MONTREAL PROTOCOL
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From the ozone scientific assessments to the IPCC

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Co-Chair, IPCC Working Group I

valmasdel

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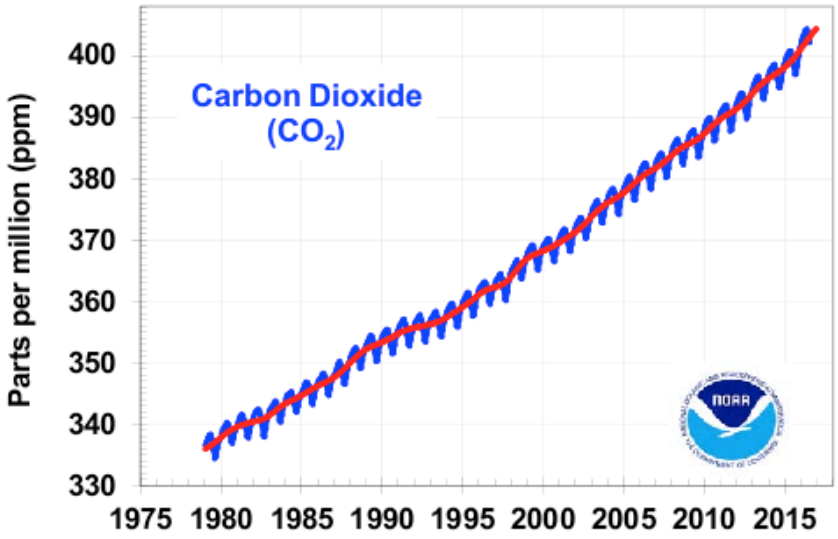
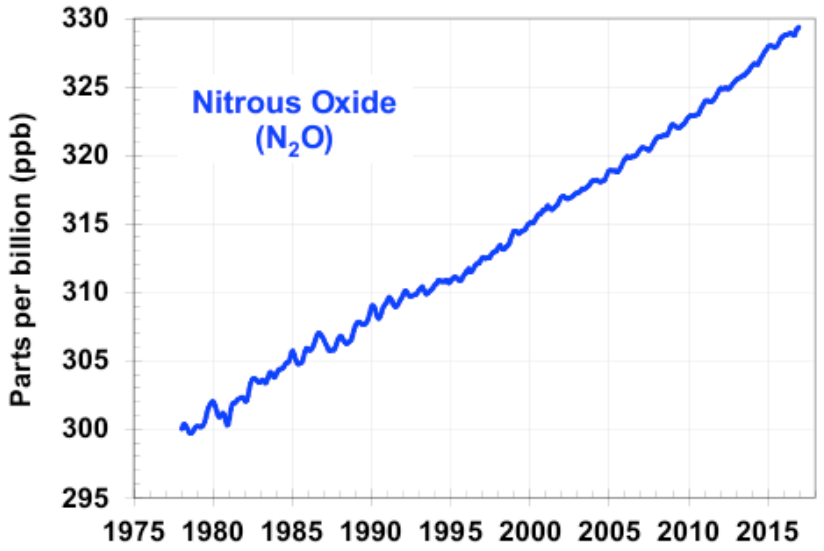
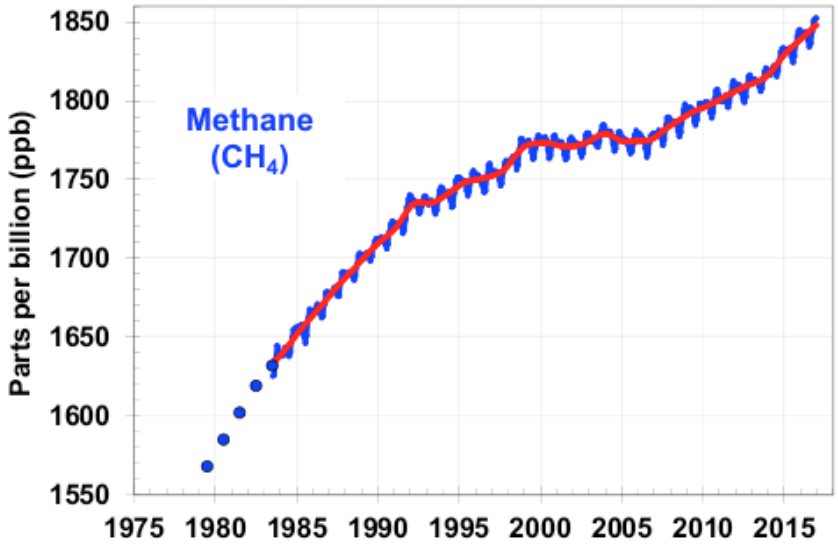
INTERGOVERNMENTAL PANEL ON climate change

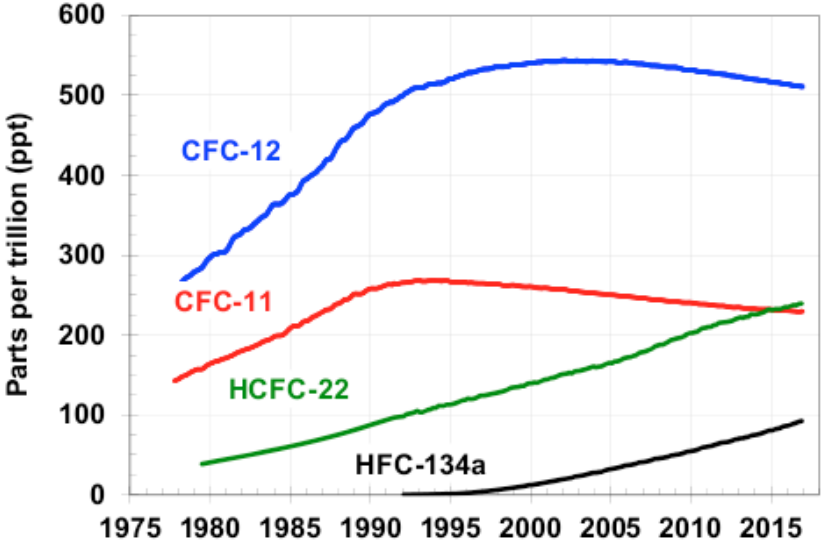
WMO UNEP

Change in atmospheric concentrations



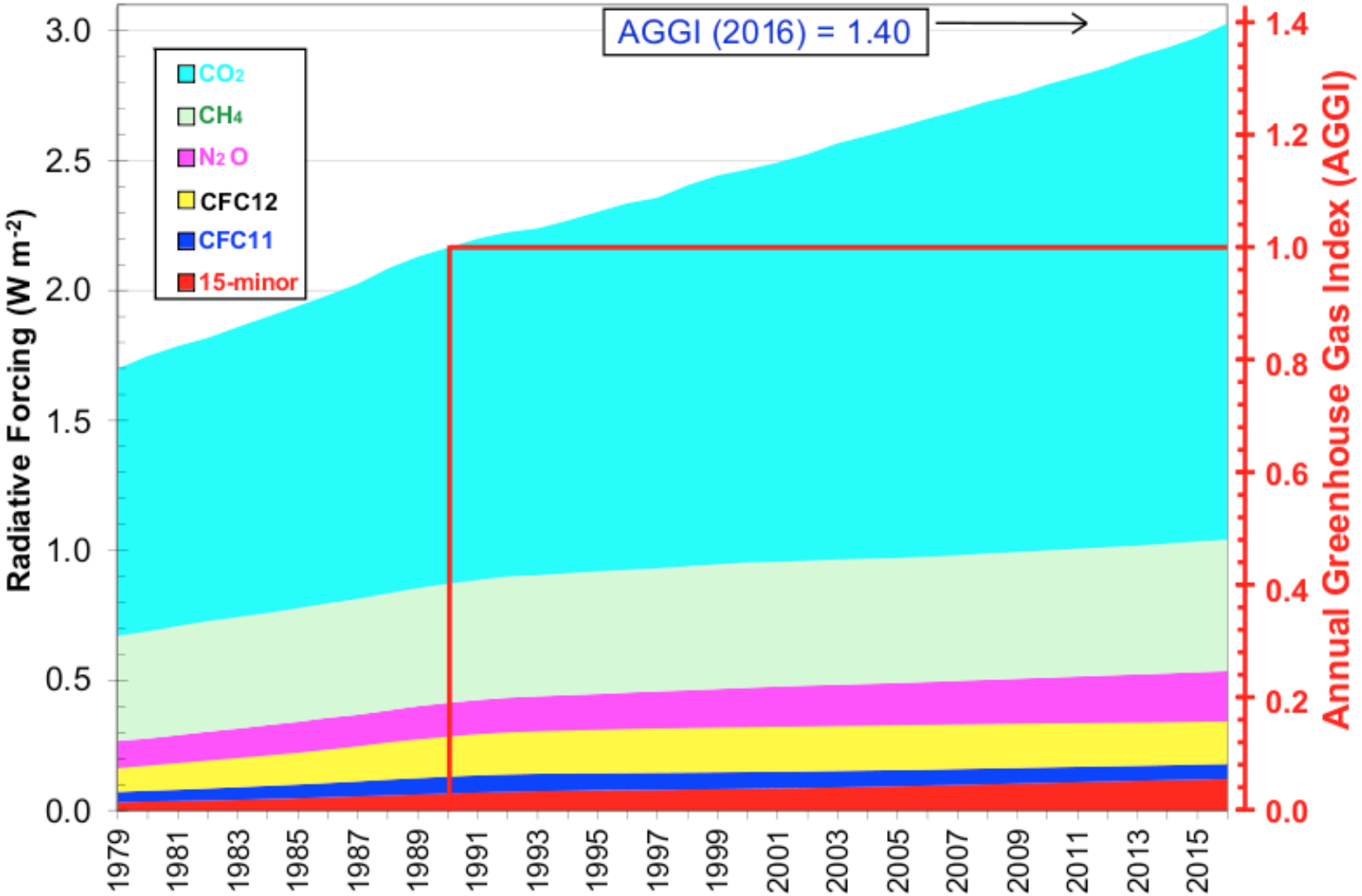






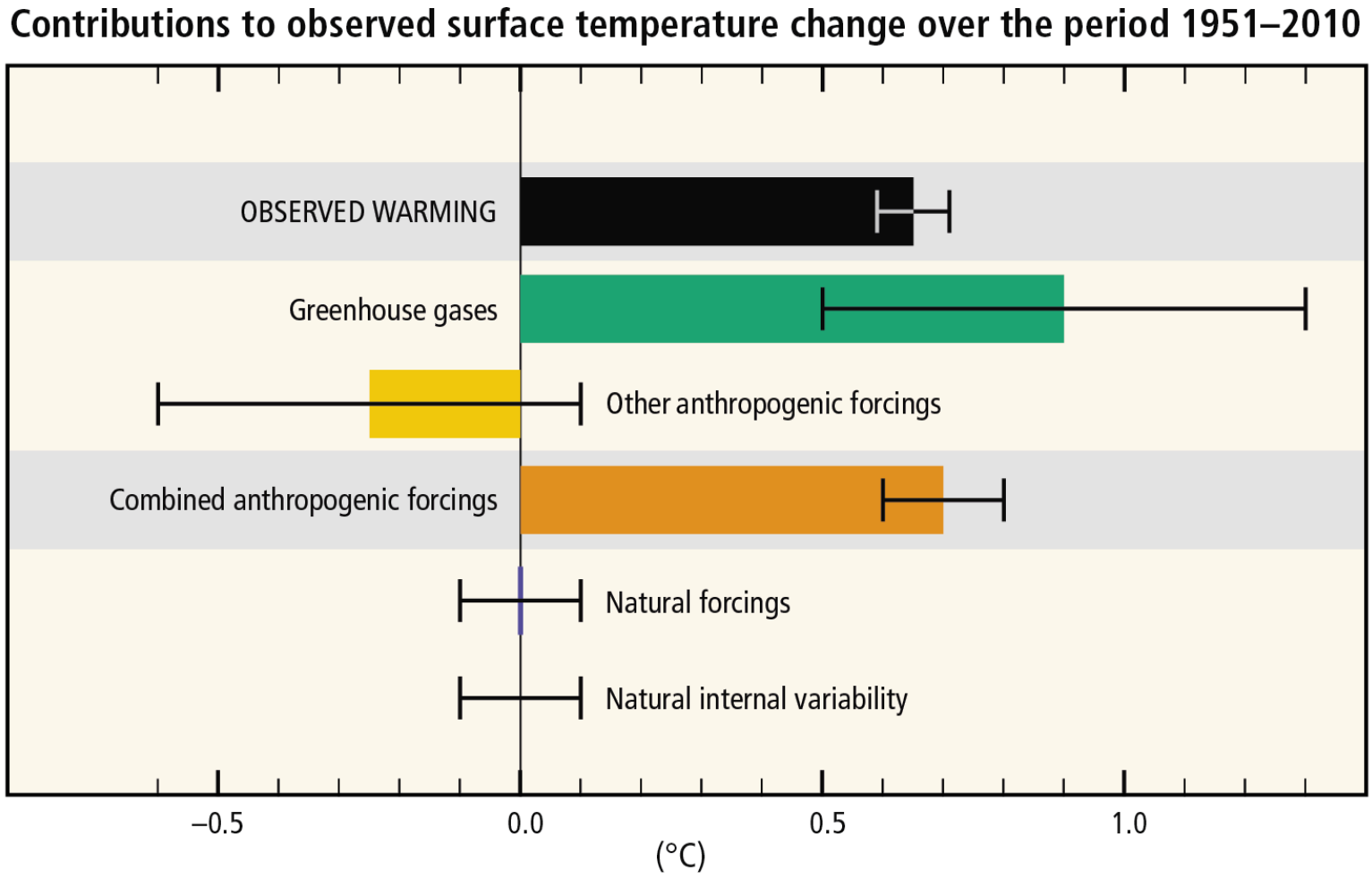
https://www.esrl.noaa.gov

Change in radiative forcing



https://www.esrl.noaa.gov

Human influence on global climate



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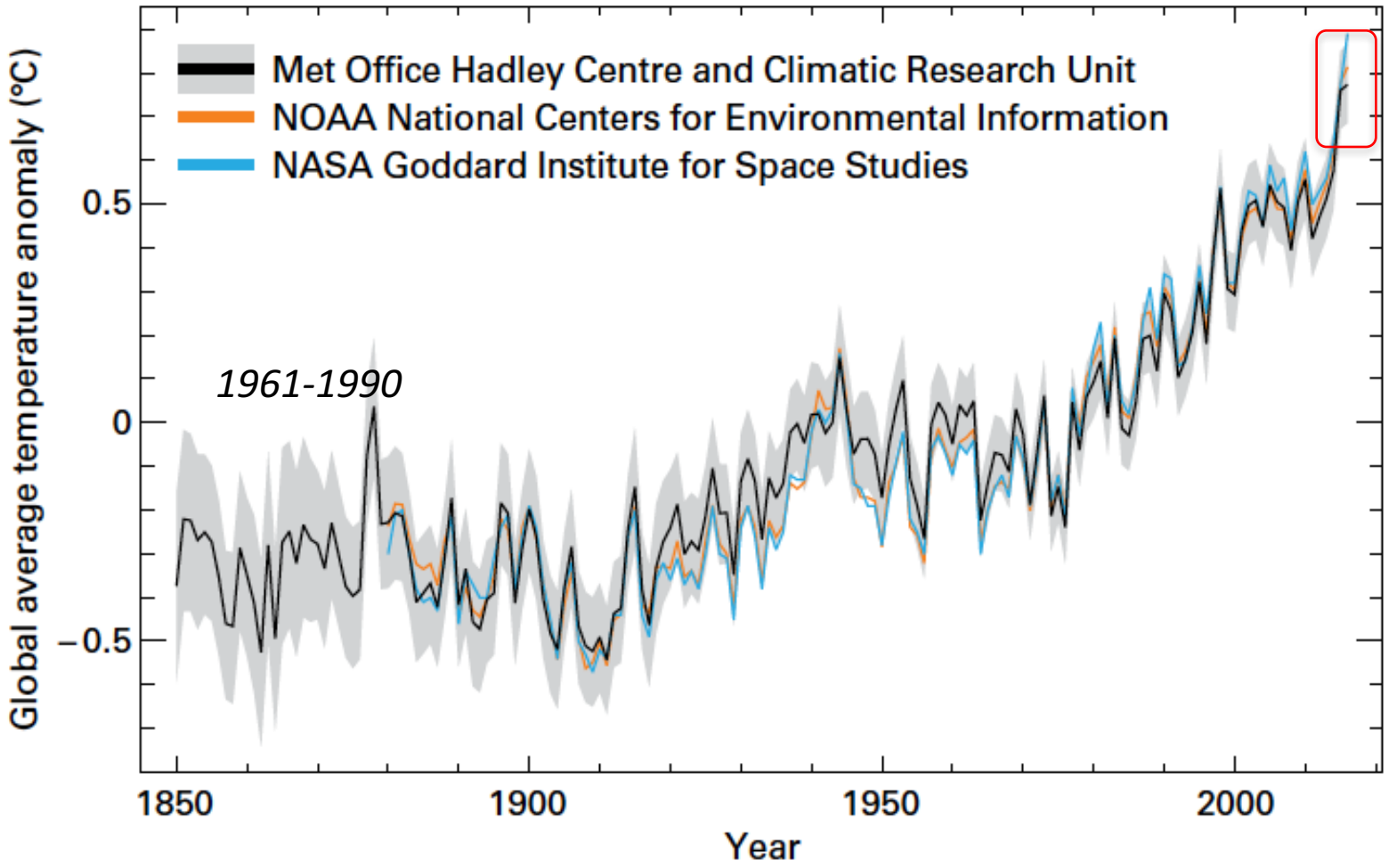
Change in global mean surface air temperature

>1°C above pre-industrial levels



WMO, 2017; Hawkins et al, BAMS, 2017

Parallel historical aspects

- Emergence of scientific knowledge related to human influence on stratospheric ozone and climate in the 1970s

- Vienna Convention for the Protection of the Ozone Layer 1985
  Montréal Protocol 1987

- IPCC established by WMO/UNEP in 1988, expanding the ICSU/UNEP/WMO Advisory Group on GHG set up in 1985 ; first report in 1990

- UNEP/WMO international scientific assessments on ozone depletion; first report in 1994

- United Nation Framework Convention on Climate Change 1992
  Kyoto Protocol 1997
  Paris Agreement 2015

Major differences

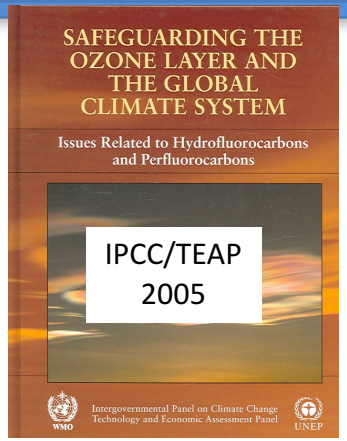
- Level of inter-disciplinarity
- Emissions of climate forcers from all sectors of activity
- Level of complexity, scientific challenges e.g. for attribution of observed climate changes and impacts to human influence
- Perception of risks (remote, long-term)
- Diversity of solutions in regions / sectors (risk management, adaptation and mitigation options), multiple levels of governance
- Ethics and equity
- Merchants of doubt

Future of the IPCC

- 30th anniversary in spring 2018 (47th Plenary Session, Paris)

- Future of IPCC
- Clear communication of findings (headline statements…)
- Relevance for a diversity of end-users (e.g. cities, industry, finance…)
- *Funding?*
- *5 year cycles of the global stocktake of the Paris Agreement?*

Key scientific intersections



- Ozone-depleting substances and stratospheric ozone are climate forcers

- Emissions of climate forcers CO_2, CH_4 and N_2O affect stratospheric ozone through changes in stratospheric temperature, water vapor, and reactive gases which affect ozone chemistry

- Well mixed greenhouse gases and ozone depletion cause low stratospheric cooling

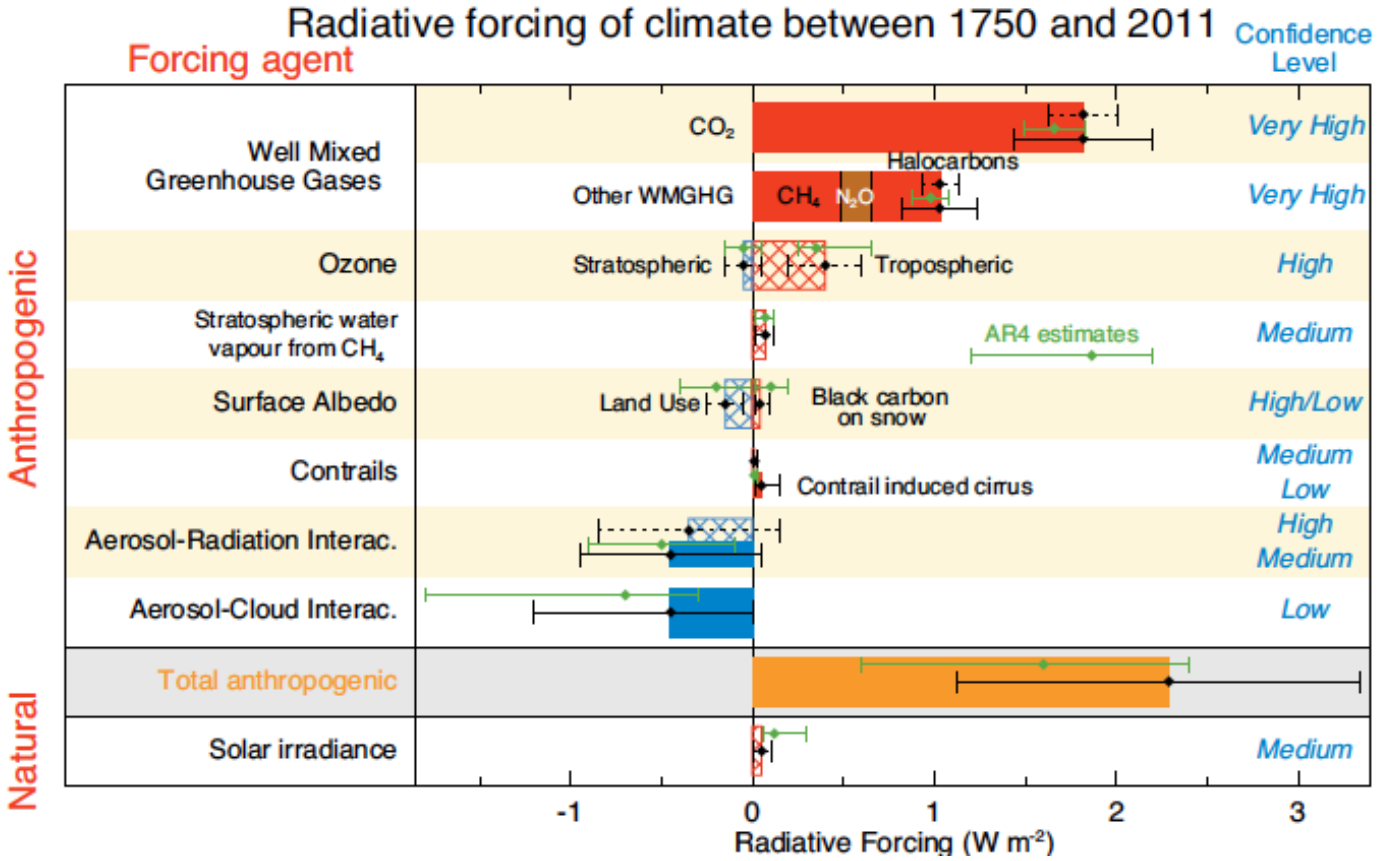
- Solar radiation management scenarios have implications for stratospheric temperature, circulation, and ozone

- Ozone depletion and human influence on climate may have counteracting consequences for Southern Hemisphere circulation changes and regional climate (including Antarctica)

Stratospheric ozone in the IPCC AR5, WGI report

Drivers of Climate Change

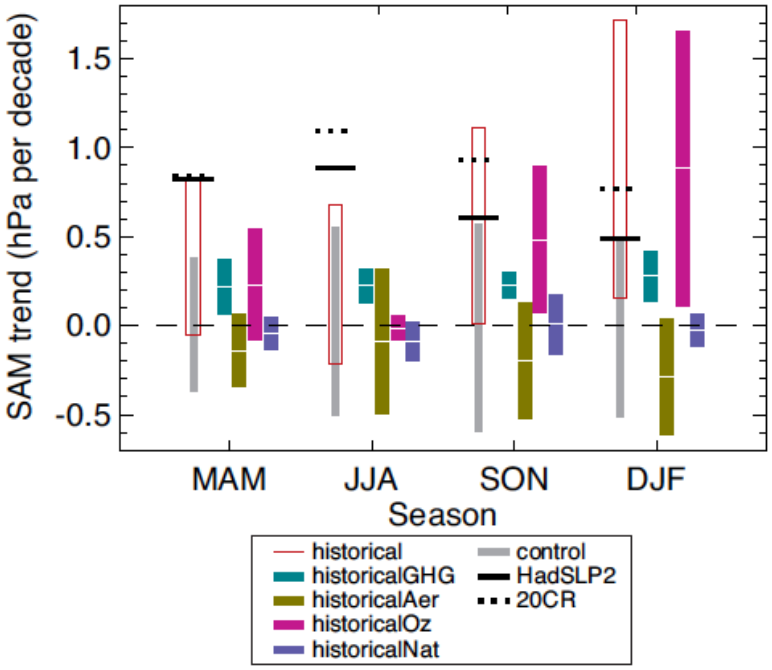
Emissions of ozone-depleting halocarbons *very likely* cause a net positive forcing as their direct radiative effect is larger than the impact of the stratospheric ozone depletion that they induce.



Stratospheric ozone in the IPCC AR5, WGI report

Understanding the Climate System and Its Recent Changes

There is *medium confidence* that stratospheric ozone depletion has contributed to the observed poleward shift of the southern Hadley Cell border during austral summer. It is *likel*y that stratospheric ozone depletion has contributed to the positive trend in the SAM seen in austral summer since the mid-20th century which corresponds to sea level pressure reductions over the high latitudes and increase in the subtropics.



Stratospheric ozone in the IPCC AR5, WGI report

Projections of Global and Regional Climate Change

Near term changes in atmospheric circulation

It is *likely* that the annual mean Hadley Circulation and the SH mid-latitude westerlies will shift poleward, while it is *likely* that the projected recovery of stratospheric ozone and increases in GHG concentrations will have counteracting impacts on the width of the Hadley Circulation and the meridional position of the SH storm track. Therefore it is *unlikely* that they will continue to expand poleward as rapidly as in recent decades.

Long term changes in atmospheric circulation

In austral summer, the additional influence of stratospheric ozone recovery in the SH opposes changes due to GHGs there*, though the net response varies strongly across models and scenarios.*

The austral summer/autumn positive trend in Southern Annular Mode (SAM) *is likely* to weaken considerably as stratospheric ozone recovers through the mid-21st century with *some, but not very well documented, implications* for South America, Africa, Australia, New Zealand and Antarctica.

Stratospheric ozone in the IPCC AR5, WGI report

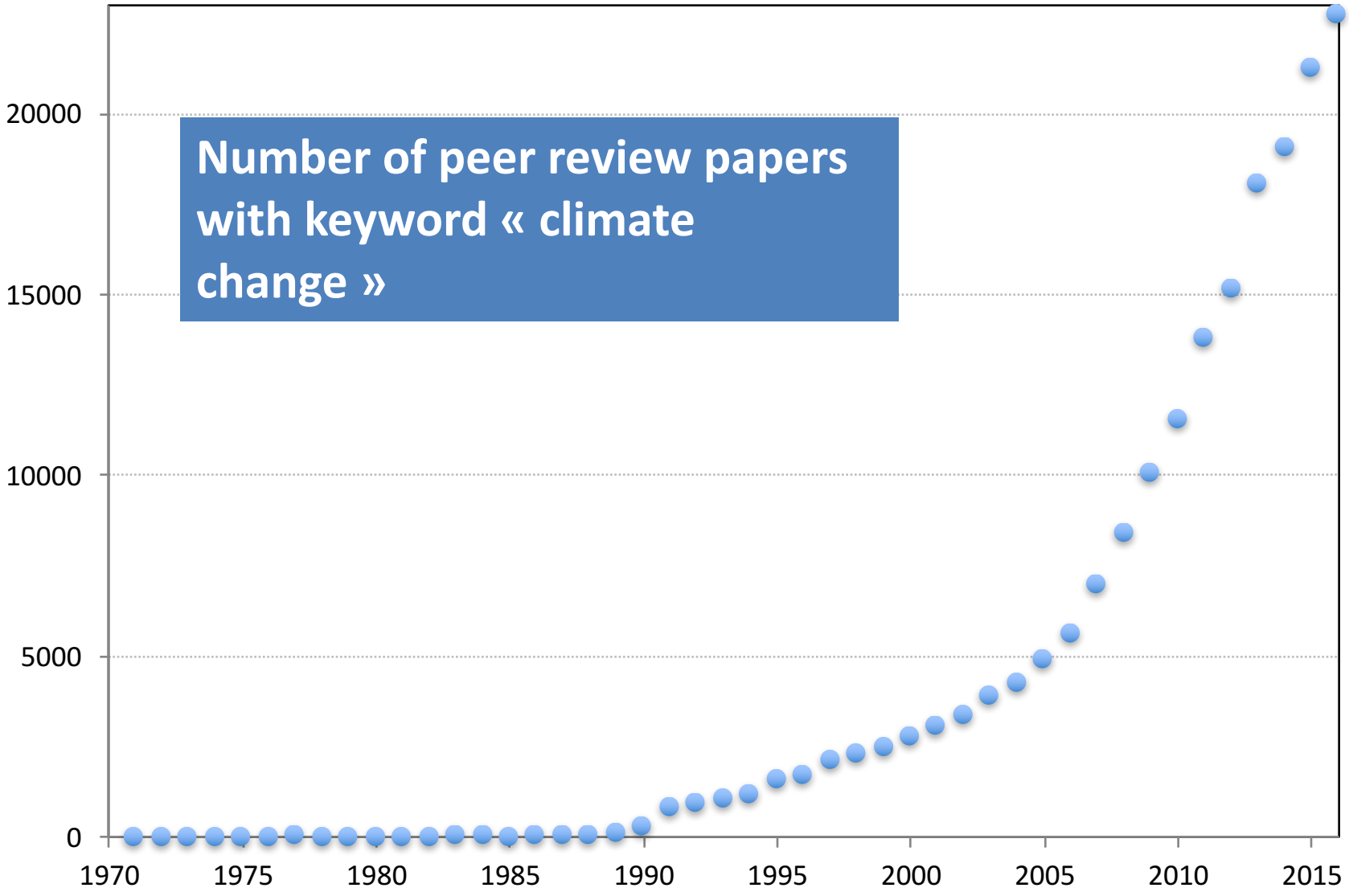
Climate geoengineering methods

Another side effect that is *relatively well characterized* is the likelihood of modest polar stratospheric ozone depletion associated with stratospheric aerosol solar radiation management.

Cross-cutting issues for the coming assessments

- Observed changes
- Process based understanding
- Model skills, fit for purpose, confidence in projections
- Detection and attribution of observed changes
- Radiative efficiencies and other metrics (global warming potential, atmospheric lifetime…)
- Predictability and near term prediction
- Scenarios and long term projections, incl. solar radiation management
- Non CO_2 in assessment of mitigation options and pathways

=> Coordination to be implemented after selection of IPCC authors



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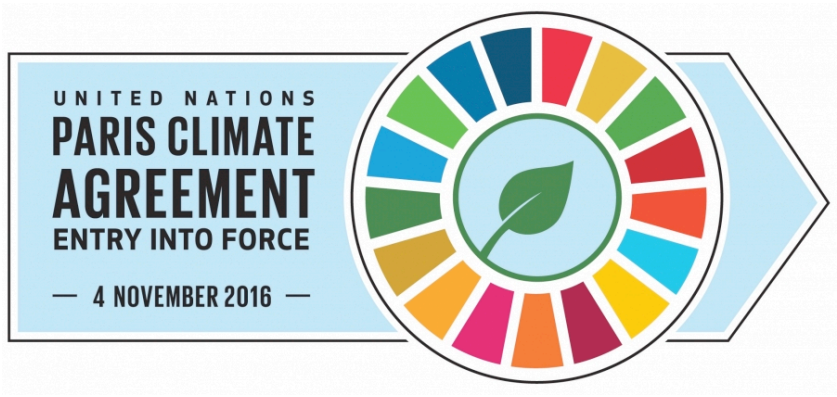
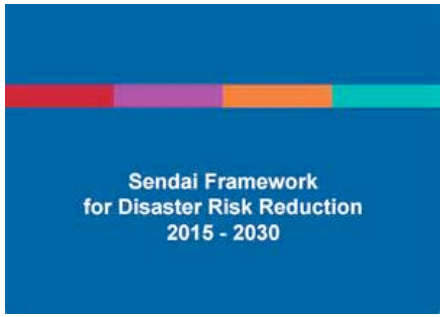
Specificities of the AR6

2030 international agenda

Global stocktake of the Paris Agreement

Scientific knowledge for risk assessment and solutions





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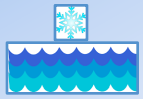
AR6 Schedule

Sept 2018

Global warming of 1.5 °C

Fall 2019

Oceans and cryosphere



April 2021

The Physical Science Basis

October 2021

Climate Change Impacts, Adaptation and Vulnerability

April 2022

The Synthesis Report

Facilitative dialogue UNFCCC

Land

Fall 2019

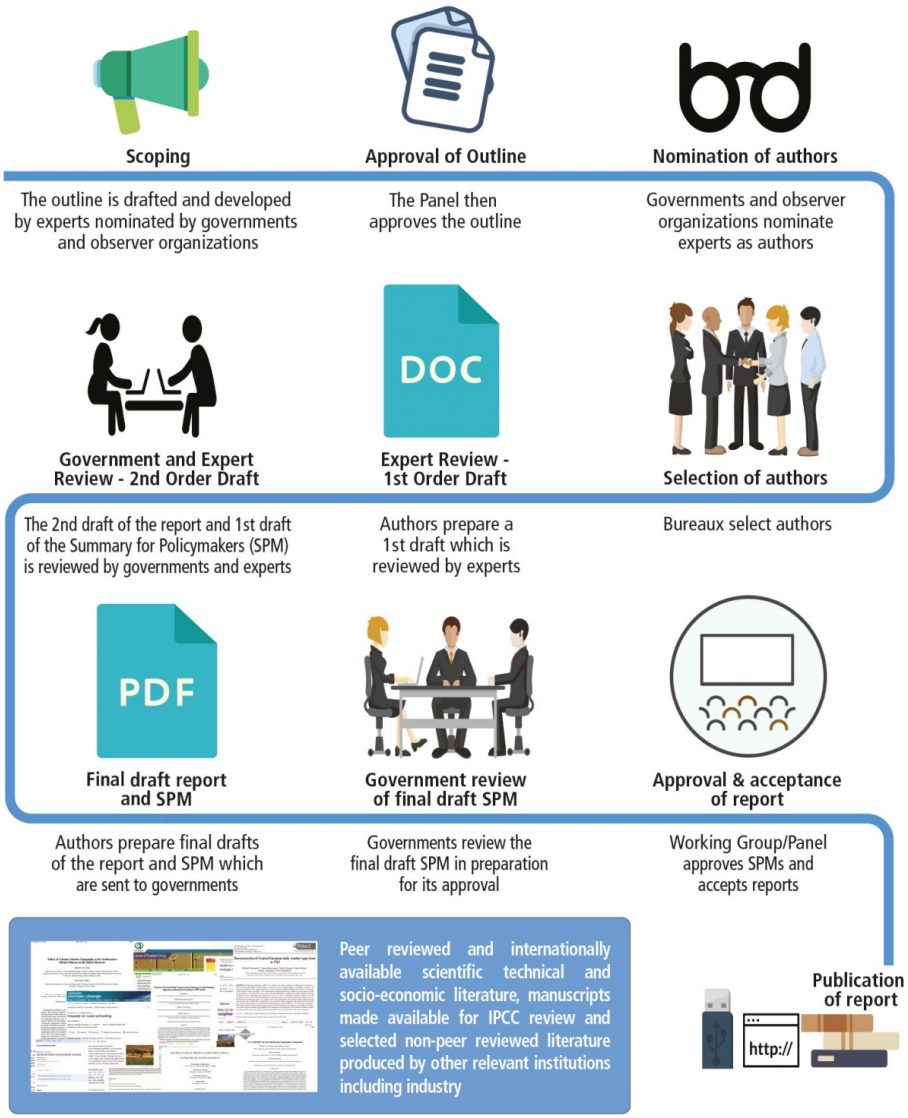
Mitigation of Climate Change

July 2021

Global stocktake 2023 UNFCCC

Cities and Climate Change Science Conferenc ch 2018)

Preparation of reports



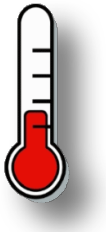
- *Co-construction :*

end-user needs & new knowledge

- *Attractivity to high profile researchers :*

volunteers, nominations, selection pressure; expert reviewers

Call for nominations for the AR6 WG reports open until **Oct 27, 2017**



Global warming of 1.5°C (SR1.5)

Chapter 1: Framing and context

Chapter 2: Mitigation pathways compatible with 1.5°C in the context of sustainable development

Chapter 3: Impacts of 1.5°C global warming on natural and human systems

Chapter 4: Strengthening and implementing the global response to the threat of climate change

Chapter 5: Sustainable development, poverty eradication and reducing inequalities

IPCC Special Report on Climate Change and Land (SRCCL)

Chapter 1: Framing and context

Chapter 2: Land-climate interactions

Chapter 3: Desertification

Chapter 4: Land degradation

Chapter 5: Food security

Chapter 6 : Interlinkages between desertification, land degradation, food security, and greenhouse gas fluxes : synergies, trade-offs and integrated response options

Chapter 7 : Risk management and decision making

In relation to sustainable development

IPCC Special Report on the Ocean and Cryosphere in a Changing Climate (SROCC)

Chapter 1: Framing and context

Chapter 2: High mountain areas

Chapter 3: Polar regions

Chapter 4: Sea level rise and implications for low lying islands, coasts and communities

Chapter 5: Changing ocean, marine ecosystems, and dependent communities

Chapter 6 : Extremes, abrupt changes and managing risks

Box : Low lying islands and coasts

Working Group I

Summary for Policy Makers
Technical Summary

First lead author meeting June 2018

Chapter 1: Framing, context, methods
Chapter 2: Changing state of the climate system
Chapter 3: Human influence on the climate system
Chapter 4: Future global climate: scenario-based projections and near-term information
Chapter 5: Global carbon and other biogeochemical cycles and feedbacks
Chapter 6: Short-lived climate forcers
Chapter 7: The Earth's energy budget, climate feedbacks, and climate sensitivity
Chapter 8: Water cycle changes
Chapter 9: Ocean, cryosphere, and sea level change
Chapter 10: Linking global to regional climate change
Chapter 11: Weather and climate extreme events in a changing climate
Chapter 12: Climate change information for regional impact and for risk assessment

Annexes incl. options for a Regional Atlas and Technical Annexes
Glossary
Index

Working Group II

1: Point of departure and key concepts

SECTION 1: Risks, adaptation and sustainability for systems impacted by climate change

2: Terrestrial and freshwater ecosystems and their services

3: Ocean and coastal ecosystems and their services

4: Water

5: Food, fibre and other services from managed ecosystems

6: Cities, settlements and key infrastructure

7: Health, wellbeing and the changing structure of communities

8: Poverty, livelihoods and sustainable development

SECTION 2: Regions

9: Africa

10: Asia

11: Australasia

12: Central and South America

13: Europe

14: North America

15: Small Islands

CROSS-CHAPTER PAPERS

- Biodiversity hotspots
- Cities and settlements by the sea
- Deserts, semi-arid areas, and desertification
- Mediterranean region
- Mountains
- Polar regions
- Tropical forest

SECTION 3: Sustainable development pathways: integrating adaptation and mitigation

16: Key risks across sectors and regions

17: Decision-making options for managing risk

18: Climate resilient development pathways and transformation

Working Group III

Chapter 1: Introduction and Framing

Chapter 2: Emission trends and drivers

Chapter 3: Mitigation pathways compatible with long-term goals

Chapter 4: Mitigation and development pathways in the near- to mid-term

Chapter 5: Demand, services and social aspects of mitigation

Chapter 6: Energy systems

Chapter 7: Agriculture, forestry, and other land uses

Chapter 8: Urban systems and other settlements

Chapter 9: Buildings

Chapter 10: Transport

Chapter 11: Industry

Chapter 12: Cross sectoral perspectives

Chapter 13: National and sub-national policies and institutions

Chapter 14: International cooperation

Chapter 15: Investment and finance

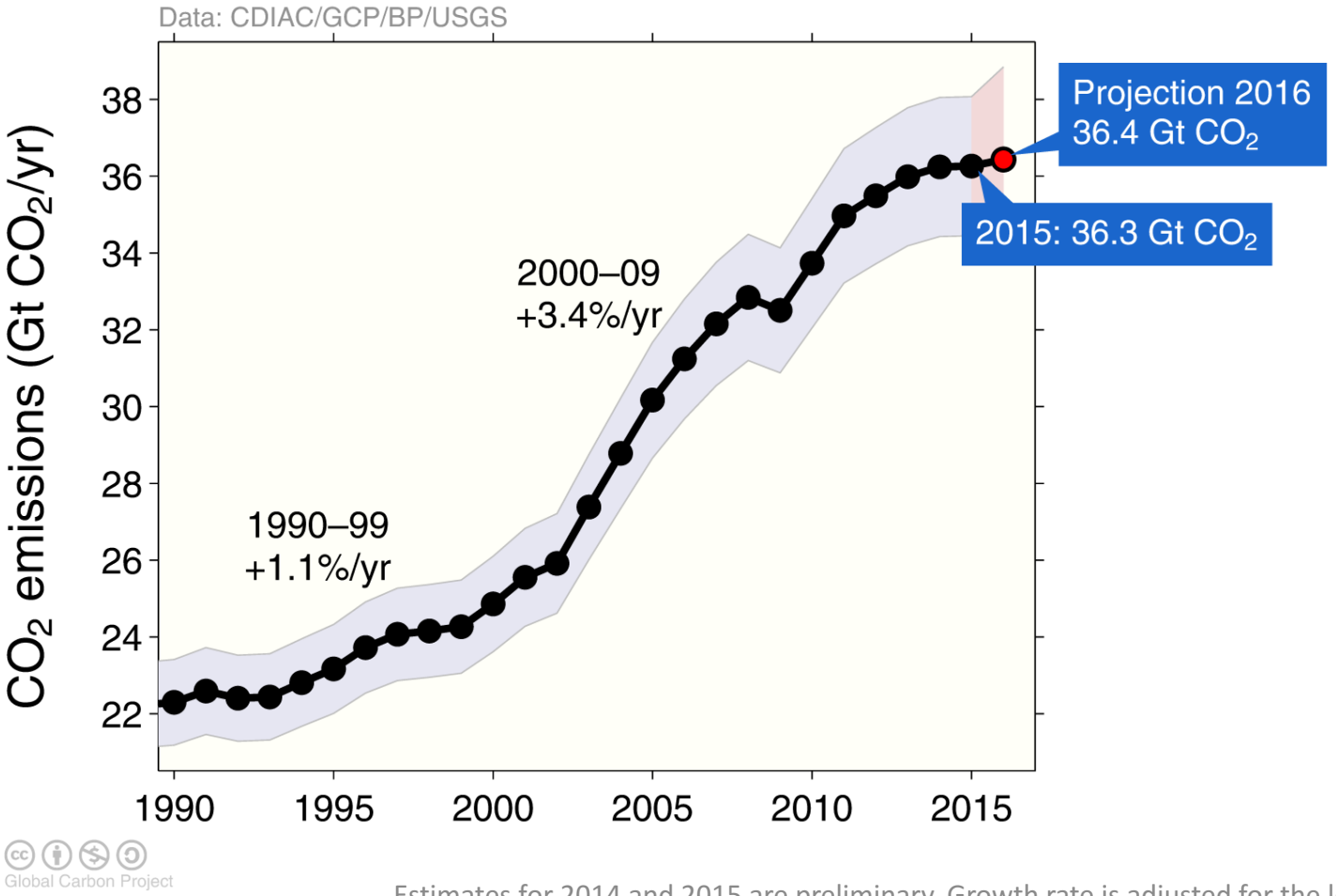
Chapter 16: Innovation, technology development and transfer

Chapter 17: Accelerating the transition in the context of sustainable development

Global CO_2 emissions from fossil fuel and industry

36.3 ± 1.8 $GtCO_2$ in 2015, 63% over 1990

Projection for 2016: 36.4 ± 2.3 $GtCO_2$, 0.2% higher than 2015



Estimates for 2014 and 2015 are preliminary. Growth rate is adjusted for the leap year in 2016.

Source: CDIAC; Le Quéré et al 2016; Global Carbon Budget 2016

Chapter 1:
Framing, context, methods

Executive Summary

- Synthesis of key findings from AR5 and earlier assessment reports, and connections to AR6 Special Reports
- Framing of the physical science information relevant for mitigation, adaptation, and risk assessment in the context of the Global Stocktake
- Assessment approach
- Observational and reanalysis developments since the AR5
- Model and experimental design developments since the AR5
- Emissions and forcing scenarios
- Treatment and evaluation of uncertainty throughout the report

Frequently Asked Questions

Chapter 2:
Changing state of the climate system

Executive Summary

- Multi-millennial context, pre-industrial to present day
- Natural and anthropogenic forcings
- Radiative forcing
- Large-scale indicators of observed change in the atmosphere, ocean, cryosphere, land, and biosphere
- Modes of variability

Frequently Asked Questions

Chapter 3:
Human influence on the climate system

Executive Summary

- Overview of model performance and development since the AR5
- Simulated large-scale indicators of change in the atmosphere, ocean, cryosphere, land, and biosphere
- Simulated modes of variability
- Natural variability versus anthropogenically-forced change
- Attribution of large-scale observed changes

Frequently Asked Questions

Chapter 4:
Future global climate: scenario-based projections and near-term information

Executive Summary

- Projections of global mean surface temperature and other key global indicators
- Evaluation of multi-model ensemble methods
- Large scale patterns of climate change
- Committed climate response, climate targets, overshoot, irreversibility, abrupt change
- Climate response to greenhouse gas removal scenarios
- Climate response to solar radiation management scenarios
- Interplay between internal variability and response to forcings, including short-lived forcers
- Variability and unexpected changes of global mean surface temperature
- Near-term predictability, sources and capabilities
- Synthesis of climate information in the near-term

Frequently Asked Questions

Chapter 5:
Global carbon and other biogeochemical cycles and feedbacks

Executive Summary

- Feedbacks between climate and biogeochemical cycles, including paleoclimate information
- Ocean acidification
- Historical trends and variability of CO_2, CH_4 and N_2O; sources and sinks
- Projections of global biogeochemical cycles from near-term to long-term
- Abrupt change, irreversibility
- Model evaluation, emergent constraints
- Transient climate response to cumulative emissions and remaining carbon budgets for climate targets
- Biogeochemical implications of land and coastal management mitigation options including greenhouse gas removal
- Biogeochemical implications of solar radiation management scenarios

Frequently Asked Questions

Chapter 6:
Short-lived climate forcers

Executive Summary

- Key global emissions: global overview, natural, anthropogenic, historical and scenarios
- Observed and reconstructed concentrations and radiative forcing
- Direct and indirect-aerosol forcing
- Implications for greenhouse gas lifetimes
- Implications of different socio-economic and emission pathways, including urbanisation, for radiative forcing
- Connections to air quality and atmospheric composition

Frequently Asked Questions

Chapter 7:
The Earth's energy budget, climate feedbacks, and climate sensitivity

Executive Summary

- Energy budget and its changes through time
- Radiative forcing: definitions, estimates, and its representation in models
- Climate feedbacks
- Sensitivity of the climate system: methods and uncertainty
- Empirical constraints on the sensitivity of the climate system, including paleoclimate
- Global warming potential, global temperature change potential, and other metrics

Frequently Asked Questions

Chapter 8:
Water cycle changes

Executive Summary

- Observations, models, methods and their reliability
- Past, present and projected changes, trends, variability and feedbacks in the physical components of the water cycle
- Circulation, processes and phenomena (e.g. monsoon systems) affecting moisture and precipitation patterns, including extremes
- Cloud-aerosol processes affecting the water cycle
- Changes in seasonality of natural storage and water availability
- Abrupt change
- Confidence in projections

Frequently Asked Questions

Chapter 9:
Ocean, cryosphere, and sea level change

Executive Summary

- Past and future changes in ocean circulation and properties (trends, variability and extremes)
- Past and future changes in marine and terrestrial cryosphere
- Evaluation of models and projection methods
- Detection and attribution
- Past global and regional sea level changes
- Projections of global and regional sea level change
- Abrupt change and long-term commitment
- Extreme water levels (tides, surge and ocean waves)

Frequently Asked Questions

Chapter 10:
Linking global to regional climate change

Executive Summary

- Regional phenomena, drivers, feedbacks and teleconnections
- Regional scale observations and reanalyses
- Interplay between internal variability and forced change at the regional scale, including attribution
- Evaluation of model improvements, methods, including downscaling and bias adjustment and regional specificities
- Confidence in regional climate information, including quantification of uncertainties
- Scale specific methodologies e.g. urban, mountains, coastal, catchments, small islands
- Approaches to synthesizing information from multiple lines of evidence

Frequently Asked Questions

Chapter 11:
Weather and climate extreme events in a changing climate

Executive Summary

- Extreme types encompassing weather and climate timescales and compound events (including droughts, tropical cyclones)
- Observations for extremes and their limitations, including paleo
- Mechanisms, drivers and feedbacks leading to extremes
- Ability of models to simulate extremes and related processes
- Attribution of changes in extremes and extreme events
- Assessment of projected changes of extremes and potential surprises
- Case studies across timescales

Frequently Asked Questions

Chapter 12:
Climate change information for regional impact and for risk assessment

Executive Summary

- Framing: physical climate system and hazards
- Region-specific integration of information, including confidence
- Information (quantitative and qualitative) on changing hazards: present day, near term and long term
- Region-specific methodologies
- Relationship between changing hazards, global mean temperature change, scenarios and emissions

Frequently Asked Questions