# Scientific Uncertainties of Post-COVID19 Pandemic and ESG

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07 Sep, 2022

# COVID-19 Pandemic과 대기질, 기후변화 대응방안

최재욱

교수, 고려대 의과대학 및 보건대학원
소장, 고려대 환경의학연구소
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07 Sep, 2022

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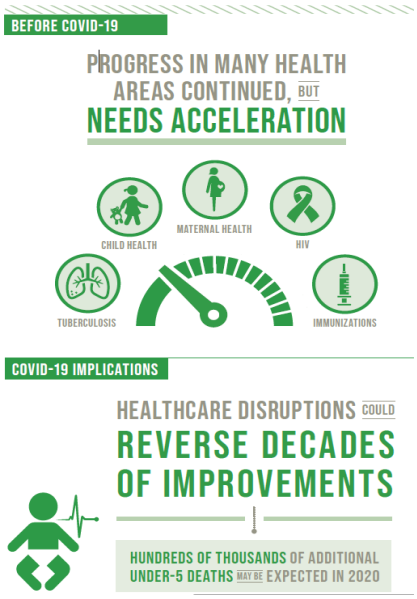
Former Dean, Graduate School of Public Health, Korea University

# Post COVID-19, Climate Change, ESG and Future Challenging Issues

1. Recognition of new health-related changes after the pandemic
2. Lessons learned from the pandemic
3. What We Need to Prevent Another New Pandemic ?
4. Can ESG and Climate Change response become a one of new alternative to pandemic prevention and response?

# The pandemic has worsened health-related situations such as SDGs



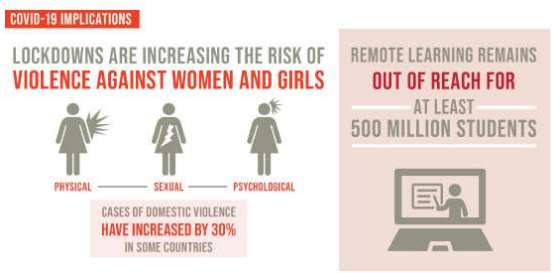


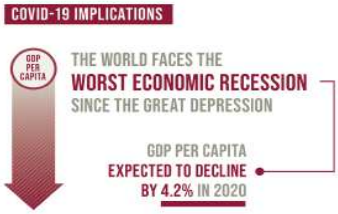
https://unstats.un.org/sdgs/report/2020/The-Sustainable-Development-Goals-Report-2020.pdf



# The pandemic has worsened health-related situations such as SDGs

- Global statistical crisis caused by difficulties in collecting usable indicators of the SDGs
- It is difficult to monitor the SDGs due to the absence of indicators and statistics that are used as important data for policy making and implementation.




Violence against women and millions of unintended pregnancies among young girls

https://www.un.org/development/desa/dpad/publication/un-desa-policy-brief-81-impact-of-covid-19-on-sdg-progress-a-statistical-perspective/

# Impact of COVID-19 on SDGs

1. EVEN BEFORE THE PANDEMIC, THE WORLD WAS OFF TRACK TO FULFILL THE SDGS
2. COVID-19 THREATENS TO REVERSE PROGRESS ON THE GLOBAL GOALS
3. IMPACTS OF COVID-19 DISPROPORTIONALLY AFFECT THE POOR AND THE VULNERABLE
4. Still need to attend to many other existing diseases such as malaria, yellow fever and others / strong concerns in dealing with COVID-19 are disrupting other disease prevention programs / mental health due to social isolation
5. To recover from the COVID-19 pandemic, we must put people at the centre of the response to achieve more equitable and resilient outcomes for all.
6. **The SDGs and the Paris Agreement are our compass** to a transformative recovery that reduces the risk of future crises and brings the inclusive and sustainable development.

- Source : Impact of COVID-19 on SDG progress: a statistical perspective, Policy Brief No.81, Department of Economy and Social Affairs, UN, Aug, 2020



# FAQ on COVID-19 and Climate Change

- Does climate change affect the transmission of coronavirus?
- Does air pollution increase the risk of getting coronavirus? Does it make symptoms worse?
- How likely are we to see infectious disease spread as a result of climate change?
- Climate change and global health policy are largely treated as separate issues by the public and media. Do we need to adjust our thinking?
- COVID-19 is killing people now and climate change

Source : 하바드대 보건대학원, 기후,보건 및 글로벌환경 센터,
https://www.hsph.harvard.edu/c-change/subtopics/coronavirus-and-climate-change/

# For those interested in research papers on air pollution and virus transmission:

- Exposure to air pollution and COVID-19 mortality in the United States (Harvard University, preprint, 2019). This study found that a small increase in long-term exposure to PM2.5 leads to a large increase in COVID-19 death rate.
- Measuring the impact of air pollution on respiratory infection risk in China (*Environmental Pollution, 2018*). This study found that worse air quality in China may increase transmission of infections that cause influenza-like illnesses.
- The association between respiratory infection and air pollution in the setting of air quality policy and economic change (*Annals of the American Thoracic Society, 2019*). A study of nearly 500,000 New York residents found that higher particulate matter air pollution levels increased the chances of hospitalization for pneumonia and emergency deparment visits, especially for influenza.
- Airborne transmission may have played a role in the spread of 2015 highly pathogenic avian influenza outbreaks in the United States (*Scientific Reports, 2019).* Researchers have found that several viruses, including adenovirus and influenza virus, can be carried on air particles. This recent paper finds that particulate matter likely contributed to the spread of the 2015 avian influenza.
- Relationship between ambient air pollution and daily mortality of SARS in Beijing (*Biomedical and Environmental Sciences, 2005*). During the SARS epidemic in 2003, this study found that increases in particulate matter air pollution increased risks of dying from the disease. SARS is a coronavirus, like COVID-19.

Source : https://www.hsph.harvard.edu/c-change/subtopics/coronavirus-and-climate-change/





# Whites are mainly to blame for air pollution, but blacks and Hispanics bear the burden, says a new

By Isaac Stanley-Becker

March 12, 2019 at 4:59 a.m. EDT

## Inequity in consumption of goods and services adds to racial–ethnic disparities in air pollution exposure

Christopher W. Tessum[a], Joshua S. Apte[b], Andrew L. Goodkind[c], Nicholas Z. Muller[d], Kimberley A. Mullins[e], David A. Paolella[a], Stephen Polasky[f,g], Nathaniel P. Springer[h], Sumil K. Thakrar[i], Julian D. Marshall[a], and Jason D. Hill[i,1]

[a]Department of Civil and Environmental Engineering, University of Washington, Seattle, WA 98195; [b]Department of Civil, Architectural and Environmental Engineering, The University of Texas at Austin, Austin, TX 78712; [c]Department of Economics, University of New Mexico, Albuquerque, NM 87131; [d]Department of Engineering and Public Policy, Carnegie Mellon University, Pittsburgh, PA 15213; [e]Energy Consulting, Lumina Decision Systems, Los Gatos, CA 95033; [f]Department of Ecology, Evolution, and Behavior, University of Minnesota, St. Paul, MN 55108; [g]Department of Applied Economics, University of Minnesota, St. Paul, MN 55108; [h]Institute on the Environment, University of Minnesota, St. Paul, MN 55108; and [i]Department of Bioproducts and Biosystems Engineering, University of Minnesota, St. Paul, MN 55108

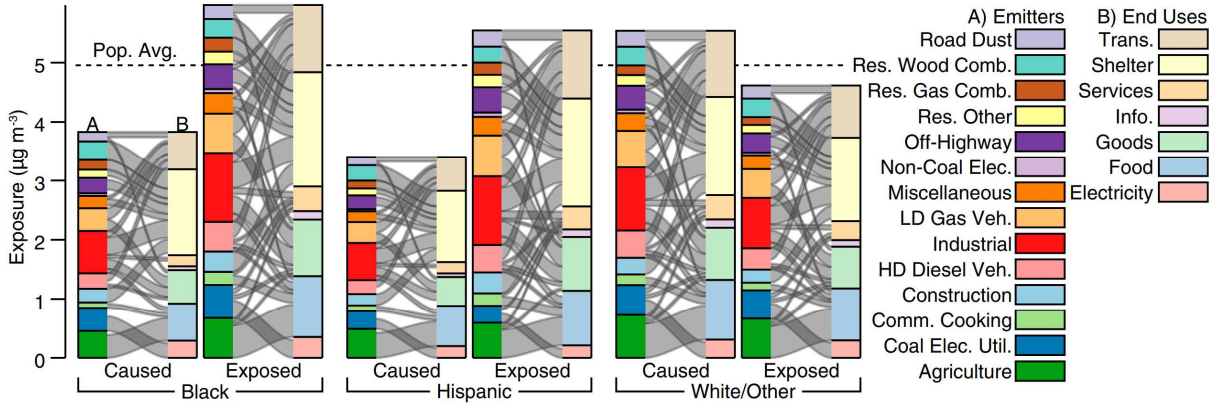
Edited by Susan Hanson, Clark University, Worcester, MA, and approved February 4, 2019 (received for review November 2, 2018)

**Fine particulate matter ($PM_{2.5}$) air pollution exposure is the largest environmental health risk factor in the United States. Here, we link $PM_{2.5}$ exposure to the human activities responsible for $PM_{2.5}$ pollution. We use these results to explore "pollution inequity": the difference between the environmental health damage caused by a racial–ethnic group and the damage that group experiences. We show that, in the United States, $PM_{2.5}$ exposure is disproportionately caused by consumption of goods and services mainly by the non-Hispanic white majority, but disproportionately inhaled by black and Hispanic minorities. On average, non-Hispanic whites experience a "pollution advantage": They experience ∼17% less air pollution exposure than is caused by their consumption. Blacks and Hispanics on average bear a "pollution burden" of 56% and 63% excess exposure, respectively, relative to the exposure caused by their consumption. The total disparity is caused as much by how much people consume as by how much pollution they breathe. Differences in the types of goods and services consumed by each group are less important. $PM_{2.5}$ exposures**

source types, at a spatial resolution varying between 1 and 48 km depending on population density. We aggregate impacts into 15 emitter groups. (See *Materials and Methods*; *SI Appendix*, Tables S1–S14 show the largest emitter types in the 14 anthropogenic and domestic emitter groups.)

We estimate a population-weighted average ambient $PM_{2.5}$ exposure concentration of 7.7 $\mu g \cdot m^{-3}$ for the United States in 2015, causing 131,000 premature deaths (Fig. 1 and *SI Appendix*, Fig. S1; see *SI Appendix*). Of these, 102,000 are caused by US anthropogenic emissions and 29,000 by other sources, largely wildfires and natural biogenic emissions (26,000), with minor contributions from Canadian and Mexican emissions (3,000). The total number of deaths reported here is higher than a commonly cited estimate of 93,000 (1), but at the low end of the range of a recently published estimate of 121,000–213,000 deaths (7), which uses a concentration–response relationship similar to the one employed here (6). (*SI Appendix*, Table S15 reports estimates of $PM_{2.5}$ mortalities using several concentration–response functions.)

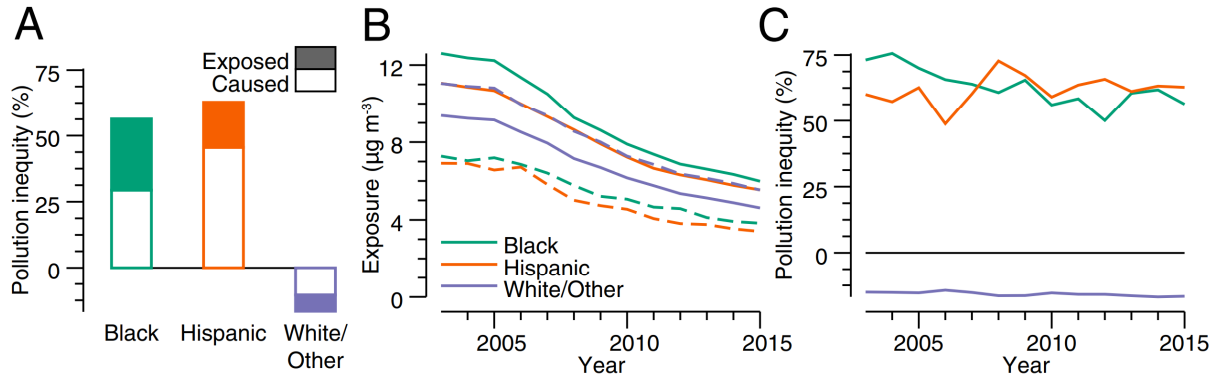
# The Reality of Social Inequality in Air Pollution Cause(Generation) and Exposure




**Ref : CW Tessum et al, https://www.pnas.org/doi/pdf/10.1073/pnas.1818859116**



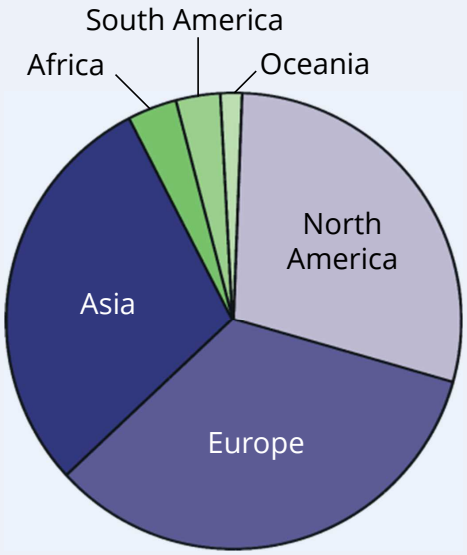
# The Reality of Social Inequality in Air Pollution Cause(Generation) and Exposure




**Ref : CW Tessum et al, https://www.pnas.org/doi/pdf/10.1073/pnas.1818859116**

# Who Causes Climate Change?

The bottom 50 underdeveloped countries account for 1% of the greenhouse gas emissions. The US, EU and China generate about 60% of greenhouse gases




# Who Does Climate Change Affect?

1. In the long run, all of humanity is under the influence of climate change. But some people are currently more affected than others and cause equity issues in most cases, the wealth of a prosperous country is created from activities that contribute to past greenhouse gas emissions.

2. Using the wealth of economic activity accumulated in the past, these countries can protect themselves from the effects of climate change.

3. But poor countries suffer the most from the effects of that because they can't adapt to climate change. They also need to focus on solving the problems caused by climate change, which reduces their development capabilities.

The countries who have contributed the least to the climate crisis are the ones who are affected the most.

**Is this fair?**

## Social Justice & Climate Justice

Climate justice means looking at the climate crisis from the perspective of social justice. Solutions must not only control climate change, but also protect and empower the most vulnerable groups of people.

We have a responsibility to consider the most vulnerable when planning climate action. It should not be forgotten that people in this group contribute the least to the causes of climate change occurrence.

Thus, climate action and action means putting people and communities most vulnerable to the effects of climate change at the center of development.

If we don't address social justice issues, climate solutions won't work. For example, if we don't address poverty, unsustainable lifestyles will continue to damage ecosystems and humanity will not be able to curb climate change.

## More important and serious revealed problems

# Why existing IPC models fail to predict the COVID-19 Pandemic?

IPC : Infection Prevention & Control

# Lessons learned

- Extreme uncertainty risk at the global level is rare. However, these crises at the organizational or community level will happen someday.

- After the COVID-19 pandemic, the existing decision-making process has been reviewed, and risk prediction and uncertainty risk management are emerging as new challenges.

# Limitations of predictive statistical models

1. Forecasts are based on statistical regularity calculated using historical indicators and figures.

2. Statistical predictive models based on historical data, trends, and patterns are difficult to predict when the model's inherent changes and exceptional deviances are occur.

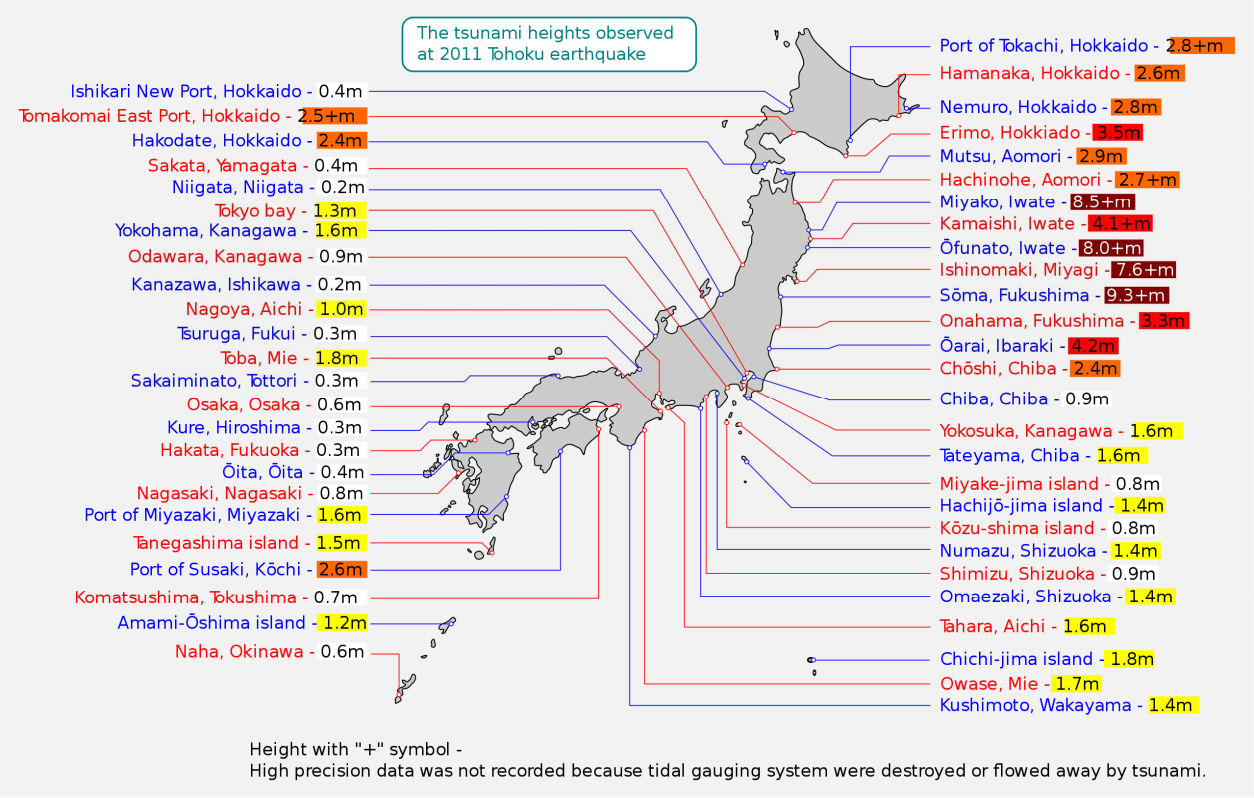
3. In extremely exceptional circumstances, when statistical regularity disappears, a situation arises in which the organization's goals are not achieved: Goodhart's law (Charles Goodhart, 1975)

# Big Data, AI ?

- As data aggregation accelerates, computers become more sophisticated in learning what they need to make data-driven decisions, and in competition with humans
- AI transcends its ability to recognize the many patterns that exist in the data and to learn vast amounts of data
- DeepMind, AlphaGo, Autonomous Driving, Automating Stock and Investment Trading…

# Fukushima vs Onagawa nuclear power plant case

- The Great East Japan Earthquake and Tsunami in March 2011
- The tsunami that pierced the breakwater that protected Fukushima's First Nuclear Power Plant was a disaster that could occur once in 1,000 years. Underestimates tsunami risk and overlooks the risk of damage from reactor-cooled seawater pumps(도쿄전력, 2002)
- The Onagawa Nuclear Power Plant (Tohoku Electric Power), 120 km from the Fukushi Bay Nuclear Power Plant, was safe from the tsunami
- What is the difference between risk prediction and safety standards for the Fukushima and Onagawa nuclear plants?




# Historical Records and Big Data Limits

- 서기 869년 일본 대지진 기록, 무로하마 어촌 사례
- 아네요시 마을의 오래된 표지석 : "이곳 아래쪽으로는 집을 짓지 말라", 1896년
- 1960년 대 오나가와 원전 건설 토목설계기사, 12 m 이상 높게 쓰나미 방파제 설계(Venkataramin B, Foresight, 2019)
- 후쿠시마 원전 방파제 설계 ?
- 역사적 기록이 없는 경우는 ?
- 기후변화와 새로운 판데믹의 예측 ?

## Rise of Uncertainty Science

# Extremely rare, unknown risk, lack of scientific evidences & uncertainty science

## Types of ‘the Uncertainty Crisis and Risk’

1. Due to the imperfections and impossibility of scientific mathematical prediction models.
2. New forms of 'socioeconomic risks or disasters' that can emerge as a paradigm shift in socio-economic and cultural
3. Disasters and risks caused by uncertainty outside the existing scientific paradigm.

"The riddle does not exist. If a question can be put at all, then it can also be answered.“

Ludwig Wittgenstein, Cambridge University, England



## Various predictive analytics techniques

1) Reverse Stress Test(Boykin Curry), Pre-mortem test(Astro Teller, Google), Prospective hindsight(Deborah Mitchell, Penn.Univ)

2) Polaris tactics to distinguish between signal and noise (Venkataramin B, Foresight, 2019)

3) Statistics-based predictions such as big data and AI learning-based predictions, relevance, trends, etc.

4) Game scenario techniques

5) An organizational culture that encourages prediction

# Is the principle of precaution an alternative?

- Precautionary prevention principle, Silver Bullet ?
- The principle of precautionary caution fundamentally presupposes scientific uncertainty
- The more proactive propaganda is strengthened, the greater the economic and social damage and cost losses.
- A trade-off in decision-making that takes into account the precautionary benefit and the economic and socio-political losses together is essential.

# Creating resilience in uncertain times

**COVID-19 impacts on business strategy**

**https://www.accenture.com/gr-en/services/strategy/coronavirus-business-impact-strategy**

## COVID-19: Busting the myths of agile transformation

- **Agility in the toughest of times**
- **Maintaining speed and agility**
- To gain true speed and agility, companies must tackle head-on the myths surrounding intelligent operating models. They must reimagine the very essence of their business. While we can't predict what will happen next, no matter the scenario, agility will be critical. Companies need to design their organizations with agility embedded across the enterprise.



# Post-Covid-19 Business Strategy ?

**Four Essential Trends For Every Post-Covid-19 Business Strategy, 4, Mar, 2021, Forbes**

**https://www.forbes.com/sites/jeroenkraaijenbrink/2021/03/04/four-essential-trends-for-every-post-covid-19-business-strategy/?sh=4ebfe5d2c4a0**

# 1: Further Digitalization

# 2: Sustainable & Responsible Business

# 3: Resilient & Agility Organization

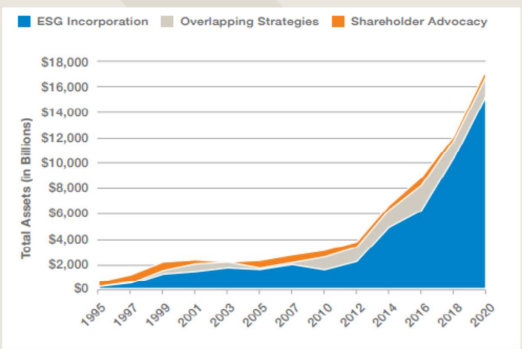
# 4: Good Employership / ESG

Reference : https://www.forbes.com/sites/jeroenkraaijenbrink/2021/03/04/four-essential-trends-for-every-post-covid-19-business-strategy/?sh=4ebfe5d2c4a0



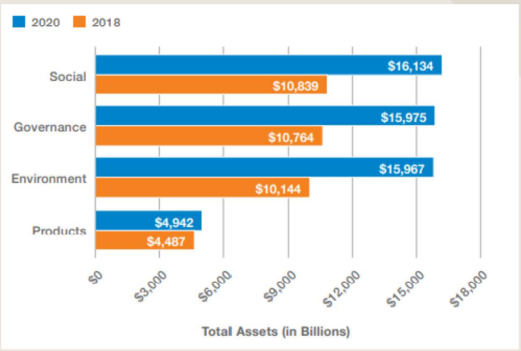
# Rising of ESG ?

**Sustainable Investing in the United States 1995-2020**




*Source: US SIF Foundation*

**ESG Categories Incorporated by Money Managers 2018-2020**




*Source: US SIF Foundation*

https://structuredfinance.org/wp-content/uploads/2021/01/Two-Graphs-V3.svg

# Companies' ESG ratings are on the rise globally


<국내 주요 평가사>

CGS Corporate Governance Service 한국기업지배구조원

대신지배구조연구소 Daishin Corporate Governance Institute

SUSTINVEST

Who's Good 지속가능발전소



# Why ESG investing is on the rise ?

- While most asset prices took a beating during the initial phase of COVID-19, ESG investments did better than most.
- In the US, ESG focused funds have seen more than a double jump to USD 51.1 billion from USD 21.4 billion, and a nearly tenfold increase from USD 5.4 billion in 2019[. In Asia excluding Japan, managed sustainable fund assets almost tripled to USD 36.7 billion in March 2021 from a year earlier.
- The pandemic has also made corporate governance a very nuanced task, which requires making important decisions related to business strategies, employee well-being, risk mitigation and managing stakeholders in an unprecedented environment.

Source : morning star.com – A Broken Record: Flows for U.S. Sustainable Funds Again Reach New Heights

scmp.com – ESG investing: what you need to know and how smaller ETFs outgun BlackRock, Vanguard with sustainable screening and benchmarking

# The triple bottom line & CSR

- The triple bottom line (by John Elkington)

- "Economic development, social development, and environmental protection are interdependent and mutually reinforcing components of sustainable development. **Sustained economic growth is essential to the economic and social development of all countries, in particular developing countries**."

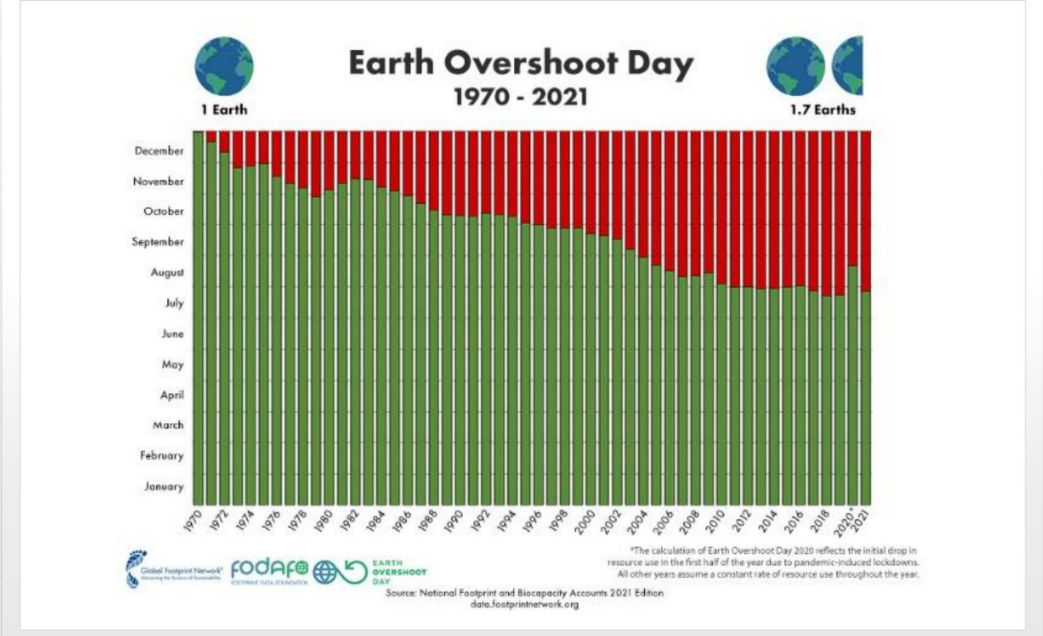
United Nations statement following the 'Rio+5' event in 1997



# It's not economy, it's business governance

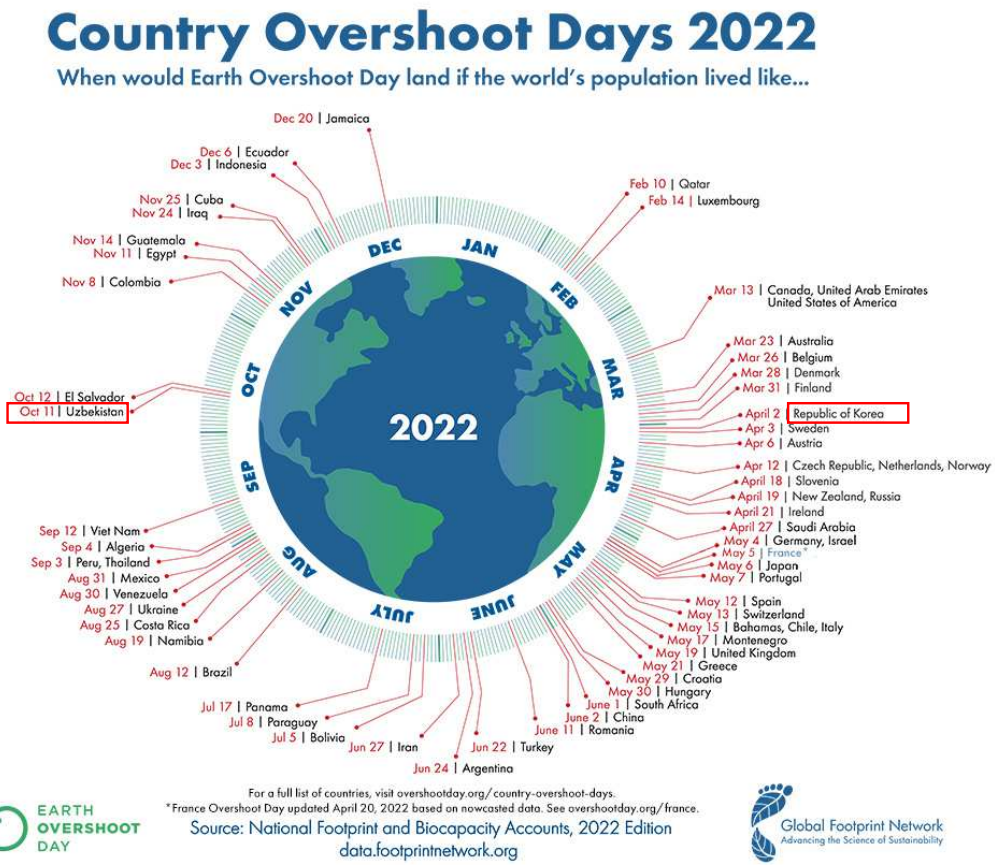
Limitations of the concept that presupposes economic development and corporate growth

# Background of the Rise of ESG/Climate Change




https://www.overshootday.org/about-earth-overshoot-day/





# DEFINING SUSTAINABLE DEVELOPMENT

- Finding the right balance:

"Sustainable development is development that meets the needs of the present without compromising the needs of future generations."

Source: World Commission on Environment & Development, Our common future



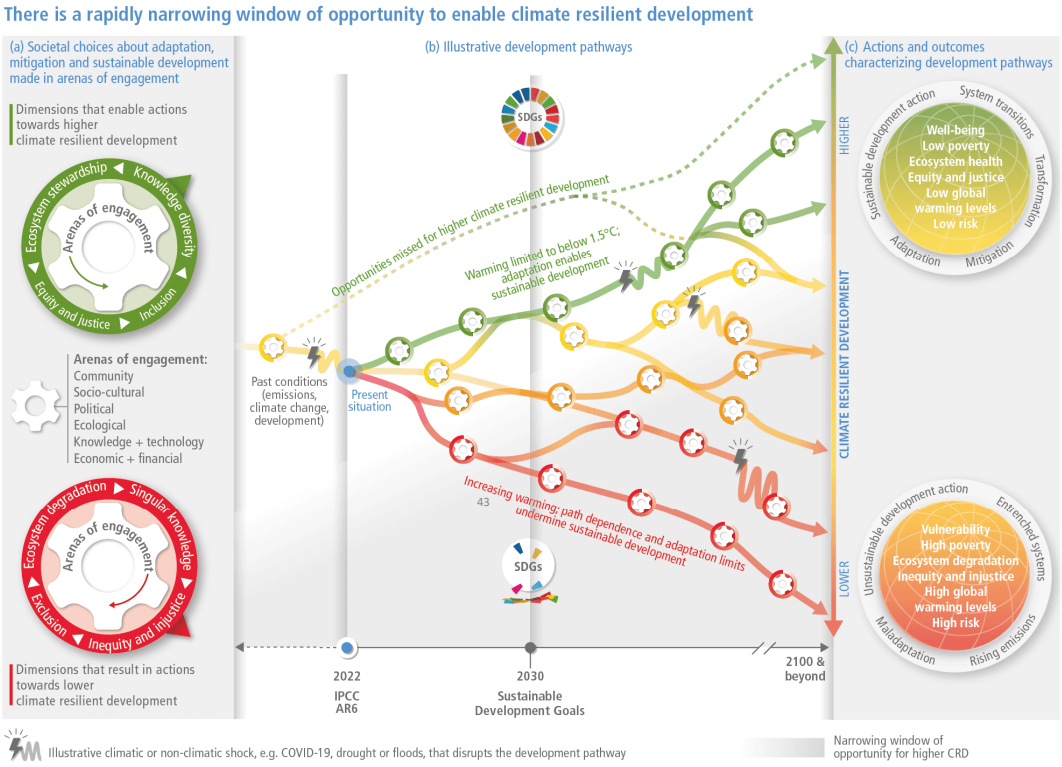
## *Conclusion and Discussion*

# Conclusion & Discussion

- In order to prepare and response to new emerging diseases, **the IPC platform requires to modify its structural functions of surveillance, monitoring and forecasting tools** to be sufficient enough to forecast the future risk. Therefore, these tools can utilize an **Artificial Intelligence (AI) and Big Data** to more precisely predict the uncertainties of next new emerging diseases.
- Nevertheless, due to the inevitable limitations of predictive science, **a new IPC platform may not** function properly against next new emerging disease or new variant of virus. In other words, current platform will **need to become a dynamic model** that can be useful for developing alternatives during such uncertainties.
- Due to the intrinsic characteristics of science, such as rigor and conservatism, flexible and **dynamic models are bound to have a fundamentally political and economic context**.

# 'Framework for response strategy against future 'New Pandemic'

| | |
|---|---|
| 1. Political Leadership | • Build political commitment and leadership at the highest level |
| 2. Sectoral Cooperation | • Align priorities and promote coordinated action at different level of government |
| 3. Scientific Evidence based | • Science advisory mechanisms at the national level to deal with the uncertainty risks and crises |




# What is the really important than money ?

Earth, Ecology & Human

## What needs to be addressed after COVID-19 pandemic ….

1. The Rise of Digital Authoritarianism
2. Surveillance Capitalism Response
3. Strengthen international cooperation and solidarity for strong ESG implementation and implementation monitoring
4. Building trust and solidarity between society and experts on scientific basis

"And once the storm is over, you won't remember how you made it through, how you managed to survive. You won't even be sure, whether the storm is really over. But one thing is certain. When you come out of the storm, you won't be the same person who walked in. That's what this storm's all about."

Haruki Murakami, Kafka on the Shore

# Thank you

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Professor
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# Assessing Exposures and Health Effects of Particle Radioactivity: An Emerging Research Field

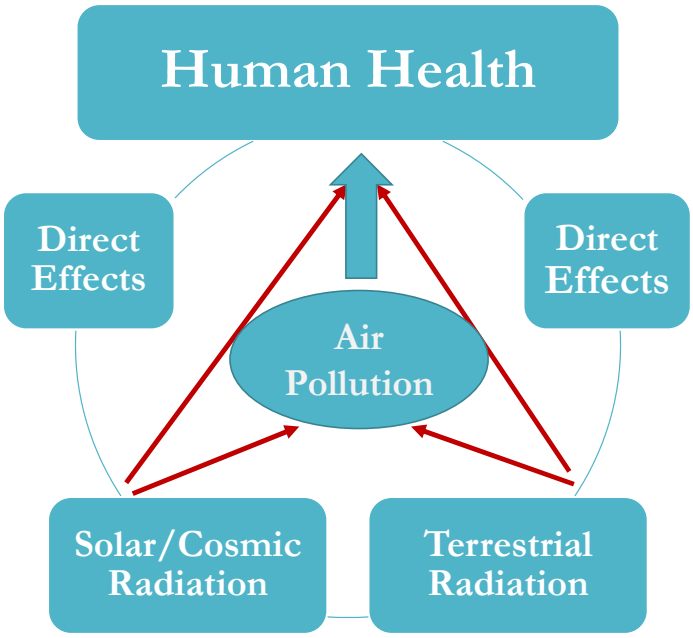
Petros Koutrakis Ph.D.
Professor of Environmental Sciences
T.H. Chan School of Public Health
Harvard University

World Clean Air Forum

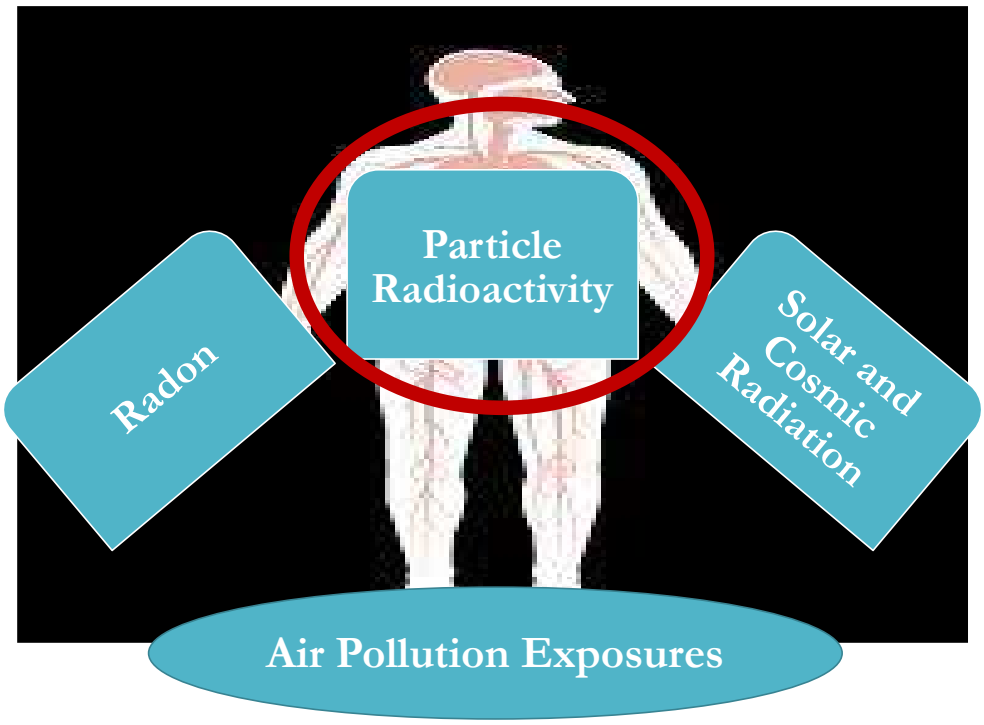
## Outline

- Introduction
- Measurements
- Exposure Assessment
- Biomarkers
- Health Effects Studies
- Conclusions
- Future Research

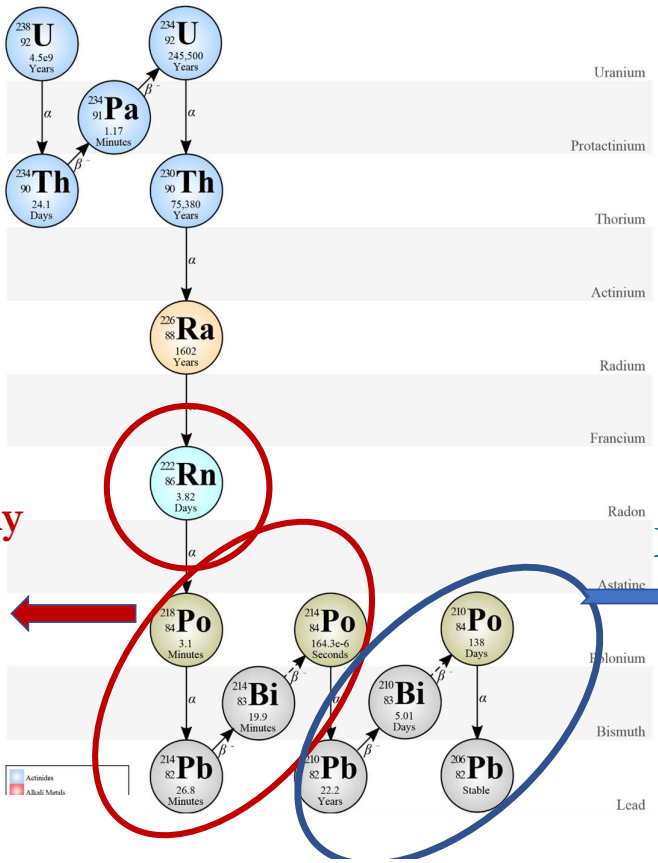
# Environmental Radiation Effects




# Environmental Health Radiation Research



# Radon Chain

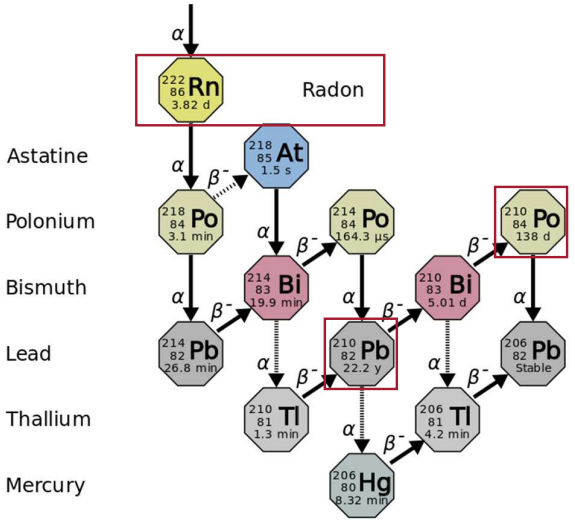



SL-α >> LL-α
SL-β >> LL-β

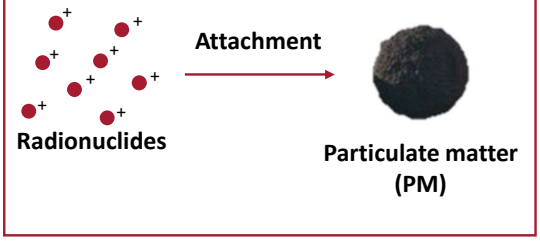
SL-α or SL-β
Short-lived progeny
Minutes to Days
Acute Effects
Bq/m³

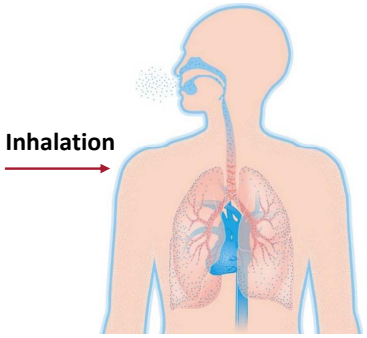
LL-α or LL-β
Long-lived progeny
Years
Chronic effects
mBq/m³

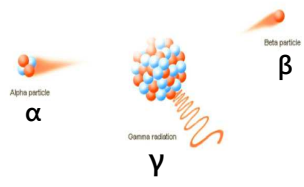
# Particle Radioactivity (PR) is just another PM property




Radon decay products/
Radon progeny




α toxicity (Linear Energy Transfer) >> β or γ

α can not penetrate the epidermis only by inhalation and ingestion

https://en.wikipedia.org/wiki/Decay_chain

# Outline

- Introduction
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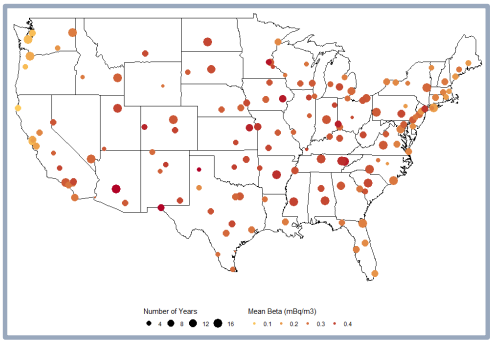
- Biomarkers
- Health Effects Studies
- Conclusions
- Future Research

# EPA Radiation Network (RadNet) LL-β

- Since 1956 to monitor radiation from nuclear testing
- Total Suspended Particles (TSP) Collected over several (3-7) days;
- PM β-activity measured after 1-2 weeks LL-β activity




- **Similar Data are collected in Europe by different countries**

# Measurements of LL gross α- and LL gross β-activities of archived $PM_{2.5}$ and $PM_{10}$ Teflon filter samples

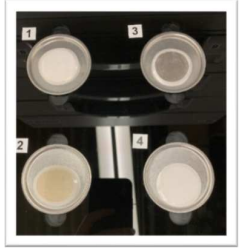
Man Liu, Choong-Min Kang, J. Mikhail Wolfson, Longxiang Li, Brent Coull, Joel Schwartz, Petros Koutrakis

**EST 2020**

## Measures of PM LL-α and LL-β activities of archived filters

### Radioactivity measurement

- **Measuring dates:** November 2018 to July 2019
- **Equipment**: low background gas proportional counter (Model LB4200, Canberra Industries, Inc., Meriden, CT)
- **Counting time**: 600 minutes for α/β
- **Calibration**: every 2 weeks (with a 0.0518 μCi NIST traceable $^{210}$Po source on 5.7 cm planchet)
- **Background level**: below 0.1 cpm
- **Limit of detection (LOD)**:
  - **0.219 mBq/m$^3$ for α and 0.355 mBq/m$^3$ for β**
  - In total, we have 1,007 samples above LOD for α activity (89%) but only 806 samples above LOD for β activities (71%)



**Lα- or Lβ- activity measured at counting** → ? → **Lα- or Lβ- activity at few days after air sampling**

# α- and β- activities of archived PM filters

LL-α and LL-β activity measured at counting ($A_{\alpha(t)}$)

LL-α and LL-β activity a few days after air sampling (C)

$$C = \frac{A_{\alpha(t)} \cdot e^{\lambda t}}{Q t_0}$$

Long-lived (LL) α/β -activity

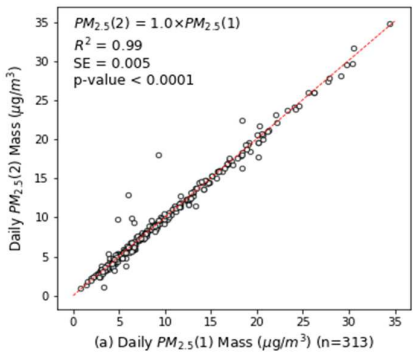
**Main assumption**

- Exponential decaying process
- The main source of α and β activity in the air is long-lived radon products

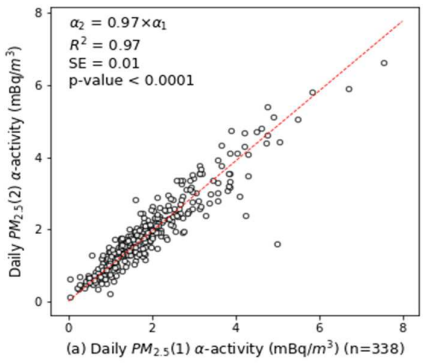
- $A_{\alpha(t)}$: α- or β- activity on the filter at counting (mBq)
- $\lambda$: decay constant for $^{210}$Pb ($8.51\times10^{-5}$ $d^{-1}$)
- **Q**: air sample rate ($m^3/d$)
- $t_0$: air sampling duration (d)
- **t**: the duration between PM sampling and counting (d)

# Comparisons between $PM_{2.5}$ duplicate samples

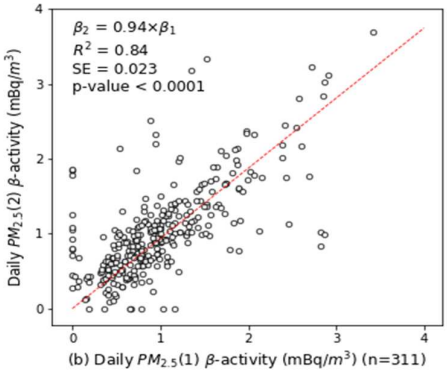
## $PM_{2.5}$ Mass




## LL-α activities

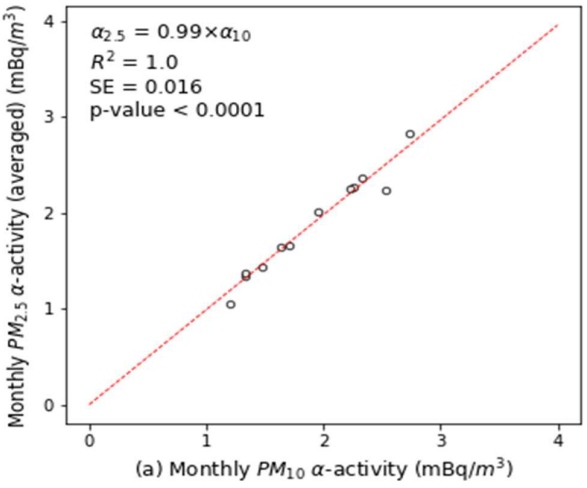



## LL-β activities

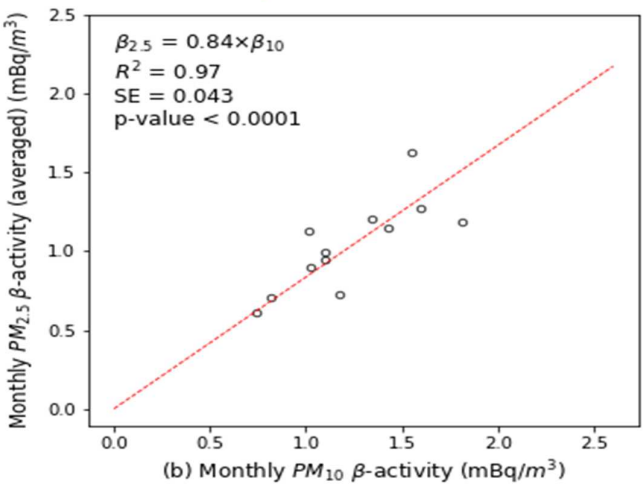


## Comparisons between monthly $PM_{10}$ and $PM_{2.5}$ activities

**LL-α activities**




**LL-β activities**



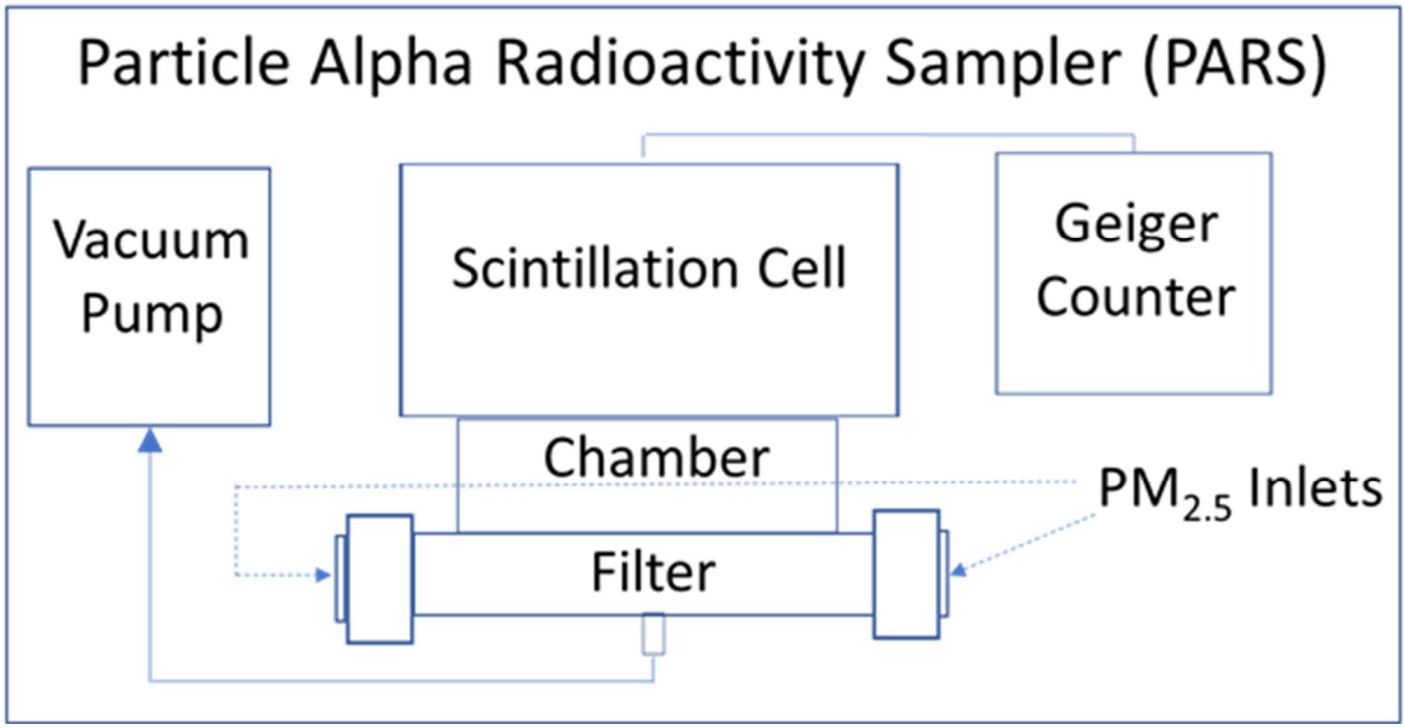

**The majority of $PM_{10}$ activity is associated with that of $PM_{2.5}$**



# Development of a $PM_{2.5}$ SL-α Monitor

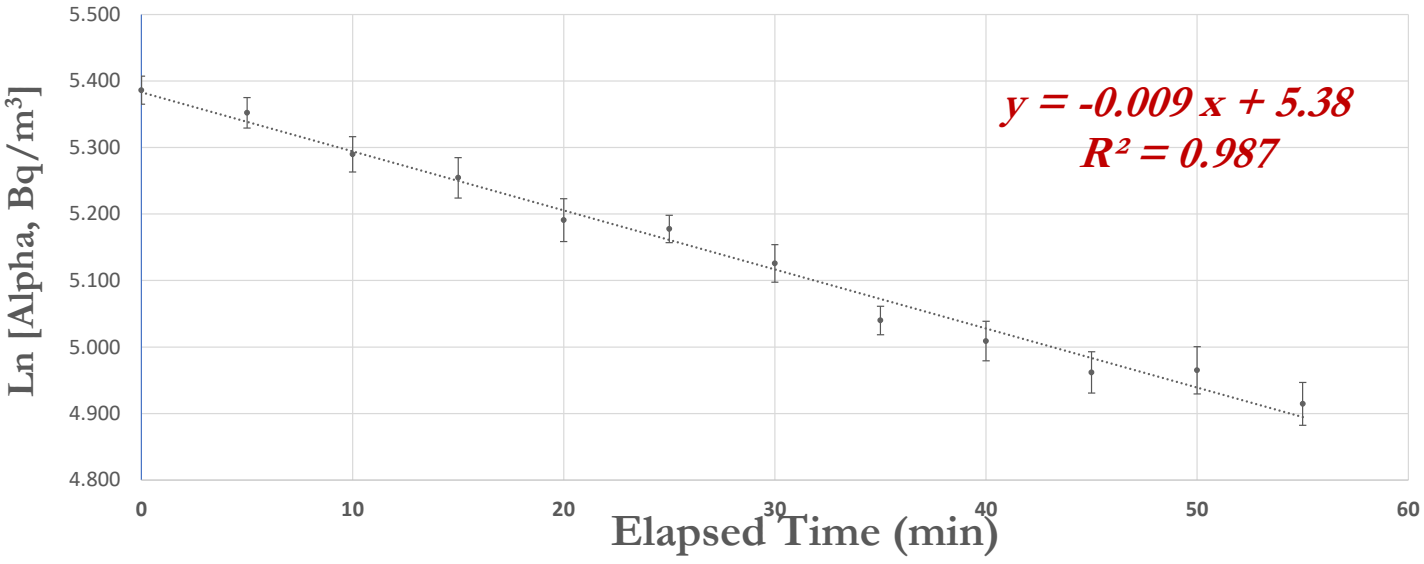
Joy Lawrence et al.

Manuscript in Preparation

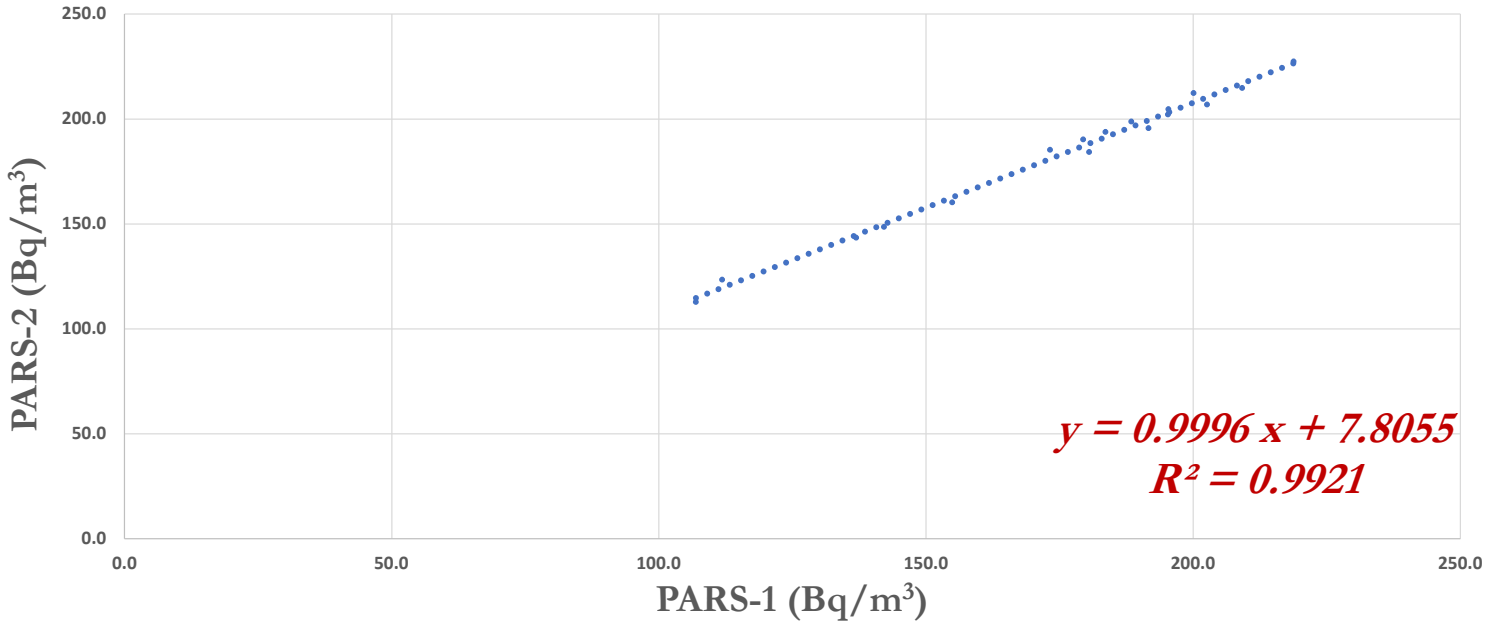



**Although it measures all α-activity (SL and LL) most is from SL-α**

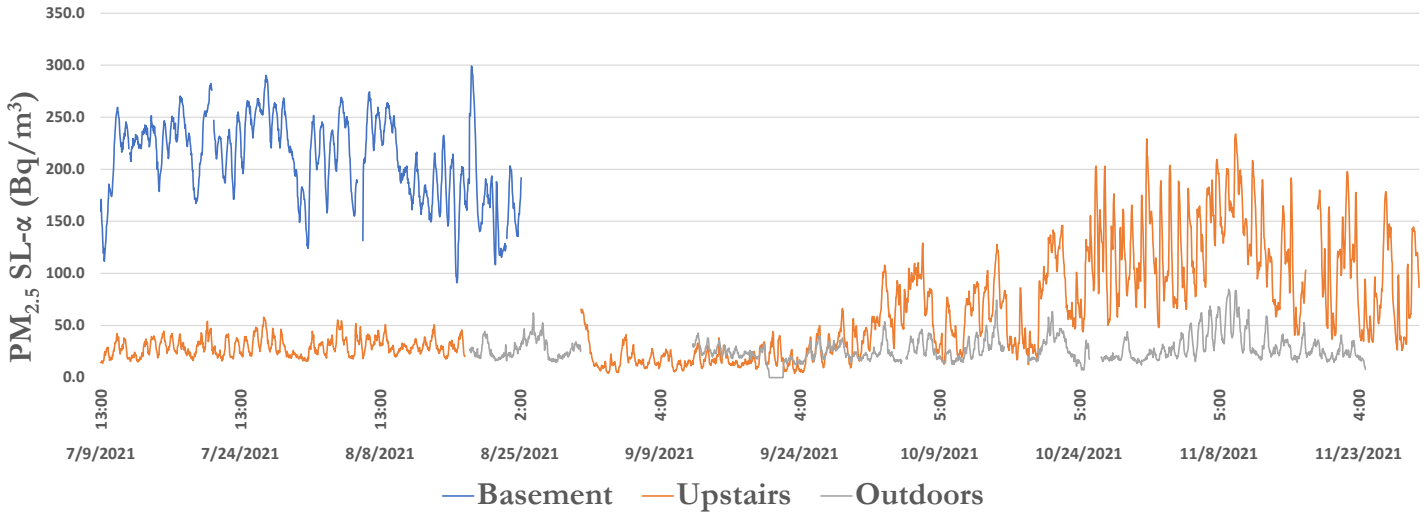
## The decay of sample α-activity suggests that the PARS measures SL-α Polonium from Rn



# Collocation of two PARS prototype devices
## (one hour sampling)

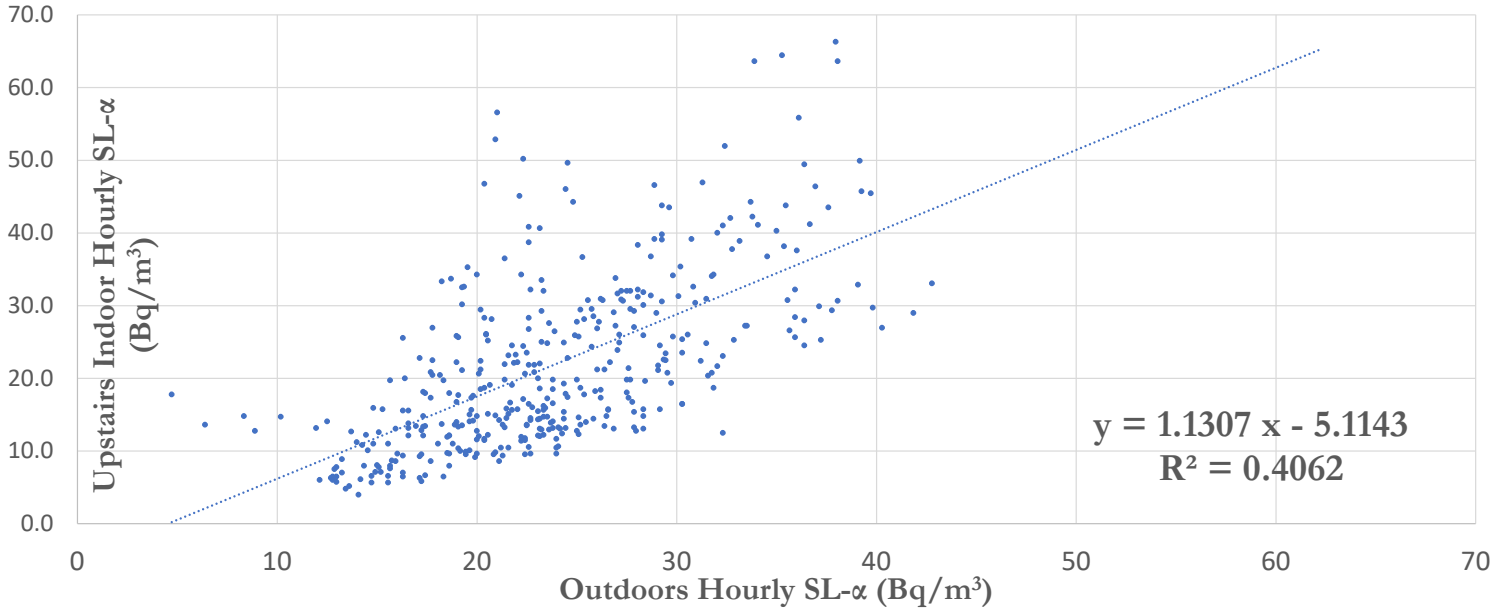



# PARS hourly levels of SL-α activity outdoors and indoors
## (basement and main living area upstairs)

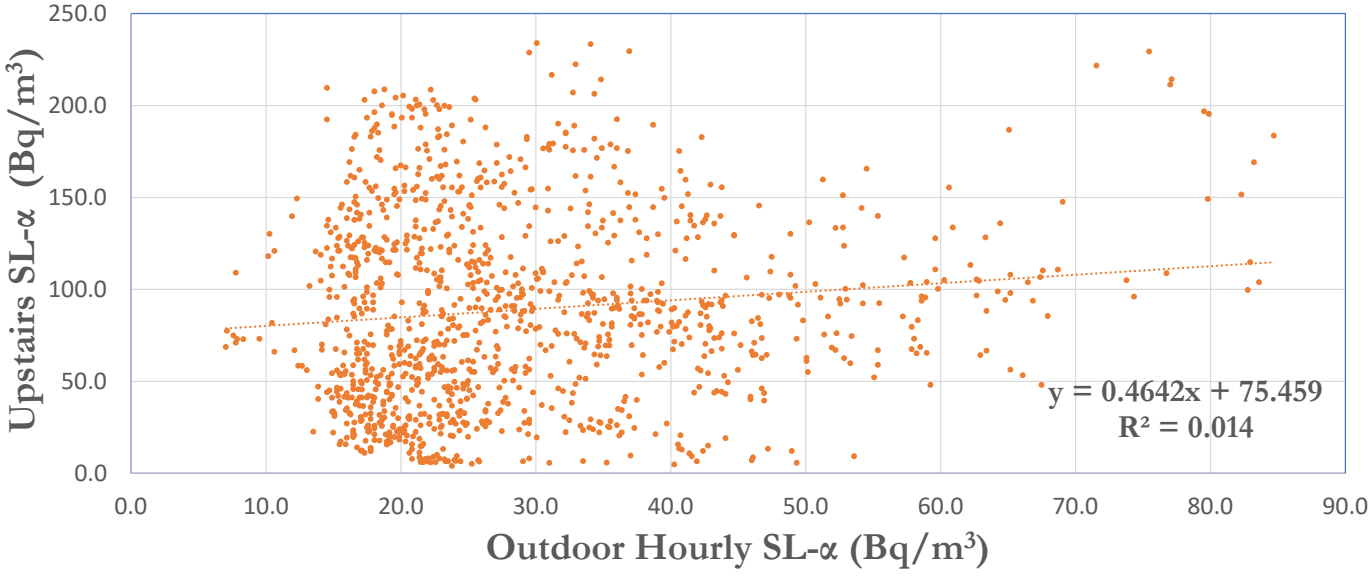



**Note that the SL-α levels (including outdoor) are 3-4 orders of magnitude higher that the LL-α we measure in archived filters**

## Relationship between hourly SL-α activity in the main living area upstairs and outdoors during the summer (July, August, September)




## Relationship between hourly SL-α activity in the main living area upstairs and outdoors during the Autumn (October, November)



# Is PR an indoor or outdoor pollutant?

- Indoor Rn levels are higher, but radon residence time is on the order of a few hours<<Rn half life of 3.8 days
  - Only a small fraction decays
  - High losses on the walls and other surfaces
- Outdoor Rn levels are lower, but residence time is on the order of days>>Rn half life of 3.8 days
  - Most decays
  - Less surface area
- **Answer?** It depends on:
  - Indoor Rn levels
  - Outdoor Rn levels
  - Season (home ventilation rate)
  - Indoor PM levels (higher ambient levels => higher PR exposures)
  - Outdoor PM levels (higher ambient levels => higher PR exposures)

**Regulations are important for PR exposures**

# Outline

- Introduction
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- Health Effects Studies
- Conclusions
- Future Research

# Possible Particle Radioactivity Exposure Data

- **Prospective Measures**
  - PARS SL-α hourly data
- **Retrospective Data**
  - **RadNet Data**
    - LL-β
    - Multi-day samples (moving daily averages)
    - About 100-150 sites depending on the year
  - **Analysis of Archived filters**
    - LL-α and LL-β
    - Mostly daily filters
  - **National Model**
    - LL-β
    - Monthly Estimates
    - 32 x 32 km spatial resolution

”

# A Spatiotemporal Ensemble Model to Predict Gross beta Particulate Radioactivity Across the Contiguous U.S.

Longxiang Li, Annelise J. Blomberg, Joy Lawrence, Weeberb J. Réquia, Yaguang Wei, Man Liu, Adjani A. Peralta, Petros Koutrakis

**Environment International (2021)**

# RadNet Monitors
# Predictors of Particle Radioactivity

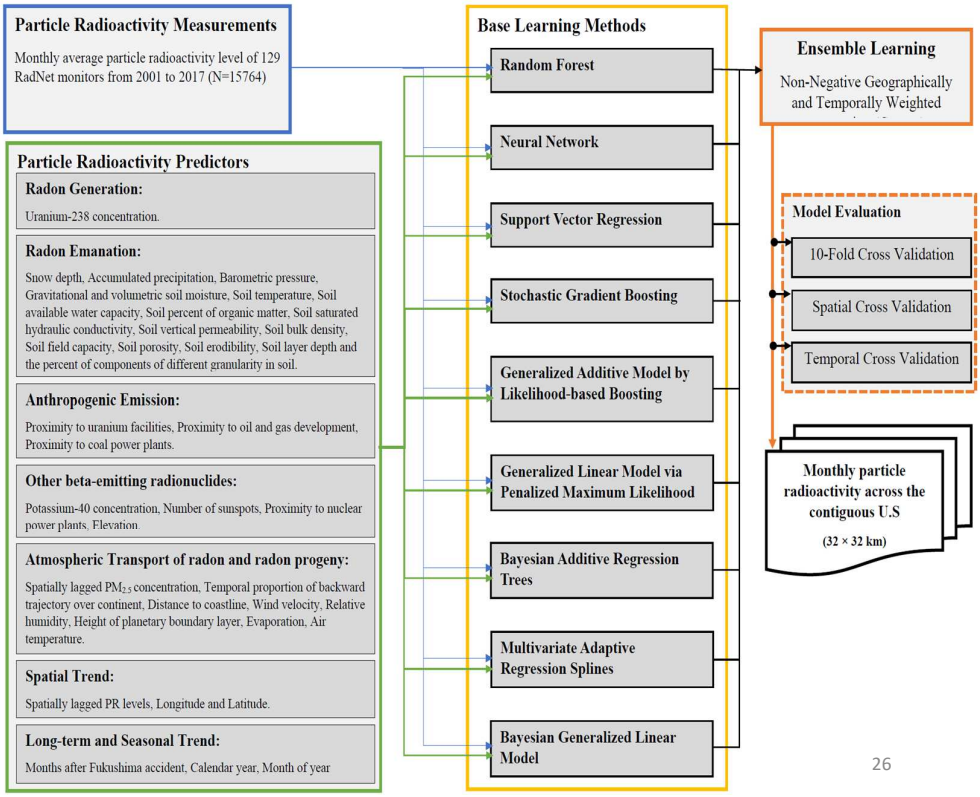


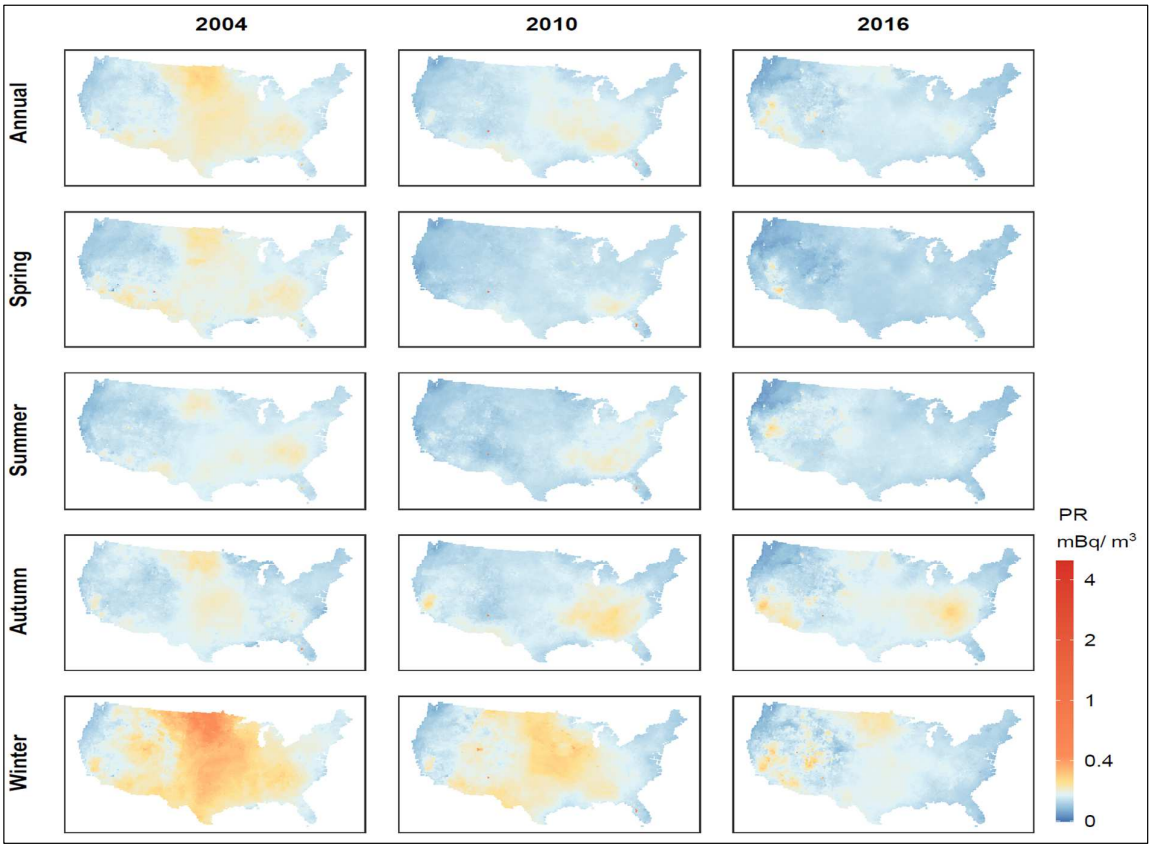

- **Base Learners**
- Model Ensemble
- Performance Metric

**We construct a two-stage model:**

The first stage contains nine distinct machine learning methods to capture the complex (probably non-linear) associations;

The second stage contains a model ensemble method to aggregate multiple predictions.








# Outline

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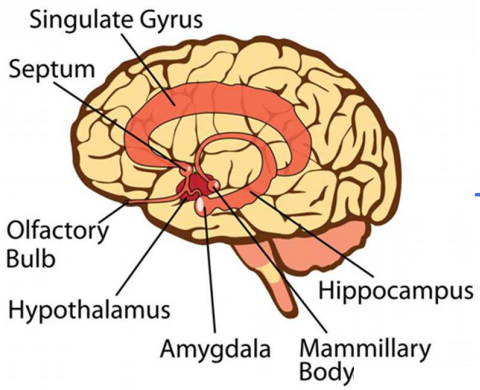
# Levels of Polonium-210 in brain and pulmonary tissues in autopsies conducted in the city of Sao Paulo, Brazil.

Villa dos Santos et al. *Nature Letters (2020)*




**Lungs = 2.3 (±2.2) Bq/kg**

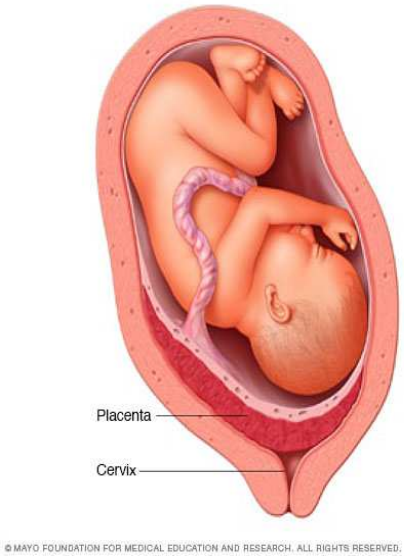
**Olfactory Bulb = 7.2 (±6.1) Bq/kg**

**Olfactory Epithelium = 2.5 (±1.9) Bq/kg**

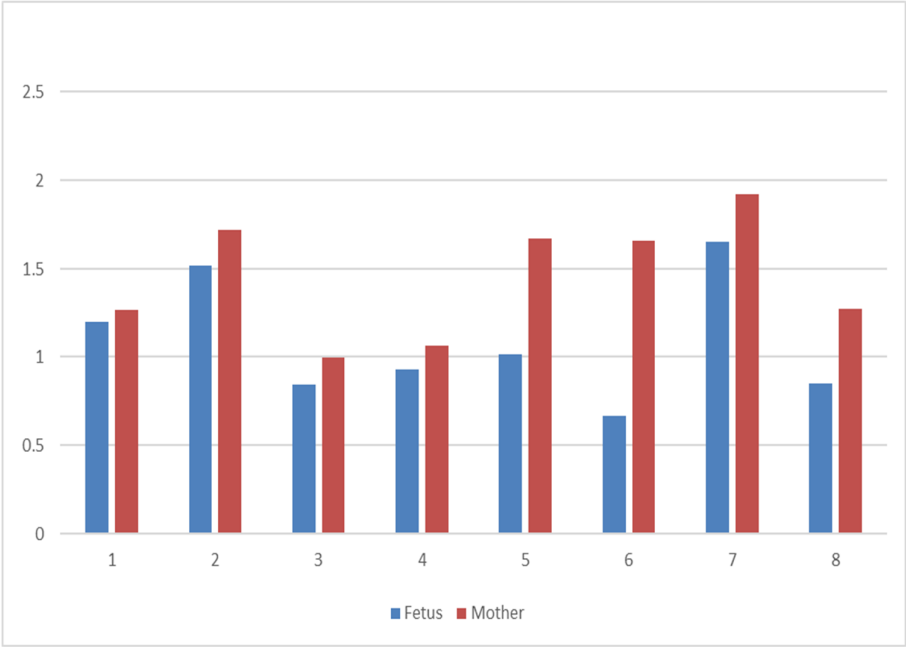
**Frontal Lob = 0.9 (±0.3) Bq/kg**

**1 Bq/kg => 3.6 α particles per gram per hour; α energy about 5 MeV**

## Po-210 in the Placenta of Eight Women in Sao Paulo in Bq/g (Fetus and Mother Sides)





# Particle Radioactivity: A potential driving factor for $PM_{2.5}$ toxicity

Petros Koutrakis[1], Haroula Baliaka[2], Man Liu[1], Choong Min Kang[1], Spyros N. Pandis[3,4], Athanasios Nenes[4,5], Carol Zilli Vieira[1], Longxiang Li[1], Rebecca A. Stern[1]

[1] Harvard T.H. Chan School of Public Heath, Boston, MA, USA
[2] California Institute of Technology, Pasadena, CA, USA
[3] University of Patras, Patras, Greece
[4] Foundation for Research and Technology Hellas, Patras, Greece
[5] École Polytechnique Fédérale de Lausanne, Lausanne, Switzerland

**Manuscript to be submitted to Nature Communications**

## Hypothesis:

- Radiation-emitting PM can lead to the formation of Reactive Oxygen Species (ROS) that induce oxidative damage and cause health effects.
- PR may be an important feature of PM oxidative potential (OP).

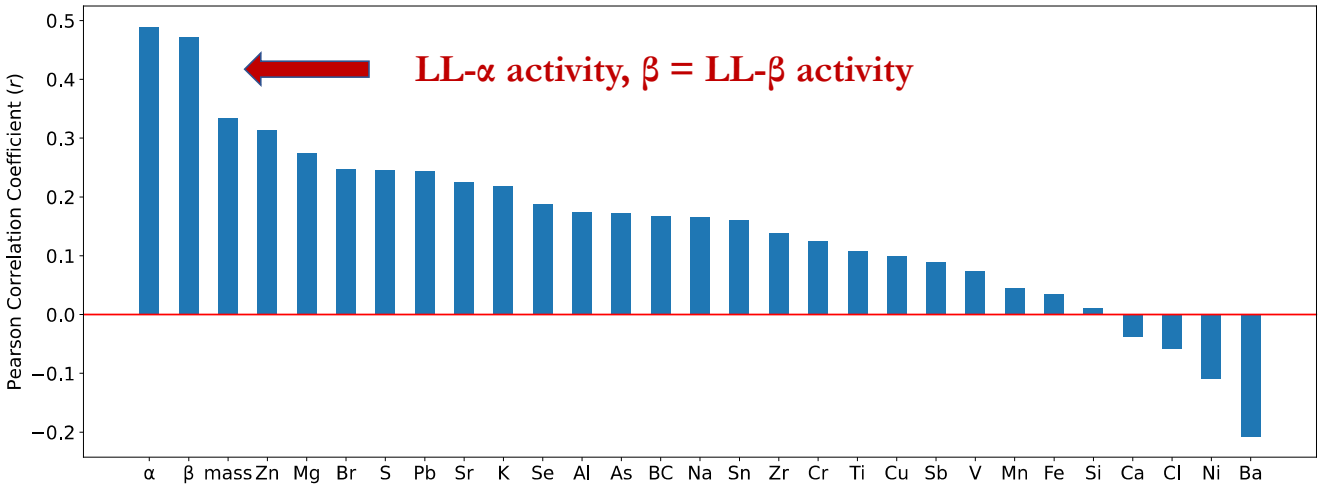
## Objectives:

- Explore the association among gross LL α- and β-activity, mass, chemical components, and **OP of $PM_{2.5}$**.

## Methods:

- We evaluated the associations among $PM_{2.5}$ OP ($N$=60), as measured by the dithiothreitol (DTT) assay, and different properties of $PM_{2.5}$ including α- and β-activity, mass, BC, and 25 other chemical components.

# Pearson correlation coefficient (*r*) between each variable and DTT activity




α = LL-α activity, β = LL-β activity, mass = $PM_{2.5}$ mass, BC = Black Carbon

# Results

- PR had the strongest association with DTTv
- $PM_{2.5}$ mass was next
- $PM_{2.5}$ chemical components had weaker correlations than radiation and mass.
- We regressed OP on PR (either α- or β-activity) and one other variable (mass or chemical component):

$$\boldsymbol{DTTv = c_0 + c_1X_1 + c_2X_2}$$

where $c_0$ is the intercept, $X_1$ is the α- or β-activity, $X_2$ is the $PM_{2.5}$ mass or species

**Only the PR component was a significant predictor ($p<0.001$)**

# Outline

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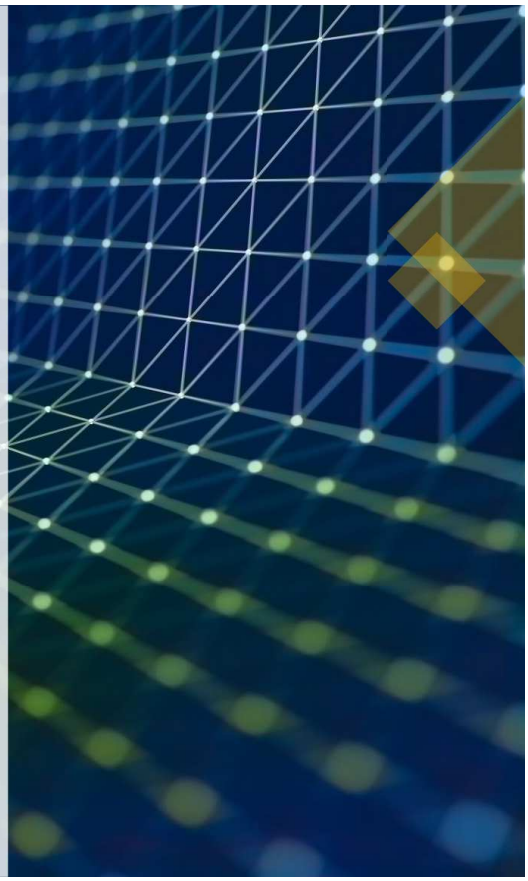


# List of earlier studies of the effects of PR

Gestational Diabetes

Science of the Total Environment 733 (2020) 139340

Contents lists available at ScienceDirect

Oxidative stress and inflammation

Environment International 121 (2018) 1210–1216

Journal of Exposure Science & Environmental Epidemiology (2021) 31:727–735
https://doi.org/10.1038/s41370-020-0204-8

Blood Pressure

Hemoglobin concentrat

Environment International 139 (2020)

Contents lists available at ScienceDirect

Environment International

journal homepage: www.elsevier.com/locate/envint

ELSEVIER

Association between ambient beta particle radioactivity and lower hemoglobin concentrations in a cohort of elderly men

Carolina L.Z. Vieira[a,*], Eric Garshick[b,c,d], Danilo Alvares[e], Joel Schwartz[a], Shaodan Huang[a], P. Vokonas[f,g], Diane R. Gold[a,c], Petros Koutrakis[a]

[a] Department of Environmental Health, Harvard T.H. Chan School of Public Health, Boston, MA, USA
[b] Pulmonary, Allergy, Sleep and Critical Care Medicine Section, VA Boston Healthcare System, Boston, MA, USA
[c] Channing Division of Network Medicine, Department of Medicine, Brigham and Women's Hospital, Boston, MA, USA
[d] Harvard Medical School, Boston, MA, USA
[e] Department of Statistics, Pontificia Universidad Catolica de Chile, Macul, Santiago, Chile
[f] VA Normative Aging Study, VA Boston Healthcare System, Boston, MA, USA
[g] School of Medicine and Public Health, Boston University, Boston, USA

Circulation

Ventricular Arrhythmias

Lung Function

Contents lists available at ScienceDirect

Environment International

Environmental Research

journal homepage: www.elsevier.com/locate/envres

Renal Function

Environment International 131 (2019) 105018

Contents lists available at ScienceDirect

Environment International

journal homepage: www.elsevier.com/locate/envint

Short-term ambient particle radioactivity level and renal function in older men: Insight from the Normative Aging Study

Xu Gao[a,*], Petros Koutrakis[b], Annelise J. Blomberg[b], Brent Coull[c], Pantel Vokonas[d], Joel Schwartz[b], Andrea A. Baccarelli[a]

[a] Department of Environmental Health Sciences, Mailman School of Public Health, Columbia University, New York, NY, USA
[b] Department of Environmental Health, Harvard T.H. Chan School of Public Health, Boston, MA, USA
[c] Department of Biostatistics, Harvard T.H. Chan School of Public Health, Boston, MA, USA
[d] Veterans Affairs Normative Aging Study, Veterans Affairs Boston Healthcare System, Department of Medicine, Boston University School of Medicine, Boston, MA, USA

# Synergistic Effects of Particle Radioactivity (LL-β) and $PM_{2.5}$ on Cardiovascular Disease Mortality

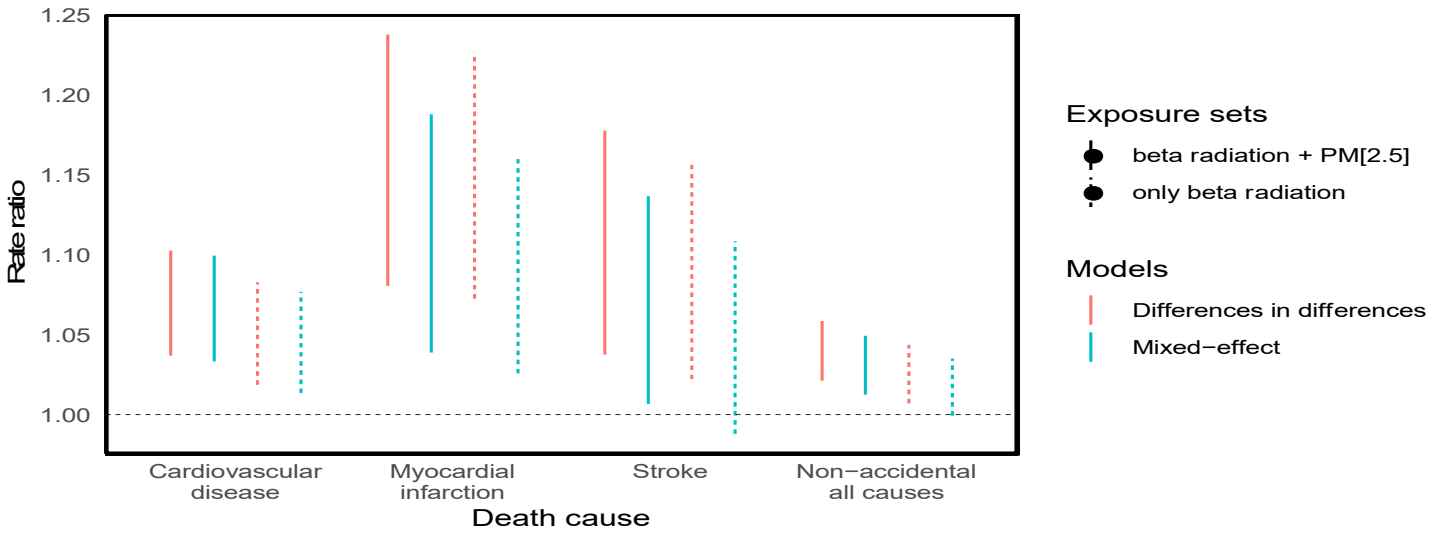
Shuxin Dong, Petros Koutrakis, Longxiang Li, Brent A. Coull, Joel Schwartz, Anna Kosheleva, Antonella Zanobetti

**Journal of the American Heart Association**
**under second review**

# MA Death Registry

- **Every death in MA from 2001 to 2015**
  - 743,873 non-accidental deaths in total
  - Data for residential address and underlying cause of death as ICD codes
  - Included deaths by cause of: All causes, CVD, MI, and Stroke
- **Spatiotemporal models for $PM_{2.5}$ LL-β activity and mass**
  - Assigned annual average exposures by ZCTA and by year
- **Method I: differences-in-difference (DID) approach**
  - A causal inference method that by design addresses the potential for both measured and residual confounding
- **Method II: generalized linear mixed model (GLMM)**
  - Included random intercept for each ZCTA and use a quasi-Poisson assumption for the outcome to allow for overdispersion

Rate Ratio for an **IQR (0.055 mBq/m³) increase in LL-β activity** using both GLMM and DID and exposures: LL-β+$PM_{2.5}$ and LL-β alone.

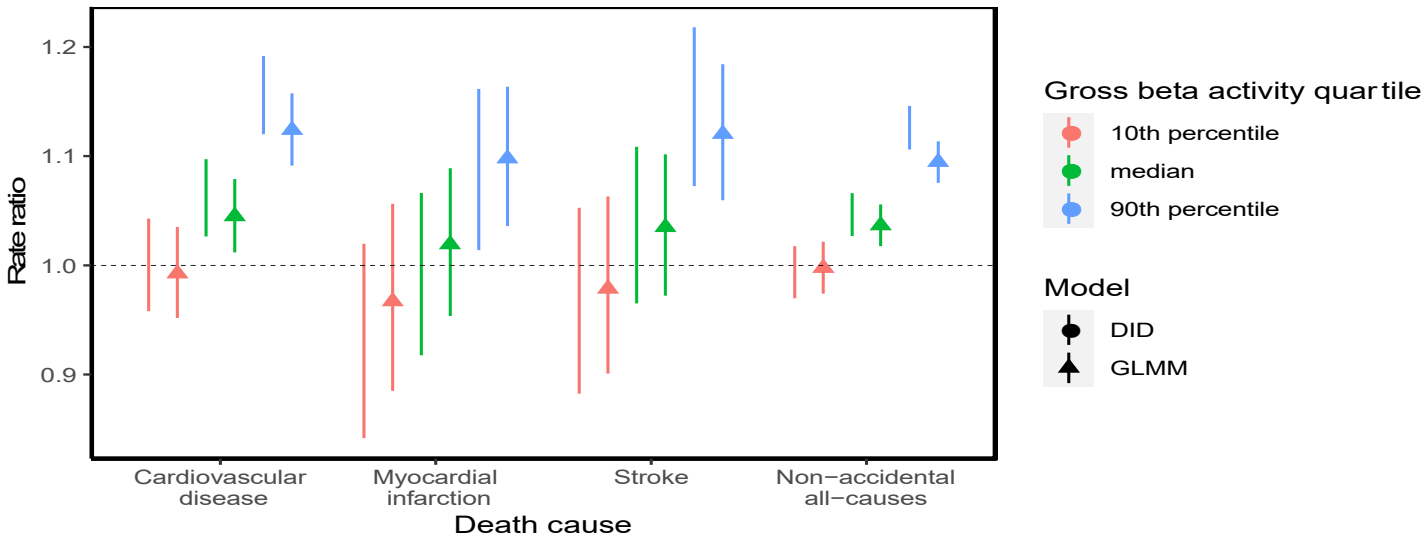



**GLMM and DID results are comparable and $PM_{2.5}$ adjustment had little effect**

→ **LL-β is independently associated with CVD mortality**



Rate ratios for **an IQR (2.82 μg/m³) increase in $PM_{2.5}$** at the 10, 50, and 90th percentile of the LL-β activity distribution using both GLMM and DID.




**The association between $PM_{2.5}$ and mortality is stronger at higher levels of LL-β**

→ **LL-β enhances $PM_{2.5}$ effect on CVD mortality**

# Outline

- Introduction
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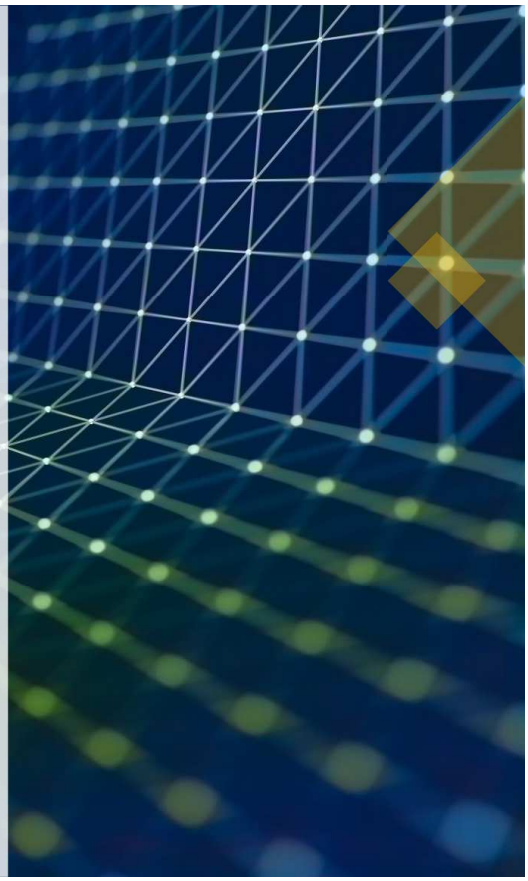

# Conclusions

- Sufficient evidence on the health effects of PR from both population and cohort studies
- PR may be an important contributor to PM toxicity
  - This research is important for NAAQS
- Measurements of SL-α and SL-β will be important to investigate the role of PR in PM toxicity
- Much of PR is related to Rn
  - **Rn problem:**
    - Both an indoor and outdoor pollutant
    - Has many non cancer effects

# Outline

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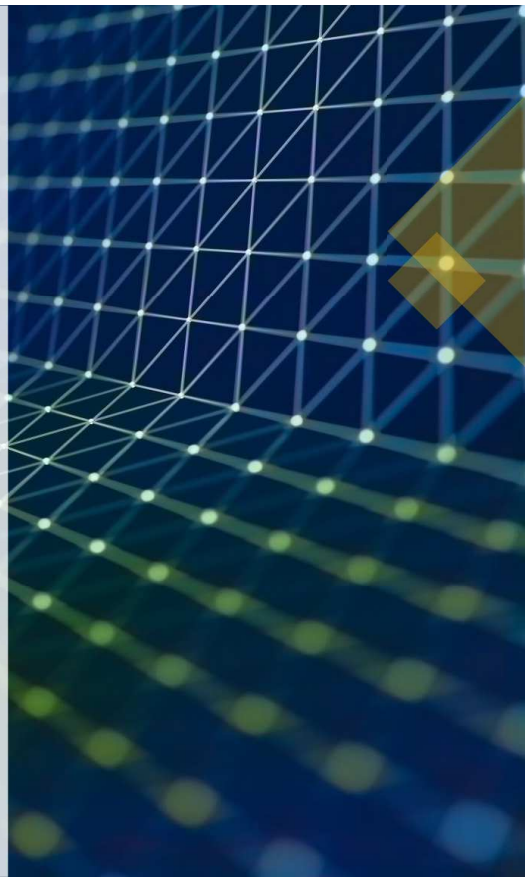


# Future Research

- Measurements of PR by networks and individual studies
  - Ideally real time SL-α
- Exposure assessment studies
  - Impact of indoor and outdoor Rn on PR
- Biomarker studies
  - Replication of DTT study with more samples and more locations
- More PR health studies using data from RadNet or National model
  - Prospective studies should measure SL-α

- **Collaborations:** We can make data, technology and knowledge available

# Acknowledgments


- Colleagues and other research groups who have participated in this research


THANKS

# Indoor Air: Science, Technology, and Health Effects

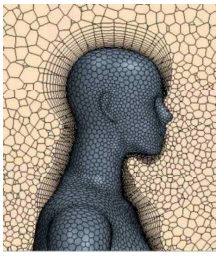
World Air Day Celebration Forum
September 7, 2022

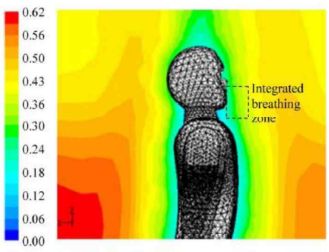
Donghyun Rim, Ph.D.
Director, PSU BREATHE (Building Research for Energy, Atmosphere, and Health) Center
The Pennsylvania State University
University Park, PA, USA

PENNSTATE 1855

## PSU BREATHE (Building Research for Energy, Atmosphere, and Health)



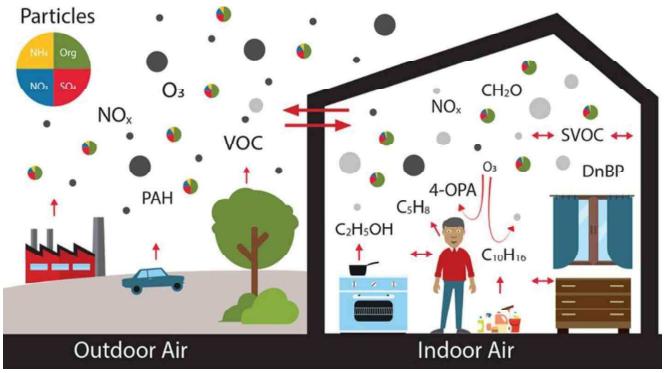





NSF · DEPARTMENT OF ENERGY · NIH · ALFRED P. SLOAN FOUNDATION 1934 · Alfred P. Sloan FOUNDATION

# People spend time …..

- Indoors 89%
  - 18 hours indoors for every 1 outdoors
  - 2/3 of time in home
- Transit 6%
- Outdoors 5%




Indoor air ≠ outdoor air

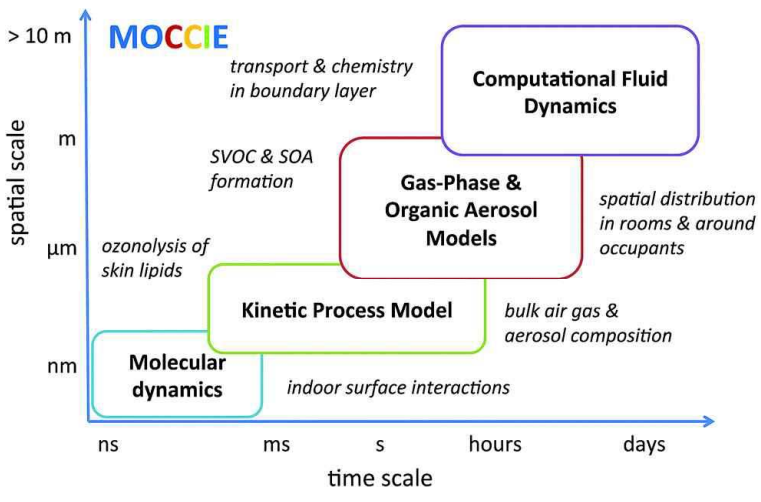
*Source: Goldstein, A. H, et al.. (2020). Klepeis et al. (2000), European Commissions (2004), Leech et al. (1996), Farrow et al. (1997),



# Chemistry of Indoor Environments (CIE) Program

ALFRED P. SLOAN FOUNDATION

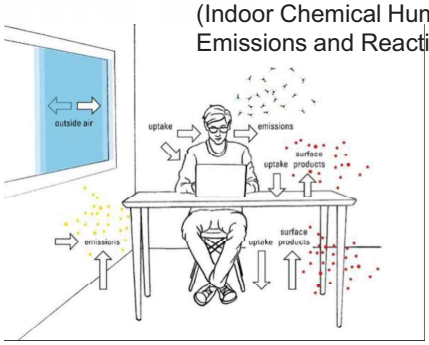
To grow a new field of scientific inquiry focused on understanding the fundamental chemistry taking place in indoor environments and how that chemistry is shaped by building attributes and human occupancy.



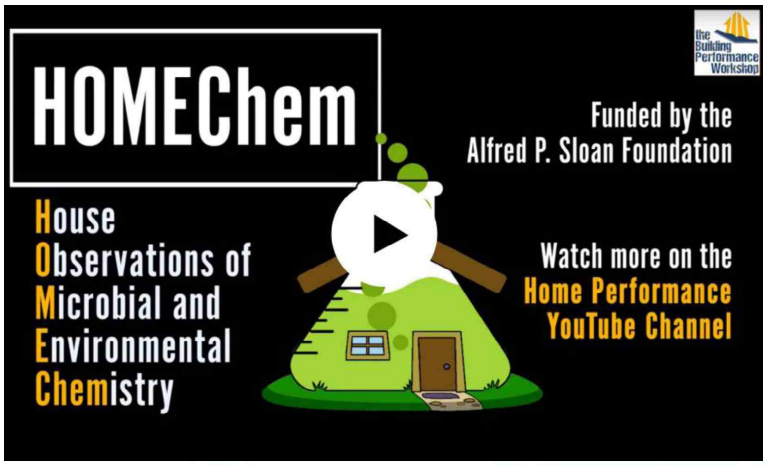

Indoor Chem

HOMEChem
(House Observation of Microbial & Environmental Chemistry)

ICHEAR
(Indoor Chemical Human Emissions and Reactivity)



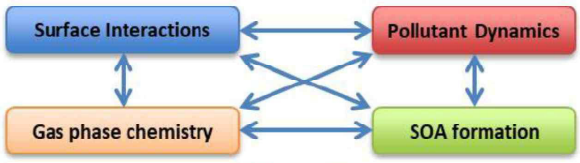
# HOMEChem Field Campaign (Austin, TX)





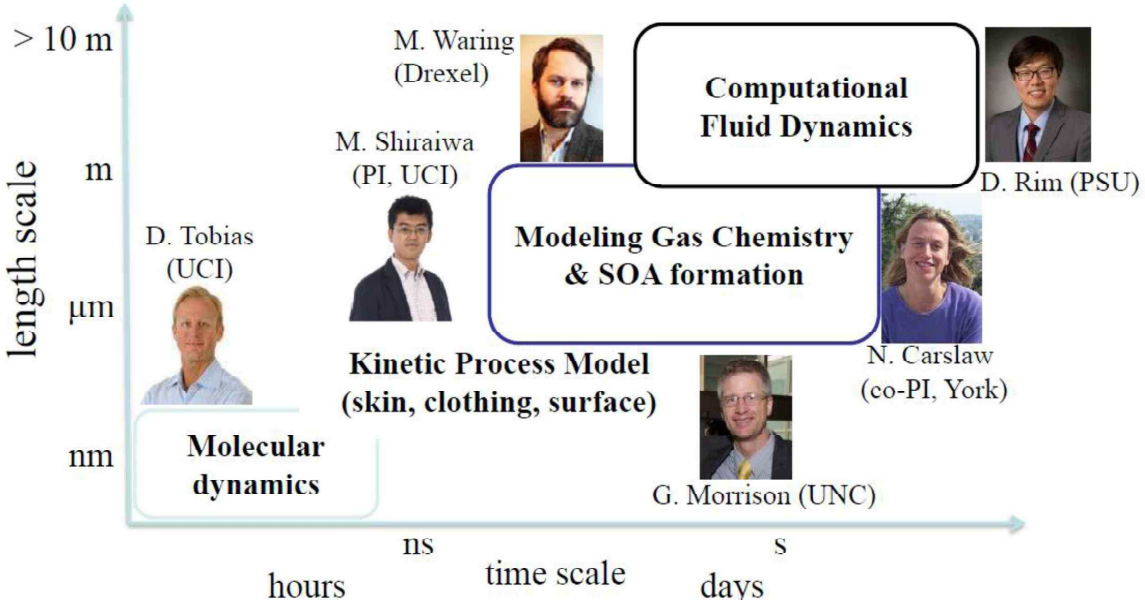

# Modeling Consortium for Indoor Chemistry

MOdelling Consortium for Chemistry of Indoor Environments



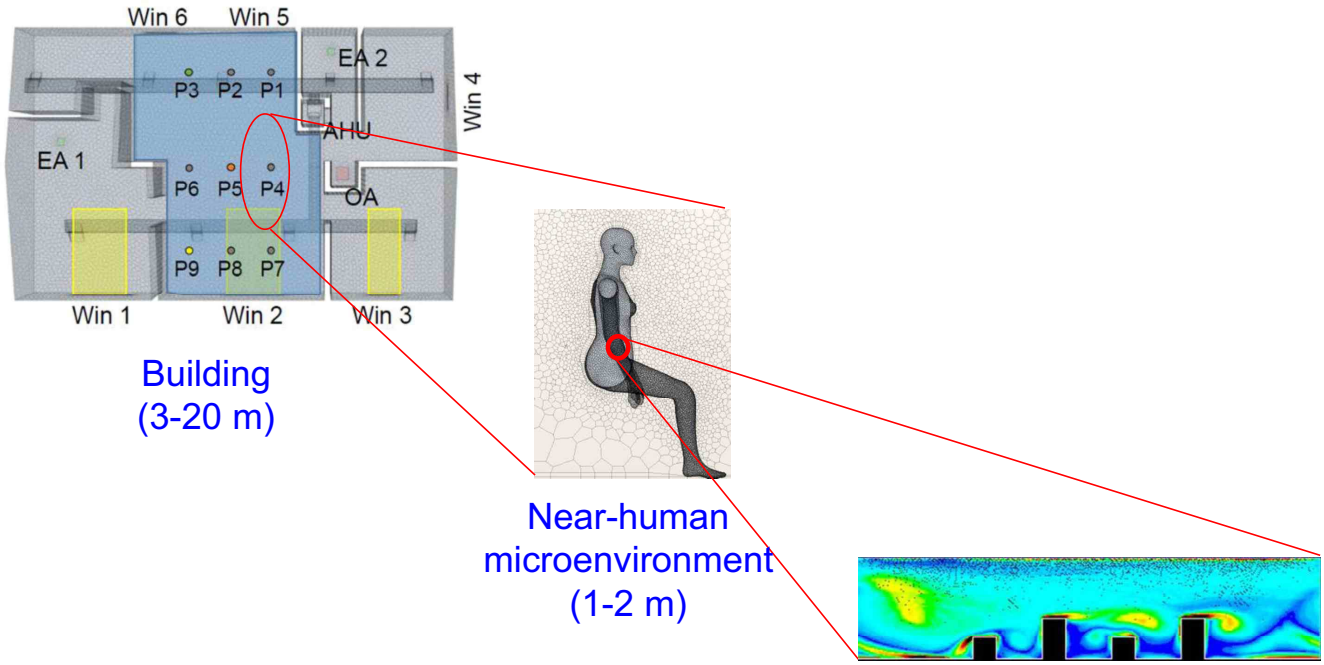

MOCCIE

Alfred P. Sloan FOUNDATION



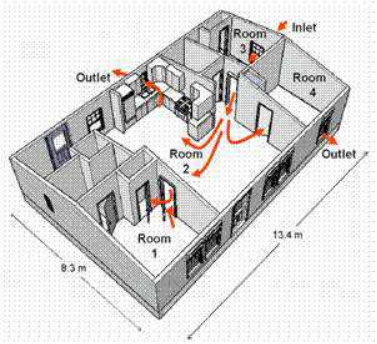
# Study objective

- Establish a framework for modeling gas-phase and surface reactions in indoor environments



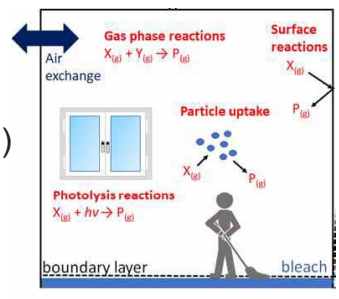

# Building scale: bleaching chemistry


UTestHouse



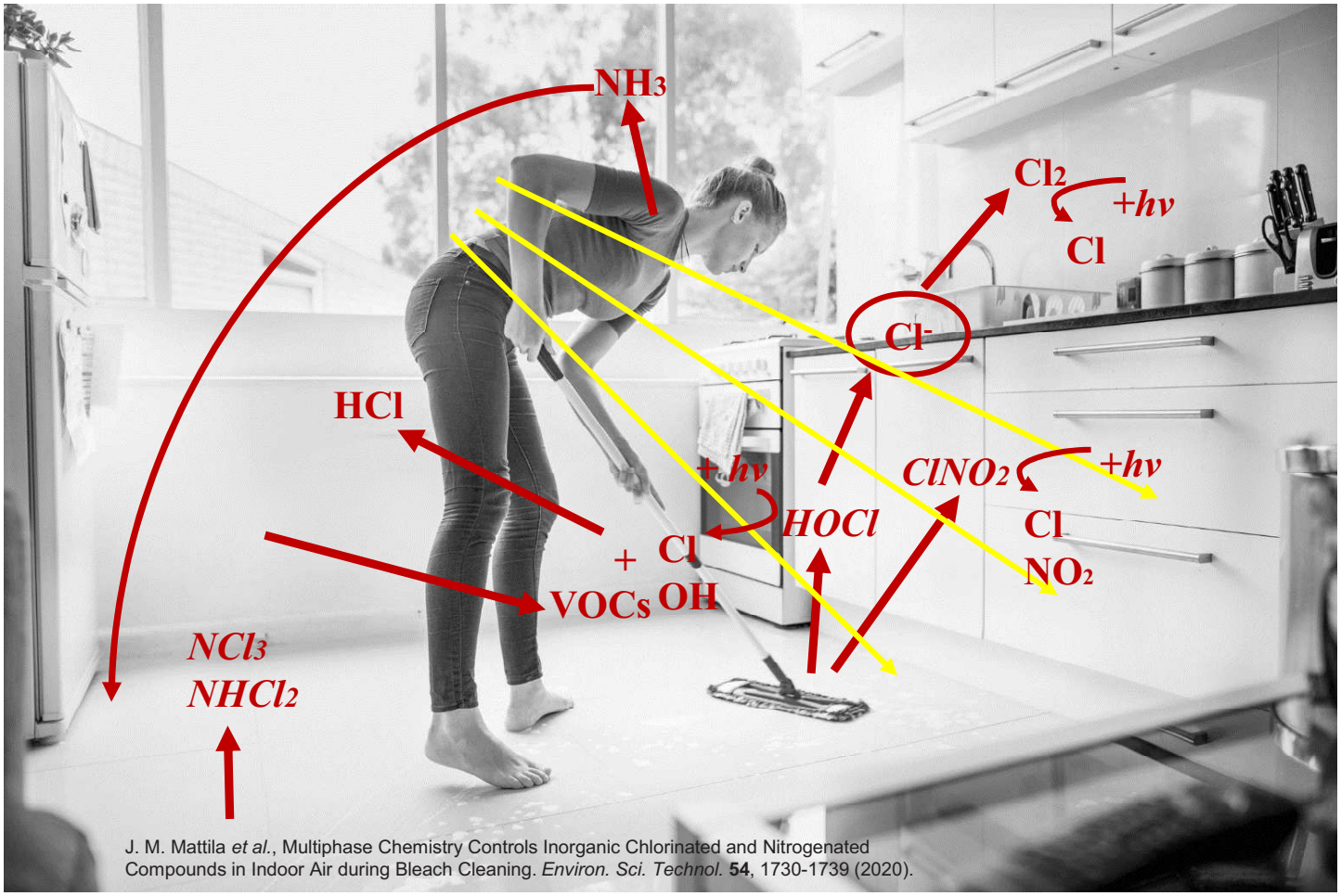

Experimental condition (HOMEChem Test House @ UT Austin)

- Area: 110 $m^2$
- Volume: 250 $m^3$
- Air exchange rate: 0.7 $h^{-1}$
- Cleaning area (kitchen & living room): 40 $m^2$
- Cleaning for 15 minutes and measuring for 2 hours
- Time-of-flight chemical ionization mass spectrometer (TOF-CIMS)
- Air mixing rate by air handling unit (AHU): 8 $h^{-1}$



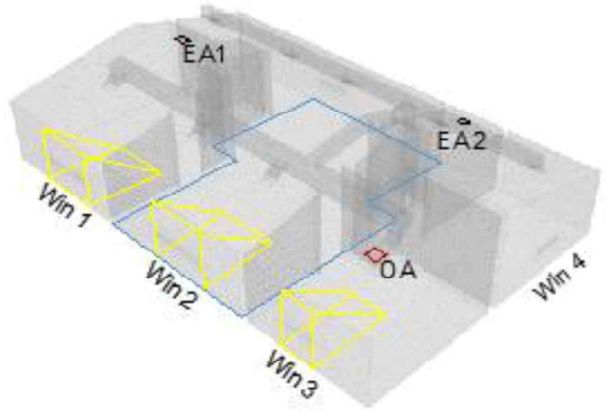

J. M. Mattila *et al.*, Multiphase Chemistry Controls Inorganic Chlorinated and Nitrogenated Compounds in Indoor Air during Bleach Cleaning. *Environ. Sci. Technol.* **54**, 1730-1739 (2020).

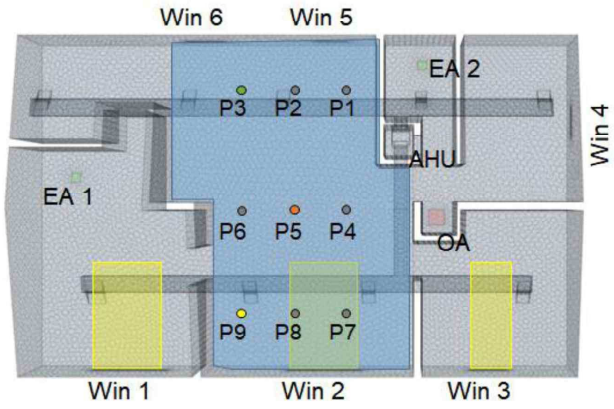
# Bleaching chemistry




J. M. Mattila *et al.*, Multiphase Chemistry Controls Inorganic Chlorinated and Nitrogenated Compounds in Indoor Air during Bleach Cleaning. *Environ. Sci. Technol.* **54**, 1730-1739 (2020).

# Chemical reactions & transport



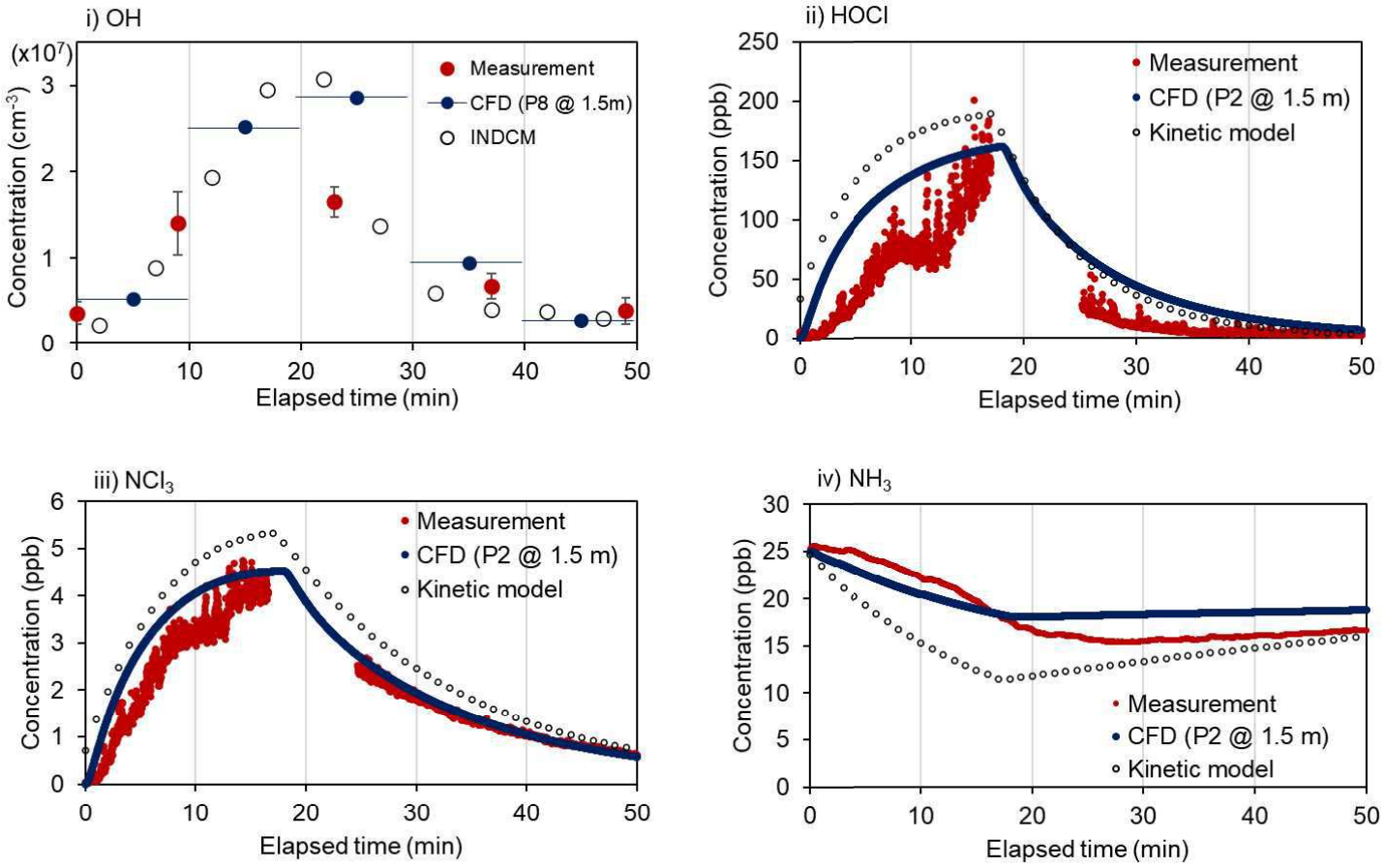




1) $HOCl + Cl^-$(aerosol surface) → $Cl_2 + H_2O$
2) $ClNO_2 + h\nu → NO_2 + Cl$
3) $HOCl + h\nu → OH + Cl$
4) $Cl_2 + h\nu → 2Cl$
5) $Cl +$ VOCs → $HCl +$ CHO
6) $OH +$ VOCs → $CHO + H_2O$

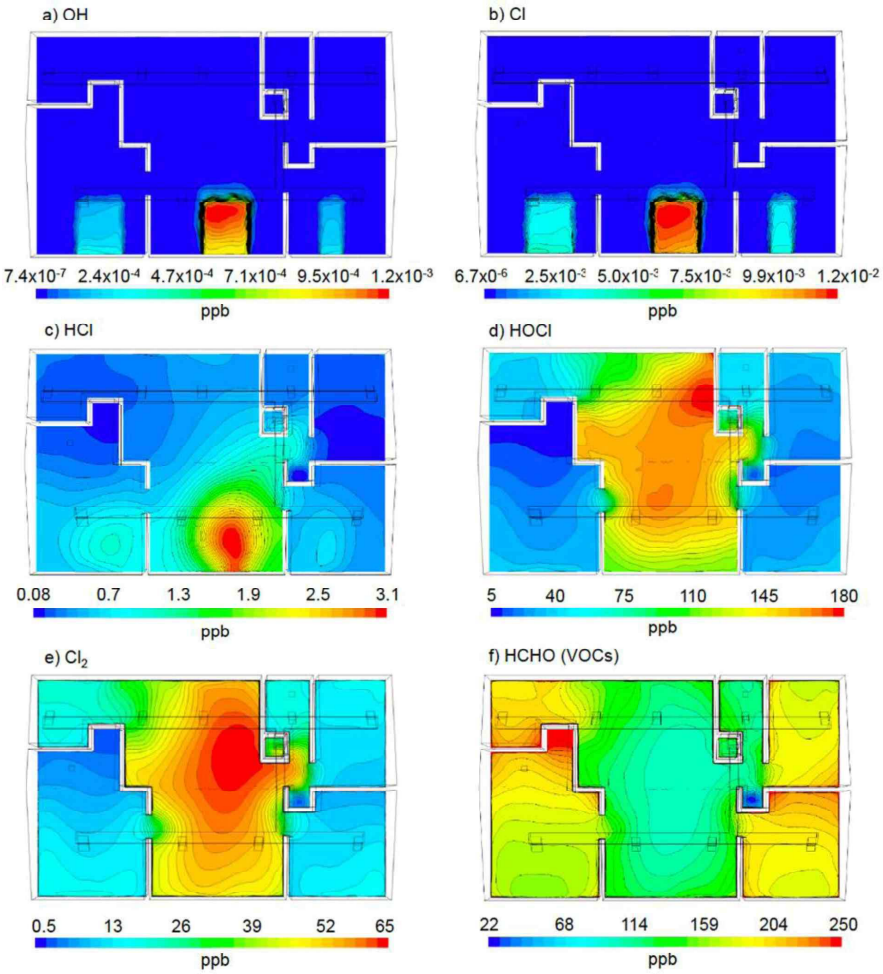
$$\frac{\partial(\rho\phi)}{\partial t} + div(\rho\phi\mathbf{u}) = div(\Gamma\, grad\,\phi) + S_\phi$$

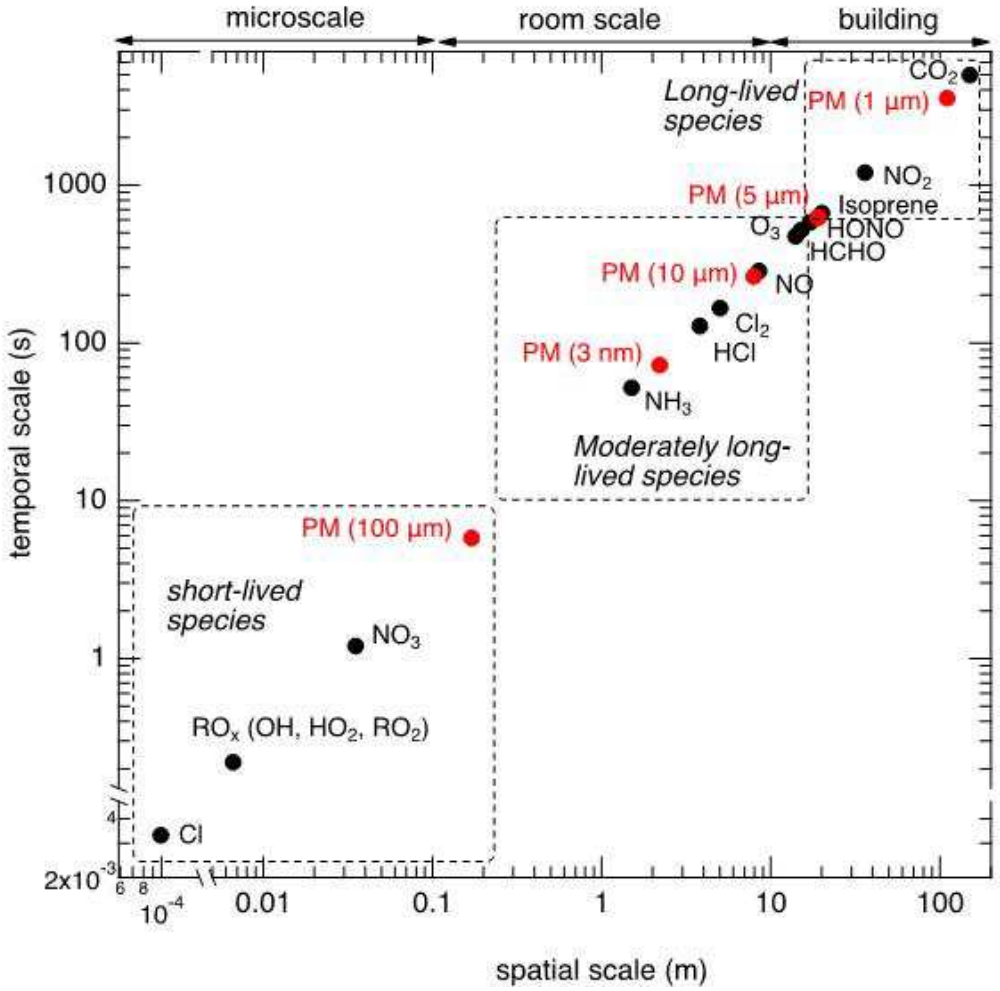
7) $Cl_2 +$ room surface → Products
8) $ClNO_2 +$ room surface → Products
9) $NCl_3 +$ room surface → Products
10) $ClNO_2 +$ room surface → Products
11) $NH_3 +$ bleach surface → Products
12) $NHCl_2$ → Surface deposition
13) $Cl_2O$ → Surface deposition

# Measurement vs. Model




# Spatial distributions of species are nonhomogeneous






### a) Temporal scale

$$t_{\frac{1}{2}} = \frac{ln\,2}{(\lambda+\gamma+J+k)}$$

$t_{\frac{1}{2}}$ = Half-life

$\lambda$ = ventilation rate

$\gamma$ = deposition rate

$J$ = photolysis rate

$k$ = reaction rate

### b) Spatial scale

Distance = $\bar{v}\ t_{\frac{1}{2}}$

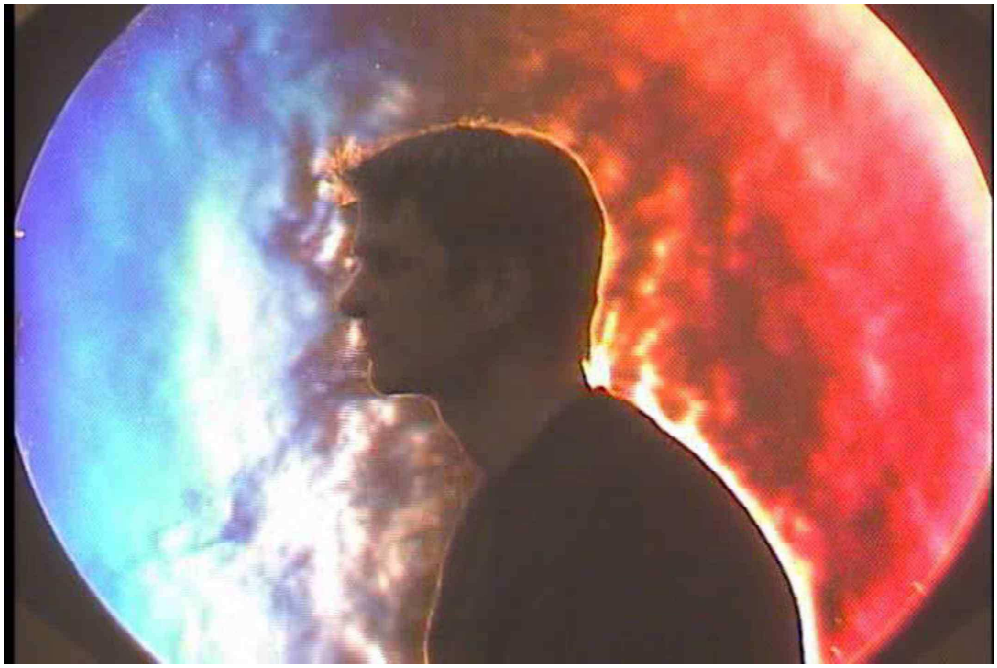
$\bar{v}$ = Room average air velocity $(m/s)$


Lakey, P. S., Won, Y., Shaw, D., Østerstrøm, F. F., Mattila, J.,... Rim, D., & Shiraiwa, M. (2021). Spatial and temporal scales of variability for indoor air constituents. *Communications Chemistry*, 4(1), 1-7.

McDonald, B. C., De Gouw, J. A., Gilman, J. B., Jathar, S. H., Akherati, A., Cappa, C. D., ... & Trainer, M. (2018). Volatile chemical products emerging as largest petrochemical source of urban organic emissions. *Science*, *359*(6377), 760-764.

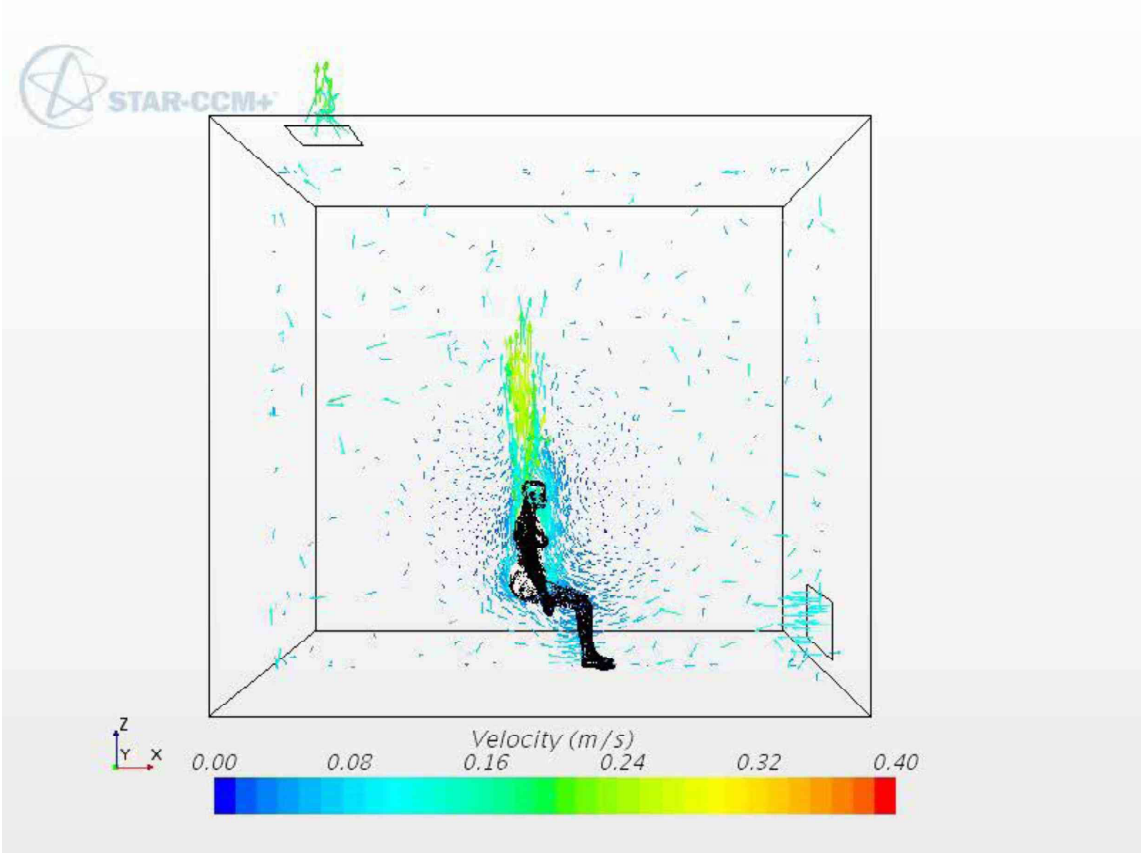

# Near human microenvironment

## Thermal plume: airflow around human body



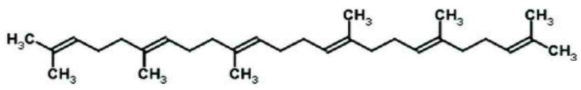
*Source: Gas Dynamics Lab (Dr. Gary Settle), Penn State Univ.

# Near human microenvironment

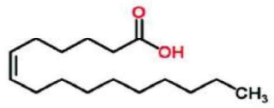



# Human surface as a chemical sink

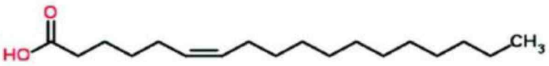
http://morganbullard.com/jergens-wet-skin-moisturizer-10-tips-to-prevent-dry-skin-this-winter/



Squalene



cis-Hexadec-6-enoic acid (sapienic acid)



cis-Octadec-6-enoic acid (petroselinic acid)

1) Skin lipids : fatty acid(25%), glycerol (25%), squalene(10%) [Nicolaides N (1974)]

2) Squalene has six carbon-carbon double bonds meaning that it reacts with ozone very easily.

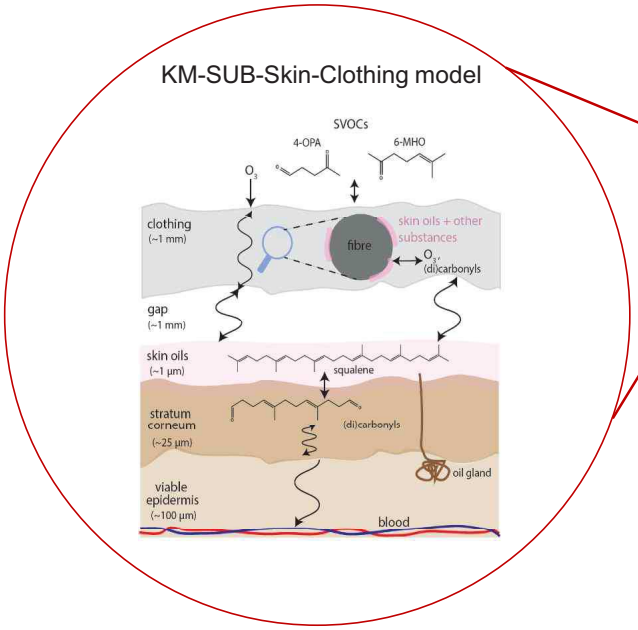
3) Squalene is responsible for 50% of ozone consumption

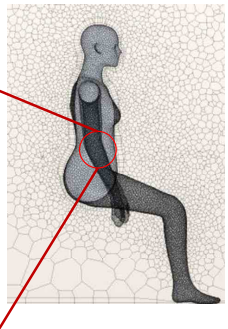
4) Primary products of squalene: 6-MHO, Geranyl acetone, Acetone

5) Secondary products of squalene: 4-OPA, 4-MON, 4-MOD [Fruekilde P et al. (1998)]

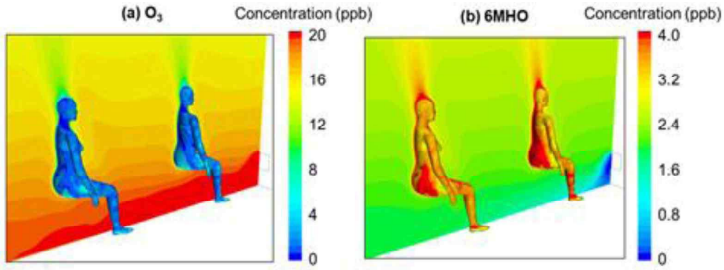
Wisthaler, A., & Weschler, C. J. (2010). Reactions of ozone with human skin lipids: sources of carbonyls, dicarbonyls, and hydroxycarbonyls in indoor air. *Proceedings of the National Academy of Sciences*, *107*(15), 6568-6575.

# Surface uptake of ozone



Won, Y., Lakey, P. S., Morrison, G., Shiraiwa, M., & Rim, D. (2020). Spatial Distributions of Ozonolysis Products From Human Surfaces In Ventilated Rooms. *Indoor Air*.

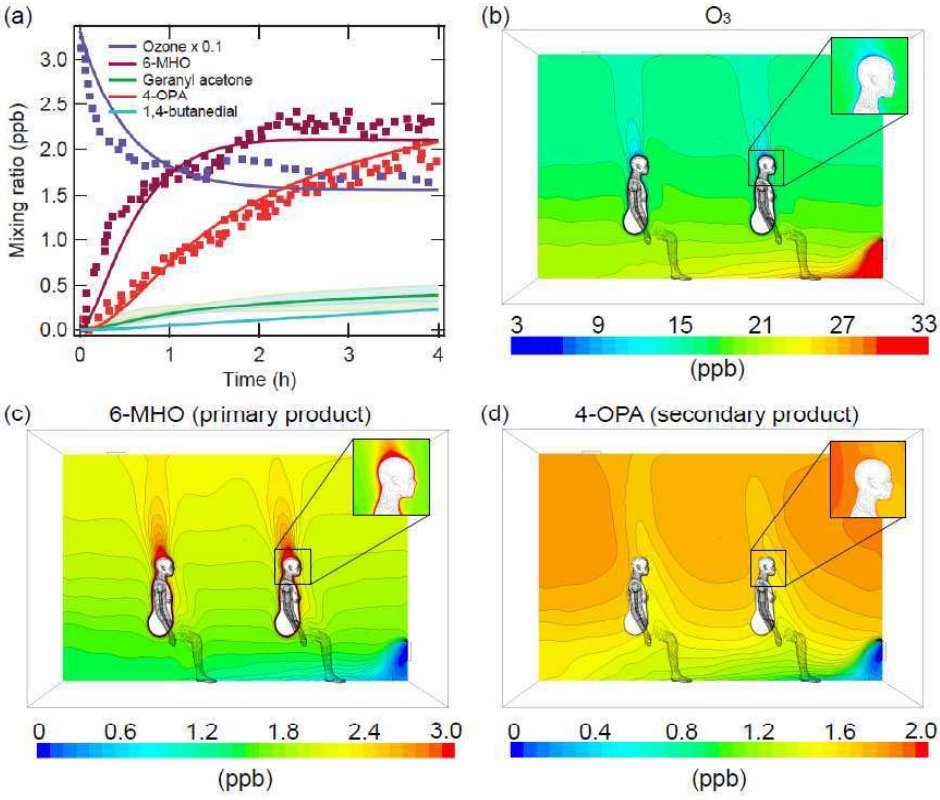



1. 6-MHO + $O_3$ → 4-OPA + Acetone — $k_g = 4.3 \times 10^{-16}$ cm$^3$ s$^{-1}$
2. Geranyl acetone + $O_3$ → 1/2 4-OPA + 1/2 4-MON + 1/2 Acetone + 1/2 6-MHO — $k_g = 8.6 \times 10^{-16}$ cm$^3$ s$^{-1}$
3. 4-MOD + $O_3$ → 4-OPA +1,4 butanedial — $k_g = 4.3 \times 10^{-16}$ cm$^3$ s$^{-1}$
4. 4-MON + $O_3$ → 2 4-OPA — $k_g = 4.3 \times 10^{-16}$ cm$^3$ s$^{-1}$

# Near-human pollutant dynamics

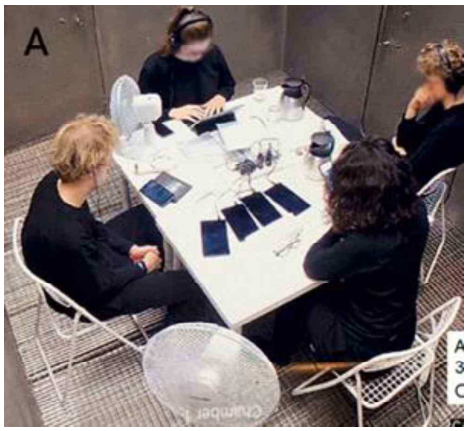
## Human skin and breath emissions

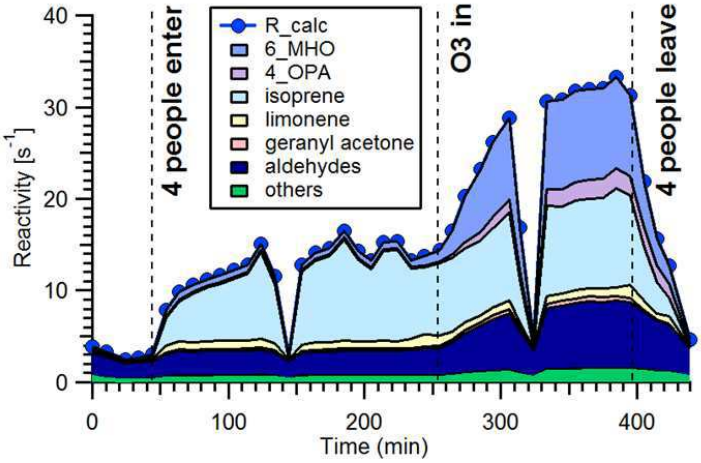
- Primary vs. secondary oxidation products



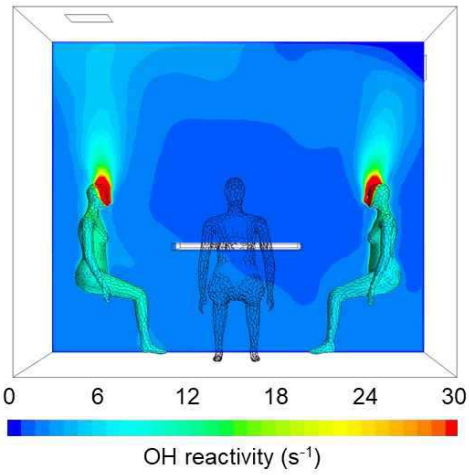

Won, Y., Lakey, P. S., Morrison, G., Shiraiwa, M., & Rim, D. (2020). Spatial Distributions of Ozonolysis Products From Human Surfaces In Ventilated Rooms. *Indoor Air*.

# OH Reactivity & Oxidation Field

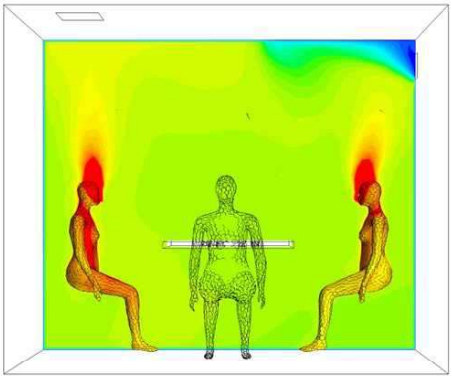



a) OH reactivity at elapsed time of 253 min




c) OH reactivity at elapsed time of 360 min



# Personal reactive clouds

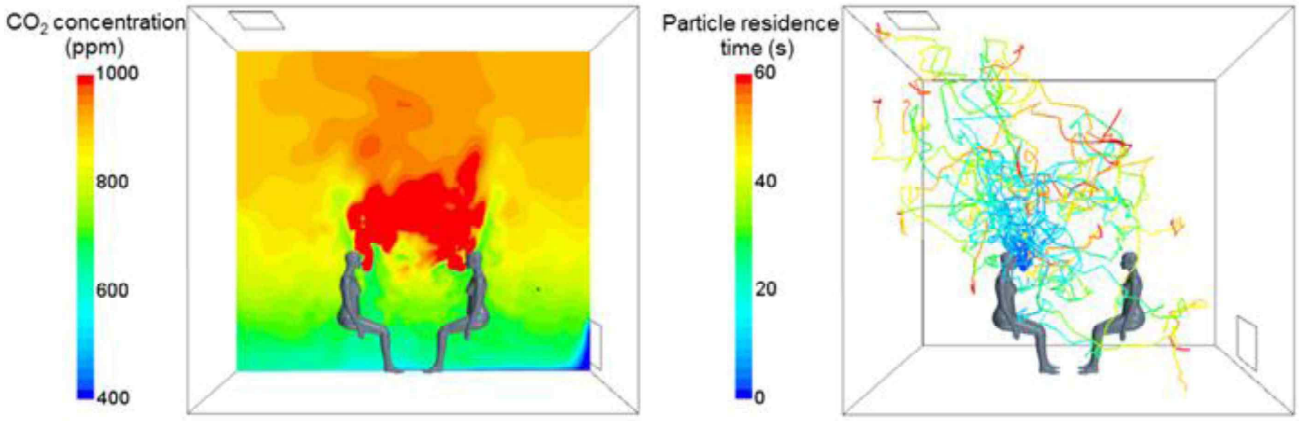



N. Zannoni, J. Williams, M. Shiraiwa, D. Rim (2022) "The Human Oxidation Field." accepted to *Science*

# Transport of airborne viral particles

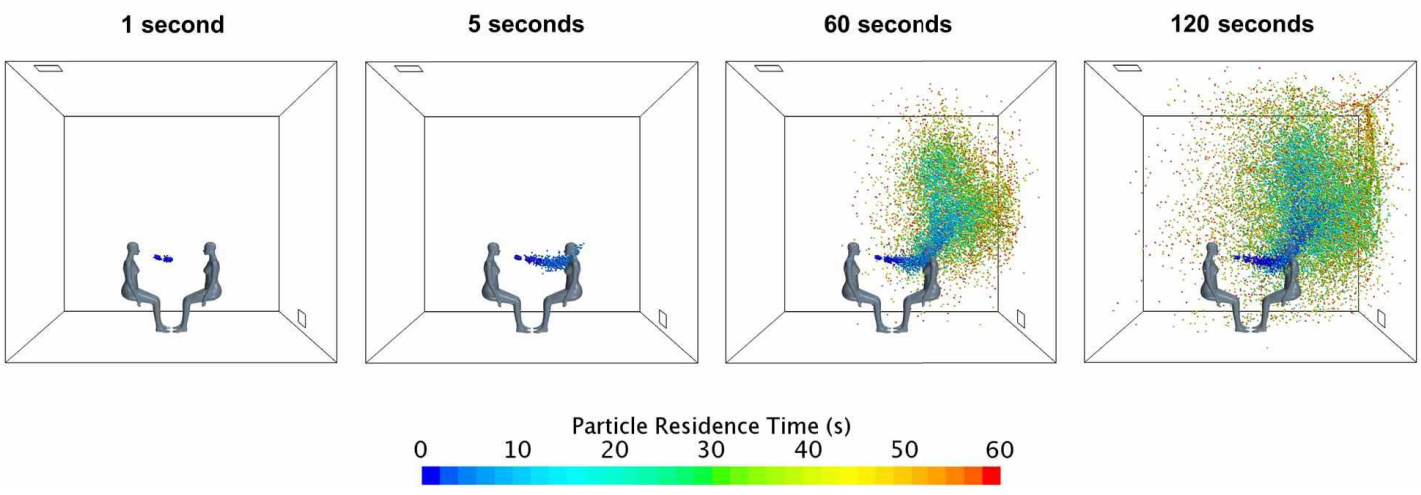
## How do viral particles transport between occupants?

- Personal distance
- building ventilation condition




RAPID: Coronavirus: Understanding aerosol transmission and potential control measures in indoor environments

# Transport of airborne viral particles




Exposure risk assessment

$$iF = \frac{M_{inhale}}{M_{exhale}} = \frac{\int_0^T Q_b C_{bz}(t)dt}{\int_0^T E(t)dt}$$

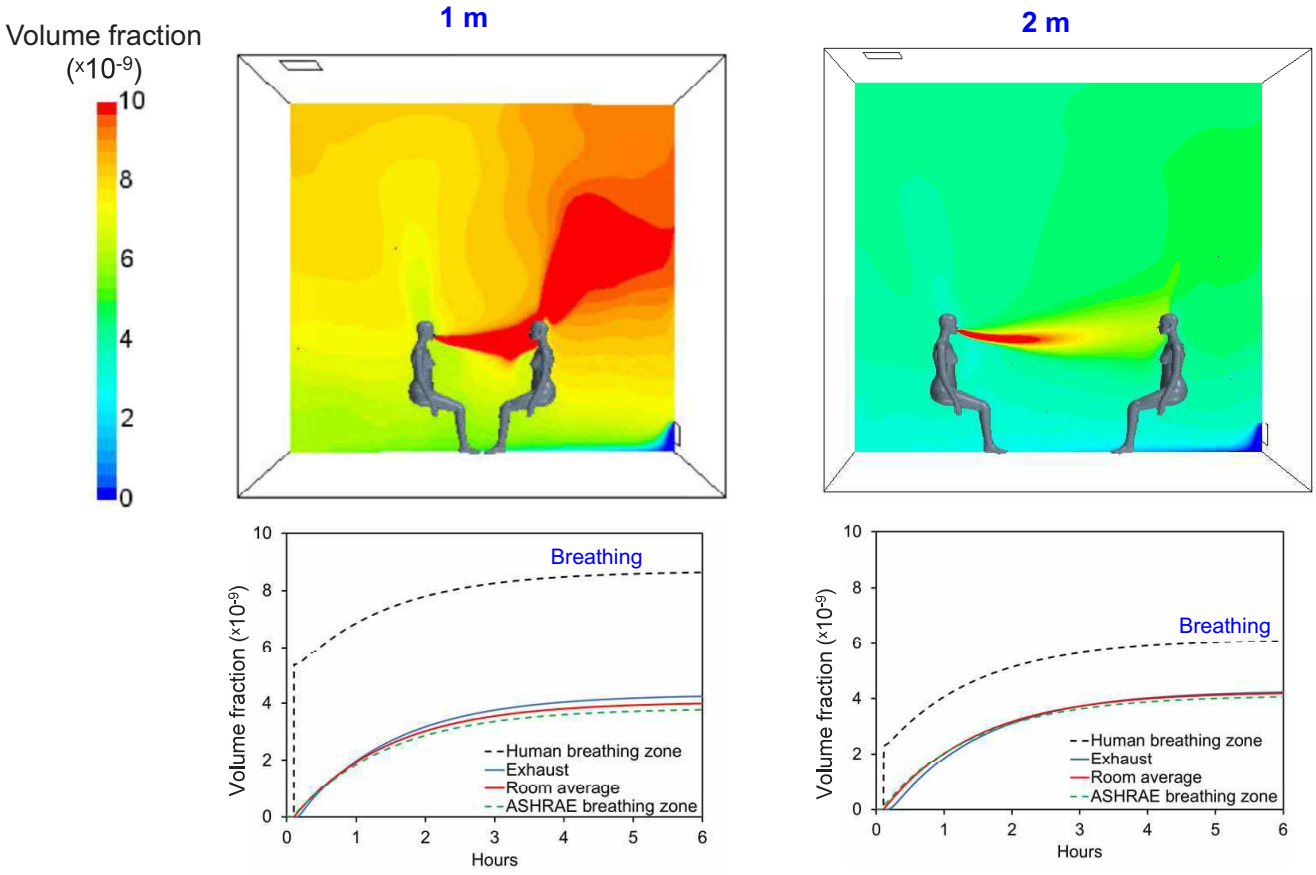
$iF$ = Intake fraction

$M_{inhale}$= Inhaled aerosol mass by exposed occupant

$M_{exhale}$= Exhaled aerosol mass from infector

Pei, G., Taylor, M., & Rim, D. (2021). Human exposure to respiratory aerosols in a ventilated room: Effects of ventilation condition, emission mode, and social distancing. *Sustainable Cities and Society*, 103090.

# Personal distance: 1 m vs. 2 m



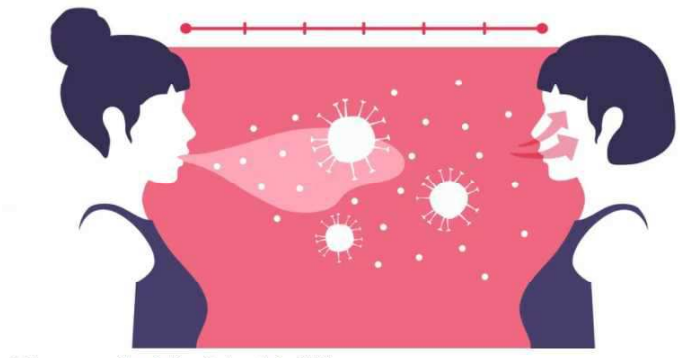

ScienceDaily

Your source for the latest research news

## Physical distancing 'not enough' when indoors

Virus particles from an infected person can travel to another person's breathing zone within one minute, even with a distance of two meters.

**Dave Yasvinski** • 3 minute read • September 16, 2021



Safety measures are still required for safe indoor gathering. GETTY

A new study says six feet of separation doesn't stop the spread of COVID-19 indoors without the use of additional control measures.

The study, conducted by the Penn State Department of Architectural Engineering and published in the journal Sustainable Cities and Society, examined three factors: the amount and rate of air moving through an indoor space, the airflow pattern associated with different methods of ventilation and the aerosol emission mode of breathing versus talking.

연합뉴스

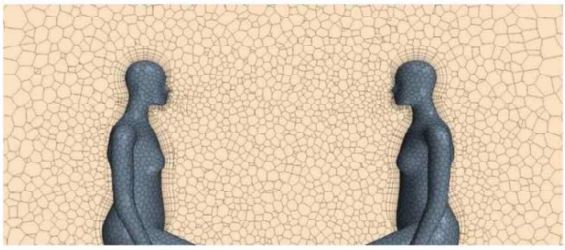
## "실내 2m 거리두기, 코로나19 감염 예방에 충분치 않다"

송고시간 | 2021-09-15 11:36

**| 펜실베이니아주립대 임동현 교수 "마스크 착용·환기 병행해야"**

(서울=연합뉴스) 이주영 기자 = 가장 일반적인 신종 코로나바이러스 감염증(코로나19) 방역수칙 중 하나인 '실내 2m 거리두기'는 감염 예방에 충분치 않으며 효과적인 방역을 위해서는 마스크 착용과 적절한 환기를 병행해야 한다는 연구 결과가 나왔다.

미국 펜실베이니아대(Penn State) 건축공학과 임동현 교수팀은 15일 과학저널 '지속 가능한 도시와 사회'(Sustainable Cities and Society)에서 실내의 물리적 거리두기와 환기 시스템이 에어로졸 입자 움직임에 미치는 영향을 조사한 결과 2m 거리두기로는 코로나19 감염 위험을 효과적으로 막기 어려운 것으로 나타났다며 이같이 밝혔다.

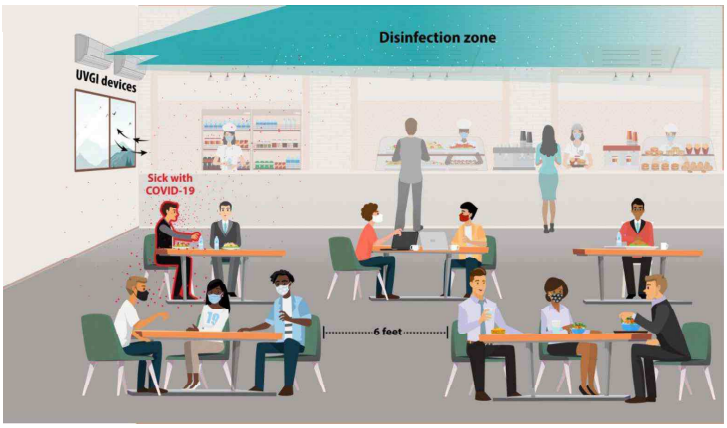


실내 환기 시스템은 감염자와 비감염자가 2m 간격을 두고 있어도 두 사람 사이의 전염 속도에 큰 영향을 미칠 수 있다. [펜실베이니아대 임동현 교수 제공. 재판매 및 DB 금지]

호흡기에서 나오는 에어로졸을 통한 공기 전염은 실내에서 전염병 확산에 중요한 역할을 한다. 이를 통제하기 위해 환기와 사회적 거리두기가 중요한 전략으로 사용된다. 하지만 바이러스가 든 에어로졸에 대한 노출 위험이 환기 조건과 거리두기에 따라 어떻게 달라지는지에 대한 과학적인 정보는 부족한 형편이다.

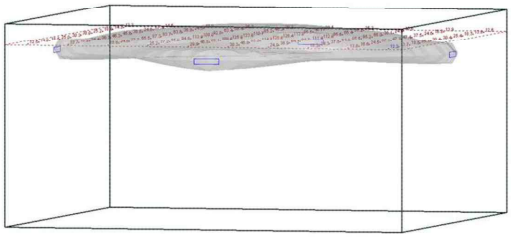
# Ultraviolet germicidal irradiance (UVGI)

Upper-Room UVGI system → 254 nm UV-C lamp




$$S = \frac{N(t)}{N(0)} = \exp(-k_\lambda I_\lambda t)$$

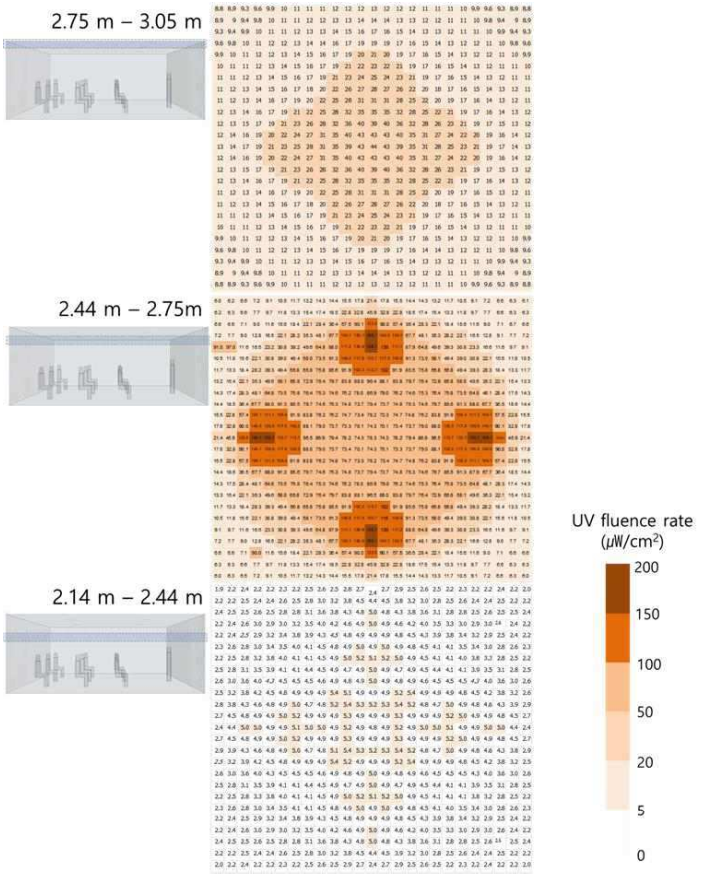
$k$: UV inactivation rate constant,
0.0025-0.0038 cm$^2$/μw-s for SARS-CoV-2
$I$: irradiance (30-50 μW/cm$^2$)
$t$: time (s).



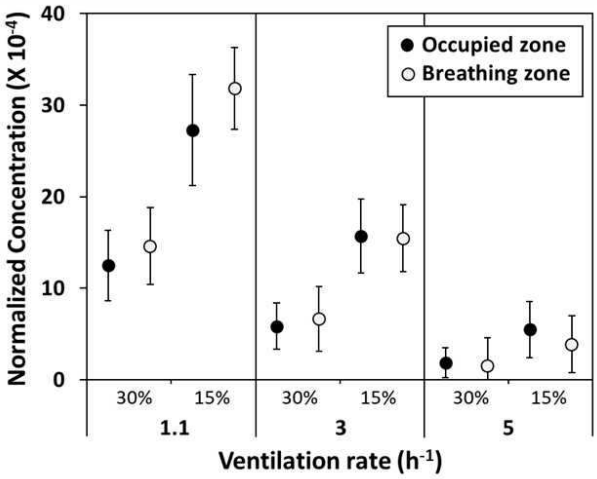
Flunce distributions (36-watt UV-C lamps )

# Effects of UV operating condition & ventilation

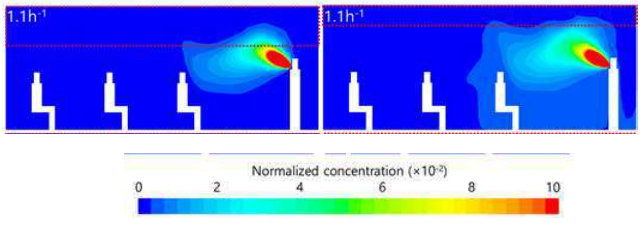
UV fluence distribution (20-50 $\mu W \cdot cm^{-2}$)




UV radiating volume vs. ventilation rate




UV radiating volume: 30% vs. 15%



# Concluding remarks

- Indoor chemical reactions play important roles in fate of the short-lived species and subsequent reactions
- Building ventilation and indoor airflow determine transport of long-lived species and fine particles.
- Human occupants participate in indoor chemical processes that influence inhalation and dermal exposures.
- A 1-2 m social distance may not be sufficient to reduce the airborne transmission of diseases in indoor environments.
- Ventilation strategy meaningfully affects the dispersion of infectious aerosols in the size range of 1-10 μm.

*Thank you! Feel free to ask questions: drim@psu.edu*

# *Management for Sustainable Clean Air in Japan*

## What are important activities ?

**Yasunobu IWASAKA, Ph.D.**

**Professor Emeritus, Nagoya University, Nagoya, JAPAN**
**Former Director, Solar-Terrestrial Environment Laboratory, Nagoya University**
**Former President, Japan Association of Aerosol Science and Technology (JAAST)**
**email: iwasaka@mit.biglobe.ne.jp**

## Contents

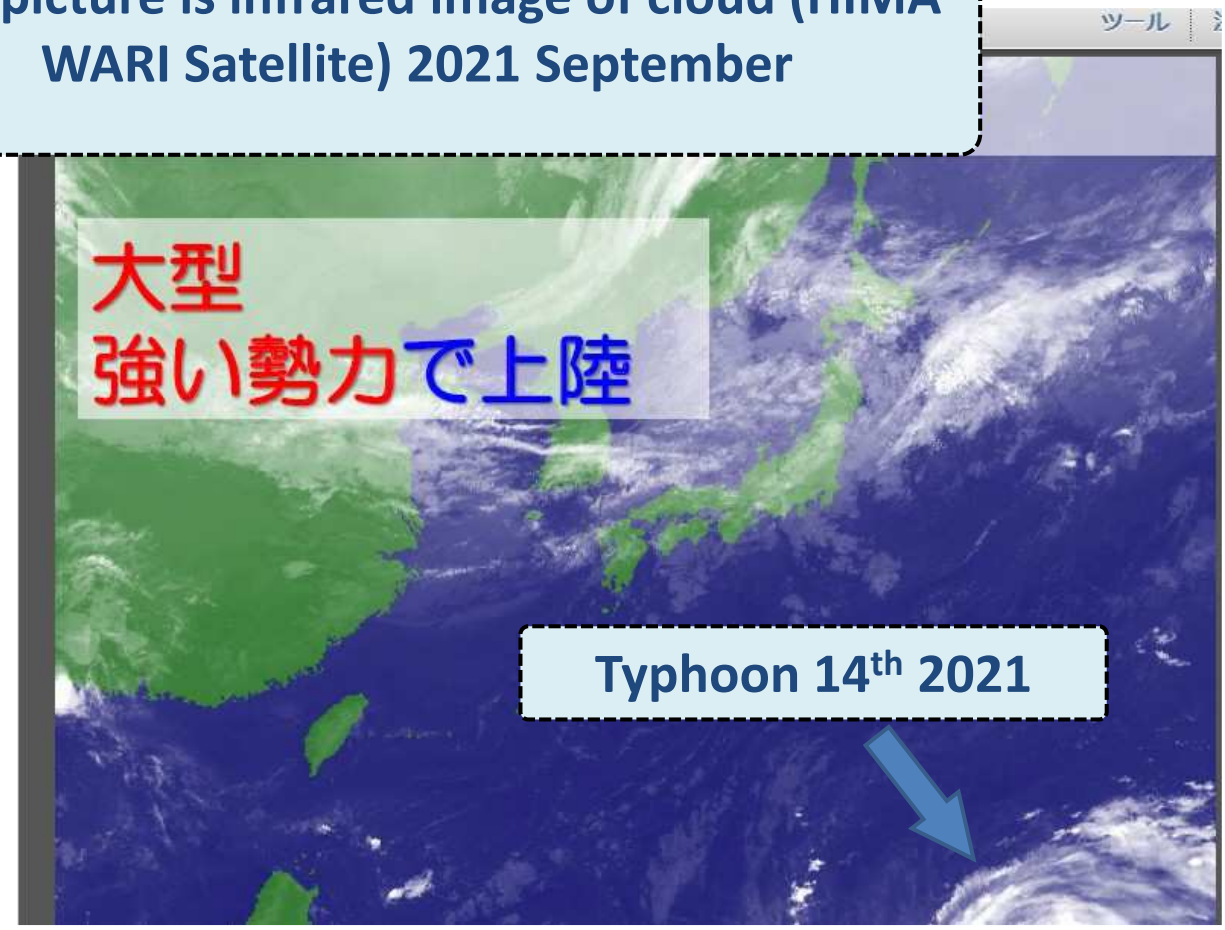
- **Background**
- **Environmental Effects of Westerly Wind**
- **Effort to get clean air in North- East Asia**
- **Corona, COVID-19, seems to give important effect to air through various channels**
- **Summary and Work from now**

# 1. Background and Westerly Wind

Many reports clarified that westerly wind strongly affected climate , weather and air quality in Japan. Therefore, it is essential for good air to have good collaboration with Korea, China, Mongolia, Russia, and many other countries and areas.

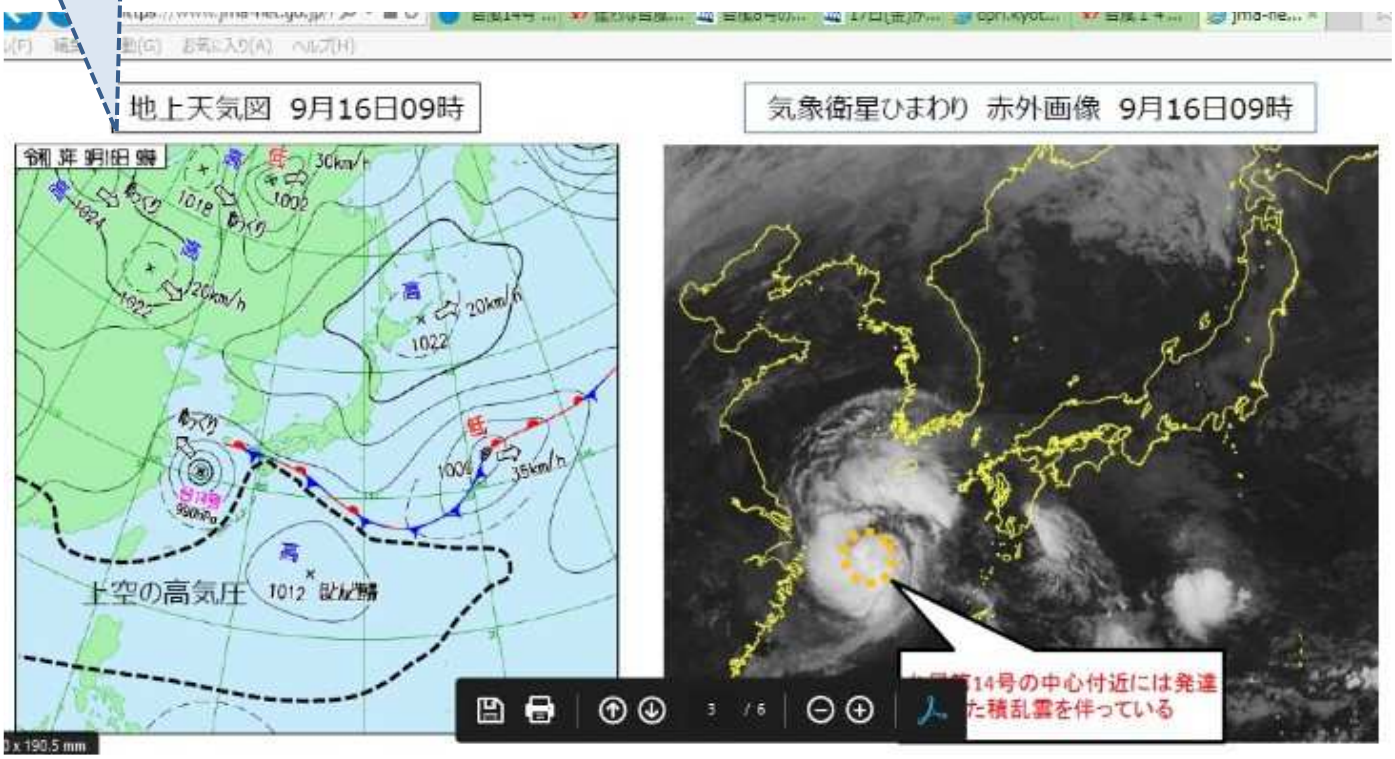
Behavior of Typhoon strongly suggested the effect of Westerly Wind in East Asia region.

This picture is infrared image of cloud (HIMA WARI Satellite) 2021 September




Watch vectors of high and low!!

The typhoon appearing north pacific ocean moved to east and soon to west owing to strong westerly wind in North-East Asia region.



# 2. Clean Air

**Long-term observation of atmospheric particulate matter concentration suggests decreasing trend.**

Concentration of PM shows interesting seasonal trend in Japan.

Most of observatories show decreasing trend in year to year observation, and higher concentration in Spring in every year.

KOSA phenomenon has been very familiar event as sign of 'spring is coming' in Japan

PM concentration also suggested the effect of Westerly Wind in East Asia region.

Spring!!

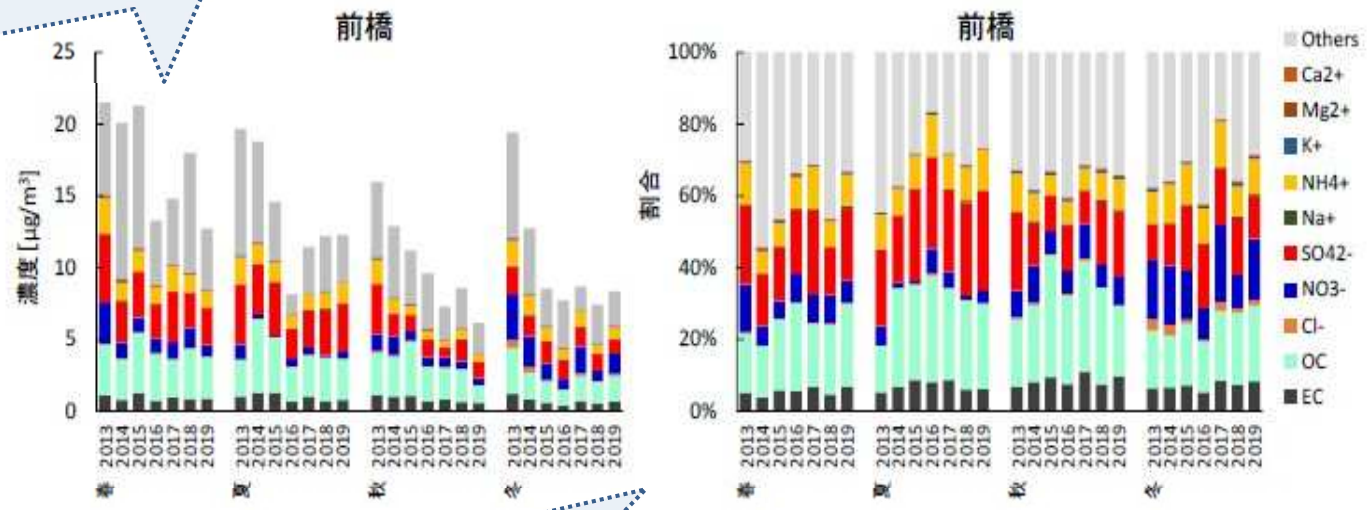



図 4　前橋における季節別の $PM_{2.5}$ 組成経年変化（左：大気中濃度、右：粒子濃度に対する割合）

Measurement (Maebashi City) of PM2.5 concentrations (left) in microgram m-3 and relative content (right) in percentage.



Decreasing trend is observed in all seasons in 2013~2019, and it suggests effective efforts of persons, industries and governments in north-east Asia.

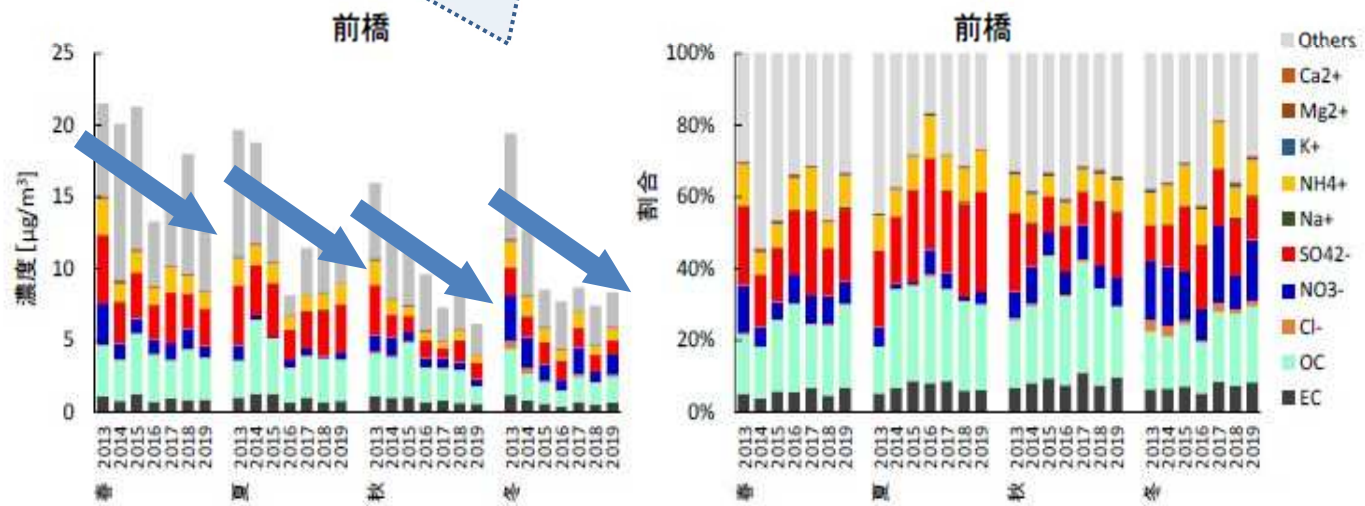
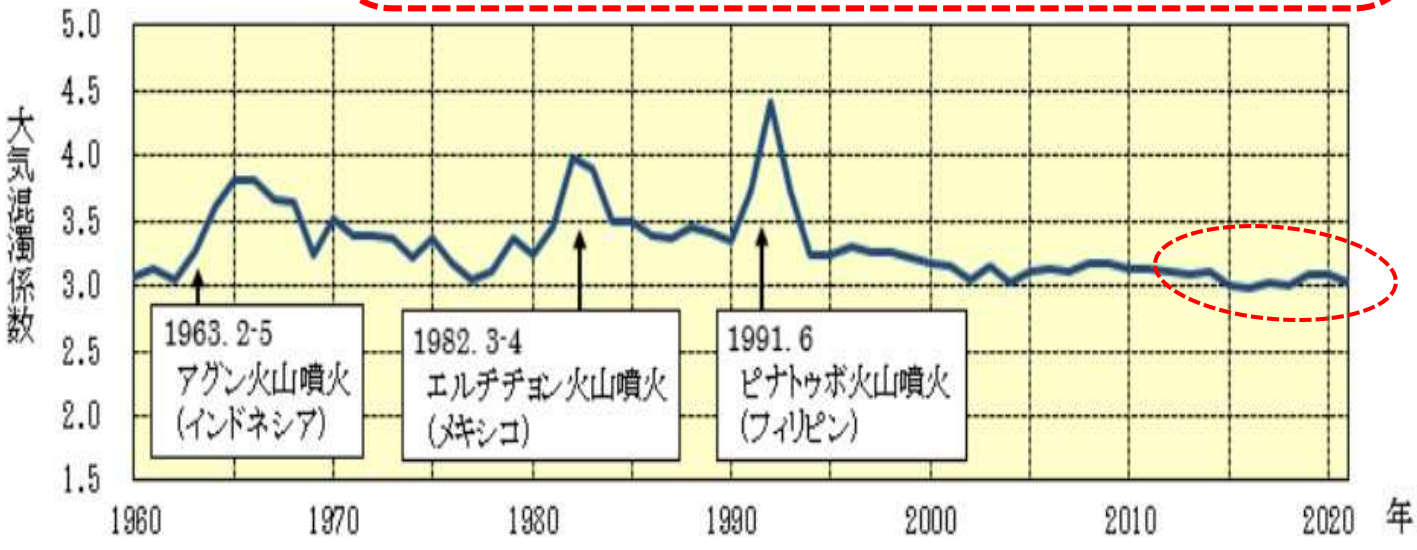


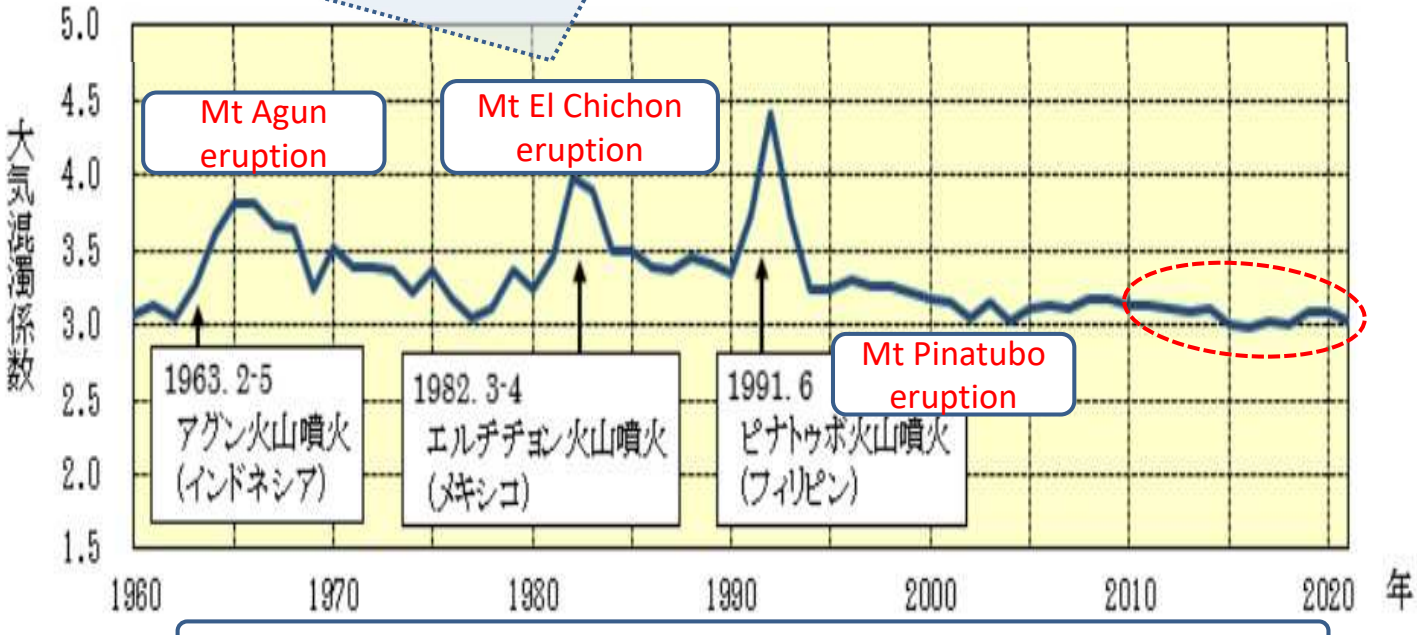

図 4　前橋における季節別の $PM_{2.5}$ 組成経年変化（左：大気中濃度、右：粒子濃度に対する割合）

Atmospheric turbidity also indicates aerosol concentration in not only the troposphere but al so the stratosphere.




大気混濁係数の経年変化(1960～2021年)

**Recently there is no report of large volcanic eruptions and recent trend possibly suggests relatively clean over Japan.**




Change in Atmospheric Turbidity (Japan Meteorological Agency)

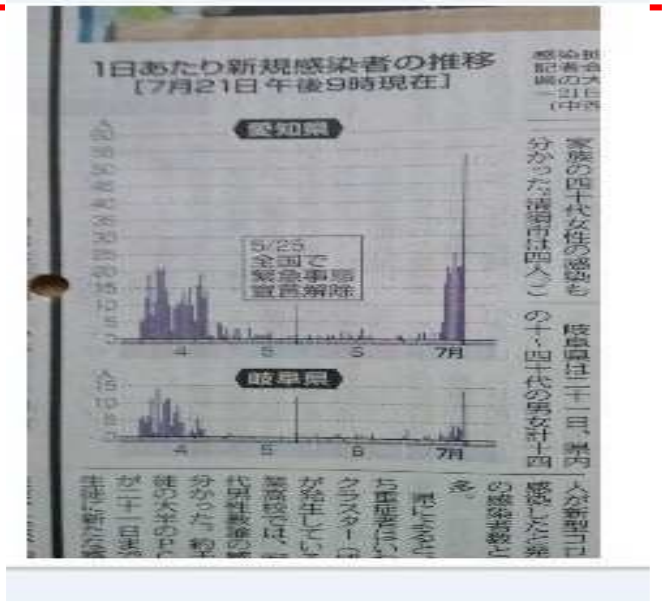
大気混濁係数の経年変化(1960～2021年)

# 3. Corona

**Corona largely disturbs Japanese persons activities, and many industries and offices also change or shrink their activities.**

COVID-19 effects rapidly expanded and many schools were closed and many offices r educed their activities in Japan.

Most of Japanese were surprised to h ear that corona virus starte d their activities in Japan.



*The Governor of Aichi Prefecture Said 'Now, we had 53 corona new patients in Aichi yesterday' and 'it is very danger'.*

*After then many schools and Universities cut down their activities.*


Now, Japan has many corona clients and number of corona patients rapidly increases now (2022, August)

Number of new client of COVID-19 show wavy change and now we have 7th peak

According to WHO, number of new patients in Japan is largest in July 18-24;

| | |
|---|---|
| Japan | 969,068 |
| USA | 860,097 |
| Germany | 565,518 |
| Italy | 531,327 |

Now, Many industries shrink their own activities, and air pollutants concentration possibly decreased, some scientists said.
However, it is not clear just now, and it takes time to clarify the effect of industrial activities to air quality.

Some doctors say it's necessary to consider the contribution of aerosols in infection processes of corona.

# 4. Summary and Work from Now

**COVID-19 problems show us**

**importance of clean air maintenance**

**and**

**new problem "relation between aerosols and virus"**


Thank You

中国科学院大气物理研究所
Institute of Atmospheric Physics, Chinese Academy of Sciences

# Management for Sustainable Clean Air in China

**Bin CHEN， Xiaofei DONG and Guangyu SHI**
Institute of Atmospheric Physics, Chinese Academy of Sciences, China

chen_bin@mail.iap.ac.cn

## Contents

Actions in China

- The government actions for Sustainable Clear Air
- Three year achievement for Sustainable Clear Air in China
- The plan of carbon neutrality

# The government actions for Sustainable Clean Air

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# The government actions for Sustainable Clean Air


## Formulation of Ambient Air Quality Standards in China

- Guidance on operational numerical prediction of ambient air quality
  - In 2020, Technical guideline for numerical forecasting of ambient air quality was issued firstly
- To provide standardized methods for the determination of pollutants in the air
  - In 2020, the standard method for the determination of $SO_2$ and $NO_X$ from stationary source emission by portable ultraviolet absorption are implemented
  - In 2020, the method for determination of As、Se、Bi and Sb from ambient air and waste gas by atomic fluorescence spectrometry takes effect


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# The government actions for Sustainable Clean Air

## Policy for Sustainable Clean Air

- **2000** — China revised the Air Pollution Prevention and Control Law
- **2010** — Ministry of Environmental Protection's Guidelines for Joint Prevention and Control of Air Pollution in Key Regions
- **2012** — • National Plan on Air Pollution Control in Key Regions during the 12th Five-Year Plan
  • Ambient Air Quality Standards
- **2013** — The first National Action Plan on Air Pollution Prevention and Control
- **2015** — The 2015 revision of the Environmental Protection Law
- **2018** — Three year action plan to win the blue sky defense war
- **2021** — Action Plan for Carbon Dioxide Peaking Before 2030
- **2021** — Responding to Climate change: China's Policies and Actions



# The government actions for Sustainable Clean Air

- The plan was issued and implemented by the State Council in July 2018.
- It aims to reduce the total emission of major air pollutants and greenhouse gas, further significantly reduced the concentration of PM2.5 and improve the air quality in three years.


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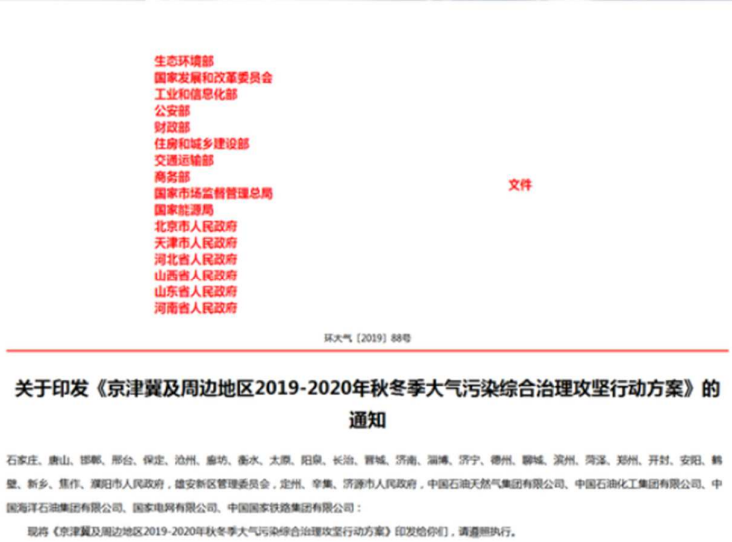
# The government actions for Sustainable Clean Air


The 2018 revision of the Prevention and Control of Atmospheric Pollution Law was set up



# The government actions for Sustainable Clean Air


生态环境部
国家发展和改革委员会
工业和信息化部
公安部
财政部
住房和城乡建设部
交通运输部
商务部
国家市场监督管理总局
国家能源局
北京市人民政府
天津市人民政府
河北省人民政府
山西省人民政府
山东省人民政府
河南省人民政府

文件

环大气〔2019〕88号

关于印发《京津冀及周边地区2019-2020年秋冬季大气污染综合治理攻坚行动方案》的通知

石家庄、唐山、邯郸、邢台、保定、沧州、廊坊、衡水、太原、阳泉、长治、晋城、济南、淄博、济宁、德州、聊城、滨州、菏泽、郑州、开封、安阳、鹤壁、新乡、焦作、濮阳市人民政府，雄安新区管理委员会，定州、辛集、济源市人民政府，中国石油天然气集团有限公司、中国石油化工集团有限公司、中国海洋石油集团有限公司、国家电网有限公司、中国国家铁路集团有限公司：

现将《京津冀及周边地区2019-2020年秋冬季大气污染综合治理攻坚行动方案》印发给你们，请遵照执行。

The governments of Beijing-Tianjin-Hebei strengthen supervision and cooperation, joint governance and control, regional cooperation in 2019.

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## 《Ecological environment and health literacy of Chinese citizen》 promulgated in 2020


It covers the basic knowledge and concepts of atmosphere, water and other aspects, and guides citizens to correctly understand the relationship between human and nature, and to establish the concept that environment and health are closely related



The government actions for Sustainable Clean Air

# Low carbon Winter Olympics mini app

**aims**

By digital means, the carbon points obtained by users in low-carbon activities such as green travel and garbage classification can be exchanged for corresponding rewards to encourage the public to live a low-carbon life and protect the environment.

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# The government actions for Sustainable Clean Air


## Responding to Climate Change: China's Policies and Actions

The State Council Information Office of
the People's Republic of China
October 2021

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# Three year achievement for Sustainable Clean Air in China

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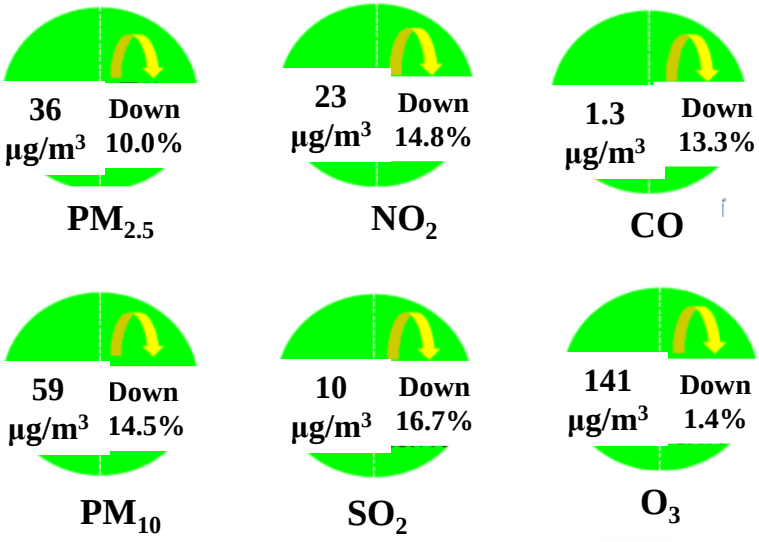
Institute of Atmospheric Physics, Chinese Academy of Sciences

- **Changes in the first half of 2020**

The national average proportion of good days was 85.0% , up 4.9%




**National** concentration change of six pollutants from January to June in 2020



Three year achievement for Sustainable Clean Air in China

- **Changes in 2020**

- The concentration of PM2.5 in 337 prefecture level and above cities was 33 μg/m$^3$, decreased 8.3% as 2019. The concentration of PM10 was 56 μg/m$^3$, down 11.1% as 2019.
- The PM2.5 concentration in the Beijing-Tianjin-Hebei region was 51 μg/m$^3$, down 10.5% year-on-year. In Beijing, the PM2.5 concentration was 38 μg/m$^3$, down 9.5% as last year.
- The PM2.5 concentration in the Yangtze River Delta was 35 μg/m$^3$, down 14.6% year-on-year.
- The PM2.5 concentration in the Fenwei Plain was 48 μg/m$^3$, down 12.7% year-on-year.

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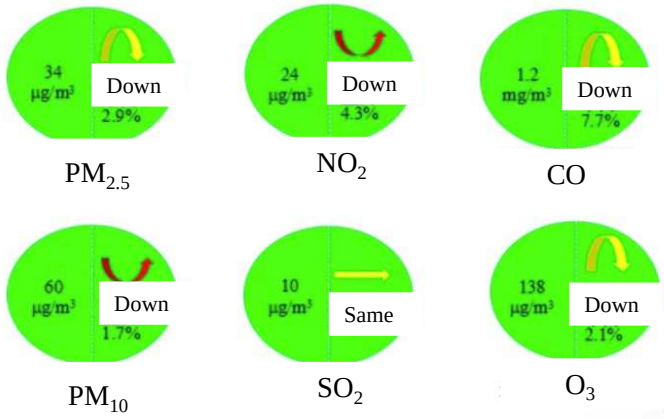
## • Changes in the first half of 2021

From January to June, the average proportion of good days in 339 prefecture level and above cities was 84.3% , down 0.7% points year-on-year; PM2.5 concentration was 34 μg/m$^3$, down 2.9% year-on-year; PM10 concentration was 60 μg/m$^3$, up 1.7% year-on-year; $O_3$ concentration was 138 μg/m$^3$, down 2.1% year-on-year; $SO_2$ concentration was 10 μg/m$^3$, same as last; $NO_2$ concentration was 24 μg/m$^3$, up 4.3% year-on-year; CO concentration was 1.2 mg/m$^3$, down 7.7% year-on-year.




Concentration and year-on-year change of six indicators from January to June in 2021



Three year achievement for Sustainable Clean Air in China

## • Changes in 2021

- The concentration of PM2.5 in 337 prefecture level and above cities was 30 μg/m$^3$, decreased 9.1% as 2020. The concentration of PM10 was 54 μg/m$^3$, down 3.6% as 2020.
- The PM2.5 concentration in the Beijing-Tianjin-Hebei region was 43 μg/m$^3$, down 18.9% year-on-year. In Beijing, the PM2.5 concentration was 33 μg/m$^3$, down 5.7% as last year.
- The PM2.5 concentration in the Yangtze River Delta was 31 μg/m$^3$ , down 16% year-on-year.
- The PM2.5 concentration in the Fenwei Plain was 42 μg/m$^3$, down 16% year-on-year.

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- **Changes in the first half of 2022**

From January to June, the average proportion of good days in 339 prefecture level and above cities was 84.6% , increased 0.3%; PM2.5 concentration was 32 μg/m$^3$, down 5.9% year-on-year; PM10 concentration was 55 μg/m$^3$, down 8.3%; $O_3$ concentration was 144 μg/m$^3$, up 4.3%; $SO_2$ concentration was 9 μg/m$^3$, down 10%; $NO_2$ concentration was 21 μg/m$^3$, down 12.5%; CO concentration was 1.1 mg/m$^3$, down 8.3% year-on-year.

| | $PM_{2.5}$ | $NO_2$ | CO | $PM_{10}$ | $SO_2$ | $O_3$ |
|---|---|---|---|---|---|---|
| Concentration(**μg/m$^3$**) | 32 | 21 | 1.1 | 55 | 9 | 144 |
| Year-on-year change | Down 5.9% | Down 12.5% | Down 8.3% | Down 8.3% | Down 10% | Up 4.3% |



# The plan of carbon neutrality

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## The plan of carbon neutrality

- **Carbon neutrality**

By calculating the total amount of carbon dioxide emissions, and then absorbing these emissions to achieve the purpose of environmental protection.

In 2020, the Chinese Government proposed that China aim to have $CO_2$ emissions peak before 2030 and achieve carbon neutrality before 2060 at the United Nations General Assembly.



## The plan of carbon neutrality

### Carbon neutrality policy

- **Specify the time point of carbon peak**

  Beijing government ⇨ decline before 2025

  Shanghai government ⇨ reach the peak before 2025

- **Supply-side reform, adjust the energy structure**

✓ Implement differentiated electricity price

✓ Optimize the industrial structure

✓ Develop new energy

- **Demand-side reform--green consumption, new energy vehicles**
- **Advanced technique：** The Institute of Yangtze River Delta carbon neutralization Strategy Development Research

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# The plan of carbon neutrality

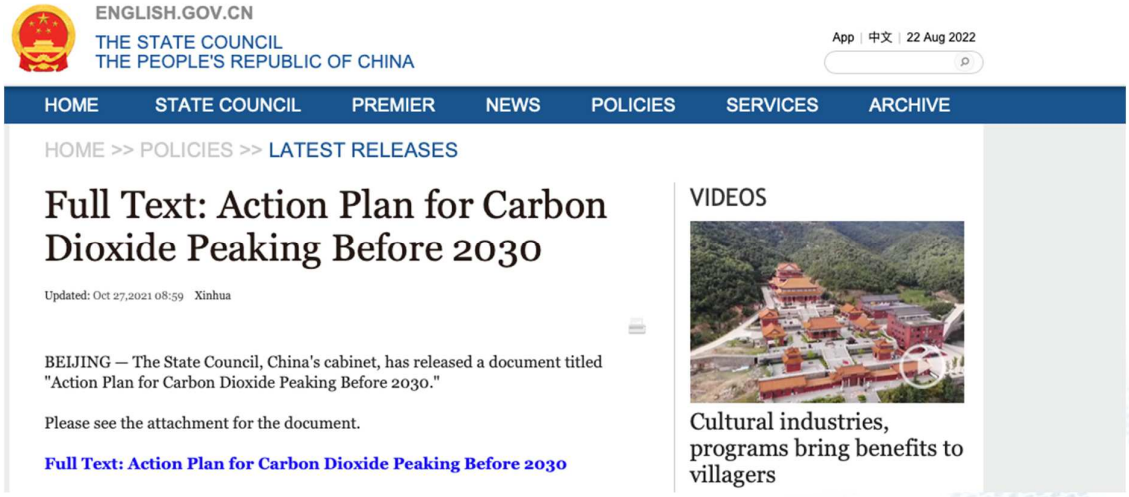
- **China Carbon Emission Trade Exchange (CCETE)**

On July 16, 2021, the national carbon emission trading market was opened， it promotes green and low-carbon transformation of economic.




# The plan of carbon neutrality

## Action Plan for Carbon Dioxide Peaking Before 2030




October, 2021

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# The plan of carbon neutrality

## IAP's carbon neutrality organizations

**Function**

- Carbon emission **observation**
- Carbon emission **evaluation**
- Carbon emission **prediction**

**Carbon Neutralization Co.**

**Institute of Carbon Neutralization Research**



# The future actions for clean air quality


Regional Cooperation Plan

# Thank you!

# Recent Advances in Prevention and Control of Air Pollution in India

**Sagnik Dey**[1,2,3,4]

[1]Institute Chair Professor, Centre for Atmospheric Sciences, IIT Delhi
[2]Coordinator, Centre of Excellence for Research on Clean Air (CERCA), IIT Delhi
[3]Associate Faculty, School of Public Policy, IIT Delhi
[4]Associate Faculty, Transportation Research and Injury Prevention Centre, IIT Delhi

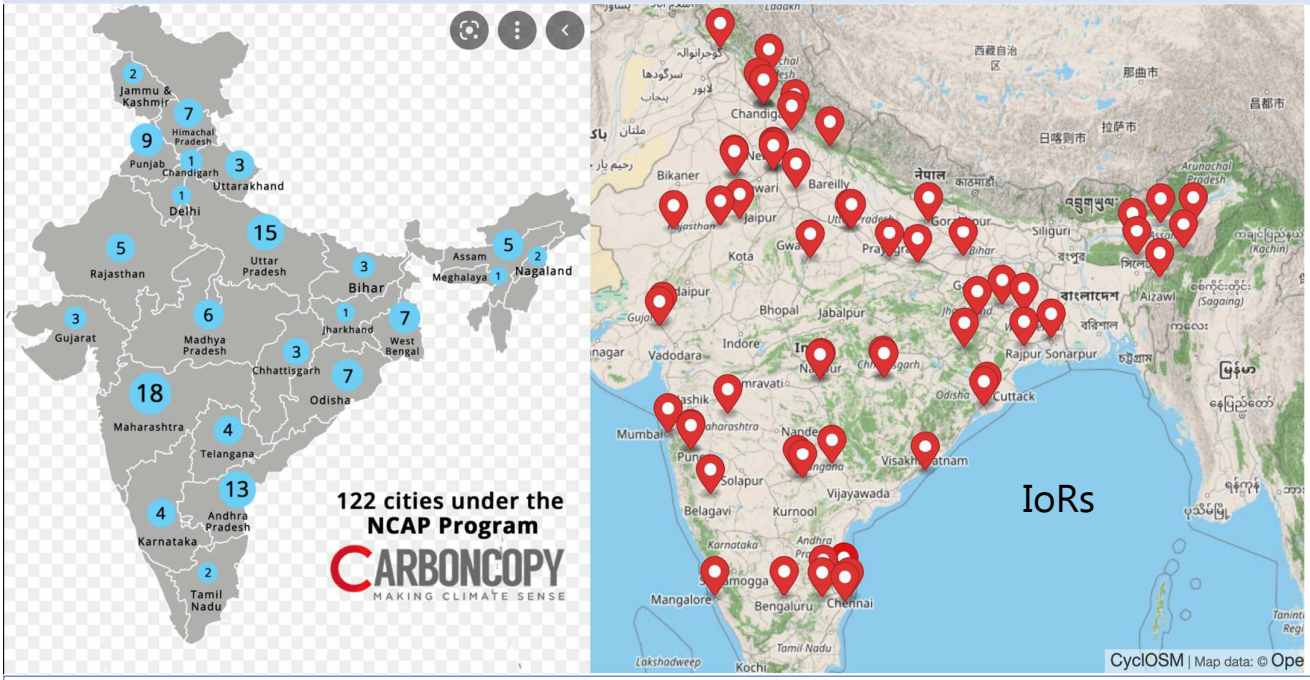
Contact: sagnik@cas.iitd.ac.in
Webpage: web.iitd.ac.in/~sagnik

7th Sep, 2022

# Clean Air Initiatives in India

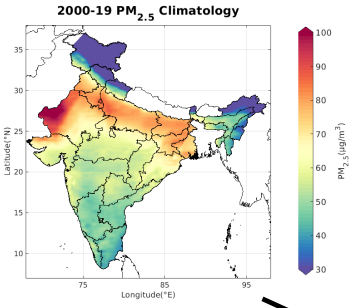
| Science | Technology | Policy | Outreach |
|---|---|---|---|
| • Emission inventory update<br>• Source apportionment at city and national scale<br>• Expansion of ground monitoring<br>• Alternate monitoring<br>• National Knowledge Network for technical input to SPCBs and ULBs | • Promoting start-ups for innovation in clean air technology<br>• National Sensor Hub – environmental monitoring<br>• Innovation to reduce emission at source (retro-fit technology) | • National Clean Air Program<br>• Clean energy transition<br>• Stringent emission norms<br>• Zig-zag technology for Brick Kilns<br>• Curbing open biomass<br>• Vehicle scrappage policy<br>• Push for EVs | • Air quality display and advisory<br>• Greater effort to reach out to citizens<br>• Capacity building programs<br>• New academic programs/certificate courses<br>• Air Quality Action Forum |

# Tripartite MoU between NKN, SPCB & ULB

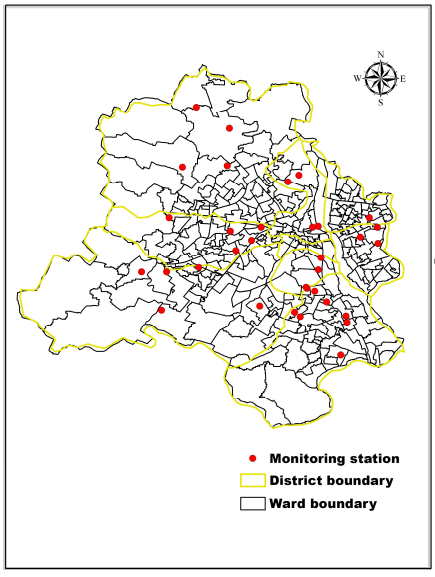


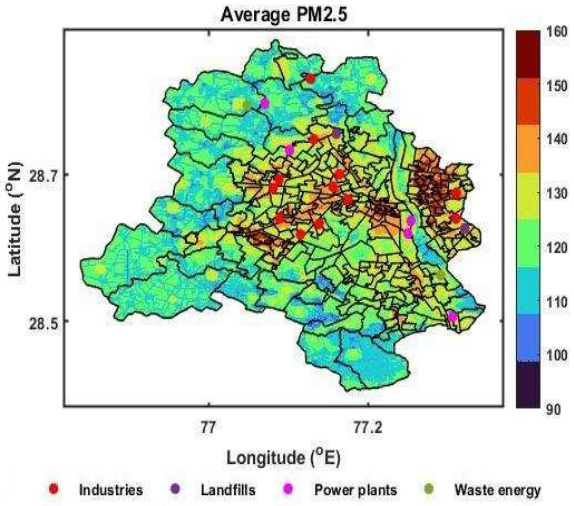

- Institutes of Repute (IoRs) are roped in to provide technical guidance to the SPCBs and ULBs in each non-attainment city

# Evolving a hybrid air quality monitoring system

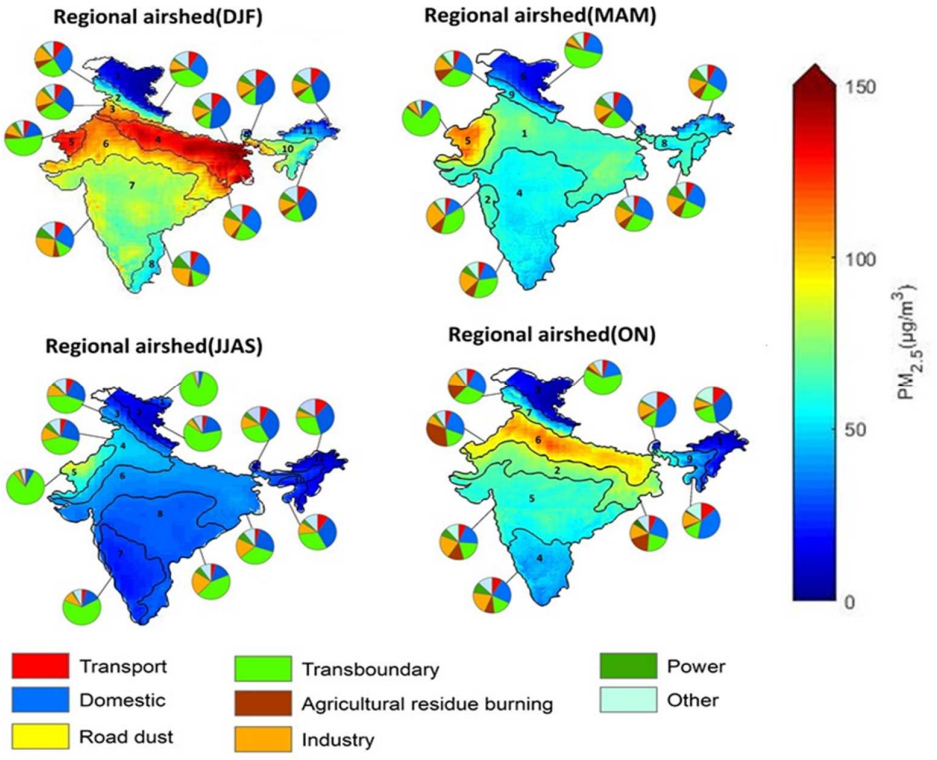



Integrate satellite, reference-grade monitors, low-cost monitors – link it to sectoral emissions



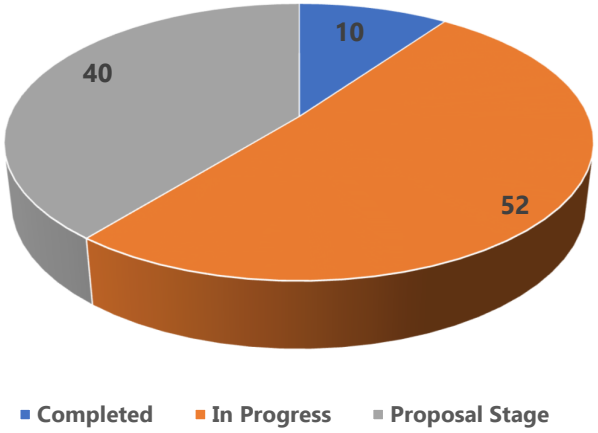



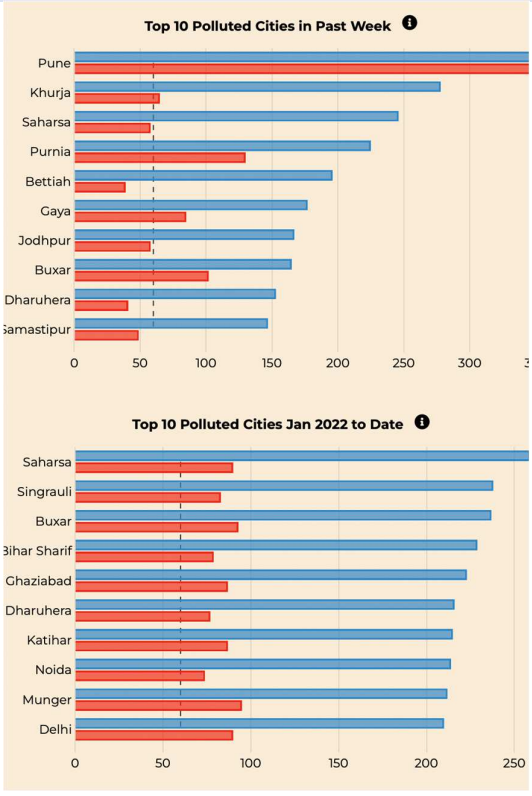
# Moving towards air shed approach




- Regional air sheds in India are identified
- Sectoral contributions for the NCAP baseline year 2017 [Dey et al., in press]
- Large contribution of transboundary transport emphasizes the importance of air shed approach

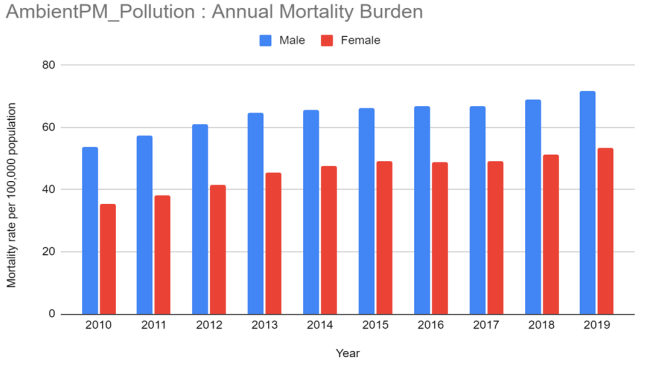
# NCAP Tracker

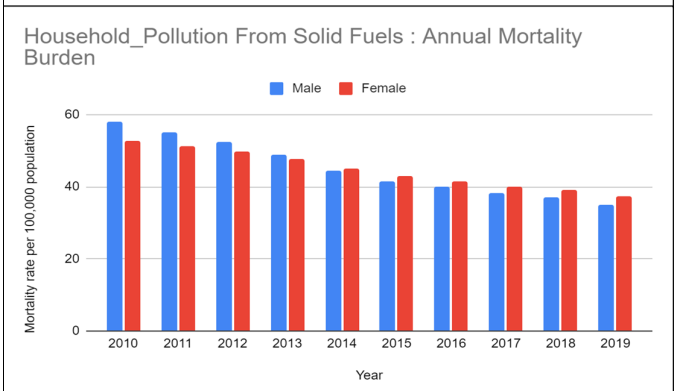



- Emission inventory and source apportionment studies are underway
- Continuous tracking of activities under clean air action plan

# Indigenous evidence of health impacts




## Disease Proportions

45% 33% 5% 18%

Air pollution has been medically linked to cardio-vascular diseases, respiratory diseases, lung cancer, Type-2 diabetes, child growth failure, anemia, neurological disorders, and many more in India

# Innovation in clean air technology

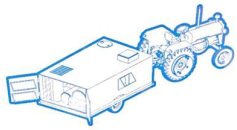
### Low-cost sensors

### Conversion to EV


### In-situ and Ex-situ Stubble Management

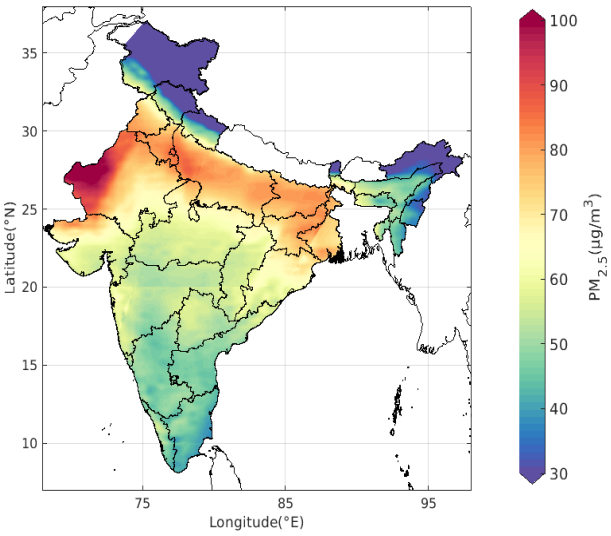

### Retrofitting DG Sets

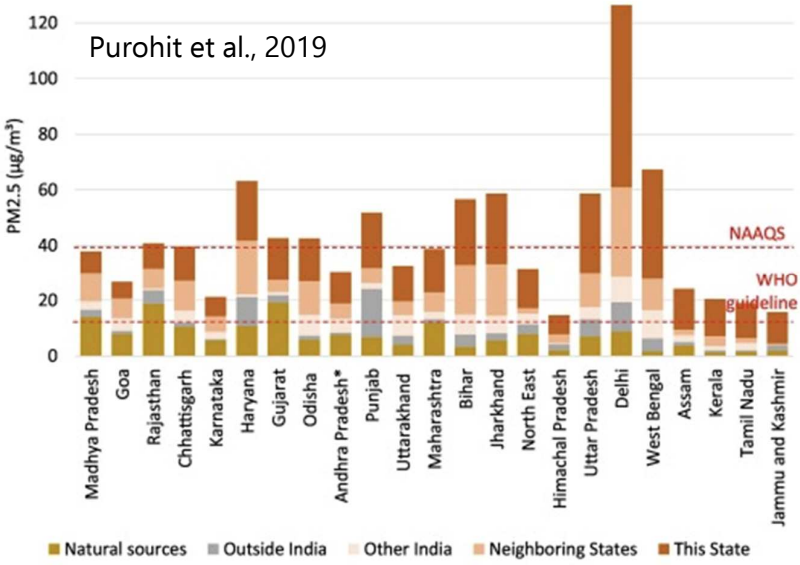

TAKACHAR



Using a novel thermo-chemical process, Takachar has developed and patented the design of small-scale, low-cost, portable equipment to convert waste biomass into solid fuel, fertilizer, and other specialty chemicals. Compared to the process of sending waste biomass to centralized conversion facilities, Takachar's system is more profitable by significantly reducing the logistics cost of hauling loose, wet, and bulky biomass.

# Assessing efficacy of interventions




- Analysis of cost-effectiveness of various control strategies using GAINS model (tuned for India) in collaboration with IIASA and World Bank

# Air Quality Action Forum | Capacity Building

Academic Institutions

CPCB and SPCBs

Corporates

Philanthropies

UN and International Agencies

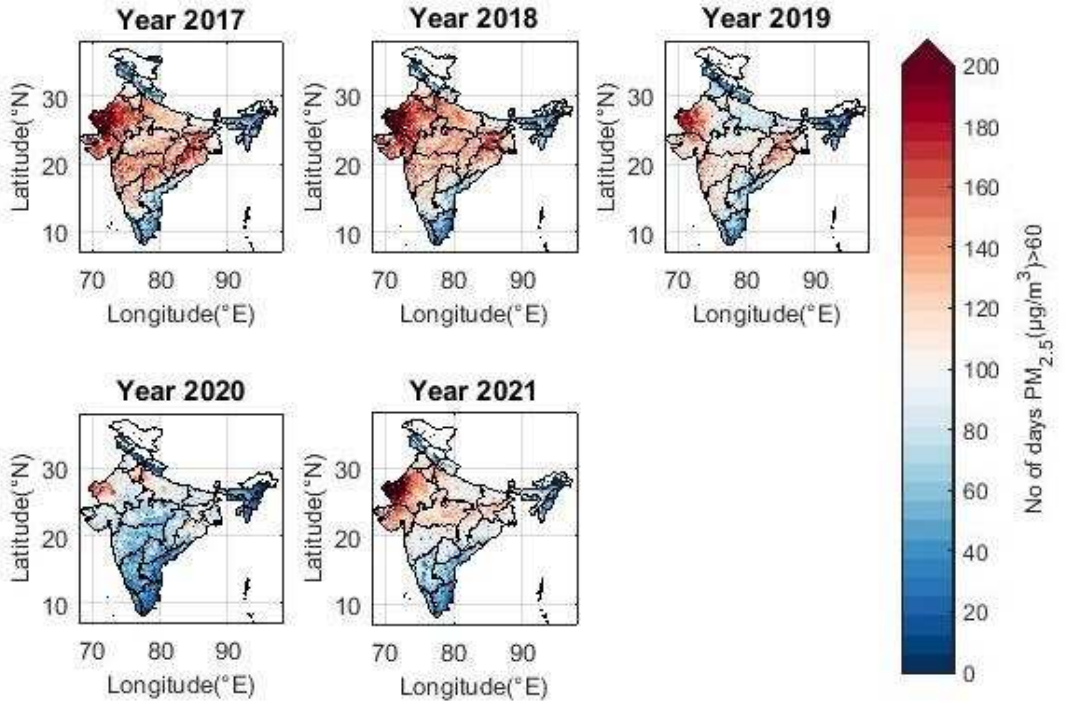
AQAF – one stop solution to the GoI

CAPHER-India

**Collaborative for Air Pollution and Health Effects Research—India**

2019 India Workshop

# Changes in air quality during the NCAP rra




**Acknowledgements**: Governmental (CPCB; SPCBs; MoEFCC; PSA Office; MoES; DST; DBT; ICMR); International agencies (World Bank, UNDP, UNEP, IIASA, NASA, WHO); Philanthropy (Open Philanthropy)

**Thank You**

# RECENT TRENDS AND MANAGEMENT POLICY OF FINE DUST IN MONGOLIA

**The 13th World Air Forum**

**07 September, 2022**

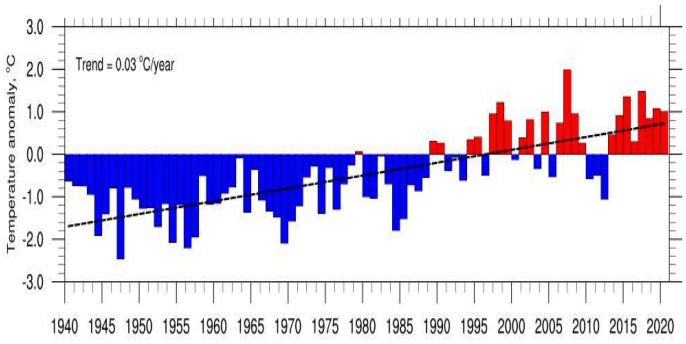
**TSATSRAL BATMUNKH**
**/Ministry of Environment and Tourism, Mongolia/**

# Contents

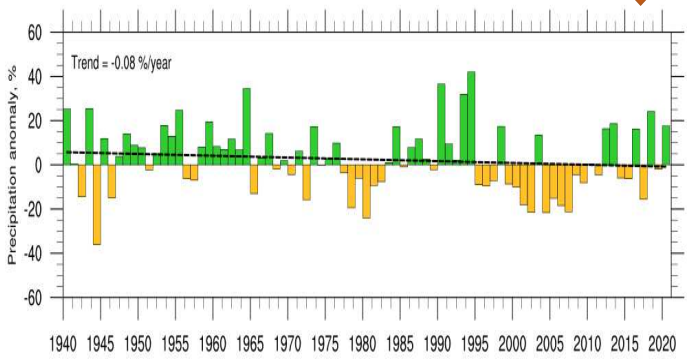
# INTRODUCTION

Mongolia is land-locked country with harsh climate, hot & dry summer and cold and dry winter, has three primary sources of energy—traditional (biomass), conventional (fossil fuels, such as coal and oil), and alternative energy (mostly renewable).

**Air temperature between** 1940-2020: 2.4°C/80 year




**Precipitation between** 1940-2020: slight decrease




- Average temperature has risen by 2.4ºC
- Annual precipitation decreased by slightly

# INTRODUCTION

Ulaanbaatar, the capital of Mongolia, is the coldest capital and one of polluted city in the world [WHO 2014],

- located in a valley of the Tuul river,
- surrounded by the Khentei Mountain

Its location causes Ulaanbaatar to experience frequent temperature inversions.

- 1.4 million residents in Ulaanbaatar
  - **42%** in residential areas
  - **58%** in ger district where **upgraded coal was used to** space heating and cooking.

# INTRODUCTION

## Source of air pollution


| 80% | 10% | 6% | 4% |
|---|---|---|---|
| 196000 household stoves, 2900 heat only boilers | 622000 vehicles 74% of them are more than 10 years old | 4 thermal and heat power plants | Waste burning, fugitive dust etc. |

# INTRODUCTION

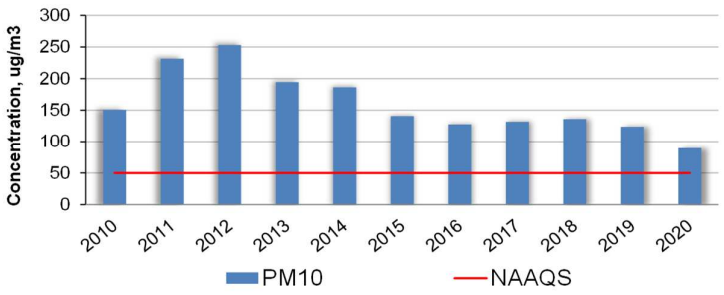
## National air quality monitoring network


42 air quality monitoring stations in Mongolia which are mainly located center of provinces to monitor air pollution level.

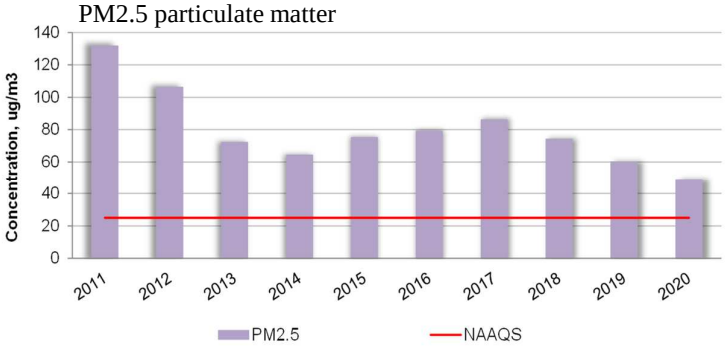
16 of 42 are located in Ulaanbaatar, capital of Mongolia.

# RECENT TRENDS OF FINE DUST

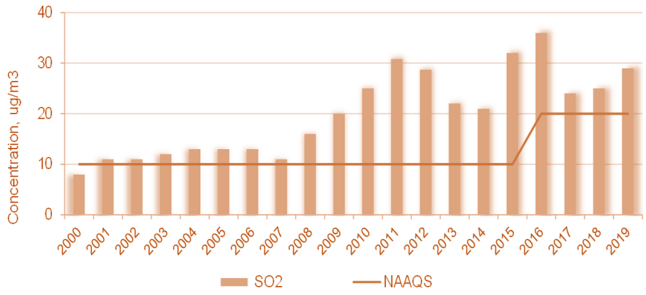
PM10 particulate matter



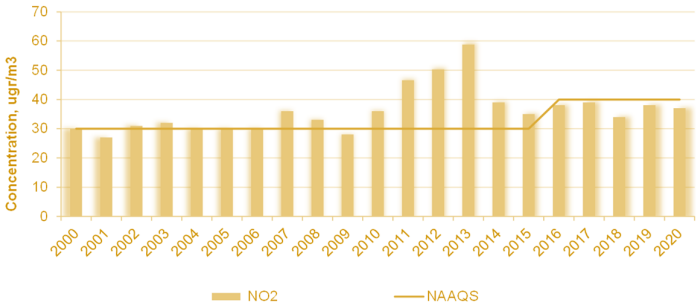

PM2.5 particulate matter




SO2

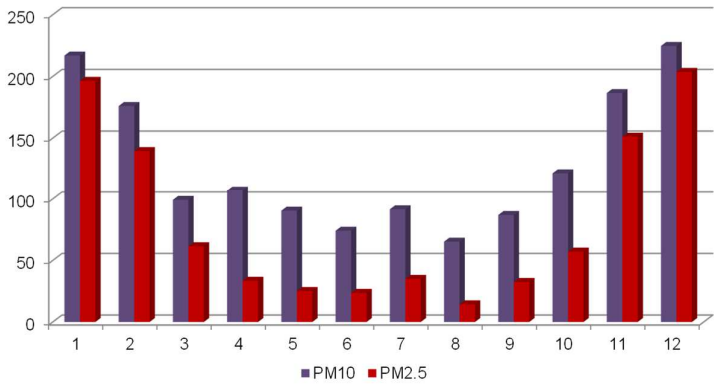


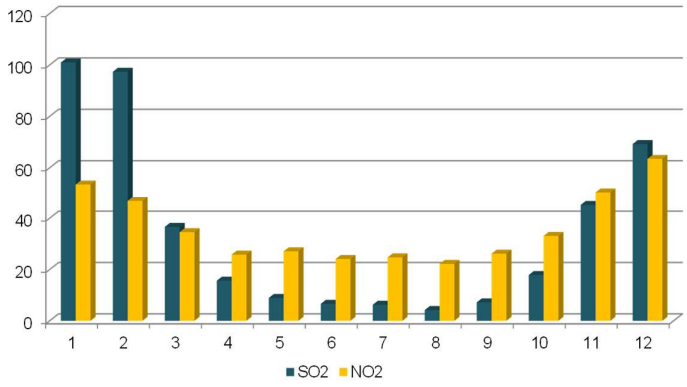

NO2




# RECENT TRENDS OF FINE DUST

## Monthly variation of air pollution in Ulaanbaatar



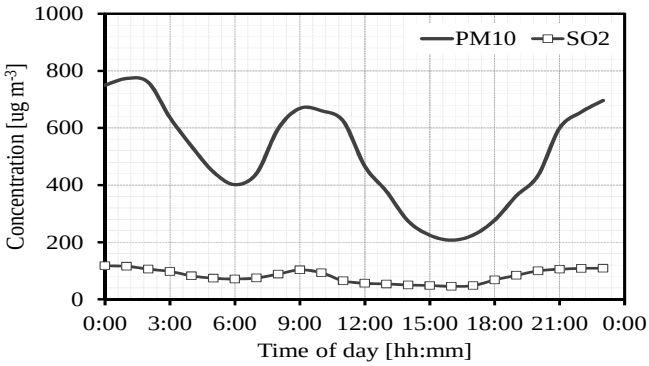




Strong monthly/seasonal variation, winter high and summer low, was observed for coarse and fine particulate matters as well sulfur dioxide due to usage of coal.

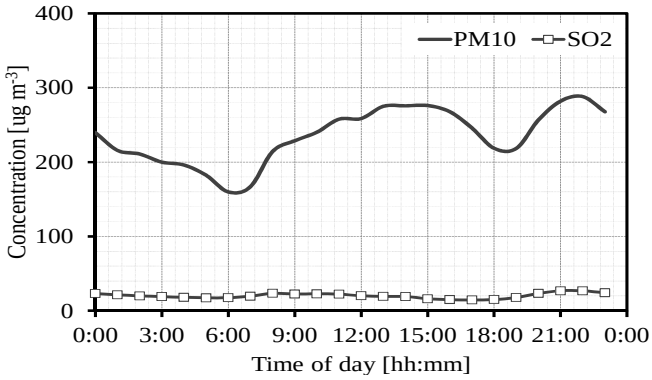
# RECENT TRENDS OF FINE DUST

## Diurnal variation of air pollution in Ulaanbaatar

**Winter season**




**Spring season**

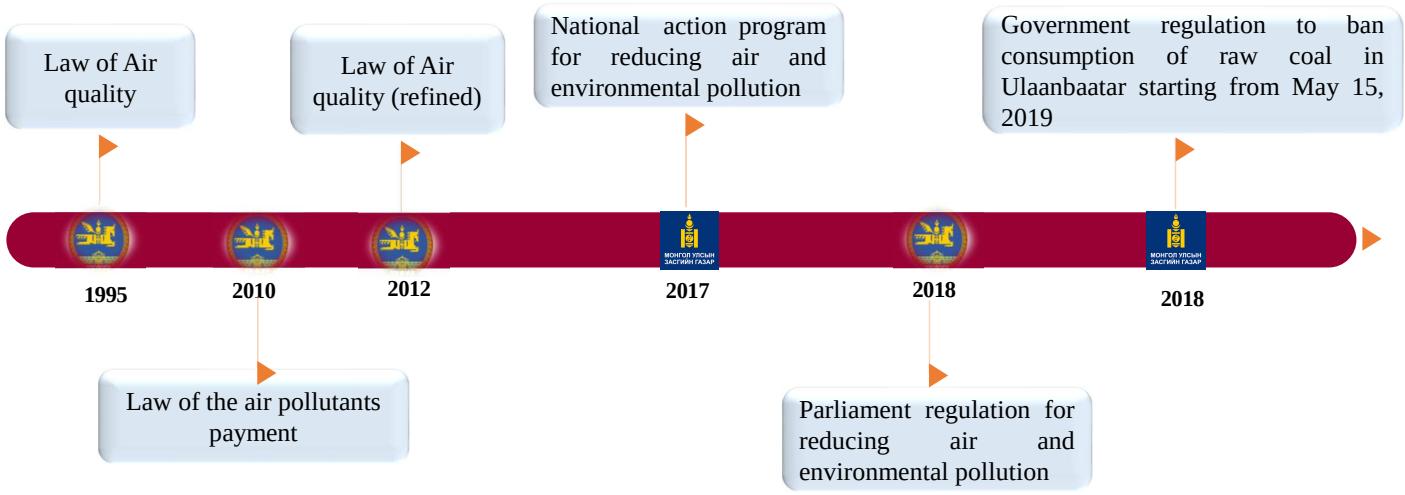



Diurnal variation was significantly depending on seasons.
Strong diurnal variation, morning and nighttime high afternoon low, was observed for PM10 and SO2 in winter and fall seasons due to coal burning for space heating.

Clear diurnal variation for PM, afternoon and evening high, morning low in spring. Evening high is might be due to burning activities. Whereas afternoon high is might be dust storm.

# MANAGEMENT POLICY OF FINE DUST IN MONGOLIA

## AIR QUALITY MANAGEMENT LEGISLATIONS




- Regulation document of air quality improvement zone /annually refined/

## MANAGEMENT POLICY OF FINE DUST IN MONGOLIA

### UPGRADED COAL

**GOVERNMENT REGULATION**

BANNING USE OF RAW COAL BEGINNING FROM 15 MAY, 2019 IN ULAANBAATAR.

**AIR QUALITY:**


PM2.5 ~ **47.3%**

PM10 ~ **40.3%**


**~727,000 tn**
Upgraded coal was used in the winter of 2021-2022.

## MANAGEMENT POLICY OF FINE DUST IN MONGOLIA

### TAX EXEMPTION ON 15 EQUIPMENT


VAT and Customs tax exemption on 15 equipment including **heat pump, electric heaters and air purifier**.

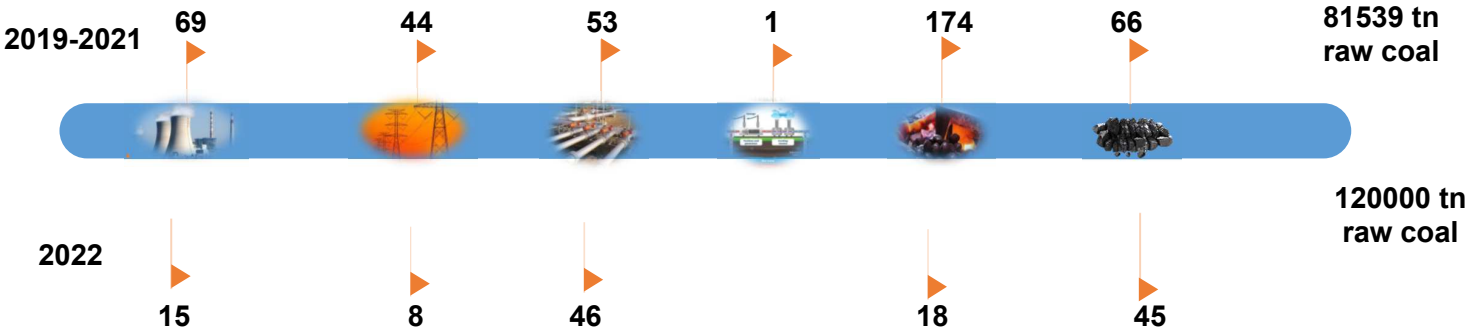
### ELECTRICITY NIGHT-TIME TARIFF DISCOUNT

- 101326 costumer – 6.8 billion tugrik in 2017
- 109213 costumer – 9.4 billion tugrik in 2018
- 116966 costumer – 19.5 billion tugrik in 2019

Green Loan

| | | |
|---|---|---|
| Individual | 10 products | Eco-friendly electric heaters, heat pump<br>Product of renewable energy, insulation materials<br>Domestic stoves with MNS5216:2016 standard … |
| Entity | 15 products | Eco-friendly electric heaters, heat pump<br>Product of renewable energy, insulation materials<br>Product of recycling, incinerator … |

## HEAT ONLY BOILERS




MANAGEMENT POLICY OF FINE DUST IN MONGOLIA

## "INFRASTRUCTURE CENTER" PROJECT

HEATING
WATER SUPPLY
POWER SUPPLY
WASTEWATER SYSTEM

**Emission of air pollutants**

Annual coal consumption
**48'400 ton**

PM
Particulate Matter
**473 ton/year**

SO2
Sulpur dioxide
**160 ton/year**

Source: DAAP

## ONE BILLION TREE NATIONWIDE MOVEMENT

ТЭРБУМ МОД
ҮНДЭСНИЙ ХӨДӨЛГӨӨН

The president of Mongolia, Khurelsukh Ukhnaa, launched a nationwide movement to plant 1 billion trees by 2030 as part of Mongolia's commitment to the United Nations Sustainable Development Goals, as well as a way to fight desertification, deforestation.

# THANK YOU FOR ATTENTION.