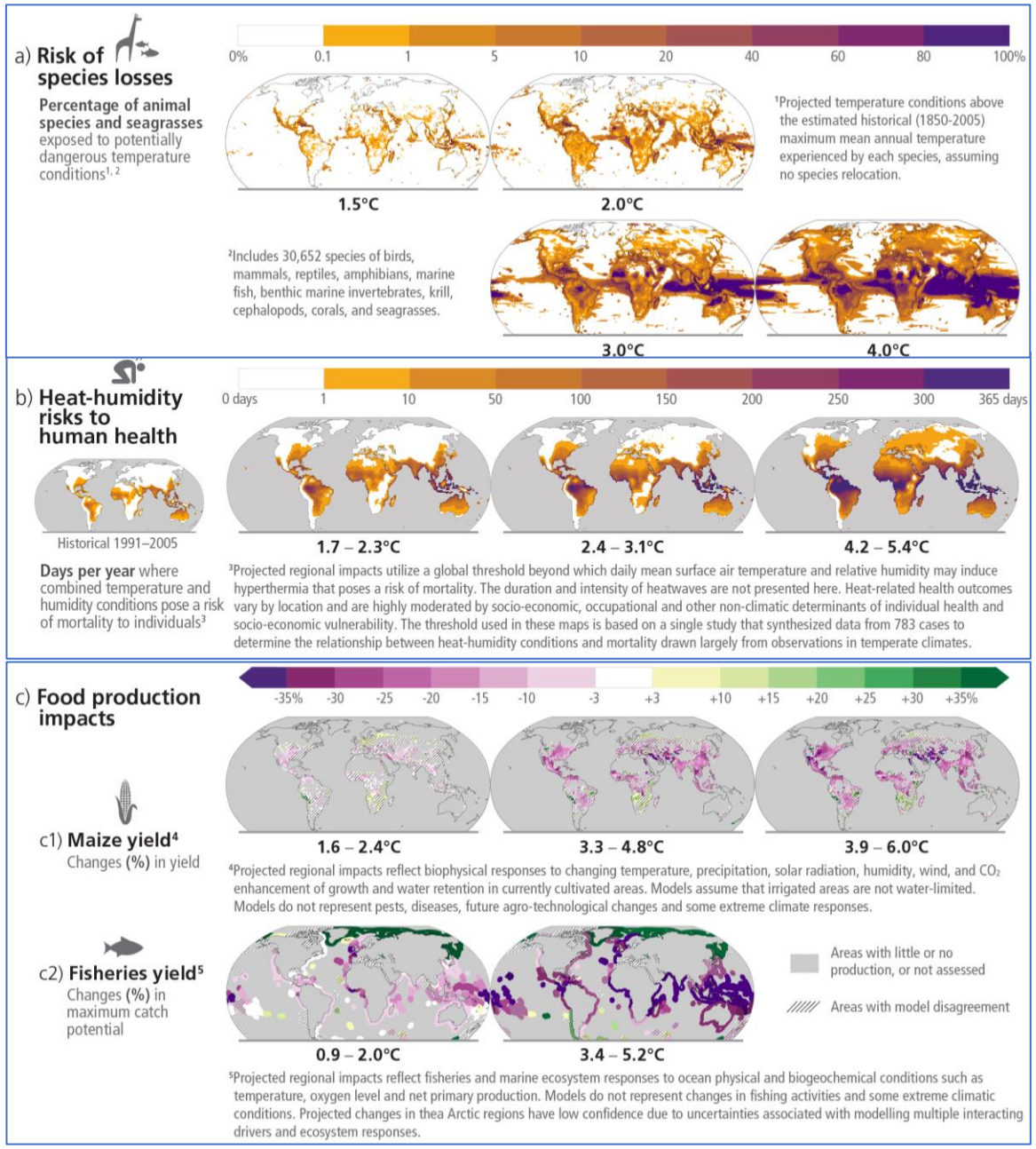
(a) 温度：年“热日”（日最高）温度随之持续增加，达全球温升水平的1.5~2倍；中纬度、半干旱区和南美季风区更为显著；城市化将会加剧极端热事件的强度。



b) 土壤湿度：土壤含水量与降水量密切相关。受到蒸散发的影响，其时空格局与降水量将存在显著差异。



c) 降水：全球水循环加剧，变率增大；大部分区域的降水量将增多，极端降水事件的频次也将增加（即使在土壤含水量降低的区域）。



Key message-2

Future climate change is projected to increase the severity of impacts across natural and human systems and will increase regional differences

未来气候变化将增加其对自然和人类系统的影响，也会加大区域差异

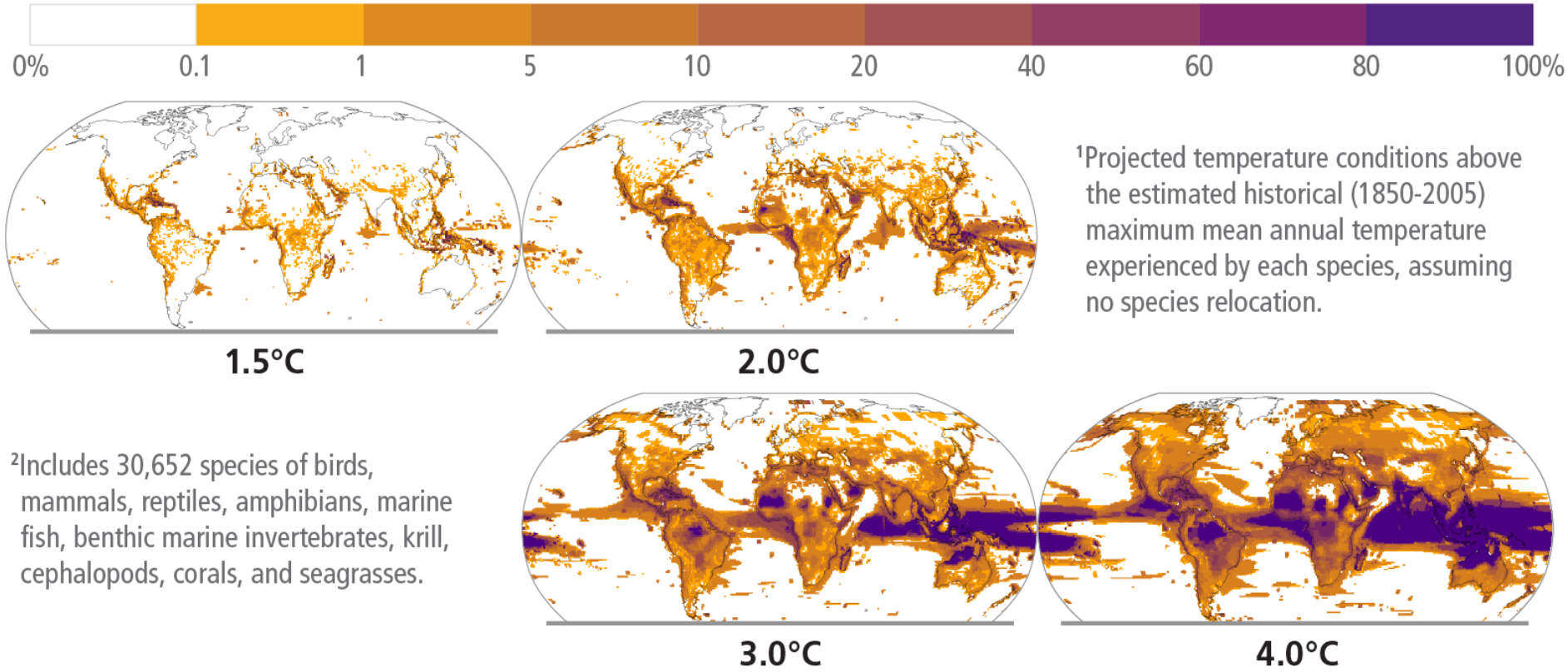
Figure SPM.3: Projected risks and impacts of climate change on natural and human systems at different global warming levels (GWLs) relative to 1850-1900 levels.

图 SPM.3: 预估在不同温升水平下(相对于1850-1900平均), 气候变化带来的自然和人类系统风险和影响。

Examples of impacts without additional adaptation

a) Risk of species losses

Percentage of animal species and seagrasses exposed to potentially dangerous temperature conditions[1, 2]



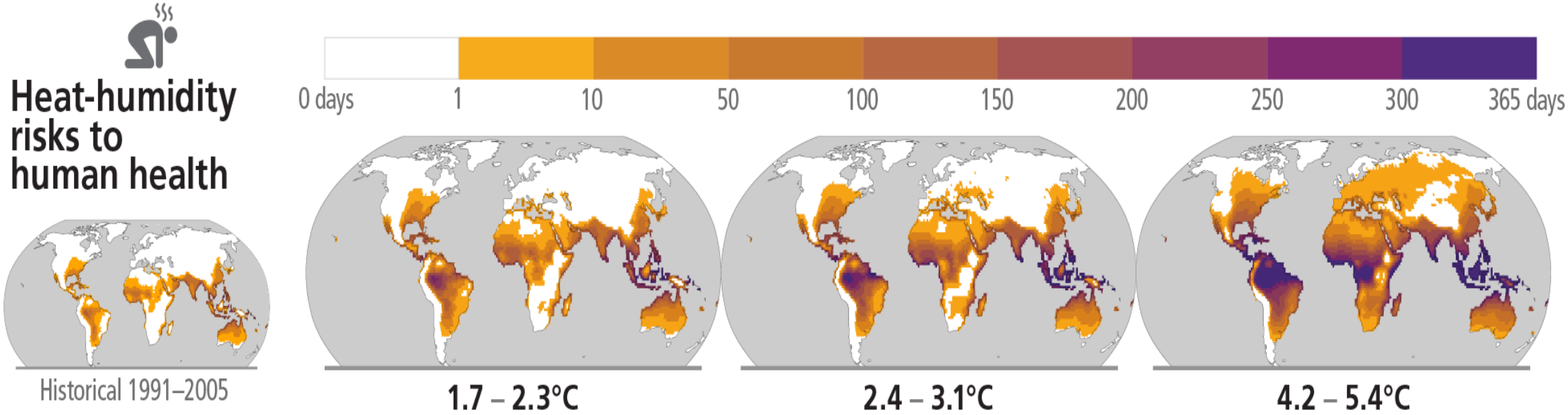
[1]Projected temperature conditions above the estimated historical (1850-2005) maximum mean annual temperature experienced by each species, assuming no species relocation.

[2]Includes 30,652 species of birds, mammals, reptiles, amphibians, marine fish, benthic marine invertebrates, krill, cephalopods, corals, and seagrasses.

At a 1.5°C warming level, 3% to 14% of species in global terrestrial ecosystems face an extinction risk, coral reefs will be reduced by 70% to 90%; at a 3°C warming level, the risk of species extinction will increase by 10 times, and there will be systemic impacts and irreversible changes; more than 4°C warming will result in the disappearance of 50% of tropical marine species.

a）物种损失：1.5°C温升下，全球陆地生态系统中3%~14%的物种面临灭绝风险，珊瑚礁将会减少70%~90%；在3°C温升下，物种灭绝的风险将会上升10倍，同时会产生系统性影响和不可逆变化；超过4°C，将会有~50%的热带海洋物种消失。

b) Heat-humidity risks to human health



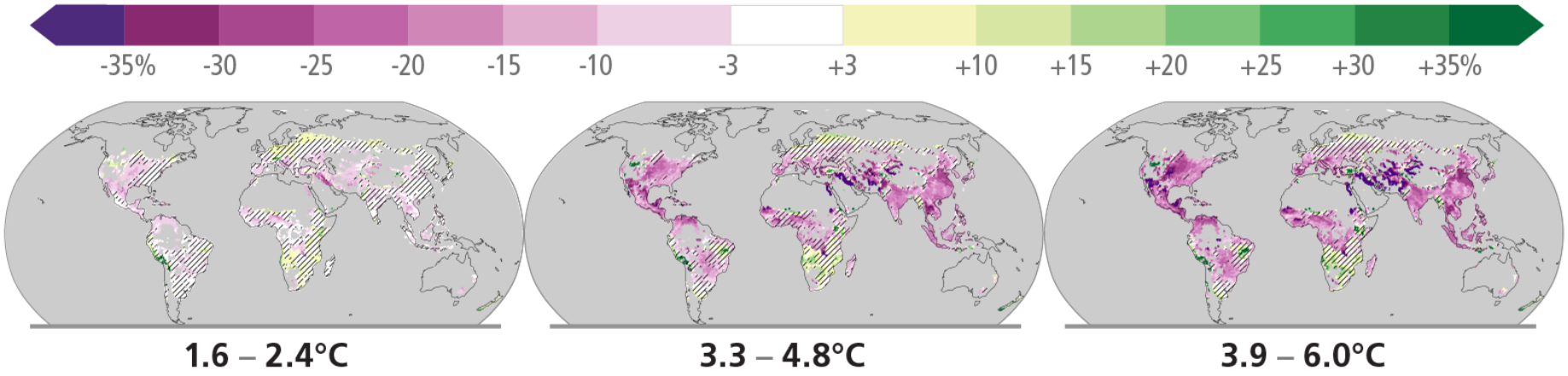
Days per year where combined temperature and humidity conditions pose a risk of mortality to individuals[3]

[3]Projected regional impacts utilize a global threshold beyond which daily mean surface air temperature and relative humidity may induce hyperthermia that poses a risk of mortality. The duration and intensity of heatwaves are not presented here. Heat-related health outcomes vary by location and are highly moderated by socio-economic, occupational and other non-climatic determinants of individual health and socio-economic vulnerability. The threshold used in these maps is based on a single study that synthesized data from 783 cases to determine the relationship between heat-humidity conditions and mortality drawn largely from observations in temperate climates.

Human health: The frequency, intensity, and duration of extreme wet-hot events are increasing, thereby increasing the risk of wet-heat-related diseases (cardiovascular diseases, heatstroke, etc.) among affected populations.

b)人群健康：极端湿-热事件的频率、强度和持续时间随之增加，加大了罹患湿热相关疾病的人群风险（心脑血管疾病、热射病等）。

c) Food production impacts



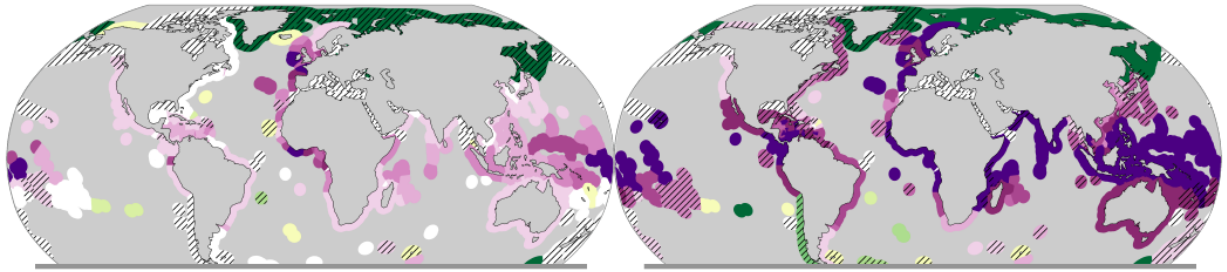
c1) Maize yield[4]

Changes (%) in yield

[4]Projected regional impacts reflect biophysical responses to changing temperature, precipitation, solar radiation, humidity, wind, and CO_2 enhancement of growth and water retention in currently cultivated areas. Models assume that irrigated areas are not water-limited. Models do not represent pests, diseases, future agro-technological changes and some extreme climate responses.

c2) Fisheries yield[5]

Changes (%) in maximum catch potential



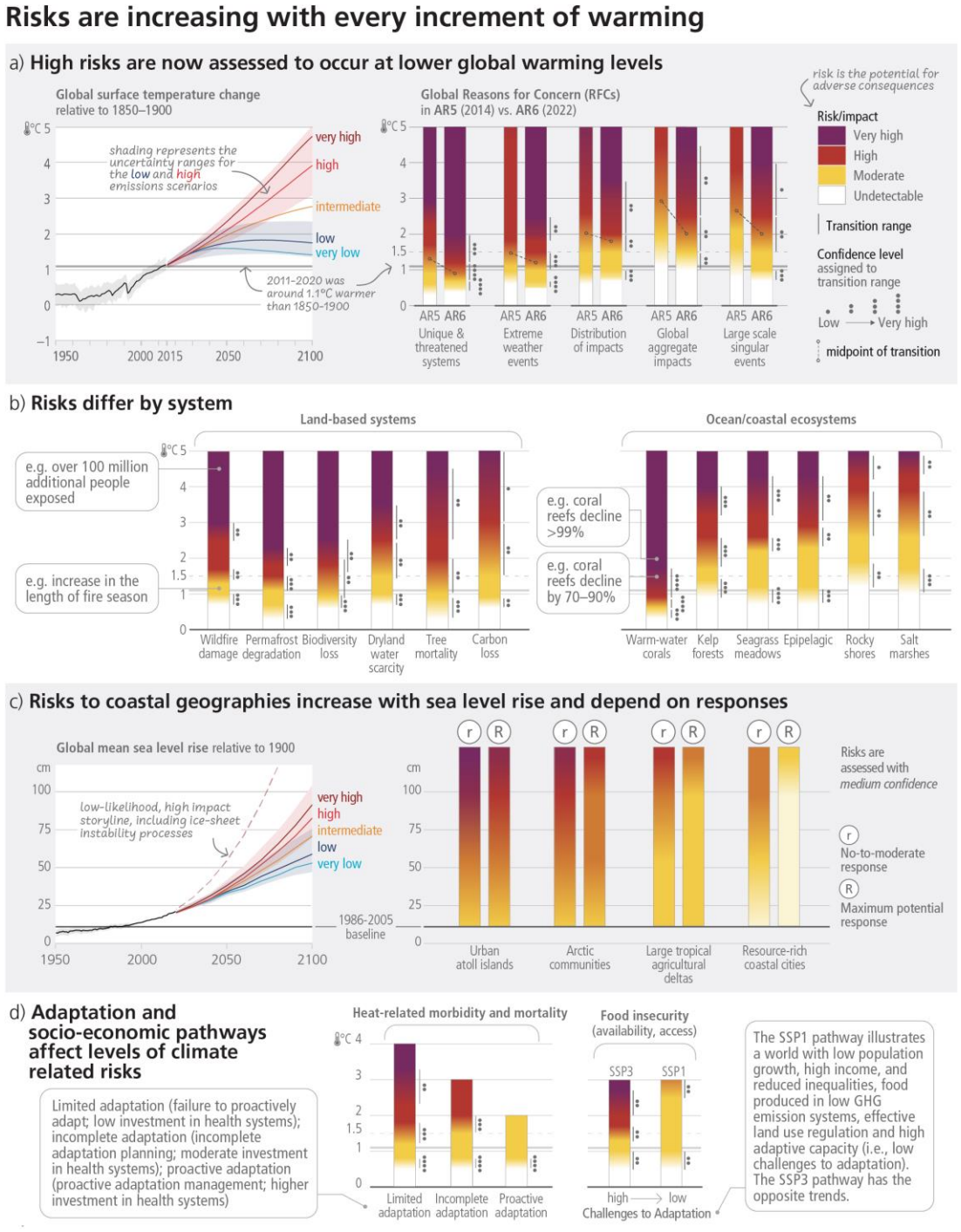
Areas with little or no production, or not assessed

Areas with model disagreement

[5]Projected regional impacts reflect fisheries and marine ecosystem responses to ocean physical and biogeochemical conditions such as temperature, oxygen level and net primary production. Models do not represent changes in fishing activities and some extreme climatic conditions. Projected changes in thea Arctic regions have low confidence due to uncertainties associated with modelling multiple interacting drivers and ecosystem responses.

The decrease of meltwater caused an irrigation water crisis. Low-income groups and areas with relatively marginal economic development are the most affected

c) 食物安全：冰雪融水减少造成灌溉用水危机。低收入人群和经济发展相对落后区域受影响最大（上图为玉米产量、渔业可捕获量的变化预估）。



Key message-3

Burning ember

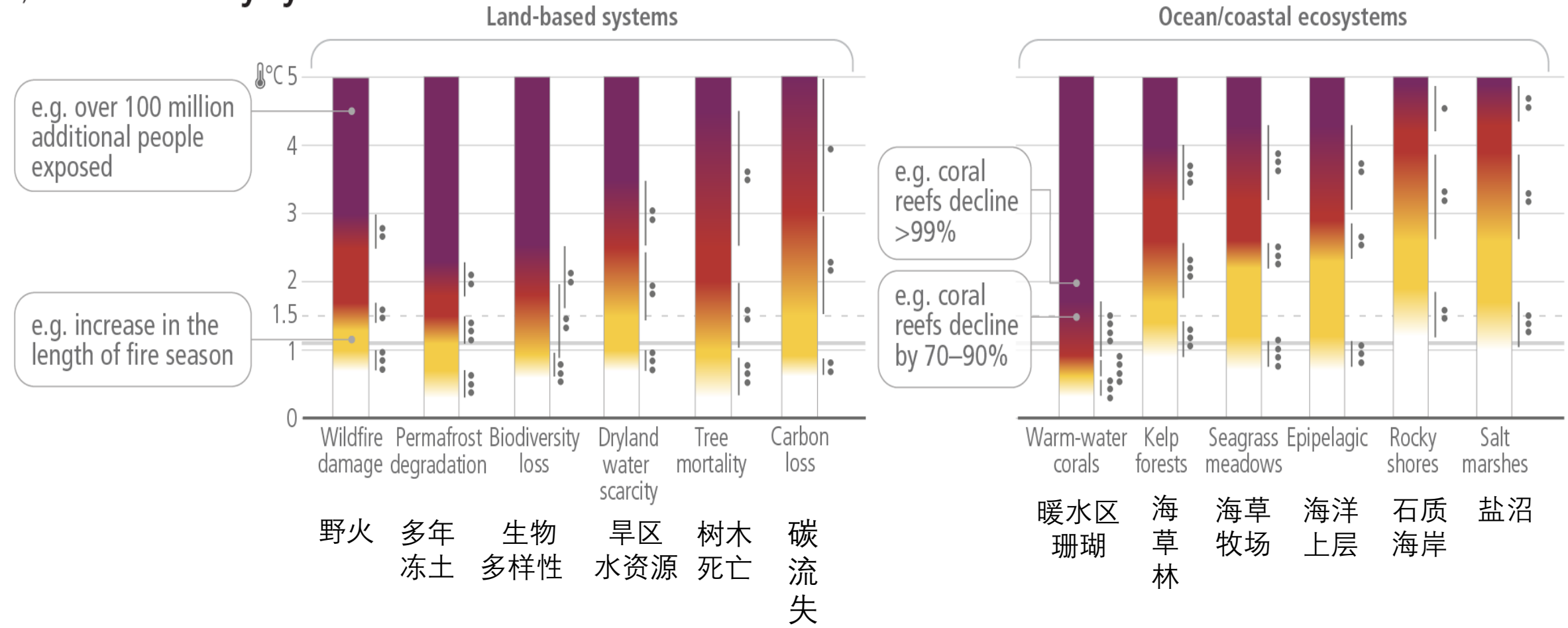
火焰图（燃烧图）

Risks are increasing with every increment of warming

每增暖一点所带来的风险

SPMFig4. Various consequences related to global/regional climate change and risk assessment

图SPM.4: *与全球/区域气候变化相关的各类后果与风险评估*

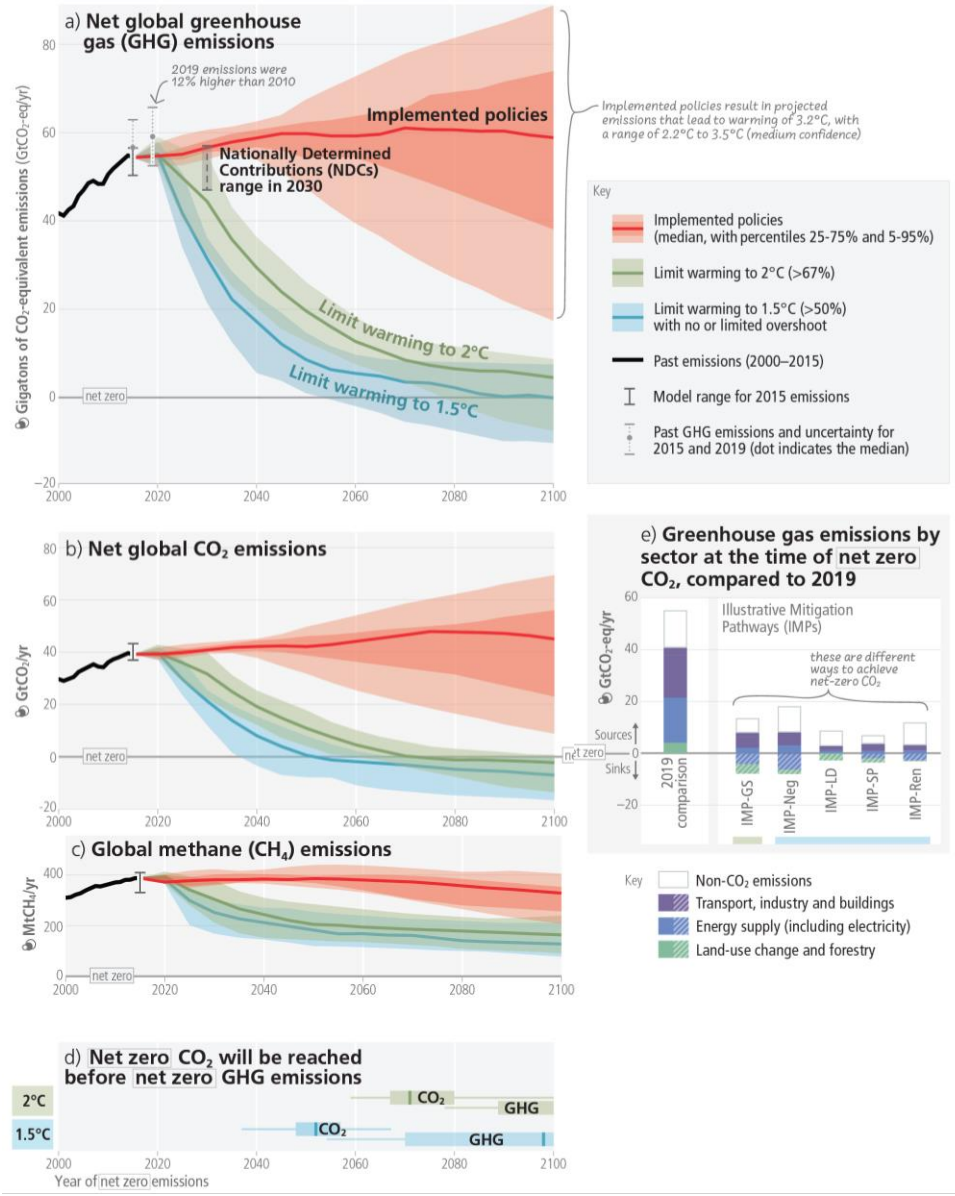


Selected global risks for land and ocean ecosystems, illustrating general increase of risk with global warming levels with low to no adaptation.

Subset of assessed climate outcomes and associated global and regional climate risks.

不同系统的风险：陆地生态系统，海洋/海岸带生态系统都将面临越来越高的风险

Key message-4

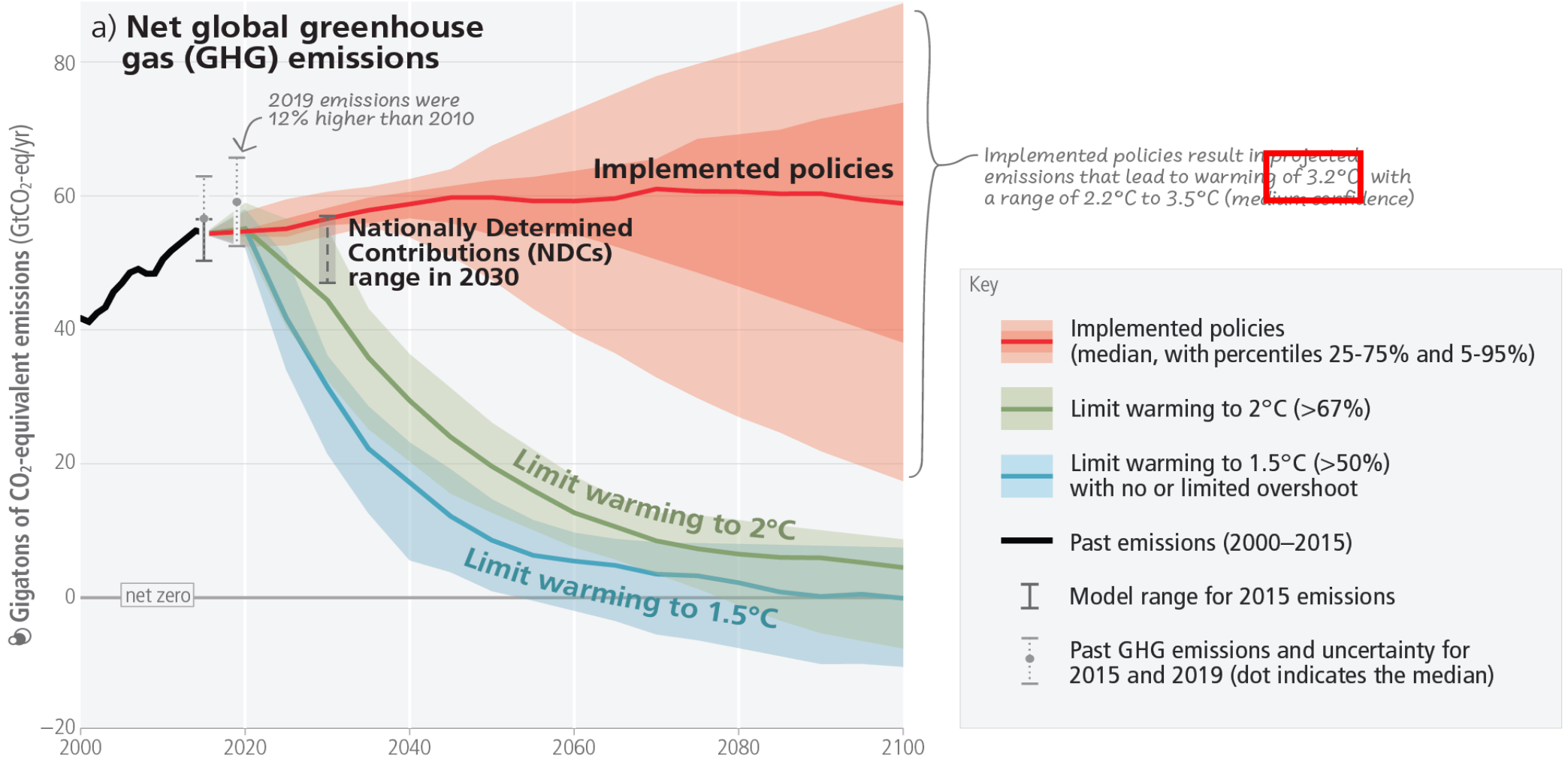


Limiting warming to 1.5°C and 2°C involves rapid, deep and in most cases immediate greenhouse gases emission reduction.

将温升保持在1.5°C和2°C内，需要快速、深度、甚至即刻的温室气体减排行动

Figure SPM.5: Global emissions pathways consistent with implemented policies and mitigation strategies

图 SPM.5 *对应于执行政策和减排策略的全球排放路径. (a), (b) 和(c)分别显示模拟的全球GHG, CO2 和CH4排放路径， (d) 显示GHG及CO2达到净零排放的大致时间。*



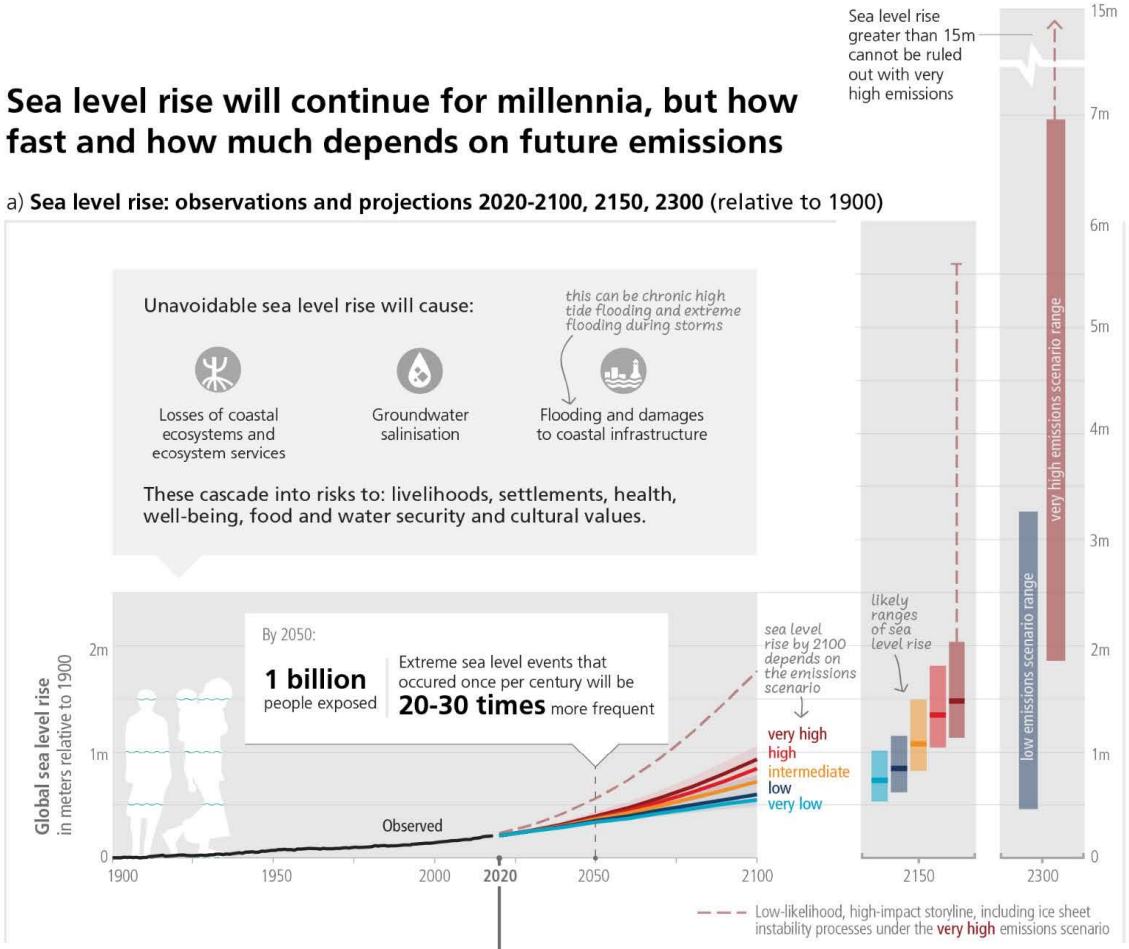
Net zero CO2 and net zero GHG emissions can be achieved through strong reductions across all sectors

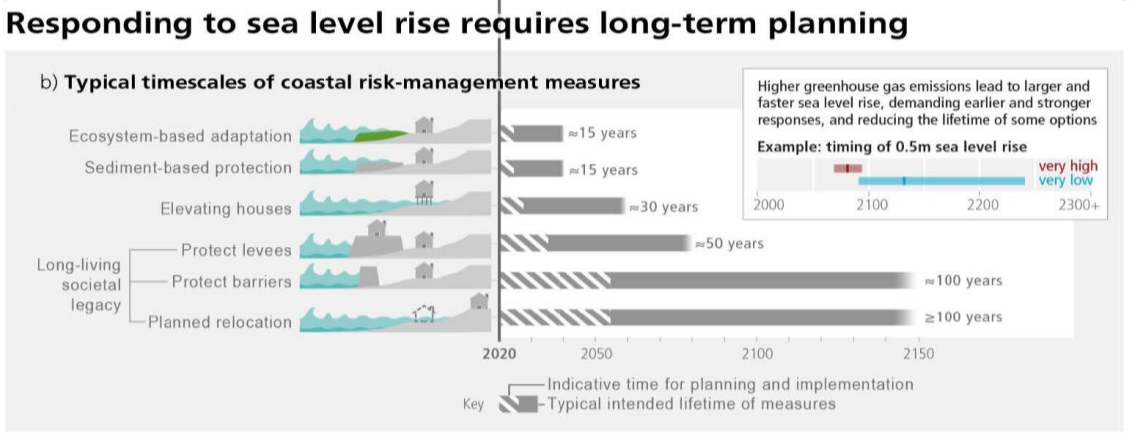
a) 净温室气体排放：将温升控制在1.5°C 和 2.0°C以内（没有或有限过冲）水平，需各行各业立即采取强有力的减排行动。

- Global greenhouse gas emissions need to peak between 2020 and 2025 (high confidence);
- The 1.5°C and 2°C warming targets require global net zero CO2 emissions by the early 2050s and early 2070s, respectively;
- By 2030, global CH4 emissions need to be reduced by 34% compared to 2019;
- CO2 will achieve net zero emissions before greenhouse gases (high confidence).

- **全球温室气体排放需在2020~2025年间达峰（高信度）**
- **对应1.5°C和2°C温升目标，分别需在2050年代初和2070年代初实现全球CO_2净零排放**
- **到2030年，全球CH_4排放量相对于2019年需减少34%**
- **CO_2将先于温室气体实现净零排放（高置信度）**

Key message-5



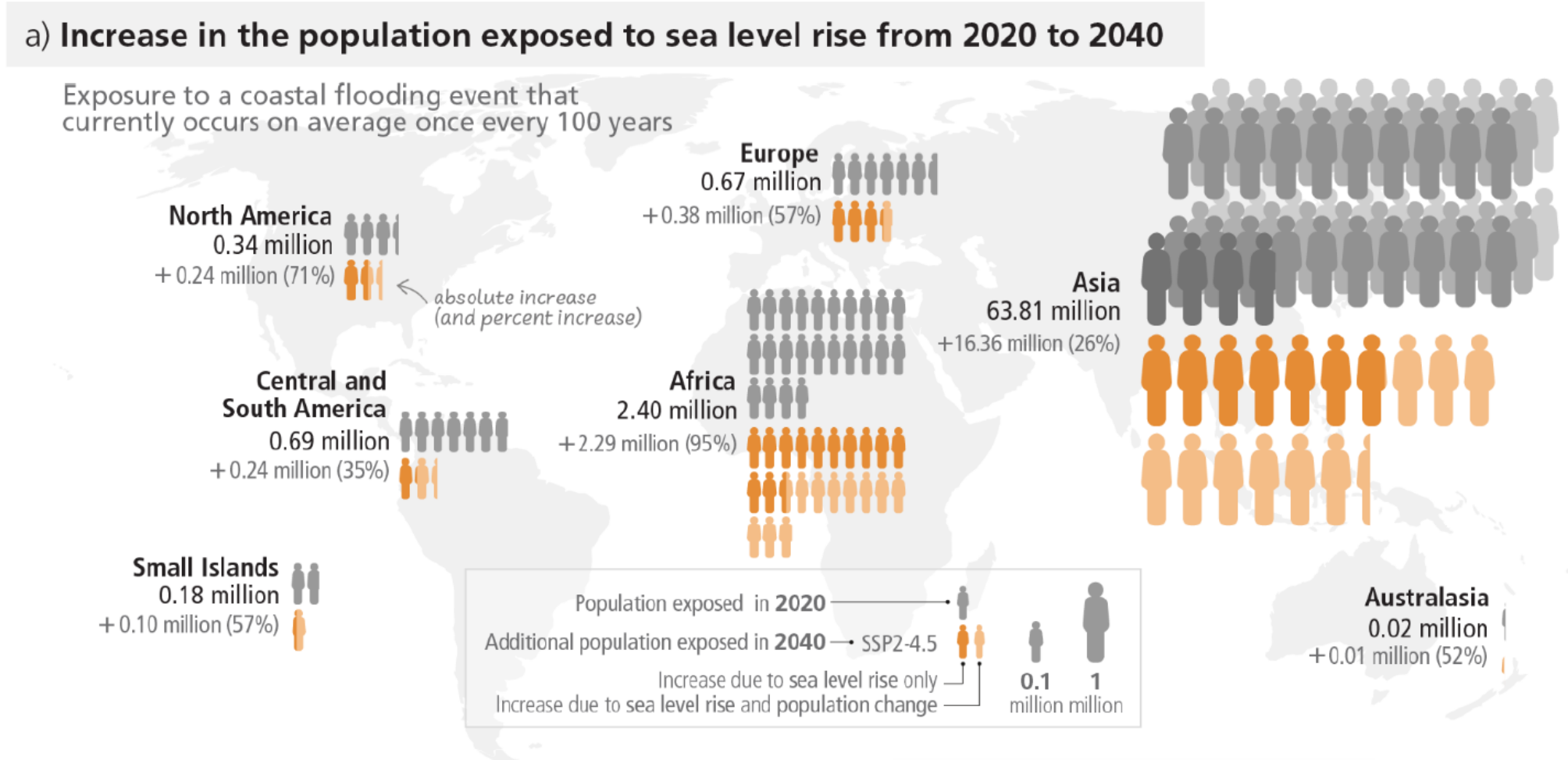


With the warming of the climate, the sea level will continue to rise in the next hundred to thousand years. Extreme water levels will occur 20-30 times more frequently by 2050, affecting 1 billion people. (Note: SLR of pre-2050 will not depend on emission scenario too much)

随着气候变暖，未来百年-千年尺度海平面将会持续上升;极端水位发生频率至2050年将是当前的20-30倍，影响10亿人;（注：2050年前随惯性变化而对情景的依赖性并不大）

Figure 3.4 Observed and projected global mean sea level changes and their impacts(a), and time-scales for risk management in coastal zones (b)

图3.4 观测和预估的全球平均海平面变化及其影响，以及海岸带风险管理的时间尺度. (a) 2020-2100, 2150, 2300海平面变化预估(相对于1900年); (b)应对海平面上升需要长远规划（海岸风险管理措施的典型时间尺度）

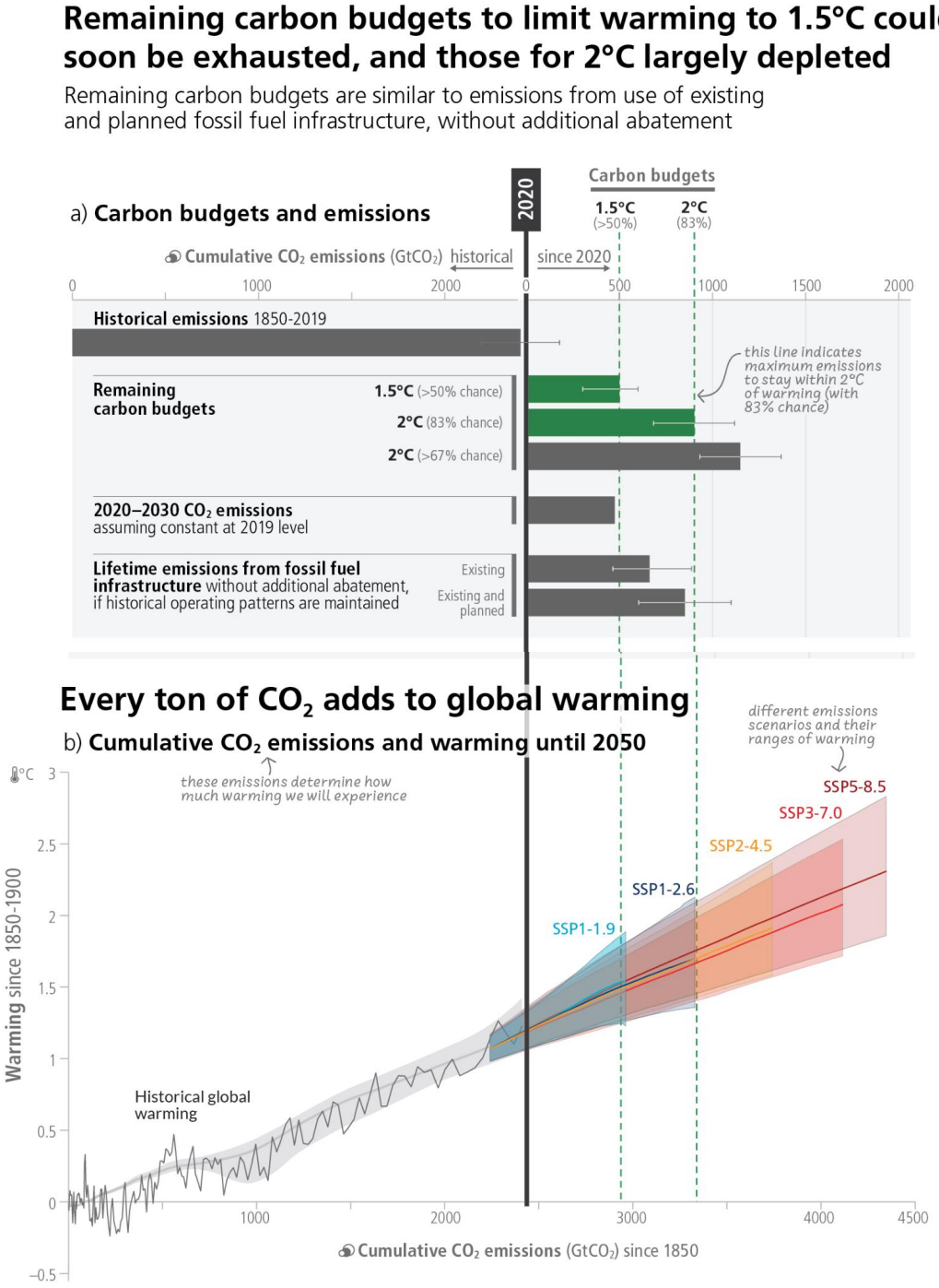


The climate risks are further intensifying, making urgent need for comprehensive action:

Due to the accumulation of carbon dioxide emissions, global warming will continue to intensify in the near future (2021-2040) and is expected to result in further increases in climate disasters in every region of the world.

气候风险进一步加剧，综合行动愈加紧迫:

由于累积二氧化碳排放量的增加，全球变暖在近期(2021-2040年)将继续加剧，预计世界上每个区域都将面临进一步增加的气候灾害



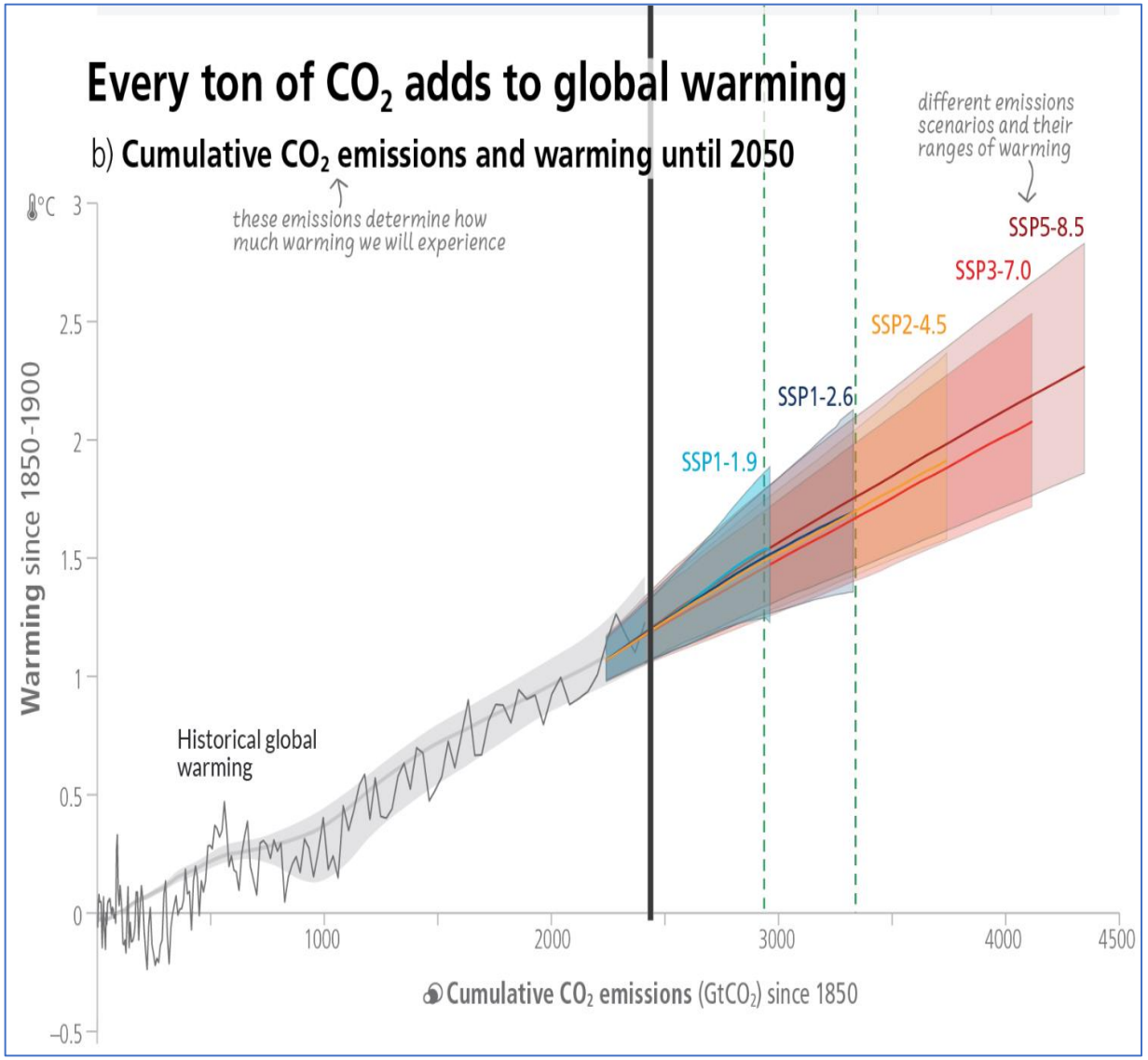
Key message-6

Remaining carbon budgets to limit warming to 1.5°C could soon be exhausted, and those for 2°C largely depleted.

将温升目标控制在1.5°C的剩余碳预算将很快耗尽，2°C目标下的剩余碳预算也已大大消耗

Figure 3.5 Past cumulative emissions, projected emissions, committed emissions and their associated global mean temp. changes

图 3.5: 过去累积排放、预估排放、惯性排放及其关联的全球平均温度变化



For every 1000 GtCO2 emitted by human activities, the global average temperature rises between 0.27°C and 0.63°C (the best estimate is 0.45°C). Therefore, carbon budget must be maintained within a reasonable range if warming is to be limited to any given target.

人类活动每排放1000GtCO_2，全球平均温升为0.27℃～0.63℃(最佳估计为0.45℃)，如果要将变暖限制在任何给定目标，必须将碳预算维持在相应合理范围

b) Every ton of CO2 adds to global warming.

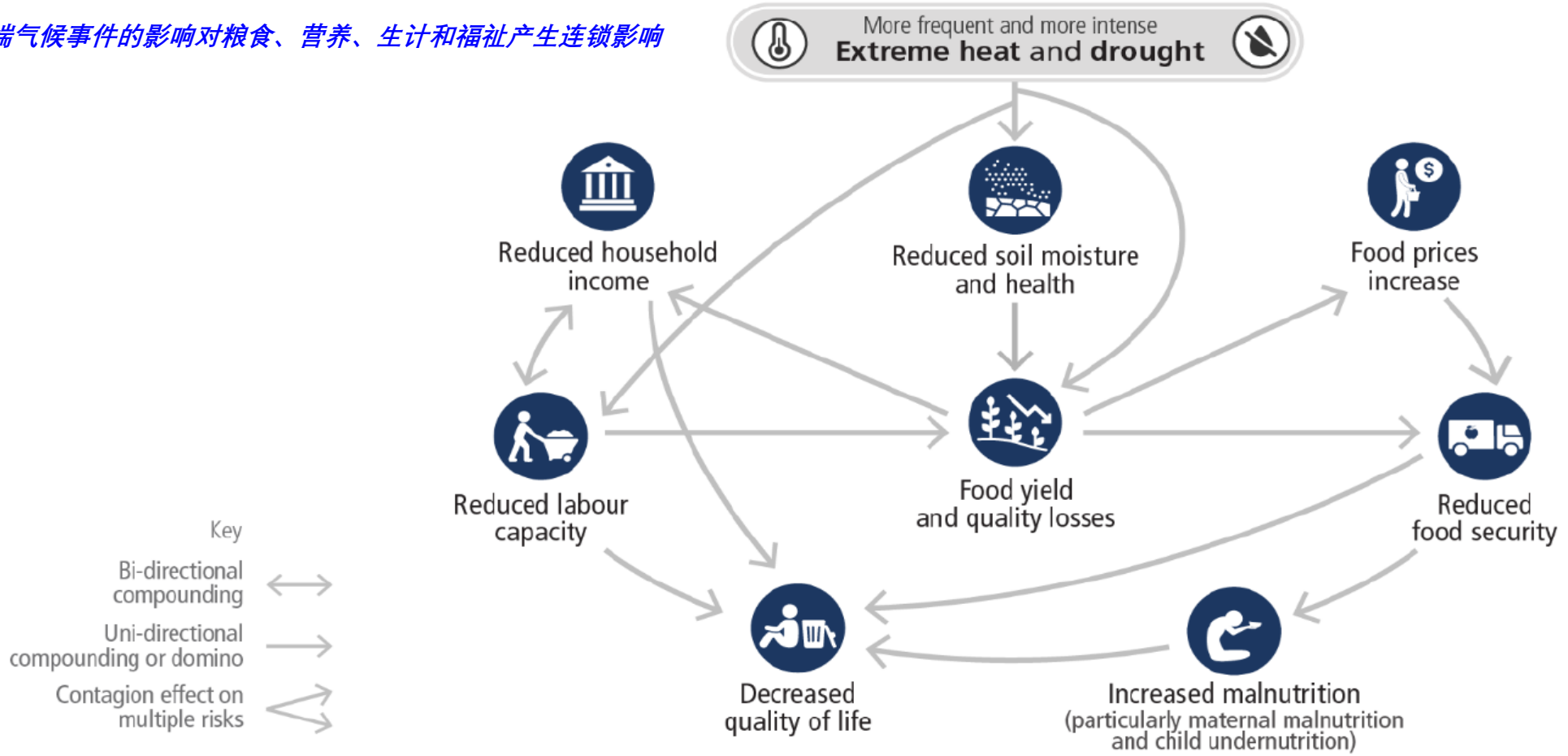
b) 累积CO2排放范围与全球温升之间（2050年前）的关系：每吨碳都是事儿！

Long-Term Interactions Between Adaptation, Mitigation and Sustainable Development

适应、减缓与可持续发展之间的长远互馈

c) **Example of complex risk, where impacts from climate extreme events have cascading effects on food, nutrition, livelihoods and well-being of smallholder farmers**

极端气候事件的影响对粮食、营养、生计和福祉产生连锁影响



Multiple climate change risks will increasingly compound and cascade in the near term

多种气候变化风险将进一步复杂化并产生级联灾害

● Point-1

Mitigation and adaptation can lead to synergies and trade-offs with sustainable development . An inclusive, equitable approach to integrating adaptation, mitigation and development can advance sustainable development in the long term (high confidence). Resilient development pathways are progressively constrained by every increment of further warming (very high confidence).

减缓和适应措施可带来与可持续发展的协同与权衡关系。包容、平等、综合的适应和减缓措施有利于可持续发展长远目标的实现（高信度）；加强气候变化减缓行动需要更快速的转型和更多的前期投资，还可以从避免损害和降低适应成本中获益。反过来，向可持续发展转型的政策和路径有利于形成减缓和适应组合拳（portfolio）（中等信度）；气候恢复力发展路径（RDP) 被一点一点的变暖持续制约着（很高信度）。

- **Point-2**

Observed impacts and related losses and damages, projected risks, trends in vulnerability, and adaptation limits demonstrate that transformation for sustainability and climate resilient development action is more urgent than previously assessed (very high confidence). Climate resilient development integrates adaptation and GHG mitigation to advance sustainable development for all

已有的影响和损失、预估风险、脆弱性趋势以及适应极限，均显示向可持续发展的转型以及气候恢复力行动，较之以往评估的都要紧迫（很高信度）。气候恢复力路径（RDP)与适应和减缓的结合将可推动全人类可持续发展。

● Point-3

The cumulative scientific evidence is unequivocal: climate change is a threat to human well-being and planetary health (very high confidence). Any further delay in concerted anticipatory global action on adaptation and mitigation will miss a brief and rapidly closing window of opportunity to secure a liveable and sustainable future for all (very high confidence).

越来越多的科学证据无可辩驳地说明：气候变化是对人类福祉和星球健康的巨大威胁（很高信度），任何推迟适应和减缓全球共同行动的行为，都将错失一个短暂而迅速关闭的机会之窗。

我们的选择将产生百年、甚至千年回响！

Our choices will reverberate for hundreds, even thousands, of years.

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