Spatial and Temporal Variations in $PM_{2.5}$ Chemical Composition during Winter 2000/2001 Episodes in Central California

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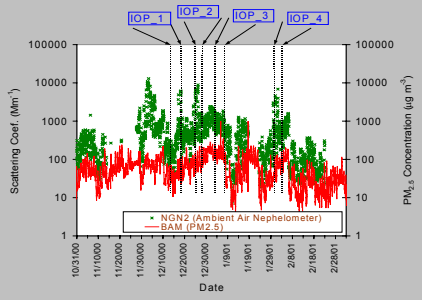
Introduction

Three winter episodes that achieved 24-hr averages of $PM_{2.5} > 100$ µg m^{-3} occurred at the Fresno Supersite between 12/10/2000 and 2/8/2001. High time- and size-resolved measurements of speciated $PM_{2.5}$ were made at five anchor sites in the California central valley during four intensive observation periods (IOPs) during these episodes. Each IOP lasted 3 to 4 days. Supplementing the regular CRPAQS 24-hour $PM_{2.5}$ monitoring, $PM_{2.5}$ sequential filter samples of 3 – 8 hour duration and 9-stage MOUDIs (0.056 µm – 5.62 µm) were operated at the Bethel Island (BTI), Fresno (FSF), Angiola (ANG), Bakersfield (BAC), and Sierra Nevada Foothill (SNFH) sites during the IOPs. These data are used to study the temporal and spatial variations of the fine particulate pollution episodes.



•Assisted by the continuous measurements of $PM_{2.5}$ by a Beta Attenuation Monitor (BAM) and light scattering by an NGN2 open air nephelometer at the Fresno Supersite, the four IOPs were selected as follows:

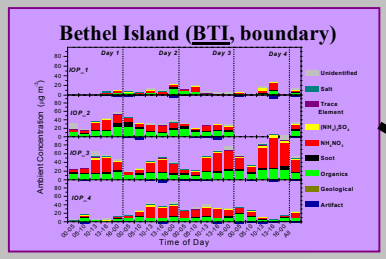
IOP_1: 12/15/00 – 12/18/00

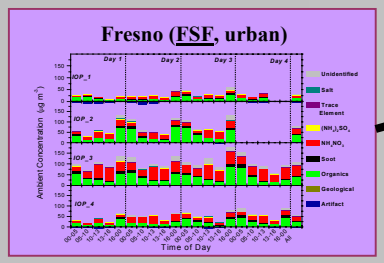
IOP_2: 12/26/00 – 12/28/00

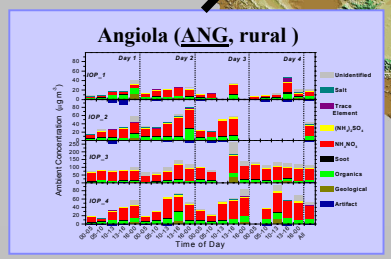
IOP_3: 1/4/01 – 1/7/01

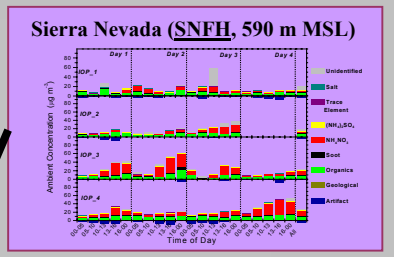
IOP_4: 1/31/01 – 2/3/01

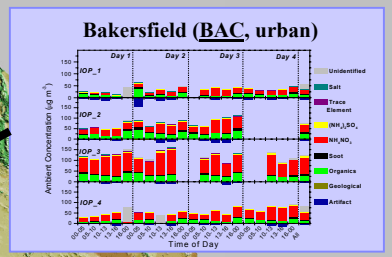
Temporal Variations*











*Geological = 1.89 × Al + 2.14 × Si + 1.4 × Ca + 1.43 × Fe

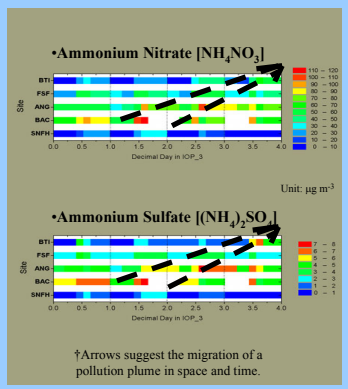
*Organic = 1.4 × Organic Carbon (OC)

*Salt = 2.54 × Na^+

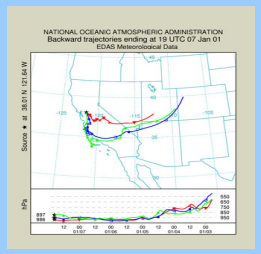
*Trace Element = All measured elements excluding geological elements and sulfur

Spatial Variations during IOP_3

• **Northward migration of a pollution plume.**

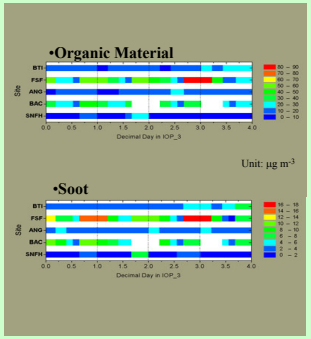


†Arrows suggest the migration of a pollution plume in space and time.



• Five-day air parcel back trajectories (to Bethel Island) indicate sluggish but generally southeasterly transport during IOP_3. Potential advection from the south valley toward the San Francisco Bay area.

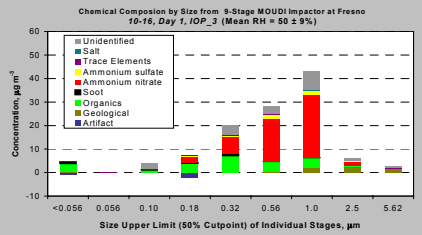
• **Local accumulation of pollutants.**



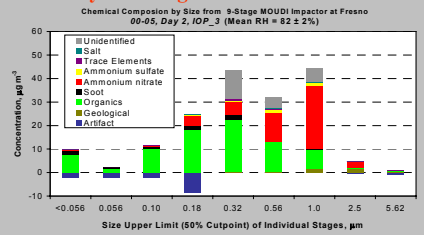
• The highest organic material and soot concentrations were observed at Fresno, followed by Bakersfield, and were low at Angiola. Accumulation was intense at nights. Contributions from wood burning and vehicle exhaust are expected to play a dominant role.

Size-Segregated Chemical Composition at Fresno during IOP_3

Mid-Afternoon



Early-Morning



• Organics and soot exist mostly in particles less than 0.5 µm in diameter, ammonium nitrate and ammonium sulfate dominate mass of particles between 0.5 – 1 µm, and geological material is in coarse particles > 1 µm. Accumulation of carbonaceous material in submicron particles was observed from mid-day to midnight, while ammonium nitrate concentration decreased moderately possibly due to dispersion and deposition.

Conclusions

• Wintertime episodes in central California were driven by elevated ammonium nitrate, which was regional in nature and enriched near the surface during afternoon hours. Both horizontal transport and vertical mixing influenced the ammonium nitrate concentration. Organic material and soot concentrations were highest at the urban sites owing to nearby emissions. Shallow surface layers concentrated these emissions at night.

References

1. Watson, J. G., Chow, J. C., Bowen, J. L., Lowenthal, D. H., Hering, S. V., Ouchida, P., and Oslund, W., Air quality measurements from the Fresno supersite. Journal of the Air & Waste Management Association 50[8], 1321-1334. 2000. **2.** Watson, J. G. and C how, J. C., A wintertime $PM_{2.5}$ episode at the Fresno, CA, supersite. Atmospheric Environment 36[3], 465-475. 2002. **3.** Watson, J. G., Chow, J. C., Lowenthal, D. H., Stolzenburg, M. R., Kreisberg, N. M., and Hering, S. V., Particle size relationships at the Fresno supersite. Journal of the Air & Waste Management Association 52[7], 822-827. 2002. **4.** Chow, J. C and Watson, J. G., Comparison and evaluation of in-situ and filter carbon measurements at the Fresno Supersite. Journal of Geophysical Research 107[D2