

SPECIAL PROJECT PROGRESS REPORT

All the following mandatory information needs to be provided. The length should *reflect the complexity and duration* of the project.

Reporting year 2021

Project Title: RAIN -Reflectivity Assimilation for an Innovative Nowcasting approach

Computer Project Account: spitlaga

Principal Investigator(s): Martina Lagasio

Affiliation: CIMA Research Foundation

Name of ECMWF scientist(s) collaborating to the project
(if applicable)

Start date of the project: March 19 2021

Expected end date: Dec 2022

Computer resources allocated/used for the current year and the previous one (if applicable)

Please answer for all project resources

		Previous year		Current year	
		Allocated	Used	Allocated	Used
High Performance Computing Facility	(units)			950000	493967
Data storage capacity	(Gbytes)			2160	1000

Summary of project objectives (10 lines max)

This project aims to build up a nowcasting system with a NWP model (WRF) using a 3-hour rapid update cycling 3DVAR of radar reflectivity observations with a new postprocessing algorithm able to take into account the timely and spatial uncertainty in the convective field simulation. The main aim is to take into account the spatial and temporal uncertainties of the meteorological model, also considering that the most recent simulation is not necessarily the best one due to, for example, the spin up process. Performing a 3-hour cycling 3DVAR with 12 hours of forecast each time it is possible to guess that, for each time instant ($dt=3$ h in this case) starting from a given time, the nowcasting scheme allows to have 3 simulations providing a 6 hour forecast covering the same time window. The final product will be a rainfall hazard scenario map for the following 6 hours based on all the simulation considered.

Summary of problems encountered (10 lines max)

At the moment no problems encountered during the project development.

Summary of plans for the continuation of the project (10 lines max)

A part of simulations needed to assess the impact of this nowcasting algorithm on the forecast improvement have been already performed on 9 days chosen as use case time period. The first analysis and validation performed over these first simulation are ongoing and, on the base of the results that will be achieved, more simulation with different reflectivity operators of error covariance matrices will be tested, possibly with the assimilation of other observations coupled with the reflectivity data assimilation. The project started 3 months ago and at the moment two different kind of reflectivity operators have been tested for the assimilation, now the simulation are under validation and from these results will be assessed the next attempts, probably coupling reflectivity and lightning or ZTD from GNSS data assimilation to find the best performing setup for nowcasting application.

List of publications/reports from the project with complete references

The analysis to achieve a first publication about this project are ongoing because the project started only 3 months ago.

Summary of results

If submitted **during the first project year**, please summarise the results achieved during the period from the project start to June of the current year. A few paragraphs might be sufficient. If submitted **during the second project year**, this summary should be more detailed and cover the period from the project start. The length, at most 8 pages, should reflect the complexity of the project. Alternatively, it could be replaced by a short summary plus an existing scientific report on the project attached to this document. If submitted **during the third project year**, please summarise the results achieved during the period from July of the previous year to June of the current year. A few paragraphs might be sufficient.

The project started three months ago, so the initial results refer mainly to technical aspects than scientific modelling outcomes. In this first period the script to provide an automatic execution of a 3-hour cycling forecast with 3dvar using the WRF model have been set up and tried with two different reflectivity operator for the assimilation: a modified direct operator and an indirect operator with retrieve of water vapor (Lagasio et al., 2019). The 9 days time period between 14 October 2019 and 22 October 2019 is taken as an example for the first evaluation of the nowcasting procedure. The period represents a typical time window on the fall season in Italy with two extreme events recorded on 14-15 October and 21-22 October spaced out by normal rainy days. Thus, those days can be

representative to test the nowcasting alert scheme different rainfall regimes that can be hardly predictable with standard NWP simulations.

The nowcasting procedure aim is to produce short-term forecasts, frequently updated with observations, to provide the most reliable information on the atmospheric state in the following few hours. This would allow, with the modern technologies, to inform the population about the risks that will affect a certain area with some hours in advance. The nowcasting scheme performed is implemented with a 3-hour cycling 3DVAR and 12-hours forecast always using the most recent initial and boundary conditions available. In the first two sets of experiments only radar reflectivity data have been assimilated and the results analysis and validation are ongoing. Future will explore the same nowcasting scheme coupling the best performing reflectivity assimilation with other kind of observations.

References:

Lagasio, M., Silvestro, F., Campo, L., & Parodi, A. (2019). Predictive capability of a high-resolution hydrometeorological forecasting framework coupling WRF cycling 3dvar and Continuum. *Journal of Hydrometeorology*, 20(7), 1307-1337.