Seismic Danger Estimate in Japan from GPS noise correlation properties

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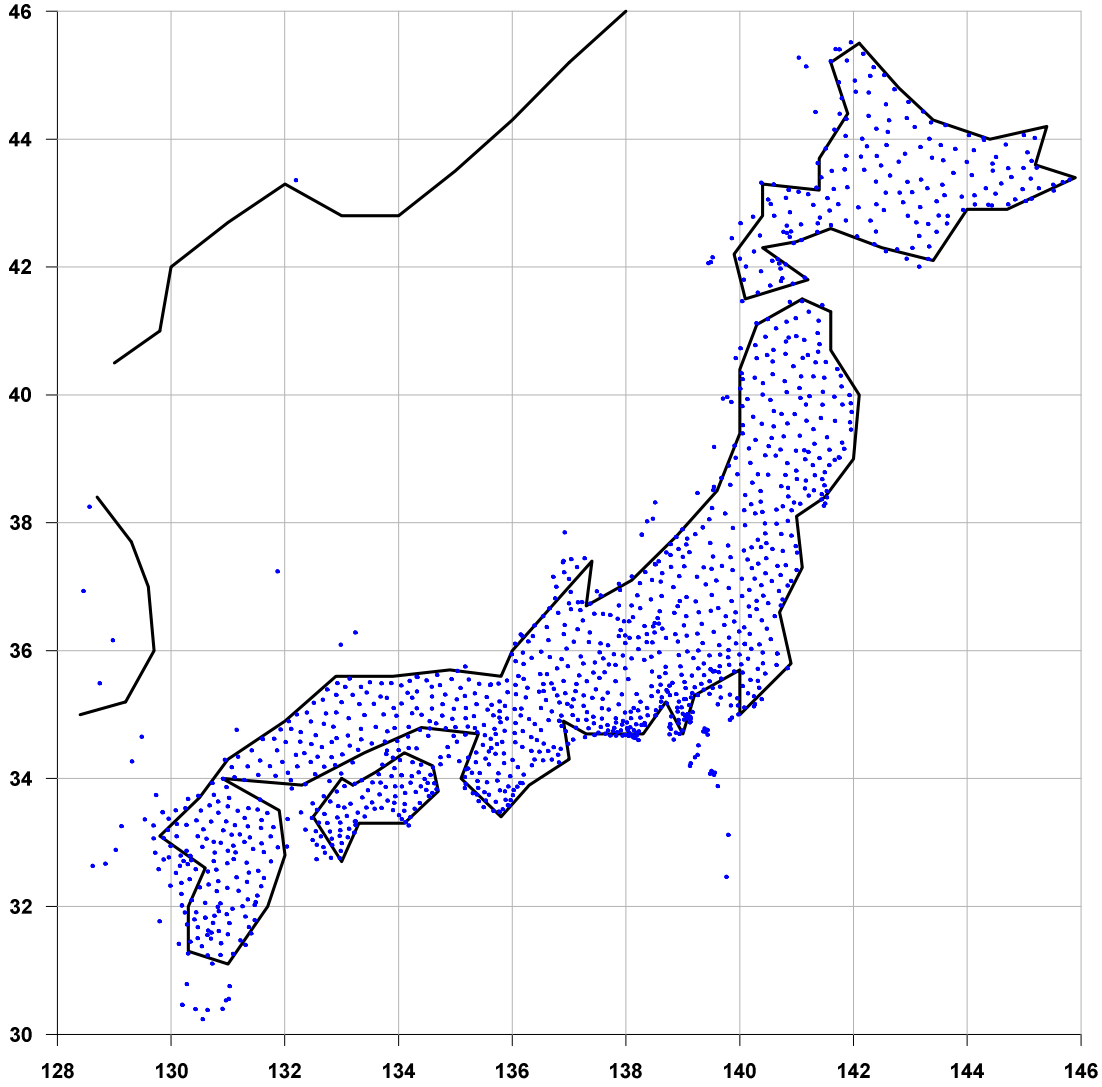
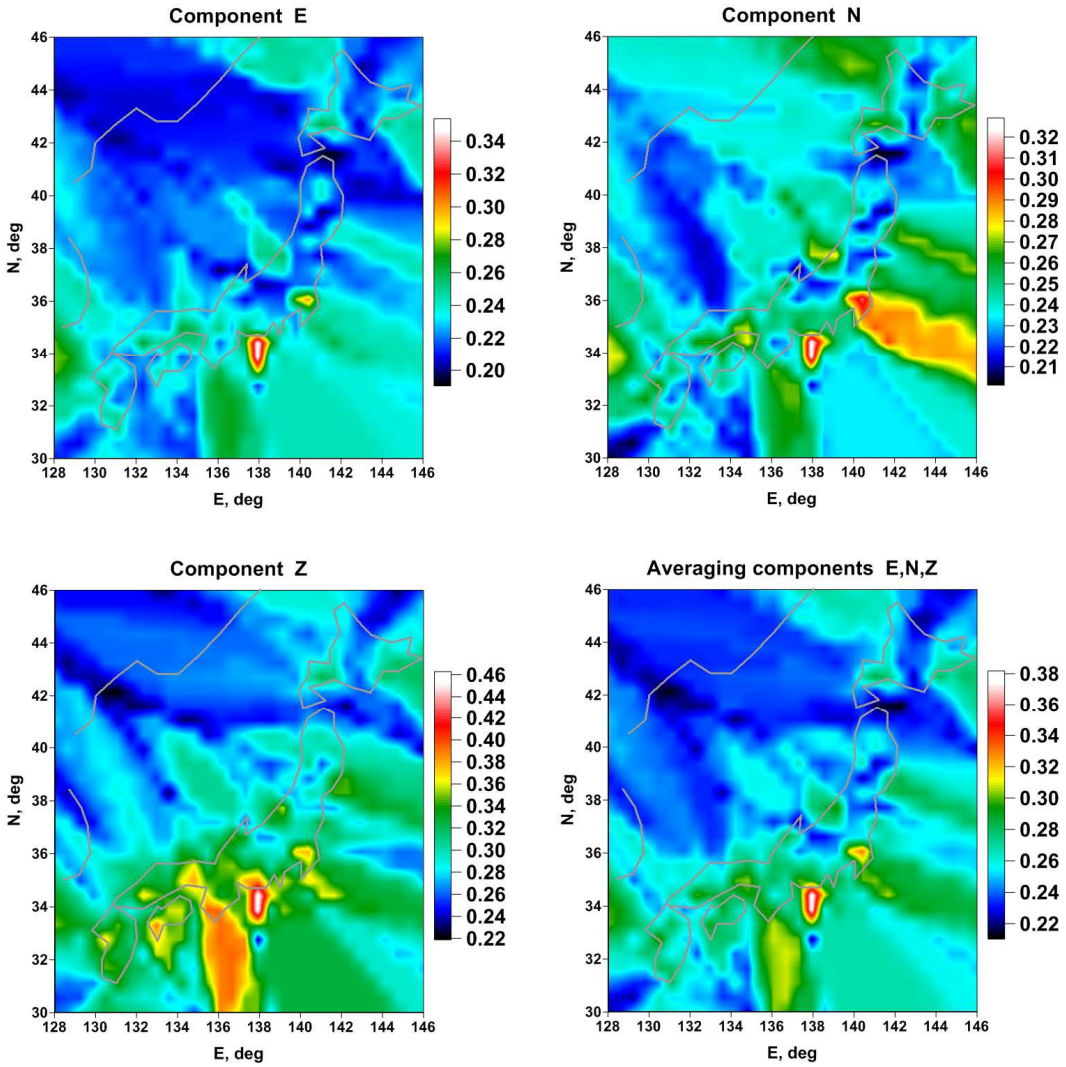


Positions of 1312 GPS stations at Japan Islands



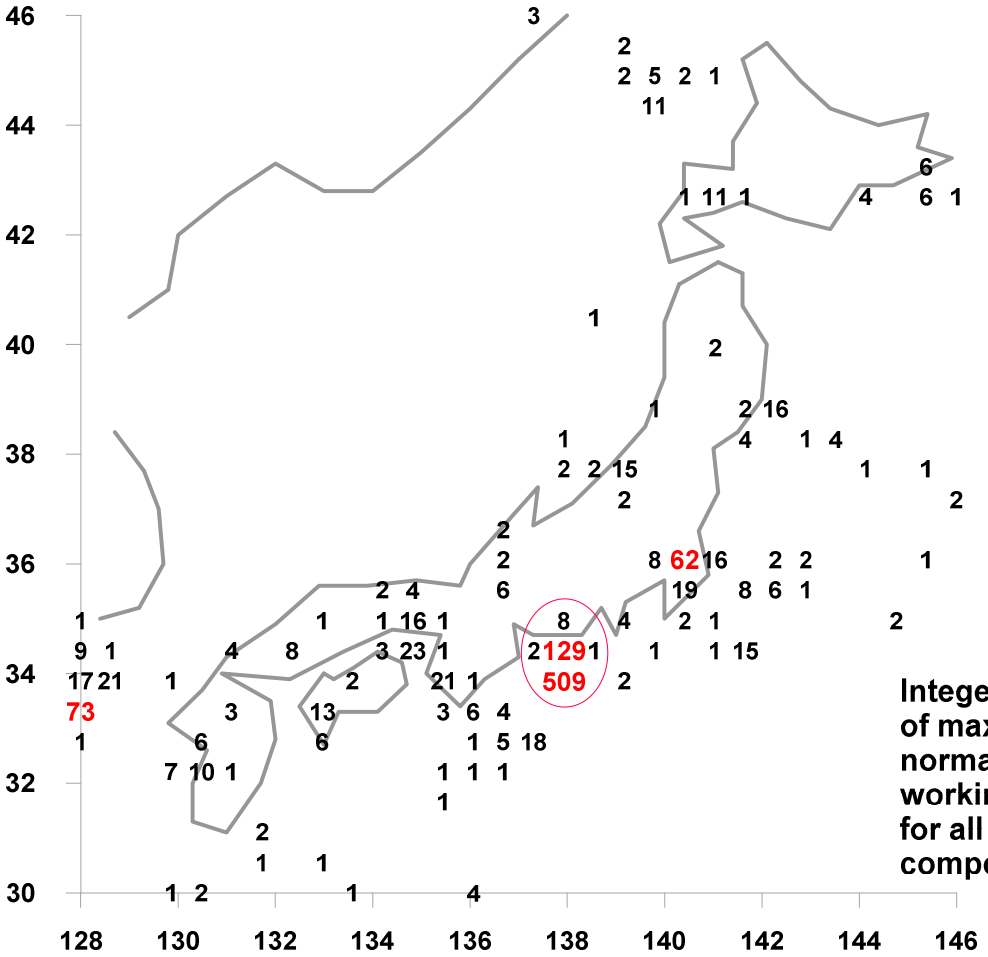
Averaged maps of maximum normalized eigenvalue (divided by the sum of all the eigenvalues) of the correlation matrix for the 3-component GPS measurements in Japan with a time step of 5 minutes are presented.

The data are taken from the Nevada Geodetic Laboratory site for a time interval 2015.03.03 - 2016.08.14:
ftp://gneiss.nbmg.unr.edu/rapids_5min/kenv/

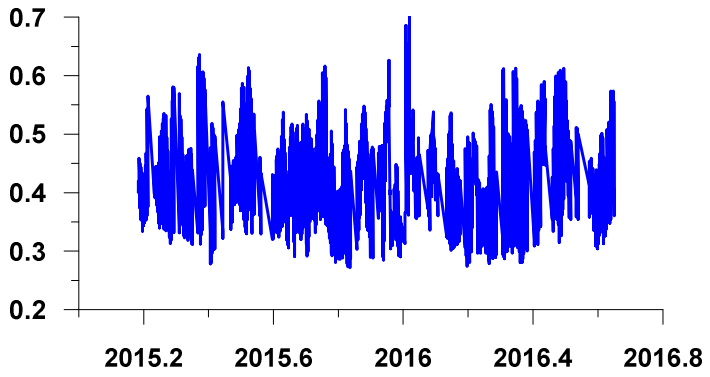
GPS network consists of 1312 stations. The correlation matrices were calculated in a moving time window of the length 1440 samples (5 days) with mutual shift 288 samples (1 day) for each node of a regular grid nodes (size 30×30) from 10 nearest workable stations. The GPS station is considered workable in the time window if its registration interval includes the considered time window and the number of missing values does not exceed a predetermined maximum allowable proportion of the total length equal to 0.1. The missed values are filled using information about records from neighbor time interval of the same length as the length of gaps. Before calculating the correlation matrix in each window the trend is removed by polynomial of 4^{th} order and $\pm 3\sigma$ winsorizing was performed.

Figures presented maps obtained by averaging all the successive "elementary maps" from each 5-day time-window for component E, N and Z of GPS time series and map obtained by averaging the three maps for each component.

For each 5 days “elementary map” for components E, N and Z let’s find the node from regular grid where the maximum normalized eigenvalue of correlation matrix (correlation measure) is maximal. Thus, we will obtain the cloud of points at the vicinity of Japan Islands where correlation measure is maximal within each time fragment of the length 5 days and for each GPS component. All these points have coordinates coinciding with coordinates of the nodes but most of nodes have no correspondent maximum correlation points and some of them have a big number of such points (most frequently visited nodes).



Graphic of sequential maximal values of maximum normalized eigenvalue of correlation martix within nodes of regular grid 30x30 for each 5 days elementary map and for each GPS component (E, N and Z).

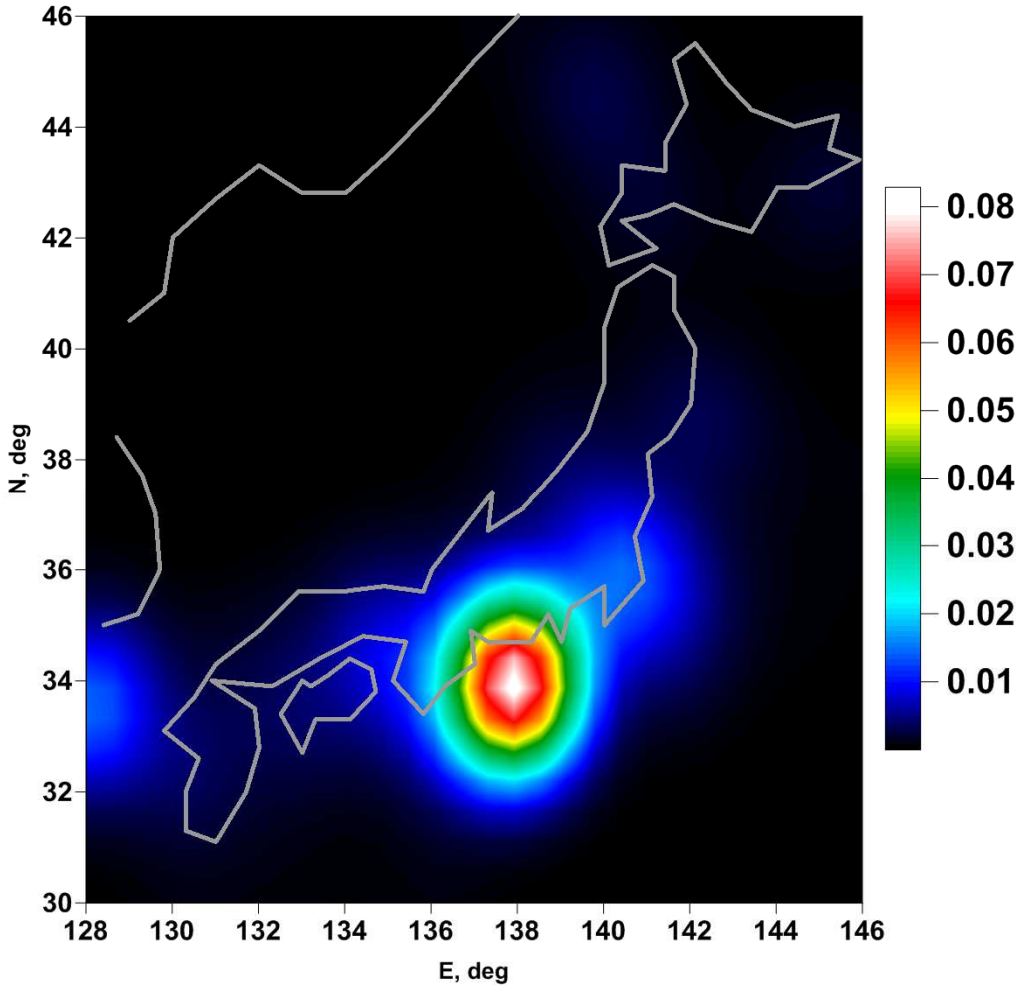


Integer numbers correspond to the number of visits of maximum values of correlation measure (maximum normalized eigenvalue of correlation matrix from 10 nearest working stations) to the nodes of regular grid of the size 30x30 for all time windows of the length 5 days and for all GPS components (E, N and Z).

Kernel estimate of 2D probability density of nodes from regular grid which were visited by maximum values of correlation measure (maximum normalized eigenvalue of correlation matrix).

Gaussian smoothing kernel with radius h = 1 degree was used: $\hat{p}(x,y\,|\,h)=\frac{1}{2\pi h^2 N}\sum_{\alpha=1}^{N}\exp\left\{-\frac{1}{2h^2}\left[(x-x_\alpha)^2+(y-y_\alpha)^2\right]\right\}$

The vicinity of the point with geographical coordinates 34°N and 138°E was visited by maximum correlation measure support most frequently.



Conclusion

The zone of collision of northern tip of the Philippine oceanic plate and Honshu is characterized by increased GPS noise correlation at the spot with center coordinates 34°N and 138°E at the Nankai trough.

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