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Supporting Information for

Seismic noises by infrastructure fiber optics reveal the impact of COVID-19 measures on human activities

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Text S1. Timeline of COVID-19 in State College, PA

After Pennsylvania announced to close schools on March 13th, Pennsylvania State University moved to remote-learning on March 18th right after spring break. Closure of the university caused a large number of people, most students, leaving the town, which lead to a big drop of population. Soon after that, a statewide stay-at-home order was applied on April 1st. The strictest quarantine policy, only life sustaining business was allowed, led to the lowest level of human activities. Then Phase Yellow was issued on May 7, which marked that human activities (including traveling and building construction) started to return to normal gradually. From May 29 until the time of completing this paper, State College PA was put in Phase Green. All the businesses reopened under certain conditions.

Text S2. Description of fiber-optic seismic data

The continuous data we use was collected by the Penn State FORESEE array of underground telecommunication fiber optic cables. The DAS array makes continuous strain rate measurements at a 500 Hz sampling frequency with a 10 m gauge length and 2 m channel spacing, leading to all 2137 sensors. The fiber route pictured in Figure 1 consists of two fiber optic sections spliced together (around channel 1340), a total fiber length of approximately 5 km. These fibers are sitting in a buried concrete conduit at a depth of roughly 1 meter underneath the city of State College, PA. The details of the DAS array installation and calibration can be found in the paper (Zhu et al., 2020).

500 samples per second fiber-optic data enable us to study seismic noise in a wide frequency range. However, high sampling rate yields over 200 GB/day. We downsample the data to 250 Hz considering the efficiency in terms of computation and storage. Owing to the unexpected power disruptions, there are no recordings between March 16 - April 15 and May 06-26. We analyze seismic noise variation of 21 weekdays at 7 distinct time periods (3 days for each group) from March 3 – June 10 2020, covering normal spring semester, spring break, quarantine after the stay-at-home order was issued and the gradual relaxation of the COVID-19 measures.

Text S3. Mobility Data

Mobility data we use are from Community mobility reports in Centre County, PA, released by Google (Google, 2020). The reports chart daily percentage changes of visits by geography, across different categories of places such as retail and recreation, groceries and pharmacies, parks, transit stations, workplaces, and residential. The baseline is the median value during Jan 3-Feb 6, 2020. For a college town like State College, the most common social activities are school activities and transportation. In our study we pick out “transit stations” category (Mobility trends for places like public transport hubs such as subway, bus, and train stations) as Transport and “workplaces” (Mobility trends for places of work) as Workplaces.

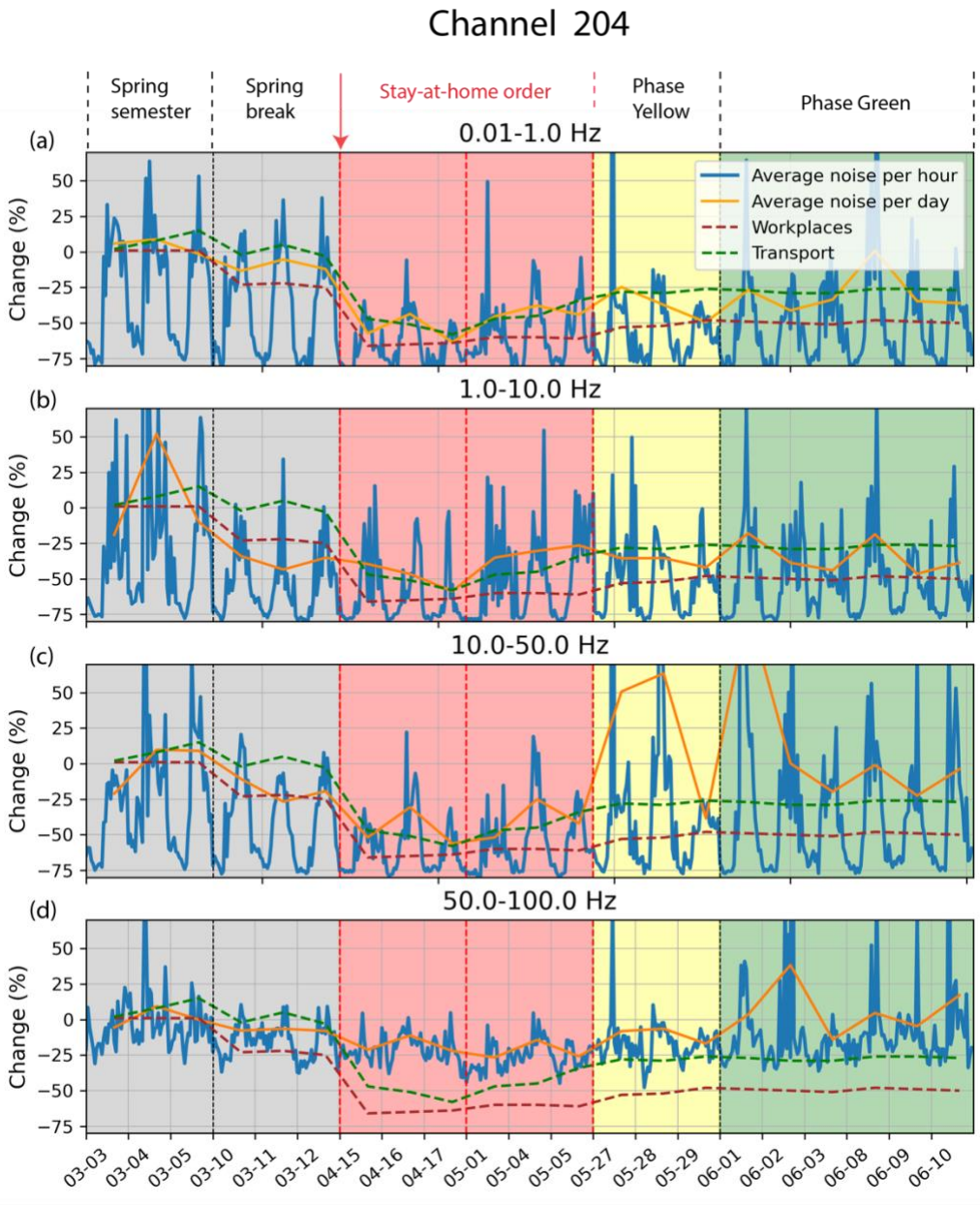

Figure S1. Noise change at Channel 204 in the frequency range of (a) 0.01-1 Hz, (b) 1-10 Hz, (c) 10-50 Hz and (d) 50-100 Hz. The daily average noise change (orange) as well as the mobility data provided by Google (dashed line) are plotted

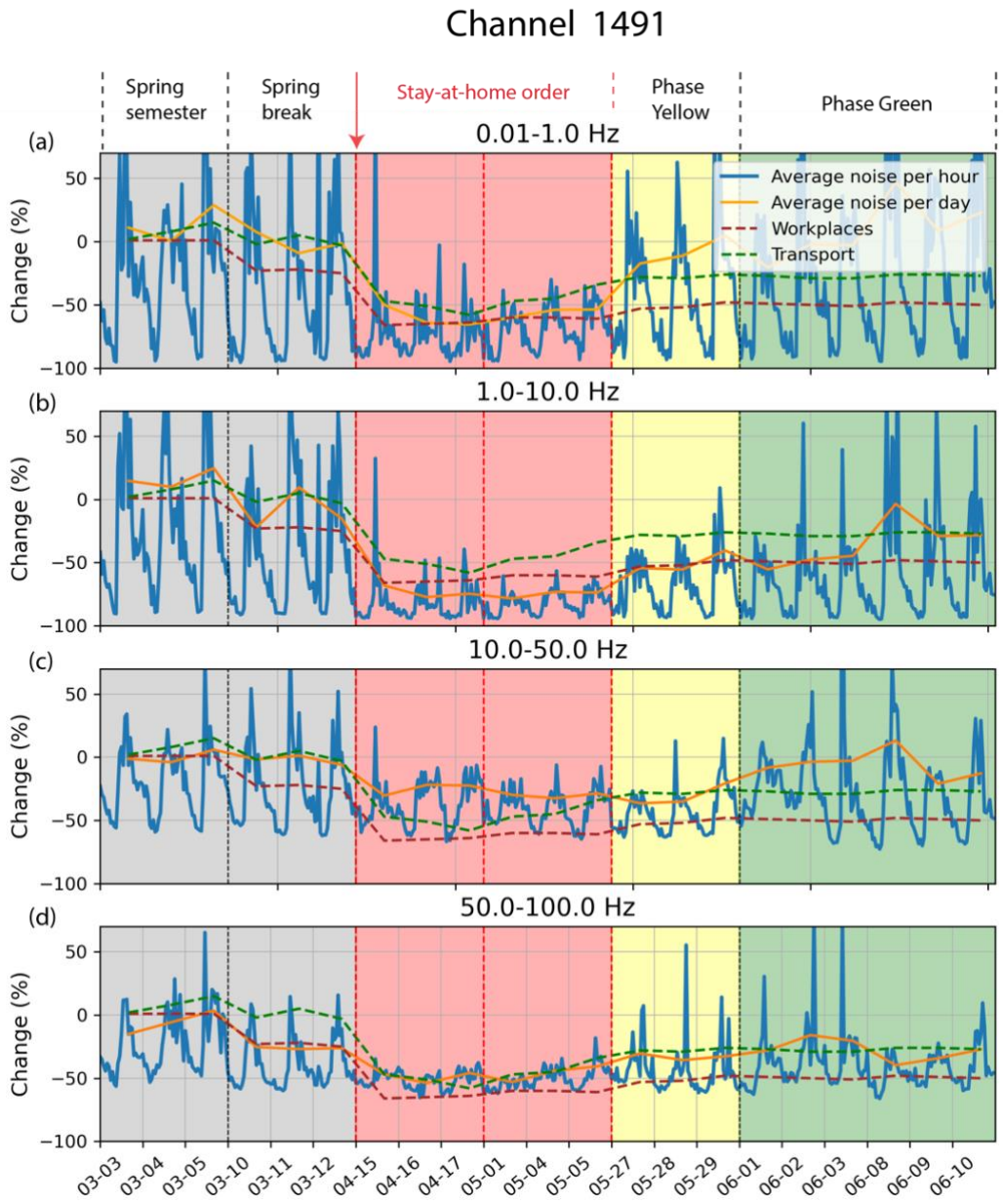

Figure S2. Noise change at Channel 1491 in the frequency range of (a) 0.01-1 Hz, (b) 1-10 Hz, (c) 10-50 Hz and (d) 50-100 Hz. The daily average noise change (orange) as well as the mobility data provided by Google (dashed line) are plotted

References From the Supporting Information

Google (2020). COVID-19 Community Mobility Reports. Available at: https://www.google.com/covid19/mobility/ (accessed: 25 September 2020).

Zhu, T., Shen, J., & Martin, E. R. (2020, June 29). Sensing earth and environment dynamics by telecommunication fiber-optic sensors: An urban experiment in Pennsylvania USA. submitted. *Solid Earth*. https://doi.org/10.5194/se-2020-103