The Great Climate Poker

Access "The Great Climate Poker" online (www.climatepoker.unibe.ch) and choose the "Mode for students".

1. Learn the basics

Question 1.1: Volcanic eruptions
Get familiar with the different climate factors described on the page "**Playing poker with the climate**". What effect do volcanic eruptions have on climate? In the game, what is probability of getting a volcanic eruption?

Question 1.2: Solar activity
What causes variations in the sun's intensity, as described in the game? If you click on the "Details" button you will see a more explicit description. What numbers on the die are possible for this climate factor?

Question 1.3: ENSO
Which die number corresponds to the strongest possible La Niña phase and how does the air circulate above the Tropical Pacific? What about the situation of a strong El Niño phase?

Question 1.4: NAO
If the NAO is in its negative mode, what is the pattern of the Polar Jet? How does this affect climate over Europe? Which dice number responds to the most negative NAO phase?

2. Limitations of describing climate as a poker game

Question 2: Assumptions of the game
Discuss the limitations and unrealistic assumptions made in the climate poker game. Create a list of points that are represented unrealistically in the game.

3. Trend and variability

Question 3.1: Noticing trends
Go to the page "**Climate poker**" and roll the dice. After how many years do you begin to notice a trend for the global time series you have rolled? What about for the time series for Lima (Peru) and Bern (Switzerland)? What is the main difference between the global and the other time series?

Question 3.2: Greenhouse gases
What happens with the "Greenhouse gases"-die? What is the main difference between this die and all the others?

Question 3.3.a: R exercise: significance of trends
After how many years are the trends for Lima, Bern, and the global series (the time series after rolling the dice and the real time series) significant at the 0.05 level? Use the non-parametric Mann-Kendall Trend Test, which depends less on assumptions than, for example, the parametric Linear Regression Trend Test. However, one important assumption underlying the Mann-Kendall Trend Test is not satisfied by all time

series: autocorrelations (i.e. when the next year is not independent from the previous year) should actually be removed before applying the trend test. In the rolled time series, there is per definition no autocorrelation. In the real time series, however, we most likely would detect autocorrelation due to the persistence of modes of the climate factors. For simplicity, we do not take into account autocorrelation.
Important: export the time series in .csv format from the page "Climate Poker" and save the file on your computer. Make sure to also activate all real time series ("real global", "real Lima", and "real Bern before exporting. You can activate or deactivate the time series by clicking on the legend of the graph (e.g., "real global". We suggest using the statistical program R (www.r-project.org), but you may also use another software. Below is the R-code we suggest to help you solve this exercise:

```
# open the file containing the time series and name it "ts"
ts <- read.csv("your_directory/average-annual-temperature-anomalies.csv", sep=";")
# change the names of the time series to "global", "Bern", "Lima", "real global", "real Bern" and
"real Lima"
colnames(ts) <- c("date","global","Bern","Lima","real global","real Bern","real Lima")
# check what the values look like
ts
# you need to install the package "Kendall" to perform the Mann-Kendall Test
install.packages("Kendall")
# activate the installed package
library("Kendall")
# test if the trends are significant (below the example for the first 100 years of the time series
"global") and find the number of years, where the p-value drops below 0.05 (tau = measure of
strength of the relationship between the time and the temperature anomalies, 2-sided = tests for
positive as well as for negative trends, pvalue = measures the significance of the trend)
MannKendall(ts$global[1:100])
```

Question 3.3.b: R exercise: estimate the trends

In combination with the Mann-Kendall Trend Test, the Theil-Sen Trend Estimate is often used for trend estimation. Use R to estimate the trend of the time series. Afterwards, compare the "global" and "real global" trend estimates. How are they different, and what might explain this?
Below is the R-code we suggest to solve this exercise:

```
# open the file containing the time series and name it "ts"
ts <- read.csv("your_directory/average-annual-temperature-anomalies.csv", sep=";")
# change the names of the time series to "global", "Bern", "Lima", "real global", "real Bern" and
"real Lima"
colnames(ts) <- c("date","global","Bern","Lima","real global","real Bern","real Lima")
# we need the "openair" package to calculate the Theil-Sen estimator (this is a large package and
will take some minutes to download)
install.packages("openair")
# activate the installed package
library("openair")
# change the format of the years as required by the package
ts[,1] <- as.POSIXct(paste0(ts[,1],"-01-01 00:00:00"))
# calculate the Theil-Sen estimator and create a plot (seen below is the example for the "global"
time series)
TheilSen(ts, pollutant = "global", dec.place=4, lab.cex=1.5, slope.text="°C/year", autocor=TRUE,
date.breaks=10)
```

4. Regional effect of climate factors

Question 4.1: Regional scale

Go to the page "**Climate master**". Which climate factors are most important for which regions? What are the differences in the effects of the climate factors for Lima (Peru), Bern (Switzerland), and the global scale?

Question 4.2: Effects in Lima

Which climate factor is most dominant for climate in Lima? Can you verify your assumption with the real time series "real Lima" (go to the page "Climate poker")?

5. Recognize anomaly patterns

Continue to the page "**Climate detective**". Now you should be ready to attribute global anomalies to specific climate modes and events. Who is the best detective; who in the class is able to obtain the highest score in the "High Scores List"?

Instructions: you will be presented with five separate cases to solve – your high score is determined by the average of all five scores. You will solve cases one at a time. Once you make your guess by clicking on the combination of climate factors (i.e. the dice) and submit your solution by clicking on "Check your solution", your answer is final and you can't try to solve the same case again (but you will see the correct solution immediately afterwards!). To solve the next case click on "Roll" but not "Start over", or you will lose your previous guesses. Good luck!