Bay Area Air Quality Management District
939 Ellis Street
San Francisco, California 94109

APPROVED MINUTES

Advisory Council Technical Committee
9:30 a.m., Thursday, April 7, 2008

1. **Call to Order – Roll Call.** Chairperson, Kraig Kurucz called the meeting to order at 9:40 a.m.

Present: Sam Altshuler, P.E., Louise Bedsworth, Ph.D. (9:44 a.m.), Robert Bornstein, Ph.D., Fred Glueck, John Holtzclaw, Ph.D., and Kraig Kurucz, Chairperson

Absent: None

2. **Public Comment Period.** There were no public comments.

3. **Approval of Minutes of February 11, 2008.** Mr. Altshuler moved to approve the minutes. Dr. Holtzclaw seconded, and the minutes were approved with minor edits.

4. **Presentation on Consequences of Changes in Temperature, Inflow Boundary Conditions, and Local Emissions on Air Quality in Central California:** *Dr. Rob Harley gave a presentation to the Committee on consequences of changes in temperature, inflow boundary conditions, and local emissions on air quality in Central California.*

   Dr. Harley spoke acknowledged and thanked the people he works with directly on research and the USEPA, for sponsoring the research.

   Dr. Harley produced slides, graphs and charts illustrating the sensitivity of air quality in California to climate change, including anthropogenic emissions of TOC and NOx estimates for the state of California for calendar year 2005. A key question is what those emissions will look like in the future considering the following factors:

   - Growing population
   - Advancing technologies
   - Climate change

   Dr. Harley explained that the EPA's Community Multi-scale Air Quality model, CMAQ, is one of several models used to predict ozone and other concentrations in future emissions scenarios, and that CMAQ was applied to Central California for a Central California ozone study in the summer of 2000. Dr. Harley referred to reaction rates of chemistry and increases in temperature, noting two effects:

   - Changes of chemical reaction rates.
   - Feedback of temperature on the emissions of isoprene and natural VOC; on hotter days, those emissions will increase.

   Also, between now and 2050, there is change in anthropogenic emissions, from growing population, emission control technology, and the new rules that the State and the Air Districts

implement to further affect emission reductions in that timeframe. One other essential penalty is the background levels coming into the Bay Area from the Pacific Ocean, may change with global changes and industrialization in China. NOx emissions in China are increasing at a very high rate right now, and around the world there are reductions in air quality standards, providing additional challenges for emission control.

With a slide entitled Modeling Domain, Dr. Harley introduced the MM5, Mezzoscale Meteorological model, scaling temperature, topography and winds in the Central Valley, the Sacramento Valley, and the Bay Area.

Dr. Harley then compared anthropogenic and biogenic VOC emissions in peak values. Spatial distribution of those emissions was reviewed, noting biogenic VOC located exactly where there is not much anthropogenic VOC. The highest emissions of VOC were located in an area of natural forest, though not necessarily the most influential location with respect to ozone levels.

Noting the different chemical regimes the in the Central California domain, Dr. Harley added that there are two ways that chemistry ends or terminates; one being peroxide formations and, where NOx is more abundant, it terminates by forming nitric acid. There are high rates of chemistry terminating by forming nitric acid in the Bay Area and urban centers in the Central Valley, i.e., urbanized areas. There are high peroxide termination rates in the mountainous areas where NOx is scarce and natural VOC abundant. Rather that saying there is one control strategy, or chemical regimes, which will work throughout this region, what is seen are very different chemical regimes, depending upon location. Especially toward the more rural, remote, natural areas, there is a dramatic shift in the chemical regime away from the NOx-saturated to the NOx-limited.

Next, Dr. Harley considered the scenario of the future as a doubling of CO_2 relative to pre-industrial levels, and added that it is the scenario of two times CO_2 levels that has been used to drive the regional climate model.

Dr. Harley noted that, unlike global models, which typically have such large grid cells that they don't have enough resolution, the regional climate model provides more detailed information about California such as 40 kilometer scale information about:

- Temperature change
- Global warming information on a regional scale
- Range of regime,
- Saturation of topography

The domain of the regional model includes all of California, and was done through a monthly analysis. The climate modeling is pre-industrial 280 parts per million CO_2, and then there is an unknown year in the future, where CO_2 is doubling.

Using 40 kilometer square pixels, the regional climate model showed larger temperature increases, on the order of 4° Celsius in the Sierras, at the Nevada border, and smaller temperature increases, almost 2°, closer to the Bay Area. These were compared with the changes in ozone during the same period, indicating the effect of temperature on chemistry, with the largest increases being south and east of San Jose in the Bay Area, and south near Fresno, and north near Sacramento.

Discussion regarding temperature variations and averages over time periods with regard to increasing the accuracy of the models ensued, and Dr. Harley noted that on the spatial side there had been some progress, on the temporal side more work could be done to produce results with more accuracy.

Dr. Harley then indicated a second effect of temperature change, an increase the biogenic VOC, or BVOC, emissions. The percent change in biogenic emissions, because of the same temperature increase was displayed in graphs, with larger percentage increases in biogenic VOC emissions, 40% or so, in the Sierras, where some of the largest temperature change is. A 20% increase was predicted in much of the more lower-lying areas. Although a big increase in biogenic VOC in the Sierras was visible, there was almost no change or a slightly negative effect on ozone there. Change in biogenic VOC is most influential in the Bay Area, where the chemistry is most strongly sensitive to VOC emissions. Dr. Harley stated that it is not that biogenic VOC are such major contributors to the budget of VOC emissions in the Bay Area; it is that our emission control programs are deliberately trying to starve the atmosphere of VOC in that area to lower ozone, and so any increments to VOC from climate change really have strong resonance in our local air quality, and again stressed the importance of influential over abundant VOC.

Dr. Bornstein discussed the change in biogenic VOC emissions and the saturating effects of enzymes, and asked Dr. Harley to explain the decrease in the mountains. Dr. Harley referred to the discussion held earlier and the supply of NOx being exhausted, stating there would be no NOx left to sustain ozone production.

Continuing with the presentation, Dr. Harley explained another aspect of future air quality, the change in anthropogenic emissions from present day to 2050. Typically people take an International Intergovernmental Panel on Climate Change (IPCC) scenario to provide a way of determining all the emissions in the United States. The regional model attempts to be more detailed than that. Different amounts of growth are expected along the coast; from the Central Valley, where the land prices are lower, higher rates of population growth are expected. In more extensive areas like the Bay Area, we expect a slower rate of population growth, or possibly higher density. Factors of change in emission include:

- Population growth, where you have the effect of higher growth reducing the emissions reductions. Lower percent reductions in areas where there is more growth.
- Technology change.

Future emissions were determined with the following assumptions and factors:

- In the year 2000, there was a baseline emissions inventory, which was not uncontrolled.
- There already had been some emission controls achieved, and so a further 80% level of control beyond what had already been achieved in 2000 was assumed.
- For carbon monoxide and VOC, there was about a 90% overall level of control.
- By 2050, the assumption is to obtain another 80% going to 90, 98% control.
- Population growth
- By NOx, it is only above 40%, but by 2050, they have a different end result.

Dr. Bornstein questioned if off-shore referred to shipping and/or aircraft. Dr. Harley said there were not a lot of shipping emissions and said the colors were not representative of this. Dr. Bornstein said he did some work with Environ for the District and volunteered to do the shipping emissions and it turns out that in the Emission Model or the Mechanics Model, they were assumed as uniform, but he checked the rate at which boats leave and come into the Bay Area, and in fact, there were variations up to a factor of 3. So the simulations done here by the District and Environ took in a day-to-day variation and not just the month to month.
Dr. Harley then exhibited graphs which displayed the change in air quality, by the year 2050, in overall emissions for the region, with a 20% decrease in the San Jose area and Fresno, and in the air flowing into the Bay Area from the Pacific Ocean, i.e., inflow boundary conditions (BC) including change in:

- Diesel NOx, which is a whole issue, still largely uncontrolled.
- CO: from 80 to 104 parts per billion (ppb)
- CH_4: from 1.7 to 2.4 ppb
- Ozone: from 30 to 40 ppb

Combined simulations, using temperature effects and change in temperature in combination with year 2050 air quality, indicated changes in ozone (ppb) for the region. Additional effects, contributing to greater sensitivity, were enumerated and
Dr. Harley expanded on some of the additional negative effects incurred with climate change, such as:

- Population growth
- Loss of natural reservoirs in the form of snow in the Sierras, due to temperature increase
- Sea-level rises
- Longer hotter dry seasons creating environmental stresses and forest fires,
- Health effects on individuals

Finally, a summary of ozone effects in the Fresno, Sacramento, and Bay Areas and projections into year 2050 was reviewed. Dr. Harley then responded to questions and comments from Council members regarding inversion formation and depletion considerations in modeling (captured by the MM5 model, but not a consideration in the regional model), magnitude and frequency in ozone peak measurement, episodes resulting from multiple-day events, constancy of influences from inflow from boundary conditions, precipitous or steep change in ozone gradient from off-shore Bay Area to south of Monterey Bay, contribution of shipping as a source of NOx, meteorology, weekend effect retroactive study, accuracy in measuring full decreases of ozone in view of coastal cooling, land use changes, and various factors in simulations.

Saffet Tanrikulu, Air District Research and Modeling Manager, joined in a discussion of visible warming in the Bay Area up to 1990. He said as it gets warmer in the global warming models, the inversion, if it stayed the same, would be decreased more rapidly but the inversion could be getting more intense. It depends upon what is causing the inversion to form. He said MM5 captures all of those interactions and this could be reviewed to determine whether if between now and 2050 the inversion is more intense, less penetrated, or other characteristics are revealed.

In response to a question from Chairperson Kurucz as to whether all work is on the peak ozone day, it was stated that the ozone standard is magnitude and frequency. If the frequency goes up but the magnitude does not, it is not good for us, as well.

Mr. Altshuler questioned whether the modeling indicates, using the 2050 year, that there might be greater frequency of those episodes that last multiple days. Dr. Harley said consistent frequency will make individual days worse, and he discussed instances which would influence impacts and results given design values and measurements.

Chairperson Kurucz asked if the influences from the boundary condition between now and 2050 are presumed to remain constant, or was it a factor that showed the boundary condition emissions coming across the ocean were increasing to 2050. Dr. Harley said the changes are all relative to present day because of the changes in boundary conditions that are noted at the bottom of the slide.

- Forest fires
- Frequency, as well as severity of high-ozone events
- Spatial and temporal details of how temperature changes
- Nighttime versus daytime temperature changes
- How anthropogenic emissions and population change will proceed over the next decades.

Dr. Bornstein said forgetting about the anthropogenic emissions, it shows that offshore, as you approach the coast, there is less background ozone. He asked if they could project that backwards because it looks like there is a rapid decrease, and it seemed to him that the background impact should be more uniform, as it falls off rapidly offshore.

Mr. Tanrikulu said the chemistry seems steep from the western boundary coming in, and the issue is the NOx boundary condition specified, the guidance of which they received from the CARB on what to use. The couple of PBB of NOx in the inflow boundary which is way too high for clean maritime air over the ocean. What is seen on the edge is a reaction of ozone with high levels. PBB of NOx is not a lot once on land and there are polluted conditions, so what he believes is assumed is that there is some recirculation of pollution that is bring some NOx out over the ocean, and this is the reason for it falling off so rapidly. He said another reason for NOx could be shipping emission lanes going up and down the coast.

Dr. Bornstein suggested looking at the meteorology for 2050 to see if it also was a year that was conducive to high ozone. If there was a year that was conducive for low meteorology and you still got higher, then it could be that for the same meteorology of 2000, you would get even much higher in 2050. Just to show 2050 has a small difference does not really same that for the same meteorology you are going to get more pollution in 2050. 2050 could have been a clean year in terms of meteorology at least, so an average position of high or frequency of some meteorology could be done in order to show that the two sets were about the same, except that there is climate change. But if you were at a different part of the cycle, then the climate change is taking this meteorology and bringing up a little bit rather than starting the year and bringing in the meteorology up here, and he believed this could be done using the output net fields.

Dr. Holtzclaw questioned if anyone has gone back in time to see whether the climate change we have already experienced may have impacted the ozone levels that were already measured

and recorded. Mr. Altshuler said the ozone level he trusts goes back to about 1980. He said he knows work has been done on the climate elements of how observed temperatures have changed over that time period, so he believed they have a stronger sense of what has happened on the meteorological side. The problem on the air quality side is that between 1980 and present day, especially in the earlier phase, there was such a dramatic improvement due to changes in anthropogenic emissions and emission control programs. So it would then be difficult to separate the effect of climate change from the effect of success in controlling local emissions, plus meteorological variability.

Dr. Bornstein said when they first found this cooling, they approached Bart Croes of CARB, and he was very intrigued and said, simulating the emission reduction does not capture the full decrease in ozone; the models are unable to capture the full decrease. And Mr. Croes thought the missing decrease in ozone could be due to coastal cooling. So, Mr. Croes encouraged Dr. Bornstein to write a proposal which was revised and resubmitted this year, and hopefully, this week the Executive Committee is going to make the final decision of their proposal. Hopefully, some money from CARB might also be obtained. He said then someone recently told him that the models have been fixed and they no longer under-estimate the rate of ozone decrease, and he felt it was possible to go back and simulate the last 25 years, both with coastal cooling and the emission reduction.

Mr. Tanrikulu said he believed that what is clear and very interesting to do that is amenable to a modeling approach which is to hold the emissions constant and change the meteorology in the way described and see what the magnitude of that effect is. There is then a clear signal that you're not changing emissions. Therefore, you can exclude certain variables from the analysis by holding them constant and then look at some of the other effects individually. This would be a very compelling analysis and important thing to consider. There might be a local benefit but a downwind dis-benefit, as well.

Dr. Bornstein said they have a Ph.D. student who is doing this and he has done only the meteorology so far and not all of it, and he is also including land use changes in terms of urbanization, irrigation changes, etc. He is focusing on the Los Angeles Basin because the land use changes are simpler. He has done preliminary simulations with the Bay Area also and he does get coastal cooling and a deeper sea breeze penetration, but is just in the beginning of getting the simulations correctly done.

Mr. Tanrikulu, discussed measurements going back to 1960, using the National Weather Service. Dr. Bornstein noted that if one looks at the global data set, it stopped warming in the mid-90's; however, this includes the ocean and the atmosphere and the ocean has cooled off because of the transition from El Nina to La Nina, but the land is still warming at the same tremendous rate it was until the mid-90's. So if someone shows data from the whole Earth and it doesn't show warming since the mid-90's; that is because it is dominated by the ocean, but the land sites are warming.

Mr. Tanrikulu said they would be happy to report their findings in a future meeting. Dr. Bornstein said Phil Duffy may attend the next meeting to discuss climate change, and Dr. S.T. Rao separately was to also provide a discussion about current and projected plans of modeling at the EPA, and he said a report from the Air District on how this overlaps with the modeling might be interesting. Dr. Bornstein discussed Dr. Rao's scheduled arrival on May 14-15, 2008 because he is planning the NATO conference.

Dr. Bedsworth reported that Dr. Rao is planning to provide a presentation on May 15, 2008; they are meeting with the full Council first and then the Executive Committee meeting afterwards to accommodate his schedule.

Chairperson Kurucz thanked Dr. Harley for his presentation. He questioned if Dr. Harley had any opinions on what areas for further study would be in getting to the synthesis of information nearing the end of the year.

Dr. Harley said in terms of prioritizing by air quality impact, forest fires is high on his list, as they could see some pretty serious situations due to eco-systems drawing out more during longer, hotter summers. He also thought more work needed to be done on the meteorological side, the frequency and severity of the high ozone events is an important question and issues of temperatures changing, and the spatial and temporal details of how temperature changes. One of the biggest uncertainties and most important questions is how anthropogenic emissions and population change will proceed over the next decades, which has a strong influence on future air quality, as well.

Also, California is now committed, by 2050, to reducing its greenhouse gases emissions to 80% below 1990 levels. Depending upon the approach of achieving this, some significant additional effects on emissions could be seen, which he has not considered in this analysis. He said he would rather see California go to electrification rather than use bio fuels or fossil fuels in the transportation system, because bio fuels when burned are not greatly superior to conventional fossil fuels in terms of local air pollutants emitted.

A brief discussion regarding expanding parks in the area, biogenics and possibly measuring the effects of emissions reductions of eucalyptus tree eradication and plantings of more redwoods by the East Bay Regional Parks Department ensued. Chairperson Kurucz stated that follow-up might be done with the Parks Department for a future presentation.

Chairperson Kurucz, on behalf of the Committee, thanked and presented Dr. Harley with Air District souvenirs in appreciation of his presentation.

5. Committee Member Comments/Other Business

Committee members, or staff, on their own initiative, or in response to questions posed by the public, asked a question for clarification, make a brief announcement or report on his or her own activities, provided a reference to staff regarding factual information, requested staff to report back at a subsequent meeting on any matter or took action to direct staff to place a matter of business on a future agenda.

Council members briefly discussed the Air and Waste Management Conference in June 2008, and would be briefed by Mary Ann Goodley, Executive Office Manager, on participation. Mr. Altshuler commented that the Air District Board could benefit from an Advisory Council perspective on EPA Certified woodstove efficiency and the renewable and low-carbon impact of wood as fuel on climate change.

In response to a question from Committee Chairperson Kurucz, Advisory Council Chairperson Bedsworth replied that the matter of wood-burning devices and wood smoke had been turned back to the Committee level, in this case, the Public Health Committee. Mr. Altshuler noted that this was not in the purview of Public Health but rather, as a matter of renewable fuel and climate change, a subject for the Technical Committee to address.

Chairperson Kurucz indicated a synthesis of information from past minutes and presentations on this topic would be appropriate, but preferred not to add future speakers to the agenda at this time. Further discussion of wood as a renewable fuel, black carbon effects on snow and synthesizing data ensued.

Jean Roggenkamp, Deputy Air Pollution Control Officer for the Air District, closed the discussion by saying that informational meetings of the Rule 6, Regulation 3 on wood smoke would be taking place shortly, and that a CEQA document addressing these kinds of issues was being prepared for that purpose.

Chairperson Kurucz noted that it would be planned to have Phil Duffy speak at the next Committee meeting, and a potential second speaker, and asked the Committee members if they would be willing to extend the meeting time an extra hour.

6. **Time and Place of Next Meeting.** 9:30 a.m., Monday, June 2, 2008, 939 Ellis Street, San Francisco, CA 94109.

7. **Adjournment.** Meeting adjourned at 11:22 a.m.

/s/ Lisa Harper
Clerk of the Boards
(for Jean Marie Mink)
Temporary Executive Secretary