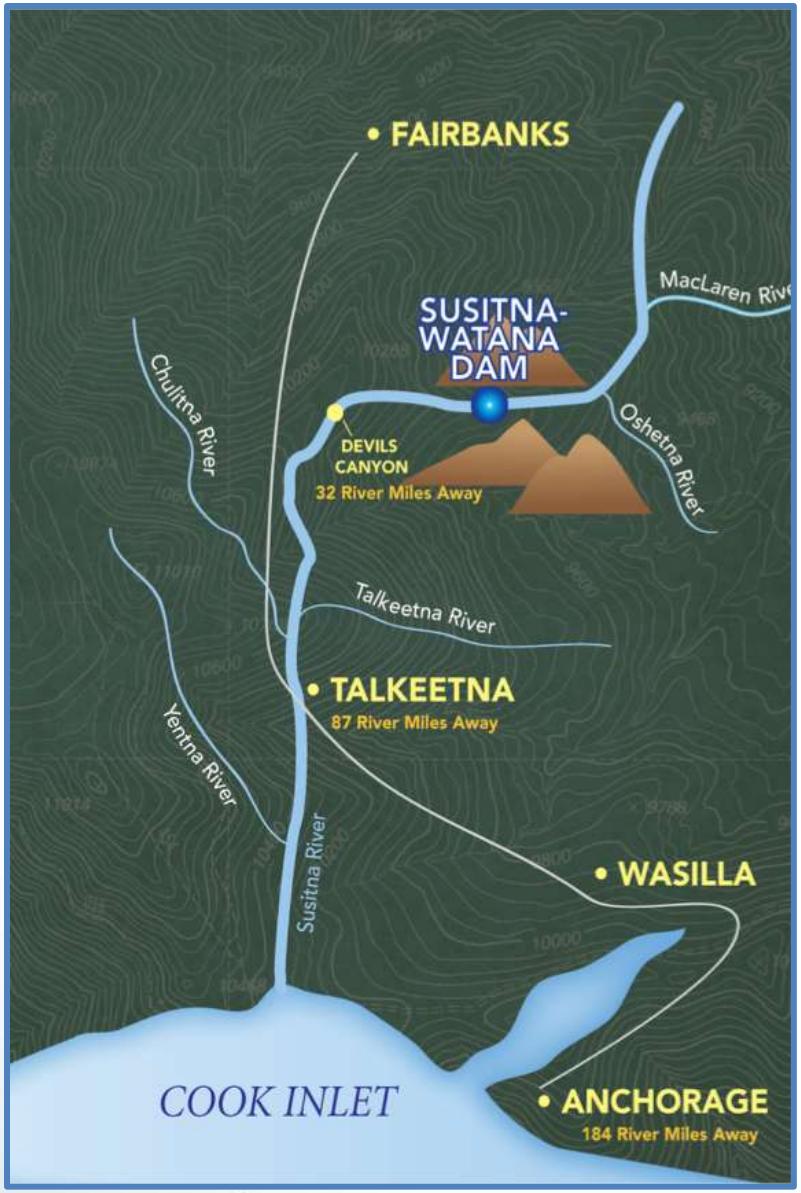


SUSITNA-WATANA HYDRO *Clean, reliable energy for the next 100 years.*

Technical WorkGroup Meeting

Glacier and Runoff Changes - Update

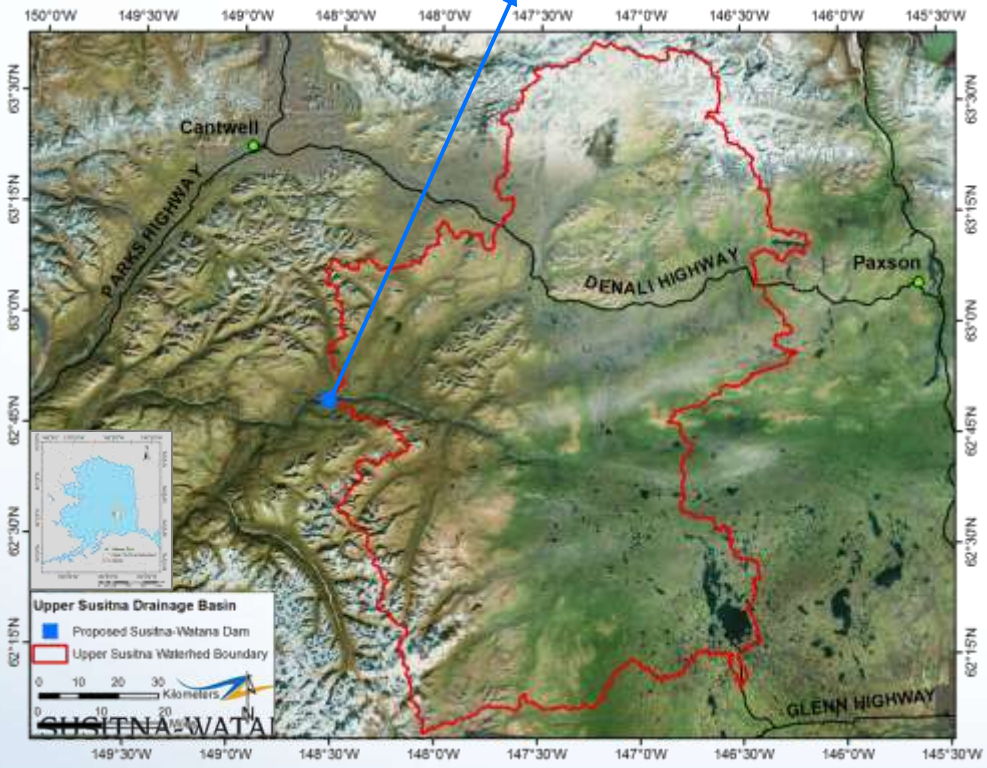
June 26, 2013

Prepared by Gabriel Wolken,

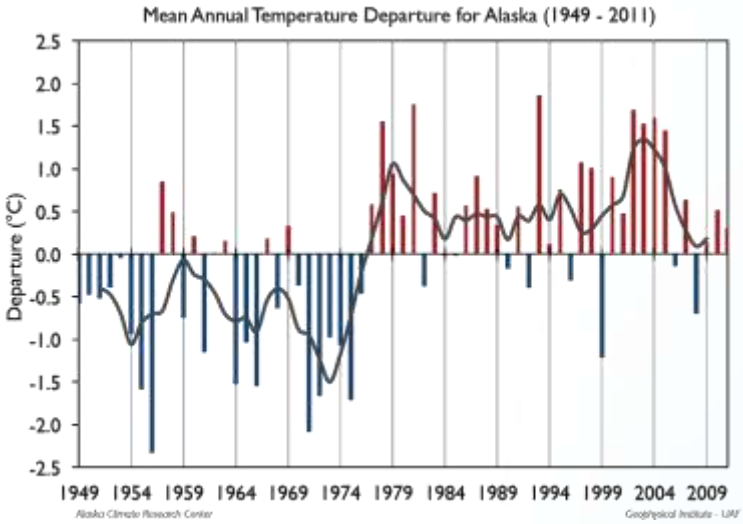
Alaska Div. of Geological & Geophysical Surveys

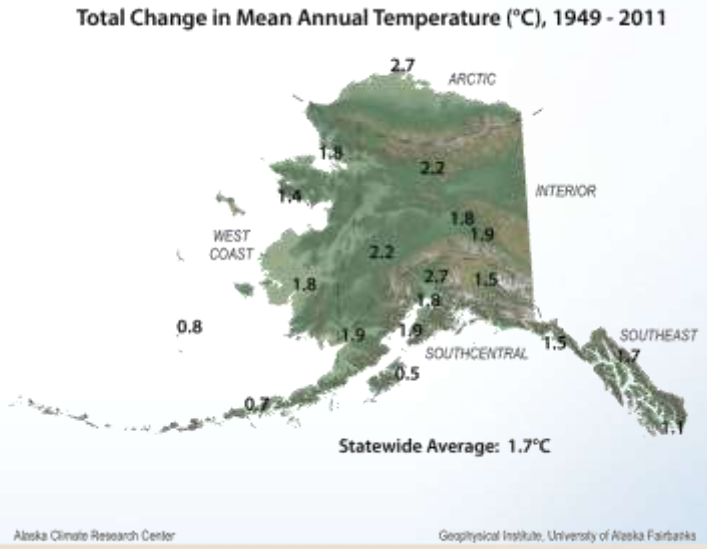
Goal

Simulate future changes in quantity and seasonality of river runoff into the proposed dam…



… under climate change conditions





Approach

Field measurements

- Ablation stakes, Snow depth, Temperature, Precipitation, Relative Humidity, Wind

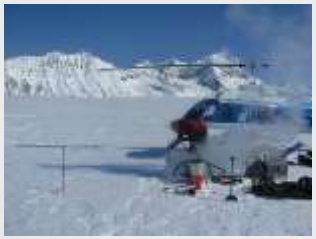
→ Supply input data to WaSiM

- Enable multi-criteria calibration and validation

+

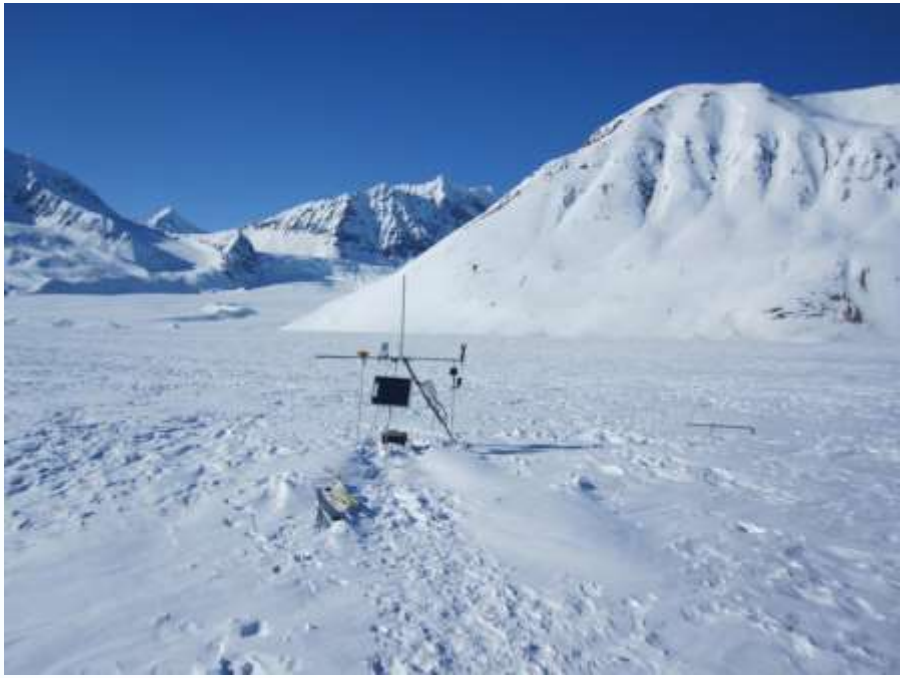
Hydrological modeling

- Reproduce:
  - historic discharge values
  - snow accumulation and snow melt
  - glacier mass balance
- Produce enhanced runoff estimates for the proposed Susitna-Watana-Dam compared to statistical flow analysis

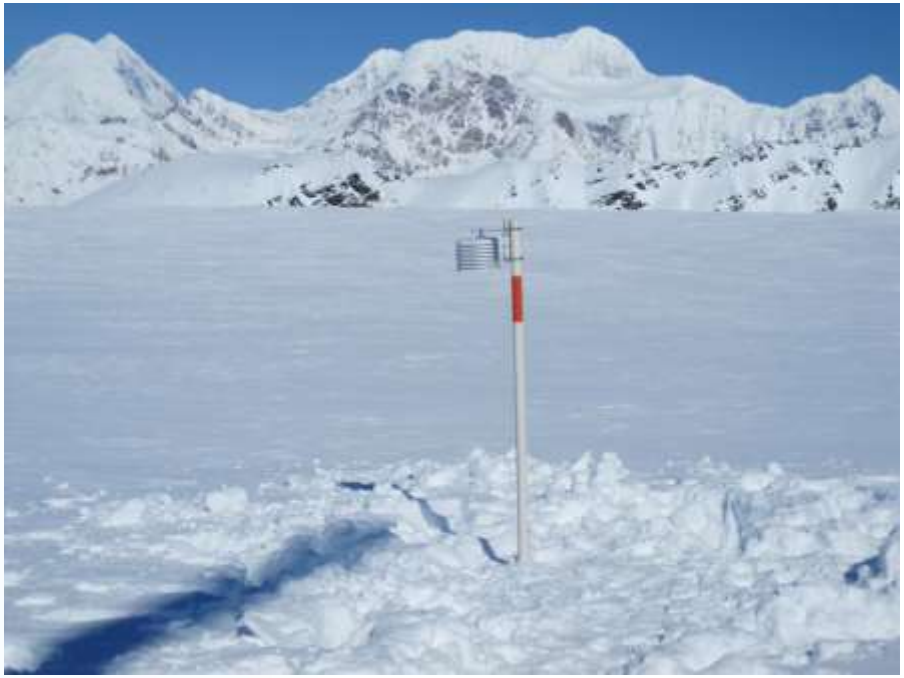


Field Measurements – Spring 2013

Field Measurements – Spring 2013



Field Measurements – Spring 2013



Field Measurements – Spring 2013

Hydrological Modeling Workflow

Meteorological Data

Temperature and Precipitation
→ Different Interpolation methods

1981 - 1983

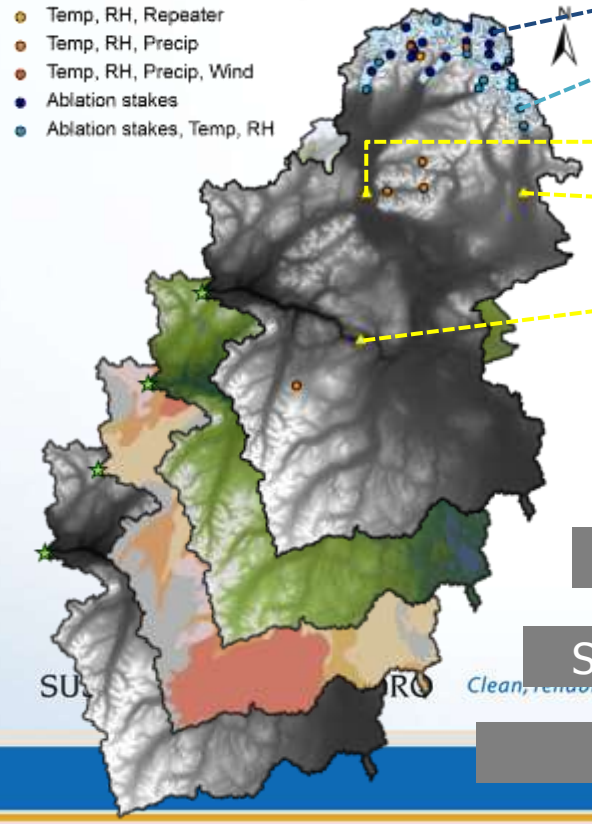
2012

Model Input

Calibration and Validation

Future Projections

Spatial Data



Glacier extent

Land cover

Soil texture

DEM

Mass balance data for 1981, 1982, 1983 2012

Glacier Mass balance

Susitna near Denali

MacLaren near Paxson

Susitna near Cantwell

Runoff data

Snow depth measurements 2012
Snow radar measurements on glaciers April 2012

Snow depth

Modeled soil temperature profiles from Permafrost Lab (1960, 1980)

Soil temperature

Until 2100

Calibration Period: 1981-1983

Runoff Calibration

- Daily Runoff
- Monthly Mean Runoff
- 3 – year Mean Monthly Runoff
- Runoff Contribution

Snow Calibration

- Snow depths at specified dates

Mass Balance Calibration

- Mass Balance in specified period

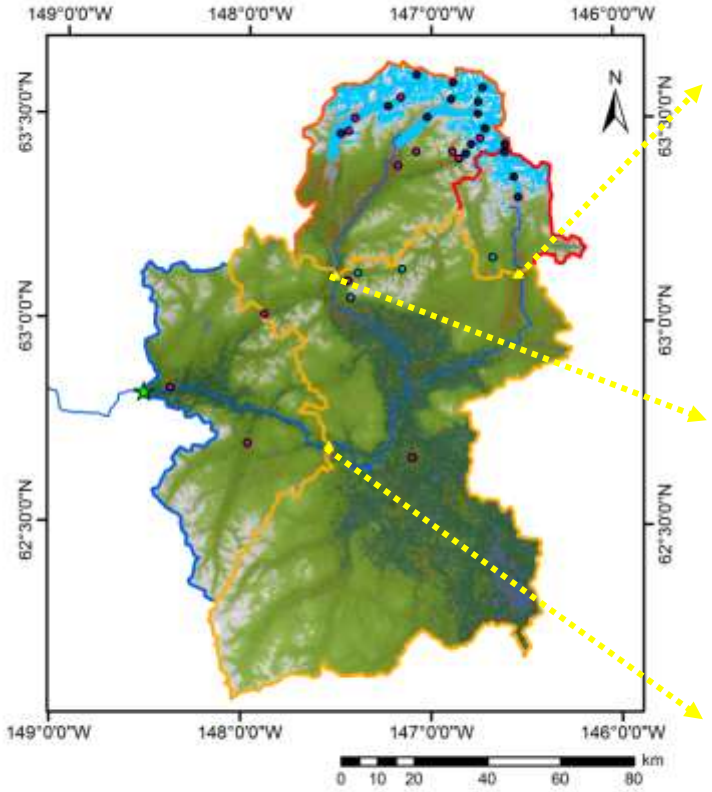
Soil Temperature Calibration

- Against Model Results from Permafrost Lab

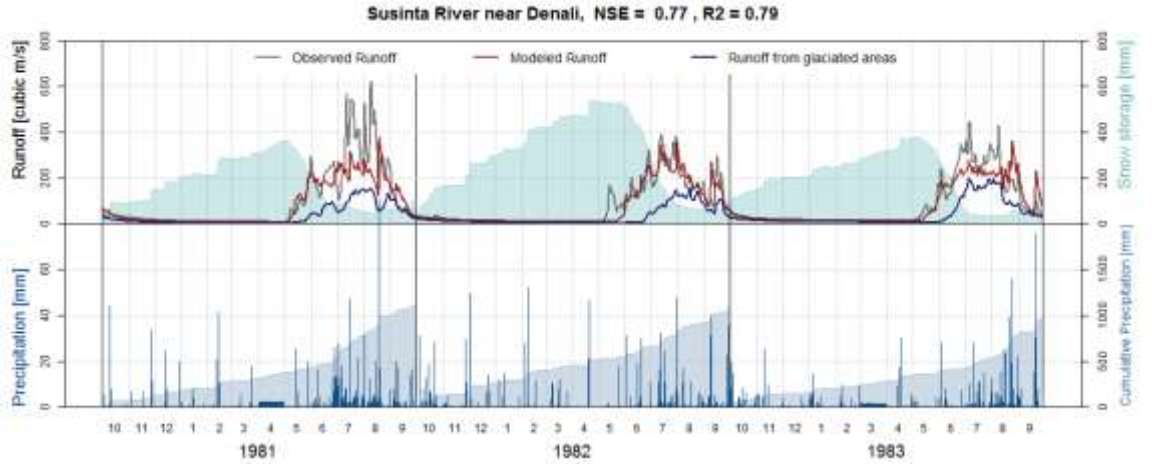
Runoff Calibration

DAILY

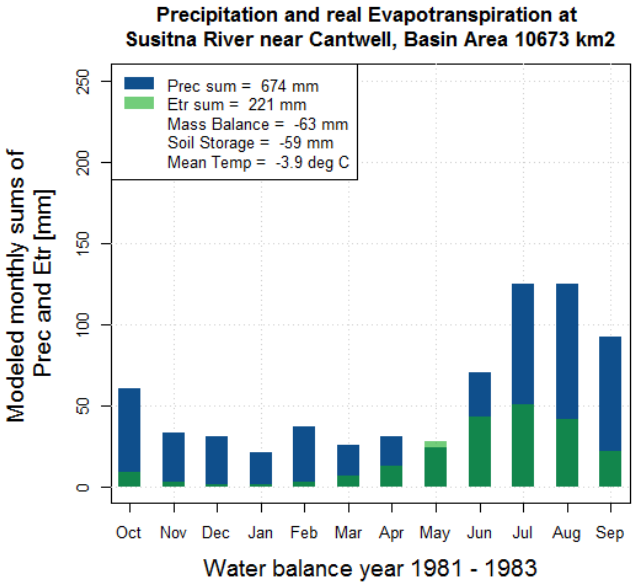
Location of river gauges, snow and mass balance measurements for calibration and validation

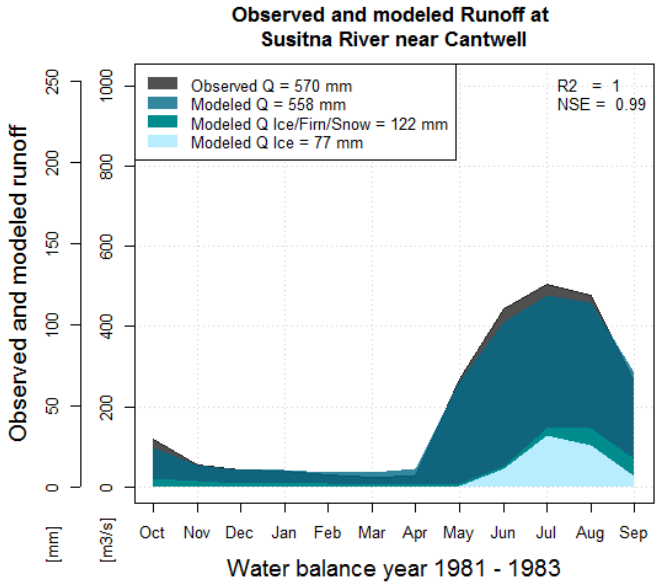


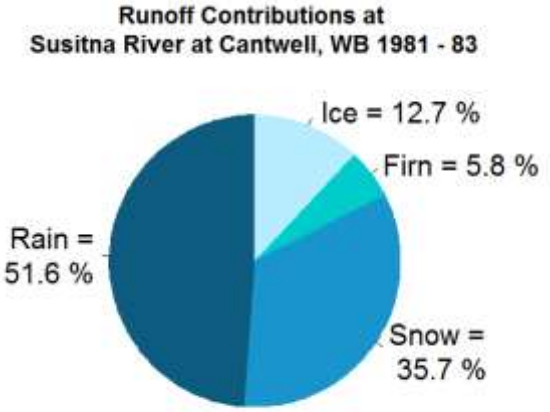
- Mass Balance 1981 - 1983 and 2012
- Snow probings 1981 - 1982
- Snow probings 2012
- USGS NWS River Discharge 1981 - 1983

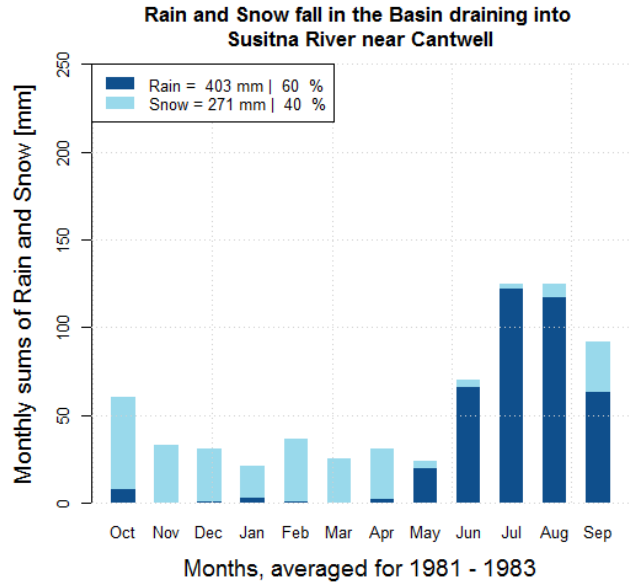


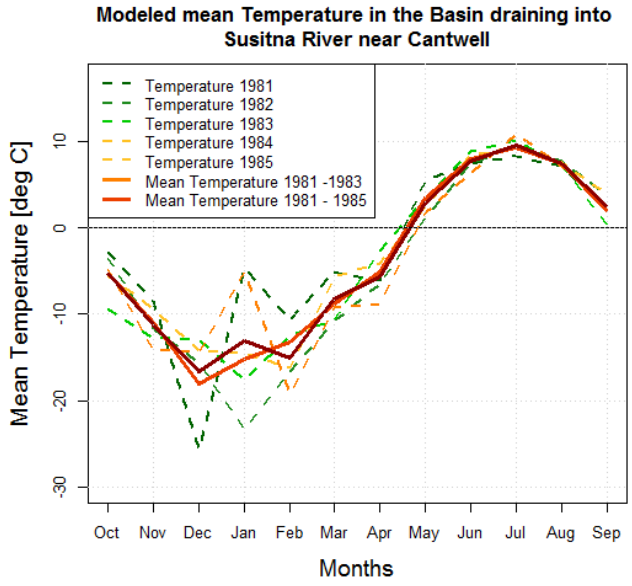
Runoff Calibration – Susitna R. near Cantwell – 3 yr mean



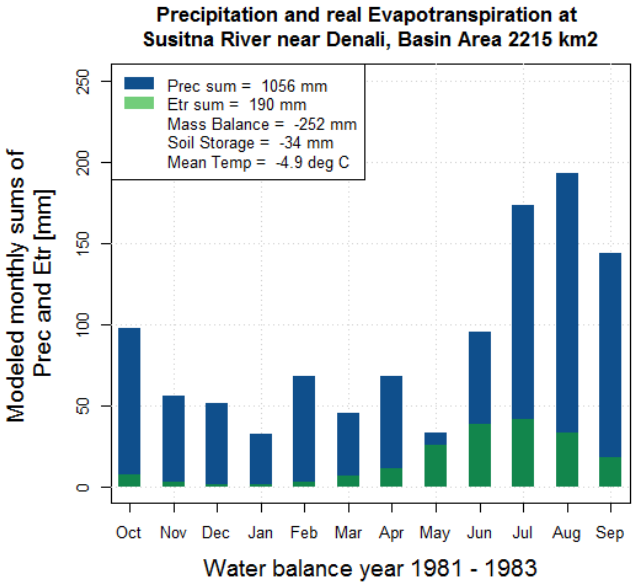


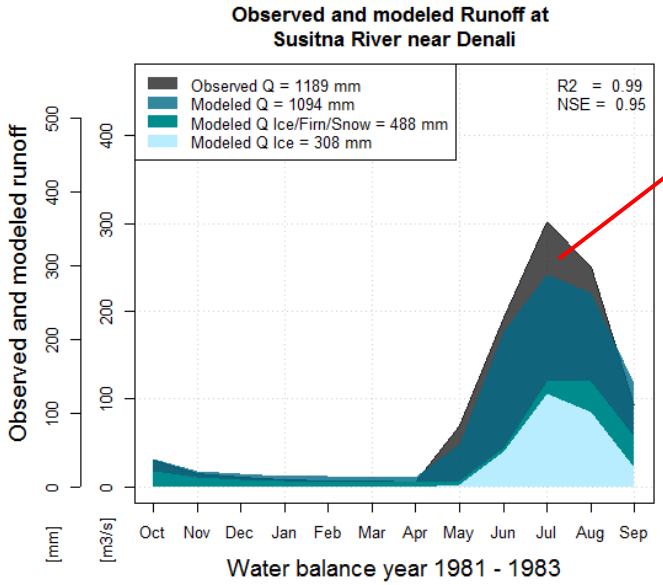




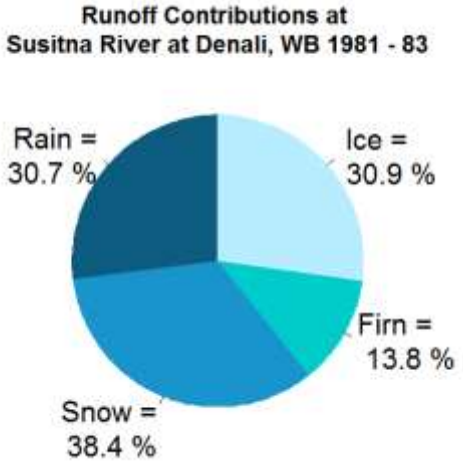


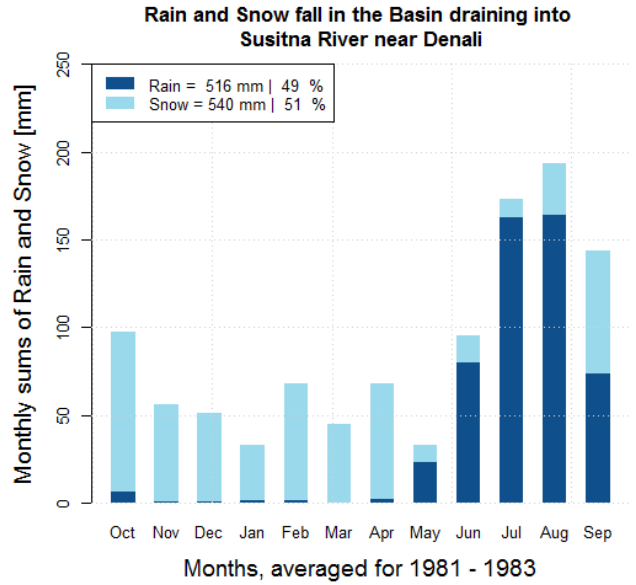
Runoff Calibration – Susitna R. near Denali – 3 yr mean

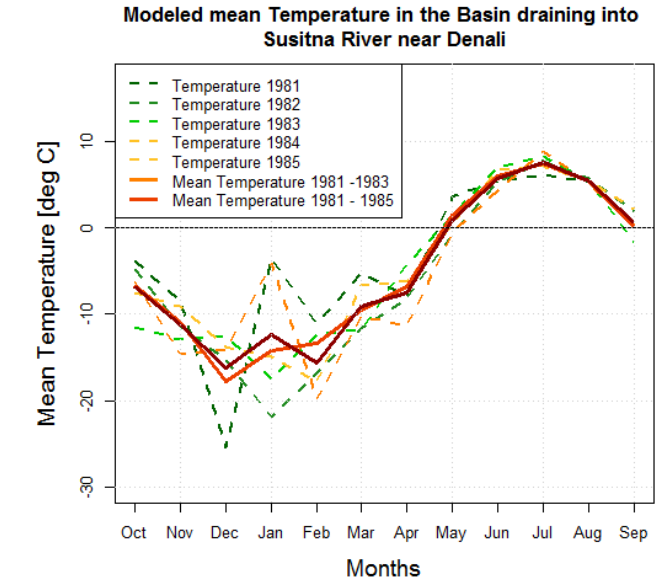




Underestimation of Glacier runoff

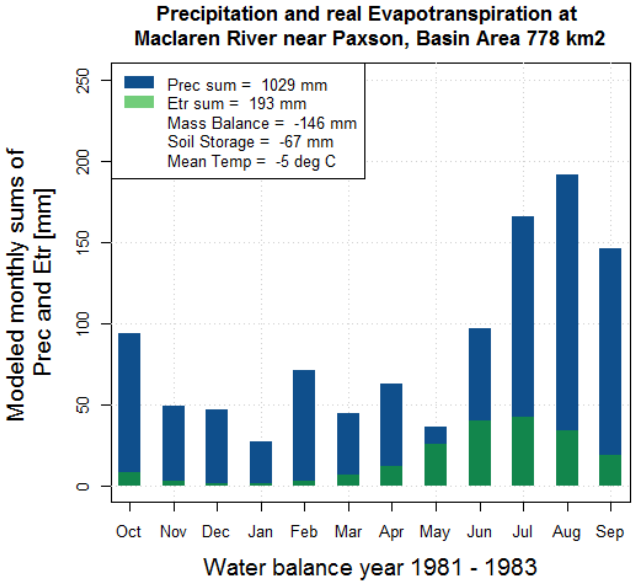


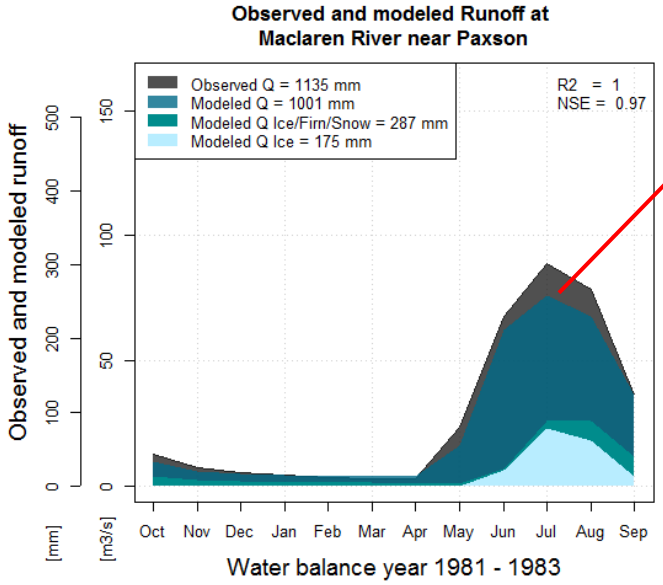




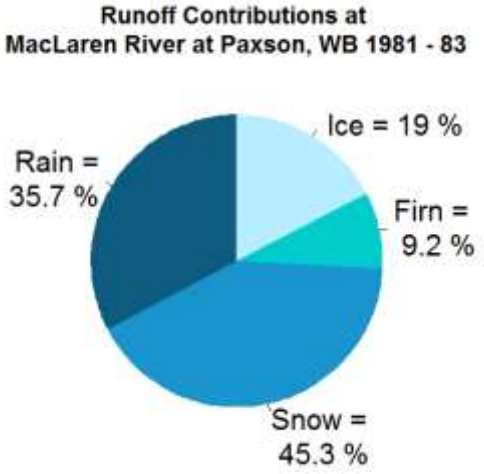
Estimated Glacier runoff contribution Clarke (1986) = 34 %

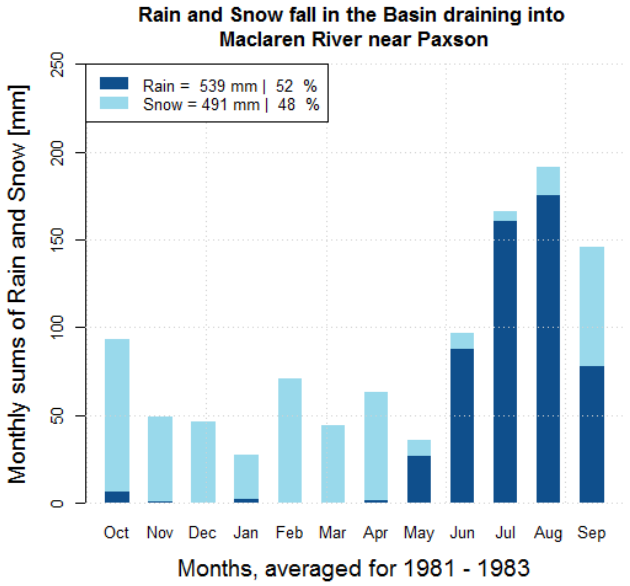
Runoff Calibration – Maclaren R. near Paxon – 3 yr mean

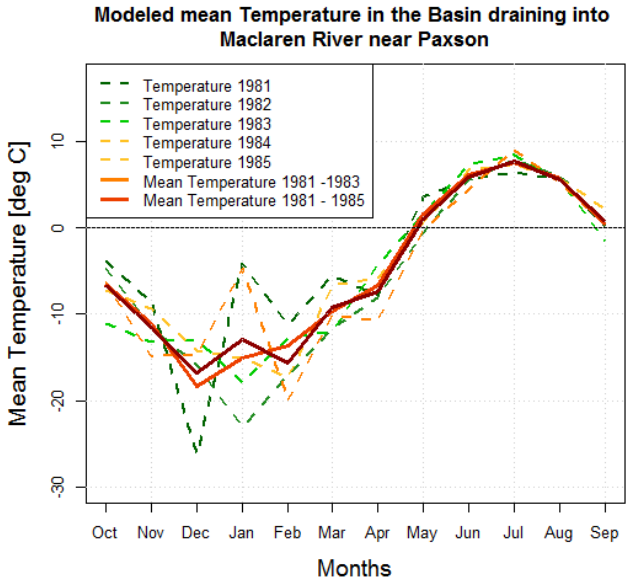




Underestimation of Precipitation

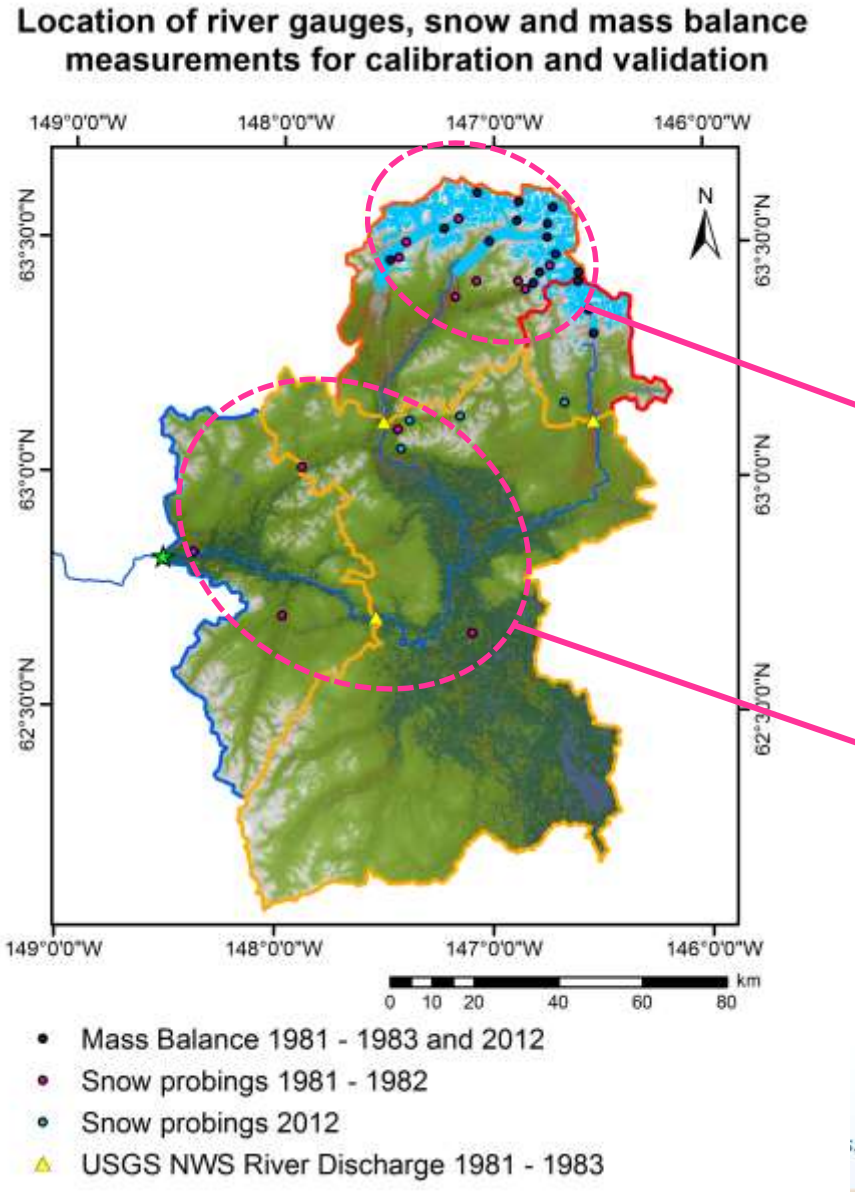


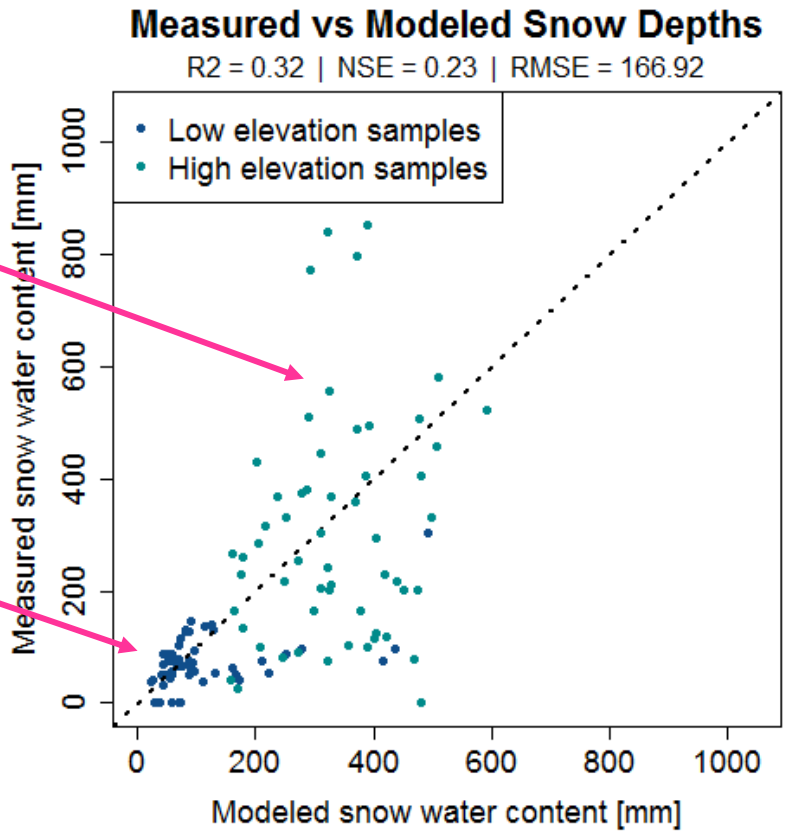




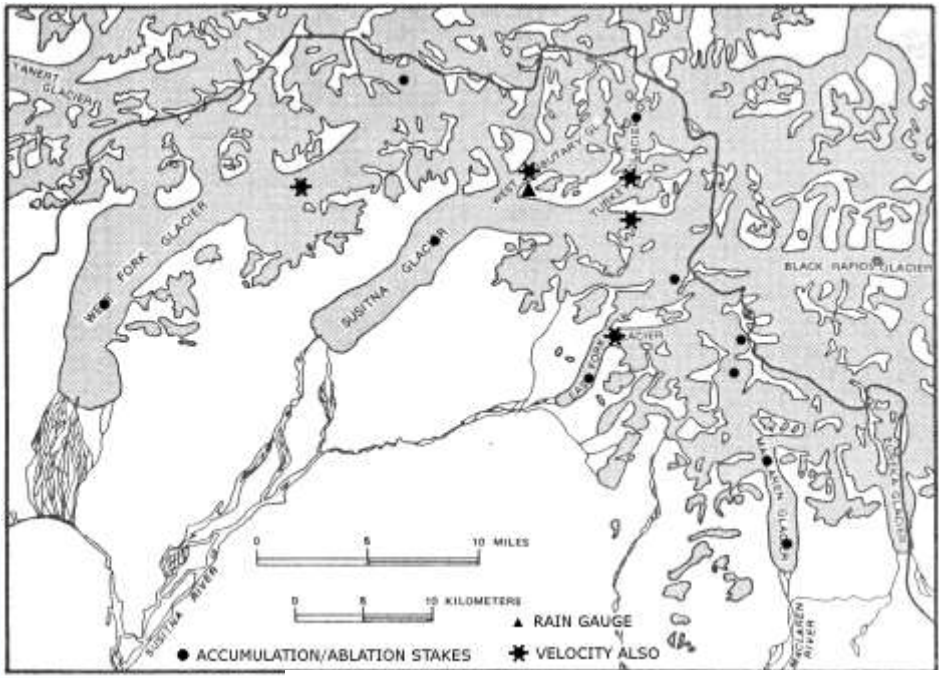
Estimated Glacier runoff contribution Clarke (1986) = 19 %

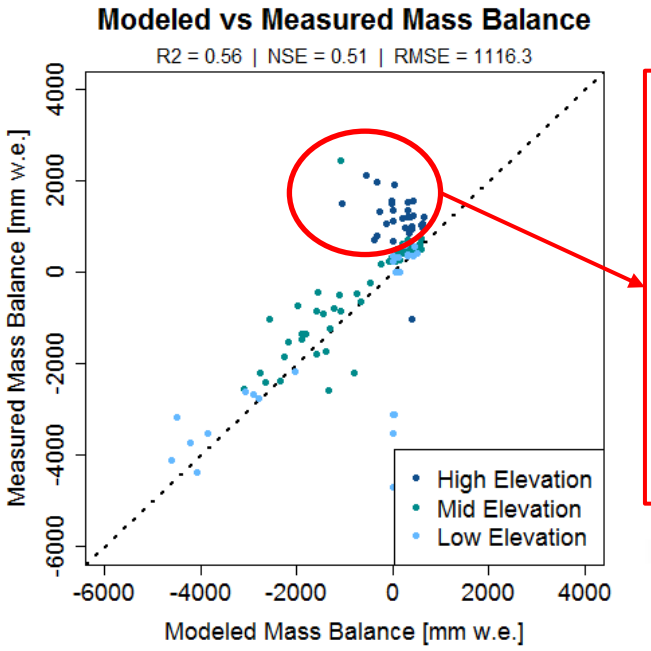
Snow Calibration





Mass Balance Calibration

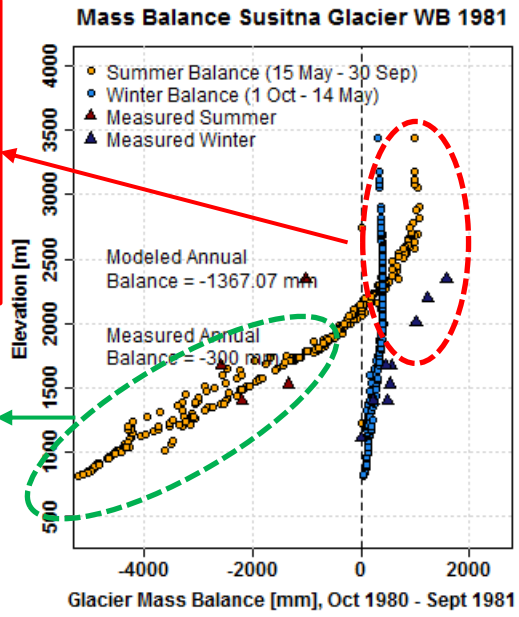


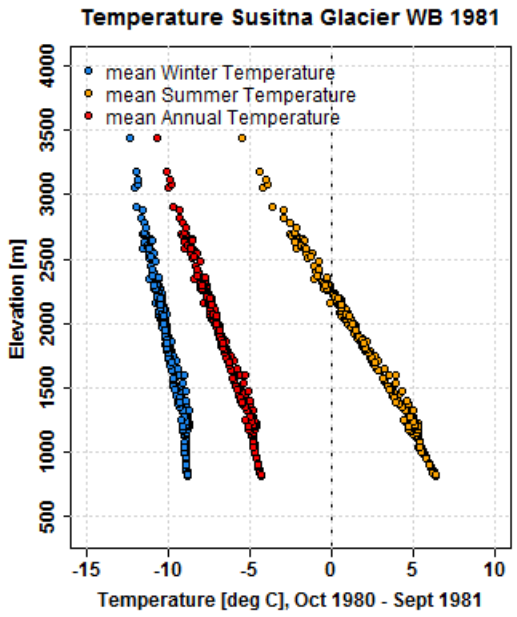


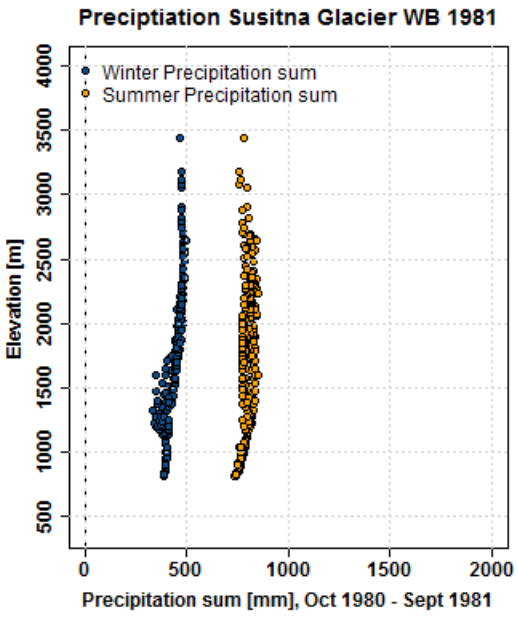
Under-estimation of Mass Balance → Too little accumulation in high Elevations

Winter accumulation → Underestimated above 1700 m

Summer ablation → good

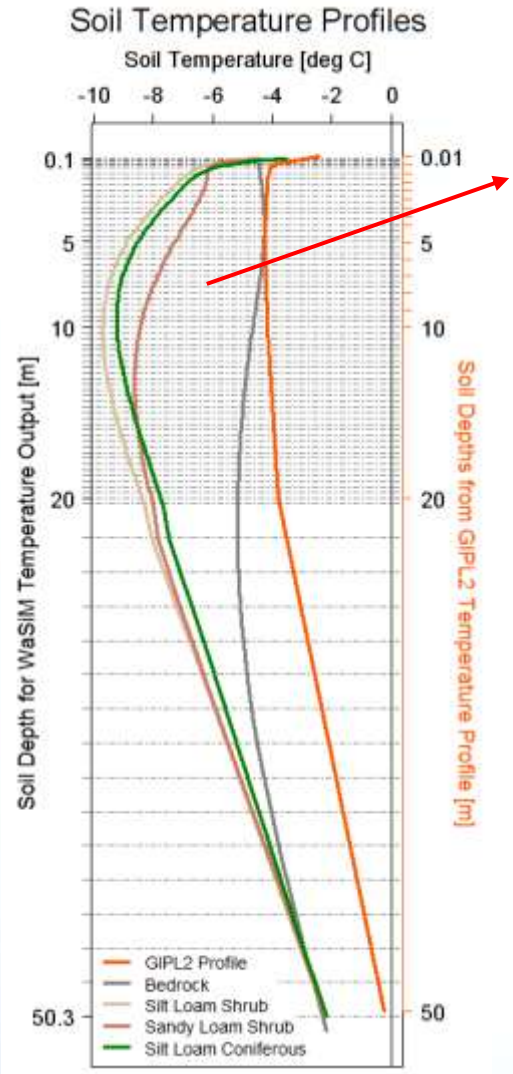






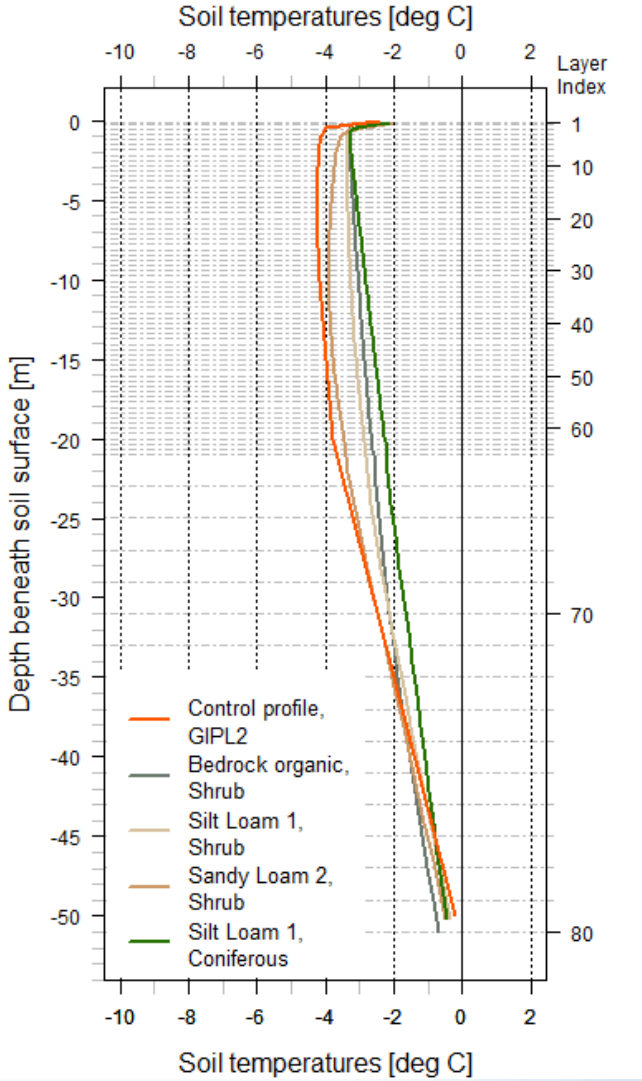
Soil Temperature Calibration

Initial Soil temperature Profiles



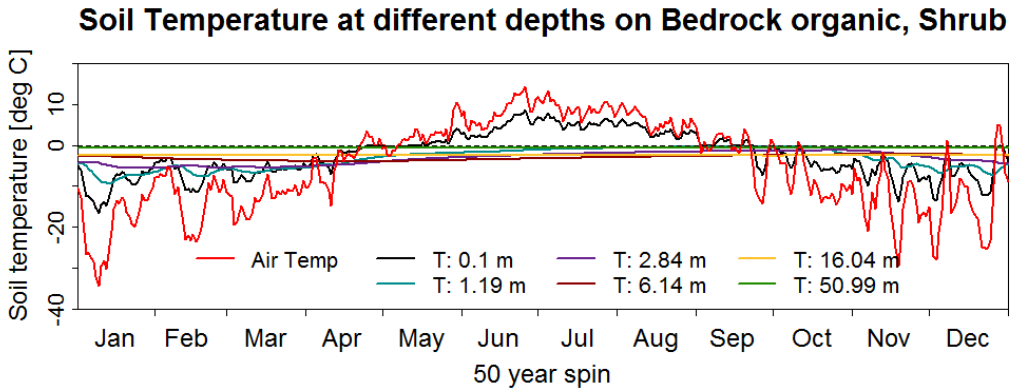
Too cold

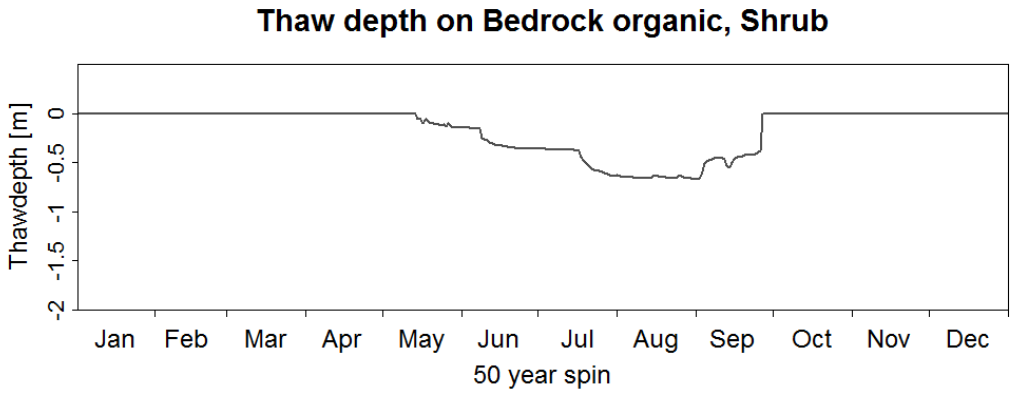
Soil temperature Profiles after Calibration

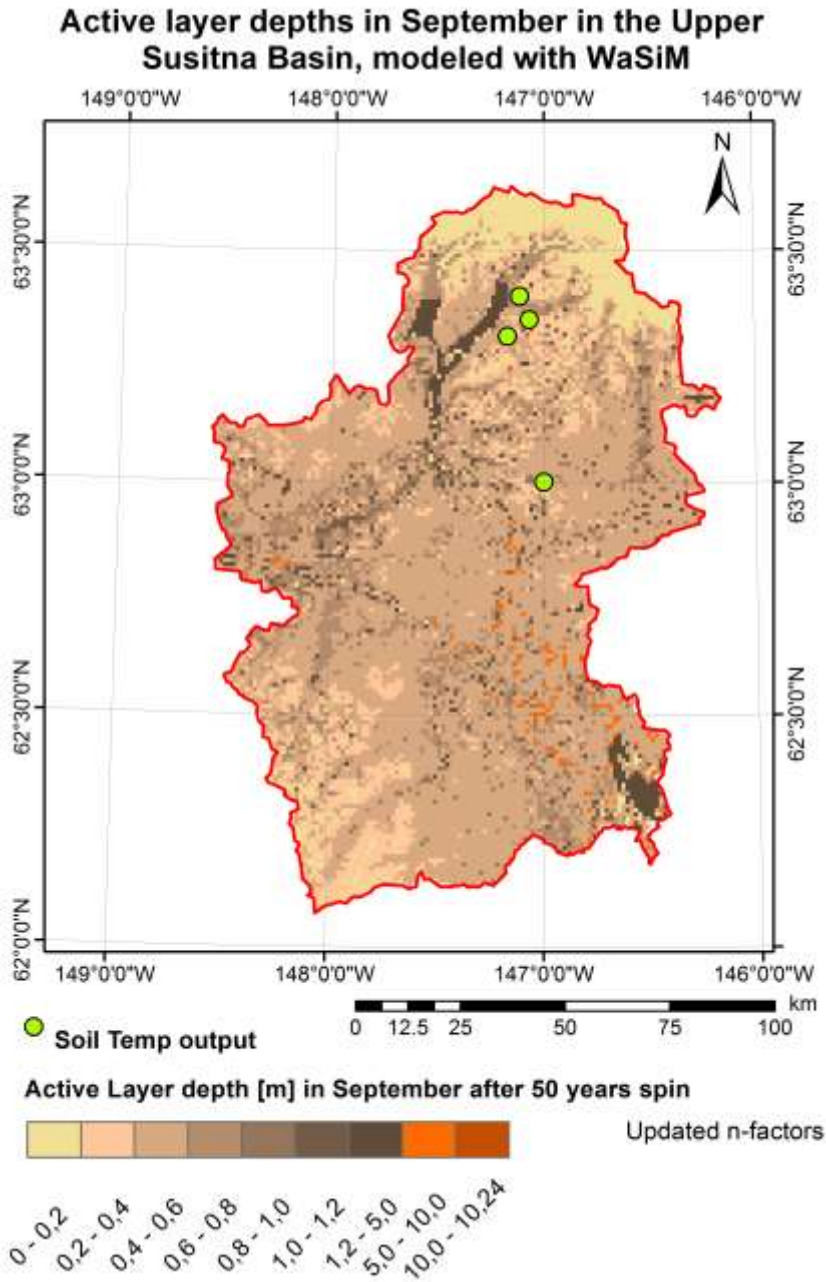


Soil Temperature Calibration

Active Layer in past Climate

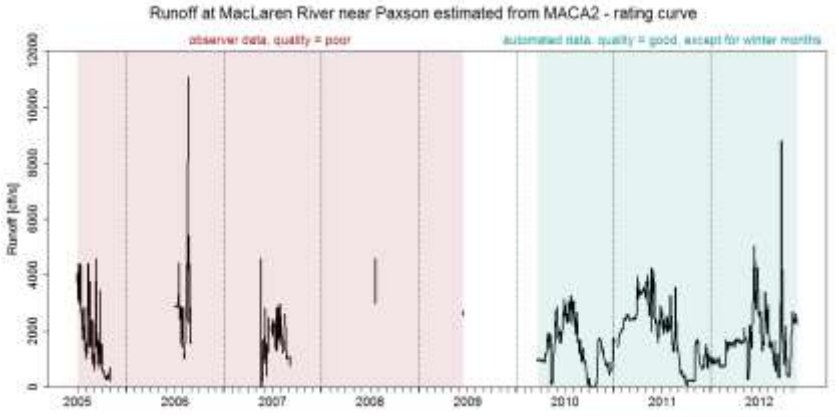


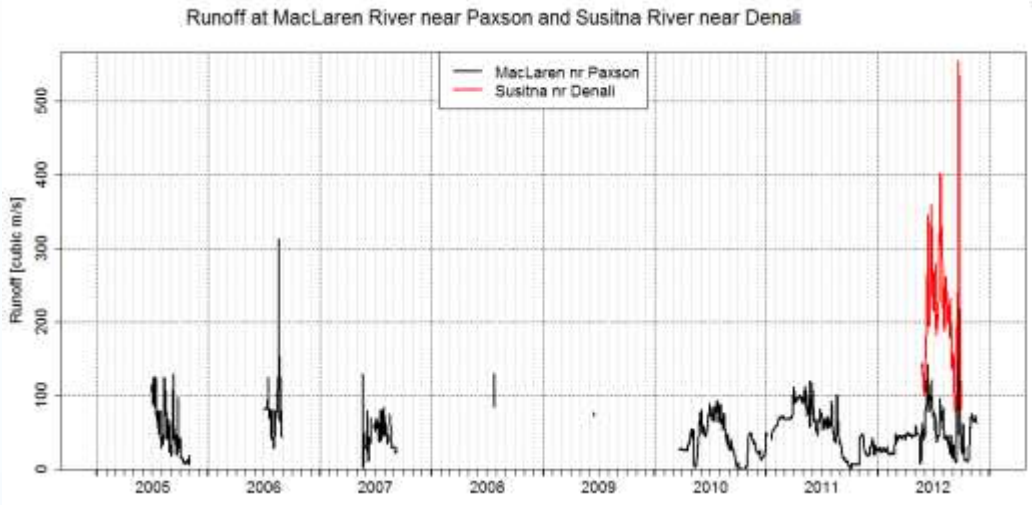




Runoff Validation

- MacLaren River near Paxson
- Susitna River near Denali





Snow Validation

- Winter snow accumulation - April 2012

Mass Balance Validation

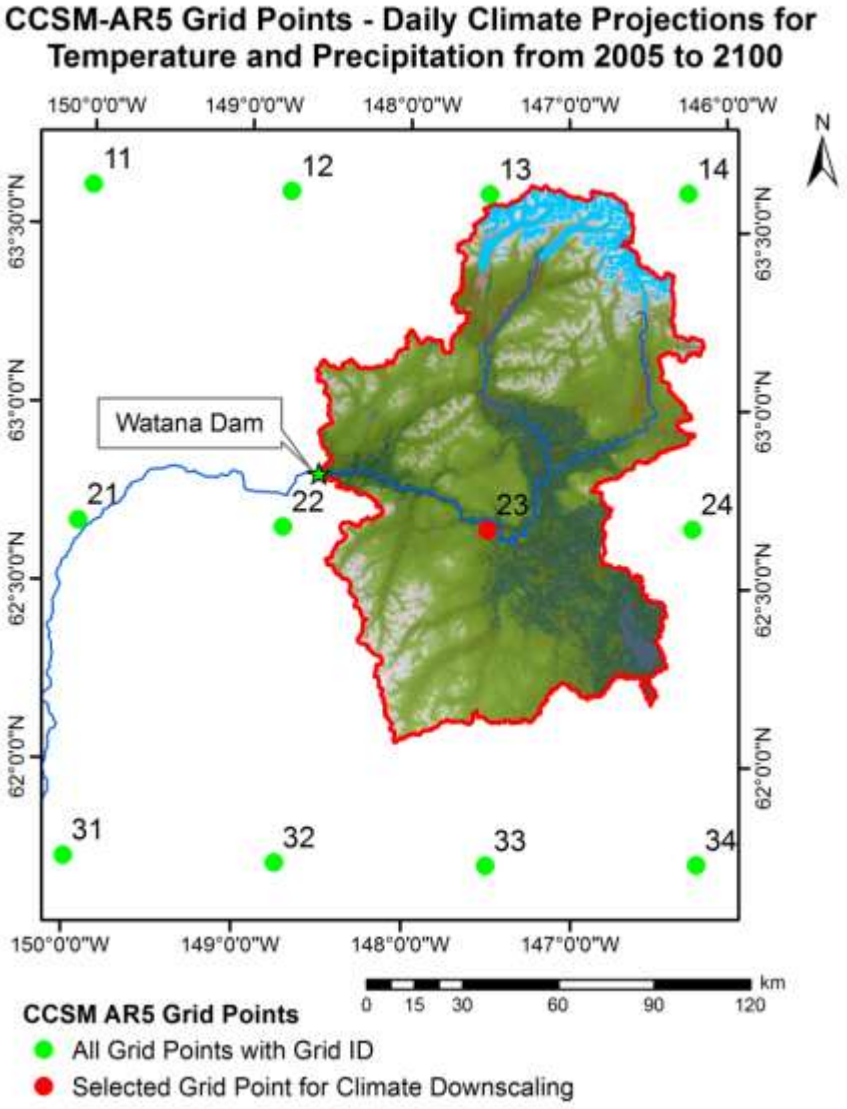
- Summer Mass Balance Data: April/May through Sept 2012

Future Projections

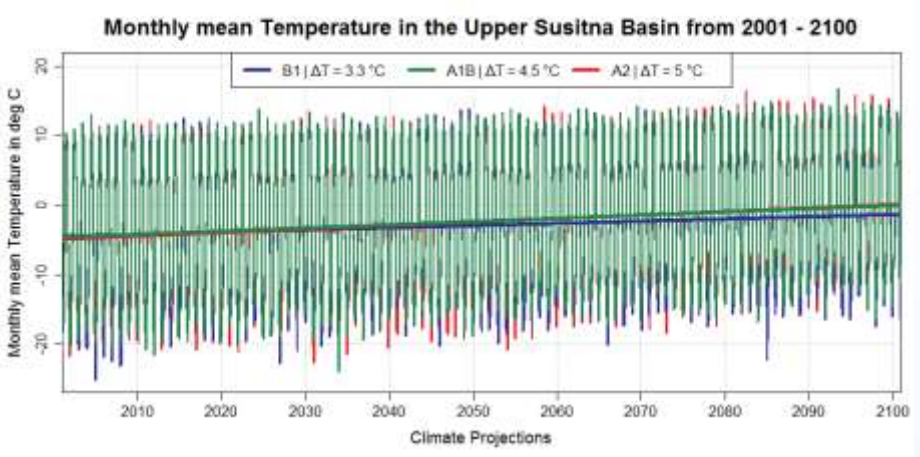
Combination of daily CCSM AR5 Data (daily)

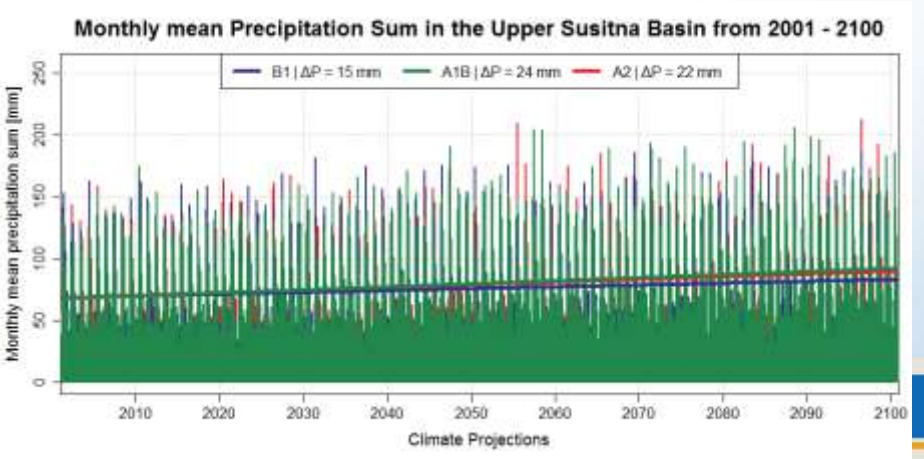
+

Spatially distributed SNAP Projections (monthly)



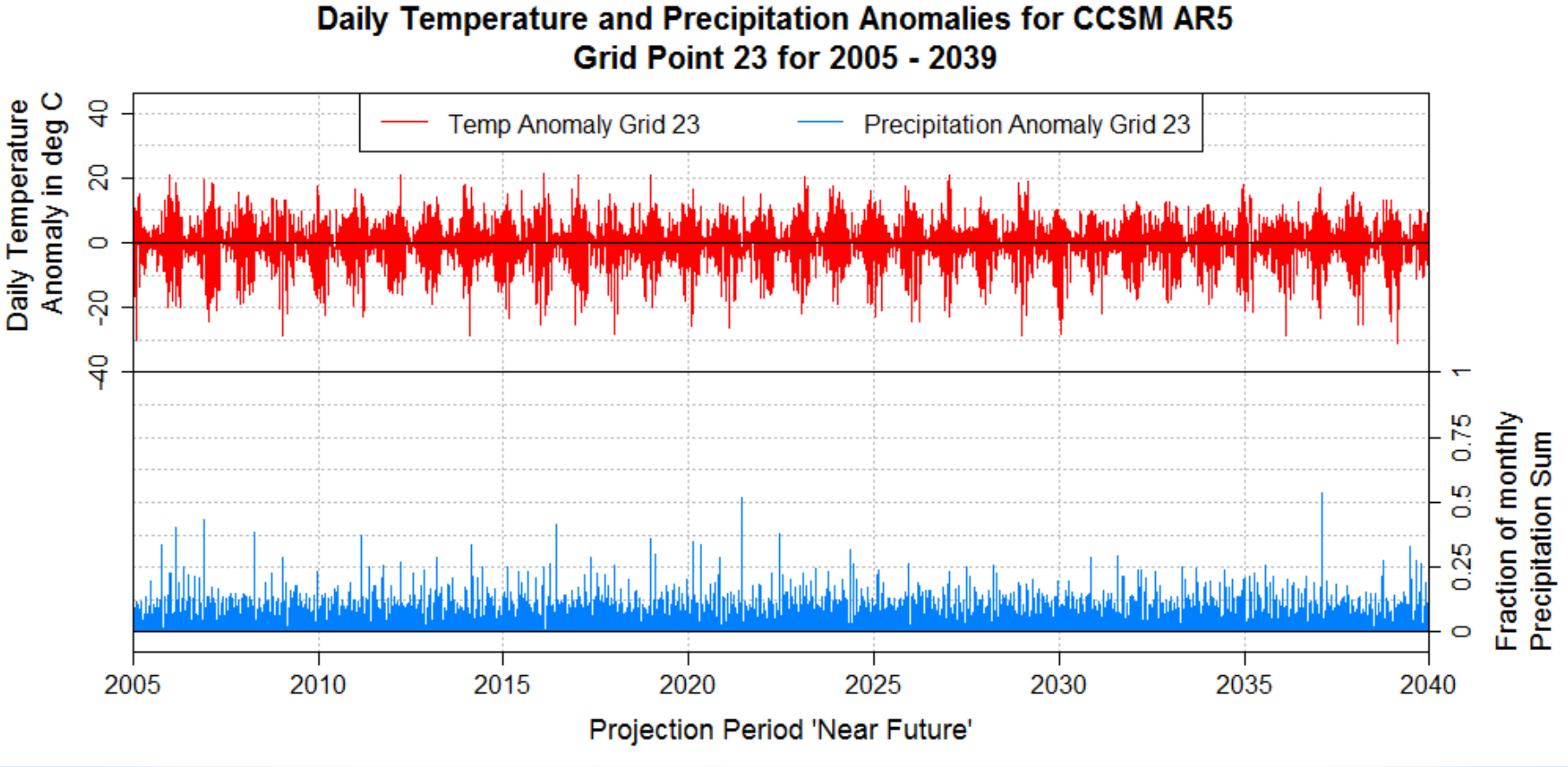
5-model mean for Scenarios: A1B, B1 and A2





Future Projections

CCSM AR5 Data → Extract anomalies for Temperature and Precipitation



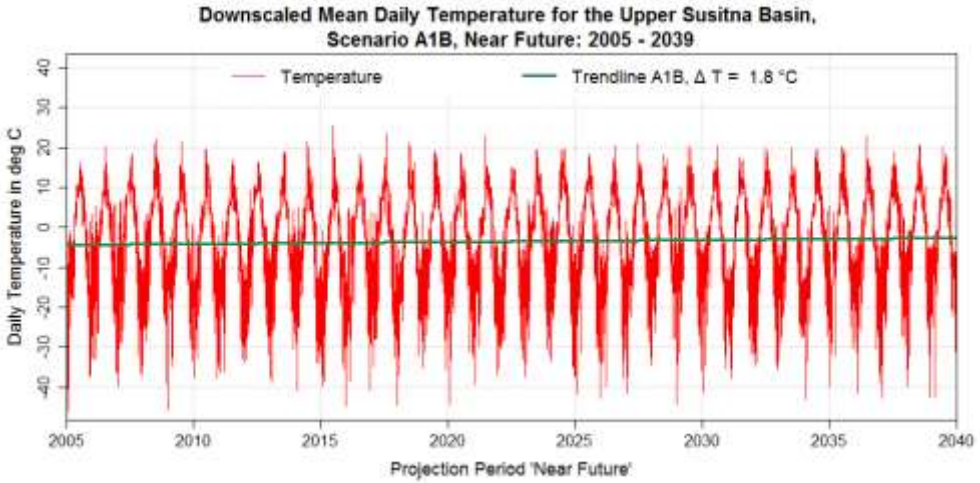
Future Projections – Near, Mid and Far

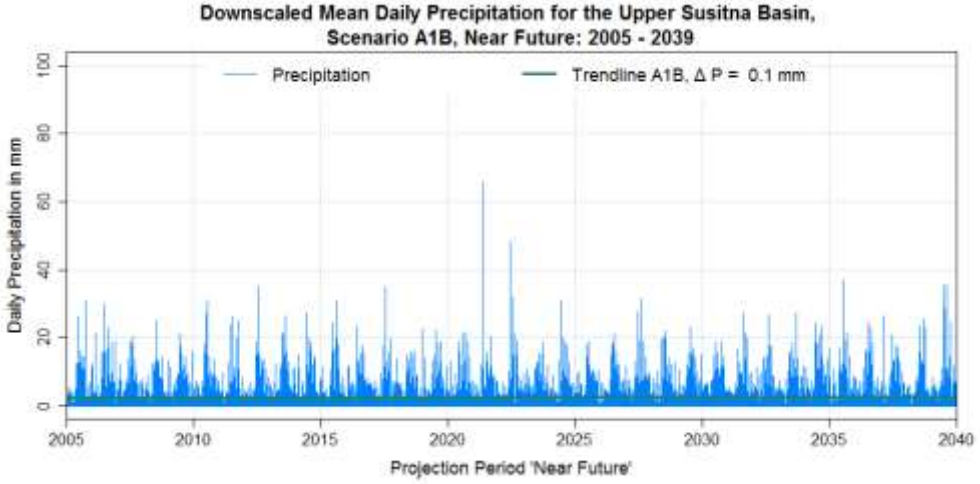
Superimpose anomalies to gridded monthly SNAP Data → 4187 "virtual" climate Stations

1. Period

NEAR FUTURE

2010 - 2039





SCENARIO A1B

Means for the whole Upper Susitna Basin