

We acknowledge the reviewer for the work on the paper.

Reviewer comment:

I would like to thank the authors for addressing all my initial comments. According to their responses, the conceptualization and novelty of the study (my major concern) are better justified. However, this is not yet clearly presented in the manuscript (Lines 111-115). I suggest enriching this part, in order to better highlight the differences with the previous studies in Italy and show that the present study builds upon previous literature and goes further, rather than going in “a similar direction”. The operational context under which the investigation is conducted should be also highlighted. In this direction, please also include in the manuscript the fact that the applied model configuration is similar to the one used by CNR-ISAC for providing weather forecasts to the Department of Civil Protection in Italy.

Answer:

We changed the lines 111-115:

“This paper goes in a similar direction in the sense that it uses the GNSS-ZTD data assimilation to improve the precipitation and water vapor forecast over Italy. It uses a period of one month (October 2019) and the data of 388 GNSS receivers widespread over the country, giving a robust assessment on the impact that GNSS-ZTD data assimilation can have on the forecast at the local scale. In addition, for the first time over Italy, the sensitivity of the results to the number of GNSS receivers used (data thinning) and to the bias correction are shown for a subperiod of 16 days (5-10 and 14-23 October).”

to:

This paper enriches the numerical experiments made over Italy to improve the precipitation and water vapor forecast through GNSS-ZTD data assimilation because it refers to a different period compared to previous studies (October 2019) and uses data of 388 GNSS receivers widespread over the country for the whole period, giving a robust assessment of the impact that GNSS-ZTD data assimilation can have on the forecast at the local scale. In addition, it considers two issues that are important in the operational context: the optimal spacing of GNSS receivers for data assimilation, and the bias removal. The first experiment estimates the observation error decorrelation length scale and applies it to optimize the GNSS-ZTD data assimilation by data thinning, while the second experiment quantifies the impact of the bias removal on the forecast performance, because the bias cannot be completely removed in an operational context. It is also noticed that a similar configuration of the WRF model used in this paper is already operational at the CNR-ISAC in the framework of the agreement between the Department of Civil Protection (DPC) and CNR-ISAC to improve the NWP forecast at different time ranges. So, the results of this paper are of practical importance as GNSS-ZTD data could also be assimilated in the near future in the operational run.