Implementation plan for the Assessment of Impacts of Dust in the marine environment of the RSA
Aerosol Impacts on Ocean Ecosystems
Implementation plan for the Assessment of Impacts of Dust in the marine environment of the RSA

Geographic coverage

BAISDS-2017 is envisaged to cover the ROPME Sea Area. Aerosol sources from both the Middle East and India and Pakistan are expected to be transported to the RSA, and consequently sampling stations will need to be situated at various strategic sites in the ROPME region.
Target elements, compounds, and biological impact assays

The priority set of target elements and compounds aerosol samples:
- Essential elements for microbial organisms (e.g. Fe, Co, N, P, Si)
- Toxic elements and compounds (Cu, PAHs) and elements that may be involved in nuisance bloom development (N, P).

- We will determine mineralogy using XRD and electron microscope (EM) techniques to determine the source of the aerosol.

- We will undertake a quantitative source apportionment of airborne particles and soluble trace elements and nutrients using receptor models.

- We will undertake atmospheric modelling of trace element and nutrient deposition, constrained by remote sensing of total aerosol deposition rates in combination with ground measurements.
Target elements, compounds, and biological impact assays

We will undertake water sampling to assess the impact of aerosol inputs on chemistry (including carbonate chemistry to assess ocean acidification) and biology.

We will further develop a local physical-biogeochemical ocean model with improved aerosol supply fluxes and biological impact quantification.

Typical anthropogenic gases, such as ozone, NOx and SO$_2$ are to be determined at selected stations to identify origin of the collected air masses.

Multispectral (UV to PIR) atmospheric aerosol optical depth (AOD) will be performed using manual photometers in the frame of the Maritime Aerosol Network (MAN) component of AERONET.
# Target elements, compounds, and biological impact assays

<table>
<thead>
<tr>
<th>Elements, compounds, gases and physical measurements</th>
<th>Matrix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Na, Mg, Al, K, Ca, Sc, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Ag, Cd, Sn, Hg, Pb, U, P, OC/EC, PAHs, molecular tracers</td>
<td>Collected aerosols (total fraction)</td>
</tr>
<tr>
<td>Na, Mg, Al, K, Ca, Sc, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Ag, Cd, Sn, Hg, Pb, U, Cl⁻, sulphate, ammonium, nitrate, phosphate, silicic acid, sulphate, DOC</td>
<td>Water soluble aerosol fraction</td>
</tr>
<tr>
<td>Al, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Ag, Cd, Hg, Pb, U, ammonium, nitrate, phosphate, silicic acid, DOC, dissolved inorganic carbon and total alkalinity</td>
<td>Seawater samples</td>
</tr>
<tr>
<td>Ozone, VOCs, NOx and SO₂ at selected stations</td>
<td>Gas phase</td>
</tr>
<tr>
<td>Aerosol optical depth (AOD, using manual photometer)</td>
<td>Atmosphere</td>
</tr>
<tr>
<td>XRD-EM mineral analysis</td>
<td>Particulate aerosol samples</td>
</tr>
</tbody>
</table>
Target elements, compounds, and biological impact assays

<table>
<thead>
<tr>
<th>Biological Impact</th>
<th>Matrix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effects of dust deposition on surface water ecosystems (chlorophyll a, photosynthetic efficiency and microbial composition of waters)</td>
<td>Surface seawaters</td>
</tr>
<tr>
<td>Dust additions from selected samples to phytoplankton cultures</td>
<td>Seawater phytoplankton culture</td>
</tr>
</tbody>
</table>
Criteria and selection of suitable sampling sites

- Criteria are required to select the optimum sampling sites, for which the following aspects are to be considered:
  - Sampling must be cost and effort effective
  - Process of selection of sampling sites should consider the wind patterns of the Region and represent locations of importance for the various air masses reaching the RSA, and anthropogenic activities (industry, urban areas, shipping). Air mass trajectory modeling experiments and regional air quality data analysis will be conducted to aid with site selection.
  - Existing ROPME Reference sites are to be carefully considered to benefit from historical data
  - Existing and planned Regional initiatives including surveys should be utilized to undertake Aeolian mineral dust sampling at sea in combination with water column sampling to assess impact of dust deposition. This harmonization will optimize sampling effort and provide important added value to the programme
  - Adaptive extension of national efforts should be ensured to cover some sites on the coast as well as in the near-shore environment through national activities as contribution to BAISDS-2017
Sampling Protocol and sample types

• The standard operating procedure of sampling for aerosols will be:

  Total suspended particle (TSP) collection using high volume aerosol collectors, employing W41 (Whatman 41) filters and also Quartz (Whatman QMA) filters.

  Full digestion will be undertaken on W41 filters for subsequent elemental analyses by ICP-MS. The digestion will involve a mixture of HCl, HNO₃, and HF to obtain complete digestion. This approach will be used for selected samples.

• XRF analyses for total elemental characterization will be undertaken to complement full digestion and ICP-MS measurements.

• A rapid deionized water (e.g. MQ water, Millipore) leach will be undertaken on W41 and QMA filters for subsequent elemental analyses by ICP-MS, and anion analyses by ion chromatography and nutrient analyses by autoanalyser, and DOC analysis, and PAHs using liquid chromatography.

• Mineralogical composition will be conducted on selected samples through X-Ray Diffraction (XRD)/EM analyses. A punch of QMA will be used for organic carbon (OC) and elemental carbon (EC) using a carbon analyser. Half of the QMA filters will be extracted with organic solvent for molecular marker analysis by GC-MS.
Bitte nicht rauchen
Please do not smoke near this.
Aerosol sampling on Cape Verde

- Low volume aerosol collection system installed at Cape Verde atmospheric observatory (June 2007)

100 ml de-ionised water drawn through filter in ca. 10 s
Sampling Protocol and sample types

• Water column sampling will be undertaken for

  • Nutrients with subsequent analysis using an nutrient autoanalyser.
  • Samples will be collected for organic carbon, organic pollutants, microbial community structure and chlorophyll a analysis.
  • Samples will be undertaken for trace elements using specialized trace metal clean techniques. Analysis will be undertaken by ICP-MS following preconcentration and matrix removal.
  • Samples will be collected for carbonate chemistry analysis (dissolved inorganic carbon and total alkalinity).
  • Temperature and salinity will be determined on-site using calibrated probes.
Oceanic Trace metal sampling

- Ti rosette frame with trace metal bottles
- Trace metal clean winch with conducting kevlar rope as CTD wire

Laboratory based isotope dilution-inductively coupled plasma-mass spectrometry with Seafast sample prep system

ID-ICP-MS for Ag, Cd, Cu, Fe, Ni, Pb, Zn, Mo, V
ICP-MS for Al, Co and Mn
Dissolved Fe (nM): Christian Schlosser
Trace metals analysis by ID-ICP-MS
Iron isotopes in seawater by MC-ICP-MS
Sampling Protocol and sample types

• Biological impact assessment of aerosols will be undertaken by

• addition of aerosol sample to phytoplankton cultures during short-term (48 h) incubation experiments, and assessment of changes in biomass (chlorophyll a) and physiological health (Fv/Fm)

• It is possible to undertake larger scale mesocosm experiment
Mesocosm experiments: the DUNE project

Optical measurements to observe the fate of Saharan dust in seawater

Optical properties of the sinking particles → size of particles, composition and amount of suspended particles, relative concentration of small to large particles

Increase in the amount of aggregated material and organic matter
Sampling Protocol and sample types

- For BAISDS-2017 we will adopt the aerosol sampling and elemental analysis protocol from the International GEOTRACES programme (Cutter et al., 2013 and Morton et al., 2013). GEOTRACES reference materials will be used.

- For nutrient and organic analyses we will use standard methods with appropriate certified reference materials (KANSO for nutrients and Hansell for DOC).

- The Scientific Group will prepare clear standard operating procedures for the full range of activities as part of the sampling and analyses activities.
Sampling frequency

- The BAISDS-2017 is an exercise of establishing a reference for the year 2017-2018 over a period of 12 months.

- A full seasonal cycle will be sampled continuously at the various sampling sites.
- Filters on the high volume pumps will be changed every 2 days. Filters will be frozen to -20C for subsequent analyses.

- Water samples will be collected every month.
- Daily AOD measurements will be undertaken. At selected sites continuous gas measurements will be undertaken.
Sampling frequency

- The sampling process management will be a coordinated operation, requiring cooperation and support of the Member States. The schema is as follows:

- ROPME will be BAISDS-2017 Coordinator and will receive guidance from the Scientific Group.

- BAISDS-2017 Coordinator will establish a sampling schedule, provide necessary technical support and prepare a Sampling Protocol in cooperation with the Regional Scientific Group and GEOMAR to be made available to the members of the sampling management team.
Sample banking

- ROPME shall archive the samples in ROPME-Sample Bank (RSB) under required conditions, pending the dispatch of sub-samples to the central laboratory for analyses.
Sample analysis and responsible laboratories

- One laboratory is designated for the analyses of samples, as this is a baseline assessment.

- For the follow-up monitoring, further laboratories can be selected and involved by conducting proficiency tests.

- In case of force majeure, it may be decided to split the samples for analyses amongst different laboratories in the Region.
Data Management and Reporting

• All data generated from the BAISDS-2017, both concerning Aeolian mineral dust and the ancillary environmental information, will be secured under ROPME copyright as they are produced.
• BAISDS-2017 Coordinator, in consultation with the Scientific Group will validate all the data.

• The validated data will be managed as per the following schema:
  • Data will be archived in ROPME and GEOMAR Data Library
  • Data will be organized into technical report with necessary interpretations, with the help of expert consultants
  • Technical report will be published by ROPME for circulation
  • Data will be hosted on ROPME Integrated Information System (RIIS)
Training needs

- There is a distinct opportunity for capacity development in the Region for both the participation in BAISDS-2017 and to carry out the follow-up activities. As such, the training needs are for:

- Effective sampling, sample preservation and analyses
  - A training course demonstrating the relevant procedures for sampling and aerosol analyses is planned with the cooperation of GEOMAR for National experts expected to participate in BAISDS-2017.
  → train the trainers’, expecting a cascading effect in the Member States.

GEOMAR is to provide the training programme along with the needs and requirements for the this training course, so as to help in preparations
Training needs

• Successful sampling and analyses of samples
  – The designated Regional Reference Laboratory will have the responsibility to train the scientists of the Region periodically to carry out the sampling and analyses of aerosols

• Data management

• ROPME in cooperation with IOC and GEOMAR and on the platform of RIIS will conduct training programmes on general marine data management as applicable to the Region, from time to time
Linkages with other ROPME activities

- Effective linkages/harmonization will be established for BAISDS-2017 with the following ROPME activities:
  - Oceanographic cruises
  - Preparation of the State of the Marine Environment Report (SOMER)
  - RIIS
Integration with other National and Regional Programmes

- It is expected that the Member States will offer an opportunity to integrate with their existing and planned national programmes of relevance in order to make BAISDS-2017 cost and effort effective.

- Voluntary sharing of responsibilities in the aerosol dust sampling programme is one important primary step.

- ROPME shall explore the possibility of involving Regional and International programmes of UNEP.

- A link to UNEP-ROWA will be important in order to link aeolian mineral dust impacts on rain events on the Indian sub-continent, and the effects of west Asian pollution aerosols on the health of the RSA.
Indicative Time Plan

• Finalization of Draft Scientific Programme: January 2016
• Meeting of the Ad-hoc Committee to finalize a detailed Scientific Programme with the identification of sampling team, players and Protocol of sampling – March 2016
• Designation of responsible Laboratories for conducting Aeolian mineral dust and seawater pilot study sampling – April 2016
• 2 weeks Training on sampling and sample preparations: May 2016
• Contribution to 2016 ROPME cruise programme
• Start of sampling for pilot study: Nov 2016 for a period of 2 months
• Completion of sample analyses of samples and reporting for pilot study: July 2017
• Start of BAISDS-2017: Nov 2017 for a 12 months period
• Completion of analyses of samples and reporting for BAISDS-2017: November 2019