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Low-cost, dual-frequency GNSS sensing node for water vapour sounding

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The effects of global warming are likely to make increasingly frequent the event of cloudbursts, which concentrate heavy rainfalls (up to 200-300 mm in few hours) over a small area, sometimes generating catastrophic floods. The difficulty to provide reliable forecasts for sudden and localized events makes it often impossible to warn the inhabitants of endangered areas, or to prepare countermeasures (e.g. by the management of water accumulation in buffer basins etc). The ubiquity of GNSS signals, whose propagation is affected by water vapor in the atmosphere, makes it possible to have a distributed probe to log data of great value to improve the forecasts by numerical models, with the final aim of alerting against the possible occurrence of these events.

Unfortunately, water vapor sounding by GNSS has traditionally required complex, professional receivers operating on different GNSS bands, making therefore expensive the deployment of sensing networks over wider areas: a problem in contrast with the increasing need to exploit GNSS techniques by a denser sampling of the tropospheric vapor distribution.

The present article reports the first embodiment of a low-cost (<1000$ in volumes of hundreds) remote sensing unit, working on the L1 and L2C GPS bands (and with minor variations on GALILEO E1/E5a), and built exploiting some smart modifications of commercial chipsets originally designed for L1-only applications in the automotive domain. The availability of raw GNSS data at two frequencies allows to eliminate the large (and imperfectly modeled) ionospheric delay error, enabling the determination of the tropospheric delay with a precision meeting the requirements of numerical weather prediction models.

The presentation describes in detail the work pursued and the results obtained by the authors' companies in the frame of the successful EUROSTAR E!10235 Project EDWIGE, and shows how the technology developed in it allows - in principle - to have sensing networks made of hundreds or even thousands sensing nodes. They can be conveniently associated to existing infrastructure (e.g. mobile network towers) to obtain a dense sampling of the tropospheric delay, from which the precipitable water vapor distribution over large areas can be calculated.

Plans to extend the use of the new receiving node also in a maritime environment are briefly touched and discussed.