Editorial for Special Issue “Convective and Volcanic Clouds (CVC)”

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Abstract. In recent years, some volcanic eruptions have focused the scientists' attention on the detection and monitoring of volcanic clouds, as their impact on the air traffic control system has been unprecedented. In 2010, Eyjafjallajökull eruption forced the disruption of the airspace of several countries generating one of the largest air traffic shutdown ever. Extreme convective events cause many deaths and injuries and much damage to property every year accounting for major economic damages related to natural disasters in several countries. Due to global warming, the Atlantic tropical cyclones have increased the maximum intensity, the hurricanes have more often become extratropical cyclones affecting northern Europe and southeastern Europe is characterized by an increasing annual stormy days.
Convective and Volcanic Clouds (CVC) are very dangerous for aviation operations, as they can affect aircraft safety and economic, political, and cultural activities. The detection, nowcasting, and monitoring of CVC is therefore vital for organizing efficient early warning systems.

The aim of this Special Issue is to collect innovative techniques to detect and to nowcast CVC and to create a solid background to be used by modelers and forecasters. The Special issue includes three papers [1,2,3] reporting new techniques to detect volcanic cloud top heights, two paper focusing on the Etna eruptions [3,4] and one paper [5] showing a new function to nowcast extreme weather events on the European area with the highest frequency of strong convection.

Cigala et al. [1] report an innovative technique to detect the volcanic cloud top height by using the Global Navigation Satellite System radio occultation signal. The radio occultation is able to sound the atmosphere with high vertical resolution and it is sensitive to the atmospheric density variation due to the presence of the cloud. This paper focuses on the 2008 Kasatochi eruption showing an error of about 1 km on the estimation of the cloud top height when compared to the Cloud-Aerosol Lidar with Orthogonal Polarization (CALIOP) measurements. This technique can be applied to all the volcanic clouds and looks very promising due to the global coverage and high vertical resolution. However, it always needs a background measurement because it is not able to distinguish different types of clouds.

In Zhu et al. [2], the combination of the CALIOP and the Spinning Enhanced Visible and Infrared Imager (SEVIRI) data is used to estimate the volcanic ash cloud top height by exploiting a hybrid deep learning methodology. The algorithm, applied to the 2010 Eyjafjallajökull (Iceland) and the 2011 Puyehue-Cordón Caulle (Chile) eruptions, is able to give reliable results in both simple and complex meteorological conditions. The volcanic ash cloud height accuracy can be further increased by the use of atmospheric temperature vertical profiles. The methodology described in this paper can be extended to all the measurements derived from the instruments on board the new generation of geostationary weather satellites.

Corradini et al. [3], perform the near real time proxymal and distal monitoring of the 24-30 December 2018 Etna eruption by using the data derived from the SEVIRI instrument on board the MSG geostationary satellite. As proxymal products the start time of the eruption, the time average discharge rate, the cumulative lava volume emitted and the height of the volcanic column are obtained while, as distal parameters, the volcanic cloud top height, ash, and the SO_2 are carried out. All the products have been validated using satellite and ground based data. The results show the ability of geostationary satellite systems to characterize eruptive events thus offering a powerful tool to mitigate volcanic risk on both local population and airspace and to give insight on volcanic processes.

Scollo et al. [4], propose a new system to monitor and forecast the tephra fallout based on quantitative volcanological observations and modelling. It combines data from low-cost calibrated visible cameras and satellite images to estimate the variation of column height with time, and to model volcanic plume and fallout in near-real-time. The system provides a reliable hazard assessment to the National Department of Civil Protection during explosive eruptions thus contributing to mitigate the effect of the volcanic eruption on local population and it is extremely interesting because can be easily adapted to other volcano observatories worldwide while the low-cost makes it available also for developing countries.

Guerova et al. [5] is the only paper of this Special Issue focusing on convection. This work studies thunderstorms developing in Bulgaria which is the European region with the highest frequency of extreme weather events. This work has improved the forecast of thunderstorms by using an index based on the combination of instability indices and Integrated Water Vapor derived from the Global Navigation Satellite System. Despite the non-optimal setting of the network used for this study, the results are encouraging showing a decrease of false alarms when compared to forecasts using the instability indices only. The function proposed in the paper has just a local validity and will be operationally used within the national thunderstorm nowcasting tool, however a similar analysis can be used and applied anywhere based on the same type of measurements.

Given the large uncertainties that still remain in monitoring and detecting the CVC, the blow-up of the research community for developing new techniques and improving our knowledge is required. A vast amount of information produced by the available techniques is not transferred in a way that is usable by the end users (e.g. airlines, pilots), and a close interaction between scientists and end-users is important to convert the new research products in operational tools. With this vision, this Special Issue collects papers showing innovative techniques with the potential to become operational, to support policy makers and final users, and to inspire new research on CVC topics.

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