

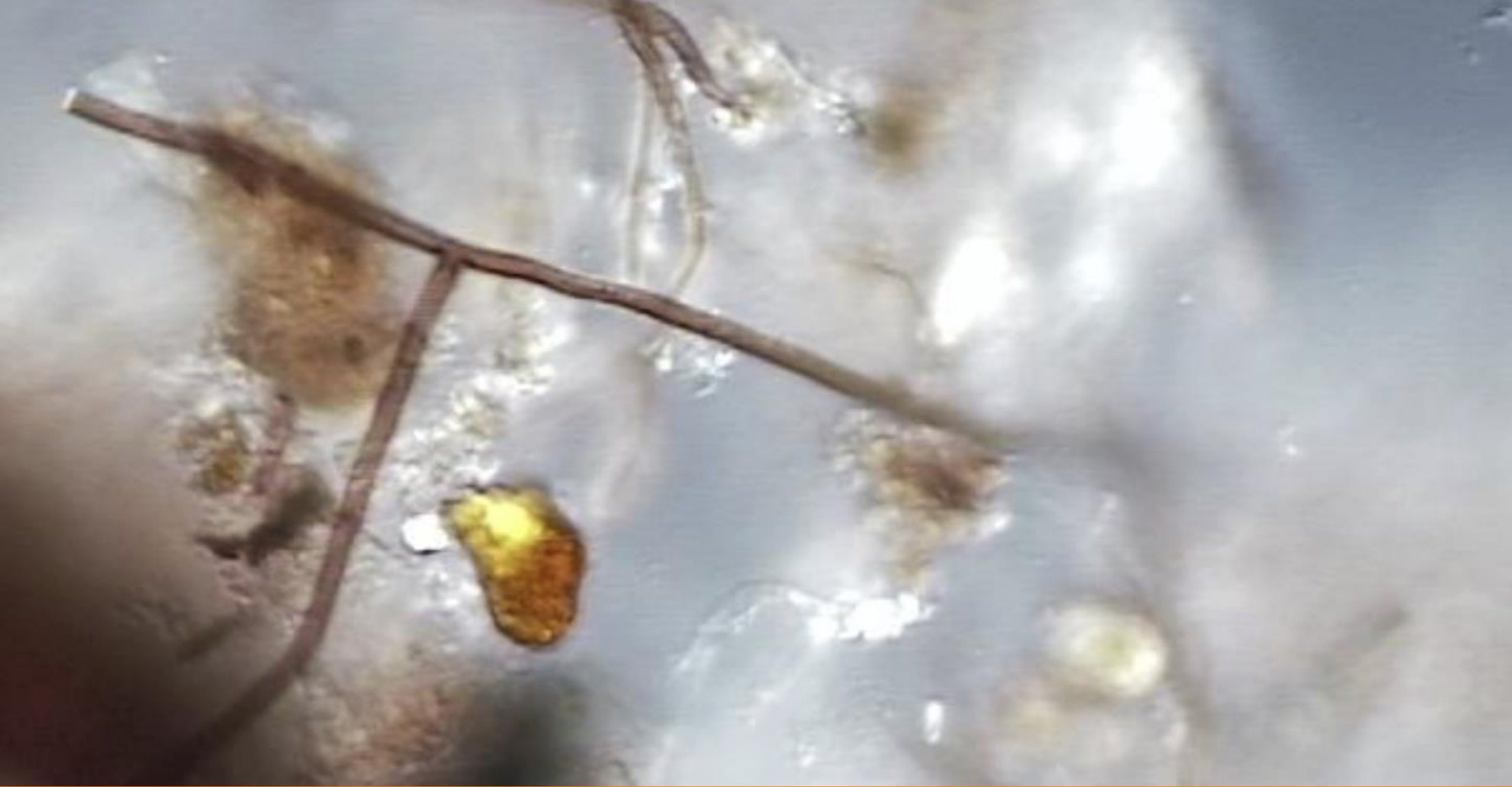
Capitalism and Crisis

ECOLOGICAL CRISIS

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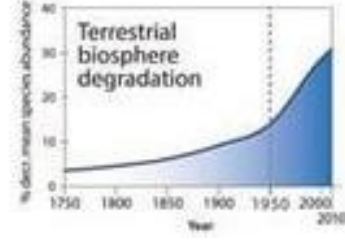
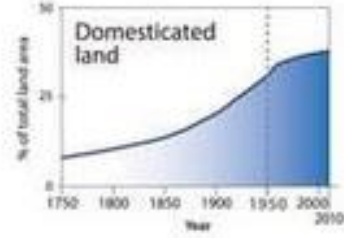
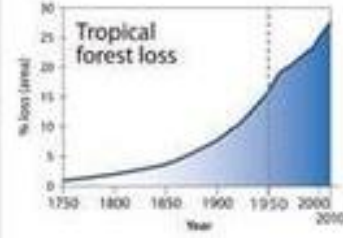
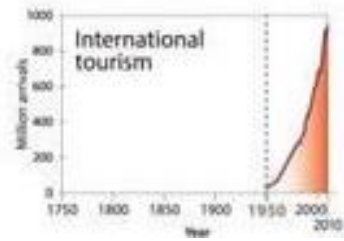
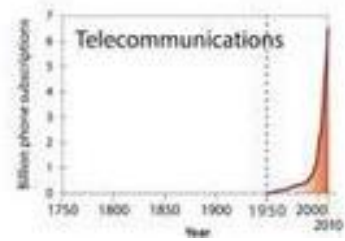
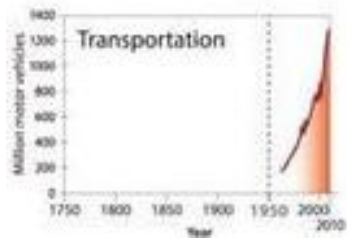
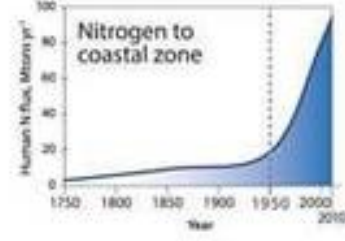
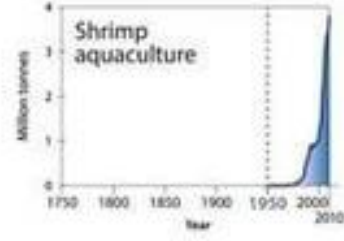
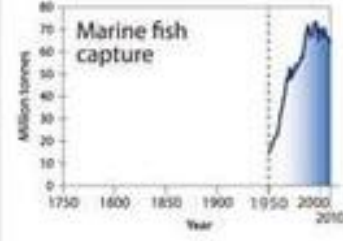
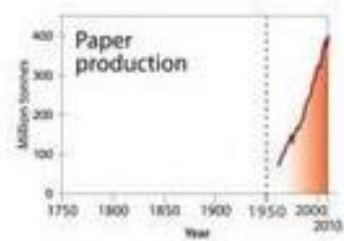
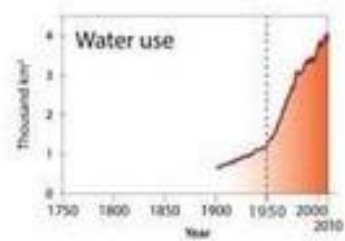
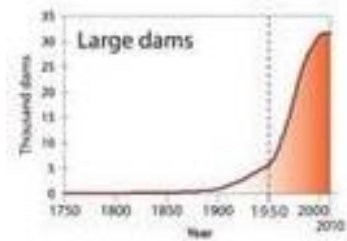
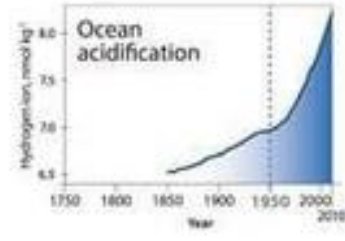
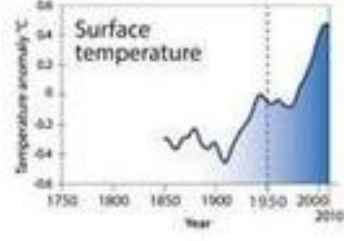
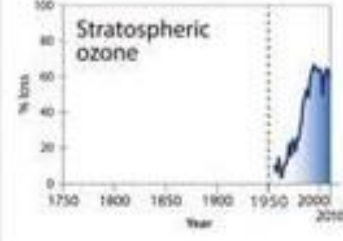
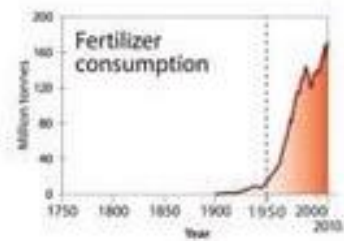
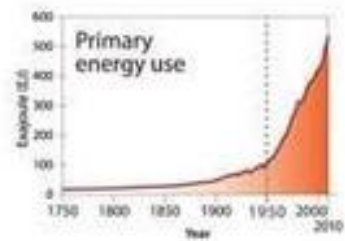
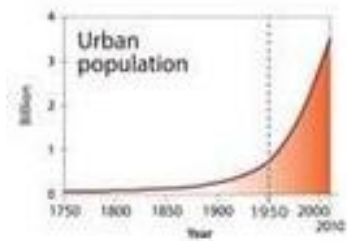
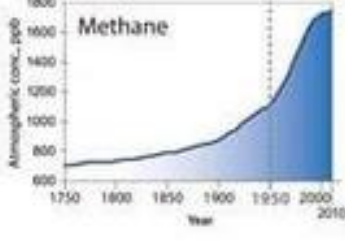
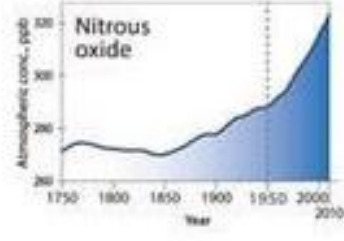
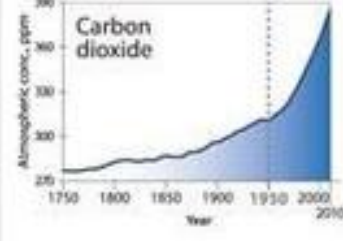
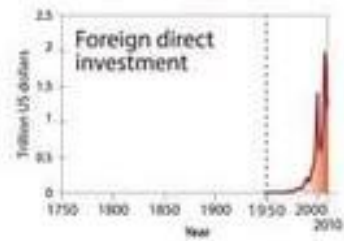
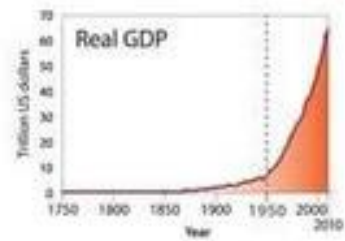
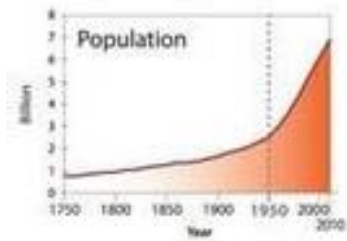
Live people eat
dead
mushrooms.
Live
mushrooms eat
dead people.











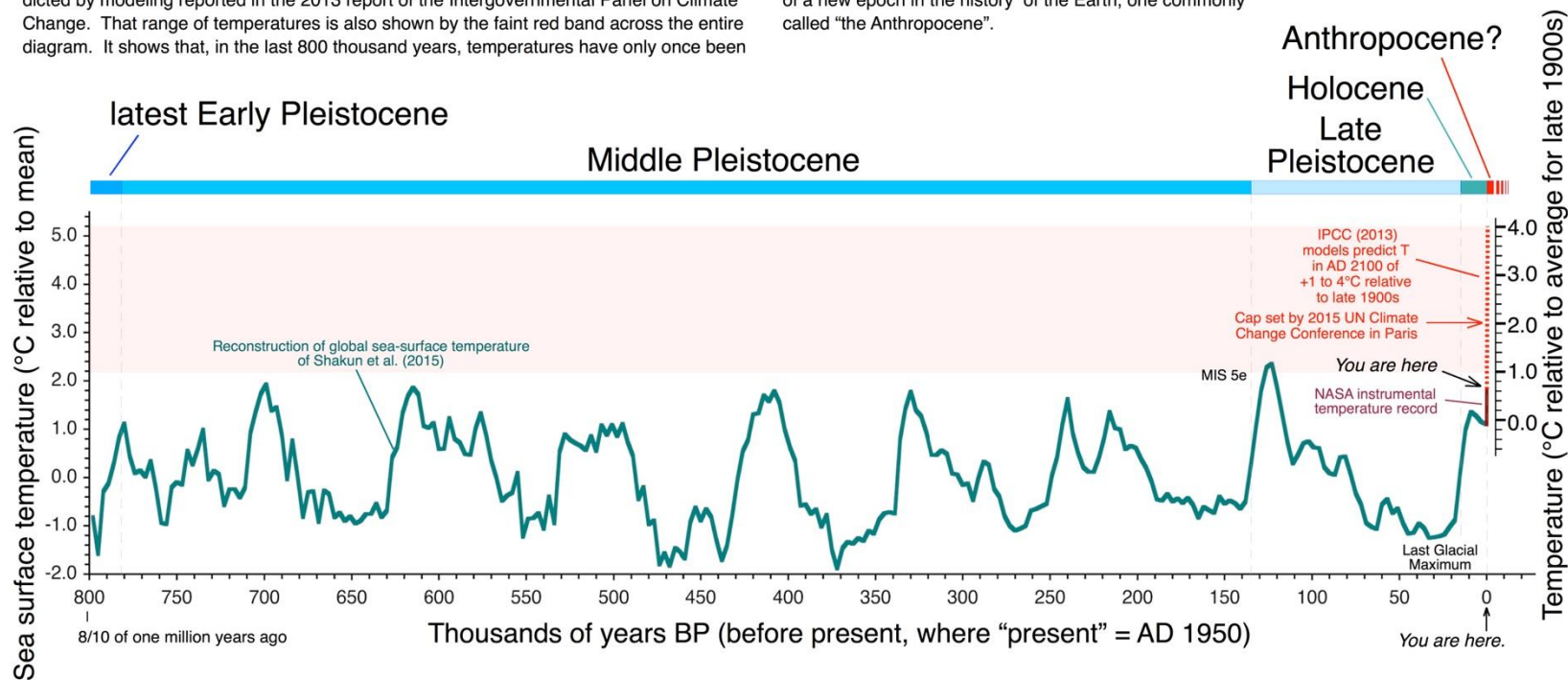
Temperatures from the Middle Pleistocene to the future

The diagram below shows in green a reconstruction of sea-surface temperature made from multiple marine sediment sequences, using the Mg/Ca ratios in the calcite (CaCO_3) of fossil planktic foraminifera. The record is plotted relative to its mean because temperatures at lower latitude locations were greater than those at high-latitude locations, but all show the same pattern and thus can be “stacked” to give one record of relative temperature.

In the rightmost part of the diagram, in the part representing the last 150 years, a dark red solid curve shows average Earth-surface temperature as derived from multiple thermometer records. A dashed bright red line shows the range of temperatures predicted by modeling reported in the 2013 report of the Intergovernmental Panel on Climate Change. That range of temperatures is also shown by the faint red band across the entire diagram. It shows that, in the last 800 thousand years, temperatures have only once been

as high as those expected by AD 2100. That one time was during the last interglacial, the Eemian or MIS 5e, when sea level was at least six meters higher than present.

Another FQS page shows the last 22 thousand years in more detail; it is called “Temperatures from the Last Glacial Maximum to the future”. Like this one, it shows that the rate of temperature increase in the last 150 years and the temperatures expected in the coming century are strikingly unlike those of the Holocene and Pleistocene. The changes that have happened and are expected are so great that they merit great concern from a societal standpoint and, from a geological standpoint, merit recognition of a new epoch in the history of the Earth, one commonly called “the Anthropocene”.



Sources, from left to right:

Shakun, J. D., Lea, D.W., Lisiecki, L.E., and Raymo, M.E., 2015, An 800-kyr record of global surface ocean $\delta^{18}\text{O}$ and implications for ice volume-temperature coupling. *Earth and Planetary Science Letters* 426, 58-68.

U.S. National Aeronautics and Space Administration (NASA) GISS Surface Temperature Analysis at data.giss.nasa.gov/gistemp/graphs_v3/ accessed 20 December 2015.

Intergovernmental Panel on Climate Change (IPCC), 2013. Summary for Policymakers.

In: Stocker, T.F., Qin, D., Plattner, G.-K., Tignor, M., Allen, S.K., Boschung, J., Nauels, A., Xia, Y., Bex, V., Midgley, P.M. (Eds.), *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Temperatures from the Last Glacial Maximum to the future

This page shows estimates of past variation in global temperature and model predictions of temperature change in the 21st century. Another *FQS* page shows a similar but much longer record, for the last 800 thousand years; that page is called "Temperatures

from the Last Glacial Maximum to the future". Both pages show that the predicted warming is unprecedented in recent geologic history.

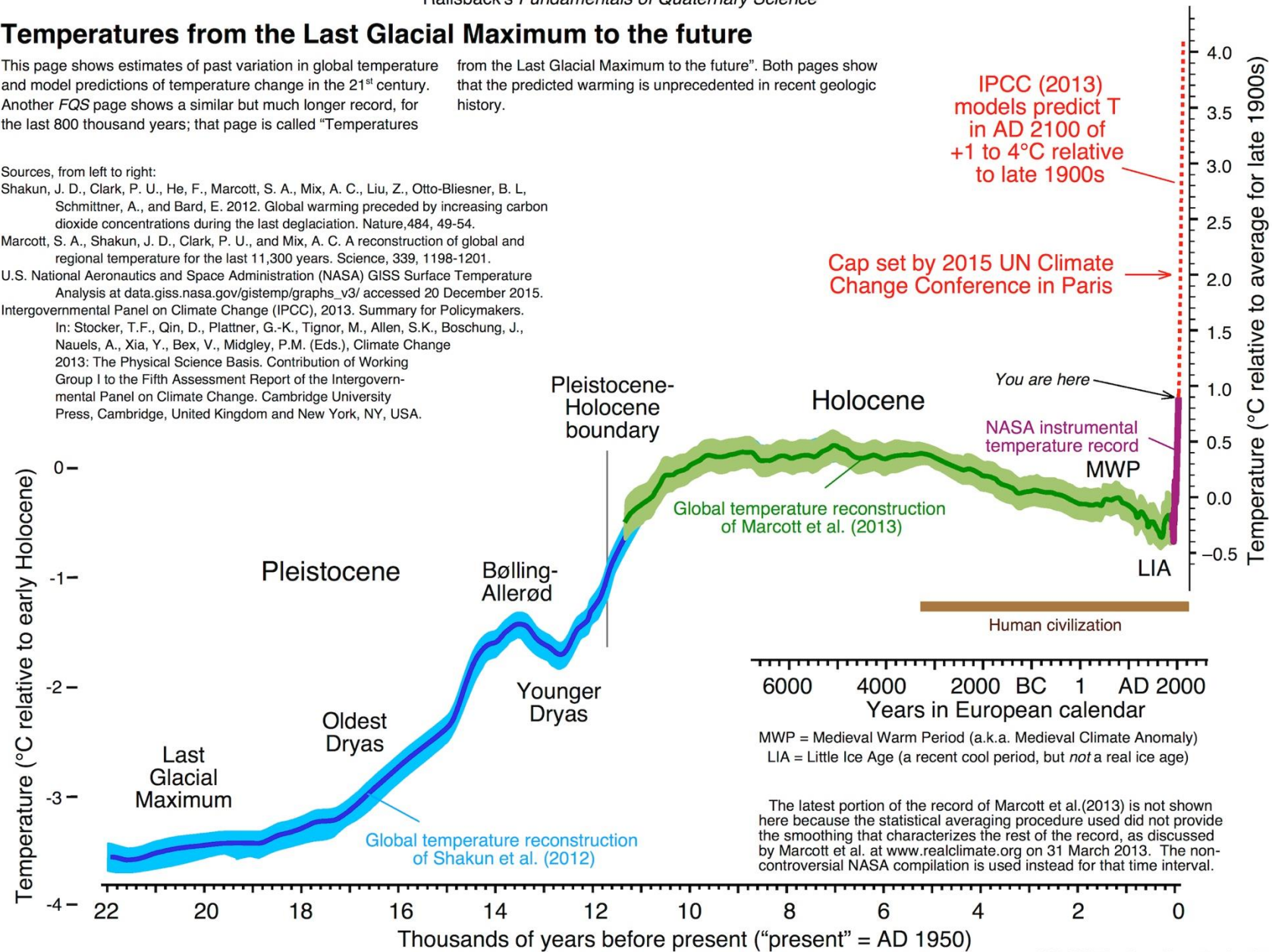
Sources, from left to right:

Shakun, J. D., Clark, P. U., He, F., Marcott, S. A., Mix, A. C., Liu, Z., Otto-Bliesner, B. L., Schmittner, A., and Bard, E. 2012. Global warming preceded by increasing carbon dioxide concentrations during the last deglaciation. *Nature*, 484, 49-54.

Marcott, S. A., Shakun, J. D., Clark, P. U., and Mix, A. C. A reconstruction of global and regional temperature for the last 11,300 years. *Science*, 339, 1198-1201.

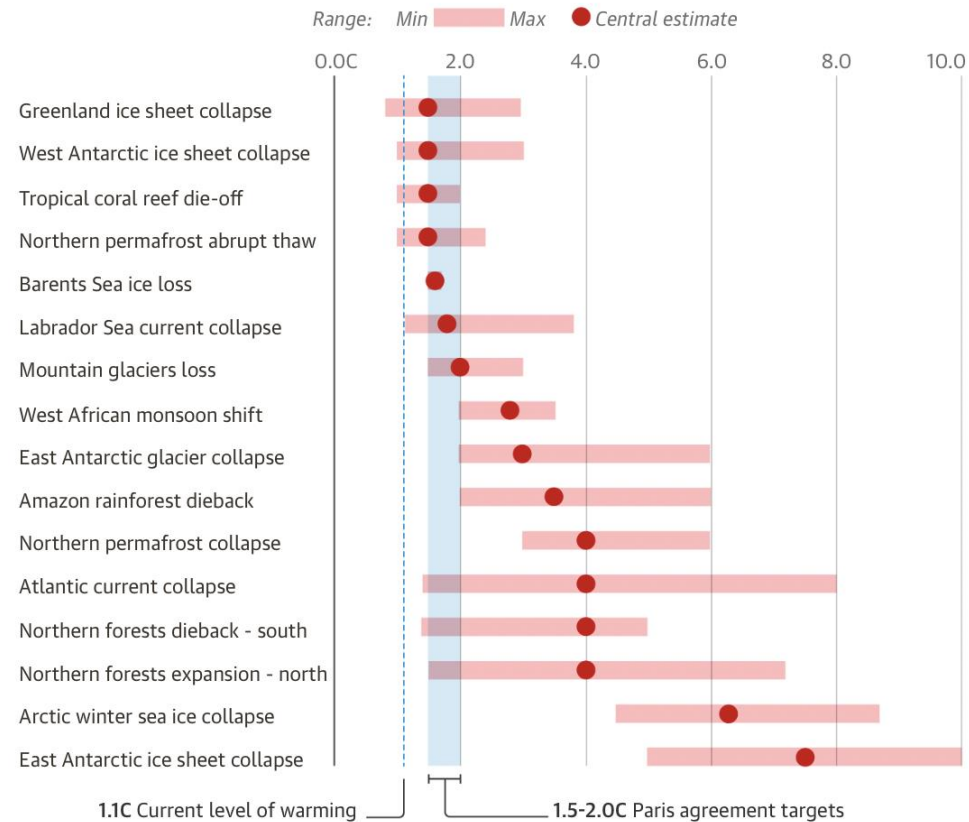
U.S. National Aeronautics and Space Administration (NASA) GISS Surface Temperature Analysis at data.giss.nasa.gov/gistemp/graphs_v3/ accessed 20 December 2015.

Intergovernmental Panel on Climate Change (IPCC), 2013. Summary for Policymakers. In: Stocker, T.F., Qin, D., Plattner, G.-K., Tignor, M., Allen, S.K., Boschung, J., Nauels, A., Xia, Y., Bex, V., Midgley, P.M. (Eds.), *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

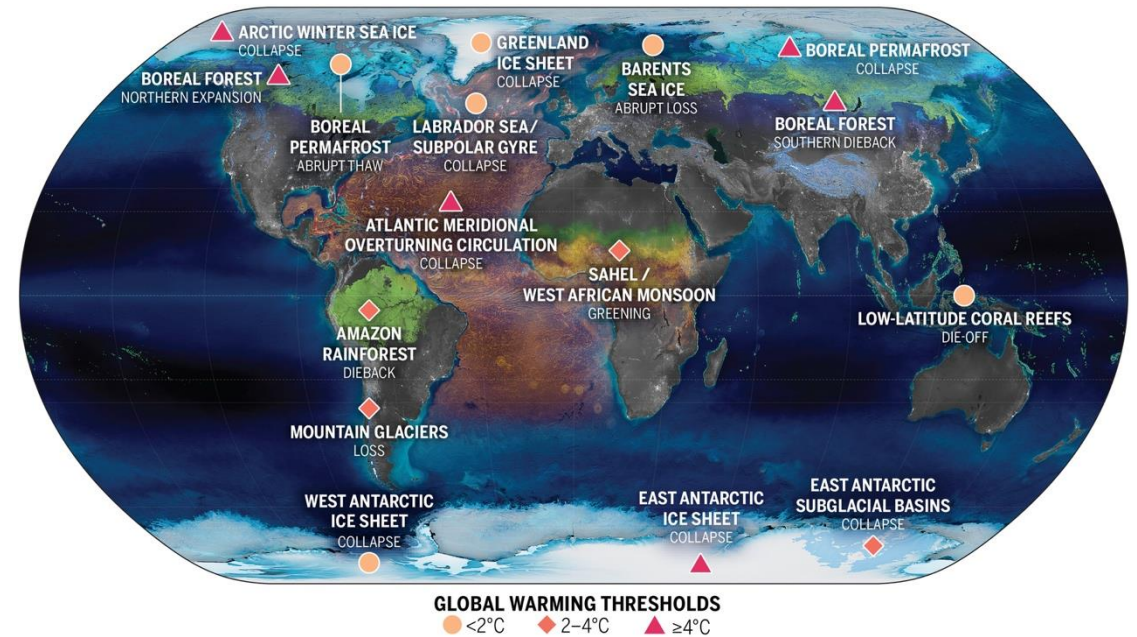


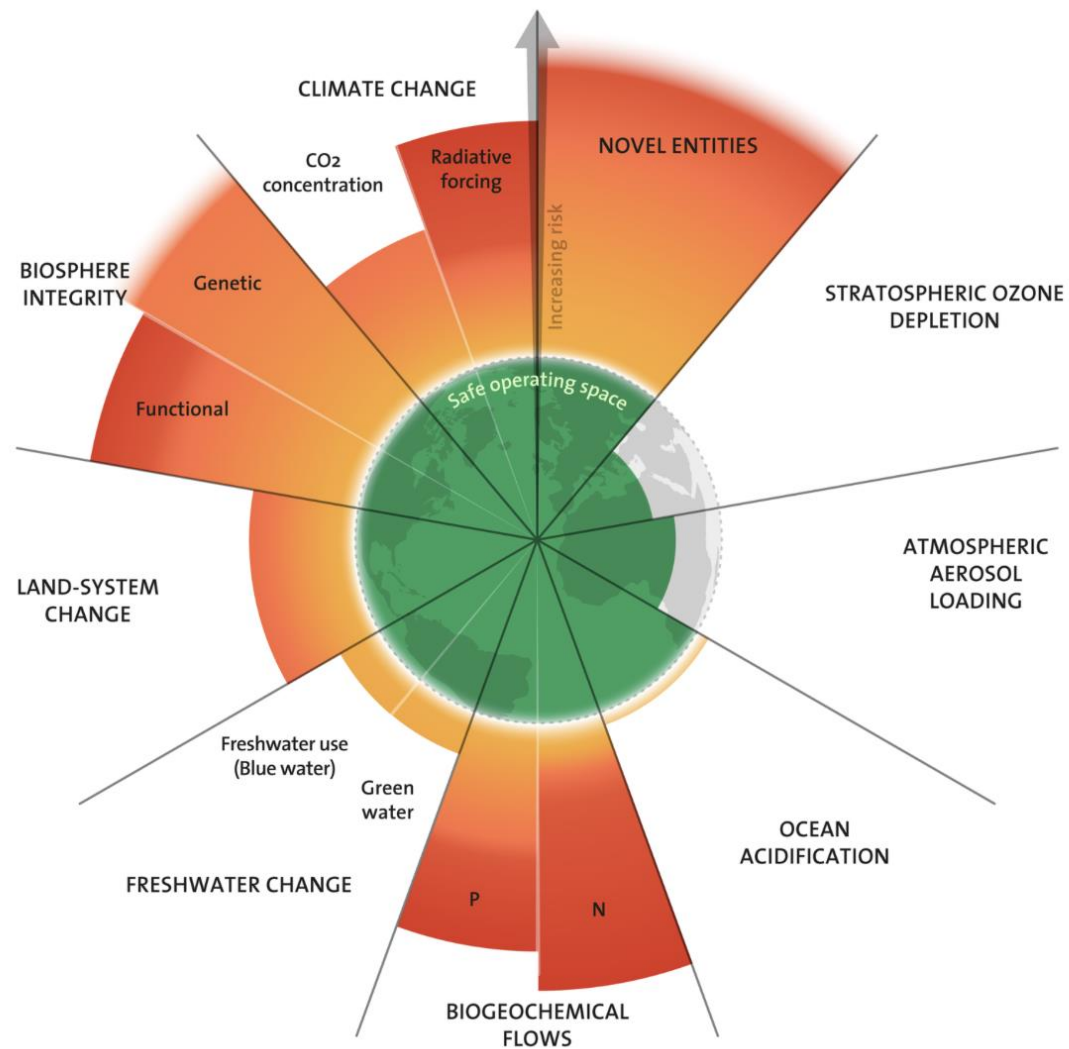
The risk of climate tipping points is rising rapidly as the world heats up

Estimated range of global heating needed to pass tipping point temperature



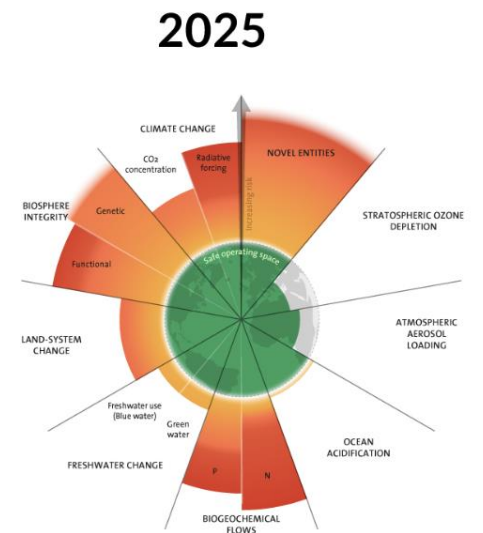
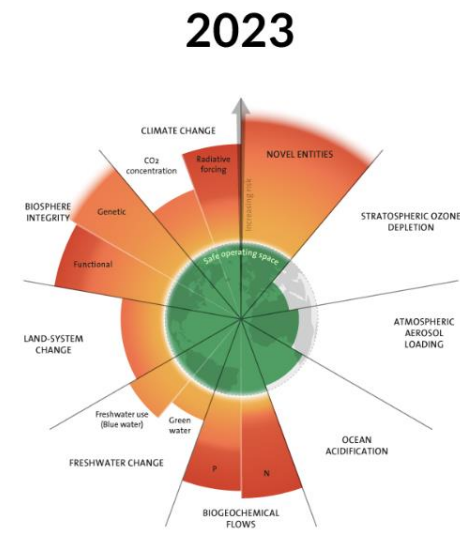
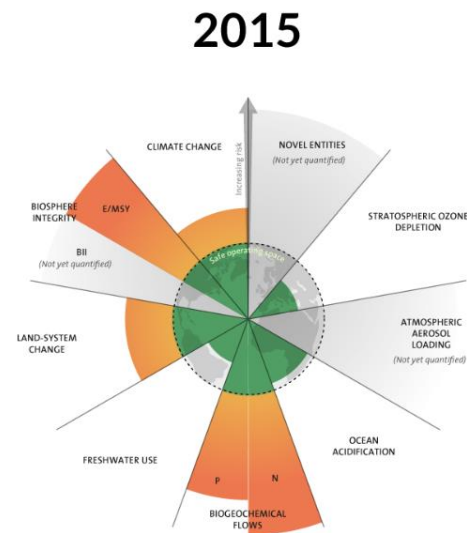
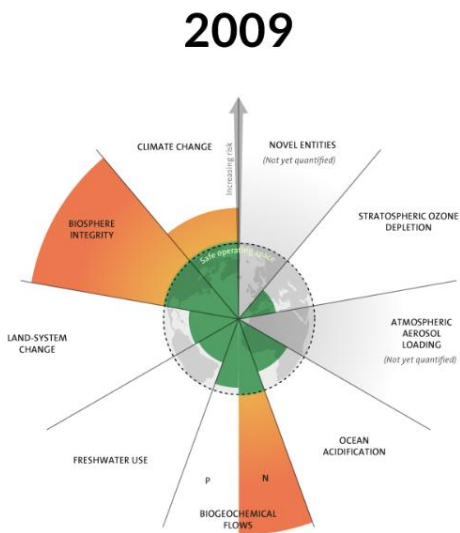
Guardian graphic. Source: Armstrong McKay et al, Science, 2022. Note: Current global heating temperature rise 1.1°C Paris agreement targets 1.5-2.0°C





The 2025 update to the Planetary boundaries. Licensed under CC BY-NC-ND 3.0. Credit: "Azote for Stockholm Resilience Centre, based on analysis in Sakschewski and Caesar et al. 2025".

Planetary boundaries



Global Temperature Rise

[Global Temperature Rise](#)

[Ice Sheets Melting](#)

- [Greenland Melting at Faster Rates](#)

[Arctic Sea Ice Sheets Melting](#)

[Carbon Dioxide Production](#)

[Sea Level Rise](#)

[Ocean Heat](#)

Planetary Limitations

What are the nine planetary limitations? Please describe one of the planetary limitations below?

Group 1 – What is biospheric integrity?

Group 2 – What is climate change?

Group 3 – What are novel entities?

Group 4 – What is stratospheric ozone depletion?

Group 5 – What is freshwater change?

Group 6 – What is ocean acidification?

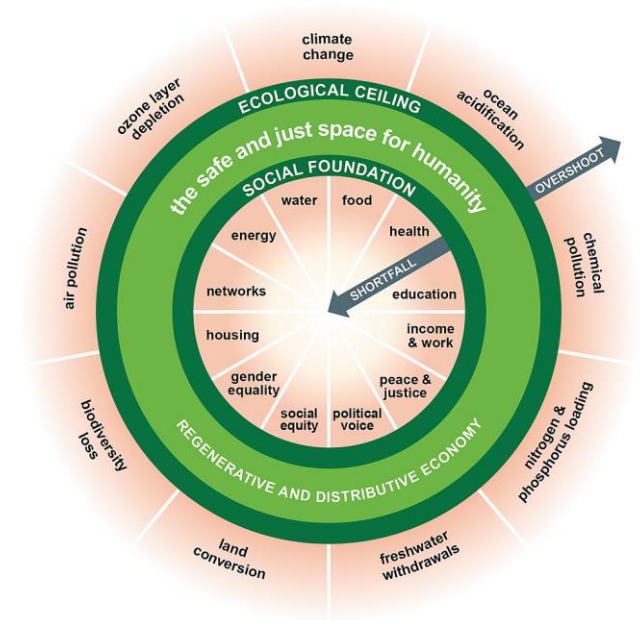
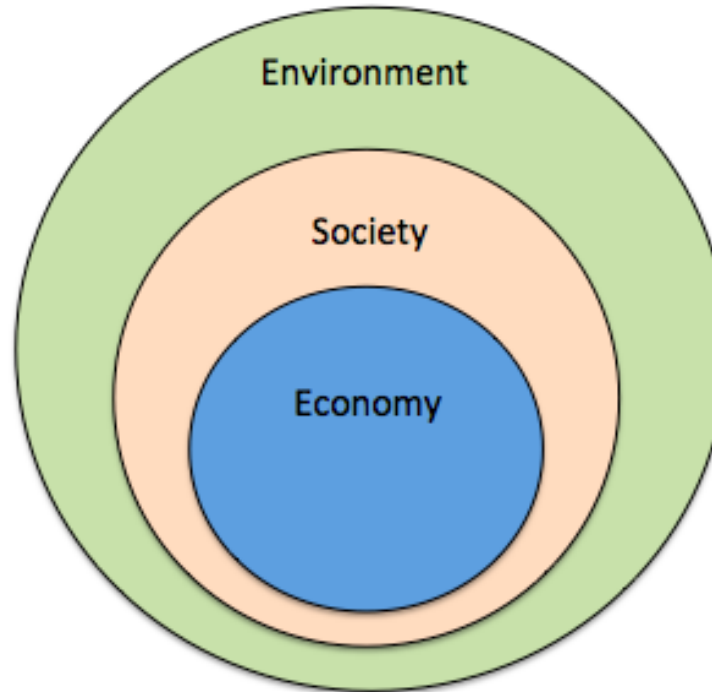
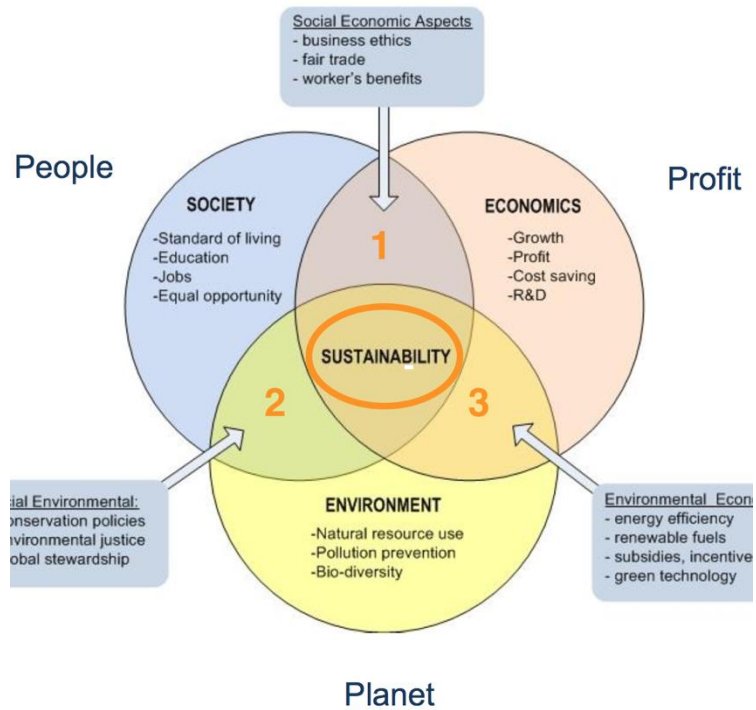
Group 7 – What are biochemical flows?

Group 8 – What is land system change?

Group 9 – What is atmospheric aerosol loading?

- How are humans pushing the planet towards each of these limitations?
- How can we prevent surpassing these planetary limitations?
- How is your topic (below) connected with the other issues (also below)?
- Why is this topic important? What is the context (summarize introduction and discussion)?
- How did your other weekly reading relate to the discussion about planetary limitations?

[Planetary Boundaries Website for More Information](#)



Discussion Question

How can we develop political and economic systems that are part of the solution to ecological, social and economic issues?

- Desirable?
- Viable?
- Achievable on a Meaningful Scale?

Reports About Rapid Ecological Change

[IPCC Reports](#)

Older Publications

[Millennium Ecosystem Assessment](#)

[International Geosphere-Biosphere Program](#)



Thank You!

Questions, concerns, comments?