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The influence of carbonate platform interactions with subduction zone volcanism on palaeo-atmospheric CO_2 and the deep carbon cycle since the Devonian

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A comprehensive body of work exists that documents the shallow carbon cycle, with only emerging research focusing on the deep carbon cycle acting across the range of short-term and geological timescales. Subduction zones and the resulting arc volcanic outgassing represent a major component of the deep carbon cycle. Much of the subducted carbon-rich sediment is liberated as CO_2 along continental subduction zones through volcanism and diffuse outgassing, which influences global atmospheric CO_2. However, when continental subduction zones intersect buried carbon-rich rocks, such as carbonate platforms, decarbonation reactions may cause a greater contribution to atmospheric CO_2 than non-intersecting segments of subduction zones. We present work that investigates the contribution of carbonate-intersecting continental subduction zones on palaeo-atmospheric CO_2 levels over the past 410 million years by integrating a plate motion models constructed using GPlates (www.gplates.org) with carbonate platforms through time. We apply a quantitative workflow, including continuous and cross-wavelet analyses as well as wavelet coherence that are used to evaluate trends between the evolving lengths of carbonate-intersecting continental subduction zones, non-carbonate-intersecting continental subduction zones, and total global subduction zones. The time series are examined for periodicities, assuming influences of the supercontinent cycle linked to the assembly and breakup of Pangea. The time series are quantitatively compared to the proxy-CO_2 record between 410 Ma and the present. Wavelet analysis reveals significant linked periodic behaviour between 75-50 Ma, where carbonate-intersecting continental subduction zone lengths are relatively high and are correlated with peaks in palaeo-atmospheric CO_2, characterised by a $\sim$32 Myr periodicity and a 10 Myr lag of CO_2 peaks following carbonate-intersecting continental subduction zone length peaks. The coherent signals may suggest that carbonate-intersecting continental subduction zones played a role in affecting global climate during the Late Cretaceous to Early Paleogene greenhouse times. At all other times, atmospheric CO_2 emissions from carbonate-intersecting continental subduction zones are not correlated with the proxy-CO_2 record. This suggests that a variety of feedbacks and an interplay of other biophysical and geochemical processes work in combination with carbon fluxes from subduction zones to modulate atmospheric CO_2 and climate throughout the Phanerozoic. Our open-source workflow, using pyGPlates libraries and Generic Mapping Tools, can generate subduction zone lengths and carbonate-intersecting arc lengths to approximate arc activity in deep geological time, and can be used as input for fully-coupled models of CO_2 flux between deep and shallow carbon reservoirs.