4 December 2020

Oral Presentations on Public Health

09:00-10:00

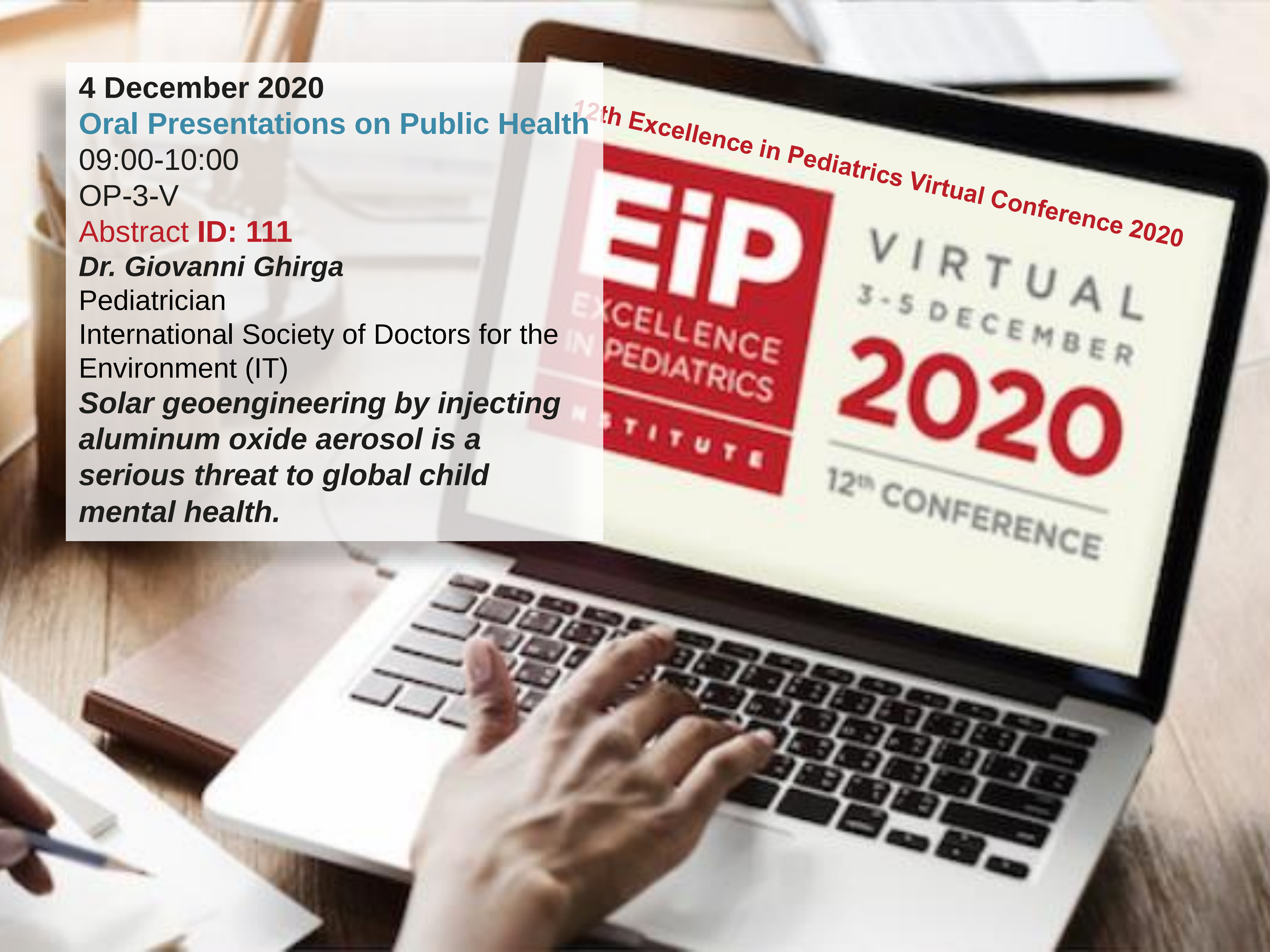
OP-3-V

Abstract **ID: 111**

Dr. Giovanni Ghirga
Pediatrician
International Society of Doctors for the Environment (IT)

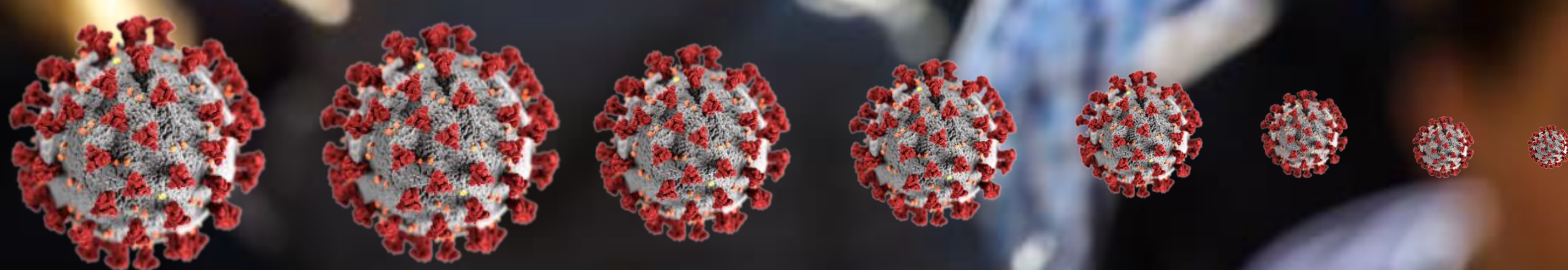
Solar geoengineering by injecting aluminum oxide aerosol is a serious threat to global child mental health.

12th Excellence in Pediatrics Virtual Conference 2020



COVID-19 will end but climate change could become unstoppable.
The world has already observed many devastating effects of human-induced climate change.

Masson-Delmotte V, Zhai P, Pörtner H-O, et al. Global warming of 1.5°C: special report. Geneva: Intergovernmental Panel on Climate Change, 2018.

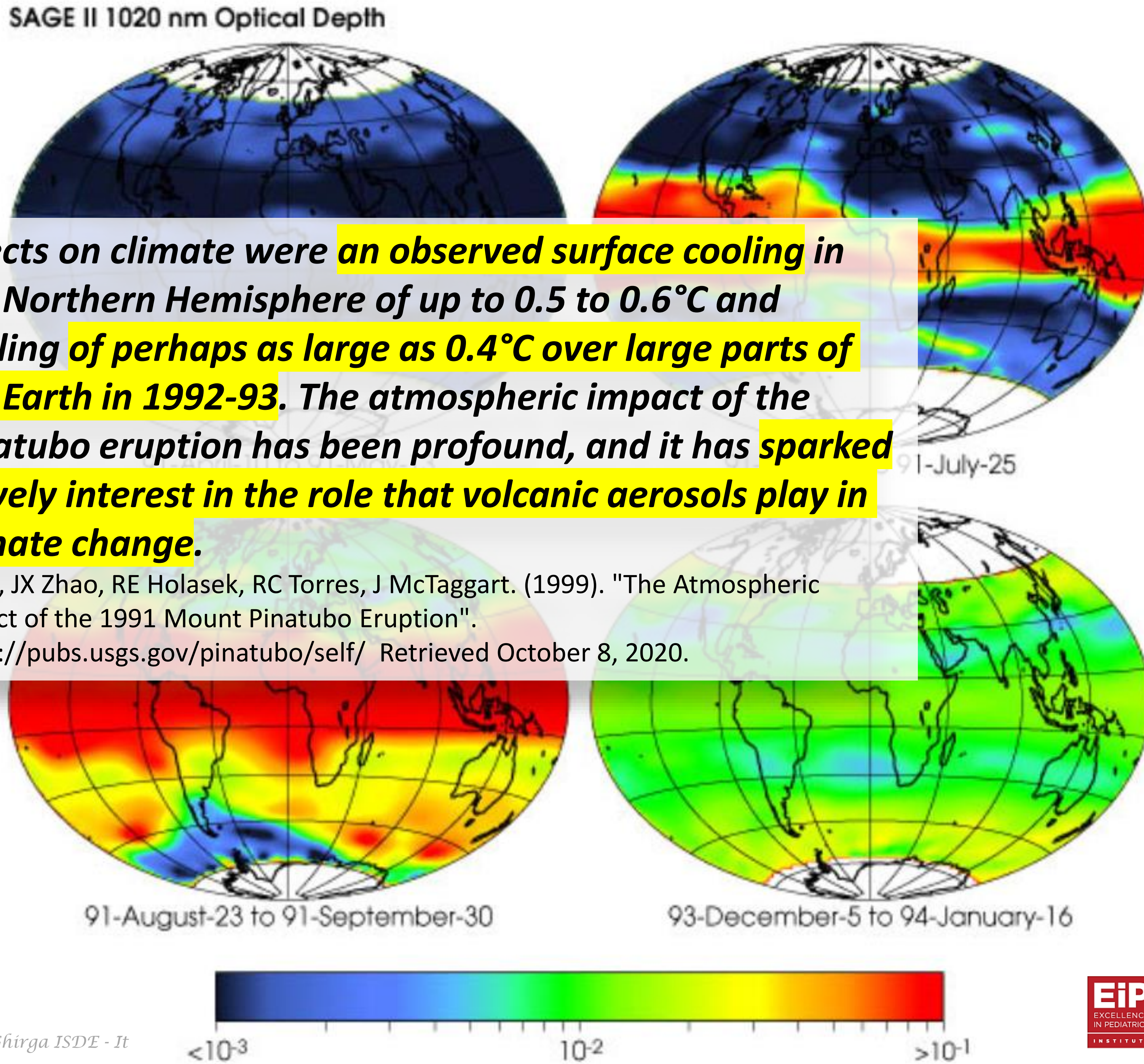


The 1991 eruption columns of Mount Pinatubo volcano, Philippines, reached 40 kilometers in altitude and emplaced a giant umbrella cloud in the middle to lower stratosphere.

The sulphate aerosol cloud produced spread rapidly around the Earth in about 3 weeks and attained global coverage by about 1 year after the eruption.

The large aerosol cloud caused dramatic decreases in the amount of net radiation reaching the Earth's surface.

https://pubs.usgs.gov/pinatubo/self/
Retrieved October 8, 2020.



Effects on climate were an observed surface cooling in the Northern Hemisphere of up to 0.5 to 0.6°C and cooling of perhaps as large as 0.4°C over large parts of the Earth in 1992-93. The atmospheric impact of the Pinatubo eruption has been profound, and it has sparked a lively interest in the role that volcanic aerosols play in climate change.

S Self, JX Zhao, RE Holasek, RC Torres, J McTaggart. (1999). "The Atmospheric Impact of the 1991 Mount Pinatubo Eruption". https://pubs.usgs.gov/pinatubo/self/ Retrieved October 8, 2020.

US scientists launch world's biggest solar geoengineering study **closely mimicking the way large volcanic eruptions cool the climate**

Research programme will send aerosol injections into the earth's upper atmosphere to study the risks and benefits of a future solar tech-fix for climate change

▲ Scientists say the planet could be covered with a solar shield for as little as $10bn a year. Photograph: ISS/Nasa

EiP EXCELLENCE IN PEDIATRICS INSTITUTE — VIRTUAL 3-5 DECEMBER 2020 12th CONFERENCE

https://pubs.usgs.gov/pinatubo/self/

HARVARD UNIVERSITY

STAY IN TOUCH

HARVARD'S SOLAR GEOENGINEERING RESEARCH PROGRAM

ABOUT US | GEOENGINEERING | EVENTS | PROJECTS | PUBLICATIONS | GET INVOLVED | BLOG

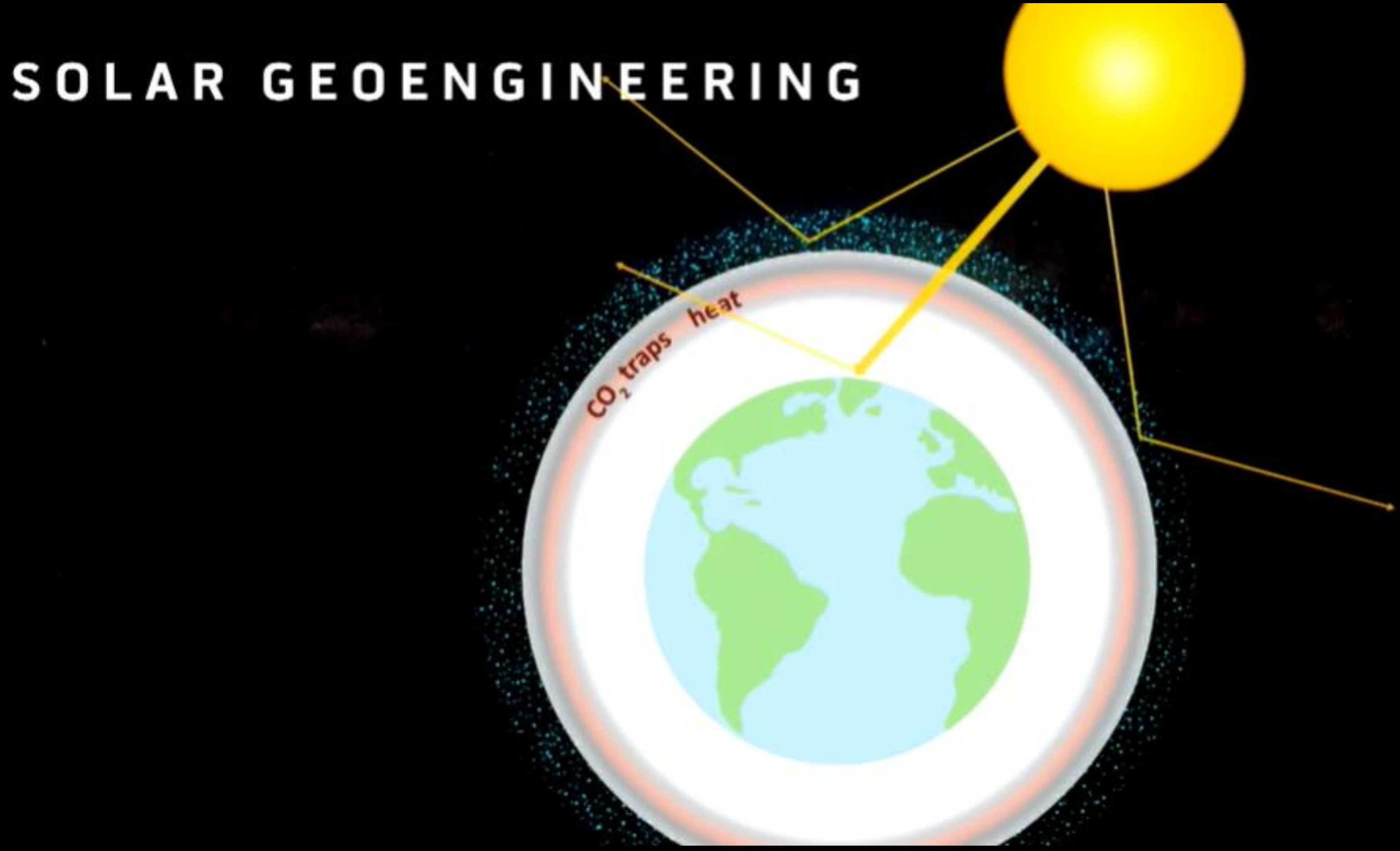
We aim to produce research that advances solar geoengineering's science and technology frontier, publishing high-impact papers, and disseminating ideas that are taken up by other researchers and government research programs.

STAY IN TOUCH

https://pubs.usgs.gov/pinatubo/self/

Injection of sulphate aerosols into the lower stratosphere will closely mimic the way large volcanic eruptions cool the climate.

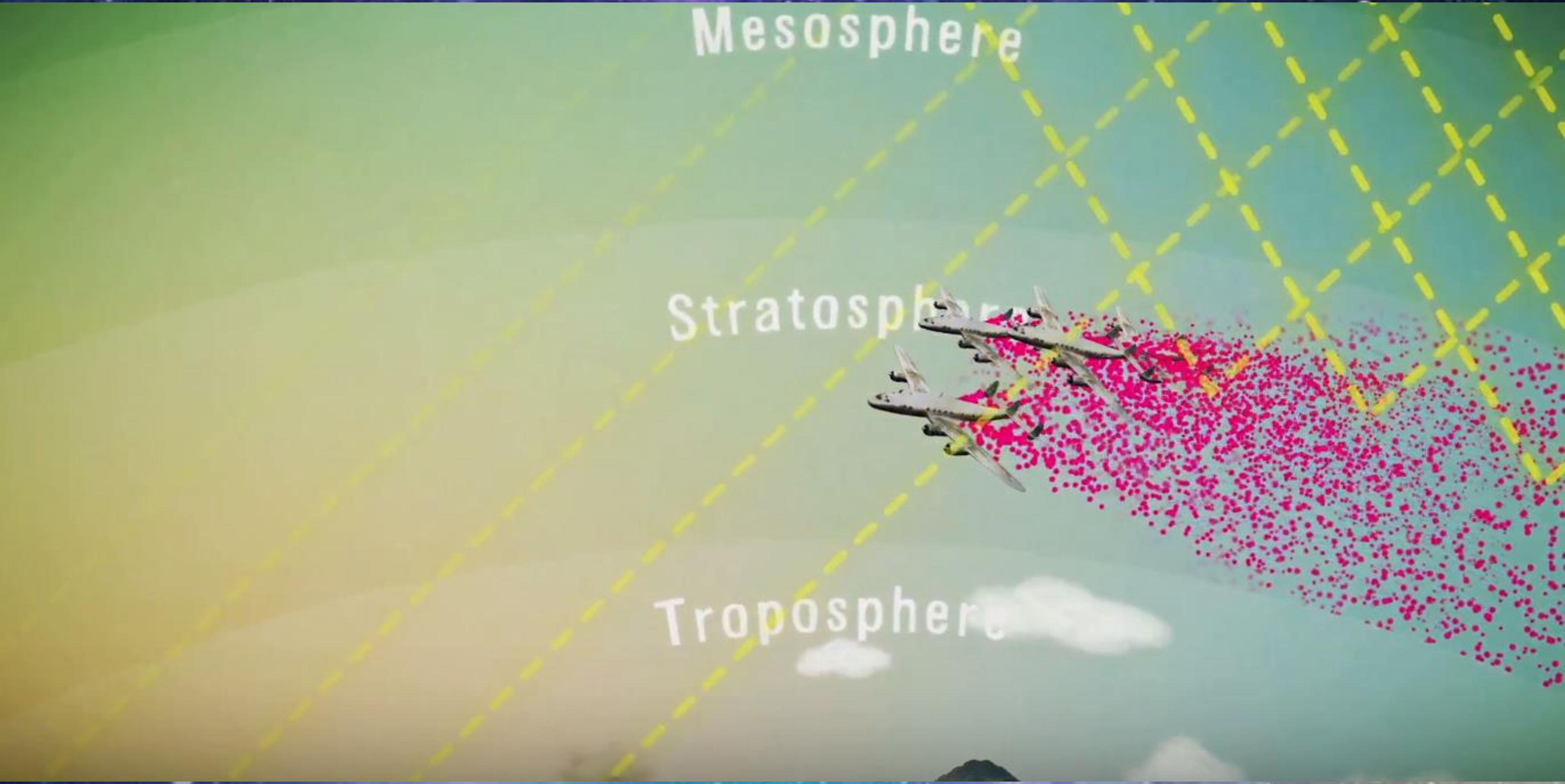
Harvard's Solar Geoengineering Research Program



https://pubs.usgs.gov/pinatubo/self/ Retrived October 8, 2020.

HARVARD'S SOLAR GEOENGINEERING RESEARCH PROGRAM

Recently the **U.S. National Academy of Sciences** and major environmental groups such as the **Environmental Defense Fund** and the **Natural Resources Defense Council** have begun **to support careful research**. The U.S. also published the Climate Science Special Report, which discussed geoengineering and called for further research.



Mesosphere
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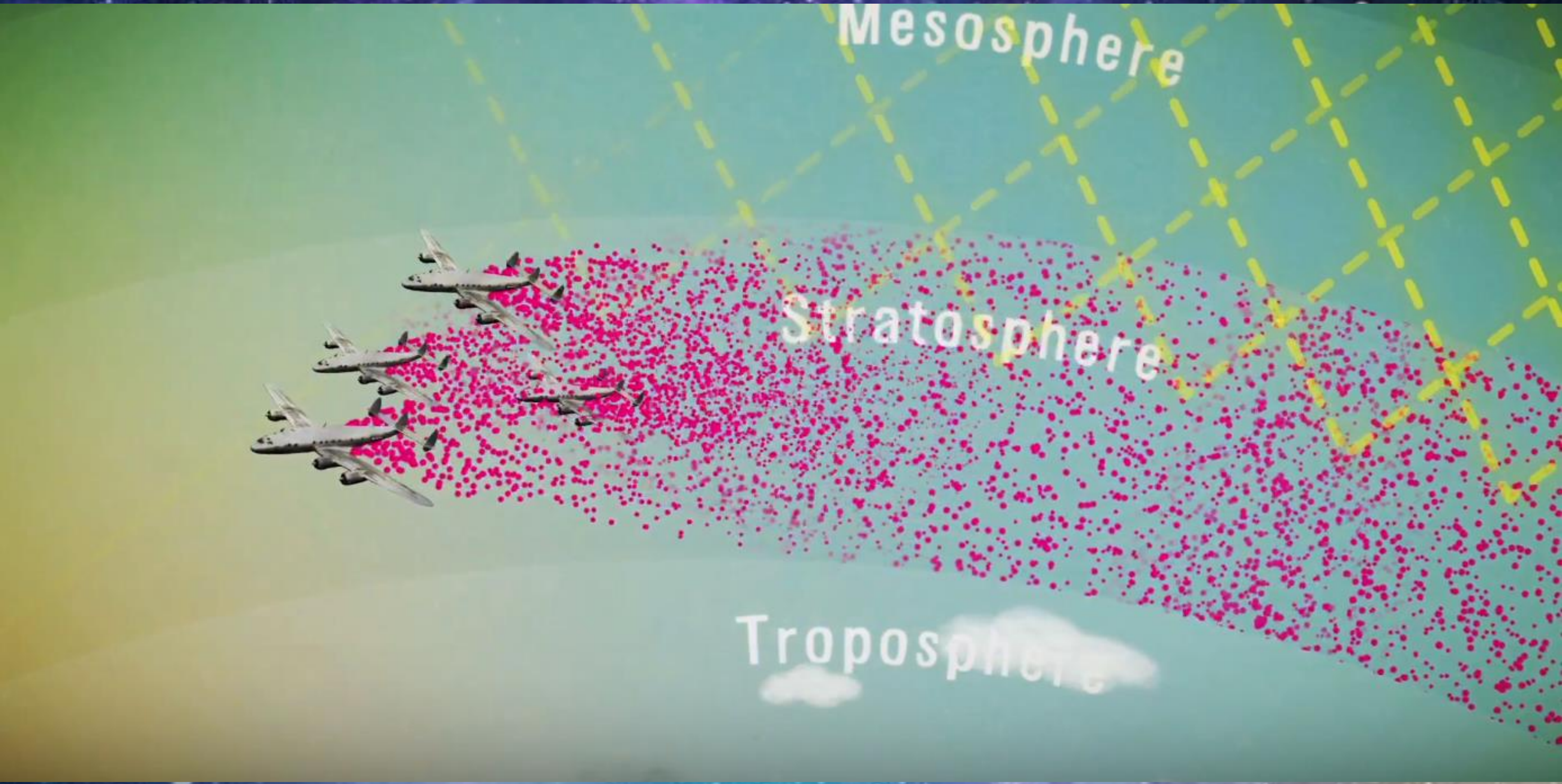
Mesosphere
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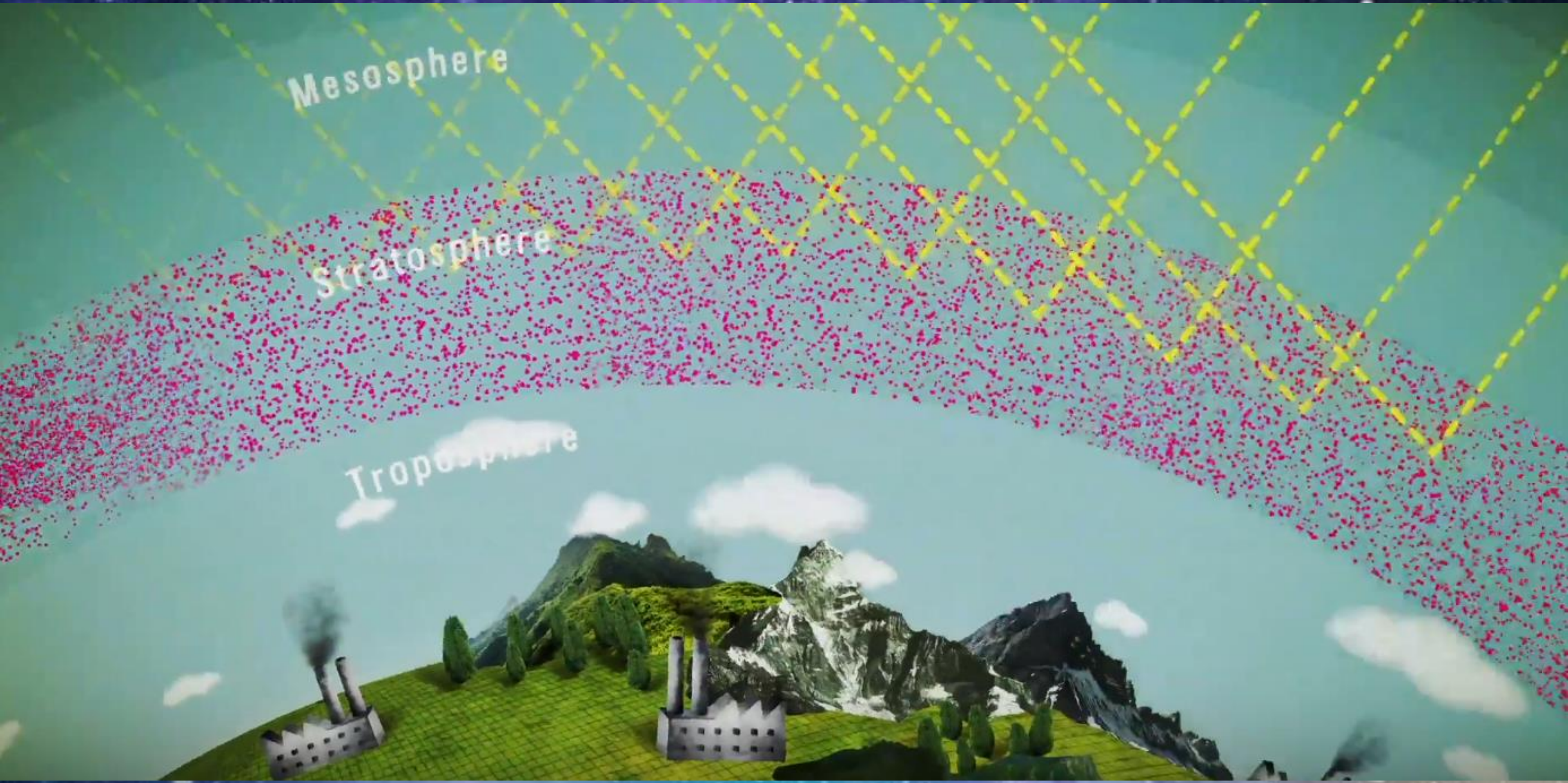

EiP EXCELLENCE IN PEDIATRICS INSTITUTE

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The average residence time of a particle in the lower stratosphere is approximately 1-2 years. After eventual transport into the troposphere, the particles undergo relatively rapid mixing processes by weather events, turbulence, cloud-scale overturning, and are mostly removed from the atmosphere by dry deposition, sedimentation, or scavenging by clouds FINALLY POLLUTING THE ENVIRONMENT.

Climate Intervention: Reflecting Sunlight to Cool Earth. By National Research Council, Division on Earth and Life Studies, Ocean Studies Board, Board on Atmospheric Sciences and Climate, Committee on Geoengineering Climate: Technical Evaluation and Discussion of Impacts. National Academy of Sciences, 2015.

<u>Air pollution can negatively affect neurodevelopment,</u> resulting in lower cognitive test outcomes (such as global intelligence quotient) and the development of behavioral disorders such as autism spectrum and attention deficit hyperactivity disorders. Research suggests that both prenatal and postnatal exposure to air pollution represent threats to neurodevelopment, particularly <u>in children with genetic susceptibility</u>

AIR POLLUTION AND CHILD HEALTH

Prescribing clean air

World Health Organization

- Exposure to air pollutants can negatively affect neurodevelopment, resulting in lower cognitive test outcomes (such as global intelligence quotient) and the development of behavioural disorders such as autism spectrum and attention deficit hyperactivity disorders.
- Research suggests that both prenatal and postnatal exposure to air pollution represent threats to neurodevelopment.

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Overview

Neurodevelopment is a fundamental phase of human growth and development, which begins in the early prenatal period with the proliferation of radial glia and neurons. While neurodevelopment continues well into the second decade of life, the first three years of age are especially important. Various processes occur during this period, including proliferation, migration, differentiation, ... cells *(1, 2)*. If neurodevelopment is ... health consequences for the child can be serious, as this may lead to a number of conditions and symptoms, including cognitive impairment, ... which are difficult to diagnose and treat and may have lifelong consequences.

... association between exposure to AAP, especially ... neurodevelopment in children *(2–4)*.

... between prenatal exposure to air pollution and neurodevelopment in children and suggested that air pollution can negatively affect their mental and motor development. Lertxundi et al. *(5)* found that prenatal exposure to $PM_{2.5}$ and NO_2 was associated with significant decreases in cognitive development and motor development in children at the age of 15 months. In a study of birth cohorts in the Republic of Korea, prenatal exposure to PM_{10} and NO_2 had significant effects on cognitive ... and motor development at 6 months of age but not at 12 or 24 months *(6)*.

The findings of studies on the effects of prenatal exposure to air pollution on cognitive function and behaviour have been inconsistent *(2)*. While one meta-analysis of cohort studies in Europe found no association between cognitive development and exposure to NO_2 and PM from traffic-related air pollution, an association was seen between prenatal exposure to NO_2 and deficits in overall psychomotor function in children aged 1–6 years *(7, 8)*.

Prenatal exposure to air pollutants can have various effects on development throughout childhood. In Japan, Yorifuji and colleagues *(9)* reported an association between prenatal exposure to air pollution and deficits in verbal and fine motor development at the age of 2.5 years. They also found an association with problems of attention, inhibition and impulsivity at 5.5 years. In the same cohort, the risks of attention problems and aggressive behaviour were found to have increased by 8 years of age *(10)*. Other studies indicate that exposure in specific periods during pregnancy is associated with certain stages of neurodevelopmental deficit, with differences by gender. Chiu et al. *(11)* reported an association between exposure to $PM_{2.5}$ at 31–38 weeks of gestational age and reduced intelligence quotient among boys and an association between exposure to $PM_{2.5}$ at 12–20 weeks of gestational age and decreased general memory index among girls.

Where children live and grow has a powerful effect on their lives. There is increasing evidence that, postnatally, childhood exposure to traffic-related air pollution is linked to neurodevelopmental outcomes such as anxiety and depression *(12)* and impaired cognitive function *(13, 14)*. In a study of 2715 children aged 7–10 years in Barcelona, Spain, Sunyer and colleagues *(15)* found that children who attended schools in highly polluted areas had slower growth in cognitive function, measured as

A systematic review and meta-analysis:

Maternal exposure to particulate matter 2.5 (PM2.5) is positively associated with Autism Spectrum Disorder.

HeeKyoung Chun, Cheryl Leung, Shi Wu Wen, Judy Mc Donald, and HH Shin. Maternal exposure to air pollution and risk of autism in children: A systematic review and meta-analysis. Environmental Pollution. Volume 256, January 2020, 113307. https://doi.org/10.1016/j.envpol.2019.113307

Atmos. Chem. Phys., 15, 11835–11859, 2015
www.atmos-chem-phys.net/15/11835/2015/
doi:10.5194/acp-15-11835-2015

Atmospheric Chemistry and Physics
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EGU

Solar geoengineering using solid aerosol in the stratosphere

D. K. Weisenstein[1], D. W. Keith[1,2], and J. A. Dykema[1]

[1]School of Engineering and Applied Science, Harvard University, Cambridge, MA, USA
[2]Kennedy School of Government, Harvard University, Cambridge, MA, USA

Correspondence to: D. K. Weisenstein (dkweis@seas.harvard.edu)

Received: 10 March 2015 – Published in Atmos. Chem. Phys. Discuss.: 21 April 2015
Revised: 7 October 2015 – Accepted: 14 October 2015 – Published: 26 October 2015

Abstract. Solid aerosol particles have long been proposed as an alternative to sulfate aerosols for solar geoengineering. Any solid aerosol introduced into the stratosphere would be subject to coagulation with itself, producing fractal aggregates, and with the natural sulfate aerosol, producing liquid-coated solids. Solid aerosols that are coated with sulfate and/or have formed aggregates may have very different scattering properties and chemical behavior than uncoated non-aggregated monomers do. We use a two-dimensional (2-D) chemistry–transport–aerosol model to capture the dynamics of interacting solid and liquid aerosols in the stratosphere. As an example, we apply the model to the possible use of alumina and diamond particles for solar geoengineering. For 240 nm radius alumina particles, for example, an injection rate of $4\,\mathrm{Tg\,yr^{-1}}$ produces a global-average shortwave radiative forcing of $-1.2\,\mathrm{W\,m^{-2}}$ and minimal self-coagulation of alumina although almost all alumina outside the tropics is coated with sulfate. For the same radiative forcing, these solid aerosols can produce less ozone loss, less stratospheric heating, and less forward scattering than sulfate aerosols do. Our results suggest that appropriately sized alumina, diamond or similar high-index particles may have less severe technology-specific risks than sulfate aerosols do. These results, particularly the ozone response, are subject to large uncertainties due to the limited data on the rate constants of reactions on the dry surfaces.

1 Introduction

Solar geoengineering, or solar radiation management (SRM) has the possibility of deliberately introducing changes to the Earth's radiative balance to partially offset the radiative forcing of accumulating greenhouse gases and so lessen the risks of climate change. Most research on SRM has concentrated on the possibility of adding aerosols to the stratosphere, and essentially all atmospheric modeling of stratospheric aerosol injection has focused on increasing the loading of aqueous sulfuric acid aerosols (Rasch et al., 2008; Heckendorn et al., 2009; Niemeier et al., 2011; Pitari et al., 2014). The possibility that solid aerosol particles might offer advantages over sulfates, such as improved scattering properties, was first suggested almost 2 decades ago, but analysis has been almost exclusively limited to conceptual studies or simple radiative transfer models (Teller et al., 1997; Blackstock et al., 2009; Keith, 2010; Ferraro et al., 2011; Pope et al., 2012).

Any solid aerosol injected directly into the stratosphere for geoengineering purposes would be subject to coagulation with itself and with the natural background or volcanic sulfate aerosol. Aggregates of solid aerosols have very different physical structure and scattering properties than liquid sulfate aerosol particles do. The lifetime and scattering properties of a solid aerosol are strongly dependent on these dynamical interactions, and the chemical properties of the aerosol depend on the extent to which it becomes coated by the ambient sulfate.

We have modified the Atmospheric and Environmental Research (AER) two-dimensional (2-D) chemistry–transport–aerosol model (Weisenstein et al., 2004, 2007) to capture the dynamics of interacting solid and liquid aerosols in the stratosphere. Our model now includes a prognostic size distribution for three categories of aerosols: liquid aerosols, solid aerosols, and liquid-coated solid aerosols. The model's coalescence kernel has been modified and extended to parameterize the interactions of particles across size bins and between all combinations of the three categories. The surface area, sedimentation speed, and coalescence cross section of an aggregate of solid particles depend on the geometry of

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For 240 nm radius alumina particles, for example, an injection rate of 4 Tg yr−1 produces a global-average shortwave radiative forcing of − 1.2 W m − 2 and minimal self-coagulation of alumina although almost all alumina outside the tropics is coated with sulfate. For the same radiative forcing, these solid aerosols can produce less ozone loss, less stratospheric heating, and less forward scattering than sulfate aerosols do. Our results suggest that appropriately sized of an aluminum derivative alumina (the oxide of aluminum), diamond or similar high-index particles MAY HAVE LESS SEVERE TECHNOLOGY-SPECIFIC RISKS THAN SULFATE AEROSOLS DO.

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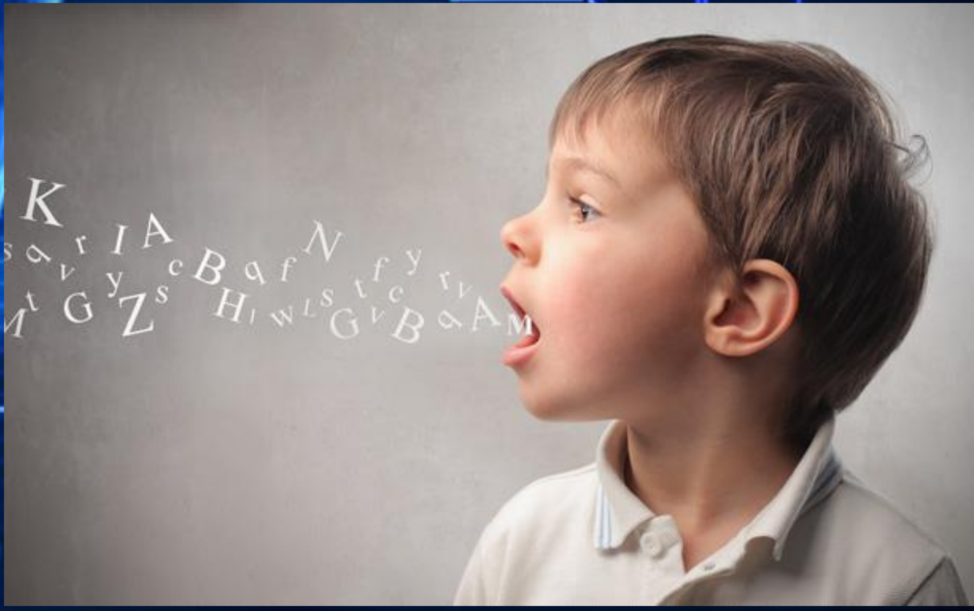
Aluminum has been included among 200 neurotoxic chemicals that are silently eroding intelligence, disrupting behaviours, truncating future achievements, and damaging societies perhaps most seriously in developing countries. This is called the "Silent Pandemic of Neurodevelopmental Toxicity in Children".

- Grandjean P, Landrigan PJ. Neurobehavioural effects of developmental toxicity. The Lancet Neurology, Volume 13, Issue 3, Pages 330 - 338, March 2014.
- Grandjean P, Landrigan PJ. Developmental neurotoxicity of industrial chemicals. Lancet. 2006 Dec 16;368(9553):2167-78.



Journal of Trace Elements in Medicine and Biology 46 (2018) 76–82

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

Aluminium in brain tissue in autism

Matthew Mold[a], Dorcas Umar[b], Andrew King[c], Christopher Exley[a,*]

[a] The Birchall Centre, Lennard-Jones Laboratories, Keele University, Staffordshire, ST5 5BG, United Kingdom
[b] Life Sciences, Keele University, Staffordshire, ST5 5BG, United Kingdom
[c] Department of Clinical Neuropathology, Kings College Hospital, London, SE5 9RS, United Kingdom

ARTICLE INFO

Keywords:
Human exposure to aluminium
Human brain tissue
Autism spectrum disorder
Transversely heated atomic absorption spectrometry
Aluminium-selective fluorescence microscopy

ABSTRACT

Autism spectrum disorder is a neurodevelopmental disorder of unknown aetiology. It is suggested to involve both genetic susceptibility and environmental factors including in the latter environmental toxins. Human exposure to the environmental toxin aluminium has been linked, if tentatively, to autism spectrum disorder. Herein we have used transversely heated graphite furnace atomic absorption spectrometry to measure, for the first time, the aluminium content of brain tissue from donors with a diagnosis of autism. We have also used an aluminium-selective fluor to identify aluminium in brain tissue using fluorescence microscopy. The aluminium content of brain tissue in autism was consistently high. The mean (standard deviation) aluminium content across all 5 individuals for each lobe were 3.82(5.42), 2.30(2.00), 2.79(4.05) and 3.82(5.17) μg/g dry wt. for the occipital, frontal, temporal and parietal lobes respectively. These are some of the highest values for aluminium in human brain tissue yet recorded and one has to question why, for example, the aluminium content of the occipital lobe of a 15 year old boy would be 8.74 (11.59) μg/g dry wt.? Aluminium-selective fluorescence microscopy was used to identify aluminium in brain tissue in 10 donors. While aluminium was imaged associated with neurones it appeared to be present intracellularly in microglia-like cells and other inflammatory non-neuronal cells in the meninges, vasculature, grey and white matter. The pre-eminence of intracellular aluminium associated with non-neuronal cells was a standout observation in autism brain tissue and may offer clues as to both the origin of the brain aluminium as well as a putative role in autism spectrum disorder.

1. Introduction

Autism spectrum disorder (ASD) is a group of neurodevelopmental conditions of unknown cause. It is highly likely that both genetic [1] and environmental [2] factors are associated with the onset and progress of ASD while the mechanisms underlying its aetiology are expected to be multifactorial [3–6]. Human exposure to aluminium has been implicated in ASD with conclusions being equivocal [7–10]. To-date the majority of studies have used hair as their indicator of human exposure to aluminium while aluminium in blood and urine have also been used to a much more limited extent. Paediatric vaccines that include an aluminium adjuvant are an indirect measure of infant exposure to aluminium and their burgeoning use has been directly correlated with increasing prevalence of ASD [11]. Animal models of ASD continue to support a connection with aluminium and to aluminium adjuvants used in human vaccinations in particular [12]. Hitherto there are no previous reports of aluminium in brain tissue from donors who died with a diagnosis of ASD. We have measured aluminium in brain tissue in autism and identified the location of aluminium in these tissues.

2. Materials and methods

2.1. Measurement of aluminium in brain tissues

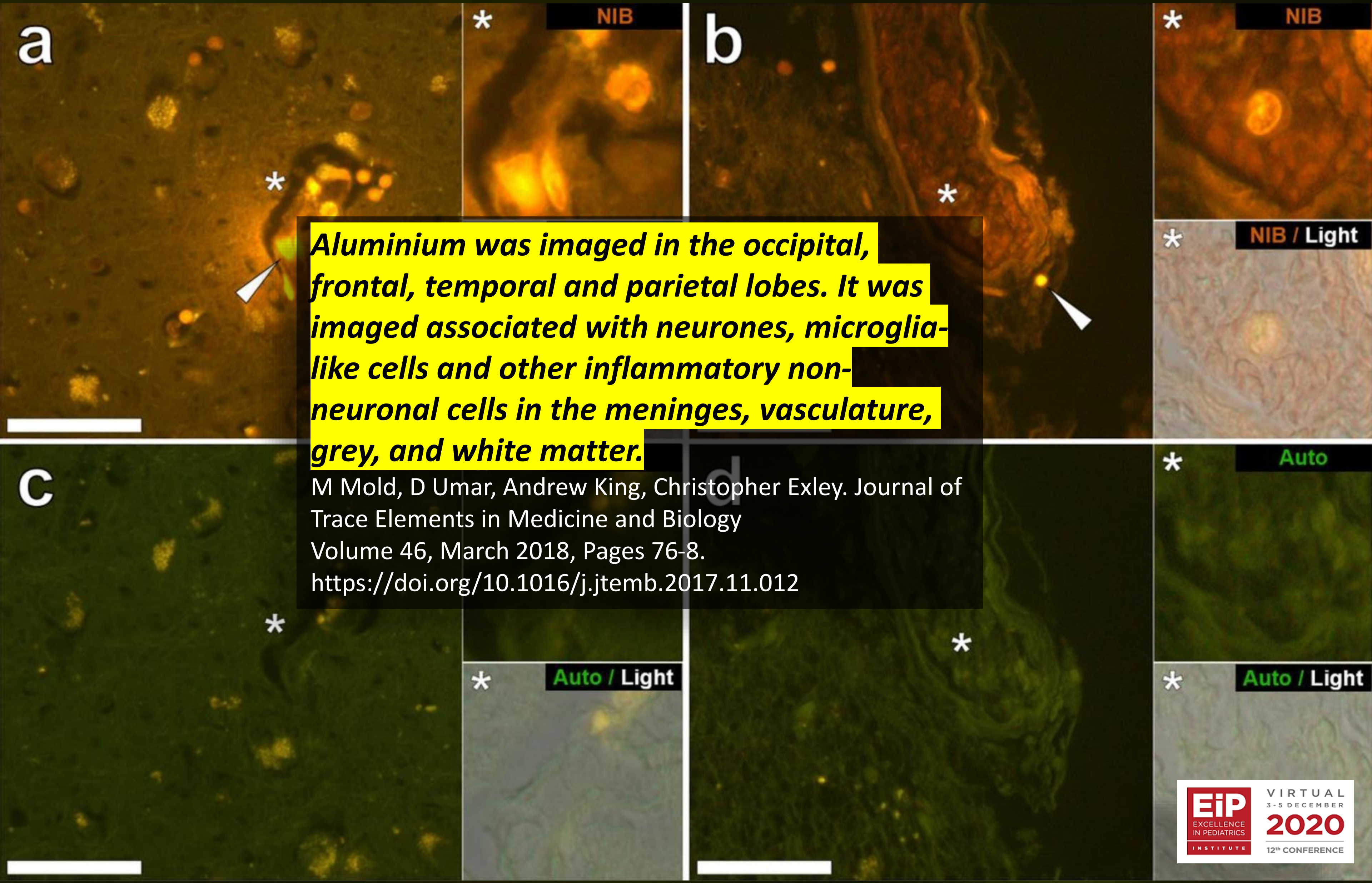
Ethical approval was obtained along with tissues from the Oxford Brain Bank (15/SC/0639). Samples of cortex of approximately 1 g frozen weight from temporal, frontal, parietal and occipital lobes and hippocampus (0.3 g only) were obtained from 5 individuals with ADI-R-confirmed (Autism Diagnostic Interview-Revised) ASD, 4 males and 1 female, aged 15–50 years old (Table 1).

The aluminium content of these tissues was measured by an established and fully validated method [13] that herein is described only briefly. Thawed tissues were cut using a stainless steel blade to give individual samples of *ca* 0.3 g (3 sample replicates for each lobe except for hippocampus where the tissue was used as supplied) wet weight and dried to a constant weight at 37 °C. Dried and weighed tissues were digested in a microwave (MARS Xpress CEM Microwave Technology Ltd.) in a mixture of 1 mL 15.8 M HNO_3 (Fisher Analytical Grade) and 1 mL 30% w/v H_2O_2 (BDH Aristar). Digests were clear with no fatty residues and, upon cooling, were made up to 5 mL volume using

* Corresponding author.

https://doi.org/10.1016/j.jtemb.2017.11.012
Received 26 October 2017; Received in revised form 21 November 2017; Accepted 23 November 2017

Discussion. **The aluminium content of brain tissues from donors with a diagnosis of Autism Spectrum Disorders was extremely high.** While there was significant inter-tissue, inter-lobe and inter-subject variability the mean aluminium content for each lobe across all individuals was towards the higher end of all previous (historical) measurements of brain aluminium content.



Aluminium was imaged in the occipital, frontal, temporal and parietal lobes. It was imaged associated with neurones, microglia-like cells and other inflammatory non-neuronal cells in the meninges, vasculature, grey, and white matter.

M Mold, D Umar, Andrew King, Christopher Exley. Journal of Trace Elements in Medicine and Biology
Volume 46, March 2018, Pages 76-8.
https://doi.org/10.1016/j.jtemb.2017.11.012

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*Scientists from the Centers for Disease Control and Prevention (CDC) and the Health Resources and Services Administration (HRSA) found that about **1 in 6 (17%) of children aged 3–17 years had a developmental disability**, and importantly, that this percentage increased over the two time periods compared, 2009–2011 and 2015–2017; increases were also seen for specific developmental disabilities in the same age group.*

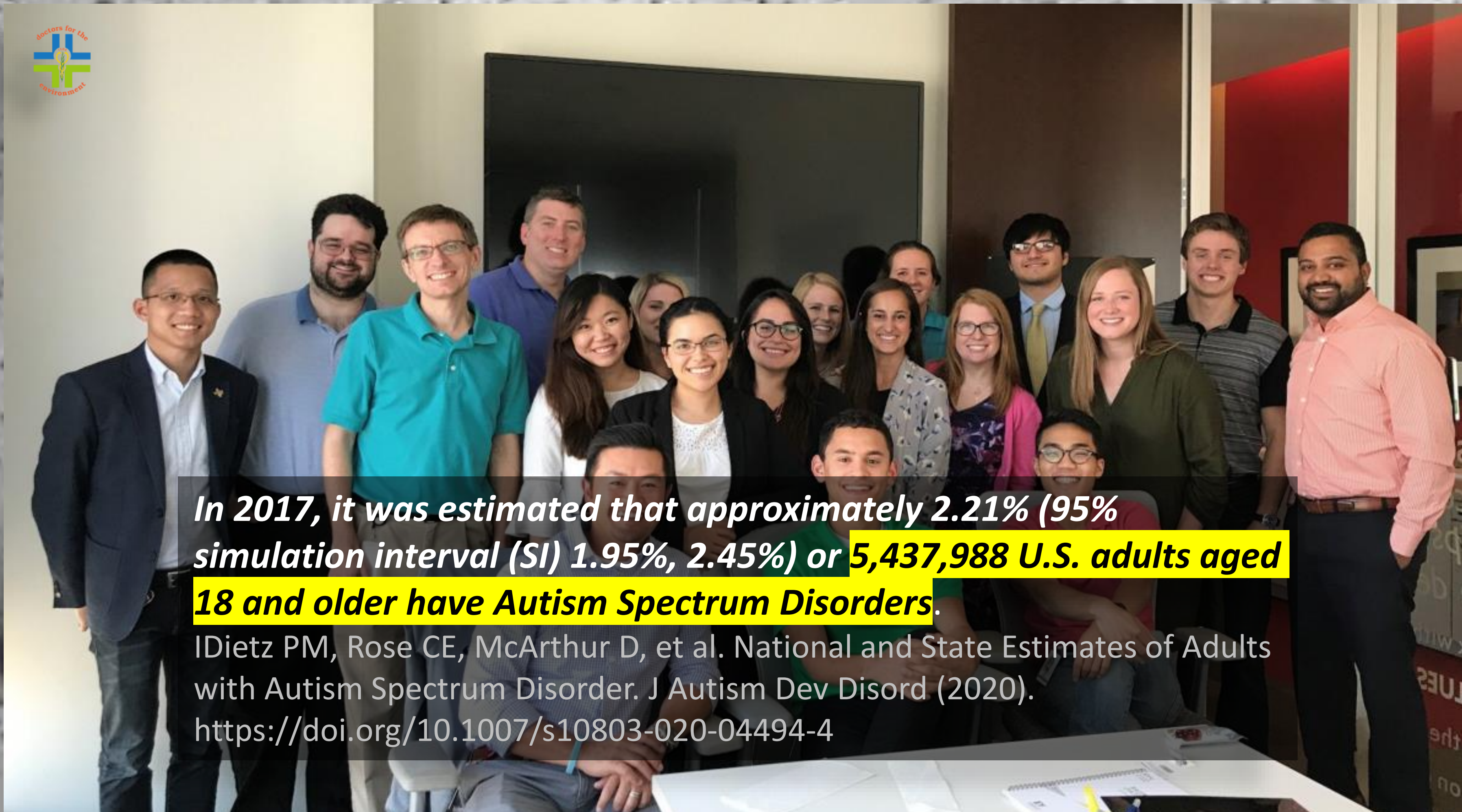
*Specifically, diagnoses increased for **attention-deficit/hyperactivity disorder** (ADHD) (8.5% to 9.5%), **autism spectrum disorder** (ASD) (1.1% to 2.5%), and **intellectual disabilities** (ID is a term used when there are limits to a person's ability to learn at an expected level and function in daily life) (0.9% to 1.2%).*

Zablotsky B, Black LI, Maenner MJ, Schieve LA, Danielson ML, Bitsko RH, Blumberg SJ, Kogan MD, Boyle CA. Prevalence and Trends of Developmental Disabilities among Children in the US: 2009–2017. *Pediatrics*. 2019; 144(4):e20190811

It is estimated that worldwide one in 160 children has an ASD. This estimate represents an average figure, and reported prevalence varies substantially across studies and countries. The U.S. prevalence rates by the CDC's Autism and Developmental Disabilities Monitoring Network (ADDM) of Autism Spectrum Disorders (ASD) showed an increase prevalence over years: 1 in 150 children in 2007 (2000 and 2002 data), 1 in 110 in 2009 (2006 data), 1 in 88 in 2012 (2008 data), 1 in 68 in 2014 (2010 data), 1 in 59 children in 2018 (2014 data), and 1 in 54 children in 2020 (2016 data).

WHO. Autism spectrum disorders. Accessed 7 November 2019. https://www.who.int/news-room/fact-sheets/detail/autism-spectrum-disorders.

CDC. Autism Spectrum Disorders: Data & Statistics, 2020.



In 2017, it was estimated that approximately 2.21% (95% simulation interval (SI) 1.95%, 2.45%) or 5,437,988 U.S. adults aged 18 and older have Autism Spectrum Disorders.

IDietz PM, Rose CE, McArthur D, et al. National and State Estimates of Adults with Autism Spectrum Disorder. J Autism Dev Disord (2020). https://doi.org/10.1007/s10803-020-04494-4

We as scientists must oppose the use of toxic chemicals, particularly aluminum, in solar geoengineering projects to protect global child mental health.

Giovanni Ghirga ISDE - It