Little Ice Age – extreme weather in Fennoscandia and its impacts on society

Large volcanic eruptions are the major drivers of natural climate variability in the pre-industrial era (Hegerl et al 2006; Schurrer et al 2014). They lead to abrupt surface cooling and change the distribution and intensity of precipitation (Iles et al., 2014; Kim et al., 2021). They are thought to be responsible for the onset, severity and duration of the Little Ice Age (c. 1450-1850) and several similar Little-Ice-Age like periods during the Holocene (van Dijk et al 2024) maintained by sea-ice and ocean feedback (Zhong et al 2011; Miller et al 2012). Global and hemispheric volcanic climate impacts are widely studied but less is known about their regional climate and extreme weather effects. Regional case studies over Southern Norway have aimed to link post-volcanic climate anomalies in the mid-6th century with simulated reductions in growing degree days across different climate regimes and topography to show a wide range of agricultural susceptibly to externally forced climate extreme (van Dijk et al. 2023). Yet there are no daily observations to benchmark the model simulations. Long-term high-resolution observations of meteorological variables are, therefore, crucial for studying historical climate variability, understanding the occurrence of past extremes, and assessing their impacts on, for example, hydrology and agriculture. Data rescue efforts uncovered numerous daily observational records for the 18th and 19th centuries that are, however, sparse in spatial coverage especially outside of Central Europe (Imfeld & Brönnimann 2025). Yet such high-resolved data of daily weather have recently proven valuable to explore the effects of volcanic eruptions on weather extremes following large volcanic eruptions such as Tambora (1815), Laki (1783-1784) or Tarumae (1739) with a geographic focus on Central Europe (Brönnimann et al 2024; Franke et al., in review; Stucki et al 2024).

This project will explore extreme weather events in Fennoscandia following selected volcanic eruptions such as in 1739, 1783-1784 and 1815. The summer students will digitize and homogenize new and use existing daily instrumental data (e.g. wind speed and direction, T_{min}, T_{max}, pressure, rain/drought and frost/hot days) and documentary data (e.g. the freezing and thawing dates of rivers and lakes, frost days, sunshine duration, cloudiness) to explore the fine-grained anatomy of volcanic extremes over Fennoscandia. Instrumental data for Fennoscandia go back to 1722 (Uppsala; Bergstöm & Moberg 2002), though not all records may be digitized. We will also use existing global compilations of instrumental and documentary records from the ModE-RA paleo-reanalysis (Valler et al 2024) and if available also daily Paleo Model Intercomparison Project 4 (PMIP4) and historical (1750-2014) model data (Marshall et al 2025; Ballinger et al 2026). The obtained data will be critical for the NORCLI and Clim-SHOCK projects to assess the pathways of societal responses to volcanic induced extreme weather.

Number of participants: 2

Supervisors Dr. Michael Sigl, Dr. Johannes Hardeng, Prof. Kirstin Krüger (NORCLI / Clim-SHOCK projects)

Number of projects: 2

Preferred project period: June - September 2026

Preferred background: Climate, Atmosphere, Ocean-Sea Ice, Environment, History

Outline of project work / deliverables:

1. Study and search literature for extreme weather events in Fennoscandia during the late LIA.
2. Define major volcanic events and periods to focus on during the late LIA.

3. Search for daily meteorological data for extreme weather events during the late LIA.
4. Visit libraries to digitize relevant written documents (e.g. Stockholm).
5. Digitize and homogenize the new and existing daily instrumental data.
6. Analyze, homogenize and visualize daily meteorological instrumental data with respect to:
   -Climatology and extremes in Fennoscandia
   -Compare with other available data from written documents and climate modelling.
   -Explore potential effects on agriculture and society (e.g. changes in growing degree days and frost occurrence relative to relevant agricultural and societal records such as crop yields and prices).
7. Participate in NORCLI-Clim-SHOCK seminars.
8. Deliver a popular science product in form of an oral/poster presentation or a contribution to a museum exhibition.

References

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Zhong, Y., et al. *Clim Dyn*, 37, 2373–2387, 2011.

Project summary:

Large volcanic eruptions are the major drivers of natural climate variability in the pre-industrial era. They lead to abrupt surface cooling and change the distribution and intensity of precipitation. They are thought to be responsible for the onset, severity and duration of the Little Ice Age (c. 1450-1850) maintained by sea-ice and ocean feedback. Global and hemispheric volcanic climate impacts have been widely studied but less is known about their regional climate and extreme weather effects.

This summer research project will explore extreme weather events in Fennoscandia following large volcanic eruptions such as 1739 Tarumae, 1783-1784 Laki, and 1815 Tambora. The summer students will search for new and existing daily instrumental meteorological and documentary written data to explore volcanic cold extremes over Fennoscandia. Instrumental data for Fennoscandia go back to the 18th century (f.e., 1722 Uppsala). They will also use the existing meteorological paleo-reanalysis ModE-RA and if available historical climate model data both on daily resolution. The obtained data will be critical to assess the pathways of societal responses to volcanic induced extreme weather.