Cruise No. He578

Short report

05.06.2021 - 08.07.2021

Port of Sailing (Bremerhaven, Germany) – Port of Arrival (Bremerhaven, Germany)

Gunnar Gerdts

Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research (AWI)

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Principal Investigators

Name	Institution
Gerdts, Gunnar, Dr.	AWI

Scientific Party

Name	Discipline	Institution
Gerdts, Gunnar, Dr.	Chief Scientist	AWI
Jebens, Hannah, BSc	Technical assistant	AWI
Wu, Fangzhu, MSc	PhD candidate	AWI
Zonneveld, Catharina, Prof. Dr.	Micropaleontology - Paleoceanography	MARUM
Versteegh, Gwerardus, Dr.	Micropaleontology - Paleoceanography	MARUM
Suaria, Giuseppe, Dr.	Environmental Sciences	CNR
Paluselli, Andrea, Dr.	Chemistry	CNR
Vianello, Alvise, Dr.	Chemistry	AAU
Georgi, Christoph, MSc	PhD candidate	TUB
Roa, Jo, Dr.	Environmental Sciences	GEOMAR
Fink, Christine, MSc	Biotechnology	GEOMAR

Background JPI-O FACTS. The cruise was conducted in the framework of the JPI-O project FACTS (Fluxes and fate of microplastics in northern European waters; https://jpi-oceans-facts.eu/), workpackage 1 „Large Scale Transport – South to North". FACTS creates new knowledge and improve our mechanistic understanding on the sources, transport, occurrence, and fate of small microplastics in the northern marine waters. FACTS combines state-of-the-art analytical, monitoring and modelling approaches in feedback cycles to describe transport and geographical sources of microplastics contamination as well as sinks from the temperate waters of the southern North Sea to the Arctic waters of the Barents Sea. It analyses the distribution of MP in the water column and quantifies Skagerrak as a major sink zone. Investigated transport processes range from drift scenarios to air transport to aggregation and sinking processes. The goal is to address the question of how MP move vertically in the water column with time under comparatively well-defined hydrodynamic conditions. FACTS will be enhanced by tackling the current challenges of nanoplastics and tyre wear particle detection in marine samples. Both particle types are currently not accessible for mass balances of marine plastics contamination.

Cruise He578. During the cruise we successfully sampled in total 23 stations from the coast of Bergen to the arctic island Bjornoya (Table 1 & Fig. 1). DSHIP station 2 was sampled twice (DSHIP 24) due to bad weather conditions during the first attempt. With respect to the initial cruise application, five

further stations (one of the Faroe Shetland Channel box and two of the Svinoy box and Gimsoy box respectively) were also not performed due to weather or time limitations. On transects between stations (Table 1 & Fig. 1, dashed line), "on the way" air and water sampling was successfully performed by using high and low volume air samplers (TUB) and the newly developed automated COMPASS water filtration system (AAU). Air samplers were installed on the compass bridge and only operated while the ship was moving. The Intake of water for COMPASS was realized by applying a submersible pump in the Moon Pool of the Heincke. The COMPASS system consists of three so called UFO units with three filtration units each (2 x 300 µm & 1 x 15 µm), providing three integrative samples of up to 1000 L. During He578, the maximum filtration time was set to 3 h per UFO unit. As a consequence on longer transects (e.g. DSHIP 7; transect from Faroe Shetland Channel box to Bjornoya W box), several subsets of the respective transect were sampled. On all stations of the Faroe Shetland Channel box, the Bjornoya W box and the most westerly or southerly stations of the Gimsoy, Svinoy and Fugloya Bjornoya boxes, the COMPASS system was operated in parallel to surface water sampling (by catamaran or buoy) and the < 15 µm filtrate was further filtered on 0.5 µm metal-sinter membranes for enrichment of submicron plastic particles (or even nanoplastics). All stations were started with a CTD cast to get an overview on the oceanographic conditions and the different water bodies present. Based on these information, sampling depths were defined (e.g. below pycnocline, below Chl a maximum, different waterbodies) for CTD (CNR), *in situ* pump (MARUM) and Marine Snow catcher (GEOMAR) samples which were taken subsequently. By using the *in situ* pumps equipped with stainless steel 15 µm meshes, it was possible to filter ~500 L at each station and depth. Surface water samples were then taken by using either a Neuston catamaran or a sampling buoy (depending on the weather conditions). The Neuston catamaran (AWI) was equipped with a 300 µm net for enrichment of larger MP particles and a newly developed on board (air driven, PTFE) pumping and filtration system for particles < 300 µm > 15 µm (Fig. 2H). An identical pumping and filtration system was used on the Heincke for water samples taken by the sampling buoy (AWI, during heavy weather). With both devices between 350 - 650 L were successfully sampled (and filtered). In total on 5 stations (see Table 1 & Fig. 1) it was possible to take undisturbed sediment cores by using a Multicorer (MARUM). The MUC was equipped with Perspex and stainless steel coring pipes. The stainless steel coring pipes facilitate contamination free samples, enabling slicing of cores and analyses of different sediment horizons for microplastics (AWI) and ^{210}Pb based sediment chronology (MARUM, AWI). All samples were stored cooled or frozen on board the Heincke and will finally analyzed in the laboratories of the cooperating partners by using FTIR Imaging/FTIR microscopy (AWI, AAU, CNR) or PyGCMS (ICBM). Submicron microplastics (or nanoplastics) will be analyzed by Raman microscopy or nanoFTIR (AWI). Marine Snow catcher samples (aggregates, water) will be subjected to in deep microbiological and microscopical analyses (GEOMAR).

It can be stated that cruise He578 in the framework of JPI-O FACTS, WP 1 "Large Scale Transport – South to North" was a full success and will for the first time provide a comprehensive picture on the transport and fate of microplastics in northern waters.

Unfortunately during the cruise, three not planned stops in Bergen, Tromsoe and Trondheim were necessary. In the first week, our colleague Gwerardus Versteegh received the message, that his father passed away due to an accident at home, so I decided to give him the opportunity to go of board in Bergen. All of us were deeply dismayed. The stop in Tromsoe was then necessary for restocking of food and the stop in Trondheim for uptake of drinking water due to a severe defect in the water supply system of the Heincke.

Table 1 Station list of He578. Displayed are initial station numbers (cruise application) and final DSHIP station numbers. Red/Yellow: Stations not performed.

Date	Station	DSHIP	Name	Latitude	Longitude	Samples						
						Water					Sediment	Air
						CTD	*in situ* pumps	Marine snow catcher	Catamaran (C)/Buoy (B)	on the way	MUC	on the way
07.06.2021	1	1	Fedje / Shetland box	60.750	4.010	x	x	x	C		x	
08.06.2021	2	2	Fedje / Shetland box	60.750	3.417	x	x	x	C			
12.06.2021	3	6	Fedje / Shetland box	60.750	1.617	x	x	x	B		x	
11.06.2021	4	5	Fedje / Shetland box	60.750	0.117	x	x	x	C			
09.06.2021	5	3	Faroe Shetland channel box	60.750	-2.000	x	x	x	C			
-	6	-	Faroe Shetland channel box	61.000	-2.500	x	x	x				
10.06.2021	7	4	Faroe Shetland channel box	61.250	-3.000	x	x	x	B			
03.07.2021	8	23	Svinoy box	62.485	4.945	x	x	x	C			
-	9	-	Svinoy box	62.720	4.433	x	x	x				
-	10	-	Svinoy box	62.957	3.917	x	x	x				
02.07.2021	11	22	Svinoy box	63.192	3.395	x	x	x	C			
29.06.2021	12	19	Gimsoy box	68.580	13.583	x	x	x	C			
-	13	-	Gimsoy box	68.850	12.800	x	x	x				
-	14	-	Gimsoy box	69.139	12.023	x	x	x				
27.06.2021	15	18	Gimsoy box	69.483	10.950	x	x	x	C			
24.06.2021	16	16	Fugloya Bjornoya box	70.667	19.967	x	x	x	C			
22.06.2021	17	14	Fugloya Bjornoya box	71.000	19.900	x	x	x	C			
23.06.2021	18	15	Fugloya Bjornoya box	71.333	19.676	x	x	x	C			
21.06.2021	19	13	Fugloya Bjornoya box	71.750	19.733	x	x	x	C		x	
20.06.2021	20	11	Bjornoya W box	74.500	16.667	x	x	x	C		x	
19.06.2021	21	10	Bjornoya W box	74.510	15.000	x	x	x	B			
18.06.2021	22	9	Bjornoya W box	74.520	12.500	x	x	x	C			
17.06.2021	23	8	Bjornoya W box	74.530	9.000	x	x	x	C/B			
13.06. . 17.06.2021	-	7	Faroe Shetland channel box to Bjornoya W box							x		x
20.06. - 21.06.2021	-	12	Bjornoya W box Fugloya Bjornoya box							x		x
25.06.-26.06.2021	-	17	Fugloya Bjornoya box to Gimsoy box							x		x
29.06.-30.06.2021	-	20	Gimsoy box to Trondheim							x		x
01.07.-02.07.2021	-	21	Trondheim to Svinoy box							x		x
04.07.2021	2	24									x	

13.06.2021	-	-	Bergen
25.06.2021	-	-	Tromsoe
01.07.2021	-	-	Trondheim

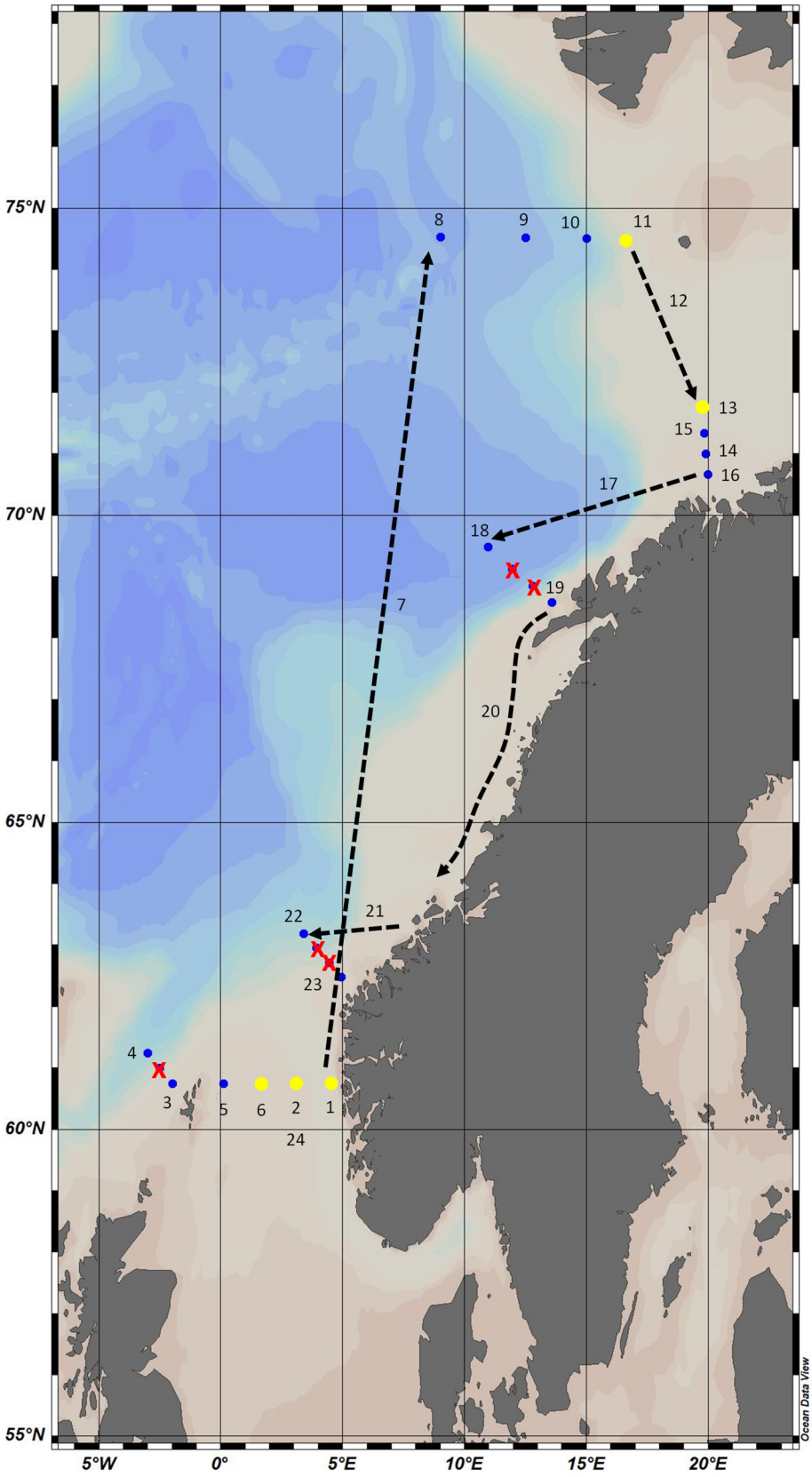

Figure 1 Station map of He578. Blue circles: CTD (up to 5 depths), *in situ* pumps (up to 3 depths), neuston catamaran (net & on board pump/filtration setup) or sampling buoy with separate on ship pump/filtration setup (surface), marine snow catcher (2 depths). Yellow circles: All devices deployed (blue circles) and Multicorer. Red crosses: Stations not performed. Dashed lines: Transects between stations used for "on the way sampling" of water and air.

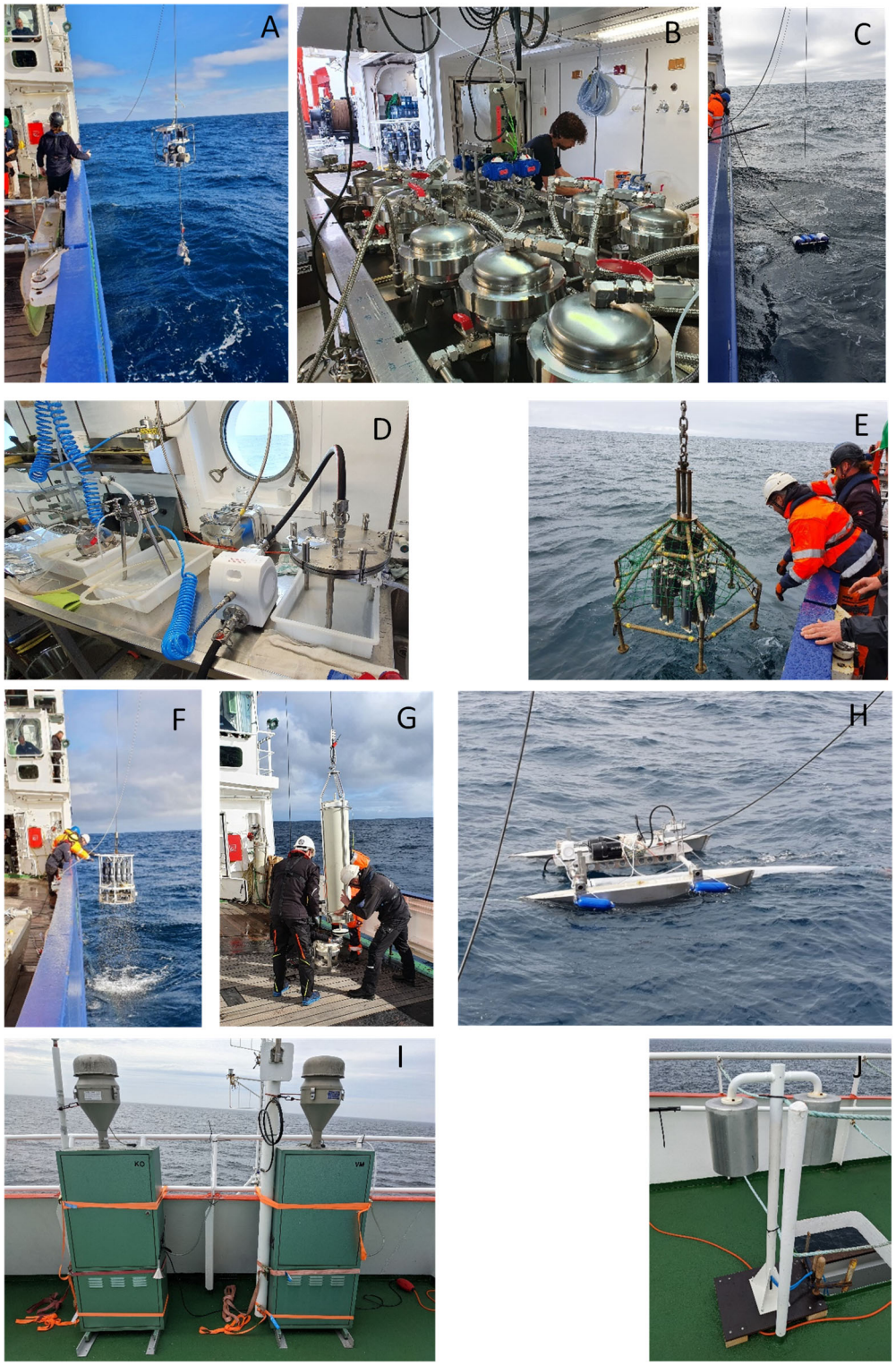

Figure 2 Sampling devices used on He578. A: *in sit*u pumps; B: COMPASS filtration system; C: Sampling buoy with separate on ship pump/filtration set up (D); E: Multicorer; F: CTD; G: Marine Snow Catcher; H: Neuston catamaran with net and on board pump/filtration setup; I & J: High (I) and low volume (J) air samplers