Christian Mark G. Salvador, Ph.D.

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Aerosol Science and Technology Research Staff
Environmental Science Division – Oak Ridge National Laboratory

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EDUCATION

Taiwan International Graduate Program (TIGP), Academia Sinica, Taiwan
National Central University (NCU), College of Earth Sciences
September 2012-January 2017

- Ph.D. in Earth System Science (Atmospheric Science)
- Recipient of Office of International Affairs NCU Scholarship for graduate students
- TIGP Outstanding Ph.D. Graduate

University of the Philippines (UP) Diliman, Institute of Chemistry, Philippines
June 2006 – April 2010

- B.S. Chemistry, with distinction (*cum laude)*

PROFESSIONAL EXPERIENCE

Environmental Science Division, Oak Ridge National Laboratory
Aerosol Science and Technology Research Staff
May 2022 – Present

- Analysis of the formation and transformation of Uranyl particles from hydrolysis reactions
- Characterization of the impact of environmental conditions such as sea spray, dusts, and NOx on the growth and coagulation of Uranyl particles
- Simulation of post-detonation nuclear events using high thermal chambers and rapid gas and particle phase instrumentation such as mass spectrometer and particle size counters.

Philippine Council for Industry, Energy, and Emerging Technology Research and Development, Department of Science and Technology (DOST)
Balik Scientist
August 2021 – February 2022

- Understanding the long-term trends of the atmospheric pollutants of Butuan, Agusan del Norte
- Characterization of the impact of biomass burning and anthropogenic emissions on regional particulate matter (PM) of two urban regions in South East Asia
- Development of **AIR PROTeCtED**: **AIR** **P**urifier for the **R**eduction **O**f **T**ransmission of **C**OVID19 and other airborn**E** **D**iseases
- Submission of DOST- Proposal regarding the analysis of ultrafine particles in four different regions in the Philippines
- Drafting of policy paper aiming at the reduction of the atmospheric oxidation potential of Butuan

Department of Chemistry and Molecular Biology, University of Gothenburg
University Researcher
September 2019-September 2021
Postdoctoral Research Fellow *with* ***Prof. Mattias Hallquist***
September 2017-September 2019

- Understanding the formation and propagation pathway of atmospheric NOx and Particulate Matter (PM), which can be further applied in a controlled system such as chamber studies
- Project management which includes coordination, identification of target variables, and post-processing of data obtained from the field measurements in China, Hongkong and Denmark
- Analysis of different interaction systems such as forest-urban and land-sea through atmospheric tracers such as organonitrates and organochlorides
- Operated and maintained the Filter Inlet for Gases and AEROsols High Resolution Chemical Ionization Mass Spectrometer (FIGAERO HR-TOF-MS) with Iodide (negative) and Water (positive) as reagent ions in both field and laboratory settings.
- Supervision of Master and Ph.D. students in different research topics such as oxidation of emissions from typical automobile exhaust, organochlorides from coast in Hong Kong, and biomass burning tracers in a rural city in China
- Contributed to international collaboration projects in China (Dezhou and Hong Kong) to investigate the mechanism of the transformation of the precursor VOCs into highly oxidized atmospheric pollutants using a mass spectrometer.
- Rapid characterization of real-world gas and particle compounds from heavy-duty vehicles/trucks, buses, and ships and determine the contribution of different fuel types and exhaust after-treatment systems in total emissions.
- Characterized a wide variety of human-related indoor volatile organic carbon (VOCs) from indoor environments (chamber and classroom) in relation to ozone chemistry using HR-TOF-mass spectrometer.
- Analyzed the emissions of a wide range of compounds of typical Swedish burners that generate a suite of biomass burning tracers that partition both in the gas and particle phase.
- Probed the molecular composition of fresh and aged biomass burning organic aerosols and linked their contribution to the formation and bleaching of brown carbon.

Research Center for Environmental Changes (RCEC), Academia Sinica Taipei, Taiwan
Graduate Student under Dr. Charles C.-K. Chou and Dr. Gin-Rong Liu 2012 – 2016
Dissertation: Perturbation of Urban Air Pollution on the Composition of Organic Aerosols in a Subtropical Forestry Area

- Handled the new PTR-TOF-Ms (8000) from its calibration, transportation, and data analysis to provide the mixing ratio of volatile organic compounds (VOC) as a precursor of aerosol nucleation.
- Determined the sources of secondary organic aerosols (SOA) mass and their influence on the microphysical processes in the atmosphere of a subtropical forest through the identification of major organic markers in the particle phase using TD-PTR-TOF-MS.
- Characterized organonitrates as potential tracer of anthropogenic activities in a forest site through specific fingerprints in PTR-TOF-MS.

Institute of Chemistry, UP Diliman Quezon City, Philippines

Undergraduate Student under Dr. Lilibeth Coo 2009-2010

The Comparative Air Analysis of the Institute of Chemistry, UP Diliman using Passive Sampler with Activated Charcoal and Commercially Available Adsorbent

- Developed a passive air sampler using an activated charcoal for indoor air analysis of ambient VOCs
- Profiled the major VOCs of an indoor air of a chemistry department using gas chromatography coupled with flame ionization detector (GC-FID)

PUBLICATIONS

(1) **Salvador, C.M.**, Alindajao, A.D., Burdeos, K.B., Lavapiez, M.A., Yee, J.R., Vii, A.T.B., Pabroa, P.C.B., Capangpangan, R.Y. **2022**. Assessment of Impact of Meteorology and Precursor in Long-term Trends of PM and Ozone in a Tropical City. Aerosol and Air Quality Research 22, 210269. 10.4209/aaqr.210269

(2) **Salvador, C.M,** Yee, J.R.d., Coronel, I.C.V., Bautista Vii, A.T., Sugcang, R.J., Lavapie, M.A.M., Capangpangan, R.Y., Pabroa, P.C.B. 2022. Variability and Source Characterization of Regional PM of Two Urban Areas Dominated by Biomass Burning and Anthropogenic Emission. Aerosol and Air Quality Research 22, 220026. 10.4209/aaqr.220026

(3) Peng, X., Wang, T., Wang, W., Ravishankara, A.R., George, C., Xia, M., Cai, M., Li, Q., **Salvador, C.M**., Lau, C., Lyu, X., Poon, C.N., Mellouki, A., Mu, Y., Hallquist, M., Saiz-Lopez, A., Guo, H., Herrmann, H., Yu, C., Dai, J., Wang, Y., Wang, X., Yu, A., Leung, K., Lee, S., Chen, J. **2022**. Photodissociation of particulate nitrate as a source of daytime tropospheric Cl2. Nature Communications 13, 939. 10.1038/s41467-022-28383-9

(4) Pabroa, P.C.B., Racho, J.M.D., Jagonoy, A.M., Valdez, J.D.G., Bautista Vii, A.T., Yee, J.R., Pineda, R., Manlapaz, J., Atanacio, A.J., Coronel, I.C.V., **Salvador, C.M**., Cohen, D.D. **2022**. Characterization, source apportionment and associated health risk assessment of respirable air particulates in Metro Manila, Philippines. Atmospheric Pollution Research 13, 101379. https://doi.org/10.1016/j.apr.2022.101379

(5) Tsiligiannis, E., Wu, R., Lee, B.H., **Salvador, C.M**., Priestley, M., Carlsson, P.T.M., Kang, S., Novelli, A., Vereecken, L., Fuchs, H., Mayhew, A.W., Hamilton, J.F., Edwards, P.M., Fry, J.L., Brownwood, B., Brown, S.S., Wild, R.J., Bannan, T.J., Coe, H., Allan, J., Surratt, J.D., Bacak, A., Artaxo, P., Percival, C., Guo, S., Hu, M., Wang, T., Mentel, T.F., Thornton, J.A., Hallquist, M., 2022. A Four Carbon Organonitrate as a Significant Product of Secondary Isoprene Chemistry. Geophysical Research Letters 49, e2021GL097366.

(6) **Salvador, C.M.**., Tang, R., Priestley, M., Li, L., Tsiligiannis, E., Le Breton, M., Zhu, W., Zeng, L., Wang, H., Yu, Y., Hu, M., Guo, S., Hallquist, M., 2021. Ambient nitro-aromatic compounds – biomass burning versus secondary formation in rural China. Atmos. Chem. Phys. 21, 1389-1406.

(7) Zhou, L., **Salvador, C.M**., Priestley, M., Hallquist, M., Liu, Q., Chan, C.K., Hallquist, Å.M. 2021. Emissions and Secondary Formation of Air Pollutants from Modern Heavy-Duty Trucks in Real-World Traffic—Chemical Characteristics Using On-Line Mass Spectrometry. Environmental Science & Technology 55, 14515-14525. 10.1021/acs.est.1c00412

(8) **Salvador, C. M**., Chou, C. C. K., Ho, T. T., Tsai, C. Y., Tsao, T. M., Tsai, M. J., and Su, T. C.: Contribution of Terpenes to Ozone Formation and Secondary Organic Aerosols in a Subtropical Forest Impacted by Urban Pollution, Atmosphere, 11, 13, 10.3390/atmos11111232, 2020.

(9) Zhou, L., Salvador, C.M., Priestley, M., Hallquist, M., Liu, Q., Chan, C.K., Hallquist, Å.M. **2021**. Emissions and Secondary Formation of Air Pollutants from Modern Heavy-Duty Trucks in Real-World Traffic—Chemical Characteristics Using On-Line Mass Spectrometry. Environmental Science & Technology 55, 14515-14525. 10.1021/acs.est.1c00412

(10) **Salvador, C.M**.; Chou, C.C.K.; Cheung, H.C.; Ho, T.T.; Tsai, C.Y.; Tsao, T.M.; Tsai, M.J.; Su, T.C. Measurements of submicron organonitrate particles: Implications for the impacts of NOx pollution in a subtropical forest. *Atmospheric Research* **2020**, *245*, 105080, doi:https://doi.org/10.1016/j.atmosres.2020.105080.

(11) **Salvador, C.M**.; Bekö, G.; Weschler, C.J.; Morrison, G.; Le Breton, M.; Hallquist, M.; Ekberg, L.; Langer, S. Indoor ozone/human chemistry and ventilation strategies. *Indoor Air* **2019**, *0*, doi:10.1111/ina.12594.

(12) Kong, X.; **Salvador, C.M**.; Carlsson, S.; Pathak, R.; Davidsson, K.O.; Le Breton, M.; Gaita, S.M.; Mitra, K.; Hallquist, Å.M.; Hallquist, M., et al. Molecular characterization and optical properties of primary emissions from a residential wood burning boiler. *Science of The Total Environment* **2021**, *754*, 142143, doi:https://doi.org/10.1016/j.scitotenv.2020.142143

(13) Tsiligiannis, E.; Hammes, J.; **Salvador, C.M**.; Mentel, T.F.; Hallquist, M. Effect of NOx on 1,3,5-trimethylbenzene (TMB) oxidation product distribution and particle formation. *Atmos. Chem. Phys.* **2019**, *19*, 15073-15086, doi:10.5194/acp-19-15073-2019.

(14) Zhou, L.; Hallquist, Å.M.; Hallquist, M.; **Salvador, C.M**.; Gaita, S.M.; Sjödin, Å.; Jerksjö, M.; Salberg, H.; Wängberg, I.; Mellqvist, J., et al. A transition of atmospheric emissions of particles and gases from on-road heavy-duty trucks. *Atmos. Chem. Phys.* **2020**, *20*, 1701-1722, doi:10.5194/acp-20-1701-2020.

(15) **Salvador, C.M**.; Ho, T.T.; Chou, C.C.K.; Chen, M.J.; Huang, W.R.; Huang, S.H. Characterization of the organic matter in submicron urban aerosols using a Thermo-Desorption Proton-Transfer-Reaction Time-of-Flight Mass Spectrometer (TD-PTR-TOF-MS). *Atmospheric Environment* **2016**, *140*, 565-575, doi:http://dx.doi.org/10.1016/j.atmosenv.2016.06.029.

(16) **Salvador, C.M**.; Chou, C.C.K. Analysis of semi-volatile materials (SVM) in fine particulate matter. *Atmospheric Environment* **2014**, *95*, 288-295, doi:http://dx.doi.org/10.1016/j.atmosenv.2014.06.046.

(17) **Salvador C.M.**, C. Faxon, M. Psichoudaki, Å. M. Hallquist, M. Hallquist. Effect of Sulfur Emission Control on Gas-Phase Ship Plume Emissions in Northern Europe. *In preparation.*

(18) **Salvador, C.M.,** Rasco, A.Z., Coo, L dlC. (2011) The Comparative Air Analysis of the Institute of Chemistry, UP Diliman using Passive Sampler with Activated Charcoal and Commercially Available Adsorbent. Proceedings of the International Conference on Basic Sciences, Indonesia ISBN: 978-602-97628-5-3

MENTORING AND CO-SUPERVISION

(1) Epameinondas Tsiligianis (2022)
Ph.D. Candidate – University of Gothenburg (Sweden)
(2) Linjie Li (2019-Present)
Ph.D. Student – University of Gothenburg (Sweden)
(3) Liyuan Zhou (2021
Ph.D. Student – City University of Hong Kong (China)
(4) Pierre Lespes (2020)
Master's Thesis in Atmospheric Sciences - Université Claude Bernard Lyon 1 (France)
(5) Veronica Geretti (2019 - Present)
Master's Thesis in Atmospheric Sciences - University of Gothenburg (Sweden)
(6) Jonalyn Madriaga (2015)
TIGP International Internship (Taiwan)

TEACHING EXPERIENCE

University of the Philippines (UP) Diliman, Institute of Chemistry
Quezon City, Philippines Laboratory Instructor III 2010-2012

- Taught a wide variety of undergraduate laboratory classes which include general chemistry, analytical chemistry, organic chemistry, integrated analytical and organic chemistry, advanced analytical instrumentation and electronics for chemistry.

CONFERENCE PRESENTATIONS/ INVITED TALKS (1/2)

Salvador, C.M. et al., A Closer look at Air-Sea interactions: Comparison of Organic and Inorganic Chlorinated Compounds from Coastal Urban Environments. ***Invited talk*** at College of Science, De La Salle University, Manila, Philippines, November 2020

Salvador, C.M. et al., Effect of Sulfur Emission Control on Gas-Phase Ship Plume Emissions in Northern Europe. Poster Presentation at Act Sustainable Research Conference, Gothenburg, Sweden, November 2020

Salvador, C.M. et al., Nitro-Aromatic Compounds (NACs) in a Rural City in China. Oral presentation delivered at European Aerosol Conference, Gothenburg, Sweden, August 2019

Salvador. C. M. et al Roadside measurement of isocyanic acid in Northern Europe: Influence of exhaust after treatment technologies and secondary formation. ***Invited talk*** at Research Center for Environmental Changes, Academia Sinica, Taiwan, November 2018

Salvador. C. M. et al., Real-time assessment of Human-Related Volatile Organic Compounds in a controlled chamber using Chemical Ionization Mass Spectrometer. Oral presentation delivered at TOF-CIMS User Meeting 2018, Seattle, USA, June 2018

Salvador. C. M. et al., Profiling of Submicron Organic Aerosols using Thermal Carbon Analyzer and Proton-Transfer-Reaction Mass Spectrometer. Poster delivered at the European Aerosol Conference 2016, Tours France, September 2016

Salvador. C. M. et al., Source and Profile Analysis of Volatile Organic Compounds using Proton-Transfer-Reaction Mass Spectrometer in an Experimental Forest. Poster delivered at Taiwan Geosciences Assembly, Taipei Taiwan, May 2016

Salvador C.M et al., Inhibition of New Particle Formation (NPF) in an Experimental Forest: Effect of NOx in a Biogenic Environment. Oral presentation delivered at American Geosciences Union Fall Meeting, San Francisco, USA December 2015

Salvador C.M et al., Analysis of Semi-Volatile Materials (SVM) in Fine Particulate Matter. Oral presentation delivered at International Aerosol Conference 2014, Busan, Korea August 2014

Salvador, C. M et al., Cadmium Sulfide as Potential Hemoglobin Labeler: The Kinetic and Conformational Analysis of Interaction of Hemoglobin and CdS Quantum Dots using Spectroscopic Methods. Poster delivered at Philippine Chemistry Congress 2011, Cebu, Philippines, April 2011

Salvador, C. M et al. The Comparative Air Analysis of the Institute of Chemistry, UP Diliman using Passive Sampler with Activated Charcoal and Commercially Available Adsorbent. Poster delivered at Philippine Chemistry Congress 2010, Subic, Philippines, April 2010

REFERENCES

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Atmospheric Science, Department of Chemistry and Molecular Biology
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