

An aerial photograph showing the Arapahoe Glacier in a mountainous region. The glacier is a large, white, irregularly shaped mass in the foreground, surrounded by rocky terrain. Several small, turquoise-colored lakes are visible, some of which are partially covered by the glacier. In the background, more mountain ranges are visible under a clear sky. The text "Temporal Glacier Retreat: Arapahoe Glacier" is overlaid in orange, and "By: Alonso Chapa" is written below it in a smaller orange font.

# Temporal Glacier Retreat: Arapahoe Glacier

By: Alonso Chapa



# Introduction/Context

- The Arapahoe Glacier is the largest glacier in the state of Colorado
- Situated immediately southeast of the Arapahoe peak.
- 12,700 feet above sea level
- Crucial water source to Boulder and other nearby communities
- Has lost over 50% of its area over the past century



# Research question

How much has the Arapahoe Glacier retreated over the past decades?

What could be the root cause of this retreat?

What are the impacts of the shrinkage in its size?

# Methods

1

Finding spatial data pertaining to the Arapahoe Glacier using USG databases

- Landsat 5: 1984 data
- Landsat 8: 2020 data

2

Processing of imagery to highlight relevant features using QGIS

- Clipping
- NDSI (Normalized Difference Snow Index)

3

Running statistical analysis using Python and Excel

- Percent change
- Correlation coefficient
- Extrapolating models

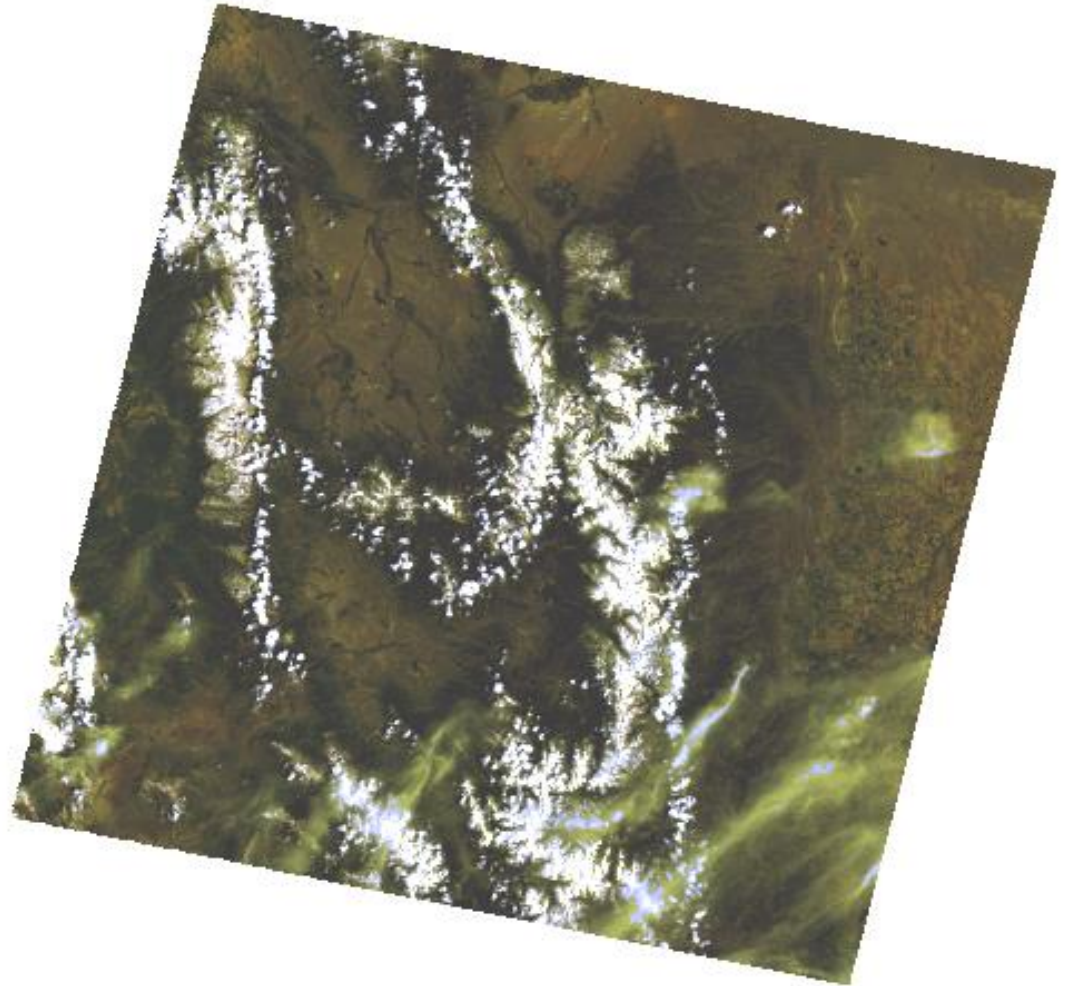


# Results: Raw imagery

2020



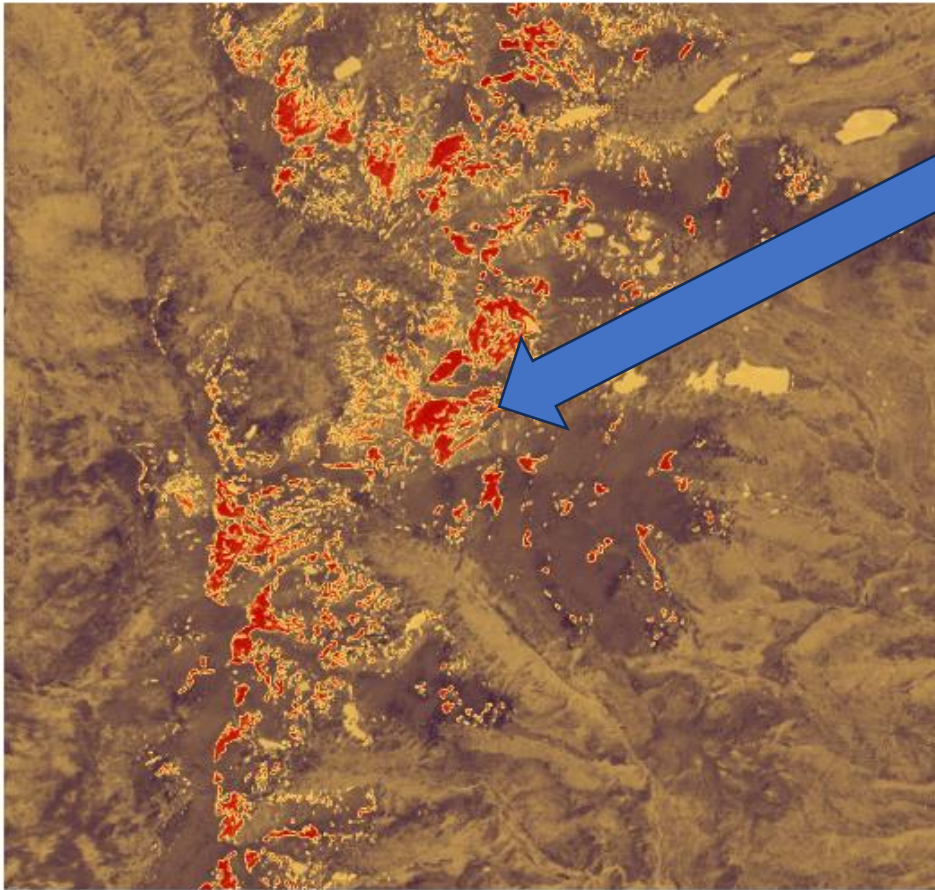
1984





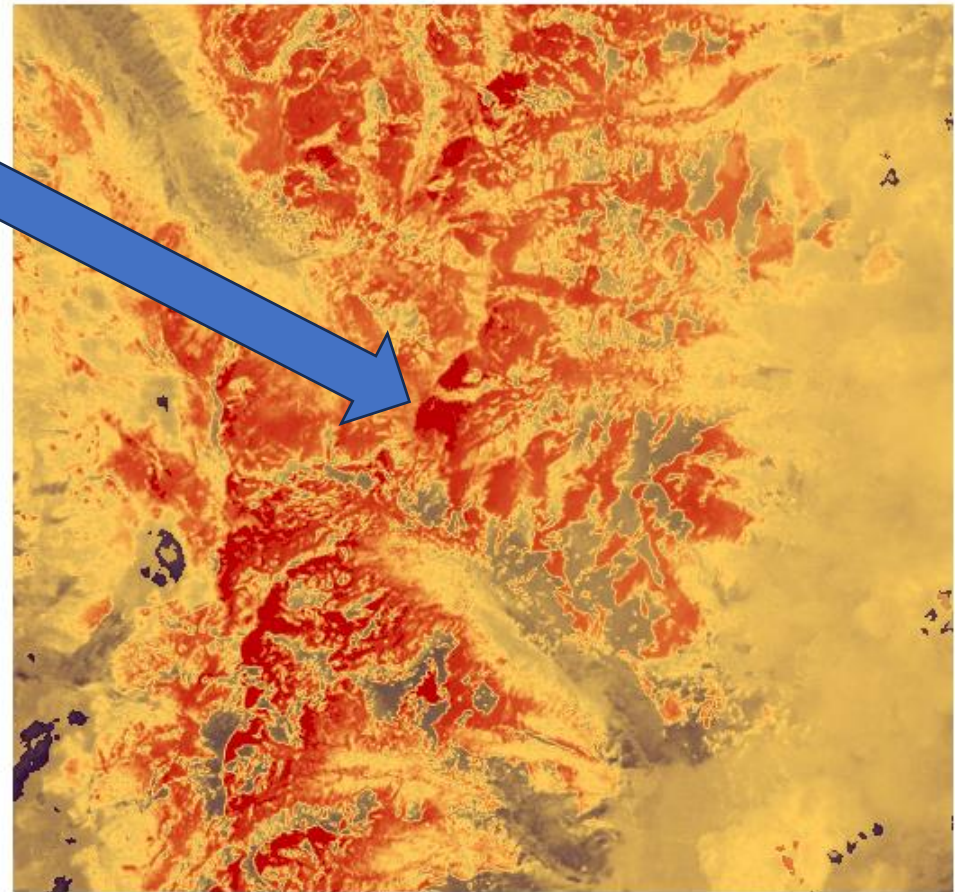
# Results: Final processed images

2020



Arapahoe  
Glacier

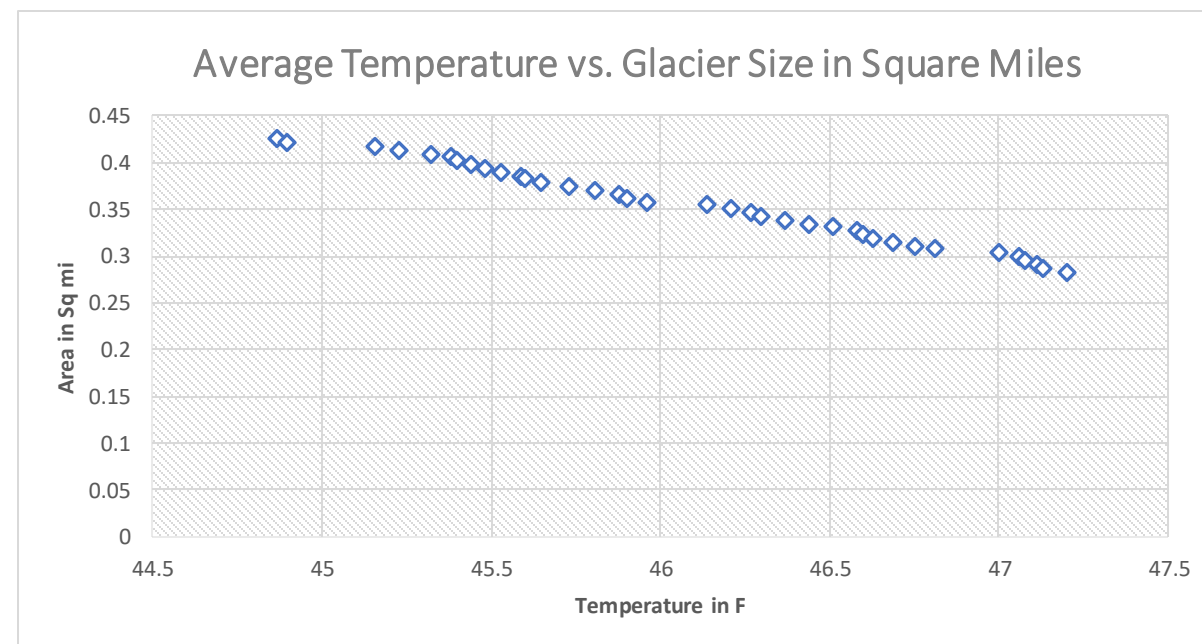
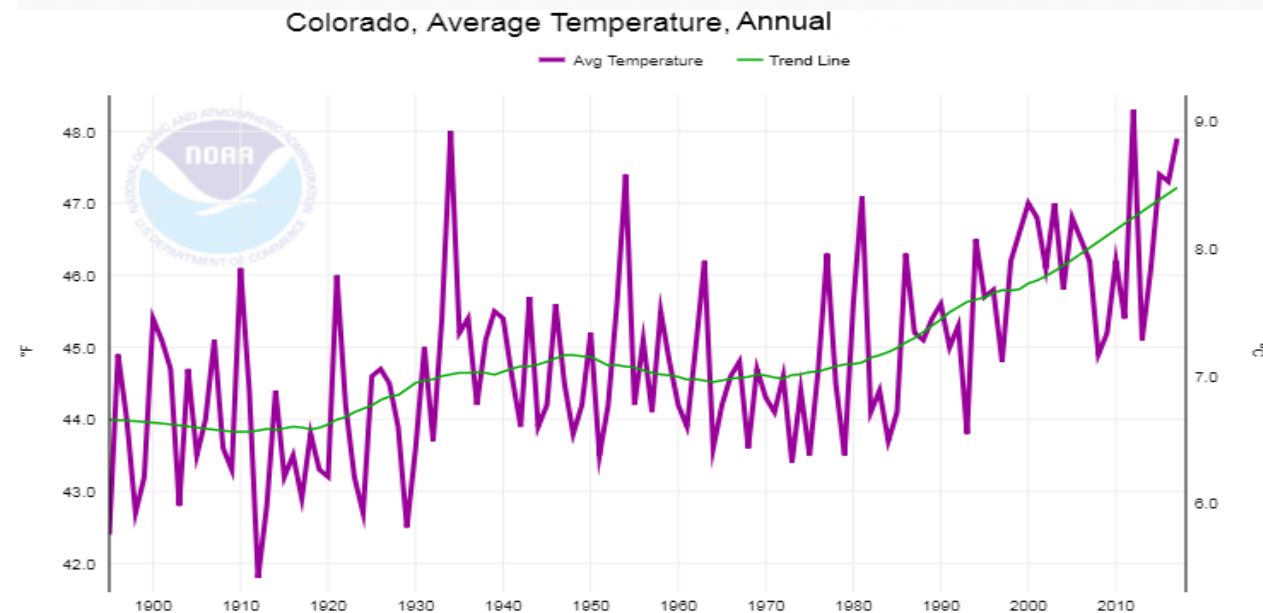
1984



# Analysis

```
[48] def FutureModel(years):  
    futureArea = Data_2020 - (diff_yearly*years)  
    PercentChange = (Data_2020 - futureArea) / Data_2020  
    if PercentChange > .999:  
        print("The glacier has melted completely during the summers")  
    else:  
        print("The predicted area of the Anapahoe Glacier in " + str(years) + " years from 2020 " + " is " + str(futureArea) + " square miles")  
        print("The predicted area of the Anapahoe Glacier in " + str(years) + " years from 2020 will have decreased by " + str(PercentChange))  
[53] FutureModel(73)  
The glacier has melted completely during the summers
```

- 33% decrease in size between 1984 and 2020
- Average 4% yearly decrease in area
- Predicted to be completely melted within the next 70 years
- 2.33 F average increase in temperatures between 1984 and 2020
- - 0.82 correlation between warming trends and glacial retreat





# Hydrograph

- No significant trend in terms of peak discharge curve
- Slight shift to the left ( Earlier snowmelt)

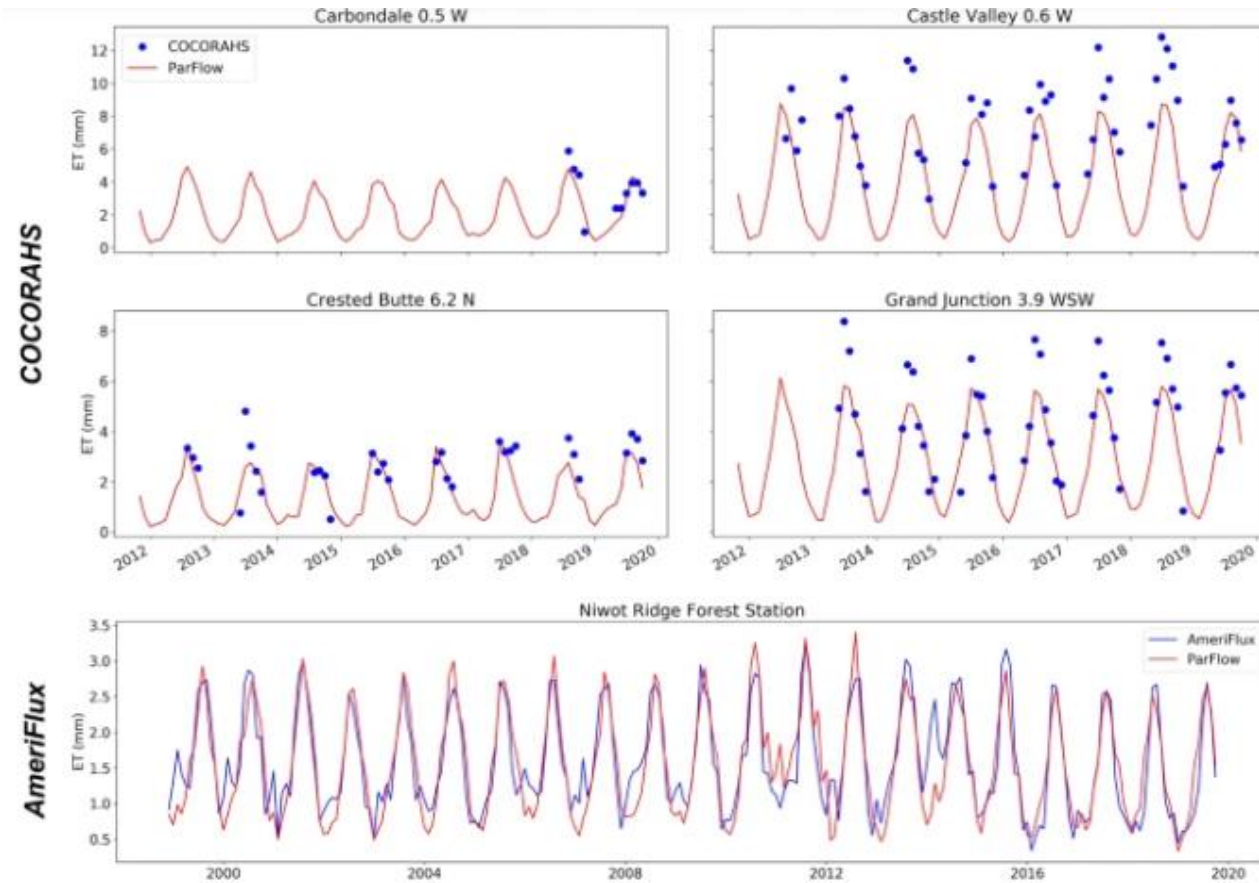
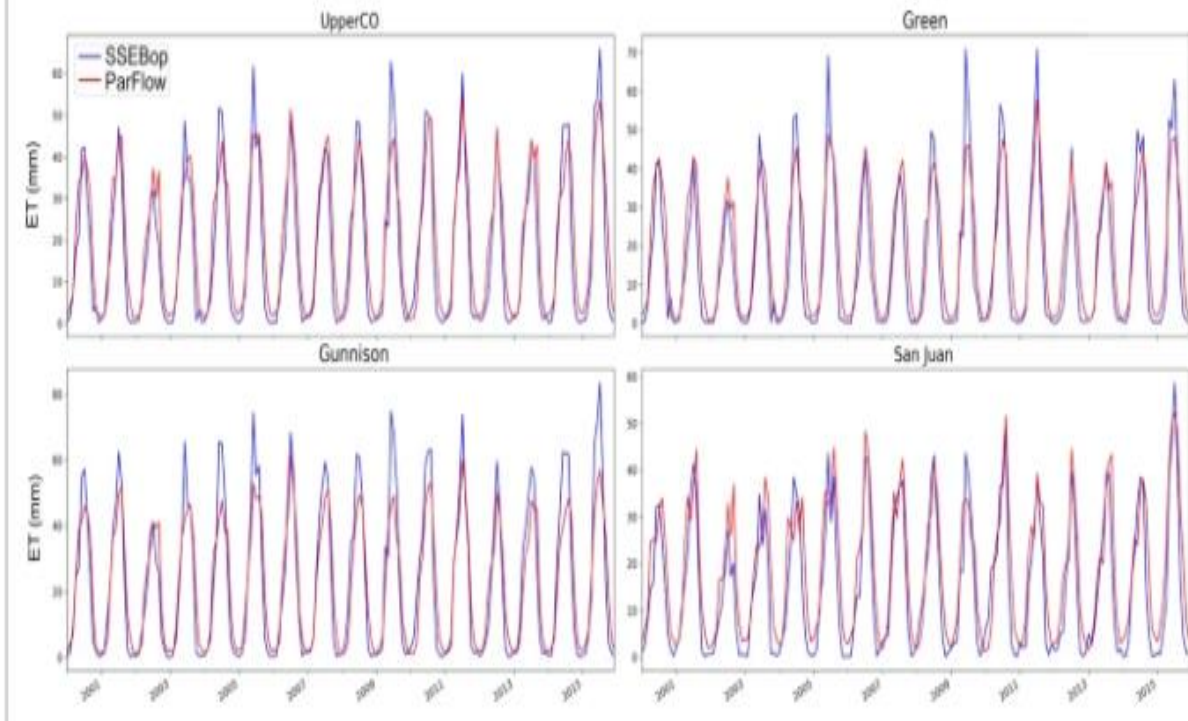


Fig. 12





# Conclusion

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- Glacial retreat impacts the water cycle
  - Decreased soil moisture
  - Lower river flows
  - Limited available drinking water
- Compromised agricultural yields
- Increased Wildfire risks
- Decreased albedo effect
  - Negative feedback loop



# References

- <https://www.nv5geospatialsoftware.com/docs/backgroundotherindices.html#Normaliz3>
- <https://waterknowledge.colostate.edu/climate/#tab-2of-3-temperatures>
- <https://www.fs.usda.gov/recarea/arp/recreation/hiking/recarea/?recid=28268&actid=51>
- <https://red.msudenver.edu/2021/the-case-of-the-disappearing-glaciers/#:~:text=Glaciers%20are%20an%20important%20water,increased%20competition%20for%20water%20rights>.
- <https://www.nature.com/articles/s41597-022-01123-w#Abs1>
- <https://earthexplorer.usgs.gov/>