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IPCC "Summary for Policymakers" in TAR: Do its Results Give a Support Always Adequate to the Urgencies of Kyoto Global Negotiations?

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SUMMARY

One of the most important reasons by which Kyoto negotiations had suffered a setback at the COP 6 conference may be the unsatisfactory state about the previsions of Global Warming. This lack of knowledge may have such an influence on the formation of human opinion that we cannot to be amazed if the policymakers did not find a common mind to proceed in the fulfilment of the Kyoto protocol. Of course, the uncertainties in the scientific knowledge cannot be avoided or attributed to something in particular. However the presentation of the complex results obtained by IPCC during many years of work has not received the right importance. In our opinion the Summary's description of the Global Warming by means of simulations stopped at year 2100 does not appear to be suitable to induce a correct risk perception. A preliminary simulation is described which may clarify this concept.

Keywords: Kyoto Protocol, world energy scenarios, CO2 global emissions

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1. Introduction

The *Intergovernmental Panel on Climate Change* (IPCC) , the UN scientific body for the study of climate evolution , has recently published the "*Third Assessment Report"* /1/ that contains the results of the simulations relevant to Global Warming. The graphics show the growing concentration of CO2 and of the average global heating *within 2100* in connection with 7 different CO2 emission scenarios. (Fig. 1)

The text does not give a clear explanation of this time limit, but probably the cause lies in the reliability problems of the complex simulations based on models of carbon cycle, hydrological cycle and climatic effects that show still some uncertainties.

To focus the attention of policymakers on the risks correlated to global heating, the "*Summary for policymakers*-WG1" stresses the calculated increases of global temperature *within 2100.* These ΔT vary from 2,0°C to 4,4°C depending on the chosen emission scenario. The maximum increase in temperature (4,4°C) is reached in the case of the scenario *"fossil intensive"(F1FI)*, but this scenario (that foresees at the end of the century a CO2 global emission equal to 4 times the current figure!) is considered *unlikely,* being related to the *lack* of global emissions rules for an *entire century*.

To assess the influence of the temperature increases in terms of global risks, one can read in the IPCC's *Assessment Reports* the description of the harmful effects that the climatic changes have on the biosphere. For the time being, it is enough to remind that the atmospheric events that in the last 20 years have increasingly struck the planet, are correlated to an increase of the global temperature equal to approximately 0,4°C.(Ref. 1)

A recent report by UNEP (Nairobi, 5^{th} February 2001) states that the increase of the atmospheric disasters to be expected in the horizon 2050, in front of an average ΔT equal to 1,0÷1,5°C, could have an annual cost of 300 billion $, whereas the annual cost of sanitary measures will increase by 30 billion $ in the USA and 21.9 billion $ in E.U. In 1990 the insurance cost of atmospheric disasters has been equal to 40 billion $.

2. Discussion about the IPCC results on Global Warming in TAR

In our opinion, the *Summary's* description of the Global Warming previsions does not appear to be suitable to induce a *correct* risk perception. This is confirmed by some facts. At *opinion maker* level, the simulation with ΔT=4,4°C is considered (hastenly) to present the *greatest* climatic risk, although it's relevant to an *unlikely* scenario. On the contrary, the fact that ***all simulations*** related to ***likely*** scenarios show, when extrapolated *beyond 2100*, ***higher*** ΔT values (corresponding to ***actual*** risks) is completely ***ignored.***

These problems arise from the cut-off at 2100. As mentioned, from a purely scientific point of view, there are valid reasons to limit the simulations at a certain horizon. However, from the point of view of Kyoto negotiations, there are *even more valid* reasons that would advise a less "timid" attitude of IPCC.

Anyhow, the choice of the 2100 horizon appears to be not adequately justified.

It would certainly be more appropriate to produce in qualified scientific documents, such as the *IPCC Assessment Reports* (whose readers may correctly appreciate the discussion upon the uncertainties of the calculations), the time intervals *subsequent to 2100* obtained from the best simulations performed with the most reliable physical models and most likely emission scenarios.

An example will clarify why this is advisable. Some preliminary simulations (described in Ref. 2) show in connection with the emission scenario denominated *Heavy* (which is intermediate among the IPCC scenarios shown in Fig.1bis) that the CO2 concentration will continue to grow after 2100, reaching in about four centuries a *peak* between 1250 and 1340 ppm (Fig. 2), while the global temperature increase (referred to now) will reach a *peak* of 8,2÷9,0°C.

For the already mentioned reasons, the calculated peaks are subject to marked uncertainties, so that, *after the peak* , the curves may *have little significance*. However, the graphic in Fig.2 has not been broken off in order to concretely show the influence of the two-hypothesis model of the ocean absorption.

The first part of the simulation, which is the more reliable, shows that the *irreversible* human damages (any severe damage should be considered *irreversible* from human standpoint if lasting for several centuries) will take place *long before* the peak temperature. The physical aspects of the *irreversible* damages are not yet clearly established. A.E. MacDonald pointed out recently (Ref.3) that to see the Global warming as a long-term gradual heating of the planetary surface misses very important real threats, which may trigger unexpected climate changes on a regional scale. These changes may happen fairly quickly and last for a long time, bringing devastating consequences even during this century. Keeping this warning in mind, in the "gradual global warming" picture the irreversible damages will probably begin when the global ΔT will reach a value between 3° and 4°C.

To find an experimental support for this supposition, we are forced to come back to the glacial era.

In the Vostok ice core experiment, extending up to 420.000 years B.P. (Ref.4), the global ΔT has never surpassed +3,2°C, i.e. the typical temperature peak of interglacial intervals (related to astronomic insolation peaks, according to the Milankovitch-Croll theory). During this time duration the CO2 concentration never exceeded the value of 285 ppm, insufficient to produce any detectable global heating.

To observe greater ΔT we are compelled to refer to the *negative* temperature trend, which reveals that ice polar cup expansion gave rise to an *(irreversible)* anthropic damage lasting for about 100.000 years, whose full expansion took place when ΔT reached a minimum of -9°C. This type of climate change is quite different from the presently arising one, but the human damages are probably equivalent.

The comparison of the above mentioned simulation with the IPCC results summarized in Fig.1 can be done by observing that the increase in temperature at year 2100 (i.e. 2,5°C, referred to now) is positioned within the *intermediate* ΔT. Therefore it is not a heavy-assumptions simulation.

Let us now consider a great intervention such as the *safe storage* of CO_2 discharges, assuming that it will concern up to 30% of the global emission peak in the period 2070 – 2080. This intervention has been simulated in Ref. 2 and is reported in Fig. 2bis.
If we limit the survey within 2100, the intervention results capable of reducing ΔT at the end of the century from 2,5°C to 2,3°C. But if we protract the simulation (assuming that the storage of CO_2 discharges will continue after 2100) we will discover that the peak of temperature will decrease from 9,0°C to about 5,8°C.
It is clear that the risk abatement is much improved, expecially with respect to the period of *lethal damages* which took place under the peak conditions. Limiting the survey within 2100 appears then to be misleading.
In fact on the basis of the results *within 2100,* one would say that this intervention is practically useless.
On the contrary, *long term* results tell us that the biosphere would pass from *certain destruction* to the *hope of recovery* (by means of other suitable interventions such those analized in Ref. 7) !
It is, therefore, not exaggerated to say that the real negotiations on global heating will start when IPCC will decide to publish (with the necessary scientific caution) the results of simulations *after 2100***!**

Now let us try to understand, beyond the language of the simulations, the *physical reasons* why global heating becomes *more insidious* when the study its evolution shifts toward the *long period.*
The strong delay in reaching the temperature peak (at least 3 centuries), could induce us to believe that there is more time at our disposal for interventions. In reality, the delay is associated to an *increase* of the risk, because the further the peak *moves away*, the *higher* it becomes.
This characteristic of the carbon cycle on the biosphere can be explained by keeping in mind that, during the phase of increasing CO_2 concentration in the atmosphere, saturation phenomena gradually take place in the biological and physical processes that determine the absorption of CO_2 in oceans. Then, under certain conditions, this absorption can diminish, giving rise to a delay in limiting the CO_2 concentration.

3. How much CO2 can be discharged without compromising the biosphere?

The above general concepts permit a *simple and effective* evaluation of the risk when they are related with the experimental measures of CO_2 concentration in the atmosphere, that has grown from 315 ppm in 1958 to the current 370 ppm.
The IPCC experts have ascertained (Ref.5) that the costs relevant to global interventions in order to reduce CO_2 emissions, increase *abruptly* when the aim is to stabilise CO_2 concentration at levels *inferior* to about 550 ppm. In other words, because of the time lost, we have *no longer* the practical possibility to stabilize the phenomenon at concentrations below 500-550 ppm!
Therefore our ***aim*** must be directed (Ref.6) to the threshold of ***550 ppm***. In this case humanity must define its development programmes so that the quantity of CO_2 in the atmosphere does not exceed this level, corresponding to about 4290 Gt.

C.D.Keeling has monitored, starting in 1958, the monthly concentration of CO_2 (Fig. 3) in the station of Mauna Loa (Hawai). The *average* annual concentration has grown in a more or less exponential manner that, projected into the future by means of simulations based on the IPCC intermediate scenarios, predicts the *surpassing* of the 550 ppm threshold within **50 ÷ 60 years**.

Since the most effective global interventions (i.e. carbon-free source development, CO_2 safe storage underground, global reforestation) have a duration of 50-70 years, we have no time to put them in action if we want to limit the concentration to the 550 ppm level. Some interventions between those reviewed by B. Matthews (such as sulfate aerosol or dust in the stratosphere, ocean sink enhancing by fertilization, pumping liquid CO_2 in the bottom of oceans) seem to require less time to give a response (Ref.7). But the author points out that their reliability against possible catastrophic feedbacks on the climate system is too low.

Let us gradually approach the problem of calculating how much CO_2 can still be emitted *without exceeding* 550 ppm. To day about 2890 Gt CO_2 are present in the atmosphere.

If we suppose that there is *no absorption* in the oceans, there would be place in the atmosphere for only (4290 – 2890) = 1400 Gt of CO_2.

In reality one can deduce from Keeling's measurements that the ocean absorption, equal to about 48% of emissions in the decade 1958-67, has increased reaching in the decade 1987-96 an average of 52%. Despite this fact, we do not know with certainty what value this absorption might have within a century.

This is why the studies on modelling the carbon cycle in the biosphere, that have not yet reached complete comprehension of the phenomena, are very important.

Therefore one can try to answer the key question ("*how much CO_2 can still be emitted counting on ocean absorption*?") only by using appropriate models.

From the survey of the preliminary simulations (Ref.2) we can find that an average 63÷67% of the amount of CO_2 that will be discharged from now to the peak (*critical* emission), will be absorbed by the oceans and therefore only about 1/3 will remain in the atmosphere, increasing the concentration accordingly.

Consequently, the ***maximum*** quantity of CO_2 that we are allowed to emit without surpassing the above threshold equals about 1400 x 3 **= 4200 Gt**.

This notable increase in the receptive capacity of the biosphere is important, *but not conclusive.*

C*ritical* emissions depend obviously on the type of scenario.

In Ref.2 a long-term scenario (named *Timely*) is considered that shows short-term energy consumptions (within 20 years) about 20% lower in comparison with today's most credited scenarios.

The emission curve of this scenario is rather low (Fig. 1bis) since it corresponds to an energy scenario which allows a sufficient economic development of the world population by using qualified low-carbon sources and low-energy technologies. But even in this scenario the *critical* emission of CO_2 (approximately 9600 Gt!) is too high if compared to the desired threshold. The causes can be found in the too ***slow*** diffusion of renewable sources and in the ***persistent*** use of fossil sources.

The CO_2 concentration ***peak***, which occurs in over 3 centuries (Fig 4), is between 750 and 795 ppm.

Thus, to fall within the threshold of *550 ppm* one must foresee *additional* specific interventions capable of ***halving*** the critical emission of the *Timely* scenario.
Keeping in mind that programs of global reforestation must be activated above all to restore the unbalanced hydrological cycle (increasing desertification, etc.), it appears also necessary to prepare an effective strategy in order to guarantee the future capacity of storing in ***safe*** ways an adequate fraction of globally discharged CO2. To give an idea of the proportions and costs of this world's strategy it is sufficient to remind that the CO2 that will have to be stored annually (in deplete gas wells, in acquiferous, etc.) is equal to 500÷600 times the quantity currently pumped in the USA in old wells to increase the retrievable oil fraction (programme *Enhanced Oil Recovery - EOR*).
Beyond the problem of this global dimension, the problem of a fair distribution of the *whole cost* has to be solved as well. In the EOR programme no costs were involved, given the commercial convenience of the oil recovery. May the CO2 storage give rise to future useful applications ?

4. The evolution of Climatic Change and the Kyoto negotiations

Attention is normally focused on the main greenhouse gas (CO2) since it is currently responsible for 53% of the radiation forcing produced by the various greenhouse gases (Ref.1), which are (in decreasing order of contribution): Methane (17,2%), Tropospheric ozone (12,5%), Halocarbons (12%), Nitrous oxide (5,3%).
Nevertheless, it is obvious that the study of the atmospheric evolution of all greenhouse gases is of great importance, as well as the most suitable interventions for reducing all their discharges.

The studies on the climatic changes performed by IPCC (and other scientific national and international bodies) proceed on a very vast front, but with a velocity that appears to be ***low*** if confronted with the ***urgency*** of establishing a strategy of global rules.
According to many scientists, it is necessary to go one step further that will enable to answer in *good time* the following question: ***"When finally a global strategy will be approved, there will be enough time to implement with success the proper interventions?*** **"**
One has to distinguish the *scientific* aspect of the problems (that request time and caution) from the *decision making* aspect linked to the Kyoto negotiation, for which the prime requirement is to know and evaluate the *maximum* level of risk that will affect the next generations.
Only in this way a correct response strategy can be formed.
Other doubts can arise from the fact that it has been suggested an *adaptation strategy* (may be in the long period) of humanity to the damaging effects of climatic change.
Since *till now* humanity is *forcedly* adapting itself to increasing desertification, extreme climate events and diffusion of tropical illnesses, the proposal of an adaptation *strategy* (which suggests the idea of "avoiding"

the damages simply by adapting ourselves) has caused amazement in a time in which it is considered of *high priority* to define proper long term interventions, which must be activated in good time.
Perhaps the adaptation "strategy" would not have risen if the most qualified sources, such as IPCC, had published the forecasts on the global temperature ***peak***, that *cancel any illusion* on the possibility of *adapting* human life to Global Warming.

Recently, F.Bierman has resumed on *Environment* (Ref.8) the proposal of a world Authority responsible for the environmental politics, reminding us that this proposal has been put forward in 1997 by the German government jointly with Brazil, South Africa and Singapore and resumed the following year by french president J.Chirac.
From the particular standpoint of the present work, this proposal appears useful since the UN climate change scientific body (IPCC) could be relieved from those elements of "self-censorship" introduced in the elaboration of the "*Assessment Reports*" by scientists compelled by an all-pervading sense of responsibility.
This situation may be harmful to the freedom of scientific research and may result not correct toward worldwide needs and expectations.

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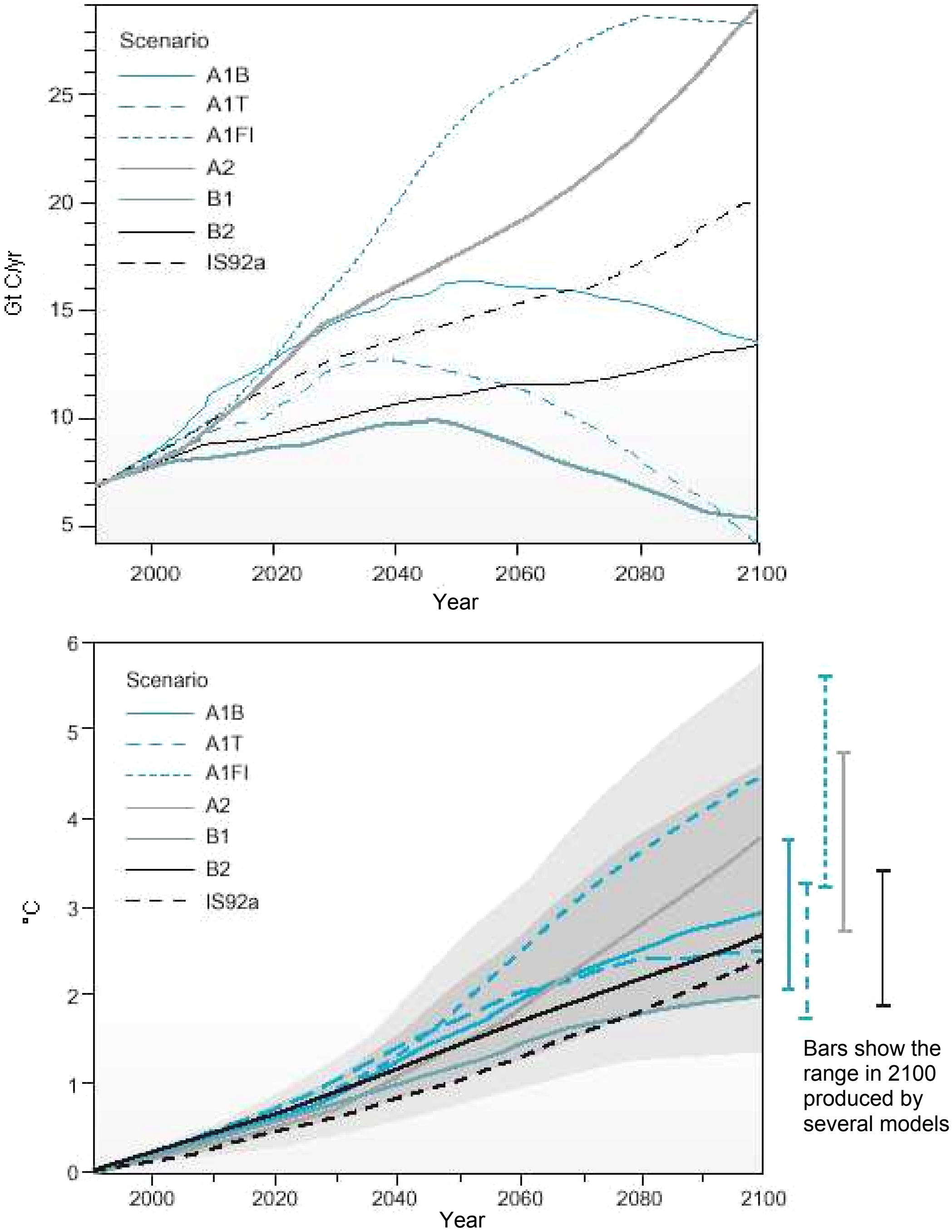


Fig. 1 ***Third Assessment Report – IPCC.*** Global warming effects calculated up to year 2100 assuming the global CO2 emission scenarios (SRES) recently presented by WG1.

- The A1 group Scenarios are relevant to the following conditions: moderate growth of world population (which peaks in the second part of the century), high economic development with energy consumes characterized by scenarios A1FI (fossil intensive), A1T (non-fossil energy sources), A1B (balance across all sources).
- The B1 scenario assumes the same population as for A1 scenario, rapid change in economic structure toward a service and information economy with reduction in the material intensity and introduction of carbon free tecnologies.
- The A2 scenario assumes a population increasing continously beyond 2100, economic development regionally oriented, slow technological growth.
- In the B2 scenario the population is continously increasing (at a rate slower than A2 scenario), the economic development shows intermediate growth with slow technological changes.
- The IS92a scenario is reported for comparison purposes from the **Second Assessment Repor**t.

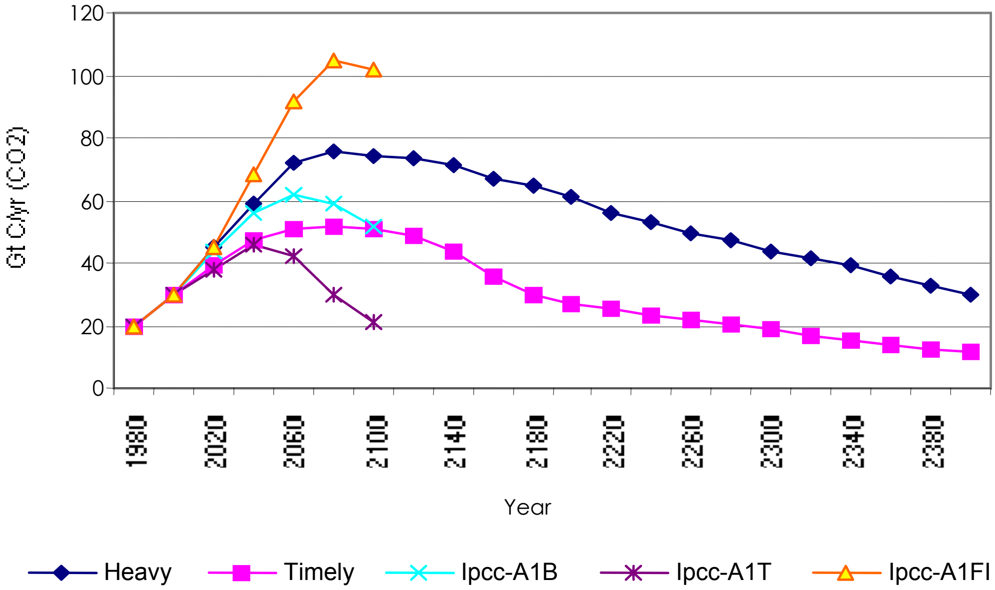


Fig.1bis ***Heavy*** and ***Timely*** CO_2 emission scenarios (Ref.2) are compared with the most likely scenarios up to year 2100 (A1FI, A1T, A1B) presented by IPCC in the “Third Assessment Report-WG1”

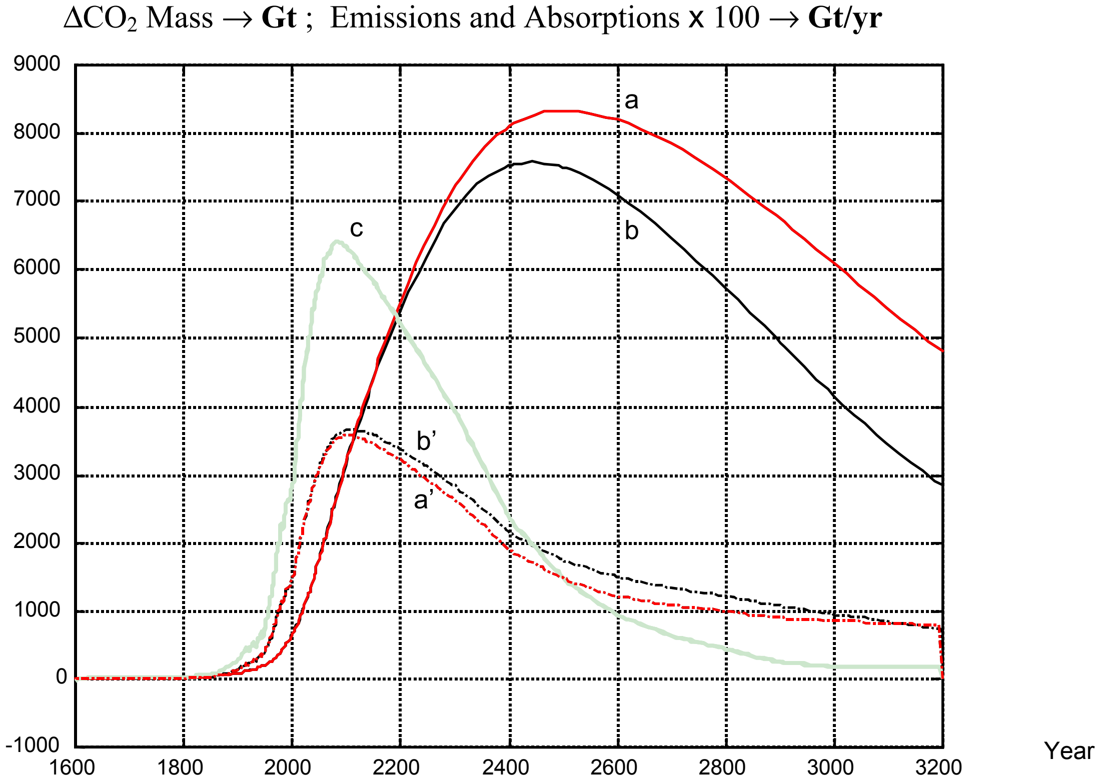
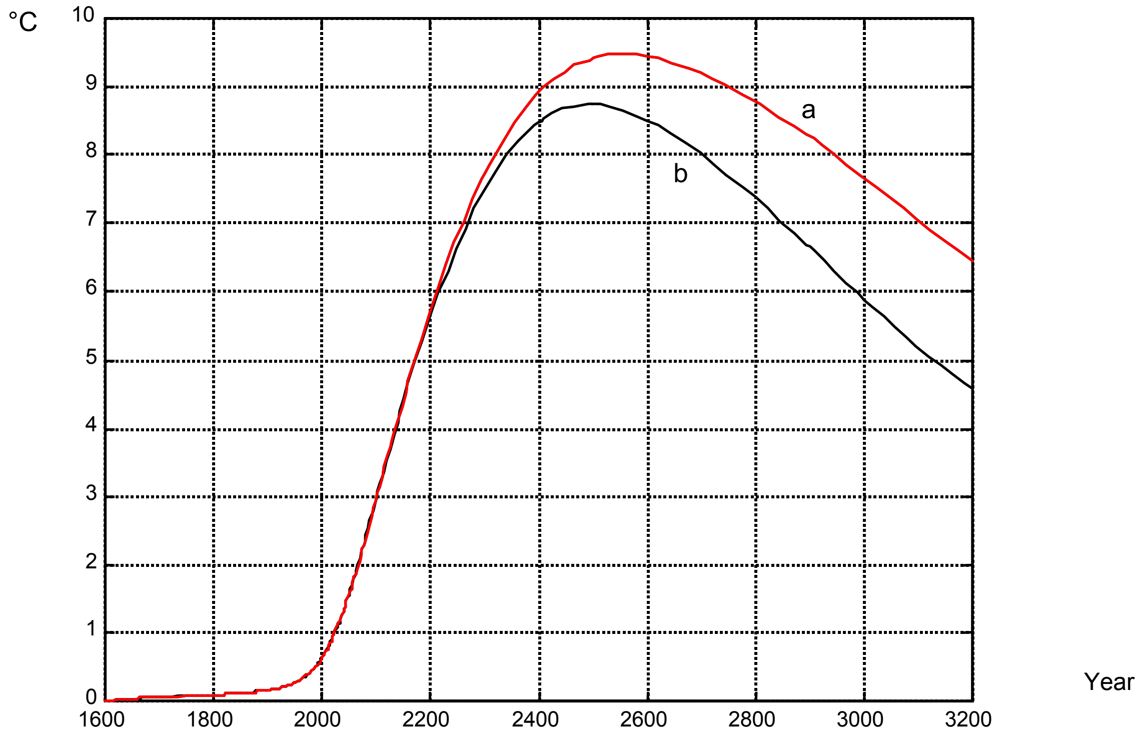


Fig.2 **Heavy** scenario – Lines *a,b* show the increase of the CO_2 mass in the atmosphere according to different hypothesys of CO_2 ocean absorption model. Lines *a',b'* represent the corresponding absorptions in the ocean. Line *c* represents, up to year 2000, the historical CO_2 global emissions. Future emissions are foreseen by the Heavy scenario. The graphic below shows the global temperature increase.



$\Delta CO_2 \rightarrow$ **Gt** ; Emissions and Absorption x 100 $\rightarrow$ **Gt/yr**

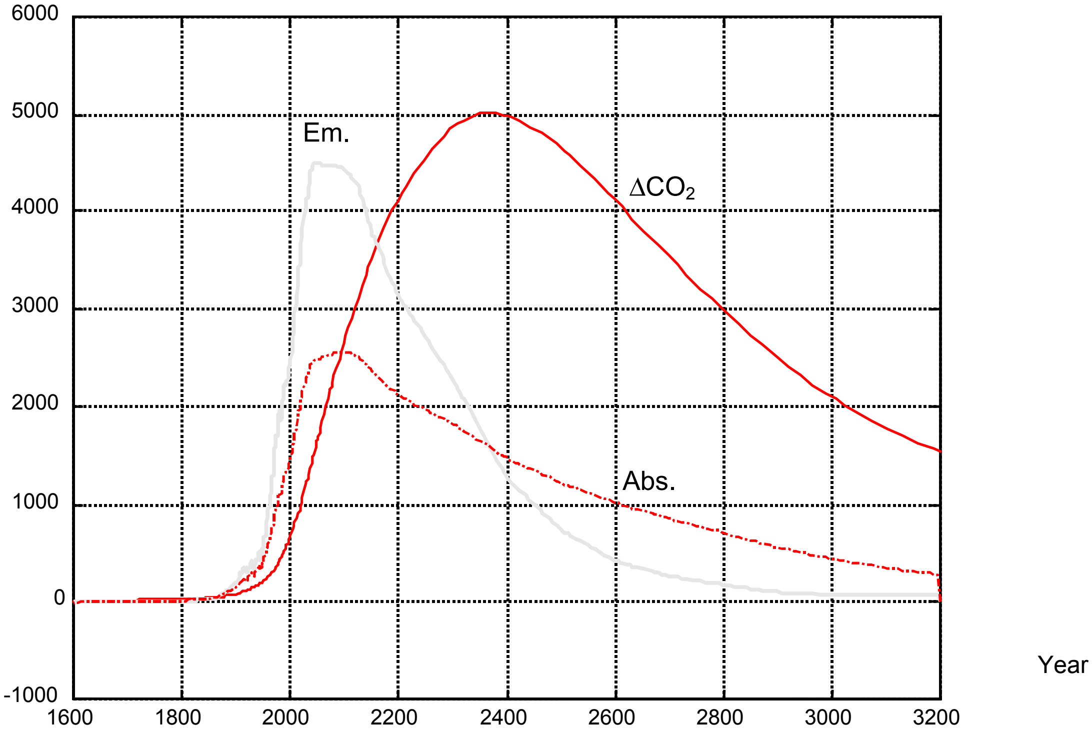
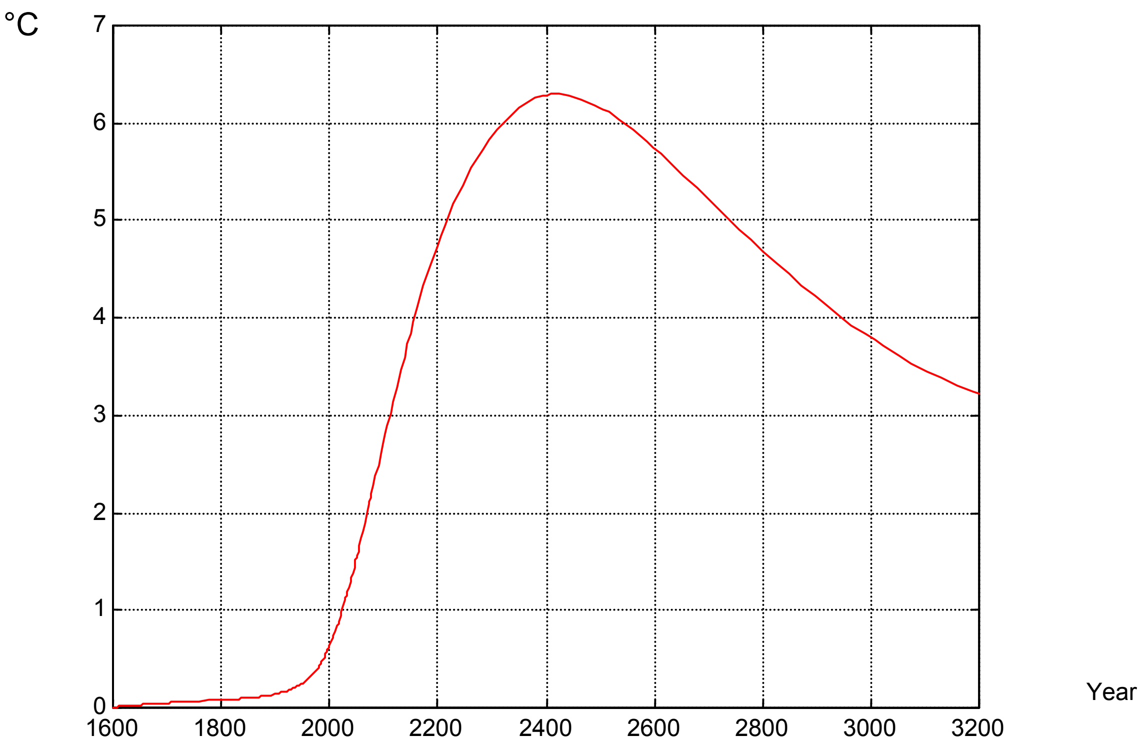


Fig.2bis **Heavy** scenario – Intervention for the safe storage of CO_2 discharges. Results of a global strategy reducing up to 30% the future emission peak in 2070-2080. The graphic below shows the global temperature increase.



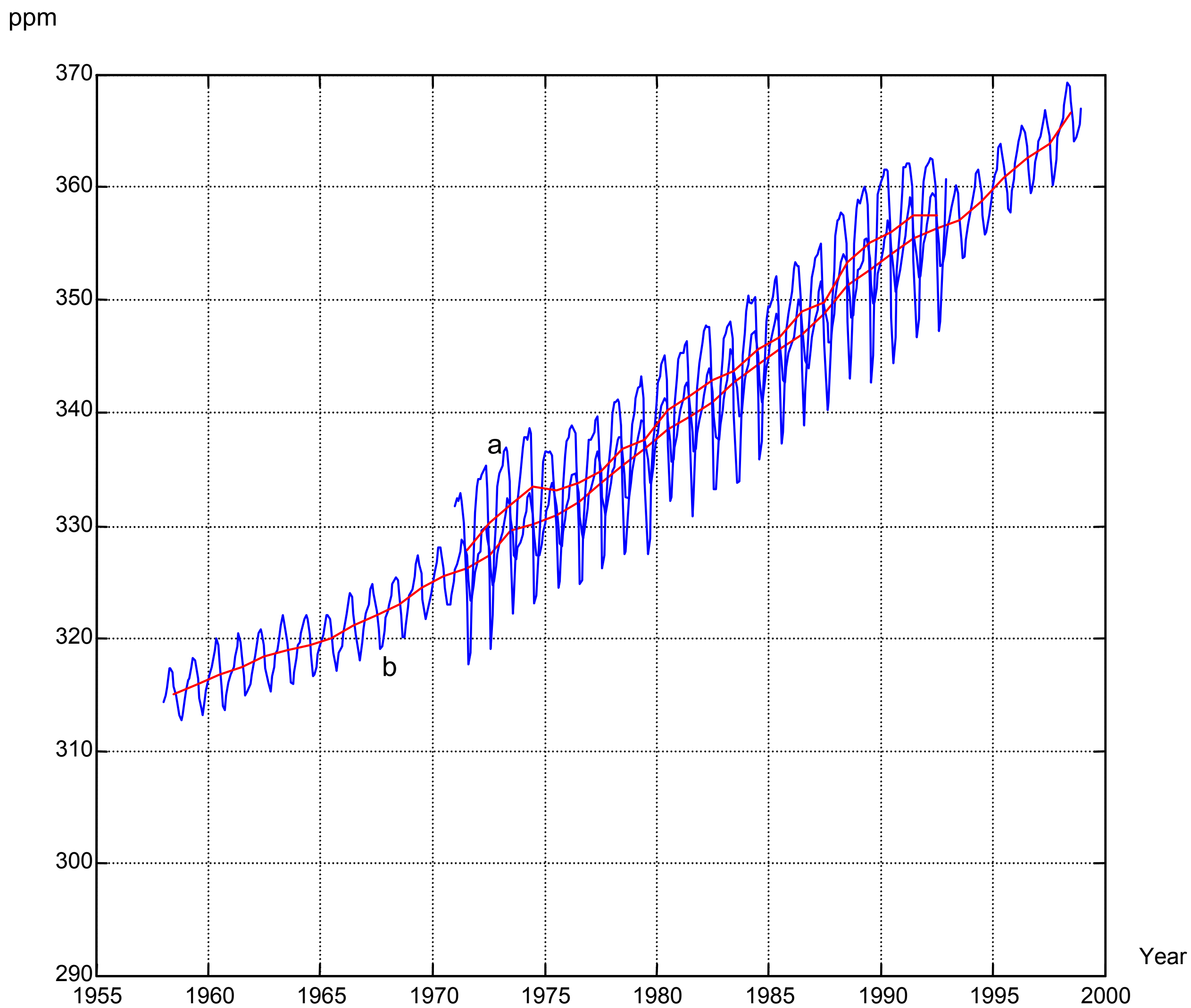


Fig.3 Monthly measures of the CO_2 concentration in the atmosphere, with relative annual mean, in various places of the world.

a) Measures from 1972 to 1993 performed near Barrow.
b) Measures from 1958 to 1998 performed at Mauna Loa (Hawai).

ΔCO_2 Mass → **Gt ;** Emissions and Absorptions x 100 → **Gt/yr**

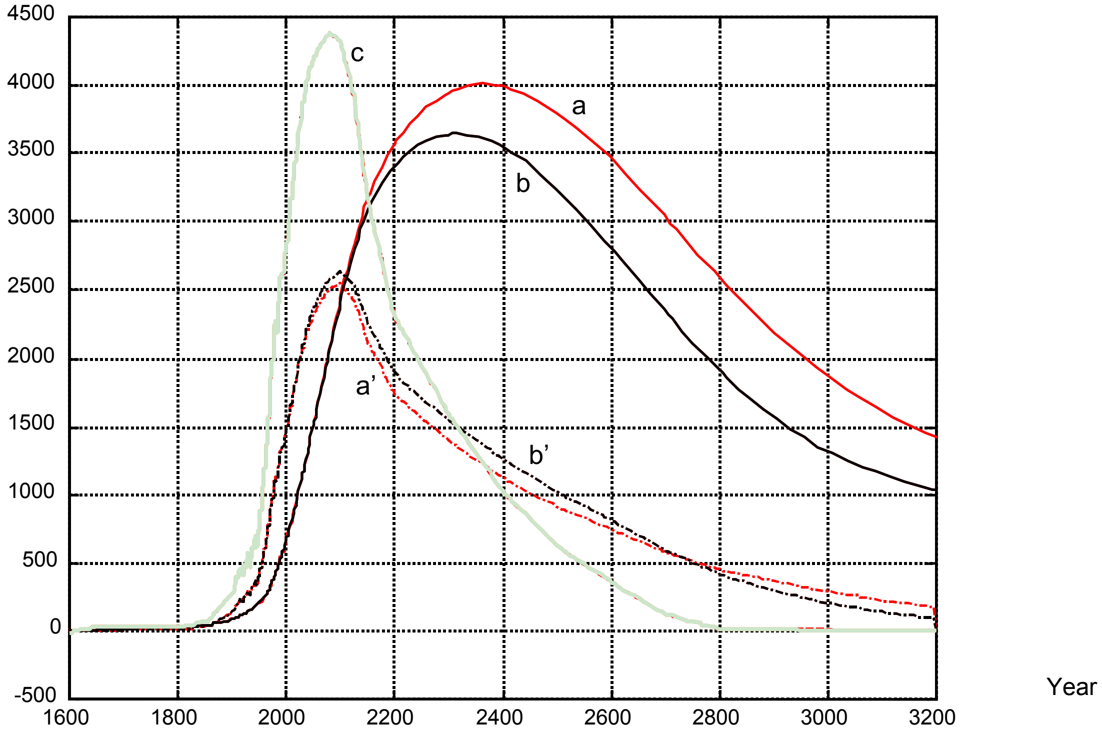
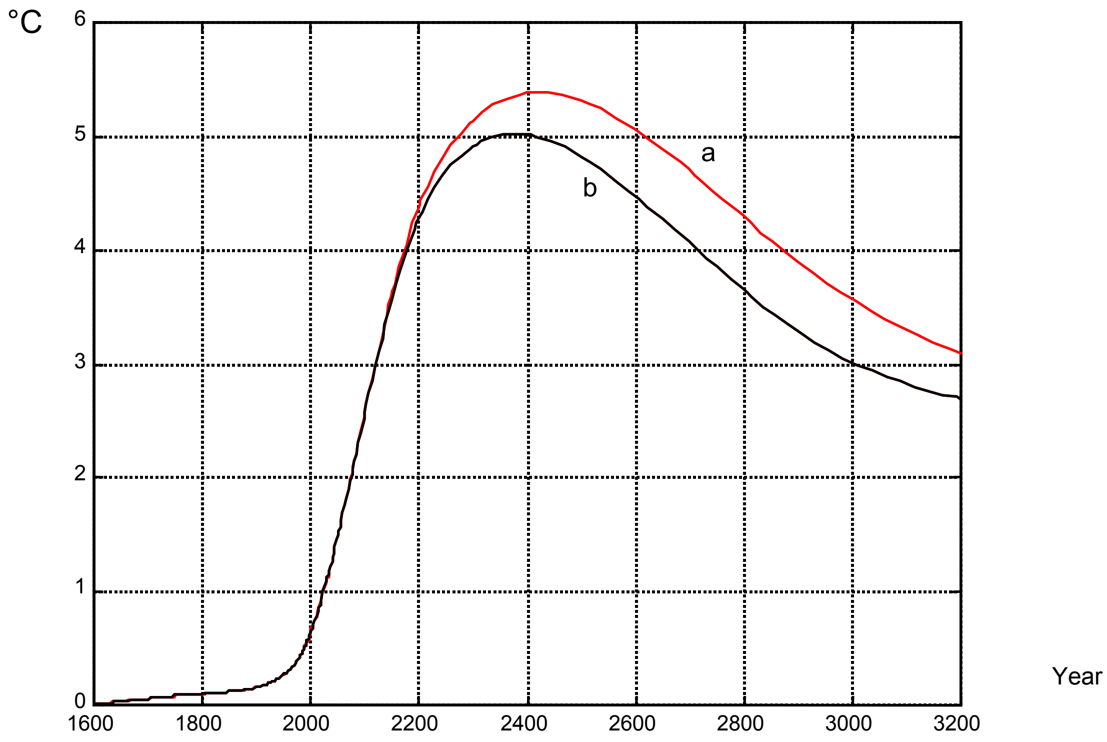


Fig. 4 **Timely** scenario –. Lines *a,b* show the increase of the CO_2 mass in the atmosphere according to different hypothesys of CO_2 ocean absorption model. Lines *a',b'* represent the corresponding absorptions in the ocean. Line *c* represents, up to year 2000, the historical CO_2 global emissions. Future emissions are foreseen by the Timely scenario. The graphic below shows the global temperature increase.



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