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Volcanic ash cloud detected by AVHRR sensor: comparison between two different methodologies for daytime and nighttime measurements

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Volcanic eruptions represent a serious hazard for air traffic because they can inject large amounts of gas and particles in the troposphere. The volcanic clouds, in addition to main gases, can contain a mix of silicate ash particles in the size range 0.1μm to mm or larger. While the bigger particles (mm of size) can damage the aircraft structure, the smalle ones (less than 10 μm) may be extremely dangerous for the jet engines, can travel for thousands kilometres transported by the winds and are undetectable by the pilots during night or in low visibility conditions.
In this work, two different techniques, the RSTASH (Robust Satellite Technique) and a Water Vapour Corrected version of the Brightness Temperature Difference (BTDWVC) procedure, are compared at detection level, which represents a critical step towards quantitative retrievals of plume parameters.
RSTASH is a specific configuration of Robust Satellite Techniques approach, based on a multi-temporal analysis of time series of satellite records and aimed at identifying signal anomalies through an automatic unsupervised change detection step.
The Brightness Temperature Difference (BTD) procedure instead is based on the difference between the brightness temperature measured in two spectral channels centred on 11 and 12 μm.
To take into account the atmospheric water vapour differential absorption in the 11–12 μm spectral range, that tends to reduce (and in some cases completely mask) the BTD signal, a water vapour correction procedure, based on measured or synthetic atmospheric profiles, has been applied.
Furthermore, since this last method revealed its weakness, for example under particular illumination conditions, as in the case of nighttime measurements, or related to the characteristic of eruption, (for example low injection of ash in the atmosphere), the two methodologies have been applied to different Adavanced Very High Resolution Radiometer (AVHRR) images for eruptions at different scale occurred at Mt Etna volcano (Italy) and both for daytime and night-time images.
The results indicate a good agreement between the BTDWVC and RSTASH techniques in terms of ash cloud area detected for all the images considered. In particular, compared with the traditional BTD procedure, the ash detection carried out by BTDWVC and RSTASH techniques is significantly improved in case of low ash loading or night-time images.