A deeper understanding about the causes of sea-level rise

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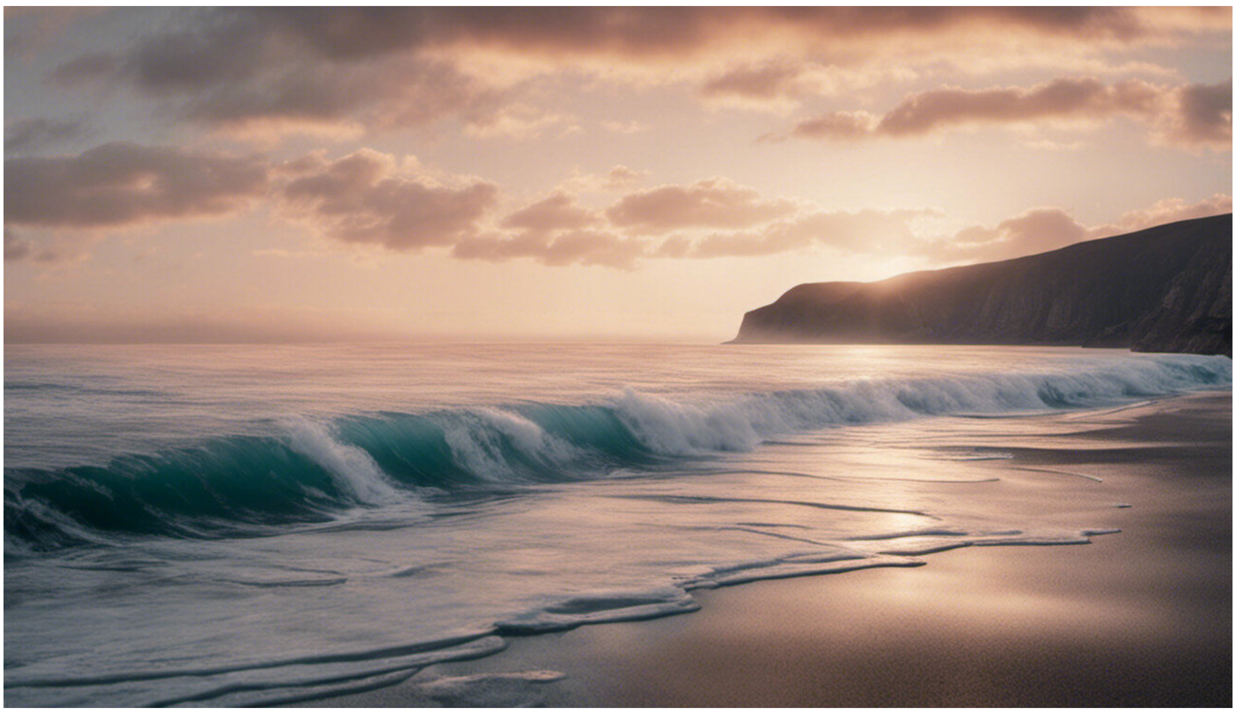

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The EU SEACHANGE project has set out to quantify and limit some of the uncertainties in modelling predictions concerning sea-level rise as a result of climate change.

Climate models contributing to the Coupled Model Inter-comparison

Project (CMIP) all predict a global mean sea level rise for the 21st century. However, predicted change differs between models and is not spatially uniform. Predictions based on emission scenarios during the 21st century vary by up to a factor of two, and are higher for centuries beyond.

Given the potential impact of sea-level rise on coastal populations and ecosystems, this gap in knowledge is worrisome. Consensus is hampered by the challenges of interpreting complex information from earth systems over varying timescales. To help reduce this uncertainty across predictive models, the EU-funded SEACHANGE project assessed the effects on sea-level due to ocean changes in temperature, salinity and circulation, over decades to centuries. These effects are comparable to the contributions from land ice (glaciers and ice-sheets).

Towards more accurate modelling

Global warming causes sea water to expand, raising the global-mean sea-level. Regional changes in ocean temperature, along with wind and salinity changes, cause local sea-level change, which can differ significantly from the global-mean rise. According to Prof. Jonathan Gregory, the SEACHANGE project coordinator, 'Whilst global mean rise is a reasonably good indicator of the impact of climate change, being able to predict more accurately and confidently, especially for localised areas, is one of the grand challenges in climate science.'

SEACHANGE set out to closely examine the simulated physical processes involved in global-mean ocean heat uptake, along with the regional distribution of projected sea-level rise from the 3D atmosphere-ocean climate models used by the Intergovernmental Panel on Climate Change (IPCC). The project studied how sea-level change is affected by various factors, such as changes in winds, and the details of model design.

Predictive models have been especially divergent in the Southern Ocean and the North Atlantic, which are regions where pronounced sea-level change is predicted. As Prof. Gregory states, 'You expect models to be somewhat imperfect, but to improve them you need to investigate the contributing elements, to work out what has to be changed or hasn't been accounted for.'

The project found that in the Southern Ocean sea-level change is influenced most strongly by surface heating and changes in winds (surface momentum flux), whilst North Atlantic change is affected mainly by surface heating with - to a lesser degree - the influence of Atlantic Meridional Overturning Circulation (MOC) weakening. Surface water fluxes (precipitation, evaporation and river inflow) were shown to be less influential on the pattern of sea-level change. The geographical pattern of anthropogenic sea-level change is expected to become apparent within the next decade or so.

Crucially, the researchers argue that setting CO2 emissions targets to limit sea-level rise would need to consider not only the cumulative emissions of CO2, but also their timing or pathway of emissions. Prof. Gregory explains that, 'The sooner emissions are cut, the greater the reduction of future sea level rise.' But due to the long timeframes necessary for anthropogenic thermal expansion to occur, even when CO2 concentration is stabilised, which brings a stabilisation of global-mean surface temperature within decades, sea-level will continue to rise for centuries. This means that actions taken in the near future will have consequences for a very long time to come.

Innovation and inspiration

In order to undertake the six-year study, SEACHANGE developed a number of innovative research approaches. The study was the first to make comparisons between the physical processes of ocean heat uptake and interior temperature change as simulated by a set of models; to quantify the surface flux influence on projections for the geographical pattern of sea-level change; and to satisfactorily account for global sea-level rise during the twentieth century.

Findings from the study informed the IPCC's projections of sea-level change and were cited in its Fifth Assessment Report (2013), which influenced the political process leading to the Paris agreement (2015) of the Conference of the Parties to the UN Framework Convention on Climate Change (COP21).

SEACHANGE has also stimulated a new international comparison of global and regional modelling for the physical processes determining ocean heat uptake and regional sea-level change, under the auspices of the CMIP.

Contribution to mitigation and adaptation efforts

With climate change affecting all EU Member States, EU institutions have agreed as much as EUR 180 billion (20 % of the 2014-2020 budget) to go towards climate mitigation and adaptation efforts, as well as EUR 864 million from LIFE, the EU's dedicated environment fund.

With considerable resources such as these being dedicated towards climate change response, accurate predictions of its likely impacts will prove invaluable for decision makers. As Prof. Gregory acknowledges, further work is required to refine and constrain models, but adds that, 'Whilst we haven't reached the final destination, we are moving towards being more quantitatively precise and confident in our projections.'

More information: CORDIS project page: cordis.europa.eu/project/rcn/94201_en.html

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