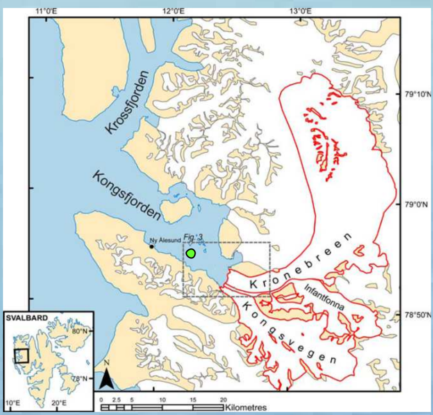
VARIABILITY OF MICROBIAL RESPIRATORY ACTIVITY IN RELATION TO PARTICULATE ORGANIC MATTER OVER SHORT TIME SCALES IN A GLACIAL ARCTIC FJORD (KONGSFJORDEN , SVALBARD)

MAURIZIO AZZARO[1]*, ROSABRUNA LA FERLA[1], GIOVANNA MAIMONE[1], FRANCO DECEMBRINI[1], FILIPPO AZZARO[1], CARMELA CAROPPO[2], STEFANO MISEROCCHI[3], FEDERICO GIGLIO[3], LEONARDO LANGONE[3], STEFANO ALIANI[4], ANDERSON S. CABRAL[5], RODOLFO PARANHOS[5]

[1*] Institute for Coastal Marine Environment (IAMC) of Messina, CNR (National Research Council), Italy; [2] IAMC of Taranto, CNR, Italy; [3] Institute for Marine Science, (ISMAR) of Bologna, CNR, Italy; [4] ISMAR of Pozzuolo di Lerici, CNR, Italy; [5] Federal University of Rio de Janeiro (UFRJ), Brazil.

*CORRESPONDENCE: Dr. Maurizio Azzaro (maurizio.azzaro@cnr.it)

Fig. 1



Prokaryotic and phytoplankton interaction plays a key role in relevant processes such as carbon fluxes and nutrient regeneration (Zaccone et al., 2004). Sinking biogenic particles drive respiration in the ocean interior, help to maintain the ocean's strong vertical gradient of inorganic carbon and related studies are important to determine the flow of organic matter along the water column (Martin et al., 1987; Karl et al., 1987). Sediment trap studies have shown that a low percentage of the surface primary production reaches the bottom. However, organic matter collected by sediment traps does not take into account the entire pool of oxidable organic matter, which includes the dissolved organic matter present in the seawater. The study of microbial respiration rates instead fills this gap, since respiration includes oxidation of both dissolved and particulate organic mater, providing an integrated estimate of the carbon utilization in the sea (Azzaro et al., 2006). In this context, a study on an Arctic fjord (Kongsfyorden, Svalbard) was done in late summer 2013, with the purpose of knowing the variability of prokaryotic and phytoplanktonic biomass and of microbial remineralization rates in relation to particulate organic matter over short time scales in a coastal station (water depth ~100 m), where a mooring (Mooring Dirigibile Italia, MDI: 78° 54 .859'N; 12° 15. 411' E) is positioned (Fig. 1).

Fig. 2

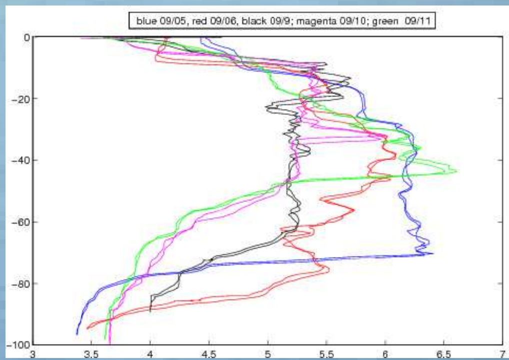


Fig. 3

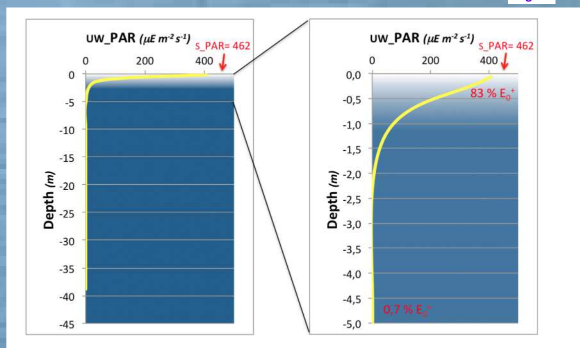
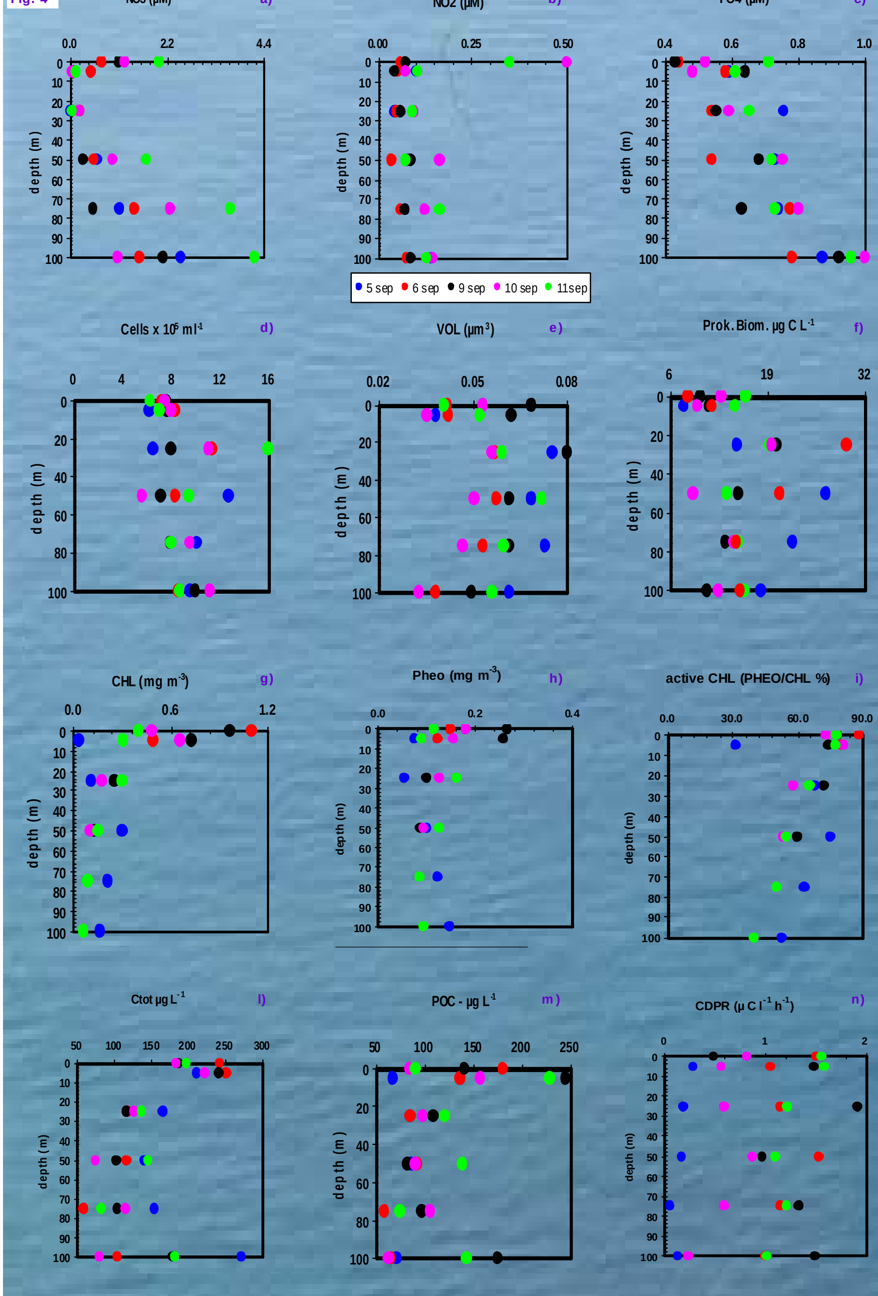


Fig. 4



The experiment comprised 5 samplings performed during a 7 day period in MDI station. For each sampling, photosynthetically active radiation (PAR), temperature and conductivity (salinity) were recorded along the water column with a PNF-300 profiler and a SeaBird Electronics SBE-911 plus profiler, respectively . Water samples were taken at five different depths (surface, 5, 25, 50 and 100 m) to determine nutrients, phytoplankton and prokaryotes biomass, particulate organic carbon and community respiration (Material and Methods according to: Langone et al., 2000; Zaccone et al., 2004) .

The Kongsfjorden was affected by inflow of Atlantic water as well as glacier melt water runoff (Cottier et al., 2005). Along the water column the intrusion of the salty and warm Atlantic water was visible in the study and the warm core varied in the time (Fig. 2). Such variability, as we shall see later, is also reflected in the chemical and biological properties. Moreover, due to melting of the glaciers in the surface water of the study site there were sediment loads which strongly limited light penetration and at 5 meters below the surface there was low irradiance (~0.7% E_0+) (Fig. 3).

Nitrates (NO3) and nitrites (NO2) distribution significantly changed along the vertical and with time and ranged between 0.001 and 4.18µM, 0.01 and 0.67µM, respectively (Fig. 4a, b). PO4 concentrations ranged between 0.43 (surface) and 1 µM (100 m) and in general the values increased from surface to bottom (Fig. 4c). NO3 and PO4 were positively correlated.

Prokaryotic abundances and cell volumes ranged between 5.6 and 15.9 x 10^5 cells ml^{-1} and 0.033 and 0.093 µm^3, respectively (Fig. 4d, e). These latter parameters, as well as prokaryotic biomass (Prok. Biom.; Fig. 4f), were positively correlated with temperature and showed a peak at 25 m depth in correspondence of incoming Atlantic water. This evidence has not been determined in chlorophyll a (CHL - range 0.034-1.102 mg m^{-3}), where the highest values were determined at the surface and 5 m depth (Fig. 4d). However CHL values were also determined below the euphotic zone, probably transported by the water masses (Hegseth and Tverberg, 2013). The percentage of active CHL along the water column would reinforce this hypothesis (Fig. 4i). CHL was negatively correlated with Salinity and PO4.

In general, the total carbon (Ctot) and particulate organic carbon (POC) decreased from the surface to the bottom and the values varied over time, as seen for other parameters (Fig. 4l, m). These parameters were negatively correlated with salinity and positively with CHL.

Community respiration (CDPR) showed high values of remineralization and variability in time, probably related to the variability thermo-haline rather than to variability of the biological pump (Fig. 4n). In addition, the positive correlation with POC, Ctot and CHL suggested a close relationship between these variables.

References

Azzaro, M., La Ferla, R., Azzaro F., (2006). Microbial respiration in the aphotic zone of the Ross Sea (Antarctica). Marine Chemistry 99, 199-209.

Cottier, F., Tverberg, V., Inall, M., Svendsen, H., Nilsen, F., Griffith, C., (2005). Water mass modification in an Arctic fjord through cross-shelf exchange: The seasonal hydrography of Kongsfjorden, Svalbard. Journal of Geophysical Research (Oceans) 110, DOI: 10.1029/2004JC002757.

Karl, D.M., Knauer, G.a., Martin, J.H., (1987). Downward flux of particulate organic matter in the ocean: a particle decomposition paradox. Nature 332, 438– 441.

Hegseth, E. N., Tverberg, V., (2013). Effect of Atlantic water inflow on timing of the phytoplankton spring bloom in a high Arctic fjord (Kongsfjorden, Svalbard), J. Mar. Syst., 113, 94–105.

Langone, L., Frignani, M., Ravaioli, M., Bianchi, C., (2000). Particle fluxes and biogeochemical processes in an area influenced by seasonal retreat of the ice margin (northwestern Ross Sea, Antarctica). Journal of Marine Systems 27, 221– 234.

Martin, J.H., Knauer, G.A., Karl, D.M., Broenkow, W.W., (1987). Vertex: carbon cycling in the Northeast Pacific. Deep-Sea Research 34, 267–285.

Zaccone, R., Caroppo, C., La Ferla, R., Zampino, D., Caruso, G., Leonardi, M., Maimone, G., Azzaro, M., Sitran R., (2004). Deep chlorophyll maximum time series in the Augusta Gulf (Ionian Sea): Microbial community structures and functions. Chemistry and Ecology 20, 267-284.

Acknowledgements

The study was carried out in the framework of the ARCA project. We are grateful to the technical staff of IAMC-CNR Messina: Mr. Michele Furnari and Mr. Enrico Armeli Minicante.