Time series homogenization with optimal segmentation and ANOVA correction: past, present and future

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Still in focus: Monthly temperature and monthly precipitation homogenisation. **Why?**

- *High potential of improving accuracy in a large number of datasets worldwide*

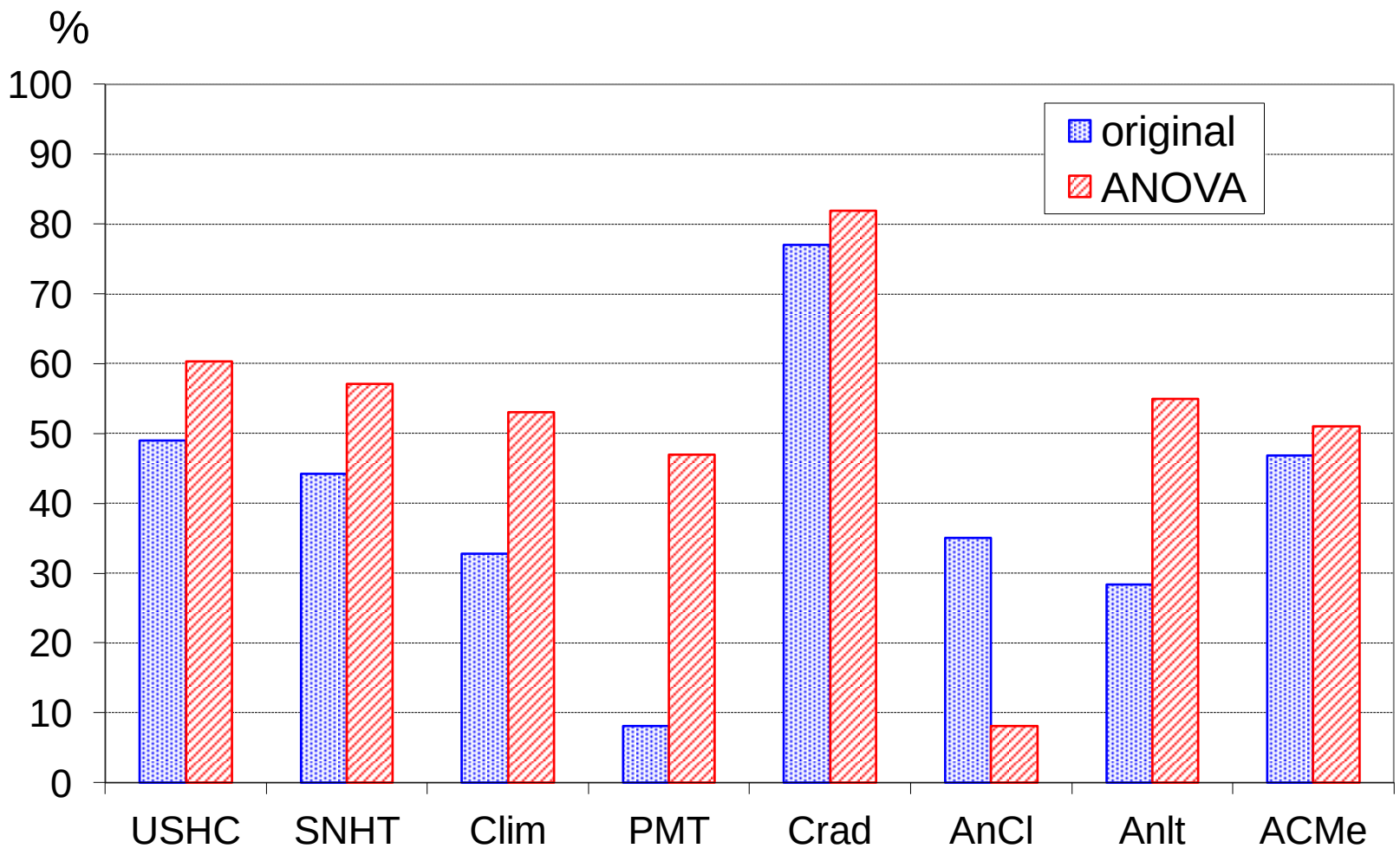
- *Key access (although not the unique access) for improving accuracy in all spatial scales and all temporal resolutions*

- 1972: Dynamic programming of optimal segmentation for time series with multiple change points (steps) for known number of steps (Hawkins – J Inst. Math. Appl.)
- 1997: Criterion for assessing the number of steps (Caussinus and Lyazrhi – Ann. Inst. Statist. Math.) [C-L criterion]
- 2004: Joint assessment of adjustment terms with network wide minimisation of the residual standard deviation ≡ ANOVA ; Publication of PRODIGE (Caussinus and Mestre – J. Roy. Stat. Soc. C)

- 2006: Efficiency tests prove that optimal segmentation with C-L criterion is the best among available break-detection methods (Domonkos – 5th Seminar for Homogenisation)
- 2008: Kriging in the optimal weighting of reference series composites and calculation of adjustment terms "weighted ANOVA" (Szentimrey – 6th Seminar for Homogenisation)
- 2011: Empirical evidence of the high performance of ANOVA (Domonkos, Venema and Mestre – 7th Seminar for Homogenisation)

Impact of ANOVA on removing trend bias

Experiments with the break lists of COST HOME



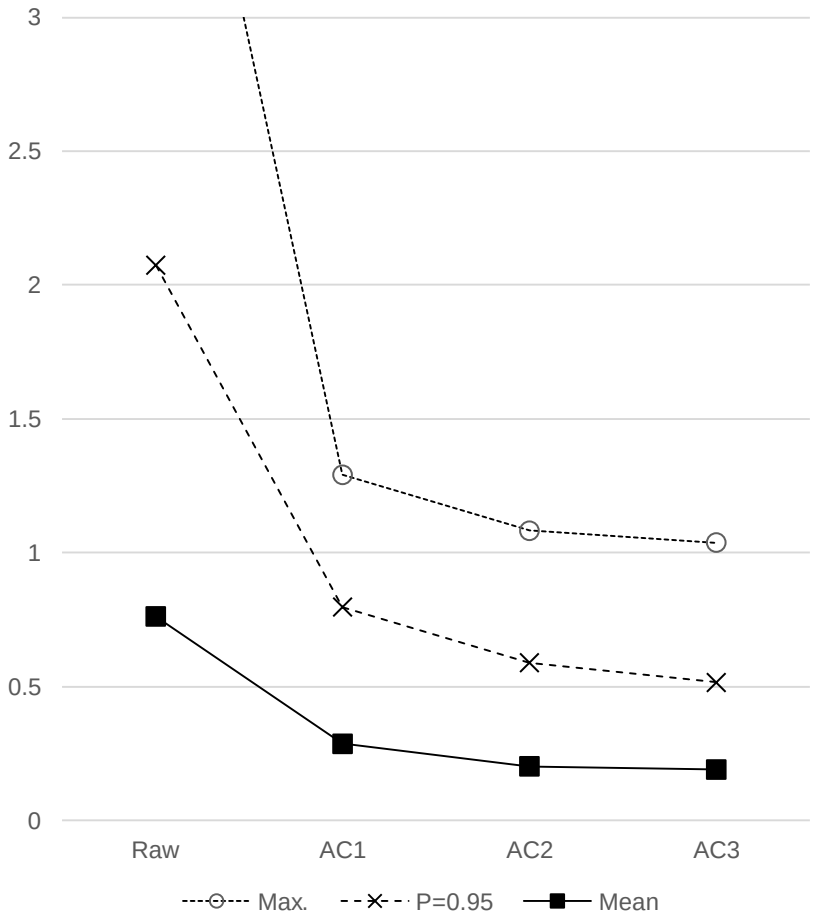
- 2011: Bivariate detection with optimal segmentation; Publication of ACMANT (Domonkos – Int. J. Geosciences)
- 2011: Network wide joint segmentation (Picard et al. – Biostatistics)
- 2012: Results of COST HOME: PRODIGE and ACMANT are among the best 5 methods (Venema et al. – Climate of the Past)
- 2013: Publication of HOMER (Mestre et al. – Időjárás)
- 2013: Correctness of C-L criterion reviewed (Lindau and Venema – Időjárás)

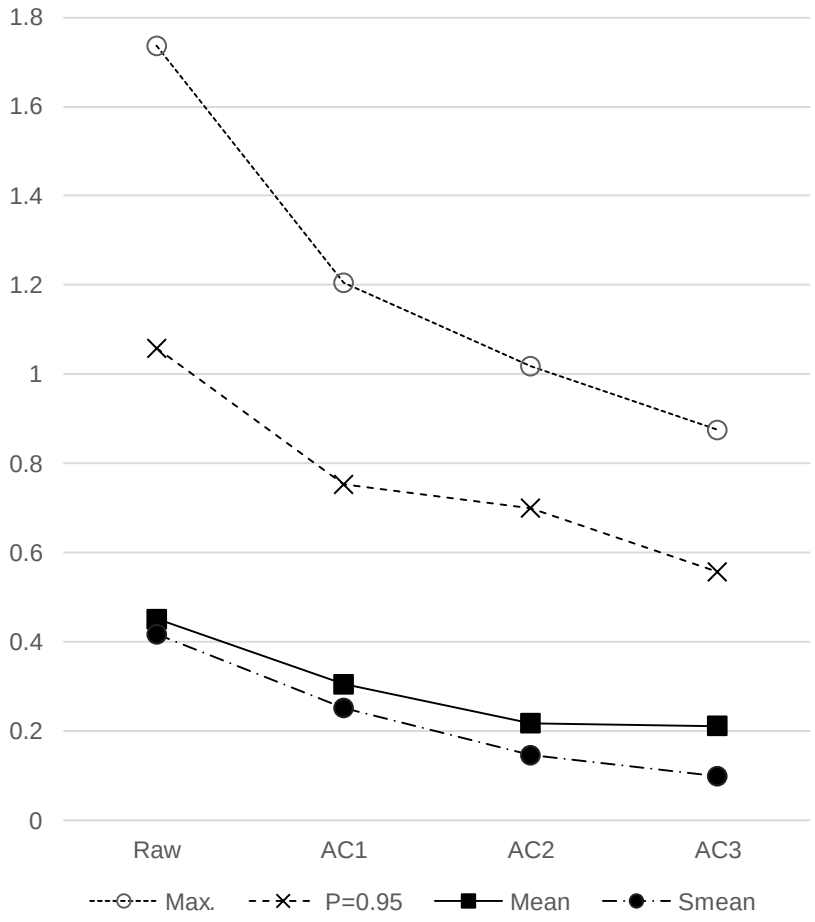
- 2014: Extension of ACMANT to other variables (Tmin and precipitation) and to daily homogenisation "ACMANT2" (Domonkos – 8th Seminar for Homogenisation)
- 2015: Precipitation homogenisation with ACMANT2 (Domonkos – Theor. Appl. Climatol.)
- 2015-16: ACMANT is among the best methods in the tests of Rachel Killick and those of "MULTITEST"
- 2016: Study on the accuracy of break detection with optimal segmentation. (Lindau and Venema – Int. J. Climatol.)

- 2016: Improvements in ACMANT → “ACMANT3”
  - ensemble pre-homogenisation
  - kriging in weighting reference composites
  - irregular shaped annual cycles of biases
  - daily preciseness of breaks
  - gap-filling with interpolation on daily scale
  - completion of time series in pre-defined period

(Domonkos and Coll – Int. J. Climatol.)

Residual errors of successive ACMANT versions, trend bias (left), network mean trend bias (right)





Strengths of ACMANT

- ☺ Low residual RMSE and trend bias
- ☺ Fully automatic and easy to use
- ☺ Very fast
- ☺ Reliable operation
- ☺ Flexible output format

downloadable from – ADDRESS CHANGED !!

http://www.c3.urv.cat/softdata.php

(Software presentation on Friday 09.00h)

Still existing problems

Drawbacks of **HOMER**:

- Shifts in the true climate are sometimes treated as inhomogeneities
- Limited tolerance of missing data fields
- Enhanced demand of memory in homogenising large networks

Drawbacks of **ACMANT**:

- Does not use metadata, thus not recommended for small networks with well documentation
- Automatic networking is not included in the software

Use of HOMER and ACMANT

- At present, the principal developers of HOMER and ACMANT (i.e. Olivier Mestre and Peter Domonkos) do not work on the field of time series homogenisation (at least formally not), which worsens the spread of the application of these powerful methods.
- The spread of HOMER is much better than that of ACMANT, as HOMER was and has remained the officially recommended method of COST HOME.
- **Author hopes that the practical use of ACMANT will be put in its right place in the future.**