

Wind River Glaciers
Wyoming's No-cost, Zero-
maintenance, Fully automatic,
High-altitude Reservoirs

WWDC Green River Basin Advisory Group

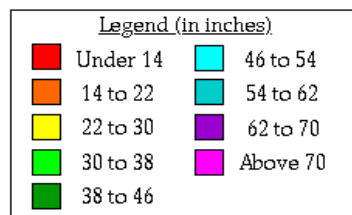
May 9, 2011





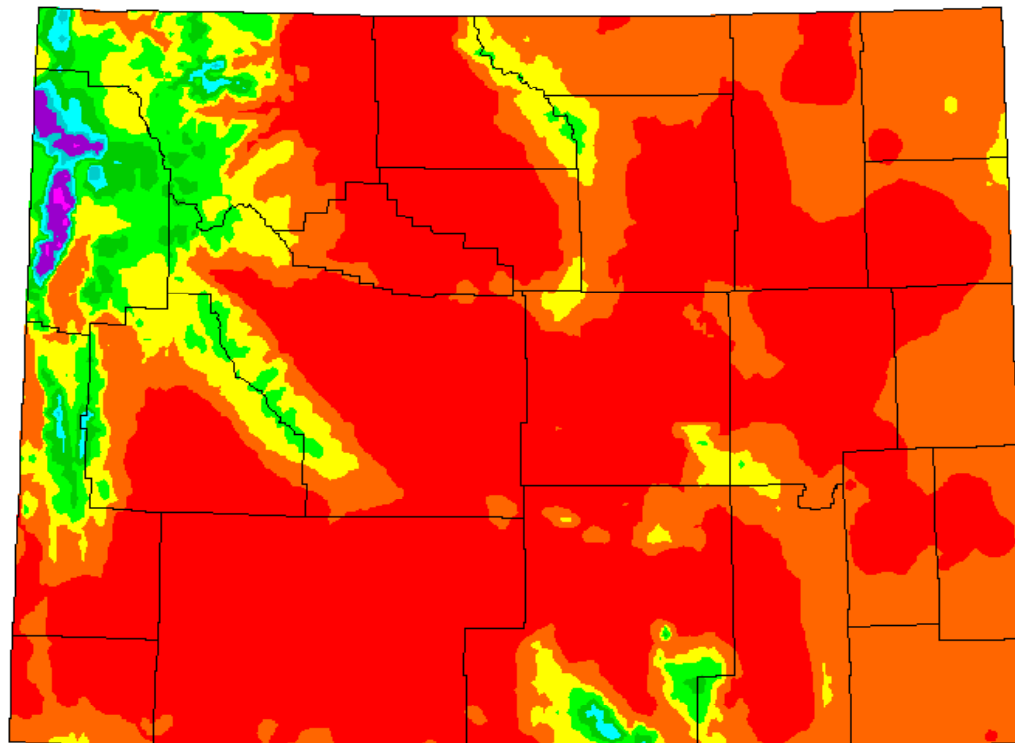
Wind River Range, Sublette Co.

Average Annual Precipitation Wyoming

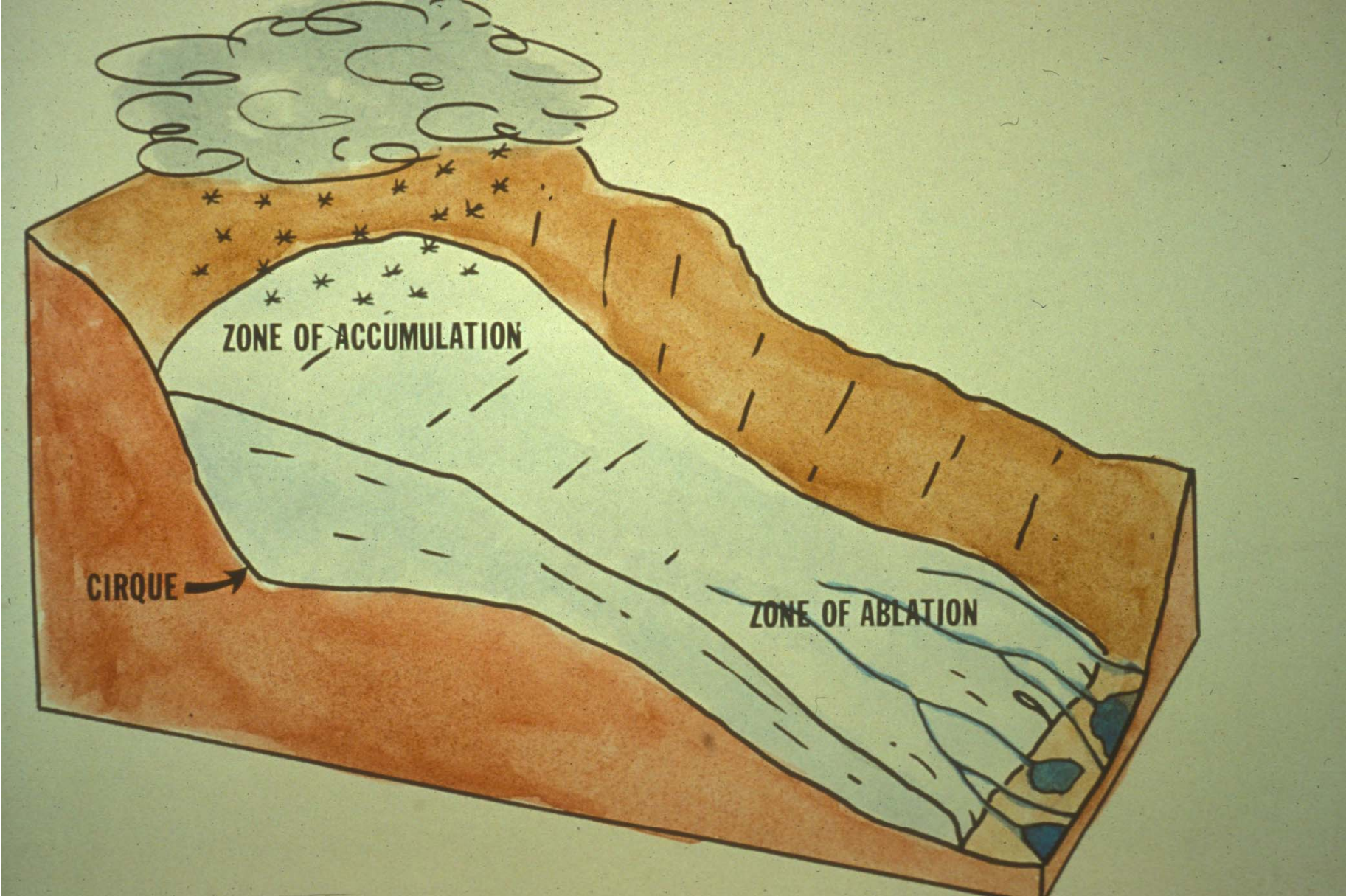


Period: 1961-1990

This map is a plot of 1961-1990 annual average precipitation contours from NOAA Cooperative stations and (where appropriate) USDA-NRCS SNOTEL stations. Christopher Daly used the PRISM model to generate the gridded estimates from which this map was derived; the modeled grid was approximately 4x4 km latitude/longitude, and was resampled to 2x2 km using a Gaussian filter. Mapping was performed by Jenny Weisburg. Funding was provided by USDA-NRCS National Water and Climate Center.



12/7/97



Thompson/Love

Wind River Range Glacier Studies

- AREA OF STUDY – Fremont Glacier Complex - Upper & Lower Fremont, Bull Lake Creek Glacier, Knife Point Glacier
- TRIPS TO GLACIERS (1984,1985,1988,1990, 1994, 2002, 2008, 2010.)
- PARTICIPATING SCIENTISTS – C. Thompson, C.M. Love, J. Carollo, P. Kos, D. Naftz, L. DeBray, J.Lockwood, M. Hale, J. Klein, G. Kerr, R. Marston L. Pochopp, K.Cheesborough, and others

Thompson/Love

Wind River Range Glacier Studies

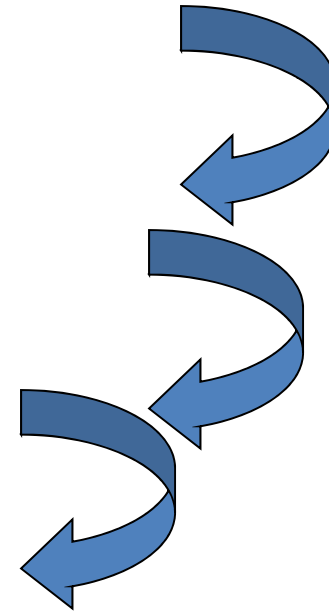
PURPOSE:

Air Quality (trace metals as indicators of long range transport of air pollutants)

Glaciology (melting, local climate, hydrology)

Discovery:

Glacier Entomology (Extinction of the Rocky Mountain Locust)



Thompson/Love Wind River Range Glacier Studies

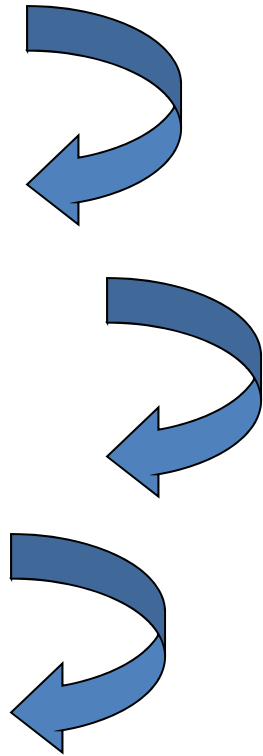
Jeff Lockwood, Larry DeBray – Fate of Locust

M. Hale Studies - Lichen on Moraine Boulders

J. Klein Studies – Cosmic Ray alteration of rock

D. Naftz Studies – Isotopes in Fremont Glacier

G. Kerr, R. Marston Studies – Glacial Geography



Thompson/Love

Wind River Range Glacier Studies

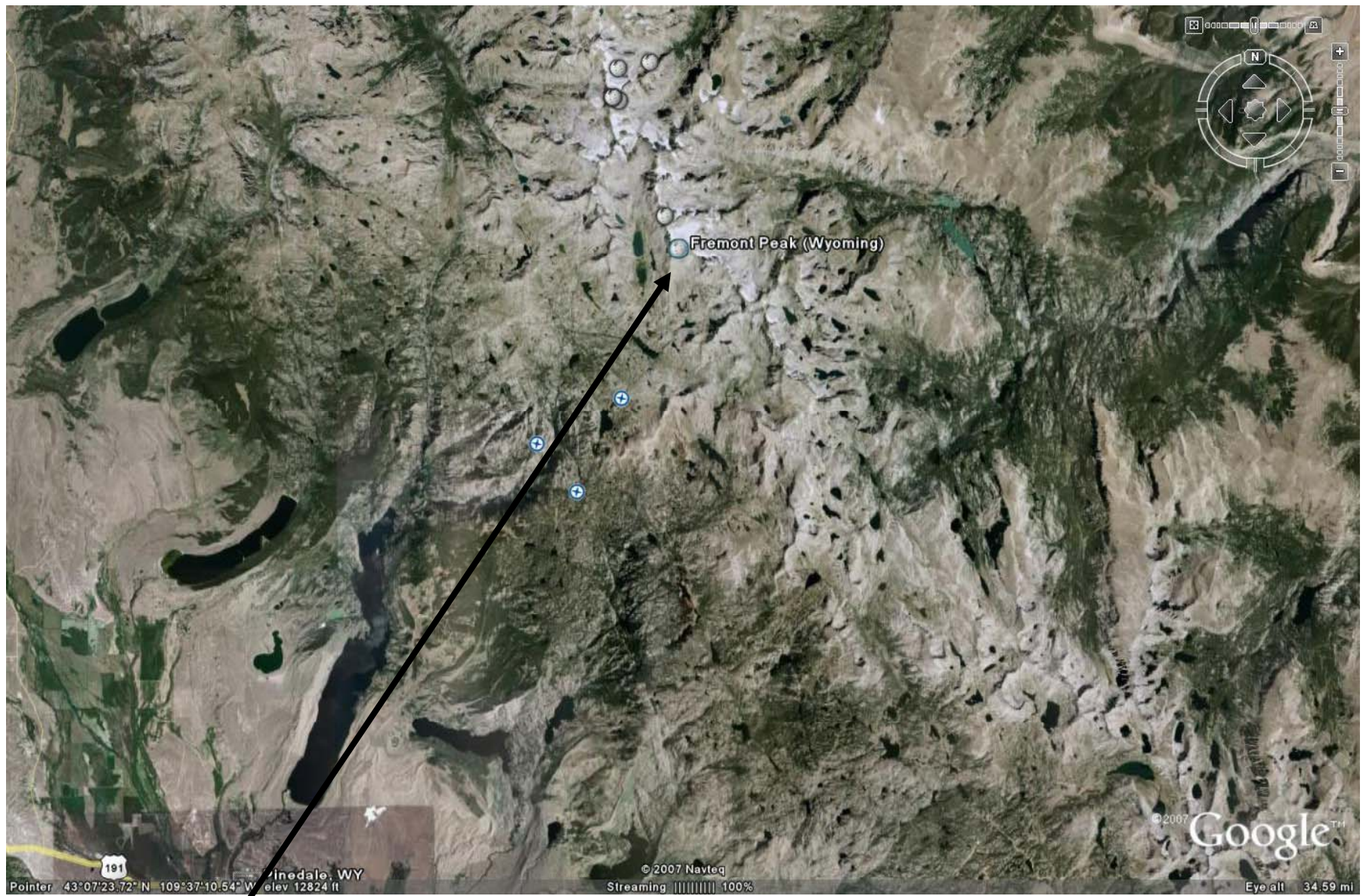
Wyoming Water Development Commission Studies
– Hydrological Impacts

M. Varuska, R. Jacobel, G. Kerr, R. Marston, L.
Pochop, D. Veryzer, 1990,

A. Fountain, 2008

G. Kerr, G. Tootle, K. Cheesbrough, 2009

C. Thompson, C.T. Robinson, M. Freestone, E. David
2010

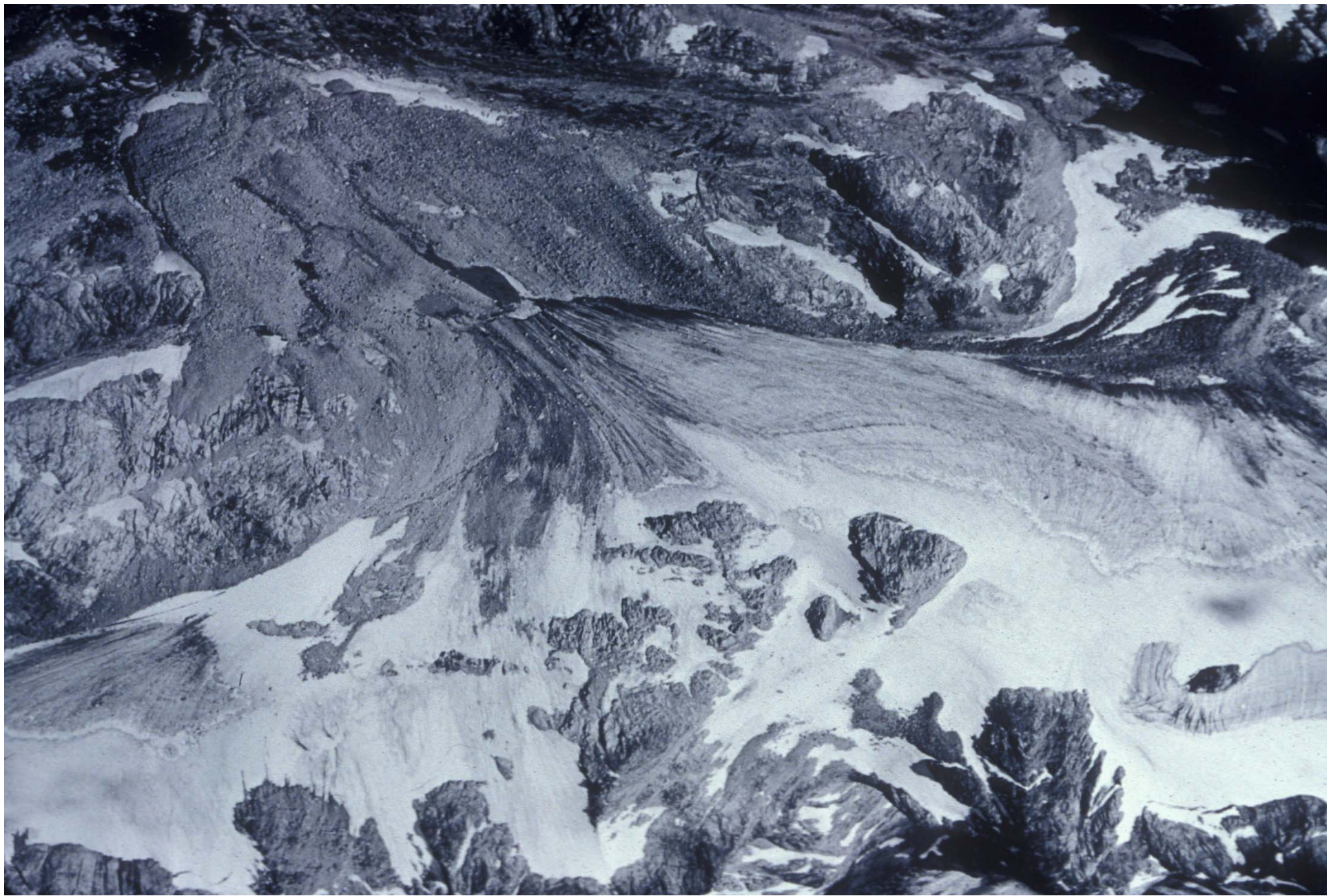


Fremont Peak



Fremont Peak

Knife Point Glacier













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often irreverent multitude.
Among our younger generation
a growing appreciation of the

slopes of the Continental Divide. He in-
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who, imbued with the spirit of the true

...expedition, there was
guide—an old timer of Wyoming's Ro-
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Fourt Glacier flanked by the Peaks of the Continental Divide.

explorer and wishing to make known to
the world at large the beauties of the
Wyoming Mountains, organized a party
to blaze trails to the glacier

ert A. Dohl; there were Sandy
State Game Warden, and Hans K
the U. S. Forest Service, who s
masters in woodcraft and mountai



nearly 11,000 feet, had just passed its period of greatest

Photograph by Sanford Mills
RAPHER TAKING PICTURES ON THE SOUTH GLACIER



Photograph by Sanford Mills

A MORE DISTANT VIEW OF THE SOUTH GLACIER, WHICH THE PARTY REACHED WITH MUCH DIFFICULTY





AMERICAN FORESTRY



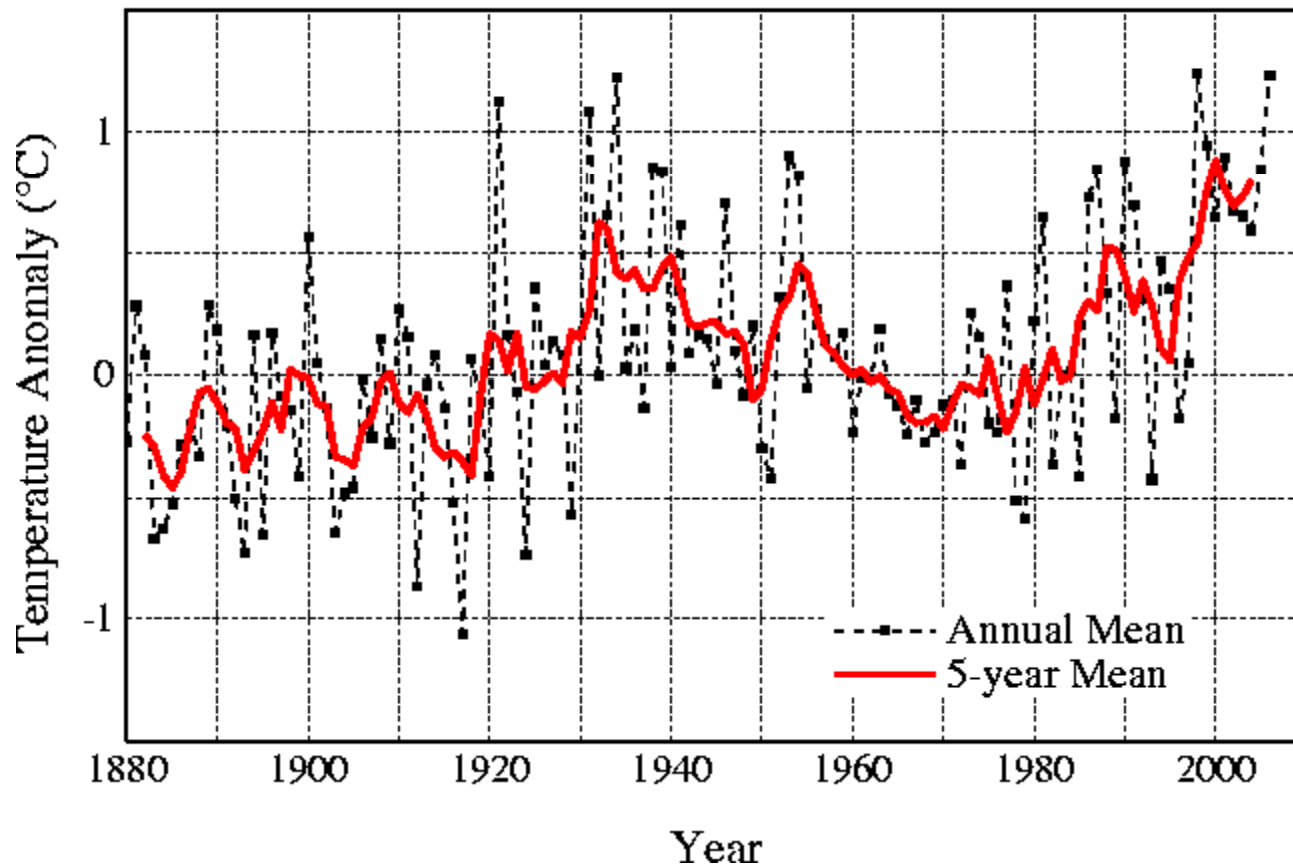
Photograph by Sanford Mills

RANGER KLEIBER AND THE PHOTOGRAPHER TAKING PICTURES ON THE SOUTH GLACIER

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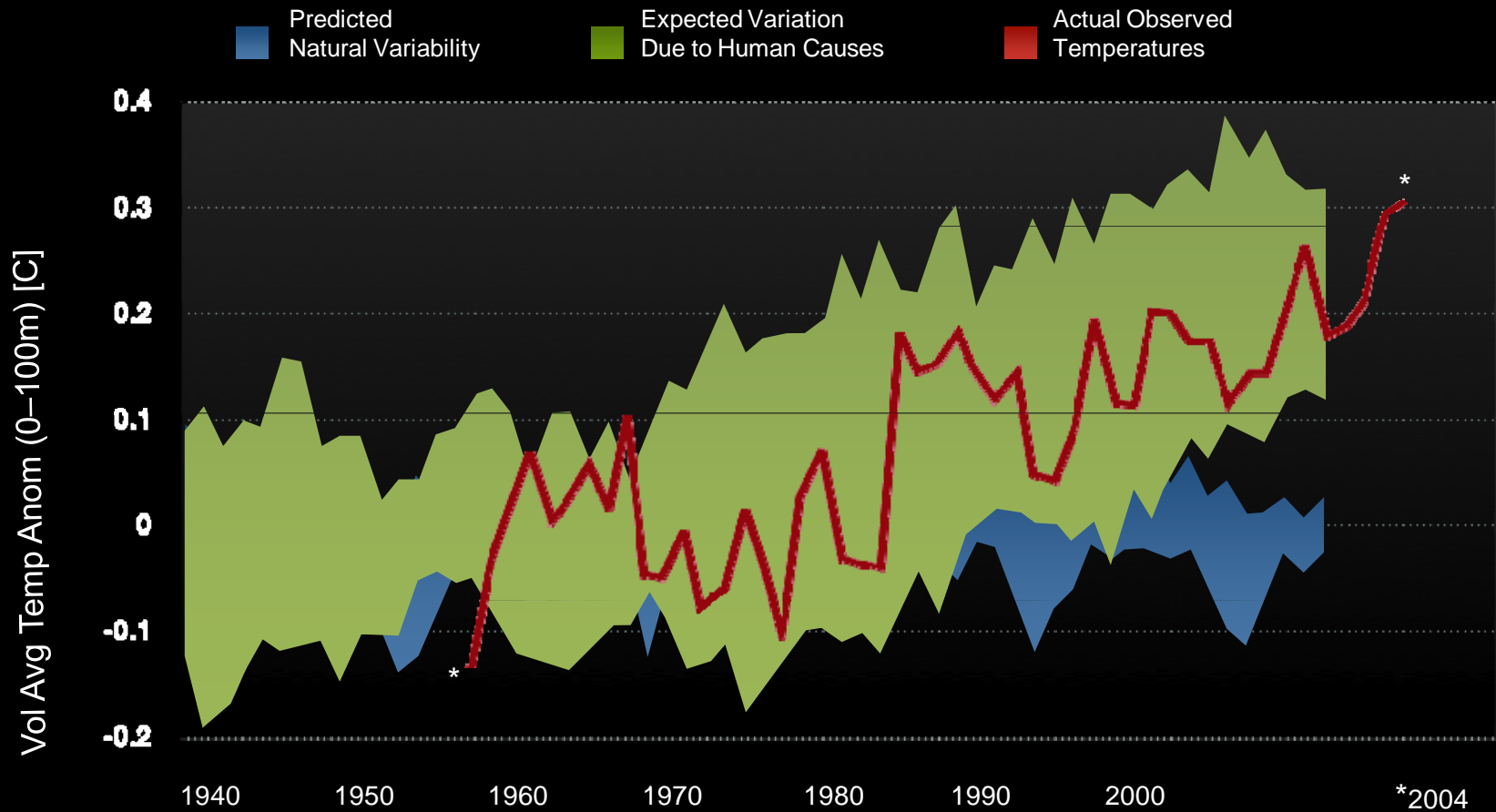


U.S. Temperature



NASA GISS Surface Temperature Analysis
(www.giss.nasa.gov)

Predicted and Observed Upper-Level Ocean Temperatures, 1940–2004



Naftz, D.L., et.al.
Journal of Geophysical Research
2002, v 107, 3.1 – 3.16

There is evidence in ice cores from
Wind River Range glaciers of rapid air
temperature increases since 1960.



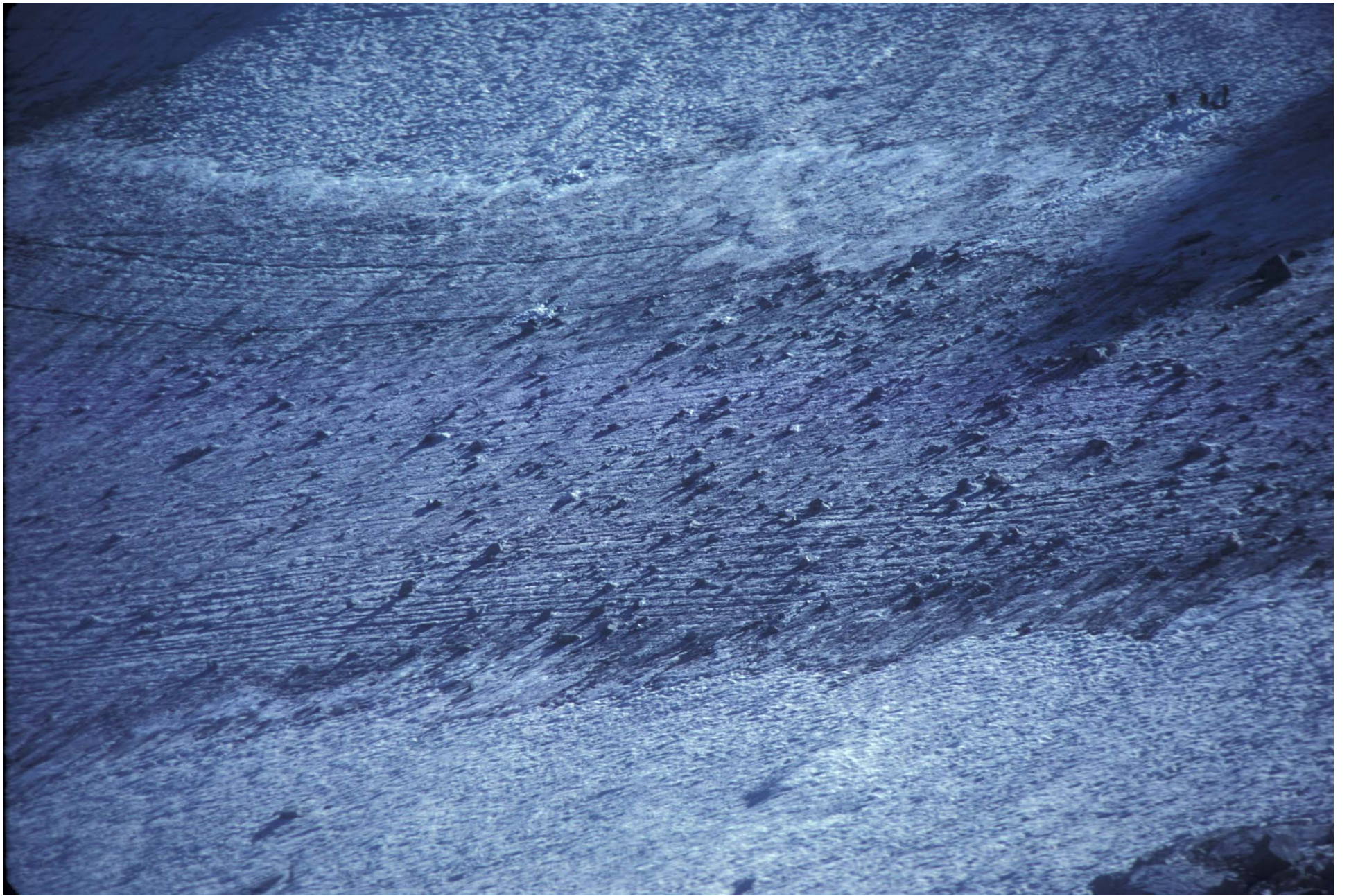
















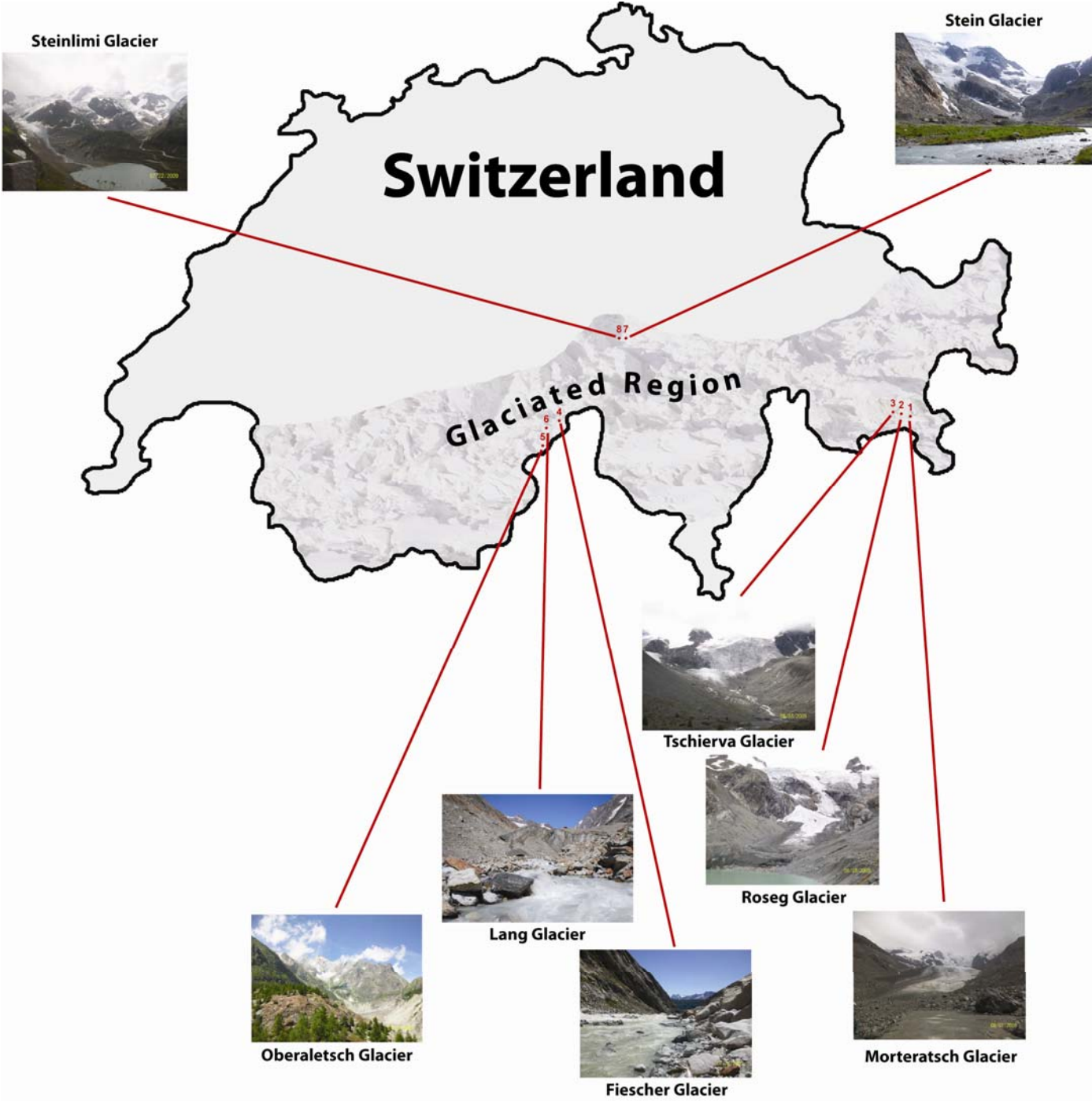














WWCC and ETH team

Special thanks to ETH, EAWAG, the National Science Foundation EpSCOR program, Wyoming NASA Space Grant Consortium, WWCC and Dr. Chris Robinson – an amazingly energetic and world-class scientist

Gannett Glacier September 2010



Sampling Location below Dinwoody Glacier September 2010





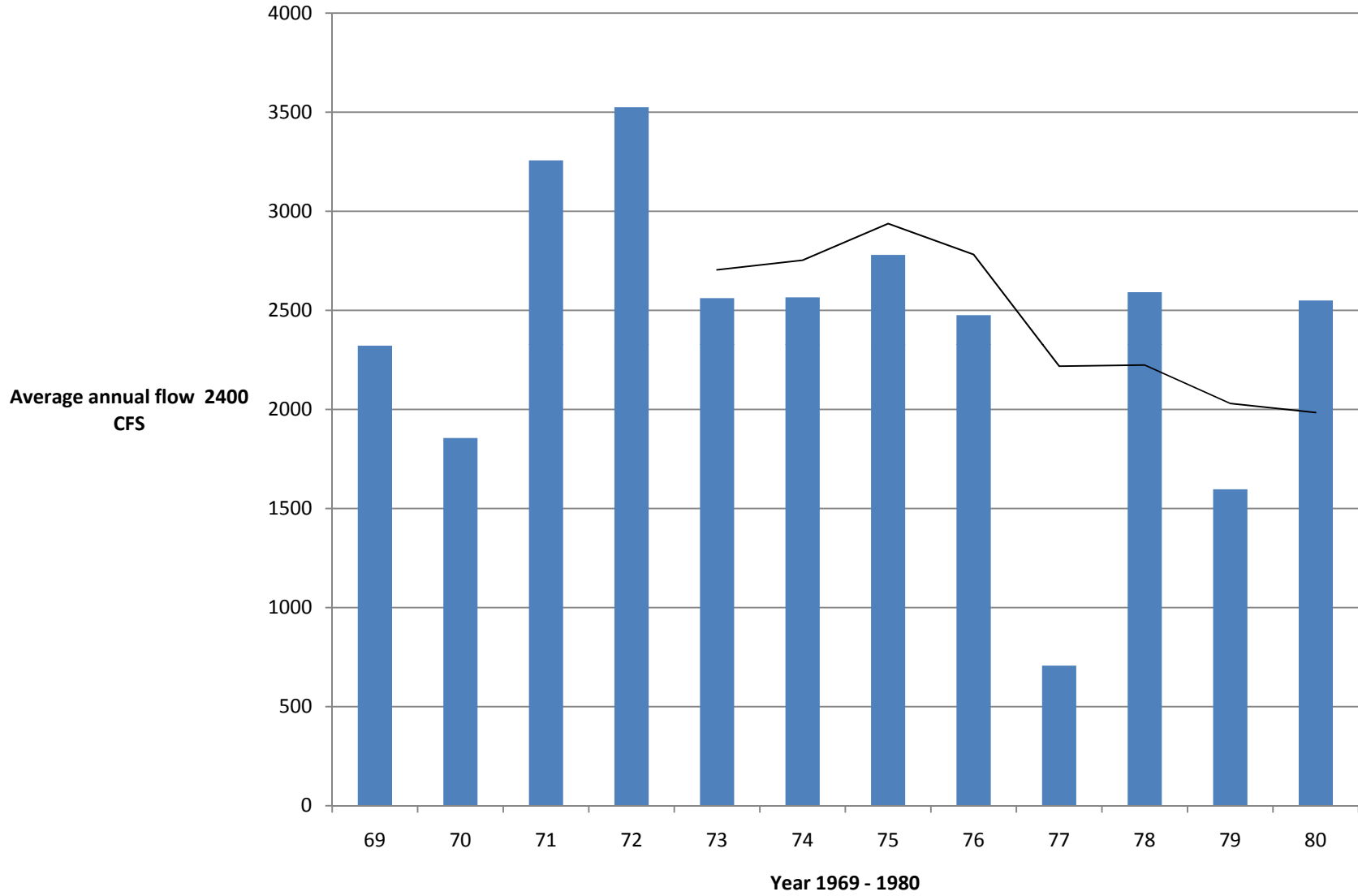
Diptera Chironomids

Diamesa sp.

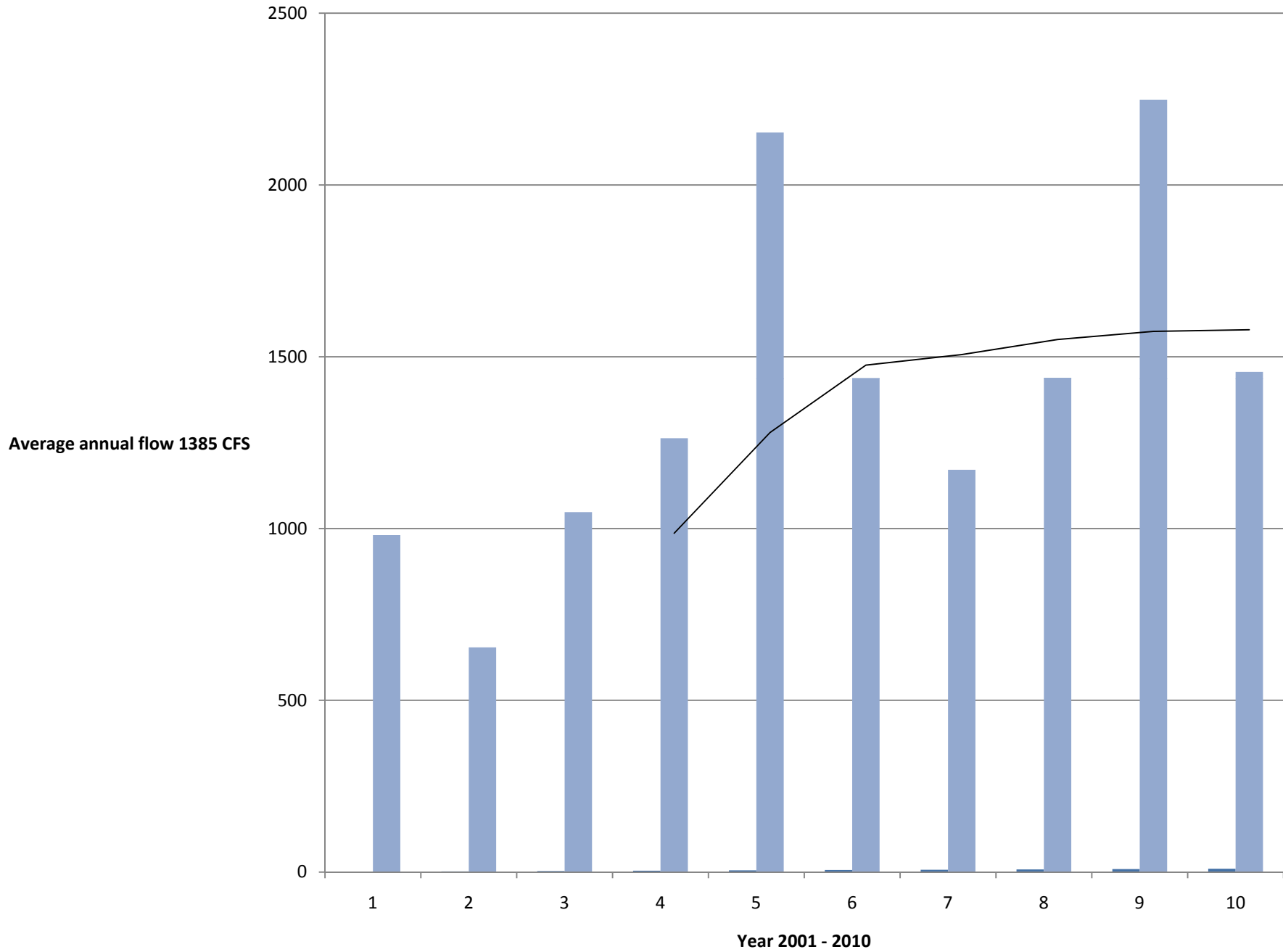
Results of 2010 Research

- Water temperatures were $< 2^{\circ}\text{C}$
- Water solute concentrations were very low $< 40 \mu\text{s/cm}$ – reflecting the granitic catchments
- Nutrients - phosphate concentrations were low while nitrate concentrations are higher reflecting inputs from atmosphere
- Several species were found for the first time including the chironomid *Diamesa* within 10m - toe of Gannett glacier
- Colonization of the melt-water streams indicates that longer periods of warmer air temperatures allow aquatic insects to emerge, breed, fly and colonize new streams at glacier toes.

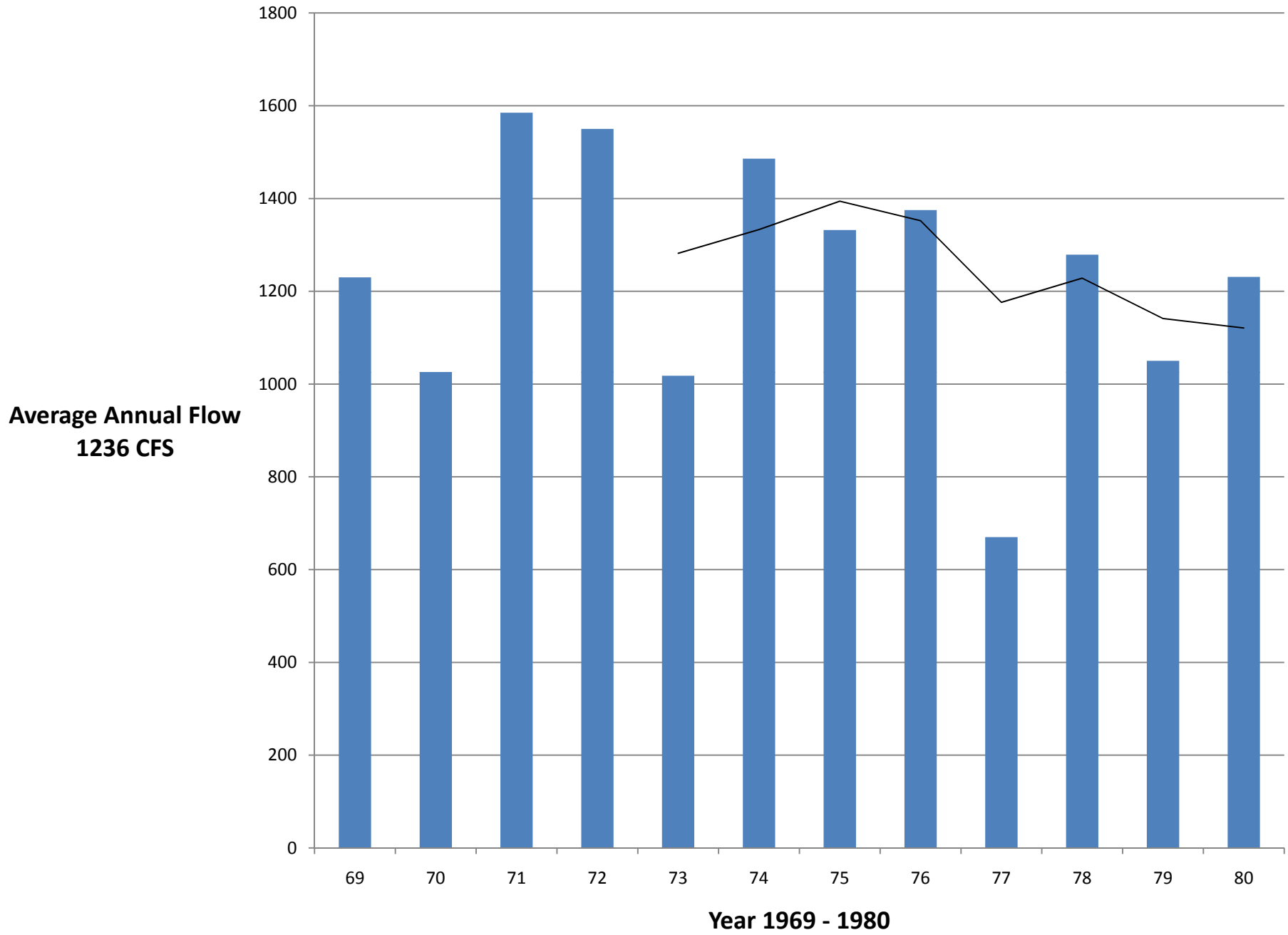
Flaming Gorge Influent



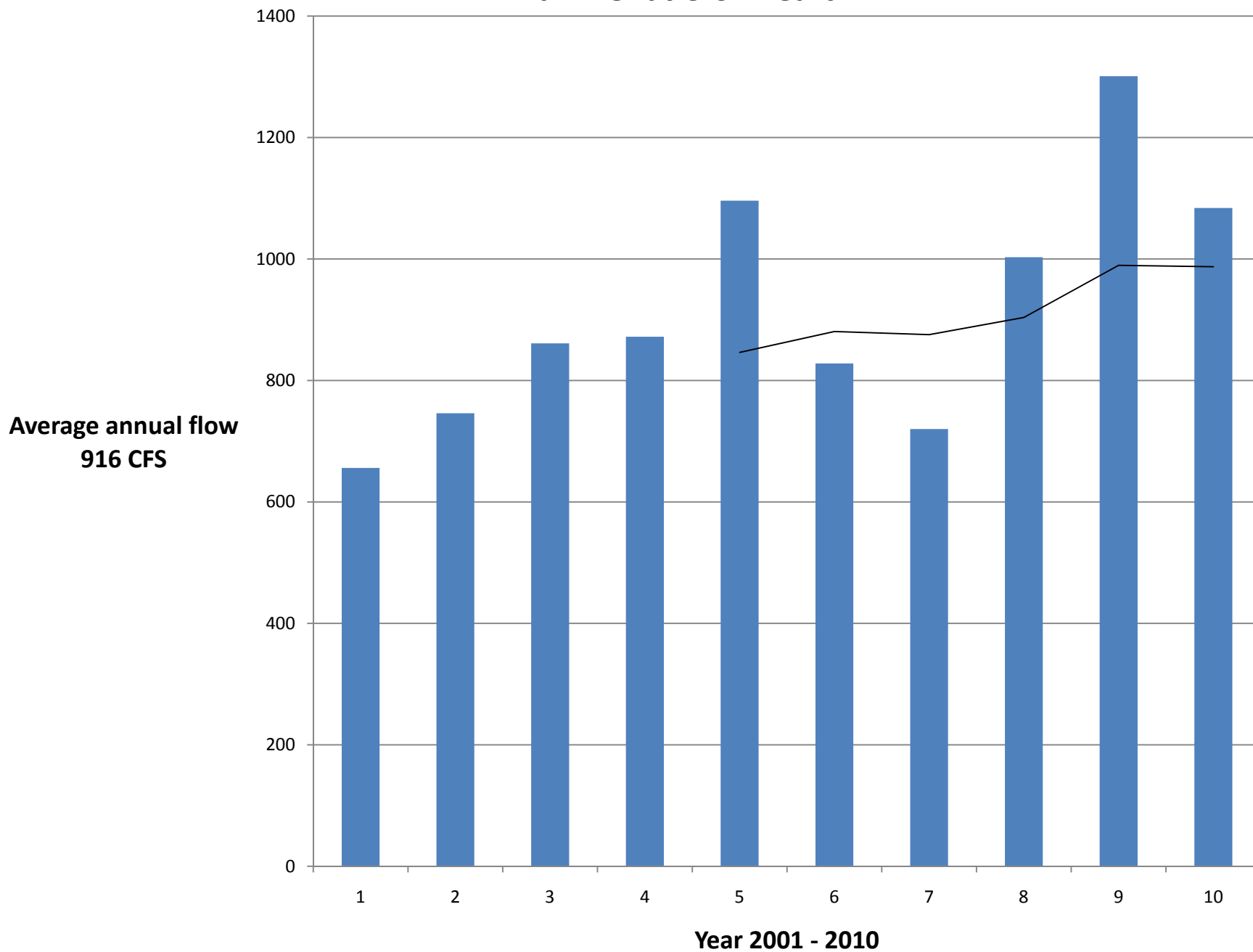
Flaming Gorge Influent



Wind River at Crowheart



Wind River at Crowheart



Conclusions

- Wind River Range Glaciers are melting back catastrophically
- The cause is decreased precipitation & local warming. Naftz et al
- The trend is consistent throughout the range and consistent with alpine glaciers worldwide
- Alpine glaciers are important - melt contribution is greater than melt waters from Greenland & Antarctica Meier et al 2007
- Bull Lake Glacier is enriched in Cu, Zn, Pb – evidence of long range transport of pollutant aerosols
- Glaciers are depositories of biological information – Knife Point Glacier documents the extinction of *Melanoplus Spretus*
- Global climate change (GCC) is accelerated by an increase in greenhouse gas concentrations in earth's atmosphere
- GCC is outside range of natural variability
- Human activities are changing the concentration of greenhouse gases and are contributing to GCC
- Watch for feedback effects, the role of oceans, clouds and 'tipping points'.



- Climate change is more than warming – IPCC predicts with 'very high confidence' 10% to 30% runoff reduction in mid latitudes & wide variability
- National Academies Science, & Engineering, The National Institute of Medicine, National Research Council, AAAS, are in agreement on climate change.
 - Most of the annual stream-flow in the western United States originates as mountain snowfall.
 - The average snowpack over the last decade is one third below normal.
 - Snowpack has fluctuated widely during this period. For example in 2010, the Belle Fourche drainage was 5% of it's normal value. This year it is 253% of average. 253% is from the web site summary.