

Marine aerosol production, chemical evolution, and feedbacks over the open ocean

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The radiative effects of atmospheric aerosols contribute the largest uncertainties in our current predictive capability for Earth's climate. Through multiphase transformations, aerosols also influence the lifetimes of trace gases and aerosol deposition is an important nutrient source for ecosystems. Bursting bubbles at the ocean surface are major global sources for aerosol mass (dominated by super- μm sea salt) and number concentrations (dominated by hygroscopic, sub- μm , organic-rich particles) in marine air. Based on characterization of primary marine aerosols (PMA) produced artificially by bubbling zero air through flowing seawater, size- and composition-resolved production fluxes of PMA were parameterized as functions of wind-driven air entrainment and dissolved organic carbon (OC) in seawater and simulated globally using the Community Climate System Model.

The evolution of size-resolved PMA over a broad range of conditions was simulated with the photochemical box model MECCA parameterized based on measurements from 52 N to 18 S through the eastern Atlantic Ocean. Super- μm PMA was acidified to pH \sim 3.0 near Europe and \sim 4.5 in the ITCZ region. At these pHs, the aqueous phase oxidation of S(IV) by hypohalous acids was unimportant. Near Europe, classic HO_x/NO_x chemistry dominated but, elsewhere, halogen-radical chemistry substantially modified photochemical regimes. Formation of halogen nitrates accelerated oxidation of NO_x thereby contributing to net destruction of HO_x and O₃. Atomic Cl was an important oxidant for alkanes and both BrO and atomic Cl were important oxidants for (CH₃)₂S in all regimes. Biogeochemical cycles in seawater and marine air are integrally coupled through PMA production, physiochemical evolution, and deposition.

Terrestrial core formation: Constraints from Copper partitioning

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The estimated CI- and Mg-normalized abundance of Cu in the Earth's mantle is very similar to that of Ni and Co [1]. This is remarkable as the geochemical properties of Cu are very different from those of Ni and Co. At one bar Cu is less siderophile but more chalcophile than Ni and its condensation temperature is below those of Ni and Co. A better understanding of the behavior of Cu during core formation will be particularly useful for estimating the influence of sulfides in extracting siderophile and chalcophile elements from the Earth's mantle during core formation. The complex dependence of Ni and Co metal/silicate partition coefficients on pressure and temperature [2] has demonstrated that a large number of experiments at various temperatures and pressures may be required to estimate the behavior of Cu during core formation. We therefore systematically studied the metal – silicate partition behavior of Cu (Cu-Dmet/sil) as function of P, T, FeCu-alloy composition as well as variable Ni, C, and S contents, and silicate composition (nbo/t: 0.9 to 1.5). Cu-Dmet/sil values do have a weak but well-defined pressure dependence with an increase of lithophilicity with increasing pressure. The temperature dependence of Cu-Dmet/sil at elevated pressure is in good agreement with the temperature dependence of Cu-Dmet/sil at ambient pressure as described by [3], with increasing lithophilicity of Cu at higher temperatures at oxygen fugacities parallel to the iron-wüstite-buffer. The influence of Cu-Dmet/sil on alloy composition reflects the highly nonideal behavior of Cu in FeCu-alloys. Furthermore, experiments with Ni-bearing FeCu alloys show that Ni (0-15 wt.%) increases the lithophilicity of Cu. This is an important observation as meteoritic metal contains significant quantities of Ni (2 to 25 wt.%). Results of modeling the influence of the composition of core-forming alloys on expected Cu concentrations in the Earth's mantle will be presented.

[1] McDonough (2001) in: *Earthquake Thermodynamics and Phase Transformations the Earth's Interior* (eds. R. Teisseyre and E. Majewski) pp. 3-23. [2] Kegler *et al.* (2008) *EPSL*, **268**, 28-40. [3] Holzheid & Lodders (2001) *GCA*, **65**, 1933-1951.