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Comparison of experimental and fossil leaf morphospace occupation suggests a role for atmospheric composition in driving morphospace change across a mass extinction boundary

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The Triassic-Jurassic boundary (∼201 mya) marks a period of intense climate change associated with a mass extinction event and major volcanism. The impact of these environmental stresses has been well-documented; however, a detailed analysis of the morphospace response of plants across the boundary has not been conducted. In order to determine the impact of changing atmospheric composition on leaf morphospace occupation, we compared a fossil flora to controlled environment experiments. We analysed morphometric data for over 2,000 well-preserved leaf fossils from nine plant beds across the TJ of Astartekløft, East Greenland. Data including leaf length, width, area, and shape were used to determine morphospace occupation for each bed at the site. In the lower Triassic beds, morphospace occupation is high compared to a severe reduction at and across the boundary, contemporaneous with peak reconstructed CO_2 and hypothesised elevated SO_2 and other volcanic gases. These findings were compared to controlled environment experiments, where the same measurements were made on leaves from nearest living equivalent taxa grown in simulated palaeoatmospheric conditions. These experiments revealed that exposure to SO_2, but not to variations in either CO_2 or O_2, produced a similar sever reduction in morphospace occupation. These findings together suggest that atmospheric composition change across the TJ, and particularly an elevation in SO_2, had a role in heavily disrupting the plant community morphospace of East Greenland.