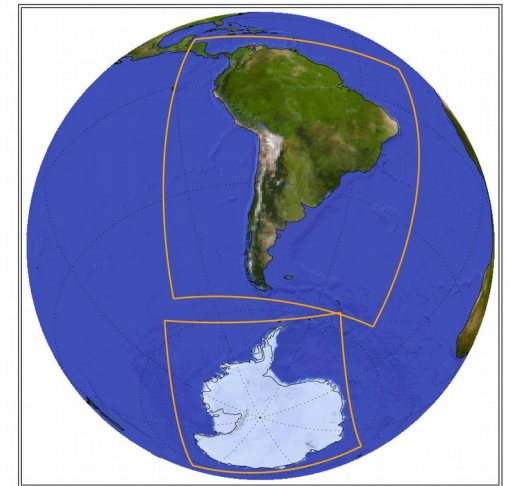
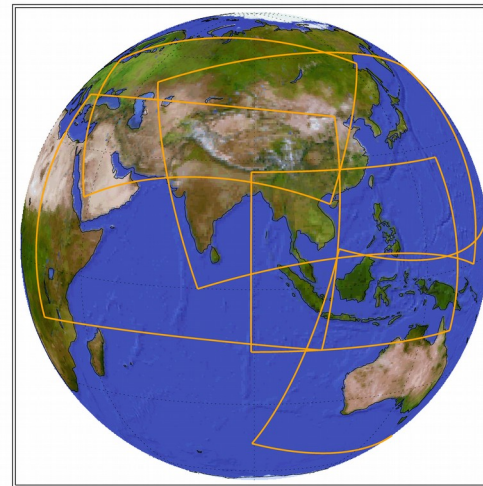
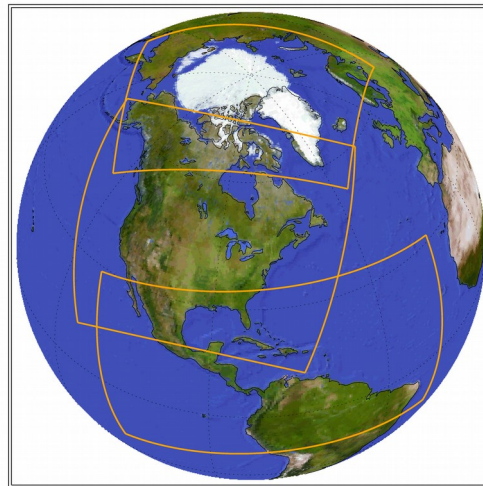
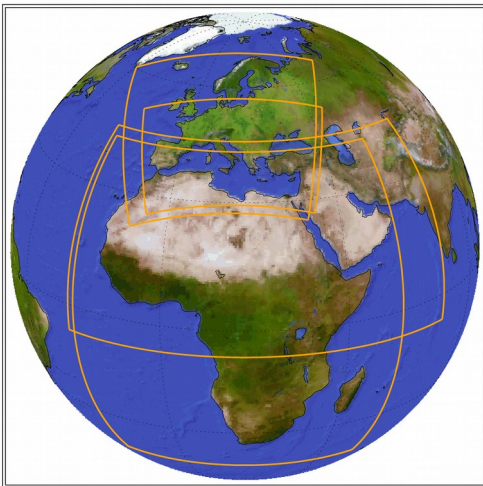


Downscaling of CMIP6 for regional climate modeling: experiences from CORDEX

Claas Teichmann

on behalf of Daniela Jacob, Filippo Giorgi
and the CORDEX-SAT

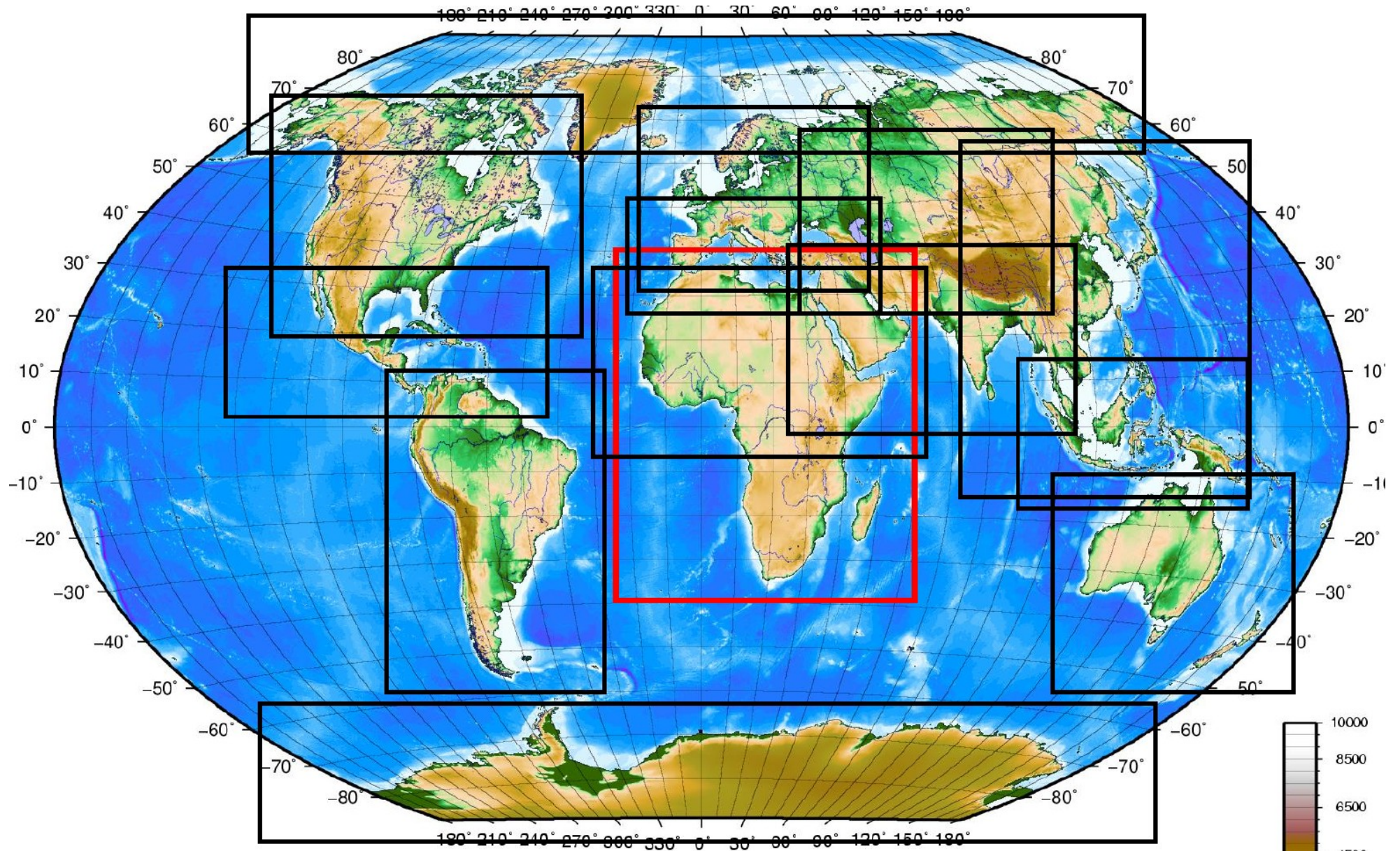


CORDEX vision and goals

The CORDEX vision is to advance and coordinate the science and application of regional climate downscaling through global partnerships.

- To better understand relevant regional/local climate phenomena, their variability and changes, through downscaling.
- To evaluate and improve regional climate downscaling models and techniques
- To produce coordinated sets of regional downscaled projections worldwide
- To foster communication and knowledge exchange with users of regional climate information

CORDEX Domains



COordinated Regional Downscaling EXperiment (CORDEX) – Management

- CORDEX Science advisory team (SAT), 12 members

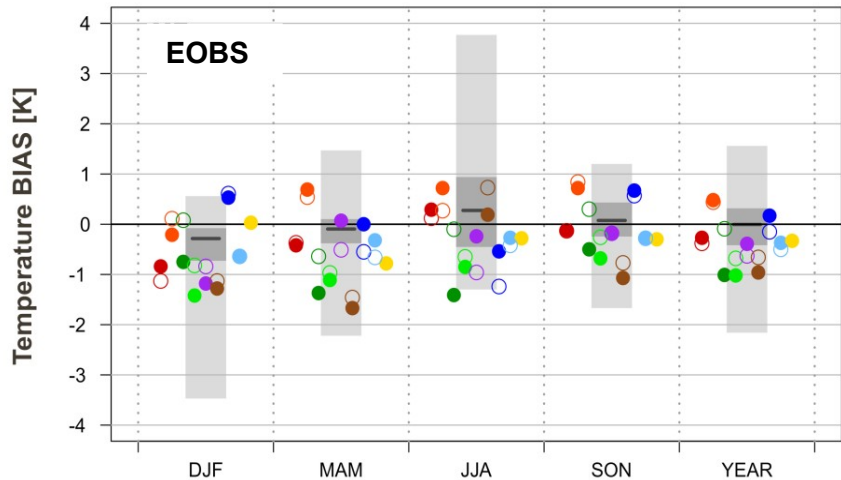


SAT-2 meeting
SMHI (Sweden)
25-27 Feb., 2015

- International Project Office for CORDEX (IPOC) hosted at SMHI since January 2015 (E. O'Rourke Head).
- CORDEX archiving coordinated by IS-ENES
- Regional points of contact (POCs), 2-3 per region

Evaluation of hindcasts

RCM multi-model ensemble evaluation



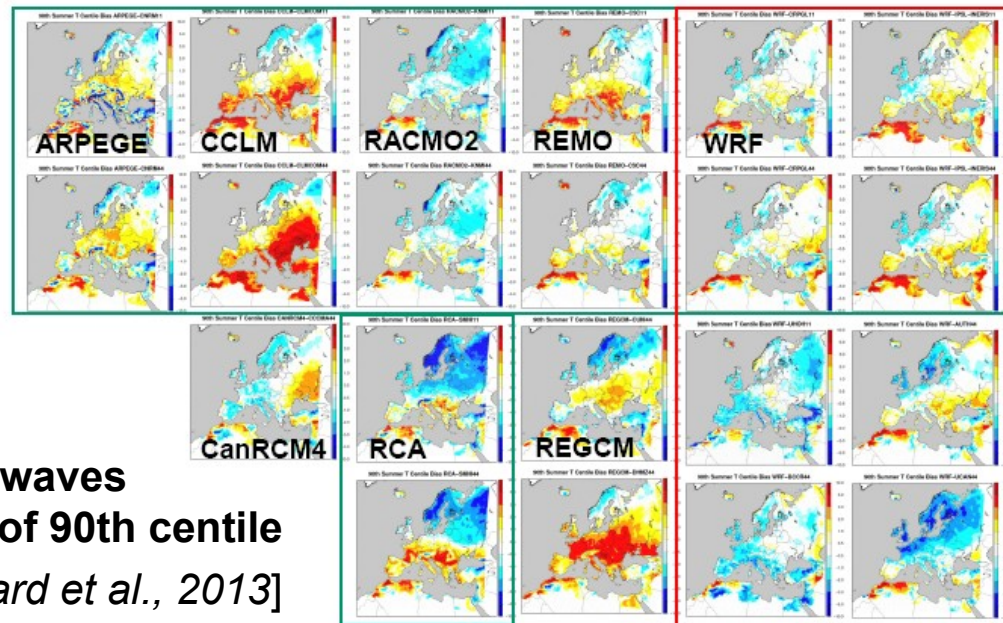
CORDEX EUR-11
 CORDEX EUR-44

“Standard” Evaluation [Kotlarski et al., 2014]

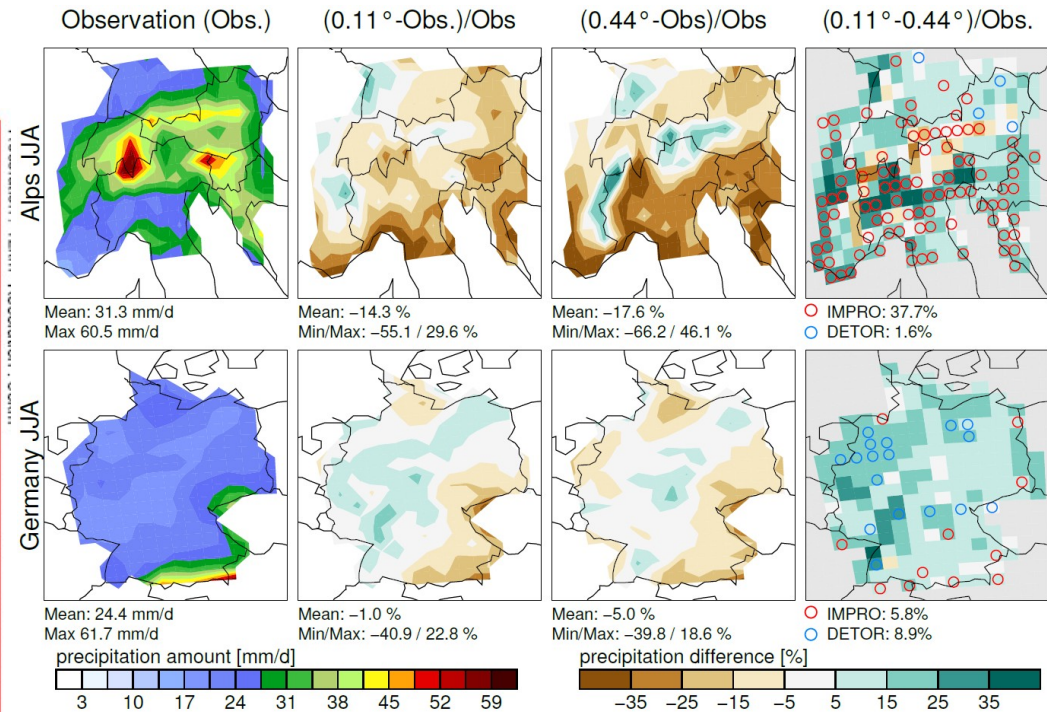
ENSEMBLES max
 ENSEMBLES p75
 ENSEMBLES median
 ENSEMBLES p25
 ENSEMBLES min

Added Value of High Resolution (EUR-11) Simulations [Prein et al. 2014]

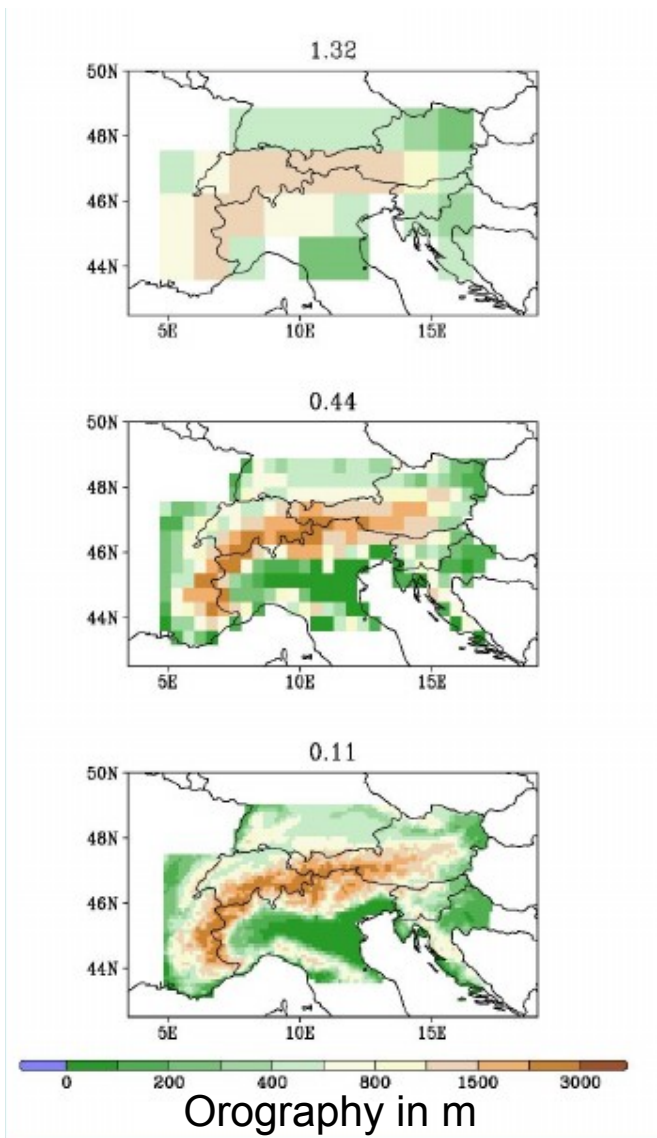
Precipitation Extremes (Q97.5)



Heat waves
Bias of 90th centile
[Vautard et al., 2013]



A study of added value using EURO-CORDEX and Med-CORDEX data



Horizontal resolutions: 1.32°, 0.44° and 0.11°

GCMs :

MPI-ES-MR

EC-EARTH

CNRM-CM5

HadGEM-ES

RCMs:

CCLM

RACMO

ALADIN

RegCM4.3

RCA4

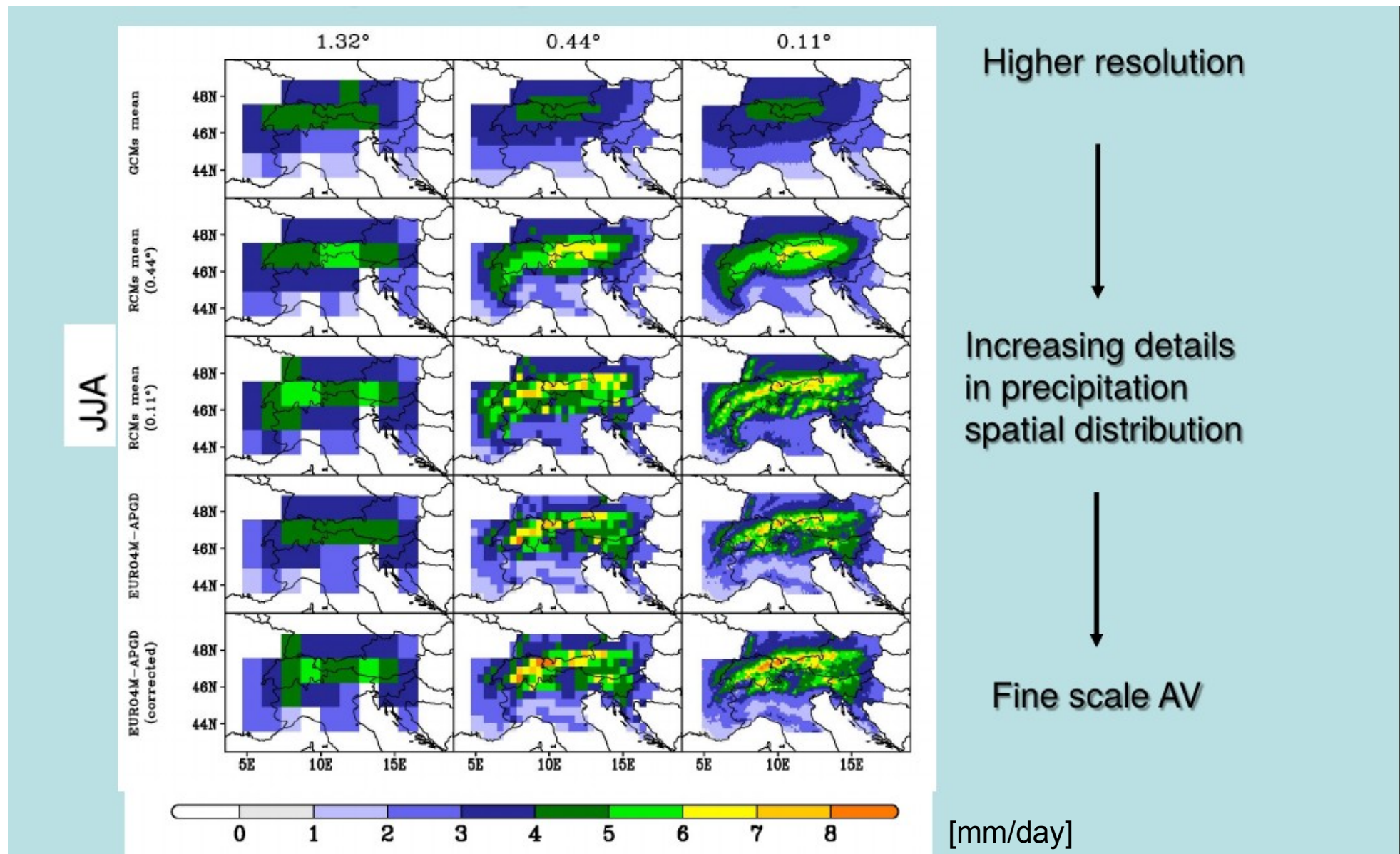
Reference period: 1975-2004

Future period: 2070-2099

Observational data: EURO4M-APGD
(Isotta et al., 2014)

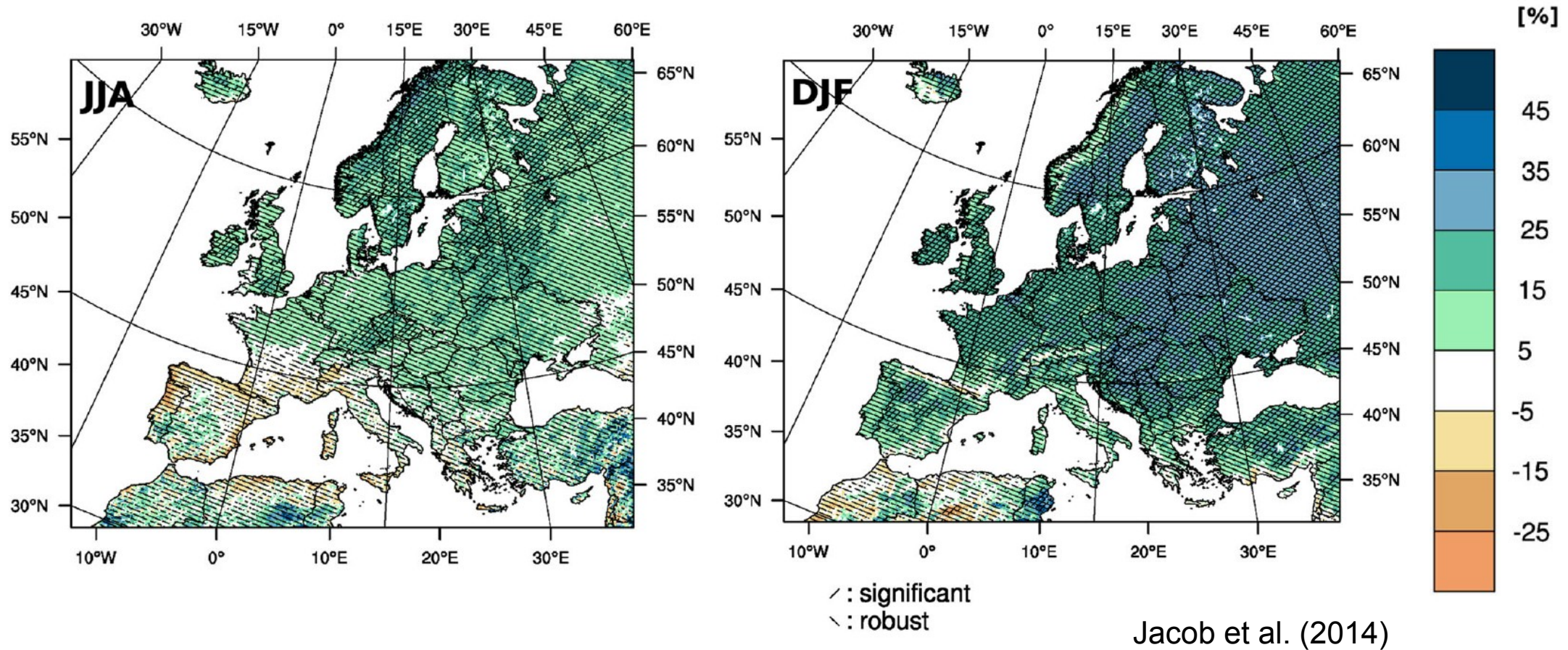
Torma et al. (2015) JGR

Simulation of spatial precipitation patterns



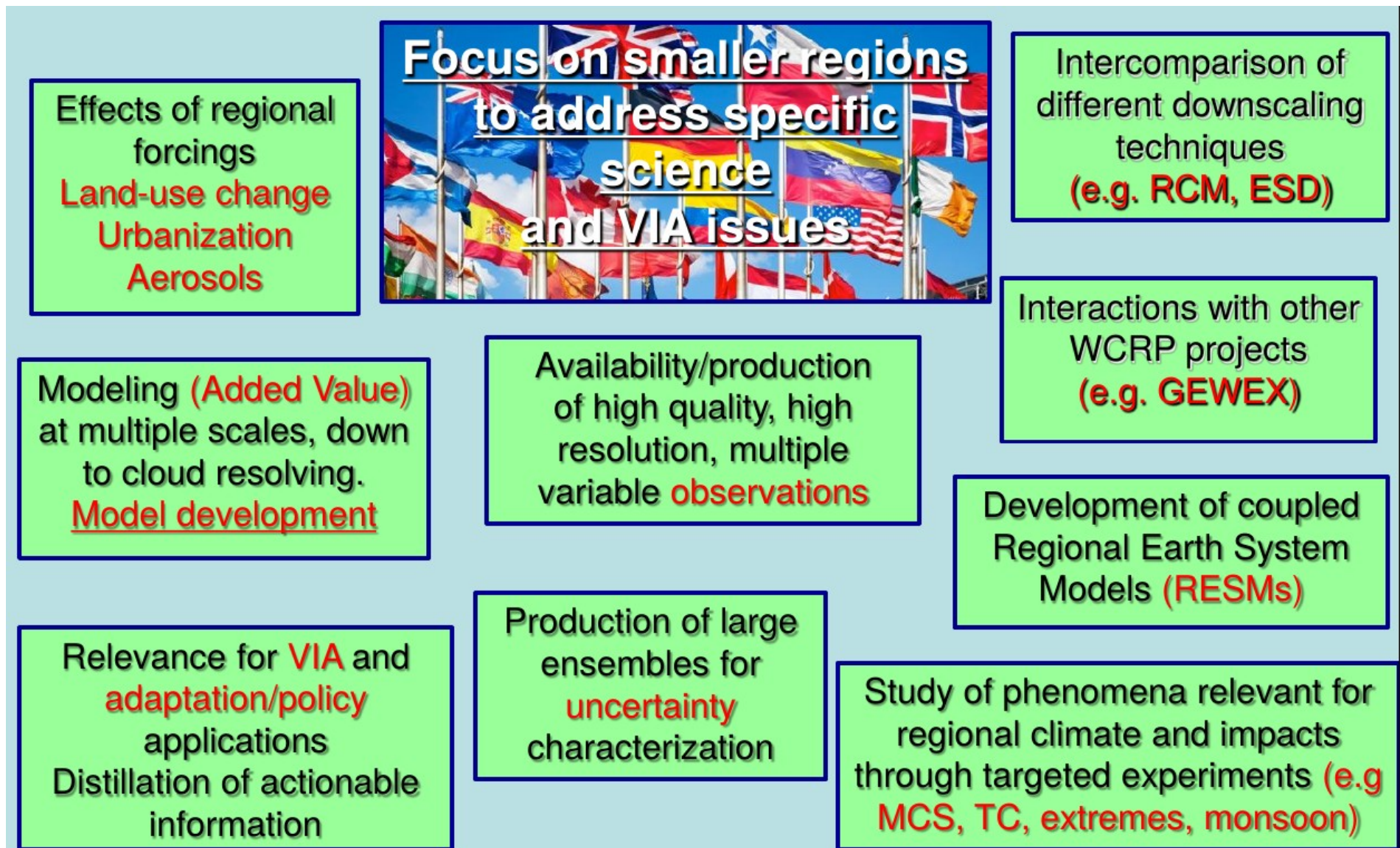
Change in heavy precipitation

RCP8.5: Projected changes of heavy precipitation 2071–2100 vs. 1971–2000



- Up to 45 % increase in large areas in winter in Northern and Eastern Europe
- no decrease besides isolated regions in Southern Europe (mostly along coastlines)

CORDEX – Flagship Pilot Studies



Thank you for your attention!

Contact:

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20095 Hamburg

claas.teichmann@hzg.de
www.climate-service-center.de



Ensembles of projections are available for most domains

CORDEX-S. ASIA

CORDEX-South Asia Multi Models Output

Historical (1950 - 2005) | Evaluation Run (1989 - 2008) | RCP 4.5

Variable name (Monthly and Daily)	SMHI-RCA4	IITM-RegCM4-GFDL	IITM-RegCM4-IMZ	COSMO-CM	IITM-IMZ
Institute's / Data Providers	Rossby Centre, SMHI	CCCR-IITM, Pune	CCCR-IITM, Pune	Goethe Inst - Univ. of Frankfurt	CCCR-IITM, Pune
Rainfall (pr)	✓	✓	✓	✓	✓
Surface Air Temperature (tas)	✓	✓	✓	✓	✓
Surface Air Temp. Maximum (tasmax)	✓	✓	✓	--	✓
Surface Air Temp. Minimum (tasmin)	✓	✓	✓	--	✓
Sea-level Pressure (psl)	✓	✓	✓	--	✓
Surface Specific Humidity (hus)	✓	✓	✓	--	✓
Surface Zonal Wind (uas)	✓	✓	✓	--	✓
Surface Meridional Wind (vas)	✓	✓	✓	--	✓
Downward Shortwave Radiation (rsds)	--	✓	✓	--	--

To download the data please [click here](#)
Regridding script example, [click here to download](#) | [script](#)

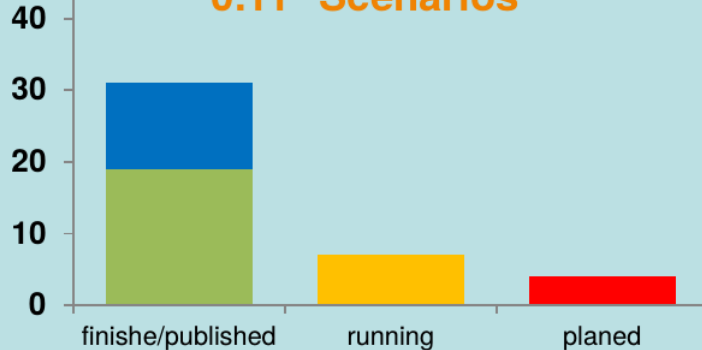
CORDEX-AFRICA

RCP4.5	CORDEX-AFRICA										sum				
	BCCR-greenWRF	CCCR-CanRCM4	CLMcom-CCLM4-8	CNRM-ALADIN	CSC-REMO	DMI-HIRHAM5	ICTP-RegCM4	KNMI-RACV02.2	MHC-GA3RCM	SMHI-RCA4		UCLM-PRONES	ULL-WRF311	UCAN-WRF34	UQAM-CRCM
CanESM2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	2
CNRM-CM5	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	2
NorESM1-M	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	1
EC-EARTH (r1)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	1
EC-EARTH (r3)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	1
EC-EARTH (r12)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	3
HadGEM2-ES	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	3
MIROC5	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	1
MPI-ESM-LR	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	4
GFDL-ESM2M	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	1
HADCM3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	1
sum	1	4	1	2	1	1	1	1	1	8					21

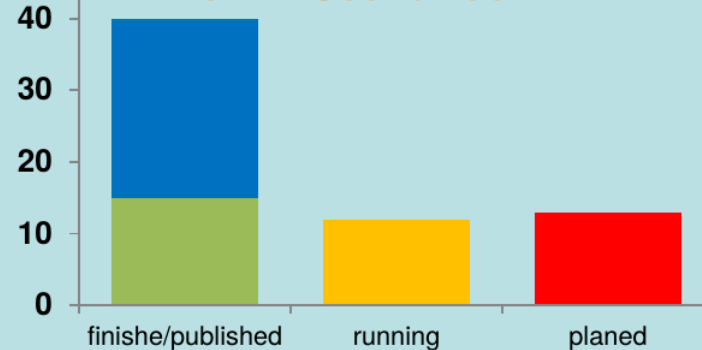
RCP8.5	CORDEX-AFRICA										sum				
	BCCR-greenWRF	CCCR-CanRCM4	CLMcom-CCLM4-8	CNRM-ALADIN	CSC-REMO	DMI-HIRHAM5	ICTP-RegCM4	KNMI-RACV02.2	MHC-GA3RCM	SMHI-RCA4		UCLM-PRONES	ULL-WRF311	UCAN-WRF34	UQAM-CRCM
CanESM2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	2
CNRM-CM5	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	2
NorESM1-M	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	1
EC-EARTH (r1)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	1
EC-EARTH (r3)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	1
EC-EARTH (r12)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	3
HadGEM2-ES	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	3
MIROC5	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	1
MPI-ESM-LR	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	4
GFDL-ESM2M	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	1
HADCM3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	1
sum	1	4	1	2	1	2	1	2	1	8					19

EURO-CORDEX

0.11° Scenarios



0.44° Scenarios



Plans for CORDEX 2

- Flexible resolution for standard domains
 - $dx = 12.5 \text{ km}$, 25 km, 50 km (higher for some regions?)
- CMIP6 (+ CMIP5?) driving GCMs
 - RCP8.5, RCP4.5, RCP2.6
- Flagship Pilot Studies
 - Proposals to be elicited from the regional communities
 - Procedure/criteria for endorsement of FPS to be designed
 - Consistent framework across FPSs
- Better integration of statistical downscaling
- ESGF framework for data storage and provision
- More emphasis on process-based model assessment and development
- **Third CORDEX Conference, Stockholm, 17-20 May 2016**

Emerging scientific challenges

- **Added value**

Internal variability & added value as functions of scale; Very high resolution modeling; Bias correction uncertainties and consistency

- **Human element**

Coupling of regional climate and urban development (e.g. coastal megacities); Land use change; Aerosol effects.

- **Coordination of regional coupled modelling**

Ocean-ice-atmosphere; Lakes; Dynamic land surface; Natural fires; Atmospheric chemistry; Carbon cycle; Aerosols; Marine biogeochemistry

- **Precipitation**

Extremes; Convective systems; Coastal storm systems; MJO/Monsoon

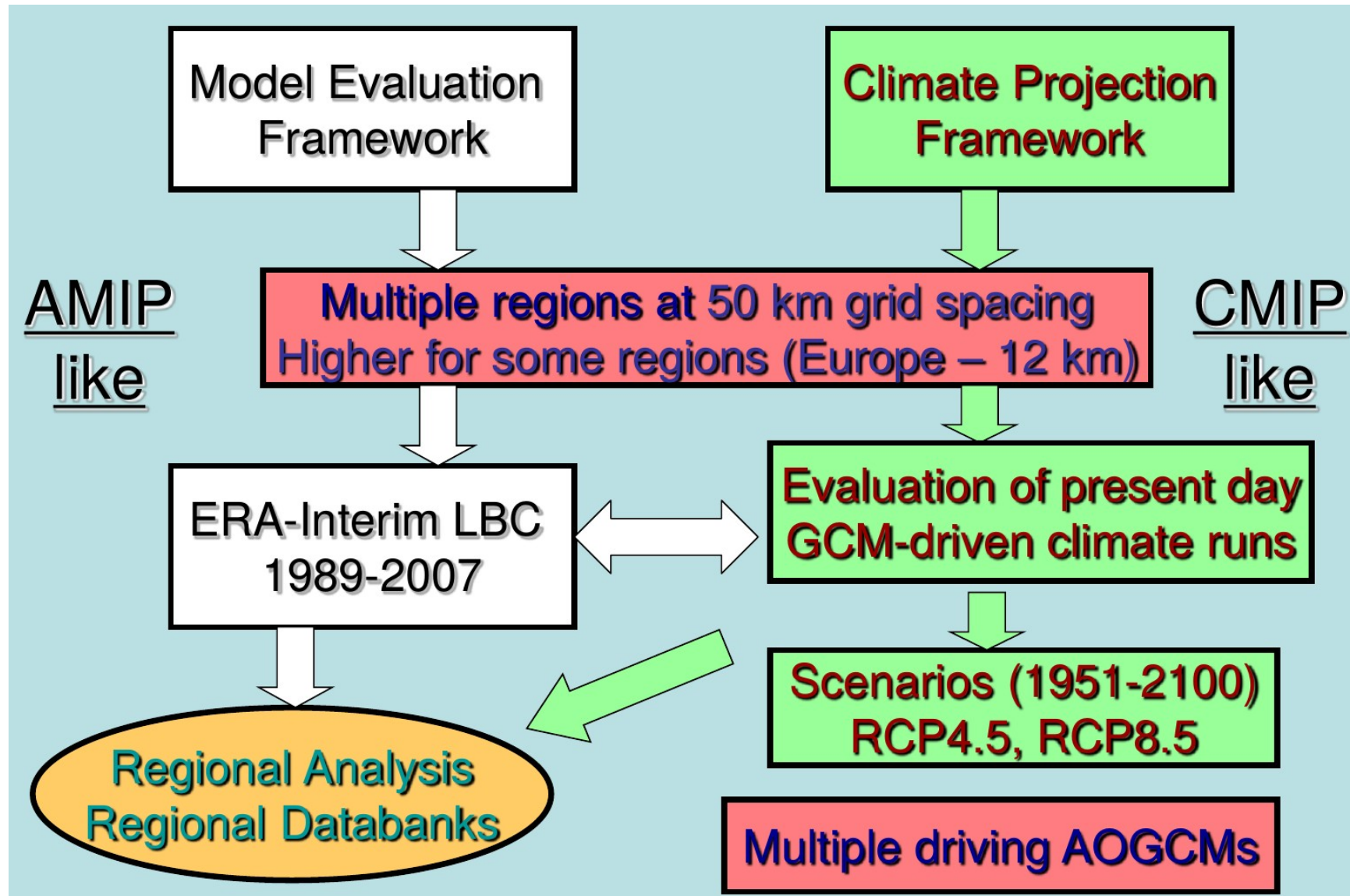
- **Local wind systems**

Wind storms; Strong regional winds; Wind energy

Some CORDEX history

- Initial discussions across the downscaling community (mostly RCM), Toulouse 2009
- Establishment by the WCRP of the Task Force on Regional Climate Downscaling, TFRCD (2010)
- Design of Phase I CORDEX framework (Giorgi et al. 2009; Jones et al. 2011) and first CORDEX Conference (Trieste 2011)
- Establishment by the WCRP of the Science Advisory Team, SAT (2012)
- Second PAN-CORDEX conference ICRC-CORDEX 2013, Brussels, 2013.
 - More than 400 abstracts presented, > 500 participants.
- Establishment by WCRP of the Working Group on Regional Climate, WGRC (2013).

CORDEX Phase I experiment design



EURO-CORDEX 2

European decadal variability and the regional forcing

Very high resolution

Investigating the uncertainty in European climate change information