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► **To cite this version:**

Marc Delepouve. The Emergency of Climate Change. Scientific Knowledge, IPCC Scenarios and Representations of Climate Change. transform!, 2016, pp.19-23. halshs-01843664

HAL Id: halshs-01843664

<https://shs.hal.science/halshs-01843664>

Submitted on 25 Feb 2022

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The Emergency of Climate Change

Scientific Knowledge, IPCC Scenarios and Representations of Climate Change

MARC DELEPOUVE

It is important to have an accurate and lucid representation of climate change, especially in establishing policies to mitigate it, which is one of the main goals of energy transition.

In what follows we will first present a picture of climate change we believe results from scientific research and its limits. Then we will present a contrasting picture of climate change, one that flows from the scenarios of the Inter-governmental Panel on Climate Change (IPCC). Finally, we will present our political conclusion.

The picture of climate change based on scientific investigation

Based on recent discoveries, there are four major lessons to draw from scientific investigations of the future of climate change:

1. current climate system change is closely intertwined with earth system change. There is strong interaction between the changes of all the components of the earth system : oceans, life, climate.
2. 'Climate change is extremely complex. Its future is a largely question that scientific knowledge cannot illuminate, because the evolution of human activities cannot be predicted, especially over several decades or a century, but also because the complexity of the earth system cannot be grasped with today's scientific knowledge.'
3. 'Today, our ability to quantify the future of climate change is very limited; most scientific knowledge lies either in the non-quantitative or not yet quantifiable realm.'
4. 'Thanks to scientific findings, humankind is aware of climate change, of its speed, of the risk of a run-away effect, and of the major threat it represents to the earth system and humanity in general.'

As we will see, these lessons are illustrated, among other things, by the cloud system, underground methane reserves (under dry ground or under the ocean floor), and by living creatures.

Clouds

The cloud system has two opposite effects on climate. One is the greenhouse effect, which is a warming effect; the other is the mirror effect, which is a cooling effect. The balance between these two effects could change with global warming, in the direction either of warming or cooling. Scientific analysis suggests that the future evolution of this balance will likely be towards warming; but today, due to insufficient scientific knowledge, it is absolutely impossible to elaborate a quantified scenario of the future evolution of this balance.

On this issue, the IPCC's Fifth Assessment Report (2013) reads in full:

» *'The quantification of cloud and convective effects in models, and of aerosol and cloud interactions, continues to be a challenge. Climate models are incorporating more of the relevant processes than at the time of AR4, but confidence in the representation of these processes remains weak. [...] [Today] model estimates of aerosol-cloud interactions and their radiative effects will carry large uncertainties.²⁹ 'The sign of the net radiative feedback due to all cloud types is likely positive. Uncertainty in the sign and magnitude of the cloud feedback is due primarily to continuing uncertainty in the impact of warming on low clouds.'³⁰*

Methane stocks in ocean floors

Scientific findings provide us with some information. Methane (CH₄) stocks in the ocean floor might release great quantities of methane gas into oceans and the atmosphere due to temperature increases, but we do not know when this is likely to happen or what the magnitude of it will be. This is not a secondary issue, because methane stocks in ocean floors are gigantic. According to a communication published in 2006 by the Geological and Geological Engineering Department of Laval University, seabed methane, in the form of methane hydrate, contains about twice the quantity of carbon of all known fossil fuel reserves in the world. Moreover, a methane molecule has at least 25 times the greenhouse effect of a molecule of CO₂. Therefore, releasing a small part

29 Full WG1 AR5 Report, p. 573, http://www.climatechange2013.org/images/report/WG1AR5_ALL_FINAL.pdf

30 Full WG1 AR5 Report, p. 574.

of the seabed methane could induce an important increase of greenhouse gases in the atmosphere³¹, which then could induce a temperature increase, which in turn could induce methane to be released again, and so on.

According to the Geological and Geological Engineering Department of Laval University (2006):

» *'A massive destabilisation of methane hydrates caused for example by an increase of 1 or 2° C in oceans temperatures, which is entirely compatible with current climate models, may produce a catastrophic increase in atmospheric greenhouse gas.'*³²

On this issue, the IPCC's full Fifth Assessment Report, in its complete final version, noted in connection with seabeds (excluding the Arctic Ocean):

» *'The likelihood of the future release of CH₄ from marine gas hydrates in response to sea floor warming is poorly understood. In the event of a significant release of CH₄ from hydrates in the sea floor by the end of the 21st century, it is likely that subsequent emissions to the atmosphere would be in the form of CO₂, due to CH₄ oxidation in the water column' (emphasis in original).*³³ Later, it enlarged the scope of its topic to Arctic permafrost: *'CH₄ release from marine hydrates and subsea permafrost may also occur but uncertainty is sufficient to prevent plotting emission rates here.'*³⁴

In 2010, the International Arctic Research Center (IARC)³⁵ at Fairbanks University, Alaska, published a study in the scholarly journal *Science* showing that leakage of methane stored under the 2 square million kilometres of the Arctic had already begun and stated that it *'might have in the future a dramatic effect on global warming'*. Here is an excerpt of a résumé of this study published by EurekAlert, website of the American Association for the Advancement of Science (AAAS):

» *'Releasing of methane from the Arctic is faster*

*than expected. The amounts of methane emerging from Arctic Ocean's submarine permafrost in atmosphere are an important and overlooked source of methane, and researchers say that similar but more widespread emissions could in future have a dramatic effect on global warming. [...] After more than 5,000 measures in East Siberian Sea, the researchers report that 80 % of the deeper water and more than 50 % of those close to the surface are supersaturated with methane from underlying permafrost. The sea-floor permafrost contains large amounts of carbon and experts fear that its release as methane leads to a warming of the atmosphere, creating a positive feedback loop with an even larger gas release.'*³⁶

In 2012, according to the Institut Français de Recherche pour l'Exploitation de la mer (Ifremer) :

» *'In releasing large quantities of methane, a gas with a strong greenhouse effect, the destabilisation of gas hydrates found in marine sediments could play a fundamental role in global climate change. It has in fact been noted that all periods of global warming over the last 60,000 years have been marked by high levels of atmospheric methane. Indeed, the mechanism "beginning of warm-up - thermal destabilisation of hydrates - methane release" has the effect of accelerating the warming.'*³⁷

Methane release from continental permafrost

The fifth IPCC full assessment report states:

» *'There is high confidence that reductions in [continental] permafrost extent due to warming will cause thawing of some currently frozen carbon. However, there is low confidence [due to lack of knowledge] on the magnitude of carbon losses through CO₂ and CH₄ emissions in the atmosphere.'*³⁸

An article in the CNRS' *Le Journal* of January 2015 states:

31 However, we should note the substitution of a likely large quantity of methane by CO₂ during its movement from the ocean floor to the atmosphere, except in the case of the Arctic Ocean's submarine permafrost.

32 'Les hydrates de méthane : une réserve énergétique énorme, mais une bombe écologique en puissance', 2 February 2006, <<http://www2.ggl.ulaval.ca/personnel/bourque/s3/hydrates.methane.htm>>.

33 Full WG1 AR5 Report, page 468-469

34 Full WG1 AR5 Report, p. 540.

35 Natalia Shakhova, Igor Semiletov, Anatoly Salyuk, Vladimir Yusupov, Denis Kosmach from Russian Sciences Academy (Vladivostok), and Örjan Gustafsson from Stockholm University. The authors are members of a research team of the International Arctic Research Center (IARC) of Fairbanks University (Alaska), coordinated by Natalia Shakhova..

36 <<http://www.aaas.org/news/science-methane-gas-release-arctic-permafrost-far-larger-expected>>.

37 <http://www.ifremer.fr/grands_fonds/Les-enjeux/Les-applications/Ressources-energetiques/Les-hydrates-de-gaz>.

38 Full WG1 AR5 Report, p. 468.

» *“Permafrost represents 25 per cent of the land in the Northern Hemisphere, equivalent to the size of Canada. This is the largest terrestrial carbon reservoir in the world, ahead of fossil fuel such as oil, gas, and coal, “1,700 billion tons of carbon of plant origin have accumulated since the last glaciation”, explains Florent Dominé. “This is more than twice the carbon now present in the atmosphere!”³⁹*

‘Florent Dominé points to a temperature increase of 5° to 8° C by 2100, while the worst case scenario of the Intergovernmental Panel on Climate Change (IPCC) is now at 4° C.’ Dominé adds: “All we know today is that we are facing a formidable positive reverse action and feedback loop. The more air temperature increases, the more the permafrost melts and the more greenhouse gases are released in the atmosphere, resulting in a further increase in air temperature, and so on ... “[...]’

The thermokarst ponds [...] these actual bioreactors, are at the heart of the frozen carbon releasing process. When permafrost thaws, chunks of ground break off and fall into the water, bringing nutrients and carbon to the bacteria and plankton present in the pond, which in turn change these nutrients into CO₂ (in the water layers close to the surface), and into methane (in the deeper areas of the pond that are deprived of oxygen).’

This *Le Journal* article illustrates the complex interactions and loops between climate change, release of methane, and life. More widely - increasing temperature, acidification of oceans, release of methane from permafrost or from the ocean floor, the decreasing oxygen rate of some ocean waters, and consequential change of life forms - all these are influenced by interactions in an extremely complex process of change that is far from being fully explained by scientific knowledge. Moreover, this process interacts with the scientifically unpredictable evolution of economic/social structures and of human behaviours (life style and production and consumption patterns). This evolution is all the more unpredictable that they are taking place within the unprecedented context of the environmental crisis and are likely to become an overwhelming factor in the coming decades.

Methane – the IPCC sounds the alarm

The full fifth IPCC assessment report stated:

» *“ Between the mid-1980s and the mid-2000s the atmospheric growth of CH₄ declined to nearly zero [...]. More recently since 2006, atmospheric CH₄ is observed to increase again [...]; however, it is unclear if this is a short-term fluctuation or a new regime for the CH₄ cycle [...].⁴⁰*

» *Further: ‘Of the natural sources of CH₄, emissions from thawing permafrost and CH₄ hydrates in the northern circumpolar region will become potentially important in the 21st century because they could increase dramatically due to the rapid climate warming of the Arctic and the large carbon pools stored there.’ ‘Supersaturation of dissolved CH₄ at the bottom and surface waters in the East Siberian Arctic Shelf indicate some CH₄ activity across the region [...] but it is not possible to say whether this source has always been present or is a consequence of recent Arctic changes. The ebullition of CH₄ from decomposing, thawing lake sediments in north Siberia [...] is another demonstration of the activity of this region and of its potential importance in the future [...].⁴¹*

The story of missing heat

Between 50 million BC to one million BC, the earth’s surface atmosphere cooled by approximately 15 ° C. To be precise, temperature constantly fluctuated following a cycle with an average temperature that was lowered by approximately 15 ° C. Since the nineteenth century, a new and reverse trend has occurred with an exponential temperature increase. However, in the last 16 years, the increase was considerably weaker than in the two previous decades. This question was the focus of an article published in *Nature* in January 2015. Here are excerpts from this article:

» *‘Sixteen years into the mysterious “global-warming”, scientists are piecing together an explanation.’ ‘...average atmospheric temperatures have risen little since 1998, in seeming defiance of projections of climate models and the ever-increasing emissions of greenhouse gases. [...] Climate scientists, meanwhile, know that heat must still be building up somewhere in the climate system, but they have struggled to explain where it is going, if not into the at-*

39 Laure Callioce, ‘Pérgélisol, le piège climatique’ [Permafrost, the Climate Trap], *Le Journal*, <<https://lejournal.cnrs.fr/articles/pergelisol-le-piege-climatique>>.

40 Full WG1 AR5 Report, p. 475

41 Full WG1 AR5 Report, p. 508.

mosphere. Some have begun to wonder whether there is something amiss in their models.' 'Now, as the global-warming hiatus enters its sixteenth year, scientists are at last making headway in the case of the missing heat': the oceans 'serve as giant sponges for heat'.

The article also noted that 'none of the climate simulations carried out for the IPCC mentioned this particular hiatus at this particular time.'⁴²

Much before the end of 2014, the heat sponge function of oceans (which soak up approximately 90 per cent of the extra energy accumulated in the system because of global warming) was a known fact; but its increase over the past sixteen years was both unseen and unforeseen. IPCC models and the fifth IPCC Assessment Report released in 2014⁴³ also failed to capture this.

Several questions arise from the heat-sponge role of the oceans, representing considerable challenges for research, especially in terms of quantifiable answers. How does this surplus heat move in the ocean and where is it going? What is happening and what will happen to the warm ocean currents? To what extent and when will this heat surplus reheat and destabilise methane stocks located in the ocean floor, causing their release? Will the surplus heat accelerate the evolution of submarine eco-systems? Will it increase the risk of a speedy development of methanogenic bacteria (which played a key role during the very warm periods of the earth's climate history)?

The current climate change is closely related to the overall change of the earth system. Strong interactions, with a risk of retroactive spirals, are at work between climate change and changes affecting all components of the earth system, creating an extremely complex totality. Uncertainties about the paths followed by climate change are essential in addressing the danger they pose for humanity. Once we have grasped the scientific findings and their limits, we can represent the future of climate change taking into account what cannot be predicted and the scope of dangers and risks, and then we can hear the alarm bells all over the planet and issue a call to general mobilisation.

42 Jeff Tollefsen, 'Climate Change; The Case of the Missing Heat', <<http://www.nature.com/news/climate-change-the-case-of-the-missing-heat-1.14525>>.

43 Full WGII AR5 Report, <<https://www.ipcc.ch/report/ar5/wg2/>>.

44 See Marc Delepouve, *Une société intoxiquée par les chiffres*, Paris : Éditions L'Harmattan, 2011, chapter 3 with subchapters 3, 4, and 5.

45 For example this target is claimed by most of the French media and most of the French environmental website. We choose here one among them, just for illustration : <http://www.actu-environnement.com/ae/news/rapport-giec-2c-emissions-ges-temperatures-hausse-21395.php4>

Representation of climate change based on IPCC scenarios

Since its inception, the IPCC has published five Assessment Reports. The last and fifth in 2013–2014, the fourth in 2007. Each IPCC Assessment Report contains a full report and a summary for policy makers. Starting with its second edition in 1995, the IPCC Assessment Report has included scenarios of climate change forecast to 2100. The interpretation of these scenarios by media and politicians has a huge impact on the public representation of climate change, on the public debate, and on the reaction of people in facing climate change.

According to the interpretation adopted by most of media and politicians of scenarios from the IPCC's Fourth Assessment Report, a good target is seen as a 50 per cent reduction of greenhouse gas emissions by 2050 compared to the beginning of the 21st century. It was the famous factor 2, a magical figure well-adapted to political communication.⁴⁴

According to the interpretation adopted the same media and politicians of scenarios from the IPCC's Fifth Assessment Report, a good target would be between '40 to 70 per cent global anthropogenic GHG emissions reductions by 2050 compared to 2010'⁴⁵. This target seems less magical than factor 2, and it could even seem to be scientific as it is presented as a confidence interval. But it is not a confidence interval, a problem to which we will return.

Both evaluation reports were thus interpreted and given an objective for the year 2050. We are now 35 years from this date up to which humans could, according to these political and media interpretations, continue quietly to release greenhouse gases into the atmosphere, in smaller but still considerable quantities. However, given the likelihood of an acceleration of climate change, even the smaller quantity seems truly out of proportion.

A few words on the IPCC's Fifth Assessment Report. It contains four climate scenarios running until 2100, based on four scenarios of greenhouse gas releases created by human activities. Each one is based on

the results of a set of climate models, with between 25 and 42 such models per scenario. Concerning global mean surface temperature change, the IPCC's full Fifth Assessment Report first states:

» *the Result is “a statistical summary of the spread in the Coupled Model Intercomparison Project (CMIP) ensembles for each of the scenarios [...] model biases and model dependencies are not accounted for; the percentiles do not correspond to the assessed uncertainty [...]; and statistical spread across models cannot be interpreted in terms of calibrated language”⁴⁶.*

More generally it states:

» *“In summary, there does not exist at present a single agreed on and robust formal methodology to deliver uncertainty quantification estimates of future changes in all climate variables [...]. As a consequence, in this chapter⁴⁷, statements using the calibrated uncertainty language are a result of the expert judgement of the authors [...].⁴⁸ “[...] in general, it remains an open research question to find significant connections that justify some form of weighting across the ensemble of models and to produce aggregated future projections that are significantly different from straightforward one model-one vote [...] ensemble results. Therefore, most of the analyses performed for this chapter [...] make use of all available models in the ensembles, with equal weight given to each of them unless otherwise stated.”⁴⁹*

In this case, using a simple average⁵⁰ is an aberration. But, because the IPCC does not have the knowledge necessary to perform a pertinent calculation, the method it uses is simple averaging. Added to this are the biases contained in the models. In this connection, the full edition of the fifth report acknowledges that several questions involving major future climate risks have either not been taken into account in the IPCC models or have been included only in some models.

However, in preparing the summary for policy makers, the IPCC chose not to warn readers about the biases and methodological weaknesses (or immaturity) of the models used in constructing the scenarios. By doing so, the IPCC opened the door to

unfounded political and media interpretations of these scenarios resulting in erroneous representations of climate change issues.

Conclusion

The IPCC is an intergovernmental panel, and the word **intergovernmental** is significant. IPCC Reports are both scientific and political. Reading the full IPCC Assessment Reports, one can get a representation of the future of climate change based on scientific findings with an awareness of their limits. But very few read the full reports. Only reading the IPCC summary for policy makers, one gets a false impression of climate change based on a great deal of figures and on scenarios projected to 2100 resulting from the quantification of the unquantifiable. What is more, this false representation is cold and technical and does not lead to mobilisation.

Scientific findings are sounding the alarm: the climate system is threatened by a rapid and major runaway effect. Humankind has to launch a general and solidarity-based mobilisation without further delay to avoid the risk of a huge and dramatic climate runaway or to limit its magnitude and effects as far as possible. The earth system is humanity's home. The earth system and its climate are under attack, by humanity itself. The chief responsibility for this lies with the richest and most powerful people and their transnational corporations. They are also the least threatened and do not want to see humanity's general and solidarity-based mobilisation. Such a mobilisation would threaten the system of production and consumption and generalised competition, among other things. It would threaten the foundation on which their wealth and power rest. It is clearly plausible that this is the motivation behind the mistaken representation of climate change based on IPCC scenarios and disseminated by most media and politicians.

How climate change is represented is an eminently political issue. For the political left, the social movements, and the environmental NGOs, it is important to construct their own representation of climate change based on scientific findings (including those given in the full IPCC Assessment Report) and knowing their limits, but not based on IPCC scenarios. This is a major issue. It is a democratic necessity.

46 Full WG1 AR5 Report, p. 1397.

47 Editors Note: This chapter assesses long-term projections of climate change for the end of the 21st century and beyond

48 Full WG1 AR5 Report, p. 1040.

49 Full WG1 AR5 Report, pp. 1040, 1044.

50 An average each of whose values are given equal weight.