Sources and climate impacts of Indian Ocean aerosols – constraints from trace metal concentrations and isotope compositions

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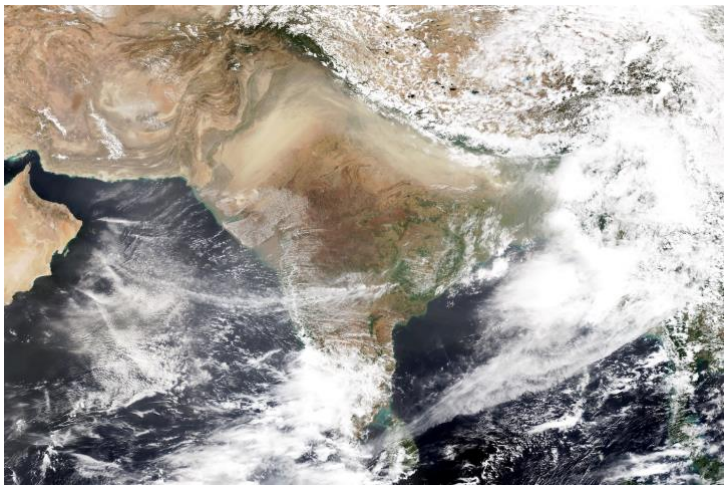
Natural fluxes of airborne dust (termed atmospheric aerosols in science-speak) have diverse impacts, including on weather, air quality, health, biogeochemical processes in the oceans, and climate – see massive dust storm over India in the picture below. Human activities, including burning of fossil fuels, metal smelting and waste incineration, generate anthropogenic aerosols, which are dispersed together with natural dust. In comparison to geogenic dust, industrial and urban aerosols, however, are often strongly enriched in metals such as Cr, Fe, Co, Ni, Zn, Cd, Tl and Pb. Some of these elements act as micronutrients whilst others are toxic to organisms even at low levels.



A particularly prominent example for the impact of anthropogenic aerosols is provided by Pb. Human activities increased Pb fluxes to the atmosphere by more than two orders of magnitude until they peaked in the 1970s, when the global phase-out of leaded petrol led to a gradual decline. Research by our group and others shows that this emission history is imprinted on the oceans, with rising Pb concentrations in surface waters of the North and South Atlantic until the 1970s, followed by a decline. Little is known, however, how the industrial and urban emissions of emerging economies are now altering atmospheric dust fluxes and subsequent metal inputs to the adjacent oceans. The current project is set up to address this shortcoming.

For this project, a unique suite of aerosol samples from the northern Indian Ocean will be analysed. The project entails determination of the elemental and isotope compositions (Pb, Zn, Cd) of the aerosols to establish the extent to which human activity has increased metal emissions to the atmosphere. The trace element and isotope fingerprints will then be employed to (i) identify the metal emission sources and (ii) evaluate impacts of the higher metal emissions on both terrestrial and marine environments.

The project may encompass a visit to our project partner P. Banerjee in India. Sample processing and analyses will primarily be carried out in the clean room and mass spectrometry facilities of the MAGIC Group at the Department of Earth Science & Engineering, Imperial College London (http://www.imperial.ac.uk/earth-science/research/ research-groups/magic/). Our group runs one of only a handful of laboratories world-wide where such challenging analyses are routinely conducted. You will also be part of the GEOTRACES programme (www.geotraces.org), an international study of the marine cycles of trace elements and their isotopes, with the mission to understand their distributions in the ocean, and to establish the sensitivity of these distributions to changing environmental conditions.

The project is suitable for a student with a background in earth, environmental or marine sciences, geology, chemistry or an equivalent qualification Further information on the research can be obtained from Mark Rehkämper (markrehk@imperial.ac.uk) and Rebekah Moore (r.moore13@imperial.ac.uk).