Lomonosov Moscow State University

Novel comprehensive field-based monitoring dataset of largest Siberian river particulate flux into Arctic ocean (ArcticFLUX)

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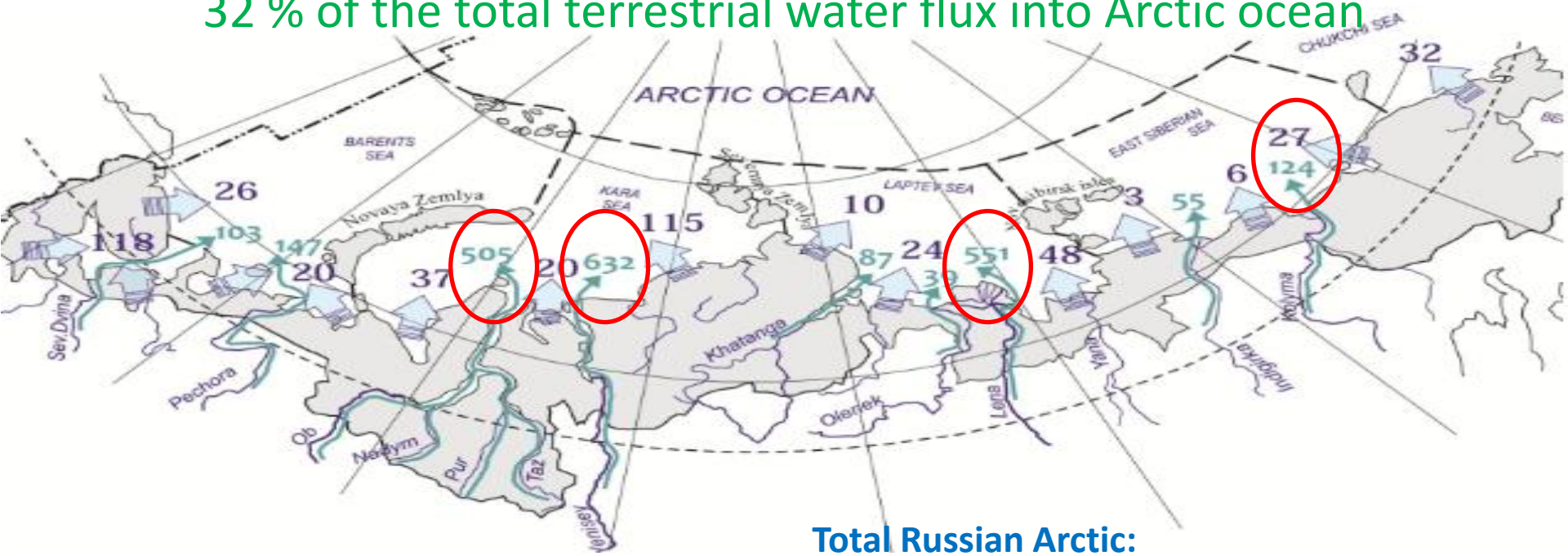
EGU2020-10424

Largest Siberian Rivers

OB Enisey Lena Kolyma

58 % of the terrestrial water flux from the Russian Arctic

32 % of the total terrestrial water flux into Arctic ocean



Total Russian Arctic:
2922 cubic kilometers of water per year

Open questions/gaps in knowledge:

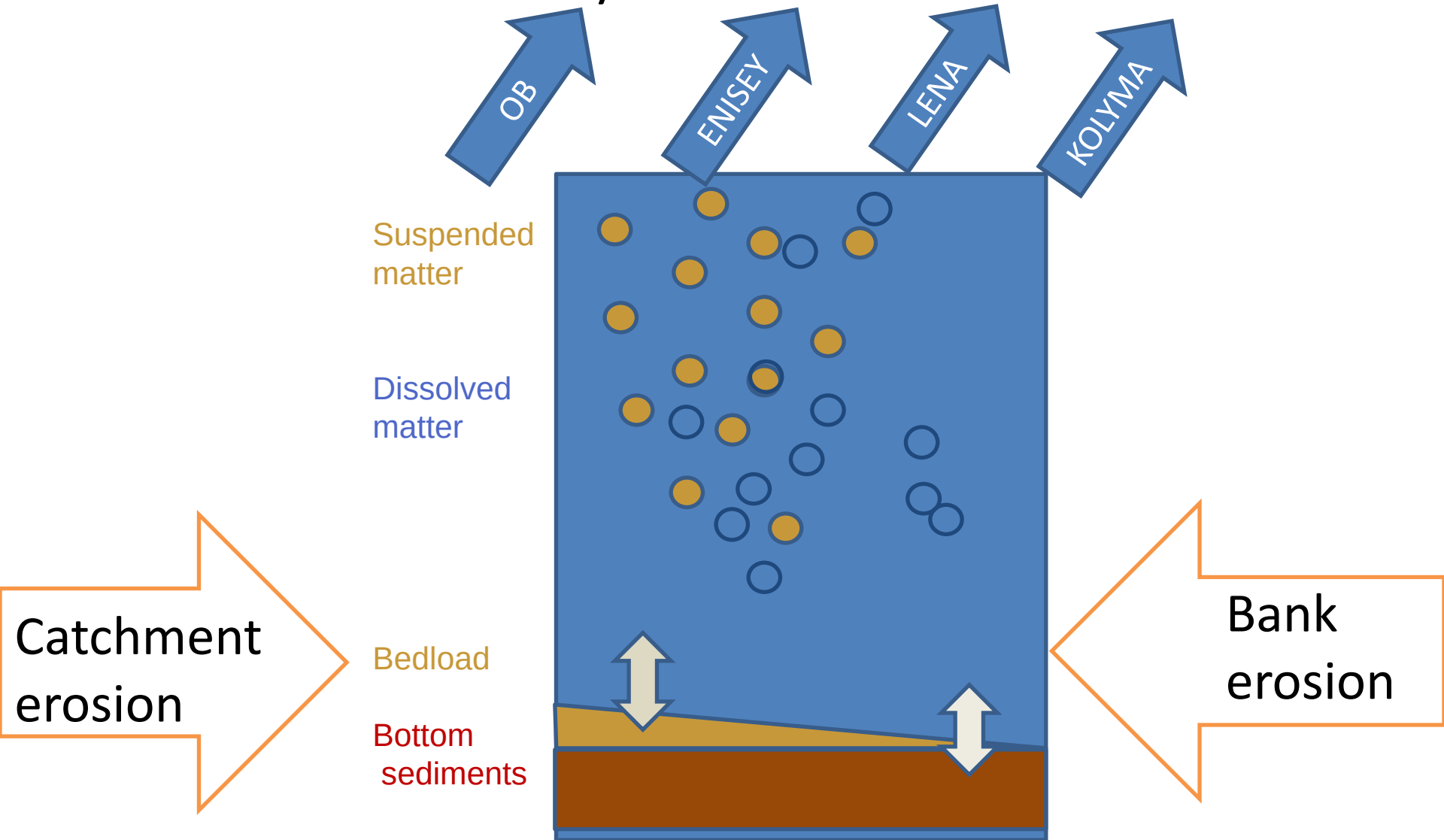
Bed load and suspended load

Chemical flux (both particulate and dissolved)

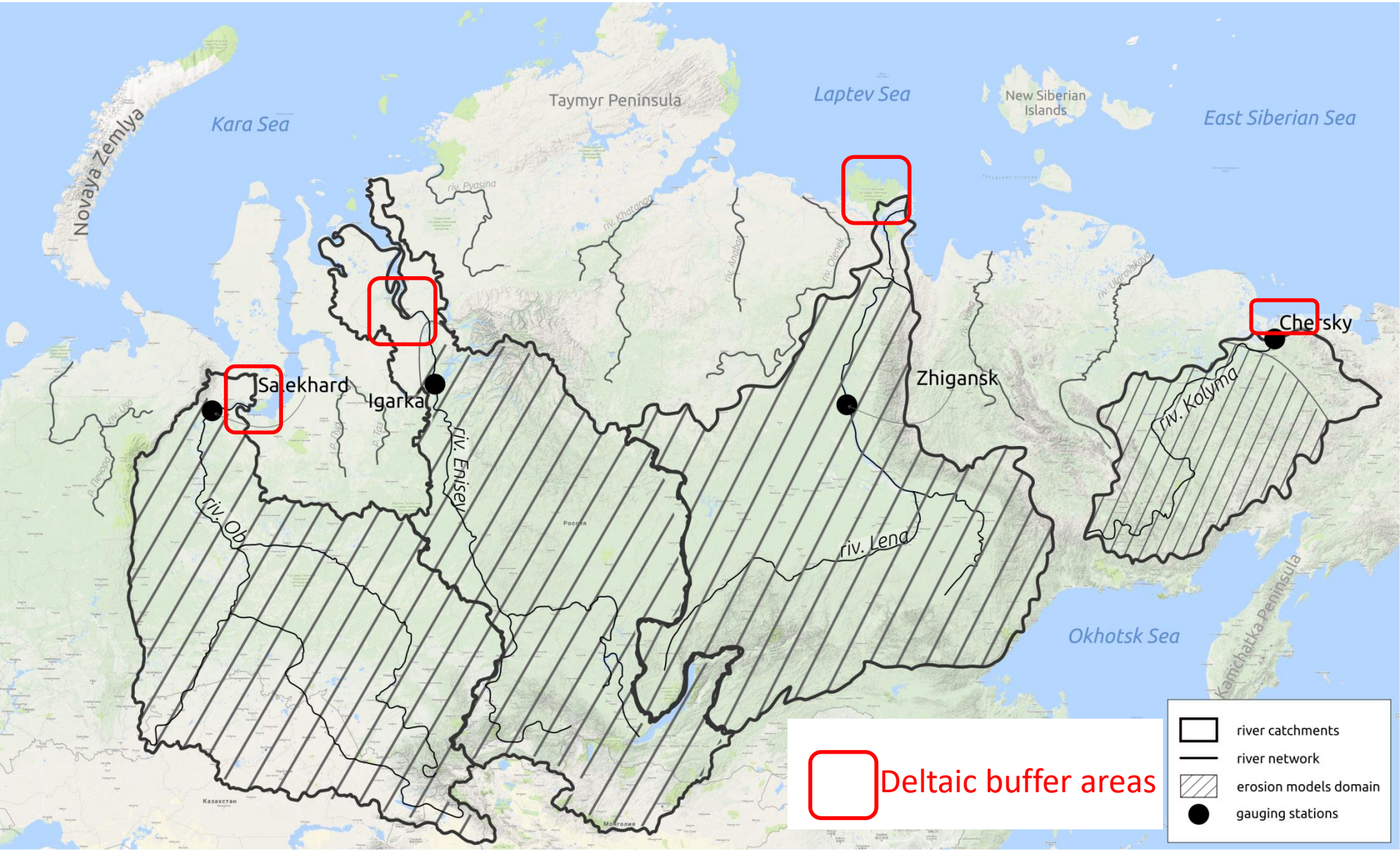
Processes in the deltas (downstream from outlet gauging stations)

Water, Sediment (bed and suspended load), grain sizes,
Metals (Fe, Mn, Pb, Co, Bi, Ni, V, Zn, Cd, Cu, Cr, W, Sn, As, U, Mo, Sb, B)
Biogens (P, N, S), Carbon (POC, DOC)

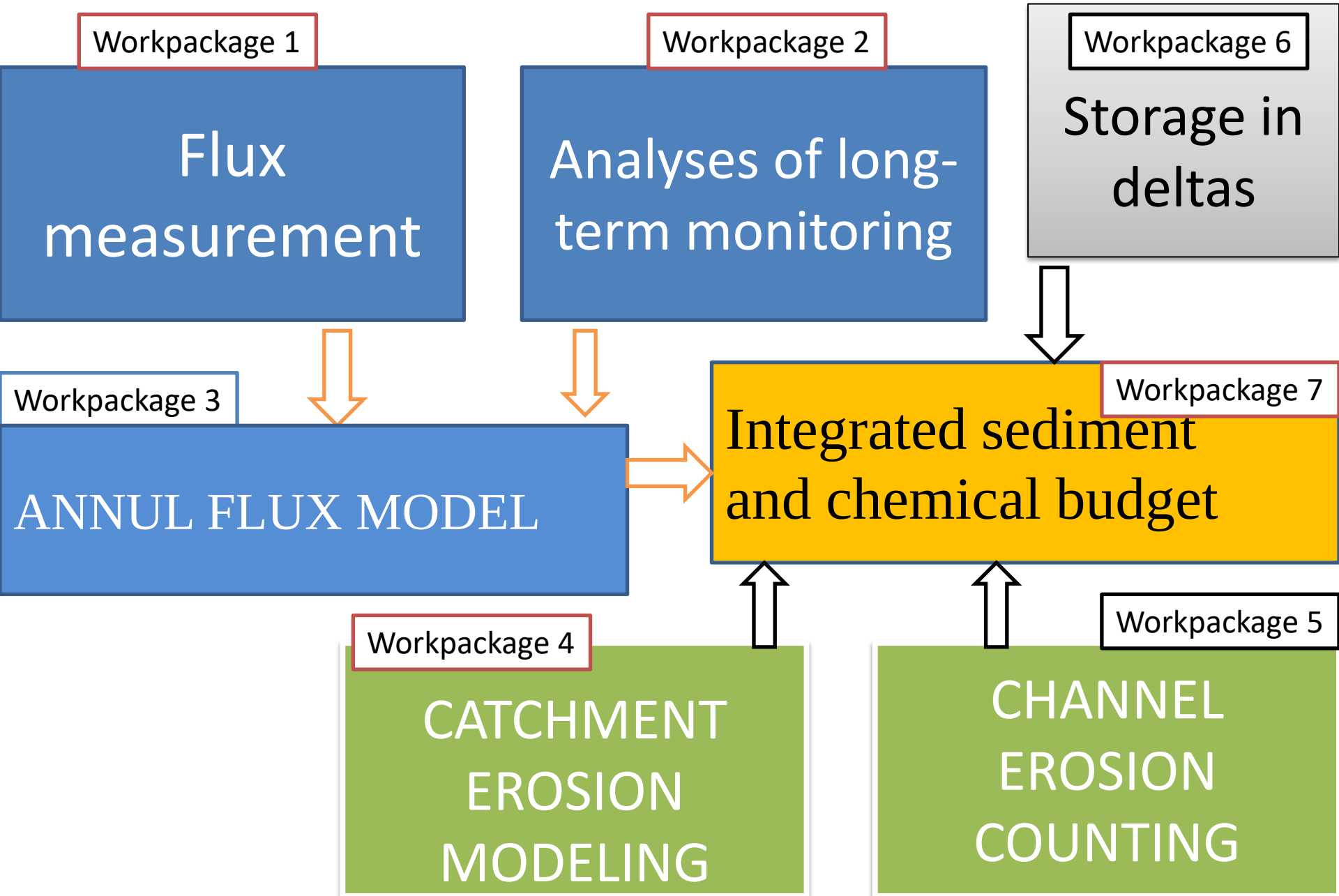
Delivery into Arctic ocean



ArcticFLUX case study areas



ArcticFLUX project workflow



This presentation will focus on:

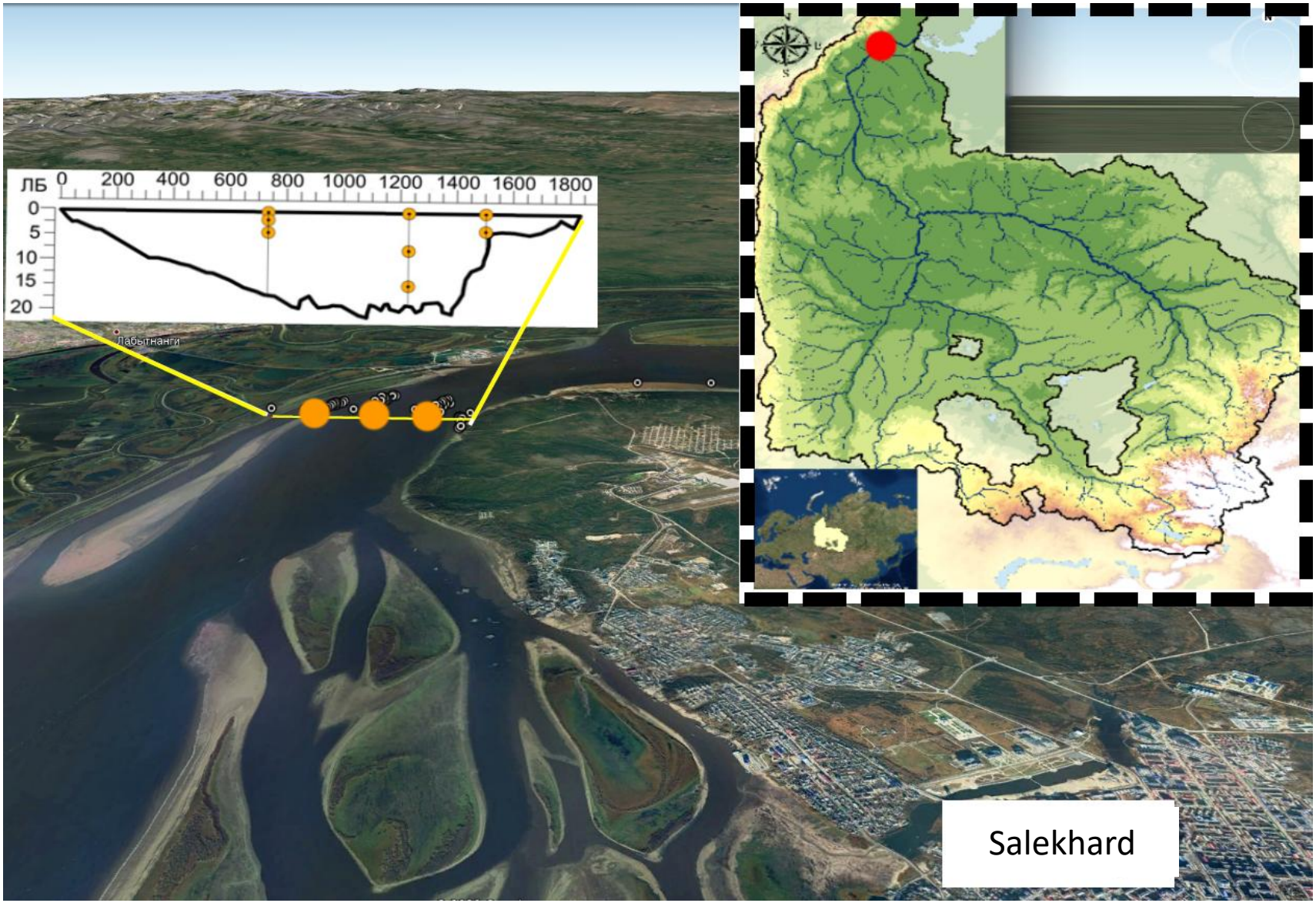
1 MEASURING TOTAL (BED AND SUSPENDED) SEDIMENT FLUX IN LARGE RIVERS USING ADCP and ROUSE MODEL

- Obtaining high-resolution grid distribution of sediment concentrations over crossestion
- Constructing annual flux

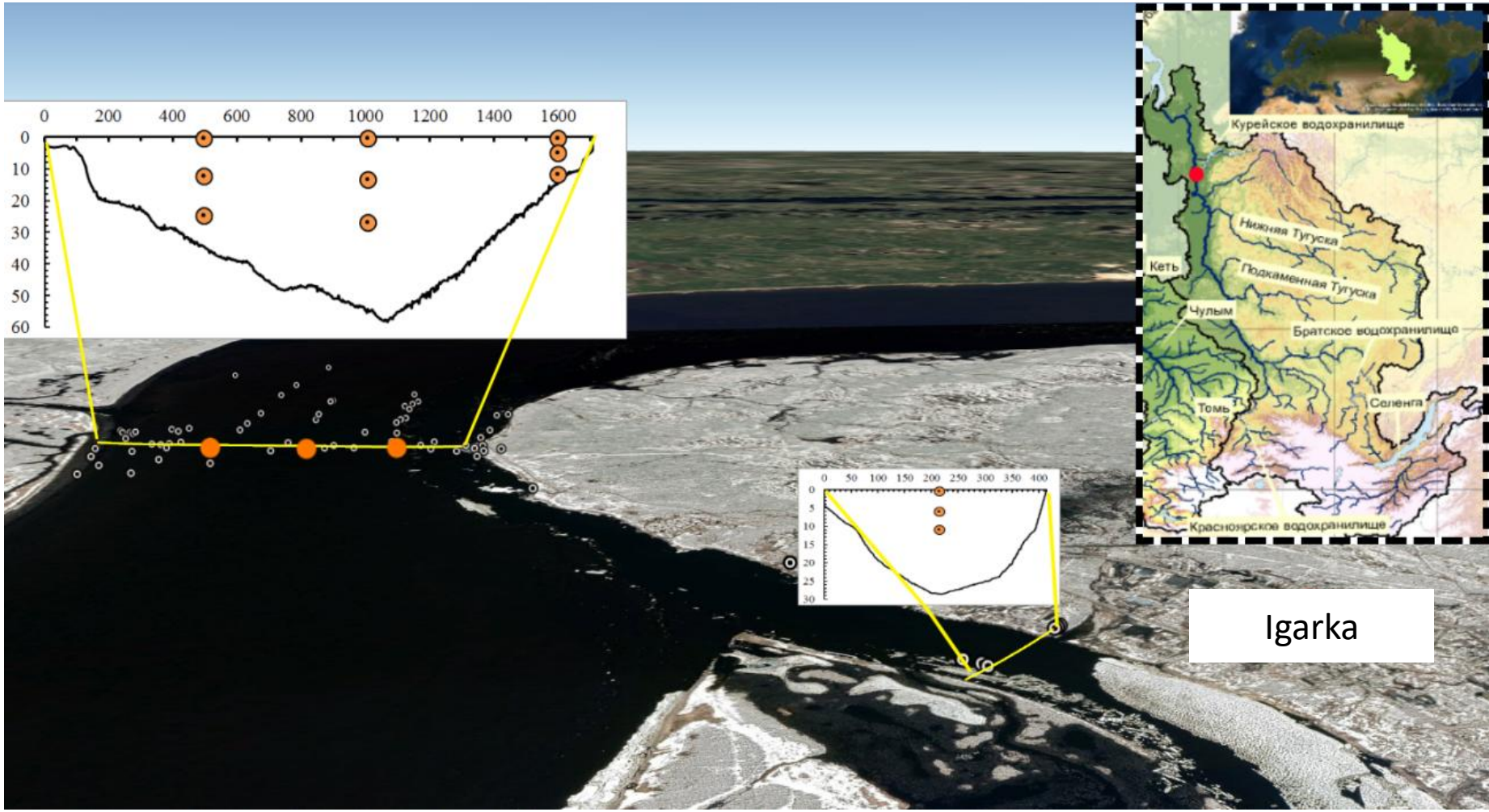
2 CONCEPTUAL MODEL TO COUNT PARTICULATE METAL FLUX

3 MEASURING FLUX TRANSFORMATION IN THE DELTAIC ZONE

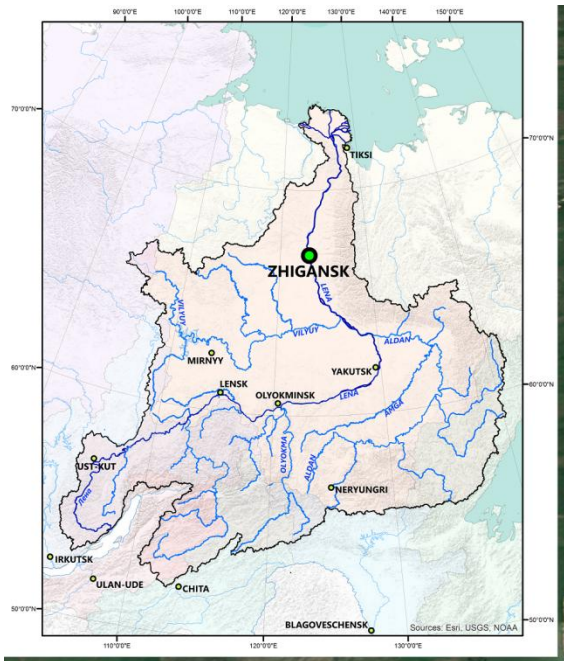
1: OB river, Salekhard

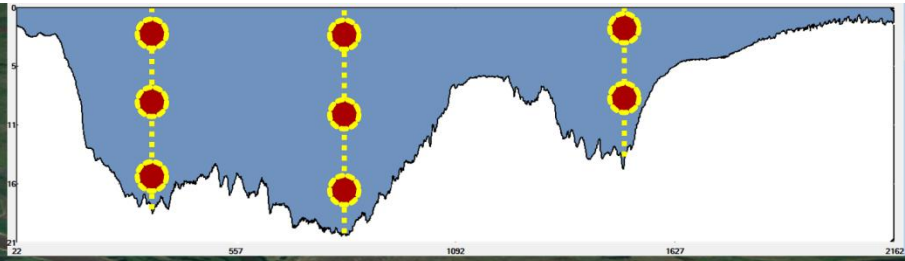


2: Enisey River, Igarka

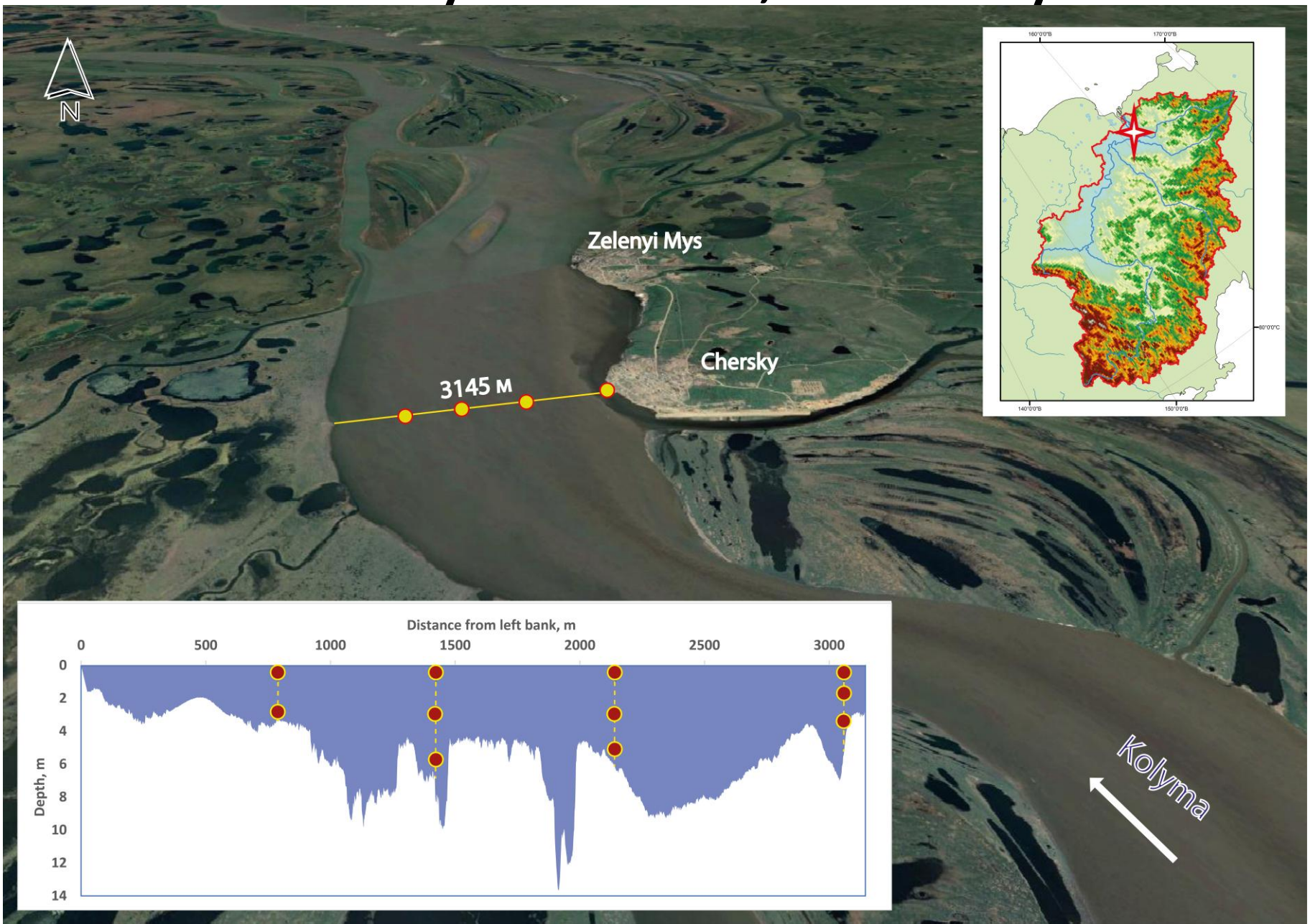


3: Lena River, Zhigansk



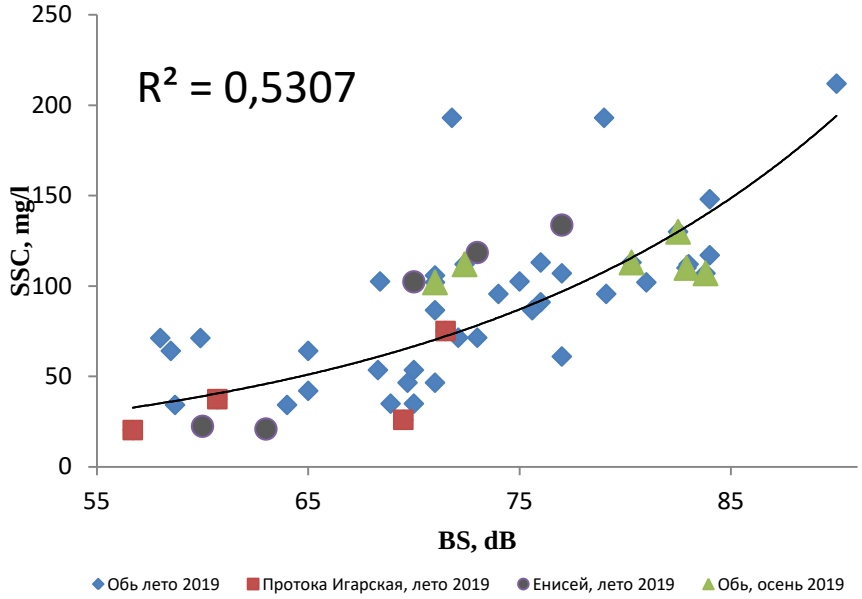


4: Kolyma River, Chersky



1

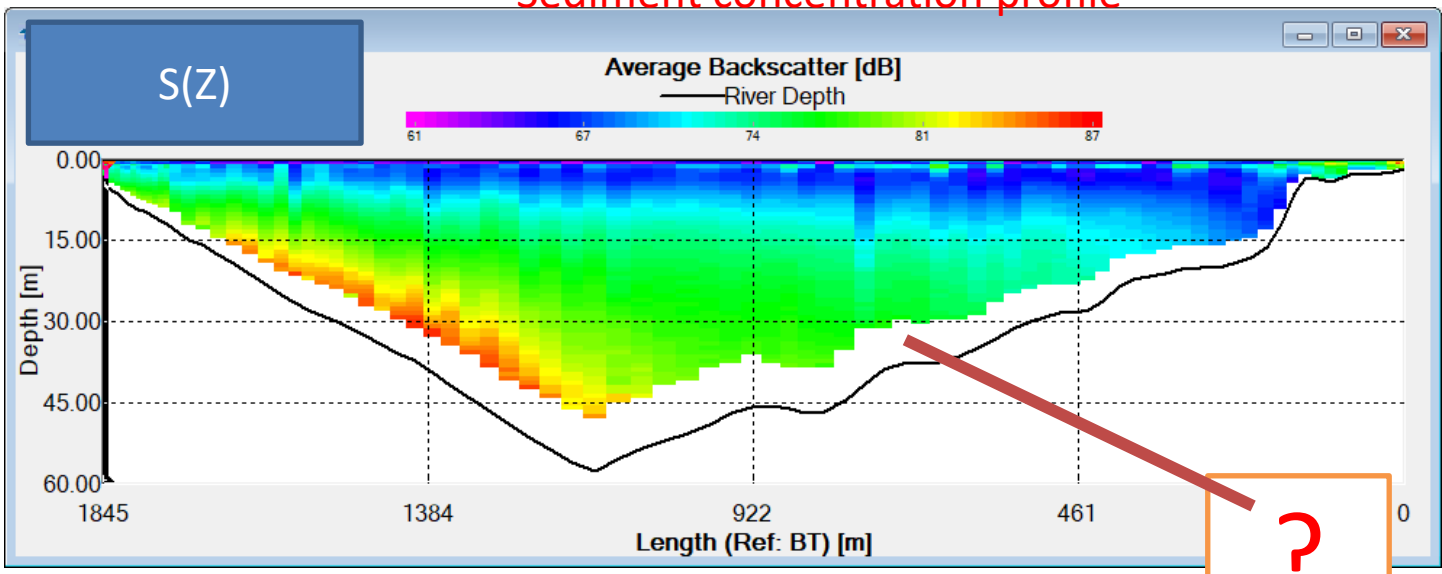
Integrating ADCP data with sediment sampling to obtain full crossectional distribution of sediment and chemicals



Relationship between ADCP backscatter intensity and SSC

ENISEY RIVER, IGARKA 14-06-2019

Sediment concentration profile



Hydrodynamic distribute particles in the rivers

ROUSE NUMBER:

$$Ro = \frac{w}{\beta k V_*}$$

(Rouse, 1937)

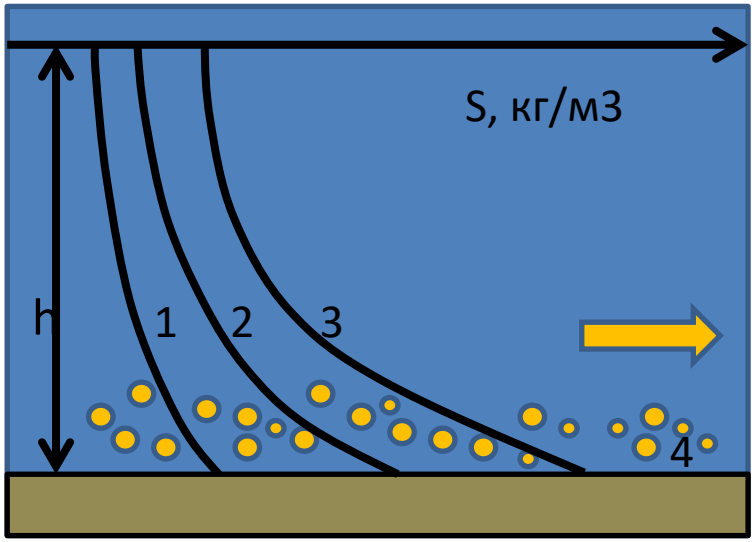
Settling forces

Track forces

Rouse-based approach to count annual sediment and chemicals flux: analytical framework

1. Calibrating Rouse model based on vertical profiles measurements

$$\frac{S}{S_a} = \left(\frac{h-z}{z}\frac{a}{h-a}\right)^{\frac{w}{\beta k V_*}}$$



2. Counting relative sediment transport rates

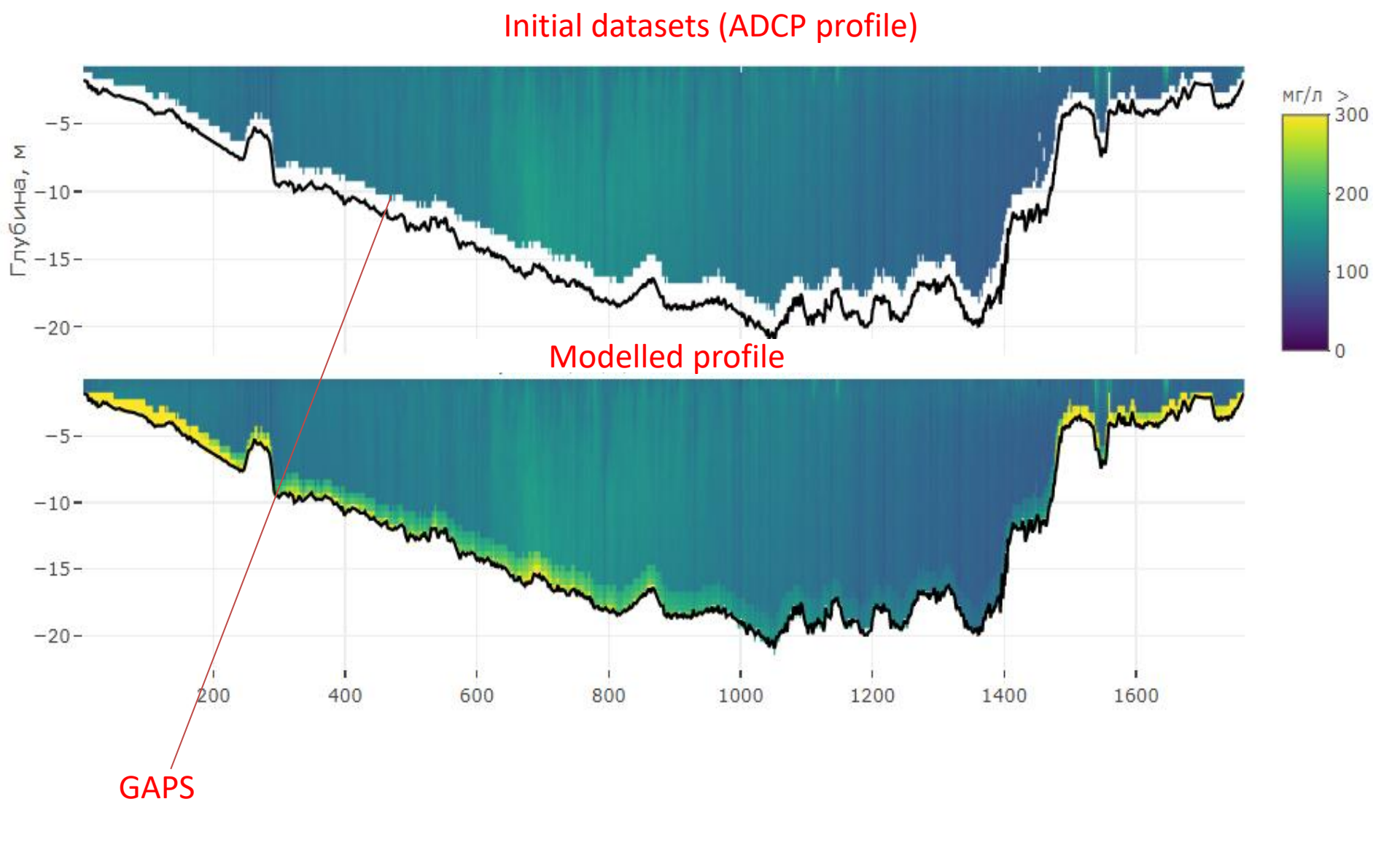
$$q_s^i = \int_a^h S(z)V_x(Z)dz$$

3. Estimating annual flux

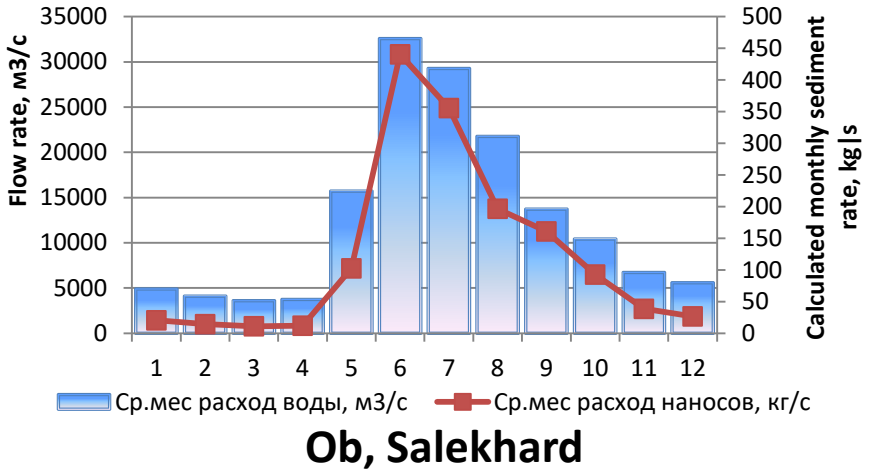
$$W_R^i = \int_a^h S_д \frac{V_*}{k}\left(\frac{h-z}{z}\frac{a}{h-a}\right)^{\frac{w}{\beta k V_*}} ln\frac{30z}{k_s}\,dz$$

Links to chemical fluxes

1 Modeling of total sediment load from ADCP data using Rouse approach (example of Enisey River)



1 Constructing annual total particulate flux



Annual total sediment yield model

$$R+G=AQ^2I$$

1. Counting A from measured data

$A = (R+G)/Q^2I$

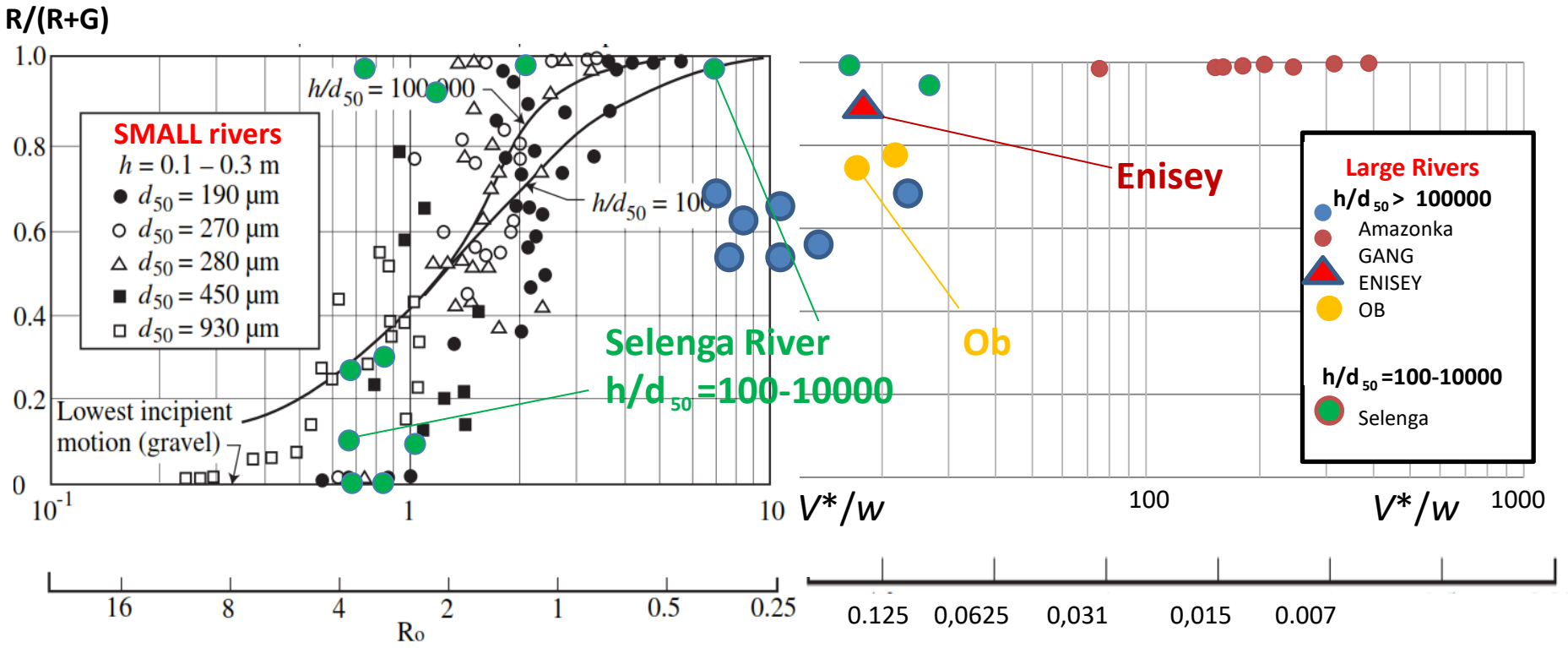
2. Integrating A into monthly discharge data

Integrated sediment budget of OB and Enisey rivers (mln t/year)

	Erosion		Deposition	Annual R+G	Budget
	Catchment	Channel			
Ob	85,0	27,1	47,5	58,2	6,3
Enisey	53,6	11,3	29,0	32,5	3,4

Sediment flux partitioning (R/R+G) versus Rouse number

Novel data for large river flux

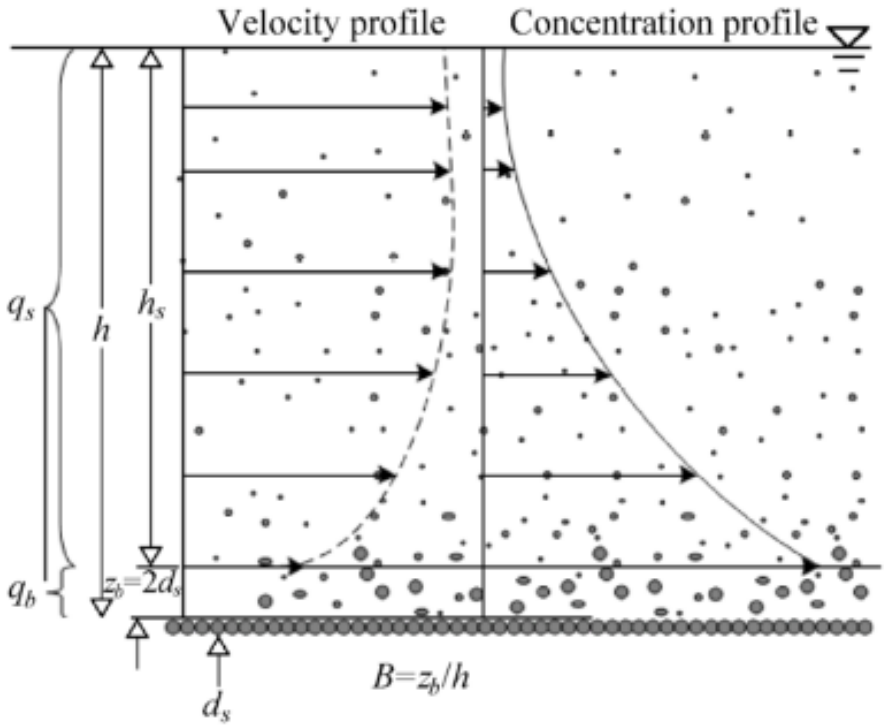


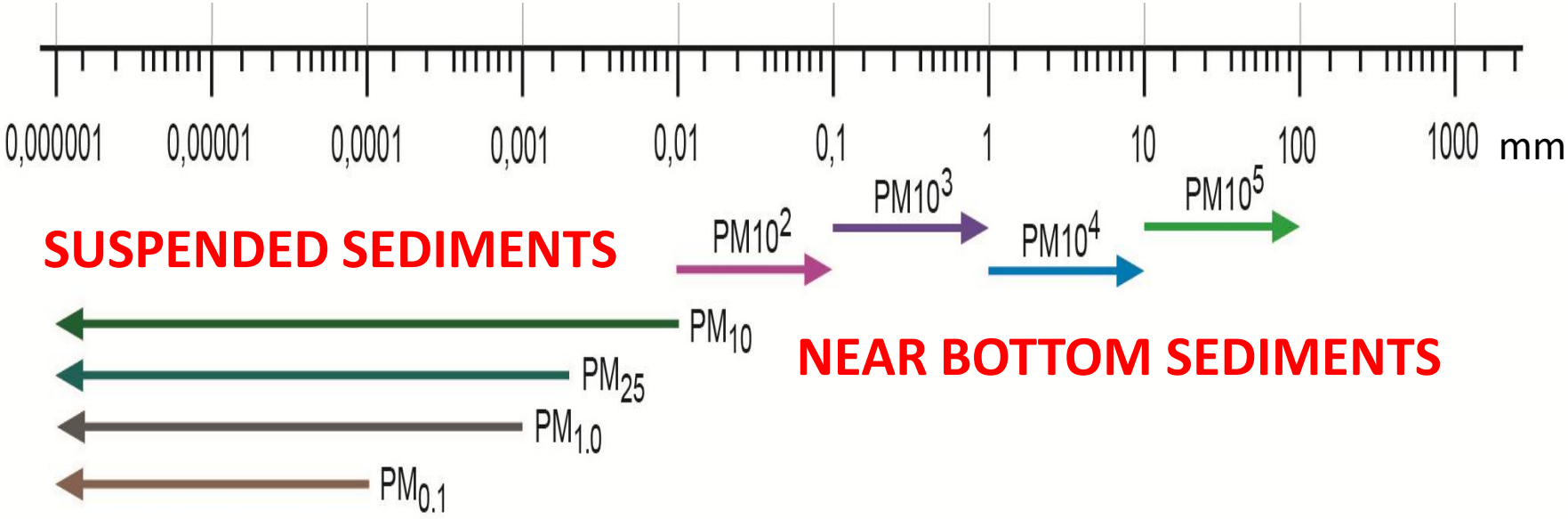
- Data for small rivers is CRU data [Guy, Simons, Richardson, 1966; Julien, 2010]
- Data for Amazonka is from [Bouchez и др., 2011], Gang [Lupker и др., 2011],

2 Modelling particulate chemical flux

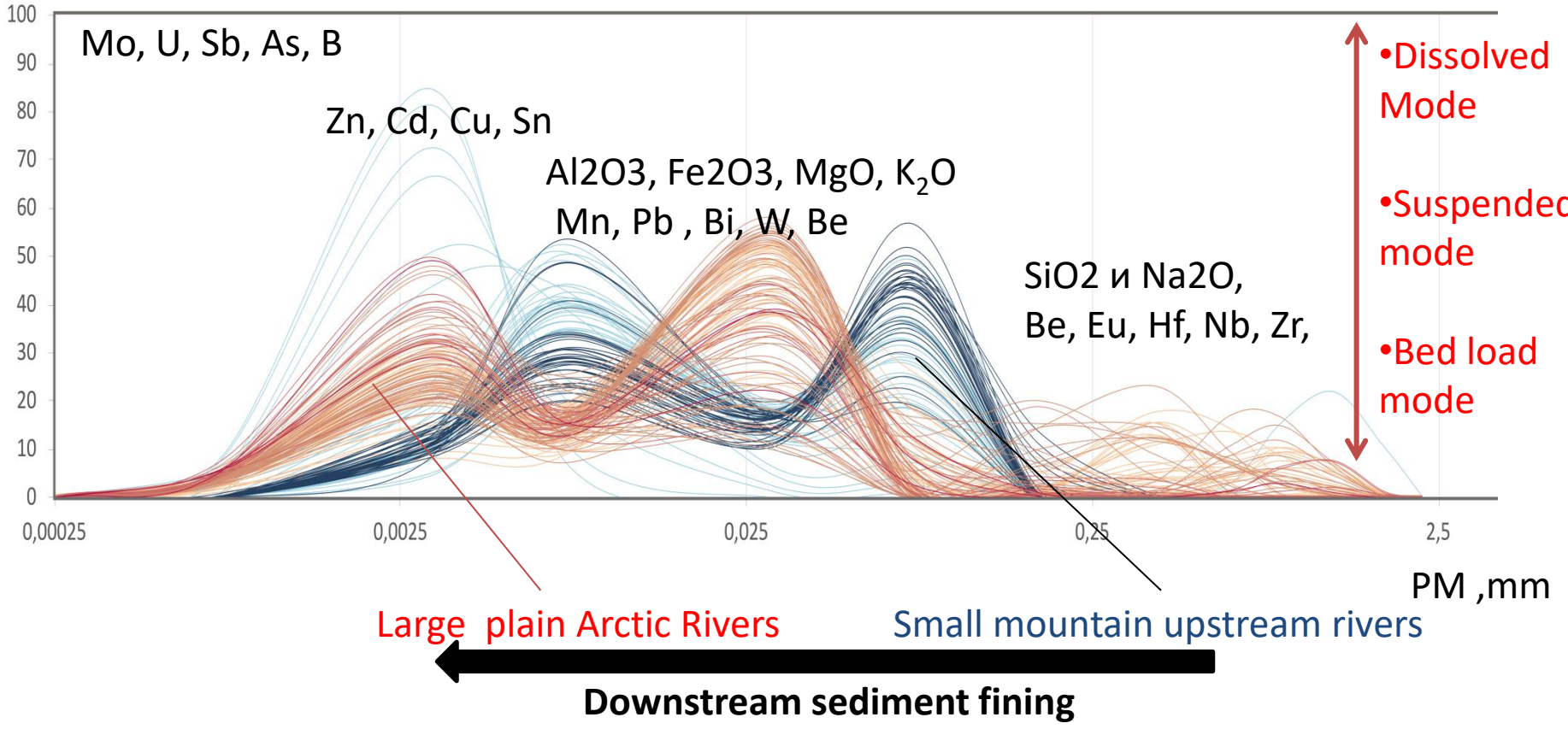
Integral drivers of

- Hydrodynamic sorting
- Geochemical sorting





2 Suspended particulate matter: two-modal distributions

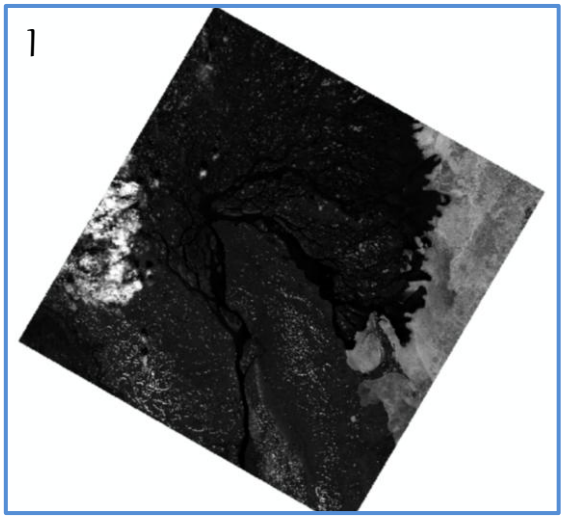


- Linking grain size to total sediment transport
- Elements concentration as a function of grain size

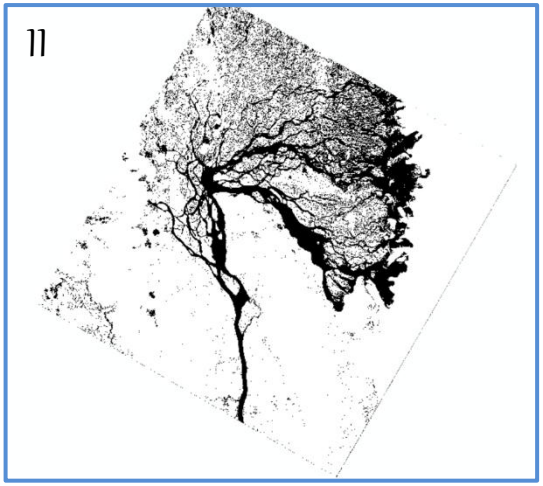
→ Total chemical particulate load

Prediction of sediment and chemical storage at the delta/coastal area: application of remote sensing data for the Lena delta

I

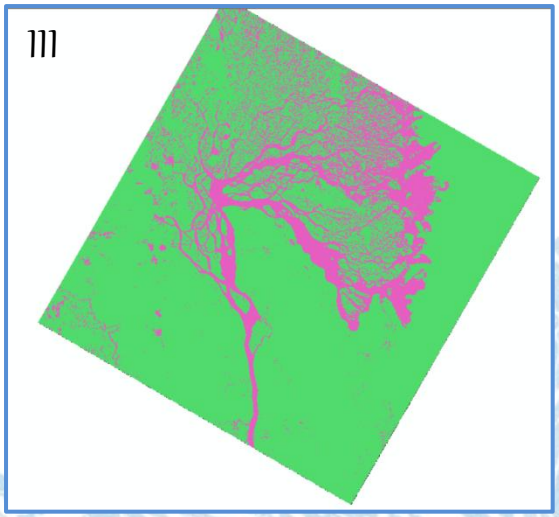


II



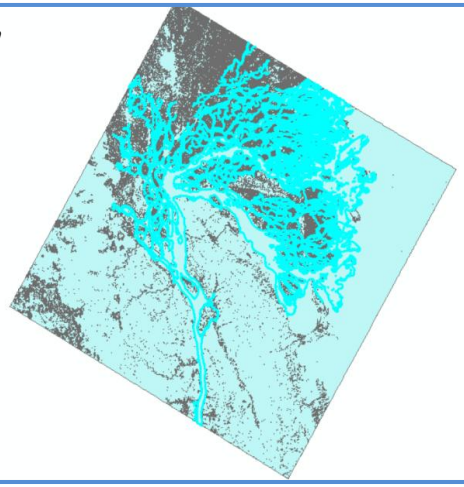
Regression model of retrieving sediment concentration data from RS images

III



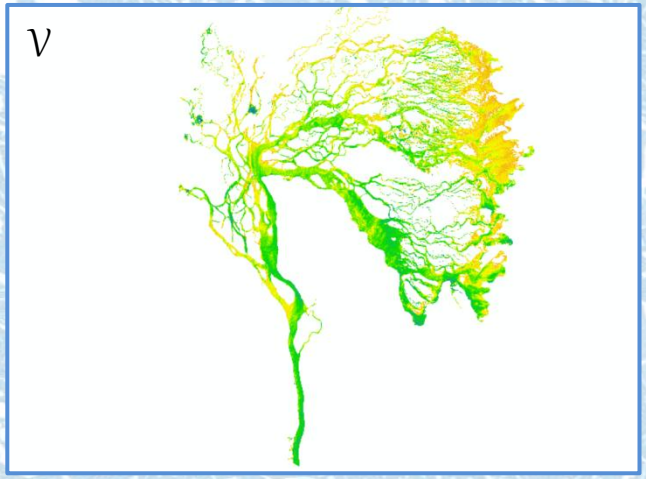
Raster classification

IV



Masking the delta area

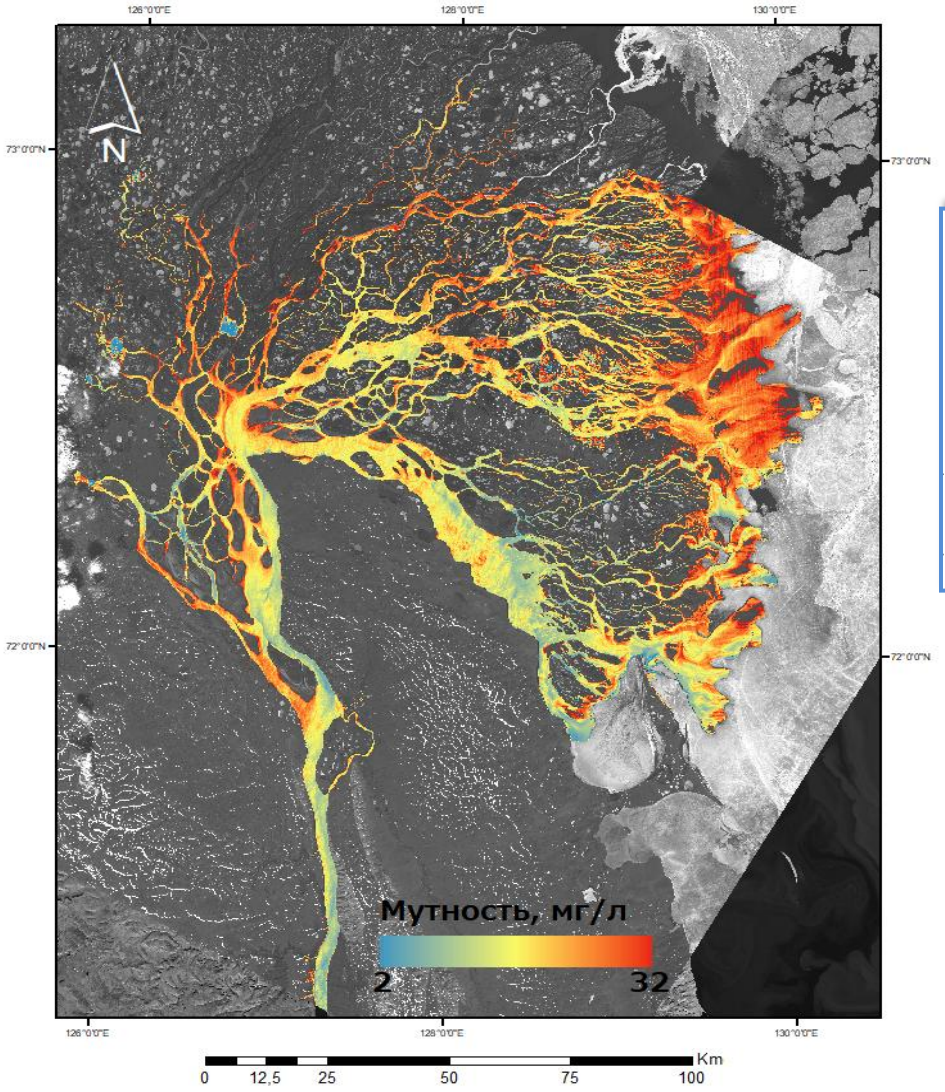
V



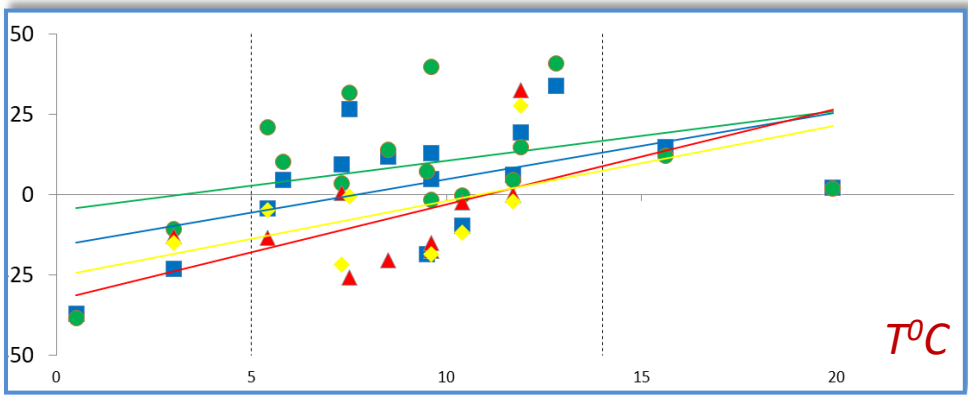
Mapping sediment concentrations and calculating sediment budget

3

Fate of sediment in deltaic downstream areas – understanding total delivery into the Arctic seas



ΔSSC_0 %



Constructing sediment budget for the Lena delta as a functions of air temperature T^0C
(colors represent various branches)

TERMOEROSION OF THE NORTHERN-ORIENTED BANKS!!

Sediment concentration maps for the delta of Lena River (June2019, Q = 31200 m^3/s).

Study outputs

- Significance of the hydraulic control for the metal partitioning within river as well as explains spatial (inter-basin) variations in particulate flux due to local hydrology, erosion rates and catchment lithology.

- Hydrogeochemical model to derive the annual flux of the sediments and particulate flux of the selected metals using (ADCP) acquisitions with sediment depth profile sampling of the Ob, Enisey, Lena and Kolyma

- Uncertainties estimates in selected sediment quantity and quality data, including contributions from vertical and crossectional variations into fluxes estimates including requirements for sampling strategy.

- Novel quantitative assessment of bank and catchment erosion contribution into chemical flux.