5.3 ASSIMILATION OF WEATHER RADAR DATA FOR THE SIMULATION OF A HEAVY RAINFALL CASE IN CENTRAL ITALY: A COMPARISON BETWEEN 3D-VAR AND 4D-VAR TECHNIQUES

VINCENZO MAZZARELLA[12], IDA MAIELLO[23], VINCENZO CAPOZZI[1], GIORGIO BUDILLON[1], ROSSELLA FERRETTI[2]

[1] Department of Science and Technology, University of Naples "Parthenope", Naples, Italy

[2] Centre of Excellence CETEMPS, Department of Physical and Chemical Sciences - University of L'Aquila, L'Aquila, Italy

[3] Department of Information Engineering, Electronics and Telecommunications - Sapienza University of Rome, Rome, Italy

vincenzo.mazzarella@uniparthenope.it

The Italian territory, characterized by densely urbanized watersheds with steep slopes, is particularly exposed to hydraulic and hydrological risk. Therefore, persistent heavy rainfall events are a highly relevant problem for damages and numerous victims caused every year. In this respect, data assimilation plays a key role in improving initial conditions and, consequently, forecast accuracy. The assimilation of a dense network of conventional observations and local measurements with a high spatial and temporal resolution, such as radar data, may produce more accurate rainfall forecasts and a better estimation of the localization of the precipitation cells.

The goal of this study is to provide a comparison/evaluation between 3D-VAR and 4D-VAR assimilation systems of the Weather Research and Forecasting (WRF) model to forecast a heavy precipitation event in a complex orography region, such as the central Italy. Radar radial velocity and reflectivity data, acquired by Mt. Midia and St. Pietro Capofiume C-band radar, and conventional observations (SYNOP and TEMP) have been assimilated into the model to estimate the precipitations occurred on 14 September 2012. The case study, used in this work, is the IOP4 of the HYdrological cycle in the Mediterranean EXperiment (HyMeX) campaign. The meteorological scenario was characterized by a cut-off low over the Southern Tyrrhenian Sea, which produced heavy and persistent precipitation along the Adriatic coast of central Italy.

The performance of 3D-VAR and 4D-VAR experiments has been evaluated using two different statistical methodologies: point to point (or traditional approach) and neighborhood. The first method compares the rainfall data, recorded by rain gauges, and the precipitation forecast in the exact location. In this respect, critical success index (CSI) and equitable threat score (ETS), have been evaluated for several threshold values. The other method applies a smoothing filter to the predicted and observed precipitation fields and then matches both fields using a neighborhood approach. In this context, the fraction skill score (FSS) index has been calculated. Finally, a sensitivity study on warm start initialization has been performed with the aim to reduce the model spin-up time and evaluate the role of data assimilation in the first hour of simulation.

The results show that radar data have a relevant contribution in the estimation of precipitation both with 3D-VAR and 4D-VAR. Furthermore, the experiments with

4D-VAR produce an improvement of statistical scores, pointing out the positive impact of this method. However, the performance concerning the high threshold values decreases outside the assimilation window, highlighting the weakness of tangent linear model (TM).