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Identifying added value in two high-resolution climate simulations over Scandinavia

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- **High resolution data are needed in order to assess potential impacts of extreme events on infrastructure in the mid latitudes.**
- **Dynamical downscaling offers one way to obtain this information.**
- **Prior to implementation in any impacts assessment scheme, model output must be validated and determined fit-for-purpose.**
- **Results from two perfect-boundary experiments downscaling ERA-interim with HIRHAM5 and WRF3.3.1 on an 8 km grid over Scandinavia are shown.**

1.) seasonal biases

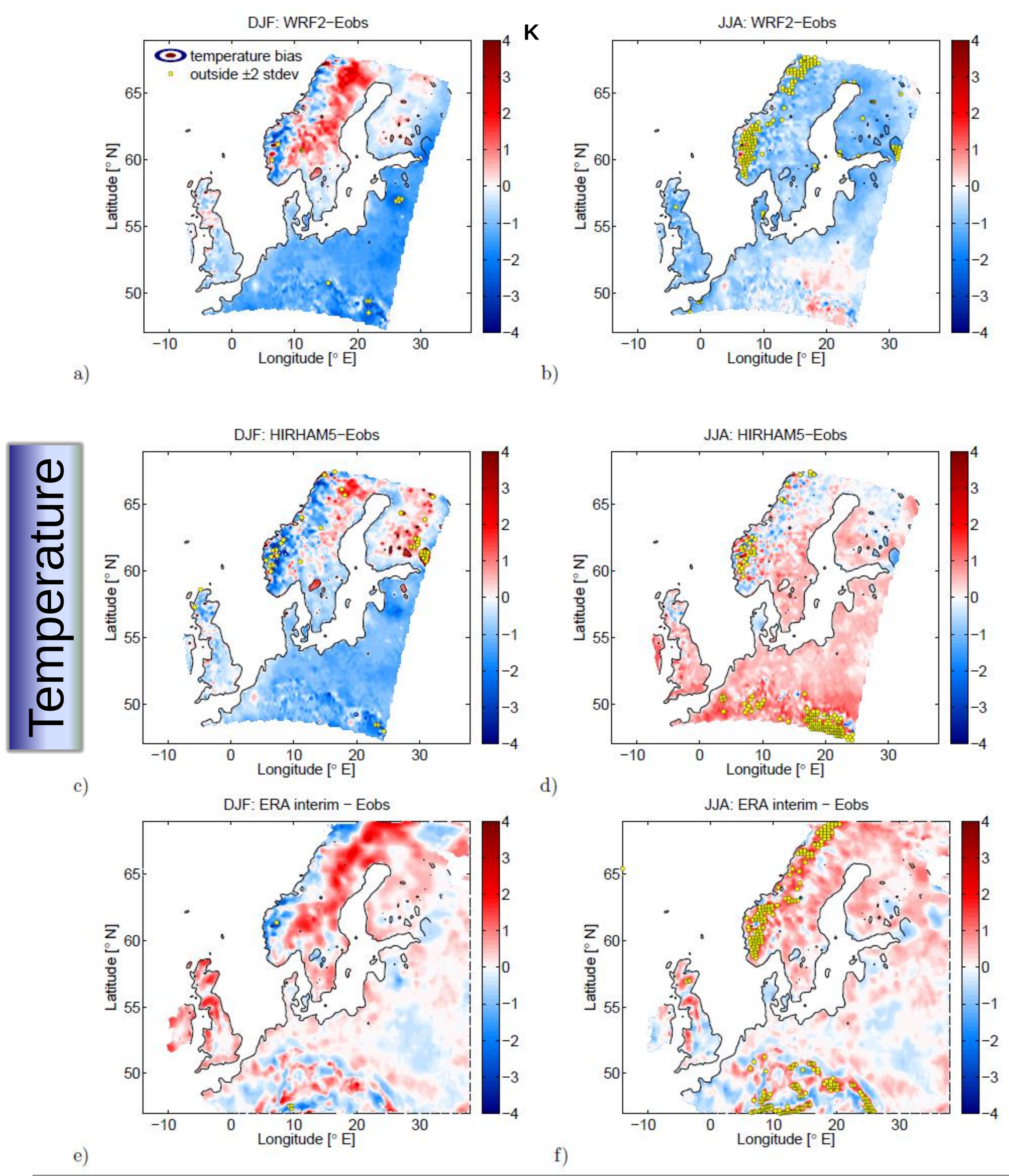

Figure 1: Biases of seasonal temperature in K (simulation minus E-OBS data) in the WRF simulation for a) winter and b) summer season; c) and d) for the HIRHAM5 simulation; e) and f) for ERA interim. Model data is re-projected to the E-OBS 0.22 rotated grid. Yellow dots indicate grid points where the model biases lie outside an interval of 2·standard error which is given within the E-OBS data set.

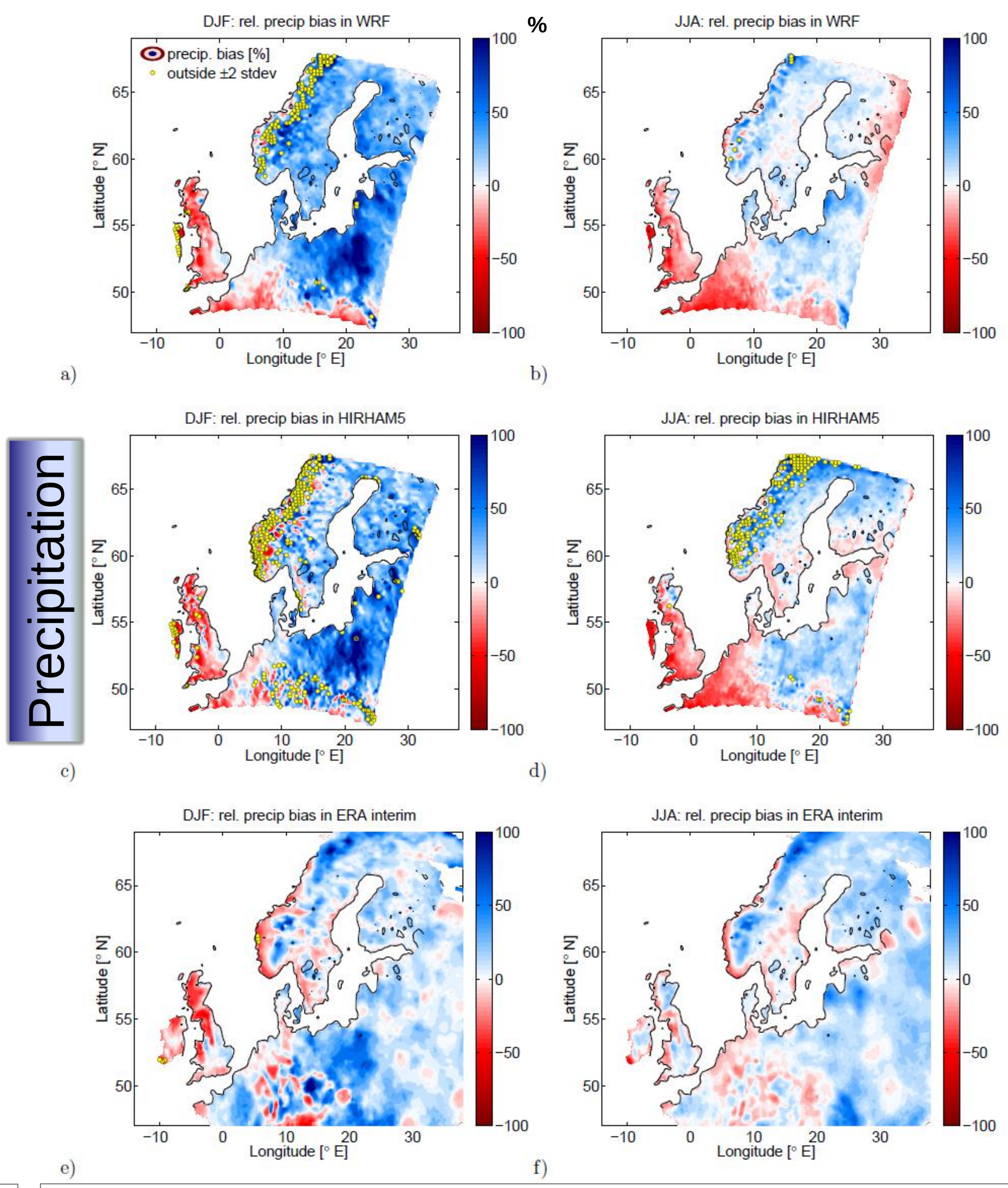

Figure 2: Relative precipitation bias in %, in the WRF simulation for a) winter and b) summer season; c) and d) for the HIRHAM5 simulation; e) and f) for ERA interim. Yellow dots indicate grid points where the model biases lie outside an interval of 2·standard error which is given within the E-OBS data set. The absolute error ranges between ±3 mm/day.

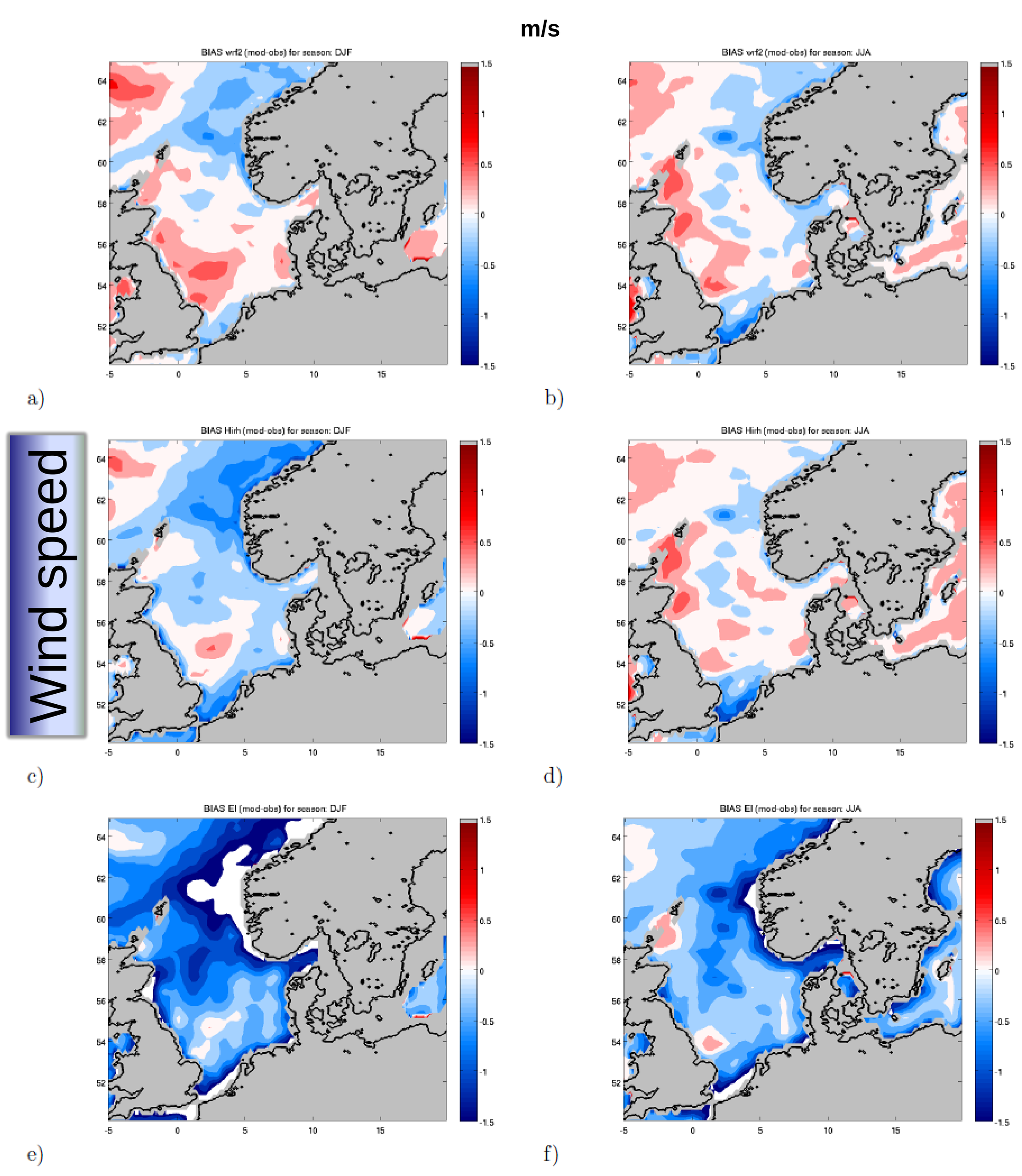

Figure 3: Biases of wind speed in m/s (simulation minus Qscat) in a) and b) WRF, c) and d) HIRHAM, e) and f) ERA interim. The winter season is shown in the left column and the summer season in the right column. Gray areas indicate no data.

2.) Local-scale precipitation

Table 1. Seasonal biases of wet-day mean precipitation in % were calculated for selected locations. A wet day is defined as a day when the precipitation amount exceeds 1 mm.

		DJF	MAM	JJA	SON
Bergen	ERA	-23.2	-28.8	-36.3	-33.6
	WRF	+10.5	-0.6	-16.6	-1.4
	HIRHAM	+14.1	+0.2	-28.9	-6.2
Oslo	ERA	-15.0	-18.6	-17.0	-26.5
	WRF	+18.8	+7.8	+7.3	+9.7
	HIRHAM	+66.6	+24.4	+1.2	+14.8
Copenhagen	ERA	-13.0	-26.6	-32.0	-25.5
	WRF	+1.3	-7.2	-11.6	-12.6
	HIRHAM	+7.6	-6.1	-1.7	+5.3

Table 2. Estimated e-folding distances in km of extreme precipitation for the duration of 3 hours and 24 hours. As in Gregersen et al. (2013) the estimates are derived from the fitted exponential models shown in Figure 4.

	3 hr	24 hr
SVK	8	13
WRF	28	42
HIRHAM	32	32
ERA	119	128

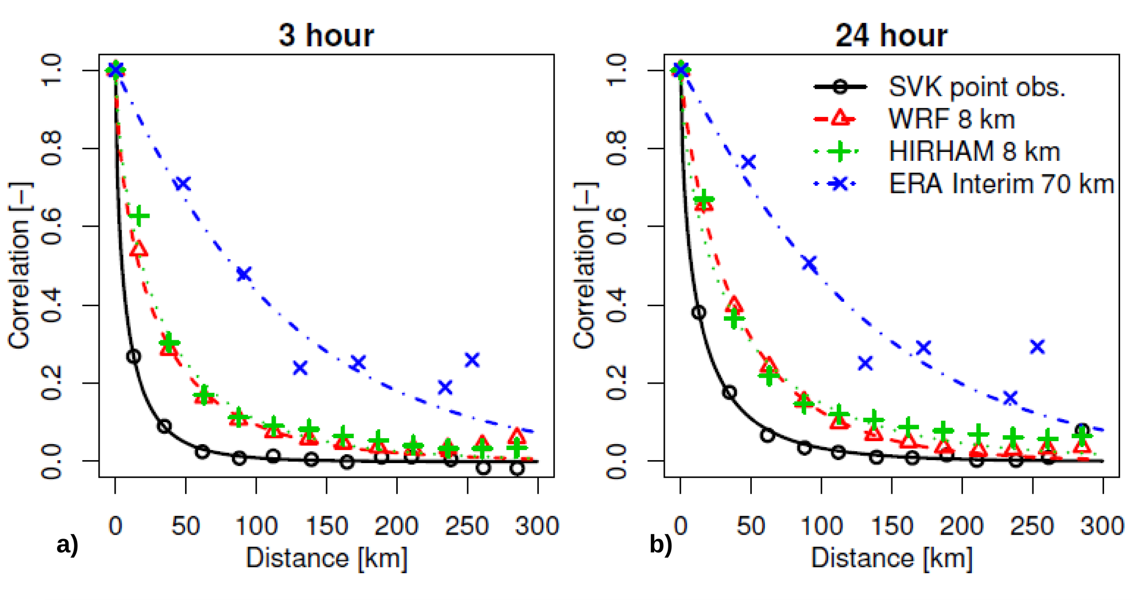

Figure 4: Spatio-temporal correlation structure of observed (SVK), ERA interim (70 km) and downscaled (8 km) mean intensities of extreme precipitation for 3 hour (a) and 24 hour (b) duration. To highlight the tendencies an exponential function is used for fitting by using least square method (Gregersen et al., 2013).

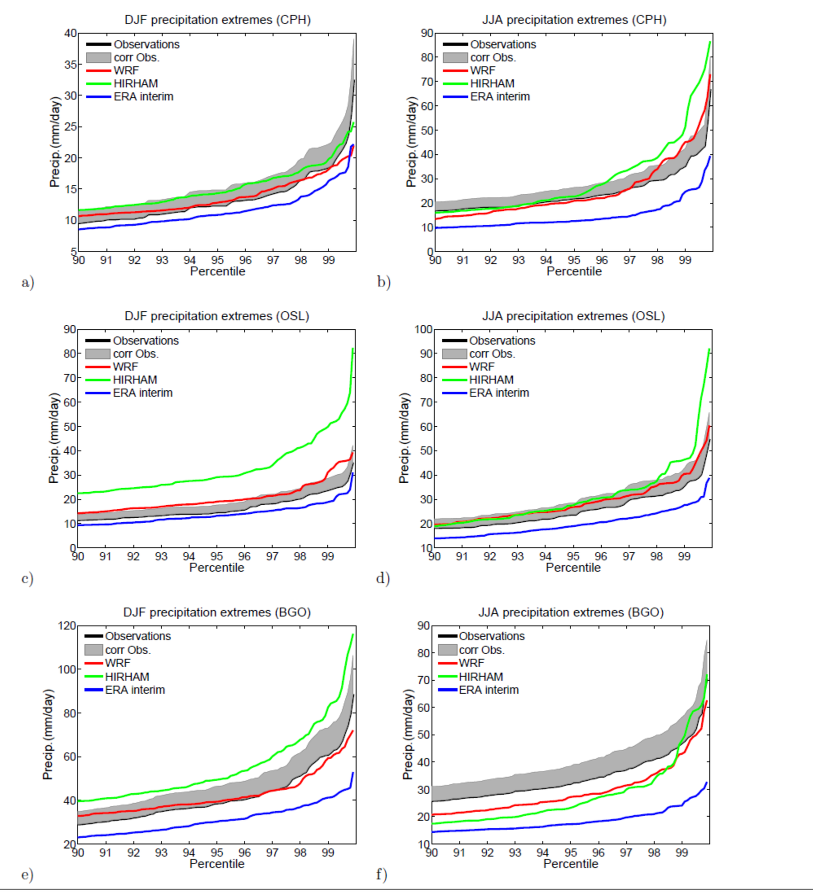

Figure 5: 90-99.9 percentiles for extreme precipitation in mm/day for a) and b) Copenhagen, c) and d) Oslo and e) and f) Bergen. Corresponding model data was retrieved with the nearest neighbor method for the single locations. An assumed observational undercatch of 20% is illustrated with a gray band.

Results The models exhibit systematic cold and wet biases on seasonal time scales (-1 K and +50-100%, respectively). However, frequency based skill scores for daily precipitation and temperature are high (not shown), indicating that the distributions of these variables are generally well captured. Wind speeds over the North and Norwegian Seas were simulated more realistically in the models than ERA-interim reanalysis (Figure 3). Most important for impacts assessments, however, is that the high-resolution models are better capable of capturing the spatio-temporal behavior of short-duration extreme precipitation (Figure 4). In this respect both models outperform the reanalysis over Denmark, where recent pluvial floods led to costly damages to infrastructure.

- Gregersen, I., Sørup, H., Madsen, H., Rosbjerg, D., Mikkelsen, P., and Arnbjerg-Nielsen, K. (2013). Assessing future climatic changes of rainfall extremes at small spatio-temporal scales. *Clim. Change*, **118**(4), 783-797.

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