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Nikita Kaushal and Nivedita Sanwlani contributed equally to the work.

Key Points:

- We show that luminescence in coral skeletons is a proxy for terrestrial chromophoric dissolved organic matter (CDOM)
- This proxy yields information on land-to-ocean dissolved organic matter (DOM) flux in historically under-sampled tropical seas
- A 24-year reconstructed CDOM record from Borneo shows large seasonal DOM flux from peatland, and likely influences of photodegradation

Supporting Information:

Supporting Information may be found in the online version of this article.

Correspondence to:

N. Kaushal, N. Sanwlani, and P. Martin,
nkaushal@ntu.edu.sg;
nsanwlani@ntu.edu.sg;
pmartin@ntu.edu.sg

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Coral Skeletal Luminescence Records Changes in Terrestrial Chromophoric Dissolved Organic Matter in Tropical Coastal Waters

Nikita Kaushal[1], Nivedita Sanwlani[1], Jani T. I. Tanzil[3,4], Nagur Cherukuru[5], Syamil Sahar[6], Moritz Müller[7], Aazani Mujahid[6], Jen N. Lee[8], Nathalie F. Goodkin[1,2,9], and Patrick Martin[1]

[1]Asian School of the Environment, Nanyang Technological University, Singapore, Singapore, [2]Earth Observatory of Singapore, Nanyang Technological University, Singapore, Singapore, [3]St. John's Island National Marine Laboratory, National University of Singapore, Singapore, Singapore, [4]Tropical Marine Science Institute, National University of Singapore, Singapore, Singapore, [5]CSIRO Oceans and Atmosphere, Canberra, ACT, Australia, [6]Faculty of Resource Science & Technology, University Malaysia Sarawak, Kota Samarahan, Malaysia, [7]Faculty of Engineering, Computing, and Science, Swinburne University of Technology Sarawak Campus, Kuching, Malaysia, [8]Faculty of Science and Marine Environment, Universiti Malaysia Terengganu, Terengganu, Malaysia, [9]Department of Earth and Planetary Sciences, American Museum of Natural History, New York, NY, USA

Abstract

Terrigenous dissolved organic matter (tDOM) carried by rivers represents an important carbon flux to the coastal ocean, which is thought to be increasing globally. Because tDOM is rich in light-absorbent chromophoric dissolved organic matter (CDOM), it may also reduce the amount of sunlight available in coastal ecosystems. Despite its biogeochemical and ecological significance, there are few long-term records of tDOM, hindering our understanding of its drivers and dynamics. Corals incorporate terrestrial humic acids, an important constituent of CDOM, resulting in luminescent bands that have been previously linked to rainfall and run-off. We show that luminescence green-to-blue (G/B) ratios in a coral core growing in waters affected by peatland run-off correlate strongly with remote sensing-derived CDOM absorption. The 24-year monthly resolution reconstructed record shows that rainfall controls land-to-ocean tDOM flux from this protected peatland catchment, and suggests an additional impact by solar radiation, which degrades tDOM at sea.

Plain Language Summary

A critical priority in biogeochemistry is to improve our understanding of the global carbon cycle so that we can make accurate predictions of future CO_2 concentrations. One important but still enigmatic aspect of the carbon cycle is the transport and fate of organic carbon from soils to the ocean. Our understanding of this flux is particularly limited by the lack of historical time-series measurements. One way of obtaining such historical data is through satellite-derived measurements, but this can only yield data for the most recent decades. Here, we show that historical records of terrestrial carbon can also be reconstructed from luminescence measurements of coral cores, which have the potential to yield centuries-long time series of carbon concentrations. Corals are carbonate archives that record different environmental parameters during their skeleton formation. Luminescence is caused by the incorporation of humic acids, an integral component of terrestrially derived dissolved organic carbon. Our 24-year long reconstruction from a coral core collected off Borneo suggests that organic carbon concentrations are driven by rainfall over adjacent peatlands, and by solar radiation that breaks down the organic carbon at sea. There is no long-term shift, suggesting that this peatland catchment has stayed protected from land-use change.

1. Introduction

The flux of terrigenous dissolved organic carbon (tDOC) from land to sea is quantitatively significant in the global carbon cycle, but the fate of tDOC in the ocean remains poorly known (Ciais et al., 2014; Cole et al., 2007). In some regions, a potentially large fraction of this tDOC flux can be oxidized to CO_2 through photodegradation and biodegradation processes, contributing to coastal ocean acidification and ultimately degassing to the atmosphere (Fichot et al., 2014; Semiletov et al., 2016; Ward et al., 2017). Moreover, tDOC is rich in chromophoric dissolved organic matter (CDOM), which is the fraction of dissolved organic matter