CARE-C
CLIMATE AND ATMOSPHERE RESEARCH CENTER

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Research Highlight

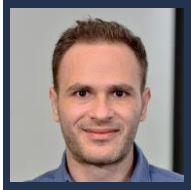
'Attribution of Excess Methane Emissions Over Marine Environments of the Mediterranean and Arabian Peninsula'

Summary

To accurately assess the current atmospheric methane budget and its future trends, it is essential to apportion and quantify the anthropogenic methane emissions to specific sources. This poses a significant challenge in the under-sampled Middle East, where estimates predominantly depend on remote sensing observations and bottom-up reporting of national emissions. Here, we present in situ shipborne observations of greenhouse gases (GHGs) and non-methane hydrocarbons (NMHCs) collected along a >10,000-km route from Vigo, Spain, to Abu Dhabi, UAE. By comparing our observations with Lagrangian dispersion model simulations, coupled with two methane emission inventories, we identify periods of considerable mismatch and apportion the responsible sources. Employing interspecies relationships with NMHCs has enabled the characterization of methane emissions from oil and gas (O&G) operations, urban centers, Red Sea deep water, enteric fermentation, and agriculture across diverse atmospheric environments.

Our analysis reveals that the Suez area is a regional emission hotspot, where simulations consistently underestimate the methane emission sources. Importantly, the Middle Eastern O&G sector has been identified as an additional source of considerable uncertainty. Here, methane emissions were alternately underestimated and overestimated by the two inventories, exposing significant gaps in our understanding of fuel exploitation-related emissions in the Middle East. This underscores the need for further targeted field campaigns and long-term observations to improve the accuracy of emission data in the inventories.

Authors' bios



Dr. Efstratios Bourtsoukidis is a tenure-track Assistant Professor in Atmospheric Sciences at the Cyprus Institute, where he leads the Reactive Trace Gases research group within CARE-C. He earned his PhD in Natural Sciences from the University of Frankfurt in 2014 and subsequently worked as a postdoctoral fellow and research associate at the Max Planck Institute for Chemistry in Mainz, Germany. He has participated in numerous ground-based, ship, and aircraft field campaigns and has authored over 40 publications. His research explores how emitted reactive trace gases affect the Earth's atmosphere, focusing on the atmospheric chemistry that governs the land-atmosphere interactions.

Impact

The study results show that, while emission inventories used in climate studies are generally reliable and explain high methane concentrations in most regions, they are deficient in the Suez and Middle East areas due to

inadequate characterization of emissions from Oil and Gas operations. The research outcomes of this study underscore the crucial role of ground-based observations in improving the accuracy of methane emission inventories and their reporting, and in supporting evidence-based policies to mitigate climate change and improve air quality.

Reference

Bourtsoukidis, E., Germain-Piaulenne, E., Gros, V., Quéhé, P.-Y., Pikridas, M., Byron, J., Williams J., Gliddo, D., Mohamed, R., Ekaabi, J., Lelieveld, J., Sciare, J., Teixidó, O. & Paris, J.D. (2024). Attribution of excess methane emissions over marine environments of the Mediterranean and Arabian Peninsula. Journal of Geophysical Research: Atmospheres, 129, e2024JD041621. https://doi.org/10.1029/2024JD041621

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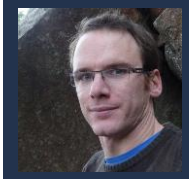

Dr. Jean-Daniel Paris is a Senior research affiliate at CYI working on greenhouse gases. He is also with the Climate and environmental sciences laboratory (LSCE) in France, a joint laboratory of the French Atomic Energy Commission, CNRS and Université de Versailles Saint Quentin. He received his PhD from UVSQ in 2008 on greenhouse gases measurements from aircraft.

His research interests are related to sources and sinks of greenhouse gases, especially methane, and atmospheric composition measurements from ship, car or aircraft. He authored more than 50 scientific publications in peer-reviewed journals (h=29).