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## ESAT, the educational satellite

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The Universidad Politécnica de Madrid (UPM) started educational innovation activities in space engineering in the academic year 2009/10. The implementation of several topics in the Conceive – Design - Implement - Operate (CDIO) syllabus was pursued, mainly focused on the next topics: Hardware and software integration, test, verification, validation and certification. With this objective, the use of demonstrator satellites was included in the practical lessons. The development of a self-designed demonstrator satellite was started leading to the ESAT's birth. ESAT has been created and developed by Theia Space, an initiative born at the Spanish User Support and Operations Center (E-USOC) which belongs to the UPM and is one of ESA's delegated centers for the operation of scientific payloads onboard the International Space Station. ESAT is an educational satellite designed for hands-on learning for all education levels: STEM education, university studies and professional training. It is a 10x10x10 cm nanosatellite based on the successful CubeSat standard and weighing less than 1 kg. ESAT has the typical spacecraft subsystems: Electrical power, command and data handling, attitude determination and control and structure. The user can choose to focus and work on each subsystem independently or to practice with the fully integrated satellite. ESAT features a Wi-Fi communication system allowing the connection with a PC, where the ESAT GUI allows an easy operation of the satellite. ESAT is perfectly fitted to train on design, manufacture, integration, validation and operation of satellites. It has been developed with the open source philosophy and the users are able to expand its functionalities. ESAT allows integrating and testing new user developments, both SW and HW. For the HW developments, the user has access to all the lines in the satellite, including power and communication lines and analog and GPIO lines.

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## Impact analysis of satellite rainfall products on flow simulations in the Magdalena river basin, Colombia

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The Magdalena river is the most important river in Colombia in terms of economic activities and is home to about 77% of the L country's population. The river faces water resources allocation challenges which require reliable hydrological assessments. In this research, the reliability of ground-based measurements, different satellite products of rainfall and their combinations are tested for their impact on the discharge simulations of the Magdalena river. Two different satellite rainfall products from the tropical rainfall measuring mission (TRMM) namely TRMM-3B42 & TMPA, have been compared and merged with the ground-based measurements and their impact on the Magdalena river flows were quantified using the representative elementary watershed (REW) distributed hydrological model. It has been found that the use of TRMM-3B42 satellite product does not produce a reliable estimation of the spatial and temporal rainfall patterns over the study area. The performance of TRMM products has clear dependence on elevation. On the other side, TRMM best performed over areas gently rolling landscape and mild rainy parts. For hydrological modeling purposes the two products did not reproduce reliable estimation for the discharge at the downstream. Both TRMM-3B42 and TMPA tended to suffer from a systematic overestimation of the peak flows. The impact of merging the rainfall products with ground-based measurements to generate a continuous rainfall field over areas with sparse rain gauges was investigated. Merging the TRMM-3B42 product with ground-based measurements had a negative impact on the model efficiency compared to the case of using groundbased data only. Merging the TMPA product with ground-based measurements had a marginally positive impact on the simulated discharge. The estimation of the heterogeneous rainfall patterns and the hydrological modeling of the Magdalena river can be improved by using an enhanced assessment of the complex rainfall fields on the basis of merged TMPA satellite rainfall and ground station measurements.

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