CICLO DE JORNADAS

LOS ODS: DESAFÍOS MEDIOAMBIENTALES PARA UN PLANETA CON FUTURO



Cambio climático:

causas y consecuencias.

J. Fidel González Rouco

fidelgr@fis.ucm.es
Departamento de Física de la Tierra y Astrofísica
IGEO-UCM
Universidad Complutense de Madrid

Facultad CC. Químicas 20.10.2021

IGEO
INSTITUTO DE GEOCIENCIAS

CAMPUS Y MEDIO AMBIENTE
UNIVERSIDAD COMPLUTENSE DE MADRID

CICLO DE JORNADAS

LOS ODS: DESAFÍOS MEDIOAMBIENTALES PARA UN PLANETA CON FUTURO

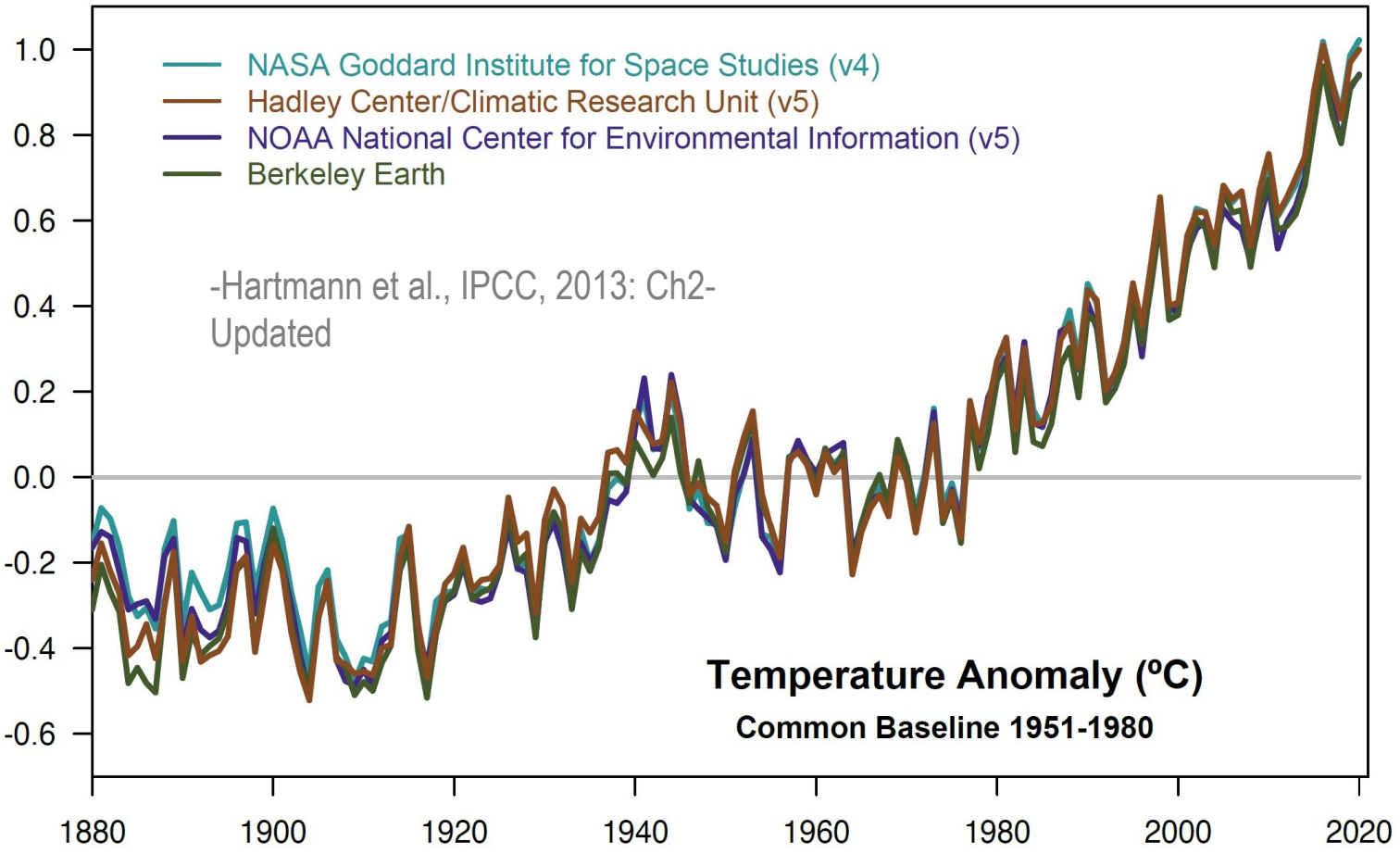


Cambio climático:

causas y consecuencias.

1. ¿Cómo sabemos que el cambio climático actual está producido por las actividades humanas?
2. ¿Cómo estimamos el cambio climático futuro?
3. ¿Estamos en una situación de emergencia?
4. ¿Qué posibilidades tenemos para controlar el cambio climático en el futuro?
5. ¿Es importante para los ODS?

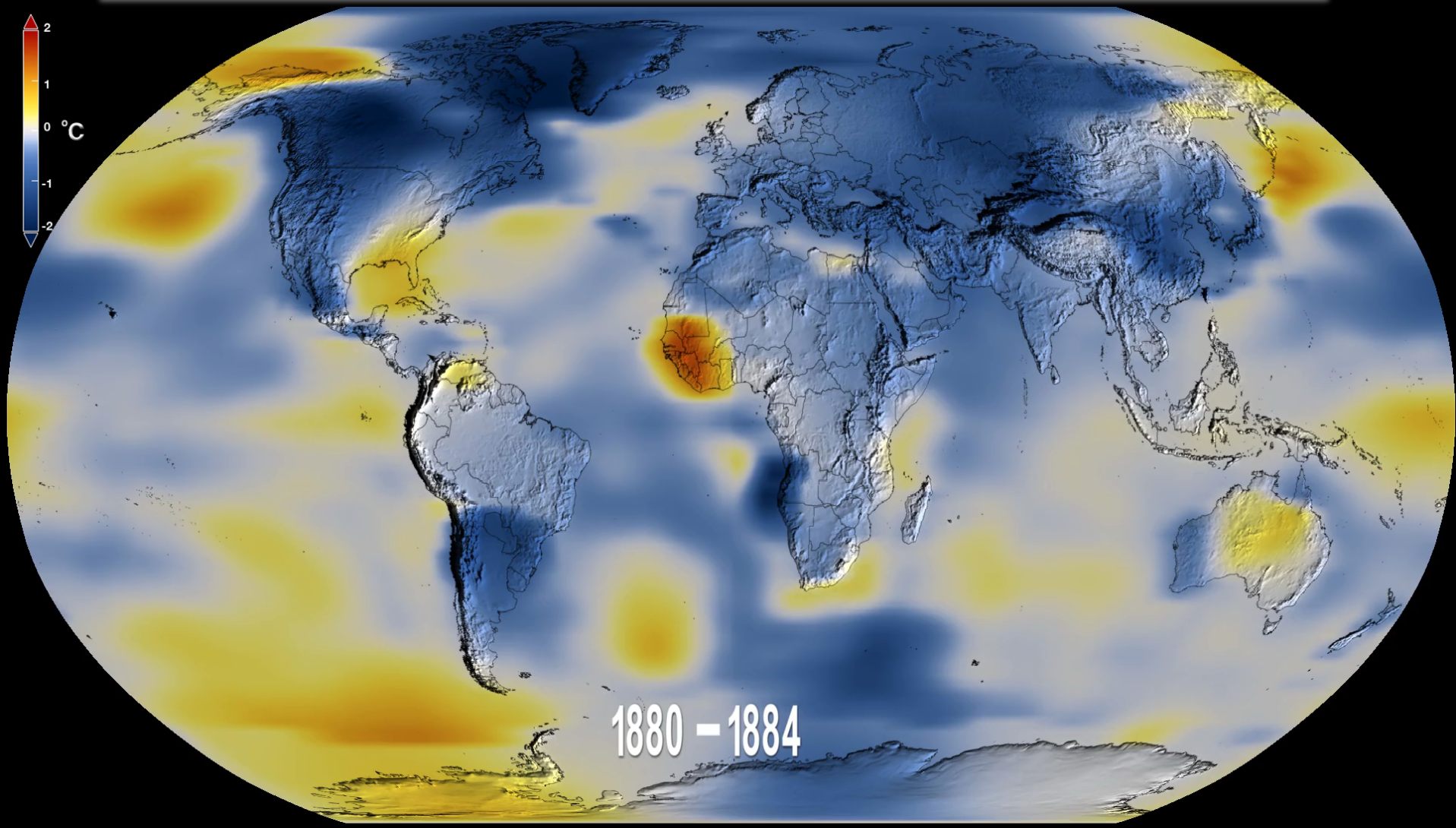
Observed changes in the climate system: atmosphere & ocean



Earth has been in radiative imbalance with more engergy entering than leaving the system since ~ 1970s.

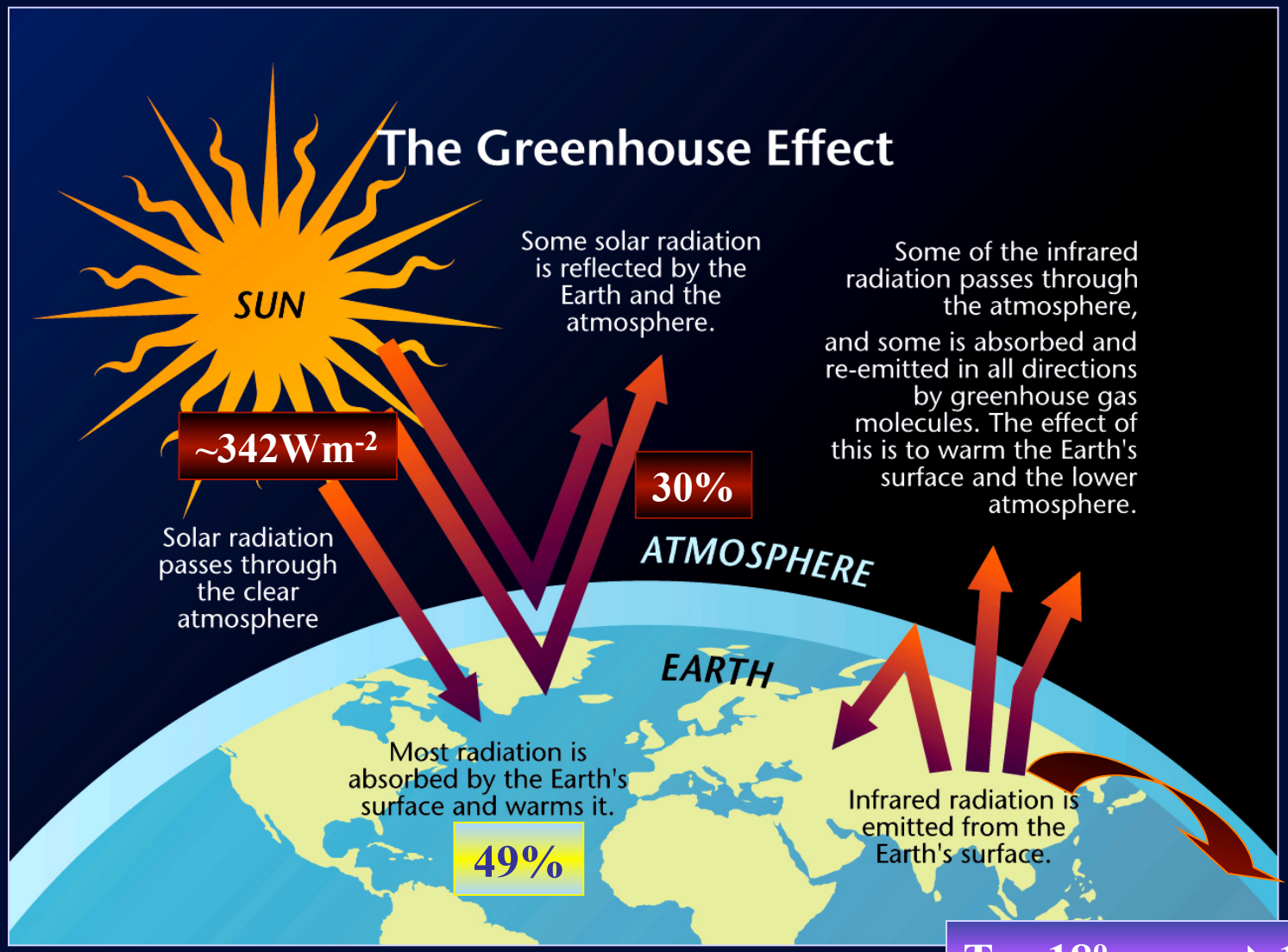
It is virtually certain that temperatures have increased more than 1K since the late 19th century.

Observed changes in the climate system: atmosphere & ocean



Warming is unequivocal, both in the atmosphere and ocean… but not only

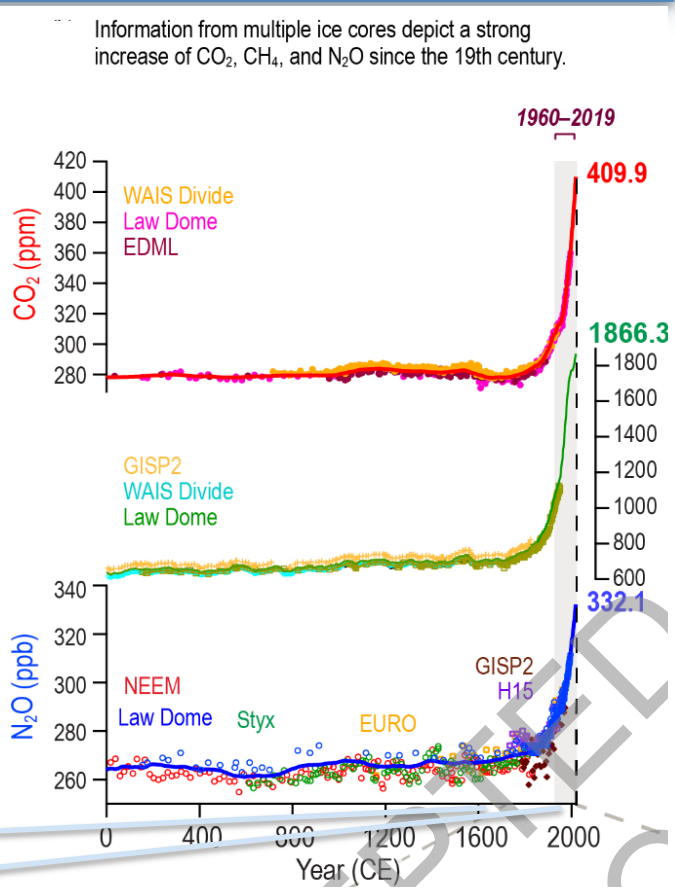
Earth's temperature is the result of radiative balance

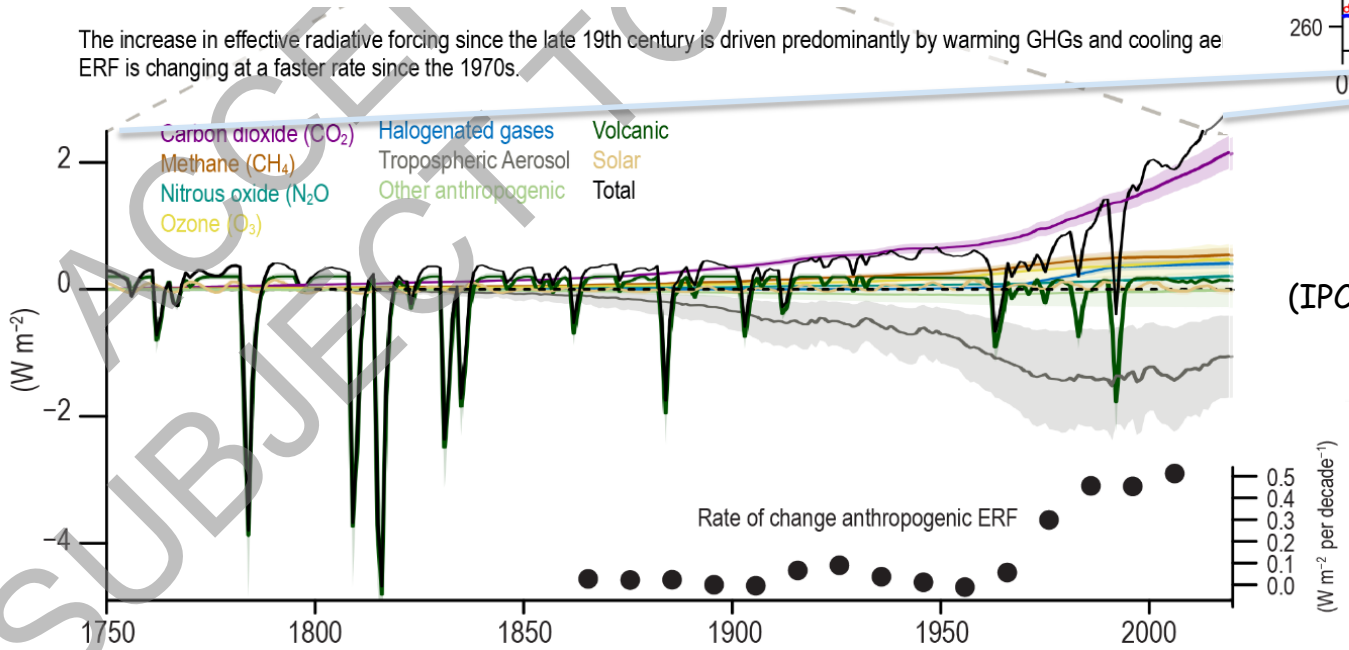


Radiative forcing factors

Natural and anthropogenic energy drivers

Natural forcings: volcanic, solar, orbital
Anthropogenic forcings: greenhouse gases, aerosols, land use land cover changes



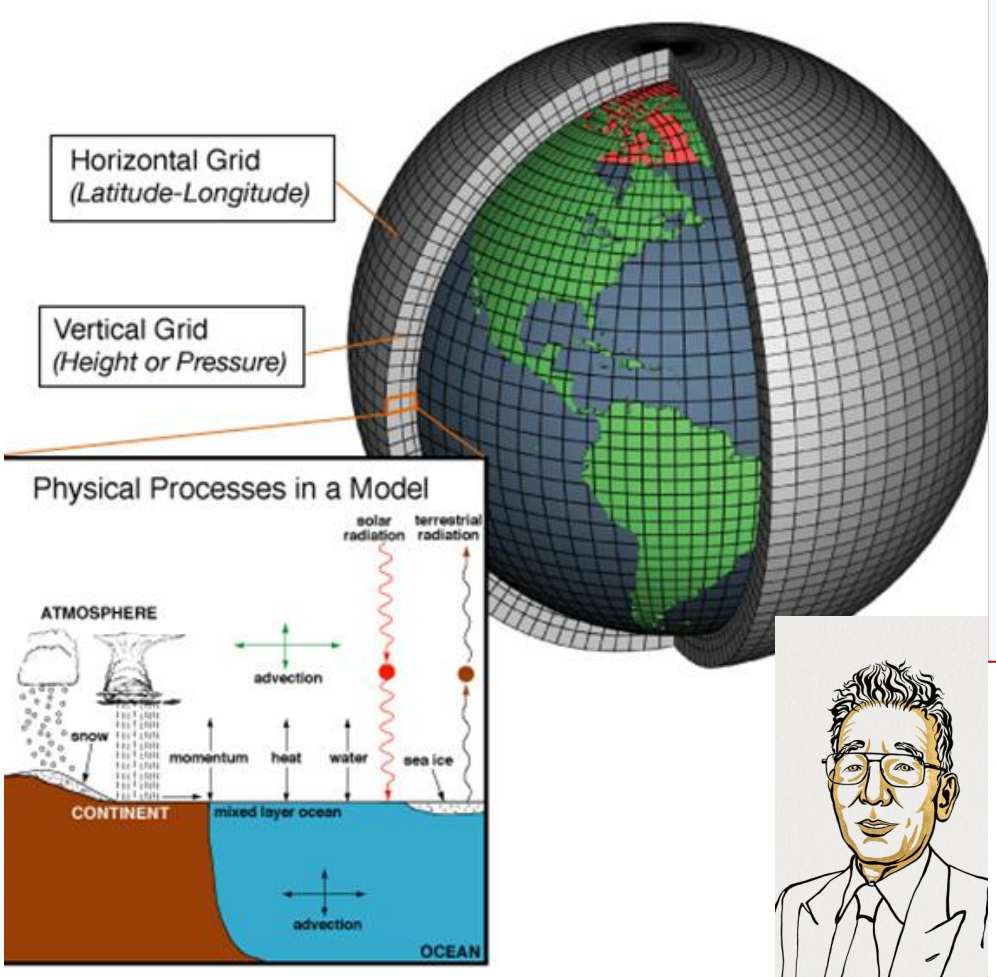


(IPCC 2021, Fig TS9)

ACCEPTED SUBJECT TO

What causes present climate change?

We need to use tools that allow for evaluating the efects of external forcing changes: los modelos climáticos

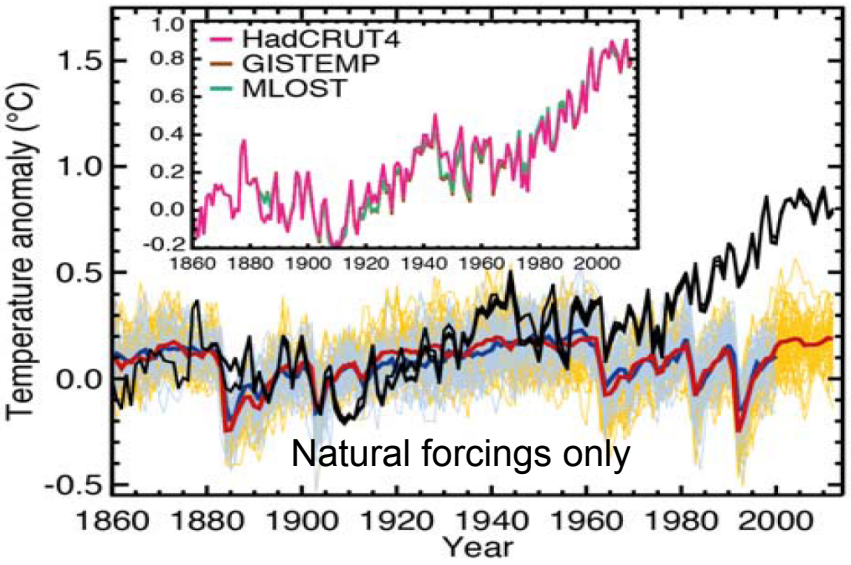


- **Climate models are computer codes that resolve the equations of the dynamics of the various climate system components (atmosphere, ocean, cryosphere, biosphere…) and their interactions.**

- **The 'dynamics' solves the Navier Stokes equations in an spatial grid. The 'physics' consists on parameterizing the sub-grid scale proceses that are not explicitely solved in the grid resolution.**

Syukuro Manabe. Nobel Fisica 2021

What causes system changes?: model evaluation & detection/attribution

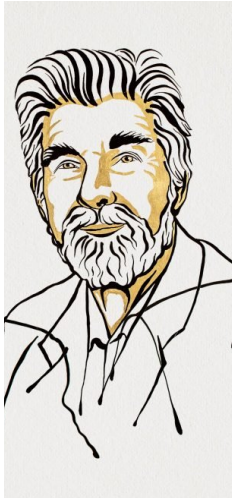


(IPCC 2013, Fig. TS.9)

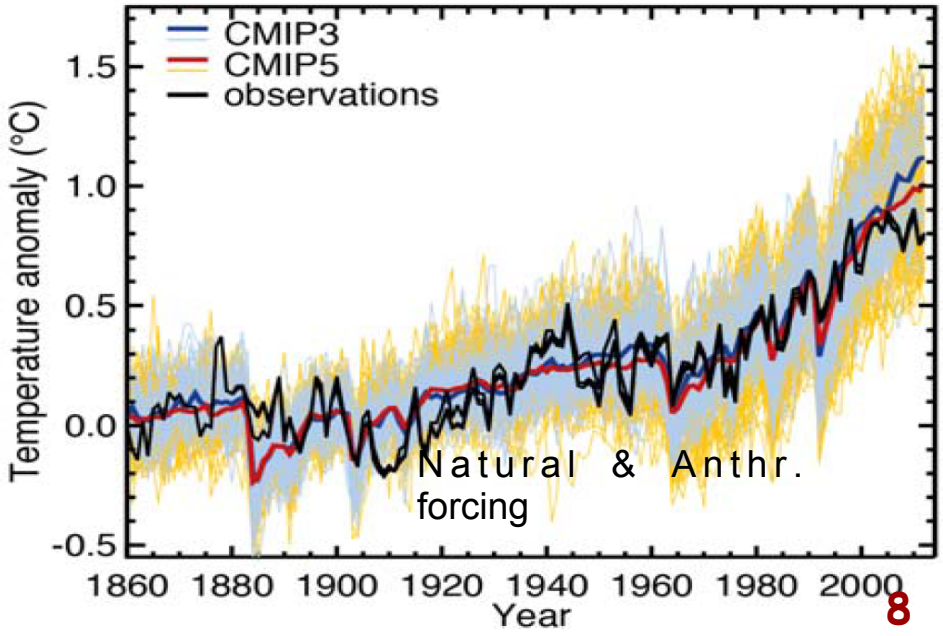
Human influence on the climate system is clear
...from increasing GHGs, radiative forcing, warming and understanding of changes

Climate models improve continuously
CMIP5+6 models reproduce observed continental-scale surface T patterns and trends over many decades including the more rapid warming since the mid-20th century and post volcanic cooling (very high conf.)

-Flato et al., IPCC, 2013: Ch9-
- Bindoff et al., IPCC, 2013: Ch10-

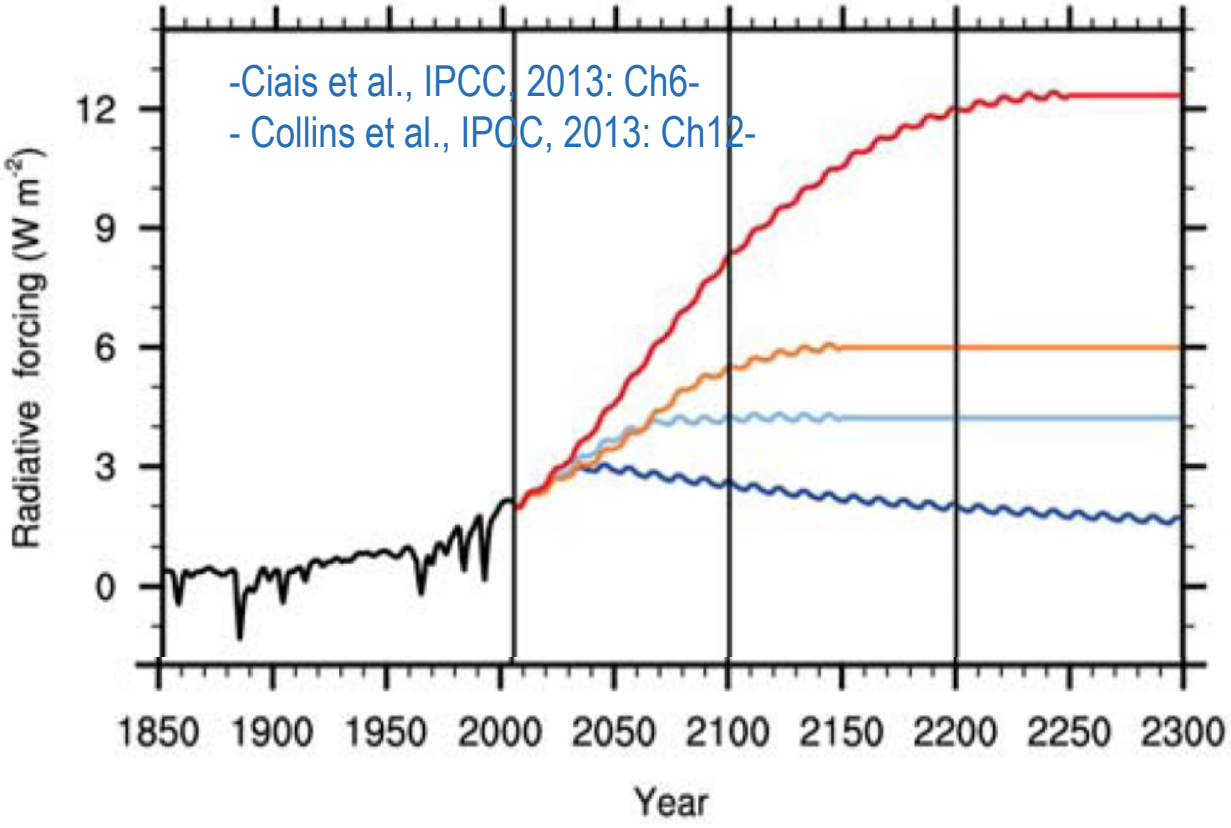


Klaus Hasselmann.
Nobel Fisica 2021



Future climate change

Scenario projections



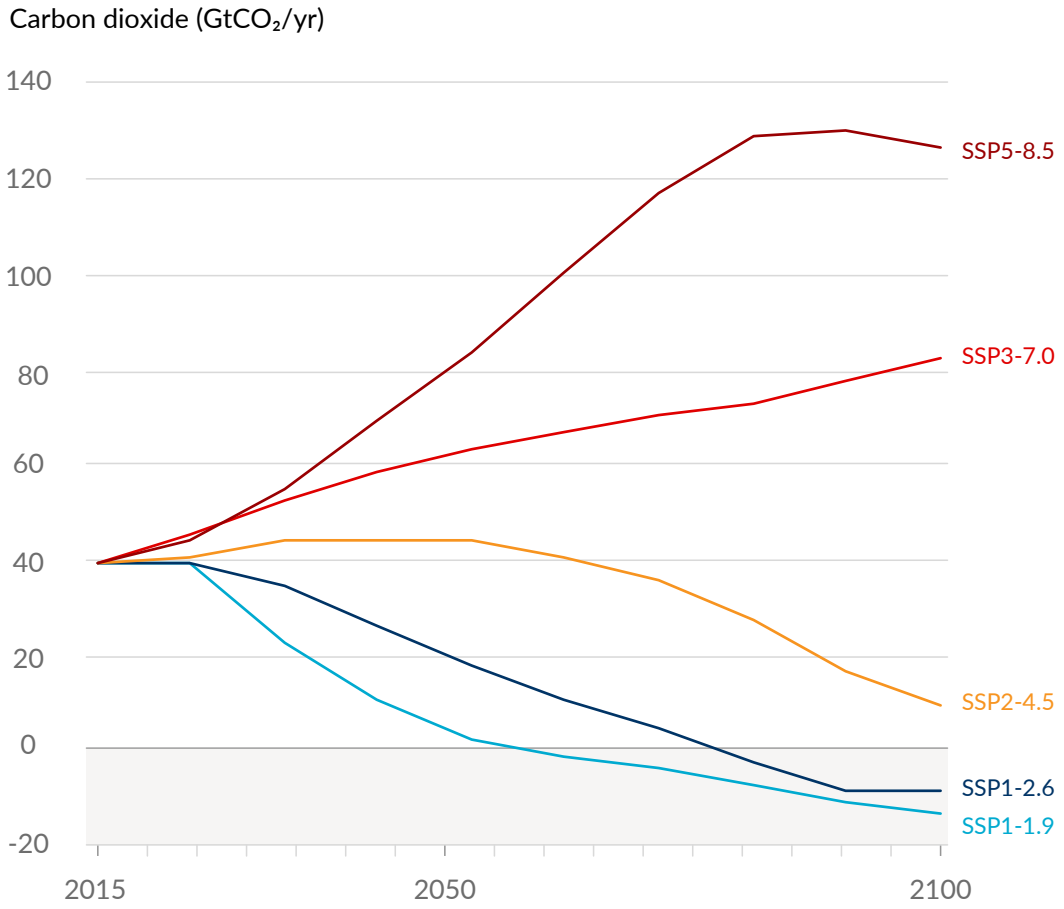
Representative Concentration Pathways are used as boundary conditions for climate change simulations.

Future climate change

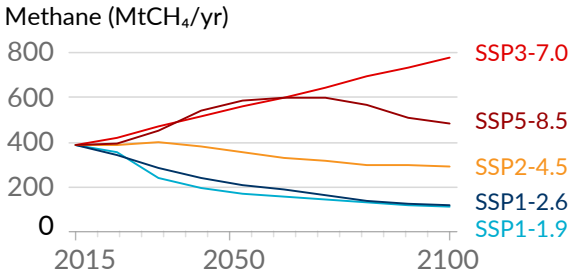
Scenario projections

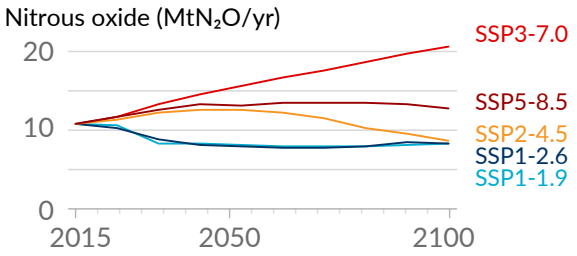
-IPCC, 2021-

Future annual emissions of CO_2 (left) and of a subset of key non-CO_2 drivers (right), across five illustrative scenarios

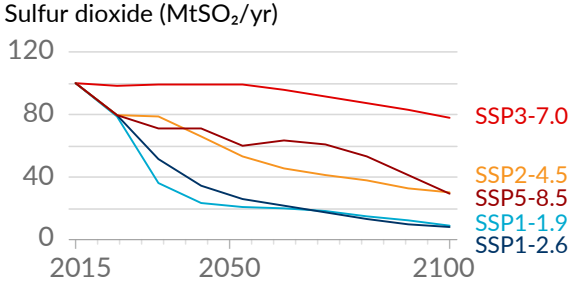


Selected contributors to non-CO_2 GHGs



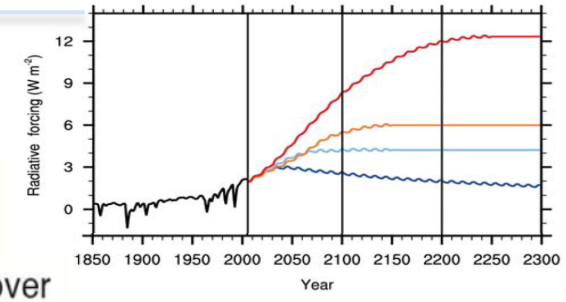


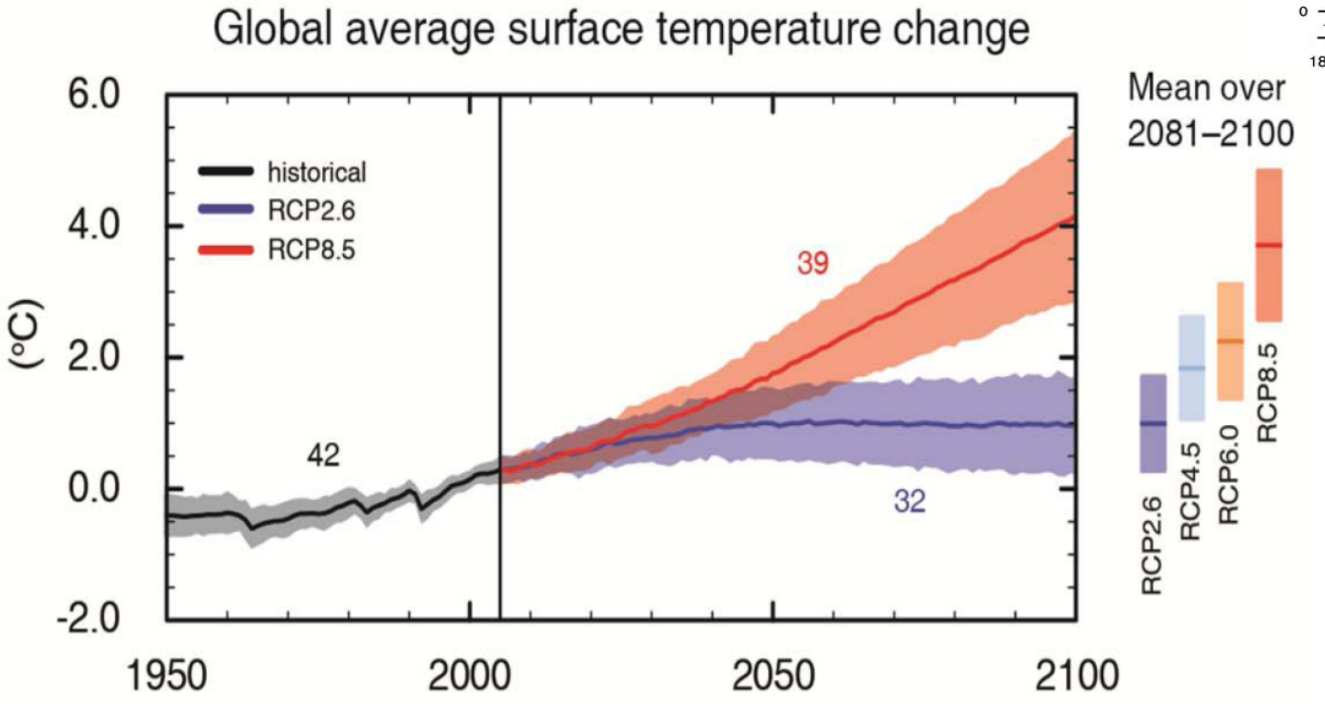
One air pollutant and contributor to aerosols



Future climate change

Scenario projections





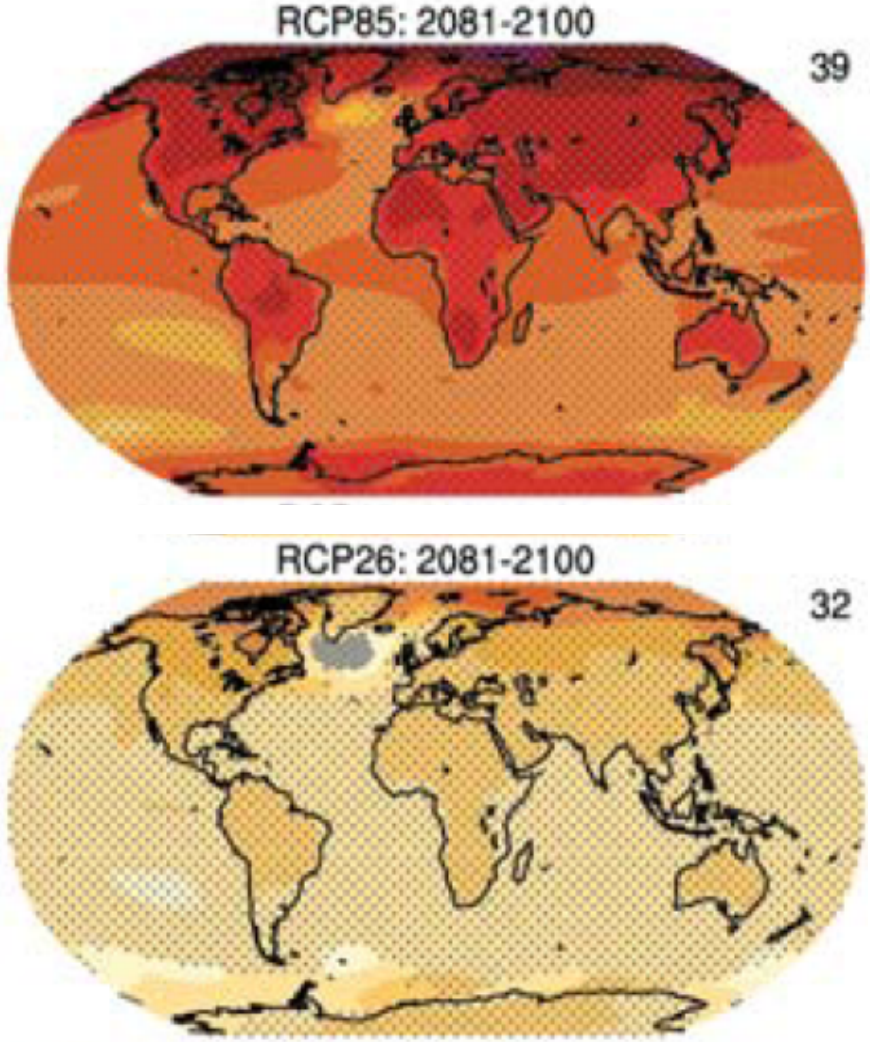
Temperature increase by the end of the 21st century will likely exceed 1.5 ºC relative to preindustrial for all RCPs

... likely ΔT> 2ºC for RCP6.0 and RCP8.5

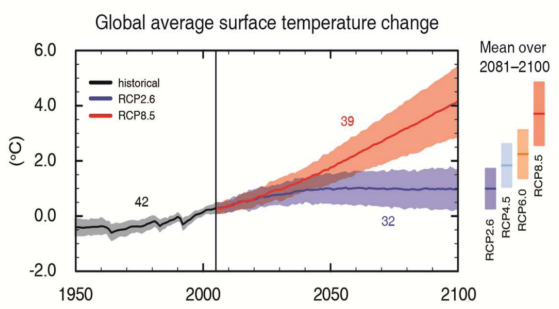
... more likely than not ΔT> 2ºC for RCP4.5

Future climate change

Scenario projections



(IPCC 2013, SPM.7 TS.15)



Continued emissions of GHGs will cause further warming and changes in all components of the climate system.

Limiting climate change will requiere substantial and sustained reduction of GHGs.

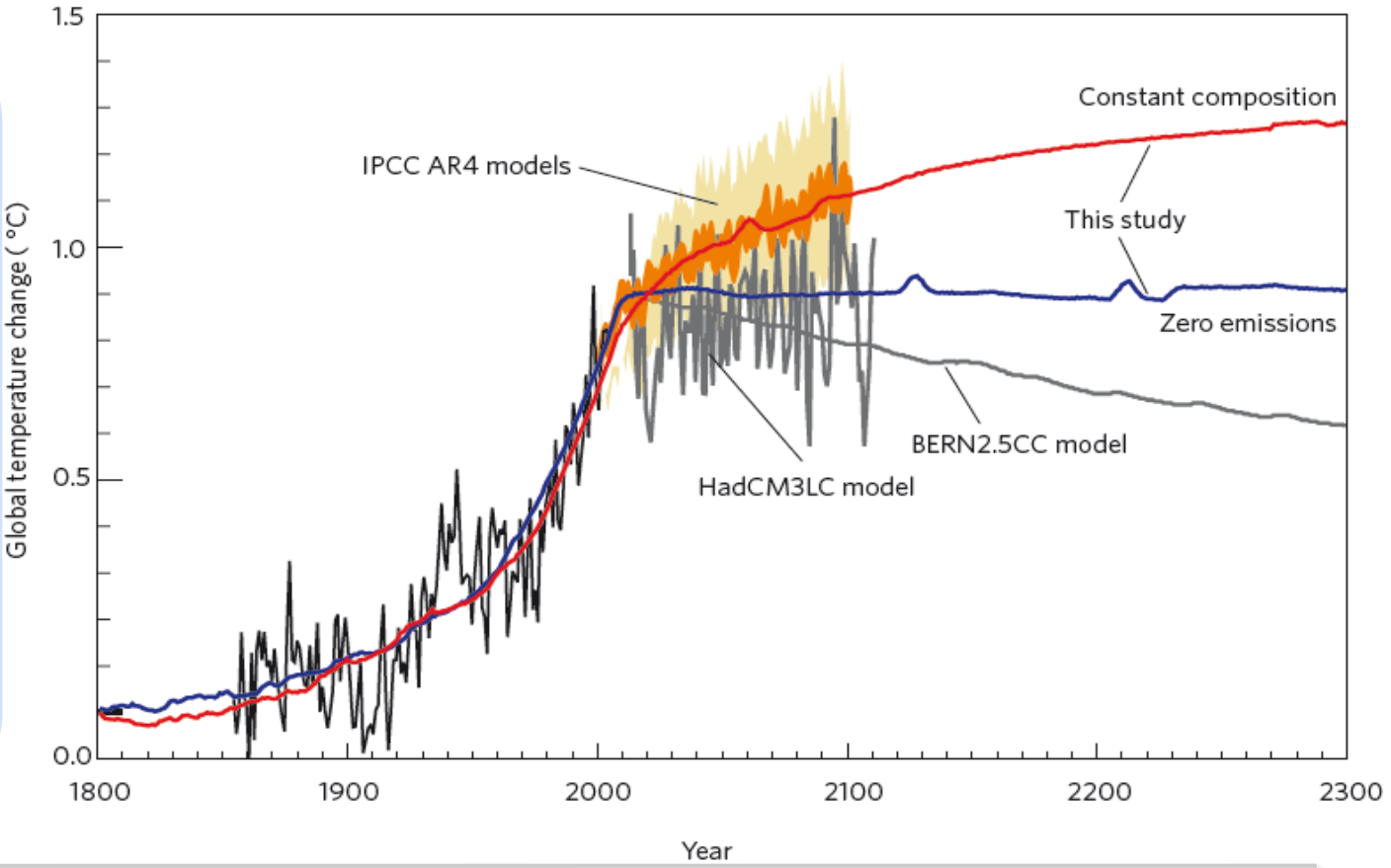
Policy relevant implications: commitment, stabilization & irreversibility

Climate change commitment: future change to which the climate system is committed by virtue of past and current forcings. It brings the concept of inertia

Constant composition commitment represents future warming associated with current CO2 concentrations

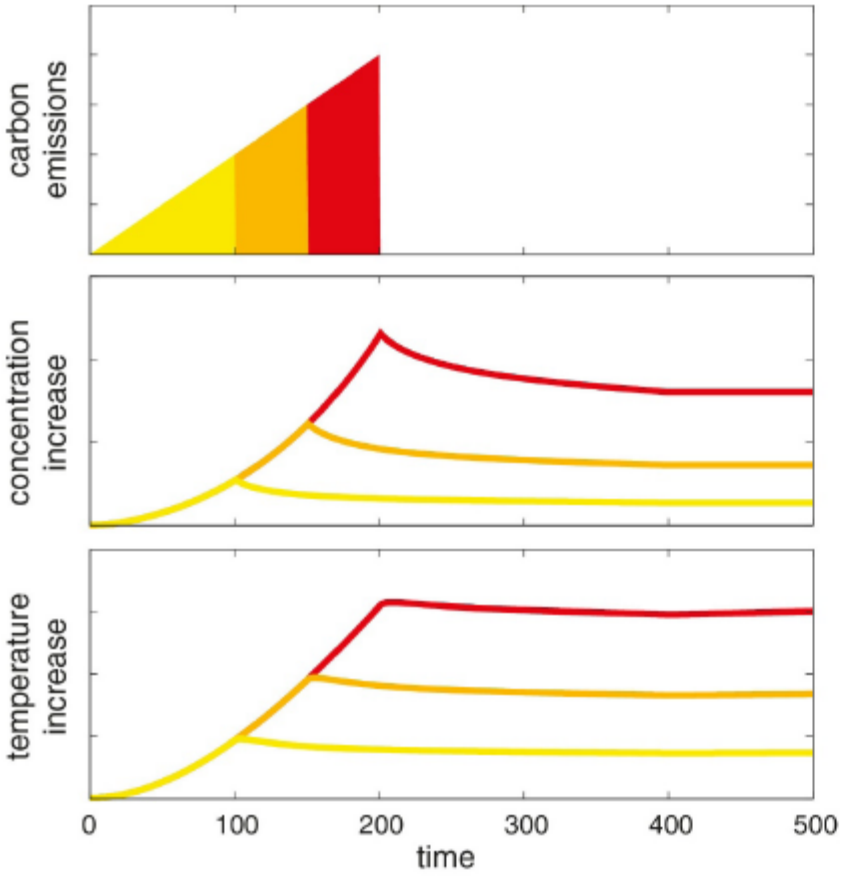
Zero emissions commitment:

Warming from past CO2 emissions.



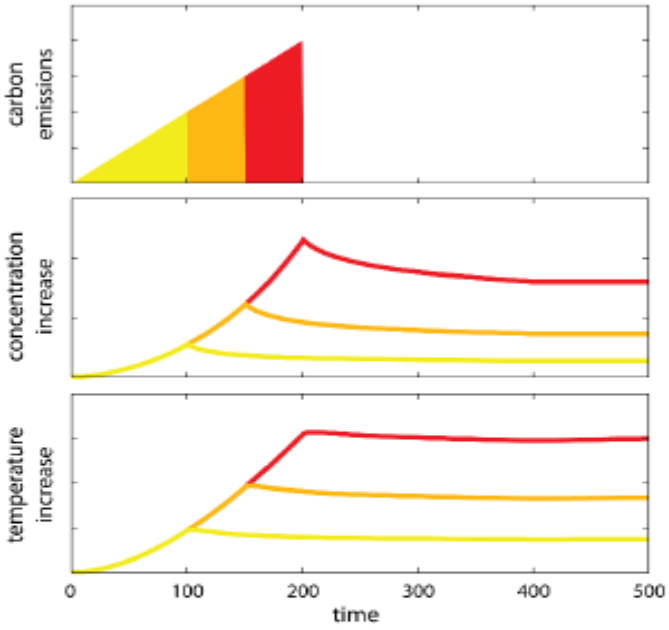
-Matthews & Weaver: Nature CC, 3, 143, 2010-

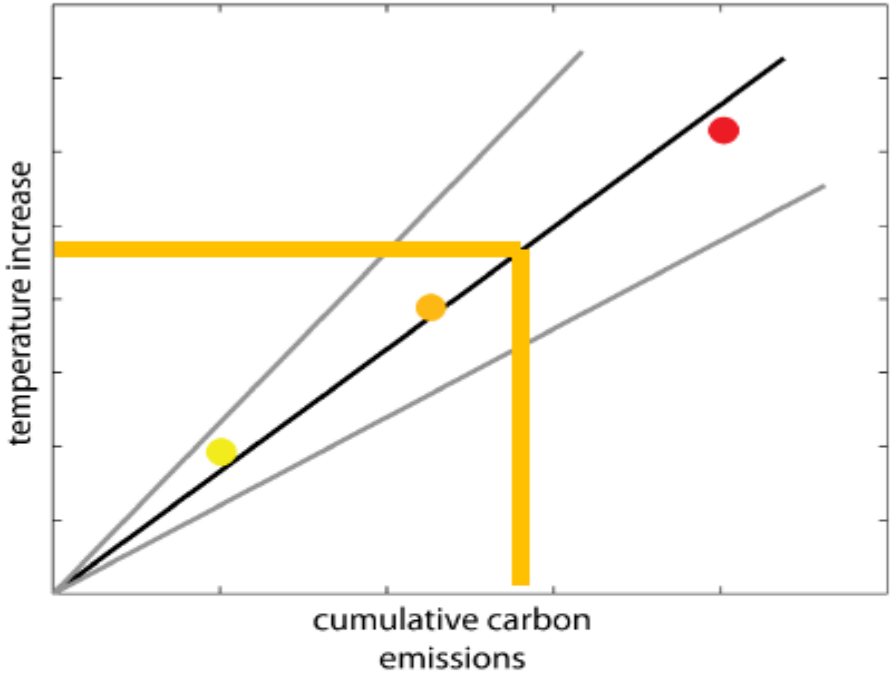
Warming will persist for centuries



- Zero CO_2 emissions lead to near constant surface temperature.
- A large fraction of climate change persists for many centuries.
- Depending on the scenario, about 15-40% of the emitted carbon remains in the atmosphere for 1000 yrs.

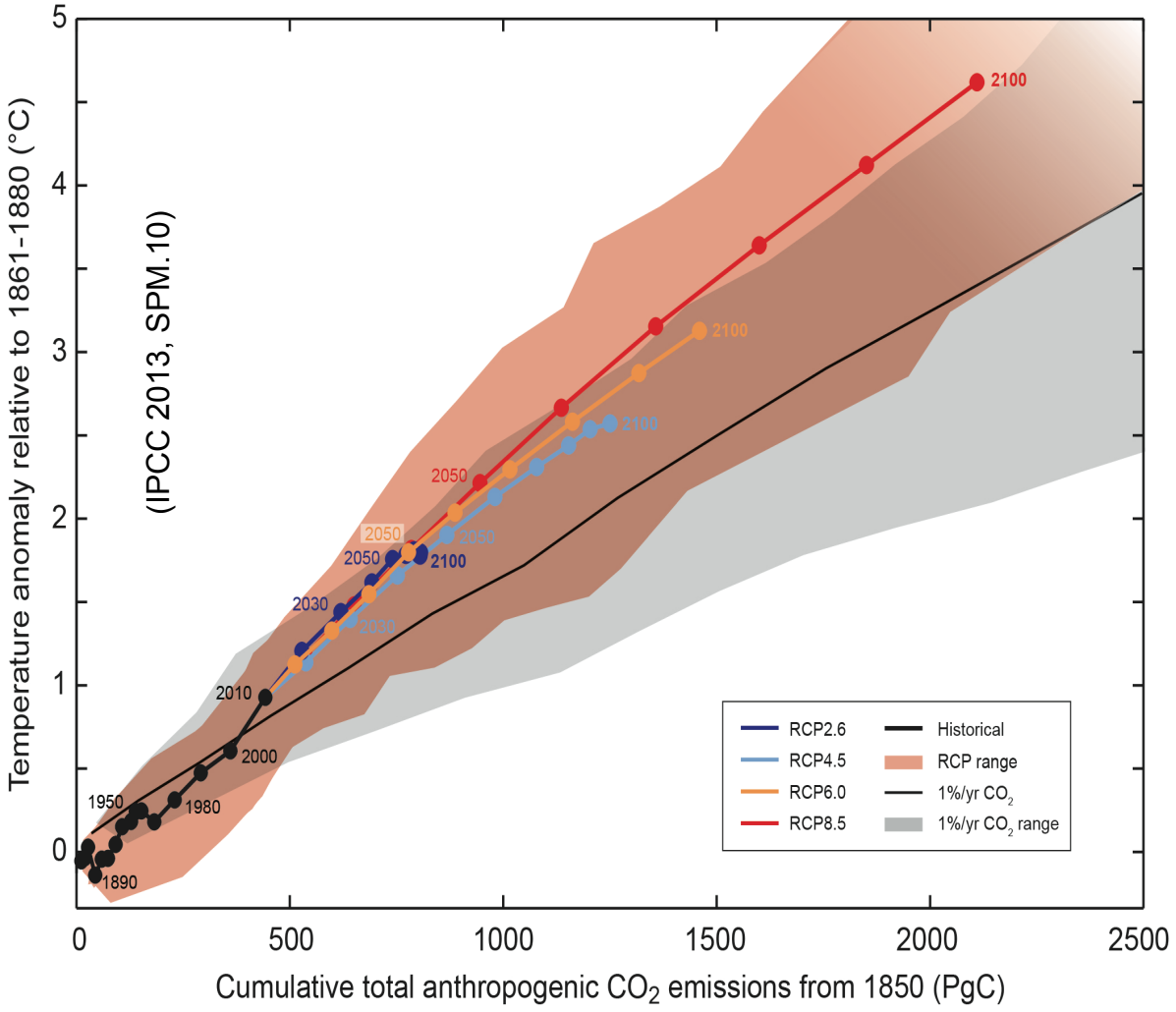
Cumulative carbon determines warming





- Peak warming is approximately proportional to cumulative (total) emissions.
- Transient climate response to cumulative carbon emissions TCRE = Warming per 1000 PgC

Policy relevant implications: commitment, stabilization & irreversibility



Cumulative emissions of CO2 largely determine global mean surface warming by the late 21st century and beyond.

Limiting climate change will requiere substantial and substained emission reductions.

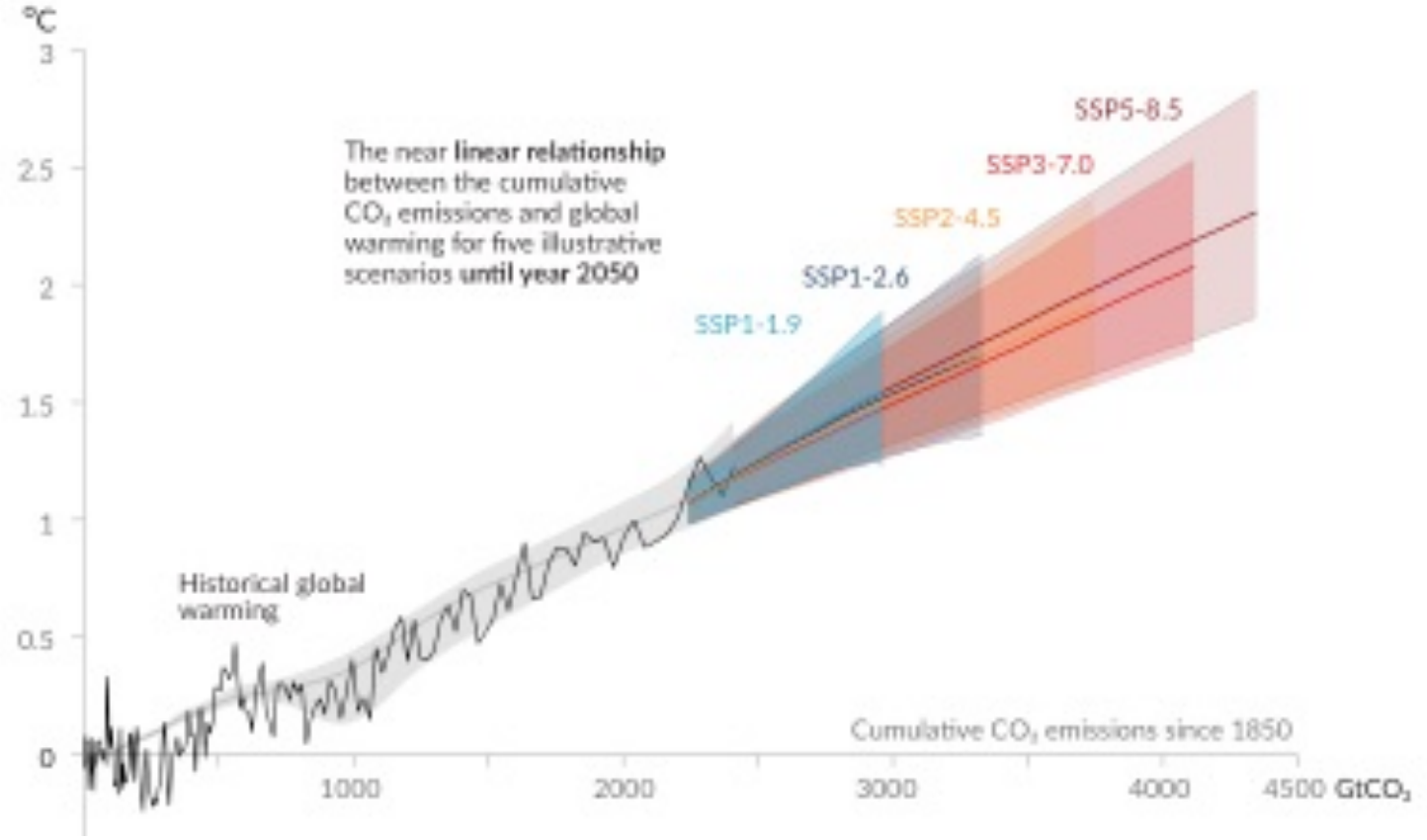
This represents a substantial multi century climate change commitment created by past, present and future emissions..

- Collins et al., IPCC, 2013: Ch12-

Policy relevant implications: commitment, stabilization & irreversibility

Every tonne of CO_2 emissions adds to global warming

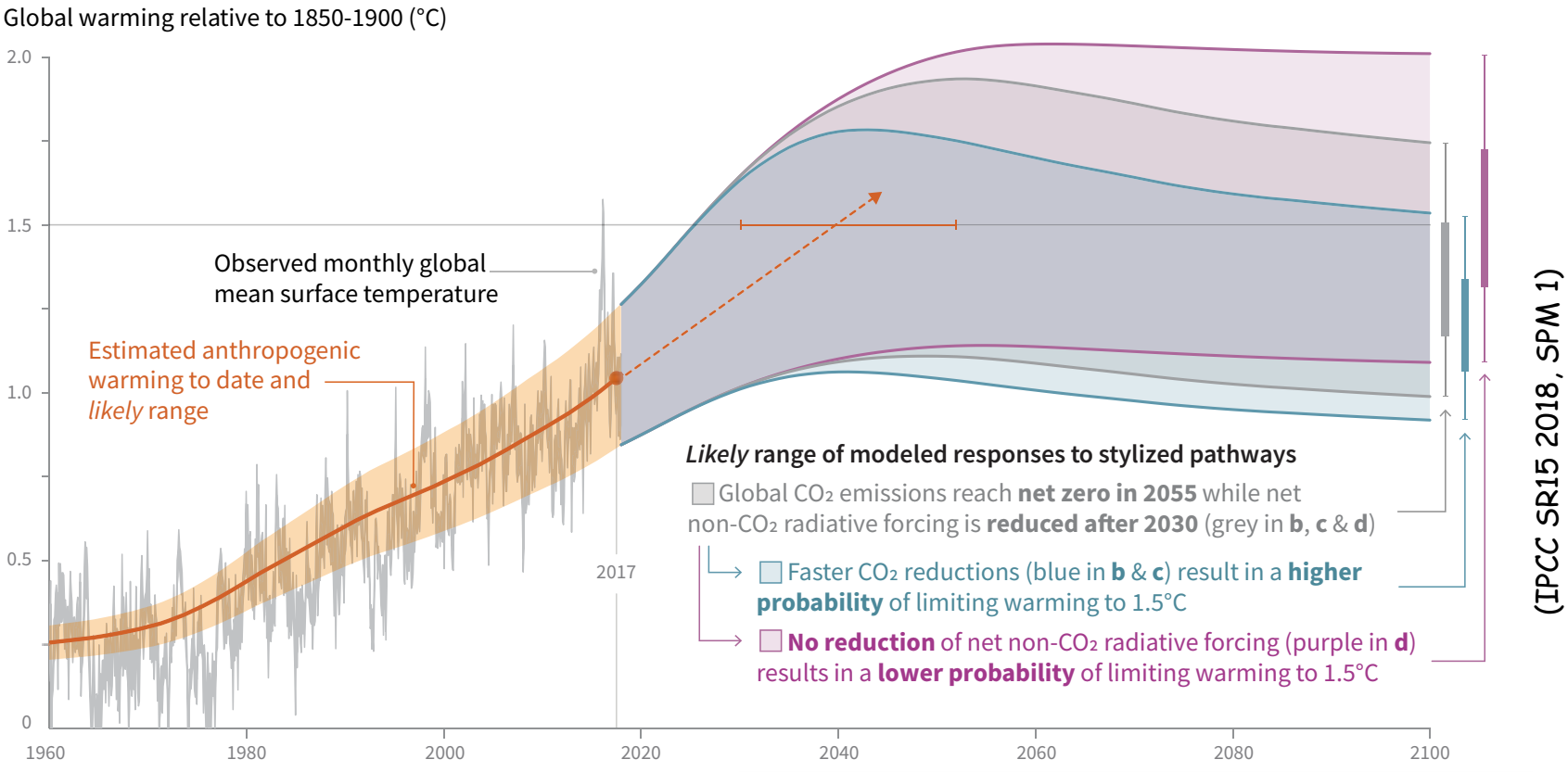
Global surface temperature increase since 1850-1900 (°C) as a function of cumulative CO_2 emissions ($GtCO_2$)



-IPCC, 2021-

Cummulative emisions of CO2 and other GHGs determine the possibility of reducing global temperature increase to 1.5 °C

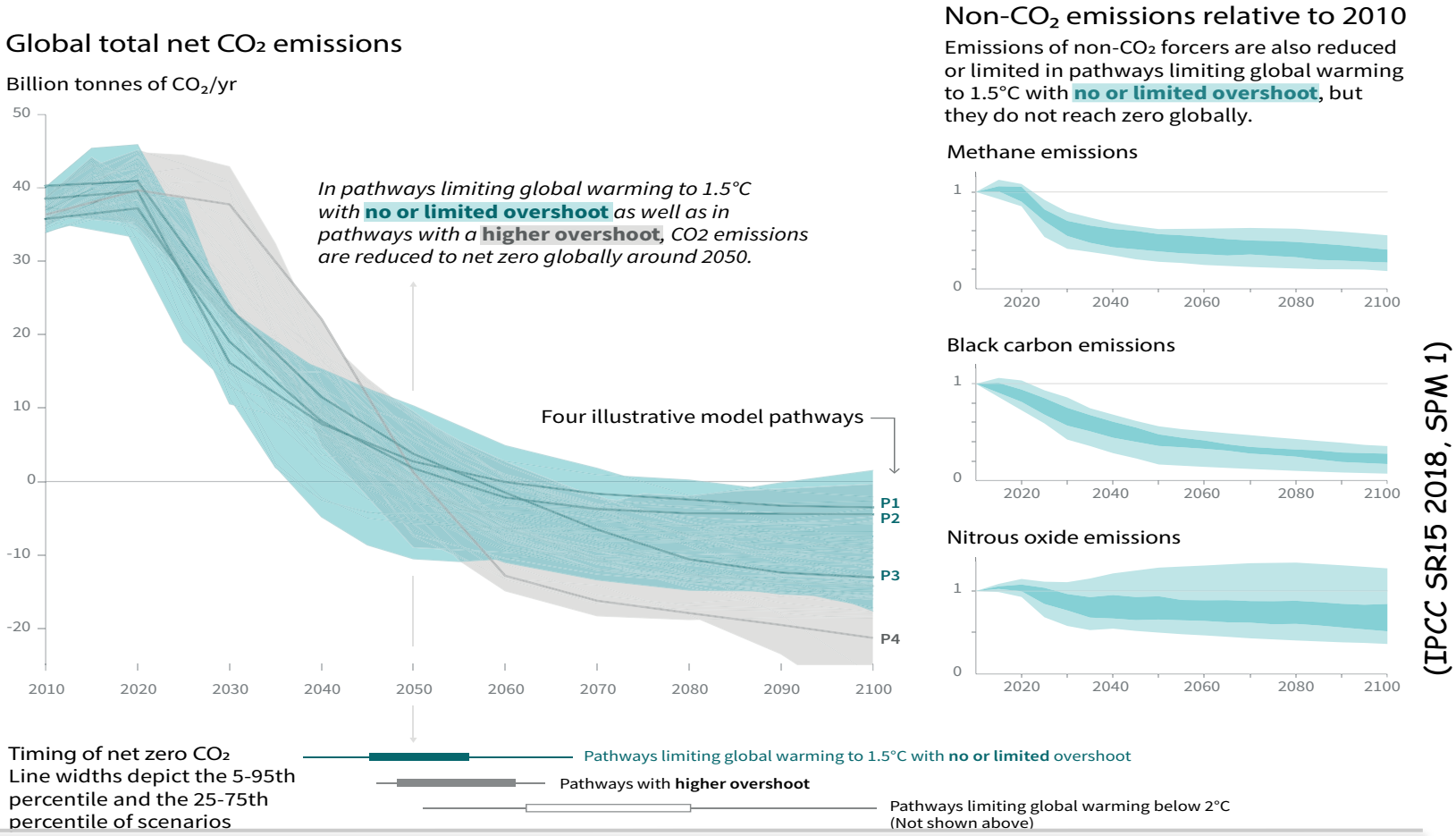
a) Observed global temperature change and modeled responses to stylized anthropogenic emission and forcing pathways



(IPCC SR15 2018, SPM 1)

- Rogelj et al., 2018. SR1.5-

Cummulative emisions of CO2 and other GHGs determine the possibility of reducing global temperature increase to 1.5 °C

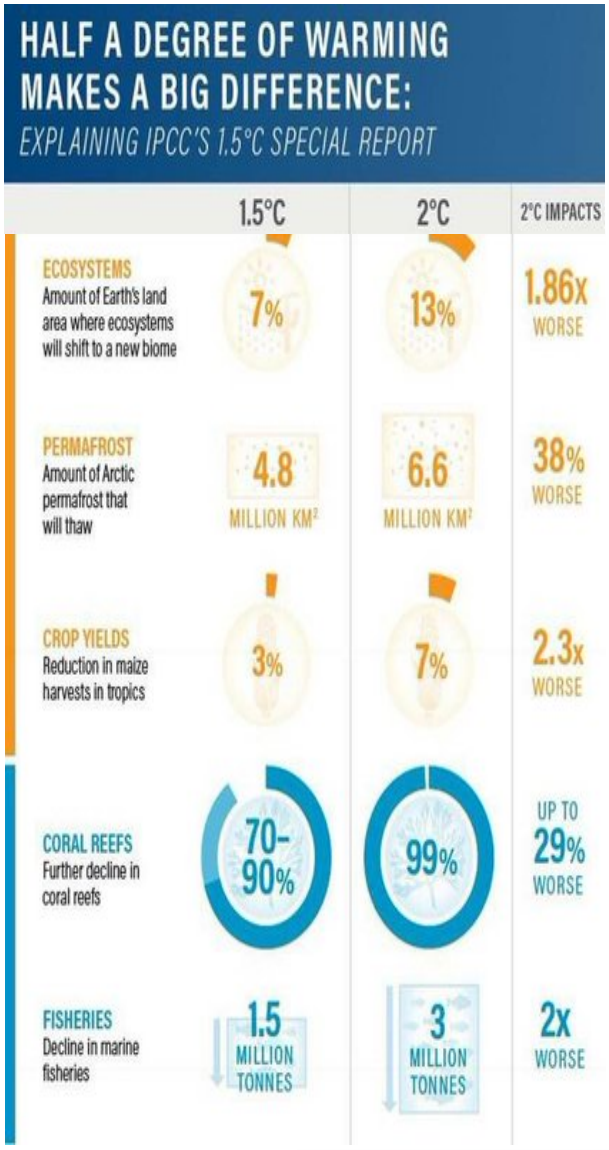


(IPCC SR15 2018, SPM 1)

- Rogelj et al., 2018. SR1.5-

1.5 °C vs. 2°C, what difference does it make?





Differences between scenarios are highly non linear. Implications of a + 0.5 ºC are severe…

…. and ugly surprises are more likely above 1.5 ºC

- Rogelj et al., 2018. SR1.5-

As for the future, it is not a question of foreseing it, but of making it possible

Antoine de Saint Exupéry, Citadelle, 1948

a) El cambio climático actual lo producen las actividades humanas.

b) Podemos estimar la magnitud del cambio futuro y sus incertidumbres. La mayor contribución a las incertidumbres son las emisiones futuras.

c) Es posible limitar el calentamiento global. Para ello se necesitan transformaciones sin precedentes en la tecnología, modelo energético…

d) Las estrategias de adaptación y mitigación son necesarias para desarrollar los ODS 2030.

e) El papel de las universidades: educación, investigación, debate educado/ informado/resposable…

→ estimación de emisiones

→ grupos de colaboración

→ justicia climática

COMPLUTENSES X EL CLIMA C x C

Grupos de Sostenibilidad



Cross-Chapter Box 4, Figure 1 | Climate action is number 13 of the UN Sustainable Development Goals.