Observational and modeling study of the relationship between aerosols and super-cooled cloud fraction

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Recent observational and modeling studies indicate that aerosols may have a strong effect on Earth's energy budget via their influence on mixed-phase clouds. Global climate studies have predicted aerosol interaction with mixed-phase clouds to warm the current climate, but estimates are uncertain because mixed-phase cloud processes in GCMs are highly parameterized and have to date been poorly constrained by satellite data. Here, we present global and regional distributions of the frequency of supercooled cloud water and its link to aerosols from two global climate models (GCMs), compared to a new satellite data set. Both GCMs link ice formation at temperatures between -40 and 0 degrees C to the simulated concentrations of aerosols with ice nucleating ability (IN), assigning different freezing efficiencies to the different insoluble aerosol species (mineral dust, bio-aerosols and soot). Consequently, both models generally simulate an anti-correlation between aerosol abundance and supercooled liquid water in clouds, a finding that was recently qualitatively confirmed by satellite observations. By studying the relationship between aerosols and the supercooled cloud fraction (SCF) from the GCMs and from the NASA spaceborne lidar instrument CALIOP (cloud-aerosol lidar with orthogonal polarization), we get strong indications of how aerosols may influence mixed-phase clouds. We argue that with the new validation of SCF and its link to aerosols, GCM estimates of aerosol effects on climate via their influence on mixed-phase clouds may become more reliable.

The magmatic, metamorphic, mineralisation and plate tectonic evolution of continents

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Around 60% of continental crust was formed by the end of the Archaean and since then some form of plate tectonics has driven periods of supercontinent formation (at c.2.7 Ga, 1.9 Ga, 1.1 Ga and 0.35 Ga). Net growth of new crust declined in the Proterozoic and Phanerozoic and at the same time there has been a change in the mode of subduction from predominantly flat in the Archaean to progressively steeper towards the present day. This, along with the gradual cooling of the Earth, has resulted in marked changes in the preserved magmatic, metamorphic and mineralisation record. The first appearance of high-pressure metamorphic rocks, implying either overthickened crust or subduction, occurs in the Late Archaean around 2.7 Ga. There is a step-change in the magmatic products of subduction at the Archaean-Proterozoic transition from dominantly TTG through sanukitoid to calc-alkaline (basalt-andesite-diorite-rhyolite) as the main mode, which is most likely a result of a change in subduction angle and the development of a mantle wedge. This marks the onset of a form of modern plate tectonics. Whilst subduction magmas have been continuously produced they have also been continuously destroyed at continental margins, except at times when supercontinents formed, leading to pronounced peaks in crystallisation ages of detrital zircons. World-class ore deposits also correlate with the supercontinent cycle. During the Palaeoproterozoic (c.2.4-2.1 Ga) there was a period of anomalously low net continental growth followed by a peak of growth and mineralisation at c.1.9-1.8 Ga. We show how Fe-Oxide and related Cu and Au deposits can be linked to this cycle by measurement of Nd isotopes within titanite. The results imply that fertile mafic crust was incubated on the margins of the Archaean craton in the early Palaeoproterozoic but mineralisation did not occur until an arc was initiated at the margin and hence provided a heat and fluid source for mobilisation and concentration of the metals. The implication is that the formation and preservation of new continental crust is related to plate tectonics and the supercontinent cycle, which in turn controls the concentration and preservation of world-class ore deposits.