CURRENT LIMITATIONS FOR CARBON RELEASE FROM WATERSHEDS OF CENTRAL SIBERIAN PLATFORM

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- The Arctic drainage basin (~24 × 10^6 km^2) processes about 11% of global runoff (Lammers et al. 2001) and 13% of dissolved organic carbon (DOC) (Raymond et al. 2007). 17-42 Tg

- Arctic and subarctic regions demonstrate most significant changes during last decades which include northward shifts of vegetation, declining permafrost and increased river discharge (Serreze et al., 2000; Kharuk et al., 2005; Peterson et al., 2002; Schuur et al., 2008).

- However, differences in geomorphology, hydrology, permafrost regime, soil types and vegetation among basins of Eurasian rivers exert uncertainty in overall response of hydrologic C export under global warming. In particular, largest Siberian rivers from west to east (Ob', Yenisey, Lena, Kolyma) demonstrates drastic diversity in watershed properties, and their reaction to climate change remain poorly understood.

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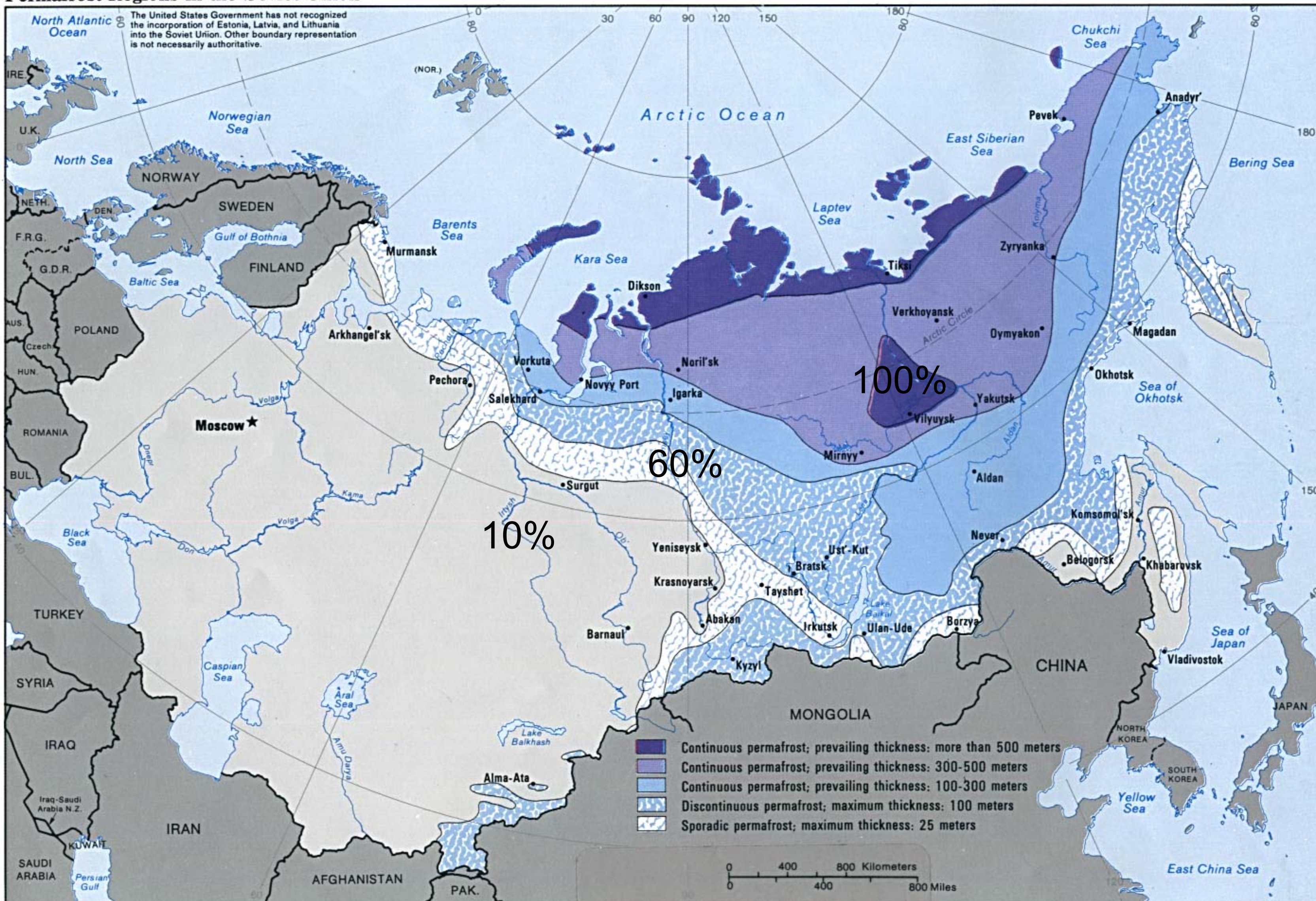
Permafrost

Permafrost Regions in the Soviet Union



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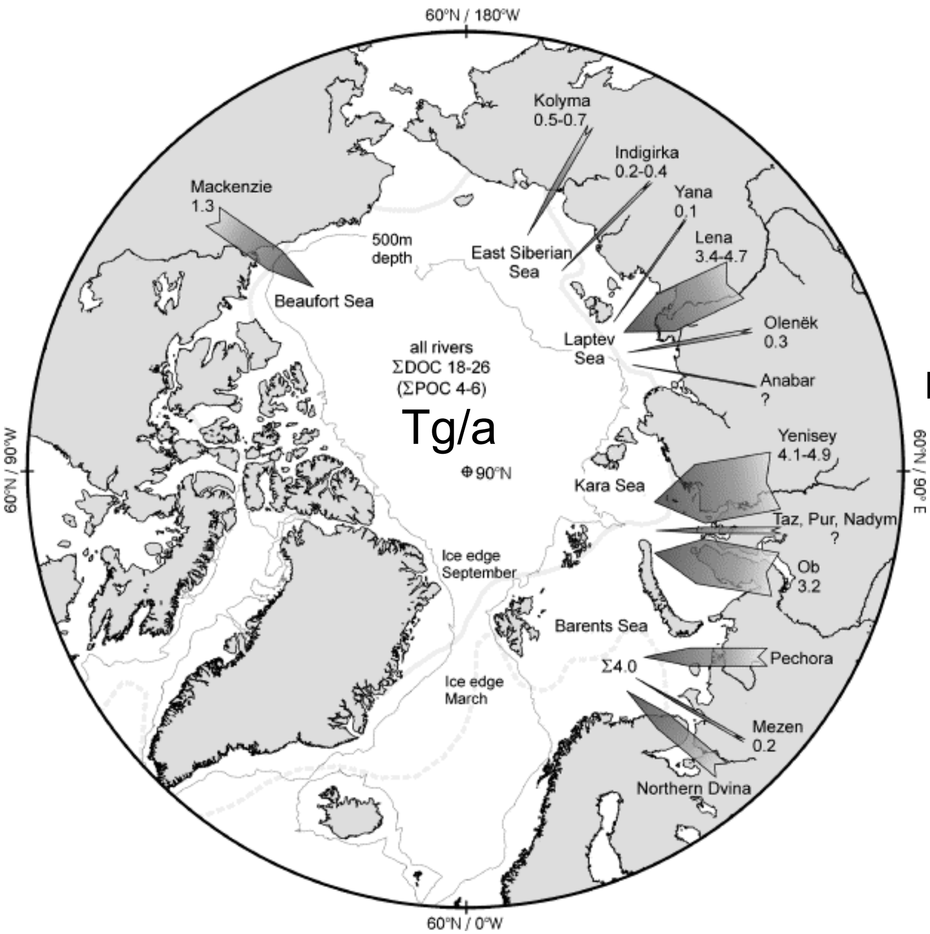
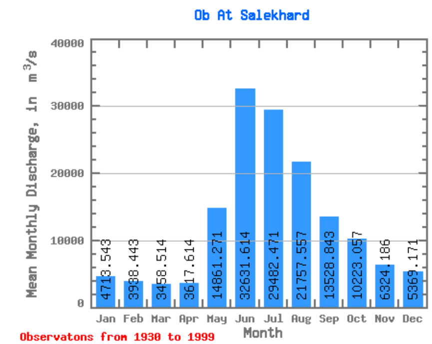
Large Arctic river discharge and C export

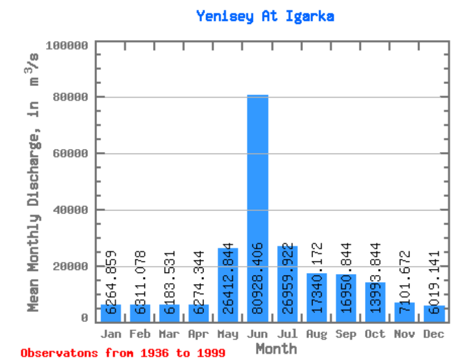


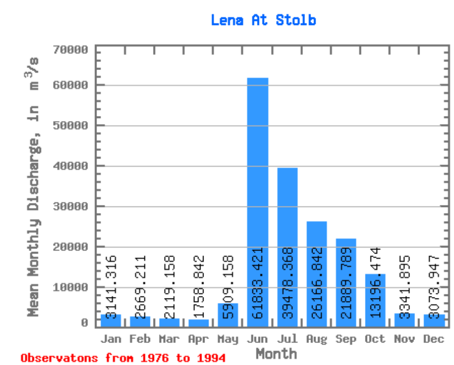
DOC export, gC/m²/a	
Ob'	0.99-1.01
Yenisey	1.15-2.23
Lena	1.19-2.34

Dittmar T, Kattner G (2003)

Raymond et al. (2007)







PARTNERS and current program
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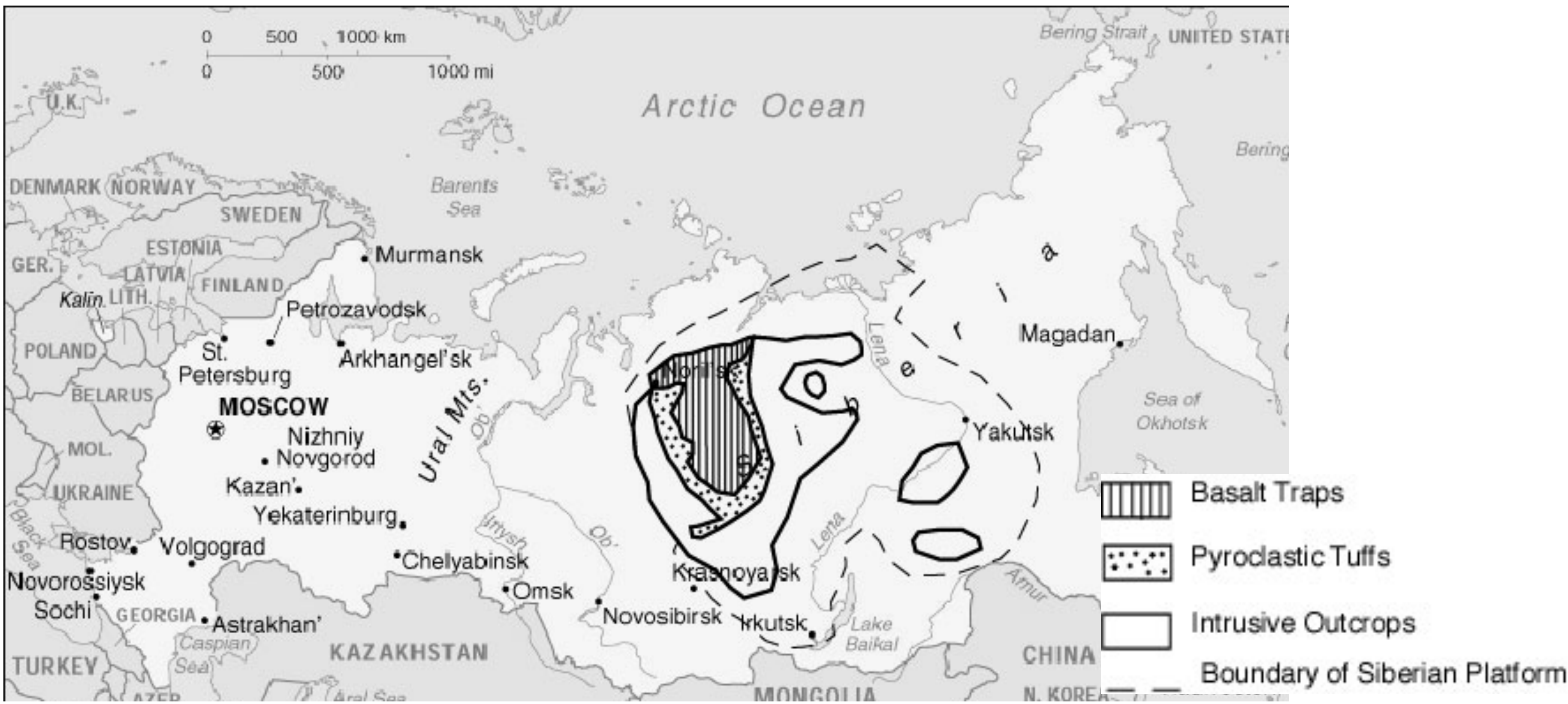
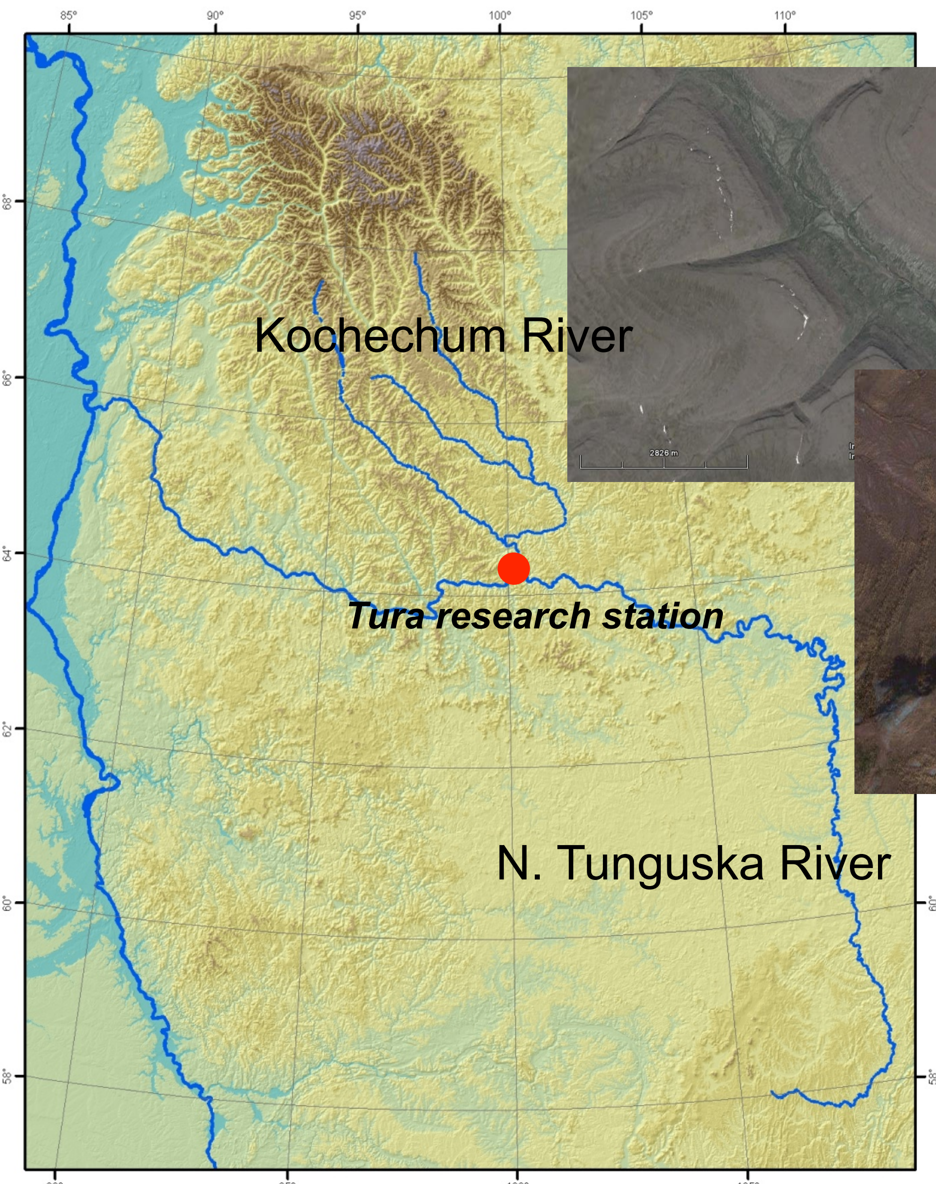
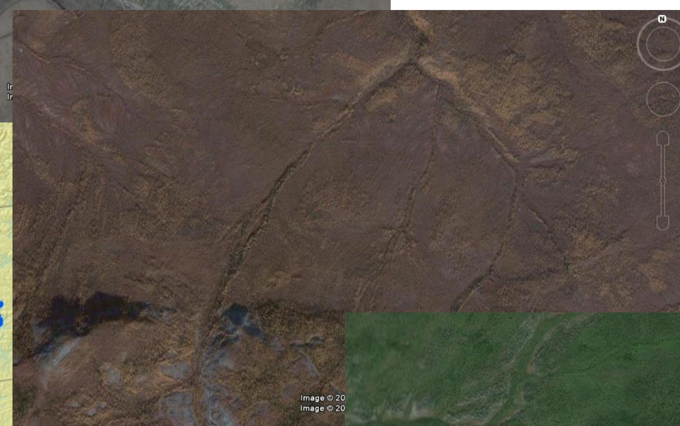
Among subarctic basins least attention was paid to the vast area of traps of Siberian platform (approximately 1,500,000 km2). The Nizhnyaya Tunguska River and its major tributary the Kochechum River draining "south" and "north" of Siberian platform provide unique opportunity for studying responses of carbon and other elements fluxes in permafrost landscapes to global warming due to almost monolithologic terrains with negligible human activity (Pokrovsky et al., 2005).

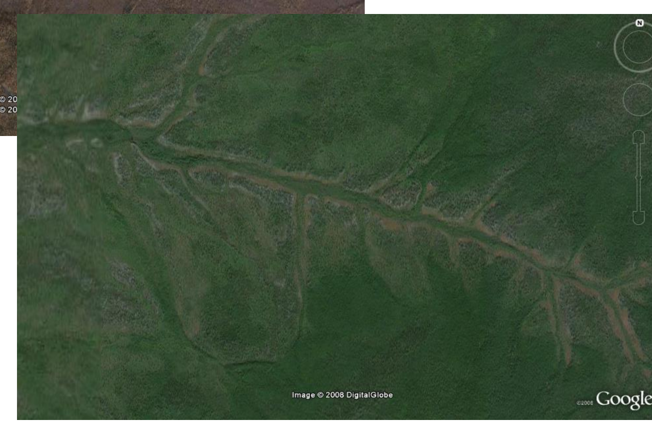
The purpose of this study was dual: 1) to fill the gap in our knowledge about riverine export of dissolved C from basaltic watersheds in Central Siberia underlain by permafrost and 2) estimate potential changes of terrestrial carbon export induced by global warming.



Nizhnyaya Tunguska basin







N. Tunguska River at Tura –
Southern part of watershed

Kochechum River at Tura –
Northern part of watershed

Carbon density map…

River basin characteristics

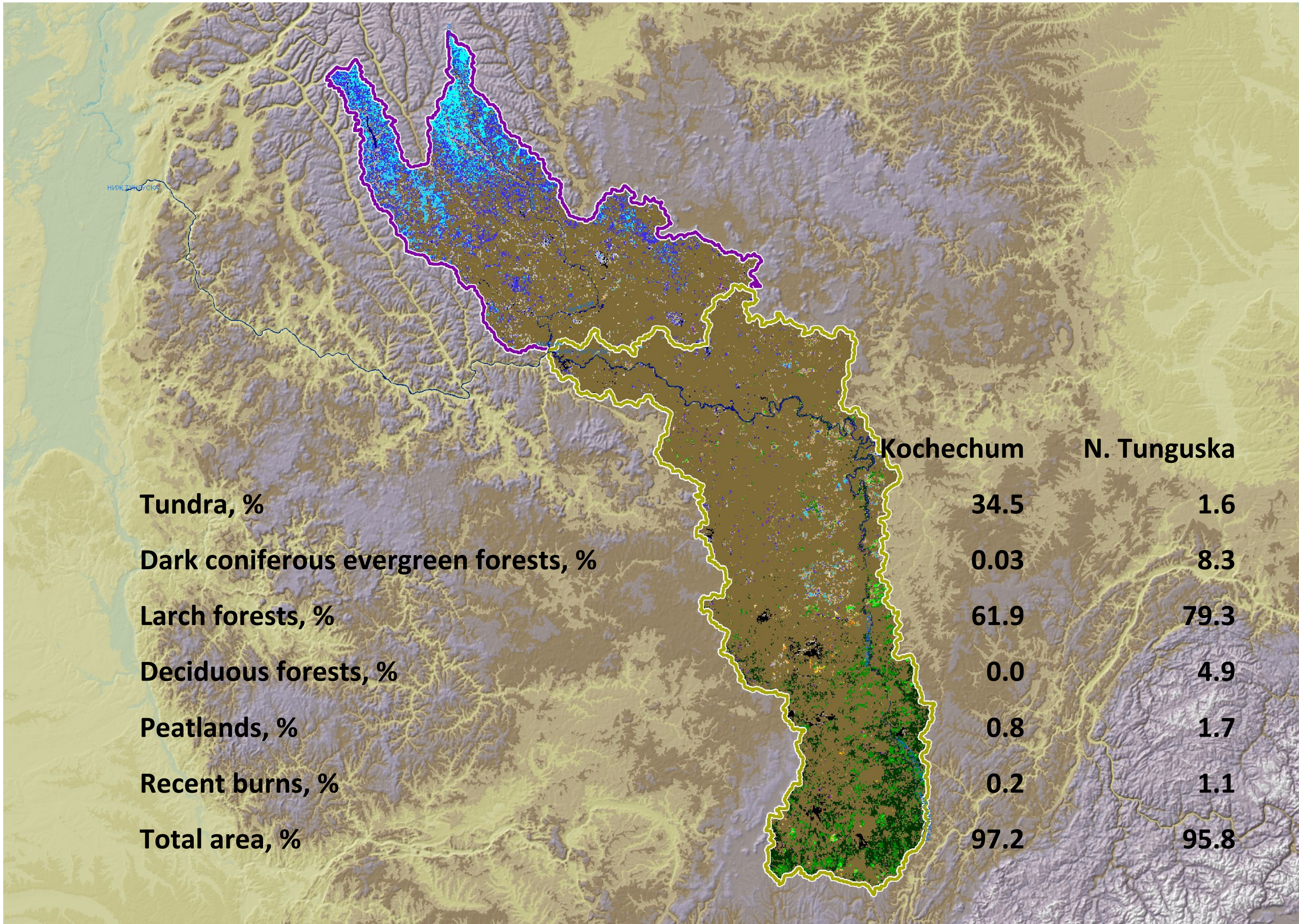
Table 1

Station	Sampling site Latitude Longitude	Drainage area, km^2	Specific runoff, mm				
			1939-1995	2006	2007	2008	2009
Nizhnyaya Tunguska 6623	61.30 N 108.00 E	77400	121	-	-	-	-
Nizhnyaya Tunguska 6625	64.15 N 100.15 E	268000	190	192	291	349	227
Tembenchi 6629	64.95 N 98.80 E	18900	421	355	495	493	348

Table 2

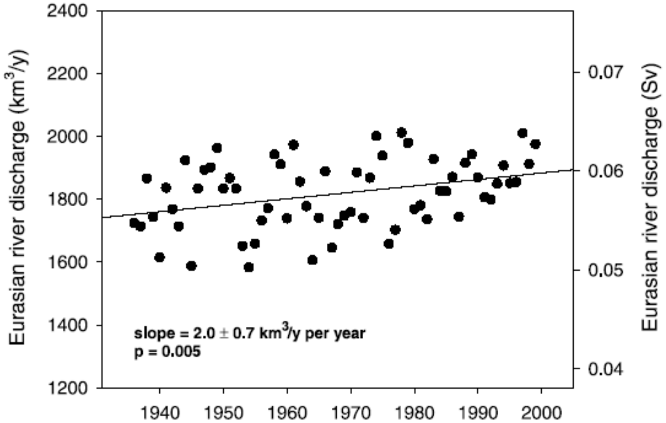
Station name and WMO ID:	Latitude Longitude	Period of record entire years	MAT, °C	MAP, mm
ERBOGACEN	61.30N	1936-2008		
24817	108.00E	59	-6,9	333,0
Tura	64.17N	1939-2008		
24507	100.07E	78	-9,0	369,9
Tembenchi	64.57N	1967-1993		
23499	98.51E	20	-11,5	459,4

Vegetation classes (GLC 2000)

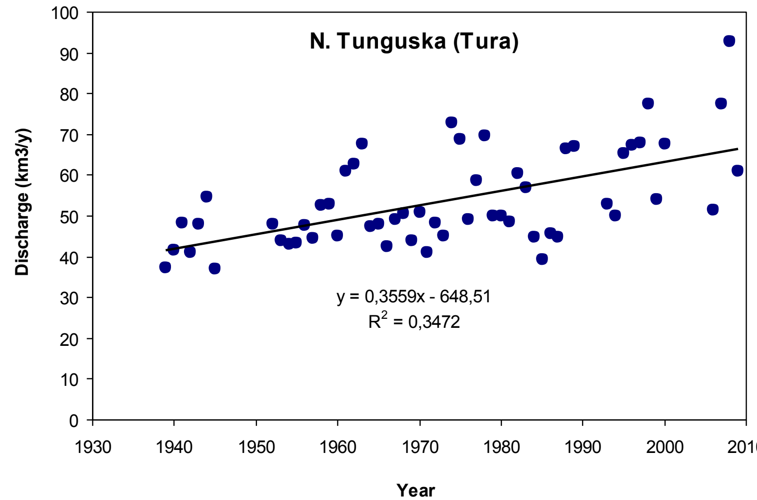


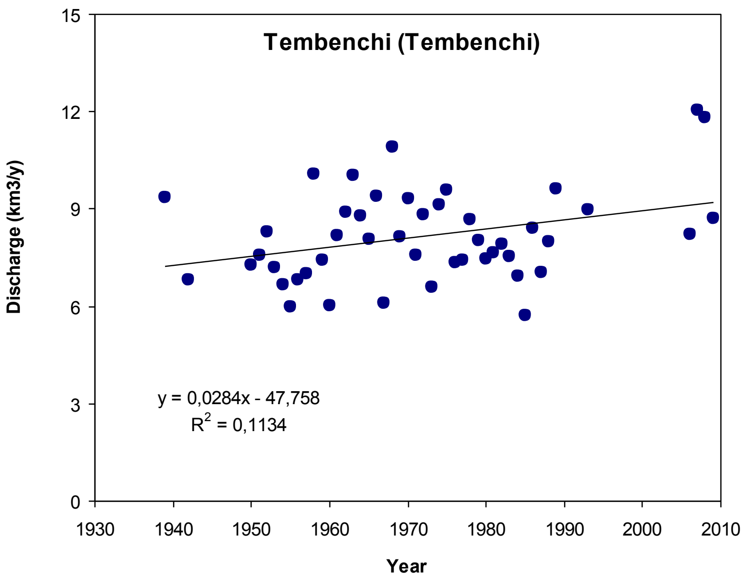
	Kochechum	N. Tunguska
Tundra, %	34.5	1.6
Dark coniferous evergreen forests, %	0.03	8.3
Larch forests, %	61.9	79.3
Deciduous forests, %	0.0	4.9
Peatlands, %	0.8	1.7
Recent burns, %	0.2	1.1
Total area, %	97.2	95.8

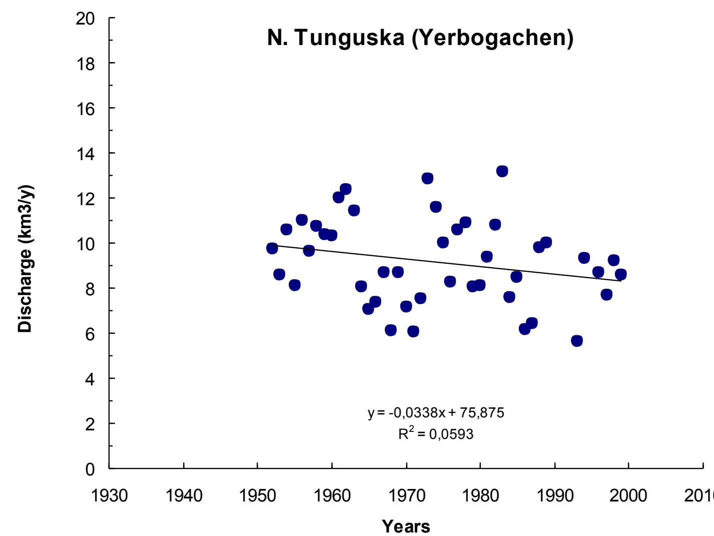
Annual river discharge



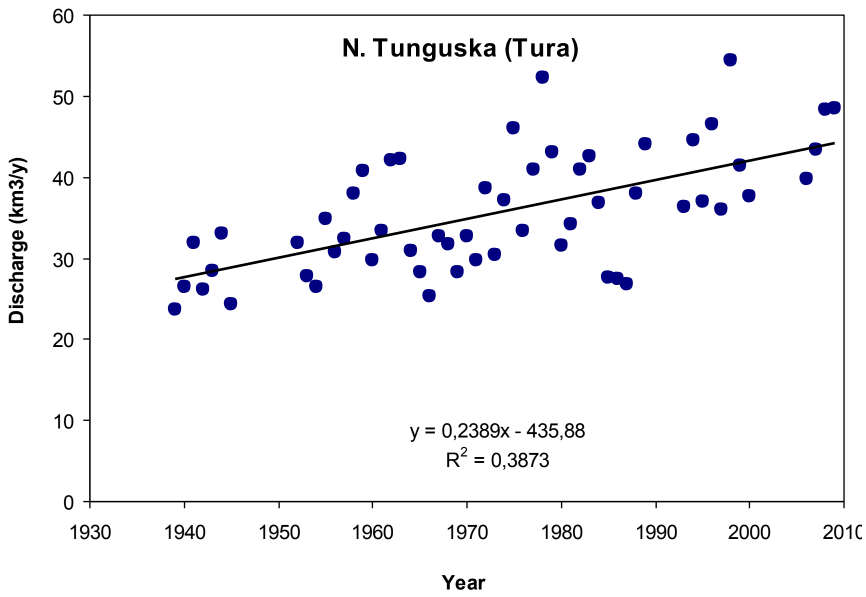
Peterson et al., 2002





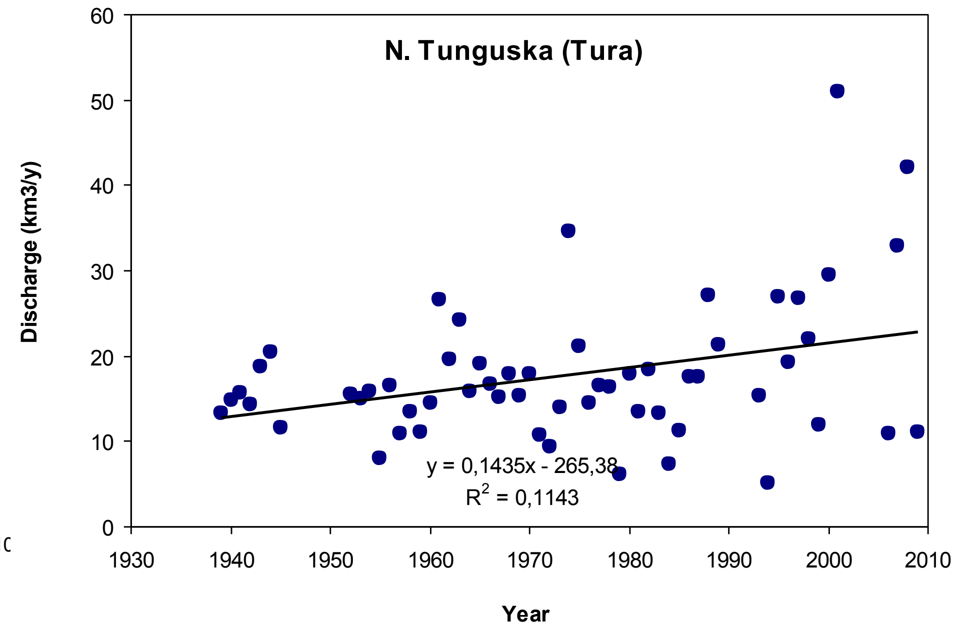


Seasonal discharge patterns



Snowmelt

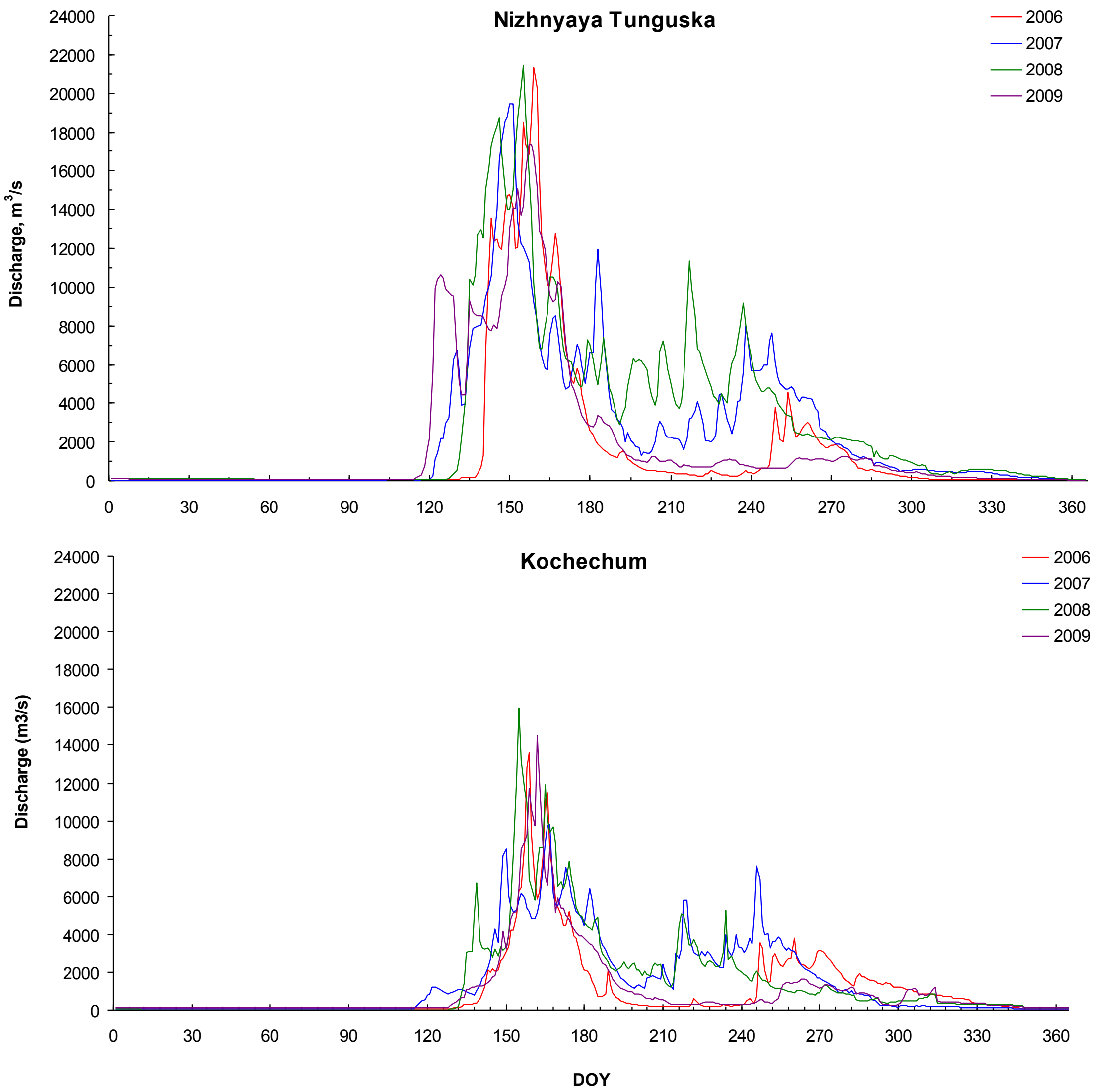
(May-June)

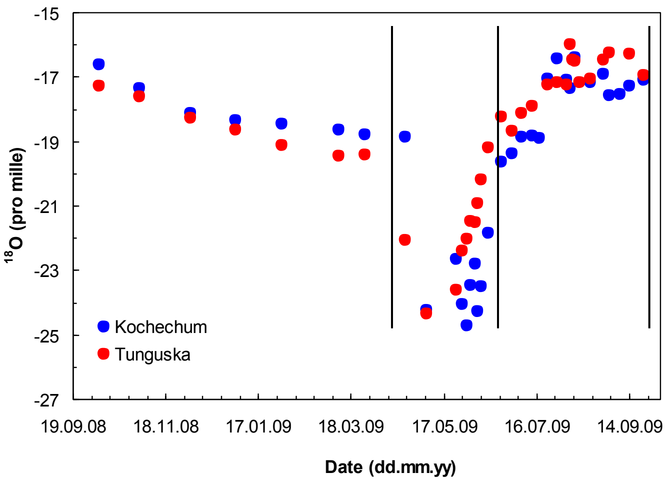


Summer-fall

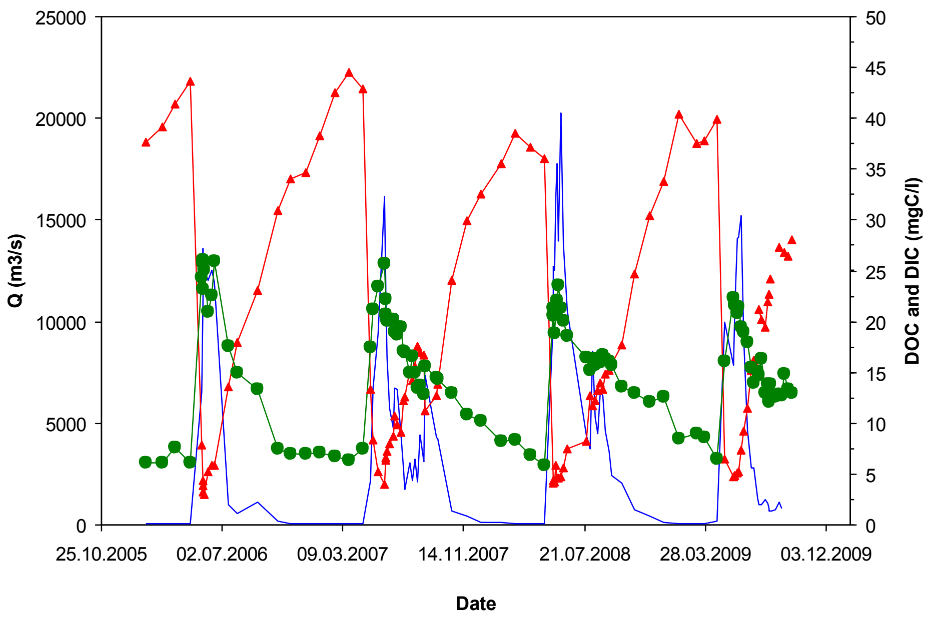
(July-October)

River discharge (2006-2009)

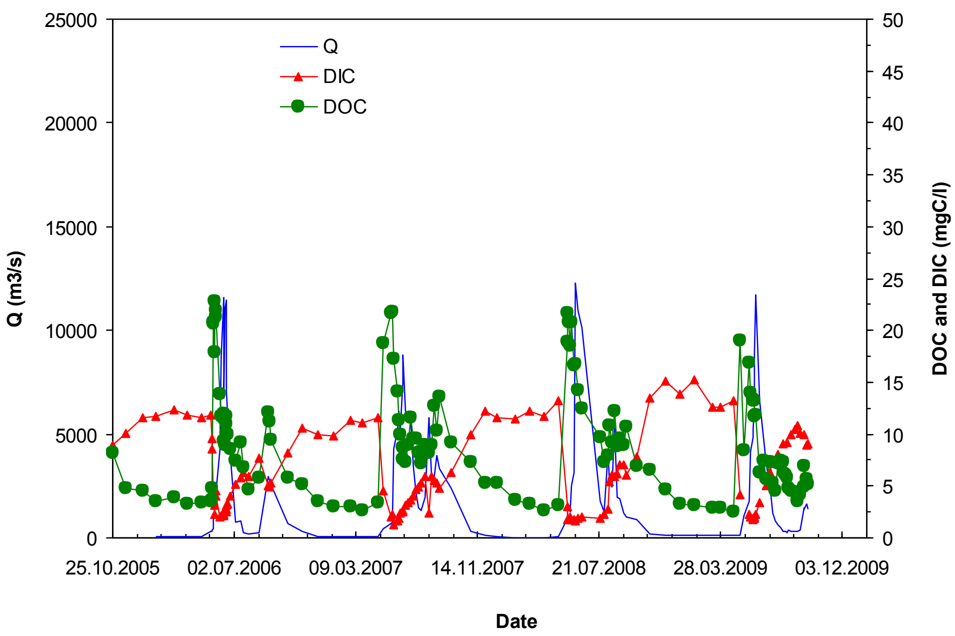




Discharge and C concentration peaks

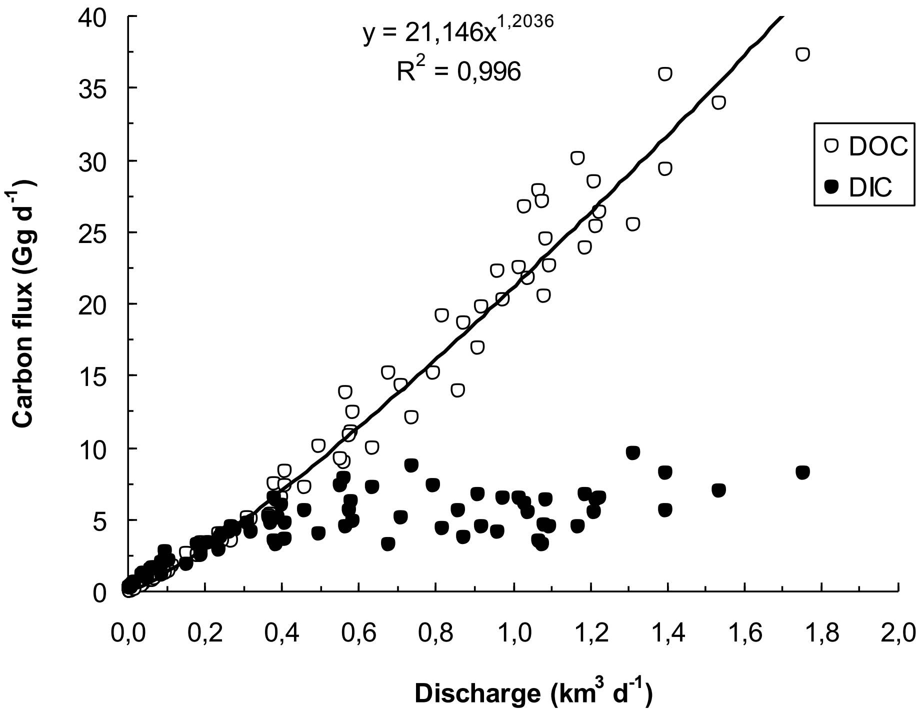


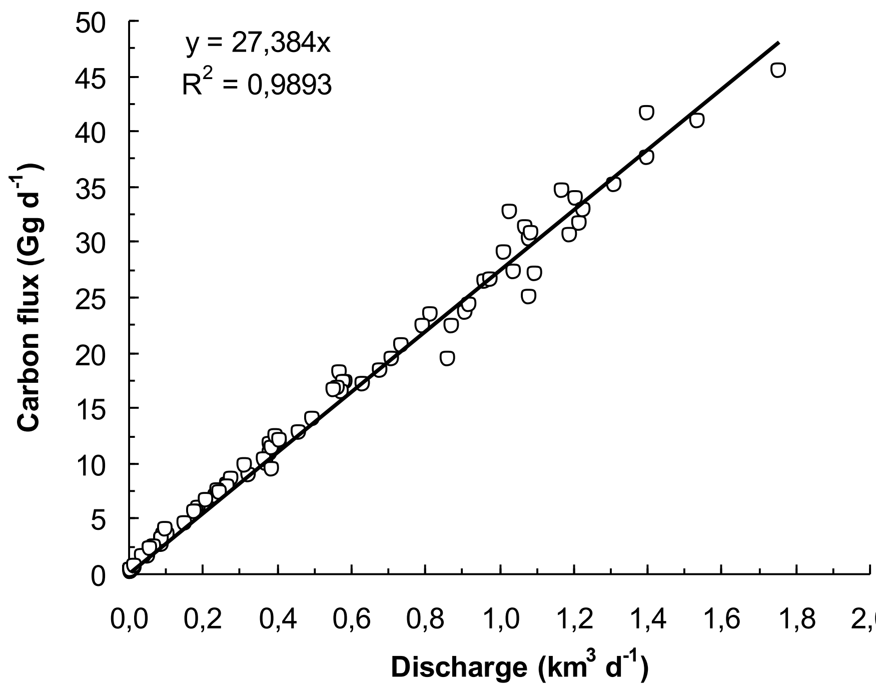
N. Tunguska



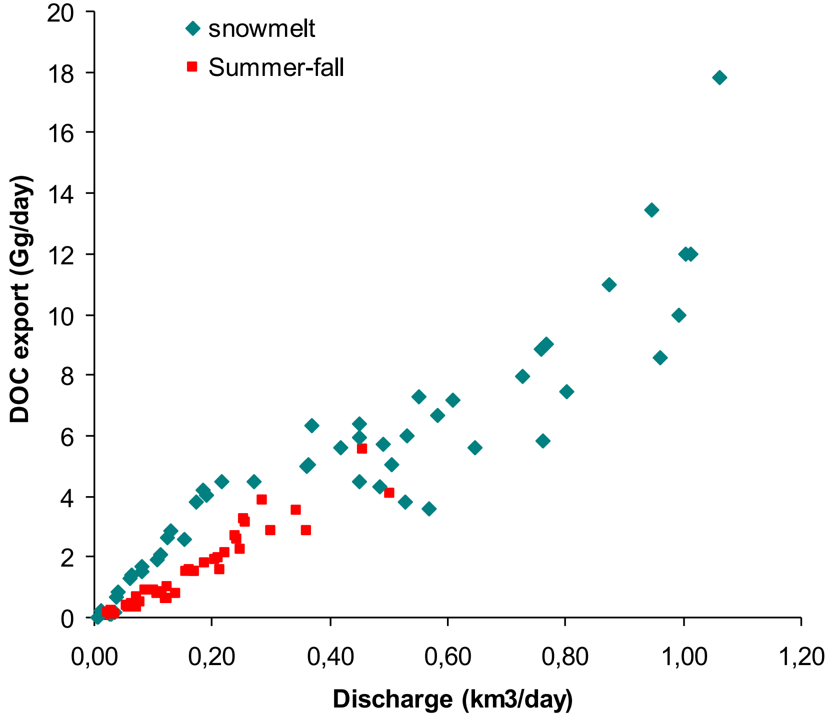
Kochechum

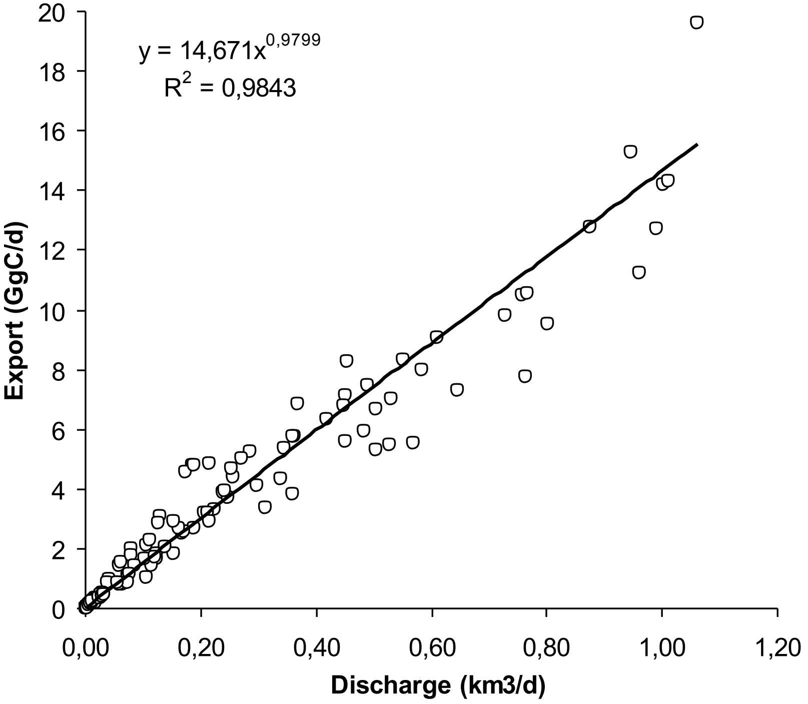
C export by Tunguska





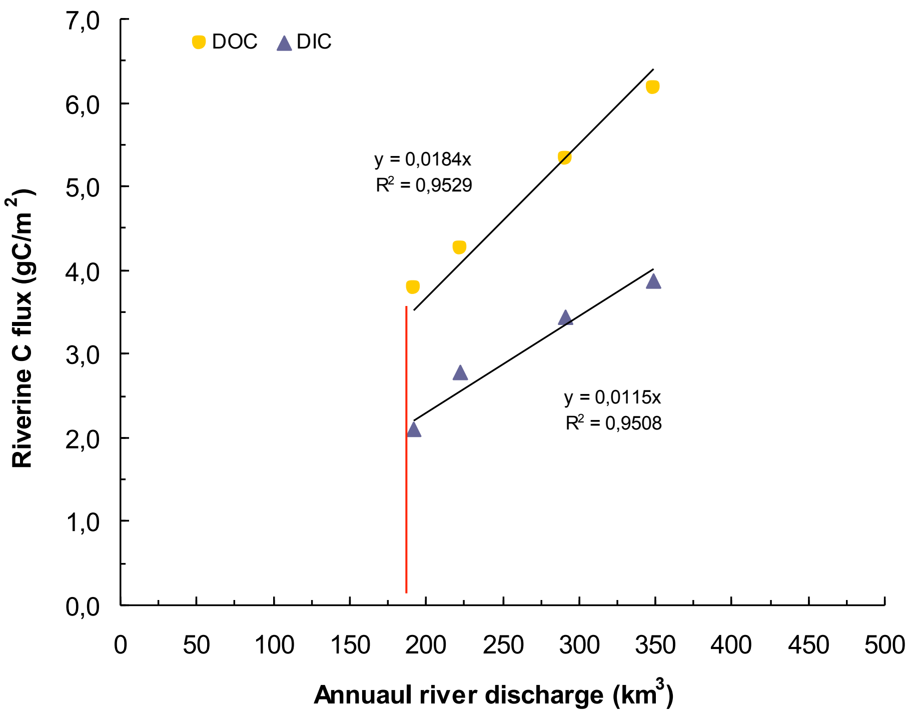
C export by Kochechum



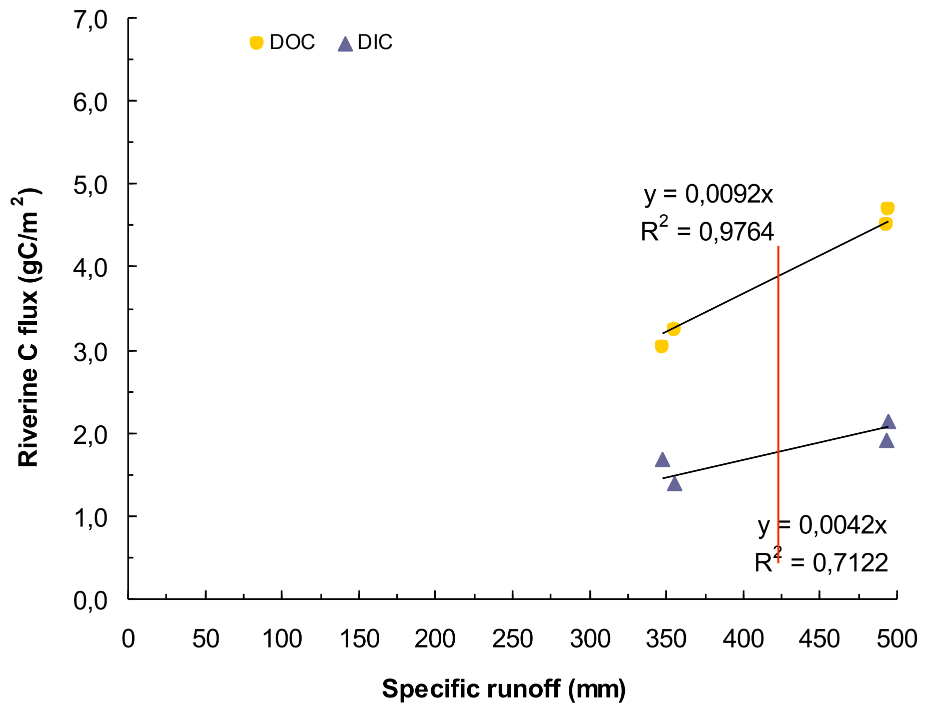


Southern part of watershed exports more Corg, suggesting C limitation in Putorana plateau

Annual riverine C export normalized to specific runoff



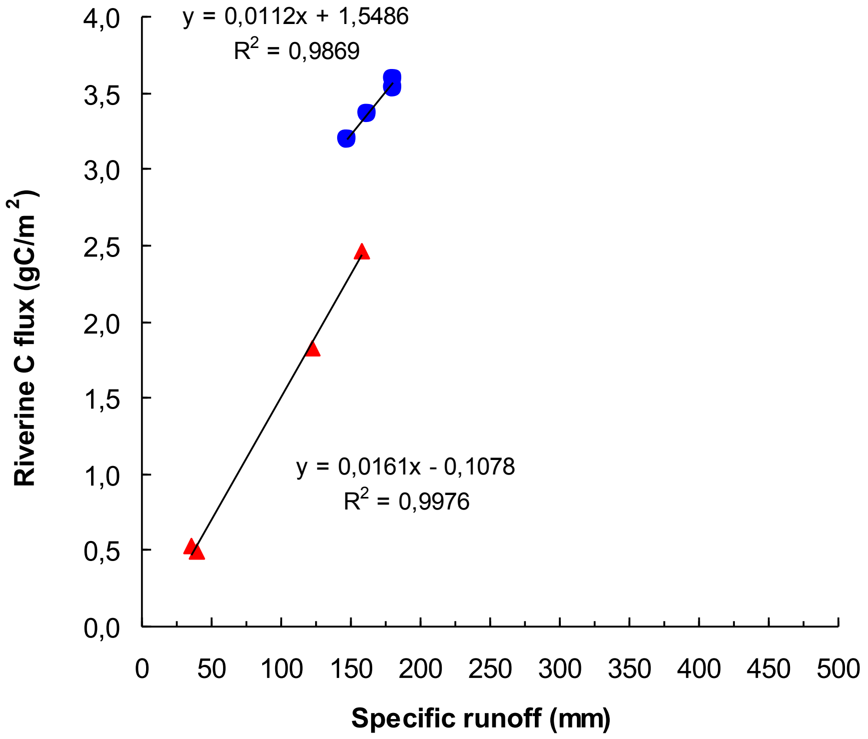
Tunguska



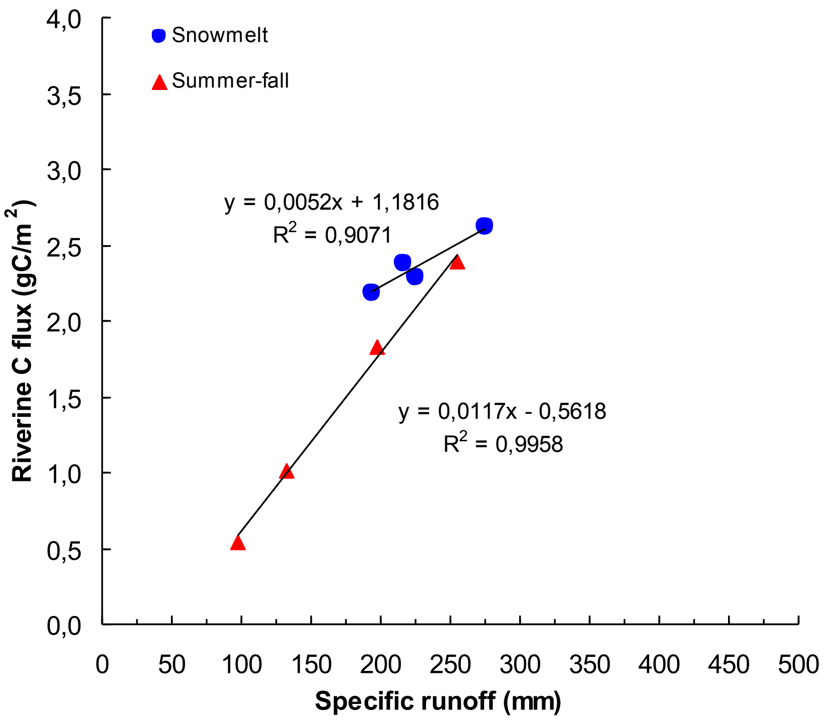
Kochechum

Water limitation of Corg export from both watersheds

Seasonal pattern

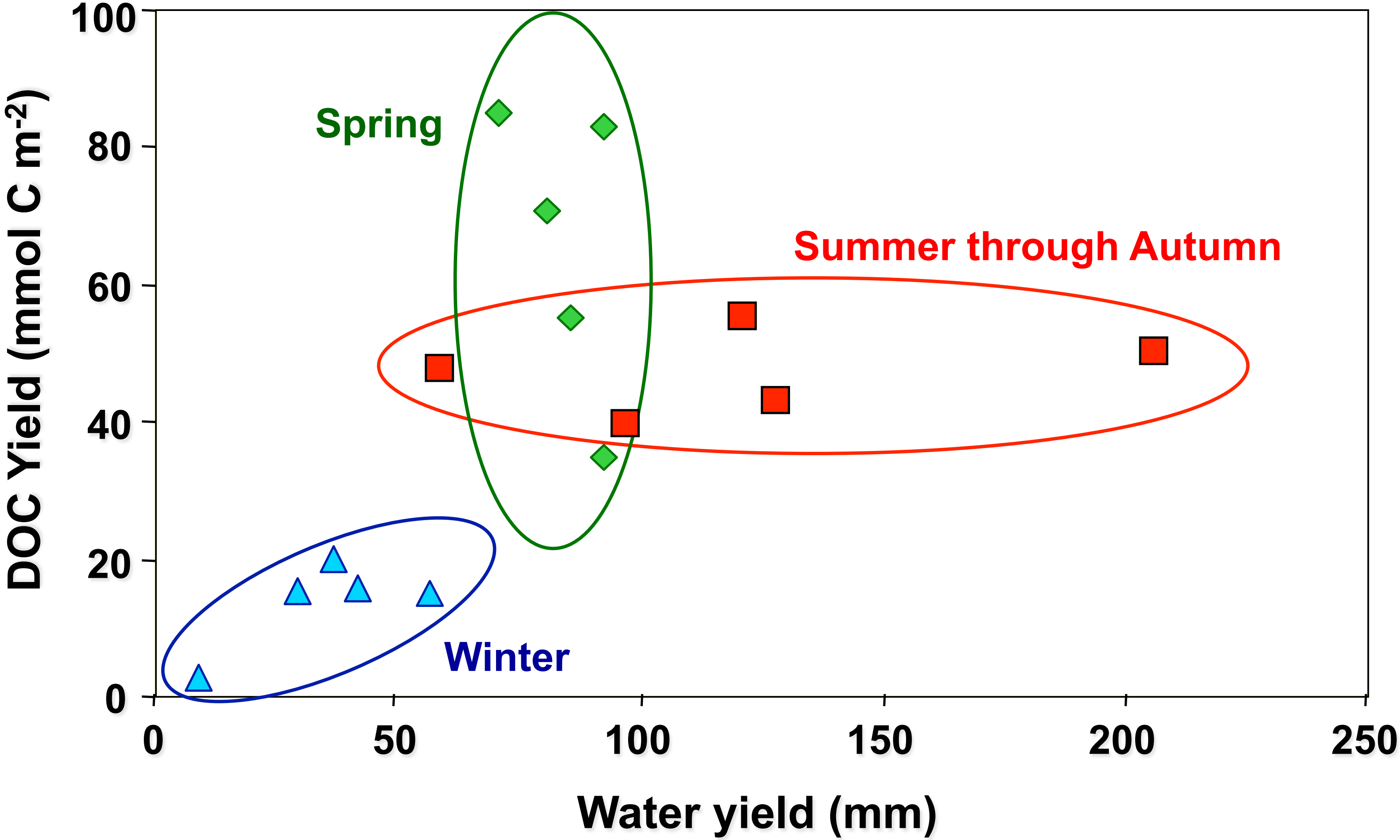


Tunguska



Kochechum

Seasonal DOC Yields of Yukon Sub-basins

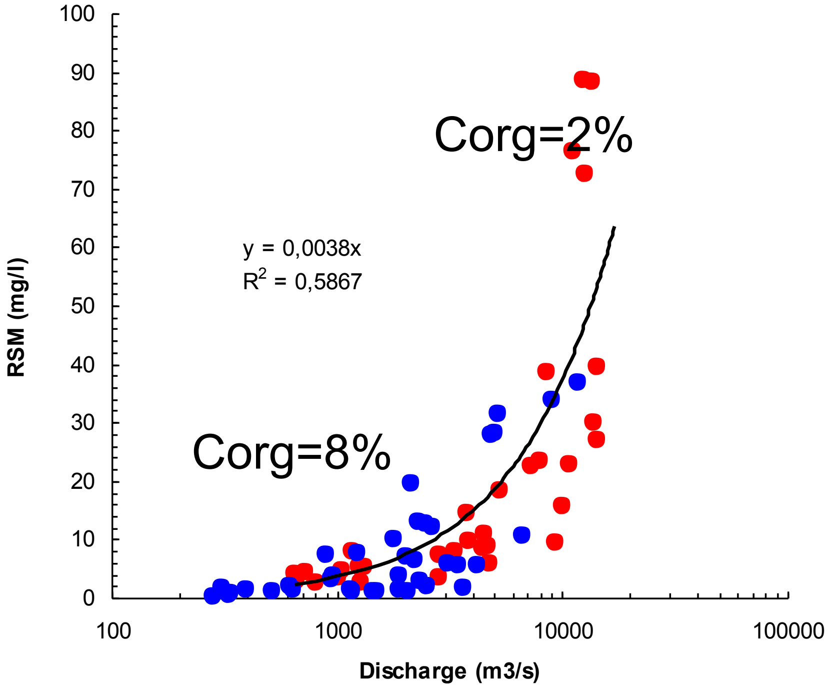


Striegl et al., WRR, 2007

Other important C species in river water

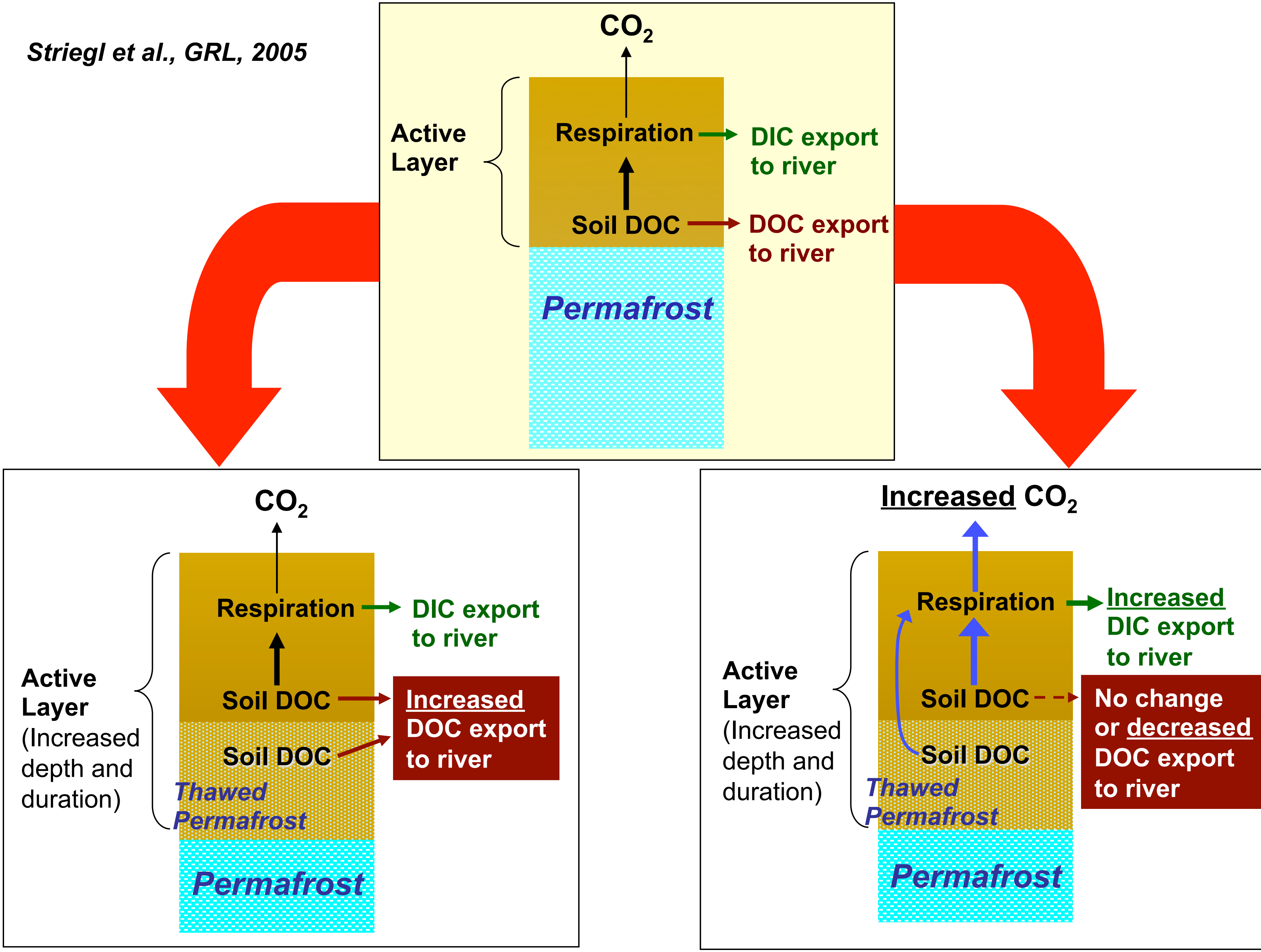
POC

pCO2



Current student works

Striegl et al., GRL, 2005



Conclusions

River basins draining Siberian platform demonstrate significant potential to increase the release of terrestrial carbon to the Arctic Ocean. Increased hydrological C losses are projected through:

- (i) enhancement of temperature-controlled DOC, DIC, POC and CO2 production processes within watersheds;
- (ii) raised precipitation, thereby increasing C mobilization from organic-rich layers;
- (iii) introduction of a new source of C as vegetation shift northward and
- (iv) release of old C from degrading permafrost (likely less important in mountainous region like Putorana Plateau) .

Acknowledgements

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Thank you for your attention!