

Ultrafine particles from ships in ports

Poster P-01: Kåre Press-Kristensen, Senior advisor: Air Quality & Climate, Green Transition Denmark

Background

Large ships in European ports use fuel with a high sulphur content (100 times more sulphur than road diesel). Ships have no catalytic converters or particulate filters. Hence, ships emit high amounts of air pollution in port cities, which are often densely populated. Cruise ships are large floating hotels with high energy demands spending a full day at berth. Ferries have frequent arrivals/departures and stay overnight at berth idling.

Cruise ships and Ferries thereby contribute significantly to local air pollution in the heart of many port cities where still more port areas transform into modern residential areas.

Shore power (and electric ferries) eliminates air pollution from ships at berth but only few ports offer shore power.

Usually, there are no air quality monitoring stations in or close to ports. Hence, it is important to start monitoring air pollution from ships in ports and effects on air quality in port cities.

Purpose

Perform systematic screenings of air pollution with ultrafine exhaust particles from cruise ships and ferries in 10 larger Mediterranean ports in Malta, Italy, Spain, France and Greece to assess the effect on air quality in the surrounding cities.

Methods

Newly calibrated P-Traks were used to measure ultrafine exhaust particles in Mediterranean port cities. Wind speed and direction, temperature and humidity were taken from local weather forecasts and controlled locally (when possible) by a WindMate350.

In each port, carefully planned systematic screenings of air pollution from cruise ships and/or ferries were made: Upwind and downwind, before/during/after ship passings, different wind conditions and in different distances from ships, etc.

Successful air pollution screenings were achieved in 8 port cities: Valletta, Piraeus, Barcelona, Marseilles, Piombino, Livorno, Civitavecchia and Genoa.

Results

Cruise ships and ferries cause significant air pollution in port cities thereby exposing the local population to high levels of toxic air pollution.

Port air (without local ship exhaust) typically contains 1,000-3,000 particles per cm^3 whereas air polluted by local ship exhaust can peak at hundreds of times higher pollution levels several hundred meters downwind ships - even during rather strong winds ($> 7 \text{ m/s}$) where the pollution plume from the ships is significantly diluted. Air pollution hundreds of meters downwind ships thereby reaches much higher pollution levels than measured along streets in the cities.

This clearly illustrates the intense air pollution from ships that pollute large city areas downwind the ports.



Discussion

The World Health Organization (WHO) has discussed an ultrafine particle quality criteria of maximum 20,000 particles per cm^3 (hourly average), 10,000 particles per cm^3 (daily average), and considers 1,000 particles per cm^3 as a low level.

The low level of 1,000 particles per cm^3 was almost met in all 10 Mediterranean ports at locations or times when no pollution was emitted from ships in the ports.

However, average pollution levels were typically 50,000-150,000 particles per cm^3 in residential areas several hundred meters downwind ferries and cruise ships at berth. The pollution plume can thereby pollute whole city areas downwind ships to much higher levels than the air quality criteria discussed by the WHO. This is a serious challenge as many cruise ships are idling all day and ferries idle over night at berth. The pollution enters apartments through open windows and balcony doors and becomes indoor pollution thereby jeopardising public health in port cities.

Many Mediterranean port cities almost complete a circle around the port and are built uphill. Hence, the main pollution plume from ship chimneys are in window height of apartments and will reach residential areas regardless of wind direction. Windows and balcony doors are open most of the year due to the warm climate.

In comparison, rush hour pollution levels alongside the large streets in the Mediterranean port cities were measured to be 15,000-20,000 particles per cm^3 . This level will continue to progressively drop as a still higher share of vehicles become electric or are equipped with particulate filters. However, shipping will remain a key pollution source as no ferries or cruise ships have filters installed (or plans to do so) and since there is no shore power in most ports.

More detailed investigations focusing on air pollution in ports and residential areas around ports should be carried out to identify pollution levels and raise awareness on the poor air quality and the connected risks of morbidity and mortality.

Recommendations

- Build shore power systems for ferries and cruise/cargo ships.
- Start investing in fully electric ferries and tour boats.
- Establish a full Mediterranean Sea Emission Control Area.
- Ban use of heavy fuel oil and scrubber systems in ports.
- Establish air monitoring stations to monitor port pollution.

Further info

Green Transition Denmark: www.rgo.dk/frontpage-english/
Life4MedECA Knowledge Center: www.life4medeca.com/
LIFE program of the EU: www.ec.europa.eu/environment/life/



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Acknowledgement

These air quality screenings were made possible by the financial support of the EU Commission – project Life4MedECA – with the purpose to designate a Mediterranean Sea Emission Control Area to reduce health and climate damages.

