Statistical postprocessing of heavy precipitation

Session HS7.10, 05 May 2020
Spatial extremes in the hydro- and atmosphere: understanding and modelling

EGU2020: Sharing Geoscience Online at a glance

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extreme precipitation events are rare

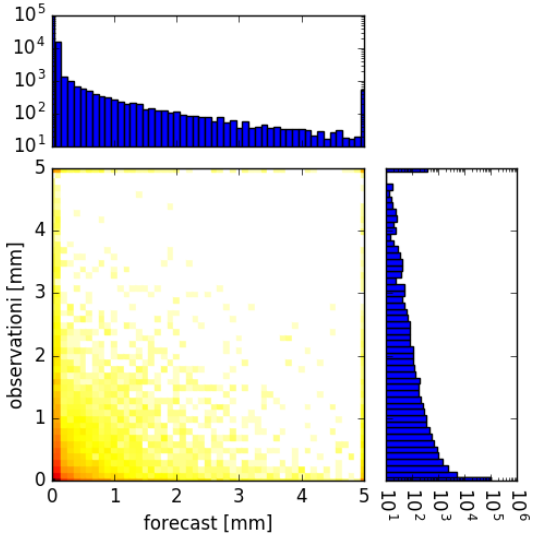
- example: RR/1h > 15mm
  - all observed events from 08.12.2010 until 31.12.2017 (> 7 years) in Frankfurt (similar in Berlin, etc.)
  - COSMO-DE-EPS starting at 12 UTC, value of the next grid point

date	hours after 12 UTC	EPS-mean	EPS-Stddev	observation
22.06.2011, 13 UTC	+01	1,4	0,4	15,2
06.08.2012, 00 UTC	+12	0,6	0,6	15,0
16.08.2012, 02 UTC	+14	1,2	1,3	37,3
08.06.2013, 18 UTC	+06	0,0	0,0	34,8
29.11.2015, 22 UTC	+10	2.0	1,8	15,6
29.05.2016, 23 UTC	+11	1,8	2,1	15,2
30.05.2016, 00 UTC	+12	1,2	2,2	17,3
14.06.2016, 16 UTC	+04	8,8	9,8	19,1

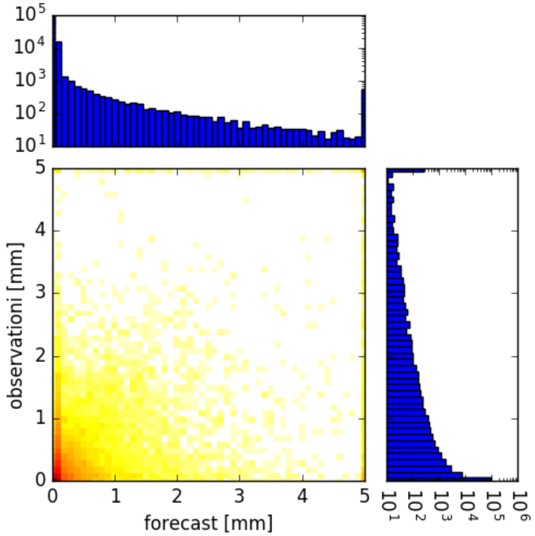
[mm]

optimisation of precipitation

- verification of precipitation amount RR/1h
  - forecast period May-June 2016
  - forecast period: 1h for MOS (3h for COSMO-DE-EPS)



COSMO-DE-EPS mean



Ensemble-MOS

- small correllation between forecast (next grid point) and observation
- small improvement by statistical optimisation with EnsembleMOS
- **climate mean might be the best statistical forecast**

optimisation of precipitation

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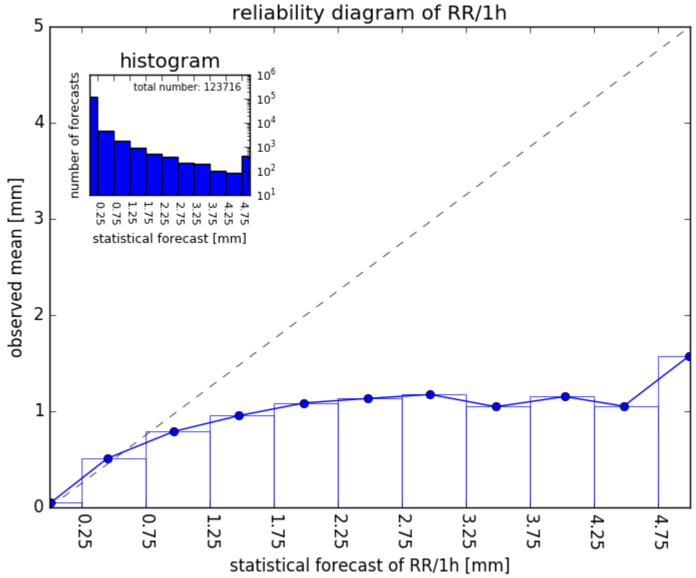
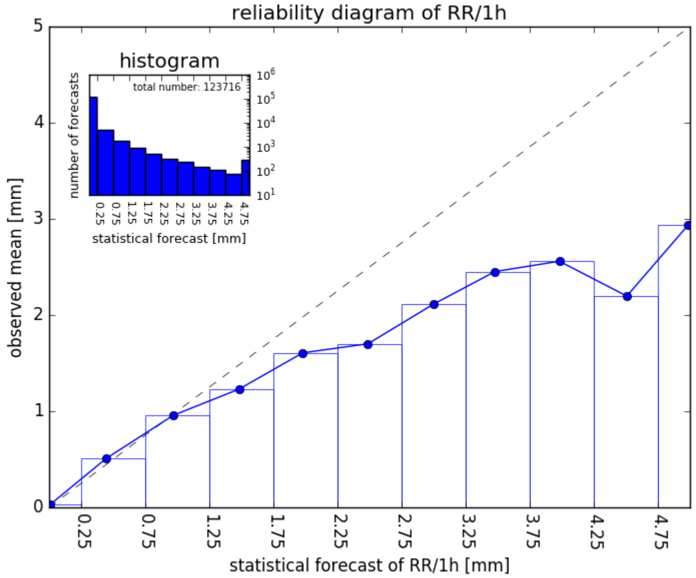
- verification of precipitation amounts RR/1h (nearest point, linear regression)
  - forecast period May-June 2016
  - forecasting time: 1h for MOS (3h for COSMO-DE-EPS)



COSMO-DE-EPS Mean

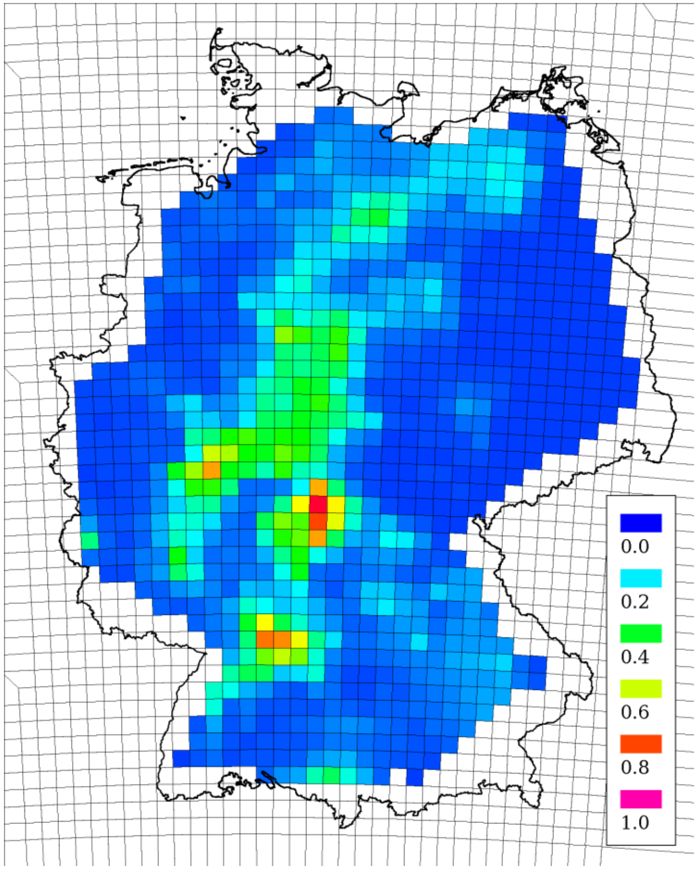


Ensemble-MOS

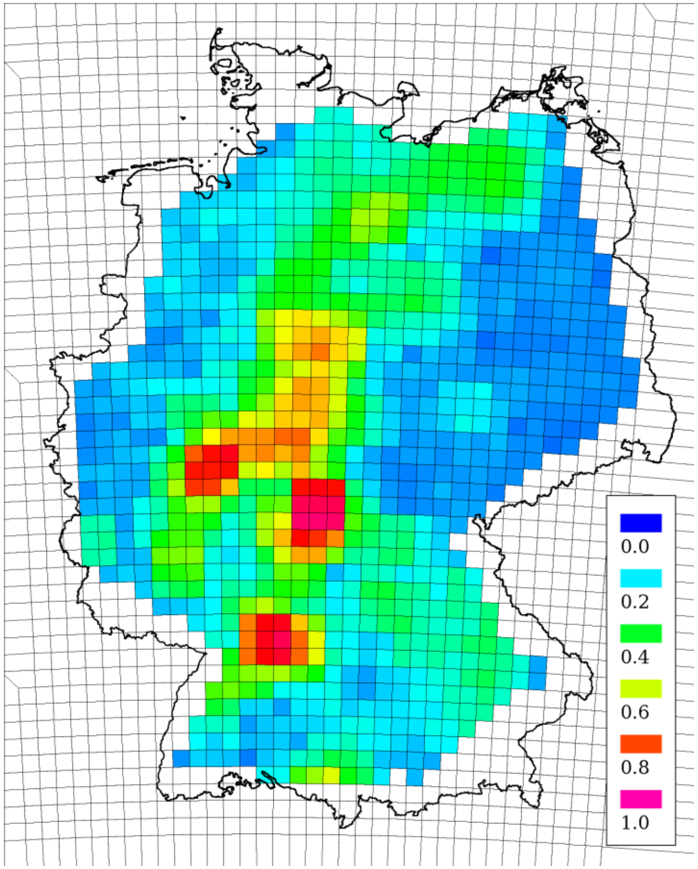
- overestimation of precipitation amounts for COSMO-DE-EPS (above about 1.5mm)
- significant improvement by statistical optimisation with Ensemble-MOS

area precipitation probabilities

- point probability: precipitation occurs exactly at given location (grid centre)
- area probability: precipitation occurs anywhere in an area (grid cell)

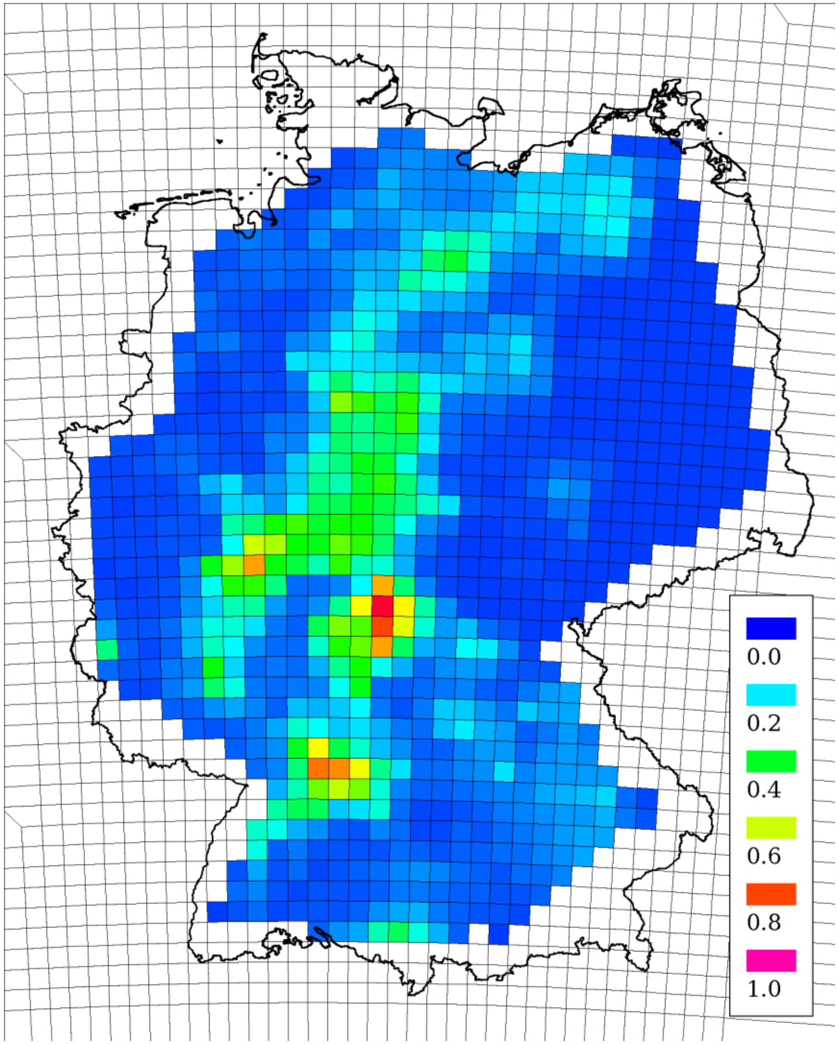


point probabilities on 20 km grid

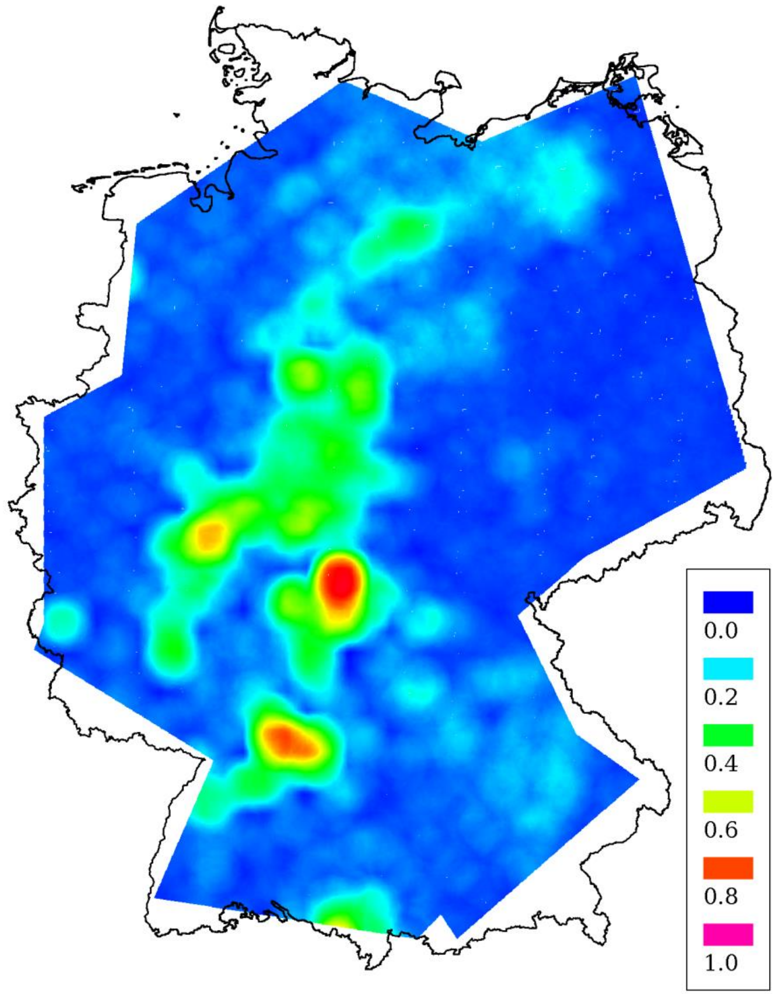


area probabilities for 20 km grid

area precipitation probabilities

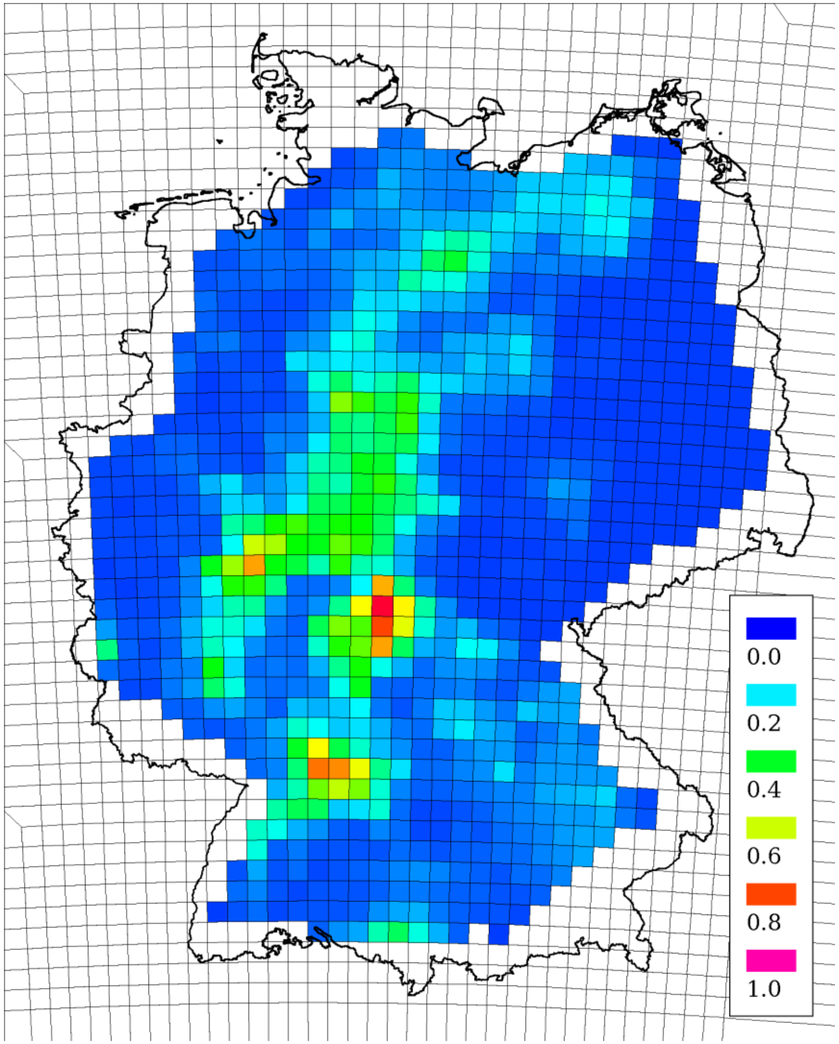


point probabilities on 20 km grid

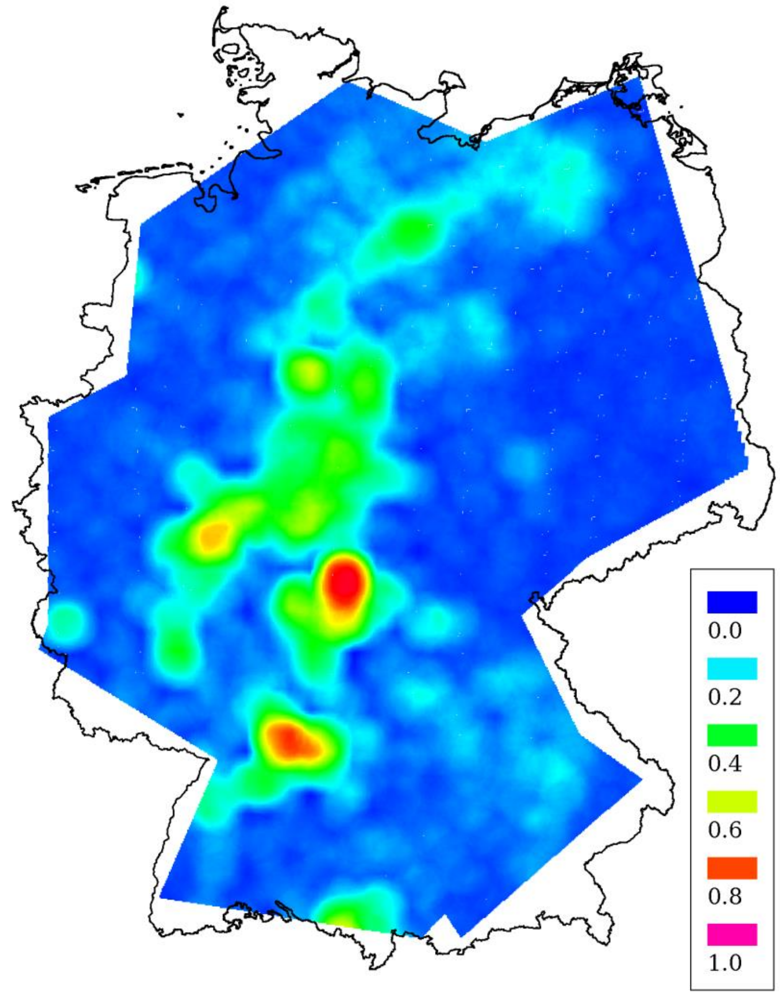


area probabilities for 0.625 km grid

area precipitation probabilities

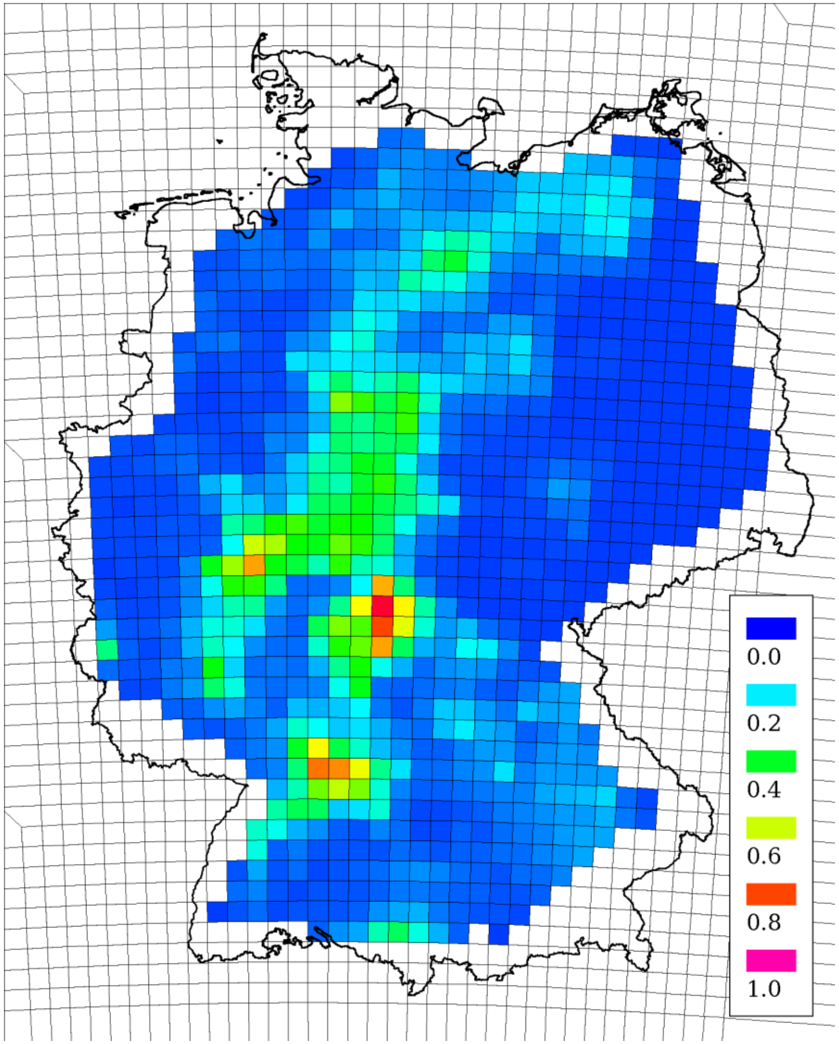


point probabilities on 20 km grid

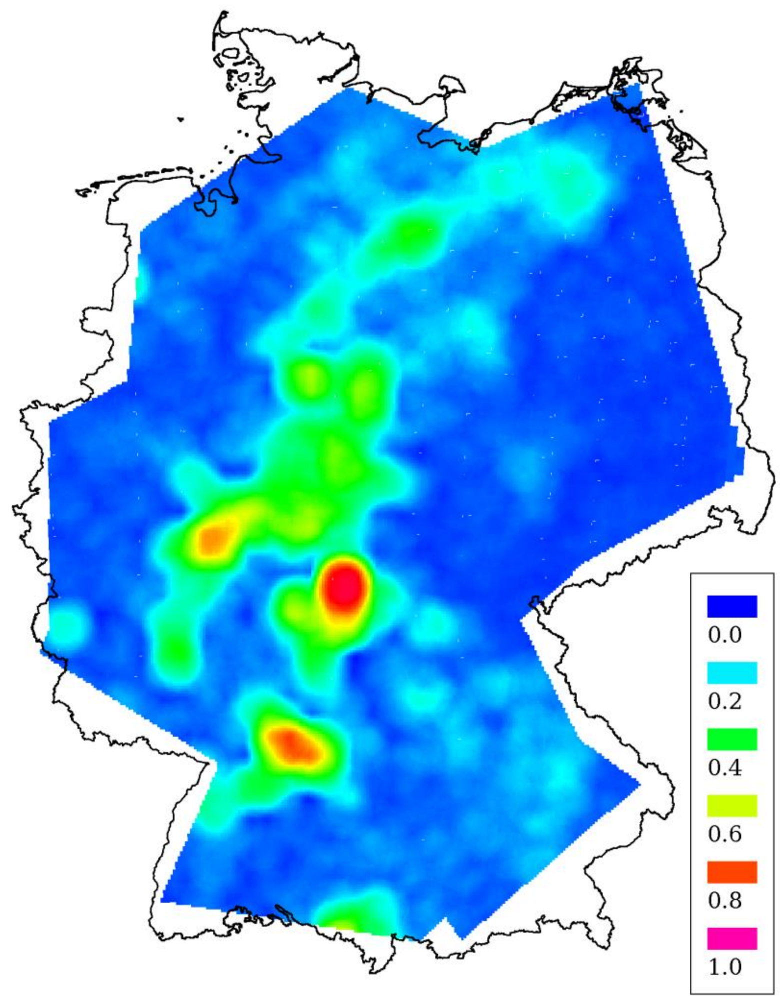


area probabilities for 1.25 km grid

area precipitation probabilities

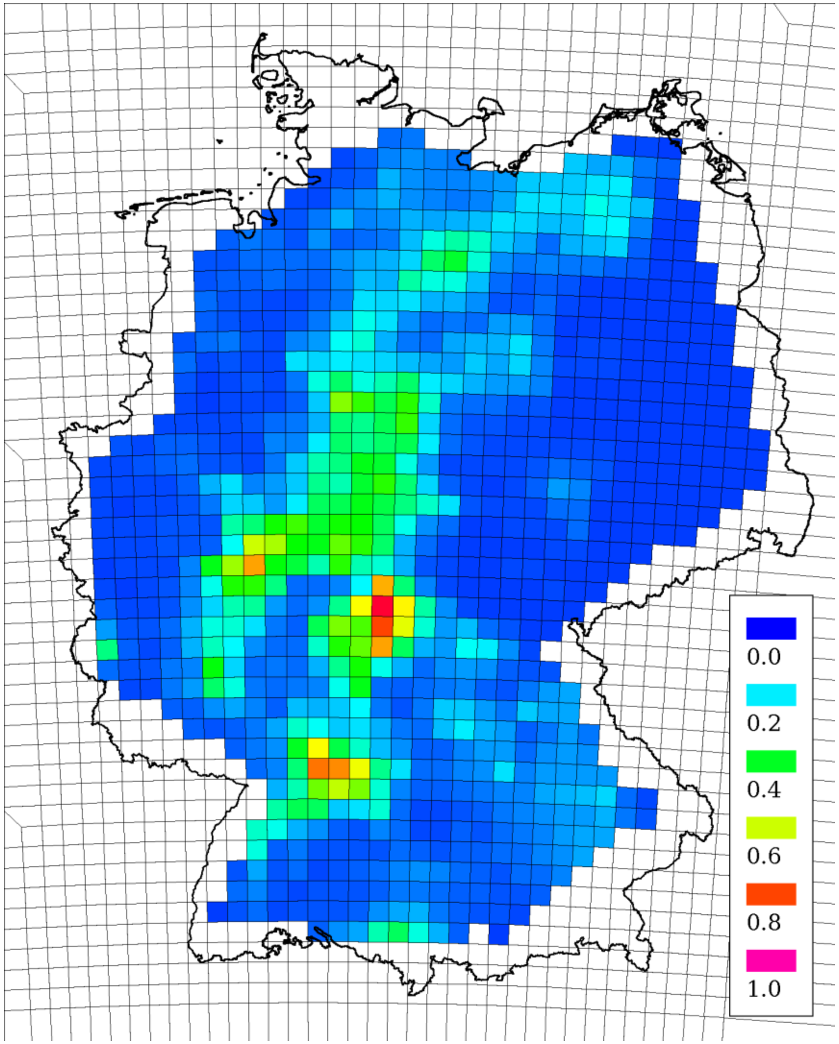


point probabilities on 20 km grid

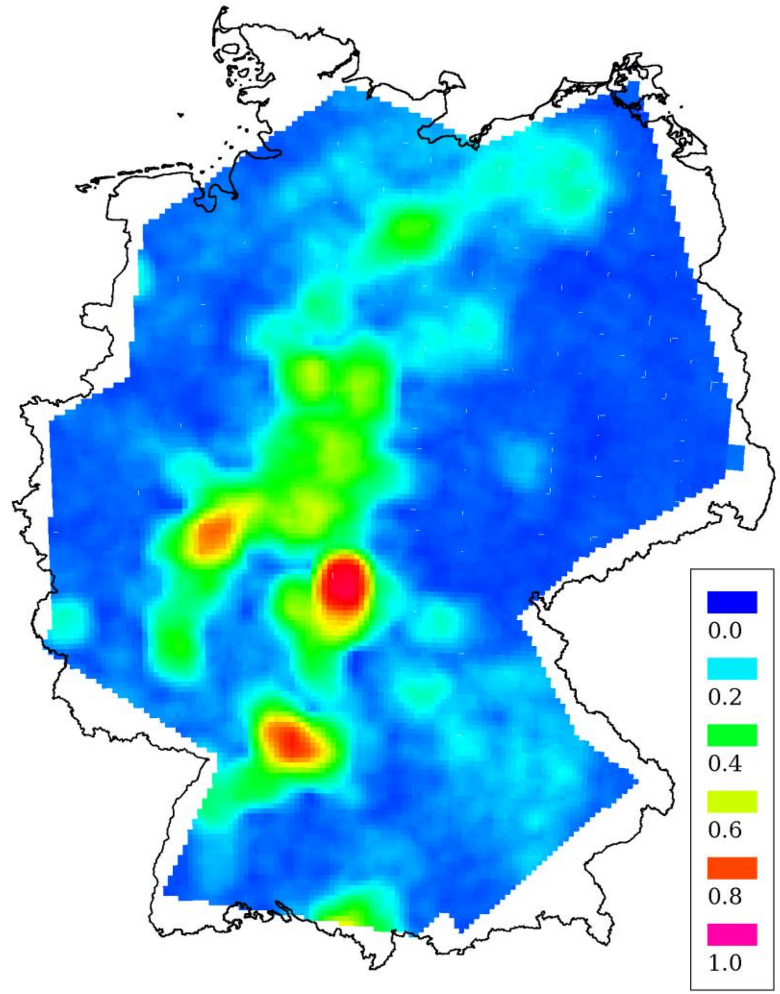


area probabilities for 2.5 km grid

area precipitation probabilities

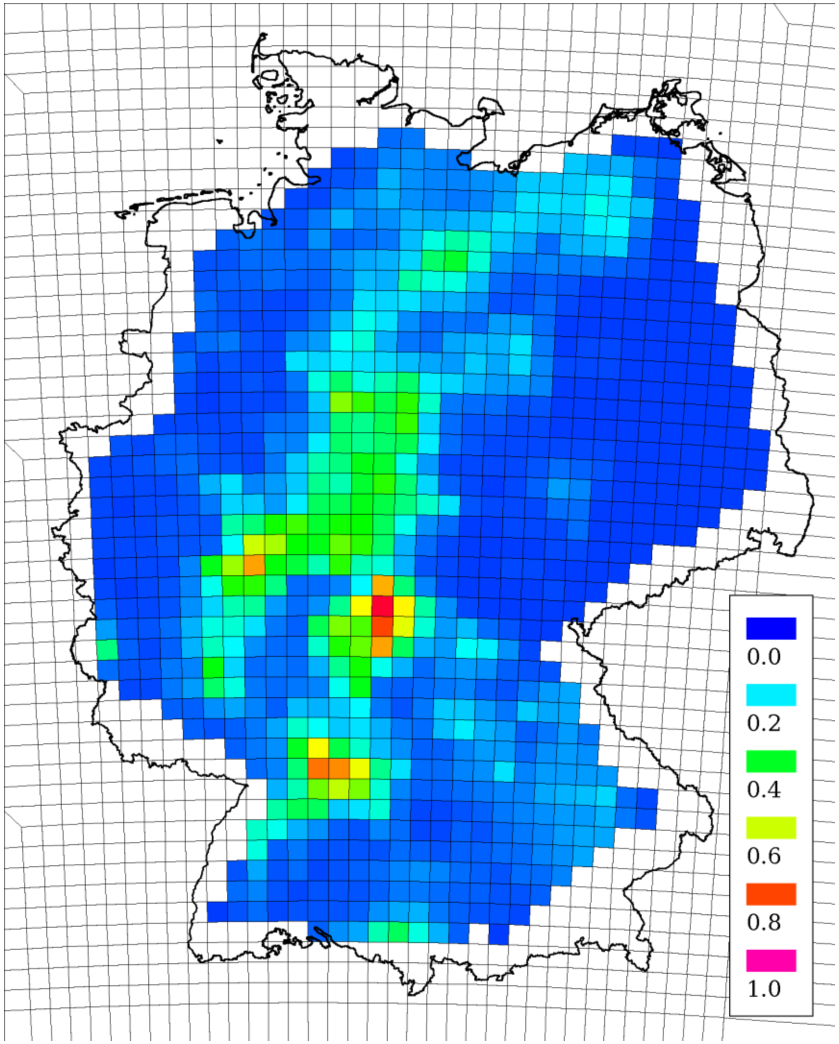


point probabilities on 20 km grid

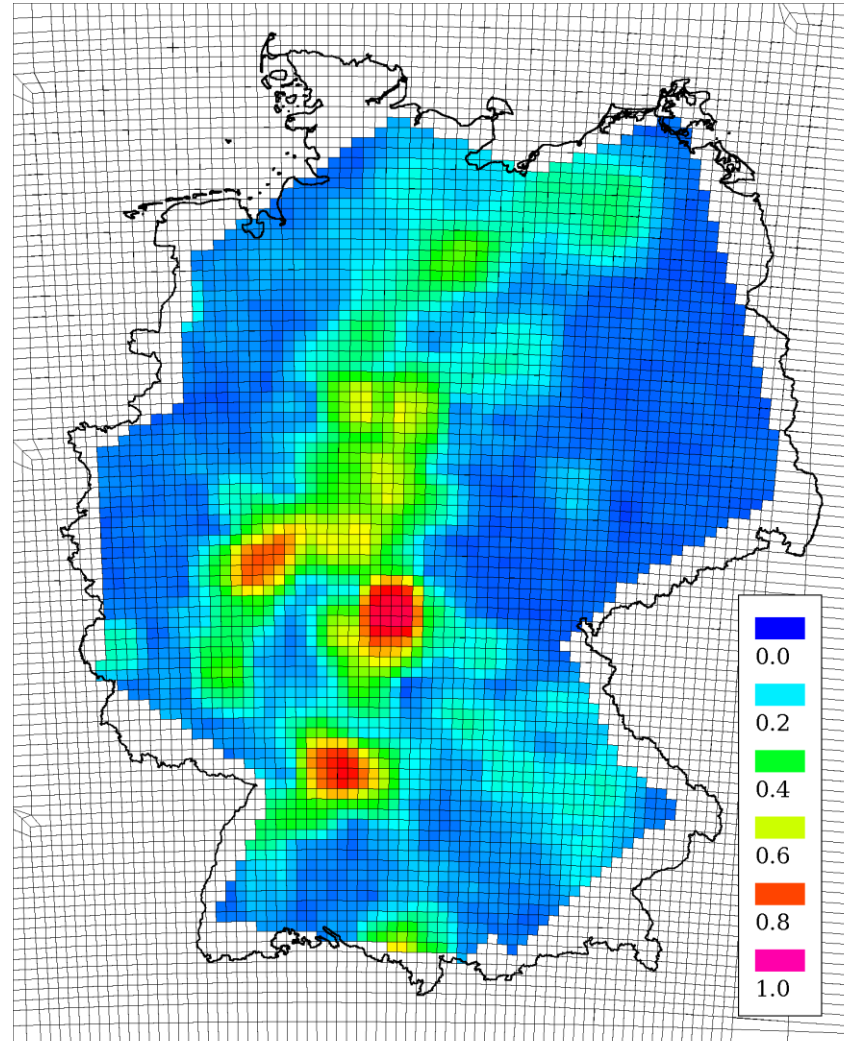


area probabilities for 5 km grid

area precipitation probabilities

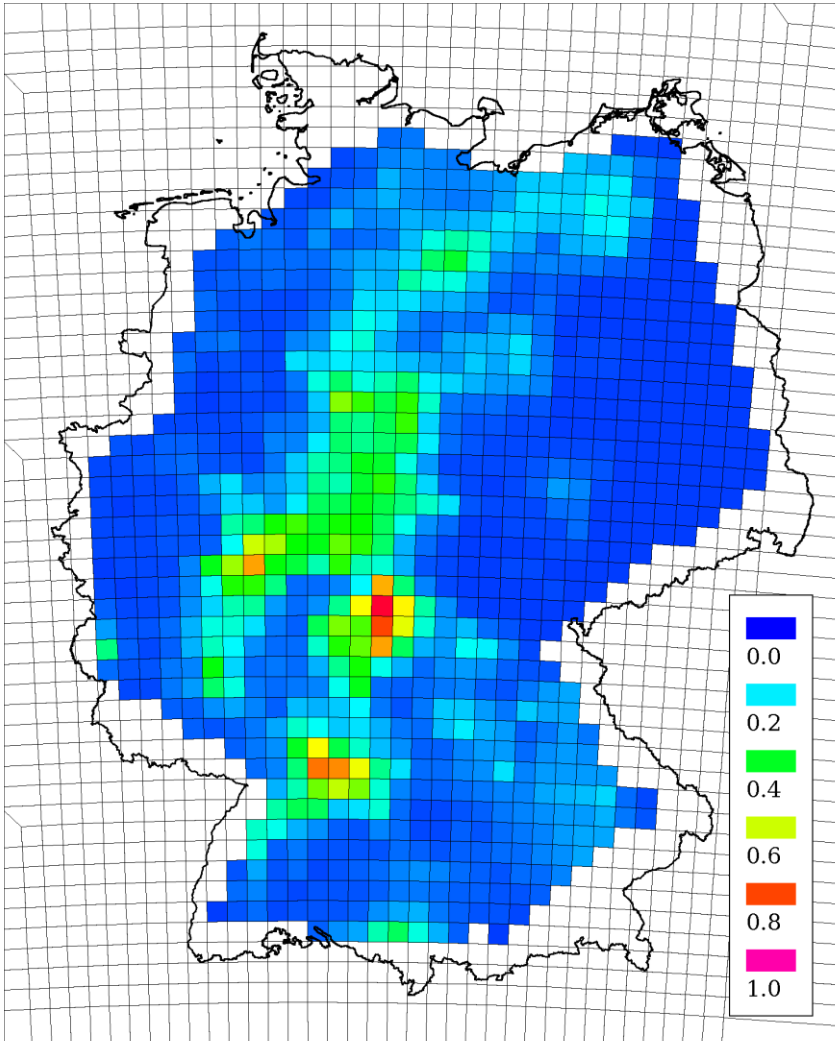


point probabilities on 20 km grid

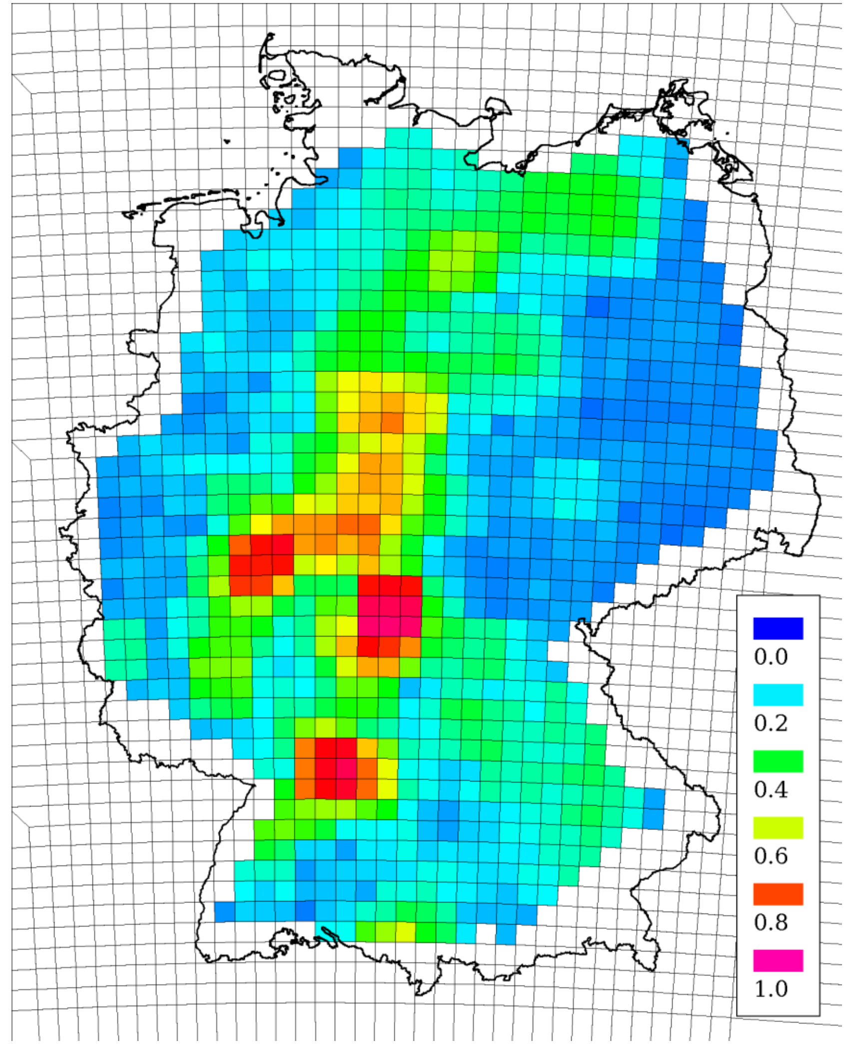


area probabilities for 10 km grid

area precipitation probabilities



point probabilities on 20 km grid



area probabilities for 20 km grid

area precipitation probabilities

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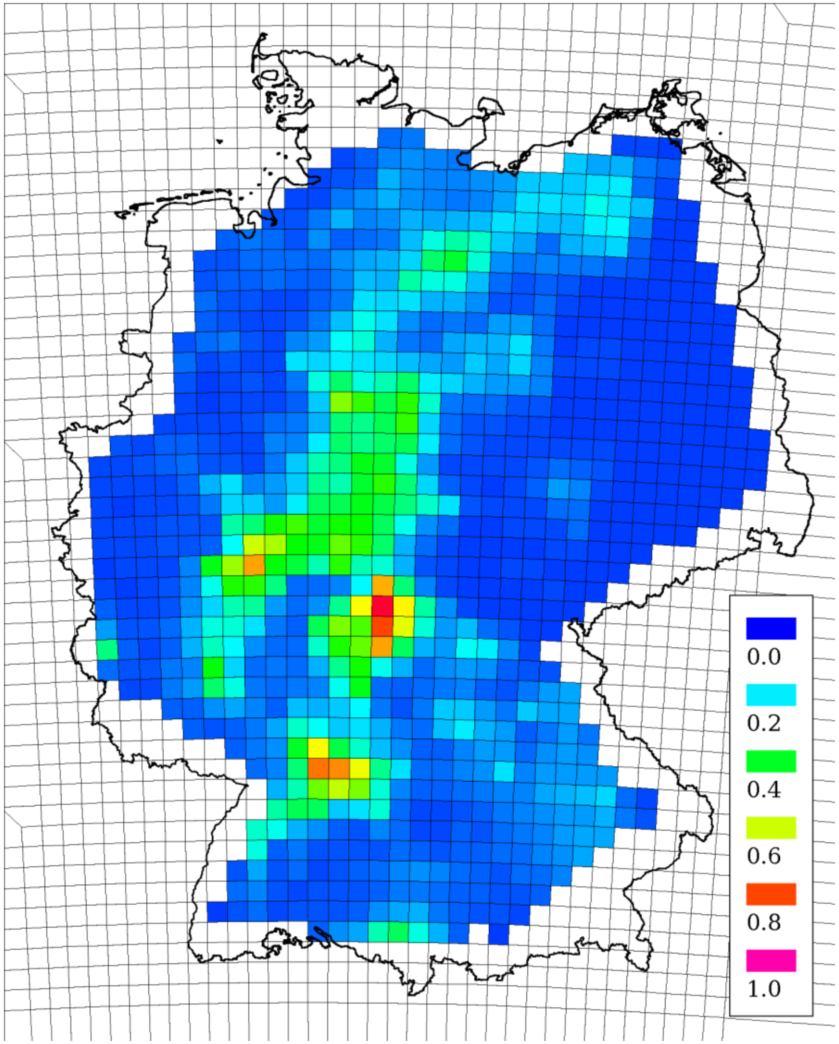
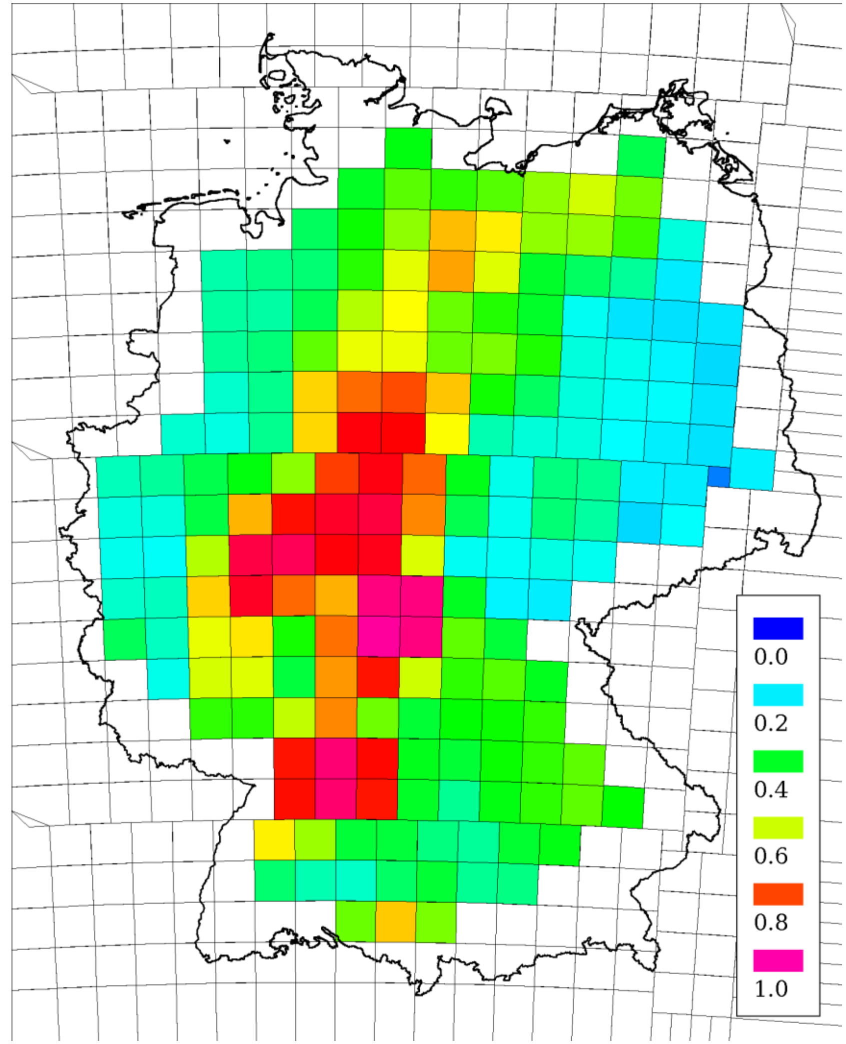


point probabilities on 20 km grid



area probabilities for 40 km grid

area precipitation probabilities

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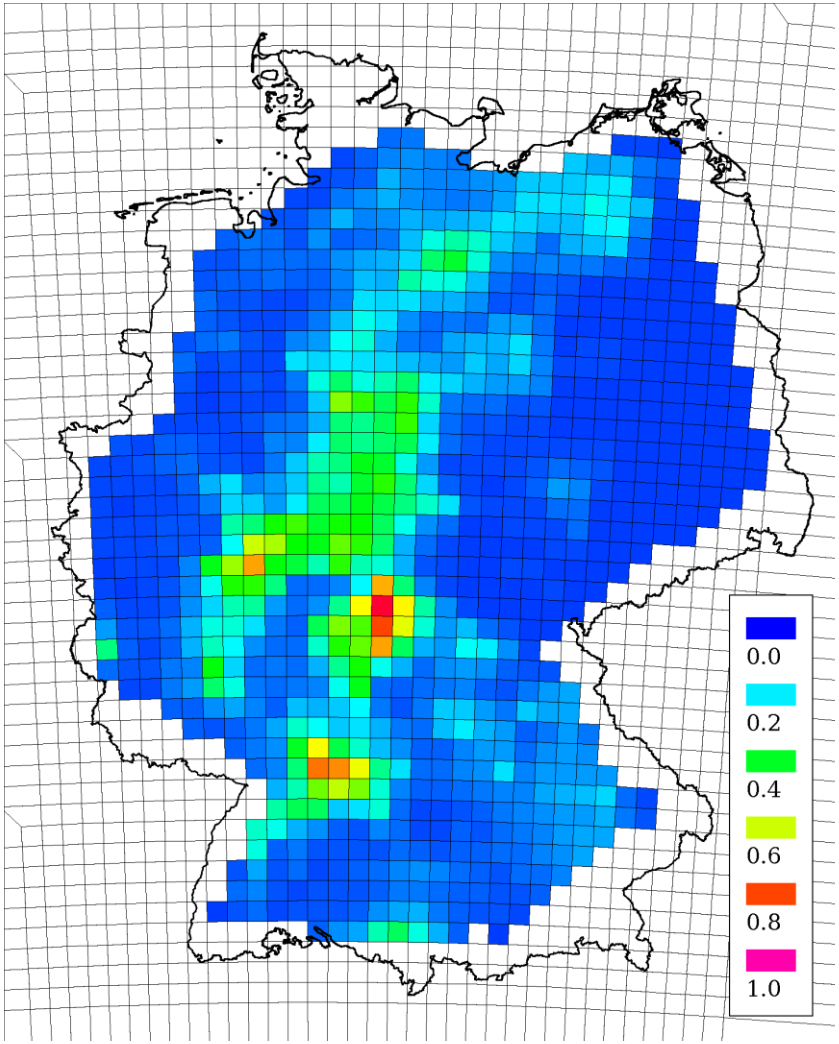
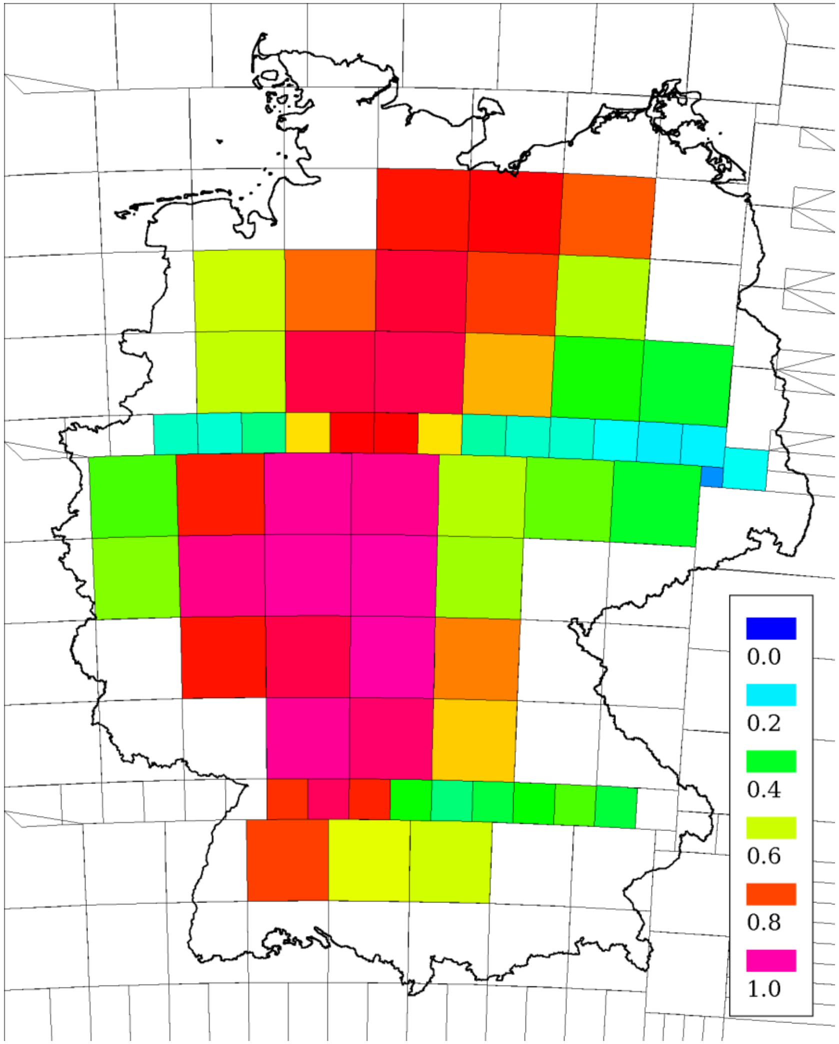


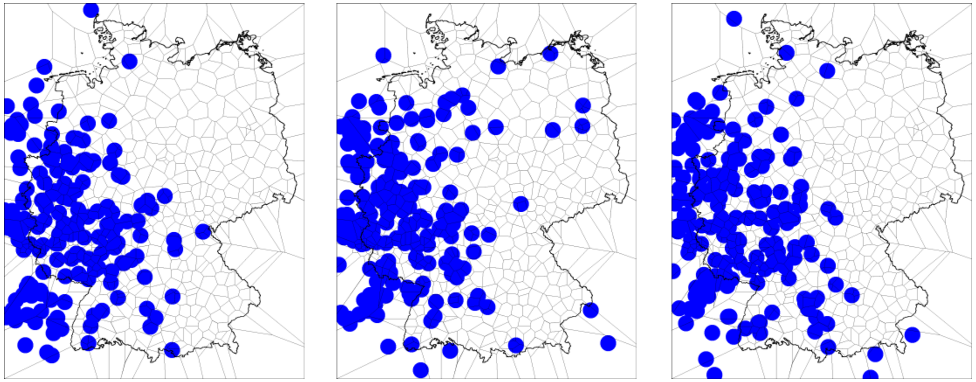
point probabilities on 20 km grid



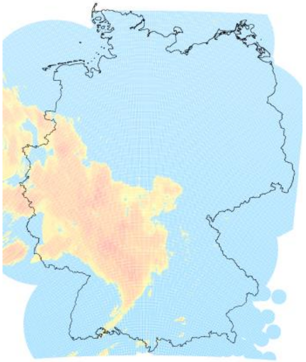
area probabilities for 80 km grid

… using stochastic geometry

- ➔ **derive area probabilities from calibrated point probabilities**
- ➔ **basic idea of approach:**
  - ➔ model precipitation as circular precipitation cells
    - ➔ cells are randomly distributed by stochastic process
    - ➔ match the relative number of coverages to point probabilites
  - ➔ for an arbitrary area: count coverages (also partial coverages)
  - ➔ radii of precipitation cells are estimated from variability of point probabilities (semivariogram)
    - ➔ adjust for convective events or large scale precipitation



3 of about 1000 Monte Carlo-simulations

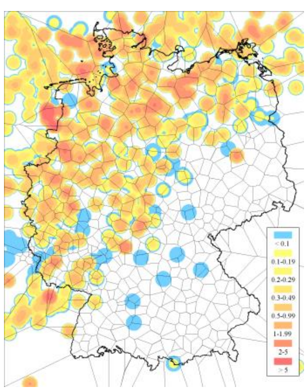


radar for validation

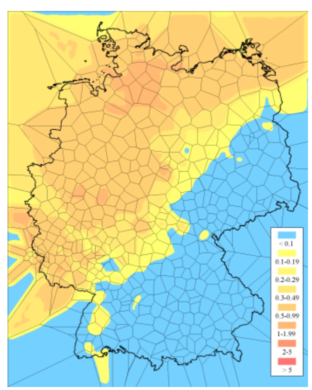
… using stochastic geometry

➔ **enhancement for high precipitation thresholds** (5 mm/h, 10 mm/h…)

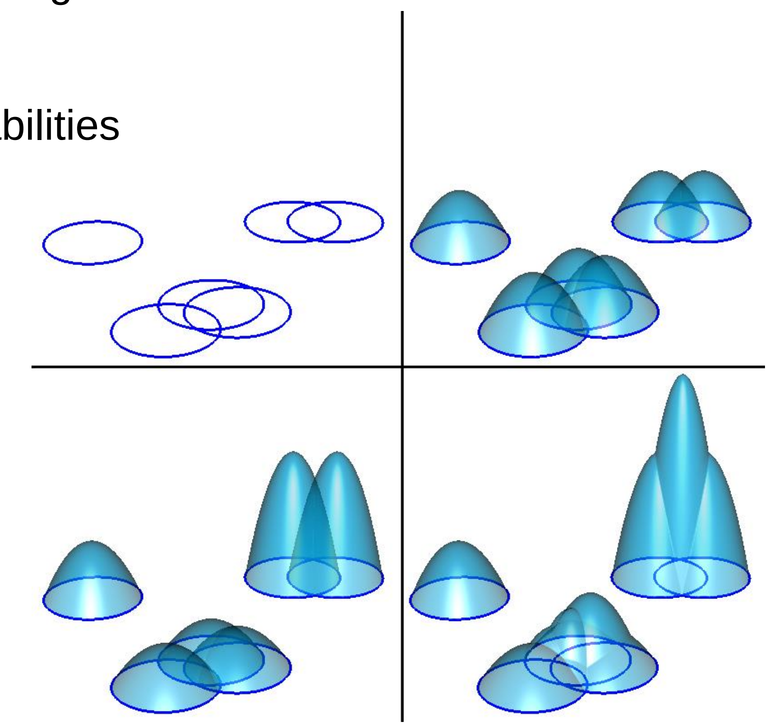
- ➔ **model area precipitation amounts**
  - ➔ assigne a symmetric response function to each cell
  - ➔ multiply response function with random scaling variable
  - ➔ sum up scaled response functions
  - ➔ fit scaled response functions to point probabilities
  - ➔ sum up for arbitrary areas
- ➔ derive probabilities for high thresholds



typical realisation



estimated amounts based on 5000 realisations



… using radar products

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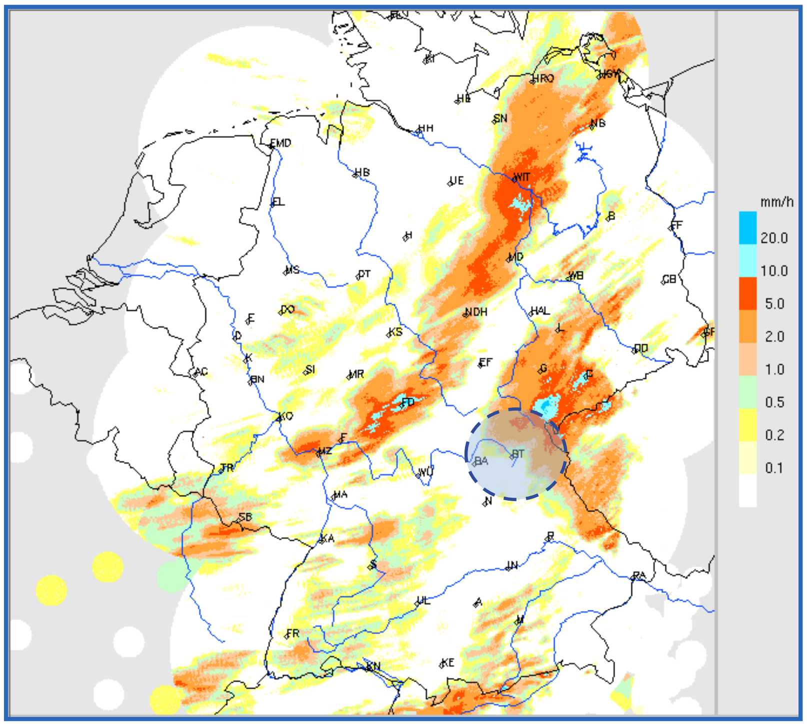
- **gauge adjusted radar products as predictands**
  - for point probabilities instead of synoptical observations
  - for area probabilities of predefined areas



1-hourly estimation of precipitation (gauge adjusted at stations)

- **radar probabilities of precipitation**
  - radar precipitation in 1x1 km resolution
    (RW-product of DWD)
  - surrounding of synoptical stations
    (r=8 km and 40 km)
  - relative frequencies in surrounding is used as predictand of point probability
  - improved statistical sample
    higher representativity
    more extreme cases
  - area related predictands

Thank you for attention

➔ **question:**

what is the best compromise between spatial resolution and predictability?