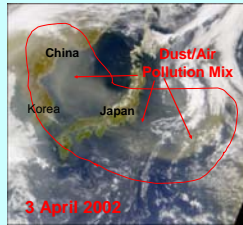


INTRODUCTION (1.)

Springtime frontal systems flowing across dry regions of China and Mongolia regularly sweep up dust and air pollution moving this dust/air pollution mix over Korea and Japan eastward into the Pacific Ocean. These dust/air pollution events can be severe enough to degrade visibility and air quality across large areas of Asia producing health and economic impacts (e.g., cancellation of commercial airline flights). This dust/air pollution is regularly transported east, over the Pacific Ocean into North America and has been measured as in California, Colorado and beyond. A number of these events are also measured at the Barrow, Alaska, Atmospheric Baseline Observatory located on the coast of the Arctic Ocean.

SCIENTIFIC QUESTIONS

- What do Barrow, Alaska, Observatory measurements tell us about these Asian dust/pollution events?
- How do Asian dust/air pollution events differ from other air pollution incursions into the Arctic such as Arctic haze that flows from Eurasia to Alaska in winter?



Satellite image of dust/air pollution event passing over Japan and Korea and being swept east over the Pacific Ocean. (NASA/SeaWiifs image).

The NOAA Barrow Observatory

- NOAA has been making up to 150 different gas, aerosol and solar radiation measurement at the Barrow (BRW) observatory since 1973.
- Barrow represents a remote arctic environment far from any appreciable sources of anthropogenic emissions.
- Remoteness, and long term record of measurements at Barrow, make it relatively easy to identify incursions of polluted air to the site.



View of the NOAA Barrow, Alaska, Atmospheric Baseline Observatory, Longitude: 71.3 N; Latitude: 156.61 W

Barrow Instrumentation for Dust/Air Pollution Measurements (2.)



Sunphotometer Measurements

- **Spectral atmospheric transmission:** sunphotometer measures optical depth at wavelengths 412, 500, 675 and 862 nm.
- **Ångström exponent:** can be determined from spectral measurements
- **Direct aerosol radiative forcing:** can be estimated in conjunction with measurements of the net surface radiation budget

In-Situ Aerosol Measurements

- **Diameter < 1 mm and <10 mm:** impactor alternates between excluding supermicron and super-10-micron particles from the aerosol system.
- **Relative humidity held to < 40%:** in-line heater gently warms the air stream to dry the aerosol.
- **Total and backward light scattering coefficients:** integrating nephelometer measures aerosol light scattering coefficients over 3 wavelengths (450, 550, and 700 nm) and 2 ranges of angular integration (7-170 and 90-170 degrees).
- **Light absorption:** filter-based light absorption photometer measures aerosol light absorption at 565 nm.
- **Ångström exponent and single-scattering albedo:** light scattering and absorption measurements permit the derivation of key optical parameters needed for aerosol forcing calculations.

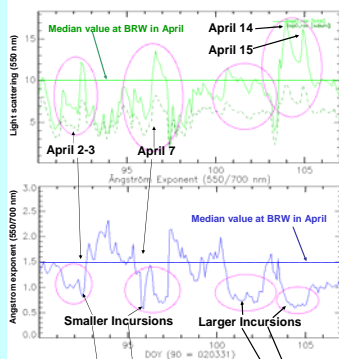


Aerosol optical depth (τ)	amount of aerosol throughout vertical column	Background: $0.05 < \tau < 0.15$ (for 500 nm) Arctic haze: $0.15 < \tau < 0.25$ Dust: $0.25 < \tau < 0.30$
Ångström exponent (α)	wavelength dependence of scattering (indicative of particle size)	Background: $\alpha \sim 1.8$ (for 550/700 nm pair) Arctic haze: $\alpha > 1.5$ Dust: $\alpha < 1.2$
Single scattering albedo (ω_s)	the ratio of scattering to extinction $\omega_s = \text{Scat.}/(\text{Scat.} + \text{Abs.})$	Background: $\omega_s > 0.95$ (for 550 nm) Arctic haze: $\omega_s < 0.90$ Dust: $\omega_s \sim ??$

Asian Dust/Air Pollution Event, Barrow, Alaska, April 14-15, 2002

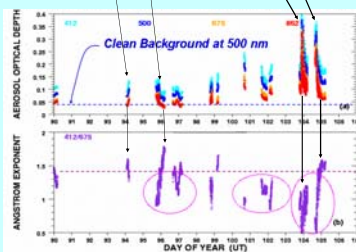
In-Situ Aerosol Results

- Surface measurements show increased light scattering coefficients during dust/pollution events.
- Up to ~50% of scattering increase during events is due to super-micron particles (typically only ~20% of scattering is due to super-micron aerosol).
- Decreases in Ångström exponent correlates with increased scattering coefficient.
- Low Ångström exponents are indicative of the presence of large particles.
- No consistent pattern in single scattering albedo (not shown) suggests that albedo is not a good dust/air pollution indicator.



Sunphotometer Results

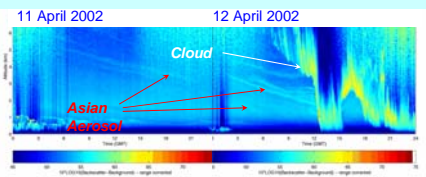
- During dust and haze events, aerosol optical depth is higher than clean background conditions at Barrow.
- Column measurements of Ångström exponent show same events as observed by surface in situ measurements. (The sunphotometer is limited to making measurements in daylight only during clear periods so there are gaps in the data due to overcast skies and nighttime)



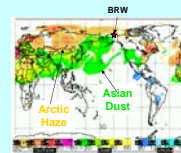
Lidar, Trajectory and Model Results for the April 2002 Event (4.)

Barrow, Alaska, Lidar Data

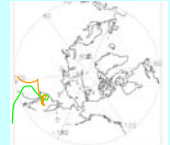
Micropulse lidar backscatter profiles for April 11-12 (day of year 101-102) over Barrow for the Asian effluent event showing layers of dust/air pollution between periods of cloudiness. Trajectories and models strongly suggest this aerosol originated in Asian about 8 days earlier



Courtesy of Department of Energy's Atmospheric Radiation Measurements (DOE/ARM) program on the North Slope of Alaska.



Aerosol transport models and air mass trajectories suggest that air masses containing Asian dust/pollution and Eurasian Arctic haze may pass over Barrow within a few days of each other. Both the plots are for April 11, 2002



NRL Aerosol Analysis and Prediction System
<http://www.rtmir.navy.mil/aerosol/#aerosolobservations>

500 mb trajectory to Barrow; Joyce Harris, NOAA

SUMMARY

- Asian dust/air pollution is regularly measured at NOAA's Baseline Observatory, Barrow, Alaska.
- The dust/air pollution has been observed both at the surface and through the vertical column above the site by a variety of instruments.
- Differences in the optical properties of the effluent events, suggest that a variety of source, transport and chemical transformations/inputs influence the optical characteristics of the dust/air pollution.

Future Work

- Utilize measurements at several NOAA Baseline Observatories to track changes in dust/air pollution properties during transport.
- Analyze trajectories and source emission models to explore how different transport and transformation pathways explain differences observed in dust/air pollution properties.
- Determine the net contribution of Asian dust/air pollution to radiative forcing in the Arctic.

Note:

Plots and data are available from the NOAA/GMD Aerosols and Radiation Group at <http://www.cmdl.noaa.gov>