Future projections of river floods hazard over the multiple CORDEX-CORE domains

F. Di Sante[1,2], E. Coppola[1], Francesca Raffaele[1], Filippo Giorgi[1], James Ciarlo[1,2], Gao Xuejie[3], Taleena Rae Sines[1], Abraham Torres[1], Sushant Das[1], Emanuela Pichelli[1], Russel Glazer[1], Moetasim Ashfaq[4], Melissa Bukovsky[5], E-S Im[6], Daniela Jacob[7], Claas Teichman[7], Armelle Remedio[7]

[1]Earth System Physics Section, The Abdus Salam International Centre for Theoretical Physics, Trieste, Italy,
[2]Istituto Nazionale di Oceanografia e di Geofisica Sperimentale (OGS), Trieste, Italy
[3]Institute of Atmospheric Physics, Chinese Academy of Sciences (IAP/CAS)
[4]Oak Ridge National Laboratory, Oak Ridge, USA
[5]National Center for Atmospheric Research, Boulder, CO, United States
[6]The Hong Kong University of Science and Technology
[7]Climate Service Center Germany (GERICS), Helmholtz-Zentrum Geesthacht, Fischertwiete 1, 20095 Hamburg, Germany

GERICS
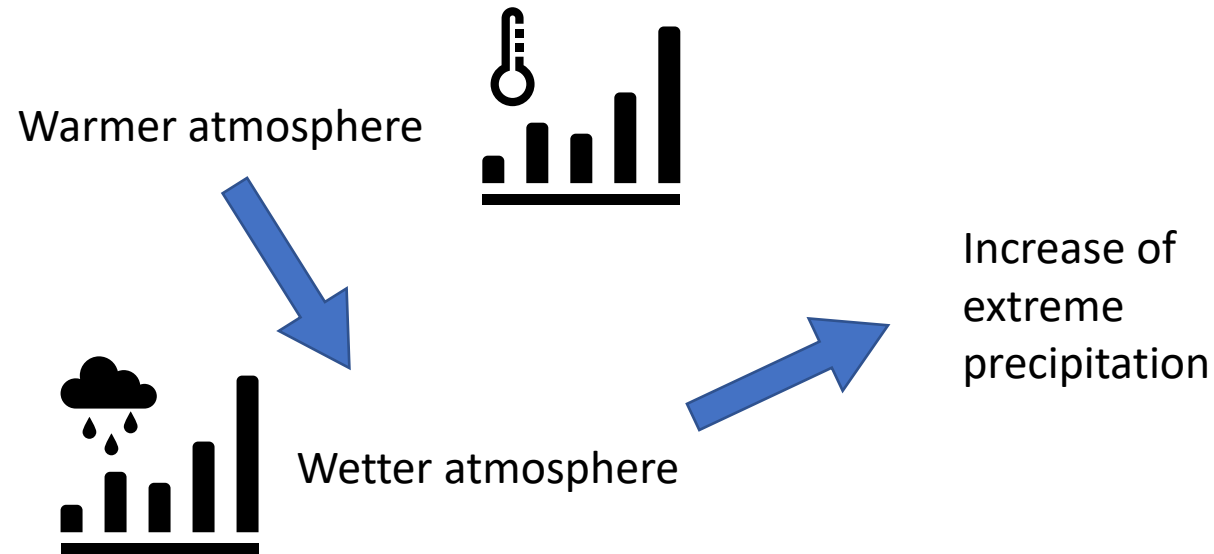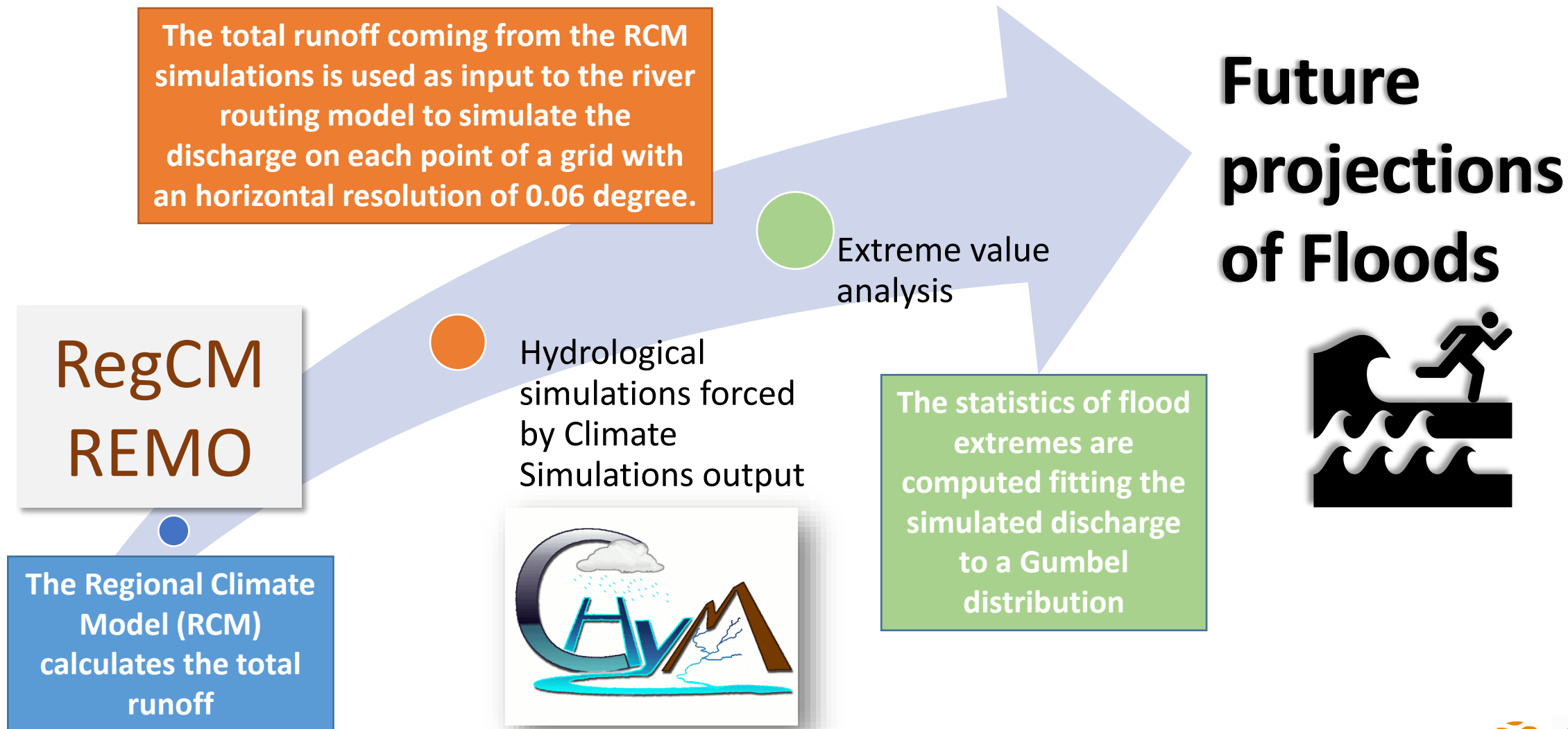Climate Service Center
Germany

OGS

ICTP

Introduction

The future projections of fatalities associated with river floods show an increase of 54% by the end of this century (Forzieri et al. 2017).
The aim of this work is to evaluate the impact of the climate change on the risk of floods hazard using the output of the CORDEX-CORE simulations.
Preliminary results are shown.

Warmer atmosphere

Wetter atmosphere

Increase of extreme precipitation

The total runoff coming from the RCM simulations is used as input to the river routing model to simulate the discharge on each point of a grid with an horizontal resolution of 0.06 degree.

Extreme value analysis

Future projections of Floods

RegCM REMO

Hydrological simulations forced by Climate Simulations output

The statistics of flood extremes are computed fitting the simulated discharge to a Gumbel distribution

The Regional Climate Model (RCM) calculates the total runoff

GERICS Climate Service Center Germany   OGS   ICTP

Methods

Domains (resolution deg)	RCM model	Driving GCM	Scenarios
Africa (0.22) South Asia (0.22) Central America (0.22) Southeast Asia (0.22) South America (0.22) East Asia (0.22) Europe (0.11) North America (0.22) Australia (0.22) Central Asia (0.22)	GERICS-REMO2015	MOCH-HadGEM2-ES MPI-M-MPI-ESM-LR NCC-NorESM1-M	rcp26 rcp85
	ICTP-RegCM4-7	MOCH-HadGEM2-ES MPI-M-MPI-ESM-LR NCC-NorESM1-M MIROC-MIROC5 NOAA-GFDL-GFDL-ESM2M	

The CORDEX CORE program gives highest priority to these GCMs: NorESM (low temperature sensitivity for RCP 2.6), MPI-ESM (medium sensitivity), HADGEM2ES (high sensitivity)

- **The water is routed following the drainage network extracted by an algorithm implemented in the code.**
- **The river routing model is run for 98 different simulations continuously for 130 years (1970-2100).**
- **In the following analysis three periods are considered:**

    1985-2014 (ref)
    2036-2065 (mid)
    2070-2099 (far)

- **We selected the return time period of 100 years as an indicator of flood hazard (Q100)**

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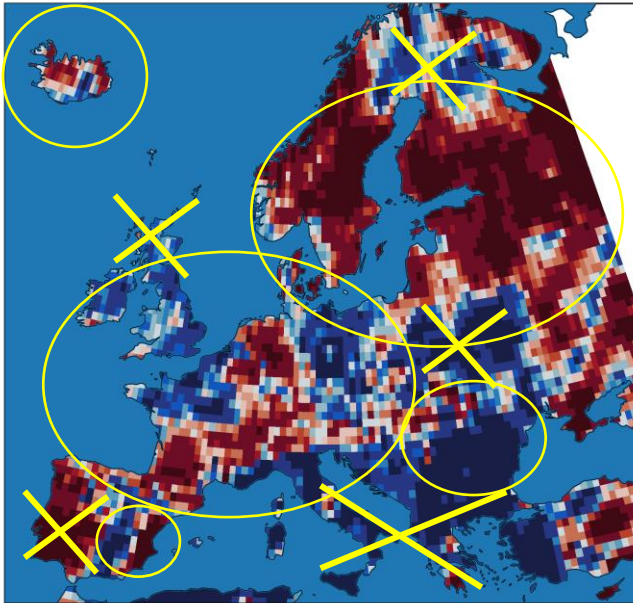
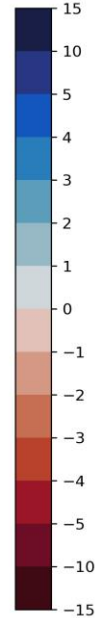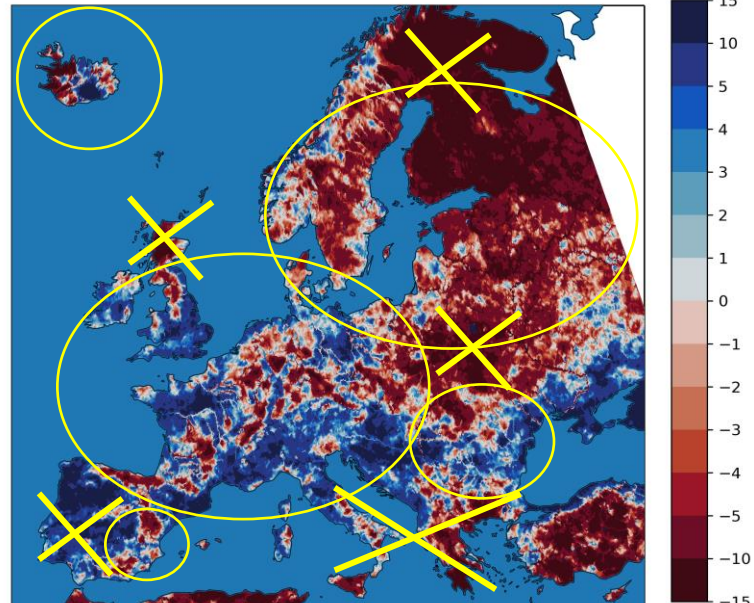# Drained area and simulated domains

European domain (validation of the trend)

GRUN (OBS)

CORDEX (MODEL)

1

Observed and simulated trend for the 1985-2014 period.
The circles indicates where the model is in agreement with the observation, the opposite is true for the crosses

2

To notice that the observed differences do not necessarily mean that the models are wrong.
The trend in some areas can be linked to natural variability and hence the signal is not present in the driving GCM…

Q100 EUR change
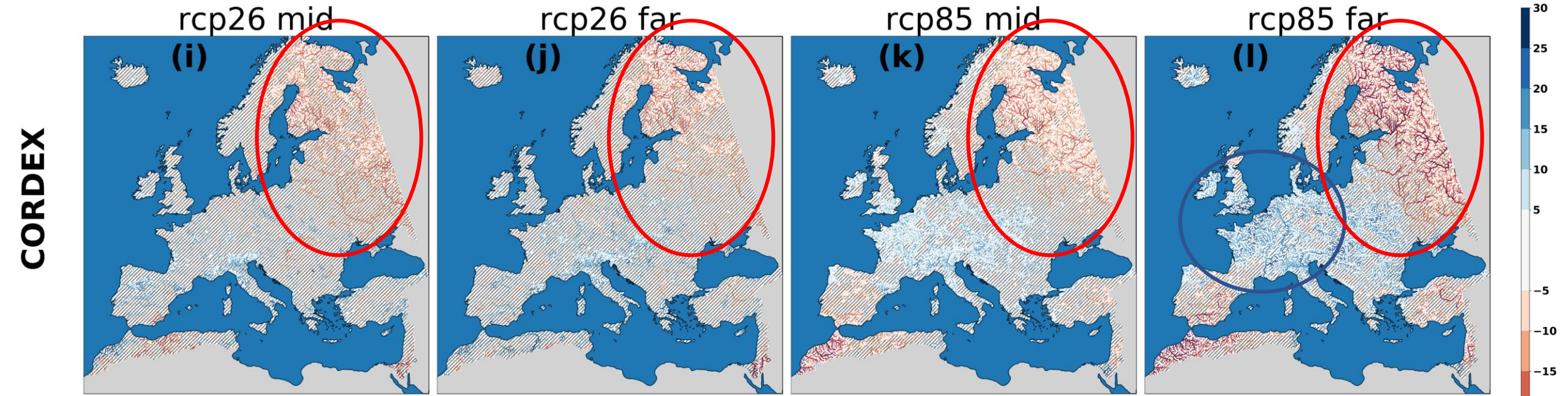
Q100 change for two scenarios (rcp26 and rcp85), two periods (mid and far) and for an ensemble of 44 CORDEX simulations (differently from the other domains, for the European domain are considered 44 CORDEX simulations. More at https://doi.org/10.5194/egusphere-egu2020-15847).
We hatched the areas where the values are not significant at 0.05 level.

- Increase of flood risk over central Europe and British islands by the end of this century (blue circle)

- Decrease of flood risk over the north east Europe (red circle)

Q100 NAM change
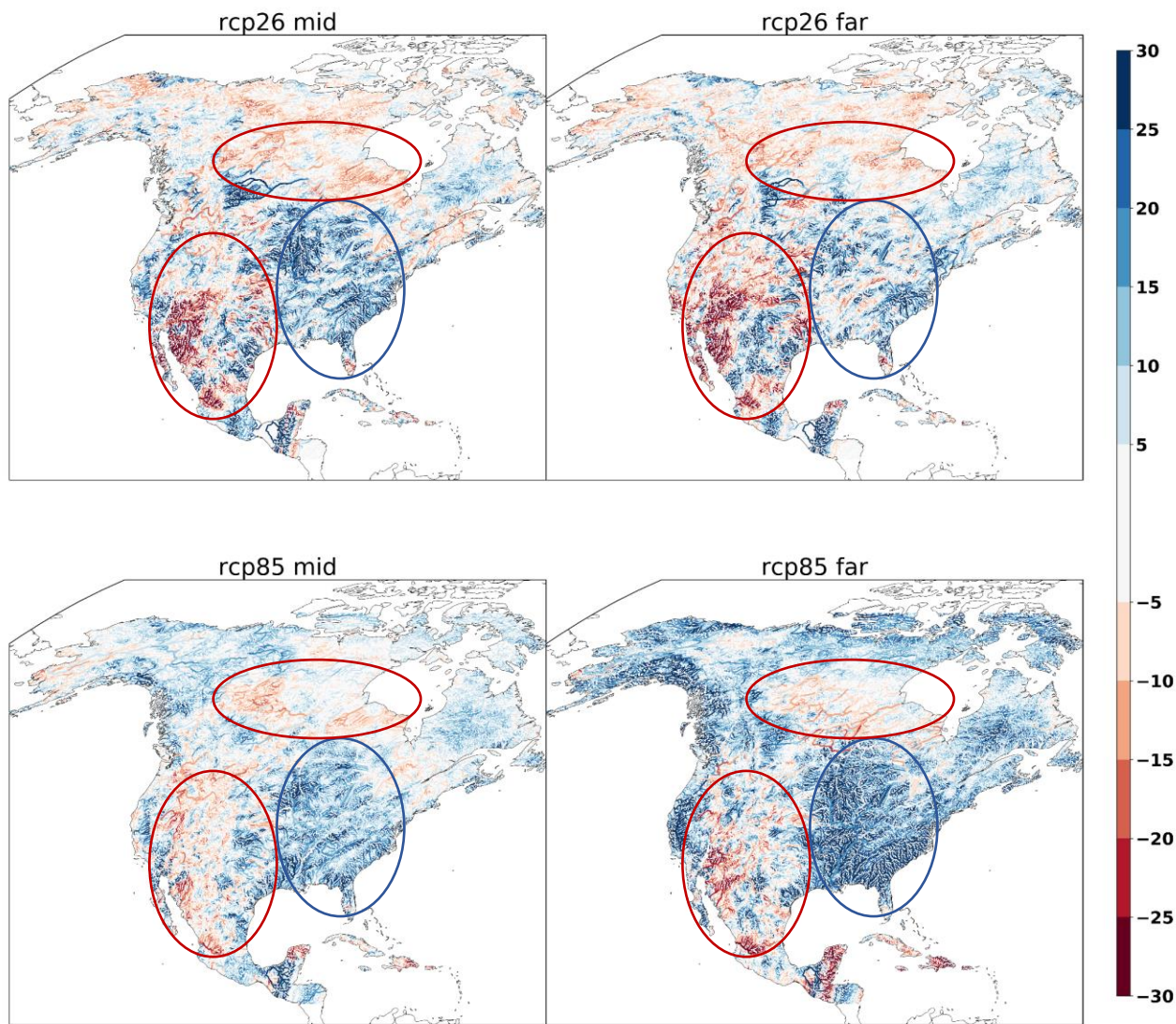
rcp26 mid   rcp26 far
rcp85 mid   rcp85 far

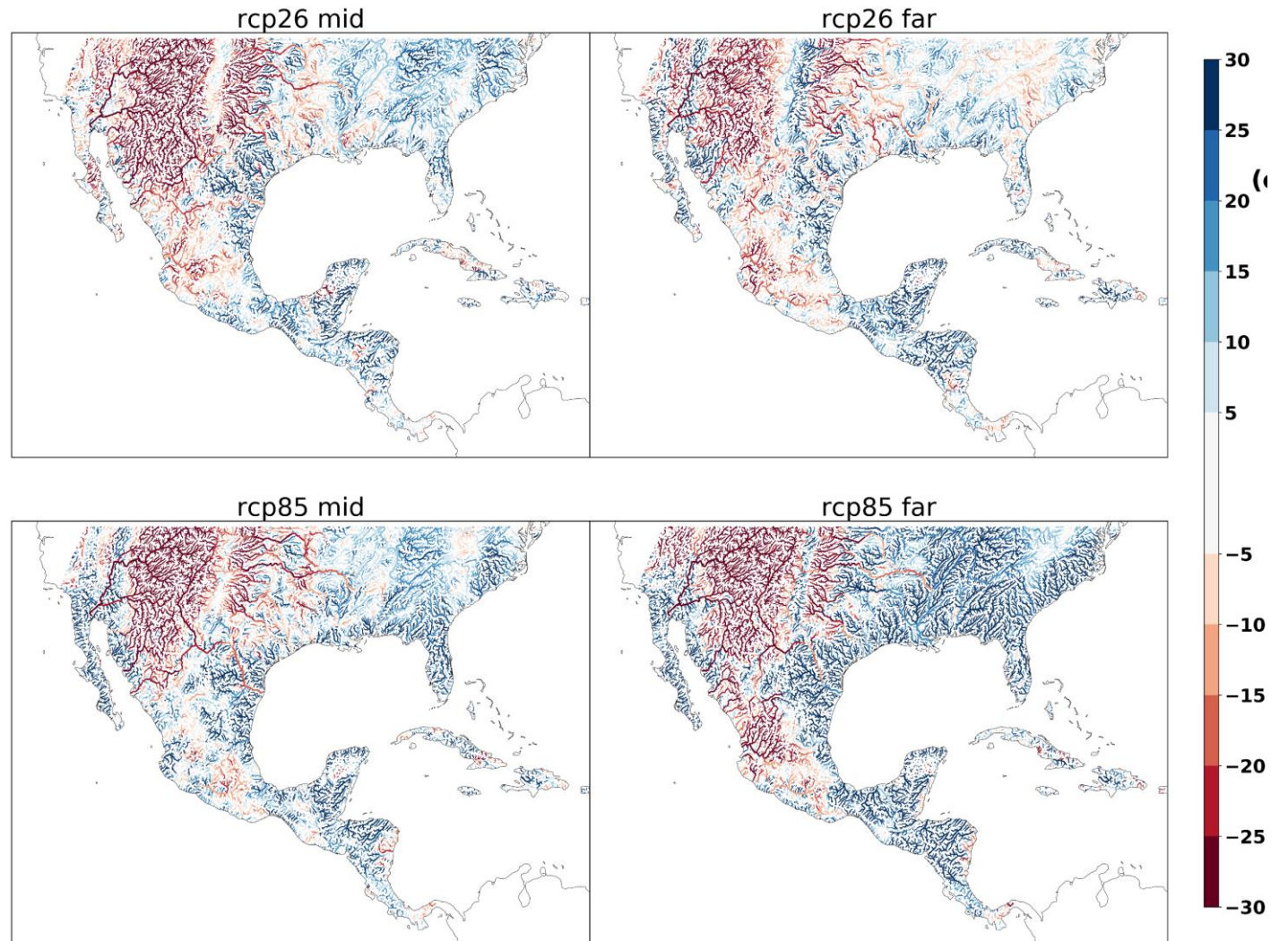| CORDEX-CORE	Driving GCM	Projection
GERICS-REMO2015	MOCH-HadGEM2-ES MPI-M-MPI-ESM-LR NCC-NorESM1-M	rcp26 rcp85
ICTP-RegCM4-7	MOCH-HadGEM2-ES MPI-M-MPI-ESM-MR NOAA-GFDL-GFDL-ESM2M	rcp85

In both scenarios can be recognized 2 areas where the signal of change related to flood is neat.
An increase of risk of flooding can be observed over the central and west part of the United States (blue circles) more pronounced during the rcp85 far period.
A decrease of risk of flooding can be instead observed over the south east part of the domain and Canada.
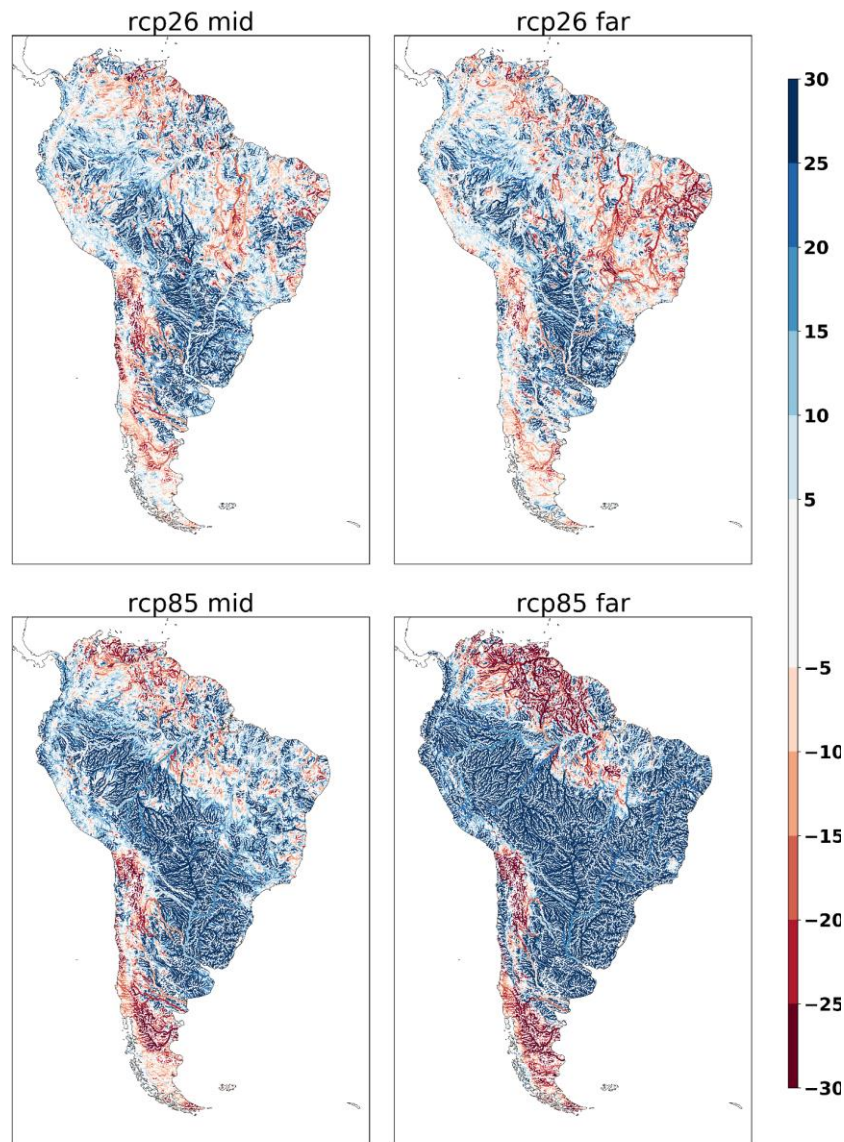
Q100 CAM change

CORDEX-CORE	Driving GCM	Projection
GERICS-REMO2015	MOCH-HadGEM2-ES MPI-M-MPI-ESM-LR NCC-NorESM1-M	rcp26 rcp85
ICTP-RegCM4-7	MOCH-HadGEM2-ES MPI-M-MPI-ESM-MR NOAA-GFDL-GFDL-ESM2M	rcp26 rcp85

- Increase of floods risk over the regions bordering the Gulf of Mexico

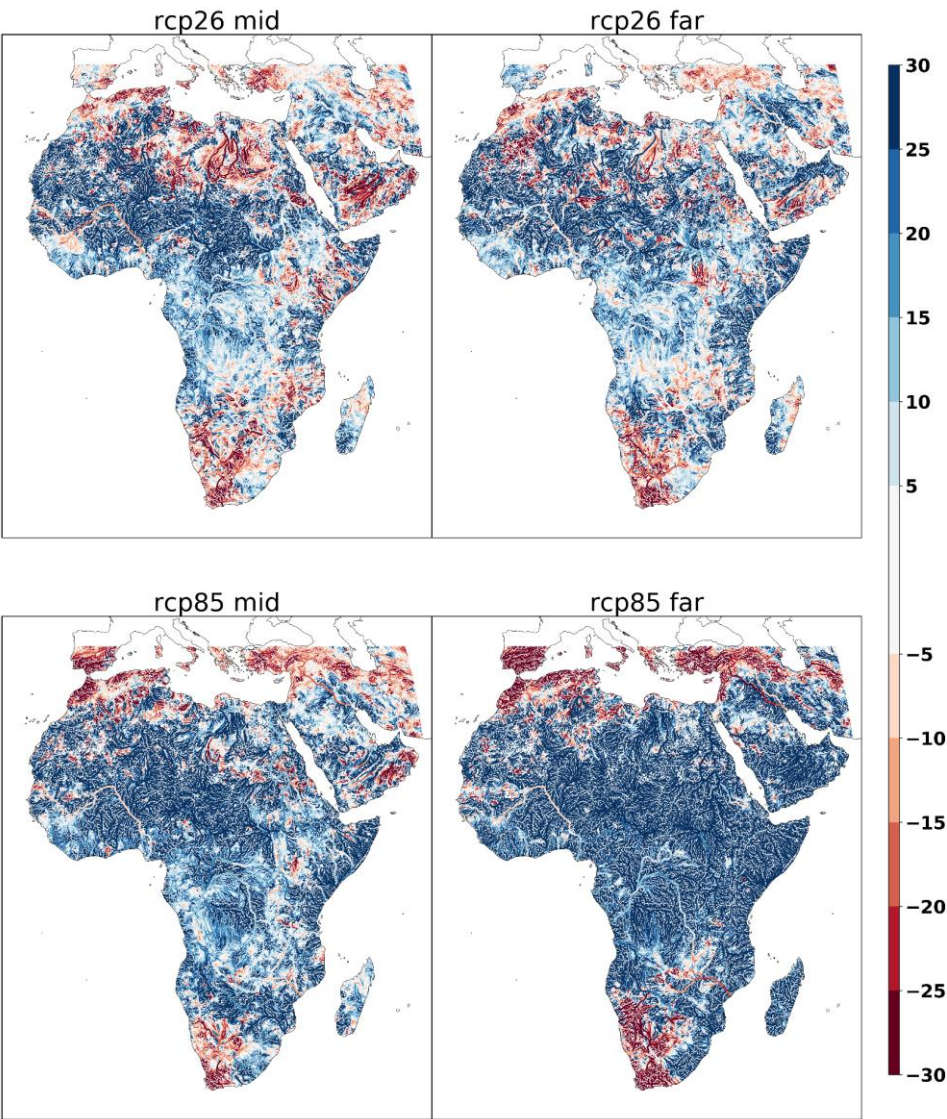- Decrease over Sierra Madre occidental and Rocky Mountains

Q100 SAM change

CORDEX-CORE	Driving GCM	Projection
GERICS-REMO2015	MOCH-HadGEM2-ES MPI-M-MPI-ESM-LR NCC-NorESM1-M	rcp26 rcp85
ICTP-RegCM4-7	MOCH-HadGEM2-ES MPI-M-MPI-ESM-LR NCC-NorESM1-M	rcp26 rcp85

Q100 AFR change

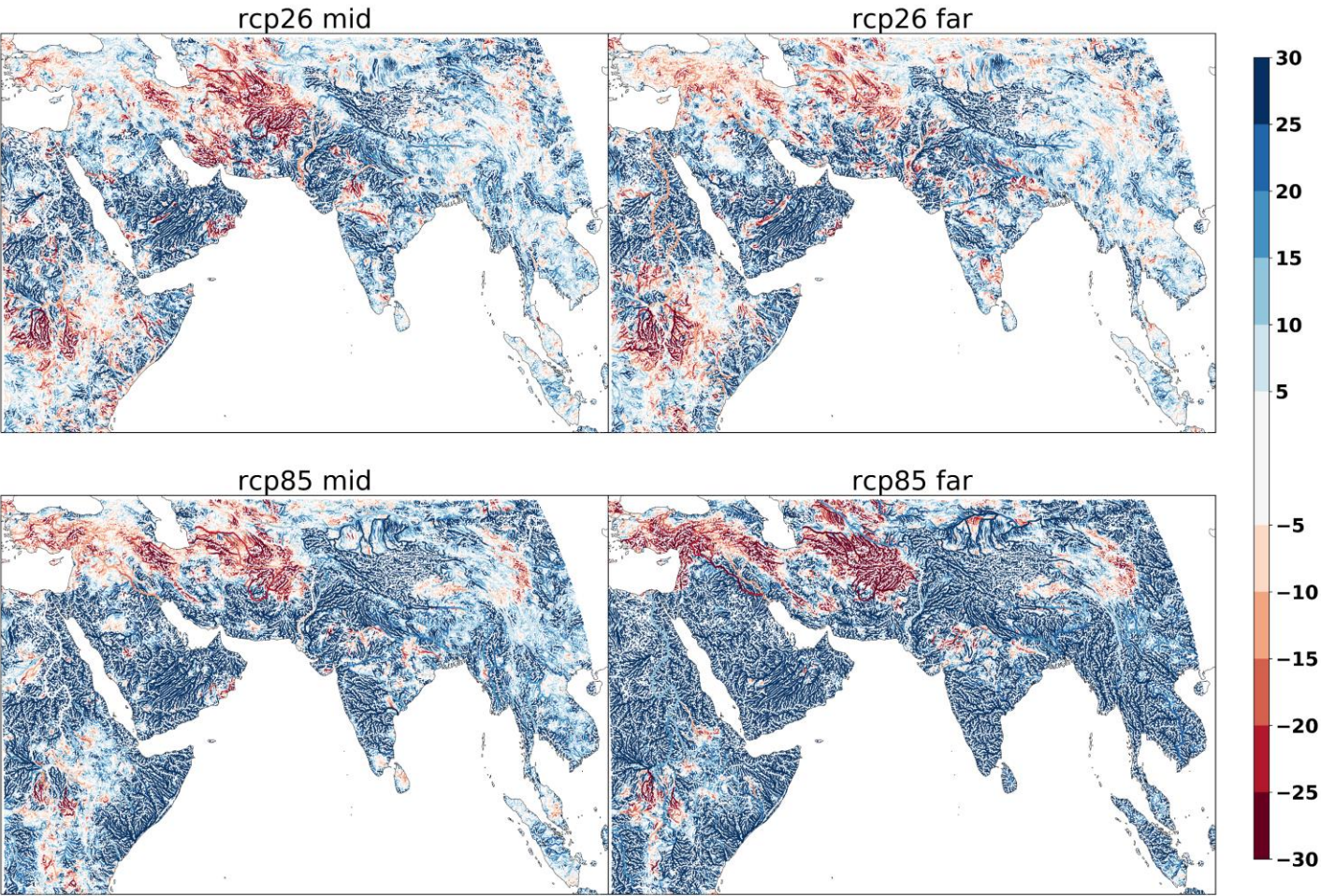| CORDEX-CORE	Driving GCM	Projection
GERICS-REMO2015	MOCH-HadGEM2-ES MPI-M-MPI-ESM-LR NCC-NorESM1-M	rcp26 rcp85
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Q100 WAS change

CORDEX-CORE	Driving GCM	Projection
GERICS-REMO2015	MOCH-HadGEM2-ES MPI-M-MPI-ESM-LR NCC-NorESM1-M	rcp26 rcp85
ICTP-RegCM4-7	MIROC-MIROC5 MPI-M-MPI-ESM-LR NCC-NorESM1-M	rcp26 rcp85

Q100 EAS change

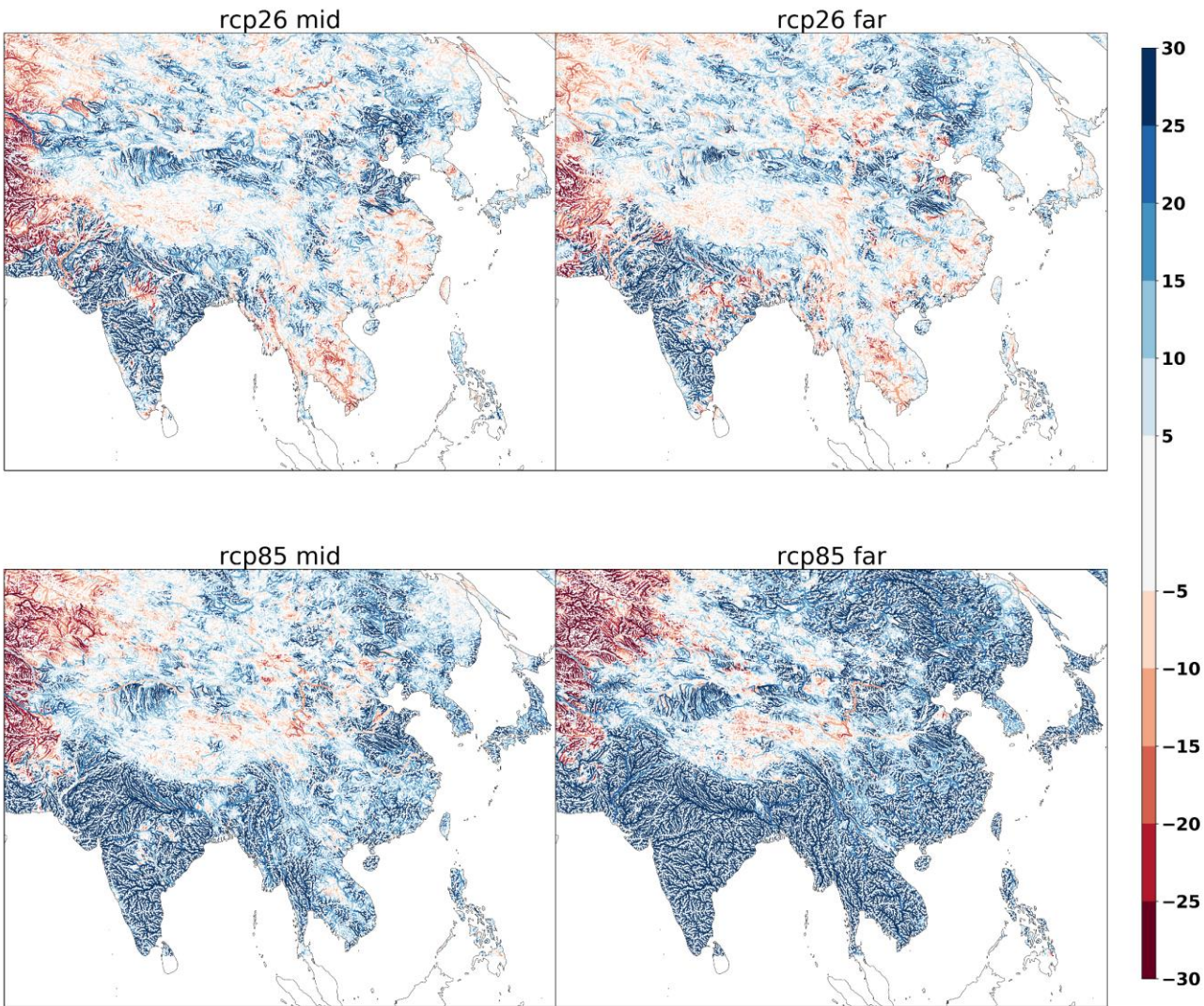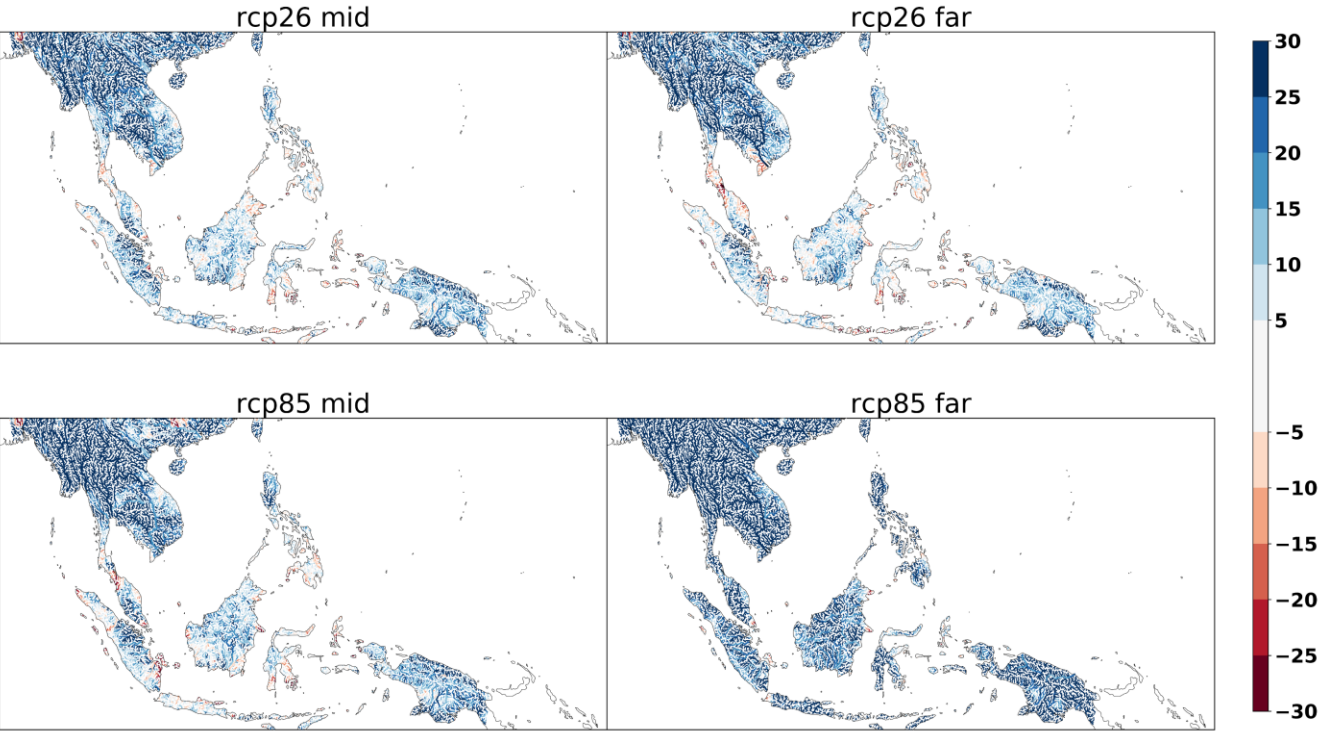| CORDEX-CORE	Driving GCM	Projection
GERICS-REMO2015	MOCH-HadGEM2-ES MPI-M-MPI-ESM-LR NCC-NorESM1-M	rcp26 rcp85
ICTP-RegCM4-7	MOCH-HadGEM2-ES MPI-M-MPI-ESM-LR NCC-NorESM1-M	rcp26 rcp85

Q100 SEA change

rcp26 mid

rcp26 far

rcp85 mid

rcp85 far

CORDEX-CORE	Driving GCM	Projection
GERICS-REMO2015	MOCH-HadGEM2-ES MPI-M-MPI-ESM-LR NCC-NorESM1-M	rcp26 rcp85
ICTP-RegCM4-7	MOCH-HadGEM2-ES MPI-M-MPI-ESM-LR NCC-NorESM1-M	rcp26 rcp85

Q100 AUS change

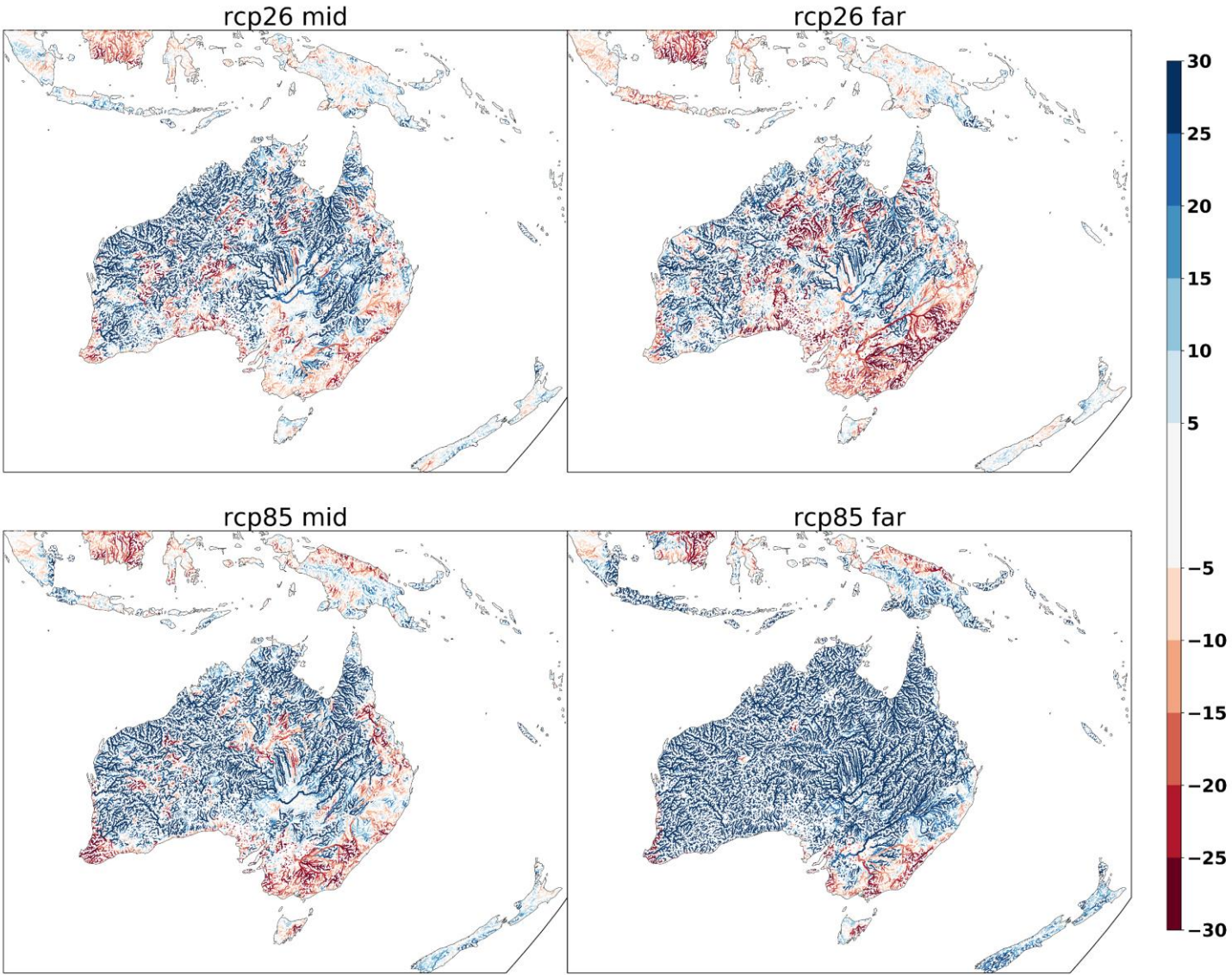| CORDEX-CORE	Driving GCM	Projection
GERICS-REMO2015	MOCH-HadGEM2-ES MPI-M-MPI-ESM-LR NCC-NorESM1-M	rcp26 rcp85
ICTP-RegCM4-7	MOCH-HadGEM2-ES MPI-M-MPI-ESM-LR NCC-NorESM1-M	rcp26 rcp85

"Conclusions"

1) The global warming could have an important role on the hydrological cycle. The increase of temperature and related increase of extreme precipitation phenomena could spur to an increase of disastrous floods

2) An increase in risk of floods can be observed in general over the Tropical regions, central Europe, British Islands, Australia, Japan, China, Korean peninsula, north Argentina and central-west of North America

3) On the other hand a decrease of floods hazard can be observed over the north-east Europe, Rocky Mountains, Sierra Madre Occidental, south-east Australia, Mediterranean region, south-west Africa, Afghanistan, Turkmenistan, north Iran

4) The method has been validated over Europe (an example in this PPT but a more deep analysis in https://doi.org/10.5194/egusphere-egu2020-15847) but still need to be validated over the other domains

5) A statistical test to assess the robustness of the signal is needed for all the domains

6) The causes of the projected changes observed in this study are not completely understood yet but for some hypothesis related to the European domain refer to https://doi.org/10.5194/egusphere-egu2020-15847

References

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Gutowski JW, Giorgi F, Timbal B, Frigon A, Jacob D, Kang HS, Raghavan K, Lee B, Lennard C, Nikulin G, O'Rourke E, Rixen M, Solman S, Stephenson T, Tangang F (2016) WCRP COordinated Regional Downscaling EXperiment (CORDEX): A diagnostic MIP for CMIP6. Geoscientic Model Development 9(11):4087{4095, DOI 10.5194/gmd-9-4087-2016