Rainfall estimation from commercial DVB-S2 receivers for interactive broadcast applications

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Accurate measurement and monitoring of precipitation events is closely linked with different applications that have an impact on human welfare such as water resources management, and floods, landslides or wildfire risk assessments. The conventional devices for the measurement or estimation of precipitation currently adopted worldwide are rain gauges, disdrometers, ground-based weather radars and satellite sensors (both active and passive) and each of them has a different measurement principle, time and space resolution, and accuracy. In the last decades, the opportunistic use of microwave telecommunication signals for meteorological applications received a growing interest. Maybe the most popular example of these unconventional approaches is the use of radio links connecting base stations of cellular networks to obtain an attenuation-based rainfall estimation. In this paper, a new technology that exploits the microwave satellite links for direct-to-home TV broadcast has been investigated to retrieve precipitation information. The idea is to estimate the precipitation starting from the attenuation of the signal along the propagation path from satellite to a user's receiver. Few studies have been carried out in this direction (such as Barthès and Mallet 2013, Mercier et al. 2015, Arslan et al., 2018) and show promising results. The regional administration of Tuscany (Italy) funded the NEFOCAST project with the aim of investigating rainfall rate estimation from attenuation measurements made available by commercial-grade interactive satellite terminals for digital video broadcasting via satellite (DVB-S2), called SmartLNBs. During the NEFOCAST project, an *ad hoc* rainfall retrieval algorithm has been developed, tuned and tested (Giannetti et al. 2017). To validate the rain retrieval algorithm, a 1-year field campaign (from January 2018 to January 2019) was conducted to compare the SmartLNB precipitation estimates with the measurements gathered by 'conventional' meteorological devices such as rain gauges, weather radar and disdrometer. A network of 24 SmartLNBs was deployed in the Greater Florence area (Tuscany, Italy) along with 11 rain gauges and one X-band dual-polarization weather radar. Furthermore, the performance of the NEFOCAST algorithm was preliminarily tested by comparing data provided from one SmartLNB installed at the Institute of Atmospheric Sciences and Climate (ISAC) of CNR in Rome (Italy) with a co-located laser disdrometer. At this site, data from the dual polarization C-band weather radar Polar55C could be compared with SmartLNB measurements along the Earth-satellite link that was operated to collect data in the same direction as the SmartLNB, thus scanning the same portion of atmosphere where the SmartLNB signal was propagating. The results show a good agreement between the total cumulative precipitation (in mm) obtained from SmartLNB data and the one collected by the co-located disdrometer during different rainfall events. The corresponding values of Normalized Mean Absolute Error (NMAE) and Root Mean Square Error (RMSE) obtained comparing the total cumulative precipitations measured by the SmartLNB and the disdrometer are 41% and 4.71 mm, respectively. Encouraging results come also from the comparison of the total precipitation amounts as measured by the SmartLNB and by the rain gauges, with values of NMAE (RMSE) that range between 39% and 53% (2.8 mm and 8.0 mm), depending on the site.

Keywords: opportunistic signal, rain estimation, DVB-S2 , satellite-earth attenuation