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Control of wind strength and frequency in the Aral Sea basin during the late Holocene

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Abstract

Changing content of detrital input in laminated sediments traced by XRF scanning and microfacies analyses reflect prominent variations in sedimentation processes in the Aral Sea. A high-resolution record of titanium from a core retrieved in the northwestern Large Aral Sea allows a continuous reconstruction of wind strength and frequency in western Central Asia for the past 1500 yr. During AD 450–700, AD 1210–1265, AD 1350–1750 and AD 1800–1975, detrital inputs (bearing titanium) are high, documenting an enhanced early spring atmospheric circulation associated with an increase in intensity of the Siberian High pressure system over Central Asia. In contrast, lower titanium content during AD 1750–1800 and AD 1980–1985 reflects a diminished influence of the Siberian High during early spring with a reduced atmospheric circulation. A moderate circulation characterizes the time period AD 700–1150. Unprecedented weakened atmospheric circulation over western Central Asia are inferred during ca. AD 1180–1210 and AD 1265–1310 with a considerable decrease in dust storm frequency, sedimentation rates, lamination thickness and detrital inputs (screened at 40-μm resolution). Our results are concurrent with changes in the intensity of the Siberian High during the past 1400 yr as reported in the GISP2 Ice Core from Greenland.

Keywords: Chemical composition; Laminated sediments; Wind dynamics; Siberian High; Aral Sea; Late Holocene

Introduction

Despite a growing understanding of the regional impacts of global climate change during the last few thousand years (Bradley, 2000, 2003; Briffa, 2000; Crowley, 2000; Bond et al., 2001; Mann and Jones, 2003; Cook et al., 2004; Moberg et al., 2005), little attention has been granted to the Aral Sea basin. Since western Central Asia is situated at a confluence where different climate dynamics control the hydrology and environmental conditions (Small et al., 2001; Khan et al., 2004; Sorrel et al., 2006), the Aral Sea is an important archive for studying possible feedbacks between relevant climate features and their driving forces. Today the moisture distribution is controlled by the North Atlantic Oscillation (NAO) when the system is in a negative phase (Aizen et al., 2001), whereas draughts are possibly controlled by ENSO as proposed by Barlow et al. (2002), Khan et al. (2004) and Nezlin et al. (2005). Precipitation, which essentially occurs during winter and early spring in the deserts of Central Asia (Lioubimtseva et al., 2005; Nezlin et al., 2005), is associated with moisture originating from the eastern Mediterranean and migrates along a northeast trajectory to western Central Asia (Roberts and Wright, 1993; Aizen et al., 2001; Lioubimtseva, 2002; Sorrel et al., 2007).

In late spring and summer, precipitation is significantly reduced and heating of the desert lowlands in the Aral Sea basin causes local to regional advection responsible for numerous violent cyclones (>100 dust storms per year; Seredkina, 1960),

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