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Russian – German Cooperation in the Siberian Arctic (LenaDNM Project) – a Preface –

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The Arctic Ocean and its shallow but extensive marginal shelf-seas are a significant component in understanding the global climate system and its modern change. The sea-ice covered polar shelf seas, over vast areas supported by submarine permafrost and affected by strong freshwater input from fluvial discharge, form a very unique environment of land–ocean–interaction along the Arctic coasts. They form a vast border zone between warmer freshwater continental runoff and the colder currents of the Arctic Ocean. This is particularly the case for the Siberian Arctic Shelf (SAS) which includes the Kara, Laptev and East Siberian seas. The SAS is a wide and relatively shallow area, with an average depth of about only 30 to 40 m, and a complex oceanographic and biogeochemical regime, which is influenced by a huge freshwater input from the Siberian rivers e.g., KASSENS et al. (1999), STEIN et al. (2003), DMITRENKO et al. (2005).

Siberian rivers flowing into the SAS provide more than 50 % of the total freshwater river runoff to the Arctic Ocean. As for the Siberian rivers, there is a tendency towards increasing annual runoff and an earlier onset of the daily water discharge rate maximum over the last 40 years due to changes in climatic conditions of runoff formation e.g. MAGRITSKY et al. 2001, TANANEV (2016), YANG et al. (2005). In addition, the huge Siberian Rivers, such as the Yenisei, Lena, Ob', Pechora, Kolyma and others represent a rich source of heat, organic and inorganic materials, which influence a wide range of processes from advection and mixing to biogeochemical interactions on the coast, shelf and Arctic Ocean e.g., WINTERFELD et al. (2015), SEMILETOV et al. 2005, VONK et al. (2010), GONÇALVES-ARAUJO et al. (2016), FOFONOVA et al. (2015), STEIN et al. (2003). Moreover, the modern estimates of the coastal erosion indicate that ~88 to 800 tons of plant-, animal-and microorganism-based carbon get into the SAS per year and kilometre of coastline (GÜNTHER et al. 2013). There is an alarming evidence of increasing coastal erosion speed due to warmer water temperature and larger amount of ice-free days. These facts demand our close attention to the Siberian Arctic coastal zone, which represents a critical physical, biogeochemical and ecological gateway for exchange between the Arctic Ocean and the terrestrial environment.

Confronted with these observations and questions, an intense Russian-German scientific cooperation has developed in the last 25 years. This started in 1993 with a workshop on "Russian-German Cooperation in and around the Laptev Sea" at the Arctic and Antarctic Research Institute (AARI) in St. Petersburg. Russian participants came mainly from the AARI and the St. Petersburg State University, from the All-Russia Institute for Geology and Mineral Resources of the World Ocean, from the Shirshov Institute of Oceanology in Moscow and the State Moscow University. German participants came from the Alfred Wegener Institute (AWI) in Bremerhaven and Potsdam, the GEOMAR Research Center and from the Federal Agency for Geosciences (BGR). This workshop combined scientists from various disciplines covering both marine and terrestrial research (KASSENS et al. 1994). It was complemented in the same year 1993 by the joint German-Russian expedition with RV "Polarstern" to the Kara Sea and Laptev Sea (FÜTTERER 1994).

Quite a number of scientific projects, field studies and joint expeditions followed during the next years, especially the lead project "Laptev Sea System" with a number of "Transdrift" expeditions to the Laptev Sea using RV "Ivan Kireyev" and other Russian research vessels (KASSENS et al. 1999). The joint research Project "Siberian River runoff into the Kara Sea" of the AWI and the Vernadsky Institute of Geochemistry and Analytical Chemistry of the Russian Academy of Sciences investigated in a multidisciplinary approach the nature of continental runoff of the rivers Ob and Yenisei and its behaviour in the adjacent Kara Sea using RV „Akademik Boris Petrov" on several joint research cruises (STEIN et al. 2003).

The successful work of the Otto Schmidt Laboratory (OSL) for Polar and Marine Research at AARI, which represents a long-term very active and successful project of Russian-German scientific cooperation by establishing a fellowship programme for young scientists, offering laboratory support, workshops as well as summer schools. This project has been working since 2000 and it has allowed to link the German efforts of AWI and GEOMAR in the area with the achievements of the Russian groups and has attracted a lot of young scientists to the investigation of the Siberian shelf seas.

A major red line in all efforts in the area has been the research dedicated to the Laptev Sea and the Lena Delta area and the Lena River freshwater and sediment input. The Lena River is the second largest river in the Arctic after Yenisei and has the largest delta among all Arctic Rivers. Despite the large number of observations in the delta head area (Fig. 1) and at several hydrological stations upstream, very little is known about discharge characteristics as concentration of organic and inorganic materials, phytoplankton and zooplankton species

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Fig: 1: Lena River at Stolb Island, head area of Lena Delta (A. Chetverova).

and heat fluxes associated with the Lena River runoff in the river mouth. These factors experience complex changes within the delta due to the processes of dispersion and redistribution of river flow over the space initiated by large amount of bifurcations of the riverbed, coastal erosion (Fig. 2), hydraulic interaction between river and sea waters and chemical and biological transformation of substances contained in the water. The channels in the delta have different geomorphologic structures and modes of functioning, the concentration of passive and active mixtures (organic and inorganic materials, phytoplankton and zooplankton species), heat fluxes in the channels do not follow the water discharge rates, which are known for main channels and for some sub-channels in the area (MAGRITSKIY 2001, BOLSHIYANOV et al. 2013, FEDOROVA et al. 2015). More than thirty thousand lakes and a multitude of flat islands also constitute components of the delta. However, we will never be able to develop predictive capacities if we do not determine the Lena River contribution to the current dynamics of the Laptev Sea and Arctic Ocean.

In 2014 the project "Development of Numerical Modules for the Lena Delta region" (LenaDNM) started, funded by the German Ministry of Education and Research (BMBF). The general goal of the project was to intensify further collaboration between Russian scientific research institutions in the frame of analysing and modelling of the dynamics in the Lena Delta region. The BMBF project gave unique possibility to organize several collaborative workshops in Germany and in Russia and to invite several young and postdoc scientists to the AWI from different Russian research institutions for several months for common work and discussion.

Fig: 2: Coastal erosion of ice-rich permafrost Yedoma sediments in the Lena Delta (Photo: A. Chetverova).

LenaDNM project has been finished in May 2017 and in the current special issue, we would like to present a summary of achieved results and a number of new findings dedicated to the terrestrial impact into the Siberian Arctic shelf seas (SAS), its circulation and estuary types, and some aspects of modelling of the coastal sediment dynamics and circulation. It is a collection of scientific topics, which required great logistics, team spirit and courage at the "edge of the World".

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