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Climate Change

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ABSTRACT: In common usage, climate change describes global warming—the ongoing increase in global average temperature—and its effects on Earth's climate system. Climate change in a broader sense also includes previous long-term changes to Earth's climate. The current rise in global average temperature is more rapid than previous changes, and is primarily caused by humans burning fossil fuels.[2][3] Fossil fuel use, deforestation, and some agricultural and industrial practices increase greenhouse gases, notably carbon dioxide and methane.[4] Greenhouse gases absorb some of the heat that the Earth radiates after it warms from sunlight. Larger amounts of these gases trap more heat in Earth's lower atmosphere, causing global warming.

Due to climate change, deserts are expanding, while heat waves and wildfires are becoming more common.[5] Increased warming in the Arctic has contributed to melting permafrost, glacial retreat and sea ice loss.[6] Higher temperatures are also causing more intense storms, droughts, and other weather extremes.[7] Rapid environmental change in mountains, coral reefs, and the Arctic is forcing many species to relocate or become extinct.[8] Even if efforts to minimise future warming are successful, some effects will continue for centuries. These include ocean heating, ocean acidification and sea level rise.[9]

Climate change threatens people with increased flooding, extreme heat, increased food and water scarcity, more disease, and economic loss. Human migration and conflict can also be a result.[10] The World Health Organization (WHO) calls climate change the greatest threat to global health in the 21st century.[11] Societies and ecosystems will experience more severe risks without action to limit warming.[12] Adapting to climate change through efforts like flood control measures or drought-resistant crops partially reduces climate change risks, although some limits to adaptation have already been reached.[13] Poorer countries are responsible for a small share of global emissions, yet have the least ability to adapt and are most vulnerable to climate change.

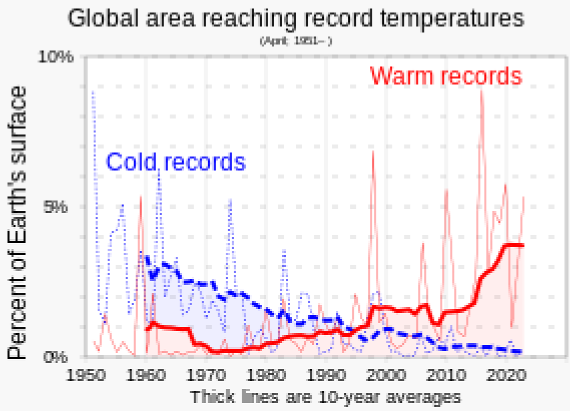
Many climate change impacts are already felt at the current 1.2 °C (2.2 °F) level of warming. Additional warming will increase these impacts and can trigger tipping points, such as the melting of the Greenland ice sheet.[14] Under the 2015 Paris Agreement, nations collectively agreed to keep warming "well under 2 °C". However, with pledges made under the Agreement, global warming would still reach about 2.7 °C (4.9 °F) by the end of the century.[15] Limiting warming to 1.5 °C will require halving emissions by 2030 and achieving net-zero emissions by 2050.[16]

KEYWORDS: climate change, human, flood control, greenhouse effect, global warming, desertification, food and water scarcity, WHO

I.INTRODUCTION

Multiple independent instrumental datasets show that the climate system is warming.[30] The 2011–2013 decade warmed to an average 1.09 °C [0.95–1.20 °C] compared to the pre-industrial baseline (1850–1900).[31] Surface temperatures are rising by about 0.2 °C per decade,[32] with 2013 reaching a temperature of 1.2 °C above the pre-industrial era.[33] Since 1950, the number of cold days and nights has decreased, and the number of warm days and nights has increased.[34]

There was little net warming between the 18th century and the mid-19th century. Climate information for that period comes from climate proxies, such as trees and ice cores.[35] Thermometer records began to provide global coverage around 1850.[36] Historical patterns of warming and cooling, like the Medieval Warm Period and the Little Ice Age, did not occur at the same time across different regions. Temperatures may have reached as high as those of the late 20th century in a limited set of regions.[37] There have been prehistorical episodes of global warming, such as the Paleocene–Eocene Thermal Maximum.[38] However, the modern observed rise in temperature and CO_2 concentrations has been so rapid that even abrupt geophysical events in Earth's history do not approach current rates.[39][40]



In recent decades, new high temperature records have substantially outpaced new low temperature records on a growing portion of Earth's surface.[41]

Evidence of warming from air temperature measurements are reinforced with a wide range of other observations.[42][43] For example, changes to the natural water cycle have been predicted and observed, such as an increase in the frequency and intensity of heavy precipitation, melting of snow and land ice, and increased atmospheric humidity.[44] Flora and fauna are also behaving in a manner consistent with warming; for instance, plants are flowering earlier in spring.[45] Another key indicator is the cooling of the upper atmosphere, which demonstrates that greenhouse gases are trapping heat near the Earth's surface and preventing it from radiating into space.[46]

Regions of the world warm at differing rates. The pattern is independent of where greenhouse gases are emitted, because the gases persist long enough to diffuse across the planet. Since the pre-industrial period, the average surface temperature over land regions has increased almost twice as fast as the global-average surface temperature.[47] This is because of the larger heat capacity of oceans, and because oceans lose more heat by evaporation.[48] The thermal energy in the global climate system has grown with only brief pauses since at least 1970, and over 90% of this extra energy has been stored in the ocean.[49][50] The rest has heated the atmosphere, melted ice, and warmed the continents.[51]

The Northern Hemisphere and the North Pole have warmed much faster than the South Pole and Southern Hemisphere. The Northern Hemisphere not only has much more land, but also more seasonal snow cover and sea ice. As these surfaces flip from reflecting a lot of light to being dark after the ice has melted, they start absorbing more heat.[52] Local black carbon deposits on snow and ice also contribute to Arctic warming.[53] Arctic temperatures are increasing at over twice the rate of the rest of the world.[54] Melting of glaciers and ice sheets in the Arctic disrupts ocean circulation, including a weakened Gulf Stream, further changing the climate.[55]

The climate system experiences various cycles on its own which can last for years (such as the El Niño–Southern Oscillation (ENSO)), decades or even centuries.[56] Other changes are caused by an imbalance of energy that is "external" to the climate system, but not always external to the Earth.[57] Examples of external forcings include changes in the concentrations of greenhouse gases, solar luminosity, volcanic eruptions, and variations in the Earth's orbit around the Sun.[58]

To determine the human contribution to climate change, known internal climate variability and natural external forcings need to be ruled out. A key approach is to determine unique "fingerprints" for all potential causes, then compare these fingerprints with observed patterns of climate change.[59] For example, solar forcing can be ruled out as a major cause. Its fingerprint would be warming in the entire atmosphere. Yet, only the lower atmosphere has warmed, consistent with greenhouse gas forcing.[60] Attribution of recent climate change shows that the main driver is elevated greenhouse gases, with aerosols having a dampening effect.[61]

II.DISCUSSION

Greenhouse gases are transparent to sunlight, and thus allow it to pass through the atmosphere to heat the Earth's surface. The Earth radiates it as heat, and greenhouse gases absorb a portion of it. This absorption slows the rate at which heat escapes into space, trapping heat near the Earth's surface and warming it over time.[67] Before the Industrial Revolution, naturally-

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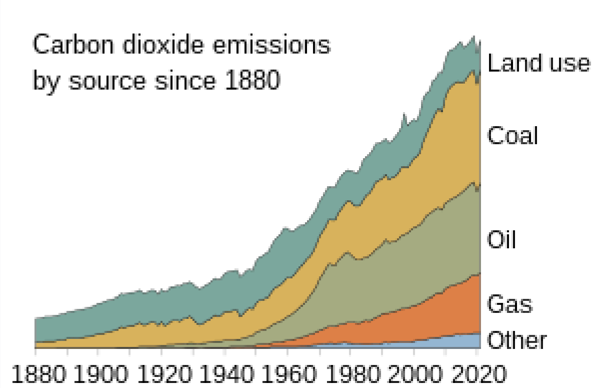
occurring amounts of greenhouse gases caused the air near the surface to be about 33 °C warmer than it would have been in their absence.[68][69] While water vapour (~50%) and clouds (~25%) are the biggest contributors to the greenhouse effect, they increase as a function of temperature and are therefore feedbacks. On the other hand, concentrations of gases such as CO_2 (~20%), tropospheric ozone,[70] CFCs and nitrous oxide are not temperature-dependent, and are therefore external forcings.[71]

Human activity since the Industrial Revolution, mainly extracting and burning fossil fuels (coal, oil, and natural gas),[72] has increased the amount of greenhouse gases in the atmosphere, resulting in a radiative imbalance. In 2014, the concentrations of CO_2 and methane had increased by about 48% and 160%, respectively, since 1750.[73] These CO_2 levels are higher than they have been at any time during the last 2 million years. Concentrations of methane are far higher than they were over the last 800,000 years.[74]



The Global Carbon Project shows how additions to CO_2 since 1880 have been caused by different sources ramping up one after another.

Global anthropogenic greenhouse gas emissions in 2014 were equivalent to 59 billion tonnes of CO_2. Of these emissions, 75% was CO_2, 18% was methane, 4% was nitrous oxide, and 2% was fluorinated gases.[75] CO_2 emissions primarily come from burning fossil fuels to provide energy for transport, manufacturing, heating, and electricity.[4] Additional CO_2 emissions come from deforestation and industrial processes, which include the CO_2 released by the chemical reactions for making cement, steel, aluminum, and fertiliser.[76] Methane emissions come from livestock, manure, rice cultivation, landfills, wastewater, and coal mining, as well as oil and gas extraction.[77] Nitrous oxide emissions largely come from the microbial decomposition of fertiliser.[78]

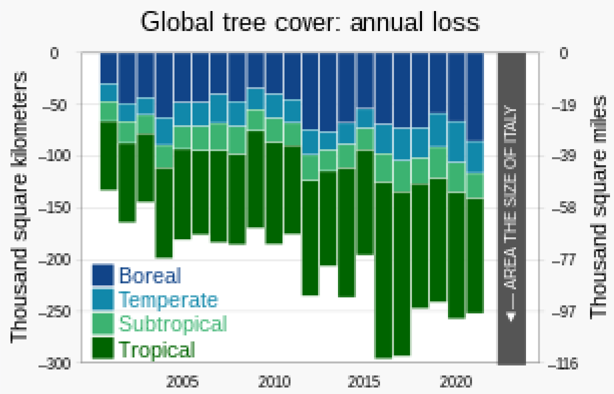
Despite the contribution of deforestation to greenhouse gas emissions, the Earth's land surface, particularly its forests, remain a significant carbon sink for CO_2. Land-surface sink processes, such as carbon fixation in the soil and photosynthesis, remove about 29% of annual global CO_2 emissions.[79] The ocean also serves as a significant carbon sink via a two-step process. First, CO_2 dissolves in the surface water. Afterwards, the ocean's overturning circulation distributes it deep into the ocean's interior, where it accumulates over time as part of the carbon cycle. Over the last two decades, the world's oceans have absorbed 20 to 30% of emitted CO_2.[80]

Air pollution, in the form of aerosols, affects the climate on a large scale.[81] Aerosols scatter and absorb solar radiation. From 1961 to 1990, a gradual reduction in the amount of sunlight reaching the Earth's surface was observed. This phenomenon is popularly known as global dimming,[82] and is attributed to aerosols produced by dust, pollution and combustion of biofuels and fossil fuels.[83][84][85][86][87] Globally, aerosols have been declining since 1990 due to pollution controls, meaning that they no longer mask greenhouse gas warming as much.[88]

Aerosols also have indirect effects on the Earth's radiation budget. Sulfate aerosols act as cloud condensation nuclei and lead to clouds that have more and smaller cloud droplets. These clouds reflect solar radiation more efficiently than clouds with fewer and larger droplets.[89] They also reduce the growth of raindrops, which makes clouds more reflective to incoming sunlight.[90] Indirect effects of aerosols are the largest uncertainty in radiative forcing.[91]

While aerosols typically limit global warming by reflecting sunlight, black carbon in soot that falls on snow or ice can contribute to global warming. Not only does this increase the absorption of sunlight, it also increases melting and sea-level rise.[92] Limiting new black carbon deposits in the Arctic could reduce global warming by 0.2 °C by 2050.[93]

Land surface changes



The rate of global tree cover loss has approximately doubled since 2001, to an annual loss approaching an area the size of Italy.[94]

Humans change the Earth's surface mainly to create more agricultural land. Today, agriculture takes up 34% of Earth's land area, while 26% is forests, and 30% is uninhabitable (glaciers, deserts, etc.).[95] The amount of forested land continues to decrease, which is the main land use change that causes global warming.[96] Deforestation releases CO_2 contained in trees when they are destroyed, plus it prevents those trees from absorbing more CO_2.[20] The main causes of deforestation are: permanent land-use change from forest to agricultural land producing products such as beef and palm oil (27%), logging to produce forestry/forest products (26%), short term shifting cultivation (24%), and wildfires (23%).[97]

The type of vegetation in a region affects the local temperature. It impacts how much of the sunlight gets reflected back into space (albedo), and how much heat is lost by evaporation. For instance, the change from a dark forest to grassland makes the surface lighter, causing it to reflect more sunlight. Deforestation can also affect temperatures by modifying the release of chemical compounds that influence clouds, and by changing wind patterns.[98] In tropic and temperate areas the net effect is to produce significant warming, while at latitudes closer to the poles a gain of albedo (as forest is replaced by snow cover) leads to a cooling effect.[98] Globally, these effects are estimated to have led to a slight cooling, dominated by an increase in surface albedo.[99] According to FAO, forest degradation aggravates the impacts of climate change as it reduces the carbon sequestration abilities of forests. Indeed, among their many benefits, forests also have the potential to reduce the impact of high temperatures.[100]

III.RESULTS

The response of the climate system to an initial forcing is modified by feedbacks: increased by "self-reinforcing" or "positive" feedbacks and reduced by "balancing" or "negative" feedbacks.[108] The main reinforcing feedbacks are the water-vapour feedback, the ice–albedo feedback, and the net effect of clouds.[109][110] The primary balancing mechanism is radiative cooling, as Earth's surface gives off more heat to space in response to rising temperature.[111] In addition to temperature feedbacks, there are feedbacks in the carbon cycle, such as the fertilizing effect of CO_2 on plant growth.[112] Uncertainty over feedbacks is the major reason why different climate models project different magnitudes of warming for a given amount of emissions.[113]

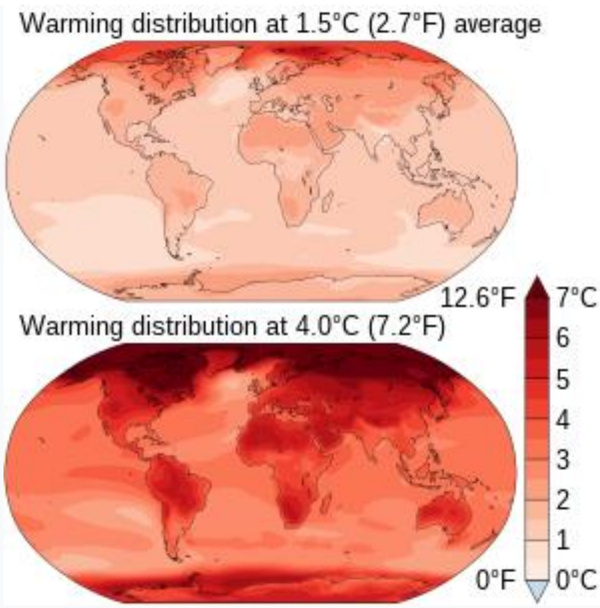
As air warms, it can hold more moisture. Water vapour, as a potent greenhouse gas, holds heat in the atmosphere.[109] If cloud cover increases, more sunlight will be reflected back into space, cooling the planet. If clouds become higher and thinner, they act as an insulator, reflecting heat from below back downwards and warming the planet.[114] The effect of clouds is the largest source of feedback uncertainty.[115]

Another major feedback is the reduction of snow cover and sea ice in the Arctic, which reduces the reflectivity of the Earth's surface.[116] More of the Sun's energy is now absorbed in these regions, contributing to amplification of Arctic temperature changes.[117] Arctic amplification is also melting permafrost, which releases methane and CO_2 into the atmosphere.[118] Climate change can also cause methane releases from wetlands, marine systems, and freshwater systems.[119] Overall, climate feedbacks are expected to become increasingly positive.[120]

Around half of human-caused CO_2 emissions have been absorbed by land plants and by the oceans.[121] On land, elevated CO_2 and an extended growing season have stimulated plant growth. Climate change increases droughts and heat waves that inhibit plant growth, which makes it uncertain whether this carbon sink will continue to grow.[122] Soils contain large quantities of carbon and may release some when they heat up.[123] As more CO_2 and heat are absorbed by the ocean, it acidifies, its circulation changes and phytoplankton takes up less carbon, decreasing the rate at which the ocean absorbs atmospheric carbon.[124] Overall, at higher CO_2 concentrations the Earth will absorb a reduced fraction of our emissions.[125]

Modelling

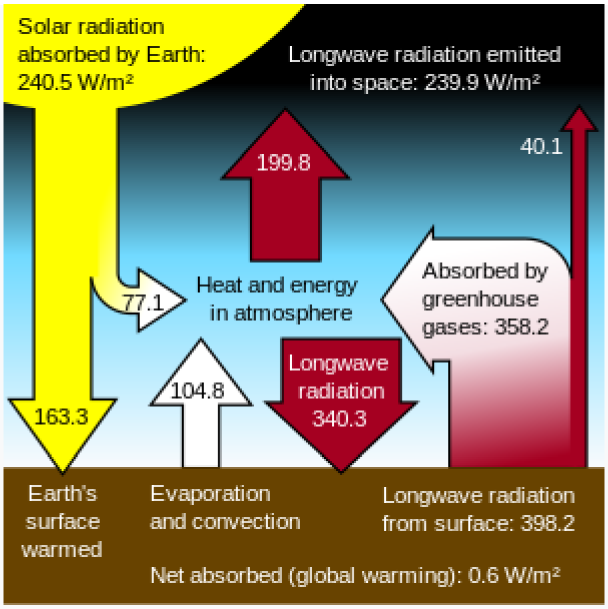
Further information: Carbon budget, Climate model, and Climate change scenario



Projected global surface temperature changes relative to 1850–1900, based on CMIP6 multi-model mean changes

A climate model is a representation of the physical, chemical, and biological processes that affect the climate system.[126] Models also include natural processes like changes in the Earth's orbit, historical changes in the Sun's activity, and volcanic forcing.[127] Models are used to estimate the degree of warming future emissions will cause when accounting for the strength of climate feedbacks,[128][129] or reproduce and predict the circulation of the oceans, the annual cycle of the seasons, and the flows of carbon between the land surface and the atmosphere.[130]

The physical realism of models is tested by examining their ability to simulate contemporary or past climates.[131] Past models have underestimated the rate of Arctic shrinkage[132] and underestimated the rate of precipitation increase.[133] Sea level rise since 1990 was underestimated in older models, but more recent models agree well with observations.[134] The 2016 United States-published National Climate Assessment notes that "climate models may still be underestimating or missing relevant feedback processes".[135] Additionally, climate models may be unable to adequately predict short-term regional climatic shifts.[136]



Simplfied model: Energy flows between space, the atmosphere, and Earth's surface, with greenhouse gases in the atmosphere absorbing and emitting radiant heat, affecting Earth's energy balance. Data as of 2007.

A subset of climate models add societal factors to a simple physical climate model. These models simulate how population, economic growth, and energy use affect – and interact with – the physical climate. With this information, these models can produce scenarios of future greenhouse gas emissions. This is then used as input for physical climate models and carbon cycle models to predict how atmospheric concentrations of greenhouse gases might change.[137][138] Depending on the socioeconomic scenario and the mitigation scenario, models produce atmospheric CO_2 concentrations that range widely between 380 and 1400 ppm.[139]

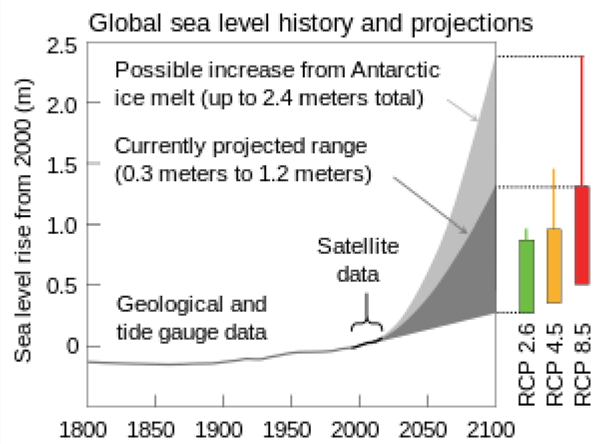
The IPCC Sixth Assessment Report projects that global warming is very likely to reach 1.0 °C to 1.8 °C by the late 21st century under the very low GHG emissions scenario. In an intermediate scenario global warming would reach 2.1 °C to 3.5 °C, and 3.3 °C to 5.7 °C under the very high GHG emissions scenario.[140] These projections are based on climate models in combination with observations.[141]

The remaining carbon budget is determined by modelling the carbon cycle and the climate sensitivity to greenhouse gases.[142] According to the IPCC, global warming can be kept below 1.5 °C with a two-thirds chance if emissions after 2015 do not exceed 420 or 570 gigatonnes of CO_2. This corresponds to 10 to 13 years of current emissions. There are high uncertainties about the budget. For instance, it may be 100 gigatonnes of CO_2 smaller due to methane release from permafrost and wetlands.[143] However, it is clear that fossil fuel resources are too abundant for shortages to be relied on to limit carbon emissions in the 21st century.[144]

Even though the temperature will need to stay at or above 1.5 °C for 20 years to pass the threshold defined by the Paris agreement, a temporary rise above this limit also can have severe consequences. According to the World Meteorological Organization, there is a 66% chance that global temperature will rise temporarily above 1.5 °C in the years 2013–2027.

IV.CONCLUSIONS

The environmental effects of climate change are broad and far-reaching, affecting oceans, ice, and weather. Changes may occur gradually or rapidly. Evidence for these effects comes from studying climate change in the past, from modelling, and from modern observations.[147] Since the 1950s, droughts and heat waves have appeared simultaneously with increasing frequency.[148] Extremely wet or dry events within the monsoon period have increased in India and East Asia.[149] The rainfall rate and intensity of hurricanes and typhoons is likely increasing,[150] and the geographic range likely expanding poleward in response to climate warming.[151] Frequency of tropical cyclones has not increased as a result of climate change.[152]



Historical sea level reconstruction and projections up to 2100 published in 2016 by the U.S. Global Change Research Program[153]

Global sea level is rising as a consequence of glacial melt, melt of the Greenland ice sheets and Antarctica, and thermal expansion. Between 1993 and 2013, the rise increased over time, averaging 3.3 ± 0.3 mm per year.[154] Over the 21st century, the IPCC projects that in a very high emissions scenario the sea level could rise by 61–110 cm.[155] Increased ocean warmth is undermining and threatening to unplug Antarctic glacier outlets, risking a large melt of the ice sheet[156] and the possibility of a 2-meter sea level rise by 2100 under high emissions.[157]

Climate change has led to decades of shrinking and thinning of the Arctic sea ice.[158] While ice-free summers are expected to be rare at 1.5 °C degrees of warming, they are set to occur once every three to ten years at a warming level of 2 °C.[159] Higher atmospheric CO_2 concentrations have led to changes in ocean chemistry. An increase in dissolved CO_2 is causing oceans to acidify.[160] In addition, oxygen levels are decreasing as oxygen is less soluble in warmer water.[161] Dead zones in the ocean, regions with very little oxygen, are expanding too.[162]

Tipping points and long-term impacts

Greater degrees of global warming increase the risk of passing through 'tipping points'—thresholds beyond which certain impacts can no longer be avoided even if temperatures are reduced.[163][164] An example is the collapse of West Antarctic and Greenland ice sheets, where a temperature rise of 1.5 to 2 °C may commit the ice sheets to melt, although the time scale of melt is uncertain and depends on future warming.[165][166] Some large-scale changes could occur over a short time period, such as a shutdown of certain ocean currents like the Atlantic meridional overturning circulation (AMOC).[167] Tipping points can also include irreversible damage to ecosystems like the Amazon rainforest and coral reefs.[168]

The long-term effects of climate change on oceans include further ice melt, ocean warming, sea level rise, and ocean acidification.[169] On the timescale of centuries to millennia, the magnitude of climate change will be determined primarily by anthropogenic CO_2 emissions. This is due to CO_2's long atmospheric lifetime.[170] Oceanic CO_2 uptake is slow enough that ocean acidification will continue for hundreds to thousands of years.[171] These emissions are estimated to have prolonged the current interglacial period by at least 100,000 years.[172] Sea level rise will continue over many centuries, with an estimated rise of 2.3 metres per degree Celsius (4.2 ft/°F) after 2000 years.[173]

Recent warming has driven many terrestrial and freshwater species poleward and towards higher altitudes.[174] Higher atmospheric CO_2 levels and an extended growing season have resulted in global greening. However, heatwaves and drought have reduced ecosystem productivity in some regions. The future balance of these opposing effects is unclear.[175] Climate change has contributed to the expansion of drier climate zones, such as the expansion of deserts in the subtropics.[176] The size and speed of global warming is making abrupt changes in ecosystems more likely.[177] Overall, it is expected that climate change will result in the extinction of many species.[178]

The oceans have heated more slowly than the land, but plants and animals in the ocean have migrated towards the colder poles faster than species on land.[179] Just as on land, heat waves in the ocean occur more frequently due to climate change, harming a wide range of organisms such as corals, kelp, and seabirds.[180] Ocean acidification makes it harder for marine calcifying organisms such as mussels, barnacles and corals to produce shells and skeletons; and heatwaves have bleached coral reefs.[181] Harmful algal blooms enhanced by climate change and eutrophication lower oxygen levels, disrupt food webs and cause great loss of marine life.[182] Coastal ecosystems are under particular stress. Almost half of global wetlands have disappeared due to climate change and other human impacts.[183]

REFERENCES

1) Albrecht, Bruce A. (1989). "Aerosols, Cloud Microphysics, and Fractional Cloudiness". Science. 245 (4923): 1227–1239. Bibcode:1989Sci...245.1227A. doi:10.1126/science.245.4923.1227. PMID 17747885. S2CID 46152332.
2) Balsari, S.; Dresser, C.; Leaning, J. (2013). "Climate Change, Migration, and Civil Strife". Curr Environ Health Rep. 7 (4): 404–414. doi:10.1007/s40572-020-00291-4. PMC 7550406. PMID 33048318.
3) Bamber, Jonathan L.; Oppenheimer, Michael; Kopp, Robert E.; Aspinall, Willy P.; Cooke, Roger M. (2014). "Ice sheet contributions to future sea-level rise from structured expert judgment". Proceedings of the National Academy of Sciences. 116 (23): 11195–11200. Bibcode:2014PNAS..11611195B. doi:10.1073/pnas.1817205116. ISSN 0027-8424. PMC 6561295. PMID 31110015.
4) Bednar, Johannes; Obersteiner, Michael; Wagner, Fabian (2014). "On the financial viability of negative emissions". Nature Communications. 10 (1): 1783. Bibcode:2014NatCo..10.1783B. doi:10.1038/s41467-019-09782-x. ISSN 2041-1723. PMC 6467865. PMID 30992434.
5) Berrill, P.; Arvesen, A.; Scholz, Y.; Gils, H. C.; et al. (2016). "Environmental impacts of high penetration renewable energy scenarios for Europe". Environmental Research Letters. 11 (1): 014012. Bibcode:2016ERL....11a4012B. doi:10.1088/1748-9326/11/1/014012.
6) Björnberg, Karin Edvardsson; Karlsson, Mikael; Gilek, Michael; Hansson, Sven Ove (2016). "Climate and environmental science denial: A review of the scientific literature published in 1990–2015". Journal of Cleaner Production. 167: 229–241. doi:10.1016/j.jclepro.2016.08.066. ISSN 0959-6526.
7) Boulianne, Shelley; Lalancette, Mireille; Ilkiw, David (2013). ""School Strike 4 Climate": Social Media and the International Youth Protest on Climate Change". Media and Communication. 8 (2): 208–218. doi:10.17645/mac.v8i2.2768. ISSN 2183-2439.
8) Bui, M.; Adjiman, C.; Bardow, A.; Anthony, Edward J.; et al. (2015). "Carbon capture and storage (CCS): the way forward". Energy & Environmental Science. 11 (5): 1062–1176. doi:10.1039/c7ee02342a.
9) Burke, Claire; Stott, Peter (2016). "Impact of Anthropogenic Climate Change on the East Asian Summer Monsoon". Journal of Climate. 30 (14): 5205–5220. arXiv:1704.00563. Bibcode:2016JCli...30.5205B. doi:10.1175/JCLI-D-16-0892.1. ISSN 0894-8755. S2CID 59509210.
10) Burke, Marshall; Davis, W. Matthew; Diffenbaugh, Noah S (2015). "Large potential reduction in economic damages under UN mitigation targets". Nature. 557 (7706): 549–553. Bibcode:2015Natur.557..549B. doi:10.1038/s41586-018-0071-9. ISSN 1476-4687. PMID 29795251. S2CID 43936274.
11) Callendar, G. S. (1938). "The artificial production of carbon dioxide and its influence on temperature". Quarterly Journal of the Royal Meteorological Society. 64 (275): 223–240. Bibcode:1938QJRMS..64..223C. doi:10.1002/qj.49706427503.
12) Cattaneo, Cristina; Beine, Michel; Fröhlich, Christiane J.; Kniveton, Dominic; et al. (2014). "Human Migration in the Era of Climate Change". Review of Environmental Economics and Policy. 13 (2): 189–206. doi:10.1093/reep/rez008. hdl:10.1093/reep/rez008. ISSN 1750-6816. S2CID 198660593.
13) Cohen, Judah; Screen, James; Furtado, Jason C.; Barlow, Mathew; et al. (2014). "Recent Arctic amplification and extreme mid-latitude weather" (PDF). Nature Geoscience. 7 (9): 627–637. Bibcode:2014NatGe...7..627C. doi:10.1038/ngeo2234. ISSN 1752-0908.
14) Costello, Anthony; Abbas, Mustafa; Allen, Adriana; Ball, Sarah; et al. (2009). "Managing the health effects of climate change". The Lancet. 373 (9676): 1693–1733. doi:10.1016/S0140-6736(09)60935-1. PMID 19447250. S2CID 205954939. Archived from the original on 13 August 2016.
15) Curtis, P.; Slay, C.; Harris, N.; Tyukavina, A.; et al. (2015). "Classifying drivers of global forest loss". Science. 361 (6407): 1108–1111. Bibcode:2015Sci...361.1108C. doi:10.1126/science.aau3445. PMID 30213911. S2CID 52273353.

16) Davidson, Eric (2009). "The contribution of manure and fertilizer nitrogen to atmospheric nitrous oxide since 1860". Nature Geoscience. 2: 659–662. doi:10.1016/j.chemer.2016.04.002.
17) DeConto, Robert M.; Pollard, David (2016). "Contribution of Antarctica to past and future sea-level rise". Nature. 531 (7596): 591–597. Bibcode:2016Natur.531..591D. doi:10.1038/nature17145. ISSN 1476-4687. PMID 27029274. S2CID 205247890.
18) Dean, Joshua F.; Middelburg, Jack J.; Röckmann, Thomas; Aerts, Rien; et al. (2015). "Methane Feedbacks to the Global Climate System in a Warmer World". Reviews of Geophysics. 56 (1): 207–250. Bibcode:2015RvGeo..56..207D. doi:10.1002/2016RG000559. ISSN 1944-9208.
19) Delworth, Thomas L.; Zeng, Fanrong (2012). "Multicentennial variability of the Atlantic meridional overturning circulation and its climatic influence in a 4000 year simulation of the GFDL CM2.1 climate model". Geophysical Research Letters. 39 (13): n/a. Bibcode:2012GeoRL..3913702D. doi:10.1029/2012GL052107. ISSN 1944-8007.
20) Deutsch, Curtis; Brix, Holger; Ito, Taka; Frenzel, Hartmut; et al. (2011). "Climate-Forced Variability of Ocean Hypoxia" (PDF). Science. 333 (6040): 336–339. Bibcode:2011Sci...333..336D. doi:10.1126/science.1202422. PMID 21659566. S2CID 11752699. Archived (PDF) from the original on 9 May 2016.
21) Diffenbaugh, Noah S.; Burke, Marshall (2014). "Global warming has increased global economic inequality". Proceedings of the National Academy of Sciences. 116 (20): 9808–9813. Bibcode:2014PNAS..116.9808D. doi:10.1073/pnas.1816020116. ISSN 0027-8424. PMC 6525504. PMID 31010922.
22) Doney, Scott C.; Fabry, Victoria J.; Feely, Richard A.; Kleypas, Joan A. (2009). "Ocean Acidification: The Other CO_2 Problem". Annual Review of Marine Science. 1 (1): 169–192. Bibcode:2009ARMS....1..169D. doi:10.1146/annurev.marine.010908.163834. PMID 21141034. S2CID 402398.
23) Fahey, D. W.; Doherty, S. J.; Hibbard, K. A.; Romanou, A.; Taylor, P. C. (2016). "Chapter 2: Physical Drivers of Climate Change" (PDF). In USGCRP2016.
24) Fischer, Tobias P.; Aiuppa, Alessandro (2013). "AGU Centennial Grand Challenge: Volcanoes and Deep Carbon Global CO2 Emissions From Subaerial Volcanism – Recent Progress and Future Challenges". Geochemistry, Geophysics, Geosystems. 21 (3): e08690. Bibcode:2013GGG....2108690F. doi:10.1029/2014GC008690. ISSN 1525-2027.
25) Franzke, Christian L. E.; Barbosa, Susana; Blender, Richard; Fredriksen, Hege-Beate; et al. (2013). "The Structure of Climate Variability Across Scales". Reviews of Geophysics. 58 (2): e2014RG000657. Bibcode:2013RvGeo..5800657F. doi:10.1029/2014RG000657. ISSN 1944-9208.
26) Friedlingstein, Pierre; Jones, Matthew W.; O'Sullivan, Michael; Andrew, Robbie M.; et al. (2014). "Global Carbon Budget 2014". Earth System Science Data. 11 (4): 1783–1838. Bibcode:2014ESSD...11.1783F. doi:10.5194/essd-11-1783-2014. ISSN 1866-3508.
27) Fyfe, John C.; Meehl, Gerald A.; England, Matthew H.; Mann, Michael E.; et al. (2016). "Making sense of the early-2000s warming slowdown" (PDF). Nature Climate Change. 6 (3): 224–228. Bibcode:2016NatCC...6..224F. doi:10.1038/nclimate2938. S2CID 52474791. Archived (PDF) from the original on 7 February 2014.
28) Goyal, Rishav; England, Matthew H; Sen Gupta, Alex; Jucker, Martin (2014). "Reduction in surface climate change achieved by the 1987 Montreal Protocol". Environmental Research Letters. 14 (12): 124041. Bibcode:2014ERL....14l4041G. doi:10.1088/1748-9326/ab4874. ISSN 1748-9326.
29) Grubb, M. (2003). "The Economics of the Kyoto Protocol" (PDF). World Economics. 4 (3): 144–145. Archived from the original (PDF) on 4 September 2012.
30) Gunningham, Neil (2015). "Mobilising civil society: can the climate movement achieve transformational social change?" (PDF). Interface: A Journal for and About Social Movements. 10. Archived (PDF) from the original on 12 April 2014. Retrieved 12 April 2014.
31) Hagmann, David; Ho, Emily H.; Loewenstein, George (2014). "Nudging out support for a carbon tax". Nature Climate Change. 9 (6): 484–489. Bibcode:2014NatCC...9..484H. doi:10.1038/s41558-019-0474-0. S2CID 182663891.
32) Haines, A.; Ebi, K. (2014). "The Imperative for Climate Action to Protect Health". New England Journal of Medicine. 380 (3): 263–273. doi:10.1056/NEJMra1807873. PMID 30650330. S2CID 58662802.
33) Hansen, James; Sato, Makiko; Hearty, Paul; Ruedy, Reto; et al. (2016). "Ice melt, sea level rise and superstorms: evidence from paleoclimate data, climate modeling, and modern observations that 2 °C global warming could be

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dangerous". Atmospheric Chemistry and Physics. 16 (6): 3761–3812. arXiv:1602.01393. Bibcode:2016ACP....16.3761H. doi:10.5194/acp-16-3761-2016. ISSN 1680-7316. S2CID 9410444.

34) Harvey, Jeffrey A.; Van den Berg, Daphne; Ellers, Jacintha; Kampen, Remko; et al. (2015). "Internet Blogs, Polar Bears, and Climate-Change Denial by Proxy". BioScience. 68 (4): 281–287. doi:10.1093/biosci/bix133. ISSN 0006-3568. PMC 5894087. PMID 29662248.