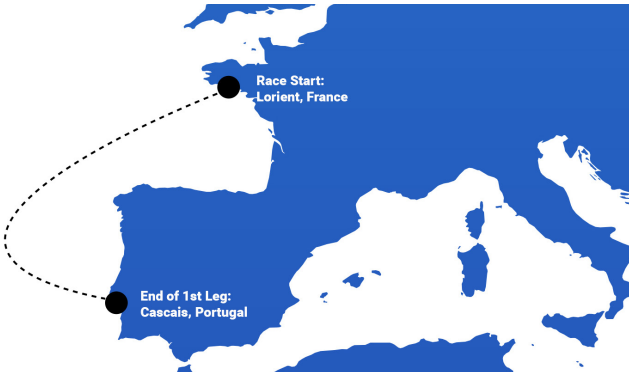
EARTHSENSE

The Ocean Race Europe

Leg 1 | Air Quality Report

Mirpuri Foundation Racing Team



About Air Pollution

Air pollution is a leading health emergency, with a global economic cost of $5 trillion (World Bank), cutting lives short. Poor air quality is an unfortunate truth of towns and cities around the world.

Road transport contributes the greatest fraction of emissions of nitrogen dioxide (NO_2) in urban areas, and an inadequate road network that cannot allow easy flow of vehicles may amplify emissions, further diminishing local air quality.

Such hotspots may breach legal limits for NO_2, meaning the air is unhealthy for those living, working and passing through such areas. These challenges extend beyond road networks as the world's oceans produces oxygen we breathe and absorbs a third of greenhouse gases and air pollution, regulating CO_2 and other man made pollutants. Due to a recent increase in emissions, these natural sinks have become insufficient in maintaining an equilibrium and the ocean's acidity has risen, harming underwater species, waterways and economies.

Zephyr® Air Quality Monitor

The Zephyr® measures several harmful pollutants that are of interest at outdoor environments. Its small form-factor makes the monitor easy to deploy on street furniture and can be powered from an internal battery, mains power or a solar panel.

The capacity to deploy a high-density Zephyr® network whilst recording on up to 10 second intervals with 15-minute latency gives the opportunity for near-real time (NRT) air pollution data to be used for decision making to better manage health effects in towns, cities.

The Zephyr® monitor measures a variety of harmful gases including nitrogen dioxide (NO_2), ozone (O_3), nitric oxide (NO), Carbon Diozide (CO_2) and fine particle matter, PM_1, $PM_{2.5}$ and PM_{10} as standard, with the option of including hardware capacity to also measure carbon monoxide (CO) and sulphur dioxide (SO_2).

How are Gas & Particle Concentrations Measured?

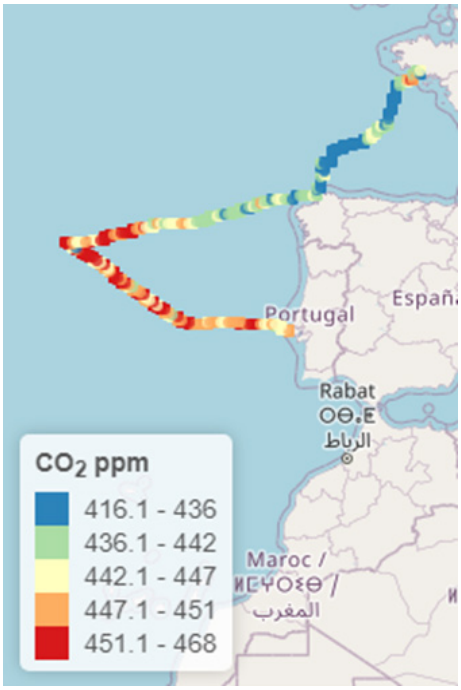
Electrochemical sensors (EC) are used in the Zephyr® monitor for the measurement of trace gas pollutants. An optical particle counter (OPC) is used in the Zephyr® to categorise and measure particule of sizes between 0.3 – 10 µm in diameter.

From this, mass concentrations are estimated to PM_1, $PM_{2.5}$ and PM_{10}.

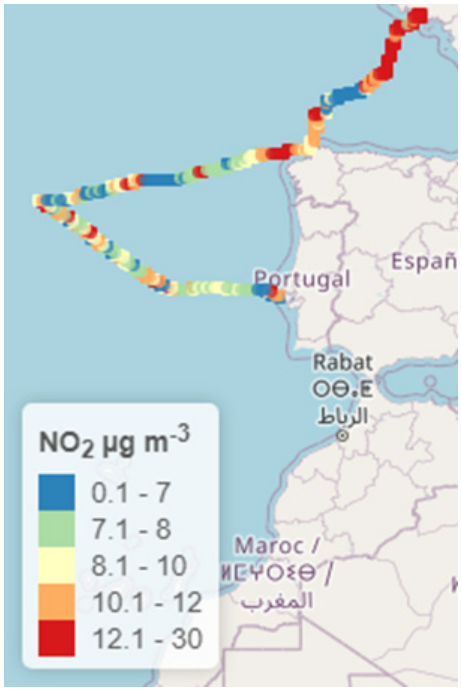
Leg 1 Pollution Overview

From: Lorient, France - 28/05/2021
To: Cascais, Portugal - 02/06/2021

Measured CO_2 Concentrations



Measured NO_2 Concentrations



Measured O_3 Concentrations

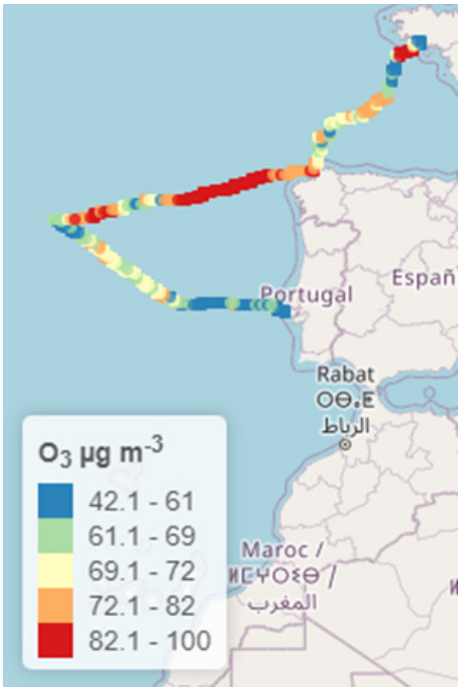


Figure 1: Real-time concentrations of CO_2, NO2 and O_3 measured during the Ocean Race Europe by the Zephyr® Air Quality Monitor on the Mirpuri Foundation Racing Team VO65 boat from 28/05/2021 - 02/06/2021.

Comparison of Measured NO_2, CO_2 & O_3 Concentrations during Leg 1 - Lorient to Cascais

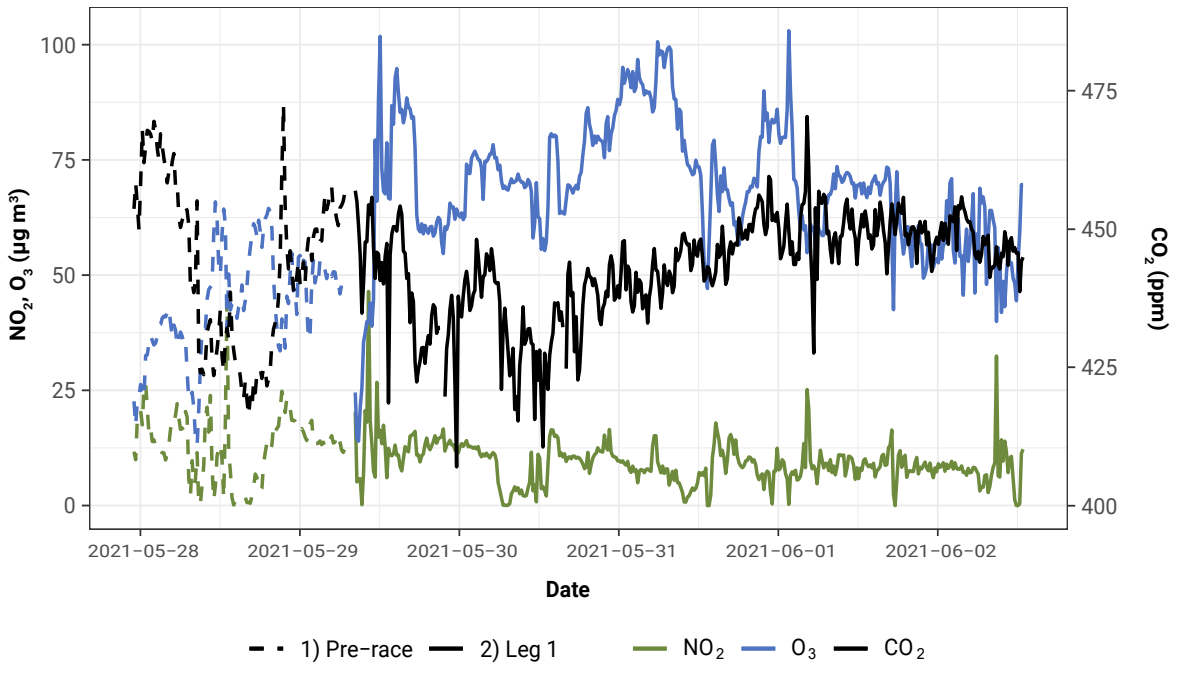


Figure 2: Real-time concentrations comparison of CO_2, NO_2 and O_3 measured during the Ocean Race Europe by the Zephyr® Air Quality Monitor on the Mirpuri Foundation Racing Team VO65 boat from 28/05/2021 - 02/06/2021.

What Does This Mean?

Concentrations of NO_2 reduced rapidly as the VO65 began the first leg of the Ocean Race Europe. Concentrations at sea were on average 10% lower than the marina. The clean ocean air is free of combustion sources, but due to the dominating easterly wind, elevated NO_2 was identified in the Bay of Biscay.

During summer months, NO_2 has a lifetime of up to 12 hours, meaning air may be polluted several kilometres from any sources.

O_3 forms from a chemical reaction with NO_2 and volatile organic compounds (VOCs) under sunlight. O_3 forms downwind from sources of NO_2 and VOCs and may last in the atmosphere for weeks.

Seawater is an important global player in removing O_3 from the air, but it is much less effective than removal processes in terrestrial environments . Because of this, ozone concentrations are often found to be higher at sea.

Taking the whole dataset, CO_2 levels in the Bay of Biscay was much lower than in the Atlantic Ocean, which suggests meteorology is playing a greater role than the route of the race.

Freight and cargo ships are big emitters of harmful pollutants and greenhouse gases, producing trails along global shipping routes that are transported by regional winds, making clean air difficult to find even at sea.

The open water may appear to be a pristine canvas of clean air, but around the waters of Europe, including the Bay of Biscay, periods of hotspot activity can be readily identified from EarthSense Zephyr® mobile air pollution monitoring on board the Mirpuri Foundation's VO65.

> **NO_2 concentrations at sea were on average 10% lower compared to the marina at Lorient.**