CORDEX Flagship Pilot Study (FPS) on convective phenomena over Europe and the Mediteranean

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GEWEX convection-permitting climate modeling workshop, Boulder, CO

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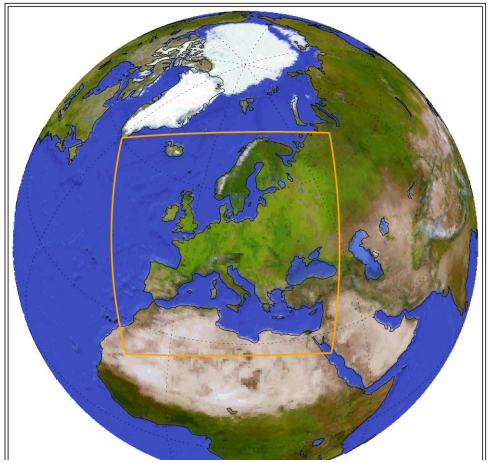
OUTLINE

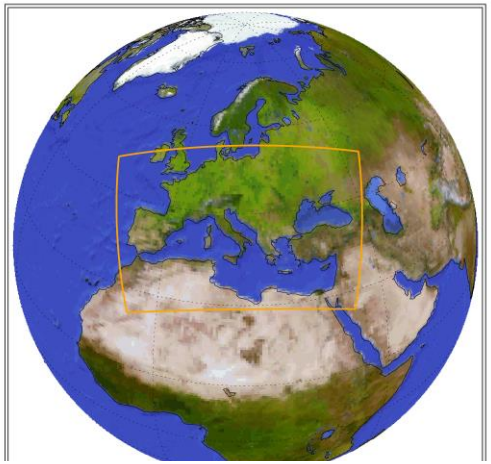
- FPS and CORDEX
- Motivation for a coordinated effort
- Scientific Aims
- Motivating research
- Challenges and practical concerns
- Discussion on the way forward

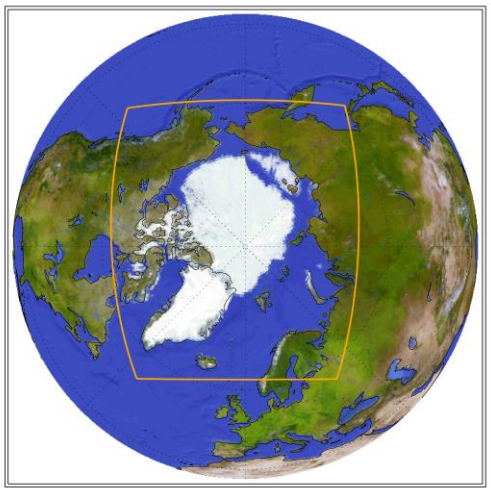
Flooding of the Seine June 2016
Source:
https://commons.wikimedia.org/w/index.php?curid=49228392

What is CORDEX?

- WCRP-sponsored core project: Coordinated Regional Downscaling EXperiments (www.cordex.org)
- “The CORDEX vision is to advance and coordinate the science and application of regional climate downscaling through global partnerships”
- All land masses, all RCPs, most CMIP5 models, @ 12-50km resolution







Pilot studies as a way to address challenges facing CORDEX

- More rigorous and quantitative assessment of the added value of regional downscaling;
- Better understanding of processes and phenomena relevant for regional climate change;
- A broader and more process-based assessment of downscaling techniques and models;
- Moving towards very high resolution, convection permitting models;
- Better integration of CORDEX with other WCRP programs (e.g. GEWEX)

A partial collection of Euro-CORDEX Convection Perimitting activites

institute_id	RCM_name	RCM_version	conv_perm_model_domain_size	resolution	driving_model_id	driving_experiment	driving_model_ensemble	nesting steps	period	output_interval	status	availability	contact	comments
MIUB	WRF	3.6.1	COSMO-DE extd w/ Alps, Rhine, Elbe catchments	480x456x50	0.0275deg ~3.1km	erainl	evaluation	N/A	erainl -> EUR-11 -> 3km	1982/11-1998/12, 2001/11-2003/12, 2009/11-2013/12	1h	finished	by request	k.goergen@fz-juelich.de, sknist@uni-bonn.de	simulation periods preceded by spinup
MIUB	WRF	3.6.1	COSMO-DE extd w/ Alps, Rhine, Elbe catchments	480x456x50	0.0275deg ~3.1km	MPI-ESM-LR	historical	r1i1p1	MPI-ESM-LR -> EUR-11 -> 3km	1995-2005	1h	running	by request	k.goergen@fz-juelich.de, sknist@uni-bonn.de	simulation periods preceded by spinup
MIUB	WRF	3.6.1	COSMO-DE extd w/ Alps, Rhine, Elbe catchments	480x456x50	0.0275deg ~3.1km	MPI-ESM-LR	rcp45	r1i1p1	MPI-ESM-LR -> EUR-11 -> 3km	2040-2050, 2090-2100	1h	running	by request	k.goergen@fz-juelich.de, sknist@uni-bonn.de	simulation periods preceded by spinup
MIUB	WRF	3.5.1	Europe	1600x1552x50	0.0275deg ~3.1km	erainl	evaluation	N/A	erainl -> EUR-11 -> 3km	Jan, Jul 2010	1h	finished	by request	k.goergen@fz-juelich.de	
UNI NO	WRF	3.5.1	2km over Crete and surrounding ocean areas	~2km	erainl	evaluation	N/A	erainl -> 2km		13-14/1/1994, 16-18/10/2008, 21-23/11/2008	15min, 1h, 3h	finished	by request	stefan.sobolowski@uni.no	
WEGC (CLMcom)	CCLM	4-8-17	greater Alpine region	424x240x40	0.0275deg ~3.1km	erainl	evaluation	N/A	erainl -> 12 km (GCLM4-8-17; Klaus Keuler, BTU) -> 3 km	1989/01-2010/12	1h	finished	by request	marie.piazza@uni-graz.at / heimo.truhetz@uni-graz.at / preiml@ucar.edu	
WEGC (CLMcom)	CCLM	5-0-1	greater Alpine region	424x240x40	0.0275deg ~3.1km	erainl	evaluation	N/A	erainl -> 12 km (GCLM4-8-17; Klaus Keuler, BTU) -> 3 km	2005/12-2010/12	1h	running	by request	marie.piazza@uni-graz.at / heimo.truhetz@uni-graz.at / preiml@ucar.edu	multiple sens. exp.
WEGC (CLMcom)	CCLM	5-0-6	greater Alpine region	424x240x40	0.0275deg ~3.1km	erainl	evaluation	N/A	erainl -> 12 km (CCLM4-8-17; Klaus Keuler, BTU) -> 3 km	1989/01-2010/12	1h	planned	by request	marie.piazza@uni-graz.at / heimo.truhetz@uni-graz.at	best config
WEGC (CLMcom)	CCLM	5-0-6	greater Alpine region	424x240x40	0.0275deg ~3.1km	MPI-ESM-LR	historical	r2i1p1	MPI-ESM-LR -> EUR-11 -> 3km	1971-2000	1h	planned	by request	marie.piazza@uni-graz.at / heimo.truhetz@uni-graz.at	best config
WEGC (CLMcom)	CCLM	5-0-6	greater Alpine region	424x240x40	0.0275deg ~3.1km	MPI-ESM-LR	rcp85	r2i1p1	MPI-ESM-LR -> EUR-11 -> 3km	2071-2100	1h	planned	by request	marie.piazza@uni-graz.at / heimo.truhetz@uni-graz.at	best config
WEGC (CLMcom)	CCLM	4-8-17	greater Alpine region	424x240x40	0.0275deg ~3.1km	IFS	evaluation	N/A	IFS (~20 km) -> 3 km	2005/12-2010/12	1h	finished	by request	andras.csaki@uni-graz.at / heimo.truhetz@uni-graz.at / marie.piazza@uni-graz.at	sens. exp.
WEGC (CLMcom)	CCLM	5-0-6	greater Alpine region	424x240x40	0.0275deg ~3.1km	IFS	evaluation	N/A	IFS (~20 km) -> 3 km	2005/12-2010/12	1h	running	by request	andras.csaki@uni-graz.at / heimo.truhetz@uni-graz.at / marie.piazza@uni-graz.at	multiple sens. exp.
WEGC	WRF	3.3.1	greater Alpine region	449x265x50	0.0275deg ~3.1km	erainl	evaluation	N/A	erainl -> 12 km (WRF331A; GRP-GL) -> 3 km	1989/01 - 2010/12	1h	finished	by request	heimo.truhetz@uni-graz.at	
WEGC	WRF	3.7.1	greater Alpine region	449x265x50	0.0275deg ~3.1km	erainl	evaluation	N/A	erainl -> 12 km (WRF331A; GRP-GL) -> 3 km	2005/12 - 2010/12	1h	running	by request	heimo.truhetz@uni-graz.at	multiple sens. exp.
WEGC	WRF	3.7.1	greater Alpine region	449x265x50	0.0275deg ~3.1km	erainl	evaluation	N/A	erainl -> 12 km (WRF331A; GRP-GL) -> 3 km	1989/01 - 2010/12	1h	planned	by request	heimo.truhetz@uni-graz.at	best config
WEGC	WRF	3.7.1	greater Alpine region	449x265x50	0.0275deg ~3.1km	MPI-ESM-LR	historical	r2i1p1	MPI-ESM-LR -> EUR-11 -> 3km	1971 - 2000	1h	planned	by request	heimo.truhetz@uni-graz.at	best config
WEGC	WRF	3.7.1	greater Alpine region	449x265x50	0.0275deg ~3.1km	MPI-ESM-LR	rcp85	r2i1p1	MPI-ESM-LR -> EUR-11 -> 3km	2071 - 2100	1h	planned	by request	heimo.truhetz@uni-graz.at	best config
CNRM	AROME	Cycle 38t1	South East France	240x240x60	2.5km	erainl	evaluation	N/A	erainl -> 12 km ALADIN	1989-2008	1h	finished	by request	antonette.alias@meteo.fr	
CNRM	AROME	Cycle 38t1	South East France	240x240x60	2.5km	CNRM-CMS	historical		CNRM-CM5 -> 12 km ALADIN	1989-2000	1h	finished	by request	antonette.alias@meteo.fr	
CNRM	AROME	Cycle 38t1	South East France	240x240x60	2.5km	CNRM-CMS	rcp85		CNRM-CM5 -> 12 km ALADIN	2089-2100	1h	finished	by request	antonette.alias@meteo.fr	
RMIB-UGent	ALARO-0	v1	Belgium	181x181x48	0.044deg ~5km	erainl	evaluation	N/A	erainl -> 50/12km -> 5km	1981-2010	1h	planned	by request	piet.termonia@meteo.be / cordex@meteo.be	
RMIB-UGent	ALARO-0	v1	Belgium	181x181x48	0.044deg ~5km	ARPEGE	historical		ARPEGE -> 50/12km -> 5km	1976-2005	1h	planned	by request	piet.termonia@meteo.be / cordex@meteo.be	
RMIB-UGent	ALARO-0	v1	Belgium	181x181x48	0.044deg ~5km	ARPEGE	rcp26		ARPEGE -> 50/12km -> 5km	2010-2100	1h	planned	by request	piet.termonia@meteo.be / cordex@meteo.be	
RMIB-UGent	ALARO-0	v1	Belgium	181x181x48	0.044deg ~5km	ARPEGE	rcp45		ARPEGE -> 50/12km -> 5km	2010-2100	1h	planned	by request	piet.termonia@meteo.be / cordex@meteo.be	
RMIB-UGent	ALARO-0	v1	Belgium	181x181x48	0.044deg ~5km	ARPEGE	rcp85		ARPEGE -> 50/12km -> 5km	2010-2100	1h	planned	by request	piet.termonia@meteo.be / cordex@meteo.be	
CLMcom	COSMO_CLM	V5.0_clm6	Belgium	192x175x40	0.025deg ~2.8km	erainl	evaluation	N/A	erainl -> 12km -> 2.8km	1981-2010	1h	running	by request	nicole.vanlipzig@ees.kuleuven.be	
CLMcom	COSMO_CLM	V5.0_clm6	Belgium	192x175x40	0.025deg ~2.8km	EC-EARTH	historical		EC-EARTH -> 12km -> 2.8km	1976-2005	1h	running	by request	nicole.vanlipzig@ees.kuleuven.be	
CLMcom	COSMO_CLM	V5.0_clm6	Belgium	192x175x40	0.025deg ~2.8km	EC-EARTH	rcp26		EC-EARTH -> 12km -> 2.8km	2010-2100	1h	running	by request	nicole.vanlipzig@ees.kuleuven.be	
CLMcom	COSMO_CLM	V5.0_clm6	Belgium	192x175x40	0.025deg ~2.8km	EC-EARTH	rcp45		EC-EARTH -> 12km -> 2.8km	2010-2100	1h	running	by request	nicole.vanlipzig@ees.kuleuven.be	
CLMcom	COSMO_CLM	V5.0_clm6	Belgium	192x175x40	0.025deg ~2.8km	EC-EARTH	rcp85		EC-EARTH -> 12km -> 2.8km	2010-2100	1h	running	by request	nicole.vanlipzig@ees.kuleuven.be	
	CCLM UCL	COSMO4.8-CLM11	Belgium	192x175x40	0.025deg ~2.8km	erainl	evaluation	N/A	erainl -> 50/12km -> 2.8km	1981-2010	1h	planned	by request	nicole.vanlipzig@ees.kuleuven.be, jean-pascal.van@uclouvain.be, cecille.villanueva@uclouvain.be, philippe.marbaix@uclouvain.be	
	CCLM UCL	COSMO4.8-CLM11	Belgium	192x175x40	0.025deg ~2.8km	MPI-ESM-LR	historical		MPI-ESM-LR -> 50/12km -> 2.8km	1976-2005	1h	planned	by request	nicole.vanlipzig@ees.kuleuven.be, jean-pascal.van@uclouvain.be, cecille.villanueva@uclouvain.be, philippe.marbaix@uclouvain.be	
	CCLM UCL	COSMO4.8-CLM11	Belgium	192x175x40	0.025deg ~2.8km	MPI-ESM-LR	rcp26		MPI-ESM-LR -> 50/12km -> 2.8km	2010-2100	1h	planned	by request	nicole.vanlipzig@ees.kuleuven.be, jean-pascal.van@uclouvain.be, cecille.villanueva@uclouvain.be, philippe.marbaix@uclouvain.be	
	CCLM UCL	COSMO4.8-CLM11	Belgium	192x175x40	0.025deg ~2.8km	MPI-ESM-LR	rcp45		MPI-ESM-LR -> 50/12km -> 2.8km	2010-2100	1h	planned	by request	nicole.vanlipzig@ees.kuleuven.be, jean-pascal.van@uclouvain.be, cecille.villanueva@uclouvain.be, philippe.marbaix@uclouvain.be	
	CCLM UCL	COSMO4.8-CLM11	Belgium	192x175x40	0.025deg ~2.8km	MPI-ESM-LR	rcp85		MPI-ESM-LR -> 50/12km -> 2.8km	2010-2100	1h	planned	by request	nicole.vanlipzig@ees.kuleuven.be, jean-pascal.van@uclouvain.be, cecille.villanueva@uclouvain.be, philippe.marbaix@uclouvain.be	
ULg-MAR36	MAR	V3.6	Belgium	110x100x25	0.044deg ~5km	erainl	evaluation	N/A	erainl -> 5km	1981-2010	1h	planned	by request	xavier.fettweis@ulg.ac.be	
ULg-MAR36	MAR	V3.6	Belgium	110x100x25	0.044deg ~5km		historical			1976-2005	1h	planned	by request	xavier.fettweis@ulg.ac.be	
ULg-MAR36	MAR	V3.6	Belgium	110x100x25	0.044deg ~5km		rcp26			2010-2100	1h	planned	by request	xavier.fettweis@ulg.ac.be	
ULg-MAR36	MAR	V3.6	Belgium	110x100x25	0.044deg ~5km		rcp45			2010-2100	1h	planned	by request	xavier.fettweis@ulg.ac.be	
ULg-MAR36	MAR	V3.6	Belgium	110x100x25	0.044deg ~5km		rcp85			2010-2100	1h	planned	by request	xavier.fettweis@ulg.ac.be	
ETH Zurich	CCLM	v4.14	greater Alpine region	500x500x60	0.02deg ~2.2km	ERA-Interim	evaluation		ERA-Interim->12km->2.2km	1998-2007	1h, 3h, 1d	finished	by request	nikolina.ban@env.ethz.ch	simulations published in Ban et al., 2014 (JGR) and 2015 (GRL)
ETH Zurich	CCLM	v4.14	greater Alpine region	500x500x60	0.02deg ~2.2km	MPI-ESM-LR	historical		MPI-ESM-LR->12km->2.2km	1991-2000	1h, 3h, 1d	finished	by request	nikolina.ban@env.ethz.ch	simulations published in Ban et al., 2014 (JGR) and 2015 (GRL)
ETH Zurich	CCLM	v4.14	greater Alpine region	500x500x60	0.02deg ~2.2km	MPI-ESM-LR	rcp85		MPI-ESM-LR->12km->2.2km	2081-2091	1h, 3h, 1d	finished	by request	nikolina.ban@env.ethz.ch	simulations published in Ban et al., 2014 (JGR) and 2015 (GRL)
ETH Zurich	CCLM	V4.19 GPU-Prototype	Europe	1536x1536x60	0.02deg ~2.2km	ERA-Interim	evaluation		ERA-Interim->12km->2.2km	1999-2008	1h, 3h, 1d	finished	by request	david.leutwyler@env.ethz.ch	same domain as E. Kendon Europe run
IMK-TRO	COSMO_CLM	COSMO4.8-CLM7	southwestern Germany	140x116	0.025deg ~2.8km	ERA40	evaluation		ERA40 ->50km ->7km ->2.8km	1968-2000	1h	finished	by request	hans-juergen.panitz@kit.edu	
IMK-TRO	COSMO_CLM	COSMO4.8-CLM7	southwestern Germany	140x117	0.025deg ~2.8km	ECHAM5	historical		ERA40 ->50km ->7km ->2.8km	1968-2000	1h	finished	by request	hans-juergen.panitz@kit.edu	
IMK-TRO	COSMO_CLM	COSMO4.8-CLM7	southwestern Germany	140x118	0.025deg ~2.8km	ECHAM5	A1b		ERA40 ->50km ->7km ->2.8km	2018-2050	1h	finished	by request	hans-juergen.panitz@kit.edu	
IMK-TRO	COSMO_CLM	COSMO_5.00_clm6	Southern Germany River Catchments	322x328	0.025deg ~2.8km	ERA40	evaluation		ERA40 ->50km ->7km ->2.8km	1968-2000	1h	finished	analysed being analysed	hans-juergen.panitz@kit.edu	
IMK-TRO	COSMO_CLM	COSMO_5.00_clm6	Southern Germany River Catchments	322x328	0.025deg ~2.8km	MPI-ESM-LR, r1i1p1	historical		GCM ->50km ->7km ->2.8km	1968-2005	1h	finished	analysed being analysed	hans-juergen.panitz@kit.edu	
IMK-TRO	COSMO_CLM	COSMO_5.00_clm6	Southern Germany River Catchments	322x328	0.025deg ~2.8km	MPI-ESM-LR, r1i1p1	RCP8.5		GCM ->50km ->7km ->2.8km	2006-2050	1h	running		hans-juergen.panitz@kit.edu	
IMK-TRO	COSMO_CLM	COSMO_5.00_clm6	Southern Germany River Catchments	322x328	0.025deg ~2.8km	MPI-ESM-LR, r1i1p1	RCP8.5		GCM ->50km ->7km ->2.8km	2068-2100	1h	running		hans-juergen.panitz@kit.edu	
Met Office Hadley Centre	Met Office Unified Model	UKV-UM7.9	Southern UK	466x366x70	1.5km	60km-HadGEM3	historical		4km variable rim, 12km intermediate nest	1996-2009	1h	finished	collab research	elizabeth.kendon@metoffice.gov.uk	
Met Office Hadley Centre	Met Office Unified Model	UKV-UM7.9	Southern UK	466x366x70	1.5km	60km-HadGEM3	rcp85		4km variable rim, 12km intermediate nest	13yrs,~2100	1h	finished	collab research	elizabeth.kendon@metoffice.gov.uk	
Met Office Hadley Centre	Met Office Unified Model	UKV-UM7.9	Northern UK	260x500x70	1.5km	60km-HadGEM3	historical		4km variable rim, 12km intermediate nest	1996-2009	1h	finished	collab research	elizabeth.kendon@metoffice.gov.uk	
Met Office Hadley Centre	Met Office Unified Model	UKV-UM7.9	Northern UK	260x500x70	1.5km	60km-HadGEM3	rcp85		4km variable rim, 12km intermediate nest	13yrs,~2100	1h	finished	collab research	elizabeth.kendon@metoffice.gov.uk	
Met Office Hadley Centre	Met Office Unified Model	UKV-UM10.1	Europe	1536x1536x70	2.2km	erainl	evaluation		no intermediate nest	1998-2008	1h	running	collab research	elizabeth.kendon@metoffice.gov.uk	
Met Office Hadley Centre	Met Office Unified Model	UKV-UM10.1	Europe	1536x1536x70	2.2km	25km-UM-GA7	historical		no intermediate nest	1997-2008	1h	planned	collab research	elizabeth.kendon@metoffice.gov.uk	
Met Office Hadley Centre	Met Office Unified Model	UKV-UM10.1	Europe	1536x1536x70	2.2km	25km-UM-GA7	rcp85		no intermediate nest	10yrs,~2100	1h	planned	research	elizabeth.kendon@metoffice.gov.uk	
Met Office Hadley Centre	Met Office Unified Model?	UKV-UM10.1	UK and Ireland	744x928x?	1.5km	erainl	evaluation		ERA-Interim->high resolution, variable resolution at boundary	1998-2008	1h	running		georgia.fosser@metoffice.gov.uk	testing ongoing
Met Office Hadley Centre	Met Office Unified Model?	UKV-UM10.1	UK and Ireland	532x654x?	2.2km	erainl	evaluation		ERA-Interim->high resolution, variable resolution at boundary	1998-2008	1h	running		georgia.fosser@metoffice.gov.uk	testing ongoing
Met Office Hadley Centre	Met Office Unified Model?	UKV-UM10.1	UK and Ireland	434x662x?	2.2km	erainl	evaluation		ERA-Interim->high resolution, no variable resolution at boundary	1998-2008	1h	running		georgia.fosser@metoffice.gov.uk	testing ongoing
Met Office Hadley Centre	Met Office Unified Model?	UKV-UM10.1	UK and Ireland	266x354x?	4km	erainl	evaluation		ERA-Interim->high resolution, no variable resolution at boundary	1998-2008	1h	running		georgia.fosser@metoffice.gov.uk	testing ongoing
SMHI	HARMONIE	Cycle 37h1.2	greater Alpine region and surrounding ocean areas	480x360x65	2km	erainl	evaluation	N/A	erainl -> 15km -- 2km	Sampling 7 summers in period 1998-2010	1h, 3h, 6h	finished	by request	petter.lind@smhi.se, david.lindstedt@smhi.se	
SMHI	HARMONIE	Cycle 37h1.2			~2km	erainl	evaluation	N/A	Erainl -> REMO 12km -- HARMONIE 2km	13-14/1/1994, 16-18/10/2008, 21-23/11/2008	15min, 1h, 3h	finished	by request	petter.lind@smhi.se, david.lindstedt@smhi.se	

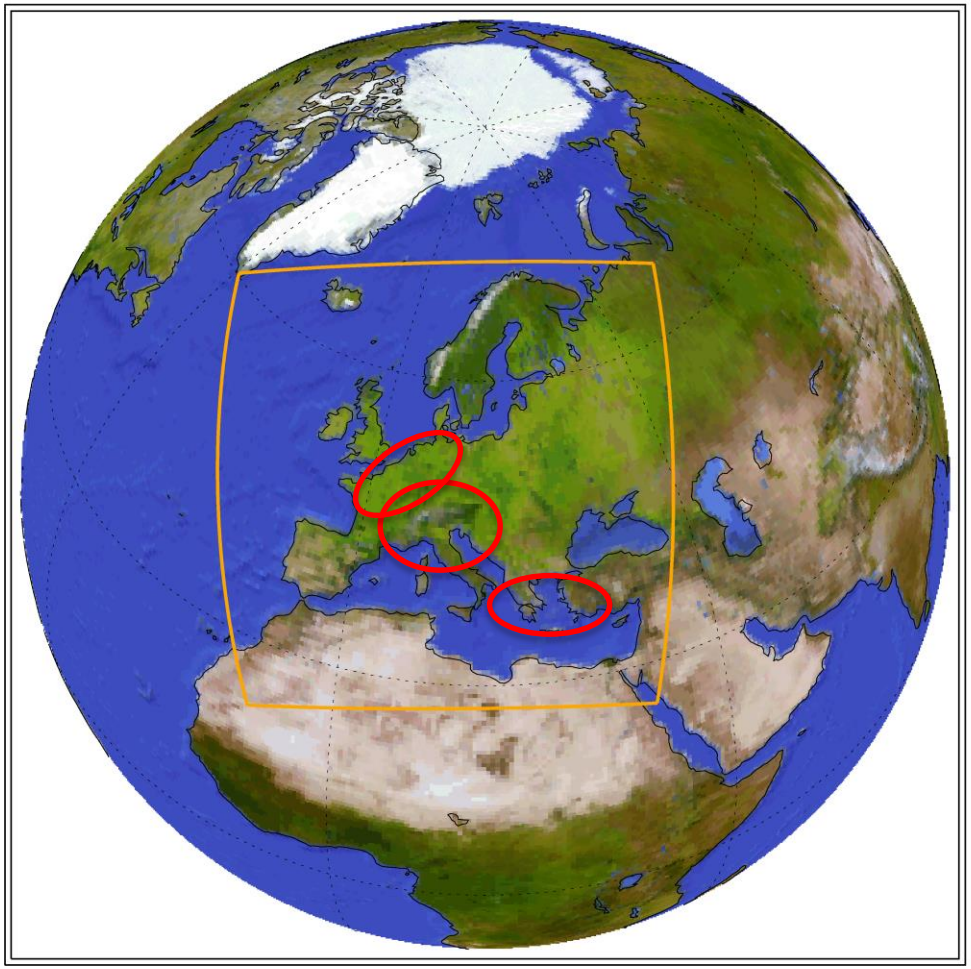
Special Thanks to Klaus Goergen for motivating this!

MOTIVATION

"An organized inter-comparison is required to both formulate scientific questions clearly, and to put scientific results into a context that will allow assessment of robust findings. A critical part of the context for the push to kilometer scale models is the widening appreciation that "stationarity is dead", but that *robust* advice about how precipitation extremes, particularly for short durations, will scale with temperature change is not yet available." – Francis Zwiers (one of the project's reviewers)

Euro-MED FPS on Convective Phenomena

- Multi-model ensemble of convection permitting simulations (<3km)
- Mandatory domain centered on the Alpine chain (see Ban et al., 2014,2015)
- ERA-interim + future time slice(s)
- Testing of configurations begins 2017



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MOTIVATION

- **Large field campaigns** dedicated to the study of heavy precipitation events such as HyMeX (http://www.hymex.org/) and **high resolution/dense observation networks**: WegnerNet (https://wegcenter.uni-graz.at/en/wegenernet/wegenernet-home/), RdisaggH (CH),COMEPHORE (Fr), SAFRAN (Fr), EURO4M-APGD (CH)
- **Computing capacity** and model development now allow limited-area convection-permitting climate simulations at longer time-scales;
- Homogeneous observation data sets collected over the years now unveil emerging **trend signals** in most extreme precipitations, particularly at sub-daily time scales (Westra et al., 2014) and in Mediterranean and Alpine mountain ranges (Vautard et al., 2015; Scherrer et al. 2016)
- Several issues linked to detection, attribution, and downscaling of the **very localized consequences of extreme convective events** can now benefit from recent progress in advanced statistical methods combined with advances in dynamical modeling (Beaulant et al., 2011).

OBJECTIVES

- **Investigate convective-scale events, related processes and their changes** in a few key regions of Europe and the Mediterranean using convection-permitting RCMs, statistical models and available observations

- **Provide a collective assessment and intercomparison** our modeling capacity at convection-permitting scale

- **Shape a coherent and robust assessment of the consequences of climate change on convective phenomena impacts at local to regional scales**

SCIENTIFIC AIMS: added value and processes

- **How do Convective events, associated damaging phenomena (heavy precipitation, wind storms, flash-floods) and related processes (e.g. initiation, interactions with topography, land surface, land-ocean contrasts) respond to changing climate conditions in different climatic regions of Europe?**
  - Identifying trends in intensity, scale and duration in past observations, in underlying processes, and understanding how these are simulated by RCMs
  - Explaining major events in the context of climate change, using both dynamical and statistical simulations, and provide storylines of future events
  - Identifying the added-value of convection-permitting models in simulating such trends with respect to standard resolution climate models, including relevant processes

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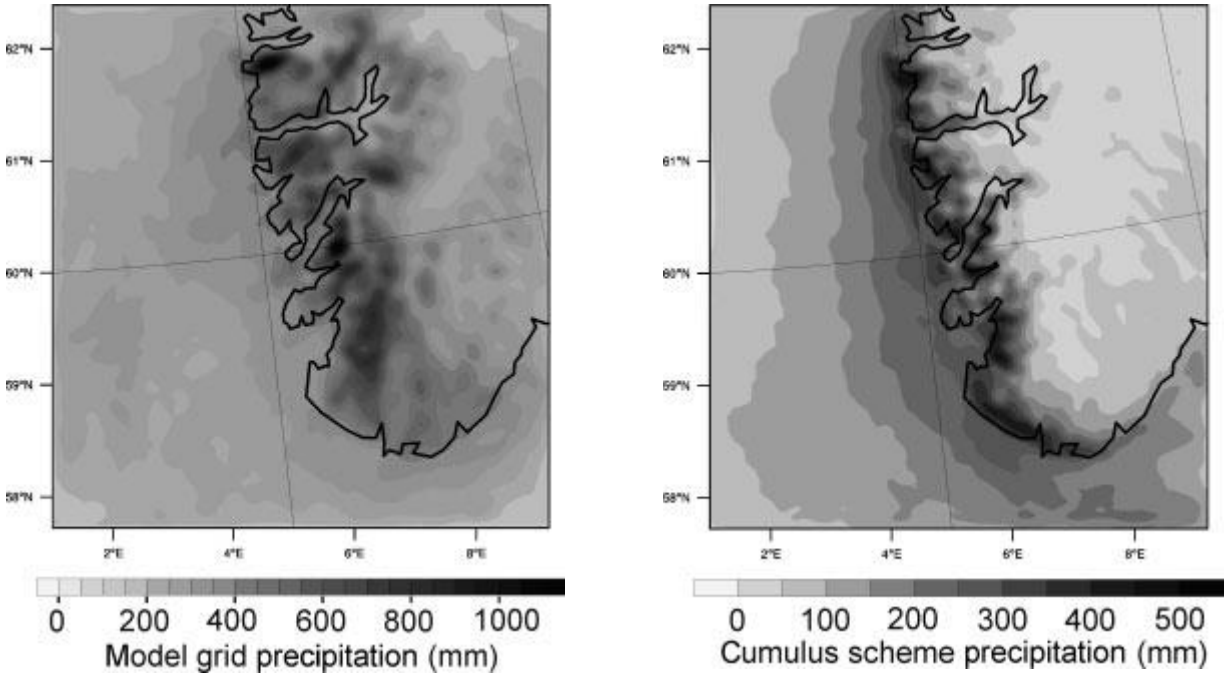
SCIENTIFIC AIMS: added value



- Combined field campaign and high resoution modeling 9-3-1km nest
- Shallow convection off coast
- Deeper convection associated with orographically induced updrafts

Source: Barstad and Caroletti (2013)
http://onlinelibrary.wiley.com/doi/10.1002/qj.2067/full

Significant improvement but also some familiar Problems @ 1km!

STOPEX	Wet (%) 10min	Wet (%) 1hr	Wet (%) 3hr	Wet (%) 24hr	Tot.acc (mm)
P1 - Bremnes	348	193	153	111	483/**543**
P2 - Børtveit	276	162	140	116	675/**938**
P8 - Hovaasen	295	167	139	109	554/**717**
P9 - Kattnakkjen	231	142	130	101	768/**1239**
P10 - Korsvik	315	172	145	110	487/**614**
P18 - Y-Sorlivatnet	289	167	143	109	693/**838**

- Wet % is the ratio of model events/observed events
- Total amounts are: modeled/observed
- Take home message: Model rains too often with too little intensity

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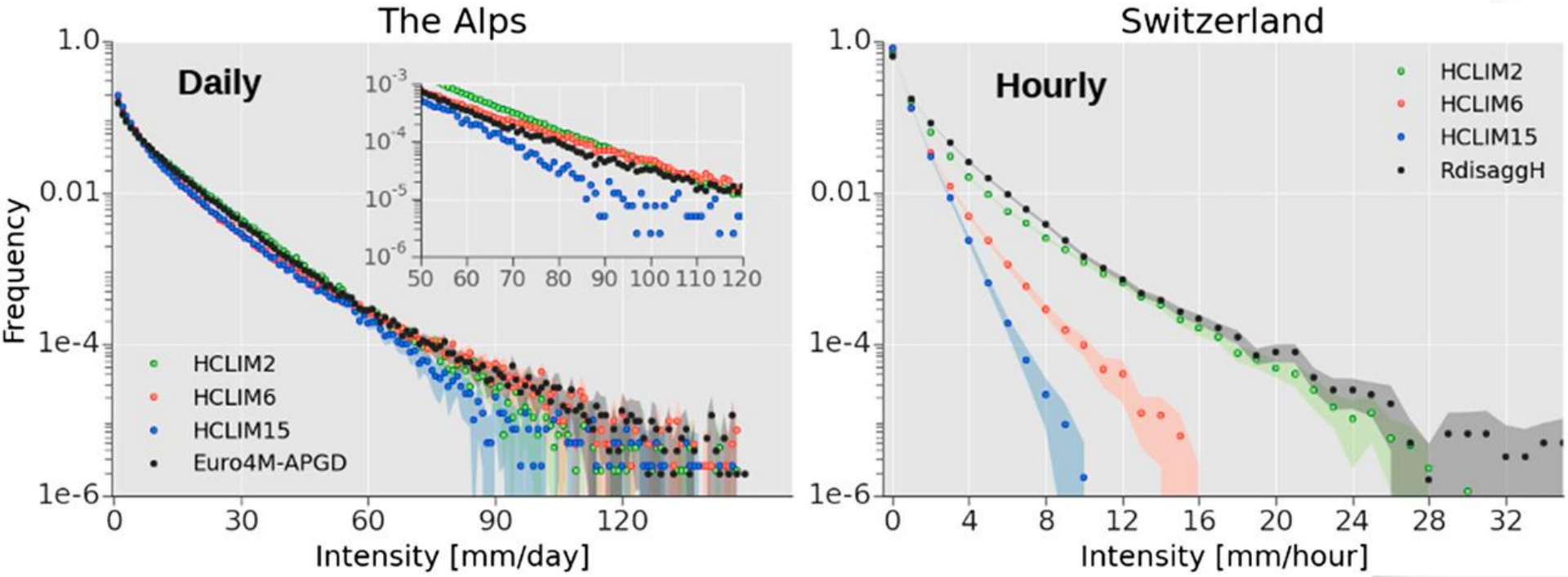

- The now familiar greater improvement in the tails at hourly scales (green dots)

Source: Lind et al. (2016)
http://journals.ametsoc.org/doi/abs/10.1175/JCLI-D-15-0463.1

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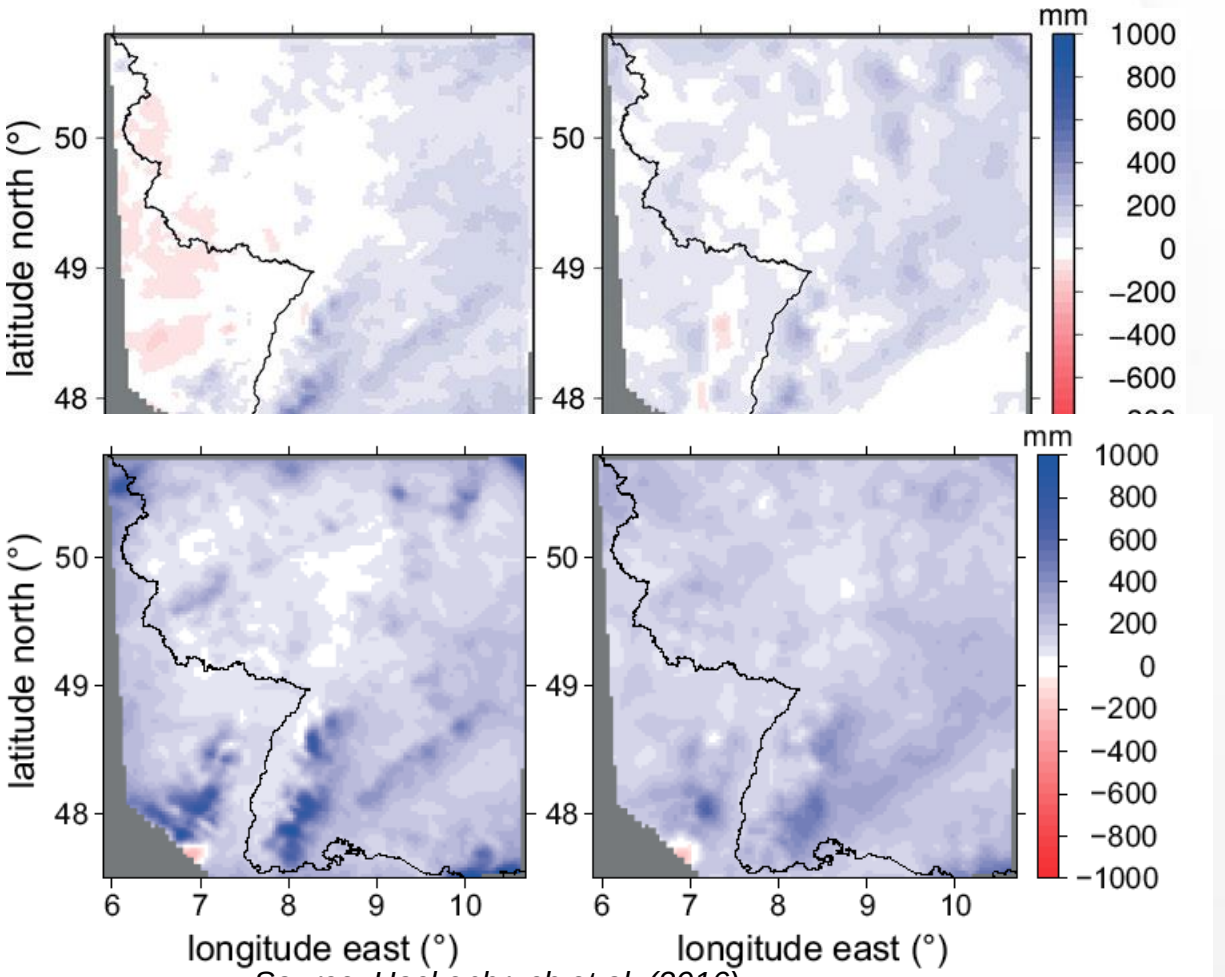
SCIENTIFIC AIMS: added value

- Improvement depends on variable, season, region and altitude
- In some cases there is even deterioration
- Raises issues of observation limitations



Source: Hackenbruch et al. (2016)

http://www.schweizerbart.de/papers/metz/detail/25/85528/Added_value_of_high_resolution_regional_climate_simulations_for_regional_impact_studies

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SCIENTIFIC AIMS: added value in AROME-Climate over SE France 2.5km

- Show familiar improvement at daily and hourly scales
- Decrease in daily extremes (bottom left)
- Increase in hourly extremes (bottom right)

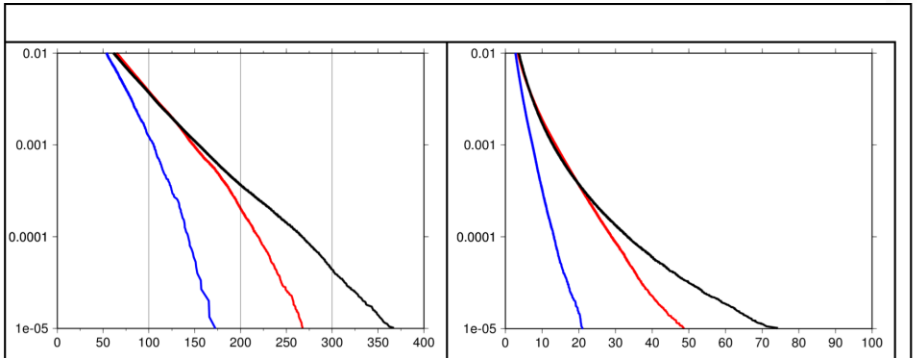

Figure 1: Tail of the complement to one of the cumulative distribution function for daily (left) and hourly (right) precipitation (mm) in the Cevennes area for the validation experiment: COMEPHORE (black), AROME (red) and ALADIN (blue); probabilities are shown in logarithmic scale.

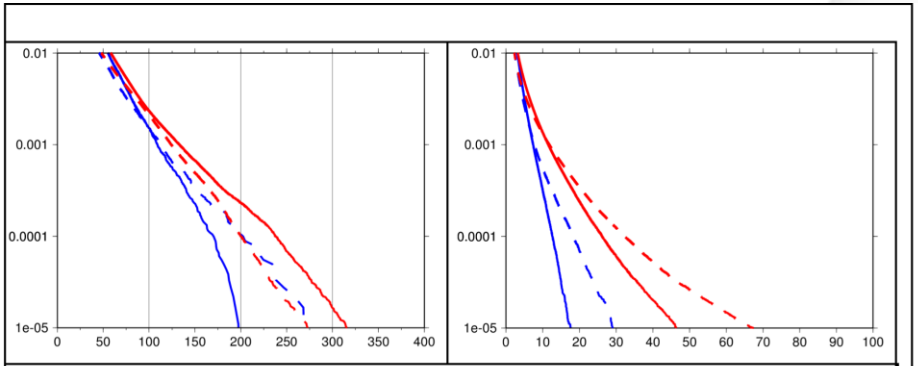

Figure 2: As Figure 1 for AROME (red) and ALADIN (blue); reference time slice (solid line) and scenario time slice (dash line).

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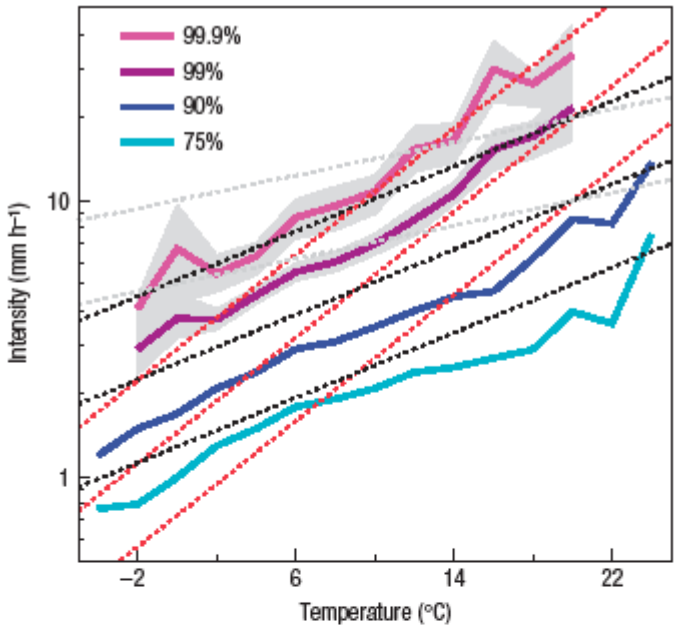
Source: Deque et al. (2016)
http://www.wcrp-climate.org/WGNE/blue_book.html)

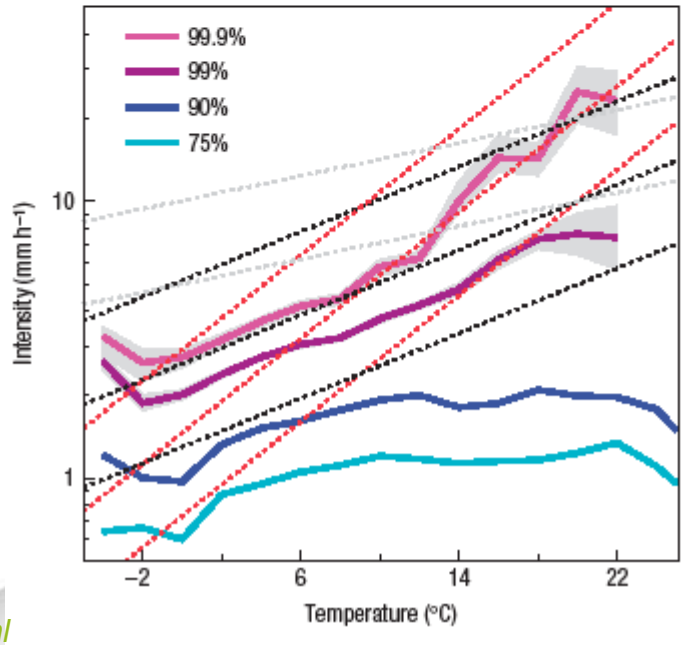
SCIENTIFIC AIMS: upscaled added value and scaling

- **Does an improved representation of convective processes and precipitation at convection permitting scales lead to upscaled added value?**
  - How improved are aggregated precipitation statistics compared to lower-resolution models up to the resolution of GCMs?
  - Do convection-permitting and parameterized models have the same temperature-precipitation intensity relation (as formulated in Lenderink & van Meijgaard, 2008)?
  - Can convection-permitting climate models serve as reference to improve convection parameterizations, from shallow to deep?
  - Are there differences in the representation of key feedback processes between parameterized and explicit convection (e.g. Hohenegger et al. 2009).

SCIENTIFIC AIMS: P scaling under warming conditions

- so-called super cc scaling (~14% K^{-1})
- Suggests that short duration high intensity events (sub-daily) scale differently than daily extremes
- Not convection permitting (25km)





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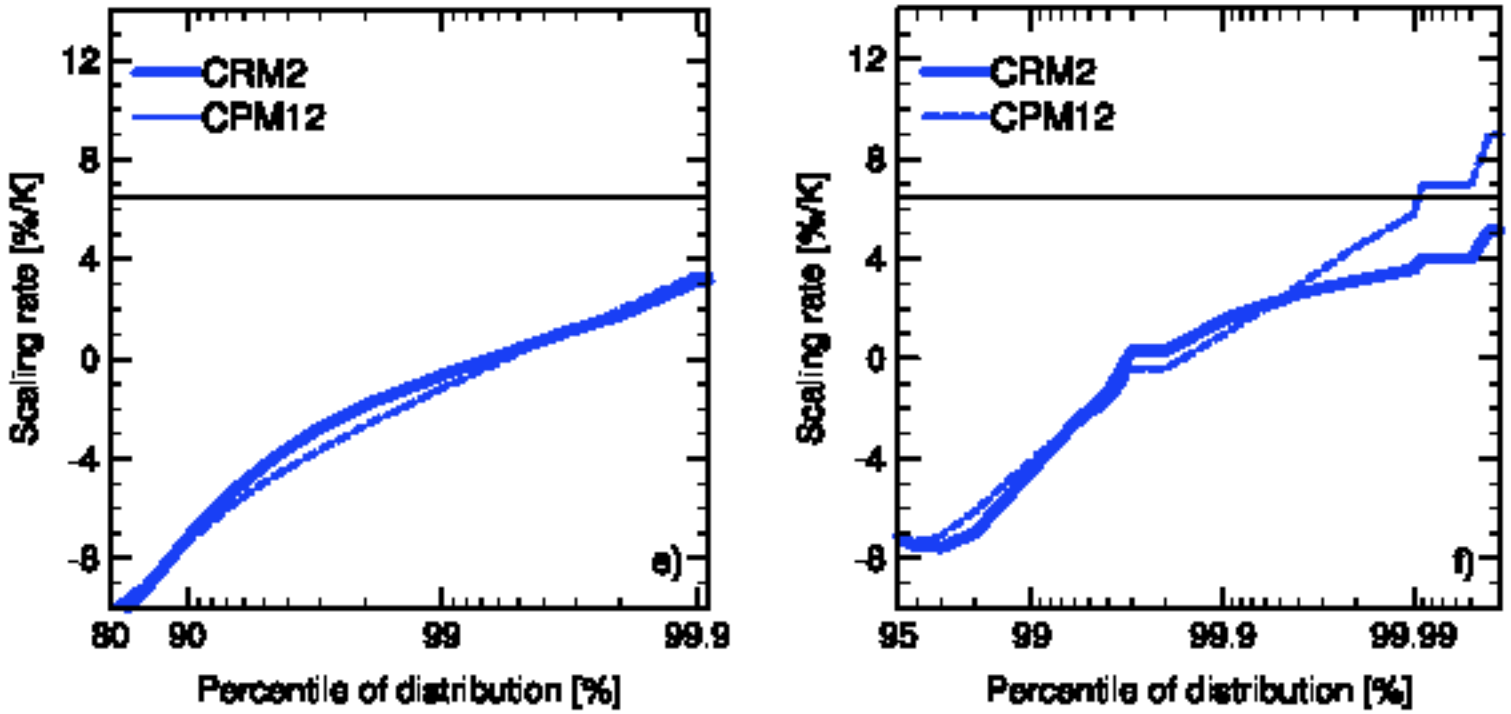
Source: Lenderink & van Meijgaard (2008)
http://www.nature.com/ngeo/journal/v1/n8/abs/ngeo262.html

SCIENTIFIC AIMS: P scaling under warming conditions



- Not so fast... over Alpine regions a different story is suggested
- CRM experiments seem to suggest that there is not super-cc scaling
- N.B. increases in frequency and intensity of heavy events and decrease in intermediate events

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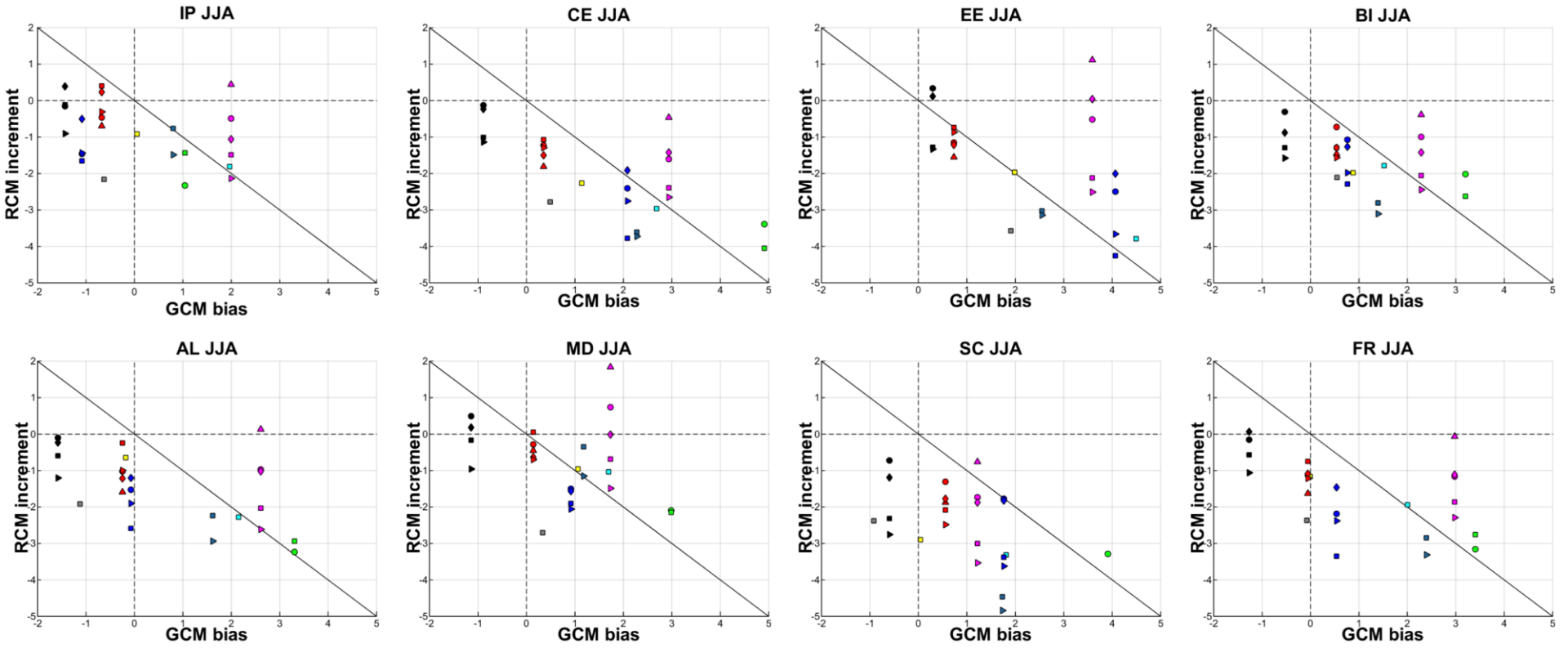
Source: Ban et al. (2015)
http://onlinelibrary.wiley.com/doi/10.1002/2014GL062588/full

SCIENTIFIC AIMS: Upscaled added value

- The RCMs tend to systematically reduce the GCM T2M bias.
- The newer (calibrated) model version has a lower bias than the older model version.
- The newer model version (50km) often has the same bias or lower bias than 12km simulation.

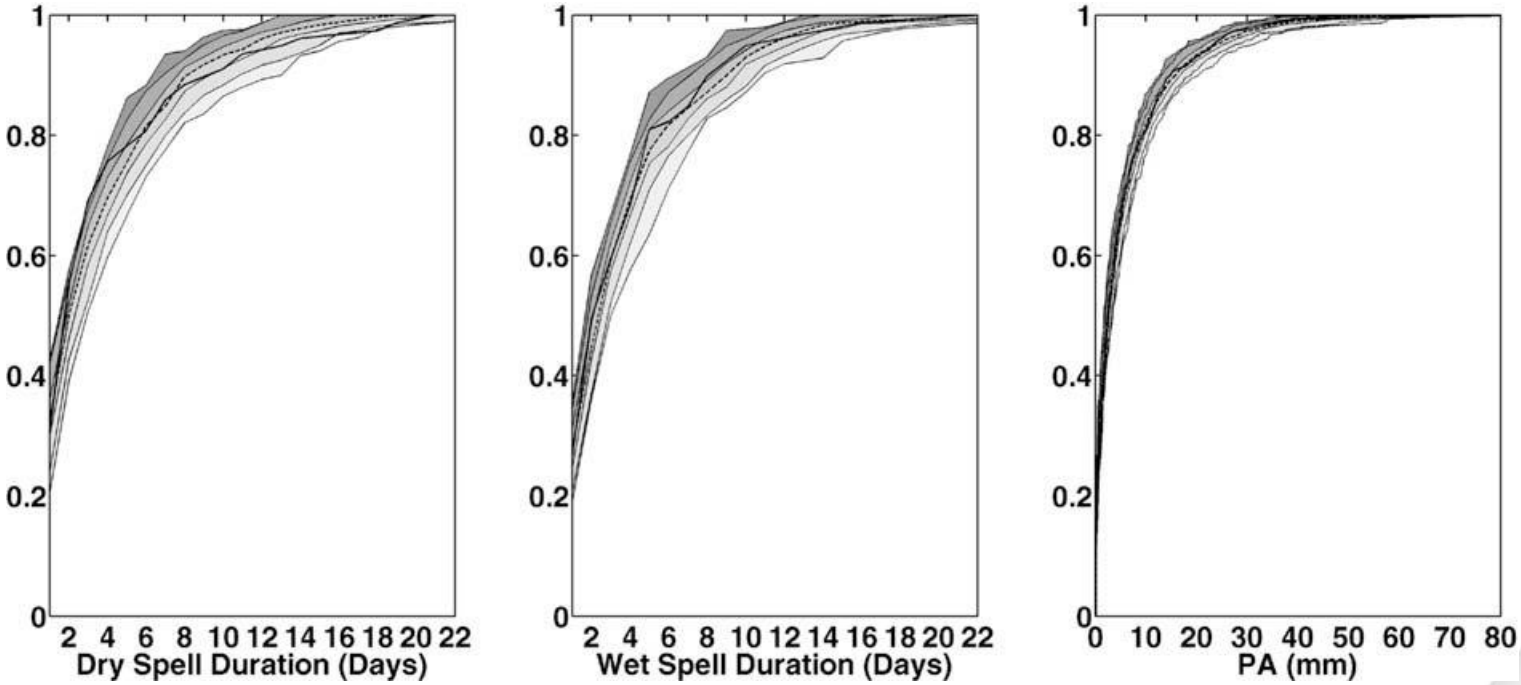
Source: Silje Sørland (ETH, Zurich)



SCIENTIFIC AIMS: Statistical emulation

- **Is it possible to augment costly convection-permitting experiments with physically defensible statistical downscaling approaches such as "convection emulators" that mimic CPMs and are fed by output of conventional-scale RCMs?**
  - Can the variability of local-scale convective precipitation be sensibly predicted by 0.11° area-averages of variables that are typically provided by RCMs?
  - Can the corresponding response to climate change be sensibly predicted by corresponding 0.11° resolution RCM predictors?

SCIENTIFIC AIMS: emulators/weather generators



- Show some promise
- But can they capture the temporal scales of interest?
- Limited expertise in the consortium

Source: Mezghani & Hingray (2009)
DOI: 10.1016/j.jhydrol.2009.08.033

SUMMARY

- A first attempt at coordinated multi-model ensemble experiments at convection resolving scales
- Development of a common process-based diagnostics and evaluation toolbox
- Robust investigations of convective phenomena, related processes and potential impacts under changing climate conditions
- The FPS is, at its heart, an attempt to build a community around these types of modeling applications

CHALLENGES

- What scientific issues can be realistically addressed in such a coordinated approach?
- How to motivate participation? Need discussion on applications relevance (national interests, GEWEX, Future Earth, etc.)
- Obervation density is great but how to integrate into the evaluation framework in a consistent manner?
- Many, many issues related to model configuration

THE WAY FORWARD: Project kick-off November 3-4, ICTP, Trieste, Italy

- What should the experiment protocol look like (domain size, LSM, soil-moisture spin up, PBL)
- Data handling sharing (need for distributed solutions)
- Incorporating statistical approaches in a strategic manner (many paths to failure)
- Standarized output specifications for CPM simulations (based on CORDEX).
- Integrate observation networks in a consistent, coordinated manner
- Need for standard, minimum set of evaluation metrics