Aerosol sounding with LOAC at the EGU 2013 General Assembly

Remember the orange ballon flying outside the Austria Center Vienna during this year's General Assembly? It was part of an experiment to measure aerosol concentration and determine air quality at the conference. Experiment-leader Jean-Baptiste Renard reports on the results here.

Measuring the concentration and mass of aerosols in the lower atmosphere is of primary importance. Their presence in the ambient air can have direct effect on human health as these pollutant particles can enter the body's airways and interfere with gas exchange in the lungs. Further, their interactions with solar radiation and clouds are likely to affect the climate and, in some occasions of very high concentrations in altitude, they can affect air traffic security.

Due to the large variety of aerosol sources, both of natural and man-made origins, and their relatively short lifetime in the atmosphere, the concentration, nature and size of the particles experience significant variability. To understand and predict aerosol impacts, it is important to develop observation and monitoring systems allowing their characterisation. To determine the size and distribution of aerosols, researchers often use optical particle counters, which work by detecting the light scattered by the suspended particles.

LOAC at the EGU General Assembly

At the EGU 2013 General Assembly, which took place in Vienna in April this year, we conducted aerosol measurements under a tethered balloon using a new kind of light aerosols counter (Fig. 1, left). The instrument, called LOAC (Light Optical Aerosols Counter), weighs 1 kg and can determine the concentration of particles in 19 size classes, with diameters from 0.3 to 50 µm. It can also inform on the main nature of the detected aerosols: carbon (such as soot), mineral (such as microscopic sands) and liquid (droplets).

We flew LOAC under a 6 m^3 tethered balloon operated by the Austrian Meteorological Office, with maximum altitudes in the 110–220 m range (Fig. 1, right). On 9 April 2013, we conducted the fights during the morning coffee break (~10:30), lunch time (~13:00) and afternoon coffee break (~15:30) while on 11 April 2013, only one flight was conducted, during the morning coffee break (~10:30). For each 30-minute session of measurements, the LOAC performed two ascents and two descents. For comparison, we also conducted indoor measurements in the main hall of the conference centre during the 10 April afternoon (15:30–16:30).

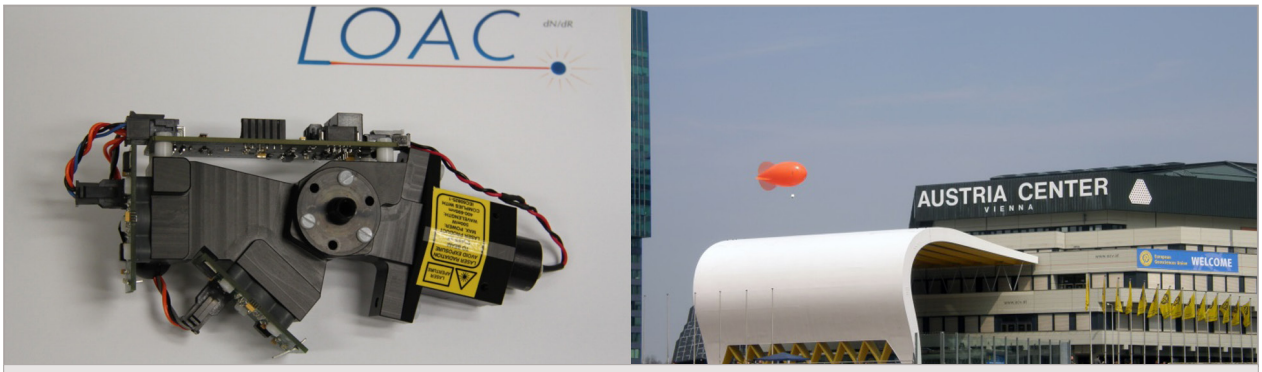

Figure 1. Left: LOAC optical chamber and electronics. Right: LOAC balloon deployment at the EGU 2013 – the aerosol counter is in the small white box under the balloon. (Credit: F. Dulac)

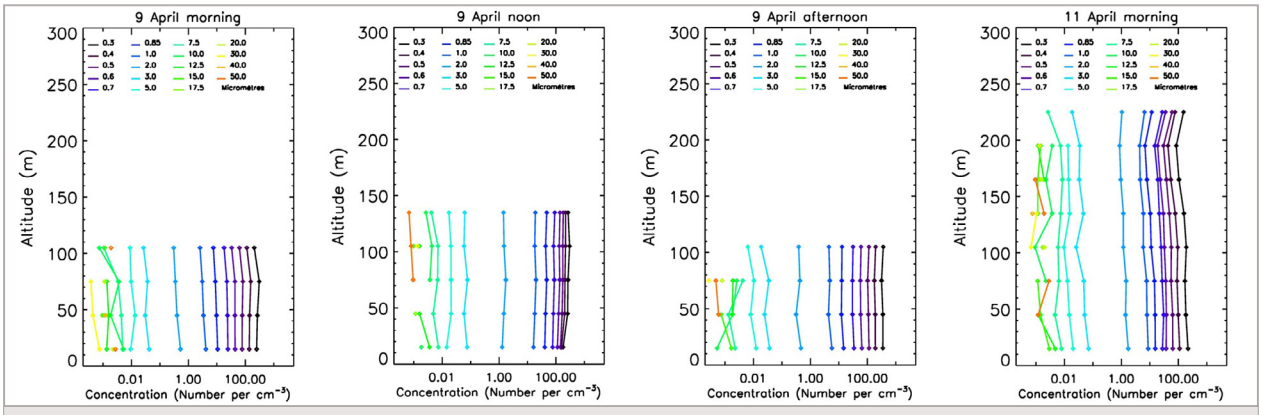

Figure 2. Vertical distributions of 19 size classes for the four LOAC flights

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Aerosol concentrations at the conference

Figure 2 presents the evolution with altitude of the concentration for 19 size classes obtained during the four outdoor flights. The concentration of particles greater than ~3 µm decreases with altitude because they are more massive than the smallest ones. This effect, shown in Fig. 3 for two different altitudes during the 11 April morning flight, induces changes in the size distribution.

The smallest aerosols exhibit significant variation of concentration with altitude, probably due to air masses of different origins. The size distribution of these aerosols also changes with time due to different processes in the aerosol formation and transport during the day.

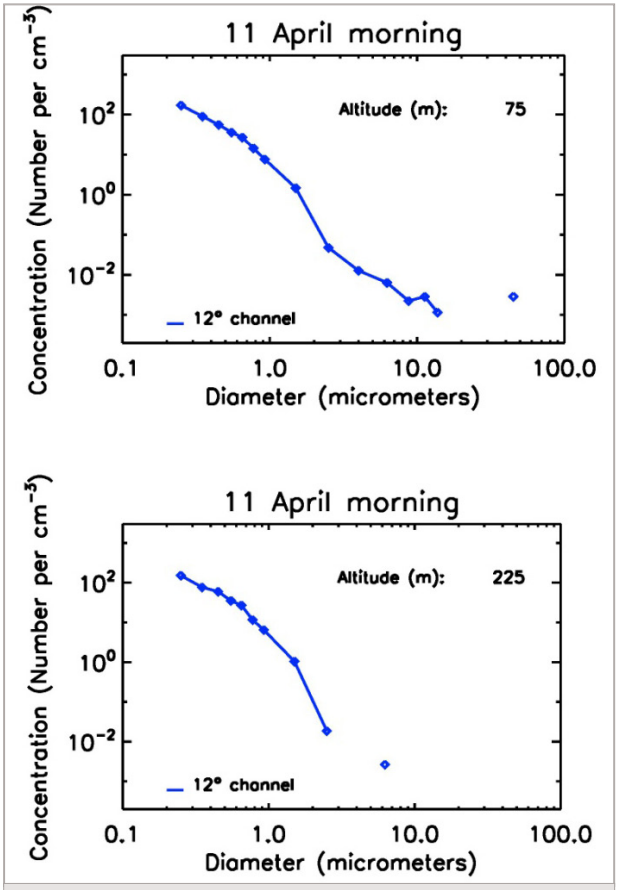

Figure 3. Size distribution at two different altitudes for the 11 April morning flight (12° channel refer to the scattering angle measurements used by LOAC for the counting)

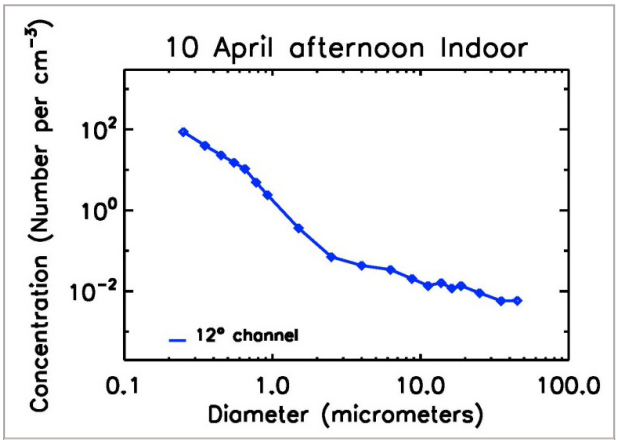

Figure 4. Indoor measurements during the 10 April afternoon coffee break

The measurements indicate various natures of particles depending on the altitude and time of measurements. During the 9 April morning flight, LOAC detected only mineral particles. At lunch time, carbon particles and large mineral particles were present at all altitudes. Then, in the afternoon, the particles were mineral for altitudes below 100 m and carbon above. On 11 April, mineral and carbon particles were present from the ground up to 150 m. Above 175 m, only carbon particles were detected, as expected for urban pollution. The presence of mineral particles below 150 m could be due to building works going on in the towers close to the conference centre. Thus, at the EGU 2013 General Assembly, mineral particles dominated the ambient air, which is unusual since carbon particles are expected to be the main population of urban aerosols.

To compare the outdoor air quality with that indoors, we present in Fig. 4 the size distribution for the aerosol measurements we conducted indoors on 10 April. The concentration of the largest particles was about five times higher than in the outdoor air, with the nature of particles being mineral and carbon. Such measurements show that the indoor air was more polluted than outside in terms of total aerosol mass, as expected since many human activities and movements were present. From the LOAC counting, it is possible to provide a rough estimation of the total mass of particles per cubic metre, assuming a mean density of 2 g/cm^3 for the particles. During peak activity, the concentration of particles smaller than 10 µm surpassed 50 µg/m^3, which is the limit daily-average value defined by EU air quality standards.

LOAC's uses

In conclusion, the flights conducted with LOAC under a tethered balloon allowed us to determine the vertical evolution of pollution particles up to an altitude of 200 m, and to point out an evolution of the nature of aerosols with altitude. These kinds of measurements can help distinguish between local sources and averaged ambient air above cities. Similar measurements are now conducted routinely with LOAC from the Observatoire Atmosphérique Generali touristic balloon in Paris, up to an altitude of 300 m.

LOAC is also involved in several campaigns, such as ChArMEx (studies of tropospheric pollution in the Mediterranean Sea) and AEROWAVE (studies of variability of aerosols atmospheric content up to the stratosphere) with flights under different types of balloons.

Jean-Baptiste Renard
Senior scientist at LPC2E–CNRS and Orléans University in France, on behalf of the LOAC team and collaborations

Acknowledgements

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Anthropocene: the exhibition

Curators from the Deutsches Museum in Munich, Germany discuss an upcoming exhibition that will present geology and environmental issues to the public and encourage the scientific community to get involved in the project.

The Anthropocene has emerged as a popular term used by scientists and the media to partition the current phase of Earth's history. The concept suggests that the scale of human impact on the planet has become so great that the collective action of the species will be found in the geological record. Currently there is an Anthropocene working group of the Subcommission on Quaternary Stratigraphy who are preparing a proposal to the International Commission on Stratigraphy to have the period formalised. The proposal is not due until 2016, but before then the Deutsches Museum will hold the Anthropocene Exhibition.

Although it has antecedents reaching back to the early twentieth century, such as Vernadsky's 'Noosphere', the term Anthropocene has only been in use for over a decade. In 2000, Nobel Prize winning chemist Paul Crutzen described the term and later in the same year gave a further impulse to the concept with a short publication (co-authored with Eugene Stoermer) that appeared in the International Geosphere Biosphere Newsletter. Soon the term was being used in the global change community. In recent years it has spread throughout many disciplines and has struck a chord with many scholars in the humanities, where the concept appears original in its genuine challenge of nature-culture dichotomies. Recently, the Rachel Carson Center for Environment and Society, a joint endeavour of Munich's Ludwig Maximilians Universität and the Deutsches Museum, hosted the conference Culture in the Anthropocene in Munich. The concept has also gained the curiosity of artists and museums looking for creative ways to explain the increasing pervasiveness of humans.

Understanding that this is both a concept with utility for science and public engagement, the Deutsches Museum has embarked upon the Anthropocene Exhibition to be opened in October 2014. The exhibition team is working on taking the concept from a complex assemblage of academic insights into a collection to showcase to the public. At this stage in the planning process we can offer a few insights into the exhibition.

Rudolf Diesel and Oskar von Miller, founder of the Deutsches Museum, 1897 (Courtesy of the Deutsches Museum)

The exhibition

The current scale of environmental issues demands that scientists and policy makers reach the public on as wide a platform as possible. Over its long history the Deutsches Museum has sought to be one of the sites to engage the public with science and technology. From the beginning of the museum, its founder Oskar von Miller and supporters like the engineer Rudolph Diesel wanted to communicate to society "the great masterworks of the natural sciences and technology". With global industrialisation and mechanisation influencing more areas of the planet, the associated changes have reached previously unimaginable dimensions and dynamics. With this, the role of the museum has also been challenged. In a survey

Ideal Moon Landscape, by Wilhelm Kranz, 1919 (Courtesy of the Deutsches Museum)

Population, meat and corn production in Germany for 1883–1909, postcard, 1911 (Courtesy of the Deutsches Museum)

of patrons we found that eighty percent of those interviewed wanted the museum to engage with controversial topics.

The exhibition will visualise the history, present and future of the Anthropocene. It will also display the deep interventions of humans into the geo- and biosphere over the last two centuries. It will not, however, be conceptualised as a history of decline, but as a complex story of destruction and shaping. Science and technology based concepts of transformation are not only to blame for past mistakes, but offer some of the greatest potential in moving towards a sustainable economy and society. Accepting that we are now living in the Anthropocene is not a move towards anthropocentricism but an attempt to overcome the dualism between humans and nature; this philosophical challenge is an equally important thread to weave into the exhibition. Topics of the exhibition will include: humankind as destroyer, but also creator and designer; the anthropogenic planet that is shaped and changed by human beings; historically grown consumption patterns and lifestyles; time and space as important factors in the Anthropocene; the future as challenge but also as chance for humankind and its political institutions, social networks and dreams.

The exhibition's main goal is to inform visitors about the Anthropocene as a scientific hypothesis and a currently debated vision of the role of humans on Earth. It shows the effects of human intervention as a biological and geological actor, increasing awareness for both temporal and spatial extent of human-invoked environmental changes. By translating the concept into a three-dimensional space, the exhibition offers the general audience a unique opportunity to experience the Anthropocene and learn about the current state of scientific knowledge and ongoing discussions.

Engaging the geologic

The exhibition is planned to run for eight months. Accompanying it, will also be a catalogue, an educational program, a lecture and film series and an online exhibition with the exhibition partner, the Rachel Carson Center.

The message of the Anthropocene makes significant contribution to the ongoing conversation about the human impact on the planet. At its heart the concept is layered with the sediments of geology and in this way we are planning to have a geological trace that runs throughout the exhibition. We would like to engage with as many scholars in the Earth sciences as possible and the curatorial team invites interested scientists who would like to contribute their knowledge to the formation of the exhibition to contact us with comments and suggestions. The Anthropocene Exhibition is set to be an original and important endeavour that brings transdisciplinary scientific knowledge about the 'age of humans' to the public.

For further information contact the project manager Nina Möllers and check the exhibition website.

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