Central Andean temperature and precipitation measurements and its homogenization

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1 Motivation

- The central Andes and communities in this region are particularly vulnerable to a changing climate [2,6].
- Information on climate and climate change is of great importance for the Central Andes region: Adaptation strategies require specific regional climate information that is either not readily available or is not of sufficient quality.
- Non-climatic influences (inhomogeneities), such as station relocations, replacements of measurement instruments or changes in the stations environment, can distort or even hide true climatic signals [1].

2 Challenges

- Much effort has been put in the development and improvement of homogenization approaches. However, this research was generally based on western high-quality station networks.
- In the Central Andes, the network density and correlation of time series is low.
- Little is known on the performance of homogenization approaches in such conditions [3].

Fig 1: Bolivian meteorological station on Isla del Sol

3 Approach

- The Swiss station network shares with the Central Andes
  - ➢ the complex terrain and
  - ➢ large spatial climate gradients,

  but in contrast to the Central Andes, the Swiss station network is
  - ➢ dense,
  - ➢ the data is of high quality,
  - ➢ station history is nearly complete and
  - ➢ an extensively homogenized dataset exists (**THOMAS** [1])
- By subsampling the Swiss station network, the conditions of a Peruvian test region is mimicked and the performance of the homogenization is analyzed.
- One of the most recent tools (**HOMER**) was used for the homogenization. HOME_R was developed within the COST Action HOME initiative [4,6] and was applied to several station networks of low density [e.g. 5,7]

4 Data

- Data to be mimicked:
  - ➢ 2 regions in central-south Peru (Cusco and Junín)
  - ➢ Time series included, which
    - ✓ cover the periode from 1964-2012
    - ✓ have ≤ 20% missing data
    - ✓ do not contain significant errors
- Benchmark data:
  - ➢ Raw data of the Swiss station network
  - ➢ Homogenzied data of the Swiss station network (**THOMAS** [1])
  - ➢ Station history of all Swiss stations
  - ➢ For temperature, station data of other European station networks were used as refrences

5 Correlation Peruvian and Swiss station network

- Correlations in Peruvian network are clearly lower than correlations in Swiss network
- Differences in correlation in the networks cannot be explained by a different climate gradient: The instrument quality, the station maintenance and operation affects the correlation

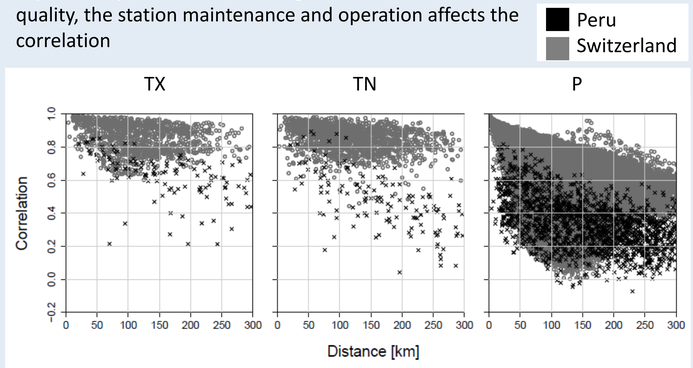

Fig. 2: Normalized Spearman correlation of Peruvian and Swiss station data in dependence on distance

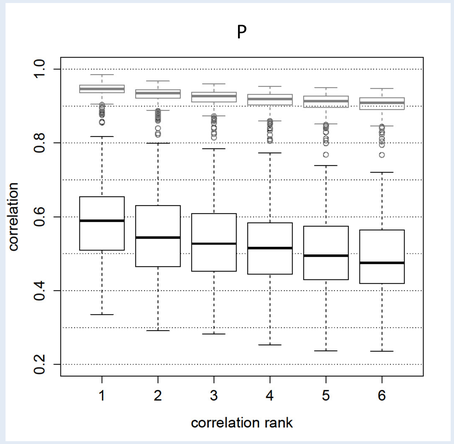

Fig. 3: Correlation of precipitation time series of the 6 best correlated neighboring stations in the Peruvian and the Swiss network

6 Swiss network groups

- 3 station groups were selected (North, South, Alps), such that the stations within each group are highly correlated
- Correlation between the groups reflect typical correlations in Peru
  - ➢ 0.60 – 0.80 for TX and TN
  - ➢ 0.45 – 0.60 for P
- 30 sub-groups were built, including 1 station of each region and additional reference stations of the same correlation range

7 Experiments

All experiments were performed on each network (**dense** and subsampled resp. **sparse**) group and on each variable, i.e. a total of 396 homogenizations were done.

1. Automatic run (**auto**)
2. Manual run without metadata (**manu**)
3. Run with breakpoints of THOMAS included independently of statistical break detection (**meta (t)**)
4. Homogenization using all available metadata to confirm or reject potential breakpoints (**meta**)

8 Results

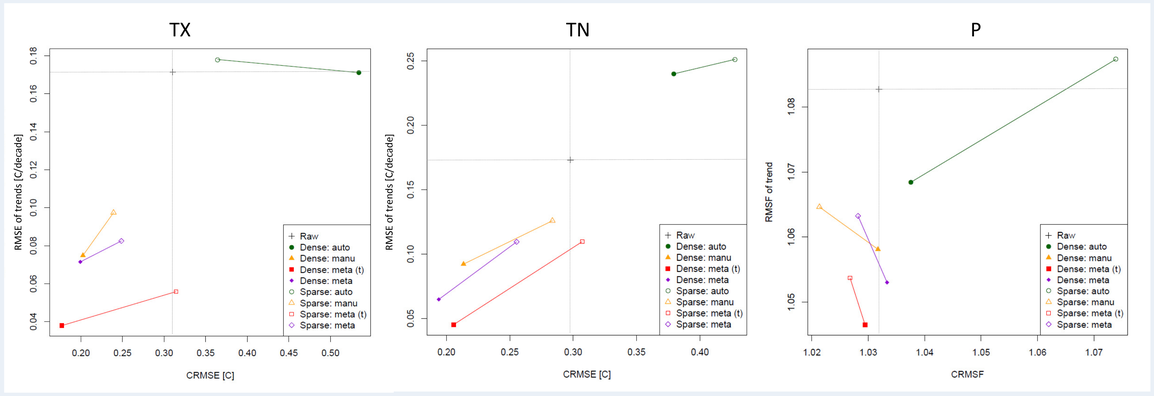

Fig. 4: Network avarages of the of the CRMSE (CRMSF) and the deviations of linear trends

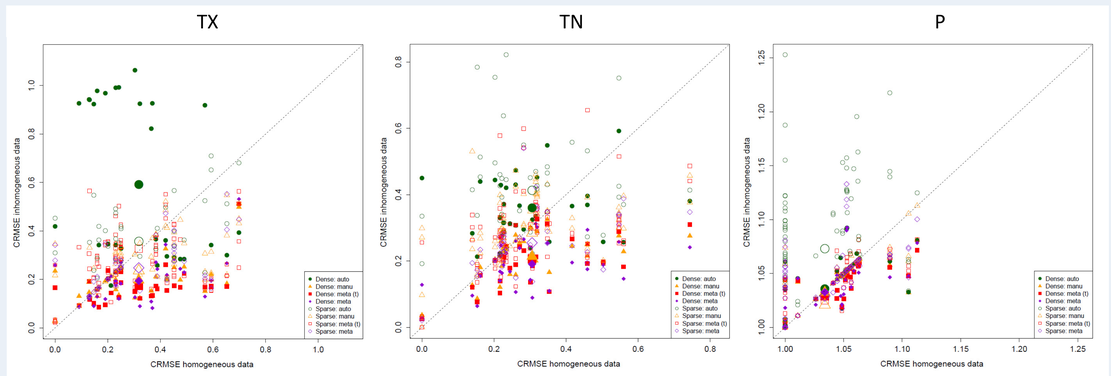

Fig. 5: Network avarages of the of the CRMSE (CRMSF) and the deviations of trends

9 Conclusions

- The use of HOMER in **the automatic mode decreases data quality** in most cases and is therefore not recommended.
- **The network trend is improved in all experiments** for the sparse network as well (except automatic), but not the CRMSE and CRMSF.
- Including breakpoints only based **on important events in station history** independently of statistical detection seems to be beneficial for highly correlating networks, but not for poorly correlating networks.

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