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1 **Contamination of planktonic food webs in the Mediterranean Sea: Setting the**
2 **frame for the MERITE-HIPPOCAMPE oceanographic cruise (spring 2019)**

3

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48 *the Mediterranean Sea: Biological pump and interactions from regional to global*
49 *approaches*”

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51 **Abstract**

52 This paper looks at experiential feedback and the technical and scientific challenges tied
53 to the MERITE-HIPPOCAMPE cruise that took place in the Mediterranean Sea in spring
54 2019. This cruise proposes an innovative approach to investigate the accumulation and
55 transfer of inorganic and organic contaminants within the planktonic food webs. We present
56 detailed information on how the cruise worked, including 1) the cruise track and sampling
57 stations, 2) the overall strategy, based mainly on the collection of plankton, suspended
58 particles and water at the deep chlorophyll maximum, and the separation of these particles
59 and planktonic organisms into various size fractions, as well as the collection of atmospheric
60 deposition, 3) the operations performed and material used at each station, and 4) the sequence
61 of operations and main parameters analysed. The paper also provides the main environmental
62 conditions that were prevailing during the campaign. Lastly, we present the types of articles
63 produced based on work completed by the cruise that are part of this special issue.

64

65 **Key words:** contaminants, plankton, Mediterranean Sea, size fractions, bioaccumulation,
66 atmospheric deposition

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76 **1. Introduction**

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78 Plankton is recognised as a key gateway of inorganic and organic contaminants into the
79 marine food web (Berroralbiz et al., 2011; Tao et al., 2018; Chauvelon et al., 2019; Li et al.,
80 2021). Phytoplankton exposure to contaminants is mainly *via* water. Phytoplankton cells have
81 a high surface area-to-volume ratio and thus large areas for exchanges, and consequently
82 display high capacities for adsorbing and absorbing and thus bioconcentrating dissolved
83 contaminants (Martin and Knauer, 1973; Fan and Reinfelder, 2003; Heimbürger et al., 2010;
84 Lee and Fisher, 2016; Chauvelon et al., 2019). Contaminant bioconcentration in
85 phytoplankton, thought to be governed mainly by partition equilibrium processes between the
86 cells and the surrounding water (Frouin et al., 2013) even though cell growth conditions may
87 prevent contaminants from reaching thermodynamic equilibrium (Swackhamer and Skoglund,
88 1993), tends to increase with decreasing size of algal cells (Fan and Reinfelder, 2003).

89 Bioaccumulation processes in zooplankton are highly complex due to 1) entry of
90 contaminants by both the water aqueous phase (bioconcentration) and diet, 2) trophic
91 interactions and/or transfers between phytoplankton and herbivorous, carnivorous and
92 omnivorous zooplankton, and 3) the contaminant elimination processes used by these
93 organisms, including metabolization, excretion and passive release (Tiano et al., 2014;
94 Alekseenko et al., 2018; Tao et al., 2018; Thomas et al., 2018; Li et al., 2020). The fact that
95 all these processes can act simultaneously in the same or opposite directions makes it difficult
96 to understand the variability of contaminant concentrations within the planktonic food web,
97 which may ultimately display biomagnification (increasing contaminant concentrations with
98 trophic level), bioreduction (decreasing contaminant concentrations with trophic level) or no
99 clear pattern (Nizzetto et al., 2012; Tiano et al., 2014; Strady et al., 2015; Tao et al., 2017a, b;

100 [Alekseenko et al., 2018](#); [Chouvelon et al., 2019](#); [Tang et al., 2020](#); [Castro-Jiménez et al.,](#)
101 [2021](#); [Li et al., 2021](#)).

102 One important biogeochemical implication of contaminant uptake by plankton is the
103 role as a “biological pump” for contaminant sequestration ([Dachs et al., 2002](#); [Galbán-](#)
104 [Malagón et al., 2012](#); [Duran and Cravo-Laureau, 2016](#); [González-Gaya et al., 2019](#); [Tang et](#)
105 [al., 2020](#)). Contaminants bioconcentrated/bioaccumulated within planktonic organisms
106 subsequently get transferred to higher trophic levels or to deep waters and sediment through
107 sinking particles. During phytoplankton blooms, contaminant uptake by plankton depletes the
108 contaminant loads in the dissolved phase of the water column and increases contaminant air-
109 water fluxes, sinking particle fluxes and sequestration in sediments ([Berrojalbiz et al., 2011](#);
110 [Nizzetto et al., 2012](#); [Everaert et al., 2015](#); [Morales et al., 2015](#); [Casal et al., 2017](#); [Ding et al.,](#)
111 [2021](#)).

112 The phosphorus-limited Mediterranean Sea is globally classified as an oligotrophic
113 marine area ([D’Ortenzio and d’Alcalà, 2009](#); [The Mermex Group, 2011](#); [Marañón et al.,](#)
114 [2021](#)) dominated by small phytoplankton (i.e., pico- and nano-sized fractions) ([Uitz et al.,](#)
115 [2006](#); [Hunt et al., 2017](#); [Mayot et al., 2017](#); [Leblanc et al., 2018](#); [Salhi et al., 2018](#); [Ramirez-](#)
116 [Romero et al., 2020](#)), even though the occurrence of regional phytoplankton blooms (bloom
117 bioregions, ecoregions; [D’Ortenzio and Ribera d’Alcalà, 2009](#); [Berline et al., 2014](#);
118 [Reygondeau et al., 2017](#); [Ayata et al., 2018](#)) leads to periods of coexistence of numerous
119 microalgal groups ([Siokou-Frangou et al., 2010](#); [El Hourany et al., 2019](#)).

120 Another feature of the Mediterranean Sea is its high exposure to chemical
121 contamination ([Hinrichsen, 1990](#); [The Mermex Group, 2011](#); [UNEP, 2012](#)). Indeed, the
122 intense human activities in its 23 bordering countries induce significant inputs of various
123 chemical contaminants, while its semi-closed geography limits possibilities for diluting them.
124 Contaminants are brought to the Mediterranean mainly by major and smaller river systems

125 (Elbaz-Poulichet et al., 2001; Radakovitch et al., 2008; Sicre et al., 2008; Guigue et al., 2014;
126 Köck-Schulmeyer et al., 2021) but also *via* effluents, runoffs, groundwater, and maritime
127 activities (Tedetti et al., 2010; Oursel et al., 2013; Tornero and Hanke, 2016; Fourati et al.,
128 2018; Jacquet et al., 2021; Llamas-Dios et al., 2021) as well as atmospheric deposition
129 (Lipiatou and Albaigés, 1994; Heimbürger et al., 2011; Castro-Jiménez et al., 2017; Barhoumi
130 et al., 2018; Desboeufs et al., 2022). Studies have demonstrated that atmospheric deposition is
131 the major source of contaminants in remote/open sea areas (Dachs and Méjanelle, 2010;
132 González-Gaya et al., 2019; Jiskra et al., 2021; Cossa et al., 2022).

133 An interesting feature of the bioaccumulation of contaminants in the Mediterranean Sea
134 is that the recorded contamination levels are significantly higher in its predatory species
135 (crustaceans, sharks, teleost fish) than in congeneric species of the Atlantic Ocean (Cossa and
136 Coquery, 2005; Bodiguel et al., 2009; Chauvelon et al., 2018). This difference may be related
137 (but not solely) to the enhanced ability of the Mediterranean planktonic food webs to
138 bioaccumulate certain contaminants, such as mercury (Hg) (Cossa and Coquery, 2005;
139 Harmelin-Vivien et al., 2009; Chauvelon et al., 2018, 2019; Cossa et al., 2022), which further
140 underscores the potential key role of the planktonic compartment in the transfer and
141 accumulation of contaminants in the Mediterranean Sea. Furthermore, contaminant-plankton
142 interactions in the Mediterranean Sea are expected to evolve in the coming years, as it has
143 been identified as a hotspot for climate change due to its high reactivity to external forcing,
144 particularly variations in water, energy and matter fluxes that will affect its circulation,
145 biogeochemical fluxes and ecosystem functioning (Lejeusne et al., 2010; The Mermex Group,
146 2011; Ser-Giacomi et al., 2020).

147 However, there are still key gaps in our understanding around the actual ability of
148 plankton to accumulate and transfer contaminants (i.e., the role of plankton as a biological
149 pump of contaminants), especially its small size fractions, i.e., pico- and nano-plankton. This

150 lack of knowledge partly comes from methodological difficulties in: 1) collecting and
151 separating plankton into its various size fractions from pico- to macro-plankton, separating
152 bacterio-, phyto- from zoo-plankton, and separating non-living suspended particulate matter
153 from plankton, 2) obtaining sufficient material in each of these fractions to perform trace-
154 level chemical analyses, and 3) clearly identifying the trophic relationships between
155 planktonic size fractions in the presence of detritus (particularly in smaller size fractions) and
156 mixing of different trophic levels within each size fraction.

157 In this context, the MERITE-HIPPOCAMPE cruise aimed to evaluate the accumulation
158 and transfer of a hugely diverse range of inorganic and organic contaminants at the
159 atmosphere-water-plankton interfaces and within the planktonic food webs, i.e., phyto-, zoo-
160 and bacterio-plankton, along a North-South transect in the Mediterranean Sea. This ultimately
161 to quantify the role of Mediterranean plankton as a biological pump of contaminants, focusing
162 on contaminant transfers into the planktonic food webs. The main collection area for
163 plankton, suspended particles and water is the deep chlorophyll maximum (DCM), which may
164 be considered as the layer with the highest biomasses of plankton, mainly phytoplankton, but
165 also zooplankton. The plankton size fractions investigated include pico- (0.2–2 μm), nano-
166 (2–20 μm), micro- (20–200 μm) and meso-plankton (200–2000 μm). The contaminants
167 examined are trace metals, organometals and metalloids (As, Cd, Cr, Cu, Fe, Hg, MeHg, Mn,
168 Ni, Pb, Sb, Zn...), organic contaminants (PAHs, PCBs, PBDEs, PFASs), radionuclides
169 (^{137}Cs), and microplastics. The specific objectives of the cruise are: 1) to determine the
170 contaminant concentration levels in various planktonic compartments (phyto-, zoo- and
171 bacterio-plankton), suspended particles and water (dissolved phase), as well as atmosphere
172 and, 2) to assess the role of dry/wet atmospheric deposition as a source of contaminants for
173 marine waters, especially in offshore areas, 3) to gauge how contaminant accumulations and
174 transfers are influenced by plankton in terms of size and community structures, trophic

175 interactions and biochemical content, and 4) to establish the link between habitat
176 characteristics and concentration levels of contaminants in plankton. The questions addressed
177 by the MERITE-HIPPOCAMPE cruise are summarised in [Fig. 1](#). In this paper, we first
178 present the implementation of the cruise project in terms of strategy, study stations, material
179 used, operations performed, sequence of operations, and main parameters analysed. We then
180 work up from a joint dataset to provide the main meteorological, hydrological, and
181 biogeochemical conditions prevailing during the cruise. Lastly, we introduce the types of
182 articles produced through the MERITE-HIPPOCAMPE cruise that are part of this special
183 issue.

184

185

186 **2. Implementation of the cruise**

187

188 **2.1. Research strategy**

189 The overall research strategy for our oceanographic cruise was as follows:

190 1) Investigate areas of contrasted ecological characteristics in the north and south of the
191 Mediterranean Sea. The selected period was the spring bloom, crossing primary production
192 and bloom areas as defined by [D’Ortenzio and d’Alcalà \(2009\)](#) as well as various fishing
193 zones, urbanised bays, and consensus regions as defined by [Ayata et al. \(2018\)](#) ([Fig. 2a, b](#);
194 [Fig. S1](#)).

195 2) Characterise the water column in these sampling sites in terms of physical and
196 biogeochemical properties through *in situ* physical and optical measurements, and determine
197 the DCM.

198 3) Implement ultra-clean on-board conditions for the collection and treatment of water
199 and plankton samples for ultra-trace-level analyses of inorganic and organic contaminants.

200 4) Collect large amounts of plankton, suspended particles, and water (dissolved phase)
201 in the DCM and, in a lesser extent, surface/subsurface waters (0–5 m depth) (Fig. 3). The
202 choice of focusing our sampling on the DCM was motivated by the need to 1) collect a high
203 biomass of plankton from the same location to determine the concentration levels of a wide
204 range of contaminants, and over a broad spectrum of planktonic size fractions, and 2) be
205 located in a relevant area for pelagic trophic interactions in both the coastal and marine areas.

206 5) Separate these large amounts of plankton and particles into various size fractions
207 (from 0.2 μm to $> 2000 \mu\text{m}$) by filtration or sieving (Fig. 3).

208 6) Share the size fractioned samples for analysis of a battery of parameters, including (i)
209 contaminants, with trace metals, organometals and metalloids (As, Cd, Cr, Cu, Fe, Hg, MeHg,
210 Mn, Ni, Pb, Sb, Zn, etc.), organic contaminants (PAHs, PCBs, PBDEs, PFASs), radionuclides
211 (^{137}Cs) and microplastics, (ii) biomass, size structure, taxonomy, cytometry, diversity and
212 pigment composition of plankton, and (iii) biogeochemical parameters, with nutrients, total
213 chlorophyll *a* (TChl*a*), suspended particulate matter (SPM), dissolved and particulate organic
214 matter, C and N isotopic ratios ($\delta^{13}\text{C}$, $\delta^{15}\text{N}$), and biochemical compounds (carbohydrates,
215 proteins, lipids) (Fig. 3).

216 7) Combine several methods (taxonomy, optical measurements, chemical analyses) to
217 tentatively distinguish the contributions of living (plankton) and non-living (detrital) materials
218 to contaminant accumulation and transfers.

219 8) Collect on-board samples of atmospheric wet deposition (rain) to assess their
220 potential importance as a source of contaminants for marine water and plankton. The
221 collection of atmospheric samples was also done in parallel on the coast by setting up two
222 ground stations, located in the northern part (Marseille, France) and southern part (Sfax,
223 Tunisia) of the Mediterranean basin (Fig. 2a), in which atmospheric total (dry and wet)

224 deposition were measured on a regular (bi-monthly or monthly) basis from March 2019 to
225 June 2020, i.e., before, during, and after the oceanographic cruise.

226 9) Sample small pelagic plankton-feeding fishes in Tunisian waters (see sampling
227 positions in Fig. 2a). The fish samples were analysed for a number of contaminants in order to
228 set bioaccumulation factors for higher trophic levels.

229

230 **2.2. Cruise track and study stations**

231 The MERITE-HIPPOCAMPE cruise took place in spring 2019, from April 13 to May
232 14, on board the French Research Vessel (R/V) *Antea* along a North-South transect (round
233 trip) in the Mediterranean Sea, from the French coast (La Seyne-sur-Mer, Northwestern
234 Mediterranean) to the Gulf of Gabès in Tunisia (Southeastern Mediterranean) (Tedetti and
235 Tronczynski, 2019) (Fig. 2a, b). Leg 1 (13–28 April 2019) ran the southward transect,
236 between La Seyne-sur-Mer and Tunis, with sampling at five stations: St2, St4, St3, S10, and
237 St11 (in this chronological order). Leg 2 (30 April–14 May 2019) covered first the end of the
238 southward transect (from Tunis to the Gulf of Gabès), and then the return trip back northward
239 from the Gulf of Gabès to La Seyne-sur-Mer. Five stations were sampled during leg 2: St15,
240 St17, St19, St9 and St1 (in this chronological order). Five stations (St1–St4, St9) were
241 situated in the French area, two stations (St10, St11) in the Italian area, and three stations
242 (St15, St17, St19) in the Tunisian area (Fig. 2a, b; Table 1).

243 The ten stations were chosen according to different criteria based on physical,
244 biogeochemical and biological conditions and anthropogenic pressures (Fig. 2a; Fig. S1;
245 Table 1). St1 and St4 were located in the urbanised bays opposite the cities of Toulon and
246 Marseille, respectively, and thus submitted to strong anthropogenic pressures. St4 was the
247 SOLEMIO station, which is part of the French national coastal observation monitoring
248 network SOMLIT (<http://somalit.epoc.u-bordeaux1.fr/fr/>). St1 and St4 were “intermittent

249 bloom” areas or “bloom” areas according to [D’Ortenzio and d’Alcalà \(2009\)](#) based on
250 SeaWiFS satellite observations of surface TChl a concentration. St2 and St3 were situated
251 offshore of Toulon and Marseille, respectively. St2 was at the limit of the continental shelf
252 and the boundary of the Ligurian consensus region ([Ayata et al., 2018](#)) ([Fig. S1](#)). St3, situated
253 at the southeast entrance to the Gulf of Lion’s continental shelf, was the JULIO station, which
254 is dedicated to the study of intrusions of the Ligurian-Provençal current ([Barrier et al., 2016](#)).
255 St2 and St3 were considered “intermittently bloom” areas or “bloom” areas ([D’Ortenzio and](#)
256 [d’Alcalà, 2009](#)). These stations (St1–St4) have hosted in the past or continue to host visits
257 serving several monitoring networks such as SOMLIT and ROMARIN, and projects
258 including MERMEX-MERITE, COSTAS and IBISCUS.

259 St9 corresponds to offshore station 1 of the PEACETIME cruise ([Guieu et al., 2020](#)). It
260 was located north of the North Balearic thermal Front (NBF), at the boundary of the Ligurian
261 consensus region ([Ayata et al., 2018](#)), in the winter convection area ([Fig. S1](#)). The NBF,
262 which is one of the main consensus frontiers of the Mediterranean Sea ([Ayata et al., 2018](#)), is
263 found between the Balearic Islands and Sardinia, but its position spans a large area and can
264 vary with wind conditions and seasons ([Barral et al., 2021](#)). St10 (offshore station 2 of the
265 PEACETIME cruise) was situated south of St9, very close to the NBF. Although St10 was
266 positioned south of the average position of the NBF, it was in fact located slightly north of the
267 front which had moved further south during the sampling period ([Rwawi et al., in prep.](#)). St11
268 (offshore station 3 of the PEACETIME cruise) was plainly positioned south of the NBF, in
269 the Algerian consensus region ([Ayata et al., 2018](#)) ([Fig. S1](#)). St10 and St11 were characterised
270 by the presence of intense mesoscale eddies: St10 was rather situated between one
271 anticyclonic and one cyclonic eddy, while St11 was located within an anticyclonic eddy
272 ([Rwawi et al., in prep.](#)). St9, St10, and St11 are referred to as “bloom”, “intermittent bloom”

273 and “no bloom” areas, respectively, according to the [D’Ortenzio and d’Alcalà \(2009\)](#) system
274 ([Fig. 2a; Table 1](#)).

275 St15, situated in the Gulf of Hammamet (Tunisia), was close to the Sicily Channel,
276 which plays host to the exchanges between the two (Western and Eastern) Mediterranean
277 basins, and submitted to the possible entrance of the Atlantic Tunisian Current branch, also
278 called the Atlantic-Ionian stream. St17 (north of the Gulf of Gabès) and St19 (south of the
279 Gulf of Gabès) were located at the boundary of and within the Gabès consensus region,
280 respectively ([Ayata et al., 2018](#)) ([Fig. S1](#)), and are typified by shallow waters, strong
281 influences of tidal pull (the highest of the Mediterranean; amplitude > 2 m) and the Atlantic
282 Tunisian Current. St17 and St19 are also characterised by nutrient inputs from Saharan dust
283 deposition or sediment resuspension and the resulting high planktonic productivity levels
284 ([Béjaoui et al., 2019](#)). Moreover, given its cumulative index of warming, overfishing and
285 pollution effects, the Gulf of Gabès has recently been recognised as a hotspot of
286 anthropogenic pressures within the Mediterranean Sea ([Reygondeau et al., 2014](#)). St15, St17
287 and St19 were zones marked by a high density of small pelagic fish and considered as “no
288 bloom” (St15) or “coastal bloom” areas (St17, St19) based on the [D’Ortenzio and d’Alcalà](#)
289 [\(2009\)](#) system. These stations (St15-St19) have been investigated in the past in the framework
290 of the Tunisian POEMM and ESSATEL programs ([Fig. 2a; Fig. S1; Table 1](#)).

291 Due to rough sea conditions that occurred during sampling of St19 (south of the Gulf of
292 Gabès; [Fig. 2a, b](#)), the ship went to shelter, first off the island of Djerba and then off the city
293 of Zarzis ([Fig. 2a, b](#)), before returning to station St19 to finish work between May 3 and 4.
294 During the transit between off Djerba and off Zarzis, atmospheric deposition sampling was
295 carried out following an intense episode of Saharan dust deposition.

296 Besides the ten stations prospected from the R/V *Antea*, two other stations (T2 and T4)
297 were sampled in the Tunisian waters during leg 2 (2–3 May 2019) on board the R/V *Hannibal*

298 for trawling small pelagic fishes. T2 was located in the Gulf of Gabès not far from St19,
299 whereas T4 was situated in the Gulf of Tunis. The duration of trawling was 40 min at T2 and
300 90 min at T4 (Fig. 2a; Table 2). The fish species captured by trawling were anchovy, sardine,
301 sardinella, and mackerel (Lajnef et al., in prep.).

302

303 **2.3. Equipment and operations**

304 At each of the ten stations, the following sampling equipment was deployed and the
305 following operations were performed at sea and on board the R/V *Antea*.

306 *2.3.1. Water sampling with Niskin and Go-Flo bottles and subsequent in-line*

307 *filtration*. A trace metal-clean carousel equipped with ten 12-L bottles (1 Niskin, 5 Niskin X,
308 4 Go-Flo) and a conductivity-temperature-depth probe (CTD; Seabird SBE 911*plus*),
309 mounted with photosynthetically available radiation (PAR) (Biospherical), TChla
310 fluorescence (Aqua Tracka, Chelsea ctg), dissolved oxygen (O₂) (SBE 43), dissolved organic
311 matter (DOM) fluorescence (WETStar, WETLabs) and transmittance (C-Star, WETLabs)
312 sensors, was deployed from the ship's moon pool *via* the electro-mechanical (conducting)
313 cable (Table S1; Fig. S2a). Vertical profiles were collected over the depth range 0–250 m or
314 surface-to-bottom when depth was < 250 m, and seawater was sampled at two depths: 5 m or
315 the DCM identified based on TChla profiles. Seven bottles (4 Niskin X and 3 Go-Flo) were
316 dedicated to DCM sampling, while three bottles (1 Niskin, 1 Niskin X and 1 Go-Flo) were
317 used for 5-m-depth sampling. The Go-Flo bottles were lowered into the water in open
318 position. At St9 and St10, sampling was also conducted down to 500-m depth to collect
319 seawater in the oxygen minimum zone (OMZ) identified based on O₂ profiles. At St9, water
320 was collected at 5 m, DCM and 440 m (identified as OMZ), whereas at St10 sampling was
321 carried out at 5 m, DCM, 100, 200, 300, 400 m (identified as OMZ) and 500 m. The Niskin X
322 bottles used here (model 101012X) are Niskin with a completely free Teflon-coated sample

323 chamber, Teflon-coated and externally-located stainless steel end plug closure springs, as well
324 as Teflon-coated air valves and drainage taps. Before the cruise, all ten bottles were
325 thoroughly washed with hydrochloric acid (HCl) 1 M, demineralized water and ultra-pure
326 water (i.e., Milli-Q water from Millipore system, final resistivity of 18.2 MΩ cm). Before
327 sampling, they were rinsed with seawater collected at 50-m and 170-m depth at the first
328 station (St2). Between two casts, working on the deck of the ship, we covered the drainage
329 taps and the top (upper stoppers) of the bottles with plastic bags to avoid any sample
330 contaminations.

331 Once on board, after water collection at 5-m depth and in the DCM, the carousel with
332 all the bottles was placed in the wet laboratory for in-line filtration (Table S1; Fig. S2b). For
333 that purpose, the bottles were pressurised to 0.5 bar with argon (UN1006, compressed, 2.2)
334 piped in using a silicon tubing system and quick-connect gas fittings replacing bottle air
335 valves. The upper and lower stoppers of the Niskin bottles were held tight by home-made
336 pairs of high-density polyethylene (HDPE) rods and clamps screwed at the top and bottom. A
337 10-cm-long piece of acid-cleaned silicon tubing was inserted into the drainage tap of each
338 bottle, and a perfluoroalkoxy (PFA) filter holder (Savillex®, 25 or 47-mm diameter) was
339 connected to the tubing. A graduated container collecting the filtered water served to indicate
340 the exact volume filtered on each filter.

341 In-line filtration makes it possible to effectively filter large quantities of water in clean
342 conditions and to recover the filters and filtered water samples for a battery of analyses.
343 Filtration was done on pre-combusted (450 °C, 6 h), pre-weighed glass fibre filters (GF/F,
344 Whatman) of 25 or 47-mm diameter (pore size: ~ 0.7 μm) for analyses of TChla, pigments,
345 SPM, particulate organic carbon (POC), particulate organic nitrogen (PON), stable isotopes of
346 carbon and nitrogen ($\delta^{13}\text{C}$, $\delta^{15}\text{N}$), biochemical compounds (carbohydrates, lipids, proteins)
347 and Hg on the size fraction > 0.7 μm. SPM measurements were done on (pre-weighed) 25-

348 mm and 47-mm-diameter GF/F filters rinsed with ultra-pure water after filtration in order to
349 remove salts, but also on (pre-weighed) 47-mm-diameter GF/F filters that had not been rinsed
350 with ultra-pure water (for which the amount of salts was estimated). Filtration was also done
351 on pre-cleaned 0.2- μm -pore-size 47-mm-diameter mixed cellulose esters (MCE) filters for the
352 analyses of trace metals/metalloids and microbial diversity on the size fraction $> 0.2 \mu\text{m}$, and
353 on 0.8- μm -pore-size 47-mm-diameter pre-cleaned MCE filters for the analyses of copper (Cu)
354 and zinc (Zn) isotopes on the size fraction $> 0.8 \mu\text{m}$. GF/F-filtered seawater ($< 0.7 \mu\text{m}$) was
355 used for the analyses of nutrients, i.e., silicates [$\text{Si}(\text{OH})_4$], nitrates (NO_3^-), nitrites (NO_2^-),
356 phosphates (PO_4^{3-}) and ammonium (NH_4^+), dissolved organic carbon (DOC), and absorption
357 of chromophoric DOM (a_{CDOM}), whereas 0.2- μm -filtered seawater was used for the analyses
358 of dissolved trace metals/metalloids and Hg (Fig. 3; Table S1). Volume of seawater filtered
359 ranged from 600 mL (25-mm GF/F filter for TChl*a*) to 12 L (47-mm GF/F filter for POC,
360 PON, $\delta^{13}\text{C}$, $\delta^{15}\text{N}$, and biochemical compounds).

361 Raw (unfiltered) seawater was taken for the analyses of total trace metals/metalloids
362 and Hg/MeHg, while seawater pre-filtered onto 100- μm silk was collected for phytoplankton
363 taxonomy and cytometry analyses. Raw seawater from the DCM was also used to perform on-
364 board experiments on microbial methylation/demethylation of Hg (at selected stations), while
365 raw seawater collected at 5-m depth and in the DCM at St1, St9, S15 and St19 was used to
366 conduct dilution experiments (see section 2.3.8). Most of these filtrations were also conducted
367 on OMZ water (at St9 and St10) for the same analyses. Raw and 0.2- μm -filtered seawater at
368 the different depths was also used for shipboard analyses of Hg (see section 2.3.9) (Table S1).
369 Filter blanks were regularly run during the cruise: filters were treated as sample filters, either
370 without passing any water on them or by rinsing with ultra-pure water, depending on the
371 parameter. Detailed information on the in-line filtration from Go-Flo and Niskin bottles,
372 including storage of samples, can be found in Fig. S3.

373 2.3.2. *In situ optical measurements.* A small CTD unit (SBE 19*plus*) equipped with
374 a TChl*a* fluorescence sensor (WETStar, WETLabs) was deployed from the moon pool on the
375 hydrographic cable, over the same depth range as the carousel (0–250 m or 0–bottom), to
376 timely determine the depth of the DCM between different sampling operations, in particular
377 just before McLane *in situ* pumps (see [section 2.3.3](#)) and MultiNet deployments (see [section](#)
378 [2.3.5](#)) ([Table S1](#)).

379 A laser optical plankton counter (LOPC, Rolls Royce) and laser *in situ* scattering
380 transmissometry-Holography (LISST-HOLO, Sequoia Scientific) were used together, fixed
381 on a small carousel, to provide information on the abundances and size spectra of particles
382 and plankton (> 20 μm for LISST-HOLO, > 100 μm for LOPC). Both systems were deployed
383 from the moon pool on the hydrographic cable. Vertical profiles were performed over the
384 depth range 0–250 m or 0–bottom ([Table S1](#); [Fig. S2c](#)).

385 2.3.3. *In situ filtration with McLane pumps.* Four McLane Large Volume Water
386 Transfer System Samplers (WTS6-142LV, 4–8 L min⁻¹), hereinafter referred to as McLane *in*
387 *situ* pumps, were used to collect large amounts of particles and plankton over different size
388 fractions in the DCM. The four pumps were attached together with clamps and chains, and
389 deployed at the same time from the moon pool on the hydrographic cable to reach the DCM
390 ([Fig. S2d](#)). Pumping lasted between 40 and 60 min, giving an average ~ 240 L of water
391 filtered by each pump. Three successive casts of the four-pump system were carried out,
392 giving a total of 12 pumping runs done at each station ([Table S1](#)).

393 Three pumps (A, B, C) were each mounted with a regular 142-mm filter-holder
394 (“McLane holder”) holding one 142-mm-diameter filter: one ~ 0.7- μm -pore-size pre-
395 combusted pre-weighed GF/F filter, one 0.8- μm -pore-size pre-cleaned MCE filter, or one 20-
396 μm -pore-size pre-cleaned Nylon filter. After installing the filters, the three McLane holders
397 were covered with a 60- μm -pore-size sock-type pre-filter so that the filtered particles size

398 fractions were 0.7–60, 0.8–60 and 20–60 μm . At three casts each, pumps A, B and C were
399 able to sample nine filters for analysis of TChl*a*, SPM, POC, PON, $\delta^{13}\text{C}$, $\delta^{15}\text{N}$, biochemical
400 compounds, PAHs, PCBs, PBDEs and Hg/MeHg on the GF/F filters (0.7–60- μm size
401 fraction), analysis of trace metals/metalloids, Cu and Zn isotopes and microbial diversity on
402 the MCE filters (0.8–60- μm size fraction), and analysis of microplastics on the Nylon filters
403 (20–60- μm size fraction) (Fig. 3; Table S1; Fig. S4).

404 The fourth pump (D) was mounted with a mini-Multiple Unit Large Volume in-situ
405 Filtration System (MULVFS) filter holder composed of baffle tubes on the top followed by
406 successive baffle and filter support plates, for sequential filtration with three different filters
407 (142-mm diameter) (Bishop and Wood 2008; Bishop et al., 2012). The baffles were designed
408 to straighten the flow, suppress turbulence, and distribute particles evenly across the filter.
409 The filter series used were either 1) one \sim 0.7- μm -pore-size pre-combusted, pre-weighed
410 GF/F filter, one 2.7- μm -pore-size pre-combusted, pre-weighed GF/D filter, and one 20- μm -
411 pore-size pre-cleaned Nylon filter, or 2) one 0.8- μm -pore-size pre-cleaned MCE filter, one 3-
412 μm -pore-size pre-cleaned MCE filter, and one 20- μm -pore-size pre-cleaned Nylon filter.
413 With its three casts, pump D was able to collect nine filters for the analysis of TChl*a*, SPM,
414 POC, PON, $\delta^{13}\text{C}$, $\delta^{15}\text{N}$, biochemical compounds, and Hg/MeHg on the 0.7–2.7, 2.7–20, and >
415 20- μm size fractions, and trace metals/metalloids on the 0.8–3, 3–20, and > 20- μm size
416 fractions (Fig. 3; Table S1; Fig. S4).

417 SPM measurements were made on (pre-weighed) 142-mm GF/F, GF/D and Nylon
418 filters rinsed with ultra-pure water after filtration in order to remove residues of the seawater
419 salts, but also on (pre-weighed) 142-mm GF/F filters not rinsed with ultra-pure water (for
420 which the amount of salts was estimated). All filters were placed in glass boxes, plastic boxes
421 or aluminium foil, depending on the parameter, and stored on board at $-20\text{ }^{\circ}\text{C}$ (Fig. S2e, f;
422 Fig. S4). A special support was purpose-designed to accommodate/fix the filter holders in the

423 wet laboratory to facilitate the process of preparing the filters before deployment, and then
424 handling, rinsing with ultra-pure water or direct drying (by connecting the filter holder to a
425 vacuum pump) the filters after deployment (Fig. S2e, f). Before pump deployment, all the
426 filter holder and filter systems were rinsed with ultra-pure water. Filter blanks were done at
427 regular intervals during the cruise.

428 *2.3.4. Water sampling and subsequent in-line filtration with an ASTI pump.*

429 Seawater was also sampled at ~ 10–20-m depth with a pneumatically-operated Teflon ASTI
430 pump (model PFD2) set up on board and connected to Teflon tubing, which was weighted
431 down and immersed from port side with the hydrology gallows (Table S1). The pumped
432 seawater was filtered in-line onto a pre-combusted 142-mm GF/F filter using a 142-mm
433 Teflon filtration holder. This filtration took place in the clean lab container (IFREMER,
434 CNXU 300022/1) installed on the rear deck of the ship. Part of the filtered seawater was
435 stored in three 20-L stainless steel jerrycans, while the other part was stored in a metal-free
436 50-L plastic container. This filtered seawater was used for sieving the large quantities of
437 plankton collected with the Multiple Plankton Sampler. The filtered seawater stored in two of
438 the stainless steel jerrycans was used exclusively for sieving on a stainless steel sieve column
439 to obtain plankton samples for organic parameter analyses, and the filtered seawater stored in
440 the plastic container was used exclusively for sieving on a nylon sieve column for analyses of
441 inorganic parameters (see section 2.3.5). Filtered seawater from the third jerrycan was
442 amended with 50 mL of dichloromethane, then shaken and degassed and stored in the
443 container at ambient temperature for subsequent analyses of dissolved (< 0.7 µm)
444 hydrocarbons (Guigue et al., in prep.) (Fig. 3; Table S1). All seawater containers (stainless
445 steel and plastic) were rinsed several times with filtered seawater before sample collection.

446 *2.3.5. Plankton sampling with a MultiNet and subsequent sieving.*

447 A Multiple Plankton Sampler (Midi type, Hydro-Bios), referred to hereafter as “MultiNet”, was

448 employed to collect plankton in the DCM. The MultiNet was composed of 5 individual
449 (exchangeable) 2.5-m-long nets with 0.25-m² apertures, a 60- μ m mesh size, and cod ends of
450 the same mesh size, together with two Hydro-Bios flowmeters (one into the mouth and the
451 other on the side) to assess the volume of water filtered by the nets, plus a CTD sensor and a
452 TChla fluorometer (Chelsea ctg). The MultiNet was connected *via* the electro-mechanical
453 cable to the operating computer to enable online monitoring of sensor feedback and opening
454 and closing of the nets, mainly based on flowmeter data and the amount of water passing
455 through the open net. It was operated from the stern A-frame. Since the device was deployed
456 horizontally in the DCM, the usual configuration (for vertical casts) was modified with a V-
457 fin deflector attached below the MultiNet and the five cod ends attached using a helicoidal
458 bucket connector (Fig. S2g, h). Ship speed while towing the MultiNet was ~ 2 knots (Table
459 S1). Once the five nets were filled (after 30 to 100 min depending on the station), the
460 MultiNet was hauled back on board, the cod ends were rinsed out with local seawater, and
461 their content was transferred to pre-cleaned 10-L HDPE bottles. The instrument was then
462 returned to the water. This operation (“cast”) had to be repeated several times (between two
463 and eight horizontal casts, depending on the station) until we got sufficient amounts of
464 plankton. At St19, due to technical issues, the MultiNet was replaced by a square net with a 1-
465 m² aperture mounted with single 60- μ m mesh-size net. Total filtered water volume with the
466 MultiNet/square net ranged from 314 (St2) to 2373 m³ (St10).

467 In the clean on-board container lab, plankton collected in HDPE bottles was then size-
468 fractionated on 1) a column of five stainless steel sieves (60, 200, 500, 1000 and 2000- μ m
469 mesh-size) by wet-sieving with the GF/F filtered seawater stored in stainless steel jerrycans
470 for subsequent analyses of organic parameters, and 2) a column of five nylon sieves (60, 200,
471 500, 1000 and 2000- μ m mesh-size) by wet-sieving with the GF/F filtered seawater stored in
472 the plastic container for the subsequent analyses of inorganic parameters (Fig. S2i, j). The

473 filtered seawater was routed with a gentle flow to the top of the sieve column by the ASTI
474 pump using Teflon tubing. The plankton size fractions recovered on the stainless-steel sieves
475 were shared out and transferred to pre-combusted glass flasks for the analyses of POC, PON,
476 $\delta^{13}\text{C}/\delta^{15}\text{N}$, biochemical compounds, PAHs, PCBs, PBDEs and PFASs, or to plastic flasks for
477 zooplankton taxonomy and imagery, TChla (60–200- μm size fraction only) and microbial
478 diversity (60–200 and 200–500- μm size fractions only). The plankton size fractions recovered
479 on the nylon sieves were shared out and transferred to pre-cleaned polypropylene flasks for
480 the analyses of trace metals/metalloids, Hg and ^{137}Cs (Fig. 3; Table S1; Fig. S5). Planktonic
481 biomass (in mg m^{-3} dry weight) was also determined in each of the size fractions (Fierro-
482 González et al., 2023). All samples were stored at $-20\text{ }^{\circ}\text{C}$ except those for zooplankton
483 taxonomy that were stored at ambient temperature after adding buffered formalin (Fig. S5).

484 *2.3.6. Plankton and micro-plastic sampling with Triple and Manta nets.* A triple
485 net, equipped with 60, 120 and 200- μm mesh-sized nets each with 0.60-m aperture diameter
486 was used to undertake two vertical tows over the depth 0–200 m (or 0–bottom if depth < 200
487 m), i.e., one tow for biomass, and one tow for taxonomy and imagery. The device was
488 deployed from port side using hydrology gallows (Table S1; Fig. S2k). After collection, the
489 cod-end contents from each of the three nets (first tow) were passed through GF/F filters that
490 were stored in Petri dishes at $-20\text{ }^{\circ}\text{C}$ for biomass measurements, while the cod-end contents
491 from the second tow were passed through a 60- μm sieve for volume reduction and transferred
492 to 250-mL plastic tubes amended with 12.5-mL buffered formalin for taxonomy and imagery
493 analyses. At St1, St9, S15 and St19, the contents of the 200- μm net were also collected to
494 analyse chlorophyll gut-contents of mesozooplankton (see section 2.3.8).

495 Two Manta nets were used for horizontal tows in surface waters: one a 330- μm mesh
496 size (1 tow, 3 knots, 20 min max) for microplastic analyses, and the other a 60- μm mesh size
497 (1 tow, 1 knot, 10 min max) for microplastics and plankton (neuston) analyses, both deployed

498 from port side using hydrology gallows ([Table S1](#)). After collection, the content of the 330-
499 μm Manta net was sieved successively through 5000 and 300- μm mesh-size sieves (if large
500 items were present in the collectors) and transferred to a 1-L glass bottle added with formalin
501 (4% final concentration). The content of the 60- μm Manta net was transferred to a 1-L glass
502 bottle added with 50-mL buffered formalin.

503 *2.3.7. In-line filtration onto cartridges.* At each station, in-line filtration was carried
504 out in the wet laboratory on seawater collected continuously at 2-m depth by the shipboard
505 pump system ([Table S1](#)). Two polypropylene cartridges (Polycap HD), the first with a 20- μm
506 pore size and the second with a 0.45- μm pore size, were mounted in series to recover the
507 0.45–20- μm and > 20- μm size fractions. Around 1000 L of seawater was filtered on the two
508 cartridges at each station. The dissolved fraction (< 0.45 μm) was collected in 20-L plastic
509 containers. These samples served for radionuclide analyses (^{137}Cs) ([Radakovitch et al., in](#)
510 [prep.](#)).

511 *2.3.8. Dilution experiments.* At St1, St9, S15 and St19, seawater collected from the
512 carousel bottles at 5-m depth and in the DCM was used to perform dilution experiments by
513 means of a thermostatic incubation chamber ([Table S1](#)). These experiments were
514 implemented to assess the phytoplankton production rates and microzooplankton grazing
515 rates. At the same stations, the contents of the 200- μm Triple nets (vertical tows) were used to
516 analyse the chlorophyll gut contents of mesozooplankton by fluorescence in order to estimate
517 the impact of mesozooplankton grazing on large phytoplankton (i.e., nano- and micro-
518 phytoplankton). These experiments and measurements served to determine the carbon fluxes
519 and type and structure of the planktonic food webs ([Medebb et al., in prep.](#)).

520 *2.3.9. Shipboard analyses.* Unfiltered and 0.2- μm -filtered seawater collected from
521 the carousel bottles at 5-m depth, in the DCM and at the other depths (profiles, OMZ) served
522 for shipboard analyses of total and purgeable Hg using a Tekran[®] auto-analyser (model 2500),

523 consisting in purge and trap of volatilized Hg species followed by cold vapour atomic
524 fluorescence spectrometry (CVAFS) detection (Table S1; Fig. S2m).

525 A part of the seawater collected continuously at 2-m depth by the shipboard pump
526 system was subsampled and routed to a CytoSense® automated flow cytometer (CytoBuoy)
527 installed in the dry laboratory. The CytoSense was employed to analyse (in terms of
528 identification and abundance) individual or colonial phytoplankton cells sized between 0.8
529 and 800 µm. Cytometry measurements were carried out continuously at the different stations
530 but also all along the transect (Table S1; Fig. S2l; Boudriga et al., 2022).

531 *2.3.10. Atmospheric deposition.* During the cruise, wet atmospheric deposition
532 samples were collected using two rain collectors placed in PVC pipes that were fixed at the
533 front of the ship (10 m above sea level). The collector for trace metal samples was composed
534 of an acid pre-cleaned, metal-free plastic bottle and funnel (Fig. S2n). The collector for PAH
535 samples was composed of a pre-combusted amber glass bottle and glass funnel (Table S1;
536 Fig. S2o). Overall, six rainwater samples were collected (Table 3): two at St10 (Rains 1 and
537 2), one at St11 (Rain 3), one at St19 (Rain 4), one during the transit from off Djerba island to
538 off Zarzis city (Rain 5, south of St19; Fig. 2a, b) (for both collectors), and one at St1 (Rain 6
539 only in the PAH collector). The “transit to Zarzis” sample was collected as a result of a dry
540 deposition episode (intense Saharan dust event). In this case, ultra-pure water was used to
541 rinse the plastic and glass funnels in order to retrieve all the dry fraction that had settled onto
542 them. Atmospheric samples collected during the cruise were frozen and stored at –20 °C (for
543 PAHs) or at 4 °C (for metals/metalloids), then filtered (at 0.2 or 0.7 µm) in the laboratory to
544 separate dissolved and particulate phases before treatments and analyses. Atmospheric
545 forecast bulletins were regularly sent to the on-board team to anticipate these rain events.
546 Detailed information on the rain samples collected during the cruise can be found in Table 3.

547 Glass collectors were also set up in two ground stations located in the northern part
548 (Marseille, France) and southern part (Sfax, Tunisia) of the Mediterranean basin (Fig. 2a; Fig.
549 S2p) for sampling total (dry and wet) atmospheric deposition and running the subsequent
550 PAH analyses. This sampling was done on a regular basis (bi-monthly, monthly, or daily in
551 the case of strong rainfall events) from March 2019 to June 2020, i.e., before, during, and
552 after the cruise (Poindron et al., in prep.).

553 2.3.11. On-vessel scientific equipment and continuous measurements.

554 Subsurface temperature and salinity were recorded continuously at high frequency all along
555 the transect from flow-through pumped seawater at 2-m depth, using a thermosalinograph
556 (TSG, SeaBird SBE 21). A weather station (Batos 1.1 D, Météo France) continuously
557 recorded atmospheric parameters (temperature, wind, pressure, humidity, PAR).

558

559 2.4. The sequence of operations and main parameters analysed on the 560 different size fractions

561 The typical sequence of at-sea/on-board operations conducted from the R/V *Antea* at
562 each station is given in Table S2. The whole sequence of operations at each station lasted 48 h
563 on average but varied depending on meteorological conditions encountered and occasional
564 technical problems. The detailed sequence and timing of the main operations performed
565 during the whole cruise are presented in Table S3, and the total number of operations
566 completed is provided Table S4. Table S5 reports the time and depth of sampling (mostly in
567 the DCM) at each station for the three main operations at sea: the water sampling with the
568 carousel/Niskin and Go-Flo bottles, *in situ* filtration with the McLane pumps, and plankton
569 sampling with the MultiNet. Table S6 summarises the main parameters analysed on the
570 different size fractions (from < 0.2 to > 2000 µm) recovered from filtration and sieving after
571 the collecting large amounts of plankton, particles, and water in the DCM and

572 surface/subsurface waters (0–5 m depth), i.e., 1) contaminants, with trace metals,
573 organometals and metalloids (As, Cd, Cr, Cu, Fe, Hg, MeHg, Mn, Ni, Pb, Sb, Zn, etc.),
574 organic contaminants (PAHs, PCBs, PBDEs, PFASs), radionuclides (^{137}Cs) and microplastics,
575 2) plankton biomass, size structure, taxonomy, cytometry, diversity, and pigment
576 composition, and 3) biogeochemical parameters, including nutrients [$\text{Si}(\text{OH})_4$, NO_3^- , NO_2^- ,
577 NH_4^+ , PO_4^{3-}], TChl a , SPM, dissolved and particulate organic matter (POC, PON, DOC,
578 a_{CDOM}), C and N isotopic ratios ($\delta^{13}\text{C}$, $\delta^{15}\text{N}$), and biochemical compounds (carbohydrates,
579 proteins, lipids).

580

581

582 **3. Environmental context during the cruise**

583

584 **3.1. Meteorological context**

585 Atmospheric deposition is known to be an external source of metals and PAHs (Castro-
586 Jimenez et al., 2012; Jordi et al., 2012; Desboeufs et al., 2022) as well as of nutrients (Guieu
587 et al., 2020) for Mediterranean surface seawater. The cruise was conducted during the spring,
588 when dust deposition events were commonplace in the Western Mediterranean (Guieu et al.,
589 2020). During the cruise, the Aerosol Optical Depth (AOD) maps derived from the Spinning
590 Enhanced Visible and InfraRed Imager (SEVIRI) satellite instrument ([https://www.icare.univ-](https://www.icare.univ-lille.fr/data-access/browse-images/geostationary-satellites/)
591 [lille.fr/data-access/browse-images/geostationary-satellites/](https://www.icare.univ-lille.fr/data-access/browse-images/geostationary-satellites/); Thieuleux et al., 2005)
592 highlighted two dust transports with high AOD (> 0.8) through the Mediterranean Sea: one
593 that occurred between 17 and 26 April 2019 (Fig. 4a; Fig. S6) and a second that occurred
594 between 3 and 4 May 2019 (Fig. 5a; Fig. S7). These events were associated with significant
595 cloud cover (Fig. 4b, 5b). The Non-hydrostatic Multiscale Model/Barcelona Supercomputing
596 Centre (NMMB/BSC)-Dust model and NASCube (<http://nascube.univ-lille1.fr/>; Gonzales and

597 [Briottet, 2017](#)) confirmed the emission and export of dust plumes from North Africa to over
598 the Western Mediterranean. The atmospheric dynamics and patterns of the first event are
599 described in detail in [Calidonna et al. \(2020\)](#). This event was associated with a northward
600 atmospheric flux loaded by dust emission from Algeria and southern Morocco. The second
601 dust plume was transported from Algeria and Tunisia by north-eastward winds (not shown).

602 For the April event, dust plume transport was mainly associated with wet deposition
603 from NMMB/BSC-Dust model forecasts, in agreement with the intensely cloudy conditions
604 ([Fig. 4c, d](#)). The geographic range of dust deposition events covered a region from the
605 Balearic basin to the Tyrrhenian Sea and then the Ligurian Sea ([Fig. 4a-d](#)), i.e., the vicinity of
606 R/V's locations during St10 and St11 between 20 and 23 April and then on 25 April along the
607 Western coastline of Sardinia ([Table 1](#)). The model predictions were confirmed by visual on-
608 board observations of precipitations around and above the R/V's location, corresponding to
609 the first three rain samples (Rains 1, 2 and 3) ([Table 3](#)). Note that wet dust deposition started
610 from the afternoon of 22 April after the R/V's arrival on St10, thus ruling out a direct impact
611 of dust deposition on the first cast completed at this station. However, rain events probably
612 impacted surface waters over a large region around the R/V's location during St10 and St11.

613 For the event in May, NMMB/BSC-Dust model forecasts point mainly to dry dust
614 deposition occurring between 3 and 4 May over the Gulf of Gabès and the Libyan coast ([Fig.](#)
615 [5c, d](#)). During this event, the R/V was at St19 in the southern Gulf of Gabès then in transit to
616 Zarzis ([Table 1](#); [Table S3](#)). Dry dust deposition was confirmed by visual observations of
617 dusty sky and substantial deposited dust material on the decks of the R/V between 3 and 4
618 May. The Rain 5 sample was collected during this event ([Table 3](#)). The inflow of desert dust
619 was also consistent with the highest temperatures and lowest pressures recorded by ship's
620 permanent instrumentation ([Fig. S8](#)). It is therefore very likely that this event represented a
621 supply of metal-bearing dust to the surface waters.

622 Outside of these desert dust transport periods, Hybrid Single-Particle Lagrangian
623 Integrated (HYSPLIT) back trajectories modelling showed that the air masses around the R/V
624 position came from Europe (not shown). Nevertheless, no intense pollution event was either
625 observed or predicted during the cruise from satellite or model outputs. Moreover, no
626 volcanic emissions from Etna were recorded during the cruise.

627

628 **3.2. Hydrological context**

629 Subsurface (2-m depth) temperature gradually increased from north to south of the
630 transect, whereas subsurface salinity decreased from North to South but increased again at the
631 extreme south of the transect (Gulf of Gabès) (Fig. 6). The lowest subsurface temperatures (~
632 14.0 °C) were recorded in the Bay of Marseille, while the highest subsurface temperatures
633 (19.5 °C) were observed in the south of the Gulf of Gabès, near Djerba and Zarzis. The
634 highest subsurface salinity values were found in the Ligurian region (38.5) and the lowest
635 (37.1) in the northern Tunisian coastal waters, particularly in the Gulf of Tunis (Fig. 2a, 6;
636 Fig. S1). Because of the vast and contrasted area covered by the cruise, CTD profiles
637 displayed huge variability with depth in temperature and salinity and in TChla and dissolved
638 O₂ concentrations between stations (Fig. 7, 8). Despite this high variability, some similarities
639 emerged. For the stations off French shores (St1–St4), temperature, salinity and TChla values
640 over the water column ranged from 13.6–14.9 °C, 37.8–38.4 and 0.02–0.86 µg L⁻¹,
641 respectively, with a slight decrease in temperature and a slight increase of salinity towards the
642 bottom (Fig. 7). Offshore stations (St9–St11) also showed a decrease in temperature and
643 increase of salinity with depth, but with a greater range of variation (compared to the stations
644 along the French coast) in terms of temperature (13.4–15.5 °C), salinity (37.3–38.7) and
645 TChla concentrations (0.00–1.49 µg L⁻¹) with manifestly deeper thermoclines and haloclines
646 (Fig. 7, 8). TChla concentrations were particularly high at St9 (Fig. 7). St11 was marked by a

647 significant increase in both temperature and salinity between 200 and 400 m followed by a
648 decrease between 400 and 430 m before remaining stable down to the bottom (Fig. 8).
649 Tunisian stations (St15–St19) showed higher water column temperatures (14.7–17.9 °C) and
650 lower salinities (37.2–37.8) compared to stations further north, in accordance with subsurface
651 data (Fig. 6), and lower TChl a concentrations (0.02–0.70 $\mu\text{g L}^{-1}$) compared to the
652 northernmost stations. At these Tunisian stations, thermoclines, haloclines and DCM were
653 located relatively deep in the water column, although St17 displayed much more
654 homogeneous profiles (Fig. 8).

655 T–S diagrams allowed us to identify the main water masses encountered at each station
656 (Fig. 9). At the northern stations (St1–St4) with temperatures of 13.6–14.9 °C and salinities of
657 37.8–38.4 over 0–150-m depths, we detected (modified) Atlantic Water (AW) coming mainly
658 from the Ligurian Sea and flowing along the continental slope with Ligurian-Provençal
659 current. These “resident” AW (RAW), which have been in the Mediterranean for a long time,
660 have been modified and are saltier (and warmer) than the AW that arrived more recently
661 through the Strait of Gibraltar (Millot and Taupier-Letage, 2005; Balbín et al., 2014). Moving
662 south, St9 was characterised by the presence of RAW over the depth 0–300 m and Levantine
663 Intermediate Water (LIW) over the depth 300–500 m (Fig. 9). LIW is formed in the Eastern
664 Mediterranean Basin by the combined effect of wintertime cooling and summertime
665 evaporation, leading to a warm (temperatures of 13.8–16 °C) and salty (salinities of 38.3–39)
666 intermediate layer that is visible over the whole Mediterranean Sea (Lascaratos et al., 1993;
667 Balbín et al., 2014; Margirier et al., 2020). Once formed, the LIW spreads throughout the
668 entire Eastern and Western Basins and can be identified through a salinity maximum at
669 between ~ 200 and 600-m depth in the Western Basin before it eventually flows out of the
670 Mediterranean Sea as one of the main components of Mediterranean outflow water (Ben
671 Ismail et al., 2012; Vargaz-Yanez et al., 2012). In addition, the presence of Western

672 Mediterranean Intermediate Water (WIW) was detected at St9 around 100-m depth with
673 temperatures of 13.2–13.9 °C and salinities of 38.4–38.6 (Fig. 7, 9). The WIW forms during
674 winter in the Northwestern Mediterranean Basin due to surface cooling of RAW and
675 intermediate convection (Salat and Font, 1987; Gasparini et al., 1999) and has been recorded
676 in the Algerian Basin by Benzohra and Millot (1995) and in the Sicily Channel by Ben Ismail
677 et al. (2012), flowing eastwards below the AW in the Algerian Current through the Channel
678 of Sardinia. The WIW is characterised by a relative minimum potential temperature located
679 between 100 and 200-m depth. The circulation of WIW has only been investigated in the
680 Algerian Basin, and there is speculation that it follows the same flow paths as the overlying
681 AW (Millot, 1999). St10 and St11 showed weak signature of the WIW and the presence of
682 marked LIW indicating a dominant influence of the northward advection of LIW rather than
683 winter cooling in the water column. The LIW water was well evident in St11, the closest
684 station to the Sardinia Channel (Fig. 8, 9). At the northernmost tip of the Tunisian coast, the
685 water temperature progressively increased and the salinity decreased, revealing the presence
686 of fresher or “new” AW (NAW) coming from the Algerian Basin. The water column arriving
687 at St15, located in the Gulf of Hammamet, was mostly made up of RAW and NAW with
688 temperatures of 14.8–17.5 °C and low salinities of 37.1–37.8 from surface to bottom. Moving
689 southward toward the Gulf of Gabès (GG), the temperature and salinity increased sharply to
690 reach 17.1 °C and 37.5 at St17 and 17.9 °C and 37.8 at St19 (Fig. 8, 9).

691

692 **3.3. Biogeochemical context**

693 The analytical methods used to determine biogeochemical parameters presented in this
694 section are detailed in Text S1. Considering the whole cruise period, the average (over 32
695 days) surface TChl a concentration derived from satellite data was higher at St9 (~ 1 $\mu\text{g L}^{-1}$)
696 than in the other stations (< 1 $\mu\text{g L}^{-1}$) (Fig. 10). The higher content of phytoplankton biomass

697 at St9 was also corroborated in the TChla concentrations actually recorded during the cruise
698 at 5-m depth, either from CTD measurements or analyses on discrete samples (with a
699 significant correlation between both measurements: $r = 0.98$, $n = 10$, $p < 0.0001$; [Table S7](#)). In
700 line with the discrete samples, the highest TChla concentrations at 5-m depth were found at
701 St9 ($2.90 \mu\text{g L}^{-1}$) followed by St4 ($1.57 \mu\text{g L}^{-1}$) and St1 ($0.84 \mu\text{g L}^{-1}$), while the lowest TChla
702 concentrations were observed at St17 ($0.15 \mu\text{g L}^{-1}$) and St15 ($0.10 \mu\text{g L}^{-1}$) ([Table S7](#)).

703 DCM was shallowest at St4 (13 m), St1 and St9 (20 m) and deepest at St10 (51 m), St2,
704 St3 (53 m) and St15 (66 m) ([Fig. 7, 8, 11a](#); [Table S7](#)). TChla in the DCM followed a fairly
705 similar pattern of distribution to TChla at 5-m depth, with a significant correlation between
706 both measures based on both CTD and discrete sample data ($r = 0.64\text{--}0.92$, $n = 10$, $p =$
707 $0.0001\text{--}0.048$). TChla concentrations measured on discrete samples from the DCM were
708 highest at St9 ($1.54 \mu\text{g L}^{-1}$), in line with the surface/subsurface TChla data ([Fig. 10](#)). High
709 TChla concentrations were also recorded south of the Gulf of Gabès (at St19: $1.45 \mu\text{g L}^{-1}$)
710 ([Fig. 11b](#); [Table S7](#)), even though at this station it was not really a DCM that was observed
711 but rather a bottom-lying bead, as can often be observed for shallow coastal stations. St4 and
712 St1 showed fairly high TChla concentrations of 0.98 and $0.77 \mu\text{g L}^{-1}$, respectively. The lowest
713 TChla concentrations in the DCM were found at St17 ($0.21 \mu\text{g L}^{-1}$), St2, and St11 ($0.38 \mu\text{g L}^{-1}$)
714 ([Fig. 11b](#); [Table S7](#)).

715 The North-to-South distribution of other biogeochemical parameters measured in the
716 DCM presented interesting features. POC concentration had a fairly similar pattern of
717 distribution to TChla, with decreasing values from St1 to St3, a maximal value at St9 (156.4
718 $\mu\text{g L}^{-1}$), then a decrease up to St17, and finally a higher value at St19 ($55.9 \mu\text{g L}^{-1}$) ([Fig. 11c](#);
719 [Table S7](#)). Si(OH)_4 concentration followed much the same pattern but with an increase from
720 St1 to St3 and a maximal value at both St9 and St19 ($\sim 2.00 \mu\text{M}$) ([Fig. 11d](#); [Table S7](#)). NO_3^-
721 concentration increased from St1 to its peak at St3 ($1.31 \mu\text{M}$), was still high at St9 ($0.96 \mu\text{M}$),

722 and then decreased along to St17–St19 (Fig. 11e; Table S7). PO_4^{3-} concentration was
723 particularly high at St3 (0.31 μM) and St19 (0.55 μM) (Fig. 11f; Table S7). Finally, DOC
724 concentration and a_{CDOM} decreased from St1 to St9 or St10 then increased up to St19 where
725 they reached maximal values (76.2 μM and 2.05 m^{-1} , respectively) (Fig. 11g, h; Table S7).

726 Principal component analysis (PCA) based on the Pearson's correlation matrix was
727 applied on these biogeochemical parameters recorded in the DCM at each station (Fig. 12).
728 The first principal component (PC1), which explained 47% of total variance within samples,
729 was mainly driven by PO_4^{3-} , DOC, a_{CDOM} , and to a lesser extent TChla and $\text{Si}(\text{OH})_4$. The
730 second principal component (PC2), which accounted for 34% of total variance, was driven by
731 POC, NO_3^- , TChla, and $\text{Si}(\text{OH})_4$. Four groups of samples (stations) emerged from this PCA:
732 1) St2, St3, St4, St10, characterised by moderate concentrations of nutrients and TChla and a
733 low organic matter content; 2) St1, St11, St15, St17, with the lowest concentrations in
734 nutrients and TChla (except St1); 3) St9, which showed the highest in $\text{Si}(\text{OH})_4$, NO_3^- , TChla
735 and POC concentrations, and the lowest PO_4^{3-} and DOM contents; 4) St19, which showed the
736 highest concentrations in $\text{Si}(\text{OH})_4$, TChla (equivalent to those of St9), PO_4^{3-} and DOM as well
737 as high POC and low NO_3^- concentrations (Fig. 12).

738 Overall, the levels of TChla, nutrients and other biogeochemical parameters observed
739 along the North-South transect in the subsurface waters and DCM in spring 2019 during the
740 MERITE-HIPPOCAMPE cruise are consistent with previous observations in the
741 Mediterranean Sea (The Mermex Group, 2011; Salgado-Hernanz et al., 2019; Guieu et al.,
742 2020; Marañón et al., 2021). The TChla levels in the different stations were also consistent
743 with their positioning in terms of bloom-condition areas and consensus regions defined by
744 D'Ortenzio and d'Alcalà (2009) and Ayata et al. (2018). TChla concentrations tended to be
745 higher at stations located north of the North Balearic front (St1–St4, St9) than stations located
746 south (St10, St11, St15, St17, St19).

747 Interestingly, two stations, St9 and St19, clearly stood apart from the others in terms of
748 biogeochemical content (Fig. 11, 12). St9 was situated at the boundary of the Ligurian
749 consensus region, in the wintertime deep convection area. Time-series of water temperature
750 recorded at different depths at the LION mooring (42° 02' N, 4° 40' E) highlighted a
751 deepening of the mixed layer depth and thus the convection process down to 1500-m depth
752 within the Ligurian area in early February 2019 (Fig. S9). In late March 2019, the end of the
753 convection process induced the occurrence of an intense phytoplankton bloom in the same
754 area (Fig. S9). This illustrates the fact that 2019 was a relatively convective and productive
755 year (Margirier et al., 2020; Bosse et al., 2022), and that St9, located at the border of this
756 convective and productive zone, still presented high concentrations of TChla, POC and some
757 nutrients in the May 2019 sampling period.

758 The high levels of TChla, Si(OH)₄, PO₄³⁻, DOM, and POC encountered at St19 south of
759 the Gulf of Gabès is probably related to the Saharan dust deposition event (see section 3.1),
760 but the effect of sediment resuspension cannot be excluded due to high wind speeds during
761 this period (Fig. S8). In the Gulf of Gabès, TChla concentrations can reach > 1 µg L⁻¹ close to
762 the coast of Djerba and Kerkennah Islands during the spring season (Bel Hassen et al., 2009).
763 The Gulf of Gabès is known to be regularly submitted to Saharan dust deposition (Béjaoui et
764 al., 2019). This Saharan dust, enriched in phosphorus, has been shown to induce
765 phytoplankton blooms in the Gulf (Hamza et al., 2016; Béjaoui et al., 2019), and as described
766 above, intense Saharan dust deposition events occurred in this area during the cruise, for
767 which we collected on-board rain and particle samples (Table 3; Fig. 5; Fig. S7, S8).
768 Furthermore, in this shallow ecosystem submitted to strong tides and resulting currents,
769 disturbance and resuspension of sediments could release elements such as nutrients and
770 organic matter into the water column, which in turn may stimulate planktonic activity (Bel
771 Hassen et al., 2009; Fourati et al., 2018; Zouch et al., 2018).

772

773

774 **4. Overview of the types of articles produced through the cruise**

775

776 [Fig. 13](#) shows the types of articles that are a part of this special issue in the frame of the
777 MERITE-HIPPOCAMPE cruise. There are a series of articles concerning the transfer and
778 accumulation of contaminants in planktonic food webs in the DCM but also in
779 surface/subsurface waters. These articles present: 1) contaminant concentrations in the
780 different planktonic/particulate size fractions and, for several of them, in the dissolved phase
781 of water (see [Table S6](#) for the size fractions–contaminant analysis correspondence), and 2)
782 their resulting factors of bioconcentration, bioaccumulation or food accumulation. The
783 contaminants investigated are trace metals/metalloids (Cr, Mn, Fe, Co, Ni, Cu, Zn, As, Se,
784 Mo, Ag, Cd, Sb, Pb...) ([Chifflet et al., 2023](#)), with a focus on Cu and Zn isotopes ([Chifflet et
785 al., 2022](#)), Hg and MeHg ([Tesán Onrubia et al., in prep.](#)), PAHs ([Guigue et al., in prep.](#)),
786 PCBs, PBDEs, PFASs ([Tronczynski et al., in prep.](#)), and radionuclides (^{137}Cs) ([Radakovitch
787 et al., in prep.](#)). Another work will treat of the abundance and composition of microplastics in
788 both surface waters and the DCM ([Fig. 13](#)).

789 There are also a series of articles dealing with the composition and structure of
790 planktonic food webs. Indeed, the paper by [Tesán Onrubia et al. \(2023\)](#) on the stable C and N
791 isotopes ($\delta^{13}\text{C}$, $\delta^{15}\text{N}$) and biochemical content (lipids, carbohydrates, proteins) of the different
792 planktonic size fractions serves to highlight the structure of planktonic food webs and the
793 transfer of organic matter within them, and to assess the factors of trophic accumulation used
794 in the contaminant-related papers. Moreover, several articles use the cytometry and
795 taxonomy/microscope analyses, imaging (zooscan, flowcam), optical *in situ* measurements
796 (LOPC, LISST-HOLO) and/or 16S and 18S rRNA high-throughput sequencing analyses to

797 cover the abundance, biomass, distribution, size structure, and composition/diversity of the
798 following planktonic groups, mostly for the DCM but also for surface/subsurface waters or
799 even within the 0–200-m depth layer (see [Table S6](#) for the correspondence with size
800 fractions): pico-, nano- and micro-phytoplankton ([Boudriga et al., 2022](#); [Bellaaj Zouari et al.,](#)
801 [in prep.](#)), micro- and meso-zooplankton and their biomass ratio with detritus ([Fierro-González](#)
802 [et al., 2023](#)), as well as free-living and plankton-associated bacterioplankton (heterotrophic
803 prokaryotes) ([Bellaaj Zouari et al., in prep.](#); [Quéméneur et al., in prep.](#)), and nano- and micro-
804 zooplankton related to the microbial loop ([Bellaaj Zouari et al., in prep.](#)). In addition, a
805 complementary paper proposes a methodological approach for the study of the microbiota
806 associated with plankton ([Cabrol et al., in prep.](#)). Also, the effect of the Saharan dust
807 deposition event on pico- and nano-phytoplankton community in the south of Gabès is
808 covered by [Boudriga et al. \(in prep.\)](#). Overall, these articles will allow us to understand which
809 planktonic groups are present and how they influence/participate in transfers of contaminants
810 within planktonic networks. Our understanding of the contaminant transfer processes at work
811 within planktonic food webs is also enhanced by the dilution experiments and the subsequent
812 determination of phytoplankton production rates and micro- and meso-zooplankton grazing
813 rates ([Meddeb et al., in prep.](#)) ([Fig. 13](#)), as well as the grazing and excretion rates estimated
814 from the zooplankton size-structure according to allometric relationships allowing an
815 estimation of grazing pressure and nutrient recycling by the metazooplankton ([Fierro-](#)
816 [González et al., 2023](#)).

817 Looking beyond plankton, there is one article dedicated to $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ stable isotopes
818 and concentrations of Hg, PAHs and PCBs in small pelagic fishes collected in Tunisian
819 waters ([Lajnef et al., in prep.](#)). This study should provide valuable pointers to help establish a
820 link between the contamination of plankton and the contamination of higher trophic levels.
821 The concentrations of trace metals and PAHs in wet (rain) atmospheric deposition samples

822 collected during the cruise and on land is investigated to assess the role of dry/wet
823 atmospheric deposition as a source of contaminants in surface marine waters (Poindron et al.,
824 in prep.). Finally, the overall transport patterns and hydrodynamic context of the cruise using
825 modelling and satellite data, and their potential implication for contaminant origin and
826 distribution are addressed by Rwawi et al. (in prep.) (Fig. 13).

827

828

829 **Data availability**

830 All data from the MERITE-HIPPOCAMPE cruise (<https://doi.org/10.17600/18000900>;
831 Tedetti and Tronczynski, 2019) is stored in the MISTRALS-SEDOO database
832 (<https://mistrals.sedoo.fr/MERITE/>) and will be made publicly accessible once all the articles
833 related to the cruise are published in the present special issue. In the meantime, data can be
834 obtained upon request from the corresponding author. In addition, navigation data and CTD
835 profiles from the MERITE-HIPPOCAMPE cruise are available *via* the IFREMER/SISMER
836 database (<https://data.ifremer.fr/SISMER>).

837

838

839 **Author contribution statement**

840 All the authors participated in the MERITE-HIPPOCAMPE project and design of the
841 manuscript.

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859

860

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915

916

917 **Supplementary information**

918 Supplementary material related to this article is available online at: xxx

919

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1312 **Figure captions**

1313

1314 **Figure 1.** Conceptual scheme and questions addressed by the MERITE-HIPPOCAMPE
1315 cruise to identify the role of Mediterranean plankton as biological pump of contaminants. It
1316 considers the accumulation and transfer of metallic/metalloid/organometallic and organic
1317 contaminants at the atmosphere-water-plankton interfaces and through the planktonic food
1318 webs, i.e., phyto-, zoo- and bacterio-plankton, with the deep chlorophyll maximum (DCM) as
1319 privileged study zone.

1320

1321 **Figure 2.** a) Location of the ten stations (black circles) investigated during the MERITE-
1322 HIPPOCAMPE cruise (13 April–14 May 2019) along a North-South transect in the
1323 Mediterranean Sea on board the R/V *Antea*. The main characteristics of these stations are
1324 provided in [Table 1](#). In addition, two other stations (T2 and T4, brown circles) were sampled
1325 in the Tunisian waters during leg 2 (2–3 May 2019) on board the R/V *Hannibal* for trawling
1326 of small pelagic fishes (see [Table 2](#) for more details). Two ground stations, located in the
1327 northern part (Marseille, France) and southern part (Sfax, Tunisia) of the Mediterranean
1328 basin, were set up for the collection of atmospheric deposition samples from March 2019 to
1329 June 2020 (i.e., before, during and after the cruise). b) Cruise track with the position of the ten
1330 stations studied on board the R/V *Antea*. During leg 1 (13–28 April; from La Seyne-sur-Mer
1331 to Tunis), five stations were sampled: St2, St4, St3, S10 and St11 (in this chronological
1332 order), while the five other stations were sampled during leg 2 (30 April–14 May; from Tunis
1333 to Gulf of Gabès, and then return to La Seyne-sur-Mer): St15, St17, St19, St9 and St1 (in this
1334 chronological order).

1335

1336 **Figure 3.** Summary of our approach with 1) the collection of large amounts of plankton,
1337 suspended particles, and water in the deep chlorophyll maximum (DCM) and
1338 surface/subsurface waters (0–5 m depth) with various collecting instruments, 2) the separation
1339 of these materials into diverse size fractions by sieving or filtration, and the sharing of the
1340 obtained size fractions for numerous biological and chemical analyses. Adapted from [Alcaraz](#)
1341 [and Calbet \(2003\)](#).

1342

1343 **Figure 4.** Saharan dust event of April. Here is presented for 22 April 2019 which is the day
1344 where the dust plume was the most intense: a) Daily Aerosol Optical Depth (AOD, unitless)
1345 product from MSG-SEVIRI, b) MODIS image from NASA worldview, and BSC-DREAM-
1346 Dust forecast of c) dry and d) wet deposition (in mg m^{-2}).

1347

1348 **Figure 5.** Saharan dust event of May. Here is presented for 3 May 2019 which is the day
1349 where the dust was located over ship's position: a) Daily Aerosol Optical Depth (AOD,
1350 unitless) product from MSG-SEVIRI, b) MODIS image from NASA worldview, and BSC-
1351 DREAM-Dust forecast of c) dry and d) wet deposition (in mg m^{-2}).

1352

1353 **Figure 6.** Distribution of subsurface **a)** temperature ($^{\circ}\text{C}$) and **b)** salinity along the North-
1354 South Mediterranean transect recorded continuously from the flow-through pumped seawater
1355 at 2-m depth. Ocean Data View (ODV) software version 4.6.5. Schlitzer, R.,
1356 <http://odv.awi.de>. 2014.

1357

1358 **Figure 7.** Vertical profiles of temperature ($^{\circ}\text{C}$), salinity, TChla concentration ($\mu\text{g L}^{-1}$) and
1359 dissolved O_2 concentration ($\mu\text{mole kg}^{-1}$) issued from the main carousel CTD deployments
1360 (Seabird SBE 911*plus*) at stations St1–St9. The dotted lines represent the depth of sampling in

1361 the deep chlorophyll maximum (DCM) for Niskin/Go-Flo bottles. In box, the depth of the
1362 station. One or two profiles are displayed for each station. For each profile, only data acquired
1363 during the upcast are presented.

1364
1365 **Figure 8.** Vertical profiles of temperature ($^{\circ}\text{C}$), salinity, TChla concentration ($\mu\text{g L}^{-1}$) and
1366 dissolved O_2 concentration ($\mu\text{mole kg}^{-1}$) issued from the main carousel CTD deployments
1367 (Seabird SBE 911*plus*) at stations St10–St19. The dotted lines represent the depth of sampling
1368 in the deep chlorophyll maximum (DCM) for Niskin/Go-Flo bottles. In box, the depth of the
1369 station. One or two profiles are displayed for each station. For each profile, only data acquired
1370 during the upcast are presented.

1371
1372 **Figure 9.** Temperature-salinity diagram and identification of the main waters masses
1373 encountered during the MERITE-HIPPOCAMPE cruise (RAW: resident Atlantic Water;
1374 NAW: new Atlantic Water; LIW: Levantine Intermediate Water; WIW: Western
1375 Mediterranean Intermediate Water; GG: Gulf of Gabès water). The colour code refers to a)
1376 depth (in m) and b) stations (St1–St19). Twenty-one carousel CTD casts were used for this
1377 plot. Ocean Data View (ODV) software version 4.6.5. Schlitzer, R., <http://odv.awi.de>. 2014.

1378
1379 **Figure 10.** Composite image of average surface chlorophyll *a* (Chla) concentration (in $\mu\text{g L}^{-1}$)
1380 over the period (13 April–14 May 2019) and area of the MERITE-HIPPOCAMPE cruise
1381 from Multi Satellite products (MODIS-AQUA, NOAA20-VIIRS, NPP-VIIRS and
1382 Sentinel3A-OLCI) (L4 product level, 1-km resolution; [Volpe et al., 2019](#)). This composite
1383 image corresponds to the average of the 32 daily images (from 13 April to 14 May 2019) for
1384 which Chla concentration was averaged during the 8 h of measurements in the area. Product

1385 name: OCEANCOLOUR_MED_CHL_L4_REP_OBSERVATIONS_009_078. Obtained
1386 from EU Copernicus Marine Service Information (CMEMS; <https://marine.copernicus.eu/>).
1387

1388 **Figure 11.** Distribution of various biogeochemical parameters recorded at the deep
1389 chlorophyll maximum (DCM) across the ten stations, from the most coastal stations in the
1390 North (St1, St4) to the southernmost stations (St17, St19): a) depth of the DCM (in m),
1391 concentrations in b) total chlorophyll *a* (TChl*a*, in $\mu\text{g L}^{-1}$), c) particulate organic carbon
1392 (POC, in $\mu\text{g L}^{-1}$), d) silicates [$\text{Si}(\text{OH})_4$, in μM], e) nitrates (NO_3^- , in μM), f) phosphates (PO_4^{3-}
1393 , in μM), g) dissolved organic carbon (DOC, in μM), and h) absorption of chromophoric
1394 dissolved organic matter at 254 nm (a_{CDOM} , in m^{-1}). Nutrients, DOC and a_{CDOM} were
1395 measured on the fraction $< 0.7 \mu\text{m}$, while TChl*a* and POC were measured on the fraction $>$
1396 $0.7 \mu\text{m}$ from samples collected with Niskin X bottles.

1397
1398 **Figure 12.** Principal component analysis (PCA), based on the Pearson's correlation matrix,
1399 applied on the main biogeochemical parameters recorded at each stations (St1–19) in the deep
1400 chlorophyll maximum (DCM): concentrations in silicates [$\text{Si}(\text{OH})_4$, in μM], nitrates (NO_3^- , in
1401 μM), phosphates (PO_4^{3-} , in μM), total chlorophyll *a* (TChl*a*, in $\mu\text{g L}^{-1}$), particulate organic
1402 carbon (POC, in $\mu\text{g L}^{-1}$), dissolved organic carbon (DOC, in μM) and absorption of
1403 chromophoric dissolved organic matter at 254 nm (a_{CDOM} , in m^{-1}). Projection of variables (i.e.,
1404 main biogeochemical parameters, in red) and distribution of samples (i.e., stations, in blue) on
1405 the first factorial plane (PC1 *versus* PC2). Four groups of samples (stations) are highlighted
1406 from this PCA and confirmed by a hierarchical ascendant classification (dissimilarity
1407 measurement between clusters based on Ward's method): 1) St2, St3, St4, St10, 2) St1, St11,
1408 St15, St17, 3) St9, and 4) St19.

1409

1410 **Figure 13.** Overview of the types of articles that are a part of this special issue in the frame of
1411 the MERITE-HIPPOCAMPE cruise.

1412 **Table 1.** Main characteristics of the ten stations investigated in spring during the MERITE-HIPPOCAMPE cruise (13 April–14 May 2019) on
 1413 board the R/V *Antea* along a North-South transect in the Mediterranean Sea. The stations are presented in chronological order in leg 1 then leg 2.
 1414

Leg	Station	Latitude (N)	Longitude (E)	Location	Features	Area	Depth (m)	Start of operations (dd/mm in 2019)	End of operations (dd/mm in 2019)
1	St2	42° 56.020'	5° 58.041'	Offshore Toulon	Limit of the continental shelf; Boundary of the Ligurian consensus region ^d ; Intermittently bloom area or bloom area (cluster #4 or #5) ^e	French	1770	14/04	16/04
	St4	43° 14.500'	5° 17.500'	Bay of Marseille (SOLEMIO ^a station)	Urbanised bay; Intermittently bloom area or bloom area (cluster #4 or #5) ^e	French	58	16/04	18/04
	St3	43° 08.150'	5° 15.280'	Offshore Marseille (JULIO ^b station)	Southeast entrance to the Gulf of Lion; Intrusions of the Ligurian-Provençal current; Intermittently bloom area or bloom area (cluster #4 or #5) ^e	French	95	18/04	20/04
	St10	40° 18.632'	7° 14.753'	Offshore (station 2 of PEACETIME cruise ^c)	Slightly north of the North Balearic Front; Intermittently bloom area (cluster #4) ^e	Italian	2791	22/04	24/04
	St11	39° 07.998'	7° 41.010'	Offshore (station 3 of PEACETIME cruise ^c)	South of the North Balearic Front; Algerian consensus region ^d ; Presence of mesoscale eddies; No bloom area (cluster #3) ^e	Italian	1378	25/04	26/04

2	St15	36° 12.883'	11° 07.641'	Gulf of Hammamet	Close to the Sicily Channel; Possible entrance of Atlantic Tunisian Current branch; No bloom area (cluster #3) ^e ; High density of small pelagic fishes	Tunisian	100	29/04	30/04
	St17	34° 30.113'	11° 43.573'	North of Gulf of Gabès	Gabès consensus region ^d boundary; Shallow area, influence of tides and Atlantic Tunisian Current; Coastal bloom area (cluster #6) ^e ; High density of small pelagic fishes	Tunisian	50	01/05	02/05
	St19	33° 51.659'	11° 18.509'	South of Gulf of Gabès	Gabès consensus region ^d ; Shallow area, influence of tides and Atlantic Tunisian Current; Coastal bloom area (cluster #6) ^e ; High density of small pelagic fishes	Tunisian	50	02/05	05/05
	St9	41° 53.508'	6° 19.998'	Offshore (station 1 of PEACETIME cruise ^e)	North of the North Balearic Front; Boundary of the Ligurian consensus region ^d ; Winter convection area; Bloom area (cluster #5) ^e	French	2575	08/05	09/05
	St1	43° 03.819'	5° 59.080'	Bay of Toulon	Nearly closed urbanised bay; Intermittently bloom area or bloom area (cluster #4 or #5) ^e	French	91	10/05	11/05

1415 ^a The SOLEMIO station (*Site d'Observation Littoral pour l'Environnement du MIO*) is part of the French national network of coastal observation SOMLIT
1416 (*Service d'Observation en Milieu LITtoral* – <http://somlit.epoc.u-bordeaux1.fr/fr/>).

1417 ^b The JULIO station (*JUdicious Location for Intrusions Observations*) is dedicated to the study of the intrusions of the Ligurian-Provençal current.

1418 ^c The PEACETIME cruise (*ProcEss studies at the Air-sEa Interface after dust deposition in the MEditerranean sea*) took place in May-June 2017

1419 (<http://peacetime-project.org/>; Guieu et al., 2020).

1420 ^d Consensus regions of the Mediterranean Sea as defined by Ayata et al. (2018).

1421 ^e Bloom/cluster areas as defined by D'Ortenzio and d'Alcalà (2009) from SeaWiFS satellite surface TChla concentration observations.

1422

1423

1424 **Table 2.** Main characteristics of the two stations investigated during the MERITE-
1425 HIPPOCAMPE cruise in May 2019 on board the R/V *Hannibal* in the Tunisian waters for
1426 trawling of small pelagic fishes.

1427

Station	Latitude (N)	Longitude (E)	Location	Depth (m)	Date (dd/mm in 2019)	Trawling duration
T2	34° 11.892'	10° 58.152'	Gulf of Gabès	45	02/05	0h40
T4	36° 59.142'	10° 19.734'	Gulf of Tunis	37	03/05	1h30

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Table 3. Information about wet (rain) atmospheric deposition samples collected on board the R/V *Antea* during the MERITE-HIPPOCAMPE cruise.

Sample	Station	Start date of sampling	Start time of sampling (UT)	End date of sampling (dd/mm in 2019)	End time of sampling (UT)	Type of deposition
Rain 1	St10	22/04/19	19h15	23/04	9h45	Rain
Rain 2	St10	24/04/19	7h30	24/04	12h30	Rain
Rain 3	St11	26/04/19	3h15	26/04	12h00	Rain
Rain 4	St19	03/05/19	5h45	03/05	14h00	Rain
Rain 5	Transit from off Djerba to off Zarzis	03/05/19	16h45	04/05	9h00	Dry deposition + rain
Rain 6	St1	11/05/19	3h00	11/05	6h15	Rain

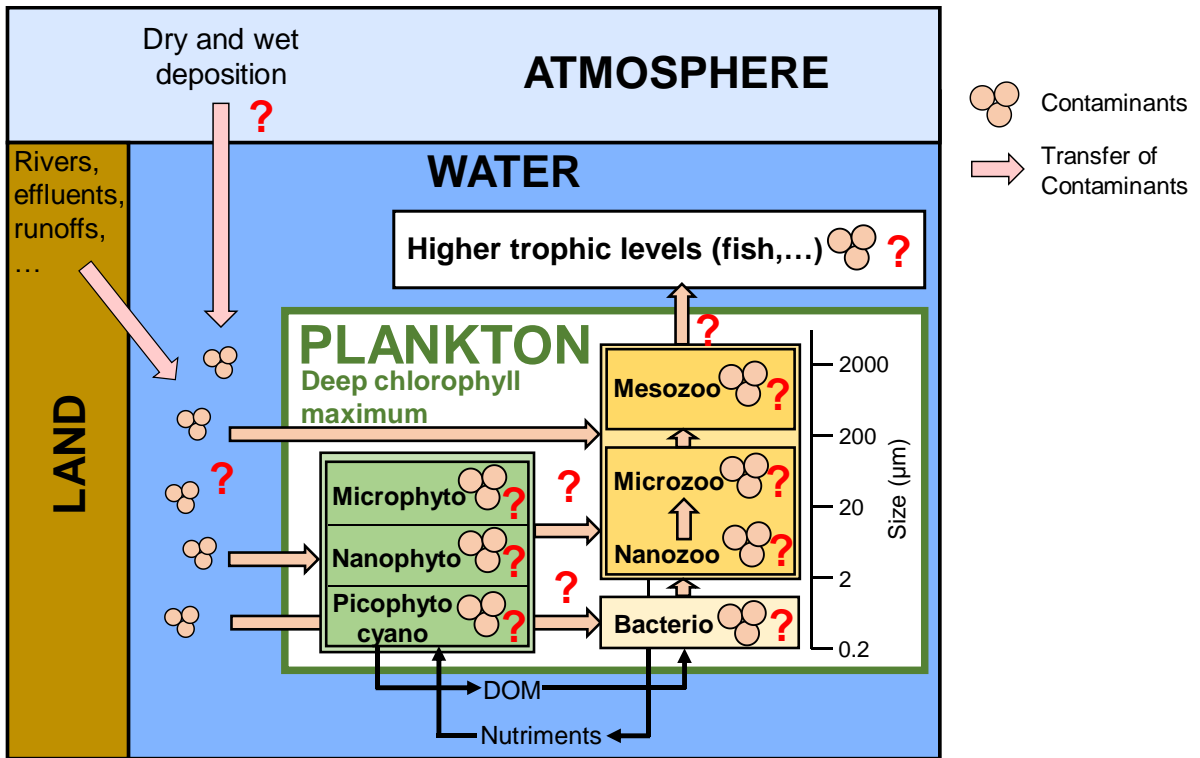


Figure 1

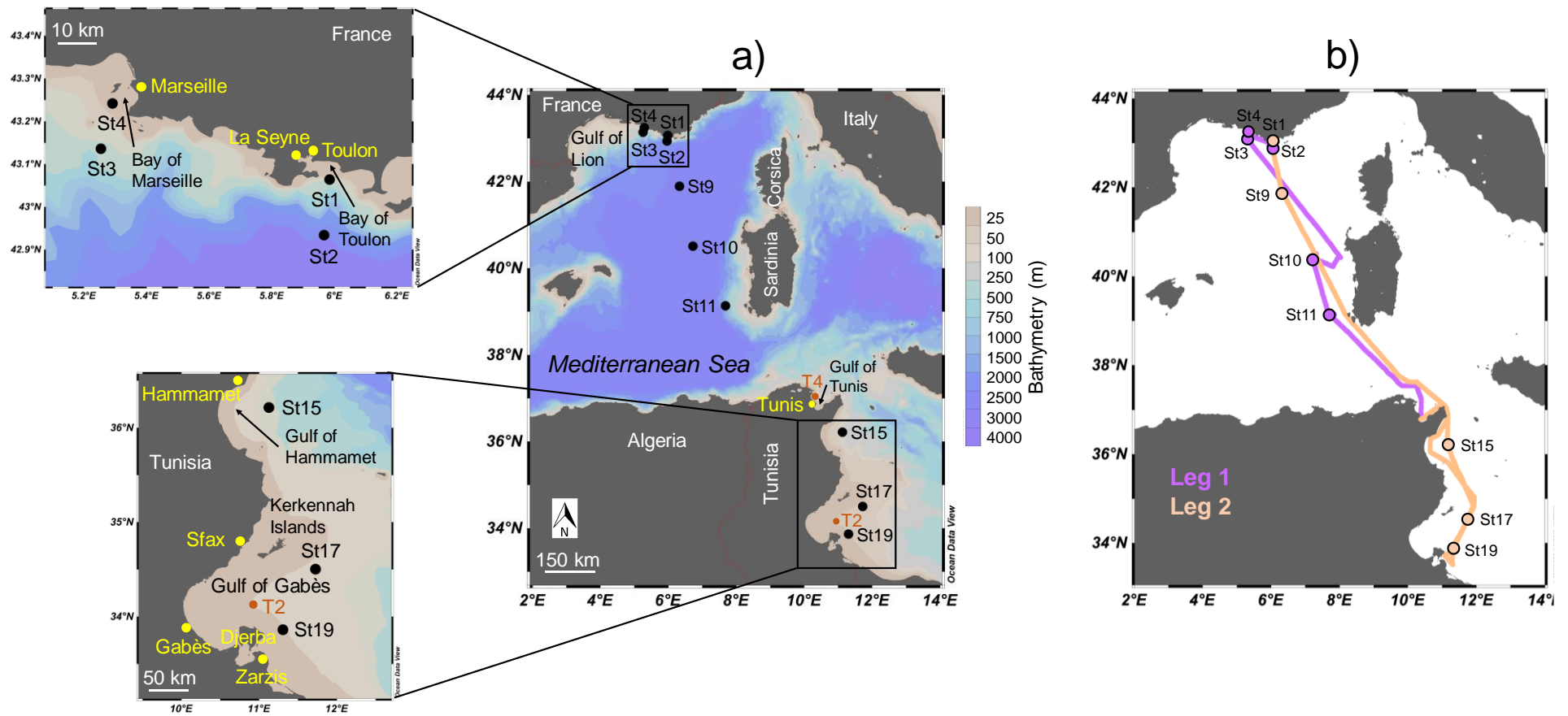


Figure 2

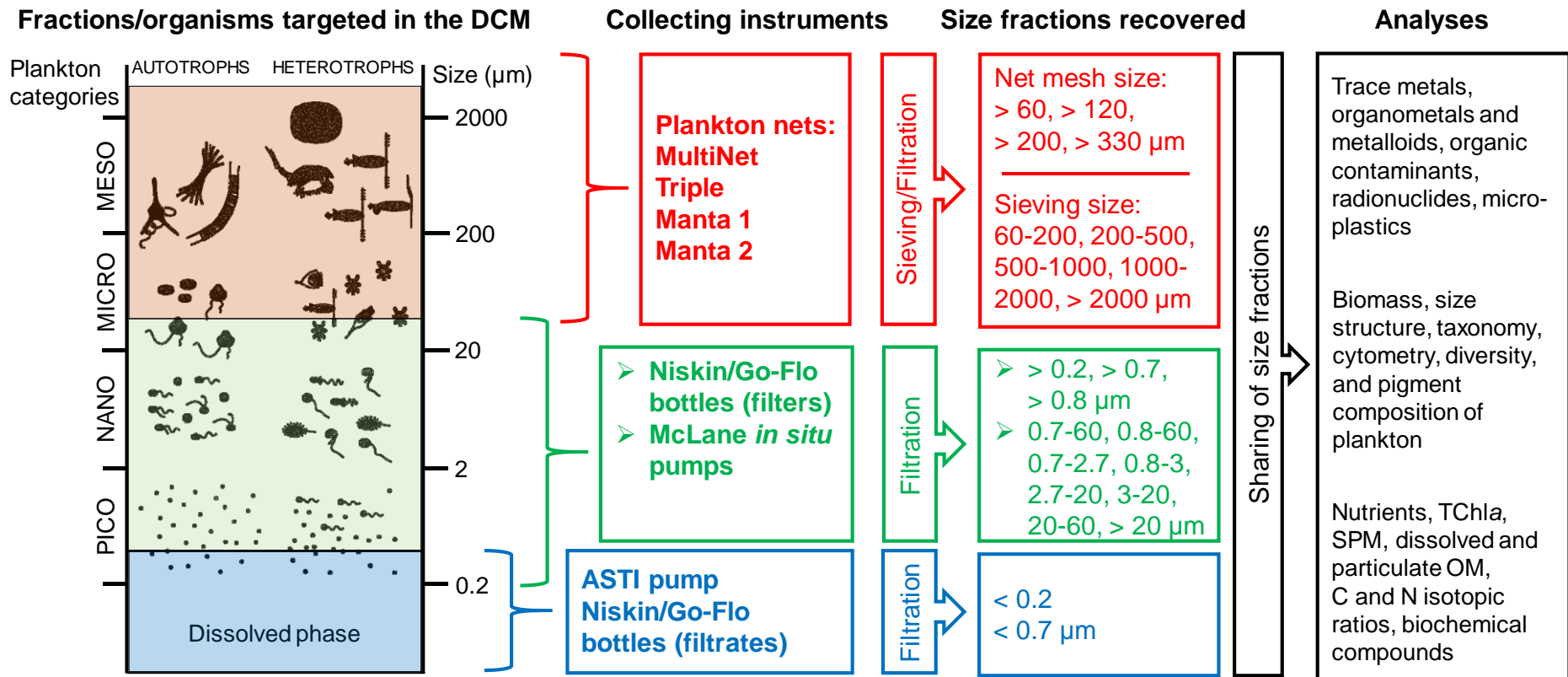


Figure 3

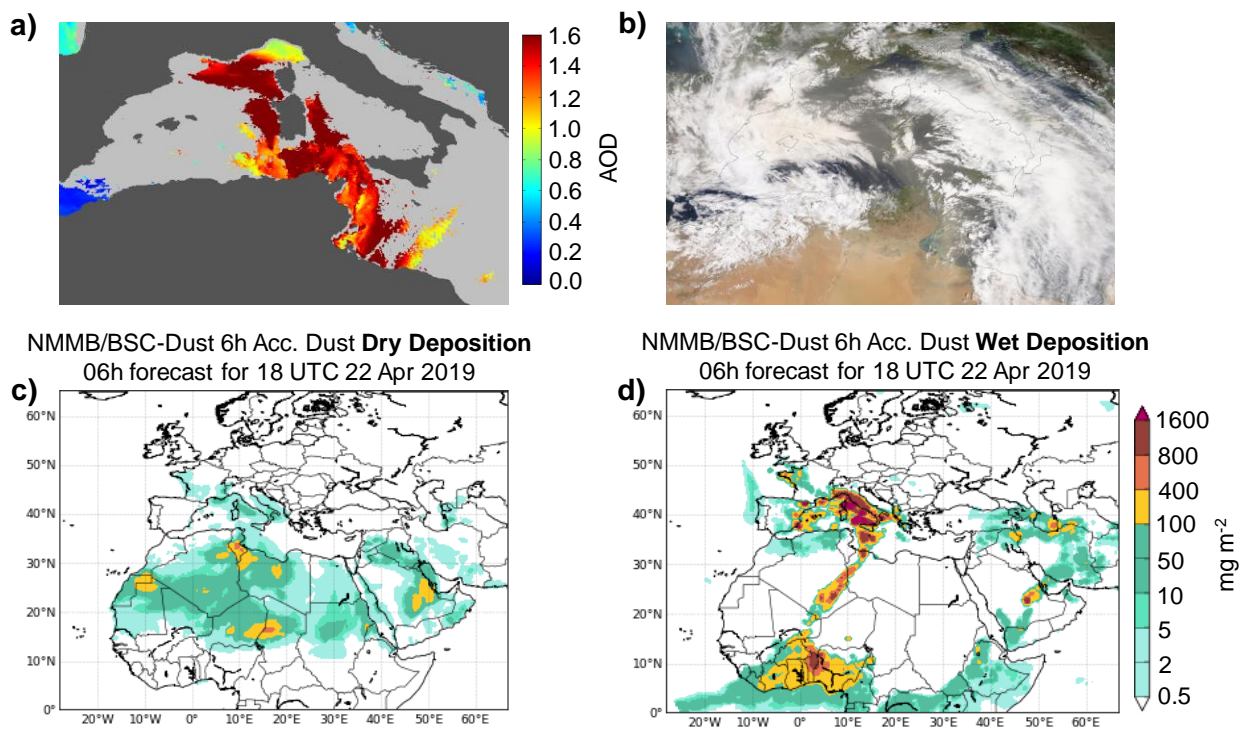
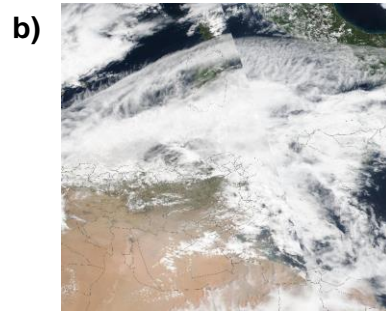
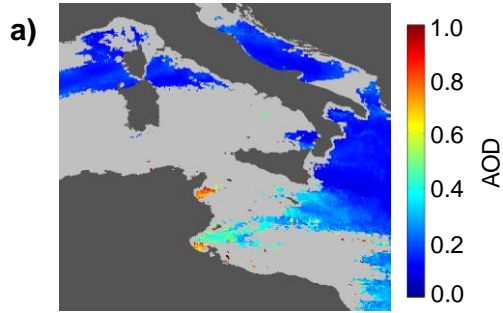
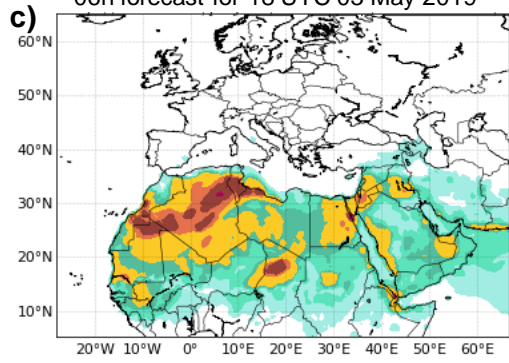


Figure 4



NMMB/BSC-Dust 6h Acc. Dust **Dry Deposition**
06h forecast for 18 UTC 03 May 2019



NMMB/BSC-Dust 6h Acc. Dust **Wet Deposition**
06h forecast for 18 UTC 03 May 2019

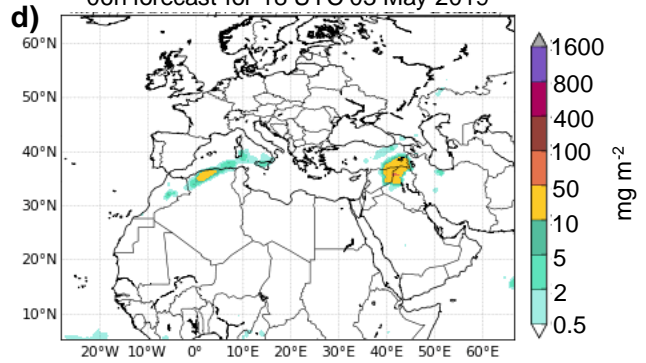


Figure 5

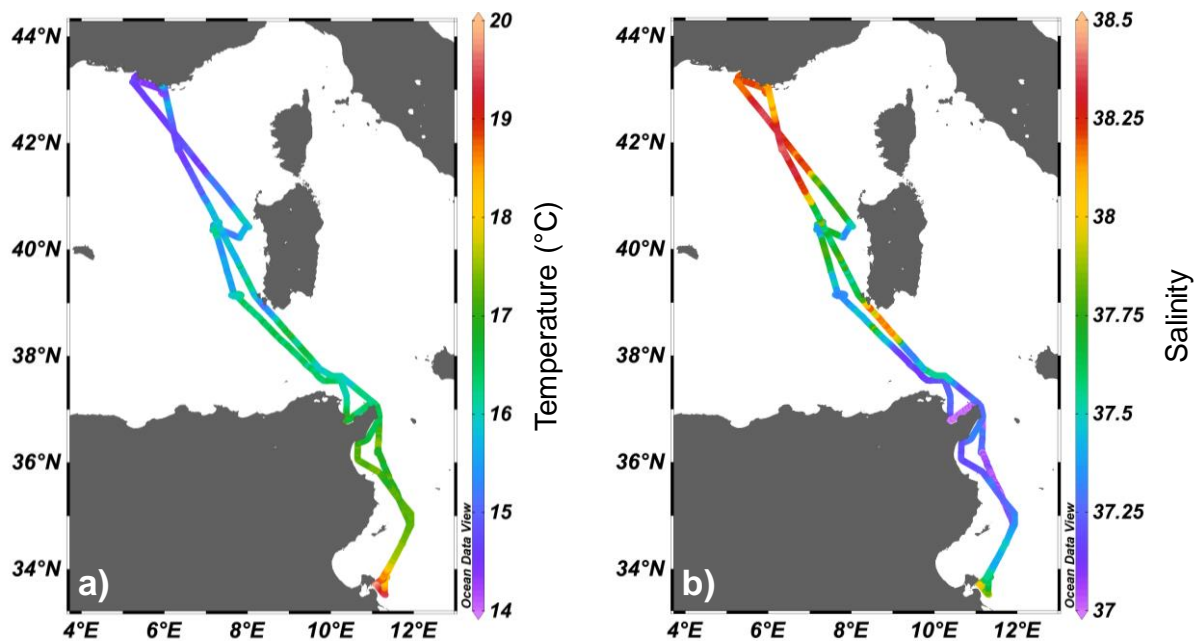


Figure 6

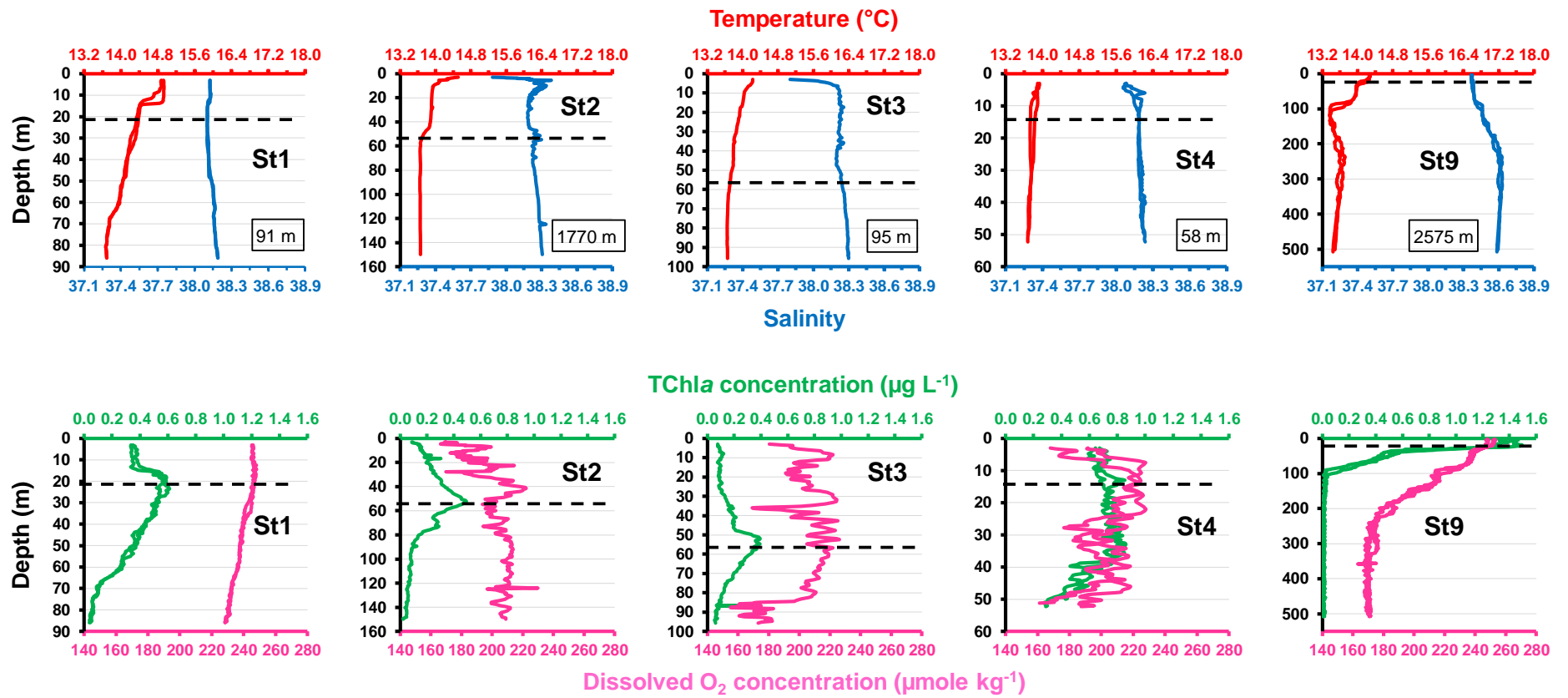


Figure 7

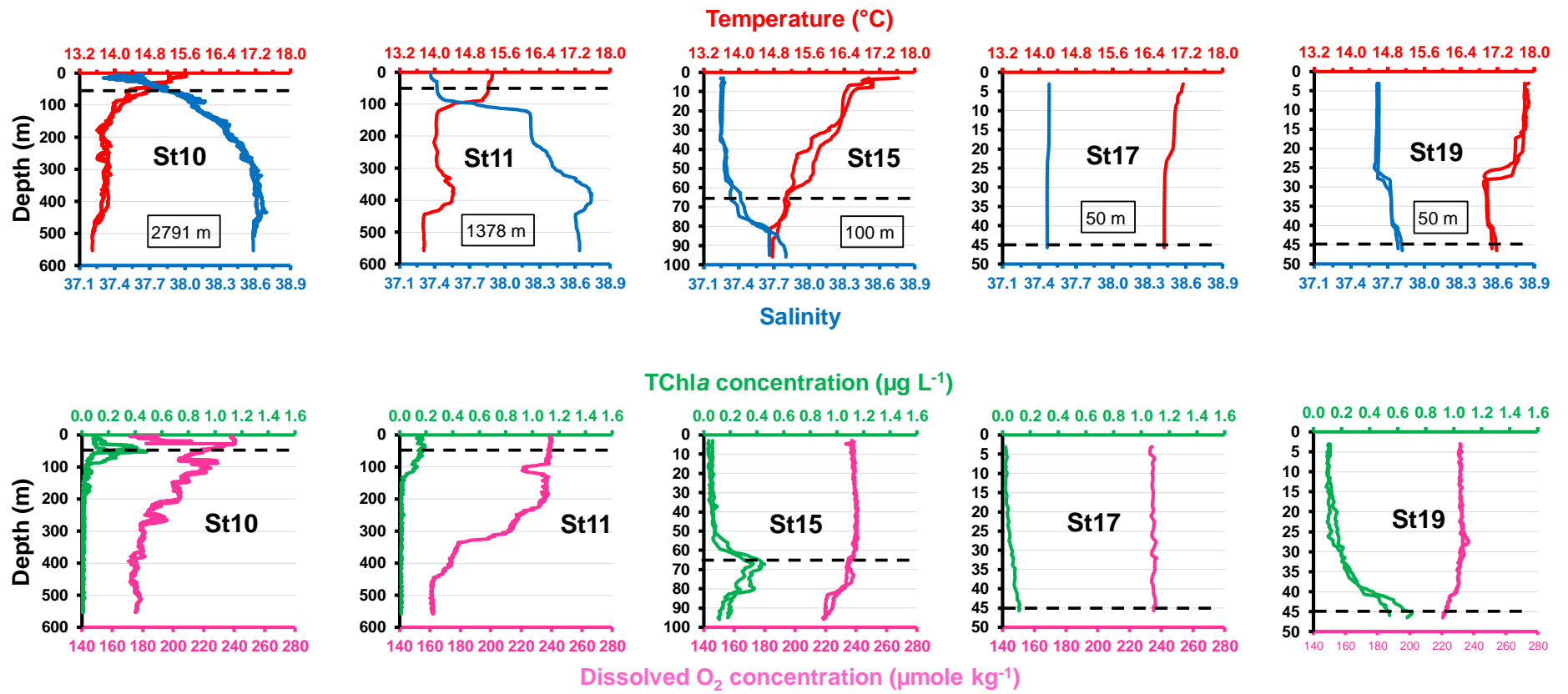


Figure 8

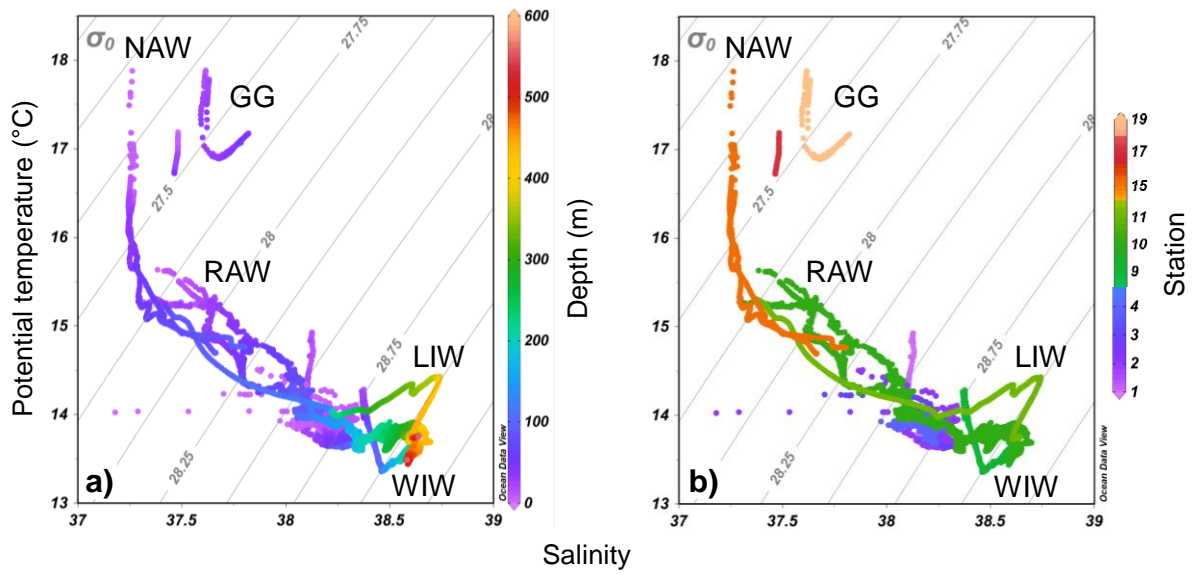


Figure 9

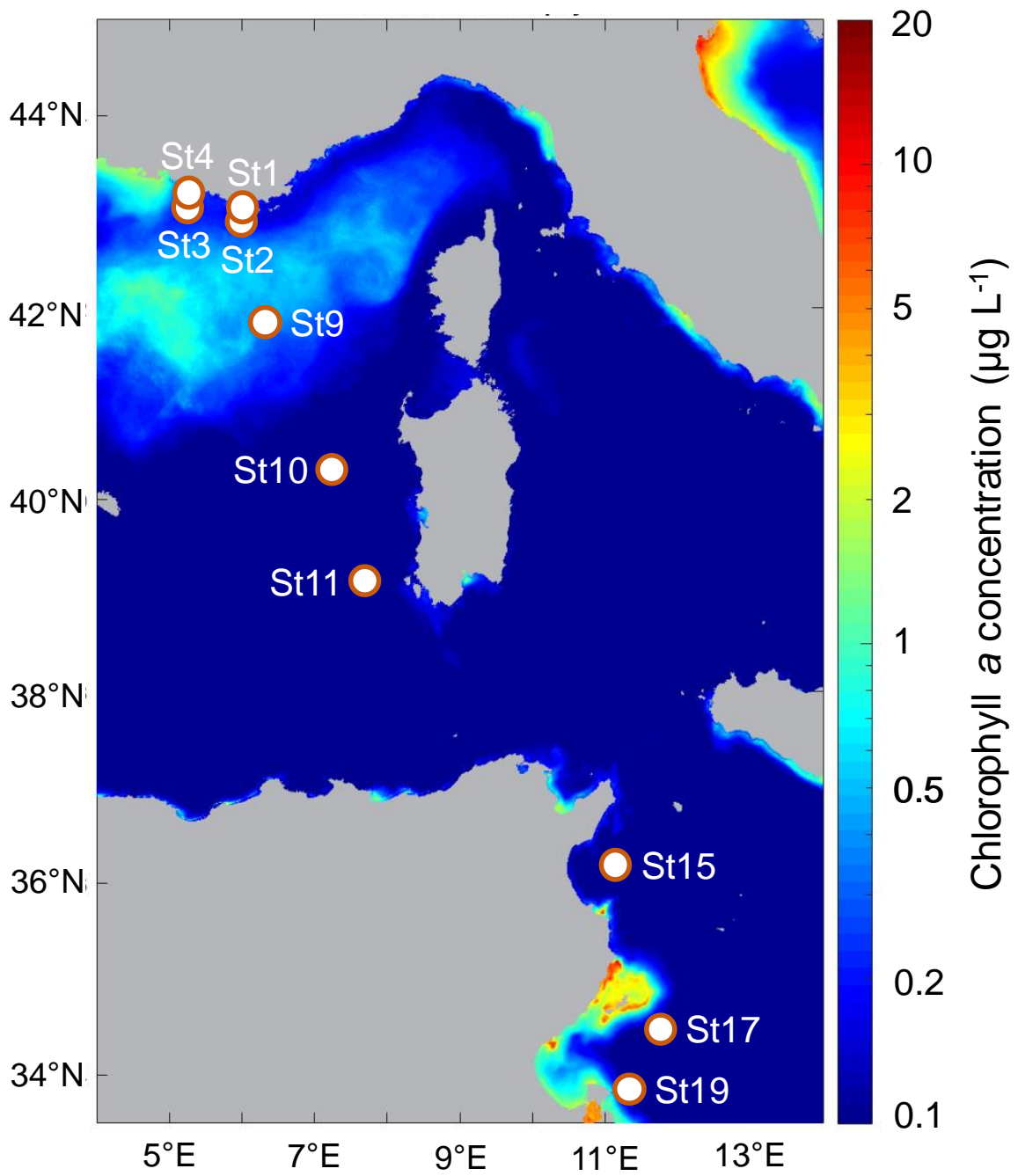


Figure 10

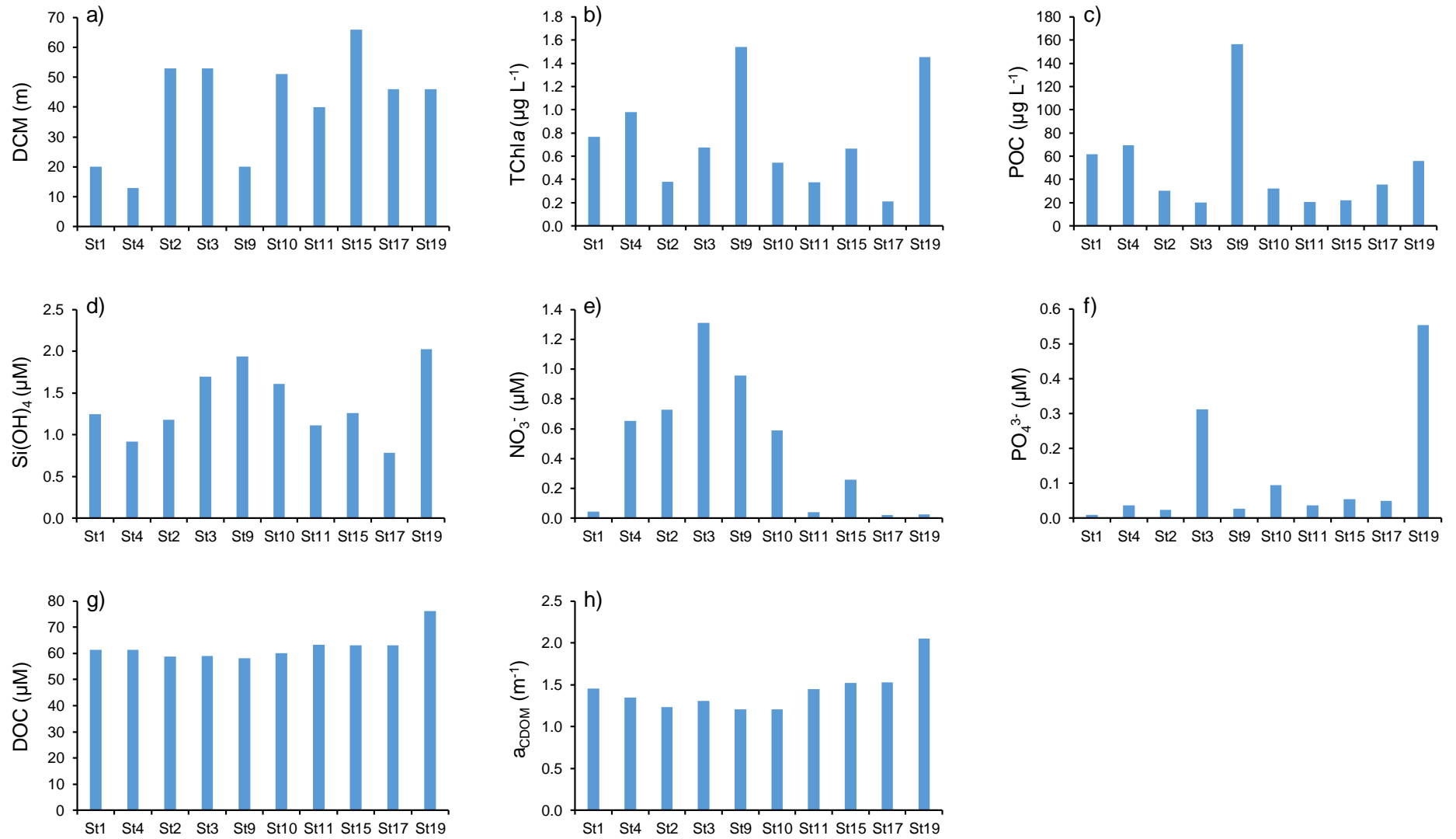


Figure 11

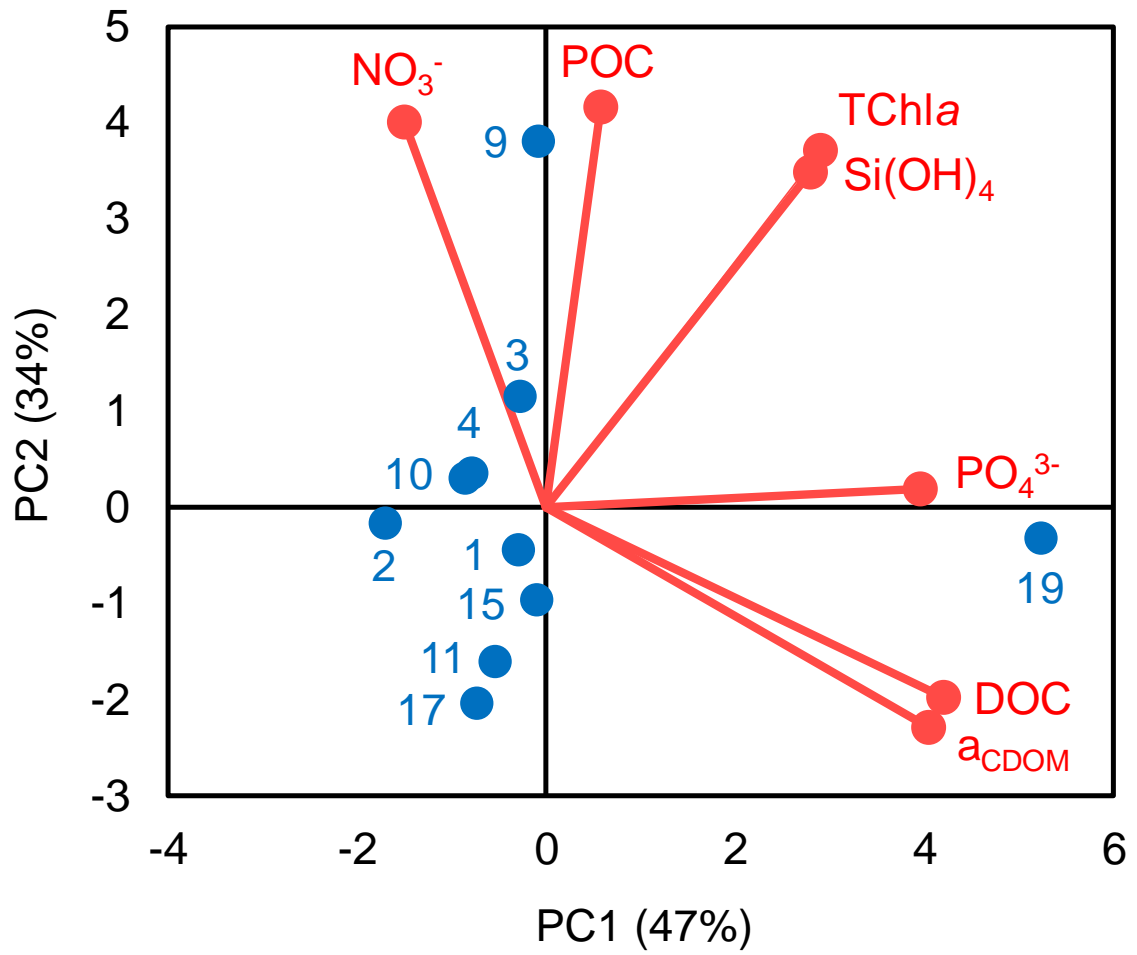


Figure 12

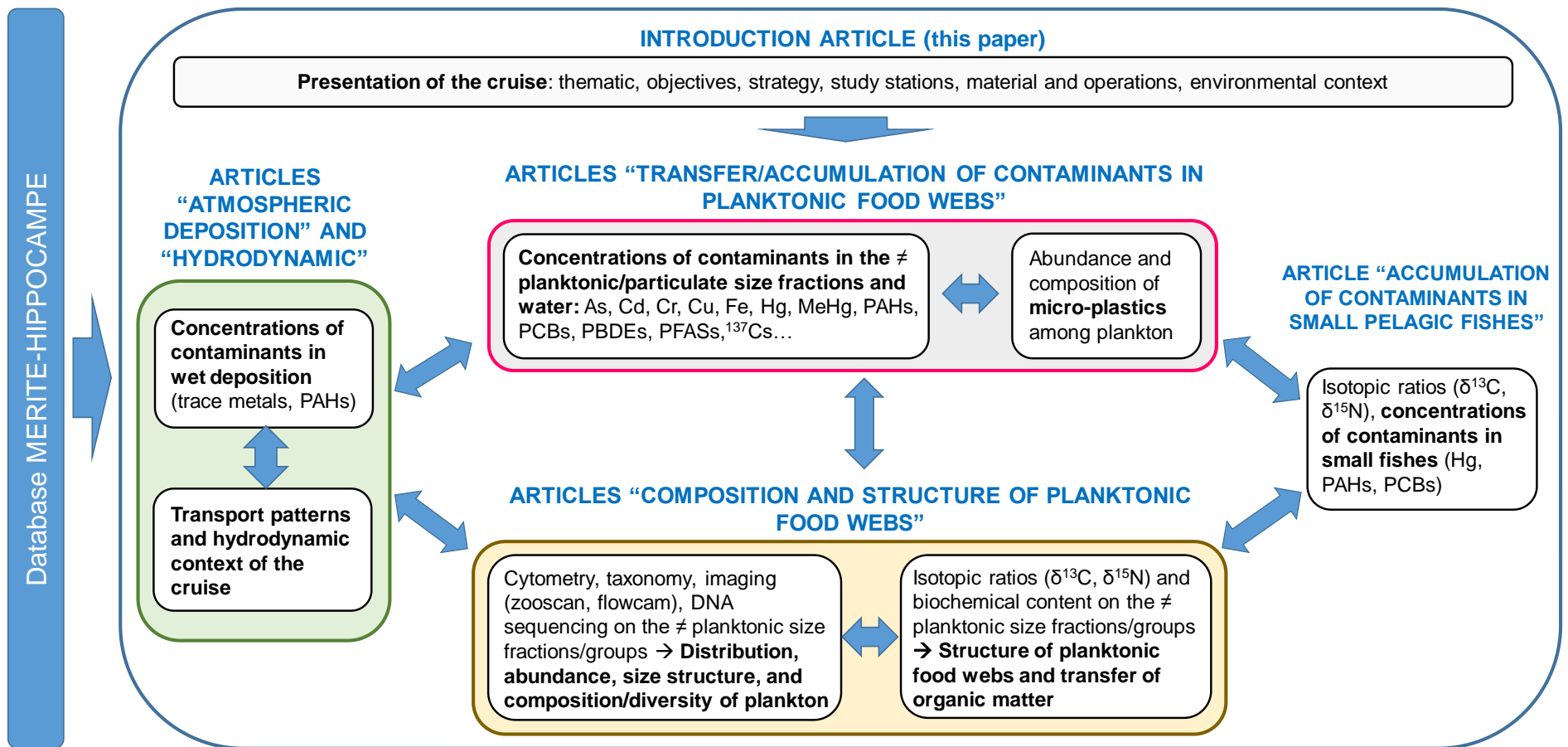


Figure 13

