ゴルフのスウィングとスコア分析

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1. はじめに

2. データの準備

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Loading required package: WaveletComp

Loading required package: png
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3. ビデオ動画から得られた位置情報の統計解析

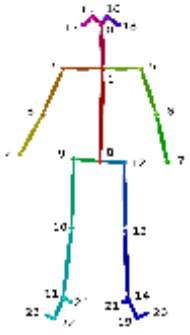
個人番号 ID を Person という列で付与しているので，2 人以上のフレームがついている場合でもトラッキング(追跡)することができるデータ・ファイルが CSV 形式でできあがっている． OpenPose では，体の得られる点として 25 ポイントが得られるモデルを利用しているので，1 人ついて 25 個の関節を認識するようになっている．その番号と位置は図 1 に与えられている．

データがとれなかったゼロの入っているポイントがある． P5, P19，半身像では P11-12, P14-15, P18 と P20 以降，P19 以降である．

全身像でも向かって右肩 P5 と右足親指 P19 がゼロになる．

半身像の動画ファイル 4,5,6 では，P11-12, P14-15 がゼロ，ファイル 4 では P18 がゼロで P20 以降がゼロ，ファイル 5 と 6 では P19 以降がゼロとなっている．

図1 OpenPose25



OpenPose 25 のモデル

3.1 関節の角度の時間経過の計算

たとえば，ひじの位置を O，肩を A，手を B，角 AOB＝θとする． それぞれの点の位置ベクトルが座標で与えられているので，$\vec{a} = \overrightarrow{OA}, \vec{b} = \overrightarrow{OB}$が計算できて，

$$x = \cos\theta = \frac{\vec{a} \cdot \vec{b}}{\sqrt{|\vec{a}||\vec{b}|}}$$

から，$\theta = \cos^{-1}x$ (プログラムでは acos(t)の部分)でひじの角度が計算できる．

3.2 関節の位置から関節の角度の計算を行う

プロセスの最後では，角度θを計算し，値を theta に保存している．その値は$theta(i,j)$であらわすが，ここでiは体の位置を計算したフレームの番号，jは 1, … , 18 までの関節の番号である．

3.3 角度の図示

18 箇所の関節の角度を 6 つずつ表示する．

- 首からひじの角度の図示 図は左右のクビ，肩，ひじにかけての角度の動きを折れ線グラフで表したものである．
- 腰からひざの角度の図示 図は左右の腰，大腿部，ひざにかけての角度の動きを折れ線グラフで表したものである．
- 足首からつまさきの角度の図示 図は左右の足首，つま先，についての角度の動きを時間を折って折れ線グラフに表したものである．

x 座標は t_movie で，フレームの枚数が図に index として表示されている．
t_movie は 0 から 1 までの値を等分している． 時刻の経過は，全体を 1 とした尺度(t_movie)で表している．

3.4 Fourier 解析による periodogram

周期的な振動を見つけようとするグラフである． グラフは 2 枚で一組で，下段の Smoothed Periodogram で見る． 左の値の小さいものは，高い振動数なので，細かなブレということになる． 基本的に細かなブレが観察されるが，大きなぶれではっきりとした周期は見られないといえる．

3.5 Wavelet 解析による periodogram と cross-periodogram

フーリエ解析のピリオドグラムでは，どの周波数(振動数, x 軸)に対して強いスペクトル密度が観察されるかが示されている．しかし，その周期性が動画のどの時点での動きから得られた値であるかがわからない． ウェーブレット解析では，それが，時間の経過とともに周期性の強度（スペクトル密度）が変化していくかを測定することができる．

ウェーブレット解析の場合，スペクトル密度(強度)は色で表されている．赤が強いことを表している． x軸は時間の流れである．y軸は周波数(振動数)である．ピリオドグラムであるので，y軸は周期(period)を表している．値が小さい方が周期が短く，振動数が大きいため，回転が速い(高周波)ということができる．

図は左右の関節部の角度が同調しているかどうかをクロス・ウェーブレット解析によって確かめてみる． 図のなかで，強いスペクトル密度が観察されている赤い領域に，矢印が描かれているが，これは影響を与えている方向を示している．

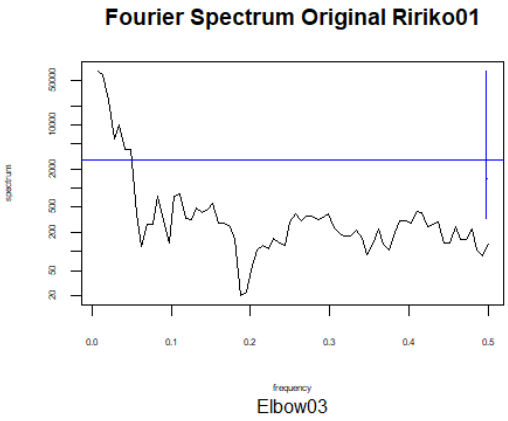
最期の図は，計測されたスペクトル密度の値がゼロと違うかどうかの統計的有意性を調べている． 赤い点が得られている周波数の点は強いスペクトル密度が得られているということができる．

各動画について，つぎの順番で図が示されている．

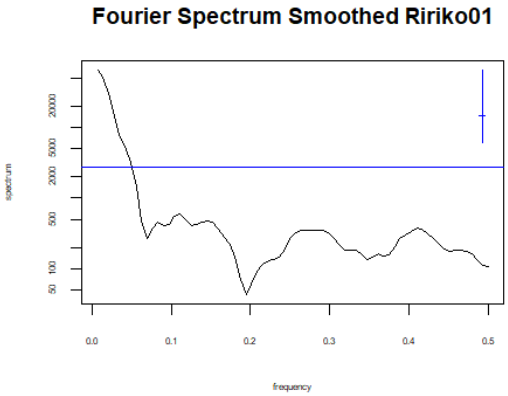
- 肩(02, 05)の関節の Fourier 解析による periodogram
- 肩(02, 05)の Wavelet 解析による periodogram と cross-periodogram
- ひじ(03, 06)の関節の Fourier 解析による periodogram
- ひじ(03, 06)の Wavelet 解析による periodogram と cross-periodogram
- 大腿部(09, 12)の Fourier 解析による periodogram
- 大腿部(09, 12)の Wavelet 解析による periodogram と cross-periodogram
- ひざ(10, 13)の Fourier 解析による periodogram
- ひざ(10, 13)の Wavelet 解析による periodogram と cross-periodogram
- 足首(11, 14)の Fourier 解析による periodogram
- 足首(11, 14)の Wavelet 解析による periodogram と cross-periodogram

関節と番号	R の変数	関節と番号	R の変数
首左肩 01	theta[, 1]	右腰腿 12	theta[,10]
首右肩 01	theta[, 2]	左ひざ 10	theta[,11]
左肩 02	theta[, 3]	右ひざ 13	theta[,12]
右肩 05	theta[, 4]	左足首 11	theta[,13]
左ひじ 03	theta[, 5]	右足首 14	theta[,14]
右ひじ 06	theta[, 6]	右足先 19	theta[,15]
左腰胴 08	theta[, 7]	左足先 22	theta[,16]
右腰胴 08	theta[, 8]	左足甲 11	theta[,17]
左腰腿 09	theta[, 9]	右足甲 14	theta[,18]

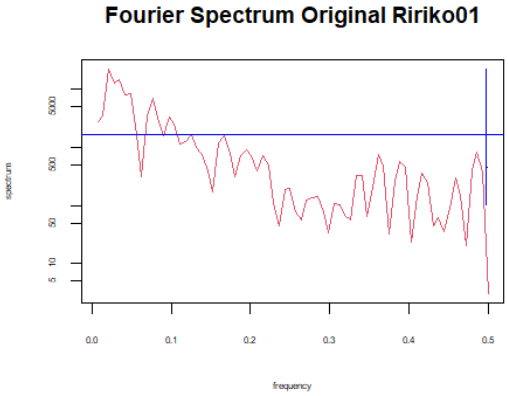
Ririko01.mp4 の動画



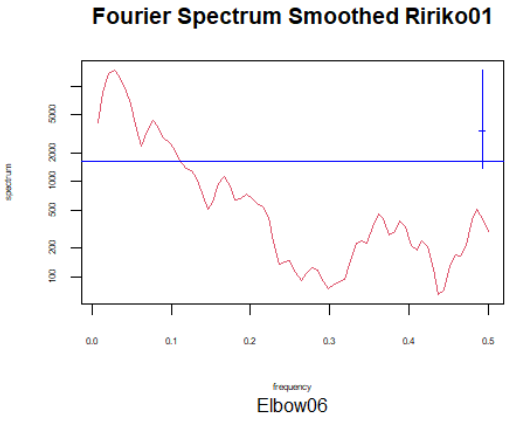
Elbow03



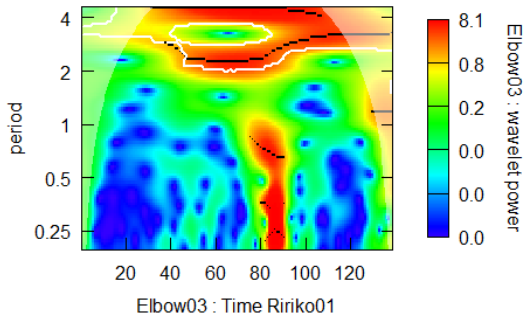
Elbow03



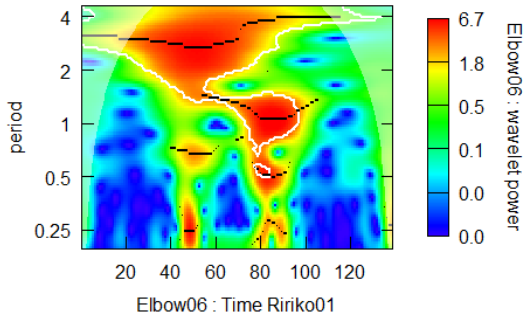
Elbow06



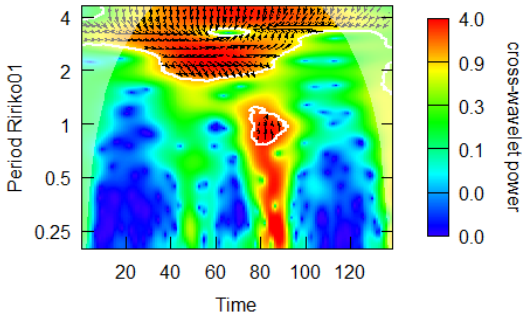
Elbow06

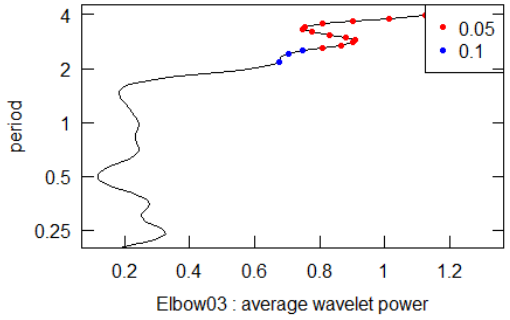


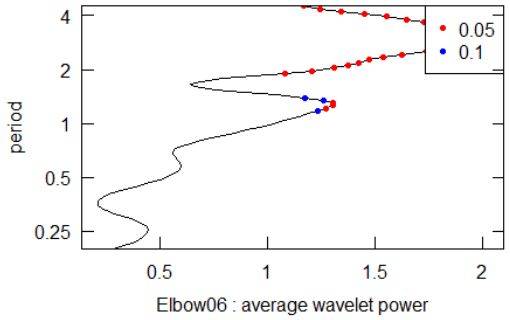
Elbow03 : Time Ririko01

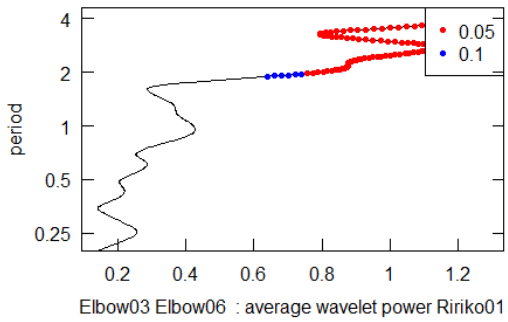


Elbow06 : Time Ririko01

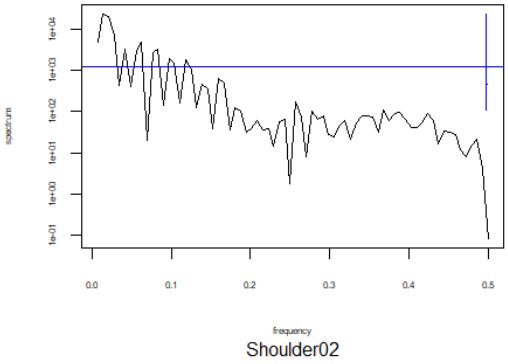

Period Ririko01
4
2
1
0.5
0.25
20
40
60
80
100
120
Time
4.0
0.9
0.3
0.1
0.0
0.0
cross-wavelet power


period
4
2
1
0.5
0.25
0.2
0.4
0.6
0.8
1
1.2
Elbow03 : average wavelet power
0.05
0.1

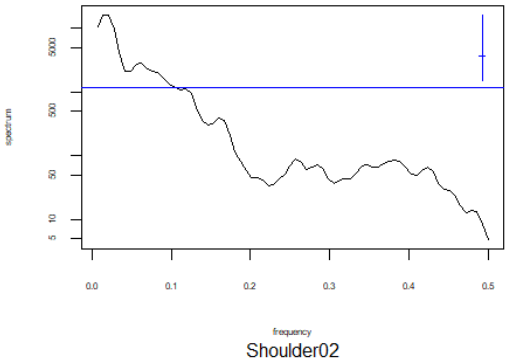

period
4
2
1
0.5
0.25
0.5
1
1.5
2
Elbow06 : average wavelet power
0.05
0.1



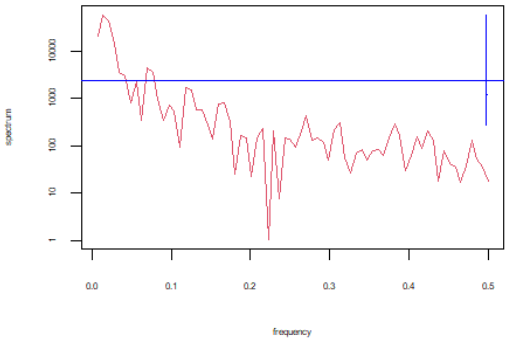
Fourier Spectrum Original Ririko01



Fourier Spectrum Smoothed Ririko01

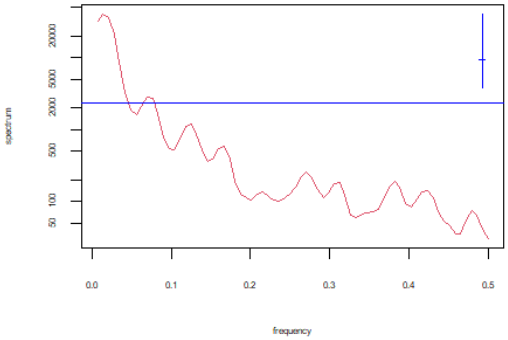


Fourier Spectrum Original Ririko01

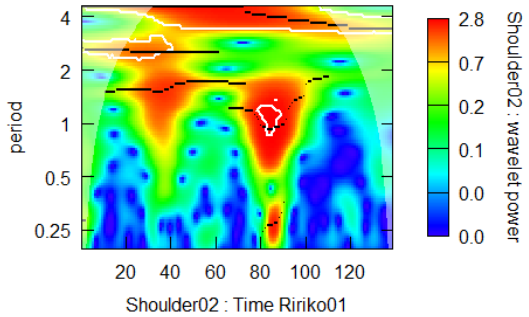


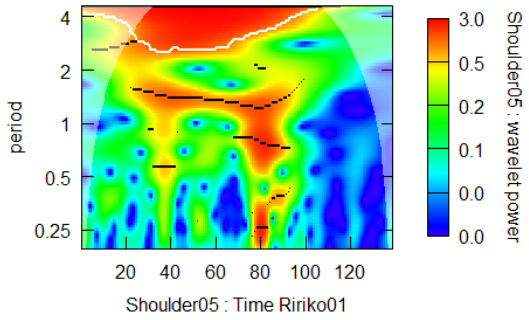
Shoulder05

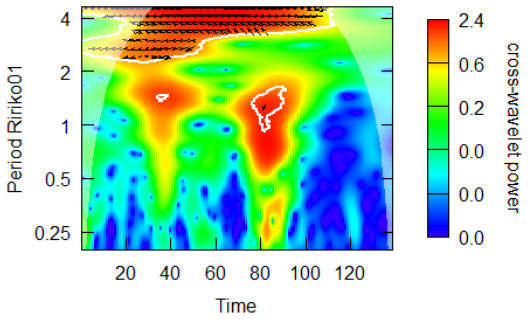
Fourier Spectrum Smoothed Ririko01

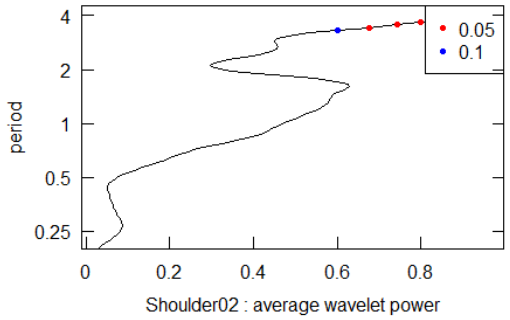


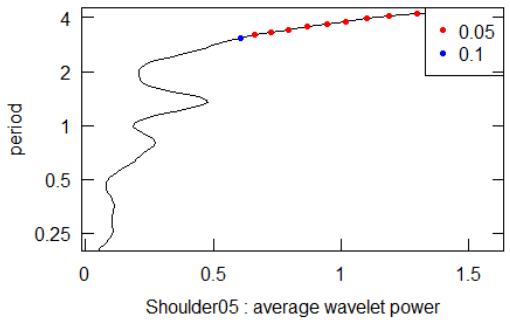
Shoulder05

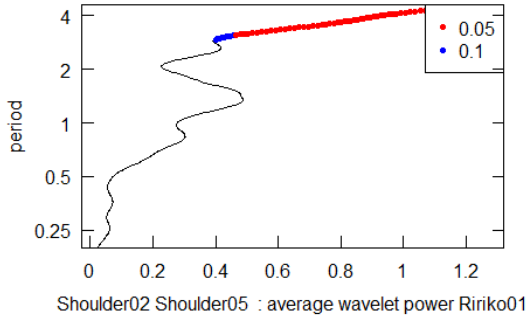


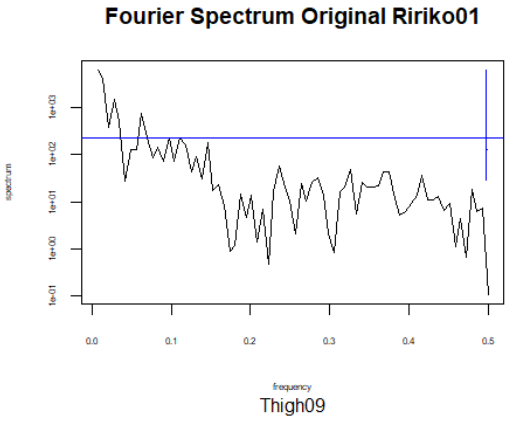

period
4
2
1
0.5
0.25
20 40 60 80 100 120
Shoulder05 : Time Ririko01
3.0
0.5
0.2
0.1
0.0
0.0
Shoulder05 : wavelet power


Period Ririko01
4
2
1
0.5
0.25
20 40 60 80 100 120
Time
2.4
0.6
0.2
0.0
0.0
0.0
cross-wavelet power

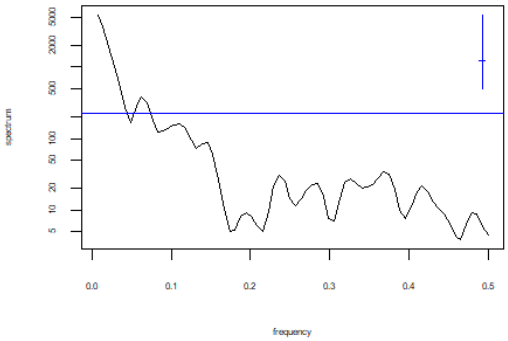

period
4
2
1
0.5
0.25
0 0.2 0.4 0.6 0.8
Shoulder02 : average wavelet power
0.05
0.1


0.05
0.1
period
4
2
1
0.5
0.25
0
0.5
1
1.5
Shoulder05 : average wavelet power


0.05
0.1
period
4
2
1
0.5
0.25
0
0.2
0.4
0.6
0.8
1
1.2
Shoulder02 Shoulder05 : average wavelet power Ririko01

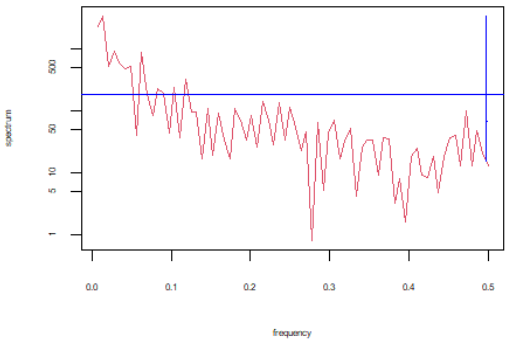

Fourier Spectrum Original Ririko01
spectrum
1e-01
1e+00
1e+01
1e+02
1e+03
0.0
0.1
0.2
0.3
0.4
0.5
frequency
Thigh09

Fourier Spectrum Smoothed Ririko01



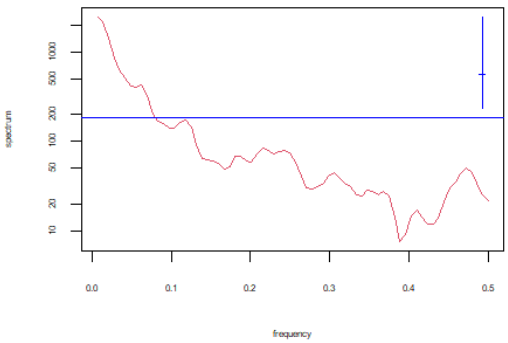
Thigh09

Fourier Spectrum Original Ririko01

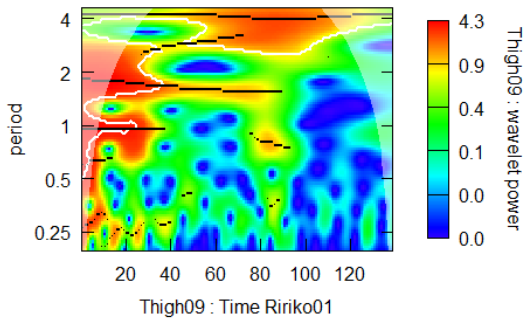


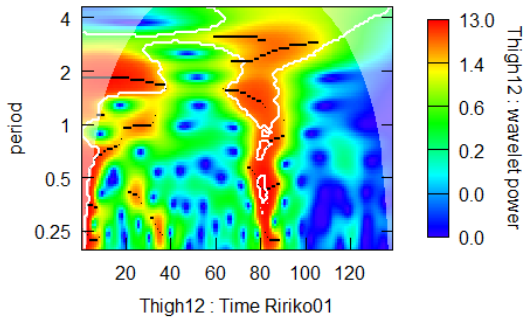
Thigh12

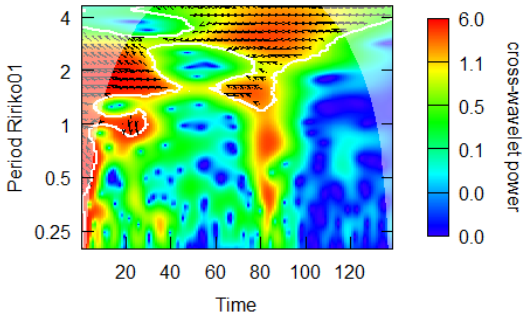
Fourier Spectrum Smoothed Ririko01

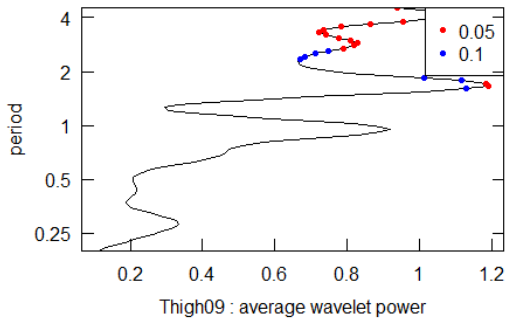


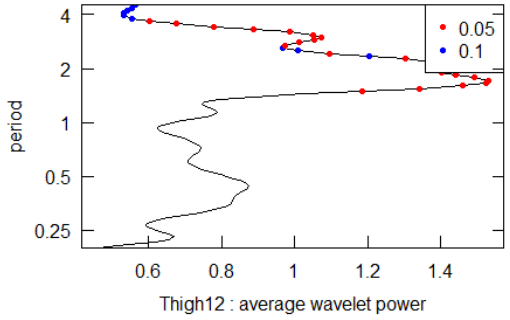
Thigh12

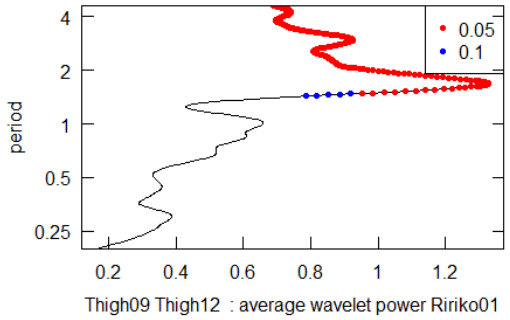

period
4
2
1
0.5
0.25
20 40 60 80 100 120
Thigh09 : Time Ririko01
4.3
0.9
0.4
0.1
0.0
0.0
Thigh09 : wavelet power


period
4
2
1
0.5
0.25
20 40 60 80 100 120
Thigh12 : Time Ririko01
13.0
1.4
0.6
0.2
0.0
0.0
Thigh12 : wavelet power

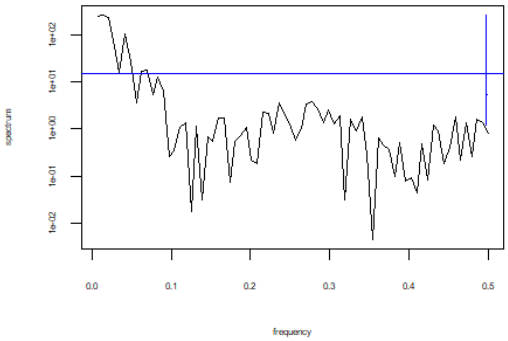

Period Ririko01
4
2
1
0.5
0.25
20 40 60 80 100 120
Time
6.0
1.1
0.5
0.1
0.0
0.0
cross-wavelet power


0.05
0.1
period
4
2
1
0.5
0.25
0.2
0.4
0.6
0.8
1
1.2
Thigh09 : average wavelet power


0.05
0.1
period
4
2
1
0.5
0.25
0.6
0.8
1
1.2
1.4
Thigh12 : average wavelet power

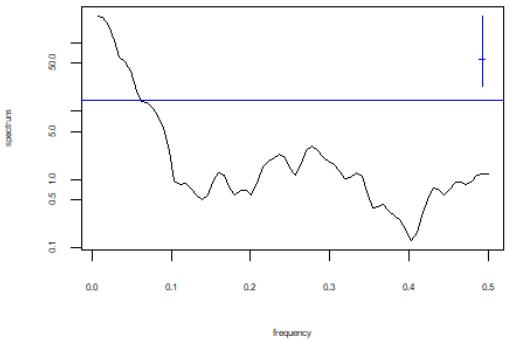

0.05
0.1
period
4
2
1
0.5
0.25
0.2
0.4
0.6
0.8
1
1.2
Thigh09 Thigh12 : average wavelet power Ririko01

Fourier Spectrum Original Ririko01



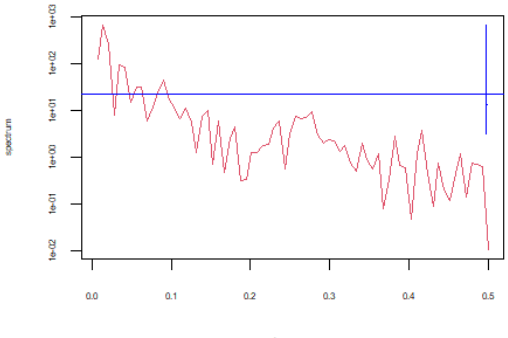
Knee10

Fourier Spectrum Smoothed Ririko01

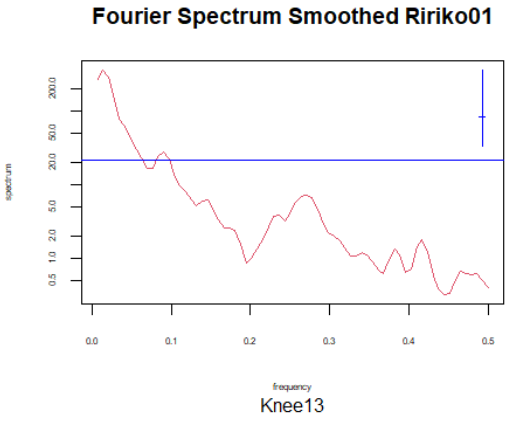


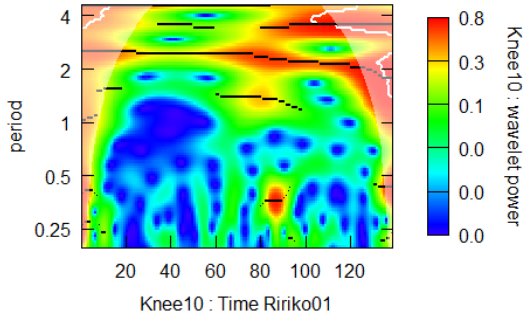
Knee10

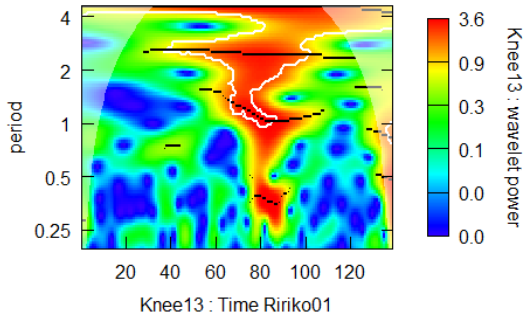
Fourier Spectrum Original Ririko01

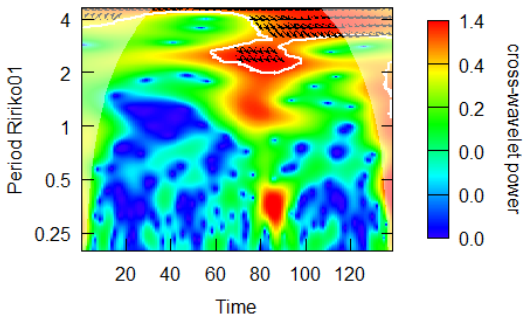


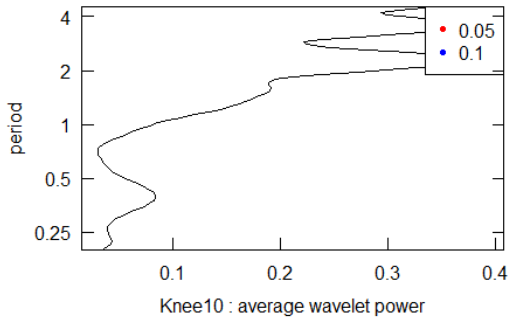
Knee13

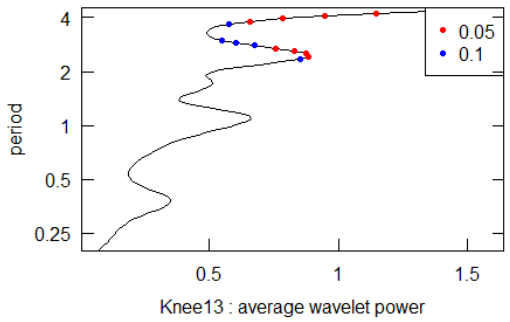

Fourier Spectrum Smoothed Ririko01
spectrum
200.0
50.0
20.0
5.0
2.0
1.0
0.5
0.0
0.1
0.2
0.3
0.4
0.5
frequency
Knee13

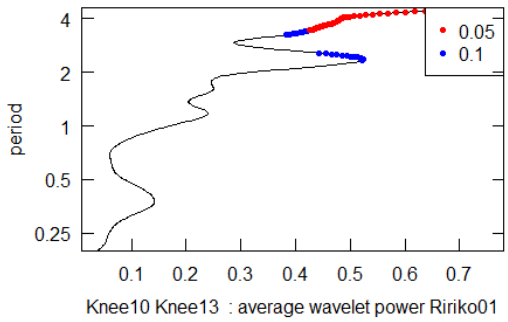

period
4
2
1
0.5
0.25
20
40
60
80
100
120
Knee10 : Time Ririko01
0.8
0.3
0.1
0.0
0.0
0.0
Knee10 : wavelet power


period
4
2
1
0.5
0.25
20
40
60
80
100
120
Knee13 : Time Ririko01
3.6
0.9
0.3
0.1
0.0
0.0
Knee13 : wavelet power

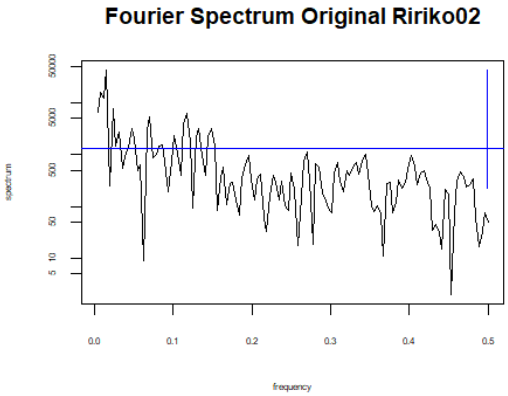

Period Ririko01
4
2
1
0.5
0.25
20
40
60
80
100
120
Time
1.4
0.4
0.2
0.0
0.0
0.0
cross-wavelet power

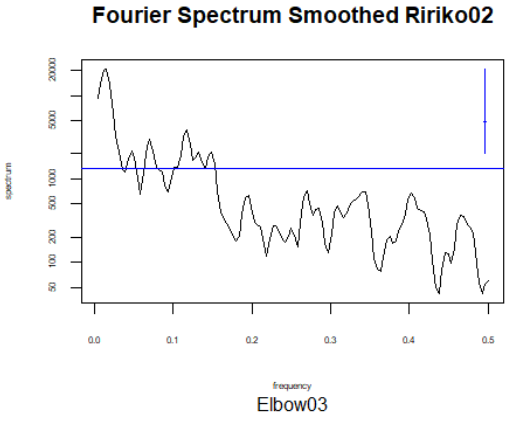

period
4
2
1
0.5
0.25
0.1
0.2
0.3
0.4
Knee10 : average wavelet power
0.05
0.1

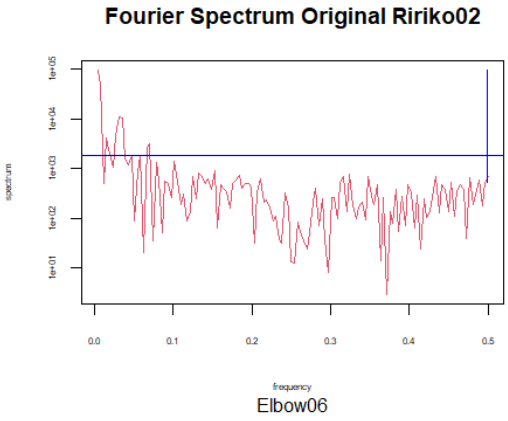

period
4
2
1
0.5
0.25
0.5
1
1.5
Knee13 : average wavelet power
0.05
0.1



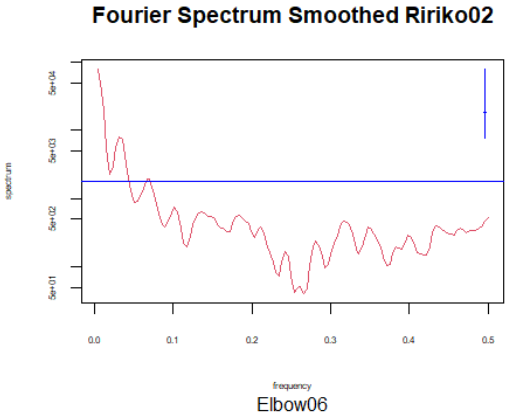
Ririko02.mp4 の動画



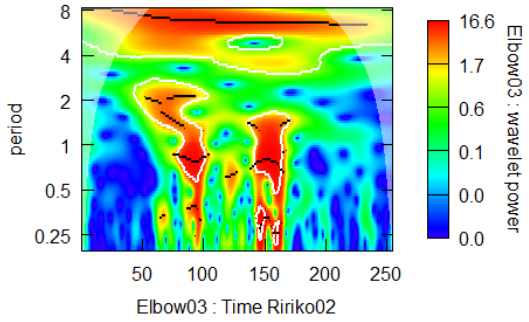


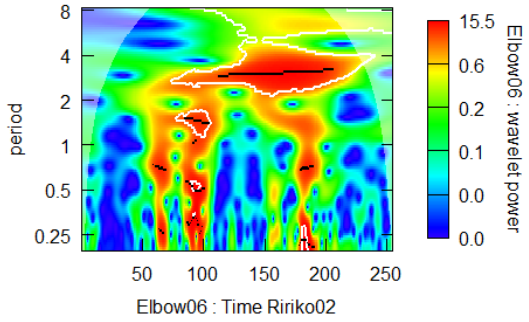


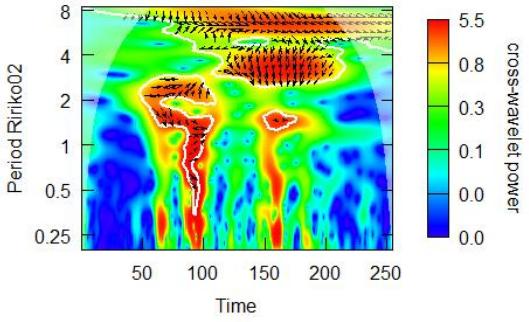
Elbow06

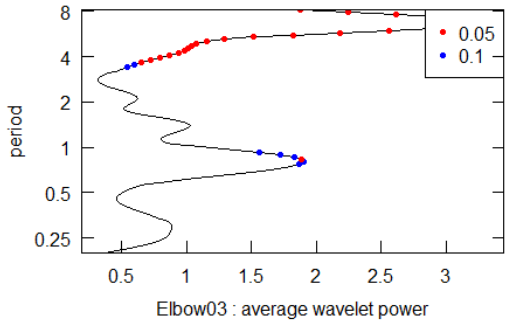


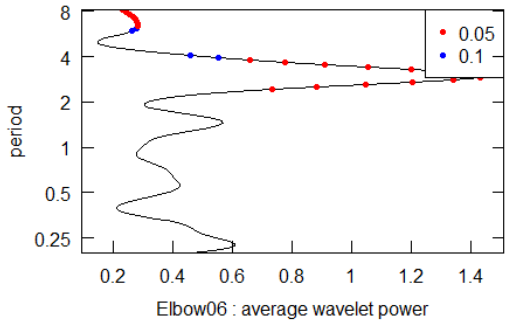
Elbow06



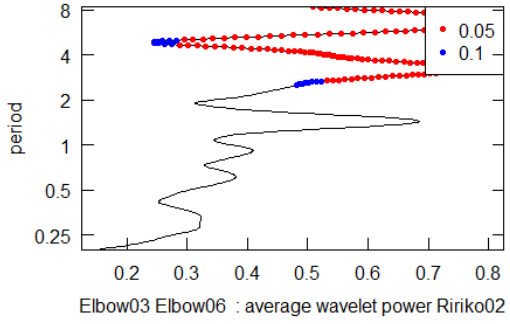

period
8
4
2
1
0.5
0.25
50
100
150
200
250
Elbow06 : Time Ririko02
15.5
0.6
0.2
0.1
0.0
0.0
Elbow06 : wavelet power


Period Ririko02
8
4
2
1
0.5
0.25
50
100
150
200
250
Time
5.5
0.8
0.3
0.1
0.0
0.0
cross-wavelet power


period
8
4
2
1
0.5
0.25
0.5
1
1.5
2
2.5
3
Elbow03 : average wavelet power
0.05
0.1

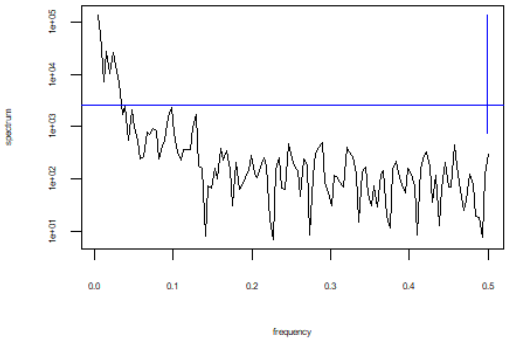


Elbow06 : average wavelet power



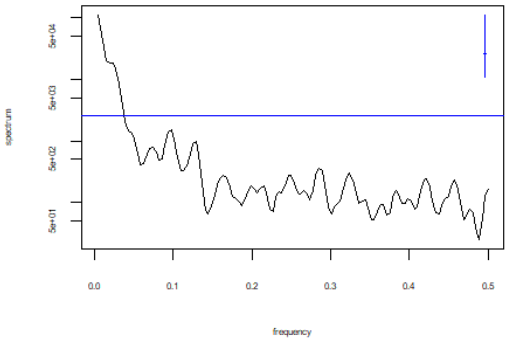
Elbow03 Elbow06 : average wavelet power Ririko02

Fourier Spectrum Original Ririko02



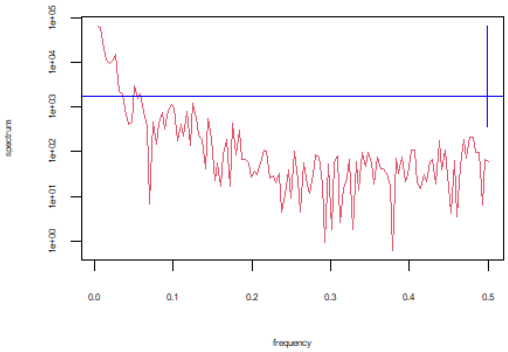
Shoulder02

Fourier Spectrum Smoothed Ririko02



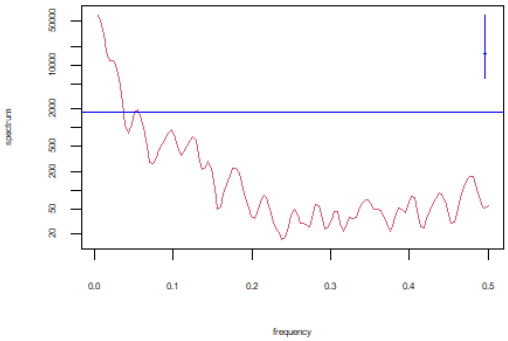
Shoulder02

Fourier Spectrum Original Ririko02

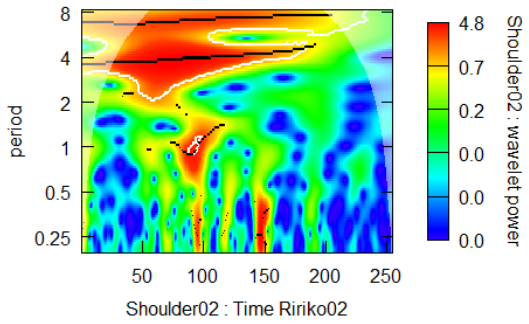


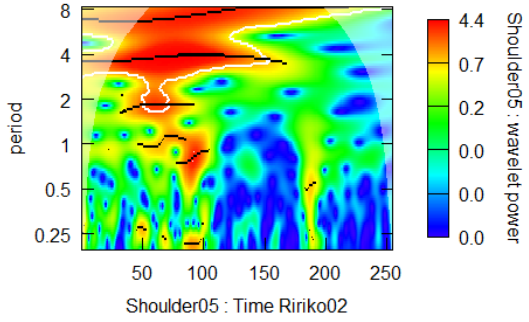
Shoulder05

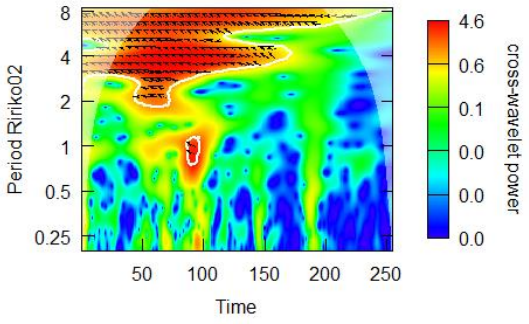
Fourier Spectrum Smoothed Ririko02

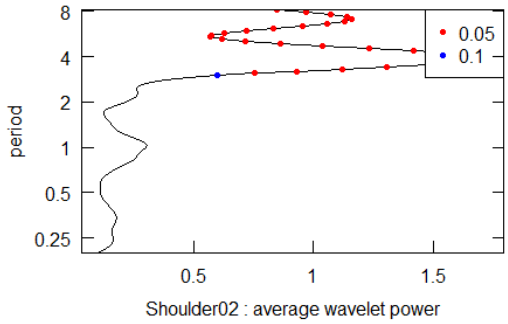


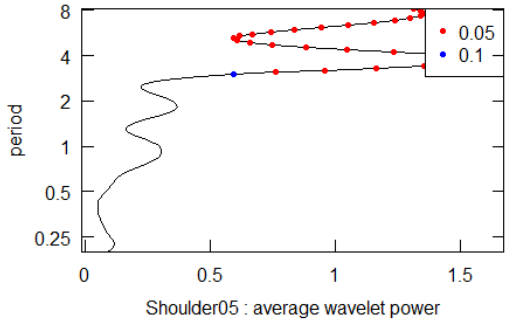
Shoulder05

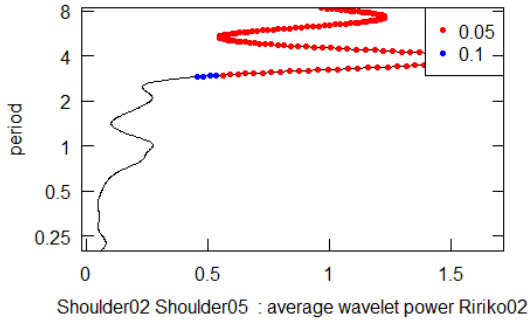

period
8
4
2
1
0.5
0.25
50
100
150
200
250
Shoulder02 : Time Ririko02
4.8
0.7
0.2
0.0
0.0
0.0
Shoulder02 : wavelet power


period
8
4
2
1
0.5
0.25
50
100
150
200
250
Shoulder05 : Time Ririko02
4.4
0.7
0.2
0.0
0.0
0.0
Shoulder05 : wavelet power

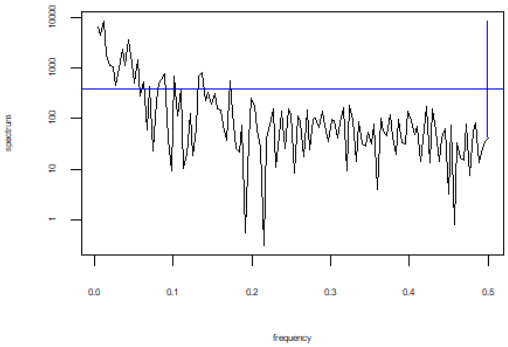

Period Ririko02
8
4
2
1
0.5
0.25
50
100
150
200
250
Time
4.6
0.6
0.1
0.0
0.0
0.0
cross-wavelet power


8
4
2
1
0.5
0.25
period
0.5
1
1.5
0.05
0.1
Shoulder02 : average wavelet power


8
4
2
1
0.5
0.25
period
0
0.5
1
1.5
0.05
0.1
Shoulder05 : average wavelet power

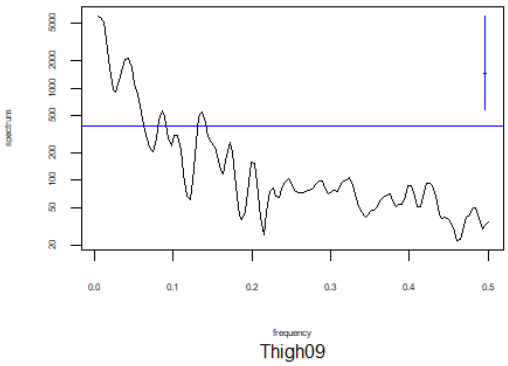

8
4
2
1
0.5
0.25
period
0
0.5
1
1.5
0.05
0.1
Shoulder02 Shoulder05 : average wavelet power Ririko02

Fourier Spectrum Original Ririko02



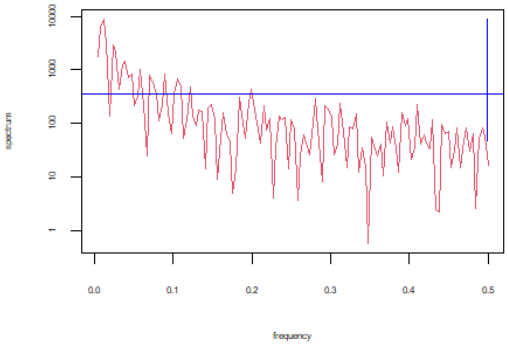
Thigh09

Fourier Spectrum Smoothed Ririko02

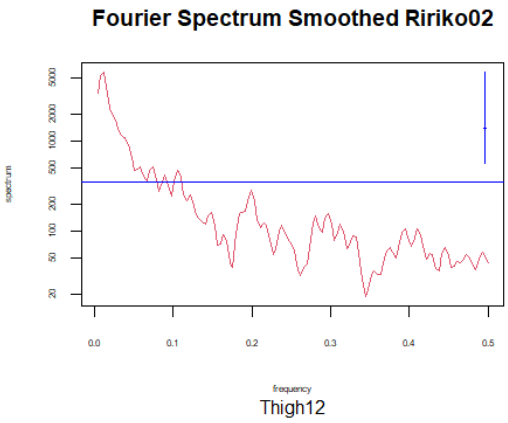


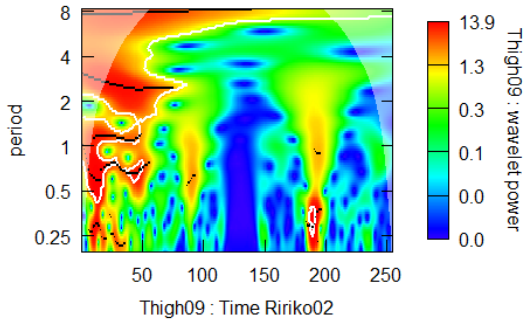
Thigh09

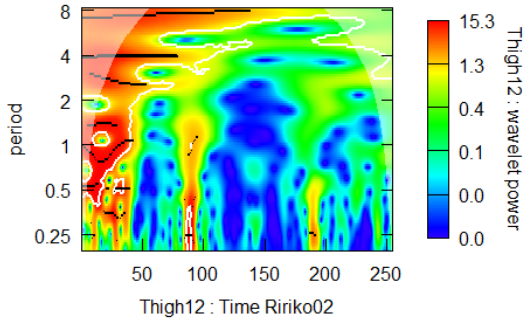
Fourier Spectrum Original Ririko02

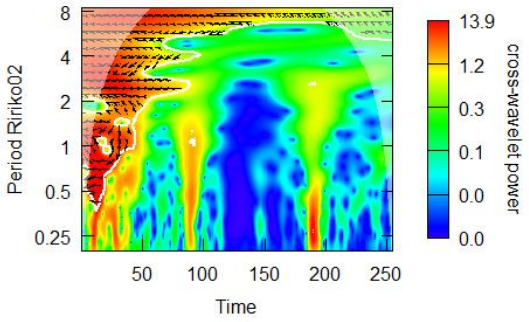


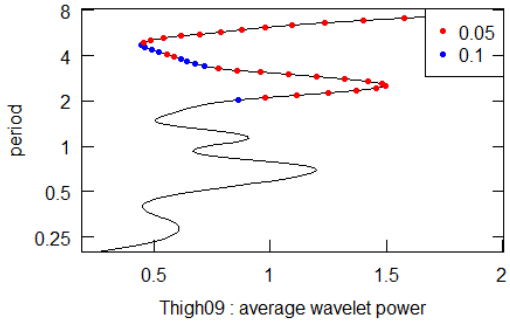
Thigh12

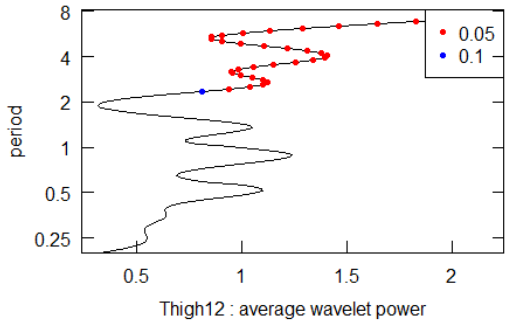

Fourier Spectrum Smoothed Ririko02
spectrum
frequency
Thigh12

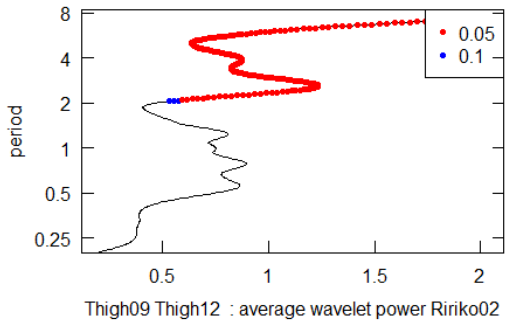

period
Thigh09 : wavelet power
Thigh09 : Time Ririko02


period
Thigh12 : wavelet power
Thigh12 : Time Ririko02


Period Ririko02
8
4
2
1
0.5
0.25
50
100
150
200
250
Time
13.9
1.2
0.3
0.1
0.0
0.0
cross-wavelet power

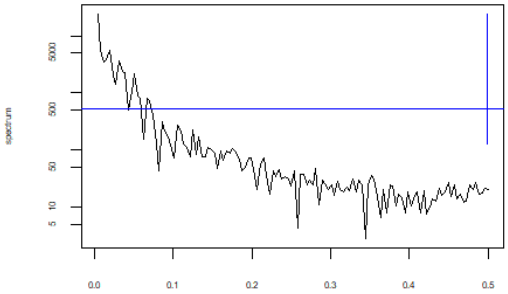

period
8
4
2
1
0.5
0.25
0.5
1
1.5
2
Thigh09 : average wavelet power
0.05
0.1


period
8
4
2
1
0.5
0.25
0.5
1
1.5
2
Thigh12 : average wavelet power
0.05
0.1



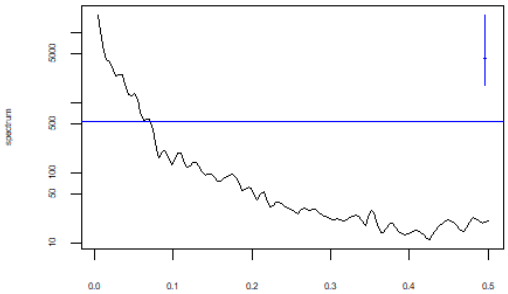
Thigh09 Thigh12 : average wavelet power Ririko02

Fourier Spectrum Original Ririko02



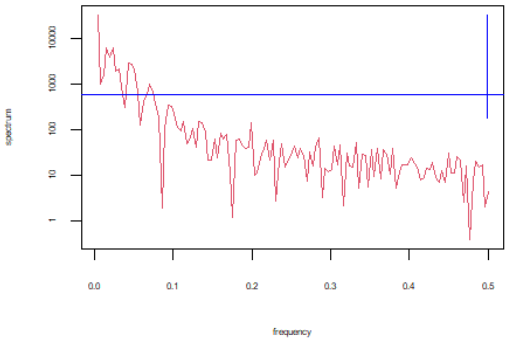
Knee10

Fourier Spectrum Smoothed Ririko02



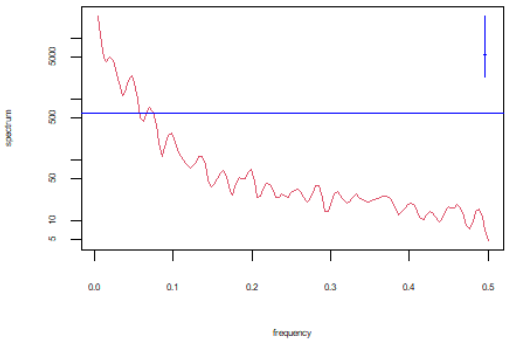
Knee10

Fourier Spectrum Original Ririko02

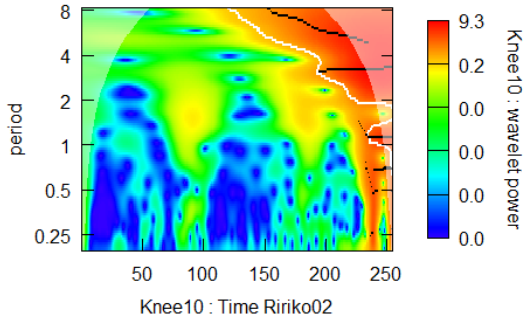


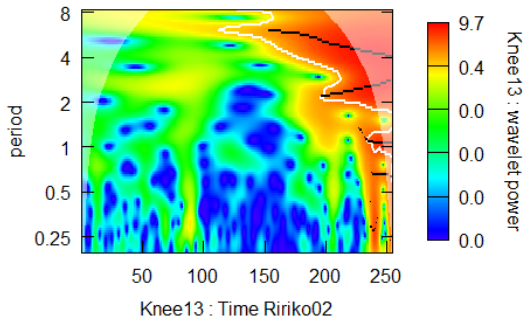
Knee13

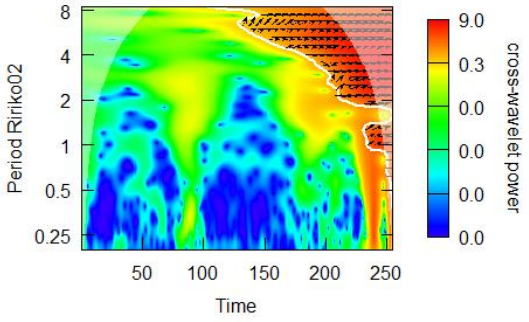
Fourier Spectrum Smoothed Ririko02

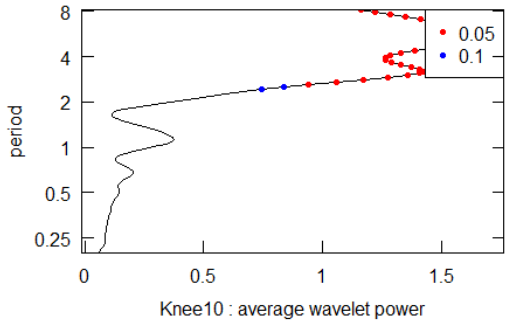


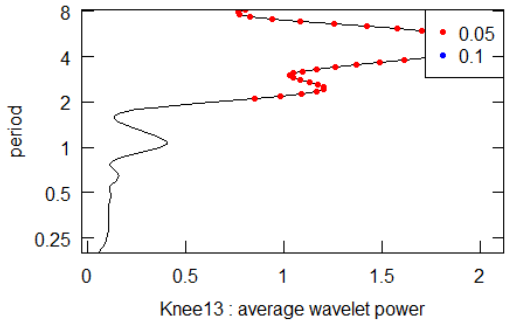
Knee13

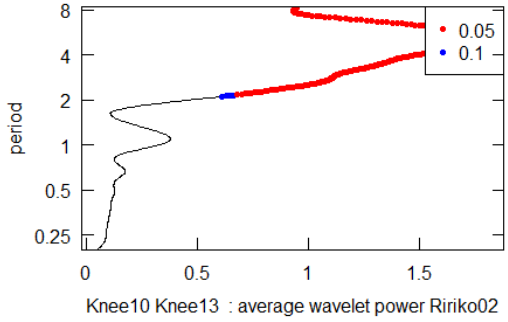



period
8
4
2
1
0.5
0.25
50
100
150
200
250
Knee13 : Time Ririko02
9.7
0.4
0.0
0.0
0.0
0.0
Knee13 : wavelet power

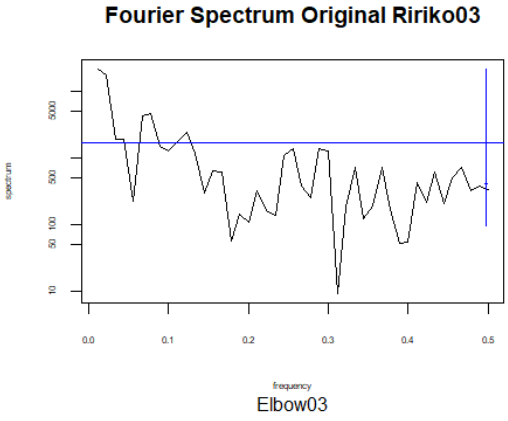

Period Ririko02
8
4
2
1
0.5
0.25
50
100
150
200
250
Time
9.0
0.3
0.0
0.0
0.0
0.0
cross-wavelet power


period
8
4
2
1
0.5
0.25
0
0.5
1
1.5
Knee10 : average wavelet power
0.05
0.1

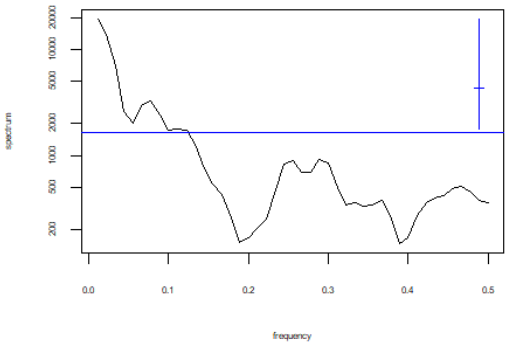




Ririko03.mp4 の動画

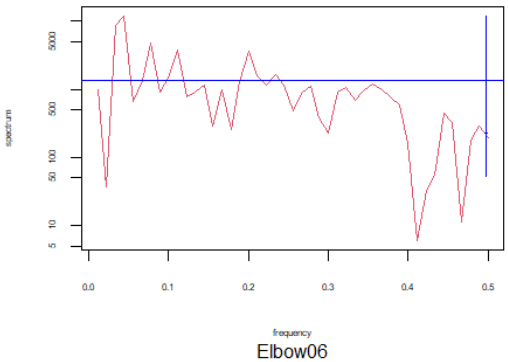


Fourier Spectrum Smoothed Ririko03



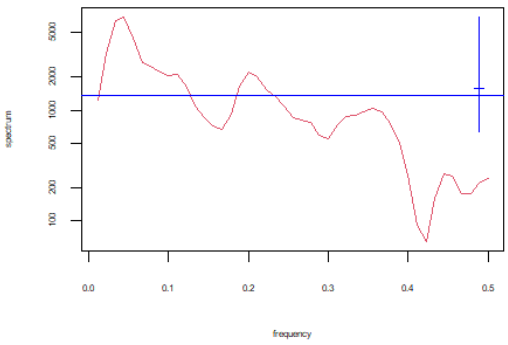
Elbow03

Fourier Spectrum Original Ririko03

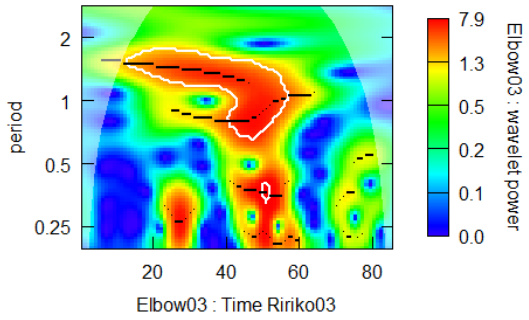


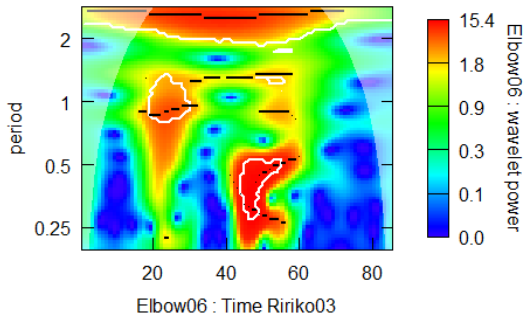
Elbow06

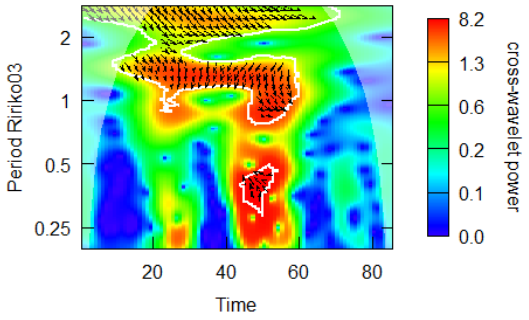
Fourier Spectrum Smoothed Ririko03

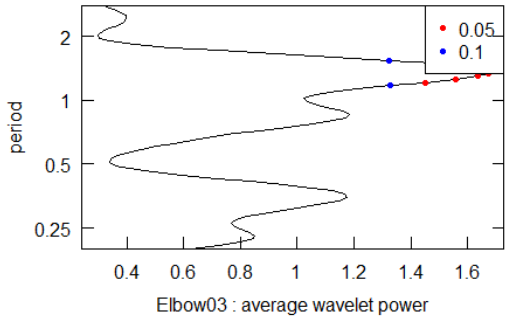


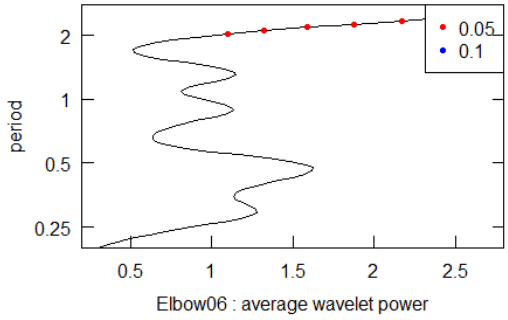
Elbow06

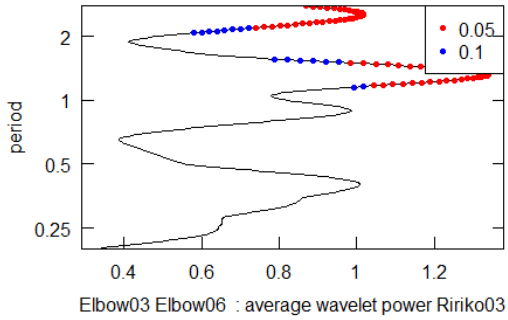

period
2
1
0.5
0.25
20
40
60
80
Elbow03 : Time Ririko03
7.9
1.3
0.5
0.2
0.1
0.0
Elbow03 : wavelet power


period
2
1
0.5
0.25
20
40
60
80
Elbow06 : Time Ririko03
15.4
1.8
0.9
0.3
0.1
0.0
Elbow06 : wavelet power

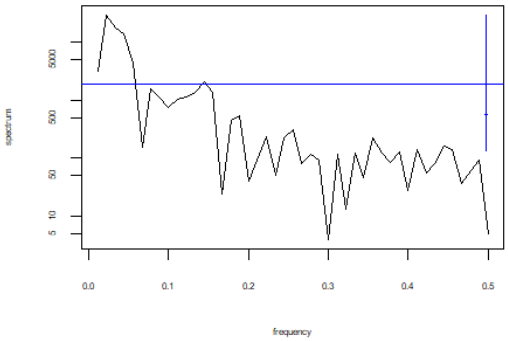

Period Ririko03
2
1
0.5
0.25
20
40
60
80
Time
8.2
1.3
0.6
0.2
0.1
0.0
cross-wavelet power


0.05
0.1
period
2
1
0.5
0.25
0.4
0.6
0.8
1
1.2
1.4
1.6
Elbow03 : average wavelet power


0.05
0.1
period
2
1
0.5
0.25
0.5
1
1.5
2
2.5
Elbow06 : average wavelet power

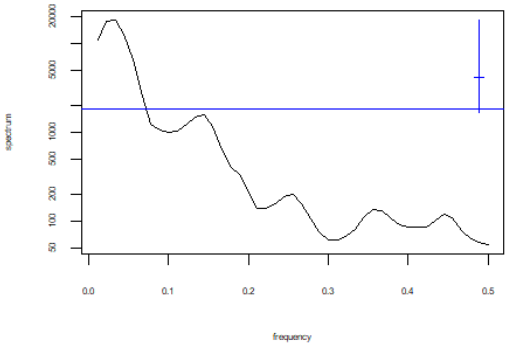

0.05
0.1
period
2
1
0.5
0.25
0.4
0.6
0.8
1
1.2
Elbow03 Elbow06 : average wavelet power Ririko03

Fourier Spectrum Original Ririko03



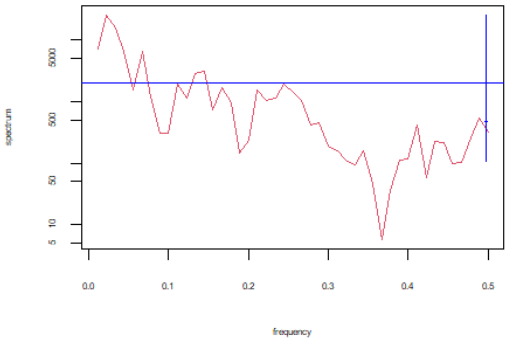
Shoulder02

Fourier Spectrum Smoothed Ririko03

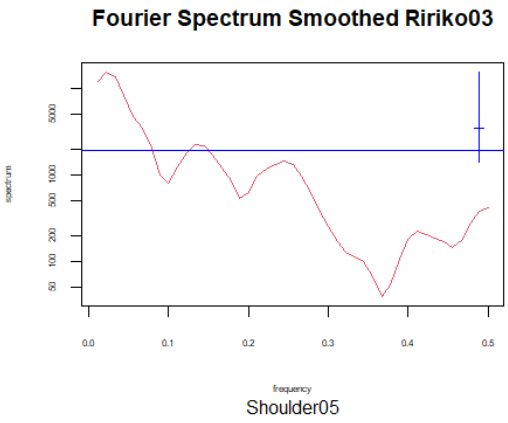


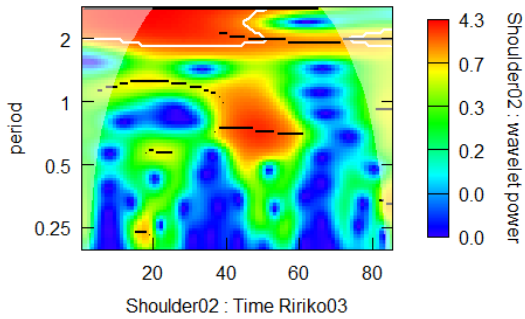
Shoulder02

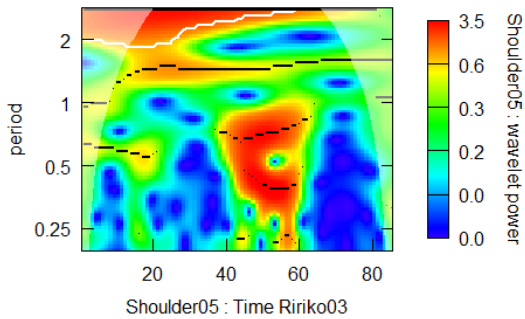
Fourier Spectrum Original Ririko03

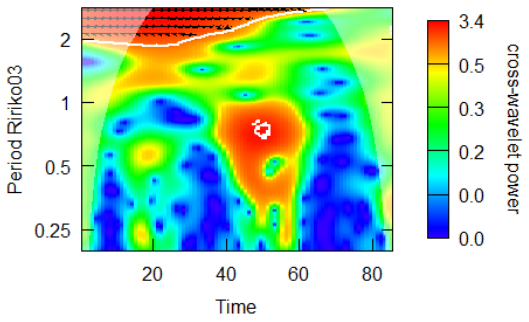


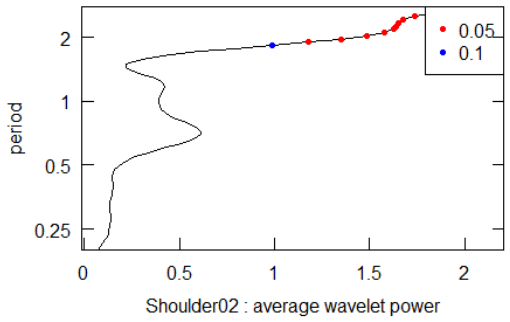
Shoulder05

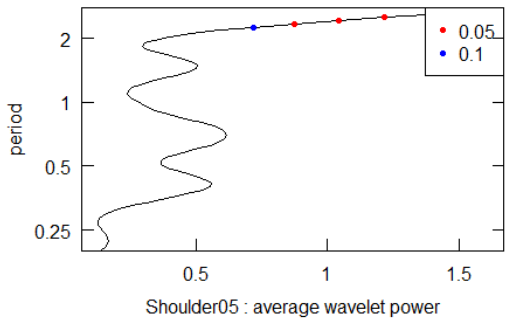

Fourier Spectrum Smoothed Ririko03
spectrum
frequency
Shoulder05

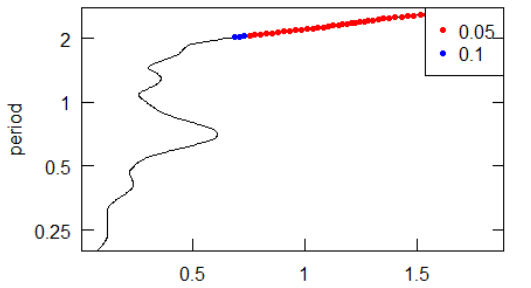

period
Shoulder02 : Time Ririko03
Shoulder02 : wavelet power


period
Shoulder05 : Time Ririko03
Shoulder05 : wavelet power


Period Ririko03
2
1
0.5
0.25
20
40
60
80
Time
3.4
0.5
0.3
0.2
0.0
0.0
cross-wavelet power

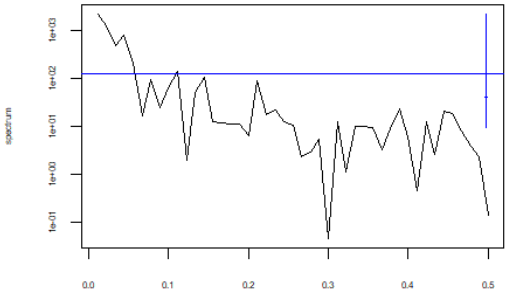

period
2
1
0.5
0.25
0
0.5
1
1.5
2
Shoulder02 : average wavelet power
0.05
0.1


period
2
1
0.5
0.25
0.5
1
1.5
Shoulder05 : average wavelet power
0.05
0.1



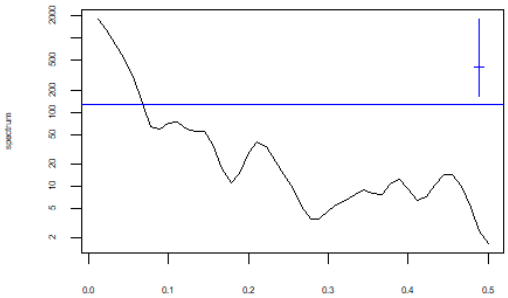
Shoulder02 Shoulder05 : average wavelet power Ririko03

Fourier Spectrum Original Ririko03

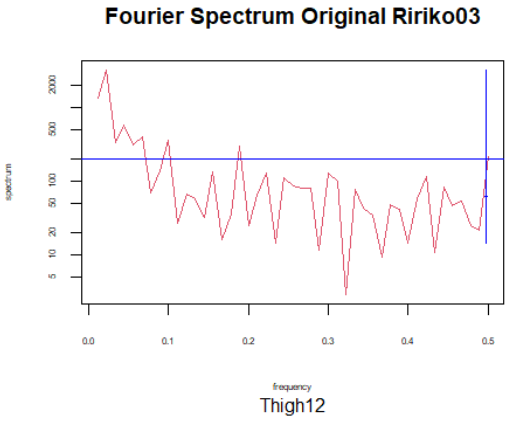


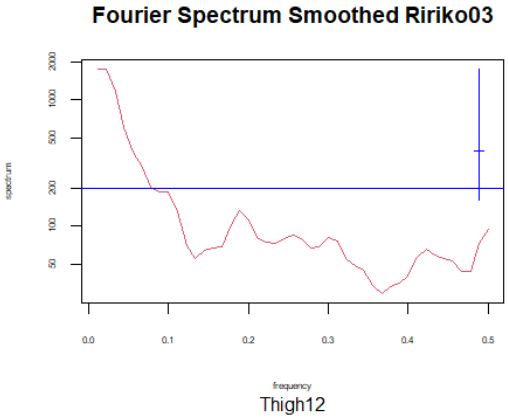
Thigh09

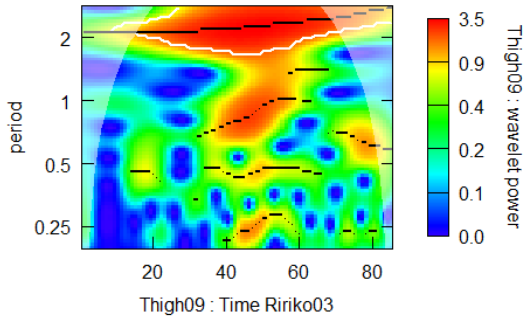
Fourier Spectrum Smoothed Ririko03

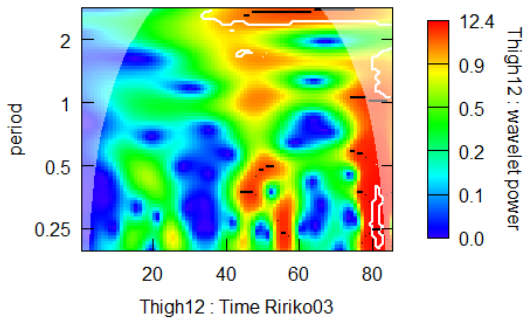


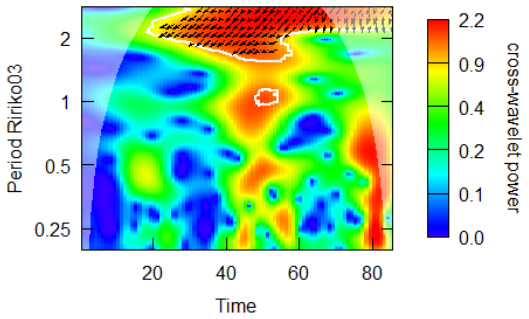
Thigh09

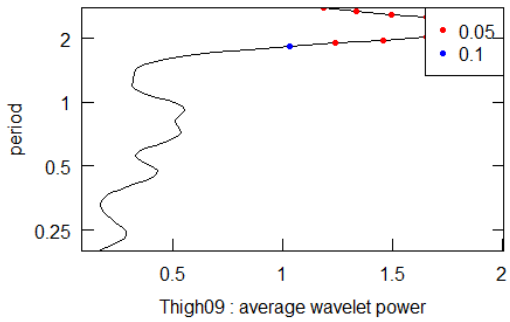

Fourier Spectrum Original Ririko03
spectrum
frequency
Thigh12

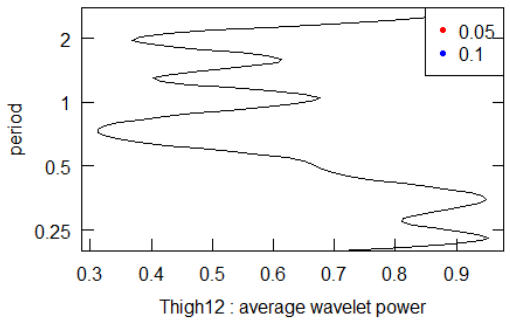

Fourier Spectrum Smoothed Ririko03
spectrum
frequency
Thigh12

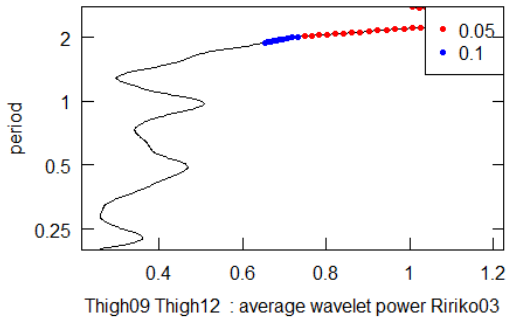

period
Thigh09 : Time Ririko03
Thigh09 : wavelet power

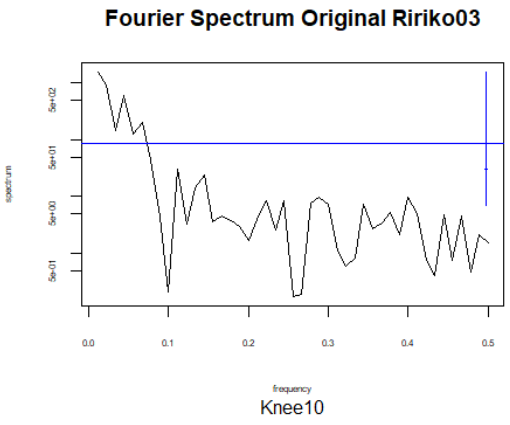

period
2
1
0.5
0.25
20
40
60
80
Thigh12 : Time Ririko03
12.4
0.9
0.5
0.2
0.1
0.0
Thigh12 : wavelet power


Period Ririko03
2
1
0.5
0.25
20
40
60
80
Time
2.2
0.9
0.4
0.2
0.1
0.0
cross-wavelet power

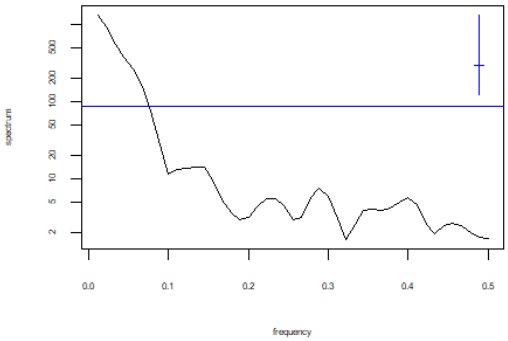

period
2
1
0.5
0.25
0.5
1
1.5
2
Thigh09 : average wavelet power
0.05
0.1


0.05
0.1
period
2
1
0.5
0.25
0.3
0.4
0.5
0.6
0.7
0.8
0.9
Thigh12 : average wavelet power


0.05
0.1
period
2
1
0.5
0.25
0.4
0.6
0.8
1
1.2
Thigh09 Thigh12 : average wavelet power Ririko03

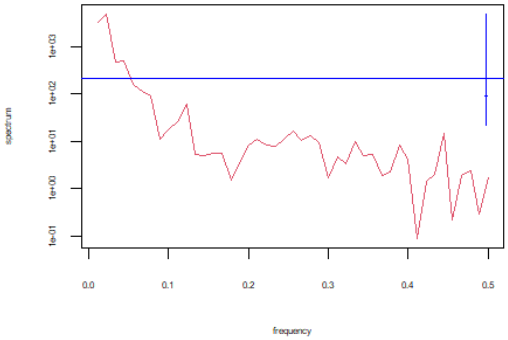

Fourier Spectrum Original Ririko03
spectrum
5e+02
5e+01
5e+00
5e-01
0.0
0.1
0.2
0.3
0.4
0.5
frequency
Knee10

Fourier Spectrum Smoothed Ririko03



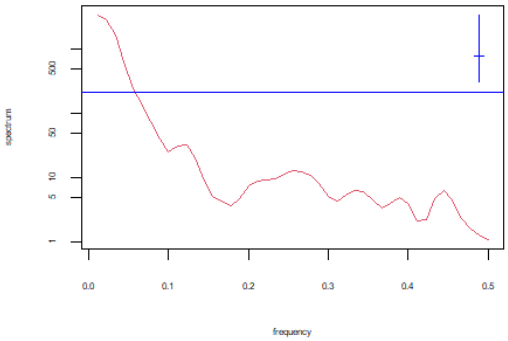
Knee10

Fourier Spectrum Original Ririko03

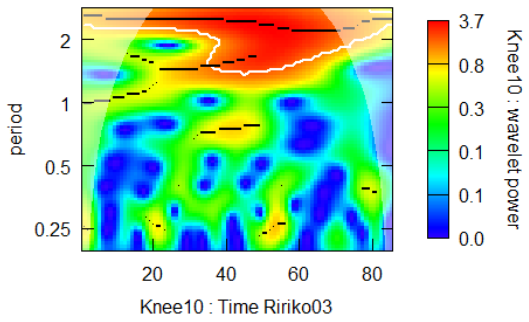


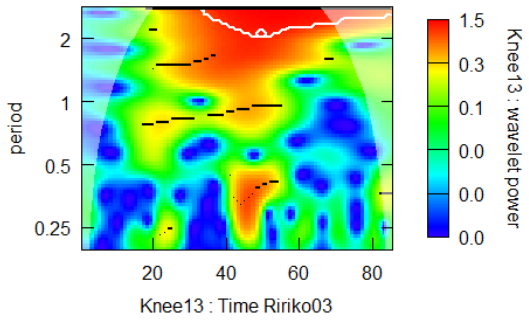
Knee13

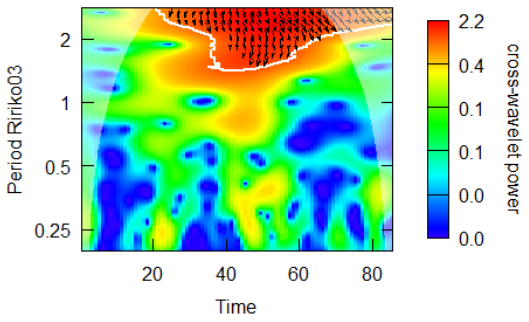
Fourier Spectrum Smoothed Ririko03

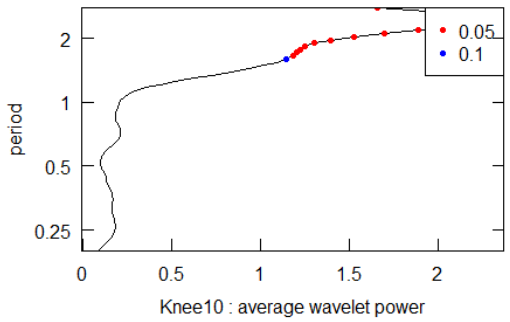


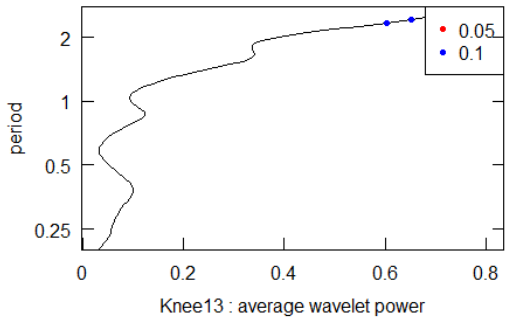
Knee13

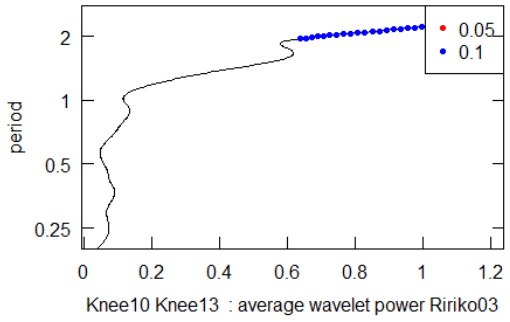

period
2
1
0.5
0.25
20
40
60
80
Knee10 : Time Ririko03
3.7
0.8
0.3
0.1
0.1
0.0
Knee10 : wavelet power


period
2
1
0.5
0.25
20
40
60
80
Knee13 : Time Ririko03
1.5
0.3
0.1
0.0
0.0
0.0
Knee13 : wavelet power

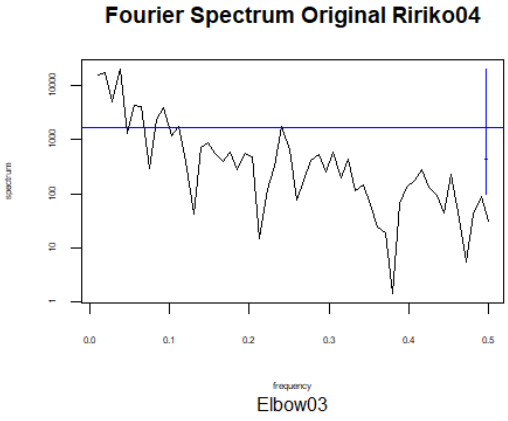

Period Ririko03
2
1
0.5
0.25
20
40
60
80
Time
2.2
0.4
0.1
0.1
0.0
0.0
cross-wavelet power


0.05
0.1
period
2
1
0.5
0.25
0
0.5
1
1.5
2
Knee10 : average wavelet power

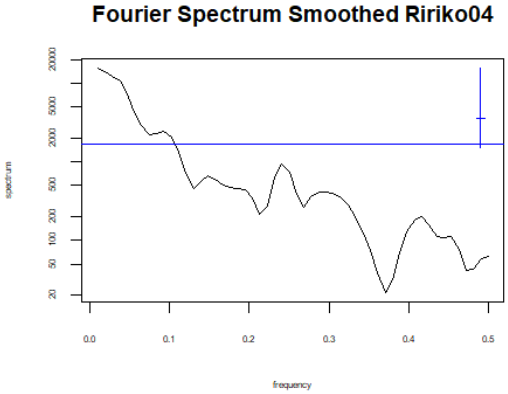

0.05
0.1
period
2
1
0.5
0.25
0
0.2
0.4
0.6
0.8
Knee13 : average wavelet power


0.05
0.1
period
2
1
0.5
0.25
0
0.2
0.4
0.6
0.8
1
1.2
Knee10 Knee13 : average wavelet power Ririko03

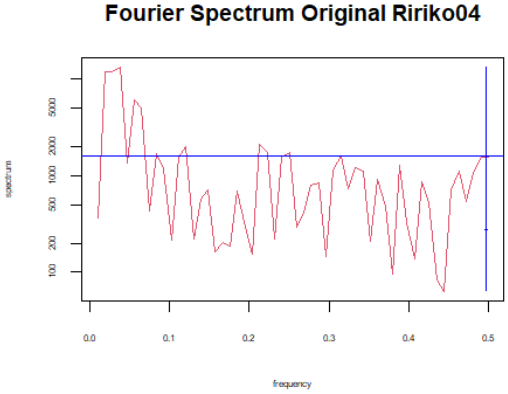
Ririko04.mp4 の動画



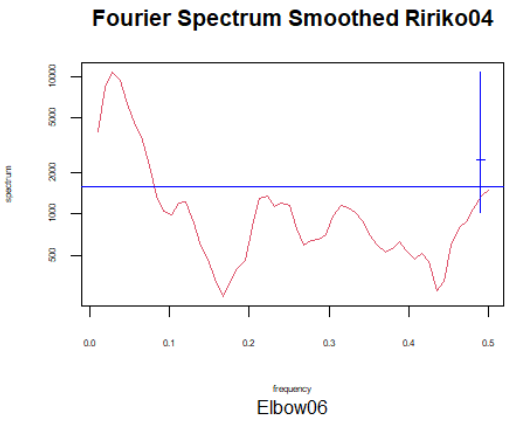
Elbow03



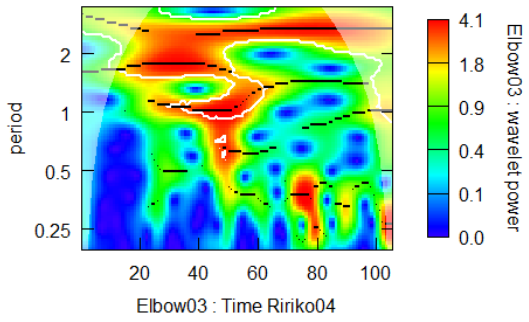
Elbow03



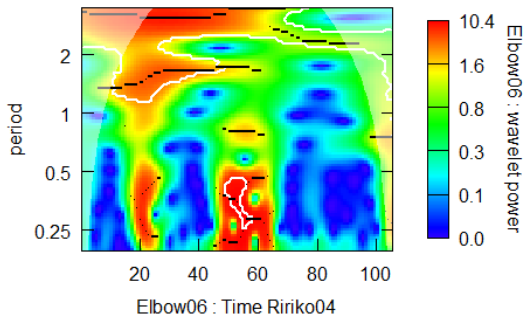
Elbow06



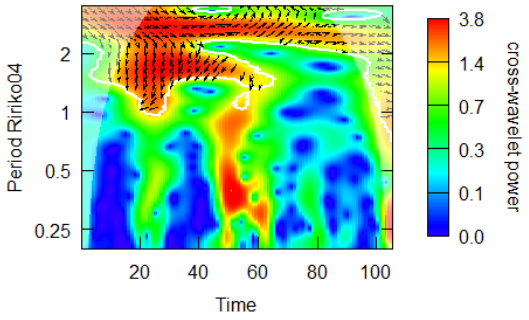
Elbow06

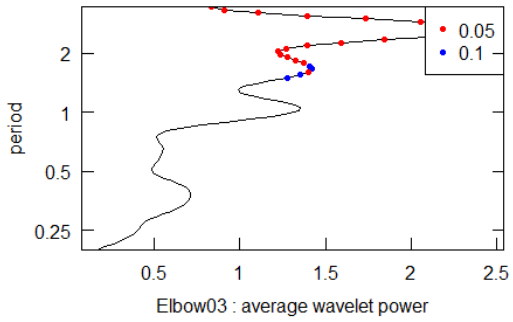


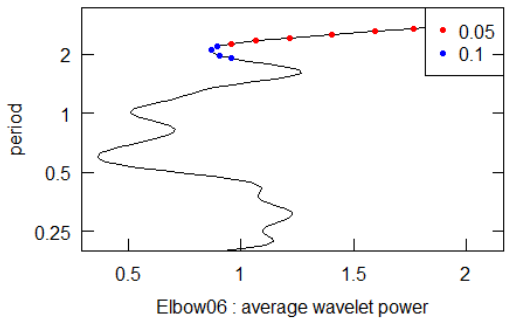
Elbow03 : Time Ririko04

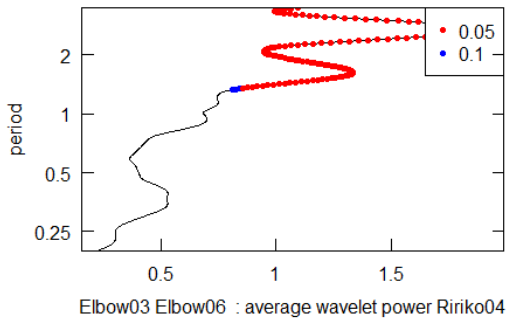


Elbow06 : Time Ririko04


Period Ririko04
2
1
0.5
0.25
20
40
60
80
100
Time
3.8
1.4
0.7
0.3
0.1
0.0
cross-wavelet power

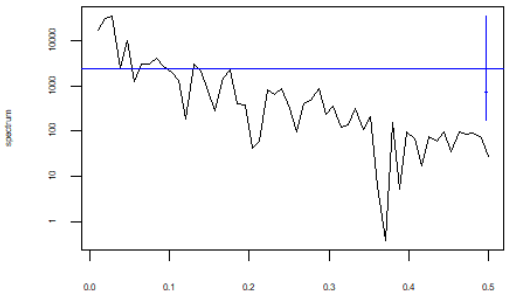

period
2
1
0.5
0.25
0.5
1
1.5
2
2.5
Elbow03 : average wavelet power
0.05
0.1


period
2
1
0.5
0.25
0.5
1
1.5
2
Elbow06 : average wavelet power
0.05
0.1



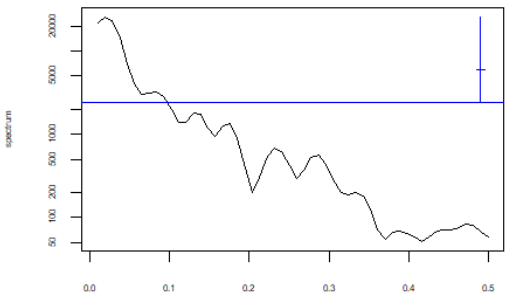
Elbow03 Elbow06 : average wavelet power Ririko04

Fourier Spectrum Original Ririko04

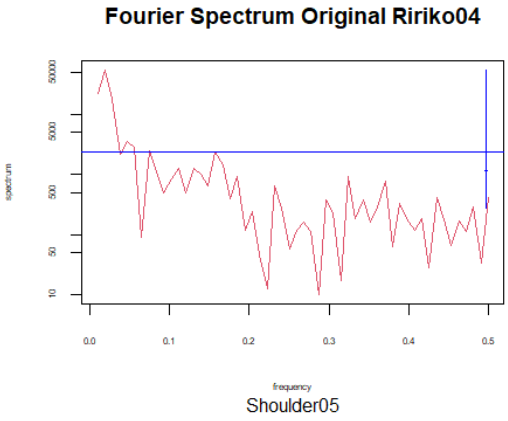


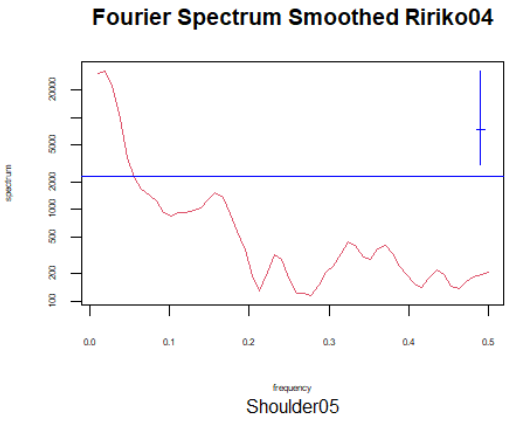
Shoulder02

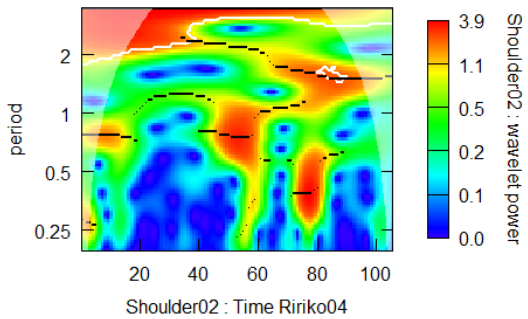
Fourier Spectrum Smoothed Ririko04

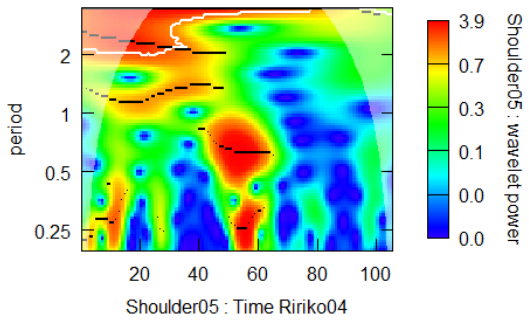


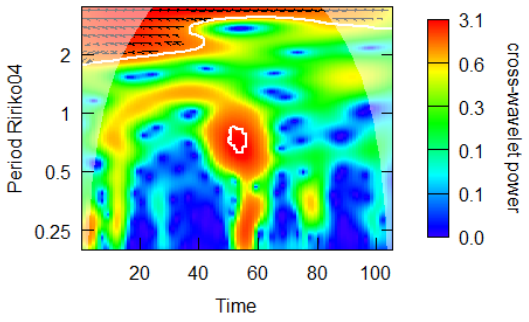
Shoulder02

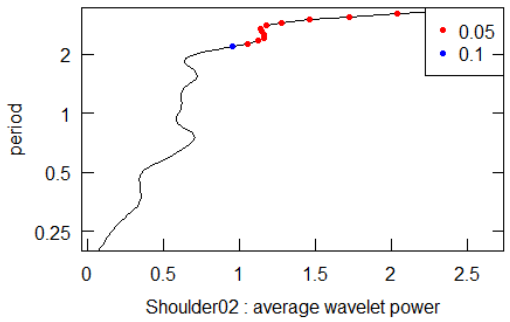

Fourier Spectrum Original Ririko04
spectrum
frequency
Shoulder05

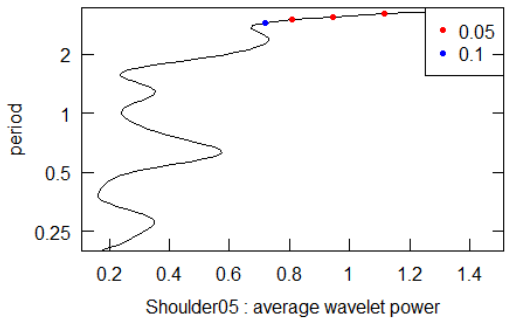

Fourier Spectrum Smoothed Ririko04
spectrum
frequency
Shoulder05

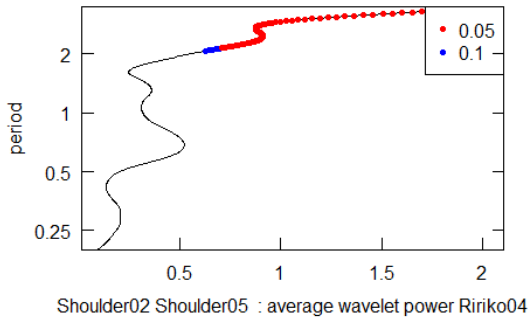

period
Shoulder02 : Time Ririko04
Shoulder02 : wavelet power

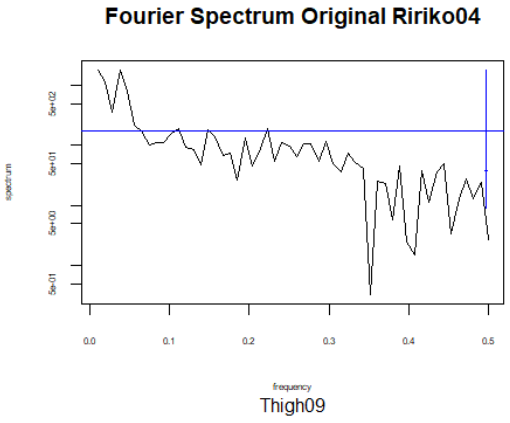

period
2
1
0.5
0.25
20
40
60
80
100
Shoulder05 : Time Ririko04
3.9
0.7
0.3
0.1
0.0
0.0
Shoulder05 : wavelet power


Period Ririko04
2
1
0.5
0.25
20
40
60
80
100
Time
3.1
0.6
0.3
0.1
0.1
0.0
cross-wavelet power

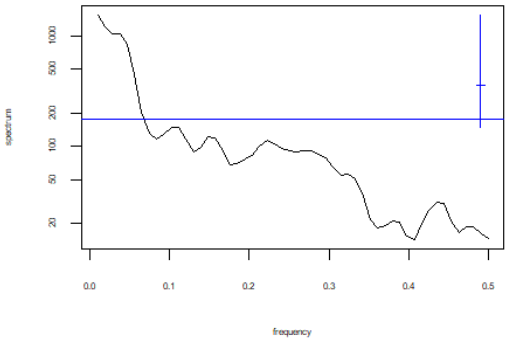

period
2
1
0.5
0.25
0
0.5
1
1.5
2
2.5
Shoulder02 : average wavelet power
0.05
0.1


0.05
0.1
period
2
1
0.5
0.25
0.2
0.4
0.6
0.8
1
1.2
1.4
Shoulder05 : average wavelet power


0.05
0.1
period
2
1
0.5
0.25
0.5
1
1.5
2
Shoulder02 Shoulder05 : average wavelet power Ririko04

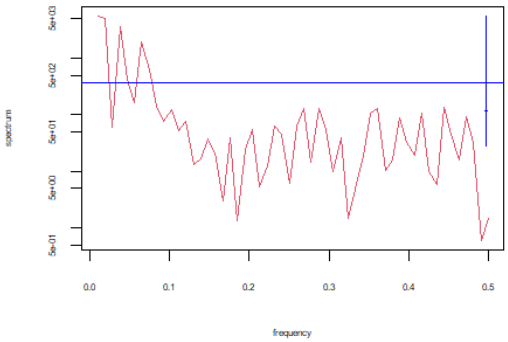

Fourier Spectrum Original Ririko04
spectrum
5e+02
5e+01
5e+00
5e-01
0.0
0.1
0.2
0.3
0.4
0.5
frequency
Thigh09

Fourier Spectrum Smoothed Ririko04



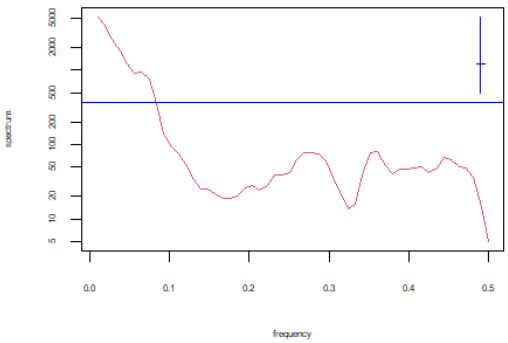
Thigh09

Fourier Spectrum Original Ririko04

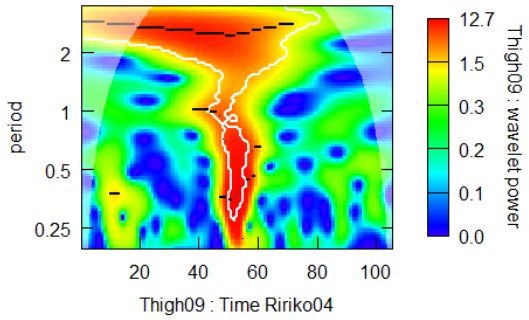


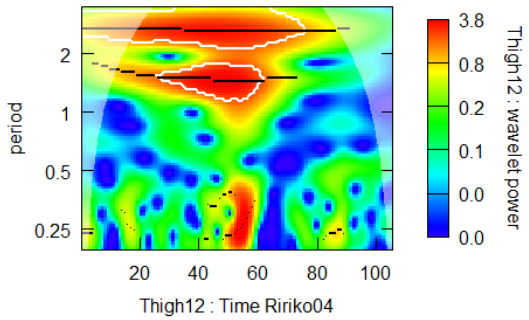
Thigh12

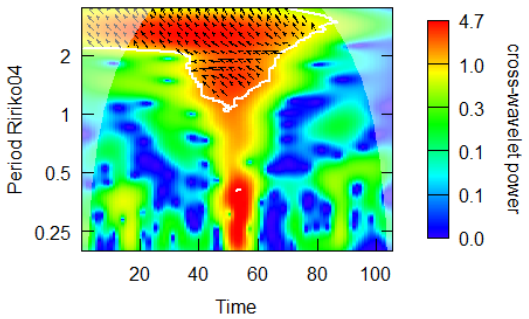
Fourier Spectrum Smoothed Ririko04

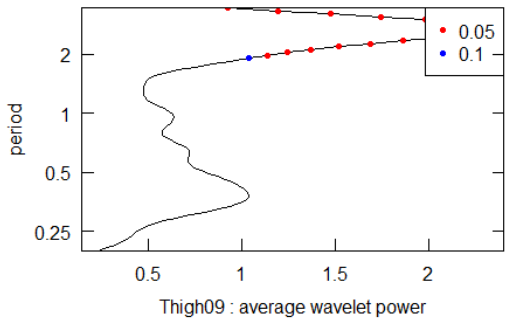


Thigh12

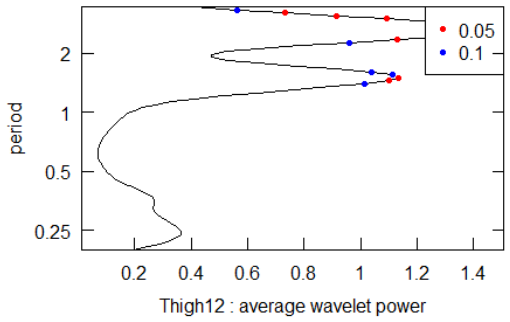

period
2
1
0.5
0.25
20
40
60
80
100
Thigh09 : Time Ririko04
12.7
1.5
0.3
0.2
0.1
0.0
Thigh09 : wavelet power


period
2
1
0.5
0.25
20
40
60
80
100
Thigh12 : Time Ririko04
3.8
0.8
0.2
0.1
0.0
0.0
Thigh12 : wavelet power

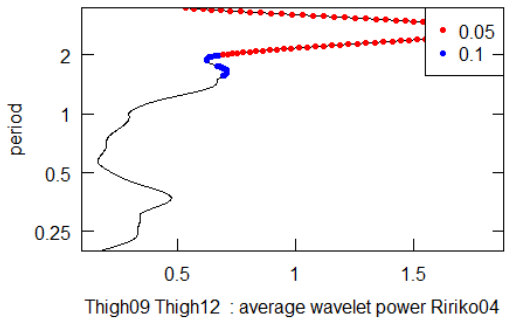

Period Ririko04
2
1
0.5
0.25
20
40
60
80
100
Time
4.7
1.0
0.3
0.1
0.1
0.0
cross-wavelet power



Thigh09 : average wavelet power

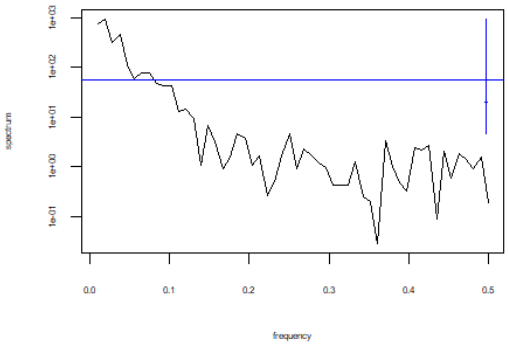


Thigh12 : average wavelet power



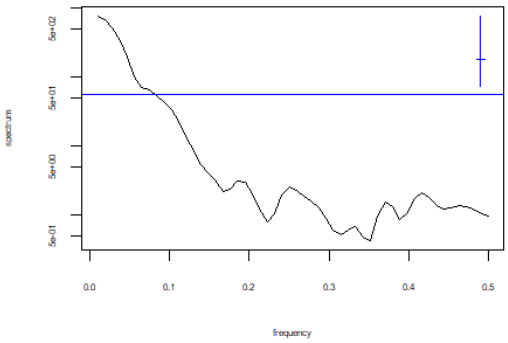
Thigh09 Thigh12 : average wavelet power Ririko04

Fourier Spectrum Original Ririko04



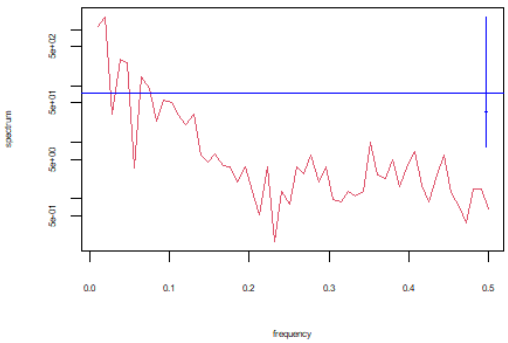
Knee10

Fourier Spectrum Smoothed Ririko04

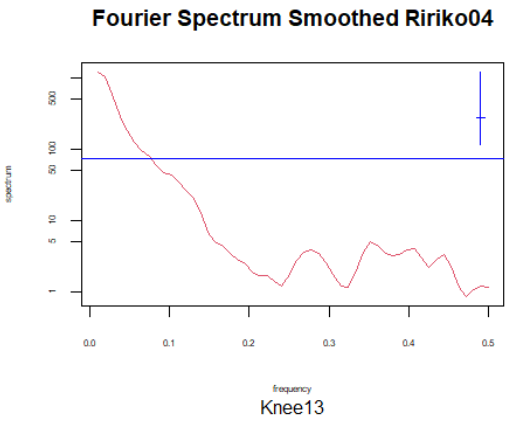


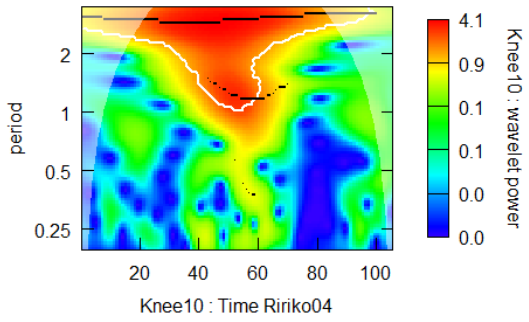
Knee10

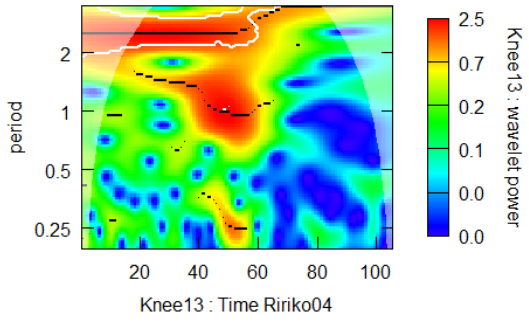
Fourier Spectrum Original Ririko04

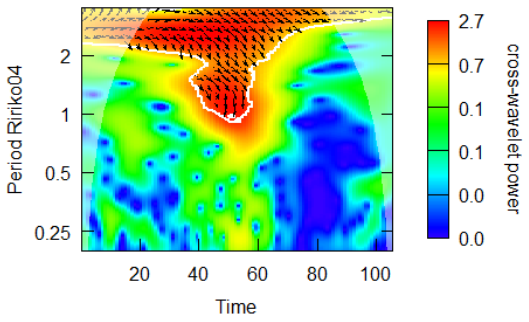


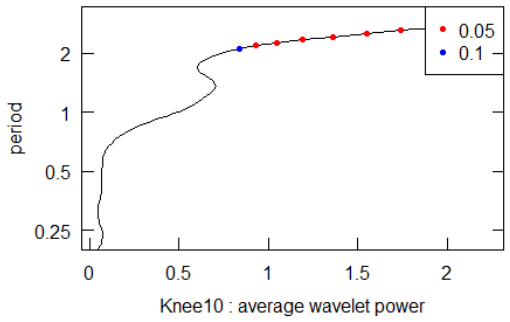
Knee13

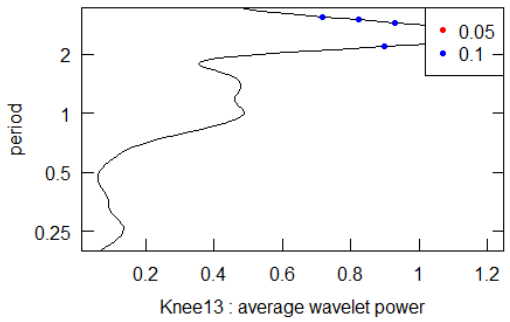

Fourier Spectrum Smoothed Ririko04
spectrum
frequency
Knee13

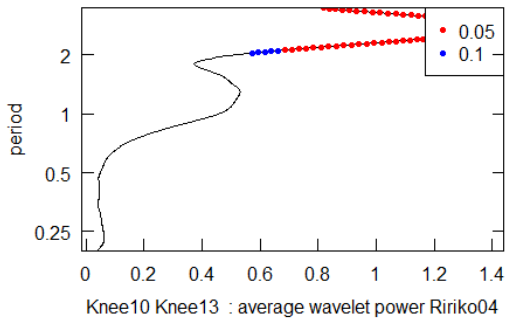

period
Knee10 : wavelet power
Knee10 : Time Ririko04


period
Knee13 : wavelet power
Knee13 : Time Ririko04


Period Ririko04
2
1
0.5
0.25
20
40
60
80
100
Time
2.7
0.7
0.1
0.1
0.0
0.0
cross-wavelet power


period
2
1
0.5
0.25
0
0.5
1
1.5
2
Knee10 : average wavelet power
0.05
0.1


period
2
1
0.5
0.25
0.2
0.4
0.6
0.8
1
1.2
Knee13 : average wavelet power
0.05
0.1


0.05
0.1
period
2
1
0.5
0.25
0
0.2
0.4
0.6
0.8
1
1.2
1.4
Knee10 Knee13 : average wavelet power Ririko04

おわりに