

Nat. Hazards Earth Syst. Sci. Discuss., referee comment RC2
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Comment on nhess-2021-396

Anonymous Referee #2

Referee comment on "The unusually long cold spell and the snowstorm Filomena in Spain in January 2021" by Philipp Zschenderlein and Heini Wernli, Nat. Hazards Earth Syst. Sci. Discuss., <https://doi.org/10.5194/nhess-2021-396-RC2>, 2022

This paper analyzes the dynamical and physical aspects on a synoptic scale that contribute to the intense snowfall and cold spell associated with the extratropical cyclone Filomena, which affected the Canary Islands and the Iberian Peninsula at the beginning of January 2021.

The authors pose three questions and the answers give substance to the article. The questions are:

- How unusual was the cold wave and what processes led to the abnormally low temperatures in Spain?
- What processes led to the formation of Filomena?
- What characteristics of Filomena facilitated the heavy snowfall?

General comments:

The authors cite a complete technical report issued by the Spanish National Weather Service (AEMET) after this episode that gives answer to the above mentioned questions:

http://www.aemet.es/es/conocermas/recursos_en_linea/publicaciones_y_estudios/estudios/detalles/informe_filomena_ola_de_frio

Nevertheless, I think that the analysis of dynamical aspects, identifying PV streamers, ridge and trough amplification, Rossby wave rupture, and WCBs is interesting and could justify the intensification of the cyclone after the tropical interaction.

The ingredients necessary for heavy snowfalls in the interior of the Iberian Peninsula are well known, cold air at low levels and humid and warm air advection. The sources of cold air mass advection over Iberian Peninsula are clearly identified too, so I think that the analysis of back trajectories does not seem to be of great interest (except for the identification of WCBs). However, the present work, based in the reanalysis and climatology of ERA-5, serves to justify the rarity of this anomalous and exceptional episode.

It is worth mentioned that the IFS and HARMONIE models successfully predicted this historic snowfall event well in advance, in the same way, the Spanish National Weather Service (AEMET) issued the corresponding forecasts and warnings well in advance.

The mesoscale characteristics, such as the complex topography of the affected area or the thermal and humidity profile in low layers were decisive in this episode, but in this work no reference is made to the snow level (around 500 m) or to the orography. Likewise, the time interval selected for the study (between 07 and 10 January) does not seem to be the most appropriate, since there were precipitations and snowfalls in the Iberian Peninsula between 06 and 10 January, and the intense snowfalls occurred on 08 and 09 January.

I think that more information should be given on the climatic characteristics of the month of January in the study area. In the months of December and January the nocturnal frosts are frequent (the period between 06 and 10 January is climatologically the lowest minimum temperature period, and at Adolfo Suarez-Barajas Madrid airport, the average number of frost days in January is 8). These frosts occur not only due to cold advection of polar or arctic air masses, but also to subsequent surface radiative processes (long nights, calm or light winds and clear skies). AEMET defines a cold spell not just an episode with minimum temperatures below 0 C in a wide area, it applies a much more demanding criteria. In this sense, according to AEMET's technical report on Filomena, only the subsequent period to Filomena is considered a significant cold spell.

Numerical model reanalysis are a useful tool, but they cannot substitute for observational data. ERA-5 has a horizontal resolution of 35 km and 37 levels in the vertical, compared to 9 km and 137 levels of the IFS-HRES model or 2.5 km and 65 vertical levels respectively of the HARMONIE limited area model. I strongly recommend the use of real observational data, taking into account the dense network of surface meteorological stations and the soundings available in the study area.

Regarding the adverse impact of Filomena, there were barely mentioned some effects that were very significant in the Canary Islands (intense rainfall and strong gusts of wind). The heavy snowfalls occurred on 08 and 09 January, but there was notable rainfall the previous days (06 and 07 January) in the southeast of the Iberian Peninsula, affected by a warm front associated to Filomena. The exceptionality of the snowfall, according to the climatology of the model, is reflected in the Extreme Forecast Index (EFI) developed by the ECMWF. In this sense, the snowfall was exceptional, fundamentally in the center of the Iberian Peninsula.

Specific commentaries.

Please also note the supplement to this comment:

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<https://nhess.copernicus.org/preprints/nhess-2021-396/nhess-2021-396-RC2-supplement.pdf>