Workshop Introduction

Some Characteristic Data on Climate Sustainability

Niklas Beisert

ITP, ETH zürich

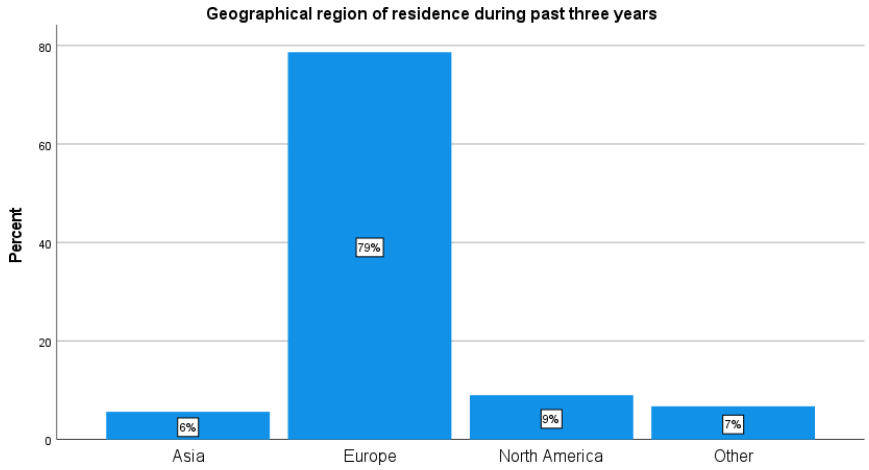
Sustainable HEP

28 June 2021

Welcome!

Participants:

- $>$ 350 registered participants
- $>$ 110 participants in Zoom meeting
- $\approx$ 20 recorded contributions
- $\approx$ 25 speakers & panelists



International Workshop:

- $>$ 40 countries of residence
- all 5 continents

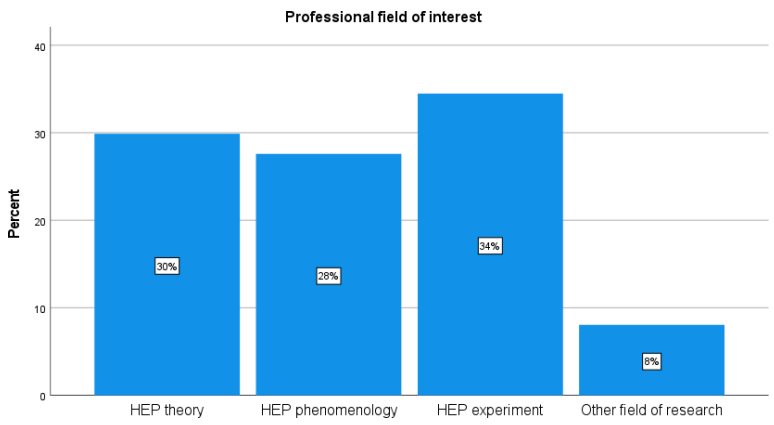
Videoconferencing enabled us to • bring together many people
• from various backgrounds • interested in a common cause
• with minor financial and logistical efforts. $\Longrightarrow$ VC a focus of workshop.

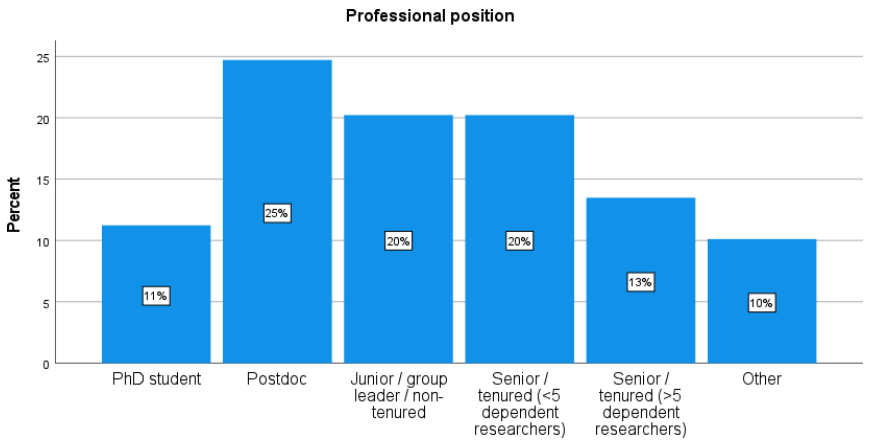
Workshop Survey:

- collaboration with Ariane Wenger; thank you!
- PhD project: "Impact of the Covid-19 pandemic on mobility at ETH Zurich"
- TdLab (Transdisciplinarity Lab), Environmental Systems Science, ETH Zürich
- 90 respondents, thank you!

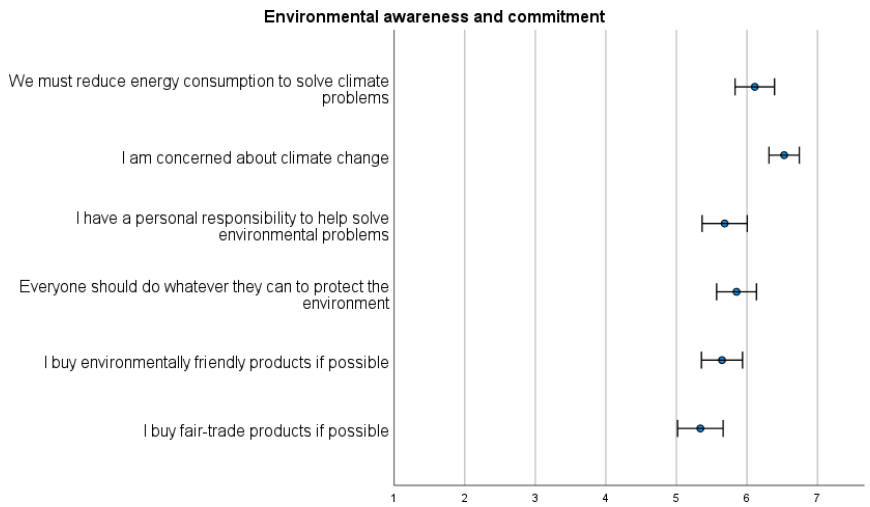
Audience

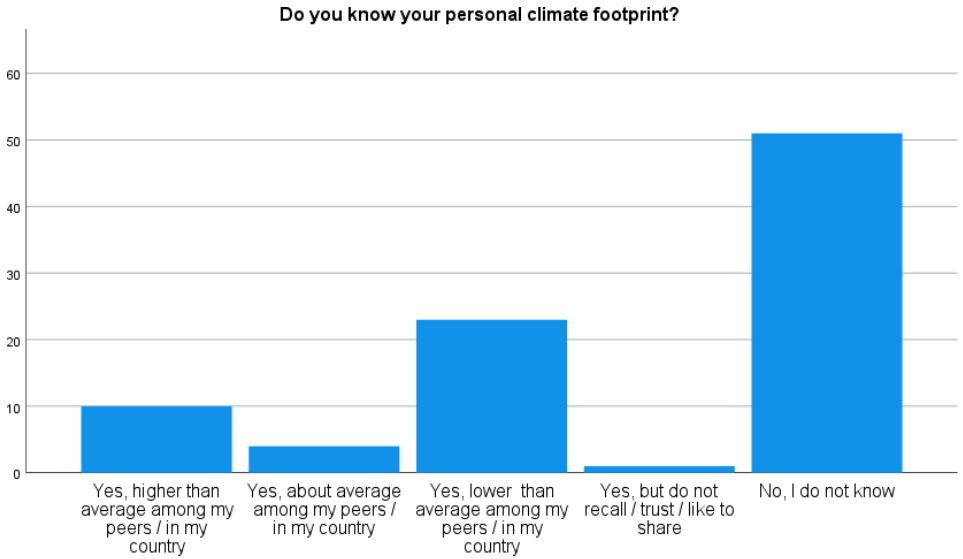
Field and Career Status: [will deposit talk slides on mattermost channel]





Environmental & Sustainability Awareness





Global Warming

Mechanisms of "Global Warming" well-understood since long. Nevertheless:

Greenhouse Effect: radiation balance (sun $\rightarrow$ earth $\rightarrow$ space)

- equilibrium: atmospheric composition $\rightarrow$ average surface temperature
- dynamics: add heat on earth $\rightarrow$ radiates to space ($\sim$ months)

CO_2 and Greenhouse Gases (GHG):

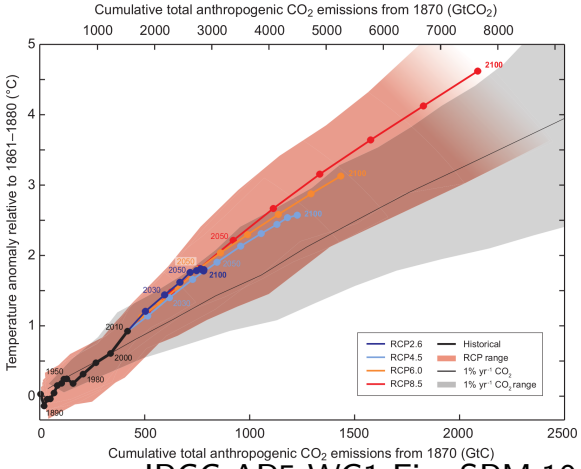
- CO_2 emissions caused by mankind (fossil fuel, land use $\rightarrow$ atmosphere) has changed atmospheric concentration by $> 100\,\text{ppm} \rightarrow \gtrsim +1°\text{C}$.

$$\boxed{+100\,\text{ppm}[CO_2] \sim +1°\text{C}}$$

- CO_2 stable ($\sim$ 1000 years) $\Longrightarrow$ integral of emissions matters.

  "every ton counts"

- other GHG relevant, too $\rightarrow$ CO_2-equivalent; e.g. methane, highly effective, short lived; F-gas
- also: albedo (clouds, ice, ground texture)
- non-linear, dynamical, climate models, ...
- here: linear approximations sufficient.



IPCC AR5 WG1 Fig. SPM.10

GHG Emission Figures

CO_2 Concentration and Global Average Surface Temperature:

- linear dependency (crude estimates, dynamical processes):

  $1°C \approx 100\,\text{ppm} \approx 800\,\text{Gt}[CO_2\text{-atm}] \approx 1\,700\,\text{Gt}[CO_2\text{-emitted}]$
- pre-industrial era $\approx 290\,\text{ppm} \rightarrow = +0°C$ [common reference point]
- present (May 2021) $419\,\text{ppm} \rightarrow \gtrsim +1°C$

CO_2 Emission Rates:

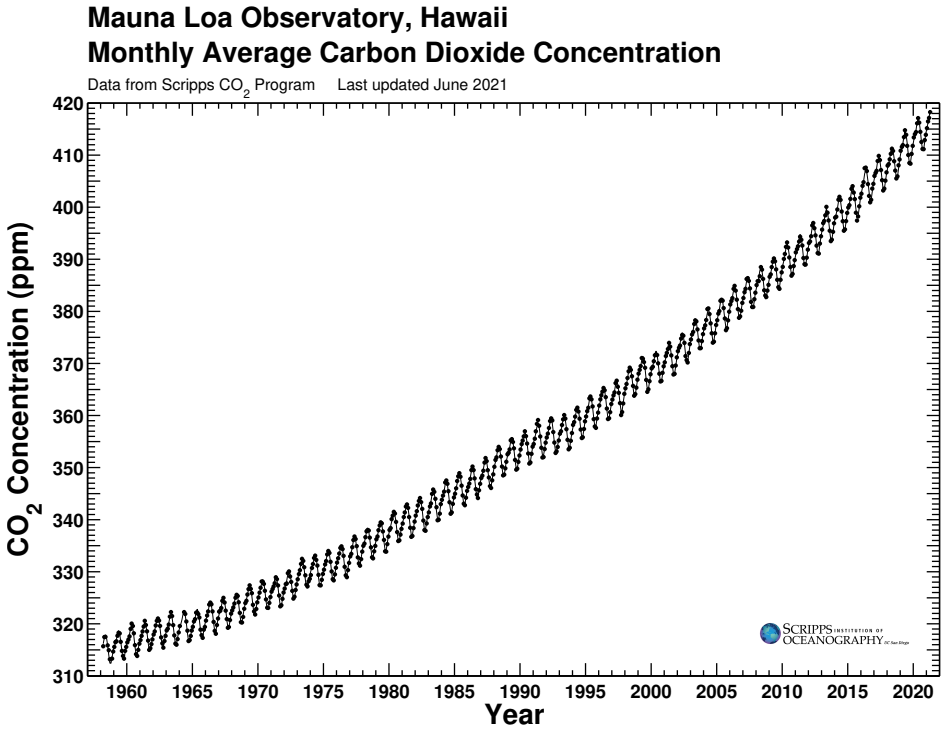
global, per decade:

$400\,\text{Gt} \approx 25\,\text{ppm} \approx 0.2°C$

per capita: population $\approx 7.5\,\text{G}$

- world average: $\sim 5\,\text{t/yr}$
- "industrialised": $\geq 10\,\text{t/yr}$
- China: $\approx 5\,\text{t/yr}$
- India, Brasil: $\ll 5\,\text{t/yr}$

[note: attributed to emission origin, not point of operation or service]



Keeling Curve (Scripps Institution of Oceanography)

International Agreements

Insights and international treaties to counteract Climate Change:
• science case well-settled since decades • IPCC • Kyoto Protocol (1997)
... did not change emission trend; global GHG emissions keep increasing.

Paris Agreement (December 2015):

- keep surface temperature increase significantly below 2.0°C,
- pursue efforts to limit increase to below 1.5°C,
- facilitate lower GHG emissions and climate resilience,
- adjust finance flows towards climate neutrality.

→ International agreement, ratified by almost all UNFCCC nations.
→ Principal goals; implementations in national policies pending.

Status and projections: (see also IPCC reports)

- currently: $\gtrsim +1°C$,
- remaining: $+0.5$–$1.0°C$ → 5–30 years left (at present rates)
- estimates without policy adjustments: $+3$–$5°C$ by 2100 (catastrophic)

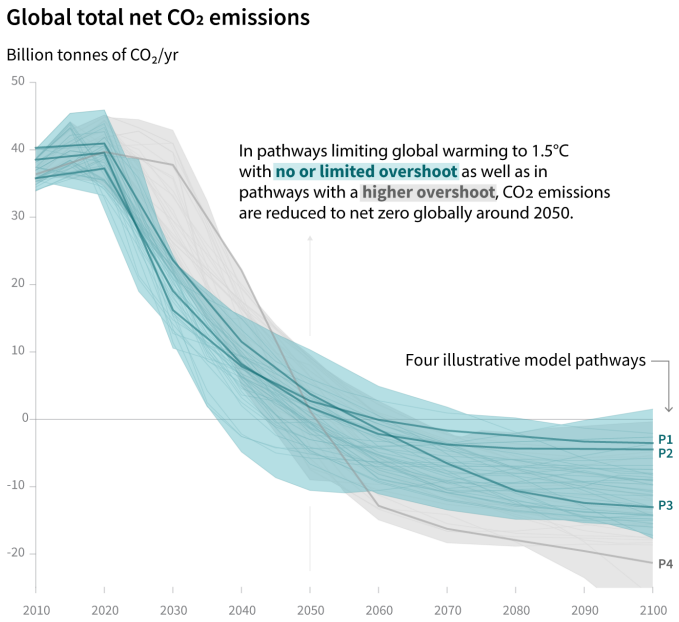
Towards Net-Zero

Temperature bound requires **Net Zero**.

Several scenarios for Paris-compatible emissions analysed in IPCC SR1.5:

Common necessary features:

- steep decent until 2030,
- reduce emissions to $^1/_2$ before 2035,
- net zero emissions before 2060,
- reliance on negative emissions.



From IPCC special report 1.5, Fig. SPM.3a

Emission reduction sectors:

- nutrition (meat, dairy)
- traffic (individual, air travel, commerce)
- buildings (concrete, heating/cooling)
- electrical energy (coal)
- consumption (short-lived, unnecessary)
- CO_2 capture (CCS, solar to fuel, forests)

most importantly:

all needed / everywhere

every ton counts

Challenges

Transformation to Net Zero is major challenge:

- Transition takes time (convince, legislate, enact).
- Exceeding 1.5–2.0°C target implies elevated GW impacts and risks.
- Available time has become crucial factor.
- Delays in implementations are to be expected.
- Individual persons / groups have very limited impact.

Transformation to **Net Zero** has benefits beyond climate:

- Renewable energies have become competitive.
- Become resilient to changes which are unavoidable and inevitable.
- Build a viable basis for the following generations.

Why do necessary changes come slowly?

Consider **HEP-Community**: sample size between individual and mankind.
Why little progress there? Or has there been progress?

Climate Impact of Research Institutions

Terminology: Types of emissions ("GHG Protocol"):

- scope 1 (direct): own heating, cooling, leaked gases
- scope 2 (indirect): purchased electricity, heating, cooling
- scope 3 (value chain): goods, construction, travel, equipment, services

Data analysis:

- scopes 1,2 easy to classify and quantify. Good data available (reports).
- scope 3: what to take into account? how? whose responsibility?

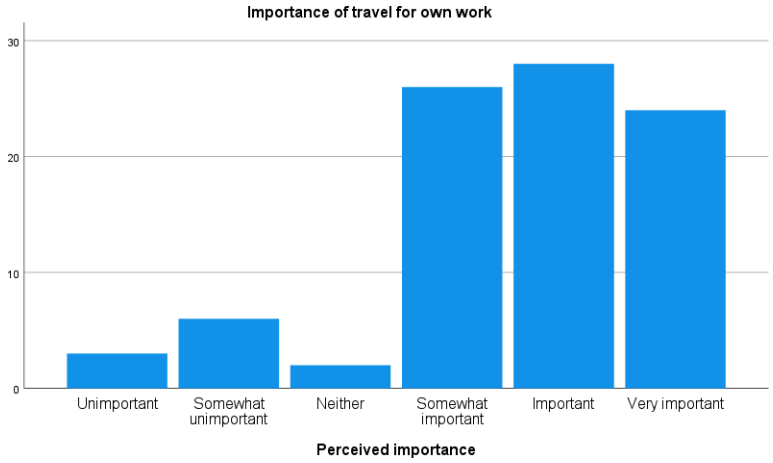
Sample annual data from sustainability reports (≈2018):

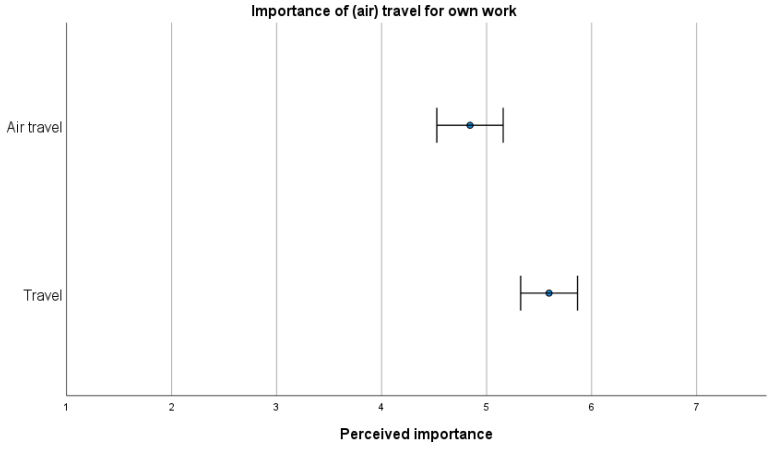
	CERN	ETH Zürich	IC London	Uni HH
employees	3600 FTE	9400 FTE	8000	11600 FTE
users / students	12500 users	21400 stud	17000 stud	38700 stud
electricity power	1200 GWh	103 GWh	57 GWh	
electricity (scope 2,1)	31700 t/yr	1400 t/yr	16000 t/yr	2100 t/yr
heating (scope 1,2)	11000 t/yr	7100 t/yr	44000 t/yr	20000 t/yr
air travel		17000 t/yr		5800 t/yr
cooling / detection	181000 t/yr			

[will deposit talk slides on mattermost channel]

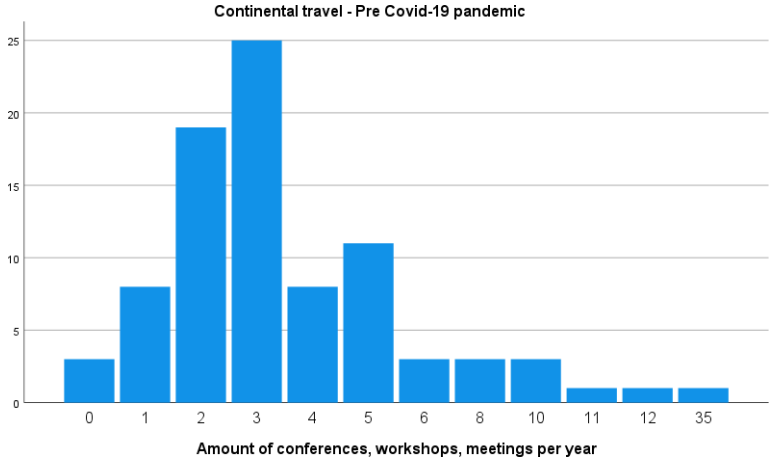
Scientific Travel Habits

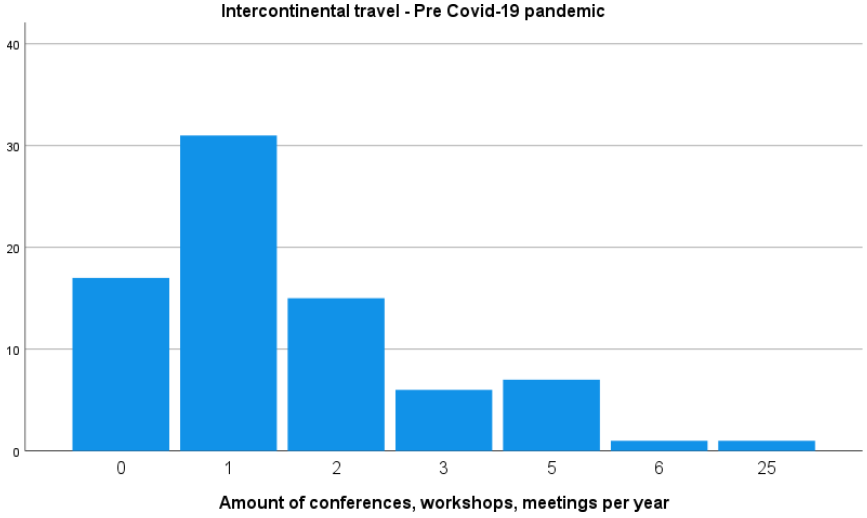
Travel Importance:





Travel Frequency: (pre Covid-19)





Travel in Science

Climate impact of travel:

mode	g[CO_2-eq]/km	remark
flight	200 – 300	RFI factor 2
car	100 – 200	single occupancy
train	1 – 80	renewable vs. fossil power

Observations at ETH Zürich:

- per employee travel-related emissions: 1.8 t[CO_2-eq]/yr/FTE.
- air travel contributes around 93% of overall travel emissions.
- long distance flights ($\geq$ 1600 km): 85% of air travel emissions.

Initiatives at ETH Zürich:

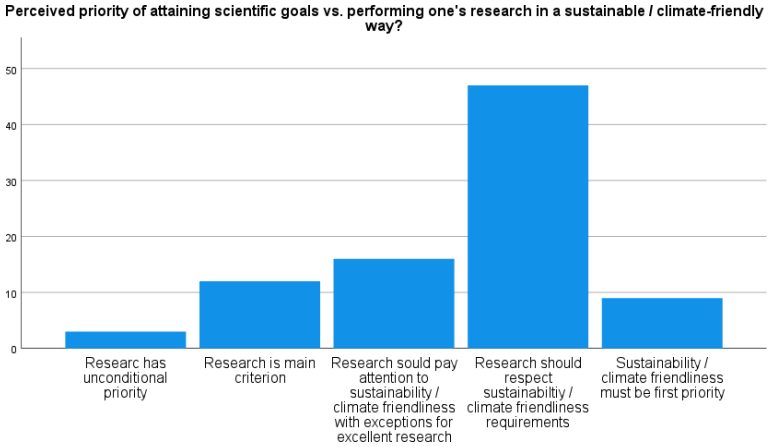
- Project to reduce emissions due to air travel (2017–2025).
- Sustainability initiative at ETH Physics Department.
  Enable: e.g. plan to offer ALL meetings at least semi-virtual.
- more to come . . .

Further information and links: D-PHYS/ETH Zürich

https://phys.ethz.ch/sustainability

Importance and Willingness to Adjust Travel

On Priority of Research vs. Sustainability:



On Air Travel and Priority to Travel by Train: