airport-sCAle seveRe weather nowcastinG project ('CARGO')

Summary

The idea is to combine the capabilities of a dense network of low-cost ground based GNSS receivers and lightning detectors together with vertical profiles from Radio Occultations and radiosondes for nowcasting severe weather with high spatial resolution. With the support of Leonardo Germany (partner of the project) we will create a tailored product which will be tested for operational use. This project perfectly fits into the thematic challenge 3: Efficient provision and use of meteorological information in ATM.

A better observational framework is required in order to improve our understanding of deep convective processes and ultimately provide better forecasts, more accurate observations and greater progress in model parametrisations for the extreme convective systems that have large impact on aviation. Airports are bottlenecks in the Air Traffic Management (ATM) network and especially impacted by thunderstorms in the vicinity. Therefore, it shall be demonstrated how the resultant product can be used in the context of Total Airport Management (TAM).

Monitoring and predicting extreme atmospheric events such as Convective Systems (CS), is very challenging especially when they develop locally in a short time range. Despite the great improvement due to the use of satellite measurements and improvements in model parametrisations, there are still **large uncertainties on the knowledge of the dynamical processes** of deep convective systems. Deep CS are destructive events causing every year many deaths, injuries and damage, they account for the major economic damages in several countries and they are one of the major risks for aviation safety. The number and the intensity of such phenomena increased in the last decades in some areas of the globe including Europe. In a climate change environment, the number and intensity of severe weather events are expected to increase and the tropical cyclones tracks are changing, impacting areas not affected before. Several studies have been developed in the past for studying the pre-convection environment and for understanding the storm genesis. On the other hand, the 85% of convection overshooting the tropopause comes from smaller systems with short lifetime and due to these reasons, harder to be detected and monitored. We are currently able to forecast with good accuracy large systems within 12-24 hours, but there are still large uncertainties on the storm intensity forecast and on the knowledge of the development processes of the storms. **The largest issues come from small cells locally developing at small spatial** (hectometer) **and temporal** (tenths of minutes) **scale** because the models are not able to resolve them. Satellite measurements have increased the severe weather forecast and monitoring accuracy using different remote sensing techniques and a large contribution was given, in the last decade, by the Global Navigation Satellite Systems **(GNSS) Radio Occultation (RO)** technique because it enables measurement of atmospheric density structure in any meteorological condition, in remote areas and during extreme atmospheric events with high vertical resolution and accuracy. Several studies have shown in the past the capabilities of **ground based GNSS** for studying and predicting severe weather events. The GNSS measurements allow the estimation of the atmospheric Integrated WV (IWV) which is the engine of the convection. The Lombardy based Advanced Meteorological Predictions and Observations (LAMPO) project, is developing a regional flooding early warning system in Lombardy Region (Italy) by using the combined capabilities of ground based GNSS and GNSS RO and is co-led by the PI of this project. The network and database of LAMPO project will be used as background to develop CARGO.

Moreover, there is evidence that an abrupt increase in the total **lightning discharge rate**, often precedes severe weather occurrences on the ground having consequence on the rapid intensification of the updraft that leads to an increasing number of ice particle collisions and thus greater charge separation and lightning activity. The positive correlation between lightning activity

preceding convective rainfall may have lag time of few minutes to nearly one hour. The trends in the total lightning (Intra-Cloud + Cloud-to-Ground; IC + CG) flash rate have shown a better performance (as compared to CG flash rates) as a tool for severe weather warning decision support.

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