

Updates on Soil Microorganism Detection and Dust Forecasting over the Southwest U.S.

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Acknowledgement: Funding and data support from NASA, NOAA and EPA

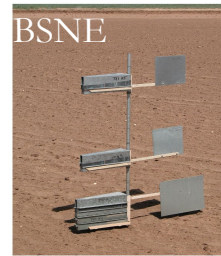
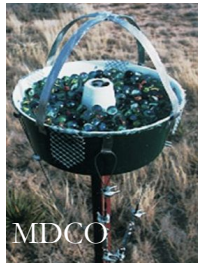
Arizona Dust Workshop, March 24, 2021, Virtual

Monitoring and Detecting Dust-Associated Microorganisms in Arizona, US

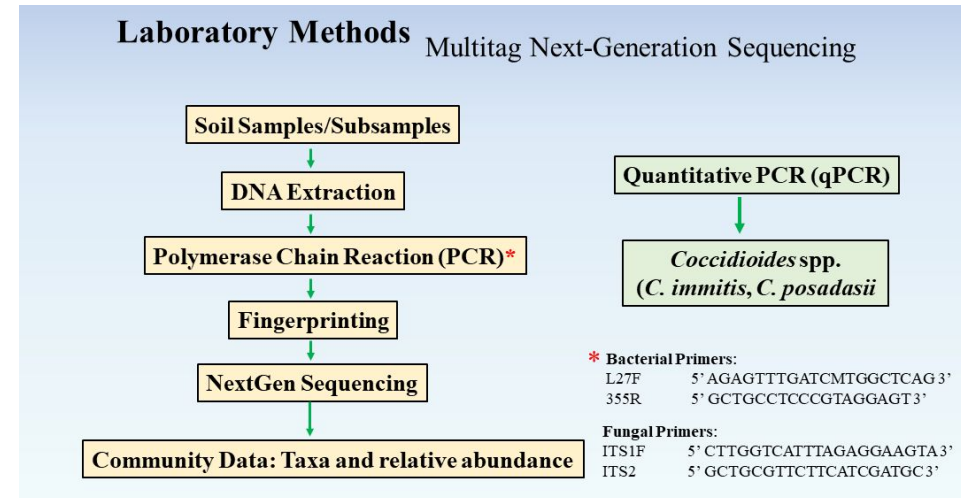
Project Objectives

- 1) Develop laboratory methods to detect microorganisms in soil and dust;
- 2) Compare the low-cost dust collectors;
- 3) Evaluate the feasibility of a large-scale and cost-effective monitoring on potential pathogens, including *Coccidioides*.

Soil and Dust Collection



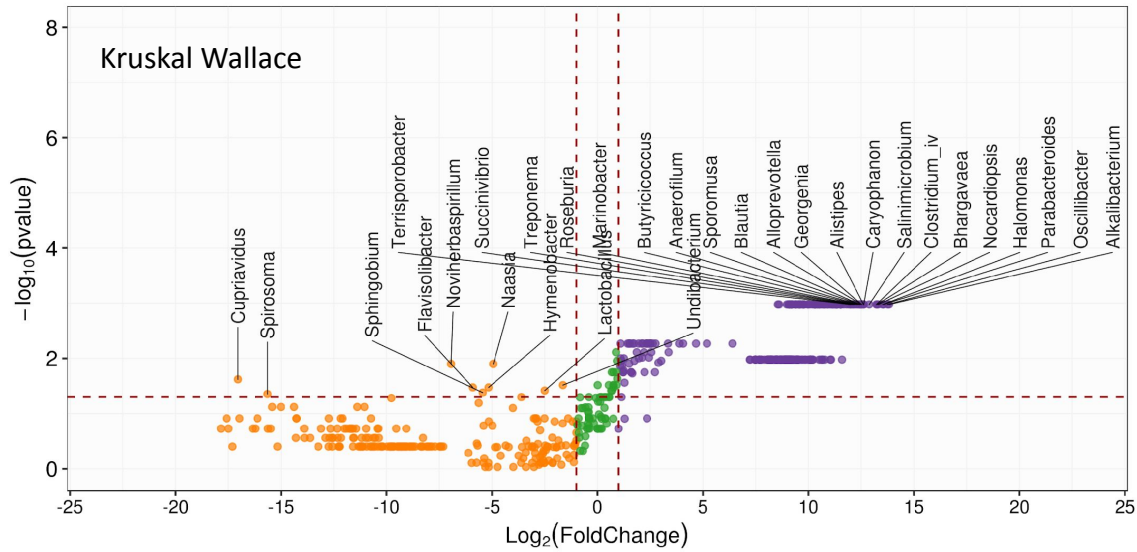
Laboratory Analysis



Potential Fungal Pathogens	Relative Abundance	
	Soil	Dust
<i>Alternaria alternata</i>	<1~27%	1~44%
<i>Cryptococcus albidus</i>	<1~3%	<1~24%
<i>Scopulariopsis brevicaulis</i>	<1~3%	ND
<i>Thyrostroma carpophilum</i>	<1 ~53%	<1~4%
<i>Cladosporium pseudocladosporioides</i>	<1 ~10%	<1~37%
<i>Phoma fungicola</i>	<1 ~52%	<1~75%

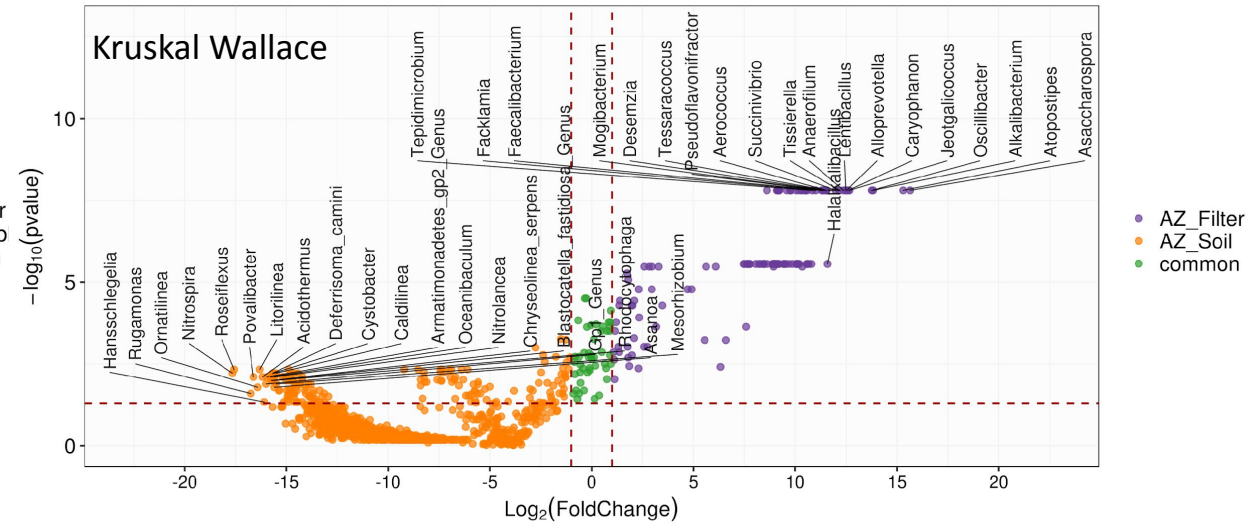
Arizona Filter versus Marble for Bacterial Genera

Feature Volcano[Genus]
Colored by fold-change direction

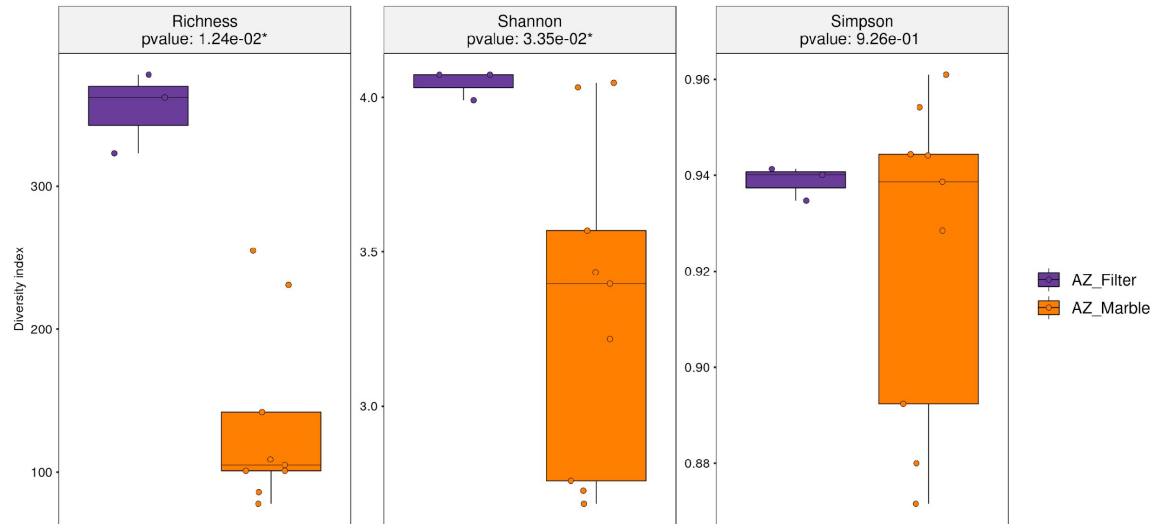


Arizona Filter versus Soil for Bacterial Genera

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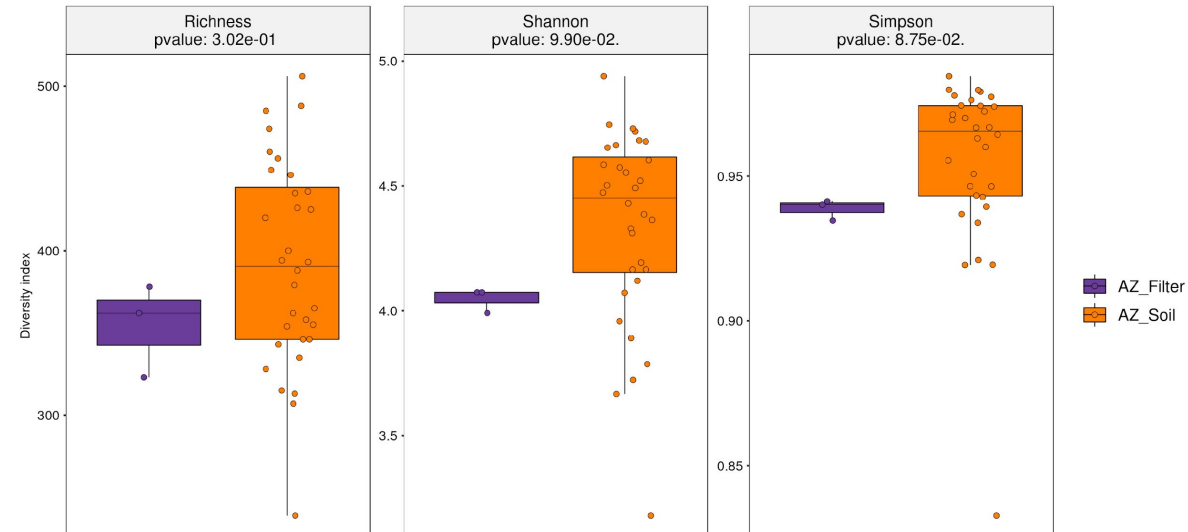


Alpha diversity[Genus]



pvalue: kruskal_wallis, BiomMiner v1.1

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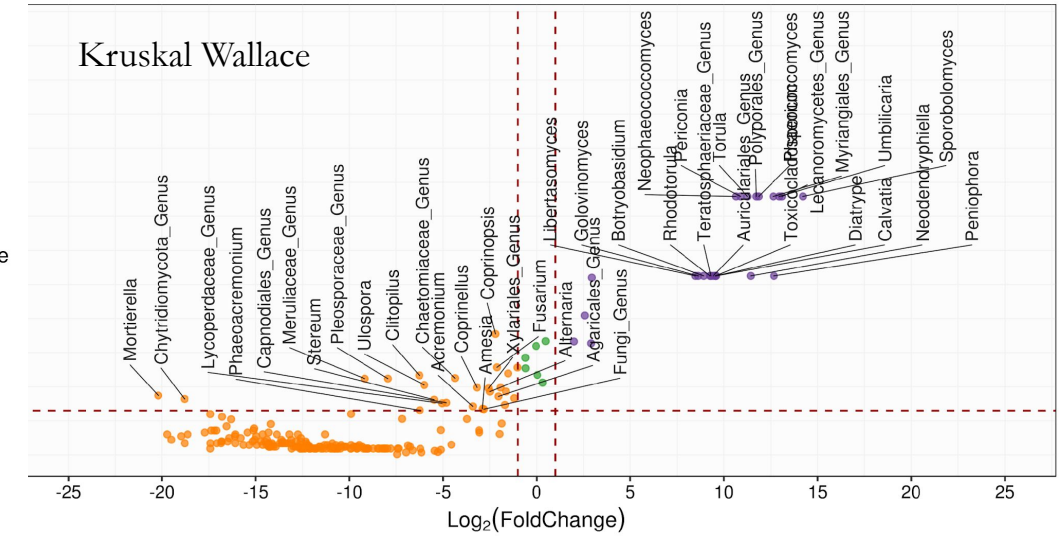
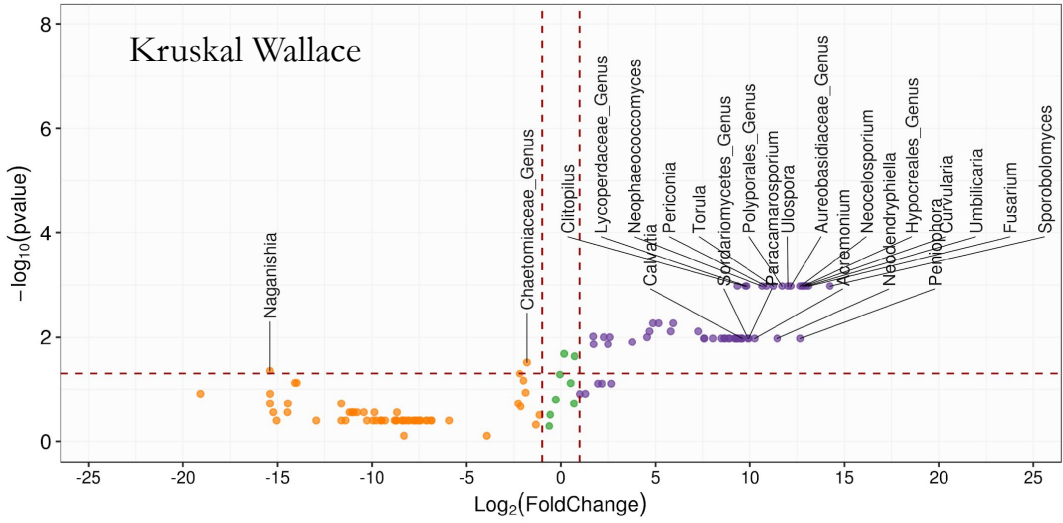
Collection device yields very different Bacterial communities

Arizona Filter versus Marble for Fungal Genera

Arizona Filter versus Soil for Fungal Genera

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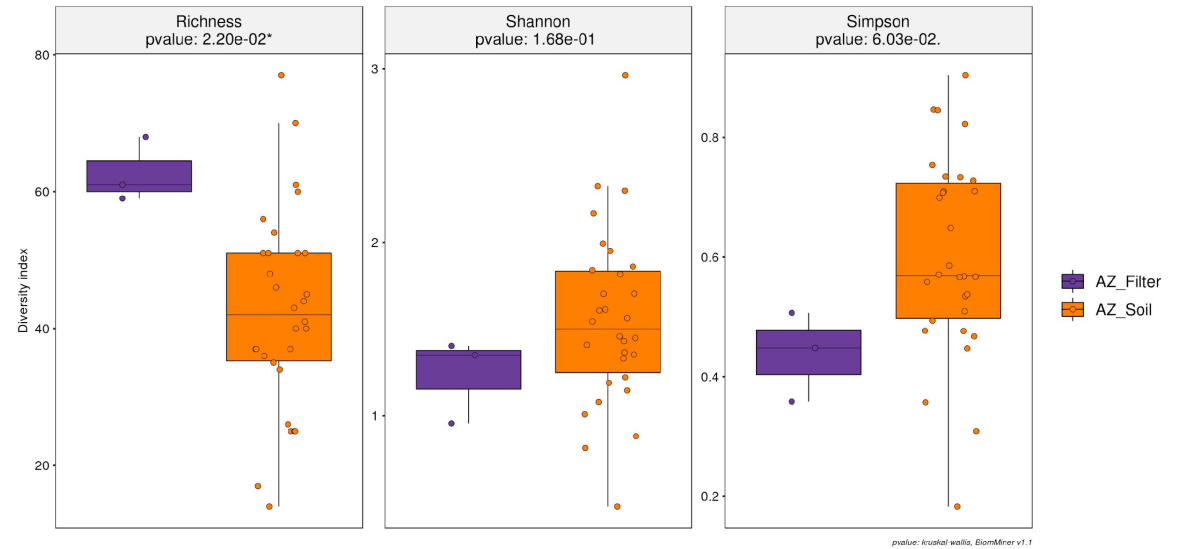
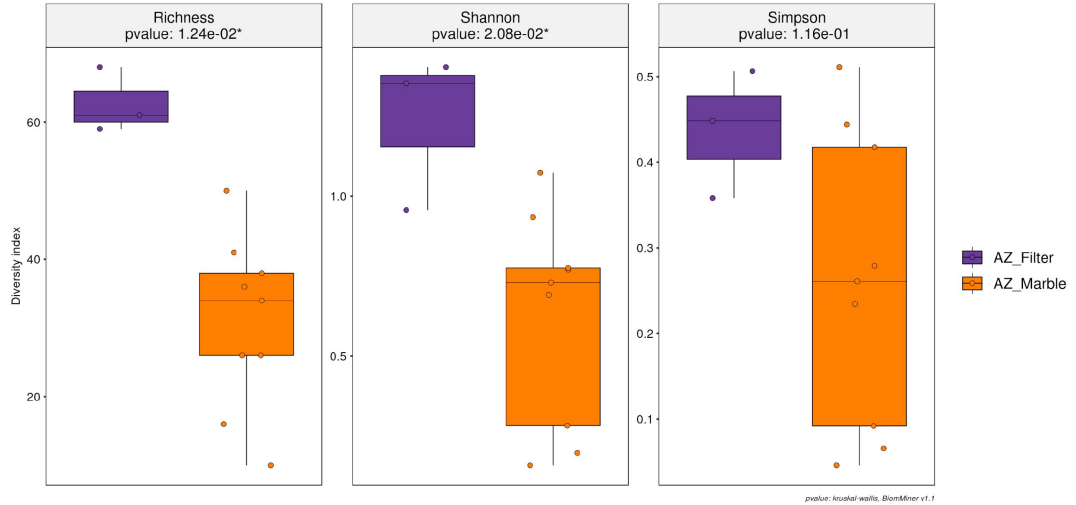


Method: kruskal_wallis

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Collection device yields very different Fungal communities

Summary of Soil Microorganism Detection

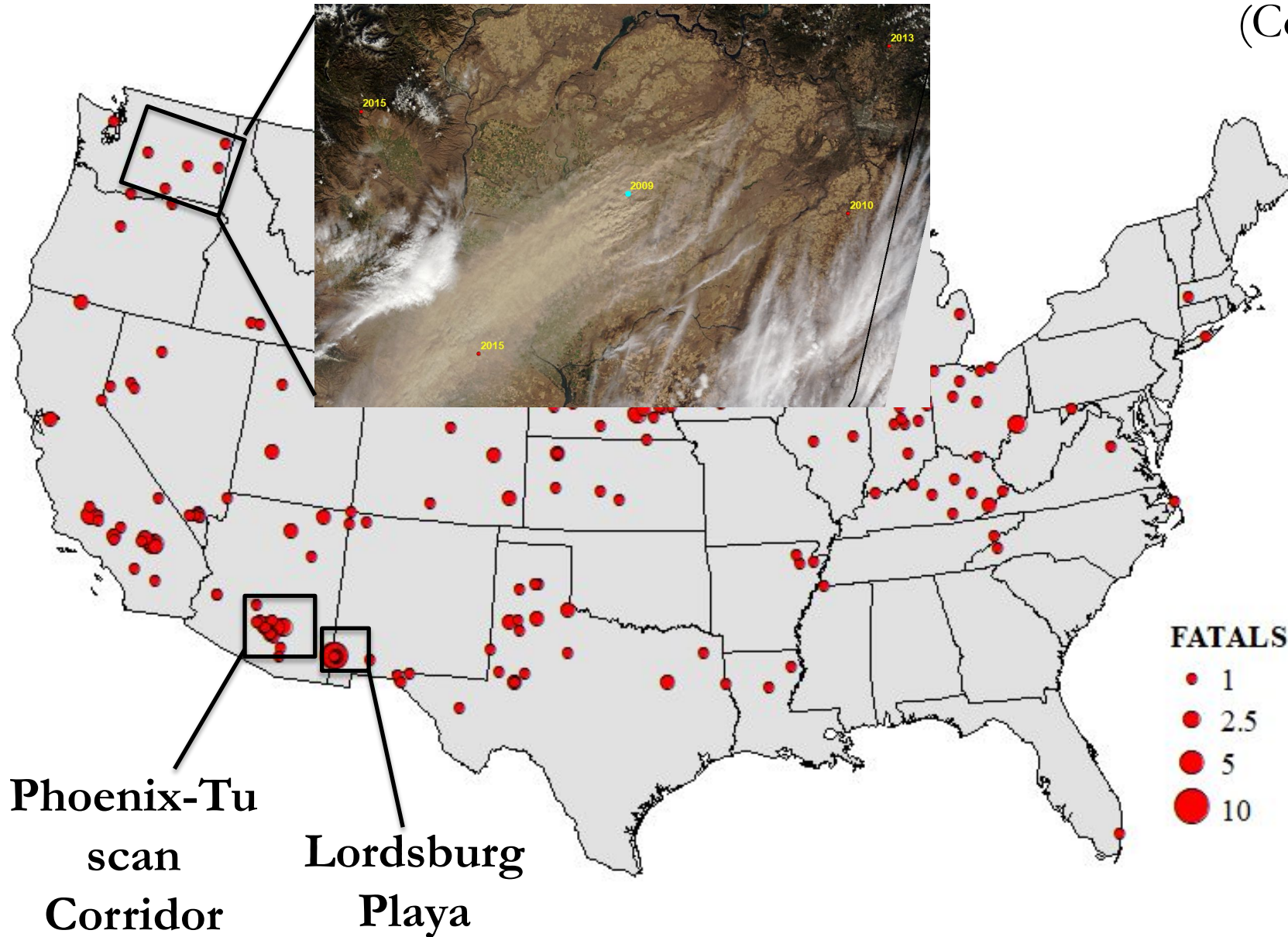
- Each collection device selects for different community
- Same for both Fungal and Bacterial communities
- All collectors differ from soil
- Is this observation dependent on particle size selection?
- Are there similar biases for Coccidioides?
- Capture common pathogens

Acknowledgements

Mariana Casal, Pinal County Public Health Department
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Patrick Armendariz, Arizona Central College
Matt Haggler, USDA, ALARC
Marcos Mendez, UTEP
Iyasu G. Eibedingil, UTEP

How Many People Were Killed by Dust Storms?

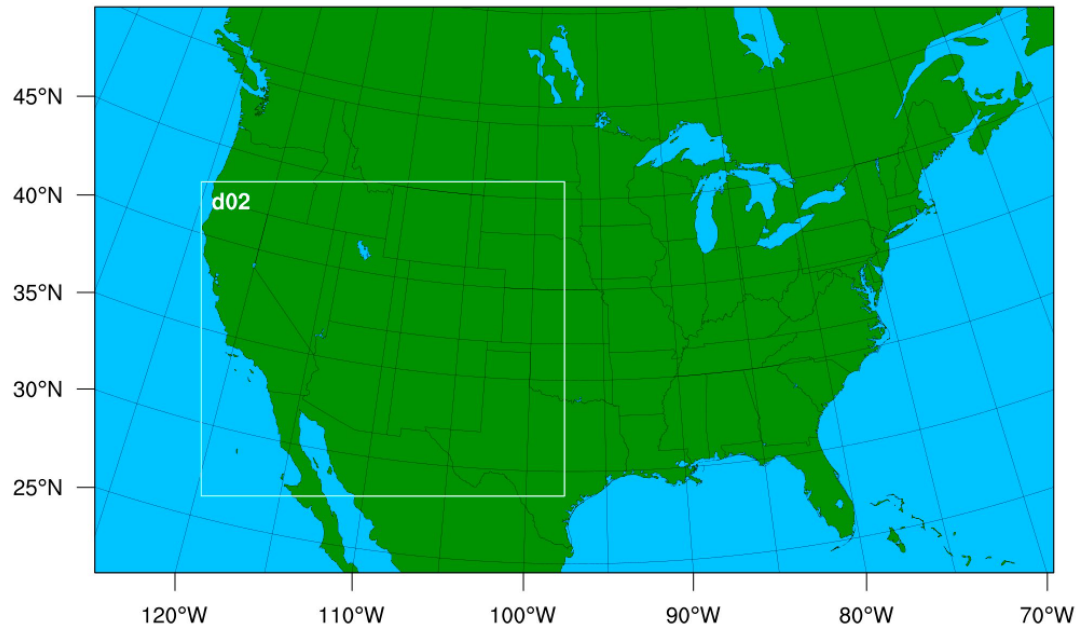
(Contributed by Irene Feng)



- 14-33 dust fatalities each year (2007-2017);
- 30% of top-ranking fatal accidents in Arizona;
- 60% of deadliest accidents along I-10.

Dust Storm and Air Quality Prediction

- Outer domain (12km): CONUS;
- Inner domain (3km): Southwest.



- Emission: EPA NEI2016 + Biogenic + Dust + Wildfires
- Meteorology: WRF4.1
- Full chemistry (CMAQ_v5.3.1) – capable of predicting general air quality (O_3 , NO_x , CO, VOCs, PM);
- Satellite-aided prediction of extreme events: Dust Storms and Wildfires.

FENGSHA Dust Emission Model

(Contributed by Janak Joshi)

- ❖ FENGSHA (“Windblown Dust” in Mandarin), initially developed at EPA based on measurements by Dale Gillette;
- ❖ FENGSHA emission algorithm :

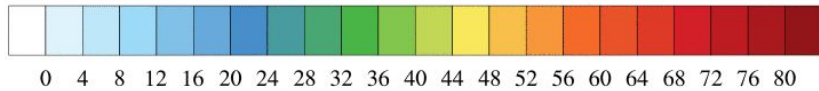
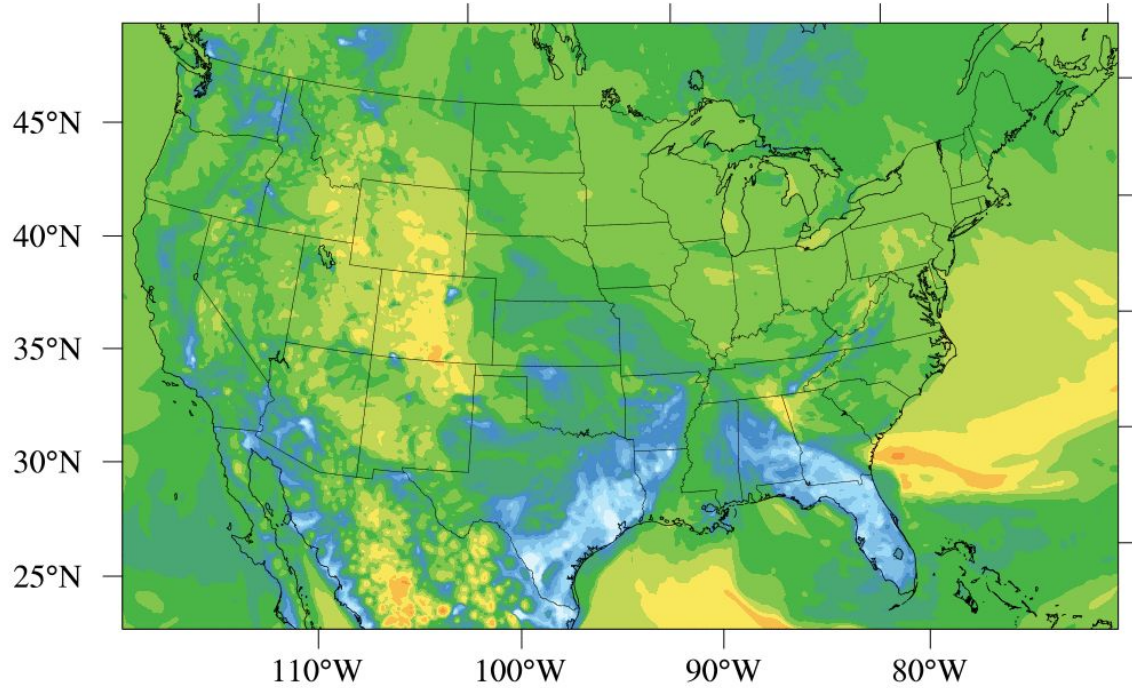
$$F = \sum_{i=1}^M \sum_{j=1}^N K \times A \times \frac{\rho}{g} \times S_i \times SEP \times u_* \times (u_*^2 - u_{*ti,j}^2)$$

Land Use Soil Texture Escape Fraction Dust Source Soil Erosion Potential Friction Velocity Threshold Friction Velocity

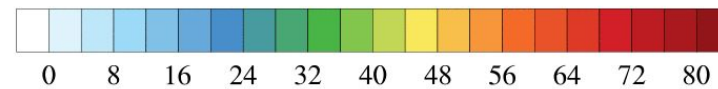
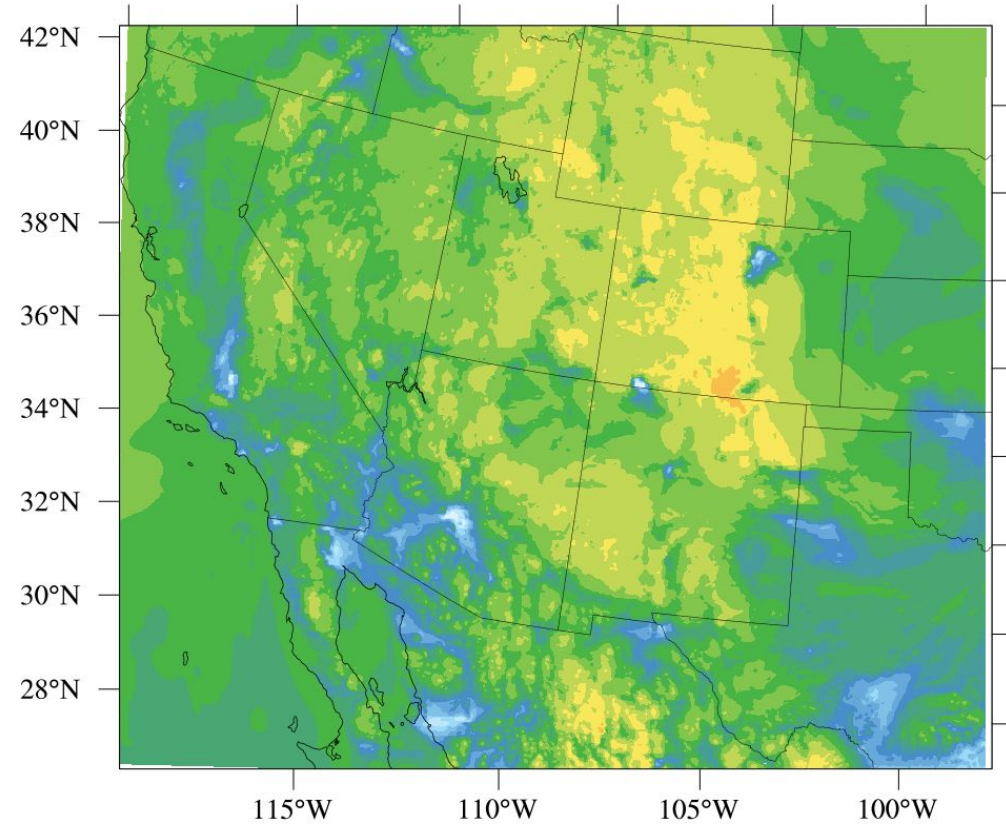
- ❖ Threshold friction velocity is further controlled by soil moisture and surface roughness.
- ❖ Special treatments for the Southwest domain:
 - Cropland updated with GMU/USDA CropScape dataset (30m);
 - Dust sources adjusted based on vegetation cover (MODIS NDVI);
 - Soil texture data from soilGrids (250m);
 - Roughness effect based on Darmenova et al. (2009).

O₃ Forecasts

2021-03-15 12 UTC O₃ Forecast (ppbV)

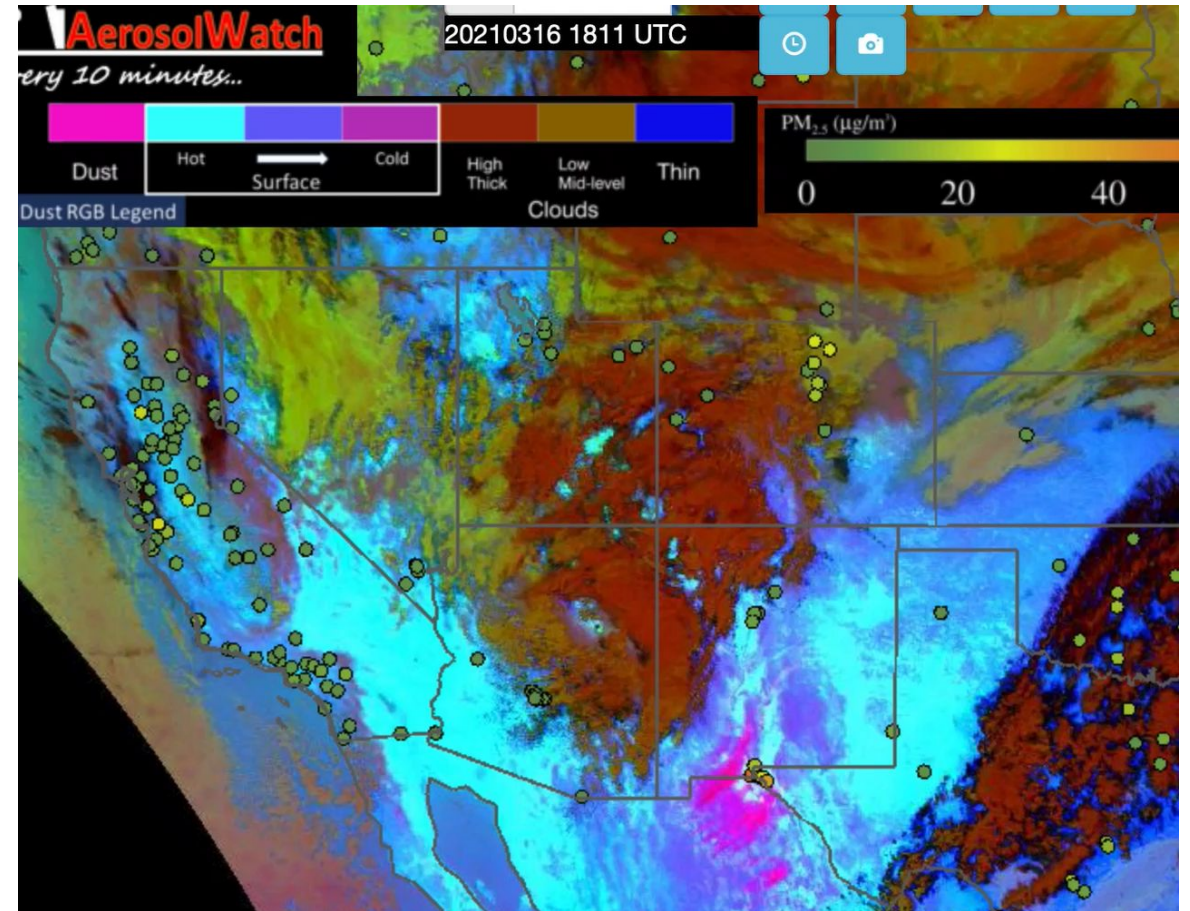
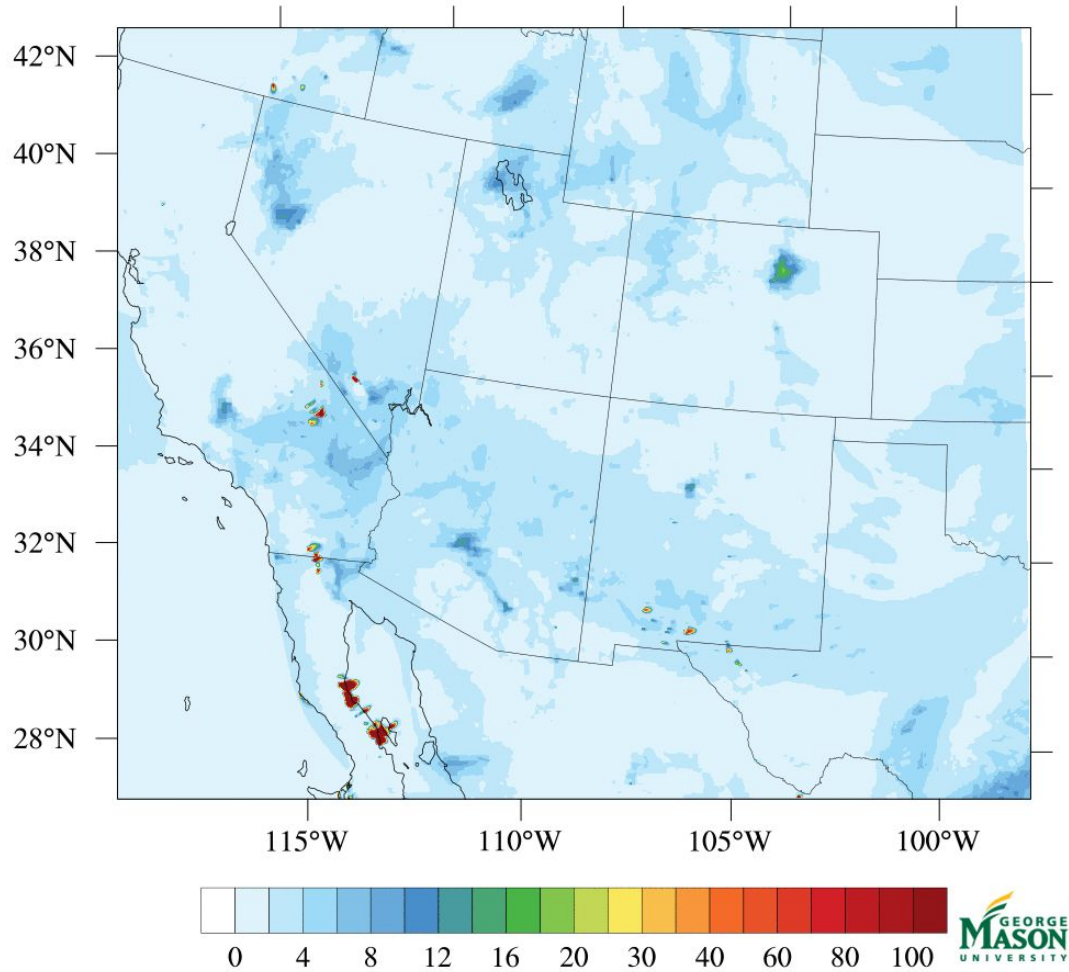


2021-03-15 12 UTC O₃ Forecast (ppbV)



PM_{2.5} Forecast during the March 15 Dust Storm

2021-03-15 12 UTC PM_{2.5} Forecast ($\mu\text{g m}^{-3}$)



International Dust Summer School

- Inspired by the Annual Arizona Dust Workshop
 - Updated Science ... in line for Potential Applications
 - For and By those who Research, Deliver Service & Set Policy
- Facilitated by the WMO Sand & Dust Storm Warning Advisory & Assessment System
- Late Summer, 2021, Virtual & Web-based, Open Registration Soon!
- Topics: Latest Research, Tools & Applications from around the world
 - Seminar format followed by panel discussion and Q & A with students
- Presented by Leaders in Science & Service: Public Health, Transportation, Environmental Quality
- Serves Global Interests—Sand & Dust Storms, Wind-Eroded Soil—With Local & Regional Implications
- Planned Annually.

(Contributed by William Sprigg)

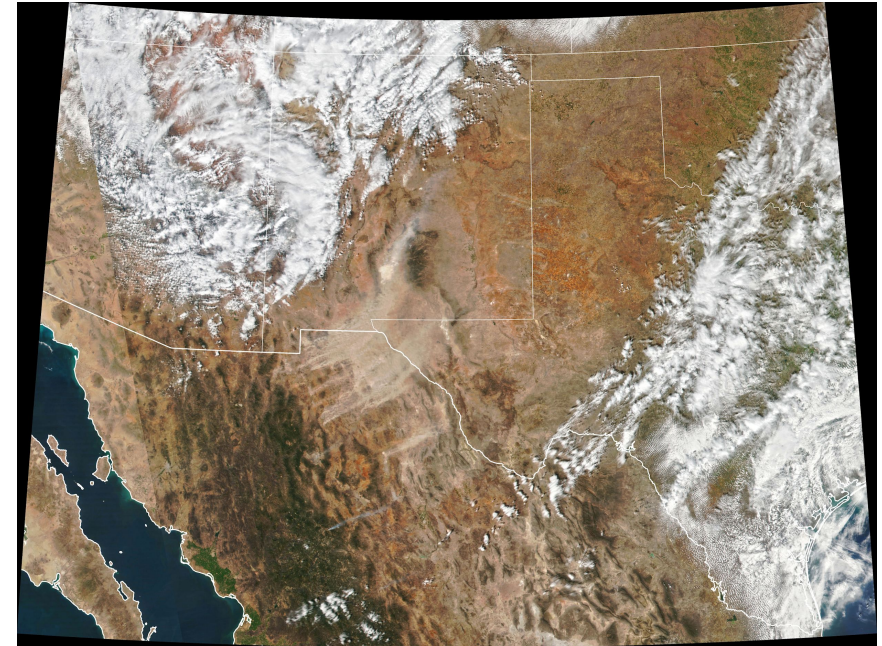


Figure complements of Dr. Tom Gill and NASA's Earth Observatory