Finding may improve models that allow predicting future climate

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A new study by the Institute of Environmental Science and Technology of the Universitat Autònoma de Barcelona (ICTA-UAB) allows validating organic markers to quantify past primary productivity in the oceans, a key factor in the global marine carbon cycle. The research, carried out from the study of alkenones as a biomarker, puts an end to decades of scientific debate about the validity of these biogeochemical proxies in the reconstruction process of past climates. The finding, which has been published in the journal *Proceedings of the National*

Academy of Sciences (*PNAS*), will represent an advance in the improvement of climate models that allow predicting the climate in the future.

In order to understand the current climate and to be able to predict future variability, paleoclimate scientists analyze the climatic conditions of other times in Earth's history. Biomarkers, mainly alkenones (organic compounds produced by phytoplankton algae), are used to reconstruct marine primary productivity, that is, the process by which CO_2 from the atmosphere that is transferred to the ocean is transformed into organic matter. It is estimated that only 0.3% of this organic matter is exported to the deep ocean, storing CO_2. "This sedimentary record is very important because it is the CO_2 that will not return to the atmosphere, and because it allows us to reconstruct the climate of the past," explains Maria Raja, ICTA-UAB researcher and lead author of the study.

Likewise, the presence of chlorophyll-a on the sea surface is an indicator parameter of the amount of existing phytoplankton biomass and, due to its role in photosynthesis, provides information on the level of primary productivity. This new study uses a combination of geochemical and remote sensing data to establish a direct relationship on a global scale between the concentration of chlorophyll-a at the ocean surface and the concentration of sedimentary alkenones. "Until now, the primary productivity of the past could only be reconstructed qualitatively, but this study gives us tools to be able to estimate the process quantitatively," explains Raja, who highlights that this is an important advance because it ends a decades-long scientific debate on the limitations of organic proxies (such as alkenones) to quantify primary productivity in the past.

Despite the fact that NASA satellites have been measuring chlorophyll-a level at the sea surface for 20 years through its green color, these data had not been used in paleoclimatology. Now it is possible to know the existing concentration at each point on the surface. The study "also offers us a spatial vision to find the relationship between the surface of the oceans and the sediments," she adds.

For the researchers, this finding makes it possible to improve climate models, and in the future to use alkenones to analyze the concentration of chlorophyll A on the surface, and thus be able to validate climate models. This paves the way to clarify the relative role of the marine carbon cycle in climate variability using field data, and tests biogeochemical models.

More information: Maria Raja et al, Appraisal of sedimentary alkenones for the quantitative reconstruction of phytoplankton biomass, *Proceedings of the National Academy of Sciences* (2020). DOI: 10.1073/pnas.2014787118

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