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High-resolution GPS tomography in the mountainous Canton of Valais (Switzerland)

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The occurrence of severe weather conditions, flooding and storms has more and more increased in recent times. To improve the weather forecasts, it is essential to determine the time-variant atmospheric water vapor distribution with a much higher spatial and temporal resolution than it is possible today.

The use of the tropospheric propagation delays of the GNSS radio signals has gained considerable importance as a valuable contribution to weather analysis. Applying a tomographic method, which processes GPS slant and zenith path delays, the spatial distribution of the water vapor can be determined. The development of small-scale high-resolution GPS tomography will help to determine and model water vapor profiles and monitor their temporal change over local catchment areas.

The main objective of the current project is the determination of a 4-dimensional distribution of atmospheric water vapor over a local region using the tomographic approach. Two dedicated field campaigns were accomplished in the Canton of Valais, were hydrological hazard is witnessed by extreme flooding events. The aim is to study the feasibility of the method for a non-permanent GPS densification network in a region with rugged topography. The GPS-derived water vapor profiles are validated with radio soundings, solar spectrometer measurements, and data of the current numerical weather prediction model aLMo of MeteoSwiss.

The refractivity profiles from GPS tomography match the profiles derived from corresponding radiosonde measurements within 10 ppm (refractivity units) and represent the characteristics of the different tropospheric layers in most cases with high significance. Compared to conventional methods, the density of humidity profiles can be increased substantially. Therefore, the implementation of GPS tomography in near real-time will ultimately allow for earlier forecasts of hydrological hazards.