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News & Views

# 1st UMN–CAS Bilateral Seminar on $PM_{2.5}$ science, health effects and control technology Xi'an, China, May 27–28, 2014

The First UMN–CAS Bilateral Seminar was successfully concluded with all the goals met. The meeting in Xi'an was informative, stimulating and enjoyable, thanks to the local host, Prof. Junji Cao, and his capable staff. The Bilateral Seminar was organized by Prof. David Y.H. Pui of the University of Minnesota and Prof. Junji Cao of the Institute of Earth Environment, Chinese Academy of Sciences. It was attended by approximately 100 delegates from the University of Minnesota (UMN), the Center for Filtration Research (CFR), the Chinese Academy of Sciences (CAS) and other famous Chinese universities. We are grateful for the opening remarks given by UMN President Eric Kaler and CAS Vice President Jinghai Li on behalf of President Chunli Bai. The panelists were all leading scientists (academicians, professors, engineers, medical doctors, directors, corporate fellows, senior managers) from their respective fields. The quality of the presentations and the Q&As were outstanding and these are summarized in the ppt slides from each presenter, which will be posted on IEECAS website (www.ieecas.cn). The stated goals of the Bilateral Seminar were (1) to provide networking opportunities among leading $PM_{2.5}$ experts at UMN, CAS/Universities in China, and leading global filtration companies, and (2) to identify top emerging areas in $PM_{2.5}$ science, health effects and control technology for research cooperation among the delegates. The delegates became acquainted with each other through many social programs during the week, and several research proposals were discussed during the meeting. Some of them may develop into long-term collaborations among top scientists in their fields. The panel titles and leaders are: Panel 1, $PM_{2.5}$ Science, Transport and Transformation, Prof. Thomas Kuehn and Prof. Xuexi Tie; Panel 2, $PM_{2.5}$ Health Effects, Prof. G. Ramachandran and Prof. Tong Zhu; and Panel 3, $PM_{2.5}$ Control Technology, Prof. Jing Wang and Academician Wenquan Tao.

The Second UMN–CAS Bilateral Seminar is now planned for May 2015 in conjunction with the CFR Meeting to be held at the University of Minnesota. Several site-visits to CFR member companies are planned as well as social programs to foster networking among the delegates.

## Panel 1: Summary of $PM_{2.5}$ Science, Transport and Transformation (Thomas H. Kuehn, Xuexi Tie)

Several grand challenges need to be met to solve the $PM_{2.5}$ problems in China. The panel members focused on specific topics that can be addressed in the near term based on the expertise and personnel at hand. The following expertise exists among the University of Minnesota faculty members who attended: cooking aerosol characterization (Kuehn), engine emissions (Kittelson), source apportionment, atmospheric chemistry, instrumentation and field measurement protocols (McMurry).

Discussion was held regarding the study of indoor air quality and outdoor air pollution. No federal mandate exists in the U.S. to study the indoor environment whereas the EPA has a mandate to address outdoor air pollution. Thus there is very little funding to study indoor air quality in the U.S. in spite of its importance to human health. The panel members felt that a similar situation exists in China, the ones who are responsible for funding research observe the outdoor haze as do members of the general public so there may be little political will to address indoor issues. This perceived lack of funding for indoor work indicates that the work initiated by these joint efforts should be focused on the outdoors.

Several concepts were proposed for education and training. One idea is to initiate two week workshops for graduate students from various universities. A challenge would be presented and the students asked to address it. Faculty members could be drawn from various universities and research institutes. Another idea was to establish a program similar to the Management of Technology Graduate program at the University of Minnesota. This is typically a two-year Masters program for industry professionals. Students are full time employees and the companies that employ them pay for the program. By focusing on solutions to environmental issues it was thought that perhaps CRF member companies would be willing to send some of their employees in China to such a program where they could become leaders in the environmental field as they continue their professional careers. Another concept would be that companies send students for advanced education and training in atmospheric research by providing corporate fellowships.

A short-term goal would be to download the daily average PM data obtained for several Chinese cities daily and archive the data for future use. According to panel members, currently the data are available for only one day and are not archived anywhere.

Collaboration on field measurements can be done by sharing instruments but export control makes this tedious. The University of Minnesota researchers have instrumentation and expertise for smaller particle sizes than currently being studied in China. Sharing protocols and expertise may be more beneficial.

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Another idea was to establish early warning systems to alert officials of an impending alert situation to have time to implement control measures to minimize the magnitude of the problem. This might be done to setting up smog chambers around major cities that could accelerate natural atmospheric processes.

Some impediments to collaboration were also identified. One is the reluctance to share data. It was pointed out the data obtained through federal funding in the U.S. must be made available to the public. There may be Chinese government restrictions on data dissemination. Funding typically stays within the country providing the funds so that funding would have to be obtained for both the U.S. and Chinese participants for any meaningful collaborative study. It was not clear what government agencies should be approached.

## Panel 2: Summary of $PM_{2.5}$ Health Effects (G. Ramachandran, Tong Zhu)

The Health Effects Panel included a wide range of experts from epidemiologists, pulmonary physicians, biologists, biochemists, molecular biologists, exposure assessors, and environmental health scientists. The Panel recommended that a series of population-based health studies and bench-top mechanistic and animal studies that complemented each other should be conducted to understand the health effects of $PM_{2.5}$ exposure in China. The group felt strongly that the addition of health outcome information (type to be determined) was essential for proper scientific inference and complete understanding of long-term environmental monitoring data.

In addition to shorter term time series studies, it is important to be able to study the effects of long-term exposures. A combination of an occupational cohort and their spouses might be one possibility. However, it is important to understand the availability of information to enable such studies. It is important to know the availability and completeness of information relating to the prevalence, incidence, and mortality due to various lung diseases including lung cancer, chronic obstructive pulmonary disease (COPD), and other non-malignant respiratory diseases. This information may be available from the Chinese Center for Disease Control and Prevention as well as local and regional agencies. Likewise, it is important to know the availability of air monitoring data from Chinese governmental networks and local governments and the ease of access to such data. Access to an occupational cohort could also be essential.

Several possible sites can be considered for potential population studies. The group expressed considerable interest in exploring Xi'an as a possible study site because of high quality monitoring data for $PM_{2.5}$ including speciation collected by Professor Junji Cao since 2003 as well as logistical advantages and opportunities to utilize existing CAS expertise. Shijiazhuang near Beijing might see reductions in $PM_{2.5}$ levels due to government intervention, and this might be an attractive location for this reason.

The group expressed the potential importance of biomarker information that could be useful in understanding potential health repercussions. This endpoint will be explored further before the next interaction. The use of biomarkers in such studies would be attractive as they can serve as early indicators of disease and can be more accurately quantified than more traditional disease indicators. Mechanistic studies of lung cancer, COPD, and fibrosis would be needed to complement the field studies to understand which components of $PM_{2.5}$ are more health relevant, the effects of different PM sources, types of fuel, and coal and regional variations on mechanisms of disease. The use of mice model experiments in conjunction with aerosol concentrators in different regions would be useful.

Several possible funding sources can be approached for funding such collaborative studies: (a) the CAS issues a call for proposals every April, (b) the Ministry of Science and Technology makes requests for proposals for international collaborative projects, and (c) joint NSF (China) and US NIH requests for proposals. The Panel has decided to immediately start working on a document that identifies the most important needs for research from a scientific as well as policy perspective and refines the research questions. The Panel will identify the availability of the information needed to conduct studies as described earlier, and the types of projects that are currently being funded by NSF (China).

## Panel 3: Summary of $PM_{2.5}$ Control Technology (Jing Wang, Wenquan Tao)

Besides the UMN and CAS delegates, the panel consists of 30 delegates from the Center for Filtration Research (CFR) at the University of Minnesota. Member companies include 3 M Corporation, BASF Corporation, Boeing Commercial Airplanes, Cummins Filtration Inc., Donaldson Company, Inc., Entegris, Inc., Ford Motor Co., H.B. Fuller Company, W.L. Gore & Associates, Inc., MANN + HUMMEL GMBH, MSP Corporation, Samsung Electronics Co., Ltd, Shigematsu Works Co., Ltd, and TSI Inc.

Source characterization including the size, concentration and composition is very important for development of effective control strategies. It would be helpful to use modeling of air pollution on the city and regional scales to understand the source and distribution of pollutants and to design effective control systems.

Cost analyses are needed for the policy makers to decide which technology to use, and what strategy is the most cost-effective in emission reduction.

The Chinese power plants have mature systems to remove PM and gaseous pollutants. Both the electrostatic precipitators and bag house filters are usually needed to ensure emissions below the regulated levels. CFR companies are developing new materials for catalysts used in flue gas treatment.

The focus of emission reduction for mobile sources may be heavy duty diesel vehicles, as the PM emission from diesel vehicles is significantly higher than from gasoline vehicles. However, usage of gasoline vehicles is on the rise and diesel vehicles may emit less when diesel particulate filters (DPFs) are used, thus the emission reduction of gasoline vehicles is important too. Retrofit installation of DPFs on city bus fleet may be a good initiative for local governments. Sulfur-rich fuel in China is a problem for catalyst; new strategy and technology would be helpful. Crankcase emission is currently not regulated in China and a standard is needed so that the industry can work toward the goal.

Emissions from coal combustion are a significant source for air pollutants in China. Currently more than 70% of the energy is from coal. Coal may remain as the primary energy source in China for the foreseeable future. Elimination of usage of coal for heating may be an efficient and fast way to lower the pollution level in China. The alternatives of coal heating should be explored, and the feasibility should be studied. Natural gas can lead to emission reduction compared to coal, however, the cost of the infrastructure may be too high. It may save money by converting the natural gas to liquid fuel, thus lowering the cost for distribution.

China should take a balanced approach in emission reduction for both the mega cities and countryside. Bio-mass burning is a significant problem in the countryside.

Control of gas emissions is needed to avoid secondary PM. Currently control systems are lacking for small scale furnaces and stoves.

Cheap and reliable personal samplers and measurement instruments for air pollution monitoring are desired. Some portable instruments exist, but the cost and function may not meet the need of the general Chinese population.

Indoor air quality needs new standards. There exist only PM standards for restaurant personnel, but the VOCs should be regulated too. A Chinese standard for respiratory protection exists but is not used on the national scale. Standards for personal protection are lacking and the general population should be educated about how to deal with severe air pollution.

The UMN–CAS group should consider establishing a website to distribute the knowledge on air quality control.

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