“Movers & Shakers” – First Virtual Meetup 2021
Organised by RaspberryShake S.A.
8 April, COVID year II

Thomas Lecocq

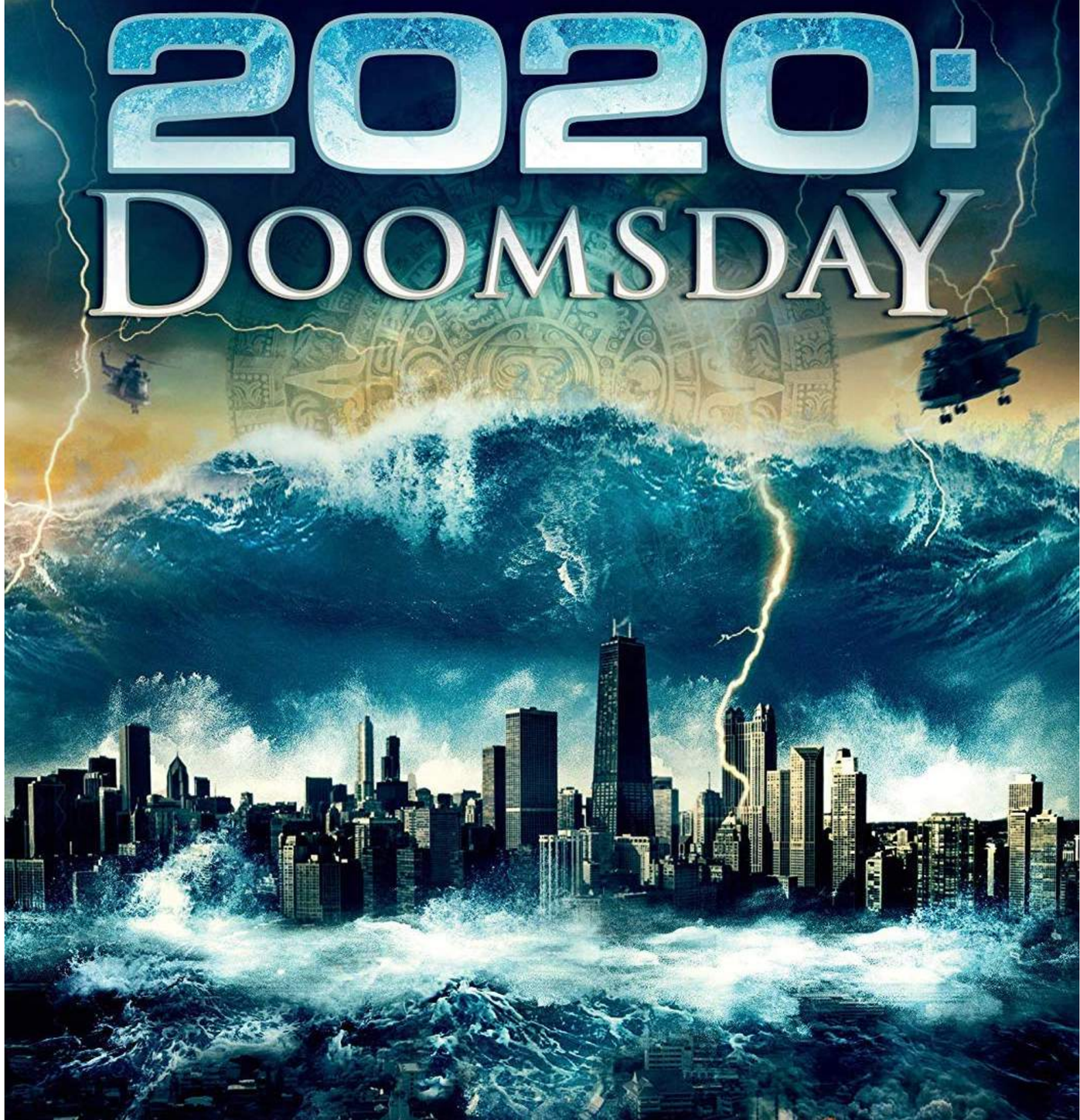
MOVERS SHAKERS

Citizens are Scientists

Contact:
@seismotom
Royal Observatory of Belgium

2020

The year Hollywood proved "true"?



COVID-19 TIMELINE

Made public on
31 December 2019

First case: 31 January
First casualty: 22 February

e.g. Belgium
First case: early February
First casualty: 11 March

Most countries report
cases after mid-march

<STARTDATE>2020-03-11</STARTDATE>

"WE HAVE THEREFORE MADE THE ASSESSMENT THAT COVID-19 CAN BE CHARACTERIZED AS A PANDEMIC"

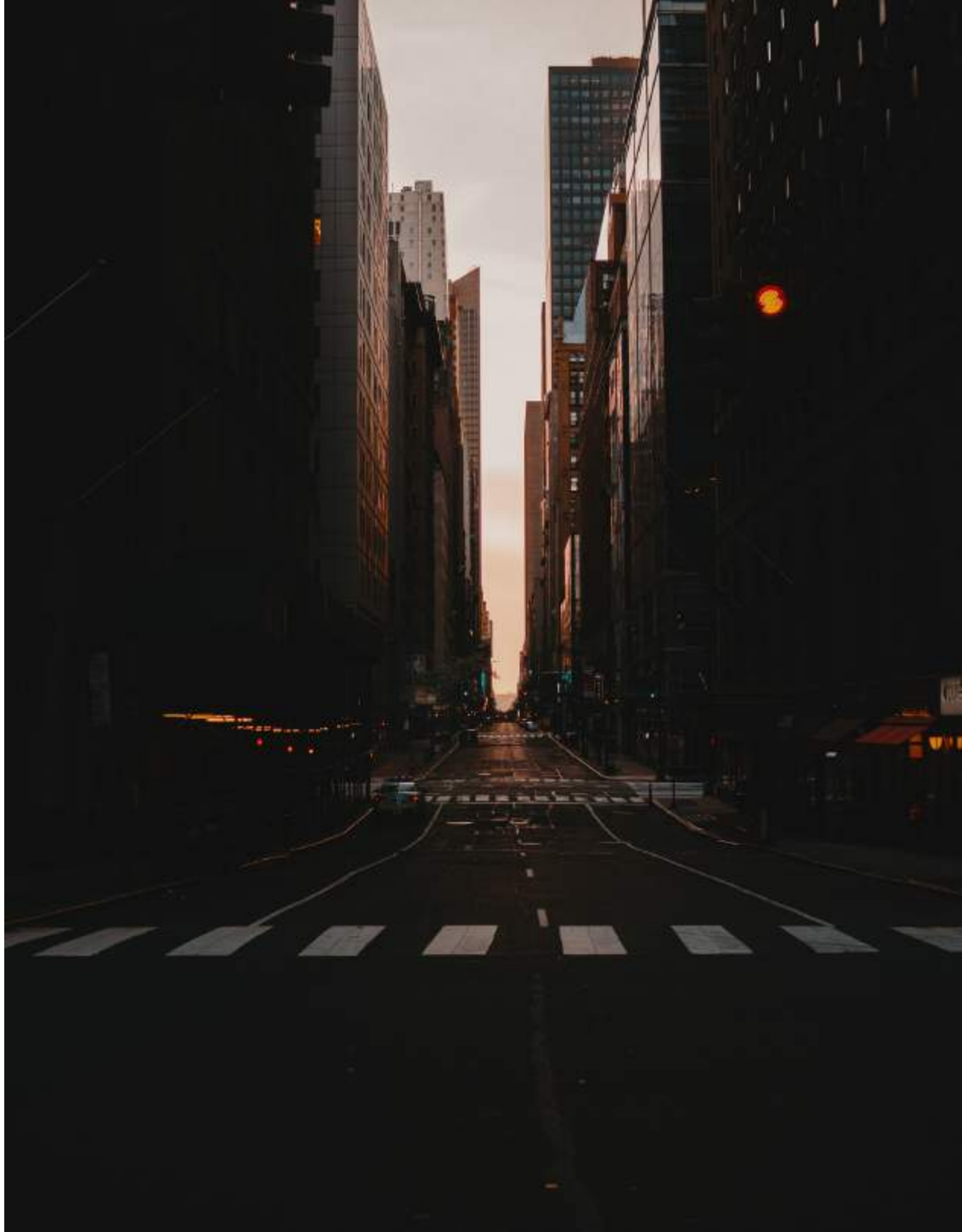
WHO DIRECTOR-GENERAL'S OPENING REMARKS
AT THE MEDIA BRIEFING ON COVID-19

LOCKDOWN MEASURES

#STAYHOME #SAVELIVES

The streets are empty
Public transport is maintained, sometimes only reduced
Telework encouraged when possible

The world discovers who "Essential Workers" are...



WHAT HAPPENS WHEN HUMANS STOP?

We have a strong impact on the environment, at **all** spatial and temporal **scales**. From **local** to **global** effects, from the **instant** to the **centuries**.

When humans act, the environment reacts.

SEISMOLOGISTS DON'T *(DIDN'T)* LIKE NOISE...

NOISE ALTERS SEISMOGRAMS READINGS

Since the early ages of seismology, scientists search for the quietest environments for installing their increasingly sensitive instruments. Seismic networks try to favour remote or rural stations to minimise the impact of human-generated seismic noise.

NOISE IS EVERYWHERE

"Noise", or "Continuous ground vibrations recorded by seismometers" have different origins. The oceans are responsible for a large part of the long-period noise. Humans are often the major culprit for high frequency noise.

NOISE OR "AMBIENT SEISMIC WAVEFIELD" IS USEFUL

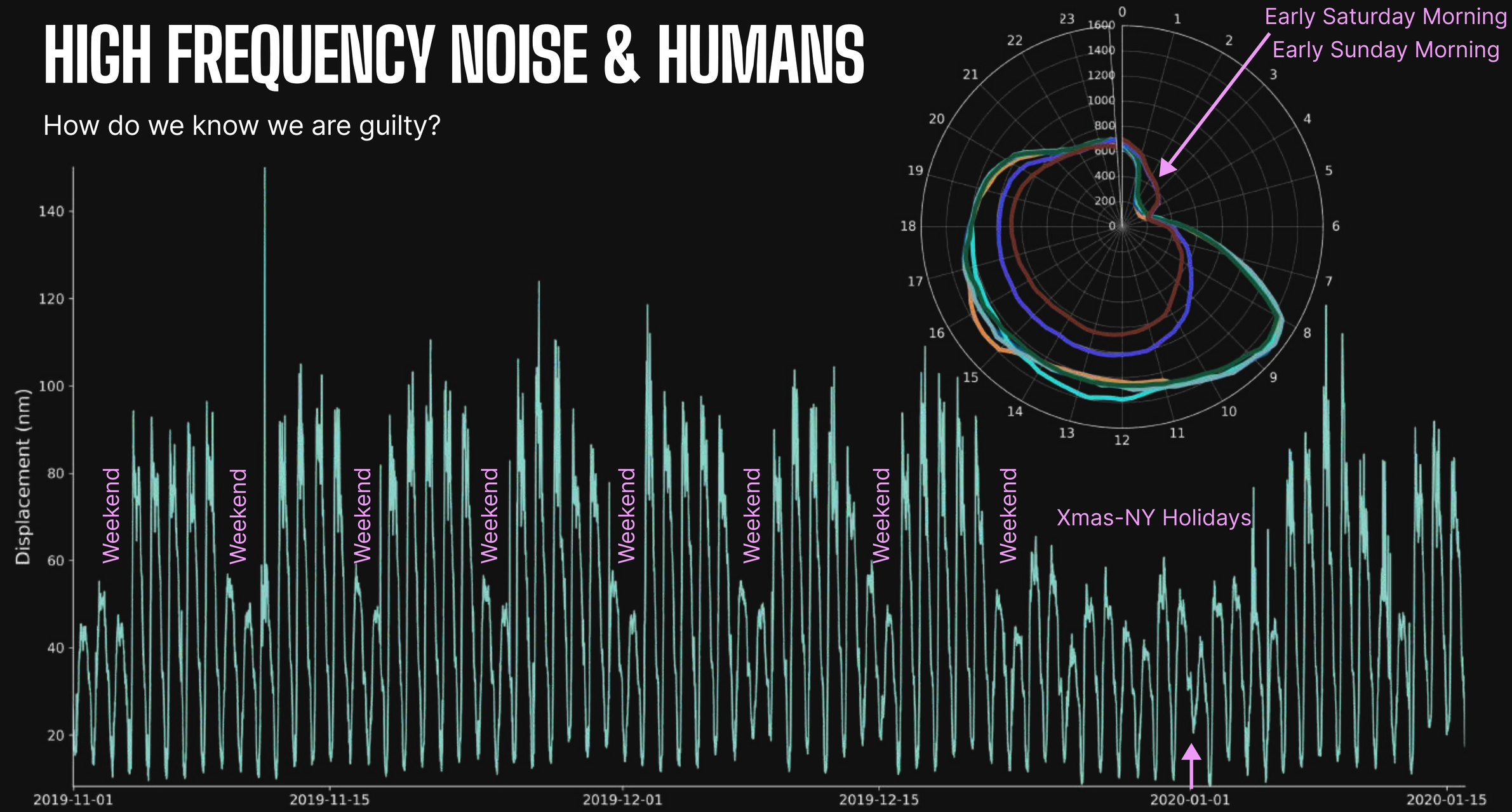
Used and studied since 1900, "seismic noise" has been *à la mode* since early 2000 when scientists showed the richness of the information stored in the continuous coherent wavefield recorded at two distinct locations.

HOW DO WE KNOW?

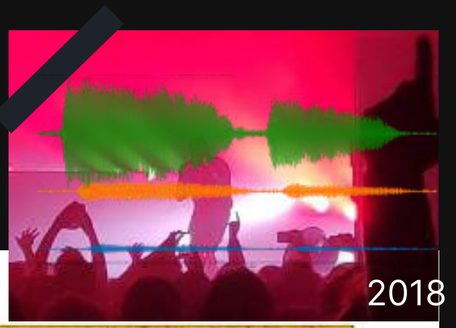
We are culprit for high frequency noise ?

HIGH FREQUENCY NOISE & HUMANS

How do we know we are guilty?



SEISMOLOGISTS ARE WATCHING YOU (AND IT'S FUN)

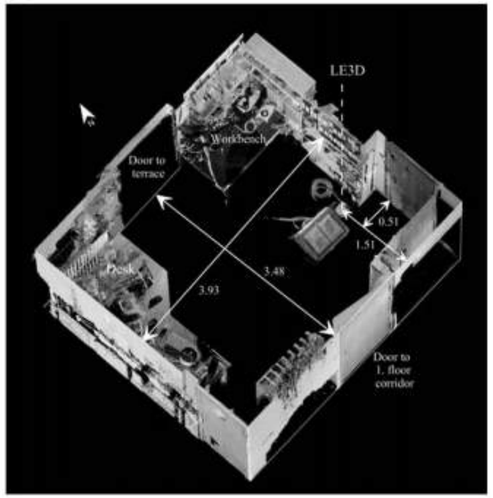


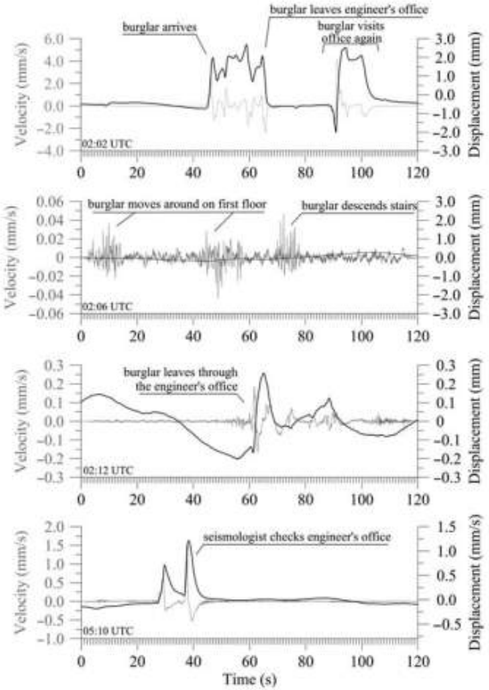
EARTHQUAKE LITES

Analysis of a Burglargram

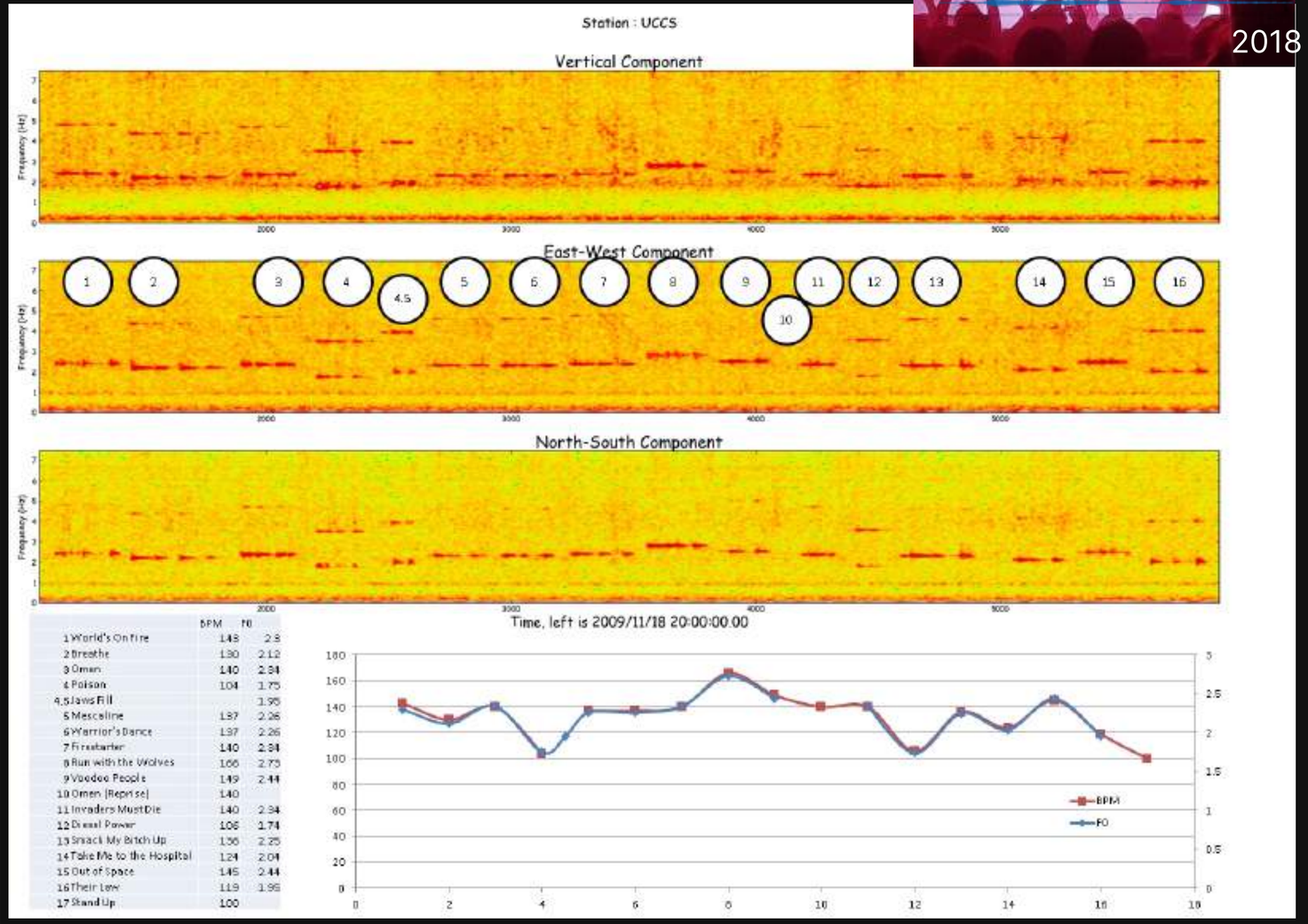
(a)

(b)





▲ **Figure 2.** Four seismograms recorded in the engineer's office (Fig. 1) of the Bensberg seismological station on 14 August 2015, during and after a burglary. The gray and black traces give the velocity and displacement of the east–west component from a 1 s transducer on the floor. The starting time of each seismogram is given in the lower left corner of the graphs.



Lecocq et al, "The Prodigy World Seismic Tour", unpublished but regularly presented since 2009

Lars-G. Hinzen, Sharon K. Reamer, Claus Fleischer; Analysis of a Burglargram. Seismological Research Letters 2015; 87 (1): 193–195. doi: https://doi.org/10.1785/0220150253

SEISMOLOGISTS ARE WATCHING YOU (AND IT'S SCARY)

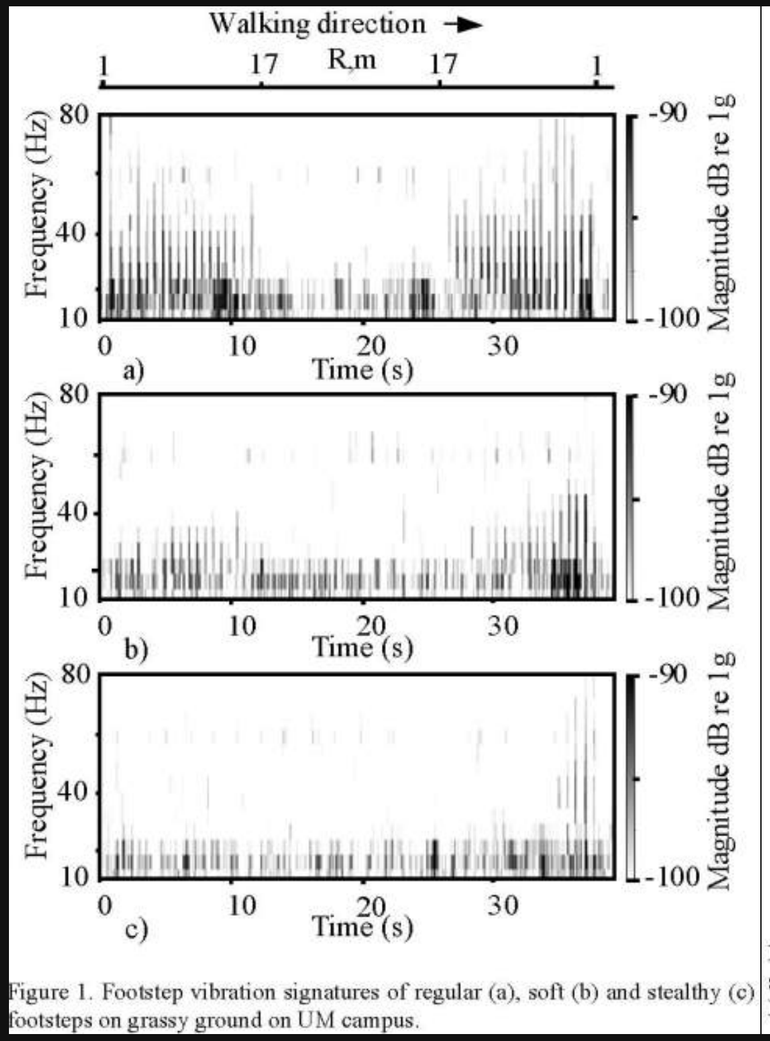


Figure 1. Footstep vibration signatures of regular (a), soft (b) and stealthy (c) footsteps on grassy ground on UM campus.

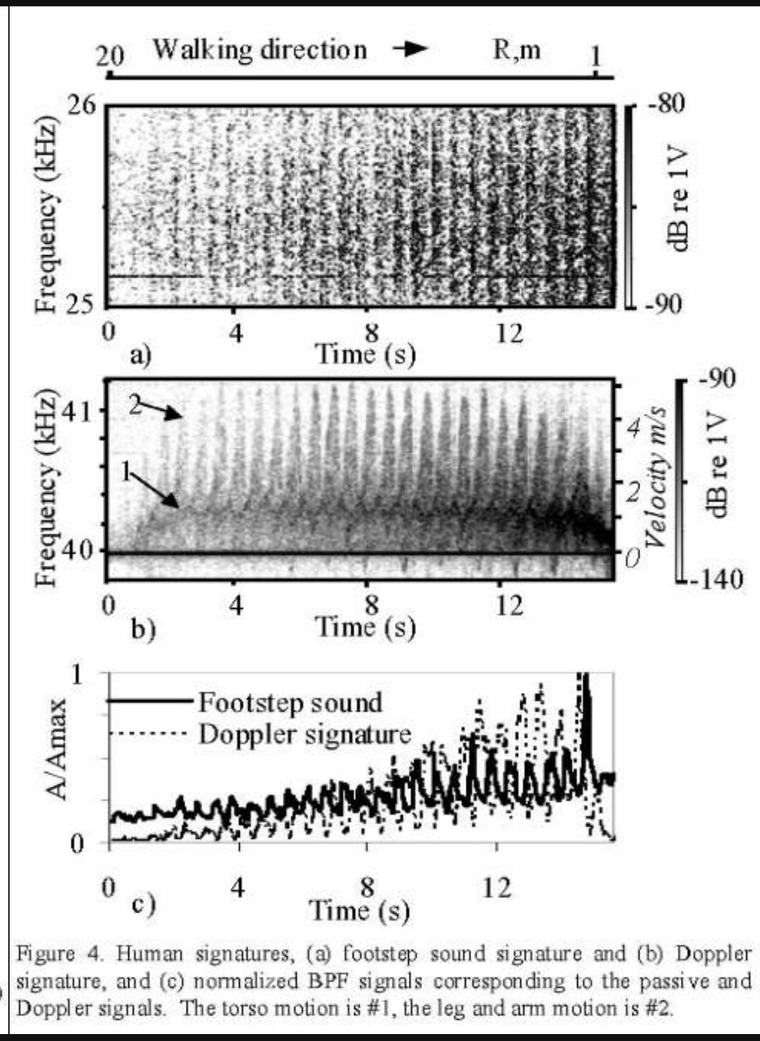


Figure 4. Human signatures, (a) footstep sound signature and (b) Doppler signature, and (c) normalized BPF signals corresponding to the passive and Doppler signals. The torso motion is #1, the leg and arm motion is #2.

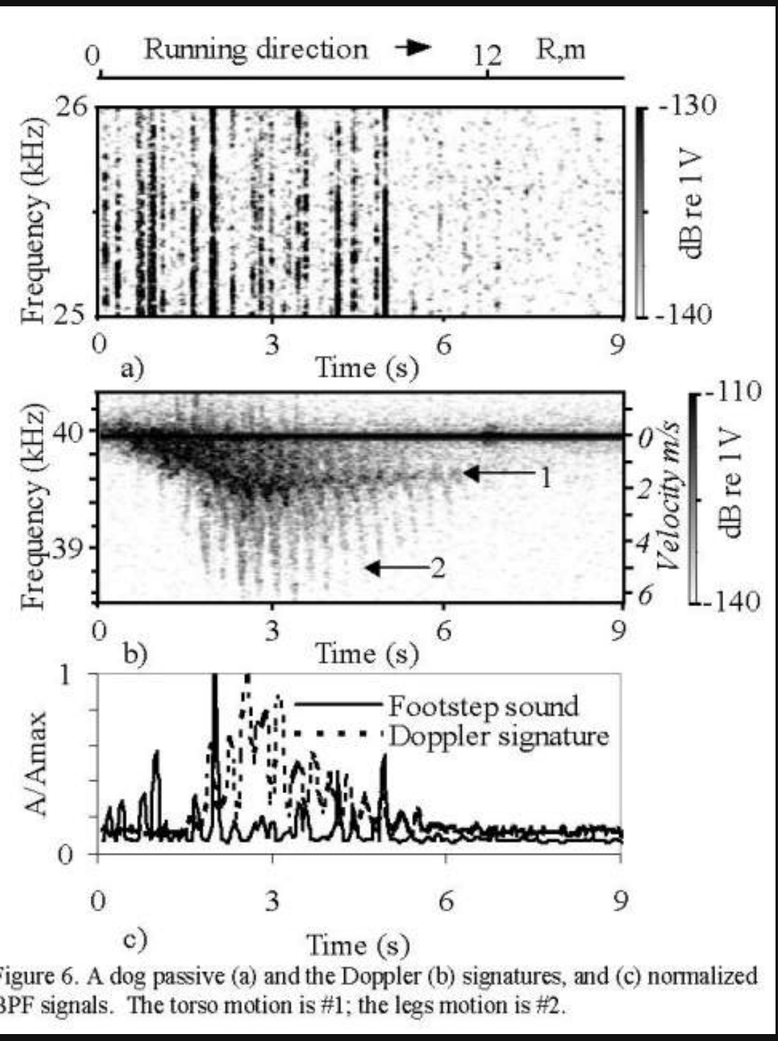
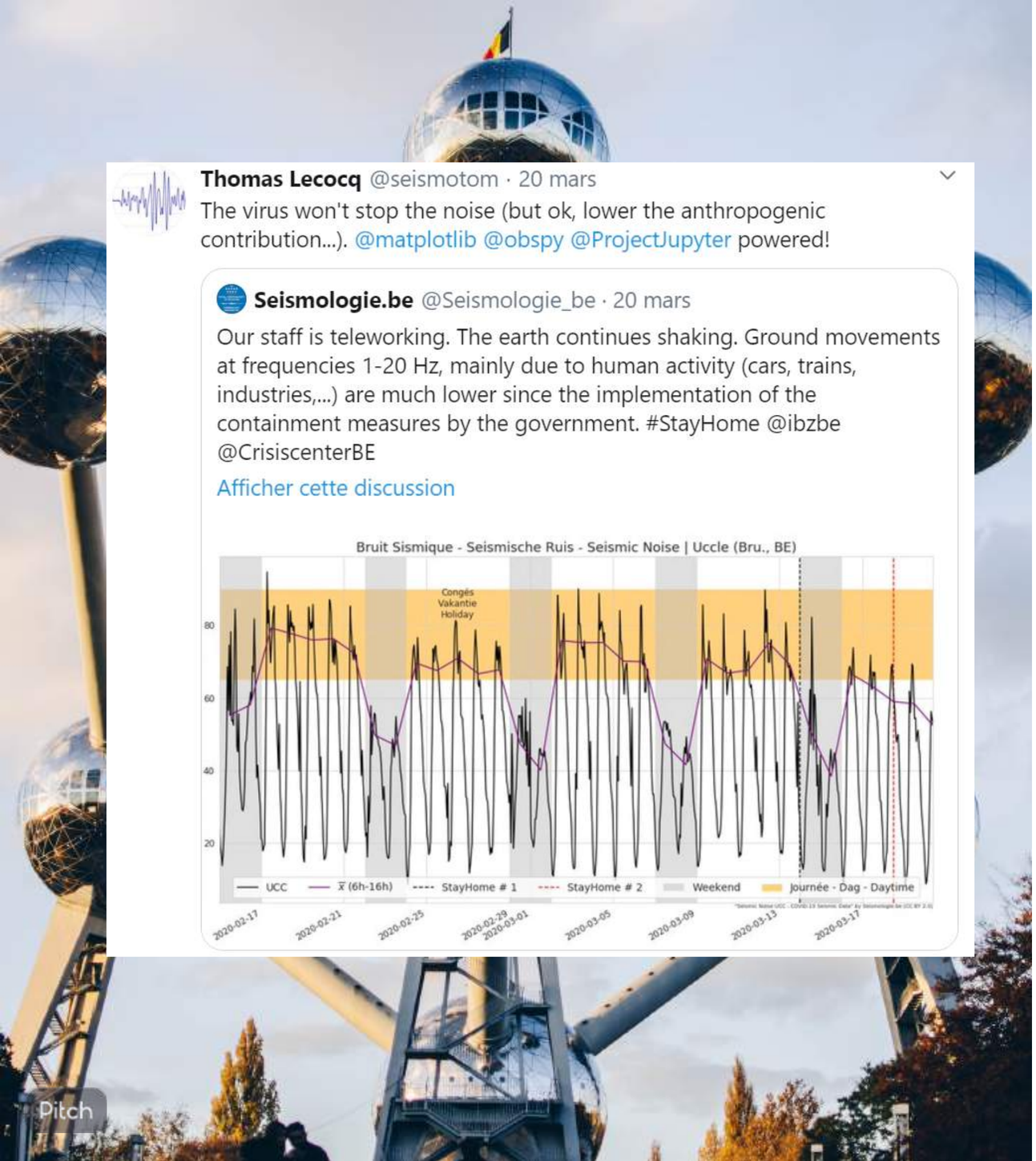


Figure 6. A dog passive (a) and the Doppler (b) signatures, and (c) normalized BPF signals. The torso motion is #1; the legs motion is #2.

Sabatier, J. M., & Ekimov, A. E. (2008). A Review of Human Signatures in Urban Environments Using Seismic and Acoustic Methods. 2008 IEEE Conference on Technologies for Homeland Security. doi:10.1109/ths.2008.4534452



SO WHEN WE PACED DOWN...

We knew the noise would go down after March 15

and even more after the 18th (strictest measures)

we were all teleworking

for some, it was the first time

...

AND IT WENT...
VIRAL
WHEN RELAYED BY GIZMODO

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EARTH SCIENCE

Seismometers Worldwide Detect Decrease in Human Activity Amid Coronavirus Lockdowns

Ryan F. Mandelbaum
3/27/20 12:50PM • Filed to: SEISMOLOGY

5 1

The plaza in front of the Lincoln Memorial in Washington D.C. is empty on March 17, 2020.
Photo: Win McNamee (Getty Images)

Seismometers around the world are recording the decreased seismic activity resulting from people staying home amid covid-19 social distancing orders.

These detectors measure seismic waves through Earth's crust, but they also pick up humans moving around, industry, and traffic in the form of higher-frequency noise patterns. Amid stay-at-home orders, Royal Observatory of Belgium geologist and seismologist Thomas Lecocq decided to look at the Royal

nature

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NEWS · 31 MARCH 2020

Coronavirus lockdowns have changed the way Earth moves

A reduction in seismic noise because of changes in human activity is a boon for geoscientists.

NATIONAL GEOGRAPHIC

SCIENCE | CORONAVIRUS COVERAG

These charts show ho 'quieted' the world

As people stopped commuting and traveling, seismologists tracked the change.

The Atlantic

CNN World

The coronavirus pandemic is making Earth vibrate less

By Harmeet Kaur, CNN

Updated 1700 GMT (0100 HKT) April 3, 2020

INDEPENDENT

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Coronavirus lockdowns worldwide make Earth's crust move less, scientists find

'We can probably learn a lesson here for other parts of the environment,' says seismologist

Jane Dalton | @JournoJane | 5 days ago |

pport The Guardian

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ockdown has cut Britain's vibrations, ismologists find

Mercredi 8 avril 2020 | Dernière mise à jour

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SCIENCE À CAUSE DU CORONAVIRUS, LA TERRE TREMBLE MOINS

L'homme se déplaçant moins sur la surface de la planète, le bruit de fond sismique qu'il provoque s'atténue sensiblement. Même en Suisse.

SCIENCE

The Pandemic Is Turning the World Upside Down

Widespread social-distancing measures have produced effects across land, air, and sea.

MARINA KOREN APRIL 2, 2020

GIZMODO | Las últimas noticias en tecnología, ciencia y cultura digit

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CIENCIA

Sismógrafos en todo el mundo actividad humana debido a la c coronavirus

Ryan F. Mandelbaum

3/28/20 4:22PM · Filed to: CORONAVIRUS

Coronavirus lockdowns around the world are making the Earth move less, scientists have discovered.

SUCHE

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Startseite › Erde/Umwelt › Coronavirus: Pandemie lässt Erde weniger stark beben

News
31.03.2020
Lesedauer ca. 1 Minute
Drucken
Teilen

CORONAVIRUS

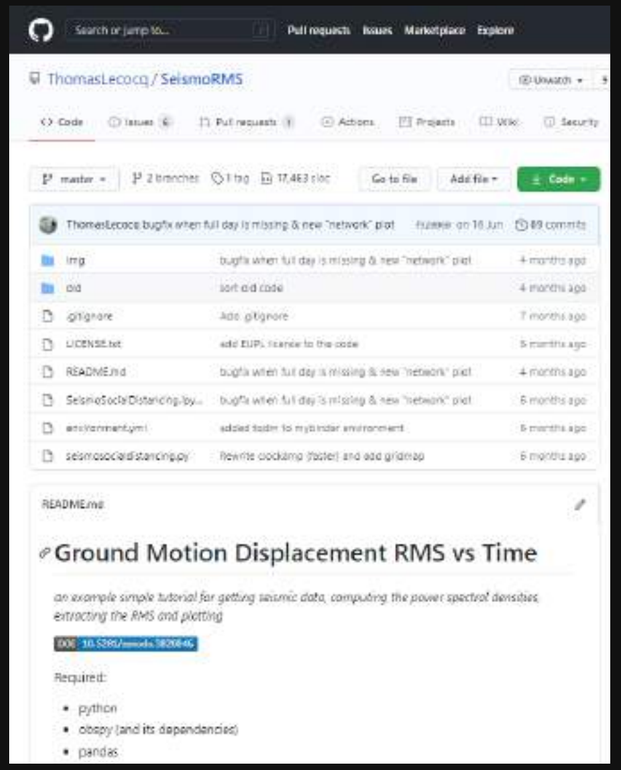
Pandemie lässt Erde weniger stark beben

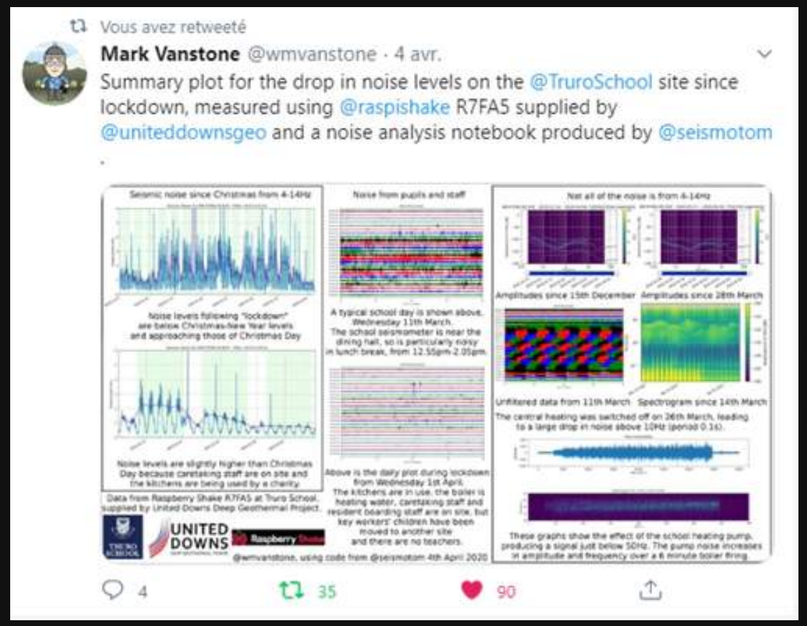
Normalerweise stören Züge, Schwerlasttransporte und Industrieanlagen seismologische Messungen. Nun stehen sie größtenteils still - eine Chance für Geologen.

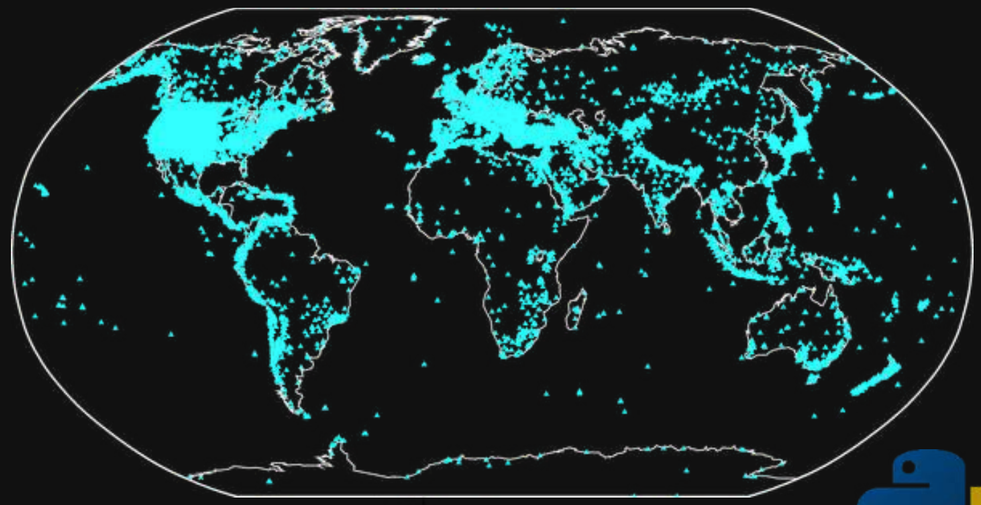
Pitch


LOCKED
DOWN
but **free** to collaborate
Pitch

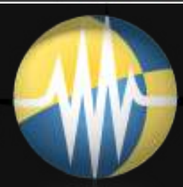
OPEN SOURCING THE CODE







pandas



ObsPy

A Python Framework for Seismology

$$D_{pow}(f) = \frac{A_{pow}(f)}{(2\pi f)^2} = \frac{10^{(\frac{A_{dB}(f)}{10})}}{(2\pi f)^2}$$

The RMS (root-mean-square) of the time-domain displacement (d_{rms}), bandpassed between f_{min} and f_{max}, is related to the power spectral amplitude (D_{pow}) by Parseval's identity:

$$d_{rms}(t) = \sqrt{\int_{f_{min}}^{f_{max}} D_{pow}(f) df}$$

Pitch

Tweeted on

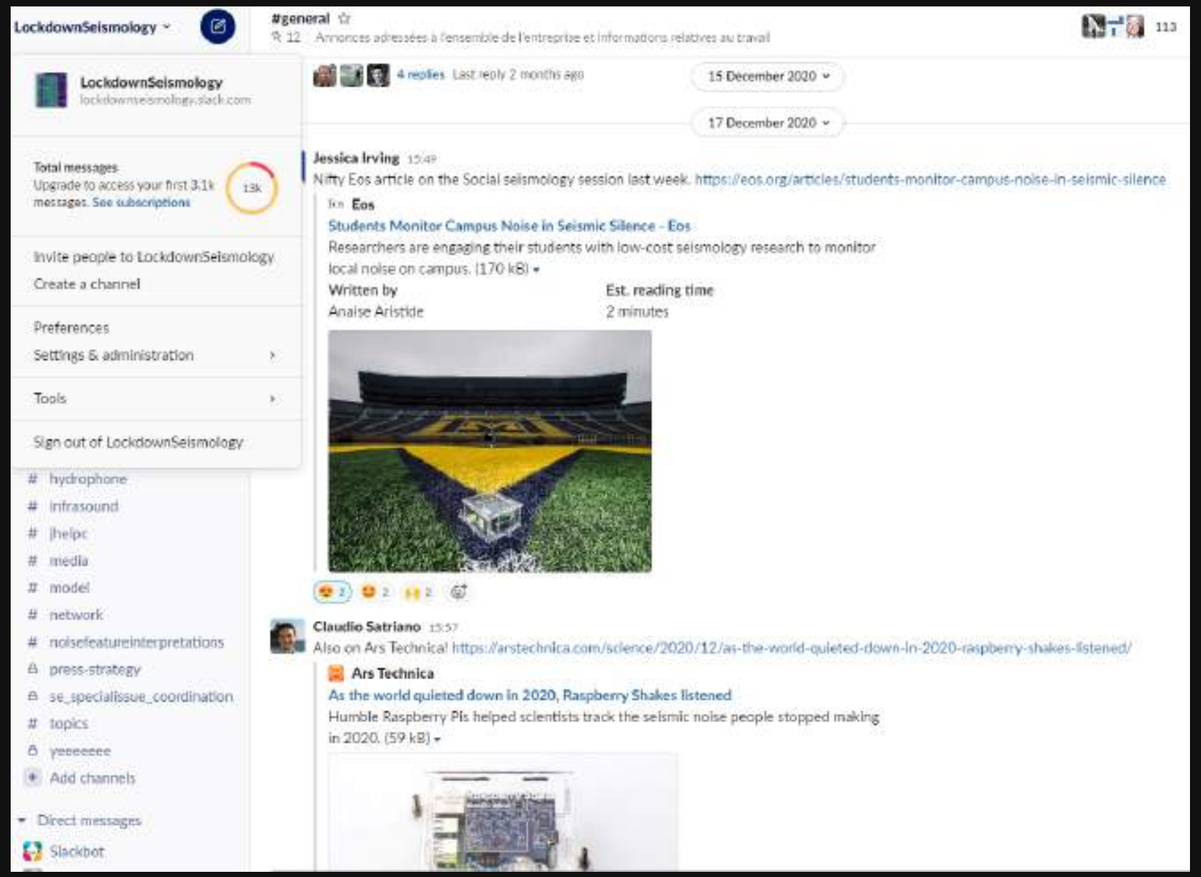
April 1st

Gathered

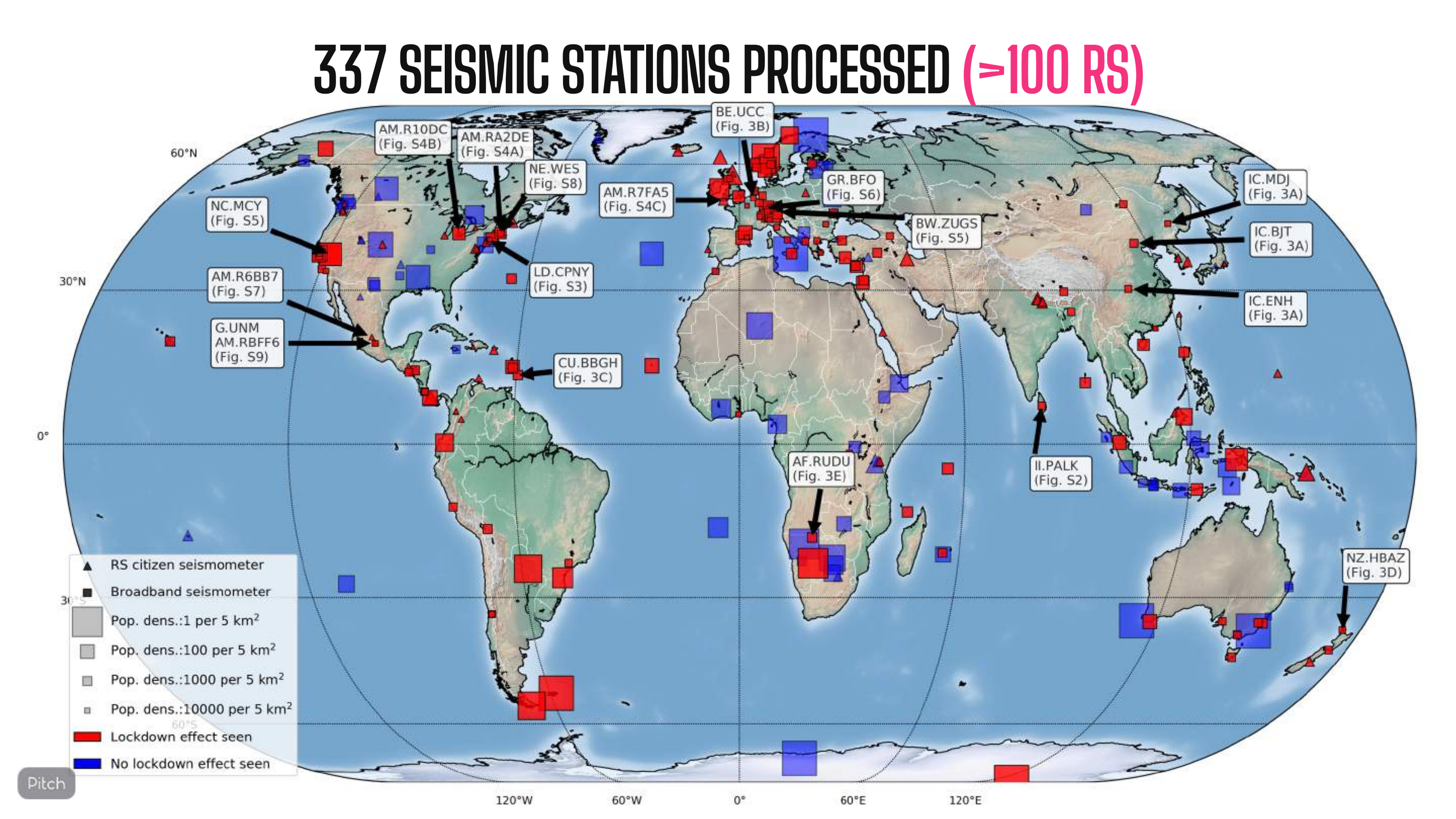
101 people on Slack

Spoiler: "*this week*" turned out to be "*10 weeks*"

ISOLATED, BUT CONNECTED LIKE NEVER BEFORE...

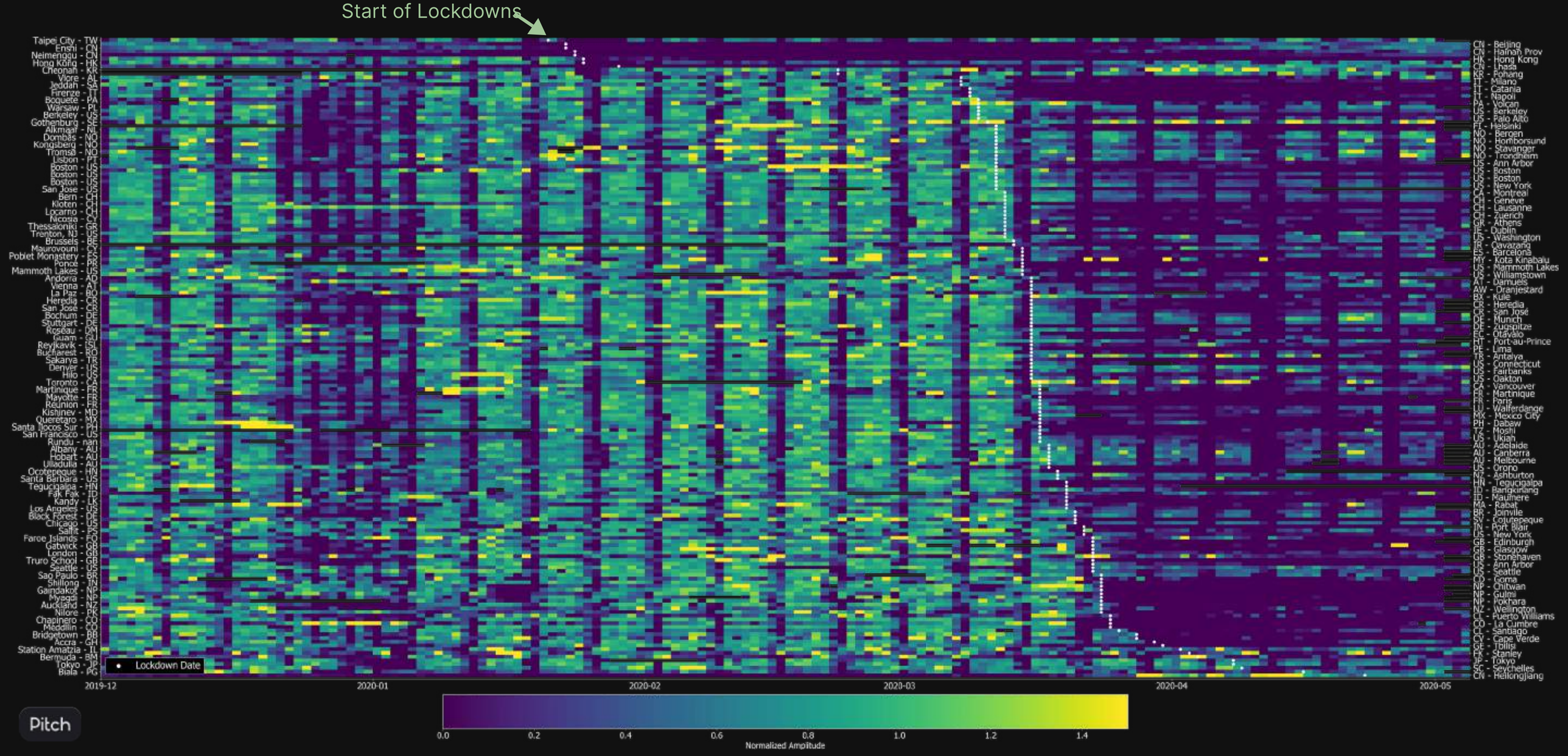


337 SEISMIC STATIONS PROCESSED (>100 RS)



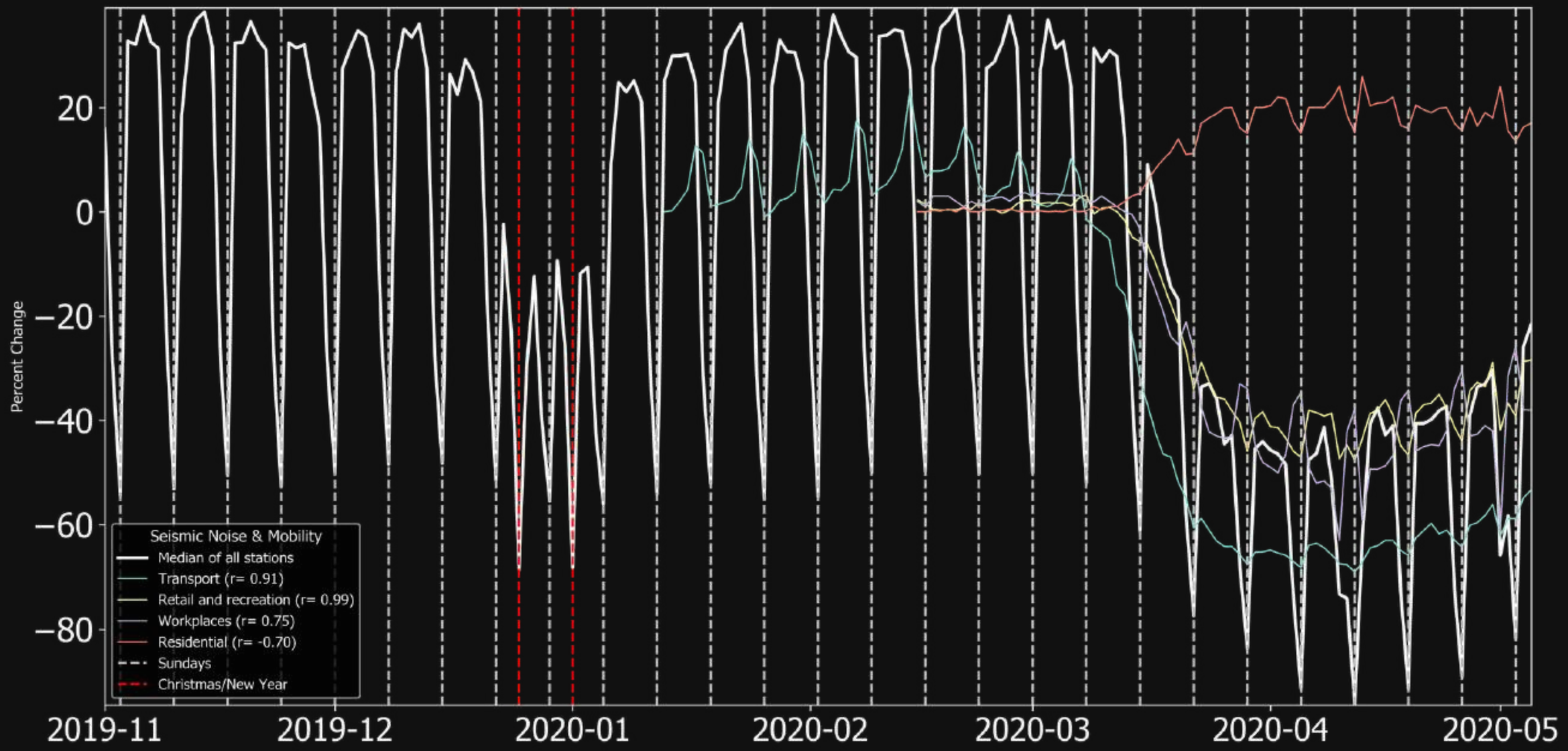
Pitch

185 SEISMIC STATIONS WHERE LOCKDOWN IS VISIBLE



Pitch

MEDIAN OF 185 SEISMIC STATIONS VS "SMARTPHONE" MOBILITY



ONE PLANET
ONE COMMUNITY

Timing

1 April - 24 July 2020

Numbers

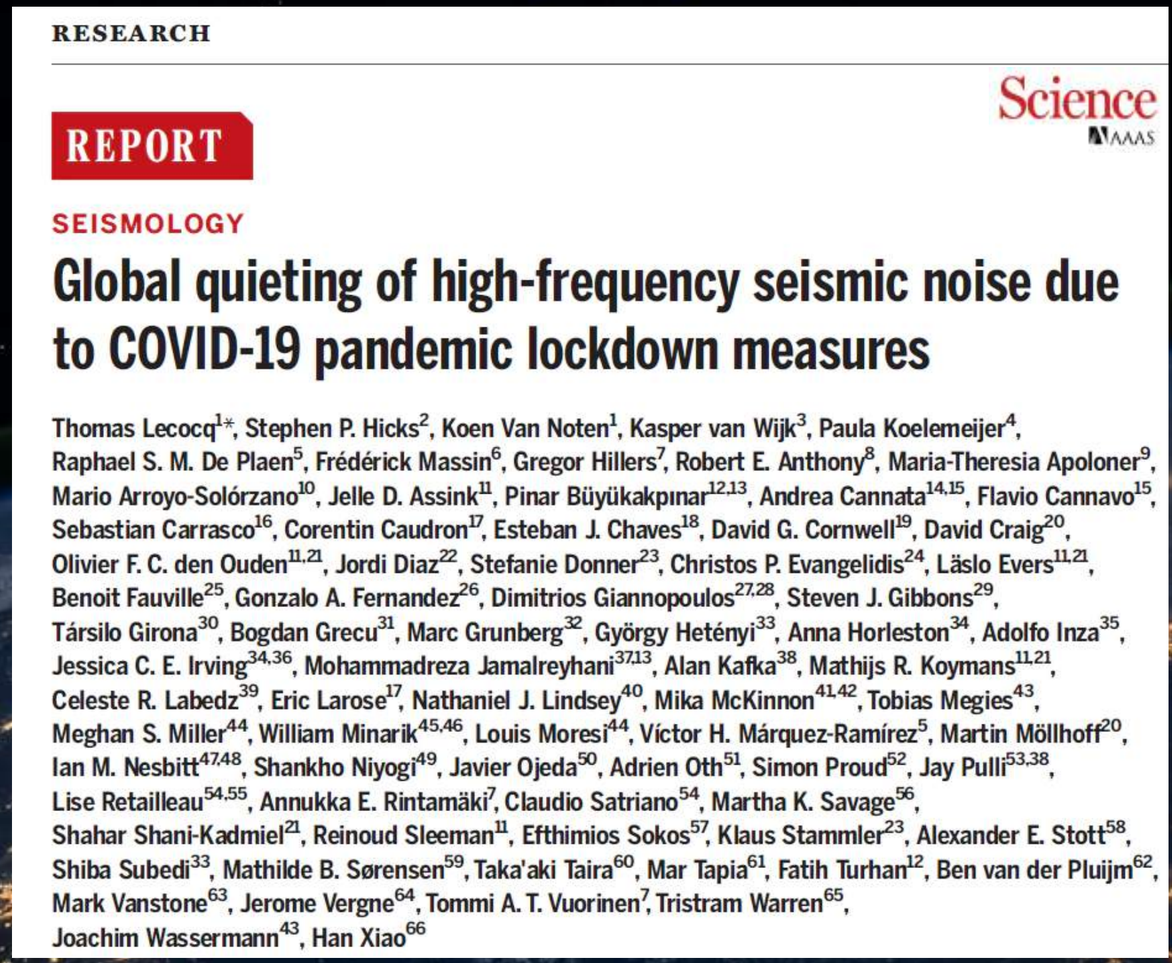
6 months of data analysed for
337 stations **(> 100 RS!)**
or 62 682 days of seismic data
or 5 415 724 800 seconds
or 541 572 480 000 samples

processed with ***one*** code

76 authors
66 affiliations
25 countries

Software

Code: Python
Community: Slack
Writing: Overleaf
Reviews: GoogleDocs



RESEARCH

Science AAAS

REPORT

SEISMOLOGY

Global quieting of high-frequency seismic noise due to COVID-19 pandemic lockdown measures

Thomas Lecocq[1]*, Stephen P. Hicks[2], Koen Van Noten[1], Kasper van Wijk[3], Paula Koelemeijer[4], Raphael S. M. De Plaen[5], Frédérick Massin[6], Gregor Hillers[7], Robert E. Anthony[8], Maria-Theresia Apoloner[9], Mario Arroyo-Solórzano[10], Jelle D. Assink[11], Pinar Büyükakpınar[12,13], Andrea Cannata[14,15], Flavio Cannavo[15], Sebastian Carrasco[16], Corentin Caudron[17], Esteban J. Chaves[18], David G. Cornwell[19], David Craig[20], Olivier F. C. den Ouden[11,21], Jordi Diaz[22], Stefanie Donner[23], Christos P. Evangelidis[24], Läslo Evers[11,21], Benoit Fauville[25], Gonzalo A. Fernandez[26], Dimitrios Giannopoulos[27,28], Steven J. Gibbons[29], Társilo Girona[30], Bogdan Grecu[31], Marc Grunberg[32], György Hetényi[33], Anna Horleston[34], Adolfo Inza[35], Jessica C. E. Irving[34,36], Mohammadreza Jamalreyhani[37,13], Alan Kafka[38], Mathijs R. Koymans[11,21], Celeste R. Labedz[39], Eric Larose[17], Nathaniel J. Lindsey[40], Mika McKinnon[41,42], Tobias Megies[43], Meghan S. Miller[44], William Minarik[45,46], Louis Moresi[44], Víctor H. Márquez-Ramírez[5], Martin Möllhoff[20], Ian M. Nesbitt[47,48], Shankho Niyogi[49], Javier Ojeda[50], Adrien Oth[51], Simon Proud[52], Jay Pulli[53,38], Lise Retailleau[54,55], Annukka E. Rintamäki[7], Claudio Satriano[54], Martha K. Savage[56], Shahar Shani-Kadmiel[21], Reinoud Sleeman[11], Efthimios Sokos[57], Klaus Stammler[23], Alexander E. Stott[58], Shiba Subedi[33], Mathilde B. Sørensen[59], Taka'aki Taira[60], Mar Tapia[61], Fatih Turhan[12], Ben van der Pluijm[62], Mark Vanstone[63], Jerome Vergne[64], Tommi A. T. Vuorinen[7], Tristram Warren[65], Joachim Wassermann[43], Han Xiao[66]

"Lecocq et al. exemplify seismological progress through best practices in scientific research: public data, open-access software and hardware, global cooperation, and ***crowdsourcing of citizen-science projects****."*

Denolle & Nissen-Meyer, Science 2020

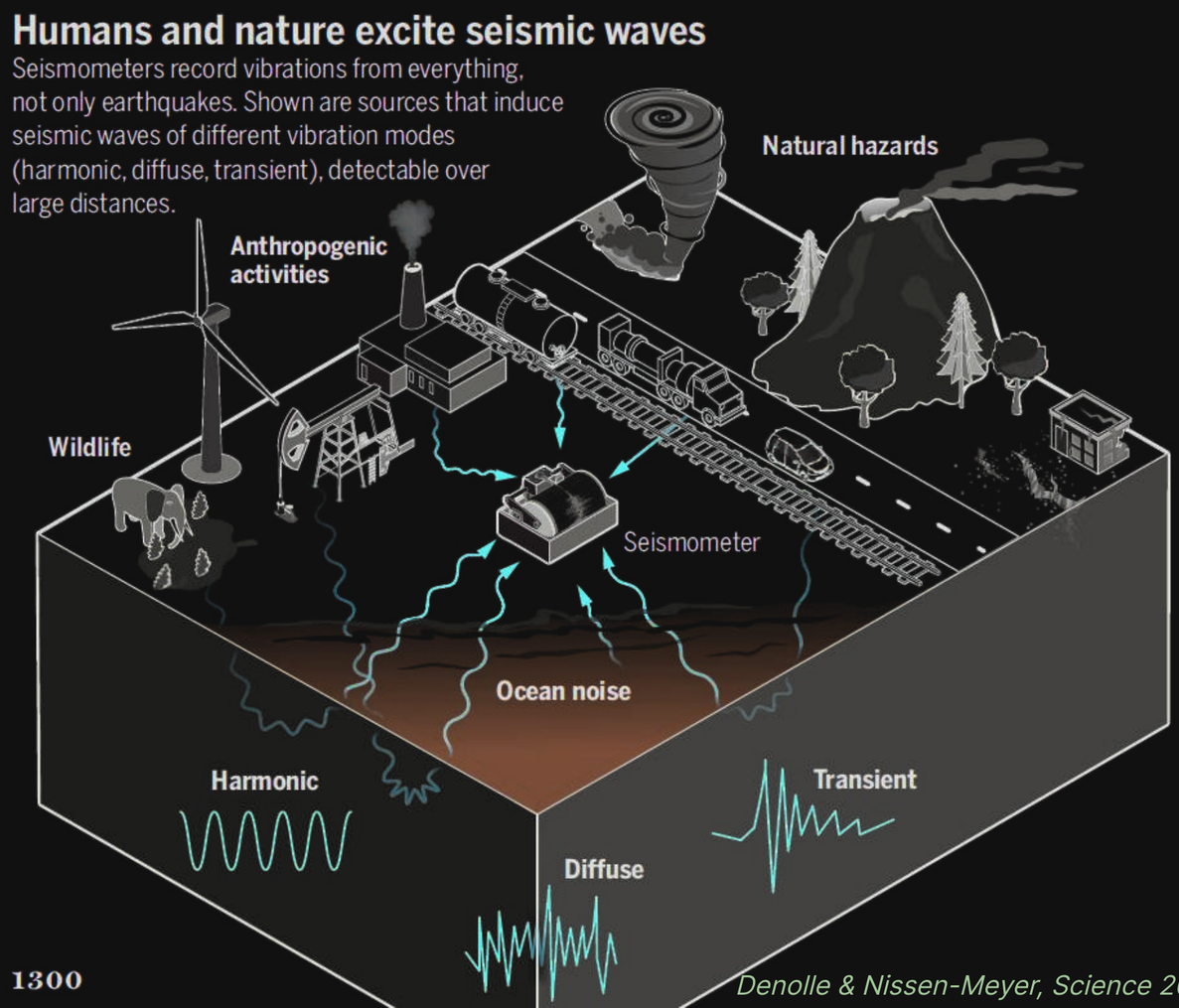
WHAT ELSE?

Numerous new studies, focussing on specific regions
Like China, Italy, USA, Japan, Brazil...

New methods: e.g. using "Dark Fibers" to monitor cars or pedestrians

WHAT'S NEXT?

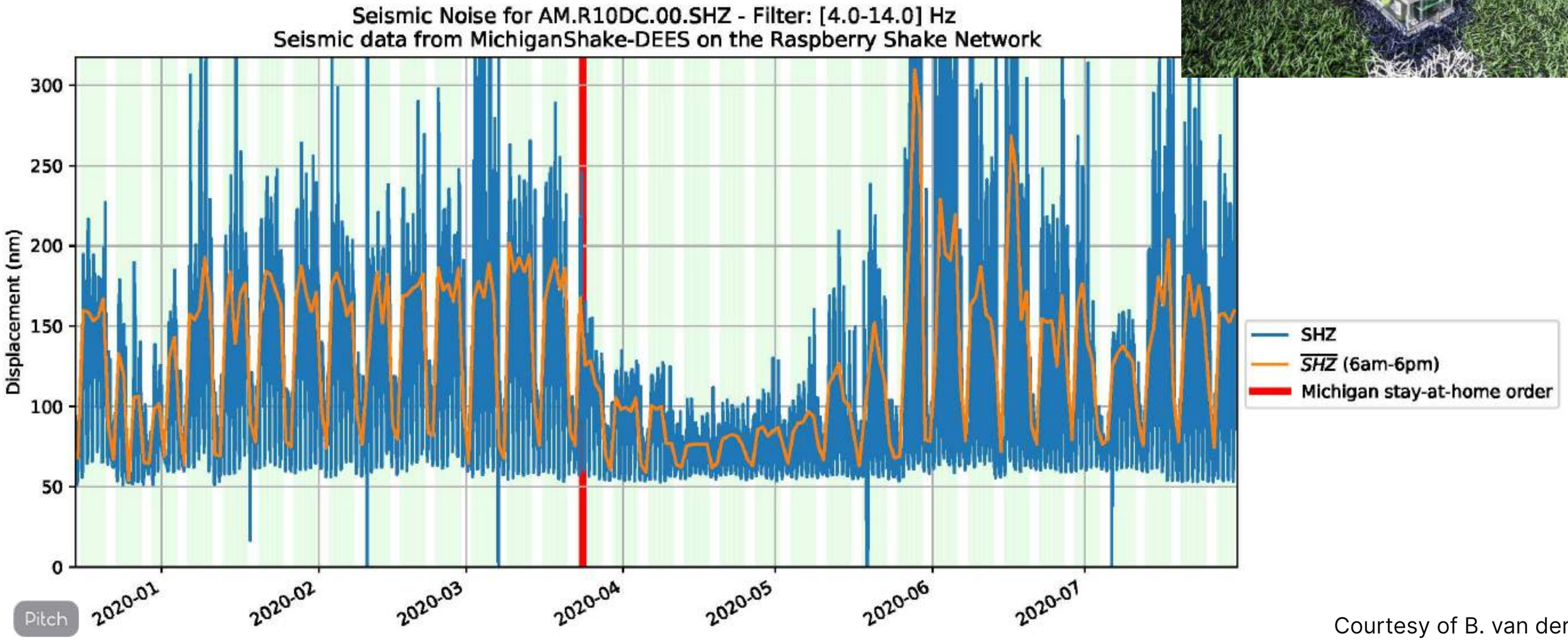
Study and understand "noise", even more
Decipher anthropogenic contributions
Understand how to improve our networks
Link with other disciplines: sound, pollution, social, ...



Denolle & Nissen-Meyer, Science 2020

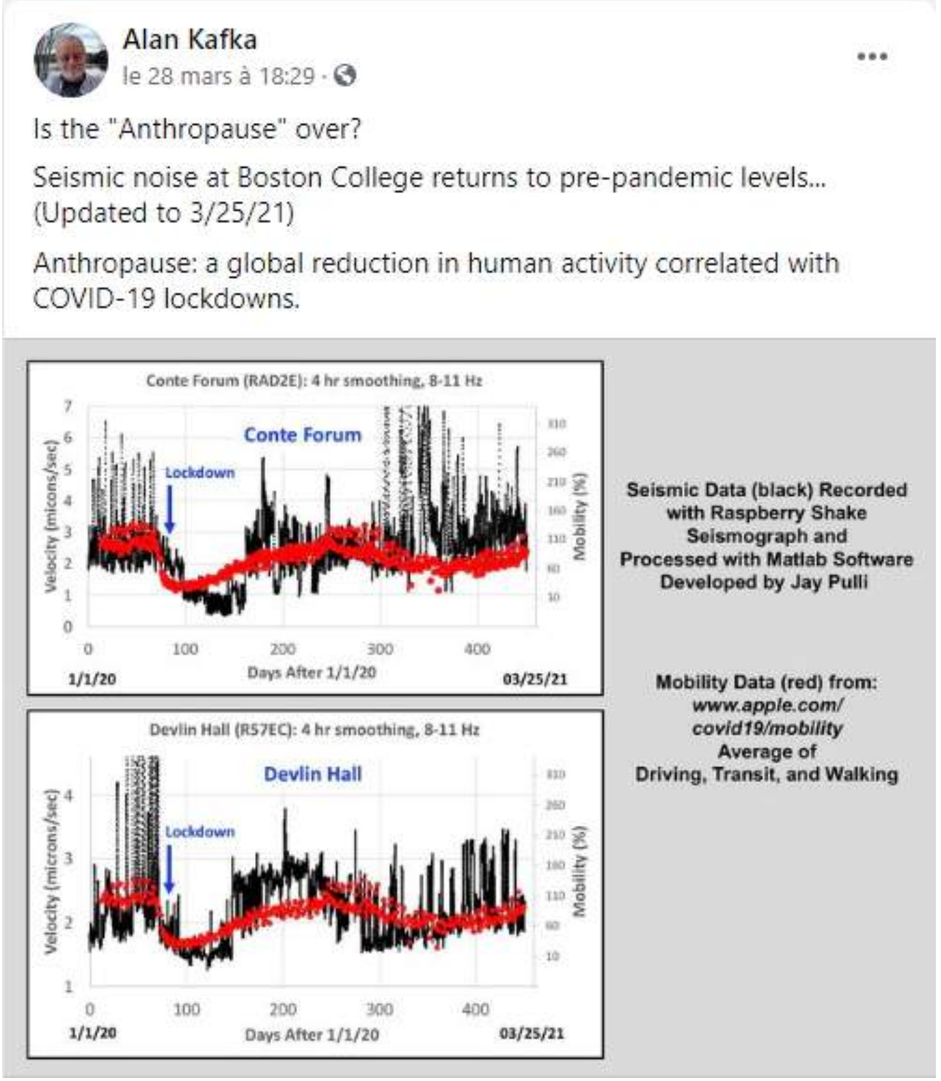
WHAT ABOUT RASPISHAKES?

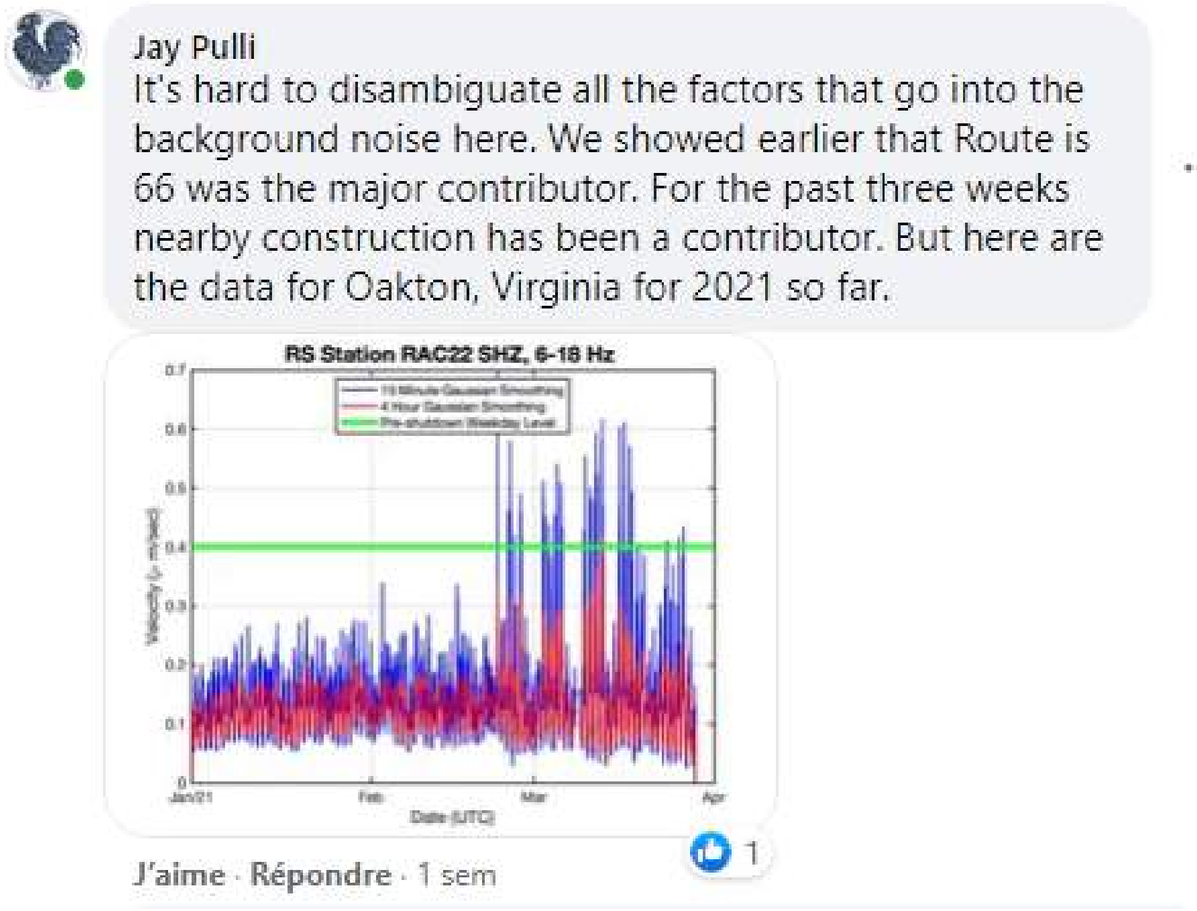
RASPBERRY SHAKES



Courtesy of B. van der Pluijm

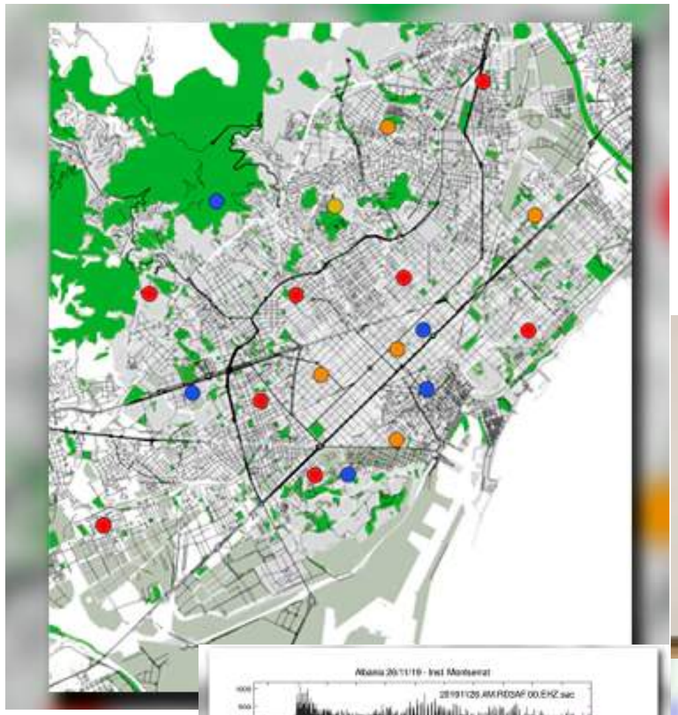
RASPBERRY SHAKES

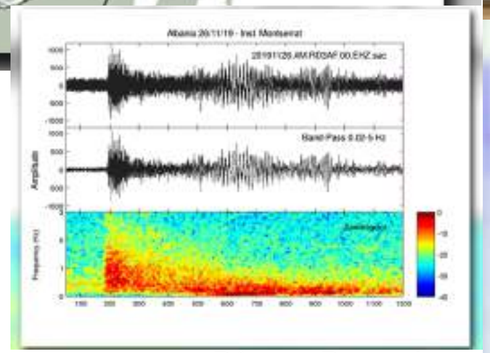




Screenshots of Alan's & Jay's Facebook

RASPBERRY SHAKES & SEISMIC (NOISE) AS A TOOL FOR EDUCATION



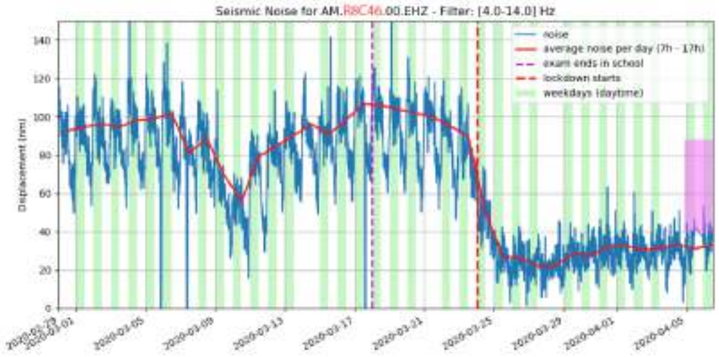


Diaz - Barcelona

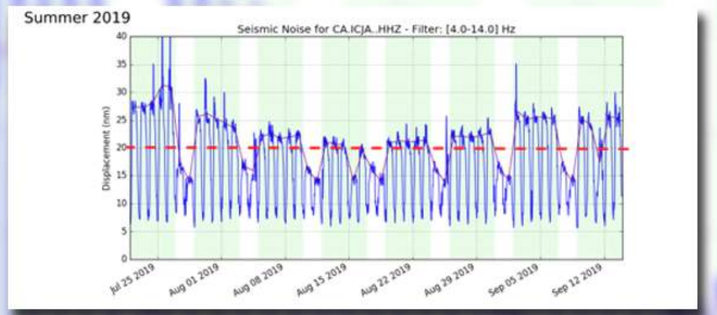
Help Save People in Nepal from Big Earthquakes

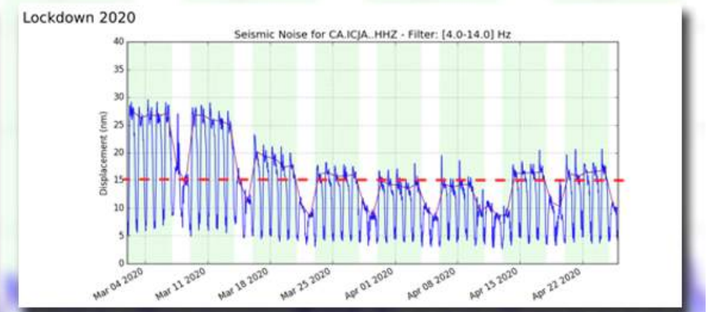
6 140 CHF
45 000 CHF
73 donateurs
292 partage
Anonyme
42 CHF

https://www.gofundme.com/f/help-save-people-in-nepal-from-big-earthquakes



Subedi - Nepal





Pitch

SEISMIC (NOISE) AS A TOOL FOR EDUCATION

Australian Seismometers in Schools - Noise monitoring dashboard

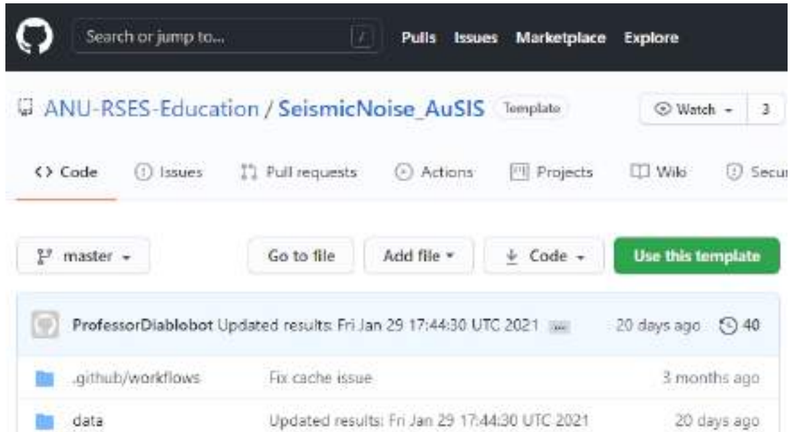
Louis Moresi
Published on 17 July 2020

Meghan S. Miller, *Australian National University* and Louis Moresi, *Australian National University*

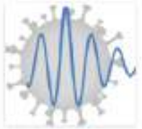
How we built a simple dashboard using Github actions with open source software and openly available (FAIR) data.

We recently wrote an article in The Conversation that shows how the Australian Seismometers in schools network registers the pulse of Australian life through changes in the seismic noise spectrum measured in local schools.

The figures in the article show the signal from Christmas 2019 through to July 2020 and, like any publication of record, they are static. But the data continue to flow into the school seismometers, so every night we update those graphs automatically and you can see the version from last night here:



Monitor My Lockdown Project and Web App



On 11 March 2020, the World Health Organization (WHO) declared COVID-19 a pandemic. Countries around the world rushed to declare various states of emergencies. Canada was no different. By 23 March 2020, all Canadian provinces and territories had enforced some forms of lockdowns, and the Canada-US border was shut.

Lockdowns are difficult decisions to make – politically and economically. Closing borders, grounding road, rail and air transport, closing schools, offices, entertainment and sports venues, and non-essential services come at a huge cost to individuals, businesses and society. But restricting human movements is essential to check the spread of the pandemic and ensure our health systems do not collapse.

Measuring Reduction in Human Movements During the COVID-19 Lockdown Using Home-Built Instrument

I conceived "Monitor My Lockdown" in June 2020 when my school doors closed due to the COVID-19 lockdown. I wanted to measure the impact of the lockdowns in reducing movements of people. As a first step, I constructed an instrument with sensors and camera, and installed it in front of my home in downtown Toronto. For four weeks, it measured changes in street sound levels, city night lights, pollution levels, and traffic on the road and recorded a 30%-40% drop in all them – a clear indicator that human activities were affected by the lockdown. But I was not satisfied.

I wanted to find out if there was a reduction in human movements across Canada because of the COVID-19 lockdown. As I could not install my instrument all over Canada, I had to think of another way.

Measuring Reduction in Human Movements During the COVID-19 Lockdown Using Seismic Data

I knew the Geological Survey of Canada (GSC) operated a Canada-wide network of seismic stations to record ground motion because of the earthquakes. The data was collected continuously and available online for many of these stations. Seismographs are very sensitive instruments. This is the reason that seismic stations are purposefully built outside the cities so that they do not record city-related noises such as construction, transportation and other cultural noises. But in many cases, I could locate seismic stations close to major Canadian cities.

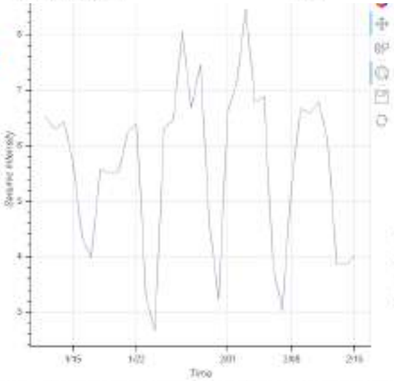
Home-built instrument to measure decrease in human movements in front of my home

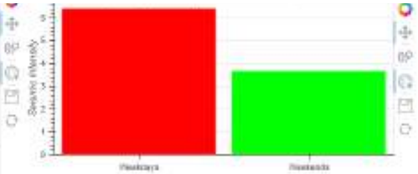
THE PROJECT
SEISMIC SILENCE OF CANADIAN CITIES

Monitor My Lockdown

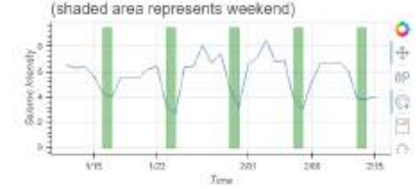
Choose city from the map: OTTAWA

The Web App provides an update on how effective the lockdowns are in reducing human movements using data from seismic stations. It provides information on (1)





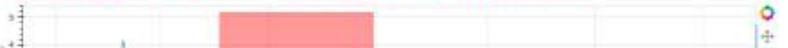
(shaded area represents weekend)



Change in Seismic Activity for Transportation and Cultural Noises?

First Lockdown
1Hz - 20 Hz

During the First Lockdown, Activity Changed by: -56.6% Since Pre-COVID Levels



Raspberry Shake

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A Manconi, V Coviello, M Galletti... - Earth Surface ..., 2018 - esurf.copernicus.org
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Seismologists have recently begun using low-cost nodal sensors in dense deployments to sample the seismic wavefield at unprecedented spatial resolution. Earthquake early warning systems and other monitoring networks (eg, wastewater injection) would also benefit from ...
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Raspberry shake-a world-wide citizen seismograph network
BC Christensen, JF Blanco Chia - AGU Fall Meeting ..., 2017 - ui.adsabs.harvard.edu
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Manconi et al

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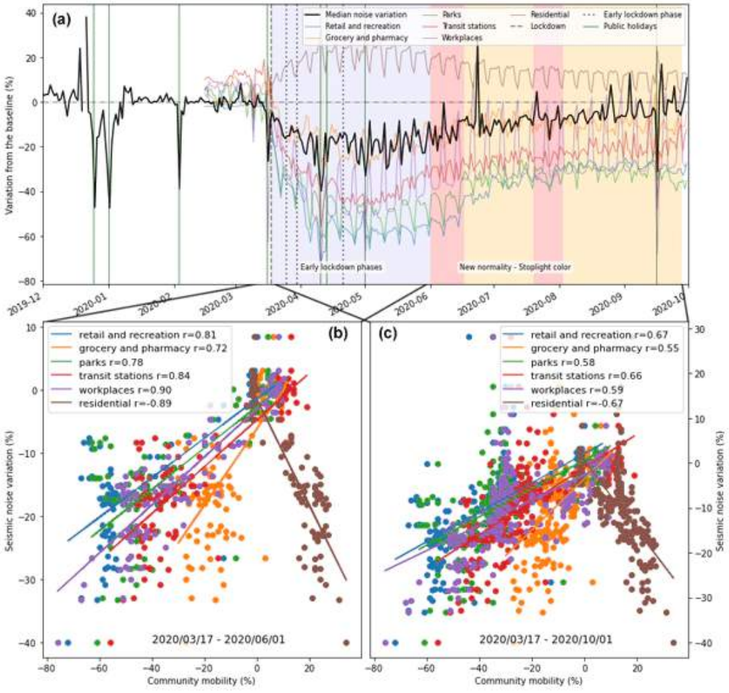


De Plaen et al

USED BY PROS TOO

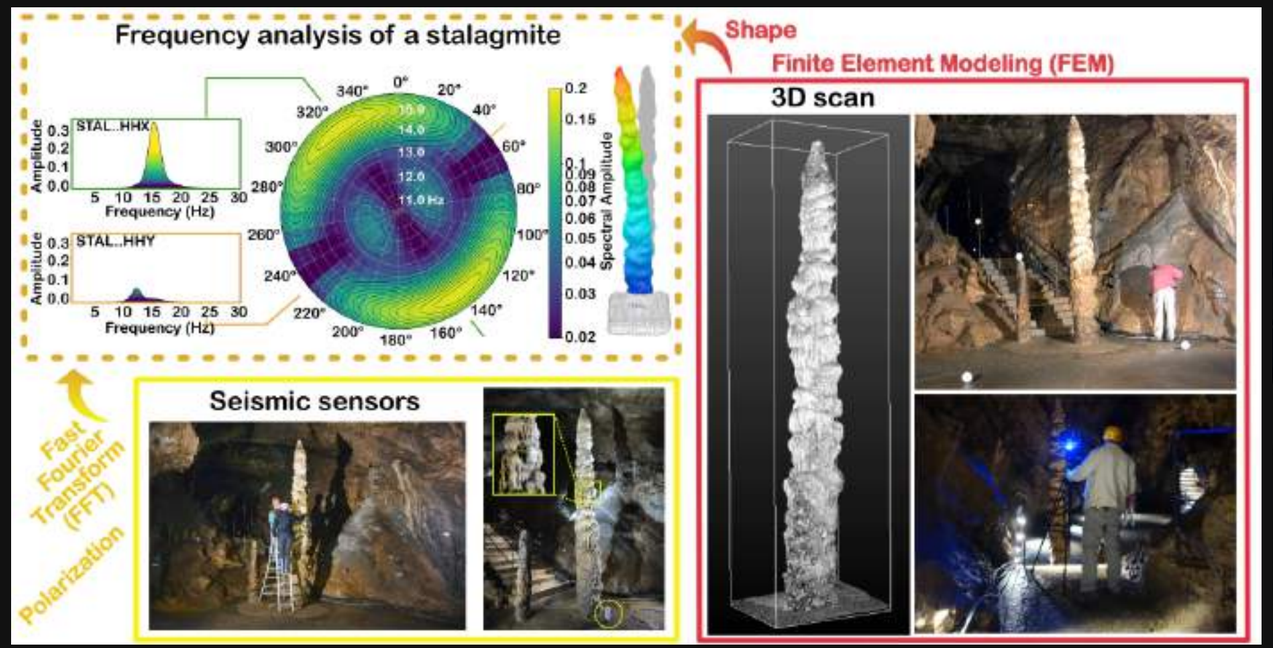
Pitch

USED BY US TOO, FINALLY!

OBJECTIVE: STUDY STALAGMITE'S RESONANCE FREQUENCIES

PHD PROJECT AURÉLIE MARTIN

ROYAL OBSERVATORY OF BELGIUM
SEISMOLOGY GRAVIMETRY



AMATEURS
OR
PROFESSIONALS

ONE COMMUNITY

IF YOU'RE A SEISMOLOGIST, RAISE YOUR HANDS!

CITIZENS ARE SCIENTISTS
HACKERS ARE SCIENTISTS
CHILDREN ARE SCIENTISTS

BUT SOMETIMES,
SCIENTISTS FORGET
THEY ARE
CITIZENS, HACKERS,
AND WERE
CHILDREN, TOO

THERE ARE MANY WAYS TO ENGAGE WITH THE COMMUNITY

RULE #1

BE OPEN

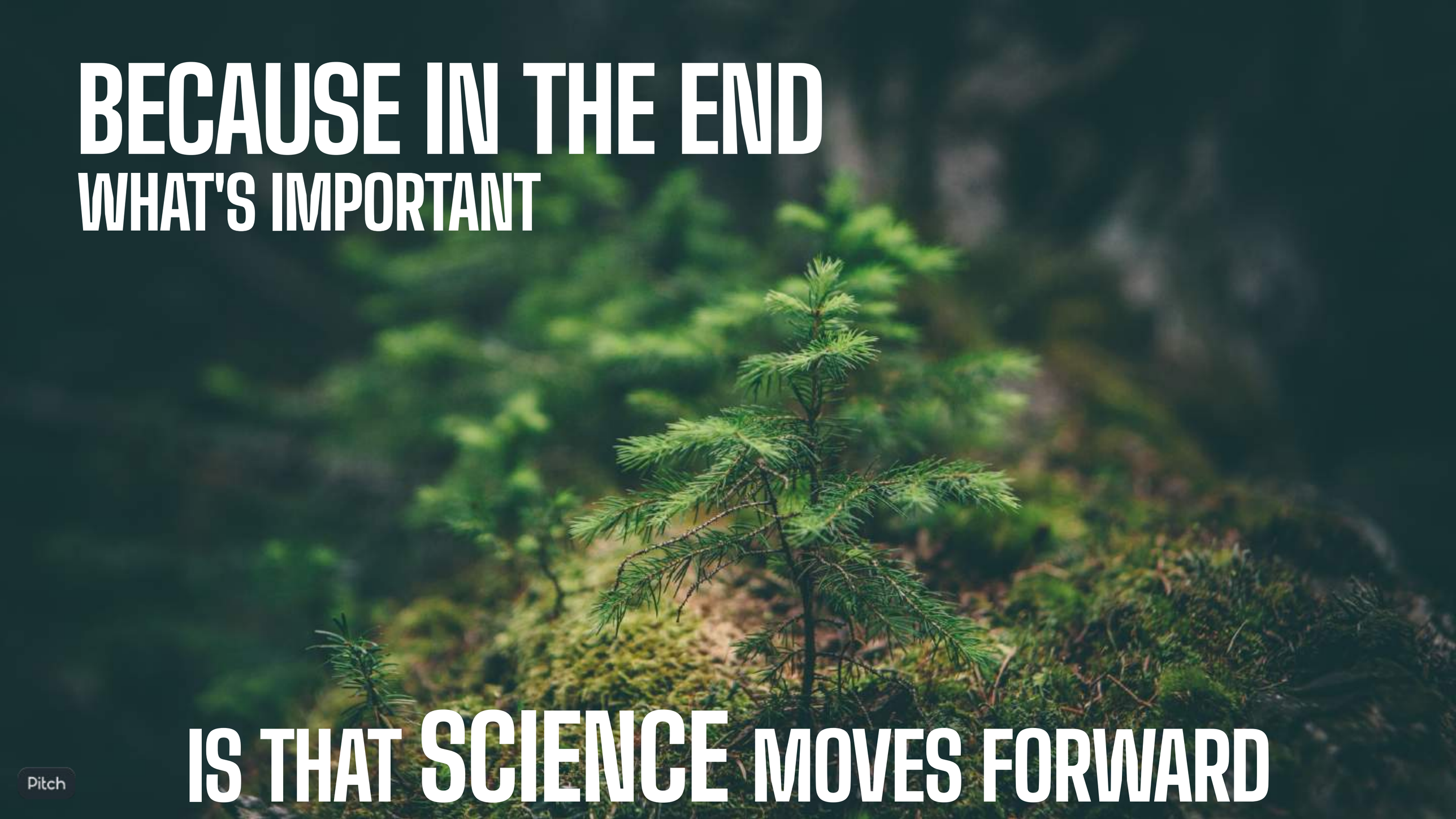
SHARE

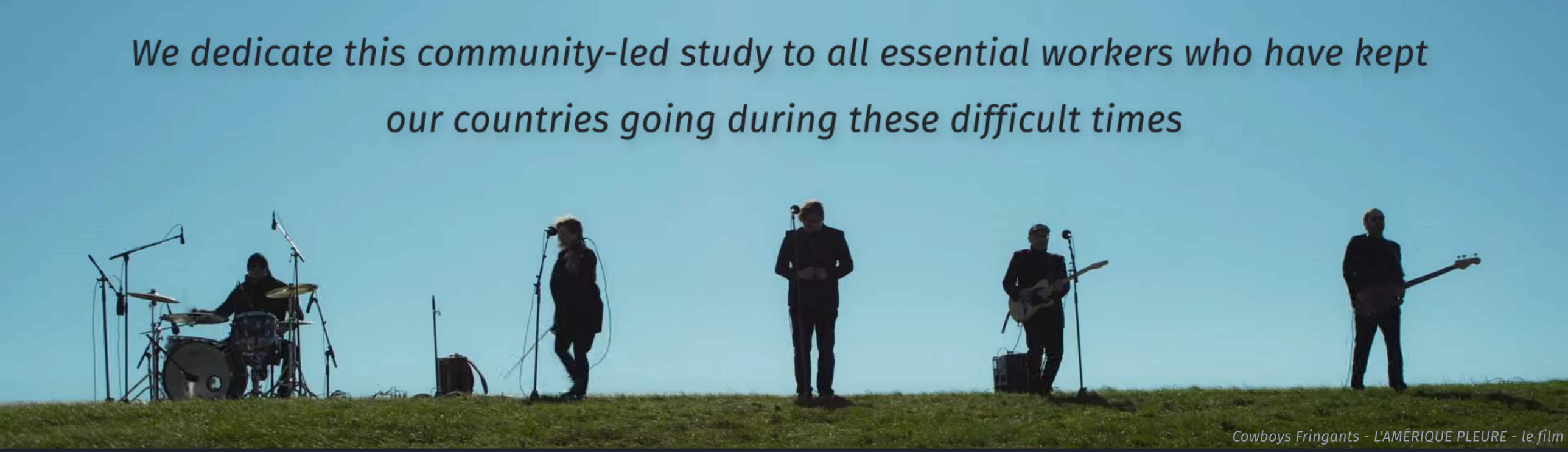
KNOWLEDGE
CODES
DATA
RESULTS
FAILURES
TIME
IDEAS

and donuts

DARE

OVERPASSING OLDSCHOOL CODES


BECAUSE IN THE END
WHAT'S IMPORTANT
IS THAT SCIENCE MOVES FORWARD



"We are extremely grateful to all seismic network managers, operators, and technicians who have helped facilitate the raw global seismic dataset.

We also kindly acknowledge all of the passionate community seismologists for running their “home” seismometers and contributing, indirectly, to a better understanding of Earth."

Thank you for your attention

#StayHome

#ShareKnowledge

#OnePlanetOneCommunity