Topics for BSc or MSc theses in Climatology, Spring Semester 2024

Title	**The preindustrial climate**
Level	BSc or MSc
Prerequisites	climatology, programming, or statistics
Methods	Statistical analyses
Description	In the IPCC reports and the UNFCCC, the preindustrial climate is defined as climate in the period 1850-1900. While this makes sense from the point of view of the availability of observations, some have argued that it already includes an anthropogenic signal. Ed Hawkins suggested to use 1720-1800. This thesis will compare the two periods in several climate reconstructions, in proxy data, and in climate model simulations. https://journals.ametsoc.org/view/journals/bams/98/9/bams-d-16-0007.1.xml
Supervisor	Prof. Dr. Stefan Brönnimann, room 506, stefan.broennimann@giub.unibe.ch

Title	**Monthly climate data from seasonal proxies**
Level	BSc or MSc
Prerequisites	climatology, programming, or statistics
Methods	Statistical analyses
Description	We have produced a monthly global climate reconstruction (ModE-RA) from 1421 to 2008 that, in the early years, assimilates only seasonal proxy data (mainly tree ring width). As each proxy reacts slightly differently to climate in different months, there could theoretically be skill on a monthly scale from seasonal proxy data. In this thesis, the ModE-RA data set will be evaluated with respect to whether or not this monthly skill can be detected.
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Title	**Tropical cyclones in ModE-Sim, 1421-2008**
Level	MSc
Prerequisites	climatology, programming, or statistics
Methods	Statistical analyses, R or Python
Description	In the context of the PALAEO-RA project, tens of thousands of years were simulated with a model of moderate resolution (2°x2°, some simulations have a higher resolution of 1°x1°), this set of simulations is termed ModE-Sim and covers the period 1421-2008. The goal of this thesis is to study tropical cyclones in this data set, to assess how well they are represented, and how they vary over time. The results from ModE-Sim can be compared to historical catalogs of typhoons in China.
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Title	**Validation and homogeneity tests of reanalysis**
Level	BSc or MSc
Prerequisites	climatology, programming, or statistics
Methods	Statistical analyses
Description	The goal is to compare the reanalyses ERA5, ERA5-land, 20CR and CERA-20C (temperature and pressure) against independent in-situ data and to analyse the homogeneity of time series of the reanalysis. The assessment will involve classical metrics (bias, correlation, variance, KGE, etc) and frequency distribution characterization. The evaluation can be stratified by decade to account for the increase in the available measurements or stratified by elevation or Köppen-Geiger climatic definitions. During the overlapping period, the reanalyses will be mutually compared and analysed with respect to the frequency distribution characterization A specific focus is on soil moisture and evaporation. ERA5-land, GLEAM & ESA CCI Soil Moisture estimates will be intercompared. Similarly, ERA5-land & GLEAM evaporation estimates will be compared to pan evaporation measurements.
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Title	**Spatial patterns of hydrometeorological variables with machine learning techniques**
Level	BSc or MSc
Prerequisites	climatology, programming, or statistics
Methods	Statistical analyses
Description	The project will used self-organizing maps for precipitation, wind speed and soil moisture patterns. The patterns will be analysed with spatial patterns of modes of climate variability.

	Furthermore, a logistic regression classifier will be used for identifying patterns of modes of variability over land areas. The aims are to apply the techniques to several meteorological fields and evaluate if the patterns are similar to the known effects of climate modes of variability. In tropical regions the modes of variability would be the ENSO, the TNA, the Atlantic El Niño. The regions of study encompass the Atlantic Ocean and tropical south America
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Title	**Meteorologische Messungen im Nationalpark**
Level	MSc
Prerequisites	climatology, programming, or statistics
Methods	Statistical analyses
Description	Nebst der MeteoSchweiz Station Buffalora (seit 1917) werden im Nationalpark auch noch an weiteren Stationen meteorologische Beobachtungen gemacht werden, so im Trupchun (SNP, ab 1996), auf Chavagl (SNP, ab 1996), auch Macun (Eawag, ab 2020) und auf Stabelchod (WSL, ab 1996). Zusätzlich werden auch noch opportune Schneemessungen gemacht, es gibt 4 Totalisatoren im Gebiet und etliche phänologische Beobachtungen. Ziel dieser Masterarbeit ist, die meteorologischen Messungen zu vergleichen, ev. auch noch mit weiteren Stationen aus der Region, und daraus eine räumliche, mikro-klimatische Analyse zu machen.
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Title	**Quantifying the Extent of Country-specific Impacts of the Tambora Volcanic Eruption of 1815 on Climate and Food Insecurity: A Historical Review**
Level	MSc
Prerequisites	climatology
Methods	Literature review and archive work, statistical analyses
Description	The largest historically observed volcanic eruption was that of Mt Tambora in Indonesia in 1815. It cooled global land temperatures in 1816 by an estimated -1.9 °C (± 0.2 °C),[2] and contributed to famines in parts of Europe, India and China.[3] Indeed, the European summer of 1816 has been described as the "year without a summer",[4] due to the extreme cold and wet conditions. Following this in 1817, some countries experienced the "year of famine".[5] A recent study of the impact of the Tambora eruption on islands, reported impaired food production in eight of the islands, with food riots and famines in some of these.1 There is other recent historical and palaeoclimate research relevant to this eruption and so there is a need for an updated review. This would not only be relevant to considering the ongoing risk of major volcanic eruptions, but also other potential sun-blocking catastrophes (eg, nuclear winter). Proposed methods: These could build on the recent island study[1] in terms of literature search strategy and relevant definitions of impacts (anomalous weather/climate; adverse impacts on food production; food insecurity/famine). Historical settings could be mapped onto current country jurisdictional boundaries to facilitate current relevance (eg, mapping from various empires to modern states). Quantitative analysis could include impact by various regions (hemisphere, tropical, temperate zone, continent etc). Qualitative descriptions would give context to the various limits of the historical and paleoclimate data. Likely outcomes: In addition to the thesis/dissertation, an article that could be published in a peer-reviewed journal, potentially also with a scholarly blog on a site covering catastrophic risks. References 1. Wilson N, Valler V, Cassidy M, et al. Impact of the Tambora volcanic eruption of 1815 on islands and relevance to future sunlight-blocking catastrophes. Sci. Rep. 2023;13(1):3649. 2. Kandlbauer J, Hopcroft PO, Valdes PJ, et al. Climate and carbon cycle response to the 1815 Tambora volcanic eruption. J. Geophys. Res. 2013;118(22):12,497-12,507. 3. Brönnimann S, Krämer D. Tambora and the "Year Without a Summer" of 1816. A Perspective on Earth and Human Systems Science. Geographica Bernensia G90, doi:10.4480/GB2016.G90.01. 4. Stommel H, Stommel E. The Year without a Summer. Sci. Amer. 1979;240(6):176-87. 5. Behringer W. Tambora and the Year without a Summer. Cambridge: Polity Press 2019.
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