Plinius Conference Abstracts
Vol. 18, Plinius18-5, 2024, updated on 13 Dec 2024
https://doi.org/10.5194/egusphere-plinius18-5
18th Plinius Conference on Mediterranean Risks

Lightning superbolts follow ship-tracks in Eastern Mediterranean winter thunderstorms

Yoav Yair[1], Menahem Korzets[1], Yanai Namia-Cohen[2], Colin Price[2], and Niv Surian[3]
[1]School of Sustainability, Reichman University, Herzliya, Israel (yoav.yair@idc.ac.il)
[2]Porter School of the Environment and Earth Sciences, Tel Aviv University, Israel
[3]Department of Life and Natural Sciences, The Open University of Israel, Ra'anana, Israel

The interaction between aerosol particles and thunderstorm evolution and properties is complex and was studied by direct observational campaigns, remote sensing from space and through numerical simulations. Aerosols invigorate convection and can lead to enhanced charging manifested in more lightning, but they can also lead to a "Boomerang Effect" where too large concentrations of particles lead to diminished vertical development and weaker electrical activity (Altaratz et al., 2010). The effects of ship exhaust on ocean cloudiness have been studied intensively in recent years, following the discovery of prolonged ship tracks in oceanic regions where maritime transportation is most heavy, leading to large-scale changes in albedo and reduced precipitation. Recently it was shown that aerosols emitted by ships also tend to increase lightning activity, by modifying the dynamics and microphysics of clouds formed close to the busiest shipping lanes (Thornton et al., 2017) and enhancing the strike probability due to the tall metal ship structure (Peterson, 2023).

We study the effects of ship-emitted aerosols on thunderstorms in one of the busiest shipping routes in the world: the Mediterranean Sea between the Suez Canal and the Gibraltar Straights (see: https://www.marinetraffic.com/). This region hosts hundreds of ships daily, and space observations show considerable enhancement of the Aerosol Optical Depth (AOD), Sox and NOx concentrations there, some from land sources and others directly related to ship emissions. The present study utilized lightning detection networks' data (ENTLN) and researched the properties of lightning (peak current, multiplicity, polarity) with respect to aerosol concentrations and meteorological conditions. The shipping exhaust data was derived from the CAMS global emission inventories.

Initial results from the Eastern Mediterranean shows a marked increase in winter (DJF) lightning activity over the main east-west shipping lanes from Suez towards Crete, where a conspicuously larger amount of cloud-to-ground lightning is observed, with a higher fraction of superbolts ($I > 200$ kA). We suggest that the synergistic action of desert dust and air-pollution aerosols acts to invigorate or diminish convection, depending on their relative concentrations and the ambient meteorological conditions. This changes the effectiveness of charge separation processes and affects the electrical activity of winter thunderstorms in these specific areas of the Mediterranean Sea.

Altaratz, O., I. Koren, Y. Yair, and C. Price (2010), Lightning response to smoke from Amazonian fires, *Geophys. Res. Lett.*, 37, L07801, doi:10.1029/2010GL042679

Peterson, M. (2023). Interactions between lightning and ship traffic. *Earth and Space Science*, 10(11). https://doi.org/10.1029/2023EA002926

Thornton, J. A., Virts, K. S., Holzworth, R. H., & Mitchell, T. P. (2017). Lightning enhancement over major oceanic shipping lanes. Geophysical Research Letters, 44(17), 9102–9111. https://doi.org/10.1002/2017GL074982