

Hydrologic Field Observations on Three Major Rivers in the North Slope Foothills Region

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Outline

- Study area
 - Anaktuvuk
 - Chandler
 - Itkillik
- Data Collection
 - Basin snow surveys
 - Meteorologic data
 - River water levels
 - River discharge
- Analysis
 - Snow water equivalent
 - Rating curve
 - Reach hydraulics
- Conclusions

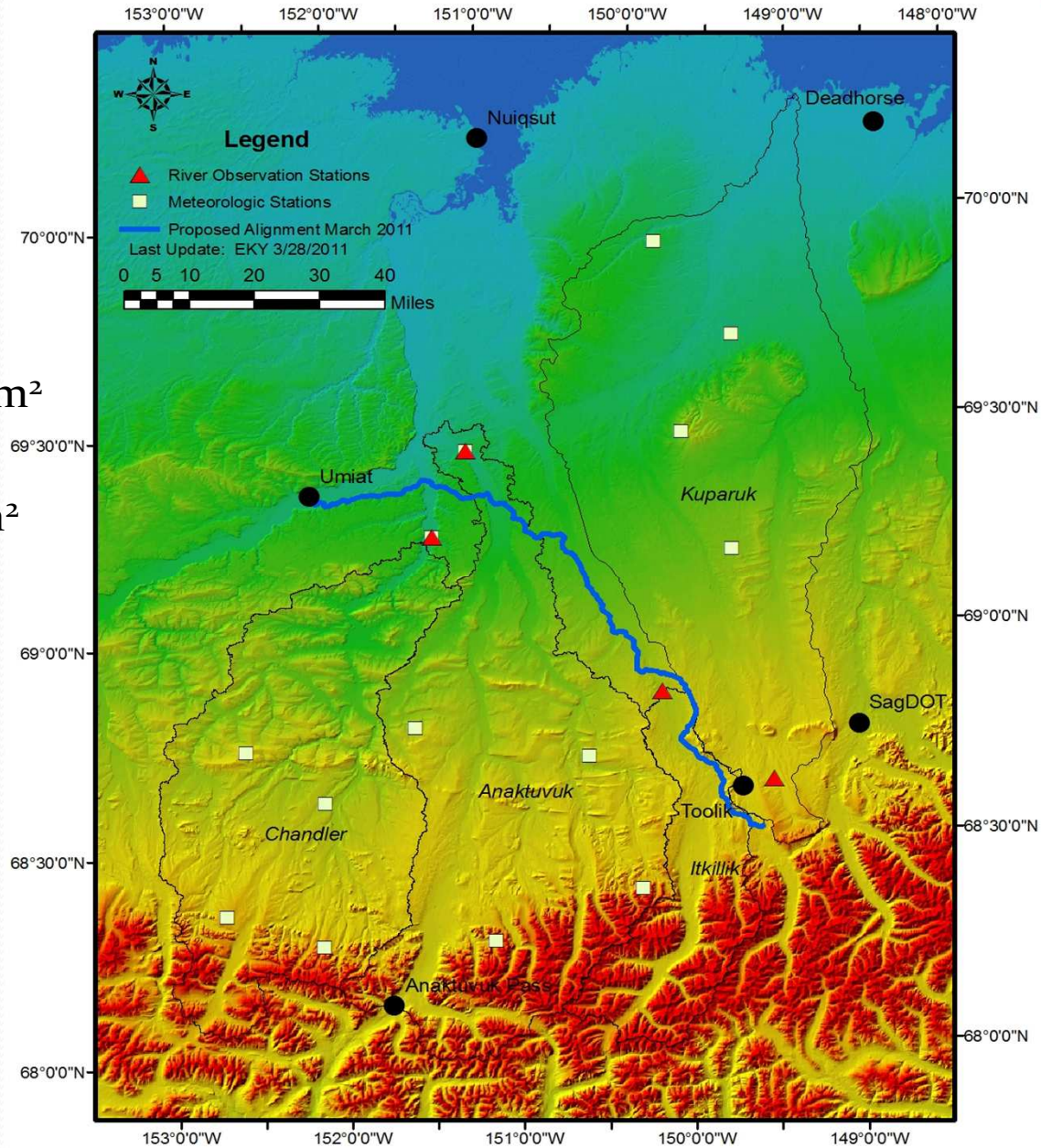


Study area

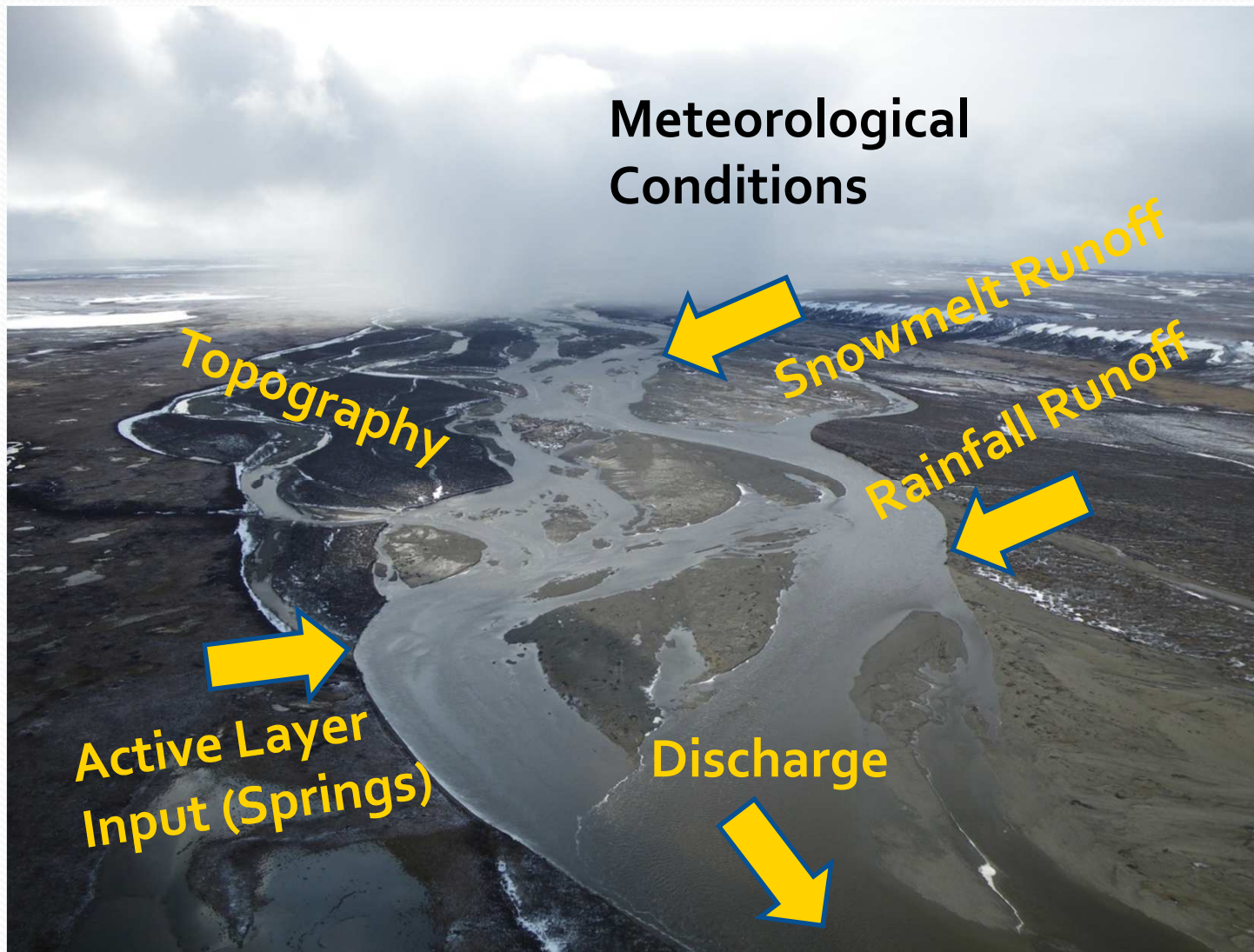
Anaktuvuk: 7000 km²

Chandler: 5800 km²

Itkilik: 1975 km²



Factors Contributing to Stream Discharge



Field work



Basin
Snow Surveys



Met Stations



River
Discharge
Measurements



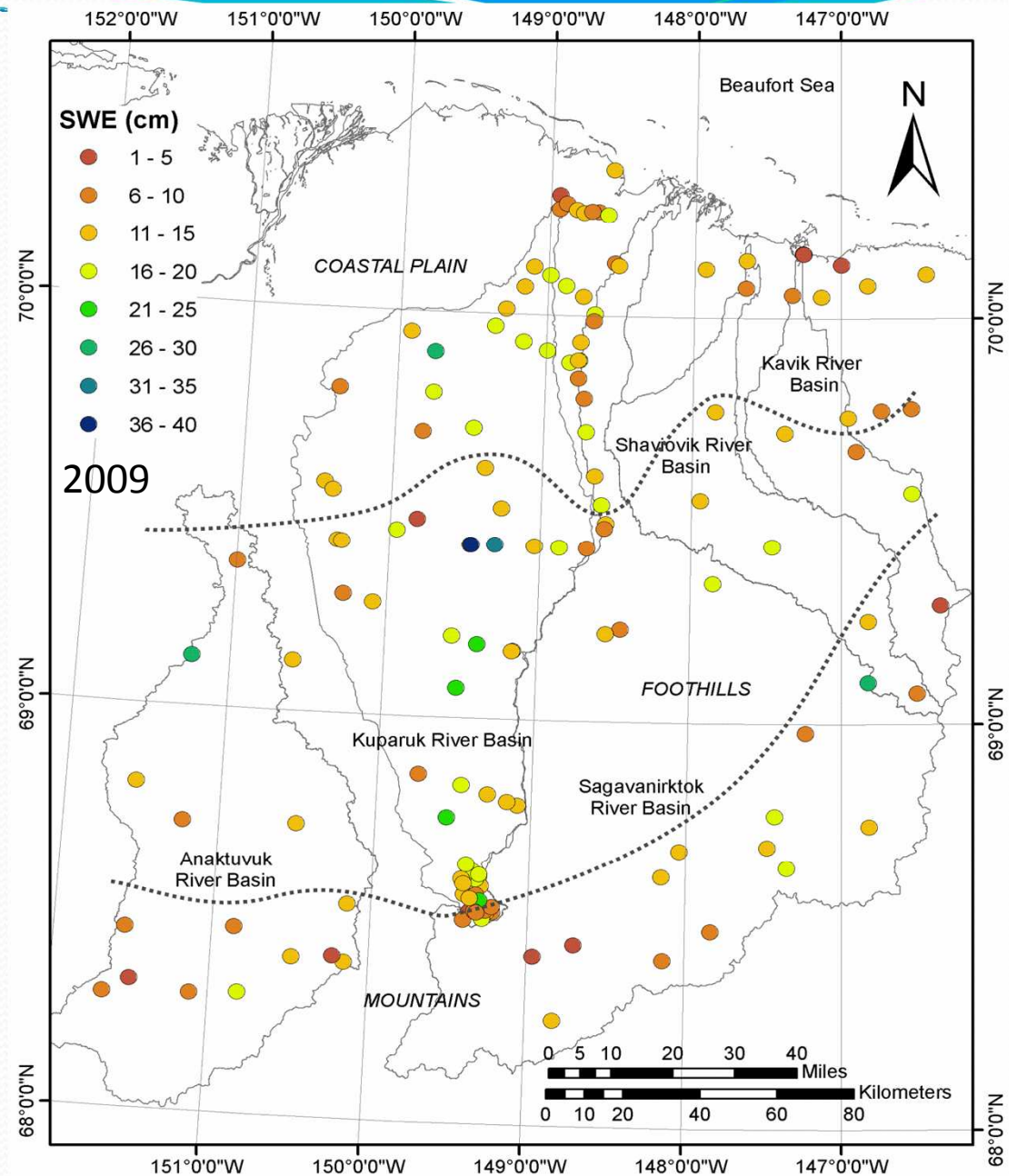
River
Observation
Stations

Snow

Snow Water Equivalent (SWE) 2009

Basin Averages:

- Kuparuk – 12.3 cm (n=83)
- Anaktuvuk – 11.4 cm (n=16)

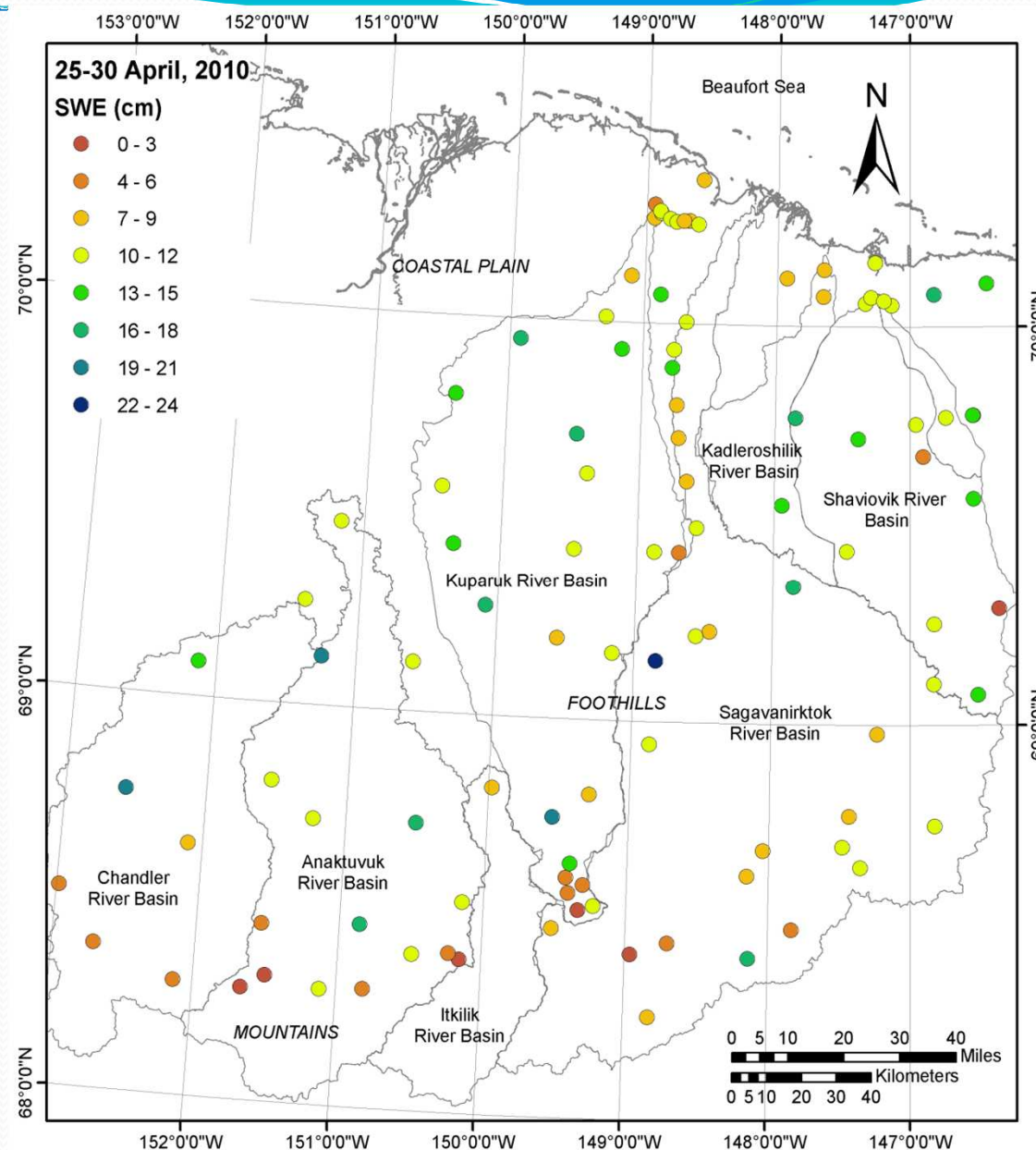


Snow

Snow Water Equivalent (SWE) 2010

Basin Averages:

- Kuparuk – 10.2 cm (n=43)
- Anaktuvuk – 8.2 cm (n=14)
- Chandler - 10.2 cm (n=8)



Rainfall

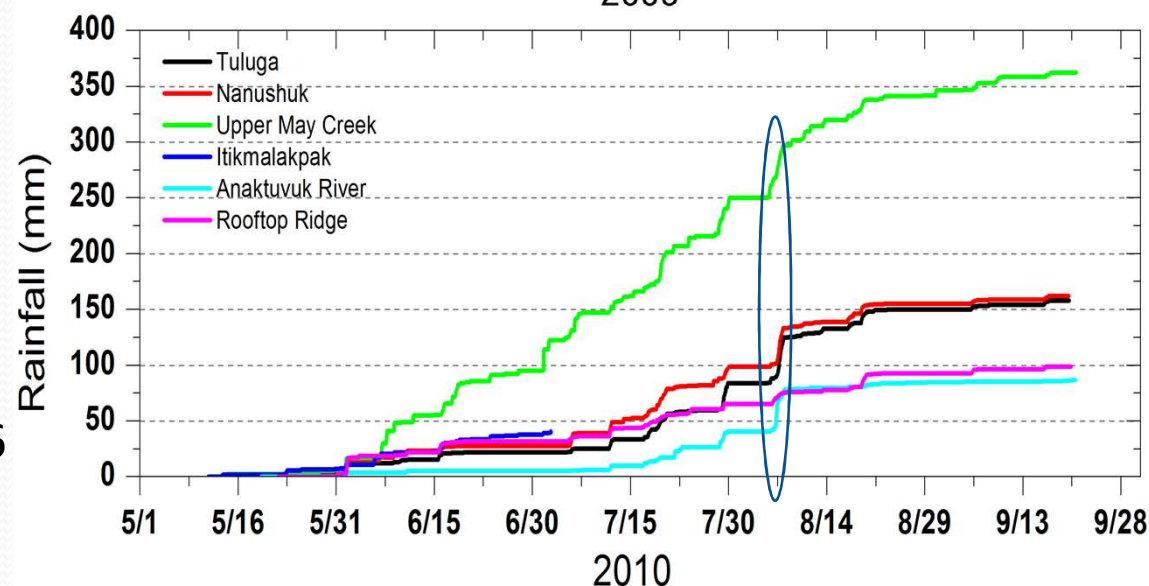
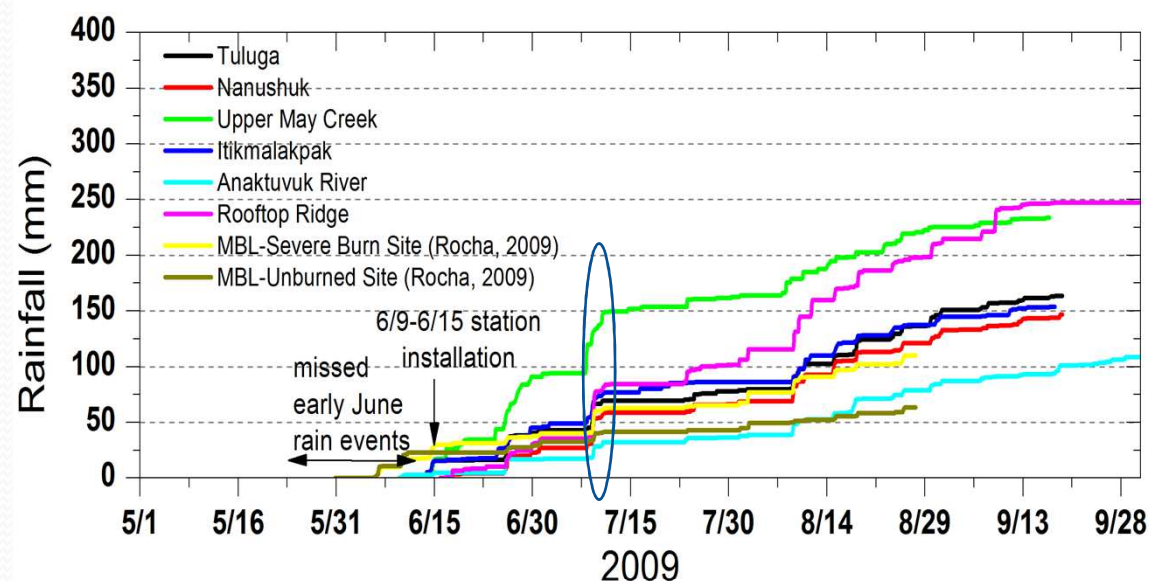
Pattern of lowest rainfall in the north (Coastal Plain/Foothills) and highest rainfall in the south (Mountains)

2009:

- Missed early June rainfall events
- Biggest rain event on July 7-9
- Dry mid July through early August
- Wet August

2010:

- Dry June
- Biggest rain event on August 6
- Dry August



Chandler



Ice
jams



Chandler



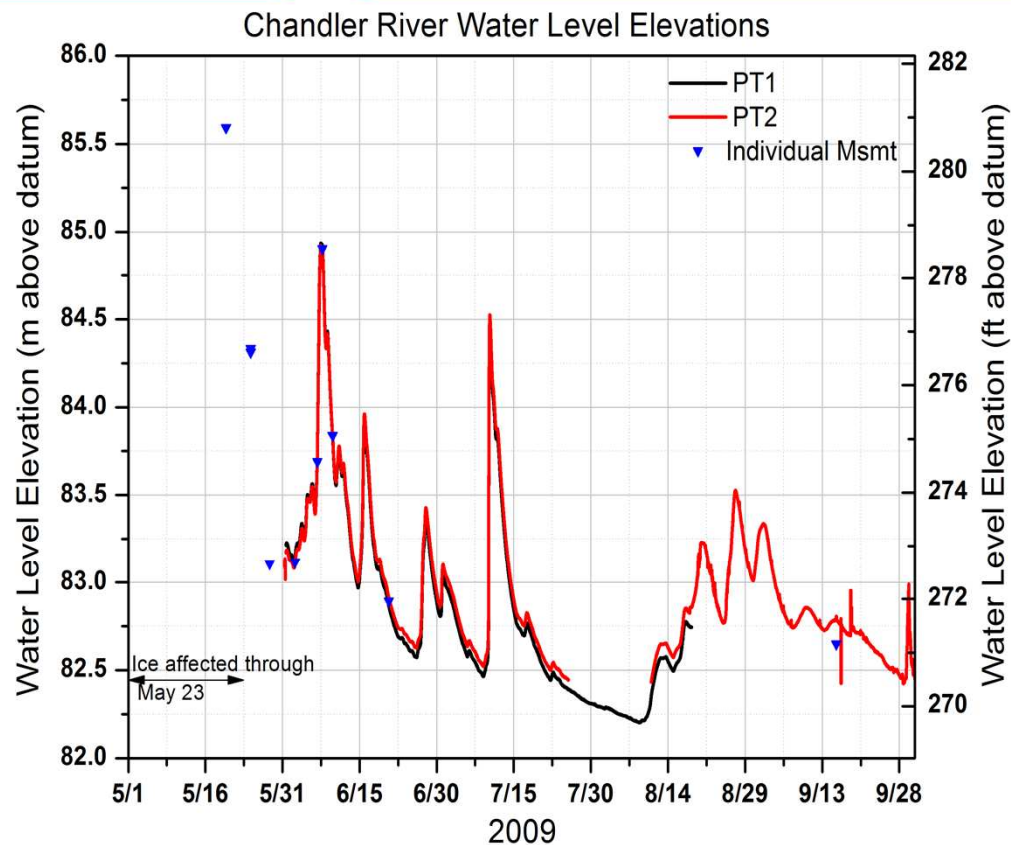
Ice blocks

Glove

Chandler



Chandler

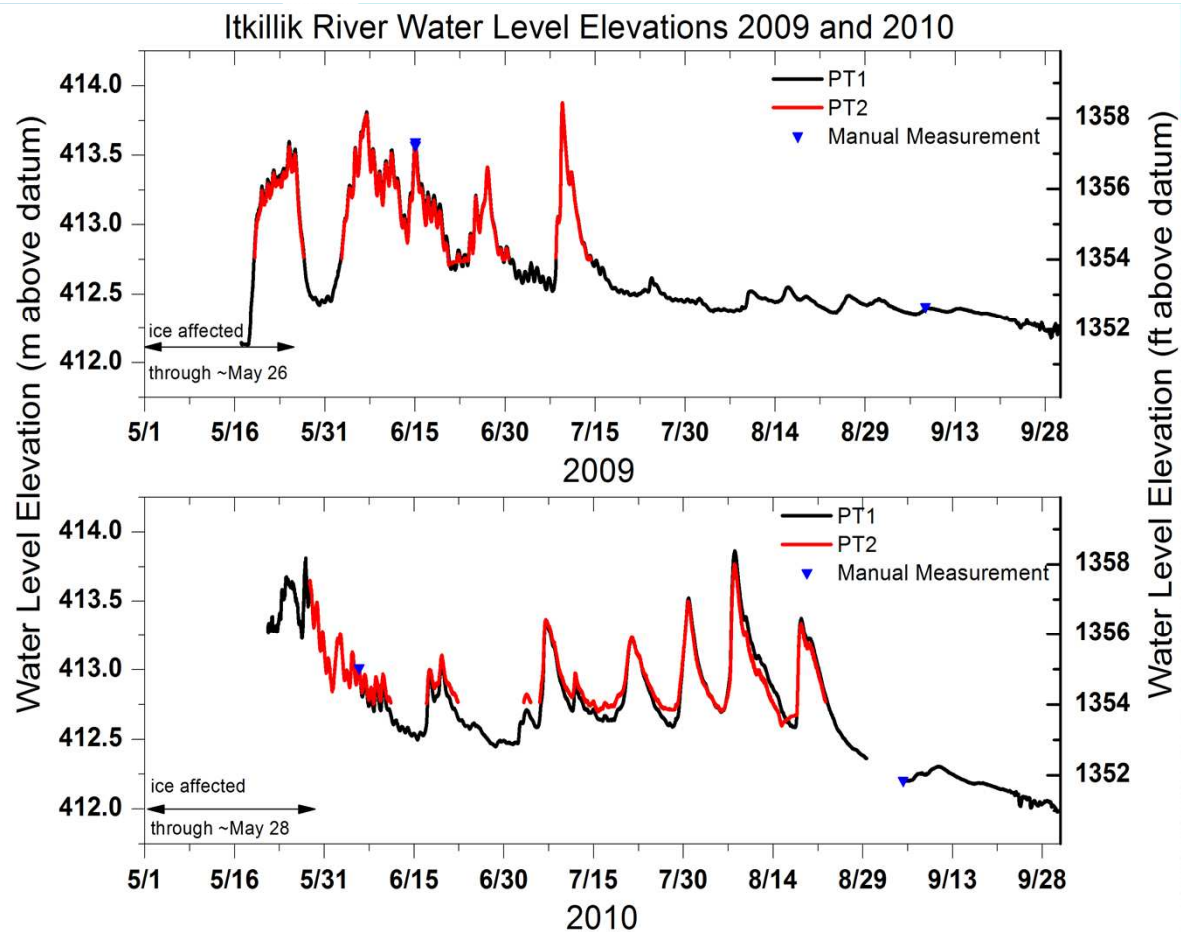


Date	Peak Water Level Elevation (m)	Peak Water Level Elevation (ft)
Spring: May 20, 2009	85.59	280.81
Summer: June 7, 2009	84.93	278.64
Spring: May 31, 2010	n/a	n/a
Summer: August 8, 2010	n/a	n/a

Itkillik



Itkillik

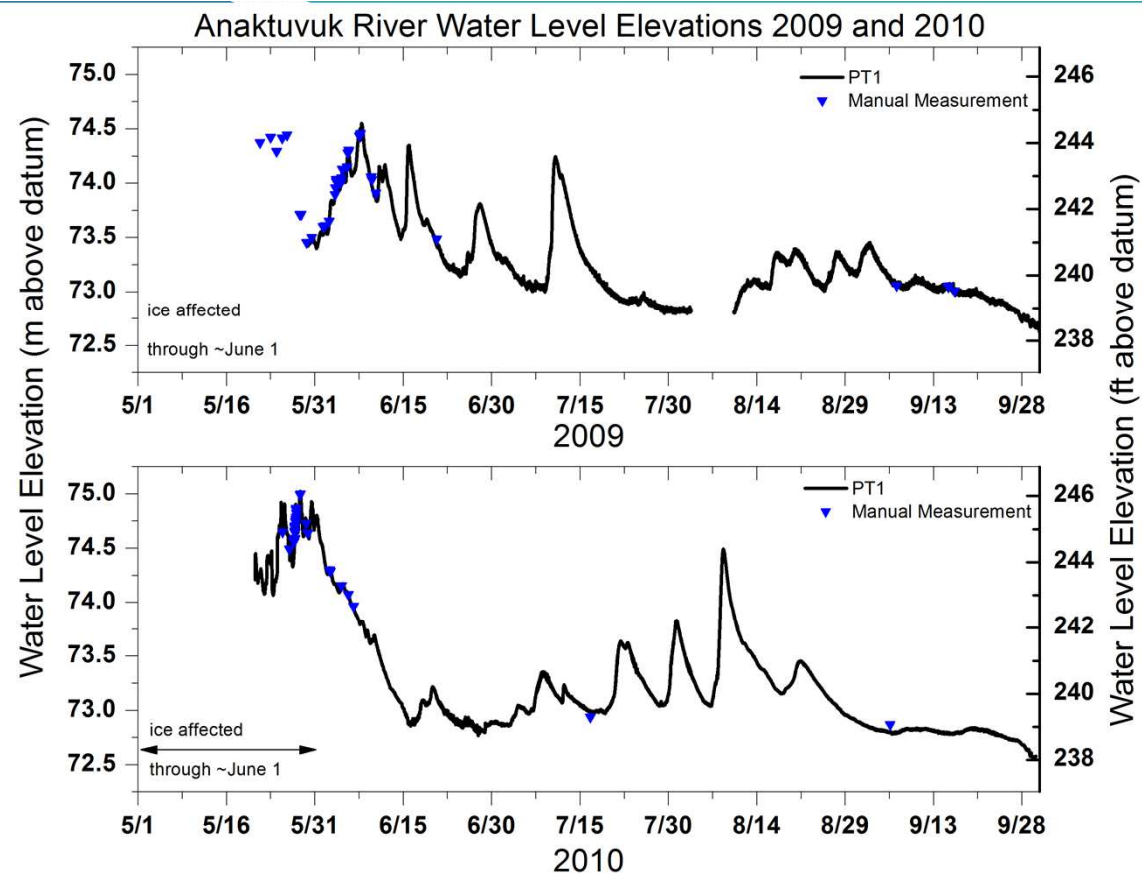


Date	Peak Water Level Elevation (m)	Peak Water Level Elevation (ft)
Spring: May 25, 2009	413.60	1356.95
Summer: July 10, 2009	413.87	1357.84
Spring: May 27, 2010	413.81	1357.64
Summer: August 7, 2010	413.86	1357.80

Anaktuvuk



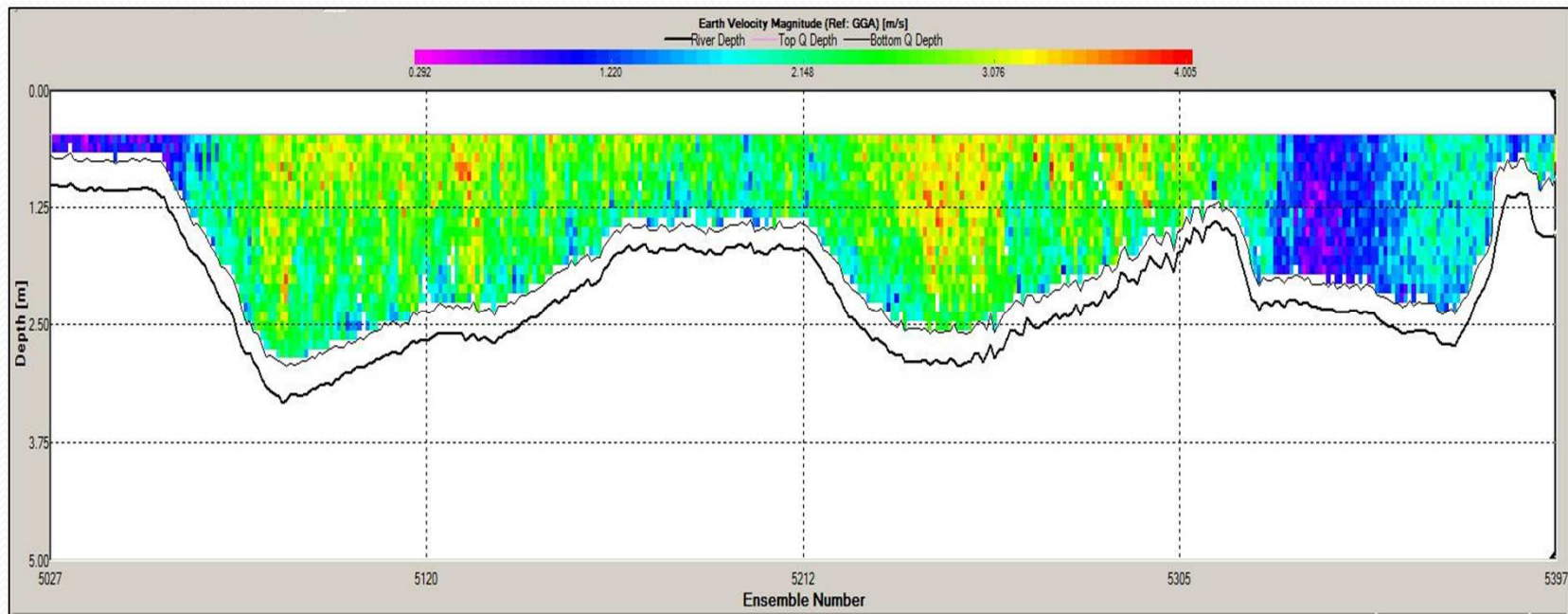
Anaktuvuk



Date	Peak Water Level Elevation (m)	Peak Water Level Elevation (ft)
Spring: May 26, 2009	74.44	244.22
Summer: June 7, 2009	74.55	244.58
Spring: May 28, 2010*	75.02	246.13
Summer: August 8, 2010	74.49	244.39

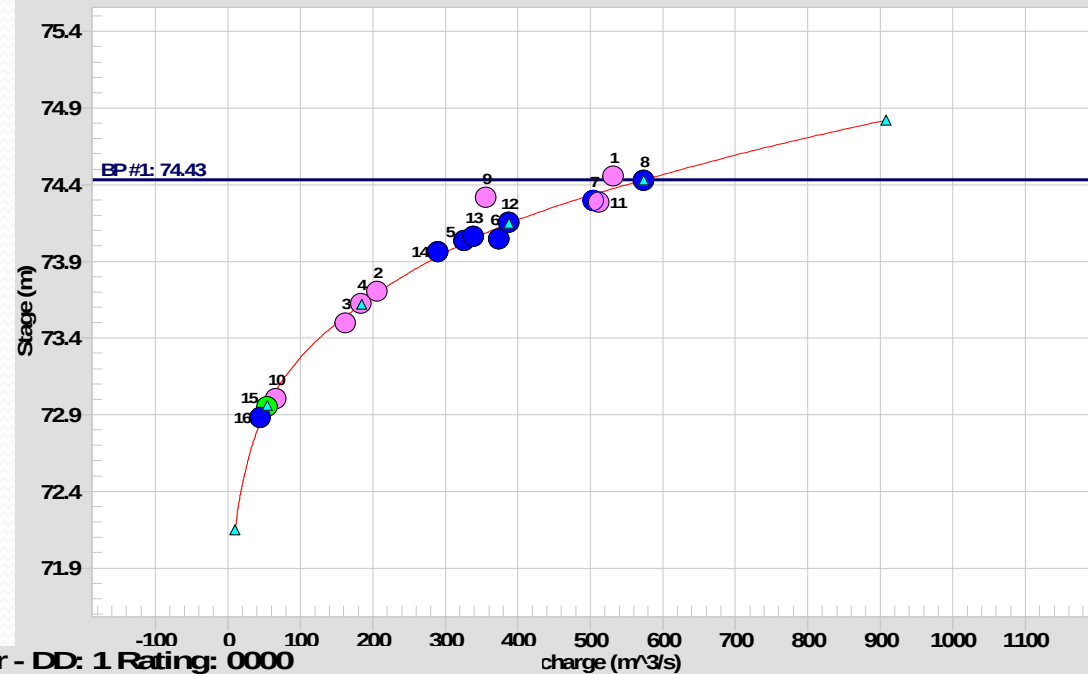
*Ice affected water level. Peak discharge probably occurred around May 31, 2010.

ADCP data

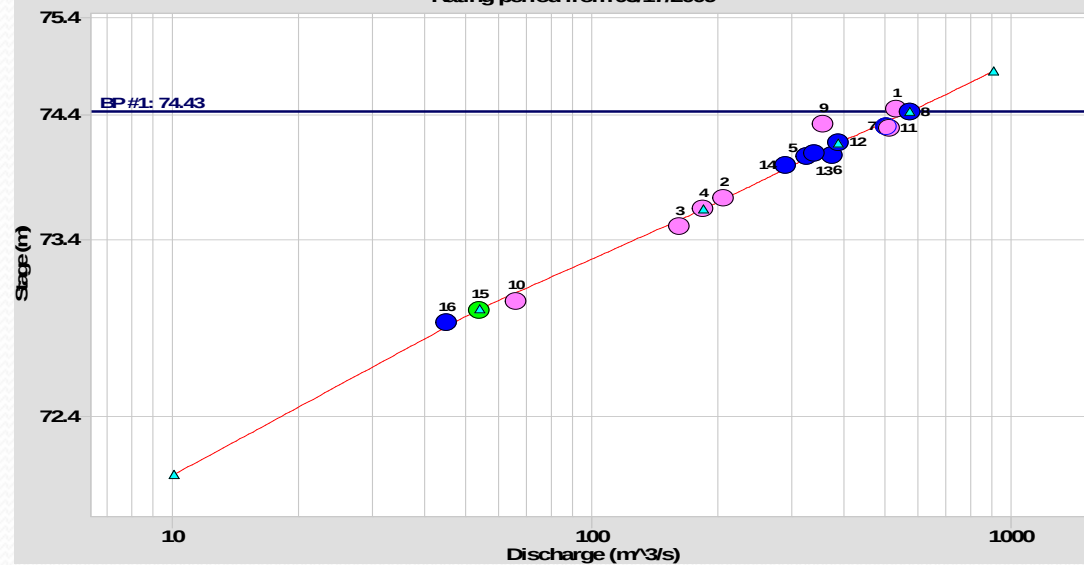


Anaktuvuk

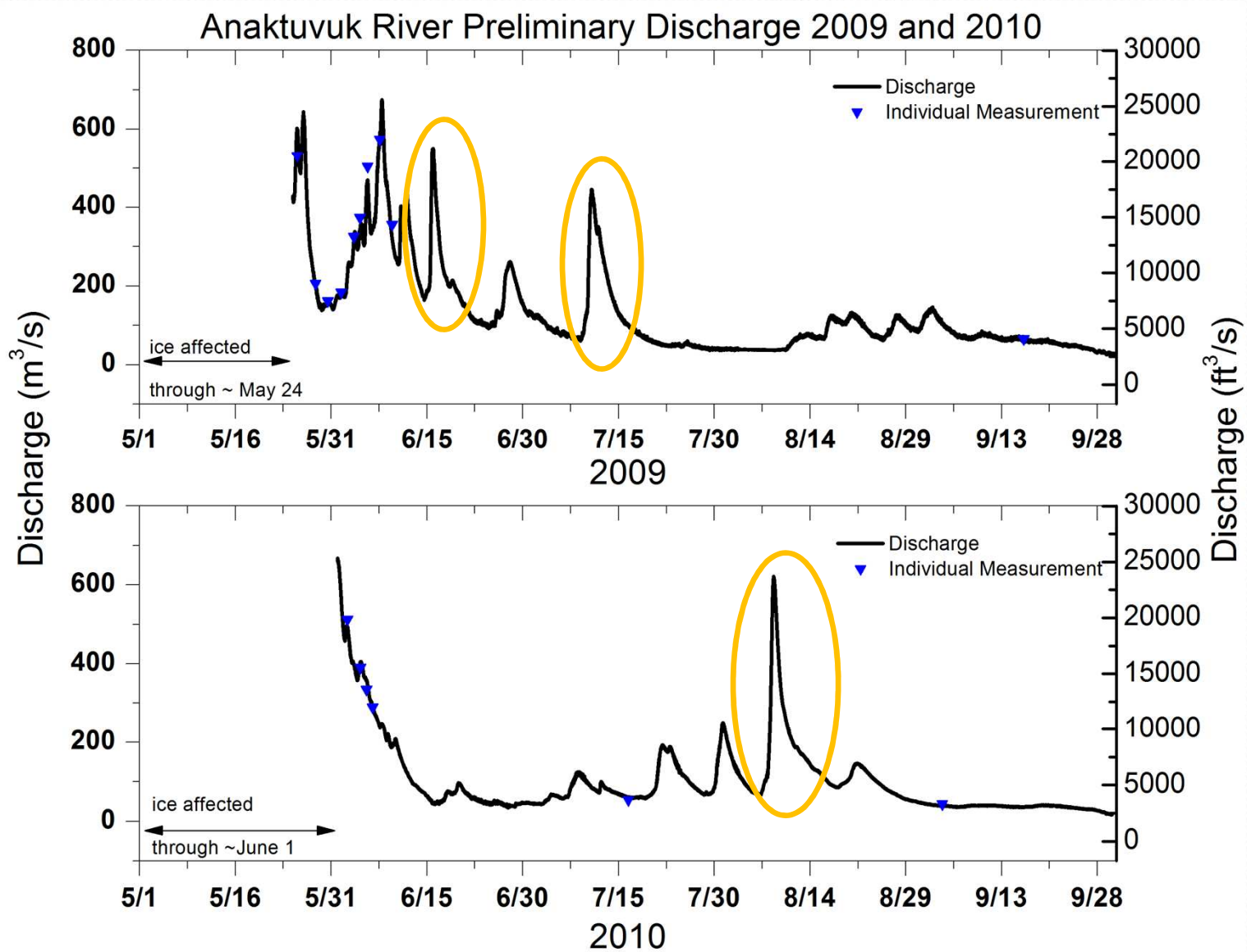
DUS2 - Anaktuvuk River - DD: 1 Rating: 0000
Rating period from 05/17/2009



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Rating period from 05/17/2009



Anaktuvuk



Anaktuvuk

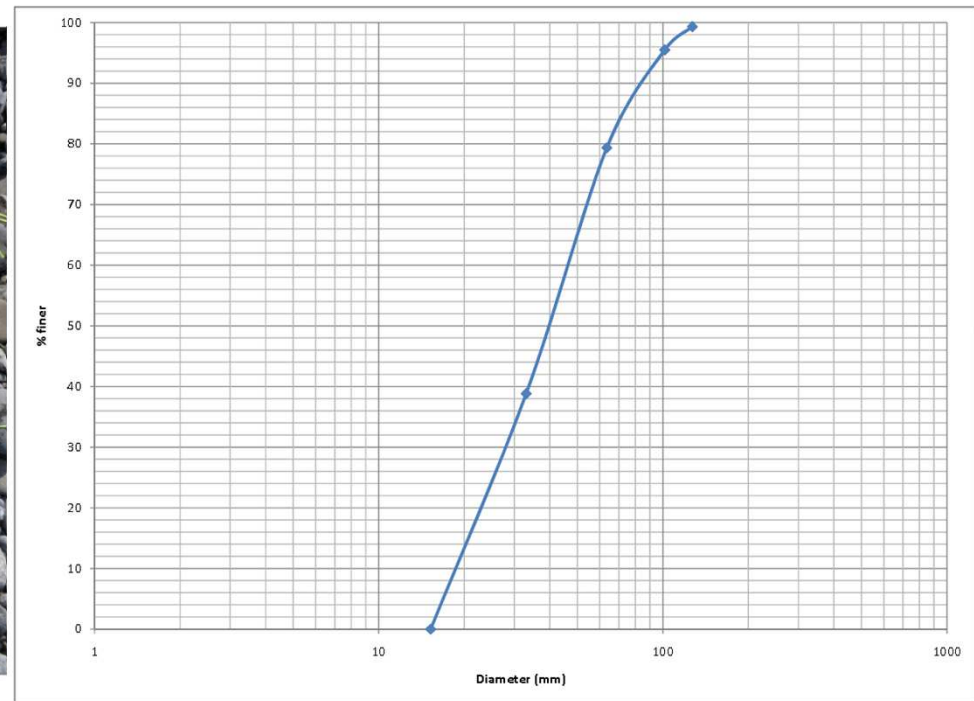


Armoring



Anaktuvuk

Bed Sediment



$d_{50} = 41 \text{ mm}$

$$n = \frac{1}{U} H^{2/3} S^{1/2}$$

$$H = \frac{A}{B}$$

$$C_f = \frac{g}{U^2} HS$$

$$C_z = \frac{1}{\sqrt{C_f}}$$

$$\tau_b = g\rho HS$$

$$Q_{bf} = 3.732 B_{bf} H_{bf} \sqrt{g H_{bf} S} \left(\frac{H_{bf}}{D_{s50}} \right)^{0.2645}$$

$$\tau_* = \tau_b / (\rho g R D_{s50})$$

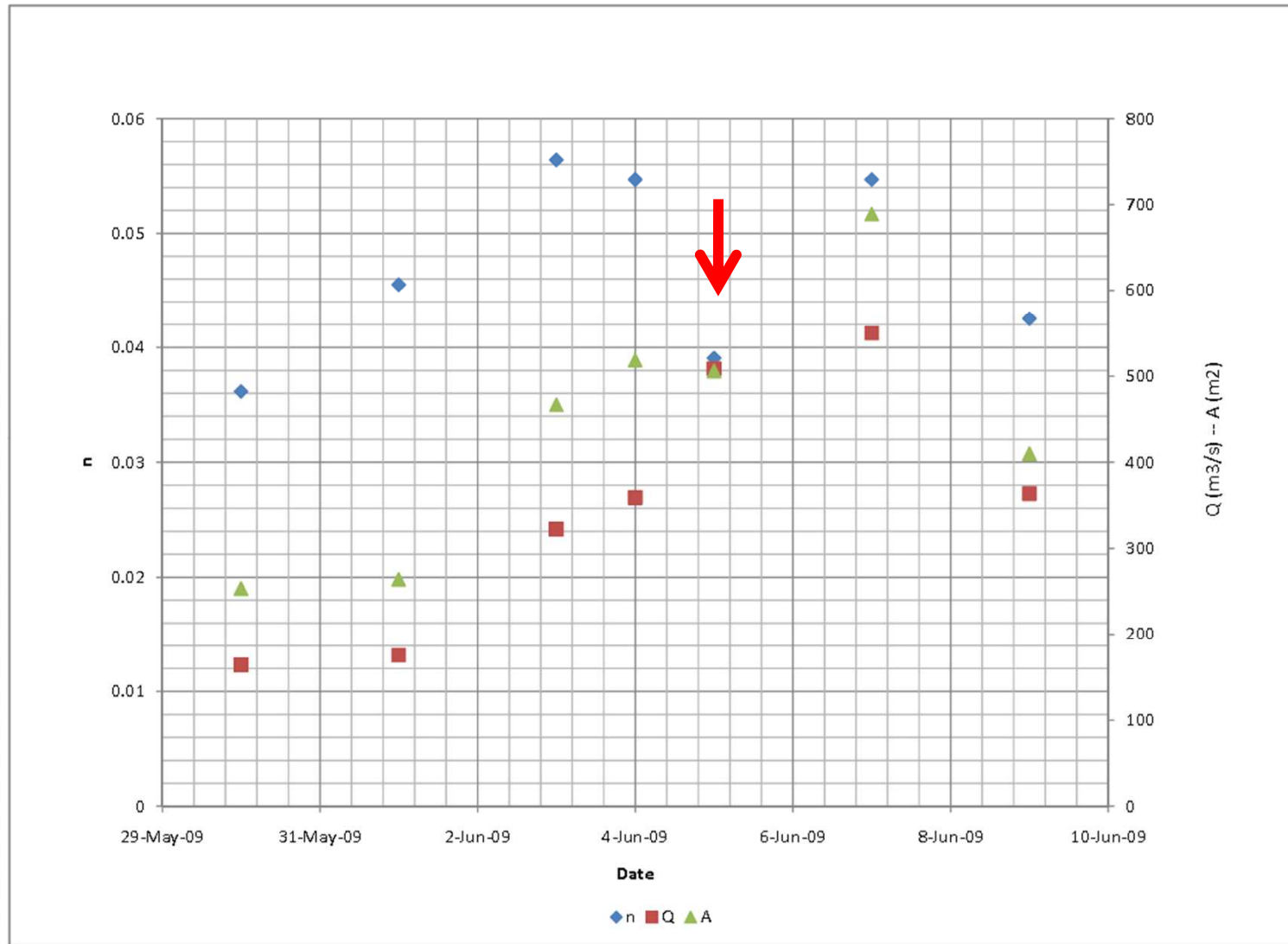
$$R_{ep} = \frac{\sqrt{g R D_{s50}}}{\nu} D_{s50}$$

A	cross-sectional area
B	channel width
C_f	dimensionless resistance coefficient
C_z	Chezy dimensionless resistance coefficient
B	channel width
B_{bf}	channel width at bankfull condition
D_{s50}	bed surface median grain size
H	cross-sectionally averaged channel depth
H_{bf}	cross-sectionally averaged channel depth at bankfull condition
Q	discharge
Q_{bf}	bankfull discharge
R_{ep}	particle Reynolds number
S	water- surface slope
U	cross-sectionally averaged velocity
g	gravity
n	Manning's roughness coefficient
ν	kinematic viscosity of water
ρ	density of water
τ_b	bed shear stress
τ_*	dimensionless bed shear stress

Anaktuvuk

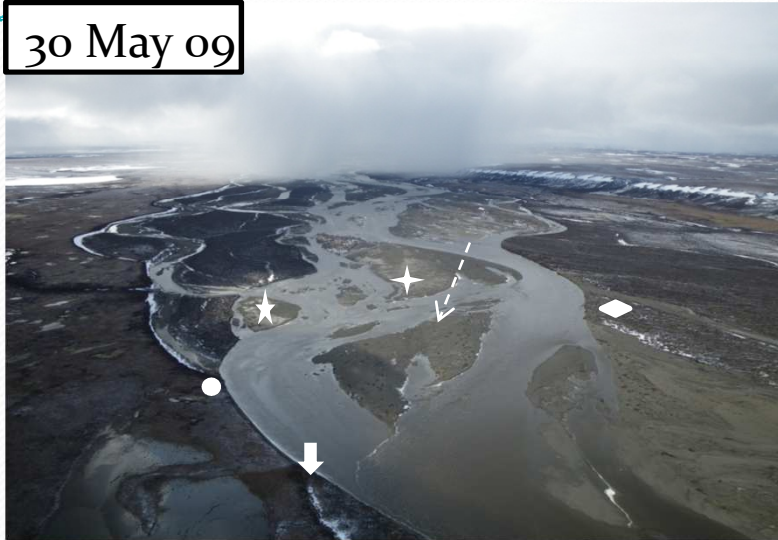
Date	Q (m ³ /s)	B (m)	A (m ²)	U (m/s)	S (x10 ⁻³)	H (m)	n	C _f (x10 ⁻²)	t _b (N/m ²)	Suspended Sediment (ppm)
5/30/2009	162	220	254	0.65	0.454	1.15	0.036	1.22	5.127	
6/1/2009	184	218	264	0.67	0.710	1.21	0.046	1.91	8.455	
6/3/2009	326	295	467	0.70	0.846	1.58	0.057	2.69	13.126	130.2
6/4/2009	374	333	519	0.72	0.795	1.56	0.053	2.34	12.158	101.7
6/5/2009	504	308	506	1.00	0.801	1.64	0.039	1.30	12.920	379.8
6/7/2009	574	418	689	0.83	1.000	1.65	0.053	2.33	16.180	227.5
6/9/2009	356	278	410	0.87	0.849	1.47	0.043	1.63	12.288	45.7
6/4/2010	388	281	486	0.80	0.538	1.73	0.042	1.42	9.126	
6/5/2010	339	267	441	0.78	0.501	1.65	0.040	1.34	8.110	
6/6/2010	291	253	390	0.75	0.269	1.54	0.029	0.73	4.067	

An interesting graph



Anaktuvuk

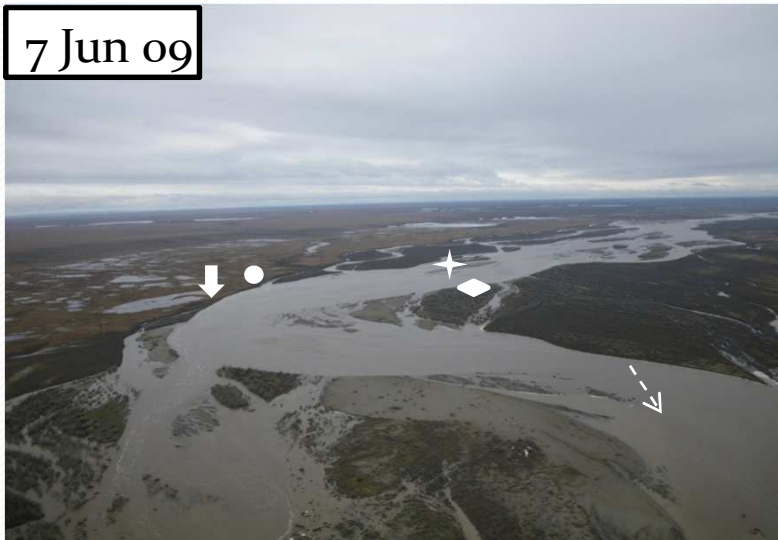
30 May 09



5 Jun 09



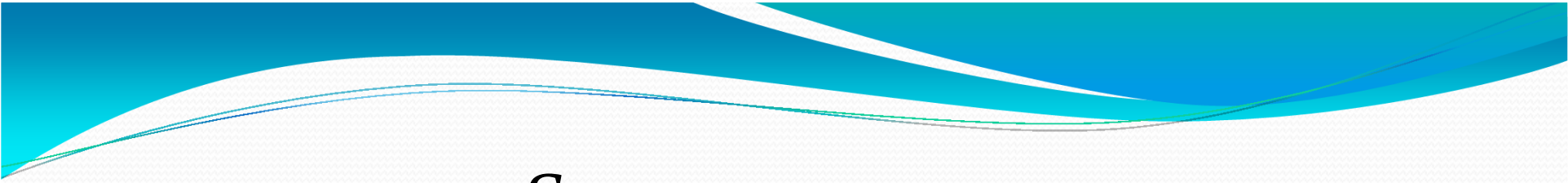
7 Jun 09



9 Jun 09

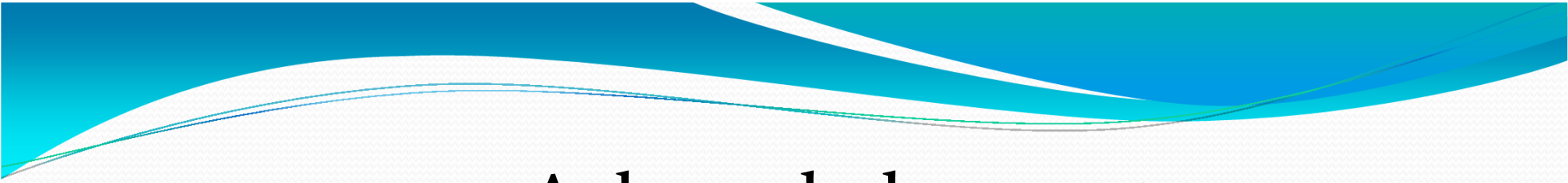


- culverts ↓ beginning of low terrace ★ exposed bar near right margin
- ✦ exposed mid bar ◆ upstream end of vegetation (tundra)



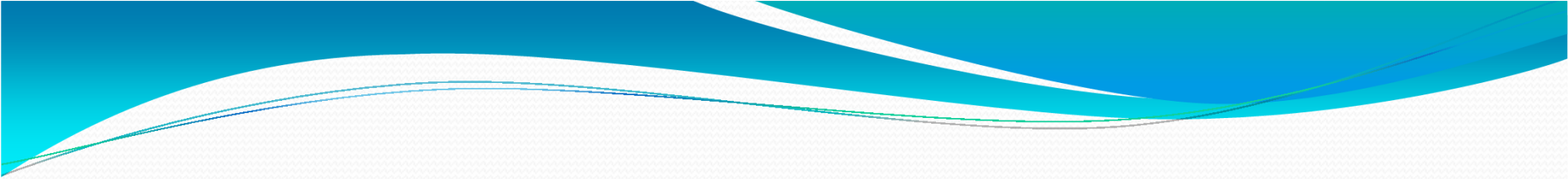
Summary

- Snow water equivalent higher in 2009 than 2010
- High runoff events can also occur during summer months at high gradient foothills rivers due to rainfall
 - Examples: June 7 2009, July 10 2009, August 8, 2010
- Anaktuvuk at gauging site: bankfull discharge around 500 m³/s
- Coarse sediment (gravel and cobbles)



Acknowledgements

- AKDOT&PF
- GWS



Thanks!