**SIXTH ASSESSMENT REPORT**
Working Group I – The Physical Science Basis

ipcc
INTERGOVERNMENTAL PANEL ON climate change

WMO UNEP

# The IPCC Sixth Assessment Report

Linda Mearns, National Center for Atmospheric Research
Lead Author: Atlas, Interactive Atlas
CAS Annual Meeting, November 8, 2021

#ClimateReport #IPCC

# Intergovernmental Panel on Climate Change (IPCC)

- Established by WMO and UNEP in 1988
- Purpose: to assess the scientific and socio-economic information regarding climate change
- The IPCC has three Working Groups:
- Working Group I: Science of the climate system
- Working Group II: Impacts, vulnerability and adaptation
- Working Group III: Options for limiting greenhouse gases
- There have been six full assessments: 1990, 1995, 2001, 2007. 2013/14, 2021, and numerous special reports (e.g., SREX, 1.5 deg).

# Increasing Confidence in the Science

- **IPCC 1990: The observed increase [*in temperatures*] could be largely due to natural variability; alternatively this variability and other man-made factors could have offset a still larger man-made greenhouse warming.**
- **IPCC 1995: The balance of evidence suggests a discernible human influence on global climate.**
- **IPCC 2001: There is new and stronger evidence that most of the warming observed over the last 50 years is due to human activities.**
- **IPCC 2007: Most of the observed increase in global temperatures since the mid-20th century is very likely (90%) due to the observed increase in greenhouse gas concentrations.**

# Increasing Confidence in the Science (continued)

- **IPCC 2013: The evidence for human influence has grown since AR4. It is extremely likely that human influence has been the dominant cause of the observed warming since the mid-20th century.**

- **IPCC 2021: It is indisputable that human activities are causing climate change.**

# IPCC Sixth Assessment Report : Some Statistics

## Author Team

234 Authors from 65 countries

28% women, 72% men

30% new to the IPCC

## Review Process

14,000 scientific publications assessed

More than 78,000 review comments

46 countries commented on final government distribution

Final plenary where SMP is accepted by country representatives

# How is the climate changing?

Observed changes in the atmosphere, oceans, cryosphere and biosphere provide unequivocal evidence of a world that has warmed.
Over the past several decades, key indicators of the climate system are increasing at levels unseen in centuries to millennia and are changing at rates unprecedented in at least the last 2000 years.

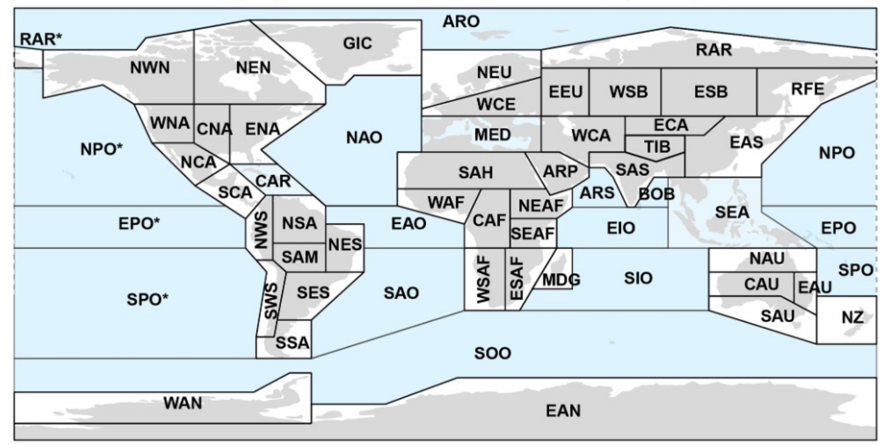
**What's new in this report?**

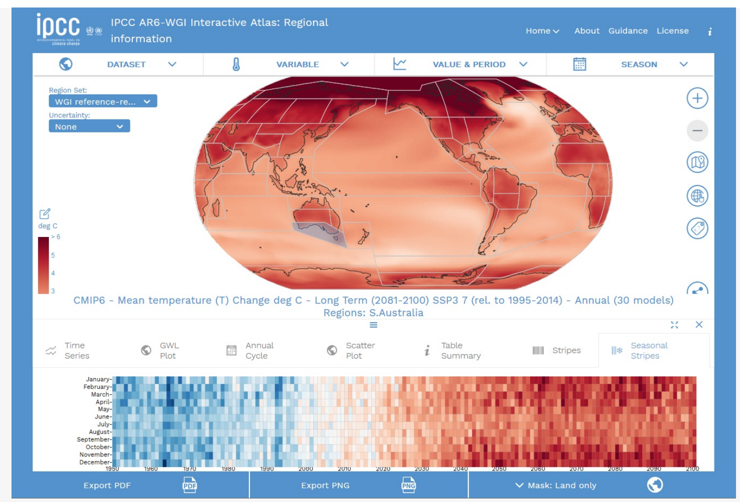
- Greater focus on regional information
- Greater integration with and production of information relevant to impacts of climate change (relevance to Working Group 2)
- Particular focus on changes in the water cycle
- More years of data
- Increasing range of observational products available
- Increasing integration of paleoclimate information
- Newer climate models (greater number) (global and regional models)

# Regional information

- Greater regional focus than any previous report
- Chapter 10 – Linking global to regional climate change
- Chapter 11 – Climate extremes
- Chapter 12 – Regional information for impact assessment, incl. 'Climate Impact-Drivers (CIDs)
- Atlas – average climate: past trends, attribution, projections
- Interactive Atlas – new online tool
- https://interactive-atlas.ipcc.ch/

(b) Updated IPCC WGI reference regions (v4)



# Key messages

*We've known for decades that the world is warming. Recent changes in the climate are* ***widespread, rapid, and intensifying****. They are* ***unprecedented*** *in thousands of years.*

*It is* ***indisputable that human activities are causing climate change****. Human influence is making* ***extreme climate events****, including heat waves, heavy rainfall, and droughts, more frequent and severe.*

*Climate change is already* ***affecting every region on Earth****, in multiple ways. The changes we experience will increase with further warming.*

***There's no going back from some changes*** *in the climate system. However, some of these changes could be slowed and others could be stopped by limiting warming.*

***Unless there are immediate, rapid, and large-scale reductions in greenhouse gas emissions, limiting warming to 1.5°C will be beyond reach.***

*To limit global warming,* ***strong, rapid, and sustained reductions in $CO_2$, methane, and other greenhouse gases*** *are necessary. This would not only reduce the consequences of climate change but also* ***improve air quality*****.**

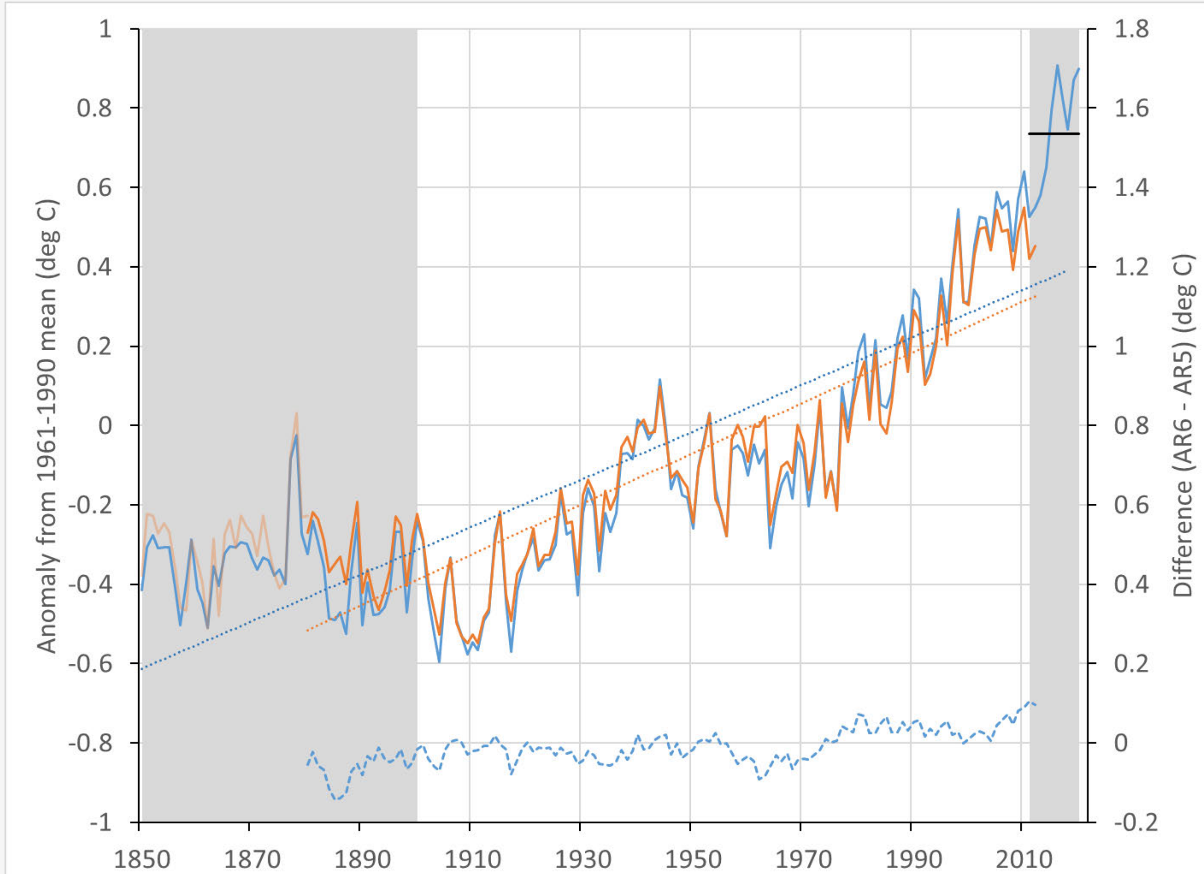
# Global mean surface temperature warmed 1.09 °C from 1850-1900 to 2011-2020

This compares with 0.85 °C warming reported in AR5

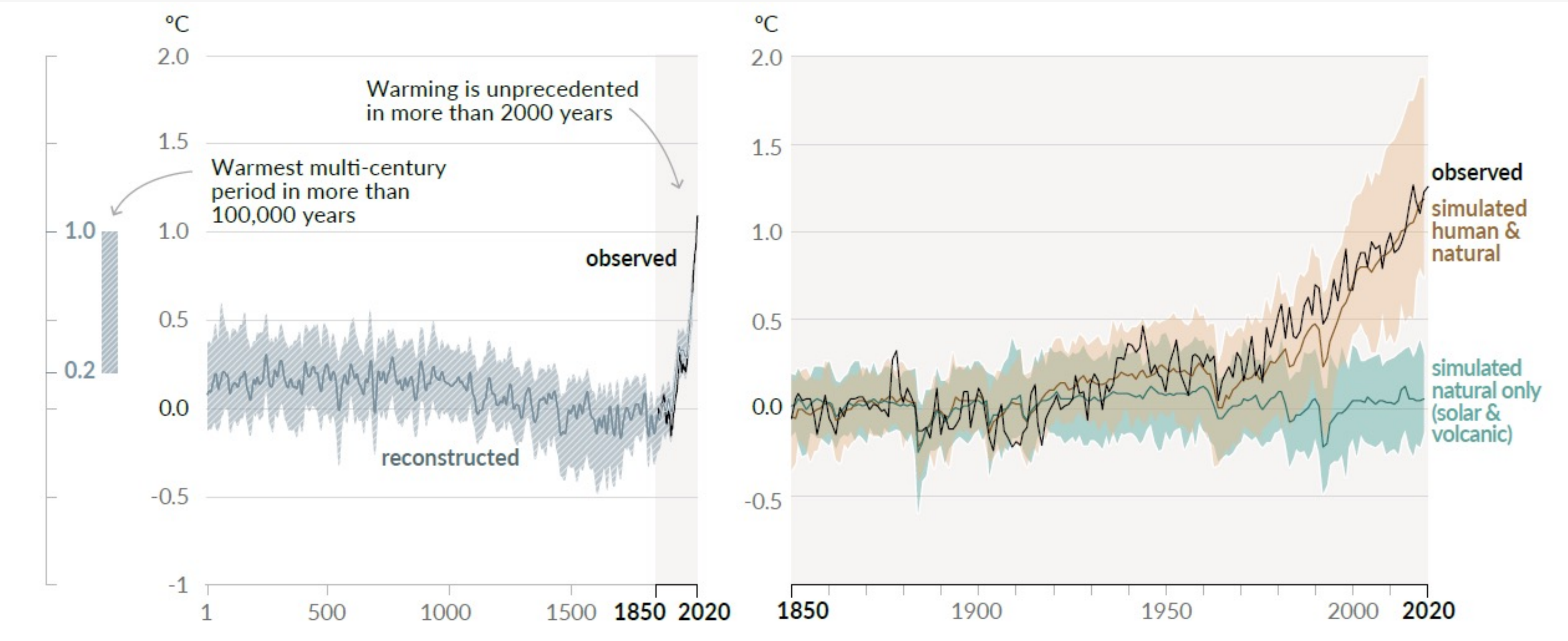
Most of this is additional warming since 2012, but new generations of data sets also contribute

Global temperature increases from 1850-1900 to 2011-2020:

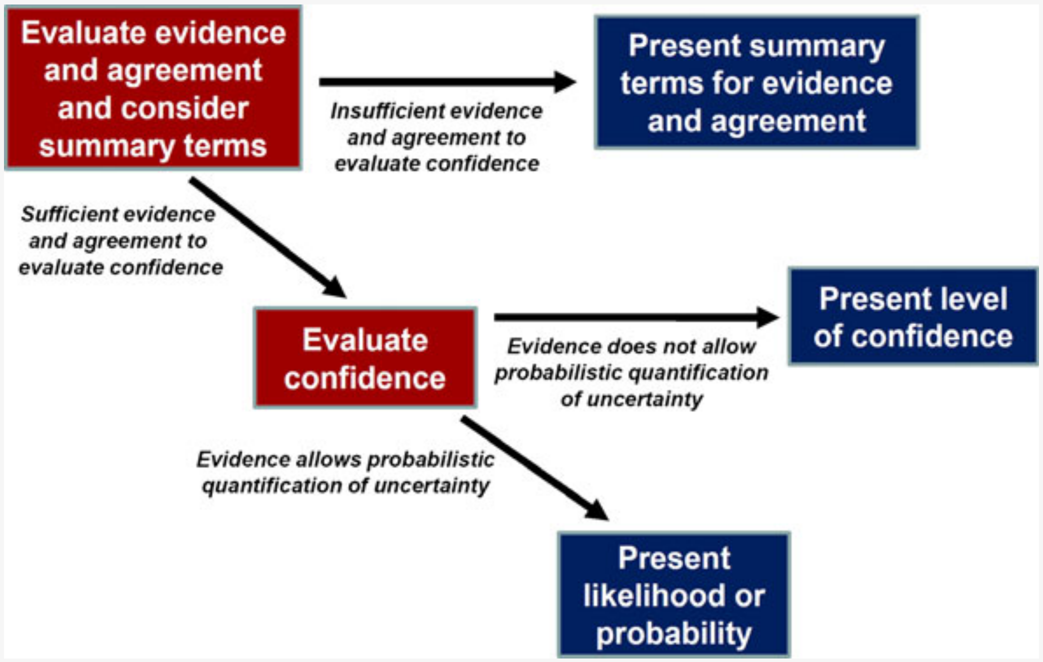
| | |
|---|---|
| Land and ocean | 1.09 °C [0.95-1.20] |
| Land | 1.59 °C [1.34-1.83] |
| Ocean | 0.88 °C [0.68-1.01] |



# Global temperature – change and attribution



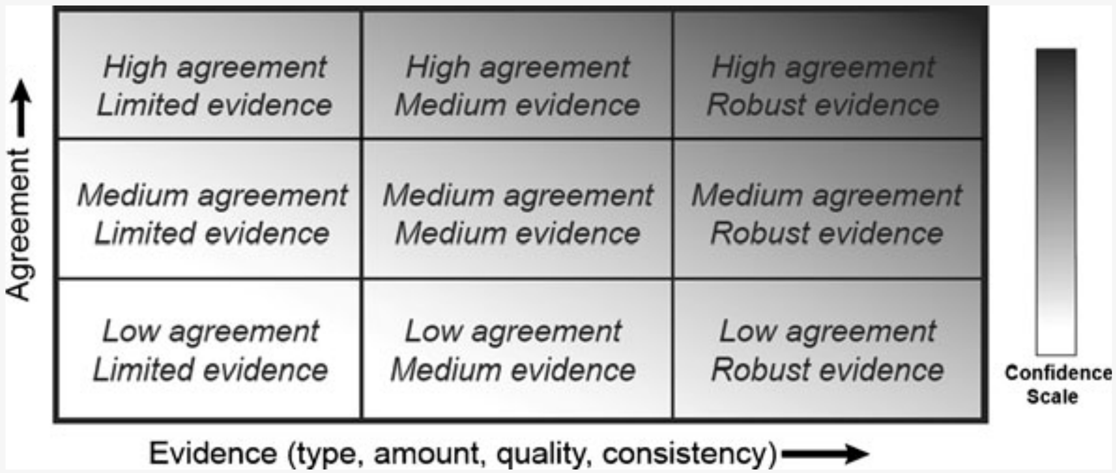
# Uncertainty in the IPCC Reports




Process for Evaluating and Communicating the Degree of Certainty in Key Findings.

Mastandrea et al., 2011 (*Climatic Change*)

# Uncertainty in the IPCC Reports




Depiction of evidence and agreement statements and their relationship to confidence.

Level of confidence provides a qualitative synthesis of authors' judgement about the validity of a finding.

Mastandrea et al. 2011

# Uncertainty in the IPCC Reports

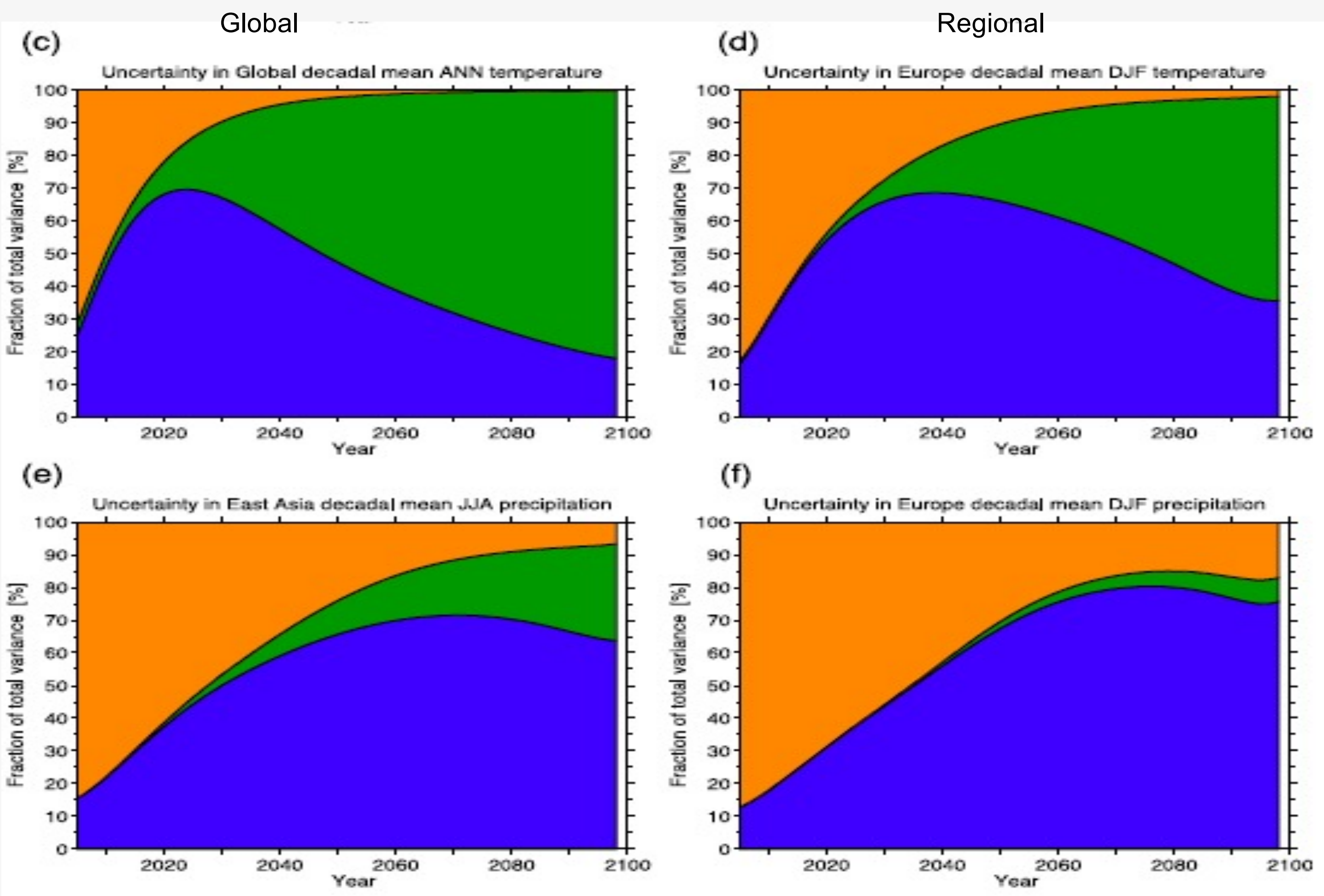
**Table 1** The likelihood scale presented in the AR5 Guidance Note. Reproduced from Mastrandrea et al. (2010)

| Term[a] | Likelihood of the outcome |
|---|---|
| Virtually certain | 99–100% probability |
| Very likely | 90–100% probability |
| Likely | 66–100% probability |
| About as likely as not | 33 to 66% probability |
| Unlikely | 0–33% probability |
| Very unlikely | 0–10% probability |
| Exceptionally unlikely | 0–1% probability |

[a] Additional terms that were used in limited circumstances in the AR4 (*extremely likely*—95–100% probability, *more likely than not*—>50–100% probability, and *extremely unlikely*—0–5% probability) may also be used in the AR5 when appropriate

Mastandrea et al. 2011

# Future Climate Uncertainties



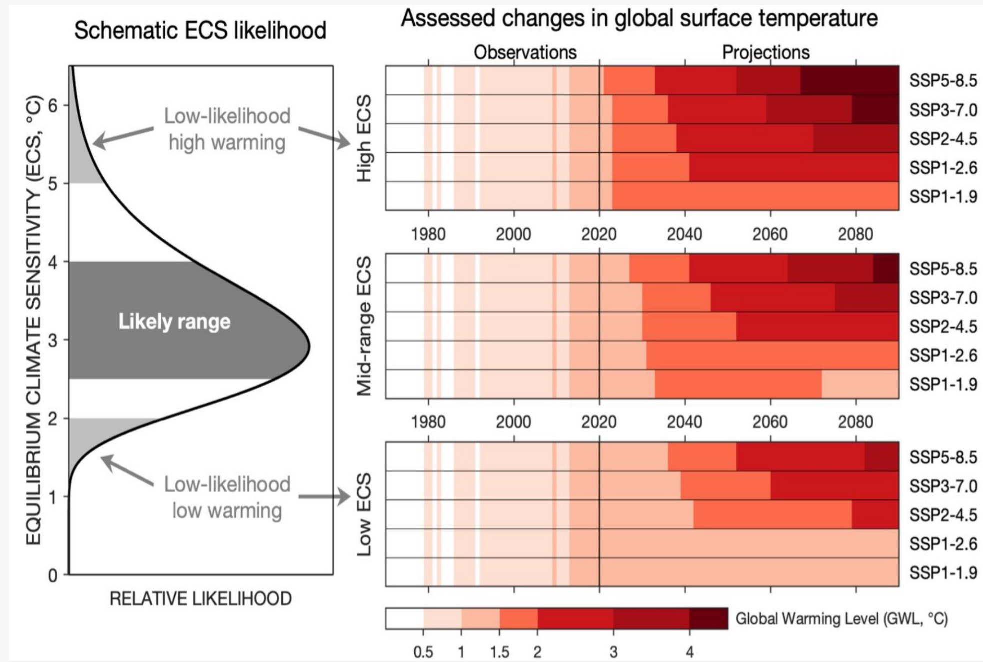

Green = scenario uncertainty;
blue = climate model uncertainty;
orange = internal variability.
(Hawkins and Sutton, 2009).

# Projections

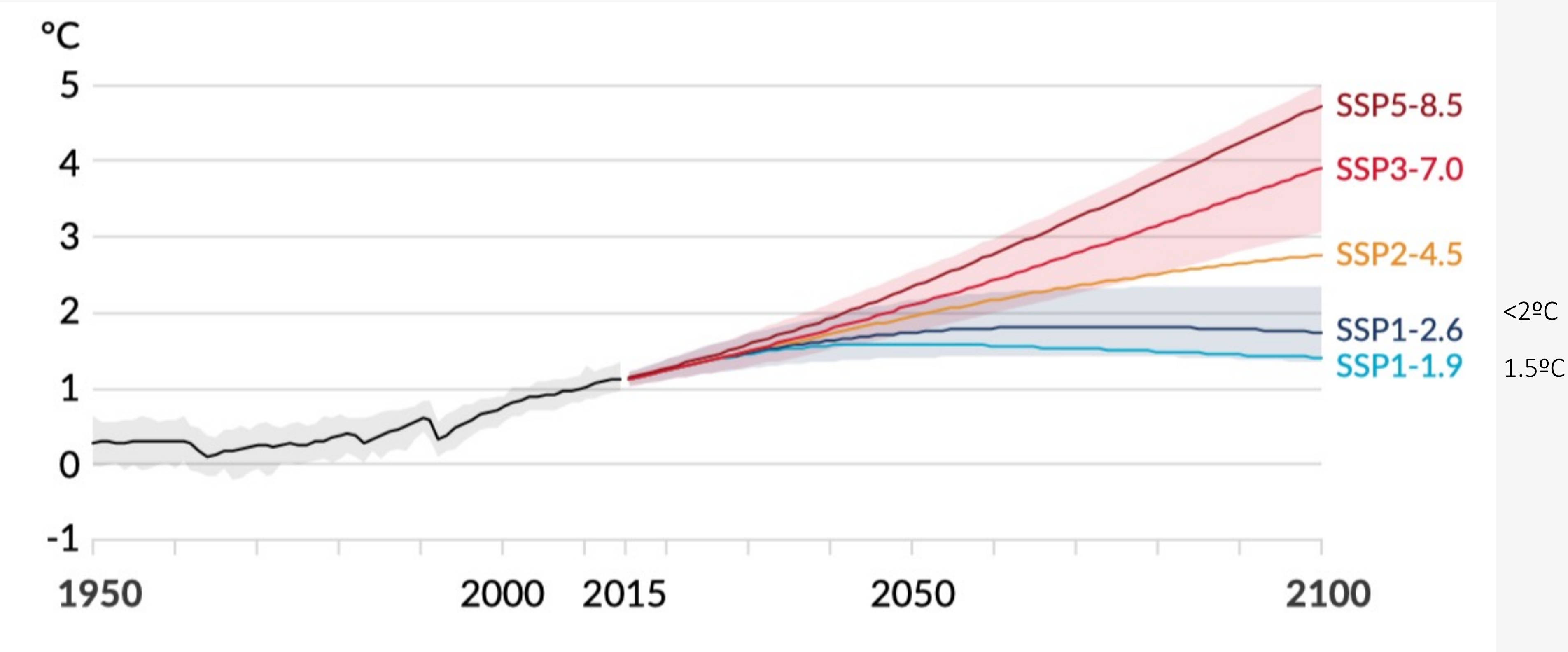
Presented in three ways:

- New Shared Socio-economic Pathways (SSPs)
  - SSP1-1.9 – Sustainability, to
  - SSP5-8.5 – Fossil-fuelled development
- Global Warming Levels 1.5, 2, 3 and 4 °C
- Warming with carbon budget

Assessed for new *likely* range of climate sensitivity (2.5 to 4 °C) and low-likelihood (<2 and >5 °C)

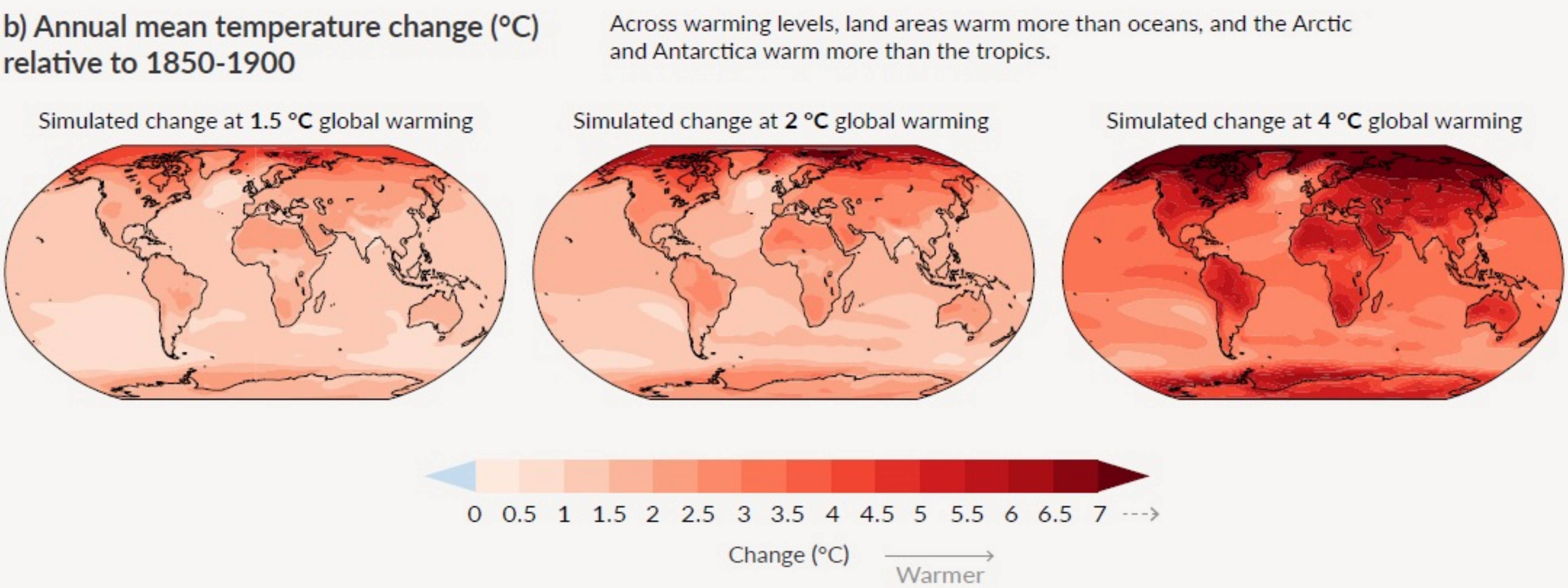


# Projections – emissions and time horizon




Extract from SPM, Fig. SPM8

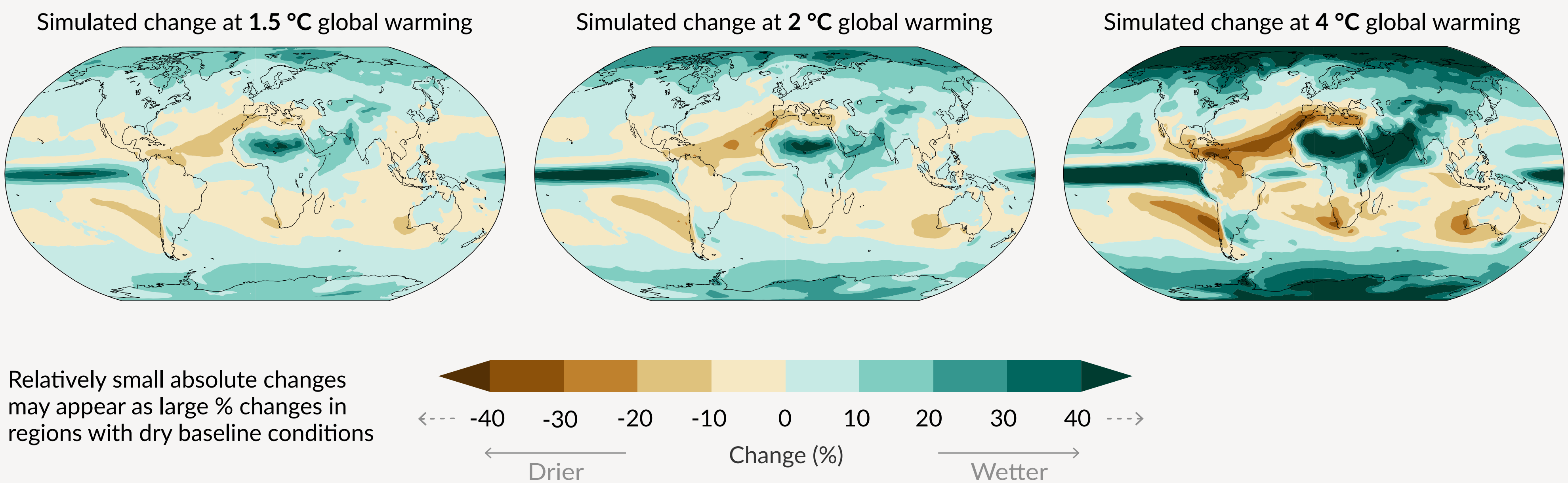
# Projections – global warming levels




Extract from SPM, Fig. SPM5

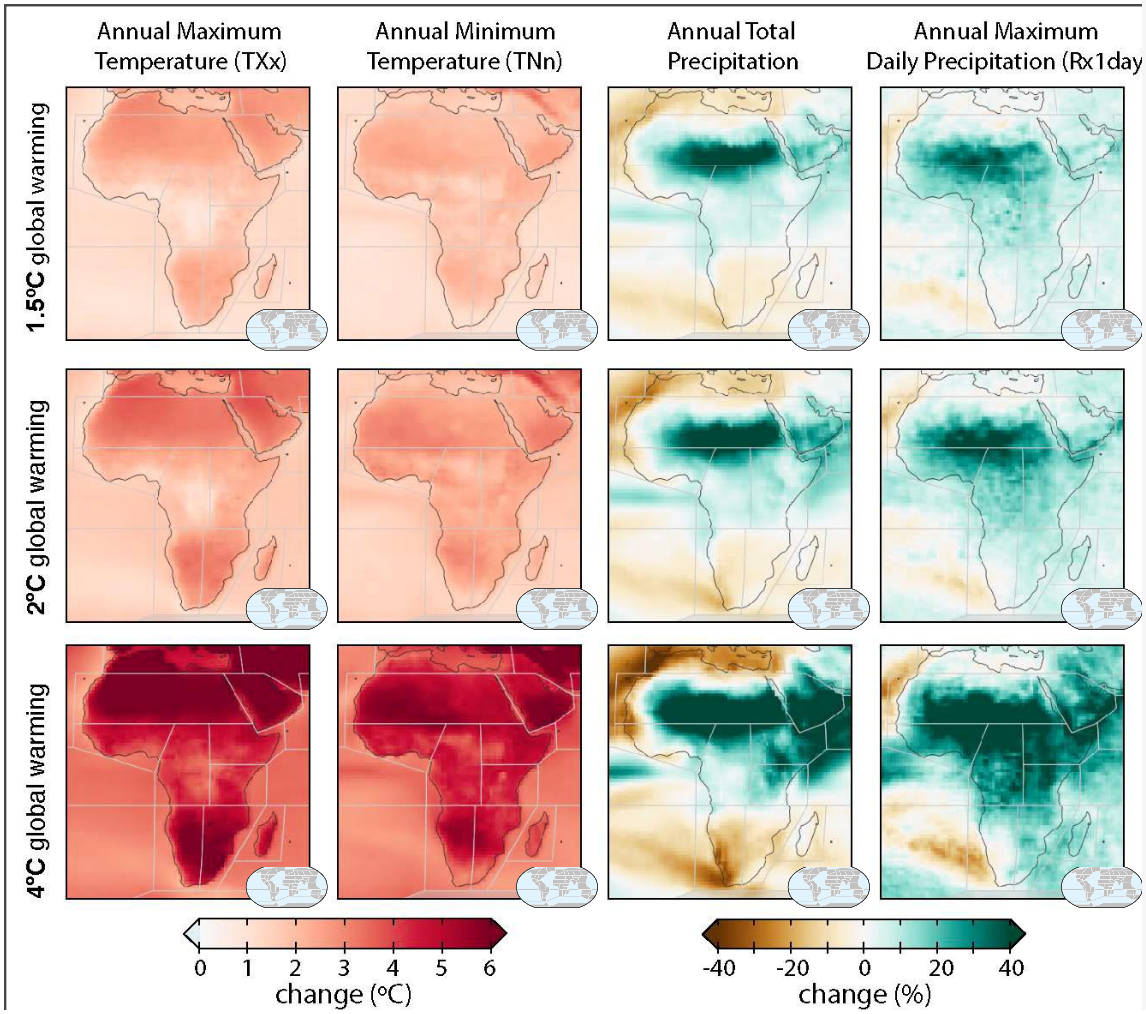
## c) Annual mean precipitation change (%) relative to 1850-1900

Precipitation is projected to increase over high latitudes, the equatorial Pacific and parts of the monsoon regions, but decrease over parts of the subtropics and in limited areas of the tropics.




Relatively small absolute changes may appear as large % changes in regions with dry baseline conditions

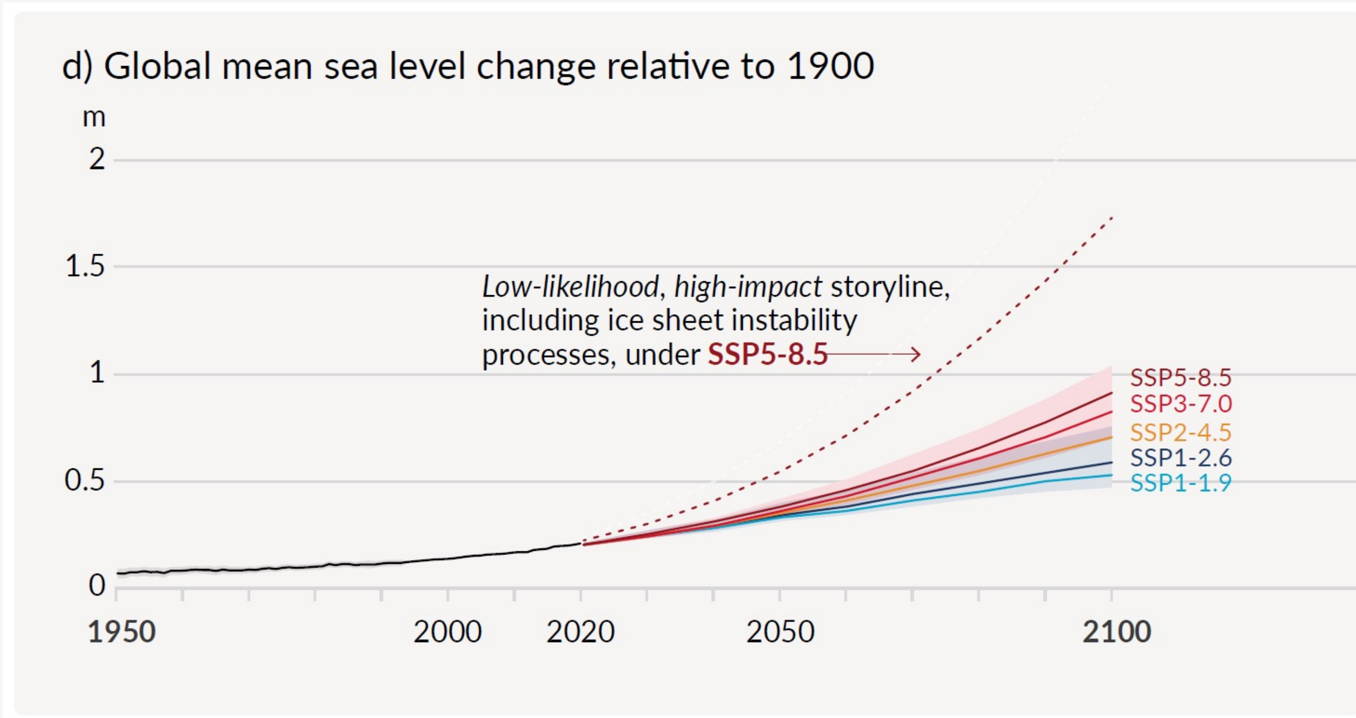
# Projections – Africa




Results for global warming levels

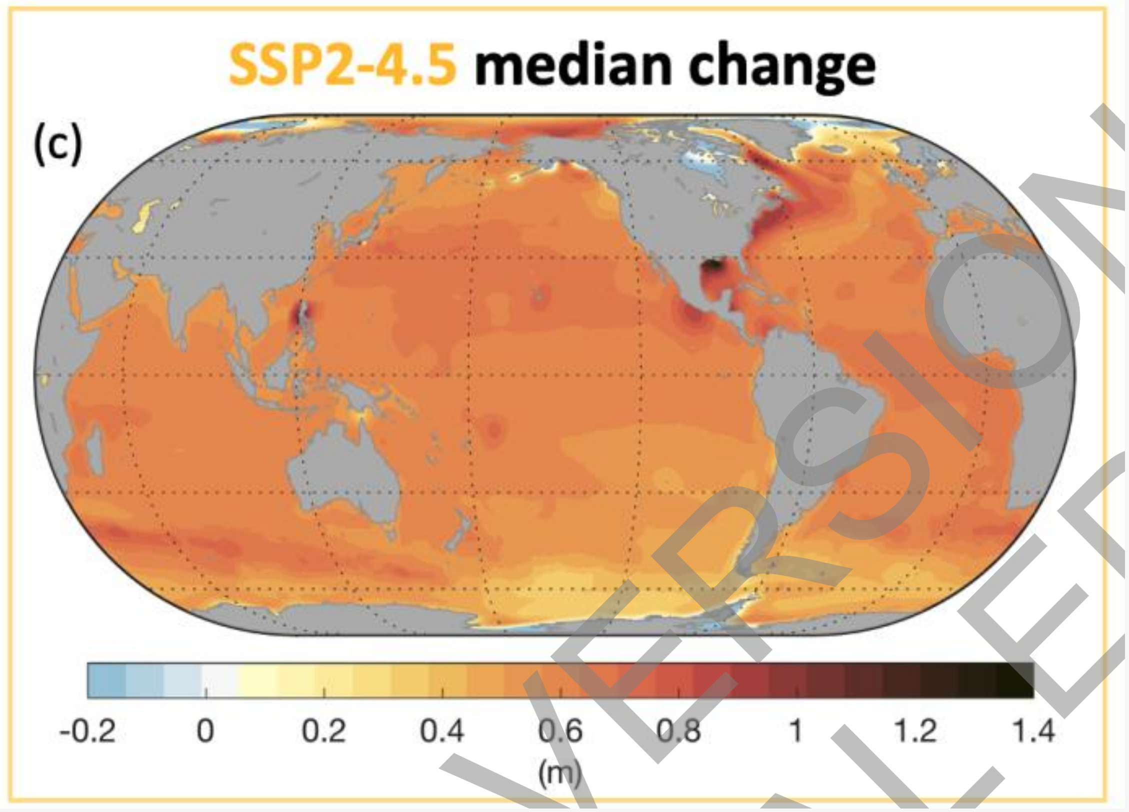
See more in Ch10-12, Atlas and https://interactive-atlas.ipcc.ch/

# Sea level rise




- Rate in last 100 years fastest in last 3000 years, accelerated in recent decades
- Faster in Australasian region than the global average
- Sandy shorelines have retreated in many locations
- Extreme sea-level events - more frequent and severe coastal flooding in low-lying areas, coastal erosion

# Regional Sea Level Rise – end of 21st Century



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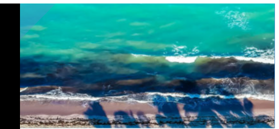
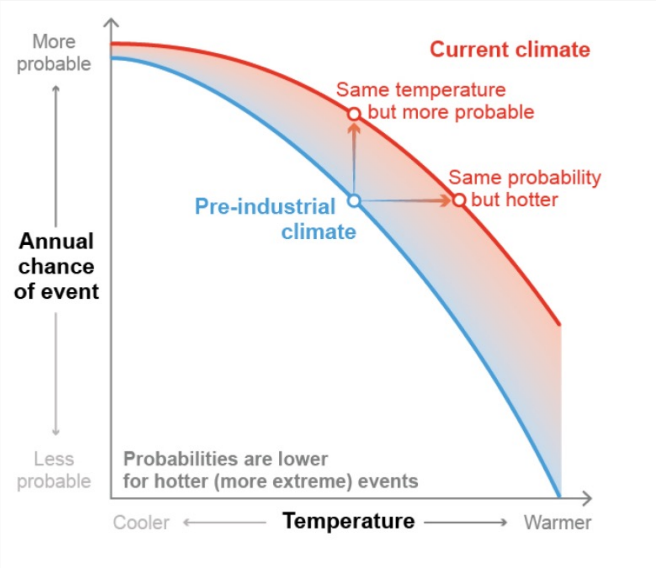


# South Florida Shoreline Change after a 1-Meter Rise in Sea Level

One meter sea level rise quite possible by end of this century

# Extremes – event attribution

- Now higher confidence in human influence on events generally, such as:
  - Heat extremes (*virtually certain*)
  - Heavier rainfall from tropical cyclones (*high confidence*)
  - The chance of compound extreme events (*likely*)
- Extremes with formal attribution, such as: (examples from different countries)
  - Heat extremes on land in 2013, 2017, 2019-20
  - Marine heatwaves – southeast, and Great Barrier Reef
  - Precipitation extremes – Rx 1 and Rx 5, North America and Eurasia, Europe
  - Conditions setting up bushfires – Queensland 2018, Tasmania 2015-16, the 'Black Summer' 2019-20



# Extremes – Major Messages

**It is an *established fact* that human-induced green house gas emissions have led to an increased frequency and/or intensity of some weather and climate extremes since pre-industrial time, in particular for temperature extremes*.***

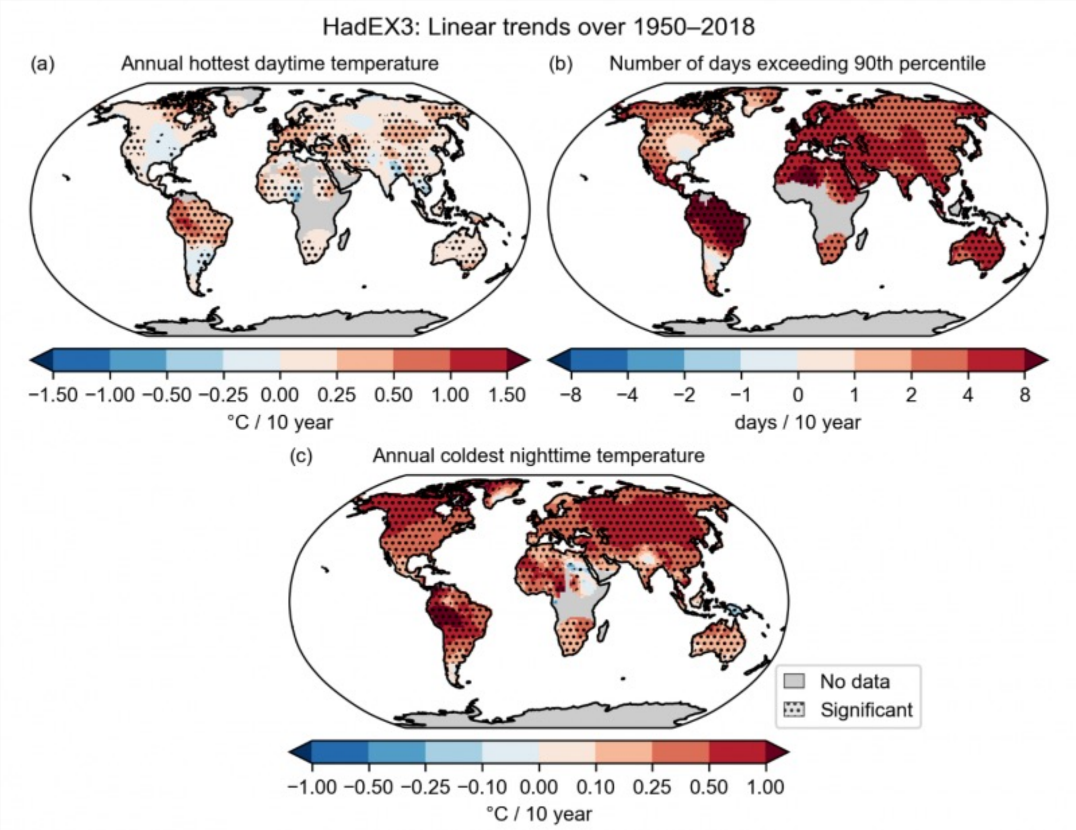
**The frequency and intensity of hot extremes have increased and those of cold extremes have decrease  on the global scale since 1950 (*virtually certain*). This also applies at regional scale, with more than 80% of AR6 regions showing similar changes assessed to be at least *likely*.**

**The frequency and intensity of hot extremes will continue to increase and those of cold extremes will continue to decrease, at both global and continental scales and in nearly all inhabited regions with increasing global warming levels.**

**The frequency and intensity of heavy precipitation events have *likely* increased at the global scale over a majority of land regions with good observational coverage. Heavy precipitation has *likely* increased on the continental scale over three continents: North America, Europe, and Asia.**

**Human influence, in particular greenhouse gas emissions, is *likely* the main driver of the observed  global scale intensification of heavy precipitation in land regions**

# Extremes are also warming strongly



# Extremes – major messages (cont'd)

## Hydrologic Elements

**Heavy precipitation will generally become more frequent and more intense with additional global warming. The increase in frequency and intensity is *extremely likely* for most continents.**

**The projected increase in the intensity of extreme precipitation translates to an increase in the frequency and magnitude of pluvial floods – surface water and flash floods – (*high confidence*), as pluvial flooding results from precipitation intensity exceeding the capacity of natural and artificial drainage systems.**

**Global hydrological models project a larger fraction of land areas to be affected by an increase in river floods than by a decrease in river floods *(medium confidence*).**

**Human-induced climate change has contributed to decreases in water availability during the dry season over a predominant fraction of the land area due to evapotranspiration increases (*medium confidence)***

**The land area affected by increasing drought frequency and severity expands with increasing global warming (*high confidence*).**

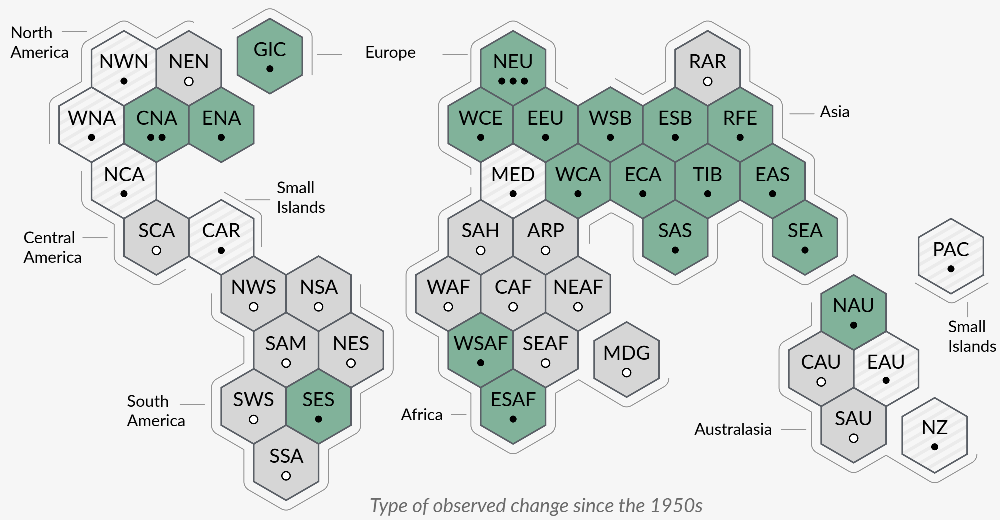
b) Synthesis of assessment of observed change in **heavy precipitation** and confidence in human contribution to the observed changes in the world's regions

**Type of observed change**
in heavy precipitation

- Increase (19)
- Decrease (0)
- Low agreement in the type of change (8)
- Limited data and/or literature (18)

**Confidence in human contribution**
to the observed change

- ●●● High
- ●● Medium
- ● Low due to limited agreement
- ○ Low due to limited evidence



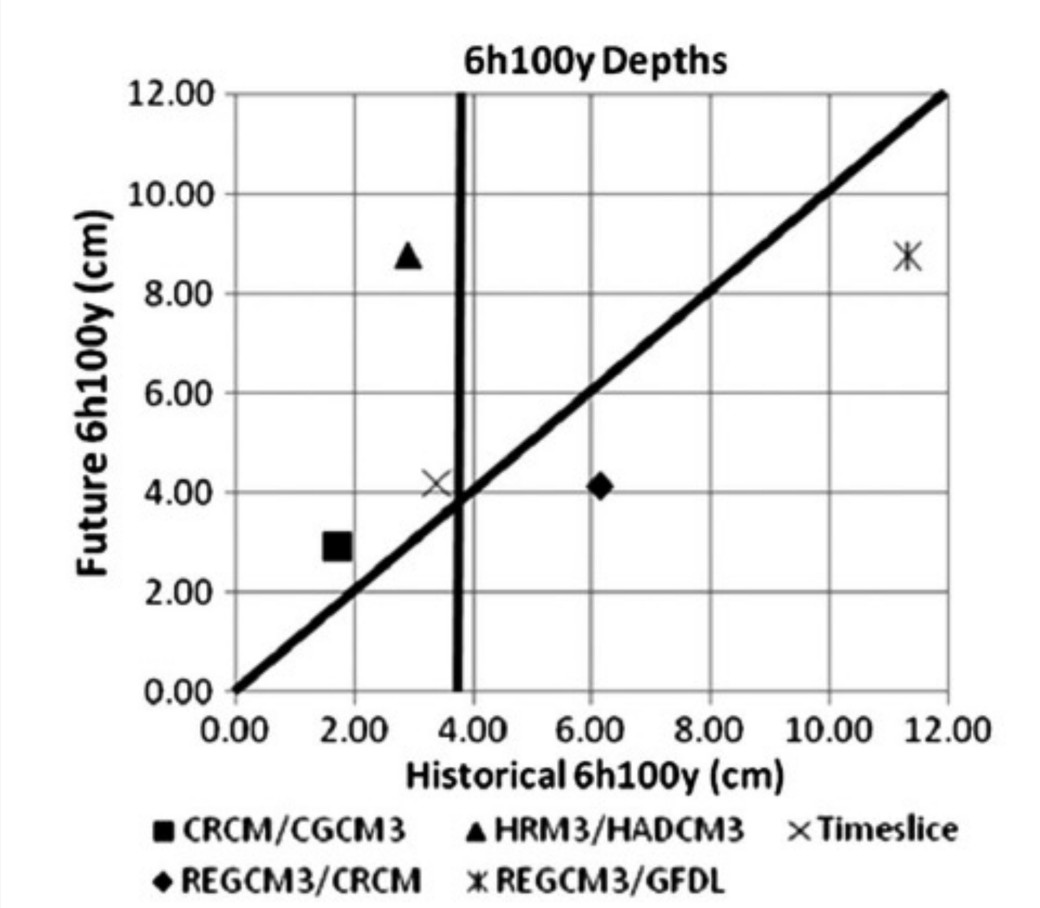

*Type of observed change since the 1950s*

# Hydrologic Engineering Study

# Using Regional Model Simulations

- Forsee and Ahmad, 2011: Evaluating storm-water infrastructure design in response to projected climate change. *J. Hydro Engineering.*
- Examined projected changes in 6-hour 100 yr design storm depth for water shed in Las Vegas Valley, Nevada
- Changes incorporated into a HEC-HMS model
- Results show some current design standards will be exceeded in future

# 6h100yr depths




Vertical line = observed value

Eliminated RCM3 sims because values too large

# Extremes – major messages (cont'd)

## Extreme Storms (including Tropical Cyclones)

**The average and maximum rain rates associated with TCs, extratropical cyclones and atmospheric rivers across the globe, and severe convective storms in some regions, increase in a warming world (*high confidence*).**

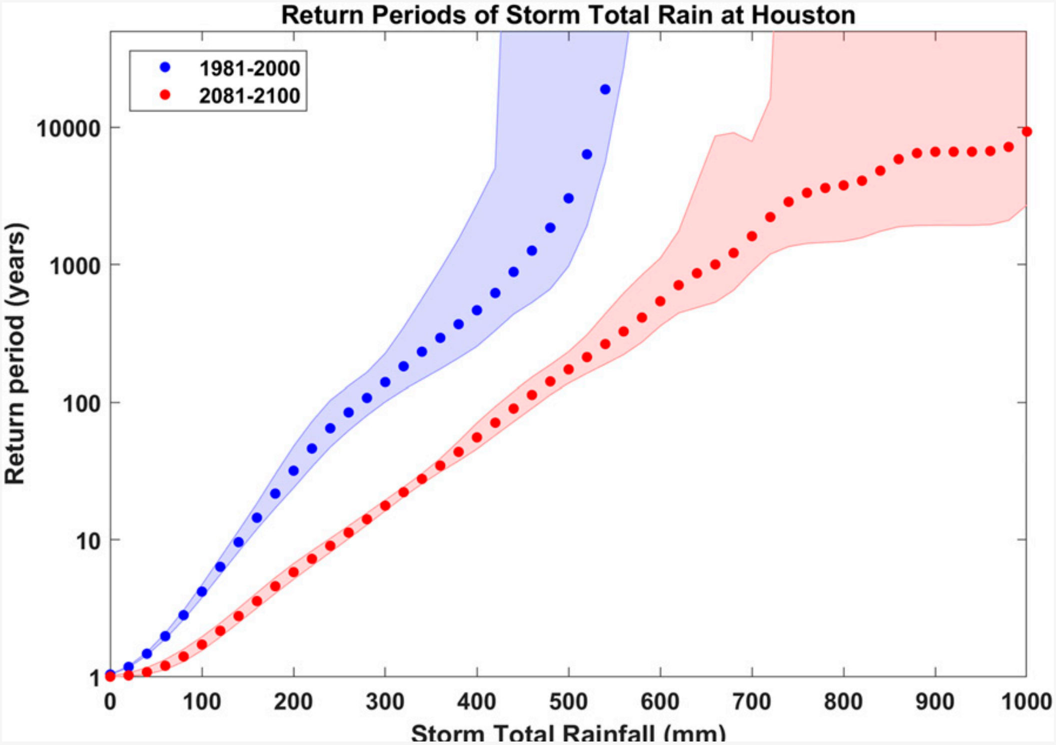
**It is *likely* that the global proportion of major TC (Category 3–5) intensities over the past four decades has increased.**

**The proportion of intense TCs, average peak TC wind speeds, and peak wind speeds of the most intense TCs will increase on the global scale with increasing global warming (*high confidence*)**

**There is *low confidence* in past changes of maximum wind speeds and other measures of dynamical intensity of extratropical cyclones. Future wind speed changes are expected to be small, although poleward shifts in the storm tracks could lead to substantial changes in extreme wind speeds in some regions (*medium confidence*).**

# Hurricane Harvey

- **K. Emmanuel: 'Assessing the present and future probability of Hurricane Harvey's Rainfall', *PNAS*, 2017**
  - Annual probability of 500 mm of area integrated rainfall was 1% 1981-2000
  - Will increase to 18% under IPCC AR5 RCP8.5, 2081-2100
  - Assuming probability increasing linearly in between, then in 2017 prob. = 6%, six-fold increase




Hurricane Harvey
Emanuel, 2017 (*PNAS*)

# Extremes – major messages (cont'd)

**Compound Events (e.g., dry/hot events, fire weather)**

**The probability of compound events has *likely* increased in the past due to human-induced climate change and will *likely* continue to increase with further global warming.**

**Concurrent heat waves and droughts – more frequent in observations and will become more so in the future (*high confidence*).**

**Fire weather conditions (compound hot, dry, and windy events) – *high confidence* they will become more frequent in some regions in the future.**

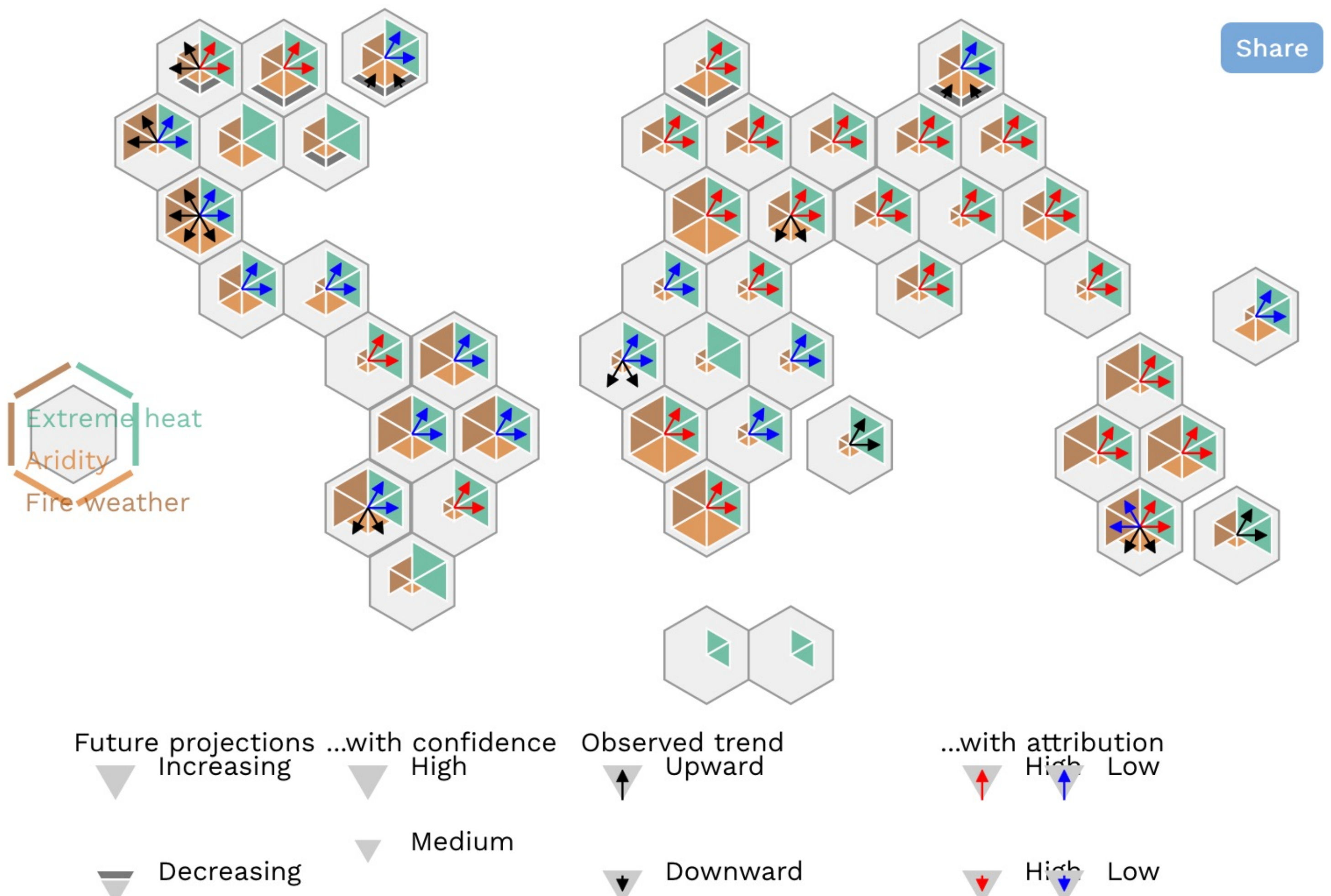
**Compound flooding (storm surge, extreme rainfall, and river flow) has increased in some areas and will continue to do so (*high confidence*).**

**Land area affected by concurrent extremes has increased (*high confidence*).**

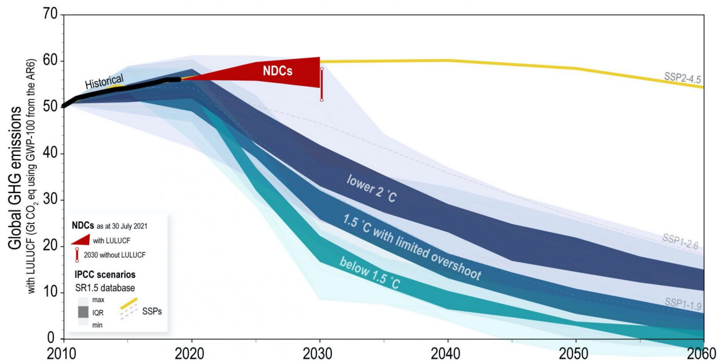
**The future occurrence of LLHI events linked to climate extremes (e.g., ) is generally associated with *low confidence*, but cannot be excluded, especially at global warming levels above 4 deg. C.**

*Sample Compound Extremes from Interactive Atlas:*

*Extreme heat, aridity, and fire weather*



# A case for cautious optimism




**On reducing emissions:** latest UNFCCC synthesis:

- Nationally determined contributions' now result in around 2.7 °C (closest to SSP2-4.5) – down from 3.4 °C in previous, and well below worst case scenario
- 'Some Progress, but Still a Big Concern'

**On awareness, taking action and adapting:**

- More engagement and conversation than ever, climate science appearing in weather reports, current affairs, talk shows and more
- IPCC report, recent extreme events and coverage – adding to momentum to reduce emissions, plan for adaptation
- Private sector is now engaged - we need governments and private sector to pull together

*Note: this is interpretation, goes beyond the report contents*

**SIXTH ASSESSMENT REPORT**
Working Group I – The Physical Science Basis

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# Thank you.

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Swiss Re
Corporate Solutions

# Developing 'fit for purpose' physical climate risk assessment

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# Outline

Overview of notable recent climate catastrophes
and economic impacts

A robust framework to assess physical
climate risks

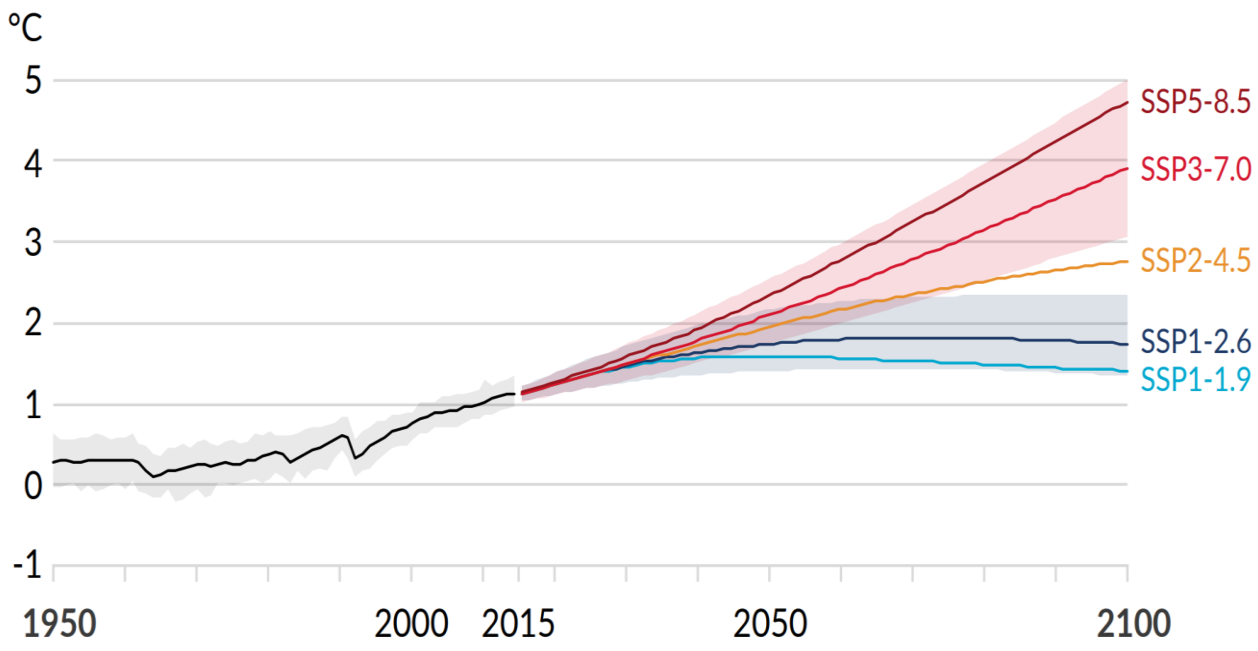
Example use case:
Impact of typhoon risk to hypothetical property portfolio

# Overview of notable climate catastrophes and economic impacts

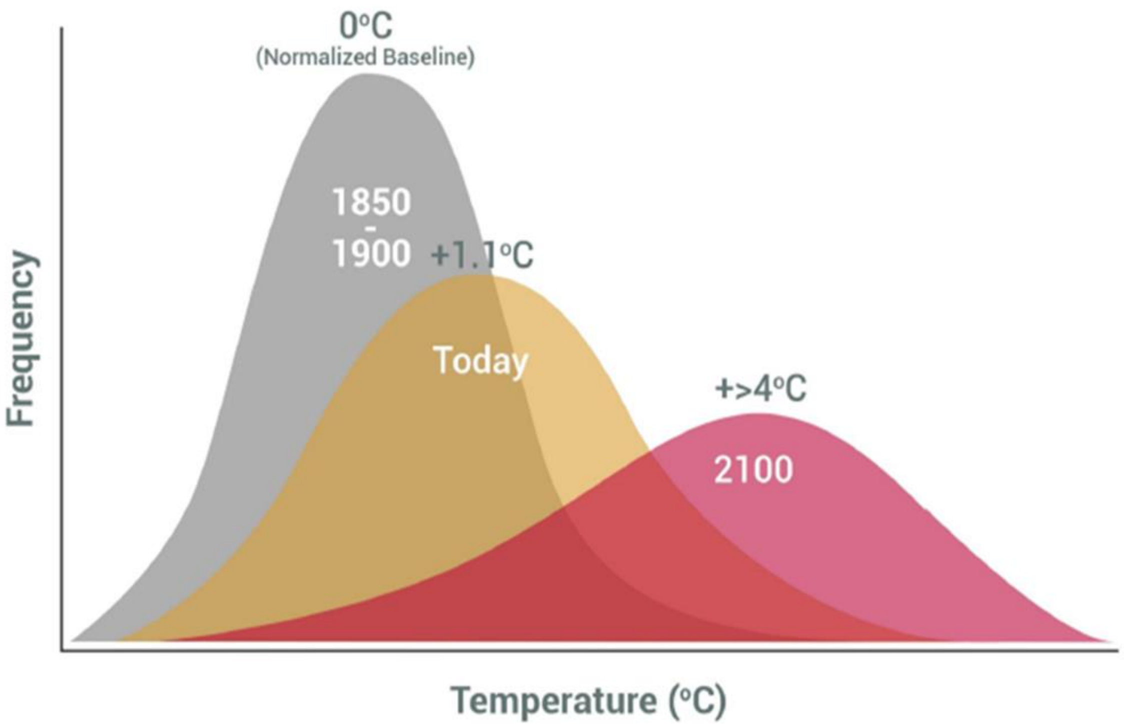
# What does our best current view of temperature projections tell us?

IPCC AR6: 'We are on a dangerous warming path, and must act now to avoid catastrophic impacts'

How bad climate change eventually gets is up to our actions today and into the future




Small changes in averages can lead to disproportionate changes at the tail .. .every little bit of improvement helps!






Source: IPCC 6th Assessment Report.

# What does our best current view of temperature projections tell us?

## IPCC AR6: Increasing urgency and certainty that humans are causing observed changes.


Swiss Re Corporate Solutions

Source: IPCC 6th Assessment Report.

# What happens when temperatures increase?

+2 deg F change from 1850-1900 baseline drives disproportionate increase in extreme heat waves

In some places, summers are looking great

While other areas are 150x more likely to to experience wildfire conditions

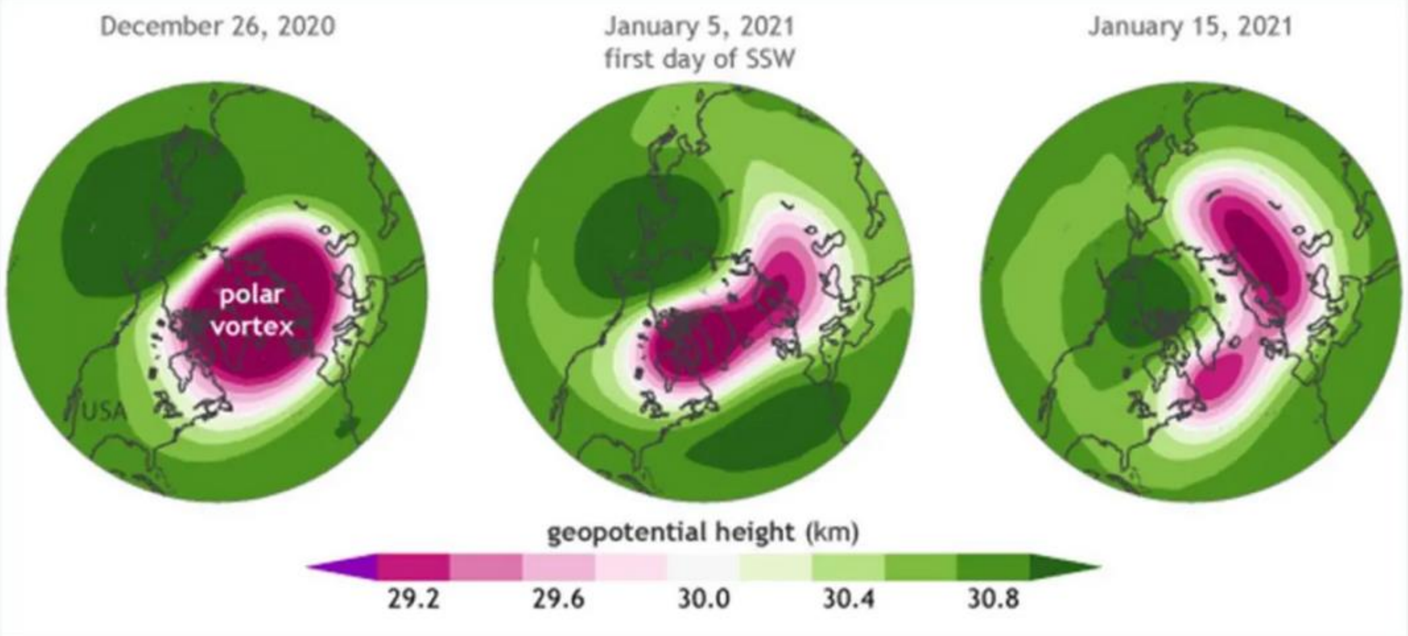
**Fire weather conditions are mostly worsening,** particularly across large swathes of US and Continental Europe.

Source: IPCC

# What happens when temperatures increase?

Don't ignore counter-intuitive threats such as winterstorms (i.e Texas, 2021)

Disruption of the Polar Vortex in lead up to the Texas snowstorm




Source: https://www.climate.gov/news-features/blogs/enso/sudden-stratospheric-warming-and-polar-vortex-early-2021

Compounding factors:
- Standalone power grid
- Scheduled winter maintenance
- Poor adaption for freezing conditions
- Poor real time event management

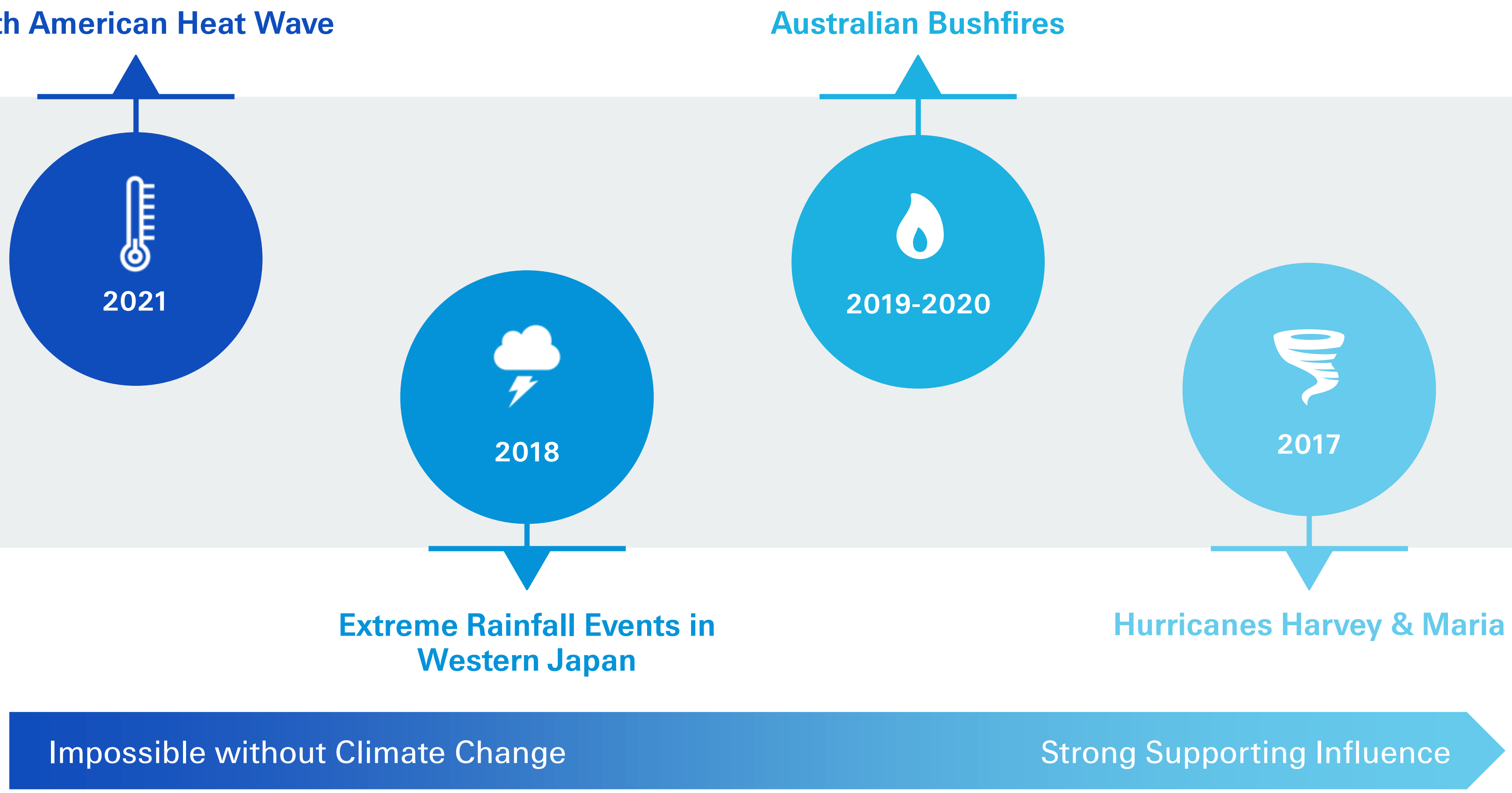


Source: Pui et al., Polar Vortex: a counter-intuitive threat of climate change? Swiss Re, 2021

# Can we already see climate change footprint in current extreme events?

## Recent advances in climate attribution science now enables ‘BUT FOR’ test for individual climate related events

**To what extent are these events influenced by anthropogenic climate change?**



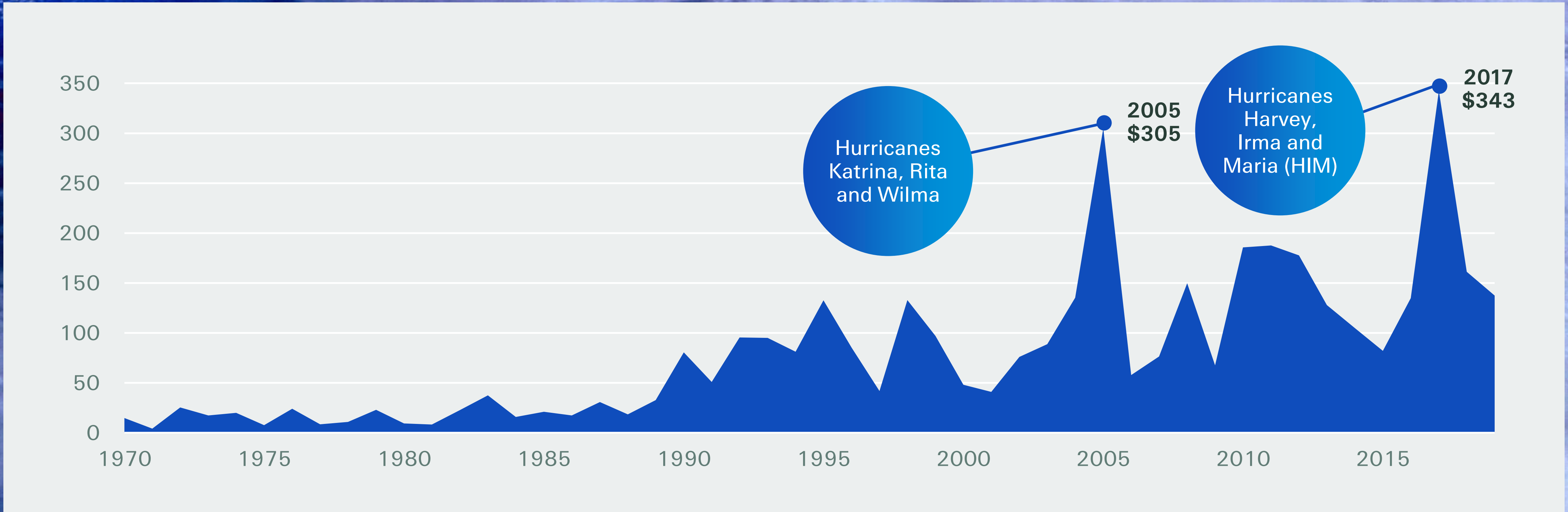



Source: Severe Weather in a Changing Climate, IAG, 2020

# Economic Loss Trends in Climate Perils

## Can observed increase in climate related economic losses be attributed to elapsed climate change?

Global Economic Losses, 1970 to 2019, US $b (norm. 2019)



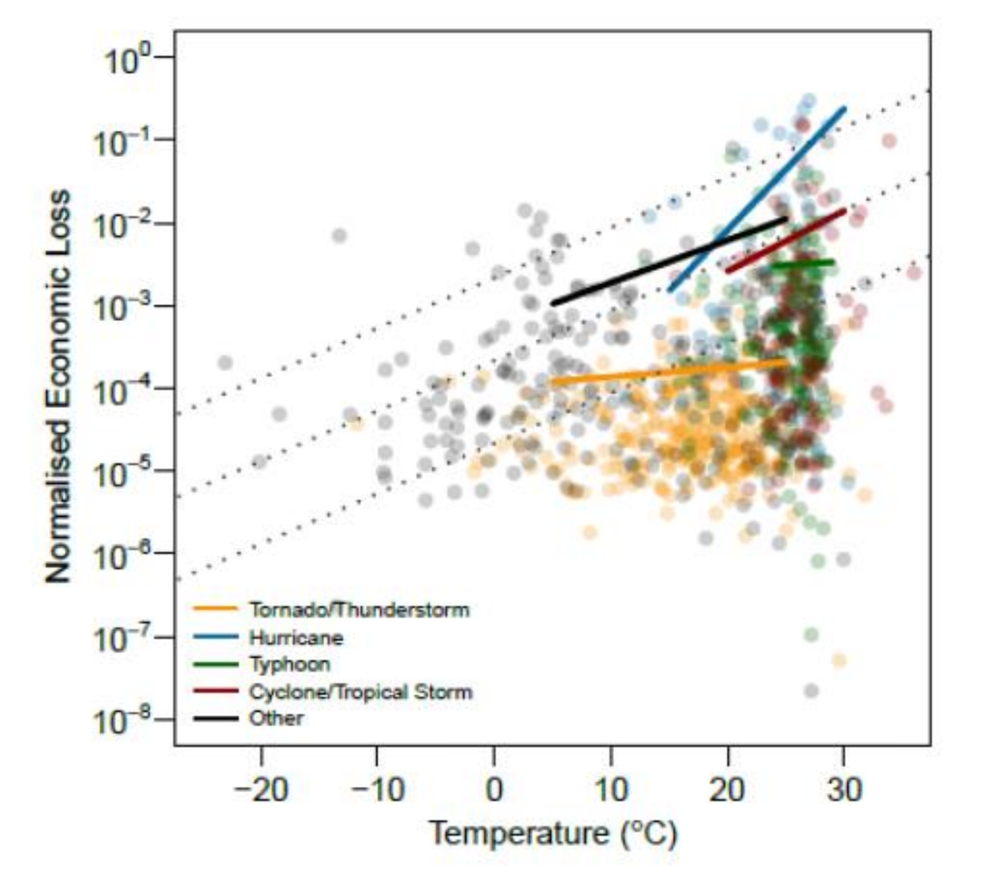

Swiss Re Corporate Solutions

Source: Swiss Re Institute

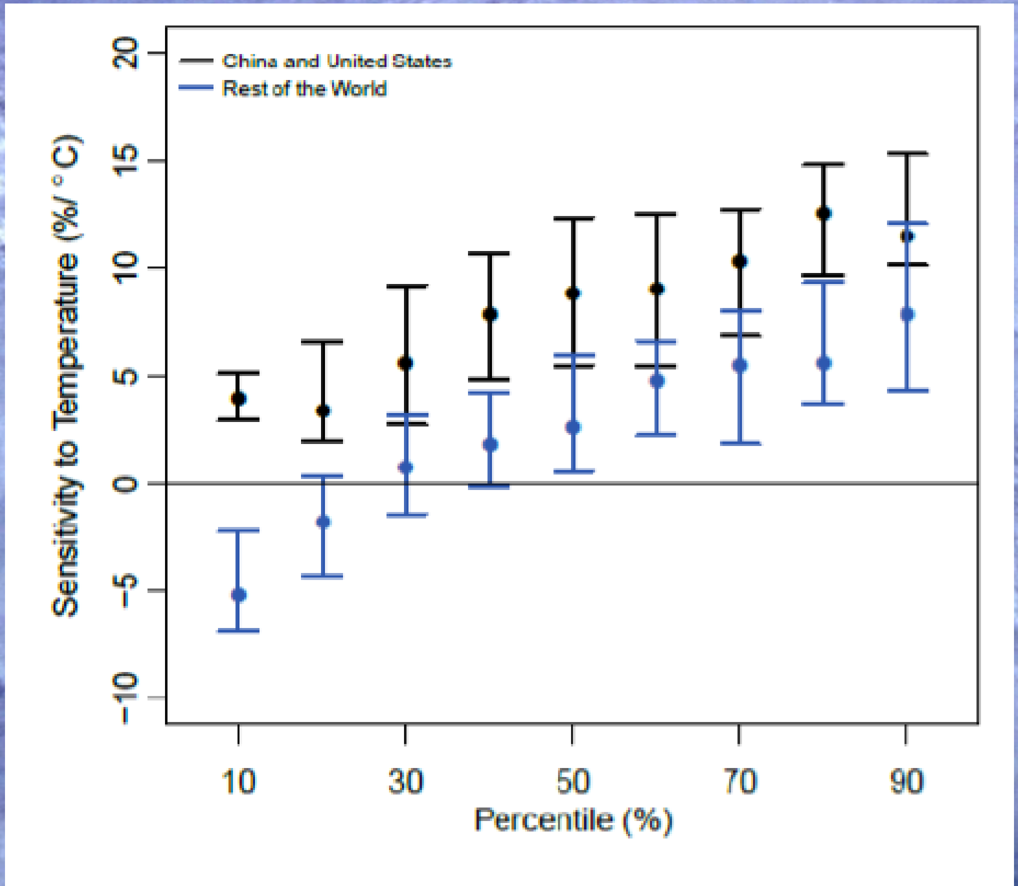
# Economic Loss Trends in Climate Perils

## Research shows that storms are 15% more damaging per degree increase in temperature

Economic loss sensitivity of different perils to temperature




Sensitivity of storms to temperature by percentile

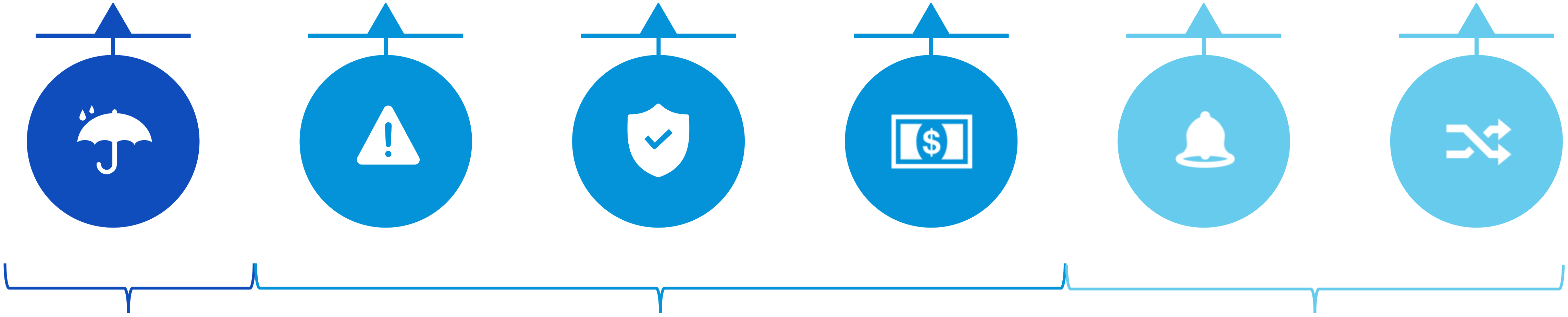


# A robust framework to assess physical climate risk

# An integrated approach to Physical Climate Risk Management adds economic value

## Using climate change projections and catastrophe modelling expertise to improve resilience

**Climate projections** | **Hazard Models** | **Exposure Resilience** | **Economic Loss** | **Risk Mitigation** | **Risk Transfer**



Driven by climate policy, technological change, latest scientific findings

Catastrophe Modelling of physical assets, insurers traditionally have expertise in this domain

Take pro-active decisions to manage climate physical risk

# Brief review of catastrophe models

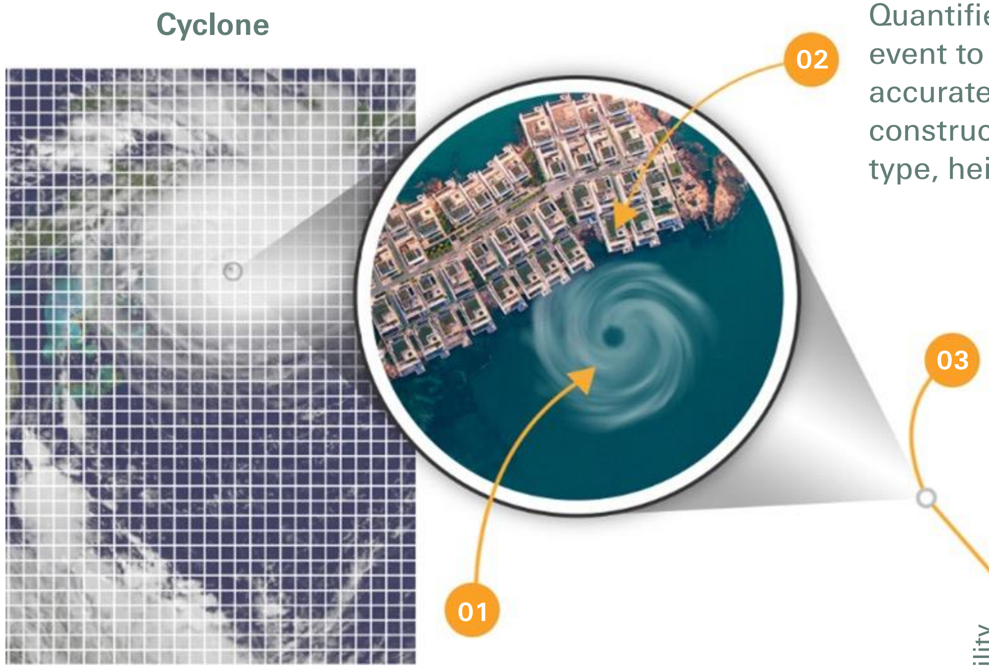
## Catastrophe models marry hazard science, engineering and financial considerations to estimate loss costs from events

**What is a Catastrophe Model?**

- Cross disciplinary model that combines fields of hazard science, structural engineering and financial considerations

**Applications**

- Better understand nat cat risk exposure
- Produces loss costs associated with specific perils
- Traditionally used to price insurance/ reinsurance programs

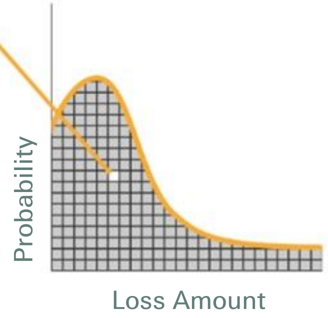



**Vulnerability Module**

Quantifies expected damage from an event to buildings at risk. Need accurate inputs for buildings construction material, occupancy type, heights etc.

**Financial Module**

Measures monetary loss from damage. Results are then stacked into a loss distribution.

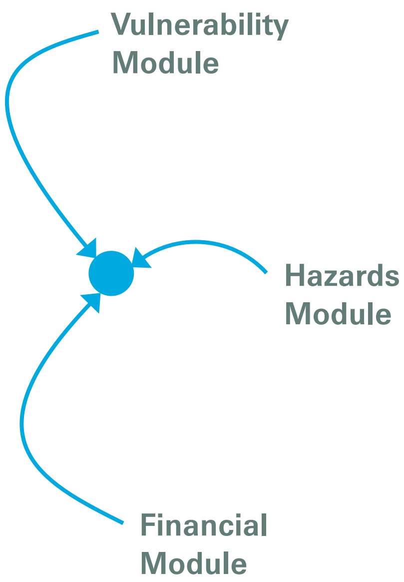



**Hazards Module**

A random event is generated from thousands of possible catastrophic scenarios based on a database of historical parameter data which is then adjusted as per the level of physical hazard specific to geographical locations using location specific risk characteristics. For cyclones, these can be sea surface temperature, atmospheric vertical wind shear, steering winds etc.

# How can Climate and Catastrophe Models help to project future risk profiles?

## Using climate model outputs to inform relevant input parameters of catastrophe models for deep dive analysis




### Climate Change Variables

**Sea Surface Temperatures**
Influences intensity of cyclone

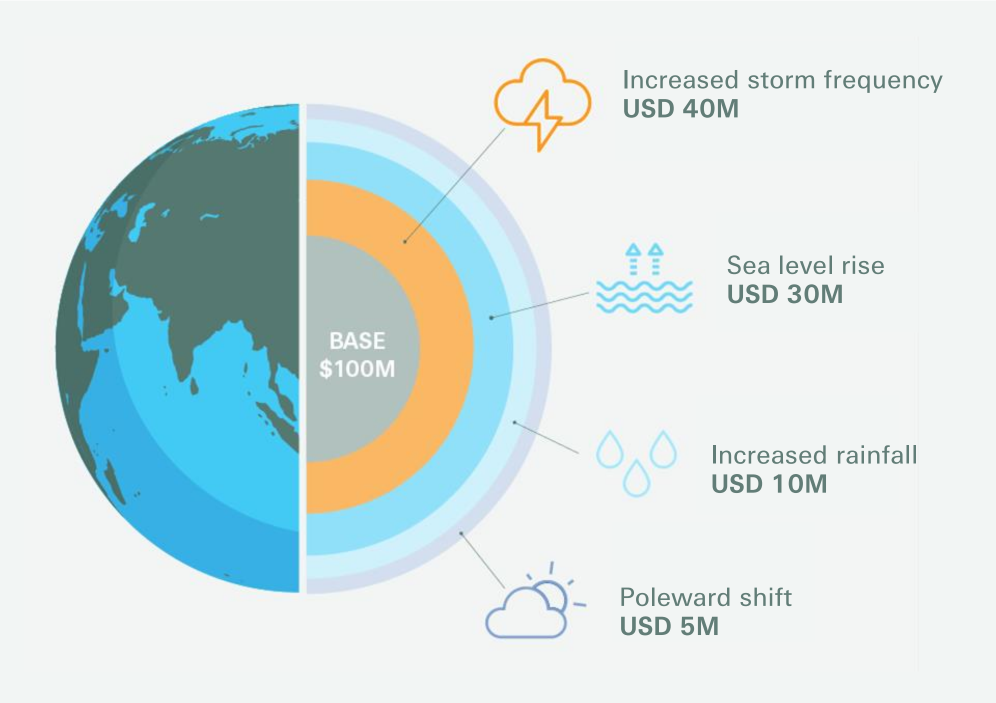
**Atmospheric Vertical Wind Shear**
Influences ability of cyclone to develop

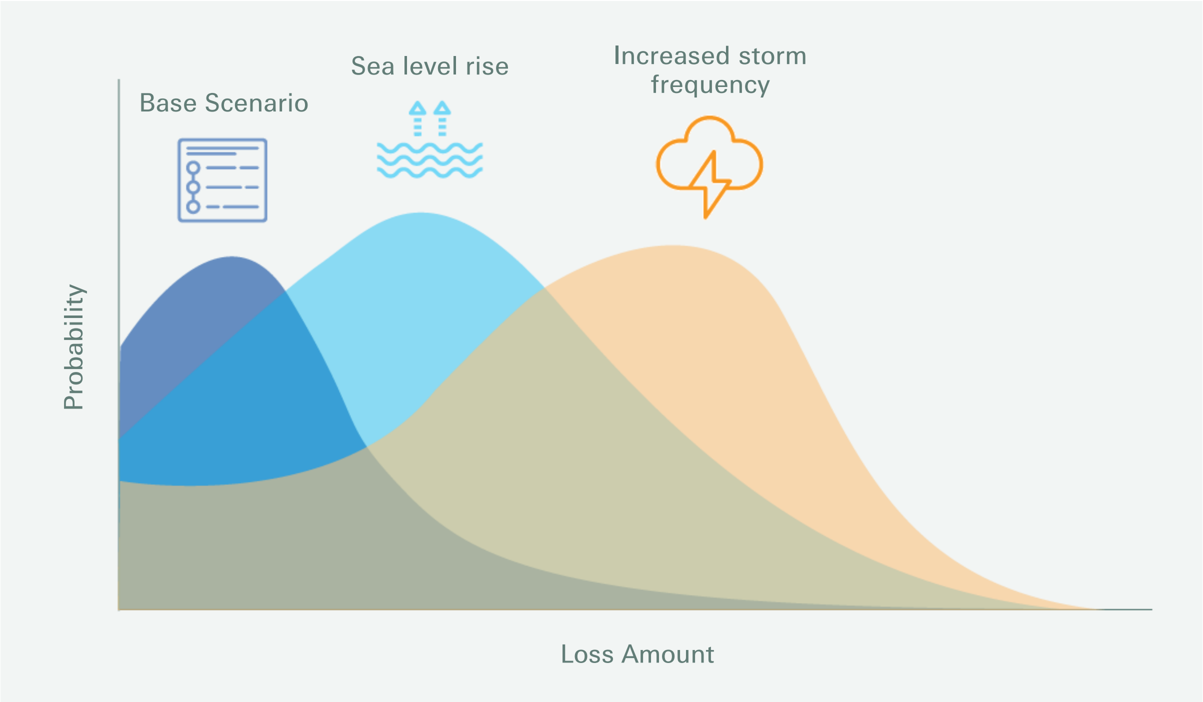
**Steering Winds**
Winds dictating the direction of a cyclone

Each of these can be modified to capture climate changes to look into what future catastrophes might look like.

# Quantifying the economic impact of physical climate risk at a more granular level

## Providing estimates of future annual loss burden, as well as changes to loss distributions



# Physical Climate Risk Assessment is a complex exercise

## Understanding the limitations and quantifying uncertainty of GCMs is key for 'fit for purpose' applications

| Dimensions | Raw GCM Outputs | | Required for applications |
|---|---|---|---|
| Time | Annual/Monthly timestep | **Downscaling** → | Weekly/Daily timestep |
| Space | Regional Level (200km x 200km) | **Downscaling** → | District/City Level (20km x 20km) |

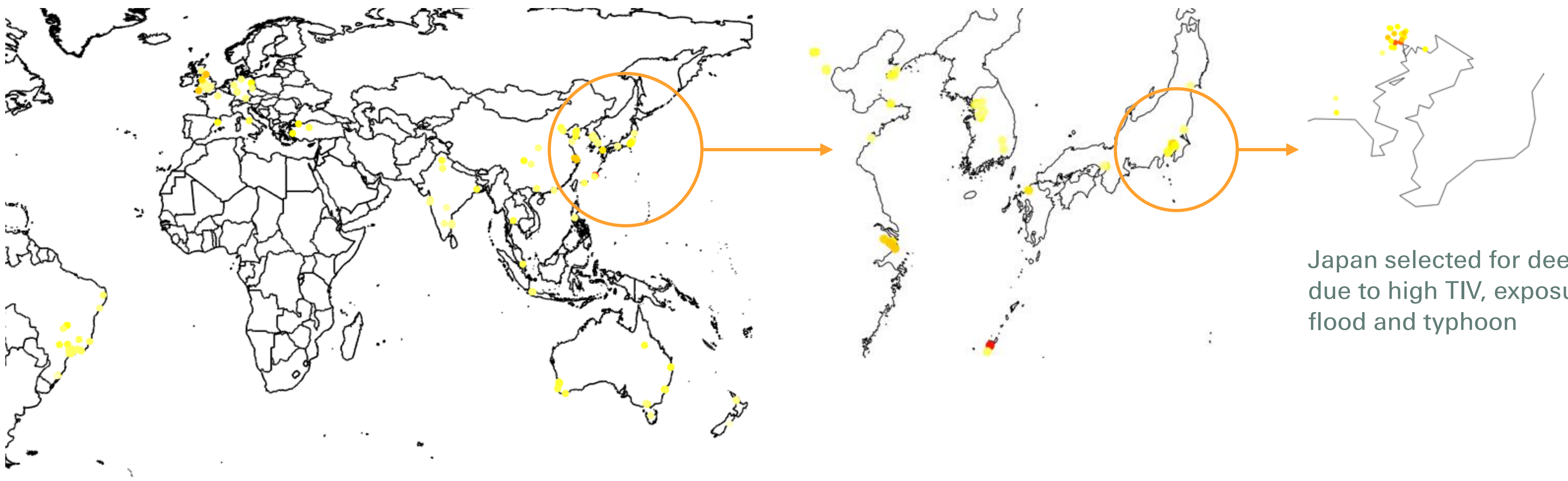
Increasing level of uncertainty →

# Example:
# Impact of future typhoon risk on property portfolio (Level 2 deep dive)

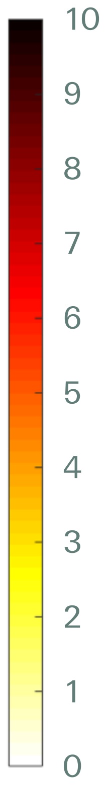
# Identifying Climate ‘Hot Spots’ in a hypothetical global real estate portfolio

## Climate Risk Score results can be used to identify hot spots for further analysis

| Global Level | Country Level | City Level |
| --- | --- | --- |



Japan selected for deep dive due to high TIV, exposure to flood and typhoon

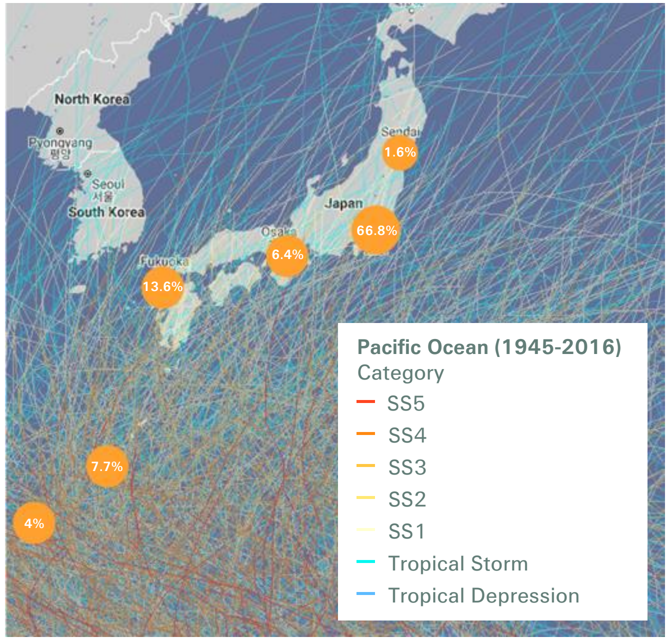


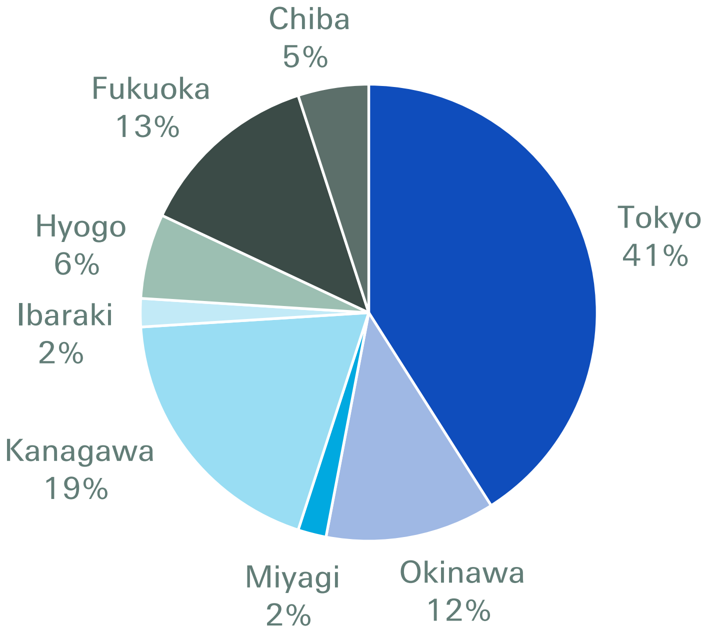

Overall Climate Risk Score Index

# Portfolio in Japan

- Exposure to Typhoon-induced wind and flood damage
- Several locations are exposed to river-flood, torrential-rainfall and storm-surge risk
- Climate change can lead to a change in typhoon:
  - Change in occurrence frequency of typhoons
  - Intensification of storms
  - Increase in extreme precipitation
  - Increase of storm-surge intensity due to sea-level rise

## Value distribution and historic Typhoon tracks in the vicinity of Japan




### Windstorm

| 50 Year Peak Gust Range [m/s] | No of Locations | Share |
|---|---|---|
| Very High (60-70 m/s) | 8 | 11.66% |
| High (50-60 m/s) | 2 | 13.55% |
| Significant (40-50 m/s) | 44 | 73.16% |
| Moderate (35-40 m/s) | 2 | 1.62% |
| Total | 56 | 100% |

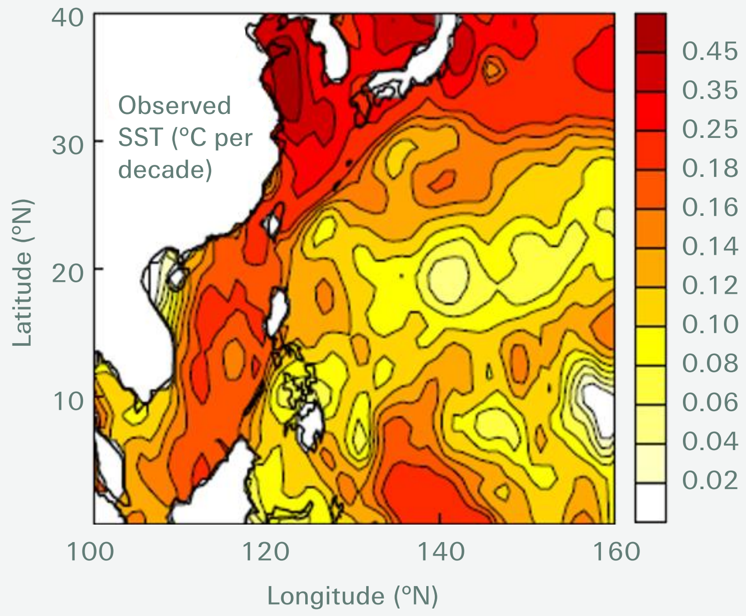
### River Flood

| Return Period | No of Locations | Share |
|---|---|---|
| 50 | 4 | 7.58% |
| 200 | 6 | 8.40% |
| 500 | 6 | 5.84% |
| Outside | 40 | 78.18% |
| Total | 56 | 100% |

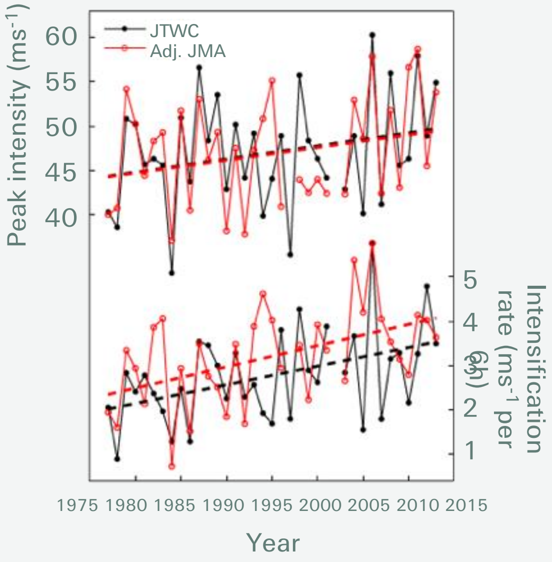
# Historical trends in North West Pacific Typhoon activity

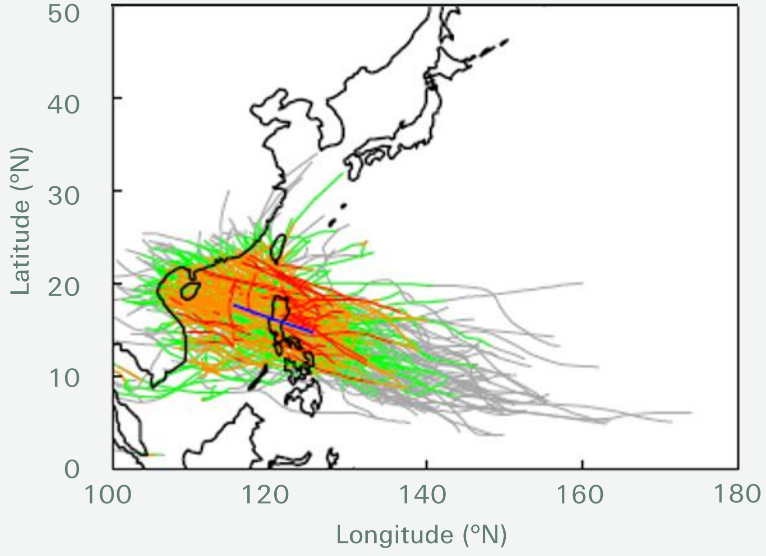
## More intense TC activity in the NW Pacific Basin consistent with increasing SSTs

### Warmer Oceans




### More Intense Typhoons



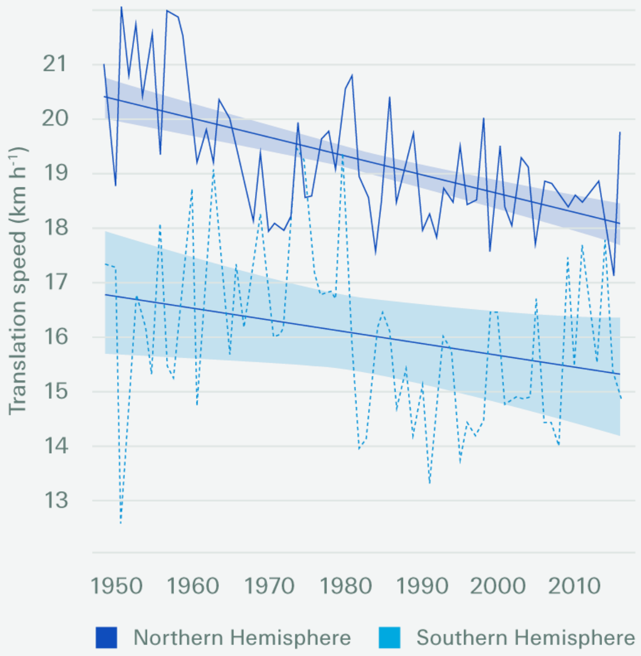




Source: Mei and Xie, Intensification of landfalling NW Pacific Typhoons since the late 1970s, Nature, 2016

# Historical trends in North West Pacific Typhoon activity

## Slower moving storms means increased risk of flood, time exposed to high winds and storm surge

### Slowing of TCs in key basins




### Characteristics of Slower Storms

**Slowing storms increases threat of TCs in 3 ways:**


- Slowing most pronounced in NW Pacific Basin - **up to 30% decrease!**
- Cause of slowing still unclear, but may be influenced by changing pressure gradients (due to polar regions warming faster than other parts of the globe)

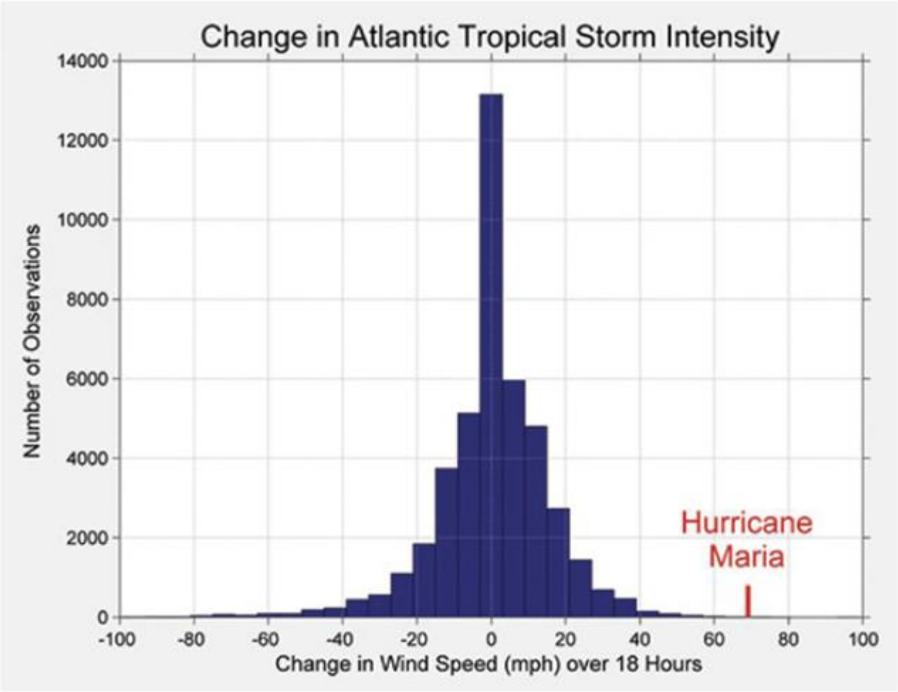


Source: Kossin J., A global slowdown of tropical-cyclone translation speed, Nature, 2018

# 2017 – the year of slow and intense storms

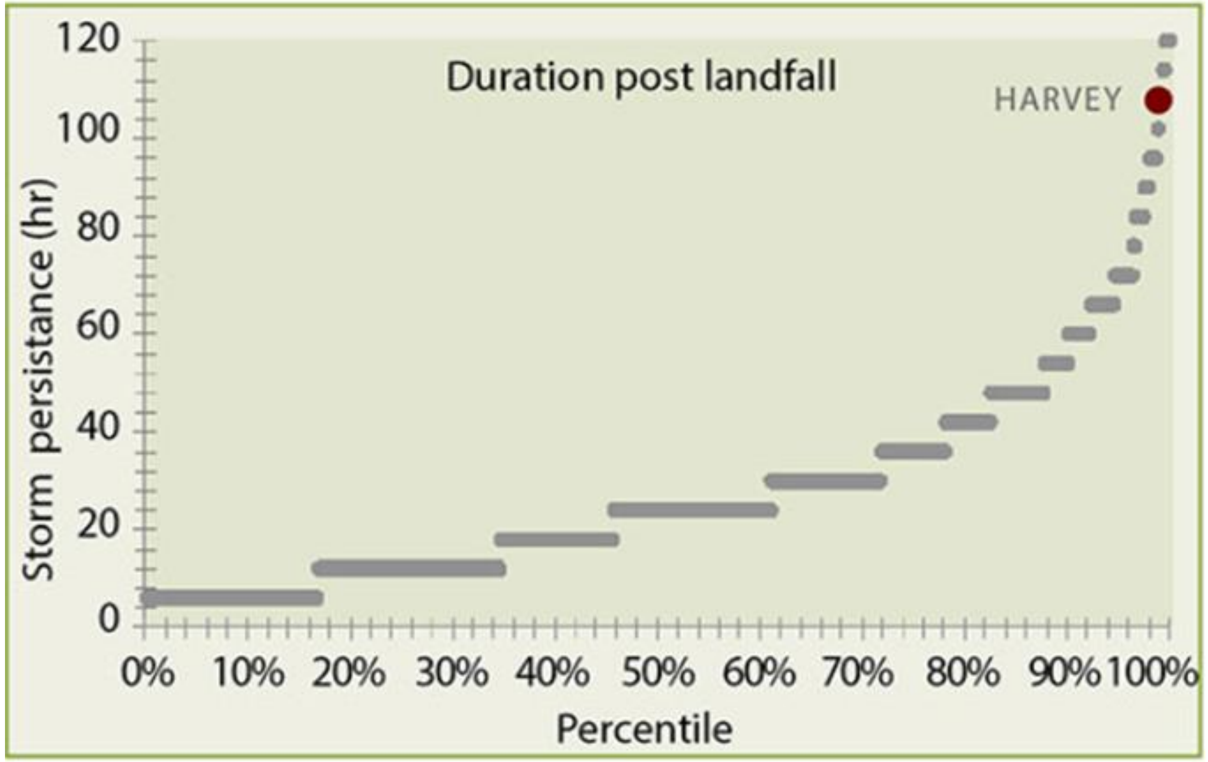
(USD 80bn), Maria ( USD70bn) gave us a scary sneak peak into the future...

## TC Maria : Example of Rapid Intensification




Source: Robert Rohde

## TC Harvey: Example of a VERY slow storm





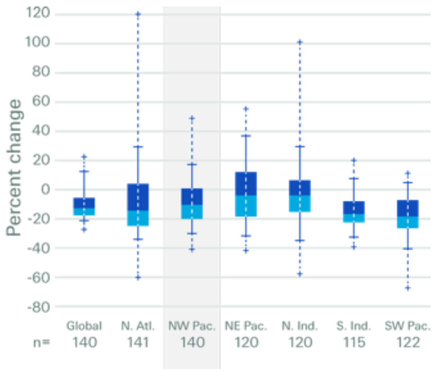

Sources: Robert Rohde, Risk Frontiers, SR Sigma all currency in USD

# Climate Scenarios

- A loss-sensitivity analysis was performed on the Japan sub-portfolio for several scenarios that could materialize in a future environment with a global mean surface temperature increase of +2°C.
- Based on past observations (Lee et al., 2019), frequency increases for Japan are expected to be above the basin-wide average (NW Pacific).

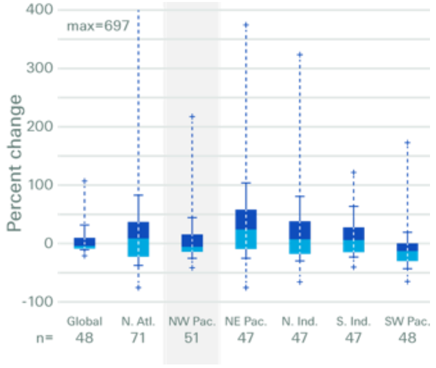
**Tropical Cyclone Frequency Change Projections: By Basin**

***Verdict: No Consensus***



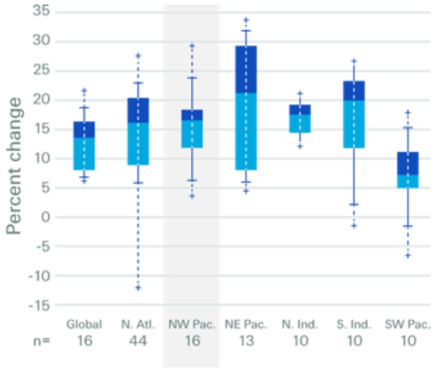

**Very Intense Tropical Cyclone Frequency Change Projections: By Basin**

***Verdict: No Consensus***




**Tropical Cyclone Precipitation Change Projections: By Basin**

***Verdict: Likely Increasing***






Source (1): Knutson et al., Tropical Cyclones and Climate Change Assessment, Part II: Projected Response to Anthropogenic Warming, BAMS 2020

# Climate Scenarios

- The effect of sea-level rise is considered small for the portfolio due to the elevated and/or protected locations.
- Getting today's view of risk right is critical as it forms the 'point of reference' in which all future climate scenarios are premised upon.

## Effect of various frequency scenarios

| Scenario | SS0 FC | SS1 FC | SS2 FC | SS3 FC | SS4 FC | SS5 FC | % change in AEL* | % change in 10yr loss | % change in 50yr loss | % change in 100yr loss |
|---|---|---|---|---|---|---|---|---|---|---|
| Baseline (Today) | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| 1 Intensification | 0% | 0% | 0% | 0% | 30% | 30% | 22% | 23% | 15% | 11% |
| 2 Increased Frequency | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 29% | 18% | 13% |
| 2 Stress Scenario 1 | 0% | 0% | 0% | 0% | 100% | 100% | 73% | 69% | 42% | 32% |
| 4 Stress Scenario 2 | -10% | -10% | -10% | 0% | 100% | 100% | 72% | 68% | 42% | 32% |

FC: Frequency Change; AEL: Annual Expected Loss; SSO-5:Saffir-Simpson Category

# Building a holistic view of peril risk beyond just GCM projections

## Robust scenario analysis should include perspectives beyond simply modelled outputs

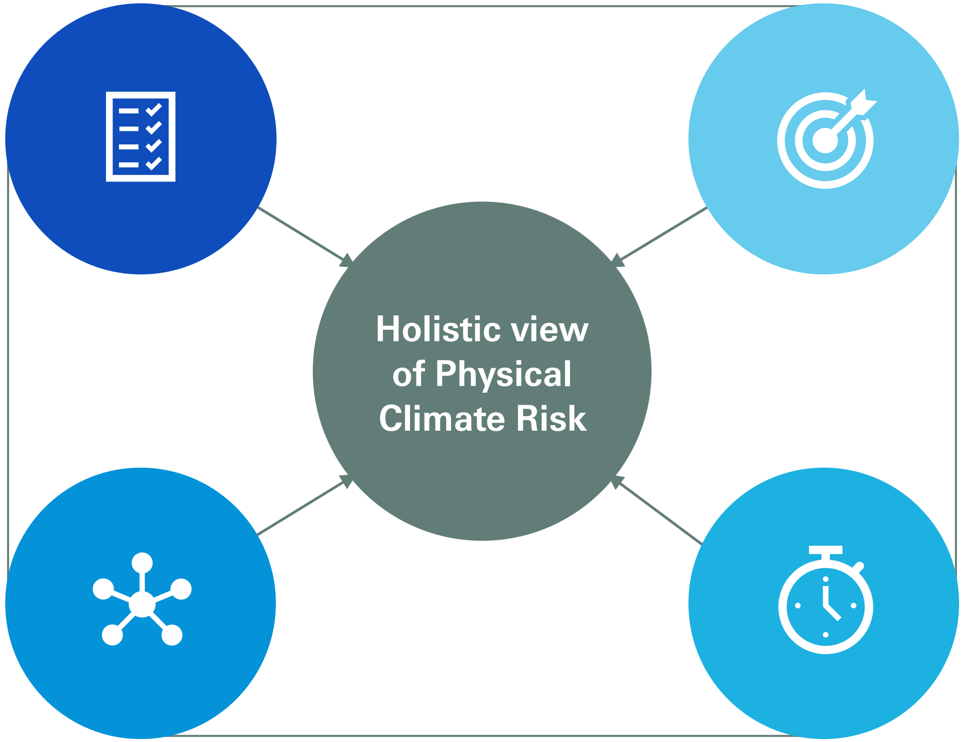
Where do we have higher/lower confidence? Do we need climate risk disclosure standards?

### Model Outputs

GCM projections
Catastrophe Model results

### Counter Factual Analysis

What can we learn from near misses?




### Inter-dependencies

Exploring hidden links and inter connectivity between climate/other events

### Paleo Data

Looking further back beyond modern instrumental records for useful clues

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