Overview and updates of the RHtestsV5 data homogenization software package

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The different versions of RHtests (currently RHtestsV5) is a software package for homogenization of climate data that have approximately a normal/Gaussian distribution, such as annual surface air temperature (SAT), de-seasonalized SAT, atmospheric pressure, etc.. This and the RHtests_dlyPrcp package (described separately in another abstract contributed to this EMS session) are the only existing data homogenization software that allows users to test both known and unknown changepoints. This software allows users to perform four statistical tests: (1) the Penalized Maximum t (PMT) test for detection of unknown changepoints (Wang et al. 2007), (2) the Student t test for determining the statistical significance of known changepoints, (3) the Penalized Maximum F (PMF) test for detection of unknown changepoints (Wang 2008b), (4) the regular F test for determining the statistical significance of known changepoints. The PMT and Student t tests are implemented in the FindU.wRef, FindUD.wRef, and StepSize.wRef functions, which are for testing changepoints with reference series. The PMF and F tests are implemented in the FindU, FindUD, and StepSize functions, which are for testing changepoints without reference series (when reference series are not available). All functions can be run in the convenient Graphic User Interface (GUI) mode.

The RHtests package also has the following unique features: (1) it accounts for lag-1 autocorrelation in the series being tested, greatly minimizing the false alarm rate (Wang 2008a); (2) it models the annual cycle and lag-1 autocorrelation (and linear trend of the base series when no reference is used) in tandem while accounting for all identified shifts (Wang 2008a); (3) it provides/outputs both the mean-adjusted and QM-adjusted data series, along with plots of the series and the resulting regression fit. The software also allows users to make Quantile-Matching (QM) adjustments (Wang et al. 2010, Vincent et al. 2012) to daily or subdaily (up to hourly) data series for the changepoints already identified in the corresponding annual or monthly data series.

In addition, its users have (i) choice of the segment to which the base series is to be adjusted, (ii) choices of using the whole or part of the segments before and after a shift to estimate the QM-adjustments, (iii) choices of the nominal level of significance at which to conduct the tests. The User Guide is written in English and French.

The RHtests package also allows users to convert the daily data series in the RClimDex standard format to the monthly mean series in the RHtests standard format. Along with the RClimDex software, and the RHtests_dlyPrcp software for homogenization of daily precipitation data, the different versions of the RHtests package have been the standard software for data homogenization used in all ETCCDI training workshops since 2004 (ETCCDI stands for the WMO-WCRP-IOC joint Expert Team on Climate Change Detection and Indices). So far it has over 3000 users worldwide. All the three software packages are available free of charge at http://etccdi.pacificclimate.org/software.shtml.

References

Vincent, L. A., X. L. Wang, E. J. Milewska, H. Wan, Y. Feng, and V. Swail, 2012: A Second Generation of Homogenized Canadian Monthly Surface Air Temperature for Climate Trend Analysis, JGR-Atmospheres, 117, D18110, doi:10.1029/2012JD017859.

Wang, X. L., H. Chen, Y. Wu, Y. Feng, and Q. Pu, 2010: New techniques for detection and adjustment of shifts in daily precipitation data series. J. Appl. Meteor. Climatol. 49 (No. 12), 2416-2436. DOI: 10.1175/2010JAMC2376.1

Wang, X. L., 2008a: Accounting for autocorrelation in detecting mean-shifts in climate data series using the penalized maximal t or F test. J. Appl. Meteor. Climatol., 47, 2423-2444.

Wang, X. L., 2008b: Penalized maximal F-test for detecting undocumented mean-shifts without trend-change. J. Atmos. Oceanic Tech., 25 (No. 3), 368-384. DOI:10.1175/2007/JTECHA982.1.

Wang, X. L., Q. H. Wen, and Y. Wu, 2007: Penalized maximal t test for detecting undocumented mean change in climate ddata series. J. Appl. Meteor. Climatol., 46 (No. 6), 916-931. DOI:10.1175/JAM2504.1.