surface ocean solas lower atmosphere study

Report for the year 2021 and future activities

SOLAS *Australia*
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This report has two parts:

***- Part 1:** reporting of activities in the period of January 2021 - Jan/Feb 2022*
***- Part 2:** reporting on planned activities for 2022 and 2023.*

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 Themes or Cross-Cutting Themes.**

1 Greenhouse gases and the oceans;
2 Air-sea interfaces and fluxes of mass and energy;
3 Atmospheric deposition and ocean biogeochemistry;
4 Interconnections between aerosols, clouds, and marine ecosystems;
5 Ocean biogeochemical control on atmospheric chemistry;
Integrated studies of high sensitivity systems;
Environmental impacts of geoengineering;
Science and society**.**

***IMPORTANT**: This report should reflect the efforts of the SOLAS community in the **entire country** 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. ?
IPO is doing an excellent job

PART 1 - Activities from January 2021 to Jan/Feb 2022
1. Scientific highlight
*Describe one scientific highlight with a title, text (**max. 300 words**), a figure with legend and full references. Please focus on a result that would not have happened without SOLAS, and we are most interested in results of international collaborations. (If you wish to include more than one highlight, feel free to do so).*

Trace elements and nutrients in wildfire plumes to the southeast of Australia

Highlights
- Wildfires are key sources of atmospheric bioavailable Fe, Mn, NO_3^- and NH_4^+.
- Fire Fe solubility increases during the atmospheric transport of the fire plume.
- Soil is the dominant source of Fe within the fire plume.

The unprecedented magnitude of the 2019–20 Australian fires have raised interest in the potential for fire emissions to supply vital nutrients to remote ocean regions. Fire emissions are episodic and unpredictable, making them difficult to investigate. Analysis of aerosols collected at the kunanyi/Mount Wellington time-series station, in southeastern Tasmania (Australia), between 2016 and 2020 enabled to characterise the signal of fire emissions (using levoglucosan as a fire tracer) to the atmosphere. Our results revealed a striking increase in the atmospheric loading of vital nutrients, namely iron (Fe), nitrate (NO_3^-), ammonium (NH_4^+) and manganese (Mn), associated with fire events. High concentrations of mineral dust in fire-impacted aerosols evidenced that strong pyro-convective winds resulted in the erosion and entrainment of soil particles into the atmosphere as a part of the fire plume. Enrichment factor (EF) analysis in aerosols suggested that soil was the dominant source of atmospheric Fe and Mn in fire emissions. Lead (Pb) enrichment was found in fire aerosols ($EF_{Pb} > 10$) and was attributed to the resuspension of soil historically contaminated by leaded petrol and mining operations. Finally, atmospheric transport was suggested to play a key role in decreasing concentrations of total Fe (T_{Fe}) and mineral dust while increasing the aeolian content of bioaccessible Fe (L_{Fe}), NO_3^- and NH_4^+ in the plume downwind of the fires. As future projections suggest an increase in fire activity worldwide, atmospheric time-series stations such as kunanyi/Mount Wellington are key to better understand future impacts of fire emissions on human health and natural ecosystems.

Citation:
Morgane M.G. Perron, Scott Meyerink, Matthew Corkill, Michal Strzelec, Bernadette C. Proemse, Melanie Gault-Ringold, Estrella Sanz Rodriguez, Zanna Chase, Andrew R. Bowie,
Trace elements and nutrients in wildfire plumes to the southeast of Australia,
Atmospheric Research, Volume 270, 2022, 106084, ISSN 0169-8095,
https://doi.org/10.1016/j.atmosres.2022.106084.

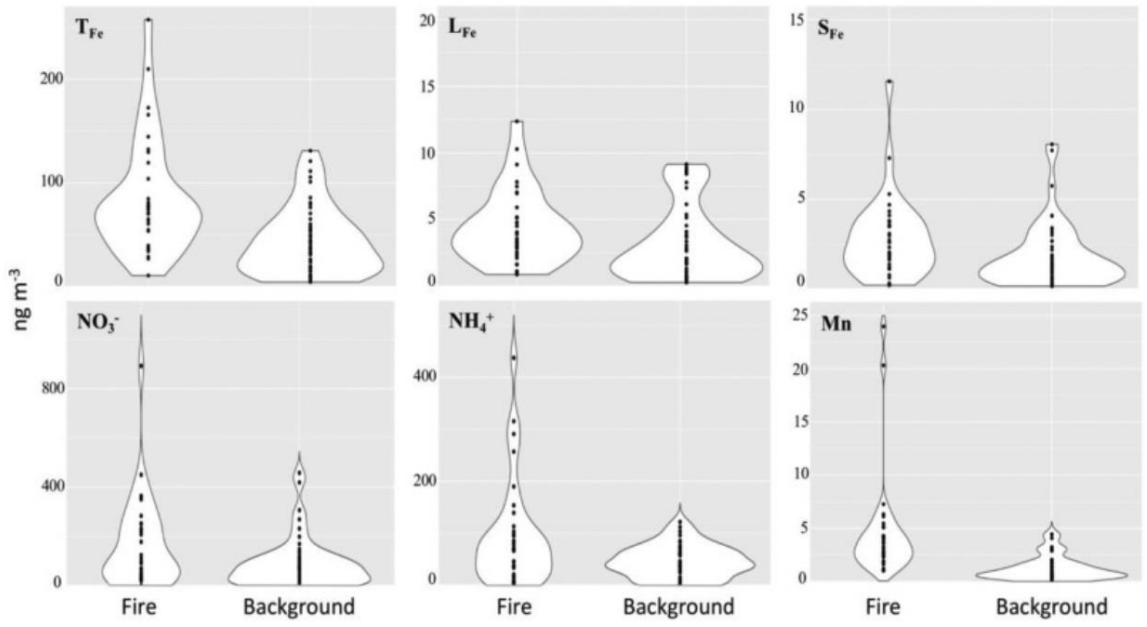

Figure. Distribution of nutrient loading (in nanogram per cubic meter of air, ng m^{-3}) in fire aerosols and during background atmospheric conditions at the kunanyi/Mt Wellington time-series aerosol sampling station (Hobart, Tasmania, Australia). The total (T_{Fe}), bioaccessible (L_{Fe}), and soluble (S_{Fe}) Fe content as well as nitrate (NO_3^-), ammonium (NH_4^+) and manganese (Mn) concentrations in aerosols are displayed.

2. Activities/main accomplishments in 2021 (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).

Field programs:

- Ongoing atmospheric measurements of the RV Investigator https://research.csiro.au/acc/capabilities/rv-investigator/
- RV Investigator Jan-Feb 2021 voyage (IN2021_V01 voyage) investigating aerosol and cloud interactions in the Southern Ocean
- Southern Ocean Time Series (SOTS) voyage, IN2021_V03, including at-sea aerosol and rain sampling for trace elements and major ions
- Commissioning of the RSV Nuyina - Australia's new ice breaker, which has cross-discipline capability, including for the first time a dedicated atmospheric chemistry laboratory. Work is ongoing to complete the fit-out of the lab for ambient sampling.
- Establishment of the PICCAASO (Partnerships for Investigating Clouds and the biogeoChemistry of the Atmosphere in Antarctica and the Southern Ocean) initiative – an international effort to coordinate and magnify the science investigating the links between clouds, aerosols and the biogeochemistry in the Antarctic and Southern Ocean.

Conferences:

Atmospheric Composition & Chemistry Observations and Modelling Conference & Cape Grim Annual Science Meeting, online November 2021.

Blowing South Symposium (10/11/21)

Iron at the Air-Sea Interface (26-30/07/21)

3. List SOLAS-related publications published in 2021 (only PUBLISHED articles). If any, please also list weblinks to models, datasets, products, etc.

- Tang, W* and Llort, J and Weis, J and Perron, MMG and Basart, S* and Li, Z* and Sathyendranath, S* and Jackson, T* and Sanz Rodriguez, E and Proemse, B and Bowie, AR and Schallenberg, C and Strutton, PG and Matear, R* and Cassar, N*, "Widespread phytoplankton blooms triggered by 2019–2020 Australian wildfires", *Nature*, **597** (7876) pp. 370–375. doi:10.1038/s41586-021-03805-8 ISSN 0028-0836 (2021)
- Humphries, R. S., Keywood, M. D., Gribben, S., McRobert, I. M., Ward, J. P., Selleck, P., Taylor, S., Harnwell, J., Flynn, C., Kulkarni, G. R., Mace, G. G., Protat, A., Alexander, S. P., & McFarquhar, G. (2021). Southern Ocean latitudinal gradients of cloud condensation nuclei. Atmospheric Chemistry and Physics, 21(16), 12757–12782. https://doi.org/10.5194/acp-21-12757-2021
- Mace, G. G., Protat, A., Humphries, R. S., Alexander, S. P., McRobert, I. M., Ward, J., Selleck, P., Keywood, M., & McFarquhar, G. M. (2021). Southern Ocean Cloud Properties Derived From CAPRICORN and MARCUS Data. Journal of Geophysical Research: Atmospheres, 126(4), e2020JD033368. https://doi.org/10.1029/2020JD033368
- McFarquhar, G. M., Bretherton, C. S., Marchand, R., Protat, A., DeMott, P. J., Alexander, S. P., Roberts, G. C., Twohy, C. H., Toohey, D., Siems, S., Huang, Y., Wood, R., Rauber, R. M., Lasher-

Trapp, S., Jensen, J., Stith, J. L., Mace, J., Um, J., Järvinen, E., Schnaiter, M., Gettelman, A., Sanchez, K. J., McCluskey, C. S., Russell, L. M., McCoy, I. L., Atlas, R. L., Bardeen, C. G., Moore, K. A., Hill, T. C. J., Humphries, R. S., Keywood, M. D., Ristovski, Z., Cravigan, L., Schofield, R., Fairall, C., Mallet, M. D., Kreidenweis, S. M., Rainwater, B., D'Alessandro, J., Wang, Y., Wu, W., Saliba, G., Levin, E. J. T., Ding, S., Lang, F., Truong, S. C. H., Wolff, C., Haggerty, J., Harvey, M. J., Klekociuk, A. R., & McDonald, A. (2021). Observations of Clouds, Aerosols, Precipitation, and Surface Radiation over the Southern Ocean: An Overview of CAPRICORN, MARCUS, MICRE, and SOCRATES. Bulletin of the American Meteorological Society, 102(4), E894–E928. https://doi.org/10.1175/BAMS-D-20-0132.1

- Sanchez, K. J., Roberts, G. C., Saliba, G., Russell, L. M., Twohy, C., Reeves, M. J., Humphries, R. S., Keywood, M. D., Ward, J. P., & McRobert, I. M. (2021). Measurement report: Cloud processes and the transport of biological emissions affect southern ocean particle and cloud condensation nuclei concentrations. Atmospheric Chemistry and Physics, 21(5), 3427–3446. https://doi.org/10.5194/acp-21-3427-2021
- Simmons, J. B., Humphries, R. S., Wilson, S. R., Chambers, S. D., Williams, A. G., Griffiths, A. D., McRobert, I. M., Ward, J. P., Keywood, M. D., & Gribben, S. (2021). Summer aerosol measurements over the East Antarctic seasonal ice zone. Atmospheric Chemistry and Physics, 21(12), 9497–9513. https://doi.org/10.5194/acp-21-9497-2021
- Twohy, C. H., DeMott, P. J., Russell, L. M., Toohey, D. W., Rainwater, B., Geiss, R., Sanchez, K. J., Lewis, S., Roberts, G. C., Humphries, R. S., McCluskey, C. S., Moore, K. A., Selleck, P. W., Keywood, M. D., Ward, J. P., & McRobert, I. M. (2021). Cloud-Nucleating Particles Over the Southern Ocean in a Changing Climate. Earth's Future, 9(3), e2020EF001673. https://doi.org/10.1029/2020EF001673
- Perron M.M.G., B.C. Proemse, M. Strzelec, M. Gault-Ringold, A.R. Bowie. Atmospheric inputs of volcanic iron around Heard and McDonald Islands, Southern Ocean, Env. Sci.: Atm. (2021). doi.org/10.1039/D1EA00054C
- Baker A.R., M. Kanakidou, A. Nenes, S. Myriokefalitakis, P.L. Croot, R.A. Duce, Y. Gao, C. Guieu, A. Ito, T.D. Jickells, N.M. Mahowald, R. Middag, M.M.G. Perron, M.M. Sarin, R. Shelley and D.R. Turner. Changing atmospheric acidity as a modulator of nutrient deposition and ocean biogeochemistry, Sci. Adv. 7 (2021). doi.10.1126/sciadv.abd8800

4. Did you engage any stakeholders/societal partners/external research users in order to co-produce knowledge in 2021? If yes, who? How did you engage?

PART 2 - Planned activities for 2022 and 2023

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

- Ongoing atmospheric measurements of the RV Investigator https://research.csiro.au/acc/capabilities/rv-investigator/
- Numerous major field campaigns as part of the PICCAASO initiative (www.piccaaso.org) with numerous Australian led campaigns. See website for details. Southern Ocean Time Series (SOTS) voyage, IN2022_V03, including at-sea aerosol and rain sampling for trace elements and major ions
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2. Events like conferences, workshops, meetings, summer schools, capacity building etc. (incl. all information possible).

Atmospheric Composition & Chemistry Observations and Modelling Conference & Cape Grim Annual Science Meeting, November 2022

CATCH Science Workshop (March 2022), with a special session on PICCAASO and CIce2Clouds.

Special sessions on PICCAASO at SOLAS Open Science meeting May 2022

3. Funded national and international projects/activities underway.

Australian Antarctic Program Partnership (AAPP), 2019-2029

ARC Discovery funding, 2019-22, "Dust to the ocean: Does it really increase productivity?" Zanna Chase, Andrew Bowie, Peter Strutton

US ASR Funding, 2022 – 2025 – High Latitude Aerosol-Cloud Interaction during MARCUS: The role of CCN variability and links to precipitation. Gerald Mace, Gannet Hallar, Ruhi Humphries

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.

International GEOTRACES program – www.geotraces.org

World Meteorological Organisation's Global Atmosphere Watch Programme
SOCRATES - https://www.eol.ucar.edu/content/socrates-project-overview
US Atmospheric Radiation Measurement facility
IGAC
PICCAASO – www.piccaasso.org

Comments

Apologies for the delay in compiling this report