# AEROSOL NETWORK NEWS

Newsletter #5 - December 2020

**Welcome!**
Yet another edition of our very (ir)regular newsletter about the NOAA Federated Aerosol Network (NFAN) is here. NFAN and this newsletter are managed by scientists at the Global Monitoring Laboratory (GML) in Boulder, and as always, there are several goals we hope to achieve with this newsletter:

- Let you (our collaborators and colleagues) know about updates to the Network (including new sites, instrument additions, software changes, etc.).
- Describe research projects utilizing data from one or more sites within the network.
- Keep you informed about publications and presentations based on network data.
- Foster collaboration among network partners.

**YOU** can help us by keeping us up-to-date on what is happening at your site(s). For example, have you... Deployed a new instrument? Presented at a conference? Published a research paper? Graduated? Got an idea you would like to share with everyone? PLEASE LET US KNOW!
(email: betsy.andrews@noaa.gov).

Please feel free to share this newsletter with colleagues that might be interested.

## What's happening around the NFAN: New Names and Sites

**Aerosol Program Updates**

There have been some changes in organization at NOAA. The Global Monitoring Division of ESRL was recently elevated to Laboratory status and is now the NOAA Global Monitoring Laboratory. The Aerosol Group has been merged with the Radiation Group, and Patrick Sheridan is now the Deputy Director of this new division. Despite these changes, the NFAN aerosol webpage remains the same: https://www.esrl.noaa.gov/gmd/aero/

Last, but definitely not least, we've been joined by post-doc Lauren Schmeisser. Lauren got her PhD from University of Washington studying marine heatwaves, but prior to that she was a research scientist in our group and led or co-authored several papers on aerosol properties. We are super excited to have her back with us!

**Station update by the numbers**
**31** operational
**1** new (SLC), **1** closed (CPT)
**3** coming soon? (PDE, RPB, WPB)
**3** non-operational* (AMY, CGO, TIK)
*either not running or not sending data via cpd

**Future NFAN stations**
**RPB - Ragged Point, Barbados**

Ragged Point has been making aerosol measurements since the 1960s. These measurements were initiated by Professor Joe Prospero from University of Miami as part of his focus on Saharan dust transport across the Atlantic and they have proved invaluable for understanding this phenomenon and for constraining model simulations of dust.

*View of Ragged Point (site indicated by red arrow)*

Currently, RPB hosts a suite of aerosol instruments, including chemical filter samplers, a NASA micropulse lidar and AERONET sunphotometer, and aerosol microphysics instruments from the Max Planck Institute. NFAN in-situ surface optical property

measurements would greatly complement these observations, and in support of this possibility, GML recently serviced University of Miami's TSI nephelometer in preparation for its use in the proposed set-up of an NFAN site. Ragged Point NFAN measurements would also complement the measurements from other NFAN sites in the Caribbean region (CPR & PDE). In addition to the aerosol measurements, Ragged Point is also a site in the GML Carbon Cycle Greenhouse Gas network and an AGAGE site.

**WPB - Wright Patterson Base, Ohio**

Collaborators Kevin Keefer and Yogi Raut from the Air Force Institute of Technology (AFIT) visited Boulder in February 2020 to learn more about NFAN instruments and operations. They took an in-person tour of the NFAN Table Mountain site to see how all the components fit together.

*Patrick Sheridan (NOAA/GML) and Kevin Keefer (AFIT) during a tour of the NFAN Table Mountain Facility in February 2020. (Photo Yogi Raut)*

In 2021, they plan to set up an NFAN site near Wright Patterson Air Force Base in Ohio to study the radiative effects of aerosols in the region and how these relate to those in other climatic regions.

**PDE - Pico del Este, Puerto Rico**

Olga Mayol-Bracero is currently setting up a second, higher elevation NFAN site in Puerto Rico to complement the sea level measurements at Cape San Juan (CPR). The PDE site will focus on aerosol-cloud interactions. Specifically, they plan to focus on CCN closure studies, cloud microphysics vs aerosol properties, cloud model validation and cloud chemistry. PDE will be located on El Yunque (elev. 1051 m asl), which is often in cloud.


*View of El Yunque (in cloud!) from Cape San Juan NFAN station*

## What's happening around the NFAN: infrastructure/support

**Obsolete Instruments and repairs**

***Due to factors beyond our control, our practice of repairing some instruments in the NFAN network has to be modified as described below.***

Several instruments that are commonly used throughout the NFAN have gone obsolete. These include two models of TSI Condensation Particle Counters (CPCs, Model 3760 and Model 3010) and the TSI Model 3563 Integrating Nephelometer (Neph). The CPCs have been out of production for many years, while TSI stopped producing the Neph in 2016. TSI will not repair the CPCs, and we don't know if they still repair a Neph. These instruments have operated long-term at all of our NOAA stations, so we've learned over many years how to service and repair them. While we are still willing and able to make some repairs, we have now identified critical failures that we cannot repair.

For the CPCs, the critical failure is that the laser diode (Sony SLD201V-3) is no longer being produced. In the past, we would simply repair collaborator TSI 3010s and 3760 CPCs, including laser replacement. Unfortunately, we can't do that anymore as we can no longer get the replacement laser.

For the TSI Neph, the critical failure involves the internal motors that turn the chopper and backscatter shutters. There were several varieties of these motors that TSI used in their Nephs, and the various generation motors (i.e., first (1G), second (2G) and third (3G)) are not interchangeable. As each generation of motor went obsolete, TSI was forced to switch to a different motor and update the motor driver chip firmware. To our knowledge, none of the 1G (used in Nephs prior to roughly 2005) and 2G

(2005-2009) motors are available today. We don't have any information on the availability of the 3G (2009-2016) motor.

If the Neph reports chopper or shutter errors, this means that the two motors (i.e., chopper and backscatter shutter motors) can't synchronize and there is a strong possibility that one or both of the internal motors has failed. If the cause of the failure is a bad bearing, there is a possibility that we can overhaul the motor by replacing the old bearing (we have successfully done this in the past). If, however, the motors fail for another reason, we likely can't fix those.

If your instruments (Neph, CPC) are beyond repair, we would happily take them off your hands to use for parts so we can potentially keep other instruments running. For example, the zero valves in the Neph and the saturator block in the CPCs are other parts that can fail and are difficult to get replacements for.

Recommendations:

- These instruments are aging, so repairs must be expected. Be prepared for them.
- We have created a library of maintenance and repair documents (for the Nephs, CPCs, and other commonly used NFAN instruments) that you can access. These are available at https://www.esrl.noaa.gov/gmd/aero/maintenance/maint_info_docs.html.
- Familiarize yourself with the repair documents so that you can make some of the simpler repairs yourself. For the more complicated repairs, we can assist remotely (email/telephone).
- Purchase a supply of the consumable parts that you will need to keep these instruments running (e.g., Neph lamps and filters, PSAP/CLAP filters (we now recommend Azumi filters for the CLAP), etc.). We can provide part numbers and vendors for these. As these may become hard to find in the future, it would be wise to stock up on the replacement parts while they are still available.
- Map out a long-term strategy for replacement of these instruments with manufacturer-supported instruments. We would be happy to discuss instrument replacement possibilities with you.

**Software Updates from Derek**

If the data acquisition computer at your station is still running 16.04 DAOS, it's time to upgrade; 16.04 goes completely out of support next year. You will need to upgrade to the Ubuntu 20.04 version of DAOS. To figure out what version of DAOS you are running, open a terminal window on the data acquisition laptop and type: lsb_release -r <enter>

The following instruments were added to the CPD data acquisition software in the last year:

- TSI MFM5xxxx
- PurpleAir
- Magee TCA-08
- Thermo 49iQ ozone monitor
- Magic CPC (water-based)

A more complete list is available here: https://www.esrl.noaa.gov/gmd/aero/instrumentation/cpd_inst.html

## What's happening around the NFAN: 2020 - Year of the Aerosol!

**Ring of fire**

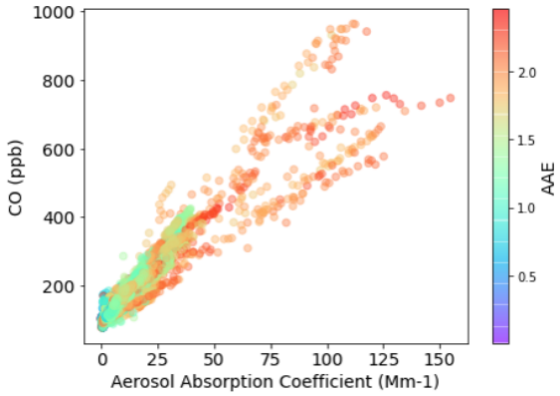
The state of Colorado experienced unprecedented wildfire activity this summer, including the two largest fires in state history. The Cameron Peak Fire and the East Troublesome Fire together burned over 400,000 acres (162K hectares) of forested lands. Thousands of structures were destroyed, wildlife was displaced, and smoke blew hundreds of miles downwind, severely affecting air quality.

*Plume from the Calwood fire over Boulder CO on 17 October, 2020 (photo Patrick Sheridan)*

Despite the devastation, these fires offered a unique opportunity to learn more about aerosols in wildfire smoke plumes, as the NFAN Table Mountain monitoring facility (BOS) was able to measure months of smoke events.

Colleagues in the NOAA GML carbon cycle group temporarily deployed a Picarro gas concentration analyzer at BOS to provide CO, $CO_2$, and $CH_4$ concentrations co-located with the aerosol measurements. This allowed us to analyze how aerosol/gas relationships change during background conditions compared to different types of smoke events.

Preliminary analyses showed CO was highly correlated with aerosol absorption and scattering. However, it is clear that aerosol/gas relationships change at high absorption Ångström exponent (AAE) values (possibly related to smoke plume age and/or origin). A back-trajectory analysis is the next step in helping to identify plume age and origin to further diagnose properties of smoke aerosols.




*Relationship between aerosol absorption coefficient and CO observed at Table Mountain Aug-Oct 2020.*

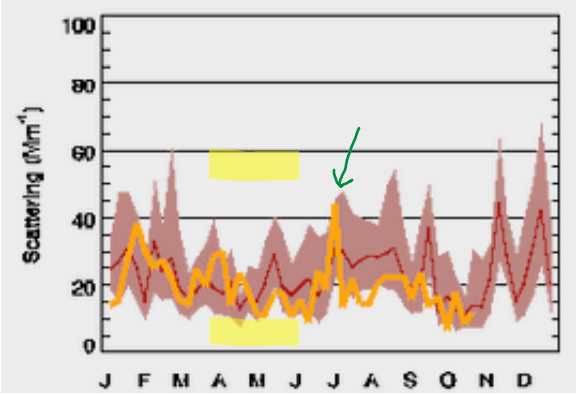
More information on these and previous smoke measurements in Boulder are on our smoke webpage: https://www.esrl.noaa.gov/gmd/smoke.html

**Dust in the wind**

In June 2020, a large Saharan dust plume travelled across the Atlantic Ocean and impacted several NFAN sites (CPR, APP and BND). Analysis of this so-called "Godzilla" dust event is on-going, including in collaboration with Rebecca Sheesley's group at Baylor University - they made aerosol optical measurements at a Texas site similar to those made by the NFAN. There will be several dust storm presentations at AGU that include NFAN data.

**Every breath you take**

Covid19 is the elephant in the room aerosol event of 2020. It appears to spread primarily through aerosols (https://time.com/5883081/covid-19-transmitted-aerosols/). It also may have had an impact on atmospheric aerosol observed at NFAN sites.




*Weekly time series of scattering coefficient at BND. Orange line is 2020 median, red is median last 3 years, pink is 25-75th percentiles. The initial 'lockdown' period (21 March to 29 May) in Illinois is highlighted in yellow. Peak in scattering at end of June (green arrow) may be Saharan dust incursion.*

Professor Jesse Kroll of MIT is evaluating whether CLAP filters from several NOAA observatories can be used to identify chemical changes in the aerosol at remote sites due to Covid19 impacts.

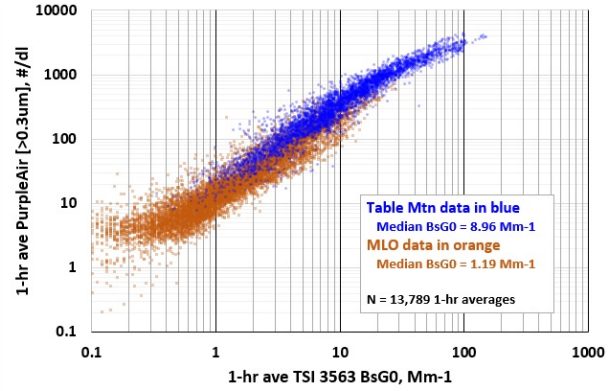
**Purple Air at MLO and BOS**

The PurpleAir (https://www2.purpleair.com) is a low-cost sensor that is widely used to monitor air quality. In collaboration with Jim Ouimette of the Sonoma Ecology Center, Purple Air sensors were installed at two NFAN sites (Mauna Loa (MLO) and Table Mountain (BOS)).

*Photo of PurpleAir sensors installed on tower near aerosol stack at MLO.*

The PurpleAir is described as a PM monitor and it reports mass and number concentrations of particles in 6 size bins. However, we found (a) unreliable results in the larger size bins and (b) its output from the smallest size channel (Dp > 0.3 μm) was highly correlated with the aerosol scattering coefficients measured by integrating nephelometer (e.g., TSI Model 3563 and Radiance Research Model M903).

Ongoing work in collaboration with the US National Park Service is evaluating how the Purple Air instrument works. Preliminary analysis suggests that it appears to behave like a reciprocal nephelometer across a wide range of aerosol loading.




*Relationship between PurpleAir (Dp>0.3*μm*) and TSI nephelometer scattering at MLO and BOS.*

## What's happening around the NFAN: Publications

**We keep an updated link of NFAN related publications at:**
ftp://aftp.cmdl.noaa.gov/aerosol/doc/newsletter/publications.html

SARGAN initiative papers

As noted in the previous newsletter, the 'SARGAN' (in-Situ AeRosol GAW observing Network) initiative, led by WMO/GAW put in significant effort to ensure that the IPCC authors would have access to information about the extent of the surface in-situ aerosol network measurements and about long-term trends in aerosol properties. This resulted in 4 papers:

1. **Laj et al. (2020)** provides an overview of the WMO/GAW aerosol observations. https://doi.org/10.5194/amt-13-4353-2020
2. **Collaud Coen et al. (2020)** analyzes trends in aerosol optical properties at WMO/GAW sites. https://www.atmos-chem-phys.net/20/8867/2020/
3. **Collaud Coen et al. (accepted)** provides an outline of methodology to calculate trends along with a repository of code (R, Matlab, Python) for applying the methodology. https://amt.copernicus.org/preprints/amt-2020-178/
4. **Rose et al. (submitted)** evaluates the temporal variability of aerosol number concentration and aerosol size distribution at WMO/GAW sites.

The SARGAN initiative is also connected to the AeroCom initiative and promoted the use of WMO/GAW in situ surface aerosol data in several model evaluation papers described below.

AeroCom papers

This year, three papers using NFAN data global climate model evaluation were published in ACP:

1. **Mortier et al. (2020)** evaluate aerosol trends from 2000-2014 in observations (e.g., NFAN in-situ, AERONET, IMPROVE, etc.) and models, and find relatively good agreement. However, they show that while negative AOD trends are found at the monitoring stations across multiple continents, there is a positive trend in global AOD. This suggests ground-based observations are best used in a regional context, while additional data may be needed to gain an accurate representation of the global picture. https://acp.copernicus.org/articles/20/13355/2020/
2. **Gliß et al. (2020)** assess model representation of both column-integrated and dry surface aerosol optical properties. Most aerosol properties were underestimated in the models, with considerable inter-model diversity. https://acp.copernicus.org/preprints/acp-2019-1214/
3. **Burgos et al. (2020)** analyze aerosol hygroscopicity within AeroCom models using measurements of the scattering enhancement factor f(RH) from 22 sites. Models showed a large diversity in simulated f(RH), with a tendency to overestimate the hygroscopicity, likely due in part to the choice of the reference RH and chemical composition of aerosol species in the models. https://acp.copernicus.org/articles/20/10231/2020/

NOAA scientists are currently performing a more detailed analysis (more sites, additional variables, higher temporal resolution) using NFAN in-situ aerosol optical property climatologies to evaluate AeroCom models. Keep your eyes peeled for these model evaluation results in 2021!

Some other NFAN paper highlights since the last newsletter:

- **Laing et al. (2020)** compared multiple absorption instruments and correction schemes at Mount Bachelor (MBO) in Oregon. They found that the equivalent black carbon from an AE33 aethelometer was much higher than for the TAP. Based on collocated SP2 measurements, they observed that biomass burning aerosols exhibited significant mass enhancements due to brown carbon. https://aaqr.org/articles/aaqr-19-06-opaa-0298

- **Leaitch et al. (2020)** combine airborne and ground-based observations in the springtime Arctic, near Alert (ALT), with simulations from a global model to show that observed light absorption by black carbon may be much larger than modelled. However, the uncertainty remains high. https://acp.copernicus.org/articles/20/10545/2020/

- **Park et al. (2020)** studied the climatology of aerosol optical properties at Mauna Loa (MLO). Radon measurements and air mass back trajectories were used to put the observations in the context of source region. https://aaqr.org/articles/aaqr-19-11-oa-0599

- **Rejano et al. (2020)** investigated the CCN activation properties of aerosol at an urban site Granada (UGR) and a mountain site Sierra Nevada Station (SNS) in Spain. They showed the impact of anthropogenic emissions on CCN concentrations and suggested that new particle formation was an important summertime source of CCN at the mountain site. https://www.sciencedirect.com/science/article/abs/pii/S0048969720366304

**Please** let us know of any recent publications or projects utilizing NFAN aerosol data so we can include them (Email to: betsy.andrews@noaa.gov). Having publication information helps demonstrate the value of the NFAN.

Useful links page: https://www.esrl.noaa.gov/gmd/aero/docs/index.html

*Our neighbors at the Table Mountain site. Happy Holidays everyone!*