New study reconciles carbon record disparities on land and on sea

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Greenhouse observations simulated a variety of controlled climate scenarios.

(Phys.org) —It's a pressing question: How will the Earth's climate respond to future increases in atmospheric carbon dioxide (CO2)? Throughout geologic history, evidence of rapid, large-scale increases in atmospheric CO2 offers unique insight into how the Earth's systems are capable of reacting.

Up until this point, however, researchers have puzzled over a key inconsistency. The geologic markers for historic disruptions in carbon cycling activity—recorded as carbon isotope excursions or CIE—tend to be much larger in terrestrial rocks than those recorded in marine rocks during the same time periods.

Scientists at the University of Hawai'i at Mānoa and the University of Louisville at Lafayette have now determined how to resolve this difference.

"Our new model reconciles the differences based on the fundamentally different nature of carbon cycling on land compared to the ocean, injecting a more sophisticated view of ecology into current paleoclimatology," said A. Hope Jahren, professor of Geology & Geophysics at the University of Hawai'i at Mānoa.

Jahren and Brian Schubert of the University of Louisiana at Lafayette developed their model based on research conducted while Schubert was a postdoctoral fellow at University of Hawai'i at Mānoa. Their work is published in an April 3 article in the scientific journal *Nature Communications*.

Using UH Mānoa greenhouse space to simulate a variety of controlled climate scenarios, Schubert and Jahren identified a unifying relationship for the effect of atmospheric CO2 on plant tissues in a wide range of carbon-fixing land plants. This relationship suggests that for any increase of atmospheric CO2, land plants are globally and systematically more likely to incorporate less 13-C into their tissues. The observed difference in CIE magnitude between land and sea results from this additional fractionation by land plants due to rising atmospheric CO2 levels, which is then propagated within the terrestrial geologic record.

Schubert and Jahren's new model offers scientists a way to use terrestrial and marine records together to reconstruct the background and maximum atmospheric CO2 levels across carbon isotope excursions.

The new model also provides insight into some future climate scenarios.

"Our method also allows us to calculate absolute atmospheric carbon

levels before and during the carbon cycle disruption recorded by the CIE," Schubert said. "Based on our calculations, atmospheric CO2 levels during the very warm greenhouse conditions 55 million years ago were much lower than the atmospheric CO2 projections of the Earth's next 200 years."

More information: Schubert, B. and Jahren, A. Reconciliation of marine and terrestrial carbon isotope excursions based on changing atmospheric CO2 levels. *Nat. Commun*. doi: 10.1038/ncomms2659 (2013)

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