surface ocean solas lower atmosphere study

Report for the year 2016 and future activities

SOLAS *Israel*

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PART 1 - Activities from January 2016 to Jan/Feb 2017

1. Scientific highlight

The impact of dry atmospheric deposition on the sea-surface microlayer in the SE Mediterranean Sea: an experimental approach

For more details see Astrahan et al. (2016).

The oligotrophic southeastern Mediterranean Sea (SEMS) is frequently exposed to desert-dust deposition which supplies nutrients, trace metals and a wide array of viable airborne microorganisms to the surface seawater layer. In this study, we experimentally examined the impact of aerosol addition, collected during an intense dust storm event in early September 2015, on the biomass and activity of pico-phytoplankton and heterotrophic bacterial populations at the sea-surface micro layer (SML) relative to the sub surface layer (SSL). We hypothesized that due to the physiochemical and biological differences between the SML and SSL, any external atmospheric addition may trigger distinct responses in these two layers.

To this end, aerosol (1.5 mg L^{-1}) was added to SML and SSL water samples in microcosms (4.5 L) and the water was frequently sampled for *Synechococcus* abundance, pico-eukaryotes abundance, nano-eukaryotic abundance, heterotrophic bacterial abundance, primary production and bacterial production measurements at 0, 1.5, 5, 9, 17, 21, 26 and 44 h after the aerosol addition. Unamended control microcosms were also carried out.

While the aerosol amendment triggered a moderate 1.5-2 fold increase in primary production in both the SML and the SSL, bacterial production increased by ~3 and ~7 folds in the SSL and SML, respectively (Figure 1). Concurrently, the abundance and flow-cytometric characteristics (green fluorescence and side scatter signals) of high nucleic acid (HNA) and low nucleic acid (LNA) bacterial cells showed a significant increase in the %HNA, in both SML and SSL samples following aerosol amendment. This shift in nucleic acid content took place at a much faster rate in the SML, suggesting a more active heterotrophic community or a more opportunistic population in the SML.

This study demonstrates the opportunistic character of the bacterioneuston communities (SML bacterial population) once nutrient-carrying airborne particles are introduced to the SML. Specifically, our results highlight that the heterotrophic microbial community inhabiting the SML is more efficient in utilizing aerosol associated constituents than the community in the SSL.

We suggest that studies of the seasonal changes in the biodiversity and physiology of these communities in relation to atmospheric deposition from different sources are needed. Furthermore, the nature and dynamics of nutrients, metals (and microorganisms) exchange between the SML and SSL is currently unknown and warrants more study.

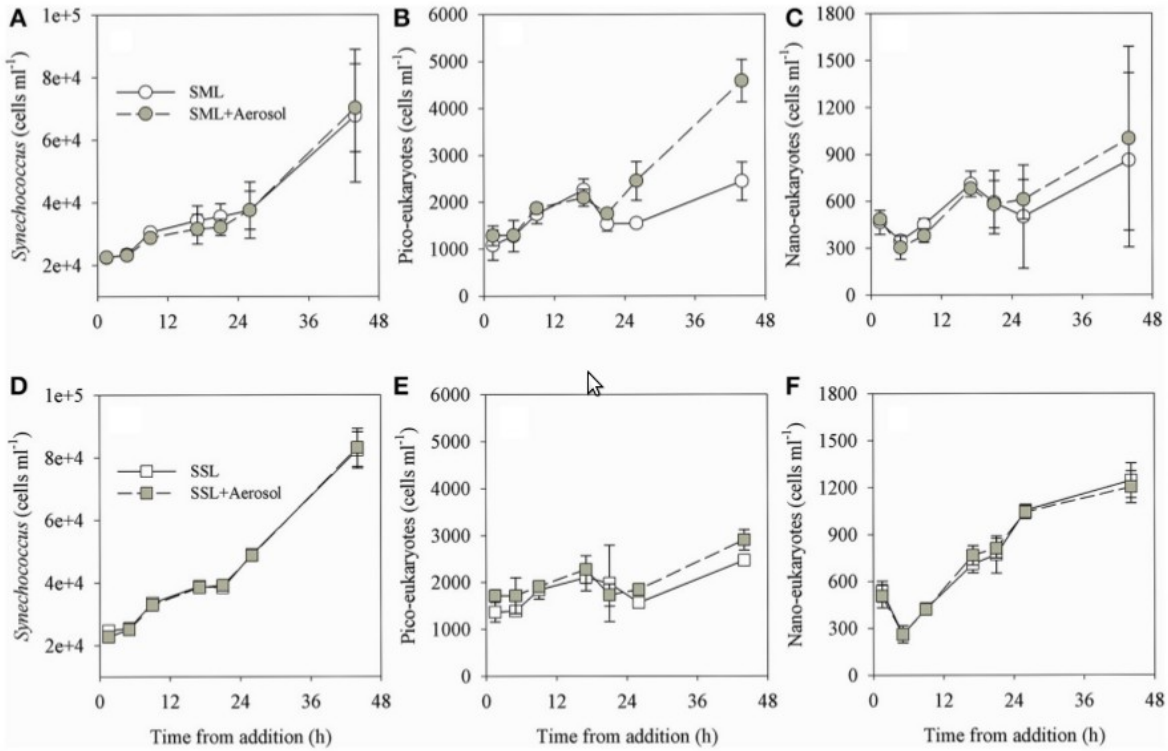

Figure 1. The temporal dynamics of Synechococcus (A,D), pico-eukaryotes (B,E) and nano-eukaryotes (C,F) in the SML (top panels) and SSL (bottom panels) microcosms. Experiments including aerosol additions (1.5 mg L^{-1}) are presented in gray, control experiments (containing no additions) are colored white. Values are the averages and standard deviation from 3 biological replicates (n = 3).

2. Activities/main accomplishments in 2016 (projects, field campaigns, events, model and data intercomparisons, capacity building, international collaborations, contributions to int. assessments such as IPCC, interactions with policy makers or socio-economics circles, etc.)

A group from Weizmann Institute of Science is currently part of the TARA PACIFIC expedition, leading the atmospheric research during the 2.5 year mission. The group explores the chemical, physical, and biological properties of marine aerosols across the Atlantic and Pacific Oceans. TARA-expeditions is one of the most important large-scale experiments in Earth sciences and oceanography, as part of an international effort to assess the biogeochemistry of the ocean. The objective of the project is to investigate how marine aerosols are influenced by the biological and chemical properties of surface seawater across the Atlantic and Pacific oceans. Specifically, the scientists aim to better understand which marine organisms are emitted to the lower atmosphere, and how they affect the marine ecosystem. The TARA PACIFIC project allows for a unique opportunity to explore transects of the Atlantic and Pacific oceans, providing much needed information on the changes in marine aerosol properties along different spatial and temporal scales.

3. Top 5 publications in 2016 (only PUBLISHED articles) and if any, weblinks to models, datasets, products, etc.

Astrahan P., Herut B., Paytan A., Rahav E. (2016), The impact of dry atmospheric deposition on the sea-surface microlayer in the SE Mediterranean Sea: an experimental approach. *Front Mar Sci* 3:222.

Stockdale, A., Krom, M.D, Mortimer, R.J.G., Benning, L.G., Carslaw, K.S. Herbert, R.J., Shi, Z., Myriokefalitakis, S., Kanakidou, M., and Nenes, A. (2016) understanding the nature of atmospheric acid processing of mineral dusts in supplying bioavailable phosphorus to the ocean. *Proc. Natl. Acad. Sci. USA* 113:14639–14644.

Kranzler, C., Kessler, N., Keren, N. and Y. Shaked. 2016. Enhanced ferrihydrite dissolution by a unicellular, planktonic cyanobacterium: insights into the bioavailability of particulate iron. *Environmental Microbiology and Environmental Microbiology Reports*. Doi:10.1111/1462-2920.13496.

Schoffman H, Lis H, Shaked Y and N. Keren .2016. Iron–Nutrient Interactions within Phytoplankton. *Frontiers in Plant Sciences* 7(1223). doi: 10.3389/fpls.2016.01223.

Lehahn Y., I. Koren, S. Sharoni, F. d'Ovidio, A. Vardi and E. Boss. Dispersion/dilution enhances phytoplankton blooms in nutrient-limited waters, *Nat. Commun. DOI: 10.1038/ncomms14868.*

4. Did you engage any stakeholders/societal partners/external research users in order to co-produce knowledge in 2016? If yes, who? How did you engage?

PART 2 - Planned activities from 2017/2018 and 2019

1. Planned major field studies and collaborative laboratory and modelling studies, national and international (incl. all information possible, dates, locations, teams, work, etc.)

Important contribution to SOLAS activities in Israel is expected to come from the oceanographic observatory THEMO (Texas A&M – University of Haifa Eastern Mediterranean Observatory) - a joint project of University of Haifa and Texas A&M University - that is expected to be operational in 2017. The observatory will include a shallow mooring (125m) in the coastal zone and a deeper one 60 km offshore in the Levant Basin of the Mediterranean Sea and will comprise of two sensor arrays attached to 2.25m diameter surface buoys. The deeper mooring (1425m) will be equipped with a profiler which will communicate to a subsea float and from there to a surface buoy. This array will also have a time-series sediment trap at 1000m. Both arrays will have acoustic capabilities, standard sensor and inductively-coupled thermistor chains. The data will be received at a shore station through a fast two-way communication link.

We expect to achieve valuable information on the impact of ocean biology on fluxes of particles across the ocean-atmosphere interface from the second of the TARA PACIFIC expedition, where continuous measurements of aerosols are conducted by researchers from the Weizmann Institue of Science.

Valuable information on ocean dynamics and biogeochemistry will be delivered by an array of three gliders, that are planned to operate continuously in the Levantine basin on of the Mediterranean.

The Gliders are operated by scientist from the Bar-Ilan University, Hebrew University, Weizmann Institute of Science and Israel Oceanographic and Limnological Research.

2. Events like conferences, workshops, meetings, schools, capacity building etc. (incl. all information possible)

As part of the annual meeting of the Israeli Association for Aquatic Sciences, we intend to have a session dedicated at SOLAS-related issues. The focus will be on the way by which the marine ecosystem affects, and is affected by, fluxes of particles across the ocean-atmosphere interface.

Researchers and students engaged with SOLAS activities in Israel will be involved in the upcoming workshop “Preparing next generation fine scale experiments in the Mediterranean sea”, aimed at identifying current trends for high resolution, biophysical satellite observations and in situ experiments in the Mediterranean.

3. Funded national and international projects / activities underway (if possible please list in order of importance and indicate to which part(s) of the SOLAS 2015-2025 Science Plan and Organisation (downloadable from the SOLAS website) the activity topics relate – including the core themes and the cross cutting ones)

4. Plans / ideas for future projects, programmes, proposals national or international etc. (please precise to which funding agencies and a timing for submission is any)

5. Engagements with other international projects, organisations, programmes etc.

Scientists working on SOLAS-related projects are engaged with the International Global Atmospheric Chemistry (IGAC), The International Commission on Clouds and Precipitation (ICCP) and the International study of the marine biogeochemical cycles of trace elements and their isotopes (GEOTRACES.