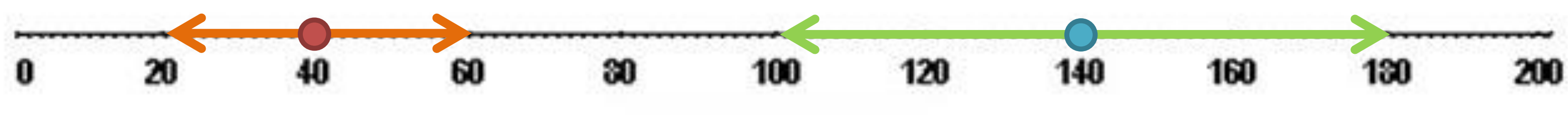
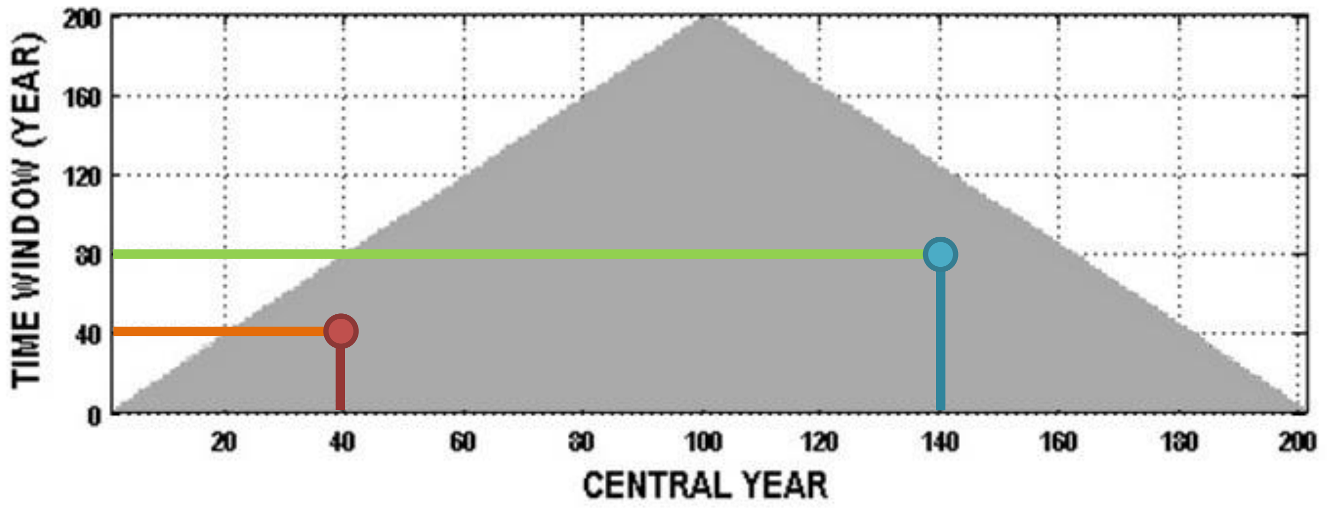
Author: Vladimiro Boselli mail at boselli[dot]vladimiro{at}gmail<dot>com

Global Time Series Analysis

Global Time Series Analysis script is conceived to further develop the idea found in ***(1) Brunetti et al. (2006) Precipitation variability and changes in the greater Alpine region over the 1800–2003 period. J. GEOPHYS. RESEARCH, VOL. 111, D11107, doi:10.1029/2005JD006674*** and in ***(2) Brunetti et al. (2009) Climate variability and change in the Greater Alpine Region over the last two centuries based on multi-variable analysis. INT. J. CLIMATOL. 29: 2197–2225 DOI: 10.1002/joc.1857*** applying the methodology to study correlation between two data series.

The original idea was to represent statistical values, on a 2D plot, calculated for sub periods extracted from an original time series, assigning to the x-axis the central year of the sub period and to the y-axis its extent.





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Single series.

A major limitation for the analysis on time series is the arbitrariness of choice of time windows to detect trends or to perform a moving average analysis.
The MATLAB script for the Global Time Series Analysis allows to notice at a glance the trend magnitude and the average value for every time series sub period .

To better understand the significance for the trend related value and for the average, the right column is dedicated to plot the significance level computed by mean of different statistical tests.

Coupled series.

The script allows to represent every single variation of correlation between the two series along with the advancing of the period.

Two series strongly correlated up to a certain t_1 can gradually weaken their correlation starting from time t_1 to time t_2 from which the correlation can regain significance. Usually these variation in correlation is not noticed or considered at first.

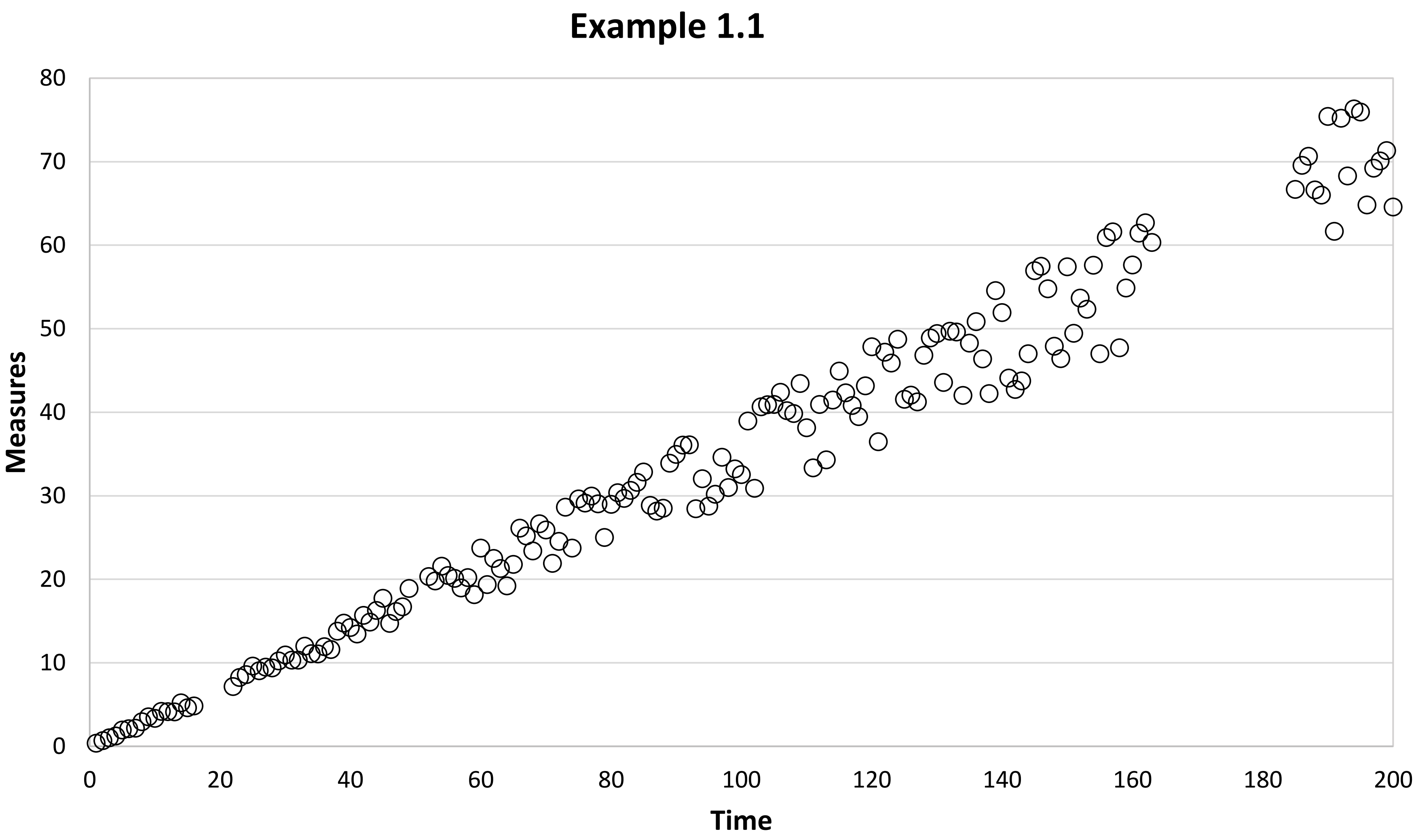
Nowadays the script can plot three different correlation coefficients: Kendall's **τ-b**, Spearman's **ρ** and Pearson's **r** along with related significance calculated by mean of a Normal Test for the first one and a T-Test for second one and the third one.

It is also available an averaged plot of the three coefficients and their significance.

Author: Vladimiro Boselli mail at boselli[dot]vladimiro{at}gmail<dot>com

1 EXAMPLE OF ANALYSIS ON SINGLE SERIES

EXAMPLE 1.1 Positive trend with increasing fluctuations and gaps.



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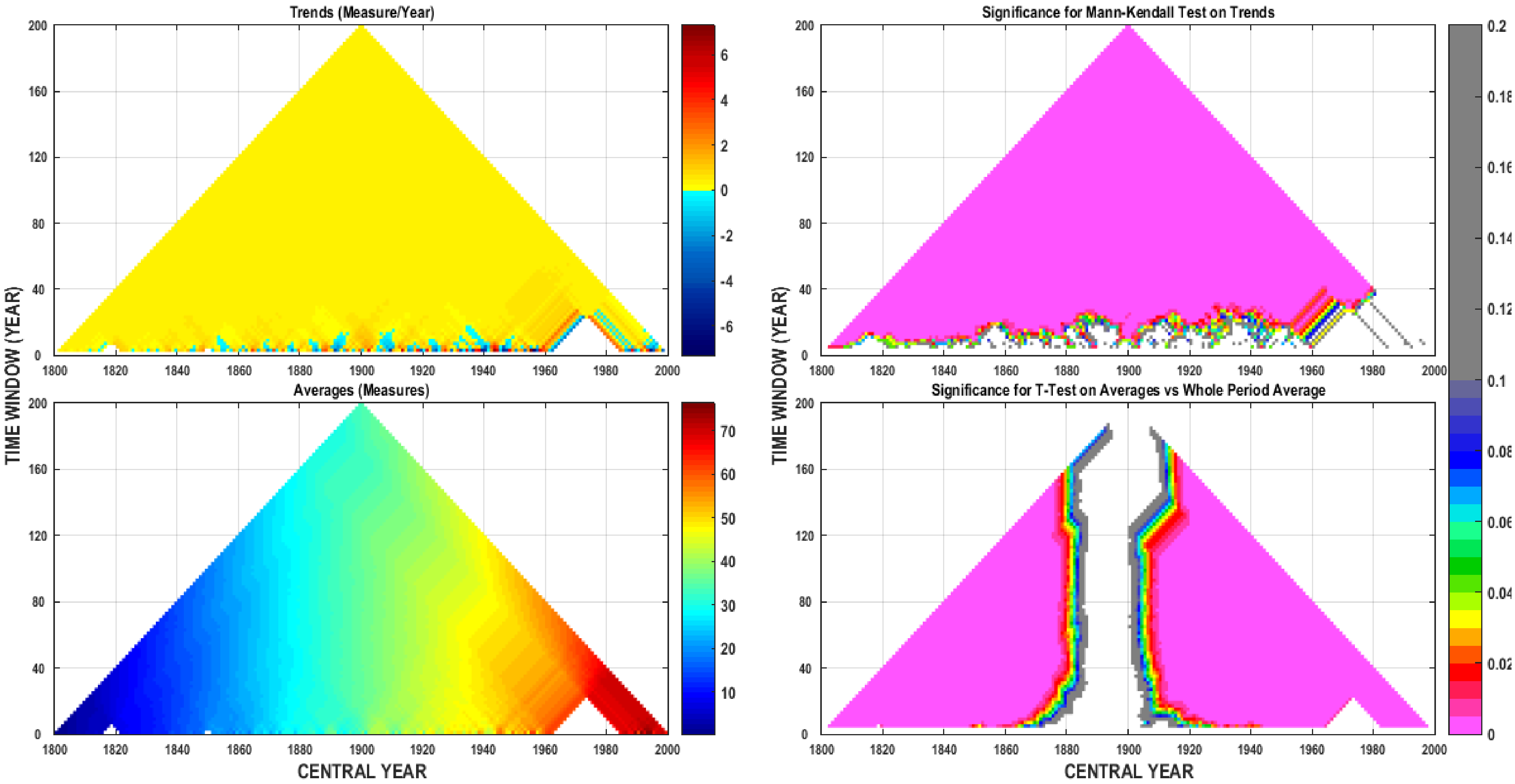

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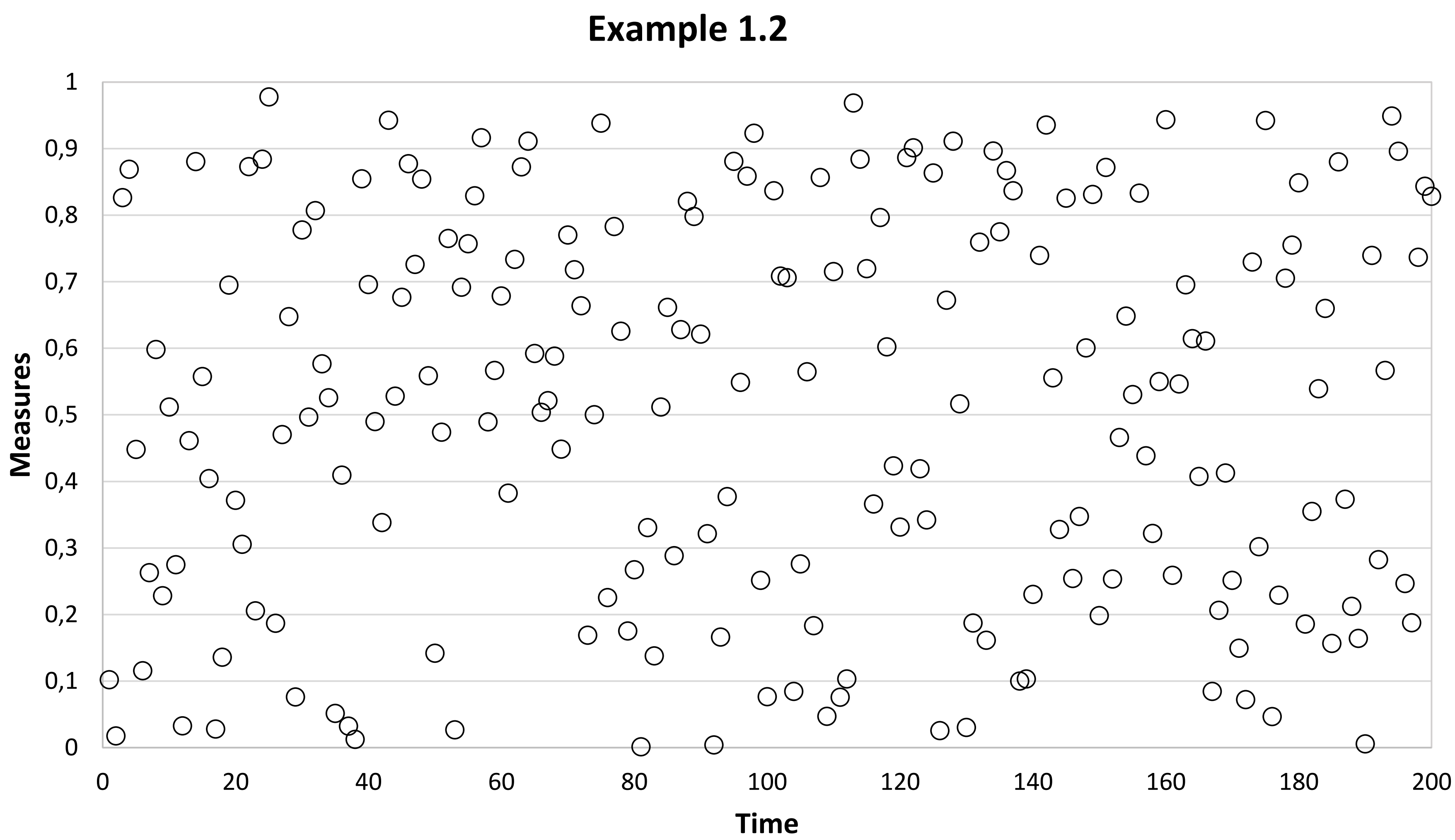
EXAMPLE 1.2 Random.



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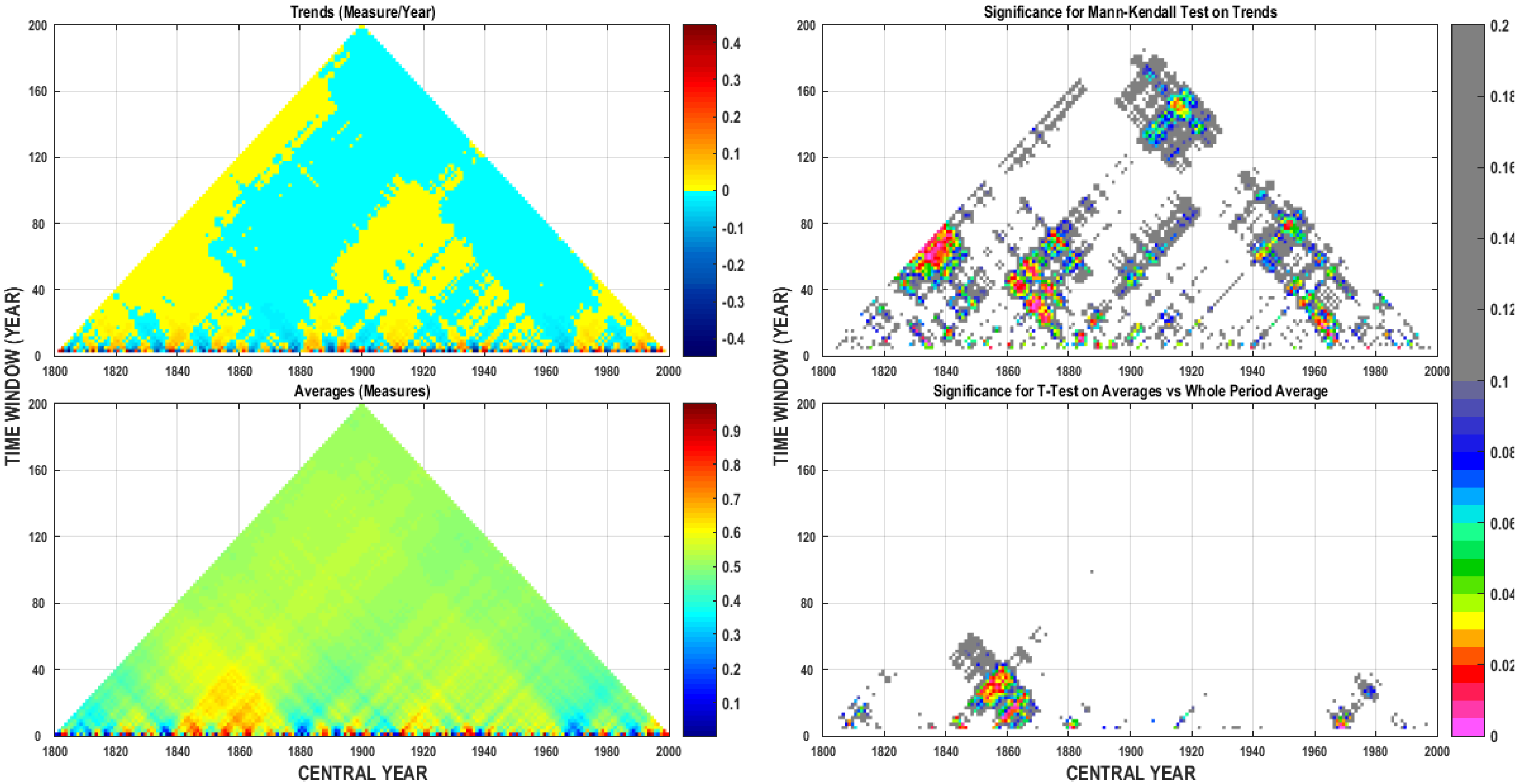

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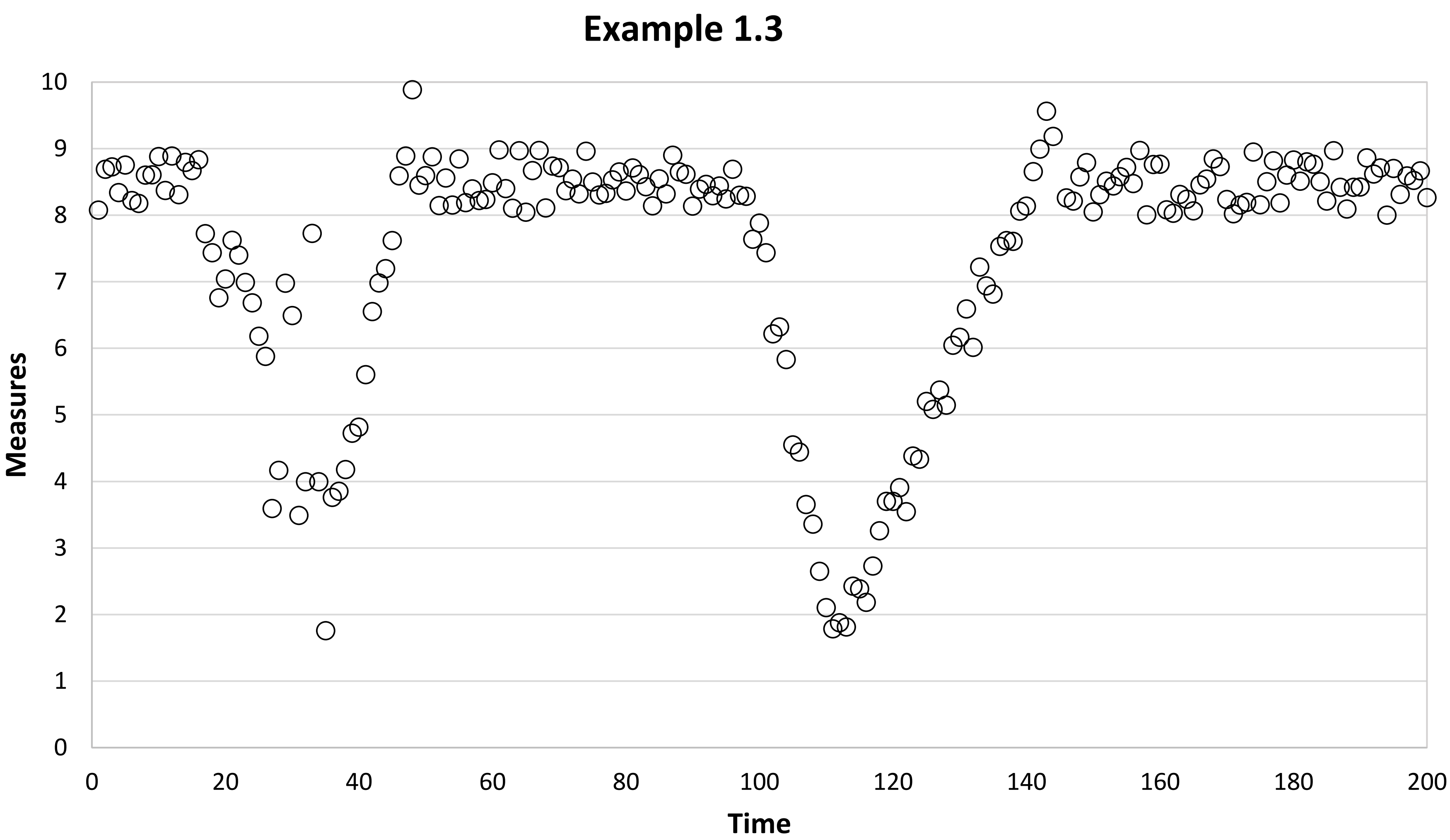
EXAMPLE 1.3 Sudden anomalies.



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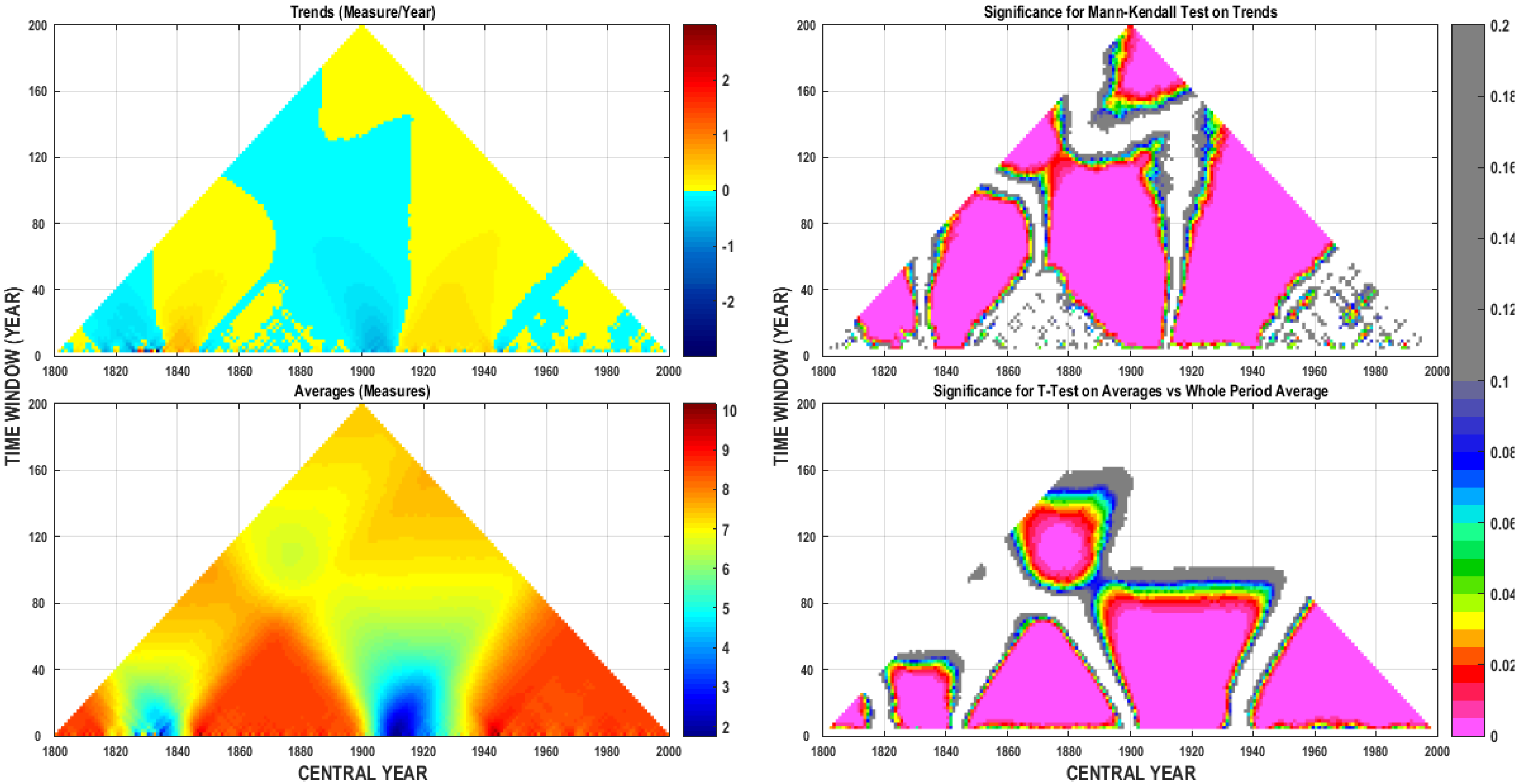

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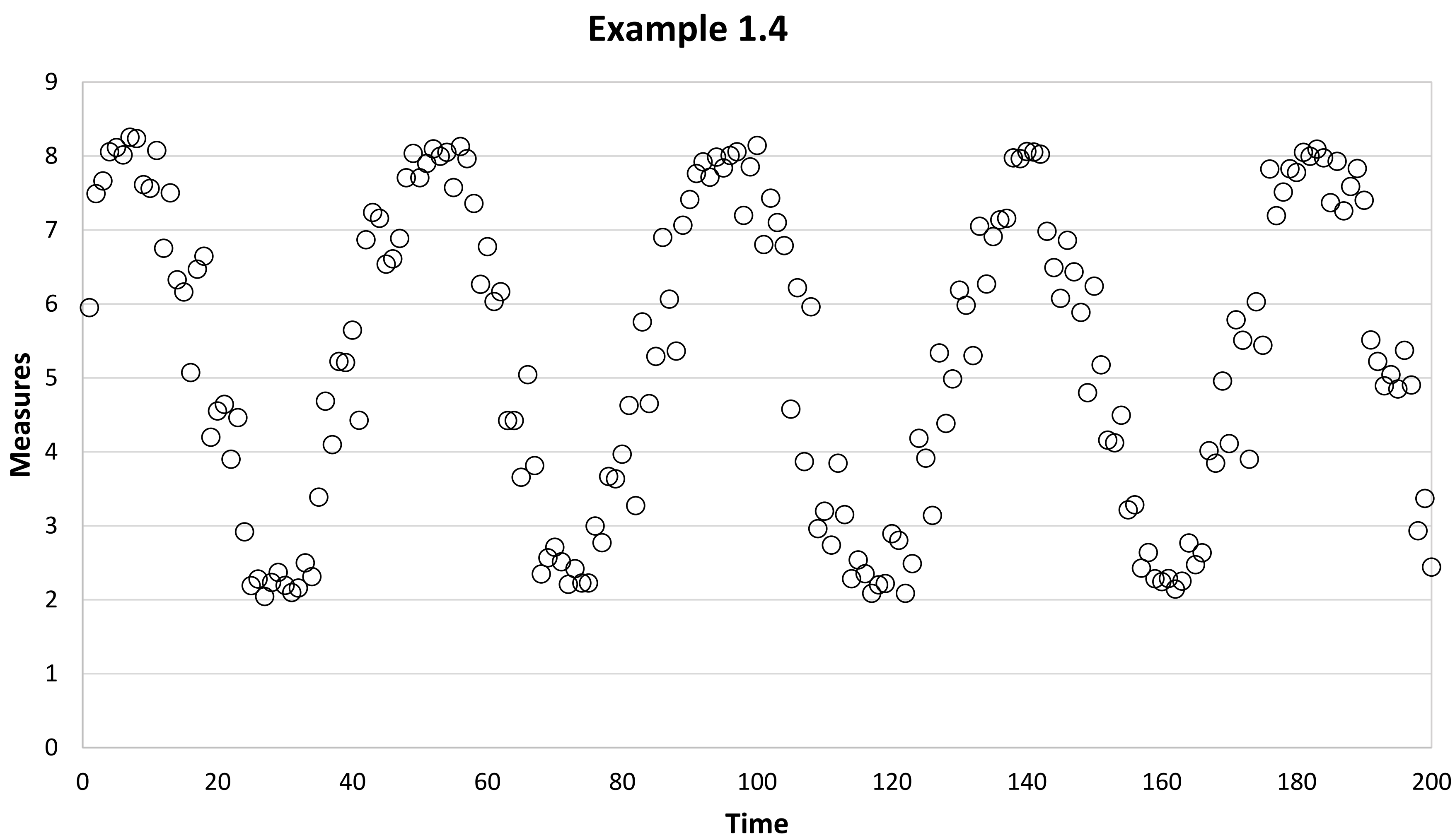
EXAMPLE 1.4 Periodicity.



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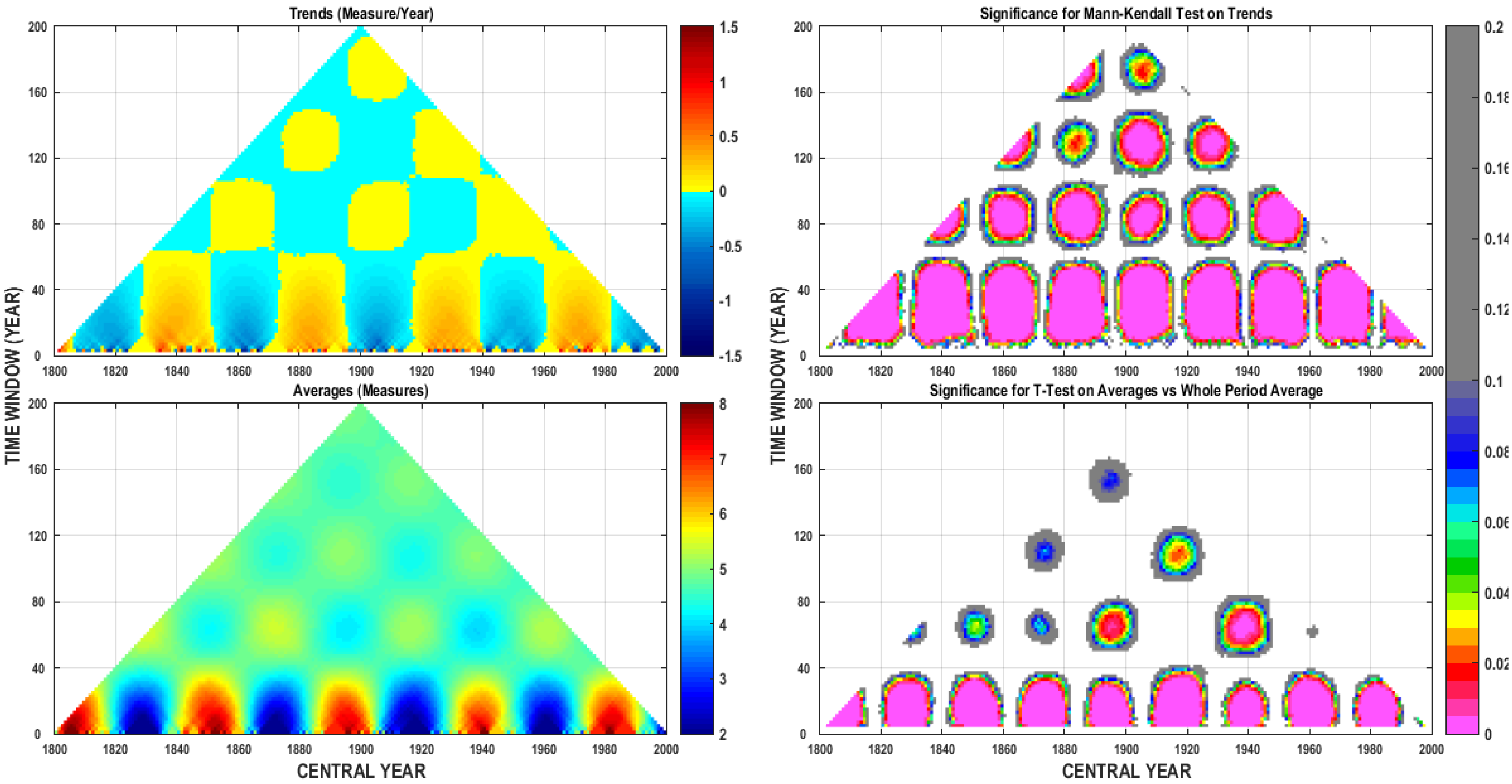
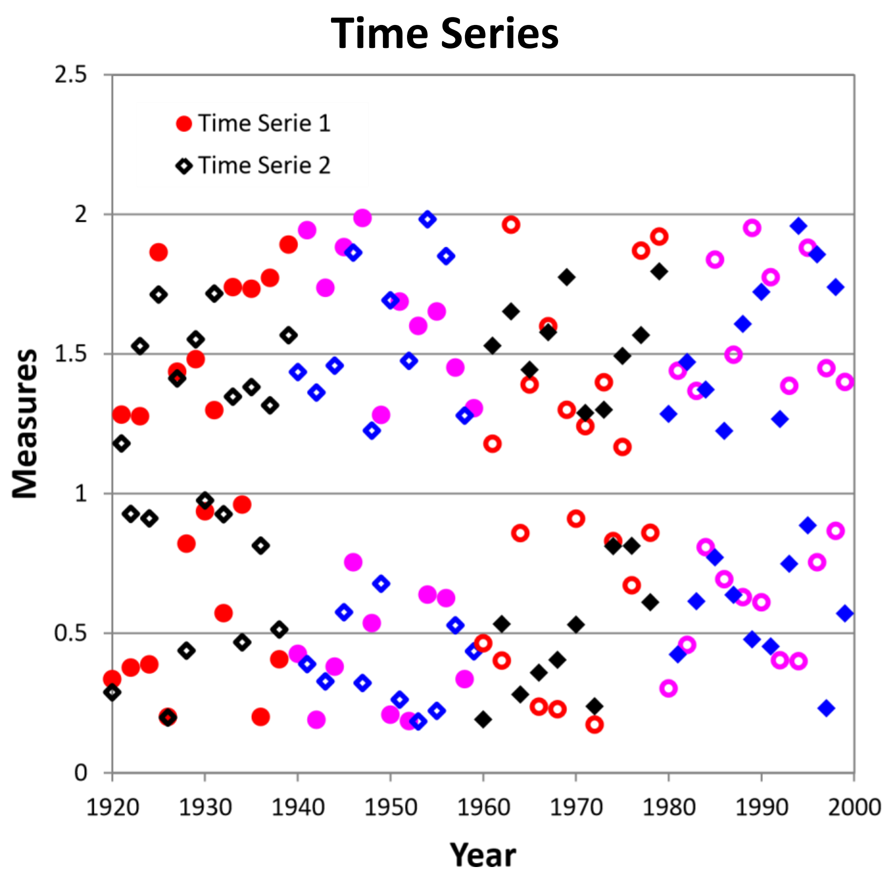
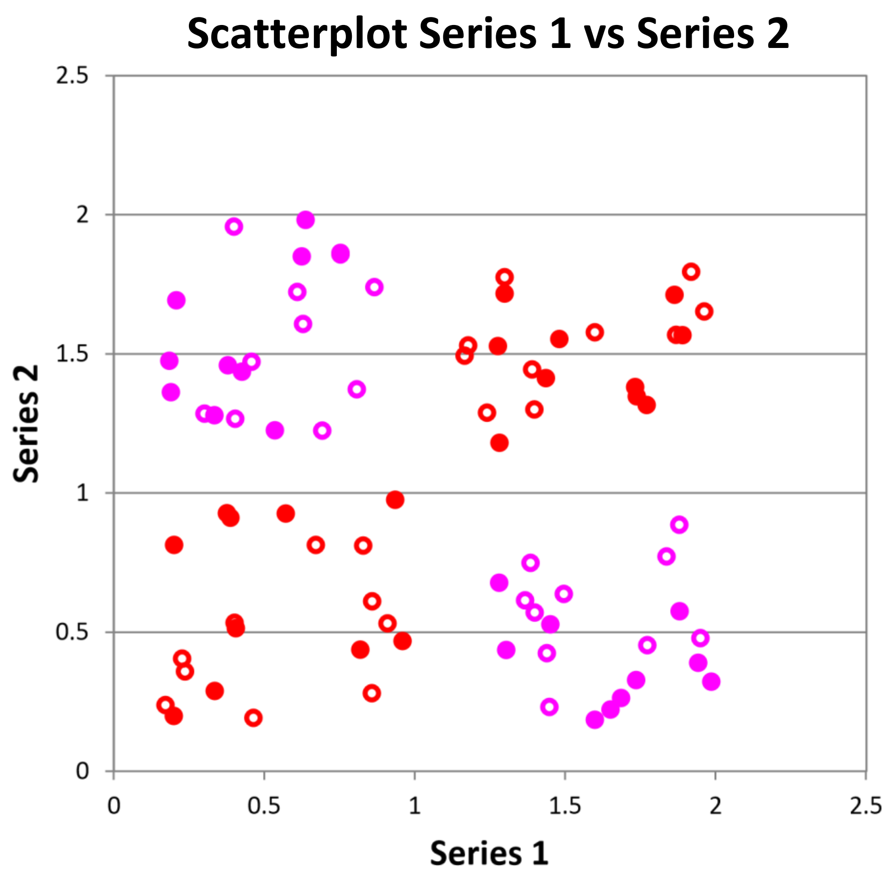


Author: Vladimiro Boselli mail at boselli[dot]vladimiro{at}gmail<dot>com

2 EXAMPLES OF ANLYSIS ON COUPLED SERIES

EXAMPLE 2.1 Sudden inversion of the correlation every 20 years.





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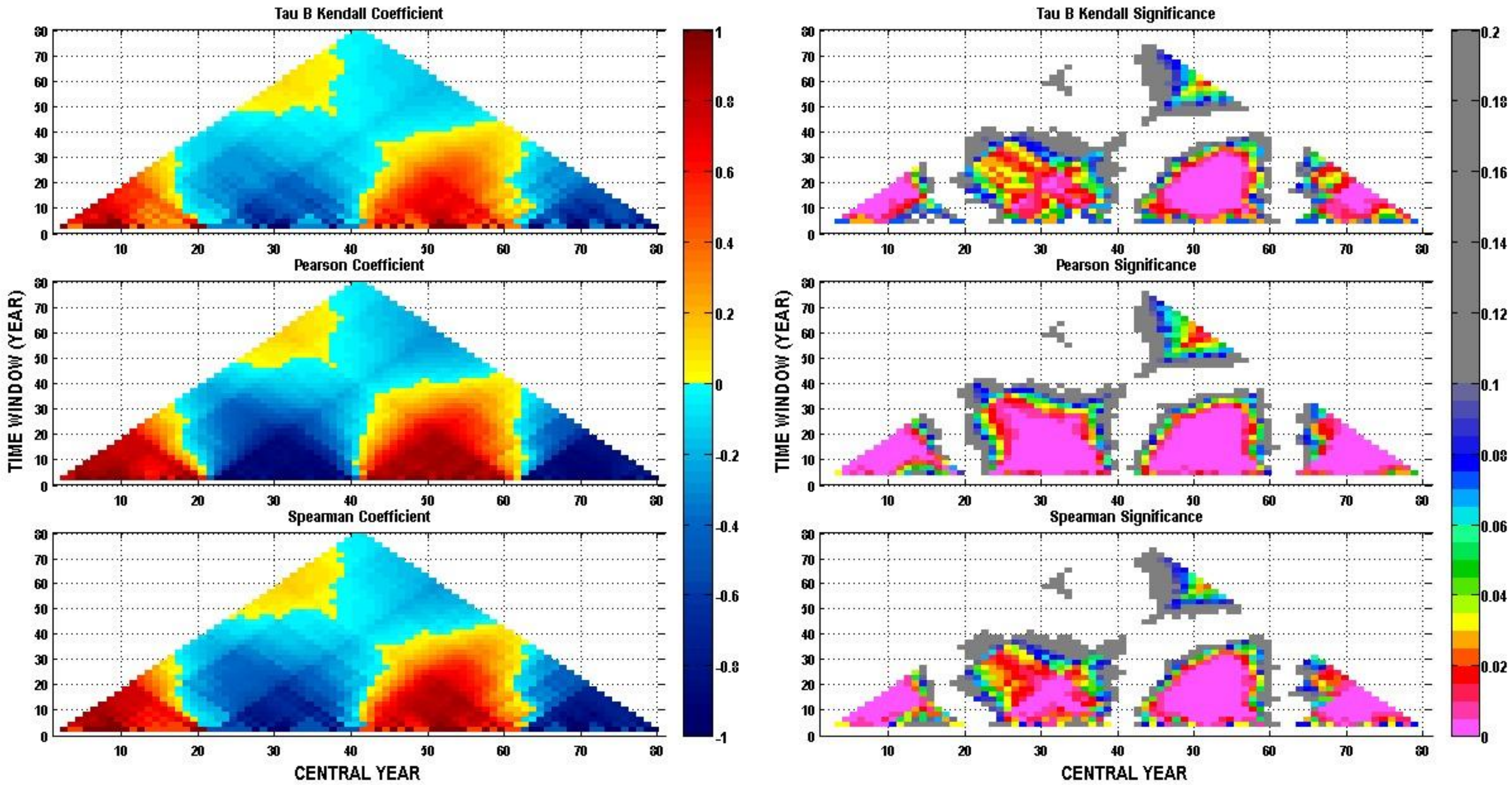
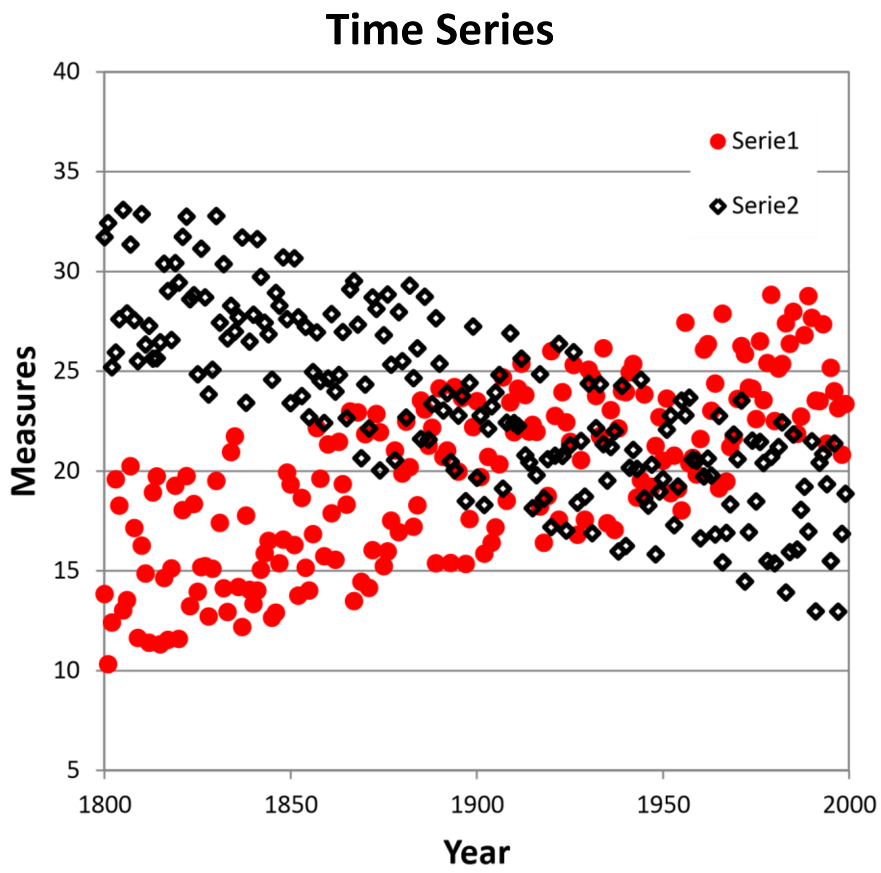


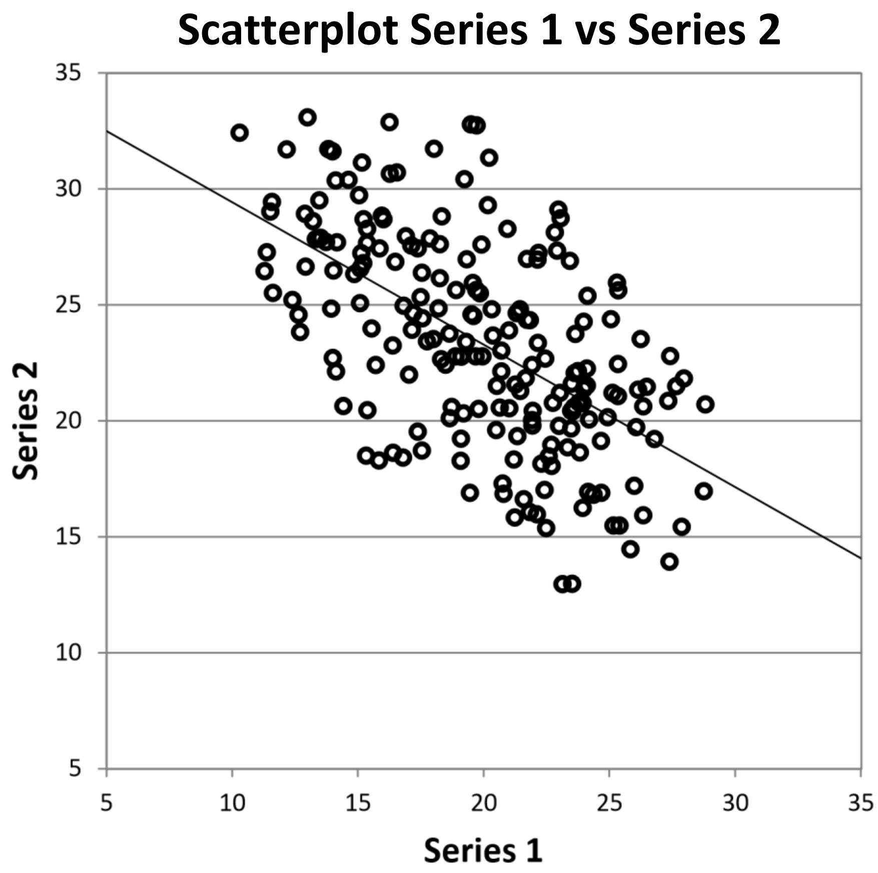
Observing the plot you can notice at a glance how the correlation between the two series suddenly reverses every 20 years, consequently significant correlation values are detected only in sub periods from 1 to 20, from 21 to 40, from 41 to 60 and from 61 to 40.

The periodicity of the correlation inversion is clearly observable at a glance only throughout this kind of analysis.

Author: Vladimiro Boselli mail at boselli[dot]vladimiro{at}gmail<dot>com

EXAMPLE 2.2 Negative correlation on the long period.





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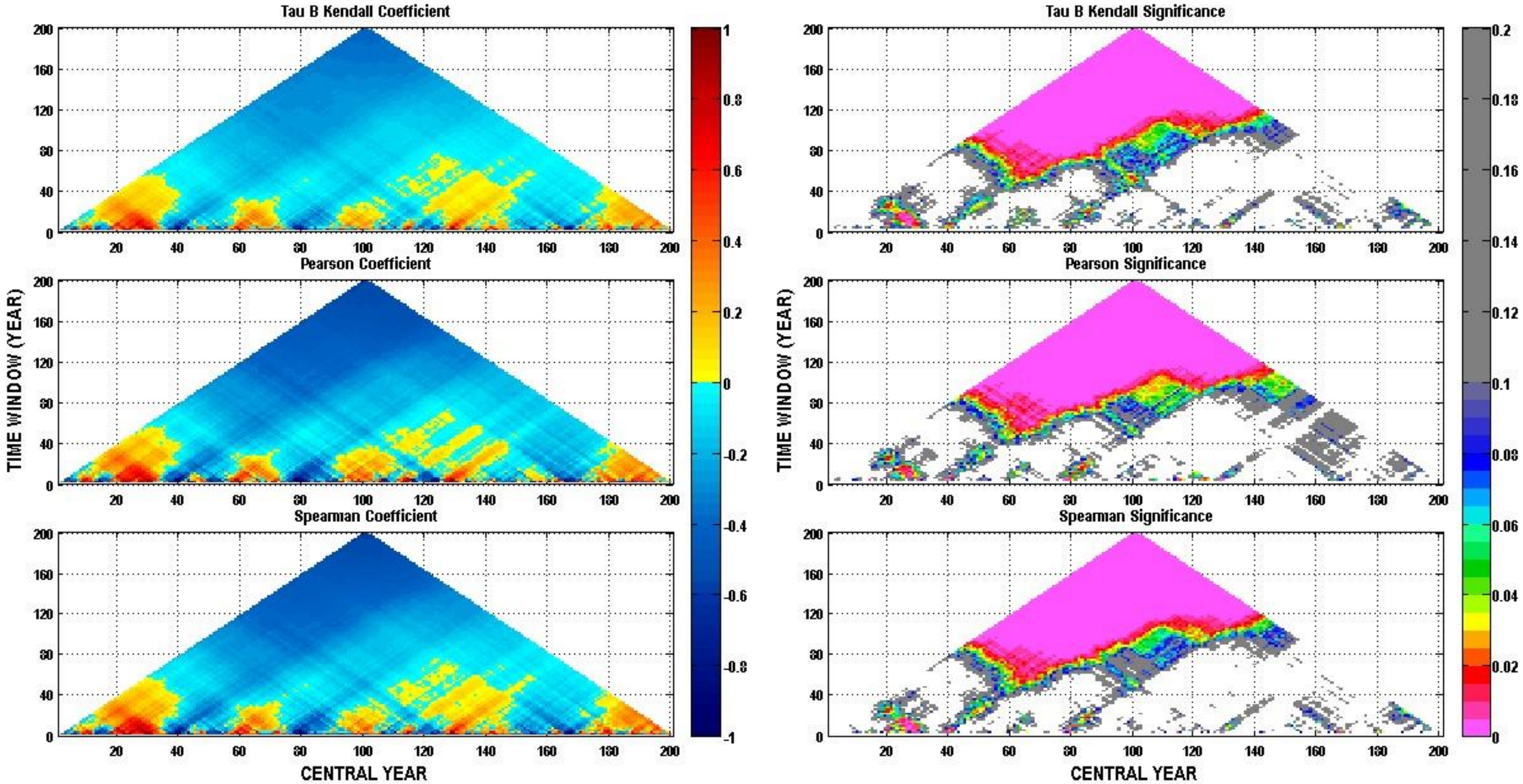
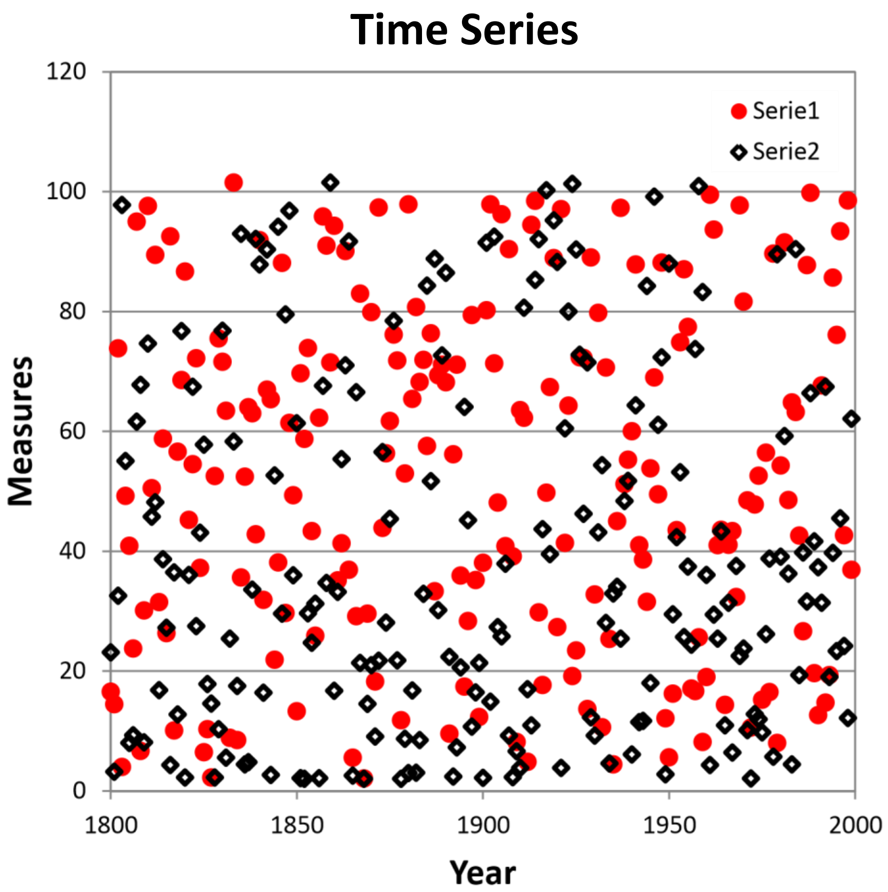
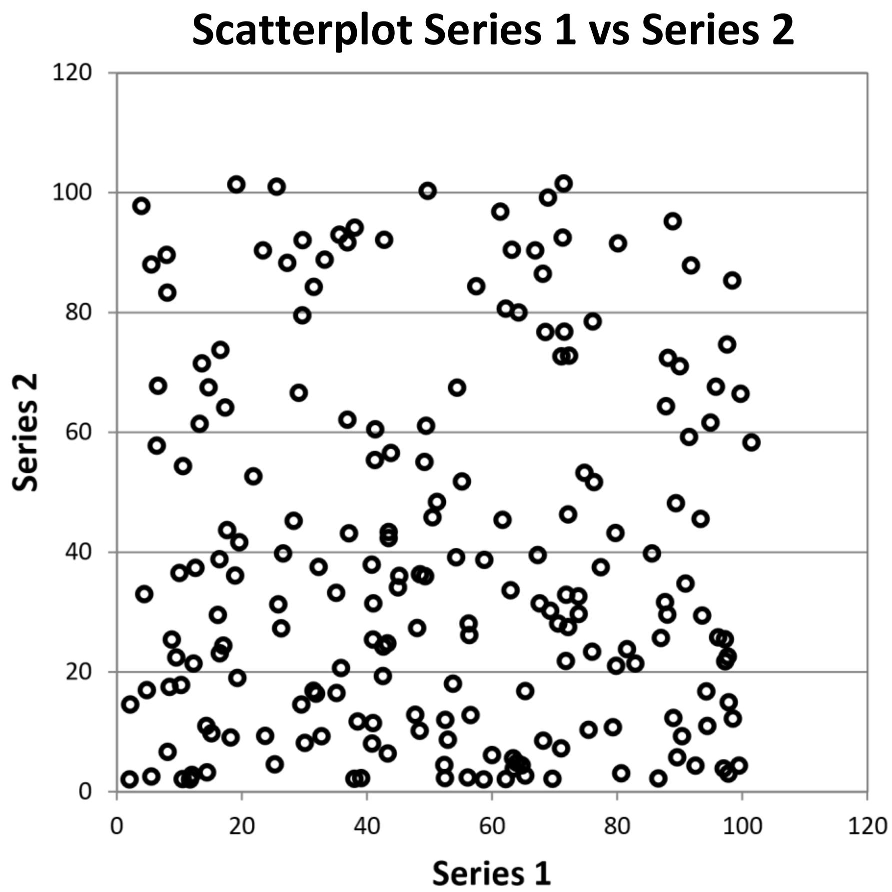


From the plot above a significant negative correlation can be noticed between the two time series starts to be present only for sub periods longer than 80 years to become fully significant for all sub periods longer than 120 years.

Author: Vladimiro Boselli mail at boselli[dot]vladimiro{at}gmail<dot>com

EXAMPLE 2.3 Absence of correlation.





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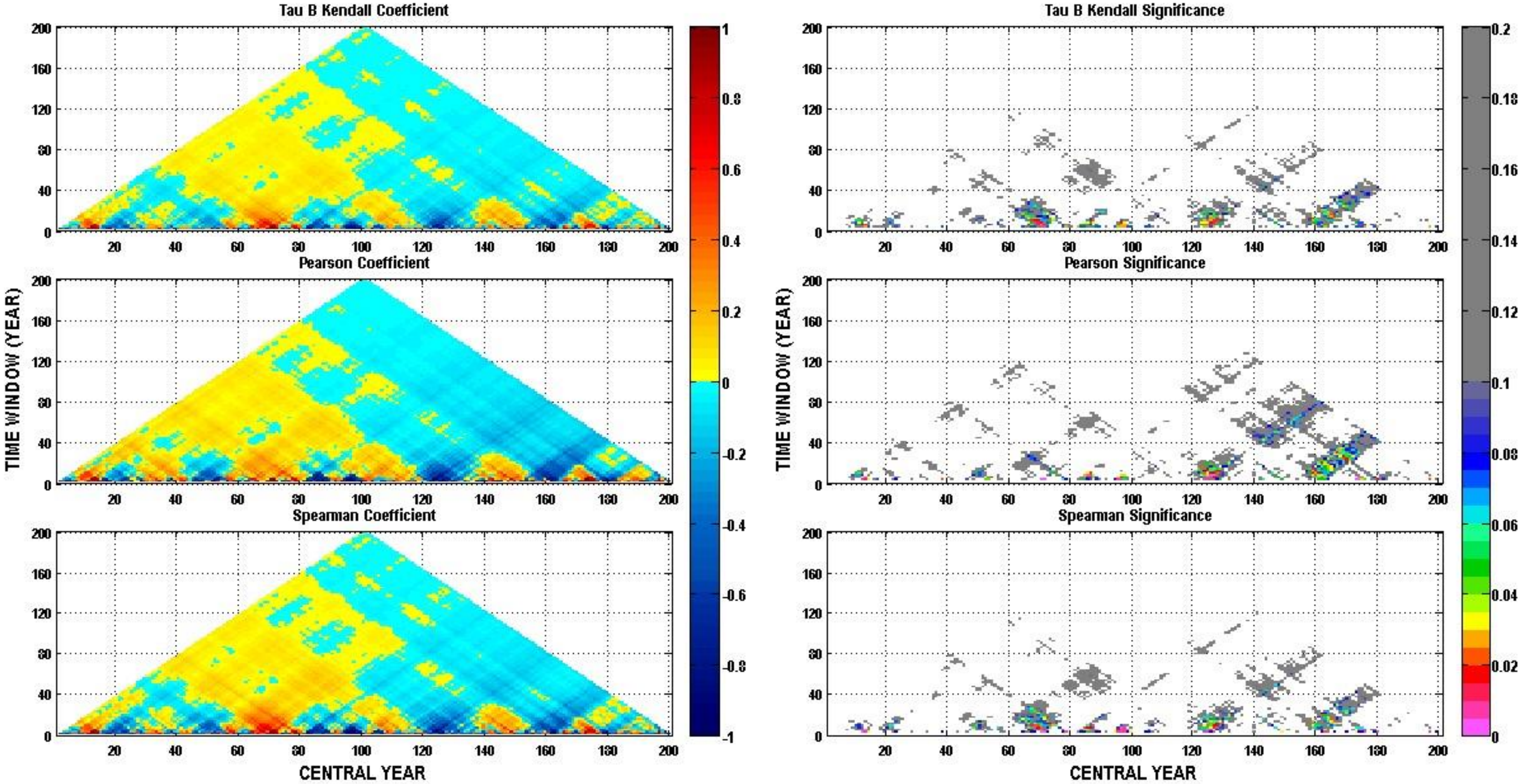

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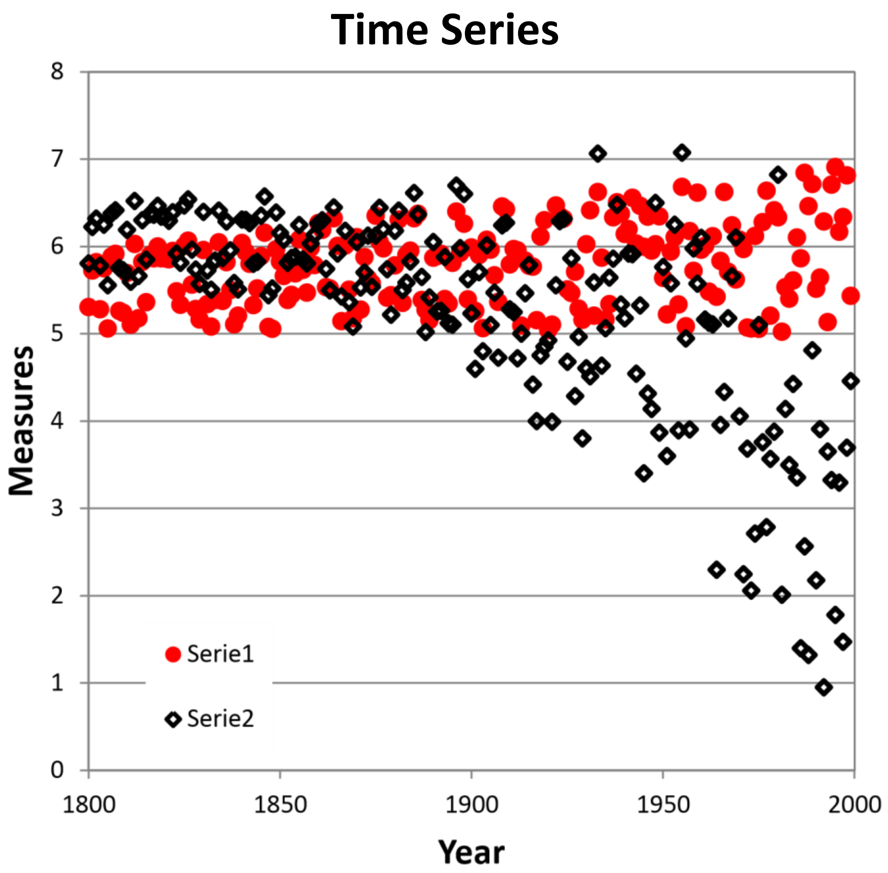
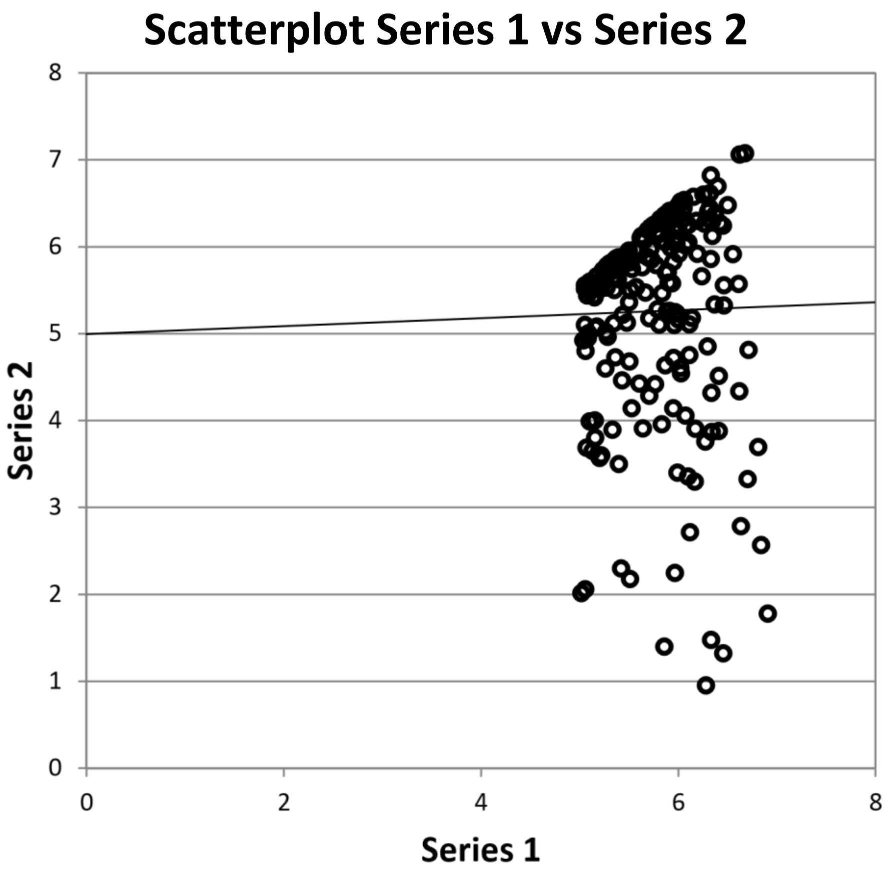
EXAMPLE 2.4 Exponential weakening of the correlation.





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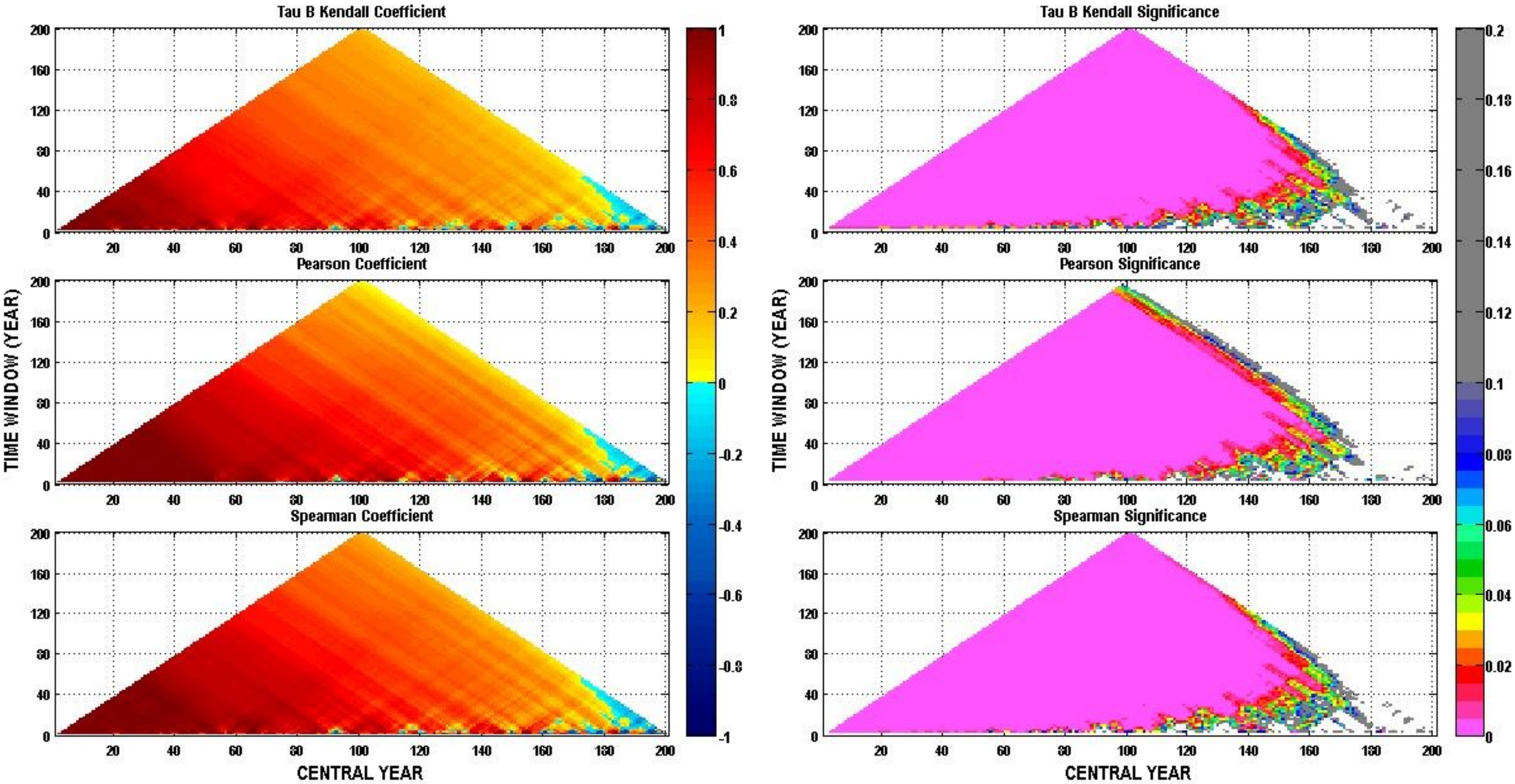

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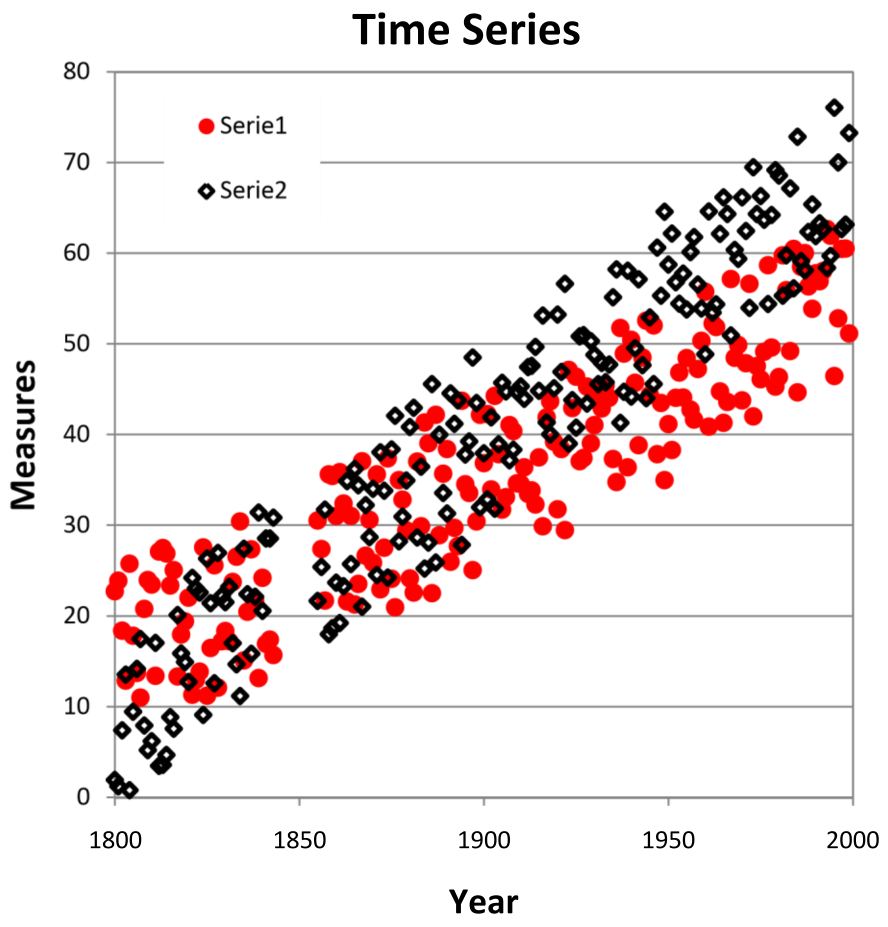
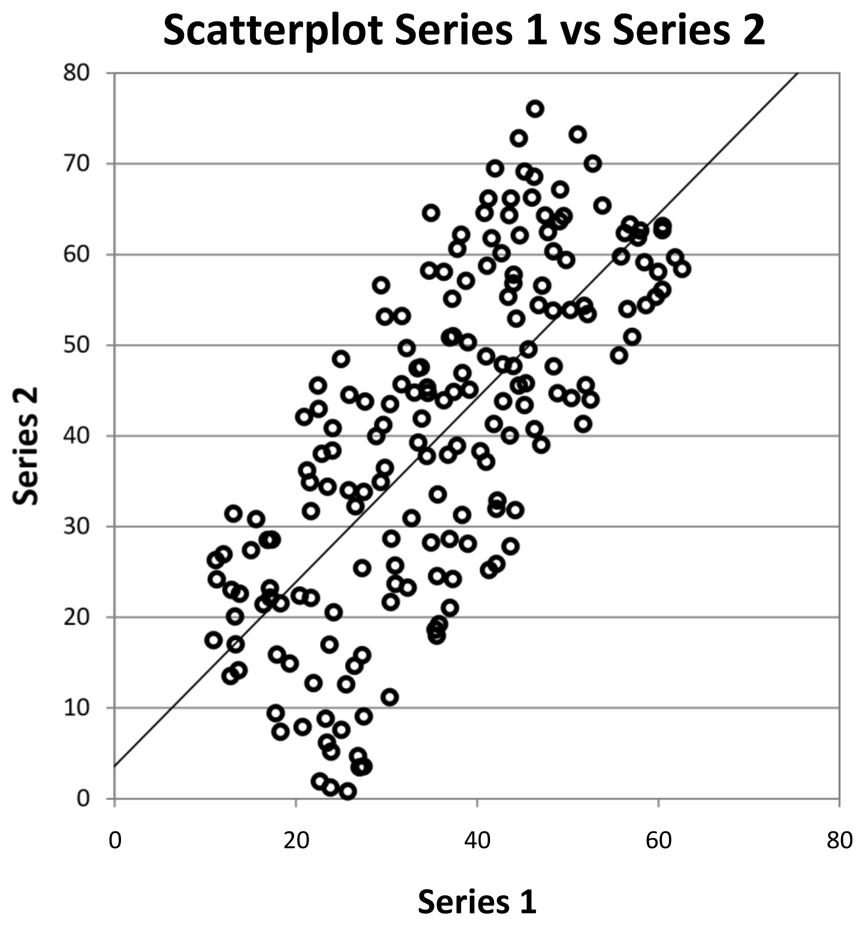
EXAMPLE 2.5 Correlation inversion for long observation periods.





The former series is generated by the formula $s1(t_i)=(t_i-1800)*0.2 + rand(t_i)*18 + 5$ and the latter one is generated as $s2(t_i)= (t_i-1800)*0.3 - rand(t_i)*18.5 + 21$ so that short term negative correlation is given by the blue terms and the long term positive correlation is given by the red ones.

EXAMPLE 2.5 Correlation inversion for long observation periods.