Geophysical Research Abstracts
Vol. 16, EGU2014-2741, 2014
EGU General Assembly 2014

Plate tectonic controls on atmospheric CO_2 levels since the Triassic

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Climate trends on time-scales of 10's to 100's of millions of years are controlled by changes in solar luminosity, continent distribution and atmosphere composition. Plate tectonics affect geography, but also atmosphere composition through volcanic degassing of CO_2 at subduction zones and mid-ocean ridges. So far, such degassing estimates were based on reconstructions of ocean floor production for the last 150 Million years (Myr) and indirectly, through sea level inversion before 150 Myr. Here we quantitatively estimate CO_2 degassing by reconstructing lithosphere subduction evolution, using recent advances in combining global plate reconstructions and present-day structure of the mantle. First, we estimate that since the Triassic (250-200 Myr) until Present, the total paleo-subduction zone length reached up to $\sim$200% of the present-day value. Comparing our subduction zone lengths with previously reconstructed ocean-crust production rates over the past 140 Myr suggests average global subduction rates have been constant, $\sim$6 cm/year: Higher ocean-crust production is associated with longer total subduction length. We compute a Strontium isotope record based on subduction zone length, which agrees well with geological records supporting the validity of our approach: The total subduction zone length is proportional to the summed arc- and ridge volcanic CO_2 production and thereby to global volcanic degassing at plate boundaries. We therefore use our degassing curve as input for the GEOCARBSULF model to estimate atmospheric CO_2 levels since the Triassic. Our calculated CO_2 levels for the mid-Mesozoic differ from previous modeling results and are more consistent with available proxy data.