Our Future and the Oceans

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The alert given by the scientific community about climate change is sometimes perceived as the same message immutably reiterated from year to year. This represents a very strong misperception of a problem which is on the contrary evolving very quickly, while the range of solutions offered to mitigate it has been constantly diminishing throughout the last decades.

As already understood since the historical work of Revelle and Suess (1957), the oceans play a key role in determining the very complex temporality of the climate problem. This is specifically true in response to CO_2: The change in its atmospheric content does not significantly depend on its chemistry, but rather on photosynthesis and exchanges with the oceanic and continental surfaces. The fact that the CO_2 being emitted into the atmosphere does not easily manage to penetrate into the ocean determines the very long CO_2 atmospheric lifetime: while one half of the CO_2 emitted by anthropogenic emissions is quickly absorbed by the continents and the oceans, the "half-life" of the remaining part is of the order of 100 years. CO_2 therefore tends to accumulate in the atmosphere. This effect is also increased by the quickly evolving rate at which anthropogenic emissions themselves have been increasing. Between the Second World War and today, the amount of CO_2 emitted into the atmosphere due to the use of fossil fuels has been multiplied by a factor of about 10, from about 1 Gt of carbon per year to about 10 Gt nowadays[1] (Fig. 1).

CO_2 is only the most important of the different long-lived gases which may stay decades in the atmosphere: methane, nitrous oxide, and CFC.

These gases stay enough to be well mixed. Above our heads, the relative amount of greenhouse gases coming from different parts of the world is therefore unchanged, wherever we may stand. The atmospheric persistence of these gases has another

[1] To convert carbon emission into CO_2 emission, the coefficient factor used is 3.7.

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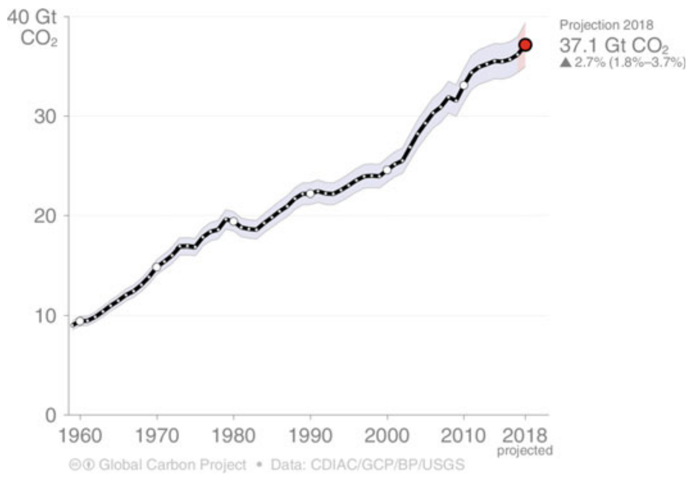

Fig. 1 Global fossil CO_2 emissions from the global carbon project (http://www.globalcarbonatlas.org/en/CO2-emissions)

effect: today's emissions will make tomorrow's climate, and from this point of view, the climate of the next 20 years is largely written, irremediably, as demonstrated by climate models. And our ability to limit the warming in the following decades also depends on what we do now.

All that does not come as a surprise: it basically confirms computations which were carried out much earlier. One of the most important early alerts on climate risks was expressed 40 years ago, in 1979, in a report to the US Academy of Sciences, based on the first climate models and coordinated by a highly respected scientist, Professor Jule Charney. This anticipation became progressively a reality in the nineties.

At the same time, the prospect of what can be achieved to limit the effects of climate warning also evolved strongly and negatively. We have now entered a new phase where many of the early objectives will be extremely difficult or impossible to meet. At this stage also, the role of the oceans is essential: the irreversibility of what is happening depends on the capacity of the oceans to capture and store more than 90% of the warming caused by greenhouse gases. The consequences are very large. The four scenarios proposed by the latest IPCC report to limit global warming below the level of 1.5° are most probably socially and politically unsustainable. They rely with varying degrees on a strong use of nuclear energy and on the—still uncertain—possibility of capturing and storing billions of tons of carbon each. Even in these conditions, the carbon balance needs to be reached before 2050, to satisfy a 1.5° limit—which means no uncompensated use of fossil fuels, a complete revolution of the world in three decades.

What does it take to allow a positive approach of such a situation: certainly, a more frank confrontation with the reality of the problems. It will be inevitable to live on a planet which will be warmer, more populated, more urbanized, with a biodiversity threatened by a whole range of different processes, and facing extreme meteorological events which will probably be more frequent and more intense. There is, of course, a very wide range of actions that need to be taken urgently to diminish the related damages, through the development of a much more sober society. But this will not be enough. The same Earth will have to feed 8–10 billion human beings, to preserve its living resources, its climate, and there will be a necessity to arbitrate contradictory choices. The oceans have a special status in this context. They constitute partly a solution, because an increasing part of the world population relies on them for their alimentation. They require protection, because they suffer twice from the effect of greenhouse gases, in terms of temperature and acidification, also because of the strong vulnerability or the Arctic and Antarctic oceans. But their potential in many areas still requires to be fully assessed, as is, for example, the case for energy production or carbon storage capacity.

We enter a new world, and the ocean will constitute a very precious help for mankind. But such a wealth of opportunities, such a variety of risks, cannot be left to arbitrary decisions, and they require a strongly oriented science-based management.

Reference

Revelle R, Suess H (1957) Carbon dioxide exchange between atmosphere and ocean and the question of an increase of atmospheric CO_2 during the past decades. Tellus 9:18–27