surface ocean **solas** lower atmosphere study

Report for the year 2022 and 2023 and future activities

SOLAS *Italy*
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This report has two parts:

*- **Part 1:** reporting of activities in the period of January 2023 - Feb/Mar 2024*
*- **Part 2:** reporting on planned activities for 2024 and 2025.*

*The information provided will be used for reporting, fundraising, networking, strategic development and updating of the live web-based implementation plan. As much as possible, please indicate the specific SOLAS 2015-2025 Science Plan Themes addressed by each activity **or specify an overlap between Core Themes or Cross-Cutting Themes.***

Core Theme 1: Greenhouse gases and the oceans;
Core Theme 2: Air-sea interfaces and fluxes of mass and energy;
Core Theme 3: Atmospheric deposition and ocean biogeochemistry;
Core Theme 4: Interconnections between aerosols, clouds, and marine ecosystems;
Core Theme 5: Ocean biogeochemical control on atmospheric chemistry;
Cross-Cutting Theme: Integrated studies of high sensitivity systems (upwelling systems, Indian Ocean, polar oceans and sea ice);
Cross-Cutting Theme: Climate intervention;
Cross-Cutting Theme: Science and society**.**

***IMPORTANT**: This report should reflect the efforts of the SOLAS community in the **entire country or region** you are representing (all universities, institutes, lab, units, groups, cities).*

First things first…Please tell us what the IPO may do to help you in your current and future SOLAS activities. ?
I have a list of previous SOLAS-related projects and research groups in Italy that the previous NCP, Dr. Santinelli, forwarded me. However, I did not have any feedback to the introductory email I wrote as new Italy NCP, nor last year, not this year. The only group who wrote back reporting its activity for 2022 and 2023 is CNR-ISAC (Dr. Rinaldi and colleagues). I would need the help of SOLAS IPO to re-establish the Italian network. I am starting with some activities planned for next year but they only involve my research group at the University of Siena (Environmental Spectroscopy Group) where I am back since September 2023.

PART 1 - Activities from January 2023 to Feb/Mar 2024

1. Scientific highlight

CNR-ISAC 2023:
Dimethylsulfide (DMS), the most ubiquitous natural source of sulfur in the atmosphere, is responsible for aerosol formation over the global ocean, impacting cloud radiative forcing and precipitations, eventually influencing the climate system. Using machine learning predictive algorithms, we reconstruct the distribution of daily DMS concentrations in the North Atlantic waters over 24 years (1998 -2021) at 0.25° x 0.25° spatial resolution. The proposed model outperforms any other methods for predicting seawater DMS concentrations deployed so far, achieving an unprecedented space and time resolution, and revealing that DMS concentration is strongly driven by regional and mesoscale patterns in phytoplankton biomass and seawater vertical mixing dynamics.

We extend machine learning algorithms, to model the sea-level atmospheric concentrations of marine biogenic aerosol MSA and nss-SO4 over the North Atlantic Ocean utilizing the constructed daily sea-to-air DMS emission flux (F_{DMS}) (Mansour et al., 2023). The in situ long-term sulfur aerosol observations at Mace Head research station, on the west coast of Ireland, and from the recent NAAMES cruises were combined with F_{DMS}, and the meteorological parameters to act as predictors for MSA and nss-SO4. The model's output has a spatial resolution of 0.25° x 0.25°, a daily time resolution, and, most importantly, covers 25 years (1998-2022), far exceeding what observations alone could achieve both space and time-wise.

CNR-ISAC 2022:

***Investigation of the marine biota impact on atmospheric aerosol over the North Atlantic Ocean from satellite data** [Matteo Rinaldi, Karam Mansour (CNR)]. A machine learning predictive algorithm based on Gaussian process regression (GPR) was used to model the distribution of daily DMS concentrations in the North Atlantic waters over 24 years (1998–2021) at 0.25° x 0.25° spatial resolution. The model was built using DMS observations from cruises, combined with satellite-derived oceanographic data and Copernicus-modelled data. Further application of the same approach to model sulfur aerosol concentration data is ongoing.*
***Studying aerosol physico-chemical properties over the Southern Ocean and Antarctica** [Matteo Rinaldi, Marco Paglione, Stefano Decesari (CNR)]. Aerosol samples have been collected during two Antarctic cruises: the R/V Laura Bassi (Italy) cruise on the Ross Sea and the R/V Hesperides (Spain) cruise on the Weddel Sea. Aerosol characterization is in progress through a multi-technique analytic approach, comprising Ion Chromatography, C and N quantification and Nuclear Magnetic Resonance Spectrometry.*

2. Activities/main accomplishments in 2023 (e.g., projects; field campaigns; workshops and conferences; model and data intercomparisons; capacity building; international collaborations; contributions to int. assessments such as IPCC; collaborations with social sciences, humanities, medicine, economics and/or arts; interactions with policy makers, companies, and/or journalists and media).

CRUISES
***CNR-ISAC** participated to two cruises between the end of 2022 and the first months of 2023:*
- *R/V Laura Bassi (Italy) cruise on the Ross Sea (within the 39th PNRA summer campaign) in the framework of the PNRA project CAIAC.*
- *R/V Hesperides (Spain) cruise on the Weddel Sea, in the framework of the Spanish funded project PI-ICE (external participant).*

3. Publications in 2023 (only PUBLISHED articles) and if any, weblinks to models, datasets, products, etc.

Mansour, K., Decesari, S., Ceburnis, D., Ovadnevaite, J. & Rinaldi, M. Machine learning for prediction of daily sea surface dimethylsulfide concentration and emission flux over the North Atlantic Ocean (1998–2021) Science of The Total Environment 871 (2023). https://doi.org/10.1016/j.scitotenv.2023.162123

Sellegri, K; … Rinaldi, M., et al., 2023, Sea2Cloud From Biogenic Emission Fluxes to Cloud Properties in the Southwest Pacific. Bulletin of the American Meteorological Society, 104 (5): E1017-E1043.

Mansour, K., Decesari, S., Ceburnis, D., Ovadnevaite, J., Rinaldi, M., 2023, Machine learning for prediction of daily sea surface dimethylsulfide concentration and emission flux over the North Atlantic Ocean (1998-2021). Science of the Total Environment, 871: 162123, DOI10.1016/j.scitotenv.2023.162123.

Galgani, L., Tzempelikou, E., Kalantzi, I., et al. (2023). Marine plastics alter the organic matter composition of the air-sea boundary layer, with influences on CO_2 exchange: A large-scale analysis method to explore future ocean scenarios. Sci. Total Environ., 857, 159624. https://doi.org/10.1016/j.scitotenv.2022.159624

Dall'Osto, M., …, Rinaldi, M., Paglione, M., et al., 2022, Sea Ice Microbiota in the Antarctic Peninsula Modulates Cloud-Relevant Sea Spray Aerosol Production. Frontiers in Marine Science, 9: 827061, DOI10.3389/fmars.2022.827061.

Mansour, K., Rinaldi, M., Preissler, J., Decesari, S., Ovadnevaite, J., Ceburnis, D., Paglione, M., Facchini, M.C., O'Dowd, C., 2022, Phytoplankton Impact on Marine Cloud Microphysical Properties Over the Northeast Atlantic Ocean. Journal of Geophysical Research, 127 (10): 2021JD036355, DOI10.1029/2021JD036355.

Dall'Osto, M., …, Rinaldi, M., Paglione, M., et al., , 2022, Leaching material from Antarctic seaweeds and penguin guano affects cloud-relevant aerosol production. Science of the Total Environment, 831: 154772, DOI10.1016/j.scitotenv.2022.154772

4. Did you engage any stakeholders/societal partners/external research users in order to co-produce knowledge in 2023? If yes, who? How did you engage?

University of Siena – Env. Spectroscopy Group (Dr. Galgani) – cross cutting theme science and society: citizen science project on surface microplastics sampling and DNA analysis with the help of volunteers on board of an eco-friendly vessel (sailing boat), July 2023, SeaPaCS project (EU funded) https://crowdusg.net/seapacs/. Follow up with sailing school kids who will sample sea-surface microplastics with a diy assembled manta net (starting April 2024). Plastic samples will be analyzed at the University of Siena.

PART 2 - Planned activities for 2024 and 2025

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

CNR-ISAC plans to adapt the machine learning developed models to predict DMS concentration, DMS fluz and sulfur aerosol atmospheric concentrations over the Mediterranean Sea.

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

- EGU 2024 – L. Galgani et al. [Plastics Affect the Ocean's Uptake of Atmospheric CO_2 across the Marine Boundary Layer](#) (talk, session OS1.7 *The ocean surface layer: multi-scale dynamics, atmosphere-ocean interactions and impacts on biogeochemistry*)

- 2025: (Funding granted, being organized) [ESA-Future Earth Joint Programme](#) funding for the development and uptake of Earth observation data by Future Earth's research networks – grant for the workshop "SPARSE": Sea-surface microPlAstic fRom SpacE: optical signals of organic compounds at the sea-surface and lower atmosphere as a proxy for plastic and microplastic detection. Lead: Dr. L. Galgani, Dr. L. Tinel (IMT Nord Europe, France) € 19,831. The workshop will be hosted at the University of Siena in 2025.

3. Funded national and international projects/activities underway.

4. Plans / ideas for future national or international projects, programmes, proposals, etc. (please indicate the funding agencies and potential submission dates).

5. Engagements with other international projects, organisations, programmes, etc.
University of Siena – L. Galgani collaboration with GEOMAR Kiel and Dr. Anja Engel group on previous projects and data analysis.

Comments