

SIXTH ASSESSMENT REPORT

Working Group I – The Physical Science Basis



Sexto Reporte del IPCC (AR6): Bases Científicas de la Física del Cambio Climático

Maisa Rojas

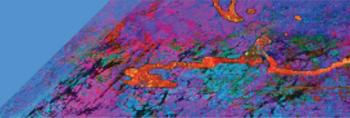
CLA capítulo 1

ETICC

26 Agosto 2021

#ClimateReport

#IPCC



Cronograma de publicación del Sexto Reporte del IPCC (AR6)

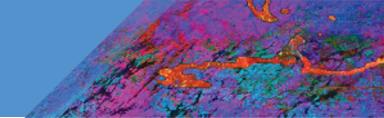
The schedule for the approval plenaries is as follows:

Working Group I – 26 July – 6 August 2021

Working Group II – 14-18 February 2022 tbc

Working Group III – 21-25 March 2022 tbc

Synthesis Report – 26-30 September 2022 tbc



Estructura del WGI AR6

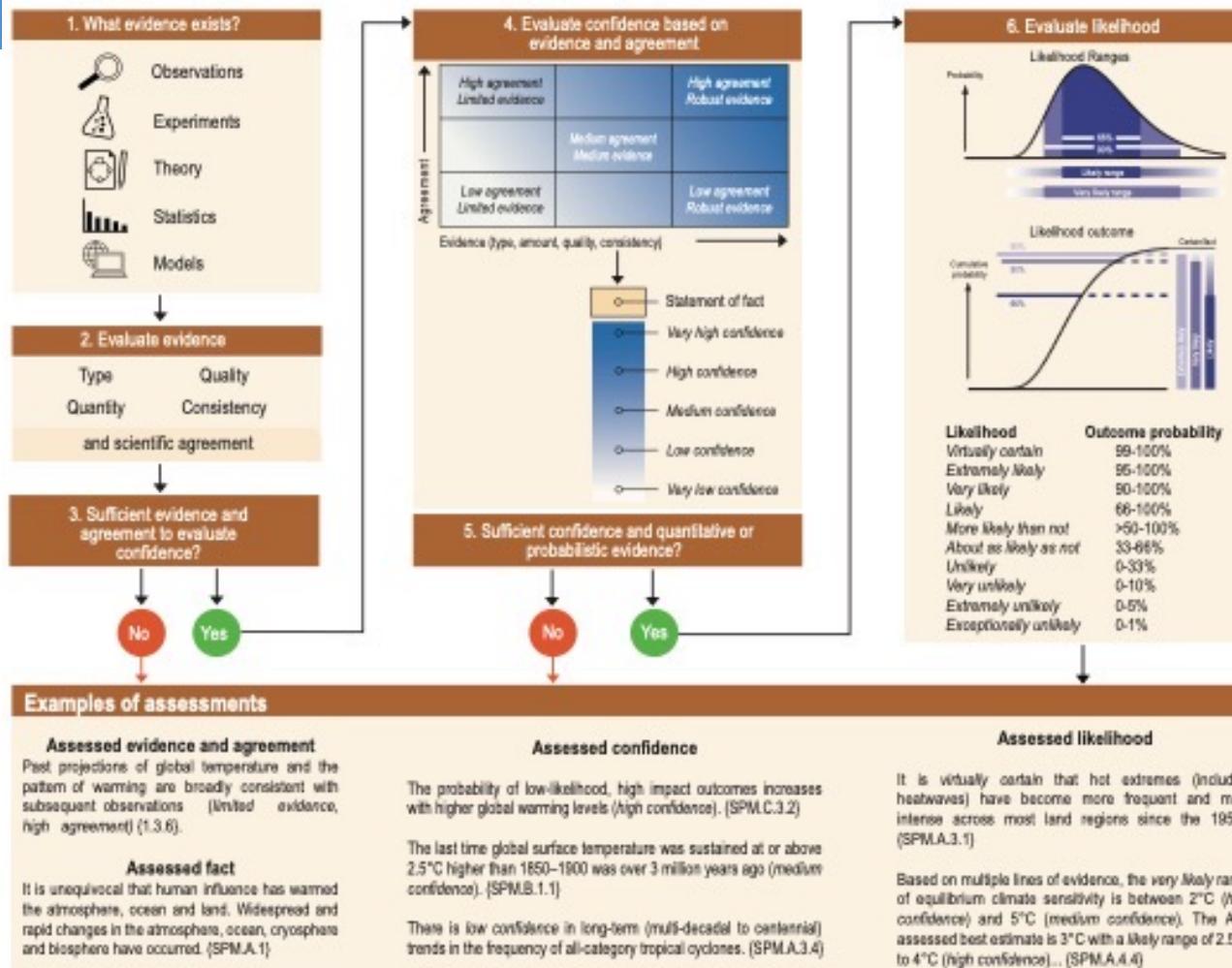
- **Ch1:** Framing, context, methods
- **Ch2:** Changing state of the climate system
- **Ch3:** Human influence on the climate system
- **Ch4:** Future global climate: scenario-based projections and near-term information
- **Ch5:** Global carbon and other biogeochemical cycles and feedbacks
- **Ch 6: Short-lived climate forcers**
- **Ch7:** The Earth's energy budget, climate feedbacks, and climate sensitivity
- **Ch8: Water cycle changes**
- **Ch9:** Ocean, cryosphere, and sea level change
- **Ch10: Linking global to regional climate change**
- **Ch11: Weather and climate extreme events in a changing climate**
- **Ch12: Climate change information for regional impact and for risk assessment**
- **Atlas (including the Interactive Atlas)**

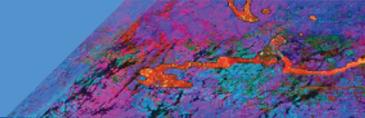
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- El proceso de “assessment” incluye varias etapas de revisión
- cada hallazgo se basa en una evaluación de la evidencia y acuerdo.
- Los autores utilizan el *lenguaje de incertidumbre calibrado del ipcc.*

Evaluation and communication of degree of certainty in AR6 findings





EL WGI AR6 EN NÚMEROS



14,000 publicaciones científicas evaluadas

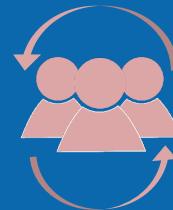


Equipo de Autores

234 autores de 65 países

28% mujeres

**30% investigadores participando
por primera vez (63% ocupando
nuevos roles)**



Proceso de revisión

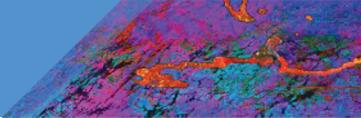
78,000+ comentarios recibidos

**46 países comentaron la versión
final de distribución a los gobiernos**



[Credit: NASA]

“ Los cambios recientes en el clima son generalizados, rápidos y cada vez más intensos, y no tienen precedentes en miles de años.



La influencia humana ha calentado el clima a un ritmo sin precedentes en al menos los últimos 2000 años

Cambio en la temperatura global en superficie relativo a 1850-1900

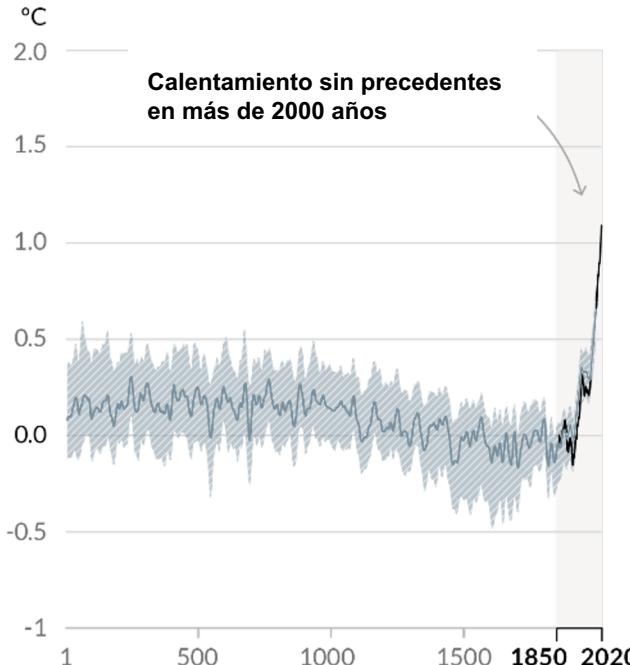
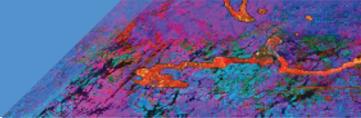


Figura SPM.1



La influencia humana ha calentado el clima a un ritmo sin precedentes en al menos los últimos 2000 años

Cambio en la temperatura global en superficie relativo a 1850-1900

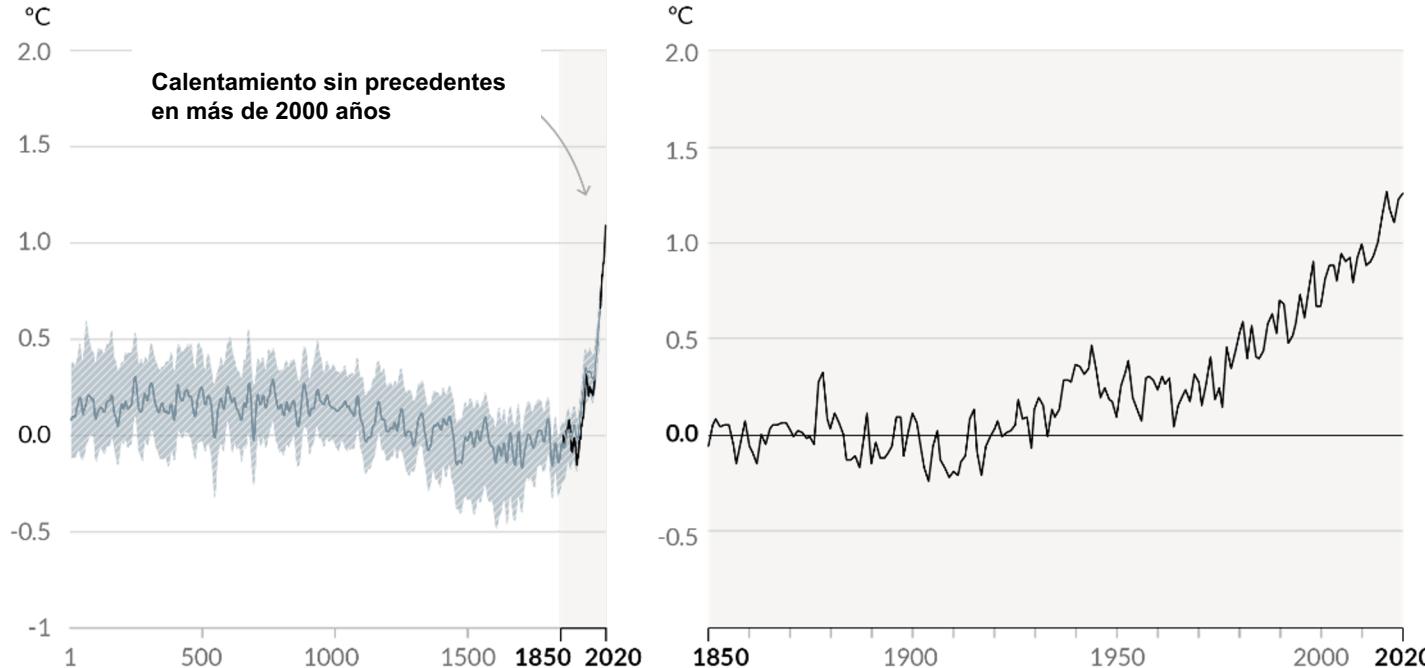
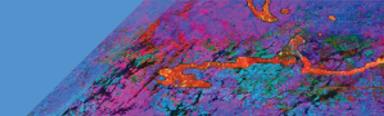


Figura SPM.1



La influencia humana ha calentado el clima a un ritmo sin precedentes en al menos los últimos 2000 años

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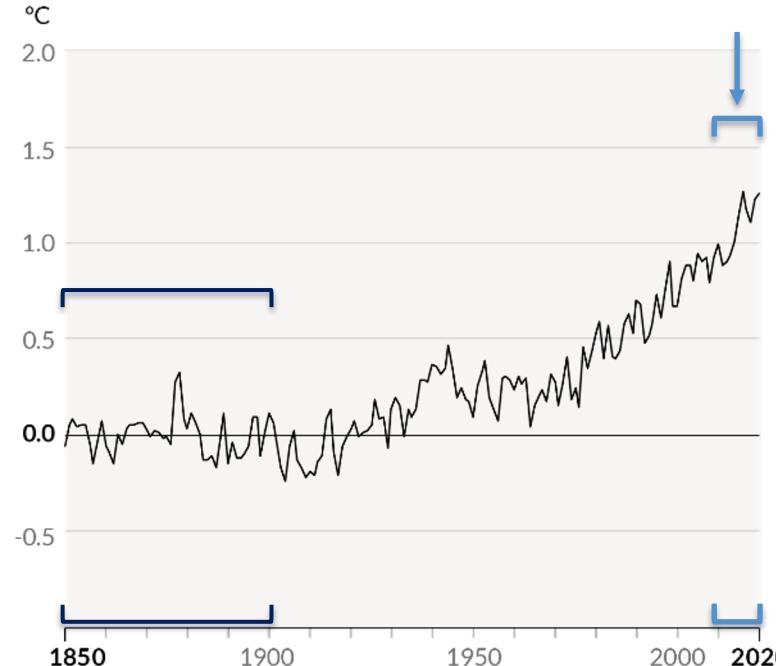
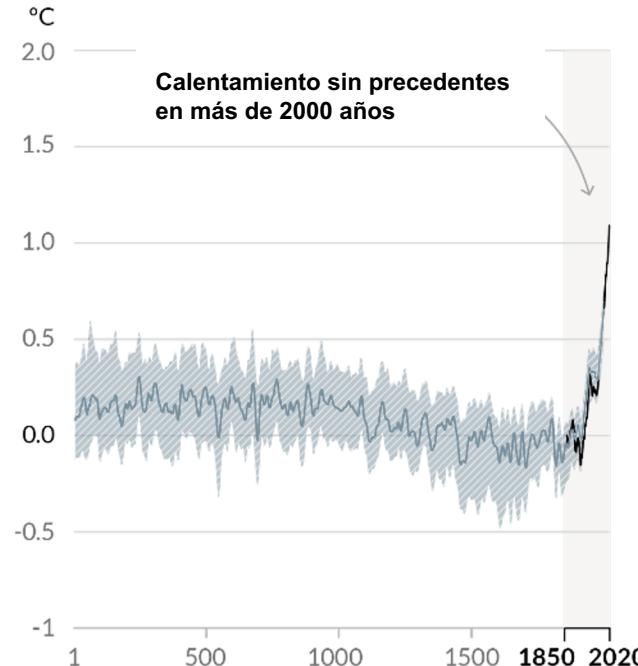
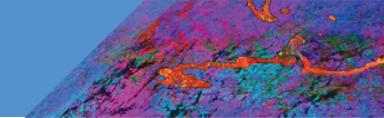
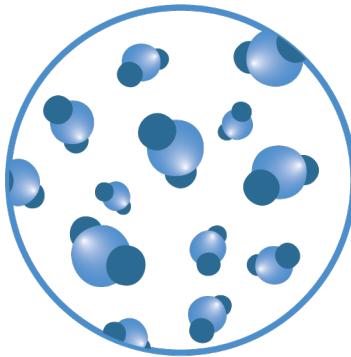


Figura SPM.1



Concentración de CO₂



La más alta

en al menos

2 millones de años

Aumento en el nivel del mar



Ritmo más

rápido

en al menos

3000 años

Área de hielo marino en el Ártico



Nivel más bajo

en al menos

1000 años

Retroceso de glaciares



Sin precedentes

en al menos

2000 años

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INTERGOVERNMENTAL PANEL ON climate change



Calor extremo

Más frecuente

Más intenso

Lluvias torrenciales

Más frecuentes

Más intensas

Sequías

Incrementos en algunas regiones

Clima de incendios

(combinación de condiciones cálidas, secas y ventosas que conducen a incendios)

Más frecuente

Océanos

Calentamiento

Acidificación

Pérdida de oxígeno

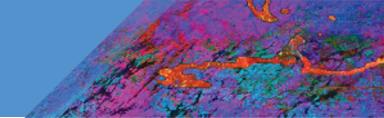


[Credit: Peter John Maridable]

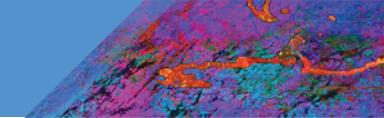
“ Se requiere reducciones inmediatas, rápidas y a gran escala de las emisiones de gases de efecto invernadero para limitar el calentamiento a 1.5°C.

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Escenarios



Scenarios: Shared Socio-economic Pathways

- AR5 usó los RCPs
- AR6 usa los SSPs

*SSPs se usa para definir:
una narrativa socio-
económica, o un escenario en
particular SSPX-Y, por
ejemplo SSP1-1.9.

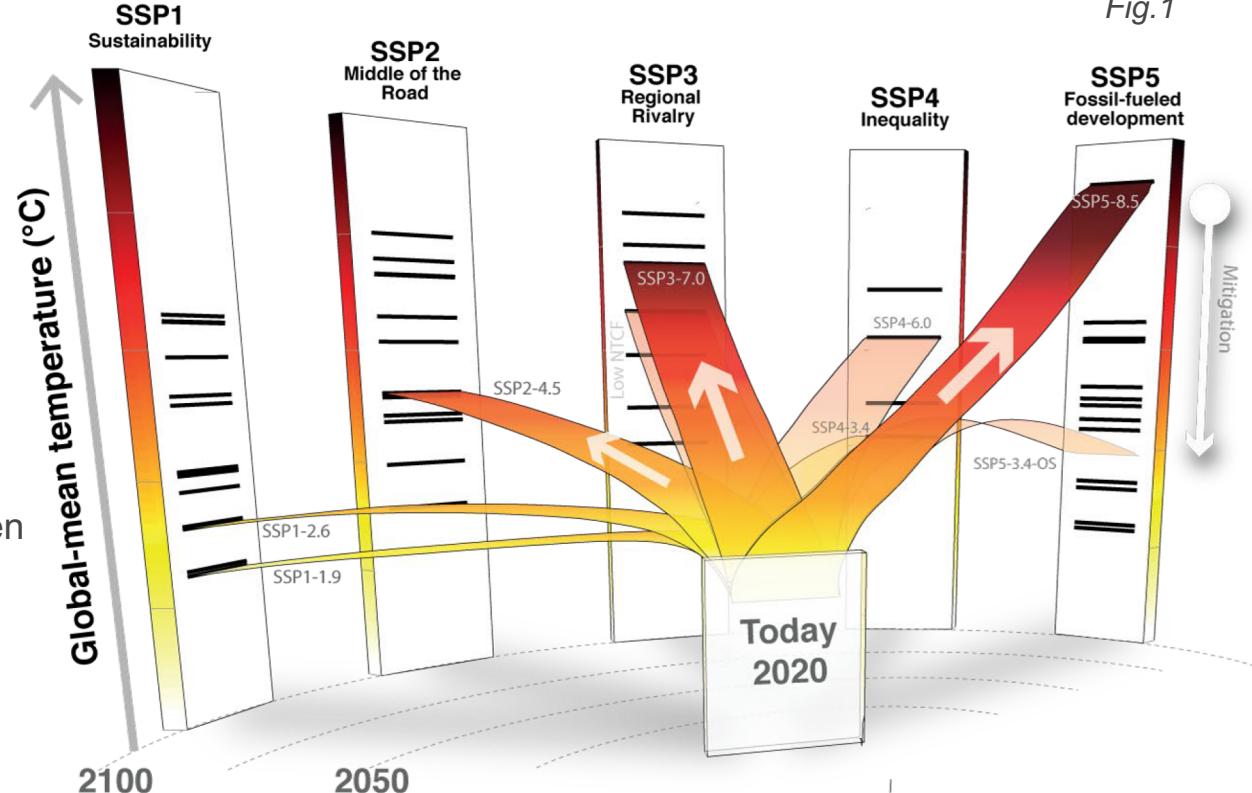
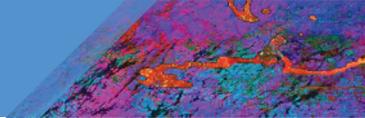


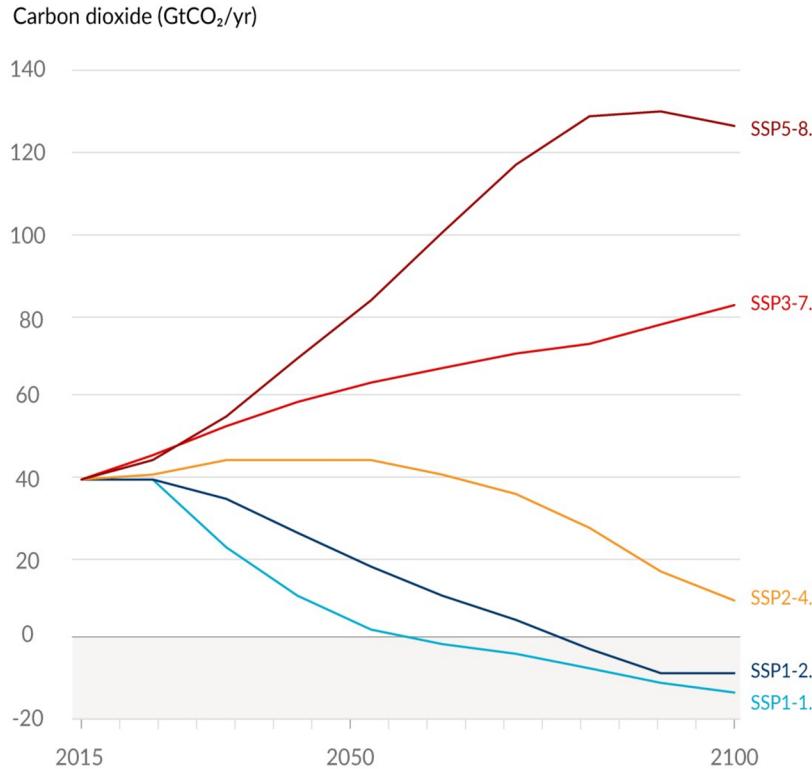
Figure CCB1.4,
Fig.1



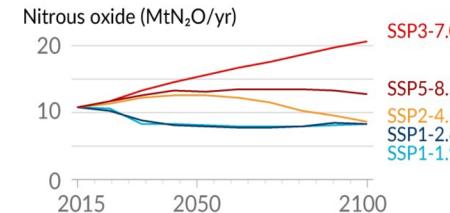
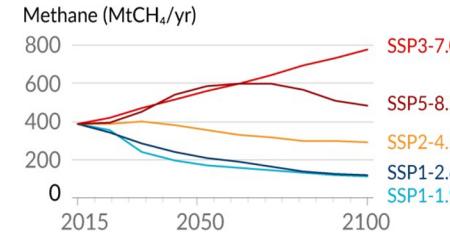
Emissions variations amongst scenarios

Figure SPM.4

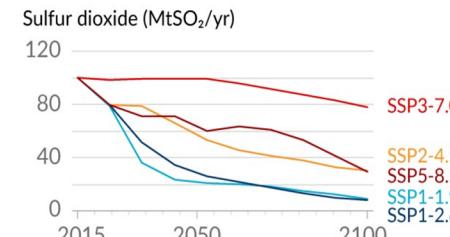
a) Future annual emissions of CO₂ (left) and of a subset of key non-CO₂ drivers (right), across five illustrative scenarios

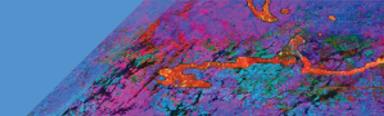


Selected contributors to non-CO₂ GHGs



One air pollutant and contributor to aerosols





Las emisiones futuras provocan el calentamiento futuro adicional

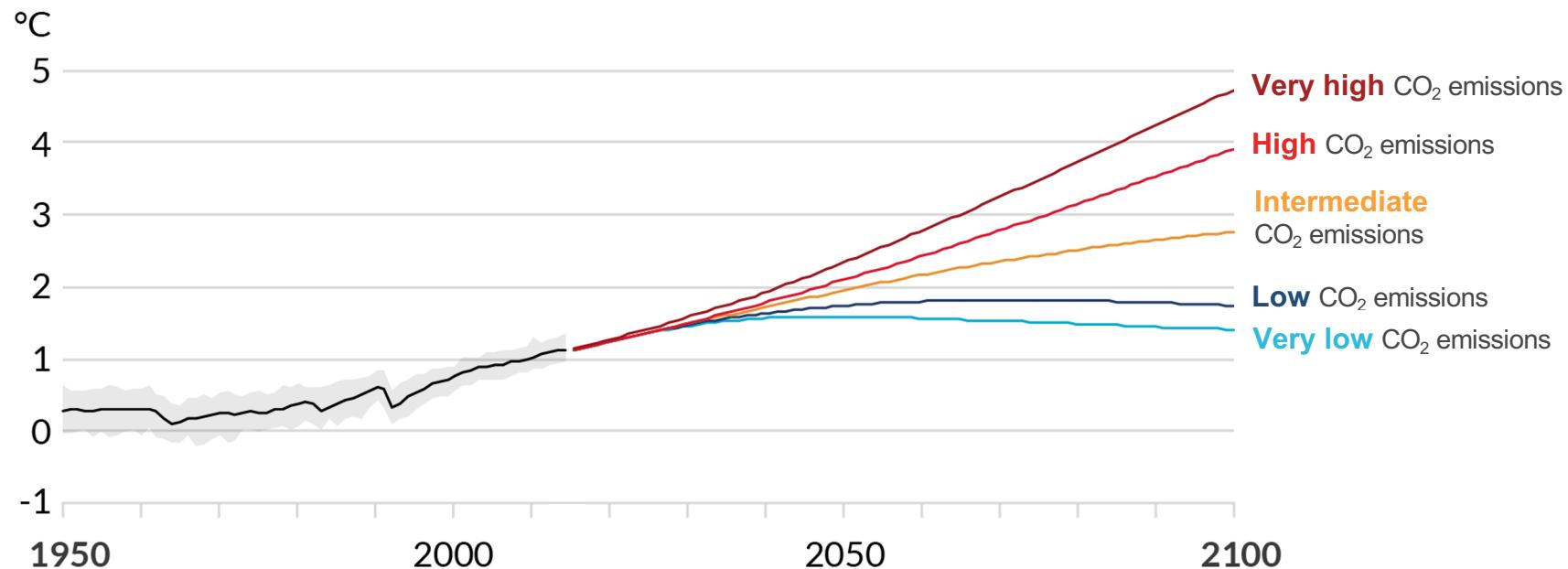
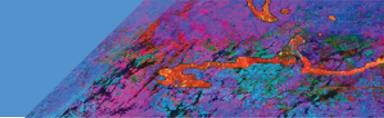


Figura 1 Box SPM.1



Las emisiones futuras provocan el calentamiento futuro adicional

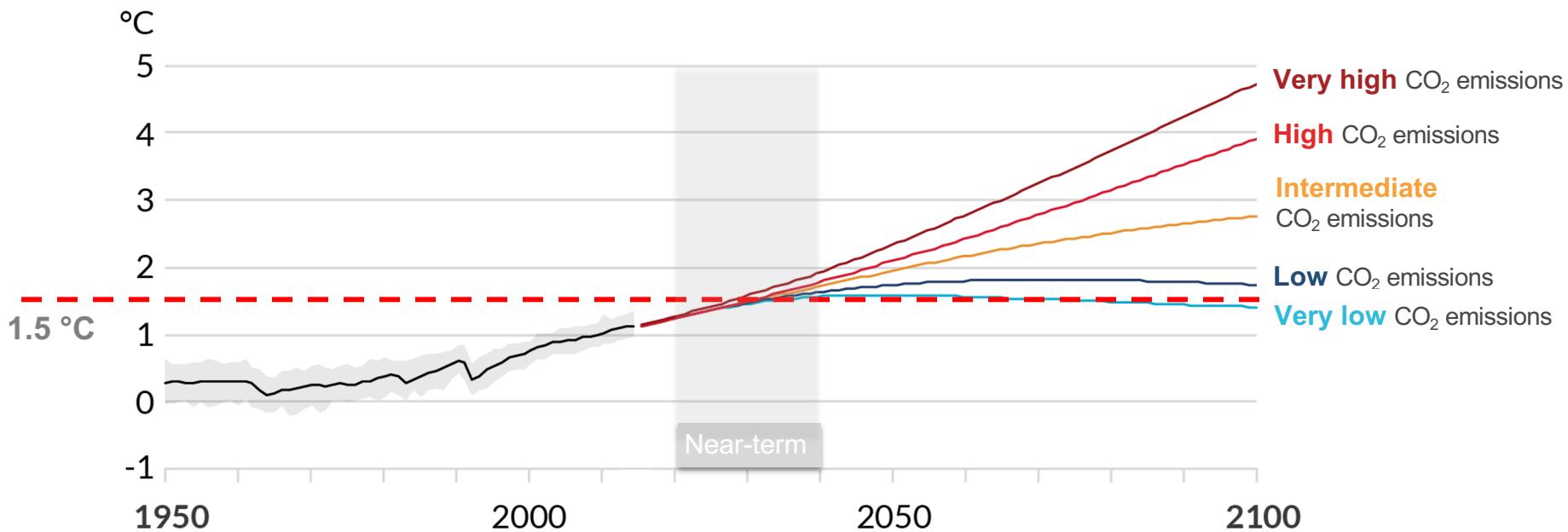
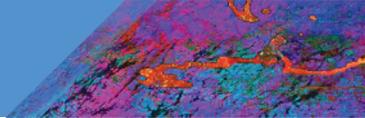


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Las emisiones futuras provocan el calentamiento futuro adicional

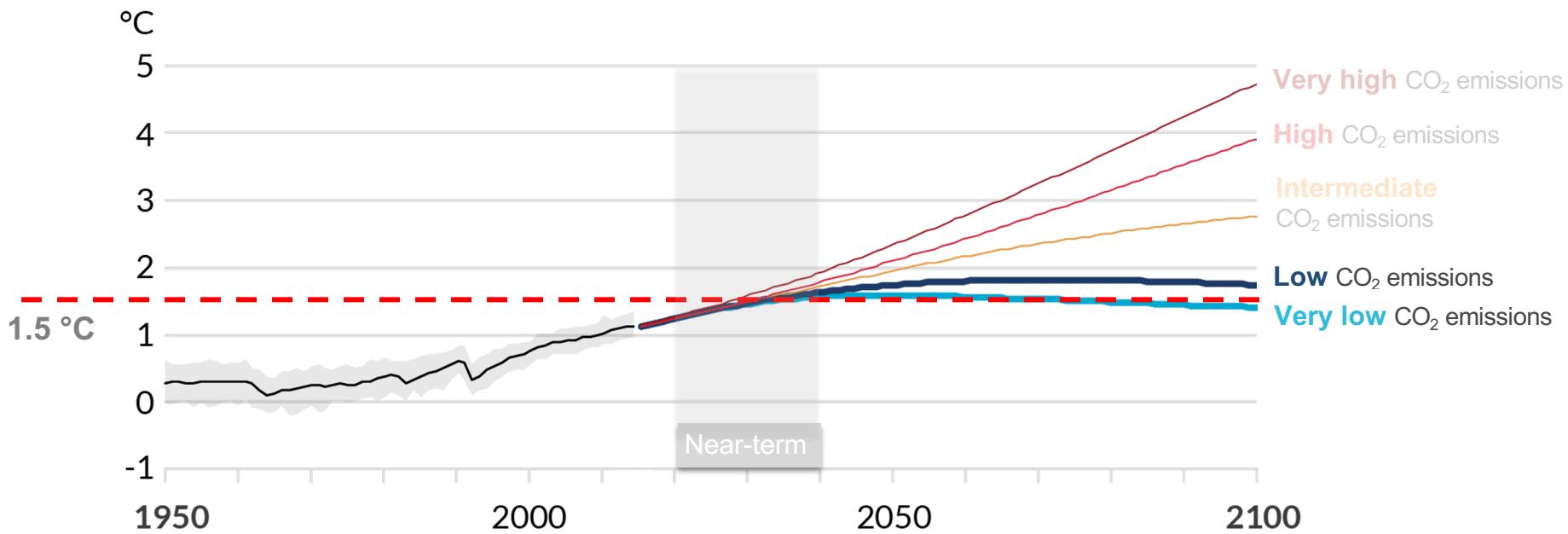
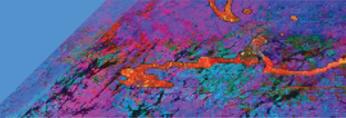


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Las emisiones futuras provocan el calentamiento futuro adicional

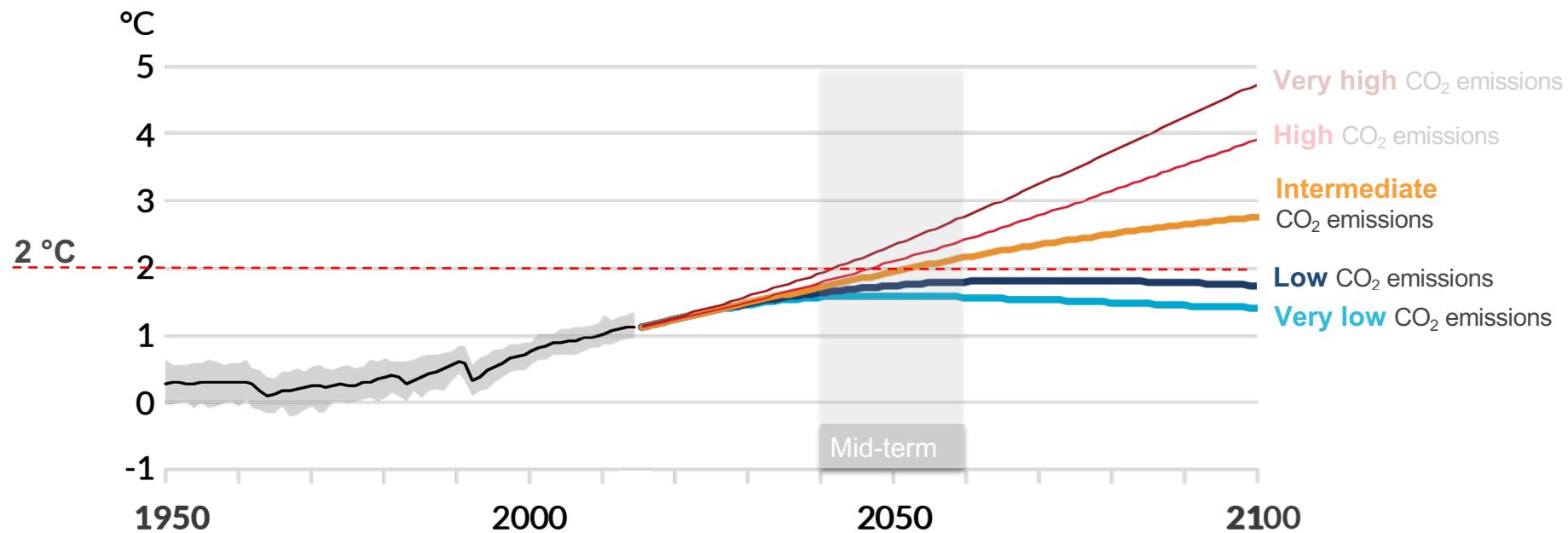


Figura 1 Box SPM.1

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INTERGOVERNMENTAL PANEL ON climate change

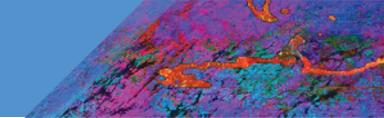
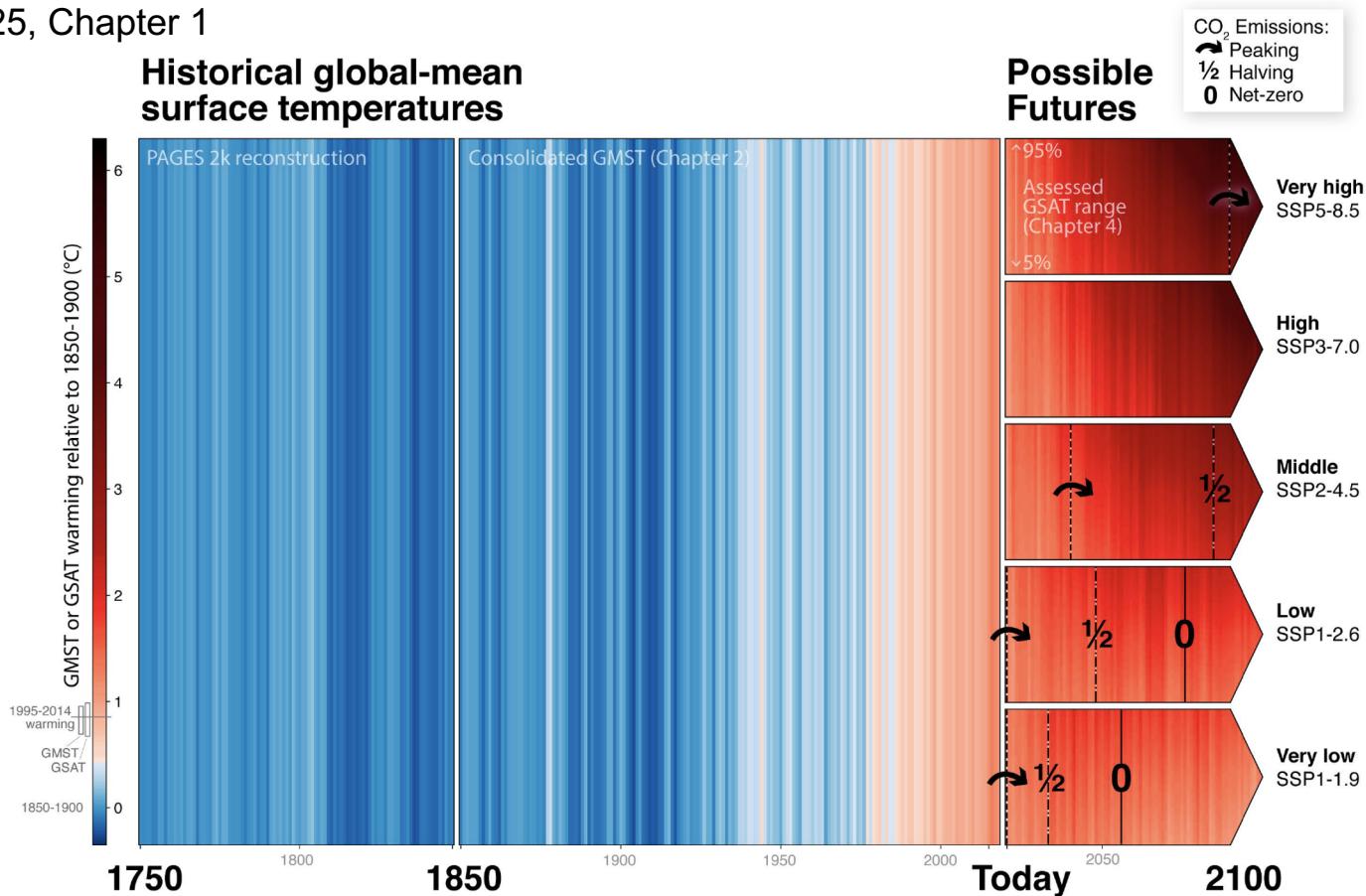


Figure 1.25, Chapter 1





[Credit: Yoda Adaman | Unsplash]

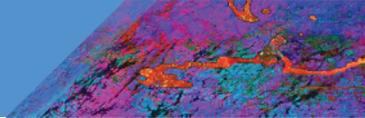
“Es indiscutible que las actividades humanas están causando el cambio climático, haciendo que los eventos climáticos extremos, como olas de calor, lluvias torrenciales y sequías, sean más frecuentes y severos.



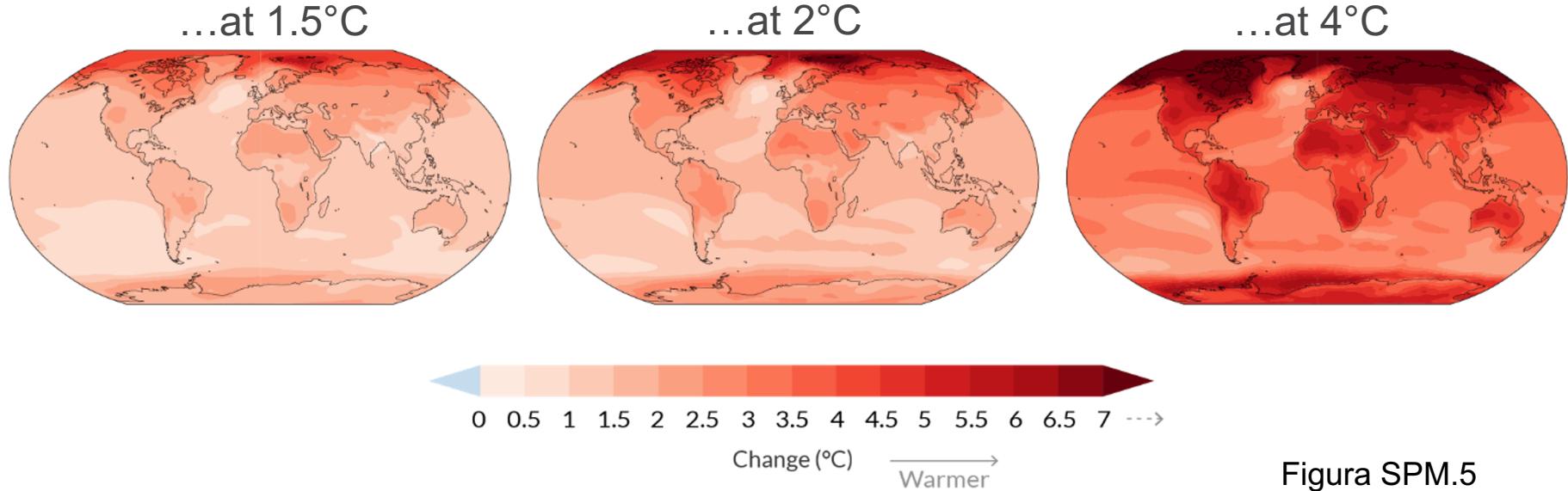
[Credit: Hong Nguyen | Unsplash]

“ El cambio climático ya está afectando a todas las regiones del planeta, de múltiples formas.

Los cambios que experimentamos aumentarán con un mayor calentamiento.

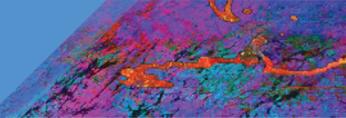


Con cada cantidad adicional de calentamiento global, los cambios se hacen mayores.



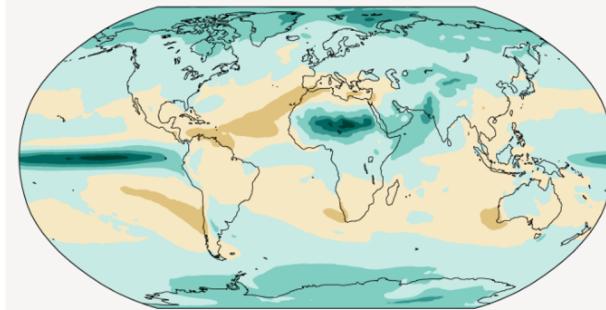
Cambios proyectados de la temperatura media anual

Figura SPM.5

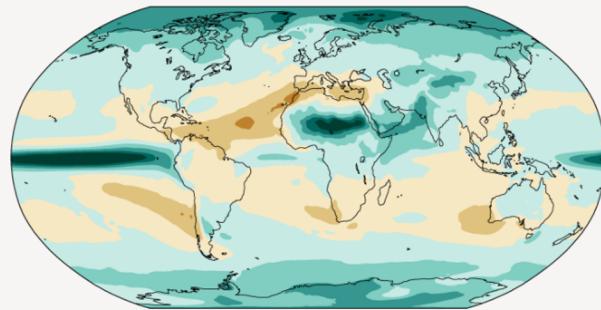


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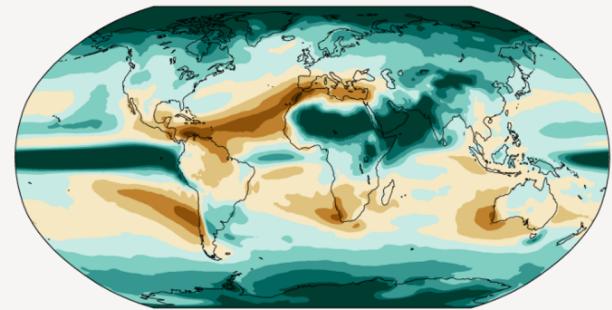
Simulated change at 1.5 °C global warming



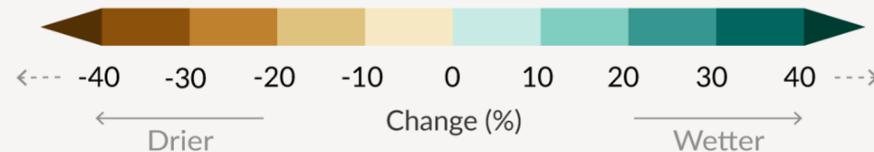
Simulated change at 2 °C global warming



Simulated change at 4 °C global warming

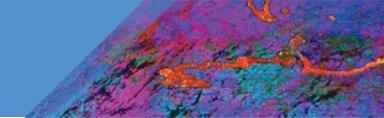


Relatively small absolute changes
may appear as large % changes in
regions with dry baseline conditions



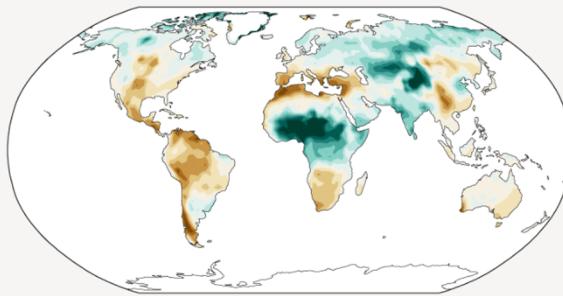
Cambios en la lluvia

Figura SPM.5

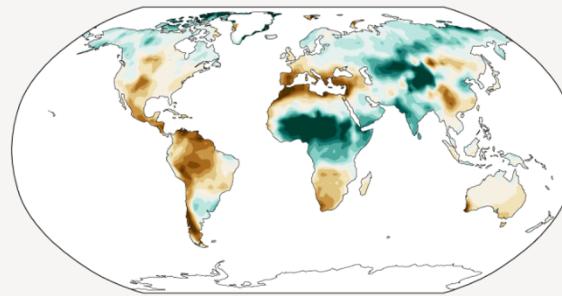


d) Annual mean total column soil moisture change (standard deviation)

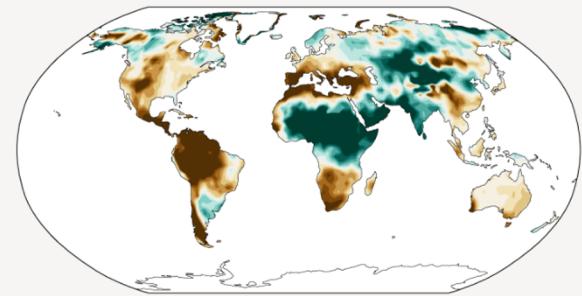
Simulated change at 1.5 °C global warming



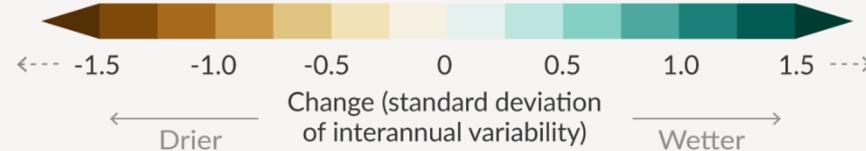
Simulated change at 2 °C global warming



Simulated change at 4 °C global warming

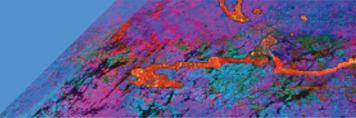


Relatively small absolute changes may appear large when expressed in units of standard deviation in dry regions with little interannual variability in baseline conditions



Cambios en la humedad del suelo

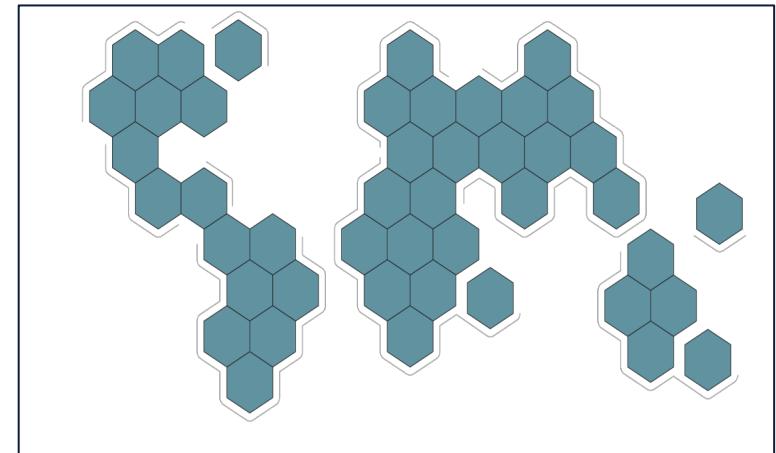
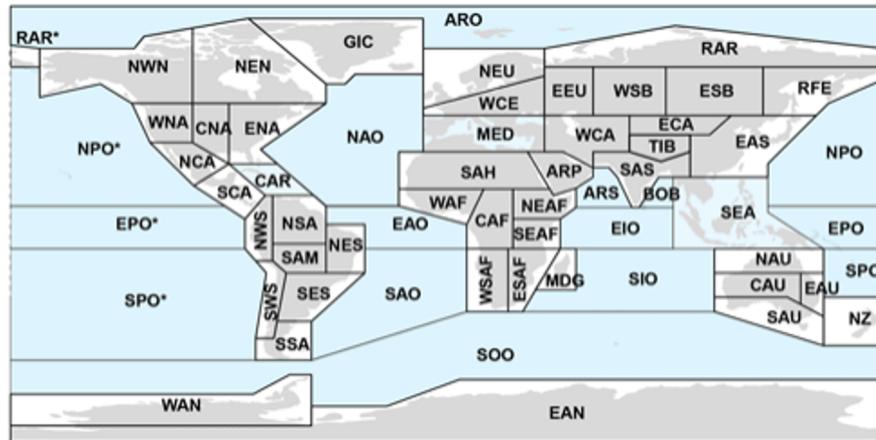
Figura SPM.5

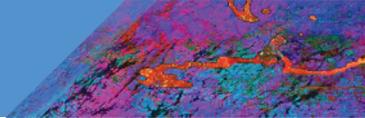


45 nuevas regiones terrestres (y su representación con hexágonos)

Para informar decisiones sobre el **manejo de riesgo y la adaptación**

Un **tercio** de nuestro informe está dedicado a **información regional**





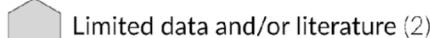
El cambio climático ya está afectando a todas las regiones habitadas del mundo, y la influencia humana contribuye a muchos cambios, incluyendo fenómenos climáticos extremos.

Figura SPM.3

Type of observed change
in hot extremes



Decrease (0)



Confidence in human contribution
to the observed change

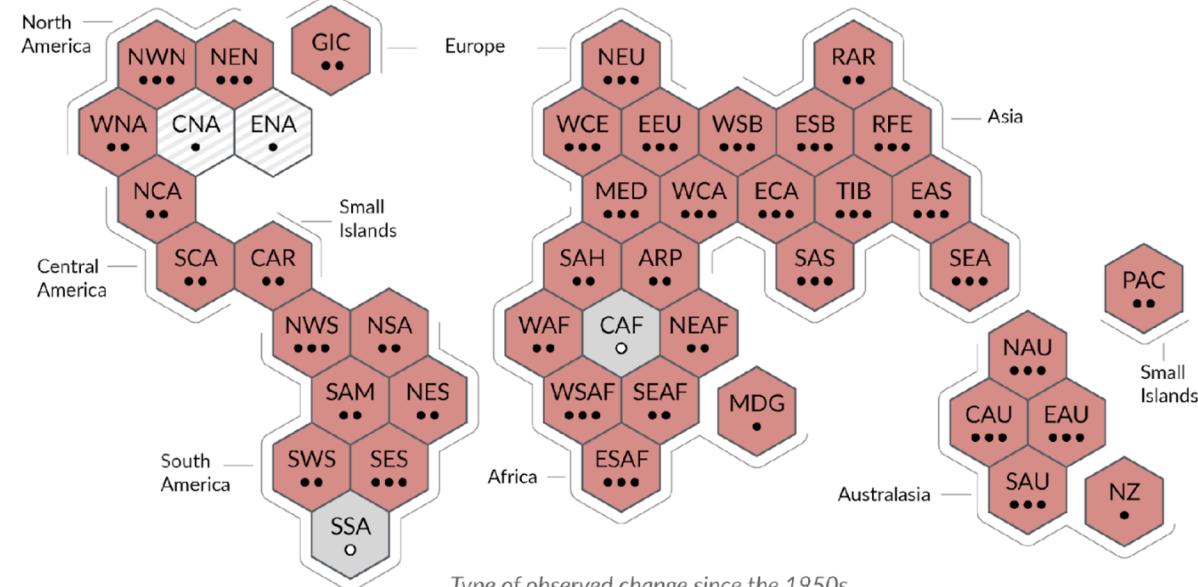
●●● High

●● Medium

● Low due to limited agreement

○ Low due to limited evidence

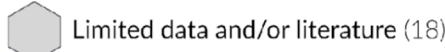
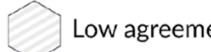
Extremos cálidos



El cambio climático ya está afectando a todas las regiones habitadas del mundo, y la influencia humana contribuye a muchos cambios, incluyendo fenómenos climáticos extremos.

Figura SPM.3

Type of observed change
in heavy precipitation



Confidence in human contribution
to the observed change

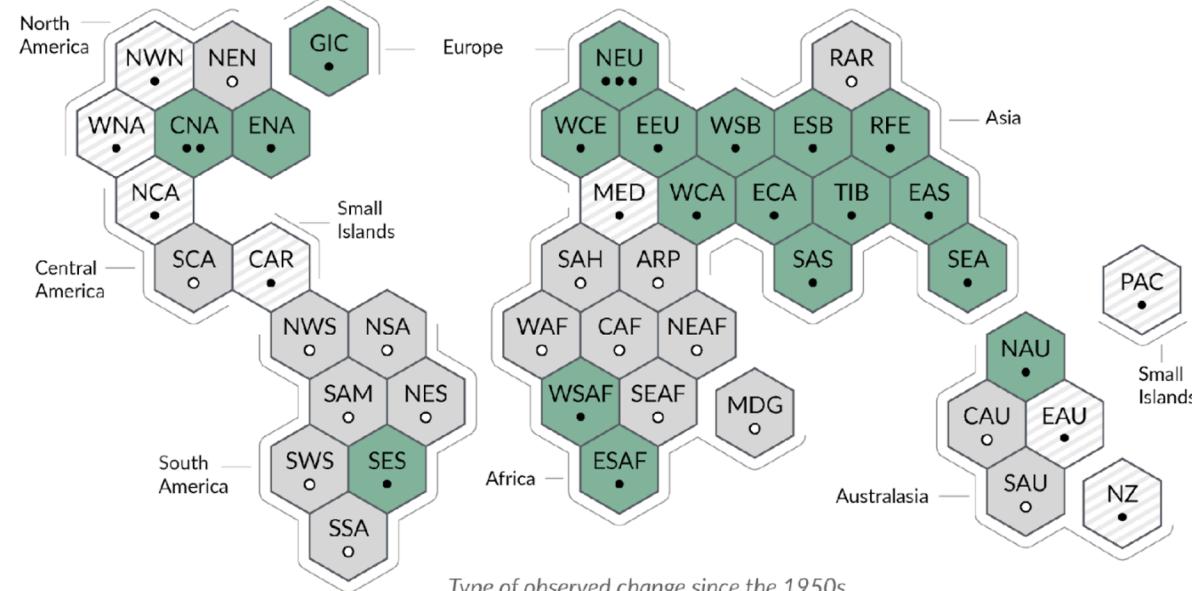
●●● High

●● Medium

● Low due to limited agreement

○ Low due to limited evidence

Extremos de precipitación diaria



El cambio climático ya está afectando a todas las regiones habitadas del mundo, y la influencia humana contribuye a muchos cambios, incluyendo fenómenos climáticos extremos.

Figura SPM.3

Type of observed change
in agricultural and ecological drought

 Increase (12)

 Decrease (1)

 Low agreement in the type of change (28)

 Limited data and/or literature (4)

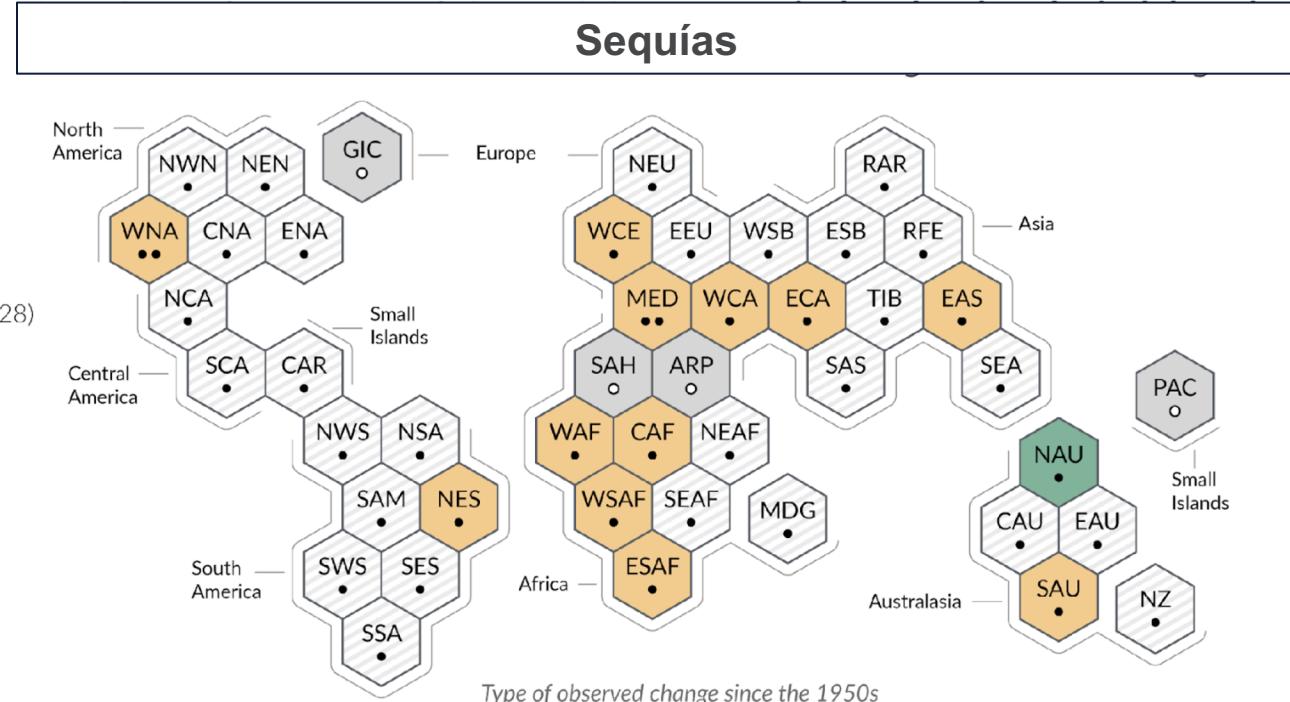
Confidence in human contribution
to the observed change

●●● High

●● Medium

● Low due to limited agreement

○ Low due to limited evidence

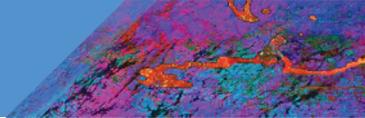


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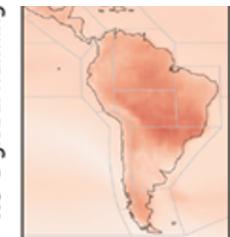
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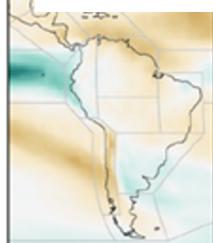
INTERGOVERNMENTAL PANEL ON climate change



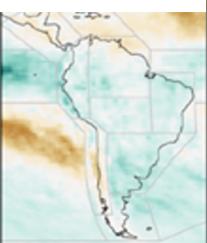
Temperatura
máxima anual



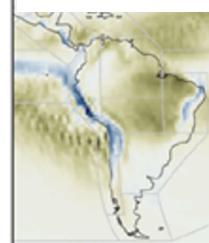
Precipitación
anual



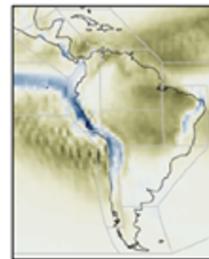
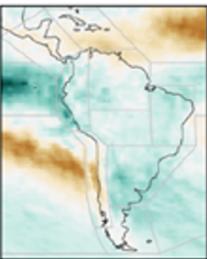
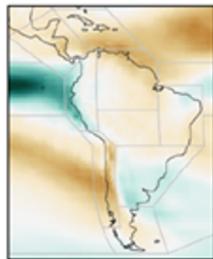
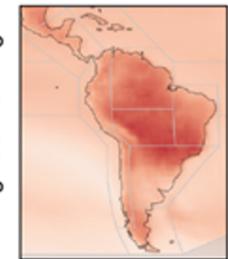
Lluvia máxima en
5 días



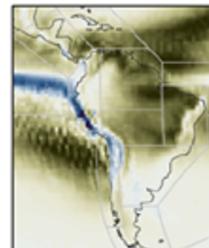
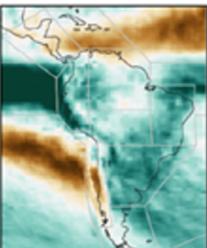
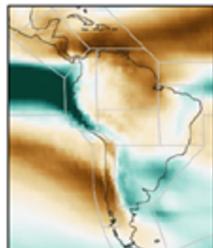
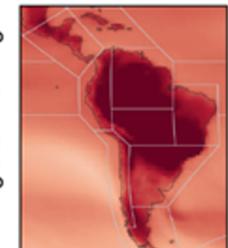
Días secos
consecutivos



1.5°C global warming



2°C global warming



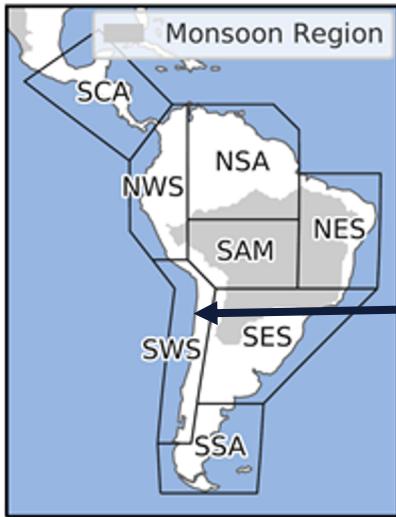
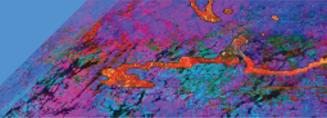
0 1 2 3 4 5 6
change (°C)

-40 -20 0 20 40
change (%)

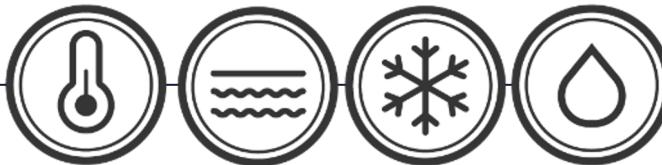
-20 0 20 40
change (days)

Cambios en Centro y Suramérica
para diferentes niveles de
calentamiento global.

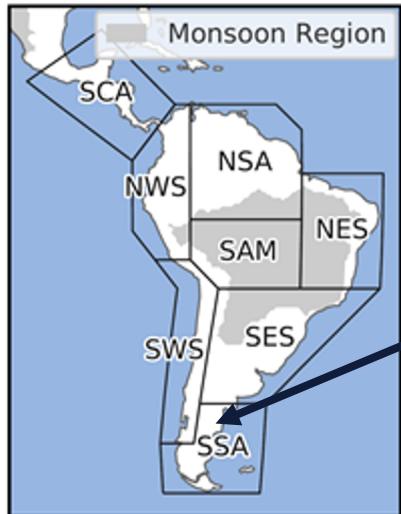
Regional fact sheet: <https://www.ipcc.ch/report/ar6/wg1/>



Suroeste de Suramérica (SWS)



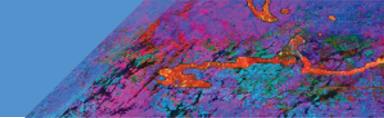
- Se observan **aumentos** en la frecuencia e intensidad de extremos cálidos desde 1950 debido a la actividad humana (*confianza media*).
- El área que sufre sequías intensas y frecuentes se **amplificará** (*confianza alta*). Aumentará la ocurrencia de la combinación de condiciones cálidas, secas y ventosas que conducen a incendios forestales (*confianza alta*).
- Las pérdidas de volumen de glaciares y el descongelamiento de permafrost **continuará** (*confianza alta*) en los Andes, causando reducciones en los corrientes de los ríos.



Sur de Suramérica (SSA)

- Se proyectan aumentos en la intensidad y la frecuencia de lluvias extremas e inundaciones para 2°C o más de calentamiento global (*confianza media*).
- Se proyectan incrementos en las sequías para 2°C o más de calentamiento global (*confianza alta*).





¿Qué es un CID?

Condiciones climáticas que conducen a impactos

FAQ 12.1: What is a climatic impact-driver (CID)?

A **climatic impact-driver (CID)** is a climate condition that directly affects elements of society or ecosystems. Climatic impact-drivers and their changes can lead to **positive**, **negative**, or **inconsequential** outcomes (or a mixture).

Climatic impact-driver

Regional climate change



Possible changes



Impacts on societies and ecosystems

Examples for seasonal snow cover

- | | |
|--|---|
| | Hazardous for crop planting |
| | Beneficial for skiing resorts |
| | Inconsequential for coastal aquaculture |
| | Impacts on snow-camouflaged species |
| | Beneficial for some predators |

Climate sciences

Impacts and risks

Nuevos índices: Condiciones climáticas que conducen a impactos



Calor
&
frío



Lluvia
&
sequía



Nieve
&
hielo



Viento



Costeras
&
oceánicas



Otras



Océano
abierto

Estos índices pueden **pasar los umbrales** que conducen a consecuencias severas para las personas, la agricultura o la vida silvestre.

Umbrales



Múltiples condiciones climáticas que conducen a impactos se proyectan cambiar en todas las regiones del mundo

Number of land & coastal regions (a) and open-ocean regions (b) where each climatic impact-driver (CID) is projected to increase or decrease with **high confidence** (dark shade) or **medium confidence** (light shade)



La figura muestra, para cada índice, la cantidad de regiones donde se proyectan cambios:

- Los índices de calor y frío cambian en casi todas las regiones.
- Los índices para zonas costeras (nivel del mar, inundación, erosión) aumentan en casi todas las regiones donde tienen relevancia.
- Los índices de nieve y hielo disminuyen en casi todas las regiones donde tienen relevancia.

Figura SPM.9

SIXTH ASSESSMENT REPORT

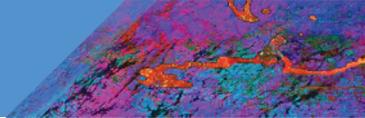
Working Group I – The Physical Science Basis

ipcc

INTERGOVERNMENTAL PANEL ON climate change



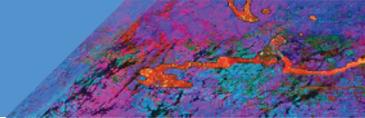
Projected warming



Warming projections

Table SPM.1. See more in
Table 4.5 and Fig 4.11

	Near term, 2021–2040		Mid-term, 2041–2060		Long term, 2081–2100	
Scenario	Best estimate (°C)	<i>Very likely</i> range (°C)	Best estimate (°C)	<i>Very likely</i> range (°C)	Best estimate (°C)	<i>Very likely</i> range (°C)
SSP1-1.9	1.5	1.2 to 1.7	1.6	1.2 to 2.0	1.4	1.0 to 1.8
SSP1-2.6	1.5	1.2 to 1.8	1.7	1.3 to 2.2	1.8	1.3 to 2.4
SSP2-4.5	1.5	1.2 to 1.8	2.0	1.6 to 2.5	2.7	2.1 to 3.5
SSP3-7.0	1.5	1.2 to 1.8	2.1	1.7 to 2.6	3.6	2.8 to 4.6
SSP5-8.5	1.6	1.3 to 1.9	2.4	1.9 to 3.0	4.4	3.3 to 5.7

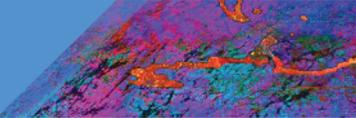


Warming projections

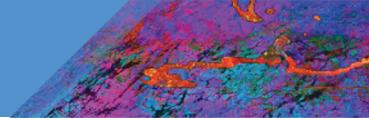
Table SPM.1

SSP1-1.9 (very low emissions):
Peak at 1.6C,
1.4C by end of century

	Near term, 2021–2040		Mid-term, 2041–2060		Long term, 2081–2100	
Scenario	Best estimate (°C)	<i>Very likely</i> range (°C)	Best estimate (°C)	<i>Very likely</i> range (°C)	Best estimate (°C)	<i>Very likely</i> range (°C)
SSP1-1.9	1.5	1.2 to 1.7	1.6	1.2 to 2.0	1.4	1.0 to 1.8
SSP1-2.6	1.5	1.2 to 1.8	1.7	1.3 to 2.2	1.8	1.3 to 2.4
SSP2-4.5	1.5	1.2 to 1.8	2.0	1.6 to 2.5	2.7	2.1 to 3.5
SSP3-7.0	1.5	1.2 to 1.8	2.1	1.7 to 2.6	3.6	2.8 to 4.6
SSP5-8.5	1.6	1.3 to 1.9	2.4	1.9 to 3.0	4.4	3.3 to 5.7



- The **very low considered scenario (SSP1-1.9)** results in temperatures around 1.5C at its peak (with limited overshoot up to +0.1C) and returns to below 1.5C warming by the end of the century.
- This very low scenario implies global **net-zero CO2** emissions around 2050.
- Is it realistic?
 - Around 60 countries around the world, representing more than 50% of global emissions, already have net-zero targets.
 - If such targets are implemented on a global level, then yes, limiting warming to around 1.5C can become a reality.

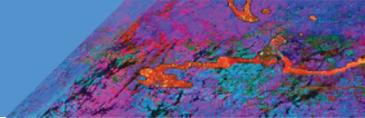


Warming projections “like current NDCs”

SSP2-4.5
(middle of the road): 2.0C by mid-century, 2.7C by end of century (and still warming)

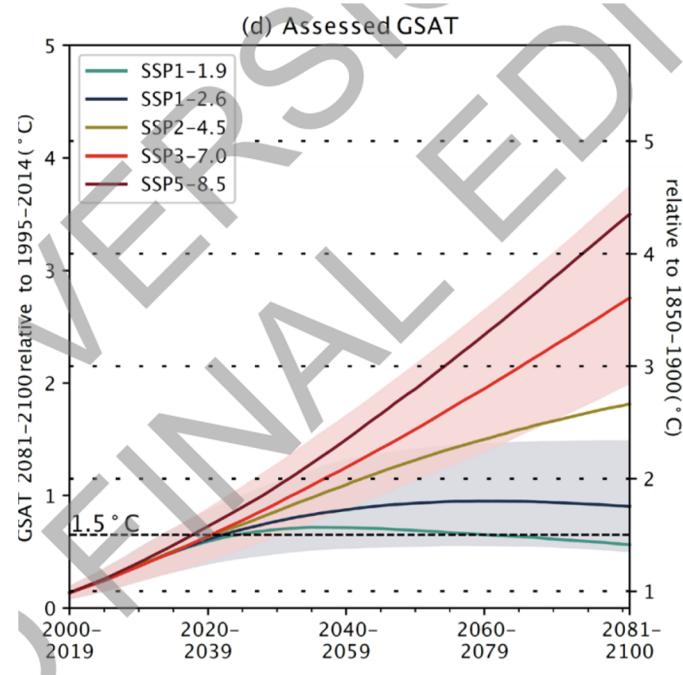
Table SPM.1

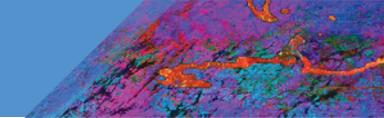
	Near term, 2021–2040		Mid-term, 2041–2060		Long term, 2081–2100	
Scenario	Best estimate (°C)	<i>Very likely</i> range (°C)	Best estimate (°C)	<i>Very likely</i> range (°C)	Best estimate (°C)	<i>Very likely</i> range (°C)
SSP1-1.9	1.5	1.2 to 1.7	1.6	1.2 to 2.0	1.4	1.0 to 1.8
SSP1-2.6	1.5	1.2 to 1.8	1.7	1.3 to 2.2	1.8	1.3 to 2.4
SSP2-4.5	1.5	1.2 to 1.8	2.0	1.6 to 2.5	2.7	2.1 to 3.5
SSP3-7.0	1.5	1.2 to 1.8	2.1	1.7 to 2.6	3.6	2.8 to 4.6
SSP5-8.5	1.6	1.3 to 1.9	2.4	1.9 to 3.0	4.4	3.3 to 5.7



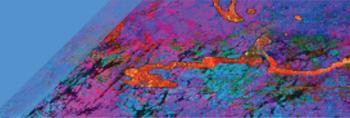
Warming projections

Fig 4.11





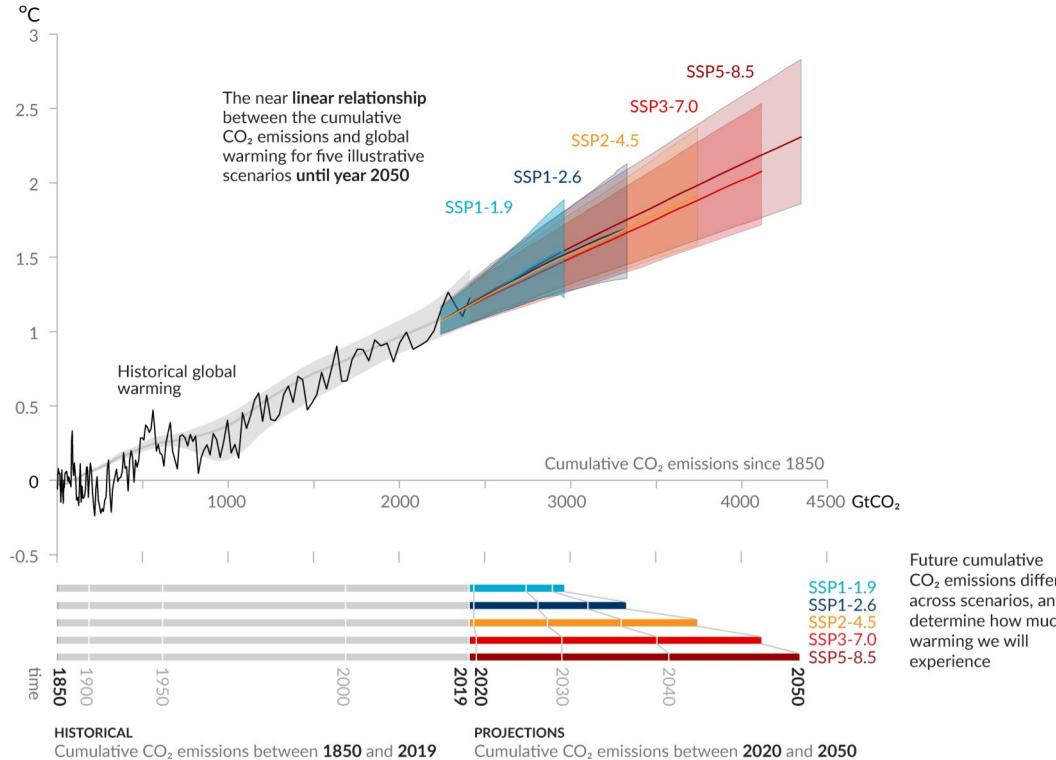
Remaining carbon budgets

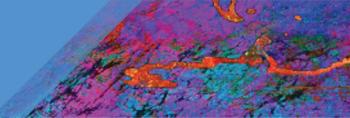


Every tonne of CO₂ emissions adds to global warming

Figure SPM.10

Global surface temperature increase since 1850-1900 (°C) as a function of cumulative CO₂ emissions (GtCO₂)

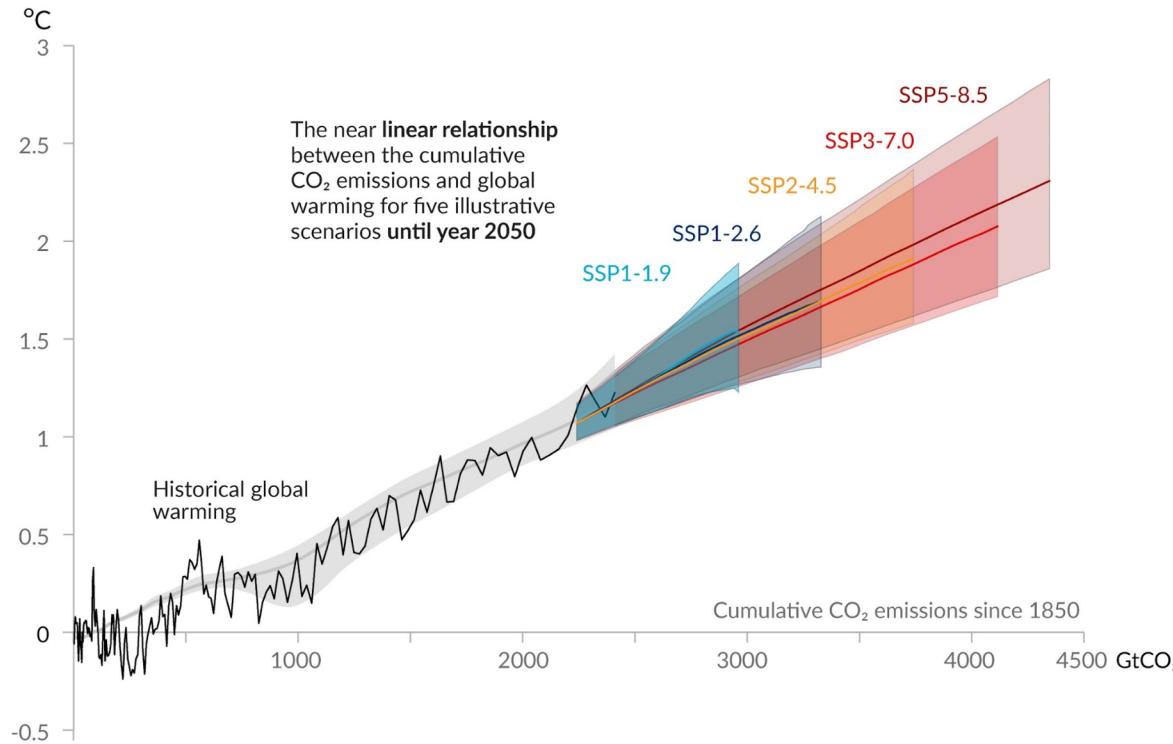


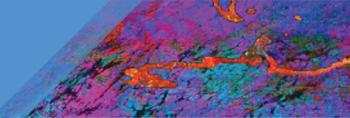


Every tonne of CO₂ emissions adds to global warming

Figure SPM.10

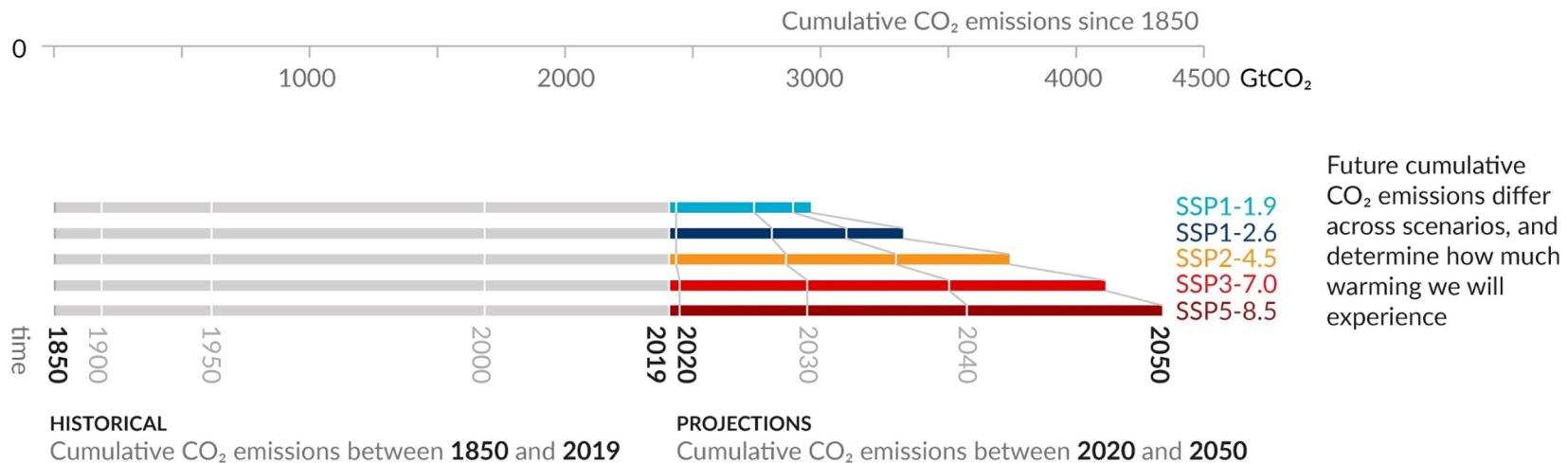
Global surface temperature increase since 1850-1900 (°C) as a function of cumulative CO₂ emissions (GtCO₂)





Every tonne of CO₂ emissions adds to global warming

Figure SPM.10



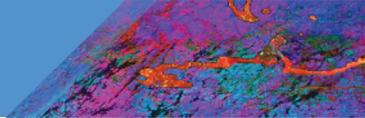


Table SPM.2

Remaining carbon budgets

Approximate global warming relative to 1850–1900 until temperature limit (°C)*(1)	Additional global warming relative to 2010–2019 until temperature limit (°C)	Estimated remaining carbon budgets from the beginning of 2020 (GtCO ₂)					Variations in reductions in non-CO ₂ emissions*(3)
		17%	33%	50%	67%	83%	
1.5	0.43	900	650	500	400	300	Higher or lower reductions in accompanying non-CO ₂ emissions can increase or decrease the values on the left by 220 GtCO ₂ or more
1.7	0.63	1450	1050	850	700	550	
2.0	0.93	2300	1700	1350	1150	900	

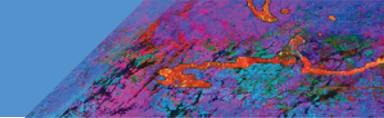


Table SPM.2

Remaining carbon budgets

Approximate global warming relative to 1850–1900 until temperature limit (°C)* ⁽¹⁾	Additional global warming relative to 2010–2019 until temperature limit (°C)	Estimated remaining carbon budgets from the beginning of 2020 (GtCO ₂)					Variations in reductions in non-CO ₂ emissions*(3)
		17%	33%	50%	67%	83%	
1.5	0.43	900	650	500	400	300	Higher or lower reductions in accompanying non-CO ₂ emissions can increase or decrease the values on the left by 220 GtCO ₂ or more
1.7	0.63	1450	1050	850	700	550	
2.0	0.93	2300	1700	1350	1150	900	

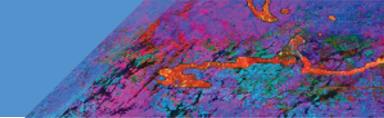


Table SPM.2

Remaining carbon budgets

Approximate global warming relative to 1850–1900 until temperature limit (°C)* ⁽¹⁾	Additional global warming relative to 2010–2019 until temperature limit (°C)	Estimated remaining carbon budgets from the beginning of 2020 (GtCO ₂)					Variations in reductions in non-CO ₂ emissions* ⁽³⁾
		<i>Likelihood of limiting global warming to temperature limit*</i> ⁽²⁾					
		17%	33%	50%	67%	83%	
1.5	0.43	900	650	500	400	300	Higher or lower reductions in accompanying non-CO ₂

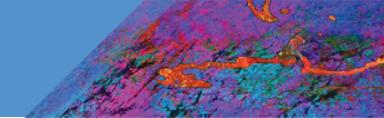
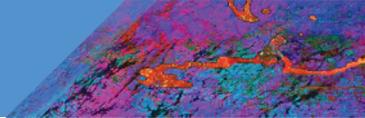


Table SPM.2

Remaining carbon budgets

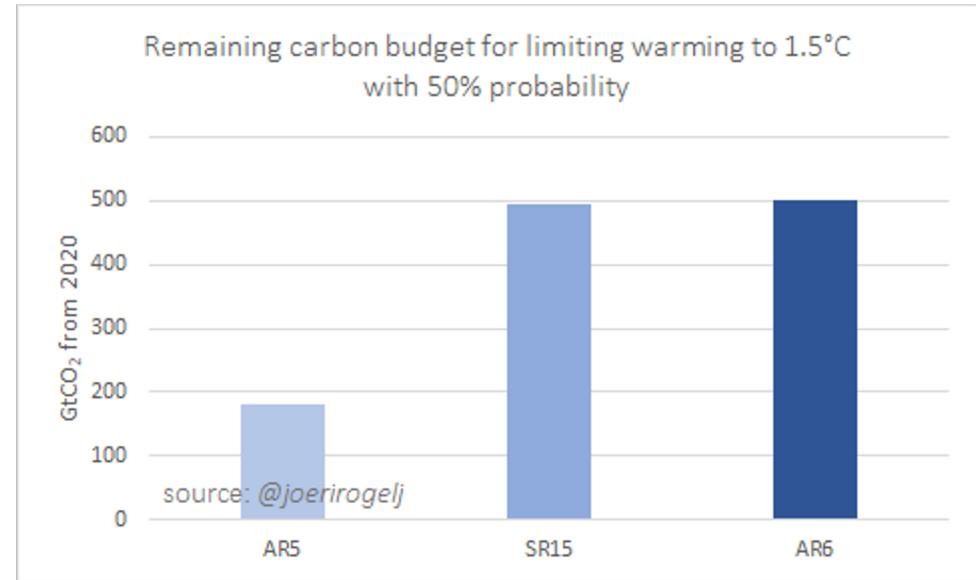
Approximate global warming relative to 1850–1900 until temperature limit ($^{\circ}\text{C}$)* ⁽¹⁾	Additional global warming relative to 2010–2019 until temperature limit ($^{\circ}\text{C}$)	Estimated remaining carbon budgets from the beginning of 2020 (GtCO_2)					Variations in reductions in non- CO_2 emissions* ⁽³⁾
		<i>Likelihood of limiting global warming to temperature limit*</i> ⁽²⁾					
1.5	0.43	17%	33%	50%	67%	83%	
1.5	0.43	900	650	500	400	300	Higher or lower reductions in accompanying non- CO_2

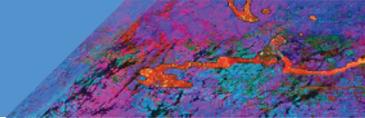


Remaining carbon budgets - AR6 vs. SR1.5

Box 5.2 and
@joerirogelj

AR6 and SR1.5 estimates for a 50:50 chance are remarkably similar (more on that in the next seminar)

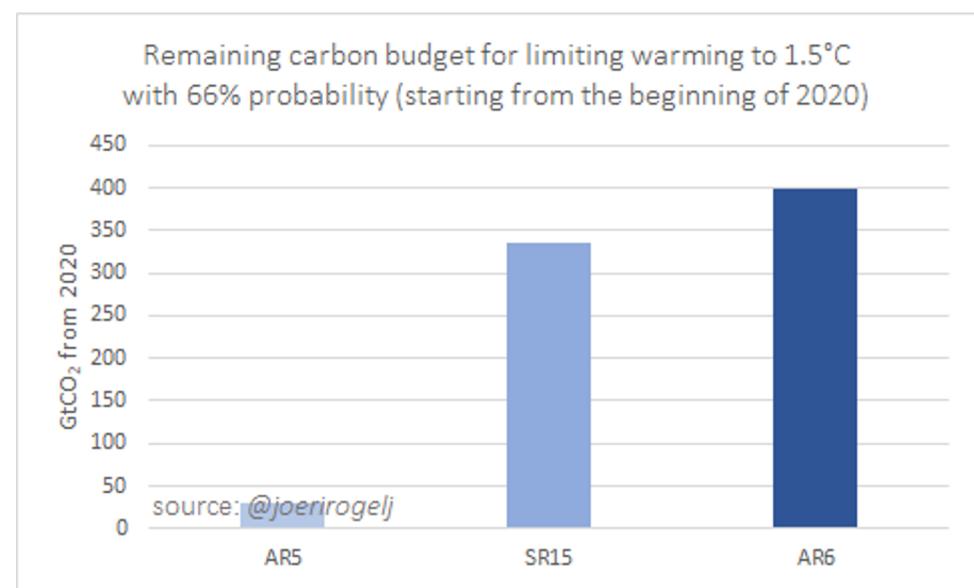




Remaining carbon budgets - AR6 vs. SR1.5

Box 5.2 and
@joerirogelj

AR6 remaining carbon budget for a 67% chance is slightly higher than SR1.5 because we are more certain about the TCRE





[Credit: Andy Mahoney | NSIDC]

“...Sin embargo, algunos cambios podrían desacelerarse y otros podrían detenerse limitando el calentamiento.



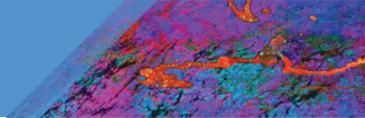
“ Algunos de los cambios experimentados son irreversibles.....

[Credit: Jenn Caselle | UCSB]

“ Para limitar el calentamiento global, son necesarias reducciones fuertes, rápidas y sostenidas de CO₂, metano y otros gases de efecto invernadero.



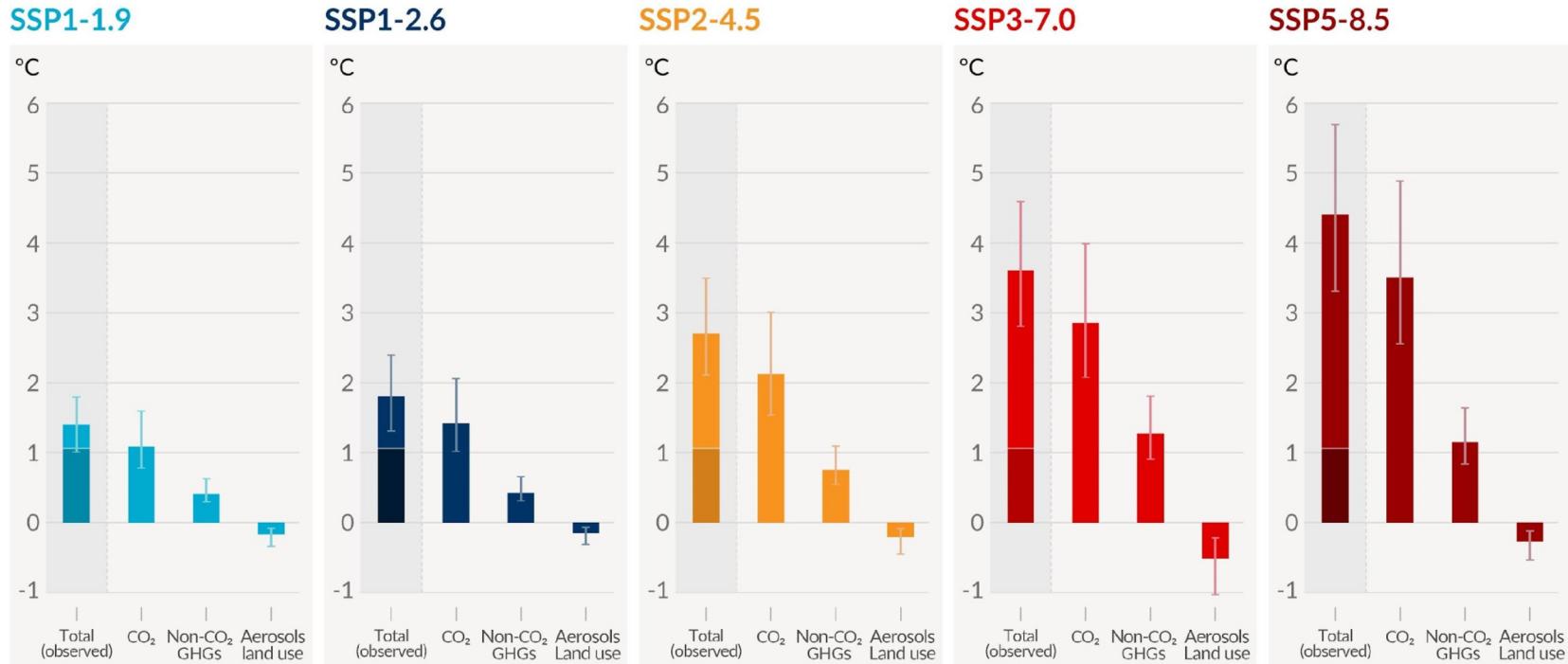
[Credit: evgeny-nelmin.]

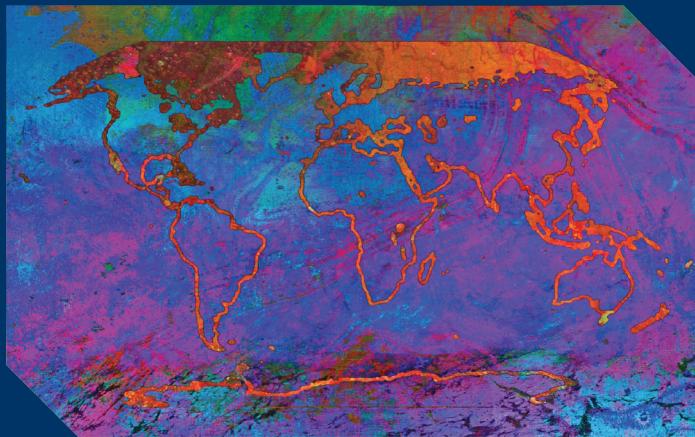


Future emissions cause future additional warming, with total warming dominated by past and future CO₂ emissions

Change in global surface temperature in 2081-2100 relative to 1850-1900 (°C)

Figure SPM.4





[Credit: Andy Mahoney | NSIDC]

“ El clima que experimentaremos en el futuro depende de nuestras decisiones ahora.