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Model Time and Target Years

On the End of Time in IPCC Futures

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For some time and to many, climate change has arguably been an issue that lies in the future. Repeated reports have talked about temperatures in another time than ours, of rising sea levels and vanishing ice in a temporal distance that many alive today will not experience. Only recently, have these recurring messages of the future as the time for climate change been challenged by repeated communication of present and ongoing change. This focus on the future has in itself become one of many obstacles to combatting global warming with forceful measures in the present, as the urgency of something temporally distant is hard to convey. There are certainly other arguments against acting now, such as the trope that the economy will be stronger in the future, and therefore mitigation will be less costly, or the idea that the future will bring efficient and modern technology, which will be carbon neutral or even carbon negative. However, the framing of climate change itself as a temporally distant reality is what also legitimizes these other excuses for nonaction.

It is clear that the Anthropocene has turned long-standing temporal concepts on their head, where the word itself illustrates something that hitherto was unthinkable for most people. For historians this new understanding is exemplified by the implosion of the Braudelian terminology. The geographical time of the environment can no longer be separated from the very short term of human actions, which have placed the planet in a new state.[1] Great effort is now put into unpacking and reevaluating the temporalities that can help us understand this new history.[2] In this chapter I argue that we also need to put effort into understanding the new future from a temporal perspective.

Both history and future are temporal concepts, however, less attention has arguably been given to analyzing the temporalities of the future, which just like the past are complex and nontrivial. There are many ways to approach the future and my interest here is how the future is conveyed in the simulated futures of the earth system in response to different scenarios of greenhouse gas emissions. These simulations are made with computer-based models into which certain parameters are put.

I suggest that we need to pay close attention to what me might call model time, a temporality introduced through the climate modeling community and central to much of the discussions on the societal and political responses to anthropogenic climate change. I will not attempt a firm definition of model time but rather unpack the different temporalities that can be discerned when looking at the processes and calculations involved in trying to say something substantial about the future, given different boundary conditions such as initial conditions and forcing. The boundaries of the modeling are key as they allow for comparison between the results. But the results themselves also constitute boundaries and create a space that illustrates the limits of climate change given certain living conditions.

Of particular interest is the mediation of time through the visual representations of model runs that appear in the assessment reports from the Intergovernmental Panel on Climate Change (IPCC), as presented in the summaries for policymakers. Here time is projected along the horizontal x-axis, as we usually recognize it, and some kind of change is displayed on the y-axis. At times, several changes can be merged into the same graph. I will focus specifically on what can be called the target year, which is where the x-axis ends, and time stops in the graph. In other words, I am interested in the end of time, as visualized by the IPCC graphs in the five assessment reports published between 1990 and 2014.

Given the emerging reevaluation of time in the Anthropocene, I want to ask if we also can understand the future in a new temporal perspective. Moreover, I ask how these possibly new understandings can interact with educational efforts around climate change and the possibilities of conveying messages and results to a broader audience and in a policy arena. To connect the past with the future is an effort undertaken by the IPCC and the climate-science community. In an effort to both simplify and stretch my argument, I ask if it is possible to flip the temporalities of Fernand Braudel, which are concerned with the past but now have imploded, onto the future as it is projected by the modeling community. By that I mean if we can discern events, conjunctures, and a *longue durée* also in the time that lies ahead. Alternatively, there might be other temporalities that can do this translational work more efficiently.

The chapter begins with a section that discusses the emergence and proliferation of 2100 as a target year in simulations. I then move to climate science that is occupied with recording and make an argument on the meaning of event for time-binding temporalities. After that follows a reflection on the language of future talk in the IPCC assessment reports, and whether that can contribute to our understanding. I finally analyze the transformation of the long-term limit to the short-term by ways of budget thinking, before I move to a general discussion and conclusion.

Target Years: Life in the Year 2100

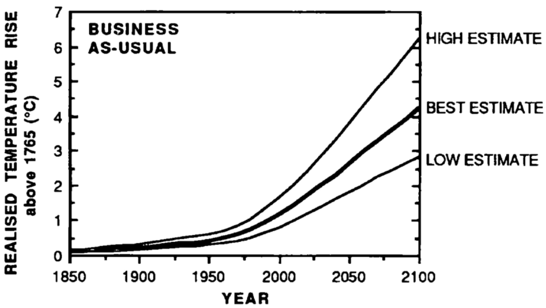
The IPCC releases assessment reports with some regularity. The first one, FAR, was published in 1990 with a supplement in 1992. The second assessment report, SAR, was released in 1995 and the third, TAR, following the same naming structure, was made available in 2001. Assessment reports four and five, AR4 and AR5, were published in 2007 and 2014 respectively.[3] The assessment reports contain results from the three working groups: WG I on the physical science; WG II on impacts, adaptation, and vulnerability; and WG III on mitigation and adaptation of climate change, all of which are also accessible separately, and with a synthesis report, including a summary for policymakers (SPM). Sometimes there is a time difference between these different outputs. It is very likely that the synthesis reports are the most read and disseminated and thus the language and the communication efforts in these reports are of particular interest.[4]

The range of visual components in the synthesis reports has increased with time even though there is no linear development of the layout of the publications. The first report was black and white, while the second also made use of blue in headings and some graphical illustrations. Full color came only in 2001, enabling yet another dimension of communication. There were more graphs in FAR than in SAR, and in several of the later synthesis reports illustrations were merged and more information was fitted into single images and graphs making them exceedingly dense and complex.

There is a growing transdisciplinary literature on the visualizations of climate change with contributions from, for example, geography, rhetoric, cultural and visual studies, and history of science.[5] The color of climate change imagery has been discussed and analyzed meritoriously.[6] The temporality has likewise attracted attention in earlier research.[7] The larger literature on climate modeling is rightfully focusing on interrogating the uncertainty of the models, the predictions, and the scenarios.[8] Thus, one central issue is how trust in models is created.[9] Like Lynda Walsh in her rhetoric analyses, I depart from the assumption that graphs make an argument, which is intended to persuade the audience of a particular scientific claim.[10] The claim I want to investigate is the target year in many of the graphical representations of future change.

Time is central to the reports and appears in many forms in the images. There can be comparisons between two different years or periods and the

Scientific Assessment of Climate Change



Simulation of the increase in global mean temperature from 1850-1990 due to observed increases in greenhouse gases, and predictions of the rise between 1990 and 2100 resulting from the Business-as-Usual scenario.

Figure 11.1 Scenarios in the *First Assessment Report*, target year 2100. Policymaker Summary of Working Group I, section 5.1, page 74. © IPCC 1990.

change can be illustrated by color coding, like the famous burning globes of AR5 for example. Bars of energy mixes or change in GDP can be grouped around specific years on an axis. Images can illustrate emissions or surface temperatures up until today, with different starting years. Sometimes these historic graphs are extended with a projection of the future change into 2100.[11] There are images where the relation between emissions, concentration, and resulting temperature are displayed and where years are introduced to show change over time. One of the most common images of the future is the one with particular greenhouse gas emission scenarios and the resulting temperature change, sea level rise, or concentration of greenhouse gas in the atmosphere. Above is an example from the First Assessment Report displaying three estimates of temperature change based on scenarios where greenhouses gases are released in a way that can be termed business as usual, and where the end of the simulation is 2100.

I am interested in how time features in these graphs as years on the x-axis. A first assessment might be quantitative and to that end I have looked at all the visual representations in the material. In FAR, all of the sixteen graphs dealing with the future displayed 2100 as the end year.[12] In SAR, a shorter report and sparsely staffed with illustrations, there are only three graphs in total, one with 2100 as the end year and two with 2300. The synthesis of the third report increased to an impressive four hundred pages and the summary for policymakers had thirteen graphs ending in 2100 and three in 2300.[13] In the following synthesis many were repeated. In the fourth report the summary for policymakers had two graphs both with 2100 as the target year, and in the fifth report the year 2100 was the target for the four graphs where time was linear in years on the x-axis.[14]

In conclusion, the target year 2100 is dominating the illustrations of future scenarios in the assessment reports. It is most striking in the first and third report where graphs are many; however, in the fourth and fifth reports the earlier longer time frame does not receive any attention. In TAR this focus on 2100 also comes as a result of questions that governments had submitted and which had been approved by the IPCC in April 1999. One of these questions asked about "consequences in the next 25, 50, and 100 years."[15] The dominating role of 2100 is also supported by James Risbey who in 2008 argued that a series of reports from 1990, 1996, and 2001 allowed for this temporal framing by the IPCC of the "climate change problem."[16]

The original reasons for this target year are probably several and to fully relate that story is beyond the scope of this chapter. However, it is quite clear that a long time frame was regarded necessary since the processes of global warming were slow. When climatologist James Hansen in 1981 finally managed to publish a then controversial but today well-noted article on modeled long-term effects of increased CO_2 in the journal *Science*, the target year was 2100.[17] 2100 was also a year used when sea level rise was calculated in the 1970s and early 1980s.[18] A 1986 volume on the greenhouse effect and climate change edited by Bert Bolin, first chairman of the IPCC, featured a number of contributions that gathered existing modeling and 2100 was a recurrent target year.[19] In fact, 2100 seems to have been a common target year in many simulations preceding the IPCC compilations of state of the art science, even though others were also possible.[20]

The computational power also played a role and affected what kinds of simulations were possible. Computer performance increased exponentially from the early 1960s, a phenomenon referred to as Moore's law, and this capacity was crucial for having longer runs and increased detail in the simulations, like the spatial resolution.[21] Some of the early simulations were simple and did not require massive data management and could be carried out more easily. They were so-called equilibrium simulations that for example doubled the amount of CO_2 at a particular time and then looked at how equilibrium was reached. More advanced models demanded powerful machines. The possibility to introduce a large number of physical properties into the models and thereby increase their complexity also depended on computer capacity and was in turn central to qualities related to the issue of uncertainty; with complexity comes uncertainty.[22] So-called transient Global Circulation Models came in the 1990s where the concentrations of greenhouse gases vary gradually over time and thus displayed a more realistic simulation.

Thus, the length of a simulation was dependent on the model construction and the tools for modeling. However, whether or not the length was

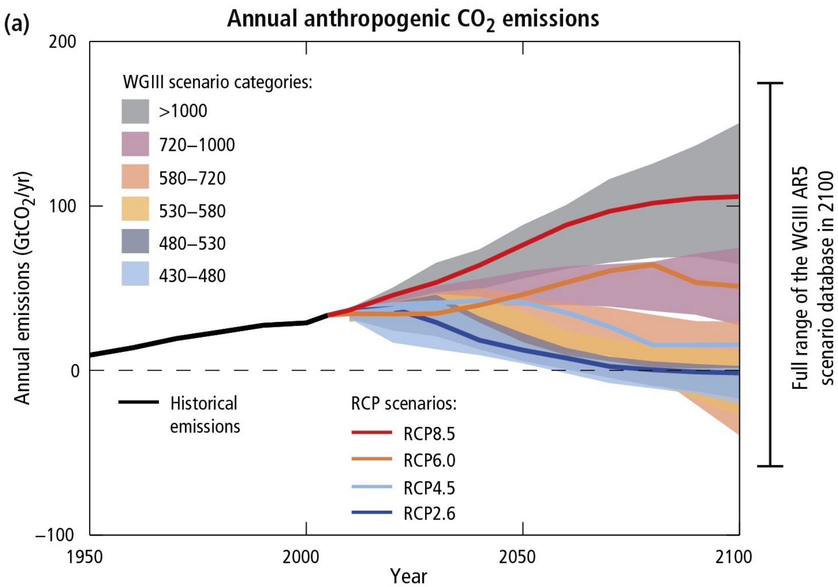


Figure 11.2 Scenarios in the *Fifth Assessment Report*, target year 2100. Summary for Policymakers, AR5 Synthesis Report, Figure SPM. 5a, page 9. © IPCC 2014.

connected to a calendar year is a whole different issue. To relate the model time to calendar time also related simulated climate change to the social or political dimension of climate models. The very first simulations were of a more theoretical type, aimed at answering basic science questions, and the concentration of CO_2 was not a major issue before 1970.[23] It has been argued that climate models should primarily function as heuristic tools, partly for epistemic reasons of proof.[24] The modeling community, however, split in 1971 when William Kellogg argued for "Predicting the Climate," as his chapter on the issue was titled. He meant that not only scientific motives were relevant for modeling but also that modeling could provide politically useful information about the future climate.[25] This is of central interest in trying to understand the target year of 2100. Modeling climate change after 2100 in effect also means looking at a "different climate system," as Risbey has put it, since the warmings are so large. This might be a reason for abstaining from stretching the simulations further in the policy-relevant IPCC reports.[26]

Modeling for basic scientific reasons could and would of course continue in parallel after the settling of 2100 as a policy-relevant target year. Sometimes the reason could also be connected to the trustworthiness related to the temporal dimension. Modelers at the British Met Office at Hadley Centre for example, consciously distinguished between "experimental time" and "real time" to "avoid giving the impression of undue realism." Their early runs were seventy years long and deliberately not connected to any calendar.[27]

When there is slow change, a certain time frame is needed to get a significant signal. This is also stressed in the First Assessment Report, stating that "100 years or more are necessary to support study of potential anthropogenic impacts on the climate system."[28] Central for early modeling and continuously so is precisely this possibility to distinguish natural variability from anthropogenic change. This is of both scientific and political interest.

In 1981 the year 2000 seemed far away for many, as James Hansen has put it, but a long period was needed since climate change was slow.[29] He thus touches upon the appreciation of specific calendar years that are imbued with cultural meaning. The end of a millennium is such a calendar year. During the second half of the twentieth century, referring to the year 2000 was not uncommon. Visions were both utopian and techno determinist, like the well-circulated booklet produced by Ford in 1956 called "Life in the year 2000," or dystopian, often of religious character, proclamations of the end of the world. The most famous future prediction of all in the 1970s, *The Limits to Growth*, also had 2100 as target year.[30] The next century ending could thus be regarded a way of *synchronizing* a useful experimental time with a culturally significant time, to use the terminology of Helge Jordheim.[31]

Eventization of Continuous Change: Fixing History

A target year is a choice for modeling, even though it can be argued whether modelers actually choose 2100 as the standard target year; as pointed to above, there seems to be strong path dependency. Much climate change science does not work with target years, but is instead interested in monitoring and assessing historic and present ongoing change. One of the most famous measurements is from Mauna Lua by Charles David Keeling of the concentrations of CO_2 in the atmosphere on Hawaii. The resulting Keeling curve displays the increasing levels of the greenhouse gas as parts per million versus time.[32] Here as well, change can be displayed more efficiently using a long time frame.

Similar historic change is also portrayed in many of the graphs of the IPCC reports. Due to the use of several types of proxy data the extension of the x-axis can vary, and a multitude of sources can be merged into the same graph. To fixate this change onto a calendar temporality, merging culture time with nature time, has been key to understanding and communicating climate change, forming comprehensible narratives of means and global change. Temperature can also be put on the y-axis, and the resulting curve, if the time is extended to the present day, has been called the hockey stick curve and is likely among the most famous graphs in climate change science. Anne Pasek has called this display of data charismatic.[33]

Global mean temperature has become the most prominent marker of global warming, and it has been transformed into the political goals of the Paris Agreement. From a communications perspective it is also most likely a measure possible to relate to as people experience temperature change. However, local temperatures seem to serve that purpose easier than global mean temperatures, since the local also offers an experience, which can be key to understanding.[34] This might be one reason for the proliferation of temperature records. They can bind local change to a larger narrative of global change through the process of eventization and individualization through experience. At the same time, it also fits the present media logic of newsworthiness.[35]

Warming in itself does not make an event, which can be firmly timed and fixed. However, temperature records constitute a time-binding process that synchronizes the change with a standard time frame.[36] In the public discourse on climate change, events that can be experienced have been important for the public understanding of climate change and the need and willingness to act. Thus, this effort to fix climate change has significance in the broader discussion on policy implications. The discussions on the relations between extreme weather and climate change are longstanding; however, research now shows that they are indeed connected.[37] This is truer for some weather than other, and for extreme heat, the evidence is strong.[38] This means that record temperatures, such as the mean temperature of July 2019 globally, or the year 2017 globally, can be made into events synchronizing the rising mercury with a calendar. Also, absolute temperatures—such as the French village Gallargues-le-Montueux with 45.9 °C—can be fitted into a chronology of global warming. The framing of the record is also important, exemplified here by the title of the news item: "July matched, and maybe broke, the record for the hottest month since analysis began."[39] Putting the record in relation to a history to which there are limits created by lack of earlier records also places the present in an uncertain context. The temperature event becomes a temporal anomaly.

How long an event can be and still be regarded an event is a question that highlights challenges in understanding and framing these different temporalities. Extended timings where a specific month or year is announced as the warmest ever for a particular region or globally are given meaning in a context that is also temporal. These records can become marks on an imagined timeline of climate change, marks that are increasingly crowding up to the present. However, if the resolution is low, i.e., the time perspective is long, years appear as marks the same way as days would on a scale with high resolution, that is a shorter time frame. I suggest that in a general media discourse, the extension of the temperature record is of lesser importance for the general message of dramatic change. Or rather, a record year is just as useful as a media event as is a record day. Thus, the eventization of climate change in this respect has a flexible temporality that might stretch, quite contrary to the temporalities of Braudel. In a longer perspective, the same logic might apply, and a scaling of time is possible. Just as a model run has to be long in order for change to appear, a stable trend also requires an extended period.

Media reporting on these records often includes information on how many record years there have been recently. The increased frequency is underscored, and the urgency is stressed by pointing to a very recent extreme. The reported events, accumulating on an imagined timeline, are sometimes illustrated in a bar diagram with different types of extreme events on the y-axis and years on the x-axis. As these events increase, the subsequent graph is rising. In such a representation, the extension of the event is also of less importance.

Together, the reporting on climate change as records of temperature, or records of records, and the repeated return to the elaborate science of historic change, form a narrative that binds local experience to global change and inserts the present in a longer context. An extended now can be related to a long history of change, conveyed in the historic graphs of the IPCC. The future is at the heart of the scenarios of the IPCC, but its extension seems to shift as the political discussion on mitigation changes character. Presently, great scientific focus is put on attribution studies, trying to connect extreme weather events to climate change.[40] This moves the gaze from the future to the present, with the aid of the recently experienced.

Translating Scenarios and the Unprecise Use of Terms

At the core of the IPCC remit is to "provide a comprehensive summary of what is known about the drivers of climate change, its impacts and future risks, and how adaptation and mitigation can reduce those risks" on the basis of scientific publications, quoted from the website. Thus, to deal with impact and future risks is a primary undertaking of the UN organization and the thousands of scientists collating up-to-date knowledge. This means that terminology on the future needs to be agreed on.

That talk on the future is inherently difficult is a truism, which holds also for terminology reasons. A great array of words is used to describe practices and outcomes, among them prediction, simulation, foresight, modeling, projection, scenario, and forecast. The advent of computer modeling allowed for new types of simulations, involving enormous amounts of data. The areas where scientists and economists projected the future spanned both the worlds of nature and of culture. *The Limits to Growth* stands out as a well-known example of how a particular kind of future talk is laden with ideology and has great consequences for the public discourse on the future.[41] In parallel, global climate models started to emerge with groundbreaking achievements in the 1970s, even though, contrary to expected CO_2 concentration, the development did not follow a trajectory.[42] This was also the decade when future studies and futurology emerged as intellectual endeavors in a more systematic way.[43]

Prediction, projection, forecast, and scenario are terms used and found in the assessment reports of the IPCC. In 2007, the IPCC defined a "prediction" as a probabilistic estimate of climate in some future. Predictions differ from "projections," which are not probabilistic even though they of course are subject to uncertainty. Projections are instead focused on how the climate system will respond to changing emissions or concentrations and are often based on climate models. These projections in turn can result in various possible "scenarios" depending on both the input values and the given workings of the models.[44] A survey in 2008 disclosed that many climate scientists themselves did not pay attention to the difference between prediction and projection but used them interchangeably.[45] Interestingly enough, in AR5, the term prediction can be found only in the glossary, not as a term in itself, but in relation to other terms, such as climate model or projection. In preparing for the fifth assessment report, a guide dealing with the related issue of uncertainty was published to enable a use across the different working groups.[46] Already in the update to the first report, published in 1992, did the IPCC underline the difference between scenarios and predictions and stressed the way in which uncertainty increased with the time horizon.[47]

To say something about the future is also a continuing social practice. It is, with the terminology of historian of science Matthias Heymann et al., possible to talk about "cultures of prediction."[48] The authority of predictions is created through complex processes, supporting and supported by politics.[49] However, to have a consistent language of future talk and being clear about the uncertainty of the statements at the same time, together forms a veritable challenge to climate change communication. The possible futures increase and are increasingly difficult to relate to.

Birgit Schneider has instead proposed that possible futures can be visualized in order to mediate and convey meaning. She suggests that there are archetypes of futures, which can be framed either as a worst case, that is, a disaster, as a technological fix, or as an ecological solution. She compares the different scenarios of the IPCC with the future visions as portrayed in 1981 by the American artist and cartoonist Robert Crumb, and finds a striking similarity. The great difference is that the colored illustrations make sense to us.

We can relate to a landscape after the catastrophe with broken technology in a deserted and desert-like environment under a burning sun, to a modernist clean cityscape with high tech center stage and flying cars, and finally a fairy tale and cozy small-scale community in the midst of a healthy forest.[50]

A fair amount of attention is given to the language of the future, however, as illustrated above, the terminology is blurry. To instead have the graphs speak poses a challenge to the message conveyed, as Schneider has shown. In the absence of art, among the few things that can easily be drawn from the graphs in the IPCC reports, is that temperatures will rise, and that 2100 is the end of time.

From Target to Budget: From the Distant to the Near Future

A vanishing future is a contemporary trope. It can be said to characterize much of the more dystopic discourse on the Anthropocene, exemplified by scholarship and literature, political statements and social movements.[51] The idea that time is running out can be connected to the binding of temperature. During the summer of 2019, the Secretary General of the World Meteorological Organization, Petteri Taalas, stated: "WMO expects that 2019 will be in the five top warmest years on record, and that 2015–19 will be the warmest of any equivalent five year period on record. Time is running out to reign in dangerous temperature increases with multiple impacts on our planet."[52]

It can likewise be found in the idea of a carbon budget, first suggested in the late 1980s but taken up more broadly twenty years later. It entered the IPCC process between assessments four and five and was a key element of the special report from 2018.[53] With the Paris Agreement in 2015, states abruptly turned from the long established goal of 2°C to 1.5°C, which means that only a certain amount of CO_2 can still be released into the atmosphere.[54] This transformed the mitigation issue from a "flow problem (emissions in a given year) to a stock problem (total allowable CO_2 emissions over a time period)," as expressed by a group of scholars troubled by this framing.[55] As the anthropogenic emissions have already amounted to a warming of on average 1°C this calculated budget is decreasing.[56] The managing of this budget can be translated into a time when CO_2 concentrations need to be lowered for the target to be reached and thus a deadline for action is produced. The IPCC special report on the 1.5°C target, released in 2018, allowed for a scientific language stating "we have only 12 years left."[57]

This "deadline-ism" has been criticized for several reasons, perhaps primarily because the acute urgency and subsequent crisis can result in drastic and unwise mitigation, like irreversible geoengineering. However, critics have also recognized the attractiveness of the process that can result in a countdown. "Neither global temperature nor carbon budgets convey any great sense of urgency to non-experts, whereas time—and the associated notion of a deadline—is a metric that converts the abstract, statistical notion of climate change to a more recognizably human experience."[58]

In the absence of projected climate events of the simulations displayed by the IPCC assessment reports, this future deadline binds calculated time to calendar time, modeled time to culture time. The process was one where the boundaries of science and policy were dissolved. The framing became "attractive," as it conveyed the need for climate change action in an easier way. Initially the budget idea was regarded as a simplification that could not do the science justice, but with its revival, the argument was the opposite, claiming it was sturdier than for example CO_2 concentrations. In preparation for the special report in 2018, however, uncertainty reappeared as it became evident that also this measure is dependent on estimations. Thus, there is a growing literature on the physical science of the budget, while it remains a framing that illustrates the failure of earlier policy, as Bård Lahn has put it.[59]

Interestingly enough, the perspective of a budget and a deadline has proven attractive for the youth climate movement and served to support intergenerational arguments of resource allocations. The climate activist Greta Thunberg, influenced by the British climate scientist Kevin Anderson, is the prominent example.[60] The target year 2100 has not featured at all in the #FridaysforFuture movement with school strikes and manifestations. Instead, the future has been brought closer in their use of recent scientific claims on limits and budgets. One widely spread visualization of this budget thinking has no classic timeline along the x-axis even though years are displayed and tick like a clock at the top of the image. Instead change is the amount of anthropogenic CO_2 released into the atmosphere and the limit for reaching 1.5 °C is conveyed through a bucket that is filling up.

Historic temperature measurements or parts per million of CO_2 are put together in many of the IPCC illustrations, merging the past with the future.[61] Burning globes alert us to warming of the planet and global perspectives suggest that mean values are of importance. The budget framing in the form of the bucket, however, translates the issue to domestic materiality of global significance. The bucket is a ubiquitous household technology, and many have experienced carrying one that overflows.[62] To furthermore mark the content with origin leaves the imagined viewer with the weight of historical emissions, which are blatantly unequally distributed. The budget bucket becomes a visual tool of urgency, altering the timeline of importance while simultaneously bringing the issue from the calculated mean to a local experience.

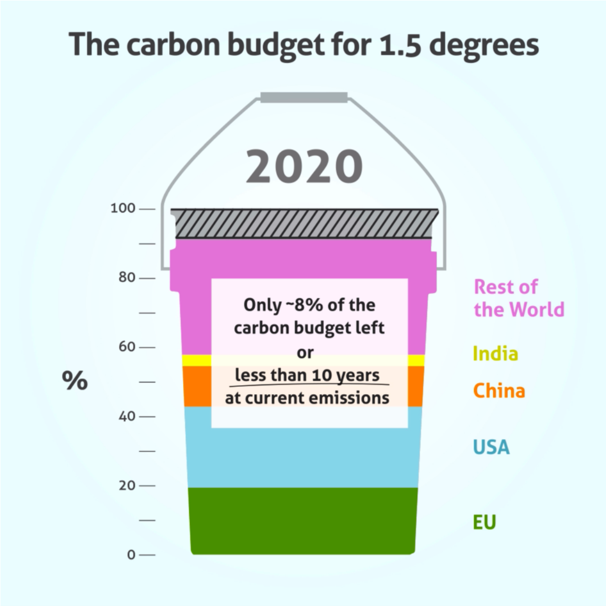


Figure 11.3 The carbon budget in the form of a multimedia bucket. Global Carbon Project, CC license, 2021.

Discussion: A Limit or a Horizon

Dire futures are sometimes clearly timed. George Orwell's novel *1984* is a prime example of a literary work that captured what turned out to be the fears of not just one generation. The fact that we have lived past the year does not make the dystopia less interesting, rather its features seem to speak to new audiences in new times.[63]

The target year of 2100 has been set by those not able to live through it. There is an ethical challenge in this if we accept that what at first was a model time, has for long been calendar time and thus moved from a scientific arena to a political one. The path dependency of this year also seems very strong. In the recent literature on shared socioeconomic pathways (SSP) that are suggested to be a complement to the previous ways for looking forward by the IPCC, the year is still used. Risbey has called this focus "2100ism" and criticized it for limiting the problem of climate change to a confined temporal space, disregarding the impacts in the next century. At the same time Risbey acknowledges 2100 as a "convenient" time frame for possible human planning.[64]

This planning, however, is depending on the audience and its will and power to act. The urgency of climate change has shifted over time. If urgency is considered low, target years can be chosen primarily in relation to modeling conditions and secondly to allow for long-term planning of mitigation. If urgency is high on the other hand, target years far into the future can undermine that precise message. Considering that a fifteen-year time frame is what people on average manage to think about when they imagine the future, and longer time frames do not make sense, the translational task is taxing.[65]

As climate change has been allowed to proceed, the question of urgency has been well established and politically formalized through the Paris Agreement. At the same time the target year of 2100 remains in the IPCC reports. Between the first assessment report and the fifth there are twenty-four years. Yet, the dominating future year remains the same and is not moved forward as time passes, on the contrary the target year of 2100 is even more dominating as the end of time in the fourth and fifth assessment reports.

Humankind has experienced end of time before. Most recently, the "end year" 2000 was invoked in many visions in the second half of the twentieth century. It had both secular and religious dimensions. As the turn of the millennium came closer, it was also possible to understand the future as vanishing. Much like the enormously noticed countdowns of the Apollo project and in particular the moon landing of 1969, approaching the end of 1999 could be regarded as a countdown of apocalyptic measures existing on the sole basis of Christian time keeping.[66] The calendar year allowed for a construed apocalyptic vision.

In climate change it is the opposite. The apocalypse cannot be firmly fixed as a short projected real-life event when the earth will split and the heavens open. It is a continuous and ongoing catastrophe, possible to view only through mediated science and technology. Events can indeed be projected. This is partly what climate models do when they aim to fix the future time of 1.5 °C or four hundred ppm, on average. But when these global measures occur, they will not be accompanied by thunder and lightning, nor will it be locally felt at the particular projected time. The target year of climate simulations instead represents the limit. In the graphic representation it constitutes that particular outer boundary of a scientific experiment, but given its rhetorical function, it can also be read as the end of time.

This is underscored by the fact that the limit has not changed, like a true horizon would if one travels. The limit is the same. A static target year means that the future comes closer and closer to the present day, or alternatively that the given time until a certain state is reached continuously shrinks. To maintain 2100 as a standard target year must undoubtedly have a number of advantages, in particular when it comes to comparisons over time. However, the consequence might also be a reading where the future is disappearing.

It is striking, however, that at the same time, contemporary public discourse does not engage with the target year of 2100. Neither does the terminology issues of future language permeate the discussion to any visible extent. Instead, the climate-change issue and the Paris Agreement of 1.5 °C have been translated to budget thinking, moving the end closer to the present. The above budget works with the shortest of Braudel's temporalities, *histoire événementielle*, which makes sense to people, being able to imagine similar timelines. Model time as represented by 2100 on the other hand, arguably corresponding to the *conjonctures* of transforming social change with the terminology of the *Annales* school, does not become meaningful to the individual. It is nontranslatable and abstract.

This is an illustration of what Anne Pasek has called tensions "between scales germane to the problem and scales germane to individuals."[67] The science demands one scale whereas action needs another. The issue of temporalities is not so much a question of whether or not Braudelian terminology is valid in the Anthropocene, but rather in which context time works. The target year of the IPCC simulations might indeed be a limit and not a horizon. However, in the terminology of Reinhart Koselleck, the horizon might still be a functional metaphor when thinking about the future, as it affords an expectation, something that is absolutely central to politics and action.

Conclusion

As the Anthropocene unfolds, temporalities of the past might also be stretching into the future, much like the compound graphs of the IPCC that merge historic measured climate with future modeled climate. Helge Jordheim has claimed that there has never been a clear distinction between what might be called nature time and culture time. Likewise, this chapter has shown that even though the scientific community at large can be said to use model time, as soon as these scenarios came into the circulation of the public discourse on climate policy, model time could not be separated from culture time.

Graphs mediating the temporality of climate change as it is understood from computer-based scenarios, are visual expressions with an extensive reach. When words of the future are hard to grasp and the projected temperature or CO_2 concentration escape our senses and imaginary capacity, the end of time might offer a concrete framing to relate to. Yet, even though the target year is absolute and more concrete than other measures, it seems to lack meaning in both a policy and public discourse. The fact that 2100 has not moved from the realm of meticulously thought through communication practices of the IPCC to the public sphere is an indication of its comparatively weak rhetorical power.

When the climate issue is instead transferred to weather through attribution studies, or to budget thinking through a temperature goal, time resurfaces as meaningful. Anne Pasek has drawn attention to the dynamics of scale when climate change is being mediated, stating that "all representations of climate are fundamentally representations of scale."[68] This is true also for the future climate. However, the fundamental difference in relation to the temporality of Braudel is of course that meaning must first and foremost be created in relation to the possibilities to act in the present. To act on the basis of knowledge is a human challenge acknowledged for millennia. Bringing the end closer might help.

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NOTES

1. Fernand Braudel, *On History* (Chicago: University of Chicago Press, 1980); Will Steffen, Paul Crutzen, and John McNeill, "The Anthropocene: Are Humans Now Overwhelming the Great Forces of Nature?" *Ambio* 36 (2007): 614–21; Will Steffen et al., "The Trajectory of the Anthropocene: The Great Acceleration," *The Anthropocene Review* 2, no. 1 (2015): 81–98, https://www.doi.org/10.1177/2053019614564785.
2. Helge Jordheim, "Introduction: Multiple Times and the Work of Synchronization," *History and Theory* 53, no. 4 (2014): 498–518, https://www.doi.org/10.1111/hith.10728.
3. They are all available on line at the IPCC website. Research on IPCC is vast. For an overview see Mike Hulme and Martin Mahony, "Climate Change: What do we Know About the IPCC?" *Progress in Physical Geography: Earth and Environment* 34, no. 5 (2010): 705–18. In the first two reports the setup was not established and there is no real synthesis report in the first assessment report. There is always a discernable summary for policy makers, even though it can be divided into different sections. I will refer to them by the shorthand mentioned in the text. IPCC First Assessment Report Overview and Policymaker Summaries and 1992 IPCC Supplement; IPCC Second Assessment, Climate Change 1995, A report of the Intergovernmental Panel on Climate Change; IPCC, *Climate Change 2001: Synthesis Report. A Contribution of Working Groups I, II, and III to the Third Assessment Report of the Intergovernmental Panel on Climate Change*, ed. R. T. Watson and the Core Writing Team (Cambridge, UK: Cambridge University Press, 2001), 398 pp; IPCC, *Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report*

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4. The same assumption of the dissemination and impact of the different reports is made by Walsh, Mahoney, and Schneider: Lynda Walsh, *Scientists as Prophets: A Rhetorical Genealogy* (New York: Oxford University Press, 2013); Martin Mahony, "Climate Change and the Geographies of Objectivity: The Case of the IPCC's Burning Embers Diagram," *Transactions of the Institute of British Geographers* 40, no. 2 (2015): 153–67, https://www.doi.org/10.1111/tran.12064; Birgit Schneider, "The Future Face of the Earth: The Visual Semantics of the Future in the Climate Change Imagery of the IPC," in *Cultures of Prediction in Atmospheric and Climate Science, Epistemic and Cultural Shifts in Computer-Based Modelling and Simulation*, ed. Matthias Heymann, Gabriele Gramelsberger, and Martin Mahony (New York: Routledge, 2017), 231–51.
5. The standard reference is Birgit Schneider and Thomas Nocke, eds., *Image Politics of Climate Change: Visualizations, Imaginations, Documentations* (Bielefeld: Transcript Verlag, 2014). See also Birgit Schneider, "Climate Model Simulation Visualization from a Visual Studies Perspective," *WIREs Climate Change* 3, no. 2 (2012): 185–93; Birgit Schneider, "Future Face of the Earth"; Lynda Walsh, "The Visual Rhetoric of Climate Change," *WIREs Climate Change* 6, no. 4 (2015): 361–68, https://www.doi.org/10.1002/wcc.342.
6. Martin Mahony and Mike Hulme, "The Color of Risk: Expert Judgment and Diagrammatic Reasoning in the IPCC's 'Burning Embers,'" in *Image Politics of Climate Change: Visualizations, Imaginations, Documentations*, ed. Birgit Schneider and Thomas Nocke (Bielefeld: Transcript Verlag, 2014), 105–24; Birgit Schneider, "Burning Worlds of Cartography: A Critical Approach to Climate Cosmograms of the Anthropocene," *Geo: Geography and Environment* 3, no. 2 (2016): e00027.
7. Sabine Pahl et al., "Perceptions of Time in Relation to Climate Change," *WIRE Climate Change* 5 (2014): 375–88; Elizabeth Callaway, "A Space For Justice: Messianic Time in the Graphs of Climate Change," *Environmental Humanities* 5 (2014):13–33; Anne Pasek, "Mediating Climate, Mediating Scale," *Humanities* 8, no. 4 (2019): 159, https://www.doi.org/10.3390/h8040159.
8. Kirsten Hastrup and Martin Skrydstrup, eds., *The Social Life of Climate Change Models: Anticipating Nature* (New York: Routledge, 2013); Catharina Landström, "Tracing Uncertainty Management Through Four IPCC Assessment Reports and Beyond," in *Cultures of Prediction in Atmospheric and Climate Science: Epistemic and Cultural Shifts in Computer-Based Modelling and Simulation*, eds. Matthias Heymann, Gabriele Gramelsberger, and Martin Mahony (New York: Routledge, 2017), 214–30; Kirsten Hastrup, "Anticipating Nature: The Productive Uncertainty of Climate Models," in *The Social Life of Climate Change Models: Anticipating Nature,* eds. Kirsten Hastrup and Martin Skrydstrup (New York: Routledge, 2013), 1–29. See also Walsh, "Climate Change and Prophecy," in *Scientists as Prophets*.

9. Matthias Heymann, "Constructing Evidence and Trust: How Did Climate Scientists' Confidence in Their Models and Simulations Emerge?" in *The Social Life of Climate Change Models: Anticipating Nature,* eds. Kirsten Hastrup and Martin Skrydstrup (London: Routledge, 2013), 203–24; Mike Hulme, "How Climate Models Gain and Exercise Authority," in *The Social Life of Climate Change Models: Anticipating Nature,* ed. Kirsten Hastrup and Martin Skrydstrup (New York: Routledge, 2013), 30–44.
10. Walsh, "The Visual Rhetoric."
11. Callaway suggests that this merging of history and the future does not happen, but that is not correct even for her case of TAR if you also look at the Synthesis report. See for example SPM 10a, page 33 and SPM 10b, 34.
12. Here I count only the 1990 report, beginning on page 47. In the 1992 supplement there are another three, all target year 2100.
13. There was also a graph for GDP reduction with target year 2050, SPM 9, 28.
14. A group of illustrations on page 23 show different outcomes for different greenhouse gas emission reductions up until 2030. The target year for those outcomes is also 2100, but time features differently on the x-axis.
15. "What is known about the regional and global climatic, environmental, and socio-economic consequences in the next 25, 50, and 100 years associated with a range of greenhouse gas emissions arising from scenarios used in the TAR (projections which involve no climate policy intervention)." SYR TAR, 8.
16. James S. Risbey, "The New Climate Discourse: Alarmist or Alarming?" *Global Environmental Change* 18, no. 1 (2008): 26–37, https://www.doi.org/10.1016/j.gloenvcha.2007.06.003.
17. Matthias Heymann and Nils Randlev Hundebøl, "From Heuristic to Predictive: Making Climate Models into Political Instruments," in *Cultures of Prediction in Atmospheric and Climate Science: Epistemic and Cultural Shifts in Computer-Based Modelling and Simulation*, eds. Matthias Heymann, Gabriele Gramelsberger, and Martin Mahony (New York: Routledge, 2017), 100–19; J. Hansen et al., "Climate Impact of Increasing Atmospheric Carbon Dioxide," *Science* 213, no. 4511 (1981): 957, https://www.doi.org/10.1126/science.213.4511.957. Personal correspondence with Hansen August 19, 2019.
18. Spencer R. Weart, *The Discovery of Global Warming* (Cambridge, MA: Harvard University Press, 2008). In the update to the FAR, a common methodology for assessing the impact of accelerated sea level rise was presented, which built on the simulated sea level rise for 2100. FAR, 38.
19. Bert Bolin and Bo R. Döös, *The Greenhouse Effect, Climatic Change and Ecosystems* (Chichester: Wiley, 1986). The year 2050 is also prevalent.
20. William Kellogg, for example, published an early prediction in 1977 that stretched until 2050. Heymann and Hundebøl, "From Heuristic."
21. Paul N. Edwards, *A Vast Machine: Computer Models, Climate Data, and the Politics of Global Warming* (Cambridge, MA: MIT Press, 2010).
22. Hulme, "How Climate Models," 32.
23. Heymann and Hundebøl, "From Heuristic," 105.

24. This was the stance of the Oreskes et al. *Science* article in 1994, referenced in Hulme, "How Climate Models," 33.
25. Heymann and Hundebøl, "From Heuristic," 106. On the social authority of models see also Hulme, "How Climate Models."
26. Risbey, "The New Climate Discourse," 33.
27. Martin Mahony, email to author, August 20, 2019. On the proliferation of the models developed by the Hadley Centre see Martin Mahony and Mike Hulme, "Model Migrations: Mobility and Boundary Crossings in Regional Climate Prediction," *Transactions of the Institute of British Geographers* 37, no. 2 (2012): 197–211; Martin Mahony and Mike Hulme, "Modelling and the Nation: Institutionalising Climate Prediction in the UK, 1988–92," *Minerva* 54, no. 4 (2016): 445–70, https://www.doi.org/10.1007/s11024-016-9302-0. Much work on future scenarios completed at the Climatic Research Unit at the University of East Anglia in the late 1980s was "atemporal." Mike Hulme, email to author, August 21, 2019.
28. FAR, 11.
29. James Hansen, email to author, August 19, 2019.
30. Donella H. Meadows, Dennis L. Meadows, Jørgen Randers, and William W. Behrens, III, *The Limits to Growth: A Report for The Club of Rome's Project on the Predicament of Mankind* (London: Earth Island, 1972).
31. Jordheim, "Introduction."
32. Joshua P. Howe, *Behind the Curve: Science and the Politics of Global Warming* (Seattle: University of Washington Press, 2014).
33. The hockey stick curve has also been the focus of great debate and attack. See for example Pasek, "Mediating Climate."
34. For several examples, see Pahl et al., "Perceptions of Time," 380.
35. For a discussion on the role of media logic in framing the public discourse on climate change see for example Miyase Christensen, Annika E. Nilsson, and Nina Wormbs, eds, *Media and the Politics of Arctic Climate Change: When the Ice Breaks* (New York: Palgrave Macmillan, 2013).
36. See also Paglia and Isberg, Chapter 10 in this volume, who deal mainly with the recording of temperature rather than specific highs or lows.
37. Peter A. Stott et al., "Attribution of Extreme Weather and Climate-Related Events," *WIREs Climate Change* 7, no. 1 (2016): 23–41, https://www.doi.org/10.1002/wcc.380.
38. AR5, 53. Italics in original.
39. World Meteorological Organization, "July Matched, and Maybe Broke, the Record for the Hottest Month since Analysis Began," August 1, 2019, retrieved October 3, 2021 from https://public.wmo.int/en/media/news/july-matched-and-maybe-broke-record-hottest-month-analysis-began; Jon Henley, Angelique Chrisafis, and Sam Jones, "France Records All-Time Highest Temperature of 45.9C," *The Guardian*, June 28, 2019, https://www.theguardian.com/world/2019/jun/28/france-on-red-alert-as-heatwave-forecast-to-reach-record-45c.
40. Mike Hulme, email to author, August 20, 2019.
41. See for example Elodie Vieille Blanchard, "Technoscientific Cornucopian Futures versus Doomsday Futures: The World Models and The Limits to Growth," in *The*

Struggle for the Long-Term in Transnational Science and Politics: Forging the Future, ed. Jenny Andersson and Eglė Rindzevičiūtė (New York: Routledge, 2015), 92–114.
42. Heymann and Hundebøl, "From Heuristic."
43. Jenny Andersson and Eglė Rindzevičiūtė, eds., *The Struggle for the Long-Term in Transnational Science and Politics: Forging the Future* (New York: Routledge, 2015).
44. Christopher P. Weaver et al., "Improving the Contribution of Climate Model Information to Decision Making: The Value and Demands of Robust Decision Frameworks," *WIREs Climate Change* 4, no. 1 (2013): 39–60, https://www.doi.org/10.1002/wcc.202.
45. Dennis Bray and Hans von Storch, "'Prediction' or 'Projection'?: The Nomenclature of Climate Science," *Science Communication* 30, no. 4 (2009): 534–43, https://doi.org/10.1177/1075547009333698.
46. Michael D. Mastrandrea et al., "The IPCC AR5 Guidance Note on Consistent Treatment of Uncertainties: A Common Approach across the Working Groups," *Climatic Change* 108, no. 4 (2011): 675, https://www.doi.org/10.1007/s10584-011-0178-6.
47. FAR, 11. The terminology issue of the future is greater than this summary treatment, including issues of epistemology and historical grounding. I thank Emil Henrik Flatø for truly valuable comments particularly in relation to this but also on the chapter as a whole.
48. Compare Matthias Heymann, Gabriele Gramelsberger, and Martin Mahony, eds., *Cultures of Prediction in Atmospheric and Climate Science: Epistemic and Cultural Shifts in Computer-Based Modelling and Simulation* (New York: Routledge, 2017), 5.
49. Heymann, Gramelsberger, and Mahony, *Cultures of Prediction*, 7; Hulme, "How Climate Models."
50. Schneider, "Future Face of the Earth."
51. See for example Roy Scranton or Clive Hamilton.
52. WMO, "July matched."
53. Bård Lahn, "A History of the Global Carbon Budget," *WIREs Climate Change* 11, no. 3 (2020): e636, https://www.doi.org/10.1002/wcc.636.
54. Hélène Guillemot, "The Necessary and Inaccessible 1.5°C Objective: A Turning Point in the Relations Between Climate Science and Politics?" in *Globalising the Climate: COP21 and the Climatisation of Global Debates*, ed. Stefan C. Aykut, Jean Foyer, and Edouard Morena (London: Routledge, 2017), 39–56.
55. Shinichiro Asayama et al., "Why Setting a Climate Deadline is Dangerous," *Nature Climate Change* 9, no. 8 (2019): 570–72, quote 570, https://www.doi.org/10.1038/s41558-019-0543-4.
56. Richard J. Millar et al., "Emission Budgets and Pathways Consistent with Limiting Warming to 1.5 °C," *Nature Geoscience* 10 (18 September 2017): 741.
57. Asayama et al., "Climate Deadline," 570.
58. Asayama et al., 570.
59. Lahn, "Global Carbon Budget." See also Bård Lahn, "Changing Climate Change: The Carbon Budget and the Modifying-Work of the IPCC," *Social Studies of Science*, July 16, 2020, https://www.doi.org/10.1177/0306312720941933.
60. Malena Ernman and Svante Thunberg, *Scener ur hjärtat* (Stockholm: Polaris, 2018).

61. See Walsh, *Scientists as Prophets*.
62. In the English language, "to kick the bucket" is slang for "to die." Correspondingly, a bucket list is something you want to do before you die. I am not exploring the possible associated framings here.
63. Amazon reported soaring sales in relation to Trump being elected president in the US, November 2016.
64. Risbey, "The New Climate Discourse," 33.
65. Pahl et al., "Perceptions of Time," 376.
66. C. P. Snow claimed that the moon-landing in effect killed futurism as we had reached as far as we possibly could.
67. Pasek, "Mediating Climate."
68. Pasek, 1, with reference to Derek Woods, "Scale Variance and the Concept of Matter," in *The New Politics of Materialism*, ed. Sarah Ellenzweig and John H. Zammito (New York: Routledge, 2017).

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