



Dust and Human Health

Why we need to rethink how we evaluate the impact of dust events on air quality and Human Health

Karin Ardon-Dryer

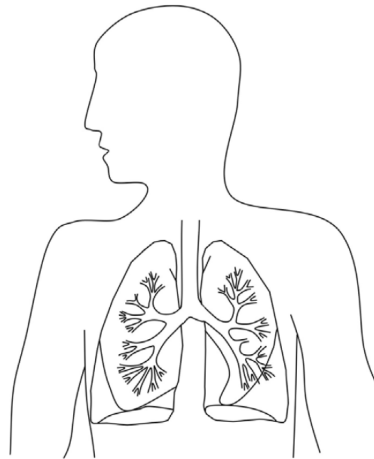
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Texas Tech University

Karin.ardon-dryer@ttu.edu

Why should we care?

Dust Storm Alerts NSW, 2020



Dust particle (diameter size)

>10µm

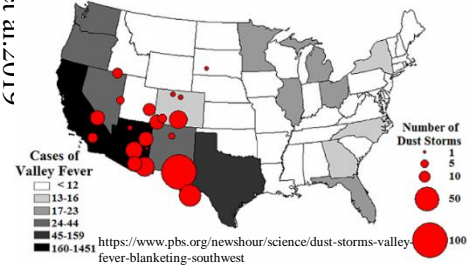
2.5-10µm

<2.5µm

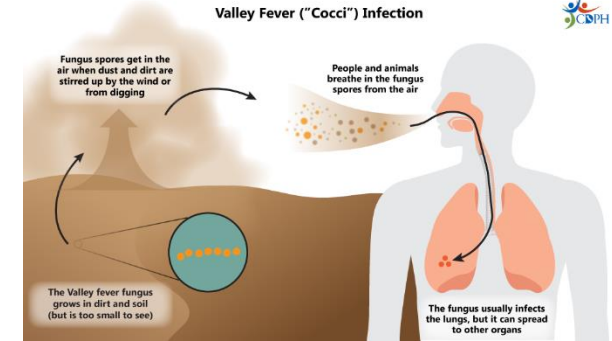
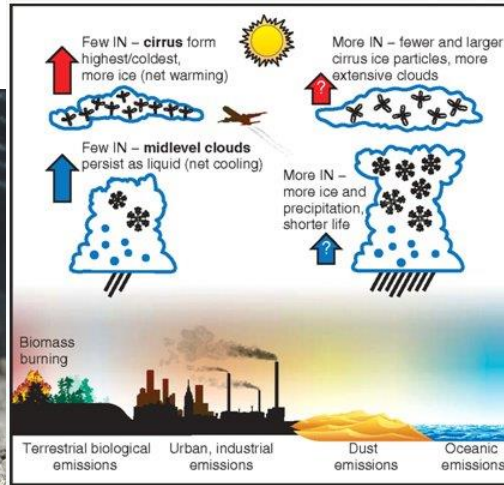
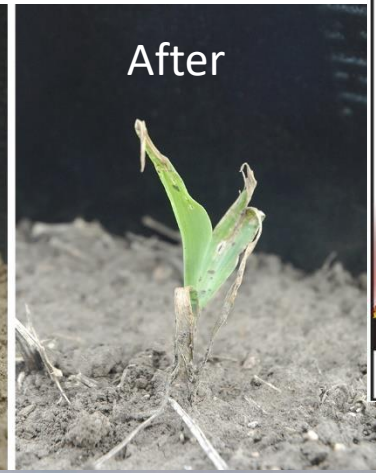
Ardon-Dryer et al. 2017



Ahmed Jadhilah, Dubai, 2015



Institute of Agriculture and Natural Science



July 2021 (I-15)
8 Fatalities
22-vehicle pile



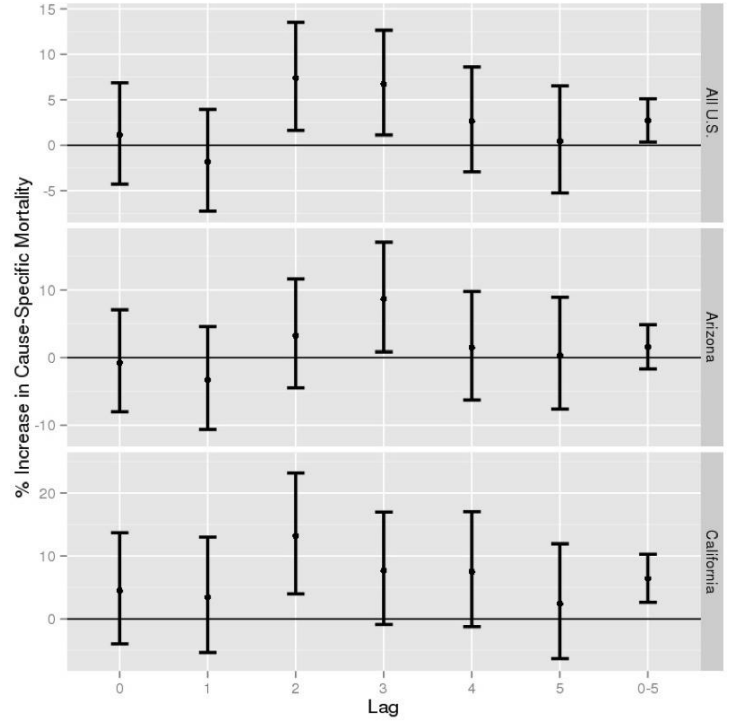
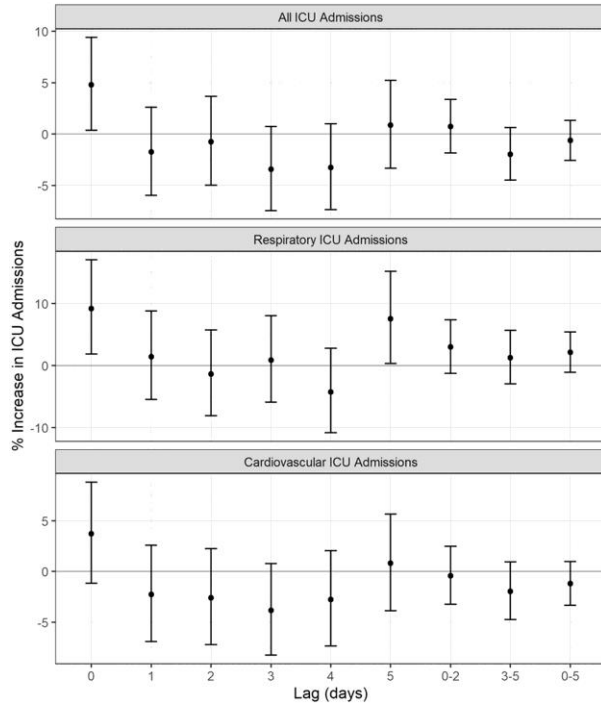
Joe Merchant



Julio Reyes

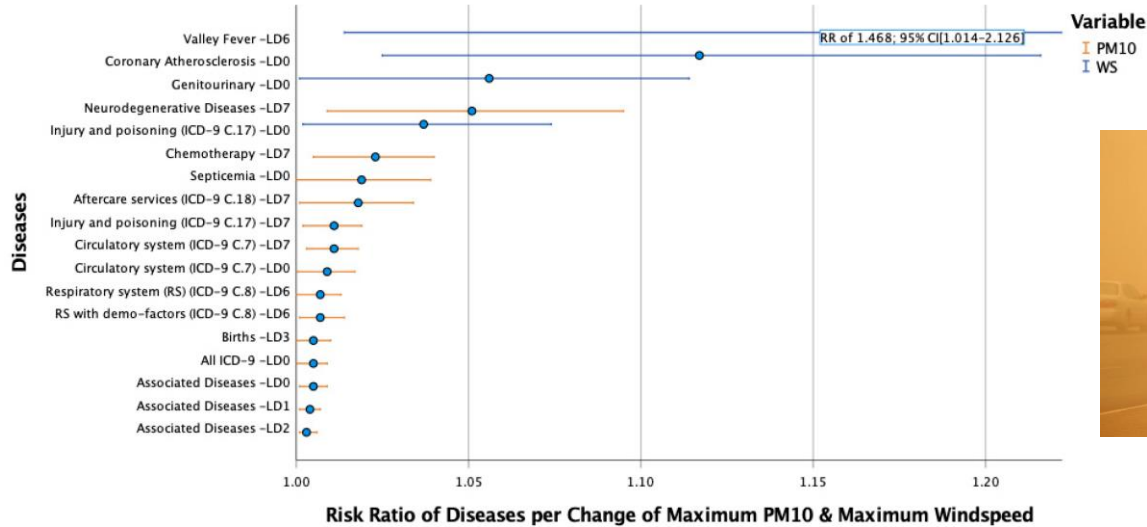
Impact on health

Rublee et al. (2020)



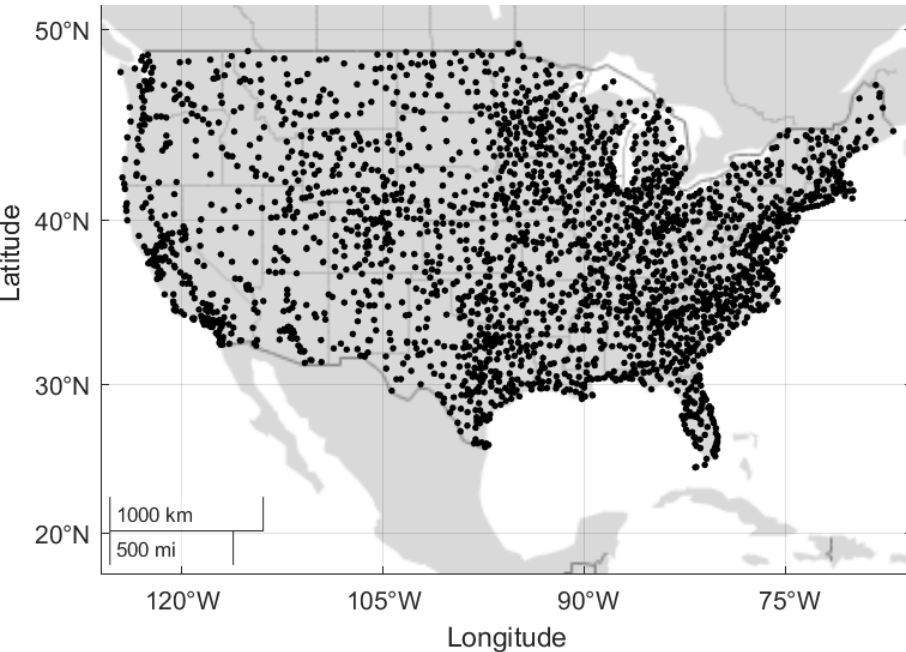
Crooks et al. (2016)

Herrera-Molina et al. (2021)



Ahmed Jadallah, Dubai, 2015

Identification of dust events across the US (2000-2020)

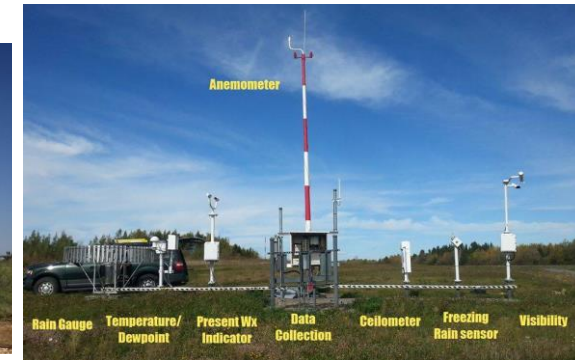


Automated Surface Observing Systems (ASOS)
METeorological Aerodrome Reports (METARs)
2699 ASOS across US mainly in airports

Automated / w. Observer



2534 ASOS across US
could be used



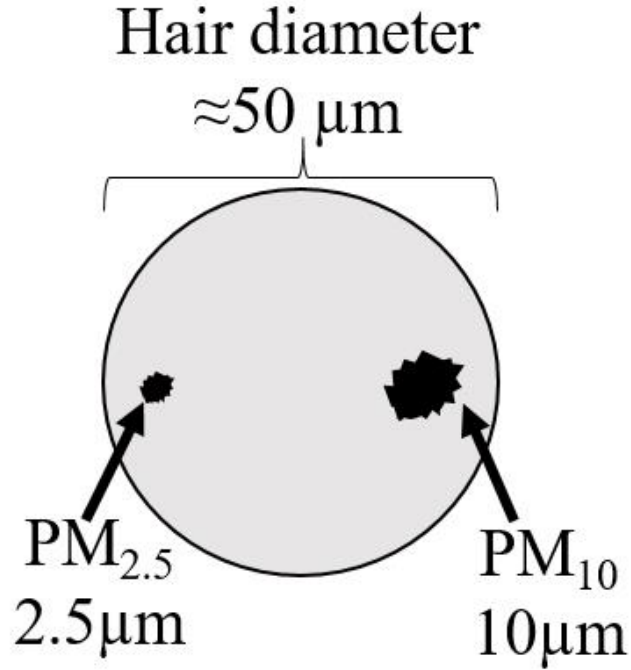
<https://pdximes.com/news/hot-summer-but-not-a-record-in-pahrump/attachment/special-to-the-pahrump-valley-times-shown-in-this-photo-provided-by-the-national-weather-service-in-eko-is-an-automated-surface-observing-system-which-helps-to-collect-weather-data/>

Provide 5-minute - hourly
meteorological measurements
including:

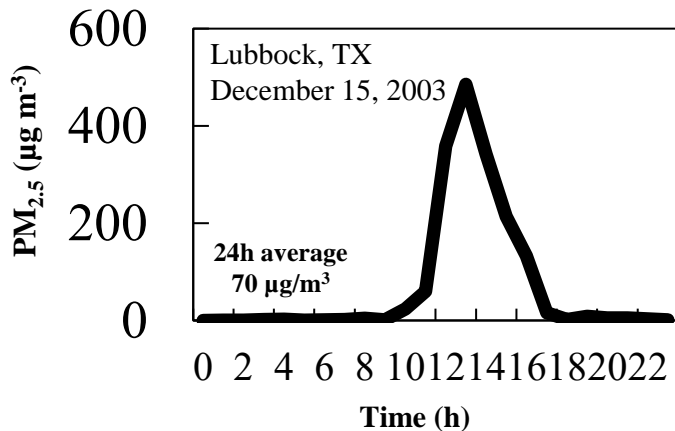
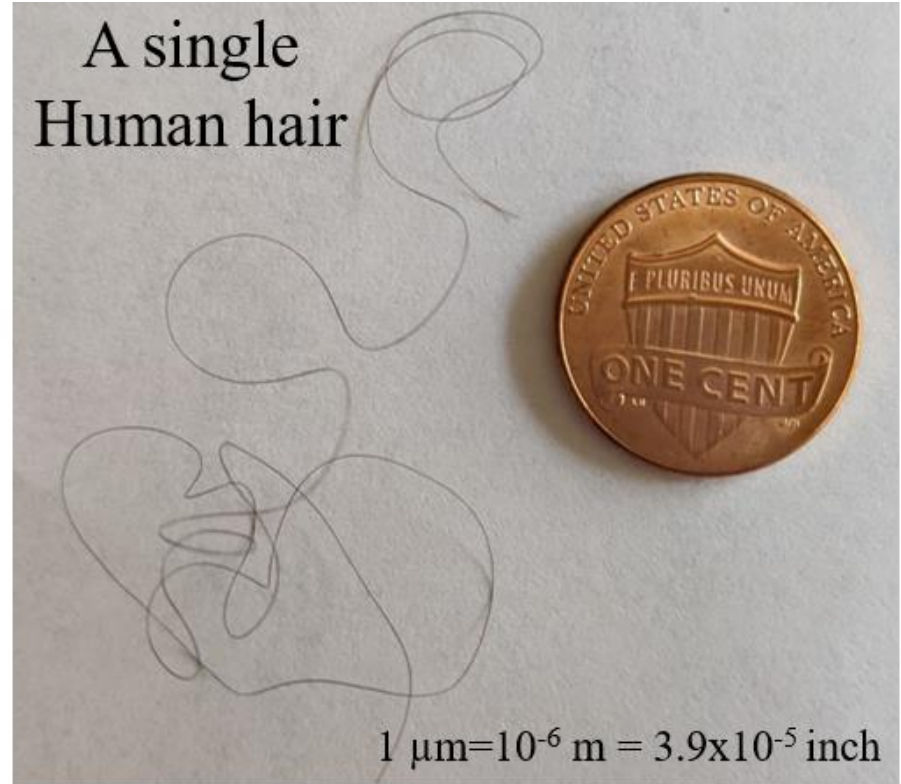
- Air temperature (T)
- Relative Humidity (RH)
- Dew point (Td)
- Wind speed (W_s) and gust (W_g)
- Wind direction (Wd)
- Pressure (P)
- Visibility
- (Vis) Precipitation
- Present Weather Code

LBB,2019-06-05 18:40,M,M,M,300.00,26.00,M,29.97,M,2.50,M,FEW,BKN,OVC,M,3000.00,5500.00,7000.00,M,+RA -,M,M,M,M,M,M,M,KLBB 052340Z AUTO 30026KT 2 1/2SM +RA -
FEW030 BKN055 OVC070 17/14 A2996 RMK T01700140 LTG DSNT ALQDS!FRQ LTGIC ALQDS TS ALQDS MOV E MADISHF

Impact on Air quality



PM_{10} particles with a diameter $< 10 \mu\text{m}$
 $\text{PM}_{2.5}$ particles with a diameter $< 2.5 \mu\text{m}$

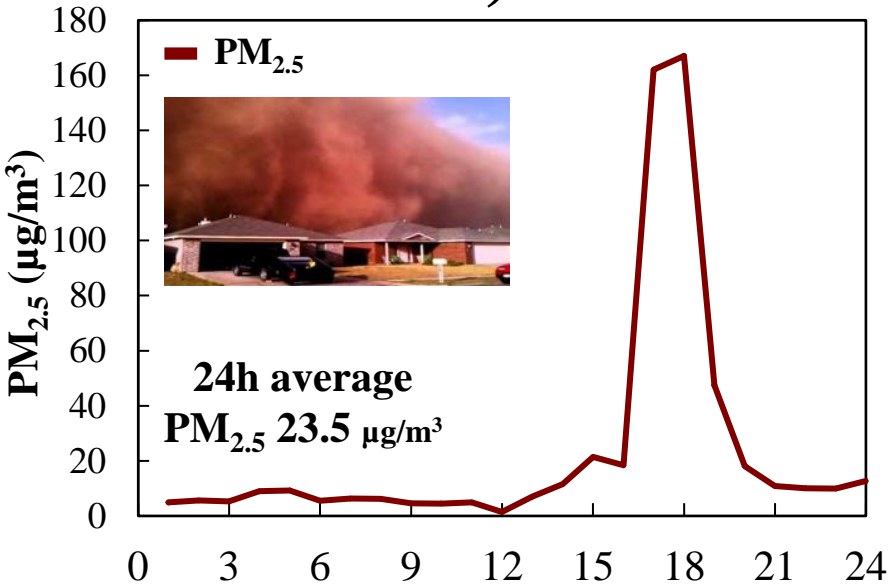


<https://www.weather.gov/lub/events-2003-20031215>

24h	WHO	EPA
$\text{PM}_{2.5}$ ($\mu\text{g}/\text{m}^3$)	15	35
PM_{10} ($\mu\text{g}/\text{m}^3$)	45	150

Updated WHO

October 17, 2011



24h

WHO

EPA

PM_{2.5} (µg/m³)

15(25_{original})

35

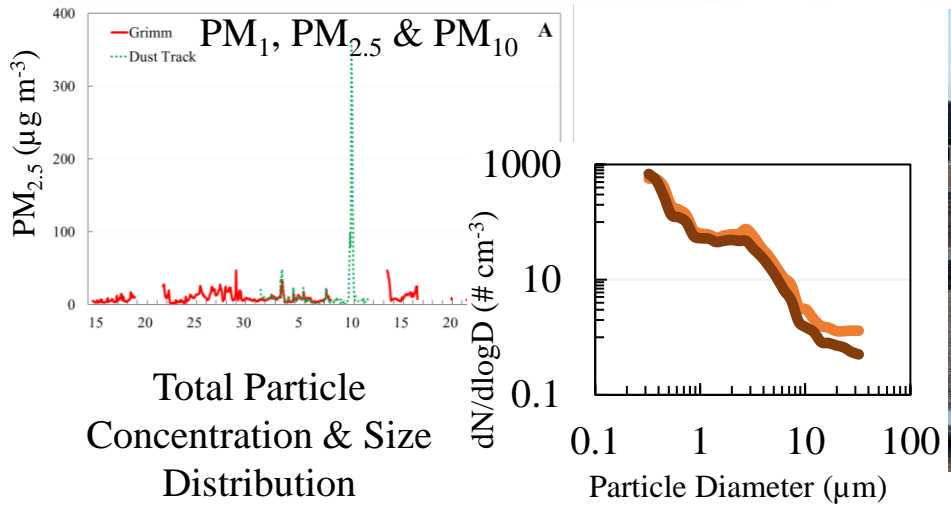
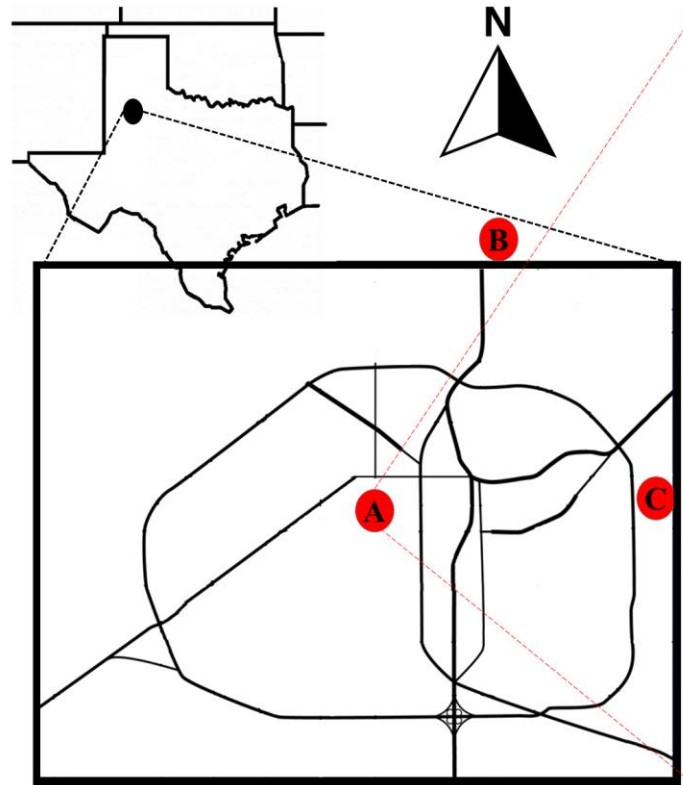
PM₁₀ (µg/m³)

45(50_{original})

150

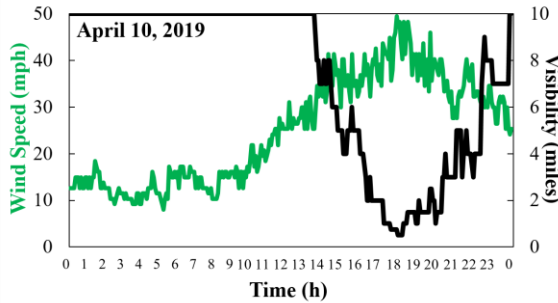
**Average across the day mask
the fluctuation (max) of the dust
concentration**

Aerosol Research Observation Station (AEROS)



April 10, 2019

Synoptic event



12h

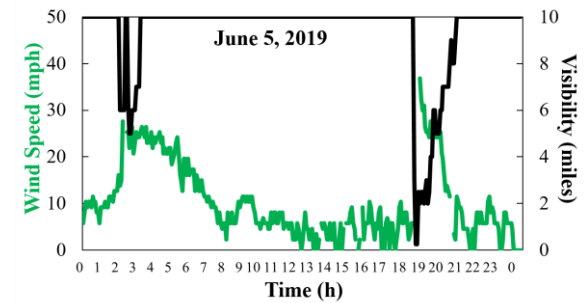


20 min



June 5, 2019

Convective events



Daily values ($\mu\text{g m}^{-3}$)	April 10	June 5
PM ₁	64.7 ±	21 ±
PM _{2.5}	72.6 ±	22.2 ±
PM ₁₀	129 ±	29.5 ±

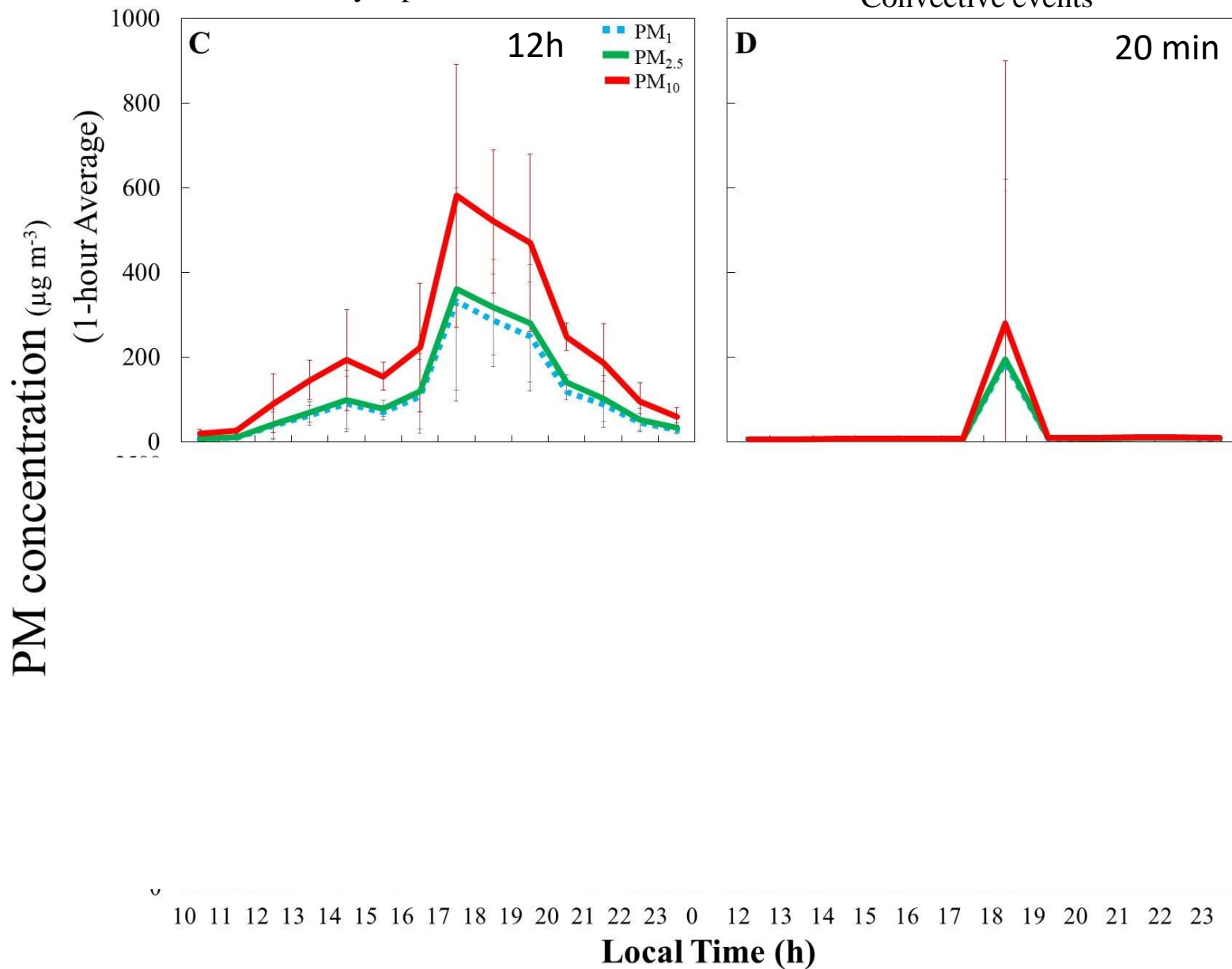
24h	WHO	EPA
PM _{2.5} ($\mu\text{g}/\text{m}^3$)	15(25 _{original})	35
PM ₁₀ ($\mu\text{g}/\text{m}^3$)	45(50 _{original})	150

April 10, 2019

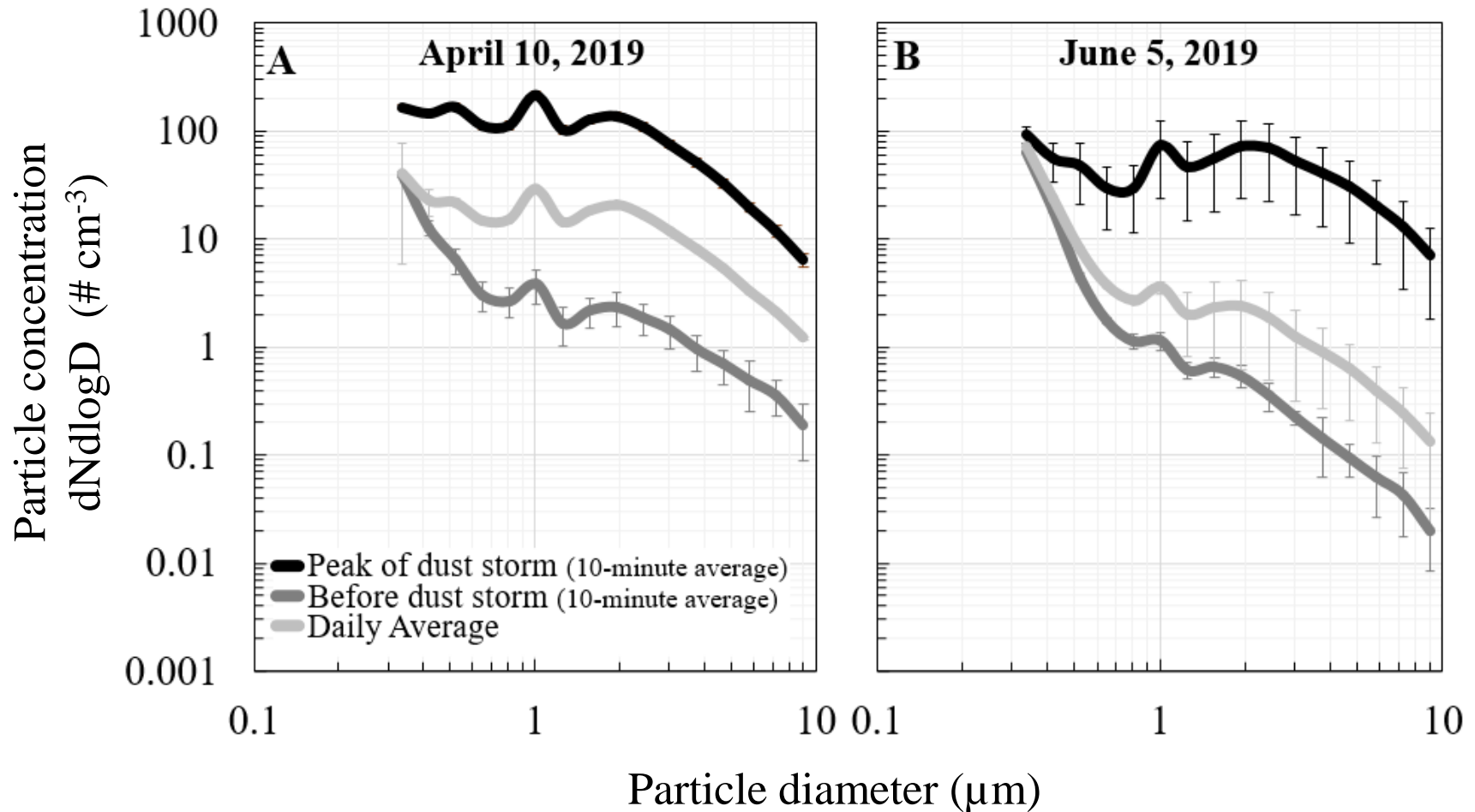
Synoptic event

June 5, 2019

Convective events



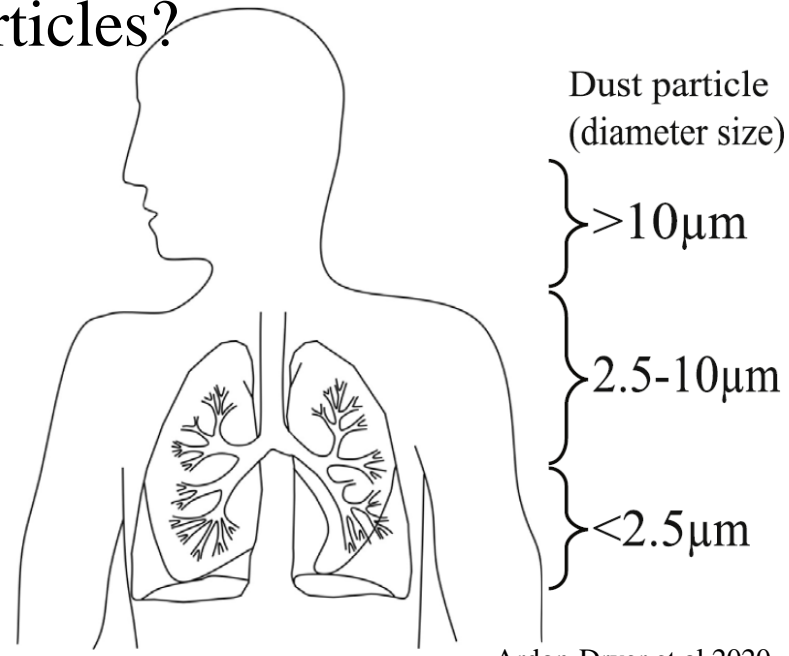
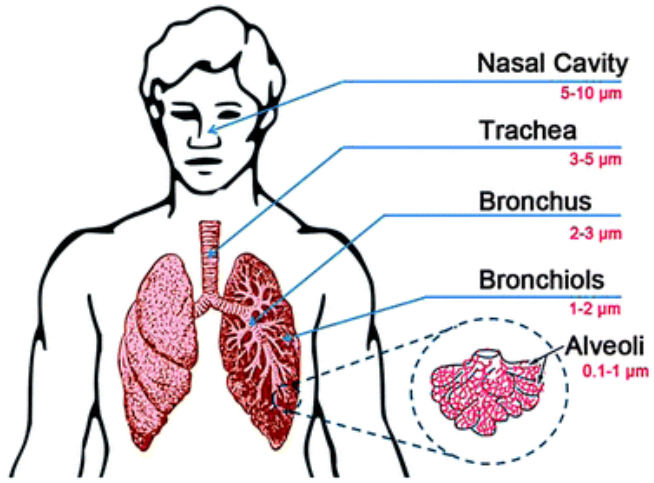
A significant difference between the dust particle concentrations when comparing measurements from before the dust event and at its peak.



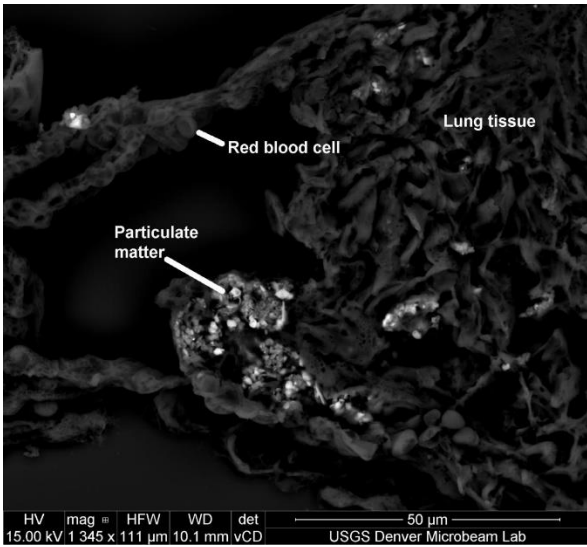
Dust events contain a high concentration of smaller particles.

What happens when we breathe these particles?

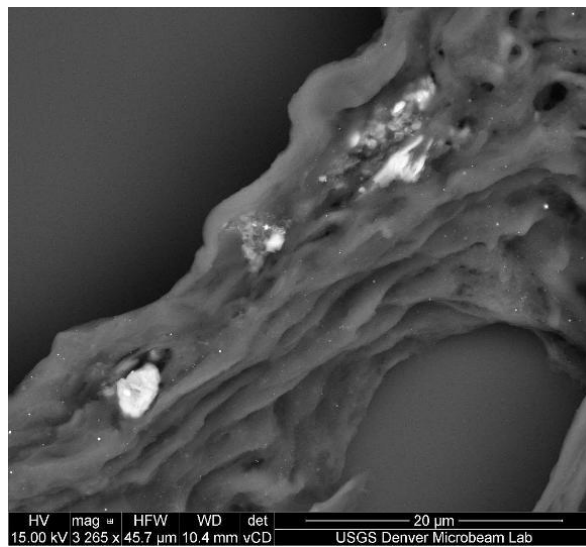
<http://www.ornl.gov/en-ca/english/fivestocks/swine/facts93-003.htm>



Ardon-Dryer et al.2020



<http://goldrushcam.com/sierrasuntimes/index.php/news/local-news/11860-investigating-lung-disease-in-iraq-and-afghanistan-military-veterans>



<https://www.sciencebase.gov/catalog/item/57ec2b60e4b090825010b86b>

Identification of PM in Lung Tissue after dust storm exposure

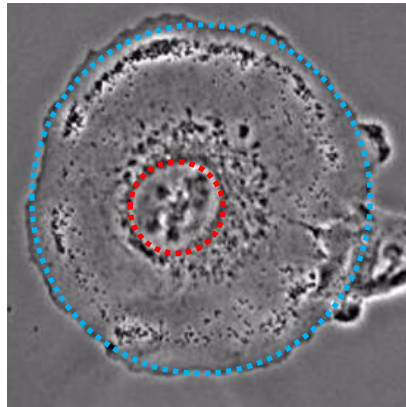


Backscattered electron image acquired with a scanning electron microscope of lung tissue (darker areas) and particulate matter (lighter areas).

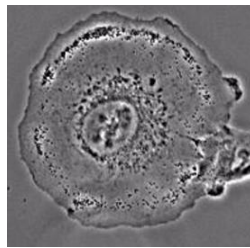
Single cell analysis

Cell line - A549 Human lung epithelial cell line (Type II).

A model for human epithelial lung cells.



Cell Nuclei
Cell Cytoplasm



A549 used in many studies : *Schwarze et al. 2002*; *Veranth et al. 2008*;
Freyria et al. 2012; *Naimabdi et al. 2016*



Control - No dust added
Follow the cells for long time duration (up to 72h), image was taken every 15 min

With the single cell method we can

- Monitor the behavior of each individual cell over time.
- Identify the interaction of each cell with the dust particles.
- Detect cell time-of-death.
- Identify type-of-death (e.g. cell explosion).

Ardon-Dryer et al 2020



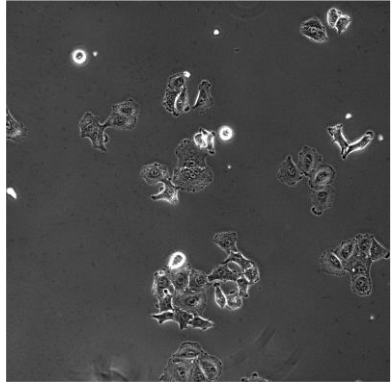
Environmental Research
Available online 7 November 2019, 108891
In Press, Journal Pre-proof



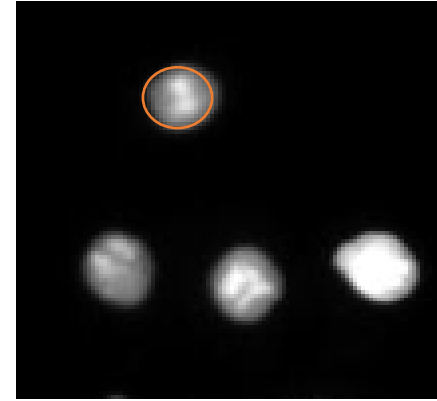
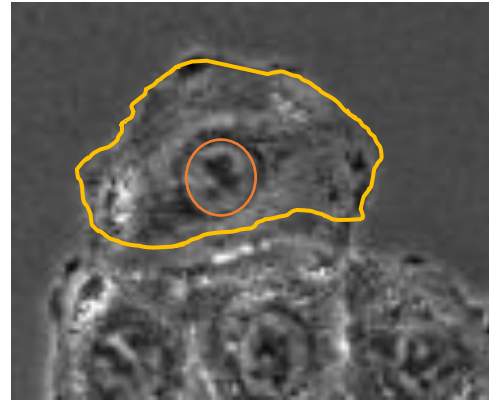
The effect of dust storm particles on single human lung cancer cells

Karin Ardon-Dryer^{a, b, c, d}, Caroline Mock^a, Jose Reyes^a, Galit Lahav^a

Low dust Concentration

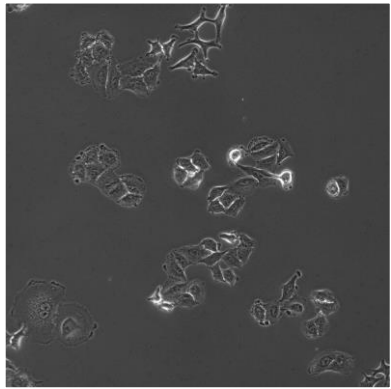


Tracking cells exposed to dust can be done with the cells nuclei marker



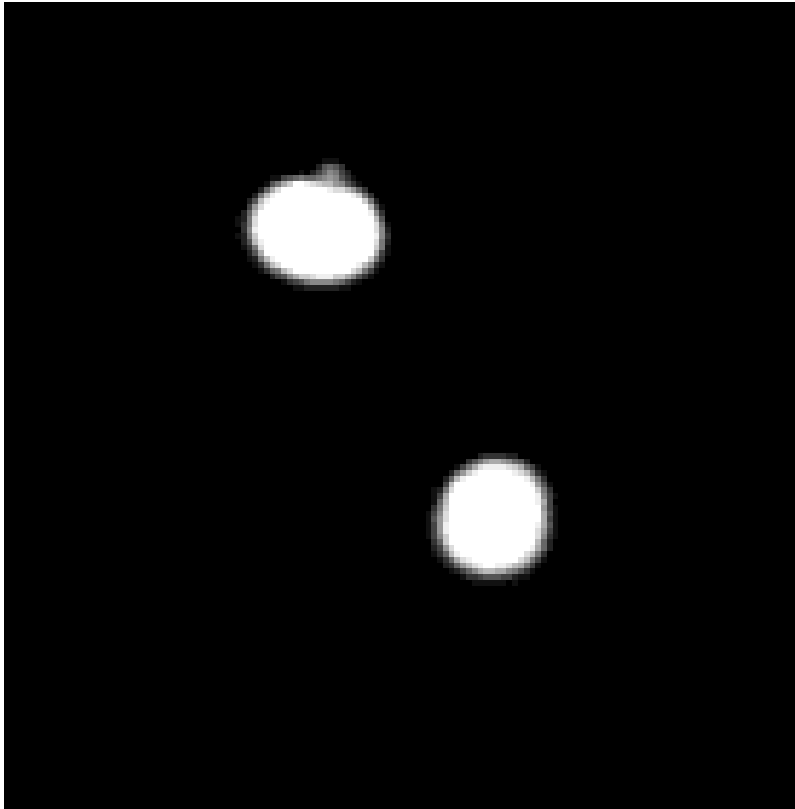
**Nuclei marker -
fluorescent
protein in the
cells nuclei**

High dust Concentration

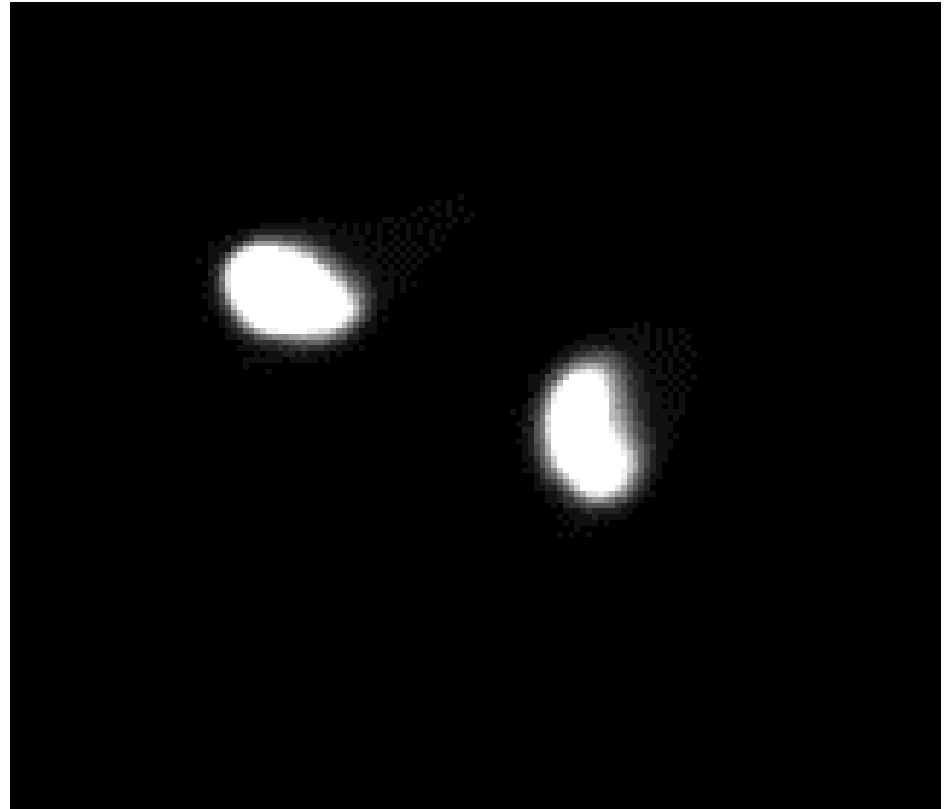


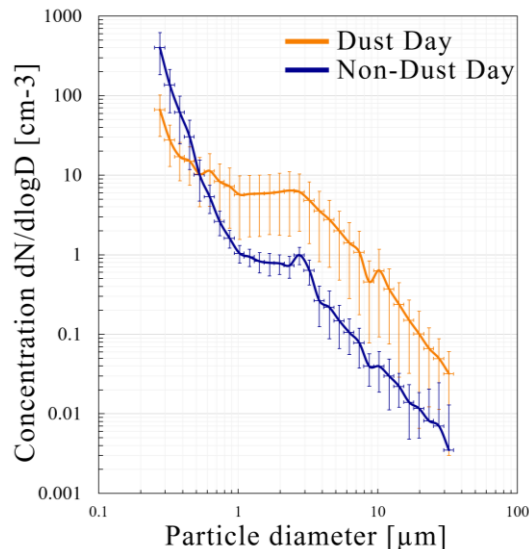
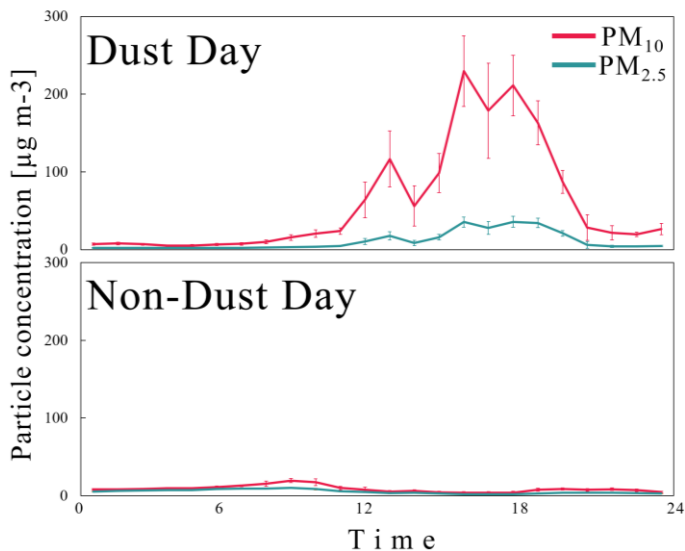
Tracking the cells that were exposed to dust allow us to identify cell death

Living cells

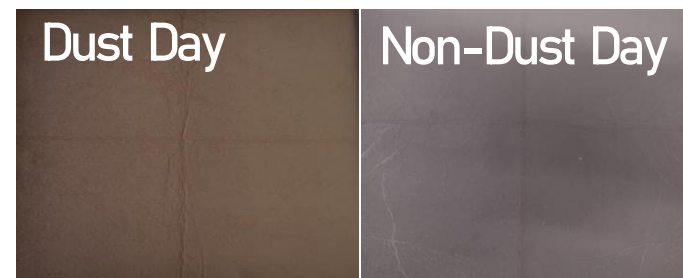


Dying cells

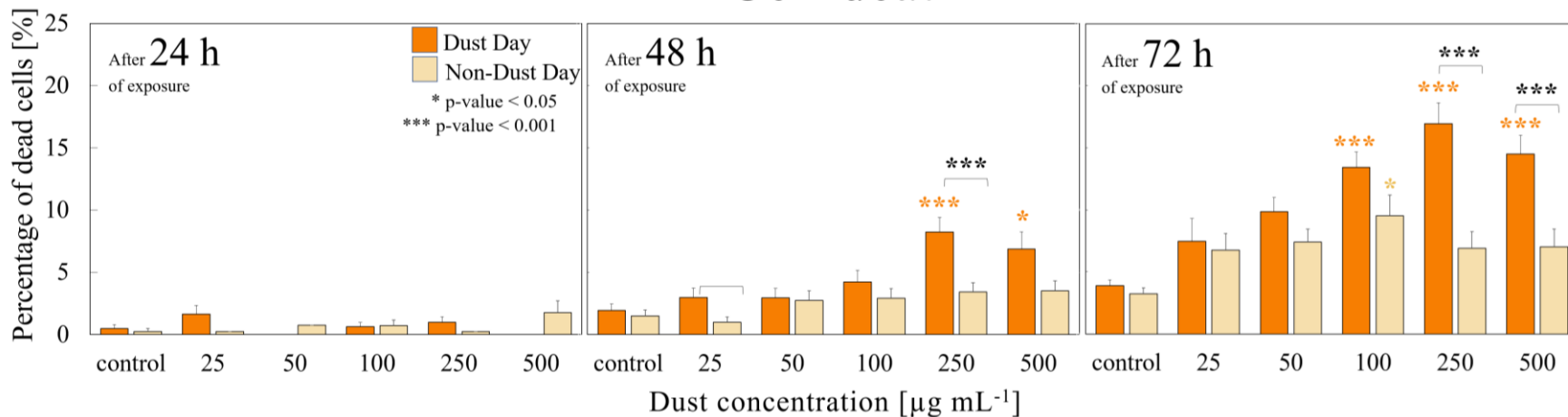




Dust-Day particles were significantly more toxic than Non-Dust Day particles.



Cell death





Dust Alliance for North America (DANA)



The Dust Alliance for North America (DANA) is an informal partnership of scientists and practitioners with purpose to accelerate transition of research into service.

Mission Statement: With a focus on North America, foster global collaboration to mitigate airborne dust risks to health, safety, and quality of life.

Call for papers



AGU Special Collection

“Dust and dust storms: From physical processes to human health, safety, and welfare”.

This special issue will be jointly published by [GeoHealth](#), [JGR-Atmospheres](#), or [Earth's Future](#).

The Dust Special collection is open for submissions now and will close on **May 31, 2024**.

DANA Webinar Series

DATES: Every 2nd Friday

TIME: @1 pm ET (12 pm CT, 11 am MT, 10 am PT)



Sign up to join DANA
dustalliance.na@gmail.com

Aerosol Lab TTU Team members



Acknowledgment:



Thank you for your attention

*Please contact me for potential collaborations
or interest in joining our group
Karin.ardon-dryer@ttu.edu*