



Heavy Precipitation in Europe under Climate Change

Spring Campus Berlin March 2017 Katrin Nissen Institut für Meteorologie Freie Universität Berlin <u>www.rain-project.eu</u>

This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement no 608166. The contents of this presentation are the author's views. The European Union is not liable for any use that may be made of the information contained therein.



This project is funded by the European Union





The RAIN Project









Outline

- What is (heavy) precipitation?
- Which thresholds are relevant?
- Data and Methodology
- Present day climate
- Climate change
- Summary











Precipitation = Rain Drizzle Sleet Snow Graupel Hail

evaporation \rightarrow moist air





Types of mid-latitude precipitation

Orography:

- humid air is forced to rise at mountain ridge
- stationary

Fronts:

- warm and cold air masses collide (at the warm and cold fronts of cyclones)
- warm air is forced to rise
- large scale

Convection:

- summer
- air warmed by sun
- evaporation and rising motion
- small scale, short duration









Freie Universität

Heavy precipitation

- 1: High atmospheric moisture content
- 2a: Rapid lifting \implies high intensity
- 2b: Stationarity and moisture convergence high amount









Freie Universität

Which thresholds are relevant?







8

Effects on Infrastructure

High amounts









Data

Present day:

- E-OBS gridded observational
- ERA-Int downscaled by EURO-CORDEX regional models



daily: 13 simulations **3-hourly:** 7 simulations

Climate change: EURO-CORDEX 0.11° (~12 km)

Scenarios RCP4.5 and RCP 8.5

	REGIONAL MODEL				
DRIVING	RCA4	RACMO22E	CCLM4-8-17	HIRHAM5	WRF331F
GCIVI					
MPI-ESM	day, 3 hour		day		
EC-EARTH	day, 3 hour	day, 3 hour	day	day	
HADGEM2	day, 3 hour	day, 3 hour	day		
CM5A-MR	day, 3 hour				day
CM5	day, 3 hour		day		





Greenhouse gas scenarios







Detection of events

Areas affected by heavy precipitation (amount and intensity) are tracked in time and space



Information about

- duration
- size
- severity (duration, size and amount)





Example August 2002



Duration: 5 days Area: 185 000 km² Severity: 50 (99th percentile of all events)

Precipitation exceeding 10-year return level (mm)









Present-day climate

10-year return level (1981-2010)

daily (high amounts)



3-hourly (high intensities)







Present-day climate



Number of events per decade exceeding 10-year return values. Events with durations between 1-3 days. 1971-2000





Present-day climate in the simulations

10-year return level (1971-2000)



mm/day

mm/3hours



Freie Universität

Climate change signal

High Amounts (accumulation 1-3 days) RCP4.5 High Intensities

(3-hourly)



Difference in number of events to 1971-2000



Freie Universität

RCP8.5

Climate change signal

High Amounts (accumulation 1-3 days)



Difference in number of events to 1971-2000

High Intensities

(3-hourly)





Climate change signal







Climate change annual mean precipitation



change between 1971-2000 and 2071-2100 EURO-Cordex ensemble

From: Jacob et al. 2014

: significant
: robust



Thunderstorms





Present day

Change between 1971-2000 and 2071-2100 RCP8.5 scenario





Púčik und Groenemeijer, 2016







Hail

Present day

Change between 1971-2000 and 2071-2100 RCP8.5 scenario







Púčik und Groenemeijer, 2016





Summary

- High intensity and high amounts are of relevance
- Legislation usually specifies return periods
- Increase in heavy precipitation predicted for most European regions:

water vapour content can be higher in warmer air number of severe events increases

• Signal especially strong for high intensity events