

ES322 Glaciers and Climate Change Lab Case Study – Grinnell Glacier, Montana

Introduction: Glaciers are ephemeral climate-related features that dramatically imprint the shape of the landscape over time. This investigation examines the historical changes to Grinnell Glacier in Glacier National Park, Montana (Figure 1). Grinnell Glacier is one of the largest remaining glaciers in the park, even though it is less than a square mile in area.

Historical Field Mapping: First measurements of glaciers in Glacier National Park were conducted as part of topographic field mapping in 1900. From the early 1900's to the 1960's, several scientists working with the National Park Service created a photographic archive of glaciers, with re-surveying on a regular basis throughout the 1900's. See the attached map (Figure 2) showing the position of the glacial front historically during the early and mid-1900's (The map is from U. S. Geological Survey Professional Paper 1180: Grinnell and Sperry Glaciers, Glacier National Park, Montana: a Record of Vanishing Ice, published by the USGS in 1980). (Several copies of a larger format version of this map are available in the lab for use, but do not remove from room so everyone can share).

Part I: Initial Observations and Predictions

Consider the attached aerial photo (Figure 3) of Grinnell Glacier, showing the areas it covered in 1850, 1937, 1968, and 1993. Note that the map in Figure 2 shows glacial front positions for 1887, 1937, 1946, 1960, and 1968.

Has this glacier been advancing or retreating over time? What factors control glacial advance and retreat?

How does the photo record relate to current theories about global climate change and human impacts to the global carbon budget.

Based on the photo evidence, in approximately what year do you think that Grinnell Glacier will be completely transformed? How did you come up with your estimate?

Part II: Data Collection and Analysis

Divide into 6 teams of 2, each team will select one of the following years: 1887, 1937, 1946, 1960, 1968, or 1993. Using a copy of Figure 2, highlight and outline the extent of Grinnell Glacier for your year. Then carefully cut out your glacier outline or trace it directly onto the 10 x 10 graph paper available on the class web site. Then count the number of squares of graph paper contained within your traced outline. Count every full square and any square that is more than halfway in your traced outline. The total should be very close to the surface area of Grinnell Glacier that year, in "squares." Determine the following (SHOW ALL OF YOUR MATH WORK):

Year of Glacial Front Used in Analysis: _____
 Total No. of Graph Squares: _____
 Map Scale of Figure 2: 1 inch = _____ meters on ground
 1 square inch on graph = _____ square meters on the ground
 No. of Graph Squares per square inch = _____
 No. of square meters per graph square: _____
 Total Scaled Area of Active Glacier for your year in square meters: _____
 Total scaled area of active glacier for your year in square kilometers: _____
 Distance of glacial front in your year, from upper most elevation of ice (m) _____
 Distance of glacial front in your year, from upper most elevation of ice (km) _____

Sharing data with other teams, complete the table below:

Grinnell Glacier Summary Data:

Year	Area of Active Glacier (sq. meters)	Area of Active Glacier (sq. km)	Distance of front from origin (km)
1887	_____	_____	_____
1937	_____	_____	_____
1946	_____	_____	_____
1960	_____	_____	_____
1968	_____	_____	_____
1993	_____	_____	_____

Using Excel, another favorite software package, or hand graphing techniques, create the following graphs:

Active Glacier Area (Y-axis) vs. Year (X-axis)

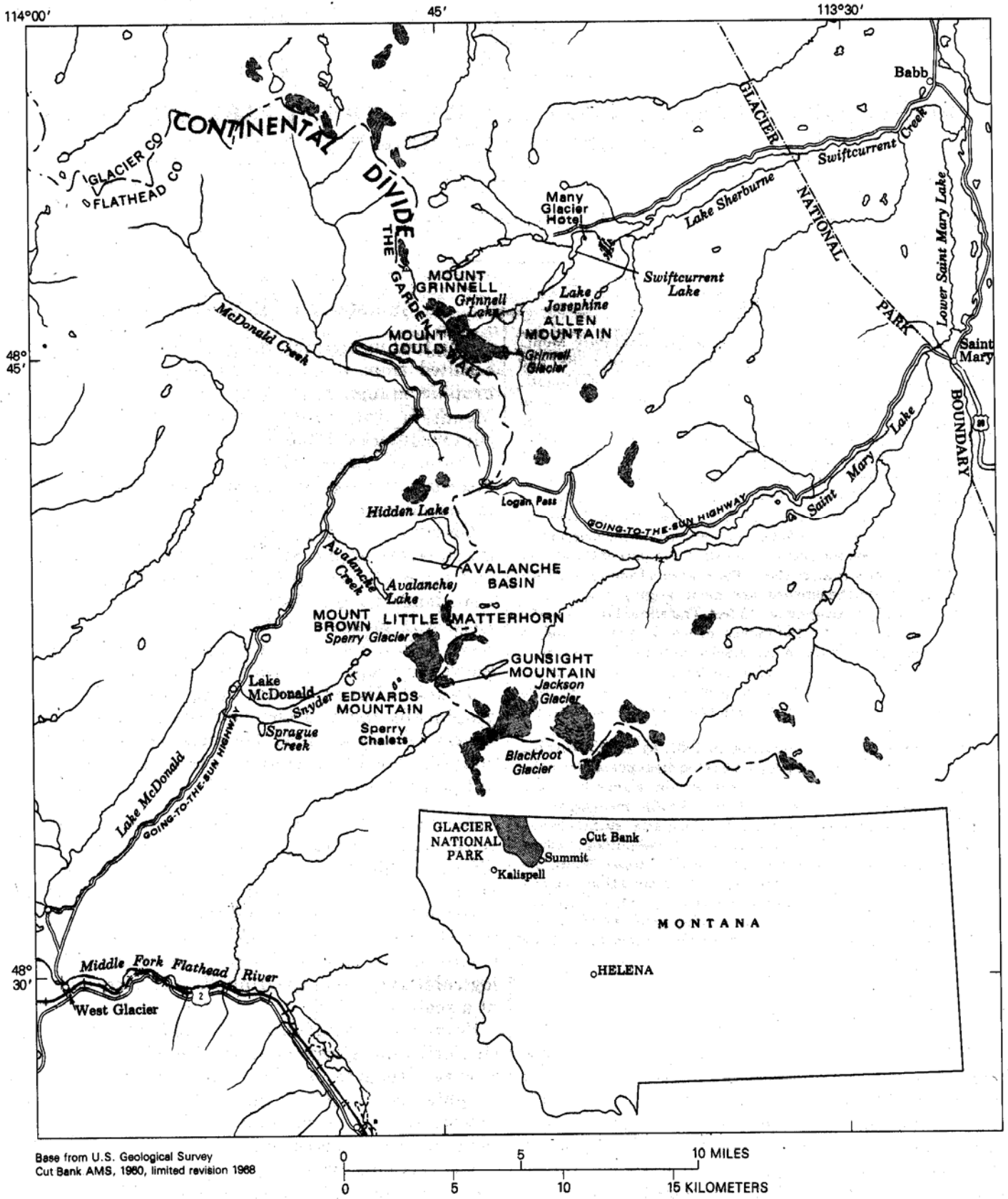
Distance of Front (Y-axis) vs. Year (X-axis)

Print your results and attach.

Part V: Interpretation

Write a 1-2 page summary of the results of your observation and analysis. In your analysis, provide a linkage between your observations at Grinnell glacier, and the historic global atmospheric temperature data depicted in the graph on Figure 4. Place your summary in the context of global climate change, possible causes for historic glacial retreat and Grinnell, and long-term implications from glacial analysis at Glacier National Park, MT.

GRINNELL AND SPERRY GLACIERS, MONTANA



Base from U.S. Geological Survey
Cut Bank AMS, 1960, limited revision 1968

FIGURE 1.—Index map of the central part of Glacier National Park, Mont., showing location of Grinnell and Sperry Glaciers. Base from U.S. Geological Survey Cut Bank 1° x 2° quadrangle map, 1960-68.

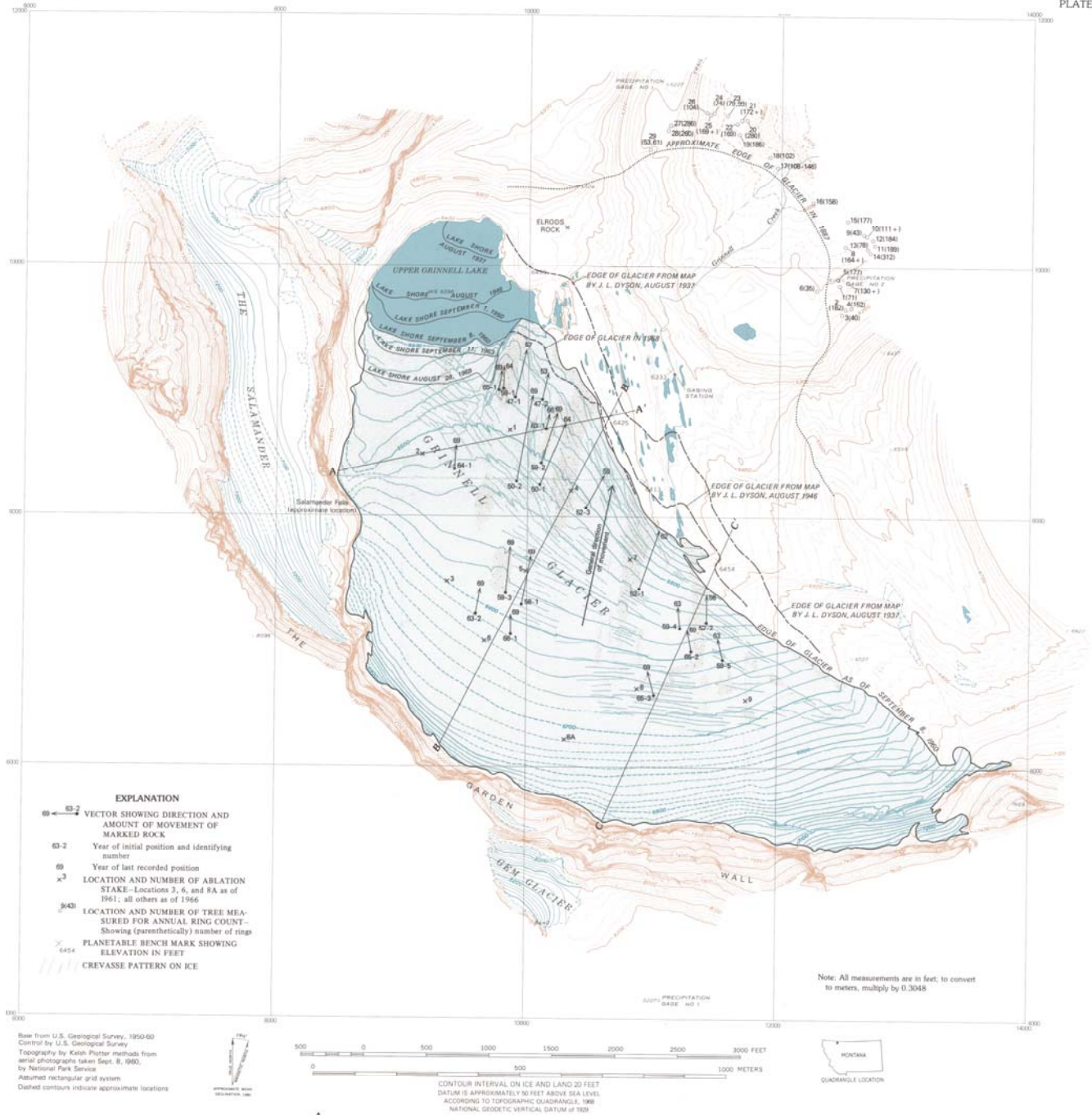
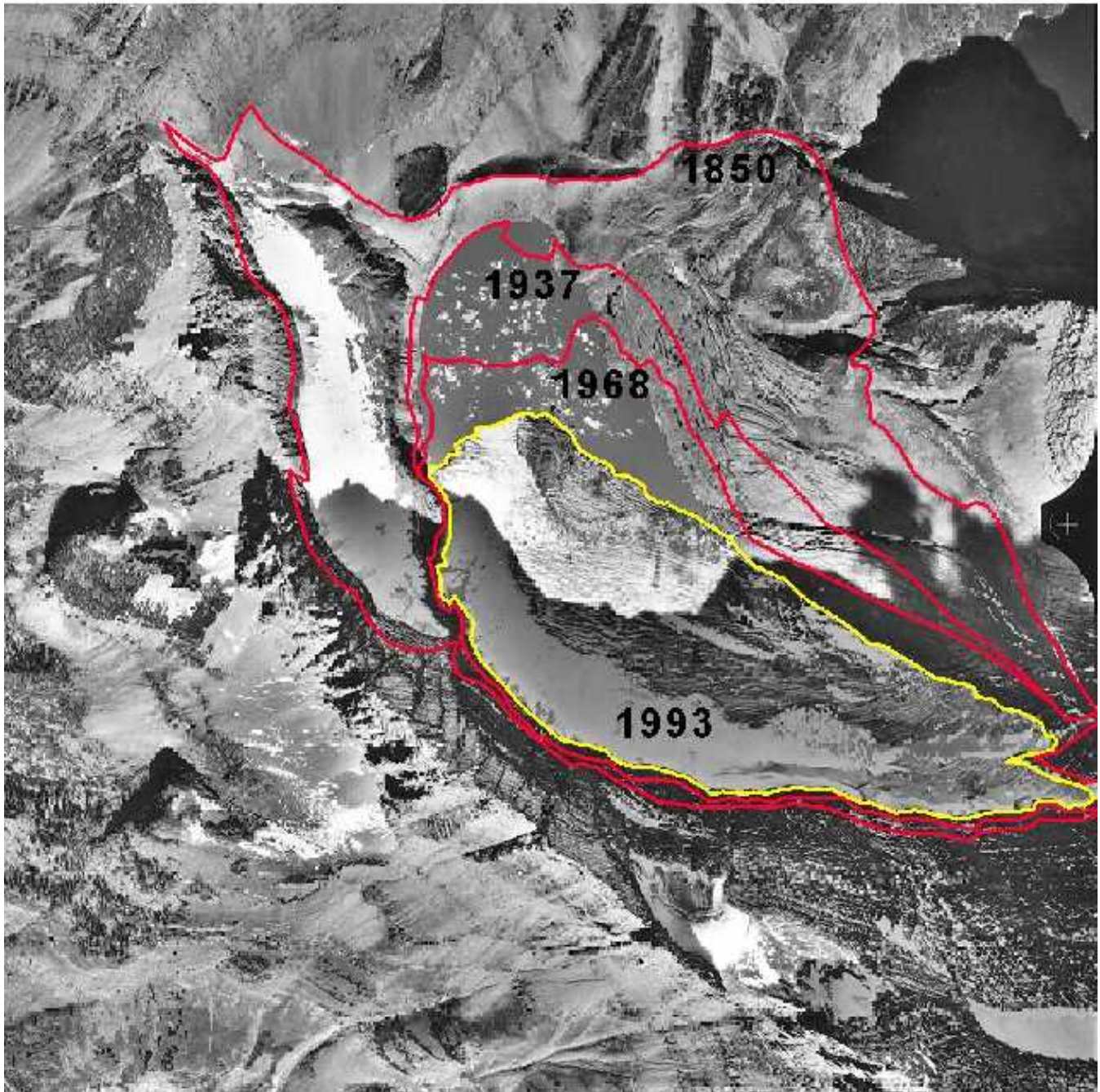


Figure 2 – Map showing historic locations of front of Grinnell Glacier, Montana.

Grinnell Glacier 1850-1993

Aerial View



Approx. Scale: 1:16342

Figure 3 – Historical photo base and locations of Grinnell Glacier lobe margins, 1850-1993.

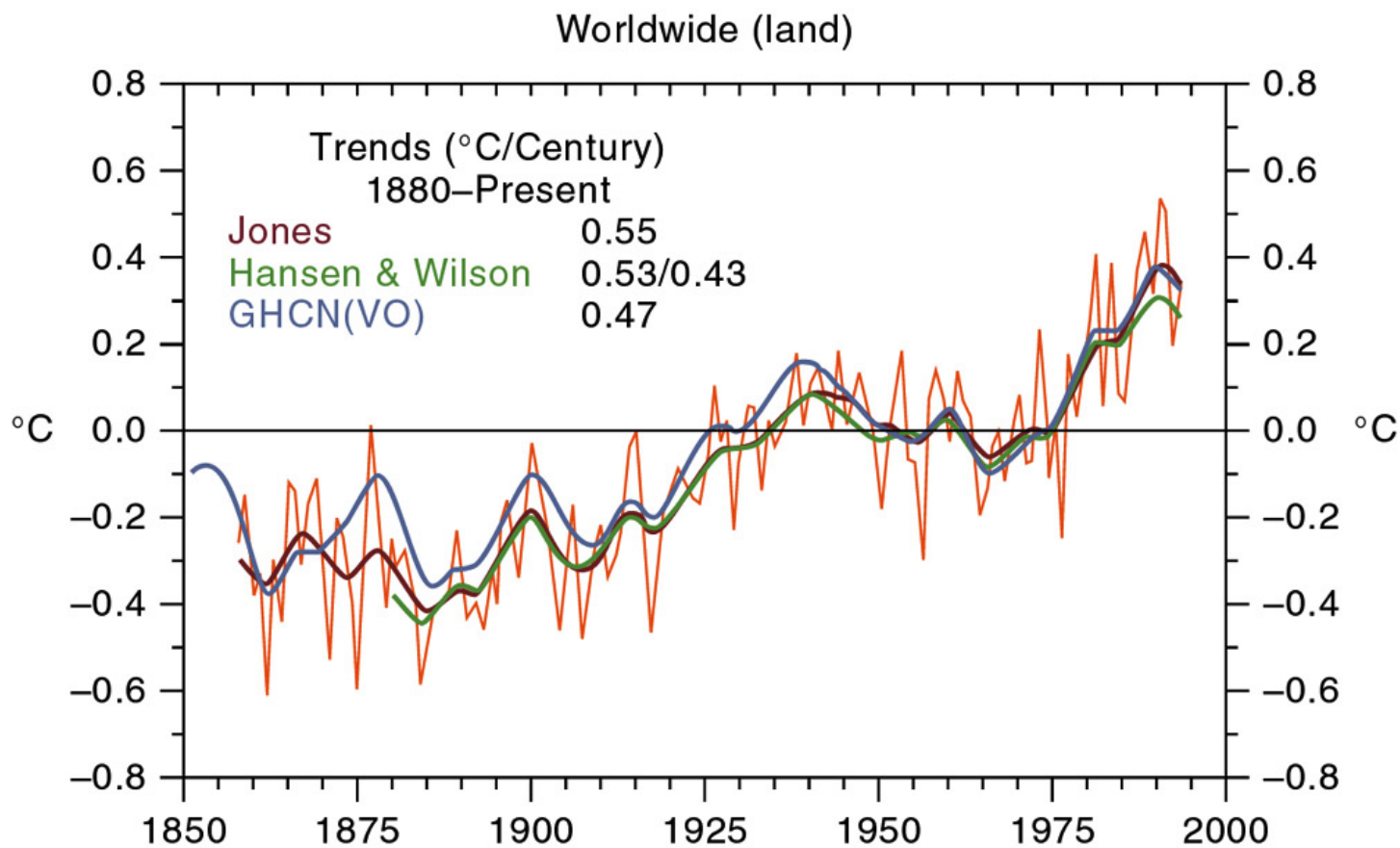


Figure 4 – Historical average atmospheric temperature on continental land masses, 1850-2000.

