Brandenburg
University of Technology
Cottbus - Senftenberg

Influence of horizontal resolution on simulations of extreme precipitation episodes

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Simulation strategy

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- Comparison of two CCLM simulations with version 5.0_clm9 and tenfold different horizontal resolution

- CCLM evaluation run on Euro-CORDEX domain
  - Configuration: recommended setup for standard version
  - Forcing: ERA-Interim reanalysis
  - Resolution: 0.11° (≈12 km), 40 layers
  - Simulation period: transient simulation 1979-2018

- Nested CCLM simulation on Alpine subdomain (Alp-HRS)
  - Configuration: CP-config. (according to MeteoSwiss 0.02° Alpine forecast)
  - Forcing: nested into CCLM evaluation run, 1 hr update of LBC
  - Resolution: 0.011° (≈1.2 km), 40 layers
  - Simulation period: multi-day episodes

Simulation strategy

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- Episodes represent the three highest integrated precipitation inputs into Southern Germany's Danube catchment area during the last decades
  - 26.07. – 07.08. 1991
  - 14.03. – 28.03. 2002
  - 27.07. – 17.08. 2002

- Reference data: HYRAS (1km) precipitation data

- Analyzed features on catchment area
  - spatial distribution and structure of daily precipitation fields
  - temporal sequence of total daily precipitation input
  - frequency distribution of daily precipitation amounts (on grid points)

Model / Data domains

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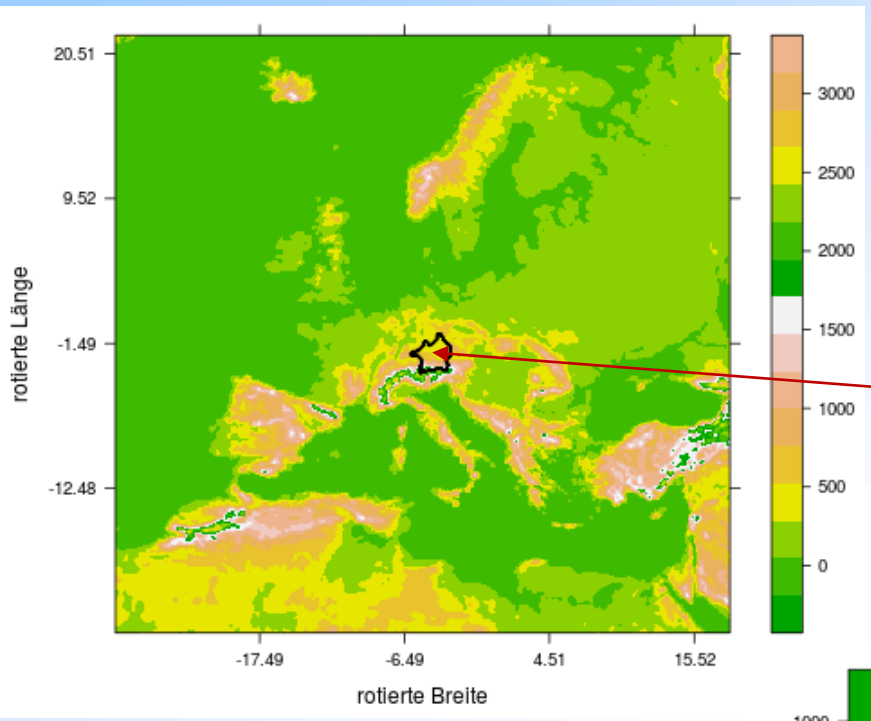
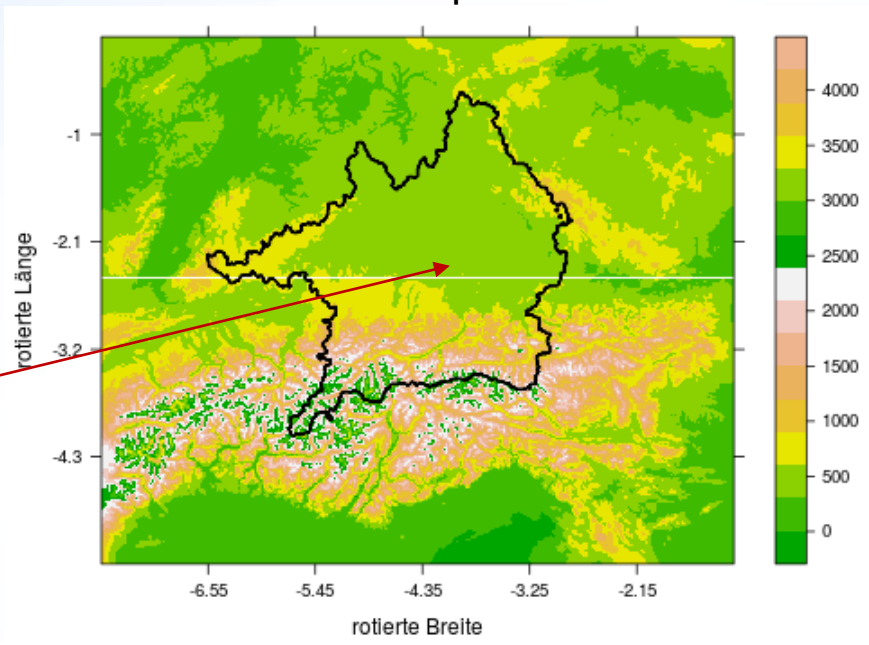
12 km Euro-CORDEX



450x438x40

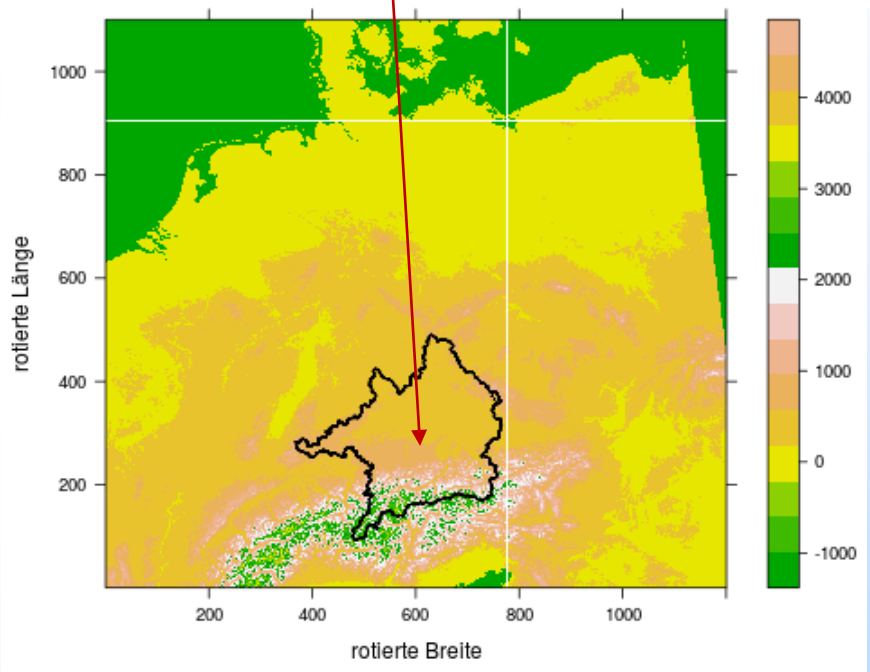
1.2 km Alp-HRS



590x490x40

catchment area

1 km HYRAS



Model/Data domains

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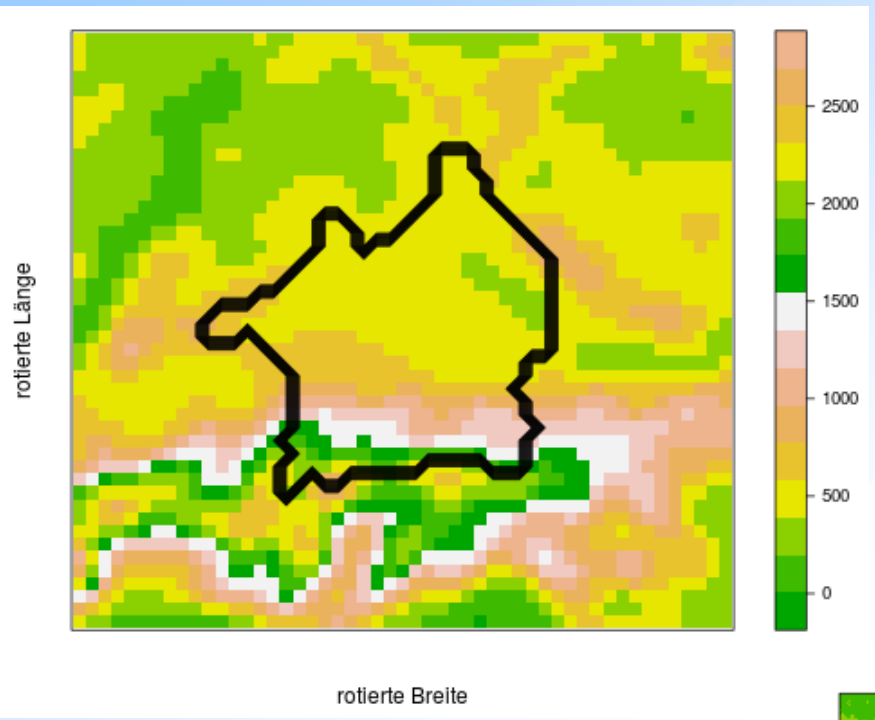
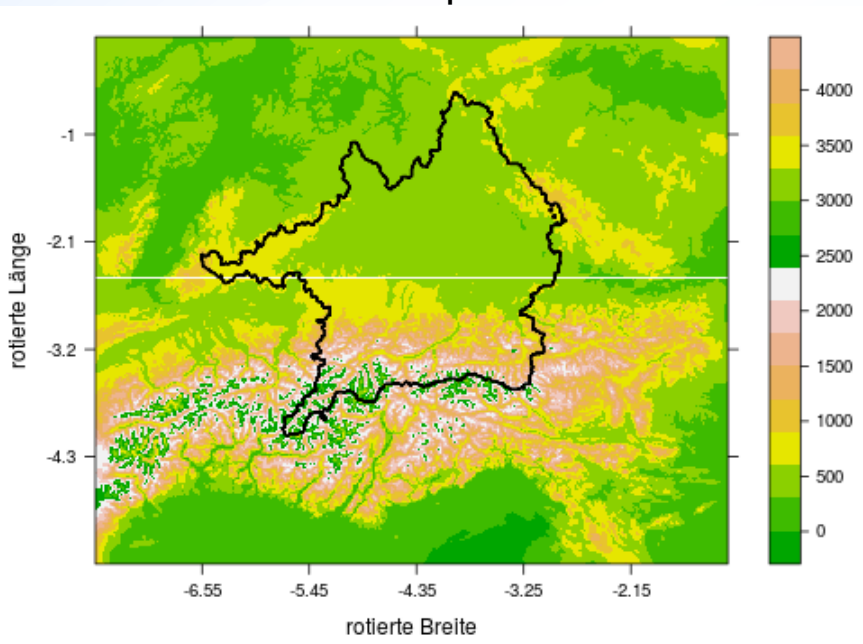
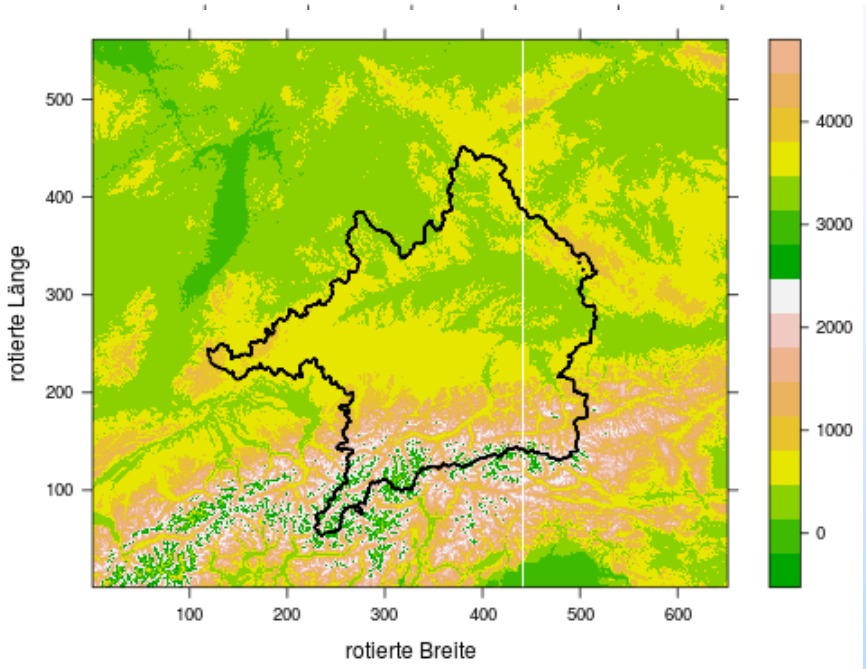
12 km Euro-CORDEX



1.2 km Alp-HRS



1 km HYRAS



Spatial structure of daily precipitation

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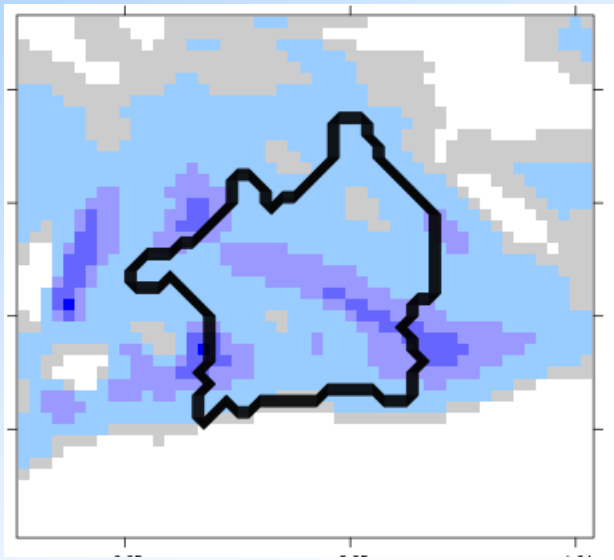
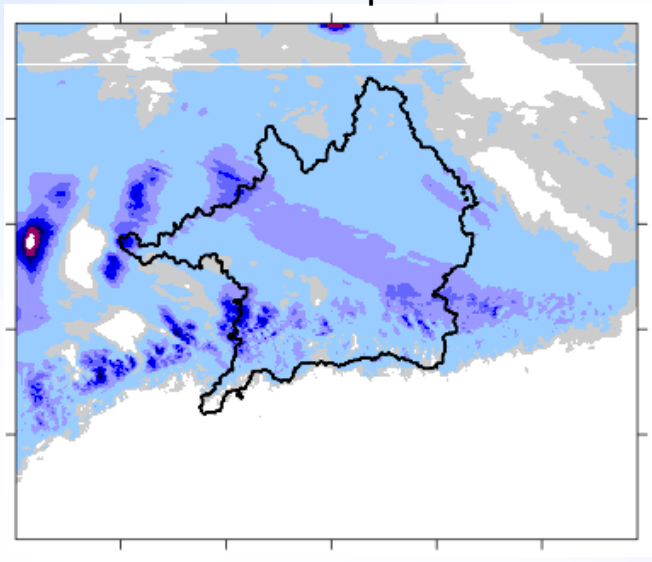
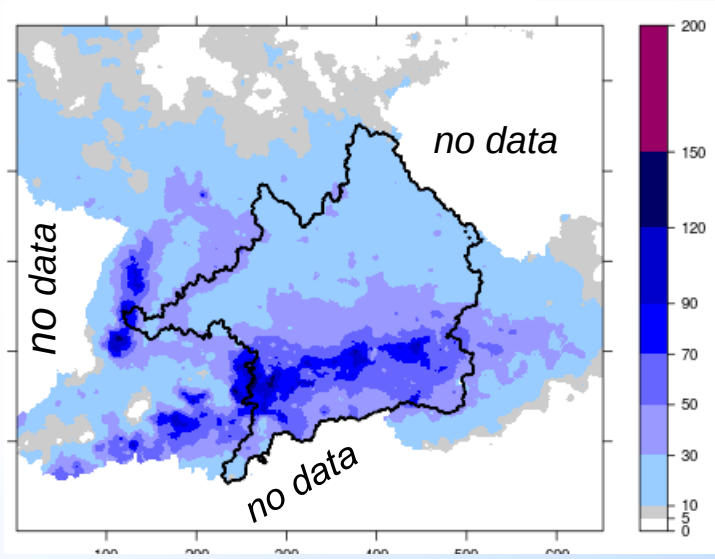
Sequence of 2nd period

12 km Euro-CORDEX | 1.2 km Alp-HRS | 1 km HYRAS

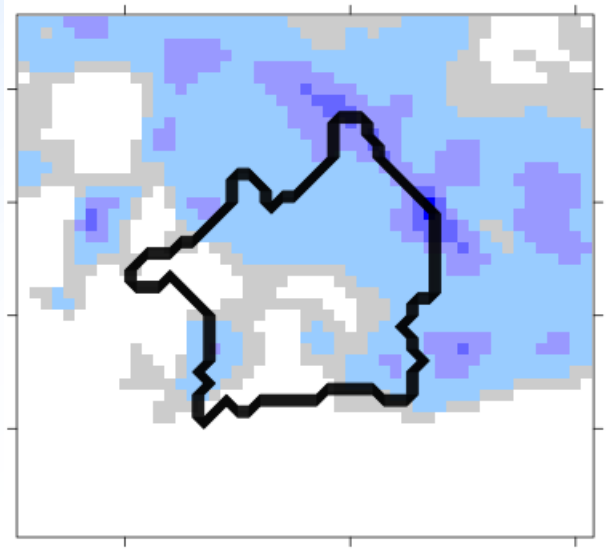
19.03. 2002

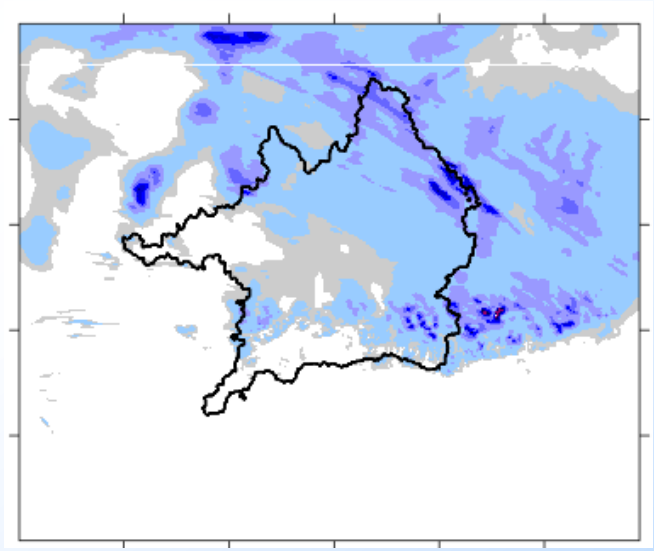


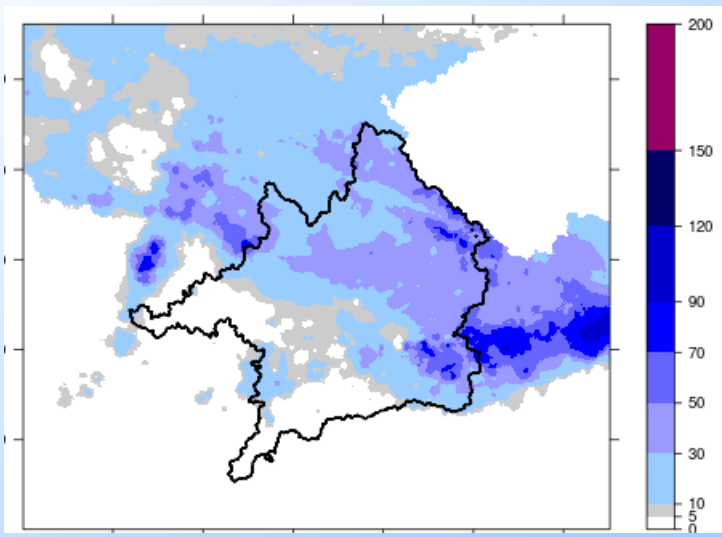




20.03. 2002







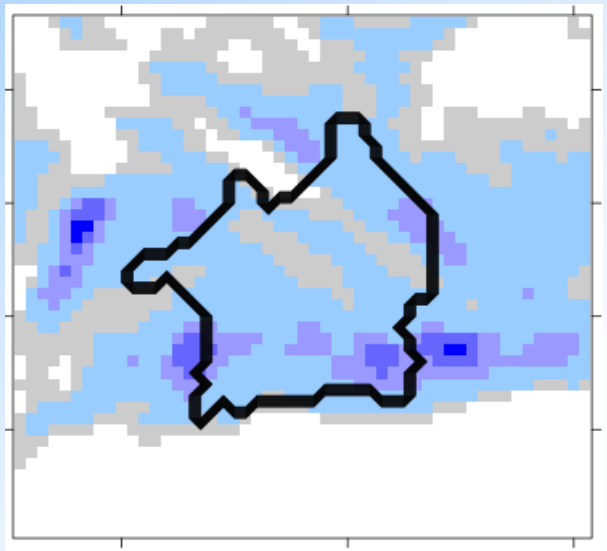
Spatial structure of daily precipitation

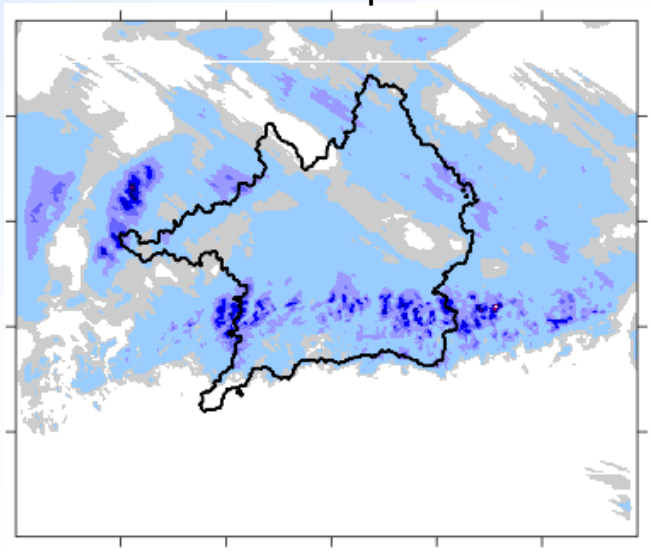
Brandenburg University of Technology Cottbus - Senftenberg

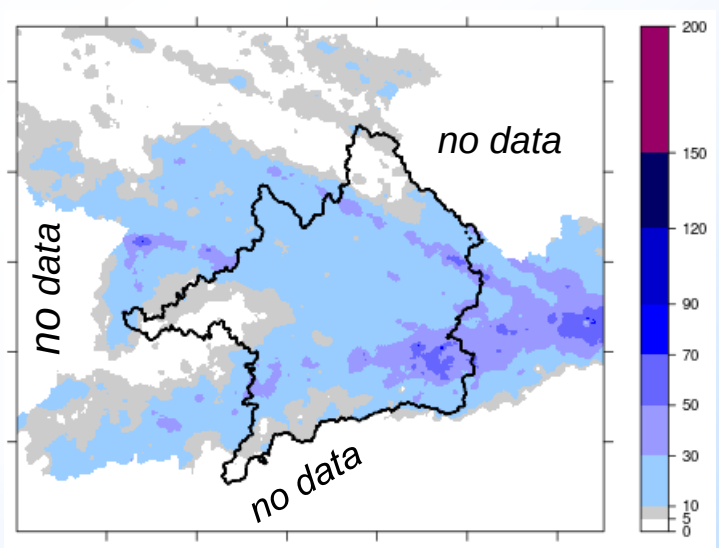
Sequence of 2nd period

12 km Euro-CORDEX | 1.2 km Alp-HRS | 1 km HYRAS

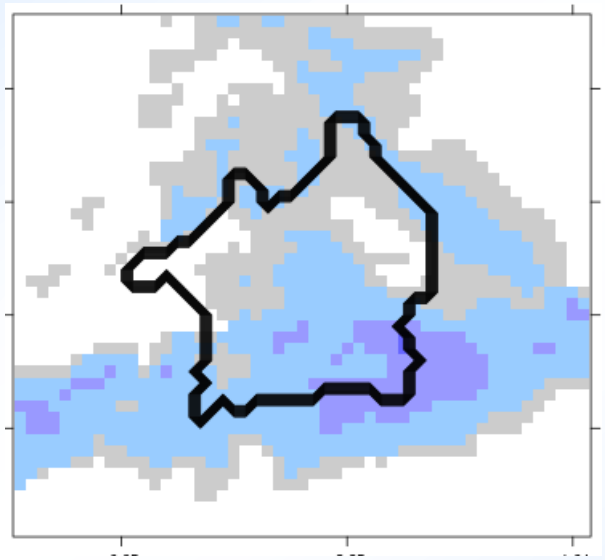
21.03. 2002

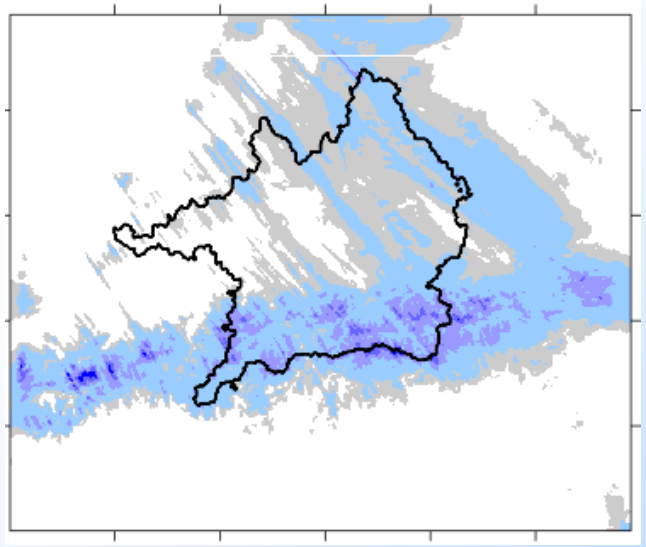


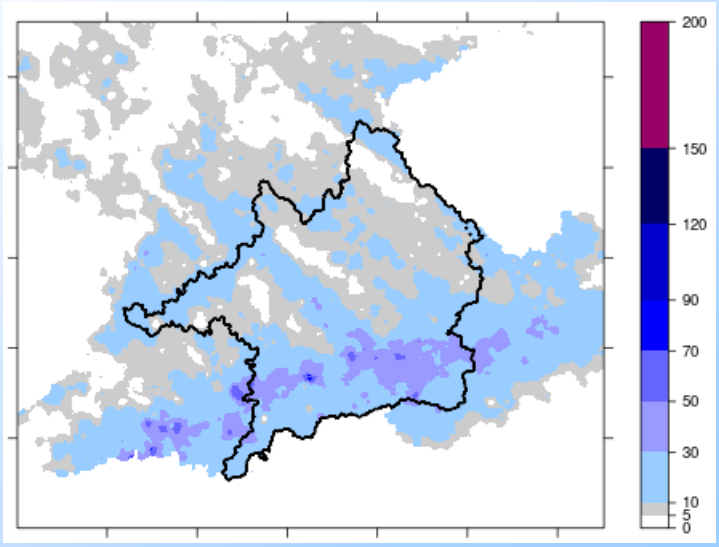




22.03. 2002







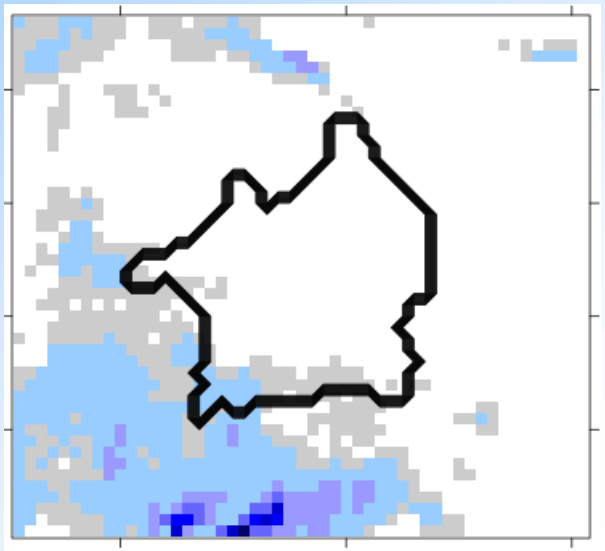
Spatial structure of daily precipitation

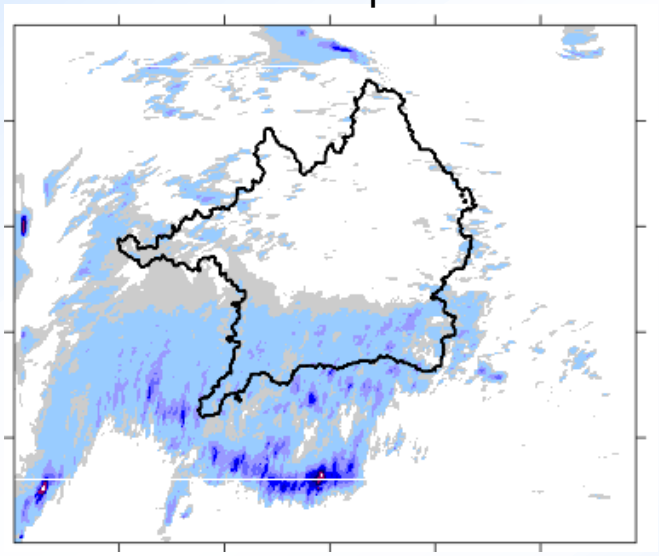
Brandenburg University of Technology Cottbus - Senftenberg

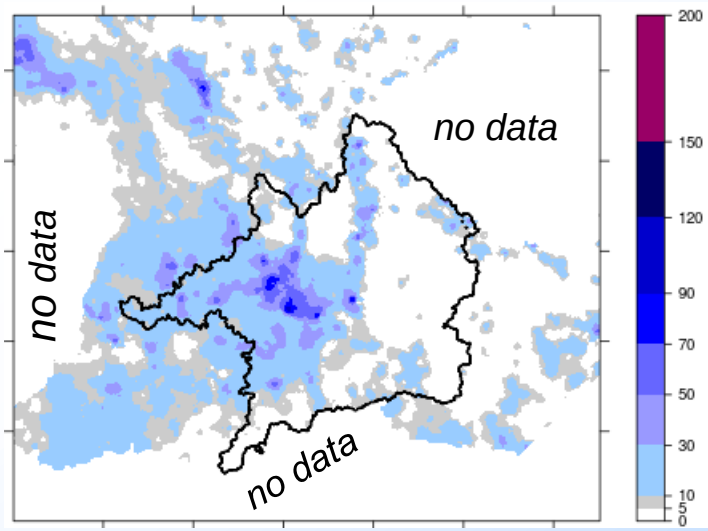
Sequence of 3rd period

12 km Euro-CORDEX | 1.2 km Alp-HRS | 1 km HYRAS

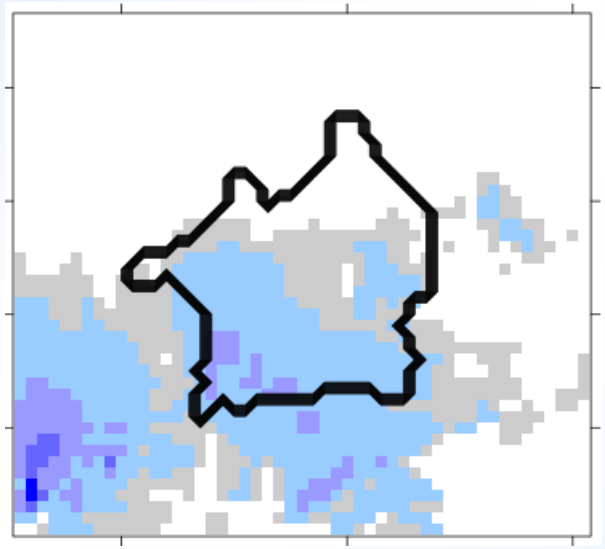
31.07. 2002

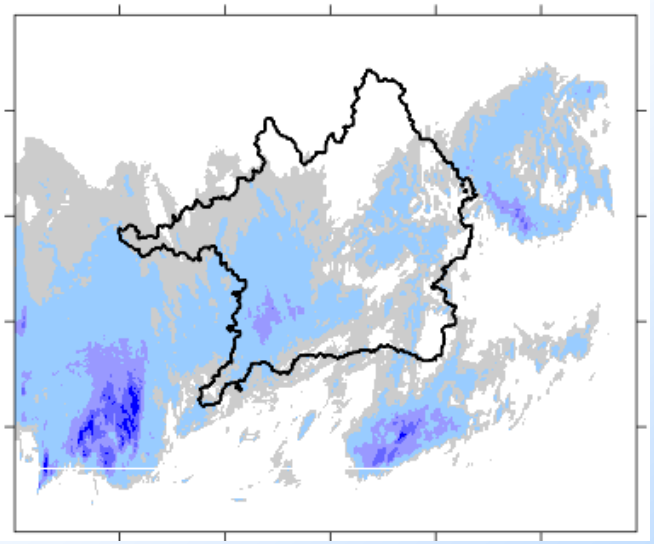


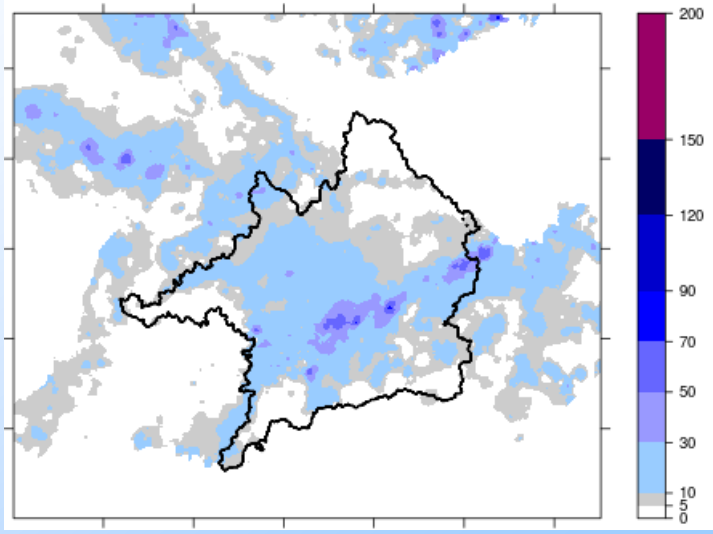




01.08. 2002







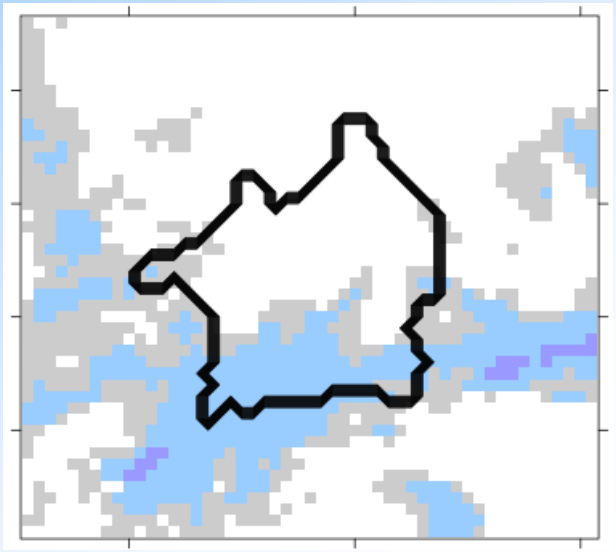
Spatial structure of daily precipitation

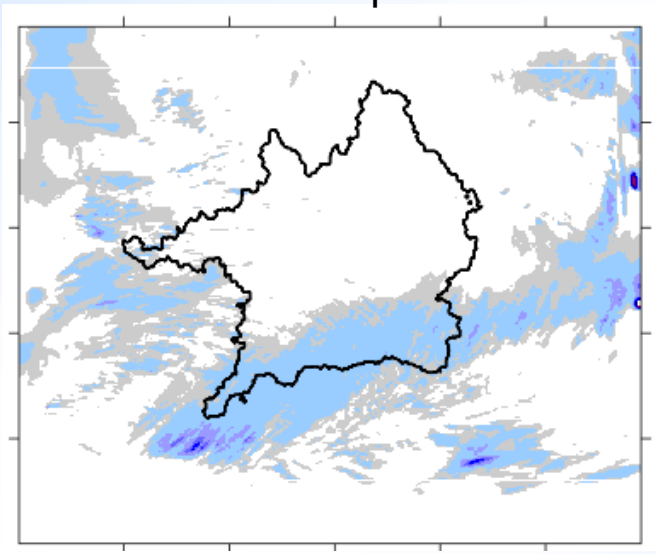
Brandenburg University of Technology Cottbus - Senftenberg

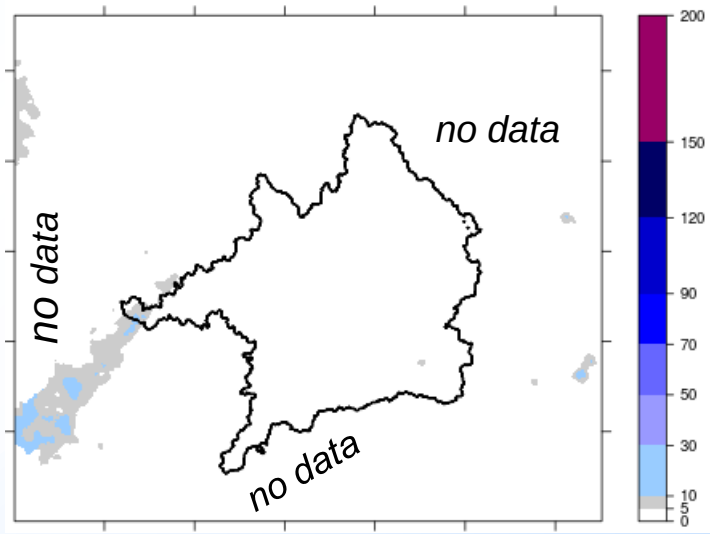
Sequence of 3rd period

12 km Euro-CORDEX | 1.2 km Alp-HRS | 1 km HYRAS

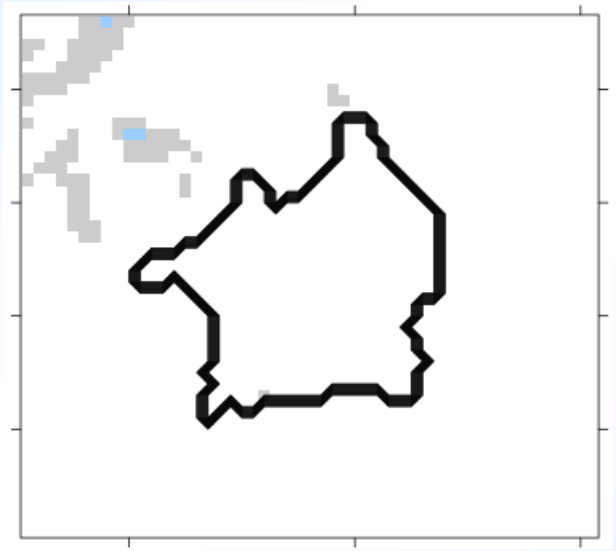
02.08. 2002

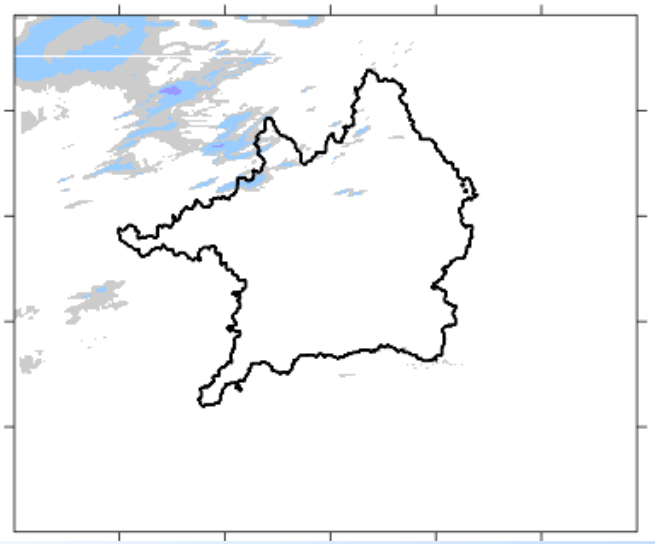


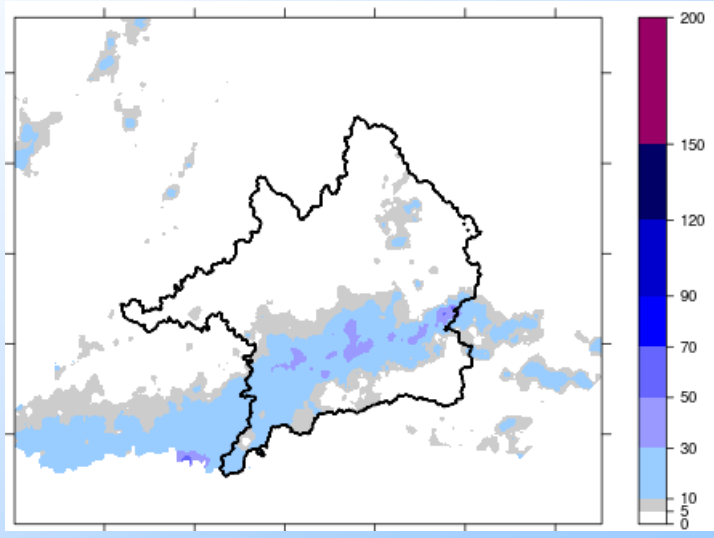




03.08. 2002







Temporal development of daily precipitation input

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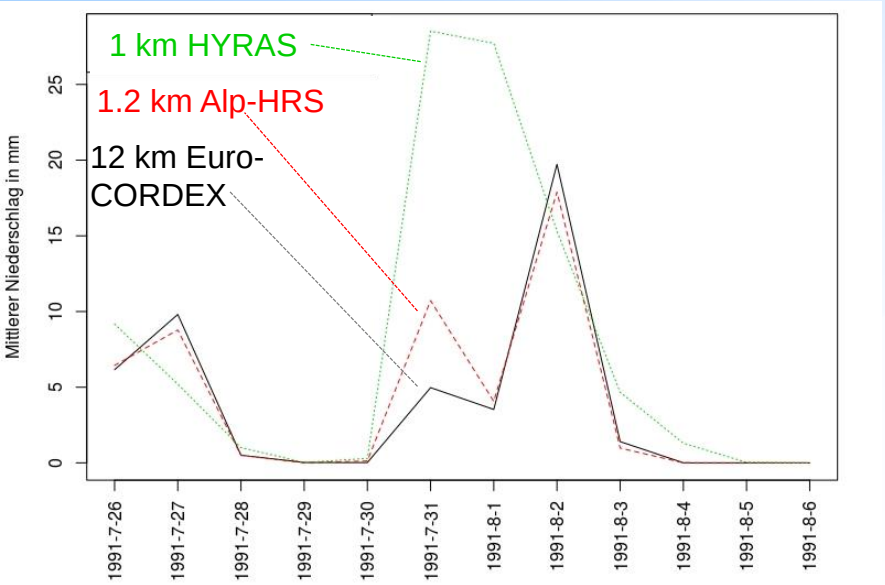
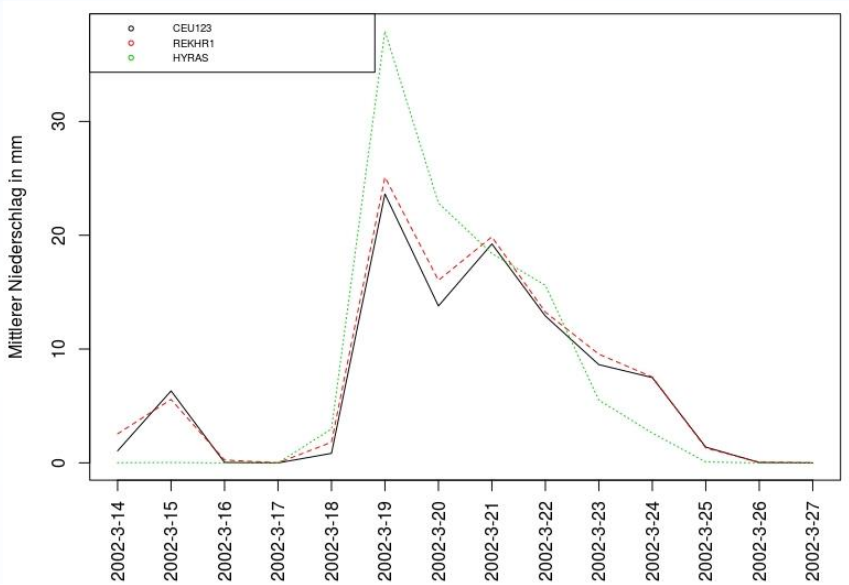
Spatial average over catchment area

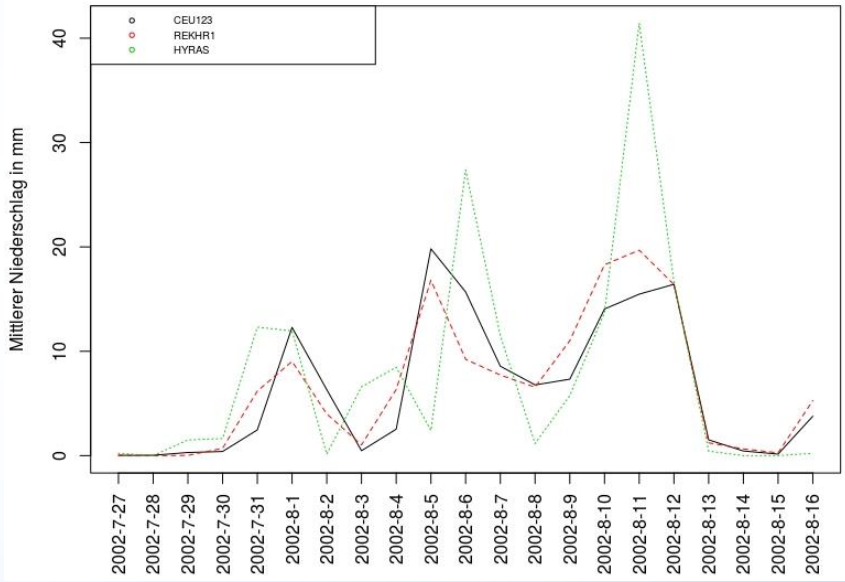
26.07. – 07.08. 1991



14.03. – 28.03. 2002



27.07. – 17.08. 2002



Frequency distribution of daily precipitation intensities

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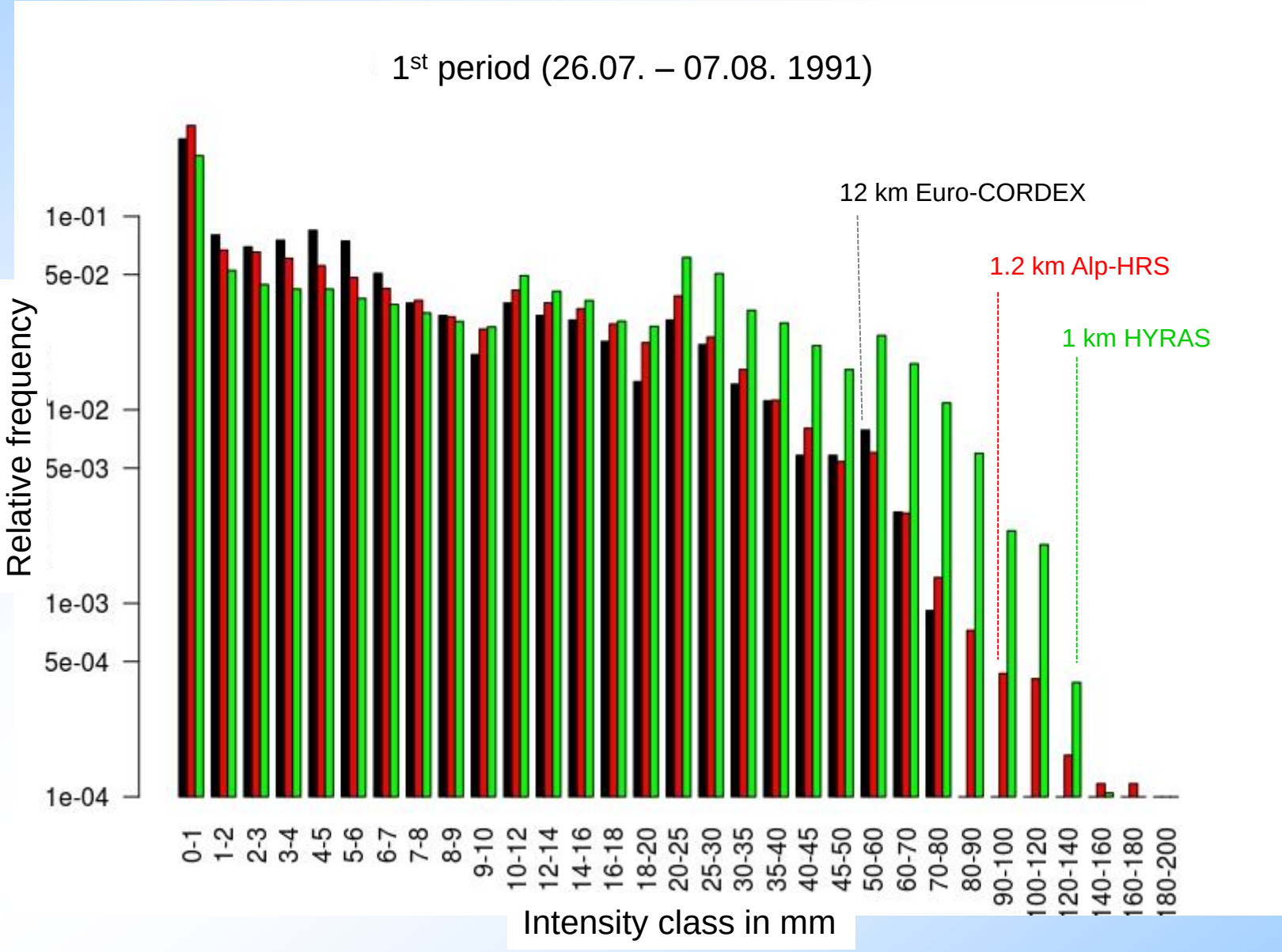
Accumulated over catchment area

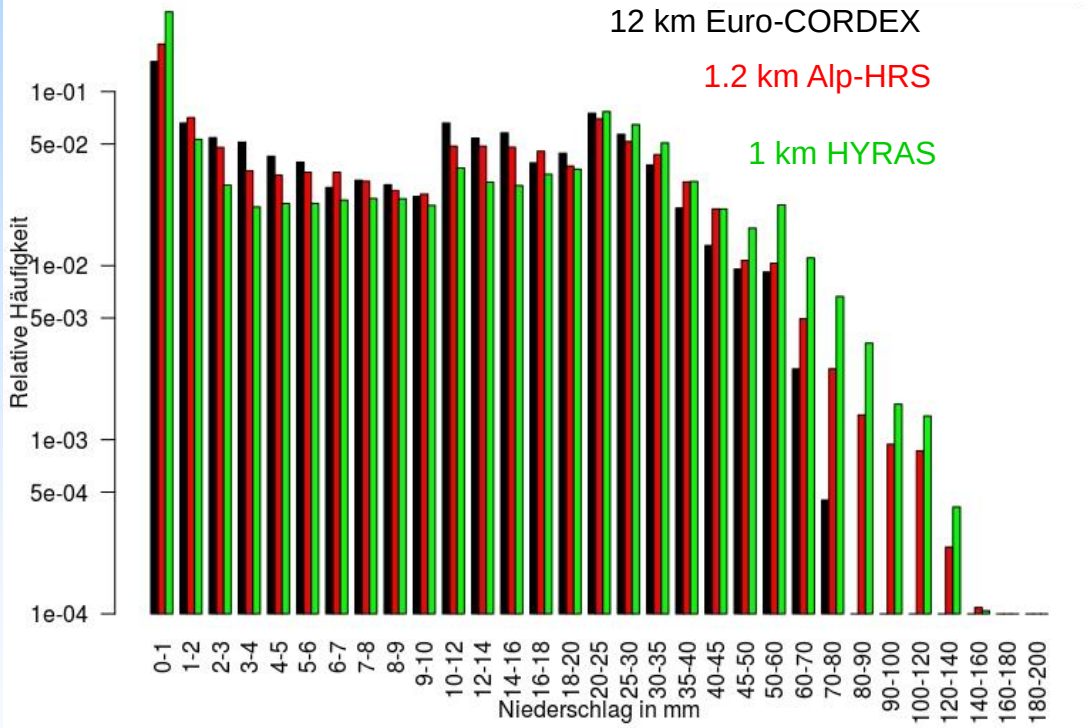


Frequency distribution of daily precipitation intensities

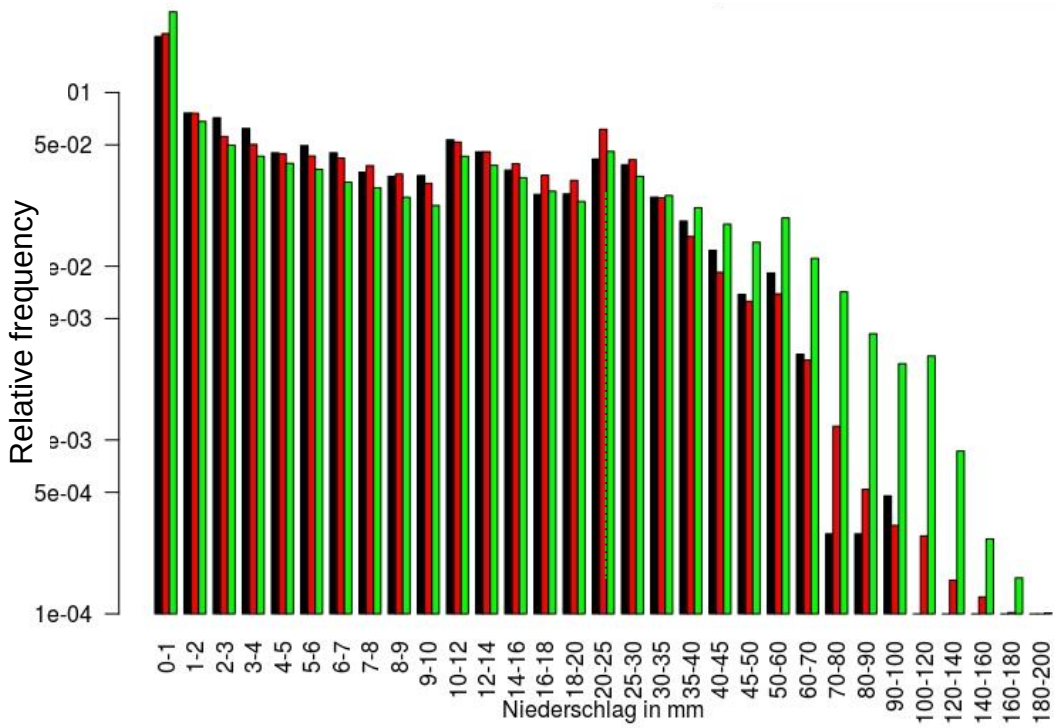
Brandenburg University of Technology Cottbus - Senftenberg

Accumulated over catchment area

2nd period (14.03. – 28.03. 2002)



3rd period (27.07. – 17.08. 2002)



Intensity class in mm

Conclusions

- Spatial distribution mostly consistent with reference data
  - better representation and detailed structure in Alp-HRS
  - effective resolution of Alp-HRS better than HYRAS
- Chronological sequence of the episodes is well represented
  - small phase shifts can occur within $<\pm 1$ day
  - Alp-HRS is strongly linked to driving Euro-CORDEX simulation
    - phase shifts are caused by the coarser Euro-CODEX Simulation
- Total precipitation input into catchment is underestimated
  - peak values up to 50 %
  - total accumulated amount about 25 %
  - in both simulations
  - no substantial improvement by Alp-HRS
- Intensity distribution is improved by Alp-HRS
  - reduction of low to medium intensities
  - amplification of medium to high intensities
  - extreme intensities only occur in Alp-HRS but are still underrepresented

Conclusions

- Potential reasons for only weak improvements in Alp-HRS
  - insufficient atmospheric water vapor induced by LBC
  - underestimated local evaporation
  - underestimated dynamics (lifting, vertical moisture transport)
  - insufficient destabilization of the atmosphere (stratification, heat transport)
  - model domain too small (local development suppressed by LBC)

- Further investigations and simulations seem necessary
  - analysis of moisture budget (e.g. compared to ERA-Interim)
  - analysis of dynamics (vertical motion, horizontal convergence)
  - HRS with enlarged model domain
  - direct nesting of HRS in ERA-Interim (without intermediate nest)
  - … ?

- **All in all, the results are (a bit) disappointing !**

Thank you for your attention !