Contribution ID: **15** Type: **Oral**

Precipitation field reconstruction and tracking using opportunistic rain sensors: the Summer 2021 catastrophic event in Germany as a case study

Thursday, June 26, 2025 4:45 PM (15 minutes)

Quantitative precipitation estimates are usually derived based on the measurements collected by professional instruments, such as weather stations, weather radars, disdrometers, and rain gauges, with different time/space resolutions, and accuracies.
Recently, the opportunistic use of pre-existing microwave communication links has been investigated to retrieve precipitation estimates. In particular, satellite-based opportunistic systems for rain monitoring, are particularly appealing due to: i) the widespread presence of existing DTH satellite receivers across the territory, which can potentially function as rain-sensing devices, offering significant geographical coverage, especially in densely populated areas; ii) the ease of installation of new terminals to obtain higher spatial density; and iii) the low cost of commercial-grade satellite receive equipment.
In this work, we present a practical application of an opportunistic technique for the estimation of rainfall intensity. It is based on signal strength measurements made by commercial-grade interactive satellite terminals. By applying some processing, the rain-induced attenuation on the microwave downlink from the satellite is first evaluated; then the rain attenuation is mapped into a rainfall rate estimate via a tropospheric model.
This methodology has been applied to a test area of 30x30 km2 around the city of Dortmund (North Rhine-Westphalia, upper basin of Ermscher river), for the heavy rain event that devastated Western Germany in July, 2021.
A spatial and temporal reconstruction of the event was obtained from a set of satellite terminals deployed in the region, using a classical spatialization method, based on the inverse distance weighting interpolation. The resulting rainfall maps were successfully compared with those provided by radar climatology of the Deutscher Wetterdienst (DWD), the national German weather service.
Acknowledgements: This work was supported by the following projects: SCORE, funded by European Commission's Horizon 2020 research and innovation programme under grant agreement no. 101003534; Space It Up, funded by the ASI, the MUR –Contract no. 2024- 5-E.0 - CUP no. I53D24000060005; FoReLab (Departments of Excellence), funded by the Italian Ministry of Education and Research (MUR); COST Action CA20136 OPENSENSE, funded by COST (European Cooperation in Science and Technology).

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Session Classification: Application of OS rainfall data

Track Classification: Application of OS rainfall data