2.8 Water temperature patterns and flow characteristics near the head of the Lena River Delta

Lasse Sander[1], Rune Michaelis[1], Svenja Papenmeier[1], Sergey Pravkin[2], (Vera Fofonova[1]: not in the field)

[1] Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research Sylt, Germany

[2] Arctic and Antarctic Research Institute (AARI), St. Petersburg, Russian Federation

Fieldwork period and location

July 30th to August 13th, 2017 (on Samoylov Island)

Objectives

Large Siberian rivers, such as the Lena, annually discharge large amounts of freshwater into the Arctic Ocean. Their size and orientation determine an effective transfer of heat over large distances and across pronounced seasonal temperature gradients. The volume of river discharge is thus an important parameter affecting water temperature and salinity in arctic deltas, estuaries and in the adjacent shallow shelf seas. Long-term changes in the characteristics of river discharge may consequently have important implications for shelf dynamics and the Arctic Ocean as a whole (Peterson et al., 2002).

At the delta head, the Lena River leaves the confines of the Verkhoyansk Mountain range and is released into a complex pattern of stream channels. With the diversification of the stream network, waters are funneled into beds of different characteristics regarding hydrography, geomorphology and ground temperature. These parameters define the effectivity of cooling at the transition from land to sea.

The aim of the field campaign was to obtain data on channel properties and temperature patterns in the Lena River and in the main Lena Delta branches (Figure 2.8-1). The data further serves to understand temperature anomalies observed in time-series of archived hydrographic data and to improve numerical models of discharge and water temperature (Fofonova et al., 2016).

Methods

Measurements with a CTD probe (Conductivity-Temperature-Depth probe; Sea and Sun Technology) were conducted as depth profiles at regular intervals of between 50 and 200 m (depending on channel widths; see Table 2.18.1) along five cross-river transects. The probe was attached to a rope and manually submerged from the side of *RV Ural*. The boat was drifting during the measurement of each profile. Additional measurements of current velocity and direction were conducted using an Acoustic Doppler Current Profiler (ADCP; WorkHorse Sentinel, RD Instruments) and in the analysis combined with multispectral land-surface information (including thermal bands) obtained from the Landsat program.

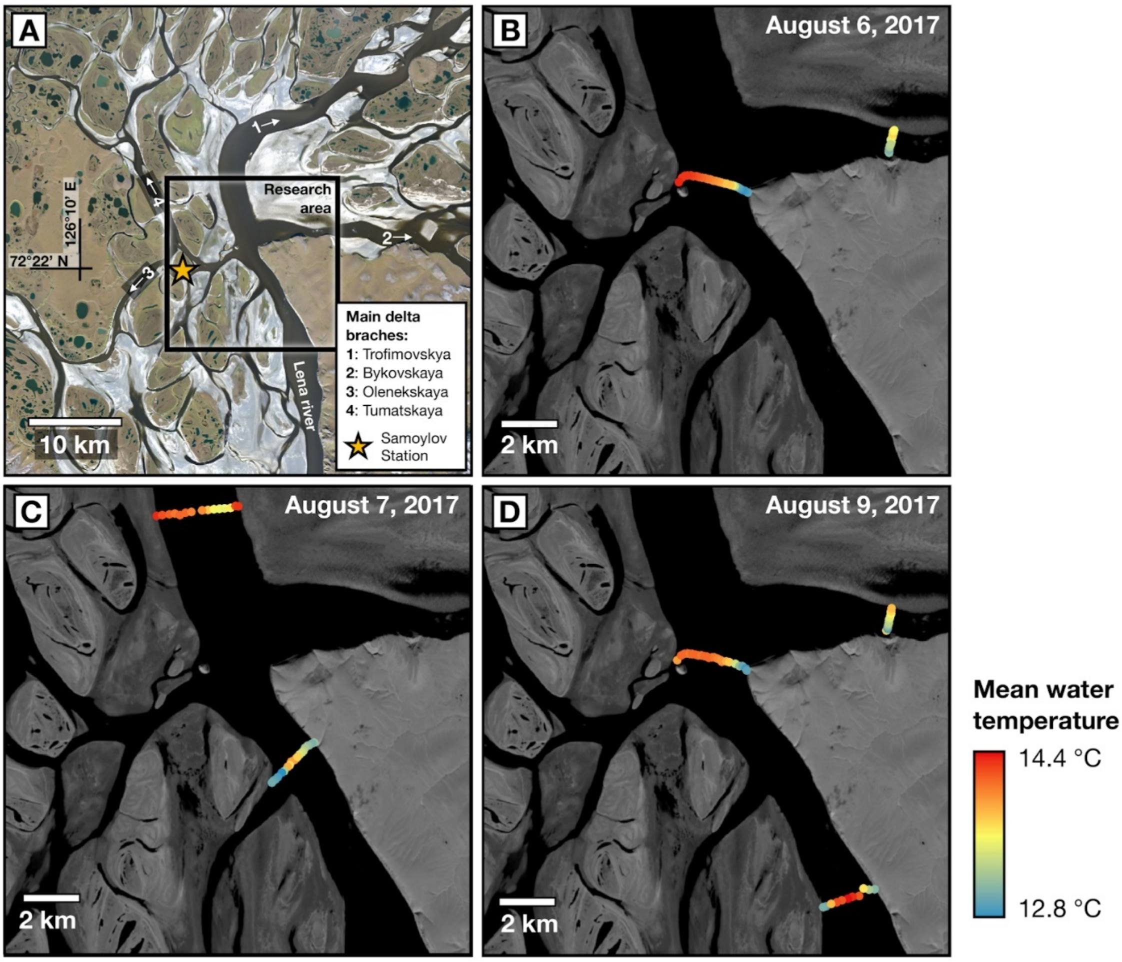

Figure 2.8-1: *(A) Location and basic geomorphology of the field site, (B-D) Mean water temperature values for the CTD profiles obtained at three different days of measurement.*

Preliminary results

For the individual profile measurements, there is virtually no variation in water temperature over depth, which suggests full mixing (i.e. high turbulence) in the water column. Across each transect however, small, but measurable, changes in temperature were observed (in the order of T = 0.2 — 0.8 °C; Figure 2.8-2). The water temperature gradually increases or decreases towards the river banks when compared to the midstream temperature. The temperature pattern in the water appears to be related to spatial differences in land-surface temperature, which determine a local cooling of the flowing water masses. A possible explanation for spatial differences in land-surface temperature is that a large proportion of the delta is flooded during the high summer runoff period. However, during periods of low discharge (between October and April), most river banks, shoals, shallow stream channels and sandbanks are exposed to low air temperatures. While the sand banks in the northern part of the research area appear to be relatively warm (when compared to the river banks in the central part of the area), the right bedrock-bound banks of the Lena River Main Channel and of Bykovskaya branch are relatively cold (cf. Figure 2.8-1 B-D).

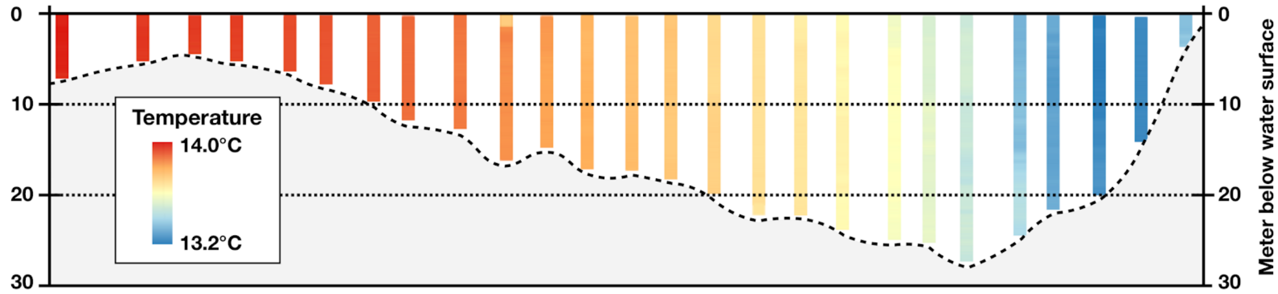

Figure 2.8-2: *Distribution of water temperatures across the approx. 2.6 km long transect B. The dashed line indicates the river bed.*

In addition, our data show a measurable variation of the overall water temperature over short periods of time (several hours to days). The likely reason for this is the passage of warm-water pulses resulting from warm weather conditions in the central Siberian hinterland. This determines that a direct comparison of measured values between the different days is not possible.

Table 2.8.1: Overview of CTD transects

ID	Date [year/ month/ day]	Start coordinate [Deg]	End coordinate [Deg]	Length [meter]	Approx. interval [meter]	Max. Depth [meter]	Number of profiles
A	2017/07/08	72.44315N/ 126.60258E	72.44718N/ 126.68808E	2900	200	15	16
B	2017/08/06 2017/08/09	72.39608N/ 126.72723E	72.39841N/ 126.6540E	2650	100	31	26
C	2017/08/06 2017/08/09	72.41021N/ 126.87353E	72.41736N/ 126.87835E	800	50	17	17
D	2017/07/08	72.37345N/ 126.77686E	72.36033N/ 126.73416E	2050	100	32	20
H	2017/09/08	72.32833N/ 126.86951E	72.32216N/ 126.81663E	1900	200	36	11