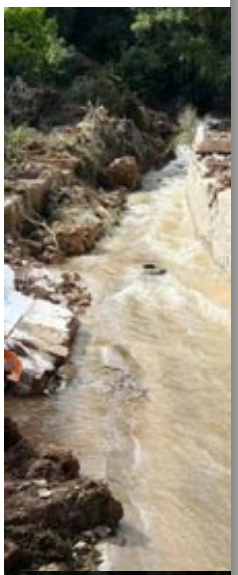


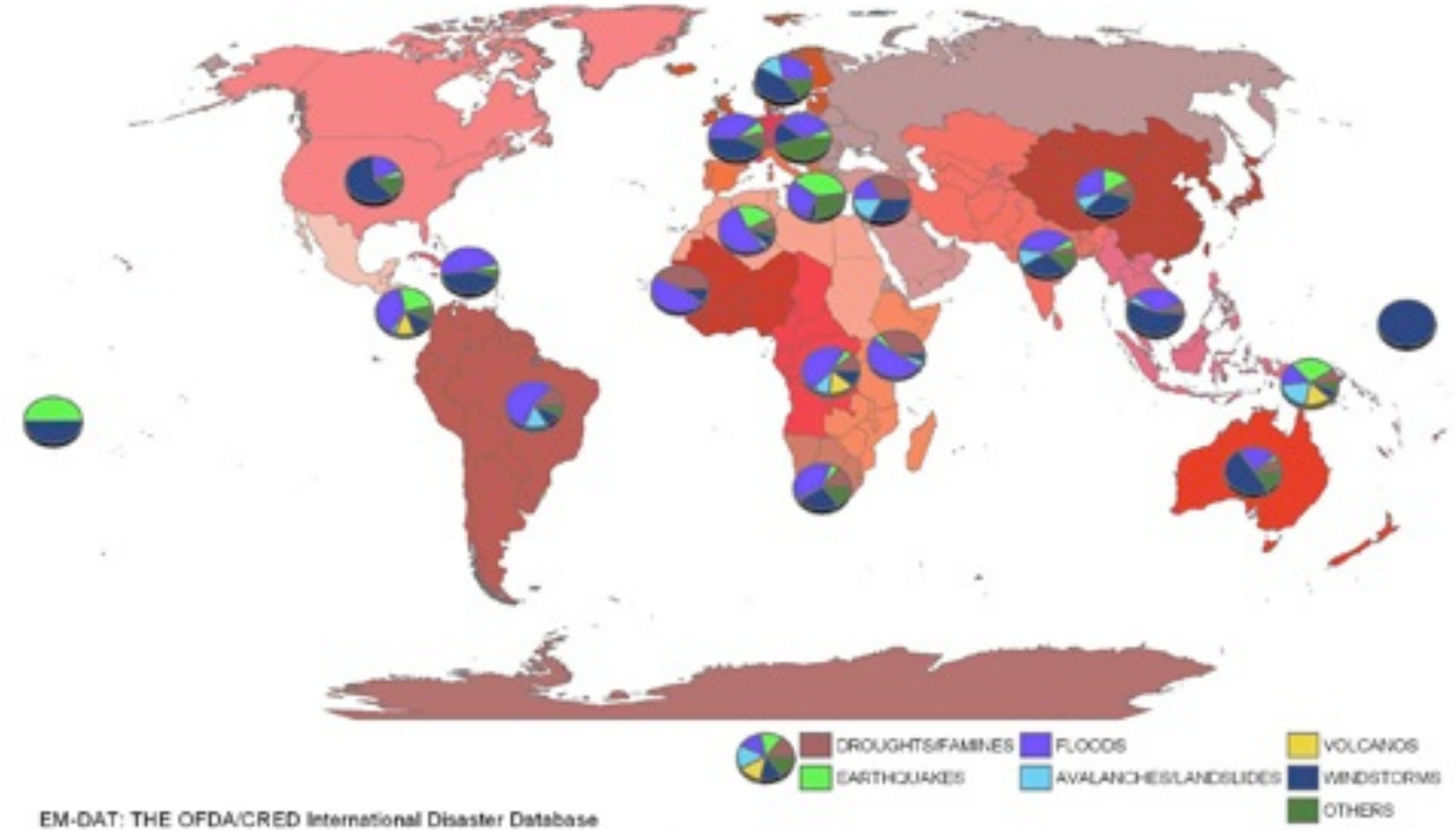
EXPRESS-HYDRO

(EXtreme PREcipitation and Hydrological climate Scenario Simulations-HYDRO)

Alexandre B. Pieri, J. von Hardenberg, A. Provenzale, A. Parodi, and D. Kranzlmueller

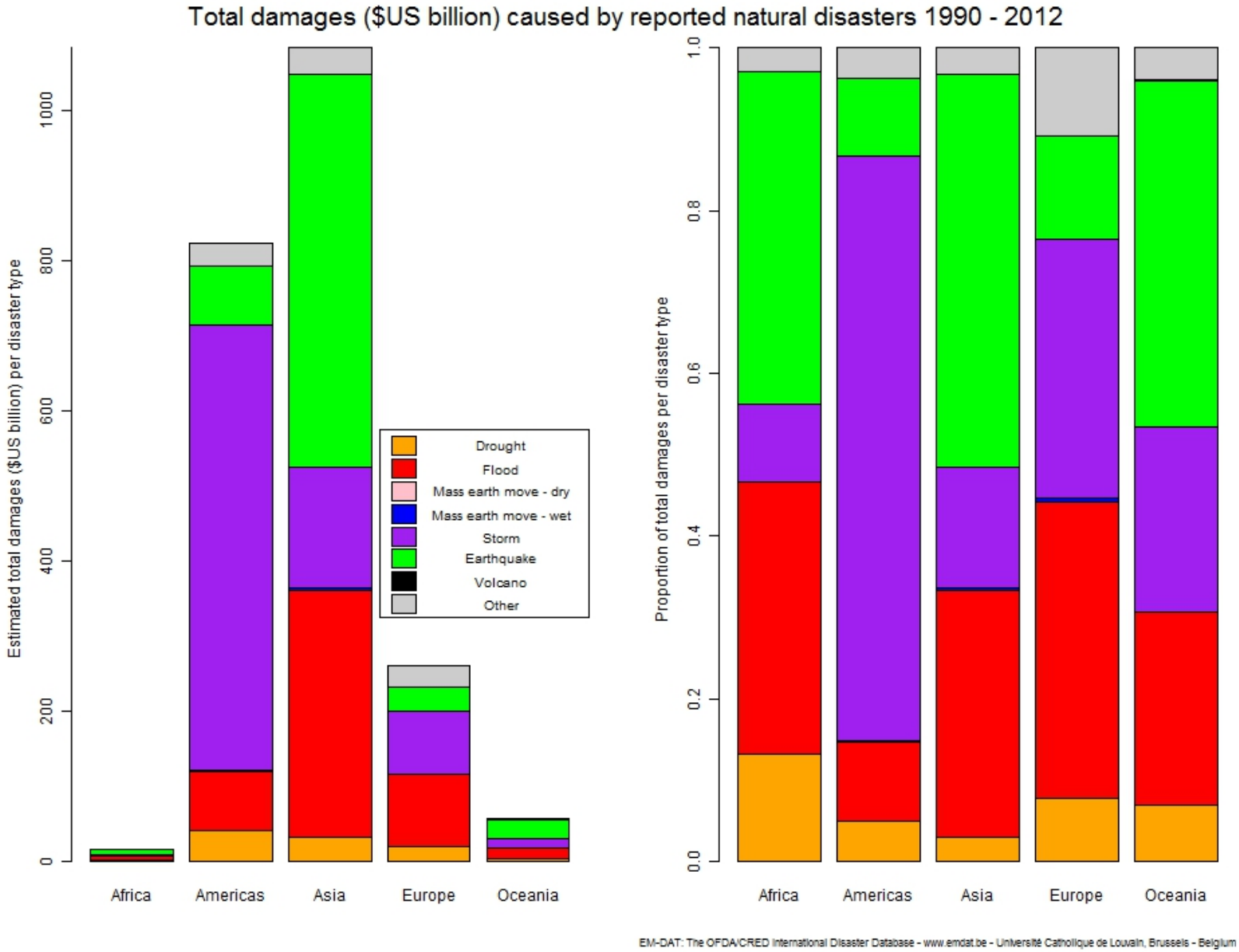
Motivations: Global scale

Disaster Type Proportions by United Nations Sub-Regions:
1974-2003

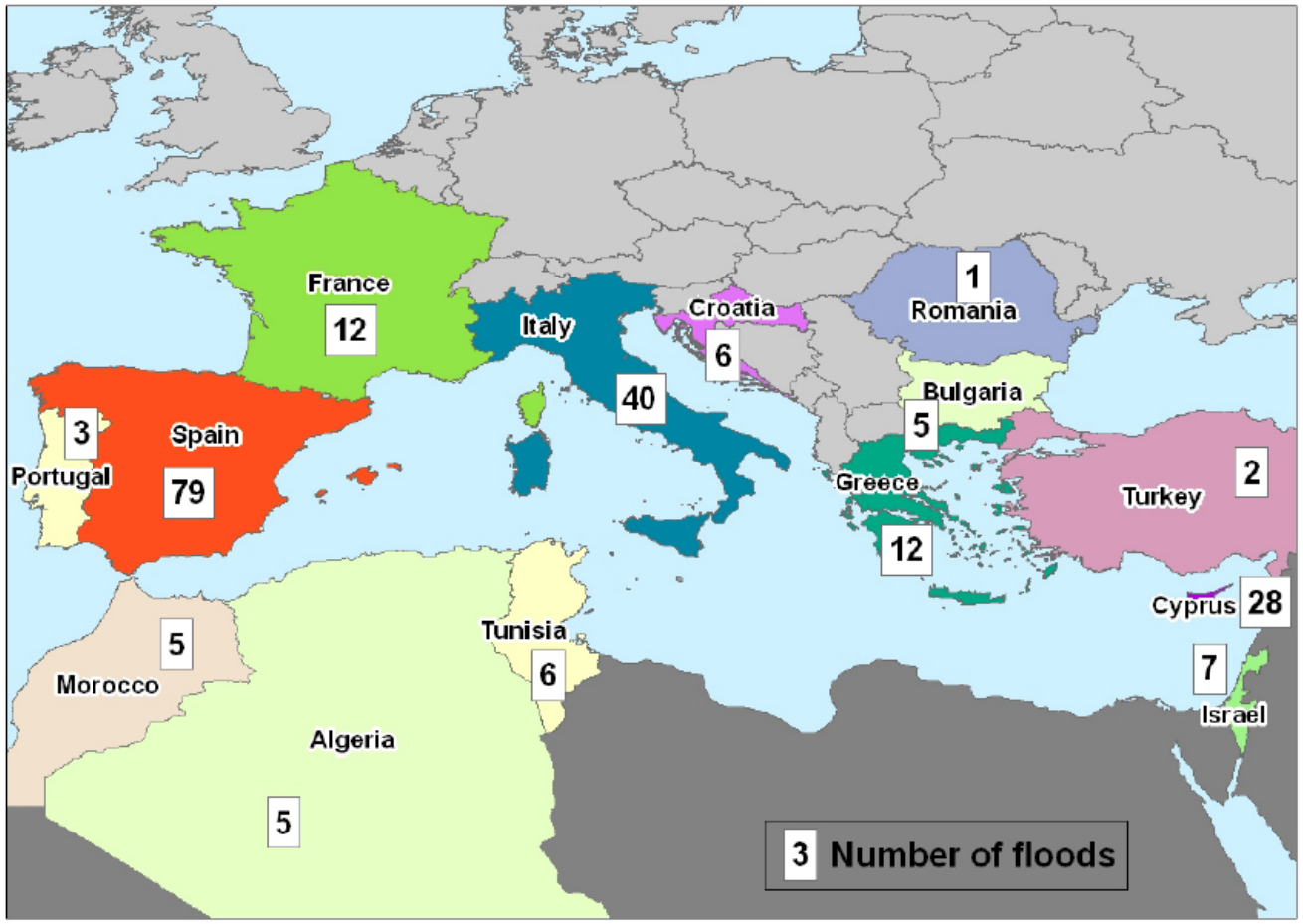


EM-DAT: THE OFDA/CRED International Disaster Database
www.em-dat.net - Université Catholique de Louvain - Brussels - Belgium

Motivations: Global scale

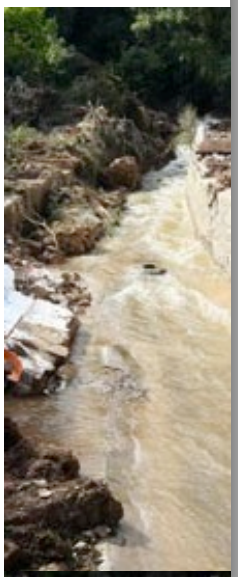


Motivations: European scale

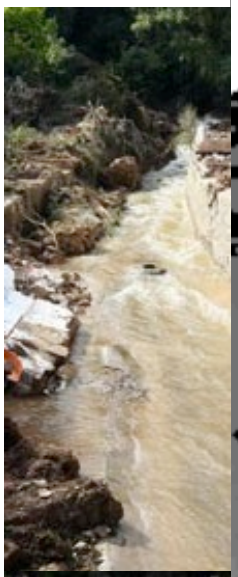


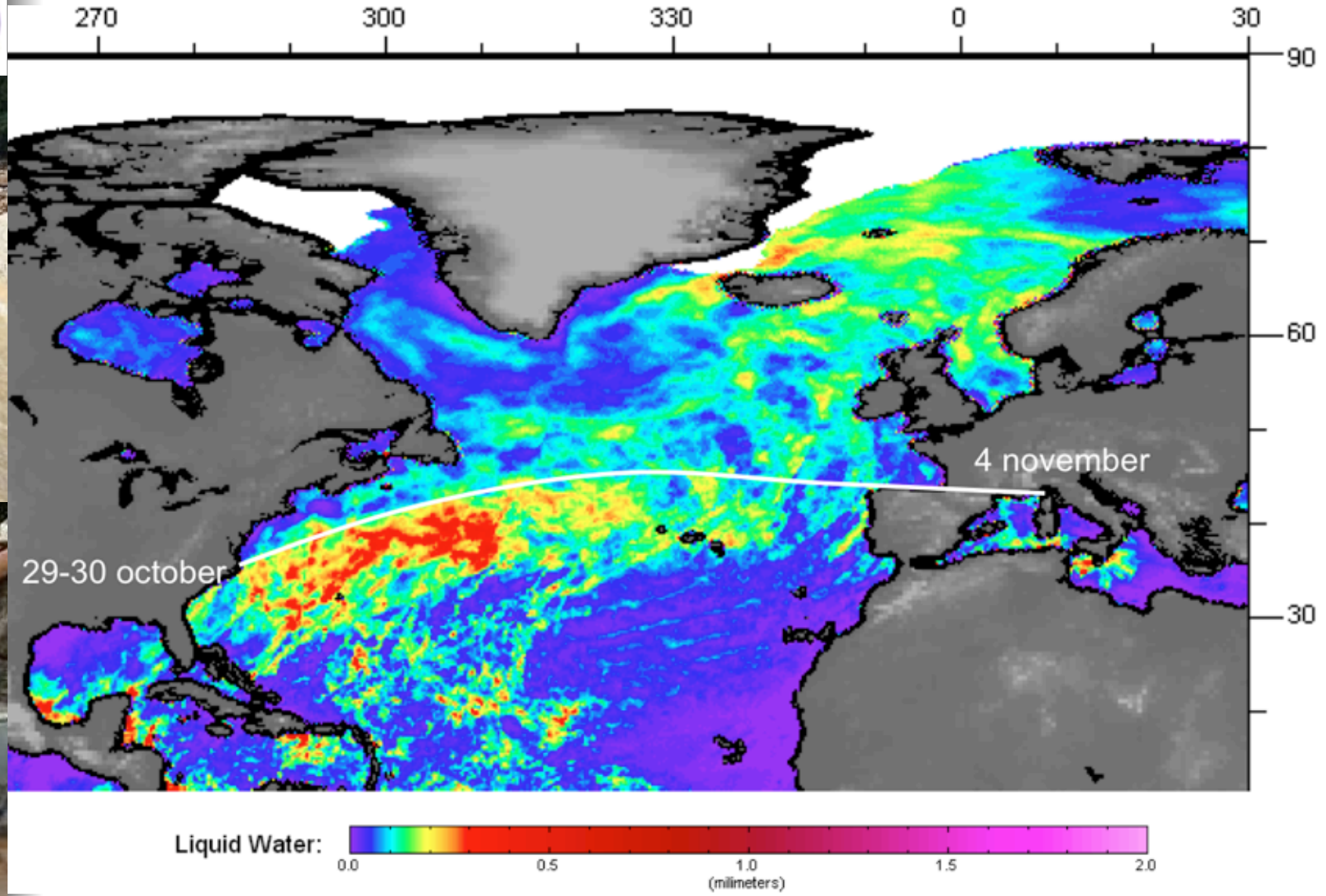
- The analysis carried out within the FLASH project estimated over 29 billion euros the material damages produced by floods in the Mediterranean region during the 1990-2006 period
- The total number of casualties has been estimated over 4,500, concentrating in the Mediterranean African countries especially.

A HMR critical case

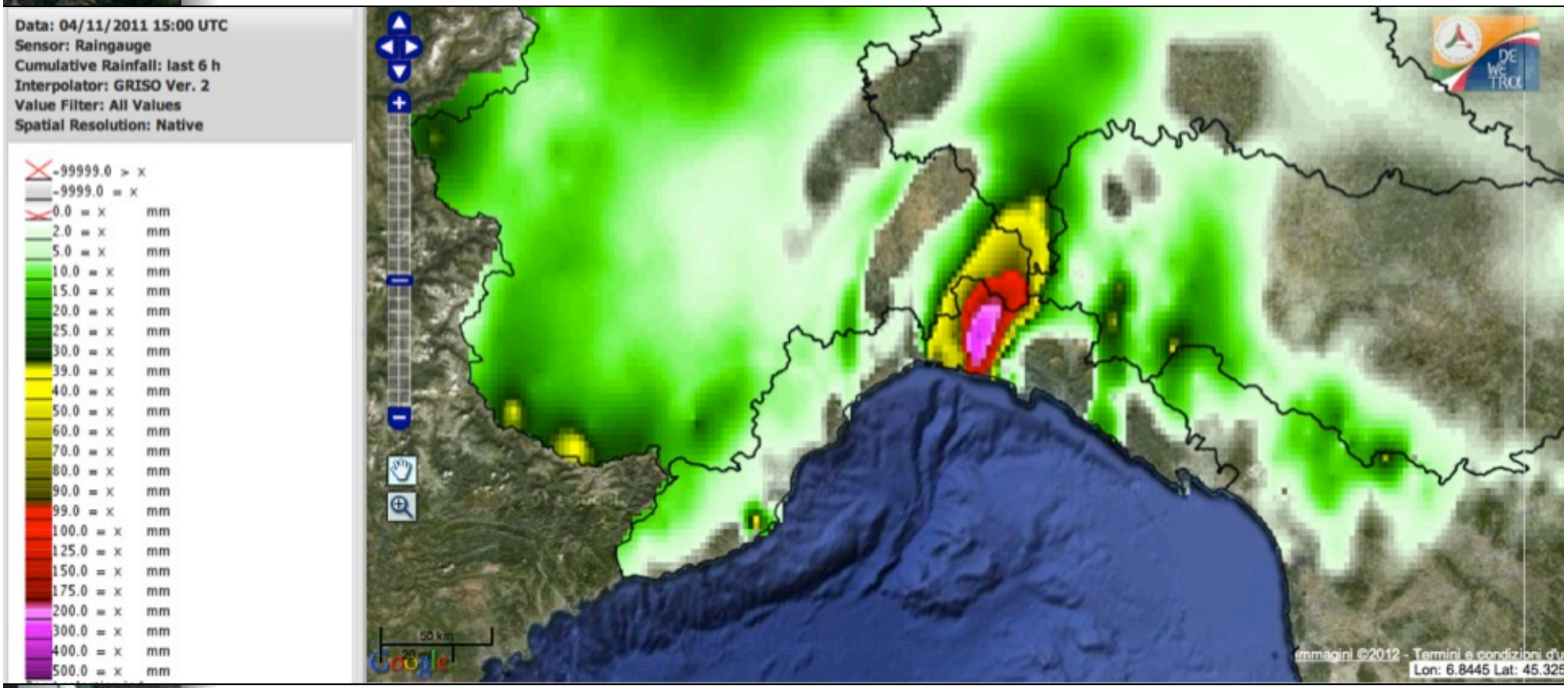


- The city of Genoa, which nestles between the Tyrrhenian sea and the Apennine mountains, was rocked by severe flash floods on 4th November 2011. About 450 millimeters of rain - a third of the average annual rainfall - fell in six hours. Six people were killed. The raging waters uprooted trees, swept cars, shattered shops and flooded the town center;
- The torrential rainfall inflicted the worst disaster Genoa has experienced since the flash flood of 1970, when a similar event killed 25 people on the 7th October.





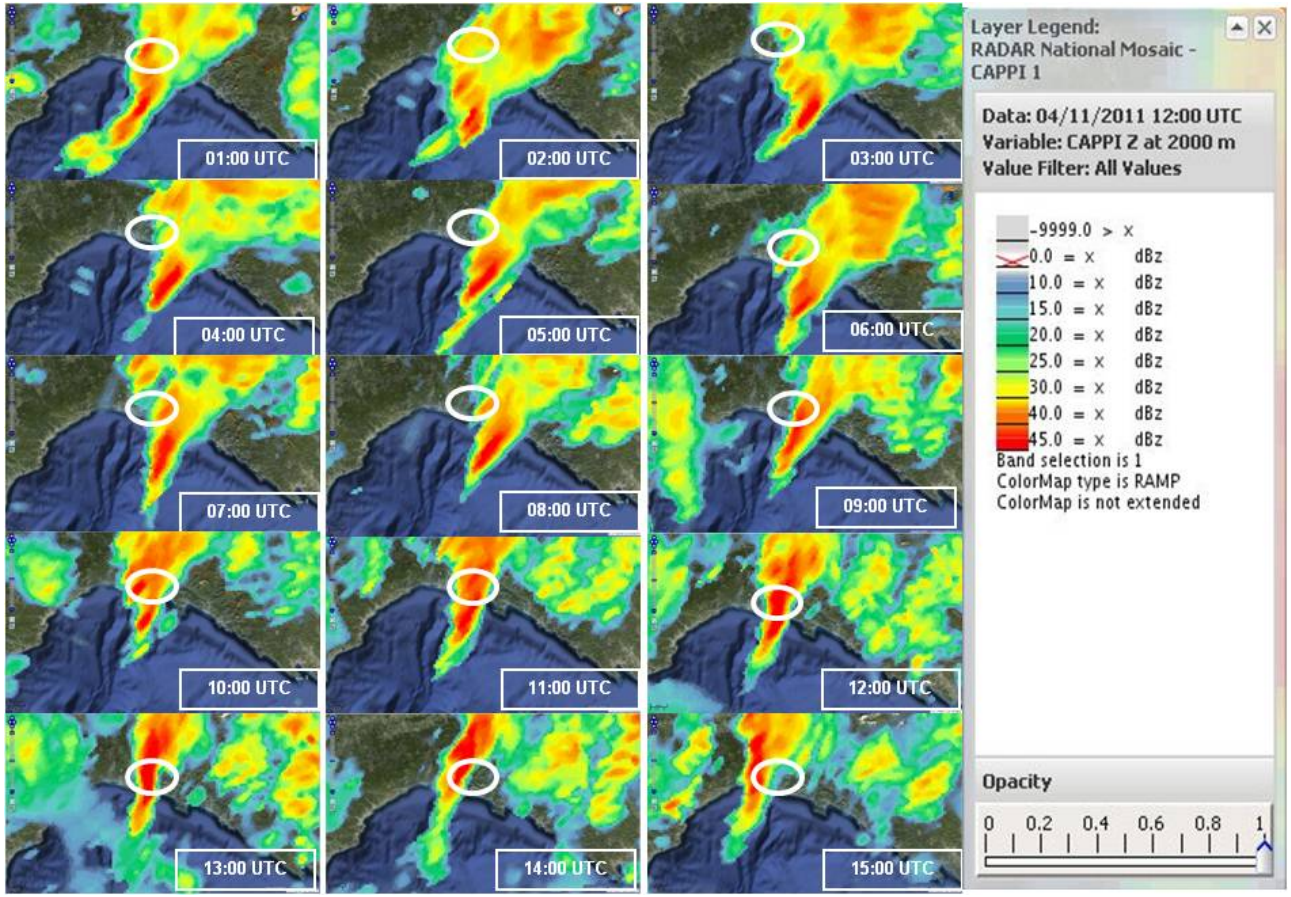
Satellite cloud liquid water composite (week ending 5/11/2011) clearly shows the cyclone track from USA east coast to Mediterranean.

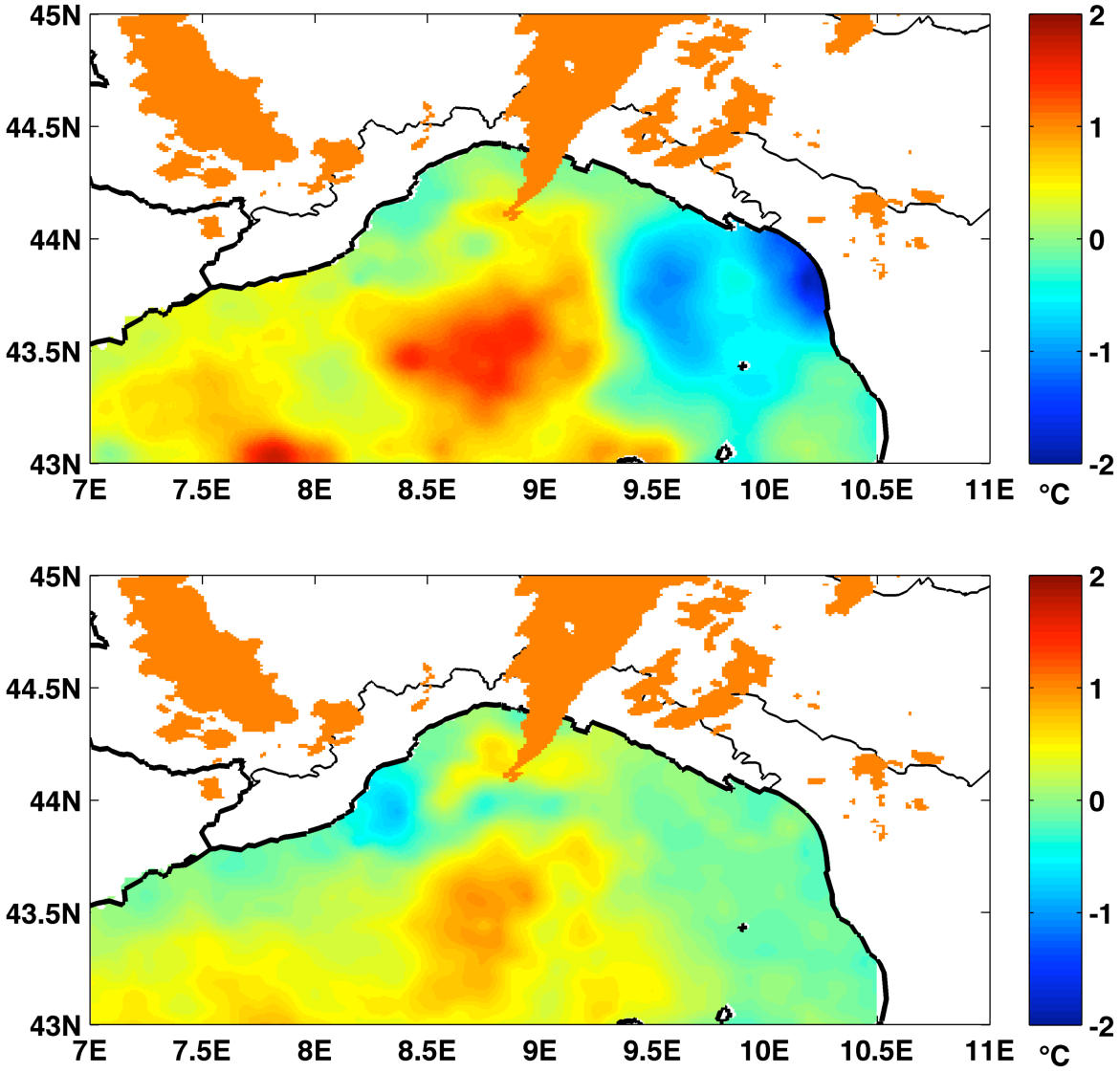


Total rainfall depth between 9 and 15UTC, as provided by the ICPD raingauge network.

Flash flood of the Genoa town center. Top rigth corner: the similar event of 1970

Radar maps from the Italian radar network showing the intense thunderstorm wandering along the Liguria coastline (1-15UTC): White ellipsoid identifies the mostly affected area





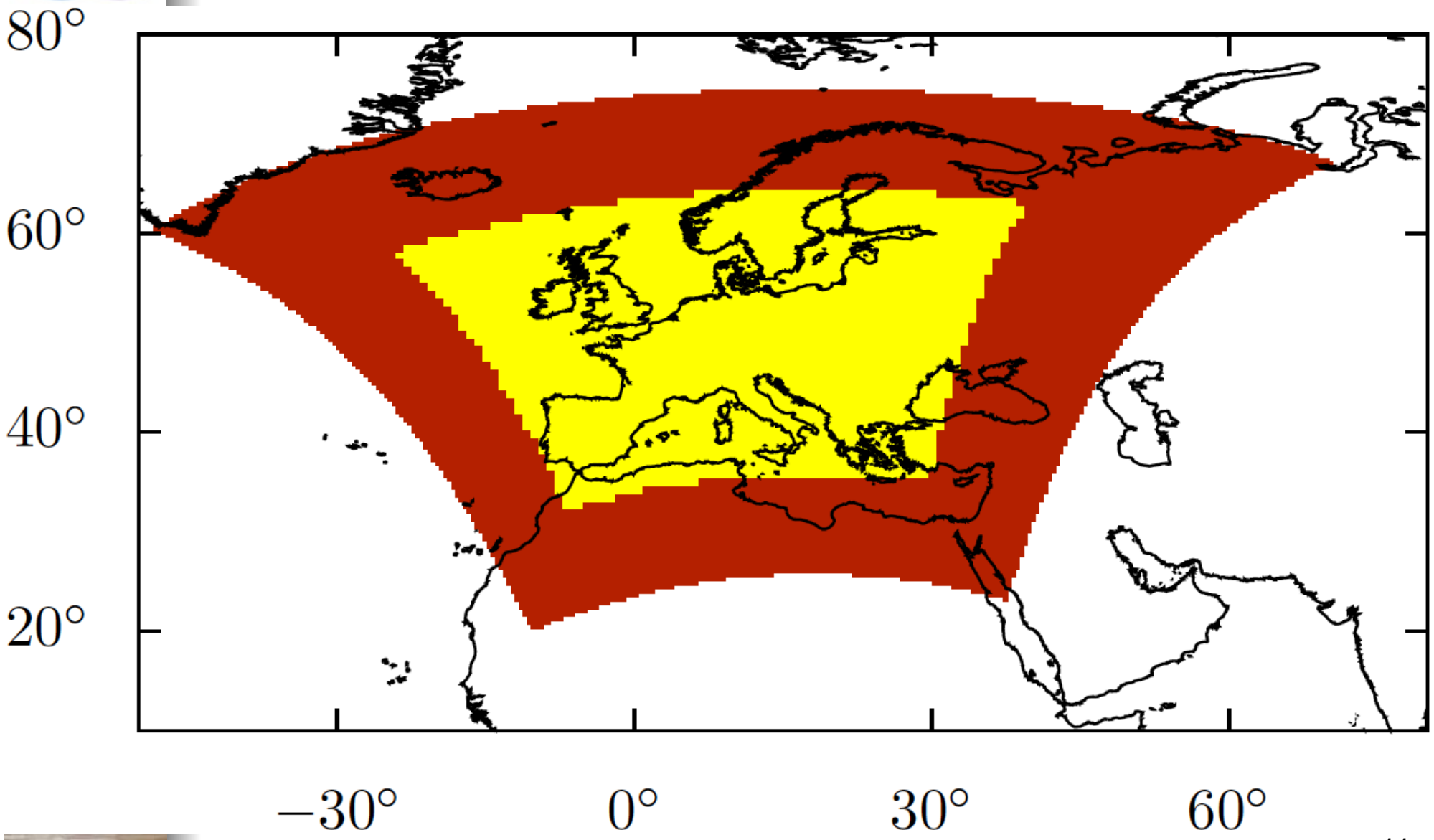
Reflectivity footprint of the precipitation structures considered in this paper: the orange areas represent the pixels with reflectivity values larger than 25 dBZ (Italian Radar Mosaic, November 4th at 11:00 UTC). Sea Surface Temperature Anomaly by G1SST (upper panel) and GMES MyOcean (lower panel).

All together, these observations challenge our current scientific understanding and call for focused and joint hydro-meteorological and ICT research to:

(a) understand, explain and predict the physical processes producing such extreme storms

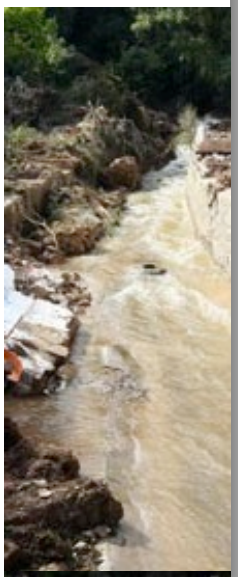
(b) understand the possible intensification of such events in the Mediterranean region and their physical origin;

(c) explore the potential of the increasing computational power and Information Communication Technology (ICT), such as grid computing and petascale computing systems, to provide deeper understanding of those events through fine resolution modeling over large areal extents


80°
60°
40°
20°
−30°
0°
30°
60°

Configurations

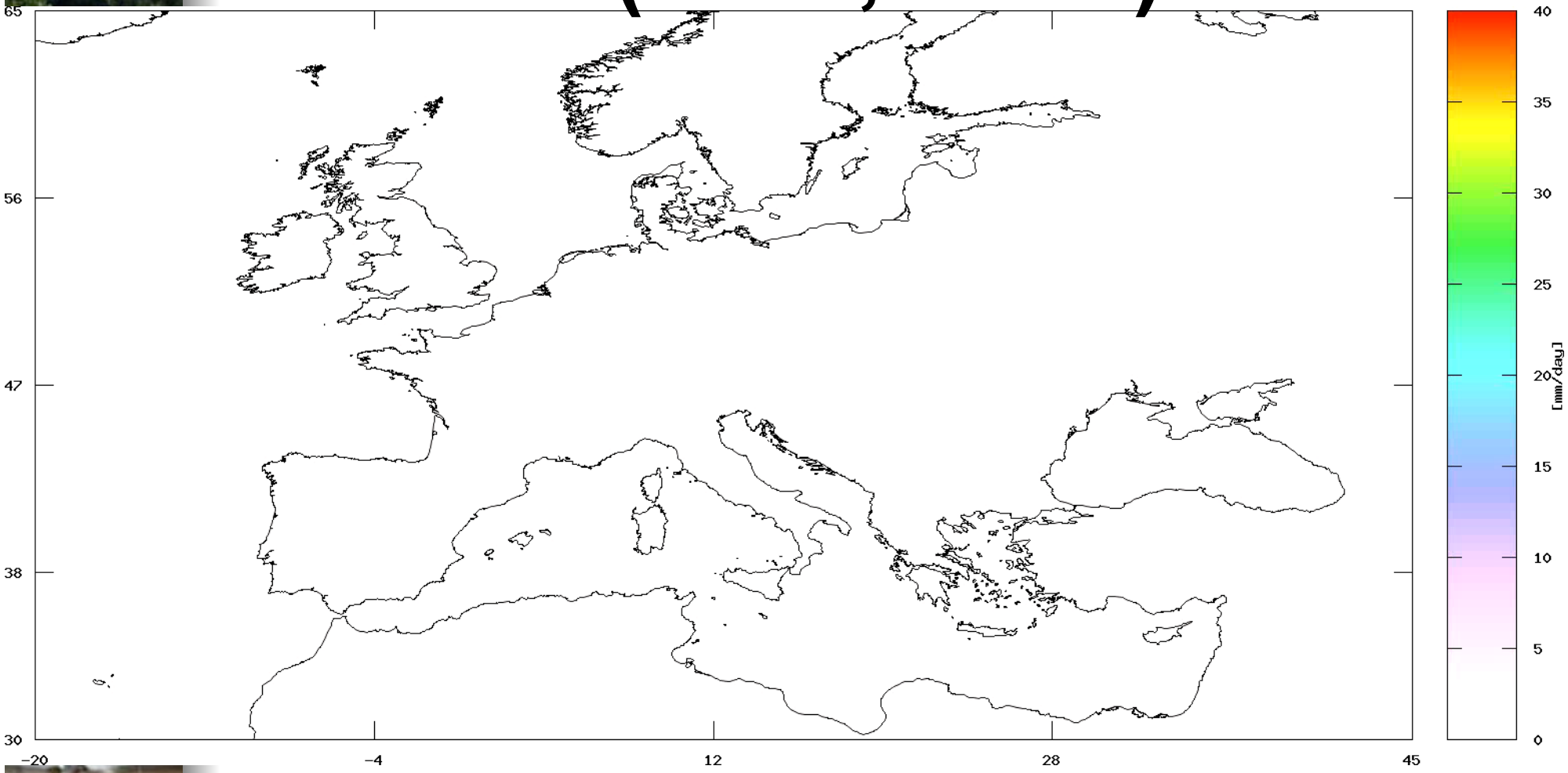
Name	Grid	Microphysics	Convective scheme
c1ei	0.11°	Thompson	Kain-Fritsch
c2ei	0.11°	Morrison	Kain-Fritsch
c3ei	0.11°	WSM6	Kain-Fritsch
c4ei	0.11°	Thompson	Betts-Miller-Janjic
c1di	**0.44°**	Thompson	Kain-Fritsch
h1e4	**0.04°**	Thompson	*explicit*



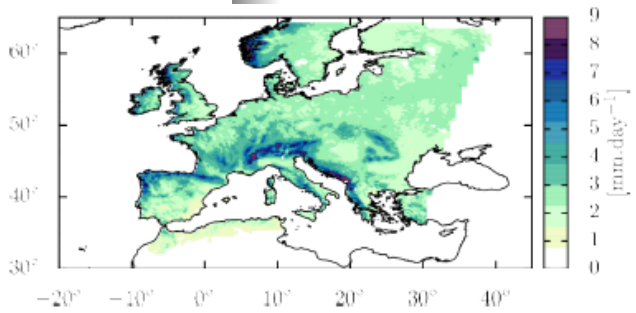
We present climate simulations for 1979 with various configurations of the Weather Research and Forecast model over the EURO-CORDEX domain. Boundary conditions are provided by ERA-Interim. While microphysics does not seem to have a significant influence on precipitation statistics, the results show strong sensitivity to the convective scheme and resolution.

Using implicit (parametrized) convection, we show that the Betts-Miller- Janjic scheme provides the best results but still presents strong over-estimation of the rainfall rate over eastern Europe and regions with complex orography. Increased resolution allowing for explicit (resolved) convection helps to reduce this artificial precipitation excess and to reproduce quite well the statistics of the rainfall rate.

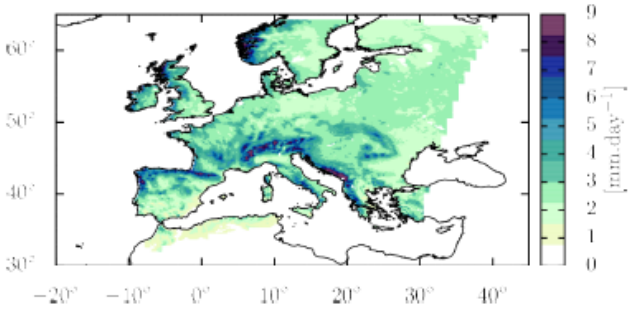
WRF Daily precipitation rate (1979, 0.04°)



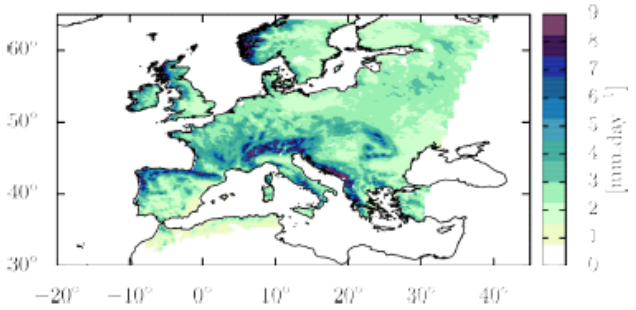
Annual european precipitation



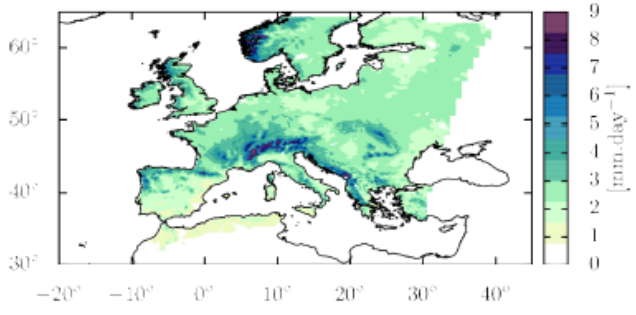
1(a) c1ei (0.11°)



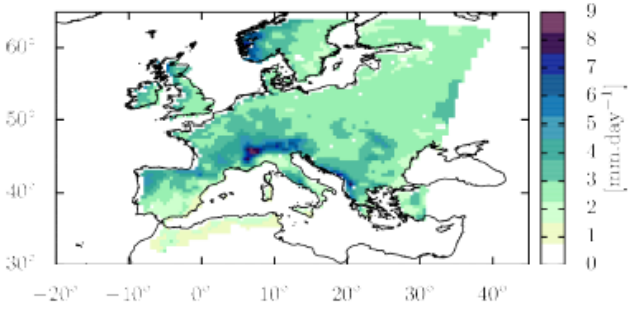
1(b) c2ei (0.11°)



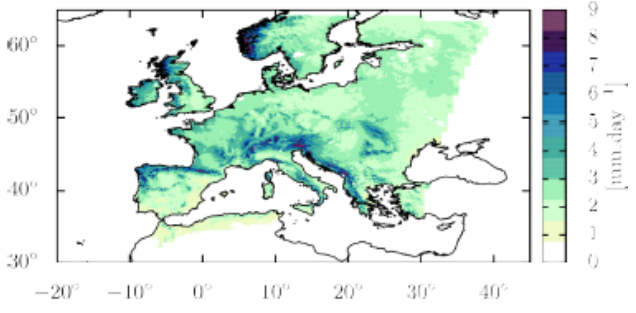
1(c) c3ei (0.11°)



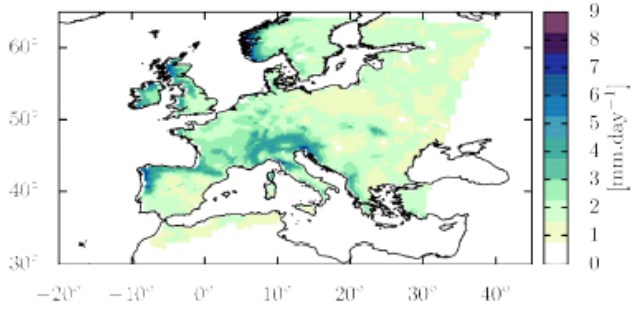
1(d) c4ei (0.11°)



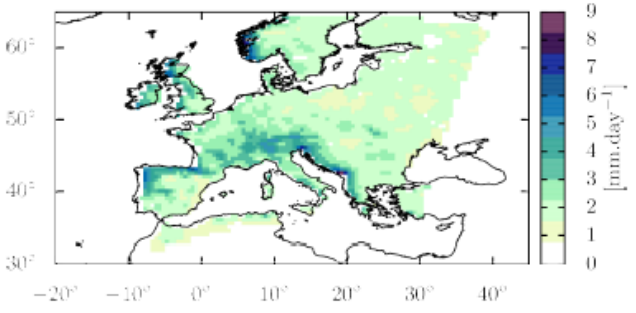
1(e) c1di (0.44°)



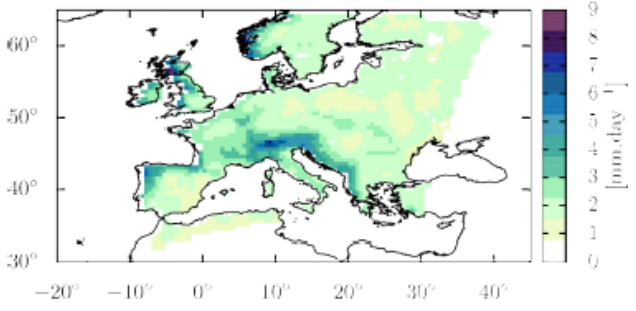
1(f) h1e4 (0.04°)



1(g) E-OBS

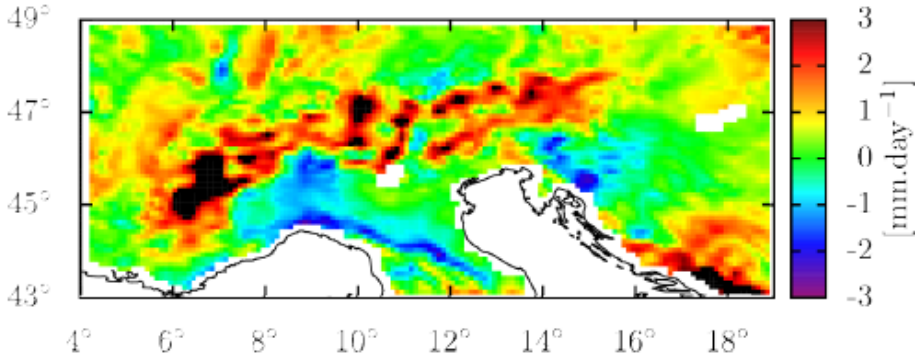


1(h) GPCC

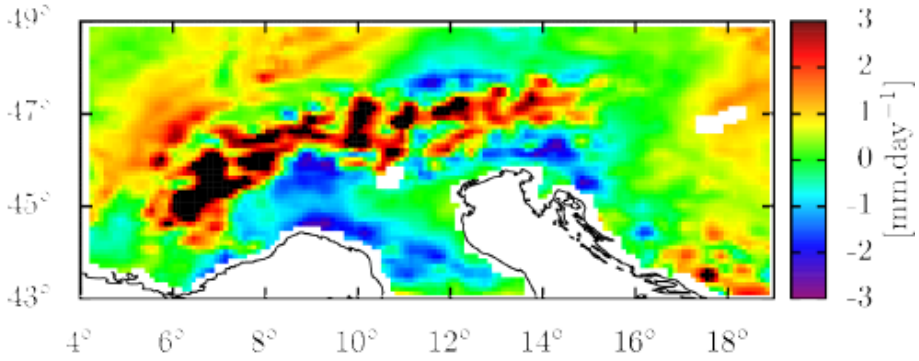


1(i) CRU

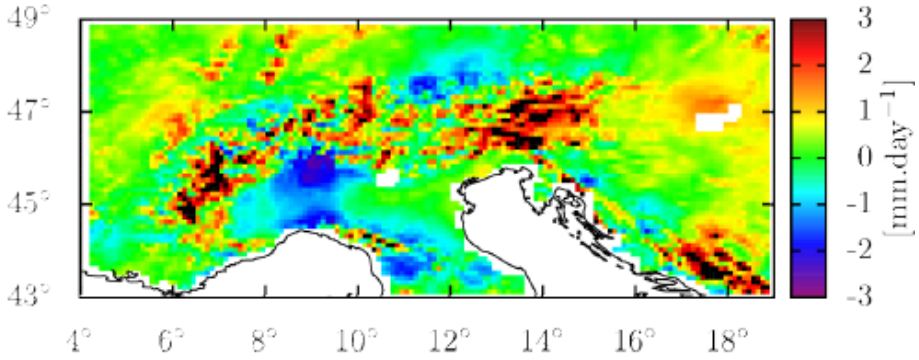
WRF-HISTALP



3(a) c1ei (0.11°)

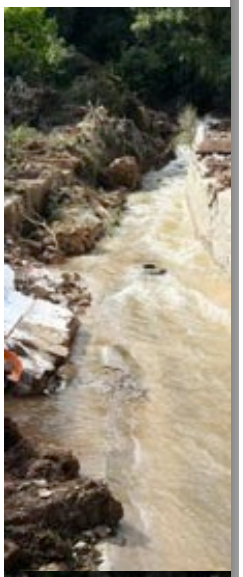


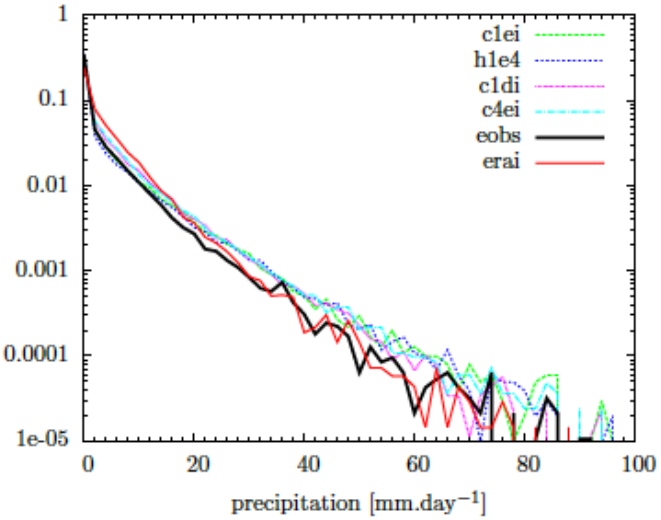
3(b) c4ei (0.11°)



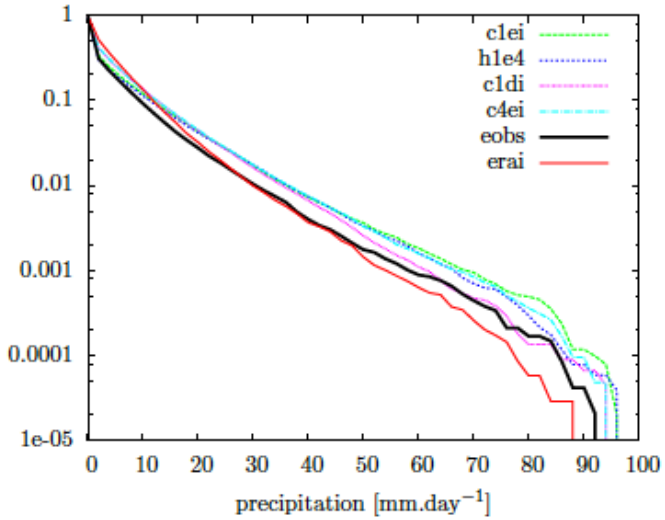
3(c) h1e4 (0.04°)

Extreme events

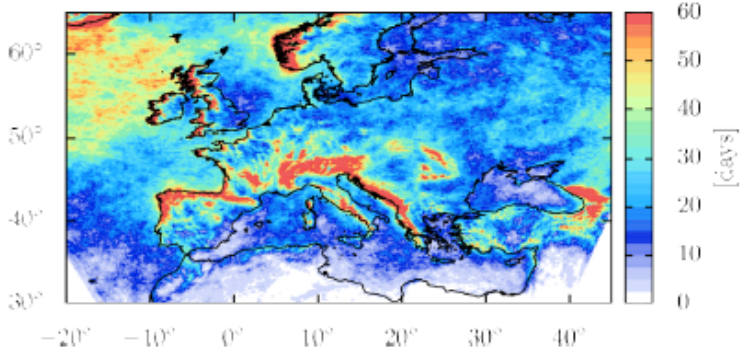




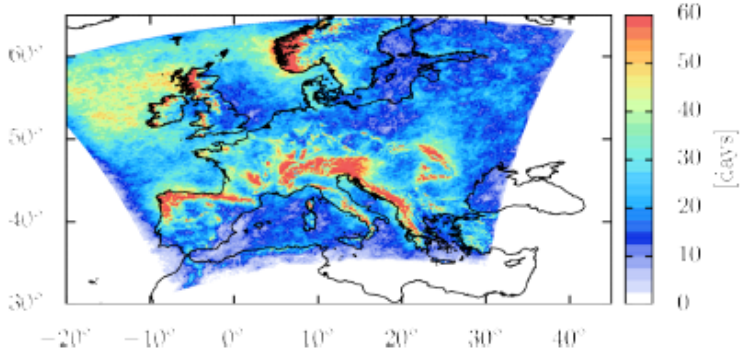
2(a) Daily rainfall rate probability distribution



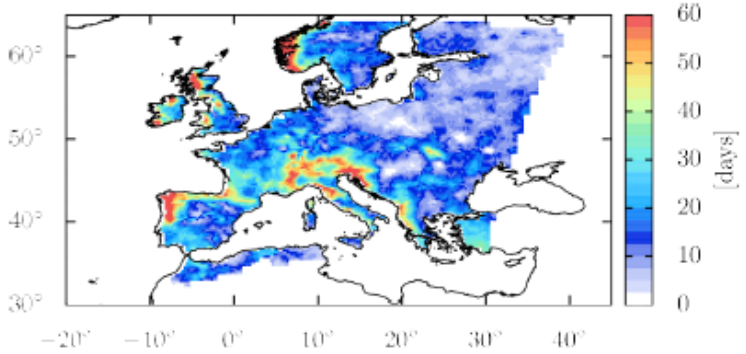
2(b) Complementary cumulative distribution function



2(c) Days $pr > 10$mm (c1ei)

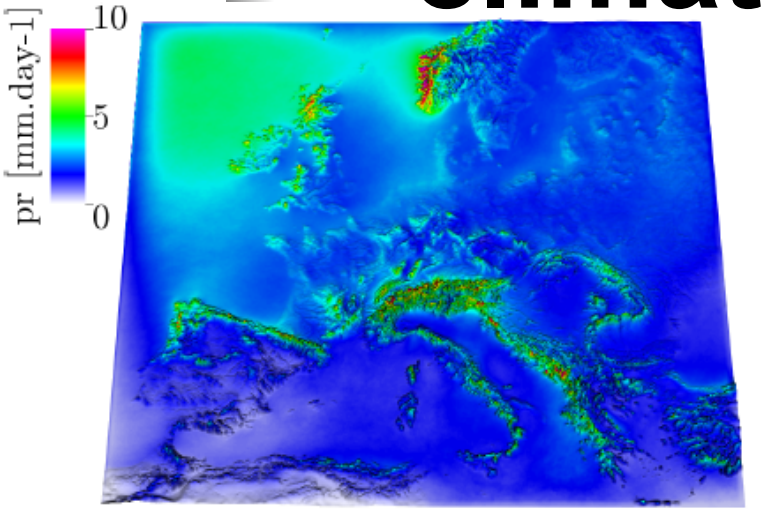


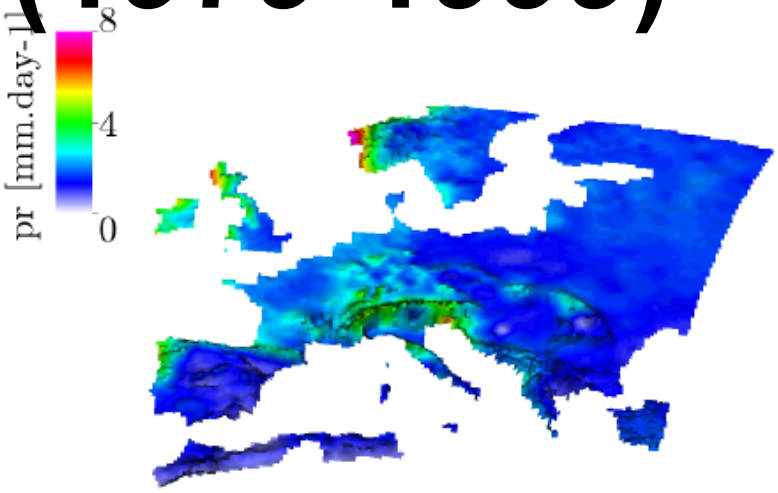
2(d) Days $pr > 10$mm (h1e4)



2(e) Days $pr > 10$mm (E-OBS)

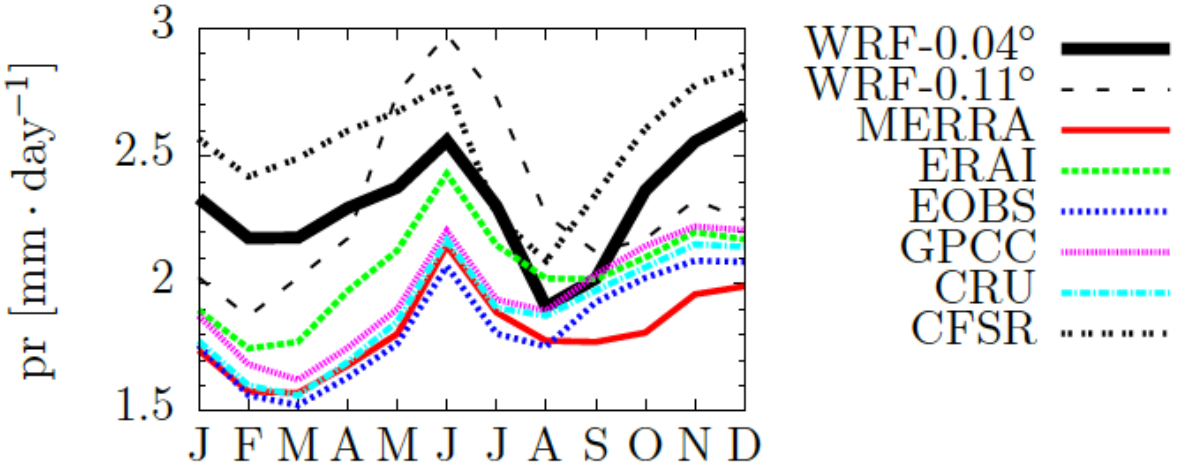
High-resolution precipitation climatology (1979-1999)

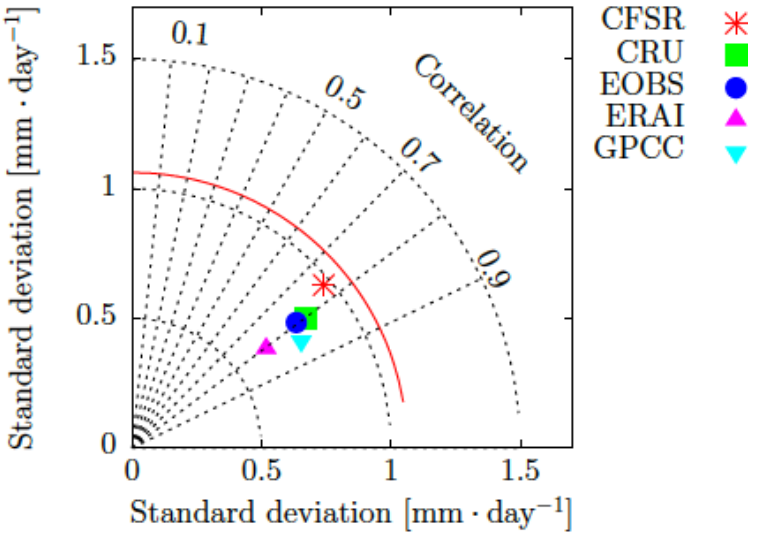




1(a) WRF (0.04°)

1(b) E-OBS (0.25°)

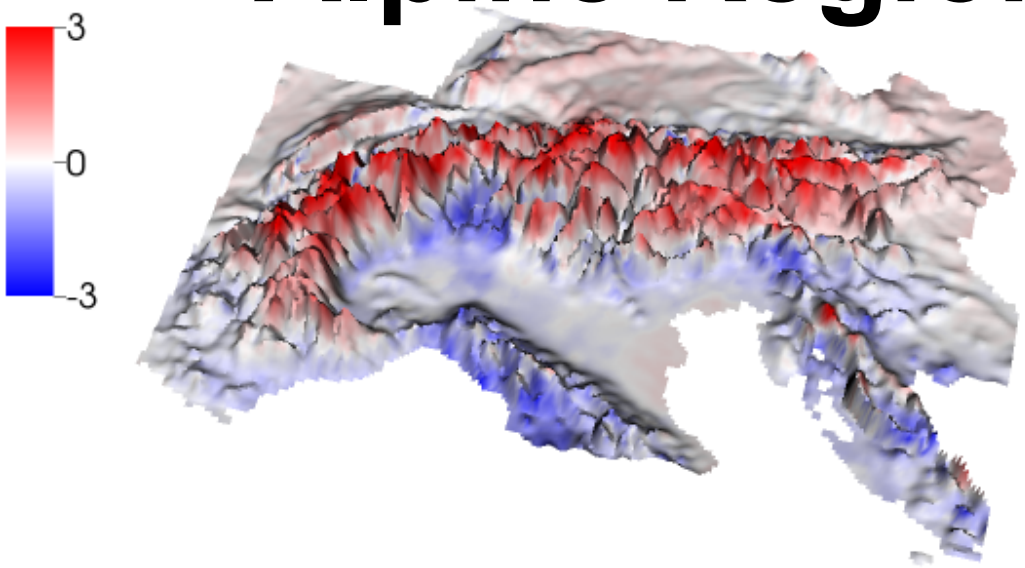




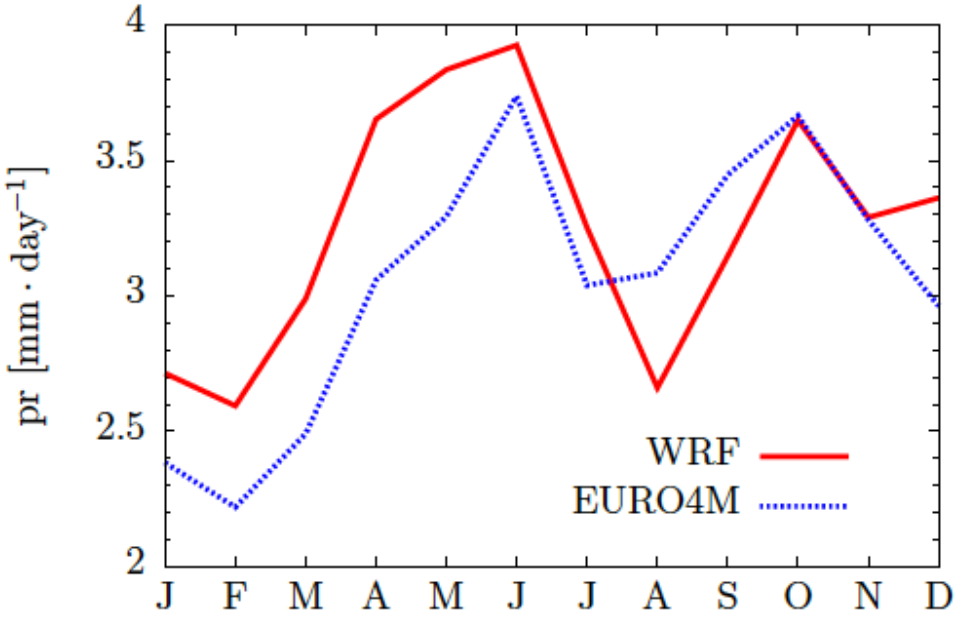
1(c) Monthly precipitation

1(d) Taylor diagram

Alpine Region



2(a) Precipitation bias [mm · day^{-1}]

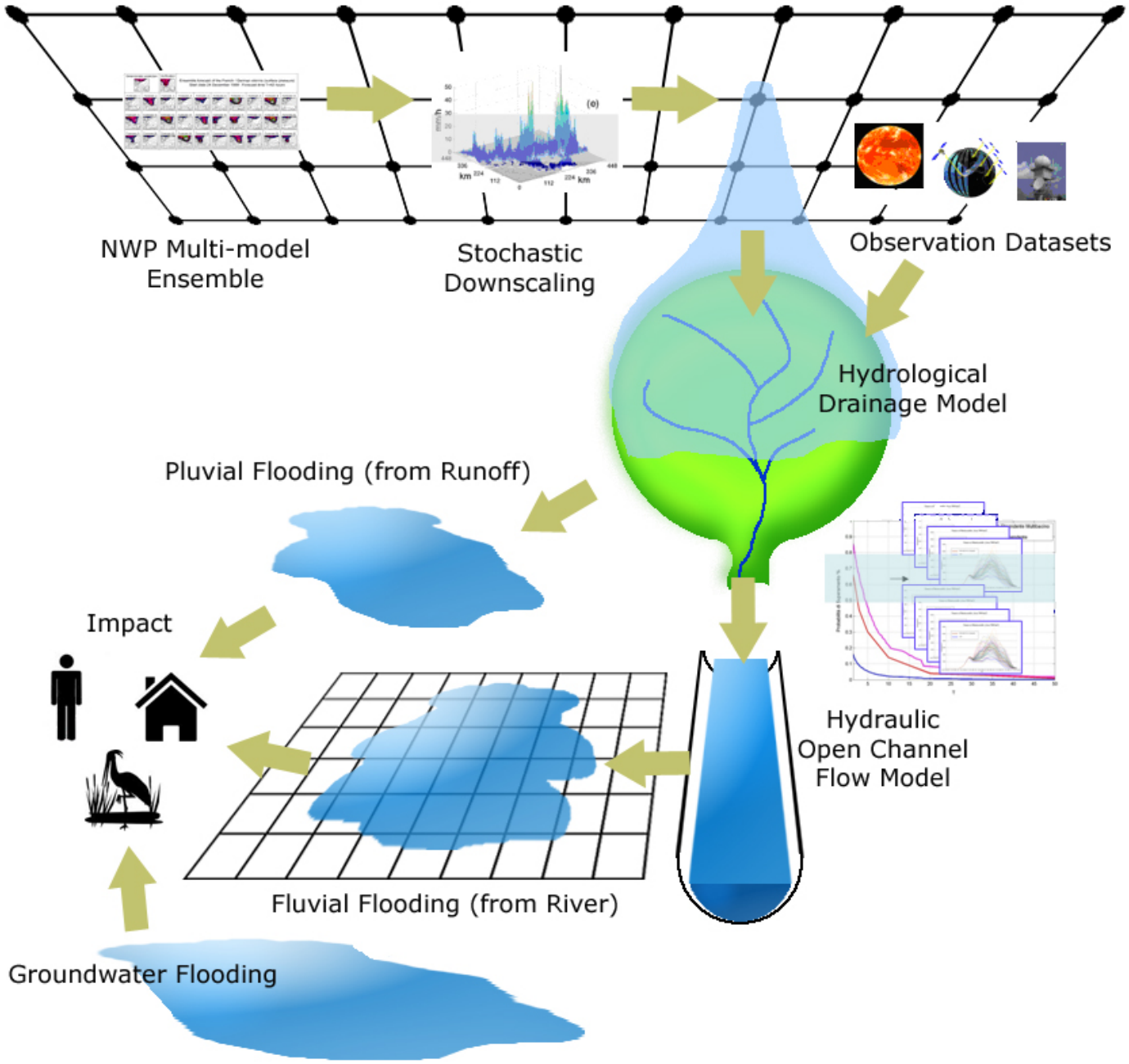


2(b) Monthly mean precipitation [mm · day^{-1}]

Current activities

We are complementing our simulation of the present climate with a future scenario projection at high-resolution, in which the WRF model is forced with CMIP5 output from the EC-Earth global climate model, with RCP4.5 greenhouse gas and aerosol concentrations, for the period 2030 to 2050. The post-processed datasets produced in this project will be used as inputs for regional impact studies, in particular forcing hydrological models and ecosystem dynamics models over selected study areas

Future activities



Experiment Suite 1
Rainfall

Experiment Suite 2
Discharge

Experiment Suite 3
Water Level,
Flow & Impact

Questions?