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Figure 15.38 Committed temperature increases under the constant concentration scenario of CO2 in the atmosphere and the zero emissions scenario <a href="https://www.carbonbrief.org/explainer-will-global-warming-stop-as-soon-as-net-zero-emissions-are-reached?utm_campaign=Daily%20Briefing&utm_content=20220224&utm_medium=email&ut_mill_global_marming-stop-as-soon-as-net-zero-emissions-are-reached?utm_campaign=Daily%20Briefing&utm_content=20220224&utm_medium=email&ut_mill_global_marming-stop-as-soon-as-net-zero-emissions-are-reached?utm_campaign=Daily%20Briefing&utm_content=20220224&utm_medium=email&ut_mill_global_marming-stop-as-soon-as-net-zero-emissions-are-reached?utm_campaign=Daily%20Briefing&utm_content=20220224&utm_medium=email&ut_mill_global_marming-stop-as-soon-as-net-zero-emissions-are-reached?utm_campaign=Daily%20Briefing&utm_content=20220224&utm_medium=email&ut_mill_global_marming-stop-as-soon-as-net-zero-emissions-are-reached?utm_campaign=Daily%20Briefing&utm_content=20220224&utm_medium=email&ut_mill_global_marming-stop-as-soon-as-net-zero-emissions-are-reached?utm_campaign=Daily%20Briefing&utm_content=20220224&utm_medium=email&ut_mill_global_marming-stop-as-soon-as-net-zero-emissions-are-reached.

Figure 15.39 Temperature increases under zero emission scenarios: zero CO2 (no change in other GHGs or aerosols), zero CO2 and aerosols, zero GHGs (no change in aerosols) and zero GHGs and aerosols https://www.carbonbrief.org/explainer-will-global-warming-stop-as-soon-as-net-zero-emissions-are-

<u>reached?utm_campaign=Daily%20Briefing&utm_content=20220224&utm_medium=email&utm_content=20220224&utm_medium=email&utm_content=20220224&utm_medium=email&utm_content=20220224&utm_medium=email&utm_content=20220224&utm_medium=email&utm_content=20220224&utm_medium=email&utm_content=20220224&utm_medium=email&utm_content=20220224&utm_medium=email&utm_content=20220224&utm_medium=email&utm_content=20220224&utm_medium=email&utm_content=20220224&utm_medium=email&utm_content=20220224&utm_medium=email&utm_content=20220224&utm_medium=email&utm_content=20220224&utm_medium=email&utm_content=20220224&utm_medium=email&utm_content=20220224&utm_medium=email&utm_content=20220224&utm_medium=email&utm_content=20220224&utm_content=2022024&utm_content=2022024&utm_content=2022024&utm_content=20220224&utm_content=2022024&utm_content=2022024&utm_content=2022024&utm_content=2022024&utm_content=2022024&utm_content=2022024&utm_c</u>

Figure 16.1 Atmospheric concentrations of greenhouse gases, carbon dioxide, methane, and nitrous oxide over the past 2000 years.

https://www.canr.msu.edu/resources/greenhouse gas basics e3148

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Figure 16.6 Ocean acidification.

m source=Revue%20newsletter.

https://www.oceanacidification.org.uk/

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Figure 16.7 Buoys providing real-time data on ocean pH in north Pacific Ocean. https://www.pacioos.hawaii.edu/projects/acid/

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https://www.arcticcentre.org/EN/arcticregion/Maps/Sea-Ice

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Figure 16.12 Arctic Sea ice extent by month to 2020. http://polarportal.dk/en/sea-ice-and-icebergs/sea-ice-extent0/

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http://nsidc.org/cryosphere/snow/climate.html
https://nsidc.org/cryosphere/seaice/processes/albedo.html

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https://www.sciencedirect.com/science/article/pii/S0012825218305907

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http://www.global-greenhouse-warming.com/permafrost.html and

https://www.nrcan.gc.ca/the-north/science/permafrost-ice-snow/permafrost/10961

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https://skepticalscience.com/The-speed-of-coastal-erosion-in-Eastern-Siberia AWI.html

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https://en.wikipedia.org/wiki/Territorial claims in the Arctic

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https://www.un.org/Depts/los/clcs new/submissions files/can1 84 2019/CDA ARC ES EN se cured.pdf

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http://woodshole.er.usgs.gov/project-pages/hydrates/

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https://www.nature.com/articles/s41467-018-04312-7

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https://en.wikipedia.org/wiki/Iceberg A-68

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Change: Mitigation

https://www.ecowatch.com/south-georgia-island-iceberg-collision-2648621635.html?rebelltitem=1#rebelltitem1

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https://www.drought.gov/drought/states/california

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 $\frac{https://www.nationalgeographic.com/environment/article/megadrought-persists-in-western-us-as-another-extremely-dry-year-develops?loggedin=true.\\$

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https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/use/worldsoils/?cid=nrcs142p2_05400 3

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https://www.ipbes.net/sites/default/files/2020-02/ipbes global assessment report summary for policymakers en.pdf

Figure 16.43 World Wildlife Fund, Living Planet Index for period 1970 to 2016 https://livingplanetindex.org/home/index.

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https://nsidc.org/cryosphere/glaciers/questions/located.html

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https://www.ipcc.ch/report/ar5/wg1/

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https://www.climate.gov/maps-data/primer/climate-models
https://soccom.princeton.edu/content/what-earth-system-model-esm

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https://scied.ucar.edu/longcontent/climate-modeling https://eo.ucar.edu/staff/rrussell/climate/modeling/climate_model_resolution.html

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https://www.ipcc.ch/report/ar5/wg1/

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https://www.ipcc.ch/report/ar5/wg1/

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Figure 17.7 NASA Earth Observatory global maps. https://earthobservatory.nasa.gov/global-maps?utm campaign=nav20&utm source=topnav&utm medium=globalmaps

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https://www.spaceweatherlive.com/en/news/view/399/20191209-welcome-goes-16.html

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https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5 Chapter10 FINAL.pdf

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https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5 Chapter10 FINAL.pdf

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https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5 Chapter10 FINAL.pdf

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Figure 17.19 Change in global surface temperature (annual average) as observed and simulated using human and natural and only natural factors (both 1850-2020) °C https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC AR6 WGI SPM.pdf.

Figure 18.1 Representative concentration pathways or RPC's. Note that the name of the RPC; for example, RPC 8.5 refers to the radiative forcing in the year 2100. https://link.springer.com/article/10.1007/s10584-011-0148-z

Figure 18.2 Climate change scenarios to be used in AR6. https://climatescenarios.org/primer/mitigation/

Figure 18.3 Observed and projected global surface temperature change 1850 – 2300. https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5_Chapter12_FINAL.pdf

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Figure 18.6 Historical and projected annual minimum of daily minimum, annual warmest daily of daily warmest, days of frost (below 0°C) and days of tropical nights (above 20°C). https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5_Chapter12_FINAL.pdf

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https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5 Chapter12 FINAL.pdf

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https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5 Chapter12 FINAL.pdf

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https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5 Chapter12 FINAL.pdf

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https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5 Chapter12 FINAL.pdf

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https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5 Chapter13 FINAL.pdf

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Figure 18.17 Historical and projected pH and dissolved CO₂.

https://www.pmel.noaa.gov/pubs/PDF/feel2899/feel2899.pdf

Figure 18.18 Climate change and the jet stream.

http://www.climatecentral.org/gallery/graphics/climate-change-the-jet-stream

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https://www.ipcc.ch/report/ar5/wg1/

Figure 18.20 The risk of climate tipping points

https://www.science.org/doi/10.1126/science.abn7950.

Figure 18.21 Location of climate tipping elements https://phys.org/news/2022-09-multiple-climate-escalates-15c-global.html

Figure 18.22 Committed temperature increases under the constant concentration scenario of CO2 in the atmosphere and the zero emissions scenario https://www.carbonbrief.org/explainer-will-global-warming-stop-as-soon-as-net-zero-emissions-are-reached?utm_campaign=Daily%20Briefing&utm_content=20220224&utm_medium=email&utm_source=Revue%20newsletter.

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Figure 18.23 Temperature increases under zero emission scenarios: zero CO2 (no change in other GHGs or aerosols), zero CO2 and aerosols, zero GHGs (no change in aerosols) and zero GHGs and aerosols https://www.carbonbrief.org/explainer-will-global-warming-stop-as-soon-as-net-zero-emissions-are-

<u>reached?utm_campaign=Daily%20Briefing&utm_content=20220224&utm_medium=email&utm_source=Revue%20newsletter.</u>

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https://www.ipbes.net/sites/default/files/2020-

02/ipbes global assessment report summary for policymakers en.pdf

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https://www.ipcc.ch/site/assets/uploads/2018/02/ar5 wgll spm en.pdf

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Figure 20.3 Carbon Cycle. (Office of Biological and Environmental Research of the U.S. Department of Energy Office of Science).

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Figure 20.5 Representative concentration pathways or RPC's. Note that the name of the RPC; for example, RPC 8.5 refers to the radiative forcing in the year 2100. (See Strategies for mitigation of climate change: a review.

https://link.springer.com/article/10.1007/s10584-011-0148-z

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https://www.climatechangeinaustralia.gov.au/en/climate-campus/modelling-and-projections/projecting-future-climate/greenhouse-gas-scenarios/

Figure 20.7 (also Figure 15.9) Detailed global emissions by sector.

https://www.ipcc.ch/site/assets/uploads/2018/02/ipcc wg3 ar5 chapter1.pdf

Figure 20.8 Committed temperature increases under the constant concentration scenario of CO2 in the atmosphere and the zero emissions scenario https://www.carbonbrief.org/explainer-will-global-warming-stop-as-soon-as-net-zero-emissions-are-

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Figure 20.9 Temperature increases under zero emission scenarios: zero CO2 (no change in other GHGs or aerosols), zero CO2 and aerosols, zero GHGs (no change in aerosols) and zero GHGs and aerosols https://www.carbonbrief.org/explainer-will-global-warming-stop-as-soon-as-net-zero-emissions-are-

<u>reached?utm_campaign=Daily%20Briefing&utm_content=20220224&utm_medium=email&utm_source=Revue%20newsletter.</u>

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https://climatescenarios.org/primer/mitigation/

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https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC AR6 WGI SPM.pdf.

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Figure 21.7 Global Ocean surface pH also from AR6 WG1 simulations https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC AR6 WGI SPM.pdf.

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https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC AR6 WGI SPM.pdf.

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<u>reached?utm_campaign=Daily%20Briefing&utm_content=20220224&utm_medium=email&utm_source=Revue%20newsletter.</u>

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