

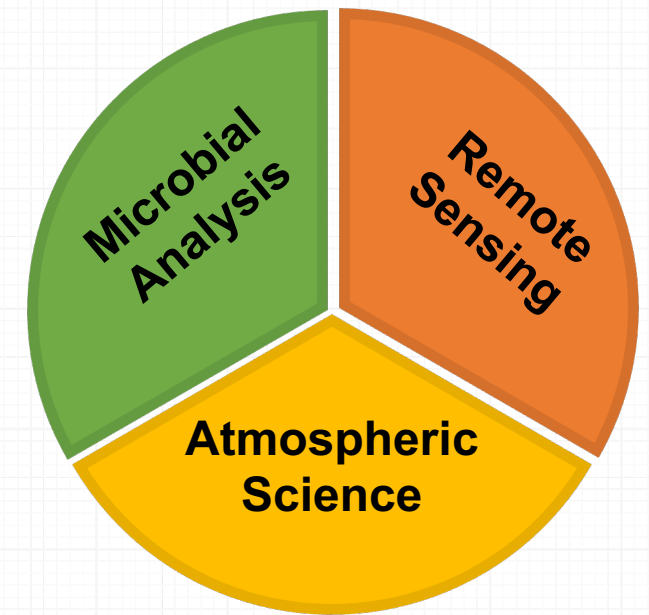
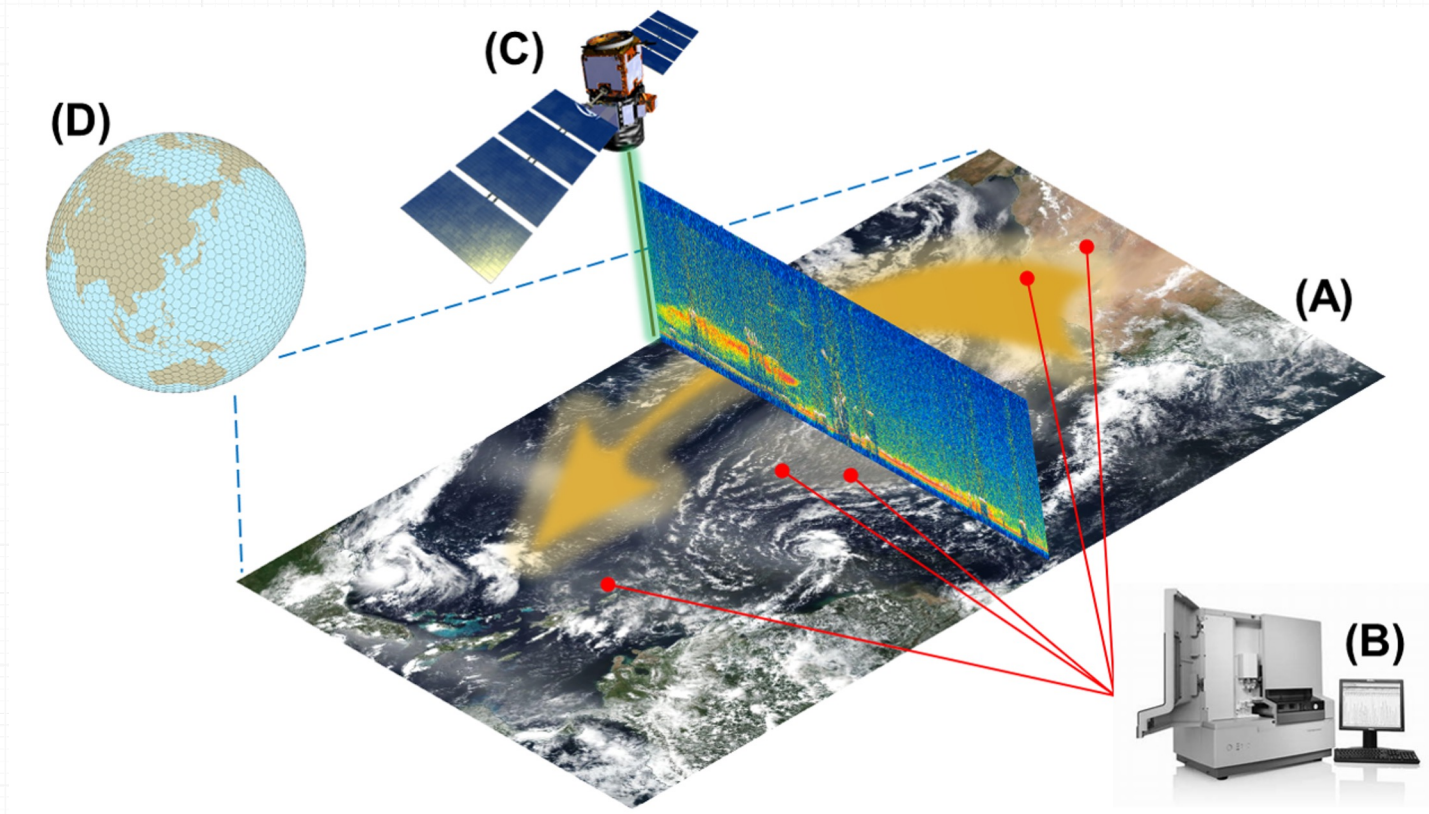
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# Multiscale Investigation of Microbial Biodiversity in Trans-Atlantic Dust Plumes

Hosein Foroutan, Virginia Tech

# Project Overview

**Overarching Goal:** To improve our understanding of microbial long-range transport and survival in dust plumes.

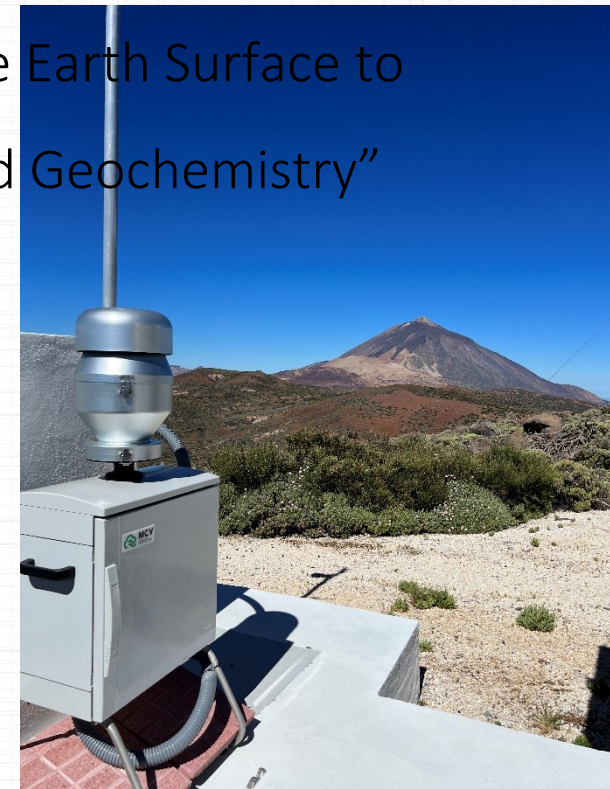
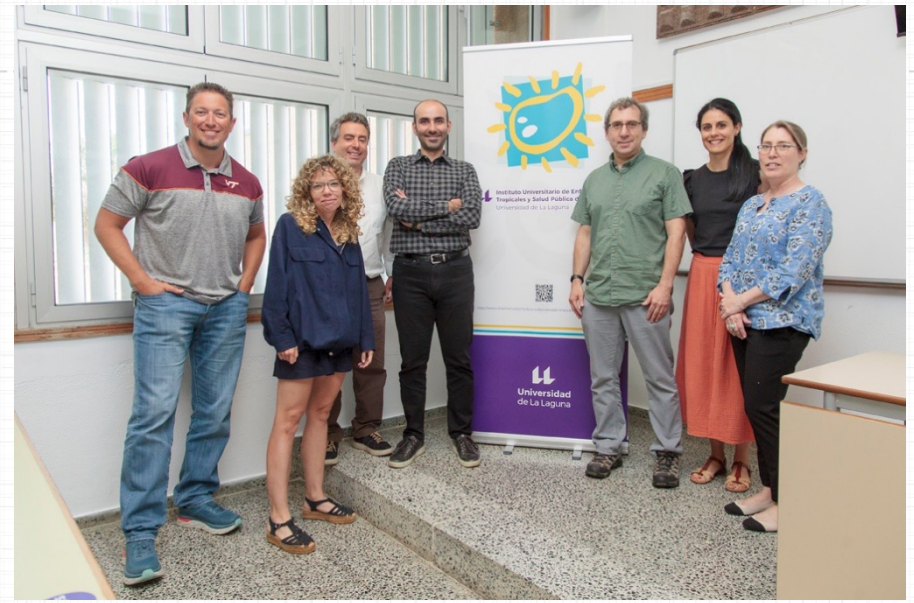


Interdisciplinary  
Approach



## Updates since May 2023

- Three ‘modeling’ manuscripts published / submitted.
- **Project 1:** Summer 2022 samples
- **Project 2:** 2009 – 2013 historical samples
- Visit to University of La Laguna, Tenerife, Spain
- **New ROSES 2024 Project:** EMIT Science and the Earth Surface to Atmospheric Aerosols: Understanding the E

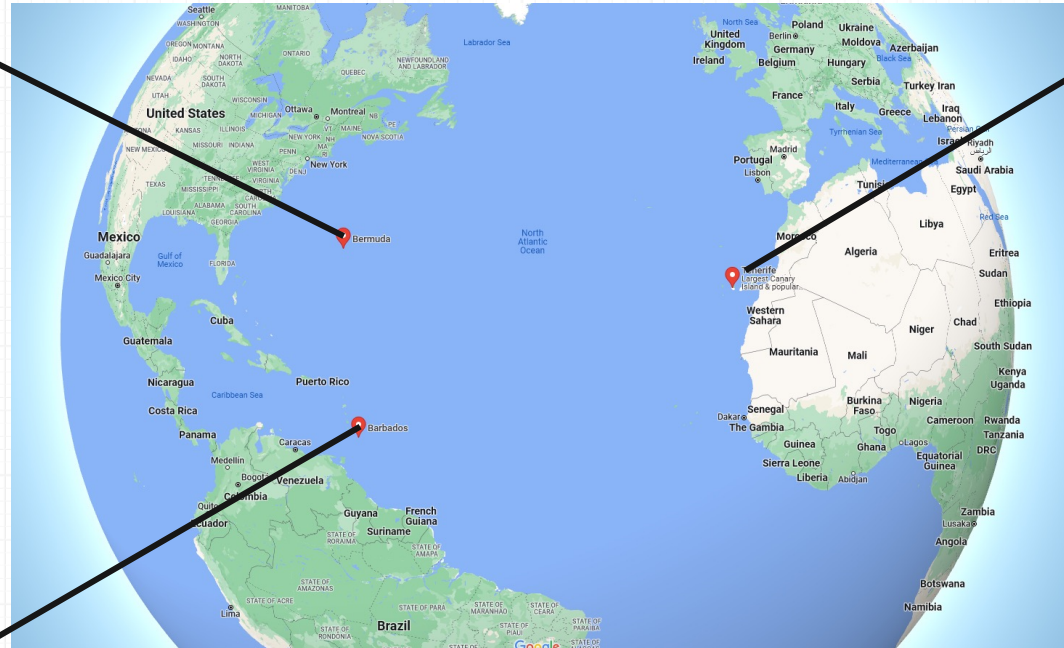


the Earth Surface to  
and Geochemistry”

# Sampling Dust and Microbes: Coordinated Sampling



NASA ACTIVATE Campaign



University of La Laguna, Tenerife



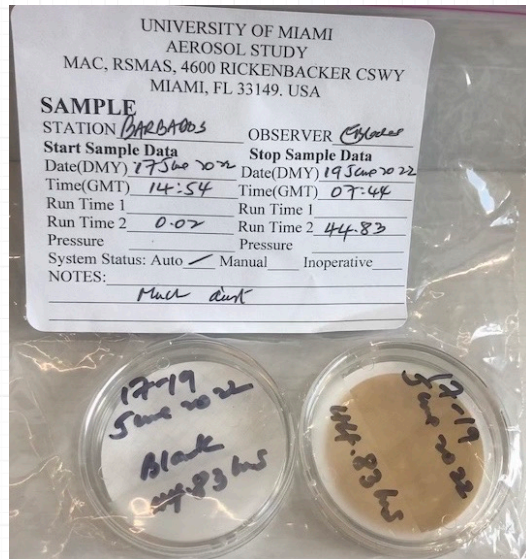
Barbados Atmospheric Chemistry Observatory, Univ. of Miami



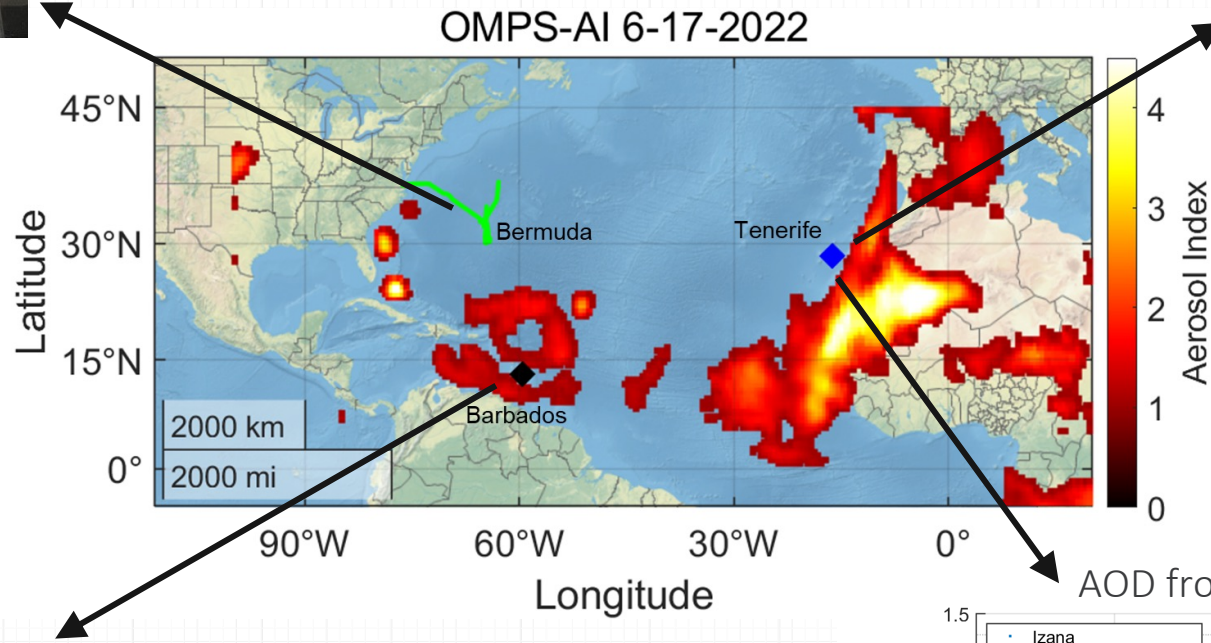
# Sampling Dust and Microbes: Summer 2022 Dust Plume



PTFE

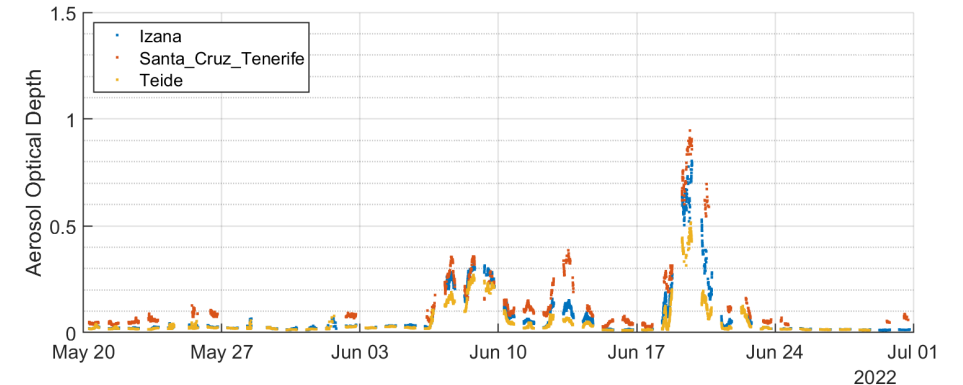


MCE

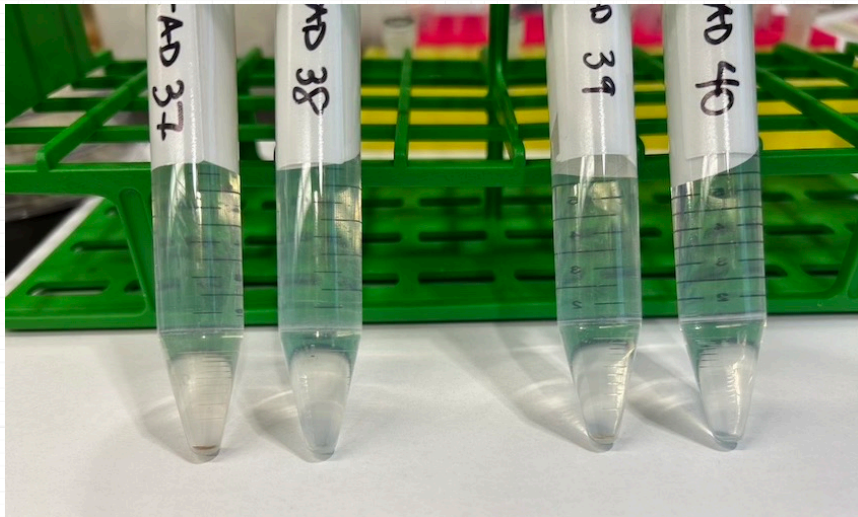
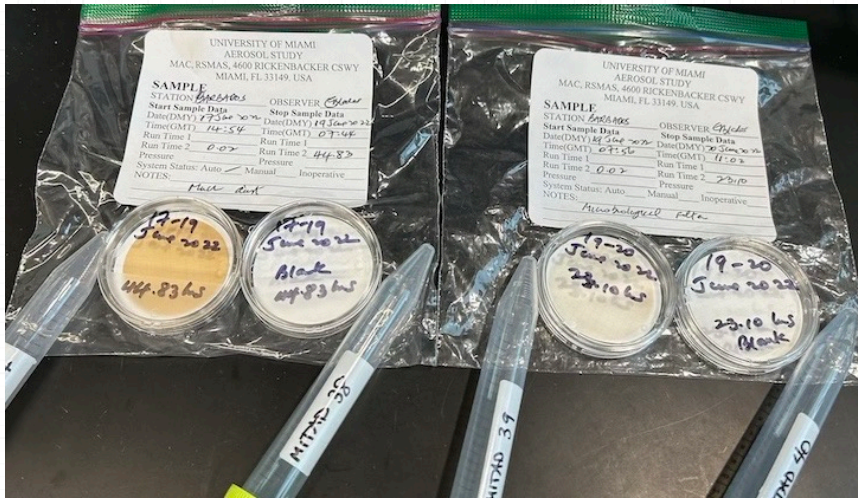


Cellulose nitrate

AOD from 3 AERONET sites in Tenerife



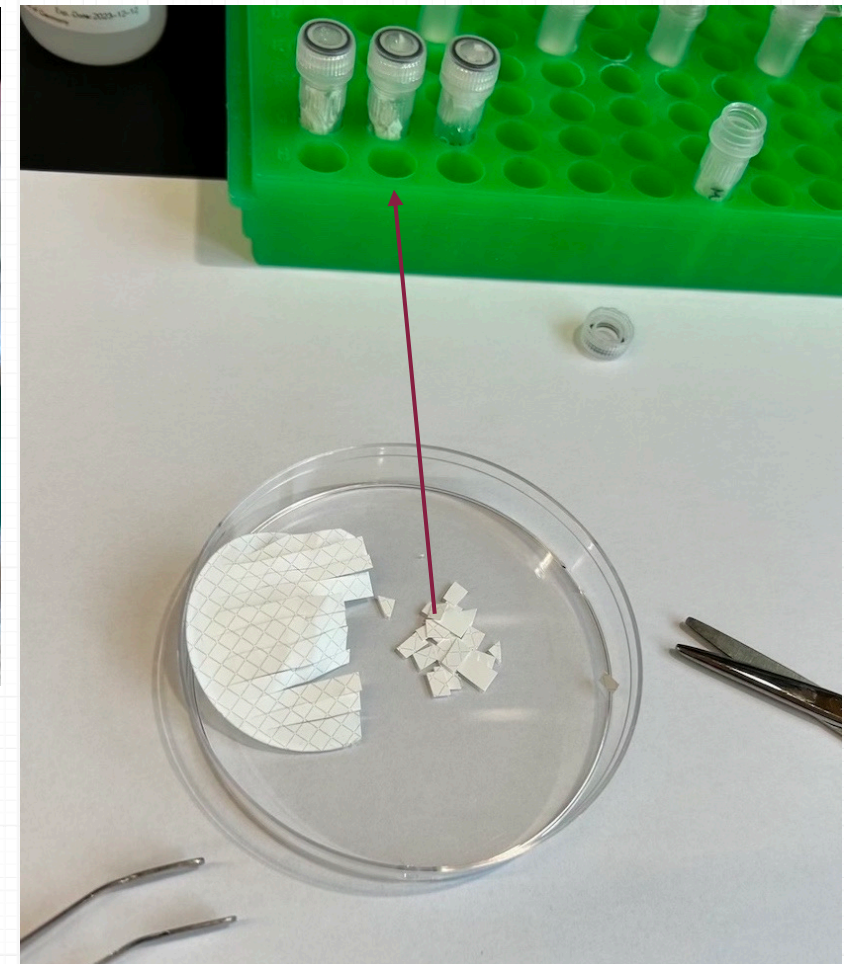
# DNA Extraction Summary



Filters are spun in buffer at low speed (15 mL or 50 mL)

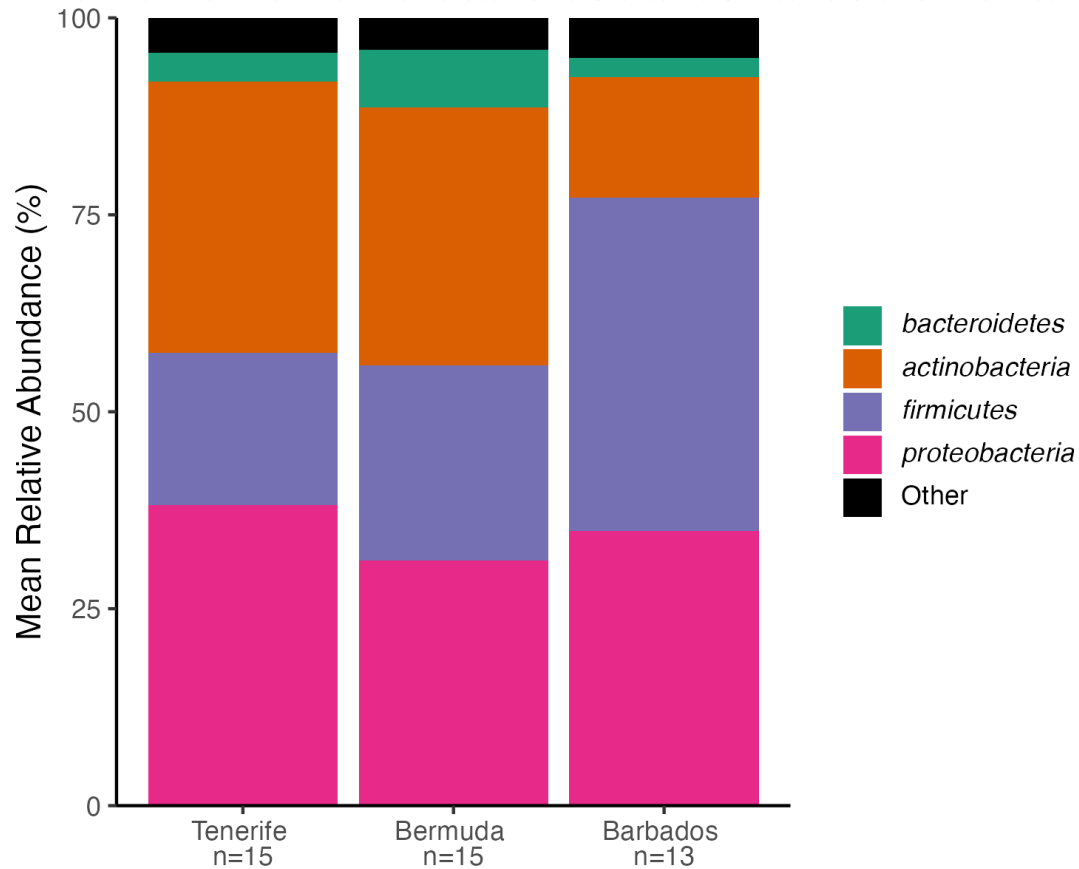


Liquid then filtered onto PES filter



PES filter cut and placed into PowerSoil Pro tube with beads

# Phylum Relative Abundance in Samples

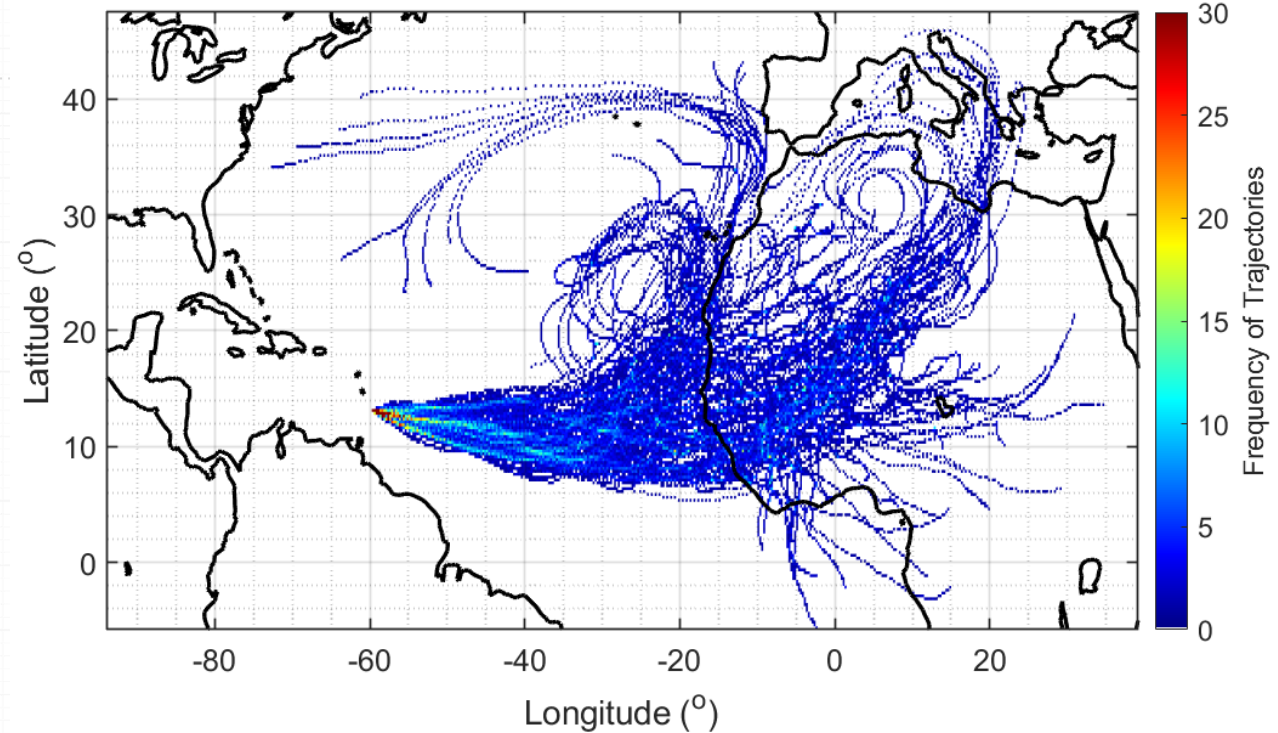


- 43 samples analyzed
- Phylum with > 3% mean relative abundance are shown
- *Proteobacteria* most abundant at Tenerife and Bermuda
- *Firmicutes* most abundant at Barbados

“Many Firmicutes are able to form spores, resting stages that are inactive, strongly dehydrated, and highly resistant to environmental stresses. Spores do contain enough energy for germination and are specifically adapted to quickly respond to substrate availability and formation of a vegetative cell able to replicate.” - Encyclopedia of Microbiology, 2009

# Dust Plume Analysis

Samples with associated trajectories which pass over both collection points are of particular interest as they represent a plume of dust being sampled at multiple locations across the Atlantic ocean.



Sample ID	Collection start time	Collection end time	Location	Total associated aerosol index	Tenerife overpass (%)
m326	6/6/2022 21:38	6/7/2022 17:52	Barbados	24731	1
m327	6/7/2022 13:26	6/9/2022 22:10	Barbados	128828	2
m329	6/10/2022 12:56	6/12/2022 14:09	Barbados	124838	6
m330	6/12/2022 14:29	6/13/2022 13:35	Barbados	54199	1
m332	6/13/2022 14:42	6/14/2022 14:42	Barbados	32312	8
m333	6/14/2022 15:23	6/15/2022 14:52	Barbados	25173	9
m334	6/15/2022 10:49	6/16/2022 15:35	Barbados	89811	8
m335	6/16/2022 14:44	6/17/2022 10:59	Barbados	99272	5
m336	6/17/2022 7:44	6/19/2022 14:54	Barbados	173412	1
m337	6/17/2022 14:54	6/19/2022 7:44	Barbados	112009	1
m339	6/19/2022 7:56	6/20/2022 11:02	Barbados	70352	1
m343	6/20/2022 11:16	6/21/2022 21:39	Barbados	70773	2
m345	6/22/2022 22:10	6/23/2022 22:40	Barbados	1032	0



## Sampling Dust and Microbes: Historical Samples

Gonzalez-Martin *et al.* (2018): 130 air samples collected in Tenerife during 2009 – 2013 showed no distinct pattern in Enteric viruses detection on dusty days

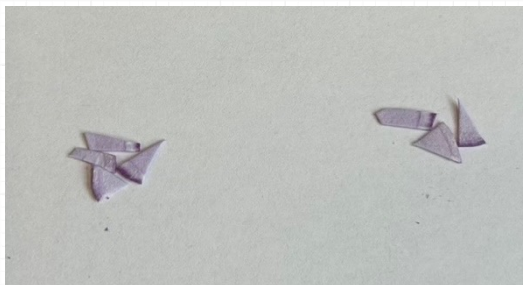
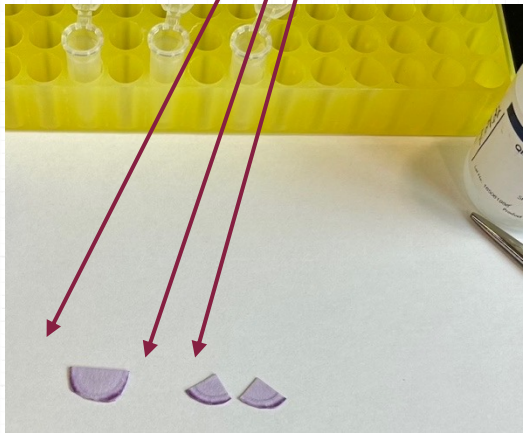
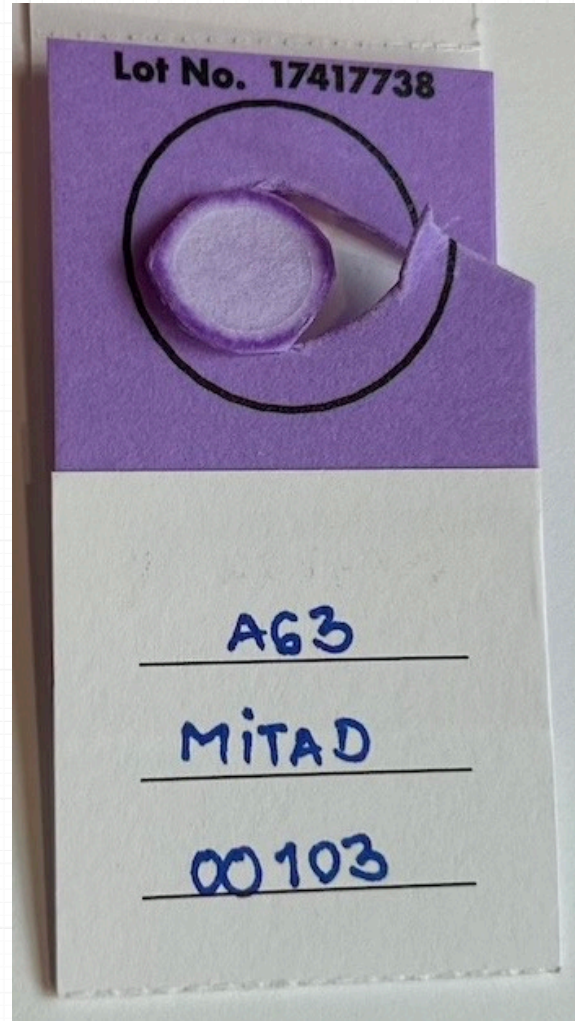
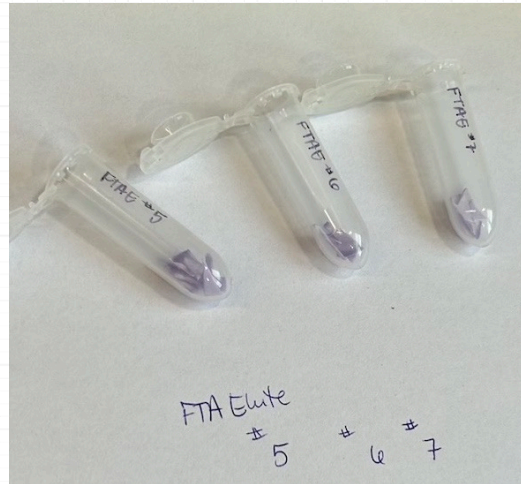
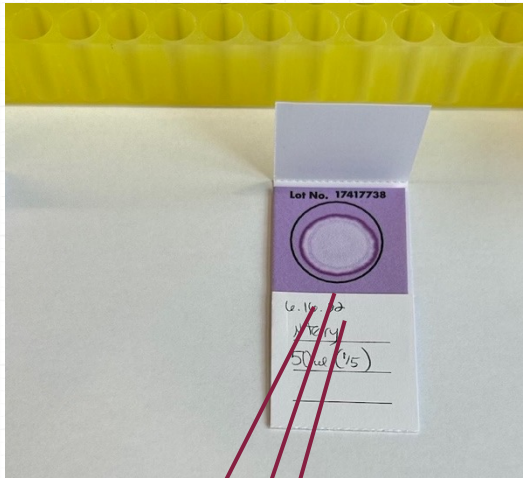
Sample	Year	Season	PM <sub>10</sub>	PM <sub>2.5</sub>	E	R	Sample	Year	Season	PM <sub>10</sub>	PM <sub>2.5</sub>	E	R
A1	2009	Winter	27.8	14.5	Y	Y	A61	2010	Spring	77.3	17	N	Y
A2	2009	Winter	52.2	27.9	Y	Y	A63	2010	Spring	N.A.	N.A.	N	Y
A3	2009	Winter	23.6	17.6	N	Y	B1	2012	Winter	125.5	38.8	N	Y
A4	2009	Winter	64.1	31.9	Y	N	B10	2012	Spring	33.5	11.0	Y	Y
A5	2009	Winter	59.3	28.4	N	Y	B12	2012	Spring	62.2	22.3	N	Y
A12	2009	Spring	32.9	16.8	N	Y	B13	2012	Spring	67.2	23.8	Y	N
A14	2009	Spring	46.8	23.3	Y	Y	B14	2012	Spring	26.0	10.0	Y	N

E – enteroviruses, R - rotaviruses

### Our Science Questions:

- What environmental factors differentiate one dust event from another?
- What about other taxa?

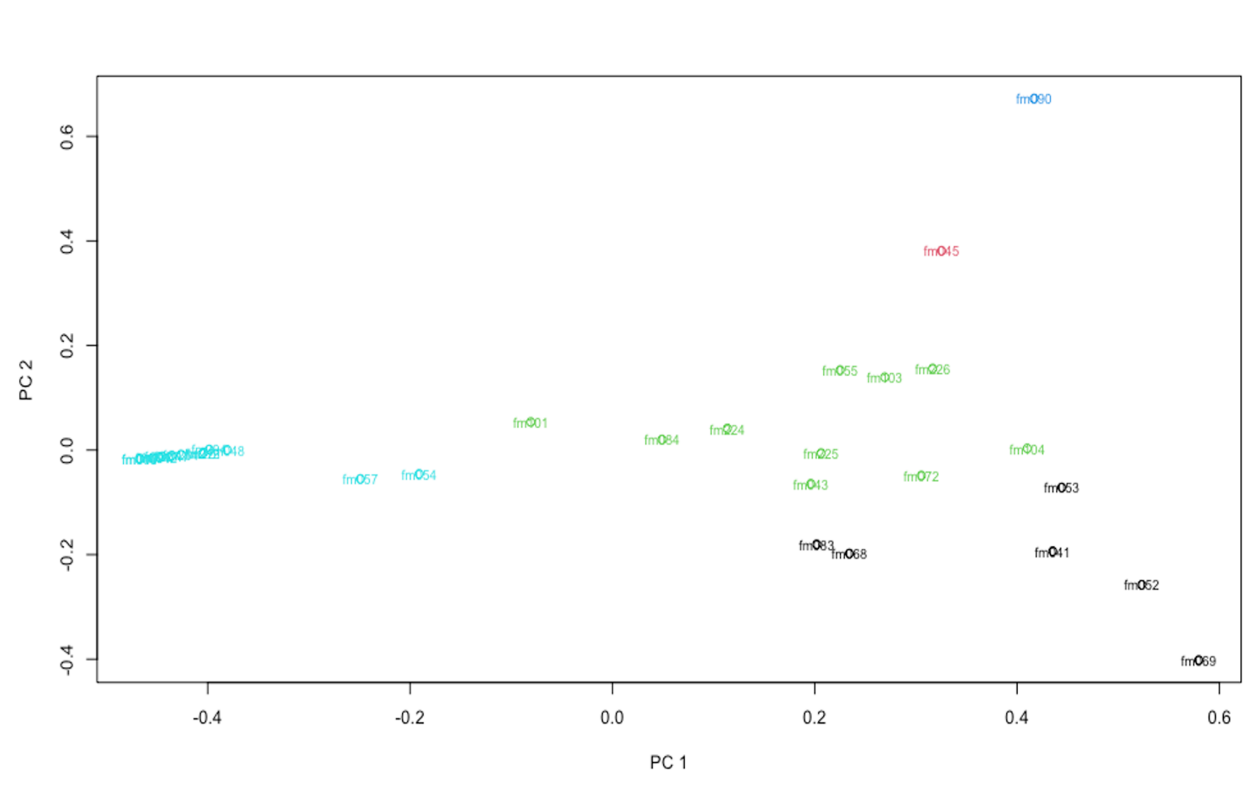
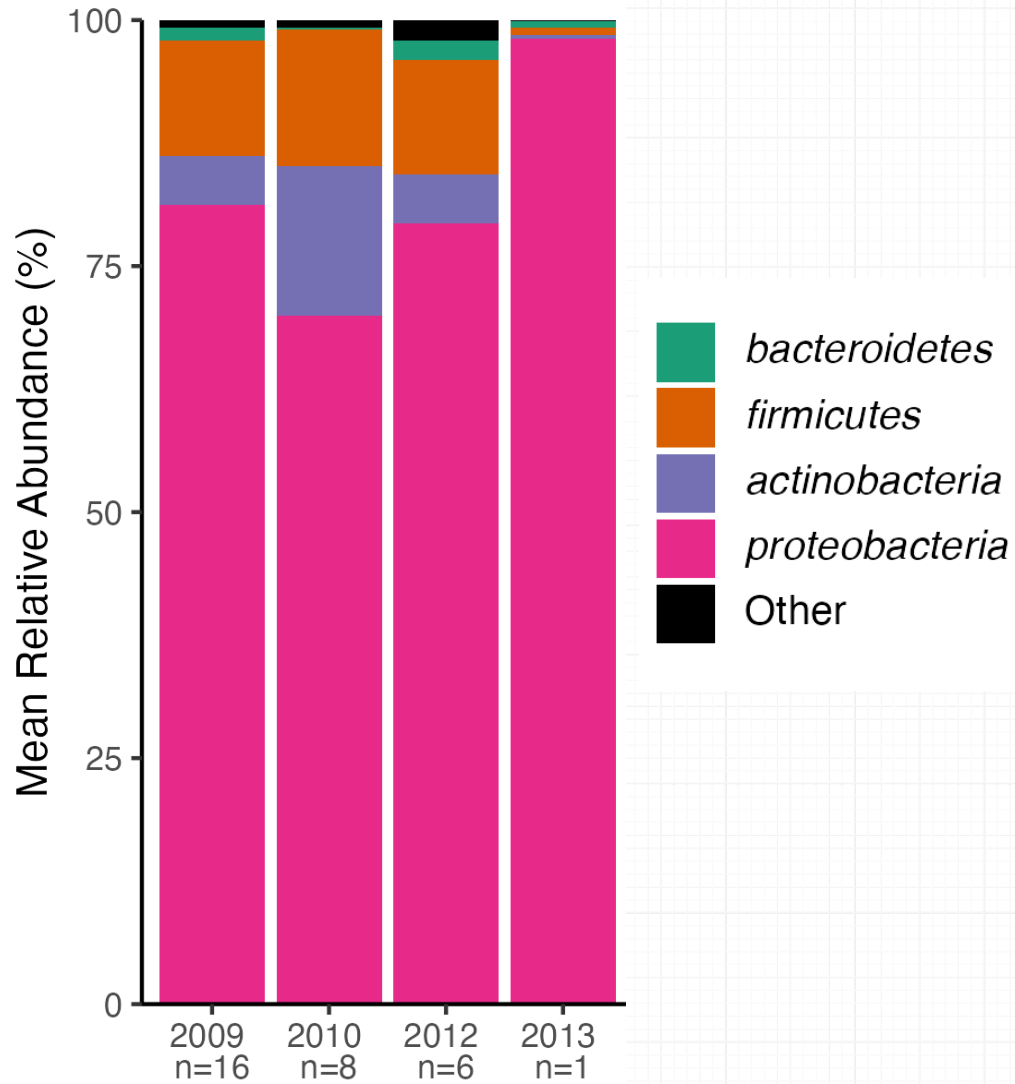
# DNA purification from FTA cards



FTA Elute Cards  
Tenerife samples (2009 – 2013)

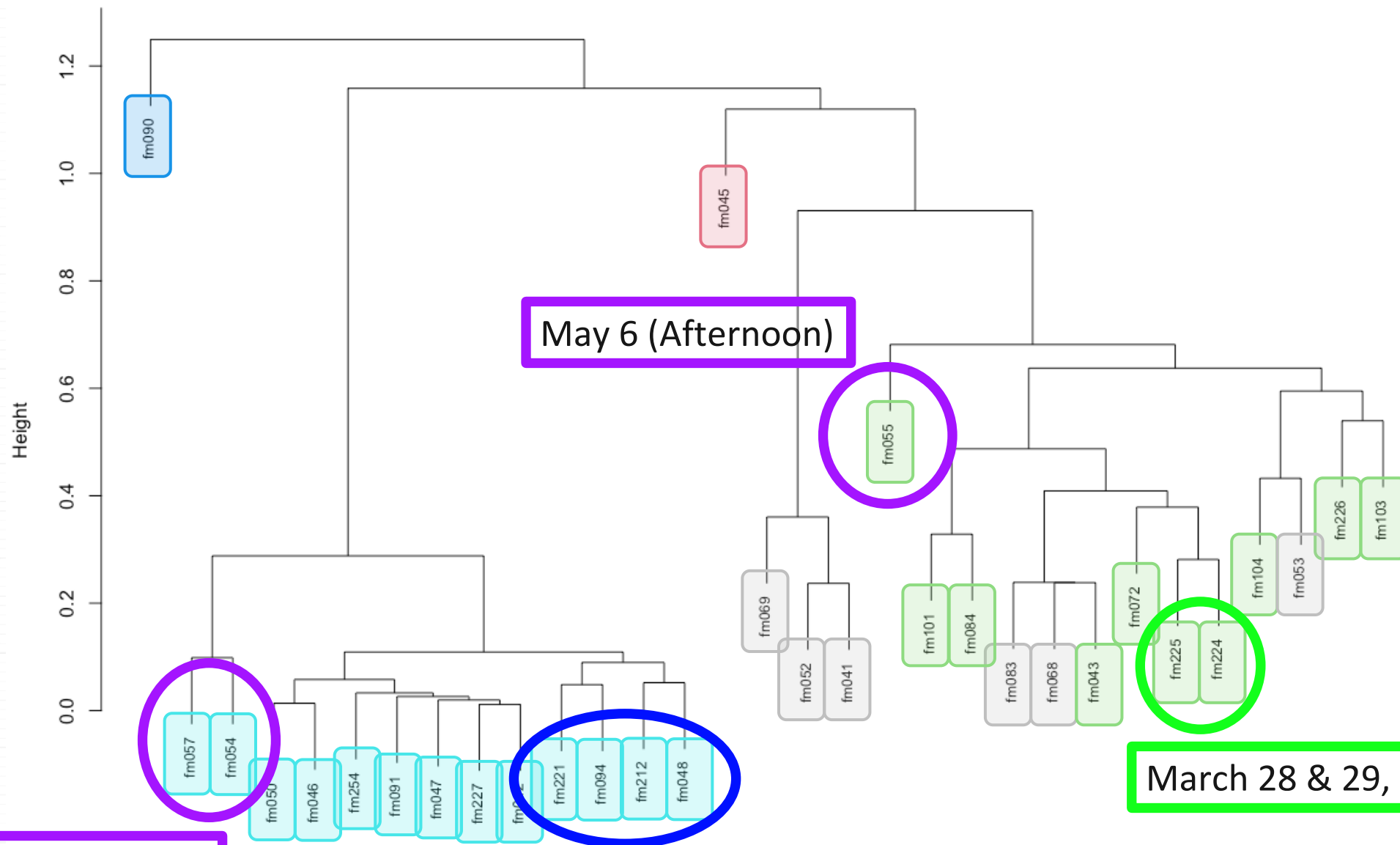


# Phylum Analysis



Kmeans group clustering for a total of 5 clusters using the set of 31 FTA card samples.

# Hierarchical Dendrogram of Samples



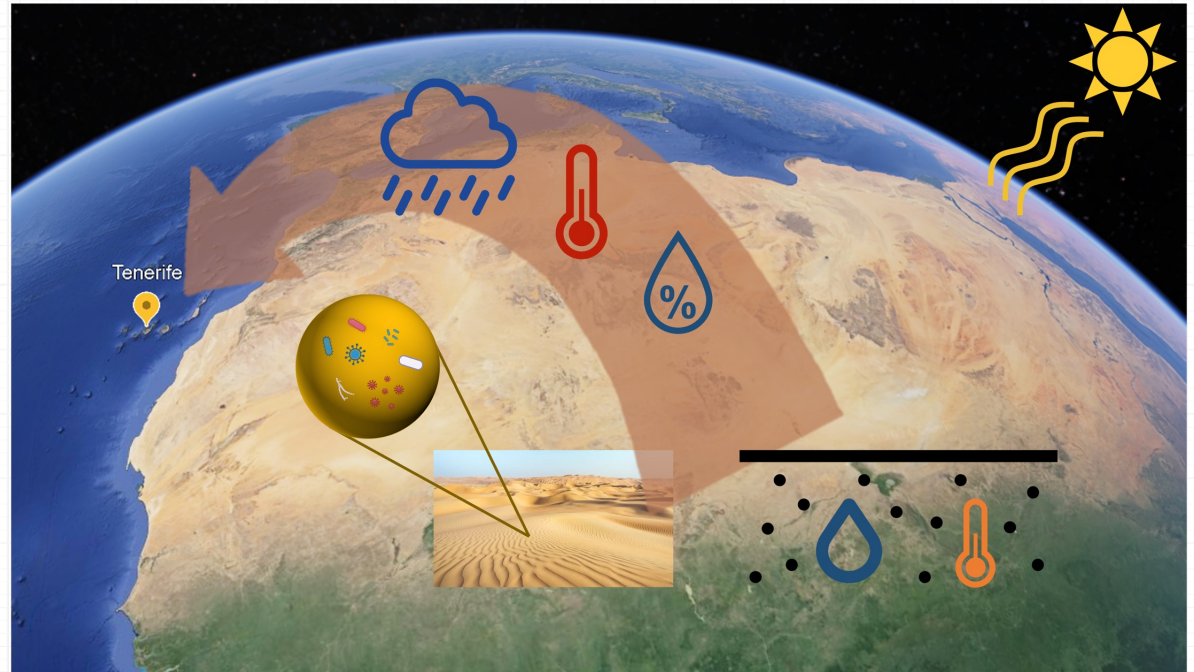
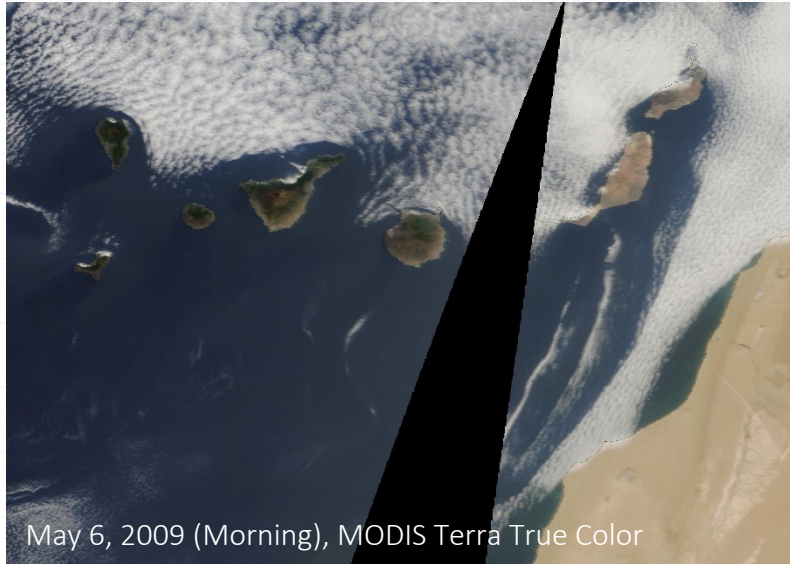
May 6 & 8 (Morning)

May 6 (Afternoon)

March 28 & 29, 2012

March 2009, 2010, 2012

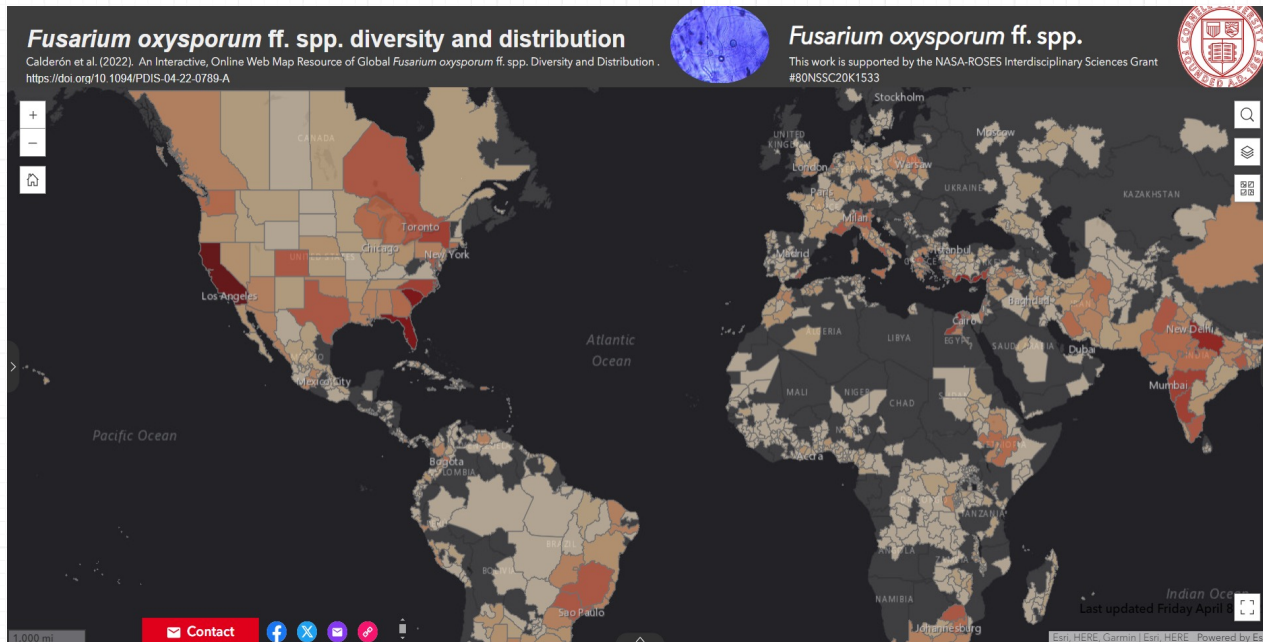
# Dust Plume Analysis



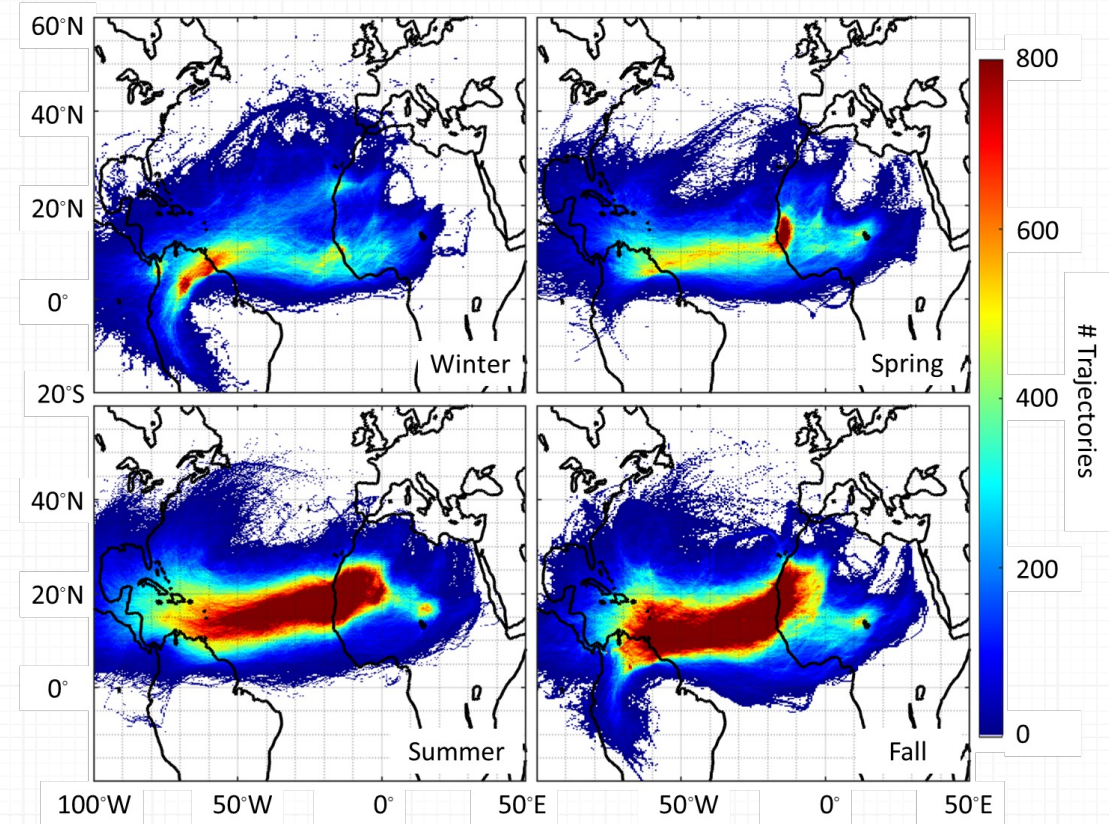
- Mean & accumulated temperature
- Mean & accumulated relative humidity
- Mean & accumulated solar radiation flux
- Precipitation
- Dust concentration
- Dust deposition
- Soil temperature
- Soil moisture



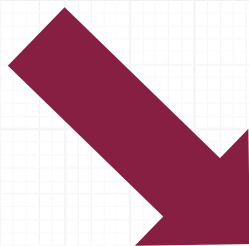
# Collaboration with our “sister” IDS project – Katie Gold *et al.*



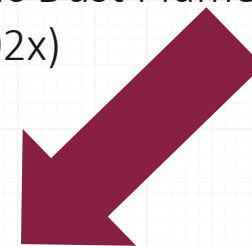
Global diversity and distribution of *Fusarium oxysporum*  
Calderón *et al.* (2022)



Long-Term Dataset of Sources and Pathways  
of Trans-Atlantic Dust Plumes  
Mardi *et al.* (202x)

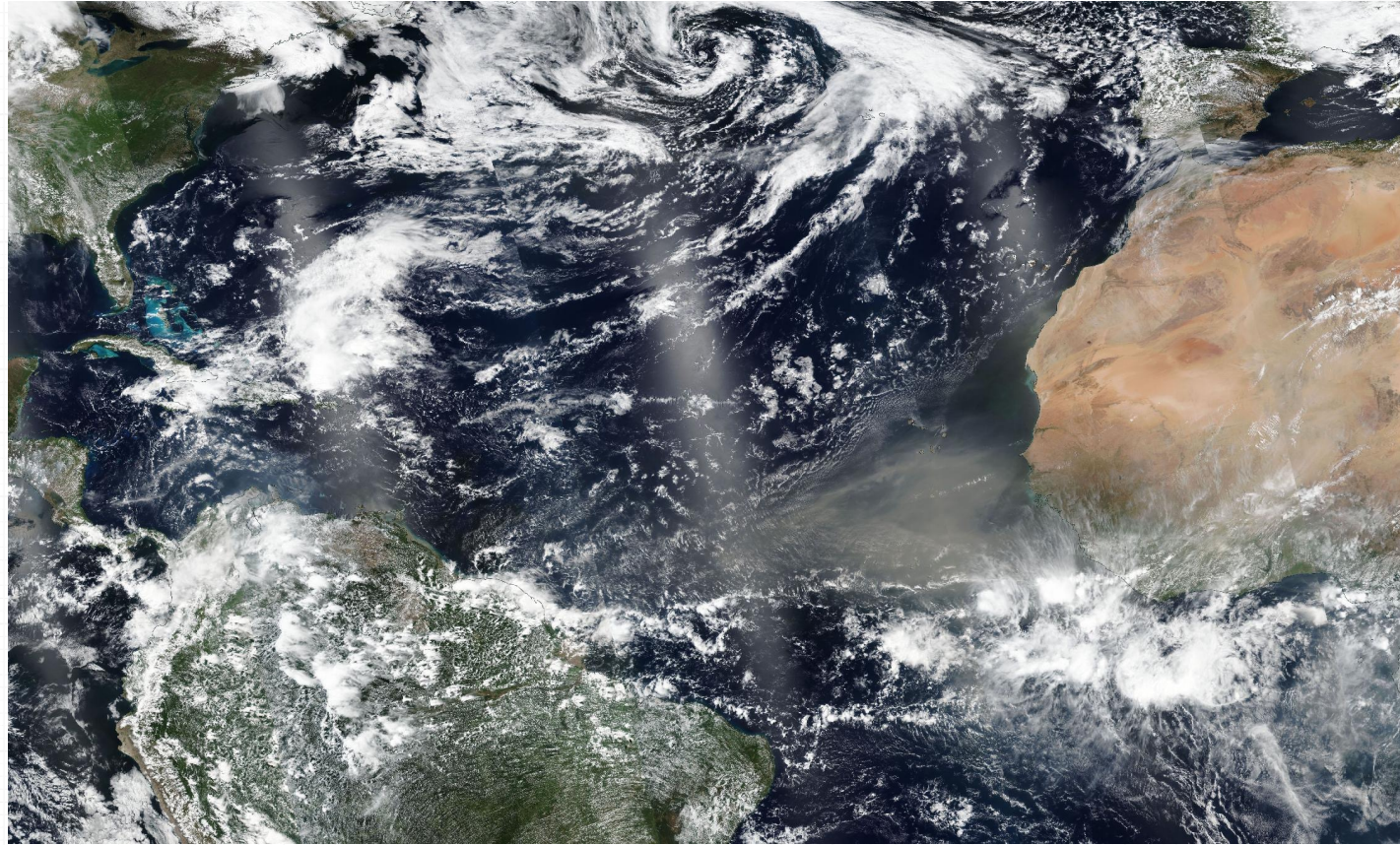


Improved Susceptibility Assessment



## └ Takeaway and Ongoing Work

- The microbial diversity of the atmosphere exhibits **significant spatiotemporal variability**.
- **Interdisciplinary research** is essential for comprehending this variability across different scales.
- In the upcoming months, we aim to enhance the **integration of our microbial data with remote sensing and atmospheric modeling datasets**.



True Color, Suomi NPP / VIIRS  
May 2, 2024

