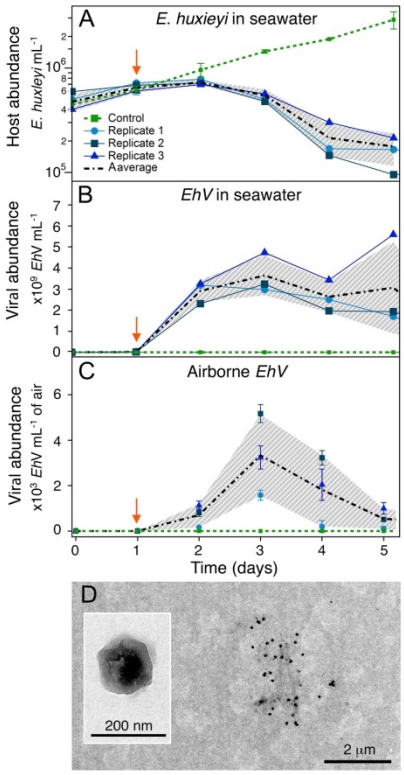
surface ocean solas lower atmosphere study

Report for the year 2015 and future activities

SOLAS Israel ***compiled by: Yoav Lehahn***

PART 1 - Activities from January 2015 to December 2015

1. Scientific highlight



Infection of bloom-forming phytoplankton by aerosolized marine viruses

Marine viruses constitute a major ecological and evolutionary driving force in the marine ecosystems, however their dispersal mechanisms remain underexplored. Here we follow the dynamics of Emiliania huxleyi viruses (EhV) that infect the ubiquitous, bloom-forming phytoplankton E. huxleyi, and show that EhV are emitted to the atmosphere as primary marine aerosols. Using a laboratory-based setup, we showed that the dynamic of EhV aerial emission is strongly coupled to the host- virus dynamic in the culture media. In addition, we recovered EhV DNA from atmospheric samples collected over an E. huxleyi bloom in the North Atlantic, providing evidence for aerosolization of marine viruses in their natural environment. Decay rate analysis in the lab revealed that aerosolized viruses can remain infective under meteorological conditions prevailing during E. huxleyi blooms in the ocean, allowing potential dispersal and infectivity over hundreds of kilometers. Based on the combined lab and in situ findings, we propose that atmospheric transport of EhV is an effective transmission vector for spreading viral infection over large areas in the ocean. This transmission vector may also have an important ecological impact on the the large scale host-virus "arms race" during bloom succession and consequently the turn-over of carbon in the ocean. For further information see Sharoni et al., 2015.

Figure: *E. huxleyi host abundance (A) and EhV abundance (B) in the culture media, and EhV abundance in the collected aerosols (C). The red arrows represent the time of viral addition to the culture media. The average of three replicates (blue lines) is presented by the dashed black line. The shadowed area represents the standard deviation of the three replicates' average. The green line is the control experiment using a non-infected E. huxleyi culture. (D) Aggregates of EhV collected from aerosols emitted from the infected culture.*

2. Activities/main accomplishments in 2015 (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[1] etc.)

Important advancement in SOLAS research in Israel is the implementation of new facilities for systematic sampling the oceanin mixed layer, by IOLR Israel Oceanographic and Limnology Research (IOLR) researcher. Using a “Harvey (1965)” like drum sampler, the scientists are able to collect high volumes (0.2-2L) of the top layer from >50m length water transects. High volumes are crucial for marine organic material concentration and chemical analysis such as GC/MS and LC/MS.

A major part of SOLAS-Israel research focuse on the Mediterranean, and especially on it eastern basin. Researchers from IOLR have shown a diverse microbial community associated with dust and other aerosol particles in the region, which differed significantly according to their geographical air mass origin. Using microcosm bioassay experiments, in which aerosols were added to sterile (0.2 µm filtered and autoclaved) SE Mediterranean Sea (SEMS) water, the researchers show that dust/aerosol deposition can be a potential source of a wide array of microorganisms, which may impact microbial composition and food web dynamics in oligotrophic marine systems such as the SEMS. On a different direction, using continuous satellite-derived sea surface temperature and elevation collected over the last 21 years, researchers from the Hebrew Unversity of Jerusalem have shown that the hypothesis that the Eastern Mediterranean upper layer heat content in fall impact winter precipitation over Israel.

On April 2015 we had a first meeting of scientists associated with SOLAS-Israel, with the goals of establishing a scientific network and identifying possibilities for financing SOLAS-related project. The meeting was a satellite event of the annual conference of the Israeli Association of Aquatic Sciences.

3. Top 5 publications in 2015 (only PUBLISHED articles) and if any weblinks to models, datasets, products, etc.

1. Rahav, E., G. Ovadia, A. Paytan, and B. Herut (2016), Contribution of airborne microbes to bacterial production and N2 fixation in seawater upon aerosol deposition. Geophys. Res. Lett. 43: 1–9. doi:10.1002/2015GL066898.
2. Sharoni, S., M. Trainic, D. Schatz, Y. Lehahn, J. M. Flores, S. Ben Dor, Y. Rudich, I. Koren and A. Vardi (2015), Infection of bloom-forming phytoplankton by aerosolized marine viruses, Proc. Natl. Acad. Sci. USA 112, 6643-6647.
3. Belkin, N., Rahav, E., Elifantz, H., Kress, N., and Berman-Frank, I. (2015), Enhanced salinities, as a proxy of seawater desalination discharges, impact coastal microbial communities of the eastern Mediterranean Sea. *Environmental Microbiology*, DOI: 10.1111/1462-2920.12979.
4. Gross, A., T. Goren, C. Pio, J. Cardoso, O. Tirosh, M.C. Todd, D. Rosenfeld, T. Weiner, D. Custódio, and A. Angert (2015), Variability in sources and concentrations of Saharan dust phosphorus over the Atlantic ocean*, Environmental Science & Technology Letters 2* (2), 31-3.
5. Gufan A, Lehahn Y, Fredj E, Price C, Kurchin R & Koren I. (2016) Segmentation and Tracking of Marine Cellular Clouds observed by Geostationary Satellites, *International Journal of Remote Sensing, 37:5,* 1055-1068.

PART 2 - Planned activities from 2016 to 2018/19

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

SOLAS-Israel is facing a new era in terms of the capacity to curry out field campaigns and to collect oceanic data in the Mediterranean. This improvement in capabilities is associated with the implementation of three gliders, and with the launching of a new advanced research vessel. The gliders project involve researchers from several instuiutes, including Israel Oceanographic and Limnology Research (IOLR), Weizmann Institute of Science, The Hebrew University and Bar Ilan

University. Both the gliders and the new research vessel will be operated by the IOLR staff.

In addition, researchers from IOLR and Weizmann institute develop advanced capabilities in simulating, measuring and analyzing fluxes of biological matter across the ocean-atmosphere interface, which opens the way to exciting SOLAS research projects.

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

In the coming year we plan to continue with the emerging tradition of having an annul SOLAS-Israel meeting. Similar to our previous gathering, the meeting, which is aimed at interdisciplinary exchange of ideas and knowledge on SOLAS-related issues, will be a satellite event of the annual IAAS meeting.

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 the activity topics relate – including the themes on 'SOLAS science and society' and 'Geoengineering')

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)

Scientists from the Weizmann Institute of Science have started a collaboration with the Tara-ocean project, and will participate in the coming campaign at the Pacific Ocean. The Weizmann group will implement aerosol sampling systems, with the goal of studying properties of marine boundary layer aerosols and relating them to changes in oceanic and atmospheric conditions.