

A review of Earth System Dynamics.

MS title:

“Water vapour fluxes at a Mediterranean coastal site during the summer of 2021: observations, comparison with atmospheric reanalysis, and implications for extreme events”

Madonna et al, 2024 an observational-core study that explores the use of high-quality observations and measurements of hydrological atmospheric features in a specific location where such measurements are deemed crucial for weather and climate predictability. They compare the results with global ECMWF ERA-5 reanalysis in the roughly corresponding grid points, to highlight the large deviations between one of the most highly used meteorological tools and observations. An emphasis is given to the role of integrated water vapour transport in generating extreme weather events, and the importance of correctly evaluating these measurements in reanalysis.

The objective of improving the performance of reanalysis data using observations is important, especially in coastal areas that are affected by sub-grid processes, and the results presented in this MS are undoubtedly of interest to the scientific community. Indeed, it is evident that major efforts were invested in this campaign, and for good reasons.

However, I suggest a major revision of the MS, especially concerning the present structure, but also possibly the choices made by the authors:

Major comments:

- 1) The choice of comparing observations to a relatively coarse reanalysis is unclear. Would it not be more beneficial to compare against a higher-resolution alternative?
- 2) In the introduction, the authors elaborate on the methods used at a highly technical level, while not emphasizing enough the motivation and knowledge gaps addressed by the study, and how the observations serve those objectives. I suggest moving the technical details to an appendix and expanding the introduction on the role of moisture fluxes in the atmosphere, why they are misrepresented especially in coastal areas in the Mediterranean, the implications, and the importance of the detailed observations you present for their better prediction.
- 3) The title of the MS could be more specific, possibly naming the location or the campaign itself. Even the scope of the results discussed throughout is larger than suggested by the title. Furthermore,

the discussion of the water-vapor fluxes is brief and does not provide new insights as for the well-known importance of these fluxes for extreme weather events. The title suggests that the water vapor fluxes were derived from observation, but that's not the case. Therefore, I suggest rephrasing the title to describe the MS more accurately.

- 4) Some of the figures (4, 6, and 14) show raw data, with highly technical captions that are not intuitive for non-expert readers. Seeing that the focus of ESD is usually not set to such levels of technicality, I recommend adding a line to the captions that recalls the physical meaning of the observed quantity.
- 5) The summary should highlight the importance of the field campaign: what new information was gained and how can it be harnessed to improve our understanding or the model performance? Simply pointing out the biases seems like an underreaching conclusion, especially when comparing measurements to global reanalysis data that does not even have a corresponding grid point in the location of interest.

Minor comments:

L65: “investigated to identify the contribution by the contribution of water vapour fluxes and convection” – unclear

Fig.1: Consider adding a larger view pointing out the location of Soverato for geographical orientation.

L88: instruments

L127: **and** smaller above.

L148-149: this sentence seems interrupted

L173: ad→and

L174: biased **at**

L208: larger values

L209: rephrase. The sentence is unclear.

L219: highlighted **that** measurements

L250-265: This fits better in the introduction

L304: noting→ to note

L324: insisting→ persisting

L325: of **a** heat wave

L326: transporter→ transport?

L334: contributing or that likely contribute.

L343: representation **of**

L376-380: long sentence, consider splitting.

L428-433: long sentence with several errors. Please rephrase.