

Surface PARTiculate mAtter Network (SPARTAN):

Collected Standard Operating Procedures (SOPs),
Quality Assurance & Quality Control methods
(QA/QC), and data management information

SPARTAN SOP-QAQC-1.1

**SOP-QAQC-1.1 Written and compiled by Graydon Snider and Crystal Weagle with
help of many others (*c.f.* Acknowledgements)**

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Illustrated SOP steps for SPARTAN

Illustrated below are the 12 sections described in this document: from pre-weighing filters and shipping filters, to uploading the data on our website spartan-network.org. Each yellow-circled number corresponds to a separate information package.

SPARTAN: Data Processing Sequence

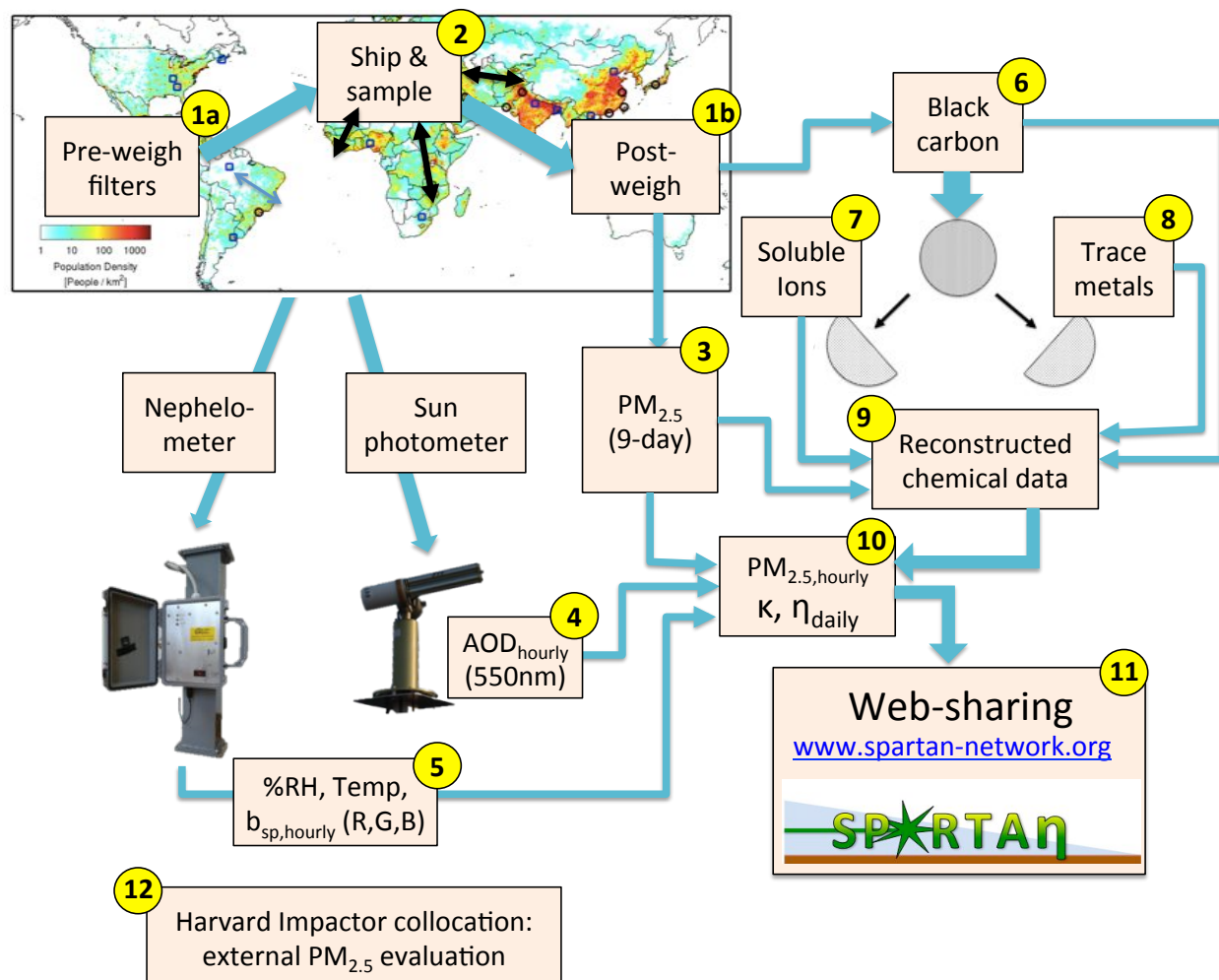


Figure 1: SOP flowchart for SPARTAN's methodology. Section 12 is an ongoing evaluation with a Harvard Impactor and runs semi-independent of network data operations.

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Affiliated Websites

QA/QC summary (relevant instrument in brackets), including

- Pre- and post- weighing filters (ultramicro balance)
- Analyzing filter cartridge flow data (rotameter + mass flowmeter)
- Equivalent black carbon (Smoke stain reflectometry)
- Water-soluble (ion chromatography)
- Acid digestion of trace metals (ICP-MS)
- Total light scatter (Nephelometry)
- Aerosol optical depth (Sun photometer)
- Calculating daily $PM_{2.5}$ /AOD (data merging) ratios and data sharing (website)
- SPARTAN/AirPhoton $PM_{2.5}$ assessment (Harvard Impactor)

Methodology and Standard operating procedures (with QA/QC noted where appropriate)

- **Section 1(a,b):** Pre- and post- weighing Teflon filters, calculating uncertainties, data-storage procedures
- **Section 2a:** *Manual for site operators* site selection, installation, and maintenance
- **Section 2b:** Cartridge loading/disassembly, costs, cartridge opening procedure
- **Section 3(a,b):** Cartridge and flow data processing, interpreting flow data, assessing quality of filter sampling, size cut test of nuclepore filters
- **Section 4:** AERONET AOD data acquisition
- **Section 5(a,b,c):** Nephelometer data acquisition & processing, cleaning, and calibration
- **Section 6:** (Equivalent) Black Carbon theory and practical determination by reflectometry,
- **Section 7:** Filter cutting, IC eluent preparation, calibration curves, and
- **Section 8:** Filter cutting, trace metal acid digestion method,
- **Section 9:** Assumptions made in reconstruction of total mass (ammonium sulfate and nitrate, sea salt, trace oxidized metals, soil, particle-bound water, and organic/residue)
- **Section 10:** Merging AOD, light scatter, $PM_{2.5}$ data into single file
- **Section 11:** Uploading/managing data on SPARTAN website
- **Section 12a:** *Manual for site operators* Harvard Impactor collocation instructions, $PM_{2.5}$ collocation results
- **Section 12b:** OC/EC quartz filter analysis

Appendices

A: File locations

B: Shipment information, SPARTAN site addresses, and site images

C: SPARTAN paper reprint

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Section 1: Matt Seaboyer and co-op student Kacie Conrad assembled the original ultramicrobalance documentation. We thank HERC lab (PIs Judy Guernsey and Jong Sung Kim) for allowing us (Graydon, Crystal, and co-op students) daily access to cleanroom facilities.

Section 2: Crystal Weagle was responsible for composing the on-site documentation. A perpetual thank you to all on-site personnel who have dutifully maintained our instruments for the duration of this ongoing project. Co-op student Matthew Zwicker created the 3D-printed filter holder used for organizing 16-packs of petri dishes.

Section 3: Crystal Weagle was responsible for creating, translating raw flow logs, and maintaining per-cartridge electronic flow data log sheets. We thank Mark Gibson for allocating space and facilities in his AFRG lab.

Section 4: AERONET is responsible for maintaining all sun-photometers, uploading data, and assuring quality control procedures (level 1.5 and 2.0). Graydon Snider created program that translates raw AOD into useable format for SPARTAN.

Section 5: AirPhoton (in particular Vanderlei Martins) is responsible for creating calibration documentation. Graydon Snider created the program that translates nephelometer data files into hourly SPARTAN-friendly format.

Section 6: Thank you to Michael Brauer for many of the ideas in this section. We thank our co-op students Matt, Chris, Dan, Kelina, and Amanda for black carbon SSR measurements, in particular Matthew Zwicker for creating original BC documentation, and creating 3D-printed SSR mask. We thank Mark Gibson for loaning the Magee Scientific transmissometer for BC testing purposes.

Section 7: We thank Mark Gibson for providing IC instrumentation, and methodology of extraction techniques. Thank you to Codey Barnett for maintaining the IC instruments. Crystal Weagle, Graydon Snider and co-op students Amanda Ring & Kelina Murdymootoo have been responsible for daily operation of IC instruments. Graydon and Crystal have been responsible for assembling, performing QA/QC procedures, and compiling all water-soluble inorganic ions concentrations.

Section 8: Graydon was responsible for ICP method development; guidance based on EPA's trace metal filter extraction methods. We thank Elliott Wright and Heather Daurie at the CWRS facility for quantifying 25 metals per sample via ICP-MS and for help with method development. Graydon and co-op students (Amanda & Kelina) have been responsible for acid digestions. Graydon and Crystal have been compiling all trace metal concentrations and performing QA/QC procedures.

Section 9: Graydon Snider was responsible for method development of reconstructed mass and calculated water retention, based in part on κ -Kohler theory. We thank Mark Gibson and Environment Canada for providing initial methodology and guidance.

Section 10: Crystal Weagle was responsible for creating upload-data sheets, combining all trace metals, water-soluble inorganic ions, equivalent black carbon, and total PM_{2.5} mass. Graydon was responsible for programming assemblage of AOD, ground light-scatter, and PM_{2.5} speciation and mass, and uploading to Spartan-network.org thereafter.

Section 11: Jason Hopper was the original architect who designed and made practical the original Spartan-network.org website. Graydon Snider and Crystal Weagle have since been maintaining website since summer of 2014. We thank all on-site SPARTAN operators for sharing images of their SPARTAN sampling stations.

Section 12: Crystal Weagle was responsible for composing the Harvard Impactor documentation. Co-op students Matt, Chris, Dan, Kelina, and Amanda were responsible for black carbon SSR measurements. We thank HERC (in particular Jacquie Yakobi and Matt Seaboyer for analyzing our OC/EC quartz filter samples and creating OC/EC SOP). Co-op student Matthew Zwicker created the 3D-printed filter cassettes used for holding additional HI filters. Thank you to Mark Gibson and Mike Brauer for loaning Harvard Impactors and Pelican cases.

Pilot Project, Though not described in detail in this SOP documentation, it spanned January - May 2013, and was an experiment in shipping abroad, collocation with similar instruments, preliminary testing of filters processing techniques and of SOPs work.

Beijing: Qiang Zhang for leading the research team at Tsinghua University (Jinlu Dong, Kebin He, Yuxuan Zhang) for past and present help running the instruments, providing collocated TEOM and 24-filter samples data, and feedback of AirPhoton instrument functionality.

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Affiliated Websites

Mark Gibson // AFRG (IC work): <http://afrg.peas.dal.ca/>

Michael Brauer <http://spph.ubc.ca/person/michael-brauer/>

Lorrain Remer & Vanderlei Martins// Air Photon (Instruments): <http://airphoton.com/>

Graham Gagnon, Elliot Wright & Heather Daurie // CWRs (ICP-MS work):
<http://centreforwaterresourcesstudies.dal.ca/>

Judy Guernsey & Jong Kim // HERC (EC/OC and absolute masses): <http://www.dalherc.net/>
(coming soon)
<http://www.innovation.ca/en/navigator/HealthandEnvironmentsResearchCentreHERC>

Randall Martin's research group: <http://fizz.phys.dal.ca/~atmos/martin/>

SPARTAN project webpage: <http://spartan-network.org/>