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A 5-year climatology of cloud droplets chemical composition from puy de Dôme

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Chemical and physical processes in the atmospheric multiphase systems significantly influence the transport, vertical redistribution, chemical transformation, and removal of chemical species from the atmosphere, and hence impact on the lifetime of both aerosols and gases. The chemical composition of cloud droplets is an important indicator of the oxidative properties of the atmospheric liquid phase. At present, most of the available knowledge in cloud chemical composition is derived from experimental field campaigns and, hence, only provides limited information on the temporal evolution of cloud chemistry.

In this study, we compiled 5 years of measurements performed at the puy de Dôme atmospheric station (1465m a.s.l., Central France) and corresponding to more than 40 cloud events and 175 collected samples. Samples have been collected throughout the year for several seasons and at different time of nights and days. Because air masses reaching the sampling site have different origins (Marine/Atlantic Ocean, Continental, Saharan) and degree of anthropogenic influence, the data base offers a very complete view of cloud composition variability. To our knowledge, this corresponds to one of the largest data base available from a free tropospheric site.

A set of parameters has been measured in each cloud sample and includes pH, conductivity, redox potential, dissolved organic carbon, cations and anions. In some cases, the measurements are completed by the determination of liquid phase concentrations of Fe(II)/Fe(III), HCHO, H2O2 as well as of the cloud liquid water content (LWC).

In addition, the data base is completed by measurements performed in a continuous basis at the station, including reactive gases and aerosol physical, chemical and optical properties. Meteorological and radiative measurements are also available at the station. Back-trajectory analyses are regularly computed to establish a climatology of the different air masses advected to the sampling site.

Our results show no significant seasonal dependence of the cloud chemical composition that appears to be rather driven by the air mass origin. Clearly, we can distinguish a significant human impact on cloud chemical composition identified with very low pH and increased redox potential, DOC and NO_3^- concentrations. On a climatological basis, the LWC does not appear to be driving the total ionic content (TIC) that is mostly controlled by the concentration of cloud condensation nuclei and soluble gas phase species concentrations.