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Nowcasting locally developed convective cells

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The climatological analysis of convective phenomena shows a greater concentration of storm cells in the northern part of Milan, in Italy. In particular, due to the characteristics of the territory, crossed by four torrential rivers (Lambro, Seveso, Groane and Olona rivers), some thunderstorms have triggered intense flash flood. Considering only the Milan municipality, the Seveso flood event of June 8th, 2014, produced damages for several million euros.
The LAMPO project (Lombardy-based Advanced Meteorological Predictions and Observations) has the goal of mitigating the impact of severe thunderstorm in the Milan area by developing a nowcasting system based on neural network approach, using water vapor observations derived by an experimental dense network of low-cost GNSS receivers.
We started by analyzing atmospheric parameters from 2001 to 2018 providing by 183 weather stations homogenously distributed in the Lombardy region and by the existent GNSS permanent networks and creating a monthly and seasonal climatology of pressure, temperature, relative humidity, integrated water vapor and wind speed. Additional information about extreme weather events has been collected from radar measurements and rain gauges with one-minute and five-minute temporal resolution. Thunderstorm Radar Tracking algorithm (TRT) has been used in order to identify and track convective cells on radar-based EchoMax products. The extreme events are selected in two different ways: rain rate higher than the 95th percentile and storm cells must be stationed at least for 25 minutes inside the area of study. The combination of these two criteria, together with the dataset of floods in the Seveso area, provides the final selection of extreme events.
Our analysis is based on the anomaly of the atmospheric parameters during the severe events in respect to the climatological values. The anomaly represents the perturbation due to the presence of the convective cell and provides the characterization of pre-convective and convective environment. We specifically focused our study on the gradient and the water vapor anomaly during the 2 hours before the event. The preliminary results, based on case studies, show large capabilities of a dense GNSS network for nowcasting locally developed convective cells. We will in the near future use the anomalies of all the atmospheric parameters (water vapor, temperature, wind, relative humidity) as input of neural networks which will be trained to nowcast the convective rain in the Seveso area. We will additionally increase the density of the GNSS receivers (from 50 km to 10 km interdistance) by installing a set of low cost receivers to evaluate the impact of a finer resolution monitoring in the nowcasting system.