GHG Emissions: Making Sense of Big Numbers and International/Historical Contexts

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Goals

- Develop emissions benchmarks to contextualize emissions numbers
- Show some ways to make numbers meaningful
  - Make numbers memorable and relatable
  - Some interesting and clever graphs
- Think about responsibility for emissions

Greenhouse Gases

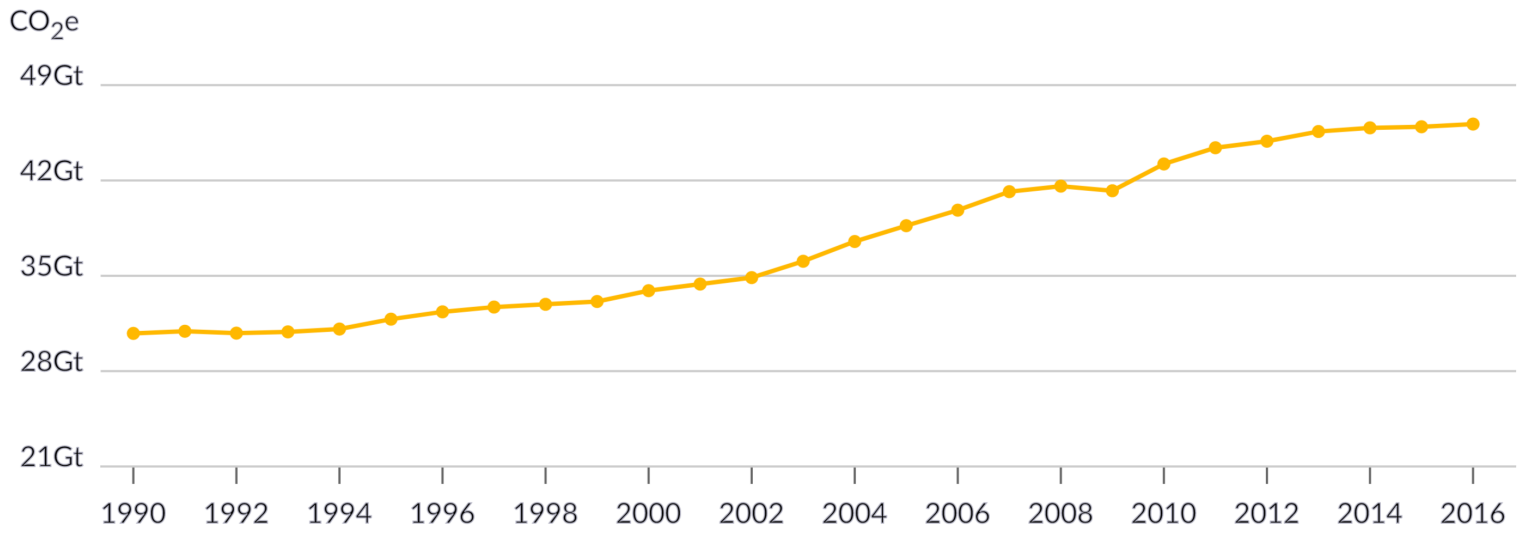
- Greenhouse gases (GHG)—mainly CO_2—are warming the planet
- It is like adding blankets to the planet. More blankets increase the equilibrium temperature.
- **These effects are cumulative.**
- The blankets last "forever".
- So to stop climate change, we need to stop emitting GHG.

World Emissions—A graph

Historical GHG emissions

CLIMATEWATCH

Data source: CAIT; Countries/Regions: World; Sectors/Subsectors: Total excluding LUCF; Gases: All GHG; Calculation: Total; Show data by Regions.



2016 worldwide emissions of CO2e is 46 Giga tonnes!!

World Emissions—Numbers and a Rectangle

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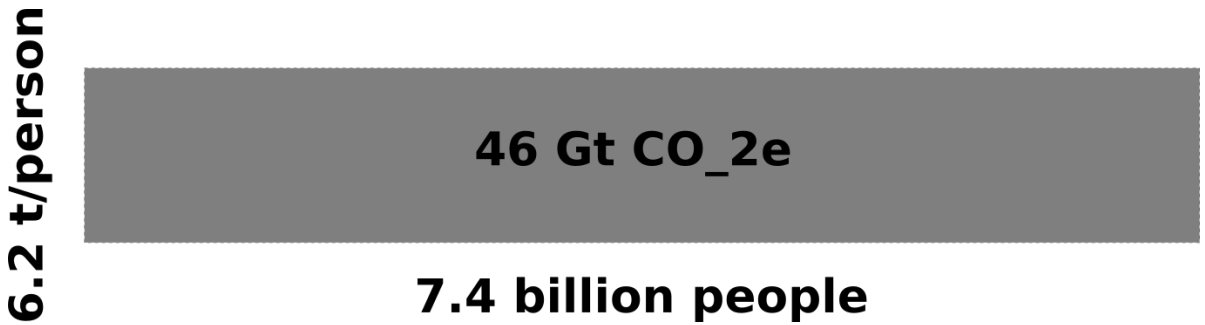
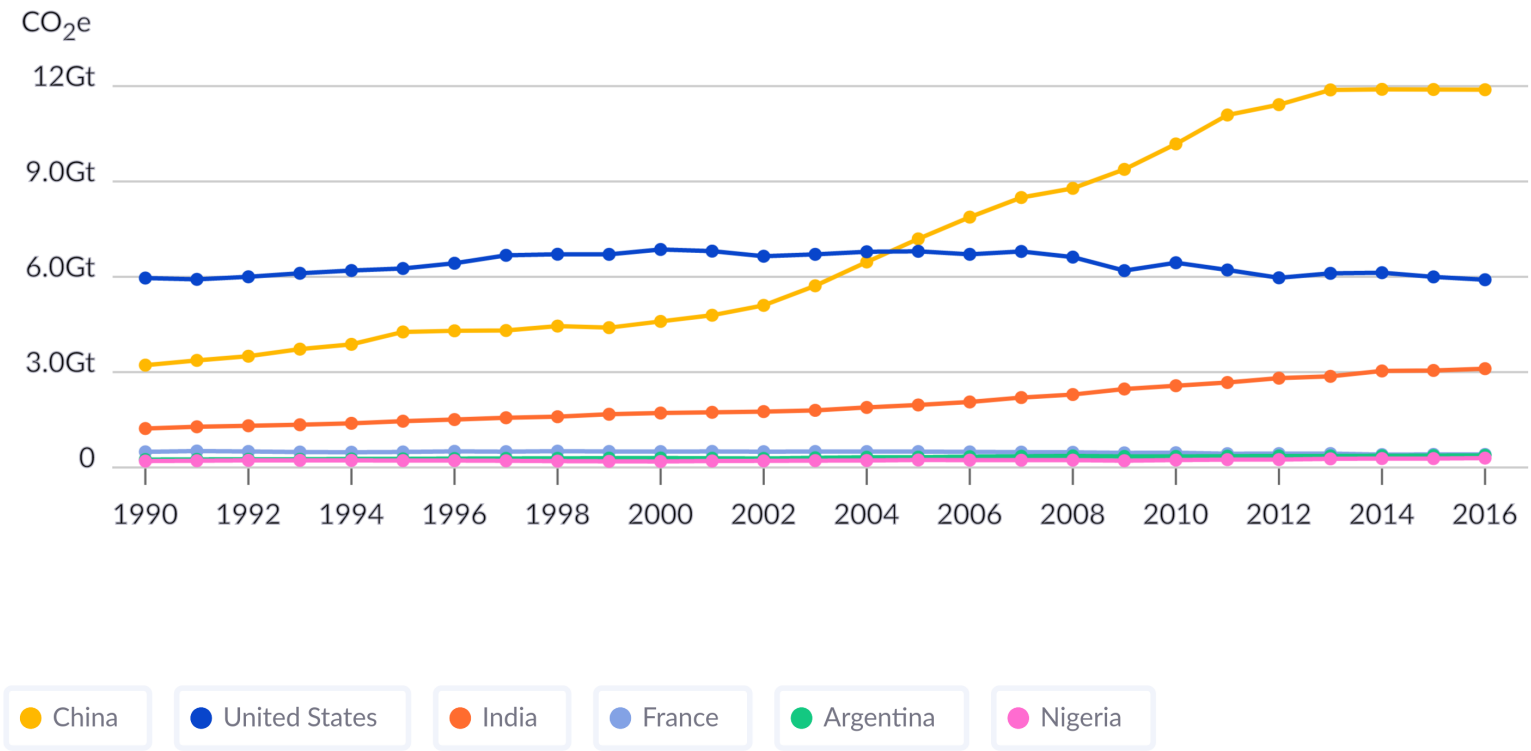


Selected Country Emissions

Historical GHG emissions

CLIMATEWATCH

Data source: CAIT; Countries/Regions: Argentina, China, France, India, Nigeria, United States; Sectors/Subsectors: Total excluding LUCF; Gases: All GHG; Calculation: Total; Show data by Countries.



Numbers and a Rectangle for the US

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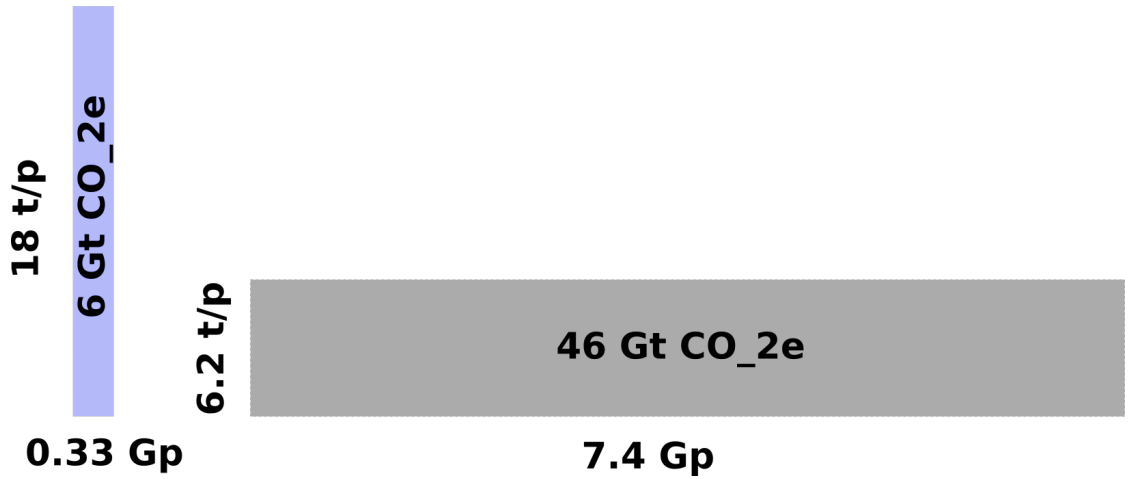
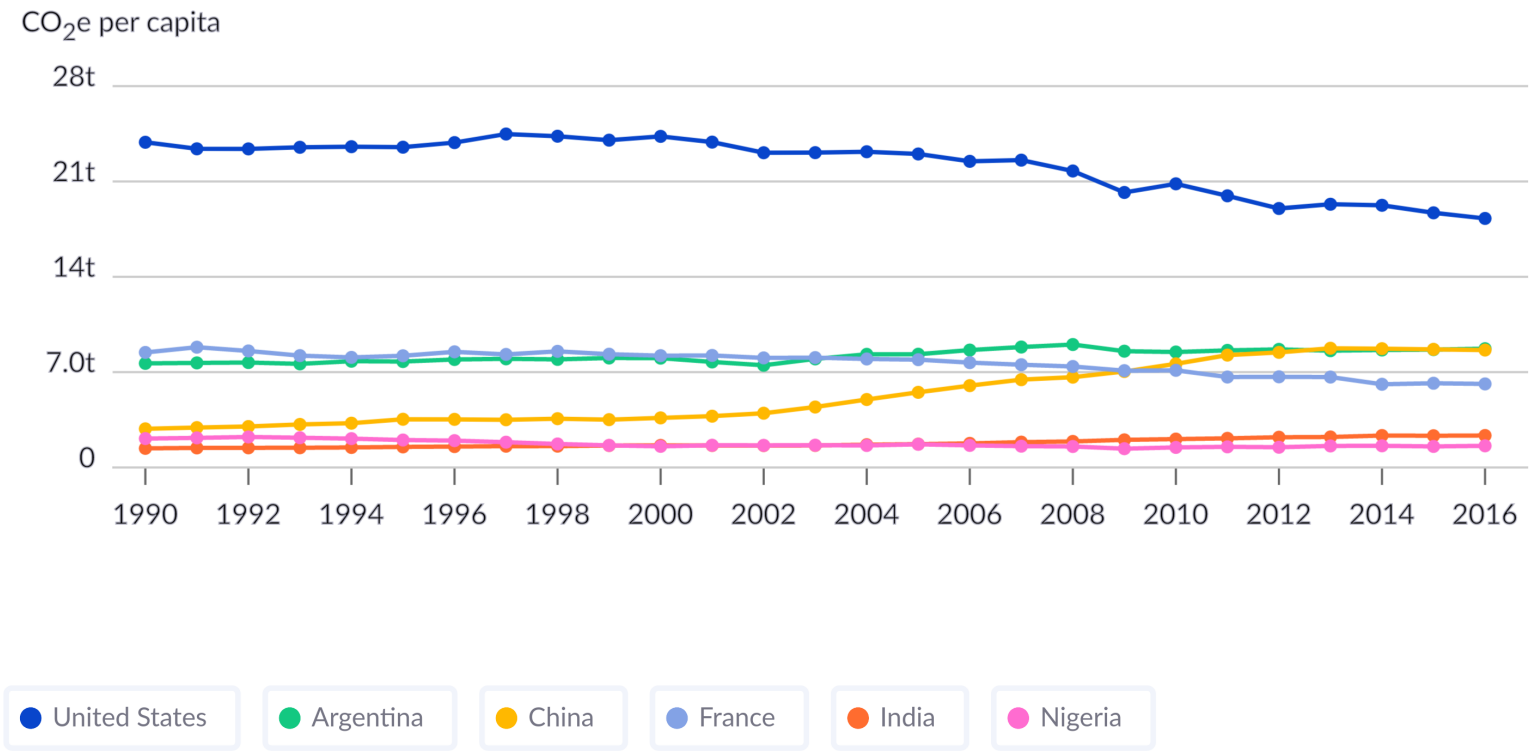


Selected Country Emissions *per capita*

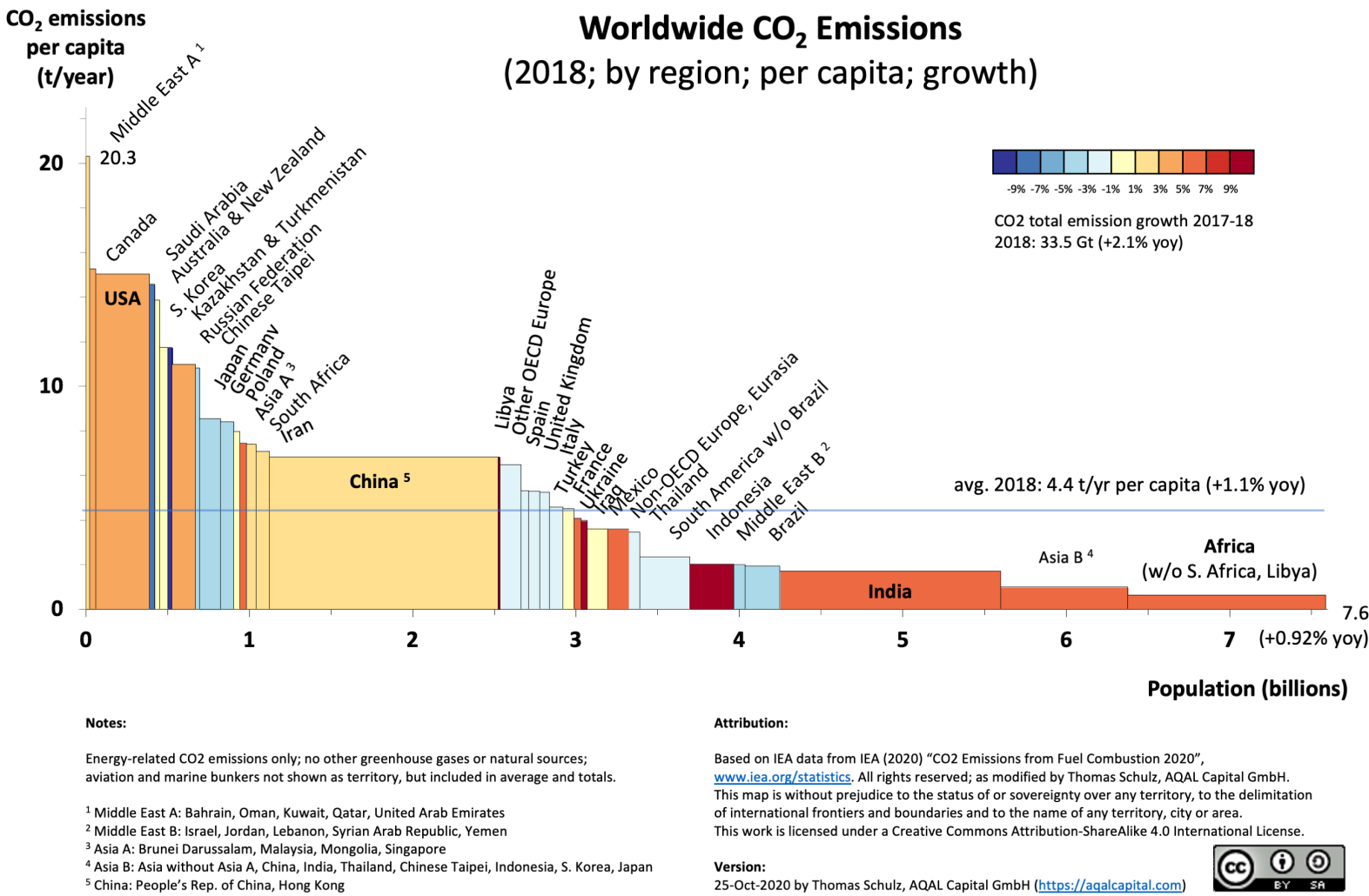
Historical GHG emissions

CLIMATEWATCH

Data source: CAIT; Countries/Regions: Argentina, China, France, India, Nigeria, United States; Sectors/Subsectors: Total excluding LUCF; Gases: All GHG; Calculation: per Capita; Show data by Countries.



Emissions by Country (CO_2 and not CO_2e)



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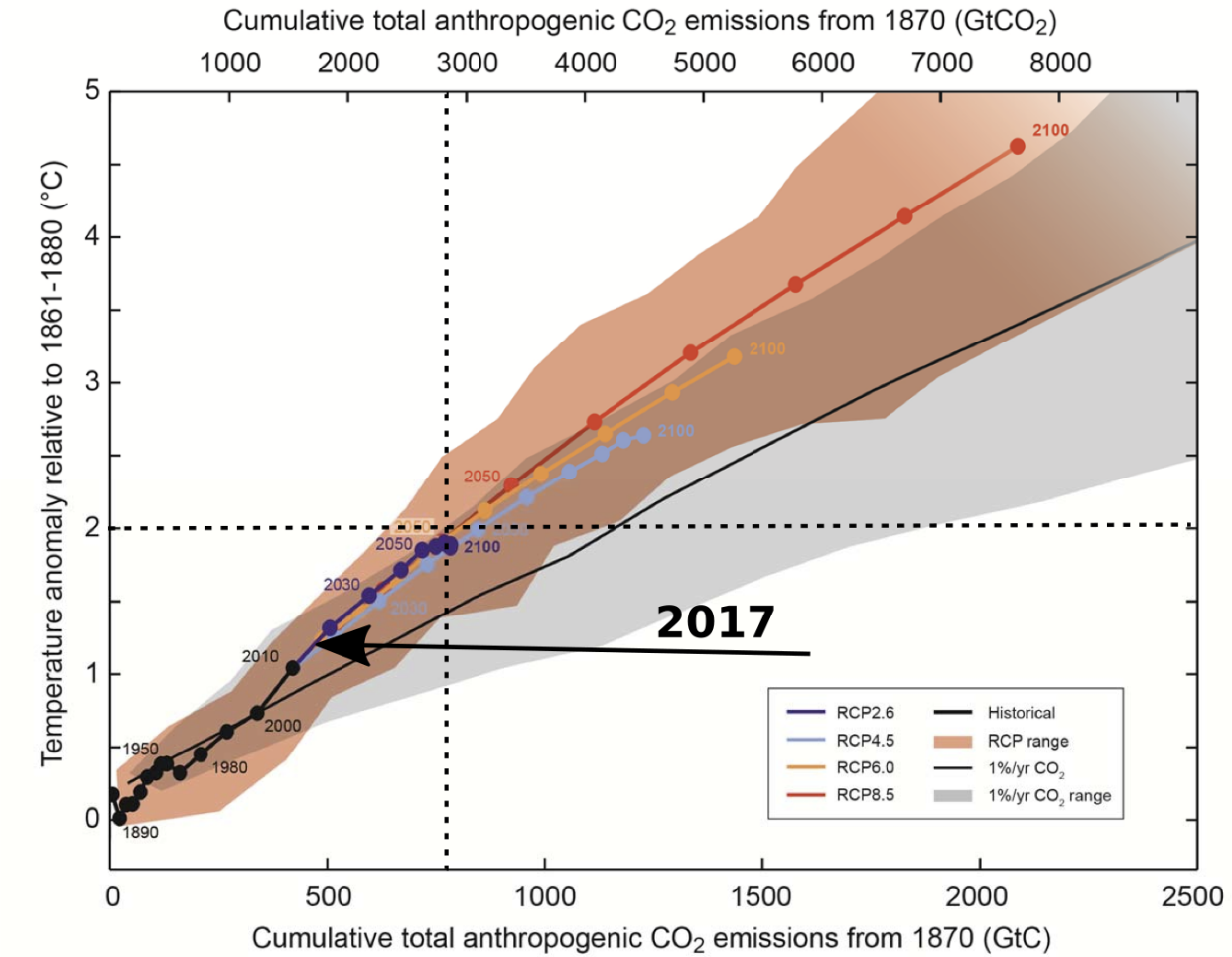
Measurement Details—Mostly Not Important for Big Picture

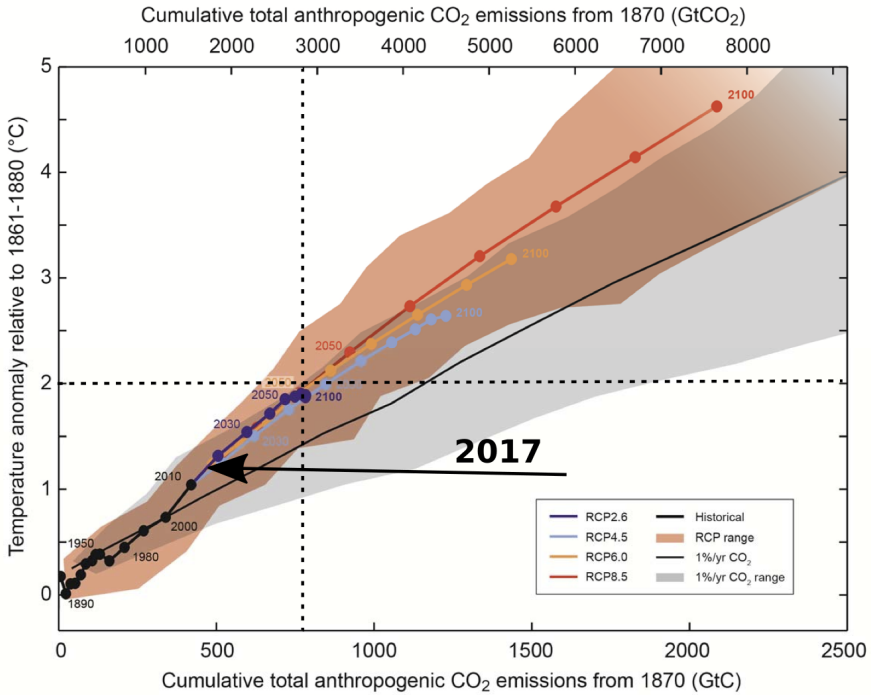
- CO_2 or all GHGs (methane, nitrous oxide, ...)
  - Other GHGs converted to CO_2 equivalent (CO_2e)
- Include emissions associated with land use change and forestry (LUCF)?
- IPPC estimates that emissions numbers accurate* within 10%.
- Include only emissions from burning fossil fuels?
- Ecologists measure C instead of CO_2. (One ton of C $\approx$ 3.7 tons of CO_2.)
- How account for international transport?

Emissions vs Warming



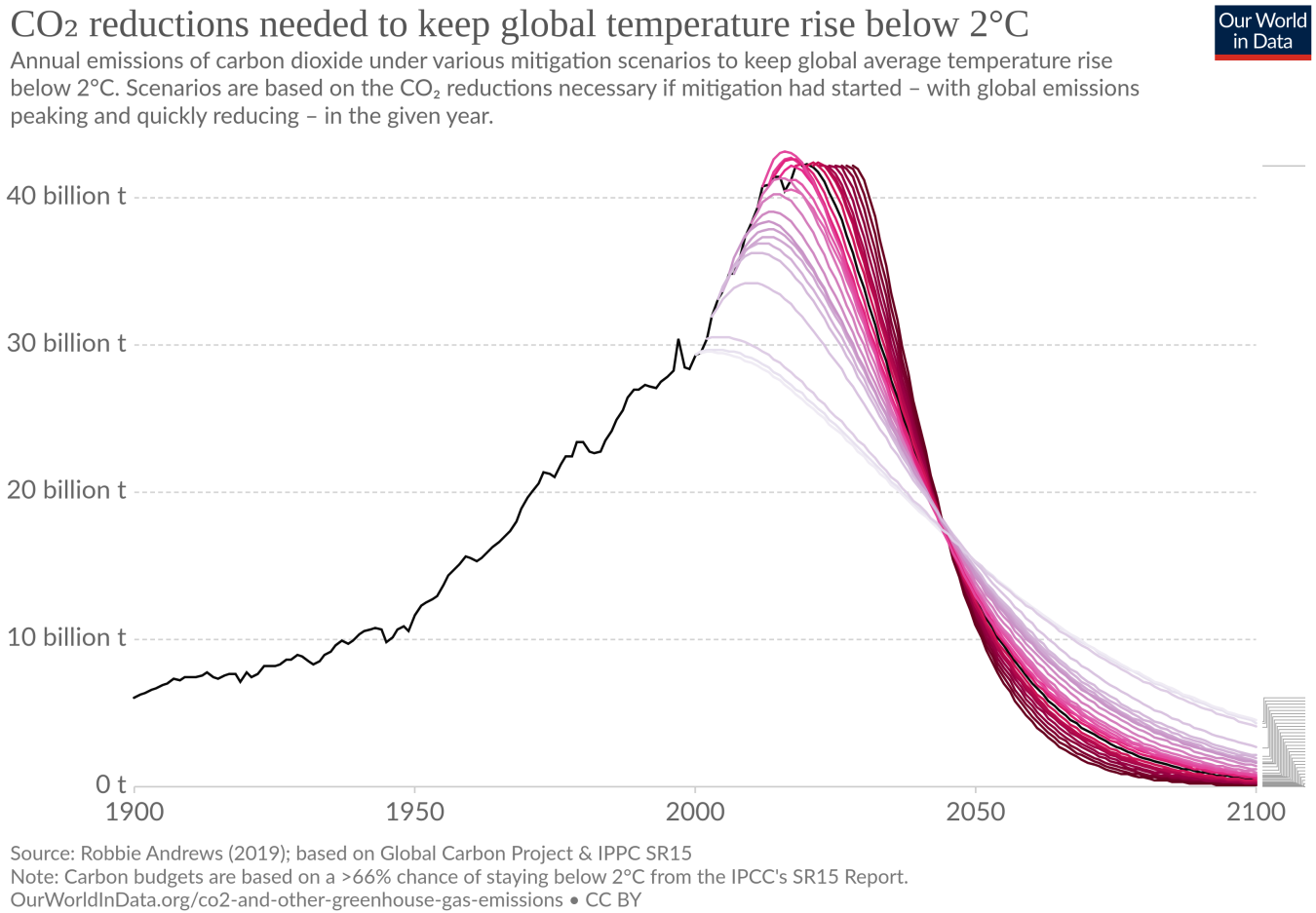
- Warming vs. emissions approximately linear
- ≈1000 Gt remaining before 2C of warming

Emissions vs Warming



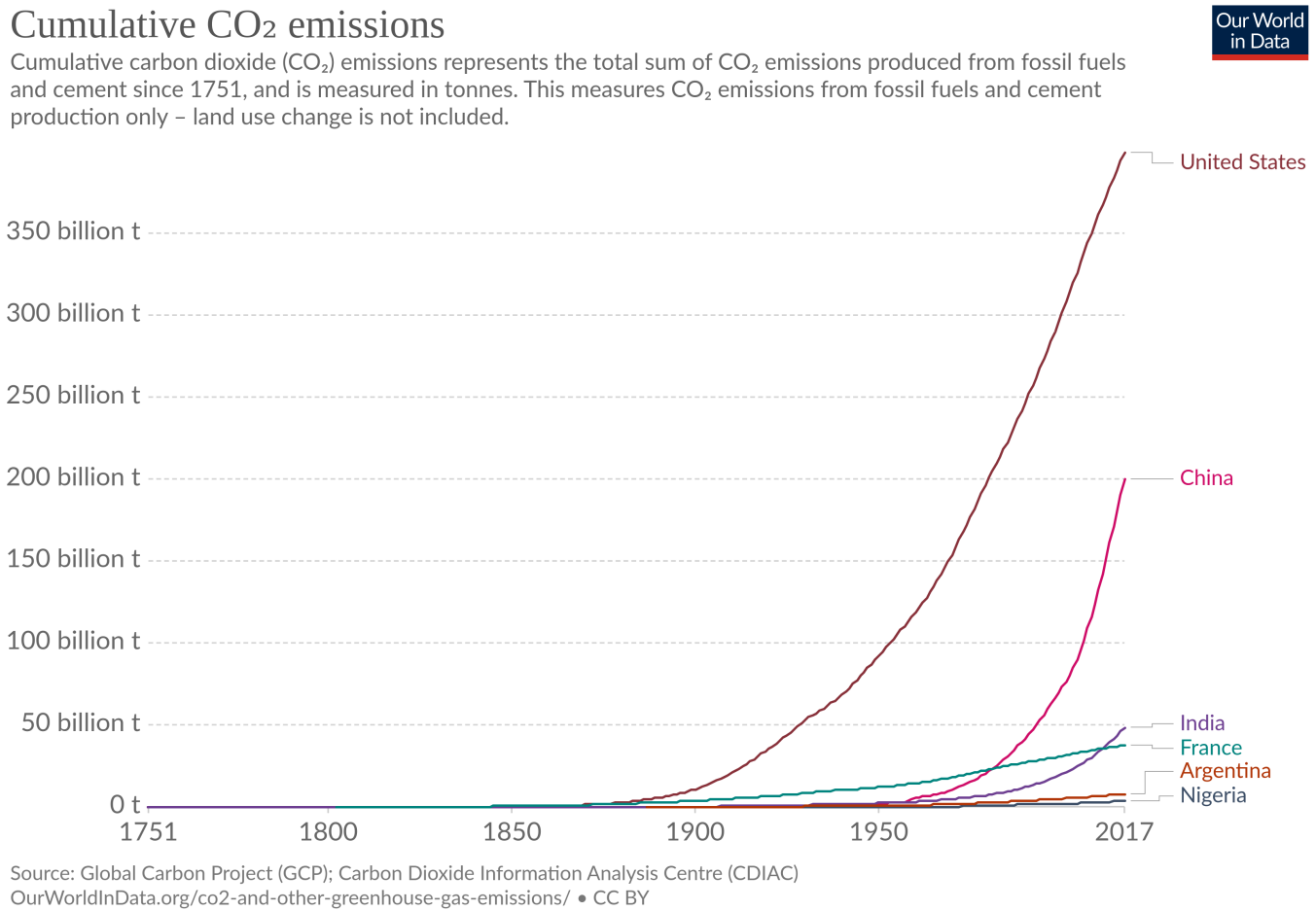
- Some disagreement over how many Gt we can emit before 2C of warming
- But regardless, we need to transition to **zero emissions**
- (Figure: IPPP AR5 Report Figure SPM10)

How to Keep Warming to 2C



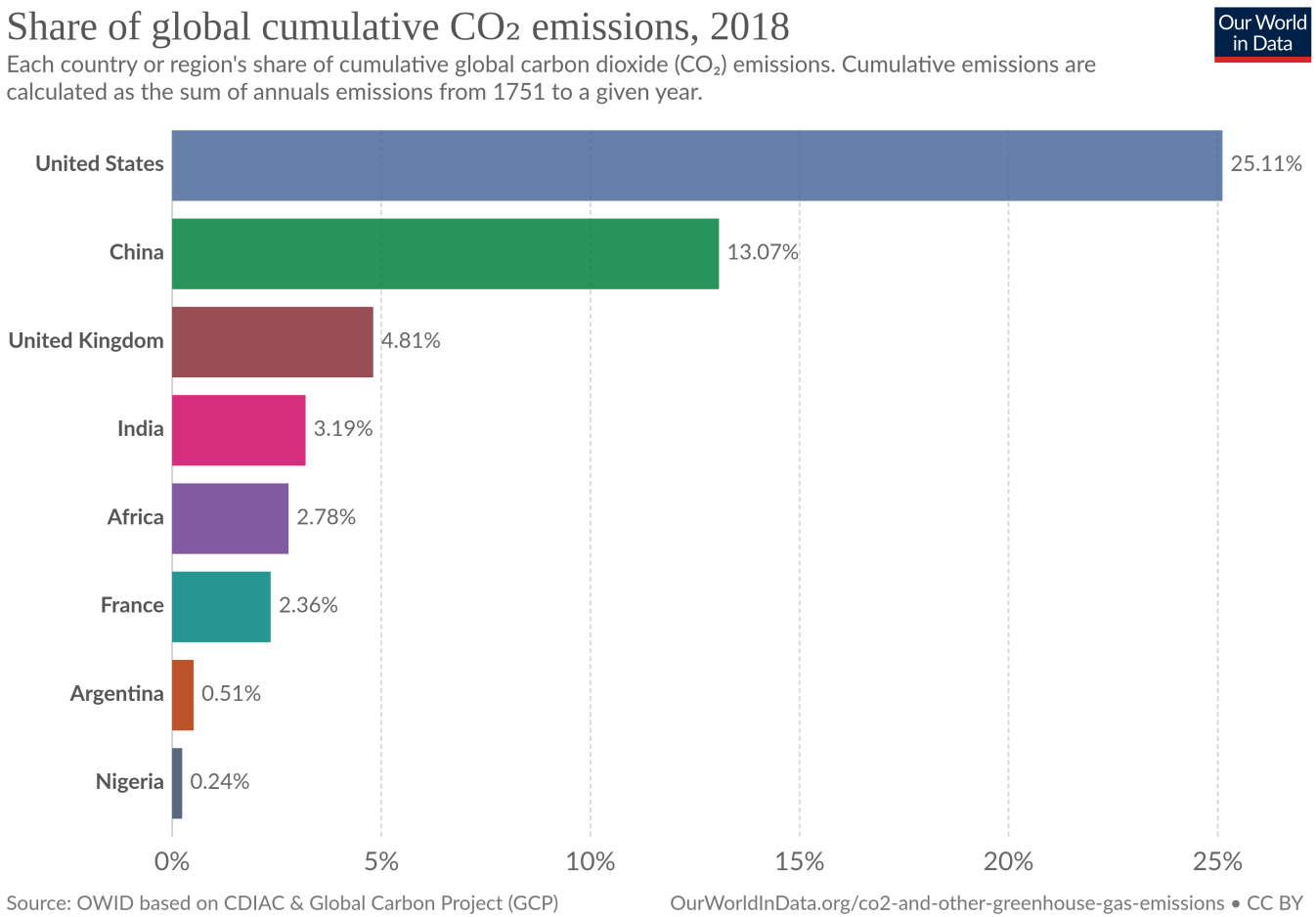
- We need to rapidly reduce emissions to zero.

Cumulative Emissions



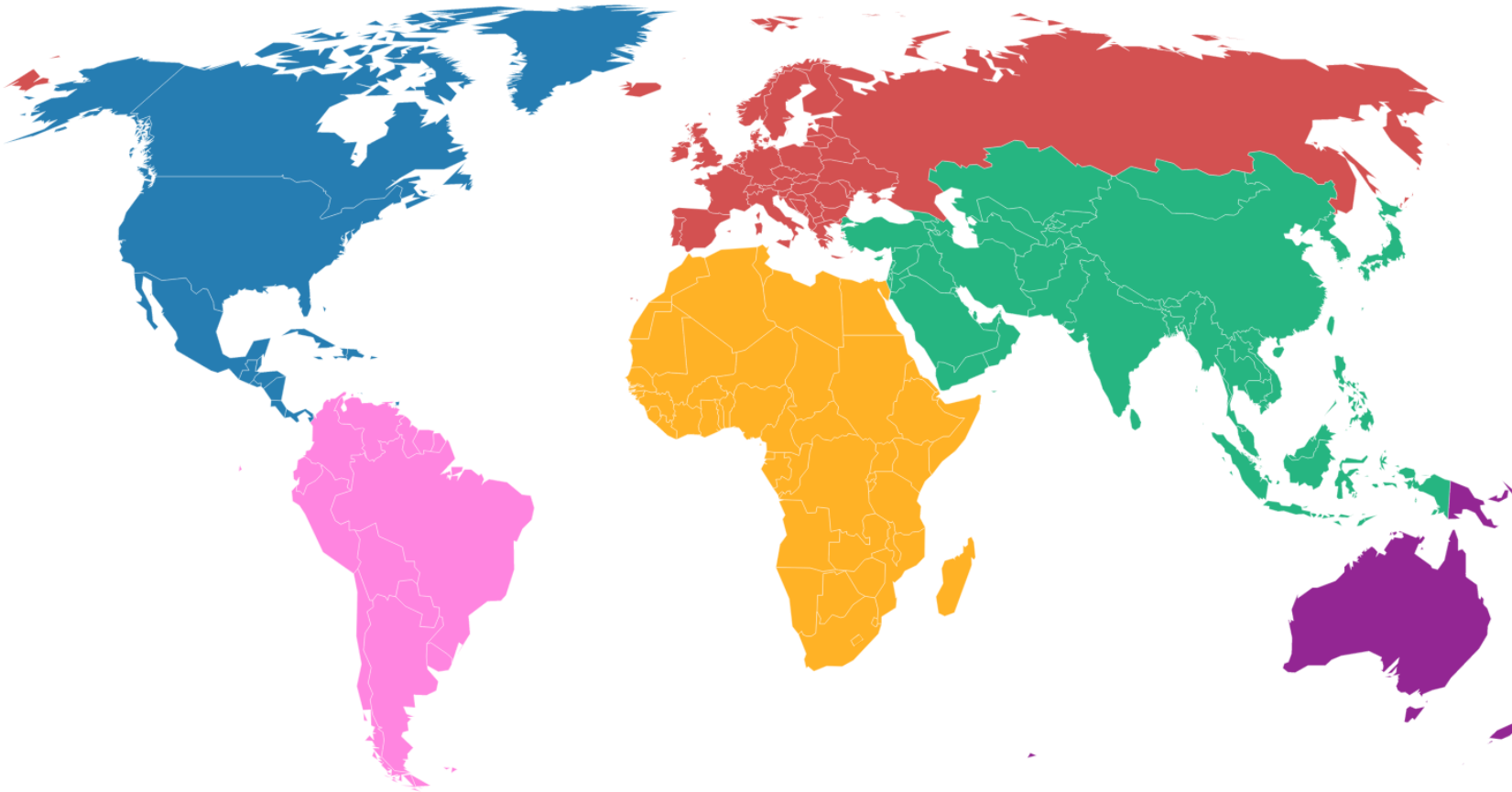
- Emissions are cumulative.
- So total historical emissions are relevant, not just present emissions.

Cumulative Emissions



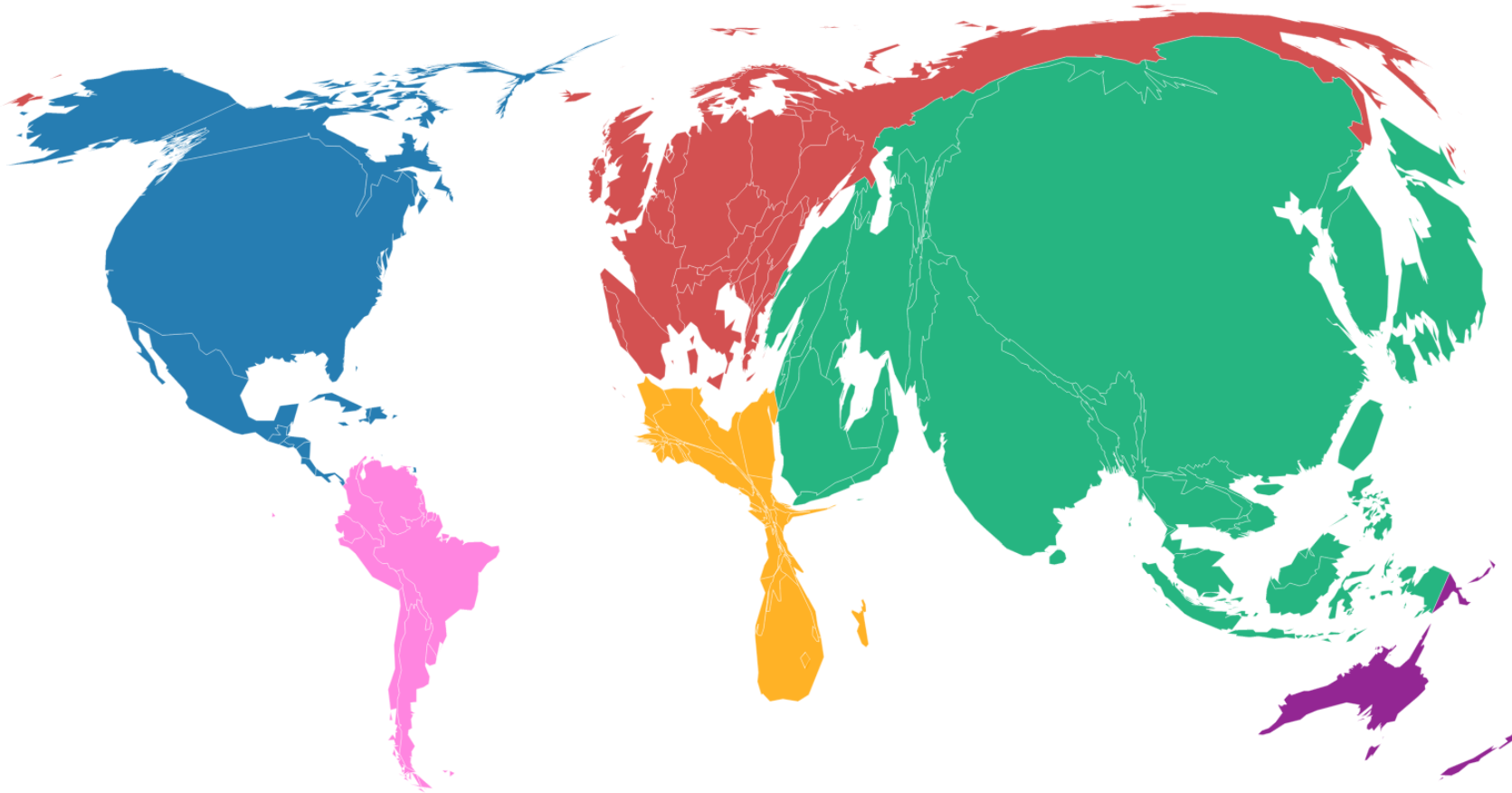
- Global North has emitted much more than the global south

A Map of the World



- http://www.carbonmap.org

Map Weighted by Current Emissions



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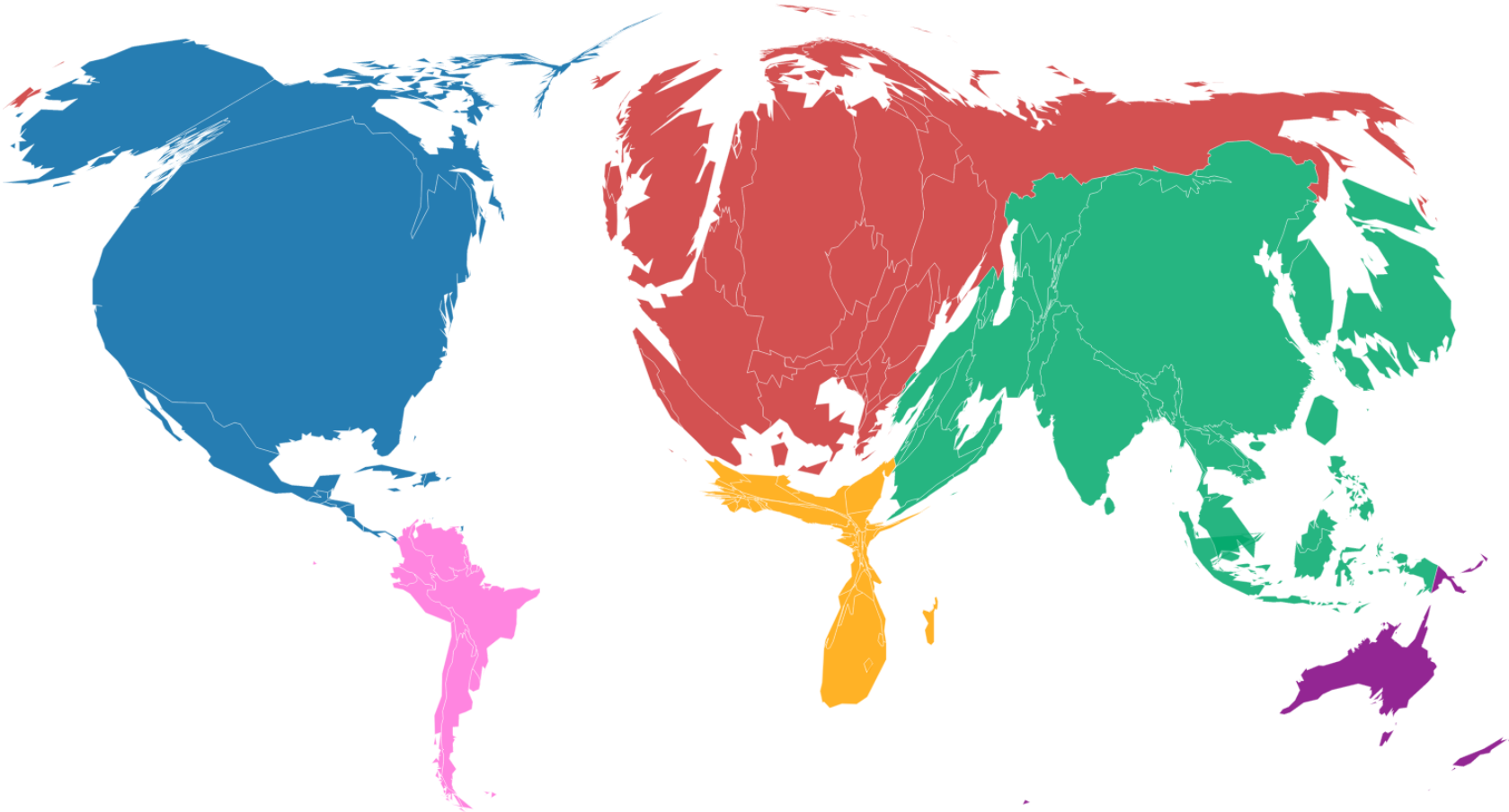
Map Weighted by Total Historical Emissions



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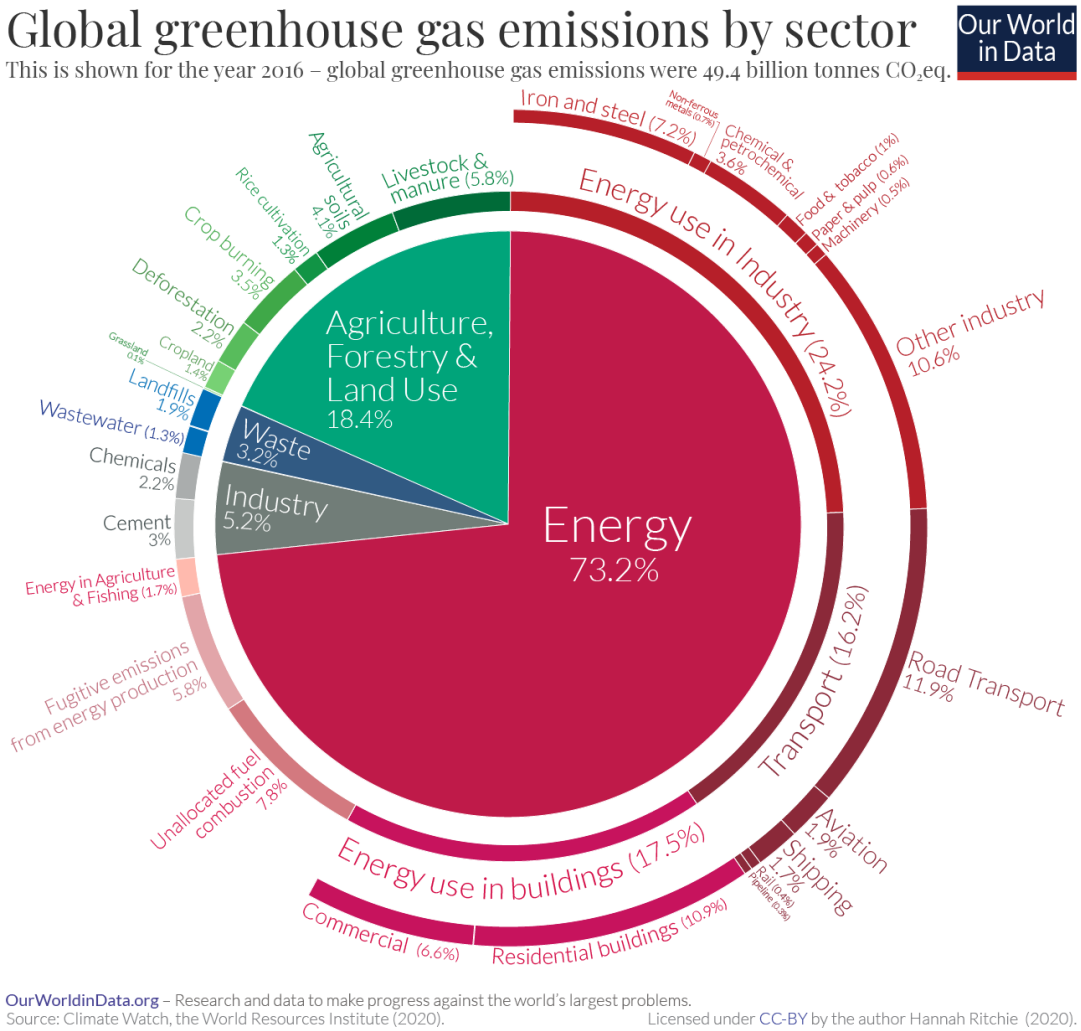
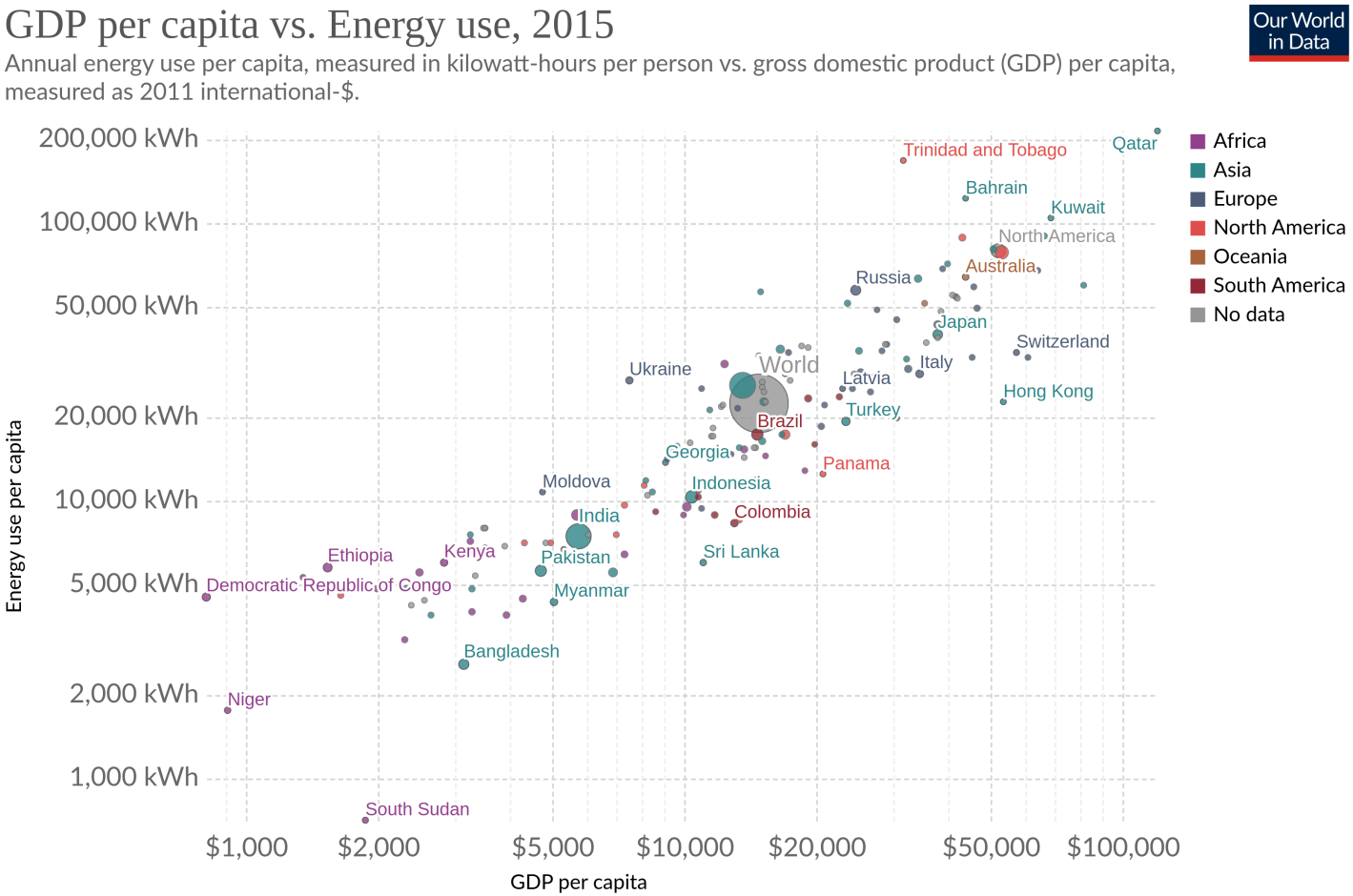
The Climate Problem is an Energy Problem



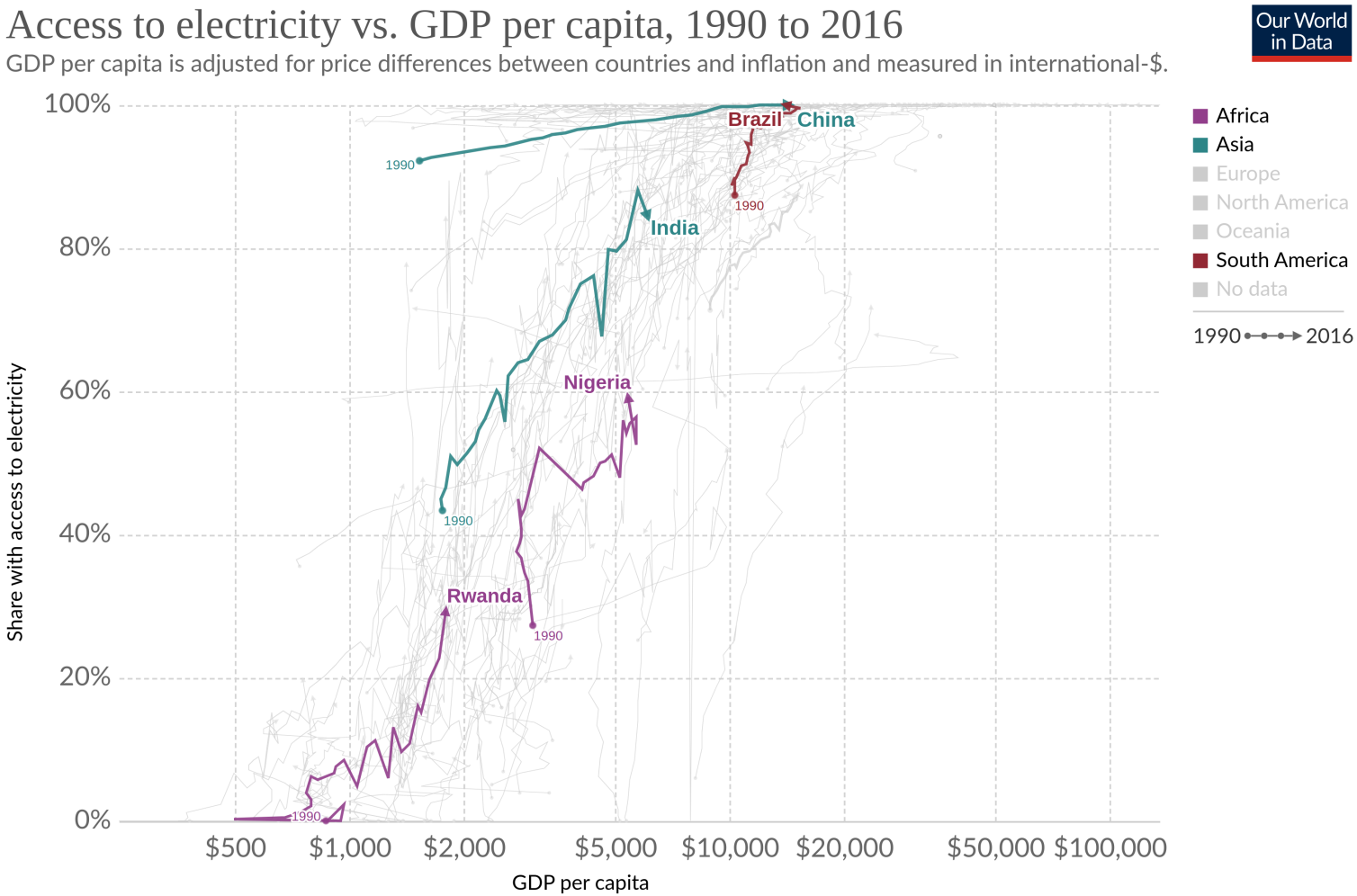
- About 3/4 of emissions due to energy use.

Energy is Associated with Prosperity



- Note the logarithmic axes

Access to Electricity is Good



Conclusions

- Effects of GHG emissions are cumulative.
- Different countries emit at different rates.
- Vast difference between North and South emissions.
- The climate problem is mostly (75%) an energy problem.
- Need to move to carbon-free energy system

Conclusions, continued

- For relatability, keep numbers between 1 and 1000
- Some key numbers:
  - World Emissions 6 tons CO_2e/p/year
  - US Emissions 18 tons CO_2e/p/year
  - Average US electricity: 1 lb CO_2/kWh
  - US Energy Use: 235 kWh/p/day
- Important to visualize data in different ways

References

- www.climatewatchdata.org/ghg-emissions
- ourworldindata.org/co2-and-other-greenhouse-gas-emissions
- https://ourworldindata.org/energy
- www.carbonmap.org
- https://flowcharts.llnl.gov/