Australian Institute of Physics NSW Branch (September News)

The September meeting of the NSW branch of the AIP was held at the University of Sydney on Tuesday 22 September 2009 and featured a public talk by Michael Box. Michael is currently working as an Associate Professor in Physics at the UNSW and his research comprises on particle scattering theory, remote sensing inversion theory, radiative transfer, aerosol optical properties and effects. Michael's work covers all aspects of atmospheric aerosols (suspended particles) and their environmental impacts and has published many papers in these areas. His group is currently investigating the distribution of aerosols in Sydney, and especially any chemical or physical variations. The work of his group is directed at studying aerosol amounts and type from space, and also at computing the climatic impact of these aerosols which his talk was based on Atmospheric Aerosols: Physics, Chemistry and Climatic Impacts

The Earth's climate is maintained by the atmospheric flows of solar and terrestrial radiation, which have almost no spectral overlap. Any change in atmospheric composition, or surface reflectivity, which alters one or both of these flows, is usually referred to as radiative (climate) forcing. The best known, and best understood, of these forcings is the impact of increasing levels of greenhouse gases on terrestrial (thermal) radiation, with a current estimate of about 2.5 Wm^{-2}.

Atmospheric aerosols are small airborne particulates, with sizes ranging from a few nanometres to 10 micrometres, or more. In the troposphere they have residence times of a few days to a week, so that they are both spatially and temporally highly variable. They may be natural or anthropogenic, and sometimes a mixture of both. Primary particles, such as windblown dust, sea spray and soot, are injected into the atmosphere directly, and are usually in the coarse mode, greater than 1 micron in size. Secondary particles are created by the condensation of precursor gases, such as sulphur dioxide and volatile organic compounds such as terpenes, either on the surface of existing particles, or forming new particles.

Photo: From left to right, Dr Fred Osman (AIP Branch Chair) and Professor Michael Box

Aerosols may constitute a health hazard, especially if they are small enough to penetrate to the deeper lung tissues. As a result, they are subject to monitoring by Environmental Protection authorities, and form part of the reported pollution indices. They are also highly effective at scattering sunlight, which may lead to degradation in visibility, and the blurring of satellite imagery. Many are hygroscopic, and may take up considerable quantities of water as relative humidity approaches 100 per cent.

They may affect climate, at least at the regional level, by impacting on the flows of both solar and longwave radiation. By scattering sunlight back to space they cool the planet, known as direct forcing. Sooty aerosols actually absorb solar radiation, changing atmospheric vertical stability. Because of their water absorbing properties, an excess of suitable aerosols in a supersaturated environment will results in condensation to form more, but smaller droplets. The resulting cloud will most probably be more reflective, and may also last longer – the first and second indirect effects. Thus an increase in aerosol loading is likely to lead to an overall planetary cooling, partially counteracting greenhouse warming.

Any change in radiation (energy) flows through the atmosphere constitutes a climate forcing. Computing the forcing due to the post-industrial increase in greenhouse gases is relatively easy. Aerosol forcing is much harder to quantify, and the error bars are much larger, but the sign is almost certainly a cooling. Despite these large uncertainties, when computer models are run with natural forcings, greenhouse gas forcings, and our best estimates of the aerosol forcing, they give a better match to the 20th century global temperature changes than when any of these forcings are omitted.

Michael's group has been investigating the physics and chemistry of mineral dust aerosols from Australia's arid interior. Their red colour is a reflection of the fact that they absorb blue light, so that it is currently uncertain whether they exert a warming or cooling influence on the planet. We have undertaken 3 field campaigns, collecting a number of sets of size-resolved samples. These have been subjected to Ion Beam Analysis to determine their metal content, Ion Chromatography for soluble ion content (including organic acids), and QEMSCAN, a revolutionary new CSIRO-developed mineralogy tool for studying individual particles. We were also able to collect samples during the recent Sydney dust storm, which should lead to invaluable intercomparisons.

Photo: Further discussions continuing later during dinner at the Buon Gusto Italian restaurant.

The talk was very well received and geared to scientists and members of the public alike with many discussions continuing later during dinner at a nearby Italian restaurant. The Australian Institute of Physics thanks Associate Professor Michael Box for his outstanding lecture!

Dr Frederick Osman - AIP NSW Branch Chair