Pioneering glaciological research by scientists and artists in the 18th/19th century – examples from the European Alps

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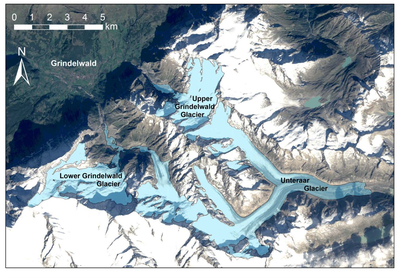
During the Little Ice Age (LIA), the attractiveness of glacier landscapes and the easy accessibility made various glaciers desirable objects of study for scientists, artists, and tourists. From this period, a wealth of pictorial and other historical documents are available for the Mer de Glace (Mont Blanc massif, France) as well as for the Grindelwald Glaciers and the Unteraar Glacier (Bernese Oberland, Switzerland).



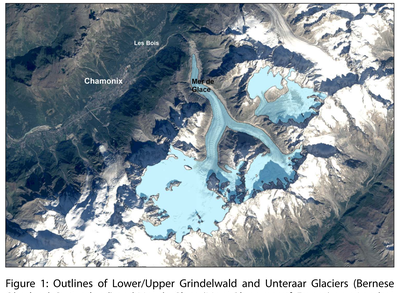


Figure 1: Outlines of Lower/Upper Grindelwald and Unteraar Glaciers (Bernese Oberland, Switzerland) and Mer de Glace (Mont Blanc massif, France) on a Landsat 5 satellite image from 25 September 2013 (source: U.S. Geological Survey).

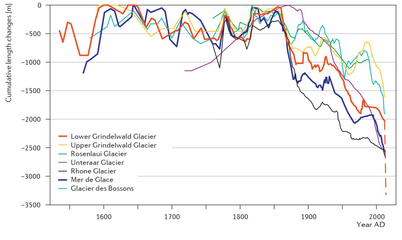


Figure 9: Glacier length changes based on historical documents (data: Zumbühl 1980; Zumbühl *et al.* 1983, 2016; Zumbühl and Holzhauser 1988; Nussbaumer *et al.* 2007; Nussbaumer and Zumbühl 2012).

Grindelwald: first glacier measurement and idealistic-realistic glacier landscapes

Probably for the first time in history of glaciology, the advancing of ice masses was measured at the Upper Grindelwald Glacier in 1773 by a shepherd boy and not a savant. Bernhard Friedrich Kuhn (1762–1825), a legal scholar and statesman born in Grindelwald, describes this measurement in his essay "An attempt on the mechanisms of glaciers":

> "A shepherd boy of about 15 years guarded his goats in 1773 near the Upper Grindelwald Glacier. He had heard of the then very rapid advance of the glaciers and the concerns of the local inhabitants, and sometimes even believed that they were approaching the neighbouring objects. His curiosity drove him to investigate this phenomenon a little closer. To this end he measured the distance of a landmark boulder from the glacier, and always noted the distances by the length of his stick with a stone. He visited the marks daily, and saw one after the other disappear under the ice. […]" (Kuhn in Höpfner 1787)

This glacier advance culminating in 1778/79 is documented impressively on a big panorama painting by Caspar Wolf (1735–1783). Caspar Wolf was the most important Swiss painter of the Alps in this period. Trained in Paris by the famous Joseph Vernet (well known for his fantastic seascapes), Wolf was commissioned to produce about 200 paintings, which he performed from 1773/74 to 1779. Of these, 61 depict glaciers in the Bernese Alps, mostly advancing at the time. These masterpieces show in an impressive way how glacier landscapes can be presented scientifically precise but also artistically idealized.

On his travels the painter was accompanied by either Abraham Wagner, his patron or Jakob Samuel Wyttenbach (1748–1830), a parson and one of the most important naturalists of that time in Berne. These field companions had a direct impact on the content of the paintings of Wolf. In the time when Wolf was making drawings or paintings, Wyttenbach was conducting topographical, geomorphological, and meteorological observations. Thanks to the unique collection of oil paintings by Wolf, probably the most famous artist of Alpine landscapes at that time, the advances of several Alpine glaciers are richly documented.

Figure 2: C. Wolf: semi-panorama of Grindelwald with Upper and Lower Glaciers between Wetterhorn, Mettenberg, and Eiger (1774 and/or 1776; oil on canvas; Aargauer Kunsthaus Aarau).

Figure 3: C. Wolf: Finsteraar Glacier in 1774 with view to the Finsteraarhorn (oil on canvas; private collection/photo provided by Kunstmuseum Basel).

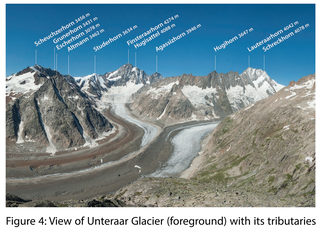


Figure 4: View of Unteraar Glacier (foreground) with its tributaries Lauteraar Glacier (right) and Finsteraar Glacier (left), with the Finsteraarhorn towering over the surrounding peaks named after famous researchers (photo A. Wipf, 29 July 2009).

Mer de Glace: scientific and artistic discoveries in the Mont Blanc area

Due to its central role in the history of alpinism, the Mont Blanc massif was the subject of several early studies, making it one of the best-documented mountain regions in the Alps. The first detailed descriptions of the area were made by the English travellers William Windham and Richard Pococke (1744), followed by, among others, the Frenchman Pierre Martel (1744) and Genevois Marc Théodore Bourrit (1787). Horace-Bénédict de Saussure set a milestone with his natural history masterpiece "Voyages dans les Alpes" (de Saussure, 1779–1796). These works contain the first descriptions of moraine ridges, glacier length fluctuations, and statements made by local people regarding the area's glaciers.

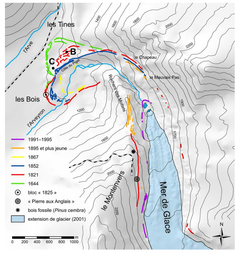


Figure 5: Schematic map of the Mer de Glace frontal area with different moraines and the approximate locations of the former hamlets Châtelard (C) and Bonanay (B) (Nussbaumer *et al.* 2012).

During this time, works by the prominent landscape artist Jean-Antoine Linck (1766–1843) from Geneva are of particular value for the LIA glacier history. Linck visited the Chamonix Valley and its glaciers on several journeys and depicted both the retreated stage of the Mer de Glace before 1800 and the subsequent re-advance at the beginning of the 19th century.

Figure 6: Frontal view of the Mer de Glace (a) around 1804, drawn with pencil, watercolour and gouache by J.-A. Linck (private collection) and (b) in August 1823, drawn with pencil, pen, watercolour, and opaque white by S. Birmann, with the village of Les Bois (Kunstmuseum Basel, Kuperstichkabinett).

According to the findings of Viollet-le-Duc (1876), from 1812 to 1817 the winters were long and severe in the valley of Chamonix and the summers were wet, particularly in 1816, the infamous "year without a summer" which followed the 1815 eruption of Mount Tambora. Consistent with these meteorological observations, the Mer de Glace advanced during this period (mainly between 1810 and 1820) to just 40 m short of the 1644 LIA maximum, as documented by several drawings by Linck (made around 1820) and Birmann (made in 1823).
The famous Swiss landscape artist Samuel Birmann (1793–1847) was full of enthusiasm for the Glacier des Bois. His notebook contains detailed descriptions of the glacier approaching the village of Les Bois by 20 steps before retreating after 1821. Several photographically accurate drawings made from different viewing positions allow a meticulous reconstruction of the glacier margin in 1823.

Unteraar Glacier: the beginning of modern glacier research

Systematic observations on the Unteraar Glacier began with the fieldwork of the naturalist Franz Josef Hugi (1796–1855) between 1827 and 1831. He made the first observations on the surface velocity of the glacier (1830). When his successor, Louis Agassiz (1807–1873), visited the glacier in 1839, he found to his surprise that Hugi's hut on the medial moraine (it was the same place which Wolf and Wyttenbach had visited 65 years earlier) had moved since 1827, an important indication of glacier movement.

Between 1840 and 1845, Agassiz conducted a research programme on the glacier that marks the beginning of modern experimental glaciology. The study, performed by an interdisciplinary team, was in part to support Agassiz' theory of ice ages. In 1842, Agassiz and geometrician Johannes Wild realized a map of Unteraar Glacier at 1:10,000 scale, probably the first detailed scientific map of a glacier. This lithograph in black and blue, an aesthetic masterpiece, depicts 8 km of the glacier tongue with a large number of surface glaciological features and a representation of surface slopes by a system of hatched lines. Another research team member, artist Jacques Bourckhardt, drew a very precise panorama in 1842 of the Lauteraar and Finsteraar Glaciers from Mieselenegg, including the "Hôtel des Neuchâtelois" – a big boulder and besides a tent where Agassiz, his collaborators, and visitors lived during the research campaigns.

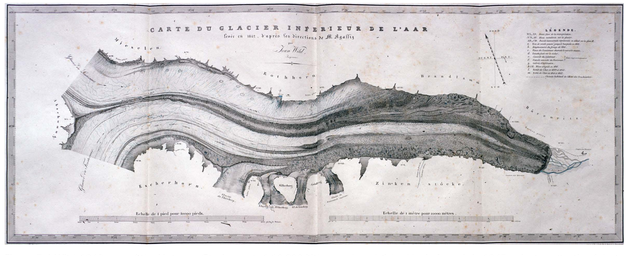


Figure 7: J. Wild: 1842 map of the Unteraar Glacier, scale 1:10,000 (lithograph, published by L. Agassiz in 1847; private collection/photo H. J. Zumbühl).

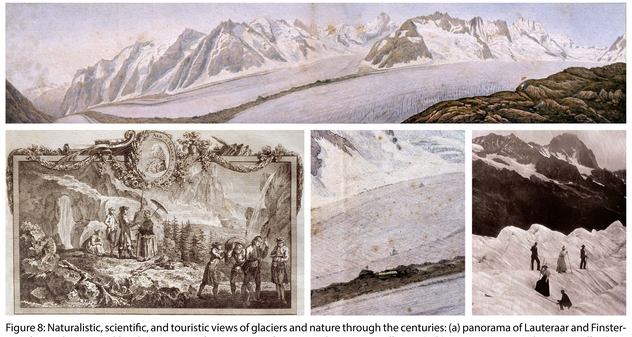


Figure 8: Naturalistic, scientific, and touristic views of glaciers and nature through the centuries: (a) panorama of Lauteraar and Finsteraar Glaciers by J. Bourckhardt (1842; pencil, pen, watercolour, gouache; private collection), (b) cover vignette with A. von Haller (medallion), A. Wagner, C. Wolf, and J. S. Wyttenbach working in Lauterbrunnen Valley (1777; etching; private collection), (c) detail from the panorama by Bourckhardt showing the rock and the tent ("Hôtel des Neuchâtelois") used as a research field station by Agassiz and his collaborators, and (d) group of tourists with mountain guide on the Lower Grindelwald Glacier (end of 19th century; photograph; private collection).