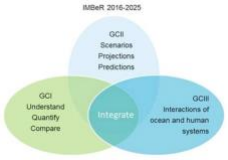


IMBeR
Integrated Marine Biosphere Research

Improving scenarios, predictions and projections of future ocean-human systems at multiple scales

***The Challenge**: To incorporate understanding of the drivers and consequences of global change on marine ecosystems and human societies at multiple scales into models to project and predict future states*

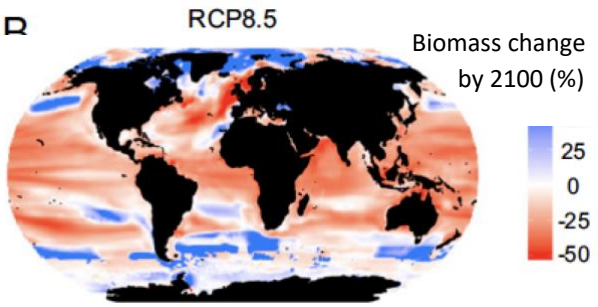
Grand Challenge 2 focuses on distinguishing and attributing causes and effects of anthropogenic processes on biogeochemical processes to inform projections and predictions of future ecosystem conditions. The priority research areas for this Grand Challenge build from Grand Challenge 1 to estimate probable future states of marine ecosystems and representative marine species, and to assess the impact of those changes for human well-being and livelihoods. The science of Grand Challenge 2 focuses on three frontiers for projecting the future of ocean-human systems: i. Scenarios and coupling, ii. Regional to local projections, and iii. Projections to prediction. These areas of research are at the cutting edge of ocean science and need considerable innovations in order to achieve this Grand Challenge. IMBeR and its partners seek to move these three areas from frontier science to broader adoption.

Frontier 1 – Developing Scenarios and socio-ecological models

Global scale projections of marine ecosystems for the 21st century mostly consider the impacts of climate change-related drivers (e.g. ocean acidification, warming, deoxygenation, ocean circulation changes). Other anthropogenic drivers that influence the state of the ocean (e.g. pollution and other human activities) are poorly represented and are not currently included as defined scenarios for incorporation in models (similar to the Representative Concentration Pathways adopted by the Intergovernmental Panel for Climate Change). To better assess the potential evolution of ocean systems, there is an urgent need for developing policy-relevant scenarios that include all dimensions of human influence on ocean systems. An alternative is to integrate an explicit representation of human activities and their drivers in oceanic socio-ecological models. This approach, demonstrated at the regional level (e.g. fisheries management), must be pursued at a broader scale.

Future decline in global ocean animal biomass

The Fisheries & marine ecosystem Model Inter-comparison Project (FishMIP) issued the first global assessment of climate change impacts on the global marine ecosystem by using multiple climate and ecosystem models. The model 'ensemble' reveals that global marine animal biomass will decline under all emission scenarios, driven largely by warming and decreasing primary production. The extent of projected losses can be constrained by emission reductions, with only a 5% decline under a strong mitigation scenario, but 17% under business-as-usual emissions in 2100



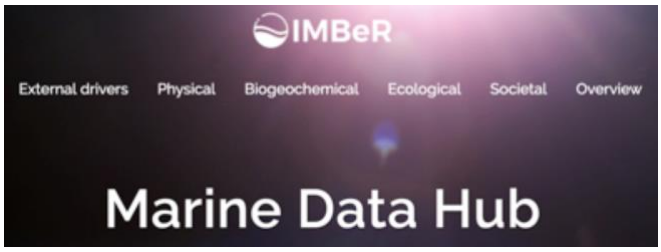
Frontier 2 – Projections at the regional and local scale

Many of the major issues regarding governance of human interactions and impacts in marine ecosystems requires knowledge of local and regional ecological and social processes. Such information is also crucial for understanding how larger scale climate impacts will affect ecosystem structure and functioning in regional systems. The current generation of global models do not resolve these processes and scales. Models are being developed (including both statistical and dynamic models approaches) that can resolve regional and local ecological processes and human interactions. For example, downscaled information from a single global model has been used to undertake a comparison of regional models of primary production in the European seas. However, there is little consistency in scope or approach to downscaling or in the construction of regional ecosystem models. Development of a coordinated approach to downscaling projections and development of higher resolution coupled models would facilitate this process. In addition, current ecological models could be improved through the development of a regional scale comparative approach

Frontier 3 – From projections to predictions

Predicting ecosystem responses over 1-10 years (the "grey zone") - a scale relevant to decision makers - is particularly challenging. State-of-the-art global climate prediction systems, built on mechanistic understanding, have some skill in forecasting ocean conditions. Lessons from the climate-ocean modelling community can improve ecosystem forecasts, building on recent progress in predicting biological variables. Correlative relationships and dynamic models coupled to statistical predictions can improve ecosystem models. This will require inclusion of high-resolution, physical and biological observations into ocean ecosystem models. Advances in integrating multiple observational platforms, improved mechanistic understanding and next-generation model systems have the potential to profoundly transform ocean predictions over the next decade.

A marine Data Hub for constraining models & projections *(https://ccdatahub.ipsl.fr)*



The IMBIZO 5 workshop (2017, Woods Hole) led to an online community initiative to provide an **interactive 'field-guide'** to high-value **interdisciplinary data** products that can be used to **drive, constrain, and evaluate global ocean models** and their associated fisheries/ecosystem/societal components. The objectives are to (i) raise awareness of high quality data products, (ii) offer a centralized location (hub) for these data, and (iii) foster interdisciplinary exchange and inspire new analyses. The data hub provides links to data repositories, provides pragmatic guidance for data selection, and a forum to discuss data products. The development of such a data hub facilitates access to the data products required for progressing the science of the three frontiers.

IMBeR is an international network that facilitates interdisciplinary marine research, within three interconnected Grand Challenges, in order to achieve sustainable ocean governance for the benefit of society. Sign up to IMBeR via http://www.imber.info/ to benefit from networking, mentoring and collaborative opportunities with world-class natural and social scientists, practitioners and researchers.

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