Insights from colder and darker places – The Alaskan Layered Pollution and Chemical Analysis (ALPACA) project

Bill Simpson, University of Alaska Fairbanks

Organizers: Kerri Pratt, Jingqiu Mao, Steve Arnold, Kathy Arnold, Julia Schmale, Bill Simpson

ALPACA workshop 14-16 May 2018

https://alpaca.community.uaf.edu

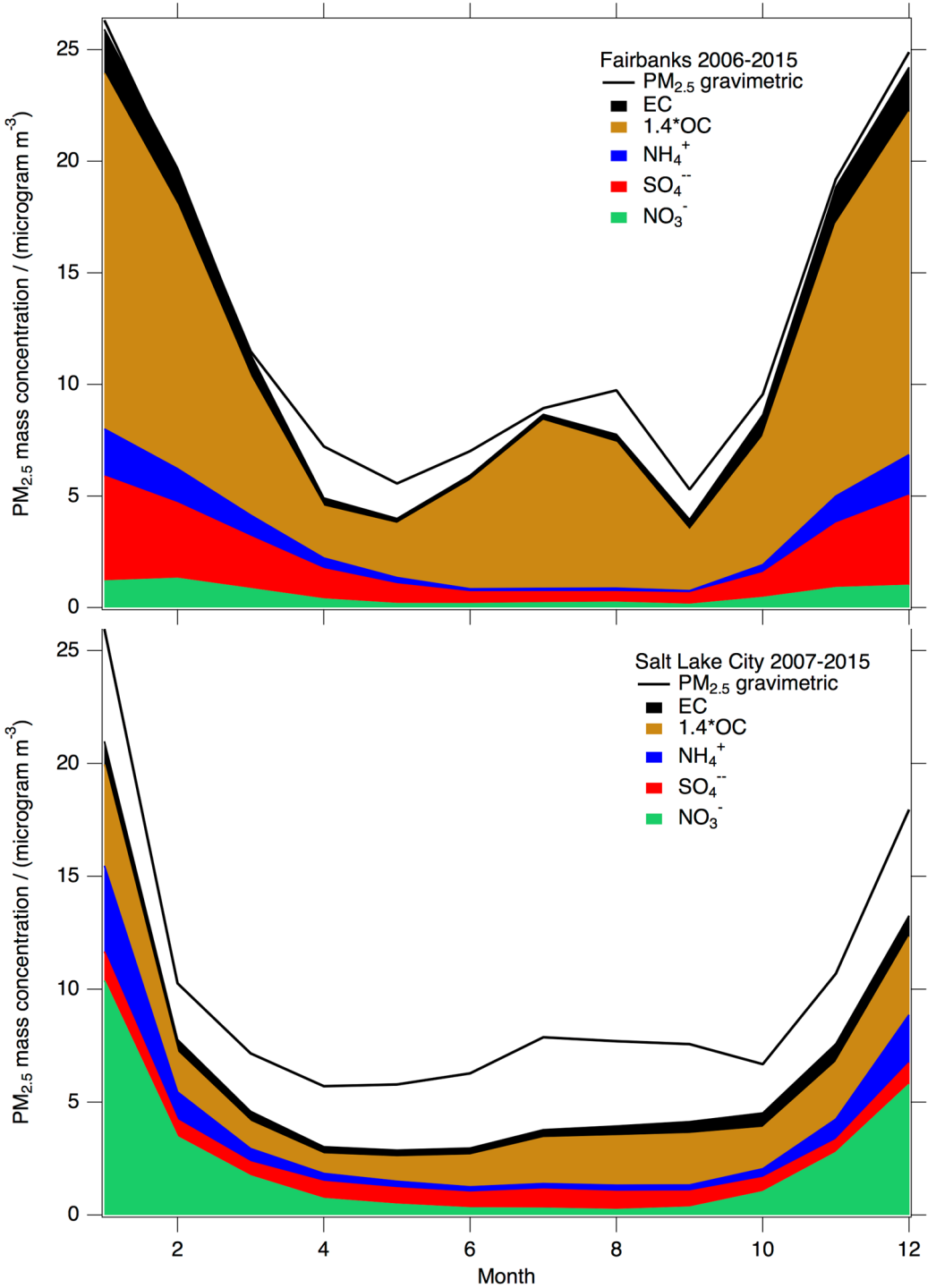
44 participants from Universities, NOAA, EPA, state/ local regulators, community, health researchers

Sponsors

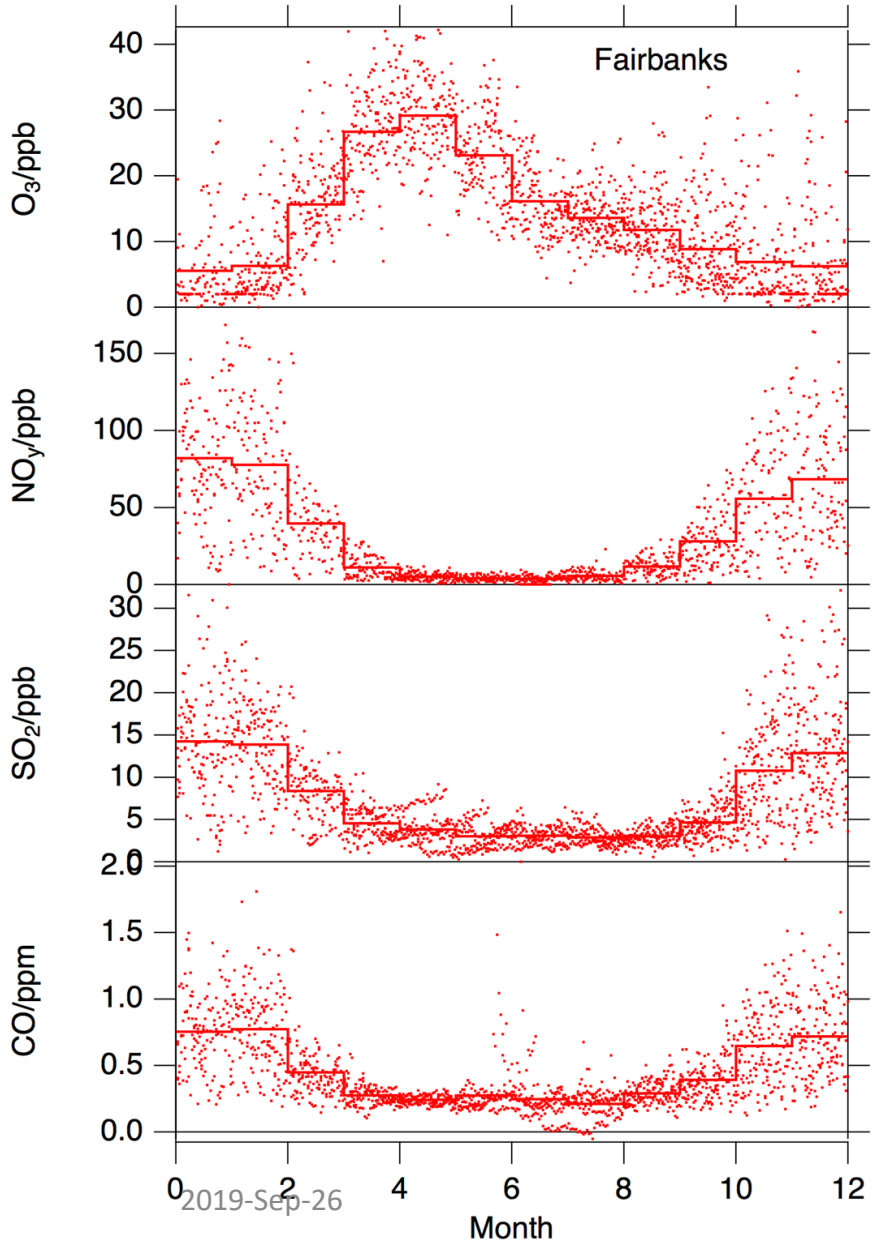
Fairbanks vs. SLC $PM_{2.5}$ composition

PM peaks in winter, similar magnitude, longer winter in Fairbanks.

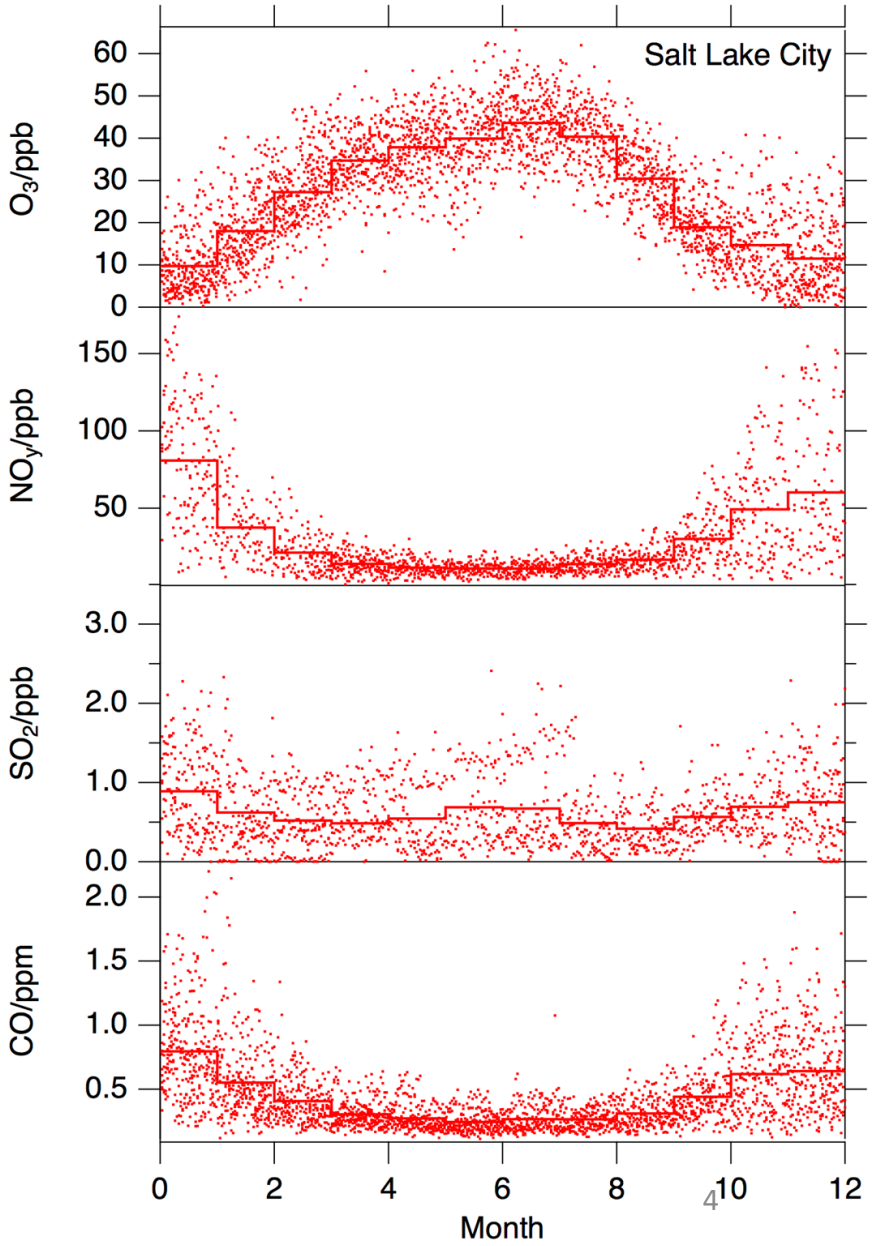
- Fairbanks has OC + sulfate, small nitrate. Summer peak from wildfire
- SLC has ammonium nitrate, lower sulfate and OC



Gas composition



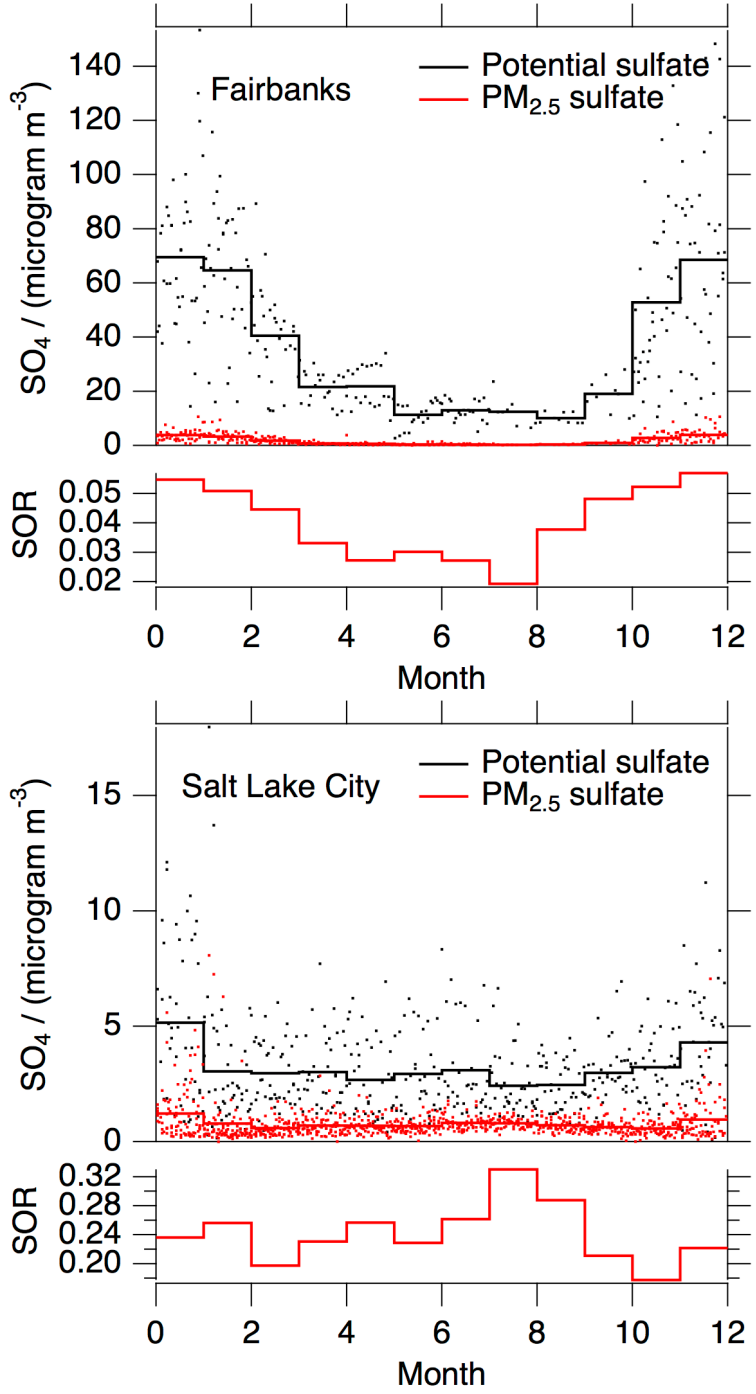
Similar CO and NO_y, but Fairbanks has ~20x more SO_2 and SLC has 2x more O_3. O_3 is often below detection limits during Fairbanks wintertime.



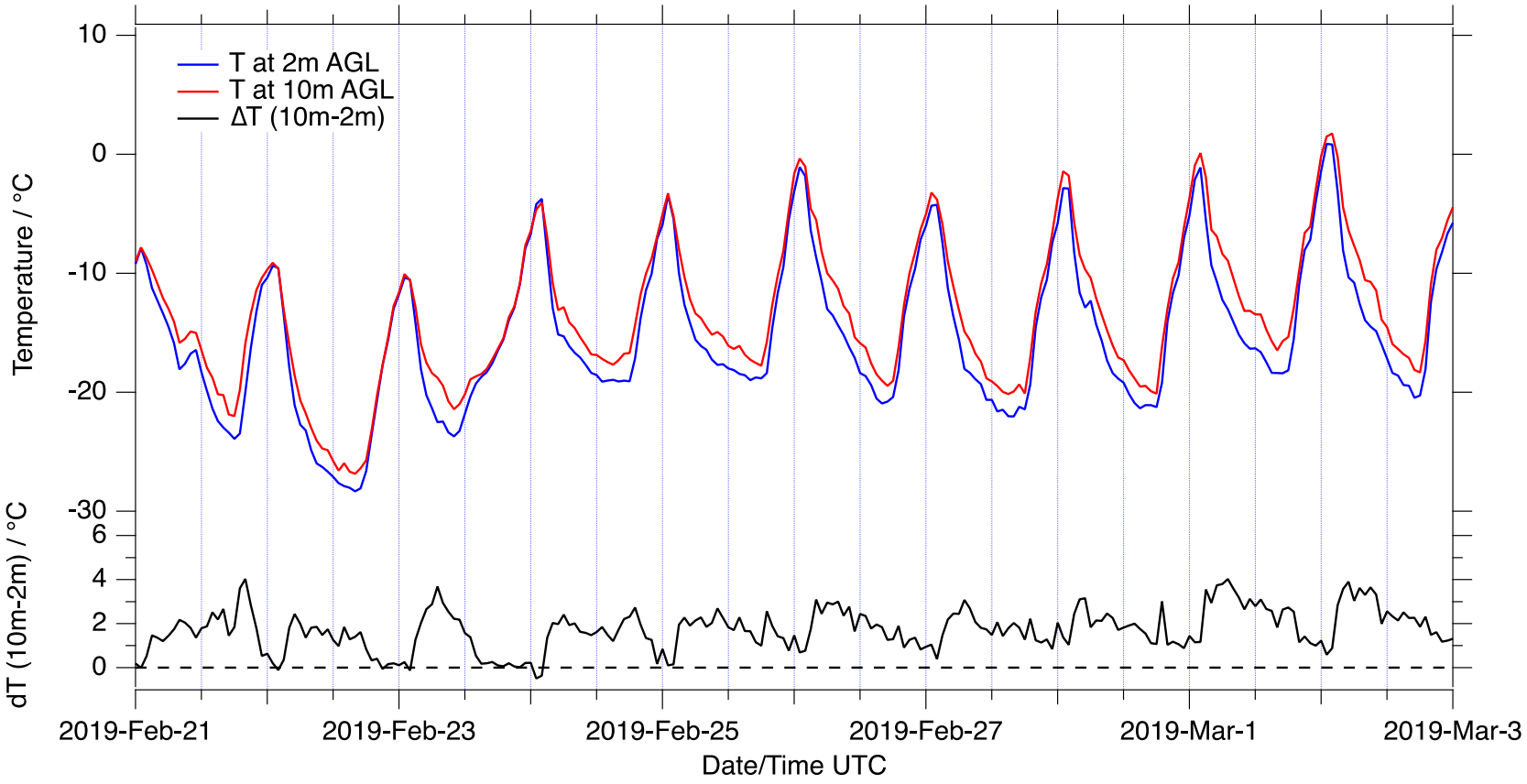
Sulfur oxidation ratio

Potential sulfate = (sulfate + 100% conversion of SO_2 to sulfate)
SOR = sulfate / potential sulfate

- SLC SOR is higher, indicating SLC is more oxidative
- Fairbanks SOR peaks in winter, potentially indicating a wintertime oxidation mechanism.



Very strong temperature inversions



- Tower data courtesy of Telyana Wong and Martin Stuefer, UAF
- Over 8 meters vertical. The lofted sensor is typically 2-4 °C warmer at night
- Inversions do not break every day, even in February

Differences between Fairbanks and SLC

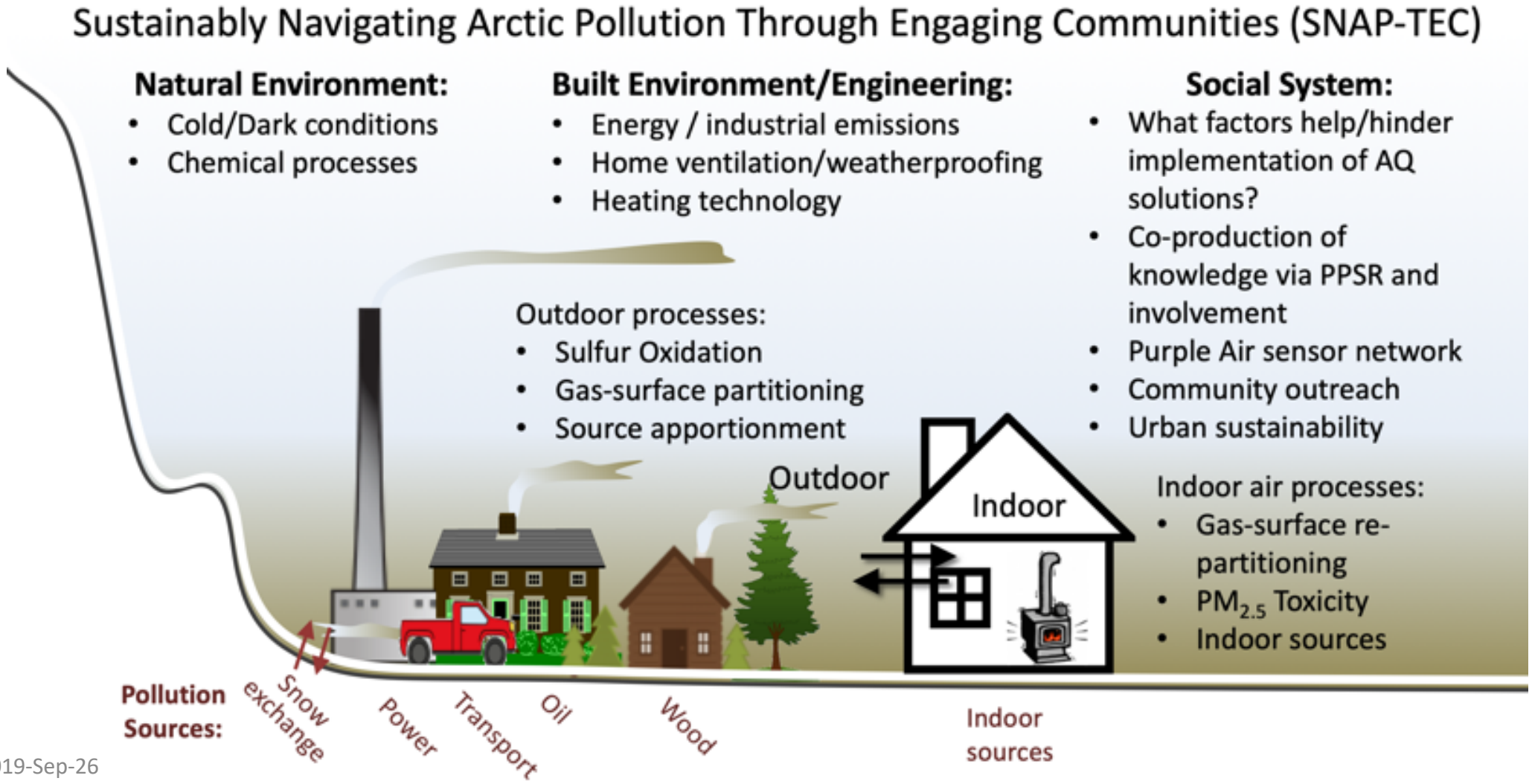
- In the cold and dark, there is lower conversion of sulfur to sulfate and less conversion of nitrogen to nitrate – less photochemistry
- However, the observed SOR is larger than expected primary emissions, so there may be dark chemistry
- With an assumed OM/OC = 1.4, the mass balance closes in the cold/dark while it appears a higher OM/OC ratio is needed in Salt Lake City – maybe OM is less oxidized in cold/dark
- Ammonia is an unknown in Fairbanks, but there is less Ag in winter.
- Temperature inversions are stronger in cold/dark, likely trapping pollution in shallower layers near the ground

Sustainably Navigating Arctic Pollution Through Engaging Communities (SNAP-TEC)

Bill Simpson, Jingqiu Mao, Nathan Kettle, Krista Heeringa, Laura Conner (UAF), Kerri Pratt (U. Mich), Peter DeCarlo (Drexel U.), Brent Williams (Wash. U. St. Louis), Rodney Weber (Georgia Tech), and Jochen Stutz (UCLA)

A National Science Foundation "Navigating the New Arctic" project that supports part of ALPACA goals and will carry out intensive field studies in Jan-Feb 2021.

(SNAP-TEC) seeks improved understanding of wintertime Arctic outdoor and indoor air pollution, built in collaboration with community members, to assist sustainable development of the Arctic and improve air quality for Arctic people.



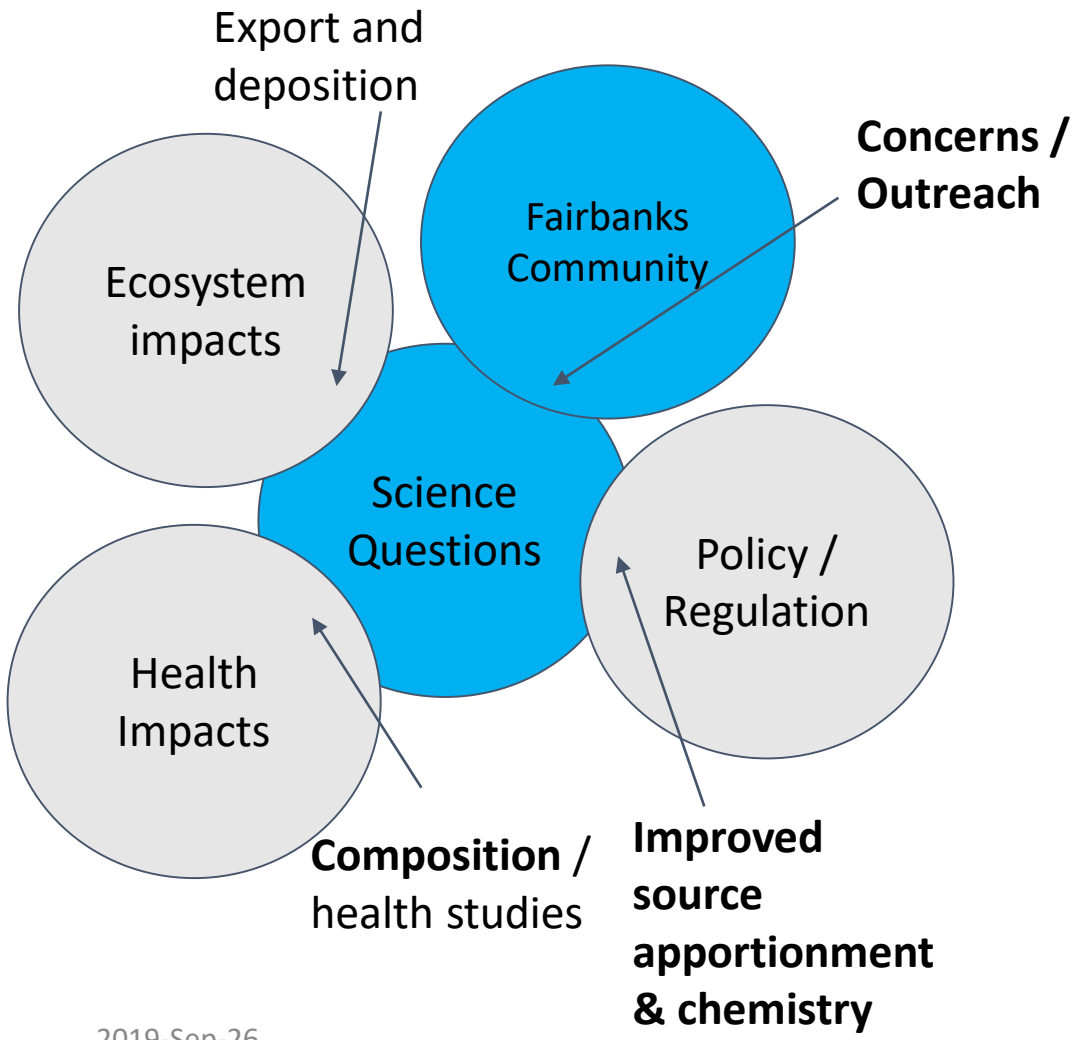
SNAP-TEC (Jan/Feb 2021) research foci:

- Community outreach and research into community perceptions of the problem
- Focused on a typical house in downtown neighborhood
- Indoor/outdoor air composition differences
- Indoor sources from heating (wood, pellet, oil)
- Semi-volatile organic partitioning
- Indoor air oxidative potential
- Sulfur oxidation mechanisms

Measurements (Jan/Feb 2021)

Measurement Parameter	Instrument(s)	Instrument PI
Real-time non-refractory PM composition	HR-AMS	DeCarlo
Semi-volatile organic aerosol and gases	TAG	Williams
Real-time single-particle composition	ATOFMS	Pratt
Gases: O_3, SO_2, CO, NO_x, CO_2, CH_4, NH_3	Standard gas monitors	Simpson, DeCarlo
Particle inorganic ion composition	MOUDI & $PM_{2.5}$ filter samples	Weber, Mao
Particle toxicity and oxidative potential	DTT assay, specific species	Weber, Williams, Pratt
Reactive gas vertical profiles: SO_2, HCHO, HONO, O_3	Long-path DOAS vertical array	Stutz, Simpson
Social factors that influence acceptability of controls	Community advisory group, broad survey	Kettle
Public Participation in Scientific Research	Community group, PurpleAir sensors	Conner, Mao
Community Engagement	Meetings, dissemination, advice to FNSB	Heeringa

Aspects in ALPACA that are not in SNAP-TEC



- Blue background a bold aspects are in SNAP-TEC
- We lack:
  - Nitrogen chemistry
  - Health studies
  - Modeling / 3-D understanding
  - Ecosystem Impacts
  - Meteorology

We welcome collaborative projects!
Please contact me or any organizer.