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Volvo Ocean Race

Science programme

Preliminary results Leg 6 – Hong Kong to Auckland

Preliminary results Leg 6

Compiled using data provided by Dr Toste Tanhua & Dr-Ing. Sören Gutekunst, GEOMAR Helmholtz Centre for Ocean Research Kiel funded by Cluster of Excellence Future Ocean.

With thanks to the Turn the Tide on Plastic team, in particular Liz Wardley, for facilitating and conducting the data collection.

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All contacts page 12

Refer to the report: **Volvo Ocean Race Science Programme - Legs 1 to 4 - Final edition** for a more detailed overview of the Science Programme and a summary of preliminary results for Legs 1, 2, 3 & 4

Executive Summary

The Volvo Ocean Race Science Programme has brought together an elite scientific consortium to capture data that will contribute to a better understanding of the world's ocean and climate.

Leg 6 of the race from Hong Kong to Auckland allowed for continued sampling of microplastics and oceanographic data by the Turn the Tide on Plastic boat. Scientific Drifter buoys were also deployed by all boats.

The route of this leg partially overlapped the track that Turn the Tide on Plastic sampled during the northbound passage to Hong Kong (Leg 4) providing a second sampling opportunity in some areas.

The preliminary results for microplastics revealed the **highest levels of microplastic pollution recorded along the race route to date**. The level of 357 particles/m^3 was detected in the sample from the South China Sea.

There was a notable difference between levels of microplastics recorded during this leg compared to Leg 4 on approach to Hong Kong. This is likely to be partly due to the patchiness of microplastic particle distribution and illustrates the **exceptional value of the Volvo Ocean Race sampling effort** in contributing to understanding microplastics pollution.

Collaboration, Funding and Support

The **onboard sampling** component of the science programme is a collaboration between Volvo Cars, GEOMAR Helmholtz Centre for Ocean Research Kiel (funded by Cluster of Excellence Future Ocean), SubCtech GmbH, bbe Moldaenke and Turn the Tide on Plastic crew. Another sampling unit was fitted to the AkzoNobel boat to provide a second sampling boat proceeding from Auckland (Leg 7). Volvo Cars is funding 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.

The sharing of **meteorological data** measured from the boats is part of a pilot project developed by JCOMM (Joint technical Commission for Oceanography and Marine Meteorology, WMO – IOC1) partners.

These organisations are 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.

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Onboard sampling

Preliminary results

Provided by Dr Toste Tanhua and Dr-Ing. Sören Gutekunst, GEOMAR Helmholtz Centre for Ocean Research Kiel

Leg 6: Hong Kong to Auckland

The Race and Microplastics knowledge advance

Leg 6 of the Volvo Ocean Race brought the race from **Hong Kong to Auckland**. This provided an interesting sampling opportunity as there was some overlap between the route covered and the previous track of Leg 4 (Melbourne to Hong Kong) thereby allowing analysis of different samples from similar areas.

There was a gap in sampling over a period of four days in the Philippine Sea as there was an electrical issue with the scientific device onboard. The malfunction was fixed by Liz Wardley and later investigated further during maintenance in Auckland.

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.

There was a notable difference between levels of microplastics recorded during this leg compared to Leg 4 on approach to Hong Kong.

Highest levels detected

The most striking finding was the measurement of a microplastic concentration of **357 particles/m^3 in the sample from the South China Sea,** the highest level recorded along the race route to date. The level recorded for a similar general area during Leg 4 was 75 particles/m^3. The latest (Leg 6) sample is possibly more representative of actual levels as this sample was taken more inshore and further north east than the earlier (Leg 4) sample.

The difference in the averages may also be related to **patchiness in the distribution** of microplastic particles closer to the source. With distance from the source there is likely to be more even distribution of particles on a local scale, but with ocean currents affecting distribution on a larger scale.

Progressing east into the north Philippine Sea, east of Taiwan, a relatively high level of **246 particles/m^3** was recorded. Significantly the area sampled coincides with the Kuroshio current which feeds into the North Pacific Subtropical Gyre.

Along the route south through the Pacific and crossing the equator average levels in the areas sampled were 103 particles/m^3 heading south of latitude 15 degrees north and 118 particles/m^3 in the area around the equator. These recorded levels again differed considerably from those recorded during the northbound passage of Leg 4 when 7 particles/m^3 were measured. Again, prevailing currents in this offshore area will be a major factor affecting microplastic density.

The recorded level decreased to 44 particles/m^3 on approach to the Solomon Islands with a spike to 128 particles/m^3 as the boat passed north of Vanuatu. In a similar area during Leg 4 concentrations of 20-23 particles/m^3 were recorded.

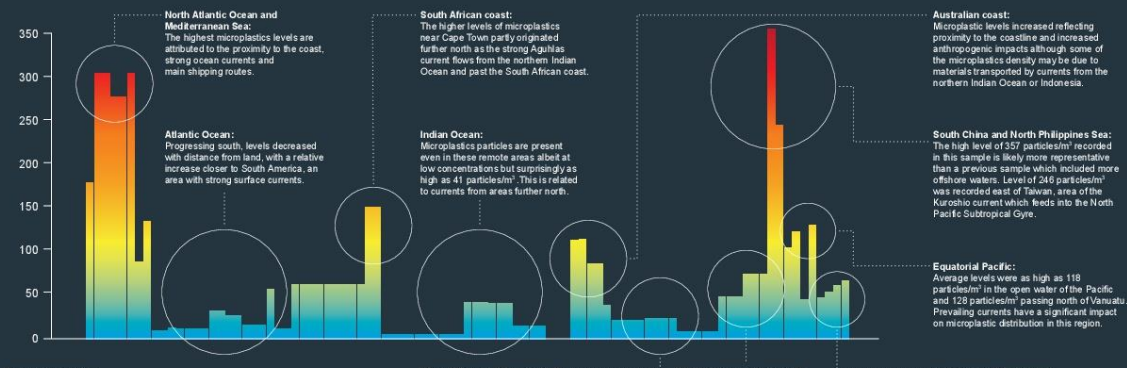
Progressing south towards New Zealand the concentration increased from 45, 50, 56 to 60 particles/m^3 in the sample closest to Auckland.

The questions posed by these latest recorded levels compared to measurements recorded from similar areas during Leg 4 give an insight into the challenge presented to scientists endeavouring to quantify microplastic pollution and understand its distribution.

Above all else this illustrates the exceptional value of the Volvo Ocean Race sampling effort in contributing to our knowledge of the seemingly unfathomable extent of microplastic pollution.

Volvo Ocean Race 2017-18

Microplastics Data



North Atlantic Ocean and Mediterranean Sea:
The highest microplastics levels are attributed to the proximity to the coast, strong ocean currents and main shipping routes.

Atlantic Ocean:
Progressing south, levels decreased with distance from land, with a relative increase closer to South America, an area with strong surface currents.

South African coast:
The higher levels of microplastics near Cape Town partly originated further north as the strong Agulhas current flows from the northern Indian Ocean and past the South African coast.

Indian Ocean:
Microplastics particles are present even in these remote areas albeit at low concentrations but surprisingly as high as 41 particles/m^3. This is related to currents from areas further north.

From Melbourne to Hong Kong:
Levels decreased in the open water areas off Nauru and the Solomon Islands where the density was 7 particles/m^3.

Philippines and Hong Kong:
Levels of 75 particles/m^3 were measured – relatively low considering the nearby population densities on land.

Australian coast:
Microplastic levels increased reflecting proximity to the coastline and increased anthropogenic impacts although some of the microplastics density may be due to materials transported by currents from the northern Indian Ocean or Indonesia.

South China and North Philippines Sea:
The high level of 357 particles/m^3 recorded in this sample is likely more representative than a previous sample which included more offshore waters. Level of 246 particles/m^3 was recorded east of Taiwan, area of the Kuroshio current which feeds into the North Pacific Subtropical Gyre.

Equatorial Pacific:
Average levels were as high as 118 particles/m^3 in the open water of the Pacific and 128 particles/m^3 passing north of Vanuatu. Prevailing currents have a significant impact on microplastic distribution in this region.

Approach to New Zealand:
Progressing south through the Coral Sea the concentration increased from 45, 50, 58 to 60 particles/m^3 in the sample closest to Auckland.

Preliminary Data provided by Dr-Ing. Sören Gutekunst and Dr Toste Tanhua, GEOMAR Helmholtz Centre for Ocean Research Kiel

Volvo Ocean Race 2017-2018

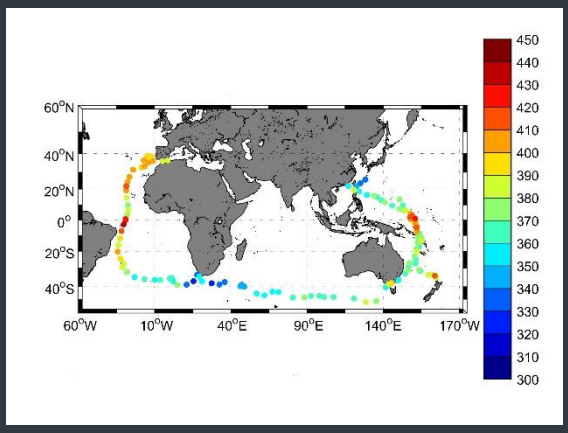
Oceanography

Low partial carbon dioxide levels were recorded northeast of Taiwan. Due to Japanese efforts this region is relatively well monitored and lower pCO_2 levels as recorded here are typical of the region.

Levels increased approaching the equator and around the equator were in excess of the atmospheric level of 400ppm. This consequence of equatorial upwelling was also observed during the northbound leg through the same area.

The 'outgassing' of CO_2 due to such **equatorial upwelling is a critical factor affecting the global carbon budget** and the annual variability in the upwelling rate in the Pacific is the single most important factor in determining the global annual budget of the carbon cycle.

Also, in relation to climate, these upwellings tend to be small during In El Niño years and therefore this CO_2 data is important for climate predictions via the Tropical Pacific Observing System (TPOS) - the single most important ocean observation unit for predicting climate on an annual and inter-annual time-scale.



pCO_2 - parts per million

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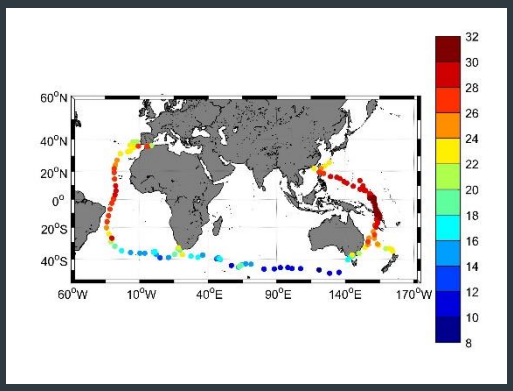
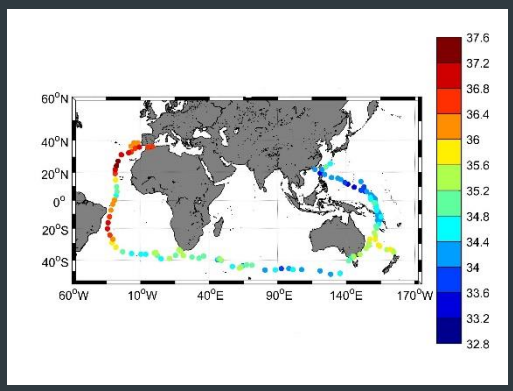
Oceanography

The temperature and salinity data support the carbon dioxide observations. The data illustrate the 'West Pacific warm pool', the warmest part of the global ocean. Relatively low salinity in the north tropical Pacific, as observed also during Leg 4, is typical of this region where heavy squall activity is characteristic.



Temperature - °Celsius

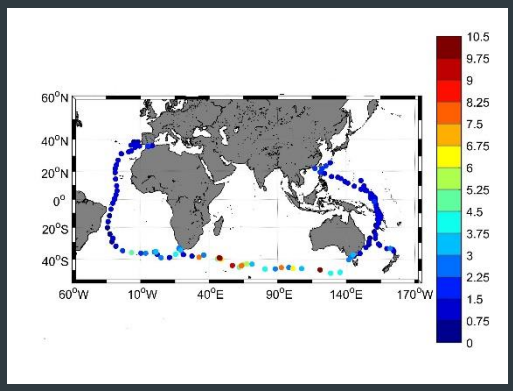


Salinity - Practical Salinity Unit

Chlorophyll a levels were relatively low along this leg. The tropics are typically low in terms of primary productivity.

Further north and south along this leg the relatively low productivity reflects the time of year as these areas were sampled outside of highest phytoplankton growth.

The map also illustrates nicely the global importance of the South Indian Ocean (Southern Ocean) for its levels of phytoplankton activity and therefore potential to absorb excess atmospheric carbon dioxide.



Chlorophyll a – mg/m^3

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Drifter Buoys

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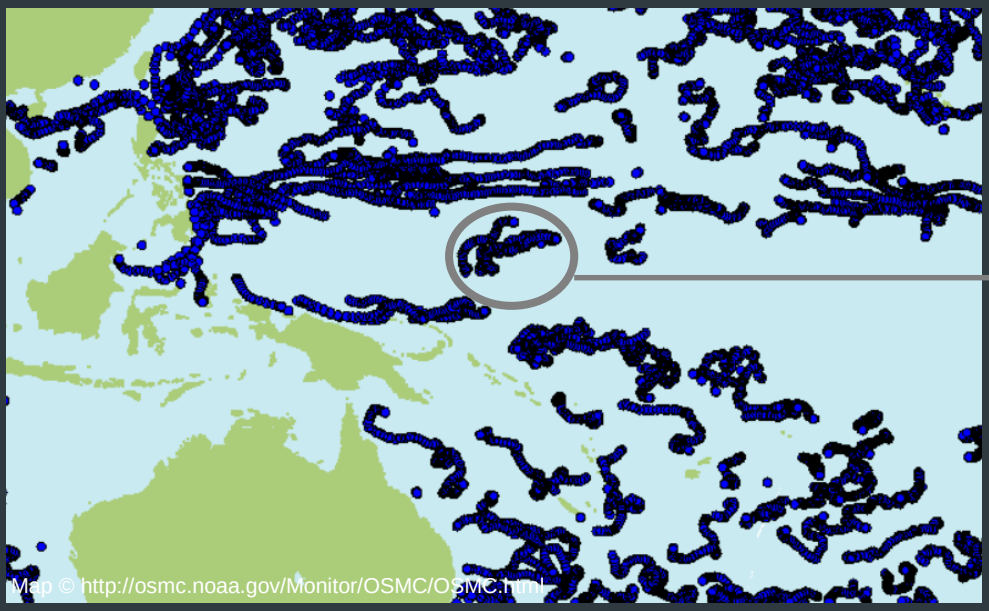
Scientific Drifter buoys



Volvo Ocean Race Drifter buoys transmitting data from a critical area lacking drifter buoy coverage

During Leg 6 each of the competing boats deployed a scientific drifter as they passed 3 degrees north of the equator. Data from this latitude is valuable in the prediction of tropical storms and longer-term monitoring of climate as these buoys will continue to transmit data on sea surface temperature and ocean current movement for up to two years.

Watch more about the Leg 6 drifter buoy deployments here: https://www.facebook.com/volvooceanrace/videos/10156622838662437/

Read more

Media Mentions:

https://www.sporttechie.com/round-world-sailing-competition-uses-technology-measure-ocean-plastic-volvo/

https://www.recyclingpoint.info/volvo-ocean-race-microplastiche-quante-ce-ne-sono-nelloceano/

Previous reports:

Volvo Ocean Race Science Programme – Preliminary Results Leg 1, 2, 3 & 4

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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