The climate impacts of natural aerosol

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Natural aerosol plays a significant role in the Earth system because climate controls many natural aerosol sources and because natural aerosol alters the radiative balance of the Earth. Here we explore a wide range of interactions and feedbacks between natural aerosol, anthropogenic aerosol and climate.

Firstly, we quantify the direct and first aerosol indirect effect of different natural aerosol sources. We explain the magnitude of these different radiative effects in terms of atmospheric chemistry and aerosol microphysics. Secondly, we quantify the impact of the natural aerosol background on the anthropogenic aerosol indirect effect. We find that a higher natural aerosol background tends to reduce the first aerosol indirect effect attributed to anthropogenic aerosol. Next, we explore the impact of anthropogenic aerosol on natural aerosol – climate feedbacks. We demonstrate that anthropogenic pollution aerosol in the Northern Hemisphere has reduced the climate feedback that occurs due to changes in natural aerosol emissions. Finally, we explore the impact of natural aerosol on diffiuse radiation and the impact on the terrestrial biosphere.

Age calibration of geomagnetic polarity reversals around the Cretaceous-Paleogene boundary

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Improved understanding of the timing of events attending the end-Cretaceous mass extinction is limited by difficulty in correlating marine and terrestrial records. The Geomagnetic Polarity Time Scale (GPTS), if well-calibrated, offers an important means to address this problem. Terrestrial sections in the Hell Creek region of Montana, interbedded with abundant sanidine-bearing tuffs, provide an opportunity to refine the ages of polarity reversals near the Cretaceous-Paleogene boundary (KPB), ultimately providing a test on the accuracy of orbital tuning chronologies e.g. [Ogg, 2012] for these reversals. Variable sedimentation rates often render terrestrial sequences unsuitable for such purposes, but in this case close stratigraphic proximity between reversals and tuffs allows very small fractional interpolations, ranging from 0.01 to 0.25 of the distance between bounding dated tuffs.

Preliminary new $^{40}Ar/^{39}Ar$ ages for 3 tuffs were combined with existing magnetostratigraphic data from two sections [Swisher *et al.*, 1993] to evaluate the potential of these records for time-scale calibration. Magnetic data gaps as large as several meters were used as conservative proxies for the uncertainty in reversal placement. Ages and uncertainties (+/- systematic sources) based on the optimization calibration of the $^{40}Ar/^{39}Ar$ system [Renne *et al.*, 2011] were determined by linear interpolation for the following three polarity reversals immediately following the KPB, and are shown compared with the GTS 2012 values [Ogg, 2012].

Chron boundary		Age (Ma)	±σ (Ma)	GTS 2012
C28r	top	64.755	0.028/0.050	64.667
C28r	base	64.900	0.044/0.061	64.958
C29r	top	65.605	0.080/0.092	65.688

The uncertainties in our ages are dominated by the coarse spacing of samples defining the Chron boundaries. Our modelling indicates that with sampling at the decimeter scale and with age precision demonstrably attainable from these tuffs [Renne *et al.*, 2013], these reversals can be dated with a resolution of ±10 ka, and an absolute accuracy of ±40 ka.

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