Atmos. Meas. Tech. Discuss., 4, C2587–C2591, 2012
www.atmos-meas-tech-discuss.net/4/C2587/2012/
© Author(s) 2012. This work is distributed under
the Creative Commons Attribute 3.0 License.

Atmospheric Measurement Techniques Discussions

Interactive comment on "In situ study of particle growth in convective eddies of the planetary boundary layer" *by* B. Alföldy et al.

Anonymous Referee #1

Received and published: 9 January 2012

General comments

The authors used a motorized glider to measure aerosol size distributions during the gliding phases and climbing phases in thermals. The differences observed are interpreted as nucleation signatures and particle growth during transport in the convective boundary layer. The work presented is an interesting approach to study particle properties in the boundary layer using a mobile platform that works as an indicator of vertical motion. As that it is a new approach and worth publishing. However, I have several concerns on the methodology and the conclusions drawn from the results. The paper thus needs substantial and major revision.

The authors state in the introduction the manuscript aims at the link between secondary aerosol formation and atmospheric dynamics. In the conclusion they claim: encouraged by the success of the simultaneous study of atmospheric dynamics and particle concentration...

These statements would require at least some discussion about the observed atmospheric dynamics, strengths of the thermals, diameter of the circle flights/thermals, typical fraction of upward and downward air vertical motion areas. However a discussion about atmospheric dynamics is completely missing in the manuscript.

Specific comments:

Atmospheric dynamics control the speed of vertical mixing in the planetary boundary layer and thus also the time available for particles to grow. To understand the processes modulation the aerosol size distribution typical time scales are necessary. For example: a thermal with an average 3 m / sec upwards velocity transports an air parcel from the ground to the upper rim of the PBL within 500 sec or less than 10 minutes. During this time the relative humidity changes possibly leading to a particle growth. How does this compare to the particle growth rates for ultrafine particles given in the literature with $\sim$ 4-8 nm/h?

The aircraft itself, even in case of a glider, cannot be used as a probe directly. As the vertical speed of the aircraft ($\sim 1 - 1.5$ m/sec) is a mixture of the velocity of descend of the aircraft (in the order of $\sim 0.5 - 1.5$ m/sec) in quiet air and the real updraft velocity of the surrounding air the strength of the updrafts possibly can be calculated from basic aircraft properties and the measured pressure differences. However, this requires an additional measurement (or at least an assumption) of the true airspeed during the measurements. A glider pilot would normally keep the glider speed for best climb in the thermals, for best gliding outside. The aircraft manual and the polar diagram of the aircraft should give details about the dependence of the downward velocity on the true air speed. Best approach would be the use of a turbulence probe (Crawford and Dobosy, 1992) or similar. As a minimum, measuring the true air speed at the Pitot tube

AMTD

4, C2587–C2591, 2012

Interactive Comment

and consulting the aircraft manual should give at least an idea about the strength of the thermals.

A detailed discussion about the different processes happening in thermal updrafts, entrainment of air from the sides would definitely help in the interpretation of the results (see below). Also, as the data are available the vertical profiles of temperature and humidity and the derive potential temperature could give important additional information.

Experimental section:

The instrumentation selected is a first guess for the intended measurements as far as ultrafine particles are concernded. It is basically possible to get into the ultrafine particle range, however the NanoCheck addition to the GRIMM OPC is not yet thoroughly characterized, at least there is no publication available about the performance, as it is for the condensation particle counters used for example by other authors. Thus a short description of the basic principle of this counter, including the cutoff threshold and the counting efficiency for the ultrafine particles would be highly desirable. Best would be an intercomparison reference with an SMPS system. The instrument is not sufficient to study nucleation processes. A threshold of $\sim$ 5 nm would be required. Otherwise nucleation cannot be separated from direct emission.

Aerosol inlet:

The aerosol inlet is an important part of the measuring chain and critical for sampling of the larger particles. The description in the manuscript as a tapered diffuser is insufficient for the purpose of the manuscript especially in the context of the discussion of the cloud passage, sampling aerosols inside clouds causes additional problems and might be affected by artifacts with a simple diffuser (splashing of cloud droplets, wet surfaces etc.). For a manuscript dealing with measuring technologies a more detailed description is required.

Results:

AMTD

4, C2587–C2591, 2012

Interactive Comment

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper

Particle concentrations as presented in figure 2 upper panel are about twice as high in the lowest part of the first ascend, than dropped rapidly in the second ascent. In case, these are two thermals they will have two different source areas on the ground. Otherwise it would be difficult to explain (and even contradict the following discussion) the sudden loss of particles in the same stream of warm ascending air. Local particle source areas are for example the motorways M2 and M3 with traffic emissions in the size range of 10 to 30 nm and possibly some industry the city of Vac. The first two reported peaks in the aerosol number are beginning when the aircraft is close to the highest altitude of the thermal ascend and continue during the descends and approaches to 800 m or below. This again is not really in agreement with particle nucleation or transport within a thermal and could be either due to local plumes or an incomplete mixing in the planetary boundary layer at the time of the flight with remaining high particle numbers at lower elevation. The potential temperature profile would probably give additional information for the interpretation. The data given in the figures are in many cases not really supporting the discussion.

Cloud passage:

The discussion in the manuscript is not correct and in agreement with the figures. Bringing the individual scales of figures 2 and 3 together it's obvious that all particle numbers decrease in the cloud and increase concurrently after leaving the cloud, though the decrease in the finest particle size fraction is less than in the larger fraction. Increases in ultrafine particles close to cloud surfaces are often observed and probably due to cloud processing, the relatively lower reduction of ultrafine particles compared to the larger fraction of 280 to 300nm could be due to the fact that particles smaller than a certain threshold in the clouds are not activated as cloud droplets. Real updraft velocities and the concentrations of water vapor (see above) would probably help with the interpretation. The few data given in the text are not sufficient to support the hypothesis.

Summary:

AMTD

4, C2587–C2591, 2012

Interactive Comment

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper

The statement that increased ultrafine particle concentrations are observed in three thermals does not agree with the data presented in the graphs. The particle number concentration increases in two out of several thermals in the uppermost meters of the thermal and continues to grow after leaving the thermal during the descent. Given the 6 sec time resolution of the GRIMM 1.109 and the rapid reaction of the sensor to the cloud encounter a timing issue can be excluded. As it is occurring not regularly in the mayority of all thermals it's probably not related to thermals, rather to local sources. This can be discussed only knowing the exact position of the thermals and the land use or 3D emission source distribution on the ground at the footprint area of the individual thermals.

Interactive comment on Atmos. Meas. Tech. Discuss., 4, 6969, 2011.

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper