On the added value of FORUM-like WV data assimilation on regional forecasts

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INTRODUCTION

In the SCIEF project (Sviluppo delle Competenze Italiane per l’Esperimento FORUM) funded by the Italian Space Agency, studies have been conducted on future FORUM capabilities to play a role in operational meteorology. Measurements of water vapour (WV) and related quantities (e.g. precipitable water PW), when properly assimilated, can critically improve meteorological predictions, especially of extreme events. The latter are main goal in operational meteorology, because of their dramatic impact on the environment and human lives, and their rapid increase throughout the world. FORUM will provide a better constrain of the atmospheric WV, with respect to other existing instruments, but only for the high troposphere. Thus we have tested the sensitivity of a state of the art meteorological model, WRF, to the assimilation of only high tropospheric WV, with values increased of the 30% with respect to the forecasted one. At the purpose we used a simplified OSSE (Observing System Simulation Experiments) that mimics the expected spatial coverage and resolution of future FORUM observations.

CASE STUDY

The severe event of Leghorn, Sep. 9-10, 2017

During Sep. 9, a slow-moving long wave trough deepened over the Western Mediterranean Sea. The trough was characterised by strong south-westerly upper level forcing and mild and very moist southerly low level flow converging towards the Italian Tyrrhenian coasts. Eight casualties and huge damages hit Leghorn. More than 240mm of rainfall fell on Leghorn in 2 hours. The precipitative system was characterised by a strong vertical development, so a significant WV quantities were expected also in the upper troposphere, where FORUM measurements are more significant.

EXPERIMENTAL ARCHITECTURE

\[ PW = \frac{1}{P_\rho} \left( x \frac{dP}{P_\rho} \right) \]
\[ x = \frac{0.622 e}{P - e} \]

\textbf{Assimilated Data}

\textbf{Measurement points}

\textbf{Measurement values: predicted (red) and assimilated (green)}

SIMULATION RESULTS

Pictures in this panel are the result of simulations relating to three different variables: PW (top-left), Precipitation (bottom left), Surface long-wave radiation (right). For each variable we provide three images: the output of the model before the assimilation, at the time of the assimilation; the difference between the assimilated run and the non-assimilated (i.e. Control) one, 3 hours after the assimilation; same as before but 6 hours after the assimilation.

REMARKS and FUTURE DEVELOPMENTS

Model simulations seem to be sensible to the assimilation of WV even if limited to the high troposphere, for a number of important variables. The sensitivity to a different precision in retrieving high tropospheric WV values, that could imply different measurement results, need however to be proved bringing out the effects specifically related to the assimilation process, to the model configuration (e.g. the horizontal resolution) and to the simulated weather conditions. In any case the benefits of assimilating future FORUM data could be fully proved only assimilating WV profiles or better the measured IR spectra. Future works need thus to proceed in this direction.