The impact of paleogeography on long-term CO_2 models

MARKUSSEN MARCILLY, C. [1]; TORSVIK, T.H [1]

[1]Centre for Earth Evolution and Dynamics (CEED), Sem Sælands vei 24, NO-0316 Oslo, Norway - c.f.m.marcilly@geo.uio.no

CO_2 is the most important greenhouse gas in the Earth's atmosphere and has fluctuated considerably over geological time, with solar, tectonic and biological forcings driving changes in atmospheric concentrations. However, proxies for past CO_2 concentrations have large uncertainties and are mostly limited to Devonian and younger times. Consequently, modeling plays a key role in reconstructing past climate fluctuations. Over geological timescales, CO_2 is mainly reconstructed by estimating the relative importance of carbon degassing and uptake by silicate weathering.

The role of paleogeography on silicate weathering fluxes has been the focus of several studies in recent years and is considered as a key factor controlling the long-term evolution of atmospheric CO_2. Associated with changes in climatic zones, the fluctuation of sea level is critical for defining the amount of land exposed to weathering. The current reconstructions used in the long-term CO_2 models do not account for sea level and consequently overestimate the amount of exposed land at time periods with high sea levels. This overestimation leads to an excessive CO_2 uptake trough silicate weathering and may explain significant proxy-model CO_2 mismatches during the Mesozoic. On the other hand, newly reconstructed larger exposed landmasses over the Ordovician suggest an underestimation of CO_2 uptake over this period. Through the construction of continental flooding maps we aim to better constrain the effective land area undergoing silicate weathering through selected periods of the Phanerozoic where proxies and models differ the most. The new maps not only reflect sea-level fluctuations but also contain climate indicators such as coal and evaporites distribution to illustrate the distribution of observed high weathering zones on Earth through time.

Paleomaps are the base of silicate weathering parameterizations in carbon-cycle GEOCLIM simulations, a box model coupled with a climate and vegetation model, which allows calculating simultaneously atmospheric CO_2 and Earth climate fluctuations. We will use GEOCLIM and the newly created maps to calculate weatherability and atmospheric CO_2 for selected time slices. Our first focus is on the Late Ordovician and the Late Paleozoic-Early Mesozoic covering the first two Phanerozoic icehouses and the transition to an Early Mesozoic hothouse.