

## Topics for BSc or MSc theses in climatology, 2020

Title	<b>Homogenisaiton of long Swiss temperature series</b>
Level	BSc or MSc (several theses)
Prerequisites	Statistics, R, climatology
Methods	Data processing, statistical analyses
Description	In the past few years old Swiss meteorological measurement series (reaching back beyond 1863) have been digitised in our group. Often these series consist of overlapping segments from different observers. The next step now is to homogenise the series and form one long, consistent meteorological series. In this thesis (or several theses, as we have several series) the series from Basel (Zurich, Aarau, Schaffhausen etc.) will be homogenised. A further possible goal could be to form a combined „Swiss“ series.
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Title	<b>Historical forest fires in the Canton of Bern</b>
Level	prerefably MSc (several theses)
Prerequisites	Historical interest, statistics, climatology
Methods	Historical analysis, archive work, data processing, statistical analyses,
Description	The risk posed by forest fires might increase in a future climate, i.e., due to a change in the hazard. The largest (in terms of area burnt) forest fires in the Canton of Bern occurred in 1911, 1915, and 1893. The goal of this thesis is to analyse these three cases in detail, including archive work (on the fire and descriptions of meteorological situation), and analysis of daily weather data from different products.
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Title	<b>Historical weather diaries</b>
Level	prerefably MSc (several theses)
Prerequisites	Historical interest of background, statistics, R, climatology
Methods	Historical analysis, archive work, data processing, statistical analyses,
Description	Weather diaries may contain categorisable or even quantifiable information that may be used for weather reconstruction. Two theses can be written on two specific weather diaries one from Wroclaw, 1692-1710 and one from Nürnberg, 1695-1704. The diaries should be described and contextualised. Quantifiable information (e.g. wind direction, rain/norain) will be digitised, for others such as cloud cover a categorisation will be sought. Eventually, this information will be combined with other available information to produce daily weather type reconstructions using a machine learning approach.
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Title	<b>The Italian precipitation network of Toaldo</b>
Level	prerefably MSc
Prerequisites	Historical interest of background, Italian language, statistics, R, climatology
Methods	Historical analysis, archive work, data processing, statistical analyses,
Description	In the late 18th century, Giuseppe Toaldo, Director of the Astronomical Observatory, Padua, built up a precipitation measurement network in Italy that operated during the 1780s. The data from this network have been digitised in the PALAEO-RA project. The aim of this thesis is to document the network and analyse the precipitation data. During the 1780s, several other networks existed in Europe, such that a detailed view of climate becomes possible.
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Title	<b>Weather reconstruction using machine learning</b>
Level	MSc (or BSc)
Prerequisites	Statistics, R, climatology
Methods	Data processing, statistical analyses,
Description	The goal of this work is to reconstruct day-to-day weather for severe winters and summers in the past such as the winter 1708/9, the winter 1684/5 or the summer of 1695. Sparse instrumental measurements will be combined with weather diaries and wind observations from ships. Eventually, in collaboration with the DKRZ in Hamburg, a machine learning approach will be used to reconstruct weather maps for every day. This thesis will focus on training data sets towards that aim, i.e., generate the same data in a period in the more recent past for which daily weather fields are available.
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Title	<b>Forward modeling of documentary data</b>
Level	BSc or MSc
Prerequisites	Statistics, R, climatology
Methods	Statistical modeling of documentary from climate series and climate models
Description	Climate proxies based on documentary data (often condensed in indices) are often used to reconstruct climate with statistical approaches that model climate as a function of the proxy. In the real world, documentary proxies are a function of climate. The goal of this thesis is to model documentary proxies (thermal and hygric indices) covering the past few centuries from climate data. The resulting function, called “forward model” will then be used for climate reconstructions in conjunction with climate model simulations.
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Title	<b>Observed interannual and decadal variability in historical SST reconstruction</b>
Level	BSc or MSc
Prerequisites	Climatology, Statistics, Python or R, CDO
Methods	Climate Data Analysis
Description	<p>Recently reconstructed global temperature by the PAGES2k consortium does not only provide a global coverage of the field in the past 2000 years, it also gives an indication of the unprecedented interannual and decadal climate variability within this period. The oceans play an important role in climate variability, driving atmospheric circulations on different timescales and providing a basis for numerical weather simulations.</p> <p>The aim of this thesis is to show the variability modes including the evolution of global warming in different time-slices, and compare frequency of occurrences within the period. This would be carried out using reconstructed SSTs from different statistical methods, in an inter-basin approach, which ignores the teleconnection patterns including those lagged in time. The study will consider past variability in the North Atlantic, Equatorial Atlantic, North Pacific, Equatorial Pacific, South Pacific, South Atlantic, Indian Ocean and the Southern Ocean. Furthermore, in recent periods where instrumental records are available, we would compare the reconstructed SSTs with observations. Influence of the number of available proxies in different basins within each time-slice, on SST variability in space and time would also be investigated.</p>
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Title	<b>Evaluation of long climate series from observations and reconstructions</b>
Level	BSc or MSc
Prerequisites	Statistics, R, meteorology or climatology
Methods	R time series analysis
Description	A recent climate reconstruction based on data assimilation methods provides global monthly fields of temperature, precipitation and other parameters back to 1600. This was based on long measurement series, weather diaries and tree rings. In the mean time further long measurement series have become available. The goal of this BSc thesis is to compare these long series with the corresponding series from the reconstructions. The analysis will be used to address inhomogeneities in the series and for the evaluation of the reconstruction.
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Title	<b>Rekonstruktion von Gebäude und Wald in Glarus, 1925</b>
Level	BSc oder MSc
Prerequisites	GIS, R, Statistik
Methods	GIS, R, Statistik
Description	Ziel des Projekts ist die detaillierte Rekonstruktion eines Föhnsturms 1925 mit Hilfe eines Modells. Dazu müssen die Gebäude sowie die Waldfläche zur Zeit des Ereignisses erfasst werden, da diese mit dem Windfeld wechselwirken. Anhand von Swisstopo-Gebäudedaten und Waldflächen aus der Landeskarte sollen diese Randbedingungen erstellt werden. Zur Verfügung stehen auch kartierte Schäden.
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Advisor	Dr. Peter Stucki, Prof. Dr. Andreas Zischg

Title	<b>Ice cores in a data assimilation framework</b>
Level	BSc, MSc
Prerequisites	Statistics, R, climatology
Methods	Data processing, statistical analyses,
Description	Ice cores are well known archives of past climates. However, going back into the past dating uncertainties may occur. In a large project in our group we would like to use ice core proxies for reconstruction. However, for this purpose they must be perfectly dated and must be reproducible from climate data. In this thesis several candidate ice cores series will be evaluated with respect to their dating and reproducibility. Dating corrections will be suggested such that the ice core information can be incorporated into a data assimilation approach.
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Title	<b>Impact of spring sea surface temperature on European summer climate – A comparison between weather models and tree ring isotopes</b>
Level	MSc
Prerequisites	Interest in climate extremes, teleconnections, climate statistics and a bit of programming
Methods	Large Climate (Gridded) Data Analysis,
Description	Data from a European oxygen isotope network from tree-rings showed a connection of Atlantic and Pacific sea surface temperatures in spring with the following European summer climate. With 400 years of this biologically recorded summer climate, we are confident enough to explore this relationship further, to understand European summer extremes (such as heatwaves) better. The goal of this thesis is to investigate this teleconnection in more detail, using brand new weather/climate model data that predict summer climate coming out of spring.
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Title	<b>Development and evaluation of a low-cost, LoRa-based measurement device for microclimatic assessments in urban environments</b>
Level	MSc
Prerequisites	Statistics; R (basics); interest in micro-electronics, programming, and environmental/climatological data
Methods	Micro-electronical development and programming, fieldwork, statistical analyses
Description	Since 2018, the Climatology Group maintains an urban heat monitoring network consisting of 65 – 85 low-cost temperature sensors within and around the city of Bern. With urban heat stress and related consequences becoming an increasingly relevant topic for urban planning, infrastructure, and health services, the monitoring network of the urban heat load of Bern will be continued over the next years. In order to enhance the quality of the data (i.e. radiative biases) and reduce maintenance efforts (i.e. reading out the data manually), this thesis focusses 1) on the further development of the sensor and radiation shield and 2) on the evaluation of the performance of the developed prototype based on inter-comparisons with automated weather station data. In detail, the task will be to design a solar-driven measurement device consisting of a low-cost temperature/relative humidity sensor and an actively ventilated radiation shield that is capable of automatically transmitting data via LoRa-Wan. Profiting from a close collaboration with the Research Centre for Digital Sustainability and the support from technicians of the Berner Fachhochschule, the potential MSc-student is sought to have experience in (statistical) programming (e.g. R, python, or equivalent), an affinity for environmental/climatological data and processes, as well as an interest in micro-electronical challenges.
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Title	<b>Urban climate models: Evaluation and validation across three generations</b>
Level	MSc
Prerequisites	Statistics and statistical modelling (R or equivalent); GIS (basics in QGIS or ArcGIS); background in meteorology and/or climatology; interest in urban climatology and numerical modelling
Methods	Statistical analyses, numerical modelling, visualization in GIS

Title	<b>Urban climate models: Evaluation and validation across three generations</b>
Description	Local- to micro-scale urban climate models are crucial for development and evaluation of urban heat mitigation strategies in urban planning. Due to advances in process understanding, computational power and input data, the temporal and spatial resolution of urban climate models has substantially increased throughout the last two decades. This MSc-project aims at comparing and evaluating three urban climate models (MUKLIMO, UrbClim, PALM4U) originating from different model development phases. By investigating the urban heat island variability in Bern during summer 2018, the thesis is sought to uncover strengths and limitations of the three models when compared to high-resolution air temperature data received from our city-wide urban heat monitoring network. Hereby, the potential MSc-student will (partly) generate and analyse the model outputs statistically and visually with regard to varying synoptic situations, resolutions, and parameters. This project will profit from a close collaboration with Meteotest AG and is particularly suited for students with a background in climatology/meteorology, statistics, and numerical modelling.
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Title	<b>Winter-time inversion dynamics in Bern</b>
Level	BSc
Prerequisites	Statistics (basics); GIS (basics); R (basics); climatology
Methods	Statistical analyses, visualization in GIS (or equivalent)
Description	Besides heat stress, air pollution imposes a significant health risk for humans within urban environments. This is particularly true in topographically complex cities where, especially during winter, temperature inversions may lead to an accumulation of air pollutants. This BSc-thesis will focus on the winter-time inversion dynamics in and around the Aare-valley in Bern. Hereby, the potential student will analyse data retrieved by a measurement campaign in winter 2018/19 by 18 temperature sensors situated along a transect from Zollikofen to Belp. On that basis, the thesis is sought to give insights into winter-time inversion dynamics (i.e. thickness, extent) across the city of Bern in different synoptic situations and could include further data such as air pollution measurements (PM10). The potential BSc-student will need to calculate basic statistics (R) to analyse the temperature data, which may then be visualized using GIS (QGIS or ArcGIS).
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Title	<b>Public perceptions of urban heat-stress</b>
Level	BSc
Prerequisites	GIS (basics); R (basics); climatology
Methods	Spatial interpolation and analyses in GIS, statistical analyses

Title	<b>Public perceptions of urban heat-stress</b>
Description	Understanding people's awareness about climatic risks is a key aspect for the design of adequate, target-specific communication strategies. Although urban heat island effects have been studied for more than 200 years, it is unclear how aware the general public in specific cities is about the problem. In order to reveal lay people's conceptions and mental maps of urban heat variability within the city of Bern, a pilot study consisting of short interviews with pedestrians was conducted during a heatwave in summer 2019. This BSc-thesis aims at comparing the hereby assessed mental maps and questionnaire data to maps of urban heat (air temperature) maps. This will include the digitisation of the analogue maps, spatial interpolation and analyses in GIS, as well as – if possible – basic statistical analyses.
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