The Role of Shared Resources in Facilitating Human and Environmental Surveillance for SARS-CoV-2

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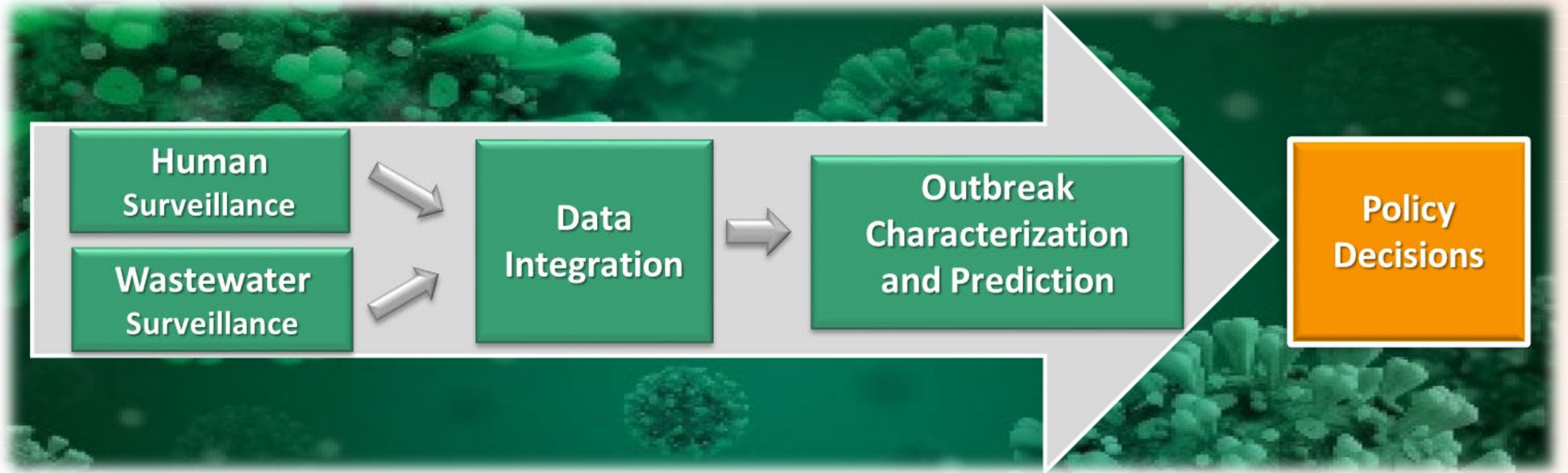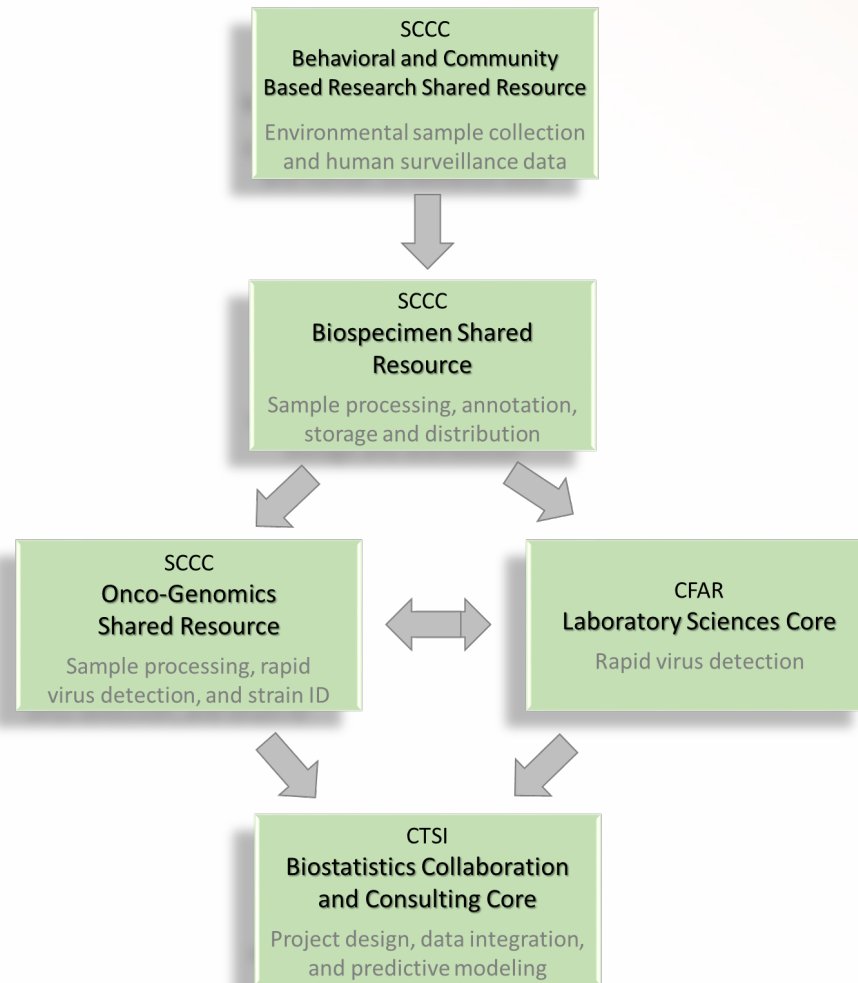
ABRF Annual Meeting
March 2022

SF-RAD: SARS-CoV-2 Wastewater-Based Surveillance

Aims

SF-RAD: SARS-CoV-2 Wastewater-Based Surveillance

Integrated Multi-Shared Resources Support

SCCC
Behavioral and Community Based Research Shared Resource
Environmental sample collection and human surveillance data

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SCCC
Biospecimen Shared Resource
Sample processing, annotation, storage and distribution

SCCC
Onco-Genomics Shared Resource
Sample processing, rapid virus detection, and strain ID

↔

CFAR
Laboratory Sciences Core
Rapid virus detection

CTSI
Biostatistics Collaboration and Consulting Core
Project design, data integration, and predictive modeling

SYLVESTER COMPREHENSIVE CANCER CENTER UNIVERSITY OF MIAMI HEALTH SYSTEM — **Sylvester Comprehensive Cancer Center**

Behavioral & Community-Based Research Shared Resource
Biospecimen Shared Resource
Onco-Genomics Shared Resource

CFAR THE MIAMI CENTER FOR AIDS RESEARCH UNIVERSITY OF MIAMI MILLER SCHOOL OF MEDICINE — **Center for AIDS Research**
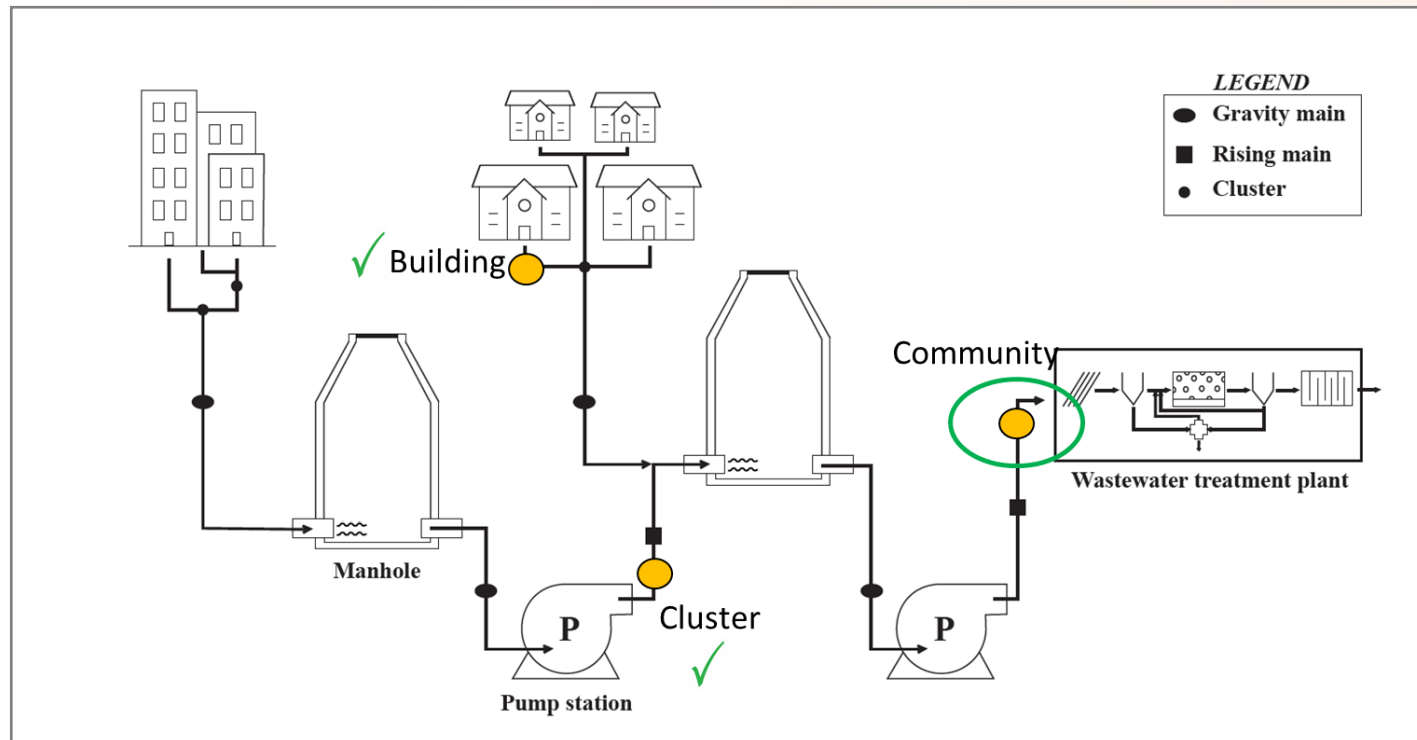
Laboratory Sciences Core

CTSI — **Clinical & Translational Science Institute**

Biostatistics Collaboration and Consulting Core

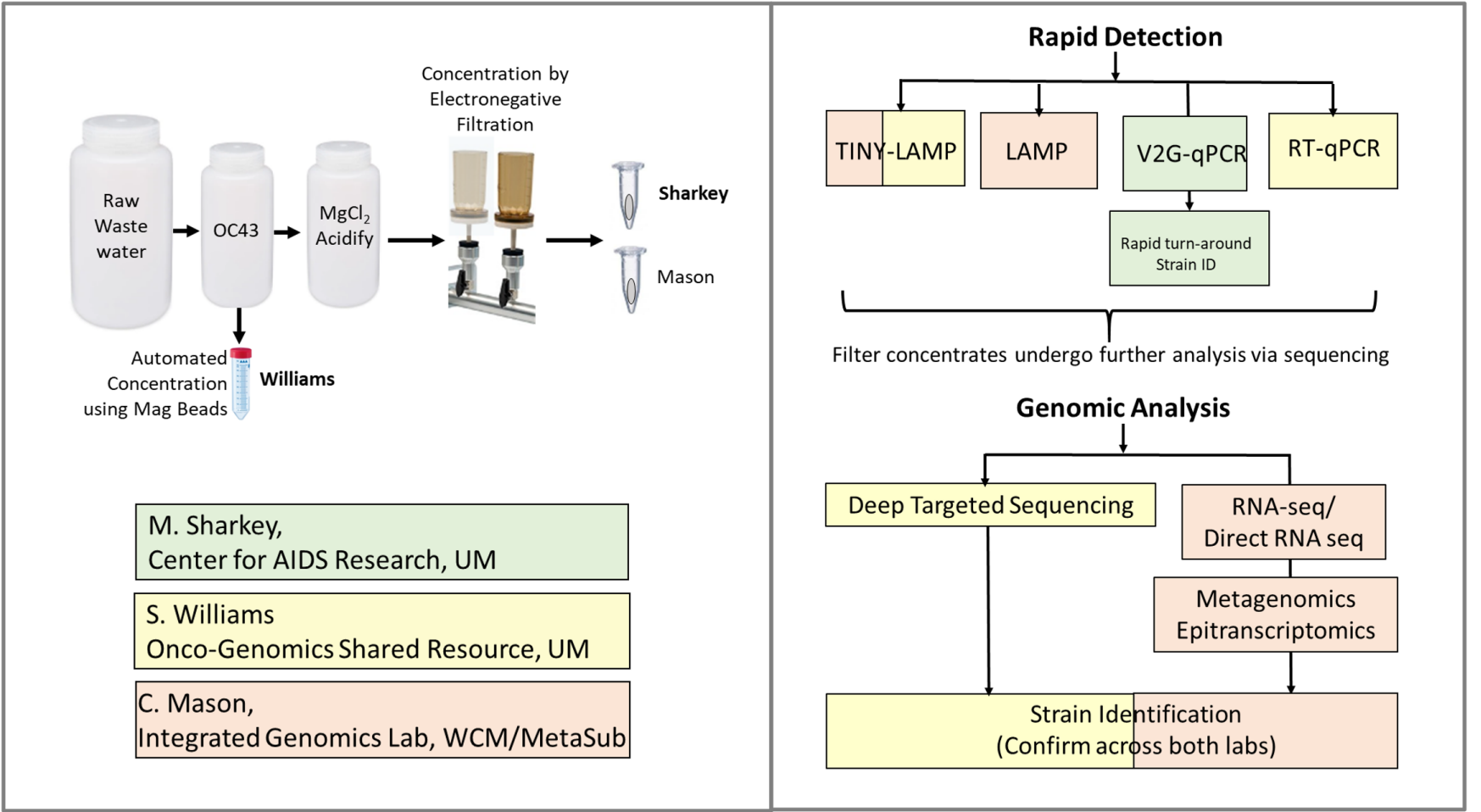# Wastewater Characterization

Aims

➢ Evaluate influence of watershed scale
➢ Evaluate sample concentration methods
➢ Evaluate sample collection method on SARS-CoV-2 measures
➢ Relate wastewater to human surveillance data

Wastewater Characterization

## Sample Processing & Data Generation

Data Standardization

➢ Establish data and metadata categories and develop metadata standards
➢ Establish end-to-end data flow process
➢ Implement operational informatics infrastructure to manage data & metadata
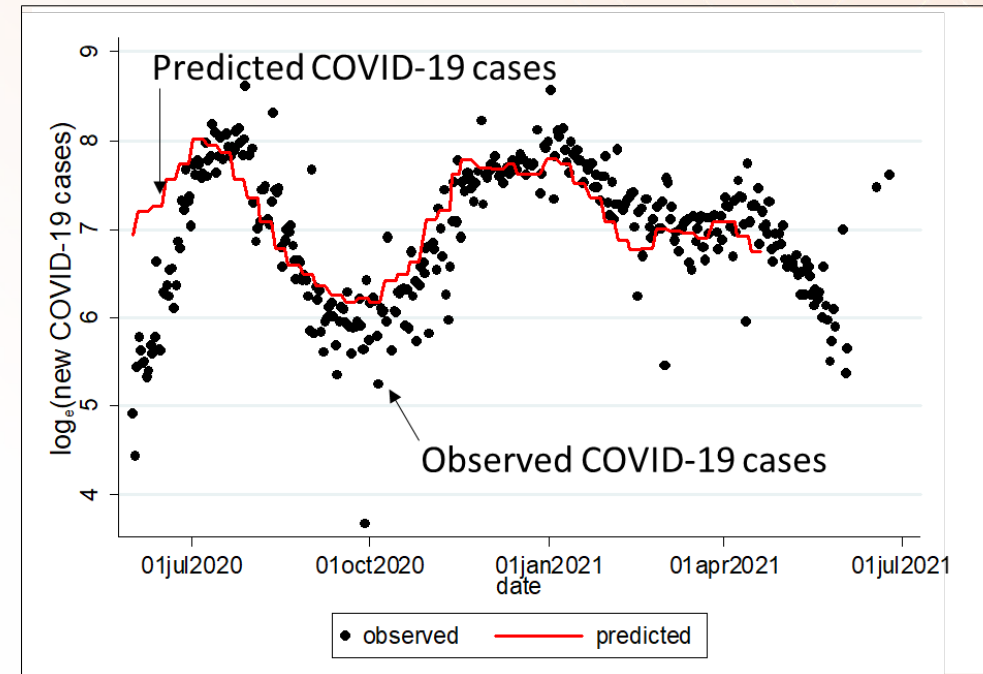➢ Implement Data Portal for data access and integration
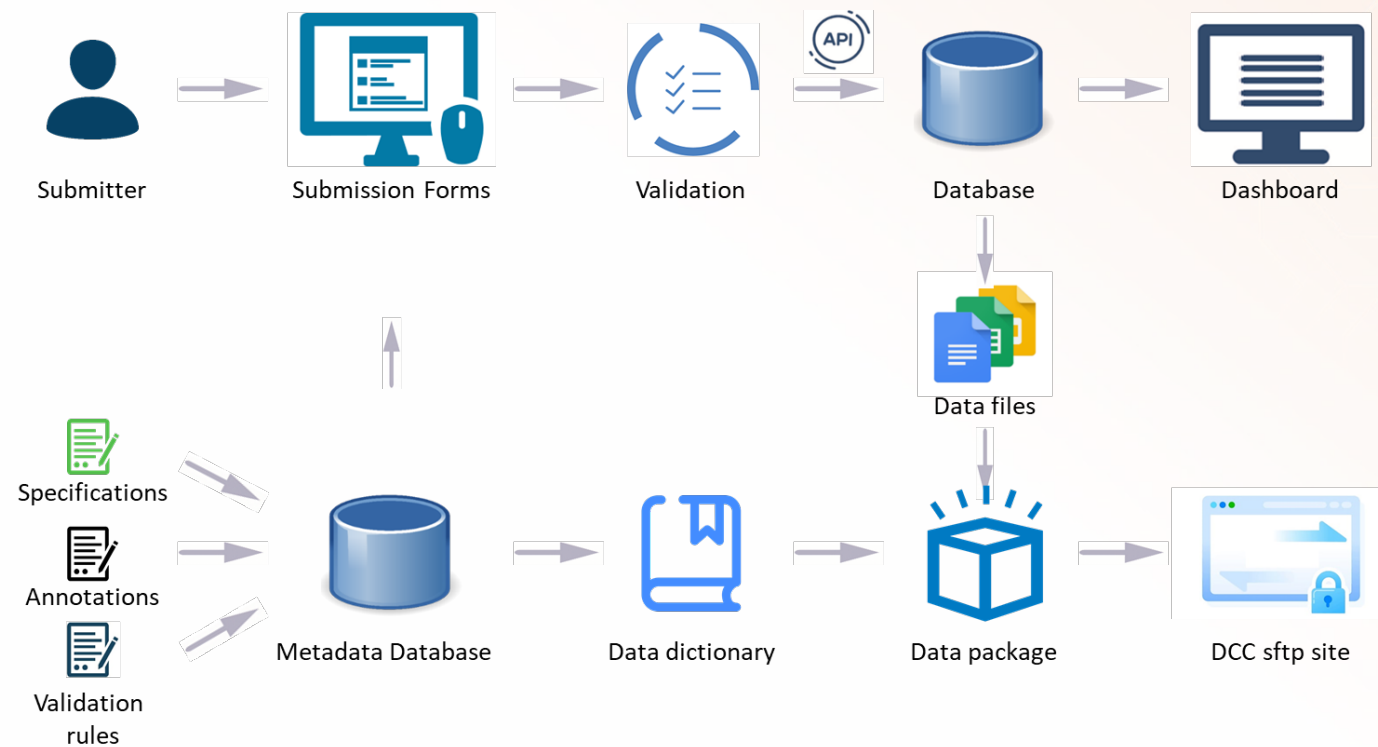
Integration of Human and Environmental Surveillance

County Scale
(Miami-Dade County, FL)
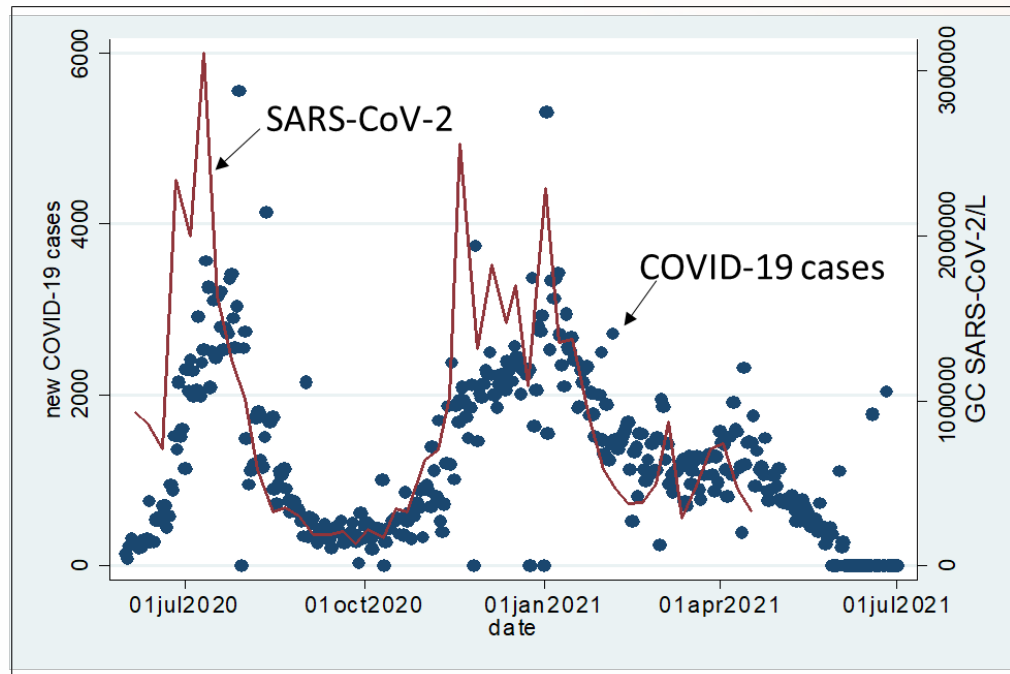
Association between SARS-Cov-2
and new COVID-19 cases in Miami-Dade

Association between observed and predicted
new COVID-19 cases in Miami-Dade

Log-log association between SARS-Cov-2 and new COVID-19 cases shows that a 1% increase in
SARS-CoV-2 was associated with 0.69% increase in COVID-19 new cases, June 2020 to May 2021
(Coefficient = 0.69, 95% CI = 0.53 - 0.85; p < 0.01)

Integration of Human and Environmental Surveillance

Building Cluster Scale
(University of Miami Campus)
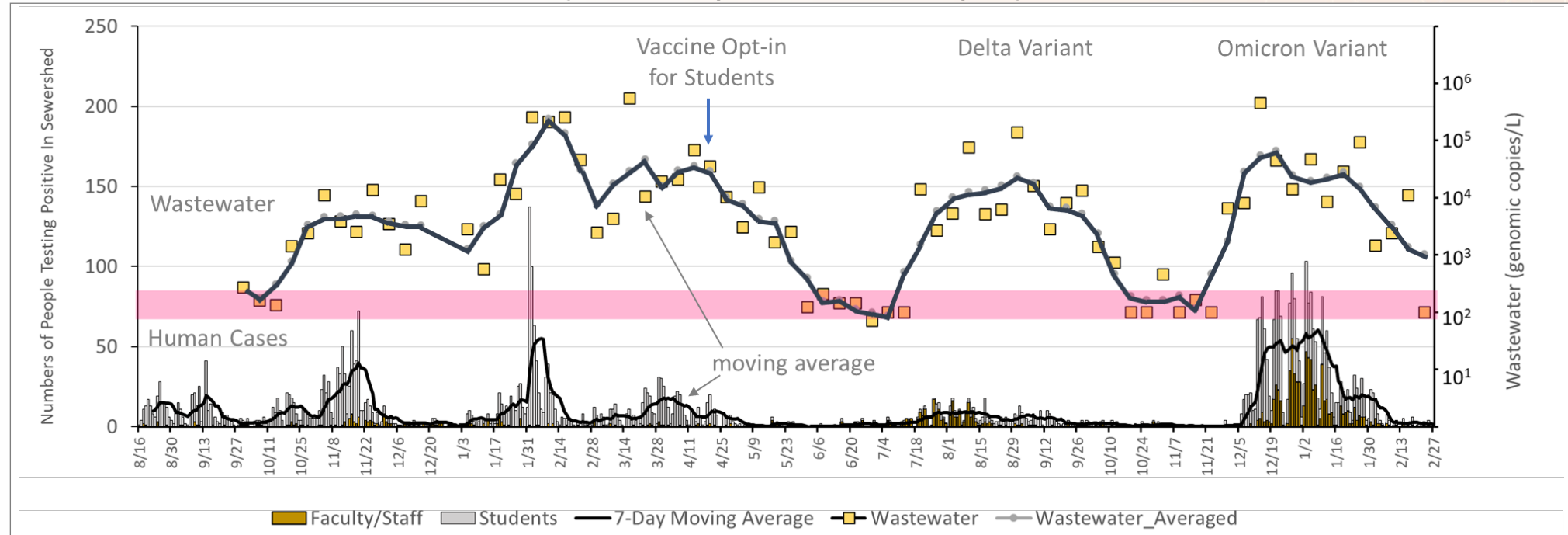
SARS-CoV-2 in wastewater was a 4-day lead indicator

Positivity (%) = 9 ln(C) / 10

10^2 gc/L of SARS-CoV-2 in wastewater associated with 4% positivity.
10^4 gc/L → 8%
10^6 gc/L → 12%

Sharkey et al. 2021, https://doi.org/10.1016/j.scitotenv.2021.149177

UNIVERSITY OF MIAMI

Weill Cornell Medicine

Correlations with Hospital Data

Correlation of wastewater data
to severity of clinical COVID-19 disease

Positive correlates:

- **Total number of COVID-19 positive cases**
  admitted on given day of wastewater sampling
  (strong, expected)

- **Mortality**
  (positive, expected)

- **Patients requiring treatment with remdesivir**
  (positive, counterintuitive
  as remdesivir disrupts viral replication)

- **Patients with immunosuppressive conditions**
  (positive, expected)

- **Patients requiring ventilators and critical care**
  (weak, expect strong correlation, but may be due
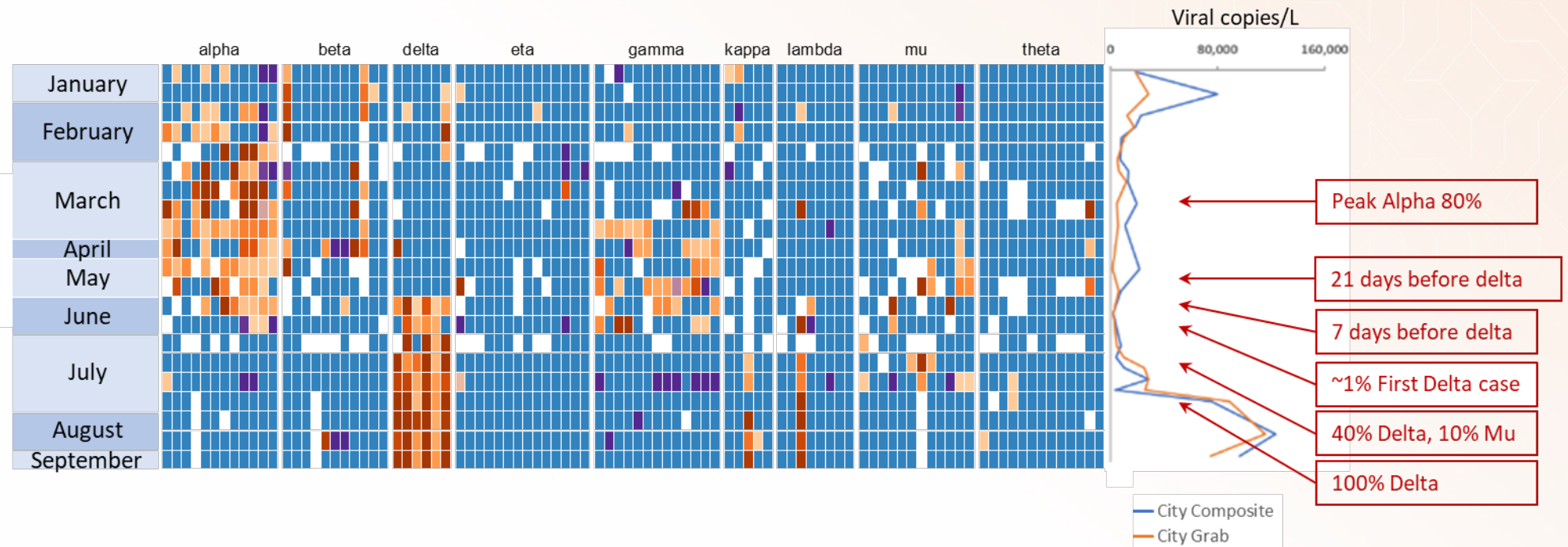 to nursing care and waste disposal into trash)
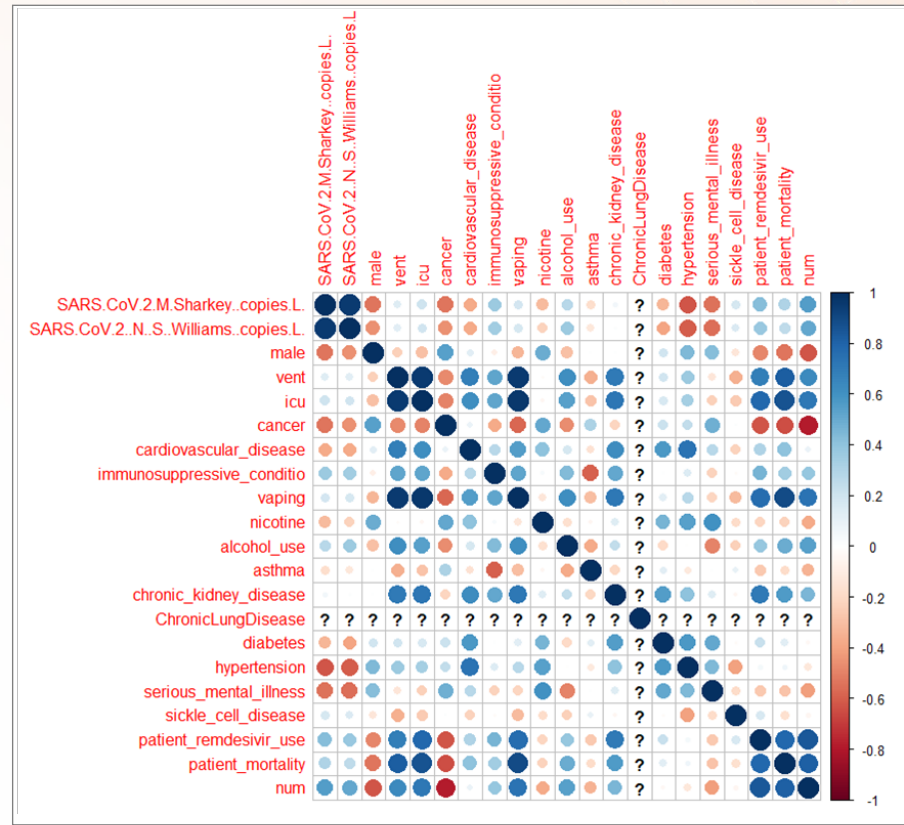
Integration of Human and Environmental Surveillance

Detection of SARS-CoV-2 lineages in wastewater

- SARS-CoV-2 lineages in City wastewater mirror patient data
- Even at low viral load lineages can be discerned
- High diversity followed by Alpha, Gamma, Mu, then Delta
- Delta detectable at -7 days before first sequenced case

City of Miami
(Jan.-Sept. 2021)

Lineages (left to right): alpha, beta, delta, eta, gamma, kappa, lambda, mu, theta

Months (top to bottom): January, February, March, April, May, June, July, August, September

Viral copies/L (0, 80,000, 160,000)

Annotations:
- Peak Alpha 80%
- 21 days before delta
- 7 days before delta
- ~1% First Delta case
- 40% Delta, 10% Mu
- 100% Delta

Legend: City Composite, City Grab

# Integration of Human and Environmental Surveillance

Monitoring of new variants-of-concern in wastewater

Dynamically updating VOCs to monitor: Samples shown here include Jan/Feb 2022 along with some summer 2021 samples. Omicron BA.2 signature mutations added in January 2022.
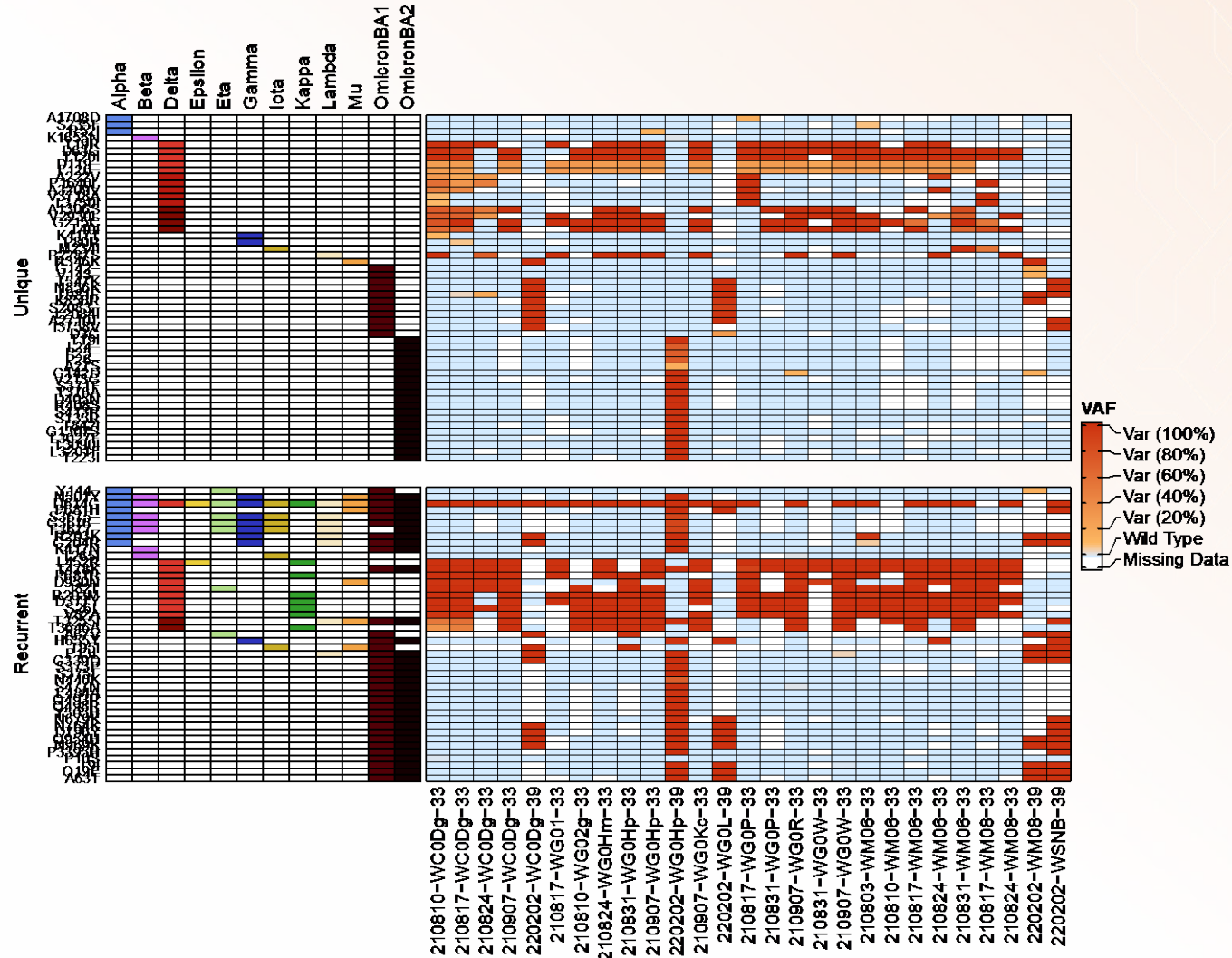
Integration of Human and Environmental Surveillance

Tracking changes in SARS-CoV-2 lineages in wastewater
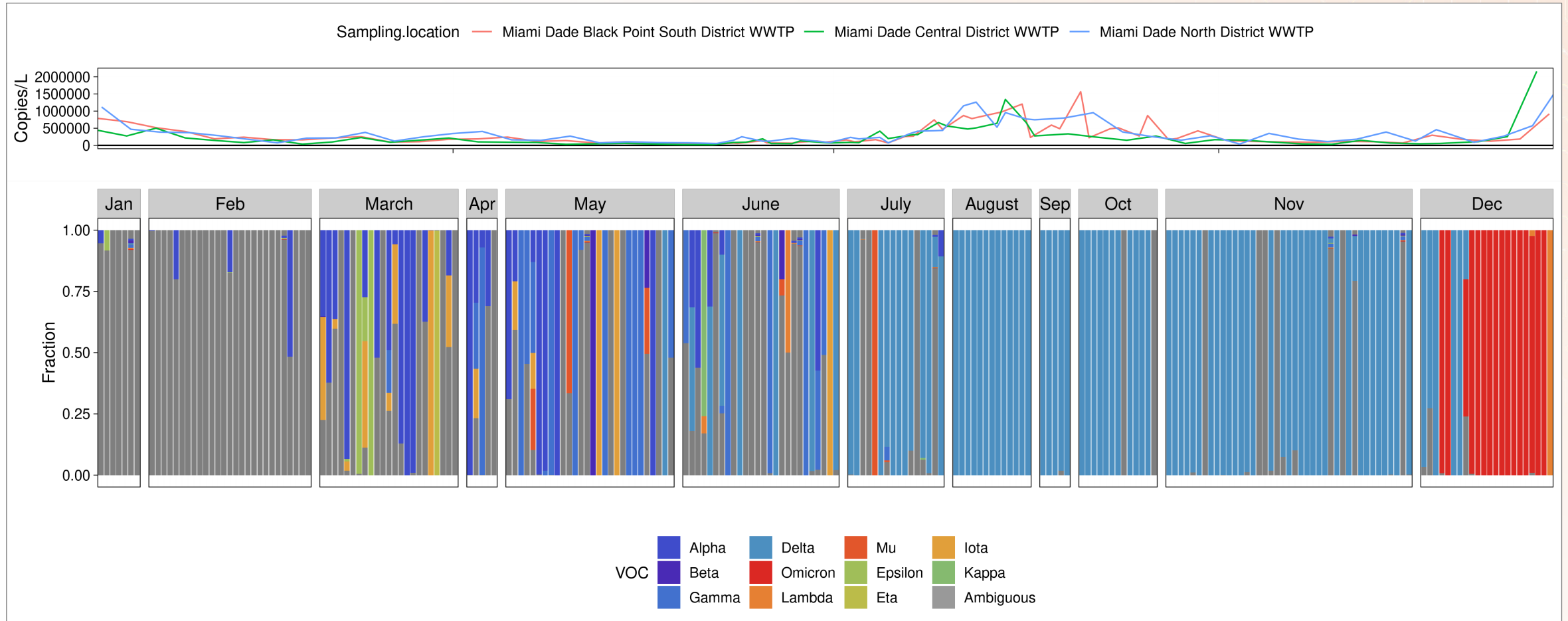
Signature mutation profiles fed into demixing model to estimate relative lineage abundances

SF-RAD

Publications

Lessons learned from SARS-CoV-2 measurements in wastewater

Sharkey ME, Kumar N, Mantero AMA, Babler KM, Boone MM, Cardentey Y, Cortizas EM, Grills GS, Herrin J, Kemper JM, Kenney R, Kobetz E, Laine J, Lamar WE, Mader CC, Mason CE, Quintero AZ, Reding BD, Roca MA, Ryon K, Solle NS, Schürer SC, Shukla B, Stevenson M, Stone T, Tallon JJ Jr, Venkatapuram SS, Vidovic D, Williams SL, Young B, Solo-Gabriele HM. **Lessons learned from SARS-CoV-2 measurements in wastewater**. *Sci Total Environ.* 2021 Dec 1;798:149177.doi.org/10.1016/j.scitotenv.2021.149177 PMID: 34375259; PMC8294117.

A rapid, isothermal, and point-of-care system for COVID-19 diagnostics

Christopher Mozsary, Duncan McCloskey, Kristina M. Babler, Juan Boza, Daniel Butler, Benjamin Currall, Sion Williams, Anne Wiley, George S. Grills, Mark E. Sharkey, Prem Premsrirut, Helena Solo-Gabriele, Yoslayma Cardentey, David Erickson, Christopher E. Mason. **A Rapid, Isothermal, and Point-of-Care System for COVID-19 Diagnostics**. *J Biomol Tech.* 2021 Sep;32(3):221-227. doi: 10.7171/jbt.21-3203-019. PMID: 35136383, PMCID: PMC8802758.

A global metagenomic map of urban microbiomes and antimicrobial resistance

David Danko, Daniela Bezdan, Evan E. Afshin, Sibo Zhu, Christopher E. Mason, et al. **A global metagenomic map of urban microbiomes and antimicrobial resistance,** *Cell.* 2021 Jun 24;184(13):3376-3393. https://doi.org/10.1016/j.cell.2021.05.002. PMID: 34043940.

Spin-off research: Ongoing and potential pilot projects

- Wastewater surveillance of COVID-19 in public schools
  - Pilot project in collaboration with a RADx/UP funded investigator at the University of Miami (1OT2HD108111, Dr. Lisa Gwynn, principal investigator)

- Airplane and airport wastewater surveillance
  - In collaboration with the CDC-NWSS, NIST, and the Rockefeller Foundation

- Wastewater surveillance for influenza, for antibiotic resistant pathogens, and for other biomarkers of disease

Metagenomics of Urban Biomes (MetaSUB) Annual Meeting

Miami, FL, Nov. 18-21, 2022

metasub.org

Acknowledgements

Helena Solo-Gabriele   Stephan Schürer   Chris Mason   George Grills

https://covidsfrad.org

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