In many parts of Europe, heatwaves are becoming more frequent and more intense. Long-lasting heatwaves are often associated with a blocking of the large-scale atmospheric flow. Such a disturbance of the mid-latitude flow pattern can generally be related to a substantial meandering of the jet stream due to the presence of upper-tropospheric Rossby wave packets.

Finite amplitude local wave activity (FALWA), a measure of waviness based on meridional potential vorticity anomalies, is a powerful tool to diagnose the local amplitude of such Rossby wave packets as a function of longitude, latitude and time. FALWA is a relatively novel diagnostic, first introduced by Huang and Nakamura in 2016, that has not been extensively applied to European heatwaves so far.

In this thesis, we therefore want to use FALWA to statistically assess the relationship between blocking and prolonged heatwaves over Europe. This analysis will be based on ERA-5 reanalysis data, which are readily available in the needed format/resolution on our LSDF data storage. Based on the same data set, readily processed FALWA data can be provided by Univ. Mainz, but an existing Python package could also be used or modified if some adaptions are necessary.

The master student is encouraged to develop a number of statistical methods to characterize and quantify the FALWA – heatwave relationship for the period 1979-2021. In addition to a detailed climatology, a particular focus is set on the question of whether the FALWA – heatwave relationship has changed substantially over the last four decades. Moreover, a comparison to other, more simple blocking metrics may be valuable in order to estimate whether FALWA provides any added value.

The master thesis is embedded into the DFG Collaborative Research Centre (CRC) 165 “Waves two Weather” in which the Univ. of Mainz and Munich are partners (https://www.wavestoweather.de). Particularly, it concerns the sub-project C4 “Predictability of European Heat Waves (https://www.wavestoweather.de/research_areas/phase2/c4/index.html). Thus the participation at project meetings and networking within the is strongly encouraged.
which was associated with a high-amplitude undulation of the upper-tropospheric jet stream. This situation would be characterized by high values of FALWA over large parts of Central Europe. (image taken from https://weather.com/safety/heat/news/2019-07-22-europe-heat-wave-forecast-france-germany-netherlands-belgium)