Enhanced arsenic bioaccumulation and formation of organoarsenicals in coral reef organisms near an arsenic-rich marine shallow-water hydrothermal system

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Total arsenic (TAs) concentration and arsenic speciation was assessed in the tissues of several coral reef organisms surrounding the arsenic-rich marine shallow-water hydrothermal system of Tutum Bay, Ambitle Island, Papua New Guinea. Reef biota included the soft flower coral *Clavularia sp*., the calcareous algae *Halimeda sp*., and the tunicate *Polycarpa sp*. Specimens were collected along a transect leading away from focused hydrothermal venting, and at a "non-hydrothermal" control site, for comparison.

All organisms from the hydrothermal area displayed distinctly higher TAs (2 to 20 times) compared to the control site, with increasing values approaching focused hydrothermal venting. Arsenic species extracted from each organism were also typically one order of magnitude higher in concentration for the hydrothermal site versus the control site specimens, including the occurrence of several unknown species present only in specimens closest to focused venting.

The dominant arsenic species in *Clavularia* were arsenobetaine (AB), dimethylarsinate (DMA^V), a sulfate arsenosugar and arsenate, both from the control site and the hydrothermal area. This suggests that – although enhanced bioaccumulation occurs - its methylation pathway is unaltered and similar to other marine organisms. *Polycarpa* tissues contained no inorganic As, but abundant AB and DMA^V, suggesting uptake of organoarsenic through the food chain. Very high concentrations of As^{III} in *Halimeda* from the hydrothermal system (11.7 mg/kg vs. nondetect in the control) suggest this organism is not efficiently methylating inorganic arsenic. AB was also detected in substantial amounts in *Halimeda*, suggesting that the biomethylation pathway for calcareous algae is different compared to commonly studied seaweeds, which typically contain low concentrations of AB.

Introducing GMXe: A new global aerosol dynamics and thermodynamics model

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This paper introduces the GMXe aerosol model which has been designed to investigate gas / aerosol partitioning on a global scale. The model, implemented within the EMAC model, combines a thermodynamic equilibrium model (EQSAM3) with a new version of the M7 aerosol microphysics model (now extended to treat more species, including Na^+, Ca^{2+}, K^+, NH_4^+, Cl^- and NO_3^-). The resulting model is capable of calculating gas / aerosol partitioning with relatively little additional computational overhead.

In this paper we give an overview of the modelling approach used and show various model inter-comparisons, including a detailed comparison of the results of the GMXe and M7 models. We show the effect of including additional aerosol components - such as nitrate aerosol - on the global aerosol distribution and on the behaviour of other aerosol species (e.g. sulfate).

We show that treating inorganic ions within the aerosol (e.g. Ca^{2+} and CO_3^{2-} in dust), has a significant effect on partitioning and therefore on the global aerosol burden; altering both the magnitude and the distribution of the aerosol. We compare to extensive observations to analyse model performance and investigate the sensitivity of the simulated distribution to the species treated.