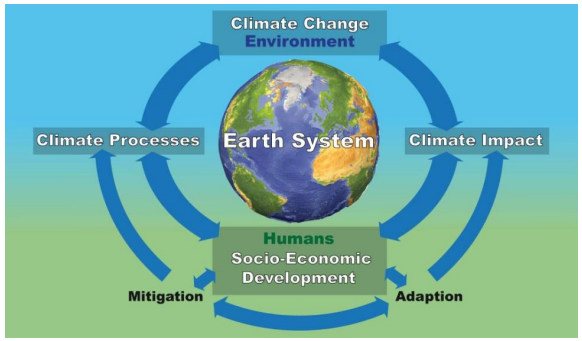
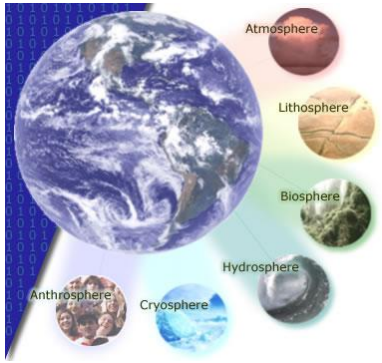
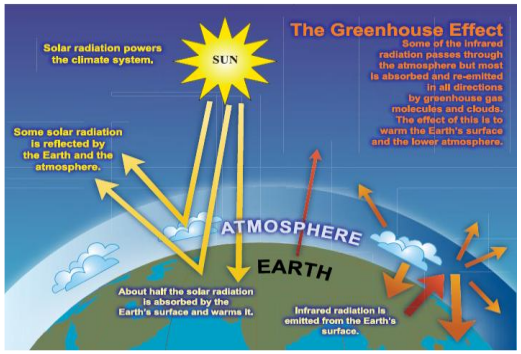
Master Program

Earth and Climate System Science (ECSS)







Dr. Hans-Stefan Bauer (ECSS Coordinator)

Prof. Dr. Volker Wulfmeyer (Head ECSS Master Course)

Planet under pressure: The Anthropocene

Food security and health

Land use (desertification, deforestation)

Population growth

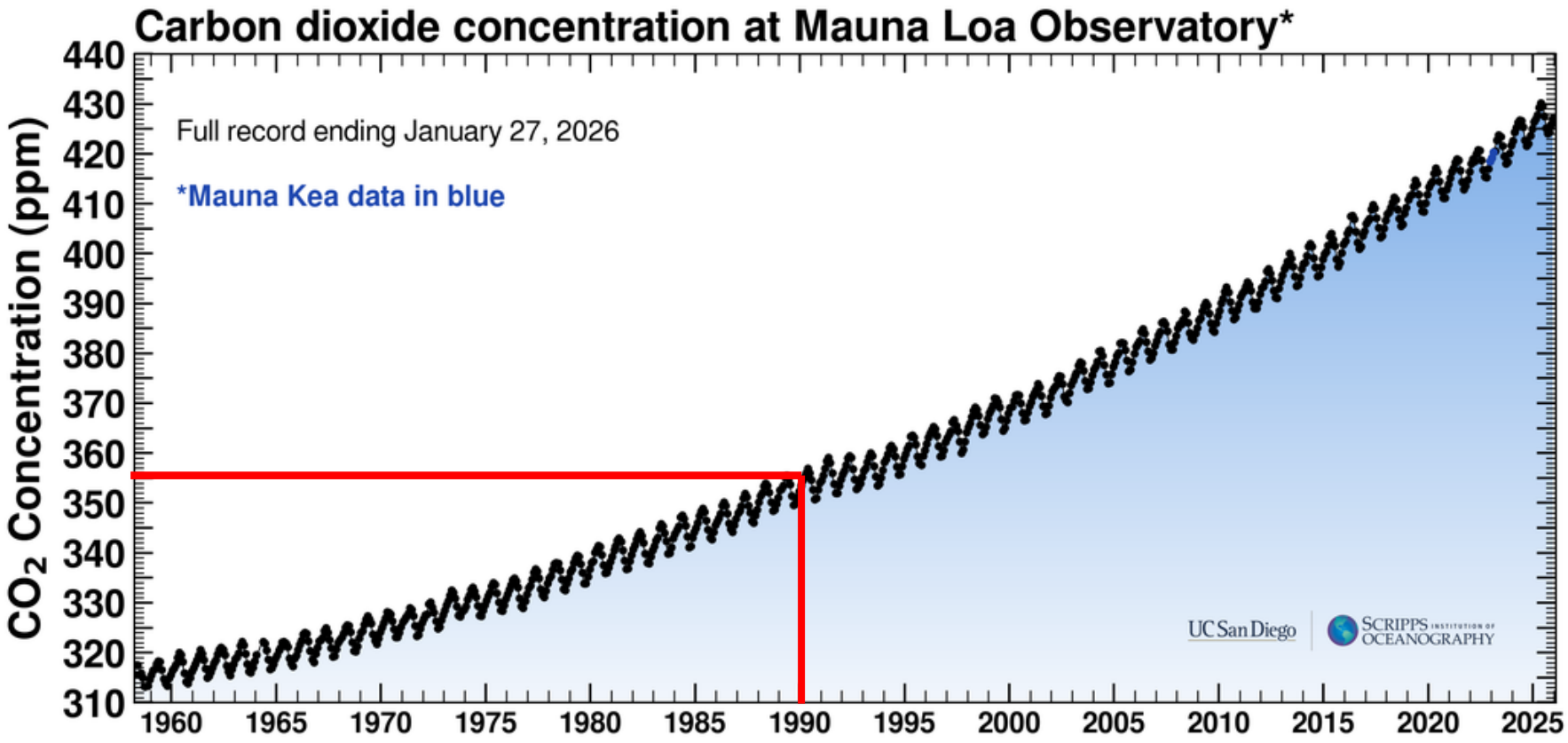
Energy production and demand

Climate variability and change

Socio-economic and political development

Vision: equitable, sustainable development

Climate Change



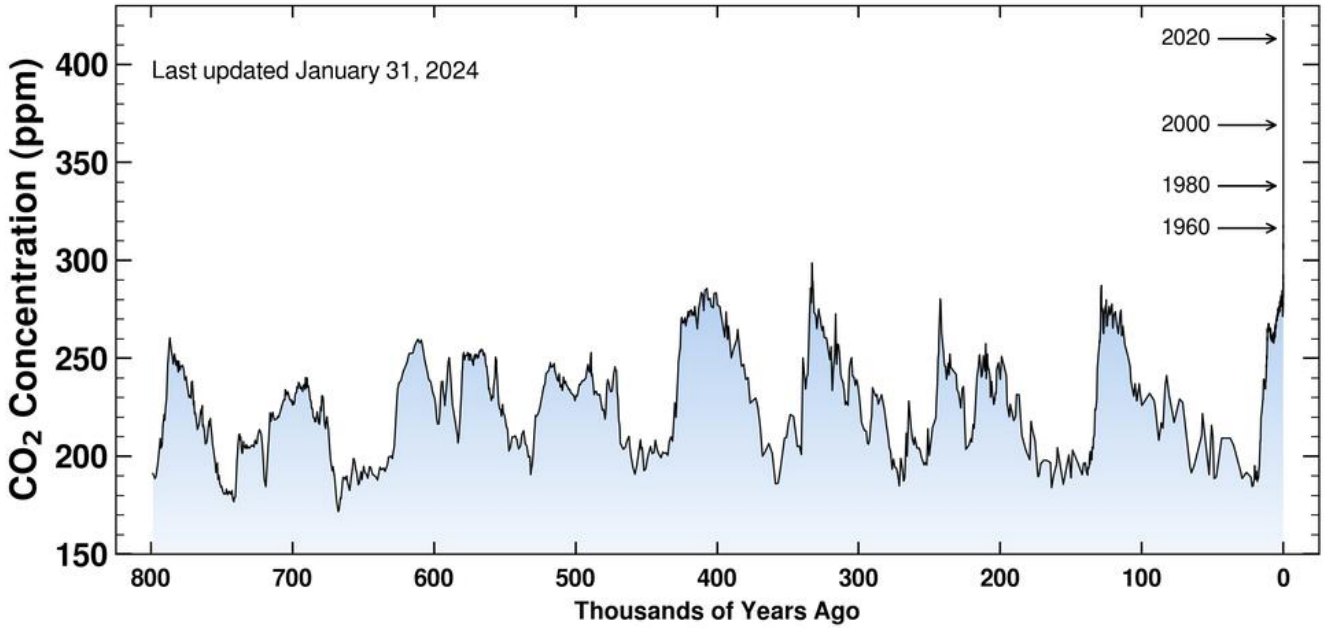
*Latest CO_2 reading: 428.17 ppm

(27.01.2026)

Source: Scripps Institution of Oceanography

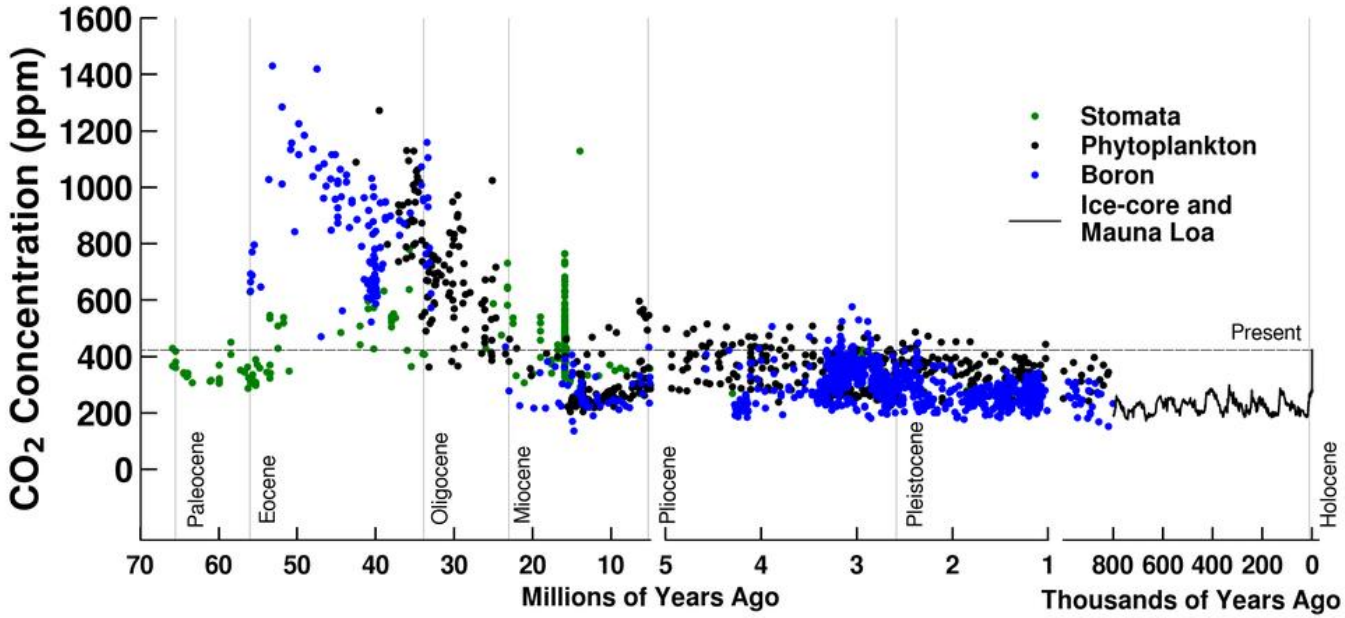
https://scripps.ucsd.edu/bluemoon/co2_400/mlo_full_record.png

https://scripps.ucsd.edu/programs/keelingcurve/



Inclusion of gas analyses from ice cores.

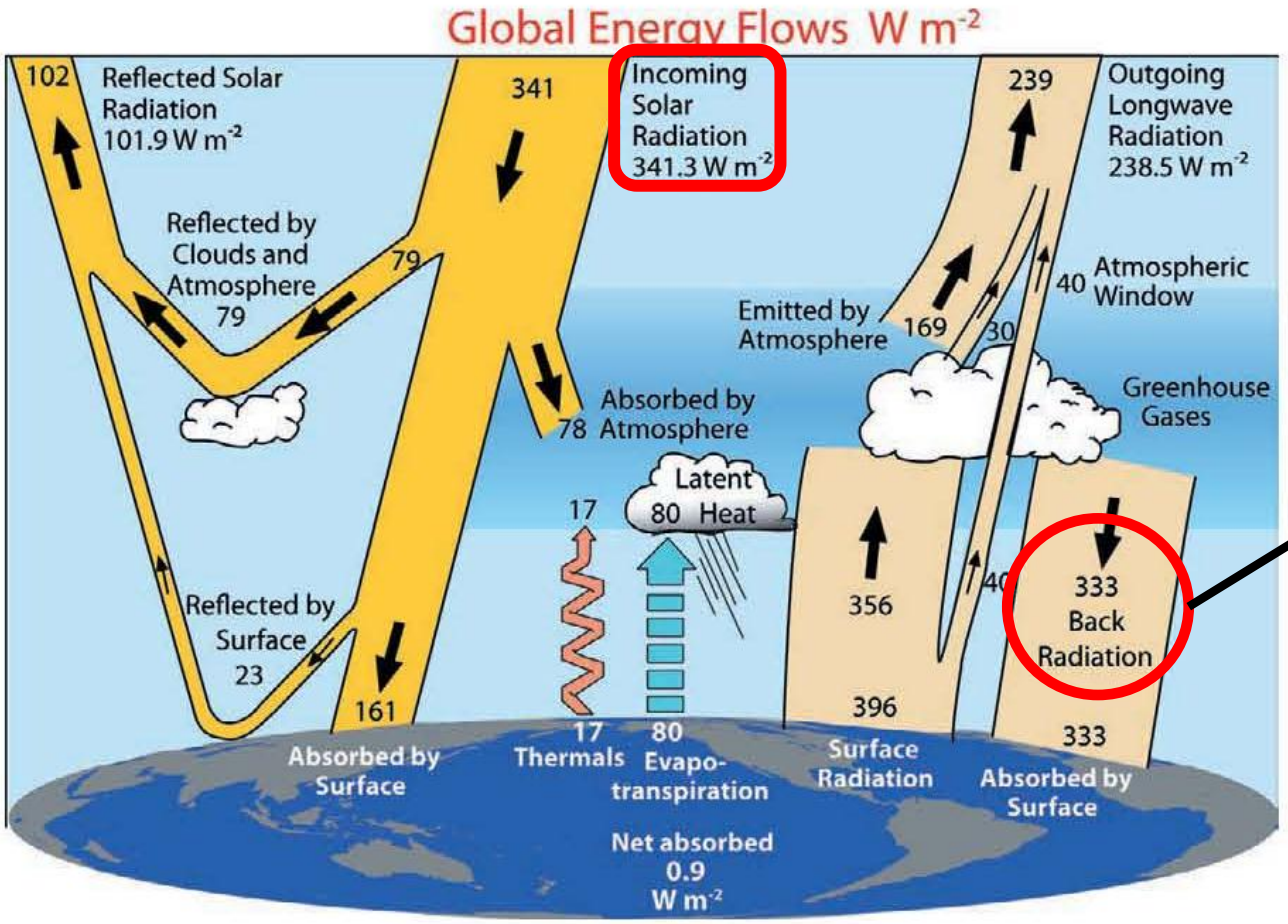
The latest ice core from Antarctica contains information from 1.2 Mio years.



Inclusion of analyses from ocean sediments.

Todays values occured for the last time more than 1 millon years ago.

The Global Energy Budget

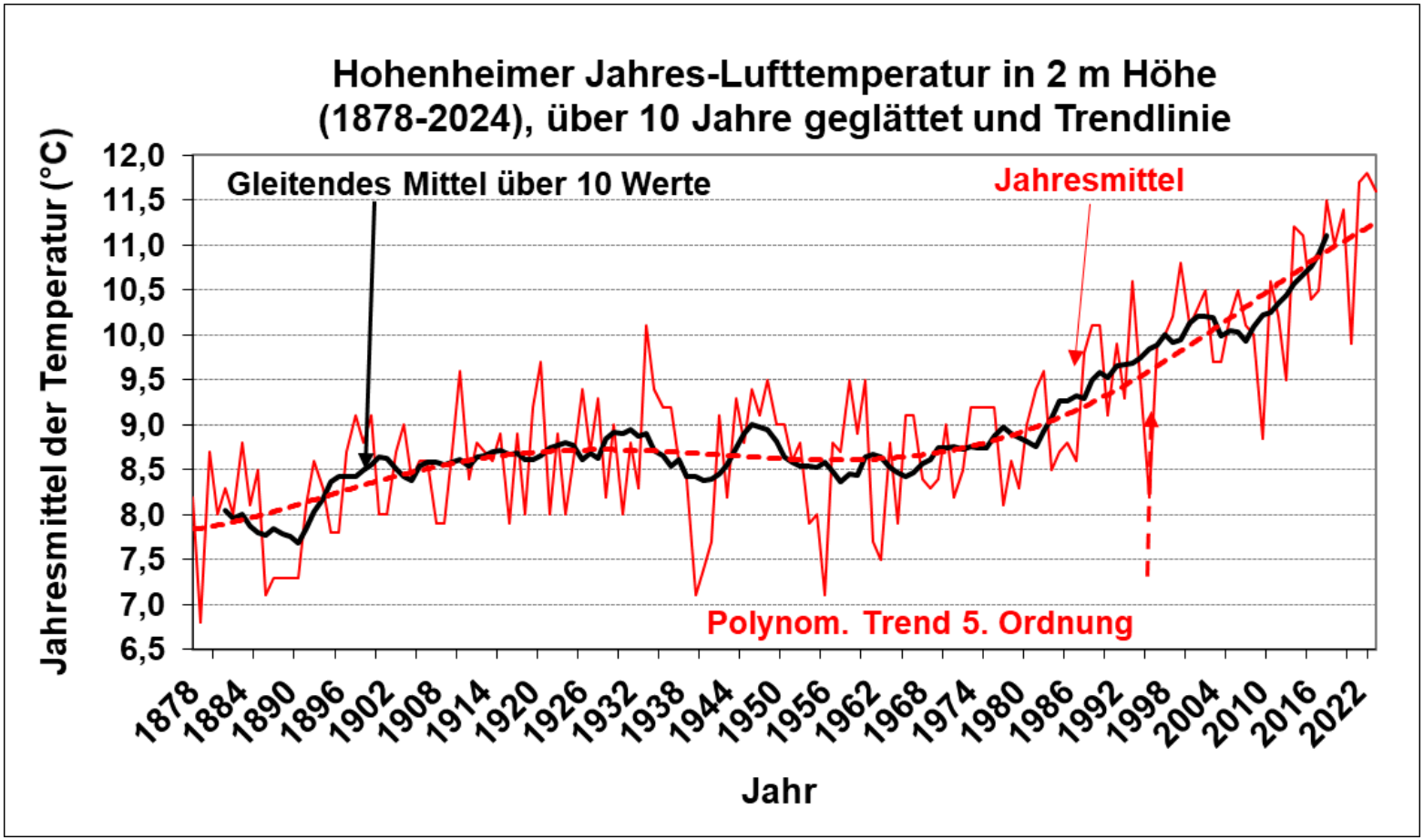


Greenhouse gases increase this Flux.

FIG. 1. The global annual mean Earth's energy budget for the Mar 2000 to May 2004 period (W m^{-2}). The broad arrows indicate the schematic flow of energy in proportion to their importance.

Source: Trenberth et al. BAMS 2009

University of Hohenheim Climate Station

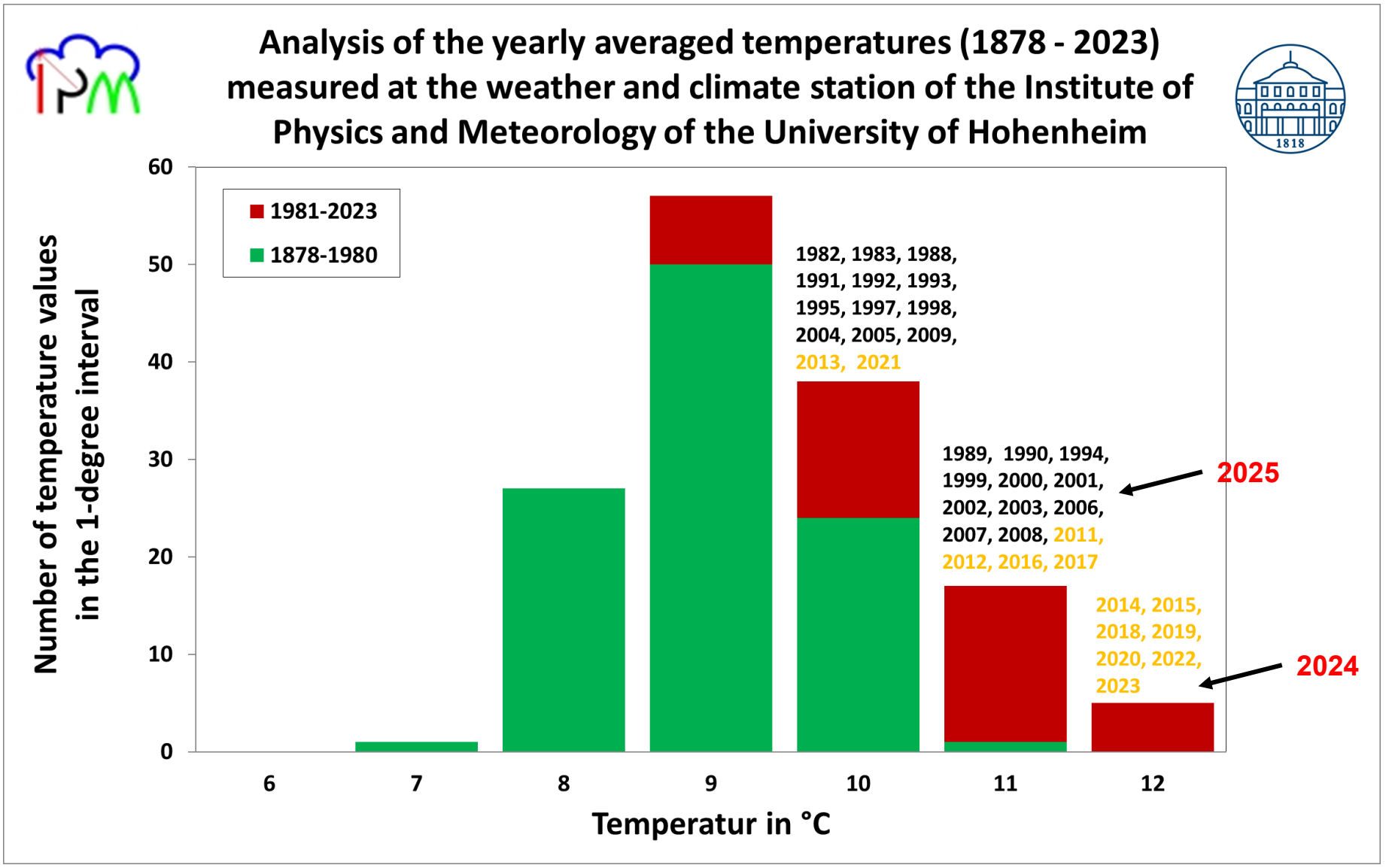


2022: 11.7 C
2023: 11.8 C
2024: 11.6 C

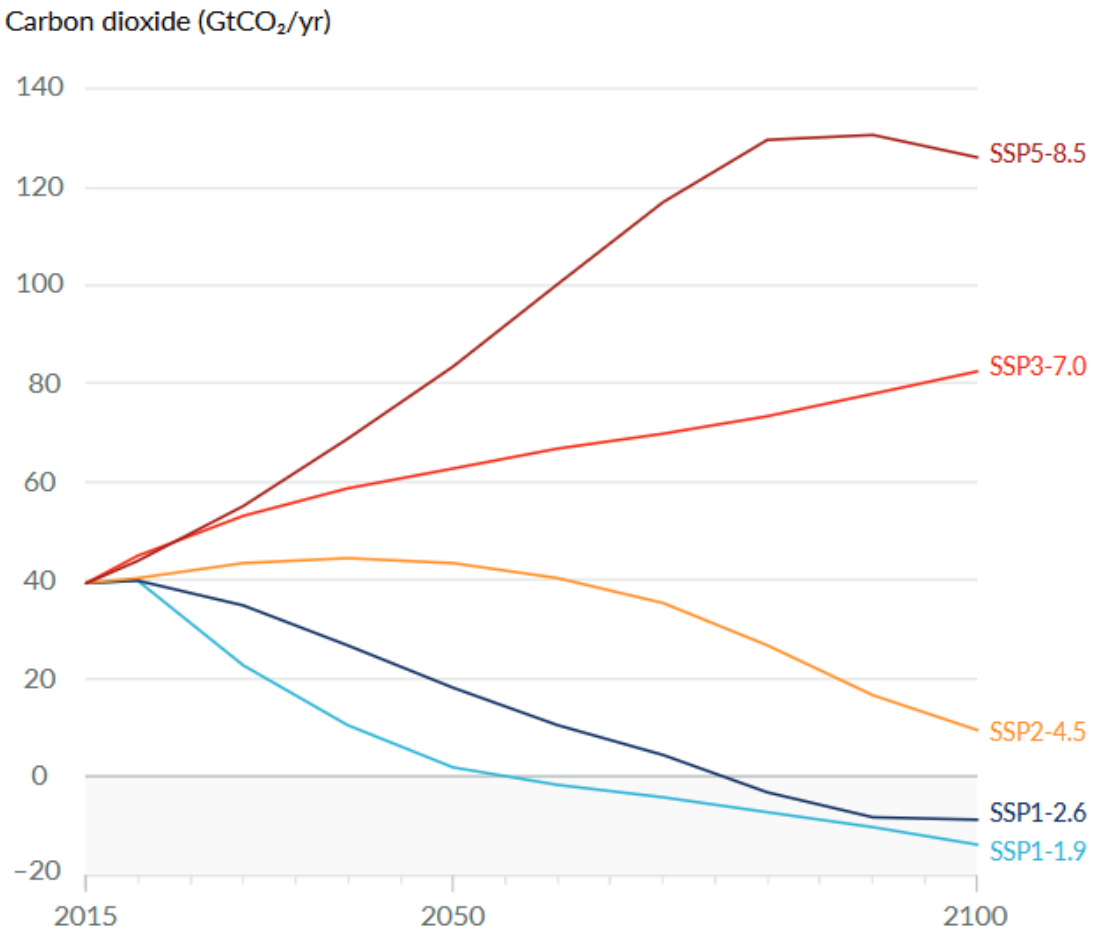
2025: 11.0 C

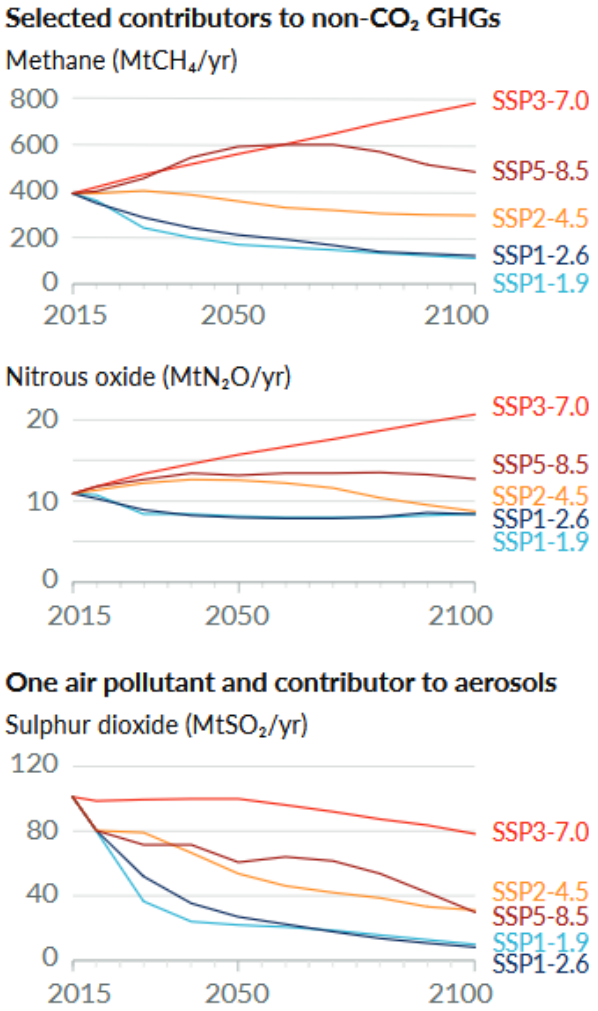
Already <u>2.5 K</u> temperature increase at this continental site between mid 20th century and today! (~3 K since the beginning of the recording).

Frequency distribution of annual mean temperatures



Emission scenarios in Climate Projections



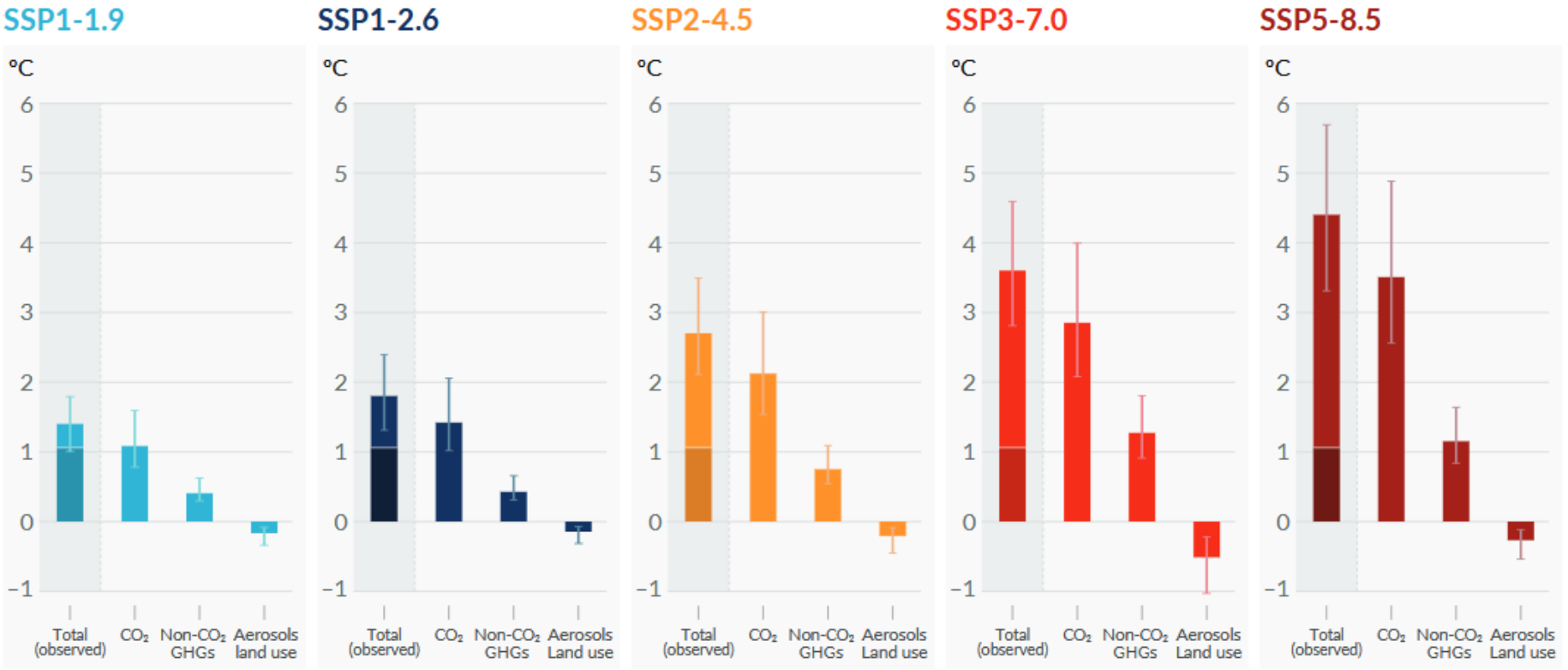


Source: IPCC Assessment report 6, 2022

Reaction of the global near surface temperature

(b) Contribution to global surface temperature increase from different emissions, with a dominant role of CO_2 emissions

Change in global surface temperature in 2081–2100 relative to 1850–1900 (°C)



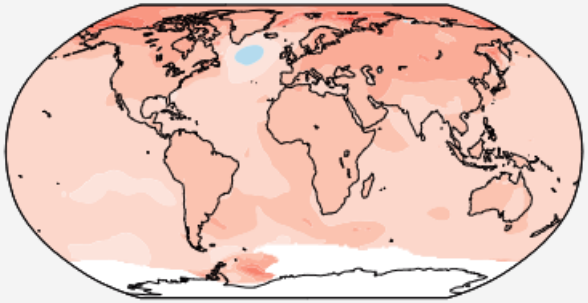
Source: IPCC Assessment report 6, 2022

UNIVERSITÄT HOHENHEIM

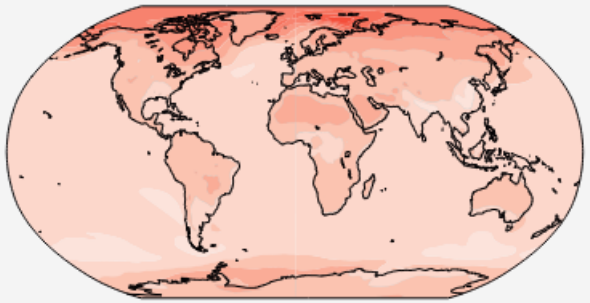
(a) Annual mean temperature change (°C) at 1°C global warming

Warming at 1°C affects all continents and is generally larger over land than over the oceans in both observations and models. Across most regions, observed and simulated patterns are consistent.

Observed change per **1°C** global warming



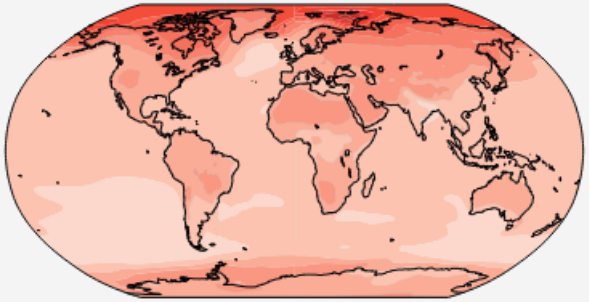
Simulated change at **1°C** global warming



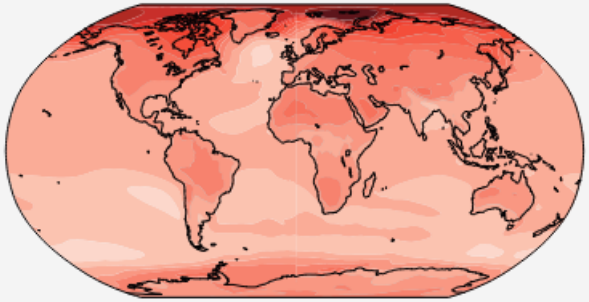
(b) Annual mean temperature change (°C) relative to 1850–1900

Across warming levels, land areas warm more than ocean areas, and the Arctic and Antarctica warm more than the tropics.

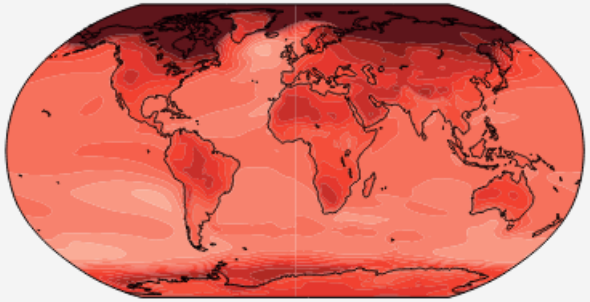
Simulated change at **1.5°C** global warming

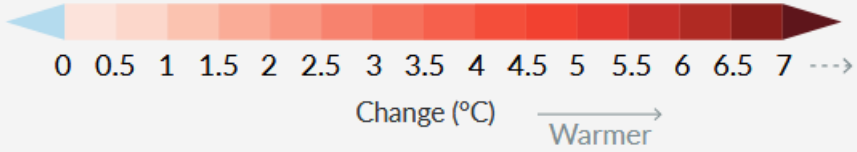


Simulated change at **2°C** global warming



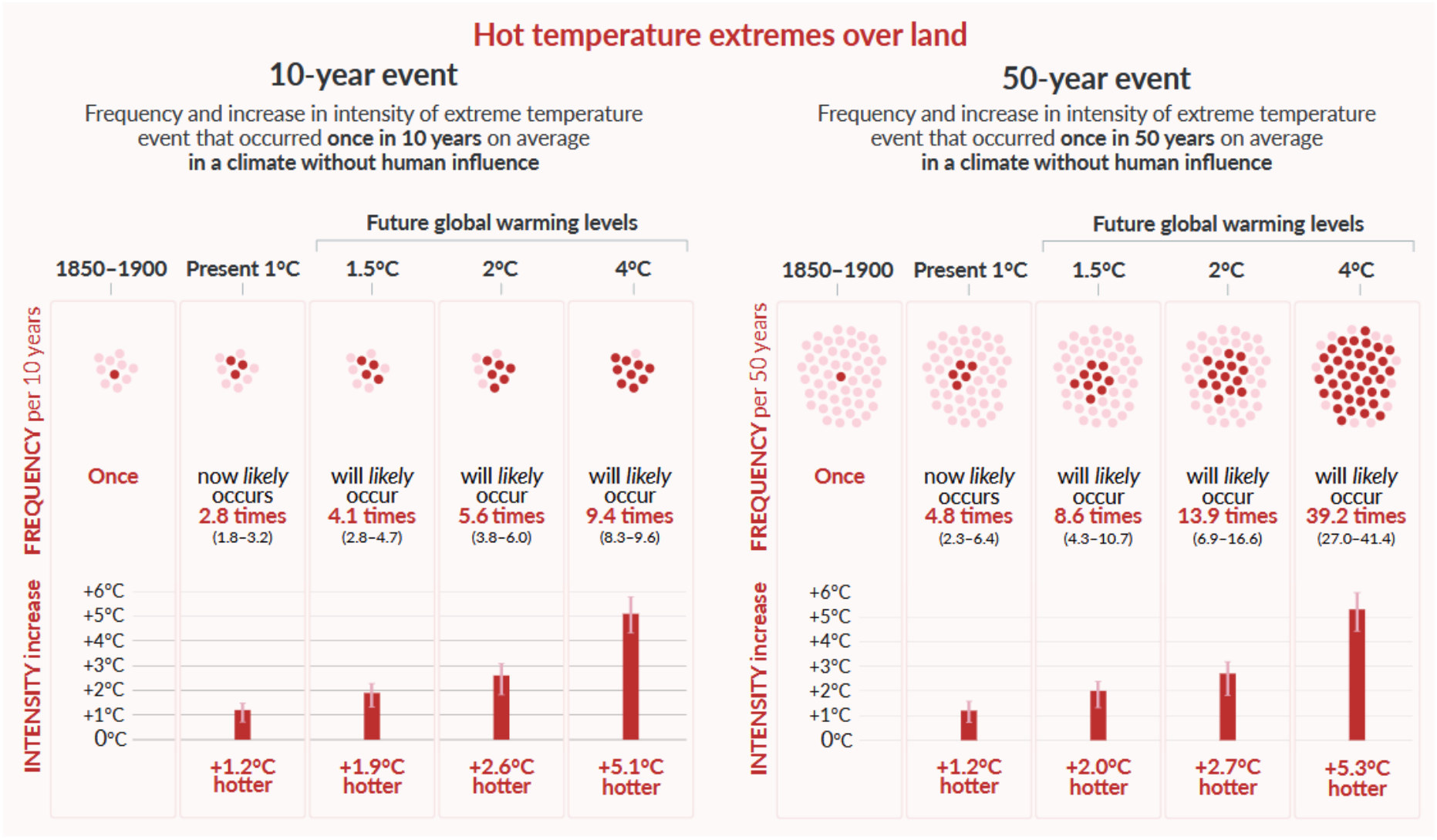
Simulated change at **4°C** global warming





Source: IPCC Assessment report 6, 2022

UNIVERSITÄT HOHENHEIM



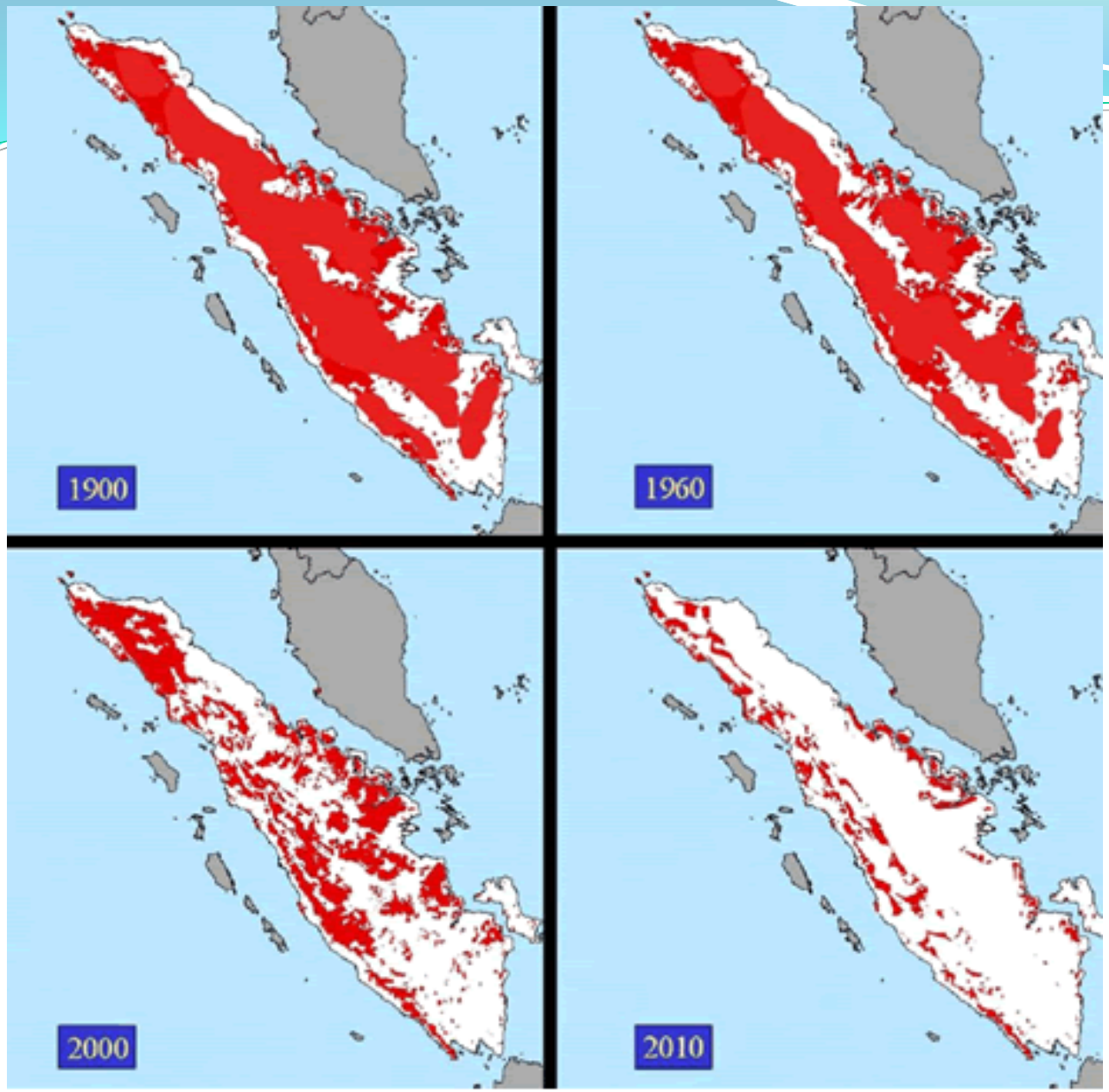
Source: IPCC Assessment report 6, 2022

Important: Those changes in temperature and precipitation amount and distributipon effect almost everything in our daily life – and those consequences become clearer and clearer …

- Ocean level rise
- Distribution of tropical diseases
- Changes needed in agriculture and forestry
- Changes and reduction of biodiversity
- Increase of extreme events – both severe precipitation and droughts
- Increased bush and forest fire thread (even in regions where more precipitation is predicted).
- …

Here you see the strong connection and interdisciplinarity of the offered master course.

In addition, human made changes worsen the problem …



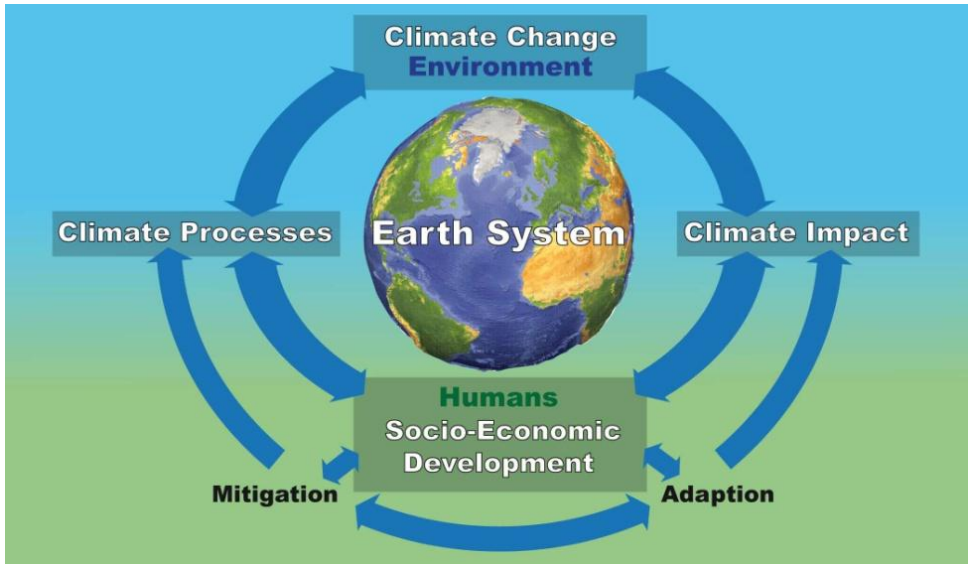
Loss of tropical rain forest in Indonesia between 1900 and 2010.

Red_ areas covered by tropical rain forest.

In addition to the oceans, tropical rain forest is a major CO_2 sink in the Earth System.

Aim of the master course

“Earth and Climate System Sciences (ECSS)”



- **Analyze and evaluate the state of the Earth system**
- **Understand the interaction and feedbacks between the system components**
- **Simulate subcomponents of this system**
- **…**

Web: https://www.uni-hohenheim.de/en/earth-and-climate-system-science-masters
https://earthsystem.uni-hohenheim.de/en

Social Media: https://www.linkedin.com/company/earth-and-climate-system-science
https://www.instagram.com/unihohenheim_master.climate

Requirements

- Interest in natural sciences
- Interest in agriculture and economics
- Interdisciplinary thinking
- Transdisciplinary communication and collaboration
- Basic knowledge in physics and mathematics
- Basic knowledge in English
  - Either certified, e.g. B2 level, TOEFL test, …
  - Or finished English bachelor
  - Or application from a country where English is an official language (e.g. U.K, USA, Australia, New Zealand, …)

Curriculum

Strong thematic interaction between modules.

	6 credits	12 credits	18 credits	24 credits	30 credits	
1st sem.	Lecture Series Earth System Science (1201-550)	Mathematics and Computational Sciences of the Earth System (1201-610)	Sustainability (5206-270)	Weather and Climate Physics (1201-580)	Chemistry of the Earth System & Pollution (1301-460)	Ecosystems and Biodiversity (2101-500)	1st sem.
2nd sem.	Climate History and Evolution of the Earth System (1201-560)	Energy and Water Regime at the Land Surface (3103-500)	Debate Seminar (1201-570)	Measurement, Modeling and Data Assimilation (1201-520)	Elective Module	Elective Module	2nd sem.
3rd sem.	**Elective Module**	Elective Module	Elective Module	Elective Module	Elective Module	Elective Module	3rd sem.
4th sem.	Master's Thesis Earth and Climate System Science (1200-500)						4th sem.

Examples for offered elective modules in Hohenheim:

- Special Topics of Earth and Climate System Science
- Remote Sensing of the Earth System
- Agricultural and Forest Meteorology
- Measurement, Modelling and Data Assimilation II
- Spatial Data Analysis with geographic information systems (GIS)
- Statistics for Natural Sciences
- Global Change Issues
- Ecotoxicology and Environmental Analytics
- Poverty and Development Strategies
- …

You can select modules related to different specializations as:

- Earth System Processes and Simulation
- Agroecosystems and Food Security
- Sustainability and Environmental Resources

Profiles

Earth System Processes - Observation and Simulation	
Winter Term	**Summer Term**
Measurements, Modeling, Data Assimilation II (1201-530)	Mathematics and Computer Sciences of the Earth Sciences II (1102-410)
Agricultural and Forest Meteorology (1201-590)	Remote Sensing of the Earth Sciences (1201-500)
Practical Introduction to Programming with Pytrhon (1511-500)	Special Topics on Earth System Sciences (1201-620)
Einführung in die künstliche Intelligenz (4407-440)	Introduction to Data Sciences with R/RStudio
Image Analysis with Deep Learning (4407-520)	Introduction to Machine Learning in Python (4407-480)
Landscape Ecology (3201-560)	Environmental Pollution and Soil Organisms (3102-440)
Plant Ecology (3202-440)	Vegetation and Soils of Central Europe (3201-620)
Methods in Landscape and Plant Ecology (3201-420)	Field Course: Soils and Vegetation (3101-570)
Spatial Data Analysis with GIS (3103-450)	Combining Ecological Models and Data (3201-590)
Environmental and Ecological Statistics (3402-480)	The role of the lanf surface in the Earth system
Community and Evolutionary Ecology (3201-570)	

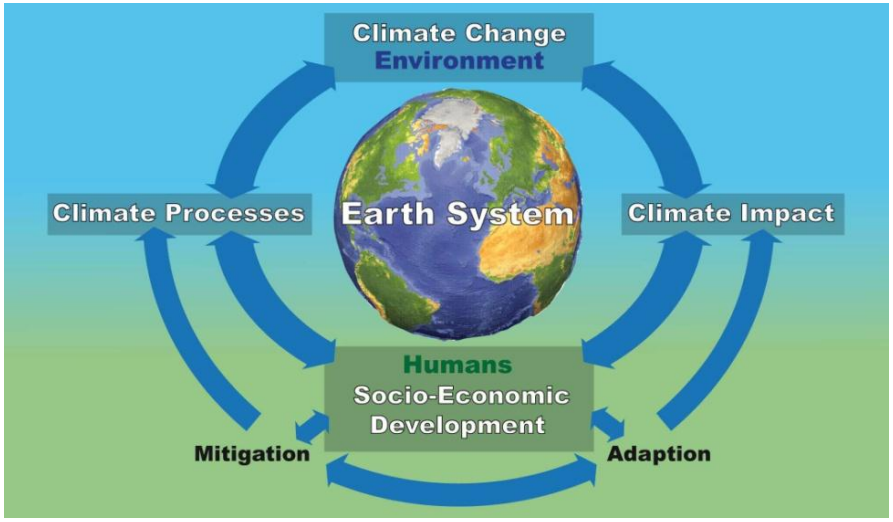
Sustainability and Environmental Resources	
Winter Term	**Summer Term**
Poverty and Development Strategies (4901-420)	Environmental and Resource Economics (4101-410)
Quantitative Methods in Economics (4901-470)	Renewable Energy for Rural Areas (4403-470)
Economics and Environmental Policy (4902-440)	Farm Economics and Strategic Management in the Bioeconomy (4101-430)
Land Use Economics (4904-430)	Economic Policy Analysis of the Bioeconomy (5213-510)
Natural Resource Use and Conservation in the Tropics and Subtropics (4907-410)	Innovations for Sustainable Agri-Food Systems (4903-510)
Policy Processes in Agricultural and Natural Resources Management (4903-500)	Financial Management (5101-590)
Analyzing Sustainability in Agri-Food Systems (4303-410)	
Environmental and Ecological Statistics (3402-480)	
Advanced Policy Analysis Modeling (4204-420)	
Governance of Sustainable Agri-Food Systems (4903-521)	

Agroecosystems and Food Security	
Winter Term	**Summer Term**
Plant and Crop Modeling (with exercises) (3103-410)	Projects in Soil Sciences (3102-420)
Plant Symbiosis for Nutrient Acquisition (3408-450)	Precision Farming (4404-520)
Plant Quality (3408-460)	Agroforestry Systems in Central Europe (3090-480)
Ethical Reflection on Food and Agriculture (4302-420)	Processing and Quality of Organic Food (3090-430)
Global Agri-food Systems: Conventional Organic and Beyond (4302-460)	Agricultural and Food Policy (4201-410)
Microbiological Safety within the Feed and Food Production (4605-430)	Artificial Intelligence for Agriculture (4407-470)
Ecology and Agroecosystems (4906-410)	Integrated Agricultural Production Systems (4905-430)
Organic Farming in the Tropics and Subtropics (3090-411)	Crop Production Effecting the Hydrological Cycle (4907-430)
Organic Agriculture in Europe (3090-490)	Plant Ecology of Cultural Landscapes (3202-460)
Irrigation and Drainage Technology (4403-440)	
Crop Production Systems (4905-420)	
Transformation Studies in Agri-Food Systems (4302-500)	
Ecology of Alien Invasive Plants and Weeds (3201-440)	
Food and Nutrition Security (4902-430)	
Organic Food Systems and Concepts (3090-440)	
Einführung in die künstliche Intelligenz (4407-440)	
Intelligente Robotik für die Landwirtschaft (4407-510)	
Farm System Modeling (4904-470)	

In addition, you can use the third semester to study at a different University (in Germany or abroad) or do an intership in e.g. a company.

Earth and Climate System Science at the University of Hohenheim:

https://www.uni-hohenheim.de/en/earth-and-climate-system-science-masters



Adapted from 4AR IPCC

In a transdisciplinary context, the students know the forces driving the state and changes in the Earth system.

They are capable of analyzing and predicting system changes and feedback mechanisms.

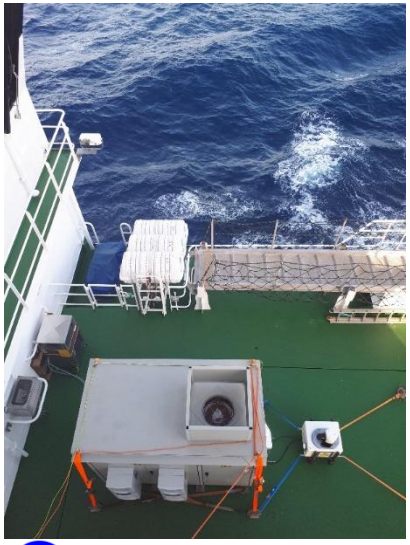
They are able to present these results to the public and to advise decision makers.

Full English course.

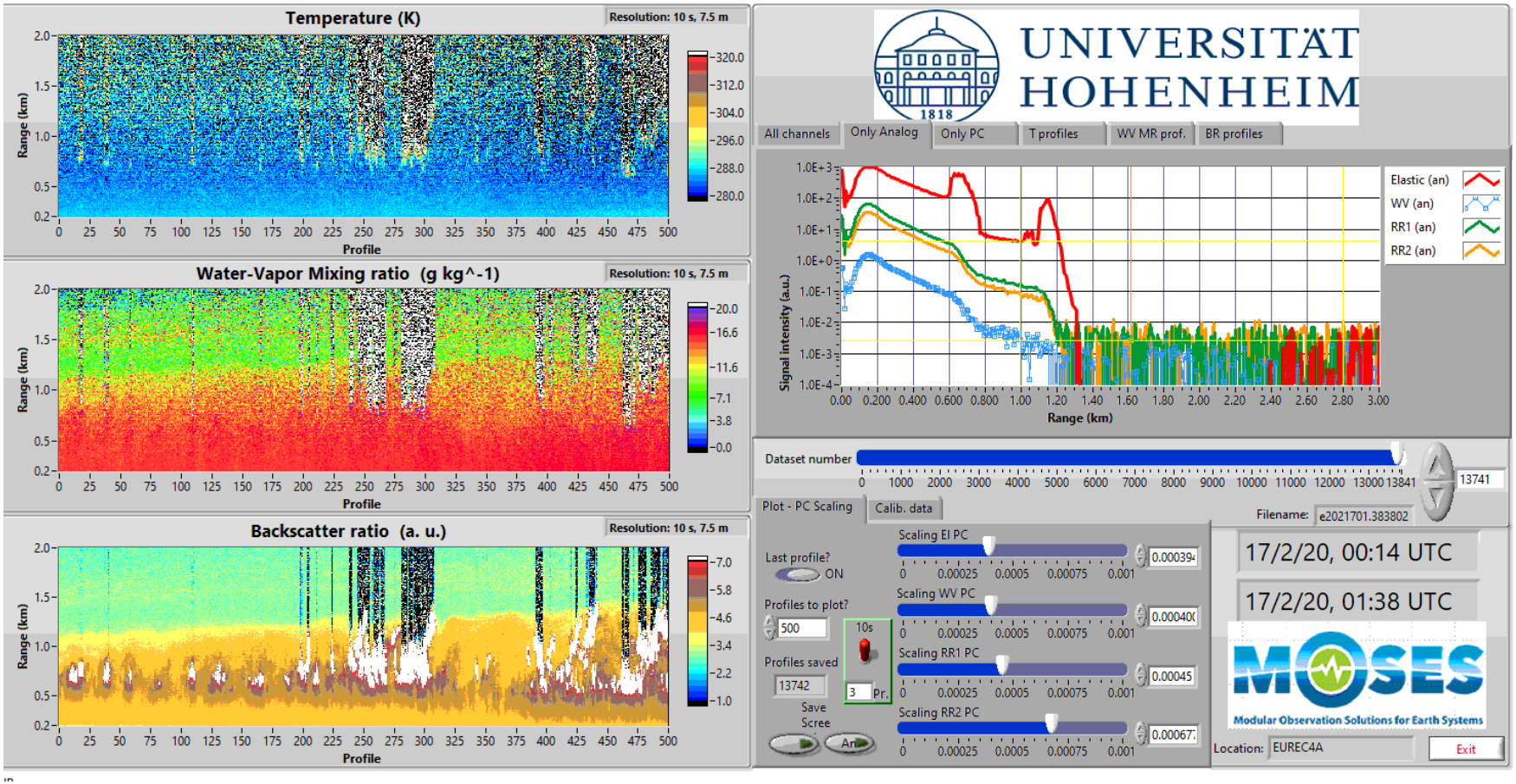
Highlights:

- **Transdisciplinary teaching of all faculties**
- **Operation and analyses of regional weather and climate models**
- **Application of remote sensing for Earth System observations**
- **Field work**

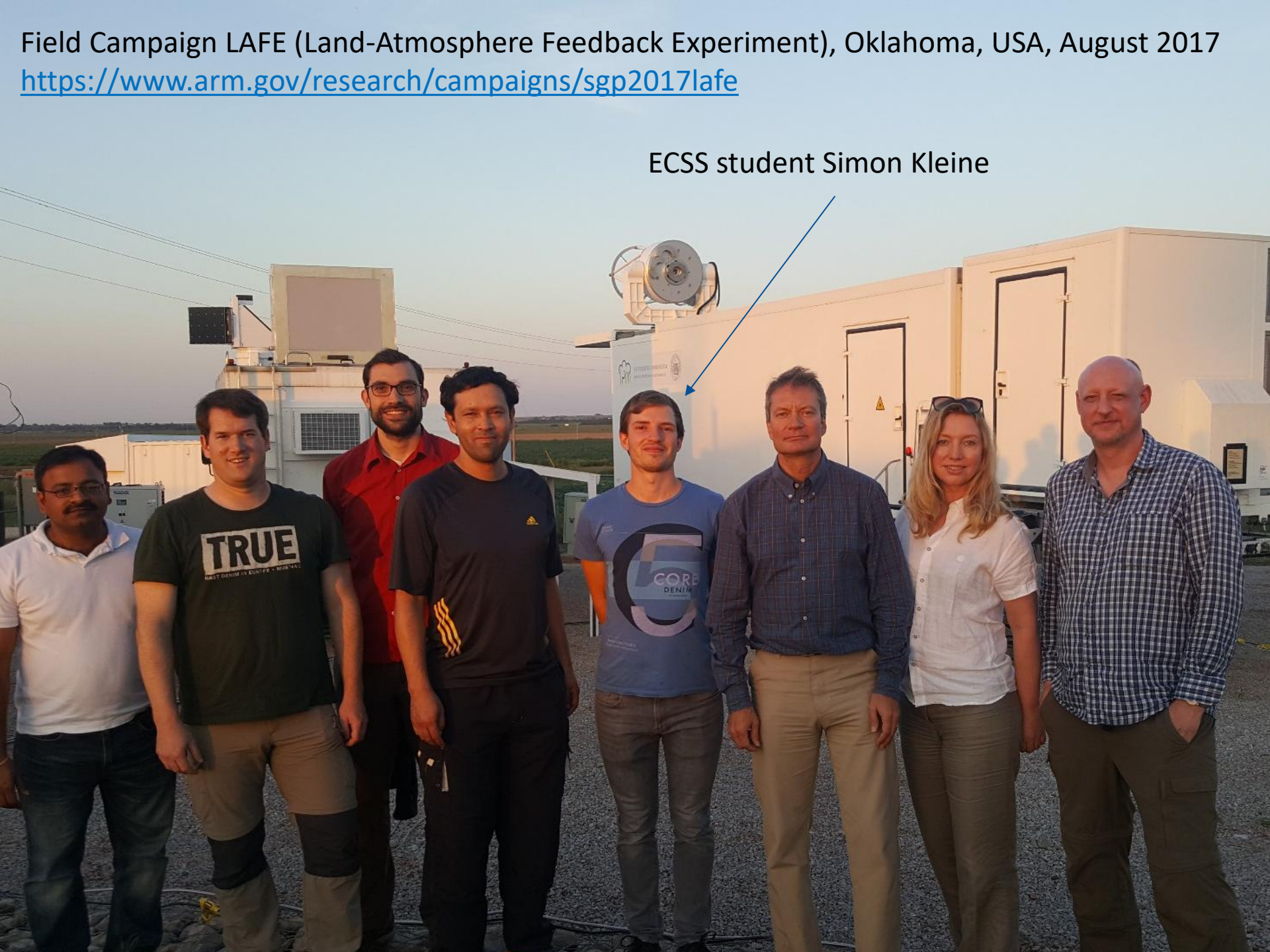
IPM Lidar Systems on the Research Vessel Merian south-east of Barbados, European-US-American Campaign EUREC4A, January-February 2020



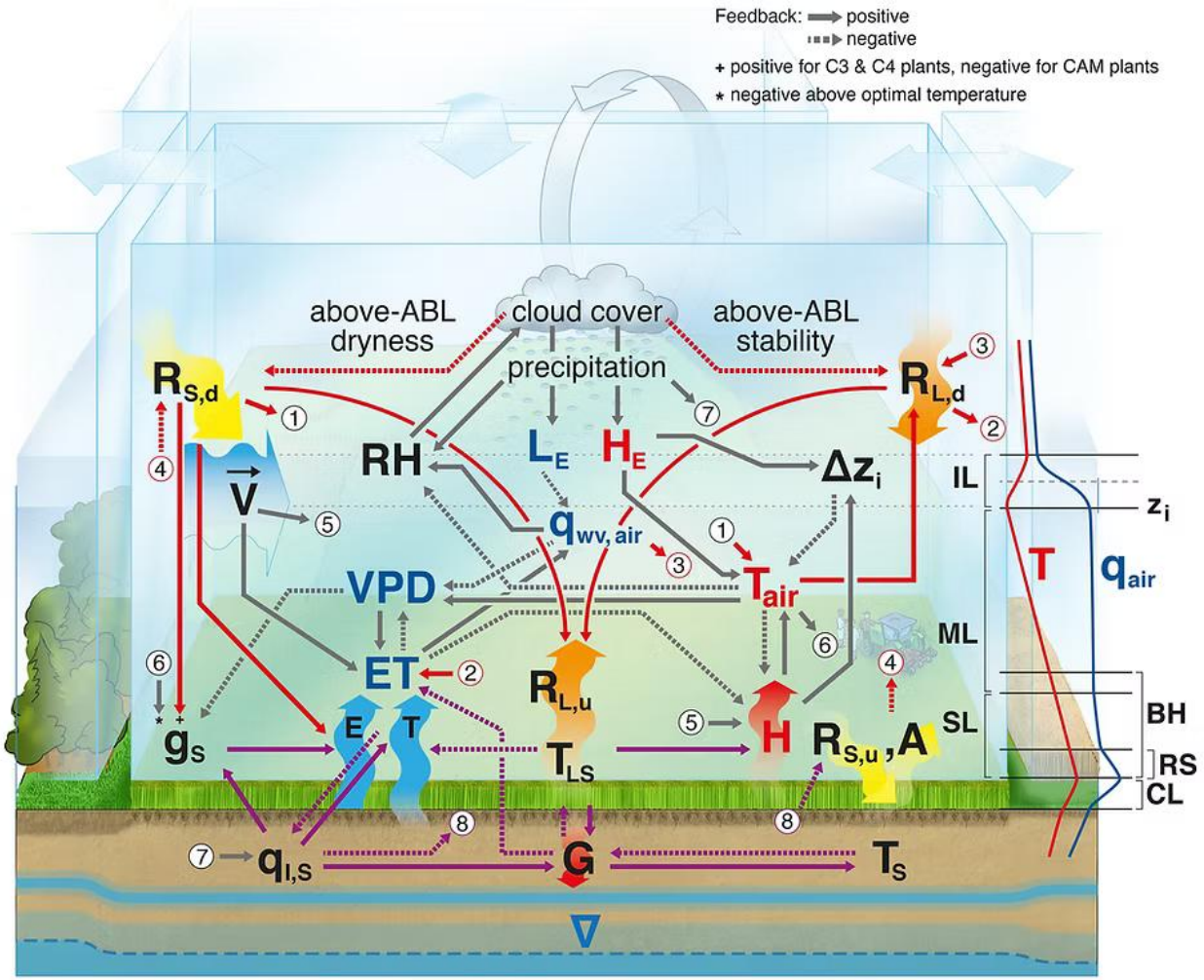
IPM Lidar Systems on the Research Vessel Merian south-east of Barbados , european-US-american Campaign EUREC4A, January-February 2020



Field Campaign LAFE (Land-Atmosphere Feedback Experiment), Oklahoma, USA, August 2017
https://www.arm.gov/research/campaigns/sgp2017lafe



Land Atmosphere Feedback Initiative (LAFI)



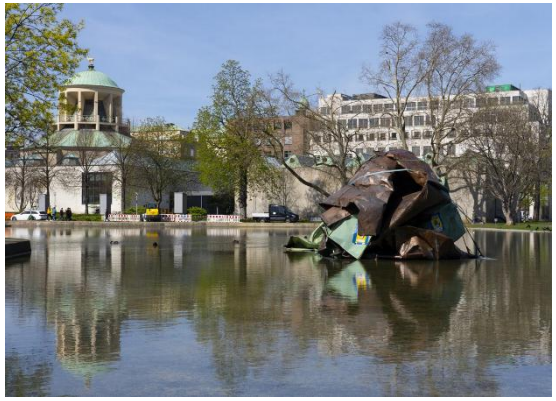
New research group founded by the German Research Foundation.

Aim is to investigate in detail the processes occurring at the land surface and ist interaction with the atmosphere above.

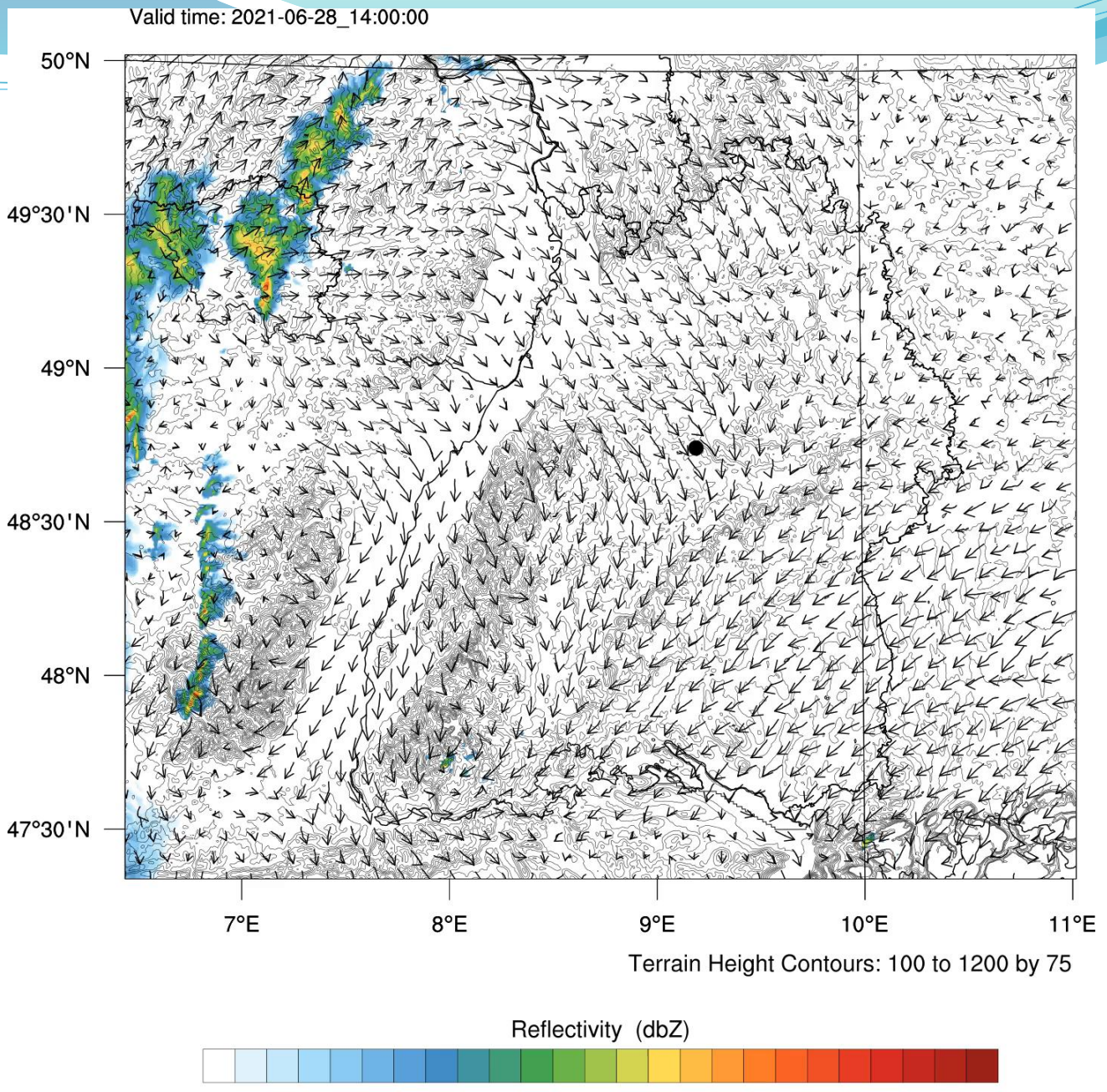
The Figure illustrates the complex interactions between the land surface and the overlying atmosphere

https://www.lafi-dfg.de/

UNIVERSITÄT HOHENHEIM



Parts of the roof of the Opera house were blown down.



Earth and Climate System Science at the University of Hohenheim:

https://www.uni-hohenheim.de/en/earth-and-climate-system-science-masters

Career Options:

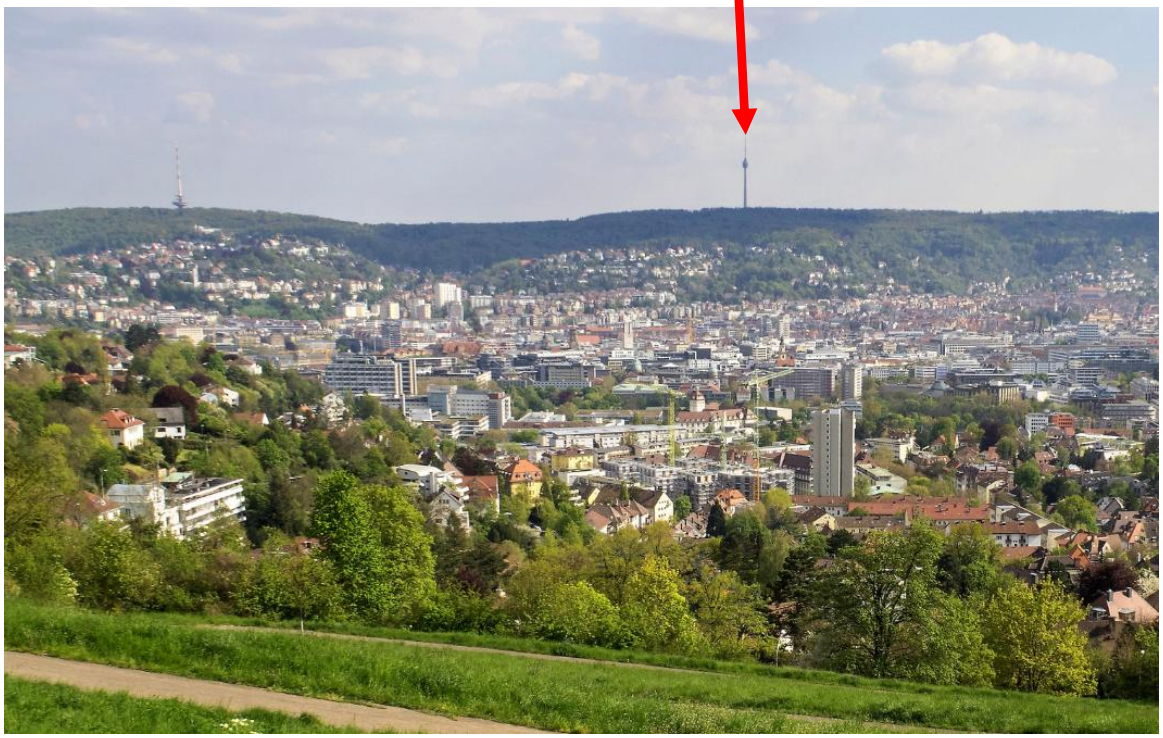
- **Very good career chances, transdisciplinary thinking is demanded in various sectors as well as practical skills like debate communication and programming**
- **Research in earth and climate system science at universities and public research institutes**
- **Applied counselling in industry and public administration**
- **Scientific writing, journalism**

University of Hohenheim

https://www.uni-hohenheim.de/en/palace

Stuttgart

The University is located ~5 km behind the TV tower.



https://www.freecountrymaps.com/map/country/germany-map-de/

https://www.fotocommunity.de/photo/stuttgart-aussicht-vom-bismarckturm-gumabe/38579764

https://www.uni-hohenheim.de/en/stuttgart-area

Population: 632.865 (end of 2022), including the environment approx. 2.8 Million

Thank you for your attention!

Questions ?