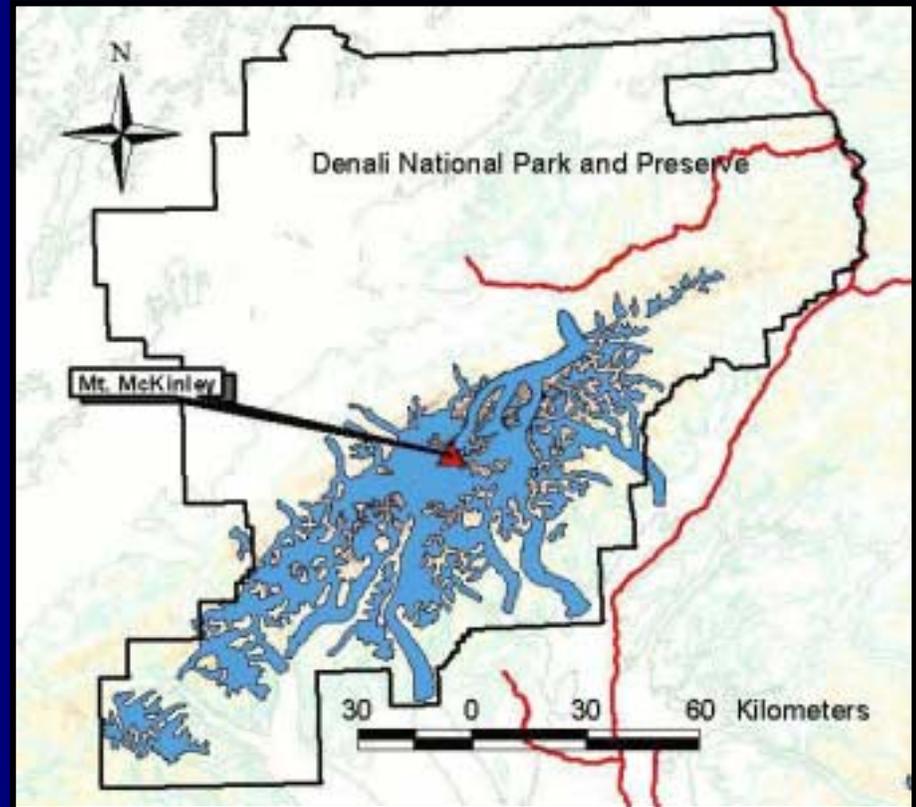


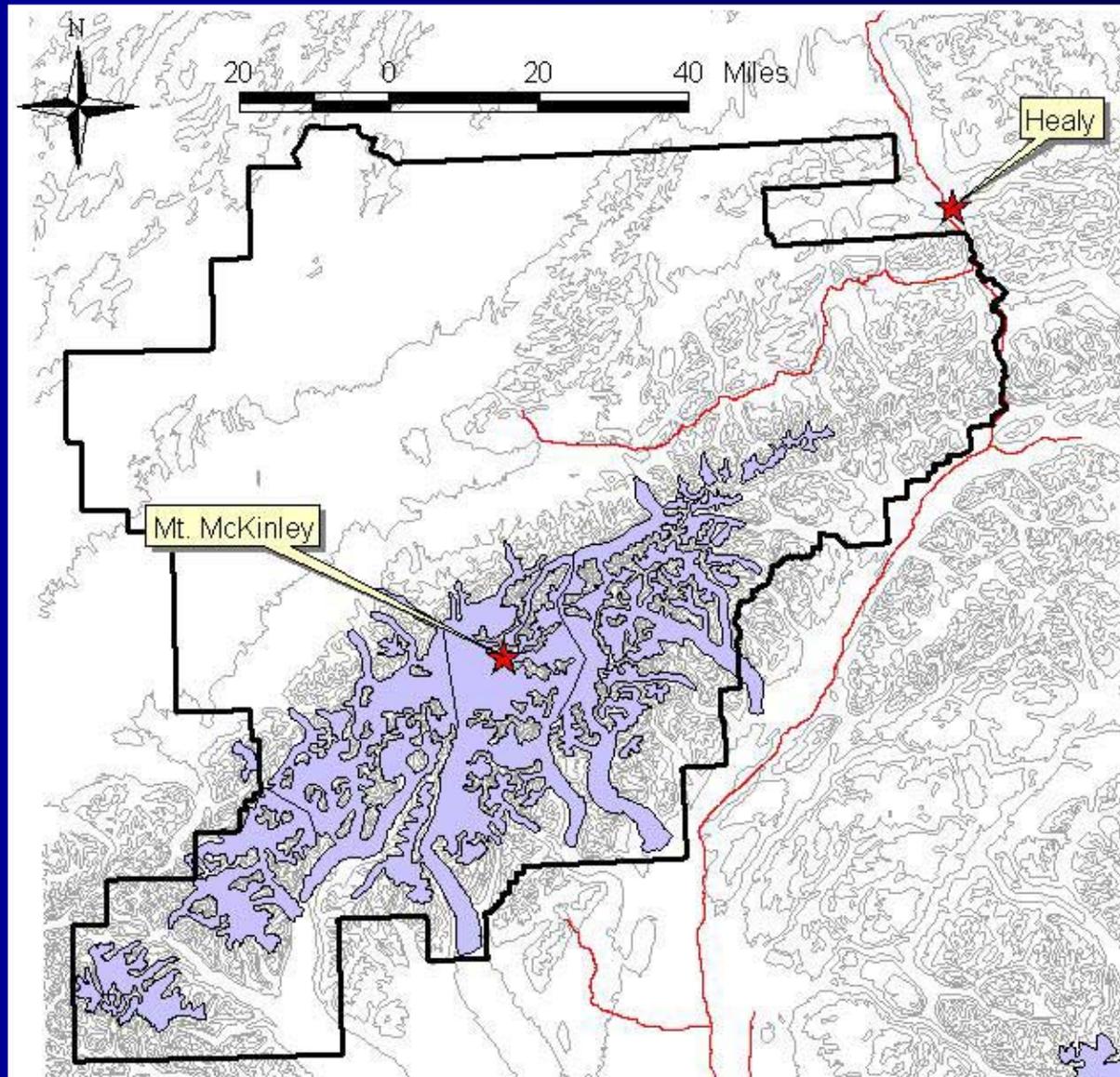
# **LTEM Glacier Monitoring in Denali**

# Modern Glaciation

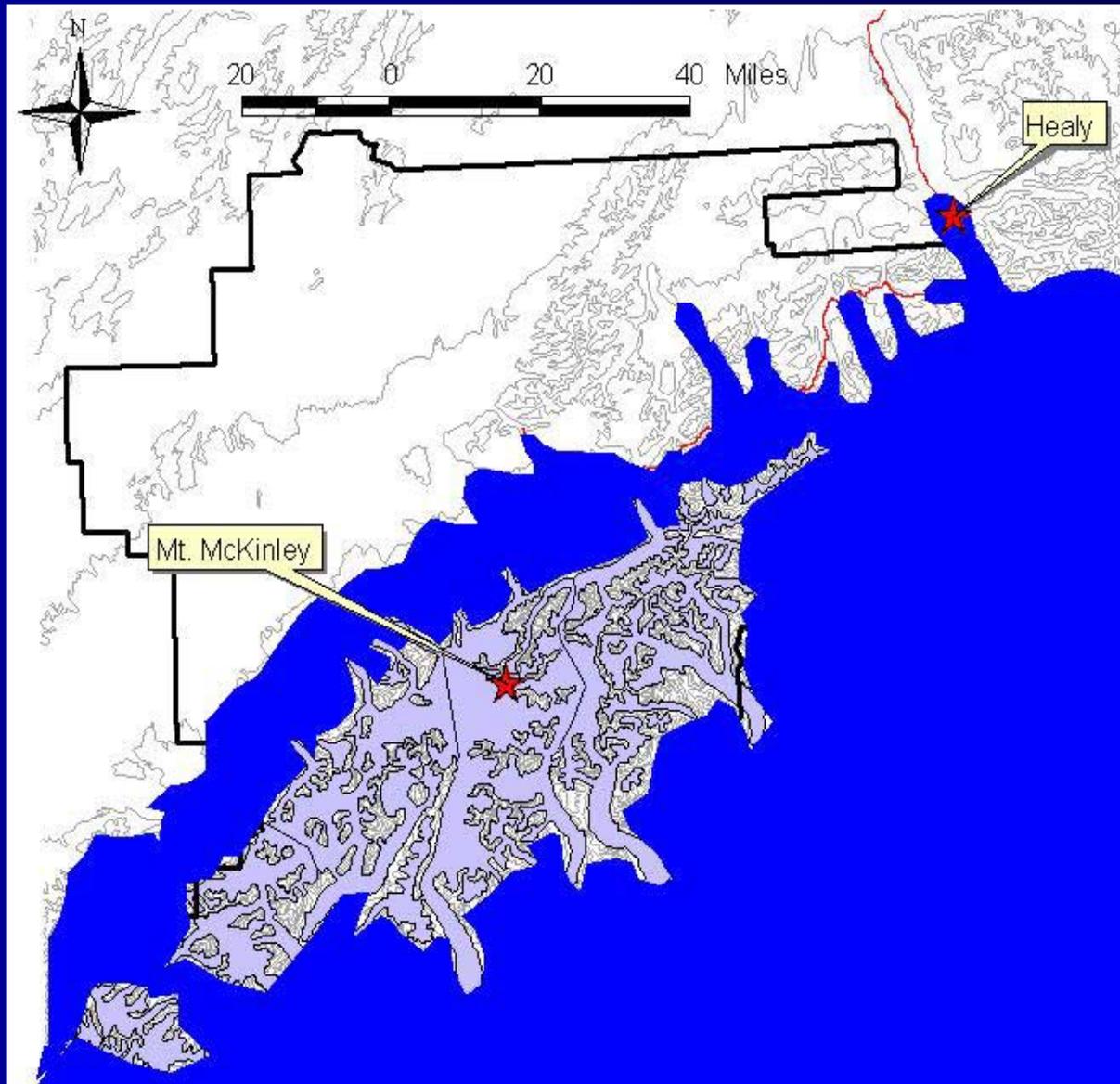
- 1 million acres of Denali are covered by glacier ice (17% of the Park).
- All Denali glaciers are valley glaciers (alpine) or hanging glaciers.
- A majority of the larger glaciers show evidence of surging.



# Past Glacial Extent

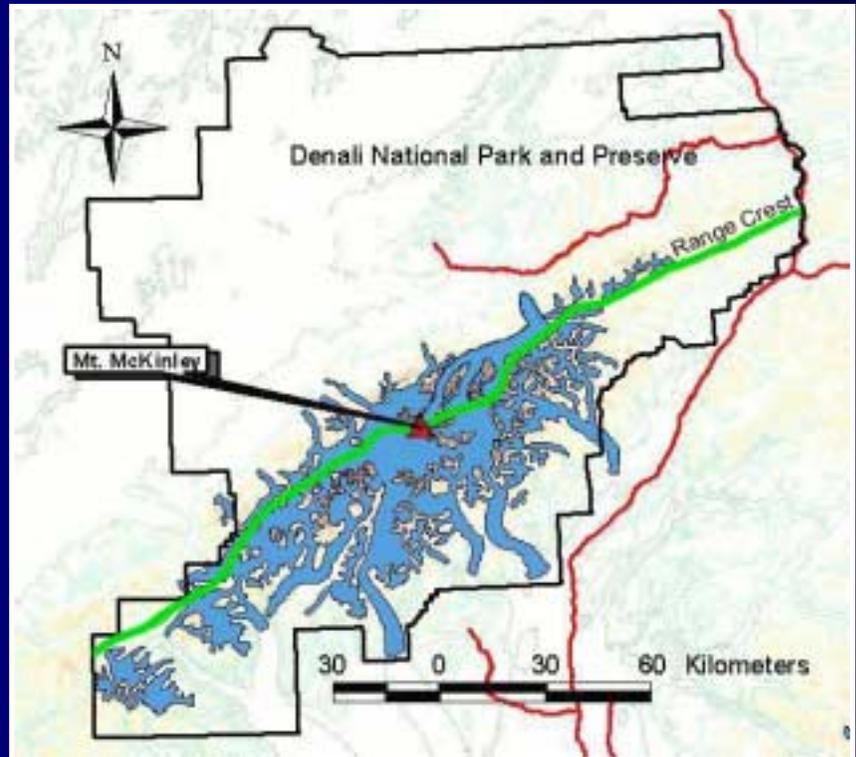


# Past Glacial Extent



## Modern Glaciation

- Glaciers on the south slope of the Alaska Range are in a transitional maritime climate (moderate temps & more snow).
- Glaciers on the north slope of the Alaska Range are in a drier continental climate (wider temp range & less snow).
- The height of the crest of the Alaska Range effects glacier size.



# LTEM Glacier Monitoring

- **Objective**: To detect and monitor climate related changes in Denali's glaciers on a Park-wide scale.
  - **Mass Balance** - The net amount of snow and ice that is gained or lost by a glacier each year.
  - **Ice Dynamics** - Changes in the motion and the geometry of a glacier that are a result of changes in mass balance.

# Monitoring Strategy

Monitoring at three spatial scales:

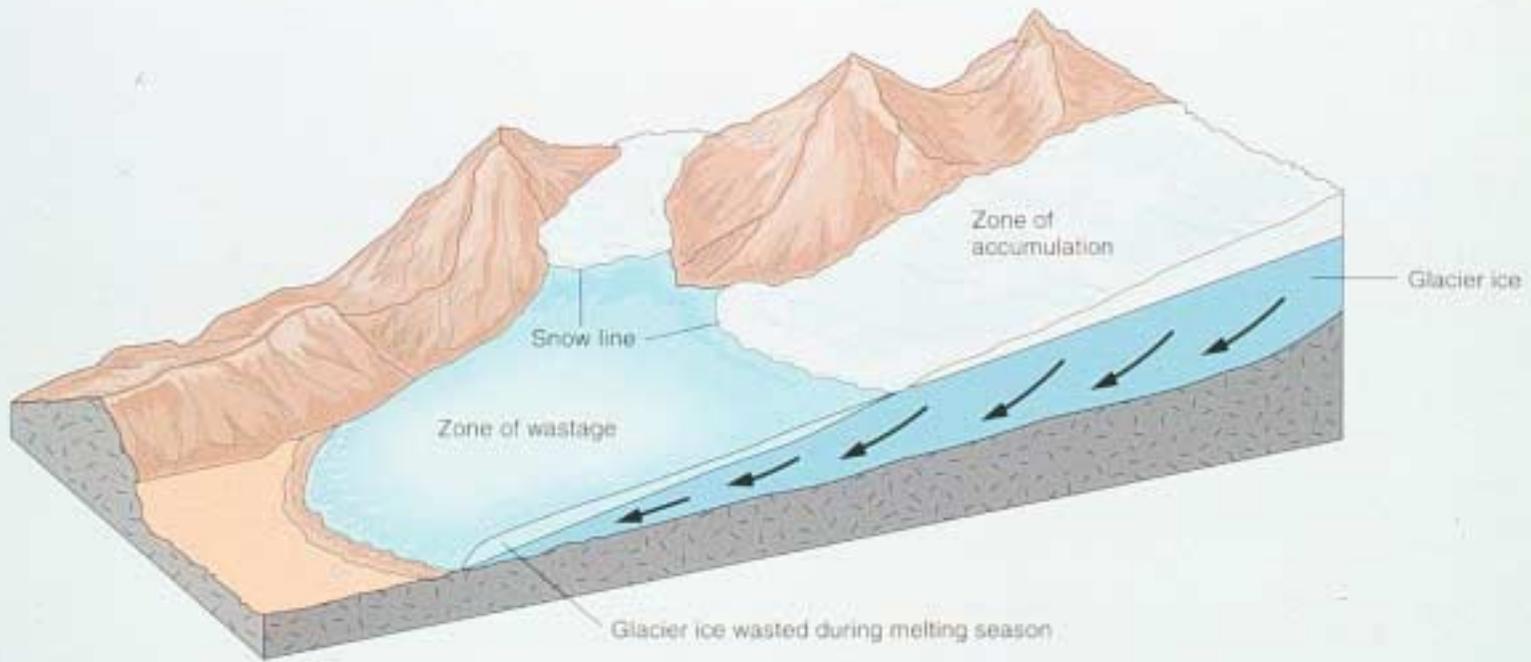
**Benchmark Glaciers** - Intensive sampling on a small glacier in each climatic region of the Park. *Allows the most accurate assessment of glacier change.*

**Index Sites** - “Regional” monitoring at key locations on two large glaciers (on each side of Mt. McKinley). *Provides a regional correlation with Benchmark Glacier data.*

**Remote Monitoring** - Park-wide monitoring of annual ELA's and terminus positions using satellite imagery or other remote sensing tools. *Uses Benchmark Glacier and Index Site data as groundtruth.*

# Monitoring Parameters

## Mass Balance & Ice Dynamics



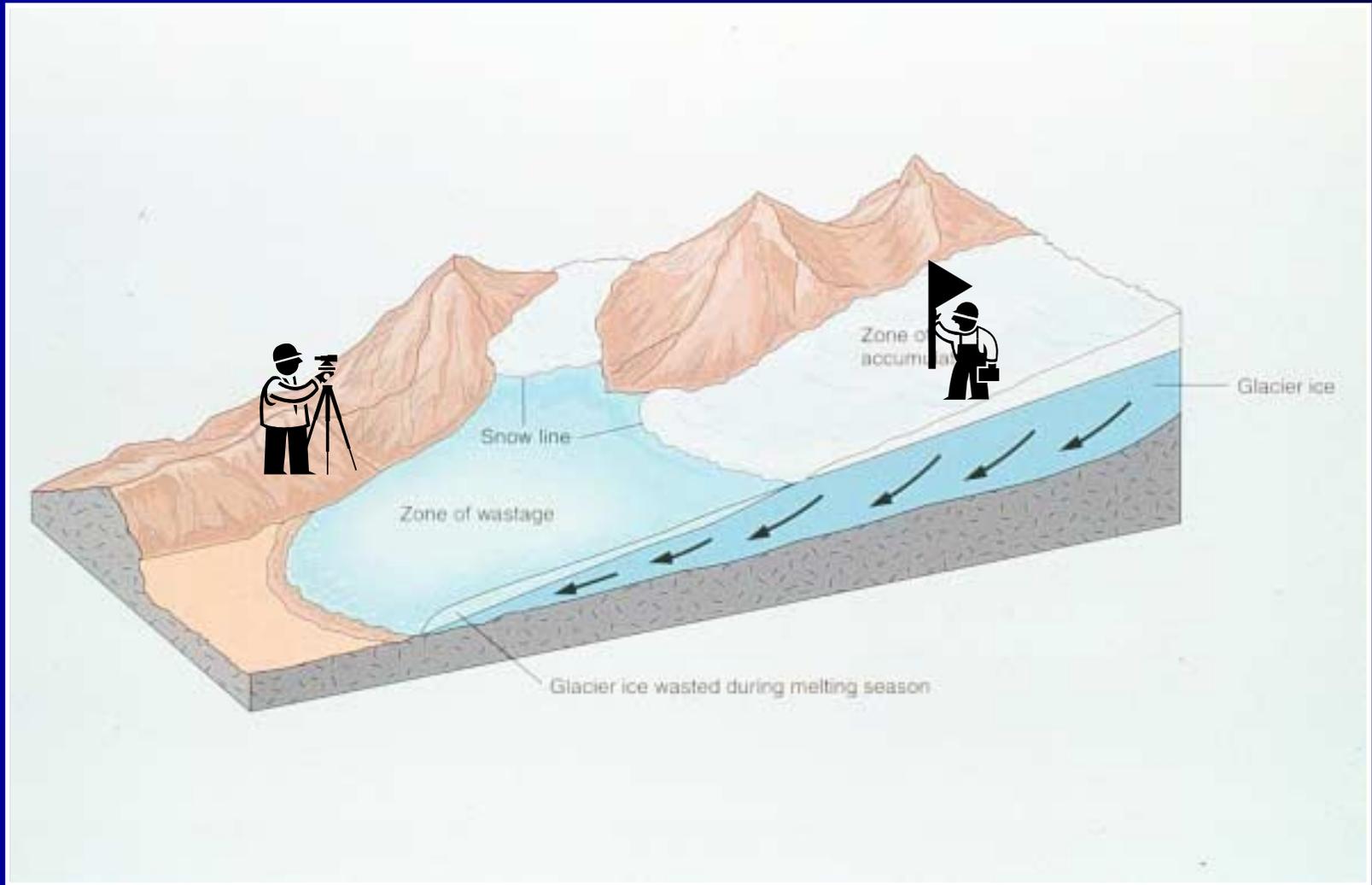
# Field Sampling Methods

Direct measurement of mass balance at index stakes:

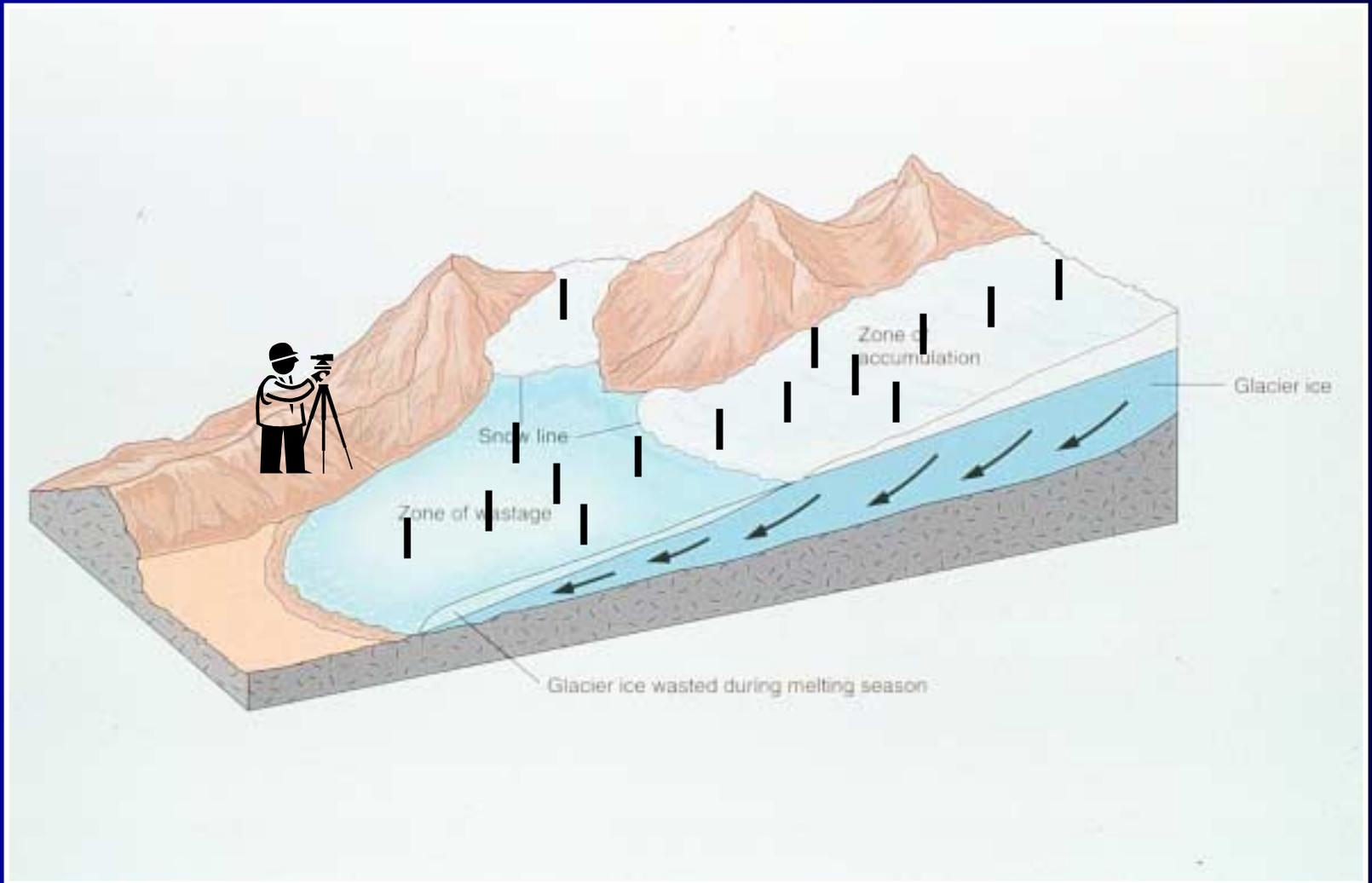
- Snow sampling by depth and density coring.
- Snow depth probing.
- Snow pit stratigraphy & depth measurements.
- Direct measurement of ice surface height on index stakes.

Conventional surveying of index stake locations and elevations.

# Field Methods



# Field Methods



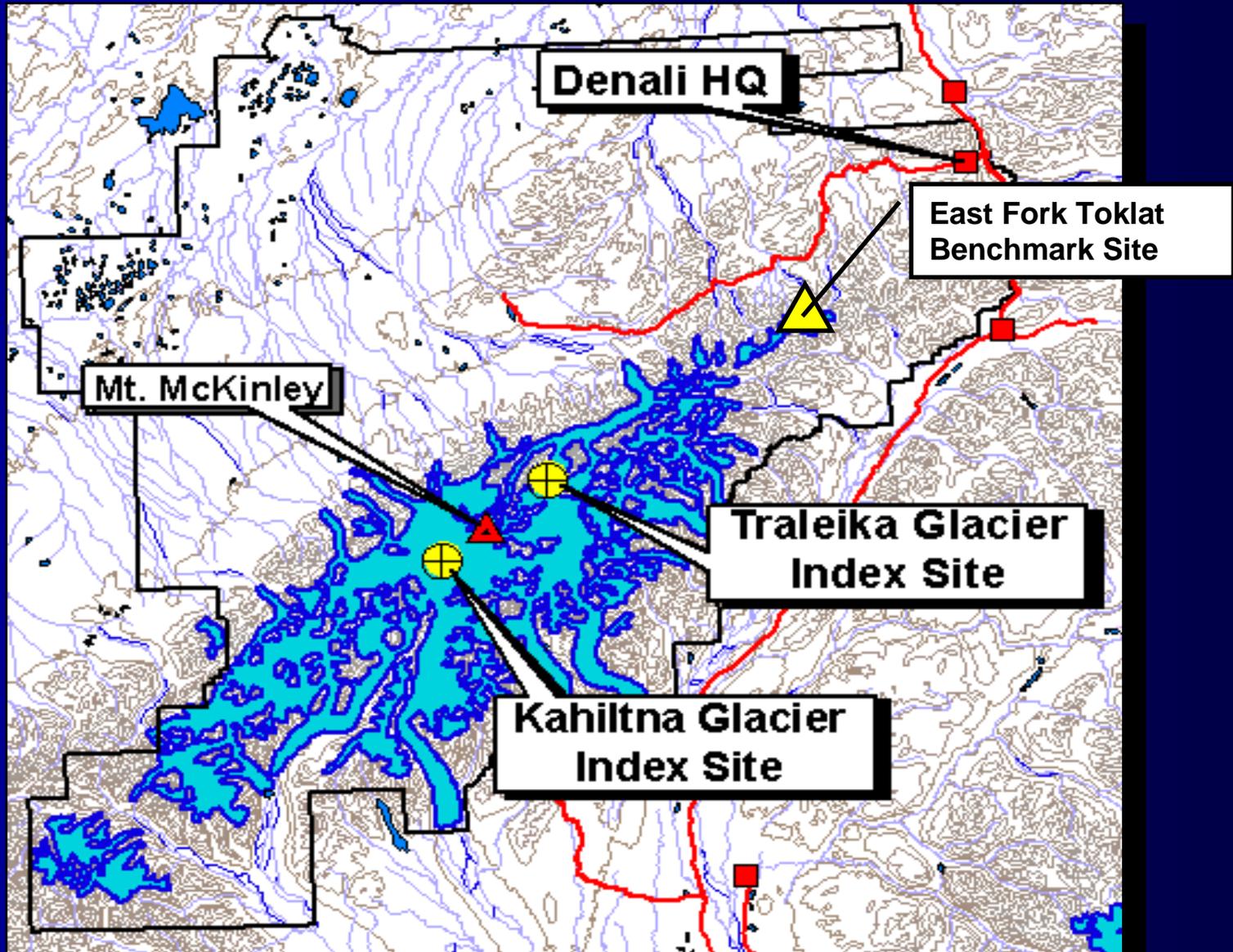
## Field Methods



## Field Methods



# Sample Sites





# Field Surveys on East Fork Toklat Glacier



## Field Methods



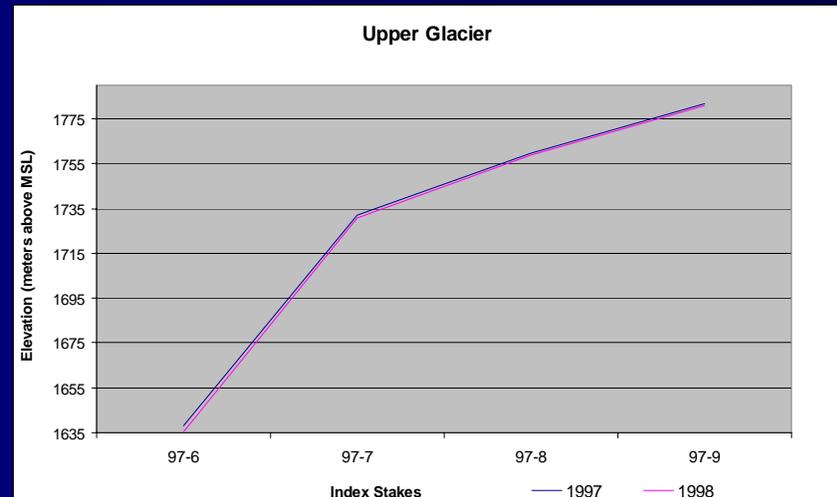
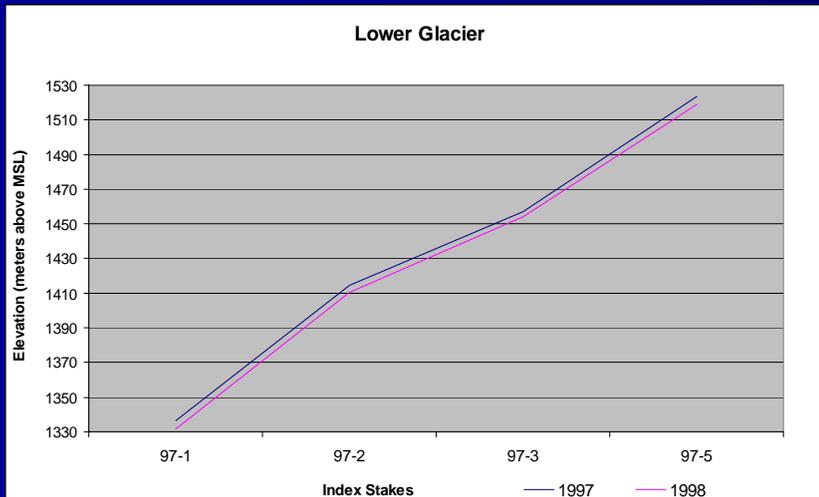
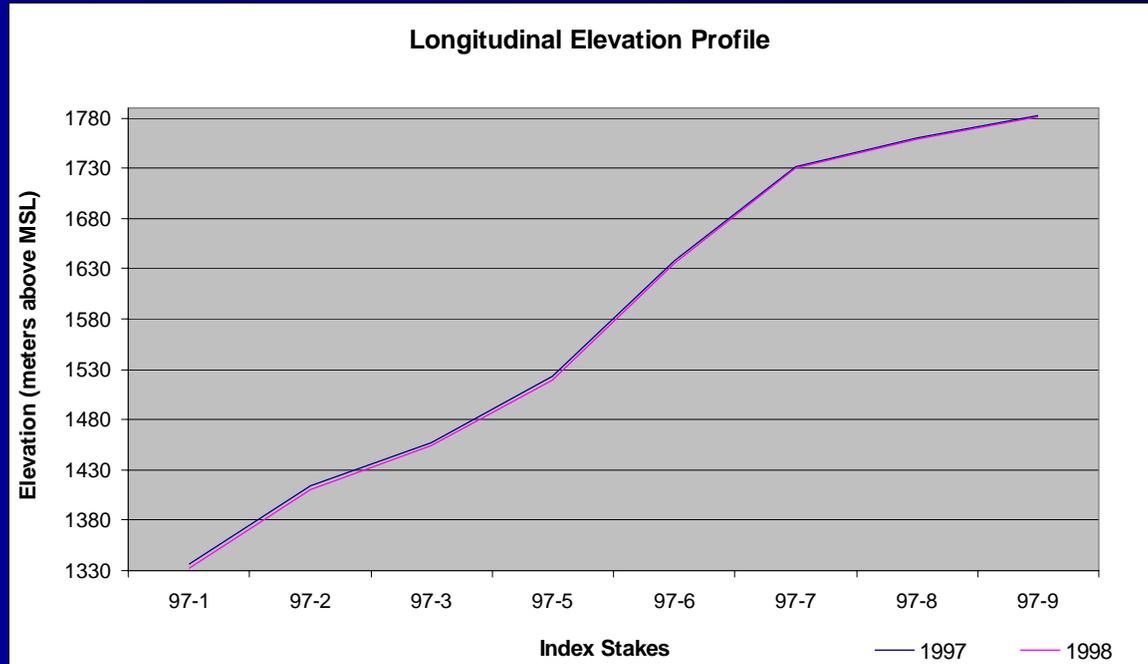
## Index Stake on East Fork Toklat Glacier



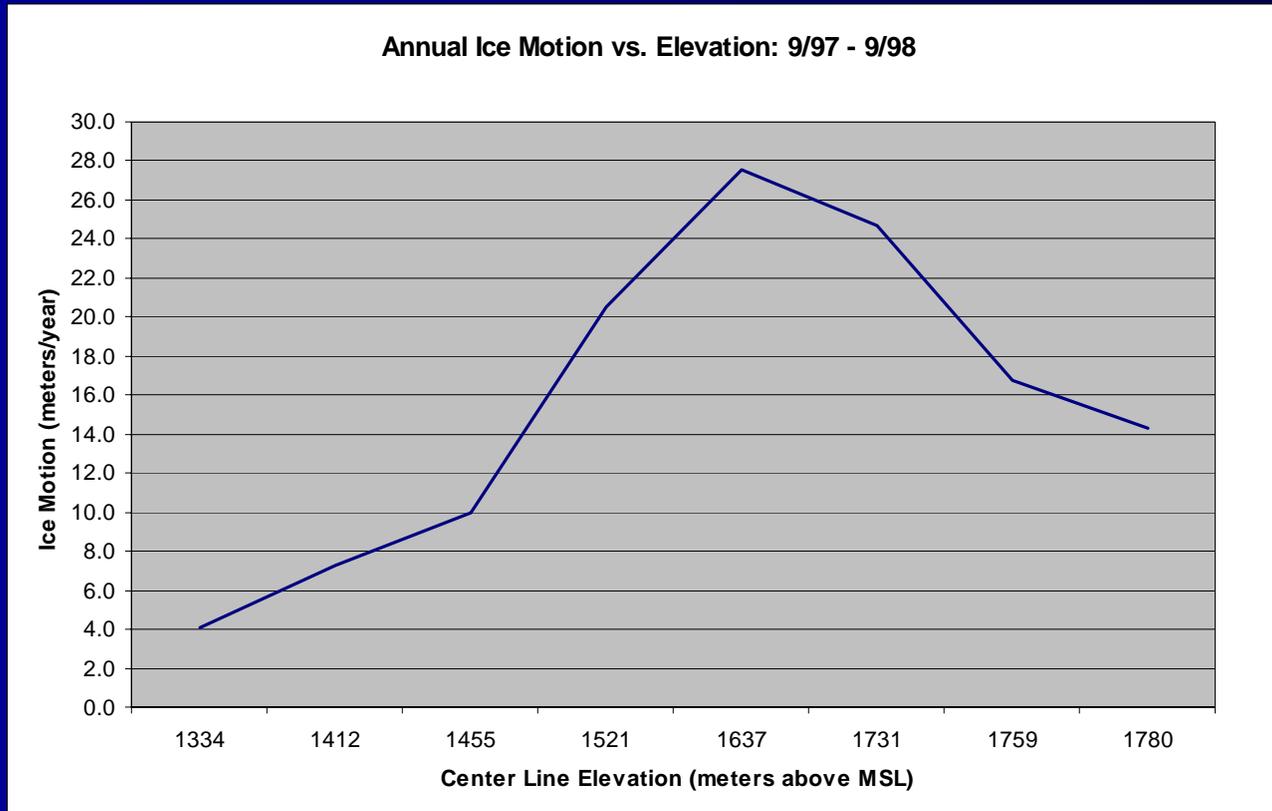
## Monitoring Glacier Changes



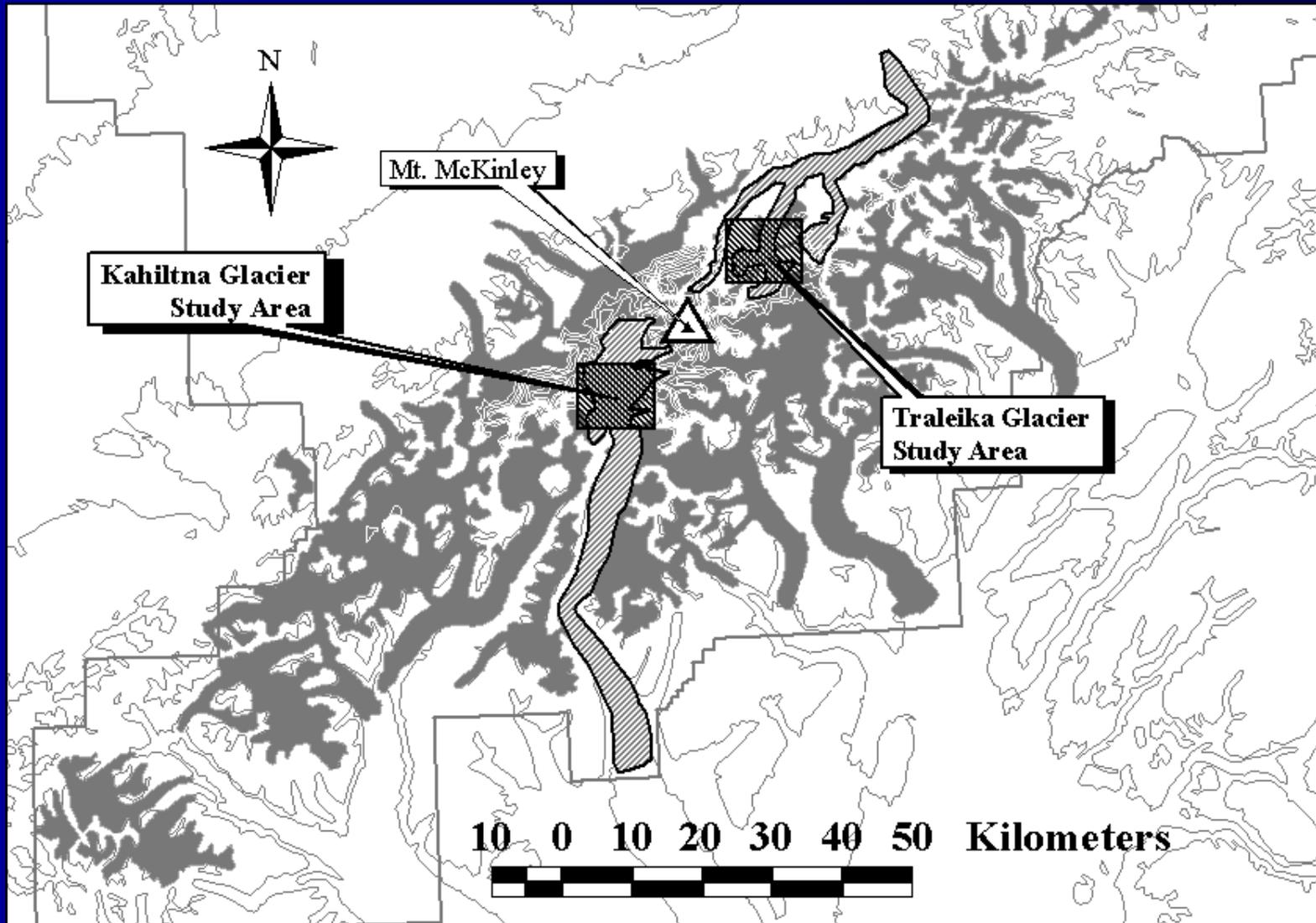
# East Fork Toklat Glacier: Surface Height Change 1997-'98



# East Fork Toklat Glacier: Ice Velocities 1997-'98



# Index Site Monitoring



# Kahiltna Glacier Long-Term Index Measurement Site

Survey Monument "FORK"

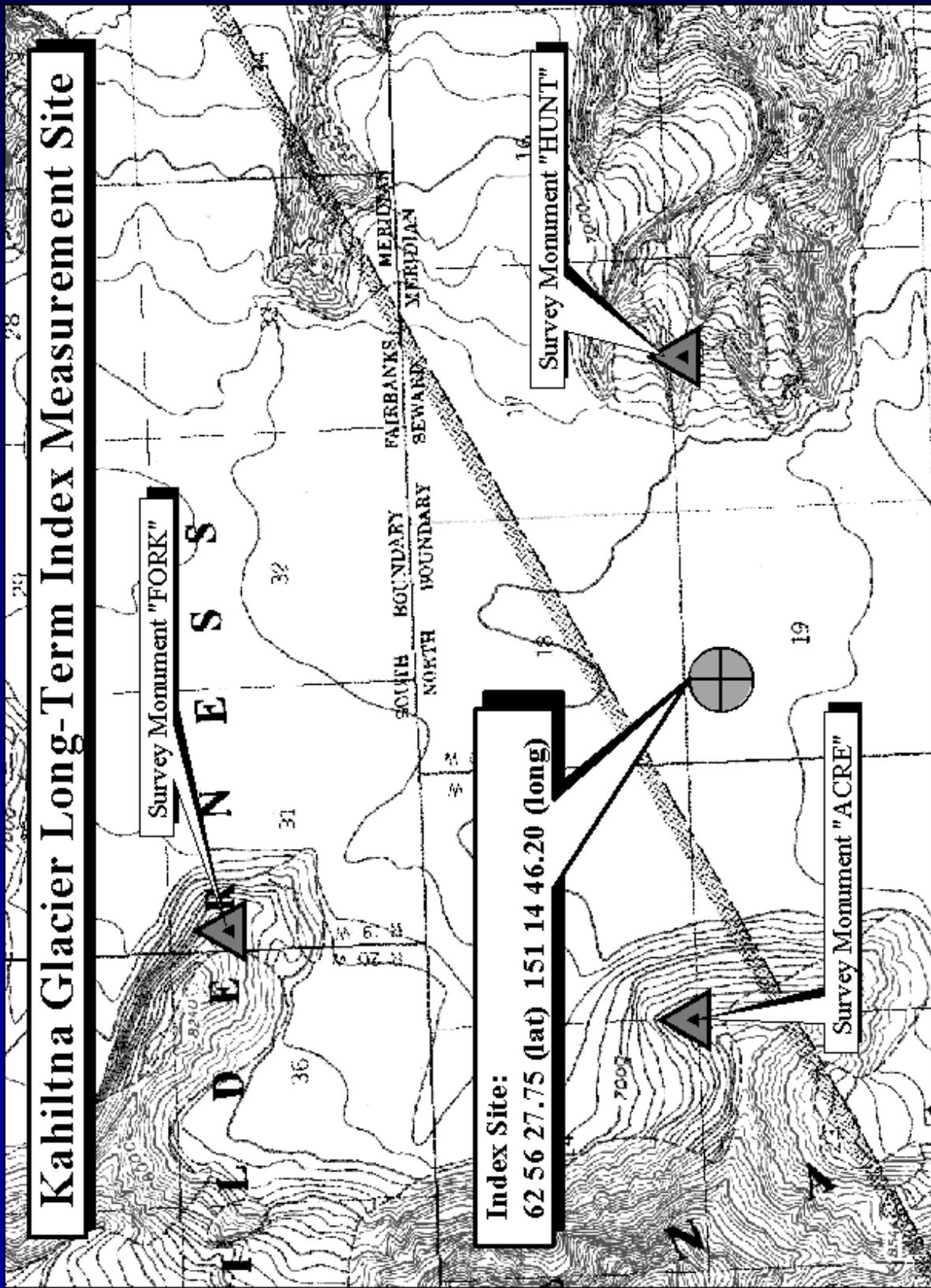
F L D E A R N E S S

Index Site:

62 56 27.75 (lat) 151 14 46.20 (long)

Survey Monument "HUNT"

Survey Monument "ACRE"



## Kahiltna Glacier Index Site



# Traleika Glacier Long-Term Index Measurement Site

Survey Monument "HARPER"



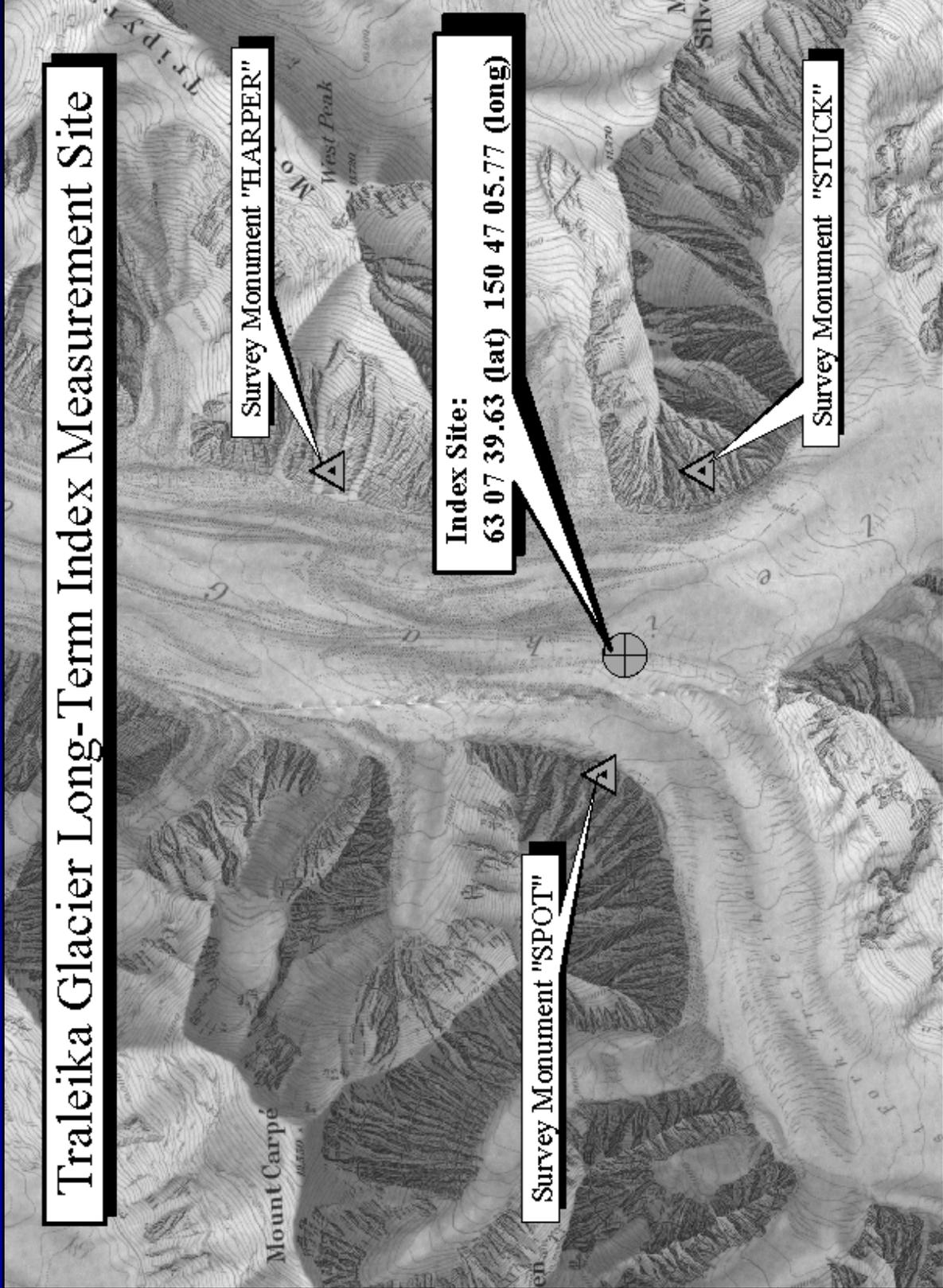
Index Site:  
63 07 39.63 (lat) 150 47 05.77 (long)



Survey Monument "STUCK"



Survey Monument "SPOT"

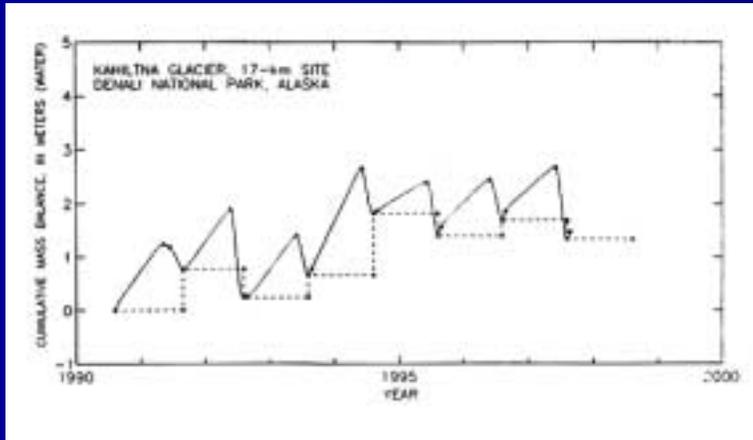


## Traleika Glacier Index Site

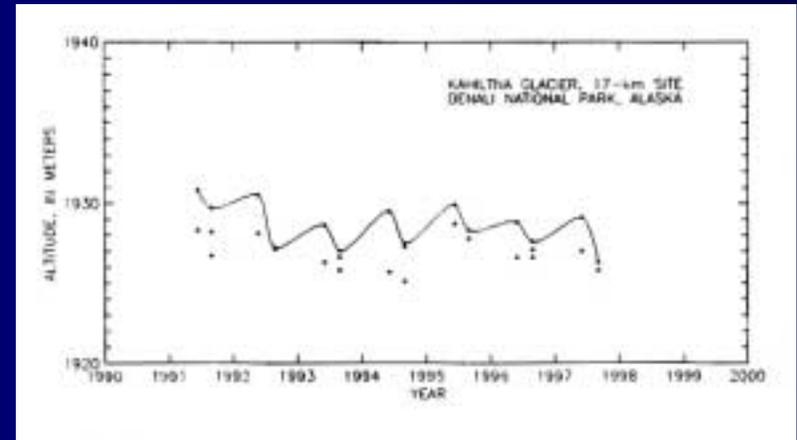


# Kahiltna Index Site Results 1991-'97

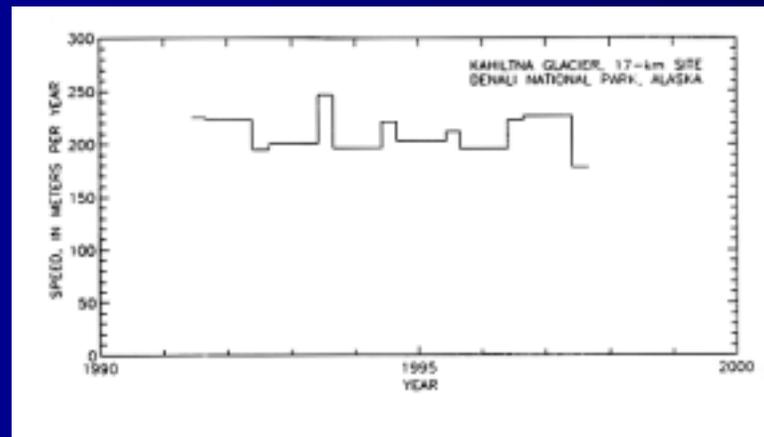
## Mass Balance



## Surface Height

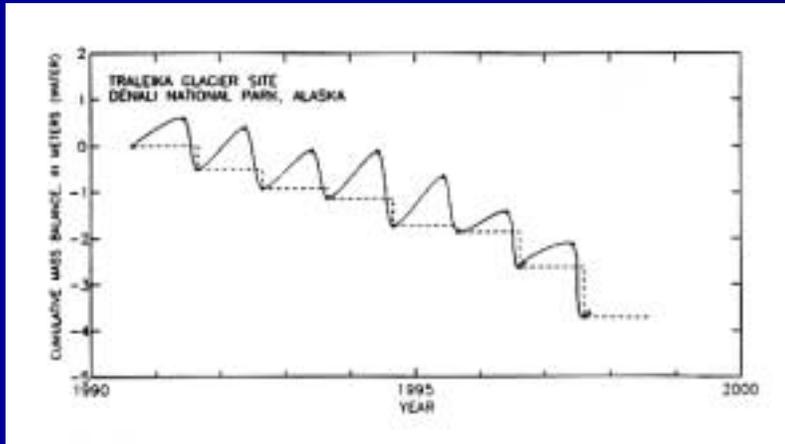


## Ice Velocity

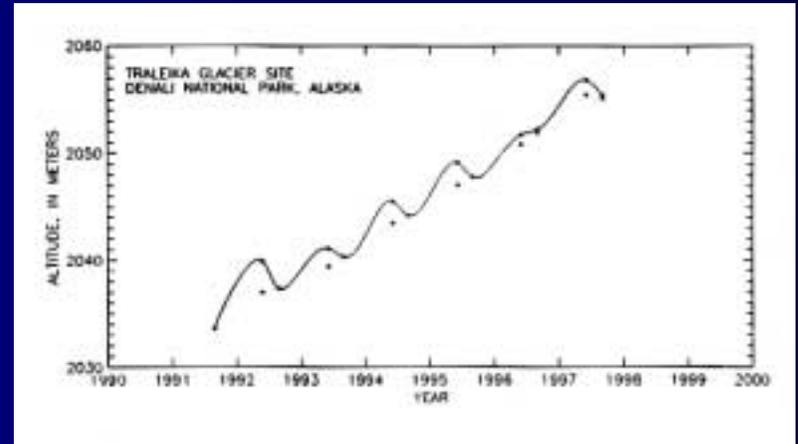


# Traleika Index Site Results 1991-'97

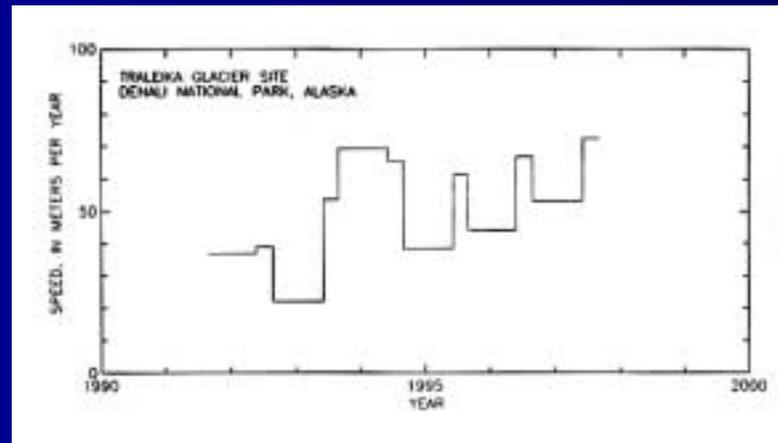
## Mass Balance



## Surface Height



## Ice Velocity



# Regional Equilibrium Line Altitudes

