

River parametrisation of the JULES land surface model for improved runoff routing at the global scale

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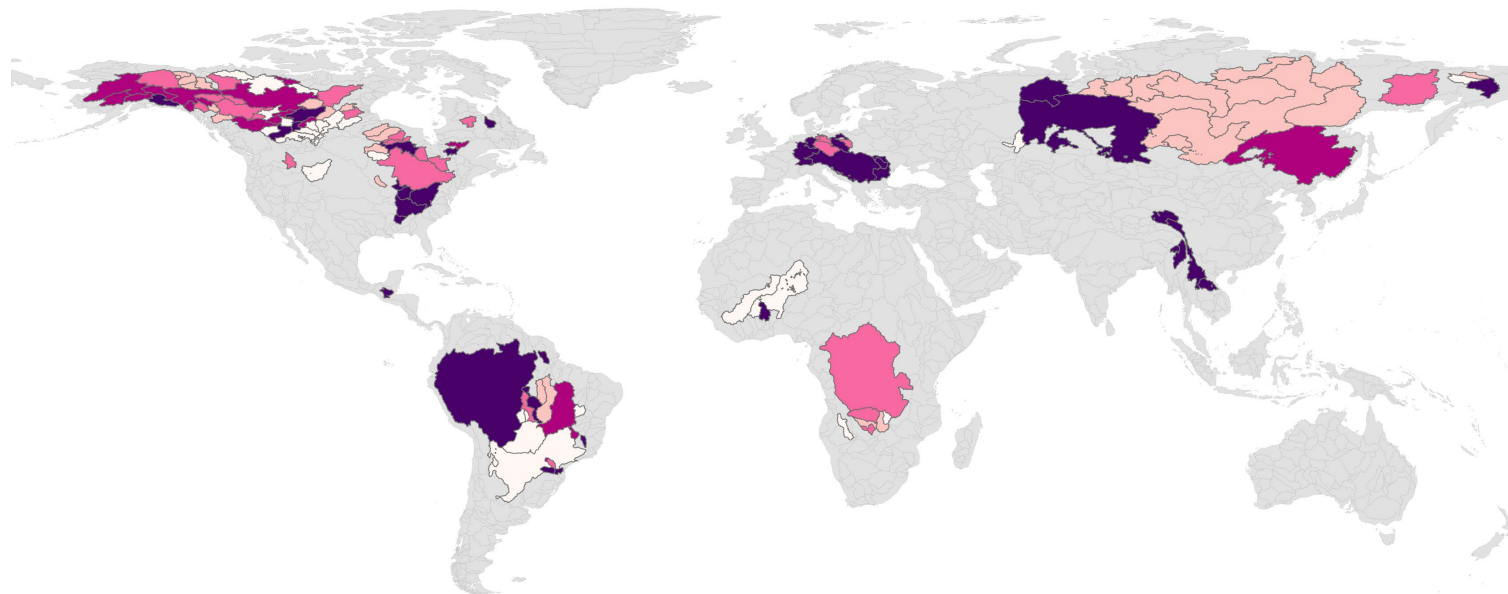
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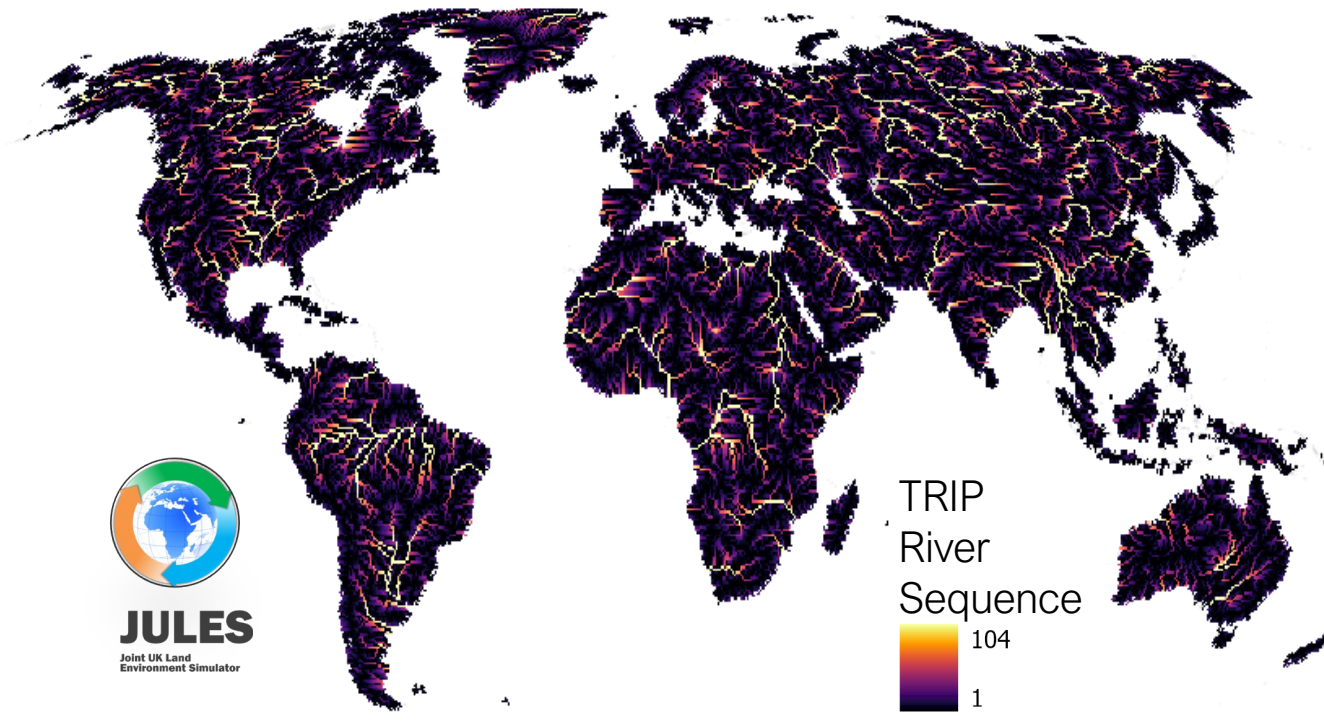


Overview

- The JULES land surface model has a wide-ranging application in studying different processes of the earth system including hydrological modeling.
- Two implementations of river routing (kinematic wave) are available:
TRIP: Total Runoff Integrating Pathways
RFM: Rapid Flow Model
- TRIP developed by Oki et al. (1999) and implemented in JULES by Falloon et al. (2007)
- Uses a simple approach of globally constant river **velocity** (0.4 m s^{-1}) and **meandering** factor (1.4) as a ratio of the actual to calculated river lengths in a river routing gridbox.

Key Questions

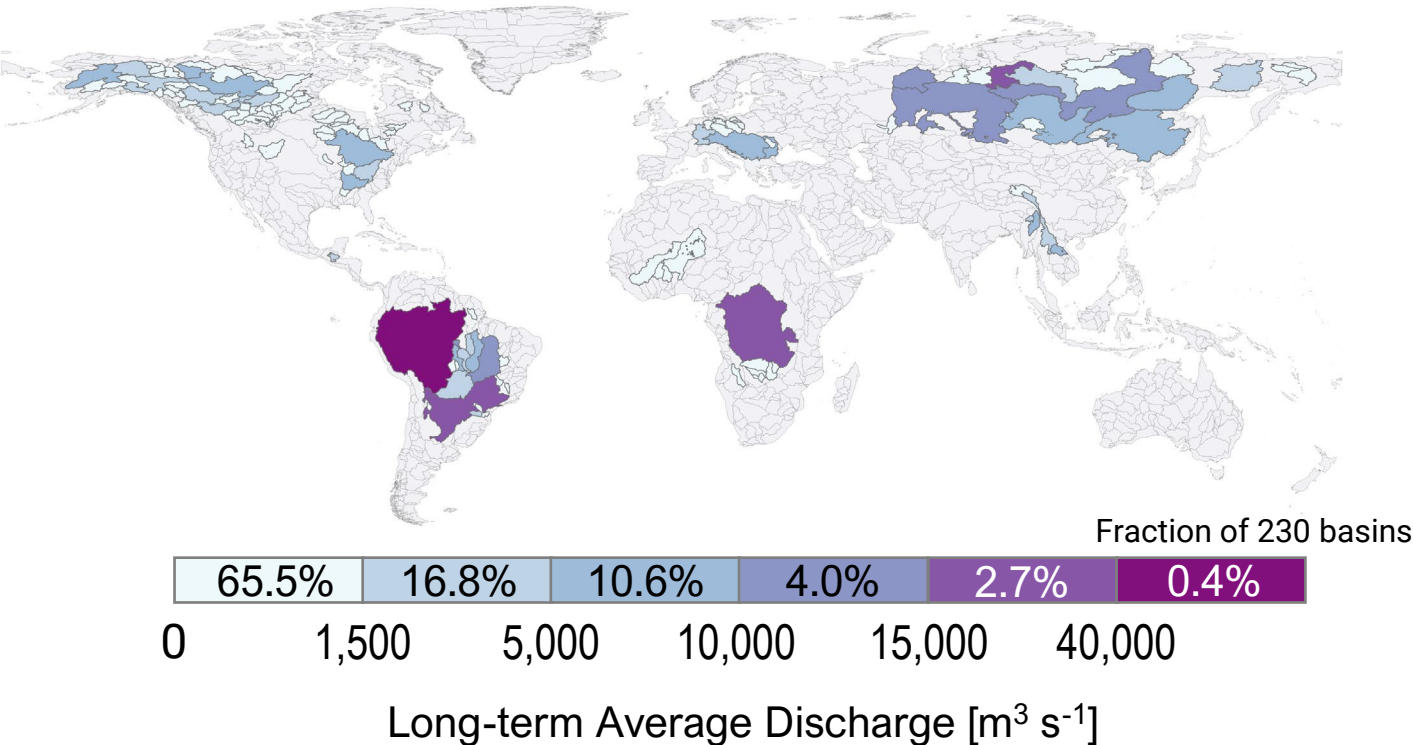
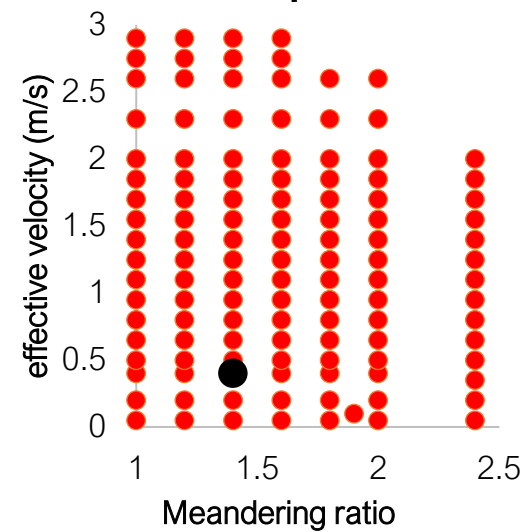
- ? The approach is sufficient to model mean long-term river flow, but is it adequate for short term fluctuations?
- ? Can we improve river routing by **tuning** the existing configuration of the global river routing scheme at 0.5° spatial resolution and improve river flow simulation performance at finer temporal scales?



Method

- We develop a factorial experiment of varying effective flow velocity and meandering ratio, driven by GSWP3-W5E5 (1971-2010)
- We test and adjust best performing configurations at the basin scale based on observations from 230 GRDC stations that exhibiting a variety of hydroclimatic and physiographic conditions.
- The analysis was focused on watersheds of near-natural conditions (Zhao et al. 2017)

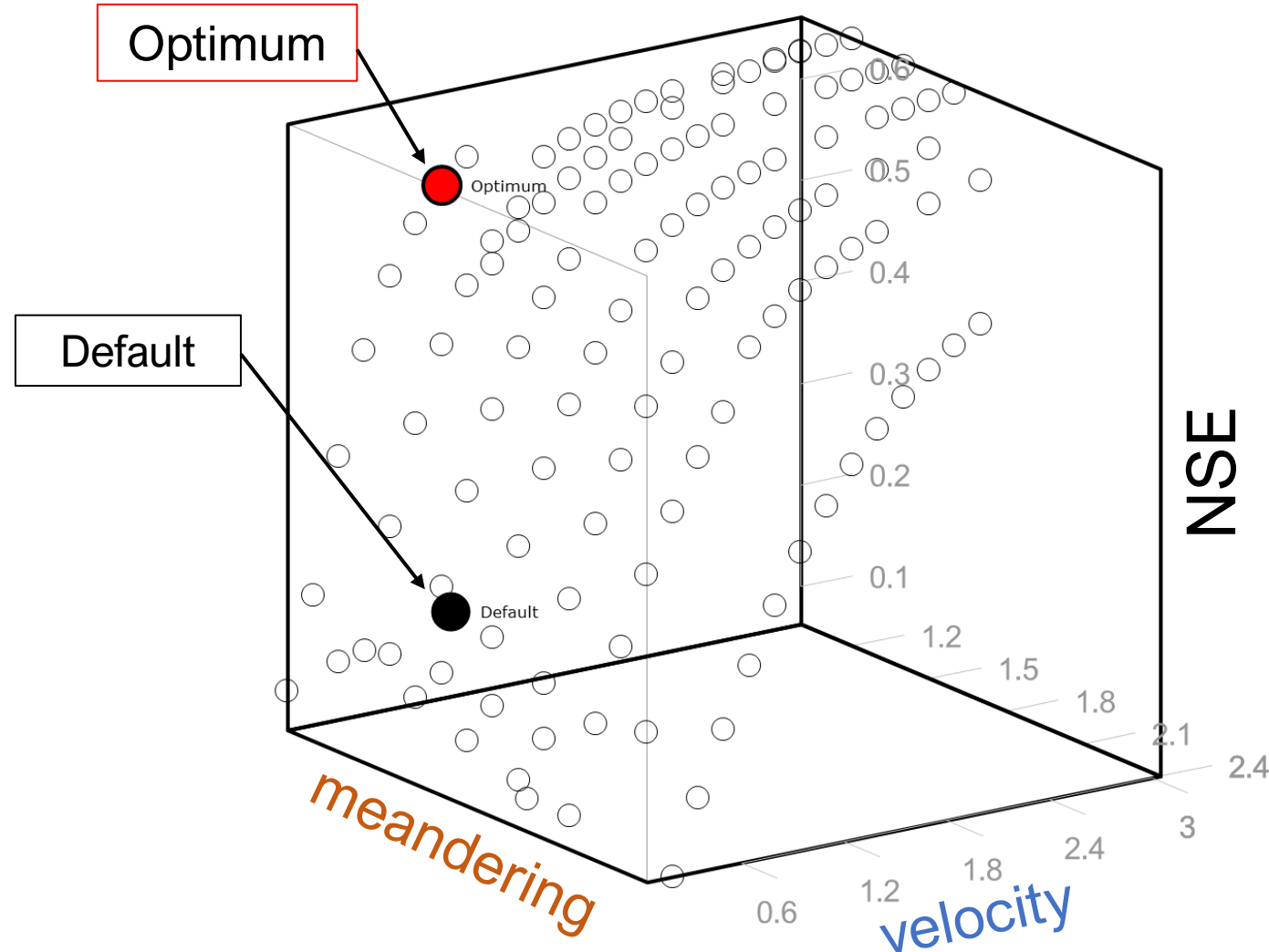
Factorial Experiment



Method

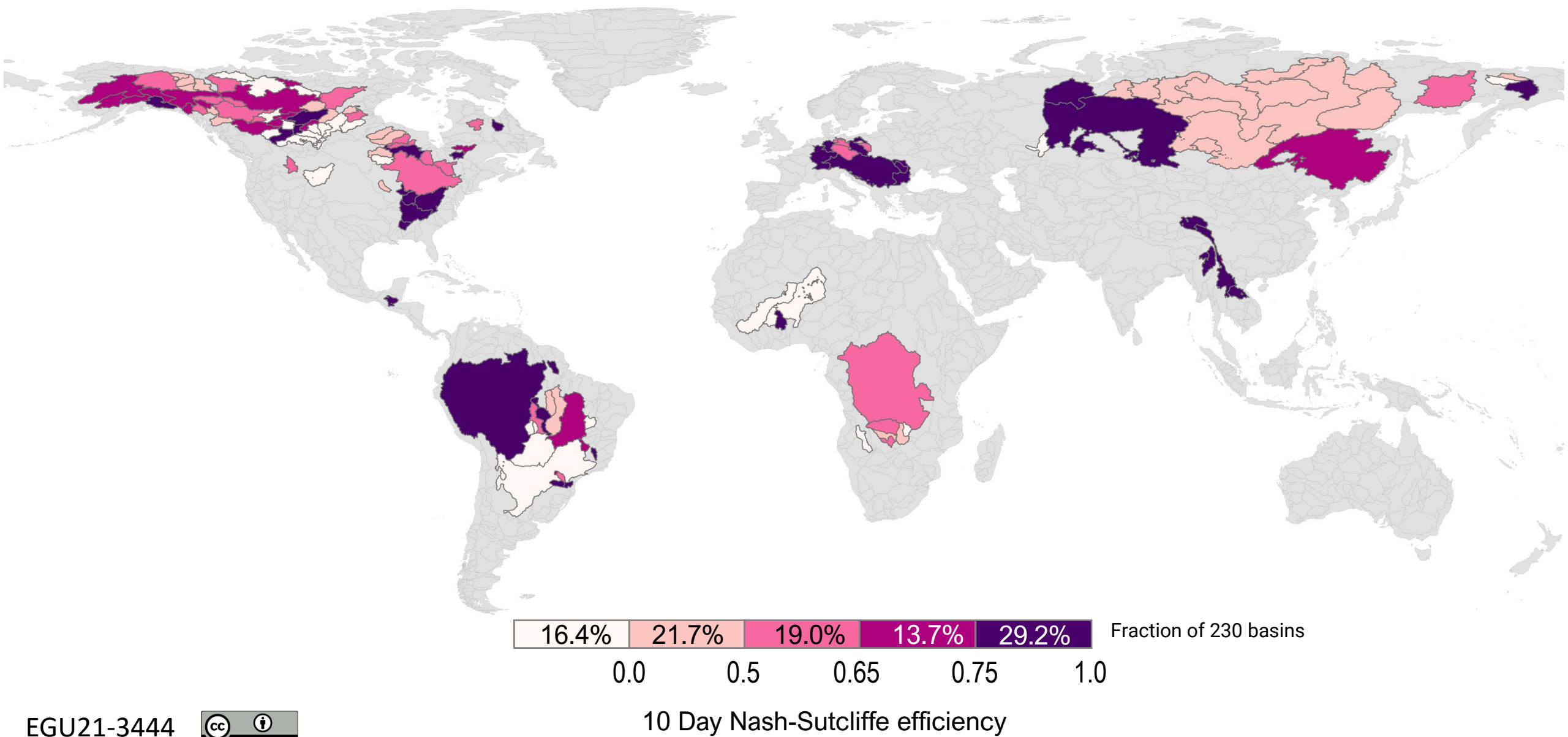
- To overcome inconsistencies between observations and forcing data at the daily temporal scale we applied the evaluation metrics at a 10day temporal time step.
- We defined a measure to select the optimum combination based on the max gain in Nash–Sutcliffe efficiency and the least deviation from the default velocity and meandering values.
- For each basin we select the best performing set of TRIP parameters per basin resulting to the optimal efficiency of river flow simulation based on the Nash–Sutcliffe efficiency

$$OPT = \max \left(\frac{\Delta(NSE_{10days})^2}{\sqrt{\Delta(meander)^2 + \Delta(velocity)^2}} \right)$$



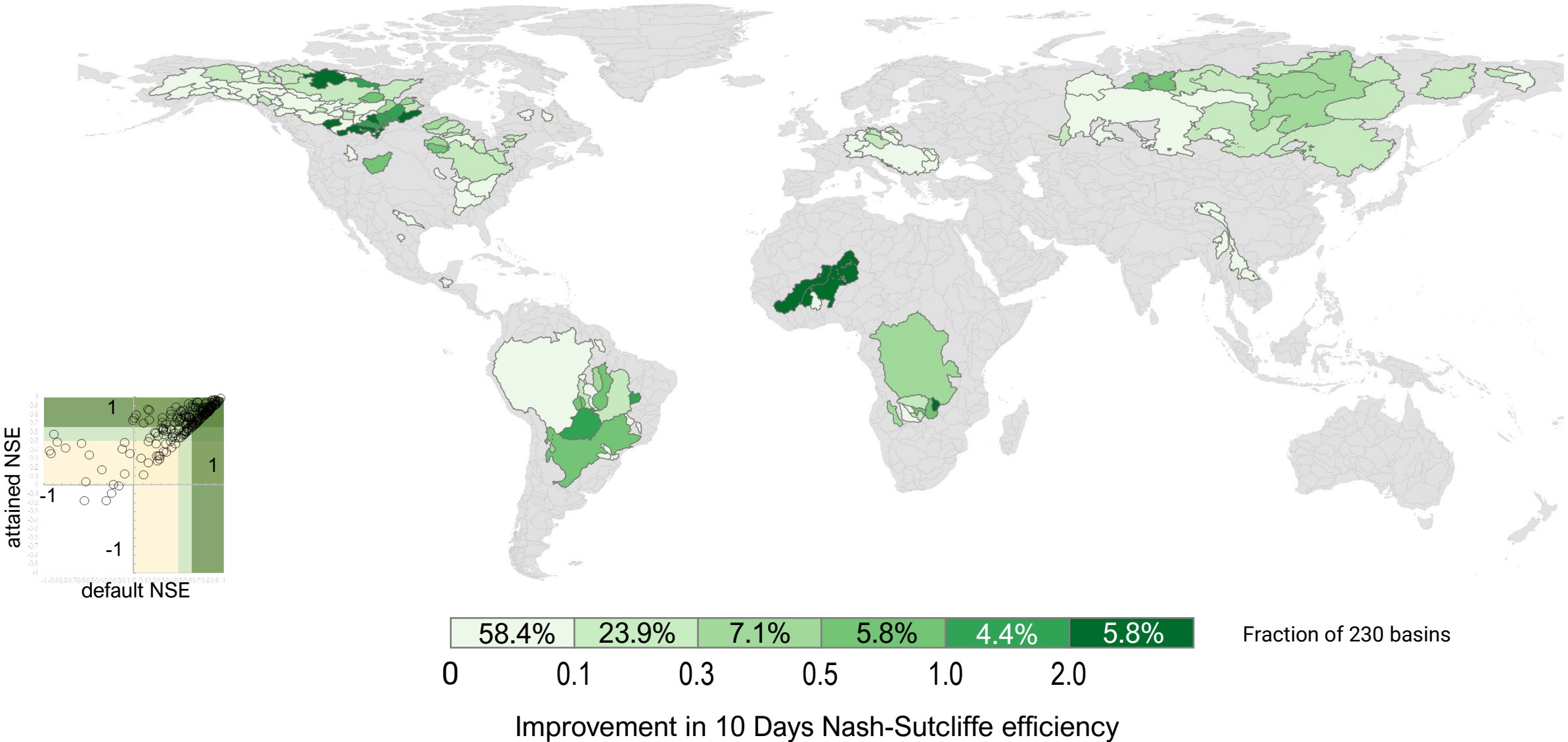
Results

Nash-Sutcliffe efficiency based on the default configuration of globally constant river **velocity** (0.4 m s^{-1}) and **meandering** factor (1.4)



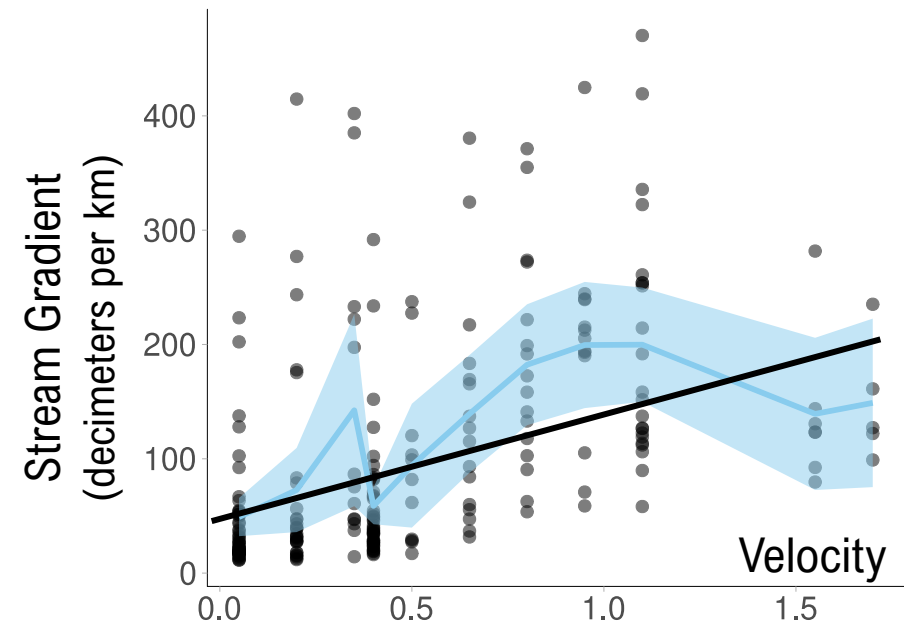
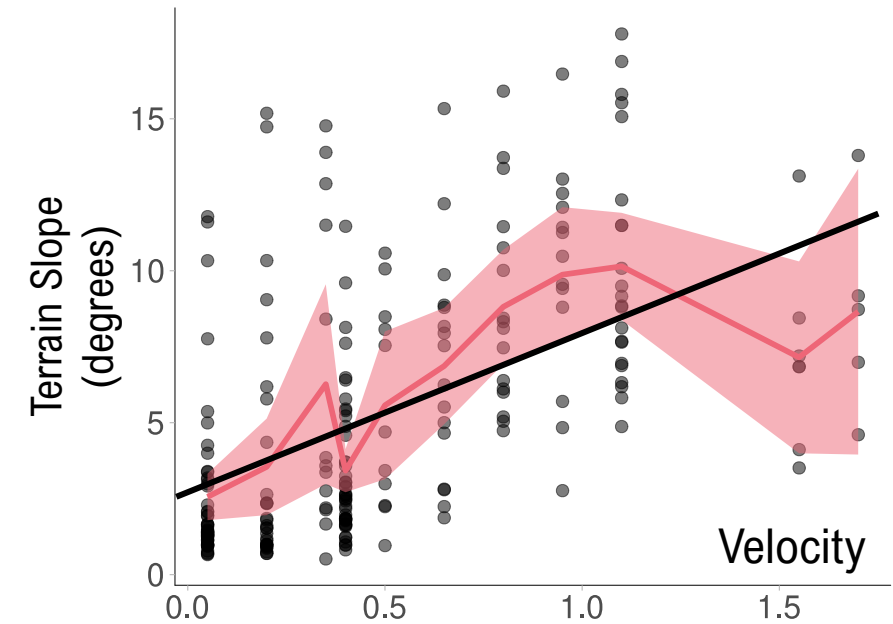
Results

Improvement in Nash-Sutcliffe efficiency based on the optimized configuration for each river basin.



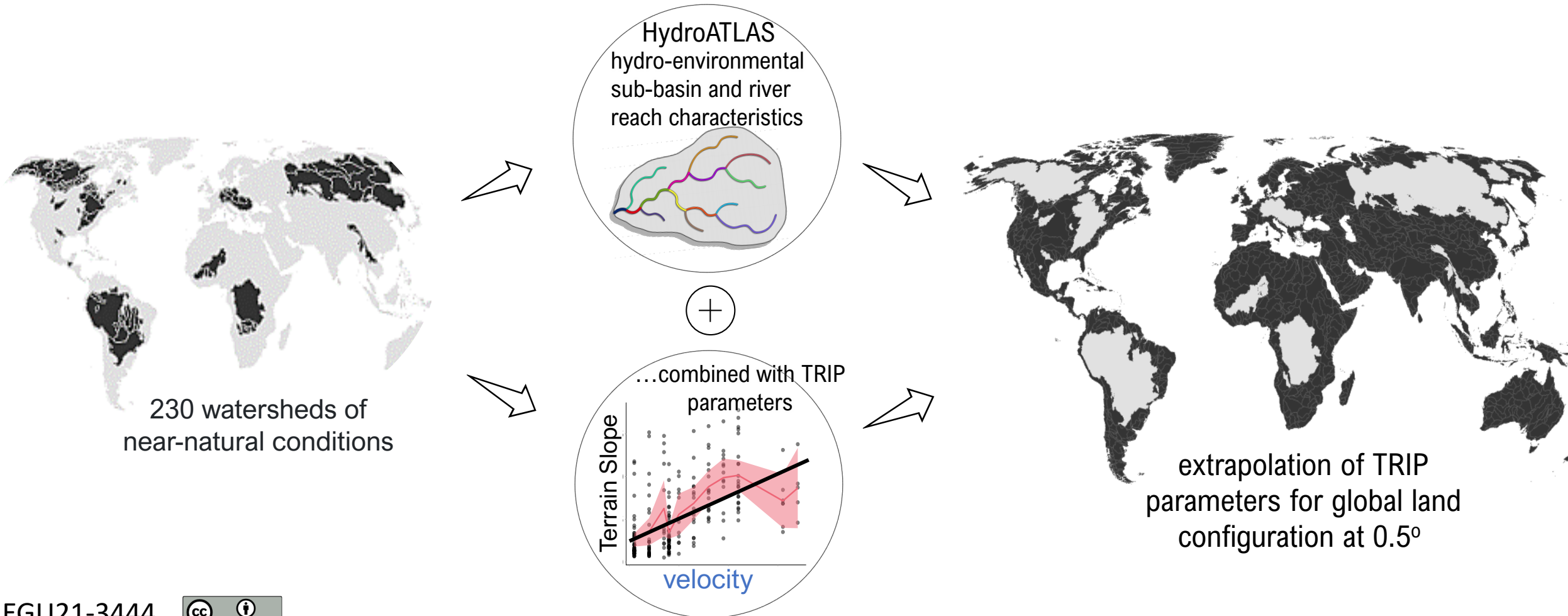
Further Analysis

- The HydroATLAS database (Linke et al 2019) was employed to identify basin scale descriptive hydro-environmental indicators that could be associated with the components of the TRIP.
- These indicators summarize hydrologic and physiographic characteristics of the drainage area of each flow gauge.
- We find that better performance is driven predominantly by characteristics related to the stream gradient and terrain slope.



Next Step

The hydro-environmental sub-basin and river reach characteristics can serve as descriptors for extrapolating the adjustment of TRIP parameters for global land configurations at 0.5° spatial resolution using regression models.



References

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Thank you

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