Royal Holloway
Geography for Schools
Lecture Series

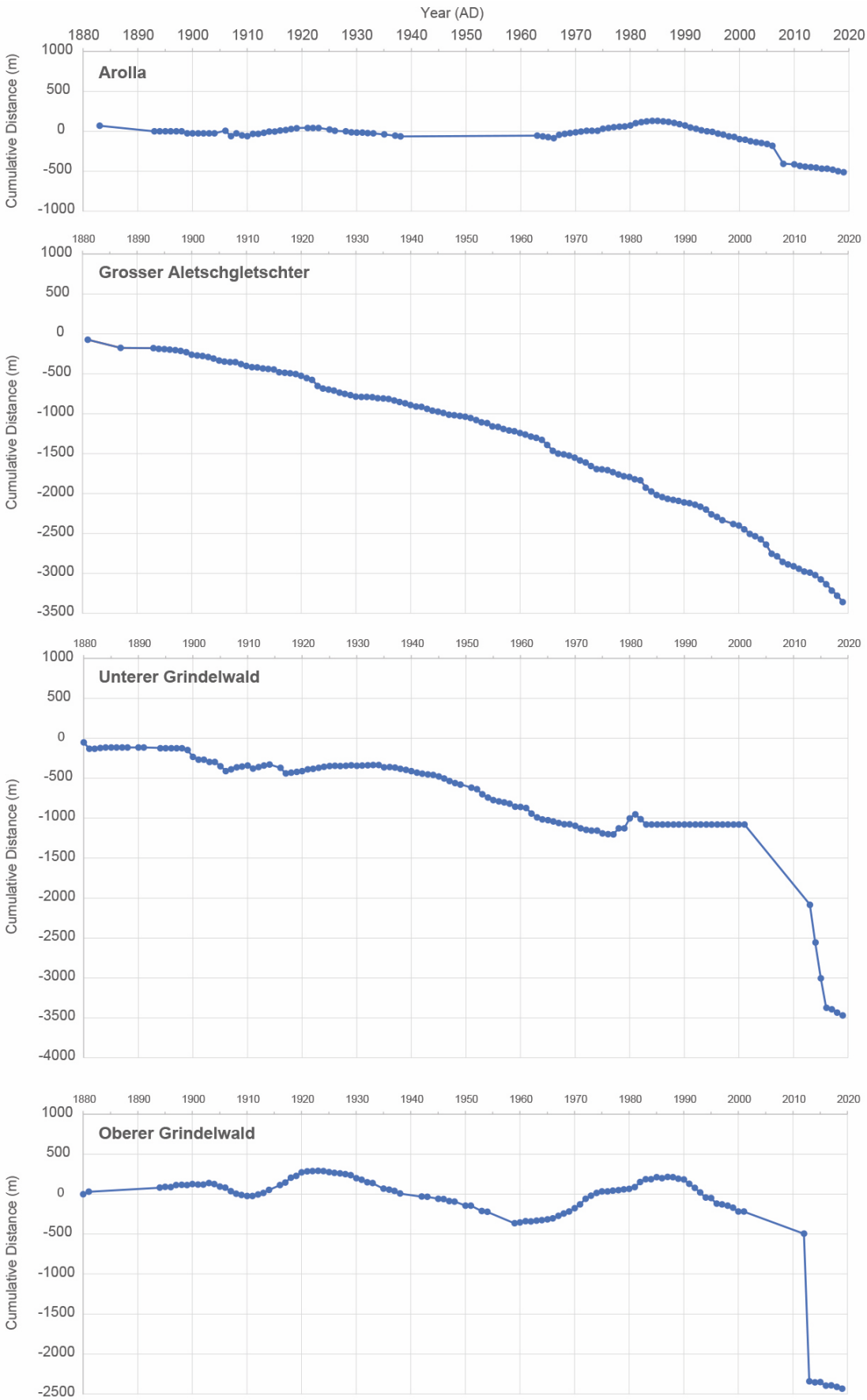
# Patterns of Ice Retreat

**Practical Exercise 1:**

**This exercise looks at a relatively short-time series of glacier front measurements in Switzerland. The following graphs show the cumulative distance (m) plotted against time (years AD) for four glaciers in Switzerland; Arolla, Grosser Aletschgletschter, Oberer Grindelwald and Unterer Grindelwald. All of the data start in the 1880's and end in 2019. The glaciers are all located relatively close to each other, and it might be expected that the behaviour of the glaciers through time will be like one another. The aim is to understand how to read the graphs and extract information about whether the ice is advancing or retreating and the rate at which this is occurring.**

**Tasks:**

1. **Use a map to find the location of each of the glaciers.**
2. **Are the glacier systems advancing or retreating over the ~140-year time window?**
3. **In the time window, starting at 1880 and ending in 2020, to the nearest 100 m calculate the total change in the position of the ice front. Which glacier has recorded the greatest change?**
4. **Is there any evidence for the glaciers advancing within this time window? If so, how many advances are there and when did the glacier reach its maximum position in relation to the start point?**
5. **In which decade is the retreat rate the fastest? Is this the same for all the glaciers?**




Arolla, Grosser Aletschgletschter, Oberer Grindelwald and Unterer Grindelwald Glaciers, Switzerland - 1880 - 2020.
Frontal variation of Glacier. Source WGMS.

**For more information about Geography at Royal Holloway visit: www.royalholloway.ac.uk/geography**

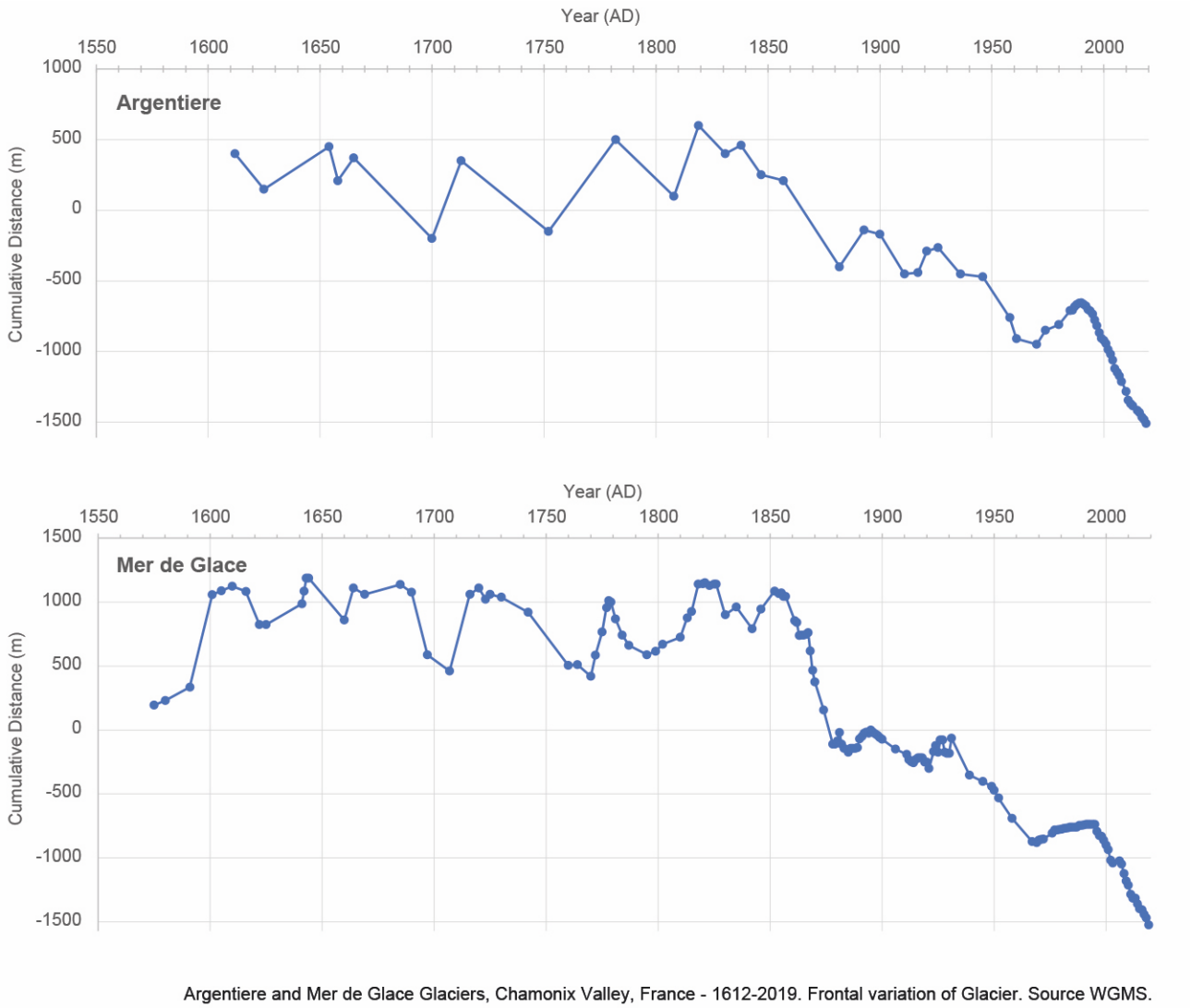
**Follow us: @RHULGeography**

**Practical Exercise 2:**

**We return to the European Alps but this time two glaciers in the Chamonix valley in France, Argentiere and Mer de Glace. These systems are spatially very close to each other and, compared to the Swiss glacier systems above, have longer time series of glacier change: we used the Mer de Glace in the lecture as an example as it has the longest observational record. Here we want to explore how the glacier system evolves over centuries, but remember some of the older observations are based on historic documents, pictures etc rather than direct observations or airborne surveys, and therefore the measurements are less precise and also there are fewer of them.**

**Tasks:**

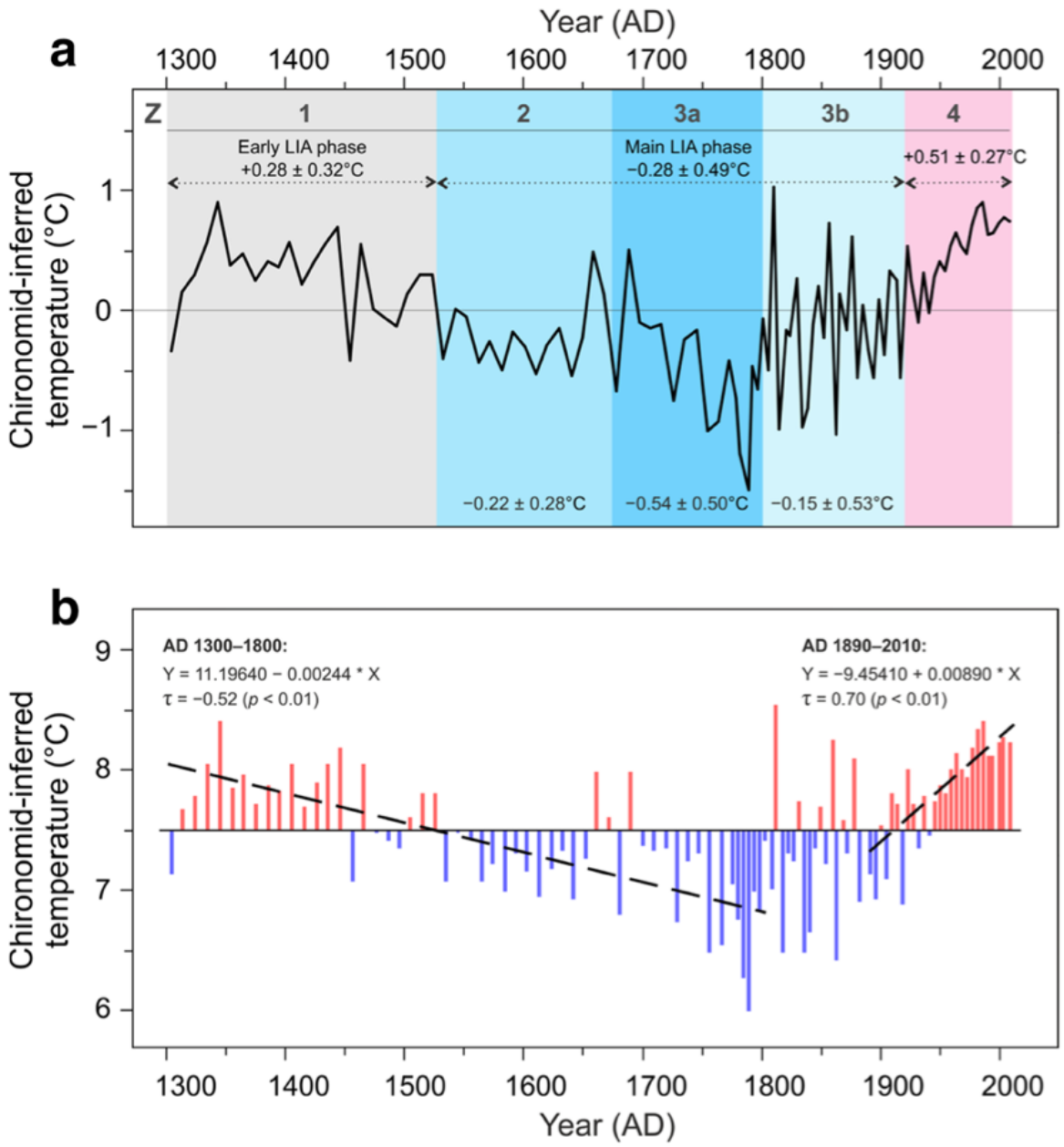
1. **Use a map to find the location of each of the glaciers.**
2. **Are the glacier systems advancing or retreating over the duration of the whole time window?**
3. **For the whole time window, to the nearest 100 m calculate the total change in the position of the ice front. Which glacier has recorded the greatest change?**
4. **Is there any evidence for the glaciers advancing within this time window? (Annotate the figure with an arrow where these advance periods are)**
    a. **If so, how many advances are there?**
    b. **When did the glacier's front reach its maximum position in relation to the start point?**
5. **In which decade is the retreat rate the fastest (you can visually estimate this)? Is this the same for both glaciers?**
6. ***The Little Ice Age is a climatic event that persisted for several centuries between 1530 and 1920 (Ilyashuk et al., 2019) where summer temperature estimates in the Austrian alps suggest a decrease of temperatures of up to ~1.5 °C within this period (See figure on page 5)***
    a. **Compare the Austrian temperature record to the Argentiere and Mer de Glace records. At centennial-scales, is the maximum glacier extent coincident with either warmer or cooler temperatures recorded in the Austrian Alps?**
    b. **Based on your answer to 6a, is the mass balance of the Mer de Glace glacier negative, positive or in balance during the following periods:**
        i. **1590-1600**
        ii. **1730-1760**
        iii. **1800-1830**
        iv. **1890-1900**
        v. **2000-2020**




Argentiere and Mer de Glace Glaciers, Chamonix Valley, France - 1612-2019. Frontal variation of Glacier. Source WGMS.

**For more information about Geography at Royal Holloway visit: www.royalholloway.ac.uk/geography**

**Follow us: @RHULGeography**




*Austrian Temperature record for the Little Ice Age Ilyashuk et al. (2019). The average temperature of 7.5 °C*

**For more information about Geography at Royal Holloway visit: www.royalholloway.ac.uk/geography**

**Follow us: @RHULGeography**