Climate macroeconomics and finance

Emanuele Campiglio[1][2]

[1]University of Bologna
[2]RFF-CMCC European Institute on Economics and the Environment

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Introductions

Course structure

- First part
  - Six hours for both Frontiers and Econ
  - Three lectures of two hours
  - 11, 16 and 19 February
  - Time: 11 Feb: 9-11; 16 Feb: 16-18; 19 Feb: 16-18
- Second part
  - Nine hours for Econ (Frontiers welcome to audit)
  - Three lectures of three hours
  - 1, 8 and 15 of March
  - Time: Always 14-17

First part (11-19 February)

- Topic: The macroeconomics and finance of climate change and the low-carbon transition
- Three lectures:
  - First introductory lecture
  - Climate and transition risks
  - Policies and institutions for transition
- Theories, history, data, policies, politics
  - Little quantitative knowledge required
- For Frontiers students:
  - Second module of 'Topics in environmental economics'
  - 1st module Tavoni

Second part (1-15 March)

- Same topics, focus on studying them through models
- Overview of methodological approaches:
  - Climate economics (IAMs, CGE)
  - Neoclassical macroeconomics (DSGE, CAPM)
  - System dynamics; macroeconometrics; SFC
  - Heterogenous agents; ABMs
- Quantitative methods welcome but not compulsory:
  - Systems of dynamic equations
  - Intertemporal optimisation
- No applied sessions:
  - BUT: do contact me after the course if you want to go deeper

Students' role

- Diversity of backgrounds, knowledge and interests
- Contributions welcome
  - Do you know a good paper on this?
- Short presentations
  - Introduce the others to a good reading/literature
  - Voluntary basis but helps assessment
- Readings before lecture
  - Readings available on Teams
- Please be on time:
  - We start 5 mins, we end 5 mins to
- Please keep video on

Main readings (on Teams)

- Some published material
  - Bolton et al. 2020. The green swan. Central banking and financial stability in the age of climate change. Bank of International Settlements.
  - Semieniuk et al. 2021. Low-carbon transition risks for finance. WIREs Climate Change 12, e678.
  - Campiglio et al. 2018. Climate change challenges for central banks and financial regulators. Nature Climate Change 8, 462468.
- Some work in progress
  - Capital stranding cascades: The impact of decarbonisation on productive asset utilisation
  - It takes two to dance: Institutional dynamics and climate-related financial policies

Assessment

- Essays
  - Reflections on topics/literature
  - Options from me + topic proposals welcome
- First essay on first half of the course
  - For both Frontiers and Econ students
  - Topics by 21 February
  - Deadline: 28 February
- Second essay on second half of the course
  - Only for Econ students
  - Topics by 21 March
  - Deadline: 28 March
- Weights:
  - Frontiers: 0.5 first essay; 0.5 Tavoni's essay
  - Weights: 0.4 first essay; 0.6 second essay

A bit more about me

- Associate prof. DSE since Sept 2020
- Assistant prof. at WU Vienna: 2016-2020
    - Research area on Climate Economics and Finance
- Postdoc at LSE: 2012-206
    - Grantham Research Institute + Geography Department
- PhD in Economics in Pavia: 2008-2012
    - Three essays on the sustainability of economic growth
- Researcher at New Economics Foundation: 2010-2012
    - The 'Great Transition' modelling project
- Bachelor and Master in International development and cooperation
    - Bocconi + Pavia

A bit more about my work

- Background in growth theory and modelling
  - 2014 paper on SCED: link
  - Ongoing paper on stranding and uncertainty: link
- Macroeconomics of climate change and the low-carbon transition
  - 2015 NCC paper: link
  - Paper on physical stranding cascades: part of lectures
- Links between financial systems and climate/transition
  - 2016 EcolEc paper on carbon pricing: link
  - 2018 NCC paper on central banks: link
  - 2021 WIREs CC paper on transition risks: link

The SMOOTH project

- Sustainable finance for a smooth low-carbon transition
  - Link to website
- ERC Starting Grant (2020-25)
  - University of Bologna
  - European Institute on Economics and the Environment
- Aims:
  - Study transition links with macro-financial dynamics
  - Design policies for a rapid and smooth decarbonisation
- Four main activities:
  - Transition expectations and investment decisions
  - Macroeconomic models of transition
  - Networks of asset stranding
  - Political economy of transitions, with focus on finance

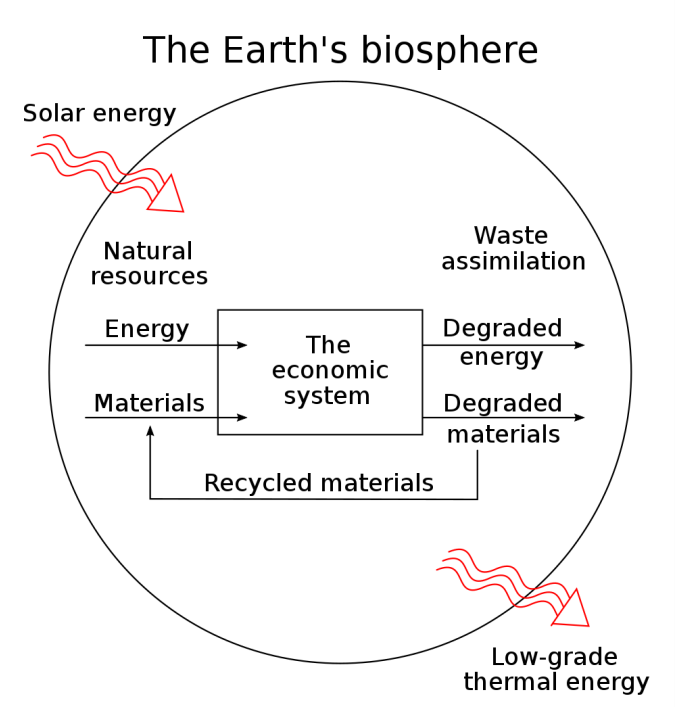
A bit about you

- Who are you? What did you study?
- What is your PhD on?
- How much do you know about climate and technology?
- How much do you know about climate economics?
- What are you looking for in this course?

Long outline

What the problem is

- Environmental constraints to human prosperity
- Environmental constraints:
  - Inputs: materials, energy services, prices
  - Sinks: waste, air pollution, climate change
- Human prosperity:
  - What are the objectives of human societies?
  - Income, satisfaction of needs, human development



Source: Wikipedia; Originally in Hall et al (1986)

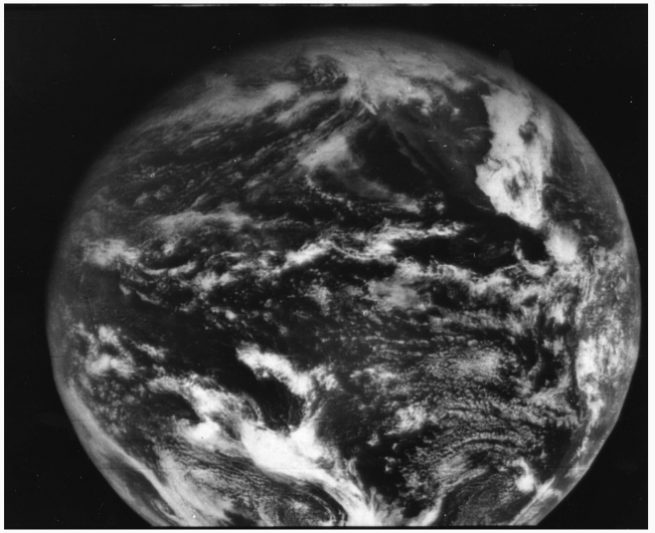
When was the problem posed? (I)

- Roots in classical political
  - T.R. Malthus (1798) 'An Essay on the principle of population'
  - J.S. Mill (1848) on a stationary state
  - Jevons (1865) on 'The coal question' and the Jevons paradox
  - A.C. Pigou (1920) on externalities and the Pigouvian taxes
  - H. Hotelling (1931) 'The Economics of Exhaustible Resources' and the Hotelling rule
- To go deeper:
  - Sandmo 2015 on REEP: 'The early history of environmental economics'

When was the problem posed? (II)

- From the 50s: increased environmental awareness
  - Great Smog of London in 1952 $\rightarrow$ UK Clean Air Act 1956
  - R. Carson (1962) 'The Silent Spring' on chemical pollution
  - First pictures of Earth from space $\rightarrow$ Moon landing in 1969
  - Oil crises in 1973 and 1979

Great smog of London, 1952; Source: Britannica



1966 image of Earth from ATS-1 satellite; Source: NESDIS

How was the issue addressed?

- Two large avenues of contributions
  - Environmental economics
  - Ecological economics
- Controversy born around substitutability of capital stocks
  - Capital approach to sustainable development
  - Man-made, human, natural and social capital
- Weak sustainability
  - High degree of substitatibility
  - Solow 1974 (link) : '(..) earlier generations are entitled to draw down the pool (optimally, of course!) so long as they add (optimally, of course!) to the stock of reproducible capital.'
- Strong sustainability
  - Low degree of substitutability
  - In particular, irreversibility of natural capital depletion

Environmental Economics

- Economists analysing environment-related problems:
  - P. Dasgupta, G. Heal, W. Nordhaus, J. Stiglitz, J. Hatrwick, M. Weitzman..
  - Focus on markets, prices, technology, growth, substitutability, smoothness, efficiency
- Some problems:
  - Optimal resource depletion plans
  - Economic value of environmental goods and services
  - Cost-benefit analysis; discounting
  - Externalities and optimal policies
- Main academic community:
  - AERE (US); EAERE (Europe)
- To go deeper
  - Pearce 2002 on AREE: 'An Intellectual History of Environmental Economics'

Ecological economics

- Economists, but also social and environmental scientists
  - Multi- and inter-disciplinary approach
  - Focus on finiteness, limits, scale, stationarity, irreversibility
- Relevant contributions:
  - K. Boulding (1966) and 'The coming spaceship Earth'
  - N. Georgescu-Roegen (1971) The entropy law and the economic process
  - Meadows et al. (1972) 'The Limits to Growth'
  - H. Daly (1977) 'Steady-state economics'
- Main academic community:
  - ISEE (intl.), ESEE (Europe)
- To go deeper
  - I. Ropke 2004-2005 on EcolEcon: 'The early history of modern ecological economics'; 'Trends in the development of ecological economics from the late 1980s to the early 2000s'

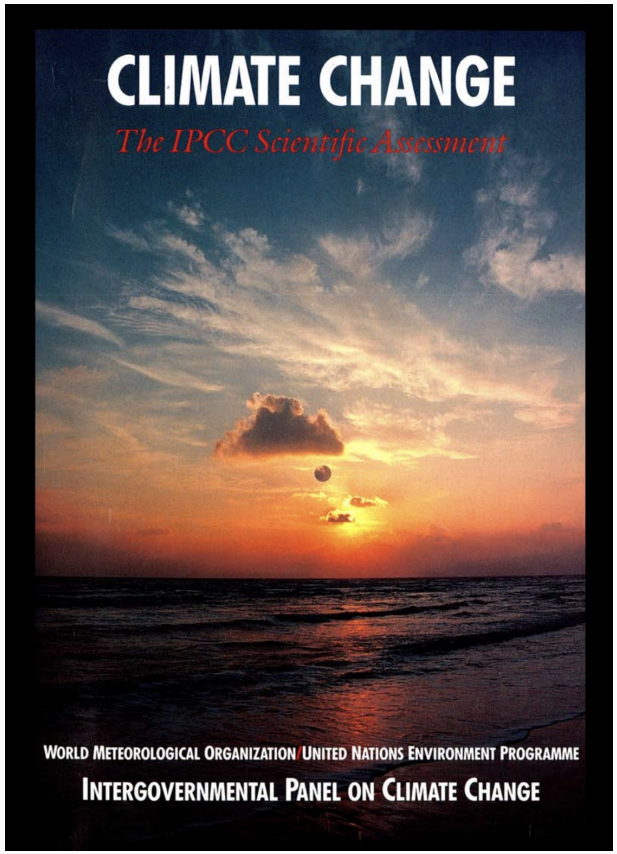
80s: Shift of focus from inputs..

- Resource scarcity less biting
  - Technological innovations
  - Exploration: large expansion of reserves
  - Energy-saving technologies, mass mobility
- Oil price fluctuations still relevant
- Geopolitical implications still relevant
- Main material constraints now:
  - Rare metals for electronics
  - Water

.. to sinks

- The Ozone layer scare
  - Montreal Protocol (1987)
- Environmental concerns
  - Oil spill and disasters
  - Loss of biodiversity
- Climate change
  - 1990: first IPCC report

Exxon Valdez oil spill (1989) Source: NOAA



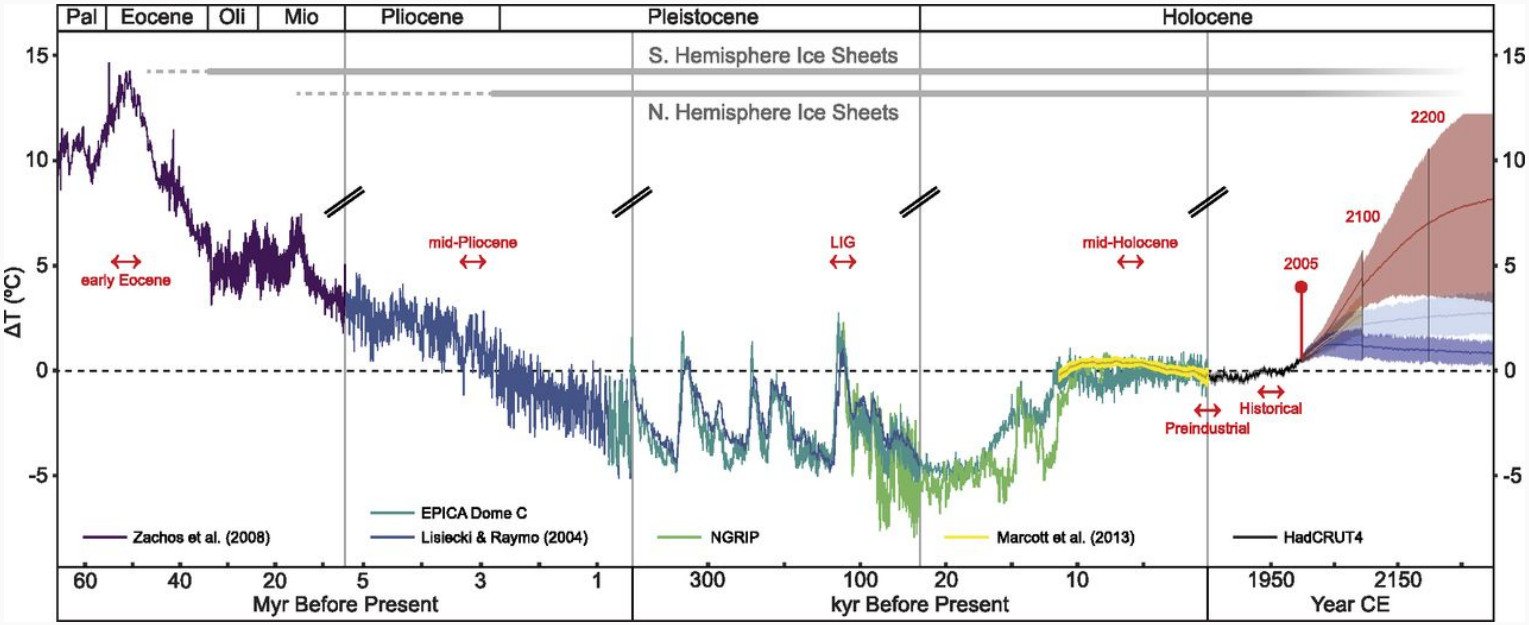
Source: IPCC 1990

Climate change

- Human production/consumption activities create emissions of 'greenhouse' gases (GWP: global warming potential)
  - Carbon dioxide (CO_2); GWP=1
  - Methane (CH_4); GWP=28
  - Nitrous oxide (N_2O); GWP=265
  - Fluorinated gases (SF_6, HFCs, PFCs); GWP up to 23500
- These modify the chemical composition of the atmosphere
- Climate damages
  - Extreme point events (weather, floods, droughts)
  - Gradual patterns (temperature, sea levels)
  - Tipping points

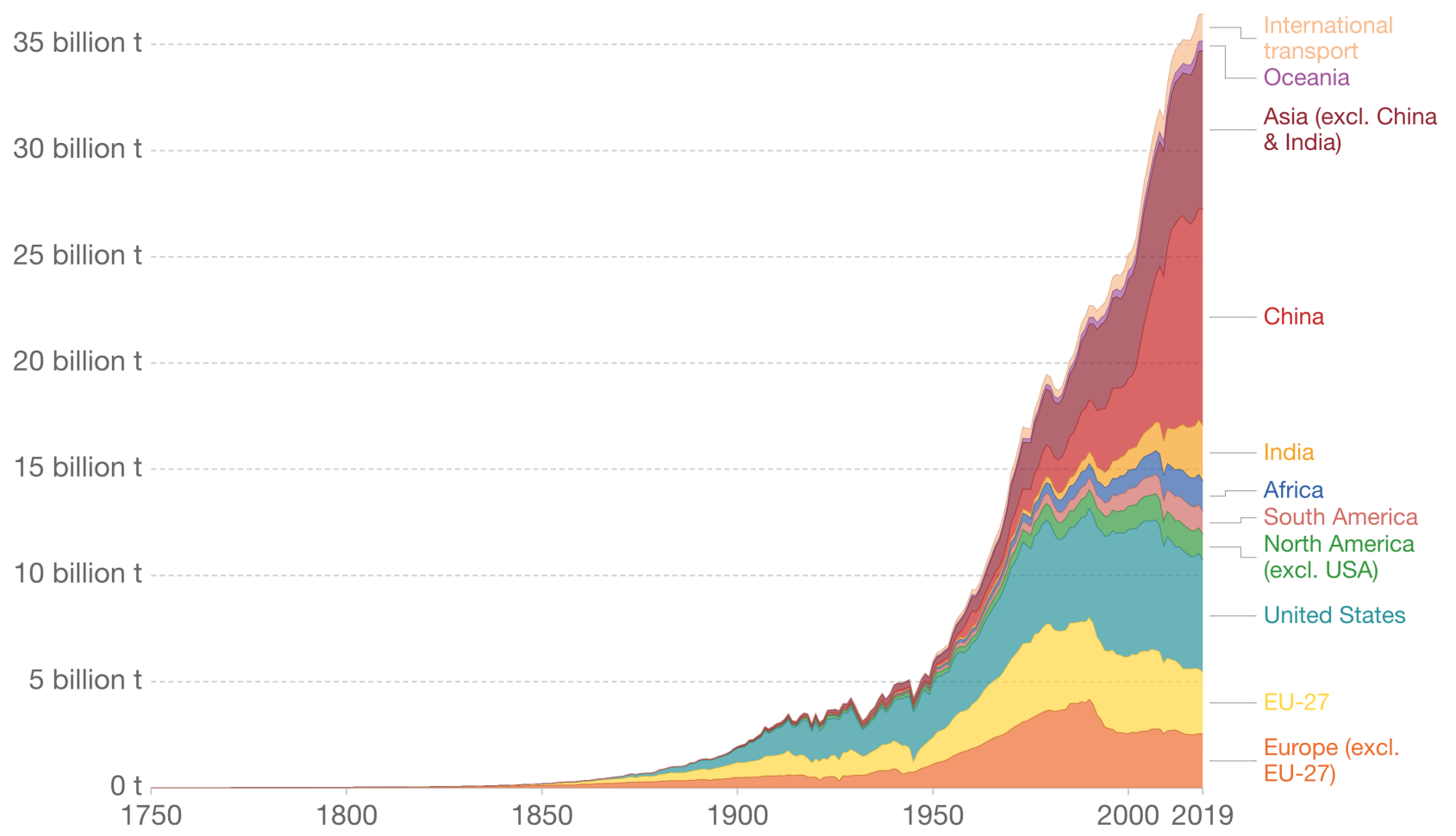
Climate has always changed.. but never due to humans

- Climate has always changed in the past
  - Longer cycles (e.g. Milankovitch cycles)
  - Shorter cycles ('little ice age')
- Climate change and human societies
  - Mild climate and agricultural development
  - Rise and fall of civilisations (J. Diamond)



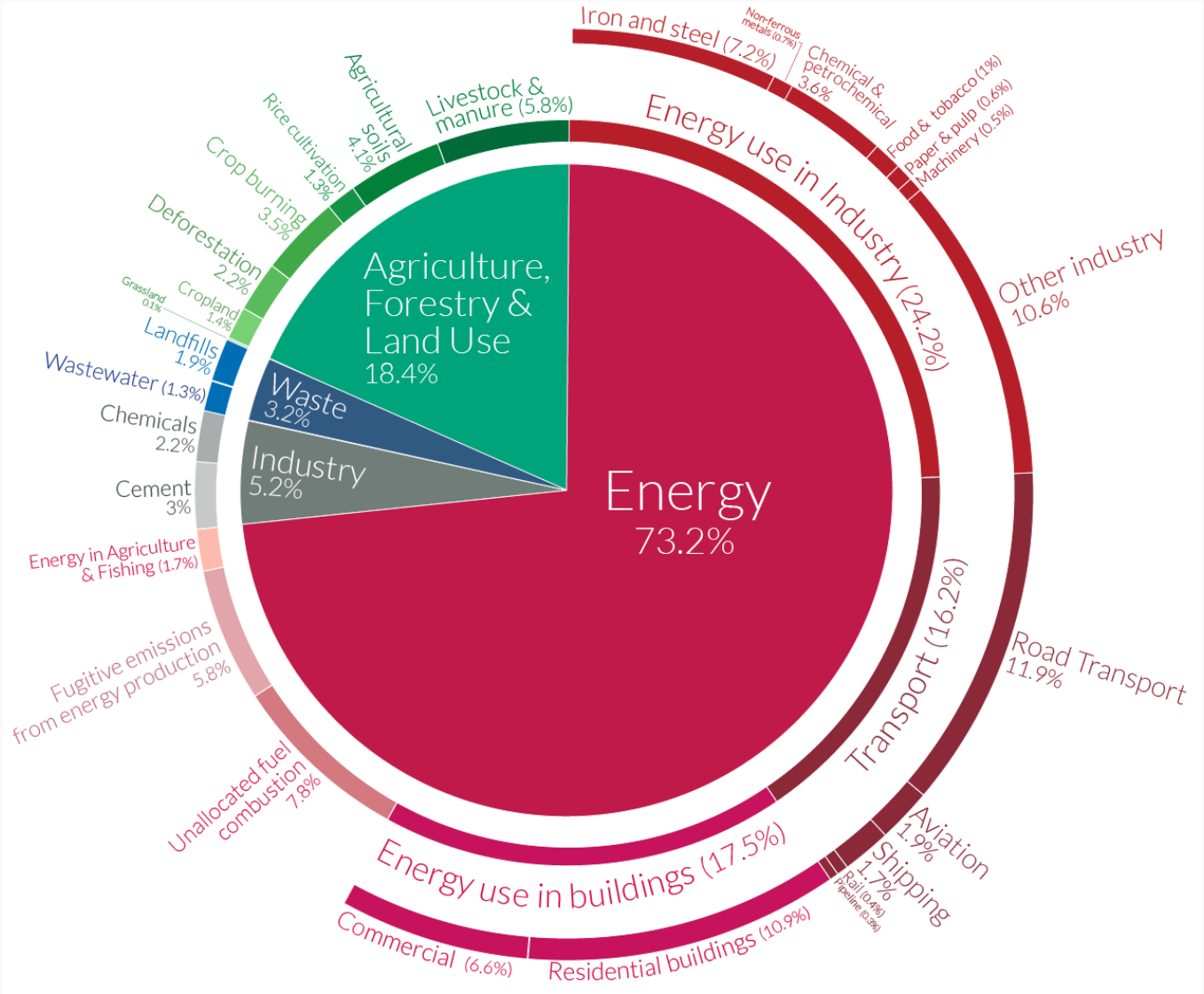
Source: Burke et al. (2018

How have emissions changed in the past?



CO_2 emissions from fossils and cement. Source: Our World in Data

Where do emissions come from?



Global GHG emissions by sector in 2016. Source: Our World in Data

What does this mean for us?

- Human productive activities currently based on fossil fuels
- For some activities, there are alternatives:
  - Electricity: renewable energies
  - Manufacturing: electric arc furnaces; bioplastic
  - Heating/cooking: electrification
  - International transport?
- Costs: these technologies are expensive!
  - Fossil-based technologies often still more convenient
- All of these produce essential intermediate inputs for all other sectors
  - Systemic implications of defossilisation?

The big trade-off

- Two seemingly contrasting objectives
  - Limit chances of disruptive climate-driven impacts
  - Limit chances of prosperity loss due to technological transition
- Two extreme scenarios
  - BAU: we continue with fossil-based technologies $\rightarrow$ climate damages
  - Immediate transition: we stop using fossil fuels today $\rightarrow$ economic disruptions
- Window of opportunity
  - A rapid and smooth transition: is it possible?

First objective of the course

- Understand climate-related risks to economy and finance
  - Drivers
  - Transmission channels
  - Impacts
- Two main blocks:
  - Climate physical risks
  - Transition risks
- Lecture on 16 February

Second objective of the course

- Understand suitable behaviours
  - Multiple choices: consumption, physical investment, financial investment, local policies, societal policies
- Policies and institutions
  - Carbon pricing and beyond; Financial policies
  - Governments, central banks, financial regulators
- Lecture on 19 February

Next lecture

- Tuesday 16 February (same Teams page)
- Please read
  - NGFS, 2019. A call for action: Climate change as a source of financial risk. Network for Greening the Financial System, Paris.
- Find at least one thing you think is missing (or wrong) from their analysis