

Update of IMPROVE Carbon Analysis

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Objectives

- Report status of IMPROVE carbon analyses
- **Review internal quality control (QC) checks**
- Discuss operational challenges and improvements

DRI's Environmental Analysis Facility (EAF) continuously operates 10-13 Model 2015 Multiwavelength Carbon Analyzers (2016-Present, analyzed over ~261,800 samples with ~120,000 for IMPROVE)



EAF Carbon Laboratory (Magee Scientific, Berkeley, CA and Aerosol, d.o.o., Ljubljana, Slovenia)

Carbon Laboratory Operations

(July 2021 – June 2022 samples, n= ~ 18,399)

- **Received ~1,655 IMPROVE samples per month** (varies from 0 to ~2,800 samples per month)
- **Operated ~15-18 hours per day, 7 days per week until April 2022, reduced to ~6-8 hours per day, 3-5 days per week in recent months.**
- **Matt Claassen has assumed responsibility since June 2021 in conjunction with Patrick Myers, who started September 2021.**



Matt



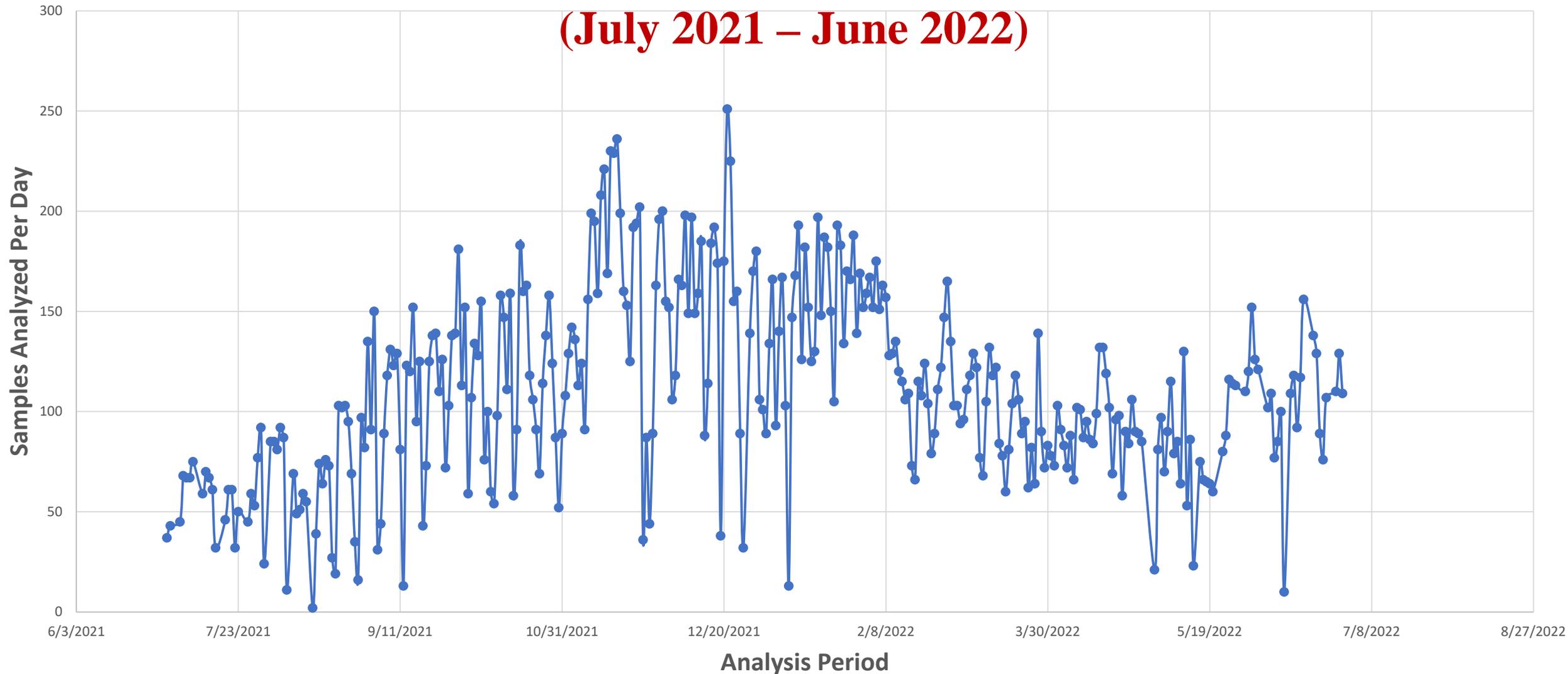
Pat

Completed submission of all 2021 samples in July 2022

(July 2021 – June 2022 samples, n= 18,399)

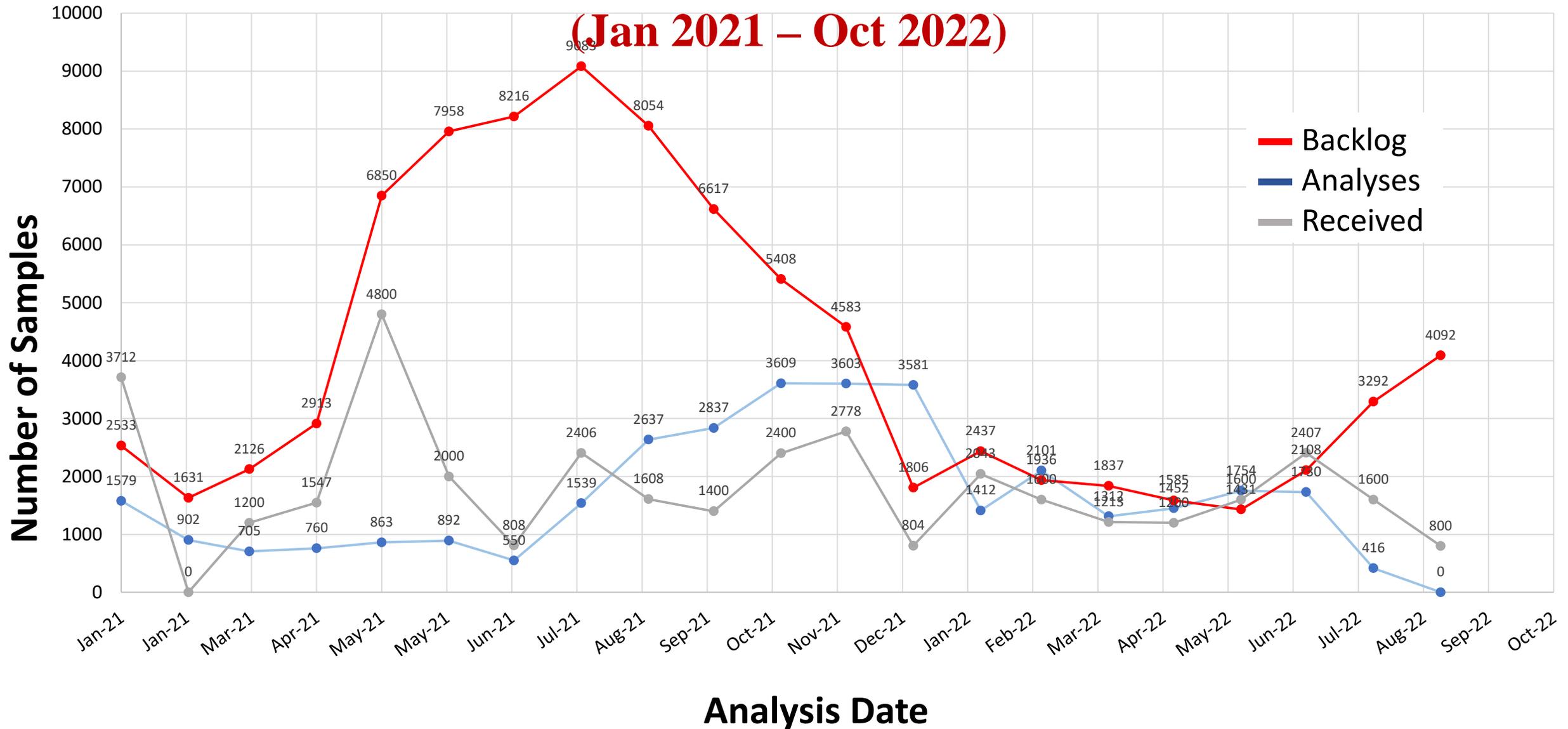
Sampling Period	Sample Receive Dates	Number of Samples Received	Analysis Completion Date
7/1/21 – 12/30/21	8/20/2021- 7/13/2022	9,227	July 2022
1/2/22 – 6/28/22	2/4/2022- 7/28/2022	9,172*	January 2023 (est.)

Carbon throughput averaged ~110 samples per day*



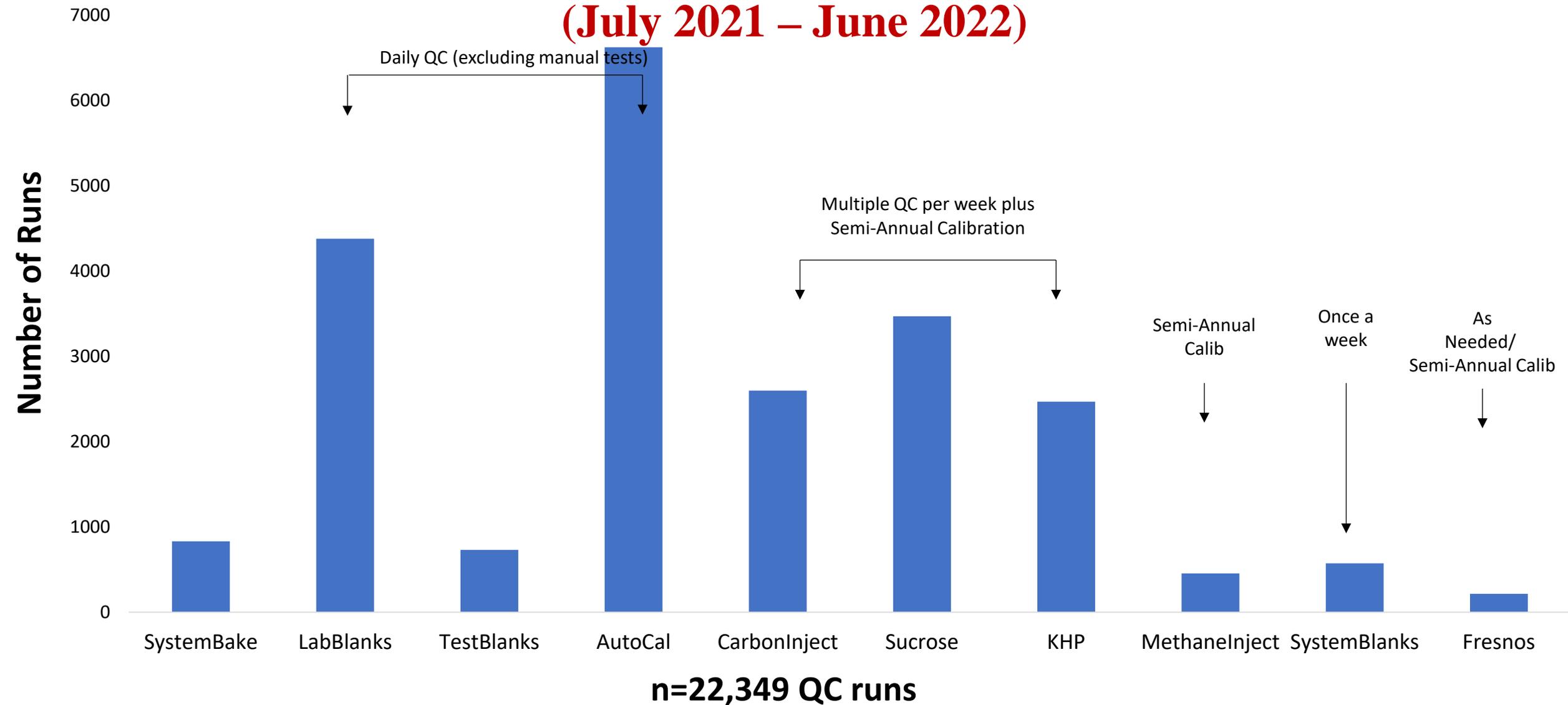
*Excludes calibration runs

Carbon throughput remained stable after elimination of backlogs at the end of 2021



Average 57 runs per day are dedicated to multiple quality control (QC) checks

(July 2021 – June 2022)



A better-insulated stranded wire replaced thermoplastic-insulated copper wire in connections to sample ovens

- Thermoplastic-insulated copper wire burned out periodically on some sample ovens, leading to potential safety hazards and machine downtime
- MG wire consists of outer fiberglass insulation with an inner mica insulation that can withstand high temperatures, up to 450°C

Hydraulic
Solenoid
Valve



Sample
oven
heater coil

MG
Wire

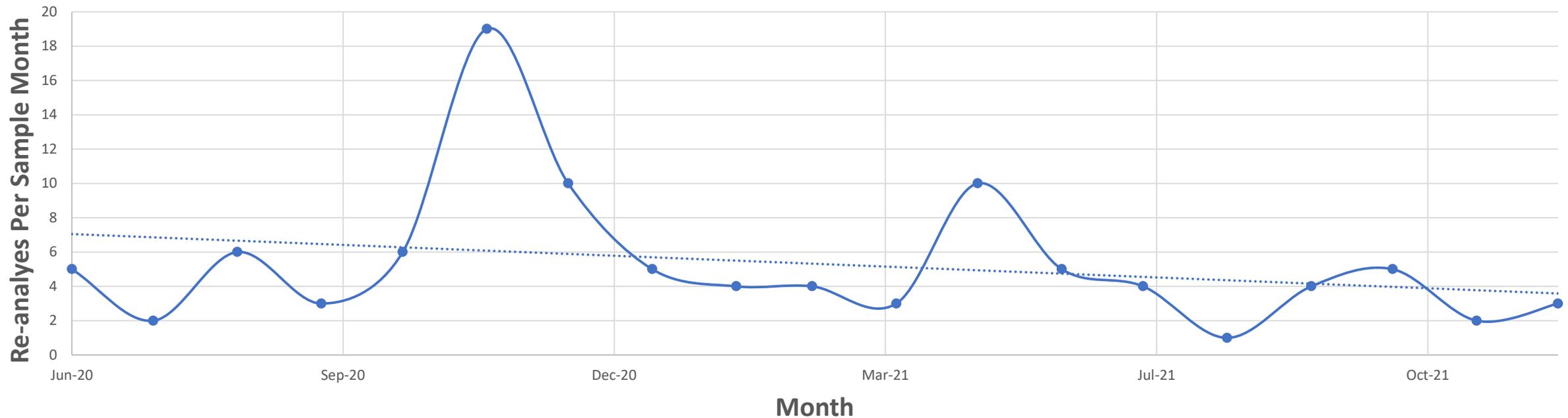
Quartz
glass oven

Ceramic
sample
oven

Initiated revised data validation protocol since June 2020

- Processing data by multiple sets simultaneously instead of in small batches.
- Created software to identify and invalidate unusual sample runs to reduce sample re-analysis rates.

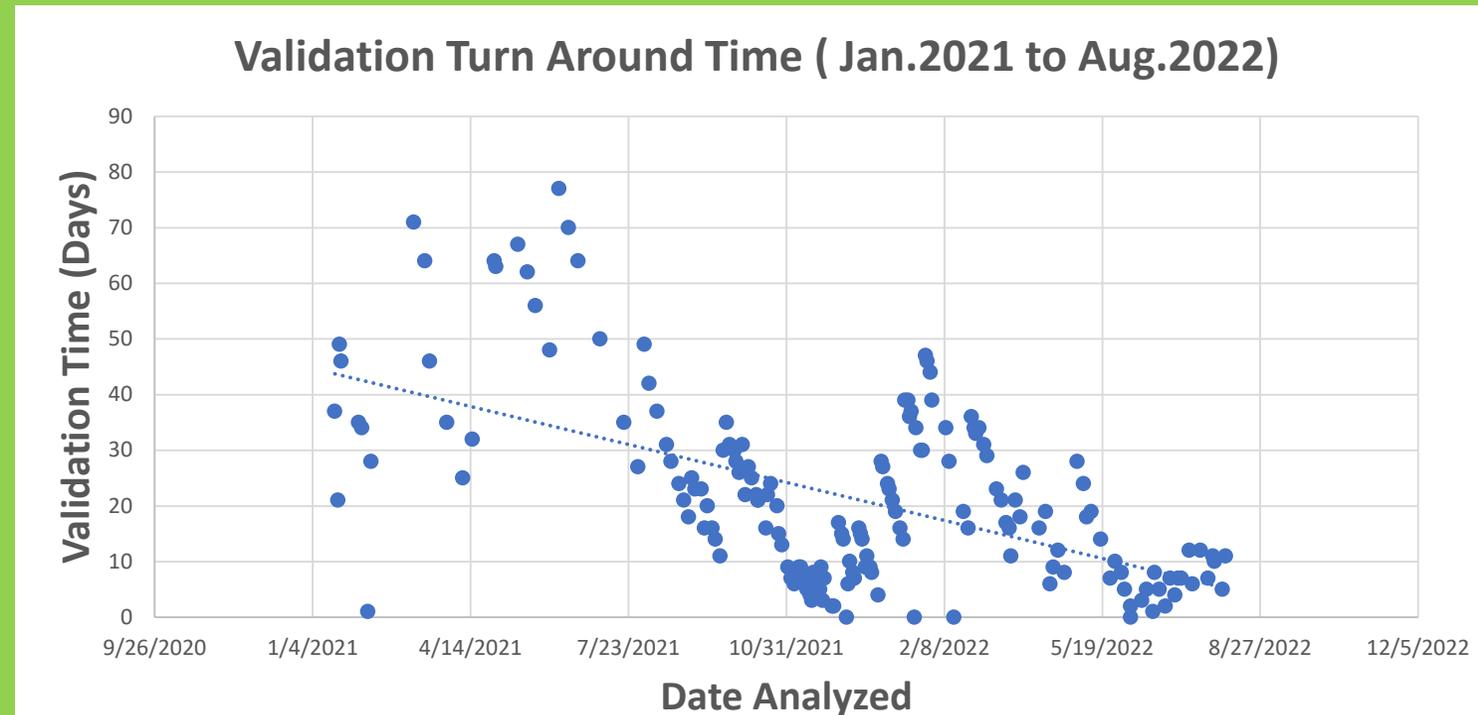
Re-analyses per Month (Jun. 2020 to Dec. 2021)



Additional criteria were added to facilitate efficient data validation

- Streamlined data-processing has shortened the reporting time.

- Improved machine-learning to validate accuracy



Example 2020-2021 publications and reports using the IMPROVE_A protocol (n= 53)

- Abbasi, B., Wang, X.L., Chow, J.C., Watson, J.G., Peik, B., Nasiri, V., Riemenschmitter, K.B., Elahifard, M., (2021). Review of respirable coal mine dust characterization for mass concentration, size distribution and chemical composition. *Minerals*, 11, 426. 10.3390/min11040426.
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- Chen, L.-W.A., Chow, J.C., Wang, X.L., Cao, J.J., Mao, J.Q., Watson, J.G., (2021). Brownness of organic aerosol over the United States: Evidence for seasonal biomass burning and photobleaching effects. *Environmental Science & Technology*, 55, 8561-8572. 10.1021/acs.est.0c08706.
- Chen, Y., Dombek, T., Hand, J., Zhang, Z., Gold, A., Ault, A.P., Levine, K.E., Surratt, J.D., (2021). Seasonal Contribution of Isoprene-Derived Organosulfates to Total Water-Soluble Fine Particulate Organic Sulfur in the United States. *Acs Earth and Space Chemistry*, 5, 2419-2432. 10.1021/acsearthspacechem.1c00102.
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Example 2020-2021 publications and reports using the IMPROVE_A protocol (n= 53)

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- Hand, J.L., Prenni, A.J., Copeland, S., Schichtel, B.A., Malm, W.C., (2020). Thirty years of the Clean Air Act Amendments: Impacts on haze in remote regions of the United States (1990-2018). *Atmospheric Environment*, 243, 10.1016/j.atmosenv.2020.117865.
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- Ni, D.F., Lin, J.J., Gao, J., Xie, J.F., Wang, J., Guo, Y.Z., Ren, J.N., (2020). Comparative analysis of new observation methods for carbonaceous aerosol (OC/EC). *Zhongguo Huanjing Kexue/China Environmental Science*, 40, 5191-5197.
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Example 2020-2021 publications and reports using the IMPROVE_A protocol (n= 53)

- Pan, L., Kim, H., Lee, P., Saylor, R., Tang, Y., Tong, D., Baker, B., Kondragunta, S., Xu, C., G. Ruminski, M., Chen, W., McQueen, J., Stajner, I., (2020). Evaluating a fire smoke simulation algorithm in the National Air Quality Forecast Capability (NAQFC) by using multiple observation data sets during the Southeast Nexus (SENEX) field campaign. *Geoscientific Model Development*, 13, 2169-2184. 10.5194/gmd-13-2169-2020.
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- Vega, E., López-Veneroni, D., Ramírez, O., Chow, J.C., Watson, J.G., (2021). Particle-bound PAHs and chemical composition, Sources and health risk of PM_{2.5} in a highly industrialized area. *Aerosol and Air Quality Research*, 21, 210047. 10.4209/aaqr.210047.
- Verma, M., Pervez, S., Chow, J.C., Majumdar, D., Watson, J.G., Pervez, Y.F., Deb, M.K., Shrivastava, K., Jain, V.K., Khan, N.A., Mandal, P., Chakrabarty, R.K., (2021). Assessing the magnitude of PM_{2.5} polycyclic aromatic hydrocarbon emissions from residential solid fuel combustion and associated health hazards in South Asia. *Atmospheric Pollution Research*, 12, 101142. 10.1016/j.apr.2021.101142.
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