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Marine primary production and export production are responsible for the capture of 25 %–35 % of the carbon emitted to the atmosphere by human activities, thereby partially mitigating the anthropogenic forcing on climate. The acquisition of carbon, nitrogen, and phosphorus by marine phytoplankton and bacteria relies, in part, on the availability of micronutrient trace elements such as iron, manganese, and zinc. On the other hand, elevated concentrations of potentially toxic trace elements such as copper or lead can hinder the performance of these metabolic processes. The supply of aerosol trace elements to remote ocean regions therefore exerts a fundamental control on bacterial and primary production and, ultimately, on oceanic carbon dioxide sequestration. Via the same pathway, aeolian trace elements can also impact fisheries, and thus have a broad societal impact.

Increased ocean stratification in the context of a warming climate is projected to decrease the internal supply of trace nutrients in the surface ocean. Hence, it becomes essential to accurately predict the external atmospheric trace nutrient load and properties using a combination of observations and global numerical models. One key aspect of the atmospheric trace nutrient supply to the ocean is that the estimated bioaccessibility of the deposited elements differs vastly between studies. While dust is the largest contributor to trace element atmospheric loading globally, anthropogenic and wildfire aerosols often contain a larger fraction of bioaccessible micronutrients, due to differences in particle size, mineralogy, and solubility-enhancing reactions with acidic and organic compounds in the atmosphere (and present in surface seawater). For this reason, it becomes essential to accurately predict the magnitude, timing, and location of aeolian deposition fluxes (be they nutrients or toxic elements) in tandem with the associated response of the marine ecosystem.

Climate is responsible for the fast-evolving physical and biogeochemical conditions in the ocean. A first challenge with respect to assessing how much aerosol inputs modulate marine biogeochemical cycles is to determine atmospheric deposition rates to the open ocean at different locations and times. A further analytical challenge is that aerosol trace element solubility (the fraction of soluble to total) cannot be measured directly. Instead, a myriad of laboratory leaching experiments have been used to operationally define and report a large range of soluble aerosol trace element fractions in the literature. Such variability makes it exceptionally challenging to compare solubilities between different studies and to relate that solubility back to natural phenomena occurring at the collection site and upwind of it. The resulting operational uncertainty introduced into modelling studies that use these observations as verification is currently unquantified, hindering an accurate representation of soluble aeolian trace element fluxes to surface waters and the associated response of marine productivity. For example, aerosol Fe solubility data reported in the literature range between 0.001 % and 100 %. As the uncertainty in the aeolian solubility reported for a number of other aerosol trace elements is just as large, it is now essential to disentangle the relative contribution of each factor to such uncertainty.

Through this special issue, the Scientific Committee on Oceanic Research Working Group 167 (SCOR WG167, https://scor-int.org/group/reducing-uncertainty-in-soluble-aerosol-trace-element-deposition-rusted/, last access: 11 January 2024) wishes to gather a collection of cutting-edge scientific studies with the following common goal: Reduce the Uncertainty in Soluble aerosol Trace Element Deposition (RUSTED) (Shelley et al., 2024). Since 2 November 2023, we have invited the international community to submit high-quality studies aimed at advancing our understanding of the sources, atmospheric processing, and deposition fluxes to the ocean and the impacts of aeolian trace elements on ocean marine biogeochemical cycles – in the past, present, or future. This special issue may contain interdisciplinary research from field observations, laboratory experiments, and numerical modelling studies.

The scope of this special issue is important and timely, as it addresses several UN Ocean Decade challenges (e.g. challenges 5 and 7) and aligns with current research priorities of large international programmes, including the Surface Ocean Lower Atmosphere Study (SOLAS, https://www.solas-int.org, last access: 11 January 2024), GEOTRACES (https://www.geotraces.org, last access: 11 January 2024), and the joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP, http://www.gesamp.org, last access: 11 January 2024). This Copernicus inter-journal special issue is an initiative of the SCOR WG167 that is led by the *Atmospheric Measurement Techniques* (AMT) journal and supported by the *Aerosol Research* (AR), *Atmospheric Chemistry and Physics* (ACP), and *Biogeosciences* (BG) journals.

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References

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