LOCALISED IMPACT OF DIFFERENT METEOROLOGICAL FORCING DATA AND SCALES IN HIGH-RESOLUTION HYDROLOGICAL MODELLING

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HIGHER RESOLUTION FORCING DOES NOT ALWAYS IMPROVE HYDROLOGICAL MODEL RELIABILITY AND MAY INCREASE UNCERTAINTY RELATIVE TO COMPUTATIONAL COST

RESEARCH QUESTION

- Climate change impacts require an improved understanding of local hydrological dynamics for informed water allocation decisions and policy
- To obtain highly localised dynamics, hydrological modelling community is increasingly adoping hyper-resolution approaches
- Yet, hydrological models are highly sensitive to meteorological forcing and higher resolution meteorological forcing data contain a higher degree of uncertainty which may result in an overall poorer performance of higher resolution models

Do higher resolution forcing data meaningfully improve model performance or do they amplify uncertainty?

STUDY AREA: EBRO BASIN, SPAIN

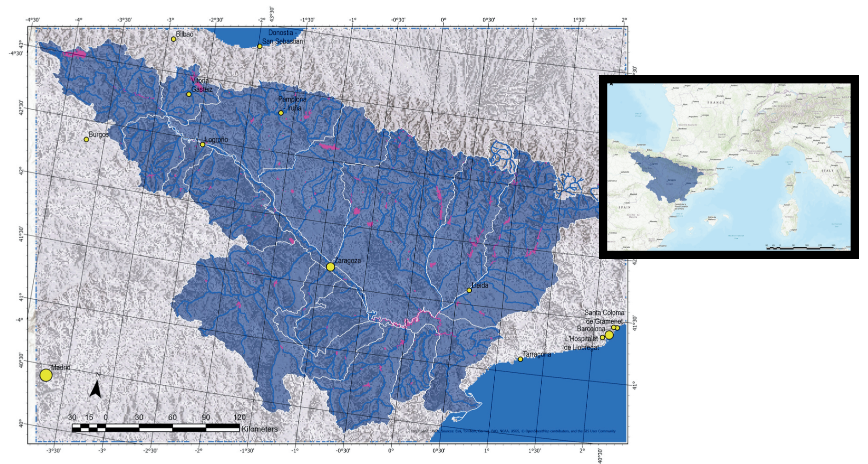


Fig. 1: Location and extent of the Ebro basin with underlying 1km-resolution drainage direction map (in grey) as basis for the hydrological model CWatM, the hydrographic network of contributaries and canals surrounding the Ebro river, the reservoirs of the region (pink), major cities (yellow) as well as a delineation of the irrigator community districts (white delineation)

- Highly variable intrabasin precipitation of 200 mm/year in the lower regions and 2000 mm/year in the Pyrenees
- Heavily human modified region with ~180 irrigation as well as hydroelectric reservoirs and irrigation canals
- Approximately 90% of the basin water use can be attributed to agriculture
- Ca. 30% of Spanish meat production and 60% of Spanish fruit production originates from this region
- Highly vulnerable region for hydrological impacts of climate change

KEY FINDINGS

NATURAL FLOWS

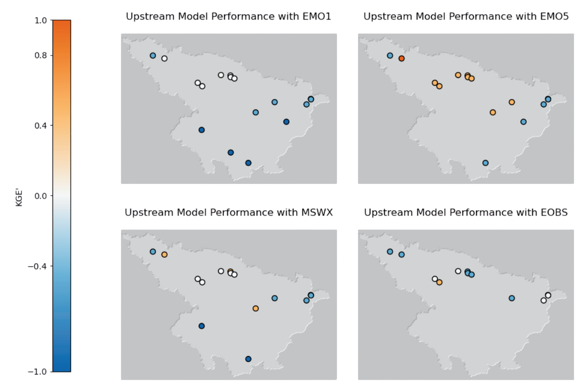


Fig. 3: Model performance with different meteorological forcing data at upstream (natural flow) gauges and inflows throughout the basin

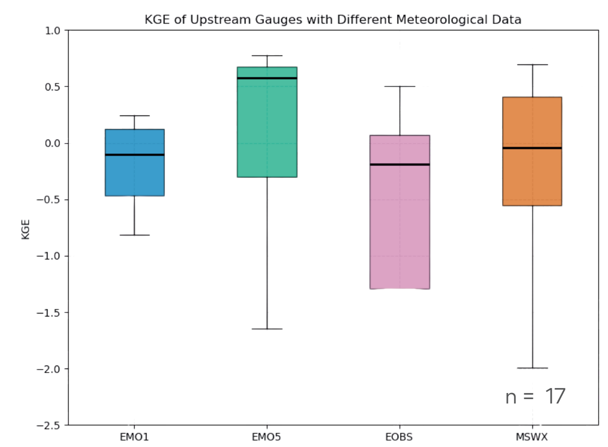


Fig. 4: Boxplot of model performance with different meteorological forcing data at upstream (natural flow) gauges and reservoir inflows throughout the basin

MODIFIED FLOWS

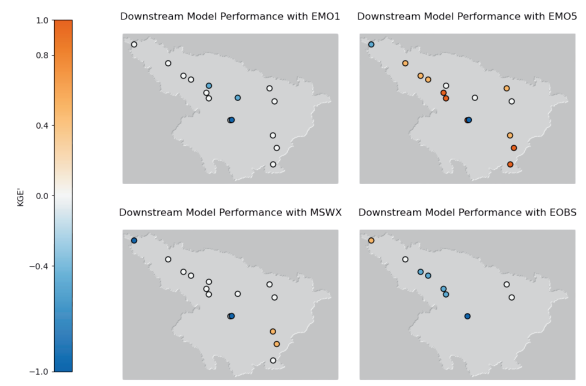


Fig. 5: Model performance with different meteorological forcing data at downstream (modified flow) gauges and inflows throughout the basin

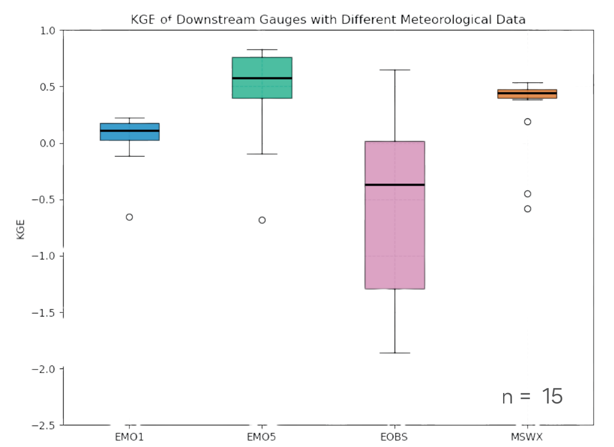


Fig. 6: Boxplot of model performance with different meteorological forcing data at downstream (modified flow) gauges and inflows throughout the basin

RESERVOIR PERFORMANCE

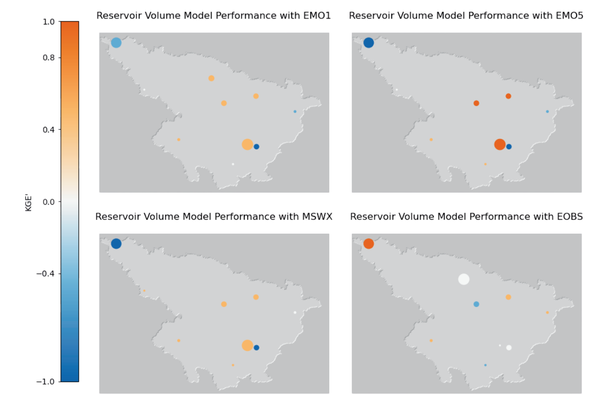


Fig. 7: Hydrograph for three reservoirs within the basin:

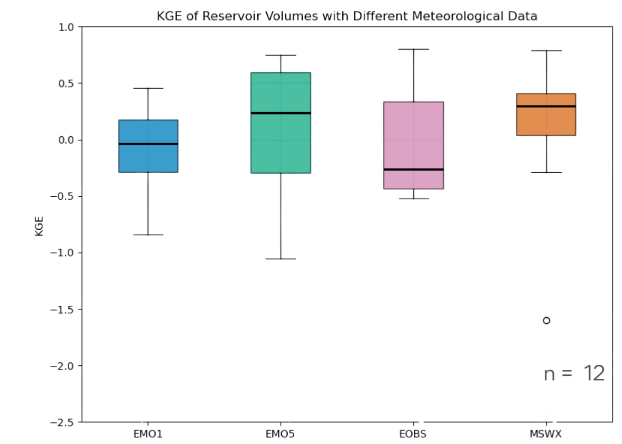
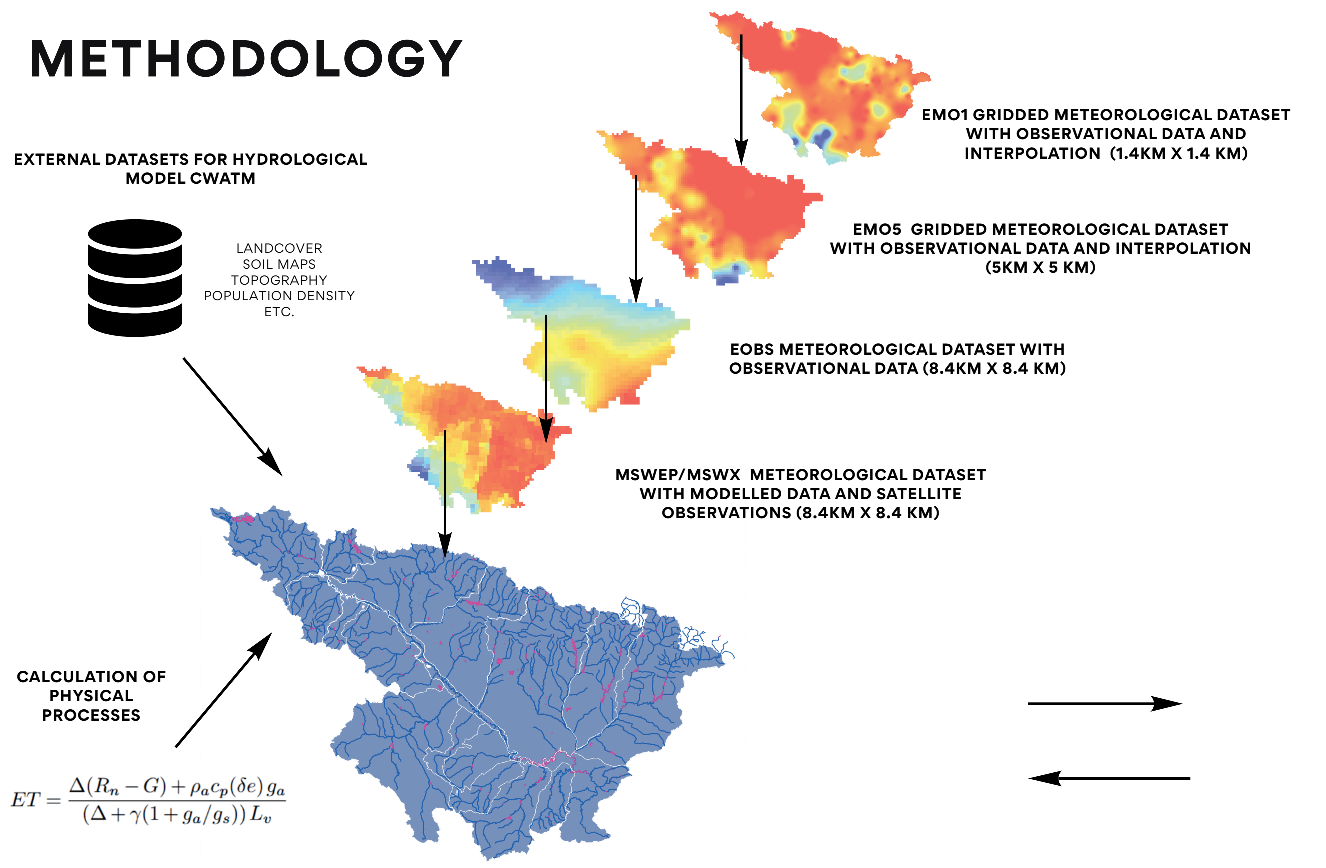


Fig. 8: Boxplot of model performance with different meteorological forcing data for reservoir volume throughout the basin

METHODOLOGY



SET-UP OF THE HYDROLOGICAL MODEL CWATM

CALIBRATION PROCESS FOR DIFFERENT METEOROLOGICAL INPUT DATA WITH EVOLUTIONARY ALGORITHM WITH KGE' OBJECTIVE FUNCTION

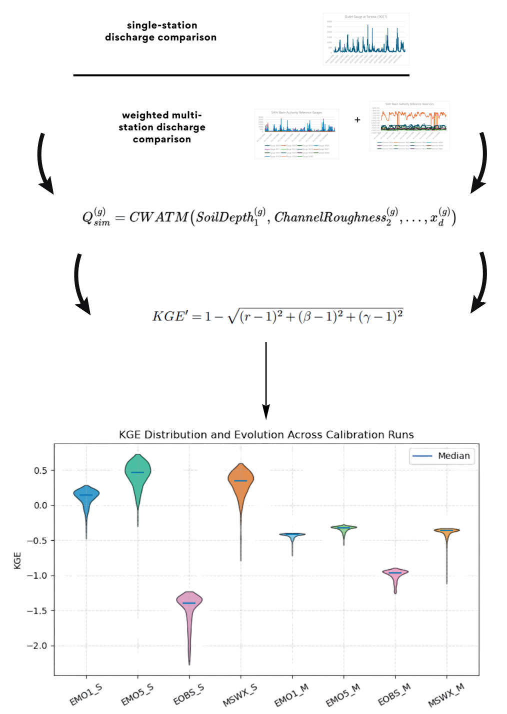


Fig. 2: Evolution of KGE' after 30 generations, with a parent generation of 256 runs and 32 children per generation per model set-up

CONCLUSION & OUTLOOK

- Model performance evaluated based on natural streamflow gauges for assessment of model performance without human modifications to streamflow
- Overall, model performance indicates a good fit for upstream streamflows in particular with EMO-5
- Model results consistently acceptable using lower resolution dataset MSWX
- Model performance was poor with observational dataset EOBS
- Model performance did not improve with higher resolution meteorological dataset EMO-1

For high resolution hydrological modelling at 1km scale, model performance of CWatM may not be impacted by merely increasing meteorological forcing. Data quality of meteorological forcing as main driver of the model has higher impact. Furthermore, the necessity to incoroporate further small-scale hydrological processes becomes evident.

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