A holistic understanding on the impacts of aerosols and trace gases on clouds and climate

Executive summary

Atmospheric aerosols (otherwise known as particulate matter), through their formation of reflective haze and cloud layers leading to an aerosol cooling effect, have been masking the true rate of greenhouse gas induced global warming. New investigations show that the present-day aerosol cooling effect will be strongly reduced by 2030 as more stringent air pollution abatements are implemented worldwide and the presently available most advanced control technologies striving towards cleaner air are utilized. These actions would increase the global mean temperature by circa 1° C. This is one of the main research outcomes of the recently concluded EUCAARI project (European Integrated Project on Aerosol Cloud, Climate and Air Quality Interaction).

The EUCAARI project, coordinated by Professor Markku Kulmala of the University of Helsinki, Finland, has provided new understanding on the impacts of aerosols and trace gases on clouds and climate. EUCAARI has been the most extensive aerosol research project in Europe so far. The total budget of the project was 15 million Euros, of which 10 million Euros was provided by the European Commission FP6 Programme. In all, 48 research institutes from 24 countries participated in this project, carried out in 2007–2010. The project has led to significantly more information on the whole physical background related to aerosol formation and impacts at all scales — from nano scale to global, from milliseconds to centuries.

The quantification of the effect of aerosols on the radiative balance (cooling or heating) of the planet has been one of the most urgent tasks to underpin more informed projections of future climate change. The project performed extensive studies from ground-based, aircraft and satellite platforms not only in Europe but also in China, South Africa, Brazil and India. These studies improved the theoretical understanding of the aerosol life cycle, enabling us to make major improvements in climate and air pollution models and present new air pollution scenarios over Europe. The project outcome has been targeted to reinforce European political decision-making to develop new strategies and implementation plans for global air quality monitoring and to give Europe a leading role in developing and applying environmental technologies.

The positive impacts of aerosols are partially off-setting global warming while the negative effects have an impact on public health. Abatement of the negative health impact is complicated due to the diversity of sources of aerosols, even within Europe. EUCAARI found that reduction in ammonia emissions is one of the most effective ways to reduce aerosol mass concentrations in Europe. Reduction in nitric

oxides is also effective, but might lead to higher ozone levels, thereby leading to another negative impact on air quality. Reduction in sulphur dioxide emissions will reduce particulate air pollution, especially in the Eastern Mediterranean area. Reduction of organic aerosol concentrations is a lot more challenging and will require reductions of gas and aerosol emissions from transportation and biomass burning.

Furthermore, it is now shown that a large fraction of organic aerosols in Europe is of modern origin (as opposed to fossil fuel origins) for which the main sources are biogenic secondary organic aerosol (boreal forests), biomass burning and primary biogenic aerosol particles. All these emission sources are expected to respond to climate change, although we are presently unable to gauge the strength of the multitude of feedback mechanisms involved.