

## Review of the paper:

Atmospheric Moisture Effects on Heavy Precipitation During the HyMeX IOP16 Using GPS Nudging and Dynamical Downscaling

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## General comment

This paper presents the impact of assimilating GPS-ZTD in the COSMO-CLIM model focusing on the case study of HyMeX-IOP16. The first part of the paper shows the physical processes responsible for the heavy precipitation of the case study, while the second part focuses on the impact of assimilating realistic humidity observations on the hindcast of the event. The impact of evapotranspiration over North-Africa for this event is shown, even if not quantified.

The paper is well written and presents an interesting subject. Nevertheless, there are points of the paper that can be improved and sometime clarification is needed. The major and minor points are reported below.

## Major points

- 1) The authors must clarify that this is a diagnostic study and not prognostic. The impact of assimilating GPS-ZTD is quantified by comparing two simulations: the first doesn't assimilate GPS-ZTD, while the second assimilates GPS-ZTD continuously. While this is an important comparison, it must be clarified that the paper doesn't assess the role of GPS-ZTD in a prognostic approach for the case study. Also the importance of sub-hourly data assimilation is not shown. To do that a comparison between two simulations one assimilating GPS-ZTD on a hourly basis and the other one assimilating GPS-ZTD every 10 minutes (as in the paper) should be performed. However, I understand that this requires adding new simulations, which can be avoided deleting the sentences where the importance of sub-hourly assimilation is emphasised.
- 2) In the section 3.3 emphasis is given to the transport of humidity from North Africa for the event. It would be interesting to give a comparison between this source of moisture and that coming from the western Mediterranean Sea to define better this contribution.
- 3) Considering the nudging scheme there is no information on the parameters of the Second order autoregressive function. How they are determined? Line 217 has a comment on the vertical adjustment that doesn't apply to the specific case. It also unclear how the  $q_v$  profile is constructed iteratively (Lines 230-232). Do you mean that it is modified by nudging until a difference is attained or something different?

## Minor points

The e-mail for correspondence seems wrong.

Line 28: there is a "." after "Additionally", while a comma is expected.

Line 33: During heavy precipitation events, rain rates can be much higher than 20 mm/h.

Line 47: Check the " ; " .

Line 188-189: Please revise the English, specifically “Where”.

Line 244: Check the sentence “given the large precipitation reduction”. Do you mean when you assimilate GPS-ZTD?

Line 248: I suggest giving more details about the Agreement Index (AI).

Line 271: “the low-level flow ...”

Line 426: the number for the 2.8 km are wrong. Check.

Line 523: Check the sentence (there is also a typo error).

Line 577-578: This sentence is rather unclear. It is important to note that, in general, the adjustment introduced by GPS-ZTD could be a function of the height if variational approaches are considered, through the background error matrix.