The CASTNET Mountain Acid Deposition Program (MADPRO) has been monitoring cloud water and its chemical constituents at Clingmans Dome, TN (CLD303) in the Great Smoky Mountains National Park since 1994. Such high-elevation (typically higher than 800 meters) ecosystems are subject to substantial levels of acid deposition from clouds that originate in polluted areas and contain high concentrations of acidic dissolved ions. High levels of acid deposition result from frequent cloud immersion, orographically-enhanced precipitation, high wind speeds, and the large leaf areas typical of mountain tree species. The steady decline in sulfur and nitrogen species concentrations measured by filter pack sampling at the lower elevation CASTNET sites and reduced estimates of total dry + wet deposition in the eastern United States have not been observed as clearly in cloud water samples from CLD303 (MACTEC, 2010a). The lack of a discernible trend in cloud water concentration measurements and deposition estimates is partially explained by the climatic and ecological factors unique to high-elevation ecosystems.

Recently, however, there have been significant reductions in sulfur and nitrogen species measured at CLD303, perhaps associated with emission reductions at Tennessee Valley Authority (TVA) power plants during the period from 2007 through 2009 (TVA, 2010). The 2009 mean sulfate and nitrate cloud water concentrations declined by 60.4 percent and 49.3 percent with respect to 2007 concentrations. Sulfur dioxide emissions from all TVA plants declined by 47 percent from 2007 to 2009. The nitrogen oxides emissions decrease over the same period was 70 percent (see graph below). Because of the substantial decline in both mean sulfate and mean nitrate cloud water concentrations, precipitation concentration data were obtained from the nearby NADP/NTN site at Emlyn, TN (TN11) to assess whether the 2009 mean seasonal (June through September) sulfate and nitrate precipitation concentrations exhibited a similar reduction. The data were compared over the same period from 2000 to 2007 and 2009.

Mean Seasonal Cloud Water and Mean Seasonal Precipitation
Sulfate Concentrations, 2000-2009

Mean Seasonal Cloud Water and Wet Sulphate Deposition Estimates, 2000-2009

Mean Seasonal Cloud Water and Wet Nitrate Deposition Estimates, 2000-2009

Although substantial decreases were observed in both cloud water and precipitation sulfate and nitrate concentrations since 2007, these decreases were not manifested by decreases in deposition. Consequently, sensitive high elevation ecosystems of the Smoky Mountains can continue to experience damage from acidification because of poorly buffered soils and other ecological factors until well after sulfate and nitrate emissions decrease. Therefore it is important to continue collection and calculation of sulfate and nitrate deposition estimates at the Clingmans Dome site. As can be seen in the concentration and deposition graphs there are no data for cloud water from 2008 when the site did not operate due to lack of funding. This was especially unfortunate timing since 2008 was an interesting monitoring year because of the substantial drop in emissions. The program is currently partially funded through the 2011 season, but at this point in time there is no funding for continuation beyond the 2011 season.