Editorial

Special Issue for the 9th International Conference on Carbonaceous Particles in the Atmosphere

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Carbonaceous particles are a minor constituent of the atmosphere but have a profound effect on air quality, human health, visibility and climate. The importance of carbonaceous particles has been increasingly recognized and become a mainstream topic at numerous conferences. Such was not the case in 1978, when the 1st International Conference on Carbonaceous Particles in the Atmosphere (ICCPA), or "Carbon Conference" as it is widely known, was introduced as a new forum to bring together scientists who were just beginning to reveal the importance and complexity of carbonaceous particles in the environment. Table 1 lists the conference dates, venues in the series as well as the proceedings, and special issues resulting form the meetings. Penner and Novakov (*Penner and Novakov*, 1996) provide an excellent historical perspective to the early ICCPA Conferences. Thirty years later, the ninth in this conference series was held at its inception site, Berkeley, California, attended by 160 scientists from 31 countries, and featuring both new and old themes in 49 oral and 83 poster presentations. Topics covered such areas as historical trends in black carbon aerosol, ambient concentrations, analytic techniques, secondary aerosol formation, biogenic, biomass, and HULIS[1] characterization, optical properties, and regional and global climate effects. The conference website, http://iccpa.lbl.gov/, holds the agenda, as well as many presentations, for the 9th ICCPA. The 10th ICCPA is tentatively scheduled for 2011 in Vienna, Austria.

The papers in this issue are representative of several of the themes discussed in the conference. Ban-Weiss et al., (*Ban-Weiss et al.*, accepted) measured the abundance of ultrafine particles in a traffic tunnel and found that heavy duty diesel trucks emit at least an order of magnitude more ultrafine particles than light duty gas-powered vehicles per unit of fuel burned. Understanding of this issue is important as ultrafine particles have been shown to adversely affect human health (*Lighty et al.*, 2000; *Pope and Dockery*, 2006). Gan et al. (*Gan et al.*, accepted) examined the indoor air quality aboard submarines and found that the diesel particulate matter concentrations exceeded the EPA 24 hour standard. Claeys et al. (*Claeys et al.*, accepted) studied the importance and sources of secondary organic aerosol (SOA) in remote marine environment during a period of high biological activity. Methanesulphonate was the major SOA compound detected and there was no evidence for SOA from isoprene. The optical properties of

[1] HULIS is an acronym for HUmic-LIke Substances and denotes particles that contain humic and fulvic acids (cf. Graber, E.R., and Rudich, Y., Atmospheric HULIS: How humic-like are they? A comprehensive and critical review, *Atmos. Chem. Phys.*, *6*, 729-753, 2006.)

gasoline and diesel vehicle particulate emissions and their relative contribution to radiative forcing was studied by Strawa et al. (*Strawa et al.*, accepted).

Characterization and source apportionment of carbonaceous particles continues to be an issue of concentrated research. Trompetter, et al. (*Trompetter et al.*, accepted) determined factors influencing ambient concentrations of carbonaceous particulate matter within a New Zealand air shed. The results of Cerqueira et al., (*Cerqueira et al.*, accepted) indicated that elemental carbon (BC)[2] is removed from the atmosphere by wet deposition less efficiently than water insoluble organic carbon (WIOC), and in turn this species is removed less efficiently than sulfate. Jia et al., (*Jia et al.*, accepted) determined that saccharides can be used as tracers for the seasonal change of carbohydrate production and utilization in a local ecosystem. Lin et al. (*Lin et al.*, accepted) found that HULIS comprised a significant fraction of water soluble organic carbon (WSOC) in an ambient aerosol in rural south China and in fresh biomass burning aerosols. Sources are postulated to include formation in cloud droplets, secondary formation through heterogeneous reactions and primary emissions from biomass burning. Ram et al. (*Ram and Sarin*, accepted) provide the first comprehensive data set on atmospheric abundance of EC, organic carbon (OC), and WSOC over the Indo-Gangetic Plain in northern India.

Improved methodologies to better characterize carbonaceous particles is also a topic of research. This special issue contains several papers related to new techniques. Proton backscatter methodology was explored by Castaneda et al. (*Castaneda et al.*, accepted) to measure carbon and oxygen concentrations in particulate matter. Vander Wal, et al. (*Vander Wal et al.*, accepted) explored the use of high-resolution transmission electron microscopy *(*HRTEM*)* images and X-ray photoelectron spectroscopy (XPS) data to identify the sources of carbonaceous particles. Using gas chromatograph – mass spectroscopy (GC-MS) and gas chromatograph – flame ionization detection (GC-FID) techniques, Kundu et al., (*Kundu et al.*, accepted) showed that stable carbon and nitrogen isotopes can explain biomass burning mechanism, and showed evidence of the chemical evolution of aerosols during an intense biomass burning period in Rondônia, Brazil (Amazonia). Based on particle-resolved model simulations Riemer et al. (*Riemer et al.*, accepted) present a new method for calculating the aging time-scale of particles containing BC.

The research presentations and discussions at the 9th ICCPA demonstrated that the state of knowledge of atmospheric carbonaceous particles and an awareness of their importance has increased dramatically since the 1st ICCPA in 1978. It was also apparent that more work needs to be done if we are to fully understand the climate and air quality impacts of carbonaceous particles in the environment. Thus it is appropriate to conclude this introduction with a brief summary of open questions and research needs in the carbonaceous aerosol community.

[2] This aerosol component is variously termed 'elemental', 'graphitic', or 'black' carbon depending partly on the measurement method. The inconsistent use of these terms and their precise definitions has been the subject of ongoing debate since the first Carbon Conference and represents one of the major hurdles that this research community has not yet successfully resolved. For consistency in this preface, we will use the term elemental carbon although several papers in the special issue use the terms black or graphitic carbon.

The uncertainty in our ability to accurately quantify the air pollution-induced perturbation of Earth's radiation balance is mostly due to our lack of understanding of the processes responsible for aerosol radiative forcing (*Solomon et al.*, 2007). Aerosols are short-lived in the atmosphere, surviving from hours to weeks before they are removed by wet or dry deposition, and thus can have significant temporal and regional variation. Regionally, the aerosol radiative forcing can be much larger than green-house gases, and can redistribute enough energy in the atmosphere to impact the hydrological cycle (*Ramanathan and Carmichael*, 2008; *Russell et al.*, 1997). Recent studies have improved source identification and apportionment (*Bond et al.*, 2004; *Novakov et al.*, 2005; *Streets et al.*, 2003) but more work is required to refine these estimates. Recent work has identified that carbonaceous particles absorb more sunlight than previously thought (*Bond and Bergstrom*, 2006; *Schnaiter et al.*, 2005). Further research is required to better quantify the amount of light absorbed by carbonaceous particles in the visible and ultra-violet spectrum (*Kirchstetter et al.*, 2004). A more thorough knowledge of the chemical composition of carbonaceous particles is important. The composition of particles affects their interaction with solar radiation and the hydrological cycle, cloud scavenging and aqueous chemistry, and the ability of carbonaceous particles to form CCN [*Facchini,* 2003*, Fuzzi, et al.,* 2006*; Ghan and Schwartz* (2007)]. At present only about 10%-20% of the organic mass of carbonaceous aerosol can be identified (*Puxbaum et al.*, 2000; *Rogge et al.*, 1993) although a range of new oxigenated organic compounds will increase the identified OC on the molecular level substantially (e.g. anhydrosugars, tetrols, and further new bio-aerosol markers) (*Bauer et al.*, 2008; *Claeys et al.*, 2007; *Puxbaum et al.*, 2007; *Surratt et al.*, 2006). The evolution of carbonaceous particles, particularly EC, changes the amount of light they scatter and absorb with consequences for climate (*Hansen and Sato*, 2001; *Jacobson*, 2001; *Menon*, 2004).

Carbonaceous particle composition includes heavy metals and polycyclic aromatic hydrocarbons (PAH), which can be toxic, and the importance of ultrafine particles which can be inhaled deep into lungs is now being recognized. Epidemiological studies have linked pulmonary disease and mortality to the inhalation of particulate matter (*Lighty et al.*, 2000; *Pope and Dockery*, 2006). The specific mechanisms responsible for this linkage are not fully understood.

Future advances in our knowledge of carbonaceous particles, their distribution, and transformation processes will require a more coordinated use of the tools at hand. These tools include laboratory, field, and satellite observations, as well as sophisticated models that more accurately describe the processes involved. Recent call for such integrated approaches (cf. (*Charlson*, 2001; *Diner*, 2004; *Trenbreth et al.*, 2002) have not been fully embraced by the research community. More integrated studies will be required to advance our understanding of the mechanisms by which carbonaceous particles impact our climate and health.

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Table 1 - 30 Years of ICCPA

Year and Venue	**Proceedings and Special Issues**
1978, Berkeley	Lawrence Berkeley National Laboratory, Report #LBL-9037, 1979
1983, Linz	Science of the Total Environment, 36, 1984
1987, Berkeley	Aerosol Science and Technology, 10(1&2), 1989; 12(1) 1990
1991, Vienna	Atmospheric Environment, 27A (8), 1993
1994, Berkeley	J. Geophysical Research, 101(D14), 1996
1997, Vienna	Atmospheric Environment, 33(17), 1999
2000, San Juan	J. Geophysical Research, 107(D21), 2002
2004, Vienna	Atmospheric Chemistry and Physics, Special Issue 2005
2008, Berkeley	J. Aerosol Science

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