Connection of Irregularity of Earth's Rotation and Properties of Seismic Noise in Japan

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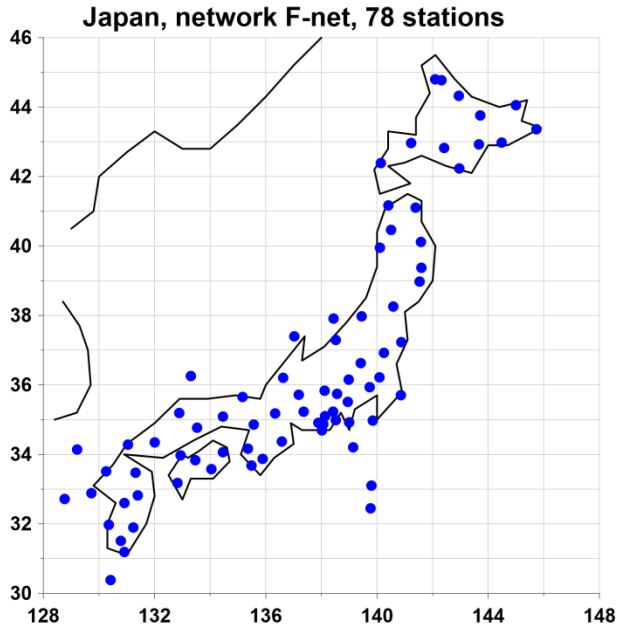
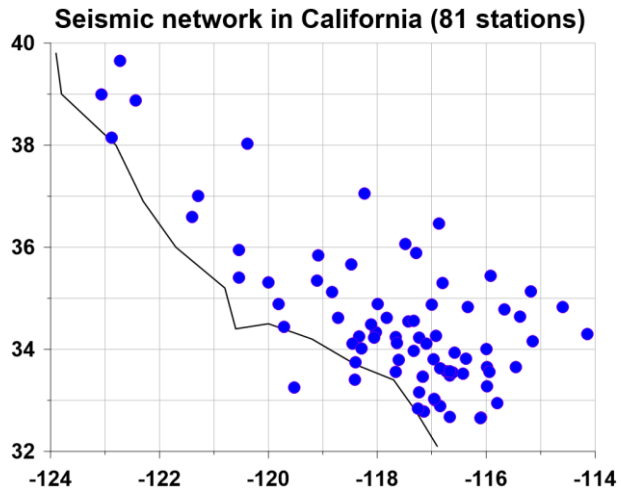
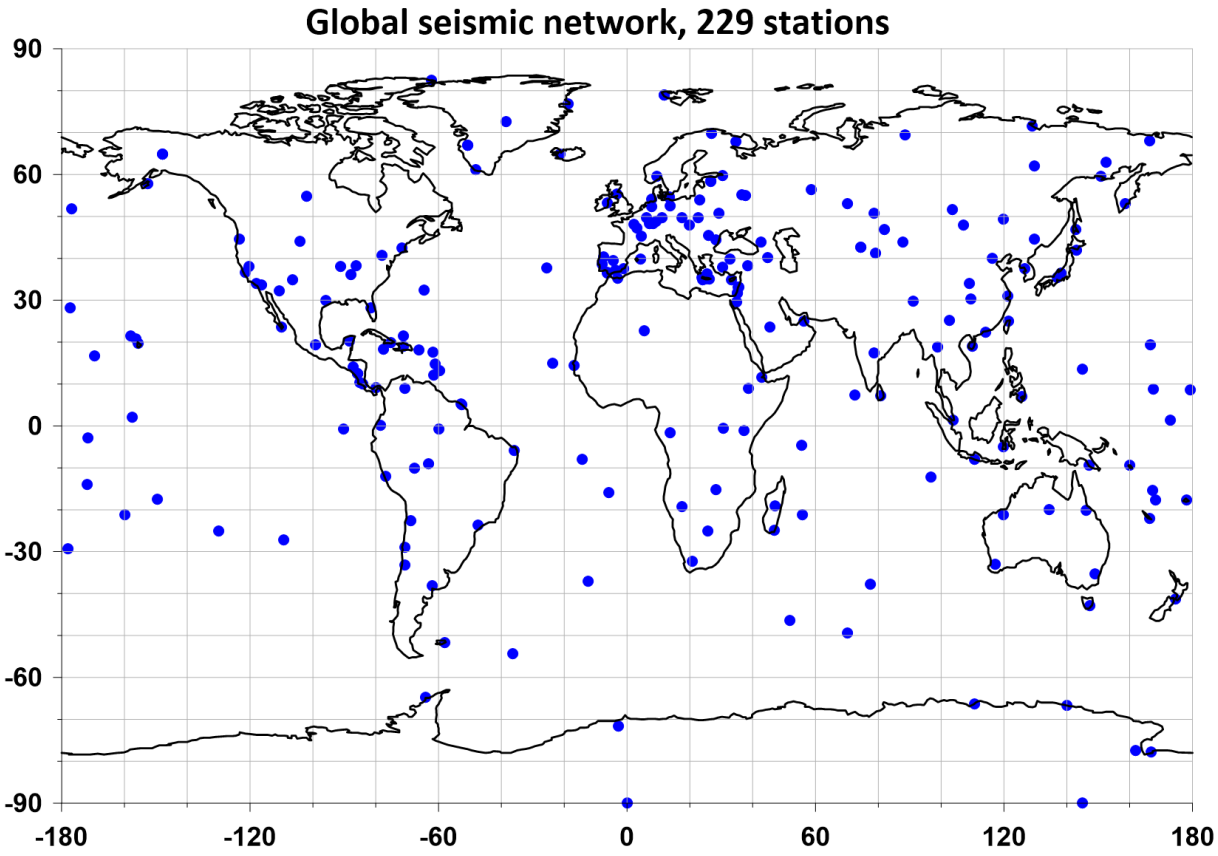
The purpose: investigate peculiarities of trends of global and regional seismic noise properties and try to explain them by the influence of Earth's rotation irregularity (length of day – LOD).

Japan is regarded as the part of global system for which main trends of seismic noise properties turn to be similar to trends of global seismic noise and trends of seismic noise properties of other regional network on other side of Pacific – in California.

Seismic networks which are analyzed for time period 1997 – 2019

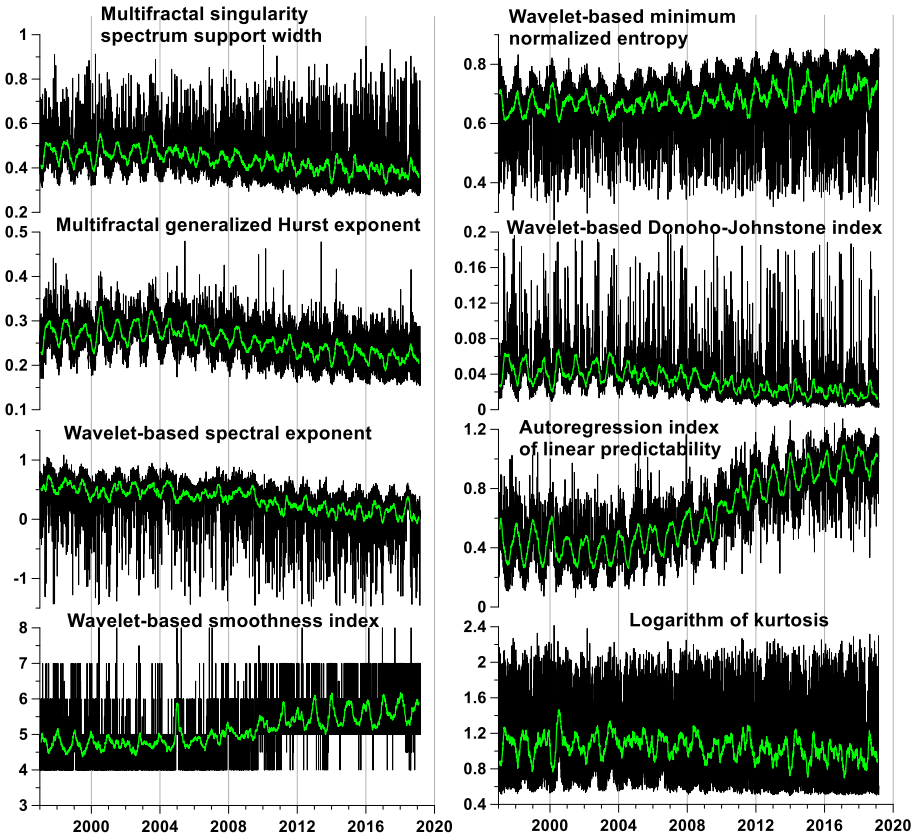




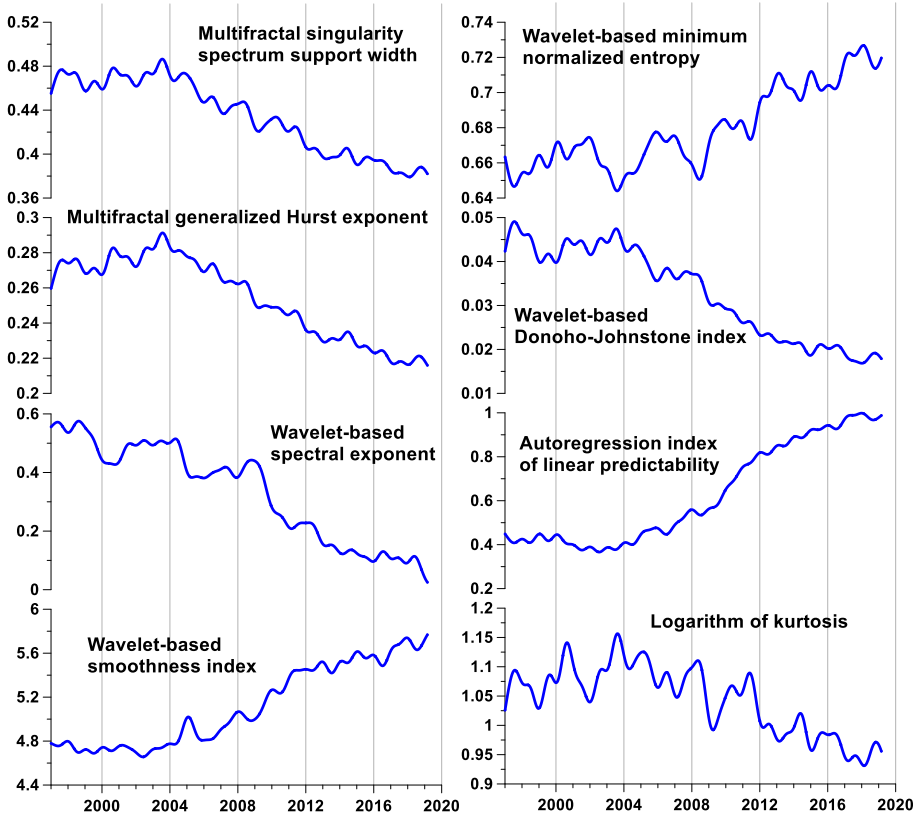


Daily median values of 8 properties of seismic noise from global network (229 stations) all over the world, 1997-2019

World, daily median values of 8 seismic noise dimensionless parameters.
Green lines present running average within time window of the length 57 days.

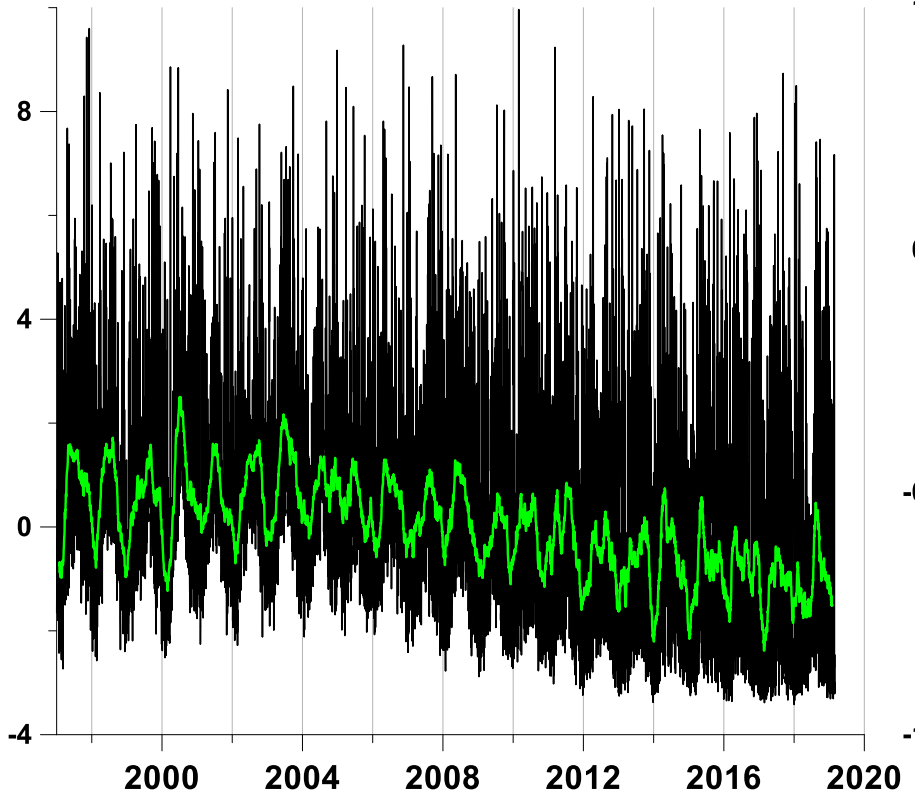


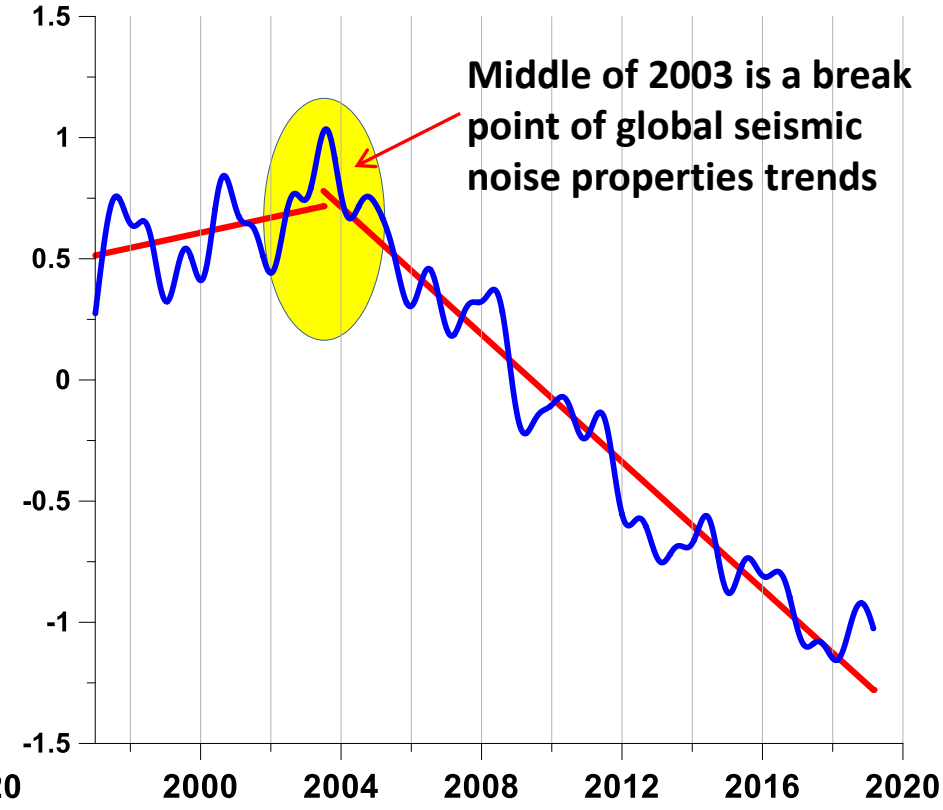
World, daily median values of 8 seismic noise dimensionless parameters after smoothing by Gaussian kernel with radius 182 days



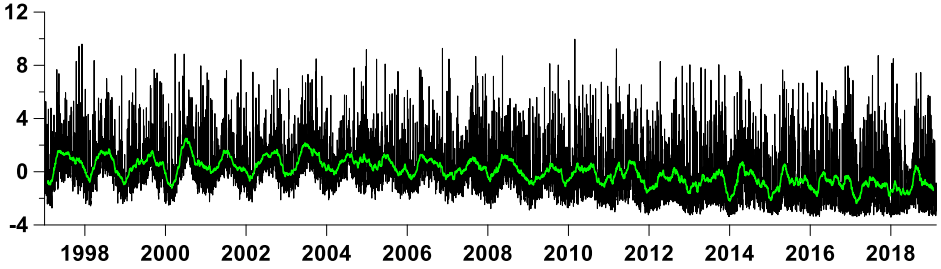
The main peculiarity: existence of trends break point somewhere in 2003-2004. Let's find this break point more precisely by applying Principal Component analysis.

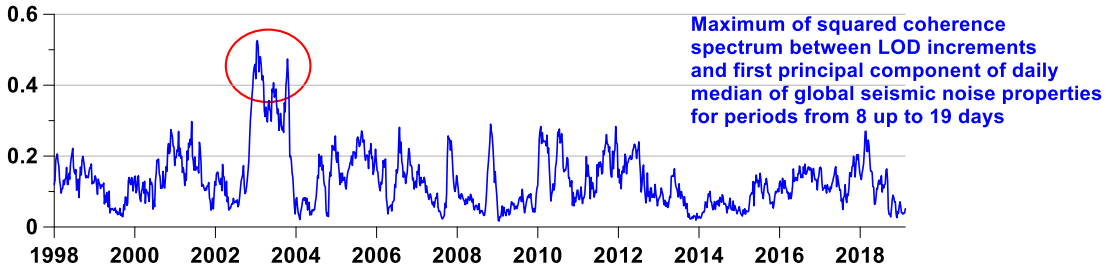
First principal component of daily median values of 8 seismic noise dimensionless properties from global network (229 stations all over the world). Green lines present running average in window of the length 57 days. Bold blue line at right panel presents smoothing by Gaussian kernel with radius 182 days. Red lines present linear trends before and after middle of 2003.



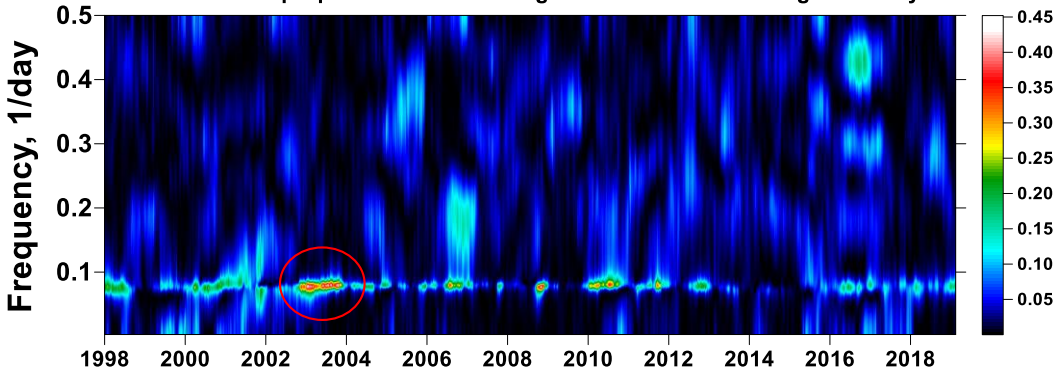


First principal component of daily median
values of 8 global seismic noise properties from broadband stations all over the world



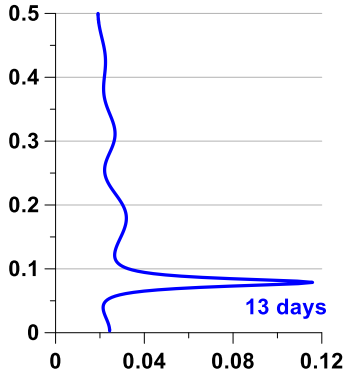


Estimate of squared coherence spectrum between LOD increments
and first principal component of daily median values of 8 global
seismic noise properties within moving time window of the length 365 days



Right-hand end of moving time window of the length 365 days

Frequency-dependent
squared coherence spectrum
averaged by all time windows



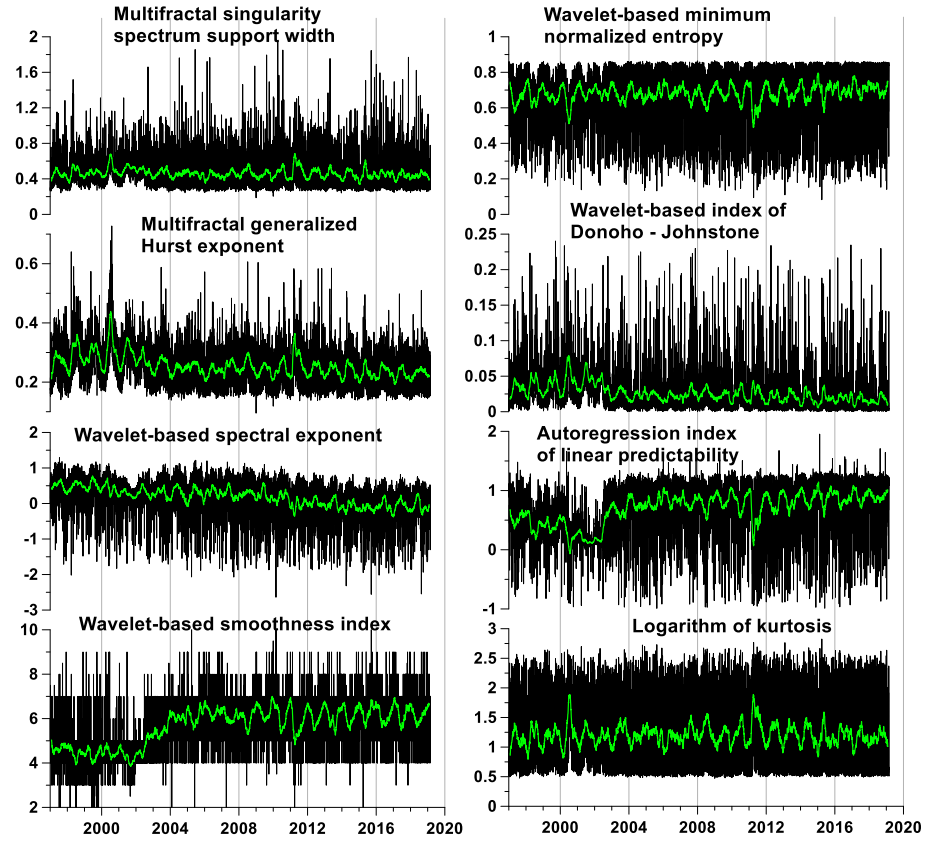
Could the existence of trends break point be explained by the influence of some global reason? For instance by irregularity of Earth's rotation.

To answer this question let's estimate the coherence spectrum between LOD and first principal component. Maximum of squared coherence between first principal component of 8 daily median values of global seismic noise properties and LOD increments corresponds to the time interval where break point of trends is observed – the middle of 2003.

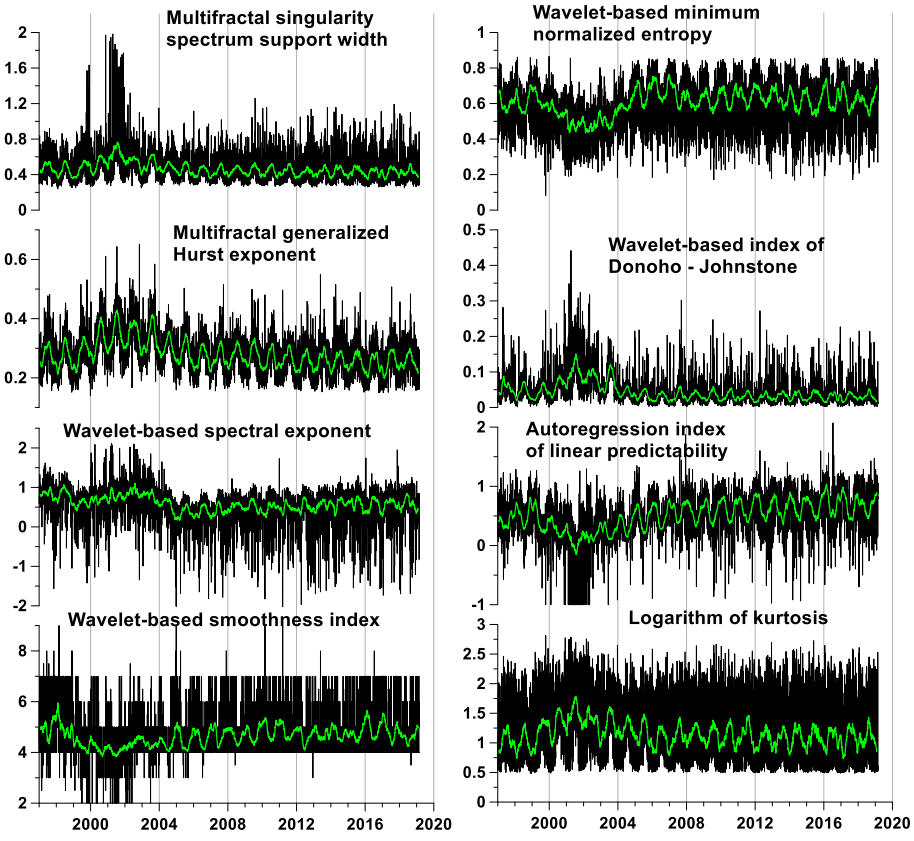
The coherence is concentrated within narrow frequency band with central period 13 days.

Daily median values of 8 properties of seismic noise from regional networks in Japan and California, 1997-2019

Japan, daily median values of 8 seismic noise parameters. Green lines present running average within time window of the length 57 days.



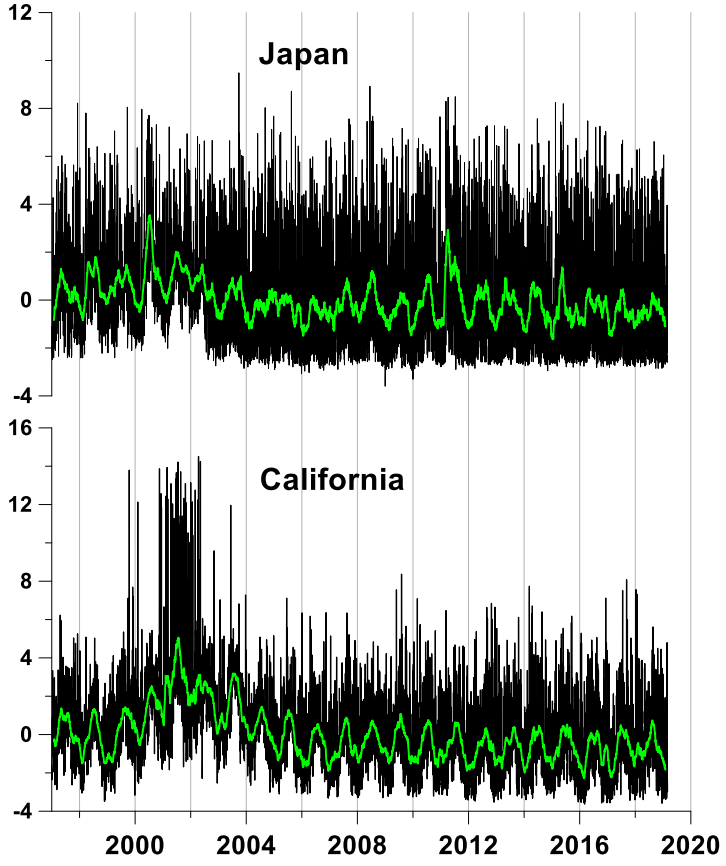
California, daily median values of 8 seismic noise dimensionless parameters. Green lines present running average within time window of the length 57 days.



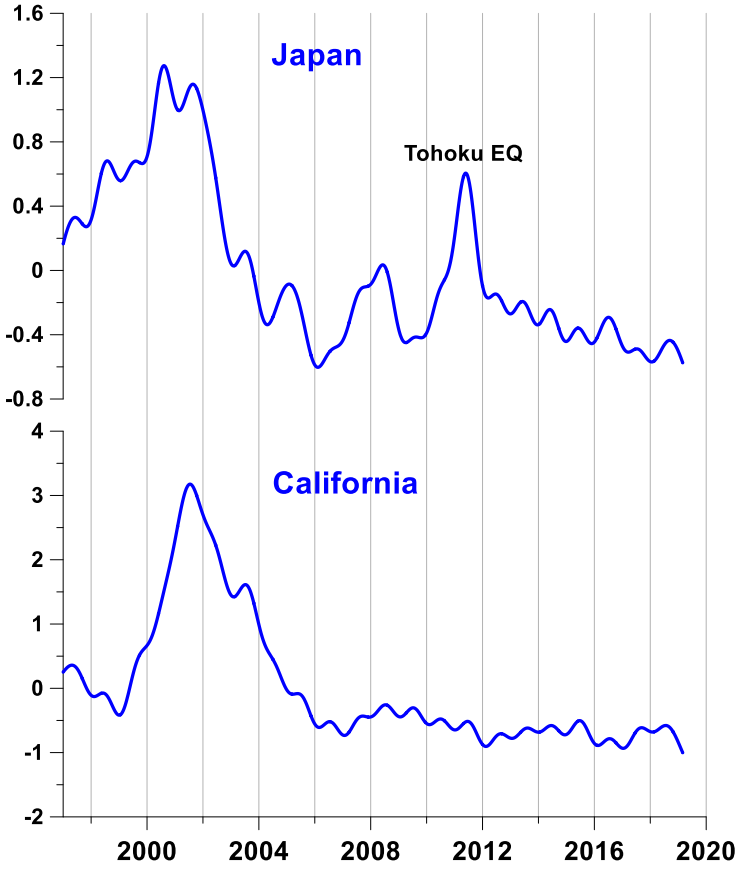
It could easily be noticed that for both regional networks time interval 2001 – 2004 is characterized by abnormal behavior. Let's try to underline these anomalies by applying principal component analysis once more.

First principal components of 8 seismic noise properties in Japan and California

First principal components of daily median values of 8 seismic noise dimensionless properties from networks in Japan and California. Green lines present running average in window of the length 57 days.

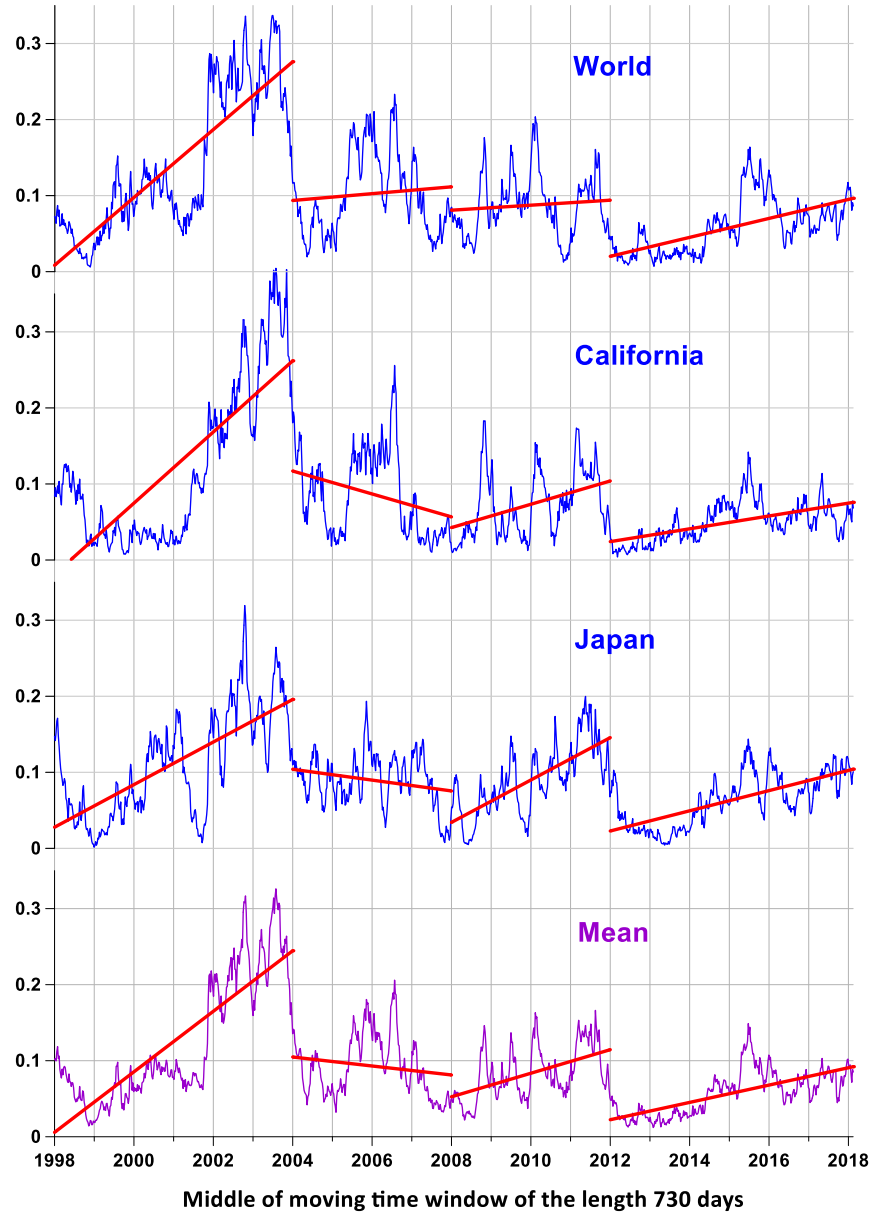


First principal components of daily median values of 8 seismic noise dimensionless properties from networks in Japan and California after smoothing by Gaussian kernel with radius 182 days



For both regional seismic networks (Japan and California) the middle of 2003 is the most abnormal time – the same as for global network

Fragmentation of seismic noise history using piecewise linear trends of maximum coherence of first seismic noise properties principal component with length of day



Maximums of squared coherence spectra between LOD and first principal components of daily median values of 8 seismic noise properties from global seismic network (World) and from regional networks – California and Japan.

Squared coherence spectra were estimated in moving time window of the length 730 days.

Maximum values of coherence are taken within frequency band with periods from 8 up to 19 days.

Break points for segments of linear trends:
2004, 2008, 2012

Conclusions

1. **The middle of 2003 is extracted as a break point in trend of daily mean global seismic noise properties. At the same time middle of 2003 is the center of 1 year time window of spectral coherence maximum between first principal component (PC) of seismic noise properties and length of day (LOD).**

2. **Hypothesis could be proposed that abrupt change in trends of seismic noise properties were initiated by the change in irregularity of Earth's rotation (LOD).**

3. **The history of seismic noise observation since the beginning of 1997 could be split into 4 time fragments by using piecewise linear trends of maximum spectral coherence between PCs of global and regional (Japan and California) mean seismic noise properties and LOD.**

4. **The 1st time fragment (1997-2004) is characterized by the most strong increasing of trends between LOD and seismic noise PCs – before Sumatra mega-earthquake at the end of 2004 which started the series of strongest seismic events all over the world.**

5. **For Japan the 3rd time fragment (2008-2012) has the positive linear trend with big slope – before the Tohoku mega-earthquake at March 2011.**

6. **The last time fragment (2012-2019) is characterized by synchronous positive linear trends between LOD and seismic noise PCs what could be interpreted as a permanent global seismic danger increasing.**