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## Marine biodiversity and the niche-environment interaction through deep time

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by modelled biological activity, and nutrient cycling to be linked to this activity. The model is being used to explore hypotheses on the effects of evolving filter feeders and burrowers on redox conditions and phosphorus cycling, but can be adapted for a range of time periods where there is interest in life-environment feedbacks, such as mass-extinction events.

14.45

### **Dust variations over the half billion years and their role in iron fertilization of the ancient oceans**

*Yixuan Xie*[1], *Dan Lunt* [1], *Fanny Monteiro* [1], *Richard Stockey* [2], *Paul Valdes* [1]

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Desert dust is a vital component of the Earth's climate system. The climate system regulates dust emission processes, such as sediment availability and wind entrainment, in various ways. Dust modulates the Earth's radiation balance, and wind-carried dust deposition provides essential nutrient iron to land and marine ecosystems. While dust science is well-developed for the modern and the Quaternary, little investigation has been done for the Earth's deep time.

Here, we present continuous simulations of dust emissions, depositions, and bioavailable iron for the first time throughout the Phanerozoic era (since 540 Ma ago). Results are derived from multiple schemes based on the paleoclimate fields output produced by the General Circulation Model HadCM3L. Our results show how dust emissions fluctuated over time with a stage-level resolution (approximately 5 Ma). We then diagnosed the controls of these fluctuations, and identified that paleogeography changes are the dominant control, whereas CO<sub>2</sub> plays a marginal role. Our ongoing research explores the influence of deposited dust on oceanic productivity and oxygen levels across various geological time periods, as modelled by cGENIE. This study aims to quantify the historical iron fertilization effect on Earth's oceans and offers insights into the variability of marine biodiversity through the lens of iron.

15.00

### **Marine biodiversity and the niche-environment interaction through deep time**

*Alexis Balembois* [1], *Bertrand Lefebvre* [2], *Alexandre Pohl* [3], *Thomas Servais* [4], *Paul J. Valdes* [5], *Dan J. Lunt* [5], *Grégory Beaugrand* [1]

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Although ~30 hypotheses or theories have been proposed to explain global species richness and its large-scale spatial arrangement in the marine and terrestrial

realms, a scientific consensus has not been reached yet. Here we use a multidisciplinary approach coupling a paleoclimatic and a macroecological model to show that the niche-environment interaction is fundamental to explain how global species richness has varied during the Phanerozoic Eon and how the resulting large-scale biodiversity patterns have been shaped through time. Although our model identifies a major mechanism, it also suggests that the niche-environment interaction is itself modulated by global climate, a mid-domain effect in the niche space, the position of the land masses, the global area available around continents and habitat fragmentation that affect environmental heterogeneity, which in turn promotes allopatric speciation that controls the global pool of species. Our study therefore demonstrates that any unifying theory on global biodiversity should consider a large number of factors that controls not only biogeographic biodiversity patterns but also their changes through deep time.

15.15

### **Climate Modelling of the late Neoproterozoic Era.**

**Stephen J. Hunter [1]**, Benjamin J. W. Mills [1] and Andrew S. Merdith [2]

School of Earth and Environment, University of Leeds [1], School of Physics, Chemistry and Earth Sciences, University of Adelaide [2]

The late Neoproterozoic Era saw deep glaciation and possible rises in atmospheric and marine oxygen levels. It has been suggested that both of these environmental changes could be the consequence of supercontinent breakup and amplified continental weathering rates, which could have drawn down CO<sub>2</sub> and liberated nutrients. But this idea has not been tested using high resolution paleoclimate models and recent paleogeographic reconstructions. Here we present a suite of HadCM3L climate model simulations covering the late Neoproterozoic Era (800 – 600 Ma) based upon a new full-plate model and palaeogeographic framework. We outline the boundary conditions and modelling strategy including the representation of continental-scale ice-sheets, and discuss initial results. To assess the implications for the carbon cycle, the resulting suite of climatologies will be incorporated into the SCION climate-chemical model to produce a self-consistent reconstruction of biogeochemistry (including chemical weathering and atmospheric O<sub>2</sub> and CO<sub>2</sub>) and climate. The ROCKE-3D planetary climate model will be implemented for comparison against HadCM3L and to investigate sensitivities such as atmospheric composition (e.g. reduced-O<sub>2</sub>) and reduced day-length.