

What will the climate be like?

Latest news regarding the Fifth Assessment Report (Part 1)

In a famous scene of *The day after tomorrow*¹, the paleoclimatologist Jack Hall presents the results of his studies to a group of delegates of the United Nations, preannouncing an imminent glaciation that will seriously endanger humanity. The people listening to him are mostly representatives of member governments, gathered in a rather small meeting room and it seems that Dr. Hall is the only scientist to be warning them of this imminent danger. Some listen with a bit of curiosity, some are skeptical, the presentation with images of the Northern Hemisphere completely covered with ice does not seem to convince them to do anything - and the words of Dr. Hall punctually become reality only a few days after. Dr. Hall and all the government representatives belong to American movie fiction, and as you will have imagined the movie cannot be an example of how things actually are and how they evolve. Actually, in fact, it is all very different! So, what to do? Have you ever wondered how scientists really communicate to the public what they know about climate change, and how they relate with the governments to inform them of their discoveries? Every 6-7 years approximately, scientists from IPCC² inform the world about all they know which is significant, through a very important document: the *Assessment Report (AR)* on climate.

Short history of an important report

IPCC, the Intergovernmental Panel on Climate Change, was established in 1988 by the World Meteorological Organization (WMO) and by the United Nations Environment Programme (UNEP), with the aim “to provide the world with a clear scientific view on the current state of knowledge in climate change and its potential environmental and socio-economic impacts”.



Fig. 1 The first session of IPCC in 1988. Credits: IPCC Photo, History of the IPCC

1 Film directed by Roland Emmerich, USA, 2004

2 For further information about what IPCC is, and what it does, go to the eniscuola webpage <http://www.eniscuola.net/it/aria/contenuti/cambiamenti-climatici/left/effetto-serra/che-cos-ippcc/>

The Assessment Report on climate (here onwards AR) is a report from IPCC that contains all we know on the climate of our planet, on the impacts and vulnerability of the natural, social and economic systems and on the possible ways of mitigation, with proposed economic estimates. If we want some extremely reliable information on the topic, this is where we can find our answers, as AR is the most updated and exhaustive document produced to date.

The Report was published for the first time in 1990, and the first edition was followed by editions in 1995, 2001, 2007, and finally the last in 2014, which is the fifth (AR5).

In 2007, IPCC and Albert (Al) Gore Jr. jointly won the Nobel Peace Prize for “their efforts to build up and disseminate greater knowledge about man-made climate change, and to lay the foundations for the measures that are needed to counteract such change”.



Fig. 2 A delegation of IPCC receive a Nobel Peace Prize in 2007. Credits: IPCC Photo

Just like the previous Reports, AR5 is subdivided into three parts, each one relates to a dedicated Working Group (WG I, WG II, WG III), that studies and examines, in detail, a particular aspect of the subject.

The first part of the fifth Assessment Report, (AR5 WG I) was presented at the end of September 2013 and described the available knowledge about climate, from a physical point of view; the second part (AR5 WGII), was released in March 2014, and it mainly regards the impact and vulnerability and exposure of human and natural systems, and the possible future risks of climate change and the possibility and limits of adapting to it; the third and last part, (AR5 WGIII), published in April 2014, discusses the mitigation methods, also proposing economic assessments.

How much time is necessary to prepare a similar report, and how long is it? How much information must the staff collect, analyse and evaluate? The situation is very different from that of Dr. Hall: the climate is something serious and complex, and discussing it requires a lot of time and many different competencies. Preparing the Report requires years of work and thousands of pages!

The complete report is subdivided into a number of chapters. Each one is about a specific theme, and for each chapter there is a specific group of authors coordinated by a lead author. Since the authors come from different countries and professional experiences, a number of subsequent meetings, which may even last a week, are necessary. During these meetings each group of authors concentrates on its working area, and an official report is edited only when all the parts agree. Every statement of the report is evaluated in qualitative terms of confidence (i.e. the reliability of a statement, rated from very low to very high), and probability (from extremely improbable to practically sure).



Fig.3 First meeting of the lead authors of WGII. Second plenary session Credit: Benjamin Kriemann/IPCC

When all the groups have each completed their chapter, a first draft of the Report is produced, and submitted for a first revision by other scientists, who are independent and outside the IPCC working groups. The revisors send a list of comments that are exact and inherent to all that is written in the document. These comments are not always requests to make changes, at times they are requests for further examination, for more details, etc. The IPCC scientists receive and discuss the comments, after which they produce a new draft, the second, which is submitted for discussion by the officers of the member states of IPCC and other experts.

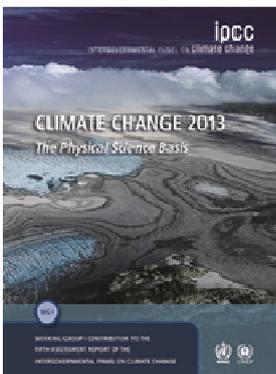
This process, which may seem long and tedious to you, is necessary in order to guarantee impartiality, accuracy and precision of the data and of the statements that are reported, and to guarantee scientific rigour of the final contents.

You will understand that when the final versions of the three parts of the report are completed, they consist of volumes of thousands of pages, and it would be very difficult for us all to read such a huge amount of information. So that the information contained in the report can be accessible to all, IPCC also publishes a *Technical summary* which is mainly meant for scientists and researchers, a *Summary for policy makers*, and a *Synthesis report*, which contain all the key messages. So that it can be published, each Report must be approved by all the member Countries of IPCC that are present at the Plenary meeting.

Now that we have discovered the large amount of work hidden in the AR, let us discover what was indicated in the fifth edition, AR5.

AR5 WGI, physical science basis of climate change

259 authors, 39 countries and 54677 comments from the revisors. And that is not all: 14 chapters, 6 attachments, 1 Technical summary and 1 Summary for policy makers, 1552 pages and a total weight of 4.5 kg! These are the figures of AR5 WGI, the first part of the fifth Assessment Report, edited by the first Working Group.



(in the image on the left, the cover of the Report).

This part provides an exhaustive assessment of the physical science basis of climate change and is based on the available scientific literature, that was accepted for publication before 15 March 2013. The Summary for policy makers was approved officially during the twelfth session of WGI held in Stockholm from 23 to 26 September 2013.

The numbers and the important data are not all here, but are all contained in the thousands of pages of AR5 WGI. As we do not have the time and space to examine them all, let us discover the 10 fundamental and most important points that arose.

First of all **the existence of global warming is unequivocal**, there are many proofs. The last three decades have been the hottest since 1850, the year in which measurements started being taken on a global scale, and in particular the last decade has been the hottest,

it is even probable that the years 1983-2012, were the hottest thirty years in the past 1440 years. Lastly, warming of the oceans at a depth between 0 and 700 m, in the period from 1971 to 2010 is practically certain.

Whose fault is it for the warming? **It is extremely probable** (with a percentage of confidence between 95%-100%, which has increased compared to the previous report) **that more than half of the increase in surface temperature observed from 1951 to 2010 has been provoked by greenhouse gas emissions, as a consequence of human activities.**

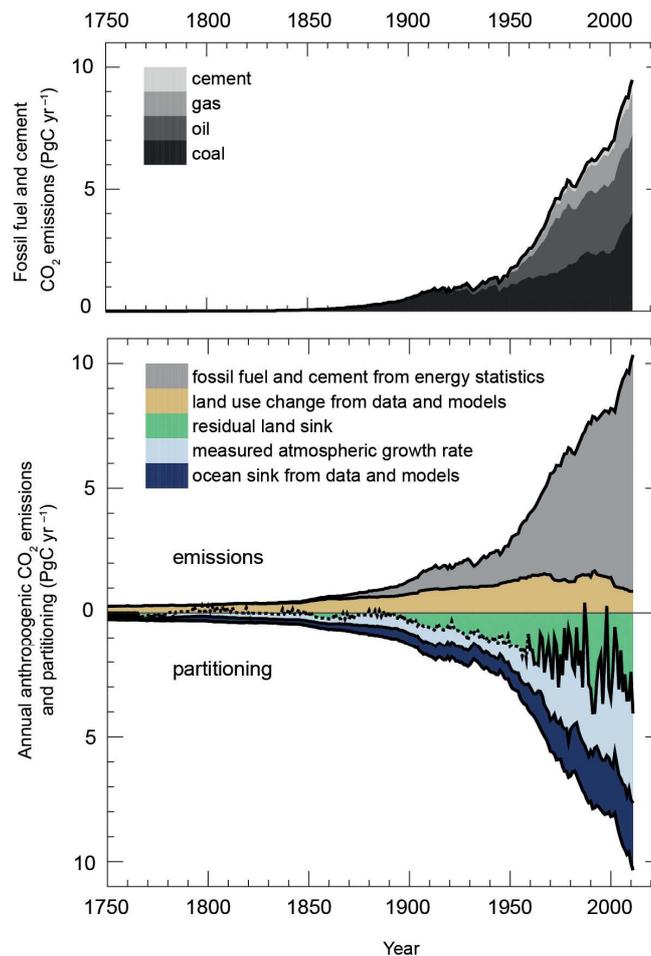


Fig. 4 Anthropogenic CO₂ emissions and the related partitioning on the planet from 1750 to 2011 (1 PgC=3.67*10⁹ ton CO₂). On top, emissions from the production of cement and energy from gas, oil and coal. From 2002 to 2011, the emissions increased at a rhythm of 3.2 PgC a year, and was more than in the 90s. Below, the partitioning of emissions between fossil fuels and cement production (grey), emissions from land use change (deforestation, light brown), ocean sink (blue), quantity in the atmosphere (light blue), and absorption of residual carbon (green). **Source:** IPCC, AR5 WGI Technical Summary, pag.51

The consequences of these emissions and warming are melting ice, decrease in the snow cover, rise in the global mean sea level and extreme climatic events in the second half of the XX century. The continuous emissions of greenhouse gas will accentuate climate change and in order to limit this, they must be reduced. The scenarios elaborated by the scientists are greatly influenced by the choices that will be made in the future with regard to this.

In particular, **IPCC proposes four scenarios of the increase in the global mean temperature** at the surface for the end of this century (around 2081-2100), the result of hundreds of examined models. The most optimist scenario foresees that the emissions will be decreased drastically in a few decades, while the most pessimist scenario is an extreme

scenario without any decreases. Two intermediate reduction scenarios are added to the first two. Compared to the pre-industrial periods, the estimated increase in temperature ranges between 1°C–2.3°C (drastic decrease scenario) and 3.2°C–5.4°C (non-intervention). And the intermediate scenarios foresee increases ranging between 1.7°C–3.3°C and 2°C–3.7°C. In other words, if we are lucky, we will remain within the 2°C range, a value which however will not exempt us from experiencing the consequences of the climate. It is practically certain that temperature extremes (hot and cold) will be more frequent, as also the heat waves.

The fourth key point is that **extreme events** (such as typhoons or hurricanes, but also high temperatures) will be **more frequent**. In fact, on a global scale, the number of cold days and nights has decreased and, vice-versa, the number of hot days and nights has increased. The frequency of the waves has probably increased in vast areas in Europe, Asia and Australia, and the amount of land affected by intense precipitation events is greater, with an increase in the frequency and intensity in Europe (as in the case of Sardinia) and North America.

The water cycle will be affected more and more by climate change on a global scale, with different effects on a regional scale, in other words more rain will fall where it already rains a lot and, on the other hand, rainfall will decrease in the regions that are already arid. For example the Equatorial areas, the higher latitudes and the monsoon areas will be affected by an increase in the precipitations, with an intensification of extreme phenomena and consequent flooding, while the arid tropical areas, on the contrary, will experience a decrease in the amount of rainfall and the number of showers.

Furthermore, scientists have noted that the ice is no longer so frozen, as the **ice-melt is accelerating**. In Greenland and in Antarctica, the mass of the ice caps has decreased, and also the extension of the arctic icepack in the summer period has decreased. The troubling datum is that most probably the mean mass loss rate of the ice cap in Greenland has passed from 34Gt/ year in the period 1992-2001 to 215 Gt/ year in the period 2002-2011, a 532% decrease! Furthermore in the whole planet almost all the glaciers have become smaller. Another proof is that in all the scenarios foreseen in the scientists' probabilistic models **the ice will continue to melt**. The annual extension of the Arctic ice will continue to decrease during the course of the century and in the more extreme scenarios a complete seasonal melting of the Arctic ice will be possible at the end of summer, by 2050. The decrease in the ice cover by 2100 will be strong, and an increase from -15% to -55% is foreseen (excluding the Antarctic) and at the same time a decrease is foreseen in the seasonal snow cover, from 7% to 25%.

The mean sea level rise, on a global scale is a sure fact, and is accelerating. Most probably it has passed from 1.7 mm/year in the period 1901-2010 to 3.2 mm/year in the period 1993-2010. However this is not all, **in the XXI century the mean sea level will continue to grow**, with different ranges depending on the scenarios hypothesized by the scientists. The sea will rise further 26-55 cm in the more optimistic scenario, to 45-82 cm in the more pessimistic scenario, to which we must add the 15 cm rise that has already been recorded.

If we were to stop emitting greenhouse gases now, would we be safe from global warming? Unfortunately this is not so, because these changes would not stop anyway, due to the time in which the greenhouse gases remain in the atmosphere (resident time can even be hundreds of years), therefore it is foreseen that **all the changes** caused by the warming **will continue for many centuries**.

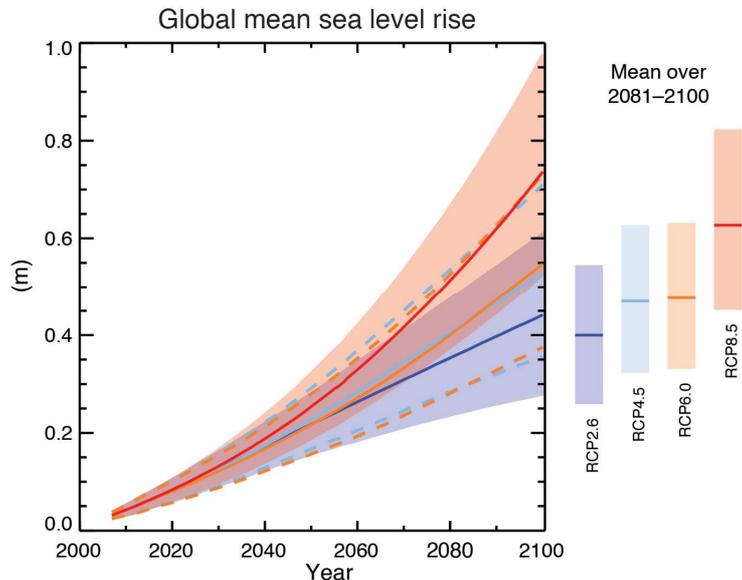


Fig. 5 Mean sea level rise in the different scenarios foreseen by IPCC: The thick solid lines indicate the mean rise provided by the models and the broken solid lines indicate the extent of the variability of RCP 4.5 and RCP 6.0 (the two intermediate scenarios of the rise in temperature) while the areas coloured pink and blue show the extent of the variability of the most optimistic scenario of the temperature (RCP 2.6) and the most pessimistic (RCP 8.5). **Source:** IPCC, AR5 WGI Technical Summary, page. 100

This is the picture of what has happened or of what will happen in the future ... what if, instead, we were to look at the impacts? Which are the areas of the planet that are most vulnerable to climate change? What are the possible interventions in order to mitigate the effects? Follow the eniscuola website and read the second part of the special report on the Fifth Assessment Report!

Author: Nadia Mirabella, eniscuola editorial office

Sources and detailed research:: IPCC, Fifth Assessment Report (AR5), <http://www.ipcc.ch/report/ar5/>

Climate Central, *Le stranezze del clima (Strange Climates)*, Chiavi di lettura– Zanichelli. ISBN 978-88-0816290-8

Climalteranti, Blog di formazione e discussione sul tema dei cambiamenti climatici (Altering climates A blog regarding training, and a discussion on the topic of climate change) - <http://www.climalteranti.it/>

Centro Euro-Mediterraneo sui Cambiamenti Climatici, IPCC AR5 – Working Group I

<http://www.cmcc.it/it/article/comunicazione-i-195-paesi-membri-dellipcc-hanno-approvato-il-nuovo-rapporto-sulle-basi-fisiche-dei-cambiamenti-climatici>

Centro Euro-Mediterraneo sui Cambiamenti Climatici, Tutto quello che dovete sapere sul 5° Rapporto di Valutazione dell'IPCC <http://www.cmcc.it/it/politica-climatica/everything-you-need-to-know-about-the-ipcc-fifth-assessment-report-wg3-mitigation-of-climate-change-2>

NASA, Six decades of a Warming Earth, https://www.youtube.com/watch?v=gaJtS_WDml