

Volvo Ocean Race

Science programme

Preliminary results Legs 10 and 11
Cardiff - Gothenburg - The Hague

Preliminary results Legs 10 and 11

Compiled using data provided by Dr Toste Tanhua and Dr-Ing. Sören Gutekunst, GEOMAR Helmholtz Centre for Ocean Research with the support of Cluster of Excellence - Future Ocean.

This is not a scientific report but rather a summary of the data collected. Detailed scientific analysis is ongoing for peer-reviewed scientific publications.

Particular thanks to the Turn the Tide on Plastic and Team AkzoNobel race teams, and notably Liz Wardley and Nicolai Sehested of those teams respectively, for facilitating and conducting the data collection.

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Executive Summary

Legs 10 and 11

The Volvo Ocean Race Science Programme continued during the final legs of the race to contribute data to extend scientific knowledge of microplastics distribution and other parameters that indicate overall ocean health.

The final stages of the race were from Cardiff to Gothenburg (Leg 10) and then the ultimate leg from Gothenburg to The Hague. These legs allowed for further sampling, by Turn the Tide on Plastic and Team AkzoNobel, of the North Atlantic and into the North Sea. There were no scientific drifter buoys deployed during either of these legs.

Based on the preliminary results of analysis the most notable finding was a relatively high level of microplastic pollution in the Skagerrak area where the North and Baltic Seas mix. The sampling done close to a busy shipping route may have showed a relatively high concentration of microplastic particles due to input from surrounding countries, rivers and shipping areas being concentrated in the zone where the Baltic equilibrates with the more open ocean.

Oceanographic measurements were within expected ranges for the time of year apart from relatively high carbon dioxide levels in the samples closest to The Hague. These resulted in low (more acidic) pH in that area. This may be due to the proximity to a highly industrialised coastline.

Collaboration, Funding & Support

The **onboard sampling** component of the science programme was a collaboration between Volvo Cars, Cluster of Excellence *Future Ocean* Kiel, GEOMAR, SubCtech GmbH, bbe Moldaenke, Turn the Tide on Plastic and Team AkzoNobel crews. Volvo Cars funded the onboard equipment through profits from the sale of their Cross Country Volvo V90 Ocean Race edition cars.

The **scientific drifter buoys** are part of the National Oceanic and Atmospheric Administration's (NOAA) drifter programme and their deployment was in collaboration with race teams and the Volvo Ocean Race Boatyard team

The sharing of **meteorological data** by Volvo Ocean Race meteorologists was part of a pilot project developed by JCOMM (Joint technical Commission for Oceanography and Marine Meteorology, WMO – IOC1) partners using a programme developed by NOAA.

These organisations were brought together by the **Volvo Ocean Race sustainability programme**, in order to increase ocean knowledge, pioneer a new area of data collection and advance the technology of instrumentation in order to contribute to create a global map of standardised data, specifically in the area of microplastic concentration.

Onboard sampling



Microplastics Preliminary Data

The preliminary data summarised here were provided by Dr Toste Tanhua and Dr-Ing. Sören Gutekunst, GEOMAR Helmholtz Centre for Ocean Research Kiel.

Leg 10: Cardiff to Gothenburg | Leg 11: Gothenburg to The Hague

Atlantic and North Sea

During Leg 10 the boats passed west of Ireland and north of the UK in the race from Cardiff to Gothenburg. This provided more sampling opportunities in the Atlantic and into the North Sea on the approach to Gothenburg. From Gothenburg the race entered the Skagerrak – a busy shipping area where the North and Baltic Seas mix, before aiming south to the finish line in The Hague.

To maintain continuity the preliminary results presented here for microplastics are those from Turn the Tide on Plastic sampling effort only. Analysis and verification of Team AkzoNobel sample results are ongoing. As for Leg 9, Turn the Tide on Plastic maintained filter changes on a daily basis. Earlier in the race the filter change frequency was every two days. The additional sampling effort provided a higher resolution picture of microplastic distribution.

It is important as always to remember the preliminary nature of these results and also to view them with consideration of ocean currents and the ‘averages’ that the numbers represent due to the potential geographical range of a single sample.

Microplastics were present in all but one sample taken along these two race legs. A notably high level was present in a sample from the Skagerrak area – the fifth highest concentration recorded during the race. The sample off the west of Ireland containing zero microplastics particles was the third such sample out of 75 collected by Turn the Tide on Plastic crew.

Microplastics Preliminary Data

High level in the Skagerrak

The microplastic level recorded on the passage out of Cardiff - 75 particles/m³, at an average distance 108 km from Cardiff, was comparable to that recorded on the approach to that stopover – 69 particles/m³ at an average distance 413 km from the Welsh capital. The more recent level in particular may seem relatively low considering the proximity to a populated coastline.

Aside from the zero measurement west of Ireland the recorded levels in this area of the north Atlantic appeared relatively consistent – 39 particles/m³ northwest of the Ireland and 61 particles/m³ off the coast of Norway. These levels seem comparable to those recorded in the north Atlantic during Leg 9's transatlantic transect – between 25 and 76 particles/m³.

Relatively higher concentrations were recorded in the Skagerrak area. 125 particles/m³ (at an average 67 km from Gothenburg) and 224 particles/m³ further north. The level of 224 was the fifth highest level recorded during the race overall. Higher levels were recorded in the South China Sea, in the inshore North Atlantic off Spain and Portugal, in the Mediterranean and in the Philippine Sea.

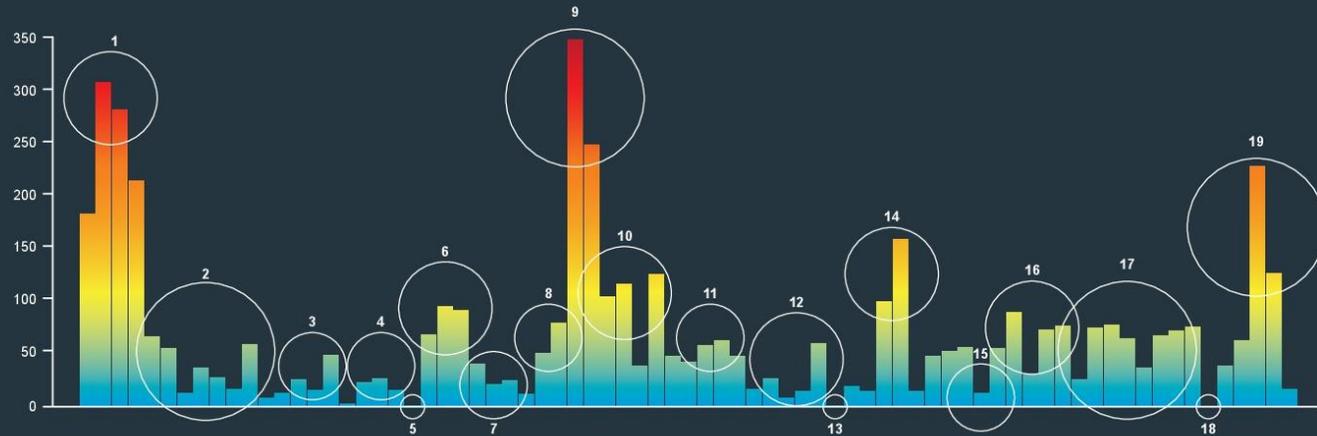
Microplastics Preliminary Data

High level in the Skagerrak

The Skagerrak is the area where the Baltic Sea mixes with the North Sea and is a very busy shipping route. The high concentration of microplastic particles may have been due to input from various countries and the many tributary rivers of the Baltic Sea being concentrated in this mixing area where Baltic water flows to equilibrate with the more open water of the Atlantic. It is also established that high concentrations of microplastics can be associated with proximity to shipping routes (GESAMP, 2015).

The last sample on the approach to The Hague showed a relatively low concentration of 16 particles/m³. The sample was taken on average in a relatively open stretch of the North Sea. The low concentration, close to busy shipping areas and densely populated European mainland may be due to patchiness of microplastic particles as pollution disperses from source (as hypothesised for previous sampling results from the Pacific).

Microplastics Data



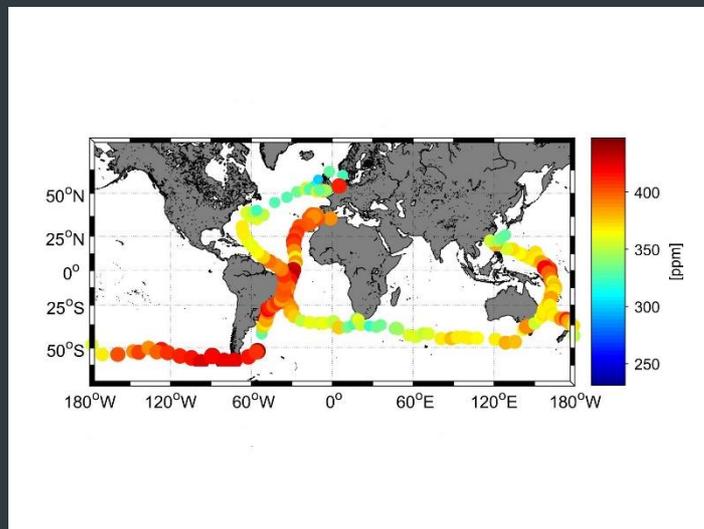
Microplastics
particles/m³

1. **North Atlantic Ocean and Mediterranean Sea:**
High microplastics levels may be attributed to the proximity to the coast, strong ocean currents and busy shipping routes.
2. **Atlantic Ocean:**
Progressing south, levels decreased with distance from land, with a relative increase closer to South America, an area with strong surface currents.
3. **South African coast:**
Microplastic pollution near Cape Town may partly originate further north due to the strong Agulhas current, which flows from the northern Indian Ocean.
4. **Indian Ocean:**
Relatively high microplastic content in these remote areas are likely due to currents originating further north.
5. **South of Great Australian Bight:**
One of only 3 sample areas where no microplastics were found.
6. **Australian coast:**
Microplastic concentrations will be affected by currents coming from the northern Indian Ocean & Indonesian archipelago.
7. **From Melbourne to Hong Kong:**
Recorded levels were lower in the open water of the Equatorial Pacific.
8. **Philippine Sea:**
The measurement of 75 particles/m³ may be due in part to patchiness of particle distribution as higher levels were recorded in a more inshore sample from this area.
9. **South China and North Philippine Sea:**
High levels were measured in an area coinciding with the Kuroshio current which feeds into the North Pacific Subtropical Gyre.
10. **Equatorial Pacific:**
Average levels in this region were higher than recorded on the previous leg. Prevailing currents have a significant impact on microplastic distribution in this area.
11. **Approach to New Zealand:**
Progressing south through the Coral Sea the concentration increased steadily to a level of 60 particles/m³ in the sample closest to Auckland.
12. **Remote Pacific near Point Nemo:**
Microplastic levels of 9-26 particles/m³ in an area further from land than anywhere else on Earth, & a level of 57 particles/m³ off Cape Horn.
13. **South America east coast:**
One of only 3 samples along the race route with 0 microplastic particles recorded.
14. **Brazilian coast:**
Levels were highest in the samples closest to mainland.
15. **Caribbean Sea:**
A low measurement in this area may have been due partly to filter blockages by sargassum seaweed.
16. **East of the USA:**
Measurements were between 30 and 89 particles/m³.
17. **North Mid-Atlantic Ocean:**
The relatively consistent levels in the open Atlantic may correspond to the North Atlantic Gyre.
18. **West of Ireland:**
One of the 3 samples containing no microplastics, out of a total of 75 samples.
19. **Skagerrak area:**
High levels in the busy shipping area where the Baltic & North Seas mix.

Oceanography

Measurements of dissolved CO_2 reflected the time of year when sampling took place. Levels were below 350 ppm in most of the Atlantic and North Sea samples. This was similar to results of sampling in the North Atlantic during the earlier transatlantic transect of Leg 9. These values show the effect of summer-time primary productivity when photosynthesizing phytoplankton sequester carbon dioxide from seawater and increase the ocean's capacity to absorb excess atmospheric CO_2 .

Relatively high carbon dioxide levels were recorded in the samples closest to The Hague – close to the atmospheric average of 400 ppm. This may be due to the proximity to a highly industrialised coastline and, in consequence, a flux from the atmosphere into the seawater.

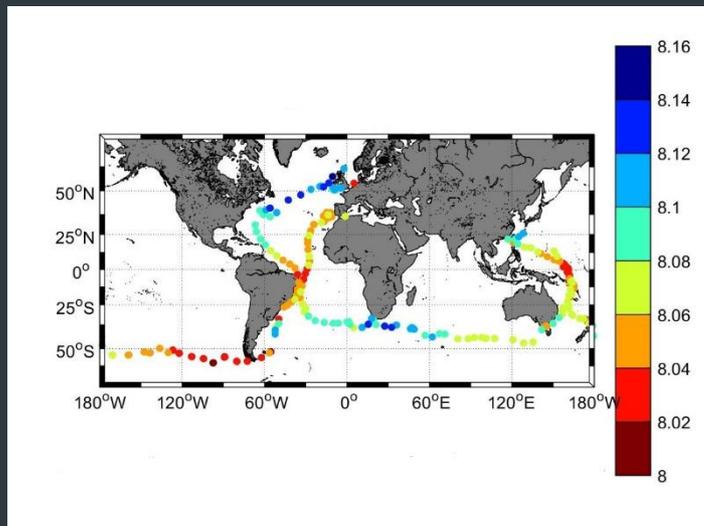


pCO₂ - parts per million

Map © Sören Gutekunst, GEOMAR Helmholtz Centre for Ocean Research Kiel

Oceanography

pH values were derived based on known relationships between other oceanographic variables. The association between dissolved carbon dioxide levels and pH was illustrated by the low pH value calculated in coincidence with a high carbon dioxide level during sampling close to The Hague. The overall drop in ocean pH below the previous assumed average of 8.2 has potential implications for marine organisms and marine ecosystem functions.

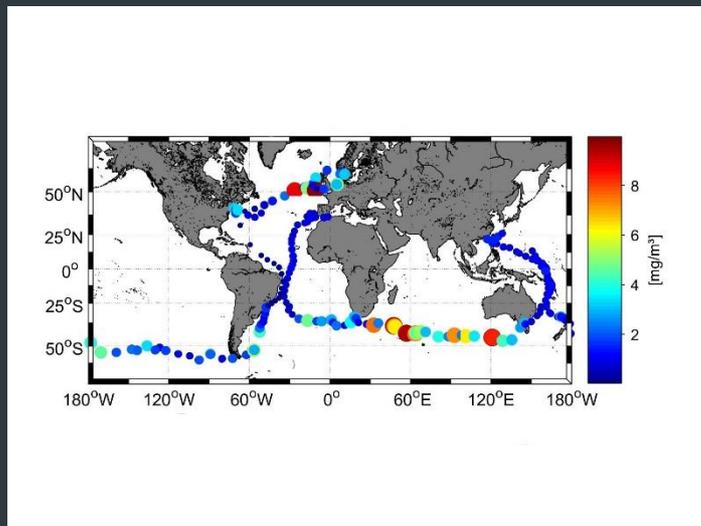


pH

Map © Sören Gutekunst, GEOMAR Helmholtz Centre for Ocean Research Kiel

Oceanography

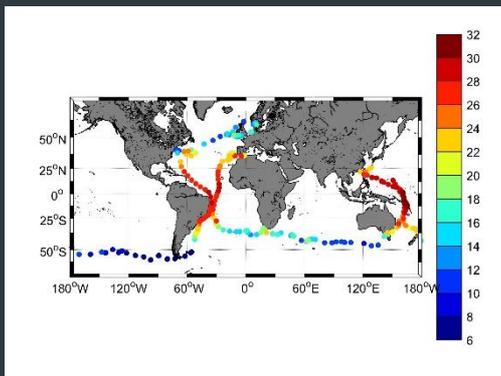
Chlorophyll a levels are a proxy measurement of primary productivity. Increased phytoplankton activity during summer-time will sequester carbon dioxide and increase the ocean's capacity to absorb excess atmospheric carbon dioxide. However, chlorophyll a measurements weren't consistently high, given the time of year, during Legs 10 and 11 - this was likely due to sampling during darkness or during low sunlight conditions.



Chlorophyll a mg/m³

Map © Sören Gutekunst, GEOMAR Helmholtz Centre for Ocean Research Kiel

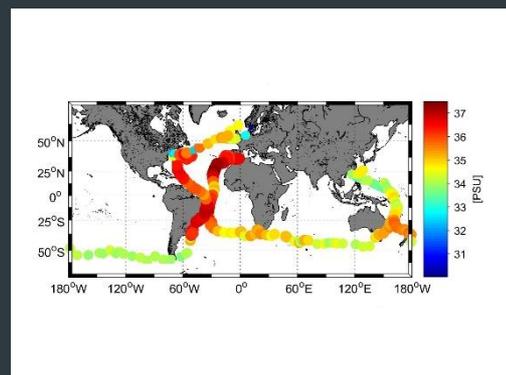
Oceanography



Temperature - °Celsius

Temperatures were within an expected range for the time of year.

Sea Surface Salinity was notably low in the Skagerrak area where the North and Baltic Seas mix. This is a feature of the area as the Baltic Sea is effectively a large estuary, common to the some 250 freshwater tributaries that flow into it. In the area where mixing occurs there is vertical stratification of the water column – a 'halocline' – as more dense saline water sinks to form a deeper layer, with less saline water at the surface.



Salinity - Practical Salinity Unit

Learn more

References

GESAMP (2015). "Sources, fate and effects of microplastics in the marine environment: a global assessment" (Kershaw, P. J., ed.). (IMO/FAO/UNESCO-IOC/UNIDO/WMO/IAEA/UN/UNEP/UNDP Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection). Rep. Stud. GESAMP No. 90, 96 p.

Previous reports

This report forms part of a suite of reports summarising the progress of data collection and preliminary analysis. Download at <https://www.volvooceanrace.com/en/sustainability/legacy.html>

Interesting links

<https://www.nasa.gov/topics/earth/features/perpetual-ocean.html>

View the Volvo Ocean Race Drifter buoys

- Search for the Volvo Ocean Race drifter buoys in the list at <http://www.aoml.noaa.gov/phod/dac/deployed.html>
- Insert the WMO# of one of the buoys at <http://osmc.noaa.gov/Monitor/OSMC/OSMC.html>, change the time range, display 'All Positions' and refresh the map to see the track line from where each buoy has been transmitting.
- Alternatively, access the 'Platform Info' to view the raw near real-time data.

Volvo Ocean Race Scientific consortium

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