SEA Cero CO_2 working group

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On behalf of the SEACero CO_2 working group

#ShowYourStripes

Outline

- Why we should worry about climate change
- Astronomer's carbon footprint
- SEACero CO_2 working group
- Travel carbon footprint
- Computing and supercomputing
- Conferences
- Outreach: how to talk about climate change
- Conclusions

Why we should worry about climate change

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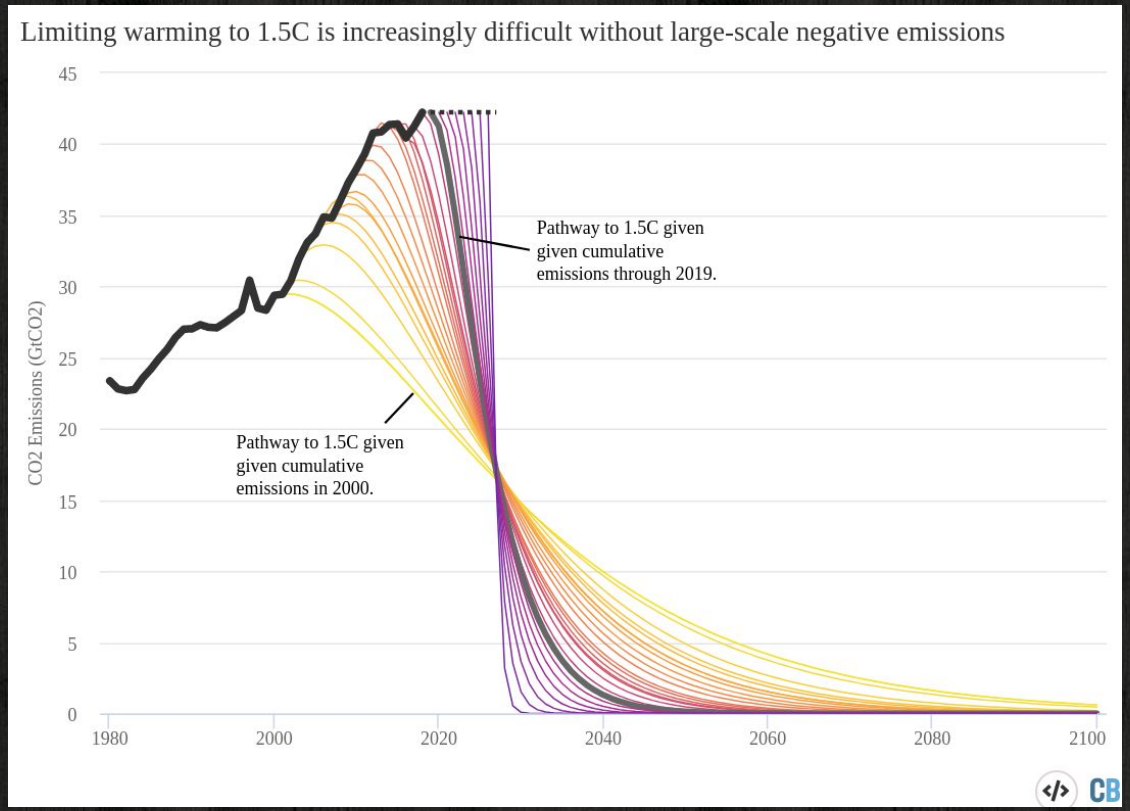

Source: https://www.carbonbrief.org/unep-1-5c-climate-target-slipping-out-of-reach

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- At current rate, we will reach an increase of 4.1-4.8 °C by 2100, with devastating and unpredictable consequences
- In addition: link with COVID-19 (see https://www.youtube.com/watch?v=BseEYCkS66w&feature=youtu.be)

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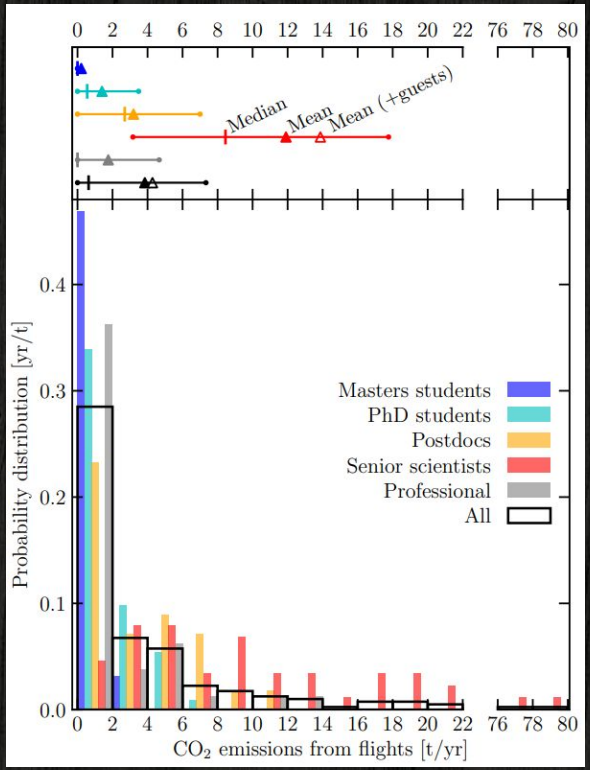

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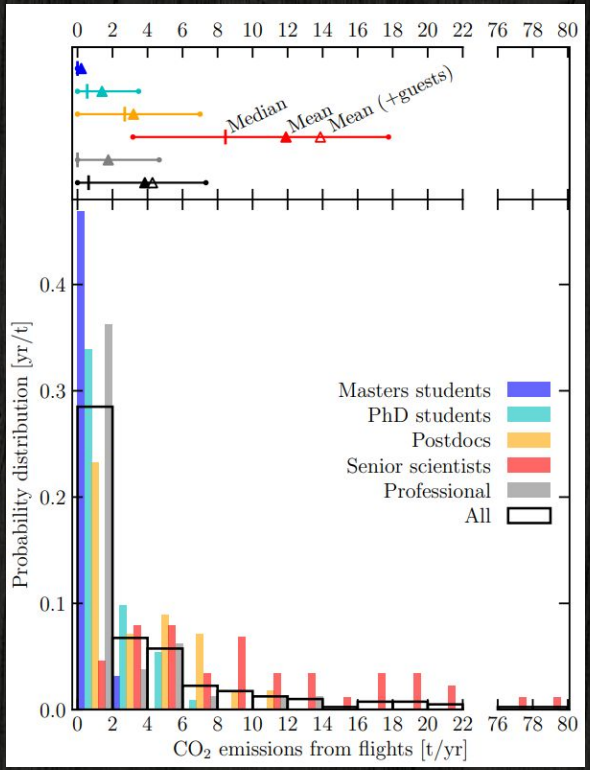

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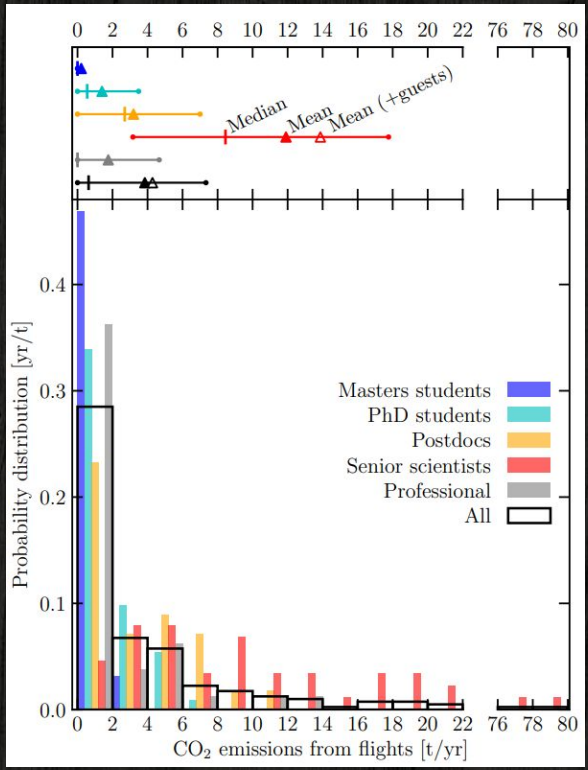
- CFHT case (EAS2020 talk by N.Flagey): 16.6 tCO_2/yr/astronomer (*only work*) ~1.3x Hawaiian average (*work+life*)



SEACero CO_2 working group

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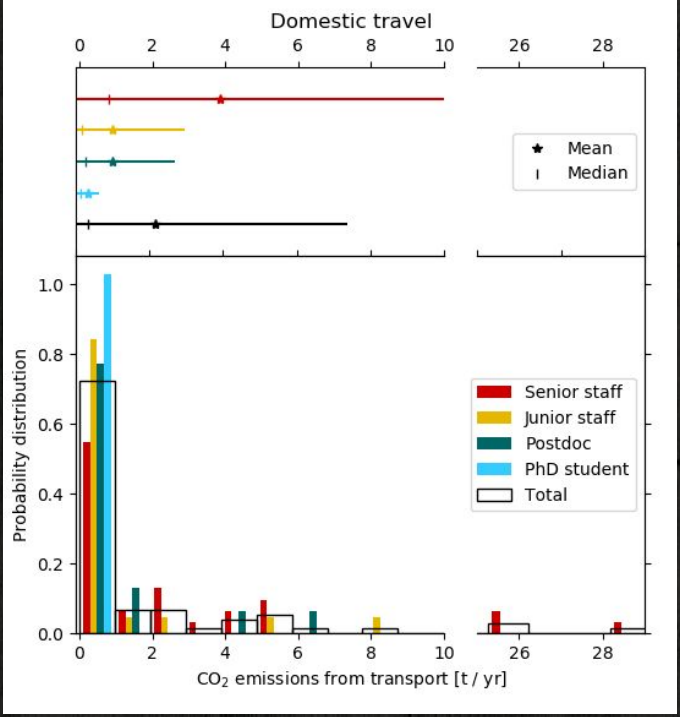
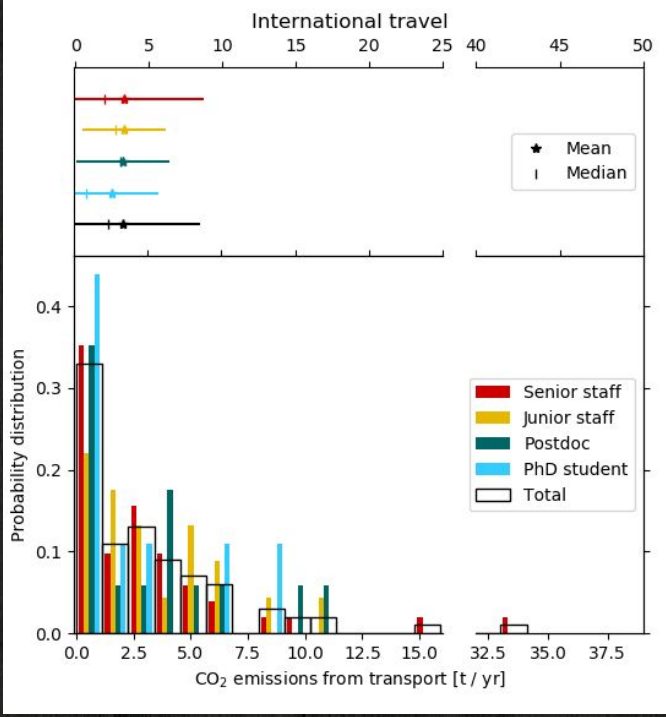
- First action: survey to evaluate the carbon footprint of astronomy in Spain
  - Questions about travel, computing, conferences...
  - 120 responses divided by job type:
    - 81 staff
    - 24 postdoc
    - 15 PhD student

Travel carbon footprint





Total CO_2 footprint for travel: ~ 5 tCO_2 /yr/person + 0.8 tons from travel to workplace

Computing and supercomputing

- Personal computers, laptops, and tablets of SEA members spend ~1.2×10^6 kW h per year corresponding to ~370 tons of CO_2 per year or ~0.5 tons per person per year* (assuming 0.3 kg of CO_2 per kW h as representative, see MITECO estimates)

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- Supercomputing consumption harder to assess due to low numbers and non-uniformity of answers. If extrapolated to the whole SEA, ~90 × 10^6 CPU hours per year corresponding to ~1600 tons of CO_2 per year and ~2 tons per person per year (assuming a 60 W consumption per CPU). The Australian community, which is similar in size to the Spanish one, has a factor 4 more supercomputing time, so this figure should be taken with caution

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Observatories

Observatory	Cosumo anual electricidad (MWh)	Autoproducción (MWh)
Observatorio de Yebes (OY)	1062	-
Centro Astronómico Hispano-Alemán (CAHA)	1800 electricidad + 900 gasoil	570 fotovoltaica + 900 biomasa (previsto 2020)
Institut de Radioastronomie Millimetrique (IRAM)	1440	-
Observatorio del Roque de los Muchachos (ORM)	5966	150 (+200 GTC 2021) fotovoltaica
Observatorio del Teide (OT)	269	35 fotovoltaica
Observatorio Astrofísico de Javalambre (OAJ)	~500	Climatización con 8 pozos geotérmicos + 2 máquinas frío/calor 45,6/52,7 MW

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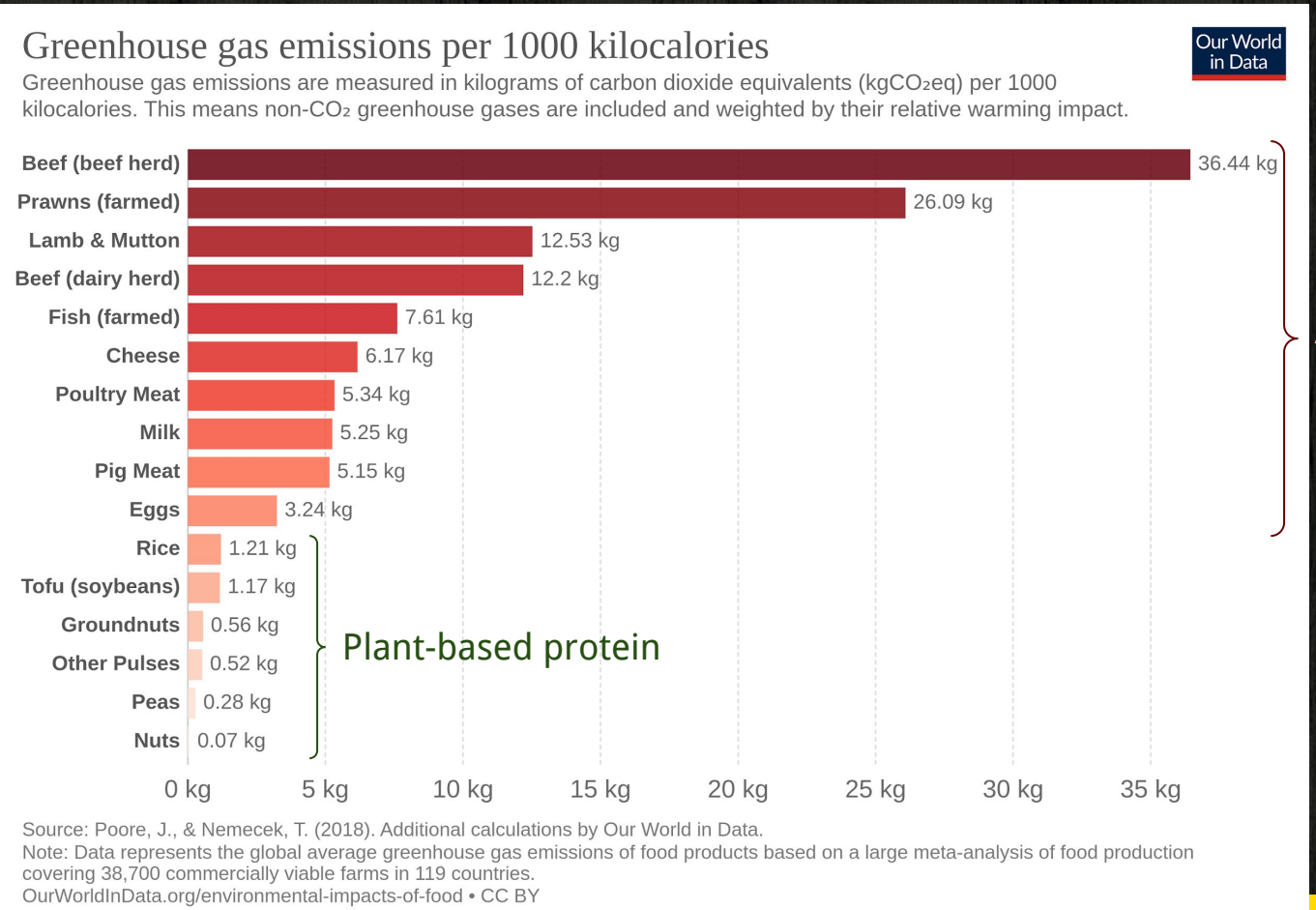
- 60% wants to keep SEA meetings biennial
- 73% agrees with a tax for our carbon footprint

Conferences: vegetarian menu?



71% agrees with or accepts vegetarian menu by default

Outreach: how to talk about climate change

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- See white paper by Williamson+2019
- See TED talk by K. Hayhoe, “The most important thing you can do to fight climate change is to talk about it”

Voyager 1, 1990

Earthrise, Apollo 8, 1968

Outreach: how to talk about climate change

- Astronomers' unique perspective on Earth
  - Lessons from sustainable living on Mars (EAS2020 talk by Dr Jasmina Lazendio-Galloway)
  - There's no planet B (exoplanets unreachable)
  - Pale Blue Dot
- More ideas
  - Carl Sagan's studies on Venus and the runaway greenhouse effect
  - ESA and NASA satellites to monitor ice melting etc
  - Quality of nights in Chile worsening due to Climate Change
  - Sun is not the cause of climate change (see https://tinieblasyestrellas.blogspot.com/2019/12/heliocentrismo-climatico-y-otras-formas.html)

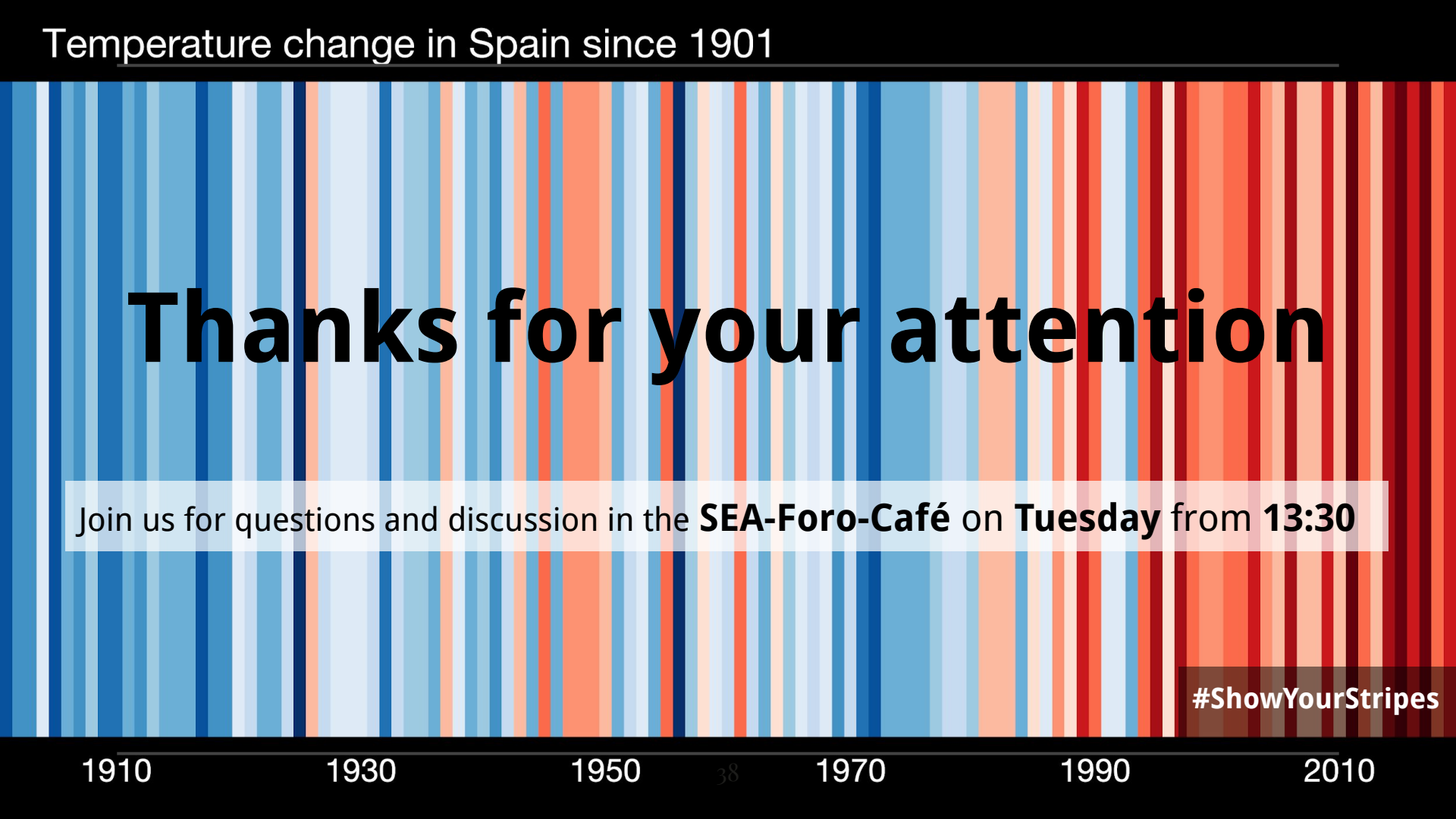
Conclusions

- ~ 5.8 tCO_2/yr/person work related travel
- ~ 2.5 tCO_2/yr/person for computing
- Observatories: work in progress

~ 8.3 tons of CO_2 per year per astronomer (*work only*) ~ 1.5x Spanish average of 5.4 tCO_2/yr/person (*work+life*) ~ 1.7x global average of 4.79 tCO_2/yr/person

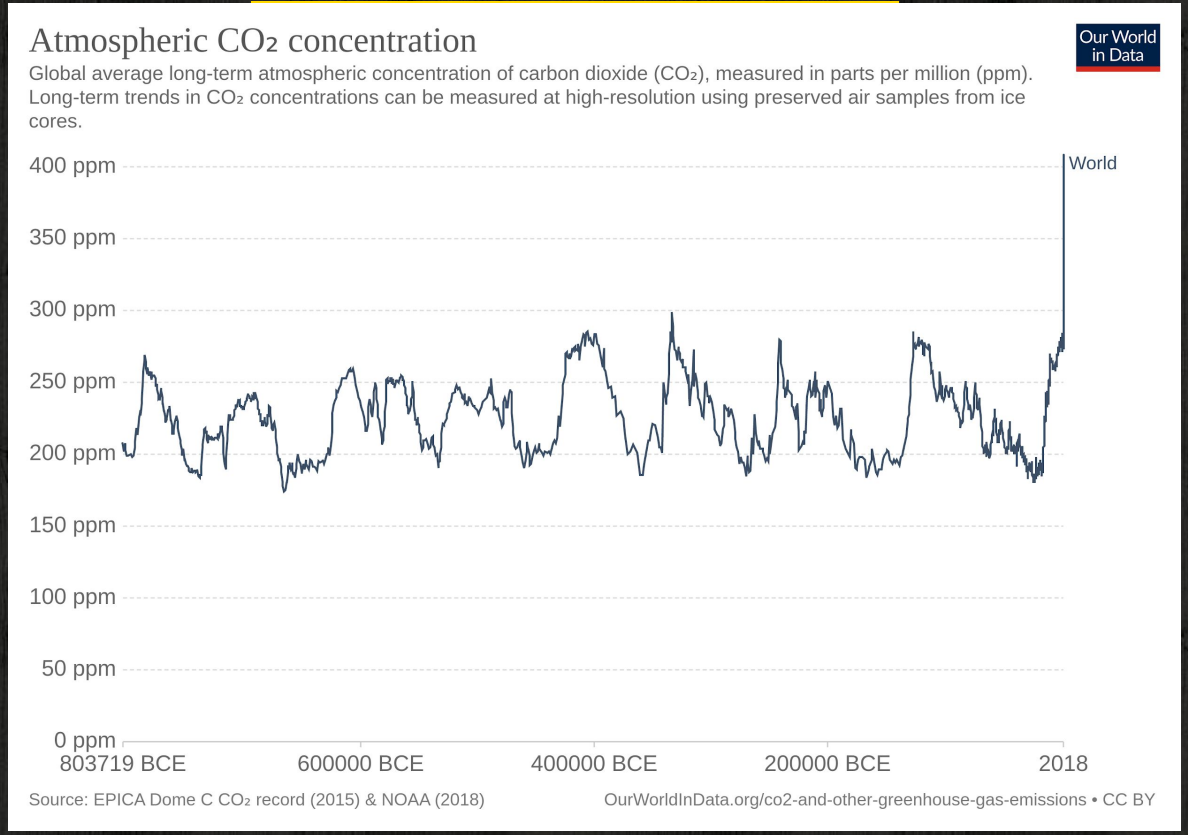
Future work

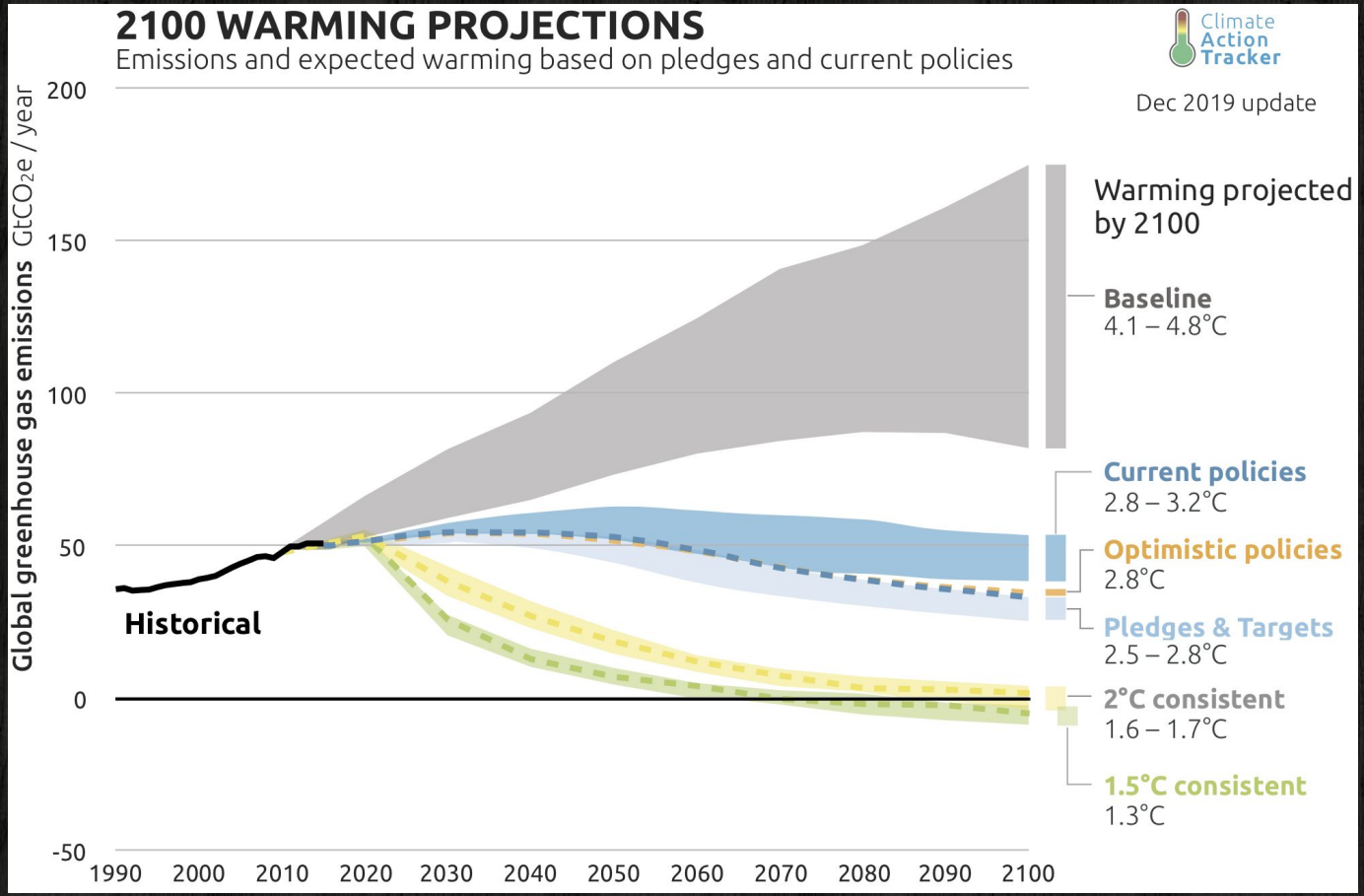
- More precise data for supercomputing
- Estimate emissions of observatories
- Publish these results in the SEA webpage
- Resources in the SEA webpage about incorporate climate change in education and outreach
- Suggestion of actions to decarbonize astronomy


Temperature change in Spain since 1901
Thanks for your attention
Join us for questions and discussion in the SEA-Foro-Café on Tuesday from 13:30
#ShowYourStripes
1910
1930
1950
1970
1990
2010

Extra slides

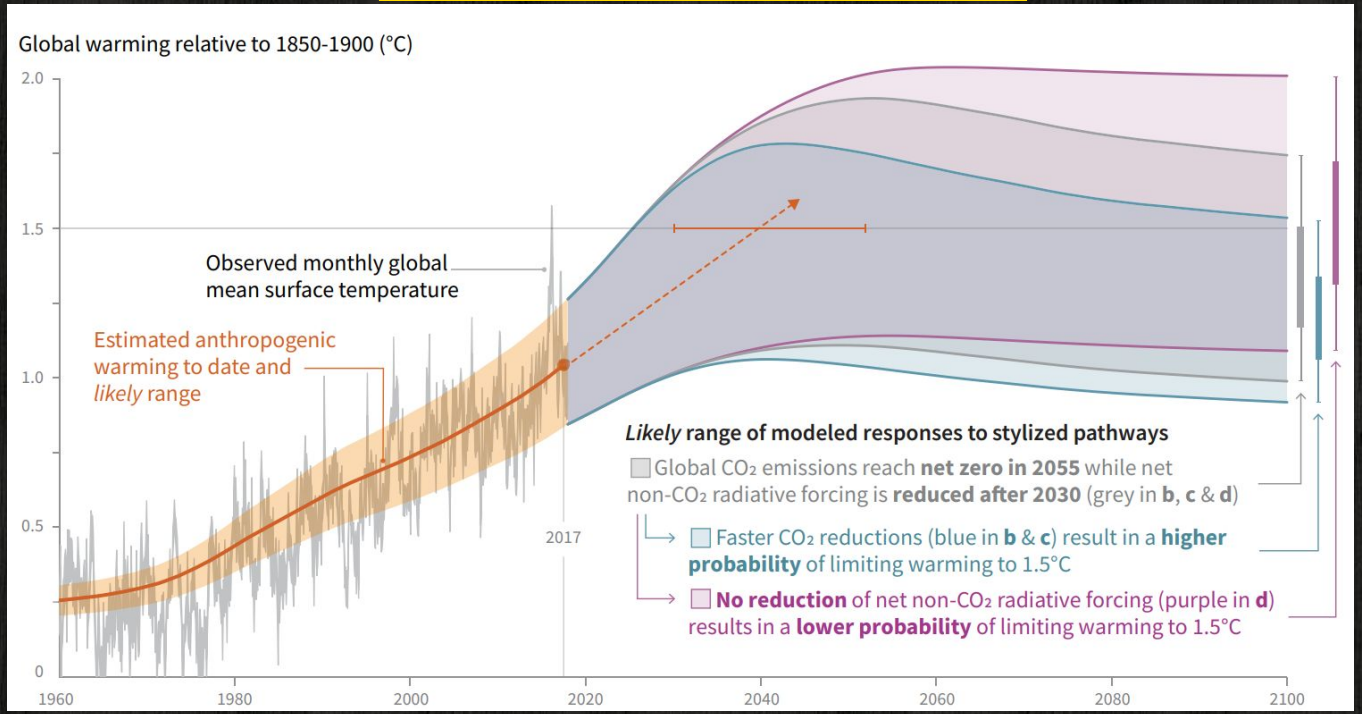
CO_2 concentration through time





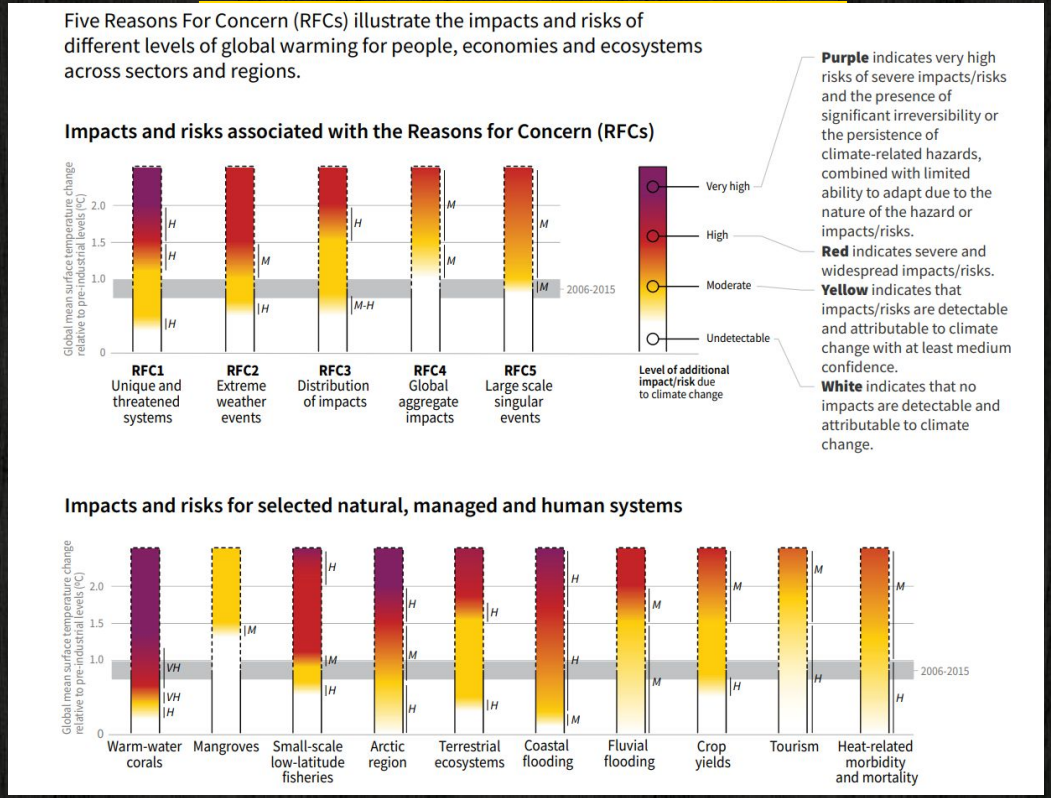
Source: https://climateactiontracker.org/global/temperatures/

Difference between going cero CO2 by 2040, 2050 or 2055



Source: Intergovernmental Panel on Climate Change (IPCC) report 15, summary for policymakers: https://www.ipcc.ch/sr15/chapter/spm/

Impact global warming



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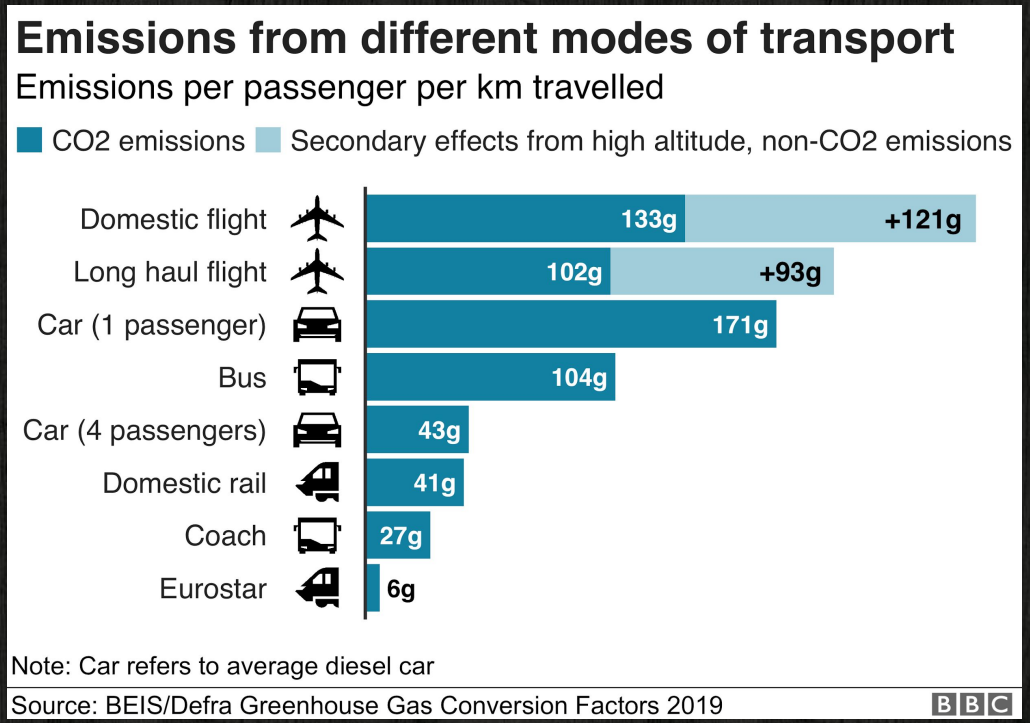
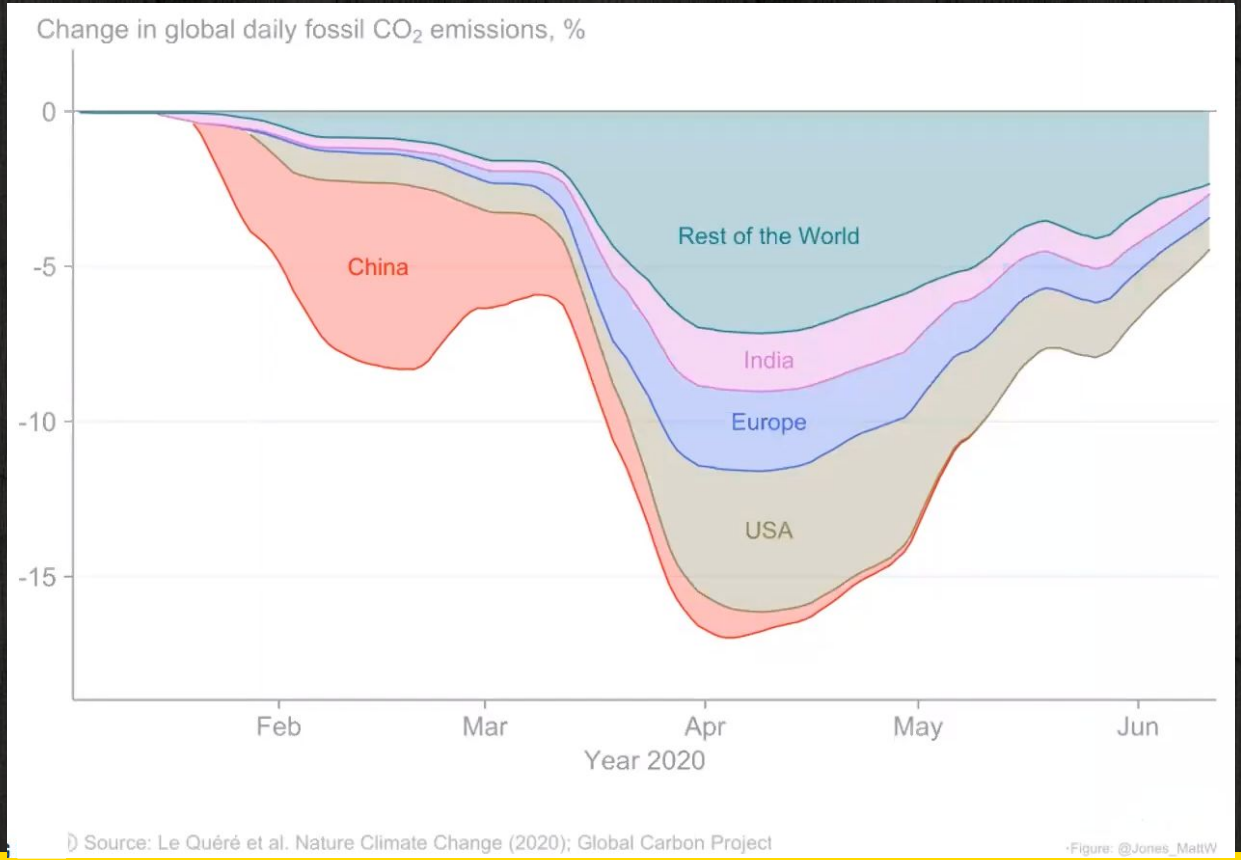
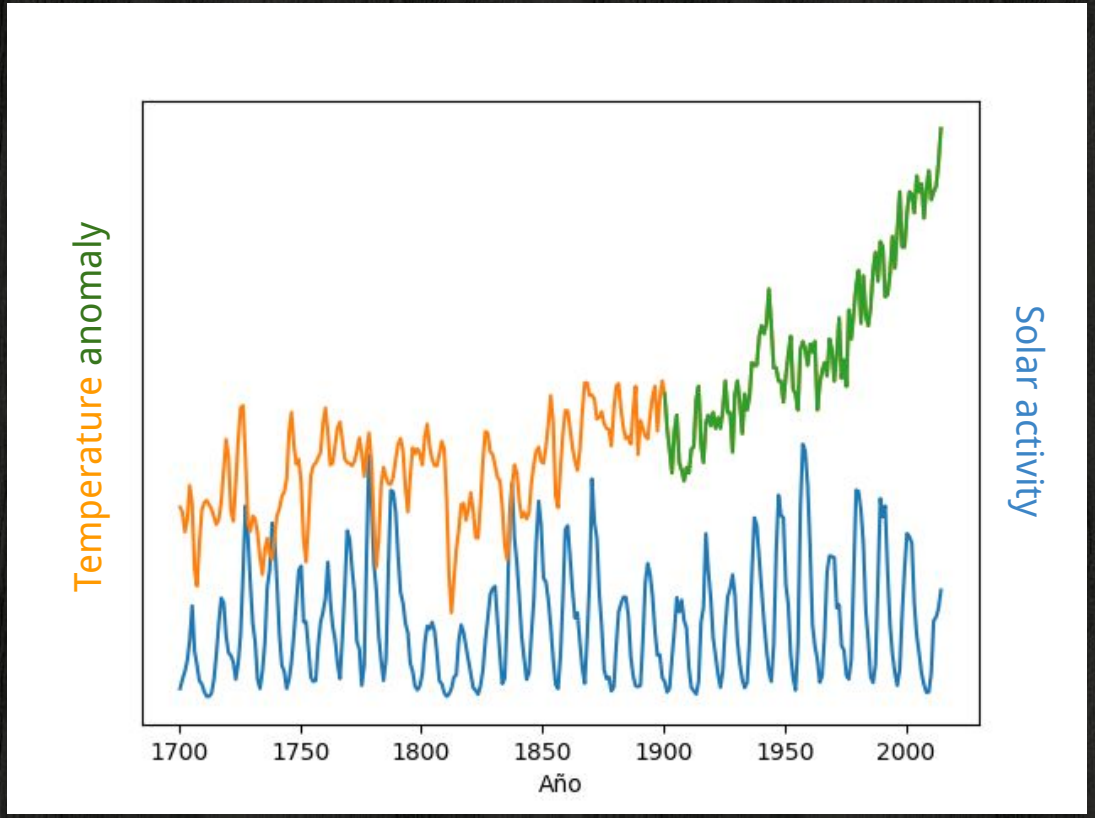
Travel carbon footprint



CO_2 emissions during lockdowns



Outreach: the Sun is not the cause

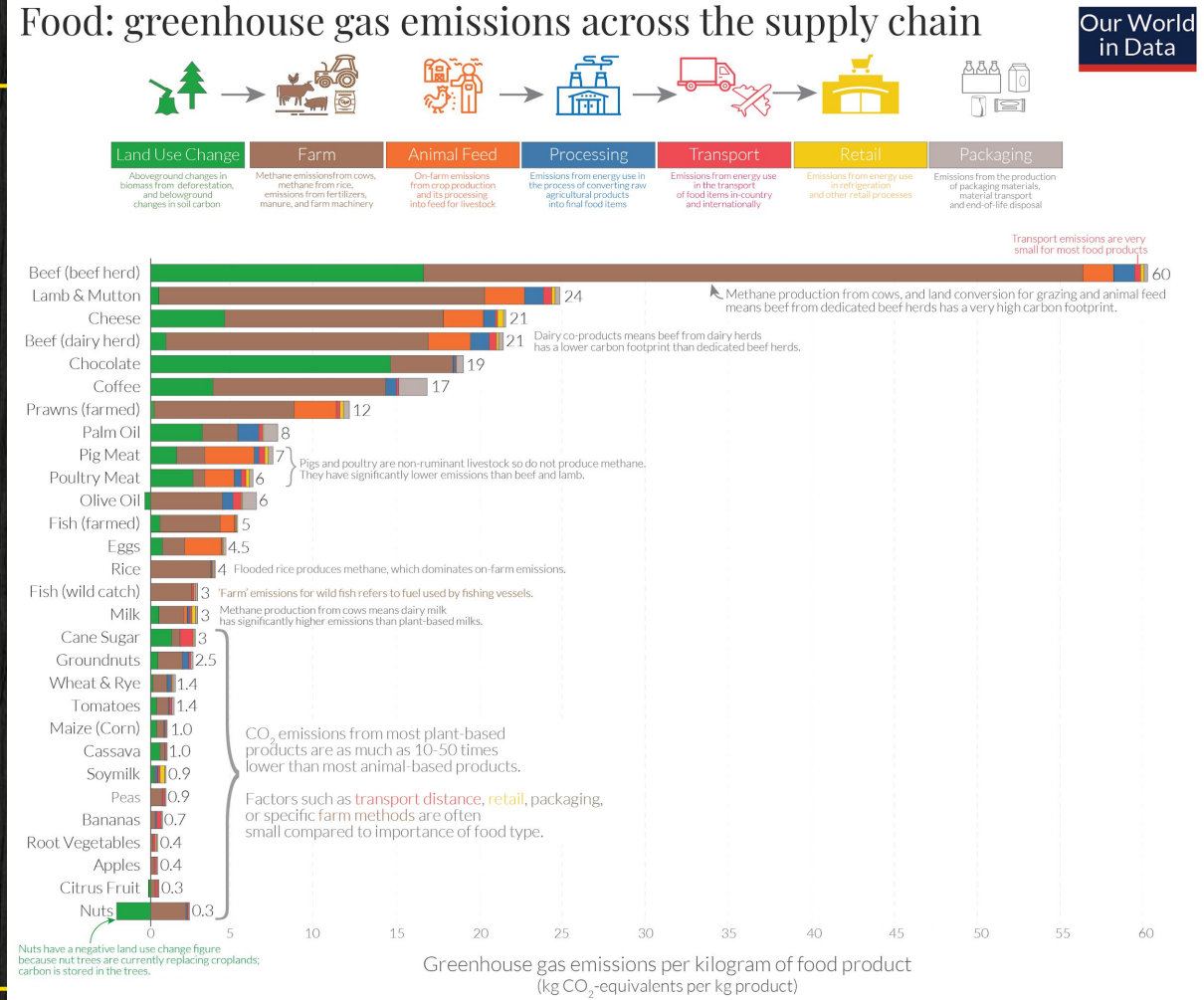


Post by astronomer Héctor Socas Navarro about why the Sun is NOT the cause of climate change:

https://tinieblasyestrellas.blogspot.com/2019/12/heliocentrismo-climatico-y-otras-formas.html

Local food vs. type of food

Source: https://ourworldindata.org/food-choice-vs-eating-local

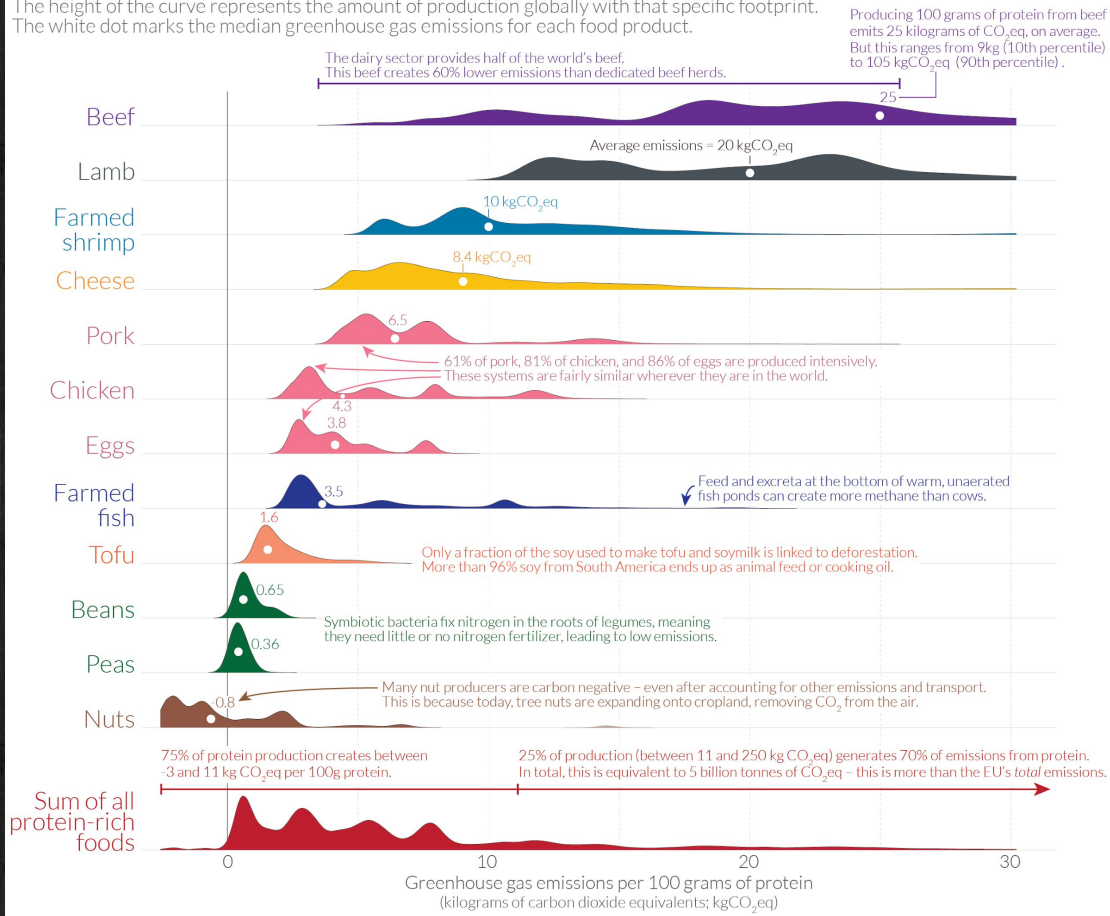


Note: Greenhouse gas emissions are given as global average values based on data across 38,700 commercially viable farms in 119 countries.
Data source: Poore and Nemecek (2018). Reducing food's environmental impacts through producers and consumers. *Science*. Images sourced from the Noun Project.
OurWorldinData.org – Research and data to make progress against the world's largest problems.

How does the carbon footprint of protein-rich foods compare?

Our World in Data

Greenhouse gas emissions from protein-rich foods are shown per 100 grams of protein across a global sample of 38,700 commercially viable farms in 119 countries.
The height of the curve represents the amount of production globally with that specific footprint.
The white dot marks the median greenhouse gas emissions for each food product.



Note: Data refers to the greenhouse gas emissions of food products across a global sample of 38,700 commercially viable farms in 119 countries.
Emissions are measured across the full supply-chain, from land use change through to the retailer and includes on-farm, processing, transport, packaging and retail emissions.
Data source: Joseph Poore and ThomasNemecek (2018). Reducing food's environmental impacts through producers and consumers. *Science*.

Social interaction in virtual meetings

- Talk by Rachel Grange in EAS 2020
  - Virtual reality poster Hub
  - Conference viewing hubs: physical places for communities to meet to attend together the virtual conference
  - See paper “How to organize an online conference”: in Nature and Arxiv

What makes a computation green

- GPU, ARM, FPGI, many-core
- Use multiple cores (parallelize your code)
- Run at low clock-frequency
- Use efficient language (not Python!)
- Optimized code
- This could save a factor million in CO_2

Source: EAS2020 talk by Simon Portegies Zwart

- Also: use more eco-friendly processors that dissipate a lot less power

Additional resources

- XR heading for extinction talk: https://www.youtube.com/watch?v=2yBkKwjy8Do&list=PLnzA40Blbb2kiECebMMSPOjg8pBGdnf2A&index=3&t=0s
- 26 ways of fighting climate change by Quantum Fracture: https://www.youtube.com/watch?v=wNQ5wvGmnEk