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Long term precipitation chemistry and wet deposition in a remote dry savanna site in Africa (Niger)

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Abstract. Long-term precipitation chemistry have been recorded in the rural area of Banizoumbou (Niger), representative of a semi-arid savanna ecosystem. A total of 305 rainfall samples (~90% of the total annual rainfall) were collected from June 1994 to September 2005. From ionic chromatography, pH major inorganic and organic ions were detected. Rainwater chemistry is controlled by soil/dust emissions associated with terrigenous elements represented by SO_4^{2-} , Ca^{2+} , Carbonates, K^+ and Mg^{2+} . It is found that calcium and carbonates represent ~40% of the total ionic charge. The second highest contribution is nitrogenous, with annual Volume Weighed Mean (VWM) for NO_3^- and NH_4^+ concentrations of 11.6 and 18.1 $\mu\text{eq.l}^{-1}$, respectively. This is the signature of ammonia sources from animals and NO_x emissions from savannas soil-particles rain-induced. The mean annual NH_3 and NO_2 air concentration are of 6 ppbv and 2.6 ppbv, respectively. The annual VWM precipitation concentration of sodium and chloride are both of 8.7 $\mu\text{eq.l}^{-1}$ which reflects the marine signature of monsoonal and humid air masses. The median pH value is of 6.05. Acidity is neutralized by mineral dust, mainly carbonates, and/or dissolved gases such NH_3 . High level of organic acidity with 8 $\mu\text{eq.l}^{-1}$ and 5.2 $\mu\text{eq.l}^{-1}$ of formate and acetate were also found. The analysis of monthly Black Carbon emissions and Fraction of Absorbed Photosynthetically Active Radiation (FAPAR) values show that both biogenic emission from vegetation and biomass burning could explain the rainfall organic acidity content. The interannual variability of the VWM concentrations around the mean (1994–2005) is between $\pm 5\%$ and $\pm 30\%$ and mainly due to variations of sources strength and rainfall spatio-temporal distribution. From 1994 to 2005, the total mean wet deposition flux in the Sahelian region is of 60.1 $\text{mmol.m}^{-2}.\text{yr}^{-1} \pm 25\%$. Finally, Banizoumbou measurements are compared to other long-term measurements of precipitation chemistry in the wet savanna of Lamto (Côte d'Ivoire) and in the forested zone of Zoétélé (Cameroon). The total chemical loading presents a maximum in the dry savanna and a minimum in the forest (from 143.7, 100.2 to 86.6 $\mu\text{eq.l}^{-1}$), associated with the gradient of terrigenous sources. The wet deposition fluxes present an opposite trend, with 60.0 $\text{mmol.m}^{-2}.\text{yr}^{-1}$ in Banizoumbou, 108.6 $\text{mmol.m}^{-2}.\text{yr}^{-1}$ in Lamto and 162.9

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mmol.m⁻².yr⁻¹ in Zoétélé, controlled by rainfall gradient along the ecosystems transect.

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