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Brief communication: Preliminary hydro-meteorological analysis of the flash flood of 20 August 2018 in Raganello Gorge, southern Italy

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Supplement

This supplement is organized as follows: in the paragraph S1, Figs. S1 to S3 are related to the synoptic analysis. Then, in the paragraph S2 Table S1 shows the list of the preliminary tests carried out in order to achieve the first optimal configuration, while accompanying text, included Fig. S4, provides a brief discussion about the reasoning for our selection.

S1. Synoptic analysis

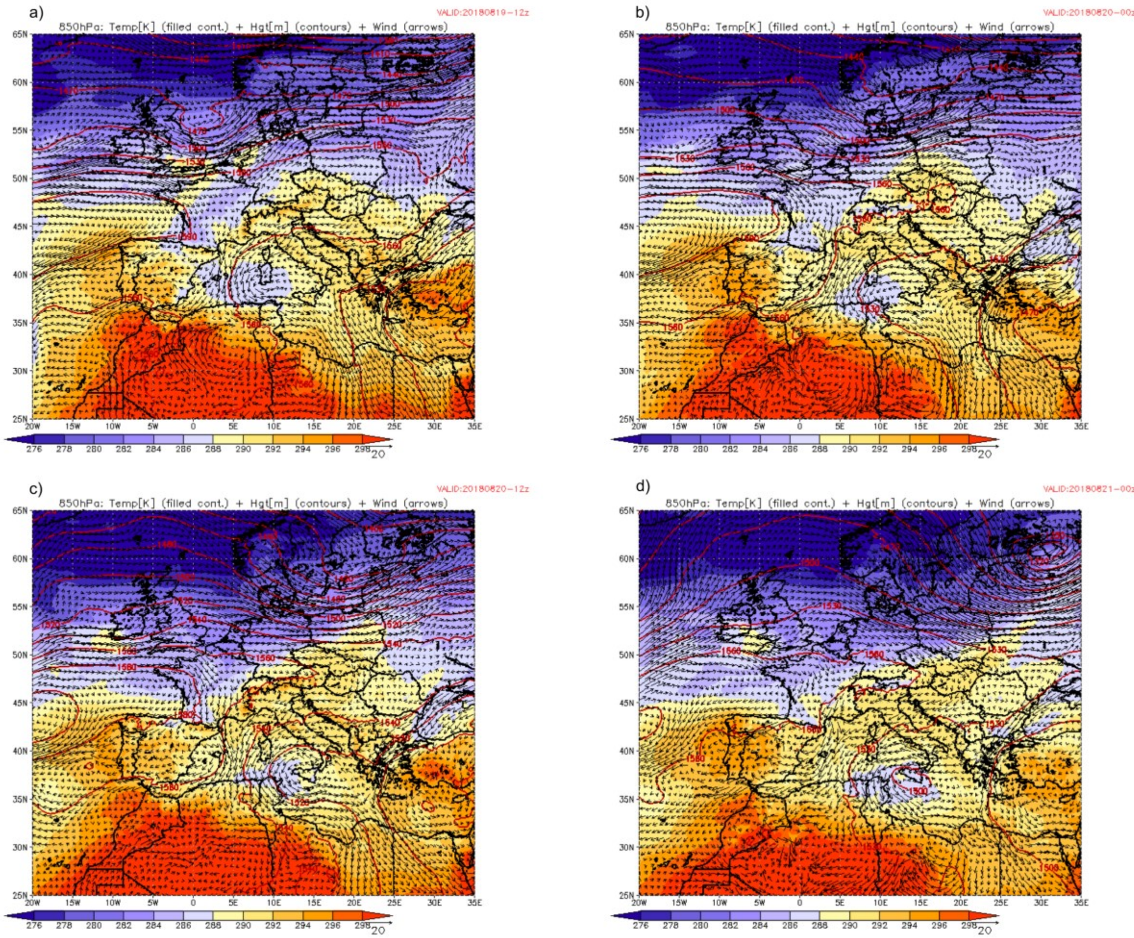

Fig. S1: (a-d) Temperature (filled-contours), geopotential height (red-contours) and wind vectors at 850-hPa every 12 h from 12 UTC on 19 august 2018 to 00 UTC on 21 august 2018. Maps from NCEP GDAS/FNL (0.25° resolution).

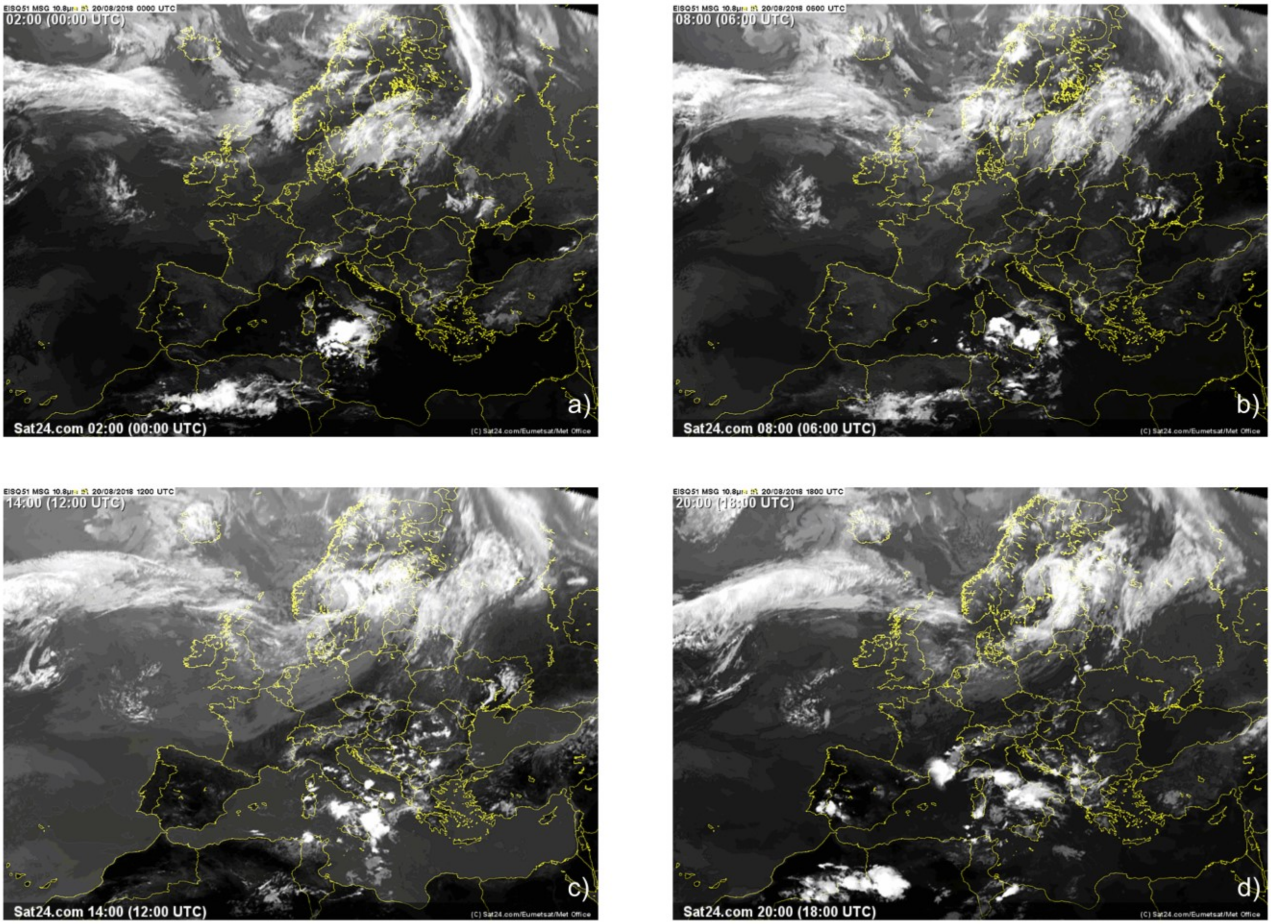

Fig. S2: (a-d) Satellite images of the thermal infrared channel (10.8 µm) every 6 h from 00 UTC to 18 UTC on 20 august 2018. Source: www.sat24.com; ©Eumetsat.

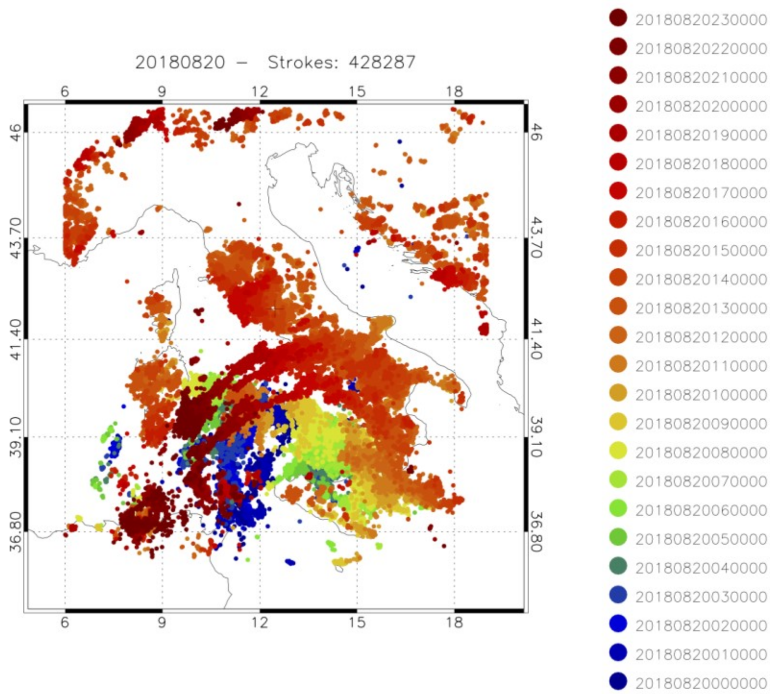

Fig. S3: Strokes recoded on 20 august. The colours show the recording time (step of 1 h). The total number of strokes recorded in the day is shown at the top of the panel.

S2. First optimal configuration selection

Tab. S1: List of the 10 preliminary tests carried out and description.

RUN	RUN time and INIT	Domains	Physics
1.	***Run*** *= 36h* ***Init*** *= GFS Forecast 12UTC 19/08/2018 (0.5°)*	***Grids*** *= 9, 3 km* ***Vertical levels*** *= 40*	***PBL*** *= ACM2 (7) &* ***SF_SFCCLAY*** *= MM5 Similarity (1)* ***MP*** *= Thompson (8)* ***CU*** *= BMJ (2) 9 km grid; explicit for 3 km grid* ***RA_LW*** *= RRTMG (4)* ***RA_SW*** *= RRTMG (4)* ***SF_SURFACE*** *= Noah Land Surface Model (2)* ***This configuration is identified as "STANDARD1"***
2.	***Run*** *= 36h* ***Init*** *= ECMWF Forecast 12UTC 19/08/2018 (0.25°)*	**""**	*STANDARD1*
3.	***Run*** *= 30h* ***Init*** *= GFS Forecast 18UTC 19/08/2018 (0.5°)*	**""**	*STANDARD1*
4.	***Run*** *= 24h* ***Init*** *= GFS Forecast 00UTC 20/08/2018 (0.5°)*	**""**	*STANDARD1*
5.	***Run*** *= 24h* ***Init*** *= ECMWF Forecast 00UTC 20/08/2018 (0.25°)*	**""**	*STANDARD1*
6.	***Run*** *= 18h* ***Init*** *= GFS Forecast 06UTC 20/08/2018 (0.5°)*	**""**	*STANDARD1*
7.	***Run*** *= 24h* ***Init*** *= GFS Forecast 00UTC 20/08/2018 (0.5°)*	**""**	*STANDARD1 except for* ***CU*** *= BMJ (2) ALSO for 3 km grid*
8.	***Run*** *= 36h* ***Init*** *= GFS Forecast 12UTC 19/08/2018 (0.5°)*	***Grids*** *= 9, 3,* ***1*** *km* ***Vertical levels*** *= 40*	*STANDARD1*
9.	***Run*** *= 24h* ***Init*** *= ECMWF IFS Forecast 00UTC 20/08/2018 (9km)*	***Grids*** *= 6, 2 km* ***Vertical levels*** *= 43*	***PBL*** *= MYJ (2) &* ***SF_SFCCLAY*** *= ETA Similarity (2)* ***MP*** *= LIN (Purdue) (2)* ***CU*** *= KF (1) 10 km grid; explicit for 2 km grid* ***RA_LW*** *= RRTM (1)* ***RA_SW*** *= Dudhia (1)* ***SF_SURFACE*** *= Noah Land Surface Model (2)*
10.	***Run*** *= 24h* ***Init*** *= ECMWF IFS Forecast 00UTC 20/08/2018 (9km)*	**""**	***PBL*** *= MYJ (2) &* ***SF_SFCCLAY*** *= ETA Similarity (2)* ***MP*** *= Thompson (8)* ***CU*** *= Tiedtke (6) 10 km grid; explicit for 2 km grid* ***RA_LW*** *= RRTM (1)* ***RA_SW*** *= Goddard (2)* ***SF_SURFACE*** *= Noah Land Surface Model (2)*

In Table S1 we summarized the 10 preliminary tests considered for the analysed event. The numbers in the brackets in the fourth column refer to the corresponding WRF physics option in the namelist. For details please refer to the WRF user-guide web page: http://www2.mmm.ucar.edu/wrf/users/docs/user_guide_V3.9/users_guide_chap5.htm.

The various configurations listed in table S1 were adopted in order to assess and compare some different physical parameterization schemes (fourth column), grid resolutions (third column) and the initial conditions (second column). The tests were performed mainly taking into account previous works, carried out also by the authors (e.g. Senatore et al., 2014; Avolio and Federico, 2018), and considering the useful indications coming from the WRF scientific community as well as from the user-guide of the model.

We highlight that this list of runs does not claim to be exhaustive and many and many other tests could have been conducted. Nevertheless, the purpose of our work is not to perform sensitivity tests of the model but, rather, to achieve a reasonable reconstruction of the extreme event occurred. Further test can be carried out, in the future, to refine these choices.

The main motivations behind the preliminary runs' choices can be roughly summarized as follows: the event was simulated using both the GFS (run 1, 3, 4, 6, 7, 8) and ECMWF forecast fields (2, 5, 9, 10) with different horizontal resolutions and starting time; the role of the horizontal grid spacing was evaluated through a high resolution WRF grid (1km resolution for run 8 and 2km resolution for runs 9, 10); we evaluated how the model performs not explicitly resolving the convection on the 3km grid spacing, but parameterizing the process (run 7). The different schemes were tested, mainly for the microphysics, radiation and planetary boundary layer, in order to evaluate which of them is able to better simulate the high-convective event analysed.

In order to individuate a basic optimal configuration, we considered three preliminary quantitative/qualitative evaluation criteria: a) the 3h precipitation pattern provided by the only SRT image available; b) the simulated rainfall peak within the Raganello catchment or in the very next boundary (one pixel buffer), which should reasonably be in the order of at least 90 mm (information derived by the SRT image); c) the simulated catchment-averaged rainfall, which should be, of course, moderate/high.

Fig. S4 shows the 3h precipitation pattern simulated by WRF, directly comparable with the radar SRT image in the manuscript (Fig. 2a).

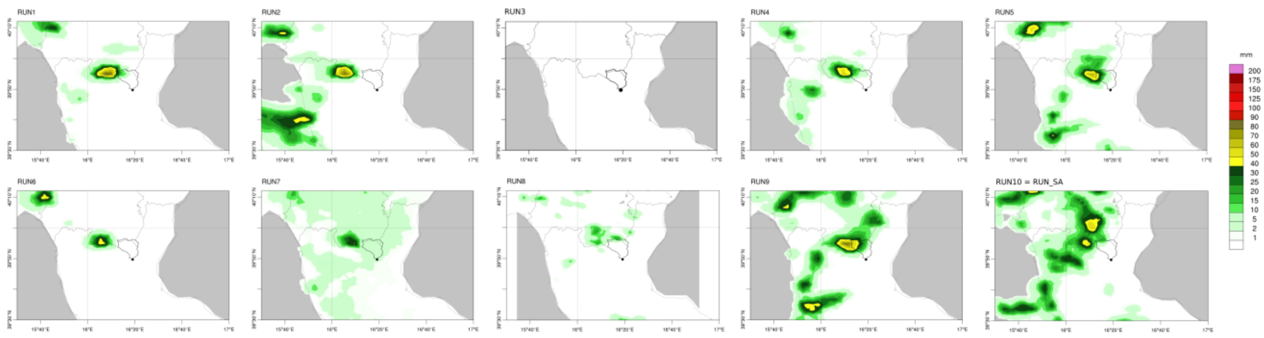

Fig. S4: 3h (10-13 UTC) accumulated precipitation simulated by WRF for the ten preliminary runs. First row: runs from 1 to 5; second row: runs from 6 to 10.

From this first qualitative comparison (corresponding to the aforementioned criterion a), it followed that the configurations better reproducing the 3h radar-derived precipitation pattern are: RUN2, RUN4, RUN5, RUN9 and RUN10. However, RUN2 and RUN9 show multiple peaks of high precipitation (yellow spot in south-west areas of the domain), not in agreement with what is shown by the radar.

Then, considering the simulated rainfall peak (in the 24h period) within the Raganello catchment or in the very next boundary (criterion b), the following results were achieved: 1.0 mm/24h (RUN2), 21.9 mm/24h (RUN4), 26.3 mm/24h (RUN5), 40.3 mm/24h (RUN9) and 52.3 mm/24h (RUN10). The RUN10 shows a higher rain-peak in the area.

Finally, considering the simulated catchment-averaged rainfall (criterion c), the following results were achieved: 0.1 mm/24h (RUN2), 9.4 mm/24h (RUN4), 10.9 mm/24h (RUN5), 18.7 mm/24h (RUN9) and 20.7 mm/24h (RUN10). Therefore, the RUN10 is also the run with higher mean rainfall in the catchment.

From these preliminary quantitative/qualitative evaluations, we assumed that the RUN10 is the model configuration that permits to simulate more realistically the effects of the rainfall event. Though its simulated rainfall peak and (especially) catchment-averaged rainfall are not extremely different from RUN9, it is preferable because its precipitation pattern agrees more with radar data. Interestingly, the physics configuration of RUN10 is similar to the "CONUS" physics suite proposed in the WRF User Guide.

In the manuscript, the simulation RUN10 is defined RUN_SA.