



Climate Change

A Data-Driven Analysis

Group 2

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Scope of Presentation



Is Climate Change Real?



What Causes
Climate Change?



What Contributes
to Greenhouse Gases?



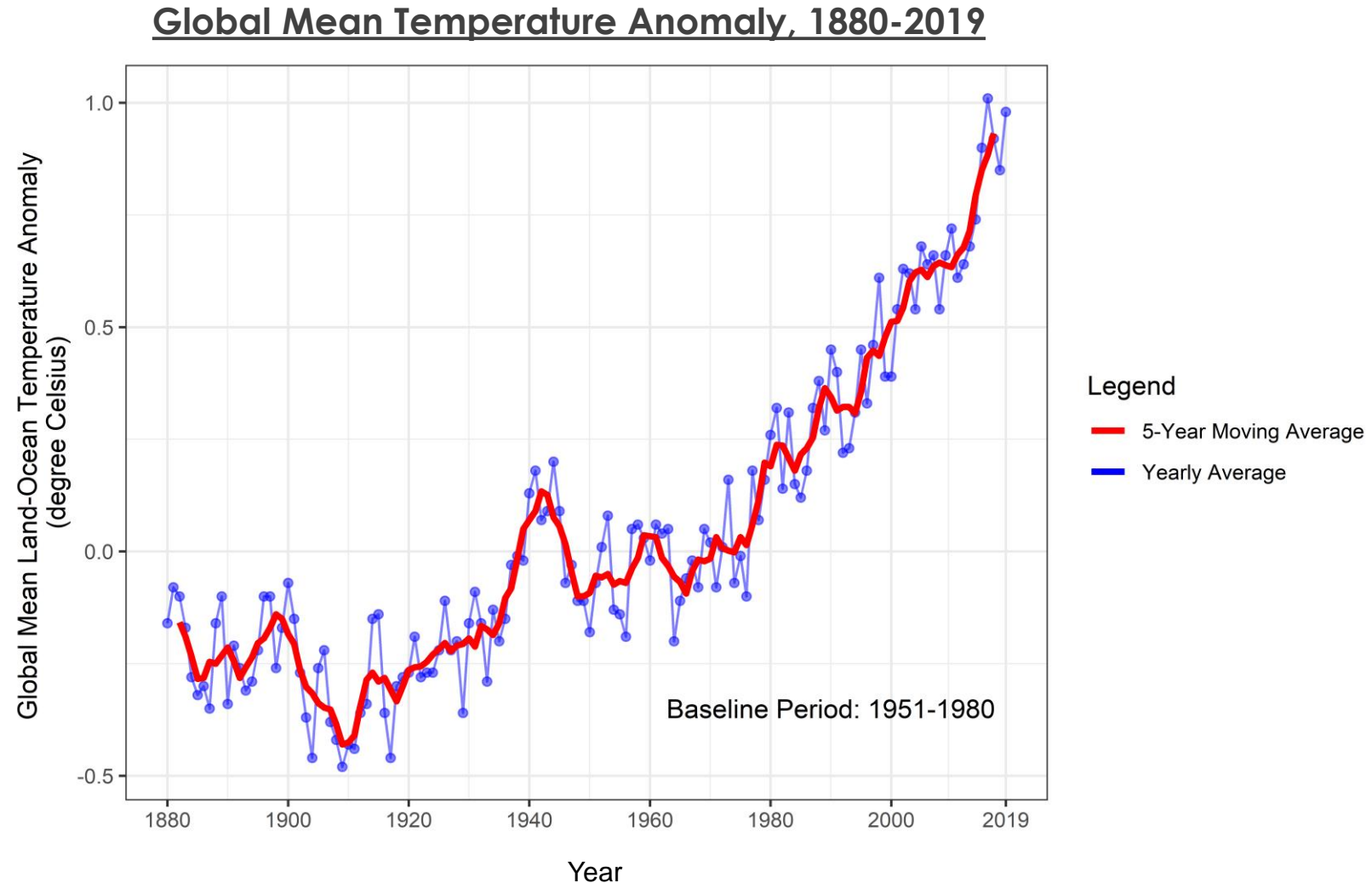
What Does the Future
Hold For Us?



Is Climate Change Real?

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Temperature Changes



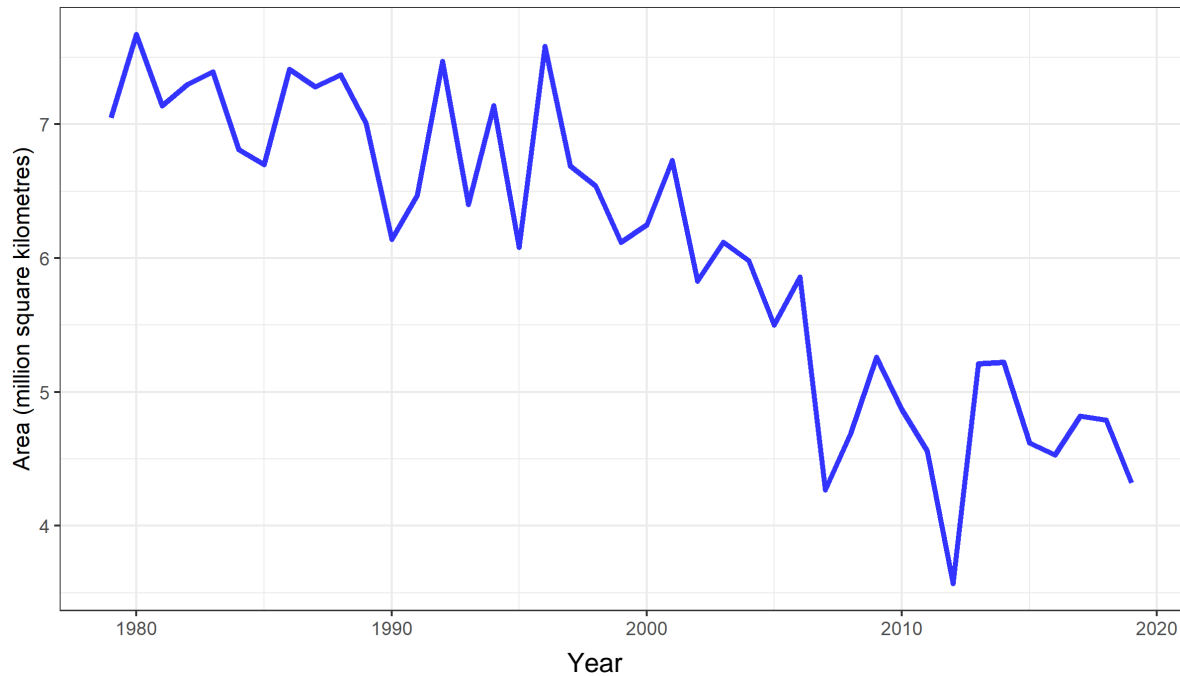
Is Climate Change Real?

Sea Ice and Seawater Levels

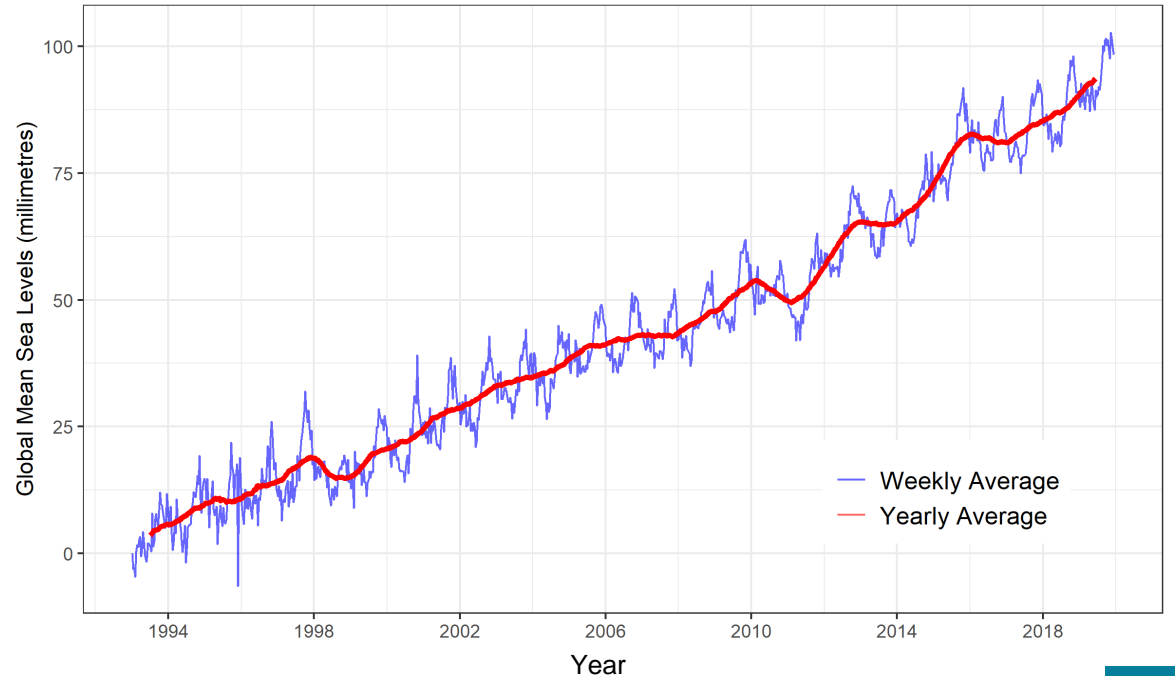
Rising temperatures result in:

- Ice sheets and glaciers melting
- The expansion of seawater

Arctic Sea Ice Levels, 1979-2019



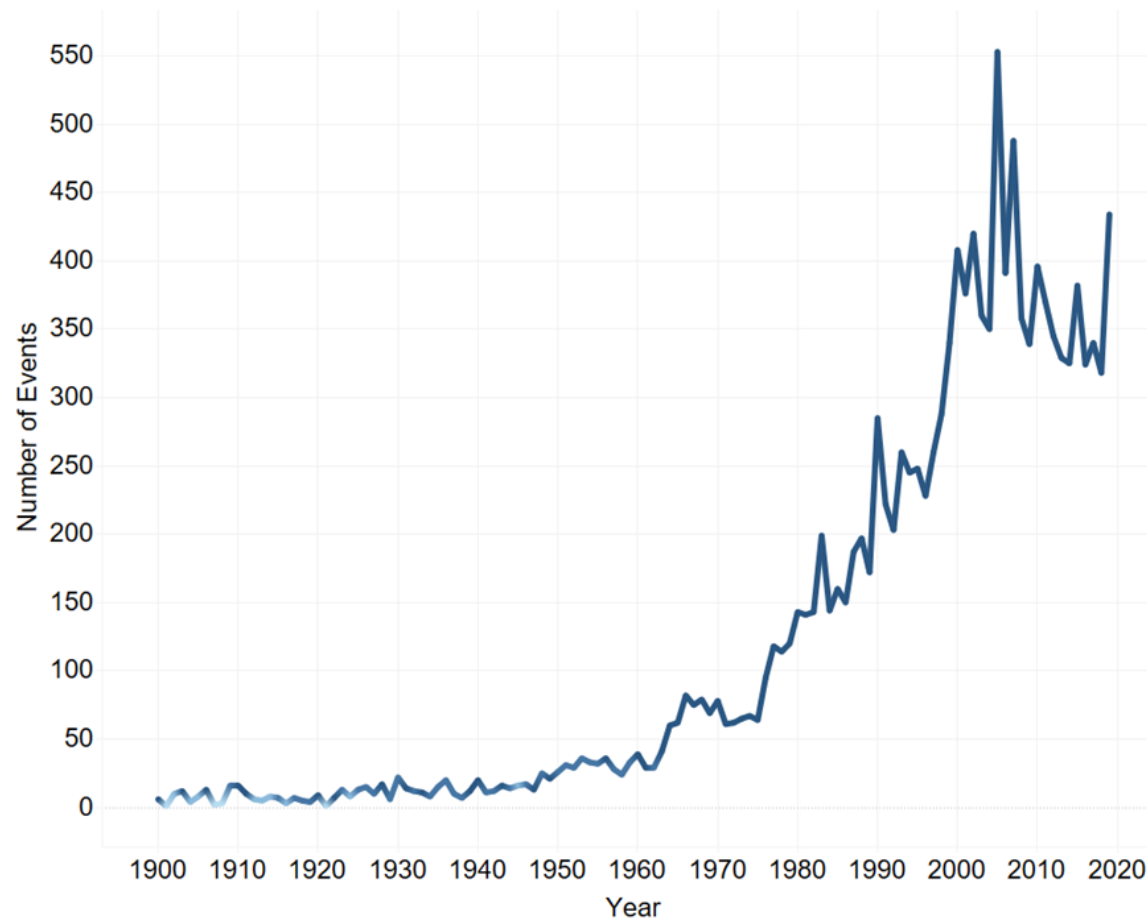
Global Mean Sea Levels, 1993-2019



Is Climate Change Real?

Extreme Weather Events

Occurrence of Extreme Weather Events, 1900-2019



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What Causes Climate Change?

What Causes Climate Change?

Greenhouse Effect



Source: NASA

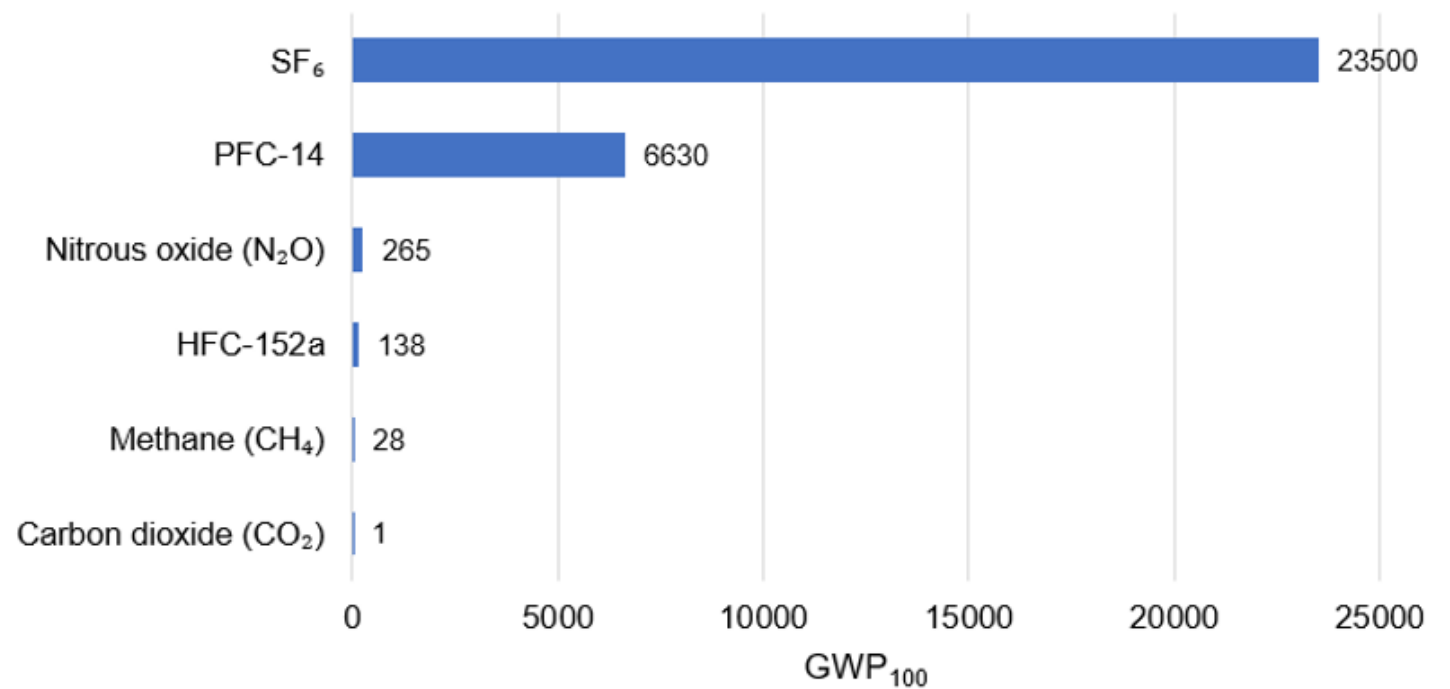
- Global warming is a result of an **enhanced “greenhouse effect”**.
- Greenhouse gases, in the right equilibrium within the Earth's atmosphere, are vital for survival.
- However, **human activities** have released **more greenhouse gases**, enhancing the “greenhouse effect” and making the Earth warmer.

What Causes Climate Change?

Greenhouse Gases – Carbon Dioxide, Nitrous Oxide, Methane and Water Vapour

- **Global warming potential (GWP)** measures the relative warming impact of one-unit mass of a greenhouse gas relative to carbon dioxide.
- The GWP_{100} value is used to combine greenhouse gases into a single emission, called **carbon dioxide equivalent (CO_2e)**.

Global Warming Potential of Greenhouse Gases Over 100-year Timescale (GWP_{100})

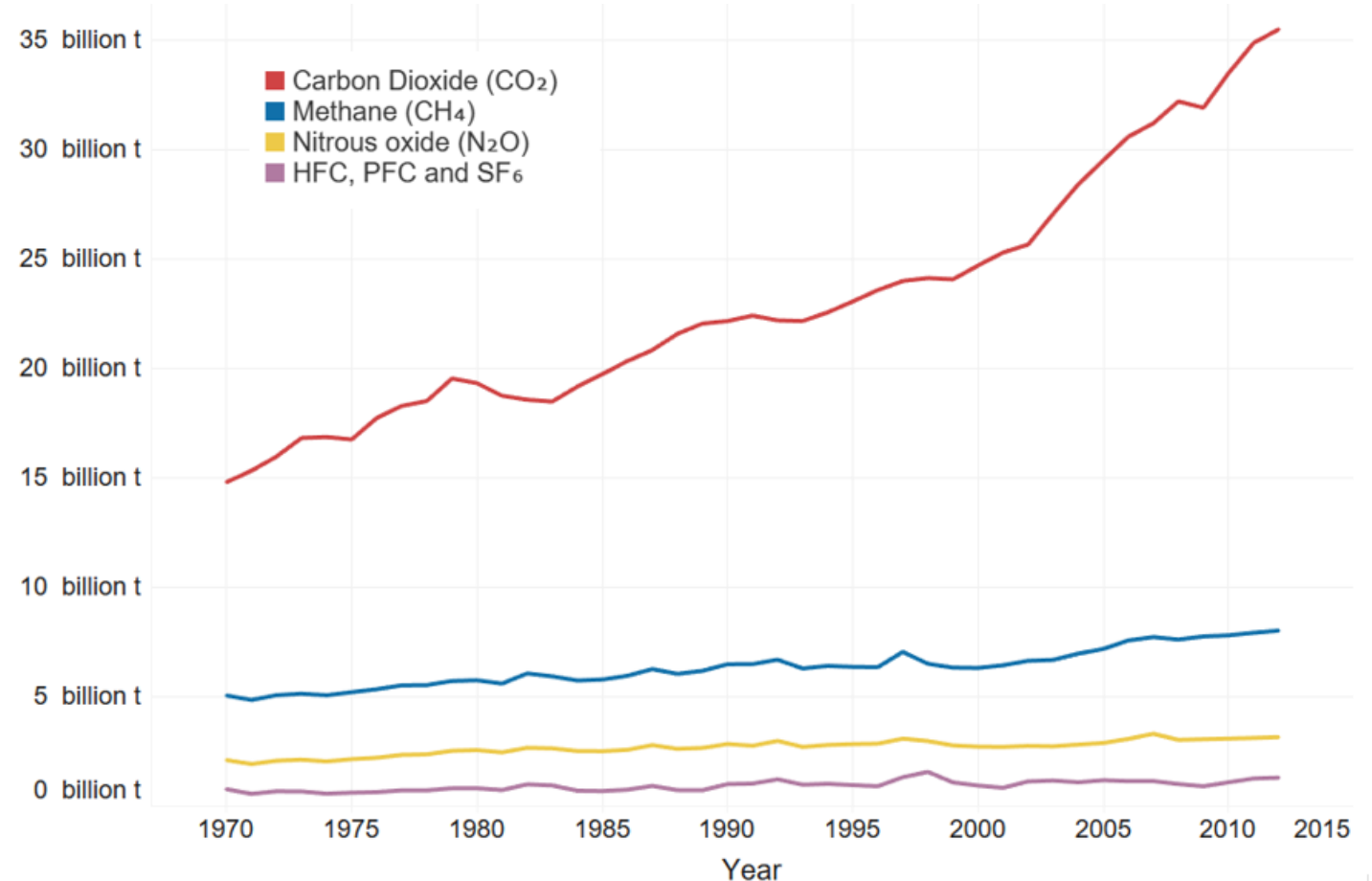


What Causes Climate Change?

Greenhouse Gases – Carbon Dioxide, Nitrous Oxide, Methane and Water Vapour

- In 2012, global **carbon dioxide** emissions account for around three-quarters of total greenhouse gas emissions.
- **Methane and nitrous oxide** are also important sources, accounting for around 17% and 7% of emissions.
- The contribution of **HFC, PFC and SF₆** to global warming is small.

Greenhouse Gas Emissions By Gas, 1970-2012



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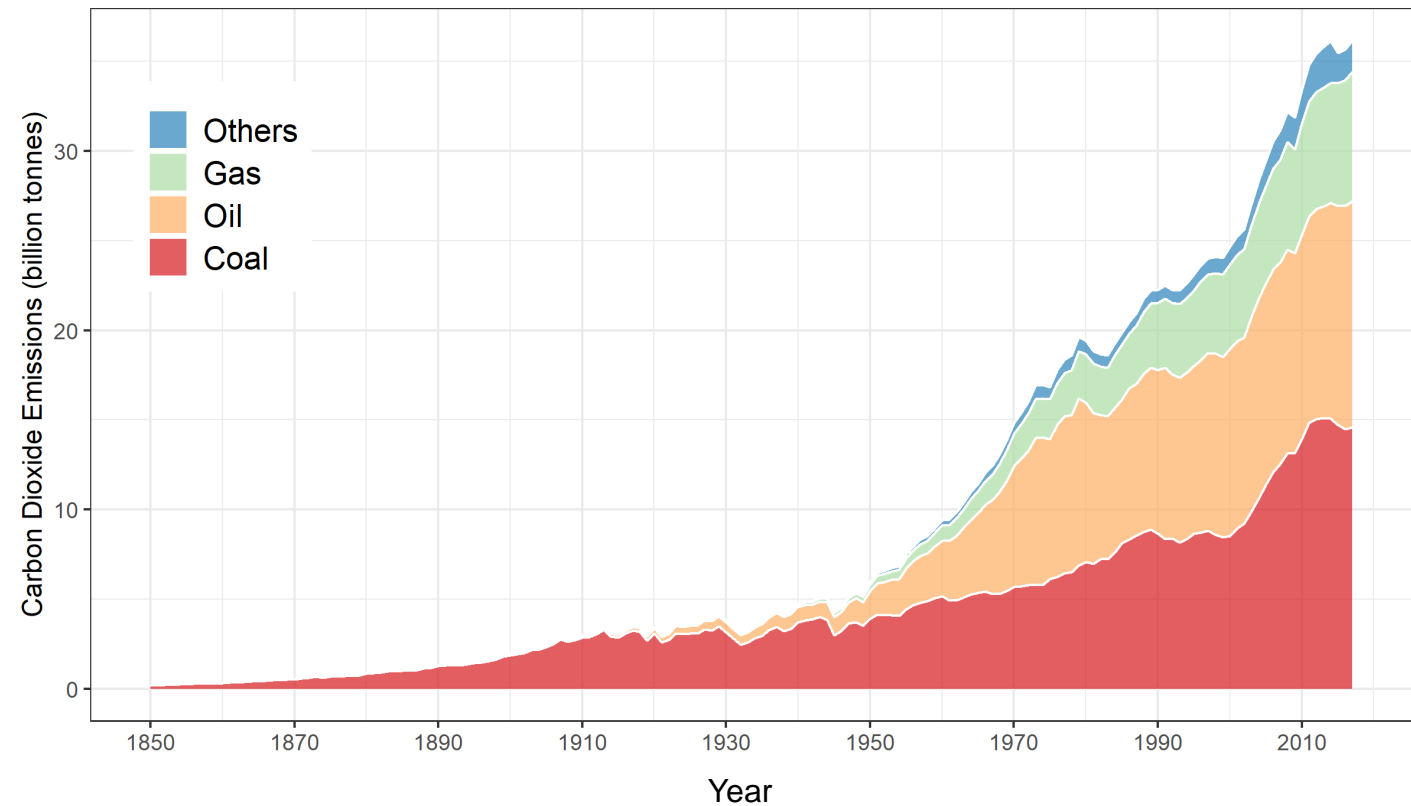
What Contributes to Greenhouse Gases?

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Fossil Fuel Combustions

- **More than 180-fold increase** in global CO₂ emissions due to fossil fuel combustions since 1850.
- **Coal** used to be the **predominant source** of fuel until late-1800s, before oil and gas emerged as alternatives.
- In 2017, **coal and oil** accounted for **three-quarters** of all fossil fuel emissions.

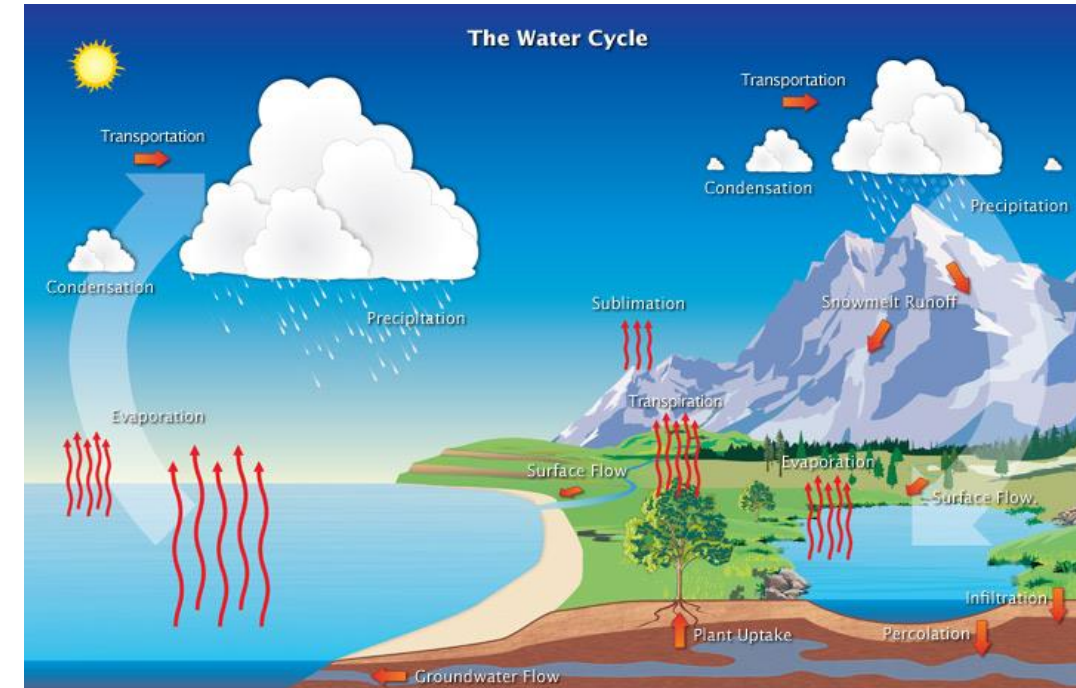
Global CO₂ Emissions by Fuel Type, 1850-2017



What Contributes to Greenhouse Gases?

Deforestation

- Deforestation causes **an increase of carbon dioxide** in the Earth's atmosphere.
 - With **less trees to absorb** carbon dioxide, the amount of carbon dioxide in the atmosphere increases.
 - Burning trees releases a substantial amount of **stored carbon** to the atmosphere.
- More heat is trapped** in the Earth's atmosphere, resulting in **temperature rise**.

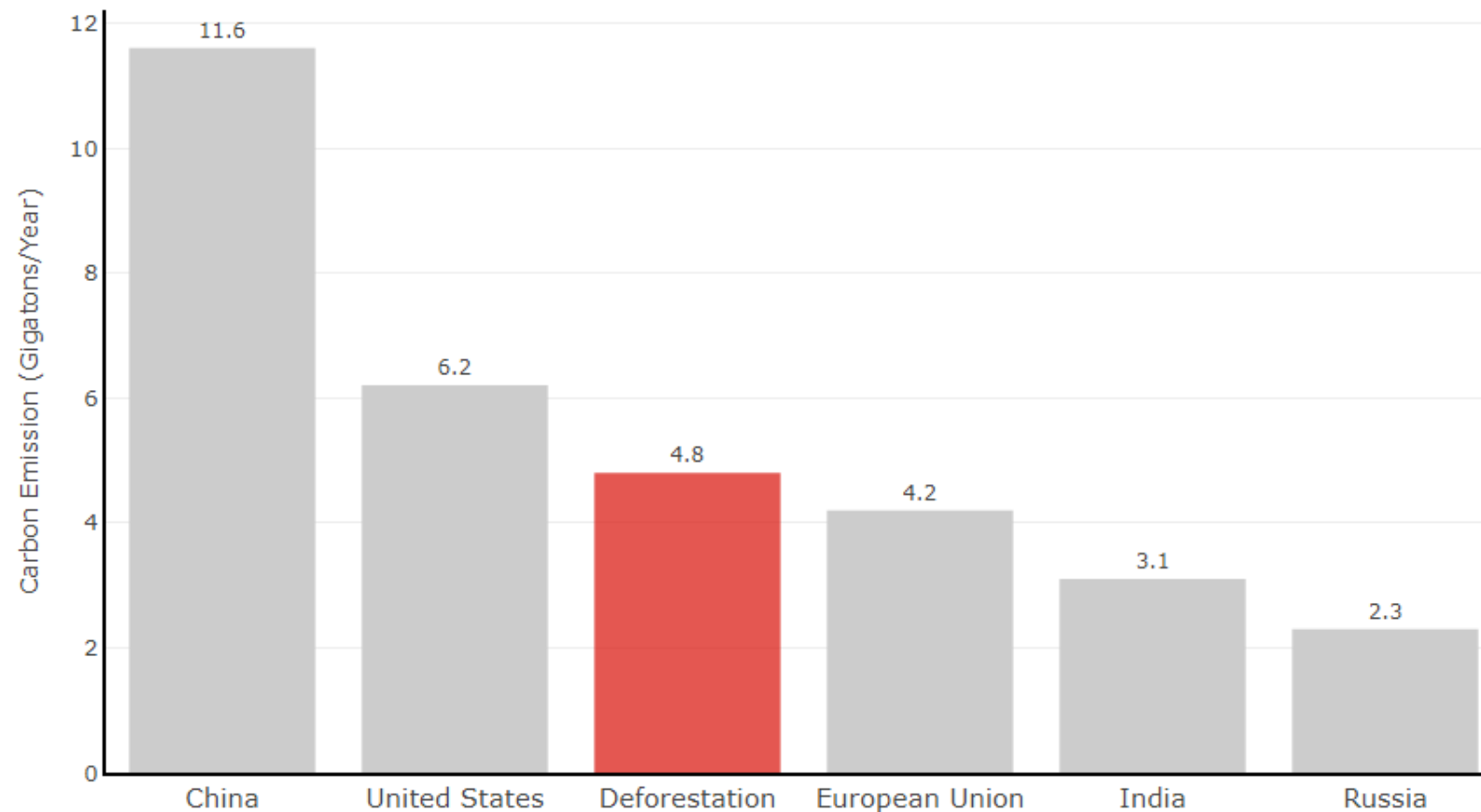


Source: NASA Earth Observatory

What Contributes to Greenhouse Gases?

Deforestation

Comparison of Average Annual Carbon Emission, 2011

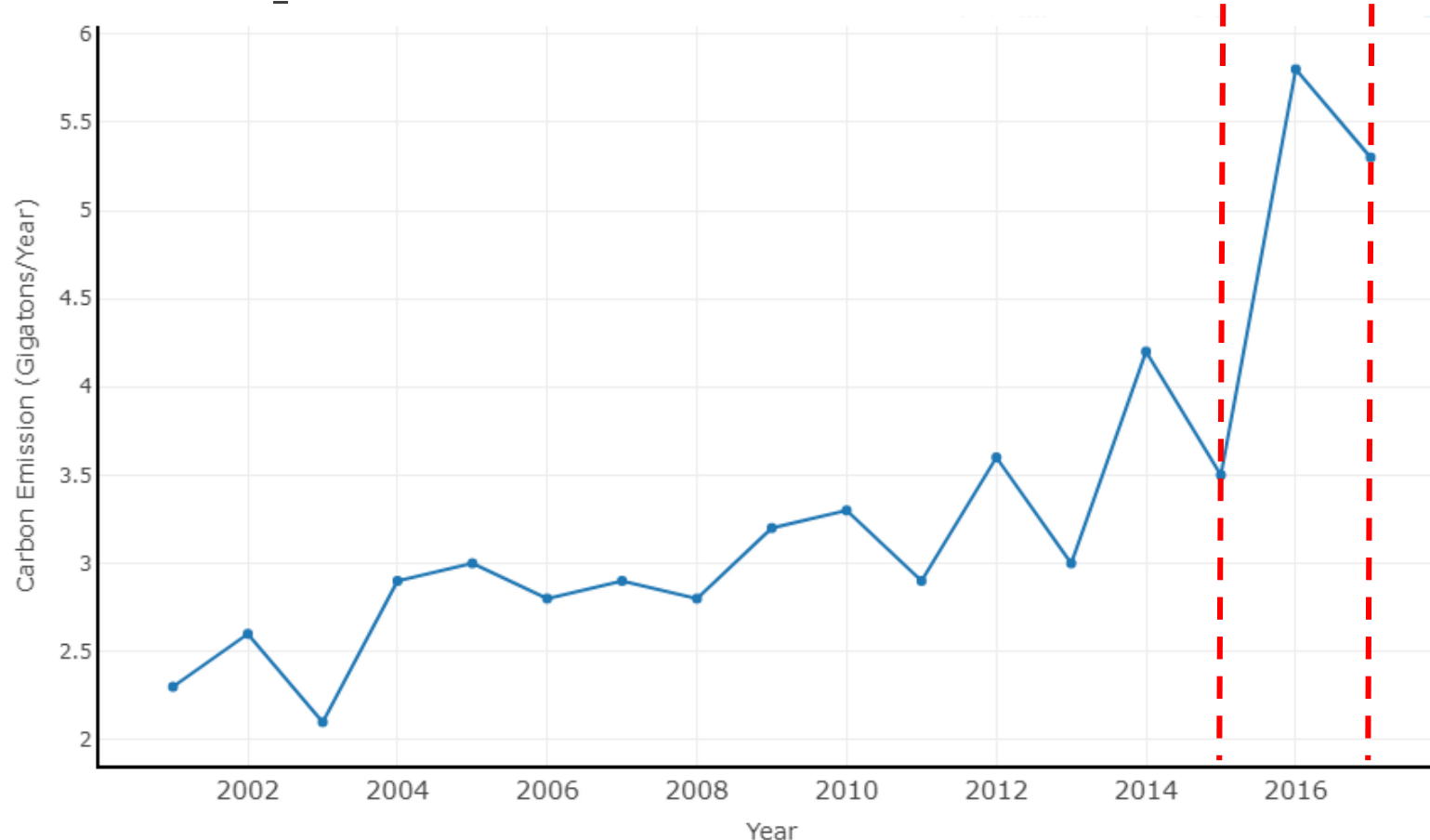


What Contributes to Greenhouse Gases?

Deforestation

Emission from 2015-2017: **63% Higher** than average from prior 14 years.

CO₂ Emission from Tropical Tree Loss, 2001-2017

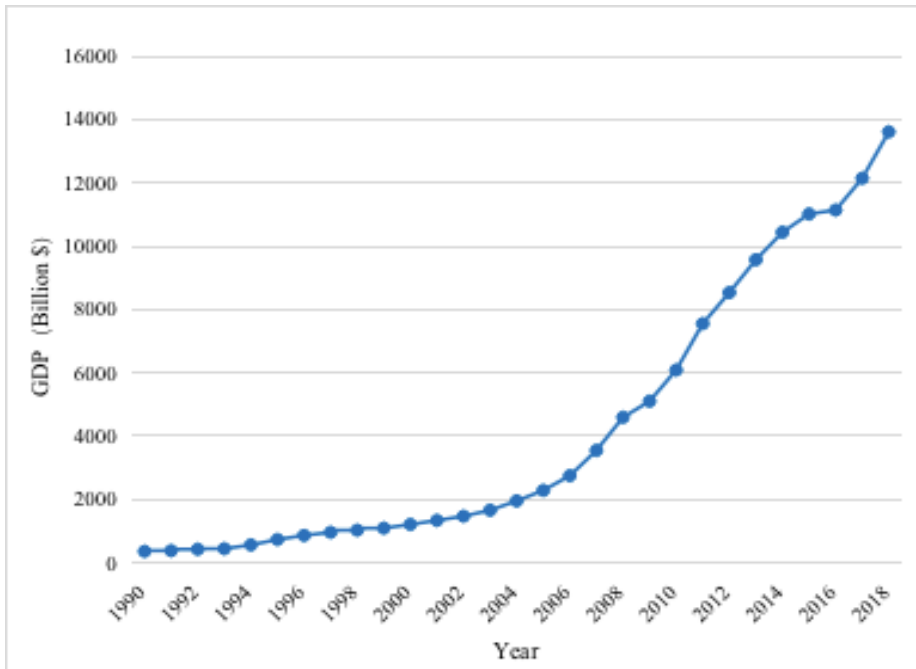


What Contributes to Greenhouse Gases?

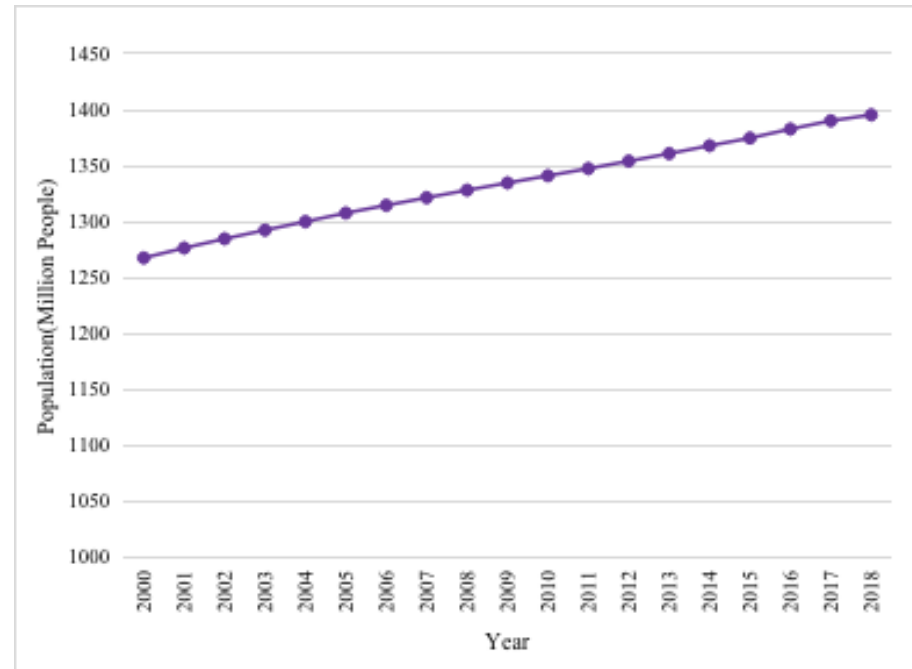
Urbanisation

- Large-scale population aggregation has changed **lifestyles**, **transportation methods**, and **consumption patterns**.
- Human activities in cities and industrial areas are the main sources of air pollution.
 - They lead to a decline of **urban air quality** and an increase of the **heat-island effect**.

GDP of China, 1990-2018



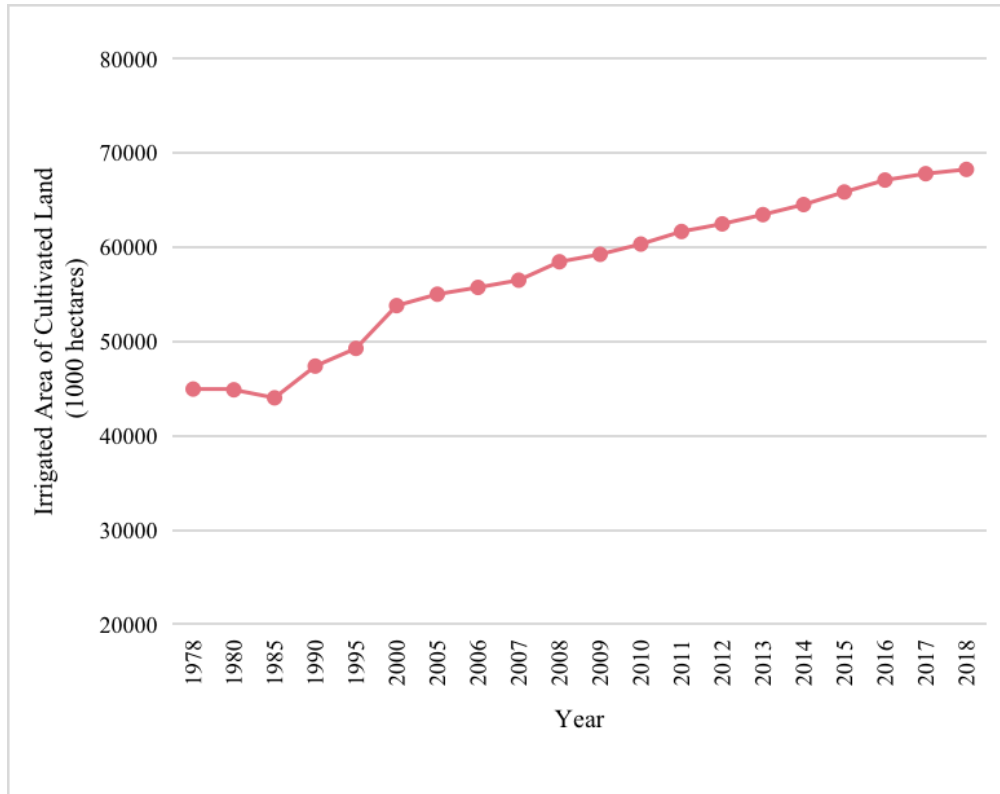
Population of China, 2000-2018



What Contributes to Greenhouse Gases?

Urbanisation

Cultivated Land Area of China, 1978-2018



Source: Baidu



Changes in properties of underlying surface, such as surface albedo, roughness and root soil moisture



Radiation, evaporation, surface runoff and sensible heat



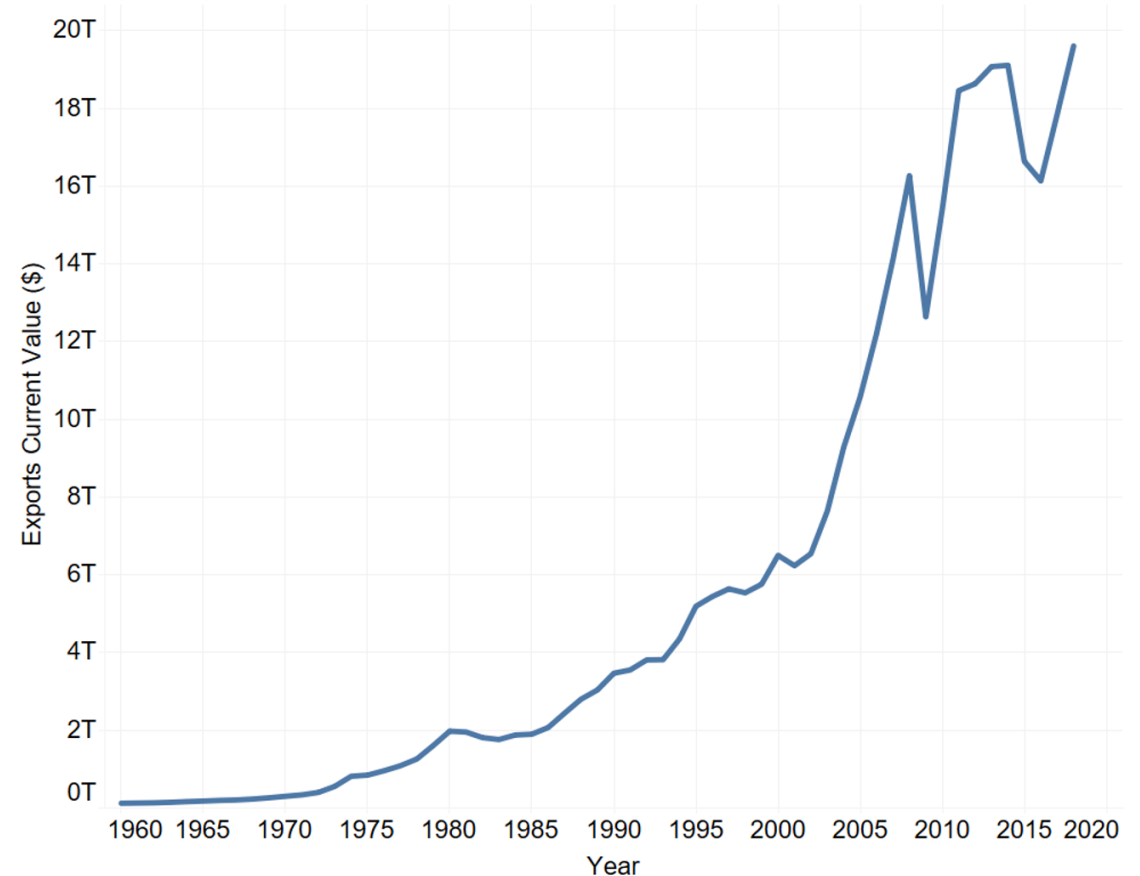
Impact on the **near surface** and even **regional climate**

What Contributes to Greenhouse Gases?

International Trade

- **Technological change** and **open trade and investment policies** have led to an unprecedented expansion in world trade.
- Trade affects greenhouse gas emissions by:
 - Increasing the usage of **transportation services**;
 - The resultant **growth of economic activity**.

Global Merchandise Export Values, 1960-2017



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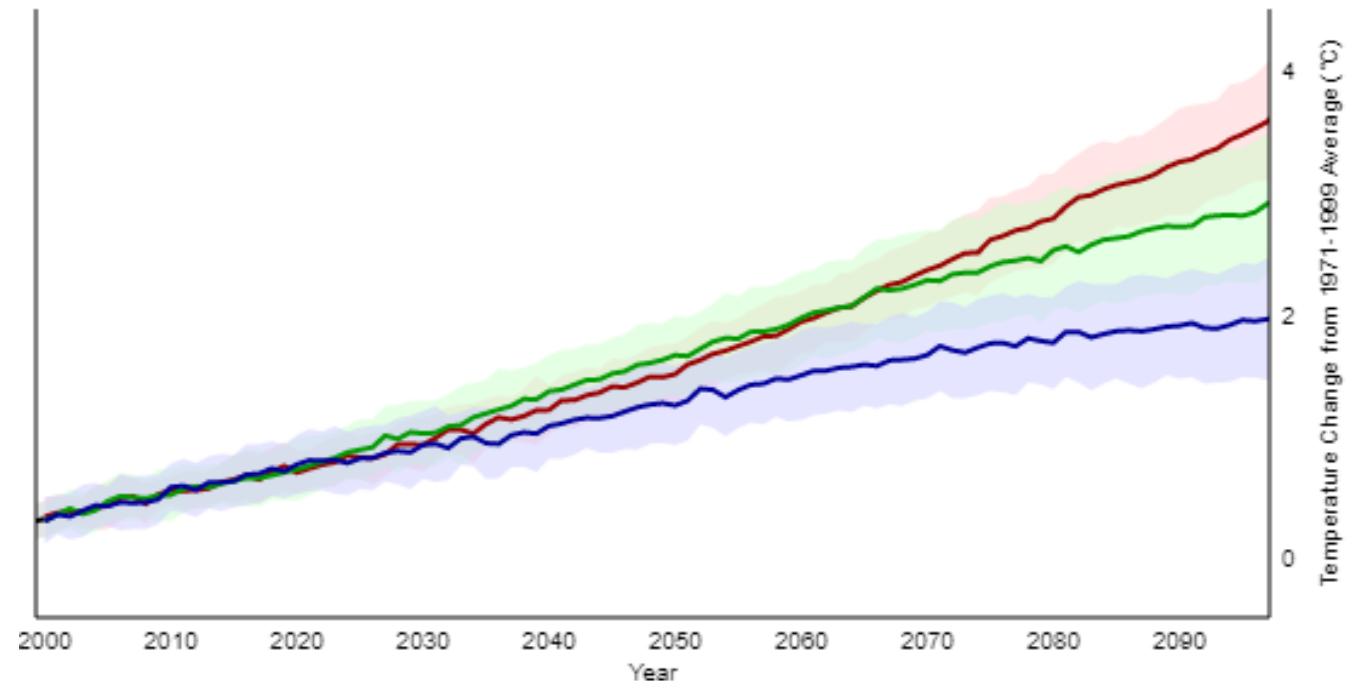
What Does the Future Hold For Us?

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Climate Model Forecasts

Source	Statement
European Environmental Agency	Temperatures expected to increase 0.2°C each decade for the next two decades.
Intergovernmental Panel on Climate Change	CO ₂ levels could double or triple throughout the next century.
National Oceanic and Atmospheric Administration (NOAA)	Climate change over the next century will be significantly higher than the past.

Global Temperature Forecasts for the 21st Century



Source: NOAA

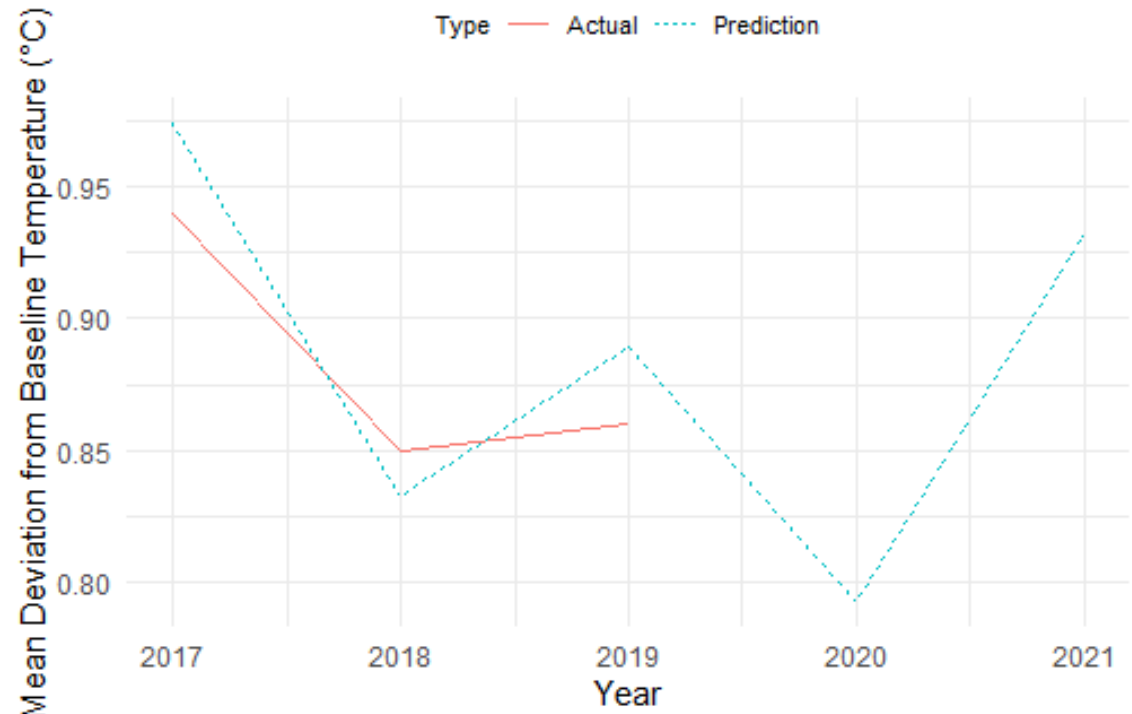
Note: Projected temperatures for the 21st century based on a range of emissions scenarios.

What Does the Future Hold for Us?

ARIMA Modelling

- ARIMA forecasts using data provided by NOAA.
- Root mean squared error for 2017 to 2019 is **0.028**.
- 2020 forecast **0.06°C** lower than 2019 known statistic.
- 2021 forecast **0.14°C** higher than 2020 forecast.

Global Temperature Forecasts, 2017-2021



Source: NOAA

What Does the Future Hold for Us?

Governmental Action and Societal Change

- **Paris Agreement (2016)**
 - Central aim is to **strengthen the global response to the threat of climate change** by keeping a global temperature rise this century well below **2°C** above pre-industrial levels.
 - Each country must submit their **Nationally Determined Contributions** (NDCs).
- **Activism**
 - Greta Thunberg – School Strike for Climate
 - Extinction Rebellion – nonviolent civil disobedience to compel government action
- **Societal Actions**
 - Switching to electric cars
 - Planting more trees

Conclusion



Climate change is real.

The data demonstrates that
the climate is changing.

It is caused by the greenhouse effect.

The greenhouse effect has
been exacerbated by
humans through a variety of
factors.

The future is uncertain.

The outlook is dependent on
global collective action.



Thank You