



Global mapping of annual streamflow at ~1 km resolution

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Summary

Annual streamflow (AF) metrics are important indicators of **global water supply** and **freshwater biodiversity integrity**. **Process-driven** global hydrological models (GHMs) represent a possible approach to map AF metrics, but currently they can achieve a spatial resolution of 5' (~10 km), which is too coarse for some applications (notably for ecology). Higher resolution can be achieved by **data-driven** approaches thanks to their simple model structure and quick parameterization.

We developed global maps of mean, maximum and minimum AF at 30" (~1 km) spatial resolution. We employed Support Vector Machine (SVM) regression based on readily available characteristics of the upstream (sub-)catchment of ~4000 worldwide gauging stations obtaining R² up to 0.97 and tested the prediction on independent data.

The resulting global maps for yearly values of mean, maximum and minimum AF for the period 1960-2015 will be stored in a public repository. The maps will be useful for a number of applications, e.g. ecological modelling, assessments for irrigation supply, hydropower and water footprinting, sediments fluxes quantification.

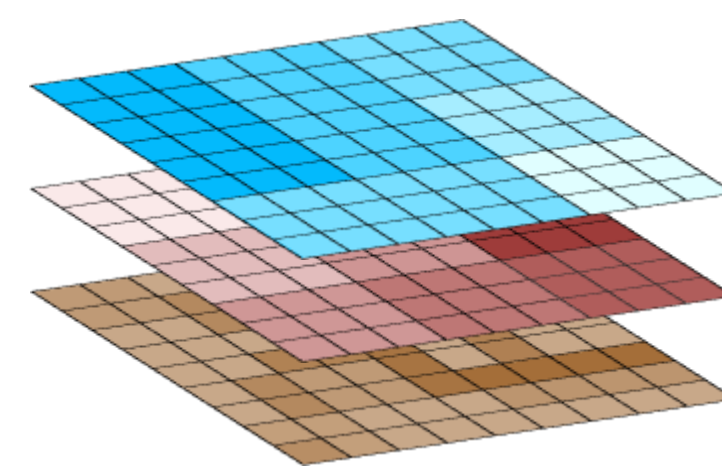
Aim

To develop global maps of mean, maximum and minimum AF at ~1 km spatial resolution spanning the period 1960-2015, employing a data-driven hydrological model based on machine-learning regression.

Approach

AF covariates layers

- Topography:** catchment area, altitude, surface slope
- Land Cover:** fraction of area equipped for irrigation, permanent snow/ice, upstream lakes and reservoirs
- Geology:** soil permeability
- Climate:** mean, maximum, minimum annual rainfall and air temperature

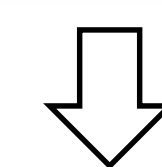


Monthly streamflow observations

- Global Runoff Data Centre (GRDC) 9252 stations globally distributed
- Re-allocation of gauging stations (n=8221) based on catchment area to match the 30" hydrography

1	2	1	2	3	1	1	1
1	2	6	1	4	5	2	1
1	1	7	1	2	9	2	1
4	1	1	9	1	2	14	2
5	1	22	24	33	1	17	4
6	17	3	1	34	1	19	1
1	5	5	2	35	36	37	63
2	1	4	1	1	4	5	5
1	1	1	1	1	1	1	1

Re-allocation



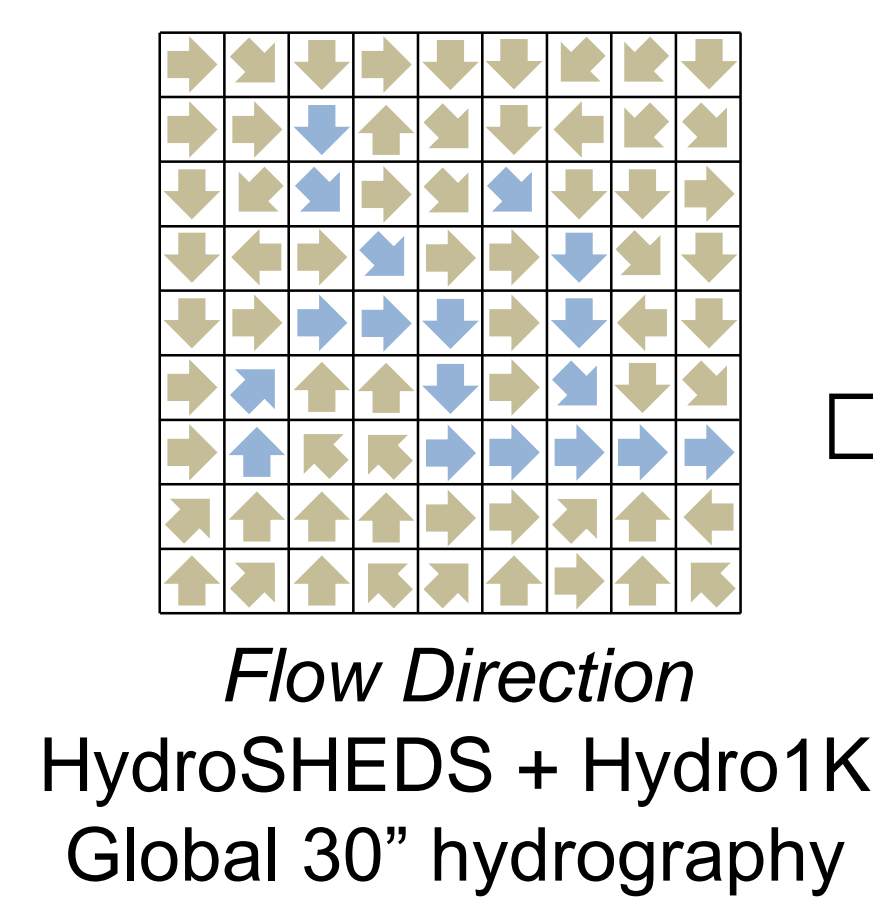
Model Calibration

- Support Vector Machine (ϵ -regression, Radial Basis Kernel)
- Mean, Minimum, Maximum AF
- 35-years average 1981-2015

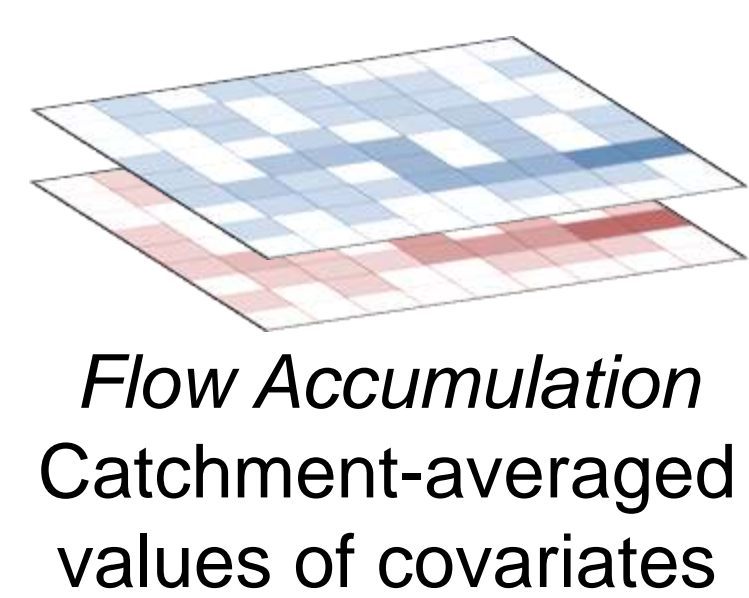


Technical Validation

- Performance testing on independent observations
- Yearly values 1971-1980

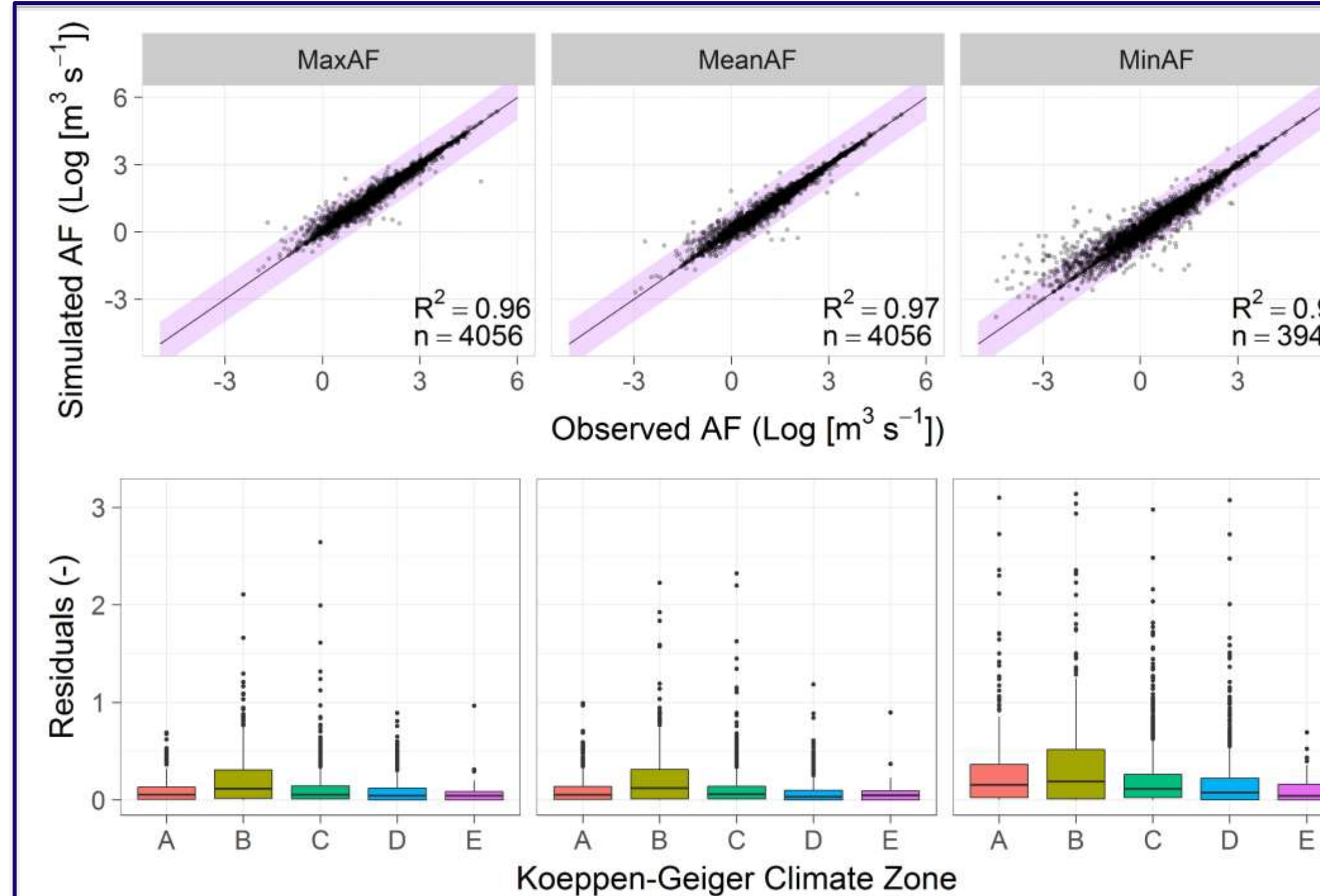


Sub-catchment-specific variables retrieval



Global streamflow layers at 30" resolution Yearly 1960-2015

Model performance



Shaded purple areas represent a difference of one order magnitude. Koeppen-Geiger climate zones: A: Equatorial, B: Arid, C: Warm Temperate, D: Snow, E: Polar

Calibration

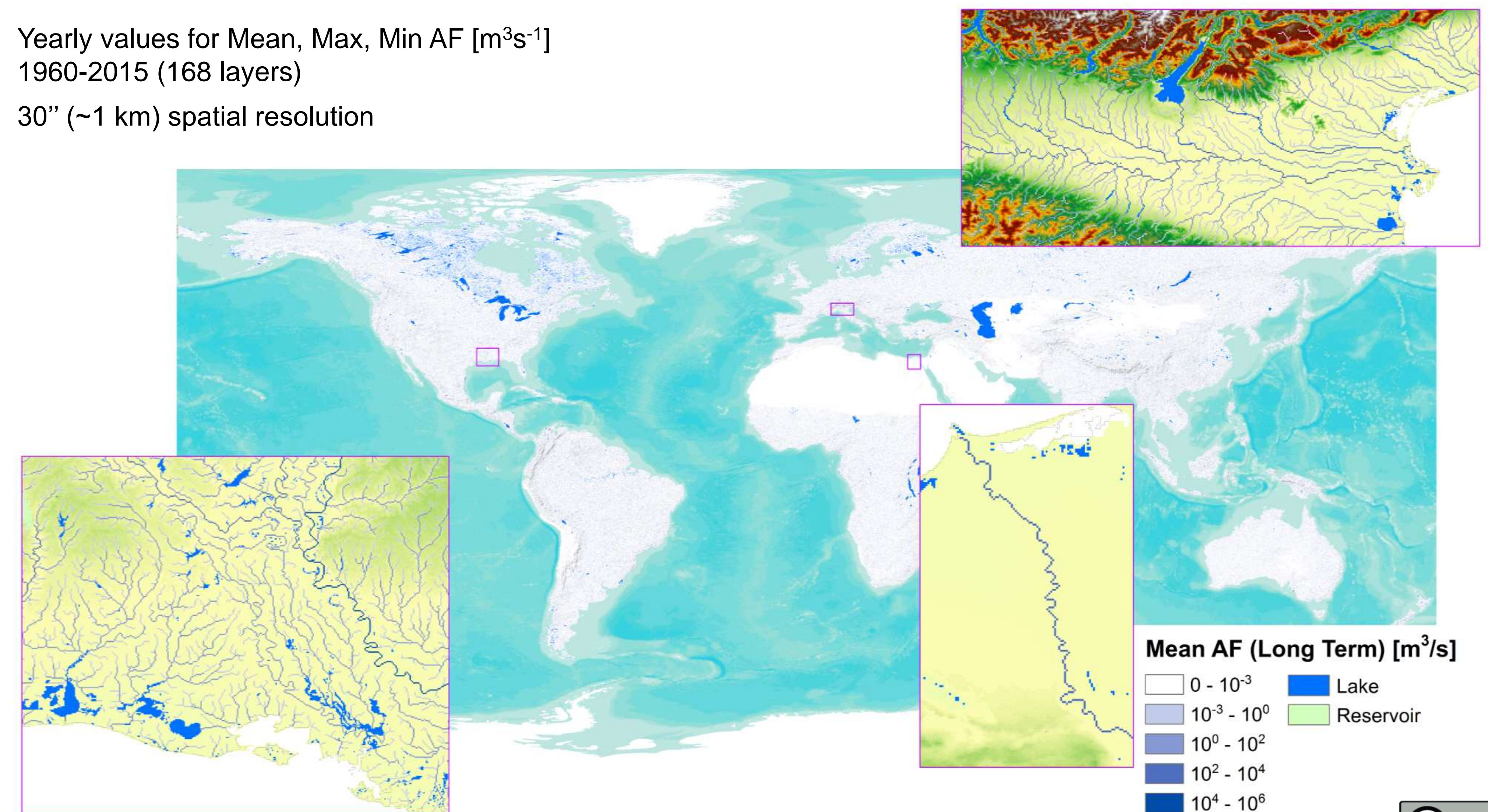
- R² of the log₁₀-transformed (Log) AF values ranged 0.91-0.97
- No apparent trend of residuals vs catchment area
- Highest uncertainty for **MinAF** and **Arid climates** (B)

Validation

- Yearly observed AF randomly sampled from ~3500 stations and averaged for increasing number of years (500 repetitions)
- R² ranged 0.83-0.90 for yearly values and up to 0.90-0.94 for 10-years average AF
- Root Mean Square Error (RMSE) ranged 0.34-0.50 for yearly values and down to 0.25-0.35 for 10-years average AF

Global maps

- Yearly values for Mean, Max, Min AF [m³s⁻¹] 1960-2015 (168 layers)
- 30" (~1 km) spatial resolution



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