Regional Climate Change and Impacts in Central Europe

P. Hoffmann

Contents

1. Introduction

Peter Hoffmann

1991- vocational training in the chemical industry as electronics technician

1999- study of meteorology

2005- Institute for Meteorology in Leipzig (PhD)
Meteorology of the Upper Atmosphere

2012- Potsdam Institute for Climate Impacts Research (PIK)
Research Domain 2: Climate Resilience
Working Group: Hydro-Climatic Risks

Research Topics

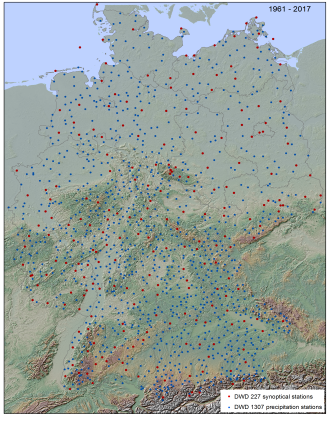
- → Regional Climate Diagnostic
  - analysis of European weather pattern
- → Seasonal Forecast
  - using early season predictors
- → Future Assessments
  - using regional climate model ensembles for Europe
- → Climate Services
  - operational weather and climate impacts for Germany

Research Projects

- → Climate and Pathogens
  - infectious diseases e.g. Pneumonia and Sepsis
- → Vulnerability Study of the Tourism Sector
  - relation between weather and tourist demand
- → Assessment of Climatic Risk for the Deutsche Bahn
  - relation between extreme weather and train failures
- → Climate Impacts Online
  - cross-sectoral climate services: agriculture, hydrology

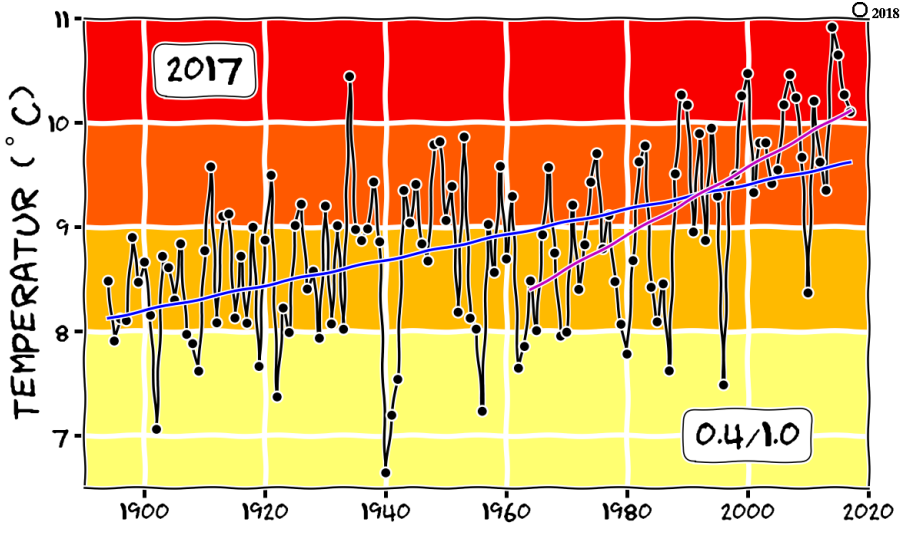
2. Observations

Climate Data & Climate Indicators



daily	unit	seasonal	annual	Indicator	unit
temperature	$°C$	mean	mean		$°C$
		—	$> 30°C$	hot days	*days*
		—	99th-perc	3rd hottest day	$°C$
		—	$< 0°C$	ice days	*days*
precipitation	*mm*	sum	sum		*mm*
		—	$> 30mm$	very wet days	days
		—	99th-perc	3rd wettest day	mm/d
wind gust	m/s	–	$> 25m/s$	severe storms	days
weather patterns	cat	frequency	duration		days

Temperature: Potsdam



+1.4°C since 1893 / +1°C per 30 yr since 1961

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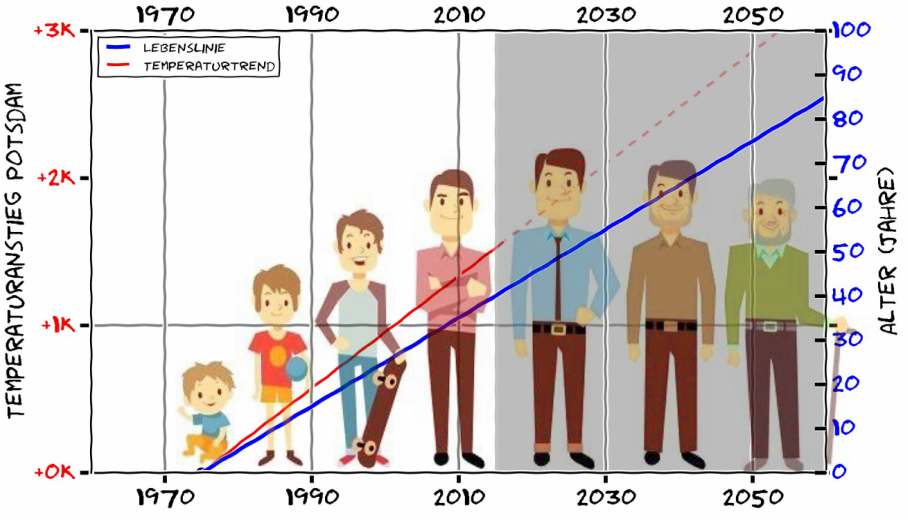
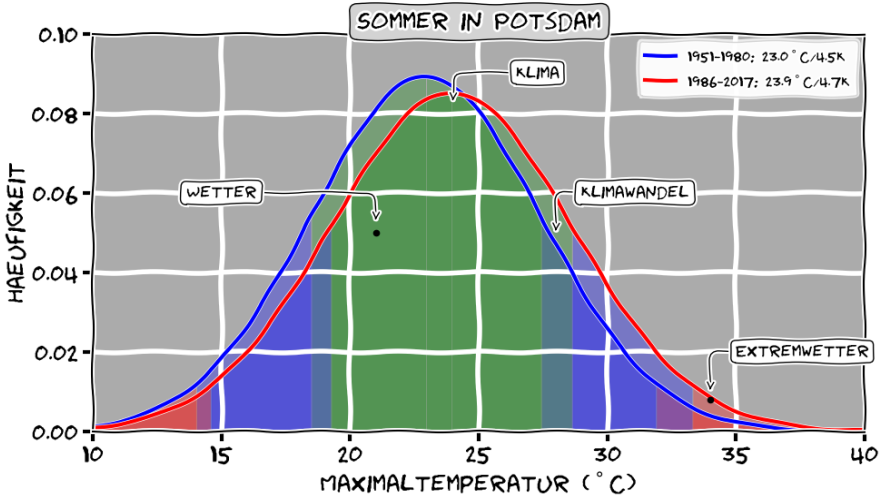
Temperature: life cycle



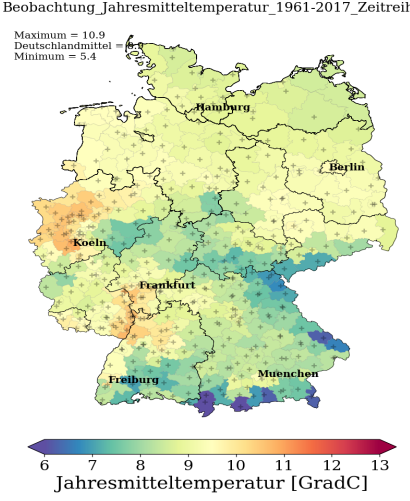
+3°C within one life

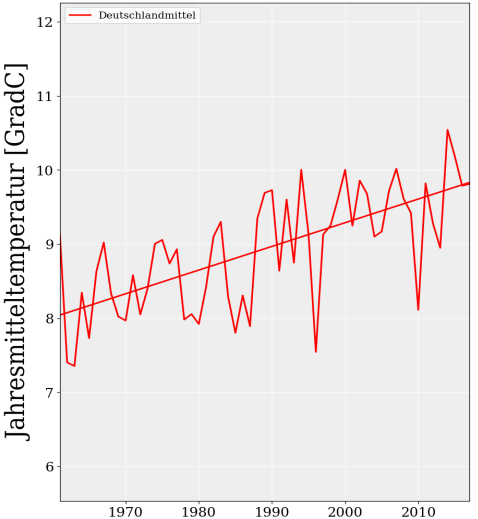
Temperature: distribution



shifting temperature distribution / heat extremes more likely

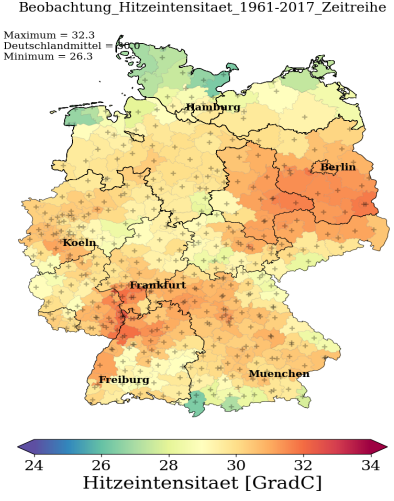
Temperature: annual mean

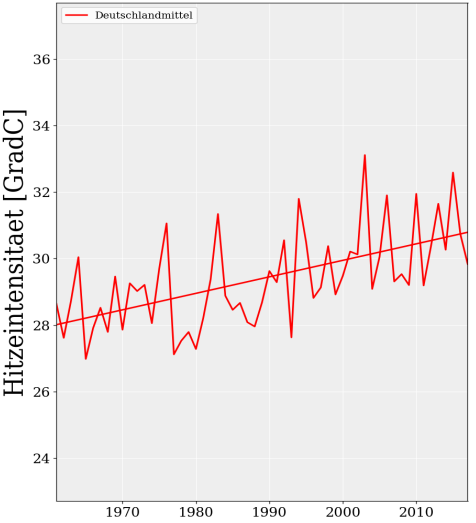




linear trend 1961-2017: 8.0°C - 9.8°C ($\Delta = +1.8°C$)

Temperature: 3rd hottest day of year





linear trend 1961-2017: 28.0°C - 30.8°C ($\Delta = +2.8°C$)

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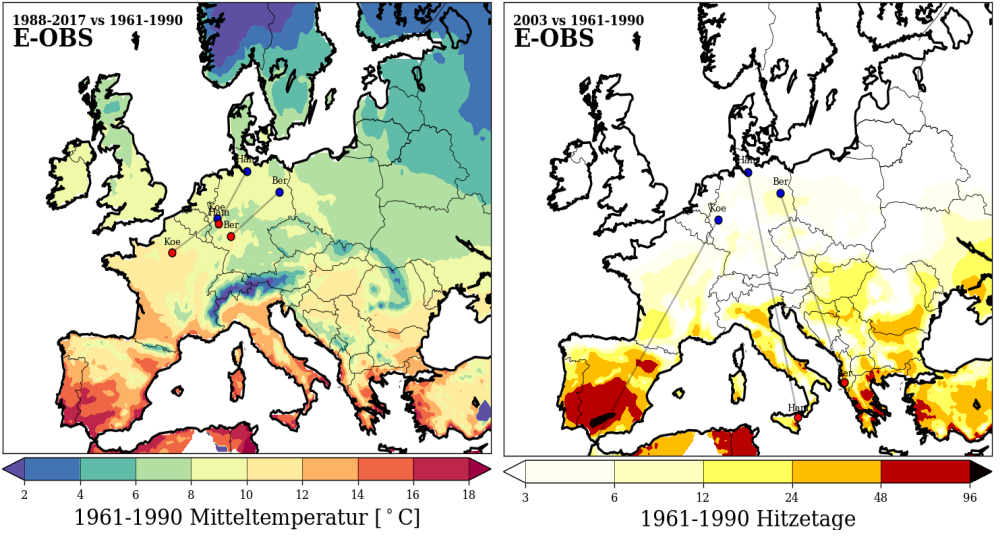
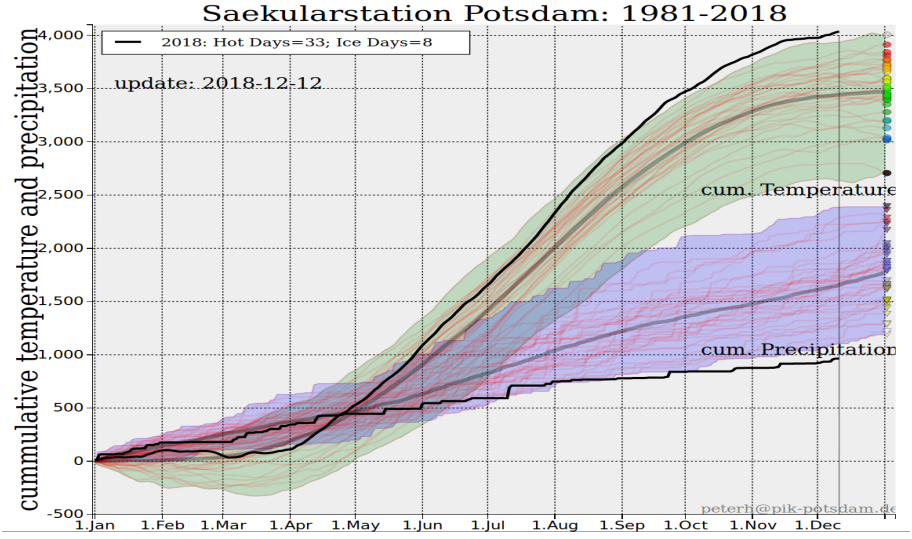
Temperature: climatic shift



today climate of Berlin similar to the climate of Freiburg in the 80s

Temperature & Rainfall



2018 was the warmest and driest year on record

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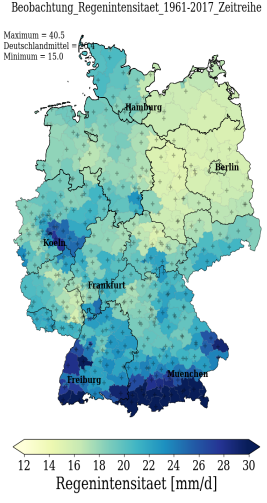
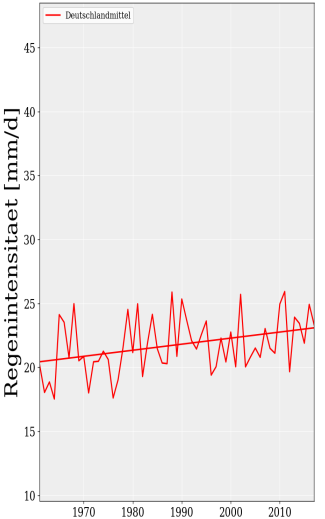
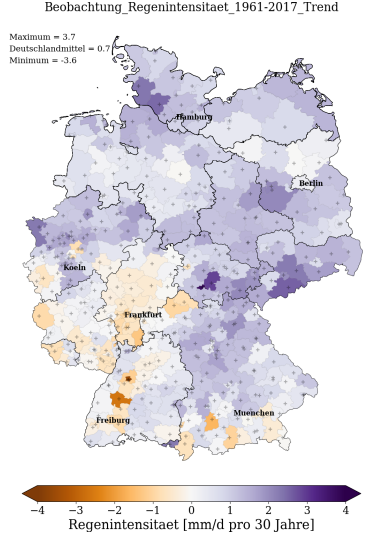
Rainfall: 3rd wettest day of year

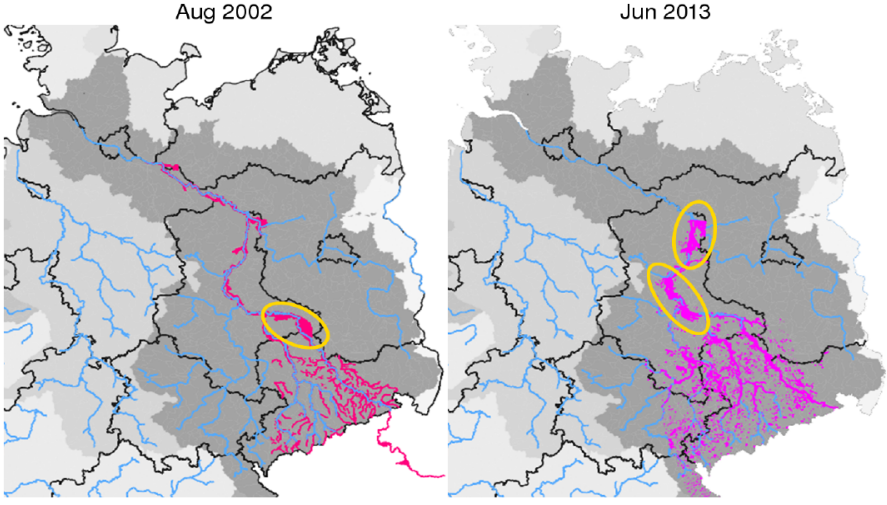






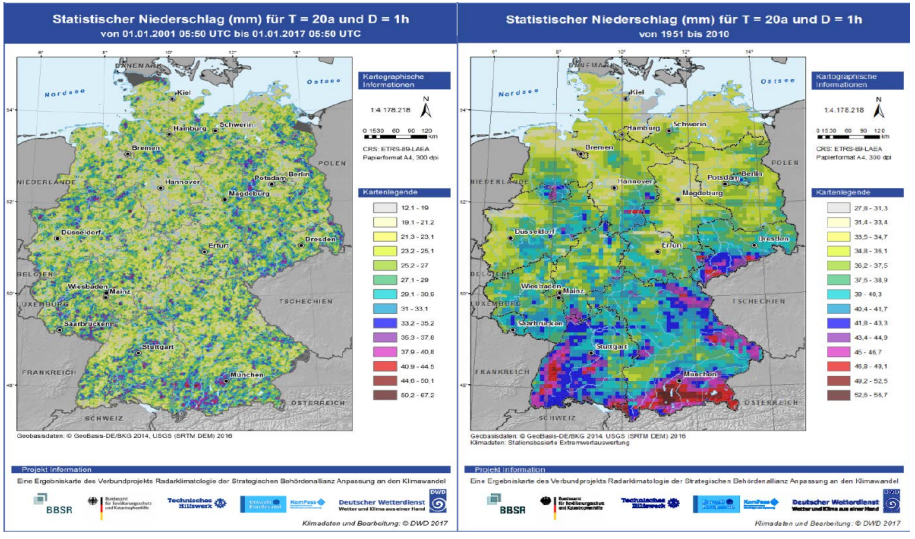
increase of rainfall intensity in almost every region

Rainfall: river floods



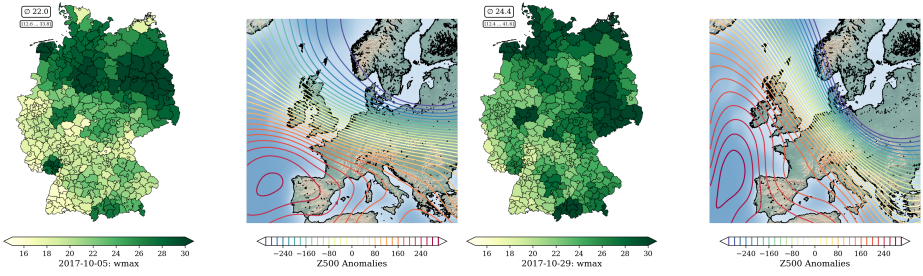
flooding maps of the 100 yr events 2002 and 2013 in the river Elbe catchment

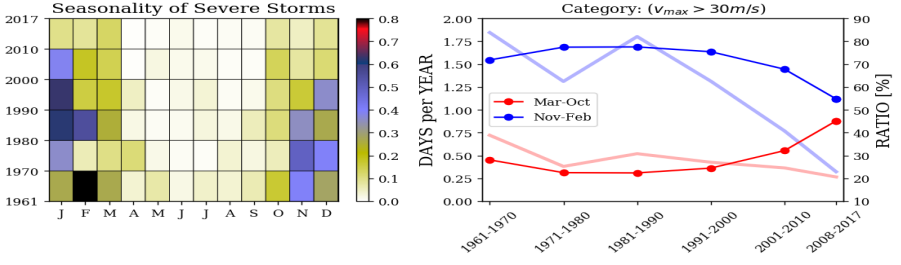
Rainfall: hourly



Radar climatology of intens hourly rainfall events (2001-2017)

Wind Speed: severe storms





possible changing seasonality of severe storms

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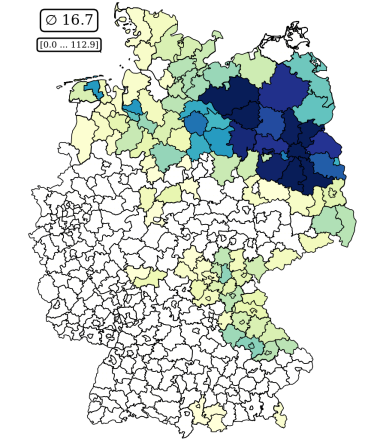
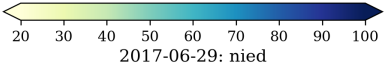
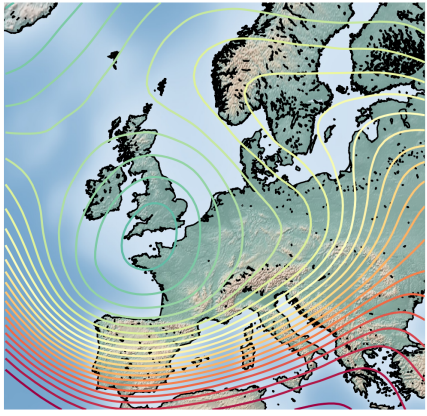
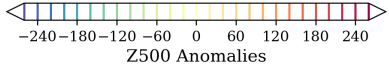
Extreme Weather



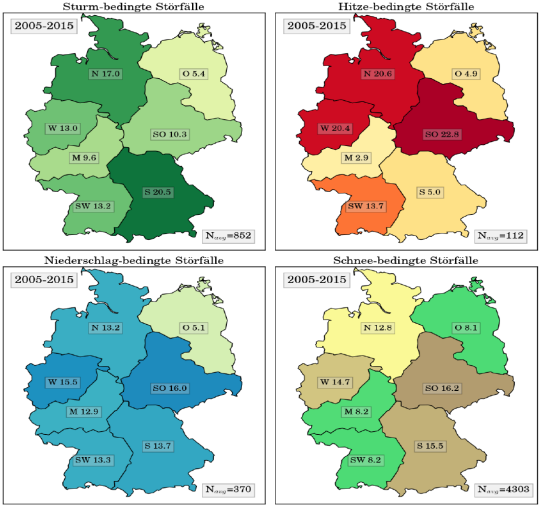






weather pattern favored extreme rainfall in North-East Germany 2017

Extreme Weather



Deutsche Bahn: Interruptions 2005-2015

storms: n=852 (S, N)

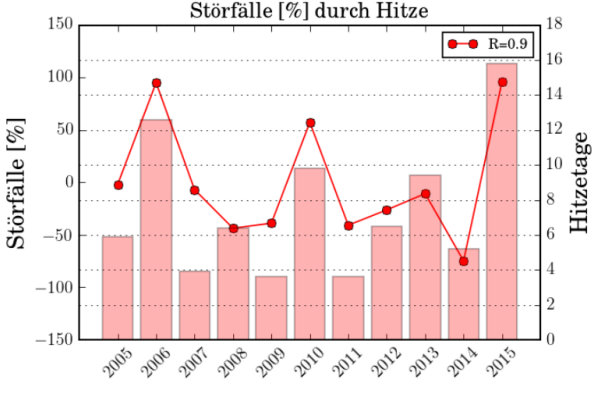
heat: n=112 (SO, N, W)

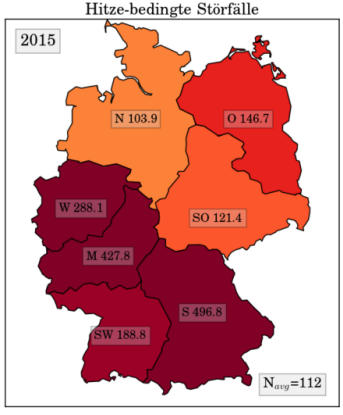
rain: n=370 (SO, W)

snow: n=4303 (SO, S)

total: SO!

Extreme Weather: heat





hot summers cause more interruption: 2006, 2010, 2015

2015: 16 hot days and 200% more interruptions in South-West

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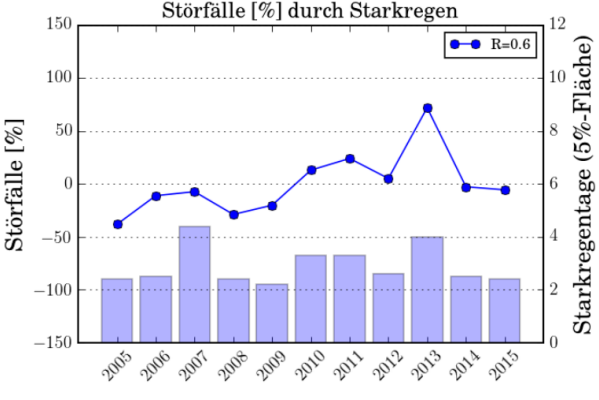
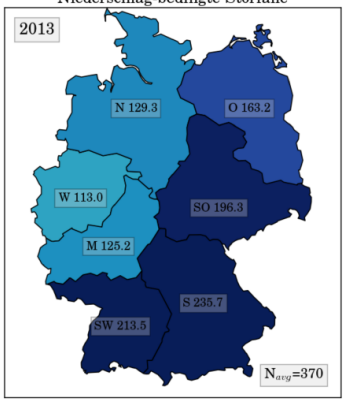
Extreme Weather: rain





heavy rain and floodings cause interruptions: 2007 and 2013

2013: 200% more interruptions in South and South-East

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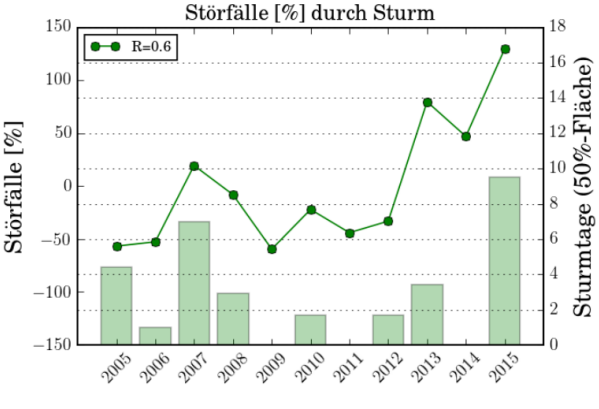
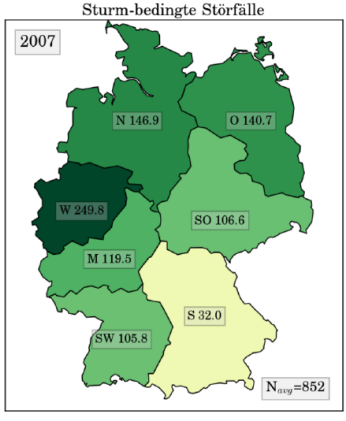
Extreme Weather: storms





severe storms cause interruptions: 2007 (Kyrill) and 2015 (Niklas)

2015: 200% more interruptions in West

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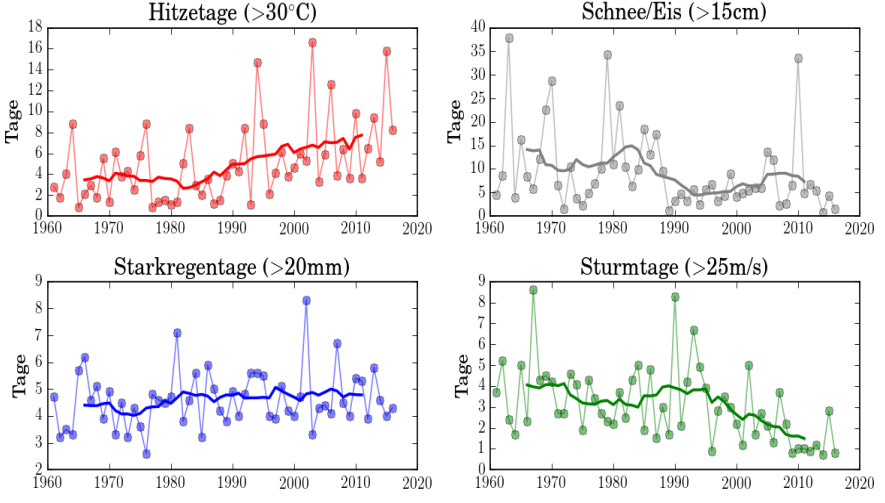
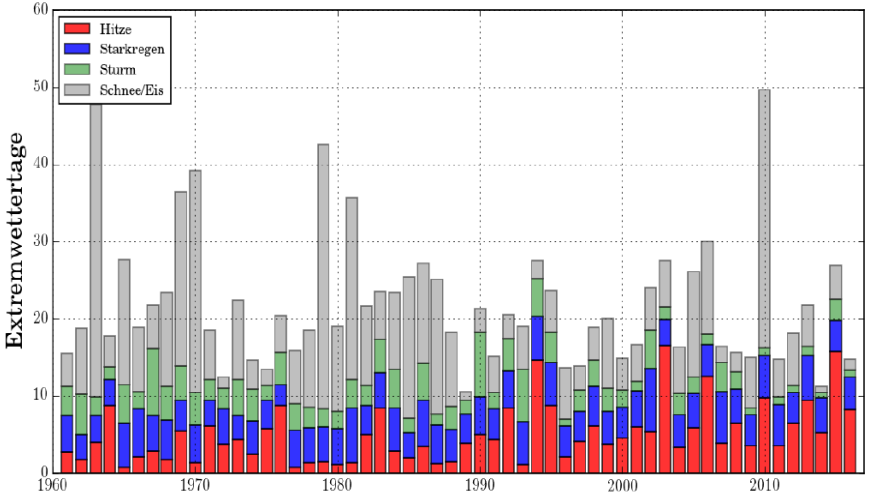
Extreme Weather



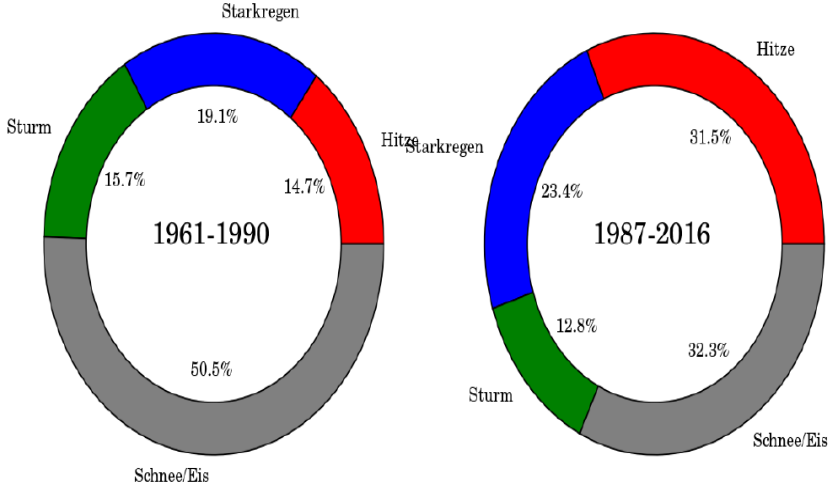
1961-2017: categories of extreme weather - observed evolution

Extreme Weather



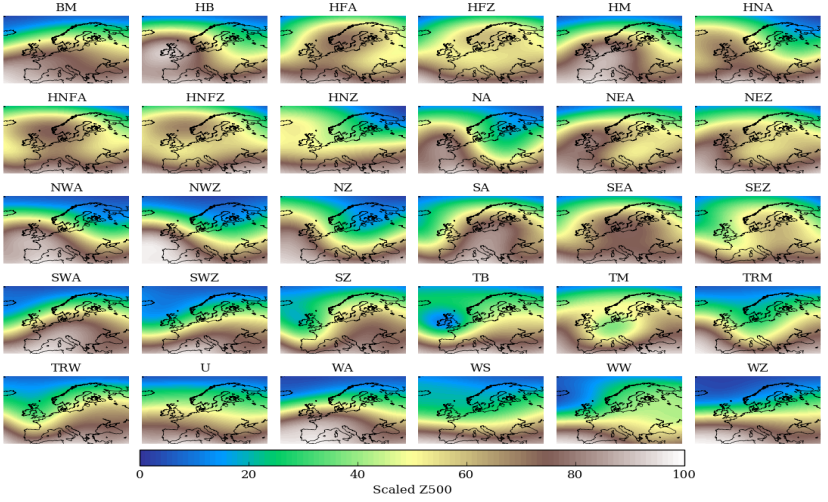
1961-2017: categories of extreme weather - observed evolution

Extreme Weather



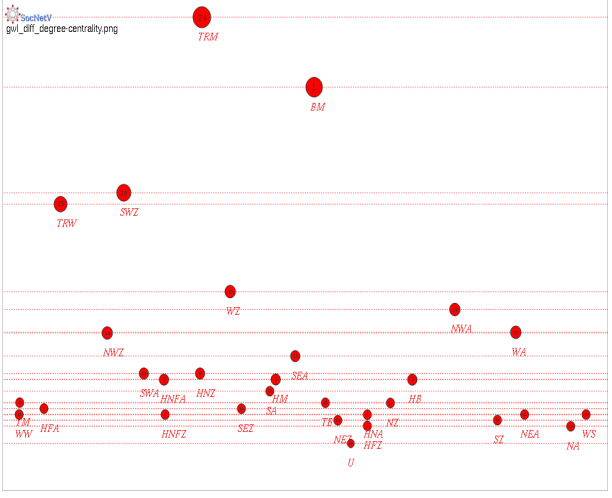
1961-2017: categories of extreme weather - observed evolution

Weather Patterns



categorical data: shape of the circulation over Europe

Weather Patterns: changes



new dominant weather patterns: TRM and BM

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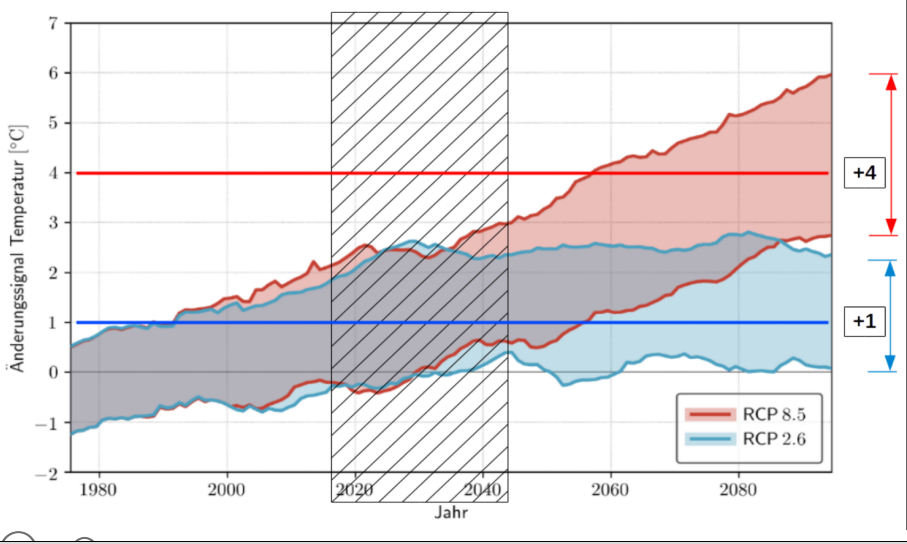
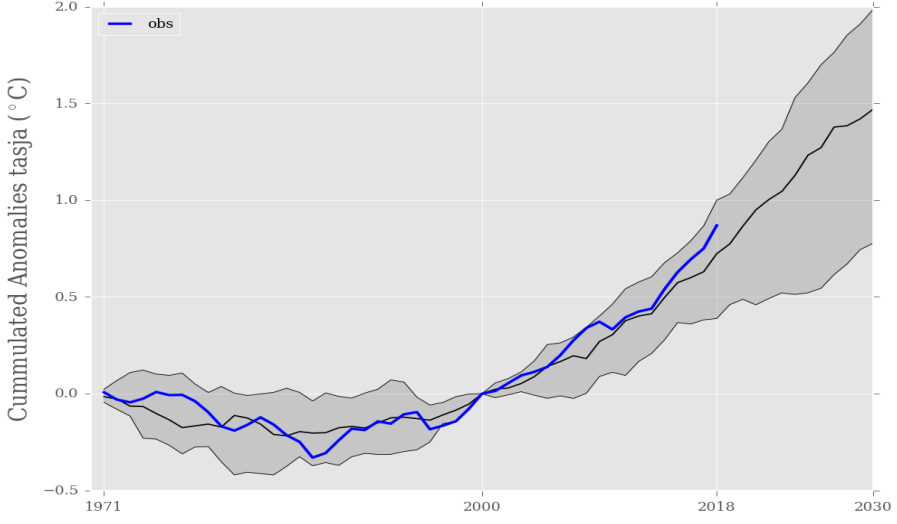
3. Projections



scenarios: ”climate protection” (+1°C) or “business as usual” (+4°C)

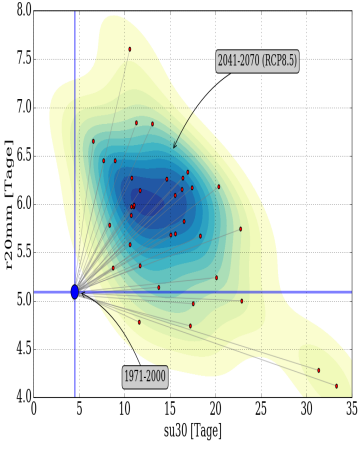
Historical Simulations



observed changes are reproduced by climate models

Germany in Numbers: 2071-2100 vs. 1971-2000

Klimaparameter	"Ist"	"Klimaschutz"	"Weiter-wie-bisher"
Jahresmitteltemperatur	**8.0°C**	+1.0°C	+3.8°C
Hitzetage	**4.3 Tage**	+3.7 Tage	+19.4 Tage
Eistage	**24.8 Tage**	-7.2 Tage	-18.9 Tage
Starkregentage	**4.9 Tage**	+0.3 Tage	+1.1 Tage
Länge d. Wachstumsperiode	**247 Tage**	+21 Tage	+67 Tage
Trockentage	**236 Tage**	+1.7 Tage	+9.1 Tage
Sommerniederschlag	**2.9 mm/d**	-3.8 %	-12.6 %
Extremniederschlag	**55.5 mm/d**	+ 5.4 mm/d	+33.6 mm/d



more heat, more intense rain, more drought, less frost

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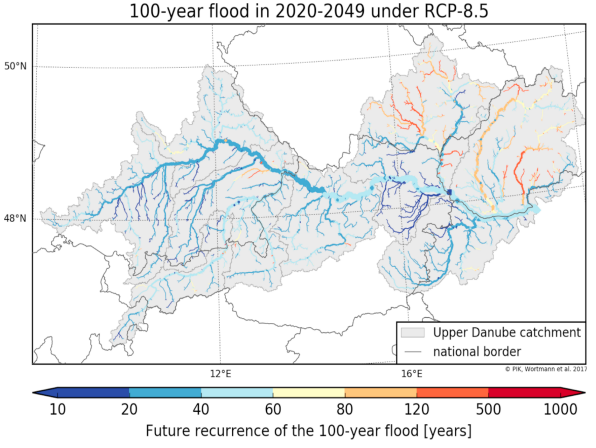
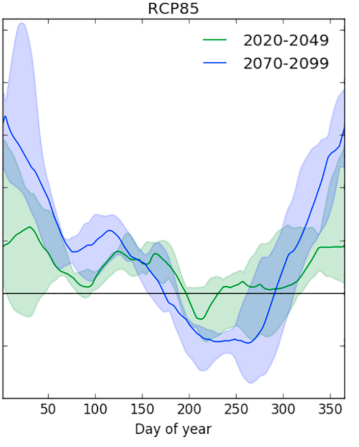
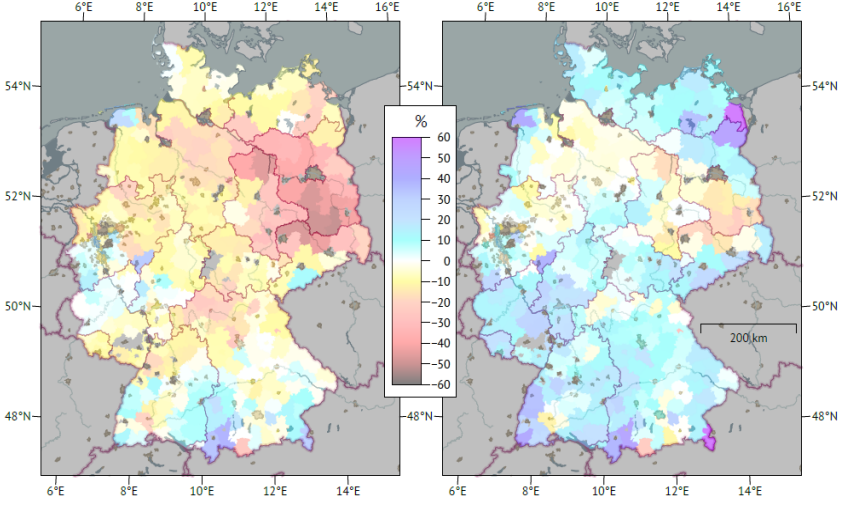
Flood Risks: Danube





shortening of recurrence of 100-yr flood events and low water

Crop Failure



2018 higher crop failure in North-East than 2003

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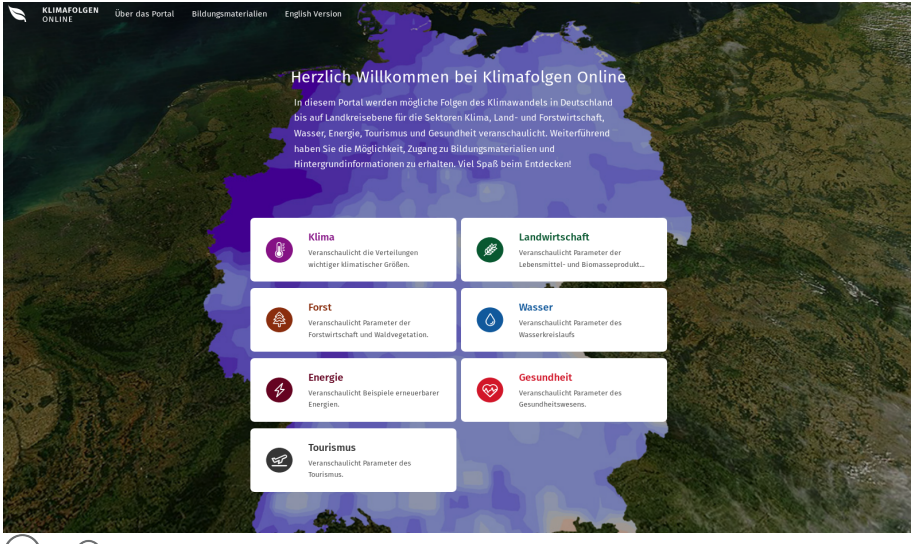
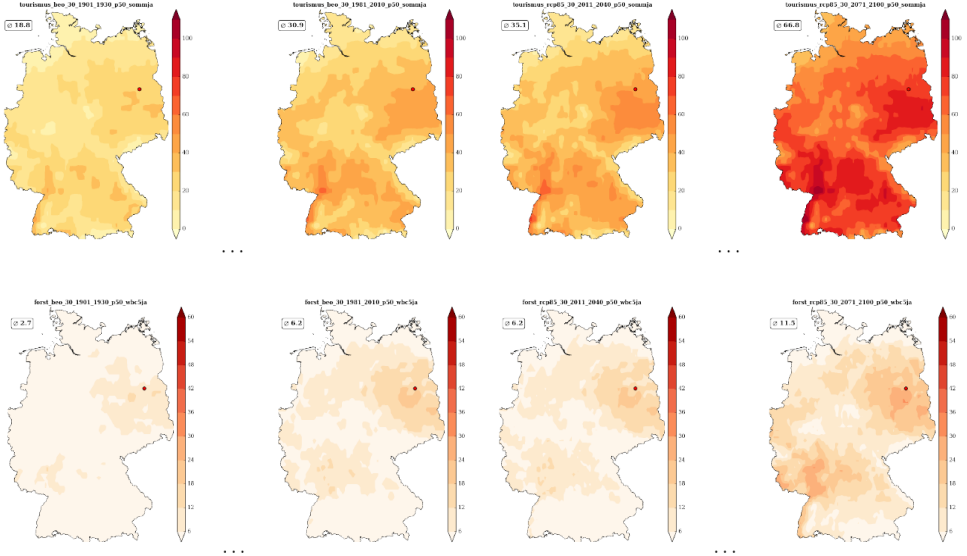
4. Climate Impacts Online



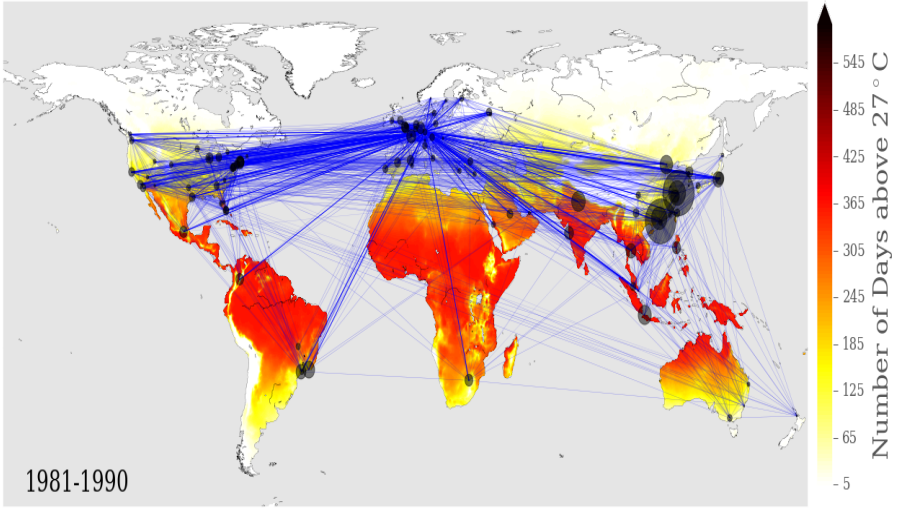
climate services across sectors for decision makers

summer days & fire risk (cat5)



observed and simulated climate and climate impact indicators (1901-2100)

5. Climate and Mobility



climate and mobility network: assessment of airports

Assessment of Airports

HYFLY

Potsdam Institute for Climate Impact Research

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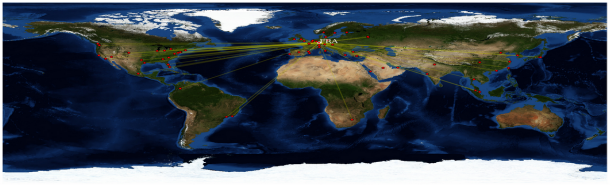
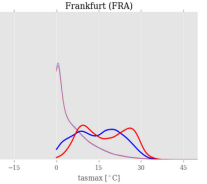
Assessment of Airports: 1979-2016 / 2041-2070 (RCP85)





Airport	IATA	Population	Longitude	Latitude	DG_1979-2016	DG_2041-2070	Δ	BC_1979-2016	BC_2041-2070	Δ	TX_1979-2016 [°C]	TX_2041-2070 [°C]	Δ	PR_1979-2016 [mm]	PR_2041-2070 [mm]	Δ	MAP
Dubai	DXB	0.381	55.364	25.253	58.748	66.742	7.994	0.021	0.021	0.001	33.8	37.0	3.269	91	69	-22.341	MAP
Bangkok	BKK	7.064	100.747	13.681	46.188	52.086	5.899	0.021	0.021	0.000	33.3	35.8	2.418	1474	1453	-20.316	MAP
Singapore	SIN	0.051	103.994	1.350	42.422	44.413	1.991	0.021	0.025	0.004	31.4	30.7	-0.617	2374	2565	191.077	MAP
Hong Kong	HKG	0.948	113.915	22.309	39.931	46.456	6.525	0.022	0.022	0.001	26.4	28.5	2.054	1907	1932	25.141	MAP
Los Angeles	LAX	2.390	-118.408	33.943	39.551	47.657	8.105	0.037	0.039	0.002	22.4	24.7	2.270	329	315	-14.157	MAP
Miami	MIA	2.226	-80.291	25.793	38.242	39.446	1.204	0.021	0.022	0.001	29.2	28.0	-1.218	1587	1536	-51.688	MAP
New York	JFK	3.650	-73.779	40.640	36.668	45.789	9.100	0.032	0.031	-0.002	17.3	20.5	3.176	1308	1324	16.237	MAP
Atlanta	ATL	1.839	-84.428	33.637	35.743	42.366	6.622	0.022	0.022	-0.000	23.4	25.7	2.279	1350	1424	73.743	MAP
Frankfurt	FRA	1.280	8.571	50.033	35.115	43.182	8.067	0.058	0.053	-0.005	14.4	17.1	2.701	748	744	-3.266	MAP
London	LHR	3.568	-0.462	51.471	35.020	43.108	8.088	0.086	0.098	0.012	14.3	16.6	2.338	744	807	63.182	MAP
Houston	IAH	2.512	-95.341	29.984	34.558	40.148	5.591	0.021	0.021	0.000	26.6	28.7	2.111	1415	1301	-113.809	MAP
Paris	CDG	0.246	2.550	49.013	33.987	41.835	7.848	0.051	0.051	-0.000	15.5	18.0	2.521	787	788	0.937	MAP
Tokyo	NRT	5.068	140.386	35.765	33.761	41.703	7.943	0.045	0.047	0.003	19.3	22.1	2.791	1541	1594	52.424	MAP
Beijing	PEK	11.167	116.585	40.080	33.753	41.696	7.943	0.103	0.099	-0.003	17.9	21.1	3.262	564	631	46.883	MAP
Dallas-Fort Worth	DFW	1.293	-97.038	32.897	33.334	39.360	6.026	0.021	0.021	0.000	25.7	28.5	2.782	946	961	15.159	MAP
Kuala Lumpur	KUL	2.222	101.710	2.746	33.191	37.472	4.282	0.021	0.021	-0.000	31.0	33.2	2.141	2330	2773	442.519	MAP
Newark	EWR	5.057	-74.169	40.693	32.841	40.845	8.004	0.026	0.026	0.000	17.6	20.8	3.208	1323	1346	23.518	MAP
Seoul	ICN	0.388	126.451	37.469	32.586	40.070	7.484	0.072	0.066	-0.006	17.7	20.9	3.195	1262	1447	185.050	MAP

LINK

sorted table: centrality of airports under consideration of climate bridges

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Thank You for Your Attention!