

Flash flood event in Western Germany (Ahr valley -- 14/15th July 2021)

Precipitation forecasts of ICON model suite

EWGLAM 2021 – Breakout Session on Verification

Christoph Gebhardt, Michael Baldauf, Klaus Stephan, Axel Seifert, Michael Hoff, Felix Fundel

Deutscher Wetterdienst, DWD





Outline

- overview of the precipitation event and impacts
- What happened in and around the Ahr valley?
- forecasts of global models and ICON-EU
- forecasts of ICON-D2 and ICON-D2-EPS
- assimilated radar data and ICON-D2 (preliminary assessment)
- verification of precipitation for ICON(-D2) (general characteristics)







cut-off low over Western Europe

- slowly moving (north)-eastwards
- coincidence of upper-level trough and low-level convergence favourable for an uplift of very moist air
- continuous rainfall and embedded intense rainfall in different regions following the 12th of July 2021







precipitation (radar) 12th July 05:50 UTC to 15th July 05:50 UTC

Tief Bernd über Deutschland, Summe des Niederschlags aus Radar: 12. Juli, 05:50 UTC - 15. Juli 2021, 05:50 UTC



Klimadaten und Darstellung: © Deutscher Wetterdienst 2021 (Stand: 15.07.2021); Geodaten: © GeoBasis-DE/BKG 2020 (Stand: 01.01.2020).

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> 13th of July

- high precipitation sums in mid and western Germany
- Ruhr area, cities of Hagen and Wuppertal with up to 66 mm within 1 hour and 240 mm within 22 hours
- ► 14th of July
 - most severe precipitation in Western Germany, Belgium, Luxemburg, Netherlands, France
 - flooding/flash floods (small rivers, Maas)
 - casualties: 180 (Germany), 41 (Belgium)









Impact in the Ahr-Valley

- the Ahr is a comparably small river with 85 km length and a drainage area of 897 km²
- narrow valley with steep slopes
- most intense precip started on 14th and lasted until the early morning of 15th July
- locally up to 147 mm in 24 hours (radar est.)
 (average of 94 mm in the drainage area)
- 130 casualties
- ca. 3000 buildings damaged (ca. 450 destroyed)
- destroyed bridges, roads, and rail tracks
- destroyed communication infrastructure
- destroyed water and electricity supply
- contaminated drinking water







<text>

© picture alliance/dpa/Polizei





Vorhersage der HVZ Rheinland-Pfalz vom 14.07.202120 Uhr



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forecasts of global models



accumulated precipitation for 72 hours 12th 06UTC to 15thJuly 06UTC (forecast start at 12th 00 UTC)



ICON global

IFS

GFS

more than 100mm in the affected regions in all three models





Case study by Martin Belluš (SHMU) See plenary presentation by Clemens Wastl (Tuesday)

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forecasts of ICON-EU



accumulated precipitation for 24 hours from 14th 06 UTC to 15thJuly 06UTC



high precipitation sums over 100mm close to or in the relevant region (a bit too far to the west in the oldest forecast)



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forecasts of ICON-D2-EPS



Probability >70mm/12hours for 14th July 09 UTC to 21UTC

 $ICON-D_2, 2021071309+36h, prob. for TOT_PREC > 70 mm ICON-D_2, 2021071315+30h, prob. for TOT_PREC > 70 mm ICON-D_2, 2021071321+24h, prob. for TOT_PREC > 70 mm/12h ICON-D_2, prob. for TOT_PREC > 70 mm/12h ICON-D_2, prob. for TOT_PREC > 70 mm/12h ICON-D_2, prob. for TOT_PREC > 7$







13/07 09 UTC run

13/07 15 UTC run

13/07 21 UTC run

Increasing probability of exceedance with improving match of the affected regions with decreasing leadtime



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Values >= 100mm/6h within the drainage area of the Ahr (white contour) for 09 and 12 UTC run, but clear decrease in the 15 UTC run



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15/07

50

20

15

10

2.5

12/07 13/07 11/0714/07EPS 90%-percentile of 6hr precipitation sum for 14th July 15 UTC to 21UTC ID2 TOT_PREC q90_6h 2021071409+12 ID2 TOT PREC q90 6h 2021071415+6 ID2 TOT PREC a90 6h 2021071412+9 51.00 50.75 50.75 50.75 200 150 75 50 50.50 -30 opnite 50.50 opnite 50.50 20 20 15 15 10 10 5 2.5 2.5 50.25 50.25 50.25 50.00 50.00 + 6.0 50.00+ 6.0 6.5 6.5 7.0 longitude longitude longitude

14/07 09 UTC run

forecasts of ICON-D2-EPS

14/07 12 UTC run

14/07 15 UTC run

More consistent in the EPS with higher values for all runs, but still reduced in this 15 UTC run



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Model start time in hours before 14/07 18 UTC









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- Radar estimates consistently below gauge measurements in the relevant region
- "dip" at 15 UTC one possible reason for the reduced intensity of the 15 UTC run
- this "dip" *could be caused* by damping along the radar beam or by a wet radom
- further investigations needed !!!!





13/07

etterdienst

14/07

DWD

fcst obs

15/07

Test: switch off Latent heat nudging

Precipitation from 15 to 16 UTC, forecast start 15 UTC

ICON-D2 with LHN and assim of 3D reflect.



ICON-D2 without LHN but with assim of 3D reflect.

11/07

12/07



Reason for this effect to be clarified

- data quality ?
- assimilation method ?

random ?

assim. of radar refl + LHN performs better in general (see talk by C. Schraff)



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Verification against radar for JJA 2021 (fraction skill score)

(for thresholds faaaaar below the values of the 14th July)





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Verification against radar for JJA 2021 (fraction skill score)

(for thresholds faaaaar below the values of the 14th July)



²¹ C. Gebhardt et al., DWD



Summary

- Severe precipitation events lasting from 13th to 18th of July leading locally to destructive flooding and flash floods
- Generally good forecasts by the ICON model suite with uncertainties to be expected on the relevant temporal and spatial scales
- Variability between forecast runs (i.e. ICON-D2+EPS) which seems to be attributable partially to systematic differences beyond statistical uncertainty
- The forecast quality for precipitation increases with model resolution and spatial scale, but decreases with precipitation threshold
- There is a lack of data for a robust verification of such events and the standard scores are not focused on statistically extreme events





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Precipitation (radar) 16th July to 18th July



precipitation events and flash floods

Lichtenhain-Mittelndorf
 77,5 l/m² in 6 h
 111,7 l/m² in 24 h

111,7 1/111 111

1 person died €70 Mio. estimated damage in in this region only

Berchtesgaden

67,5 l/m² in 3 h 99,3 l/m² in 24 h

1 person died €86 Mio. estimated damage in *public* infrastructure in this region only

