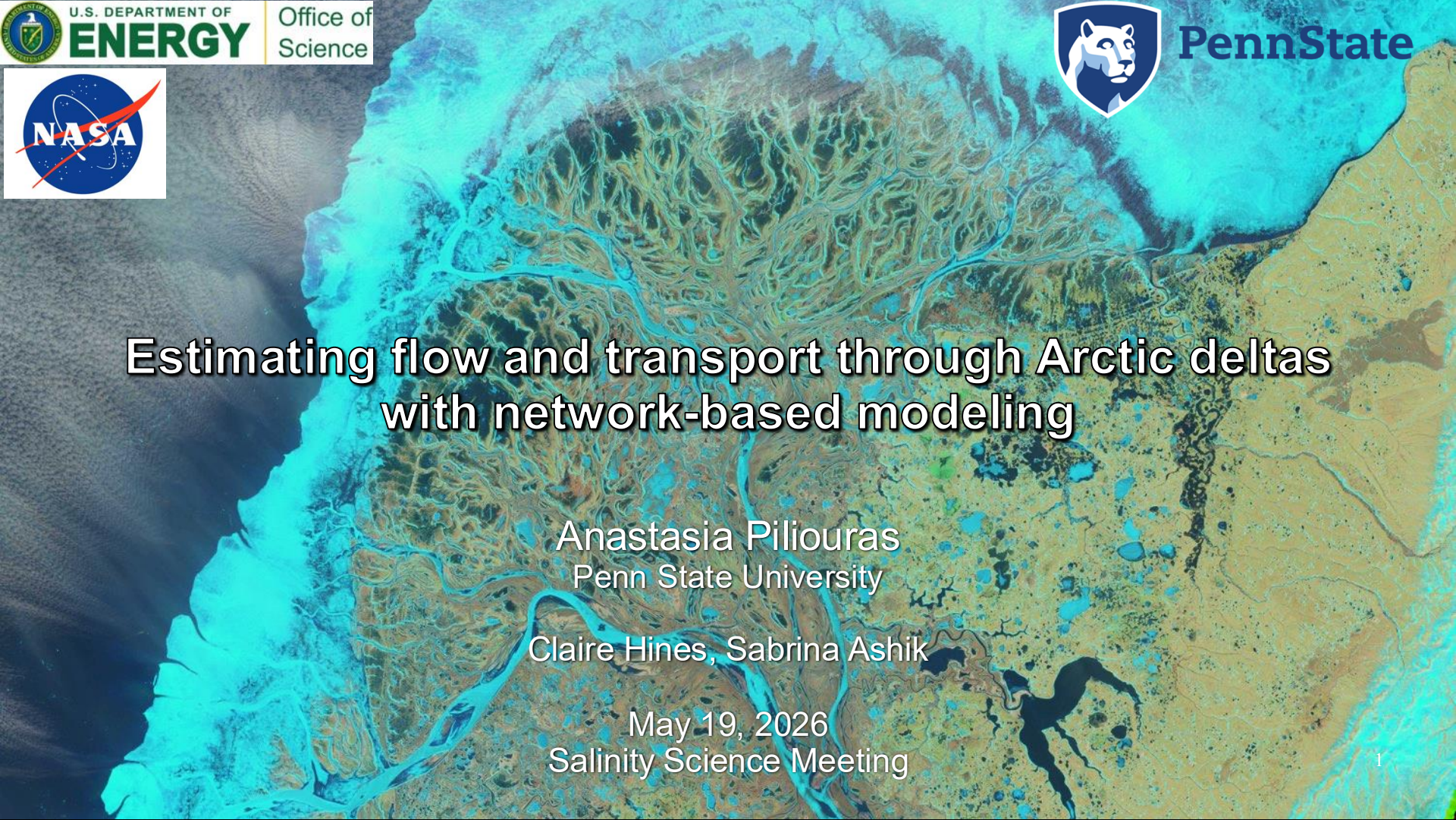


Estimating flow and transport through Arctic deltas with network-based modeling

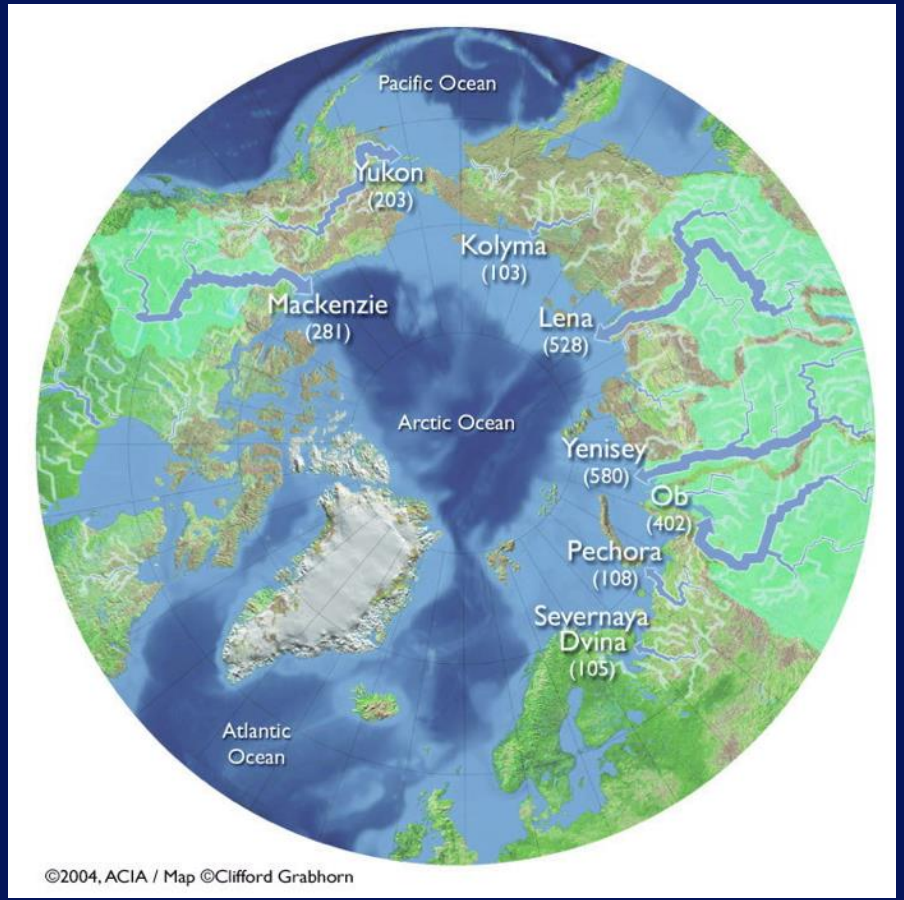
Anastasia Piliouras
Penn State University

Claire Hines, Sabrina Ashik

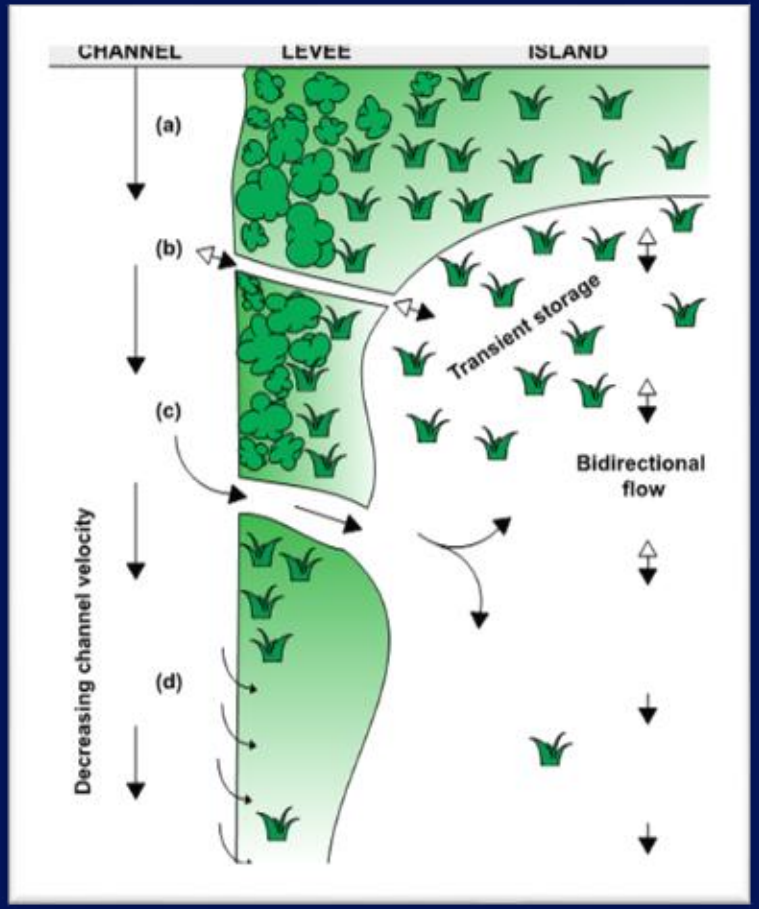
May 19, 2026
Salinity Science Meeting

Arctic rivers influence temperature and salinity in the Arctic ocean

Annual water volumes in km^3



Deltas store sediment and nutrients



Hiatt and Passalacqua (2015)

- Delt

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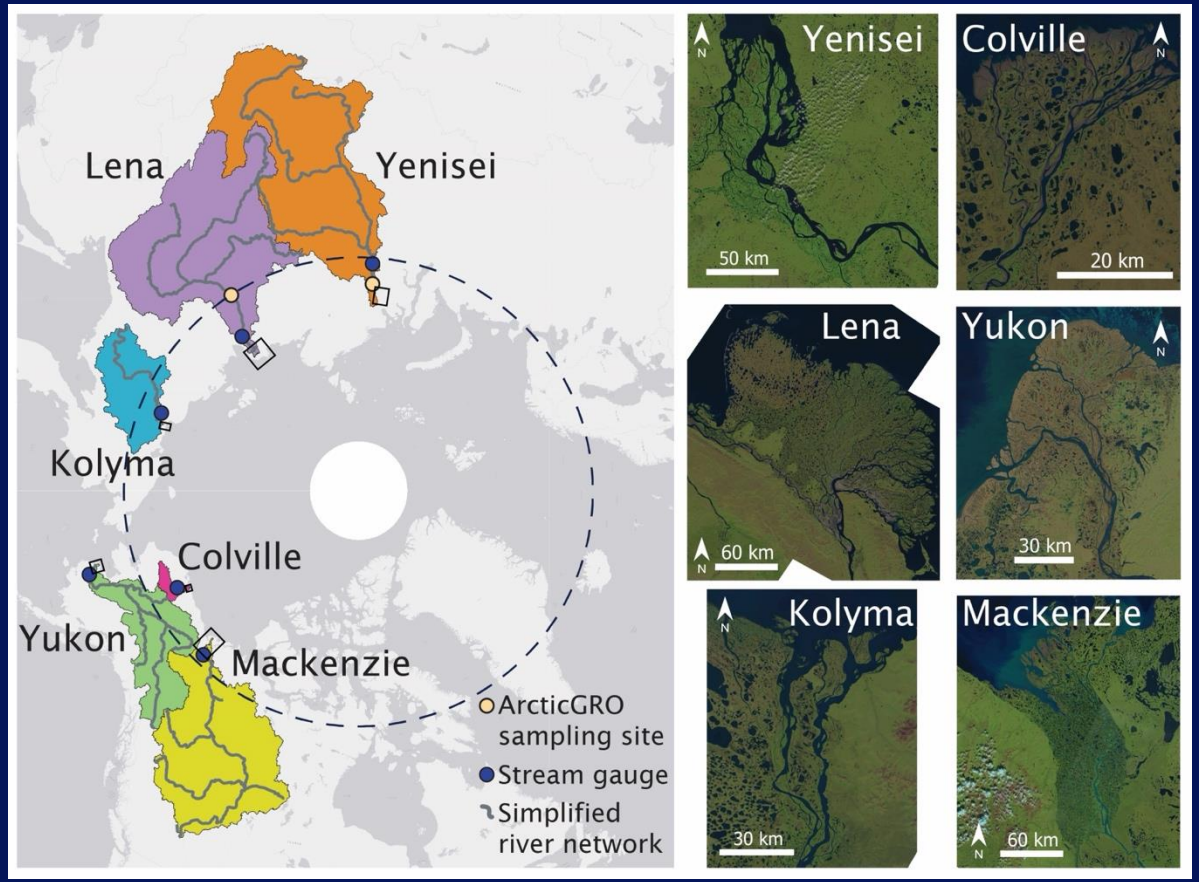
Research Question

How do Arctic deltas influence transport and storage of suspended sediments from the river to the ocean?

- implications for coastal turbidity, light attenuation, marine primary productivity
- may also shed light on particulate nutrient transport
- especially important for the small Arctic ocean basin where coasts are responsible for ~30% of primary production

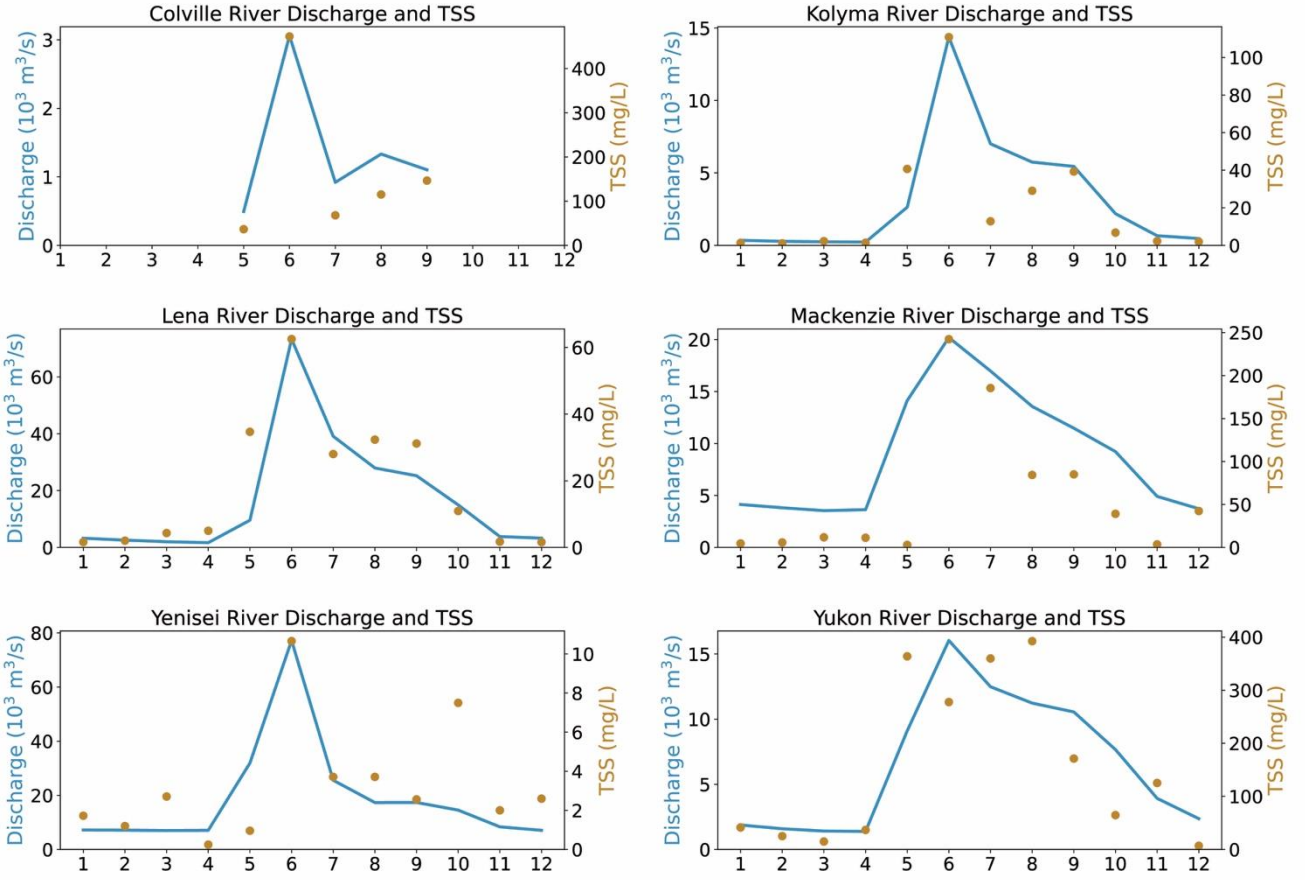
European Space Agency

How do Arctic deltas influence suspended sediment transport and storage?



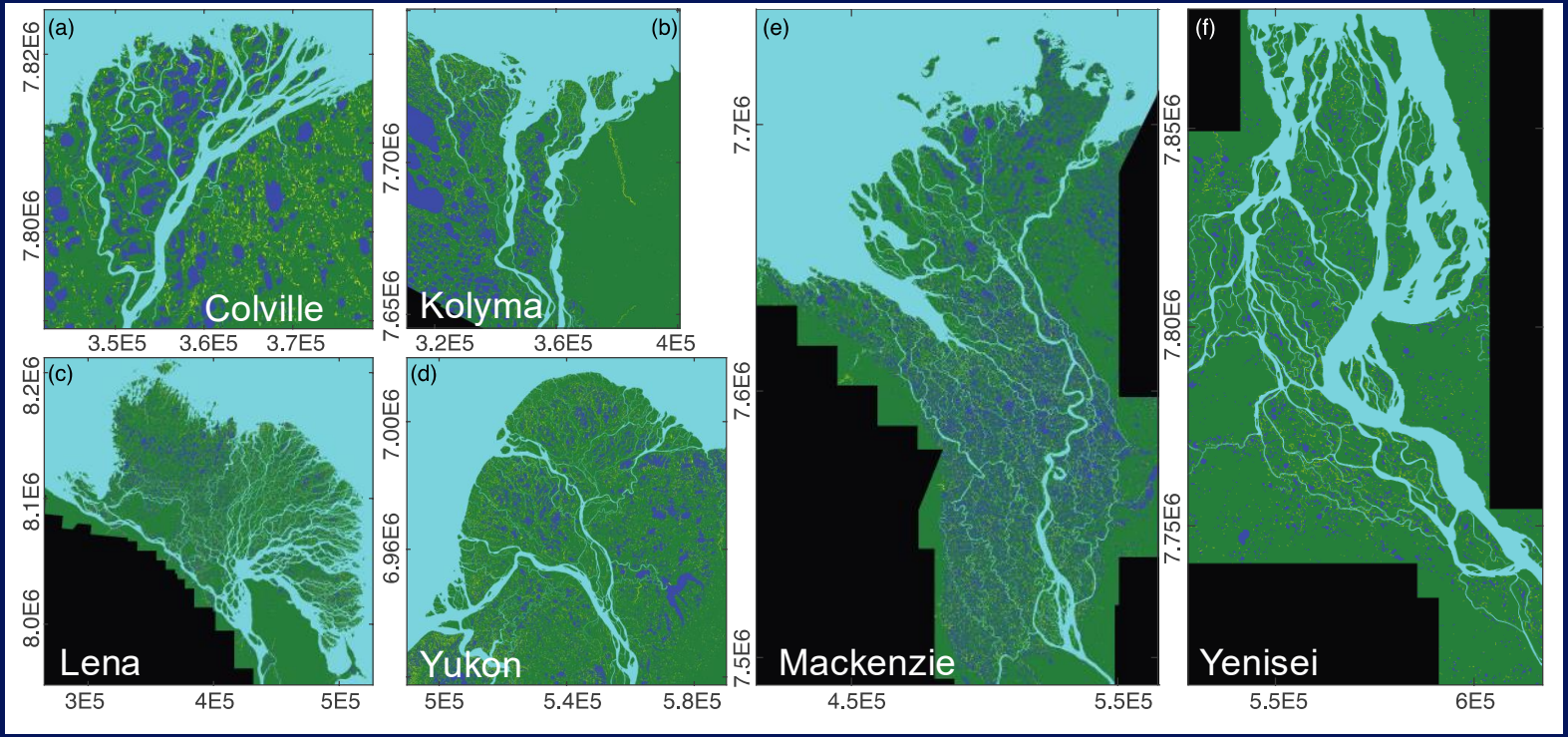
Hines & Piliouras (2024, JGR-ES)

Arctic GRO measurements upstream



Hines & Piliouras (2024, JGR-ES)

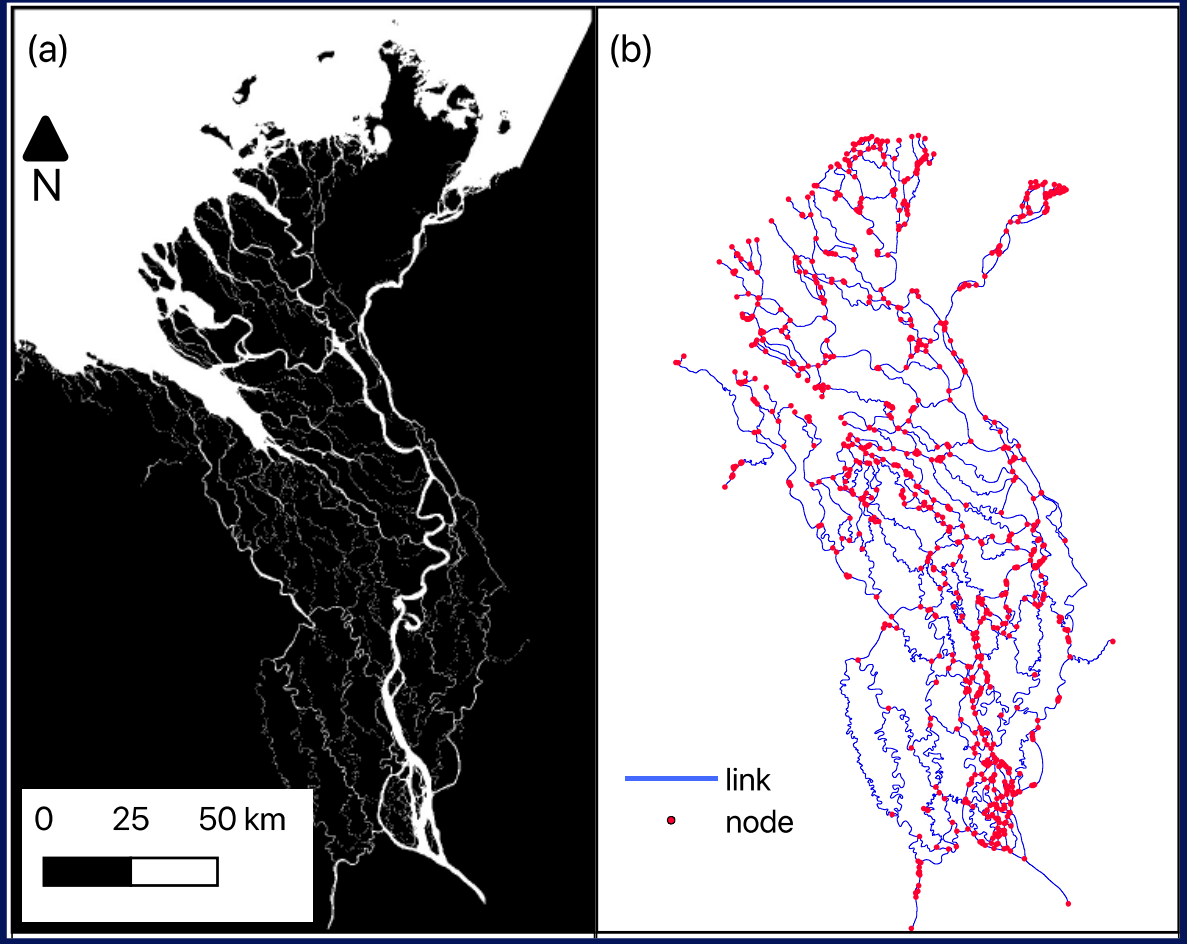
Remote sensing of delta morphology



- Landsat late summer imagery to classify land, channels, lakes
- ~Modern representative image to get channel network structure and lake coverage

Piliouras & Rowland, 2020, *JGR-ES*

A network-based model for suspended sediments

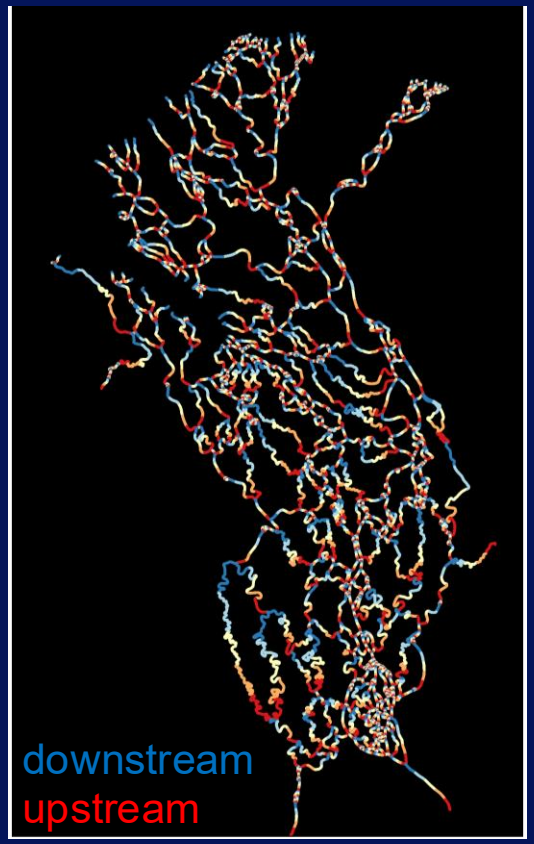


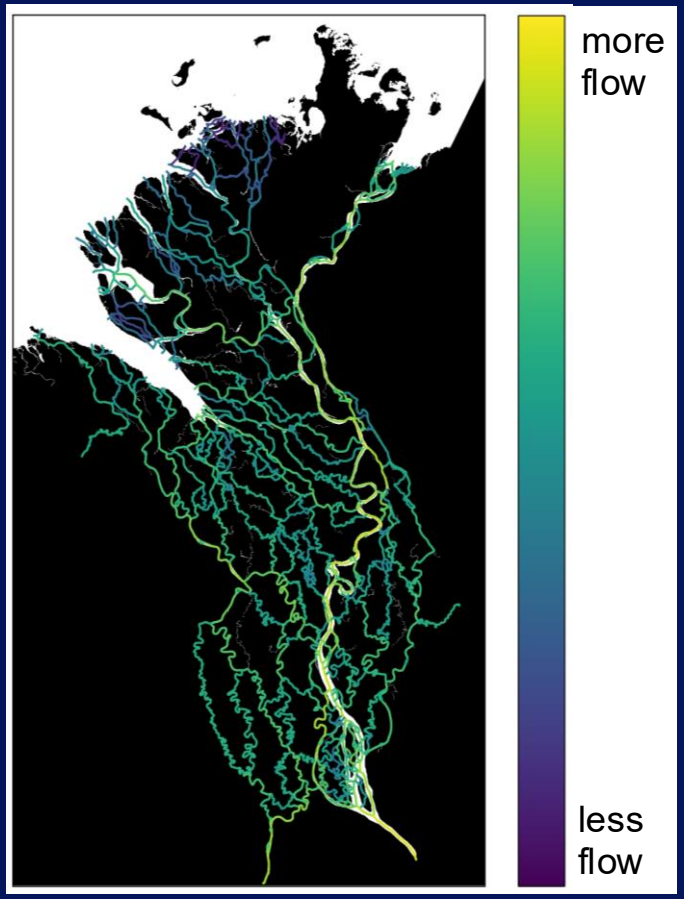
Example of binary mask and network of links and nodes on the Mackenzie delta

Extracted used RivGraph python package

Schwenk et al., (2020, Esurf)
Schwenk & Hariharan (2021, JOSS)

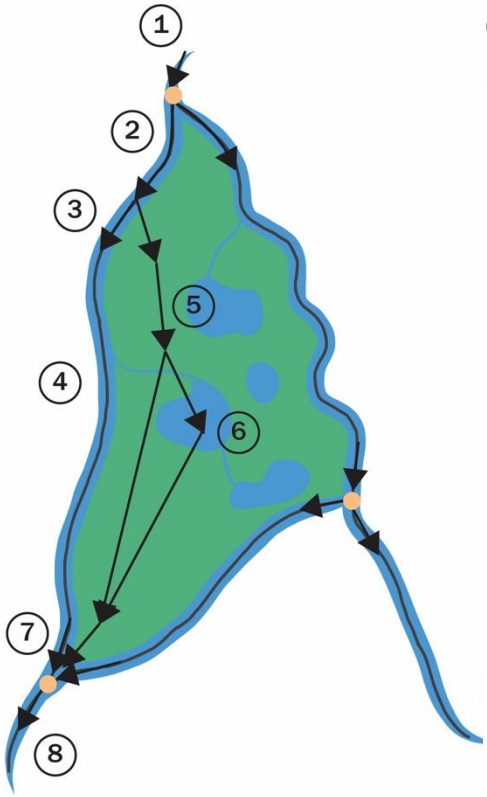
A network-based model for suspended sediments





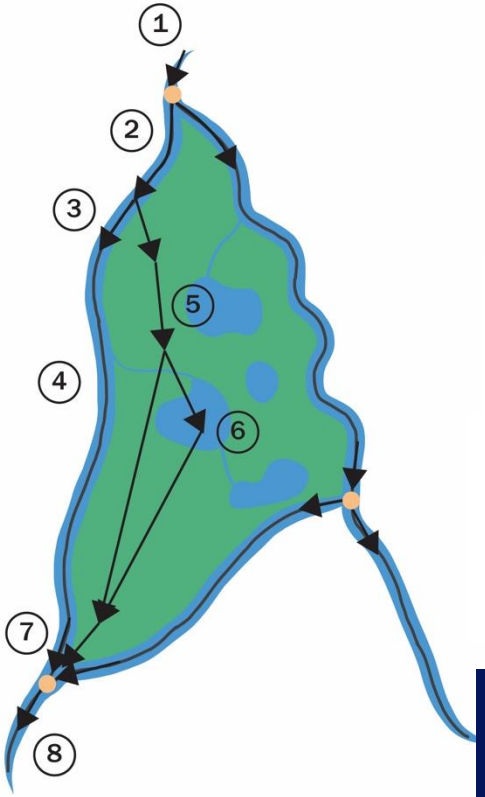
- Direction Predicting Algorithms
- Width-weighted flux routing scheme
- Long-term steady state flux distribution

A network-based model for suspended sediments



1 Input upstream suspended sediment concentration (SSC) and water discharge (Q)

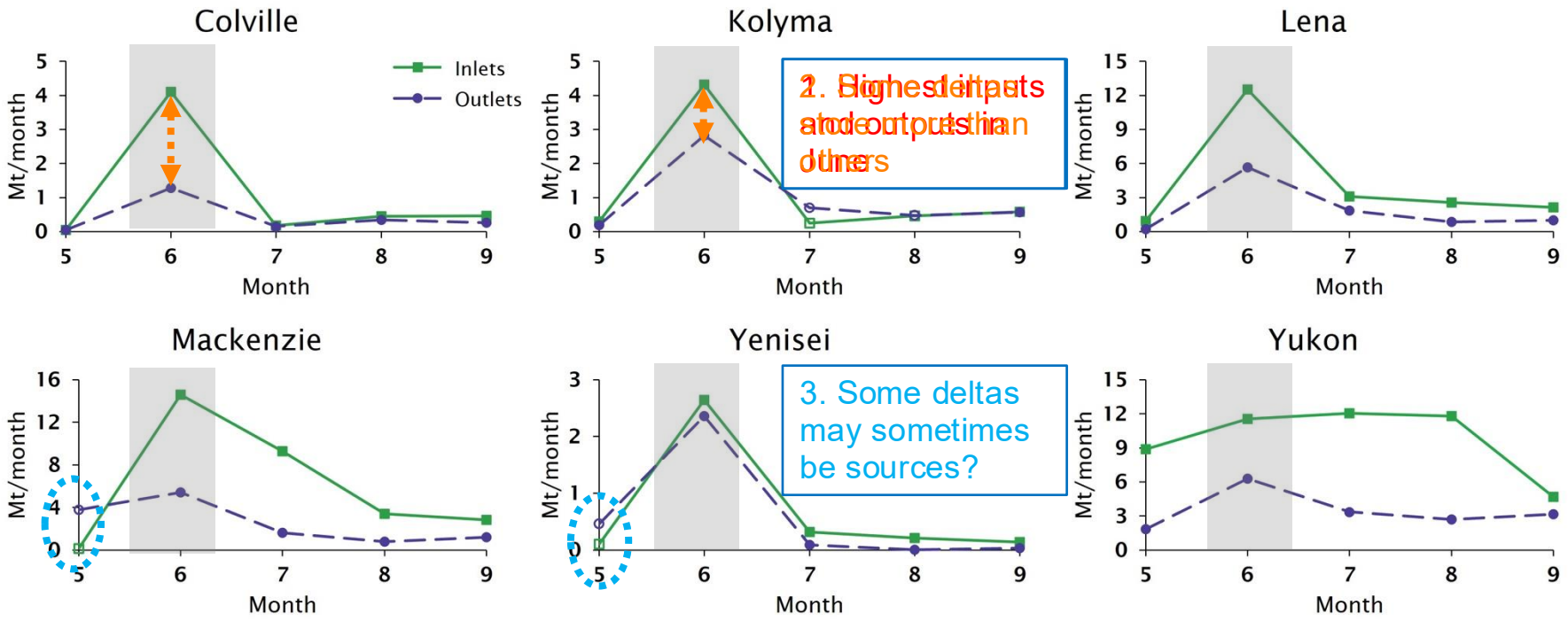
A network-based model for suspended sediments



5 Retain sediment in delta wetlands based on wetland trapping efficiency, which increases with vegetation and decreases with discharge

Hines & Piliouras (2024, JGR-ES)

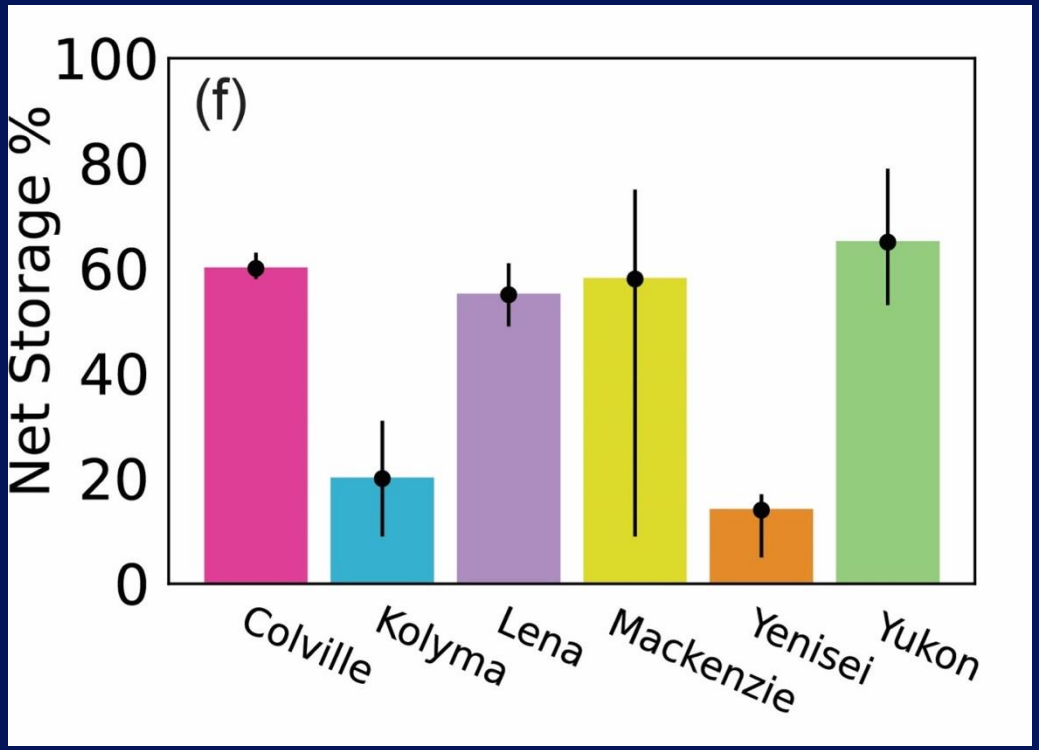
Delta storage changes seasonally and varies by delta



Hines & Piliouras (2024, JGR-ES)

Arctic deltas store 10-70% of incoming suspended sediment

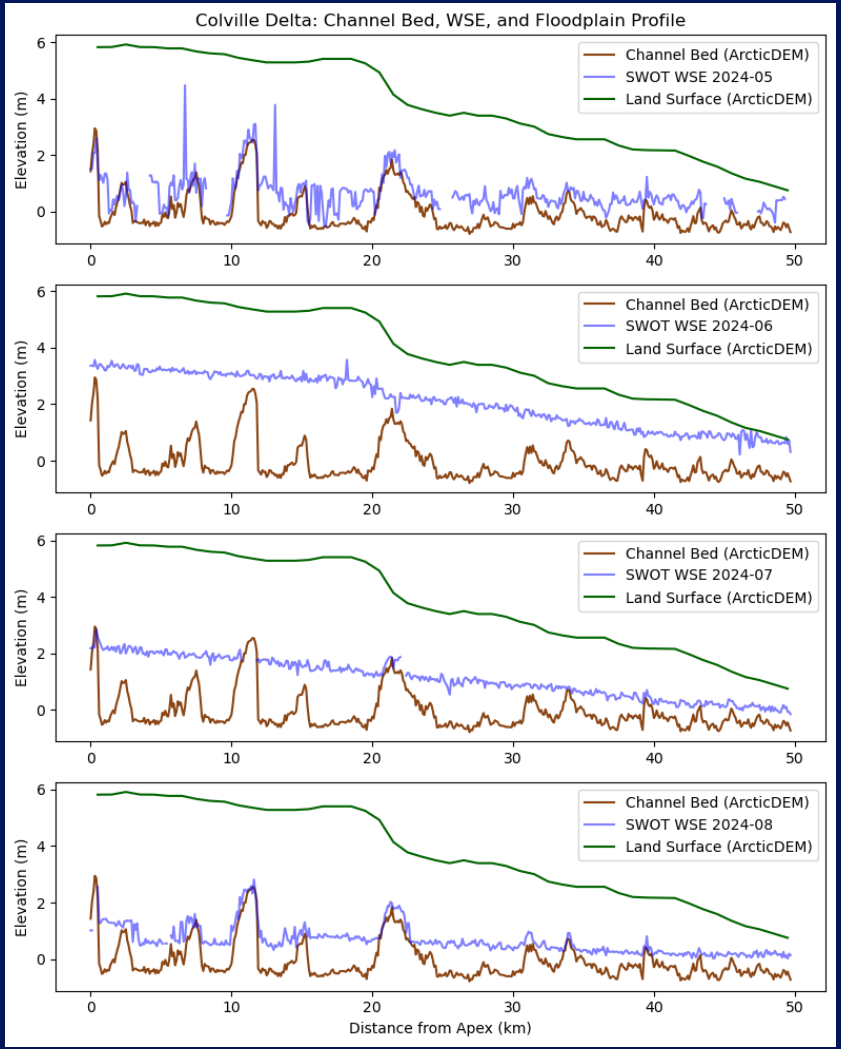
Delta	Net Storage %
Colville	60.4
Kolyma	19.5
Lena	55.1
Mackenzie	57.7
Yenisei	13.6
Yukon	64.6



Net storage depends on hydrograph, delta size, and river SSC

So what's next?

- Network-based modeling is really useful for first order estimates in data poor environments
- New data: SWOT
- Approach highly dependent on the leakiness approximation
- SWOT water surface information can help us determine how applicable and transferrable the Mackenzie-based leakiness information is, or is not…



Acknowledgments

HiLAT-RASM team, CoLD group

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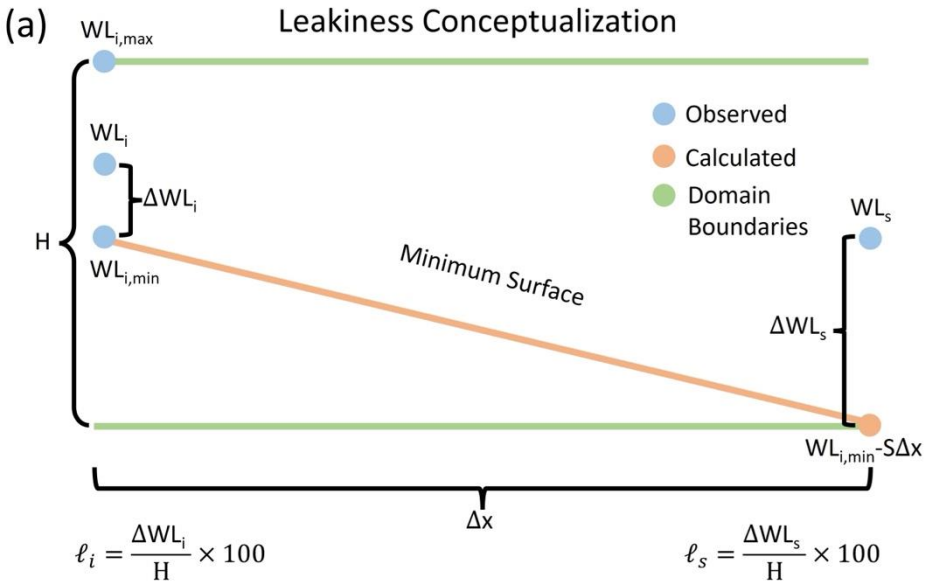
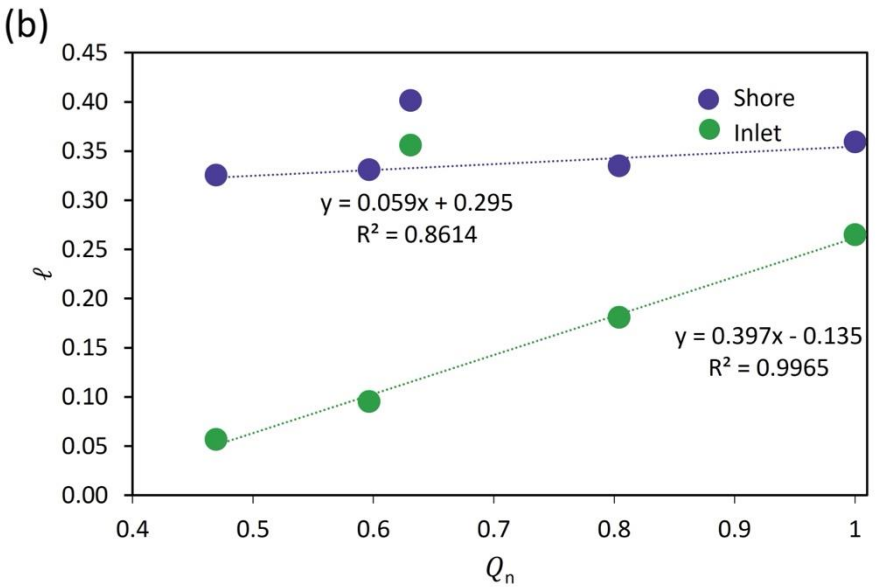
Email: anastasia@psu.edu





$$\ell = I_f(AQ_n + B)$$

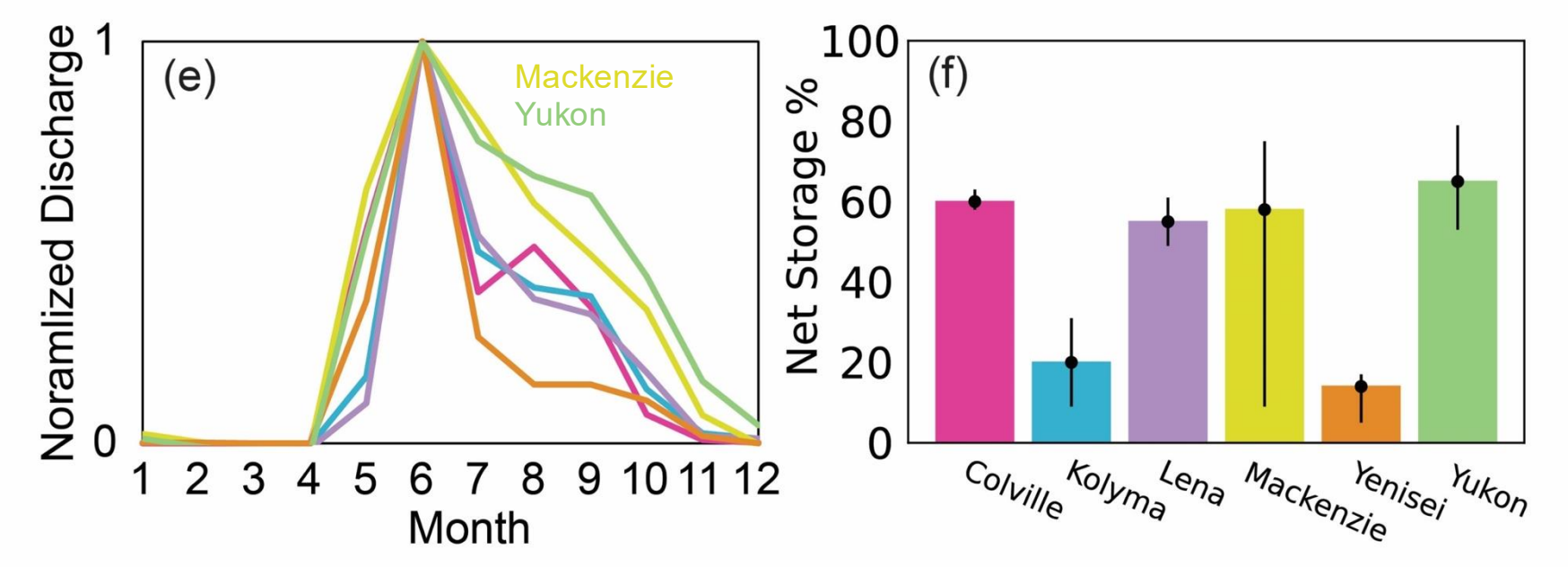
I_f = ice factor
1.2 at shore, 3.1 at inlet

A and B are constants

A, B, and I_f based on data for Mackenzie delta

$$Q_n = \frac{Q - Q_{winter}}{Q_{max} - Q_{winter}}$$

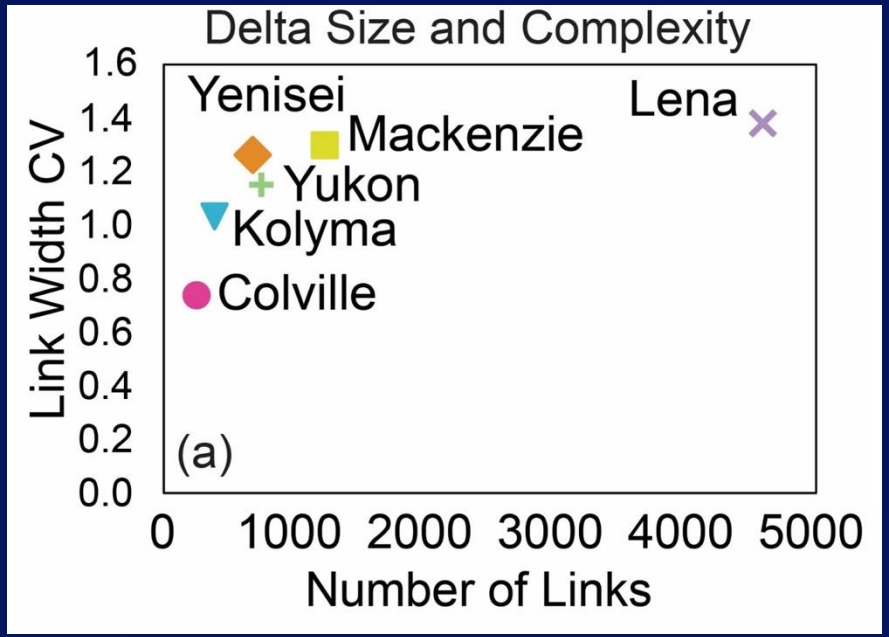
Net storage depends on hydrograph, delta size, river SSC

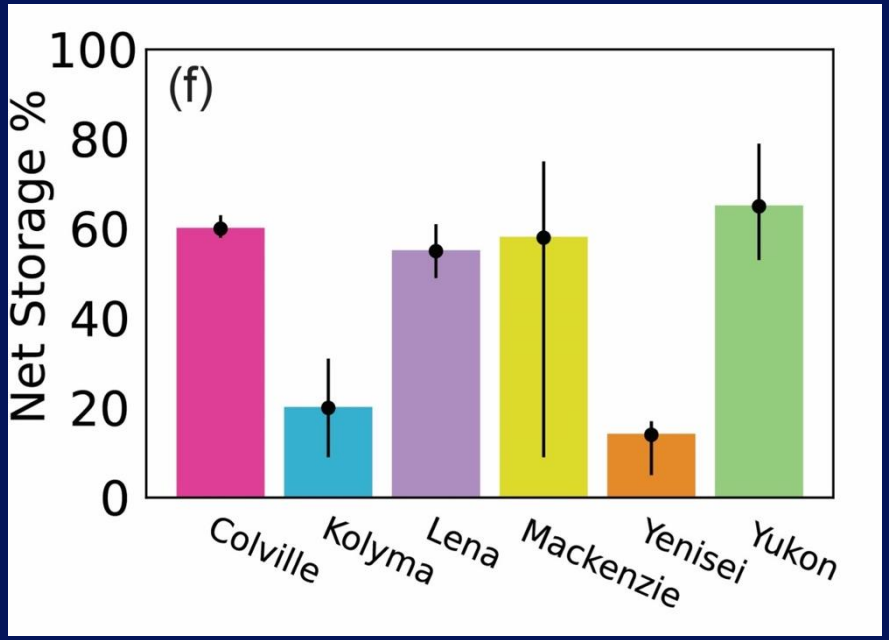


Deltas with longer periods of moderate discharge store the most sediment

Hines & Piliouras (2024, JGR-ES)

Net storage depends on hydrograph, delta size, river SSC

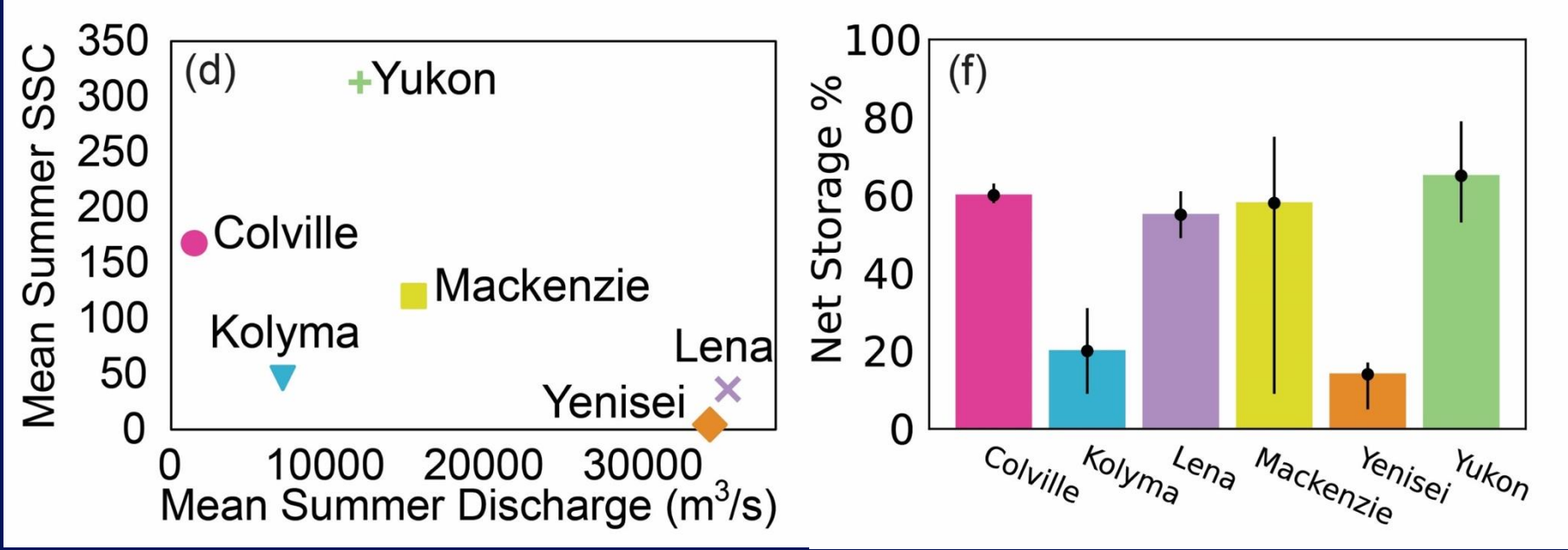




Larger deltas are more complex and store the most sediment

Hines & Piliouras (2024, JGR-ES)

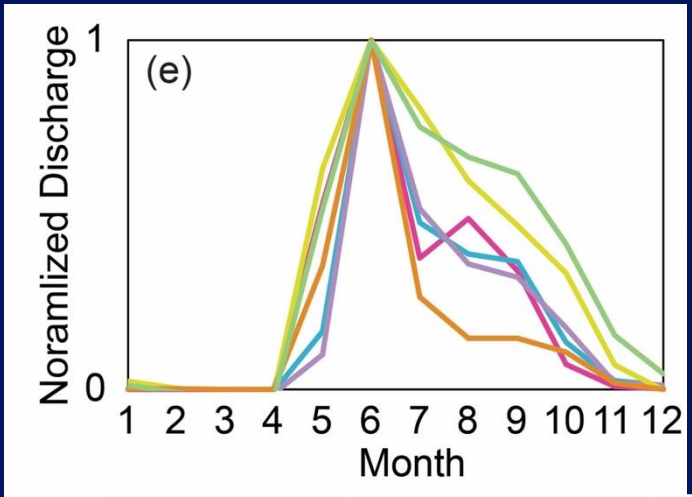
Net storage depends on hydrograph, delta size, river SSC

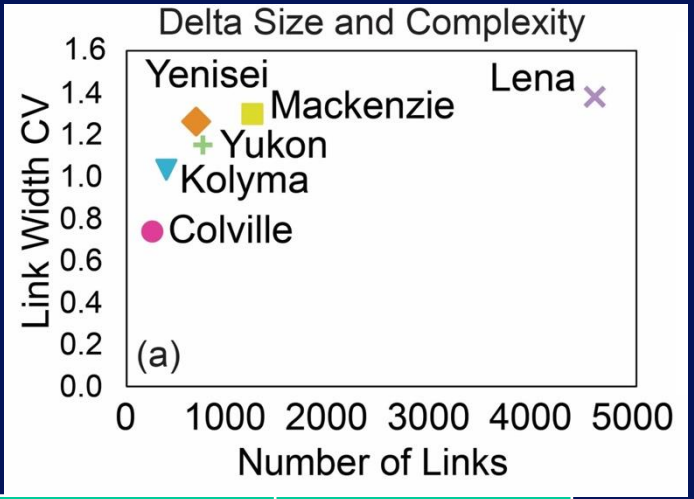


Deltas with high incoming SSC store the most sediment

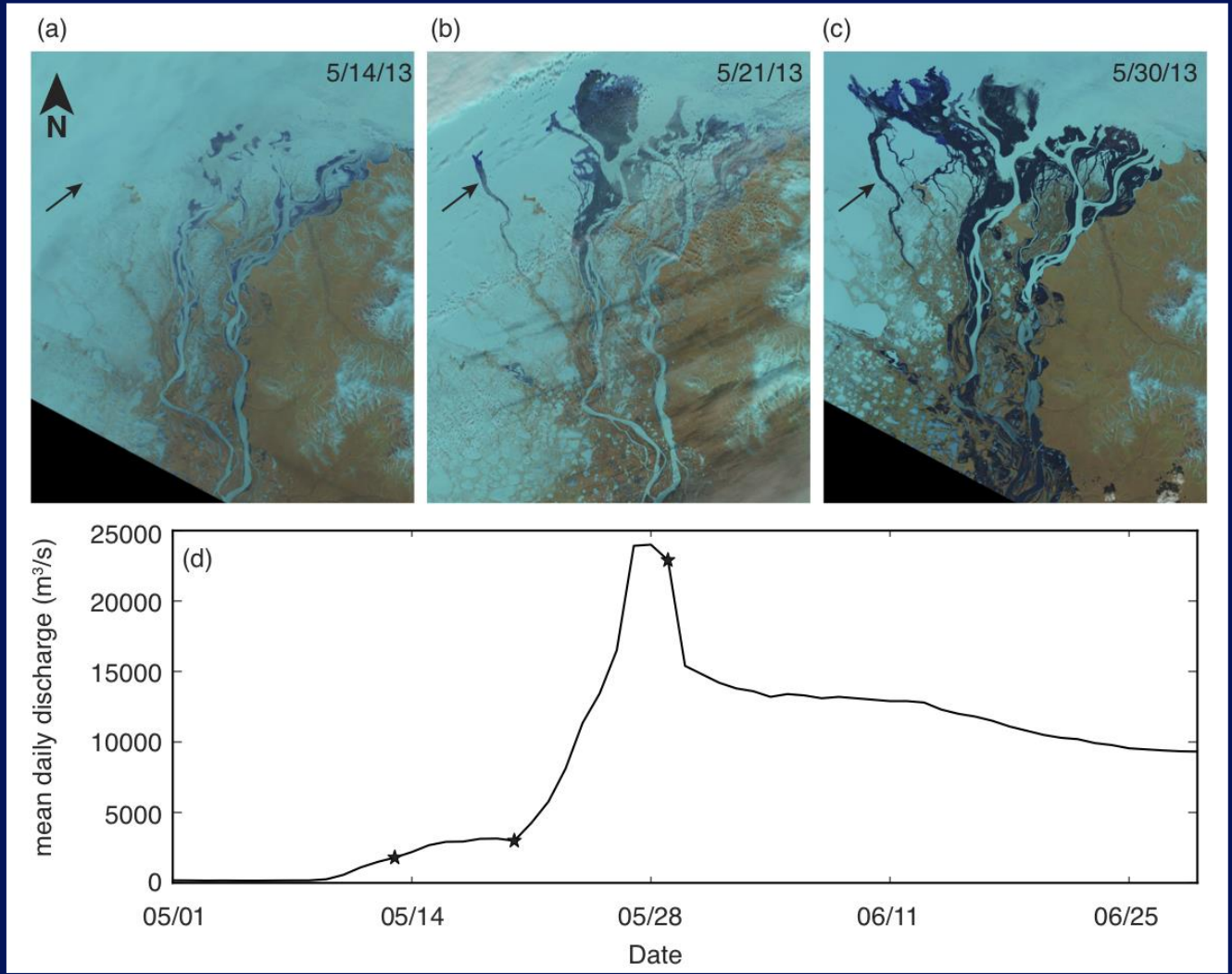
Hines & Piliouras (2024, JGR-ES)

Arctic deltas store 10-70% of incoming suspended sediment





Delta	Input Flux (Mt)	Output Flux (Mt)	Net Storage %
Colville	5.2	2.1	60.4
Kolyma	5.9	4.8	19.5
Lena	21.3	9.6	55.1
Mackenzie	30.2	12.8	57.7
Yenisei	3.4	3.0	13.6
Yukon	48.9	17.3	64.6


(a)
(b)
(c)
5/14/13
5/21/13
5/30/13
N
(d)
mean daily discharge (m³/s)
25000
20000
15000
10000
5000
0
05/01
05/14
05/28
06/11
06/25
Date