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Paleoclimatic scales in the past 800ka based on the high resolution EDC dust record

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Dust fluxes from the East Antarctic EPICA Dome C ice-core with unprecedented near complete 25 year resolution over more than 800 kyrs are systematically analyzed over 8 glacial-interglacial cycles and within each cycle over 8 “phases”, each “phase” a successive segments of a cycle. This is the first scaling analysis that has documented systematic changes within the ice age cycle while confirming the relative robustness of the cycle itself over 8 cycles.
We find that whereas there is relatively little systematic variation from one ice age to another, there is a strong dependency of the scale by scale variability (as revealed by scaling fluctuation analysis) on the phase of the ice age. The analysis reveales that the transition scale from macroweather to climate (from fluctuations decreasing with scale to fluctuation increasing with scale) starts off in the range 1 – 2kyrs in the first two phases (i.e. at the end of a cycle), but then decreases to ca. 300 years over the last 6 phases (the long glacial inception). A long transition scale means that fluctuations at a fixed scale (e.g. 10 kyr) will be small since they have not had much of a range of time scales over which to develop.
We also consider the intermittency, the tendency for the series to be “spiky”, non Gaussian. We find a similar transition for medium intermittency - comparable to turbulence - to high intermittency over the middle phases (intermediate glacial conditions).
Finally, we examine the probability distributions of concentration changes at the 25 year scale. This shows that the fluctuations are of the extreme power law, “fat tailed” type associated with “black swan” events.