

The continuing evolution of the “Key Risks” of climate change

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Drawing on work from:

History: Joel Smith, John Schellnhuber, Rik Leemans

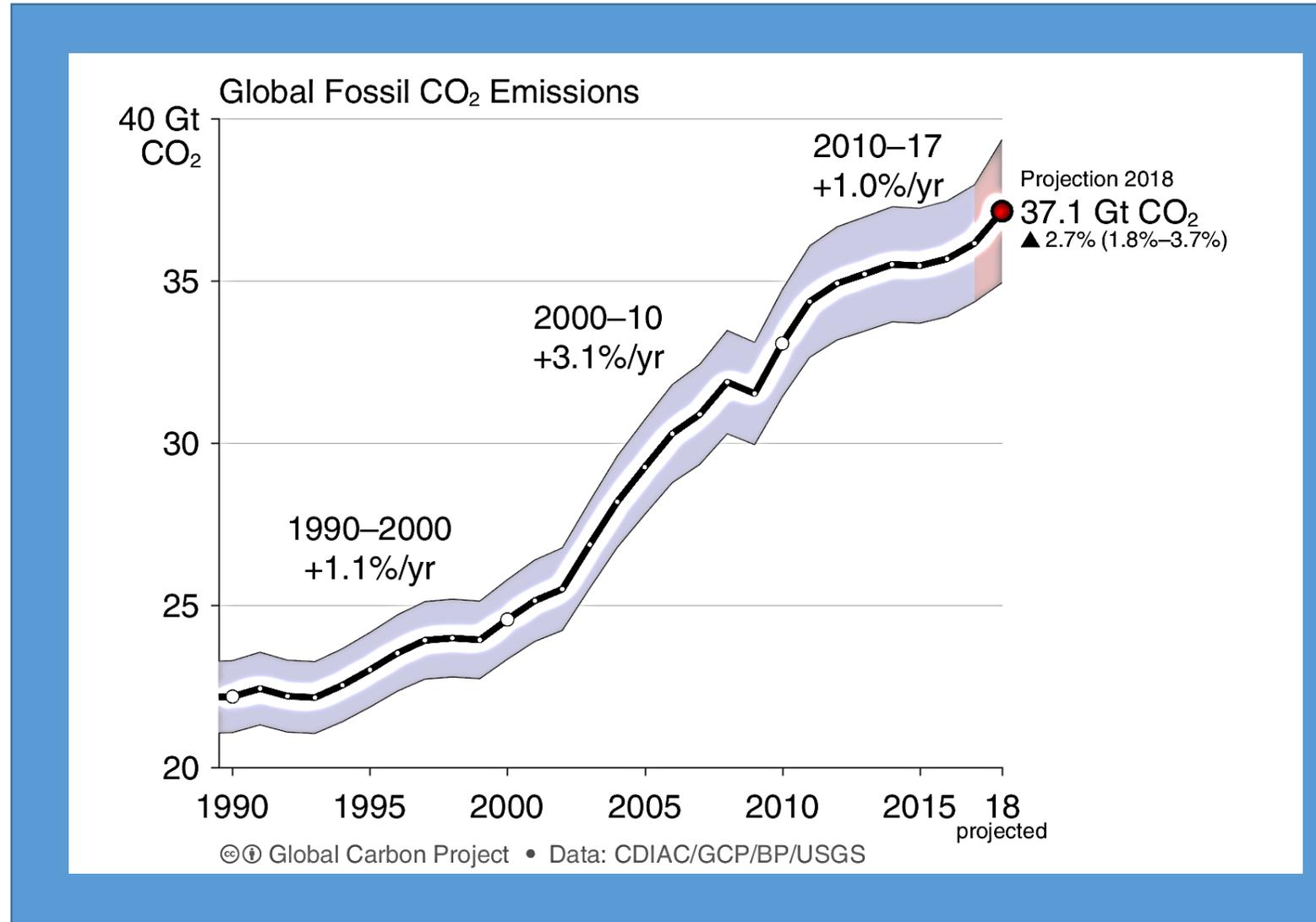
IPCC AR5: Michael Oppenheimer, Rachel Warren, Joern Birkmann, Stephane Hallegatte, Bob Kopp, Rachel Licker, Katie Mach, Phillippe Marbaix, Michael Mastrandrea, Hans Poertner, Bob Scholes, Kiyoshi Takahashi, Jeff Price, Jean-Pascal van Ypersele, Gary Yohe

IPCC AR6: Rachel Warren, Matthias Garschagen, Alex Magnan, Maarten Van Aalst, Zelina Ibrahim

Special Reports: Rachel Warren, Kate Calvin, Alex Magnan

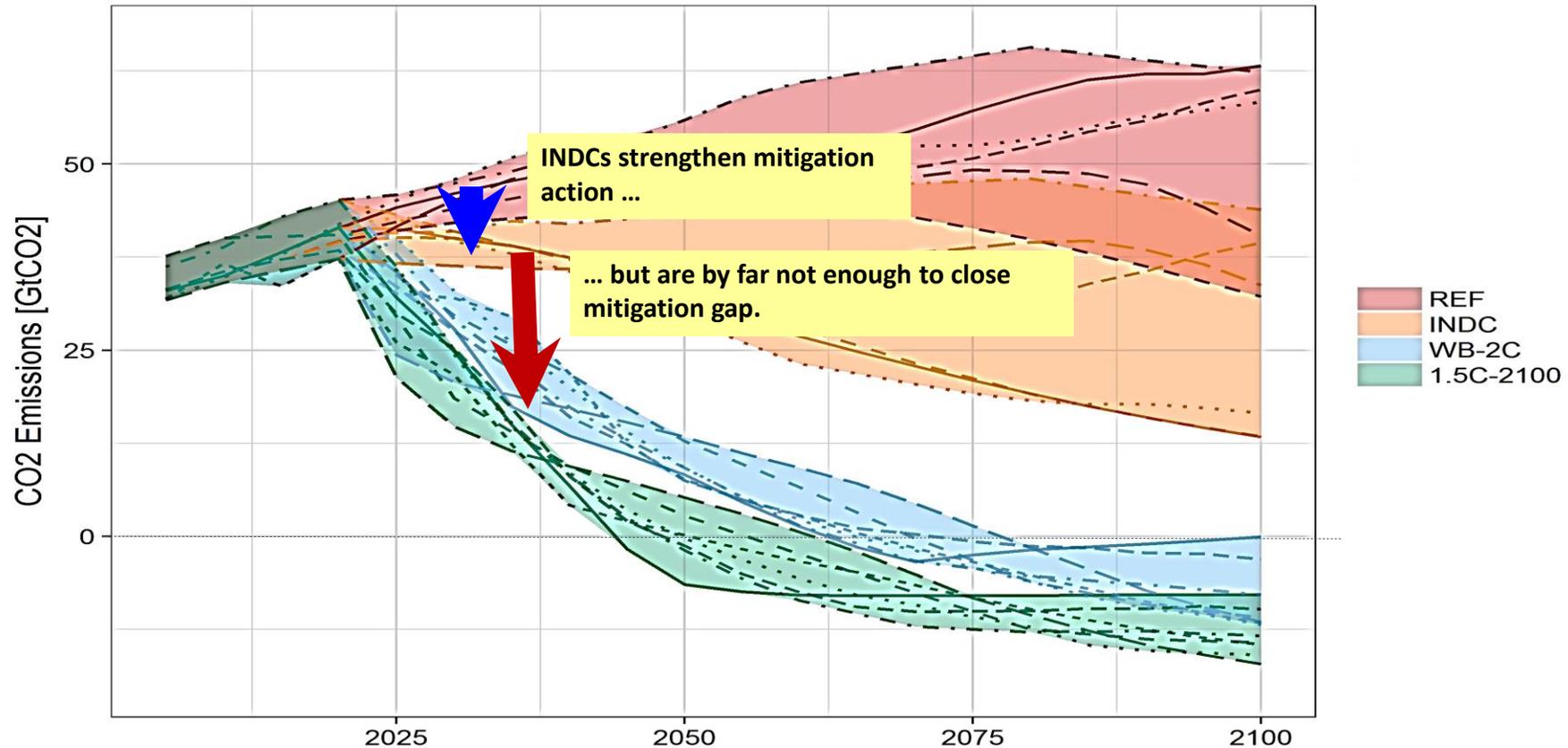
GTAP Annual Meeting, Warsaw, 19 June 2019

Emissions are rising



Thanks to:
O. Edenhofer

Reaching the 2°C or 1.5°C Paris goals



Luderer et al. (2018) *Residual fossil CO emissions in 1.5–2°C pathways*. Nature Climate Change

Thanks to:
O. Edenhofer

Definitions: Key Risk (AR5, AR6)

“A key risk is defined as a potentially severe risk relevant to the interpretation of ‘dangerous anthropogenic interference with the climate system’ (DAI), in the terminology of United Nations Framework Convention on Climate Change (UNFCCC) Article 2, meriting particular attention by policy makers in that context. ...”

Key Risks and Reasons for Concern

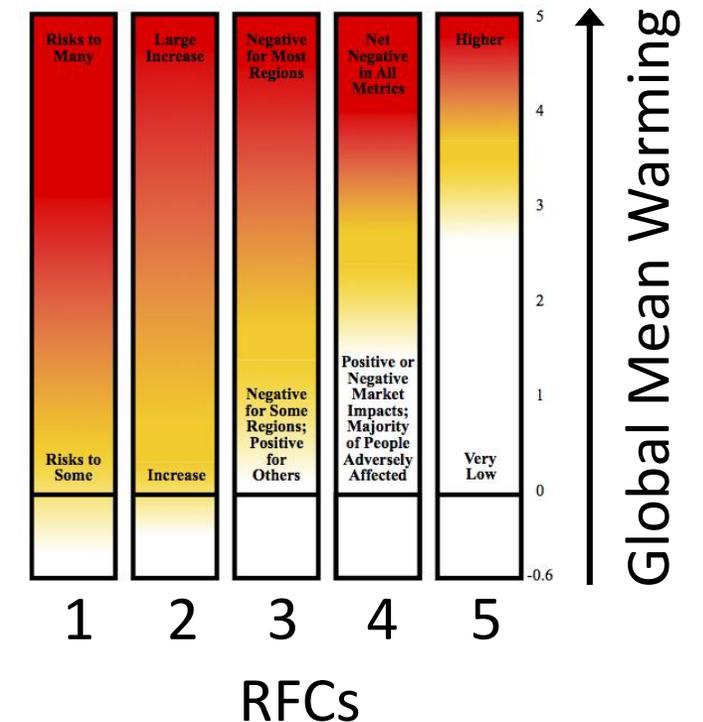
Key Risks → Reasons for Concern → Burning Embers

By region and by sector:

Loss of biodiversity
 Loss of endemic species
 Reduced economic growth
 Coastal damage from SLR
 Loss of coral reefs
 Mortality/morbidity from extreme heat
 Reduced food security
 Increased violent conflict
 Etc. ...

Risks to/associated with:

1. Unique and threatened systems
2. Extreme weather events
3. Distribution of impacts
4. Global aggregate impacts
5. Large-scale singular events



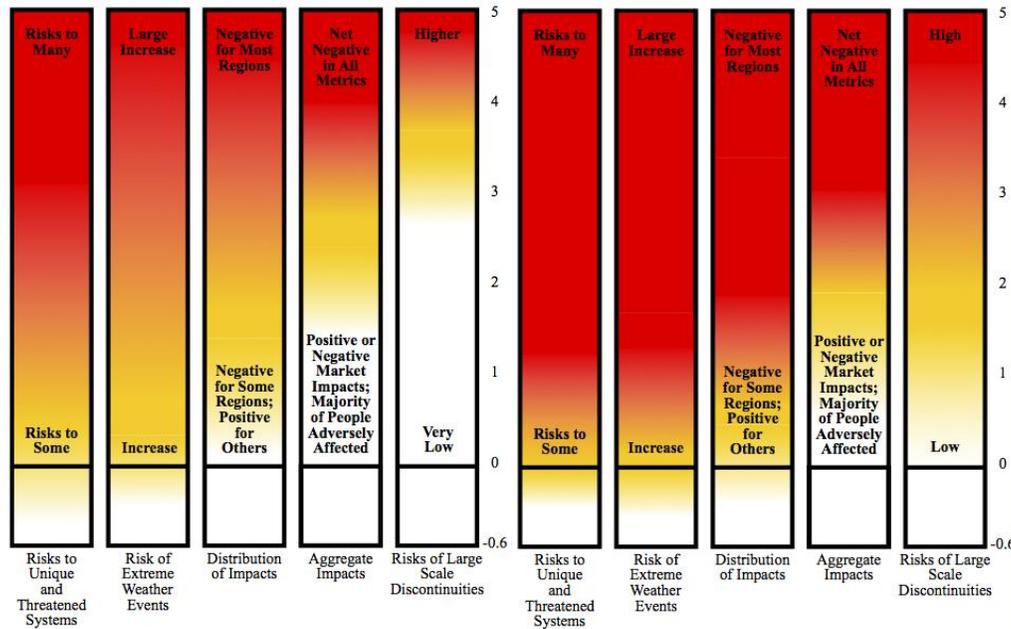
The UN Framework Convention on Climate Change

Article 2 OBJECTIVE:

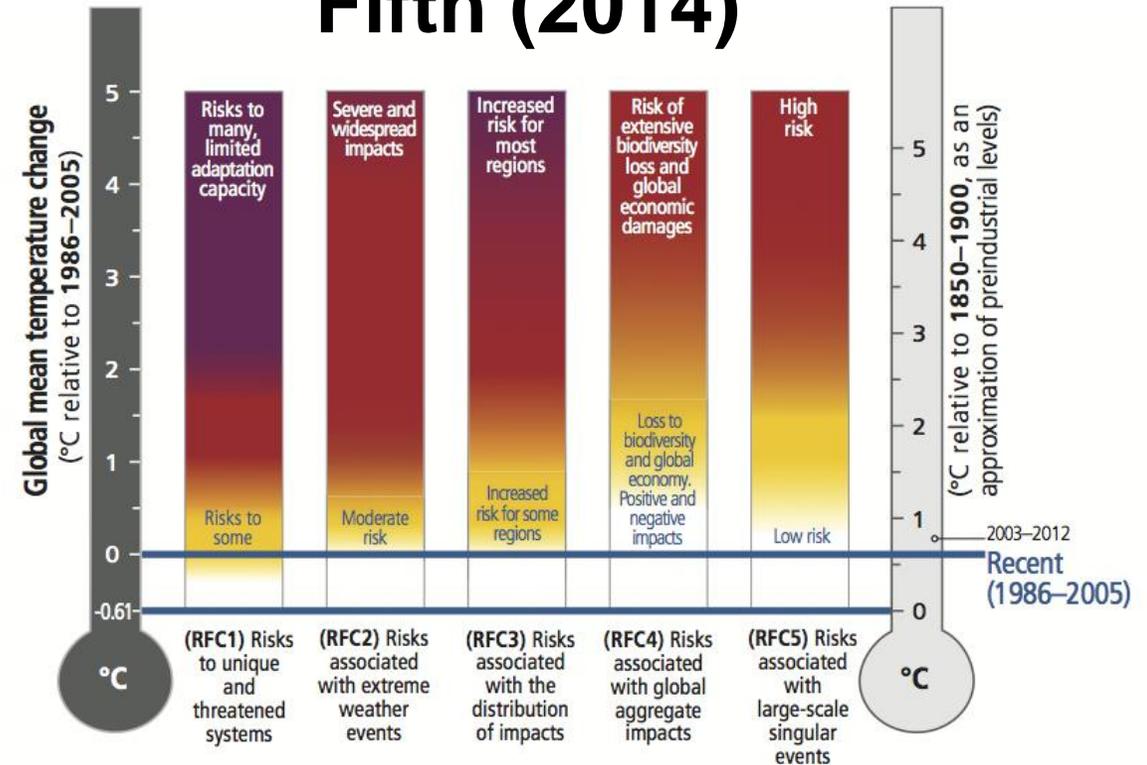
“The ultimate objective ... is to achieve ... stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time-frame sufficient to **allow ecosystems to adapt naturally** to climate change, to ensure that food production is not threatened and to **enable economic development to proceed in a sustainable manner.**”

Reasons for Concern by IPCC Assessment Report

Third (2001) Fourth (2007)



Fifth (2014)



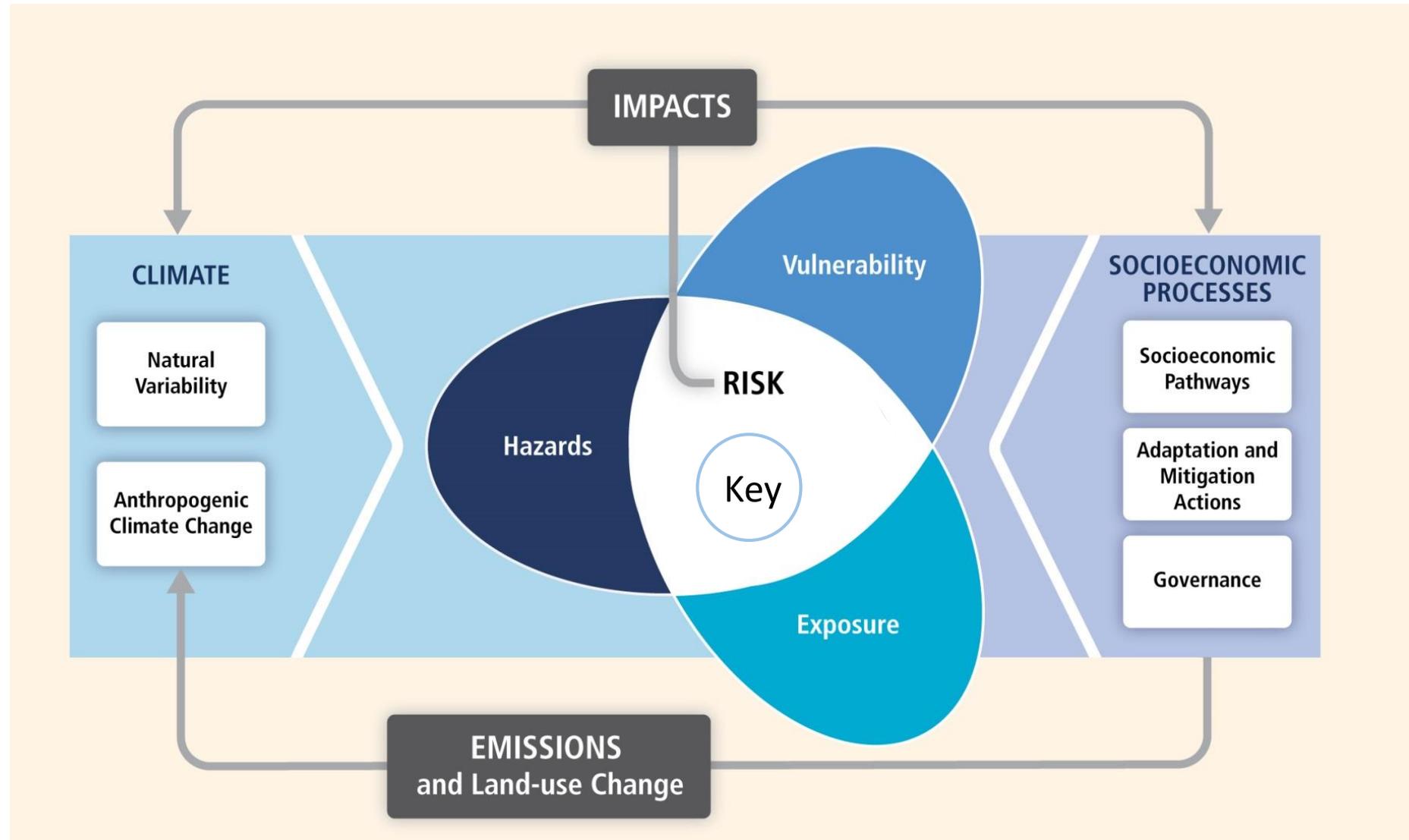
- 5 global Reasons for Concern
- Function of Global Mean Temperature



Risk, key risks, and determinants

Risk: The potential for negative consequences to human or ecological systems

Key risk: relevant to the definition and elaboration of “dangerous anthropogenic interference (DAI) with the climate system,”



Key risk criteria (AR6), related to:

1. the nature of adverse consequences for systems

- Magnitude

- Irreversibility

- Potential for thresholds/tipping points

2. uncertainty in the adverse consequences

- Likelihood of serious consequences

3. the timing of the risk

- Persistence

- Timing, rate of change in risk

4. the ability to respond to the risk

- Limited ability to reduce hazards, exposure, or vulnerability

- Limited ability to adapt to/cope with impact should it occur

Level of additional risk due to climate change



Undetectable

White to
yellow

Yellow

Yellow to
red

Red

Red to
purple

Purple

Moderate

High

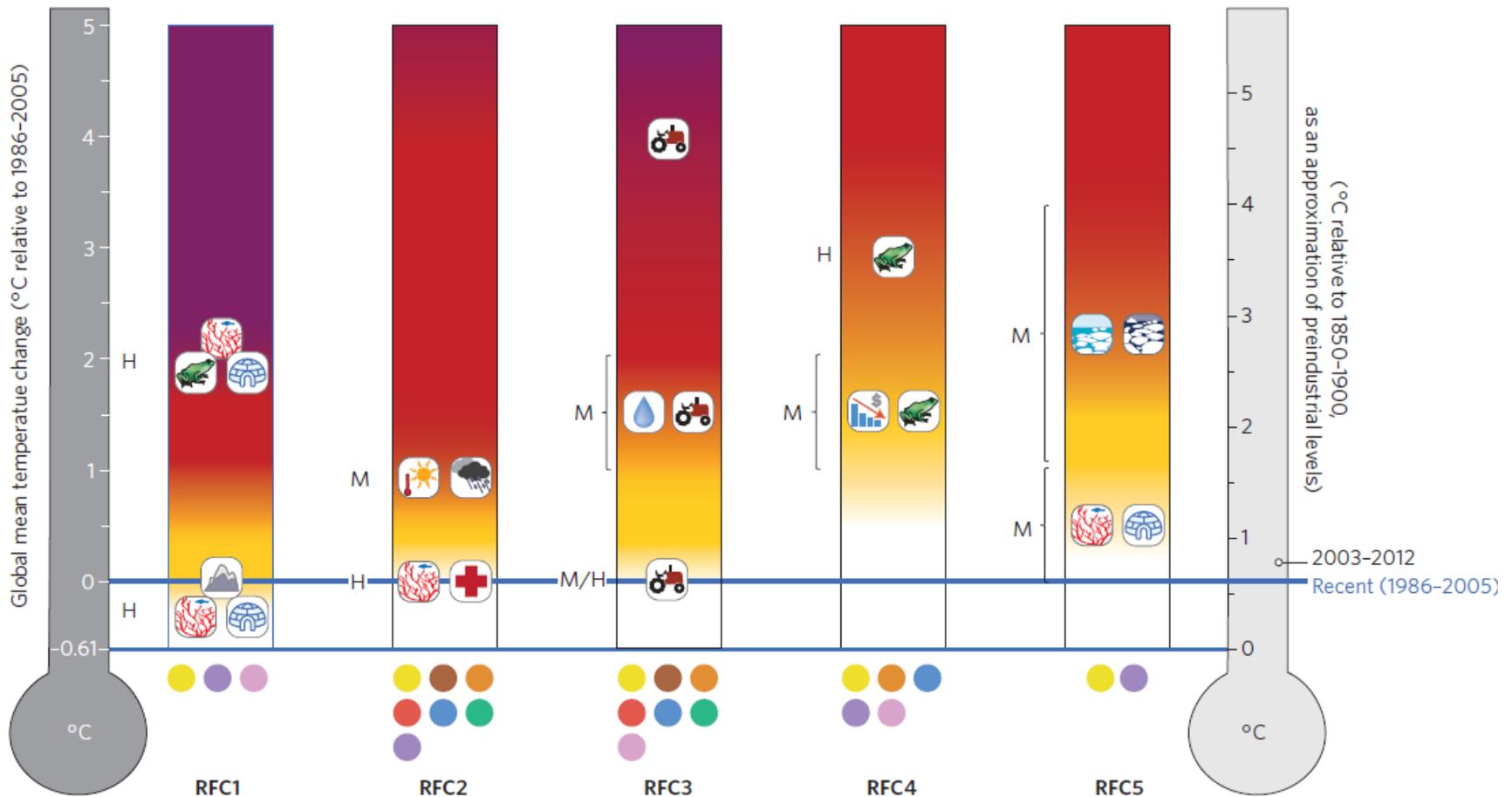
Very high

at least medium confidence
that impacts are both
detectable and attributable to
climate change; also
considering magnitude

Increasing magnitude
or likelihood of
impacts

Risk of severe and
widespread impacts; "high"
on one or more KR criteria

"high" on all KR criteria,
including limited ability
to adapt



Confidence
M Medium
H High

Level of additional risk due to climate change
Undetectable Moderate High Very high

Global key risks
KR i KR v
KR ii KR vi
KR iii KR vii
KR iv KR viii

Selected key risks
Biodiversity Arctic systems Heat waves Agriculture Human health Greenland ice sheet
Coral reefs Mountain systems Extreme precipitation Economic damages Water stress Antarctic ice sheet

Underlying Risk Judgements

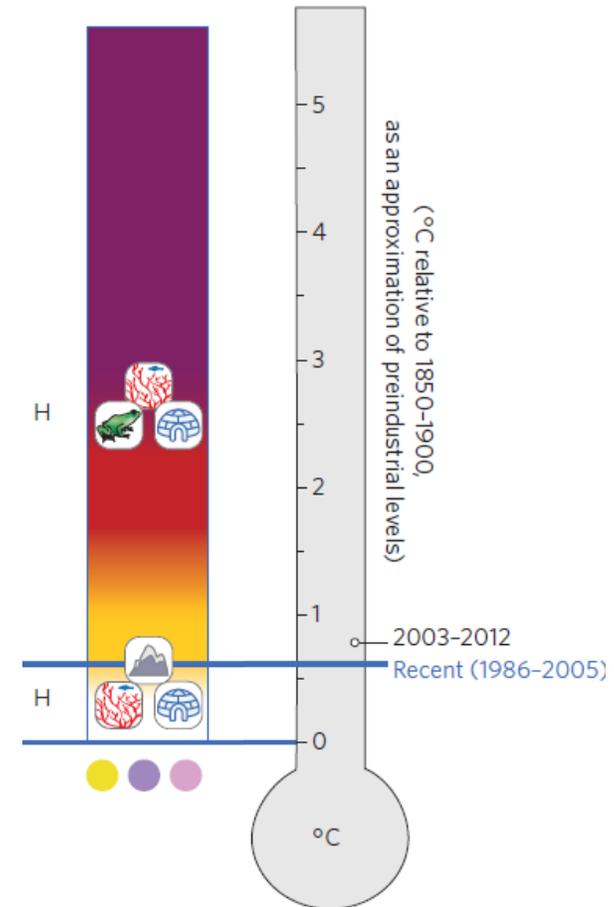
RFC1: Unique/Threatened Systems

Definition

- Geographic range restricted by climate
- High endemism or other distinctive properties

Examples

- Coral reefs, unique indigenous communities, tropical glacier systems, mangrove ecosystems, etc.



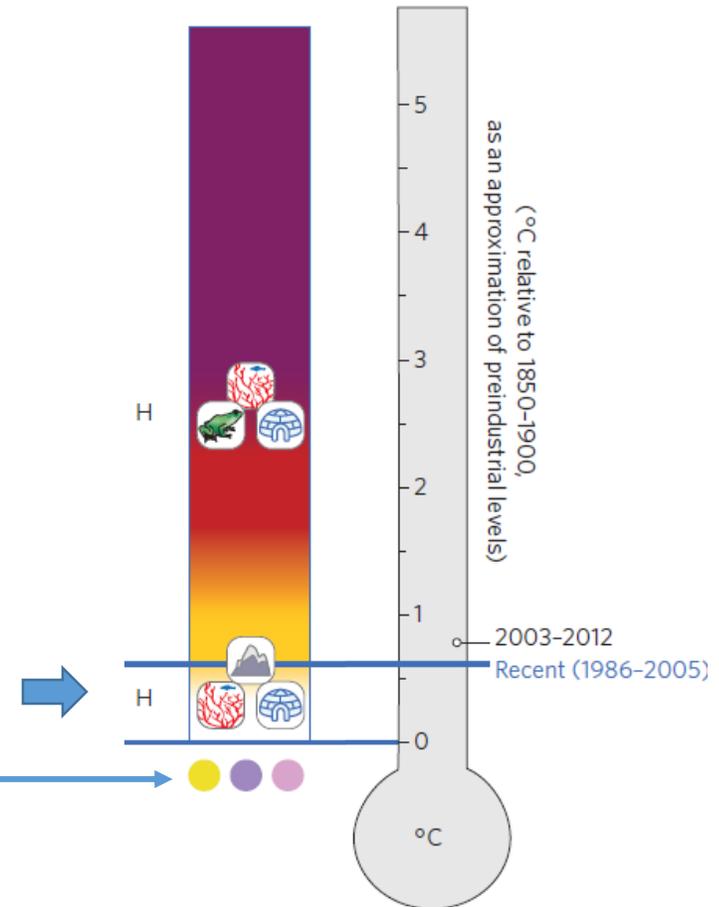
RFC1: Unique/Threatened Systems

“Recent”

detection and attribution of impacts on Arctic, mountain and coral reef systems (Cramer et al., 2014, WG2 Ch. 18)
Informed by overarching Key Risks:
Risks to low-lying coastal zones and small island developing states

Risk of loss of marine and coastal ecosystems

Risk of loss of terrestrial and inland water ecosystems



Global assessments, major role of climate change:

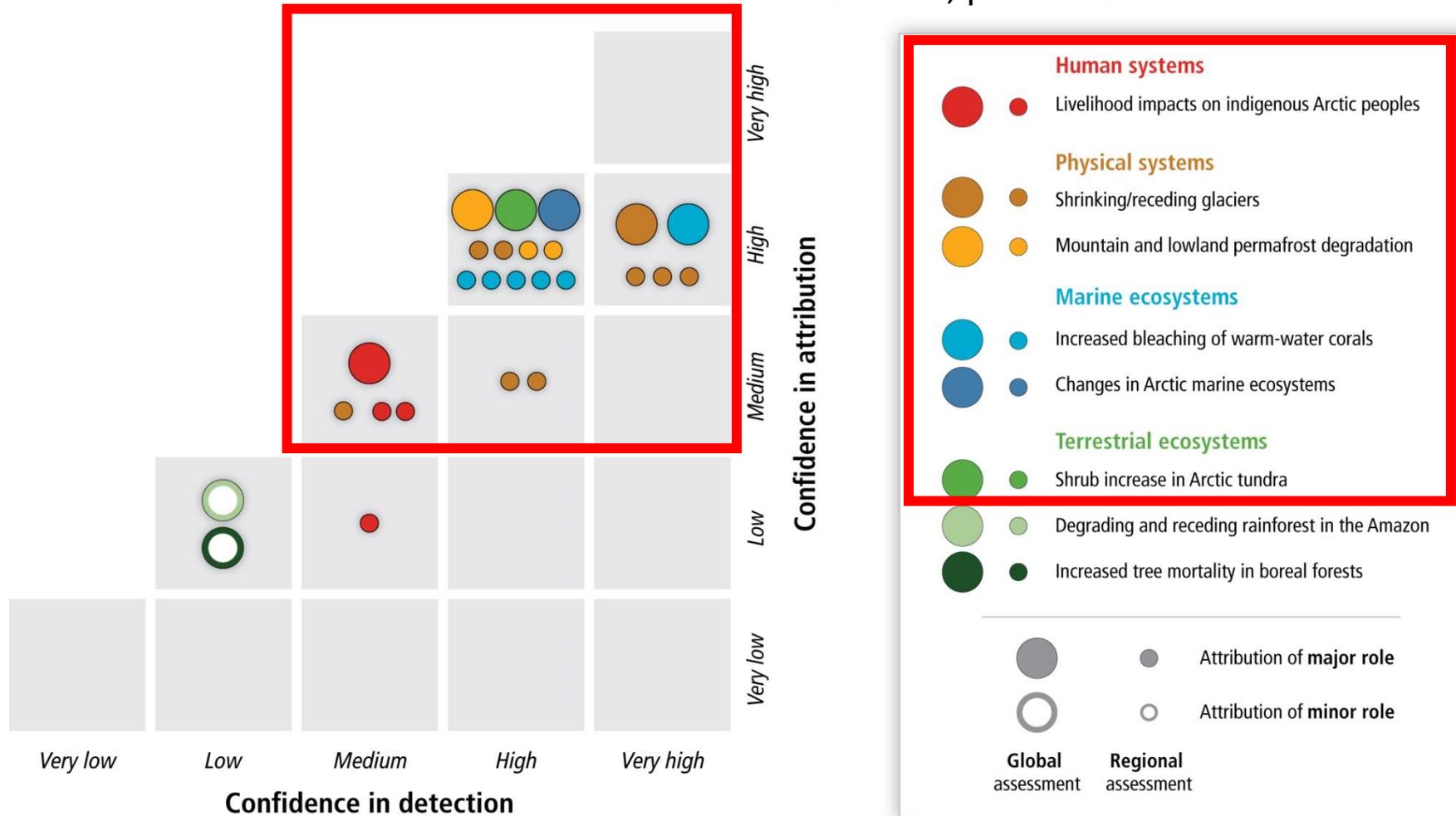
Arctic marine ecosystems, shrubs,

livelihoods of indigenous people

Coral bleaching

Glaciers, permafrost

At least medium confidence in D & A



IPCC AR5 WG2 Ch. 18 (Cramer et al.), Figure 18-5.

RFC1: Unique/Threatened Systems

~2.5 C

Very high risk to species and ecosystems, limited ability to adapt

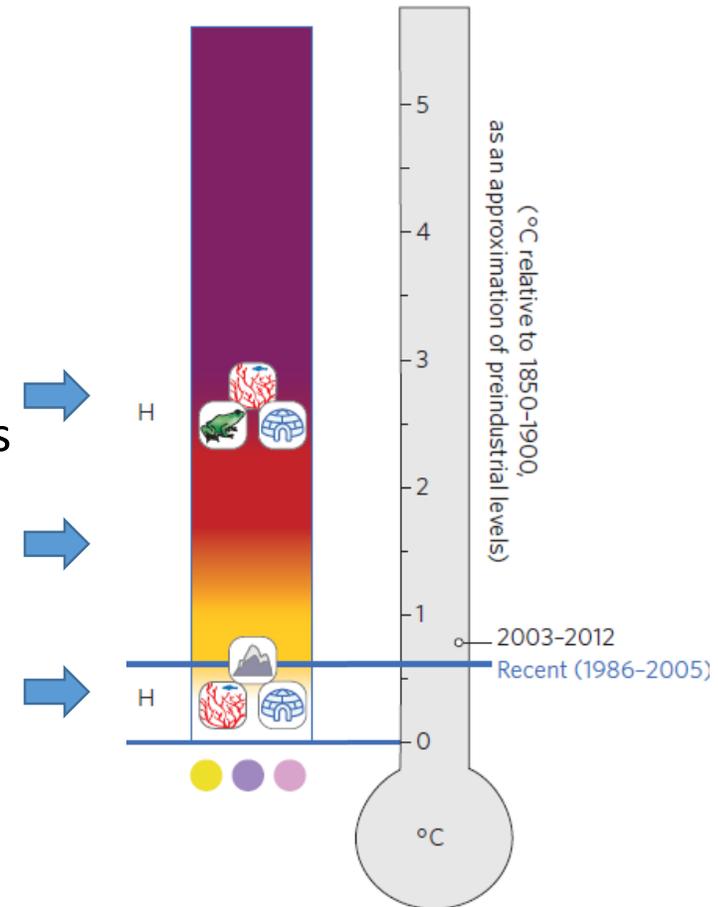
nearly ice free Arctic in September, most CMIP5 models (WG1 Ch. 12)

many species highly vulnerable (e.g. Foden et al., 2013; 2 C warming: 24-50% of birds, 22-44% of amphibians, 15-32% of corals)

limited adaptation, based on uncertainty; species quantitative evidence for Arctic sea ice, coral reefs

“Recent”

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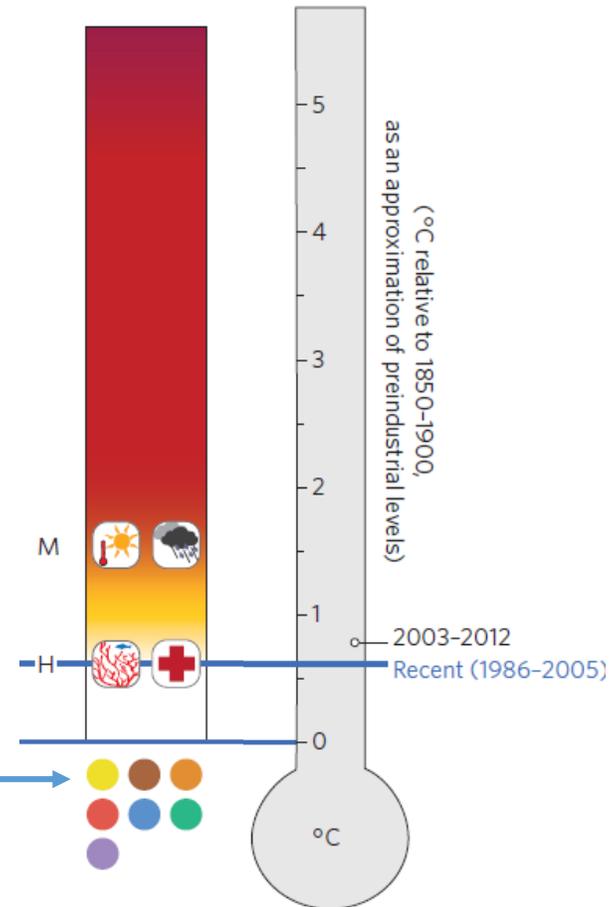


RFC2: Extreme Weather Events

Definition

- Risk to human health, livelihoods, assets, and ecosystems
- Risk from heat waves, heavy rain, drought and associated wildfires, and coastal flooding

Informed by 7 of 8 overarching
Key Risks



RFC2: Extreme Weather Events

~1.5 C (2030s)

Projected temperature and precipitation extremes, e.g.:

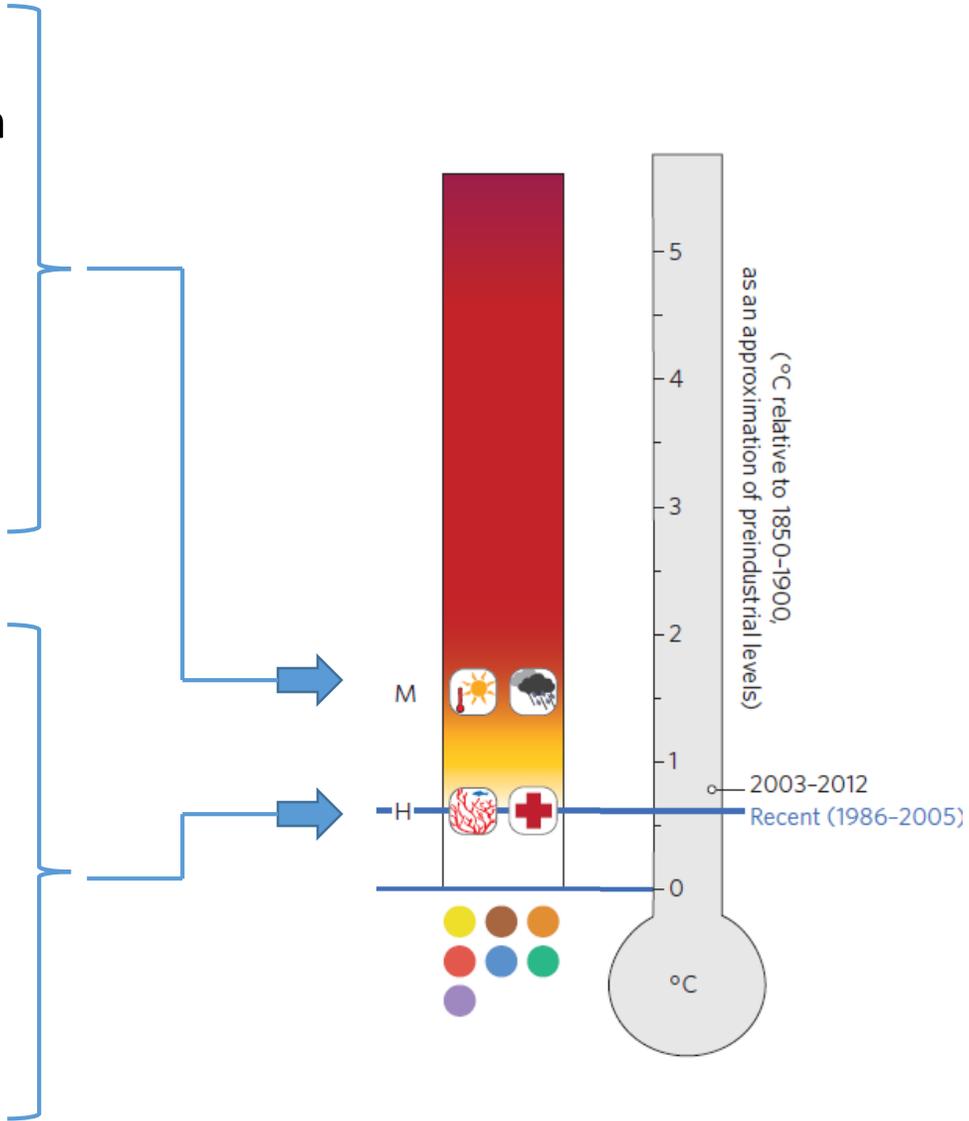
- 25-30% of daily maximum temperatures exceed historical 90th percentile value (AR5)
- 20-year precipitation events become 14-year events (SREX)

“Recent”

Detection/attribution of extreme heat impacts:

- coral reefs
- human health/mortality in some regions

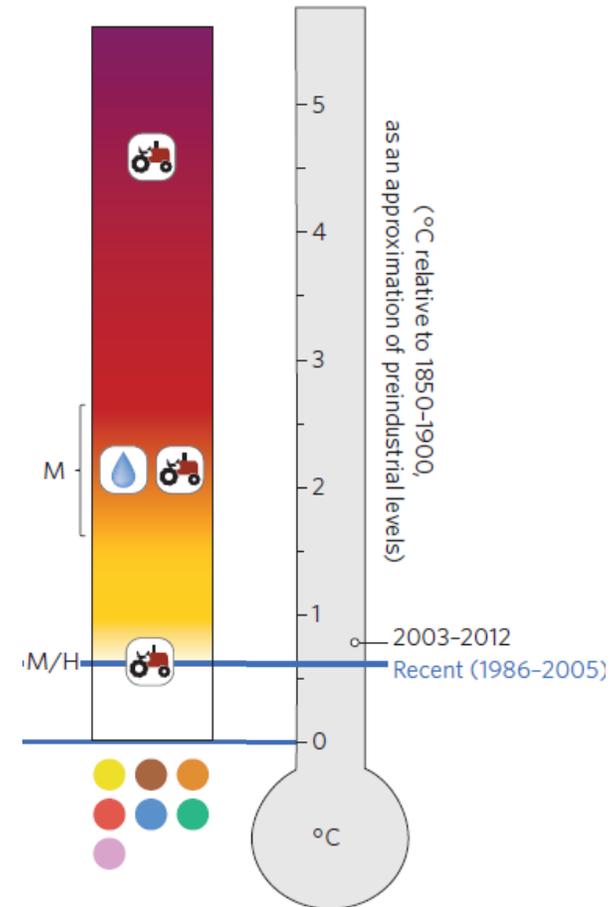
Also consideration of current vulnerability



RFC3: Distribution of Impacts

Definition

- Disproportionate impacts due to uneven distribution of physical climate change hazards, exposure or vulnerability
- Unevenness with respect to geographic location, income and wealth, gender, age, or other physical and socioeconomic characteristics



RFC3: Distribution of Impacts

~1.5-2.5 C

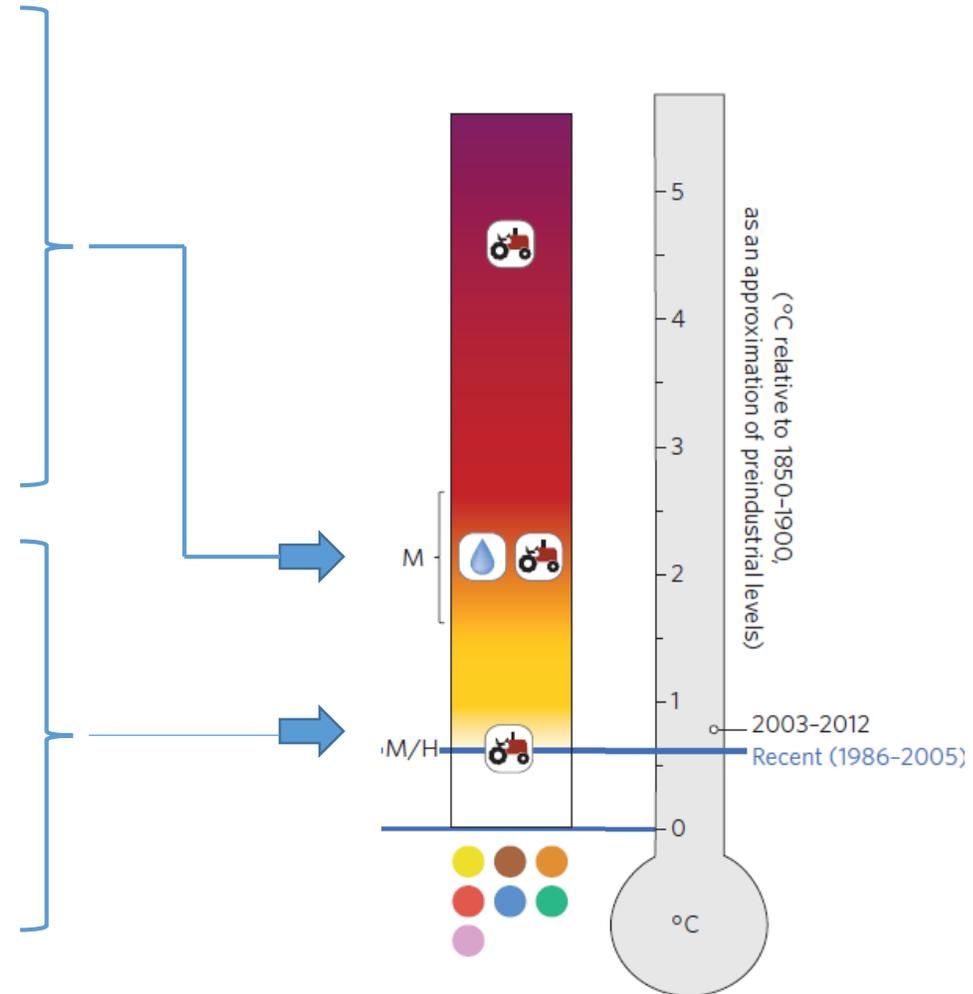
Projected regional yield impacts and water scarcity, especially toward 2.5 C

- Yield loss especially in low latitudes
- “Severe” (>20%) reduction in water resources for 8-14% of population, esp. around Mediterranean

“Recent”

Detection/attribution of yield impacts:

- Wheat in Europe, S America
- “Early warning” of impacts on food security
- Some positive impacts also detected



RFC3: Distribution of Impacts

~4.5 C

Large impacts on crop yields and water resources

Limited scope for agronomic adaptation

- Other types of adaptation possible

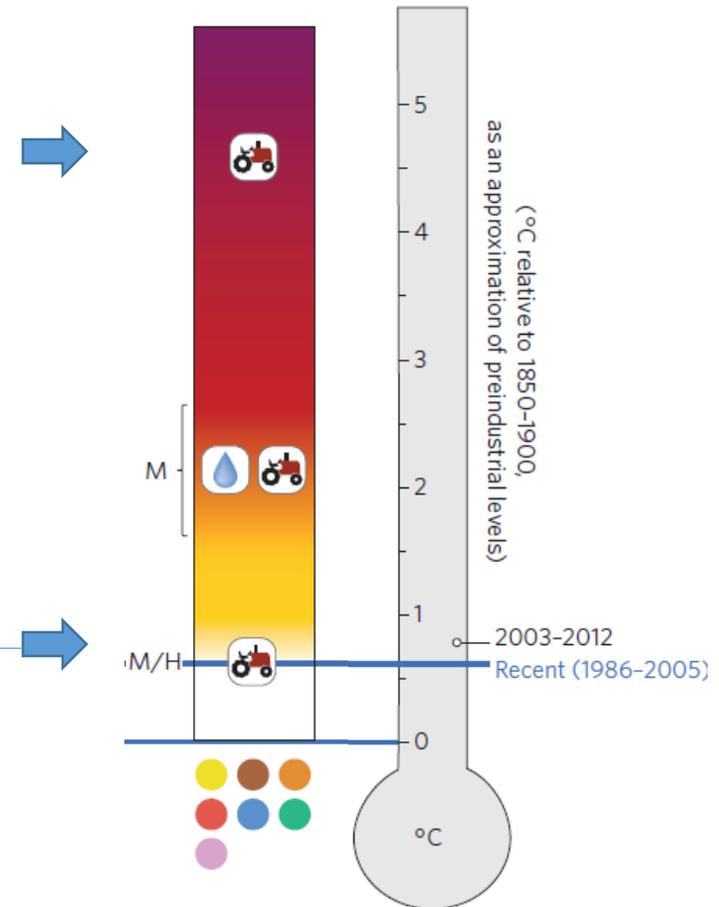
“Recent”

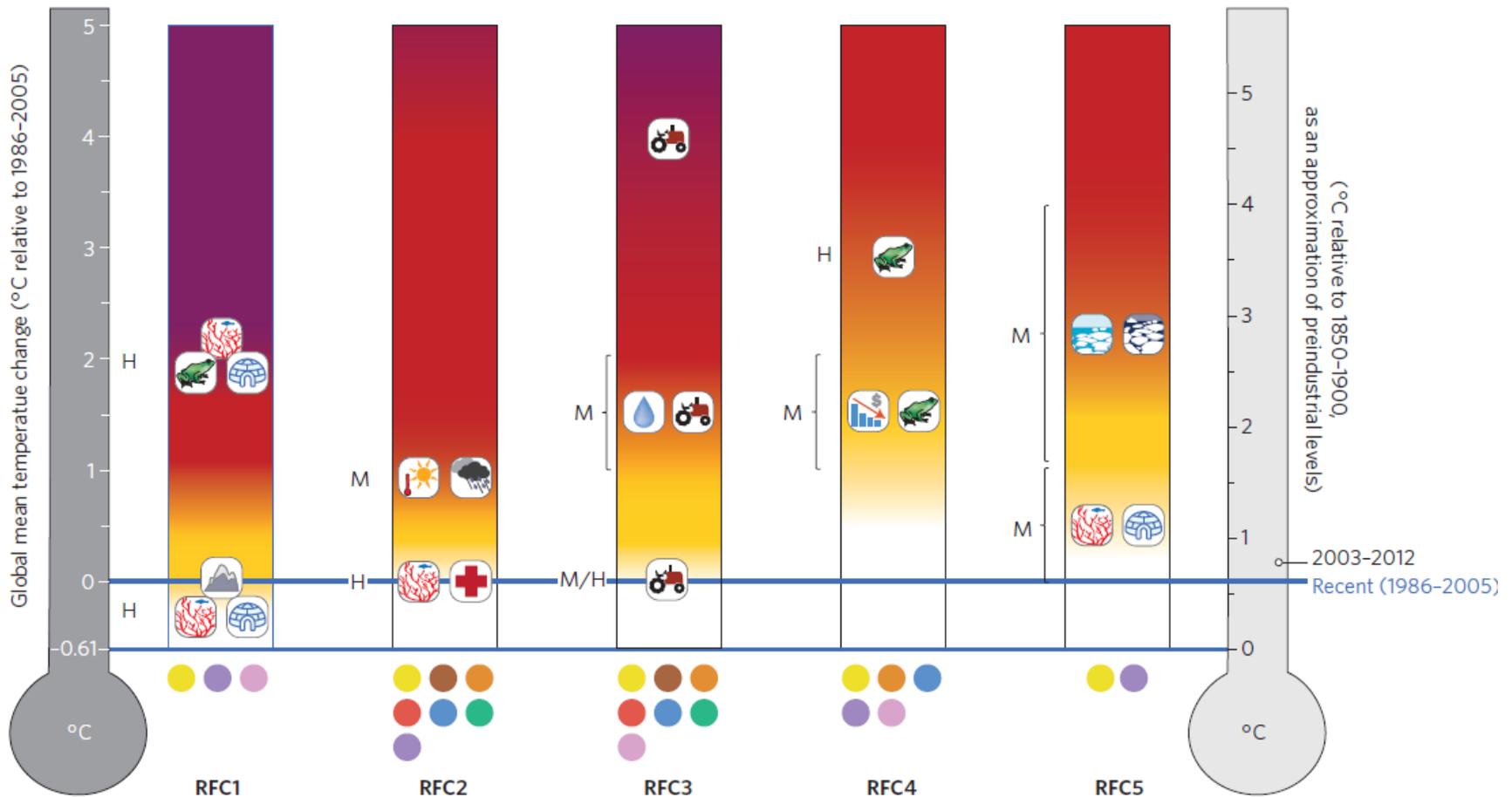
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Features of RFCs from BE diagram

Evidence base is uneven across RFCs

Judgments in some RFCs based primarily on physical impacts

Some RFCs based on few sectors involved

- RFC on distribution of impacts draws heavily on agriculture

Some risks figure prominently across several RFCs

- coral reefs, arctic systems, biodiversity inform RFCs 1, 2, 4, 5

Sensitivity to development pathway and adaptation not included

Method of arriving at risk judgments not transparent

Evolution since AR5

IPCC Special Report on 1.5 C (2018)

Fleshed out assessment at low levels of warming

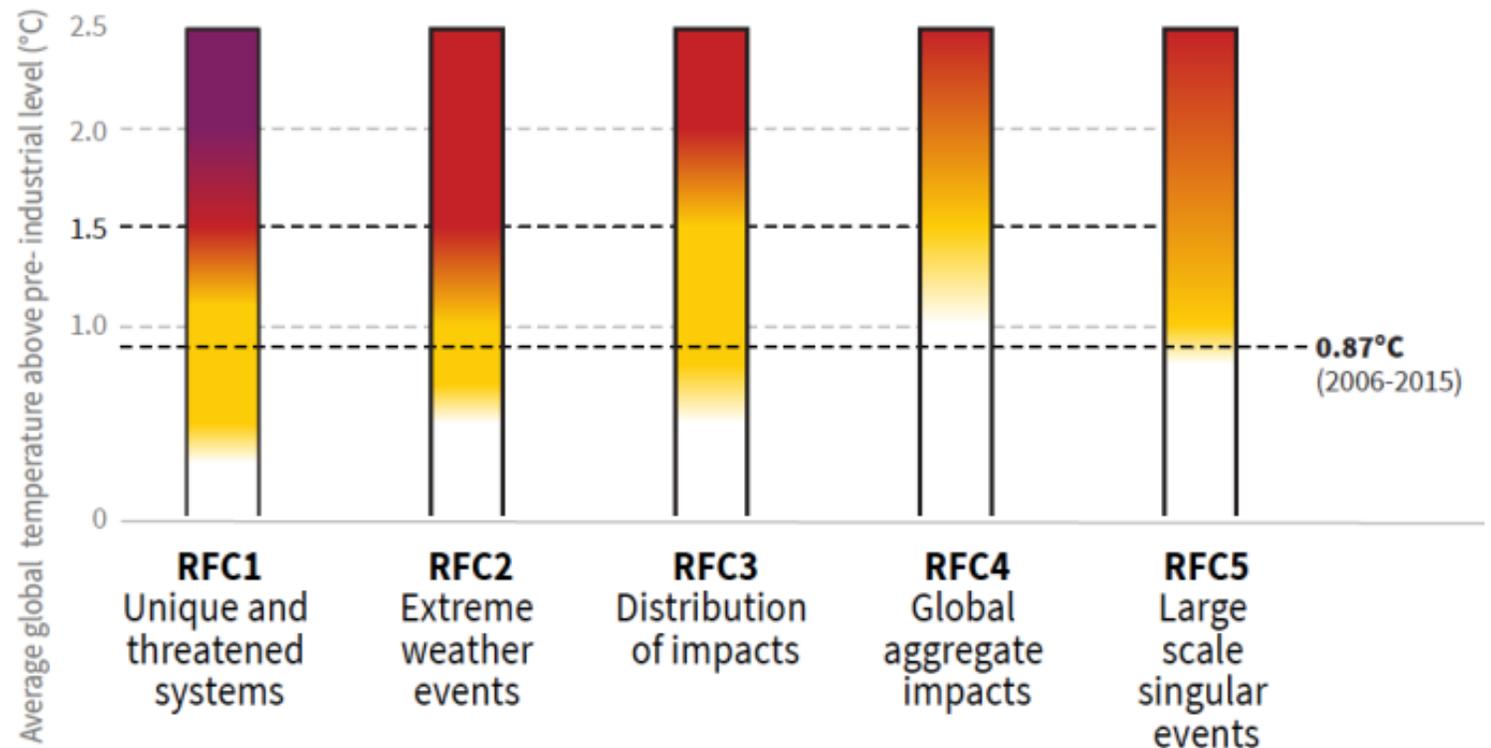
Updated assessment up to 2.5 C warming

Overall increase in risks

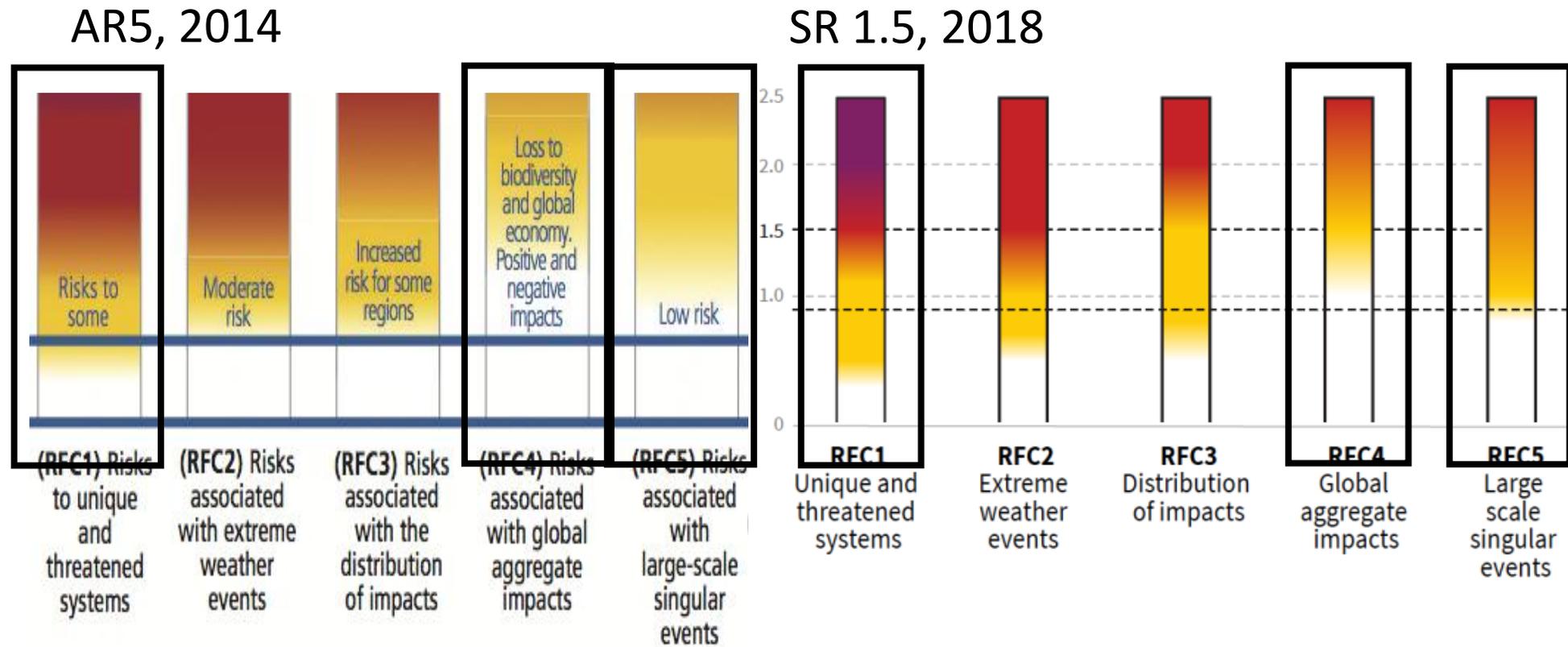
Biggest changes:

- RFC1: Risks to coral reefs
- RFC4: Risks of aggregate economic impacts
- RFC5: Risks from sea level rise due to ice sheet melting

Risk associated with the Reasons for Concern (RFCs)



IPCC Reasons for Concern



IPCC Special Report on Climate Change and Land

Risks due to climate change and societal conditions

Draft, not for citation or dissemination!

IPCC Sixth Assessment Report

Definition of RFCs (all preliminary thoughts!)

Likely to retain five global RFC categories for continuity

Possible additional aggregations of key risks into RFCs for:

- Sectors

- Regions

- New topical aggregations with less overlap

- Differentiated by adaptation levels

- Differentiated by development pathways

Evolution of methods for risk judgments

SR 1.5 C

Similar to Fifth Assessment Report

SR Climate Change and Land

Formal expert elicitation

SR Ocean and Cryosphere

Expert judgment with scoring of risk indicators

Sixth Assessment Report

Expert judgment with scoring of key risk criteria?

Precedents in the literature: Piontek et al., 2014; Byers et al., 2018.

Climate risks in context

Climate and Poverty

Shock Waves Report (World Bank, Hallegatte et al., 2015)

| | Additional people in poverty (Millions) |
|-----------------------------------------------------------------|-----------------------------------------|
| Effect of climate change (vs no climate change), 2030 | 3-122 |
| Effect of pessimistic (vs optimistic) development pathway, 2030 | 758 |

Climate and Hunger

Hasegawa et al., 2018

| | Additional people in hunger (Millions) |
|-----------------------------------------------------------------|----------------------------------------|
| Effect of climate change (vs no climate change), 2050 | ~5-85 |
| Effect of pessimistic (vs optimistic) development pathway, 2050 | ~500 |

Conclusions and open questions

Key risks and Reasons for Concern remain an important means of communicating climate change risk results

Approaches are evolving to improve on weaknesses, but issues remain

Questions:

What if new methods of assessing key risks lead to changes in risk judgments, independent of change in evidence?

How (and whether) to take relative risk into account?

How to transparently reflect risks of mitigation?

How to synthesize assessment of key risks with assessment of mitigation and of climate outcomes?