

Today's Lecture (Lecture 1): Introduction

Reference

Hartmann, Ch. 3

Peixoto and Oort, Ch. 6 (much more detailed than our treatment)

Peixoto and Oort, Sec. 3.1, 3.2, 3.4, 3.5 (in preparation for next week); skip discussion of oceans until one week later

Organization

Lectures Wednesdays 10:00–11:30 vor dem Hospitaltore

Exercises First session on April 18 in the CIP Pool
Wednesdays 12:30–14:00

Slide copies On course web page: <https://home.uni-leipzig.de/jmuelmen/lehre/cd/cd2018.html>, with a link from the Sommersemester page

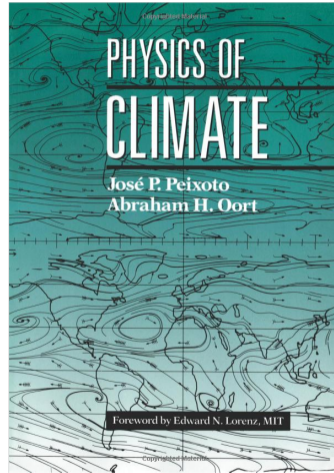
Language Input: de/en, output: en

Miscellaneous Please interrupt with questions! Comments welcome. Also by email:
johannes.muelmenstaedt@uni-leipzig.de

Exams July, by appointment, 30-minute oral exam

Course materials

- ▶ Books available at the library or (ocean) online
- ▶ Papers (occasionally) linked from course web page



1 – Introduction

1. Introduction

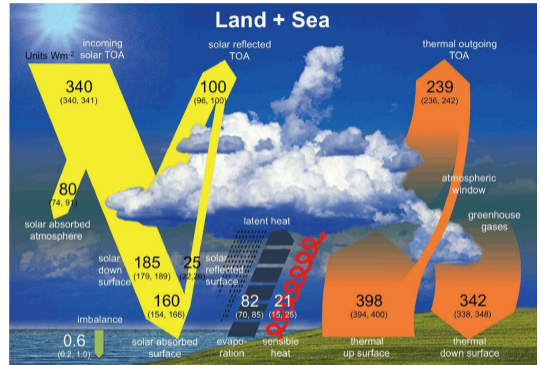
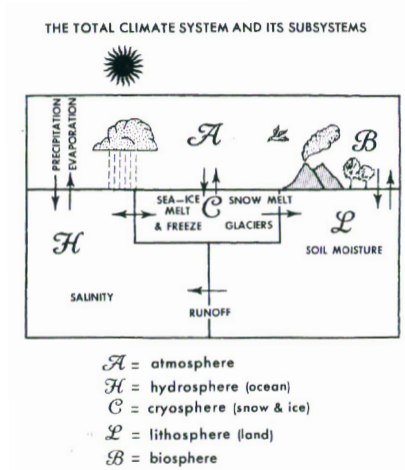
1.1 The climate system

1.2 Internal variability

1.3 Forcing and feedbacks

1.4 Anthropogenic climate change

1.1 – The climate system



Conservation laws are fundamental to our physical understanding of the system

Radiation

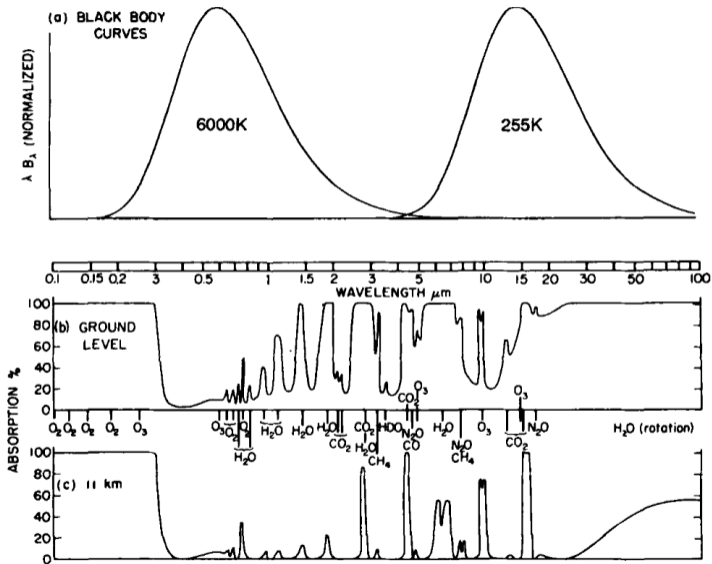
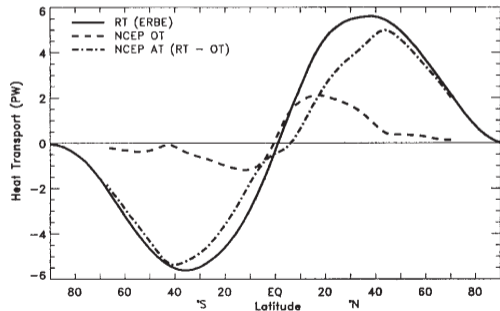
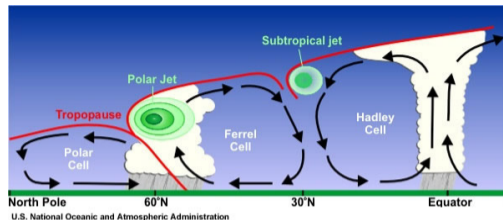


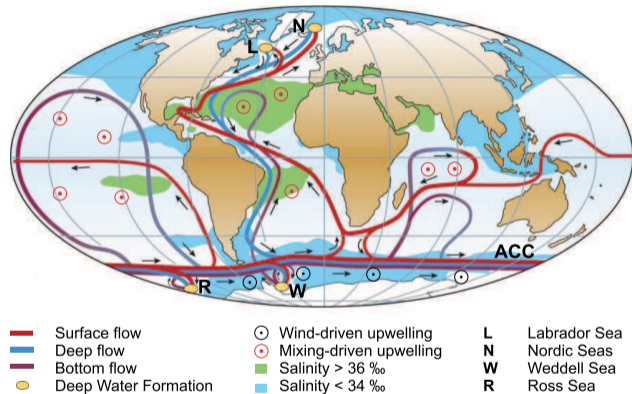
Figure: Goody and Yung (1989)

Atmosphere

- ▶ Primitive equations
- ▶ The role of water vapor, liquid water, ice
- ▶ The role of greenhouse gases
- ▶ The role of aerosols
- ▶ Atmospheric circulation
- ▶ Coupling to land and sea, perturbation response time scales
- ▶ What is the function of the atmosphere in the climate system?



- ▶ Primitive equations
- ▶ The role of salt
- ▶ "Thermohaline" (oceanic) circulation
- ▶ Coupling to atmosphere and cryosphere, perturbation response time scales
- ▶ What is the function of the ocean in the climate system?



Land and cryosphere

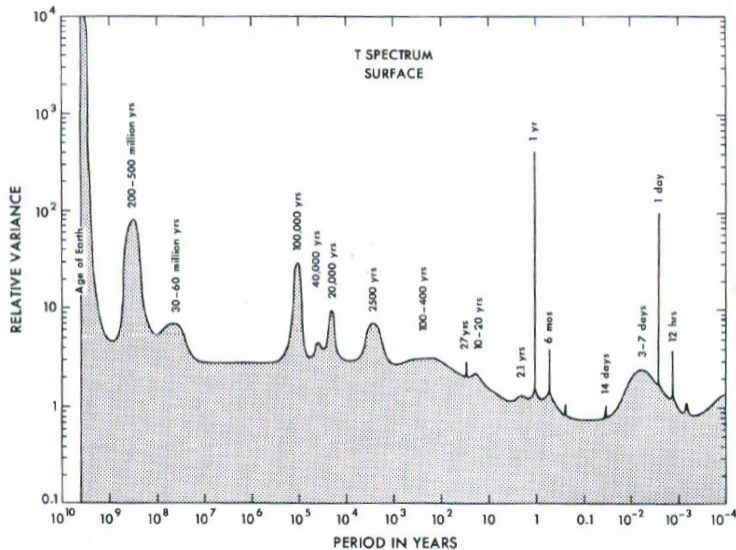
Land (lithosphere and biosphere)

- ▶ Primitive equations? – unknown
- ▶ Time scales from very short (energy cycle, diurnal) to very long (carbon cycle, geologic)

Cryosphere

- ▶ Primitive equations? – unknown
- ▶ Coupling to land, sea, atmosphere
 - ▶ Albedo change
 - ▶ Sea-level rise
 - ▶ Release of permafrost methane
- ▶ Response to perturbation very slow, but can be irreversibly “locked in” far in advance — example of “committed climate change”

1.2 – Internal variability

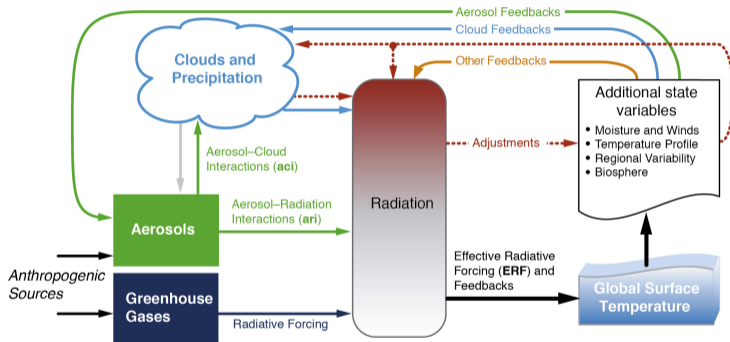


A variety of time scales

- ▶ Mid-latitude storms
- ▶ Madden-Julian oscillation
- ▶ ENSO
- ▶ Teleconnections
- ▶ PDO/NAO/AO

Figure: Peixoto and Oort

1.3 – Forcing and feedbacks



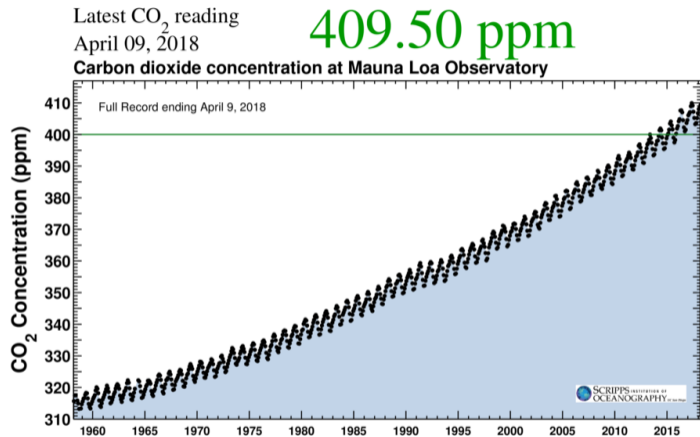
Forcing

- ▶ Natural: solar cycles, orbital cycles, volcanic eruptions, geologic carbon cycle
- ▶ Anthropogenic: greenhouse gases, aerosols, land-use change

Feedbacks

- ▶ “Planck” feedback
- ▶ Water vapor feedback
- ▶ Lapse rate feedback
- ▶ Cloud feedback
- ▶ Ice albedo feedback

1.4 – Anthropogenic climate change – the uncontrolled experiment



- ▶ History
- ▶ Attribution
- ▶ Projections, uncertainties, and the role of models
- ▶ Mitigation, adaptation, geoengineering
- ▶ The scientist/policy-maker dichotomy
- ▶ How to counter denialists?

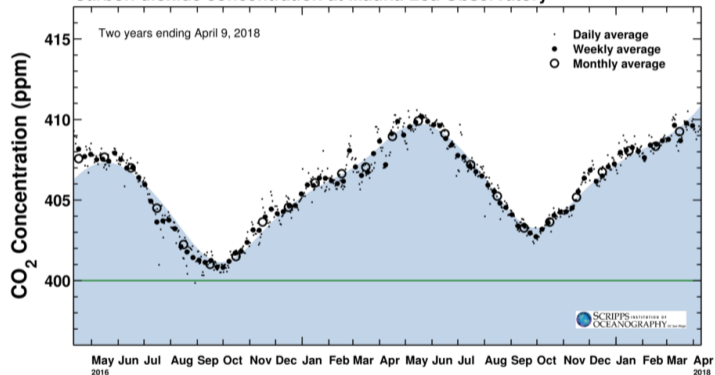
Figure: Scripps CO₂ program

1.4 – Anthropogenic climate change

Latest CO₂ reading
April 09, 2018

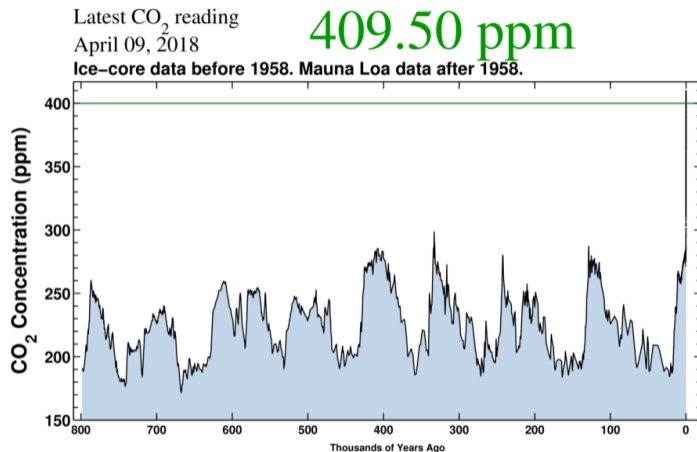
409.50 ppm

Carbon dioxide concentration at Mauna Loa Observatory



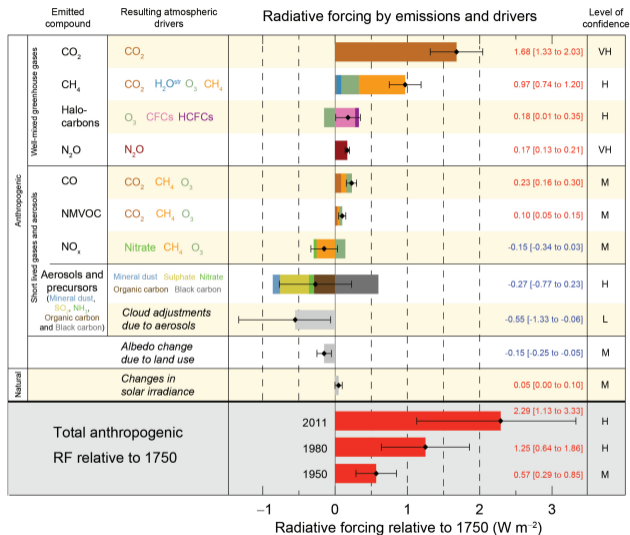
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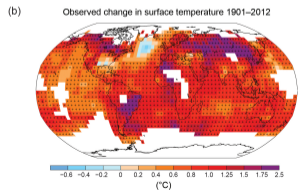
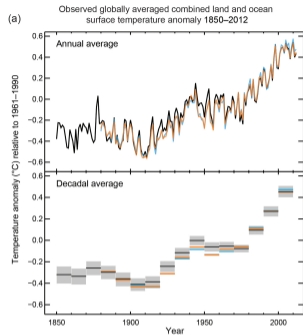
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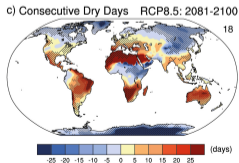
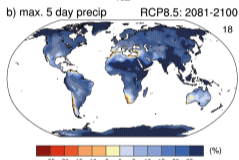
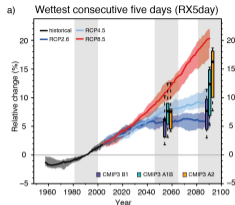
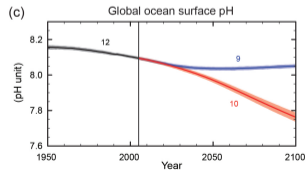
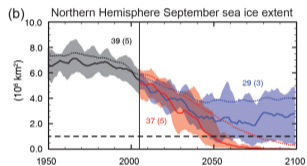
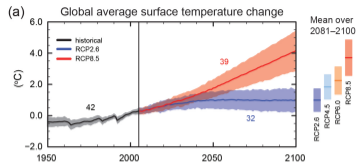
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What you should get out of this course

If you want to work in climate science: Context for your Master's thesis topic

If you want to work in any other area: A general introduction to the climate system

Either way: Respond knowledgeably when friends and family ask you about the climate or climate change

So please ask lots of questions!