

Evidence for Hydrological System Regime Change from the Fish Creek Watershed in northern Alaska



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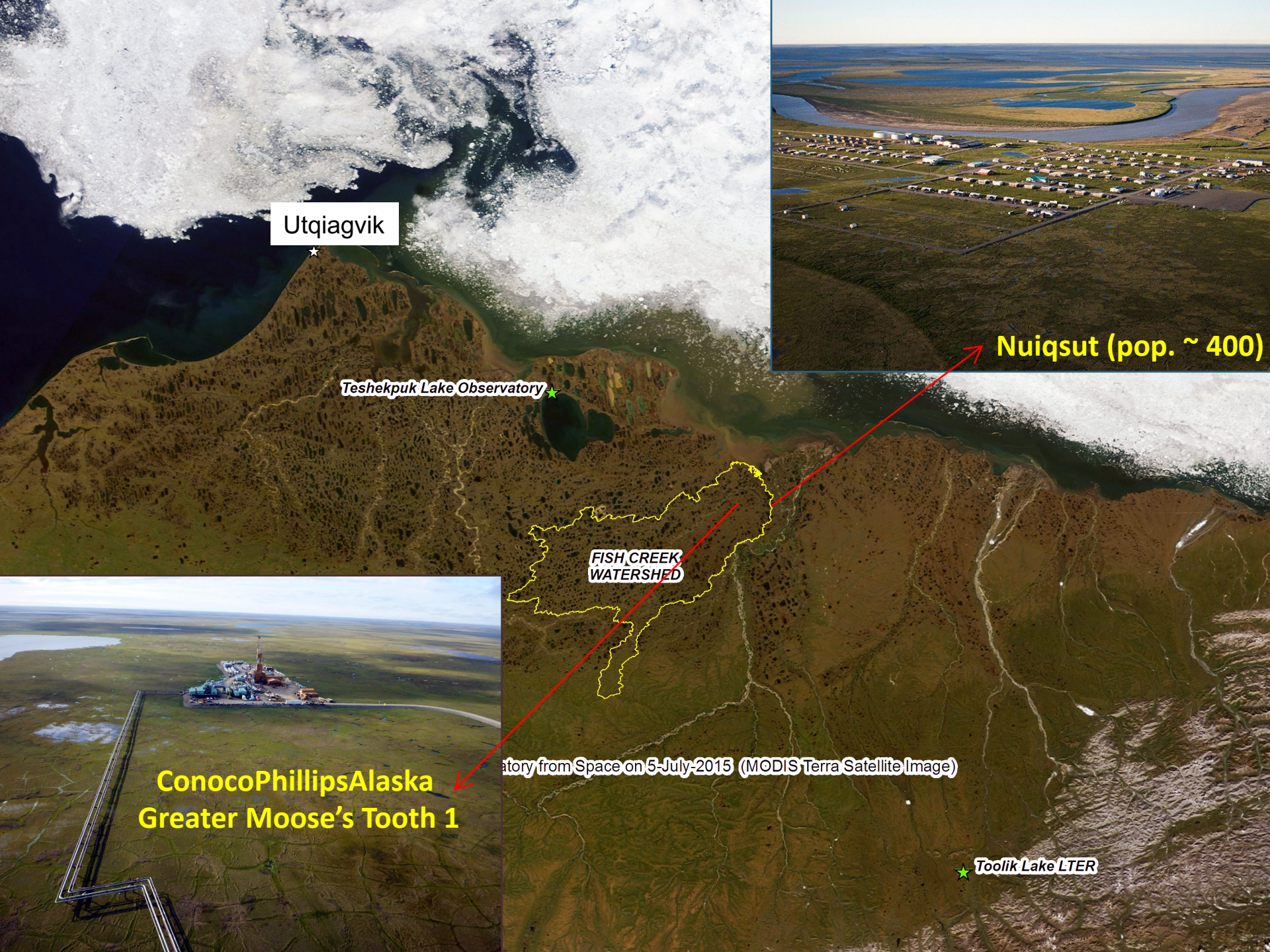
Matthew Whitman & Richard Kemnitz

Bureau of Land Management, Arctic Office

Outline of Talk

1. **Where is the Fish Creek Watershed & what's happening there?**
2. **Paired catchments capturing range of Arctic Coastal Plain characteristics**
3. **19 year of runoff data evidence hydrologic intensification & regime shift**
4. **Broader context for environmental change in the Arctic**





Utqiagvik

Teshekpuk Lake Observatory

FISH CREEK
WATERSHED



Nuiqsut (pop. ~ 400)



ConocoPhillips Alaska
Greater Moose's Tooth 1

...atory from Space on 5-July-2015 (MODIS Terra Satellite Image)

Toolik Lake LTER

Inigok Field Camp – Bureau of Land Management (BLM)

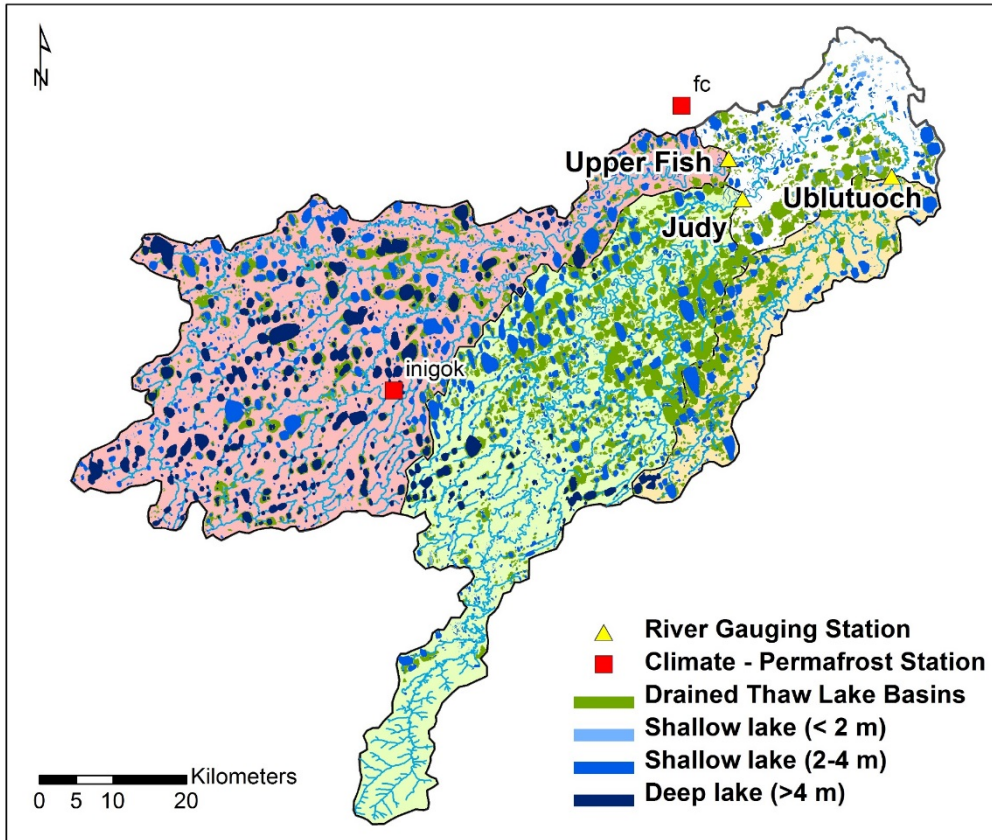


Richard Kemnitz
BLM hydrologist



Matthew Whitman
BLM fish biologist

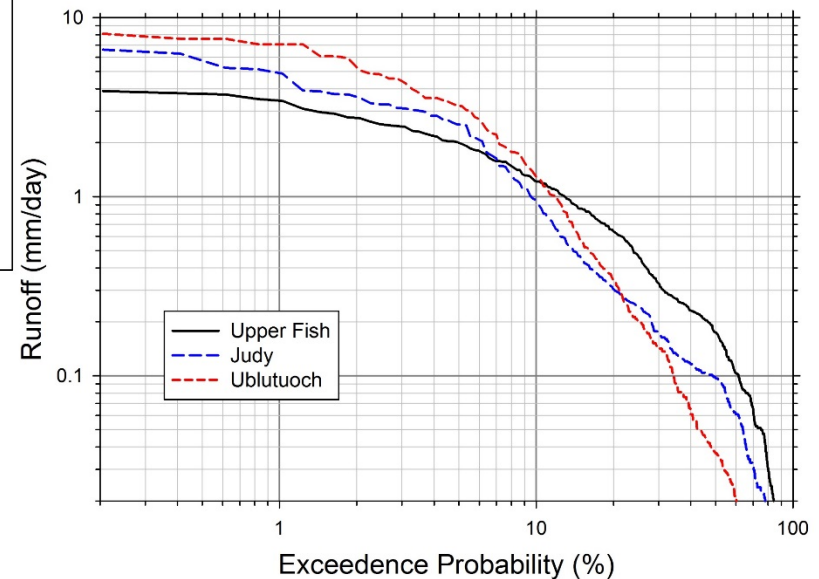




Fish Creek Watershed Observatory

Excellent Hydrography for Comparing Link between Watershed Characteristics and Runoff Generation

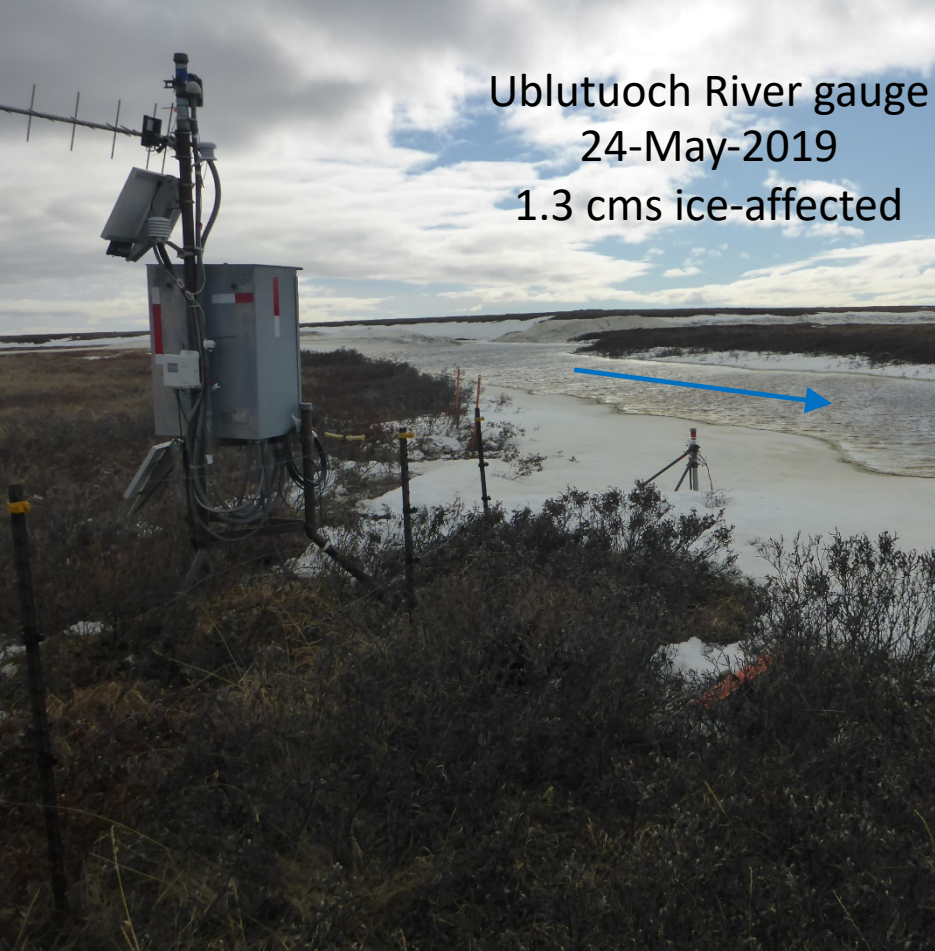
BLM-USGS-WERC Gauging Records since 2001



Upper Fish Creek (*Iqalliqqiq*) – 2016 km²;
20% lake area, 10% drained lakes; eolian sand

Judy Creek (*Uulutuuq*) – 1647 km²;
12% lake area, 21% drained lakes; headwaters in foothills with bedrock control

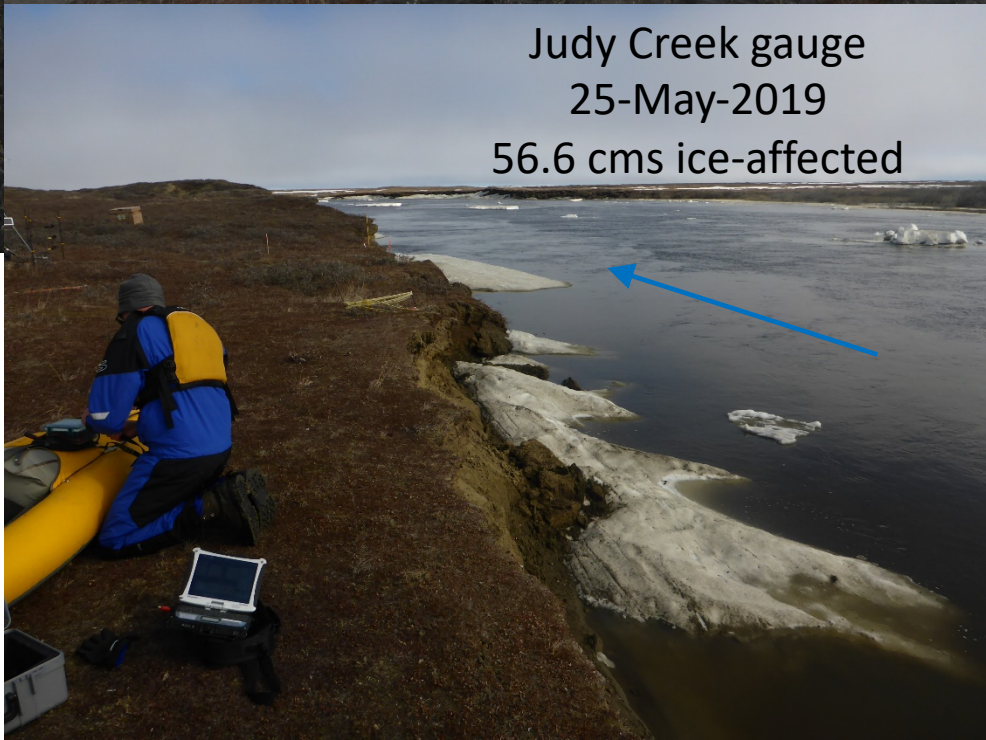
Ublutuoch River (*Tingmiaqsiuqvik*) – 483 km²;
13% lake area, 32% drained lakes; marine silt



Ublutuoch River gauge
24-May-2019
1.3 cms ice-affected



Upper Fish Creek gauge
31-May-2019
79.8 cms ice-affected near bankfull



Judy Creek gauge
25-May-2019
56.6 cms ice-affected

Near-realtime Data

<http://ine.uaf.edu/werc/projects/npra-hydrology/>

Archived Data

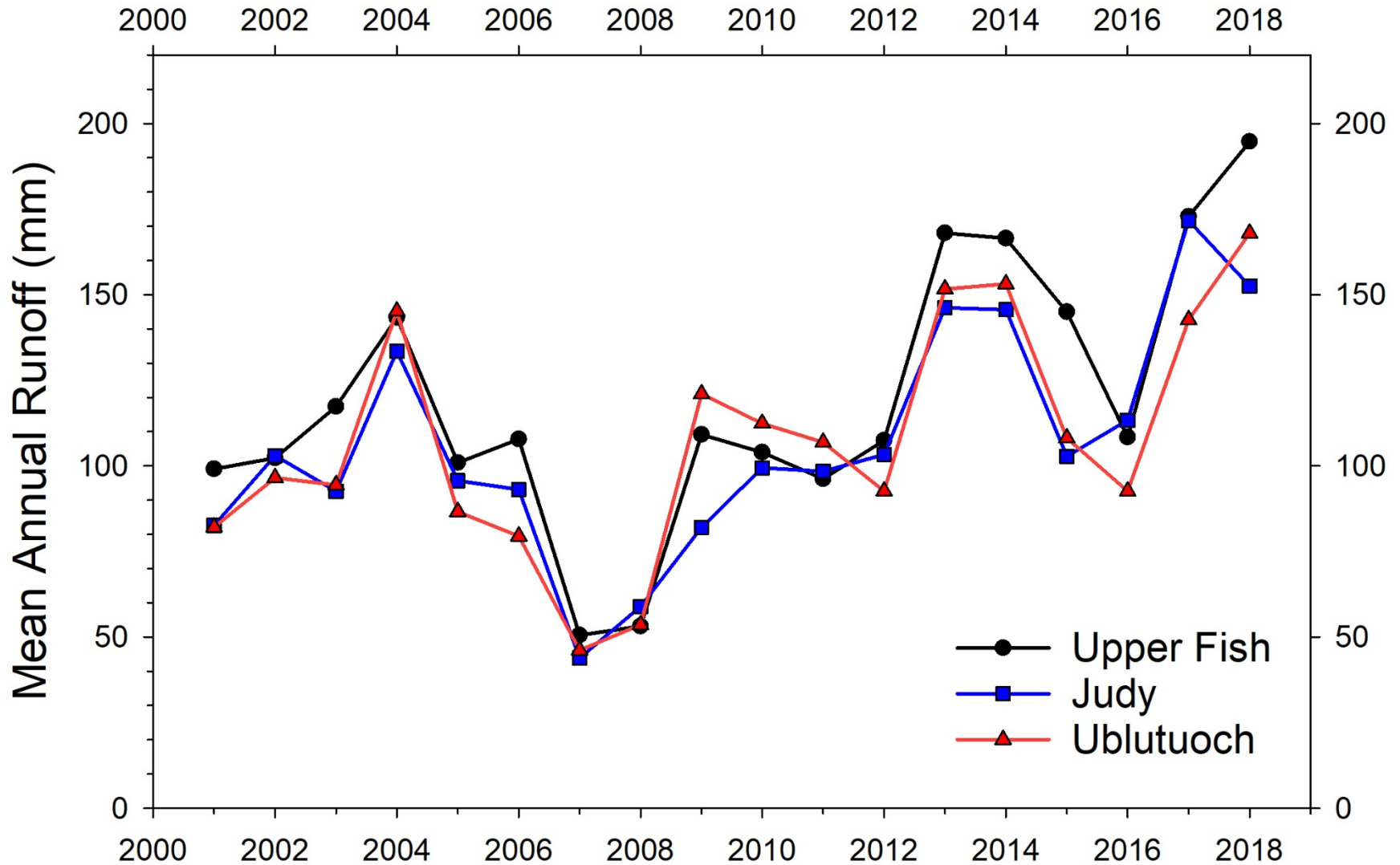
<https://arcticdata.io/>

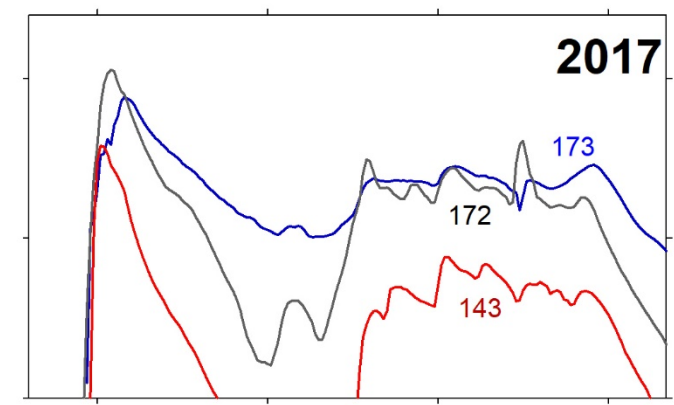
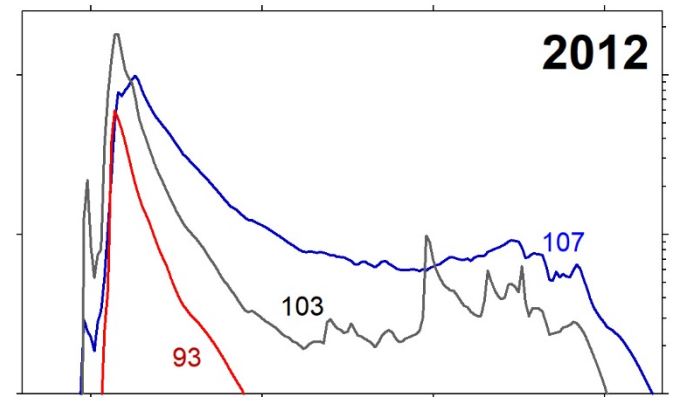
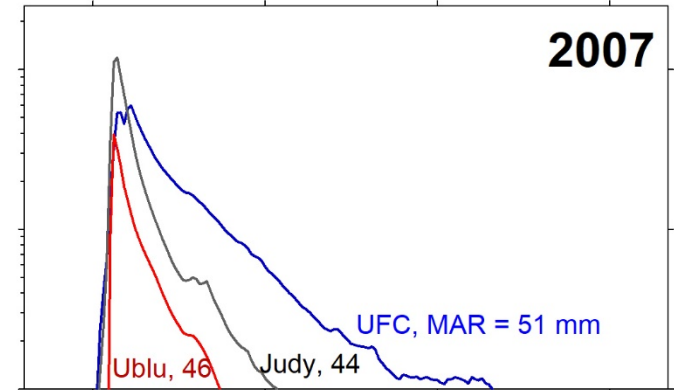
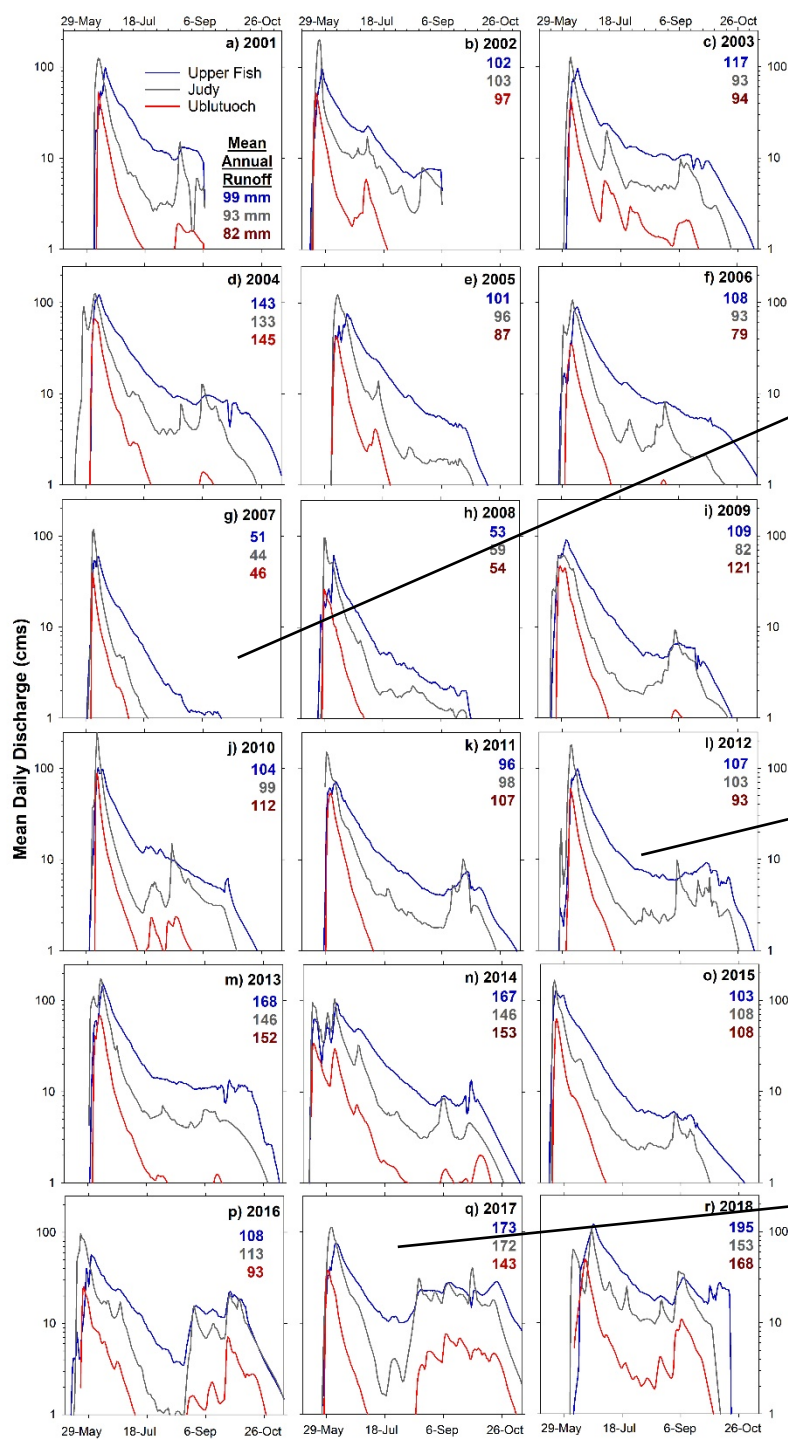
[Kemnitz et al. 2018. River discharge data, National Petroleum Reserve, Alaska, 2001-2017. Arctic Data Center. doi:10.18739/A2P55DG5N.](#)

Hydrologic Regime of Arctic Coastal Plain Watersheds

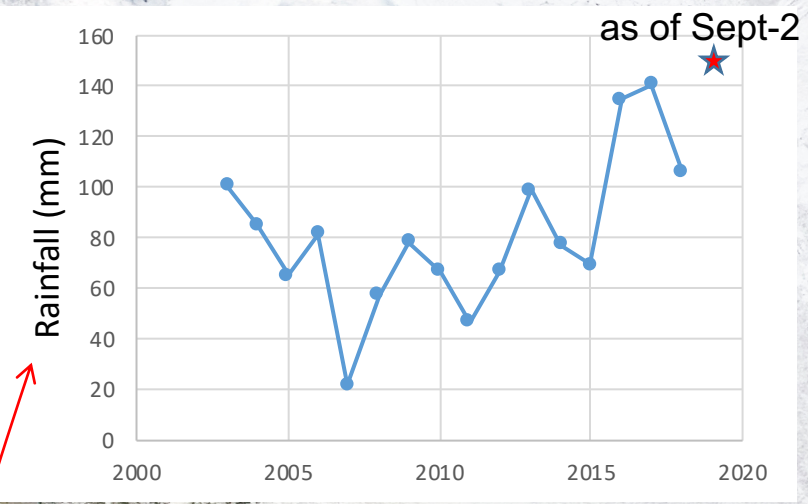
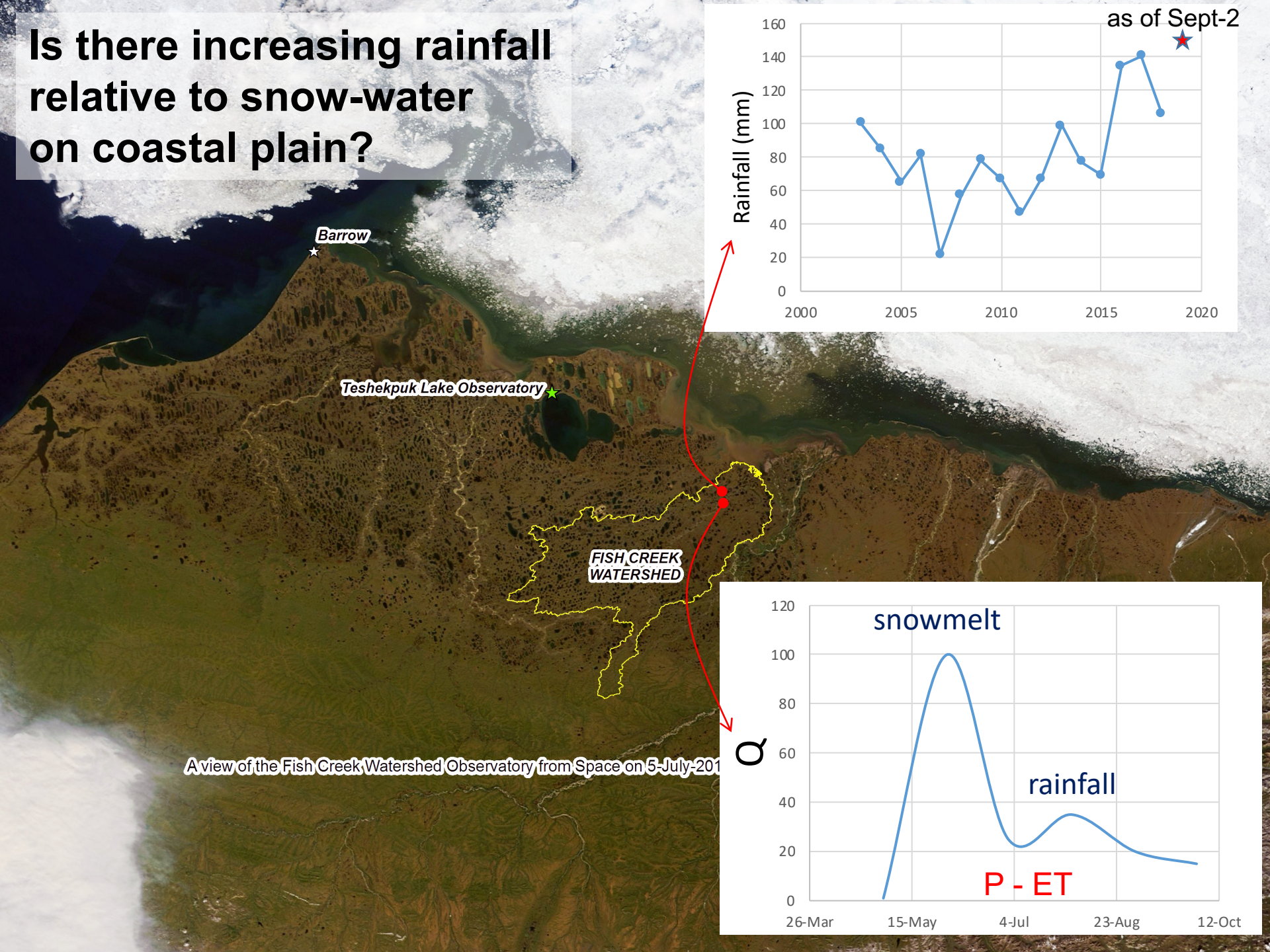
1. Snowmelt (nival) dominated flows supplying 60-80% of runoff (Church 1974, Marsh & Woo 1981, Kane & Yang 2004)
2. Building evidence for increasing runoff from arctic watersheds (Peterson et al. 2002, Dery et al. 2009, Stuefer et al. 2017, Makarieva et al. 2019)
3. Predicted intensification of the hydrologic cycle in arctic systems (Dery et al. 2009, Rawlings et al. 2010) and shift towards rainfall-dominated runoff (Instanes et al. 2016)
4. Higher and later runoff may result in greater sediment flux (Beel et al. 2018), channel erosion (McNamara & Kane 2009), and flood frequency uncertainty (Kane et al. 2003)

General Increase in Runoff and Coherence among Basins

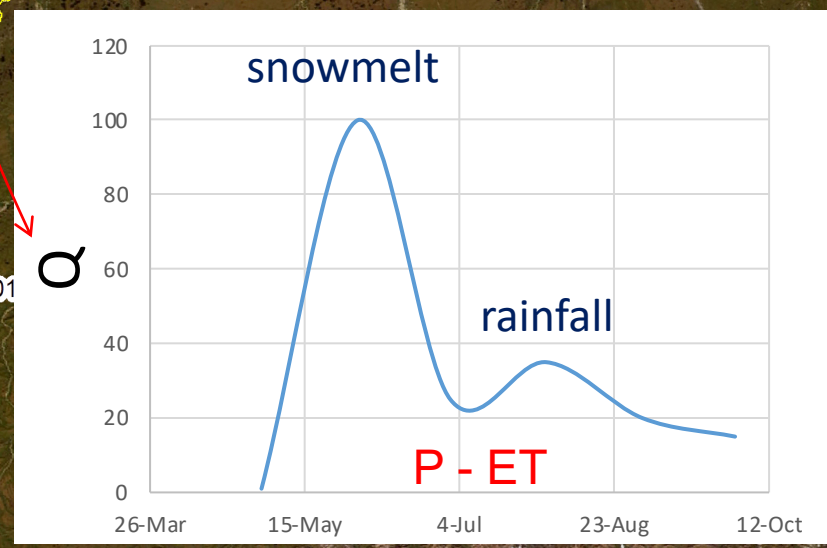




Is there increasing rainfall relative to snow-water on coastal plain?



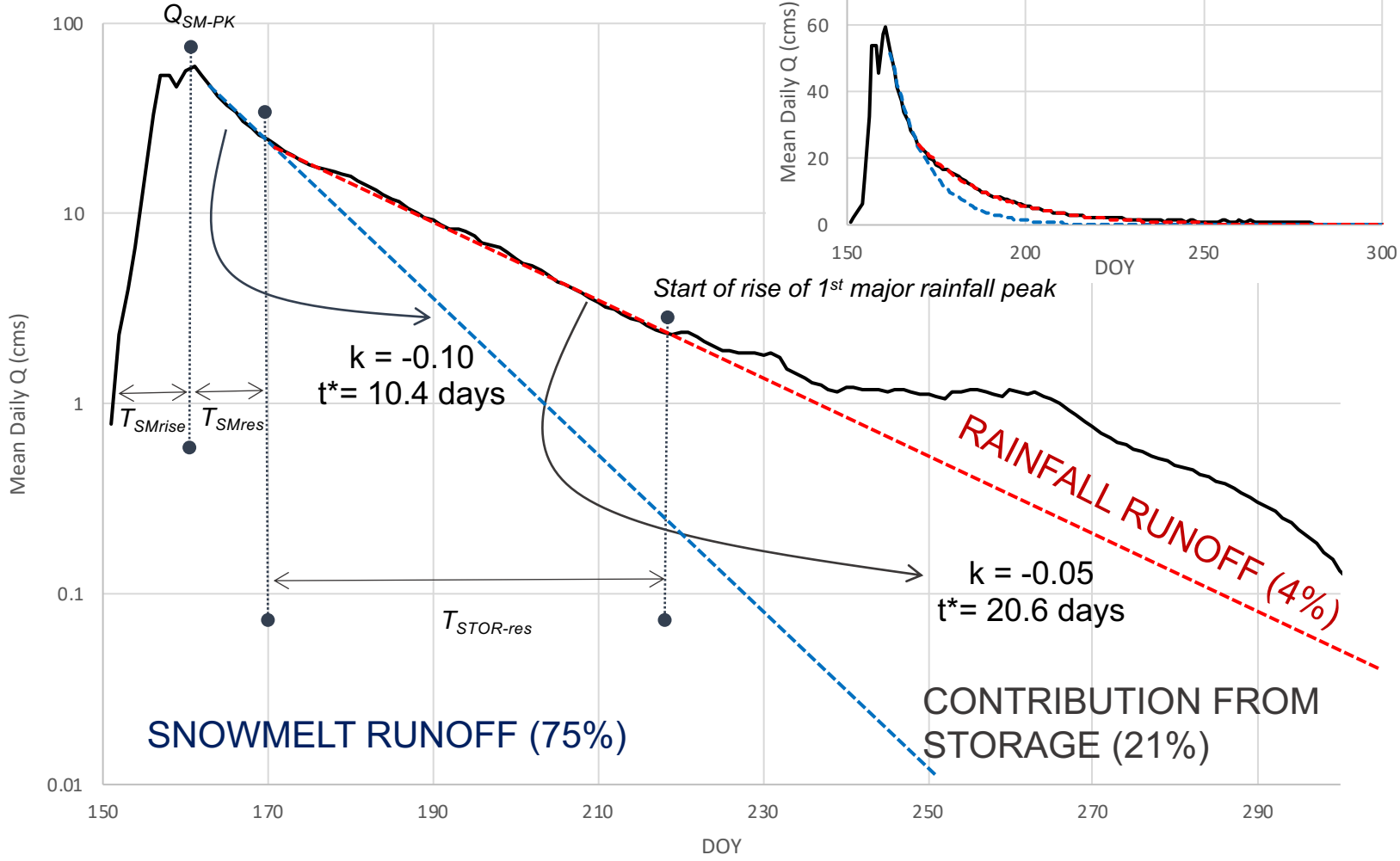
A view of the Fish Creek Watershed Observatory from Space on 5-July-2011



Example of Graphical Hydrograph Separation to Quantify Runoff Contributions

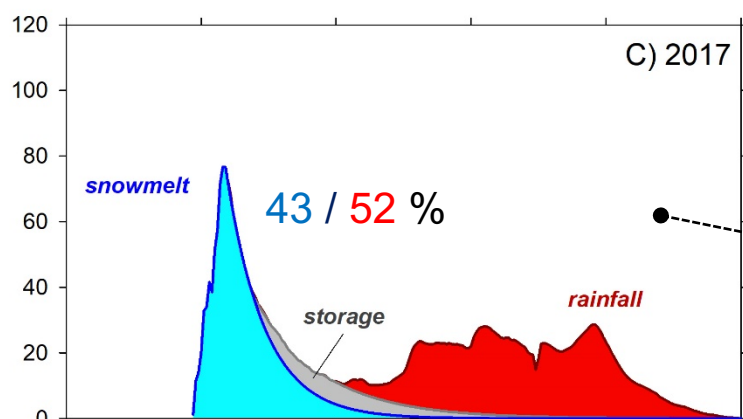
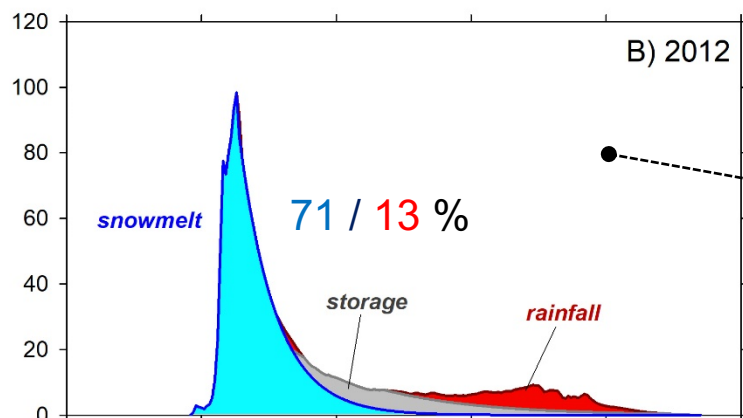
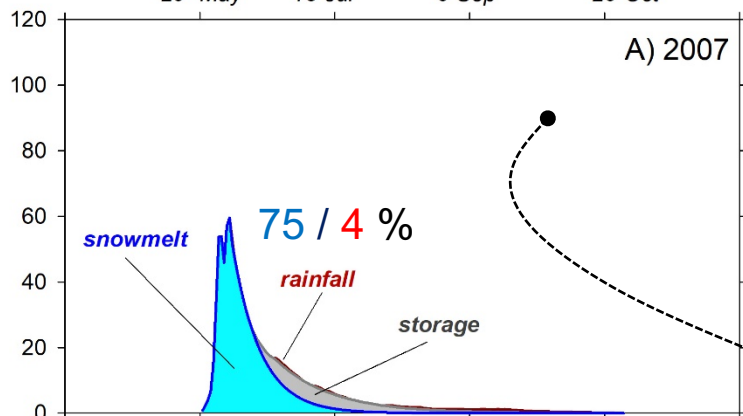
Upper Fish Creek - 2007

Upper Fish Creek - 2007



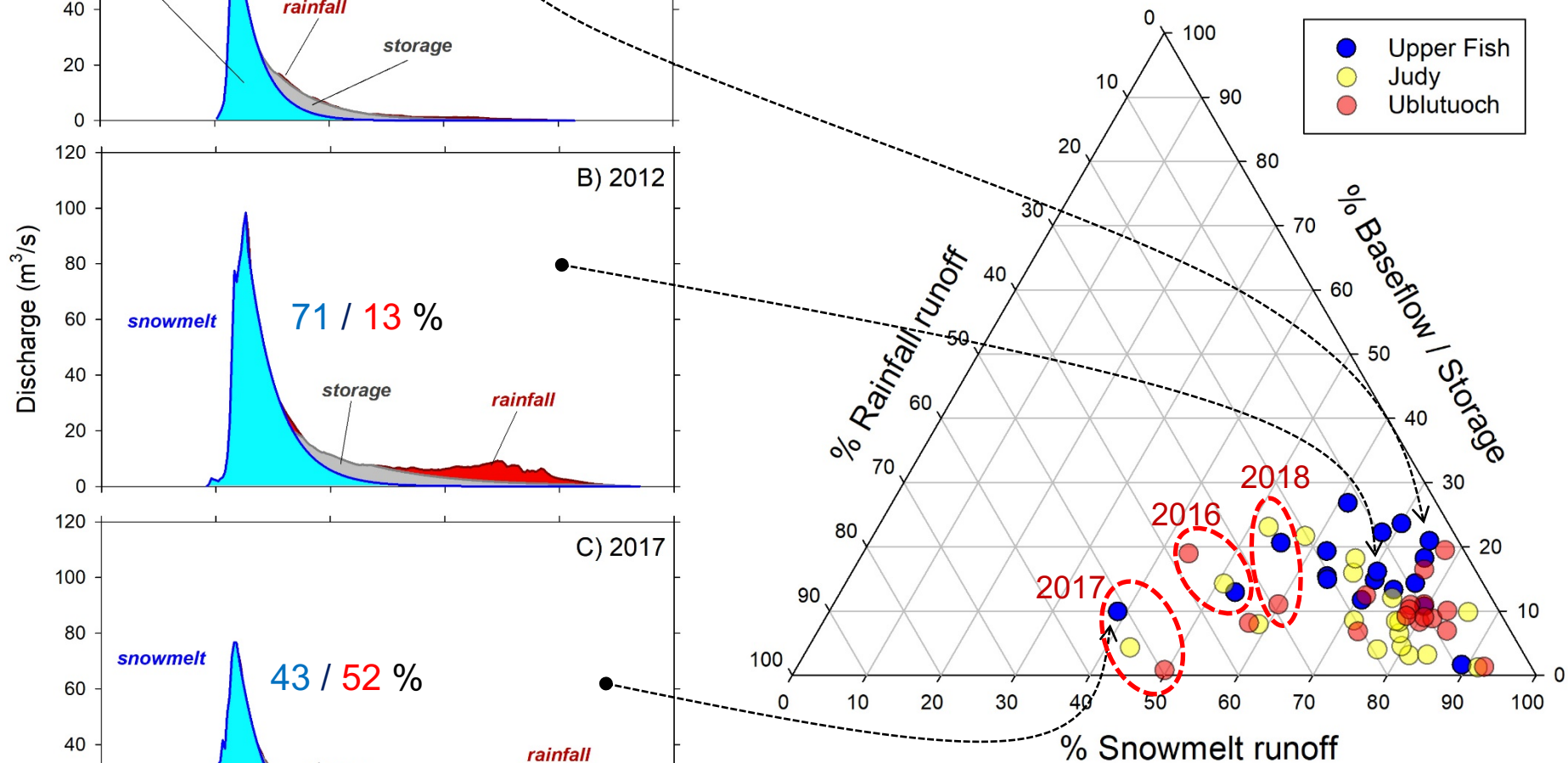
Upper Fish Creek example years separated

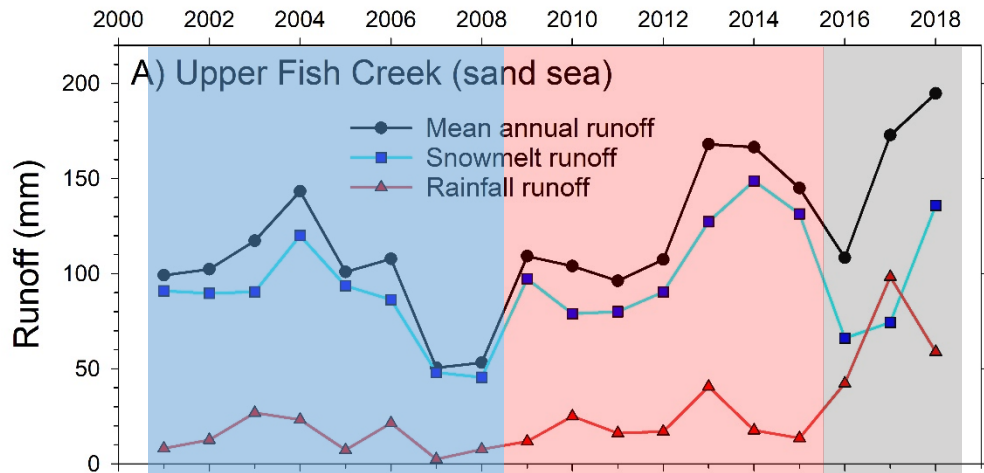
29- May 18-Jul 6-Sep 26-Oct 15-Dec



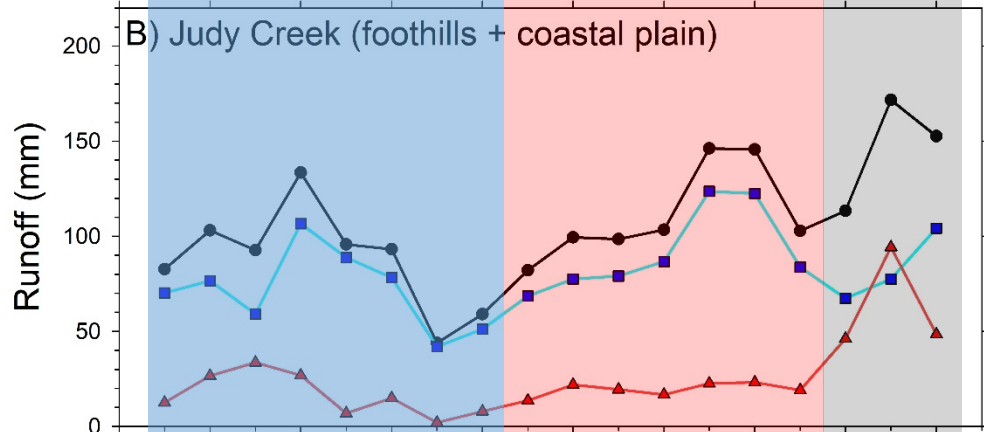
29- May 18-Jul 6-Sep 26-Oct 15-Dec

Fish Creek Watershed Hydrograph Separation (2001 - 2018)

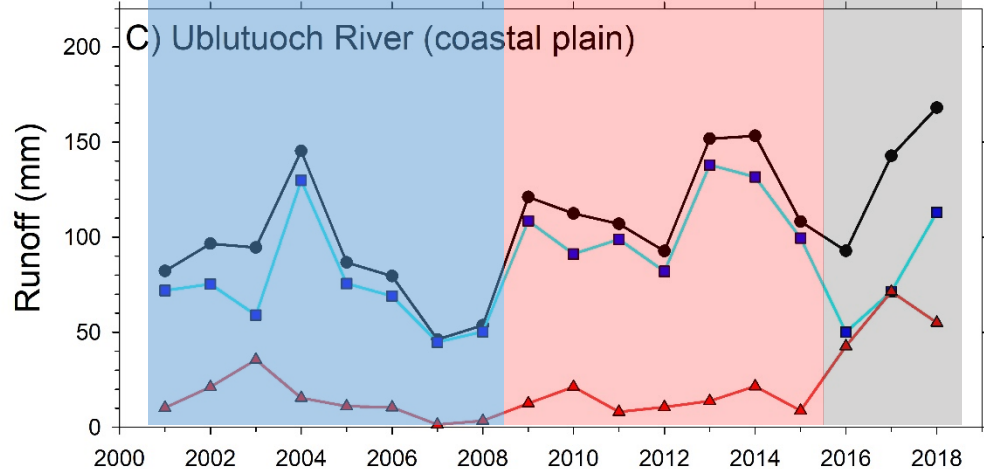




2001 – 2008
 MAR = 90 mm ± 29
 $Q_{pk} = 87 \text{ cms} \pm 42$
 $T_{pk} = 6\text{-Jun} \pm 6$
 Rain* = 28 mm ± 16
 $Ta^* = 6.8 \text{ }^\circ\text{C} \pm 2.2$
 snowmelt runoff = 74% ± 10



2009 - 2015
 MAR = 120 mm ± 26
 $Q_{pk} = 107 \text{ cms} \pm 54$
 $T_{pk} = 4\text{-Jun} \pm 7$
 Rain* = 41 mm ± 22
 $Ta^* = 6.3 \text{ }^\circ\text{C} \pm 1.1$
 snowmelt runoff = 76% ± 7

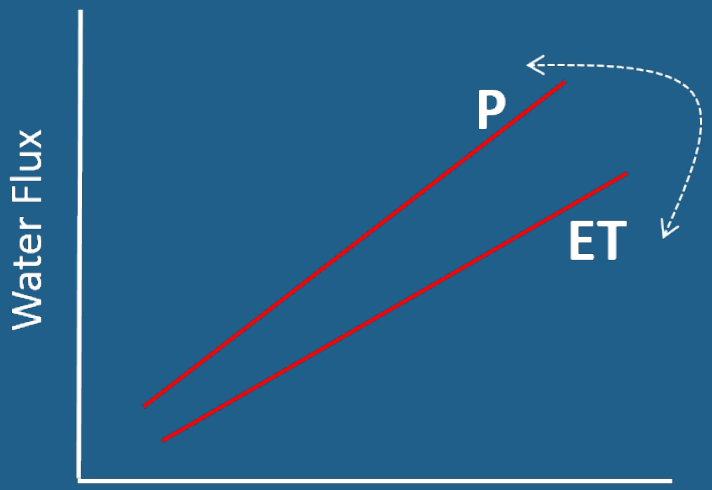


2016 - 2018
 MAR = 146 mm ± 35
 $Q_{pk} = 76 \text{ cms} \pm 35$
 $T_{pk} = 7\text{-Jun} \pm 12$
 Rain* = 80 mm ± 20
 $Ta^* = 5.7 \text{ }^\circ\text{C} \pm 1.0$
 snowmelt runoff = 50% ± 7

*August-Sept mean

Causes of Hydrologic Intensification & Regime Shift

Will the Arctic get dryer or wetter?



Temperature

Predicted Increase in Precipitation from Arctic Ocean

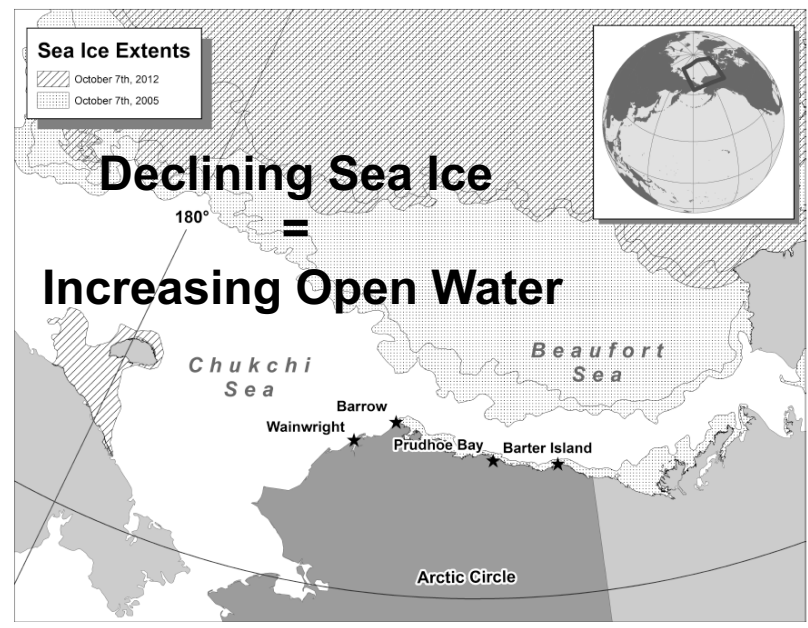
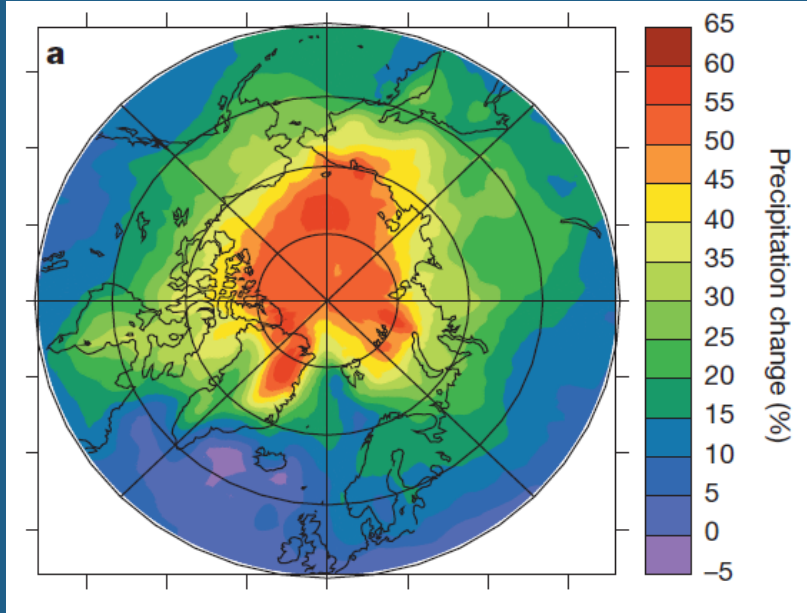


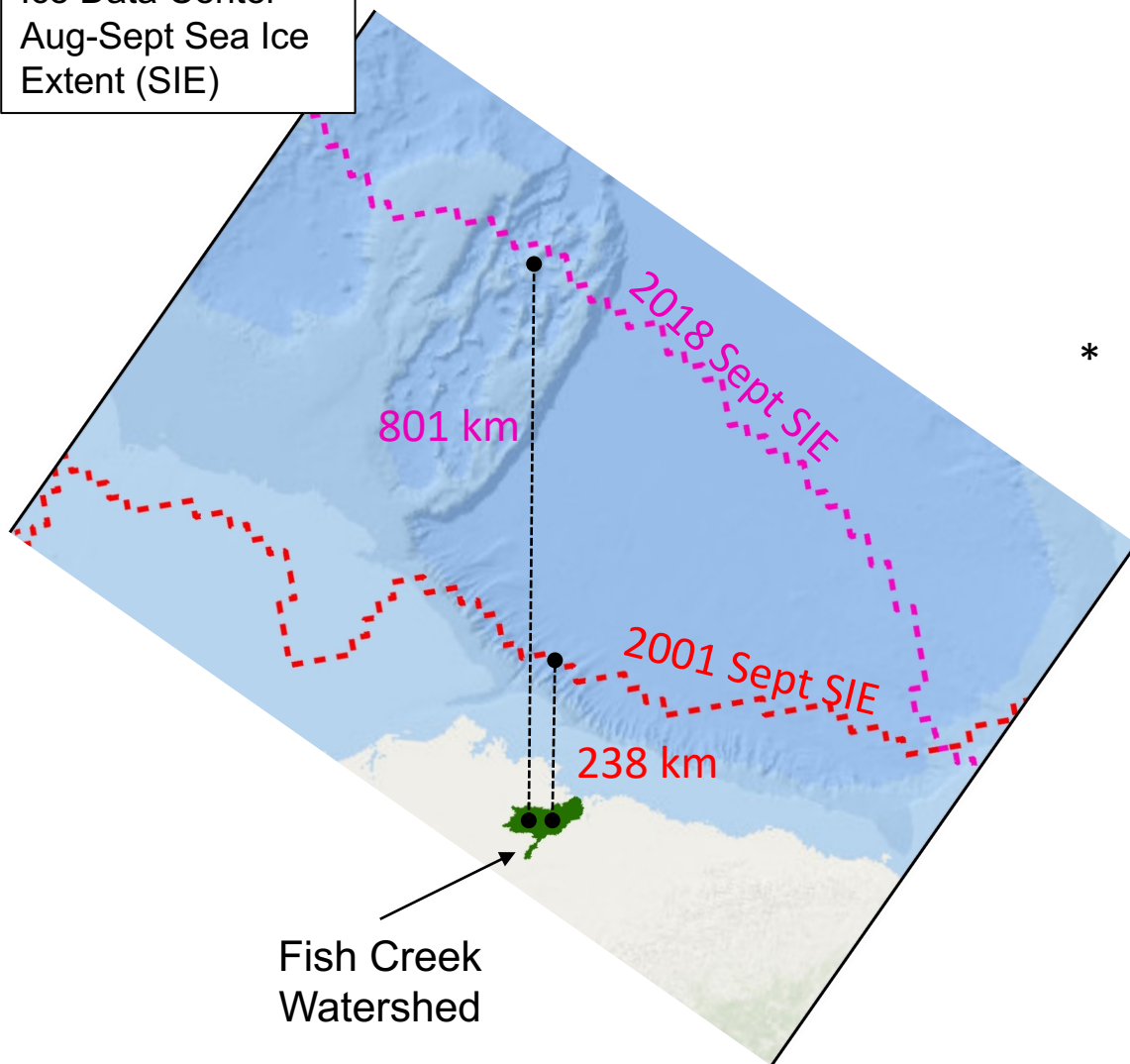
Fig. (1). Alaska's Arctic is the area north of the Arctic Circle, roughly the Brooks Range, and is generally referred to as the North Slope. Further, the extreme amounts of open water for both, the Chukchi and Beaufort Sea is also presented.

Wendler et al. 2014 Open Journal of Atmospheric Sciences

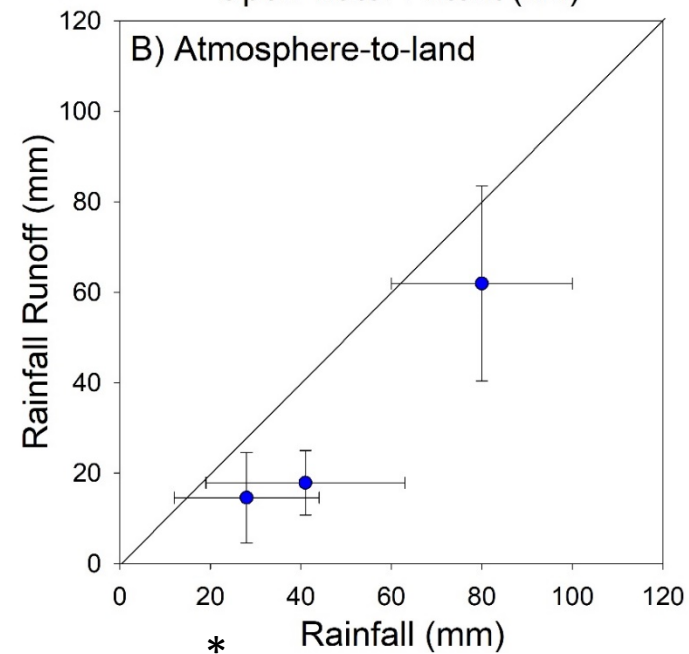
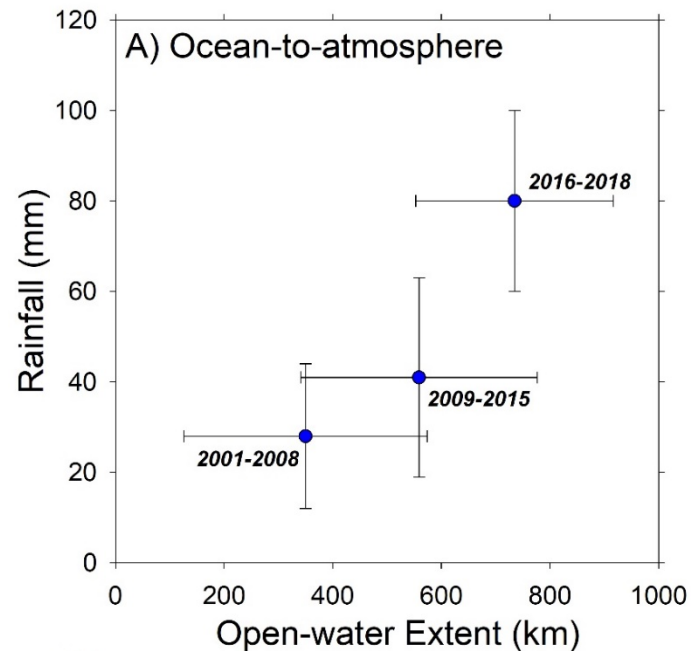


Bintanja and Selten 2014 Nature

National Snow and
Ice Data Center
Aug-Sept Sea Ice
Extent (SIE)



* Aug-Sept Rainfall in FCW



How will arctic infrastructure designed for nival runoff regimes fare with channels responding to enhanced rainfall runoff?



Summary

1. Emerging evidence of hydrologic intensification and regime shift from the Fish Creek Watershed
2. Sea ice decline and warming temperatures should lead to enhanced snowfall and rainfall
3. Implications for aquatic habitats and organisms, subsistence resources, human infrastructure, channel dynamics and sediment flux, and permafrost stability

Questions?

Late winter aufeis field and rapid snowmelt on Sagavanirktok River near Deadhorse cause a major situation in May 2015!



AK-DOT photo



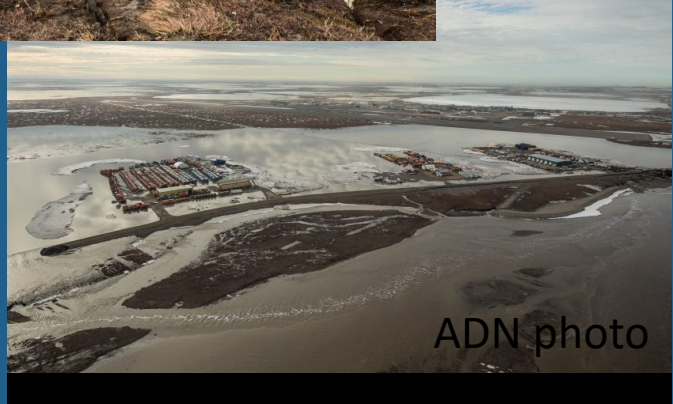
ADN photo



ADN photo



ADN photo



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