New particle formation at free tropospheric site

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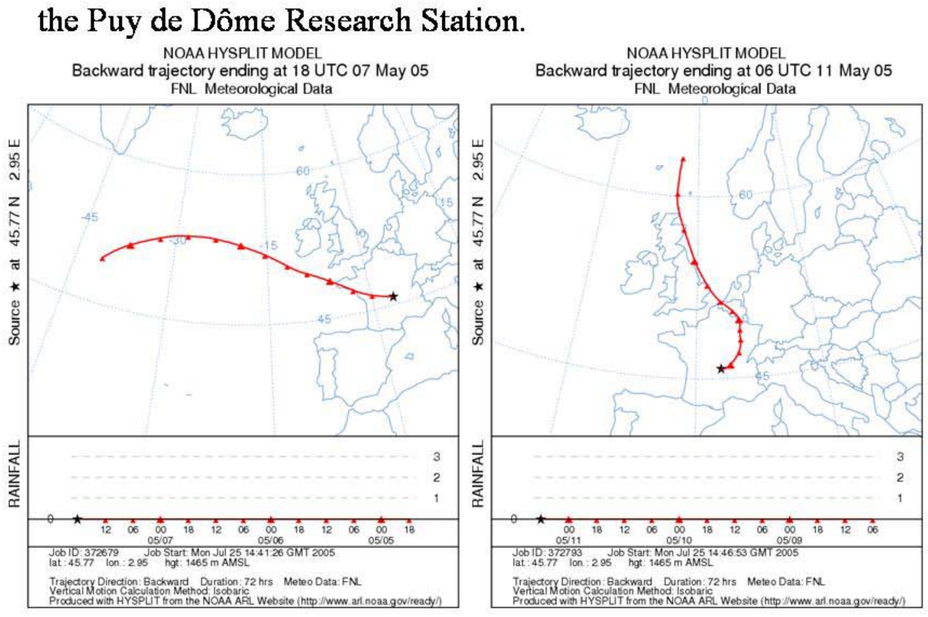
SCIENTIFIC CONTEXT

Aerosol particles play an important role in climate, by interfering with the solar radiations and taking an active part in the radiative earth budget In order to be able to predict the particle number concentration at a given time and location, formation of new particles processes need to be understood. Particle formation events or aitken mode bursts have been often observed at the top of the boundary layer (Keil and Wendish, 2001; Siebert et al., 2004) and synoptic conditions should be explored as an explaination for favouring new particle formation. In this context, The atmospheric observatory of the puy de Dôme can provide long term and full sets of data that can help outlining specific relationships between atmospheric parameters and new particle formation. This work reports on new particle formation events observed during the Spring 2005, on the free tropospheric site of the Puy de Dôme Research Station.



Figures 1a and 1b Air mass back trajectory calculated from the Hysplit model (NOAA) (a) ty pical of the 07th to 10th of May, 18:00 UTC period (b) typical of the 11thof May.

Results presented in the present work are relative to a 5 days period when the air mass type was North-Western, as represented on Figure 1 (7th to 10th of May, total particle number ranged from 500 to 2800 particles cm-3) to North-Eastern (on the end of the 10th and 11th of May 2700 to 4200 particles cm-3)

New particles have been detected at the puy de Dôme Research Station with a size of 5 nm. On two consecutive days, these particles appear to grow to larger sizes during the day, reaching 40 to 50 nm particles in size (Figure 2). The apparent growth of these particles would indicate an horizontally homogeneous spatial extension of the new particle formation. Followinf the new particle formation events, the accumulation mode number concentrations are significantly enhanced, indicating that the process could contribute to the total particle number found in the free troposphere.

The growth rate of the newly formed particles calculated from these data is about 3 to 4 nm per hour for the Northern air mass (11th of May), which is about twice as high compared to the Western air mass (on the 10th). The growth of the newly formed particles might be favored in more polluted air masses. These growth rates can be extrapolated to particles smaller than 5 nm, indicating that 1 nm particle would have started growing three hours earlier on the 10th, at about 60 kms away, and one hour and a half earlier on the 11th, 40 km away from the puy de Dôme.

New particle formation events seem to be unlinked to eventual inputs from the boundary layer into the troposphere, as indicated by the lack of correlation with anthropogenic indicators such as BC. The strongest dependence of new particle formation occurrence was found on radiation and a strong anticorrelation was observed between the total number of particles and the relative humidity.

MEASUREMENTS

The puy de Dôme Research Station, central France, is located at 1465 m asl on the first mountain chain facing dominant western winds. It is equipped with a complete instrumentation for meteorological parameters measurements, ozone, CO and CO2, Rd, NOx, SO2, BC and several aerosol and cloud characterizing parameters.

Particles size distributions were calculated from data obtained from a twin-SMPS (Scanning Mobility Particle Sizer) recently installed at the station and operated during the Spring period when most of new particle formation are observed at other locations (Boreal Forest, Finland, Boy and Kulmala 2002; Po Valley, Italy Laaksonen et al. 2005)

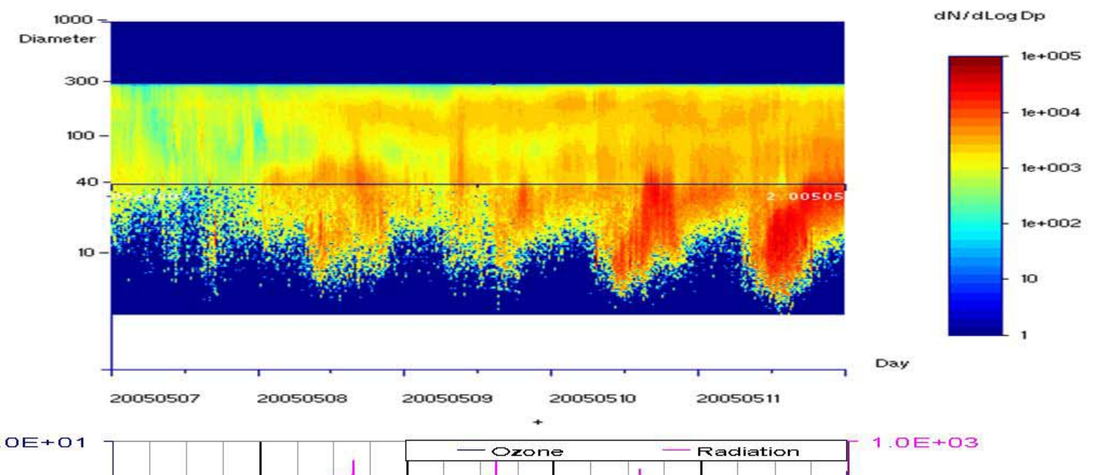


Figure 2. Particle size distributions as a function of time over a five-day period obtained from the twin SMPS. New particles have been formed at close distance from the Research station (5 nm particles are observed) on the 10th and 11th of May.

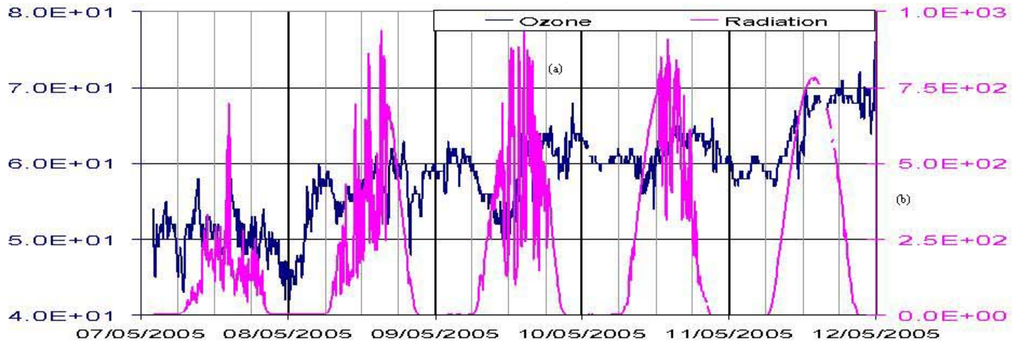


Figure 3. Ozone mixing ratios and visible radiation on the five-day measurement period. The presence of clouds appear to inhibit the formation of new particles. Ozone mixing ratios are higher on nucleation days.

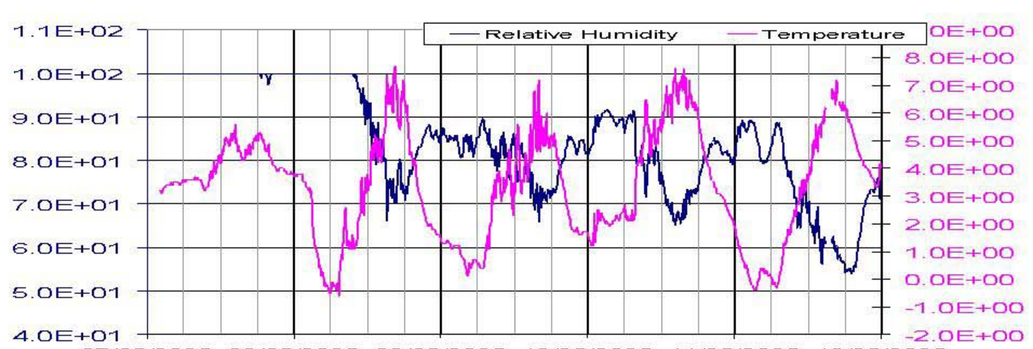


Figure 4. Relative humidity and temperature are anticorrelated, as expected, but there is also a strong anticorrelation between the relative humidity and the presence of nanoparticles (from 5 to 20 nm).

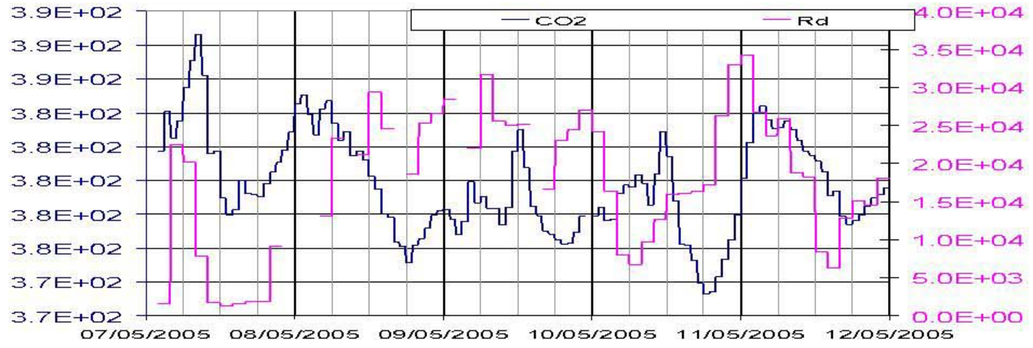


Figure 5. Radon is indicative of continental air masses from the boundary layer. On the two nucleation days, the Rd mixing ration is not correlated with the appearance of new particle formation, indicating that they do not originate from pollution in the boundary layer.

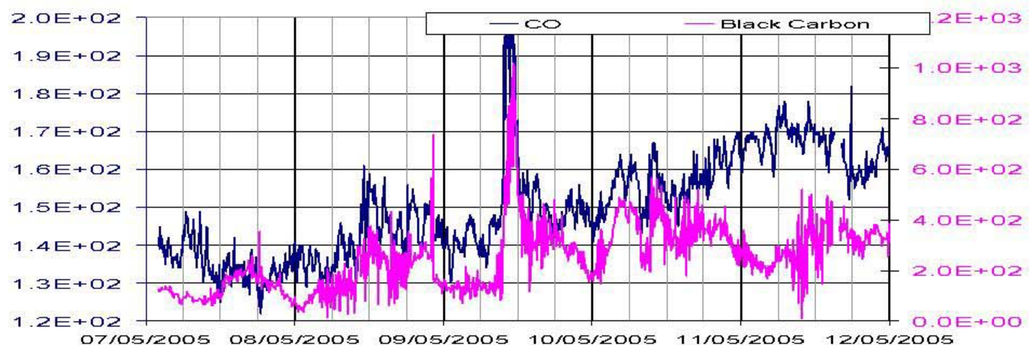


Figure 6. CO and Black carbon are mostly correlated, both indicative of combustion processes. They are not correlated to any particle formation events.

REFERENCES

Keil, A. and M. Wendisch, *Journal of Aerosol Science*, 32, 649-660, 2001.
Siebert, H., F. Stratmann, and B. Wehner, *Geophysical Research letters*, 31, L09102, doi:10.1029/2003GL019086, 2004.
Boy M. and M. Kulmala, *Atmos. Chem. Phys.*, 2, 1-16, 2002.
Laaksonen, A. et al., GRL, 32, doi:10.1029/2004GL022092, 2005.

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