Comparison of Break Point Detection Methods for global radiation in Austria

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Motivation

- **Little attention** has been paid to **homogenization** of **global radiation**.
- The total shortwave radiation hitting the Earth's surface is called global radiation. It is the sum of diffuse and direct radiation.
- Global radiation is an **important source of energy** for the climate system.
- Radiation processes are of **great interest**, both for the natural and anthropogenic contribution to the **climate system and its changes**.
- In order to make a clear statement about the **current state and trends**, it is **important to detect inhomogeneities** that do not reflect the actual state and **to correct** them as best as possible.

Data

- Global radiation measurements are available at **284 stations** in Austria.
- At **56 stations**, measurement series of **more than 30 years** are available.
- **Pyranometers** are used as measuring devices.

- Also the parameter "downward surface solar radiation" of ERA5-Land reanalysis is used.

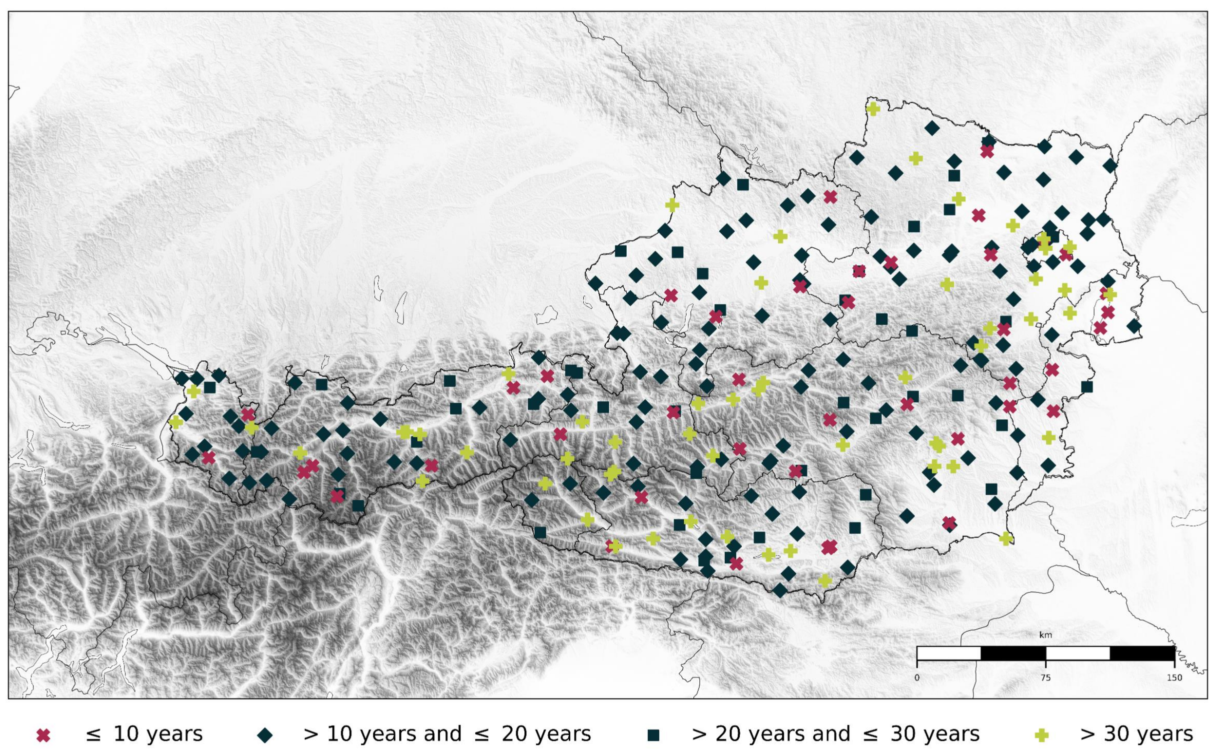

Fig.1: Spatial Distribution of Global Radiation measurements in Austria.

Results – Target station Fischbach

As an example the station Fischbach is displayed. In Figure 2 Fischbach and the chosen reference stations are marked. The correlation of the reference station to the stations in the networks was calculated with Spearman's correlation coefficient. Stations in the network have a correlation between 0.61 and 0.79.

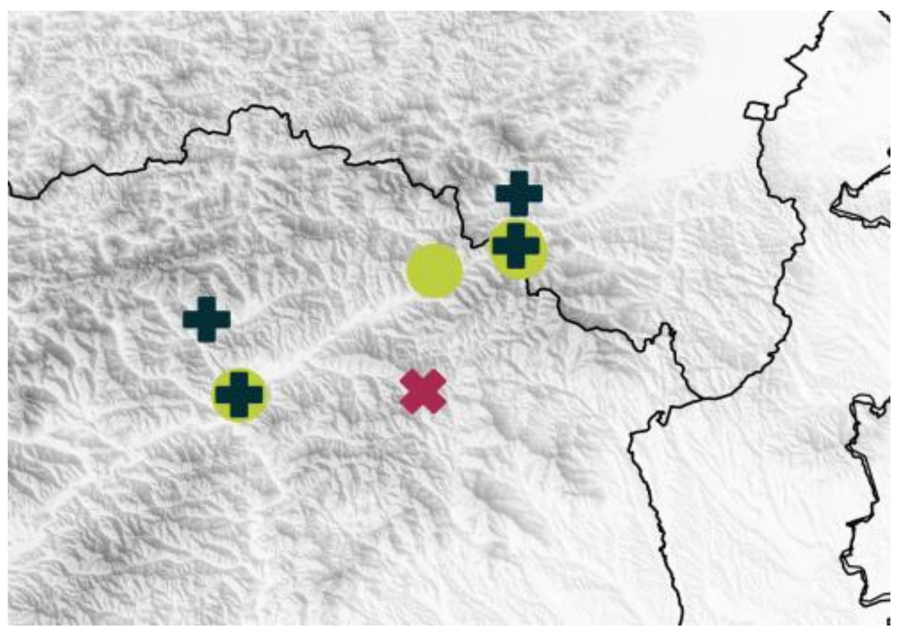

Fig.2: Fischbach is highlighted in red, stations of Network 1 are displayed in light green, stations of network 2 are in dark green.

Network 1 (light green):
- Hirschenkogel
- Mürzzuschlag
- Kapfenberg
- Semmering

Network 2 (dark green):
- Kapfenberg
- Semmering
- Reichenau/Rax
- Aflenz

Figure 3 depicts the time series of monthly means for global radiation at the target station, the mean of the chosen networks and the networks build from ERA5 Land reanalysis data. For the networks from the reanalysis, the time series were extracted at coordinates of the stations. In addition, the optically expected break points are drawn in red.

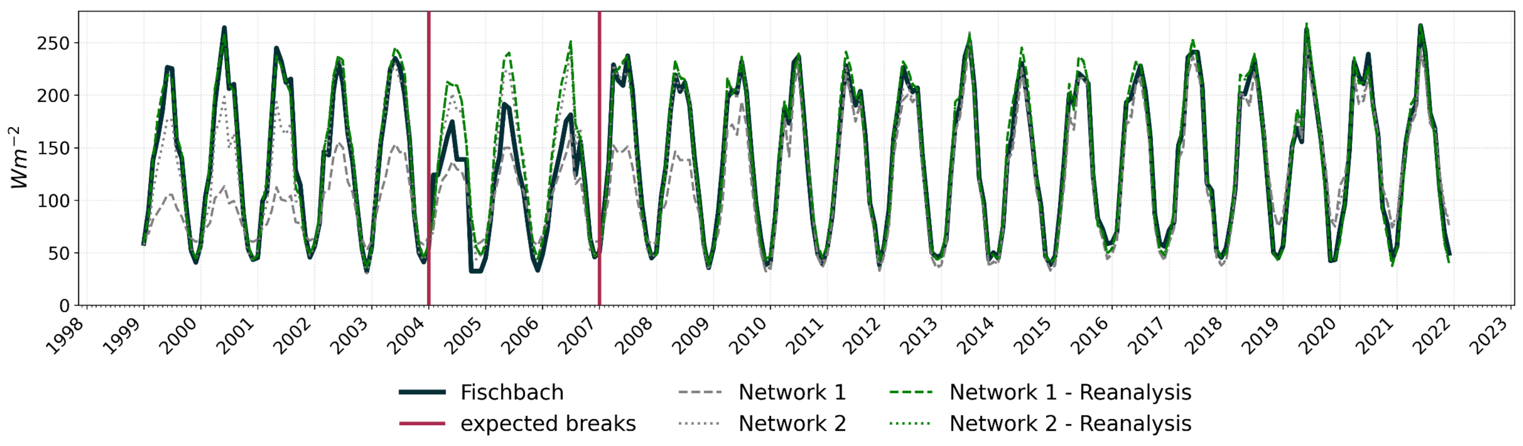

Fig.3: Monthly mean time series of Fischbach, the means of the networks from station data and from reanalysis data.

For break point detection **ACMANT**, a rolling window **SNHT** and the Python package ***ruptures*** were used. For SNHT and *ruptures* the reference series was formed as the mean of the anomaly time series of the network.

In Table 1 the dates of the detected break points using station data are shown. Except for one outlier at *ruptures*, the suspected break points are well detected in network 2. Unfortunately, for this station there is no indication in the meta data where break points may be located.

Detected Break Points					
Network 1			Network 2		
ACMANT	SNHT	*ruptures*	ACMANT	SNHT	*ruptures*
None	**2003 – Sep** **2006 – Oct** 2007 – Jun 2010 – Jul 2016 – Apr	**2003 – Oct** 2004 – Mar **2006 – Sep** 2009 – Oct	**2004 – Jan** **2006 – Sep**	**2007 – Jun** 2010 – Sep 2015 – Aug	**2004 – Mar** **2006 – Sep** 2009 – Aug

Tab.1: Detected months with break points by ACMANT, SNHT and python ruptures for Network 1 and 2 using station data. Written in bold are the break points that fit best to the estimated breaks shown in Fig.3.

Figure 4 shows the sensitivity of the break point detection with the SNHT. Using the network of reanalysis, the break points are found in September 2003 and June 2007.

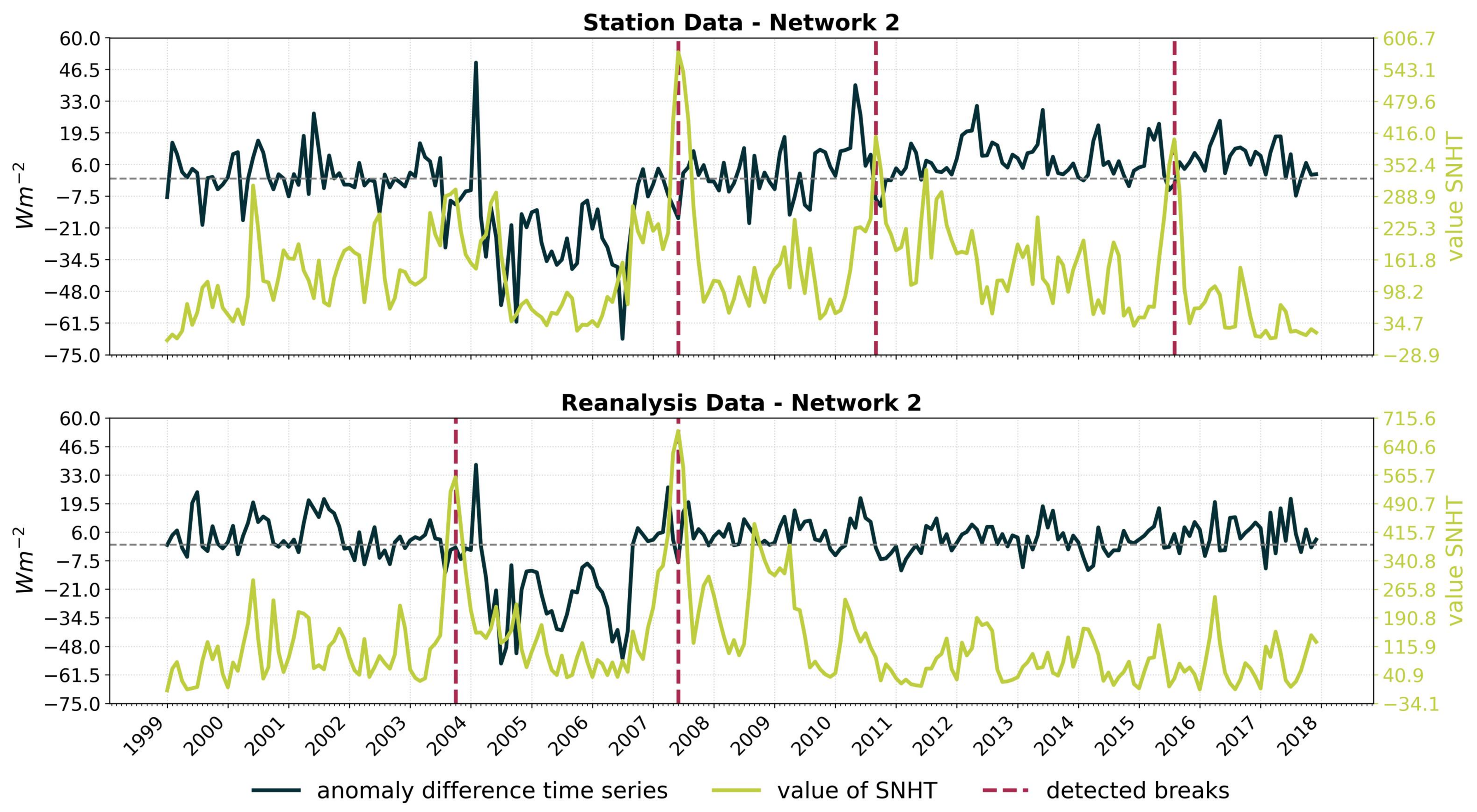

Fig.4: Results of break point detection with SNHT for station of network 2. Top: Network build of station data, bottom: Network build of reanalysis data.

Discussion

There are numerous break point detection methods that lead to different results. Station meta data can help here, but they are mostly incomplete (like in the example given).
Also, different compositions of reference stations can strongly influence the results. It requires a precise selection of reference stations, knowledge on meta data and evaluation of the homogenization results, to ensure a reliable homogenization result.

Summary and Outlook

This poster provides information on global radiation measurement in Austria are shown and break detection in time series is discussed. The difficulty is to find a method that works well for all stations with inhomogeneities. In the future, a classical method will be applied and a machine learning method for break detection will also be tested. In addition, the focus will be on correcting the inhomogeneities.
The homogenized global radiation data will be freely available via the GeoSphere Austria data portal after completion.

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