Foreword

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For decades, climate change negotiations did not take the ocean into consideration. The following texts reveals a change in mindset and that this planetary environment has finally been given the importance it deserves in climate issues. This document addresses concerns such as the part the ocean plays for the climate and the impacts of climate change on the ocean.

The climate of our planet is largely dependent upon the ocean, but who is aware of this nowadays?

The ocean regulates the climate at a global scale due to its continuous exchanges with the atmosphere, whether they are radiative, mechanical or gaseous. The heat from the sun is absorbed, stored and transported by the ocean, thus affecting the atmospheric temperature and circulation. Although its ability to store heat is much more efficient than that of the continents or the atmosphere, the limits of this storage capacity are still unknown.

Marine waters are warming up, thus impacting the properties and dynamics of the ocean, the interactions with the atmosphere, and the marine ecosystems and habitats. Coral reefs, for example, cover a small area of the ocean, but they shelter close to a third of known marine species. An increase of less than a degree beyond a given threshold may cause bleaching and potential loss of a reef. The consequences are significant because these bioconstructions provide many services including a direct source of livelihood for more than 500 million people worldwide.

It is not sufficiently acknowledged that each day, the ocean absorbs a quarter of the CO_2 produced by humankind. This is followed by a chemical modification of the sea water which results in the acidification of the ocean. Ocean acidity has increased by 30% over two and a half centuries and this phenomenon continues to amplify, thus directly threatening marine species.

In fact, the ocean is clearly a carbon sink, as it can concentrate fifty times more carbon than the atmosphere. Both physical and biological mechanisms contribute to the absorption and storage of oceanic carbon, the planktonic ecosystem being the main contributor to the biological pump. Although this biological carbon pump has been identified, the scope of its action still remains to be determined. It is worth noting that marine biodiversity only represents 13% of all described living species on Earth. This is particularly low, considering the colossal volume of the ocean. The future should tell whether this is related to a lack of knowledge. Nonetheless, the still unknown domain of the deep ocean may provide an answer once it is explored, as this deep environment represents more than 98% of the volume of the ocean. The ocean is often seen as a stable and homogeneous environment, with low biological activity, covering vast desert areas. This does not truly reflect the diversity of deep-sea ecosystems, nor their sensitivity to climate change.

With increasing seawater temperature, the ocean expands and sea level rises. This phenomenon is amplified when ice melt accelerates. Numerical models forecast an increase by more than a quarter of a meter by the end of this century with a maximum over 80 cm. The causes and variability of this phenomenon are questions that are addressed in this booklet which also presents a state of our knowledge on the evolution of oxygen concentration in the ocean.

Humanity will have to face the impacts of climate change on coastal populations, as well

as on industrial activities in the Arctic region or on the fishing and aquaculture sectors. Islanders are at the frontline of these global evolutions linked to climate change.

Everything cannot be assessed here, and new documents will progressively complete the set of topics that we believe are relevant, including issues related to the anoxia of marine waters, to the Arctic and Polar Regions, to coastal waters which have only been discussed here for island environments, and more generally to the vulnerabilities related to oceanic phenomena. On the basis of these syntheses focused on specific areas, progress can be achieved in the development of possible solutions, strategies and concrete proposals.

What do we know about these processes at "human" space-time scales, annual or decennial, regional or local scales? Actually, there is very little knowledge because these data are currently not available. For the moment, only long geological periods, and vast areas, have been assessed. Moreover, given the spatial diversity, the small-scale mechanisms at work cannot yet be clearly deciphered. This is particularly the case for thermal variations, carbon uptake mechanisms, sea level changes, impact of acidification on marine ecosystems as well as the interactions between these different factors. To which extent can life adapt today, whether it is natural species or those exploited by fisheries or produced by aquaculture? Furthermore, how will tomorrow's ecosystems cope with these changes? Observations relative to these phenomena need to be carried out and evaluate the consequences on ecosystem services, in order to understand the overall mechanisms and to infer the outcomes for our civilization.

Can the characteristics of the global ocean be averaged in a reasonable manner? In order to assess the dynamics of the ocean ecosystem in response to the combined effects of natural, climatic and anthropogenic instabilities in different parts of the ocean, the couplings between climate fluctuations and stability of ecological functions need to be described; this highlights a few research topics for scientists in the future.

These texts intend to draw public attention towards questions raised upon what is known about climate change, but also to highlight issues that still remain unsure. In fact, facing climate change, the ocean still acts as a shield upon which the future of our planet greatly depends.