Progress in Oceanography 124 (2014) 54–65

Contents lists available at ScienceDirect

Progress in Oceanography

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

Signatures of the late Holocene Neoglacial cold event and their marine–terrestrial linkage in the northwestern Pacific margin

So-Young Kim [a], Dhong-il Lim [b,*]

[a] Arctic Research Center, Korea Polar Research Institute, Incheon 406-840, Republic of Korea
[b] South Sea Research Institute, Korea Institute of Ocean Science and Technology, Geoje 656-830, Republic of Korea

ARTICLE INFO

Article history:
Received 2 February 2013
Received in revised form 19 March 2014
Accepted 23 March 2014
Available online 1 April 2014

ABSTRACT

Marine microfossil assemblages in core sediments from the northern East China Sea (ECS) were investigated to understand late Holocene paleoclimatic changes in the northwestern Pacific margin. We find a pronounced alternation of ocean condition during the late Holocene characterized by an abrupt decrease in dinoflagellate cysts and Kuroshio water species of planktonic foraminifera centered at *ca.* 4000–2500 ^{14}C yr BP. Compilation and merger of new and previously published data show that this oceanic event corresponds with terrestrial cooling and dry episodes in the northern China. The synchronicity between marine and terrestrial records is considered to be linked to a weakened Kuroshio influence that is in coupled with intensified winter monsoon, highlighting a significance of oceanic-atmospheric dynamics in determining moisture and heat distribution over both oceanic and terrestrial domains. Superimposed on the late Holocene, the synchronicity between this particular climatic shift in the northwestern Pacific and the Neoglacial cold events in the northern high-latitude regions is tentatively indicative of a global climate signal, possibly associated with dynamics of the North Pacific gyre system and the high latitude North Atlantic thermohaline circulation, and therefore positions of the mean latitude of the Kuroshio extension.

Introduction

The marginal seas of the northwestern Pacific (e.g., Yellow Sea and East China Sea) are an important paleoclimate archive recording a wide variety of geologic and climatic processes in this area. As a transition between the world's largest continent and its ocean, these marginal seas contain sedimentary sequences that often provide detailed information regarding the evolution of continent-ocean-climate interactions through time (e.g., Ijiri et al., 2005; Li et al., 2007). Furthermore, understanding the climate systems of this region is particularly important, because it has strong societal relevance to the surrounded countries and worldwide. The East China Sea (ECS) is an open marginal sea in the northwestern Pacific and is considered to be a large source and reservoir of energy and materials originating from both land and ocean. The Kuroshio Current (KC), which covers the ECS shelf, is the main western boundary current of the northwestern Pacific. It is known to be a key component of the Asian climate system through the meridional transport of water mass, heat and freshwater, strongly affecting the climatic evolution of the adjacent continent, as well as ocean systems in the ECS shelf (e.g., An et al., 2000; Liu et al., 2007; Xiang et al., 2007). Several lines of evidence suggest that paleoceanographic records from the ECS region can provide insight into the evolution of regional climate and hydrographic conditions in the western Pacific near East Asia (e.g., Lin et al., 1996; Li et al., 2007; Chang et al., 2008).

Research has revealed that much of the Holocene period can be characterized by abrupt, small-magnitude climatic fluctuations (e.g., Bond et al., 1997; Xiang et al., 2007; Yoo et al., 2009). Millennial-scale climate oscillations during the Holocene are well recorded in proxy records such as ice-rafted debris events in the subpolar North Atlantic (Bond et al., 1997, 2001), cooling events in the subtropical North Atlantic off West Africa (deMenocal et al., 2000; Marret et al., 2006) and Arabian Sea (Sirocko et al., 1996), and reduced rainfall episodes in Oman (Neff et al., 2001) and Dongge Cave in China (Dykoski et al., 2005; Wang et al., 2005). Of particular interest is a discernible climatic signature of the late Holocene recorded in northern China and the East and South China seas, being generally characterized by cooler and drier climatic conditions (Jin et al., 2004; Xiang et al., 2007). However, an integrated perspective for marine and terrestrial sequences in this region has been lacking, although it is of primary importance to understand mechanisms transferring such climatic variability between both domains.

Microfossil assemblages preserved in the sedimentary record have been widely applied in paleoceanographic and paleoclimatic

* Corresponding author. Tel.: +82 55 639 8580; fax: +82 55 639 8509.
E-mail address: oceanlim@kiost.ac (D.-i. Lim).

http://dx.doi.org/10.1016/j.pocean.2014.03.010
0079-6611/

studies. For example, the abundance and species composition of planktonic foraminifera in marine sediments are useful tools for reconstructing past surface-water hydrography (e.g., Gupta et al., 2006; Xiang et al., 2007), since the distributions of modern planktonic foraminifera are known to be controlled by water mass and circulation patterns as well as upwelling and biological productivity (Bé and Tolderlund, 1971; Hemleben et al., 1998). Additionally, major shifts in benthic foraminiferal communities have been used to identify changes in depositional environments (e.g., Lim et al., 2006; Kang et al., 2010) as well as bottom-water salinity (e.g., Kim and Kucera, 2000; Xiang et al., 2008). Over the last decade, the use of dinoflagellate cysts for reconstructing paleoceanographic and paleoenvironmental conditions has been increased in parallel with an improvements in our understanding of modern dinoflagellate cyst distributions in relation to environmental parameters (e.g., Marret and Zonneveld, 2003; Matthiessen et al., 2005; de Vernal and Marret, 2007; Kim et al., 2010).

In this study, microfossil assemblages in sediment cores from the northern ECS were investigated and compared with existing marine and terrestrial records in order to identify a mechanism transferring the late Holocene climate fluctuations between marine and terrestrial environments in the northwestern Pacific margin.

Environmental setting

The ECS is one of the marginal seas of the western Pacific Ocean, bounded on the east by Ryukyu Islands, on the south by the island of Taiwan, and on the west by mainland China and the Asian continent (Fig. 1). It is connected to the South China Sea by the Taiwan Strait and with the East/Japan Sea by the Korea Strait, and it opens in the north to the Yellow Sea. The northwestern part of the ECS is characterized by a wide continental shelf with depths shallower than 200 m. The southeastern part of the ECS is occupied by the Okinawa Trough along the outer edge of the continental shelf that reaches up to *ca.* 2700 m in water depth (Zhang and Su, 2006).

The hydrography of the ECS is largely influenced by the KC, which originates from the North Pacific Equatorial Current. The KC enters the ECS along the east side of Taiwan and then flows into the Pacific through the south of Kyushu, Japan. A branch of the KC intrudes to the East Sea through the Korean/Tsushima Strait between Korea and Kyushu. Since the KC waters are warm (about 20 °C) and have relatively high salinities (about 34), it transports a large amount of heat and moisture from the tropics to the middle latitudes as it flows along the western edge of North Pacific (Hsueh, 2000; Ichikawa and Chaen, 2000). The northwestern part of the ECS is governed by coastal waters with lower temperatures and salinity under influences of two large rivers, the Yangtze River (Changjiang) and Yellow River (Huanghe). These rivers discharge a large amount of fresh water and terrestrial materials into the ECS, and their large nutrient input supports high primary production in the surface waters (Hama et al., 1997).

Sea surface temperature (SST) and salinity of the ECS are also regulated by the East Asian monsoons. The observed mean annual SST of the ECS is ~24.7 °C, with a seasonal range between ~28.6 °C (July) and ~21.8 °C (January). Mean annual sea surface salinity (SSS) is ~34.4, with a summer low of ~34.1 and a winter high of

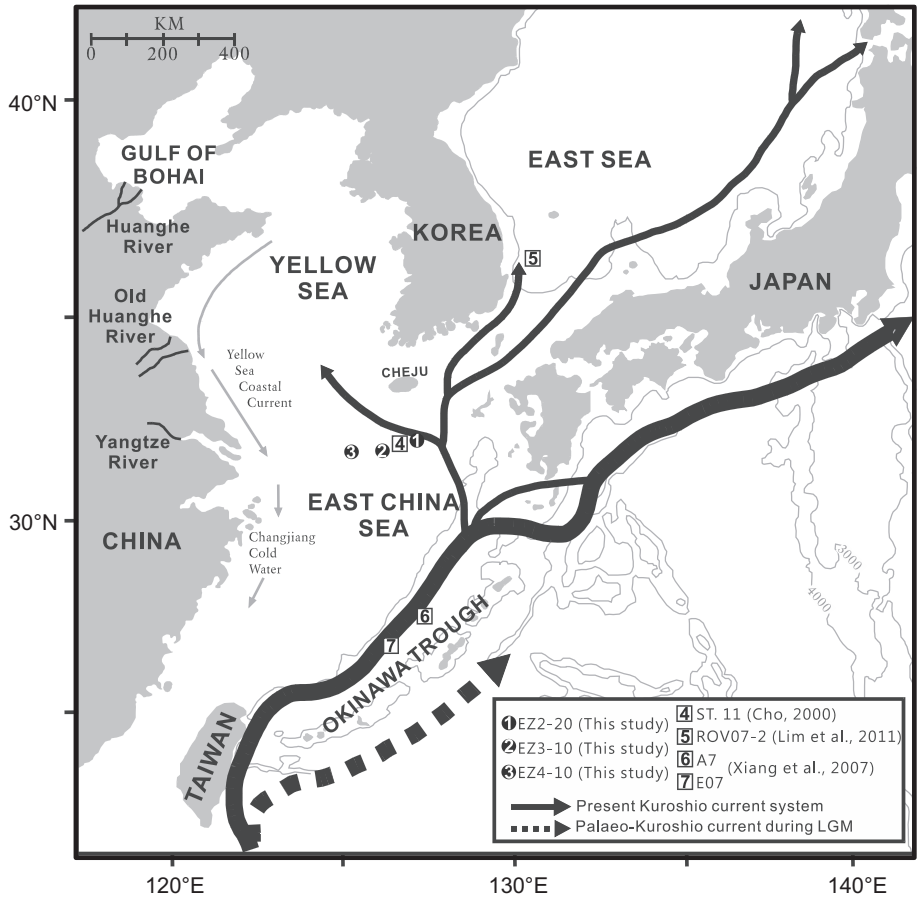

Fig. 1. The map showing the study area with the location of three piston cores collected for this study and previous reported cores, as well as the main path of the Kuroshio Current in the northwestern Pacific marginal seas. Black arrows indicate the Kuroshio Current and its branches (after Ujiié et al., 2003).