Helmholtz-Zentrum Geesthacht
Centre for Materials and Coastal Research

GERICS
Climate Service Center Germany

How to calculate the extremes avoided in a future climate change scenario? (including CORDEX)

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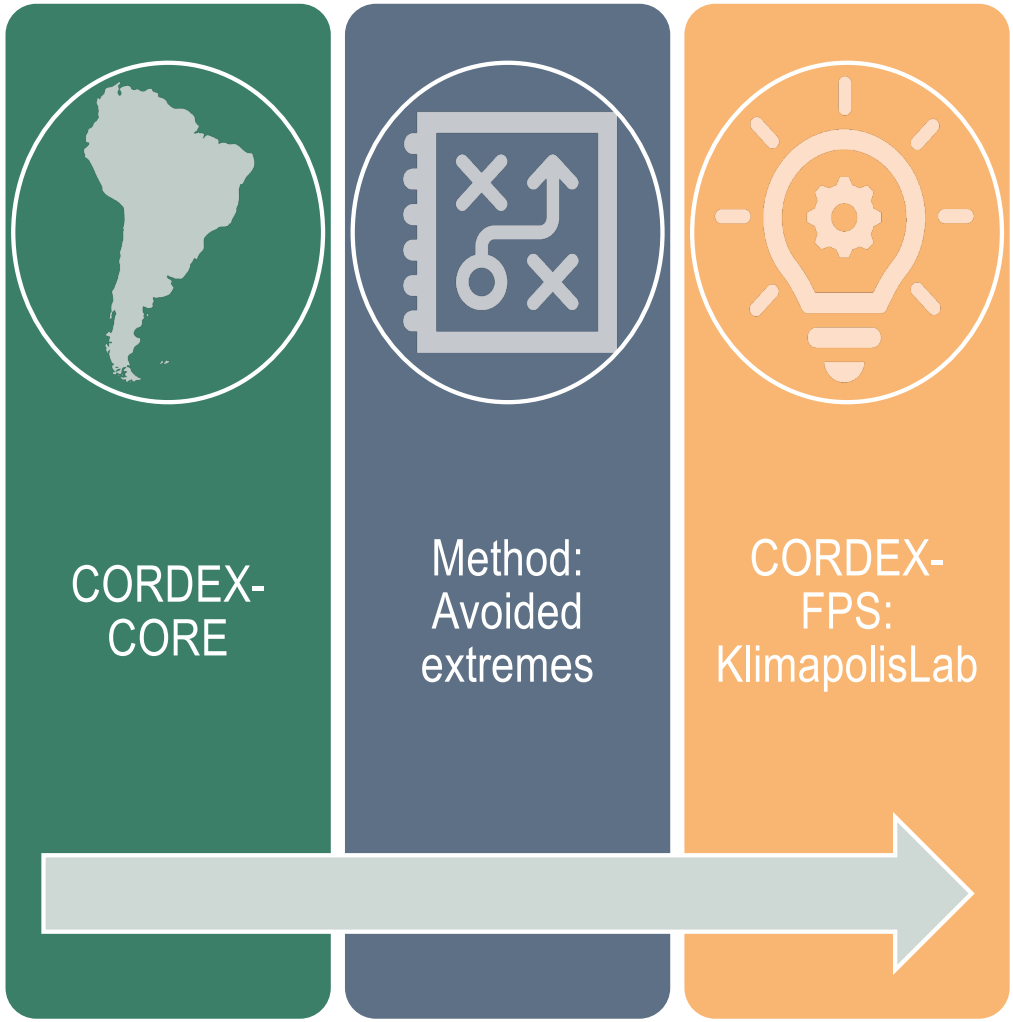
Third Klimapolis Workshop, IAG, Sao Paulo, Brazil

22 May 2019

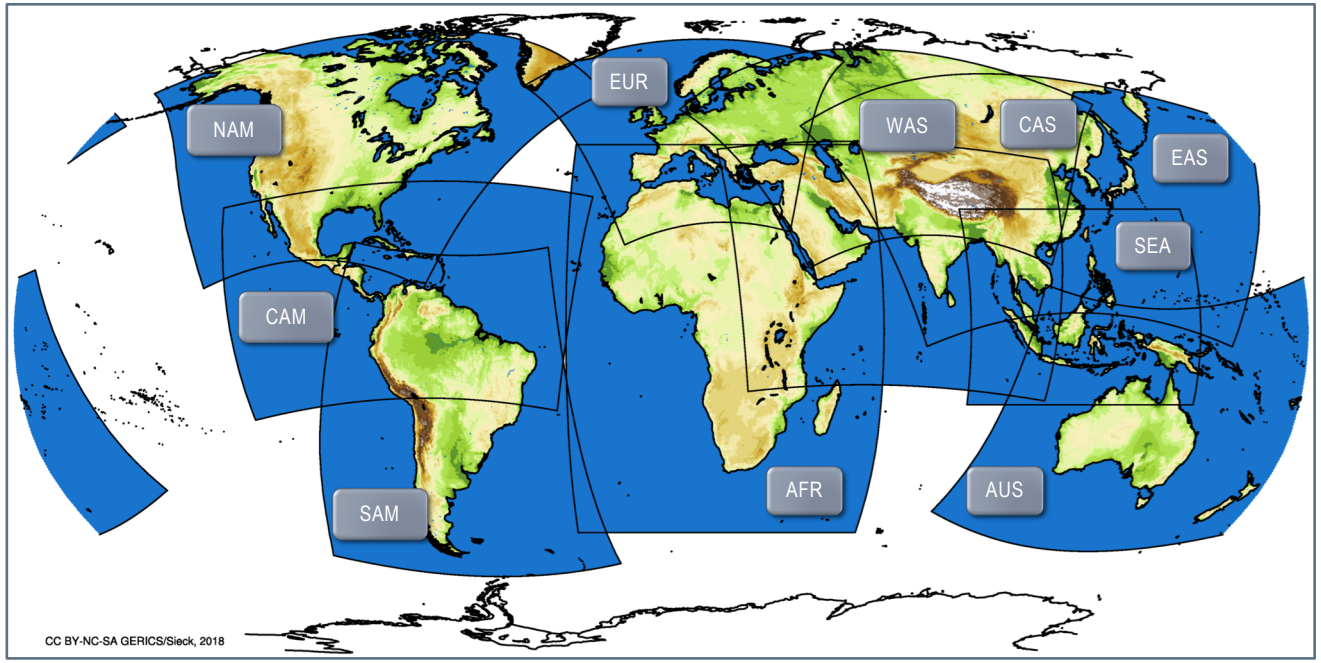
Outline

- Adding to the available pool of regional climate model simulations (RegCM and ETA)
- Calculating the extremes avoided in a future climate change scenario (e.g. 1.5 °C)
- Adding to the pool of ideas on possible Klimapolis participation to the CORDEX-FPS



CORDEX-CORE

- The WCRP CORDEX Coordinated Output for Regional Evaluation (CORDEX-CORE): a response to the IPCC needs for coordinated high resolution simulations (Gutowski et al., 2016)
- Models: REMO and RegCM
- Resolution of 0.22° (~25km) with at least 27 vertical layers
- Nine CORDEX-CORE domains including South America
- evaluation: ERA-Interim (1979-2010)
- historical (1971-2005) and rcp 2.6 and rcp 8.5 (2006-2100):
    - 3 GCMs: MPI-ESM, HadGEM, NorESM



- Climate data will be available by the end of Summer 2019!

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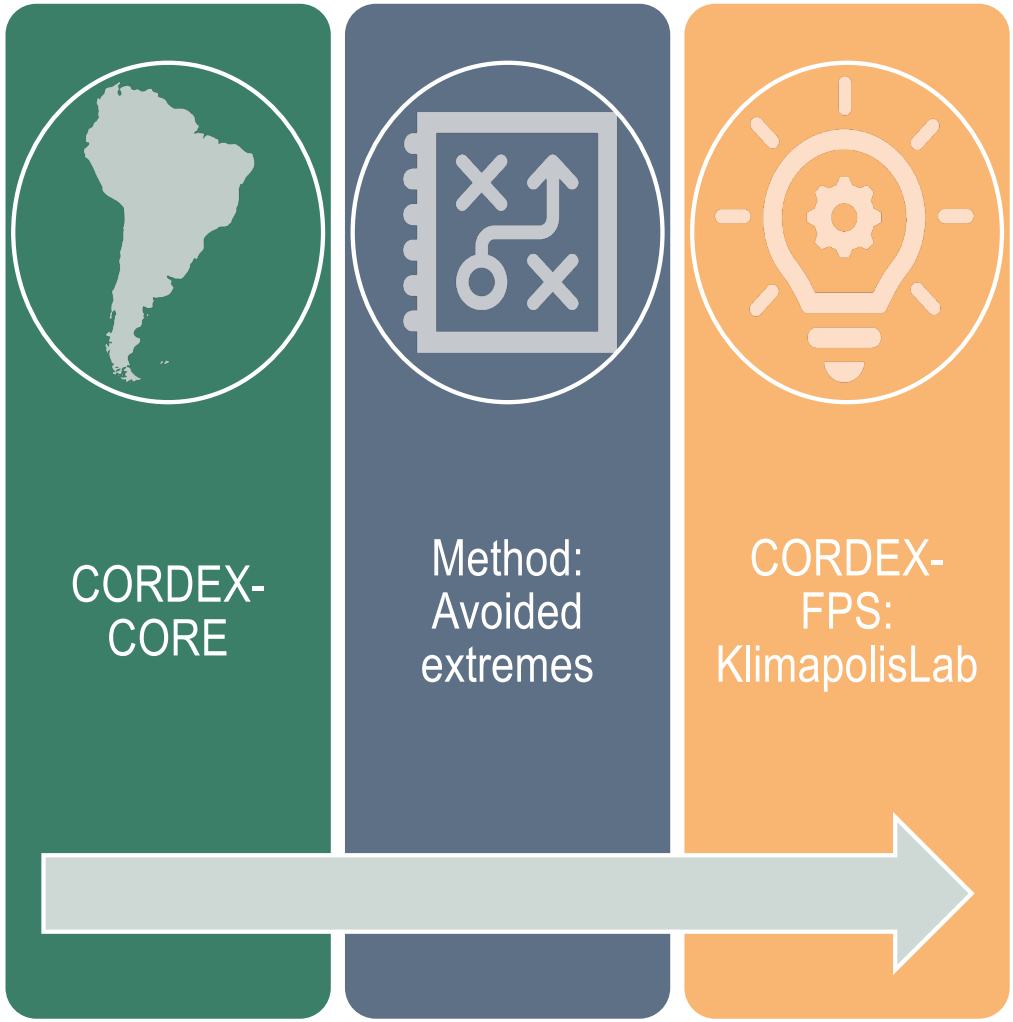


Method on avoided extremes

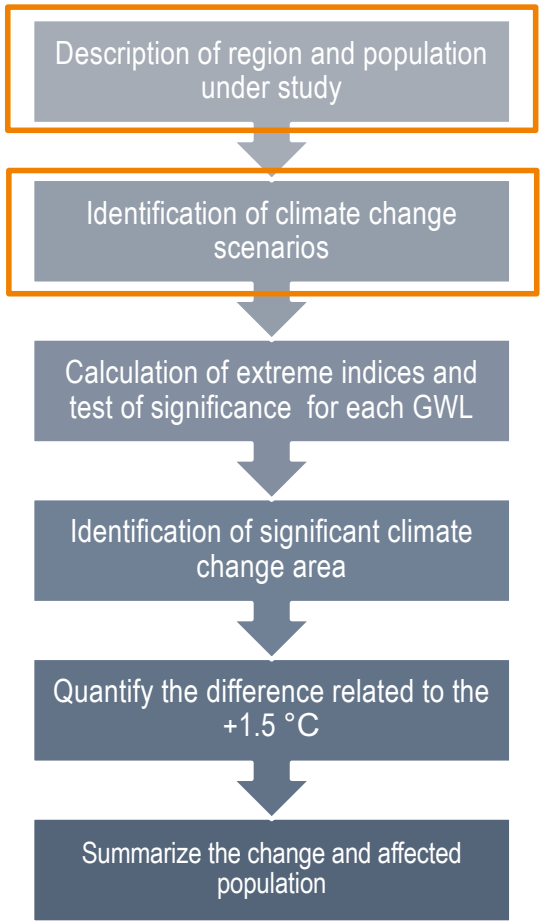
- Avoiding extremes: Benefits of Staying below +1.5 °C Compared to +2.0 °C and +3.0 °C Global Warming (Teichmann et al., 2018)
  - COP21 decision to limit global warming to +1.5 °C → what are the extremes under +2.0 °C and +3.0 °C related to the +1.5 °C and how much of the population will be affected in Europe

- Aim: Quantify the benefits of staying at 1.5°C global warming level compared to 2°C and 3°C global warming over Europe

- Indices calculated were:

Description	Abbreviation	Definition	Unit	Reference
Hot days	Hot days	Number of days with a maximum temperature Tmax > 30 °C	days/year	Adapted from ETCCDI
Tropical nights	Tnights	Number of nights with minimum temperature Tmin > 20 °C	days/year	ETCCDI
Number of dry days	Rlt1mm	Number of days with precipitation pr < 1 mm	days/year	Adapted from ETCCDI
Number of heavy precipitation days	R10mm	Number of days with precipitation pr > 10 mm	days/year	ETCCDI
99th percentile of precipitation	R99p	99th percentile of wet days per year (days with precipitation r ≥ 1 mm)	mm/day	ETCCDI

Steps for calculating the avoided extremes



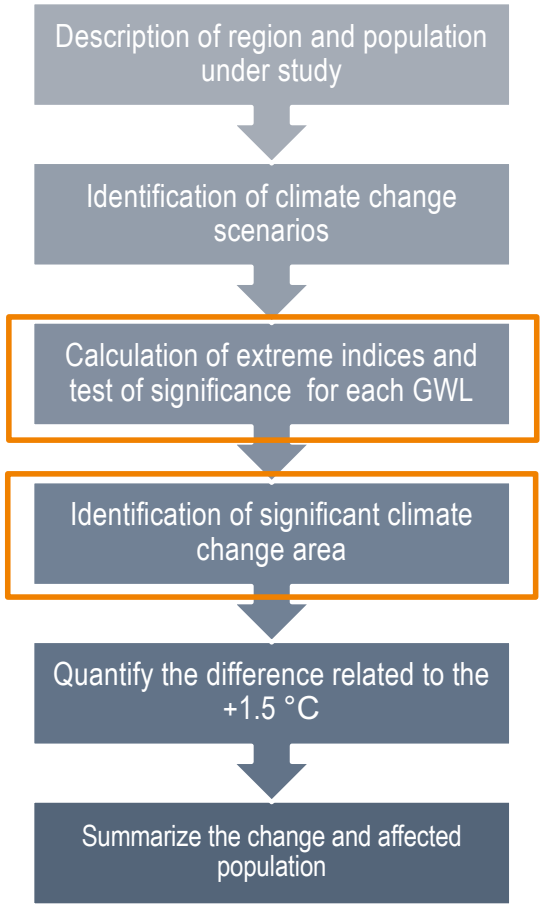
- EURO CORDEX Ensemble: 0.11 degree or about 12.5 km, focus on Alps (coordinated setup to eliminate domain uncertainty)
- Data basis:
  - E-OBS as reference
  - Fixed population density data for 2015 interpolated to EUR-11

- 30 year periods in which the driving GCM projects a +1.5 °C, +2 °C and +3 °C global warming level

Table 2. Regional climate model (RCM)-general circulation model (GCM) combinations (16 in total) of the simulations used in this study, and the 30-year period centers under which the GCM shows a global warming level (GWL) of +1.5 °C, +2.0 °C and +3.0 °C. RCP: representative concentration pathway.

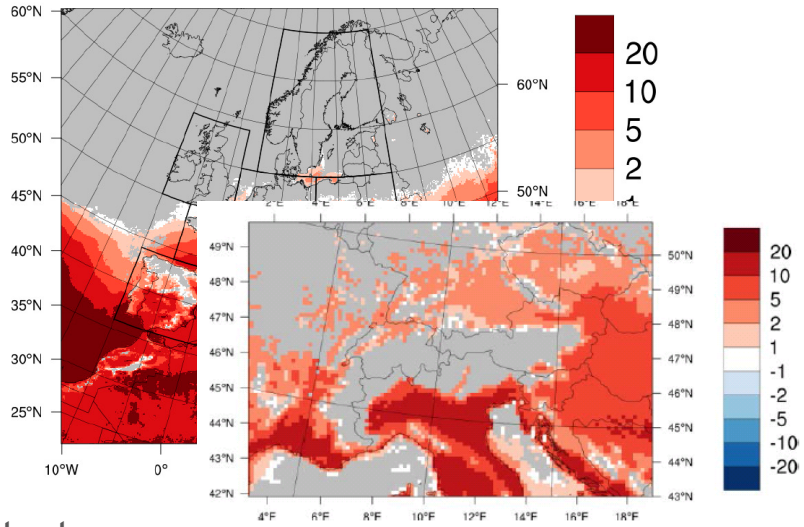
GCM, RCP, Realization	RCMs	+1.5 °C Period	+2.0 °C Period	+3.0 °C Period
CNRM-CM5, RCP8.5, r1i1p1	CCLM, RCA4	2015–2044	2030–2059	2053–2082
EC-EARTH, RCP8.5, r12i1p1	CCLM, RACMO, RCA4	2012–2041	2027–2056	2052–2081
IPSL-CM5A, RCP8.5, r1i1p1	WRF, RCA4	2008–2037	2021–2050	2040–2069
HadGEM2, RCP4.5, r1i1p1	CCLM, RACMO, RCA4	2007–2036	2023–2052	2055–2084
HadGEM2, RCP8.5, r1i1p1	CCLM, RACMO, RCA4	2006–2035	2016–2045	2037–2066
MPI-ESM, RCP8.5, r1i1p1	CCLM, REMO2009, RCA4	2014–2043	2030–2059	2053–2082

Steps for calculating the avoided extremes



- Climate change signal (CCS) for number of hot days per year

CCS under +1.5 ° C



- Significance test
  - Mann-Whitney-U test (90% confidence level)
  - Ensemble-CCS is significant if >66% of simulations show a significant CCS

Steps for calculating the avoided extremes

Description of region and population under study

↓

Identification of climate change scenarios

↓

Calculation of extreme indices and test of significance for each GWL

↓

Identification of significant climate change area

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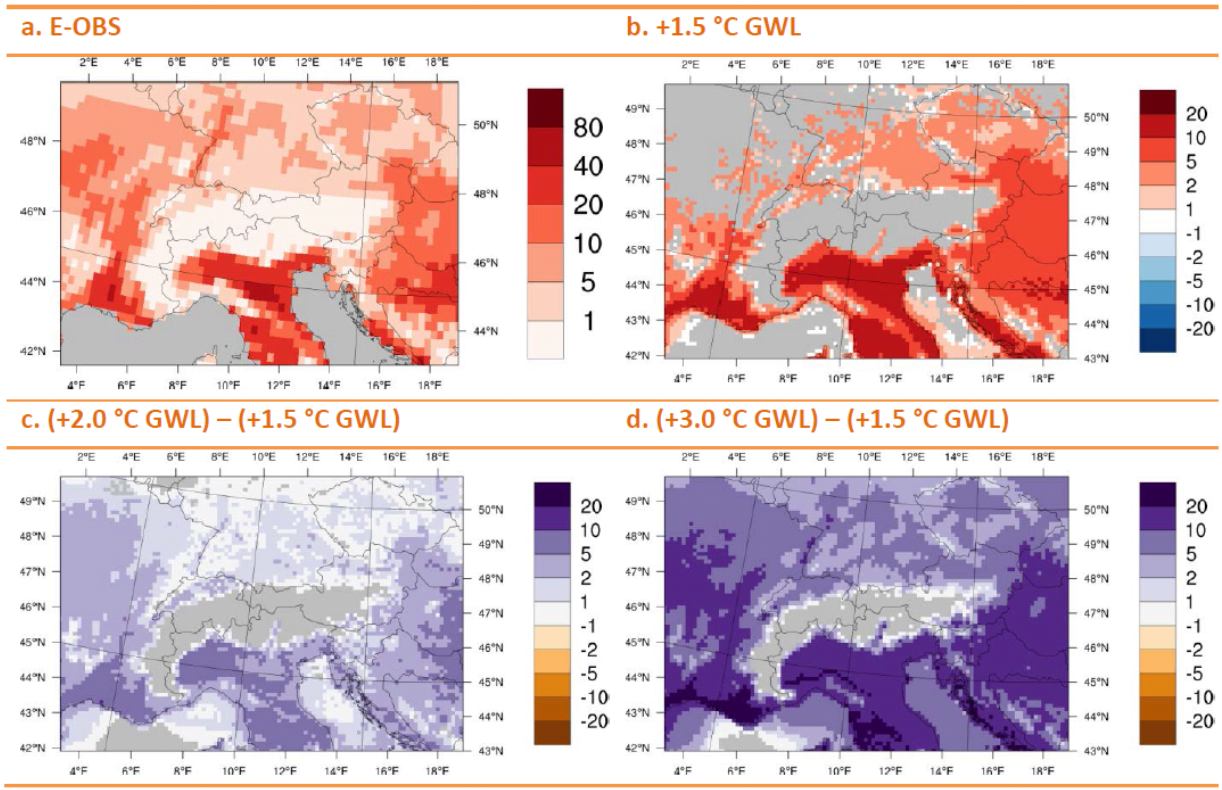
Quantify the difference related to the +1.5 °C

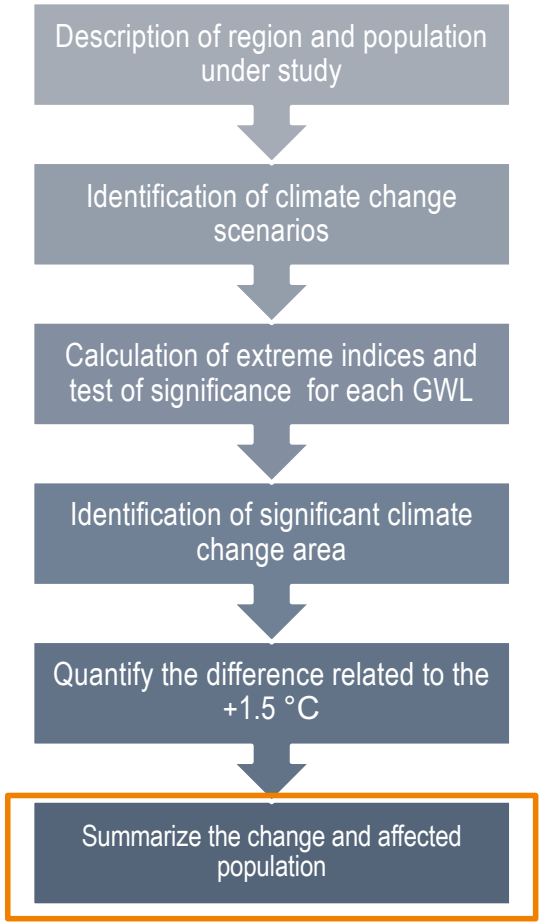
↓

Summarize the change and affected population

- Extreme index: hot days per year



Steps for calculating the avoided extremes



- Summary over the Alps

Index	Parameter	Alps		
		+1.5 °C	+2.0 °C	+3.0 °C
Hot days	E-OBS in CCS area	12.2	10.2	8.8
	CCS (ens min/max)	6.1 (1.1/13.7)	7.8 (1.8/23.0)	13.5 (4.6/31.2)
	pop/pop densly in %	81.7/90.7	91.3/97.6	95.6/98.6
	area in %	52.6	66.8	77.3

Summary

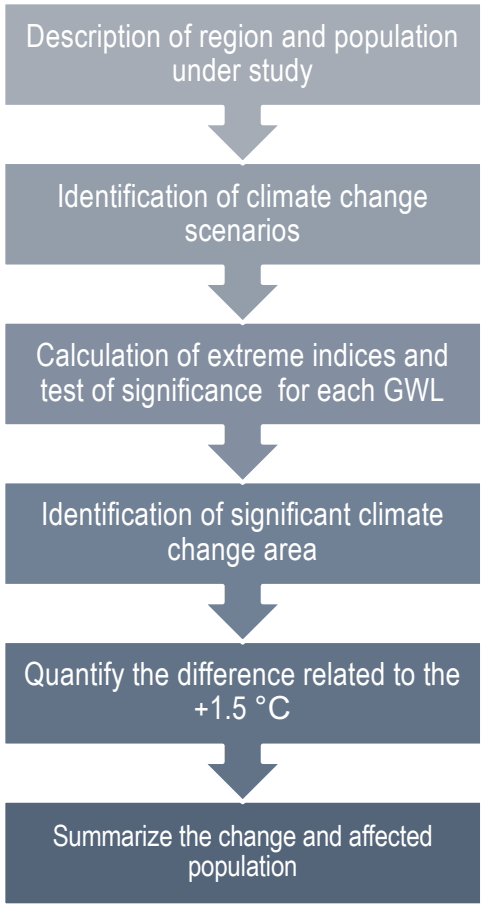
- In a +1.5 °C GWL, the number of dry days, heavy precipitation days, and extreme precipitation values have insignificant changes within the Alpine Region.

- Comparing the +2.0 °C GWL and +3.0 °C GWL to a +1.5 °C GWL, significant changes were found especially an increase in the number of heavy precipitation days and extreme precipitation values in a +3.0 °C GWL. These significant changes were found mainly in the western side of the Alpine region and the Mediterranean region.

- The significant changes of the number of dry days in a +3.0 °C GWL compared to a +1.5 °C GWL occurred mainly over southern France.

Index	Parameter	Alps		
		+1.5 °C	+2.0 °C	+3.0 °C
Hot days	E-OBS in CCS area CCS (ens min/max) pop/pop densly in % area in %	12.2 6.1 (1.1/13.7) 81.7/90.7 52.6	10.2 7.8 (1.8/23.0) 91.3/97.6 66.8	8.8 13.5 (4.6/31.2) 95.6/98.6 77.3
Tnights	E-OBS in CCS area CCS (ens min/max) pop/pop densly in % area in %	5.9 10.3 (2.6/19.5) 69.1/80.1 43.7	4.7 13.0 (3.5/28.2) 80.4/90.9 53.2	3.6 19.3 (6.9/37.5) 91.5/96.3 67.4
Rlt1mm	E-OBS in CCS area CCS (ens min/max) pop/pop densly in % area in %			257.5 10.1 (−1.1/19.5) 2.0/0.9 7.0
R10mm	E-OBS in CCS area CCS (ens min/max) pop/pop densly in % area in %		3.5 (−1.1/8.7) 0.9/0.0 1.4	31.0 4.0 (−0.7/10.6) 6.1/2.4 6.8
R99p	E-OBS in CCS area CCS (ens min/max) pop/pop densly in % area in %		39.4 5.9 (−0.9/13.4) 0.1/0.0 0.7	33.7 7.5 (0.9/17.9) 24.6/25.7 20.5

How we can apply the method (and if we would like/need to…)



- Overview of the simulations available:
  - coordinated activities
  - different institutions
  - different domains (global to regional to local scale)
  - different resolutions
  - different scenarios
- Select region of interest
- Select the relevant indices
  - Based on the 27 indices from ETCCDI
  - Develop own index

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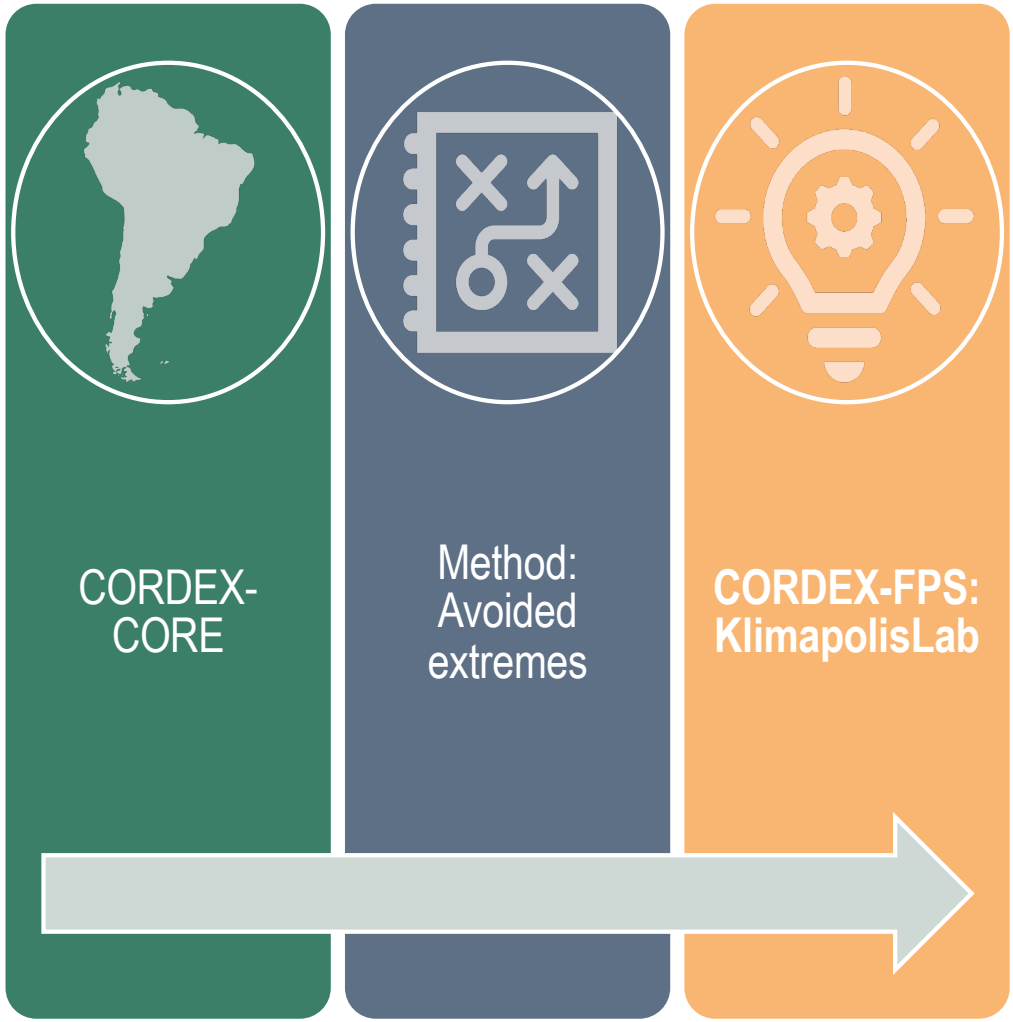

CORDEX-FPS Scientific Challenges

- 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;
- Better integration of Empirical-Statistical Downscaling (ESD) within the CORDEX framework;
- Moving towards very high resolution, convection permitting models;
- Development of coupled regional earth system models, in particular including the human component (e.g. urbanization, dams, pollution emissions, adaptation etc.)
- Assessment of the effects of regional forcing, such as land-use change and aerosols;
- Distillation of actionable information from multiple sources of downscaled projection information; and
- Better integration of CORDEX with other WCRP programs (e.g. GEWEX)

- http://www.cordex.org/experiment-guidelines/flagship-pilot-studies/

CORDEX-FPS focii

- The FPS will focus on sub-continental-scale targeted regions, so as to allow a number of capabilities towards addressing key scientific questions motivated by several issues:
  - Run RCMs at a broad range of resolutions, down to convection-permitting;
  - Promote side-by-side experimental design and evaluations of both statistical and dynamical downscaling techniques at scales more typical of VIA applications;
  - Design targeted experiments aimed at investigating specific regional processes and circulations;
  - Investigate the importance of regional scale forcings (aerosols, land-use change, vegetation etc);
  - Compile and use high quality, high resolution (both spatial and temporal), multi-variable observation datasets for model validation and analysis of processes;
  - Coordinate with specific activities in other WCRP projects, most notably the GEWEX regional hydroclimate projects;
  - Design end-to-end, climate-to-end-user, projects demonstrating the actionable value of downscaled climate change projections;
  - Increase the potential for funding by focusing on specific issues of interest for a certain region

CORDEX-FPS

- **How to submit a FPS proposal**
  - Review the full 'FPS Criteria & Guidelines' document carefully
  - Complete the FPS application template
  - Submit the completed application to the ipoc@cordex.org

- **Deadlines**
  - There will be 1 deadline per year for FPS proposals in February. The next deadline for applications will be **Thursday 1st February 2019 and the successful proposals from this round will be presented at the CORDEX web.**

- **Seven Endorsed FPS** (2 Mediterranean, 1 Europe, 1 Europe + Mediterranean, 1 South America, 2 Africa)
  - FPS on extreme precipitation: South America: Extreme precipitation events in Southeastern South America: a proposal for a better understanding and modeling
  - FPS LUCAS: Impact of land use changes on climate in Europe across spatial and temporal scales

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