Insights from modelling Holocene and glacial cycle atmospheric methane

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There is considerable debate on the origin of the Holocene atmospheric methane signal. Methane concentrations as derived from ice-core records display a high degree of correlation with northern hemisphere summer insolation on orbital precession timescales. Over the last 5000 years there has been an increase in the atmospheric conentration of methane, which appears to be anomalous when compared with insolation forcing in the context of the last few hundred thousand years.

Proposed mehcanisms for the origin of the late Holocene methane increase include the Early Anthropocene hypothesis that early rice cultivation practises contributed significantly to increased methane emissions; an increase in tropical wetland emissions; increases in high latitude boreal wetland emissions; and decreases in the main methane sink (hydroxyl radicals). Here, we use global climate simulations of the last glacial cycle (130, 000 years) to drive a global vegetation and wetland model to reconstruct and investigate the natural changing sources of methane.

Identification of U(VI) sorption products and precipitates on magnetite by GI-SAXS, GI-XAS, and microscopy

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Uranyl uptake by magnetite is likely dominated by three interactions: (1) formation of surface complexes at [Fe (O, $OH)_6$] sites; (2) formation of surface complexes and/or coprecipitation with ferrihydrite formed by the release of Fe (II) and subsequent oxidation; and (3) heterogeneous reduction of U (VI) to U (IV) by Fe (II). These processes have been investigated by grazing incidence X-ray absorption spectroscopy (GI-XAS), grazing incidence small angle X-ray scattering (GI-SAXS), and atomic force microscopy (AFM) to determine the composition, structure, and size of surface complexes and precipitates on magnetite. *In situ* AFM images collected under batch conditions (pH 5 and 25 μM uranyl) indicates that particle formation occurs within an hour of exposure and the particles were approximately 20 nm in diameter and 5 nm in height. Within a day, particle aggregates on the order of 400 diameter nm formed, however the aggregate height remained at 5 nm. Energy dispersive X-ray spectra measured during SEM imaging indicated that these particles were U-bearing precipitates on the magnetite surface. Further X-ray diffraction and spectroscopic techniques will be used to characterize the composition and structure of U-bearing nano-phases. Preliminary GIXAS experiments indicate that under stop-flow conditions, no U (VI) reduction occurs within one day of exposure, and the sorption complex stoichiometry changes as a function of pH and the presence of carbonate.