Reducing the risk of SARS-CoV-2 and flu transmission in the classroom:

DIY techniques for assessing & improving indoor air ventilation & filtration

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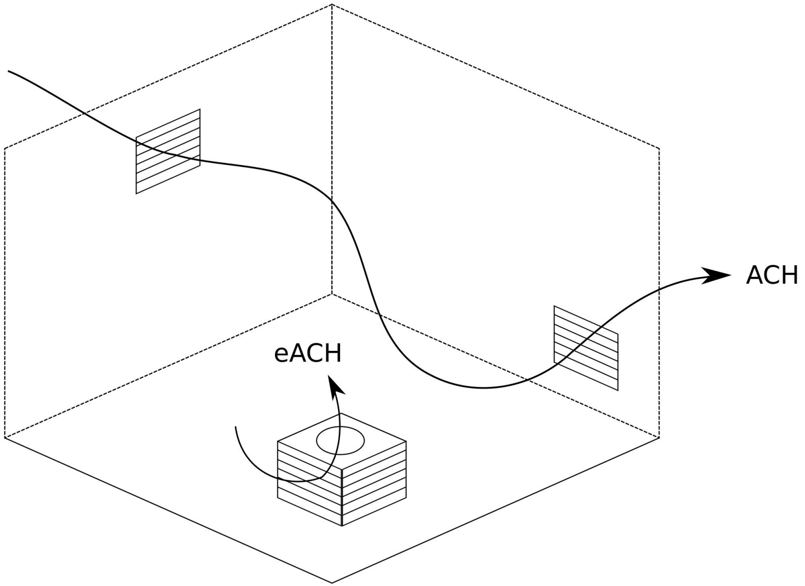

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Belfast Area High School

https://twitter.com/Jousefm2/status/1433550195703246884?s=20

Table 1. Time to Infectious Dose for an Uninfected Person (Receiver)*

Source is wearing (% outward leakage)		**Receiver is wearing** (% inward leakage): Nothing	Typical cloth mask	Typical surgical mask	Non–fit-tested N95 FFR	Fit-tested N95 FFR
		100%	75%	50%	20%	10%
Nothing	100%	15 min	20 min	30 min	1.25 hr	2.5 hr
Typical cloth mask	75%	20 min	26 min	40 min	1.7 hr	3.3 hr
Typical surgical mask	50%	30 min	40 min	1 hr	2.5 hr	5 hr
Non–fit-tested N95 FFR**	20%	1.25 hr	1.7 hr	2.5 hr	6.25 hr	12.5 hr
Fit-tested N95 FFR	10%	2.5 hr	3.3 hr	5 hr	12.5 hr	25 hr

*The data for % inward and outward leakage of cloth and surgical masks were derived from a study by Lindsley et al (2021). Data for non–fit-tested N95 FFRs come from a study by Brosseau (2020). Data for fit-tested N95 FFRs are derived from the OSHA-assigned protection factor of 10 for half-facepiece respirators. Also, times were established before wide circulation of the more transmissible Delta variant.

**FFR = filtering facepiece respirator; N95 = not oil-proof, 95% efficient at NIOSH filter test conditions

https://www.cidrap.umn.edu/news-perspective/2021/10/commentary-what-can-masks-do-part-1-science-behind-covid-19-protection

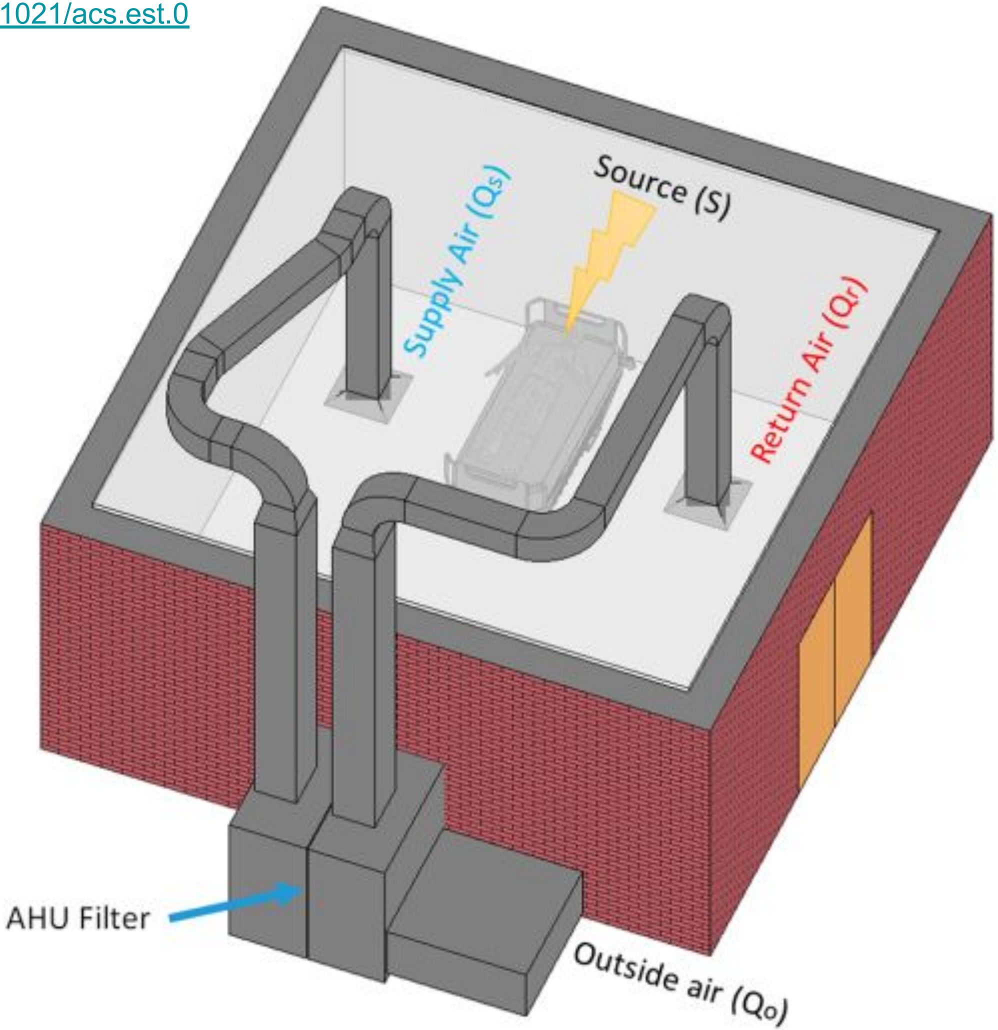
Outdoor transmission of the virus is rare. You might have heard that less than 10 percent of documented viral transmission happens in outdoor settings. That "10 percent" figure has been tossed around a lot, even by the CDC. It comes from a comprehensive analysis of relevant research published last November, but most experts, including the authors of that paper, believe that the actual risk of outdoor transmission is far lower — likely less than one percent. That higher "conservative estimate," the authors explain, included several studies in which the exact location of viral transmission was unclear — like five cases of transmission among construction workers that could have happened outdoors but might as easily have occurred in an enclosed portion of a building under construction. Or an outbreak of COVID-19 at a summer camp in Georgia that was clustered by sleeping-cabin assignments but where outdoor transmission could not be completely ruled out.

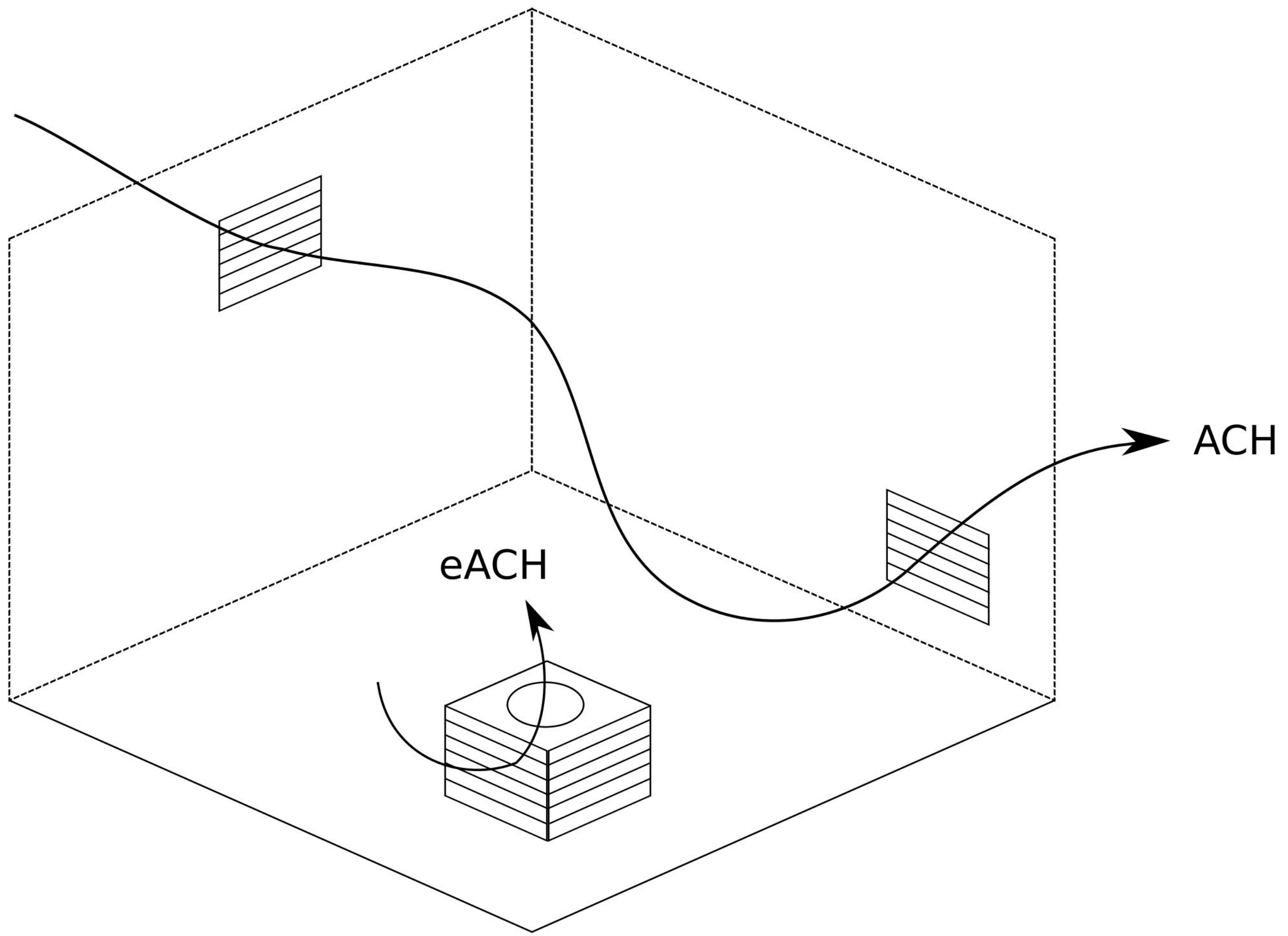
Less ambiguous studies show just how infrequently the virus is transmitted outdoors. For example, a Chinese study done in the early days of the pandemic found just one case, out of more than 7,300, connected to outdoor transmission. A Japanese investigation of 110 cases found the probability of transmission to be 18.7 times higher indoors compared to an "open-air environment." And a more recent study, which looked at transmission between 18 infected construction workers and 496 of their close contacts, showed that the infected individuals were nearly 25 times more likely to spread the virus to coworkers in enclosed spaces compared with outdoor settings. They transmitted the virus to 26 percent of their indoor coworkers while infecting only 1.4 percent of their outdoor workmates — this despite being significantly more likely to share meals and talk loudly while working outside.

When outdoor transmission has been shown to occur, it's almost always been associated with lengthy, close interactions — the riskiest type of interaction in any environment. Even with the more transmissible Delta variant, fleeting outdoor interactions, like passing someone on the street or on a bike path, carries negligible risk.

https://medical.mit.edu/covid-19-updates/2021/08/how-safe-outdoor-activities#:~:text=Outdoor%20transmission%20of%20the%20virus%20is%20rare.&text=It%20comes%20from%20a%20comprehensive,likely%20less%20than%20one%20percent.

https://pubs.acs.org/doi/pdf/10.1021/acs.est.0c03247




ACH
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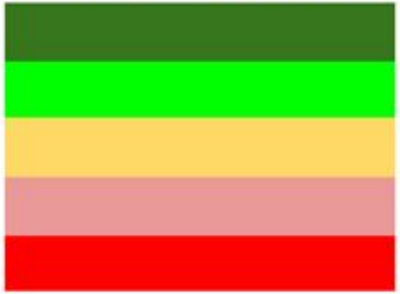
824
pvos.org/co2/rev_t

TARGET IS AT LEAST 5 TOTAL AIR CHANGES PER HOUR



Ideal (6 ACH)

Excellent (5-6 ACH)

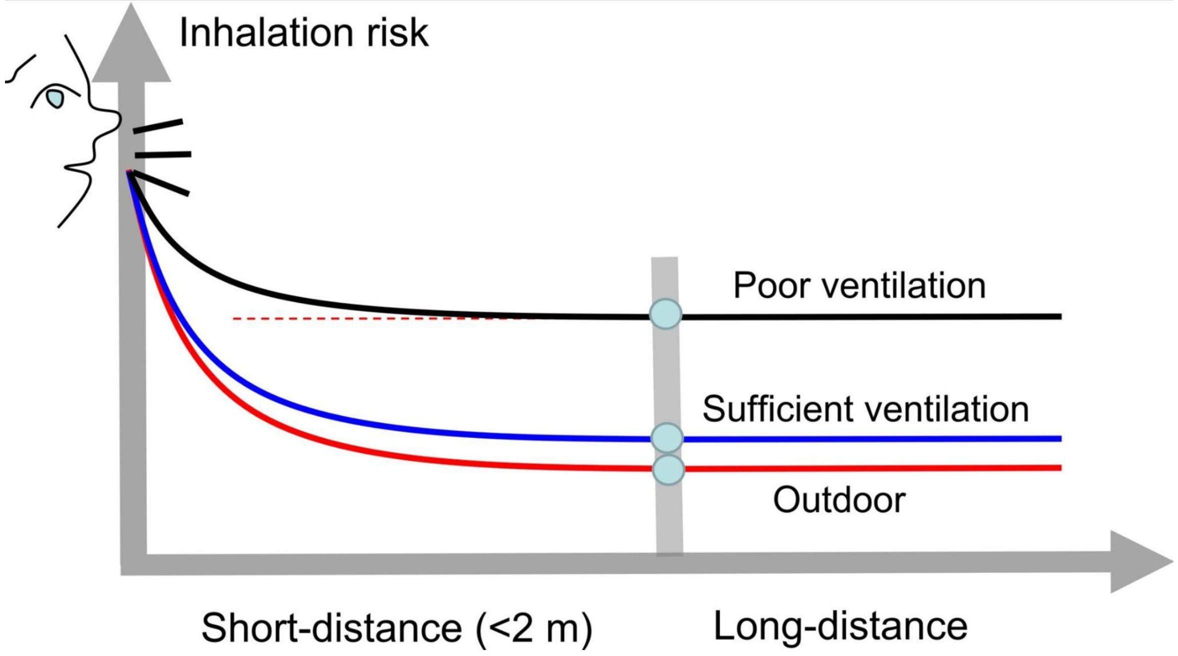
Good (4-5 ACH)

Bare minimum (3-4)

Low (<3 ACH)

https://twitter.com/linseymarr/status/1454195979457028102/photo/1

https://onlinelibrary.wiley.com/doi/full/10.1111/ina.12946



https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.463.2065&rep=rep1&type=pdf

According to VDI (2001) 4300, part 7, air change is defined as the ratio of air supply Q(t) into a zone (i.e. a room or space) in relation to the volume of this zone V_R (room volume) and is generally expressed as air change per hour [h^{-1}] or [ACH]. The following equation expresses this definition:

$$\lambda(t) = Q(t)/V_R \qquad (1)$$

$\lambda(t)$ is the ventilation rate or air change rate [h^{-1}],
Q(t) is the air supply into a room [m^3/h],
V_R is the room's volume [m^3], and t = time [h].

characterised by the following features: If no tracer gas is emitted into the room (i.e. E = 0), and there is already a non-zero tracer gas concentration C_0 present at the time t = 0 which is higher than the outdoor air concentration C_a, then the expression $(C_0 - C_a) \exp(-\lambda t) + C_a$ describes the elimination of the tracer gas out of the room. The curve starts with the initial concentration C_0 and decays exponentially until the ambient tracer gas concentration C_a or any other constant background concentration is reached. If a tracer gas is used, which does

$$V_R{*}dC_i(t)/dt = -C_i{*}Q + C_a{*}Q + E$$

- Transport of tracer gas from the room air to the outside: $Q{*}C_i$ [mass per time unit]
- Transport of tracer gas from the outside air into the room air $Q{*}C_a$ [mass per time unit]
- (Constant) emission E of tracer gas into the space by a tracer gas source [mass per time unit]

$$dC_i(t)/dt = -(C_i - C_a){*}Q/V_R + E/V_R \qquad (2b)$$

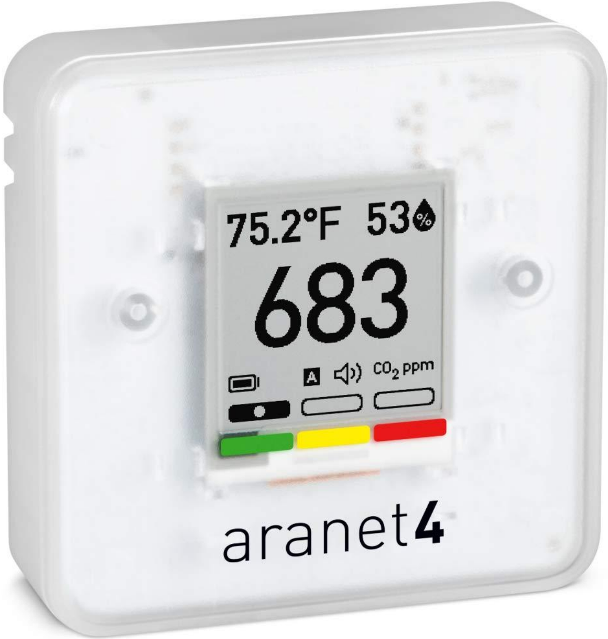
C_a: tracer gas concentration in outside air [mass / volume]
C_i: tracer gas concentration in the indoor air [mass / volume]
Q: exchange air flow between room and outside [volume / time unit]
E: amount of tracer gas emitted per unit time [mass / time unit]
V_R: room volume
t: time
As stated above, Q/V_R is defined as the air change rate. When Q/V_R in Eq. 2b is replaced by λ (Eq. 1) we obtain Eq. 2c:

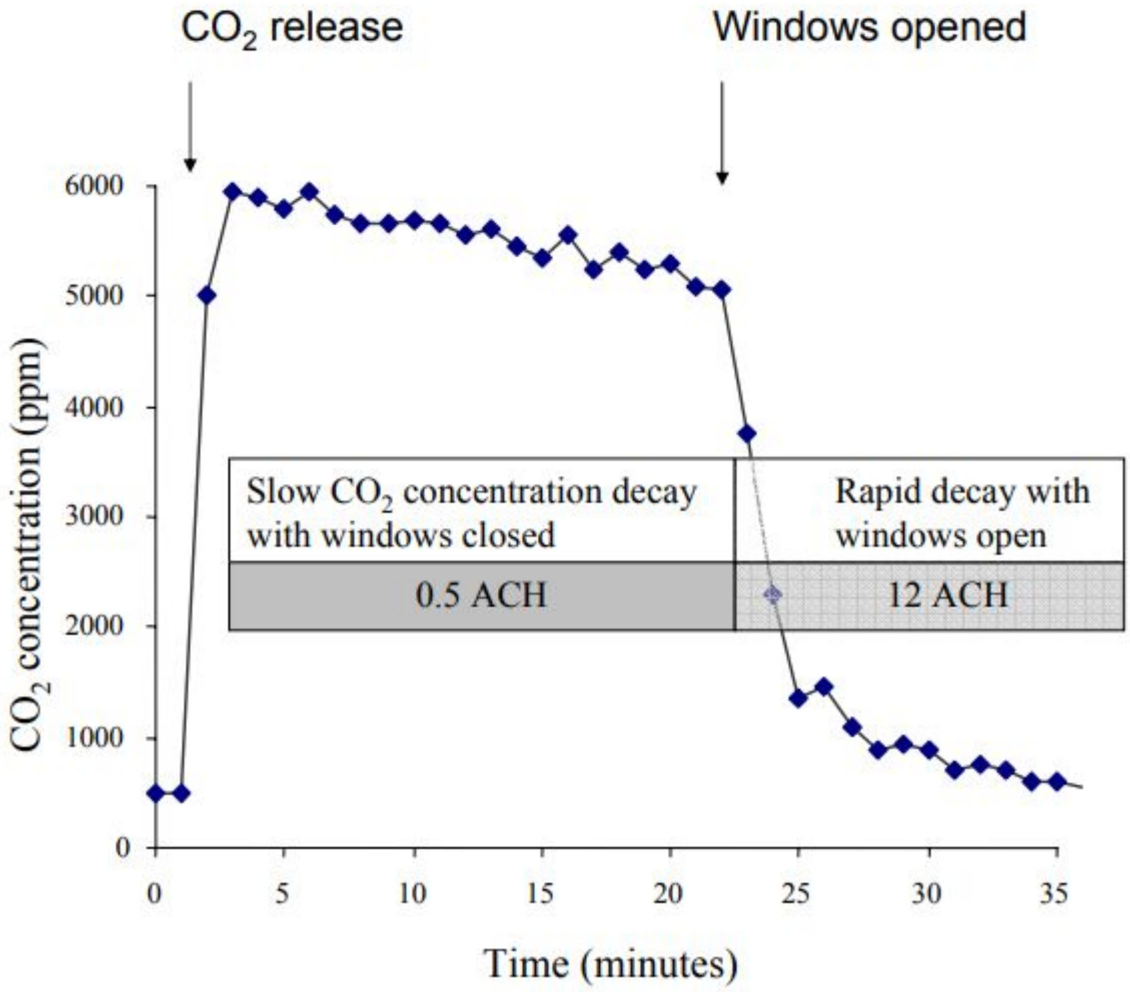
$$dC_i(t)/dt = -(C_i - C_a){*}\lambda + E/V_R \qquad (2c)$$

$$C_i(t) = (C_0 - C_a) \exp(-\lambda t_i) + C_a + E/(\lambda{*}V_R)\,[1 - \exp(-\lambda t_i)]$$

https://www.cdc.gov/infectioncontrol/guidelines/environmental/appendix/air.html

ACH § ¶	Time (mins.) required for removal 99% efficiency	Time (mins.) required for removal 99.9% efficiency
2	138	207
4	69	104
6+	46	69
8	35	52
10+	28	41
12+	23	35
15+	18	28
20	14	21
50	6	8


75.2°F 53%
683
A
CO2 ppm
aranet4

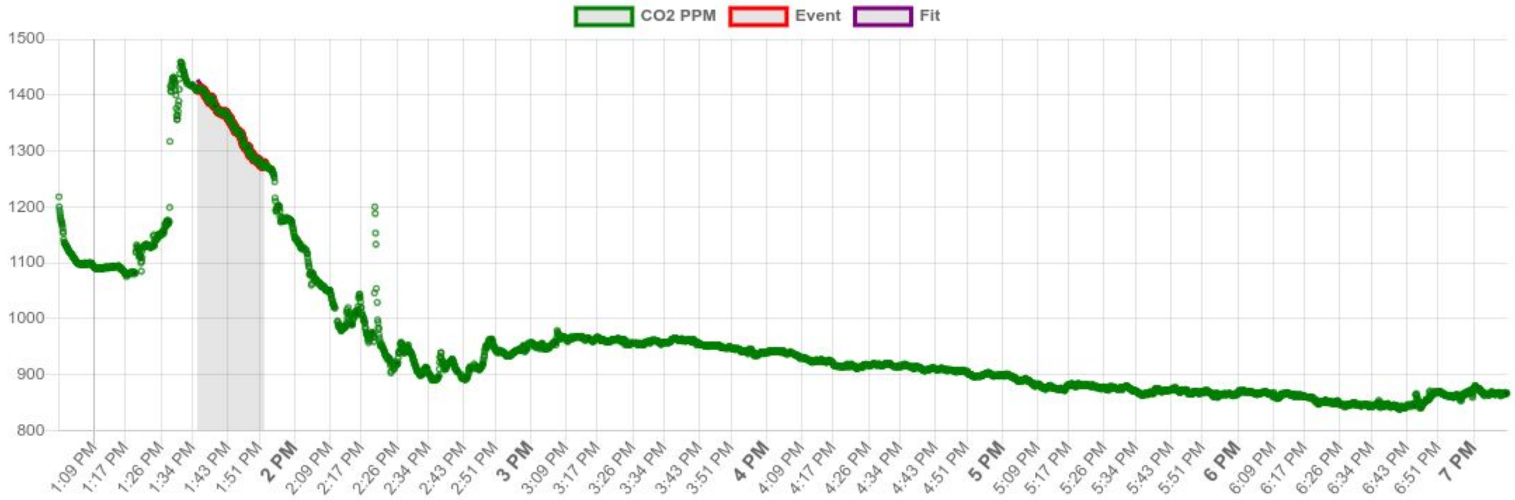


CO2 release
Windows opened
6000
5000
4000
3000
2000
1000
0
CO2 concentration (ppm)
Slow CO2 concentration decay with windows closed
Rapid decay with windows open
0.5 ACH
12 ACH
0
5
10
15
20
25
30
35
Time (minutes)

Belfast High School: baking soda & vinegar experiment

Windows closed

Estimated ACH: 1.1



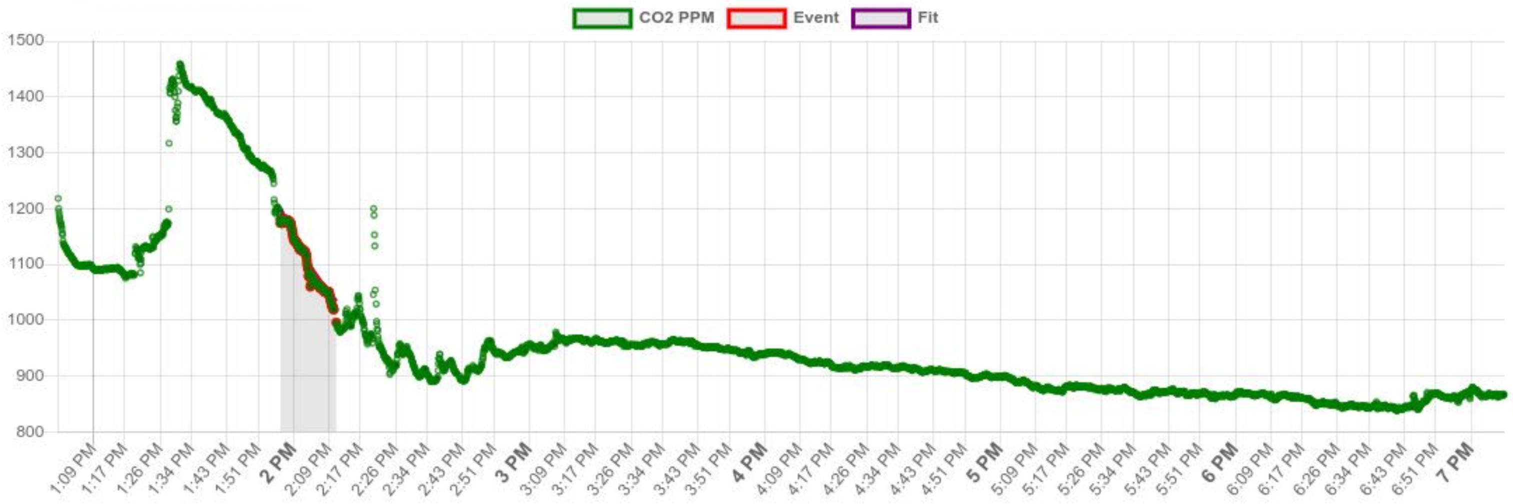
Plot and Linear Fit of **ln[(co2-co2_ambient)/co2[t=0]-co2_ambient)]**:

Fit parameters: **Slope**: -1.10; **Intercept**: 0.03; **R2**:0.98

Belfast High School: baking soda & vinegar experiment

Window open

Estimated ACH: 3.03



Plot and Linear Fit of **ln[(co2-co2_ambient)/co2[t=0]-co2_ambient)]**:

Fit parameters: **Slope**: -3.03; **Intercept**: 0.08; **R2**:0.97

co2_ppm:

Node_0
2000
1800
1600
1400
1200
1000
800
600
400
7:36 PM
7:38 PM
7:40 PM
7:42 PM
7:44 PM
7:46 PM
7:48 PM
7:50 PM
7:52 PM
7:54 PM
7:56 PM
7:58 PM
8 PM
8:02 PM
8:04 PM
8:06 PM
8:08 PM
8:10 PM
8:12 PM
8:14 PM
8:16 PM
8:18 PM
8:20 PM
8:22 PM
8:24 PM
8:26 PM
8:28 PM
8:30 PM
8:32 PM
8:34 PM
8:36 PM
8:38 PM
8:40 PM
8:42 PM
8:44 PM
8:46 PM
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8:52 PM
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8:56 PM
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9 PM
9:02 PM
9:04 PM
9:06 PM

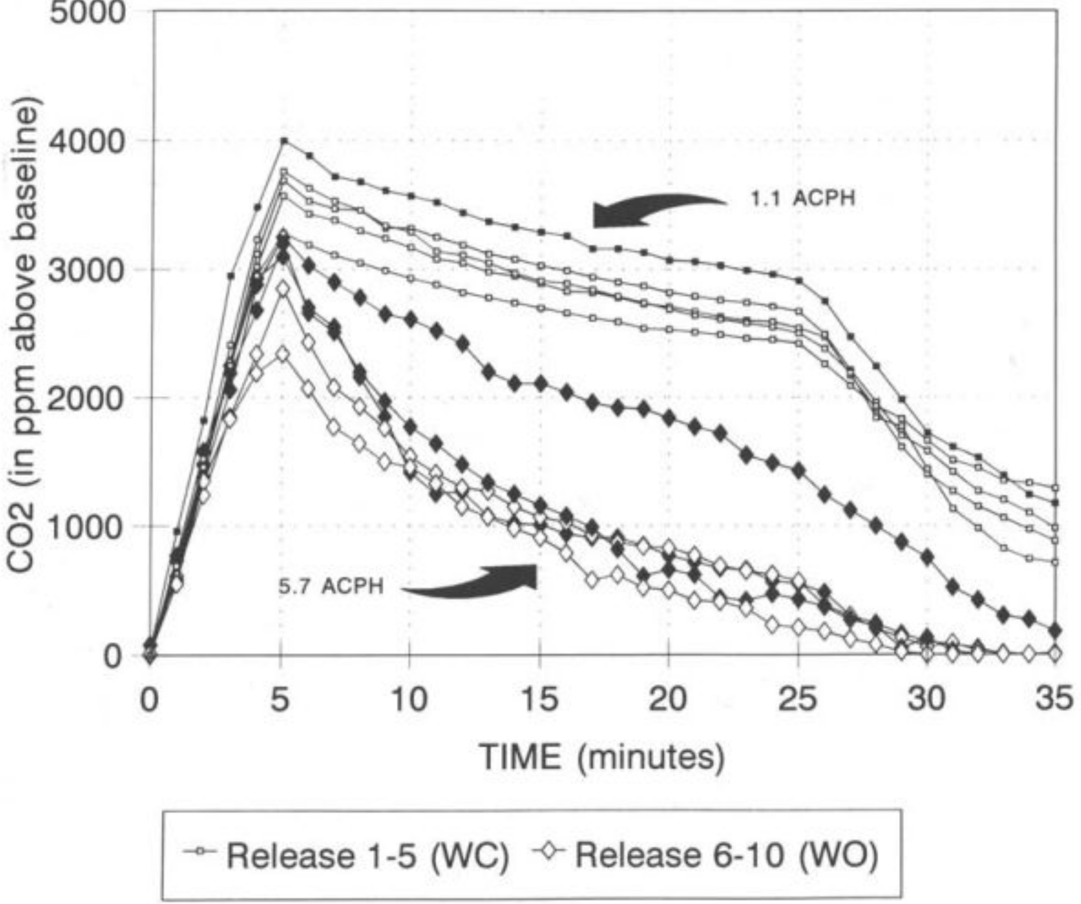
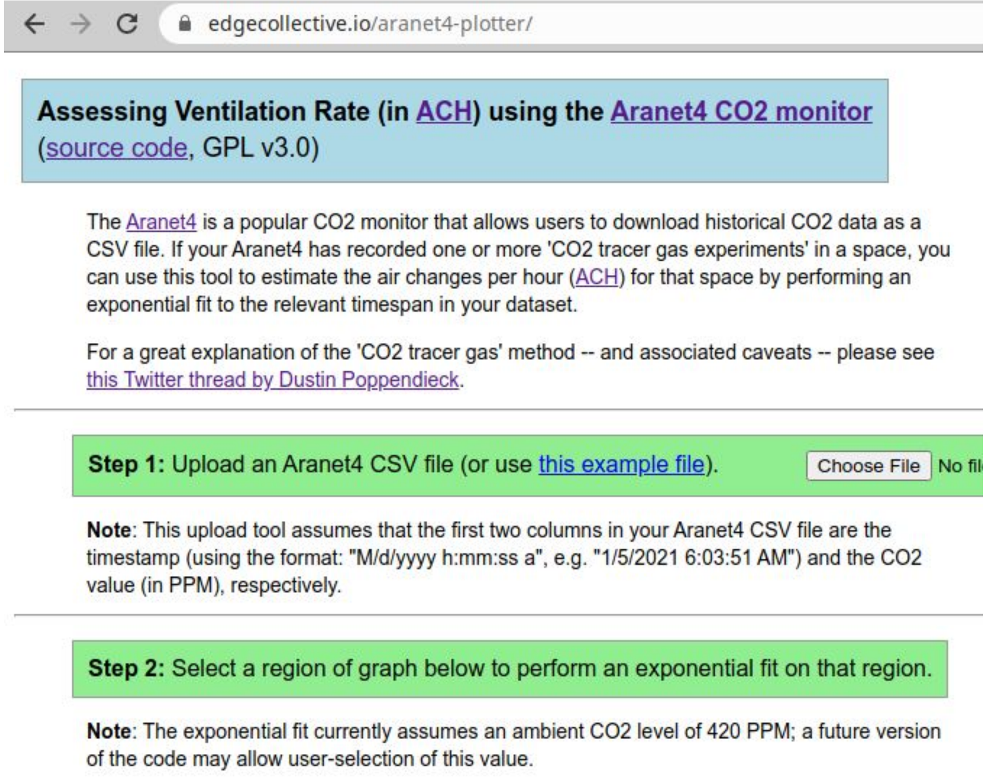


Figure 1. Repeated releases in naturally ventilated room. Window closed: release 1–5. Window open: release 6–10. (Door closed 0–25 min, door opened 26–35 min.)

https://github.com/edgecollective/aranet4-plotter


edgecollective.io/aranet4-plotter/

Assessing Ventilation Rate (in ACH) using the Aranet4 CO2 monitor (source code, GPL v3.0)

The Aranet4 is a popular CO2 monitor that allows users to download historical CO2 data as a CSV file. If your Aranet4 has recorded one or more 'CO2 tracer gas experiments' in a space, you can use this tool to estimate the air changes per hour (ACH) for that space by performing an exponential fit to the relevant timespan in your dataset.

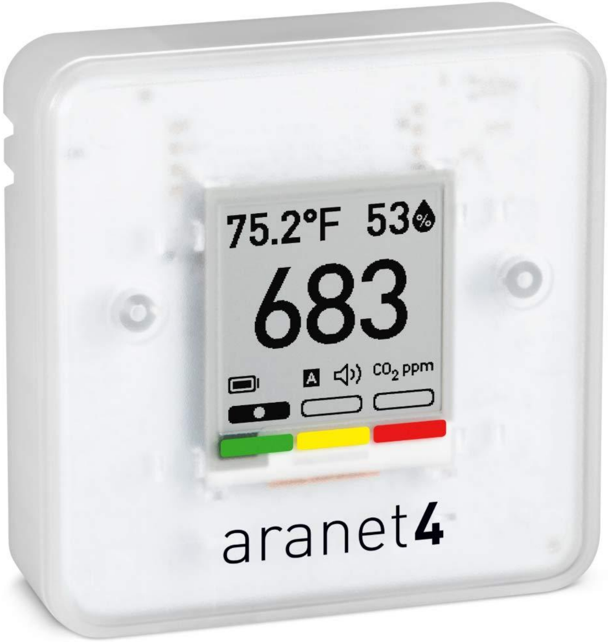
For a great explanation of the 'CO2 tracer gas' method -- and associated caveats -- please see this Twitter thread by Dustin Poppendieck.

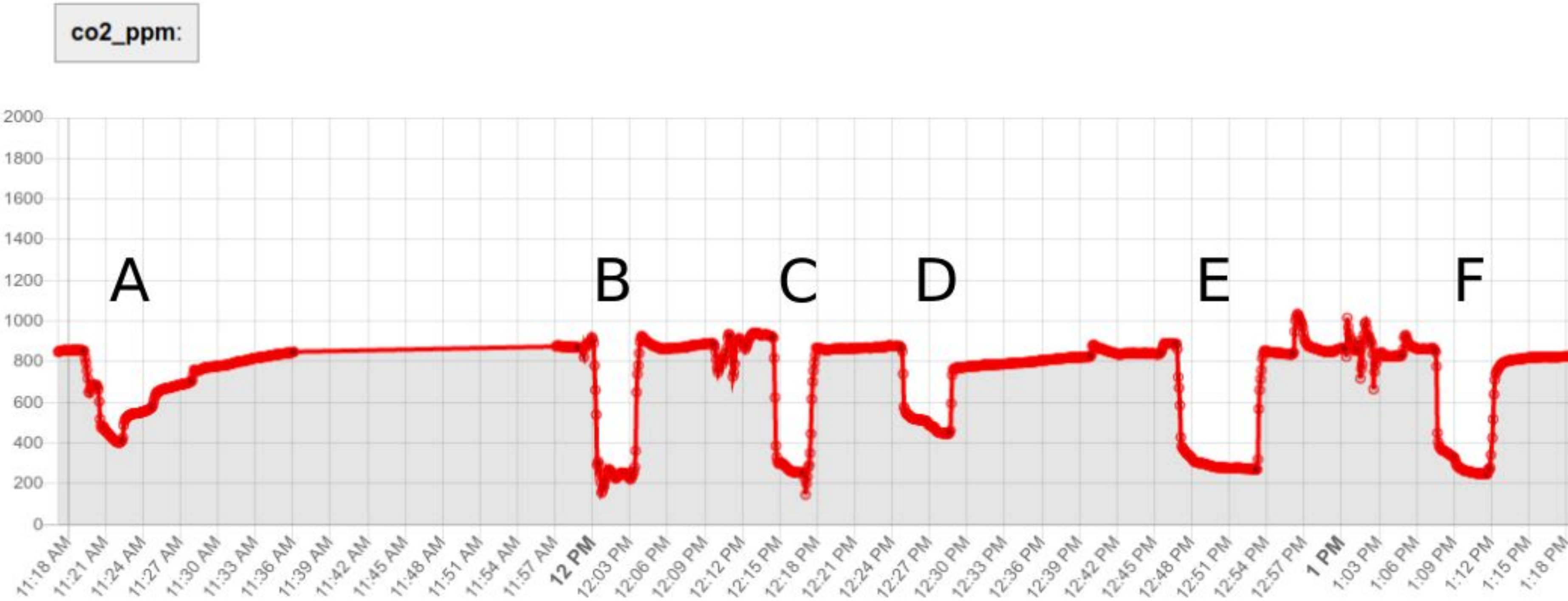
Step 1: Upload an Aranet4 CSV file (or use this example file). Choose File No fil

Note: This upload tool assumes that the first two columns in your Aranet4 CSV file are the timestamp (using the format: "M/d/yyyy h:mm:ss a", e.g. "1/5/2021 6:03:51 AM") and the CO2 value (in PPM), respectively.

Step 2: Select a region of graph below to perform an exponential fit on that region.

Note: The exponential fit currently assumes an ambient CO2 level of 420 PPM; a future version of the code may allow user-selection of this value.





co2_ppm:
2000
1800
1600
1400
1200
1000
800
600
400
200
0
A
B
C
D
E
F
11:18 AM
11:21 AM
11:24 AM
11:27 AM
11:30 AM
11:33 AM
11:36 AM
11:39 AM
11:42 AM
11:45 AM
11:48 AM
11:51 AM
11:54 AM
11:57 AM
12 PM
12:03 PM
12:06 PM
12:09 PM
12:12 PM
12:15 PM
12:18 PM
12:21 PM
12:24 PM
12:27 PM
12:30 PM
12:33 PM
12:36 PM
12:39 PM
12:42 PM
12:45 PM
12:48 PM
12:51 PM
12:54 PM
12:57 PM
1 PM
1:03 PM
1:06 PM
1:09 PM
1:12 PM
1:15 PM
1:18 PM

Example: Applying ASC algorithm on field-data.

Figure 3 shows recorded CO2 concentration data from a stressed SCD30 in a typical office environment over a period of 31 days (blue line). The orange line corresponds to the same data when ASC algorithm is activated. Note that the ASC algorithm here was applied via post-processing. The red dots correspond to the measured minima in the CO_2 concentration.

After collecting seven minima that are mutually separated by at least 18 hours, the self-consistency check verifies that the measured minima lie within a range of $\pm$ 50 ppm. After verification, the reference value is determined from the stored minima and used for updating the calibration-offset. This results in a sharp rise of the orange curve, setting the recalibrated values to 400 ppm after the 7th minimum. The green line corresponds to a calibrated reference. It can be seen that readings of the reference and ASC-calibrated readings of the SCD30 show high consistency (within the range < $\pm$ 10 ppm). Note that an SCD30 with ASC activated will output the orange line only.

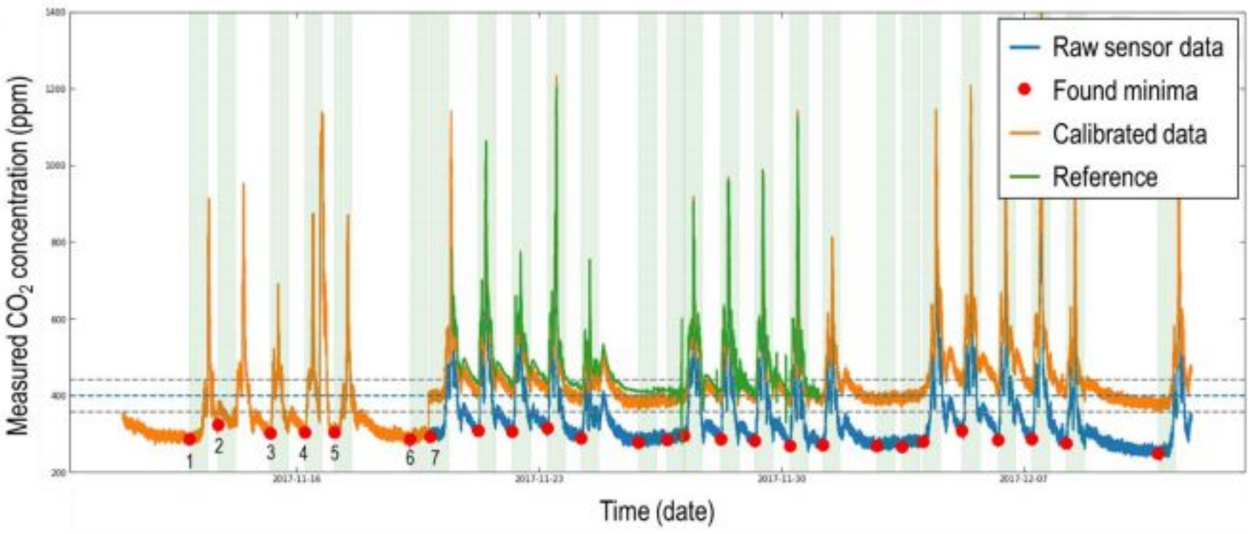


Figure 3: Illustration of ASC calibration algorithm applied to field data. The blue line corresponds to raw sensor data (ASC deactivated), the orange line to the same data with ASC applied. Red dots identify the found minima and green line corresponds to a calibrated reference sensor.

Not secure | pvos.org/co2/rev_t/

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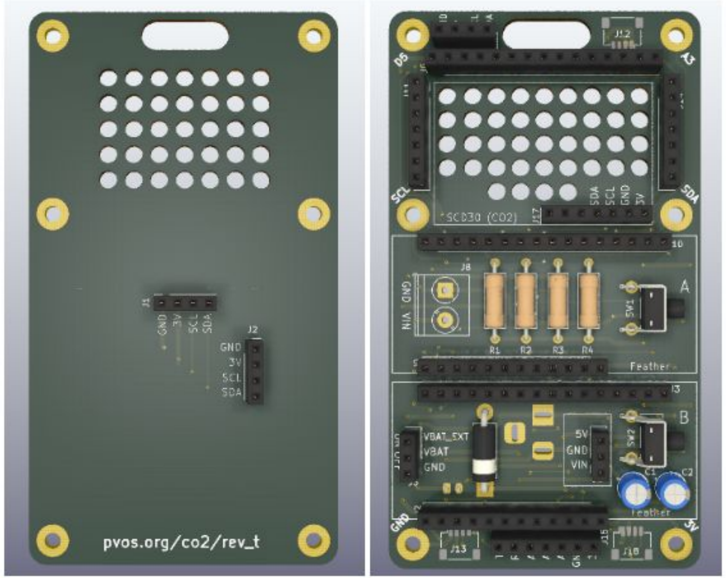
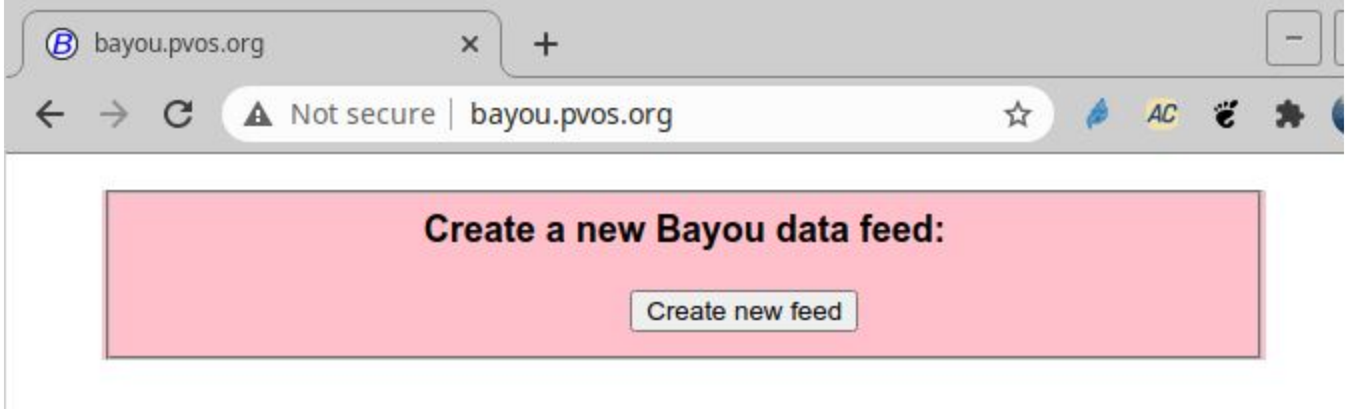
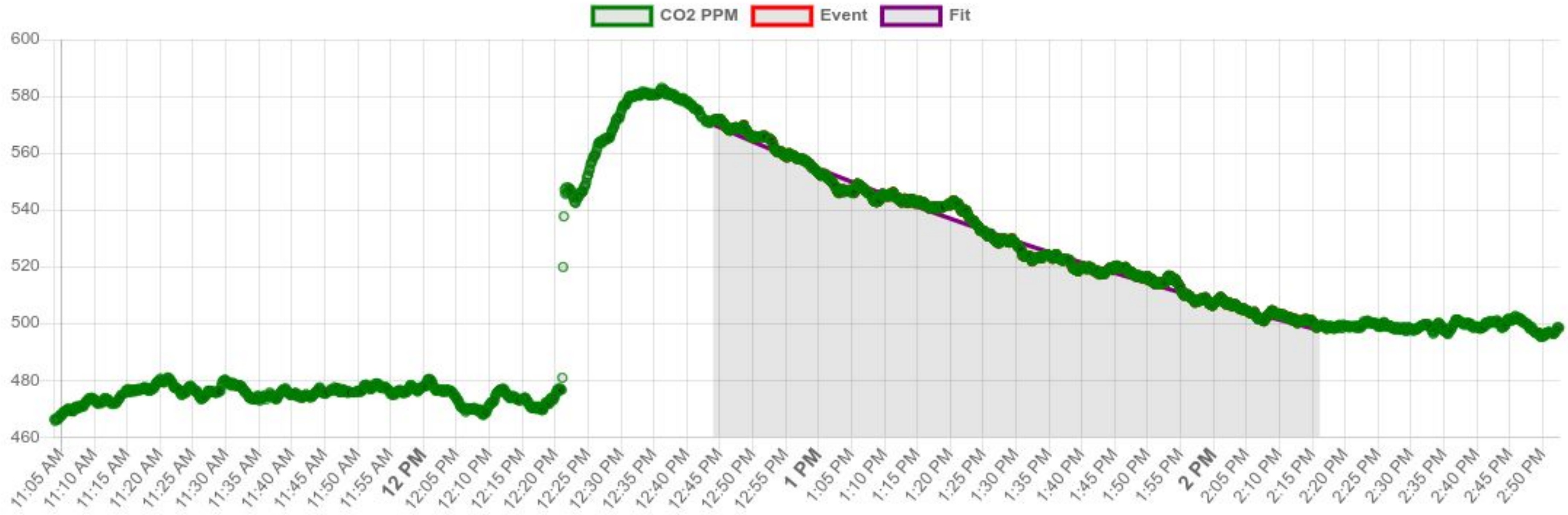
PVOS CO2 Monitor, Revision 'T'




AC/DC ADAPTER


bayou.pvos.org
Not secure
bayou.pvos.org
Create a new Bayou data feed:
Create new feed

ACH: 0.36



Plot and Fit of **ln[(co2-co2_ambient)/co2[t=0]-co2_ambient)]**

slope: -0.36; **intercept**: -0.01; **R2**:0.99

http://pvos.org/co2_lending/

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CO2 Monitor Lending Library

What is a tool lending library?

Lending libraries are a great way to share resources that are only needed for a short period of time -- not just books, but all sorts of things, including tools (e.g. chainsaws, sewing machines, scientific instruments).

Another advantage to maintaining a tool library is that often this allows groups to organize tool training, regular maintenance, and upgrading of the tools in the library. Saws can be kept sharp; sewing machines can be kept in working order; air monitors can be calibrated.

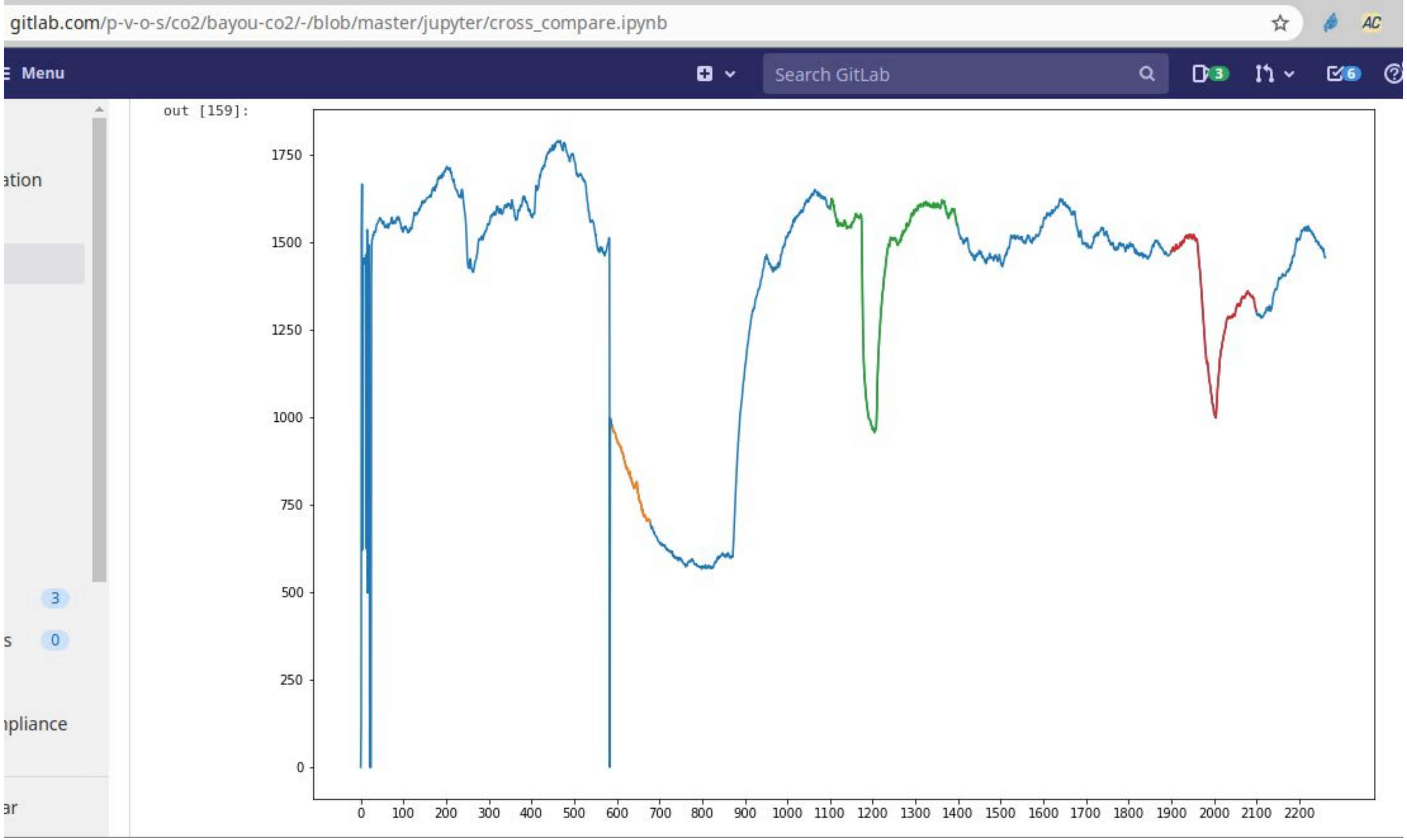
Why is CO2 Monitoring Useful?

CO2 monitoring has long been used for determining the effectiveness of indoor residential ventilation. Changes in indoor CO2 concentration can indicate whether air inside a room has 'refreshed' since its most recent occupants left, or whether there is sufficient space and/or ventilation inside a building that people are unlikely to spread airborne illness.

Indoor CO2 PPM and COVID-19 transmission. Recently, researchers have been exploring CO2 monitoring as factor in the assessment of the relative risk of indoor transmission of COVID-19. In the case of airborne illness, there are a few very common questions that CO2 monitoring can help answer:

- How long should people wait for air in a space occupied by another 'pod' to 'turn over' before entering it?

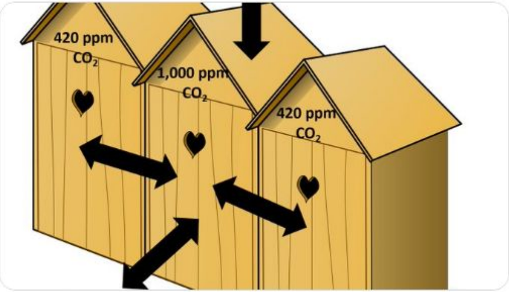
https://gitlab.com/p-v-o-s/co2/bayou-co2/-/blob/master/jupyter/cross_compare.ipynb



https://twitter.com/CathNoakes/status/1431998165662806019?ref_src=twsrc%5Etfw%7Ctwcamp%5Etweetembed%7Ctwterm%5E1431998165662806019%7Ctwgr%5E%7Ctwcon%5Es1_&ref_url=https%3A%2F%2Fthreadreaderapp.com%2Fthread%2F1432105769680375814.html

Dustin Poppendieck @Poppendieck · Feb 28 ···

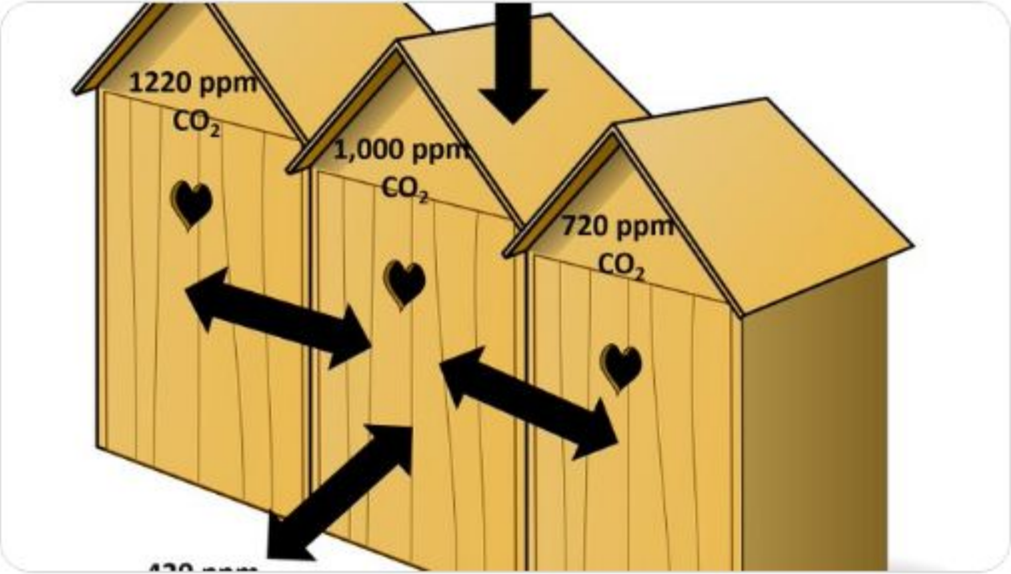
COMPLICATION #6: Rarely are all rooms in a space well mixed, as is assumed in doing this air change analysis. If we do an CO2 decay while neighboring rooms are empty we will overestimate the outdoor air change rate. (It will quantify how much is leaving the room). 19/



1 · 1 · 31

Dustin Poppendieck @Poppendieck · Feb 28 ···

COMPLICATION #6 (Cont): If we do it while neighboring rooms are occupied our assumptions of the mass balance model are no longer valid. If we ignore this error we will underestimate the outdoor air change rate. 20/



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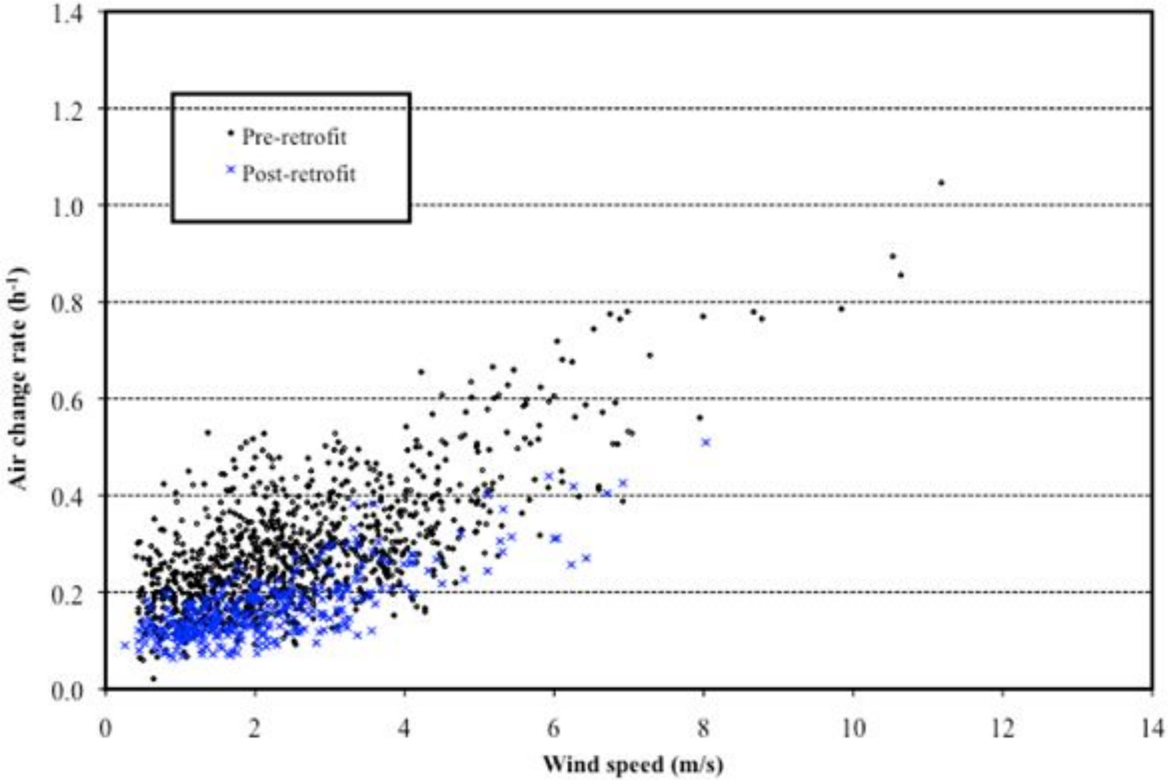
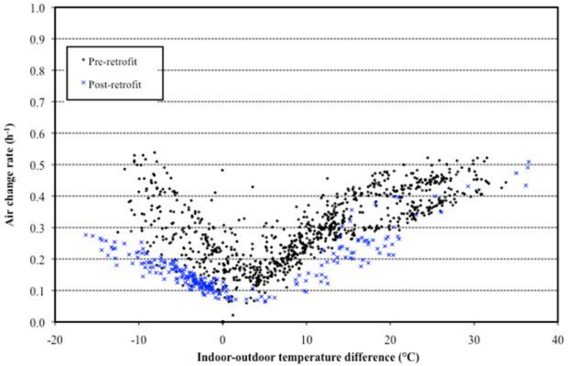




https://twitter.com/Poppendieck/status/13660551848

GREEN PLEAT
24 x 24 x 2

https://energy.ucdavis.edu/wp-content/uploads/Case-Study_DIY-Portable-Air-Cleaners-083121.pdf

Figure 2 - Fan configurations tested

2A. Fan with cardboard shroud

2B. Fan with cardboard shroud + one filter

2C. Fan with cardboard shroud + four filters (Corsi-Rosenthal box)

Division of Biological Sciences Dean Kit Pogliano and Kimberly Prather, distinguished professor at Scripps Institution of Oceanography and the Department of Chemistry and Biochemistry, assemble an air filter.

https://cleanaircrew.org/boxfanfilterfaq/

https://twitter.com/CorsIAQ

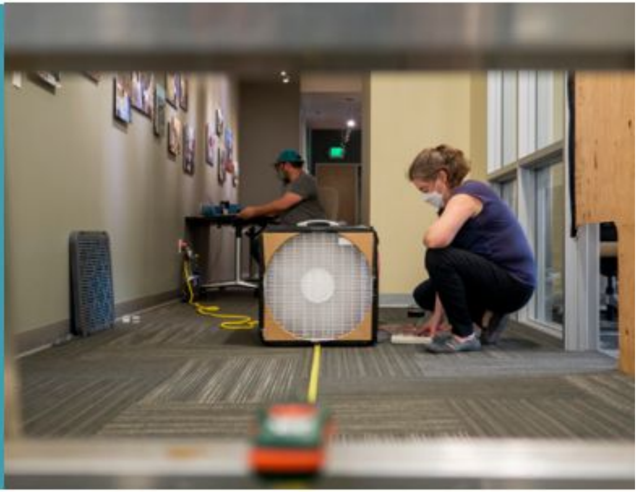
https://twitter.com/JimRosenthal4

https://energy.ucdavis.edu/wp-content/uploads/Case-Study_DIY-Portable-Air-Cleaners-083121.pdf

UCDAVIS
Western Cooling Efficiency Center

CASE STUDY
August 2021

TESTING DIFFERENT CONFIGURATIONS OF DO-IT-YOURSELF PORTABLE AIR CLEANERS



This DIY air cleaner performs similarly to residential portable air cleaners in terms of estimated clean air delivered and costs approximately three times less.

Box Fan A with Four Filters

The DIY box fan filter that provided the best value was the least expensive box fan (A) with the four-filter configuration (Table 1, green highlight).

- Depending on speed, the measured airflow was 306-443 CFM, with an **estimated clean air delivery rate (CADR) of 165-239**, based on a 54% filtration efficiency for the MERV 13 filters. This is within the range of commercially available portable air cleaners designed for the residential market[1]. The calculated face velocity of the airflow through the filter was 34-49 fpm, which is significantly lower than the test velocity that filtration efficiency was measured at (492 fpm). Therefore, the CADR estimated is conservative and actual filtration efficiency and resulting CADR are likely to be higher.
- The **estimated energy efficiency was 2.17-2.19 CADR/watt**, which exceeds the Energy Star requirement of 2.0 CADR/watt[2].
- In terms of first cost, **cost per unit of air cleaning was $0.17-$0.24 per CADR**, depending on speed. This was significantly less expensive than commercially available small portable air cleaners that cost at least $0.71 per CADR[1].
- **Noise readings were in the 53-61 dB range**, with increasing noise as speed increased. This is within the range of noise reported for commercially available portable air cleaners[1]. If used in a classroom, a reasonable approach would be to operate the DIY portable air cleaner at low speed while teaching and then increase the speed to high during the lunch break to provide additional air cleaning prior to afternoon classes.
- Because the four-filter configuration contains such a large filter surface area, the filters are expected to provide up to a year of service. Performance degradation (i.e., reduced airflow) due the filter loading was not tested.

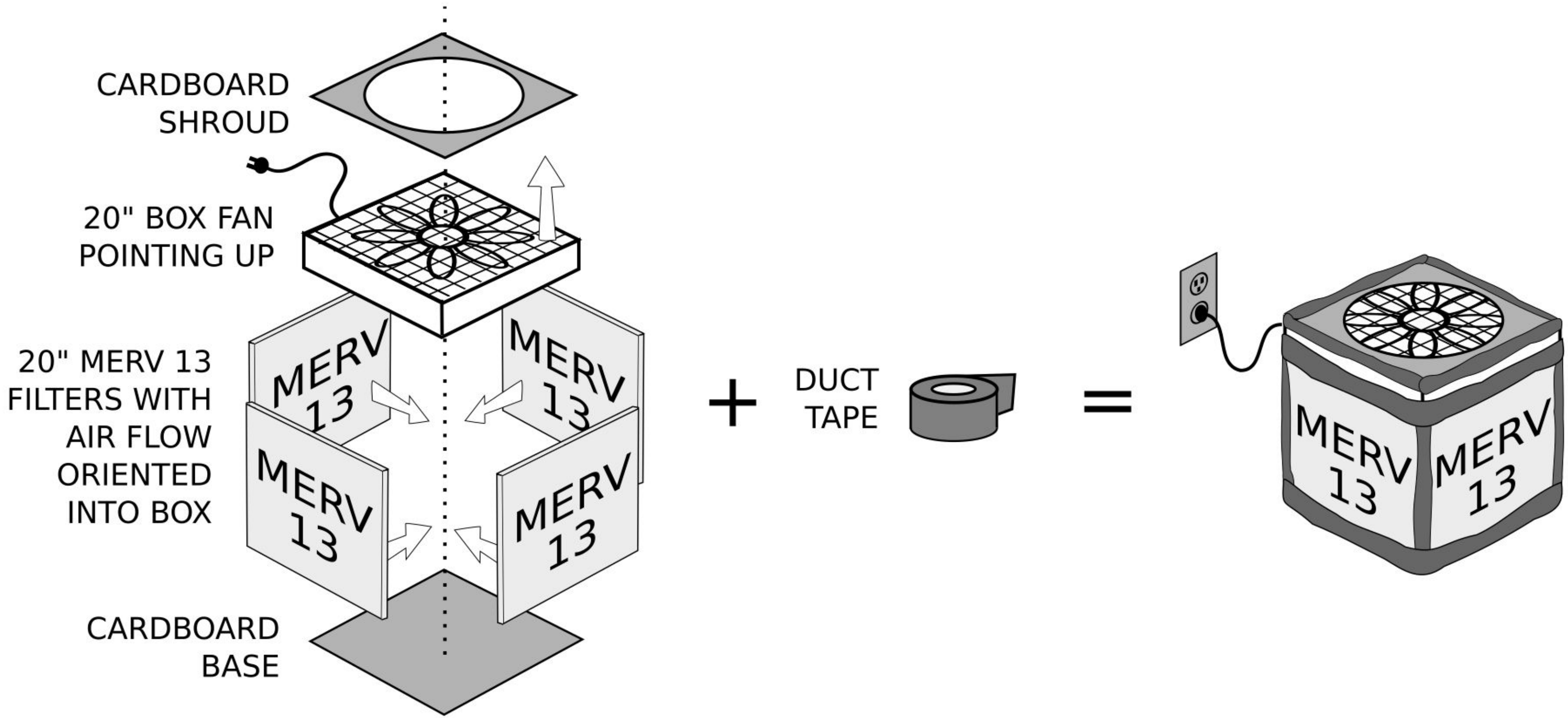
Box Fan B with Four Filters

Performance of the more expensive box fan (model B) with the four-filter configuration was similar to model A, with the minor difference that the CADR was estimated to be about 12% greater at high speed. However, this benefit was not justified by the additional cost of the fan. It would be more cost effective to build two DIY box fan filters with the lower cost fan if additional filtration is desired.

Box Fan A/B with One Filter

Performance of DIY box fan filters with the one-filter configuration was poor. In both cases regardless of speed, the CADR was 83 or less and the energy efficiency was 0.75 CADR/watt or less. This configuration is not recommended.

https://energy.ucdavis.edu/wp-content/uploads/Case-Study_DIY-Portable-Air-Cleaners-083121.pdf


CARDBOARD SHROUD
20" BOX FAN POINTING UP
20" MERV 13 FILTERS WITH AIR FLOW ORIENTED INTO BOX
MERV 13
MERV 13
MERV 13
MERV 13
CARDBOARD BASE
+
DUCT TAPE
=
MERV 13
MERV 13

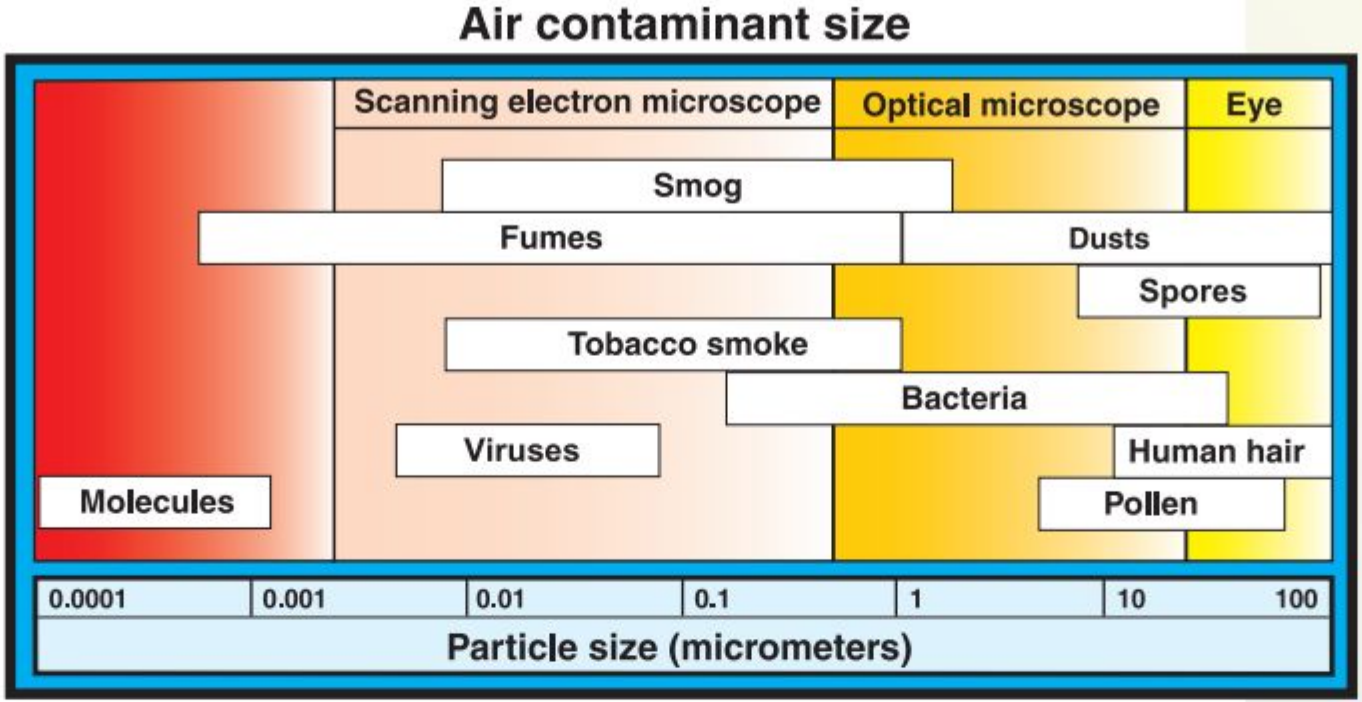


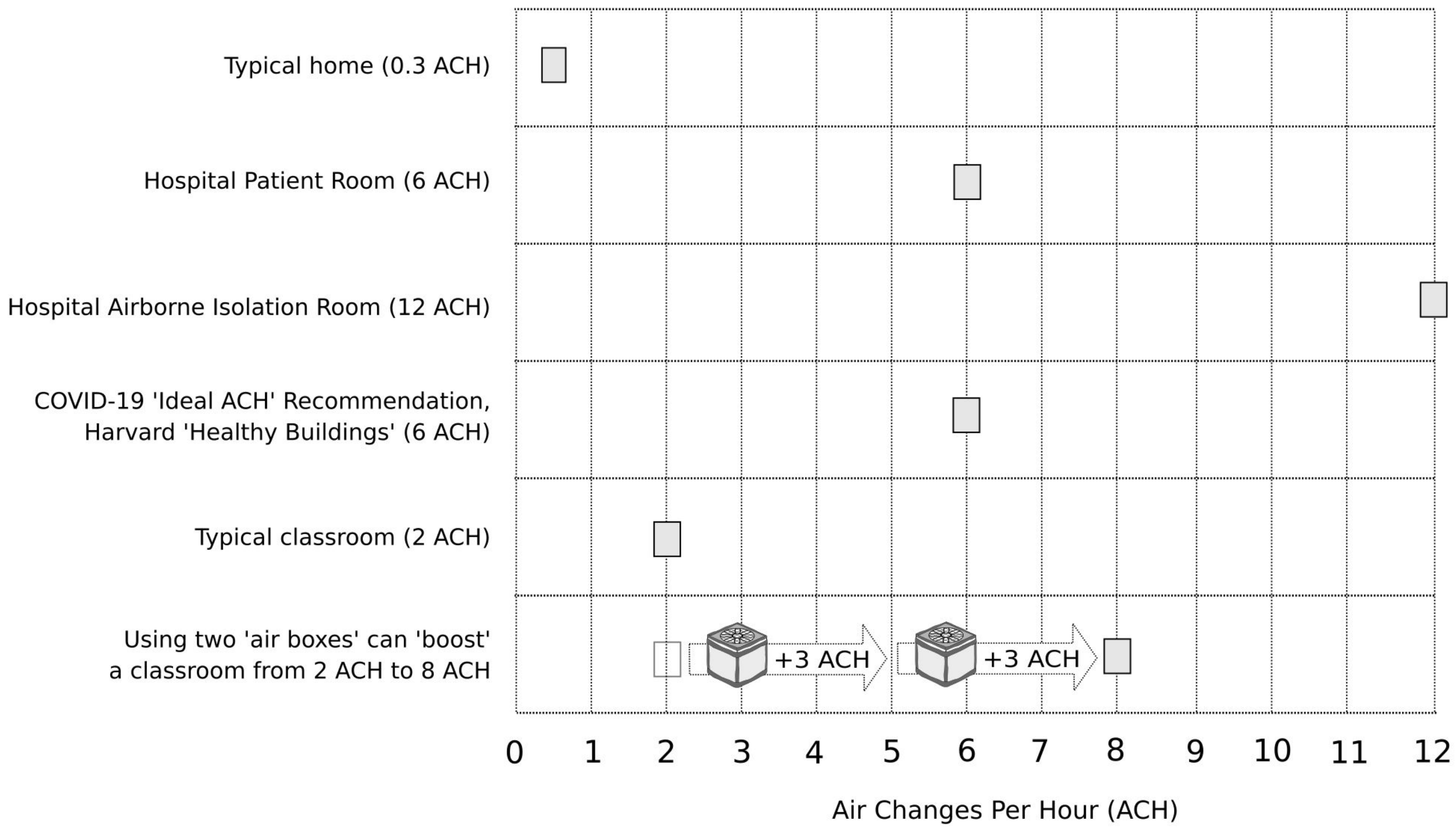
Figure 1. Common air contaminants and their relative sizes [Hinds 1982].

MERV Rating	Air Filter will trap Air Particles size .3 to 1.0 microns	Air Filter will trap Air Particles size 1.0 to 3.0 microns	Air Filter will trap Air Particles size 3 to 10 microns	Filter Type ~ Removes These Particles
MERV 1	<20%	<20%	<20%	Fiberglass & Aluminum Mesh ~ Pollen, Dust Mites, Spray Paint, Carpet Fibres
MERV 2	<20%	<20%	<20%	
MERV 3	<20%	<20%	<20%	
MERV 4	<20%	<20%	<20%	
MERV 5	<20%	<20%	20% - 34%	Cheap Disposable Filters ~ Mold Spores, Cooking Dusts, Hair Spray, Furniture Polish
MERV 6	<20%	<20%	35% -49%	
MERV 7	<20%	<20%	50% - 69%	
MERV 8	<20%	<20%	70 - 85%	
MERV 9	<20%	Less Than 50%	85% or Better	Better Home Box Filters ~ Lead Dust, Flour, Auto Fumes,Welding Fumes
MERV 10	<20%	50% - 64%	85% or Better	
MERV 11	<20%	65% -79%	85% or Better	
MERV 12	<20%	80% - 90%	90% or Better	
MERV 13	Less Than 75%	90% or Better	90% or Better	Superior Commercial Filters ~ Bacteria, Smoke, Sneezes
MERV 14	75% - 84%	90% or Better	90% or Better	
MERV 15	85% - 94%	95% or Better	90% or Better	
MERV 16	95% or Better	95% or Better	90% or Better	
MERV 17 = HEPA 13	99.97%	99% or Better	99% or Better	HEPA & ULPA ~ Viruses, Carbon Dust, <.30 pm
MERV 18= HEPA 14	99.997%	99% or Better	99% or Better	
MERV 19 = UL5	99.9997%	99% or Better	99% or Better	
MERV20= U16	99.99997%	99% or Better	99% or Better	

Illustration Provided by LakeAir / www.lakeair.com

EQUIVALENT ACH (AIR CHANGES PER HOUR) **= CADR * 60 / ROOM_VOLUME**

E.G.: FOR 30 FT x 30 FT x 10 FT ROOM, TYPICAL ESTIMATED **EQUIVALENT ACH** ~ + 3 **ACH**


Typical home (0.3 ACH)
Hospital Patient Room (6 ACH)
Hospital Airborne Isolation Room (12 ACH)
COVID-19 'Ideal ACH' Recommendation,
Harvard 'Healthy Buildings' (6 ACH)
Typical classroom (2 ACH)
Using two 'air boxes' can 'boost'
a classroom from 2 ACH to 8 ACH
+3 ACH
+3 ACH
0
1
2
3
4
5
6
7
8
9
10
11
12
Air Changes Per Hour (ACH)

IAQ and Box Fan Filter Build

Theresa Pistochini & Robert McMurry

Funded By :
SMUD™

https://ucdavis.app.box.com/s/j0j363eul5z5a1hi06dzqmb40j5r2zjh

Thank you!

donblair@pvos.org

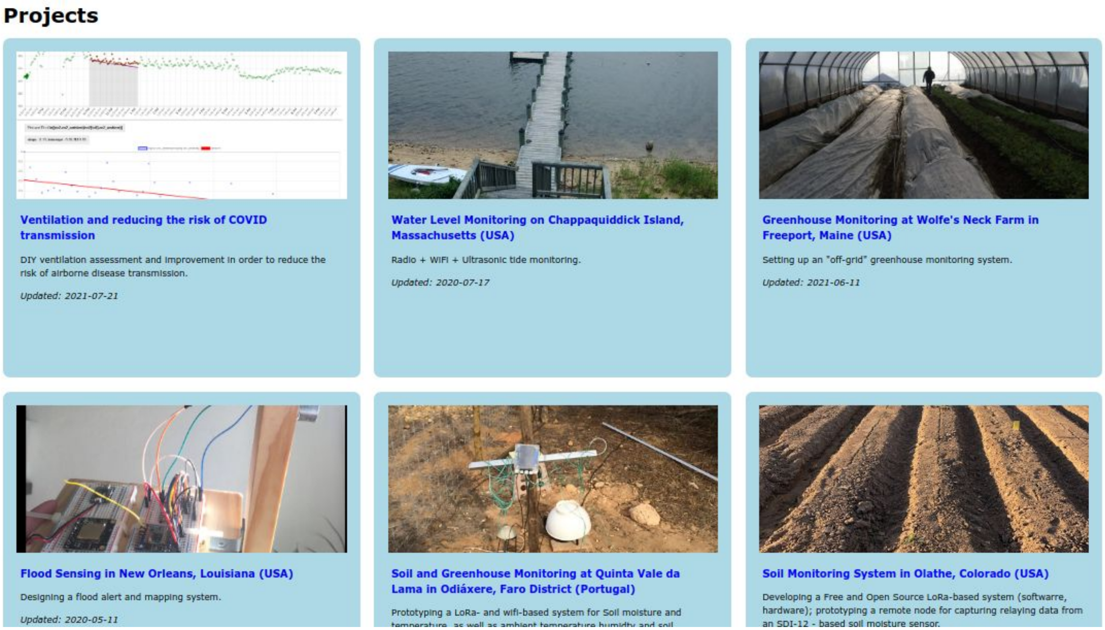
https://edgecollective.io/airbox

https://edgecollective.io/co2

https://cleanaircrew.org/boxfanfilterfaq/

edgecollective.io

pvos.org



[extra material]

The science behind respiratory protection

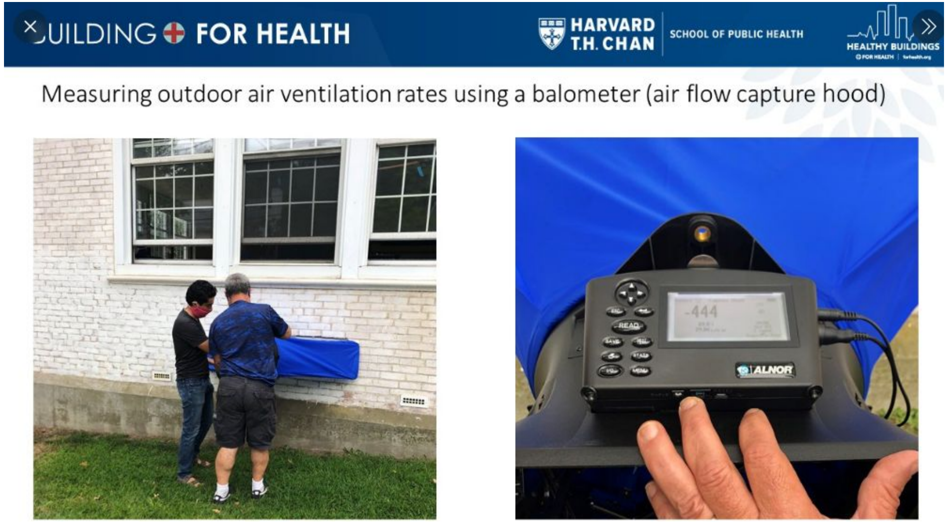
Aerosol inhalation requires different interventions

Despite early overwhelming evidence[3] that SARS-CoV-2 is transmitted primarily by inhalation of infectious particles in the air (aerosols), it took the WHO and CDC many months to recognize this mode of transmission in their scientific briefs.[4,5] Neither agency, however, has adequately directed its guidance away from droplet and contact transmission toward interventions that focus primarily on preventing aerosol inhalation.

Droplet transmission, or propulsion of large particles from sneezing or coughing into the nose, mouth, and eyes of those nearby, could be prevented by erecting barriers between people, physical distancing, and wearing masks with filters that capture large particles. None of those interventions, however, is effective for smaller inhalable particles, which are the predominant size created by people in high concentrations when breathing, talking, singing, etc. Smaller particles stay in the air for long periods (hours), are easily distributed by diffusion and air currents throughout a space (thus negating the effects of physical distancing), and can carry many virions. Masks have filters that do not efficiently capture smaller airborne particles and leave gaps around the mask that allow small particles to leak both in and out.[3,6]

The interventions that prevent aerosol inhalation are those that reduce the *concentration* of small particles in a shared space and the *time* someone spends in that space inhaling those small particles. Particle concentration can be reduced by having fewer people in the space, sharing space for shorter periods, using ventilation that removes particles quickly near the source, and using source controls (masks and respirators) with good filters and fit.

https://www.cidrap.umn.edu/news-perspective/2021/10/commentary-what-can-masks-do-part-1-science-behind-covid-19-protection https://www.usgbc.org/resources/school-iaq-fact-sheets-entire-series



Step 3, Option A. Determine Outdoor Air Ventilation Rate (Unit Ventilators)

Goal: Measure incoming outdoor air flow via mechanical ventilation through unit ventilators.

How to:

1. Choose a capture hood for the balometer with the closest form factor to cover the air diffusers (i.e. pick a hood that has a shape similar to the air diffuser's shape). In case the capture hood does not cover the entire diffuser, use a piece of cardboard and tape to direct the flow exclusively through the capture hood.
2. Start outside and use the balometer to measure the flow rate (in cubic feet per minute [CFM]) coming into the building through the grille where air is sucked in.
3. Move inside the classroom and use the balometer to measure the flow rate (in CFM) at the air diffusers where air is supplied, or blown into, to the room.

https://twitter.com/CathNoakes/status/1431998165662806019?ref_src=twsrc%5Etfw%7Ctwcamp%5Etweetembed%7Ctwterm%5E1431998165662806019%7Ctwgr%5E%7Ctwcon%5Es1_&ref_url=https%3A%2F%2Fthreadreaderapp.com%2Fthread%2F1432105769680375814.html

Prof Cath Noakes #Ventilate 😷 💙 @CathNoakes · Aug 29

OK lets look at ACH compared to CO2 concentrations. This very much depends on room size. If you have a 180 m3 high school classroom with 30 people in it, then 10 l/s/p is approx. 800ppm and approx. 6 ACH. 14/

1 8 81

Prof Cath Noakes #Ventilate 😷 💙 @CathNoakes · Aug 29

But if you take those same people and put them doing the same activity in a very large space (e.g. sports hall) at 4000 m3, then 10 l/s/p is still 800ppm, but the ACH is now 0.27 ACH 15/

2 6 78

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Although you would want your sports hall to have a higher vent rate than 10 l/s/p to deal with the emissions during higher activities, you would be unlikely to ever get 6 ACH – this would be 222 l/s/p for 30 people and would be v hard to achieve 16/