TECHNISCHE UNIVERSITÄT DRESDEN

Faculty of Environmental Sciences,
Department of Hydrosciences
Institute of Hydrology and Meteorology,
Chair of Meteorology

DRESDEN concept

Global BROOK90: validation, uncertainties, current progress and future outline

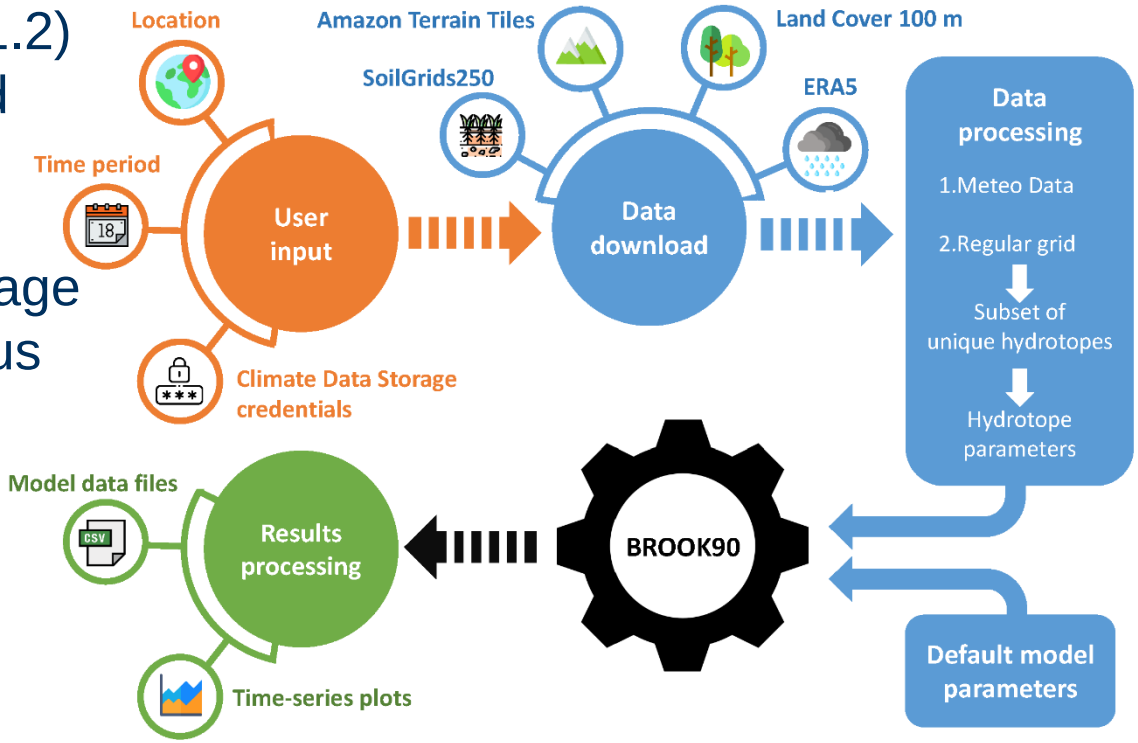
Vorobevskii Ivan, Kronenberg Rico

Presenter: Vorobevskii Ivan

Dresden, 26/04/2021

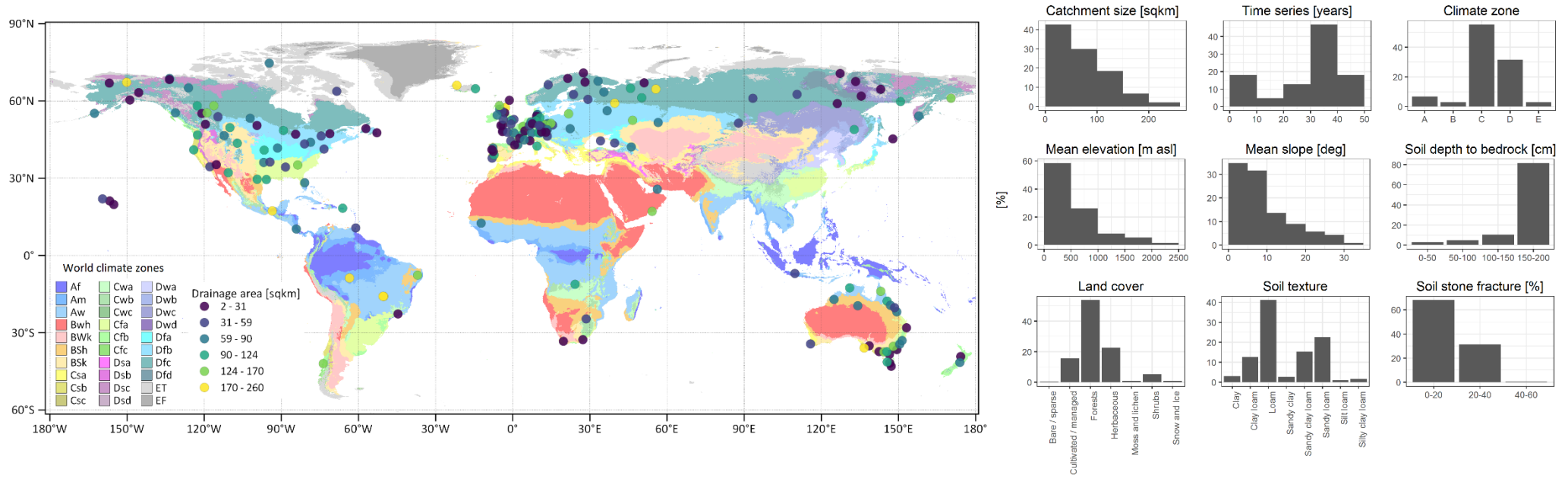
Global BROOK90 - first fully automatic open-source framework to model the water balance components at any location [1]

- R Github library (current version 1.2)
- Minimum input from user required (location, time-period)
- Automatic data download, processing, modelling, result storage
- Global parameterization for various land cover and soil types
- Global meteorological forcing (ERA5)
- 1D physically-based soil-plant-atmosphere BROOK90 model
- Daily historical simulations



Global BROOK90 framework

Validation of runoff component [2]: data

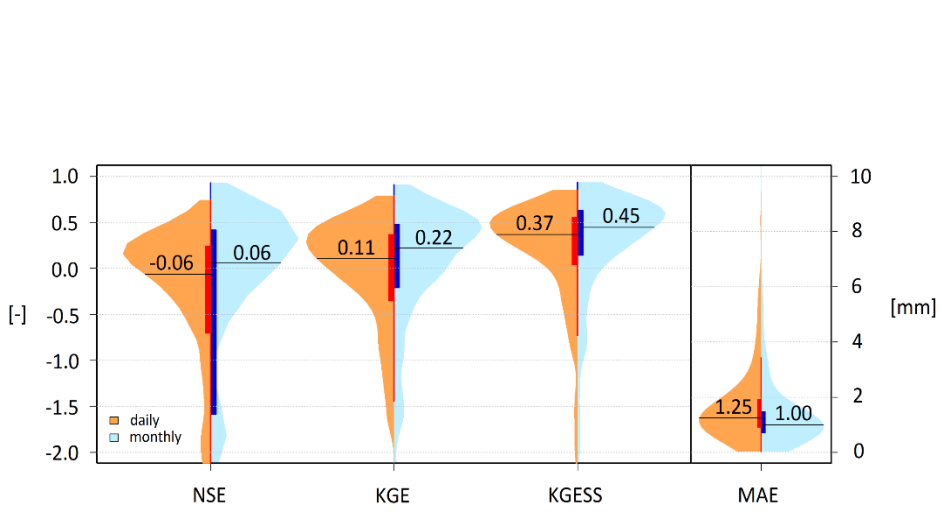


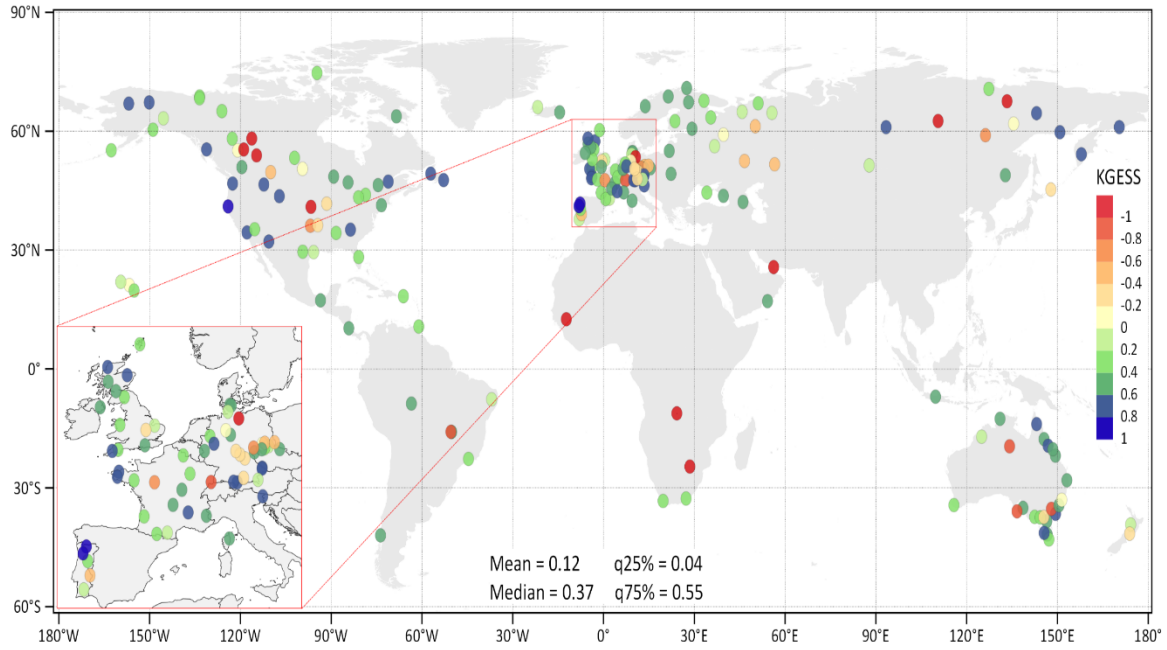
Location and main characteristics of the chosen catchments

- 190 small catchments (median size 64 sqkm)
- 1979-2020 time period (median length 30-40 years)
- Location – all over the globe (various climate, land use, soils)
- Natural regime

Validation of runoff component: results

- Satisfactory performance for more than 75% sites (KGESS > 0)
- Outperform GLOFAS-ERA5 (for the same catchment size category)

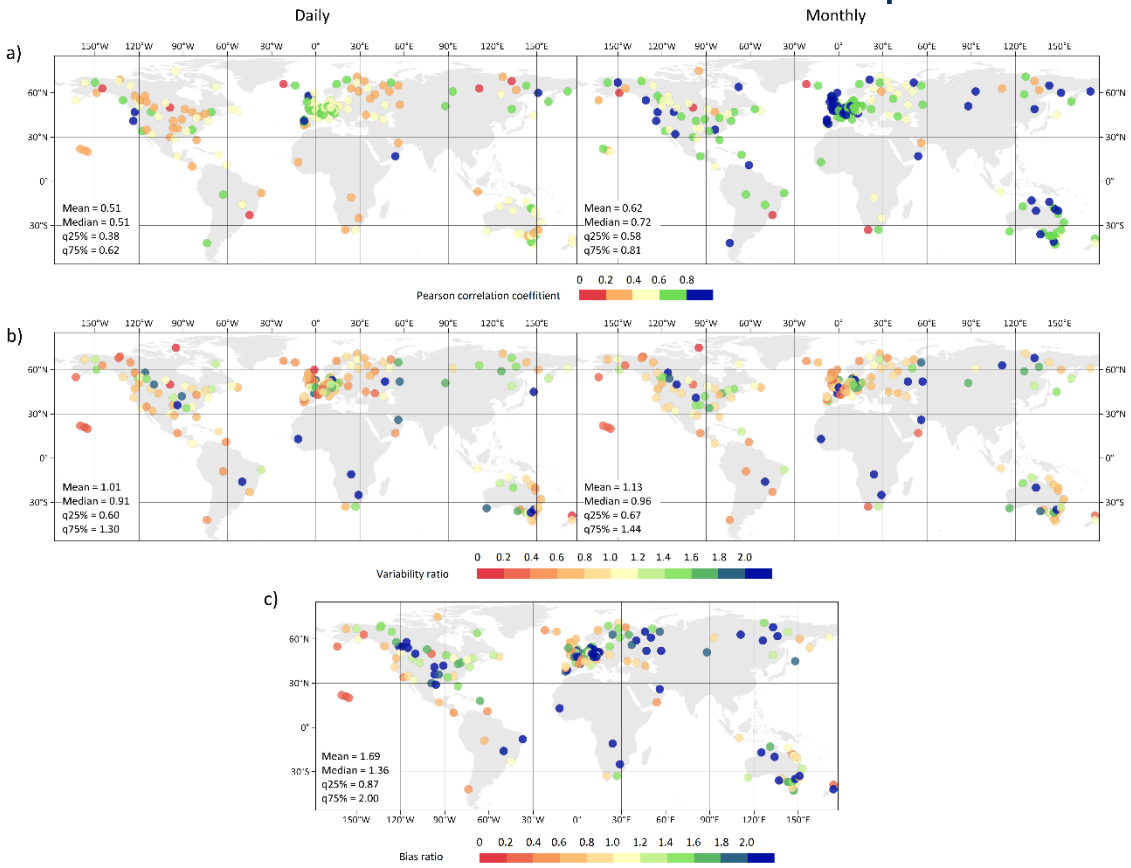




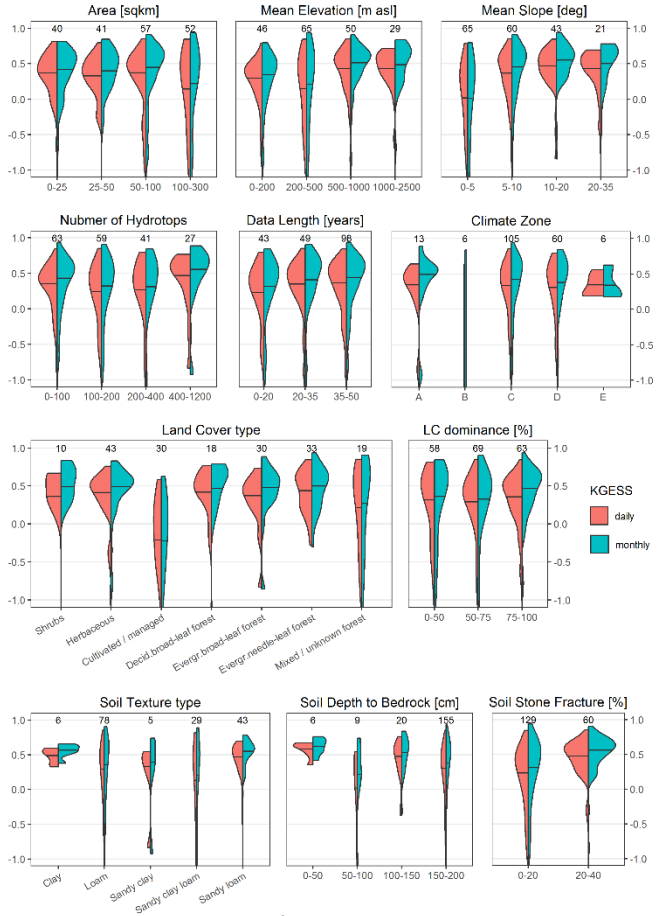
Aggregated and spatially distributed model performance metrics

Validation of runoff component: results

- Good representation of variability, but noticeable positive bias
- Significantly better results on monthly scale
- Significant influence of topography, land cover, soil depth and stone fracture, HRU number on the framework performance



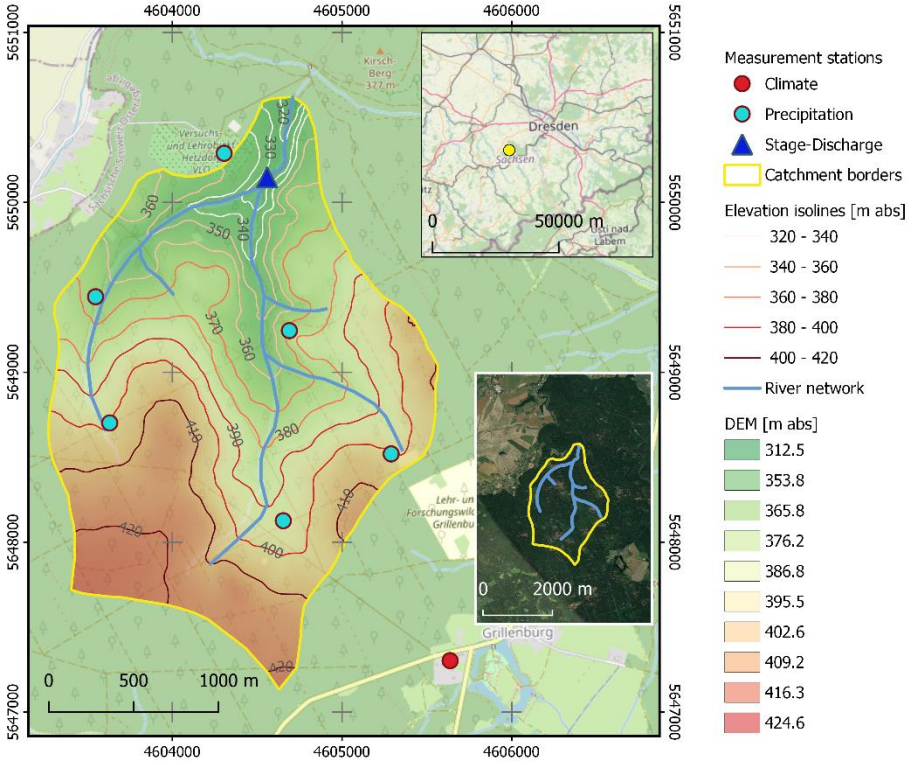
KGE decomposition



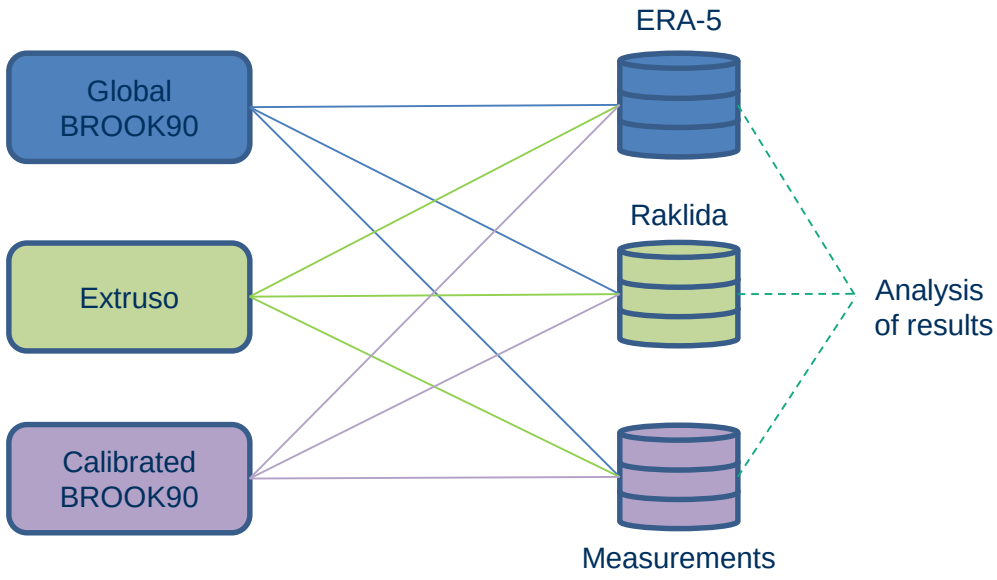
Result's clustering

Comparison of BROOK90 frameworks: local to global scale

- BROOK90 frameworks with a mix of meteo inputs
- 3 scales – global (Global BROOK90 and ERA5 [3]), regional (EXTRUSO [4] and RAKLIDA [5]) and local (calibrated BROOK90 [6] and measurements [7]
- Case study of small forested Wernersbach catchment (4.6 sq km)



Wernersbach catchment



Experiment set-up

Comparison of BROOK90 frameworks: results

- Local and regional scale frameworks show the highest and close performance results, global parameterization with global datasets give the lowest scores
- Forcing of regional and local parameter frameworks with ERA5 still gives satisfactory results
- Combination of global parameterization with regional or local datasets gives acceptable results
- Good meteo data significantly improves Global BROOK90 performance
- All frameworks showed better representability of mean and high quantile flow
- Implicitly, parameterization brings higher uncertainty than meteo data

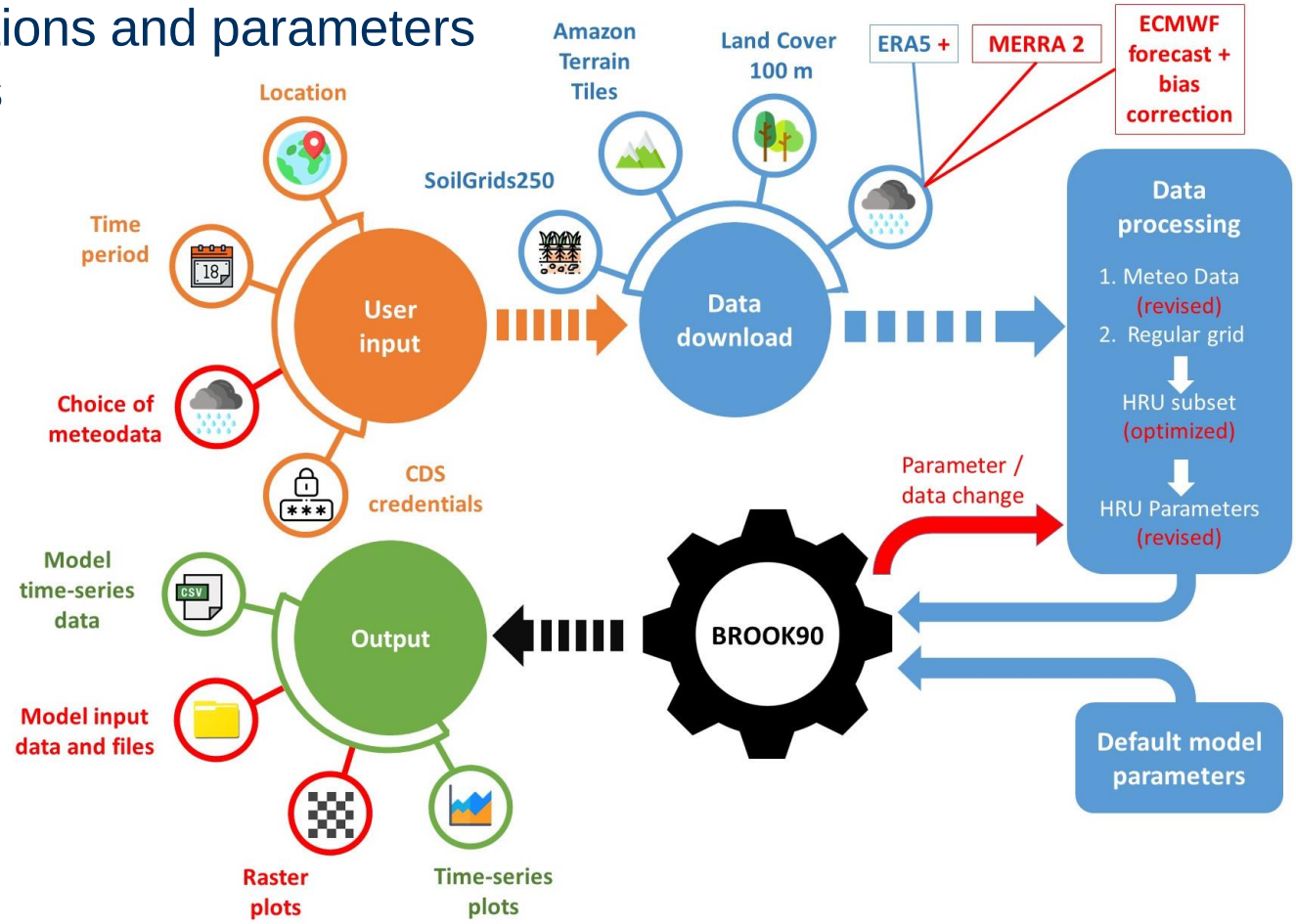
Meteodata	Global BROOK90					EXTRUSO					Calibrated BROOK90				
	KGE	R^2	Var. ratio	Bias	MAE	**KGE**	R^2	Var. ratio	Bias	MAE	**KGE**	R^2	Var. ratio	Bias	MAE
ERA 5	**-0.7**	0.6	0.9	2.6	1.1	**0.6**	0.7	0.7	1.1	0.4	**0.5**	0.7	0.6	1.0	0.3
RAKLIDA	**0.3**	0.5	0.5	0.7	0.5	**0.7**	0.8	0.8	0.8	0.3	**0.7**	0.8	0.9	0.8	0.3
Meteostation	**0.5**	0.6	0.7	1.1	0.5	**0.7**	0.8	1.1	1.2	0.3	**0.8**	0.8	1.0	1.2	0.3

BROOK frameworks performance validated with observed discharge (1960-2018)

Global BROOK90: new version to be released later this year

- ERA 5 extension (now from 1950) and MERRA 2 (from 1980)
- Long-term ensemble forecast (ECMWF up to 7 months) with bias correction
- Revision of all main functions and parameters
- More data saving options
- Bugs fixing

Remains on ToDo List
Interface
Website
Climate projections
GBR90 based tools



Upgrades for the Global BROOK90 framework

TECHNISCHE UNIVERSITÄT DRESDEN

Faculty of Environmental Sciences,
Department of Hydrosciences
Institute of Hydrology and Meteorology,
Chair of Meteorology

DRESDEN concept

Where to find me: ResearchGate **/Ivan Vorobevskii/**

Thank you!

Literature

[1] Vorobevskii I, Kronenberg R, Bernhofer C. Global BROOK90 R Package: An Automatic Framework to Simulate the Water Balance at Any Location. *Water*. 2020; https://doi.org/10.3390/w12072037

[2] Vorobevskii I, Kronenberg R, Bernhofer C. On the runoff validation of 'Global BROOK90' automatic modeling framework. *Hydrology Research* 2021; https://doi.org/10.2166/nh.2021.150

[3] Copernicus Climate Change Service (C3S) (2017): ERA5: Fifth generation of ECMWF atmospheric reanalyses of the global climate, 'Copernicus Climate Change Service (C3S): ERA5: Fifth generation of ECMWF atmospheric reanalyses of the global climate. ERA5 hourly data on single levels from 1979 to present.', 2018. 10.24381/cds.adbb2d47

[4] Luong TT, Pöschmann J, Vorobevskii I, Wiemann S, Kronenberg R, Bernhofer C. Pseudo-Spatially-Distributed Modeling of Water Balance Components in the Free State of Saxony. *Hydrology*. 2020; 7(4):84. https://doi.org/10.3390/hydrology7040084

[5] Kronenberg, R. and Bernhofer, C.: A method to adapt radar-derived precipitation fields for climatological applications, Meteorological Applications, 22(3), 636–649, doi:10.1002/met.1498, 2015.

[6] Federer, C. A., Vörösmarty, C., & Fekete, B. (2003). Sensitivity of Annual Evaporation to Soil and Root Properties in Two Models of Contrasting Complexity, *Journal of Hydrometeorology*, *4*(6), 1276-1290, https://doi.org/10.1175/1525-7541(2003)004%3C1276:SOAETS%3E2.0.CO;2

[7] Pluntke, T., Bernhofer, C., Grünwald, T., Renner, M., Prasse, H., Eichelmann, U., Hehn, M., 2020. Long-term climatological and ecohydrological analysis of a paired catchment – flux tower observatory in the Tharandt Forest (Germany) - Measurement & Analysis (in review). Journal of Hydrology: Regional Studies.