Evaluation strategies to identify the best simulation after a zonal calibration process using SWAT+: Application to the Tagus headwaters

Rodríguez-Castellanos, Jose Manuel;

Sánchez-Gómez, Alejandro; Bieger, Katrin;

Martínez-Pérez, Silvia; Senent-Aparicio, Javier;

Molina-Navarro, Eugenio*

*Geology, Geography and Environment Department,

University of Alcalá (Madrid, Spain)

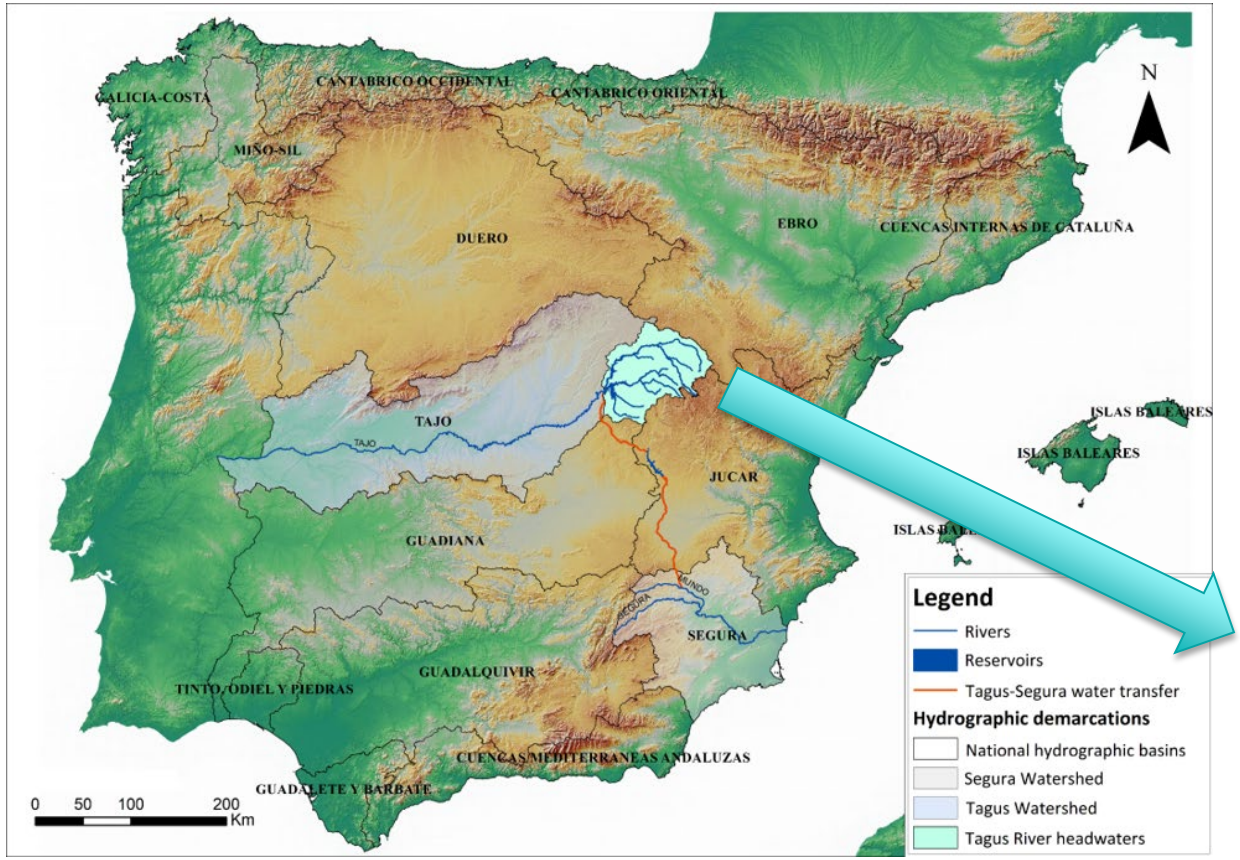
Universidad de Alcalá

ACMA Agua, Clima y Medio Ambiente

HML – UAH Hydrological Modelling Lab

Introduction

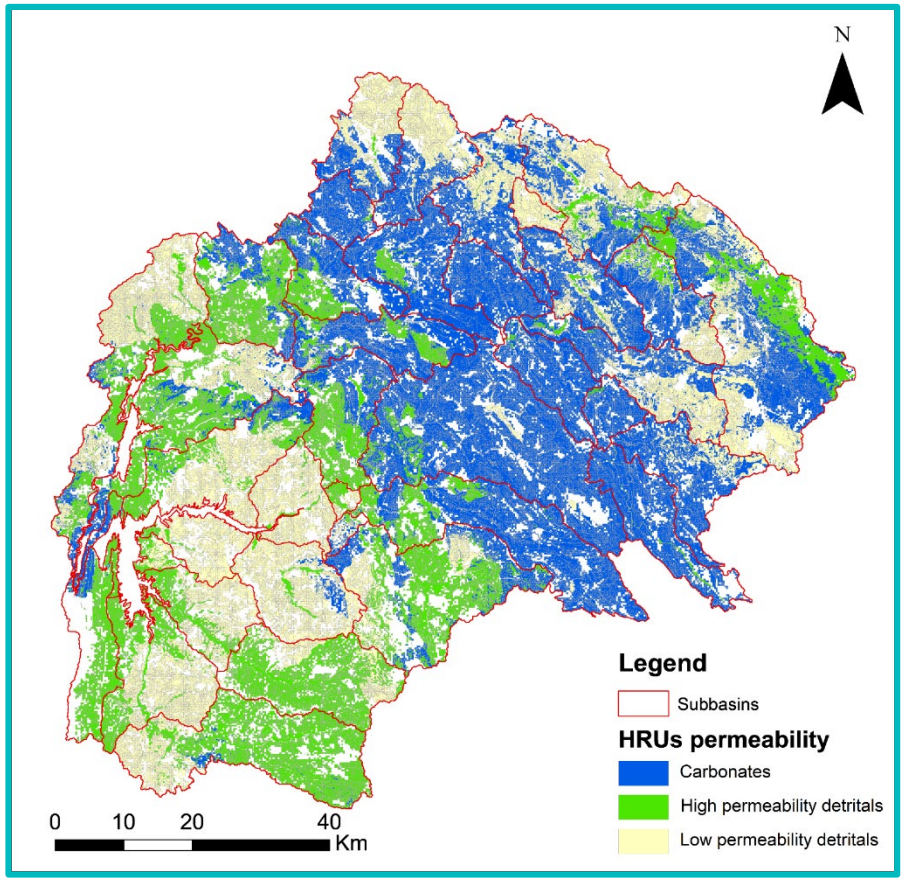
The Tagus River

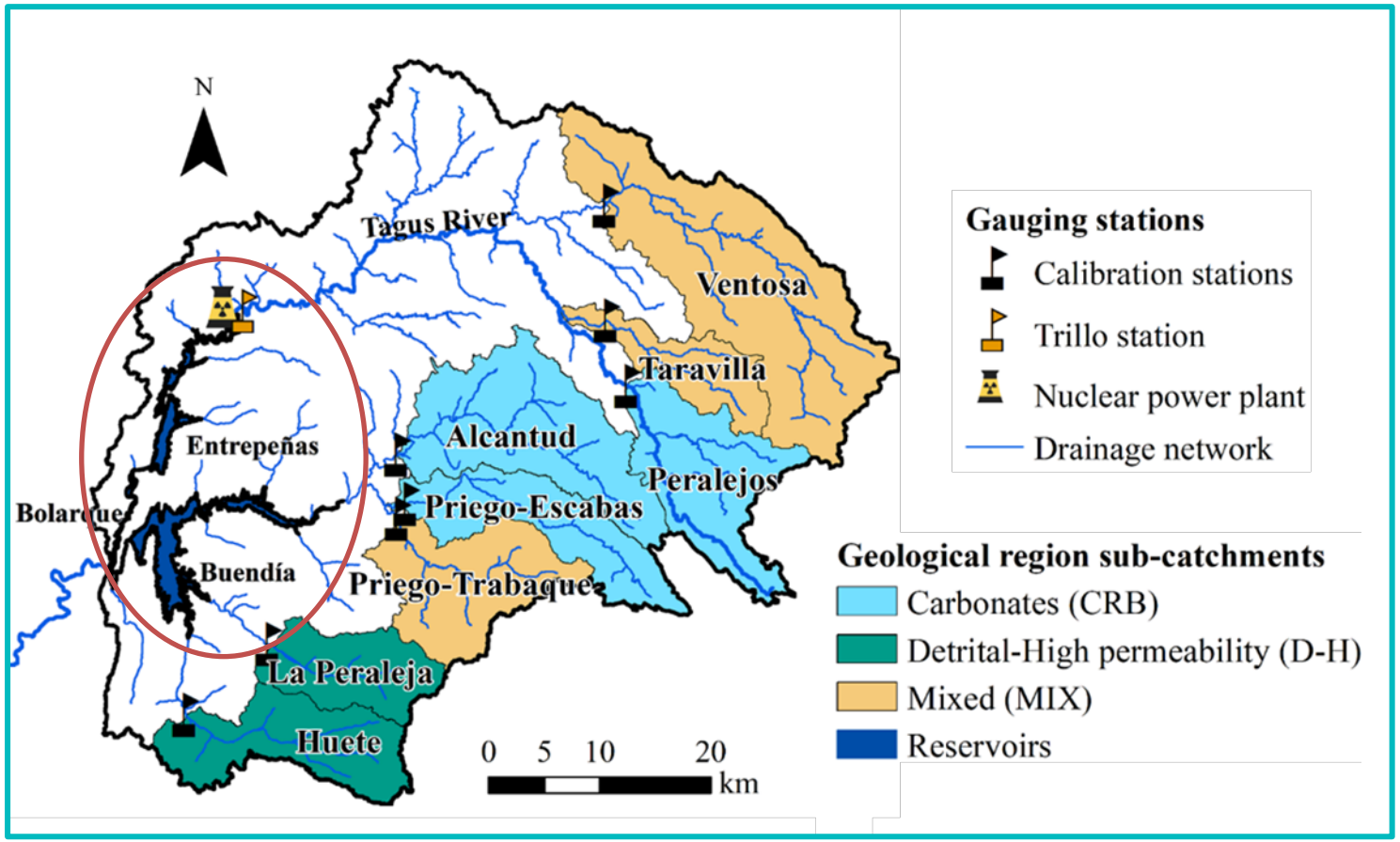


- Most populated basin in the Iberian Peninsula
- Highly regulated by reservoirs
- Already noticeable effects of climate change
- HEADWATERS: Great relevance
  - Water availability has decreased 50% in the last 40 years
  - Tagus-Segura water transfer (330 hm^3/y)

SWAT+ setup

3 geological regions defined and sub-catchments analyzed for soft and hard calibration





Soft calibration

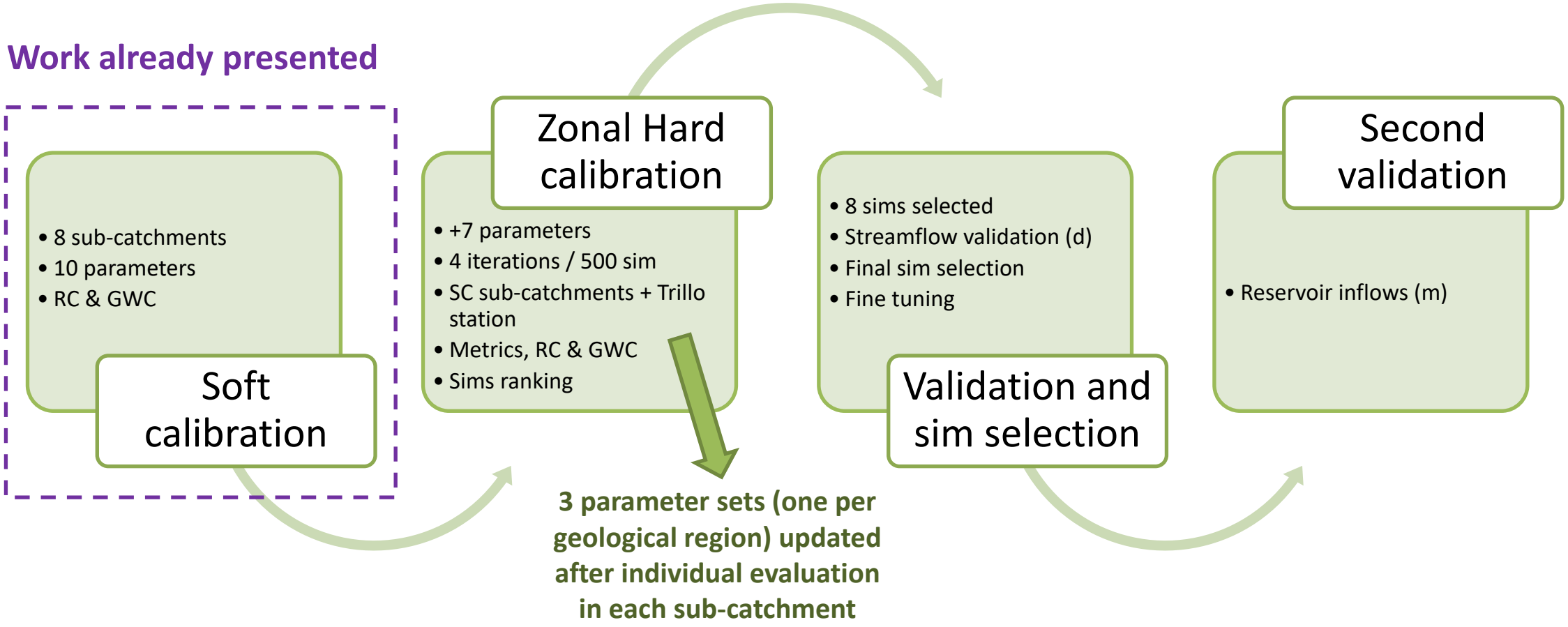
- For 2 hydrological indices: Runoff coefficient (RC) and groundwater contribution to streamflow (GWC)
- Yielded satisfactory results: Presented at SWAT2023 Conference

Objectives

- To perform a hard calibration
- To design a strategy to identify the best simulation
  - Selecting several simulations for validation
  - Testing them on aggregated daily streamflow
  - Choosing and fine-tuning the best simulation
  - Performing a second validation on reservoirs inflow

Methodology

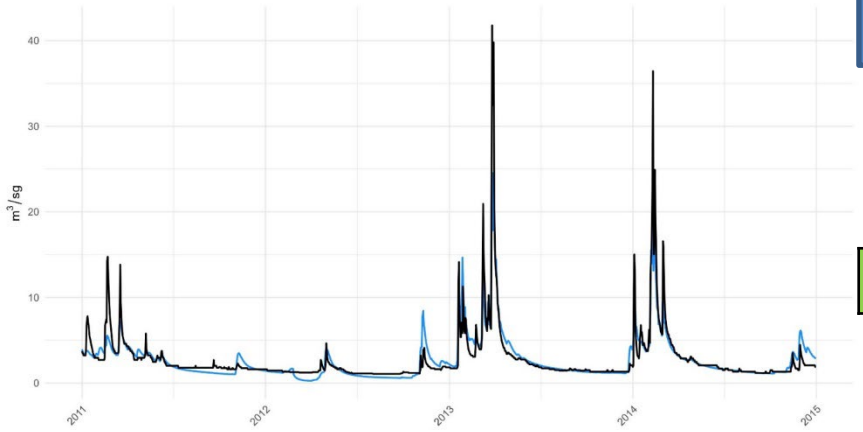
Calibration-Sim Selection-Validation



Results

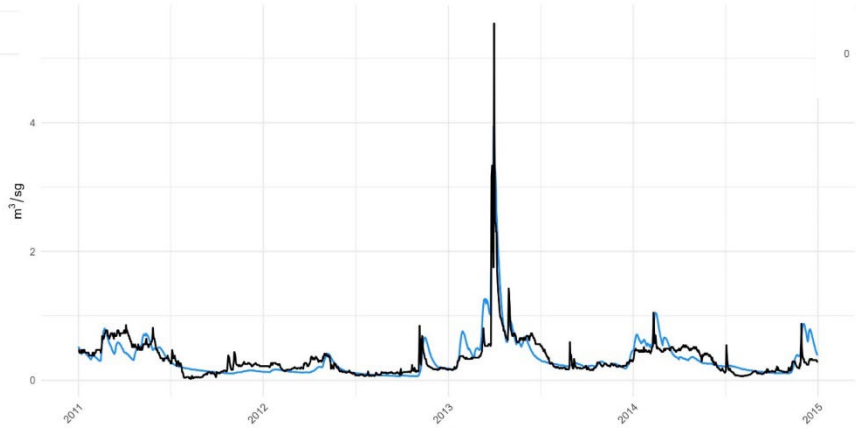
Hard calibration

CRB | **Priego Escabas**

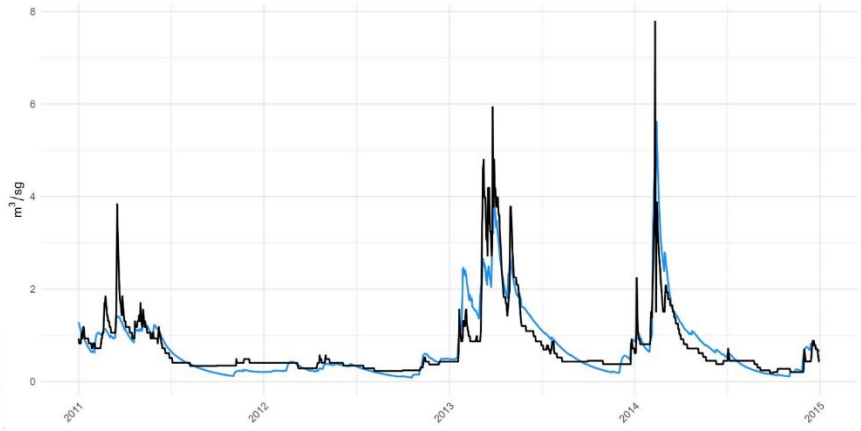


Results at sub-catchment level

D-H | **Huete**



MIX | **Taravilla**



PROBLEM:
Best simulation is a different one in each sub-catchment!

Selection of simulations

- 4th HC iteration sims were statistically ranked
- 8 selected (repeated in at least 3 sub-catchments belonging to different geological regions -2 if included in Trillo-)

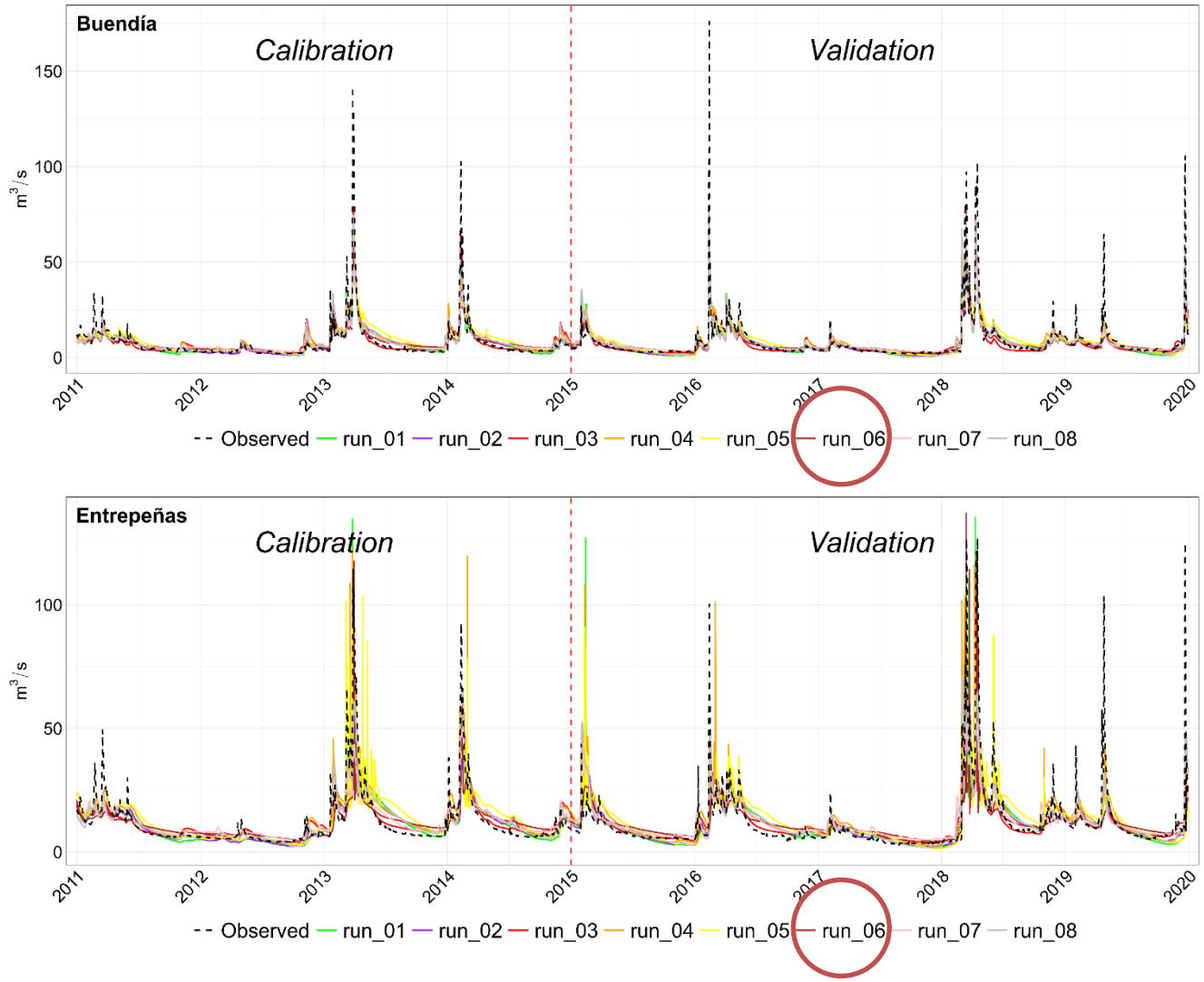
20 statistically best sims per sub-catchment

1 Peralejos	41 Alcantud	45 Priego-Escabas	172 Huete	173 La Peraleja	186 Priego-Trabaque	268 Taravillas	30 Ventosa	Trillo
457	194	371	54	147	67	231	334	47
135	286	141	498	193	81	191	304	394
116	394	135	234	477	247	149	473	332
71	47	77	361	231	472	208	242	416
236	275	22	30	360	300	213	282	262
235	212	94	84	369	320	345	149	286
60	267	126	216	273	395	485	406	208
448	239	103	243	234	307	176	475	409
164	143	211	127	208	89	406	278	96
249	104	246	247	431	199	441	386	120
362	409	349	395	75	315	46	332	212
88	438	156	350	310	456	434	35	395
410	307	449	381	472	229	262	307	61
169	8	164	4	37	334	283	453	87
491	332	57	278	139	227	188	223	252
255	337	365	185	82	23	54	63	152
283	137	88	397	123	80	148	152	483
314	388	116	231	443	278	87	157	330
22	395	1	305	381	208	8	120	143
24	120	268	404	89	233	386	47	491

	CRB
	DH
	MIX
	CRB MIX
	CRB Trillo
	CRB MX Trillo
	DH MIX
	DH MIX Trillo
	MIX Trillo
	All

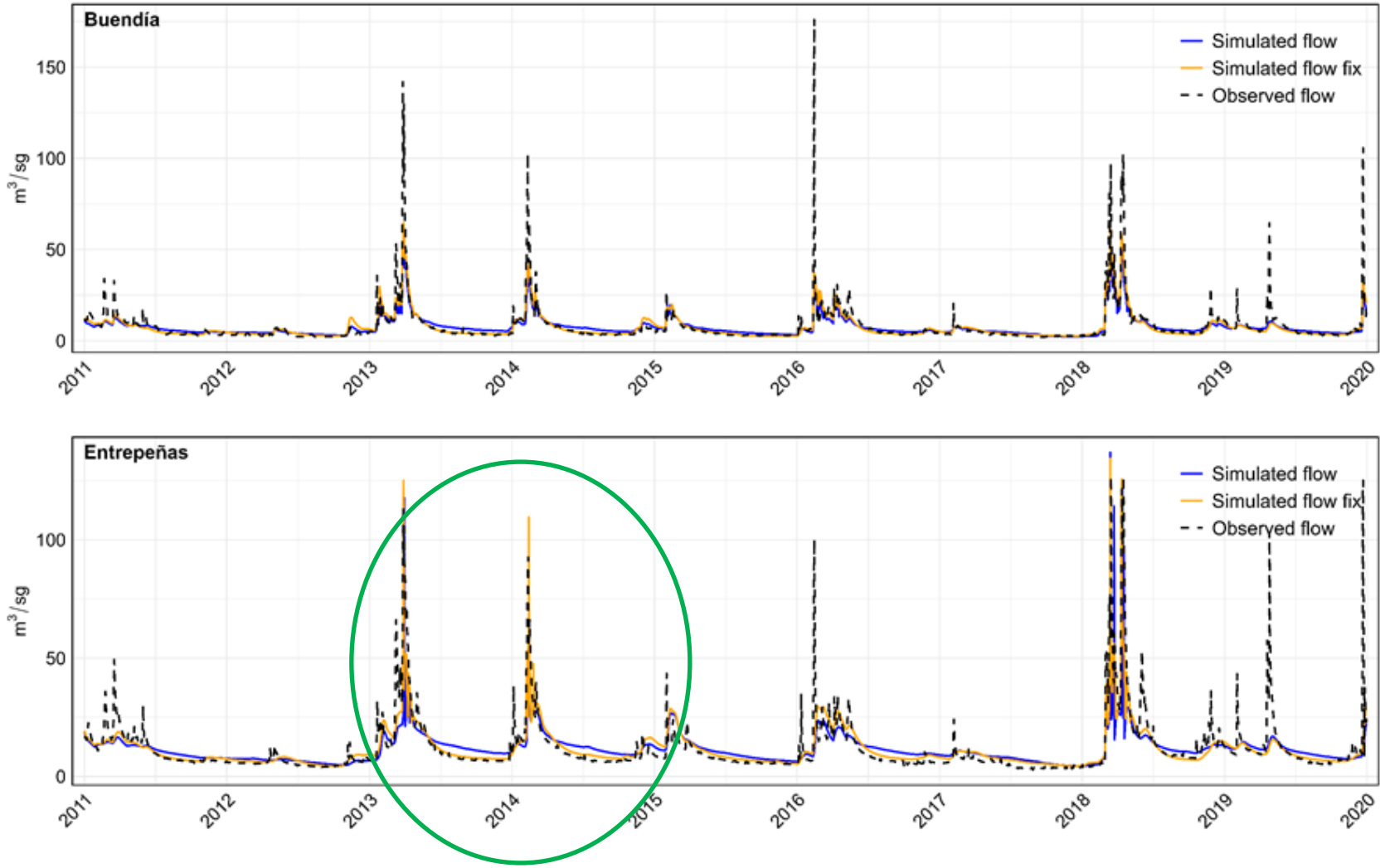
395	All
208	DH MIX Trillo
47	CRB MX Trillo
283	CRB MIX
231	DH MIX
307	CRB MIX2
262	MIX Trillo
394	CRB Trillo

Sims evaluation and best sim selection



- Parameter values extracted for 8 selected sims
- Daily streamflow aggregated per reservoir catchment
- Sims evaluated for CAL and VAL periods, also checking RC and GWC
- Run #06 selected → realistic simulation of RC and GWC

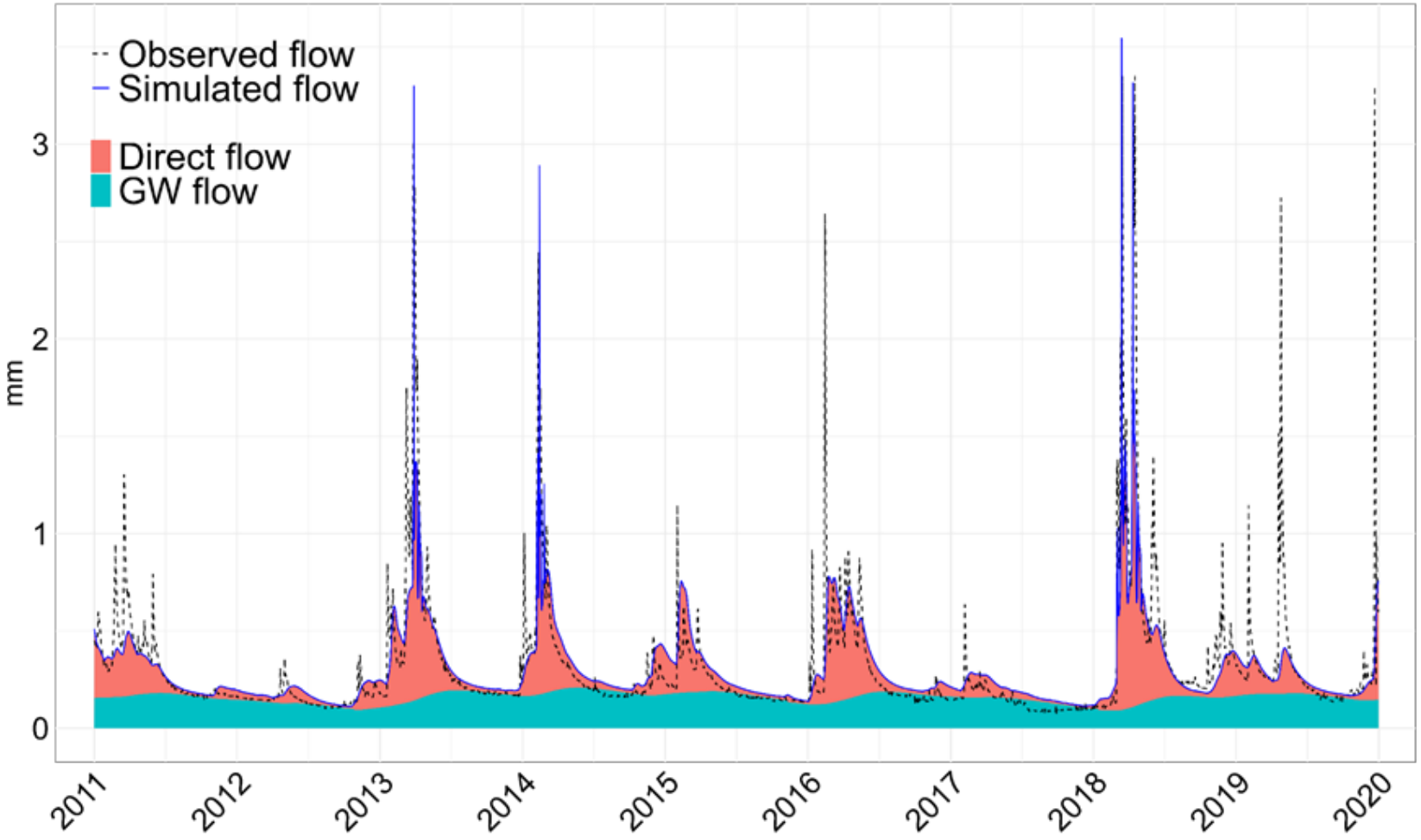
Fine tuning



- Run #06 overpredicted flow during low flow periods
- lat_ttime was manually recalibrated

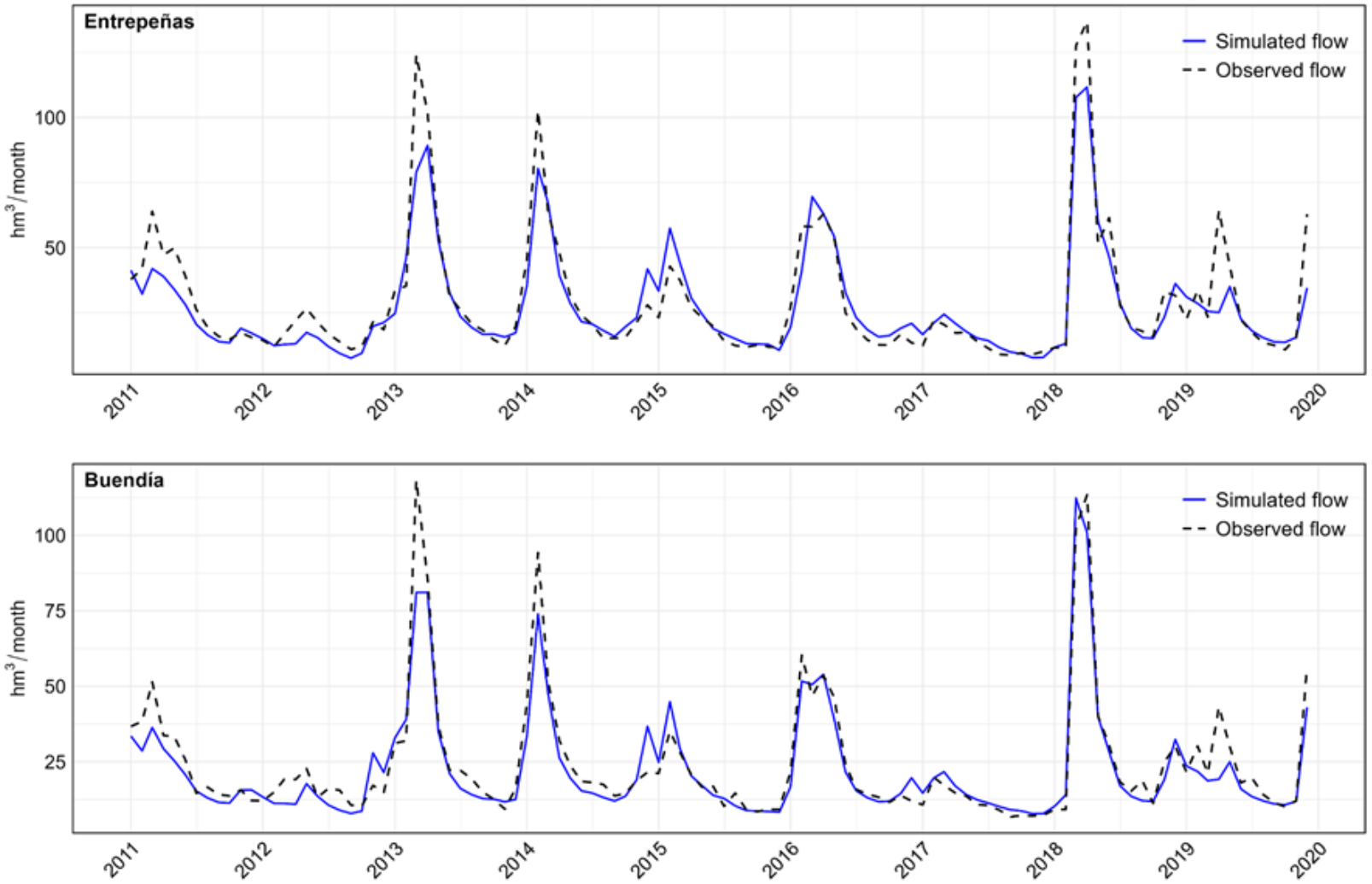
	Modified lat_ttime			
	NSE	R^2	PBIAS	RMSE
E_Cal	0.73	0.75	-3	6.01
E_Val	0.52	0.52	-3.9	9.13
B_Cal	0.74	0.8	-4	5.3
B_Val	0.67	0.72	-12.9	6.24

Fine tuning



NOT ONLY STATISTICALLY SATISFACTORY BUT ALSO REALISTIC SIMULATION

Second validation



	Entrepeñas	Buendía
NSE	0.86	0.89
R^2	0.88	0.91
PBIAS	2.5	-8.5

Conclusions

Conclusions

- A complex procedure has been designed to address a zonal hard calibration
- 8 simulations were tested for validation after HC, selecting one that yielded both satisfactory metrics and realistic simulation of hydrological indices.
- Further fine tuning was needed to achieve the best performance possible, particularly regarding low flows.
- The results obtained reveal the robustness of the methodology, achieving a parameters set that correctly simulates three geological regions.
- The model can be use for decision-making in water management, and can inspire SWAT+ users developing better calibration strategies towards more realistic models

Acknowledgements

MERCI!

Contact:

✉ eugenio.molina@uah.es

𝕏 @emolinanavarro

in www.linkedin.com/in/eugenio-molina-navarro

Cofinanciado por la Unión Europea

MINISTERIO DE CIENCIA, INNOVACIÓN Y UNIVERSIDADES

MINISTERIO DE HACIENDA Y FUNCIÓN PÚBLICA

AGENCIA ESTATAL DE INVESTIGACIÓN

Castilla-La Mancha

Fondos Europeos

Universidad de Alcalá