Water and chemical input via hydrometeors in central European mountains with Szrenica as an example

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Atmospheric pollutants are transferred to the ground by the contribution of various types of hydrometeors. These are atmospheric precipitation and non-precipitation components belonging to the atmospheric deposits (dew and hoarfrost as well as rime and liquid fog). Due to the different techniques concerning sampling and measurements, comparative analyses between them are often neglected. Hence, the main goal is to compare chemistry of different types of hydrometeors and their role in both: water balance and pollutants deposition.

Precipitation, dew, hoarfrost, liquid fog and rime samples were collected daily all through the 2009 year at the Szrenica Mt. [1330 m a.s.l.]. It is situated in the western part of the main ridge of the Karkonosze Mts. which falls steeply northward on the Polish side and forms a distinct slope about 1000 m high. During typical westerly wind conditions the Karkonosze Mts. are exposed to highly polluted air from heavy industry densely situated at the distance of tens to hundreds kilometers on the windward side of the mountains.

Precipitation is the main source of water flux at the Szrenica Mt. reaching 1430 mm annually, with the highest molar concentrations of ammonia, nitrates and sulphates (33%, 21% and 14% respectively). However the average TIC (Total Inorganic Ionic Content) of precipitation (273 $\mu$Moles•l$^{-1}$) was the lowest when compared with other non-precipitation hydrometeors, discussed below. This results from relatively clean air in middle and/or upper parts of troposphere where atmospheric processes responsible for precipitation formation take place. That is also the reason why chemical composition of low-level clouds forms an appropriate indicator of the local and regional scale anthropogenic pollution and for larger scale comparisons of chemical components in cloudy environments. Summarizing, direct pollutant deposition via cloud droplets to vegetation is larger than via precipitation because of much higher pollutant concentration of the former.

Dew and hoarfrost provide water quantities much lower to fog or rain, but is a modest supplementary source of water (approximately 0.8% when compare with precipitation). They appear especially during the anticyclonic type of weather with no wind and clear night skies, rare at summit position. TIC for dew and hoarfrost samples was a bit higher in comparison with precipitation (346 $\mu$Moles•l$^{-1}$), but chemical composition quite different to others hydrometeors (chloride – 20%, sodium – 19% and calcium – 18%). It might be explained by air subsidence from the upper part of atmosphere, typical for the mountain summits in anticyclonic type of weather. Stable thermal stratification limits vertical air pollutant transport, especially of anthropogenic origin, and the thickness of the atmospheric mixing layer is visibly lessened. Hence, maritime aerosol is much more important in such circumstances.

Both climate and landscape in Poland are similar to major part of central and western Europe so you can expect that relationship between different components of water flux and pollutant deposition observed at the Mt. Szrenica are applicable also to other European countries where similar natural conditions are found.