

Welcome to The Physics of Climate Change!

► Syllabus

- Course organization and assignments
- Grading and Evaluation
- Overview and Calendar of Topics

Week	Lecture Topic (Tue)	Laboratory (Wed)	Discussion (Thu)
Aug 26–28	Temperatures and CO ₂ over Time	Measurement and Uncertainty	Earth's History of Temp
Sep 2–4	Contemporary Climate Change	Global Average Temperature	Weather Indicators of Clim Ch
Sep 9–11	Energy and Equilibrium	Mechanical equilibrium (leaky buckets I)	Energy and Energy Transf
Sep 16–18	EM Radiation (light) and Blackbody	All the light you cannot see (BB rad)	BB Body Rad & Earth Temp
Sep 23–25	Atmosphere and Greenhouse Eff I	Heating by radiation	Earth temp: w/Atmosphere
Sep 30 – 2	Atmosphere and Greenhouse Eff II	Absorption of radiation / Blanketing	Atmosph Absorption Spectra
Oct 7–9	Water and Phase Transitions I	Cloud Formation	Evaporation/Condensation
Oct 14–16	Water and Phase Transitions II	Phase Transitions	Earth Temp: Rad-Conv Equil
Oct 21–23	Fall Break (no class)	No Lab (probably)	Intro to Milankovitch Cycles
Oct 28–30	Paleo Perturbations of Temperature	Milankovich Cycles	More Paleo and Milankovitch
Nov 4–6	Climate Sensitivity	IR absorption by GH gases	CO ₂ absorption line
Nov 11–13	Timescales of Climate Change	Equilibration: buckets and radiation	Rates of Change, Timescales
Nov 18–20	Modeling Climate Change	Computational Climate Models	
Nov 25–27	Oceans and Ice	Thanksgiving (no class)	
Dec 2–4	work on project	Ice and Thermal Exp of H ₂ O	work on project
FINAL EXAM TIMESLOT: Thursday, December 11, 2025, 10am–Noon (Poster Presentations)			

Climate Change is (mostly) a story of Temperature

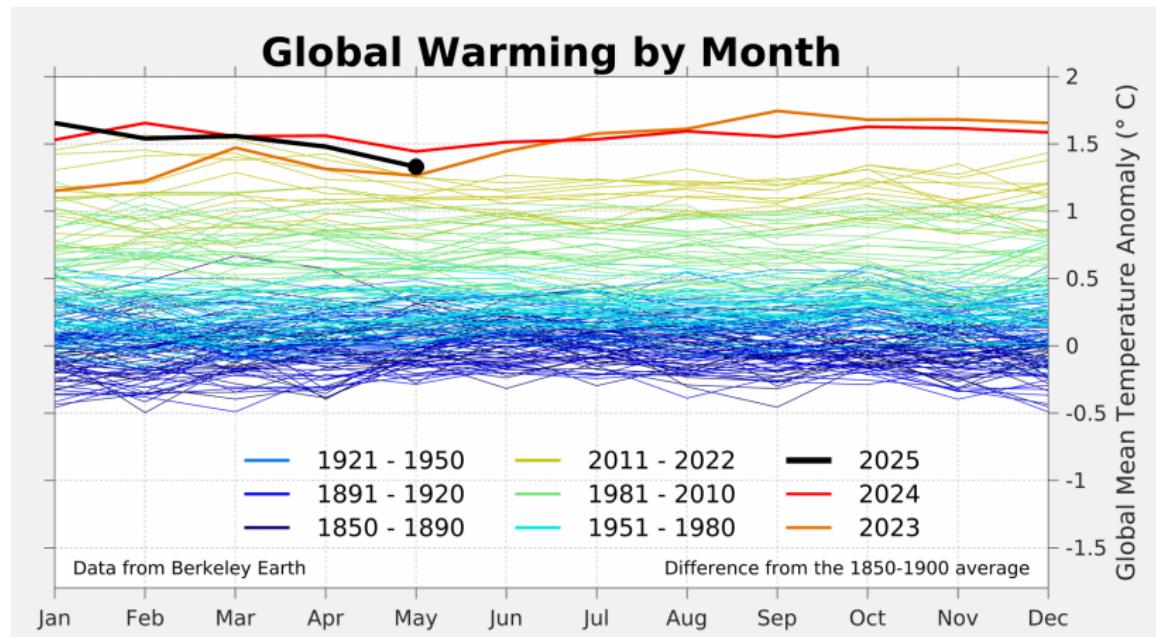


Image and data From Berkeley Earth May 2025 update
NASA "Climate Spiral" Animation (1880–2021)

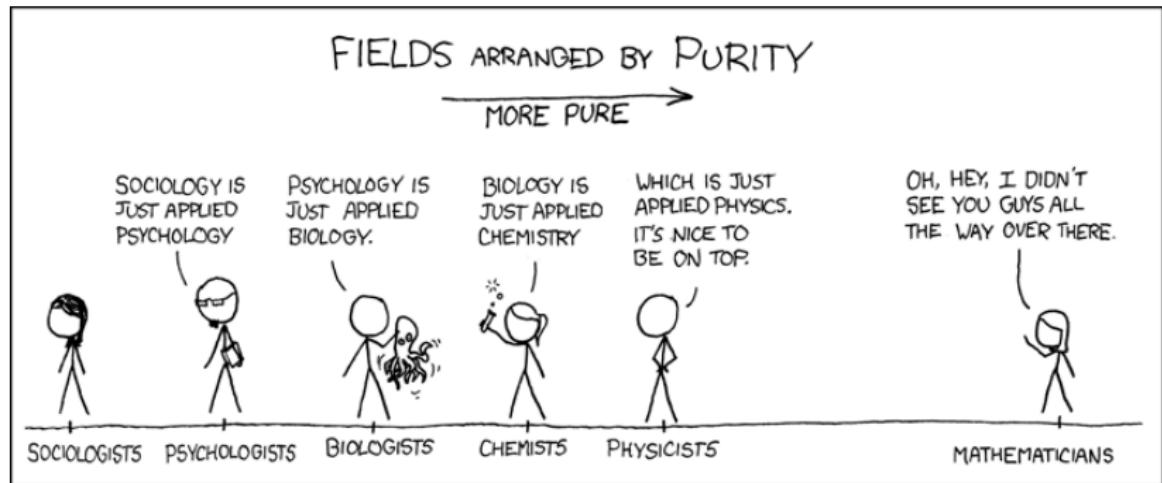
But what *is* Temperature? It is a physical quantity, so . . .

What is Physics???

Physics is the precise characterization of natural phenomena, enabled by measurement and described by theoretical (mathematical) models.

What is Physics???

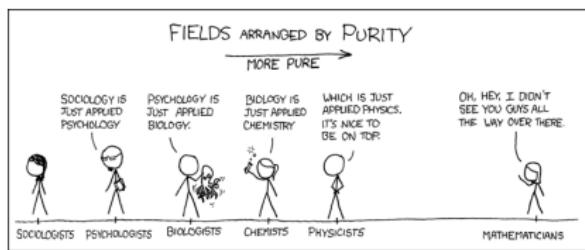
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xkcd (Randall Monroe): Purity

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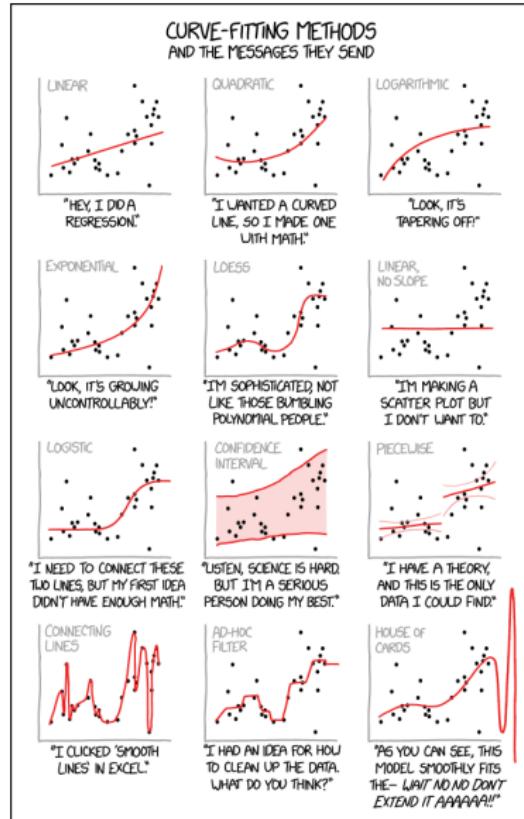
O Hai!,

PHILOSOPHERS

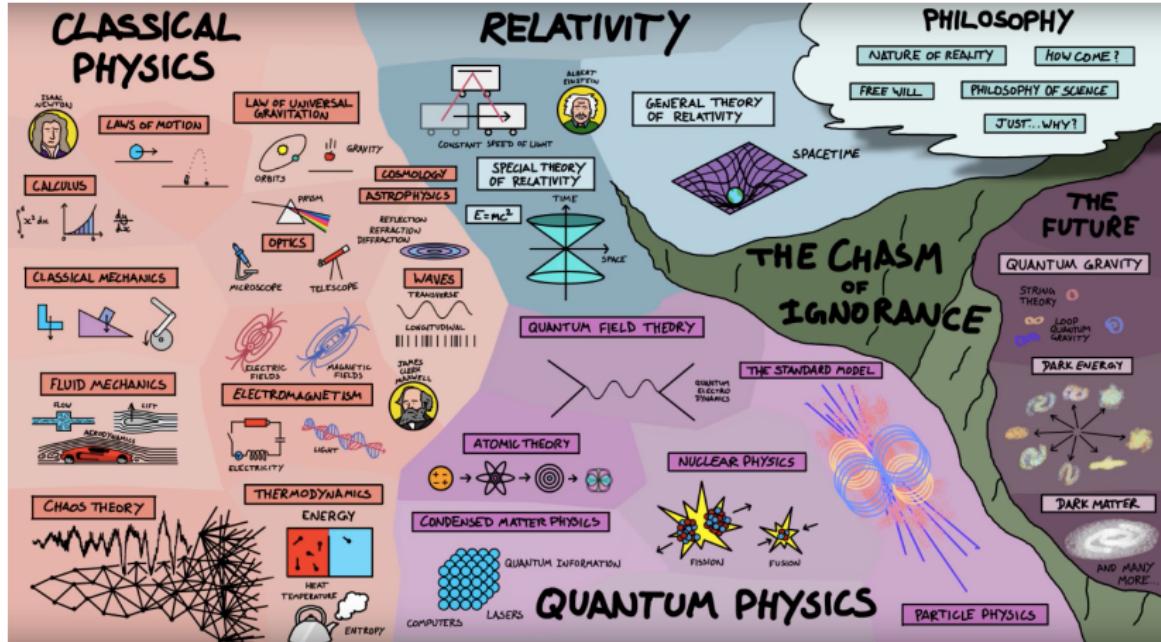


Data, Theoretical Models, and Uncertainty

- ▶ “dots” (*measurement values*) are the job of the experimental physicist
- ▶ developing a “line” (*theoretical/mathematical model*) is the job of a theoretical physicist
- ▶ Each dot should actually have “bars” to indicate the *uncertainty* of each measurement
- ▶ A “good” theory is the simplest line that goes through the dots, taking into account the uncertainties

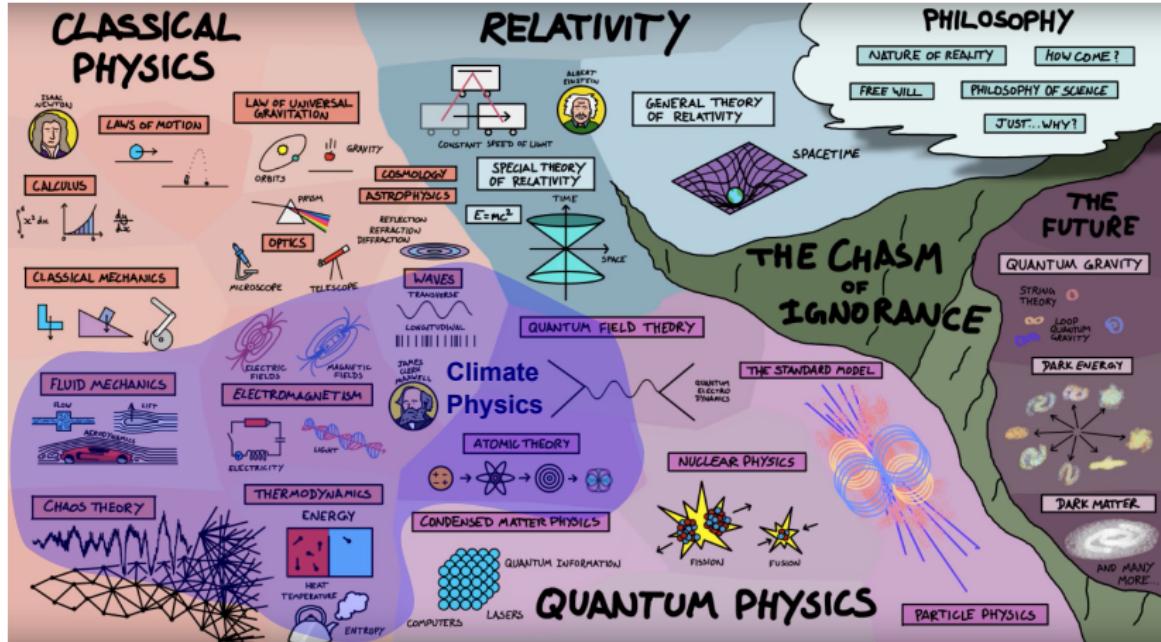


What is Physics: Sub-disciplines



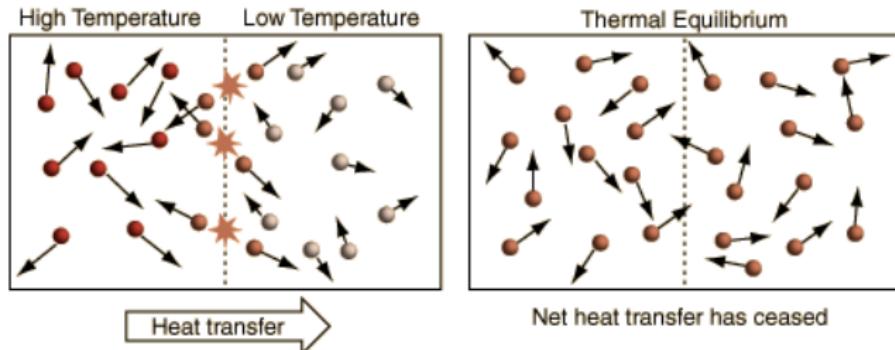
"The Map of Physics" by Dominic Walliman — 2016 youtube video

What is Physics: Sub-disciplines



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Thermodynamics: Energy, Temperature, and Equilibrium

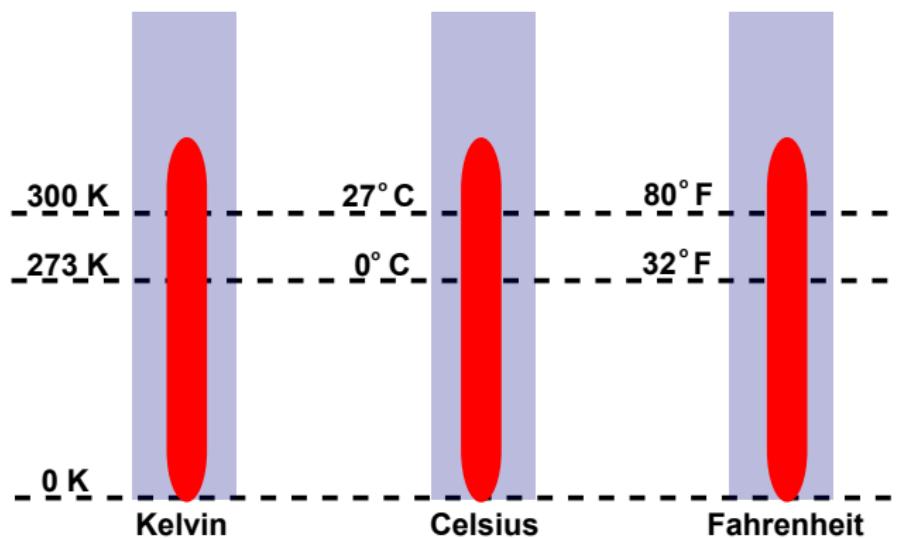


From [Hyperphysics — A More General View of Temperature](#)

- ▶ The *internal energy* of an object is the random “thermal” motion of its constituent particles.
- ▶ *Temperature* is a measure of (proportional to) that energy
- ▶ *Thermal contact* between two objects at different temperatures will eventually result in a common temperature (*thermal equilibrium*)

Temperature Scales

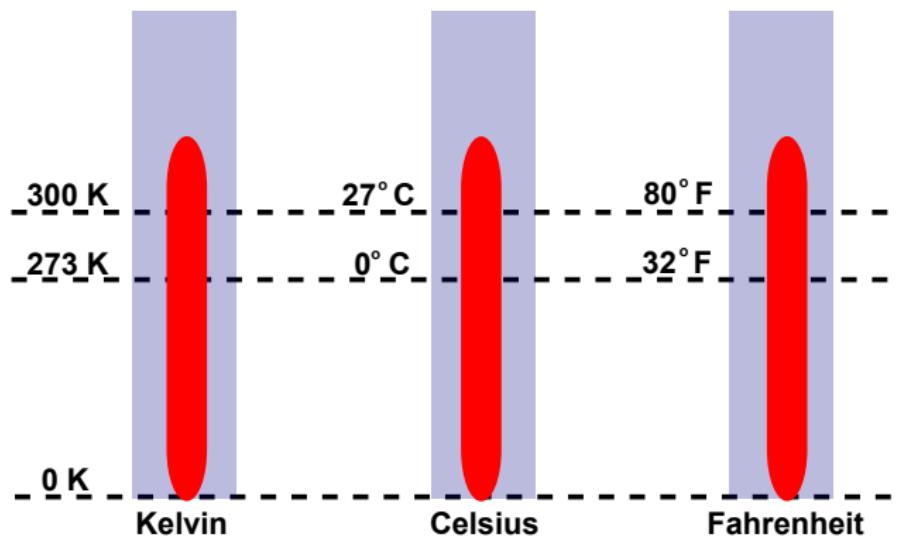
There are three common units of temperature.



- ▶ The first (Kelvin) is the physicist's standard unit
- ▶ The last (Fahrenheit) is just weird, but comfortable
- ▶ We will primarily use the second (Celsius)

Thermometers

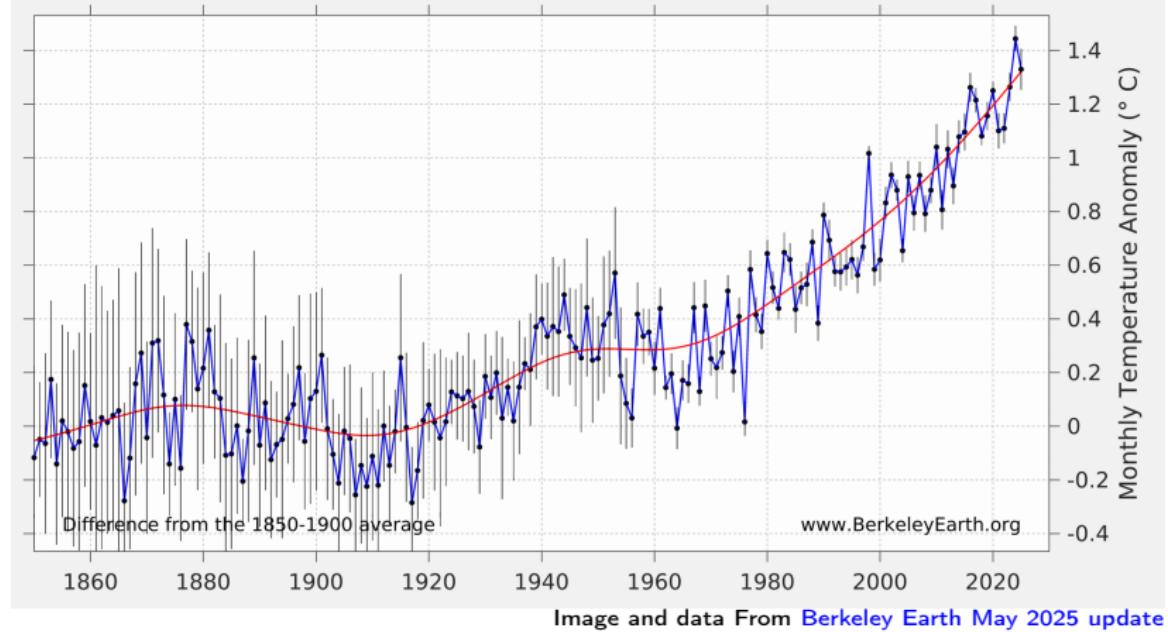
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Climate Change is (pretty) Recent

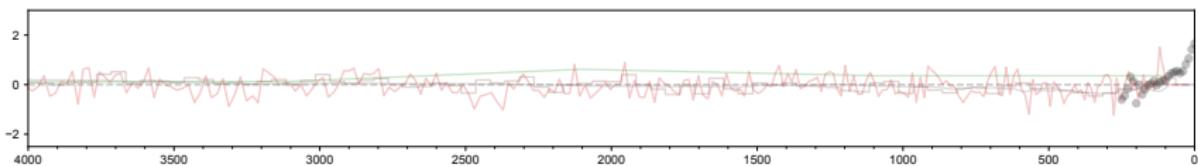
Berkeley Earth - Global - May



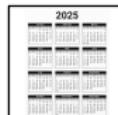
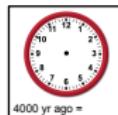
- ▶ Note: *uncertainty* on each point and temperature *anomaly*
- ▶ Temperature increase is outside uncertainty, but perhaps just *natural variation*?

Paleo-record of temperature (proxies)

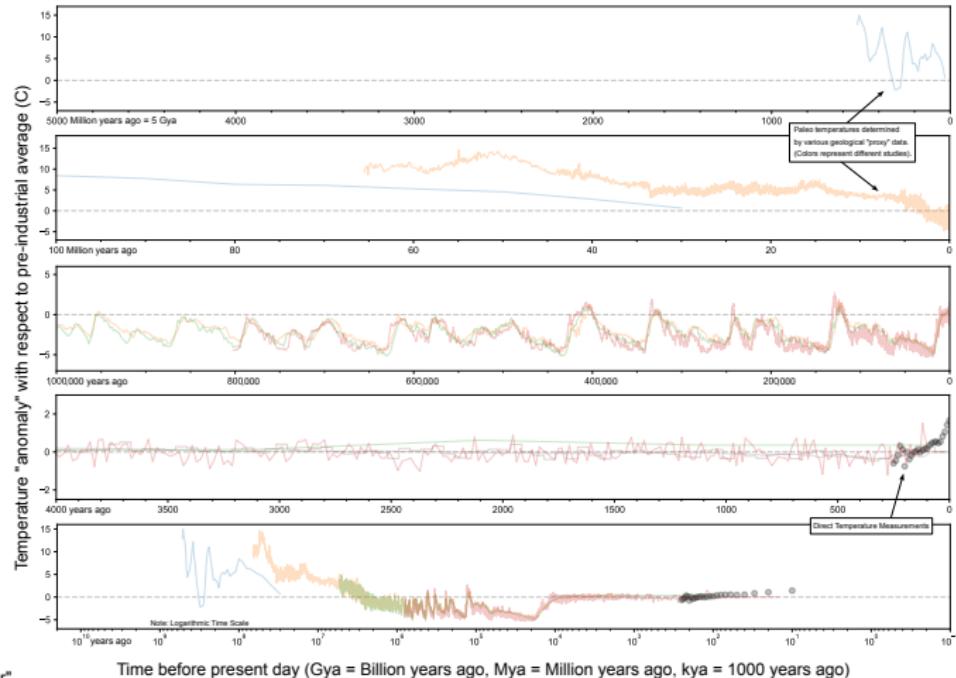
Looking at 4000 years of (proxy) temperature measurements...



This week in Discussion...



Segment of the
Universe's "Calendar"
(13.8 Billion years old)



(Proxy) Temperature record over the history of the Earth