Continental Shelf Research 29 (2009) 1276–1288

Contents lists available at ScienceDirect

Continental Shelf Research

journal homepage: www.elsevier.com/locate/csr

Spatial variability in organic material sinking export in the Hudson Bay system, Canada, during fall

Amandine Lapoussière [a,b,*], Christine Michel [b], Michel Gosselin [a], Michel Poulin [c]

[a] Institut des sciences de la mer de Rimouski (ISMER), Université du Québec à Rimouski, 310 allée des Ursulines, Rimouski, Québec, Canada G5L 3A1
[b] Freshwater Institute, Fisheries and Oceans Canada, 501 University Crescent, Winnipeg, Manitoba, Canada R3T 2N6
[c] Research Division, Canadian Museum of Nature, PO Box 3443, Station D, Ottawa, Ontario, Canada K1P 6P4

ARTICLE INFO

Article history:
Received 3 September 2008
Received in revised form
25 January 2009
Accepted 7 February 2009
Available online 27 February 2009

Keywords:
Hudson Bay
Sedimentation
Sinking export
Carbon
Protists
Fecal pellets
Bacteria
Arctic

ABSTRACT

Spatial variations in the sinking export of organic material were assessed within the Hudson Bay system (i.e., Hudson Bay, Hudson Strait and Foxe Basin) during the second oceanographic expedition of ArcticNet, on board the CCGS *Amundsen* in early fall 2005. Sinking fluxes of particulate organic material were measured using short-term free-drifting particle interceptor traps deployed at 50, 100 and 150 m for 8–20 h at eight stations. Measurements of chlorophyll *a* (chl *a*), pheopigments (pheo), particulate organic carbon (POC), biogenic silica (BioSi), protists, fecal pellets and bacteria were performed on the collected material. In parallel, sea surface salinity and temperature were determined at 121 stations in the Hudson Bay system. Three hydrographic regions presenting different sedimentation patterns were identified based on average surface salinity and temperature. Hudson Strait was characterized by a marine signature, with high salinity (average = 32.3) and low temperature (average = 2.1 °C). Eastern Hudson Bay was strongly influenced by river runoff and showed the lowest average salinity (26.6) and highest average temperature (7.6 °C) of the three regions. Western Hudson Bay showed intermediate salinity (average = 29.4) and temperature (average = 4.4 °C). Sinking fluxes of total pigments (chl *a*+ pheo: 3.37 $mg\,m^{-2}\,d^{-1}$), diatom-associated carbon (19.8 $mg\,m^{-2}\,d^{-1}$) and BioSi (50.2 $mg\,m^{-2}\,d^{-1}$) at 50 m were highest in Hudson Strait. Eastern Hudson Bay showed higher sinking fluxes of total pigments (0.52 $mg\,m^{-2}\,d^{-1}$), diatom-associated carbon (3.29 $mg\,m^{-2}\,d^{-1}$) and BioSi (36.6 $mg\,m^{-2}\,d^{-1}$) compared to western Hudson Bay (0.19, 0.05 and 7.76 $mg\,m^{-2}\,d^{-1}$, respectively). POC sinking fluxes at 50 m were low and relatively uniform throughout the Hudson Bay system (50.0–76.8 $mg\,C\,m^{-2}\,d^{-1}$), but spatial variations in the composition of the sinking organic material were observed. A large part (37–78%) of the total sinking POC was unidentifiable by microscopic observation and was qualified as amorphous detritus. Considering only the identifiable material, the major contributors to the POC sinking flux were intact protist cells in Hudson Strait (28%), fecal pellets in eastern Hudson Bay (52%) and bacteria in western Hudson Bay (17%). A significant depth-related attenuation of the POC sinking fluxes (average loss between 50 and 150 m = 32%) and a significant increase in the BioSi:POC ratio (average increase between 50 and 150 m = 76%) were observed in Hudson Strait and eastern Hudson Bay. For all other sinking fluxes and composition ratios, we found no statistically significant difference with depth. These results show that during fall, the sinking export of total POC from the euphotic zone remained fairly constant throughout the Hudson Bay system, whereas other components of the organic sinking material (e.g., chl *a*, BioSi, fecal pellets, protist cells) showed strong spatial variations.

1. Introduction

Over the last few decades, there has been a growing interest in climate change and its effect on arctic and subarctic environments (e.g., Johannessen et al., 1995; Moritz et al., 2002; Serreze et al., 2007). Environmental changes already observed include a decline in the volume and extent of the sea-ice cover (Johannessen et al., 1999; Comiso et al., 2008), an advance in the melt period (Overpeck et al., 1997; Comiso, 2006), and an increase in river discharge to the Arctic Ocean (Peterson et al., 2002; McClelland et al., 2006) due to increasing precipitation and terrestrial ice melt (Peterson et al., 2006).

Hudson Bay, Hudson Strait and Foxe Basin (the Hudson Bay system) make up a large inland sea in the Canadian subarctic region (Jones and Anderson, 1994). Hudson Bay is a shallow

* Corresponding author at: Institut des sciences de la mer de Rimouski (ISMER), Université du Québec à Rimouski, 310 allée des Ursulines, Rimouski, Québec, Canada G5L 3A1.
E-mail address: amandine.lapoussiere@uqar.qc.ca (A. Lapoussière).

0278-4343/$ - see front matter © 2009 Elsevier Ltd. All rights reserved.
doi:10.1016/j.csr.2009.02.004

embayment (average depth = 120 m; Prinsenberg, 1984) strongly influenced by riverine input, mainly from the Nelson, Severn, Churchill, Great Whale, Winisk, and James Bay rivers (Fig. 1; Déry et al., 2005). Hudson Strait, with an average depth of 400 m, links Hudson Bay and Foxe Basin with the Labrador Sea (Drinkwater and Jones, 1987; Jones and Anderson, 1994). The climate of this system is anomalously cold in comparison to other regions of similar latitudes because of the presence of a seasonally varying ice cover (Rouse, 1991). Its subarctic location and the presence of a seasonal ice cover make the Hudson Bay system particularly vulnerable to climate-related changes. Indeed, the sea-ice extent in Hudson Bay decreased by $2000 \pm 900\,km^2\,y^{-1}$ between 1978 and 1996 (Parkinson et al., 1999). An increase in the mean annual sea surface temperature, earlier ice breakup and delayed freeze-up were also detected in Hudson Bay between 1971 and 2003 (Gagnon and Gough, 2005a). The average surface water temperature projected for 2070–2099 is between 4.8 and 8.0 °C higher than the average for 1961–1990 (Gagnon and Gough, 2005b).

The global carbon cycle, and particularly the increase in atmospheric CO_2 concentrations, plays a key role in the warming trend observed over the past decades (IPCC, 2007). As part of the global carbon cycle, atmospheric CO_2 is transferred to the surface ocean by diffusion and can be converted into organic carbon by primary producers. The fate of surface primary production, i.e., channeling through grazers, recycling in the water column or sinking export to depth, is influenced by a variety of factors, including the taxonomic composition of the phytoplankton (e.g., Boyd and Newton, 1995) and zooplankton communities (e.g., Pasternak et al., 2002; Wexels Riser et al., 2002) as well as transformation processes taking place during sinking (e.g., Boyd et al., 1999). Since phytoplankton cells and fecal pellets from herbivores constitute important channels for the sinking export of organic material to depth, these constituents are typically quantified in sinking export studies (e.g., Turner, 2002; Caron et al., 2004). Nevertheless, a few studies have shown that the contribution of bacteria to the sinking export of organic material can also be important (e.g., Pedrós-Alió et al., 1989; Turley and Mackie, 1994). Hence, it is important to quantify bacteria sinking fluxes to better quantify and understand processes controlling the sinking export of organic material. The amount and composition of sinking particles are commonly characterized using particle interceptor traps, while transformation during sinking is assessed from changes in particle sinking fluxes with depth (e.g., Martin et al., 1987; Michel et al., 2002; Juul-Pedersen et al., 2008).

In the Hudson Bay system, several studies have focused on the phytoplankton (e.g., Anderson and Roff, 1980; Drinkwater and

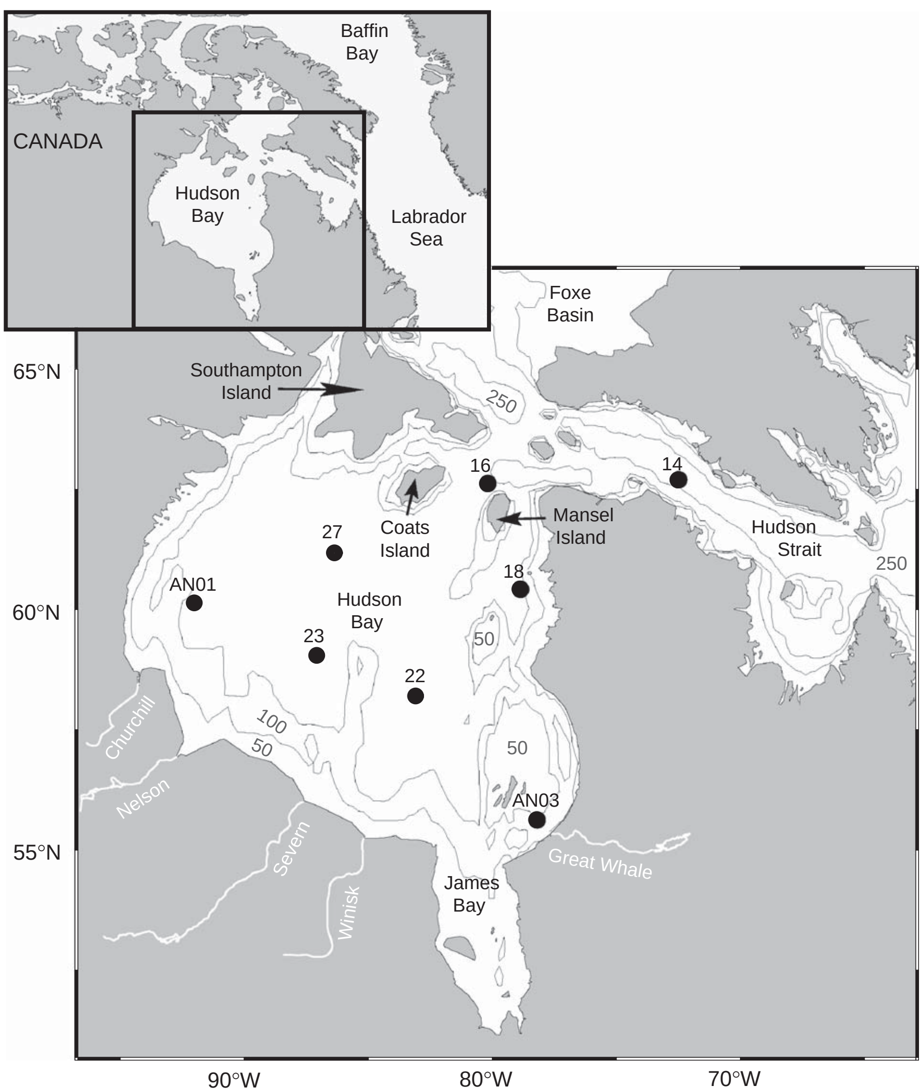

Fig. 1. Location of the sampling stations in the Hudson Bay system during early fall 2005. Isobaths are in meters.