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Wintertime Arctic Air Pollution over Alaska

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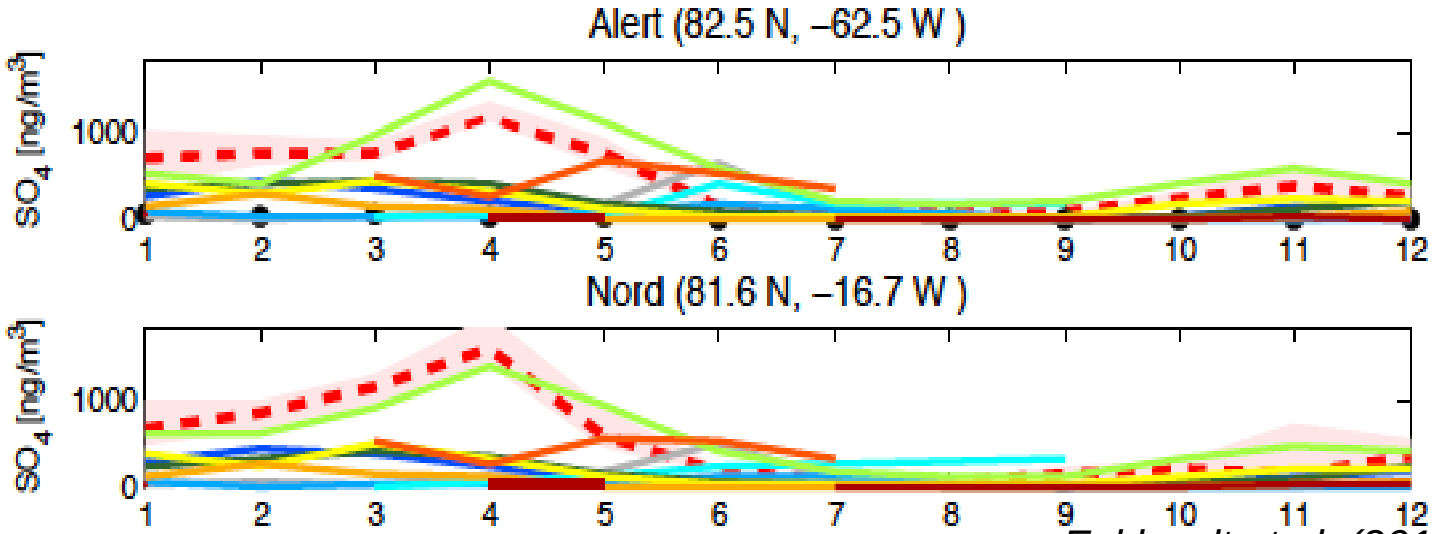
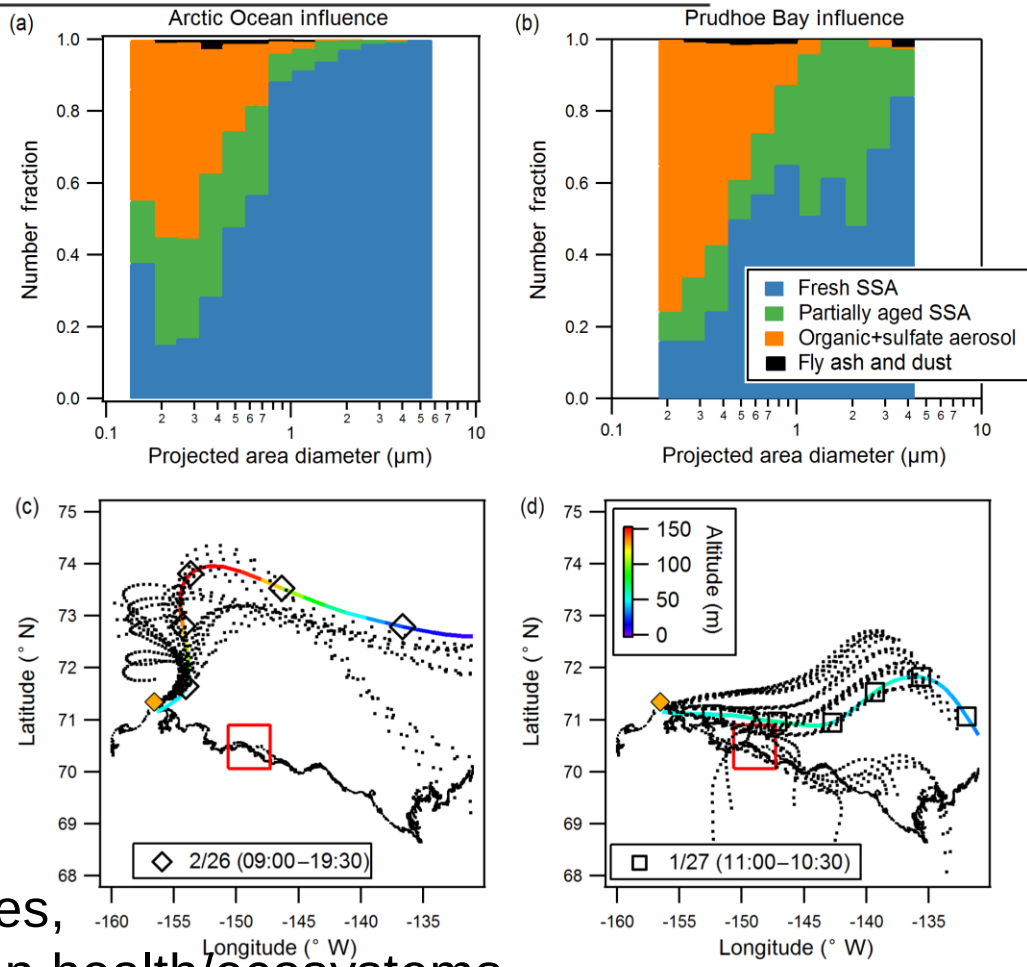
Motivation: Winter pollution over Alaska

Kirpes et al. (2018)



Eckhardt et al. (2015)



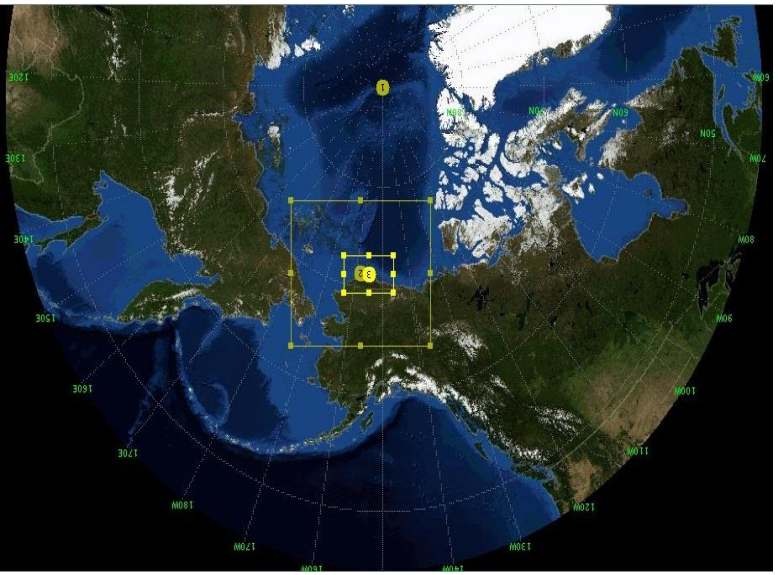
Arctic Haze: long-range transport of short-lived climate forcers leads to Arctic warming (BC) and cooling (SO4, OA, NO3)

Local Alaskan sources: coal-fired power stations, diesel vehicles, wood burning, oil/gas extraction (e.g. Prudhoe Bay) → impact on health/ecosystems

Science Issues: models underestimate winter-spring Arctic aerosols → chemical formation mechanisms unclear (organics, sulphate) and role of dynamics (e.g. strong temperature inversions)

Field campaign in Utqiagvik 2014 → improve modelled aerosol composition (Arctic Haze) - role of sea-salt aerosols (sources of organics) at coastal Arctic sites (*Kirpes et al., 2018, 2019*)

Model setup: WRF/ WRF Chem – Meteorology at 4km



WRF/WRF-Chem v.3.8.1

- 100x100km hemispheric domain (AMAP WRF-Chem simulation)
- 20x20km over Alaska
- 4x4km over Utqiagvik/Prudhoe Bay

Physics Parameterizations

- FNL (meteorology)
- Morrison → microphysics
- RRTMG → LW, SW Radiation
- NOAH MP → Land Surface Model
- MYNN → Boundary & surface layer

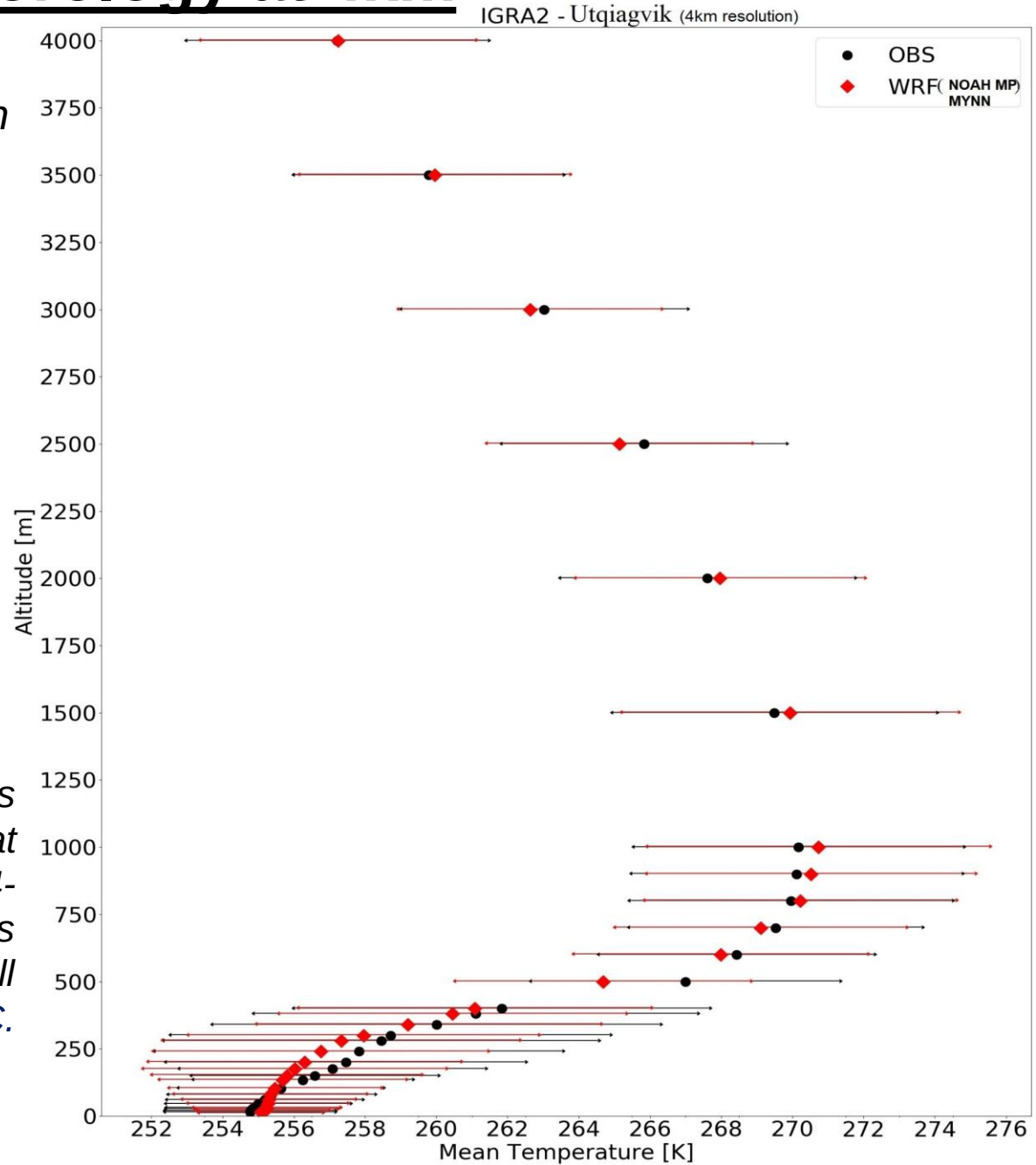
AMAP simulation (*part of the AMAP Expert Group on SLCFs*)

- MOZART (chemical)
- ECLPISE v6 50x50
- MEGAN Emissions
- FINN Fire emissions
- SAPRC-99 (gas phase)
- MOSAIC (8-bin aerosol scheme)

ECLISPSEv6: courtesy IIASA (Zig Klimont)/AMAP

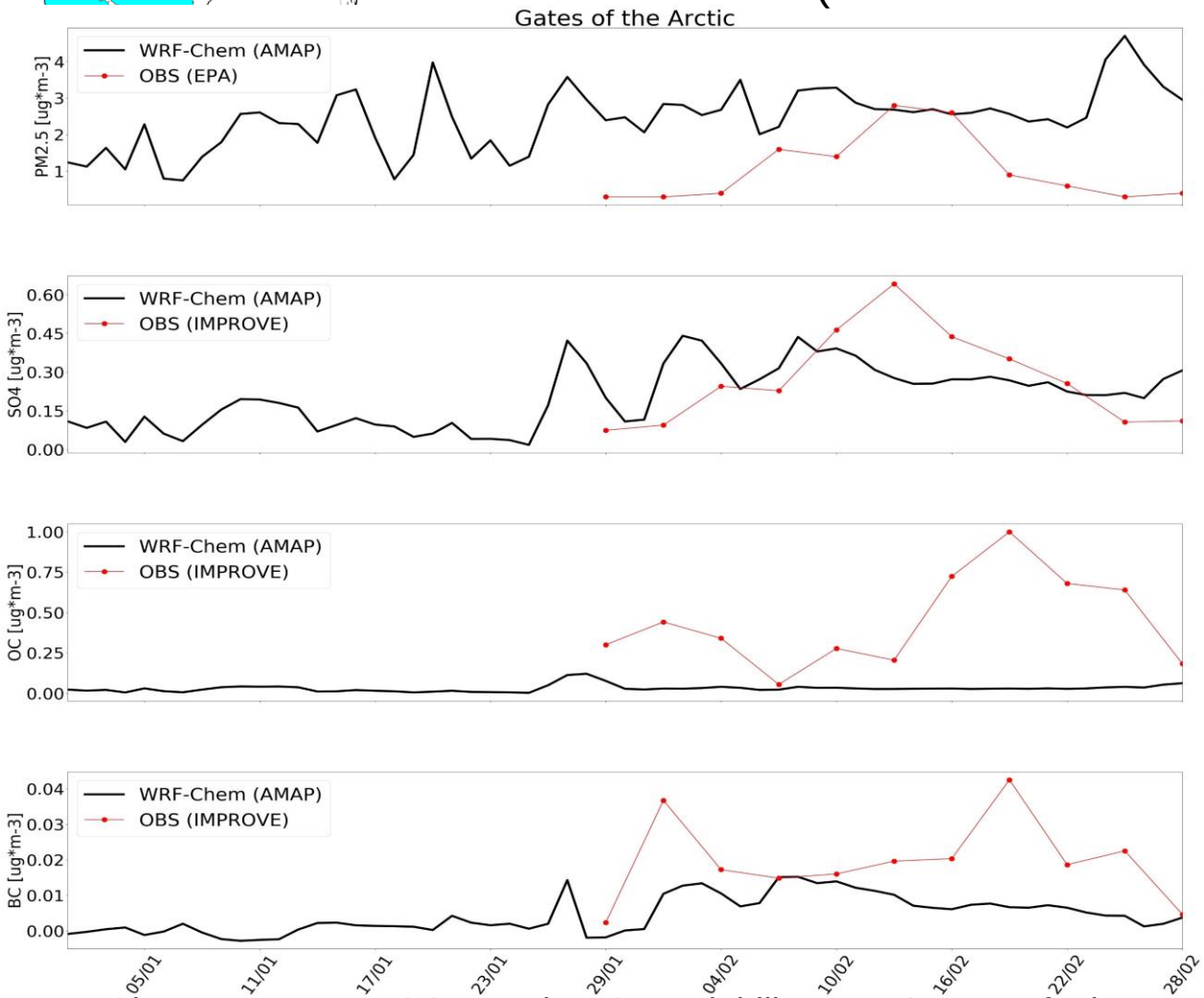
MOSAIC :Zaveri et al, 2008

The Figure on the right *shows averaged temperature profile at 4km over Utqiagvik between 24-28/02/2014. WRF captures observed profile with small differences up to 1 deg. C.*

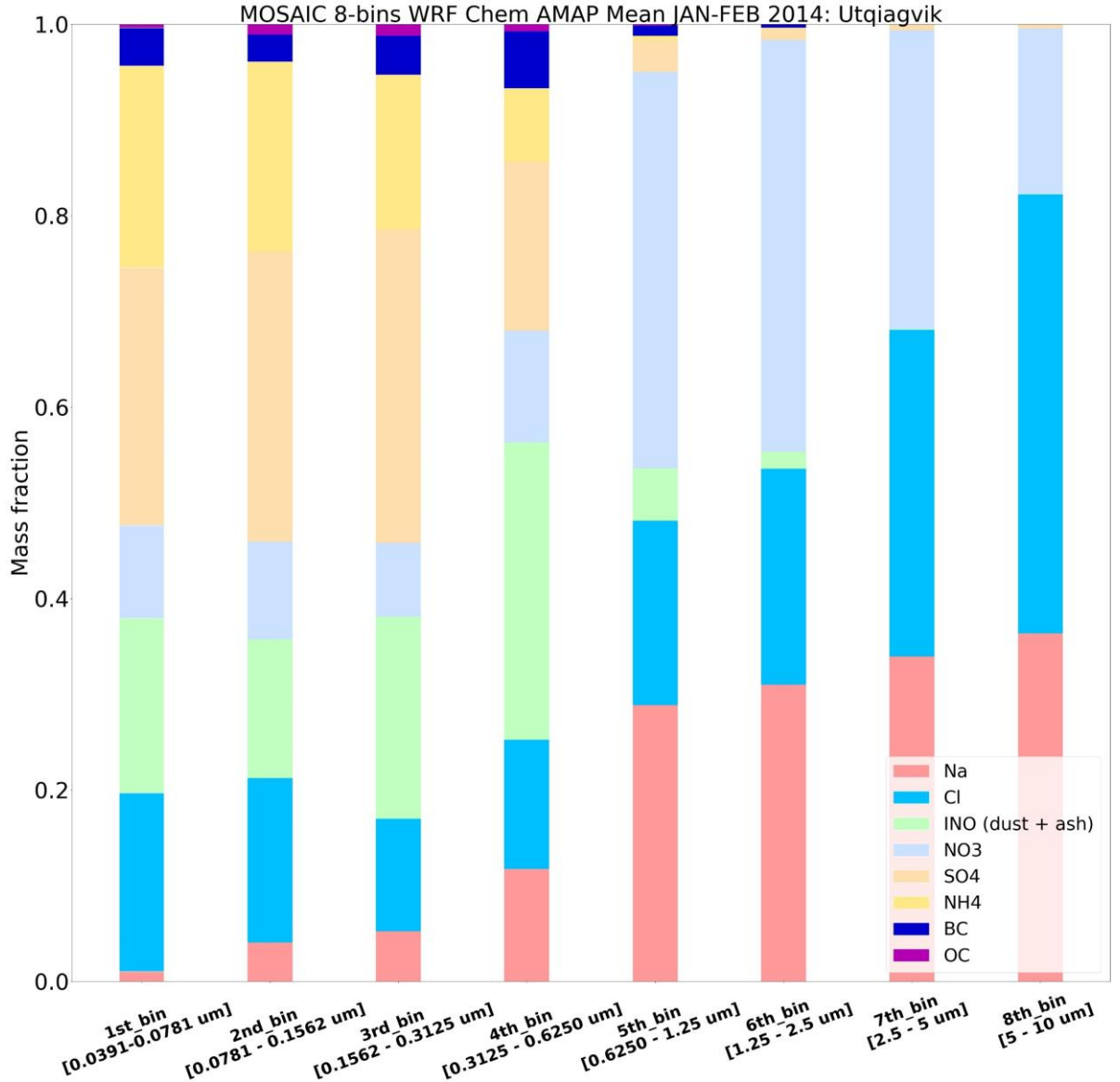


AMAP WRF-Chem results: Northern Alaska (January – February 2014)

The Figure on the left shows the location of Utqiagvik, Prudhoe Bay and Gates of the Arctic (IMPROVE-EPA data)



WRF-Chem captures SO_4 and BC variability at Gates of the Arctic (background site), but overestimates NO_3 (such as in Denali/not shown here)



The Figure above shows averaged mass fraction of all species between Jan.-Feb. 2014 at Utgiagvik using MOSAIC scheme (AMAP simulation/ ***preliminary results***)

Conclusions & Future Work:

Model simulations of meteorology and aerosol composition over northern Alaska during winter 2014:

- WRF at 4km resolution captures observed temperature profiles (and other meteorological parameters, such as wind speed – not shown here) at Utqiagvik
- WRF-Chem captures SO4 and BC variability at Gates of the Arctic (background site) during January-February 2014, but overestimates nitrate (*also high at Utqiagvik in the AMAP results*)

Next steps:

- Investigate nitrate overestimation at the model (aerosol acidity?, heterogeneous reactions?)
- Run WRF-Chem at 20km and 4km resolution
- Detailed evaluation against aerosol mixing state data (Kirpes et al. 2018) and size distributions, aerosol composition (NOAA) → investigate reasons for model discrepancies
- Examine influence of Prudhoe Bay oil field emissions versus Arctic Haze

Acknowledgements:

- ***IGRA2:*** *Durre, Imke; Xungang, Yin; Vose, Russell S.; Applequist, Scott; Arnfield, Jeff. (2016) Integrated Global Radiosonde Archive (IGRA), Version 2. NOAA National Centers for Environmental Information. DOI:10.7289/V5X63K0Q [2020]*

- ***IMPROVE*** *is a collaborative association of state, tribal, and federal agencies, and international partners. US Environmental Protection Agency is the primary funding source, with contracting and research support from the National Park Service. The Air Quality Group at the University of California, Davis is the central analytical laboratory, with ion analysis provided by Research Triangle Institute, and carbon analysis provided by Desert Research Institute.*

- ***EPA:*** https://aqs.epa.gov/aqsweb/airdata/download_files.html