Detection of Anthropogenic Elements from Long-Transport Aerosols at Greenland Summit Station

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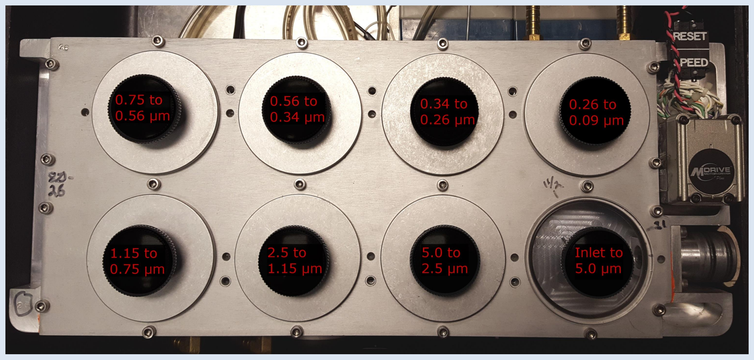
Understanding Particulate Matter

Particulate matter (PM) contributes most of the uncertainty in global climate models. Unlike gases, PM varies in size, morphology, composition (layering), and optical properties. Conventional methods are impractical to characterize long-term monitoring as a function of particle size. The application of rotating-disk impactors with nuclear analytical methods is a cost-effective alternative that has been employed at Greenland Summit Station since 2003. The DRUM-style impactor collects particles in 8 size bins (shown below) with variable time bin settings. At Greenland, the time bins have varied from 6 to 24 hours. Since 2009, the DRUM has been operating at 12 hour time bins.



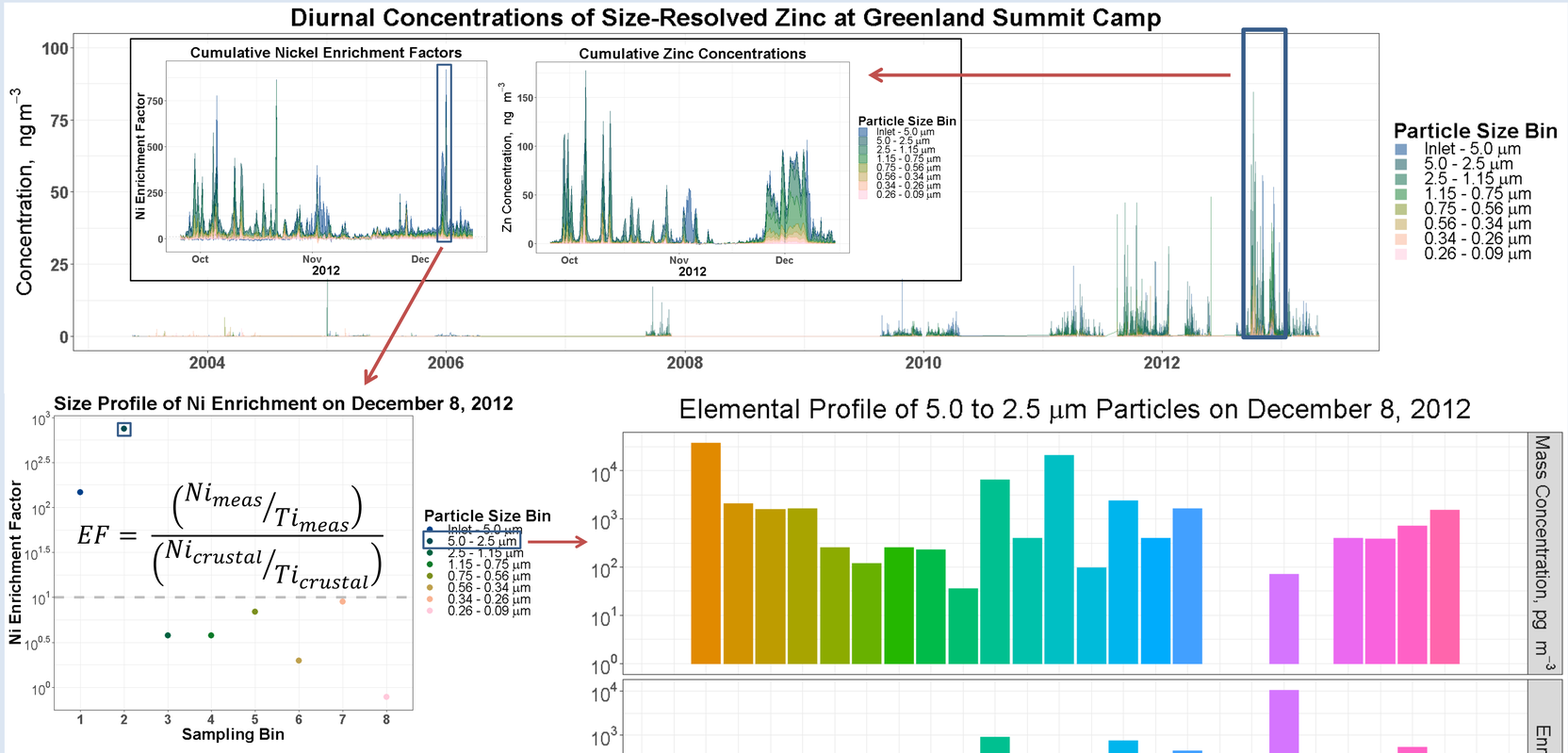
Size- and Time-Resolved Sampling Coupled with Nuclear Analysis

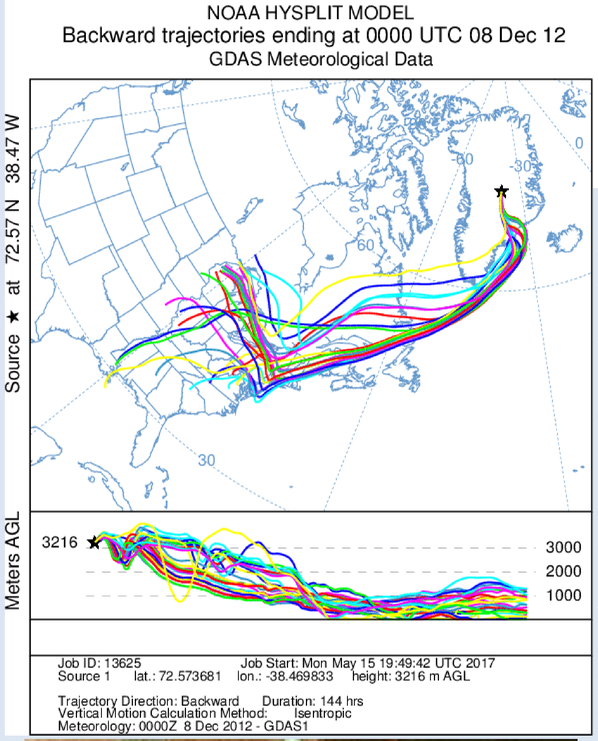
Rotating Lundgren-style impactor, 8 size cuts, 10 liters/minute with user-specified time bins. Due to very small sample loading, conventional methods for analysis cannot be used. The following methods have been developed specifically for this sampling technique.

Mass: Soft-Beta ray Attenuated Mass (Ni-63 source, λ = 101 years)
Optical: Broadband Transmission/Reflectance Spectroscopy
Elements: Synchrotron-induced XRF,
Advanced Light Source, LBNL – Na to Mo plus Pb
Stanford Synchrotron Radiation Lightsource, SLAC – K to U

Blue – data in archive; Green – data in process

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2003					Start	Funds	NSF					
2004						Foil	Fail	→	→	→		
2005												
2006												
2007	Cold	Fail	→	→	→	→						Try
2008	6 hr	data	Cptr	Fail	→	→	→	→	→	→	→	→
2009	→	→	→	→	→	→	→					
2010						DRUM	Rot.	Fail	→	→	→	→
2011												
2012												
2013					Funds	Fail	→	→	→	→	→	→
2014	→	→	→	→	Private	Funds	avg	only				
2015							Private	funds	full			
2016							Funds	NSF				
2017						Funded	NSF	→	→	→	→	→
Funded 2021	→	→	→	→	→	→	→	→	→	→	→	→





Identifying Sources

Metals are excellent tracers for long-transport PM since they are not photochemically "aged" like organic compounds. Individual elements may be used as unique tracers for emission sources (i.e. platinum from catalytic converter emissions) while elemental ratios and profiles may be used effectively in source apportionment modeling (e.g. chemical mass balance, positive matrix factorization). In the example shown above, the coarse size bin detected elevated concentrations of a number of anthropogenic metals typically observed from the Ohio river valley and the northeastern US.

Cr – primarily emitted from decorative plating processes as well as an alloy in stainless steel
Co – used as an alloy in steel (stainless and stellite), for coloring glass bottles and insulators, and as a foam stabilizer in beer manufacturing
Ni – common plating material and alloy element for stainless steel
Cu – myriad electrical applications as well as cast brass/bronze plumbing production
Zn – primarily used to galvanize steel and as an alloy ingredient in brass
Se – important tracer for coal combustion

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	Dr. Jason Snyder, data reduction and archiving
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And at Summit:	Prof. John Burkhart, currently University of Oslo, who set up the original site and the techs who keep things working in brutal conditions.