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Mid-Point Progress Report
For
Real-time Source Apportionment of Atmospheric Particles
Impacting the San Diego Bay

I have made significant progress with respect to the project that was funded to analyze spatial and temporal variations in air quality and source apportionment around San Diego Bay. As preparation for our trailer sampling period this upcoming winter we have identified multiple potential sampling locations around the bay to assess which sites will provide the most pertinent information when we deploy our mobile laboratory with its instrumentation. The second task we have been working on involves analyzing particle mass concentrations we obtained from the San Diego Air Pollution Control District (APCD) to determine a baseline for pollution levels around San Diego County and specifically near San Diego Bay. Lastly we have worked on analyzing data collected by our group at the Scripps Institution of Oceanography Pier (SIO) in La Jolla.

Site evaluation was conducted for ten locations around the periphery of the San Diego Bay. The locations chosen that will be used will depend on weather conditions on the day of sampling. These locations included a mix of background (West Point Loma, West Coronado, and Silver Strand), moderately polluted (East Point Loma, East Coronado, Imperial City), and heavily polluted (Chula Vista South, Chula Vista North, South San Diego Harbor, and North San Diego Harbor). For each of these locations sites were evaluated based on geographic location and safety for the instruments and operators. The locations are included in Figure 1. The likely sources of pollution levels at the different sites will be analyzed during the intensive sampling period the combination of standard particle measurement techniques and the single particle information collected by the Aerosol Time-of-Flight Mass Spectrometer (ATOFMS). The ATOFMS determines the size and chemical composition of individual atmospheric particles in real time. These spectra are then grouped into particle types by their mass spectra using a clustering algorithm (ART-2a). These particle types are then analyzed for primary and secondary chemical markers to determine sources and their contribution to air pollution.

To understand what PM values in San Diego County are typically PM_{2.5} measurements from 3 sites in San Diego County operated by the San Diego Air Pollution Control District (SDAPCD) were analyzed. The average PM_{2.5} measured at the SIO pier during the study (16 $\mu\text{g}/\text{m}^3$) was similar to the other sites (downtown 10 $\mu\text{g}/\text{m}^3$, Escondido 18 $\mu\text{g}/\text{m}^3$, and Alpine 16 $\mu\text{g}/\text{m}^3$). The downtown San Diego site operated by the APCD is the most comparable site to the SIO Pier due to its close proximity and air mass back trajectory patterns. Despite 12 miles separating the SIO Pier and downtown sites, similar trends in PM_{2.5} mass were observed at both sites during the study (Figure 4). This suggests that San

Diego County is impacted by both regional and local particulate matter sources. However, the downtown site had more short-term spikes in particle mass concentration indicating more local sources and is something we will focus on during our sampling in the area.

Data on the impact of emissions transported from the LA-LB port region on San Diego were collected during August-October 2006 at the SIO Pier and have recently been submitted to the Environmental Science and Technology journal (1). This data showed that mass concentrations increased during time periods when air masses passed over the LA-LB port region. Figure 3 shows the air mass back trajectories calculated using the HYSPLIT model during sampling at the SIO Pier(2).

Figure 4 compares the size resolved chemical composition during transport periods and non-transport periods. Transport periods are defined as time periods when regionally transported particles (likely from the Ports of LA and LB) are significant contributors to the aerosol sampled at the SIO Pier. Regional transport events showed higher mass concentrations across all submicron sizes (4.7-6.5 $\mu\text{g}/\text{m}^3$) when compared to non-event time periods (2.9-3.8 $\mu\text{g}/\text{m}^3$). During regional transport events, the aged soot particles represent the most significant fraction of submicron mass in each bin (35-44%), while heavy metal containing particles contribute 10-19% of particle submicron mass. Note that this is a unique single particle perspective of the mass fractions, and it focuses on the mass fraction of the entire particle type. The majority of the mass of these particles was most likely sulfate, nitrate, and water, as well as a smaller amount of carbonaceous species from residual oil and secondary organic carbon. Non-event time periods had much lower aged soot (4-22%) and heavy metal (2-10%) mass fractions, showing significantly higher fractions of background particle types. These background types included more sea salt (16-81%) and biomass burning (9-43%) than sea salt (4-28%) and biomass burning during (11-28%) regional events. During these periods, PM_{10} mass represents only 36% of $\text{PM}_{2.5}$ compared with 60% during regional events. The increase in the overall PM mass and contributions from aged soot and heavy metals during regional events shows the major influence of transported emissions on San Diego air quality.

The goal of our remaining work is to sample this winter with ATOFMS and additional particle and gas phase instrumentation to determine the sources that are contributing to particle pollution around San Diego Bay. We will make use of our mobile laboratory (housing our suite of instrumentation) at 2-4 locations around San Diego Bay in an effort to determine which portions of the bay are most impacted by air pollution spatially. We will also analyze wind patterns and particle chemical composition to assist in determining which sources are contributing to this pollution. Our goal is to sample the Feb 9-12, 2009 and include sites from those listed above on both the east and west sides of the bay. We look forward to completing this report and submitting the findings with the goal of assisting efforts to improve air quality in the San Diego region.



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References

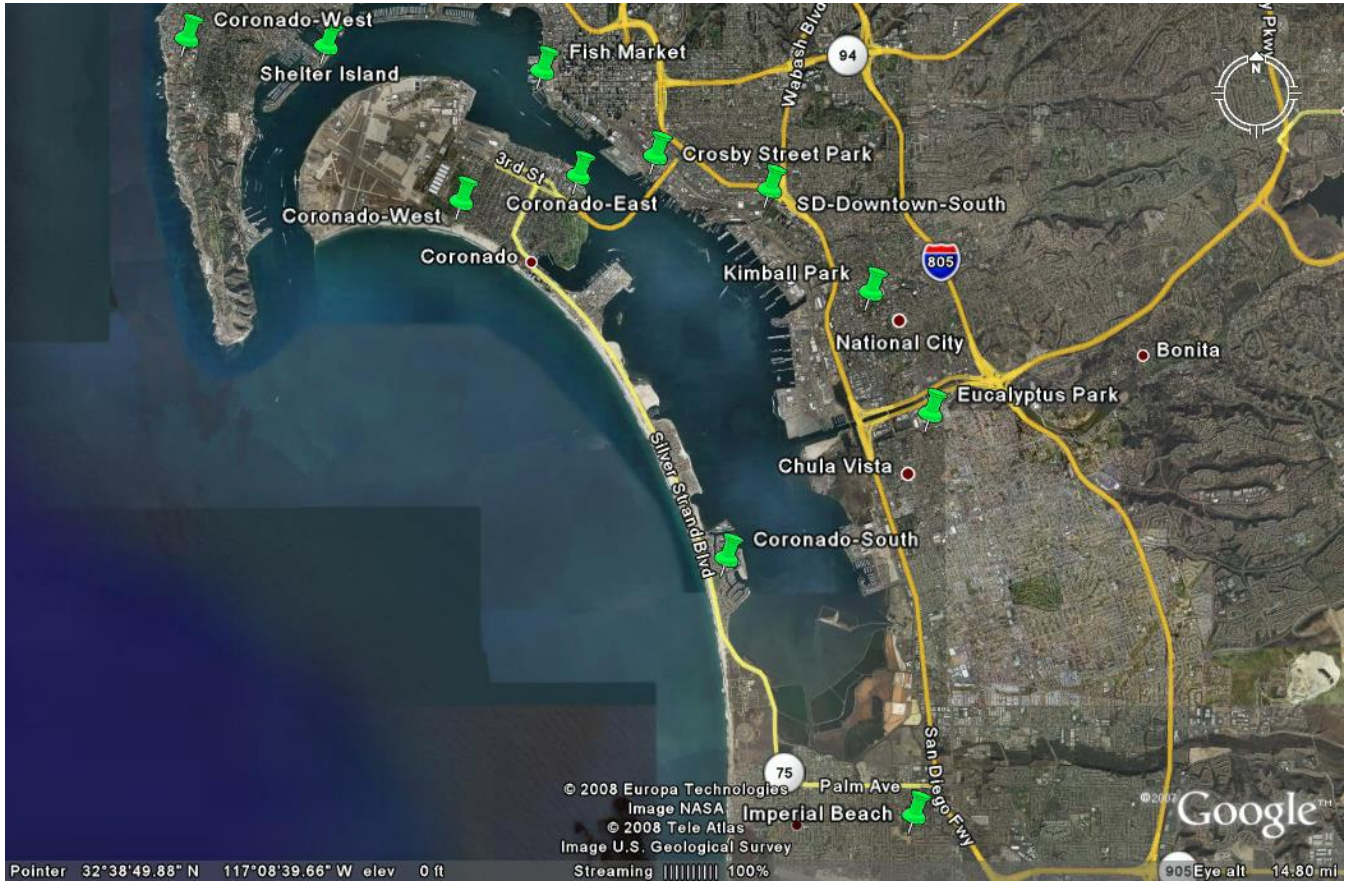


Figure 1: A map of the San Diego Bay with potential sampling sites listed. Sites will be chosen for sampling depending on meteorological factors on the day of sampling.

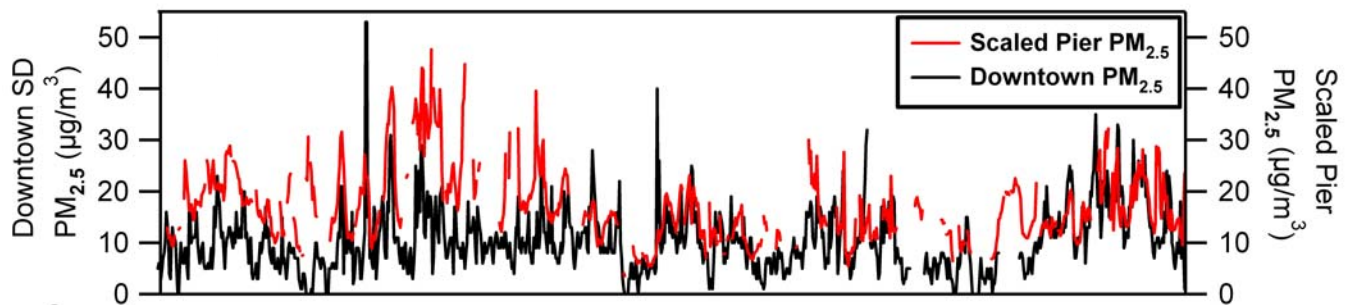


Figure 2: Mass concentrations for particles less than 2.5 micrometers at the SIO Pier and at an APCD site in downtown San Diego. The two time series are similar, although the downtown site has more brief spikes in concentration.

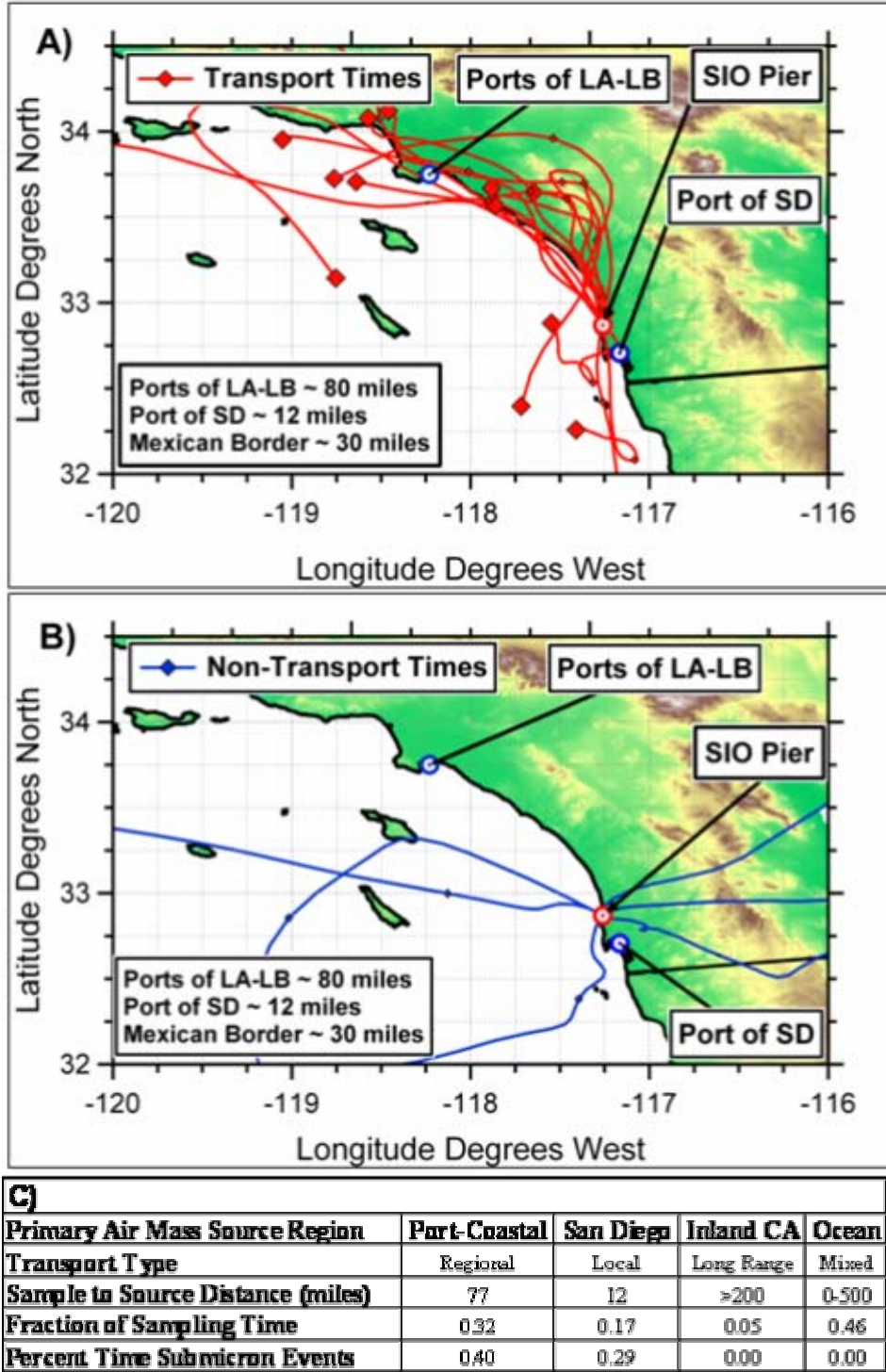


Figure 3: Air mass source regions from sampling at the SIO pier in La Jolla are shown and the fraction of time they represent is displayed.

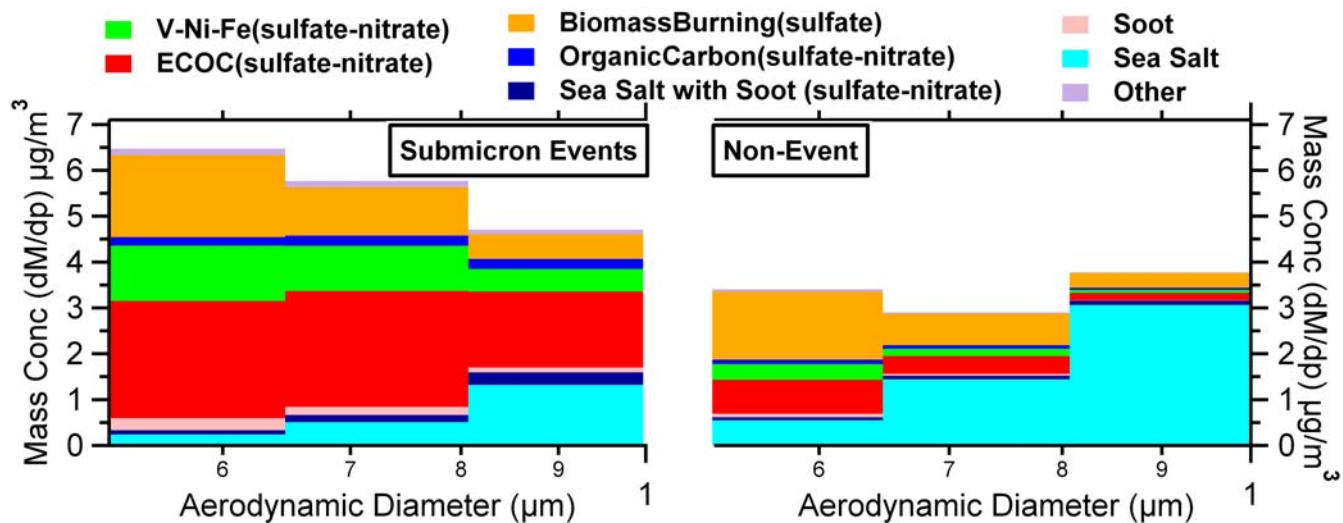


Figure 4: Comparison of the mass size distribution for regional event transport events to non-event time periods during sampling at the SIO Pier. ECOC(sulfate-nitrate) represents aged soot and V-Ni-Fe(sulfate-nitrate) represents aged heavy metal containing particles.