On the suitability of RCM simulations to study the water balance of large watersheds

P. Quintana Seguí[1] and E. Sánchez Gómez[2].
1: Observatori de l'Ebre (Universitat Ramon Llull – CSIC), Spain.
2: CNRS-CERFACS, Toulouse, France.

Introduction

The water resources in the Mediterranean area are characterised by a high variability at several spatial and temporal timescales. Furthermore, it has been shown that increasing human activities and global change can induce dramatic changes in the Mediterranean hydrological cycle, making water resources management more difficult in the future. Future climate projections are widely used to assess the impacts of climate change on water resources in the Mediterranean sector. In this study, the water budget simulated by the regional climate models (RCMs) participating in the FP6 EU ENSEMBLES project (25 km resolution, scenario of emissions A1B) was estimated over a large basin (the Ebro river basin) and at the monthly time step, to assess the quality of the water budget estimations calculated by the last generation of RCMs.

Method

Simulations

- ENSEMBLES simulations (http://ensemblesrt3.dmi.dk/).
- Emission scenario SRES A1B.
- Only the simulations that produce runoff and cover the complete period were selected.

Institució	RCM	GCM
ETHZ	CLM_SCN	HadCM3Q0
DMI	HIRHAM5	ARPEGE
ICTP	REGCM3	ECHAM5
KNMI	RACMO2	ECHAM5
MPI	REMO	ECHAM5

- Precipitation was compared with CRU's.

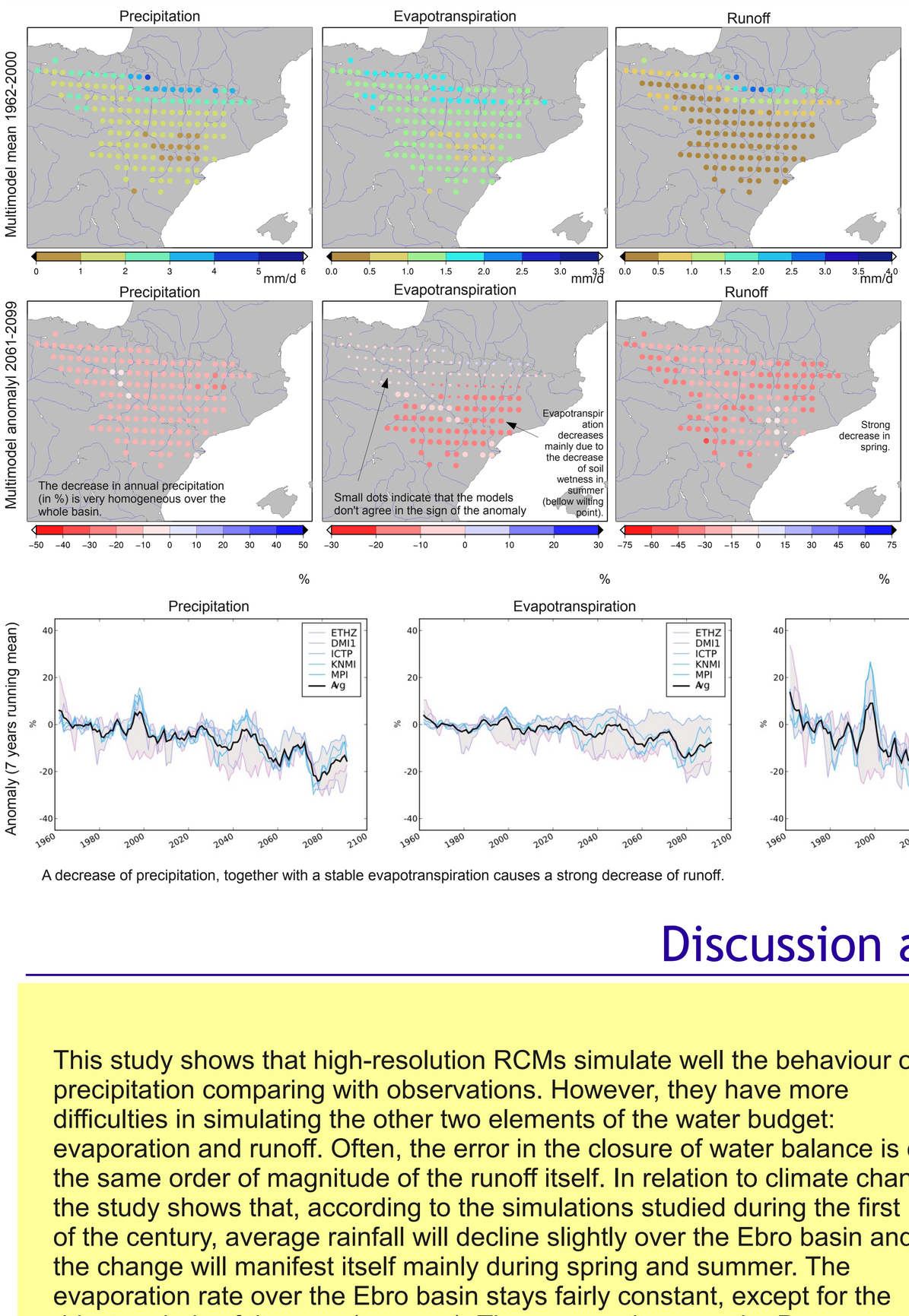
Periods

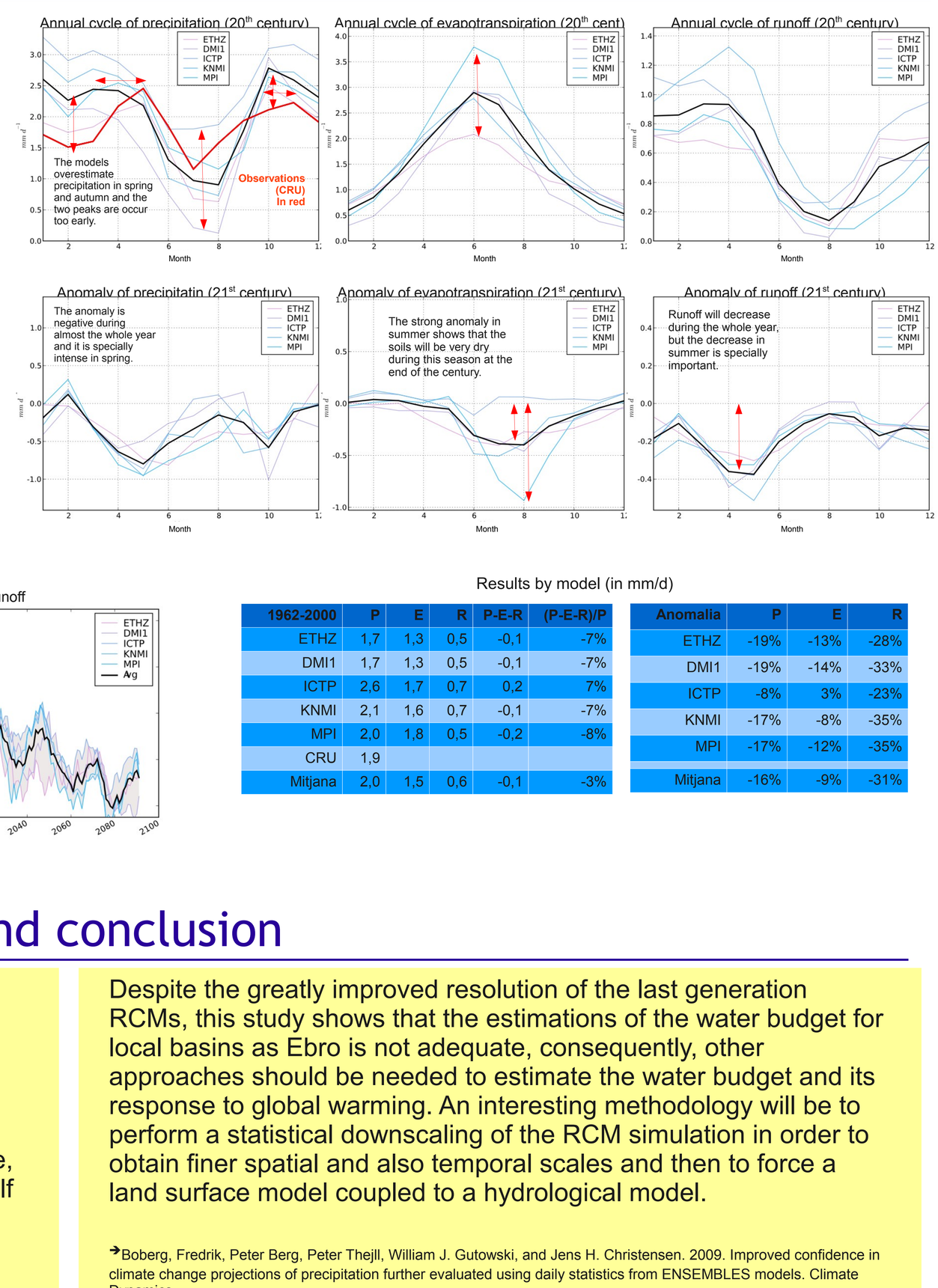
- 1962- 2099.
- Monthly data
- Two periods of reference, used to calculate the anomalies:
  - **20th century**: 1962-2000
  - **21st century**: 2061-2099

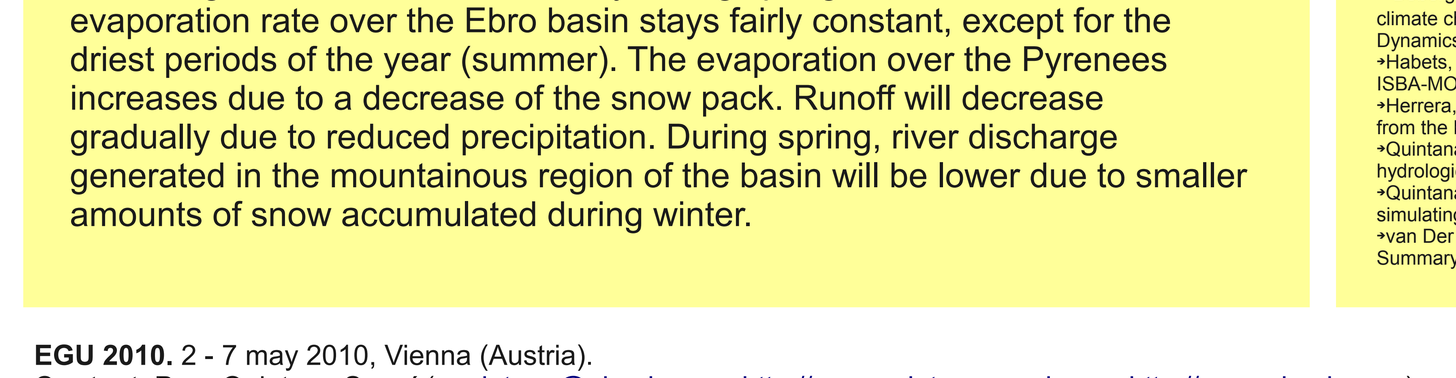
The Ebro basin

The Ebro basin is situated on the north east of the Iberian peninsula. It covers an area of 85,362 km ². Its main axis goes from north west to south-east. The Pyrenees are situated on the northern limit of the basin, where snow related processes play an important role. On the north west the climate is greatly influenced by the Atlantic Ocean, on the south east, the climate is Mediterranean. The basin is very affected by anthropisation. The management of its water resources is an issue politically sensitive in Spain. The basin is also sensitive to global warming, which can strongly diminish the snowpack and may also increase the water stress in summer.

Results







A decrease of precipitation, together with a stable evapotranspiration causes a strong decrease of runoff.

Results by model (in mm/d)

1962-2000	P	E	R	P-E-R	(P-E-R)/P
ETHZ	1,7	1,3	0,5	-0,1	-7%
DMI1	1,7	1,3	0,5	-0,1	-7%
ICTP	2,6	1,7	0,7	0,2	7%
KNMI	2,1	1,6	0,7	-0,1	-7%
MPI	2,0	1,8	0,5	-0,2	-8%
CRU	1,9				
Mitjana	2,0	1,5	0,6	-0,1	-3%

Anomalia	P	E	R
ETHZ	-19%	-13%	-28%
DMI1	-19%	-14%	-33%
ICTP	-8%	3%	-23%
KNMI	-17%	-8%	-35%
MPI	-17%	-12%	-35%
Mitjana	-16%	-9%	-31%

Discussion and conclusion

This study shows that high-resolution RCMs simulate well the behaviour of precipitation comparing with observations. However, they have more difficulties in simulating the other two elements of the water budget: evaporation and runoff. Often, the error in the closure of water balance is of the same order of magnitude of the runoff itself. In relation to climate change, the study shows that, according to the simulations studied during the first half of the century, average rainfall will decline slightly over the Ebro basin and the change will manifest itself mainly during spring and summer. The evaporation rate over the Ebro basin stays fairly constant, except for the driest periods of the year (summer). The evaporation over the Pyrenees increases due to a decrease of the snow pack. Runoff will decrease gradually due to reduced precipitation. During spring, river discharge generated in the mountainous region of the basin will be lower due to smaller amounts of snow accumulated during winter.

Despite the greatly improved resolution of the last generation RCMs, this study shows that the estimations of the water budget for local basins as Ebro is not adequate, consequently, other approaches should be needed to estimate the water budget and its response to global warming. An interesting methodology will be to perform a statistical downscaling of the RCM simulation in order to obtain finer spatial and also temporal scales and then to force a land surface model coupled to a hydrological model.

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Contact: Pere Quintana Seguí (pquintana@obsebre.es, http://pere.quintanasegui.com, http://www.obsebre.es)
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